



**AI FOR
DRUG DISCOVERY,
BIOMARKER DEVELOPMENT
AND ADVANCED R&D
LANDSCAPE OVERVIEW
2018 / Q2**

**Companies - 100
Investors - 220
Corporations - 30
R&D Centers - 20
Conferences - 20**

AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview 2018 / Q2

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AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2018 Q2

Companies - 100
Investors - 220
Corporations - 30

Drug Discovery

Advanced R&D

Investors
AI Companies
Corporations



Biomarker Development



Diversification of AI for R&D and Drug Discovery process

Companies - 100
Investors - 220

Companies

Investors

Drug Design

Data Aggregation & Analysis

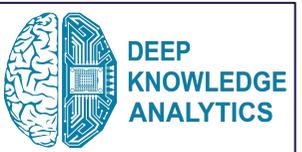
Clinical Trial Design, Optimization, Recruitment

Repurposing Existing Drugs

Researching Mechanisms of Disease

Design Preclinical Experiments

Preclinical Experiment Execution



AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2018 Q2

Companies - 100
Investors - 220
Corporations - 30

Regional Position

Investors
AI Companies
Corporations

UK

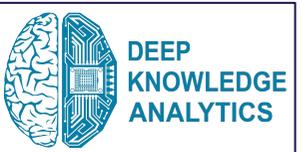
Canada

Other Regions

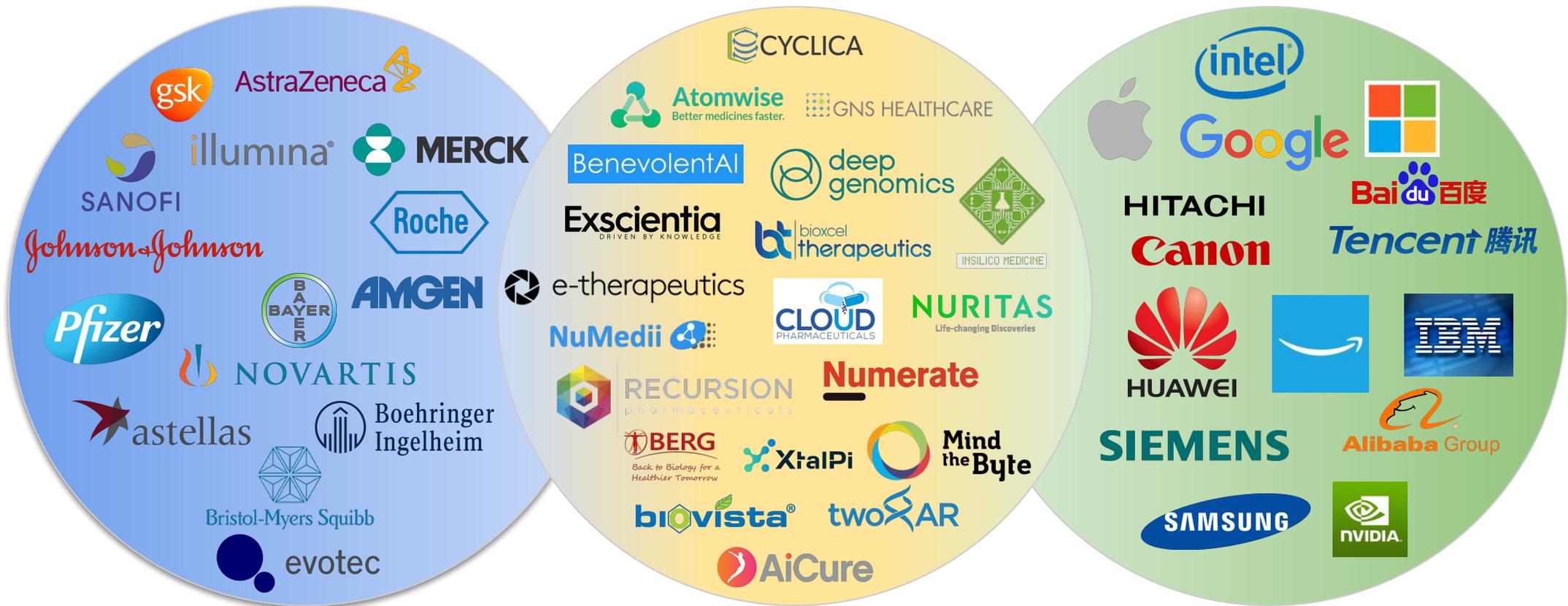
EU

Asia

USA



Leading IT and Tech Corporations / AI Companies / Pharma Corporations Advanced AI in Healthcare and Drug Discovery



Executive Summary

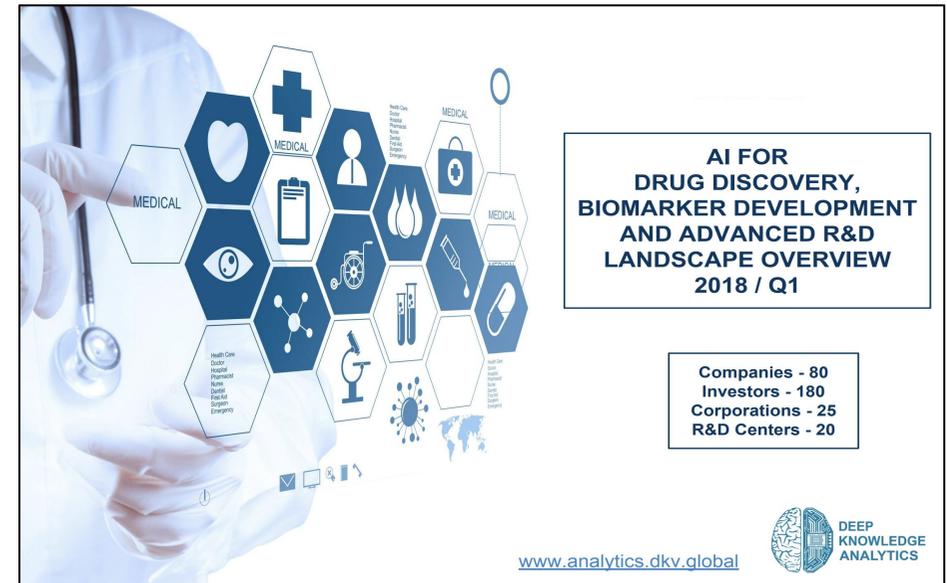
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In the end of 2017 our analytical department released its inaugural report on the state of AI for Drug Discovery industry, entitled "[AI for Drug Discovery Landscape Overview 2017](#)".

In April 2018 we released a subsequent report entitled "[AI for Drug Discovery & Advanced R&D Q1 2018](#)".

The present report is a significantly extended edition with more in-depth coverage of specific topics, and which has aggregated all important industry developments occurring in the second financial quarter of 2018.

The second quarter of 2018 saw major changes, significant investments, acquisitions, and the establishment of substantial joint ventures. This serves as a stark reminder of how fast the AI for Drug Discovery, Biomarker Development and Advanced R&D sector is advancing. Many trends noted in our last report have continued and intensified, while other new trends have emerged as well.



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The present report is structured in such a way as to meet the needs of different kinds of readers and stakeholders according to their specific interests and specialisation. It includes both broad chapters that describe the underlying fundamentals of different areas of the AI for Drug Discovery sphere, as well as chapters that give specific attention to industry trends and developments, and chapters that provide comparative analyses of companies, investors, R&D centers, IT, Tech and pharma corporations.

- The report begins with several infographic MindMaps that deliver an understanding of the scope of the industry landscape at a single glance, including segmentation (by application and by region) of companies, investors and R&D centers.
- The report's **Executive Summary** charts the major trends and significant developments that have occurred in the industry during the second quarter of 2018.
- The report's **Introduction (Background and Fundamentals of AI for Drug Discovery)** lays the groundwork and background for an understanding of its more specialized chapters, offering a basic introduction to AI in Drug Discovery, the broader AI in healthcare industry, the specific factors that cause resistance to change in the BioPharma industry, and an introduction into the ways in which IT and Tech corporations are entering the sphere of AI in Drug Discovery.

Section I: AI for Drug Discovery Landscape Overview (Industry Developments Q2 2018) provides a detailed overview of the entire AI for Drug Discovery landscape in Q2 of 2018, discussing trends in investments and M&A deals, BioPharma on-boarding AI for Drug Discovery into their own internal activities, the entry of IT and Tech corporations into the space, government initiatives aiming to put certain countries on the forefront of the industry in the years to come, and industry-specific conferences and media coverage.

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Chapter I: Landscape of AI for R&D and Drug Discovery Q2 2018 aggregates, lists and categorizes the various different organizations and entities that are profiled in greater detail in the Appendices of the report. It features lists (which break down each type of entity according to industry segmentation/application and location) of 100 companies, 230 investors, 20 leading R&D centers, 25 corporations (10 BioPharma corporations and 15 IT & Tech corporations), 20 industry-specific conferences and 20 journalists writing on the topic of AI for Drug Discovery.

Chapter II: Regional Comparison: USA, UK, EU and Asia-Pacific delivers a comparative analysis of AI for Drug Discovery companies, investors, corporations (IT & Tech corporations and BioPharma corporations active within the field) and conferences, in order to give readers an idea of the comparative levels of activity and growth of the industry in specific regions.

Chapter III: Trends of Investment and M&A Deals gives a broad overview of trends in investments and M&A deals specifically tuned to industry progress in Q2 of 2018, detailing an overall increase in investments, the active participation BioPharma corporations (largely in the form of joint ventures with AI and AI for Drug Discovery companies), the increasing activity of IT and Tech corporations, and the surge of activity from Chinese investors and Tech corporations.

Chapter IV: BioPharma Corporations Onboarding AI for Drug Discovery discusses the major occurrences happening in the BioPharma sector, and outlines how the BioPharma industry is now actively participating in the AI for Drug Discovery and biomarker development space via internal R&D, investment and acquisition, in contrast to 2017, during which time they remained largely skeptical of the disruptive impact of AI.

Chapter V: IT & Tech Corporations Entering the AI for Drug Discovery Space details how IT & Tech Corporations are continuing to enter the space; this was already a major trend in 2017, and it is continuing apace into 2018, remaining one of the strongest hallmarks of the subsector's exponential dynamic of development.

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Chapter VI: Government Initiatives gives specific coverage of various AI for Drug Discovery government initiatives launched over the past several years in the USA, UK, EU and Asia-Pacific region, all of which aim to utilize industry and government partnerships in order to secure each nation's position as a leader in AI for Drug Discovery over the course of the next several years. It gives particular focus to the number of new initiatives that were launched in 2018.

Chapter VII: Industry-Specific Media & Conferences charts the industry-specific conference and media landscape. It lists 20 conferences dedicated to AI in Drug Discovery and analyzes some of the most predominant conference topics and trends, and gives attention to the fact that, in addition to the overall increase in the number of conferences dedicated specifically to the topic, 2018 is also witnessing the inclusion of an AI for Drug Discovery track, session, forum or panel in the majority of the leading traditional BioPharma conferences aimed at major pharmaceutical executives. It also lists 20 journalists who are regularly reporting on the topic of AI for Drug Discovery, and who possess a certain minimum level of expertise on the topic, outlining some of the major trends and topics dominating media coverage of the industry.

Section II: Novel Technologies & Trends (Industry Forecast 2019-2020) is devoted to in-depth coverage of the science and technology behind the industry, and to analysis of emerging subsectors within the industry, charting the near future of the industry from 2019 to 2020.

Chapter VIII: Deep Learning in Drug Discovery gives an in-depth overview of topics, trends and advancements occurring in deep learning for drug discovery, one of the specific forms of AI which has now emerged as the leading technology delivering practical and tangible results in the industry, and pays particular attention to the emergence of Generative Adversarial Networks (GANs) as a highly disruptive sub-class of deep learning that may come to dominate industry progress in the years to come.

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Chapter IX: Longevity Research (AI and Advanced R&D) is devoted to the use of AI in Drug Discovery for Longevity research, which can be considered to have started in mid-2017 with an event held at the Buck Institute for Research on Aging, at which Atomwise, BioAge and Insilico Medicine held a workshop, and which has just recently been formally solidified through Insilico Medicine being awarded the 2018 North American Artificial Intelligence for Aging Research and Drug Development Technology Innovation Award by leading business consulting firm Frost & Sullivan.

Chapter X: Next Generation AI, convergence with Blockchain and Digital Medicine charts the ongoing convergence of AI for Drug Discovery with other advanced technologies including blockchain, personalised medicine and digital medicine, illustrating how these technologies and industries are being synergistically integrated so as to expedite the dynamic of progress in the AI for Drug Discovery sphere.

Section III: Comparative Industry Analysis & Classification Framework (Investor and M&A Guide) is devoted to an in-depth comparative and quantitative analysis of the entire AI for Drug Discovery landscape, specifically tuned for investors, business analysts and decision makers who wish to gain a deeper understanding of the industry in Q2 of 2018

Chapter XI: Comparison of Leading AI Companies directs its attention to the most active and scientifically validated AI for Drug Discovery companies, and details their activities side by side. The chapter also performs a quantitative analysis of many of the AI for Drug Discovery companies covered and profiled in this report using of a variety of tangible metrics that can be used to acquire an understanding of their level of scientific validation and industry activity, including the proportion of AI specialists among their total staff, number of publications, number of patents, etc. It then uses these metrics to rank AI for Drug Discovery companies side by side, and to build a classification framework by which these companies can be better categorized according to their specific focus, application and industry segmentation.

Chapter XII: 2010 - 2016 - Investment Rounds, M&A Deals and Notable Events summarizes some of the most notable investment rounds, M&As and other notable events from 2010-2016, including but not limited to Benevolent AI's \$87M raise, ThoughtSpot's \$100M raise and Meta's \$23M raise.

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Chapter XIII: 2017 - Investment Rounds, M&A Deals and Notable Events summarizes some of the most notable investment rounds, M&As and other notable events in 2017, including but not limited to Exscientia's €250M raise, AiCure's \$15M raise and Insilico Medicine's \$10M raise.

Chapter XIV: Q1 2018 - Investment Rounds, M&A Deals and Notable Events summarizes some of the most notable investment rounds, M&As and other notable events in Q1 of 2018, including but not limited to AtomWise's \$45M raise, XtalPi's \$15M raise, and twoXAR's \$10M raise.

Chapter XV: Q2 2018 - Investment Rounds, M&A Deals and Notable Events summarizes the major investments, M&As and other notable events (e.g. joint ventures, public announcements, etc.) that have occurred within the AI for Drug Discovery space specifically in Q2 of 2018, including but not limited to ThoughtSpot's \$145M raise, Benevolent.AI's \$115M raise, Celsius Therapeutics' \$65M raise, and Datavant's \$40.5M raise.

This current edition considers the industry landscape in greater depth than our previous reports, and provides updated profiles of the companies, investors and influencers comprising the industry.

It also features several new chapters, including a chapter dedicated to IT and Tech corporations into the AI for Drug Discovery space, the continuing entry of BioPharma corporations into the industry, and an entirely new section -- **Section III: Comparative Industry Analysis & Classification Framework (Investor and M&A Guide)** -- that delivers an extended and comprehensive comparative analysis of AI for Drug Discovery companies by industry segmentation, level of scientific validation and location.

While our previous reports highlighted the need for BioPharma corporations to commit significant resources (and perhaps even more importantly, significant will and the implementation of AI-focused strategies) to the acquisition of AI specialists and AI for Drug Discovery companies, this report details how this has already begun to occur, with increasing interest in the AI for Drug Discovery realm from traditional BioPharma corporations.

AI for Advanced R&D and Drug Discovery 2018 / Q2

Our previous report noted a reversal of what we referred to in our first two reports on the subject of AI in Drug Discovery as the “**Big Gap**”, i.e., the fact that throughout 2016 and 2017 IT and Tech corporations recognized and supported AI for healthcare startups, in terms of both investment and acquisitions, while BioPharma lagged behind, still skeptical of the impact that AI could make upon drug discovery, biomarker development and other BioPharma niches.

Our most recent analysis seems to indicate that this “Big Gap” is now to a large extent **neutralized**, and the BioPharma industry now has significant interest in AI, and belief in its ability to facilitate fundamental paradigm shifts in their traditional modes of operation. Some BioPharma companies have now become actively involved in the AI for Drug Discovery sector, while others still lag behind, skeptical of the sector’s potential for impact and disruption, or finding themselves unable to acquire or implement these novel technologies in any relevant capacity. All indications still point to the conclusion that 2018 will mark the year that will test the strength, resolve and foresight of BioPharma as a whole.

Those BioPharma companies that commit significant will and resources to acquiring strong AI specialists, technologies and acquisitions will flourish, and those that do not will stagnate, and by the time their profit margins force them to realize the disruptive potential of AI for Drug Discovery and other biomedical niches, they will have missed the boat, with the majority of talent, technology and companies having already been acquired by their competitors.

Meanwhile, Chinese IT and Tech corporations, such as Alibaba, Baidu and TenCent, have made significant investments and acquisitions in the AI in Healthcare and Drug Discovery sector in particular, showing that the number of IT-corporations committing to the sector is growing not just regionally but also globally. This trend was noted in our last report, and continued to gain momentum, with even more investors in the Asia-Pacific region entering the space.

At the same time, the lack of AI specialists that was alluded in our previous reports is still present. The majority of talented AI specialists in general have been acquired by traditional IT-corporations and have been applied for purposes other than AI in healthcare, creating a lack of enough specialists to support the activities of AI for Drug Discovery companies in particular.

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And it is not just traditional BioPharma companies that are suffering from this lack of specialists; indeed, even companies specializing specifically in **AI for Drug Discovery are feeling the effects of this lack, with AI specialists still comprising only 15.6% of such companies staff.** One of the central aims of this report is to summarize this gap, and chart the possible ways forward in order to neutralize it.

Deep Learning in general, and Generative Adversarial Networks (GANs) in particular, started to be applied intensively by the leading AI for Drug Discovery companies, and this specific niche is now recognized as the most promising subsector for the entire AI for Drug Discovery industry.

Overall, the AI in healthcare and BioPharma subsector is growing at a steady rate, both in terms of new companies, investments and acquisitions, and in terms of the extent with which it is disrupting the traditional modes of operation of BioPharma as a whole. What is now a subsector and niche is poised to grow into perhaps the leading sector in BioPharma in the next 2-3 years, one that will have the greatest transformational impact on the industry, and one that will distinguish the leaders of the industry from the stagnators. By the end of 2018, we can predict that there will be intensive competition between the largest BioPharma companies and the largest IT and Tech corporations for the acquisition of new AI specialists, technologies and startups, in much the same way that 2014 – 2016 saw intense competition between IT-corporations to acquire the best AI assets and resources.

The total valuation of the AI for Drug Discovery subsector grew approximately 1.5-2x during the first half of 2018. Notably, this appears to be a result of the general growth of the industry itself, and the entry of several new large players, companies and investors, rather than due to breakthrough practical applications in any particular AI for Drug Discovery company itself. While companies are achieving steady progress, with indications that a few such companies could progress to the point of achieving practical applications in the clinic by the middle of 2019, no one company has yet brought a new blockbuster drug. Given the current dynamic of industry and technology progress, we can reasonably project that such a moment could occur as soon as 2019/2020. Meanwhile the fact that the industry is witnessing steady growth despite any one company yet bringing a blockbuster drug to the market shows that AI for Drug Discovery is still an undervalued space, therefore we can expect to see the total capitalization of this subsector to grow significantly (e.g. on the order of 5-10x). At the same time, there is a possibility that a global financial crisis could occur within the next few years according to the opinions of several notable financial market players, which could decrease the dynamic that we have seen in this space in the first half of 2018.

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Another significant trend developing in Q2 of 2018 is the emergence of new geographic locations, such as the EU, Asia and China, which are beginning to participate much more actively in the industry. The US was the main epicenter of activities in this space throughout the past several years, but we are now seeing industry involvement and a profusion of AI for Drug Discovery-themed events and conferences in the UK and EU. Meanwhile, the number of investors based in the Asia-Pacific region, including China and Singapore, are also beginning to make active investments in this space, with a slew of large investment rounds occurring in the first half of 2018.

2018 has also seen an increase in the number of Chinese investors entering the space. The Chinese IT-corporation Tencent, for instance, led a \$155 million round of funding was held by AI in healthcare company iCarbonX. Tencent also recently co-invested in a \$15 million round held by AI for Drug Discovery company XtalPi with Google and Sequoia China. Chinese IT-corporation Alibaba has also entered the AI for healthcare space with the launch of what they refer to as "ET Medical Brain", a platform that leverages Alibaba's formidable computational resources in order to generate new AI medical applications.

In June 2018 prominent Chinese pharma company Wuxi AppTec invested in AI for Drug Discovery company Insilico Medicine alongside Pavilion Capital (a VC firm owned by the Singaporean government), as well as several Western VC firms including BOLD Capital Partners and Juvenescence Limited. In a recent Forbes article on the subject of Wuxi AppTec's recent investment Insilico's CEO Alex Zhavoronkov noted: *"I think this really shows that China is becoming a bigger player in AI. The emergence of China in AI, in research in particular, shows they are no longer a follower. So the US needs to invest in AI and biotech more than in military or trade wars that only make geopolitical tensions worse. Investing in biotech benefits everyone on the planet. It's a pretty good trend."*

In terms of whether it is the USA, EU, UK or Asia-Pacific region that comes out on top will remain to be seen. There are however, some factors that could come to play out to the advantage of the Asia-Pacific region generally, and China in particular, in the coming years that may be worth noting. China currently is low on the list of the top countries competing in the Pharma industry. It falls significantly behind its Western competitors, due chiefly to the fact that it has focused on selling drugs that were innovated elsewhere, and lags behind in terms of actual pharma innovation.

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But, we have seen an influx of Chinese investors into life sciences industries over the past several years. For instance, The entry of Chinese investors into the broader biotech and drug industry landscape also mounted significantly in 2018, rising to \$1.4 billion into US-based biotech and drug firms compared to just \$125.5 million during the same period the previous year. Furthermore, the Chinese government has recently shown significant interests in building up their AI industry, and in prioritizing AI in healthcare in particular. In an AI Strategic Plan released in July 2017, they outlined their intentions to catch up in the AI race by 2020, make major breakthroughs by 2025 and become a world leader in AI by 2030. But, in order to excel within the BioPharma industry they will need to reformulate their IP regulations, which are currently not tight enough to retain proprietary control over novel pharma innovations that they might develop in the coming years.

There are two additional advantages that China could possibly use in the coming AI for Drug Discovery race. Firstly, they have shown success in generating a massive amount of real-time medical data from their enormous population of citizens, made possibly by their sheer population size, as well as their current flexible privacy laws. Since AI in general (and machine learning and deep learning in particular) feed on data, this could potentially be used to the nation's benefit. Secondly, they have the raw materials needed for the most scarce resource in the industry: namely, a large quantity of Data scientists and AI specialists. If the Chinese government were to commit substantial resources to the training of additional AI and data scientists, they could potentially grow to surpass their Western competitors over the next 3-5 years. In the West, players in the AI for Drug Discovery race will suffer a severe scarcity of AI specialists in the coming years because the majority of them have been acquired by the IT and Tech industry for other purposes. China has the potential to leapfrog this issue.

Furthermore, while we can expect to see traditional BioPharma and IT & Tech Corporations battle it out for supremacy in the AI for Drug Discovery race over the next several years. There are several factors that put IT & Tech corporations at an implicit advantage over BioPharma corporations. Firstly, IT & Tech corporations work from a solid foundation of AI and IT specialists, IP, resources and expertise, which is the very area that is the most scarce in the race, and the factor that constitutes the primary bottleneck in the ongoing progress of the AI for Drug Discovery industry. There is a limited number of AI specialists and resources to go around, and IT & Tech corporations already have the large majority of them.

Secondly, IT and Tech corporations are used to change and to reformulating their business models and internal operations from the ground up in order to keep pace with the increasing rate of change in their industry.

AI for Advanced R&D and Drug Discovery 2018 / Q2

They operate within a space that changes more rapidly than any other industry, and in order to have become an AI, IT or Tech corporation in the first place, they need to have been willing and able to absorb and embrace change in a fundamental and systemic manner.

This is not so with traditional BioPharma, which has operated with the same business model in mind for several decades. The BioPharma industry is often thought of as an elite and stagnant industry which is very resistant to change. This is a state of affairs recognized both within and outside of the Pharma industry.

John Baldoni, Senior VP of Platform Science and Technology at GSK, and one of the most outspoken pharma executives on the disruptive impact of AI for Drug Discovery, admits that "pharma is using a model that was becoming increasingly dated". Another factor putting AI, IT and Tech corporations at an advantage is the comparatively larger market cap of their industry, and the larger revenues they generate. This means that they have more resources to play with, and can offer more monetary incentive to keep their AI-specialists in place.

However, while the AI, IT and Tech corporations begin the race from a more advantageous starting line, their success is not set in stone. If the BioPharma industry were to show enough will and commitment to embrace change, and allocate enough funding and resources to the acquisition of AI-specialists and AI for Drug Discovery startups, it is not impossible for them to win the race. Furthermore, when it comes to will and commitment, they may even be at an advantage in comparison to AI, IT and Tech corporations, in the sense that they have more to lose. For AI, IT and Tech corporations, entering into healthcare and drug discovery will be an additional revenue stream, auxiliary to their main focus. For BioPharma corporations, to lose the race is to lose everything, and amounts to either keeping or losing their main source of revenue. Whether this proves enough to overcome the stangantion and resistance to change typical of BioPharma will remain to be seen in the years to come.

Main Trends for Q2 2018: AI for Advanced R&D and Drug Discovery

- **IT & Tech corporations are now outcompeting BioPharma corporations in the AI for Drug Discovery race.** The combined capitalization of the 15 BioPharma corporations that we have profiled in this report has remained on the same level for the past 5 years while the capitalization of the 15 IT & Tech corporations profiled in this report is growing significantly and the GAP is increasing. This can be considered as an evidence that the BioPharma industry is stagnating in general, while the IT & Tech industry is progressing. This is why it is so notable that the number of IT corporations has already matched the number of BioPharma corporations active in this subsector.
- **The industry is growing at a steady pace**, with a substantial increase in investments and joint ventures in Q1 and Q2 of 2018 compared to 2017. We are also seeing a significant increase in industry participation and activity from large corporations. As can be seen in Chapter IV: BioPharma Corporations Onboarding AI for Drug Discovery, whereas BioPharma corporations were previously resistant and skeptical towards the disruptive impact of AI for Drug Discovery, many BioPharma corporations are now actively participating through the investment of joint ventures and M&A deals. Meanwhile, as can be seen in Chapter V: IT & Tech Corporations Entering the AI for Drug Discovery Space, the number of IT and Tech corporations active in this space is also steadily increasing, and still surpasses activity from BioPharma corporations.
- **The industry is seeing an increasing level of regional diversification.** Whereas historically the US has dominated the AI for Drug Discovery race in terms of companies, investments and industry conferences, we are seeing an increased level of activity from the UK and EU, and a dramatic increase in activity from the Asia-Pacific region generally, and from China in particular. Chinese investors are now aggressively investing in AI for Drug Discovery startups, and Chinese IT & Tech corporations are entering the space with level of activity that at least equals US IT & Tech giants. Furthermore, China's massive population and governmental will to rapidly advance their global leadership position in AI means that if they prove committed to increasing the number of AI specialists and Data scientists, China could overtake their Western competitors in this subsector in the next 3-5 years, when USA, UK and EU companies feel the impact of the coming scarcity of AI-specialists and Data scientists in the coming years.
- **We could see the arrival of the AI-industry's first blockbuster drug by 2019/2020.** While no AI for Drug Discovery company has brought a blockbuster drug to market yet, many now have drugs developed using AI in clinical trials. The first arrival of such a drug to market will signal the tangible scientific validation of the entire AI for Drug Discovery approach, and will cause a massive increase of investments and capitalization of this industry.

Introduction:

Background and Fundamentals of AI in Drug Discovery

Introduction

The present chapter aims to give readers a basic background and fundamentals required to understand and effectively contextualize the more specialised chapters in this report.

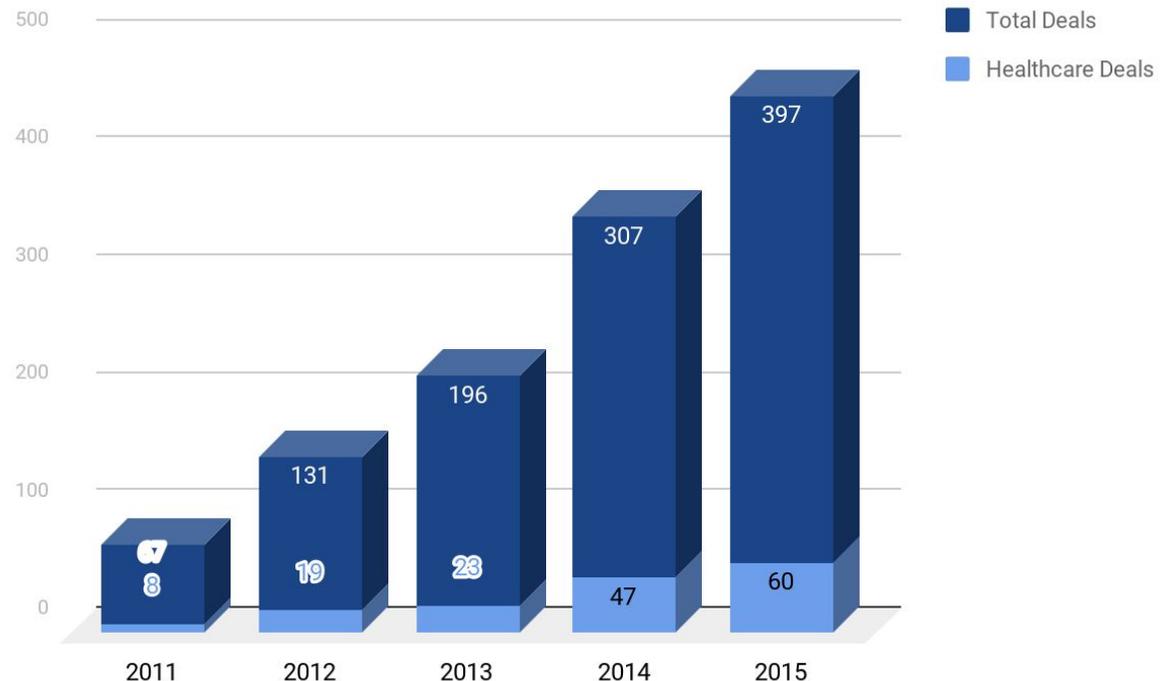
It offers a brief overview of:

- AI in Healthcare
- AI's Broader Role in the Healthcare Industry
- AI in Healthcare Applications & Use Cases
- AI for Drug Discovery, and how it fits into the broader AI in healthcare industry
- Roadblocks and barriers in the traditional BioPharma industry
- How the “broken business model of BioPharma” creates resistance to change and puts large BioPharma corporations unwilling to embrace and absorb technological innovations relevant to their industry at a disadvantage compared to IT and Tech corporations
- The various applications and use-cases for AI in Drug Discovery and Advanced R&D
- Emerging Trends in AI for Drug Discovery
- A brief look at the near future of AI for Drug Discovery

AI's Broader Role in the Healthcare Industry

Artificial intelligence is becoming an integral part of modern life. In recent years, machine learning scientists have made astonishing progress implementing AI in numerous industries in a short span of time. From stock trading to project management, AI is now a crucial part in the normal functioning of the world economy; a study conducted in Oxford shows that 47% of all existing jobs can be automated with artificial intelligence technologies. It is natural that AI is rapidly developing in a modern healthcare system. NPOs, government organizations, and enterprises alike include algorithms to enhance their therapies.

The number of healthcare deals occurring in the overall AI market is on the rise, up from just 8 large deals in 2011 to over 60 large deals in 2015. Similarly, the number of startups entering the healthcare AI space has increased in recent years, with over 50 companies raising their first investment rounds since January 2015. Deals to healthcare-focused AI startups went up from less than 20 in 2012 to nearly 70 in 2016.



Growing healthcare AI market compared to the overall AI market. Source: <https://www.slideshare.net/galengrowthasia/cb-insights-ai-in-healthcare>

Source: https://www.huffingtonpost.co.uk/2014/01/17/rise-of-the-machines-economist_n_4616931.html

AI in Healthcare Applications & Use Cases

Artificial intelligence will revolutionize the healthcare industry. Indeed healthcare will be leading the Fourth Industrial Revolution, and a major catalyst for change is going to be artificial intelligence (AI).

AI in health represents a collection of multiple technologies enabling machines to sense, comprehend, act and learn so they can perform administrative and clinical healthcare functions. Unlike legacy technologies that are only algorithms and tools that complement a human, health AI today can truly augment human activity.

AI has already found several areas in healthcare to revolutionize, starting from the design of treatment plans through the assistance in repetitive jobs to medication management or drug creation. And it is only the beginning.

The field of AI has been actively growing since 2015. But 2017 became year of the 'Cambrian explosion' of AI in healthcare.

This market is primarily being driven by factors like the rise of personalized medicine in tests for clinical decision-making, big data in the healthcare industry, and the growing adoption of AI in genetics.

Also, AI created a real-time monitoring system, and wearables are playing a crucial role in digital healthcare monitoring.

AI in Healthcare:

- Drug Discovery
- Wearables
- Medical Imaging and Diagnostics
- Research
- Mental Health
- Lifestyle Management
- Digital Health Monitoring
- Patient Data and Risk Analytics
- Virtual Assistants
- Surgery
- Hospital Management

The Rise of AI in Healthcare

I believe that AI is a sleeping corporation for healthcare in general

Eric Horvitz,
director of Microsoft Research Labs
in Redmond, Washington



The number of startups entering the healthcare AI space has increased in recent years, with over 50 companies raising their first equity rounds since January 2015. Deals to healthcare-focused AI startups went up from less than 20 in 2012 to nearly 70 in 2016.

The field of AI for Healthcare has been actively growing since 2015. The market is primarily being driven by factors like the rise of personalized medicine in tests for clinical decision-making and big data in healthcare industry and the growing adoption of AI in genetics. Also, AI created real-time monitoring systems and healthcare wearables are playing a crucial role in digital healthcare monitoring.

A report published by The BMJ in 2016 noted that medical errors claim 250,000 lives each year, making it the third leading cause of death in the U.S. AI in healthcare and medicine could organize patient routes or treatment plans better, and also provide physicians with all the information they need to make a good decision.

“I have no doubt that sophisticated learning and AI algorithms will find a place in healthcare over the coming years,” Andy Schuetz, a senior data scientist at Sutter Health said. “I don’t know if it’s two years or ten — but it’s coming.”

Global Healthcare AI Market Growth Through 2024

Figure 6: Global Healthcare AI Market Growth Through 2024



The U.S. healthcare AI market exceeded \$320 million in 2016, and is estimated to grow by more than a 38% CAGR through 2024 (Global Market Insights, “Healthcare AI Market Size, Competitive Market Share & Forecast, 2024”).

The Global Healthcare AI market, among the AI industry’s fastest growing sub-sectors, is expected to grow at a 39.4% CAGR to over \$10 billion in worldwide revenue by 2024.



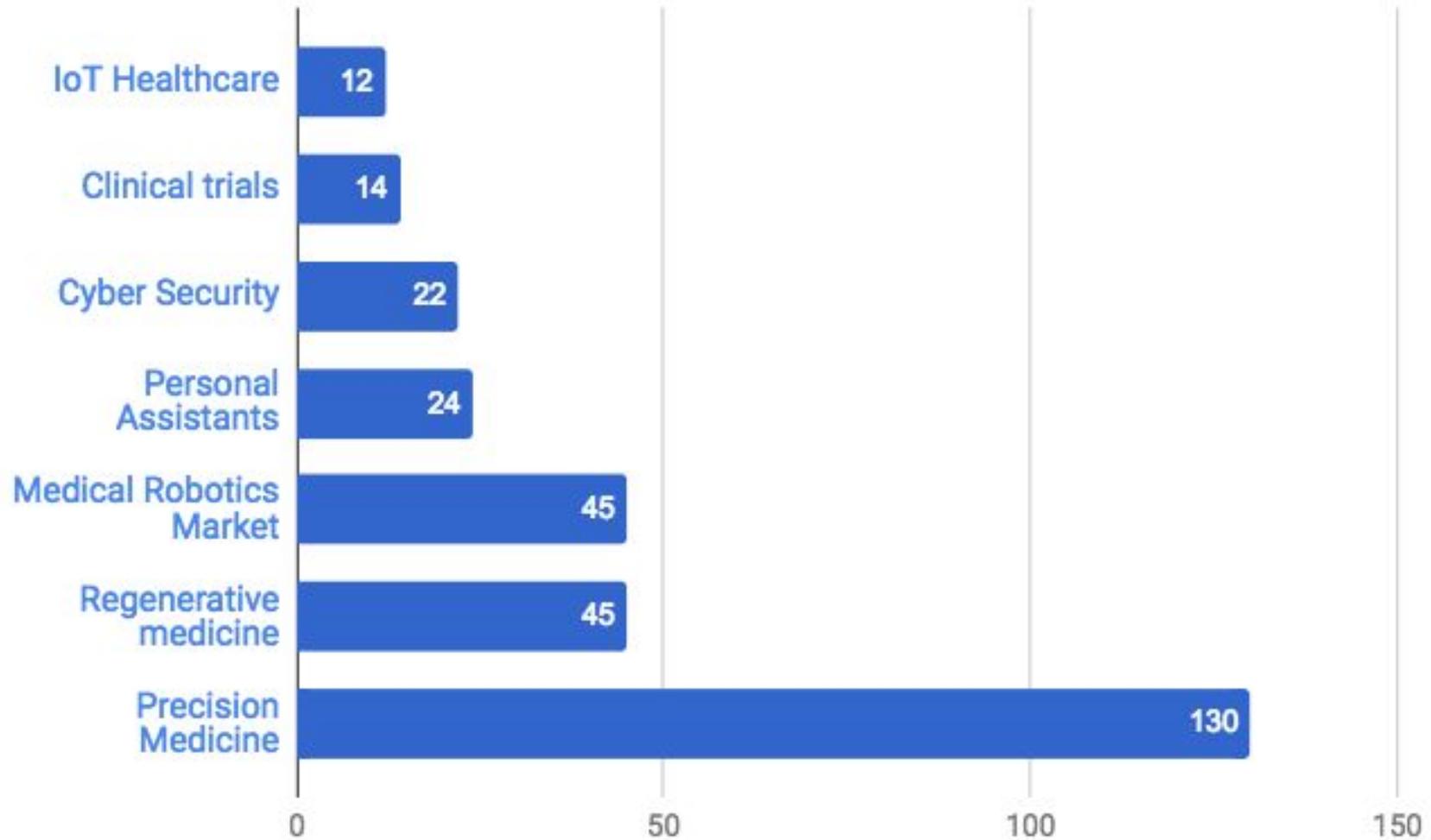
Top 10 AI Applications

APPLICATION	VALUE*
Robot-Assisted Surgery**	\$40B
Virtual Nursing Assistants	\$20B
Administrative Workflow Assistance	\$18B
Fraud Detection	\$17B
Dosage Error Reduction	\$16B
Connected Machines	\$14B
Clinical Trial Participant Identifier	\$13B
Preliminary Diagnosis	\$5B
Automated Image Diagnosis	\$3B
Cybersecurity	\$2B
TOTAL =	~\$150B

Source: Accenture analysis
 * "Value" is the estimated potential annual benefits for each application by 2026.
 ** Orthopedic surgery specific

Source: TM Capital “The Next Generation of Medicine: Artificial Intelligence and Machine Learning” Report

Global Healthcare AI Market Growth Through 2024 in \$Billions



Source: Deep Knowledge Analytics

How AI in Drug Discovery Fits into the Broader AI in Healthcare Industry

The most disruptive impacts of AI will be on the business model of Advanced R&D, Biomarker Development and Drug Discovery.

Specific attention should be paid to those projects capable of applying Next Generation Artificial Intelligence techniques, Deep Learning and in particular GANs (Generative Adversarial Networks) and reinforcement learning for:

- Drug Discovery and Drug Repurposing
- Biomarker Development
- Clinical Trials Predictors
- Aging Research
- AI Solutions in convergence with Blockchain

The leading players in this specific niche will become game-changers for the entire market and significantly influence the capitalization of pharma companies.

The global healthcare AI market is highly fragmented and characterized by the presence of large number of industry players, while the AI for Drug Discovery segment has a comparatively lower level of competition because this market segment only accepts companies with very high levels of expertise. Even this, however, is beginning to change with the entry of large BioPharma corporations and IT/Tech corporations.

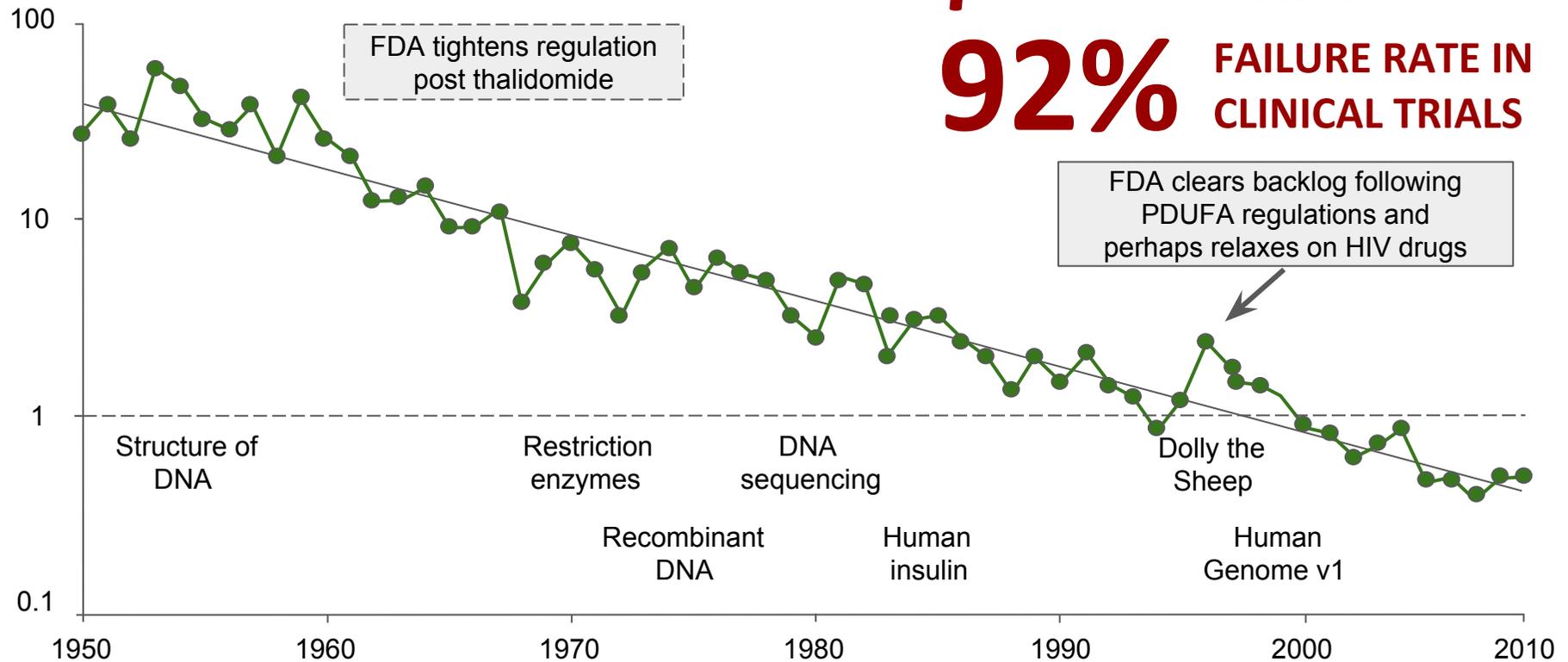
The breakthroughs in AI for Drug Discovery will change the R&D process of BioPharma, and will have a tremendous impact on the whole BioPharma industry. That is why the players from the AI for Drug Discovery market can become game changers and significantly influence the capitalization of the pharma industry.

Pharma Efficiency is Declining Steadily

>\$2.6B TO DEVELOP ONE DRUG

92% FAILURE RATE IN CLINICAL TRIALS

NMEs per \$B R&D spent (inflation adjusted)



Bernstein Research: The Long View - R&D Productivity, 2010

46 NEW DRUGS launched in 2014

Source: adapted from Insilico Medicine investor presentations, www.insilico.com

GLOBAL SALES:

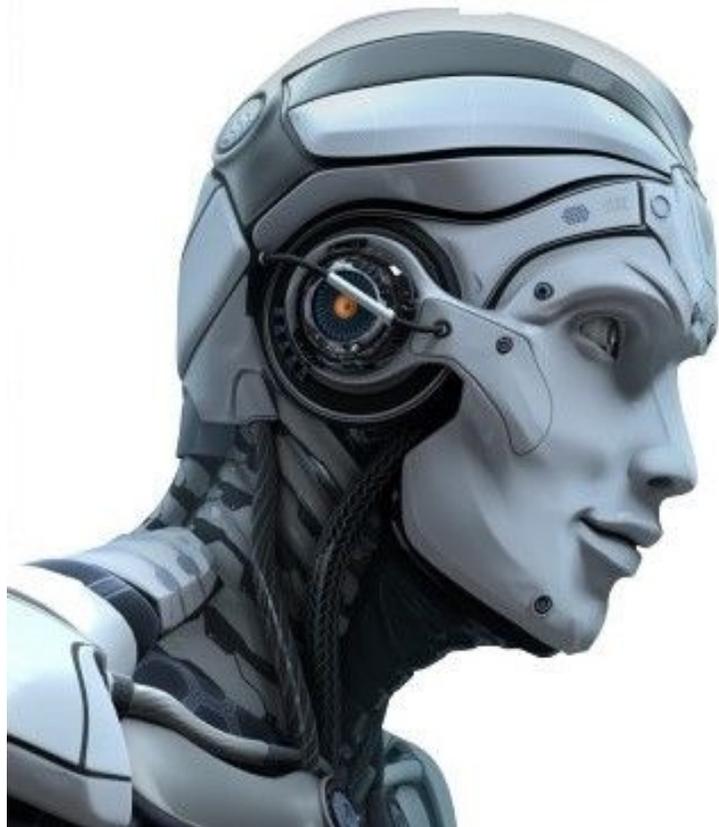
>\$1 Trillion

GLOBAL R&D:

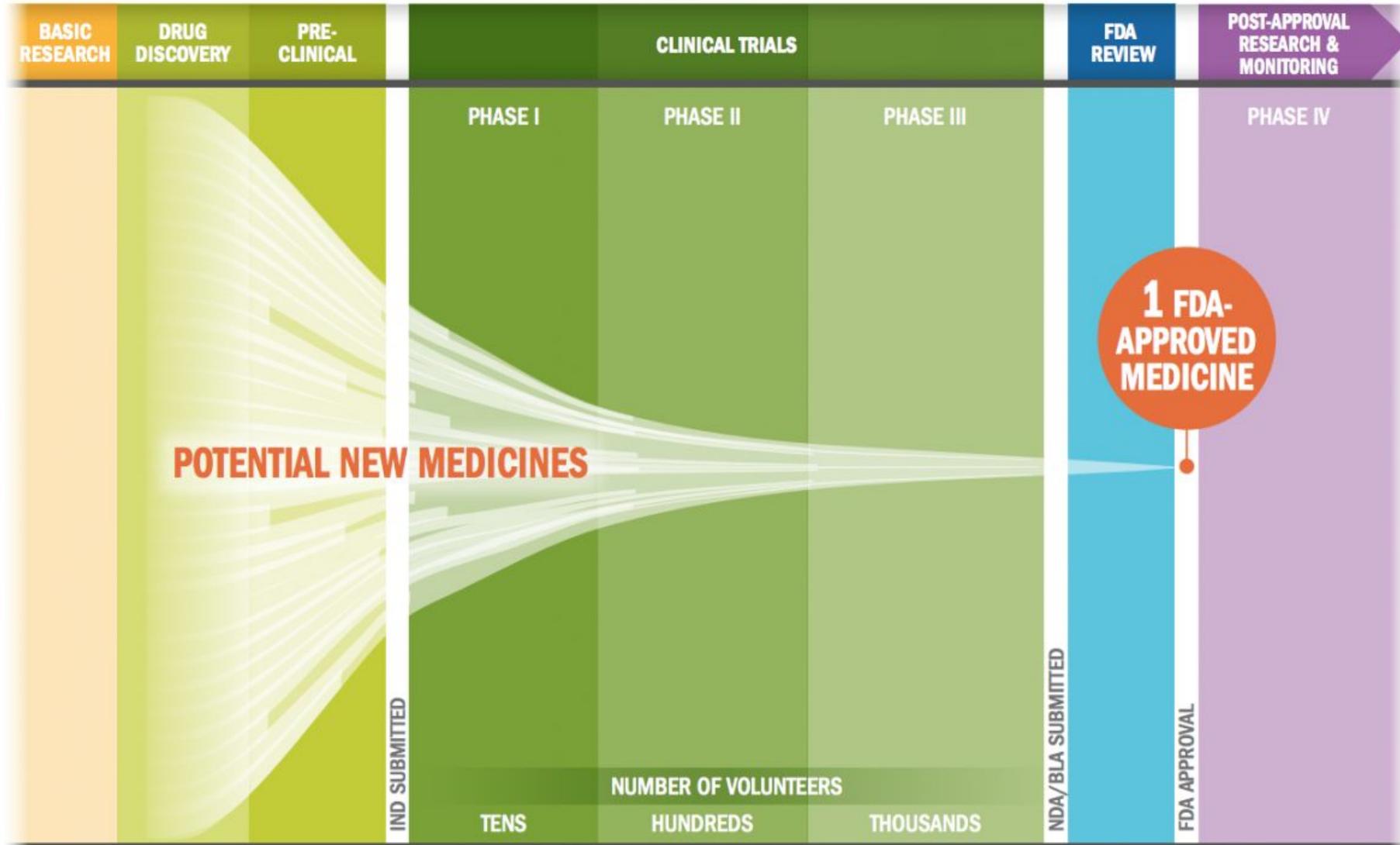
>\$150 Billion

>\$2.6B TO DEVELOP ONE DRUG

92% FAILURE RATE IN CLINICAL TRIALS



THE BIOPHARMACEUTICAL RESEARCH AND DEVELOPMENT PROCESS



Source: Biopharmaceutical Research & Development, PRMA http://phrma-docs.phrma.org/sites/default/files/pdf/rd_brochure_022307.pdf

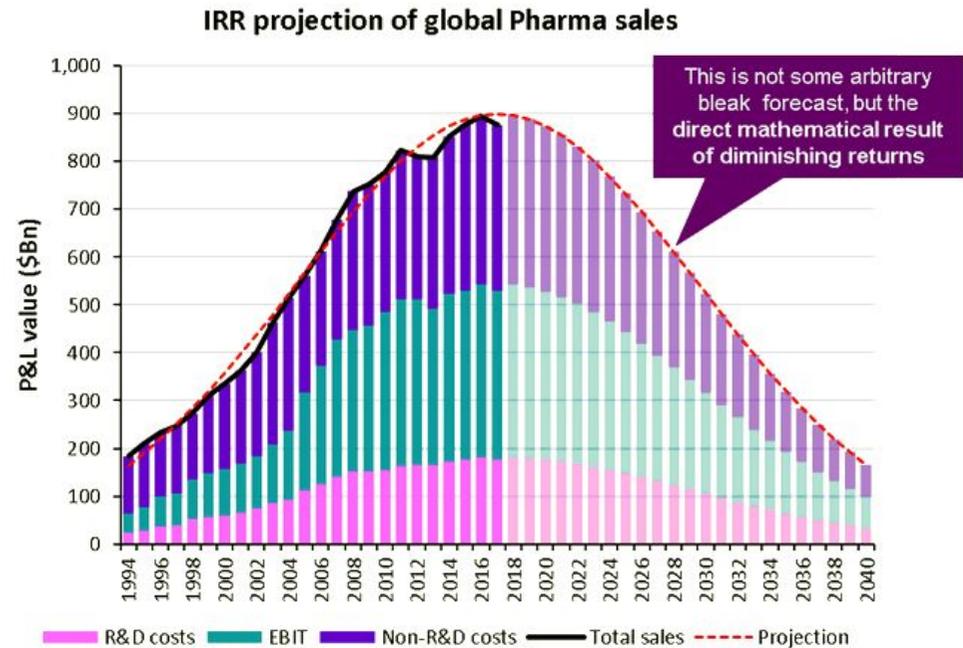
BioPharma's Source of Stagnation is Strategy, Not Capital

The pharmaceutical industry has accumulated vast amounts of capital but remains conservative, bureaucratic and risk-averse in its investment strategy. As government budgets become ever more constrained, it is increasingly urgent that the roadblocks to medical advancement be eliminated.

This may reflect the inefficiency of the organizations themselves and capital-intensive barriers to entry, more than the intrinsic intractability of complex biological systems - indeed, the most successful drugs historically have been discovered serendipitously.

In any case, the sector shows signs of sluggishness: twenty years ago, 20% of Swiss GDP was derived from pharmaceuticals — now it is down to 5.7% of GDP.

Banks and IT corporations are snapping up the best AI specialists and startups, and pharma will inevitably require the same scarce technology and talent.



Source: EvaluatePharma, IRR analysis

Source: <https://endpts.com/pharmas-broken-business-model-an-industry-on-the-brink-of-terminal-decline/>

The Broken Business Model of BioPharma

The efficiency of research and development (R&D), defined as the number of successfully approved drugs given the budget allocated to new drug development, has declined for decades.

The cost of drug discovery and subsequent development is a massive challenge in the pharmaceutical industry.

A typical drug can cost upwards of \$2.5 billion and a decade or more to identify and test a new drug candidate. Today, only about one in ten drugs that enter phase 1 clinical trials reaches patients.

Drug makers need to find a more efficient way of developing medicines. AI can speed up drug discovery, cut R&D costs, decrease failure rates in drug trials and eventually create better medicines.

What we have is an industry that is entering a vicious cycle of negative growth and terminal decline as its fundamental business model has run out of steam by the Law of Diminishing Returns: Diminishing R&D productivity and return on investment leads to diminishing growth in sales. Eventually, growth turns negative and sales start to contract. Decreasing sales then limits the amount of money available to invest back into R&D, which causes sales growth to decline even further. And so on, until the industry is gone altogether.

Pharma as we know it will shrink out of existence, and there is nothing we can do to stop it. The Pharma and Biopharma industries together will evolve into something quite different, most likely continuing the historic trend of increasing complexity towards more complex biological solutions to pressing healthcare problems, such as cell & gene therapy, tissue engineering and regenerative medicine.

Source: <https://www.linkedin.com/pulse/pharmas-broken-business-model-industry-brink-terminal-kelvin-stott/>
<https://www.drugtargetreview.com/news/29432/new-2018-role-artificial-intelligence-drug-discovery/>

Why AI? BioPharma's Outdated Business Model

The first practical results in AI for Drug Discovery will yield a number of domino effects, as BioPharma budgets are significantly related to spending on R&D and failures in clinical trials, meanwhile the breakthroughs in the use of AI for Drug Discovery will have dramatic impact on not just Biopharma companies but all biotech startups and biotech VC funds. All of them will be disrupted. The major progress in these technologies is coming not from the biotech side but from the IT side.

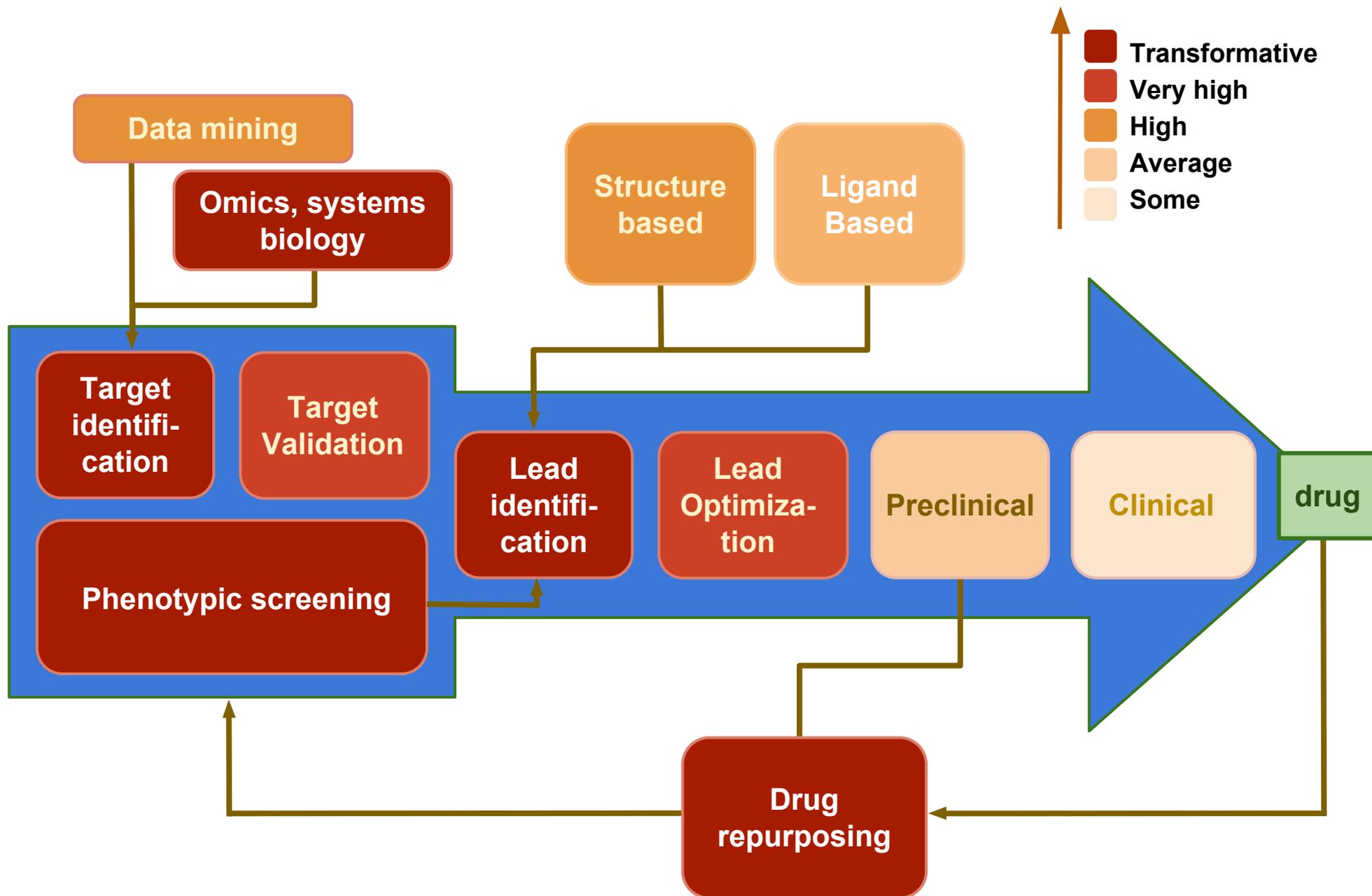
Due to the lack of AI specialists and promising AI & Drug Discovery startups, only a select few BioPharma players will emerge as the leaders of the AI race. Meanwhile others, even with substantial budgets and the will to succeed in this area, will fail if they are even one year late to the race, because all of the top AI specialists and AI in healthcare startups will have been acquired by then. The number of experts in the field of AI for Drug Discovery is insufficient to meet the demand of all big pharma companies, so only those few pharma companies and investors who will partner with the best AI for Drug Discovery companies in time will benefit from these collaborations and increase their capitalization accordingly.

Those BioPharma companies that create strong AI for R&D and Drug Discovery divisions and that will succeed to acquire the best AI startups will become the leaders of the field in as few as 3 to 5 years from now. *Consider the acquisition of DeepMind by Google for \$0.5B in 2014.* Companies that invest heavily in AI for their drug discovery department will see their market capitalization skyrocket in coming years.

Bio Pharma companies that do not utilise AI will repeat the mistakes of Kodak. Once the leader of its industry, Kodak went bankrupt because it failed to embrace digital photography as the disruptive trend it was, despite the fact that the digital camera was invented inside Kodak labs. If Bio Pharma found the courage to spend 10% of their marketing budget on R&D in AI, they could blow IBM Watson out of the water, and by learning from their mistakes, reinvent themselves and come one step closer to halting the looming threat of the Silver Tsunami.

While our previous reports have put great emphasis on this big gap. However, as later chapters will show, this gap is already beginning to close, with significant displays of will and commitment through investments, M&As and even the launch of whole in-house AI for drug discovery departments being shown by pharma corporations.

The "heat map" of AI potential value for various R&D areas



The Application of AI for Advanced R&D

Generate Novel Drug Candidates

- Analyze data sets, form hypotheses and generate novel insights
- Identify novel drug candidates
- Analyze data from patient samples in both healthy and diseased states to generate novel biomarkers and therapeutic targets
- Predict binding affinity and other pharmacological properties of molecules
- Allow filtering for drug-like properties of molecules
- Reduce complexity in protein design

Aggregate and Synthesize Information

- Extract knowledge from literature
- Generate insights from thousands of unrelated data sources
- Improve decision-making
- Eliminate blind spots in research
- Identify competitive whitespace

Repurpose Existing Drugs

- Rapidly identify new indications for many known drugs
- Match existing drugs with rare diseases
- Conduct experimental biology at scale by testing 1000+ of compounds on 100+ of cellular disease models in parallel
- Generate novel biomarkers and therapeutic targets

Design and Run Preclinical Experiments

- Reduce time, money, and uncertainty in planning experiments
- Decode open- and closed-access data on reagents and get actionable insights
- Automate selection, manipulation, and analysis of cells
- Expedite development of cell lines and automate manufacturing of cellular therapeutics
- Automate sample analysis with a robotic cloud laboratory

Clinical Trials

- Optimize clinical trial study design
- Transform diverse streams of biomedical and healthcare data into computer models representative of individual patients
- Deliver personalized medicine at scale, by revealing optimal health interventions for individual patients
- Analyze medical records to find patients for clinical trials
- Automate matching cancer patients to clinical trials through personal medical history and genetic analysis
- Improve pathology analysis
- Identify patients that would benefit from novel therapies

Computation-based Drug Discovery



Millions of
Compounds



1000s of
Compounds



Clinical Trials
FDA Approval
Process

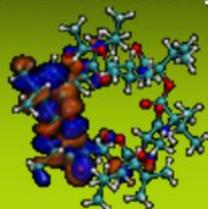
Synthesize new
Chemical Compounds

Robot-assisted screening
High Throughput Screening

Testing for Efficacy,
Side Effects, Safety

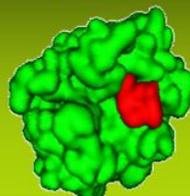
Computational Chemistry

- Synthesize compounds based on similarity



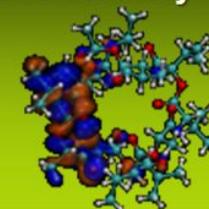
Virtual Screening

- Check if compounds bind to target proteins



Lead Optimization

- Modify chemicals to improve efficacy



1

Source: <https://blogs.nvidia.com/blog/2010/01/22/accelerating-the-pace-of-drug-discovery-using-gpus/>

AI and Drug Discovery: Deeper Insights, Quicker Results

Drug discovery comes at a very high cost, but success brings significant benefits to mankind. A breakthrough drug can cure a critical disease for hundreds of thousands of patients across the globe and can earn the company making the drug billions of dollars in revenue.

That is why, just to bring one of the breakthrough drug to market, companies spend hundreds of millions of dollars on decades on a single avenue of research, not knowing where the research will bear fruit. This deep exploration of potential false avenues brings with it the potential for a tremendous amount of wasted time, money and effort.

But this research landscape is changing. Machine learning, unencumbered by human intuition and armed with vast quantities of data, can cut down on waste by prioritising research. The reliability of AI-driven drug trials lies in the fact that hypotheses are generated not from occasional human epiphanies but from masses of cold hard data, yielding less wasteful hypotheses.

Drug companies have already been using artificial intelligence to decide in advance whether, for example, it is worth investigating whether a particular drug might bind to a particular protein. But there is trend toward ever more advanced estimates, such as how the same drug might subsequently affect a patient's cells or tissues.

AI for Drug Discovery and Biomarker Development

- Applying AI for Advanced R&D, Biomarker Development and Drug Discovery will bring the most disruptive impact on the business model of the Pharma and entire Biotech industry.
- Specific attention should be paid to those projects capable of applying Next Generation Artificial Intelligence techniques, Deep Learning and in particular GAN's (generative adversarial networks) and reinforcement learning for:
 - Drug Discovery and Drug Repurposing
 - Biomarker Development
 - Clinical Trials Predictors
 - Aging Research
 - AI Solutions in convergence with Blockchain
- The leading players in this specific niche can become new game changers for entire market and significantly influence the capitalization of pharma companies.



Source: <https://www.technologynetworks.com/drug-discovery/lists/4-toxicology-approaches-in-drug-discovery-294488>

Emerging Trends in AI for Drug Discovery

- Today, drug discovery is a trial-and-error process that eats up enormous amounts of research time. AI can significantly narrow the focus of researchers by rapidly assimilating and analyzing the information in public and proprietary databases.
- Beyond scanning health records to help providers identify chronically ill individuals who may be at risk of an adverse episode, AI can help clinicians take a more comprehensive approach for disease management, better coordinate care plans and help patients to better manage and comply with their long-term treatment programmes.
- The use of AI is enabling review and translation of mammograms 30 times faster with 99% accuracy, reducing the need for unnecessary biopsies.
- Researcher Frost & Sullivan said artificial intelligence systems will generate \$6.7 billion in global revenue from healthcare by 2021, compared with \$811 million in 2015.
- In 2018, even more extreme challengers and disruptors will arrive with the convergence of next generation AI, blockchain and precision medicine.
- The global healthcare AI market is highly fragmented and is characterized by the presence of large number of industry players, while the AI for Drug Discovery segment has a comparatively lower level of competition because this market segment only accepts companies with very high levels of expertise. There are more than 300 AI in Healthcare companies, but only 30 of them are capable of entering the AI in Drug Discovery sector.
- The breakthroughs in AI for Drug Discovery will change the R&D process of Bio Pharma, and it will make tremendous impact on whole BioPharma industry.
- That is why the players from the AI for Drug Discovery market can become new game changers and significantly influence the capitalization of pharma companies.

Where is AI for Drug Discovery Heading?

The broad field of AI in Healthcare has already experienced a significant rise over the past several years, especially in the application of computer vision, text analysis and chatbot technologies. These techniques, first developed in the IT sector, have been effectively repurposed for the healthcare sector.

However, the use of AI in Advanced R&D is limited to companies and researchers with very high levels of expertise. This creates a specific scarcity for AI specialists in this niche.

2018 is expected to become the year in which AI will be recognized as the most powerful driver of progress in solving the crucial challenges of the most advanced sectors of science and R&D in the healthcare and Biotech industries.

The use of AI in Advanced R&D, Biomarker Development and Drug Discovery will make the most disruptive impact on the business model of the Pharma and entire Biotech industry. This is why the players in the AI for Drug Discovery market can become new game changers and significantly influence the capitalization of pharma corporations.

The efficiency of research and development (R&D), defined as the number of successfully approved drugs given the budget allocated to new drug development, has declined for decades. The cost of drug discovery and subsequent development is a massive challenge in the pharmaceutical industry.

A typical drug can cost upwards of \$2.5 billion and can take a decade or more to identify and test a new drug candidate. Today, only about one in ten drugs that enter phase 1 clinical trials reaches patients. Drug makers need to find a more efficient way of developing medicines. AI can speed up drug discovery, cut R&D costs, decrease failure rates in drug trials and eventually create better medicines.

Section I

AI for Drug Discovery Landscape
Overview
(Industry Developments Q2 2018)

Section I: AI for Drug Discovery Landscape Overview (Industry Developments Q2 2018) provides a detailed overview of the entire AI for Drug Discovery landscape in Q2 of 2018, discussing trends in investments and M&A deals, BioPharma corporations on-boarding AI for Drug Discovery into their own internal activities, the entry of IT and Tech corporations into the space, government initiatives aiming to put certain countries on the forefront of the industry in the years to come, and industry-specific conferences and media coverage.

Chapter I: Landscape of AI for R&D and Drug Discovery Q2 2018 aggregates, lists and categorizes the various different organizations and entities that are profiled in greater detail in the Appendices of the report. It features lists (which break down each type of entity according to industry segmentation/application and location) 100 companies, 220 investors, 20 leading R&D centers, 30 corporations (15 BioPharma corporations and 15 IT & Tech corporations), 20 industry-specific conferences and 20 journalists specialising on the topic of AI for Drug Discovery.

Chapter II: Regional Comparison: USA, UK, EU and Asia-Pacific delivers a comparative analysis of AI for Drug Discovery companies, investors, corporations (IT & Tech corporations and BioPharma corporations active within the field) and conferences, in order to provide an idea of the comparative levels of activity and growth of the industry in specific regions.

Chapter III: Trends of Investment and M&A Deals gives a broad overview of trends in investments and M&A deals specifically tuned to industry progress in Q2 of 2018, detailing an overall increase of investments, the active participation BioPharma corporations (largely in the form of joint ventures with AI for Drug Discovery companies), the increasing activity of IT and Tech corporations, and the surge of activity from Chinese investors and Tech corporations.

Chapter IV: BioPharma Corporations Onboarding AI for Drug Discovery discusses the major occurrences happening in the BioPharma sector, and outlines how the entire BioPharma industry is now actively participating in the AI for Drug Discovery and biomarker development space via internal R&D, investment and acquisition, in contrast to 2017, during which time they remained skeptical of the disruptive impact of AI.

Chapter V: IT & Tech Corporations Entering the AI for Drug Discovery Space details how IT & Tech Corporations are continuing to enter the space; this was already a major trend in 2017, and it is continuing apace into 2018, remaining one of the strongest hallmarks of the subsector's exponential dynamic of development.

Chapter VI: Government Initiatives gives specific coverage of various AI for Drug Discovery government initiatives launched over the past several years in the USA, UK, EU and Asia-Pacific region, all of which aim to utilize industry and government partnerships in order to secure each nation's position as a leader in AI for Drug Discovery over the course of the next several years. It gives particular focus to the number of new initiatives that were launched in 2018.

Chapter VII: Industry-Specific Media & Conferences charts the industry-specific conferences and media landscape. It lists 20 conferences dedicated to AI for Drug Discovery and analyzes some of the most predominant conference topics and trends, and gives attention to the fact that, in addition to the overall increase in the number of conferences dedicated specifically to the topic, 2018 is also witnessing the inclusion of an AI for Drug Discovery track, session, forum or panel in the majority of the leading traditional BioPharma conferences aimed at major pharmaceutical executives. It also lists 20 journalists who are regularly reporting on the topic of AI for Drug Discovery, and who possess a certain level of expertise outlining some of the major trends and topics dominating media coverage of the industry.

Chapter I

Landscape of AI in R&D and Drug Discovery Q2 2018

Introduction

The present chapter aims to deliver an overview of the AI for Drug Discovery landscape, including lists of Companies, Investors, R&D Centers, Conferences & Media in one fell swoop.

It features detailed lists of:

- 100 companies applying AI for Drug Discovery & Advanced R&D
- 220 investors in AI for Drug Discovery companies
- 20 leading AI for Drug Discovery R&D centers
- 15 IT and Tech corporations entering AI for Discovery and advanced AI in Healthcare
- 15 Biopharma corporations using AI for Drug Discovery
- 20 conferences focused on AI for Drug Discovery and advanced R&D
- 20 journalists regularly covering AI for Drug Discovery in media with a certain level of expertise and specialization in the topic

All of these entities are profiled in depth in this report's appendices. Here, our aim is simply to list them and, where applicable, to classify them according to application, industry segmentation, and regional location. Companies, for instance, are categorized according to industry segmentation (i.e. focusing on Drug Discovery, Biomarker Development, or Advanced R&D, respectively), while investors are classified according to their regional location and the companies in which they invested.

These lists have been extended in comparison to our previous report (AI for Drug Discovery, Biomarker Development and Advanced R&D Q1 2018) in order to include those companies, investors and entities that rose into prominence in Q2 of 2018. We have added 5 corporations, 20 companies, 40 investors, 20 conferences, and 20 journalists.

15 Pharma Corporations using AI for Drug Discovery

Company Name	Based in	Website
1. Pfizer	United States	https://www.pfizer.com/
2. Astrazeneca	United Kingdom	http://www.astrazeneca.com/
3. Sanofi	France	http://m-en.sanofi.com/
4. Roche	Switzerland	http://www.roche.com/
5. GSK	United Kingdom	http://www.gsk.com/
6. Novartis	Switzerland	http://www.novartis.com/
7. Illumina	United States	https://www.illumina.com/
8. Merck	United States	http://www.merck.com/
9. Johnson & Johnson	United States	http://www.jnj.com/
10. Bayer	Germany	http://bayer.com/
11. Amgen	United States	https://www.amgen.com/
12. Astellas Pharma	Japan	https://www.astellas.com/
13. Boehringer Ingelheim	Germany	https://www.boehringer-ingelheim.com/
14. Bristol-Myers Squibb	United States	https://www.bms.com/
15. Evotec	Germany	https://evotec.com/

15 Tech Corporations Interested in Advanced AI Applications in Healthcare

Company Name	Based in	Website
1. Alibaba	China	http://www.alibaba.com/
2. Amazon	United States	http://amazon.com/
3. Apple	United States	http://www.apple.com/
4. Google	United States	http://www.google.com/
5. Huawei	China	http://huawei.com/
6. IBM	United States	http://www.ibm.com/
7. Microsoft	United States	http://www.microsoft.com/
8. Canon	United States	https://www.usa.canon.com/internet/portal/us/home
9. Nvidia	United States	http://www.nvidia.com/
10. Samsung Electronics	South Korea	http://www.samsung.com/us
11. Siemens	Germany	https://www.siemens.com/global/en/home.html
12. Baidu	China	http://www.baidu.com/
13. Tencent	China	https://www.tencent.com/en-us/
14. Intel	United States	http://www.intel.com/
15. Hitachi	Japan	http://www.hitachi.com/

20 Leading R&D centers

R&D Centers	Location
La Jolla Laboratories	US
Merck Exploratory Science Center (MESCC)	US
Roche Innovation Center Copenhagen	Danmark
Sanofi Pasteur R&D Centre	Canada
Johnson & Johnson Pharmaceutical Research and Development	China
Centre for Drug Research and Development	Canada
Warren Family Research Center for Drug Discovery and Development	US
Ritsumeikan Research Center for Drug Discovery and Development Science	Japan
Astellas Drug Discovery Research Centre	Japan
Drug Discovery Oxford	UK
Babraham Research Campus	UK
Janssen Pharmaceutical Companies of Johnson & Johnson	US
Chinese Thoracic Oncology Group (CTONG)	China
The Development Center for Biotechnology	Taiwan
Korea Pharmaceutical and Bio-Pharma Manufacturers Association	South Korea
Pande Lab - Stanford University	US
Center for Computational Health - IBM Research	US
The R&D Centre China LTD (RRDCC)	China
China R&D Center (CRDC) - Pfizer	China
Merck Serono Pharmaceutical R&D Co., Ltd	China

100 Companies Applying AI for Drug Discovery and Advanced R&D

	Company Name	Based in	Category
1	AccutarBio	Asia	Drug Discovery
2	Acurastem	US	Drug Discovery
3	AiCure	US	Biomarker Development
4	Antidote	UK	Advanced R&D
5	Arbor Biotechnologies	US	Drug Discovery
6	Athelas	US	Biomarker Development
7	ATOM	US	Drug Discovery
8	Atomwise	US	Drug Discovery
9	Bactevo	UK	Drug Discovery
10	BenchSci	Canada	Biomarker Development
11	BenevolentAI	UK	Drug Discovery
12	Berg LLC	UK	Drug Discovery
13	BioAge Labs	US	Drug Discovery
14	Biorelate	UK	Advanced R&D
15	BioSymetrics	US	Advanced R&D
16	Biovista	US	Drug Discovery
17	BioXcel	US	Drug Discovery

100 Companies Applying AI for Drug Discovery and Advanced R&D

	Company Name	Based in	Category
18	Brite Health	US	Biomarker Development
19	BullFrog AI	US	Biomarker Development
20	C4X discovery	UK	Drug Discovery
21	Cambridge Cancer Genomics	UK	Biomarker Development
22	Celsius Therapeutics	US	Drug Discovery
23	Clinithink	UK	Biomarker Development
24	Cloud Pharmaceuticals	US	Drug Discovery
25	CloudMedX	US	Biomarker Development
26	Cotinga Pharmaceuticals	Canada	Drug Discovery
27	Cyclica	Canada	Drug Discovery
28	CytoReason	Others	Biomarker Development
29	Cyttox	UK	Drug Discovery
30	Datavant	US	Drug Discovery
31	Deep 6 AI	US	Advanced R&D
32	Deep Genomics	Canada	Drug Discovery
33	Desktop Genetics	UK	Biomarker Development
34	e-therapeutics	UK	Drug Discovery

100 Companies Applying AI for Drug Discovery and Advanced R&D

	Company Name	Based in	Category
35	Emerald Cloud Lab	US	Advanced R&D
36	Engine Biosciences	US	Drug Discovery
37	Envisagenics	US	Drug Discovery
38	Euretos	EU	Biomarker Development
39	EvidScience	US	Advanced R&D
40	exscientia	UK	Drug Discovery
41	FDNA	US	Biomarker Development
42	Globavir	US	Drug Discovery
43	GNS Healthcare	US	Biomarker Development
44	GTN	UK	Drug Discovery
45	Healx	UK	Drug Discovery
46	HelixAI	US	Advanced R&D
47	IBM Watson Health	US	Drug Discovery
48	Iktos	EU	Drug Discovery
49	Imagia	Canada	Biomarker Development
50	Inato	EU	Advanced R&D
51	Innoplexus	EU	Advanced R&D

100 Companies Applying AI for Drug Discovery and Advanced R&D

	Company Name	Based in	Category
52	Insilico Medicine	US	Drug Discovery
53	Insitro	US	Advanced R&D
54	Intellegens	US	Advanced R&D
55	Iris.ai	Others	Advanced R&D
56	Juvenescence AI	US	Drug Discovery
57	Kyndi	US	Advanced R&D
58	Lantern Pharma	US	Drug Discovery
59	MediBIC Group	Asia	Drug Discovery
60	Mendel.ai	US	Advanced R&D
61	Meta	US	Advanced R&D
62	Micar21	EU	Drug Discovery
63	Mind the Byte	EU	Drug Discovery
64	nference	US	Advanced R&D
65	Novoheart	Canada	Advanced R&D
66	nQ Medical	UK	Biomarker Development
67	NuMedii	US	Drug Discovery
68	Numerate	US	Drug Discovery

100 Companies Applying AI for Drug Discovery and Advanced R&D

	Company Name	Based in	Category
69	Nuritas	EU	Drug Discovery
70	Owkin	US	Advanced R&D
71	PathAI	US	Biomarker Development
72	Pepticom	Others	Drug Discovery
73	Peptone	UK	Drug Discovery
74	Pharnext	EU	Drug Discovery
75	Phenomic AI	Canada	Biomarker Development
76	Plex Research	US	Advanced R&D
77	ProteinQure	Canada	Drug Discovery
78	Qrativ	US	Drug Discovery
79	Quantitative Medicine	US	Drug Discovery
80	Recursion Pharmaceuticals	US	Drug Discovery
81	Resonant Therapeutics	US	Drug Discovery
82	Reveal Biosciences	US	Biomarker Development
83	Reverie Labs	US	Drug Discovery
84	ReviveMed	US	Biomarker Development
85	sciNote	US	Advanced R&D

100 Companies Applying AI for Drug Discovery and Advanced R&D

	Company Name	Based in	Category
86	Sparrho	UK	Advanced R&D
87	Spring Discovery	US	Drug Discovery
88	Standigm	Asia	Drug Discovery
89	Structura Biotechnology	Canada	Biomarker Development
90	Synthace	UK	Advanced R&D
91	TeselaGen	US	Drug Discovery
92	ThoughtSpot	US	Advanced R&D
93	Transcriptic	US	Advanced R&D
94	Trials.ai	US	Biomarker Development
95	TwoXAR	US	Drug Discovery
96	Verge Genomics	US	Drug Discovery
97	Virogin	Asia	Drug Discovery
98	Virvio	US	Drug Discovery
99	WinterLight Labs	Canada	Biomarker Development
100	XtalPi	US	Drug Discovery

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
1	11.2 Capital	United States	Deep Genomics
2	500 Startups	United States	Transcriptic
3	6 Dimensions Capital	China	Engine Biosciences
4	8VC	United States	PathAI
5	A-Level Capital	United States	Insilico Medicine
6	Accelerate Long Island	United States	Envisagenics
7	Advantage Capital	United States	Recursion Pharmaceuticals
8	Afore Capital	United States	BenchSci
9	Agent Capital	United States	Verge Genomics
10	AGORANOV	France	Iktos
11	Alexandria Real Estate Equities	United States	GNS Healthcare
12	AllBright	United Kingdom	Sparrho
13	Alphabet	United States	XtalPi
14	ALS Investment Fund	The Netherlands	Verge Genomics
15	Amadeus Capital Partners	United Kingdom	Antidote
16	AME Cloud Ventures	United States	Atomwise
17	Amgen Ventures	United States	GNS Healthcare

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
18	Andreessen Horowitz	United States	BioAge Labs
19	ARCH Venture Partners	United States	Arbor Biotechnologies
20	Atlas Venture	United States	Numerate
21	Aurinvest	France	Pharnext
22	B Capital Group	United States	Atomwise
23	Baidu Ventures	China	Atomwise
24	Baird Capital	United States	AiCure
25	Bakken & Baeck	Norway	Iris.ai
26	BDC Venture Capital	Canada	Imagia
27	Beast Ventures	United Kingdom	Sparrho
28	Bioeconomy Capital	United States	Synthace
29	Biomatics Capital Partners	United States	AiCure
30	Bios Partners	United States	Lantern Pharma
31	Bloomberg Beta	United States	Deep Genomics
32	BOE Technology Group	China	Meta
33	Bold Capital Partners	United States	Meta, InSilico Medicine
34	BootstrapLabs	United States	Mendel.ai

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
35	Boundary Capital Partners LLP	United Kingdom	Desktop Genetics
36	Caffeinated Capital	United States	BioAge Labs
37	Cambia Health Solutions	United States	GNS Healthcare
38	Capital One Growth Ventures	United States	ThoughtSpot
39	Casdin Capital	United States	Celsius Therapeutics
40	Cathay Innovation	United States	Owkin
41	Celgene	United States	GNS Healthcare
42	China Equity	China	CloudMedX
43	Citrix Systems	United States	Kyndi
44	Claremont Creek Ventures	United States	NuMedii
45	CLI Ventures	United States	TwoXAR
46	Comcast Ventures	United States	Meta
47	Creative Destruction Lab	Canada	Kyndi
48	Crowdcube	United Kingdom	Mind the Byte
49	CRV	United States	Recursion Pharmaceuticals
50	Cultivian Sandbox Ventures	United States	Nuritas
51	Danhua Capital	United States	PathAI

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
52	Darling Ventures	United States	Kyndi
53	Data Collective	United States	Atomwise
54	DCM Ventures	United States	Mendel.ai
55	Deep Knowledge Ventures	Hong Kong	Insilico Medicine
56	DFJ Growth	United States	Helix
57	Digital Science	United Kingdom	Transcriptic
58	Dolby Family Ventures	United States	Atomwise
59	Dorm Room Fund	United States	Athelas
60	Draper Associates	United States	Atomwise
61	Draper Dragon	United States	CloudMedX
62	Dynamk Capital	United States	Envisagenics
63	EDBI	Singapore	Engine Biosciences
64	Empire State Development	United States	Envisagenics
65	Endure Capital	United States	Cambridge Cancer Genomics
66	Eniac Ventures	United States	Meta
67	Enterprise Ireland	Ireland	Nuritas
68	Entrepreneur First	United Kingdom	Sparrho

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
69	EPIC Capital	Canada	Cyclica
70	EPIC Ventures	United States	Recursion Pharmaceuticals
71	European Union	United Kingdom	Nuritas
72	Fairhaven Capital Partners	United States	PathAI
73	Faridan	United States	Arbor Biotechnologies
74	Felicis Ventures	United States	BioAge Labs
75	Fenox Venture Capital	United States	Meta
76	Fifty Years	United States	Athelas
77	Finance Wales	United Kingdom	Clinithink
78	Fly Ventures	Germany	Inato
79	Foundation Capital	United States	Numerate
80	Founders Factory	United Kingdom	Iris.ai
81	Founders Fund	United States	Transcriptic
82	FREES FUND	China	XtalPi
83	Frontier IP Group plc	United Kingdom	Exscientia
84	FundersClub	United States	CloudMedX
85	Gaorong Capital	China	Meta

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
86	General Catalyst	United States	ThoughtSpot
87	Geodesic Capital	United States	ThoughtSpot
88	GM&C Life Sciences Fund	United Kingdom	Biorelate
89	Golden Venture Partners	Canada	BenchSci
90	GQY	China	Meta
91	Gradient Ventures	United States	BenchSci
92	Grand Central Tech	United States	Envisagenics
93	Grand Challenges Canada	Canada	Atomwise
94	Great Oaks Venture Capital	United States	Verge Genomics
95	GreenSky Capital	Canada	Cyclica
96	GV	United States	Transcriptic
97	Hacking Health Accelerator	Canada	Imagia
98	Hanhai Studio	United States	Cyclica
99	Health Wildcatters	United States	Lantern Pharma
100	Healthbox	United States	Desktop Genetics
101	Heritage Provider Network	United States	GNS Healthcare
102	Hewlett Packard Pathfinder	United States	ThoughtSpot

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
103	Horizons Ventures	Hong Kong	Meta
104	IA Ventures	United States	Verge Genomics
105	Illumina	United States	Helix
106	Indie Bio	United States	Mendel.ai
107	Initialized Capital	United States	Athelas
108	InnoSpring Seed Fund	United States	Meta
109	iNovia Capital	Canada	BenchSci
110	IQ Capital Partners LLP	United Kingdom	Desktop Genetics
111	J. Hunt Holdings	United States	Kyndi
112	Juvenescence	United States	Insilico Medicine
113	Karlin Ventures	United States	Verge Genomics
114	KdT Ventures	United States	PathAI
115	Khosla Ventures	United States	ThoughtSpot
116	Kima Ventures	France	Inato
117	Kleiner Perkins Caufield & Byers	United States	Helix
118	Lansdowne Partners	United Kingdom	BenevolentAI
119	Lanza Tech Ventures	United States	Numerate

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
120	LaunchCapital	United States	Helix
121	LB Investment	South Korea	Standigm
122	Lenovo	United States	Meta
123	Lightspeed Venture Partners	United States	ThoughtSpot
124	Lilly Ventures	United States	Numerate
125	Liquid2 Ventures	United States	Athelas
126	London Co-Investment Fund	United Kingdom	Desktop Genetics
127	Lundbeck	United Kingdom	BenevolentAI
128	Lux Capital	United States	Recursion Pharmaceuticals
129	Masa Life Science Fund	United States	Cytox
130	MassChallenge	United States	ReviveMed
131	Matrix Partners	United States	nference
132	Mayo Clinic	United States	Helix
133	Menlo Ventures	United States	Recursion Pharmaceuticals
134	Merck Global Health Innovation Fund	United States	Antidote
135	Mission and Market	United States	Atomwise
136	MIT delta v	United States	ReviveMed

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
137	MITS Fund	United States	Transcriptic
138	Mitsui & Co	Japan	GNS Healthcare
139	Monsanto Growth Ventures (MGV)	United States	Atomwise
140	Mubadala Investment Company	United Arab Emirates	Recursion Pharmaceuticals
141	National Institutes of Health	United States	Envisagenics
142	National Science Foundation	United States	Cloud Pharmaceuticals
143	Nest.Bio Ventures	United States	Engine Biosciences
144	Nesta Ventures	United Kingdom	Cytox
145	New Leaf Venture Partners	United States	AiCure
146	New Protein Capital	Singapore	Nuritas
147	New Wave Ventures	United Kingdom	Bactevo
148	NewDo Venture	United States	Cambridge Cancer Genomics
149	NJF Capital	United Kingdom	Owkin
150	Obvious Ventures	United States	Recursion Pharmaceuticals
151	Octopus Ventures	United Kingdom	e-therapeutics
152	OS Fund	United States	Atomwise
153	Otium Capital	France	Owkin

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
154	Palm Drive Capital	United States	CloudMedX
155	Pavilion Capital	United States	Insilico Medicine
156	Pear Ventures	United States	BioAge Labs
157	Pentech Ventures	United Kingdom	GTN
158	Perivoli Innovations	United States	Cytox
159	Pillar Companies	United States	PathAI
160	Pitch@Palace	United Kingdom	Sparrho
161	PivotNorth Capital	United States	Kyndi
162	Plug and Play	United States	Owkin
163	Presence Capital	United States	Meta
164	Pritzker Group Venture Capital	United States	AiCure
165	Real Ventures	Canada	Imagia
166	Refactor Capital	United States	PathAI
167	Renren Inc.	China	XtalPi
168	Rivas Capital	United States	ReviveMed
169	Rough Draft Ventures	United States	Reverie Labs
170	Seneca Partners	United States	Cytox

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
171	Sequoia Capital	United States	Athelas
172	Seraph Group	United States	NuMedii
173	Serena Capital	France	Inato
174	ServiceNow	United States	ThoughtSpot
175	Silicon Badia	Jordan	Transcriptic
176	Silicon Valley Bank	United States	Transcriptic
177	Slow Ventures	United States	Verge Genomics
178	Smedvig Capital	United Kingdom	Antidote
179	Sofinnova Partners	France	Synthace
180	Softbank Ventures Korea	South Korea	TwoXAR
181	Sorrento Therapeutics	United States	Globavir
182	SOSV	United States	Mendel.ai
183	Square 1 Bank	United States	Recursion Pharmaceuticals
184	StartUp Health	United States	Cyclica
185	StartX	United States	TwoXAR
186	Sutter Hill Ventures	United States	Helix
187	SV Angel	United States	Envisagenics

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
188	SV Tech Ventures	United States	CloudMedX
189	SyndicateRoom	United Kingdom	Desktop Genetics
190	Techammer	United States	Transcriptic
191	TechU Angels	United States	ReviveMed
192	Tencent Holdings	China	Atomwise
193	The Thiel Foundation	United States	Envisagenics
194	Third Kind Venture Capital	United States	Envisagenics
195	Third Rock Ventures	United States	Celsius Therapeutics
196	TIPS	South Korea	Standigm
197	Tribeca Venture Partners	United States	AiCure
198	True Ventures	United States	Deep Genomics
199	Truffle Capital	France	Pharnext
200	TSVC (formerly TEEC Angel Fund)	United States	NuMedii
201	Two Sigma Ventures	United States	Verge Genomics
202	UK Innovation & Science Seed Fund	United Kingdom	Synthace
203	Uni-Innovate Group	United States	Cyclica
204	Unshackled Ventures	United States	Brite Health

220 Investors AI for Drug Discovery

	Company Name	Based in	Invested in
205	Upsher Smith Laboratories	United States	BenevolentAI
206	Vanguard Atlantic	United States	Clinithink
207	VTF Capital	United States	Meta
208	Warburg Pincus	United States	Helix
209	Westcott LLC	United States	Meta
210	White Cloud Capital	United Kingdom	Sparrho
211	WI Harper Group	United States	Engine Biosciences
212	Wild Basin Investments	United States	Recursion Pharmaceuticals
213	Woodford Investment Management	United Kingdom	BenevolentAI
214	WorldQuant Ventures LLC	United States	ReviveMed
215	Wren Capital	United Kingdom	Cytox
216	WuXi AppTec	China	Engine Biosciences, InSilico Medicine
217	Y Combinator	United States	Atomwise
218	Zappos	United States	Meta
219	ZhenFund	China	Transcriptic
220	Zillionize Angel	United States	Meta

Top-20 Conferences on AI for R&D and Drug Discovery 2018-2019

Name	Date	Location	Website
2nd Annual Artificial Intelligence in Drug Development Congress	20-21 September 2018,	UK	https://www.oxfordglobal.co.uk/artificialintelligence-congress/
2nd Global Pharma R&D Informatics and AI Congress	29th-30th October 2018	UK	http://www.global-engage.com/event/pharma-informatics-congress/
ADVANCED MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE FOR DRUG DISCOVERY & DEVELOPMENT	19th - 20th June 2018	EU	https://www.bisgrp.com/portfolio/conferences/pharmaceutical/advanced-machine-learning-and-artificial-intelligence-for-drug-discovery-development
AI Health & Pharma Summit	14 June, 2018	UK	https://theaisummit.com/health/
AI in Pharma Summit 2018	9th October 2018	US	https://www.cambridgeconsultants.com/events/ai-pharma-summit-2018
AI IN PHARMA: OPPORTUNITIES & CHALLENGES	12th June 2018	UK	https://telecomstechacademy.knect365.com/ai-in-pharma-opportunities-challenges/
AI Pharma	10-11 September 2018	Japan	https://10times.com/ai-pharma-japan
AI Pharma Innovation: Drug Discovery Summit	26-28 February 2018,	US	http://ai-drugdiscovery.com/
Artificial Intelligence and Big Data in Pharma	March 21 2018	EU	http://www.mpg-alumni.de/conferences/aiworkshop/
Artificial Intelligence and Machine Learning for Drug Discovery	November 27, 2018	EU	http://www.worldpreclinicaleurope.com/AI-ML-Drug-Discovery

Top-20 Conferences on AI for R&D and Drug Discovery 2018-2019

Name	Date	Location	Website
Artificial Intelligence for Drug Discovery	May 23, 2018	US	https://www.BioPharmatrend.com/post/57-artificial-intelligence-for-drug-discovery-may-23-2018-cambridge-ma-usa/
BioData World	28 - 29 November 2018	Switzerland	https://www.terrapinn.com/conference/biodata/index.stm
Artificial Intelligence in Pharma Industry Summit	19- 20 February 2018	EU	https://www.asdevents.com/event.asp?id=17278
Artificial intelligence to speed up drug discovery: the revolutionary road to advancing innovation	4th December 2018	EU	https://www.biofit-event.com/conference/artificial-intelligence-speed-drug-discovery-revolutionary-road-advance-innovation/
Artificial Intelligence Transforming Pharma R&D	Feb 21-22, 2018	US	https://benevolent.ai/events/previous/artificial-intelligence-transforming-pharma-r-d/
BASEL LIFE Artificial intelligence and blockchain in healthcare innovation forum	11–14 September 2018	Switzerland	https://www.basellife.org/basel-life-2018/basel-life/innovation-forums/scientific-programme/artificial-intelligence-and-blockchain-in-healthcare.html
HEALTHCARE & MEDICAL RESEARCH CONFERENCE SESSIONS	March 18-22, 2019	US	https://www.nvidia.com/en-us/gtc/topics/healthcare-and-life-sciences/
Pharma AI & IoT 2018	11th-12th July 2018	UK	http://www.virtueinsight.com/pharma/Pharma-AI--IoT-2018/
SMI's 2nd annual Drug Discovery conference	21-22 March 2018	UK	https://www.drugtargetreview.com/news/29432/new-2018-role-artificial-intelligence-drug-discovery/
THE Summit for ChangeMakers Using AI in Biopharma	25-26 October 2018	US	https://pharmaphorum.com/events/ai-applications-summit-BioPharma/

20 Journalists Specializing in AI for Drug Discovery

Name	Based in	Associated Media Entity
1. Richard Staines	United Kingdom	Pharmaphorum
2. Nick Paul Taylor	United Kingdom	Freelance
3. Joy Persuad	United Kingdom	Freelance
4. Alaric DeArment	United States	MedCity News
5. Dave Muoio	United States	MobiHealthNews
6. Derek Lowe	United States	Science Translational Medicine
7. Amirah Al Idrus	United States	FierceBiotech
8. Bill Siwicki	United States	HIMSS Media
9. Heather Mack	United States	The Wall Street Journal
10. Jeff Lagasse	United States	HIMSS Media
11. Bernie Monegain	United States	HIMSS Media
12. Mike Miliard	United States	HIMSS Media
13. Conor Hale	United States	FierceMedTech, FierceBiotech
14. Andrew McConaghie	United Kingdom	Pharmaphorum
15. Joseph Keenan	United States	FierceBiotech, FiercePharma
16. Julian Upton	United Kingdom	Pharmaceutical Executive
17. Gemma Jones	United Kingdom	PMLiVE
18. Phil Taylor	United Kingdom	Freelance
19. Kumba Sennaar	United States	Kumba Sennaar
20. Daniel Faggella	United States	TechEmergence

Chapter II

Regional Comparison:
USA, UK, Canada, EU, Asia

Introduction

The present chapter delivers an overview of the global landscape of AI for Drug Discovery and performs a comparative analysis of the USA, EU, UK, Canada, Canada, Asia regions for the following categories:

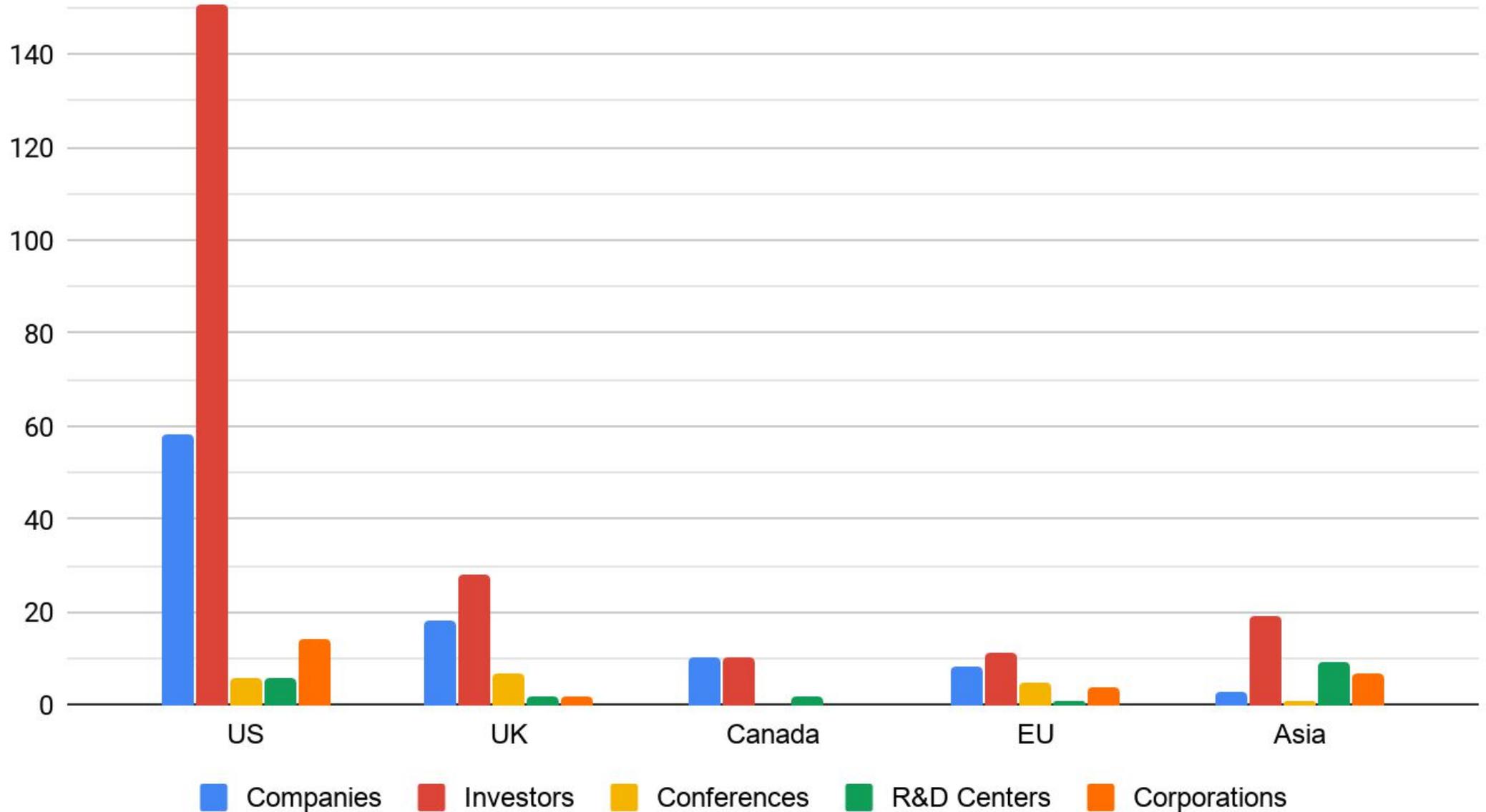
- AI Companies
- Investors
- R&D centers
- Conferences
- Corporations applying advanced AI for Healthcare and Drug Discovery

By comparing a number of key variables, we can gain a deeper understanding of the overall dynamic of development occurring in the AI for Drug Discovery industry in different regions.

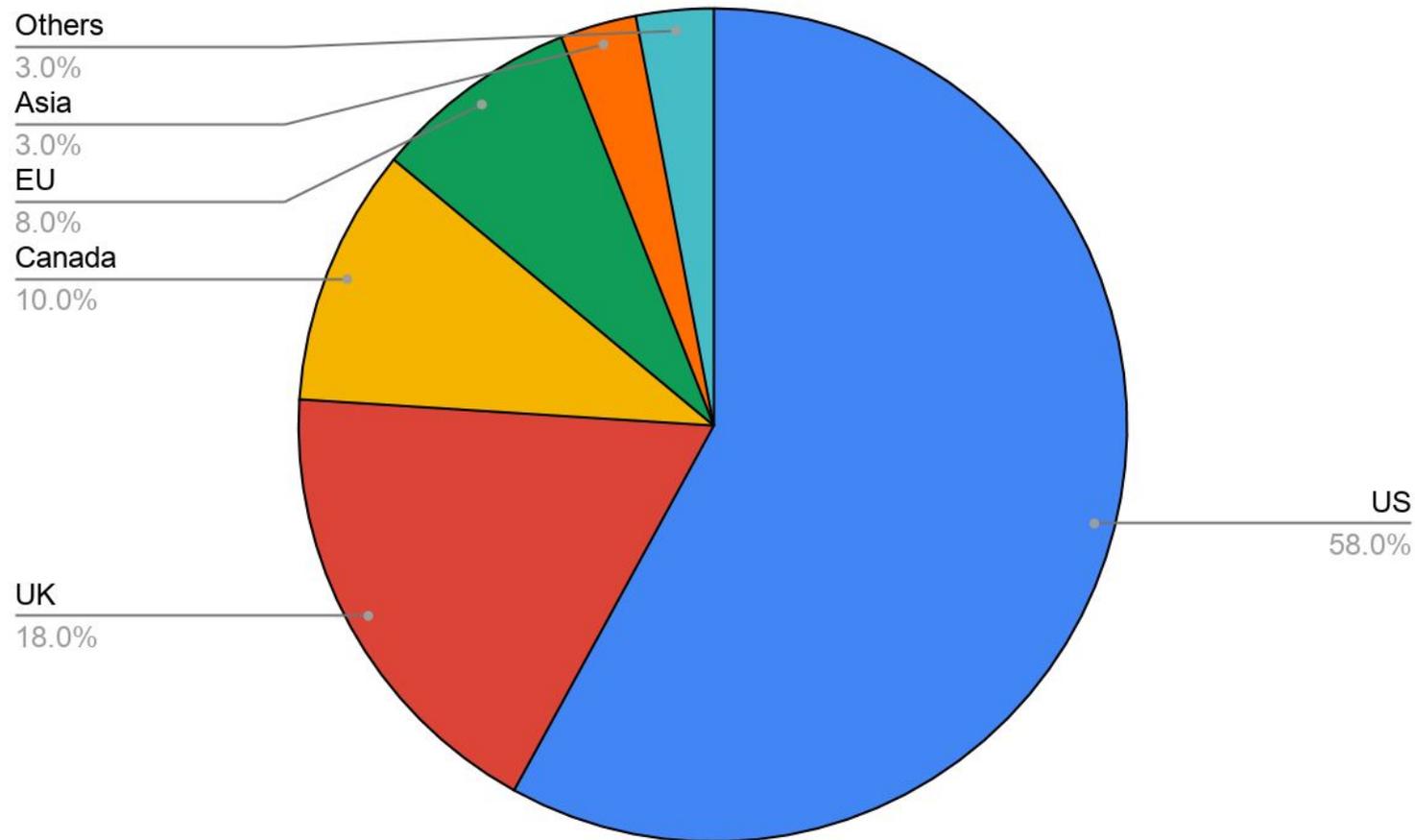
The following slides show a number of notable trends and insights, including the fact that the US is by far the global leader in terms of AI for Drug Discovery companies, and the leader in investments in this sphere by a truly staggering degree.

And while the UK has maintained its second-place leadership position after the US, it is notable that EU and Asia, but China especially, are increasing their dynamic of progress in this sphere as well. Additionally, Canada is also becoming increasingly active in the field.

Regional Comparison of AI for Drug Discovery Companies/Investors/R&D Centers

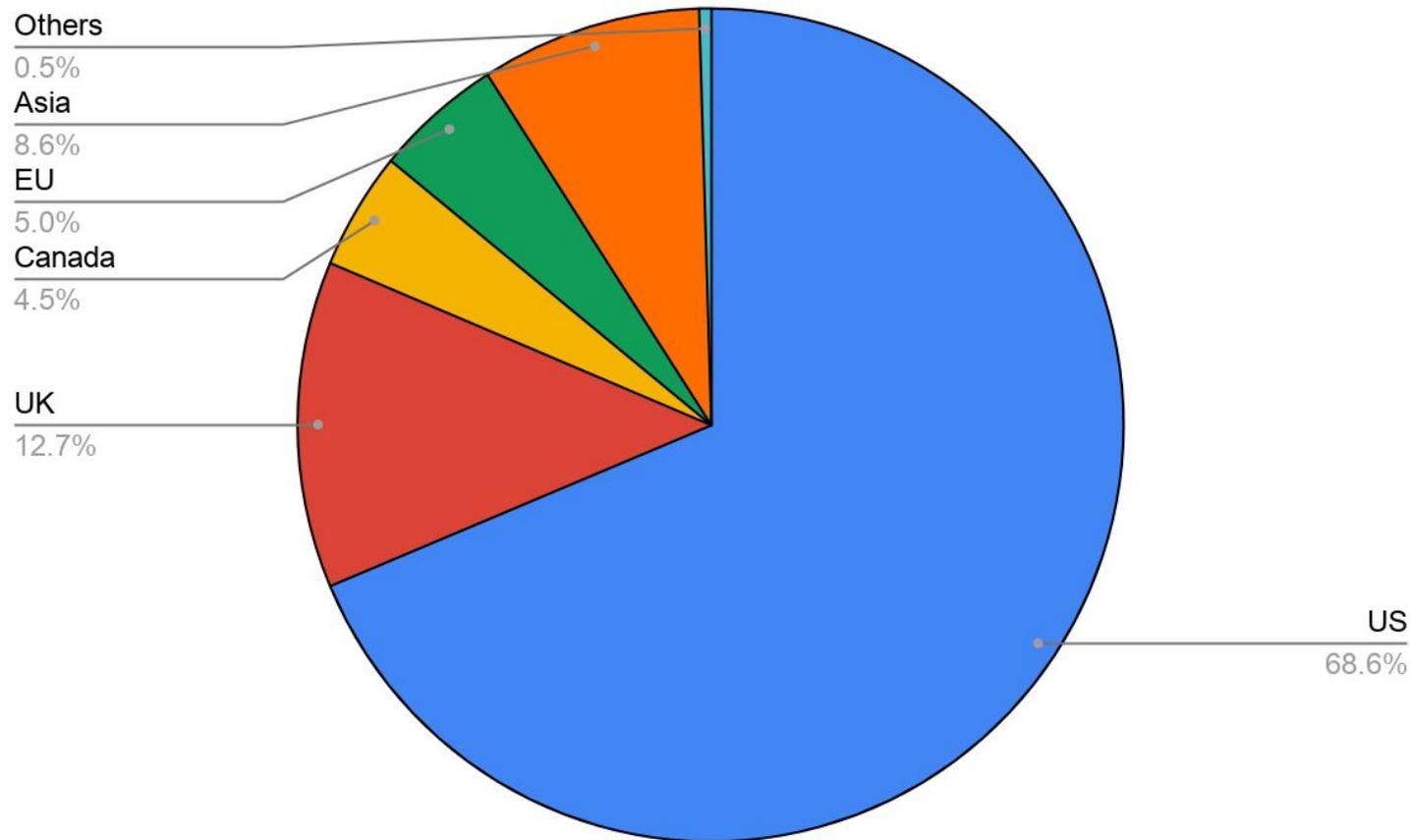


100 AI Companies: Regional Proportion



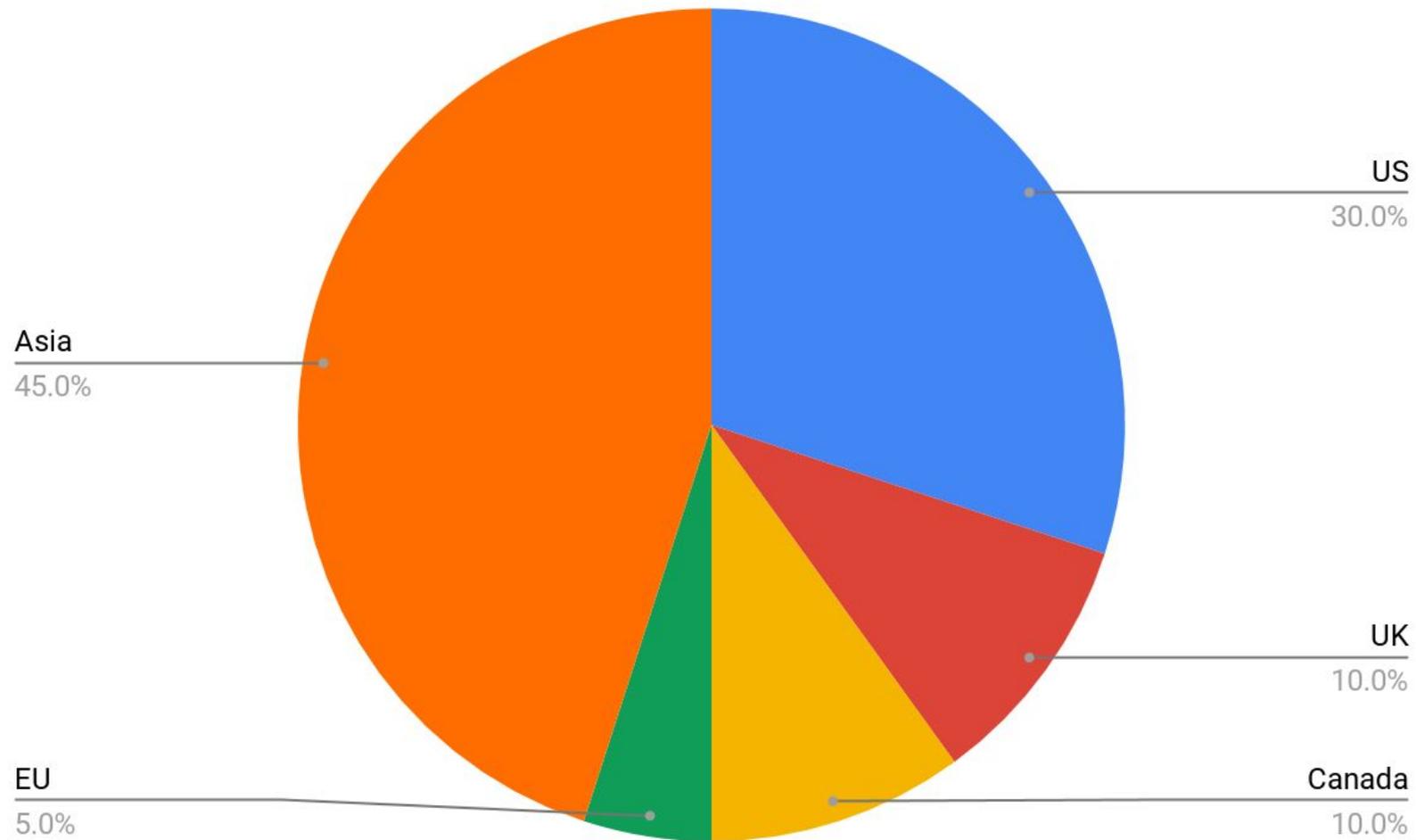
The US is still firmly in the lead in terms of its proportion of AI for Drug Discovery companies. Interestingly, Asia currently has the fifth-lowest proportion of AI for Drug Discovery companies. The Asia-Pacific region has, however, begin to aggressively increase their activity in the space in terms of investments into foreign companies (largely US-based companies), and we can expect to see an increase in the number of AI for Drug Discovery Companies located in the Asia-Pacific region generally, and in China particularly.

220 Investors: Regional Proportion



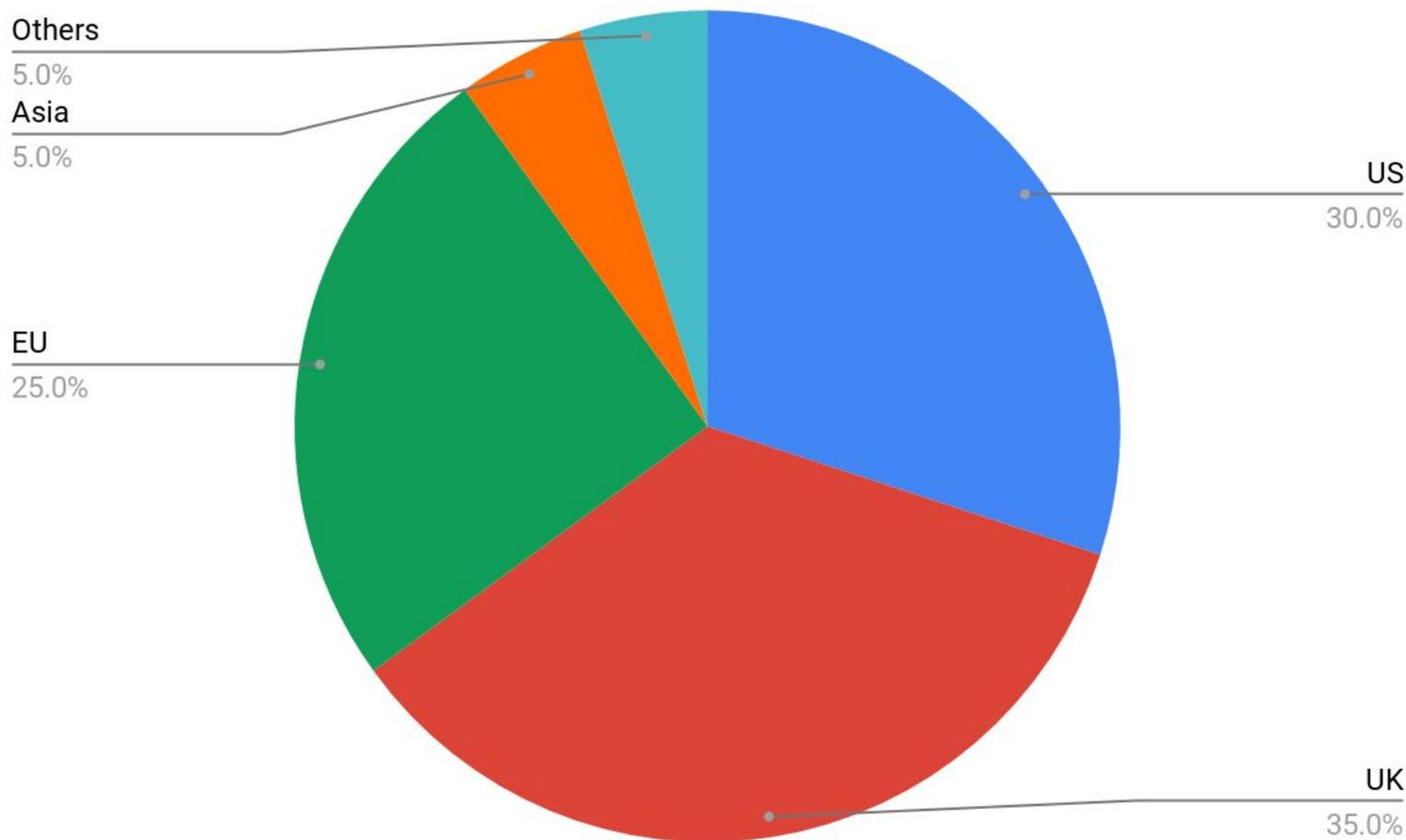
The US still leads the rest of the world in the proportion of AI for Drug Discovery Investors. This is sensible given that they also have the largest proportion of AI for Drug Discovery companies. However, it is interesting to note that, while the UK is home to the second-largest proportion of investors in this space, Asia has now overtaken the EU is rapidly advancing to acquire the #2 position. This past year has seen a substantial increase in the number of Asian investors, as well as Asian Tech & IT corporations, entering the AI for drug discovery industry.

20 Leading R&D Centers: Regional Proportion



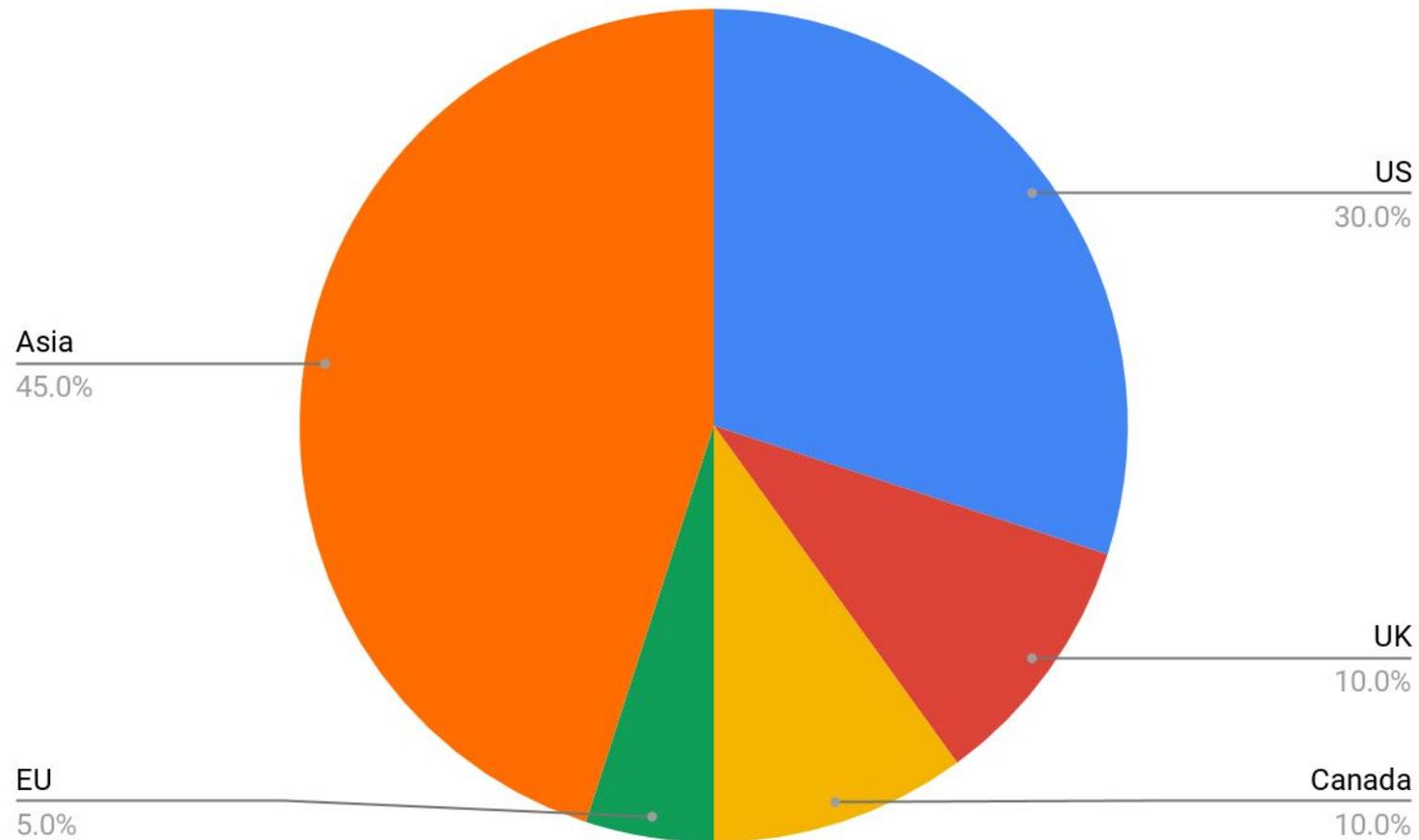
The figure above shows that while the US leads the world in terms of the number of R&D Centers focused on AI for Drug Discovery, China is rapidly catching up. This makes sense within the context of the recent increase in the number of Chinese investors entering the AI for Drug Discovery space, and the Chinese government's recent commitment to lead the world in AI by the year 2030.

Top-20 Conferences on AI for R&D and Drug Discovery 2018-2019: Regional Proportion



As can be seen in the figure above, whereas previously the US has dominated the AI for Drug Discovery conference landscape (which follows naturally from the fact that it also leads in terms of the total number of AI for Drug Discovery conferences and investors), we have seen a significant increase in the number of AI for Drug Discovery conferences located in the UK and EU.

30 Corporations Applying Advanced AI in Healthcare and Drug Discovery



Does 2018 Signal the Rise of China as a New Epicenter of AI for Drug Discovery Activity?

In terms of whether it is the USA, EU, UK or Asia region that comes out on top will remain to be seen. There are however, some factors that could play out to the advantage of the Asia region generally, and China in particular, in the coming years that may be worth noting. China currently is low on the list of the top countries competing in the Pharma industry. It falls significantly behind its Western competitors, due chiefly to the fact that it has focused on selling drugs that were innovated elsewhere, and lags behind in terms of actual pharma innovation. But, we have seen an influx of Chinese investors into life sciences industries over the past several years. For instance, The entry of Chinese investors into the broader biotech and drug industry landscape also mounted significantly in 2018, rising to \$1.4 billion into US-based biotech and drug firms compared to just \$125.5 million during the same period the previous year.

Furthermore, the Chinese government has recently shown significant interests in building up their AI industry, and in prioritizing AI in healthcare in particular. In an AI Strategic Plan released in July 2017, they outlined their intentions to catch up in the AI race by 2020, make major breakthroughs by 2025 and become a world leader in AI by 2030. But, in order to excel within the BioPharma industry they will need to reformulate their IP regulations, which are currently not tight enough to retain proprietary control over novel pharma innovations that they might develop in the coming years. There are two additional advantages that China could possibly use in the coming AI for Drug Discovery race. Firstly, they have shown success in generating a massive amount of real-time medical data from their enormous population of citizens, made possibly by their sheer population size, as well as their current flexible privacy laws. Since AI in general (and machine learning and deep learning in particular) feed on data, this could potentially be used to the nation's benefit. Secondly, they have the raw materials needed for the most scarce resource in the industry: namely, a large quantity of Data scientists and AI specialists. If the Chinese government were to commit substantial resources to the training of additional AI and data scientists, they could potentially grow to surpass their Western competitors over the next 3-5 years. In the West, players in the AI for Drug Discovery race will suffer a severe scarcity of AI specialists in the coming years because the majority of them have been acquired by the IT and Tech industry for other purposes. China has the potential to leapfrog this issue.

Could UK, EU or Asia Government Initiatives be the Key to Overtaking the US in the AI for Drug Discovery Race?

The US has led the AI for Drug Discovery race in terms of both total investments and the number of US-based companies focusing on AI for Drug Discovery. The USA is also home to the largest pharma corporations in the world, putting it in an excellent position to grow its AI for Drug Discovery industry if, as recent trends seem to indicate, the BioPharma industry continues to build up their internal AI for Drug Discovery resources and increase their number of AI for Drug Discovery startup acquisitions.

With that being said, there is also mounting interest in the AI for Drug Discovery sector from the EU, UK and Asia region as well. While the USA leads the pharma race generally, as we have discussed elsewhere in this and earlier reports, the AI for Drug Discovery sector is poised to become the central factor that will determine who is the winner of the drug discovery race in the years to come.

If the EU, UK or China proves more willing to grow their AI for Drug Discovery industry, especially through something akin to a national development strategy, whereby a significant amount of government funds are earmarked for such a purpose, then it is possible that the US could be overtaken in terms of its current leadership position in the pharmaceutical industry. It all depends on the actions and commitments taken by the US government, as well as by the current US-based leaders of the BioPharma Industry, and by US-based IT-corporations.

The Chinese government, for instance, does appear to be committed to prioritizing Artificial Intelligence industry. In an AI Strategic Plan released in July 2017, they outlined their intentions to catch up in the AI race by 2020, make major breakthroughs by 2025 and become the world leader in AI by 2030. In a parliamentary meeting held around the same time as the report's release, China science and technology minister Wan Gang noted that government finance will lead the way in AI research, including the development of supercomputers, and high performance semiconductor chips, software and the hiring of key talent to lead the field. If they remain true to their commitment, they could succeed in building up the necessary resources in order to dominate the AI for Drug Discovery space.

Could UK, EU or Asia-Pacific Government Initiatives be the Key to Overtaking the US in the AI for Drug Discovery Race?

The UK has also had a recent increase in governmental support for AI generally, as well as for AI in healthcare in particular. In April 2018, the UK government confirmed its commitment to keep up with other countries in the AI race through a very large government initiative worth £1 billion. Titled the AI Sector Deal, the deal between government and industry (involving over 50 leading UK tech companies) was announced by Business Secretary Greg Clark and Digital Secretary Matt Hancock, and will involve more than £300 million in new private sector investment, as well as 1000 new government-funded AI PhDs.

In a press release on the topic of the initiative, the UK government noted that "The deal will help establish the UK as a research hotspot, with measures to ensure the innovators and tech entrepreneurs of tomorrow are based in the UK, with investment in the high-level post-graduate skills needed to capitalise on technology's huge potential. It includes money for training for 8,000 specialist computer science teachers, 1,000 government-funded AI PhDs by 2025 and a commitment to develop a prestigious global Turing Fellowship programme to attract and retain the best research talent in AI to the UK."

This new initiative builds upon the commitment already made by the UK government in its Industrial Strategy and AI grand challenge, which put AI's use in healthcare at the forefront of their commitment. Coinciding with the recent £1 billion pact between industry and government to put the UK on the forefront of the global AI race, the government also commissioned an independent review to assess the need of NHS staff to be trained in AI in order to equip them with the skills required to keep abreast of the latest developments in healthcare. The review was announced in April 2018 by Jeremy Hunt, Secretary of State for Health and Social Care. UK Business Secretary Greg Clark recently announced £103m in funding for a new institute that will aim to utilize AI for Drug Discovery. The Rosalind Franklin institute will utilize AI to create new drugs, diagnostics and treatments. Founded as part of the UK's AI and Data Grand Challenge, it will be built upon the UK Government's modern Industrial Strategy and aim to keep the UK on the forefront of the pharma and life sciences industry. Remarkably and ambitiously, its stated aim is to "generate new drugs for clinical testing within a few weeks."

Conclusions

Generally speaking, our analysis has revealed the continuation and intensification of several trends identified in our previous report, AI for Drug Discovery & Advanced R&D Q1 2018, as well as the emergence of several new trends.

Namely:

- The US continues to lead investments in AI for Drug Discovery companies from a total-landscape perspective
- The UK remains the home of the highest-valuated Drug Discovery company, Benevolent AI, which recently raised an additional \$115 million at a \$2 billion valuation.
- The industry is seeing an increasing influx of investors from the Asia-Pacific region, and most particularly from China and Singapore. The Chinese IT-corporation Tencent, for instance, led a \$155 million round of funding was held by AI in healthcare company iCarbonX. Tencent also recently co-invested in a \$15 million round held by AI for Drug Discovery company XtalPi with Google and Sequoia China. Chinese IT-corporation Alibaba has also entered the AI for healthcare space with the launch of what they refer to as "ET Medical Brain", a platform that leverages Alibaba's formidable computational resources in order to generate new AI medical applications. In June 2018 prominent Chinese pharma company Wuxi AppTec invested in AI for Drug Discovery company Insilico Medicine alongside Pavilion Capital (a VC firm owned by the Singaporean government), as well as several Western VC firms including BOLD Capital Partners and Juvenescence Limited.
- 2018 has seen increased governmental support for AI in healthcare from both the UK and Chinese government. Large-scale government initiatives could prove to be the key for certain nations to overtake the US in the AI for Drug Discovery race.
- The general trend of IT & Tech corporations entering the AI for healthcare space continues to spread, previously applying most particularly to US-based entities, but now including prominent Chinese IT and Tech corporations, including Tencent and Alibaba.

Chapter III

Trends of Investment and M&A Deals

Investments and industry capitalization

2013-2015. During these years the first scalable AI approaches for Drug Discovery and Advanced R&D were developed and several industry players with forward-thinking executives started launching pilot collaborations and making small investments.

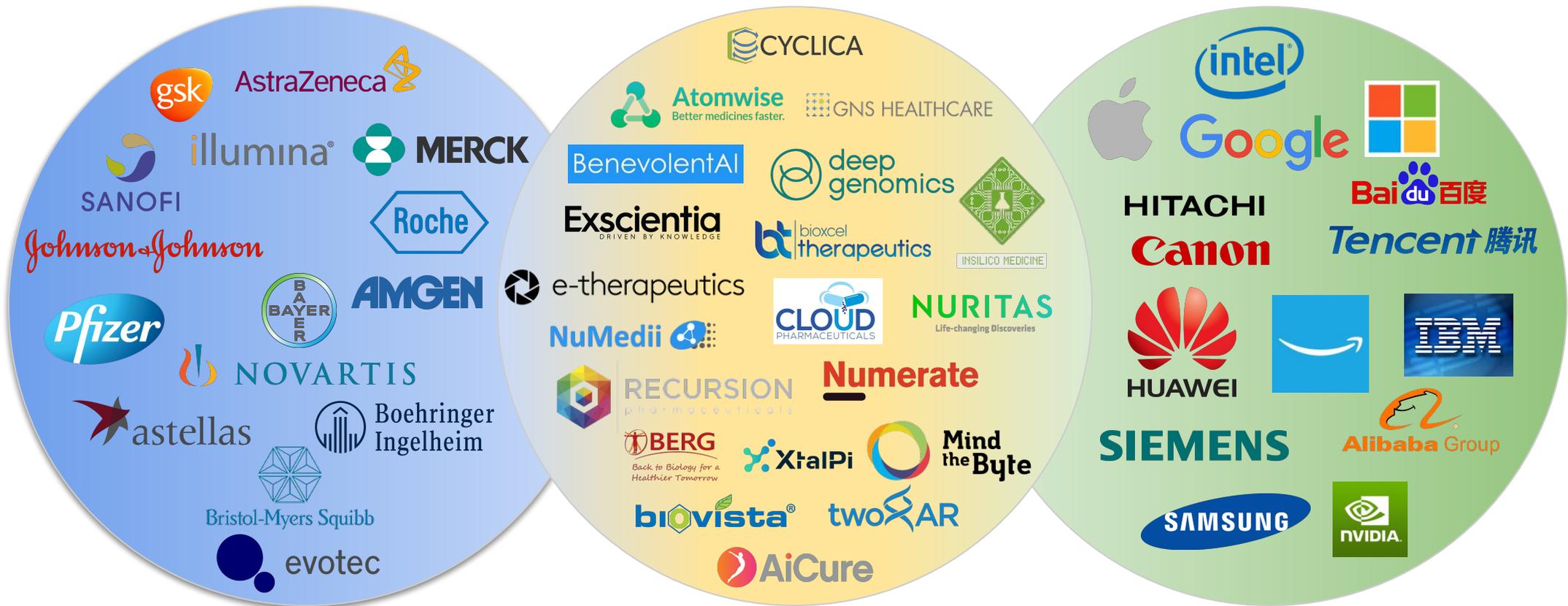
2016-2017. Because AI is still a young approach within the life sciences, many pilot projects failed, creating a lot of criticism towards the use of deep learning for Drug Discovery and Advanced R&D. Therefore, there were significant concerns regarding the scalability of such an approach, and whether they could deliver truly disruptive results, above and beyond traditional R&D departments in BioPharma. By the beginning of 2017 the first tangible results were achieved by a number of AI companies and new benchmark methods for the application of AI were established, and new collaborations between Pharma and AI startups yielded much better results. Since then the race for the acquisition of the best AI startups began.

2018. Now the capitalization of the industry is continuously growing. If there will be major breakthroughs, the growth leading up to 2020 could approach 20x or more. Over the next several years, we can expect to see VC firms and subsidiary funds focused exclusively on the AI for Drug Discovery subsector, and funds that invest in a maximally-diverse number of AI for Drug Discovery companies so as to bet on the entire subsector, in such a way as to tie the performance of the fund to the performance of the entire sector rather than any individual company.

Conclusions:

- 1. Diversification.** In 2015 and 2016, 26 and 22 investment rounds were conducted, and this number increased to 30 in 2017.
- 2. Increased amount of investments.** 2017 and 2018 showed significant growth of investments. Comparing to 2015 and 2016, when AI R&D startups raised \$231M and \$230M accordingly, 2017 showed significant growth to \$469M. The industry saw a total of \$455M in Q2 of 2018, compared to \$159M in Q1 2018. This is almost as much as was raised in all of 2017 combined (\$468M).
- 3. Consistency.** During 2013-2016 there was some growth in the amount of capital raised by the industry players, however the trend was not steady. In 2017-2018 we observed stable growth of the investments in the industry, an increase in the number of IT and Tech corporations entering the field, and active participation from traditional BioPharma corporations, largely in the form of joint ventures.

Leading IT and Tech Corporations / AI Companies / Pharma Corporations Advanced AI in Healthcare and Drug Discovery



Three Modes of Involvement

Investments in AI for Drug Discovery and R&D are growing. Moreover, at least 15 Big Pharma companies are onboarding AI for Drug Discovery technologies in different ways, either through the development of internal departments focusing on AI for Drug Discovery, through joint ventures with other more specialized companies, or through mergers and acquisitions, while at least 15 IT and Tech corporations are actively participating in the AI for Drug Discovery space at this point in time. Below, we have identified the three main modes through which these 30 corporations are active in the space: awards and grants, collaborations (joint ventures), and acquisitions (M&As).

Awards & Grants

Collaboration

Acquisitions

Awards & Grants

- **Johnson & Johnson** Innovation and Janssen Research & Development launched the Artificial Intelligence for Drug Discovery QuickFire Challenge. Johnson & Johnson Innovation will award up to \$100,000 in grants, one year of JLABS residency & mentorship to the individuals or teams who submit the best ideas, technologies, or solutions that are using artificial intelligence to advance healthcare.
- **Novartis** provides funding opportunities for innovative, high-risk projects that have the potential to open up novel research directions beyond incremental innovation and discovery. In this year's call, proposals in the field of AI will be accepted, namely: AI in Drug Discovery, AI in clinical development and medical practice, AI and the patient. Grants are for a period of 18 months. A maximum of 15 projects will be funded, depending on the quality of the proposals as judged by the review committee.
- **Merck**, a leading science and technology company, announced in 2017 recipients of €1 Million Grant at the fifth annual Grant for Multiple Sclerosis Innovation (GMSI) during the 7th JointECTRIMS-ACRIMS Meeting in Paris, France.

Collaborations

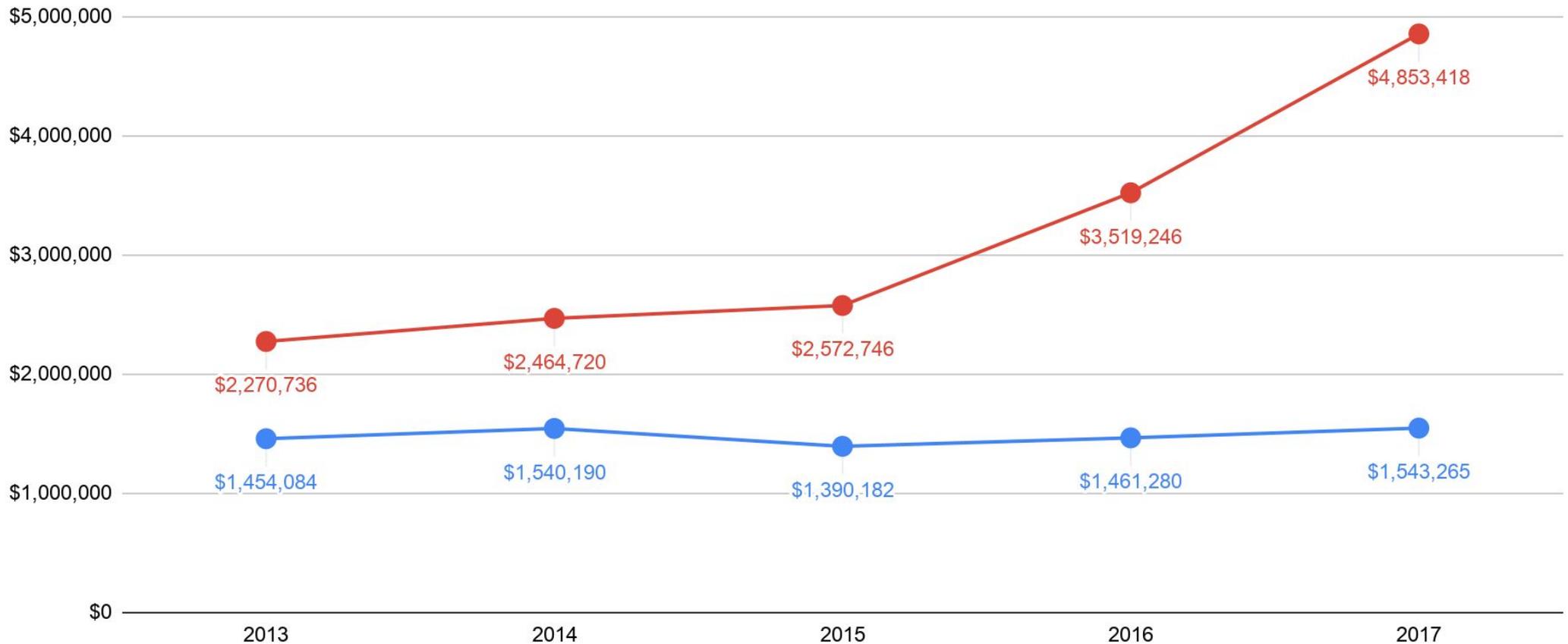
- **Genentech**, a member of the Roche Group, in the summer of 2017 announced their own collaboration with Cambridge, MA-based GNS Healthcare. GNS Healthcare's mission statement is to use the latest innovations in machine learning to turn biomedical data into solutions and treatments on cancer therapy.
- **Johnson & Johnson** and IBM announced in 2015 plans to collaborate around a new generation of intelligent virtual coaching solutions and applications designed to enhance the patient experience and deliver improved health outcomes.
- **Janssen Research & Development**, LLC, another organization in the Johnson & Johnson family of companies, has been working with WinterLight Labs and their speech-based AI platform to analyze Janssen's growing collection of speech data acquired from ongoing clinical trials.
- **Johnson & Johnson's** medical device company, **Ethicon**, is collaborating with Google on an initiative aiming to integrate big data analytics capabilities into a digital surgery platform.
- **Pfizer** in late 2016 announced a collaboration that will utilize IBM Watson for Drug Discovery. Pfizer is using IBM's AI technology for its immuno-oncology research, a strategy of using the body's immune system to help fight cancer.
- **GlaxoSmithKline** has invested \$43 million into Scottish artificial intelligence (AI) company Exscientia, which aims to use deep learning to develop new drugs. It also partnered with Insilico Medicine "after completing over 18 months of pilots". The terms were not disclosed.
- **AstraZeneca** teamed up in 2017 with US biology and technology company Berg to search for new drugs to treat Parkinson's Disease and other neurological disorders using artificial intelligence.
- **Sanofi** has signed a 250 million euro (\$273 million) research collaboration and licence option agreement in metabolic disease with Exscientia in 2017.

Sources: <https://www.techemergence.com/machine-learning-drug-discovery-applications-pfizer-roche-gsk/>

Acquisitions

- **Johnson & Johnson** Medical Devices Companies, through French affiliate Apsis S.A.S., announced in 2018 the acquisition of Orthotaxy, a privately-held developer of software-enabled surgery technologies, including a differentiated robotic-assisted surgery solution. This proprietary technology is currently in early-stage development for total and partial knee replacement, and the Johnson & Johnson Medical Devices Companies plan to broaden its application for a range of orthopaedic surgery procedures. Financial terms of the transaction were not disclosed.
- **Roche** in 2018 acquired Flatiron Health, developer of a cancer electronic health record software that collects and aggregates data from cancer patients, for \$2.1B.
- **Roche** acquired in 2017 Viewics Inc., a laboratory business analytics platform. Under the terms of the agreement, Roche is acquiring all shares of the company. Financial details of the acquisition were not disclosed.
- **Astrazeneca** acquired in 2013 AlphaCore Pharma, an Ann Arbor-based biotech company working on a drug to treat atherosclerosis through MedImmune (its the biologics division). The terms of the deal were not disclosed.
- **Astellas Pharma**, a Japanese pharmaceutical and biotechnology company, is acquiring in 2018 Seattle biotech Universal Cells. Astellas will pay up to \$102.5 million for Universal Cells in upfront and milestone payments, assuming the company hits certain benchmarks in developing its universal stem cell technology.
- **QIAGEN** announced in 2018 that they entered into an agreement to acquire STAT-Dx, a privately-held company developing the next generation of multiplex diagnostics for one-step, fully integrated molecular analysis of common syndromes using a novel system based on real-time PCR technology and proven QIAGEN chemistries.

Combined Capitalization of 15 IT & Tech Corporations vs 15 BioPharma Corporations In Millions of USD



As can be seen in the figure to the left, the combined capitalization of the 15 BioPharma corporations profiled in this report have remained on the same level for the past 5 years while the capitalization of the 15 IT & Tech corporations profiled in this report is growing significantly.

This can be considered as evidence that the BioPharma industry is stagnating in general, while the IT & Tech industry is progressing.

This is why it is so notable that the number of IT corporations has already matched the number of BioPharma corporations active in this subsector.

15 IT&Tech Corporations
15 BioPharma Corporations

Source: Deep Knowledge Analytics

IT & Tech Corporations Involvement in BioPharma

- In April 2017 **Amazon Web Services** and Merck announced a developer competition that plans to harness artificial intelligence for diabetics. Dubbed the Alexa Diabetes Challenge, and powered by Luminary Labs, the contest aims to incentivize startups and individual developers to create apps that harness Amazon's Alexa, particularly for patients recently diagnosed with Type 2 diabetes.
- In 2014 **Google** bought DeepMind, a British AI startup for around \$600 million. DeepMind's work is based on a solid grounding in neuroscience. Another DeepMind project involves a collaboration with London's Moorfields Eye Hospital. DeepMind has been given access to one million images from historical eye scans, along with associated patient data.
- In 2017 **IBM** developed machine learning models to analyze correlations between diseases and side effects commonly caused by the medications used to treat them. IBM also built an association engine to identify significant associations between predicted therapeutic indications and side effects, and a visual analytics system to support the interactive exploration of these associations.
- In September 2016 **Microsoft** announced a quartet of new initiatives focusing on using artificial intelligence in health care. One such initiative from Microsoft is to apply AI to radiology, using machine vision tools to analyze CT scans of tumors. Microsoft's Project Hanover is using ML technologies in multiple initiatives, including a collaboration with the Knight Cancer Institute to develop AI technology for cancer precision treatment, with a current focus on developing an approach to personalize drug combinations for Acute Myeloid Leukemia (AML).
- In March 2017 MedyMatch Technology, Ltd. and Samsung NeuroLogica Corporation, the healthcare subsidiary of **Samsung Electronics Co., Ltd.** announced a collaboration to integrate artificial intelligence clinical decision support applications with Samsung NeuroLogica's medical imaging hardware in the acute care marketplace. This collaboration aims to create support tools which provide a second read capability to help caregivers quickly and accurately assess patients in prehospital environments.

IT & Tech Corporations Involvement in BioPharma

- In April 2018 **NVIDIA** and **Canon Medical Systems** partnered to accelerate Deep Learning in healthcare. NVIDIA and Canon Medical Systems expect to make a significant contribution to promoting the use of data-intensive deep learning techniques in medical and related research, as well as to driving the uptake of AI in the healthcare sector. Canon Medical Systems will use NVIDIA DGX systems to process large volumes of medical data generated by Abierto VNA, the proprietary, in-house, medical data management system it launched in January.
- In July 2017 **Alibaba** announced that is charting a way to push the application of artificial intelligence (AI) in diagnostics and healthcare to make medical treatment more accessible, timely, and affordable. Alibaba Cloud is actively working on AI-powered solutions to tackle health care problems in China and globally. In March 2017 Alibaba Cloud launched ET Medical Brain, a suite of AI solutions designed to ease the workload of medical personnel. Alibaba Health also unveiled its first AI service for medical diagnostics called 'Doctor You,' which can use imaging in early diagnosis of cancer. Other projects include the partnership between Alibaba Cloud and Wuhan Landing Medical High-tech Co. on a system that leverages AI and visual computation technologies to detect early stage cervical cancer by using cell cytology. Alibaba Cloud is also working on a project to train machines to detect lung cancer using high-resolution CT scans.
- In February 2017 **Baidu** pushed further into the AI market with the acquisition of Raven Tech, a startup behind the 'Flow' digital assistant. Baidu is looking to use artificial intelligence algorithms for drug discovery technology so it can significantly shorten the duration of drug development.
- In February 2018 **Medopad** teamed up with Chinese tech giant **Tencent** to develop artificial intelligence-enabled clinical decision support software and medical chatbots. The partnership will combine Tencent's data assets and AI technology with Medopad's mobile apps. According to Forbes the collaboration gives Medopad access to the nearly 1 billion users of Tencent's WeChat messaging service.
- In March 2018 **Mitsubishi Tanabe Pharma** and **Hitachi** announced a partnership to use AI to more efficiently develop drugs. The aim of the collaboration is to use Hitachi's advanced digital technology, including AI, to shorten the development period for new drugs and reduce development costs, while reducing the possibility of expensive trial failures.

Chapter IV

BioPharma Corporations Onboarding AI for Drug Discovery

AI in BioPharma R&D: Pharma Companies Started to Close “The Big GAP”

- Biopharma budgets are significantly related to spending on R&D and failures in clinical trials, meanwhile the breakthroughs in applying AI for Drug Discovery will have dramatic impact on not just BioPharma companies but all biotech startups and biotech VC funds. All of them will be disrupted by AI for Drug Discovery.
- The major progress in these technologies is coming not from biotech side but from IT side.
- Due to the lack of AI specialists and promising AI & Drug Discovery startups, only a select few BioPharma players will emerge as the leaders of this trend.
- Meanwhile others, even with substantial budgets and the will to succeed in this area, will fail if they are even 1 year late to the race because all of the top AI specialists and AI in healthcare startups will have been acquired by then.
- The number of experts in the field of AI for Drug Discovery is insufficient to meet the demand of all big pharma companies, so only those few pharma companies and investors who will partner with the best AI for Drug Discovery companies in time will benefit from these collaborations and increase their capitalization accordingly.
- In the past six months a large number of deals and acquisitions are made between Big Pharma companies and AI startups.

BioPharma: The Road Forward

- Those Bio Pharma companies that will create strong AI for Drug Discovery divisions and that will succeed to acquire the best AI startups will become the leaders of the field as little as 3 to 5 years from now. Consider the acquisition of DeepMind by Google for \$0.5B in 2014. Those companies that will invest heavily in their AI for Drug Discovery departments will see their market capitalization skyrocket in coming years.
- Those Bio Pharma companies that do not accept AI will repeat the mistakes of Kodak, who were once the leader of their industry, but went to bankruptcy because they failed to embrace digital photography as the disruptive trend it was, even despite the fact that the digital camera was invented inside Kodak labs.
- If Bio Pharma would find the courage to spend 10% of their marketing budget on R&D in AI, they could blow IBM Watson out of the water by learning from their mistakes, reinventing themselves and coming one step closer to halting the looming threat of the Silver Tsunami. We see now that our forecasts in the previous version of the report were true. Big Pharma companies are now actively investing in and collaborating with the smaller companies from the AI for Advanced R&D industry.



Main Acquisitions & Collaborations Between Pharma Companies and AI Startups

1. **Pfizer** announced in late 2016 a collaboration that will utilize IBM Watson for Drug Discovery. Pfizer is using IBM's AI technology on its immuno-oncology research, a strategy of using a body's immune system to help fight cancer.
2. **Genentech**, a member of the Roche Group announced in the summer of 2017 their collaboration with Cambridge, MA-based GNS Healthcare. This collaboration's first focus will be on oncology. Genentech plans to use the GNS REFS™ (Reverse Engineering and Forward Simulation) causal machine learning and simulation platform to find and validate potential new drug candidates. They will also look for genetic patient response markers that could lead to targeted therapies.
3. One of the largest by drug discovery collaborations and strategic leasing agreements in 2017 was between pharmaceutical maker **Sanofi** and artificial intelligence driven drug discovery company Exscientia. Exscientia is responsible for inventing new potential drugs while Sanofi will be responsible for making them, testing them, and bringing them to clinical trial.
4. Exscientia signed a deal with pharmaceutical company **GlaxoSmithKline** in July 2017. The drug maker is employing Exscientia to discover novel and selective small molecules for up to 10 disease-related targets.
5. Last year BenevolentAI reached a deal to license potential drugs from **Johnson & Johnson**. BenevolentAI licensed the right to develop, manufacture and commercialize a select number of novel clinical stage drug candidates from Johnson & Johnson.
6. **AstraZeneca** announced this year a partnership with Alibaba to apply technology including artificial intelligence to patient diagnosis and treatment.
7. **Mitsubishi Tanabe Pharma** partnered in 2017 with Hitachi to optimize clinical trial planning with AI. The pair wants to utilize AI technology such as natural language processing and deep learning to automate the process. The approach can shorten the time spent on information search and collection by about 70%.

AbbVie: Partnerships with Atomwise and AiCure (September 2016)

While AbbVie has remained largely quiet about the specifics of its involvement in AI for Drug Discovery, it does have a confidential project with AtomWise. Atomwise was founded in 2012 and utilizes deep learning for drug discovery. They recently raised \$45 million series A funding led by Monsanto Growth Ventures, DCVC (Data Collective), and B Capital Group, and claims to screen 10 million small molecule drug candidates a day.

In 2016 the pharma corporation also partnered with AiCure to determine how its AI-based patient monitoring platform improved patient compliance and adherence in a phase 2 trial of one of its schizophrenia drugs. In a press release on the subject of the partnership, AiCure CEO Adam Hanina stated: "The ability to increase adherence to 90% in challenging patient populations over 6 months is a powerful demonstration of the value of the platform in clinical research and clinical practice. Typical adherence in patients with schizophrenia is 50%. This research adds to the growing body of scientific evidence showing the advantages of using artificial intelligence to increase statistical power and reduce sample size in clinical trials, thereby decreasing costs and accelerating drug development. Utilizing AiCure's proprietary platform, the accurate and clinically actionable data are setting a new gold standard in clinical research and clinical practice."



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AiCure announces new study results demonstrating 90% adherence from Phase 2 Abbvie study

Source:

<https://aicure.com/aicure-announces-new-study-results-demonstrating-90-adherence-phase-2-abbvie-study/>;
<https://www.atomwise.com/partners/>

abbvie



Bristol-Myers Squibb: Partnership with Sirenas (February 2018)

2018 also saw pharma corporation Bristol-Myers Squibb ink a deal with Sirenas, a machine learning company utilizing ML to discover microbiome-based therapeutics.

The deal involves utilizing Sirena's proprietary data mining technology (ATLANTIS) to identify drug candidates from among Sirena's microbiome-based chemical library.

In a press release associated with the announcement, Sirenas CEO Jake Beverage stated:

"We believe science-focused BioPharma companies can benefit from our innovative approaches to access breakthrough chemistry in delivering drug candidates for difficult biological targets. We look forward to a fruitful collaboration with Bristol-Myers Squibb, one of the finest drug discovery teams in the world, to identify potential new therapies to treat the world's highest unmet medical needs."

Phil Baran, Co-Founder of Sirenas added: "Sirenas has built a remarkably effective platform that combines powerful computational approaches, deep natural product expertise, and state of the art synthesis to rapidly deliver new drug candidates. We are committed to using computational approaches like ATLANTIS™ with our partners to uncover novel therapies from the profound chemistry hidden in the diversity of nature."



Source: <https://www.prnewswire.com/news-releases/sirenas-enters-into-multi-target-collaboration-with-bristol-myers-squibb-300596468.html>

Amgen: Partnership with Owkin & Involvement in MIT's Machine Learning for Pharmaceutical Discovery and Synthesis Consortium (May 2018)

Amgen was revealed in May 2018 to be a member of MIT's Machine Learning for Pharmaceutical Discovery and Synthesis Consortium.

As with many of the companies listed as members of the consortium, little is known about the specifics of their involvement, but it does signal that they have a vested interest in machine learning for drug discovery.

A later report the same month also announced a partnership between Amgen and medical machine learning company Owkin.

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MedTech

Amgen-partnered Owkin bags \$11M to scale AI platform

by Nick Paul Taylor | Jan 17, 2018 7:45am

MIT MLPDS

Machine Learning for Pharmaceutical Discovery and Synthesis Consortium

Source: <https://www.fiercebiotech.com/medtech/amgen-partnered-owkin-bags-11m-to-scale-ai-platform>

AMGEN



Artificial Intelligence for Predictive Medicine

Amgen: Partnership with Owkin & Involvement in MIT's Machine Learning for Pharmaceutical Discovery and Synthesis Consortium

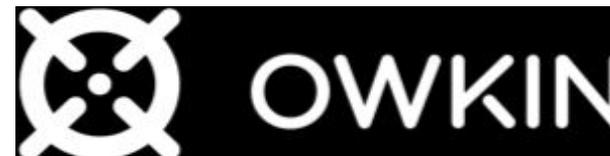
Pharma Corporation AstraZeneca and Berg Health, a company that "merges biology with technology to map the nature of diseases", announced in late 2017 a partnership to discovery novel therapeutic targets for neurological diseases.

In Q1 of 2018, AstraZeneca also announced a partnership with Ali Health, a healthcare subsidiary of Alibaba, to apply Alibaba's formidable AI resources to patient diagnosis and treatment.

The announcement revealed few details on the partnership, but state that it aims to "deliver new smart health services driven by the Internet and artificial intelligence to help patients find and stay on the right medicines."



A 2018 press release on Google Ventures' recent investment into medical machine learning startup Owkin mentioned pharma company Ipsen among its big pharma partnerships (alongside Amgen and Roche), but very little has been disclosed about the partnership. Nonetheless, it does show that an increasing number of big pharma companies are putting their money where their mouths are in relation to the disruptive impact that AI for Drug Discovery is posed to make upon their industry, albeit without disclosing too many details.



Source: <https://www.reuters.com/article/us-astrazeneca-ai-berg-idUSKCN1B81G1>

Astellas: Partnerships with Biovista (2015) and Numedii (2016)

Astellas also seems to have its eyes in using AI for drug repurposing.

The company announced a partnership with Biovista around drug repurposing in 2016, and in 2015 announced a similar repurposing partnership with NuMedii, a company that applied Big Data analysis to life sciences research.

In a press release on their partnership with Biovista, Biovista president Aris Persidis stated: “We look forward to working with the Drug Repurposing and Application Management at Astellas to compliment their work. Our very large scale systematic drug repositioning technology (the Clinical Outcome Search Space – COSS(tm) offers the advantages of speed, comprehensiveness and depth of clinical outcome exploration, which we hope will help patients in need benefit even more from Astellas drugs.”

In a press release on the partnership with Numedii, NuMedii's CTO Asim Siddiqui stated: "NuMedii's predictive Big Data intelligence technology enables the discovery of new uses for both marketed drugs and shelved development assets across a number of therapeutic areas. We are excited to partner with Astellas to explore new indications for a number of their assets which we hope will be of benefit to patients in need and the physicians who treat them."



Source: <https://www.fiercebiotech.com/r-d/astellas-hooks-up-numedii-to-continue-drug-repurposing-deal-drive>

Bayer AG Eyes AI via its LifeScience iHub & MIT's Machine Learning for Pharmaceutical Discovery and Synthesis

Pharma corporation Bayer AG also seems to have its eyes on AI for Drug Discovery, though specific details are not yet clear. MIT announced that Bayer was part of its Machine Learning for Pharmaceutical Discovery and Synthesis Consortium.

Bayer also has a department called LifeScience iHUB, led by Bayer VP of Digital Innovation Dirk Schapeler, which aims to "forge collaborations between tech companies and Bayer to find uses for innovative sensors, AI/machine learning and digital apps for human health, animal health and agriculture."

It has also shown interest in funding artificial intelligence programmes through its digital accelerator, Grants4Apps. In a March 2018 article in PMLive, Dieter Weinand, president of Bayer Pharma, stated that Bayer has high hopes for AI, and has already collaborated with Verily (a life sciences subsidiary of Alphabet), as well as IBM Watson and Deep Blue.

Bayer Life Science iHub in the heart of Silicon Valley...
... explores new Life Science applications



LifeScience iHub

► **Mission:** Leverage digital technologies to support the Bayer core business



► **iHub competencies**

- Sensors
- Machine Learning
- App development
- Business Model Innovation

► **Example initiatives**

- Develop and test new technologies for **remote patient monitoring** during clinical trials
- Speed up **patient acquisition/recruitment** during clinical trials
- Discover market insights using **advanced data analytics and machine learning**
- Explore **anti-counterfeiting** solutions in Crop Science and Pharma using digital technology

Page 6 - Janssen-Fachbereich - Bayer AG - Juni 2016

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Source: http://www.pmlive.com/blogs/digital_intelligence/archive/2018/march/bayer_looks_to_leverage_ai_across_the_pharma_value_chain

Bayer AG Eyes AI via its LifeScience iHub & MIT's Machine Learning for Pharmaceutical Discovery and Synthesis

"We're looking into all these areas across the entire value chain, from R&D all the way to commercial. I believe that artificial intelligence will make a huge difference with analytics - I can envision modelling of clinical trials in outcomes with artificial intelligence that would allow you therefore to significantly more focus your clinical trials, make them smaller, faster and less costly. I can see artificial intelligence in diagnosis. IBM Watson has a 90% correct diagnosis of lung cancer and the best [clinicians] in the world have 50%, so you can see that artificial intelligence, computer-aided diagnosis will significantly enhance outcomes."

- Dieter Weinand, President, Bayer AG

Source:

http://www.pmlive.com/blogs/digital_intelligence/archive/2018/march/bayer_looks_to_leverage_ai_across_the_pharma_value_chain



Boehringer Ingelheim: 2011 Partnership with Numerate and 2018 Partnership with Bactevo; Bayer AG Eyes AI via its LifeScience iHub & MIT's Machine Learning for Pharmaceutical Discovery and Synthesis

Boehringer Ingelheim is one pharma company that has had AI for Drug Discovery on its radar for perhaps longer than any other pharma corporation. In 2011, Boehringer's Canadian arm announced a partnership with Numerate to leverage "the power of cloud computing and novel computational methods to transform the drug design process," utilizing Numerate's "proprietary in silico drug design technology to generate novel small molecule drug leads for an undisclosed infectious disease target."

In a press release, Numerate CEO Guido Lanza stated that "Using our large-scale computational drug design methods, we expect to greatly reduce the time and cost of delivering new lead-stage, small molecule drug candidates in this important program for Boehringer Ingelheim. This collaboration is the latest in our growing number of partnerships with pharmaceutical companies that are looking to Numerate's comprehensive in silico drug design technology to help them increase their success rate in generating novel, patentable small molecule leads."

And in May of 2018, the company announced a partnership with Bactevo to utilize its Totally Integrated Medicines Engine platform (TIME) in combination with synthetic chemistry technology to "further enhance speed, efficiency and quality when detecting novel in vivo enabled leads." In an associated press release, David Williams, CEO of Bactevo, stated that "We are pleased to be commencing this highly complementary collaboration with Boehringer Ingelheim. It combines our cutting-edge TIME drug discovery platform with the powerful therapeutic drug development and commercialisation experience at Boehringer Ingelheim to create much needed new medicines in areas outside of our current therapeutic focus."



Source: <http://www.numerate.com/numerate-boehringer-ingelheim-canada-form-drug-discovery-collaboration/>

Evotec: Partnerships with Bayer, Sanofi, Janssen, Sanofi, Genentech & UBC

Evotec is a "drug discovery alliance and development partnership company" that has disclosed partnerships with Bayer, Sanofi, Genentech, Janssen, and UCB. It also appears to have a strong partnership with Excentia, announcing first an initial collaboration in April 2016 and then an investment in 2017, both of which focus upon generating small molecule immuno-oncology drugs that are bispecific -- that is, which can target two distinct cancer targets simultaneously.

Genentech also announced a partnership with precision medicine company GNS Healthcare (a member of the Roche Group) in June 2017 a collaboration with Genentech to "leverage GNS REFS™ (Reverse Engineering and Forward Simulation) causal machine learning and simulation platform to power the development of novel cancer therapies."

In a press release associated with the partnership, Iya Khalil, CCO of GNS Healthcare, stated "As the race to match patients with the right therapies continues, pharmaceutical companies are looking for innovative approaches to harness the unprecedented volume of data at their fingertips. We are excited to partner with Genentech to apply GNS' breakthrough REFS™ causal machine learning and simulation platform to illuminate the underlying drivers of disease, stratify patients more accurately, and accelerate the development of novel therapies to treat cancer."



Source: <http://www.gnshealthcare.com/news/gns-healthcare-announces-collaboration-to-power-cancer-drug-development/>;
<http://www.gnshealthcare.com/news/gns-healthcare-announces-collaboration-to-power-cancer-drug-development/>;
<https://www.businesswire.com/news/home/20180508006891/en/Evotec-Reports-Quarter-2018-Results-Corporate-Update>

GlaxoSmithKline: In-House AI for Drug Discovery Unit (July 2017) & Partnerships with Multiple AI for DD Startups

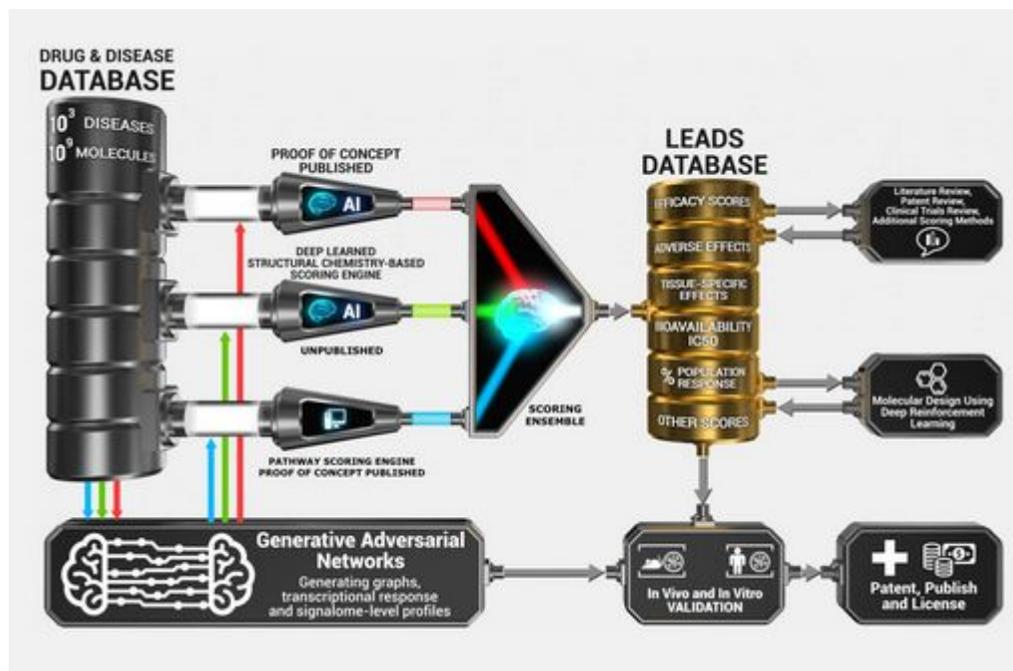
GSK, as our earlier reports would indicate, appears to be the most active pharma corporation in the realm of AI for Drug Discovery. Unlike many other Pharma corporations, which have focused on specific partnerships and collaboration with AI and/or AI for Drug Discovery companies, GSK actually created its own in-house AI unit (initially titled "Medicines Discovered Using Artificial intelligence", but now titled "In silico Drug Discovery Unit.") Besides this development, it has also announced partnerships with AI for Drug Discovery companies.

"Exscientia will apply its AI enabled platform and combine this with the expertise of GSK, in order to discover novel and selective small molecules for up to 10 disease-related targets, nominated by GSK across multiple therapeutic areas. In addition to research funding, Exscientia is eligible to receive near-term lead and preclinical candidate milestones if all objectives are achieved. The total amount payable by GSK to Exscientia on achieving these milestones is £33 million, if all 10 projects are advanced."

In an associated press release, CEO of Excentia stated: "This agreement with GSK is the second we have signed in recent months with a top global pharma company. The alliance provides further validation of our AI-driven platform and its potential to accelerate the discovery of novel, high-quality drug candidates. Applying our approach to client discovery projects has already delivered candidate-quality molecules in roughly one-quarter of the time, and at one-quarter of the cost of traditional approaches. Our intention therefore is to apply these capabilities to projects selected by GSK. Delivering efficiencies to drug discovery has the potential to revolutionise the way early projects are executed, enabling more dynamic target selections from the burgeoning set of opportunities. We look forward to a productive collaboration with GSK." Meanwhile, John Baldoni (Senior Vice President, Platform Science and Technology at GSK) added: "Exscientia has built an excellent team with proven innovation in drug discovery technologies. We anticipate that their industry-leading approach will accelerate the discovery of new molecules against high value GSK targets with speed and confidence, and without compromising quality."

GSK: Partnership with Insilico Medicine

GSK also announced a August 2017 partnership with Insilico Medicine, starting with GSK evaluating Insilico's proprietary technology for identifying novel biological targets and pathways of interest. In an associated press release John Baldoni, Senior Vice President, Platform Technology Sciences at GSK, stated: "We are delighted to be working with the Insilico team, as they have exhibited curiosity, agility and AI expertise that we value. GSK recently established a drug discovery unit to explore how this rapidly developing field might drive drug discovery at a higher velocity, with greater precision and at a reduced cost. The collaboration with Insilico represents one of several approaches we are exploring to take advantage of emerging technology that might make us more effective and efficient, always keeping in mind the patients who need new medicines."



Source: https://www.eurekalert.org/pub_releases/2017-08/imi-iec081417.php

GSK: Partnership with Cloud Pharmaceuticals

And in May 2018, GSK announced a partnership with Cloud Pharmaceuticals to use AI to design novel small-molecule agents for GSK-specified targets.

In an associated press release, Ed Addison, CEO of Cloud Pharmaceuticals, stated: “Application of Cloud Pharmaceuticals technology has been proven to dramatically shorten the time from target validation to lead molecule. We believe this agreement validates the strength of this process and reinforces the value we can offer accelerate the discovery of novel, high-quality drug candidates.” In the same release, Cloud Pharmaceuticals COO, Don Van Dyke, added: “It is estimated that the traditional discovery process to arrive at a clinical candidate molecule takes greater than 5 years. Cloud has consistently been able to reduce that to a matter of a few months.”

In addition to both its in-house AI for Drug Discovery unit, and three partnerships with leading AI for Drug Discovery companies, GSK is also a part of the Accelerating Therapeutics for Opportunities in Medicine (ATOM) Consortium, which has the ambitious aim to leverage AI for Drug Discovery so as to reduce the timeline from drug target identification to a clinic-ready drug to less than a year. Their involvement with ATOM involves providing ATOM with chemical and in vitro biological data for more than 2 million compounds that GSK has screened.



Source: <https://www.businesswire.com/news/home/20180530006184/en/Cloud-Pharmaceuticals-forms-Drug-Design-Collaboration-GSK>

Jon Baldoni on the Power of AI for Drug Discovery at GSK

"I began realizing that pharma is using a model that was becoming increasingly dated. I guess at this point in my career, it's like, what do you have to lose? Let's be curious, let's be courageous, and have a discourse about it. Go where it looks like there will be breakthroughs. To serve patients better. It's really important, I think, that our industry be strong. Because if it isn't strong, if it's weakened, then these diseases that have been the scourges of humanity, they're not going to go away."



- **John Baldoni, Senior Vice President of Platform Science and Technology at GSK**

Janssen: Partnership with BenevolentAI

In November 2016, Janssen announced a partnership with BenevolentAI to utilize BenevolentAI's AI for Drug Discovery technology to identify drug candidates with untapped potential from Janssen's existing portfolio. The partnership allows BenevolentAI to licence the right to develop, manufacture and commercialize clinical stage drug candidates from Janssen's portfolio.

More recently, BenevolentAI launched a phase 2b trial for a drug derived from the partnership to treat sleep-related symptoms in patients with Parkinson's disease, which could be an indication that the partnership is already starting to deliver practical, actionable, clinical-grade results.

In a press release associated with the partnership announcement, Jackie Hunter, Board Director of BenevolentAI and CEO of BenevolentAI Bio, stated:

“We are delighted to have acquired rights to these compounds under a license agreement from Janssen. The agreement adds further depth to our clinical and pre-clinical development pipeline and marks a very exciting time for the role of artificial intelligence to benefit scientific discovery and humanity. The compounds come with a wealth of clinical and biological data that enables BenevolentAI to have further insights into the biology of diseases. Securing these novel clinical drug candidates perfectly aligns with our strategy of developing first-in-class and best-in-class stratified medicines to help patients with high unmet needs.”

BenevolentAI

Roche Partnership with Owkin (May 2018); Lilly Announced as Member of MIT's Machine Learning for Pharmaceutical Discovery and Synthesis Consortium (May 2018)

A May 2018 announcement revealed that Roche has a stealthy partnership in the works with Owkin, an AI for Drug Discovery startup that appears to have established partnerships with numerous other Big Pharma corporations.

Neither company has yet revealed any specific details regarding the partnership.

Lilly is another pharma corporation with ambiguous publicly-disclosed interests in AI for Drug Discovery, but on which very little concrete details can be found.

IN May 2018, MIT announced that Lilly was a member of its Machine Learning for Pharmaceutical Discovery and Synthesis Consortium, but the actual details and fruits of the consortium are scarce at this point.



Machine Learning for Pharmaceutical Discovery and Synthesis Consortium

Merck: Partnerships with Numerate (March 2012) and Atomwise (2017)

Pharma corporation Merck has thus far disclosed two partnerships with AI for Drug Discovery companies.

It announced an early partnership with Numerate in March 2012 focusing on the generation of small molecule drug leads for an unspecified cardiovascular disease target.

In a press release associated with the announcement, Guido Lanza, CEO of Numerate, stated:

“We are pleased to add Merck, a recognized leader in drug discovery innovation, to our growing number of pharmaceutical collaborators. This collaboration is focused on increasing the speed, cost-efficiency and likelihood of generating new small molecule drug leads through the use of our large-scale computational drug design methods.”

Additionally, it also has a confidential project with Atomwise, who listed Merck as one of their partners in 2017. No details regarding the partnership’s details or focus have yet been disclosed formally, although one Wall Street Journal article did suggest that Merck is tapping into Atomwise’s deep learning algorithms in order to identify new drugs for neurological conditions.



Source: <http://www.numerate.com/numerate-forms-drug-discovery-collaboration-merck-utilize-numerates-silico-drug-design-technology/>;
<https://venturebeat.com/2017/04/19/atomwise-launches-research-program-to-accelerate-drug-discovery-with-ai/>

Nestlé: Partnerships with Insilico Medicine (November 2016) & Nutritas (February 2018)

While not a pharma corporation per se, Nestlé is nonetheless a large multinational corporation with deep pockets and a life science division.

Nestlé scientists have also published with AI for Drug Discovery company Insilico Medicine (along with co-authors from BioTime, Novartis and others) on Insilico Medicine's in silico Pathway Activation Network Decomposition Analysis (iPANDA) technology for novel biomarker development, which the company uses for "biologically-relevant dimensionality reduction when training the deep neural networks to predict the various pharmacological properties of molecules and developing biomarkers using highly-variable, sparse and highly-dimensional gene expression data".

Meanwhile, in February 2018, the company announced a partnership with Nutritas to utilize AI to discover therapeutic peptides in foods. In a press release on the announcement, Nora Khaldi, Founder and Chief Scientific Officer of Nutritas, stated: "At Nutritas our mission is to positively impact billions of lives worldwide and we therefore are delighted to be collaborating with Nestlé, the world's largest food and beverage company on such an important project. We are really looking forward to beginning this impactful journey together".

In the same press release, Richard Stadler, Head of Food Safety and Analytical Science at the Nestlé Research Centre added: "As our understanding of food and nutrition continues to grow, our global research and development network is looking ahead to discover how we can help enhance quality of life and contribute to a healthier future for everyone. Research partnerships such as that with Nutritas help us achieve that goal."



Source: https://www.eurekalert.org/pub_releases/2016-09/imi-imt090116.php

Novartis: Plans to Develop In-House AI for Drug Discovery Resources (June 2018)

In September 2017, Novartis CEO Vas Narasimhan announced his plans to partner with or acquire an undisclosed AI and data analytics company. And in June of 2018, in an interview with Business Insider, Jay Bradner (president of Novartis Institutes for BioMedical Research (NIBR) stated that 4% of NIBR's 6000 scientists are data scientists.



Our Company

Our Focus

Our Scier

Machine learning poised to accelerate drug discovery

Technology used to tag friends on social media could change the way drug discovery is done.

By Charlie Schmidt | May 07, 2018

Learn how Novartis is using #machinelearning to accelerate #drugdiscovery.

Source: <https://www.ft.com/content/5ab8ba6e-9c7a-11e7-9a86-4d5a475ba4c5>;
<https://www.businessinsider.com/novartis-jay-bradner-on-silicon-valley-intersecting-with-pharma-2018-6>

Novartis: Partnerships with QuantumBlack & IBM Watson (January 2018)

In a January 2018 article, it was revealed that Novartis had announced a partnership with McKinsey's QuantumBlack to utilize machine learning in order to analyze clinical trial operations -- an endeavor which they stated has reduced patient enrolment times by 10-15%.

They also announced a partnership with IBM Watson in March 2018 to optimize clinical trial recruitment and to use what they referred to as a "digital cortex" to predict medication efficacy.

In May 2018, MIT also announced that Novartis was a member of its Machine Learning for Pharmaceutical Discovery and Synthesis Consortium, the details of which are sparse and as-yet undisclosed (as with the large majority of the consortium's publicly-disclosed partners).

IBM Watson Health



Source: <https://www.bloomberg.com/news/articles/2018-03-15/novartis-ceo-turns-to-tech-formula-in-race-for-blockbusters>;
<https://www.novartis.com/news/media-releases/novartis-announces-ground-breaking-collaboration-ibm-watson-health-outcomes>

Pfizer: Immuno-Oncology related AI for Drug Discovery Partnership with IBM Watson Health (2016)

Pfizer was involved in a 2016 partnership with IBM Watson relating to drug discovery applied to novel immuno-oncology therapies. However, no concrete results as a result of that partnership has been announced to date.

In a press release associated with the partnership, Mikael Dolsten, President of Pfizer Worldwide Research & Development, stated: "Pfizer remains committed to staying at the forefront of immuno-oncology research. With the incredible volume of data and literature available in this complex field, we believe that tapping into advanced technologies can help our scientific experts more rapidly identify novel combinations of immune-modulating agents. We are hopeful that by leveraging Watson's cognitive capabilities in our drug discovery efforts, we will be able to bring promising new immuno-oncology therapeutics to patients more quickly."

In the same release, Lauren O'Donnell, Vice President of Life Sciences at IBM Watson Health, added: "We believe that the next great medical innovations will emerge as researchers and scientists find new patterns in existing bodies of knowledge. In order to do this, they need access to R&D tools that can help them efficiently navigate the opportunities and challenges presented by the explosion of data globally. IBM is honored to collaborate with Pfizer, and put Watson for Drug Discovery to work to support efforts in bringing life-saving immunotherapies to doctors and patients worldwide."



IBM Watson Health™

Source: https://www.pfizer.com/news/press-release/press-release-detail/ibm_and_pfizer_to_accelerate_immuno_oncology_research_with_watson_for_drug_discovery

Pfizer: Partnership with XtalPi for Machine Learning and Quantum Mechanics for Drug Discovery (May 2018)

In May 2018, Pfizer announced a partnership with XtalPi to develop an "artificial intelligence-powered platform to model small-molecule drugs as part of its discovery and development efforts."

The partnership combined quantum mechanics and machine learning to predict pharmaceutical properties of candidate compounds. The two companies are currently collaborating on crystal structure prediction and screening to optimize the process of drug design and solid-form selection.

In a press release associated with the announcement Shuhao Wen, XtalPi's co-founder and chairman of the board, stated:

"The collaboration allows us to apply our expertise in molecular modeling, AI, and cloud computing towards improving existing computational methods while exploring new algorithms to address a wide range of drug design challenges.



Source:

<https://www.prnewswire.com/news-releases/xtalpi-inc-announces-strategic-research-collaboration-with-pfizer-inc-to-develop-artificial-intelligence-powered-molecular-modeling-technology-for-drug-discovery-300644351.html>

Pfizer: Launch of In-House AI Analytics Platform (May 2018)

Pfizer also appears to be developing its own AI analytics platform, which may signal that it is gearing up to, like a select few other Pharma corporations, begin committing internal resources and in-house staff to the AI for Drug Discovery race.

A recent Wall Street Journal article, which appeared in May of 2018, stated: "Pfizer Inc.'s recently-built analytics platform is helping employees from different divisions within the company collaborate in an effort to identify patients with rare diseases that might previously have gone undiagnosed, company executives said. With the help of machine-learning algorithms, the analytics platform is now yielding new insights that were previously difficult to identify in a short amount of time because there too many disparate datasets to sift through. The cloud-based Virtual Analytics Workbench tool officially launched in 2017 and more than 350 employees are using it including mainly data analysts and research and development teams. The goal is to scale it more broadly across different departments."

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Seeking Insights into Rare Diseases, Pfizer Scales AI Analytics Platform

Data science shouldn't be confined to mathematicians, says CIO Jeff Keisling

Source: <https://blogs.wsj.com/cio/2018/05/09/seeking-insights-into-rare-diseases-pfizer-scales-ai-analytics-platform/>

Pfizer: Involvement with \$1.4 billion Government Initiative to Boost the UK's AI Industry (April 2018)

An April 2018 release also indicated that Pfizer was involved in a UK-based initiative that would increase government funding for UK AI initiatives.

The specific context in which Pfizer would be participating, however, remains unclear and undisclosed.

Nonetheless, when coupled with Pfizer's historical and recent partnerships with AI for Drug Discovery companies, and the recent launch of its own in-house AI analytics platform, could signal that Pfizer is indeed gearing up to join a select few other Big Pharma corporations in committing its own internal resources to the AI for Drug Discovery race.

Q Search

Bloomberg

Technology

U.K. Unveils \$1.4 Billion Drive Into Artificial Intelligence

By [Jeremy Kahn](#) and [Alex Morales](#)

April 25, 2018, 7:00 PM EDT *Updated on April 26, 2018, 1:29 PM EDT*

- ▶ Ministers announce 300 million pounds of new expenditure
- ▶ Sector deal is fourth under May's flagship industrial strategy

Source: <https://www.bloomberg.com/news/articles/2018-04-25/u-k-announces-1-4-billion-drive-into-artificial-intelligence>

AI in Drug Discovery Survey

AI for Drug Discovery company BenchSci recently conducted a survey among 330 scientists working in the area of drug discovery and drug development, to determine the extent with which their institutions currently use or plan to incorporate AI into their drug discovery efforts. Their results appear to show that:

- The use of AI for Drug Discovery may be on the horizon for more pharma companies than previously expected.
- Lack of education and understanding of AI is one of the foremost barriers for institutional adoption.
- Nearly half of respondents expected their institutions use of AI to stay the same, while 38% expected it to increase, and 16% expected it to increase substantially.

When asked about the specific activities that their companies and institutions utilize AI for, 40% said that they use AI for target identification and validation, 34% for safety tests, 29% for compound discover, 25% for lead optimization, and 21% for preclinical studies. The survey also analyzed the perceived vs real benefits of applying AI to drug discovery, finding the following use-cases had differences in the real vs. perceived level of benefits:

- increasing speed of drug discovery: 44% real benefits, 61% perceived benefits
- increasing research comprehensiveness: 32% real benefits, 46% perceived benefits
- increasing opportunities for existing compounds: 25% real benefits, 45% perceived benefits
- increasing novelty of targets and compounds: 28% real benefits, 45% perceived benefits
- decreasing cost of drug discovery: 22% real benefits, 41% perceived benefits
- decreasing experimental failure: 18% real benefits, 29% perceived benefits

When asked about the biggest barriers preventing broader adoption of AI for Drug Discovery in the pharma industry, 62% selected lack of knowledge and expertise, 43% selected prohibitive cost, 42% selected lack of knowledge regarding available companies and tools, and 28% selected lack of relevant case studies at their particular organization.

Source: <https://blog.benchsci.com/6-things-we-learned-about-artificial-intelligence-in-drug-discovery-from-330-scientists>

Conclusion

Thus, we are seeing a vast increase in the number of pharma corporations who are entering the AI for Drug Discovery space, either through the development of in-house AI departments and resources (as in the case of GSK most prominently, as well as Pfizer), or through M&As.

Meanwhile, it is very possible that more activity is going on in this sphere among the boardrooms of large pharma companies without having publicly-available indication of such a situation. Pharma companies do not typically announce what new activities and plans they have on the horizon prior to the official launch of a new in-house unit or project, for example.

In a recent Forbes article Simon Smith, Chief Growth Officer at BenchSci, noted that “It's possible we'll see it in 2018. Most companies plan to expand the use of AI for Drug Discovery this year. Fifty-nine percent of scientists told us their organization will do so, and 94% told Pistoia they'll increase use of machine learning within two years.” If this proves true, then it is likely that a larger number of pharma companies will be on-boarding AI into their operations over the next several years than we have concrete publicly-available indication of through the announcement of new projects, departments, investments and M&As.

The pharma industry is a typically-bureaucratic industry resistant to change, and one that is somewhat more conservative than other industries, and less willing to try what might seem like “untested” and “non-validated” technologies given the tremendous 99% failure rate that they experience even with methods that have been tried and true for decades, and which brought the world's biggest blockbuster drugs to market.

Nonetheless, they seem to be taking note of the paradigm shift already visible on the horizon. They face an up-hill battle against the advantages held by IT and Tech corporations venturing into the AI for Drug Discovery space, what with their possession of the scarcity of resources in the industry - namely, AI specialists and IP - but with enough will and commitment, they could emerge to win the race in the years to come, and retain their positions as the leaders of the pharma industry.

Chapter V

IT & Tech Corporations Entering the AI for Drug Discovery Space

Tech Corporations and Drug Discovery

Tech Corporations are more flexible with new technologies, moreover their revenue depends on cutting edge technologies, which they are using and implementing in their products. AI and machine learning technologies became a part of their technologies. These technologies are used in advanced R&D and drug discovery. In our opinion using advanced technologies by Tech Corporations give them a huge advantage over BioPharma companies on drug discovery.

The interest and application of AI is relatively faster in healthcare and life sciences are many tech corporations like Google, Apple, IBM, Qualcomm, AT&T, GE, Amazon, and Microsoft have shown interest by investing, acquisitions and partnering with life sciences companies in this space. In the life sciences sector, an enormous amount of data has been generated and the big data is getting bigger and bigger by minute from omics, biomarker research, drug discovery, clinical trials, smart pills and devices, manufacturing supply chain sensors, patient data and from commercial functions.

AI & Machine Learning are universal and can be used in various industries, and drug discovery is not an exemption.

Tech Corporations are more flexible than BioPharma companies, they do have much more capabilities to implement new technologies in advanced R&D and drug discovery sectors. The future of the BioTech sector may lie on their shoulders.

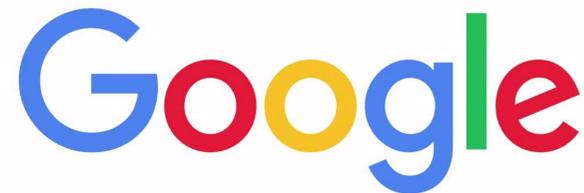
Additionally, companies like Facebook, Google and Amazon have other advantages, these companies do have access to billions of customers worldwide, who can be monitored and researched. Based on this information and developed biomarkers, the industry of drug discovery will make a step forward and would be more precise than ever.

In this section 10 Tech Corporations and their involvement in advanced R&D and drug discovery were analysed. It's important to mention that every and each company has its own vision and the level of involvement differs from one company to another, however, overall, IT Corporations are interested in advanced R&D and drug discovery sector.

Google, Apple, Alibaba and Amazon

Google - according to an article in Nature outlining the field, the firm's deep learning project, Google Brain, is growing its biosciences team, and industry watchers wouldn't be surprised to see them target drug discovery. Now, Google Brain is focused on 4 directions: Artificial-intelligence-devised encryption system; Image enhancement; Google Translate; Robotics. However, in a nearest future AI technologies which were developed by Google Brain can be applied to drug discovery industry.

Alibaba has a special division called **The ET Medical Brain**. It is a suite of AI solutions designed to ease the workload of medical personnel by using computers to act as virtual assistants for patients and in medical imaging, drug development and hospital management. Healthcare requires huge quantities of data to be processed from different sources. "AI allows computers to play a significant role in assisting decision-making, freeing medical personnel from complex repetitive tasks to focus on delivering quality care to patients," according to Alibaba Cloud. The company has focused some of their efforts on AI systems that can detect certain types of early stage cancers. Alibaba Health developed a diagnostic tool that uses imaging to make early diagnoses, while Alibaba Cloud is leveraging AI and visual computation technologies to detect cervical cancer and training machines to find lung cancer using high-resolution CT scans. Recently, Alibaba teamed up with AstraZeneca to help expand the drug maker's market in China. Alibaba and AstraZeneca will work together to deliver smart health services driven by the Internet and AI. With these developments, it's clear that China's tech industry sees AI as a real solution to improve the country's healthcare.



Source: <https://www.linkedin.com/pulse/how-ai-transforming-drug-discovery-nagesh-jadhav/>;
<http://www.alizila.com/alibaba-cloud-wants-to-democratize-artificial-intelligence-technology/>

Google, Apple, Alibaba and Amazon

Amazon has a program Biotech and Pharma in the Cloud Accelerate scientific discovery and enable operational efficiencies in the AWS Cloud. Data Lakes With the AWS cloud, developers, scientists and business users can store, process, and analyze data across previously siloed product and therapeutic teams. One of the main ideas on the program is to gain further insight and accelerate innovation for new drugs and treatments.

In 2016 **Apple** has found its first ever partnership with a drug company. British firm GlaxoSmithKline has announced it will be using ResearchKit (a medical platform designed to turn the iPhone into a diagnostic tool for clinical trials and studies) to conduct a medical study on rheumatoid arthritis.

Apple seeks to form partnerships with medical companies and establish itself as a legitimate player in the health industry. Pharma companies are moving into a new area in drug R&D, by using Apple's ResearchKit platform to gather data from iPhone users to draw on when developing new drugs.

The Amazon logo, featuring the word "amazon" in a bold, lowercase, black sans-serif font. Below the text is a curved orange arrow that starts under the letter 'a' and points to the right, ending under the letter 'n'.

Source: <https://www.linkedin.com/pulse/how-ai-transforming-drug-discovery-nagesh-jadhav/>

L'Oreal, Baidu, Tencent, Intel and Hitachi

Cosmetics brand **L'Oreal** has sworn not to test on animal, and in 2015 L'Oreal started using 3D printers that mimic human skin as a testing ground for new products. L'Oreal partnered in 2015 with bio-engineering firm Organovo, the latter of which both designs and creates "multicellular, dynamic, and functional human tissues for use in drug discovery and medical research," according to Allure. Together, they will craft tissue that is similar to human skin, which leads to faster, easier, and totally humane testing methods. Bin Chen Lab, together with Butte Lab and Hadley Lab, received in 2017 funds from L'Oreal to discover drugs for hyperpigmentation.

Chinese web corporation **Baidu** pushed in 2017 further into the AI market with the acquisition of Raven Tech, a startup behind the 'Flow' digital assistant. Baidu is betting on AI and intends to lead its growth beyond virtual assistants to more niche areas where increasing computing power can analyse big data and make big decisions simple. One such area is medicine, where Baidu is looking to use artificial intelligence algorithms for drug discovery technology so it can significantly shorten the process.

In 2018 was announced that Medopad has teamed up with Chinese tech corporation **Tencent** to develop artificial intelligence-enabled clinical decision support software and medical chatbots. The partnership will combine Tencent's data assets and AI technology with Medopad's mobile apps. As well in 2018 British pharmaceutical corporation AstraZeneca has teamed up with Chinese technology powerhouses Alibaba and Tencent to deliver smart healthcare services through the use of artificial intelligence (AI) and the internet of things (IoT) in China. Tencent Holdings Ltd joined in 2018 Alphabet Inc's Google and Sequoia Capital China to a \$15 million B series funding round for Boston- and Shenzhen-based artificial intelligence (AI) pharmaceutical firm XtalPi Inc.

The **Intel** Xeon Scalable platform offers potent performance for all types of artificial intelligence (AI). Kyoto is one of many leading healthcare providers and research institutions that are working with Intel and using Intel artificial intelligence technology to tackle some of the biggest challenges in healthcare.

Mitsubishi Tanabe Pharma and **Hitachi** have become the latest companies attempting to use artificial intelligence (AI) to more efficiently develop drugs. The aim of the collaboration is to use Hitachi's advanced digital technology, including AI, to shorten the development period for new drugs and reduce development costs, while reducing the possibility of expensive trial failures.

IBM, Huawei, Samsung, NVIDIA, Microsoft

IBM created the Watson for Drug Discovery, which is a cloud-based, cognitive solution that analyzes scientific knowledge and data to reveal known and hidden connections that can help increase the likelihood of scientific breakthroughs. The platform allows researchers to generate new hypotheses with the help of dynamic visualizations, evidence-backed predictions and natural language processing trained in the life sciences domain. It is used for both new drug target identification and drug repurposing.

Huawei is Chinese Tech Corporation, which is also involved in the race. Collaborating with established genomic data experts WuXi NextCODE and WuXi AppTec, Huawei created the platform, which is aiming to support the Precision Medicine Initiative taken up by the Chinese government, and link researchers across China through a secure nationwide network.

Samsung NeuroLogica, the healthcare subsidiary of Samsung Electronics, is integrating its computed tomography (CT) and other imaging equipment with artificial intelligence (A.I.) clinical decision support technology developed by Israeli startup MedyMatch. So far, this Corporation is not very close to advanced R&D and drug discovery, however, we can assume that the situation will be changed in following few years.



SAMSUNG
NeuroLogica



Source: <https://www.ibm.com/us-en/marketplace/ibm-watson-for-drug-discovery>;
<https://www.dr-hempel-network.com/digital-health-technology/huawei-precision-medicine-genomics/>;
<https://www.meddeviceonline.com/doc/samsung-medymatch-collaborate-on-ai-directed-acute-stroke-detection-0001>

Nestle

NVIDIA is implicitly involved in Advanced R&D and Drug Discovery. This company produces hardware which is used by AI companies which are involved in the Advanced R&D and Drug Discovery process. For example, BenevolentBio's deep learning software, powered by the [NVIDIA DGX-1](#) AI supercomputer, ingests and analyzes the information to find connections and propose drug candidates.

Microsoft - the last Tech Corporation in our list - is also applying computer science expertise to enable data-driven healthcare, enhance wellness and accelerate progress in life sciences. Artificial intelligence, machine learning and exponential leaps in data availability and cloud computing fuel research initiatives to understand biology at molecular and cellular levels, guide the development of medical treatments and analyze data streams to detect health threats, predict disease outbreaks and counsel patients.

Finally, **Nestlé** - which is not IT nor Tech Corporation, but is highly involved in the AI for Advanced R&D industry. It is known that Nuritas, a biotech company, which combines artificial intelligence and genomics to discover and unlock natural Bioactive Peptides with extraordinary health benefits, wants to revolutionize the discovery of natural active ingredients that can support and improve human health. The company uses artificial intelligence (AI) to look closely at the foods we eat to find peptides that could provide extraordinary benefits. The biotech has joined forces with **Nestlé**, the world's largest food and beverage company, which will provide its expertise in the area of food and nutrition to validate the biotech's discoveries.

Conclusions: It's important to mention that every and each company has its own vision and the level of involvement differs from one company to another, however, overall, IT Giants are interested in advanced R&D and drug discovery sector.

Source: <https://blogs.nvidia.com/blog/2017/02/08/ai-drug-discovery/>; <https://www.microsoft.com/en-us/research/research-area/medical-health-genomics/>;
<https://labiotech.eu/artificial-intelligence-peptides-nuritas/>

IMB & Watson Health: The Early Years

Much of IT and Tech Corporations' activity in the AI for Drug Discovery space has focused on "Machine Learning as a service" business models, whereby they offer their AI and IT expertise to pharmaceutical companies who lack specialised AI and IT staff.

The entry of AI and IT corporations entering the AI for healthcare space in general and AI for Drug Discovery space in particular began with IBM's launch of Watson Health, with the aim of using their natural language processing (NLP) AI Watson as a platform available for use by life sciences companies.

The first real fruits of this effort began in 2013, when IMB partnered with WellPoint to apply Watson to utilization management decisions in lung cancer treatment at Memorial Sloan-Kettering Cancer Center.

This was followed by a partnership with Cleveland Clinic in 2012 to assist medical professionals in treating patients, and with a 2013 partnership with Maine Center for Cancer Medicine and Westmed Medical Group to use Watson for lung cancer treatment recommendations.

The most recent fruits of Watson Health include the launch of IMB Watson for Oncology at Manipal Hospital (one of the largest hospitals in India).

IBM Watson Health

Google Invests in XtalPi (January 2018) & BechSci (May 2018)

This pioneering effort by IBM also falls under the general business model of IT corporations offering "AI as a service" to life sciences and pharma companies.

However, we can predict that this will move increasingly toward the development of internal AI for Drug Discovery and AI in healthcare activities, largely through investments and acquisitions of AI for Drug Discovery companies.

We can see this trend already forming, Google, for instance, has recently invested in two such companies: XtalPi, an AI for Drug Discovery company, and BenchSci, a company that uses AI to perform antibody discovery.

Furthermore, Google has also shown interest in pharmaceutical and life sciences companies generally, outside of the specific realm of AI for Drug Discovery. They have made investments in gene-therapy company Fulcrum Therapeutics, vaccine company Spy Biotech, stem cell company Magenta Therapeutics, bacterial infection treatment-company Spero Therapeutics, and immunotherapy companies Forty Seven and Arcus Biosciences.

So too with the broader AI space as well. Google recently announced the formation of an AI-focused venture fund called GRadiant Ventures, which was the entity they used to invest into BenchSci in May of 2018.



Introducing
Gradient Ventures



Source: <https://techcrunch.com/2018/01/23/xtalpi-google-tencent-sequoia-china/>;
<https://venturebeat.com/2018/05/02/googles-ai-focused-gradient-ventures-invests-in-benchsci-to-speed-up-biomedical-discoveries/>

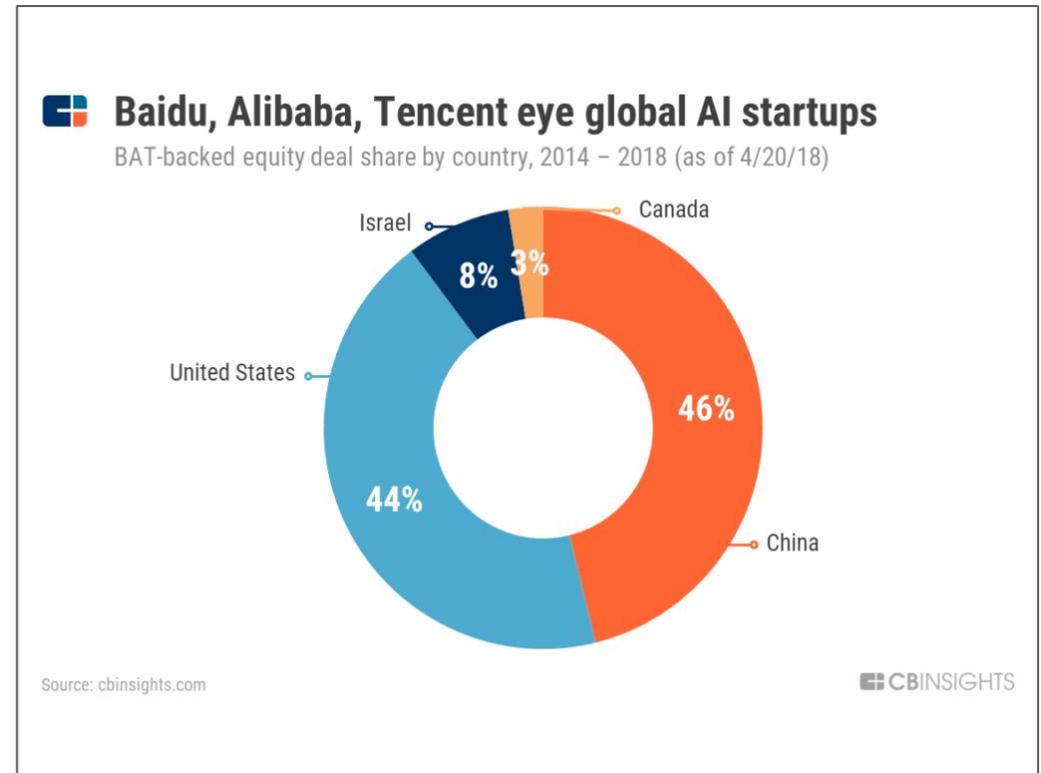
Chinese Tech Corporations Enter the Scene: Tencent & Baidu Ventures Invest in Atomwise (March 2018)

Interestingly, in 2018 we are also witnessing the entry of Chinese IT and Tech Corporations entering the space as well.

Tencent, a Chinese internet corporation, recently led a \$155 million investment round into AI for healthcare company iCarbonX, as well as co-invested alongside Google in XtalPi.

Daisy Cai, a partner at Baidu Ventures, recently told CNBC that "We are looking at companies (that) use artificial intelligence algorithms in their drug discovery technology, so it can significantly shorten the drug discovery cycle."

Furthermore, Tencent is leading the pack with AI-related investments in the USA, participating in a total of 12 AI-related funding rounds, including its joint investment in Atomwise with Baidu Ventures. This can be compared to Baidu Venture's total of 5 AI-focused deals in the US.



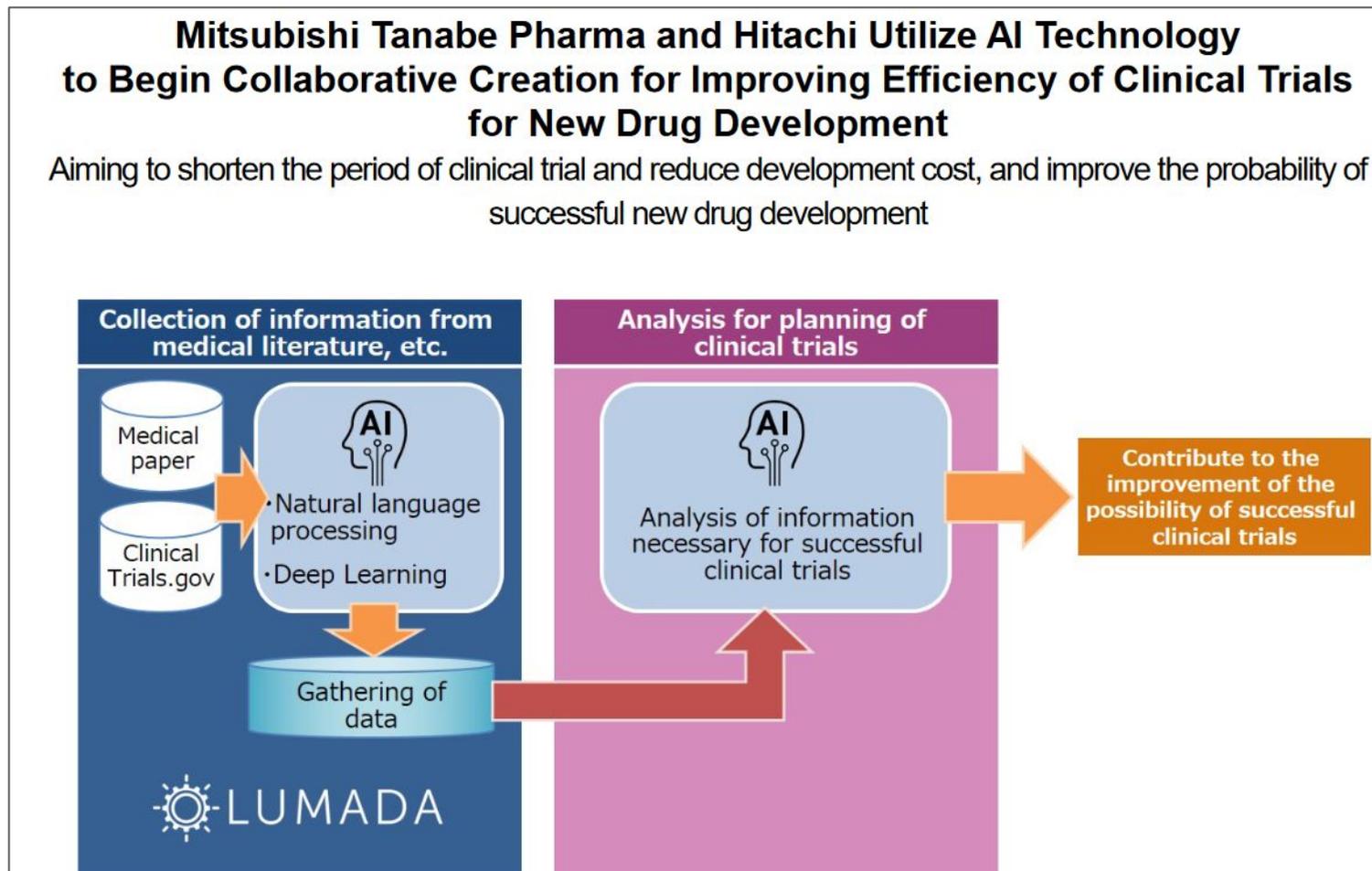
Tencent 腾讯

Baidu.ventures
百度风投

Source: <https://www.cnbc.com/2017/02/15/chinese-tech-giant-baidu-bets-on-ai-and-virtual-reality.html>

Mitsubishi Tanabe Pharma: Partnership with Hitachi for AI-Driven Clinical Trial Planning (March 2018)

Mitsubishi Tanabe Pharma announced a March 2018 partnership with Hitachi to optimize their clinic trial planning via AI. The collaboration will use Hitachi's Lumada platform in order to mine information from scientific papers and ClinicalTrials.gov. A pilot study was conducted as part of the partnership and found time savings of up to 70%.



Source: <http://www.hitachi.com/New/cnews/month/2018/03/180326a.html>

Intel & AI for Drug Discovery

“Healthcare is one area where the immediate benefits would be profound. De-identified data from medical records, genomic data sets, research and treatment programs could give AI the insight needed to make breakthrough discoveries in mental health, cardiovascular disease, drug therapies and more. Allowing federated access to data from distributed repositories held in different sites – all while preserving privacy and security – would propel AI forward in our global quest for better health.”

- Naveen Rao, corporate vice president and general manager of the Artificial Intelligence Products Group at Intel Corporation.



Naveen Rao, VP of AI Product Groups at Intel Corporation

Source: <https://newsroom.intel.com/editorials/how-governments-can-help-advance-artificial-intelligence/>

Intel & AI for Drug Discovery

In a March 2018 article on Intel's blog entitled "Powering Precision Medicine with Artificial Intelligence", Hema Chamraj, Intel's Director, Strategic Business Development for Health and Life Sciences, Artificial Intelligence Products Group, stated: "Intel is working at multiple levels to help organizations use AI to advance the cause of precision medicine. Intel covers the full stack of AI solutions—including algorithms, frameworks, libraries, and processor technology. These include the Intel® Deep Learning Deployment Toolkit, which delivers optimized inferencing on Intel® architecture without the need for specialized hardware such as GPUs to keep deployment costs lower. This toolkit helps bring the power of AI to clinical diagnostic scanning and other healthcare workflows." In the same article, she added: "As artificial intelligence (AI) enters the precision medicine picture, it can help organizations capitalize on precision medicine in multiple ways. In terms of data challenges, AI leverages deep learning approaches to overcome the obstacles inherent in large data sets and unstructured data. In clinical settings, AI functions as an assistant that helps clinicians work more efficiently and make more accurate diagnoses, which helps improve the productivity of healthcare workers. And at a broader level, AI helps companies accelerate drug development to cut costs and achieve faster time to medicine while reducing errors in the system."



Source: <https://ai.intel.com/powering-precision-medicine-artificial-intelligence/>

Intel Partners with Novartis & AI for Drug Discovery

In a May 2018 announcement, Intel revealed that they are partnering with Pharma corporation Novartis to utilize deep neural networks to accelerate high-content screening, aiming to cut the time it takes to train image analysis models from 11 hours to 31 minutes.

A recent intel press release goes into further detail regarding the partnership:

“The promise of deep learning is that relevant image features that can distinguish one treatment from another are “automatically” learned from the data. By applying deep neural network acceleration, biologists and data scientists at Intel and Novartis hope to speed up the analysis of high content imaging screens. In this joint work, the team is focusing on whole microscopy images as opposed to using a separate process to identify each cell in an image first. Whole microscopy images can be much larger than those typically found in deep learning datasets.”

“For example, the images used in this evaluation are more than 26 times larger than images typically used from the well-known ImageNet* dataset of animals, objects and scenes. The collaboration team with representatives from Novartis and Intel have shown more than 20 times improvement in the time to process a dataset of 10K images for training. Using the Broad Bioimage Benchmark Collection* 021 (BBBC-021) dataset, the team has achieved a total processing time of 31 minutes with over 99 percent accuracy. For this result, the team used eight CPU-based servers, a high-speed fabric interconnect, and optimized TensorFlow. By exploiting the fundamental principle of data parallelism in deep learning training and the ability to fully utilize the benefits of large memory support on the server platform, the team was able to scale to more than 120 3.9-megapixel images per second with 32 TensorFlow* workers.”

Will Tomorrow's BioPharma Corporations Be Today's IT & Tech Corporations?

While we can expect to see traditional BioPharma and IT & Tech Corporations battle it out for supremacy in the AI for Drug Discovery race over the next several years, they do not necessarily start from level playing fields. There are several factors that put IT & Tech corporations at an implicit advantage over BioPharma corporations.

Firstly, IT & Tech corporations work from a solid foundation of AI and IT specialists, IP, resources and expertise, which is the very area that is the most scarce in the race, and the very factor that constitutes the chief bottleneck in the ongoing progress of the AI for Drug Discovery industry.

There are only so many AI specialists and resources to go around, and IT & Tech corporations already have the large majority of them.

Meanwhile, there is no such scarcity among pharma and life sciences staff.

It will be much harder for BioPharma corporations to build up their internal AI and IT staff and resources than it will be for IT & Tech corporations to build up their internal pharma and life sciences departments.

It is not impossible for BioPharma to succeed in launching internal AI for Drug Discovery units, as we have seen with several pharma corporations including GSK, Pfizer and Merck, but they will need to pay top dollar in order to attract AI specialists away from their current positions at AI and Tech corporations.

Secondly, AI, IT and Tech corporations are used to change, and to reformulating their business models and internal operations from the ground up in order to keep pace with the increasing rate of change in their industry.

Will Tomorrow's BioPharma Corporations Be Today's IT & Tech Corporations?

They operate within a space that changes more rapidly than any other industry, and in order to have become an AI, IT or Tech corporation in the first place, they need to have been willing and able to absorb and embrace change in a fundamental and systemic manner.

This is not so with traditional BioPharma, which has operated with the same business model in mind for several decades.

The BioPharma industry is often thought of as an elitist and stagnant industry which is very resistant to change.

This is a state of affairs recognized both within and outside of the Pharma industry, with Job Landoni, Senior VP of Platform Science and Technology at GSK, and one of the most outspoken pharma executives on the disruptive impact of AI for Drug Discovery, admits that "pharma is using a model that was becoming increasingly dated.

Another factor putting AI, IT and Tech corporations at an advantage is the comparatively larger market cap of their industry, and the larger revenues they generate.

This means that they have more resources to play with, and can offer more monetary incentive to keep their AI specialists in place.

However, while the AI, IT and Tech corporations begin the race from a more advantageous starting line, their success is not set in stone.

If the BioPharma industry were to show enough will and commitment to embrace change, and allocate enough funding and resources to the acquisition of AI specialists and AI for Drug Discovery startups, it is not impossible for them to win the race.

Will Tomorrow's BioPharma Corporations Be Today's IT & Tech Corporations?

Furthermore, when it comes to will and commitment, they may even be at an advantage in comparison to AI, IT and Tech corporations, in the sense that they have more to lose.

For AI, It and Tech corporations, entering into healthcare and drug discovery will be an additional revenue stream, auxiliary to their main focus.

Another factor to consider is the fact that the combined capitalization of the 15 BioPharma corporations that we have profiled in this report has remained on the same level for the past 5 years while the capitalization of the 15 IT & Tech corporations profiled in this report is growing significantly and the GAP is increasing. This can be considered as an evidence that the BioPharma industry is stagnating in general, while the IT & Tech industry is progressing. This is why it is so notable that the number of IT corporations has already matched the number of BioPharma corporations active in this subsector.

For BioPharma corporations, to lose the race is to lose everything, and amounts to either keeping or losing their main source of revenue. Whether this proves enough to overcome the stangantion and resistance to change typical of BioPharma will remain to be seen in the years to come.



Chapter VI

Government Initiatives

Introduction: AI for Drug Discovery Government Initiatives in the US, UK, EU and Asia Pacific

Just as the past several years has seen a stark rise in the number of AI for Drug Discovery companies, investments, M&As, collaborative ventures, public recognition, conferences and media coverage, the past few years have also brought an increased interest in and commitment to AI for Drug Discovery by several governmental bodies in the USA, UK, EU and Asia Pacific region. This is sensible given the increasingly widespread consensus that AI will disrupt the BioPharma industry, and that existing drug companies, as well as entire health care systems, will need to begin investing time, funds and other resources into AI for Drug Discovery in order to stay competitive.

Some countries, for instance, seem to see it as one of the means by which they can increase their global leadership position in AI generally, such as China. Others simply recognize the need to begin investing public funds and resources into it in order to keep their healthcare systems in step with the ongoing pace of technological change.

The increased commitment and interest of governmental bodies will bode well for the broader AI for Drug Discovery industry. Aside from increasing the total amount of funding available for AI for Drug Discovery and Advanced R&D generally, it also helps to keep governments aware of the secondary effects of the industry, once companies begin to bring practical results into the clinic.

Foremost among these is the likelihood for the time and cost it takes to go from concept to trial to clinic will be substantially reduced, which will necessitate changes to existing pharmaceutical regulatory frameworks. By keeping abreast and apace of industry and R&D developments, governmental bodies can gain a deeper understanding of what to expect and how to reformulate existing operating procedures in order to account for them.

The present chapter aims to provide readers with an overview of the largest and most important government initiatives relating to AI in Drug Discovery and Advanced R&D that have occurred both within the past few years generally, and in 2018 in particular.

USA

The US has led the AI for Drug Discovery race in terms of both total investments and the number of US-based companies focusing on AI for Drug Discovery.

The USA is also home to the largest pharma corporations in the world, putting it in an excellent position to grow its AI for Drug Discovery industry if, as recent trends seem to indicate, the BioPharma industry continues to build up their internal AI for Drug Discovery resources and increase their number of AI for Drug Discovery startup acquisitions.

With that being said, there is also mounting interest in the AI for Drug Discovery sector from the EU, UK and Asia-Pacific region as well.

While the USA leads the pharma race generally, as we have discussed elsewhere in this and earlier reports, the AI for Drug Discovery sector is poised to become the central factor that will determine who is the winner of the drug discovery race in the years to come.

If the EU, UK or Asia Pacific region proves more willing to grow their AI for Drug Discovery industry, especially through something akin to a national development strategy, whereby a significant amount of government funds are earmarked for such a purpose, then it is possible that the US could be overtaken in terms of its current leadership position in the pharmaceutical industry.

It all depends on the actions and commitments taken by the US government, as well as by the current US-based leaders of the BioPharma Industry, and by US-based IT corporations.

USA: FDA Launches AI in Healthcare Incubator, Information Exchange and Data Transformation (INFORMED)

In order to continue encouraging the use of AI for Drug Discovery, the FDA has announced the launch of a new incubator focused in AI in healthcare. Called Information Exchange and Data Transformation (INFORMED), the incubator will focus on AI for drug development and oncology research. The launch of this incubator strengthens the FDA's already-voiced intention to try and design regulatory frameworks that are inclusive of AI for Drug Discovery and that are capable of keeping up with innovation in the AI for healthcare and digital health spheres. The FDA also established a pre-certification program (Digital Health Software Precertification Program) for digital health companies last year, offering a streamlined regulatory process specifically for companies operating in the digital health industry.

"AI holds enormous promise for the future of medicine, and we're actively developing a new regulatory framework to promote innovation in this space and support the use of AI-based technologies. So, as we apply our Pre-Cert program — where we focus on a firm's underlying quality — we'll account for one of the greatest benefits of machine learning — that it can continue to learn and improve as it is used."

- **Dr. Scott Gottlieb, FDA Commissioner**



**Scott Gottlieb,
FDA Commissioner**

Government Initiatives: FDA Digital Health Innovation Action Plan

The Pre-Cert program was initially proposed in the FDA's Digital Health Innovation Action Plan, released in 2017. Interestingly, a number of IT and Tech Corporations can be seen on the list of nine companies chosen (out of over 100 applicants) to participate in the program, including Apple and Samsung, as well as Big Pharma corporations including Roche and Johnson & Johnson.

“From mobile medical apps and fitness trackers, to software that supports the clinical decisions doctors make every day, digital technology has been driving a revolution in health care. This Digital Health Innovation Action Plan outlines our efforts to reimagine FDA’s approach for assuring that all Americans, including patients, consumers and other health care customers have timely access to high-quality, safe and effective digital health products.”

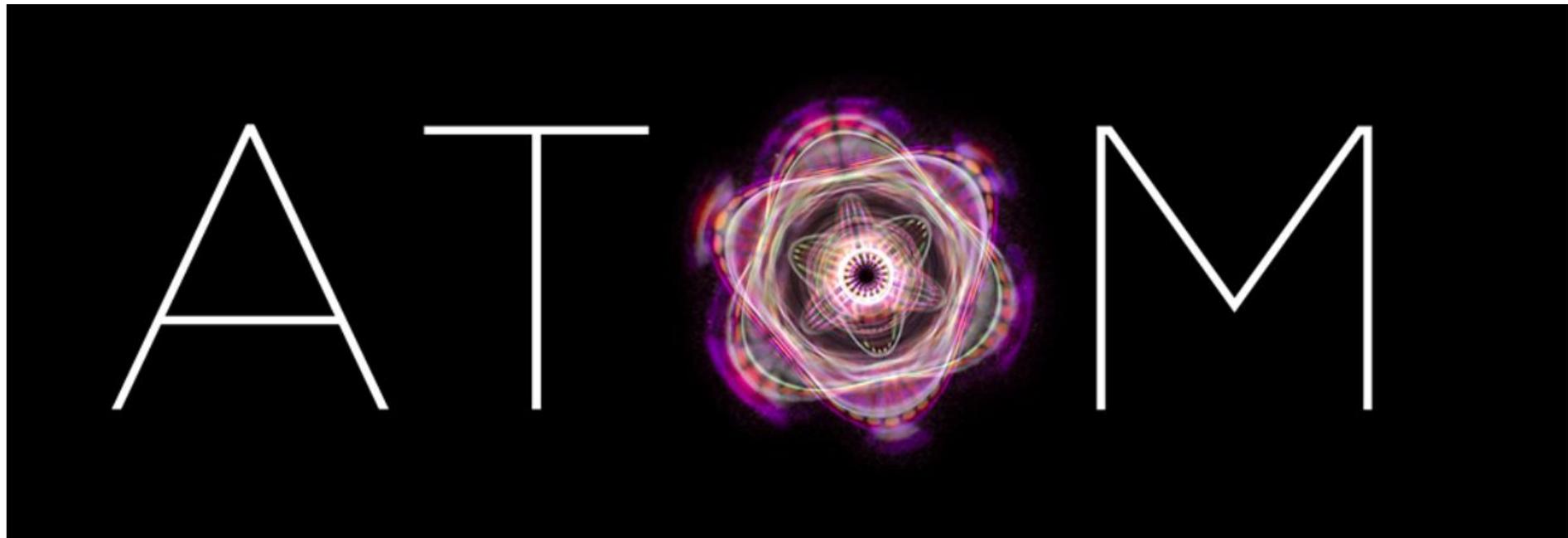
- **FDA Digital Health Innovation Action Plan**



GSK & the US Department of Energy & National Cancer Institute Launch The ATOM Consortium

In June 2016, GlaxoSmithKline, the United States Department of Energy & the United States National Cancer Institute launched the Accelerating Therapeutics for Opportunities in Medicine (ATOM) consortium s one of the United States Government's Cancer Moonshot task forces via funding through the 21st Century Cures act.

The founding members of the consortium include GSK, Lawrence Livermore National Laboratory, Frederick National Laboratory for Cancer Research, and the University of California, San Francisco. The consortium aims to use the latest advanced in AI in order to enhance drug discovery efforts in the united states.



Source: <https://atomsience.org/welcome/#what-we-do-section>

GSK & the US Department of Energy & National Cancer Institute Launch The ATOM Consortium

VISION

Our goal is to transform drug discovery from a slow, sequential, and high-failure process into a rapid, integrated, and patient-centric model. We are integrating high performance computing, diverse biological data, and emerging biotechnologies to create a new pre-competitive platform for drug discovery.



From target to patient-ready in <1year

In the words of the consortium:

"ATOM develops, tests, and validates a multidisciplinary approach to drug discovery in which modern science, technology and engineering, supercomputing simulations, data science, and artificial intelligence are highly integrated into a single drug-discovery team approach that can ultimately be shared with the drug discovery community at large and applied to other disease areas. The consortium will achieve its goals by building new tools, models, and processes that it intends to make broadly available as a shared resource to accelerate drug discovery. Scientific understanding and vast amounts of data gathered from decades of research will be used by the consortium in hopes that the information will be leveraged to find solutions for cancer patients. The ATOM team will combine publicly available data, the data provided by GSK, and that of future consortium members, to generate new dynamic models that can better predict how molecules will behave in the body, potentially bringing new drugs to patients faster. In this effort, Lawrence Livermore National Laboratory will contribute its best-in-class supercomputers, including its next-generation system Sierra, as well as its expertise and innovative approaches to modeling and simulation, cognitive computing, machine learning, and algorithm development."

Japan

In Q4 of 2016, several Japanese pharmaceutical and tech corporations, including Takeda Pharmaceutical, Shionogi & Co., NEC, Fujitsu and Fujifilm Holdings established a consortium to advance the state of the nation's AI for Drug Discovery industry. The consortium also includes the government-affiliated research institution, Riken Institute, as well as Kyoto university. In order to facilitate this, the Japanese government allocated 2.5 billion yen (\$22.9 million) in order to support the project. More recently, the Ministry of Health, Labour and Welfare (MHLW) announced that they remain committed to strategically advancing AI and big-data in drug discovery. While Japan's pharmaceutical industry ranks low on the global scale, by prioritizing investments into AI for Drug Discovery may enable them to climb the ladder and possibly out-compete their Western rivals. 2018 also saw Japanese pharmaceutical corporation Shionogi & Co. partner with US-based IT consulting corporation Accenture in order to leverage their 15k data scientists in order to develop its own AI for Drug Discovery department.

While Western pharmaceutical companies lead the industry globally, Japan's pharma industry currently ranks low -- 17th in the world. But, if it can strategically prioritize AI for Drug Discovery to a greater extent than other regions,, it is possible that the nation could climb the global pharma ladder in the years to come.



BUSINESS

Japan to launch initiative for AI-based drug discovery

Source: <http://www.nedo.go.jp/content/100799736.pdf>; <https://www.japan.go.jp/innovation/drugdiscovery.html>;
<https://medium.com/osadc/artificial-intelligence-in-japan-r-d-market-and-industry-analysis-a738c3295b16>; <http://www.nedo.go.jp/content/100799736.pdf>
; <https://journal.accj.or.jp/artificial-intelligence-can-japan-lead-the-way/>

China

The entry of Chinese investors into the broader biotech and drug industry landscape also mounted significantly in 2018, rising to \$1.4 billion into US-based biotech and drug firms compared to just \$125.5 million during the same period the previous year. China's generally increased interest in biotech and pharmaceutical investments, coupled with President Xi Jinping's call-to-action to catch up with the US in terms of developing practical applications in the AI industry, means that a surge of Chinese interest and investment in the AI for Drug Discovery sector will only be natural. In a recent article in TechNode, Mark Vermette of Boston-based biotech consulting group Halloran noted that “There are opinions that China’s ability and willingness to aggregate and share patient health data across drug development in China is an advantage. Data is a key input to AI for drug development for patient recruitment, outcomes analysis, genotyping, etc. This could be an advantage in drug development but a major challenge to patient privacy, which is a substantial consideration in Europe and the US.”

Furthermore, while China's pharma industry has historically focused on the manufacture of drugs discovered and developed elsewhere, there are mounting commitments from the Chinese government to move toward the development of their own pharmaceuticals. In the same TechNode article, Ron Li of Novoheart in Hong Kong noted that “When it comes to the pharmaceutical industry, we know that China has been focusing on the production of generic drugs. The market sector is huge here. But we can tell that there are commitments from the Chinese government that they now want to upgrade from the production of generic drugs to their own drugs, or new drugs. The good thing is by producing generic drugs, they have the infrastructure, facilities, and scale and with experience. All they have to do now is come up with their own formulations. They need to have IP-protected formulations and then they can go ahead and produce new drugs, and, with the advances in the last decade or so and the returnees, you can see that new drug candidates are starting to emerge. This is a huge market.”

Having noted all of the above possible disadvantages, however, China also excels in certain areas that are pivotal for the AI in Drug Discovery process, foremost among them being the massive amount of real-time medical data that they are capable of generating from their enormous population of citizens.

Source: <https://www.bloomberg.com/news/articles/2018-01-31/china-needs-to-quicken-ai-adoption-in-the-real-economy-xi-says>;
<https://technode.com/2018/04/24/better-drugs-through-chinese-ai/>

China

In an article in South China Morning Post, Andy Chun notes that "AI relies greatly on data for machine learning and predictive analytics, and China has no shortage, with its population generating massive amounts of real-time medical data. The Chinese population is eager to use technology and adopt AI."

According to recent data from the UN, China is aging more rapidly than any other country in the world, largely as a result of its previous one-child policy, and will have roughly 330 million citizens over the age of 65 by the year 2050. Thus, the Chinese government have perhaps more incentive than any other developed nation to prioritize innovations in healthcare that could help them avoid economic turmoil due to the healthcare costs associated with an aging population. The Chinese government does seem to be setting their sights on prioritizing AI in healthcare as well. In an AI Strategic Plan released in July 2017, they outlined their intentions to catch up in the AI race by 2020, make major breakthroughs by 2025 and become the world leader in AI by 2030.

In a parliamentary meeting held around the same time as the report's release, China science and technology minister Wan Gang noted that government finance will lead the way in AI research, including the development of supercomputers, and high performance semiconductor chips, software and the hiring of key talent to lead the field. If they remain true to their commitment, they could succeed in building up the necessary resources in order to dominate the AI for Drug Discovery space.

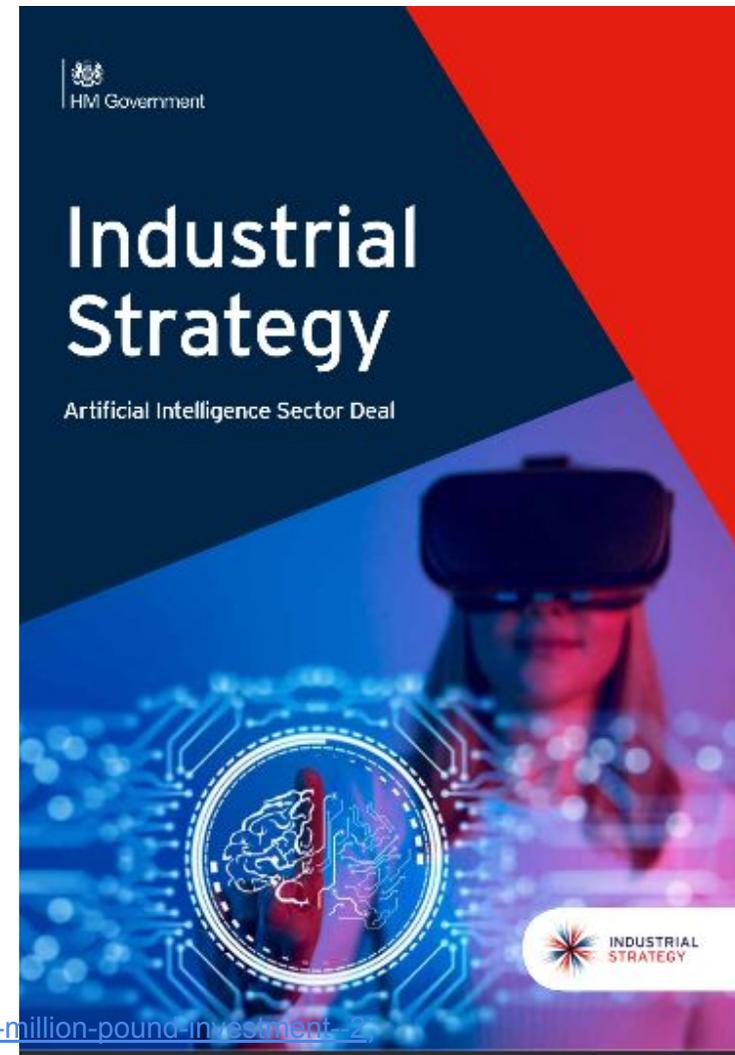
Indeed, as we have noted elsewhere, the current bottleneck that limits progress in AI for Drug Discovery, and the most crucial factor that will determine who emerges as the leader of this space in the years to come, is the limited pool of AI specialists available to be acquired. Given China's formidable population, they have the raw materials to generate, via education, incentives and prioritization, the most valuable resource in the entire AI for Drug Discovery landscape: AI specialists.

Source: <https://www.scmp.com/tech/article/2077845/future-here-china-sounds-clarion-call-ai-funding-policies-surpass-us>;
<https://www.scmp.com/tech/enterprises/article/2103568/world-dominance-three-steps-china-sets-out-road-map-lead-artificial>;
<https://www.scmp.com/comment/insight-opinion/article/2152087/artificial-intelligences-greatest-contribution-may-be-health>

United Kingdom

In April 2018, the UK government confirmed its commitment to keep up with other countries in the AI race through a very large government initiative worth £1 billion Titled the AI Sector Deal, the deal between government and industry (involving over 50 leading UK tech companies) was announced by Business Secretary Greg Clark and Digital Secretary Matt Hancock, and will involve more than £300 million in new private sector investment, as well as 1000 new government-funded AI PhDs. Commenting on the initiative, Uk Digital Secretary Matt Hancock noted that "Artificial Intelligence is at the centre of our plans to make the UK the best place in the world to start and grow a digital business. We have a great track record and are home to some of the world's biggest names in AI like Deepmind, Swiftkey and Babylon, but there is so much more we can do. By boosting AI skills and data driven technologies we will make sure that we continue to build a Britain that is shaping the future. In a press release on the topic of the initiative, the UK government noted that "The deal will help establish the UK as a research hotspot, with measures to ensure the innovators and tech entrepreneurs of tomorrow are based in the UK, with investment in the high-level post-graduate skills needed to capitalise on technology's huge potential. It includes money for training for 8,000 specialist computer science teachers, 1,000 government-funded AI PhDs by 2025 and a commitment to develop a prestigious global Turing Fellowship programme to attract and retain the best research talent in AI to the UK."

Source: <https://www.gov.uk/government/news/tech-sector-backs-british-ai-industry-with-multi-million-pound-investment-2>,
<https://www.gov.uk/government/publications/artificial-intelligence-sector-deal>;
<https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges#artificial-intelligence>;
<https://www.gov.uk/government/topical-events/the-uks-industrial-strategy>



United Kingdom

Governance

Oversight of the implementation of the Sector Deal will be led by the Office for Artificial Intelligence, which will review progress against objectives regularly.

The new government Office for Artificial Intelligence will be established with responsibility for implementing this Sector Deal. It will support the AI Council which will oversee and drive the implementation of the deal.

An early role for the Office for AI will be to agree implementation plans for each section of the deal, including agreed success metrics.

Membership of the AI Council will be announced ahead of the first meeting. The main aim of the AI Council will be to provide strategic leadership and momentum in delivery.

The Office for AI will report to the AI Council regularly and will be subject to challenge sessions from government ministers on progress in implementing the Sector Deal. The Industrial Strategy team will provide the challenge on delivery timetable, metrics and ambition on outcomes as well as providing updates and escalation to ministers across the suite of Sector Deals.

Case Study: ASI - Creating capability in tomorrow's leading scientists

ASI helps organisations develop capability in AI through a combination of expertise, technology and training. They run Europe's most prestigious programme for helping top STEM PhDs to transition into real world data scientists. Nearly 10% of the UK's STEM PhDs apply for their fellowship every year, and the programme has enabled British firms like easyJet, Babylon Health, Asos, Ovo Energy and Zopa to access the skills needed to build some of the

most sophisticated AI capabilities in the world. ASI's in-house data science team use cutting edge machine learning expertise to help clients solve problems ranging from making trains run on time to detecting terrorist propaganda online. And all of this is powered by their data science platform, SherlockML, which has been developed to be the world's best environment for data scientists to efficiently develop and deploy artificial intelligence algorithms.

Industrial Strategy Artificial Intelligence Sector Deal

Implementation plan

Key deal activities

Date	Milestone
Oct 2017	Publication of the AI Review
Nov 2017	Industrial Strategy White Paper published Announcement of £20m Industrial Strategy Challenge Fund (ISCF) support for Next Generation Services using artificial intelligence, and £210m ISCF support for Data to early diagnostics and precision medicine which includes using AI to analyse medical images in digital pathology
Q2 2018	Sector Deal launched Establishment of AI Council, interim Centre for Data Ethics and Innovation, and Office for AI First meeting of the AI Council First funded challenges are launched, including Next Generation Services
Q1 2019	Annual Review of the Sector Deal

United Kingdom: The AI Grand Challenge

This new initiative builds upon the commitment already made by the UK government in its Industrial Strategy and AI grand challenge, which put AI's use in healthcare at the forefront of their commitment.

Mission: Use data, Artificial Intelligence and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030

Using AI and data, there is an opportunity to accelerate medical research in early diagnosis, leading to better prevention and treatment of disease. Within 15 years better use of AI and data could result in over 50,000 more people each year having their cancers diagnosed at an early rather than late stage. This would mean around 20,000 fewer people dying within 5 years of their diagnosis compared to today.

This mission aims to put the UK at the forefront of the use of AI and data in early diagnosis, innovation, prevention and treatment. Success in this mission is one of a number of steps towards saving lives and increasing NHS efficiency by enabling earlier diagnosis and reducing the need for costly late stage treatment. The opportunity - working with academia, the charitable sector, and industry and harnessing the power of AI and data technologies - is considerable. It should lead to a whole new industry of diagnostic and tech companies which would drive UK economic growth.

The mission builds on the £210 million of funding announced for the [Data to Early Diagnostics and Precision Medicine Industrial Strategy Challenge Fund](#).

NHS to Offer Staff Artificial Intelligence Training

Coinciding with the recent £1 billion pact between industry and government to put the UK on the forefront of the global AI race, the government also commissioned an independent review (conducted by cardiologist Dr. Eric Topol) to assess the need of NHS staff to be trained in AI in order to equip them with the skills required to keep abreast of the latest developments in healthcare.

The review was announced in April 2018 by Jeremy Hunt, Secretary of State for Health and Social Care.

In a statement associated with the announcement, Mr. Hunt states: “Every week we hear about exciting new developments surfacing in the NHS which could help provide answers to some of our greatest challenges such as cancer or chronic illness. These give us a glimpse of what the future of the whole NHS could be, which is why in the year of the NHS’s 70th birthday I want to empower staff to offer patients modern healthcare more widely and more quickly.”

Dr. Topol, who will lead the review, added: “While it’s hard to predict the future, we know artificial intelligence, digital medicine and genomics will have an enormous impact for improving the efficiency and precision in healthcare. Our review will focus on the extraordinary opportunities to leverage these technologies for the healthcare workforce and power a sustainable and vibrant NHS.”



ANALYSIS NEWS

NHS to train staff in AI and robotics, says government

By Sooraj Shah - April 27, 2018

United Kingdom: The Rosalind Franklin Institute

UK Business Secretary Greg Clark recent announced £103m in funding for a new institute that will aim to utilize AI for Drug Discovery.

The Rosalind Franklin institute will utilize AI to create new drugs, diagnostics and treatments. Founded as part of the UK's AI and Data Grand Challenge, it will be built upon the UK Government's modern Industrial Strategy and aims to keep the UK on the forefront of the pharma and life sciences industry.

Remarkably and ambitiously, its stated aim is to "generate new drugs for clinical testing within a few weeks."



United Kingdom: The Rosalind Franklin Institute

“The new Rosalind Franklin Institute will lead a revolution in drug development and diagnosis to improve the lives of millions of patients. And with over 10 million people in Britain alive today expected to live to 100, now more than ever it is vital that the Government invests in the development of new technologies and techniques which will support people to have healthier lives. The RFI will pioneer disruptive technologies and new ways of working to revolutionise our understanding of biology, leading to new diagnostics, new drugs, and new treatments for millions of patients Worldwide. It will bring university researchers together with industry experts in one facility and embrace high-risk, adventurous research, that will transform the way we develop new medicines.”

- **Greg Clark, Secretary of State for Business, Energy & Industrial Strategy**



Chapter VII

Industry-Specific Media & Conferences

Introduction

The landscape of conferences and media covering AI for Drug Discovery is a useful window into the broad patterns that are emerging among the industry's thought-leader, and the topics covered by journalists and conferences gives some indication as to how industry players regard the maturity and near-future prospects of the industry, as well as the topics and applications that are gaining the greatest prominence within the industry.

More than that, an understanding of the media and conference landscape surrounding the industry also gives some indication. Generally, we are seeing an increase in the number of conferences focused specifically on AI for Drug Discovery, as well as an increase in the prominence of AI for Drug Discovery panels in conferences aimed at traditional BioPharma executives. This year has also seen a broader degree of global coverage of AI for Drug Discovery at both niche and generalized BioPharma conferences. Whereas the USA dominated the conference landscape in the past several years, we are seeing an increasing number of conferences specifically dedicated for AI for Drug Discovery in the UK, EU and Asia-Pacific region.

We are also witnessing an increase in the number of articles appearing in the media about the topic of AI for Drug Discovery.

An interesting question is whether we are seeing an increase in the quality of coverage from journalists, and to what extent they are beginning to give a clearer and more objective picture of the industry's prospects and growth.

Generally speaking, we do see a decrease in the number of articles skeptical of the potential for AI to reduce the time and cost it takes to develop drugs, and of its potential to have a serious impact upon the BioPharma industry at all.

We are also seeing an increase in the number of articles that frame the topic in an objective light, discussing major roadblocks and what needs to be done in order to let the industry bear its fruit, rather than hailing it as a panacea that will transform the process of drug discovery within a year.

Top 20 Global AI for Drug Discovery Conferences



Conference
AI Pharma
 10-11 Sep 2018 (remind.me)
 Tokyo, Japan

Interested **Going**

Cambridge Healthtech Institute's Inaugural
Artificial Intelligence & Machine Learning for Drug Discovery
 27 NOVEMBER 2018
 SHERATON LISBOA HOTEL & SPA | LISBON, PORTUGAL



Part of **WPC EUROPE** 9th Annual WORLD PRECINCTUAL CONGRESS

12th June 2018
 De Vere Canary Wharf, London

AI IN PHARMA: OPPORTUNITIES & CHALLENGES

Get ahead of the curve in this AI strategy masterclass for executives in Pharma.
 Pre-Conference Think-Tank



ADVANCED MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE FOR DRUG DISCOVERY AND DEVELOPMENT

Berlin, Germany 19-20th June



GPU TECHNOLOGY CONFERENCE AGENDA ATTEND PRESENT EXHIBIT MORE

SILICON VALLEY MARCH 18-22, 2019

HEALTHCARE & MEDICAL RESEARCH CONFERENCE SESSIONS



ASDEvents
 conference, seminars & trainings

Artificial Intelligence in Pharma Industry Summit

19 February, 2018 - 20 February, 2018,
 Berlin, Germany



The AI Health & Pharma Summit®

Co-located with
The AI Summit LONDON

14 JUNE 2018
 ExCeL EXHIBITION CENTRE, LONDON



Smi
 LINKING BUSINESS with INFORMATION



DRUG DISCOVERY

21ST MARCH TO 22ND MARCH 2018,
 LONDON, UNITED KINGDOM



Cambridge Consultants

EVENT
AI in Pharma Summit 2018

9th October 2018
 Boston, MA
 Venue: The State Room



Global Pharma R&D Informatics and AI Congress

WHEN
 29th-30th Oct 2018
 Registration from 8am

WHERE
 London, United Kingdom
 Radisson Blu Edwardian Heathrow



Home / Conferences / ARTIFICIAL INTELLIGENCE TO SPEED UP DRUG DISCOVERY: THE REVOLUTIONARY ROAD TO ADVANCING INNOVATION

ARTIFICIAL INTELLIGENCE TO SPEED UP DRUG DISCOVERY: THE REVOLUTIONARY ROAD TO ADVANCING INNOVATION

Top 20 Global AI for Drug Discovery Conferences



May 23, 2018
DoubleTree Suites Boston-Cambridge
Cambridge, MA



**2ND GLOBAL PHARMA R&D
INFORMATICS & AI CONGRESS**

29-30 OCTOBER 2018 – LONDON, UK



**Artificial Intelligence in Drug Development
Congress**

27-28 September 2017, London, UK



11-14 September 2018

Congress Center Basel
Switzerland

Artificial intelligence and blockchain in healthcare



**OXFORD
GLOBAL**

**2nd Annual Artificial Intelligence in Drug
Development Congress**

20-21 September 2018, London, UK

**AI PHARMA
INNOVATION
DRUG DISCOVERY**



**ARTIFICIAL INTELLIGENCE
TRANSFORMING PHARMA R&D**



11th & 12th July 2018,
Canary Riverside Plaza Hotel,
London UK



MAX PLANCK ALUMNI ASSOCIATION
Artificial Intelligence and Big Data in Pharma

Impact on drug development on the role of the industry

March 21, 2018
Max Planck Institute of Biochemistry, Munich

Topics Featured at AI for Drug Discovery Conferences

Among the specific topics featured at industry-specific AI in Drug Discovery conferences, those that seem to be emerging as predominant ones being featured to a high degree at several conferences include:

- How BioPharma companies can effectively face the challenge of big data, and the issue of needing to prioritize big data analytics and AI in order to be capable of generating novel insights from the increasing amount of data being generated by the BioPharma industry;
- How AI can expedite the time it takes to go from drug discovery to clinical validation, decreasing the cost of the drug development process;
- How AI can optimize lead generation and predict drug toxicity and adverse effects;
- How AI can be leveraged to create more adaptive, responsive and effective diagnostic and prognostic tools;
- How AI can assist in the development of personalized medicines, targeting drug regimes to the specific omic profiles of select patient demographics;
- How non-AI experts can gain a better understanding of the AI for Drug Discovery process and apply it to their own activities;
- AI and big data analytics as clinical decision support tools;
- Gain a better understanding of the applications and use-cases of AI in Drug Discovery through actionable and practical case studies;
- How advanced AI in Drug Discovery change the regulatory process, and how the regulatory infrastructure of healthcare systems can respond to and be affected by the rise of AI in the BioPharma industry.

AI for Drug Discovery Becomes a Featured Topic at Top Conferences

Not only are we seeing an increase generally in the number of conferences devoted exclusively to AI in Drug Discovery.

We are also witnessing an increase in the number of presentations, panel discussions and sessions on the topic in the world's leading BioPharma conferences, typically aimed to traditional BioPharma executives.

AI for Drug Discovery panels have appeared such conferences as Financial Times' 2018 Global Pharmaceutical and Biotechnology Conference, at the 2018 Basel Life Sciences Conference, and at the 2018 JP Morgan Healthcare



Artificial intelligence and blockchain in healthcare

You are here: [basellife.org](#) [BASEL LIFE 2018](#) [BASEL LIFE](#) [Innovation Forums](#)

Date

Thursday & Friday, 13-14 September 2018

Chairs

Alex Zhavoronkov (Insilico Medicine, Baltimore, United States)
Verner De Biasi (GSK, London, Switzerland)

36TH ANNUAL J.P. MORGAN HEALTHCARE CONFERENCE

JANUARY 8, 2018
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3:40pm

Panel: Envisioning the Future of Diagnostics

Some 70% of medical decisions, it is claimed are driven by diagnostics. As we enter the era of precision medicine, tailored therapeutics and AI, and as ever more rare diseases are investigated, diagnostics will continue to grow and the definition of what constitutes diagnostics will evolve.

Media Main Trends: Big Pharma On-Boarding AI for Drug Discovery

We are also witnessing an increasing number of articles that discuss the entry of major BioPharma corporations into the AI for Drug Discovery space.

The previous edition of this report notes the big gap between AI for Drug Discovery startups and traditional BioPharma executives, and this updated version attempts to show that that gap has to a large extent now been neutralized, with an increasing number of pharma corporations on-boarding AI for Drug Discovery specialists, assets and projects (see Chapter II).

Writing for Nature News, Nick Fleming reports:

“An enormous figure looms over scientists searching for new drugs: the estimated US\$2.6-billion price tag of developing a treatment. A lot of that effectively goes down the drain, because it includes money spent on the nine out of ten candidate therapies that fail somewhere between phase I trials and regulatory approval. Few people in the field doubt the need to do things differently. Leading BioPharmaceutical companies believe a solution is at hand. Pfizer is using IBM Watson, a system that uses machine learning, to power its search for immuno-oncology drugs. Sanofi has signed a deal to use UK start-up Exscientia’s artificial-intelligence (AI) platform to hunt for metabolic-disease therapies, and Roche subsidiary Genentech is using an AI system from GNS Healthcare in Cambridge, Massachusetts, to help drive the multinational company’s search for cancer treatments. Most sizeable BioPharma players have similar collaborations or internal programmes. If the proponents of these techniques are right, AI and machine learning will usher in an era of quicker, cheaper and more-effective drug discovery. Some are sceptical, but most experts do expect these tools to become increasingly important. This shift presents both challenges and opportunities for scientists, especially when the techniques are combined with automation (see ‘Here come the robots’). Early-career researchers, in particular, need to get to grips with what AI can do and how best to acquire the skills they need to be employable in the job market of tomorrow.”

Source: <https://www.nature.com/articles/d41586-018-05267-x>

Media Main Trends: Big Pharma On-Boarding AI for Drug Discovery

Writing for Pharmaceutical Technology, the organization GlobalData Healthcare writes:

“More and more, big pharma is partnering with AI-driven companies in hopes of more accurately predicting drug candidates and cutting R&D costs and time, prompting GlobalData to ask—Is AI the future of drug discovery? Pharmaceutical corporation Merck is one such company taking a lead in implementing AI-based solutions in drug discovery. Merck entered the AI space early, in 2012, striking a partnership with Numerate, an AI-based company leveraging algorithms and cloud computing to transform the drug design process. The collaboration was initially developed for Merck to utilize Numerate’s computer-based drug design technology to develop novel small molecule drug leads for an undisclosed cardiovascular disease target. In addition, Merck is working with Atomwise, the creator of AtomNet, which uses deep learning technology for the discovery of novel small molecules. Although the project is confidential, Merck is leveraging Atomwise’s AI-based technology to scan existing medicines that could be redesigned to fight old and upcoming diseases. Merck is just one of many pharmaceutical companies partnering with AI-focused companies to advance drug discovery. Celgene partnered with GNS Healthcare to utilize its Reverse Engineering and Forward Simulation causal machine learning and simulation platform; GSK entered a \$43M drug discovery collaboration with UK-based AI-driven startup Exscientia; Pfizer entered collaboration with IBM Watson for immuno-oncology drug discovery research, and the list goes on.”

Source: <https://www.pharmaceutical-technology.com/comment/artificial-intelligence-future-drug-discovery/>

Media Main Trends: AI Can Help Discovery Obscure & Elusive Drug Targets

In addition to the ways in which AI can improve upon the things that pharma companies already do best, we are also seeing an increasing emphasis on the ways in which AI can help pharma companies become more effective at the things they currently struggle with, such as the identification of obscure and elusive drug targets,

Writing for Medium, CoralHealth notes:

“Virtually all large pharma and academic research institutions are turning towards AI to increase efficiencies and design better drugs against well characterized targets. For example, HER2 is a messenger protein that promotes cell growth and division. HER2 protein is elevated and/or mutated in a quarter of breast cancer patients, with this subtype referred to as HER2-positive or HER2+. The first line treatment for HER2+ breast cancer is a combination of two HER2-targeted antibodies along with docetaxel, a chemotherapeutic agent that is indiscriminately cytotoxic to dividing cells. However, not all HER2-positive patients are receptive to the treatment. AI has identified a candidate experimental pancreatic cancer drug that has the potential to slow or reverse HER2+ breast cancer (Mullin, 2018). In addition, AI is being used to predict druggable interactions and binding sites for RAS, an elusive target which is mutated in a third all cancer patients. RAS proteins are challenging targets due to their interaction with the cellular membrane, involvement in complex signaling pathways and structural flexibility. By using computational approaches, researchers are identifying oncogenic conspirators of RAS, which could be used to guide the development of novel targeted interventions in oncology (Ascr-discovery.science.doe.gov, 2018).”

Source: <https://www.pharmaceutical-technology.com/comment/artificial-intelligence-future-drug-discovery/>

Media Main Trends: Largest Barrier Facing AI for Drug Discovery is a Lack of Knowledge & Education Among Pharma Scientists

In a recent Forbes article by Simon Smith, Chief Growth Officer at AI for Drug Discovery startup BenchSci notes that one of the top barriers to AI in Drug Discovery is effective outreach and education within the pharma industry as well as within the broader scientific community.

"We found that 41% of scientists working in drug discovery are unfamiliar with AI. This includes 15% who are very unfamiliar. Pistoia's survey found that 8% know 'next to nothing.' Why aren't more scientists familiar with AI? I have long worked in health tech. So I assumed a conservative culture or concern about data privacy inhibited experimentation. Not so: 18% and 16% of respondents said so, respectively. The top barrier in our survey was "lack of knowledge and expertise about the technology" (62%). Another was "lack of knowledge and expertise about available companies and tools" (42%). Pistoia also found technical expertise the most cited barrier, at 30%. Without deeper knowledge, many scientists will be skeptical."

This is an increasingly voiced concern in the media - the lack of widespread knowledge regarding the impact of AI for Drug Discovery among drug discovery specialists. Furthermore, this insight highlights the important role that drug discovery media and conferences will come to play in the years to come. If it is true that part of BioPharma's previous resistance to AI for Drug Discovery is due to a lack of sufficient understanding, then its increasing visibility in media, in the conference space, and as a featured topic in the biggest traditional BioPharma conferences could serve to enable a greater degree of penetration among the minds of BioPharma executives.

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Source: <https://www.pharmaceutical-technology.com/comment/artificial-intelligence-future-drug-discovery/>

Media Main Trends: AI Can Dramatically Accelerate the Pace of Drug Development

Writing for Inside Big Data, Gunjan Bhardwaj notes: *“Another barrier to the successful development of new treatments is the high attrition rate in the industry. Studies show that only about 9.6% of drugs that start Phase I trials eventually get approved to market. At first glance, this might seem like a good thing. If a drug doesn’t work, or if it is potentially harmful it should never make it to shelves. However, a better way of looking at it is that less of these drugs should make it to trials in the first place. By using the latest big data analytics technologies, pharma companies can better forecast the success of a drug sooner in the development process. This can speed the development of new cures because if unsuccessful drugs are abandoned sooner, there will be more capacity for researching better ones. Healthcare and life sciences companies looking to implement any data solution should do their due diligence in finding qualified partners. Through the use of AI, we can speed the development of new treatments, and democratize access to medical data, making it available to every layer of the healthcare industry.”*

Writing for SingularityHub, Vanessa Bates Ramirez notes: *“To create a new drug, researchers have to test tens of thousands of compounds to determine how they interact. And that’s the easy part; after a substance is found to be effective against a disease, it has to perform well in three different phases of clinical trials and be approved by regulatory bodies. It’s estimated that, on average, one new drug coming to market can take 1,000 people, 12-15 years, and up to \$1.6 billion. There has to be a better way—and now it seems there is. Last week, researchers published a paper detailing an artificial intelligence system made to help discover new drugs, and significantly shorten the amount of time and money it takes to do so. The system is called AtomNet, and it comes from San Francisco-based startup AtomWise. The technology aims to streamline the initial phase of drug discovery, which involves analyzing how different molecules interact with one another—specifically, scientists need to determine which molecules will bind together and how strongly. They use trial and error and process of elimination to analyze tens of thousands of compounds, both natural and synthetic. AtomNet can reportedly screen one million compounds in a day, a volume that would take months via traditional methods.”*

Source: <https://www.pharmaceutical-technology.com/comment/artificial-intelligence-future-drug-discovery/>;
<https://singularityhub.com/2017/05/07/drug-discovery-ai-can-do-in-a-day-what-currently-takes-months/#sm.0000iwwp9t6mwf2rtqo1fmm5nefj9>

Main Trends: Large Surge of Industry Activity in 2018

Writing for BioPharmaTrend, Andrii Bavailo notes:

“The idea of using artificial intelligence (AI) to accelerate drug discovery process and boost a success rate of pharmaceutical research programs has inspired a notable amount of activity over the last several years with a considerable number of initiated research collaborations between AI-driven R&D vendors and top pharmaceutical companies in 2016-2017. A busy beginning of 2018 shows that the area is getting even “hotter” and things start unfolding faster in the emerging “AI for Drug Discovery” space. Judging by the increasing activity in the “AI for Drug Discovery space” over the last two years, it is expected that 2018 will be a year of a more widespread curiosity among BioPharma companies about AI-based technologies and tools. As a consequence, a growing number of new AI-vendors will be pitching in, offering solutions for novel use cases and more flexible collaboration models, and more research initiative will be launched on the side of “big” and “middle” pharma players. It means the market of R&D outsourcing will be growing even faster in 2018, at least in the segment of outsourcing AI, cloud and big data technologies and expertise. On the other hand, AI-vendors will face a more pressing challenge of finding ways to prove their value proposition for the pharmaceutical and biotech partners in more practical and measurable terms -- in order to overcome a growing skepticism fueled by sometimes irresponsibly overhyped claims about “AI revolution” in the mass media.”

Source: <https://singularityhub.com/2017/05/07/drug-discovery-ai-can-do-in-a-day-what-currently-takes-months/#sm.0000iwwp9t6mwf2rtqo1fmm5nefj9>

Main Trends: BioPharma Will Increasingly Utilize R&D Outsourcing & M&As to Increase their Presence in the AI for Drug Discovery Sphere

Another notable trend noted increasingly often in the media is the comparative disadvantages that pharma corporations have in terms of the internal resources necessary to do AI for Drug Discovery work on-house, and the increasing extent with which BioPharma's role in the AI for Drug Discovery race will take the form of outsourcing to AI and IT corporations, as well as through M&As.

Writing for BioPharmaTrend, Andrii Buvailo notes:

“With an increasing interest in AI-driven technologies among the leading BioPharmaceutical companies, a strategic focus of pharma and biotech businesses will be further shifting towards R&D outsourcing and M&A activity as means to quickly get access to the required expertise and know-hows. Complex nature of AI-based technologies, a need for costly and sophisticated IT infrastructure, a fast pace of progress in the field, and a relative scarcity of highly skilled data science specialists to support specialized machine learning research -- these are some of the key drivers of the ascending outsourcing trend.”

Source: <https://www.BioPharmatrend.com/post/34-BioPharmas-hunt-for-artificial-intelligence-who-does-what/>

Media Main Trends: BioPharma Will Increasing Utilize R&D Outsourcing & M&As to Increase their Presence in the AI for Drug Discovery Sphere

Writing for another article in BioPharmaTrend, Andrii Buvailo adds:

“An increasing lack of innovation in pharma seems to be among the underlying reasons why drug makers tend to outsource research to academia or CROs. However, it is rare that BioPharmaceutical companies have all the required expertise and infrastructure in-house to fully embrace the new technologies’ potential. Thus, companies more often choose to outsource their research programs to specialized CROs or academic centers focused on a particular area of knowledge and capable of providing a state-of-the-art expertise in certain areas. A vivid example when R&D outsourcing appears to be a smart approach for accessing a novel technology early in the drug discovery process is a collaboration with companies offering artificial intelligence (AI) and machine learning (ML) capabilities for big data analysis, hypothesis probing, accelerating hit exploration activities and identifying hidden dependencies in data patterns. The modern world is characterized by rapidly changing technological paradigms, exponentially growing data, and the increasing role of the interdisciplinary collaboration and expertise. Developing sophisticated in-house infrastructure and substantially expanding the count of staff with specific expertise in advanced areas of research is not only costly but also risky for a pharmaceutical company. Especially it is true at the earliest stages of drug discovery process when the uncertainty is the highest. Maintaining only the most important core functions and competencies, while outsourcing research-intensive programs with yet uncertain results to specialized CROs or academic labs, seems to be a reasonable strategy.”

Source: <https://www.BioPharmatrend.com/post/30-pharma-rd-outsourcing-is-on-the-rise/>

Section II

**Novel Technologies & Trends
(Industry Forecast 2019-2020)**

Section II: Novel Technologies & Trends (Industry Forecast 2019-2020) is devoted to in-depth coverage of the science and technology behind the industry, and to analysis of emerging subsectors within the industry, including an in-depth look at one of the forms of AI making the largest impact on enhancing drug discovery (Deep Learning), an analysis of the intersection of the AI for Drug Discovery sector with the Longevity Industry, and the convergence of next-generation AI for drug discovery with Blockchain and Digital Medicine.

- **Chapter VIII: Deep Learning in Drug Discovery** gives an in-depth overview of topics, trends and advancements occurring in deep learning for drug discovery, one of the specific forms of AI which has now emerged as the leading technology delivering practical and tangible results in the industry, and pays particular attention to the emergence of Generative Adversarial Networks (GANs) as a highly disruptive sub-class of deep learning that may come to dominate industry progress in the years to come.
- **Chapter IX: Longevity Research (AI and Advanced R&D)** is devoted to the use of AI in Drug Discovery for Longevity research, which can be considered to have started in mid-2017 with an event held at the Buck Institute for Research on Aging, at which Atomwise, BioAge and Insilico Medicine held a workshop, and which has just recently been formally solidified through Insilico Medicine being awarded the 2018 North American Artificial Intelligence for Aging Research and Drug Development Technology Innovation Award by leading business consulting firm Frost & Sullivan.
- **Chapter X: Next Generation AI, Convergence with Blockchain and Digital Medicine** charts the ongoing convergence of AI for Drug Discovery with other advanced technologies inclusion blockchain, personalised medicine and digital medicine, illustrating how these technologies and industries are being synergistically integrated so as to expedite the dynamic of progress in the AI for Drug Discovery sphere.

Chapter VIII

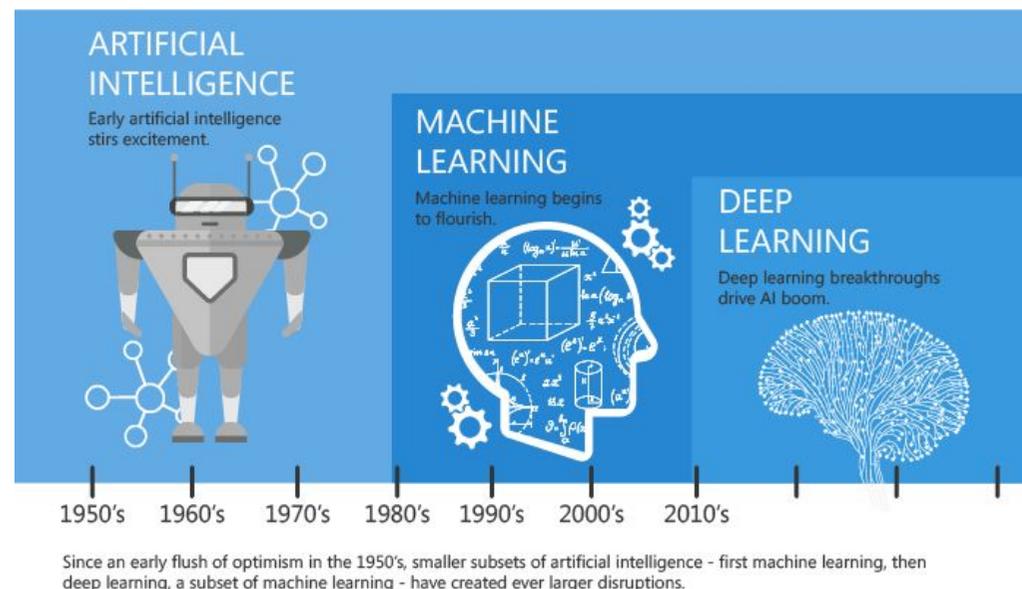
Deep Learning in Drug Discovery

Deep Learning in Drug Discovery

Deep learning is a subset of machine learning consisting of artificial neural networks, famous for its capacity to learn in an unsupervised manner by being “trained on” unstructured and/or unlabelled data.

Its distinction with respect to traditional machine learning can be best thought of as its depth - i.e., deep learning uses “deeper” layers of artificial neural networks which are layered on top of each other.

Machine learning has been in use for almost two decades in the process of drug discovery.



Since the inception of deep learning as a field, it has progressed by leaps and bounds, and has become famous in the public eye for replicating many functions which previously were once thought of as the exclusive domain of humans.

For instance, over the past few years deep learning algorithms have allowed computers to see, read, and write, in ways that are less error-prone than older, more traditional methods of AI, such as decision trees.

For instance, the use of deep learning algorithms trained to analyze and interpret medical images with an error rate of just 6%, which some experts claim to be less error-prone than human doctors. Deep learning has a place in a wide variety of healthcare niches, including medical image analysis, medical device data evaluation, sequencing data analysis, virtual drug screening, drug adherence analysis, drug efficacy analysis, metabolomic profiling, sequencing, molecule profiling, biomarker identification, and drug lead identification, virtual testing and optimization.

Source: https://www.rootsanalysis.com/reports/view_document/deep-learning-in-drug-discovery-and-diagnostics-2017-2035/156.htm

Deep Learning in Drug Discovery

Importantly, deep learning algorithms have shown substantial capacities in significantly reducing the time and cost required to bring a drug to market.

Bringing the average drug to market has been known to cost as much as \$2.5B over a period of 12 years, and deep learning algorithms have in some cases been shown to reduce the cost of bringing a drug to market by as much as 50%.

Some experts predict that the annual cost savings associated with the development and deployment of deep learning-based solutions to drug discovery could result in cost savings nearing \$100B, with nearly \$35B projected savings in the diagnostics niche alone.

One of the most ripe commercial opportunities for the picking with regards to deep learning for healthcare is the AI-supported diagnostic imaging subsector, due to the abundance of data available, as well as the consistency of how such data is organized across different databases.

One of the starkest examples of the power of deep learning is in AlphaGo, popularly known to have bet the world champion in the game Go in a remarkably short amount of time. By emulating the computational patterns of human thought in a much more naturalistic manner than, for example, traditional, brute-force decision trees, it required less computational steps in order to arrive at the decisions it needed to make, and managed to win 100 out of 100 games after training on Go data for just three days.

Remarkably, more than 55% of deep learning companies focusing on the image recognition sector are applying their efforts to diagnostic imaging. Of these 55%, a remarkable 78% focus on medical imaging. Meanwhile, out of all deep learning companies, 35% are focusing their efforts on drug discovery, and 57% of those 35% aim to provide deep learning based drug discovery platforms.

Source: <http://www.gbm.hsbc.com/solutions/global-research>



Deep Learning in Drug Discovery

Medical data can be used to build knowledge maps and then be applied to applications like AI-assisted diagnosis and diagnostic imaging. A good example of this is Watson, IBM's collection of artificial-intelligence technologies used to interpret, analyze and predict data patterns. Its global medical database includes 100m patient records, 30m images and 200m insurance records.

According to Chinabgao.com and other research institutes, 10-20% of Chinese hospital revenue comes from medical imaging, the visualisation of body parts, tissues, and organs for use in clinical diagnosis and treatment.

HSBC Research Report assume that by 2021 the charge for single-patient AI-assisted diagnosis reaches RMB3,000 and the number of diagnosis accounts for one in a thousand of the 3bn hospital visits, the size of this market size would be around RMB9bn. Industry Research Institute estimates that sales of medical robots can reach USD4.8bn by 2021 and the overall market of AI healthcare applications is likely to total RMB100bn within five years.

The current revenue model for image diagnosis and AI-assisted diagnosis is similar to that of traditional medical informatisation companies. They both generate revenue from selling software and hardware products and undertaking informatisation projects for hospitals. The application of AI technologies can increase the value of products by improving doctors' efficiency and diagnosis accuracy. Government investment in medical and healthcare generates most of the revenue.

Deep learning technology, together with cloud computing and big data, are expected to trigger a new round of technological innovation. Software companies are usually asset-light and they focus on continuous innovations and technological upgrades. Their real value lies in the quality of their research teams and the ability of the management to turn R&D into products and sales. AI drug discovery platforms have the potential to have a real impact on the pharmaceutical industry. Over just the past year, many of the big drug makers seriously examine the potential of the technology via numerous tests, official collaborations of different sizes, and licensing agreements.

Source: <https://www.techemergence.com/machine-learning-drug-discovery-applications-pfizer-roche-gsk/>

Deep Learning in Drug Discovery

Deep learning has been proven capable of achieving lower error rates in image and voice recognition and natural language processing compared to traditional machine learning algorithms. Famous in the eyes of the public for things like self-driving cars, natural language processing and image/voice recognition, its impacts on the drug discovery process have only recently begun to accumulate. So, if deep learning is supposed to be a closer approximation to the kinds of information processing occurring in the human brain, then how does it differ? One of the starkest differences is that, whereas humans require relatively little data in order to extrapolate trends and patterns, deep learning algorithms are famous for their dependence on very little data. Consider the example of a human seeing a pattern one time, and extrapolating it to other instances.

This, in deep learning, is referred to as one-shot learning. Research has shown that deep learning algorithms perform better when the datasets they are trained on are large. While work on specific architectures that allow for deep learning-based classifiers and predictors to be built that operate according to one-shot and even zero-shot learning, for now, the performance deep learning algorithms are somewhat limited to the available size of the datasets used to train them. Deep learning algorithms have proven highly effective in modeling the chemical reactions between candidate drugs and their molecular targets, through which they exert their mechanisms of action. This has allowed researchers to hone in on a much more precise suite of candidate molecules in silico, prior to in vitro validation.

While much work in the real of deep learning for drug discovery is happening in the US, such as through the work of Insilico Medicine, a Baltimore-based AI for age-related drug discovery and biomarker development company, important work in this arena is also occurring abroad as well. In the UK for example, researchers from Warwick's School of Engineering have developed a deep learning algorithm capable of predicting whether or not a candidate drug molecule will bind to its target protein with 99% accuracy. Take, for instance, the case of Chuna, which recently launched a next-generation AI development plan which includes such AI platforms as Baidu's self-driving car algorithms, AliCloud's "city brain", Tencent's medical imaging algorithms and iFlytek's natural language processing algorithms. The Chinese healthcare system is ripe for the development of deep learning algorithms, because China's network of hospitals and healthcare institutions generated vast swatches of data regularly, so much so that the digitisation, classification and processing of such data was valued at RMB30b in 2016

Source: <https://www.sciencedirect.com/science/article/pii/S1359644617303598>; <https://www.sciencedaily.com/releases/2017/12/171214144442.htm>

Deep Learning in Drug Discovery

Furthermore, the use of AI and Big Data Analysis has also made great strides in predicting the safety and predicting possible toxic side-effects of new drugs as well. In a July 2018 paper published in *Toxicological Sciences*, a team of US researchers created a machine-readable database of 10,000 chemicals based on 800,000 animal tests. Through big data analysis, the team was able to compare new chemicals (e.g. drugs) to existing chemicals in the database, and estimate the probability of toxic effects by comparing it to its degree of similarity to chemicals in the database. It essentially performs the work of a human toxicologist in an automatic fashion.

One of the strongest results of the teams study is that their big data-based analysis is actually more accurate than animal tests for certain types of toxicity, because it compares a new drug's probability of toxic side effects to data on the effects of a chemically similar drug derived from more animal models than could ever be feasibly conducted in a study.

This study is a very strong source of validation for the AI for Drug Discovery industry because it effectively demonstrated that AI and Big Data analysis can assess the safety profile of new drugs not only faster than humans, but with greater accuracy as well.



NEWS • 11 JULY 2018

Software beats animal tests at predicting toxicity of chemicals

Machine learning on mountain of safety data improves automated assessments.

Source: <https://academic.oup.com/toxsci/advance-article/doi/10.1093/toxsci/kfy152/5043469>; <https://www.nature.com/articles/d41586-018-05664-2#ref-CR1>

Computer toxicity test to put an end to animal testing

On 12th July 2018 Clive Cookson wrote for the Financial Times that Scientists in the US have developed the first computer system that can predict instantly the toxicity of any new chemical, more accurately than expensive, contentious and time-consuming animal tests.

On 11th July 2018 in a paper published in Toxicological Sciences, the authors reported that its algorithm can accurately predict toxicity for tens of thousands of chemicals, a range much broader than other published models achieve, across nine kinds of test, from inhalation damage to harm to aquatic ecosystems.

To improve the software, Thomas Hartung (a toxicologist at Johns Hopkins University in Baltimore, Maryland) and his team created a giant database with information on roughly 10,000 chemicals based on some 800,000 animal tests. These data were originally collected by the European Chemicals Agency (ECHA) in Helsinki as part of a 2007 law known as REACH (registration, evaluation, authorization and restriction of chemicals), which requires companies to register safety information for most chemicals marketed in the European Union. As of May 2018, the closing date for registrations, the agency had received information on more than 20,000 substances.

The next steps for the project include strengthening the database, by including more forms of toxicity and persuading holders of proprietary data such as drug companies to contribute information in an anonymised form that preserves corporate confidentiality.

According to Nature, other researchers and firms are developing machine-learning algorithms, too, although they have not published papers about their work. Mike Rasenberg, head of computational assessment at the European Chemicals Agency (ECHA), said that in the EU, the ECHA has also encouraged companies to avoid animal tests by using read-across and methods based on analysis of lab cells where possible.

Sources: <https://www.ft.com/content/4be6617e-85dd-11e8-96dd-fa565ec55929>
<https://www.nature.com/articles/d41586-018-05664-2>

Chapter IX

AI and Advanced R&D for Longevity Research

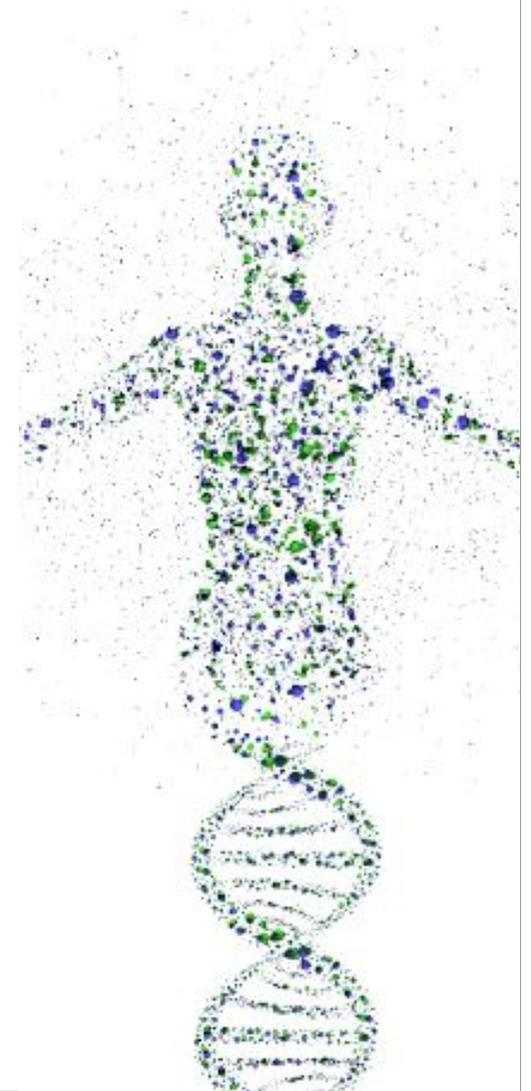
“ We have the means right now to live long enough to live forever. ”
~Ray Kurzweil

The following chapter describes the manner in which these technologies combine to form an industry.

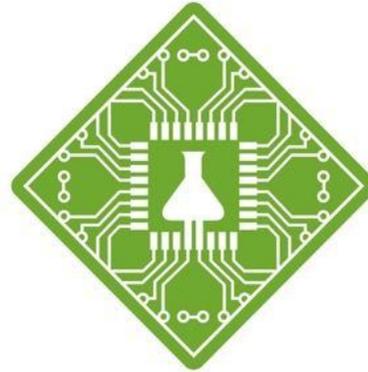
But any industry worthy of the Industrial Revolution title must have some form of automation or technological optimisation, and a system of finance behind it.

This chapters examines how AI and blockchain technology form the engine of the future industry, and touches upon some novel financial systems.

“I see a bright future for the biotechnology industry when it follows the path of the computer industry, the path that von Neumann failed to foresee, becoming small and domesticated rather than big and centralized. ” ~Freeman Dyson



AI Companies in Longevity



INSILICO MEDICINE



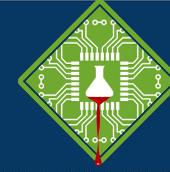
Atomwise
Better medicines faster.

Atomwise



BioAge

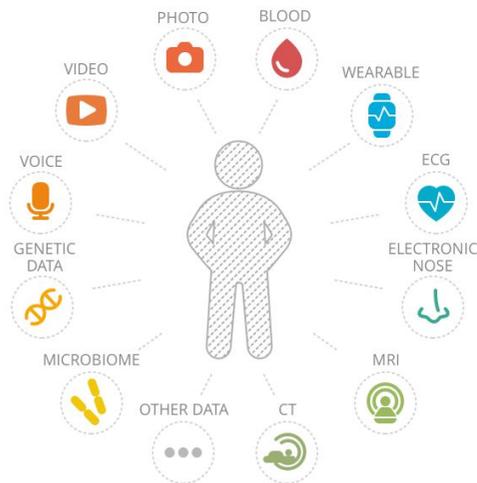
Insilico Medicine Aging.AI 2.0



INSILICO MEDICINE

One of the most promising projects developed by Insilico Medicine is called Aging.AI 2.0, which is an AI-empowered platform integrating multiple predictors of clients age and used to track changes of health over time and optimize clients lifestyle.

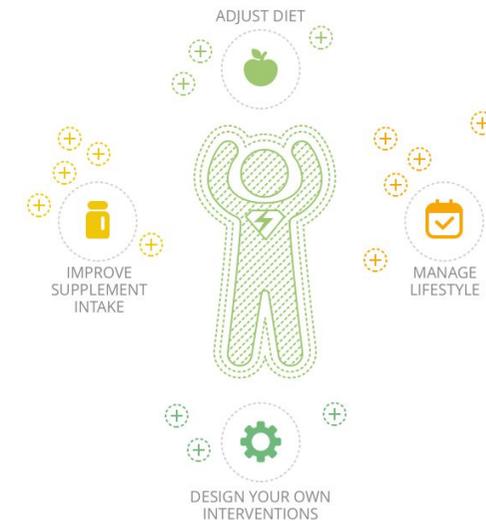
<http://young.ai/>



Track your age
at every level!



See what makes you
younger or older!



Stay young!

Insilico Medicine



INSILICO MEDICINE

Insilico Medicine's mission is to extend healthy longevity through innovative AI solutions for drug discovery and aging research. Insilico Medicine is committed to transforming the pharmaceutical industry with next-generation artificial intelligence. They are developing new tools for drug discovery and repurposing, biomarker development and pursuing novel strategies for rapid validation. Their projects combine advances in genomics, big-data analysis, deep learning and reinforcement learning.

Insilico Medicine and Biotime announced in 2016 the launch of a beta version of Embryonic.AI, an artificially intelligent system for analyzing the embryonic state of human cell samples using gene expression data.

Insilico established in 2017 a collaboration with GSK to discover novel biological targets and molecules. As a first stage of the collaboration, GSK will evaluate Insilico's technology in the identification of novel biological targets and pathways of interest to GSK.

In 2018 a collaboration occurred between Insilico Medicine and Juvenescence AI Limited, which is a drug development and artificial intelligence company focused on ageing and age-related diseases. Juvenescence AI combines advances in artificial intelligence with classical development expertise in order to prioritize and develop compounds from Insilico Medicine, Inc.'s end-to-end automated drug discovery pipeline through to clinical proof of concept.

By using AI and deep learning, the company can analyze how different compounds will affect certain cells, determine what drugs can be used to treat the symptoms, and any possible side effects that may occur.

Even though it's only been around a few years, Insilico has already been named by NVIDIA as one of the 5 top AI companies. With R & D resources spread out across the globe in the UK, Russia, and Belgium and a backing of \$14 million behind it.

Sources: https://www.eurekalert.org/pub_releases/2017-08/imi-iec081417.php
<https://www.businesswire.com/news/home/20180205005024/en/Insilico-Medicine-Juvenescence-Announce-Drug-Candidate-Joint>



Atomwise is the creator of AtomNet, the first Deep Learning technology for novel small molecule discovery, characterized by its unprecedented speed, accuracy, and diversity.

Today, drug-resistant bacteria and pandemic viruses threaten to send us back to the time of plague and smallpox. Persistent, neglected diseases remain a dark spot on our collective conscience. And while we're all living longer, diseases of aging like Alzheimer's still have no cure. Atomwise has the unique ability to research hundreds of millions of potential medicines rapidly, making it fundamentally easier to tackle these big problems.

Atomwise's AtomNet platform uses structural information to predict binding between molecular targets and small molecules by processing millions of data points regarding successful and unsuccessful ligand-binding interactions. The company has more than 50 molecular discovery programs, including confidential projects with AbbVie Inc. and Merck & Co. Inc.

In April 2017, Atomwise started a program to motivate academic scientists to explore the drug-hunting potential of its technology. Researchers can apply to the company's Artificial Intelligence Molecular Screen (AIMS) awards program by identifying the disorder they hope to treat, and the disease-causing biomolecules they want to defeat with a drug. Successful applicants will receive 72 compounds that Atomwise predicts are most likely to work as that drug.

Atomwise has been partnering up with big pharmaceutical firms, biotechnology companies, and university research labs in an effort to speed up the discovery of new drug candidates for neurodegenerative diseases, cancer, and other disorders. In June, the startup also announced a collaboration with Monsanto to find compounds that might protect crops against pest infestations and diseases.

Source: <http://www.chematria.com/>
<http://www.4-traders.com/ABBVIE-12136589/news/AbbVie-AI-drug-discovery-company-Atomwise-raises-51M-series-A-26122374/>
<https://www.xconomy.com/san-francisco/2018/03/07/atomwise-raises-45m-to-grow-ai-driven-drug-discovery-business/>

BioAge



BioAge is committed to contribute to and support the evidence-based medical approach to a healthy lifestyle, accomplished through diet, exercise, supplementation and the use of integrative medicine.

The overall aim of the proposed staff exchange programme is to build, extend and strengthen sustainable international collaborations between the partners so as to create a knowledge base for biomarker based research related to aging, sampling techniques in the elderly and biomonitoring studies.

BioAge develop biomarkers and drugs that impact human aging by coupling genomic data with machine learning. BioAge is building a platform that doesn't require waiting for its subjects to actually age. Instead, it wants to measure biological age using signals floating in a drop of blood.

BioAge Labs raised \$10.9M in Series A financing to accelerate drug discovery for aging in 2017. BioAge is betting on the power of high-throughput human data, coupled with innovative machine learning, to substantially accelerate drug discovery for aging. The company take a hybrid experimental and computational approach to identifying the molecular signatures that drive aging, working with multiple partners in academia and industry. The funding will enable BioAge to build their team, refine and test their signatures of aging, and begin in vivo evaluation of drug candidates. Their initial targets for drug development will be specific diseases where aging is causal; however, their ultimate goal is more ambitious—to combat the suffering and disability caused by all aging-related diseases, and to restore both the quality and quantity of life that is so often lacking in old age.

Sources: <https://medium.com/@BioAge/bioage-labs-raises-10-9m-in-series-a-financing-to-accelerate-drug-discovery-for-aging-31974fcb3229>
<http://bioage.com/about.html>
<https://a16z.com/2017/07/28/bioage/>

Biomarkers of Aging

While many anti-aging interventions have demonstrated life-extending or other geroprotective effects in model organisms, practical limitations continue to hamper translation to the clinic. One problem is that the evaluation of aging changes and possible anti-aging remedies requires a comprehensive set of robust biomarkers.

Large-scale longitudinal programs like MARK-AGE have been launched to analyze changes in multiple biomarkers during aging and correlation between biological and chronological age. Several “aging clocks” able to predict human chronological age using various biomarkers have already been proposed. Methylation-based markers such as epigenetic aging clocks are currently the most accurate, while transcriptomics and metabolomics have shown to be less so.

Recent studies show that biomarkers of age-related pathologies could be used to evaluate senescence modifications based on the connection between age-related pathologies at the signaling pathway level. However, most of these biomarkers are not representative of the health state of the entire organism or individual systems and are not easily measured or targeted with known interventions.

Machine learning (ML) techniques, such as support vector machines (SVM), are routinely used in biomarker development and rapid increases in labeled data are enabling deep neural networks (DNNs). Methods based on deep architectures have outperformed classical approaches not only in image analysis, but also in solving a wide range of genomics, transcriptomics and proteomics problems.

Using Artificial Intelligence (AI), **Insilico Medicine** has developed a system that measures the biological age using readings found in a common blood test. Insilico Medicine calls it the Aging Clock, and it is based on biomarkers of aging found in our blood chemistry. Insilico Medicine says its number-crunching has yielded the most precise measure of a person’s biological age. To develop their algorithm, the company used AI techniques to analyze the blood tests of an international group of 130,000 people.

Sources: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4931851/>
<http://longevityfacts.com/ai-based-app-measures-bodys-aging-clock/>

Biomarkers of Aging

Vadim Gladyshev, Professor of Medicine at Brigham and Women's Hospital, Harvard Medical School:

"The use of the new tool to track human biological age may enable discovery of drugs and other interventions that target the fundamental process of aging, thereby delaying the onset of all chronic diseases at once, instead of targeting one disease at a time. The project has parallels with MouseAge, a tool for assessing biological age in mice, which we develop jointly with In Silico Medicine."

Insilico Medicine, Inc., a Baltimore-based company specializing in the application of artificial intelligence for drug discovery, biomarker development and aging research, announced in 2018 a publication of a research paper titled "Population-specific biomarkers of human aging: a big data study using South Korean, Canadian and Eastern-European patient populations" in The Journal of Gerontology. Insilico believe AI will transform biomarker development and drug discovery much sooner than most pharmaceutical companies and regulators expect.

In the paper, the authors present a novel deep-learning based hematological human aging clock, a biomarker that predicts the biological age of individual patients.

In 2017 the company announced the launch of the Beta 1.0 version of YOUNG.AI. The first version was publicly unveiled on September 12th, 2017 at the 4th Aging Research for Drug Discovery Forum and the Artificial Intelligence and Blockchain for Healthcare Forum in Basel, Switzerland, 11-13 of September. The beta 1.0 version features deep learned photographic and basic blood biochemistry-based predictors of age as well as the ability to track drug and supplement intake.

Sources: https://www.eurekalert.org/pub_releases/2018-01/imi-apd011118.php
https://www.eurekalert.org/pub_releases/2017-09/imi-ant091117.php

AI for Drug Discovery is Now Recognized as an Official Niche within the Longevity Research & Geroscience Community

While work being done by the companies discussed above has been progressing now for several years, the inauguration of AI for Drug Discovery and biomarker development as a legitimate niche within the broader longevity research, recognized as such by thought leaders and major players within geroscience, can be considered to have occurred in Q4 of 2017, when several leading AI for Drug Discovery companies focused on longevity research held a mini-conference at the Buck Institute for Research on Aging, the United State's most well-funded non-profit research institution devoted to aging research and the development of healthspan-extending interventions.

In a press release associated with the conference, Buck Institute CEO Eric Verdin stated: "The Buck Institute for Research on Aging generates an enormous amount of biological data, which has intriguing possibilities for combining with AI. We would like to explore synergies and invite the AI community from the Bay Area and all over the world to learn about our progress and contribute."

The min-conference featured talks by researchers from Insilico Medicine, Atomwise, Numerate, BioAge and Illumina.



AI & LONGEVITY MINI CONFERENCE
AND MEETUP @ THE BUCK INSTITUTE
FOR RESEARCH ON AGING
WITH THE CEO, DR. ERIC VERDIN

DECEMBER 14, 2017, NOVATO, CA

- ★ Get a tour of the largest biomedical research center focused on longevity
- ★ Learn about the latest research in artificial intelligence for drug discovery and biomarker development from top experts
- ★ Hear personal stories about career changes from IT to longevity research
- ★ Mingle with AI experts from the Bay Area and Silicon Valley
- ★ Learn how to get involved and contribute to aging research



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Juvenescence
Ageless Generation

HEAR THE STORIES FROM THE EXPERTS



Buck Institute Brings Insilico Medicine CEO on as Adjunct Professor to Spearhead their AI for Longevity Research Activities

Following this mini-conference, the Buck Institute also acquired Insilico Medicine's CEO Alex Zhavoronkov as an Adjunct Professor, in order to spearhead the Buck's activities in utilizing the latest advanced in AI and deep learning for longevity research.

The fact that the leading aging research foundation in the United States is devoting their time and resources towards the use of AI and deep learning for geroscience research is yet another indication that AI, machine learning and deep learning is now recognized as a legitimate niche within the broader geroscience community.

In a press release associated with the announcement, Buck Institute CEO Eric Verdin stated:

“We are incredibly excited about the potential of AI to accelerate aging research. The Buck has been at the forefront of asking the most important questions in the field. Now, with the latest in bioinformatics and artificial intelligence, and with the involvement of world-class experts like Dr. Zhavoronkov, we will finally have the tools to answer them. Fully utilizing these powerful technologies, we will dramatically increase our understanding of how aging works, and what we can do about it.”



AI for Drug Discovery in Longevity Research Reaches a New Degree of Credibility Through Frost & Sullivan's Best Practices Award

Meanwhile, in 2018, AI for Drug Discovery as a legitimate and official subsector within the broader longevity research landscape, and longevity research as a legitimate niche within the broader drug discovery landscape, attained a new degree of recognition.

This occurred when leading business consulting firm Frost & Sullivan awarded Insilico Medicine the North American Artificial Intelligence for Aging Research & Drug Development Technology Innovation Award, as part of their 2018 Best Practices Awards.

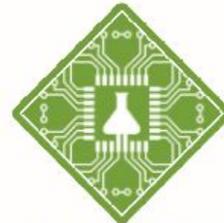
More than this, the fact that a highly respected business consulting firm like Frost & Sullivan created a specific category of award for this specific area of research and development is highly indicative of the increasing level of repute that AI in Drug Discovery for aging research is garnering from both the broader geroscience community as well as the wider drug development communities.

This new development may also serve to highlight the high degree of synergy that is possible through the convergent integration of two cutting-edge and highly innovative classes of R&D.



Insilico Medicine Earns Accolades from Frost & Sullivan

F R O S T & S U L L I V A N



INSILICO MEDICINE

2018 North American Artificial Intelligence for Aging Research
and Drug Development Technology Innovation Award

Insilico Medicine Technology Innovation Score

FROST & SULLIVAN

BEST PRACTICES RESEARCH

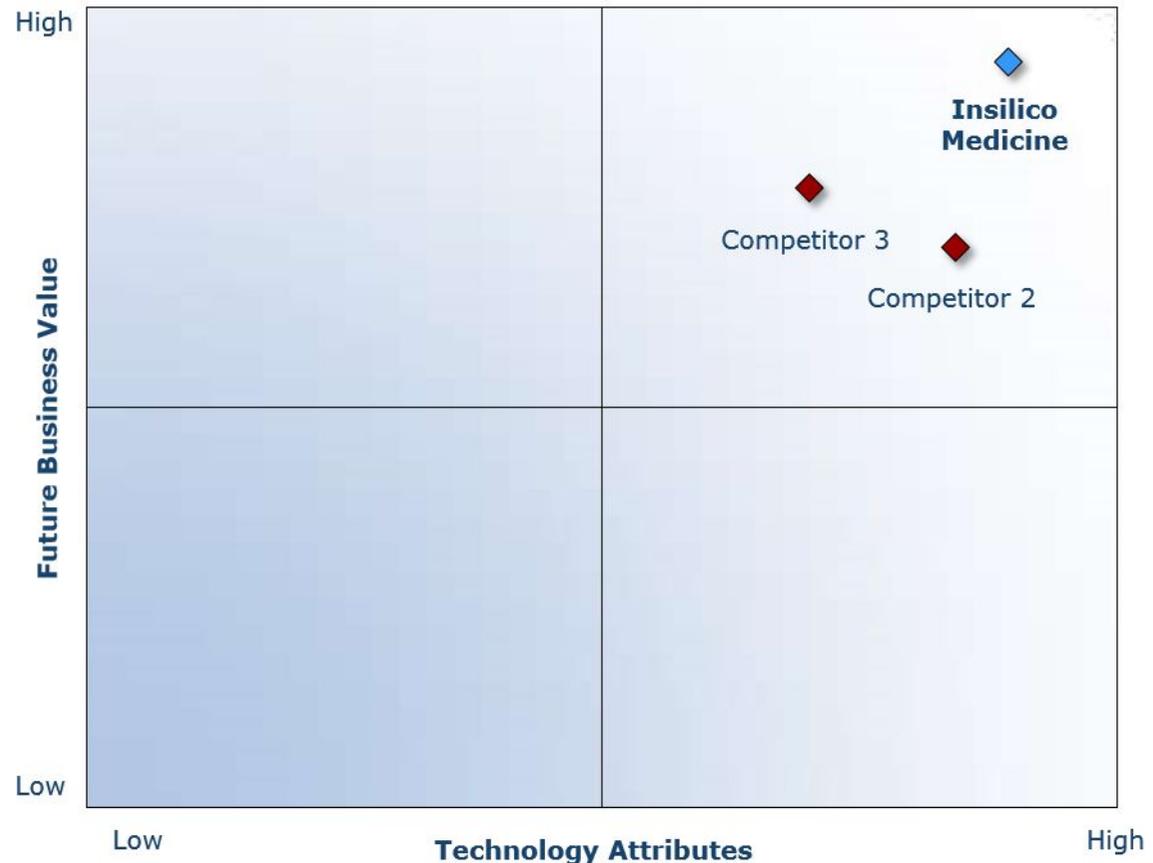
The results of this analysis are shown below. To remain unbiased and to protect the interests of all organizations reviewed, we have chosen to refer to the other key participants as Competitor 2 and Competitor 3.

<i>Measurement of 1-10 (1 = poor; 10 = excellent)</i>			
Technology Innovation	Technology Attributes	Future Business Value	Average Rating
Insilico Medicine	9.0	9.0	9.0
Competitor 2	8.0	7.0	7.5
Competitor 3	7.0	8.0	7.5

Insilico Medicine's Future Business Value & Technology Attributes Ranking in Comparison to Top 2 Competitors

The analysis performed by Frost & Sullivan included an estimation of the winning business' future value and technology attributes. Assessing the company's technology attributes involved analyzing its industry impact, product impact, scalability, visionary innovation and application diversity, while assessing the company's future business value involved analyzing its financial performance, customer acquisition, technology licencing, brand loyalty and human capital.

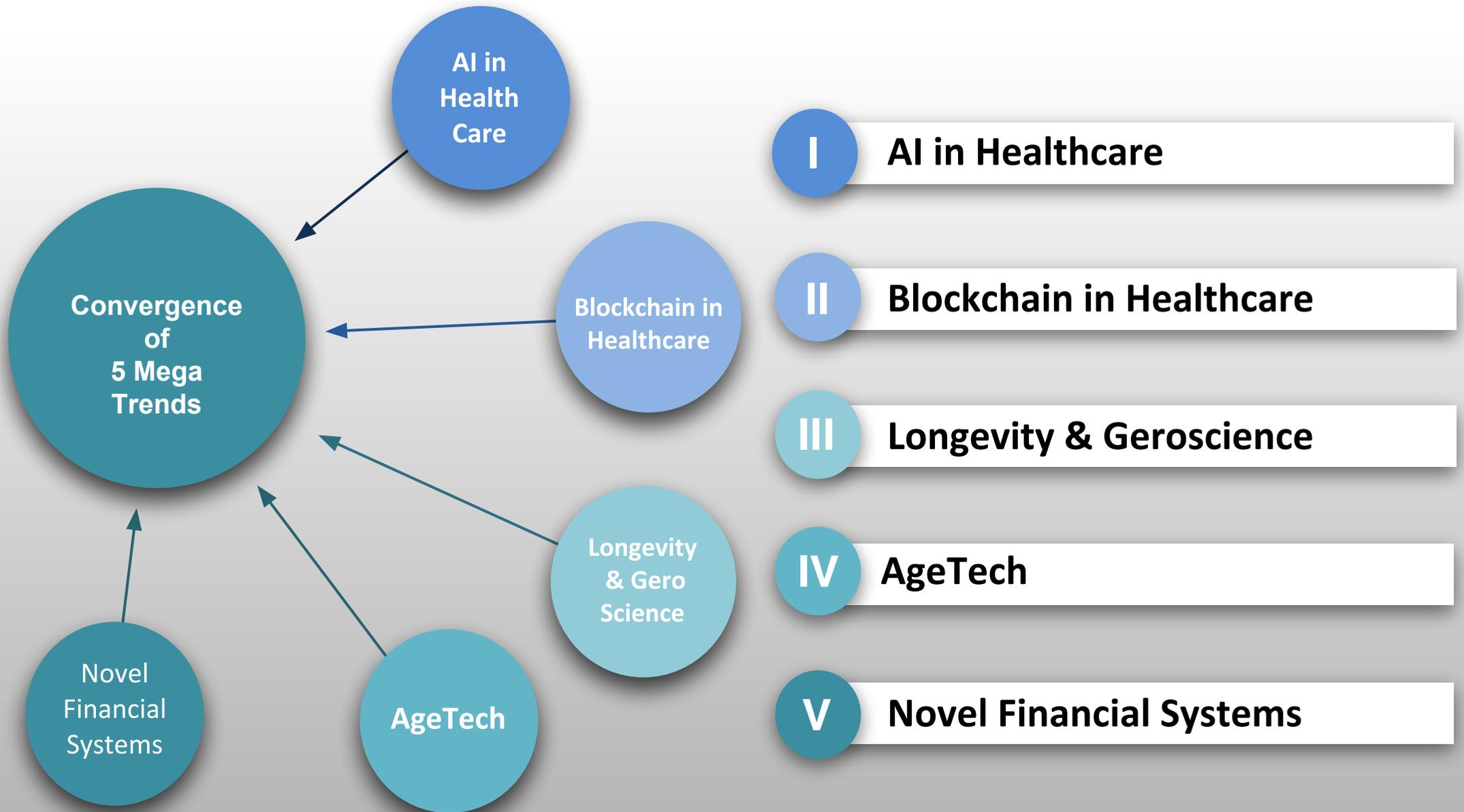
As Frost & Sullivan explain in their report: "Technology innovation begins with a spark of creativity that is systematically pursued, developed, and commercialized. That spark can result from a successful partnership, a productive in-house innovation group, or a bright-minded individual. Regardless of the source, the success of any new technology is ultimately determined by its innovativeness and its impact on the business as a whole"



Chapter X

Next Generation AI for Drug Discovery
and Biomarker Development:
Convergence with Blockchain and Digital Medicine

5 Mega Trends to Disrupt the BioTech & BioMedicine Industries in the next 5 Years



Consequence: The Major Shift in the BioMedicine Industry

The emergence to the AI and Blockchain technologies in Biopharma and Biomedicine industry will start the rapid development of these technologies, the mass emergence of new startups and the fundamental changes in the world politics and economy

The window of opportunity to launch such technology startup will remain open for maximum 2 years from now. After that, the market will be full and these new nowadays technologies will be adapted by the large corporations and governments in the next 5 years

In this period, approximately to 2022, the pharma companies will openly embrace the AI and Blockchain technologies and will focus on their development instead of relying the 'old-school' technologies, which are in use nowadays.

2017

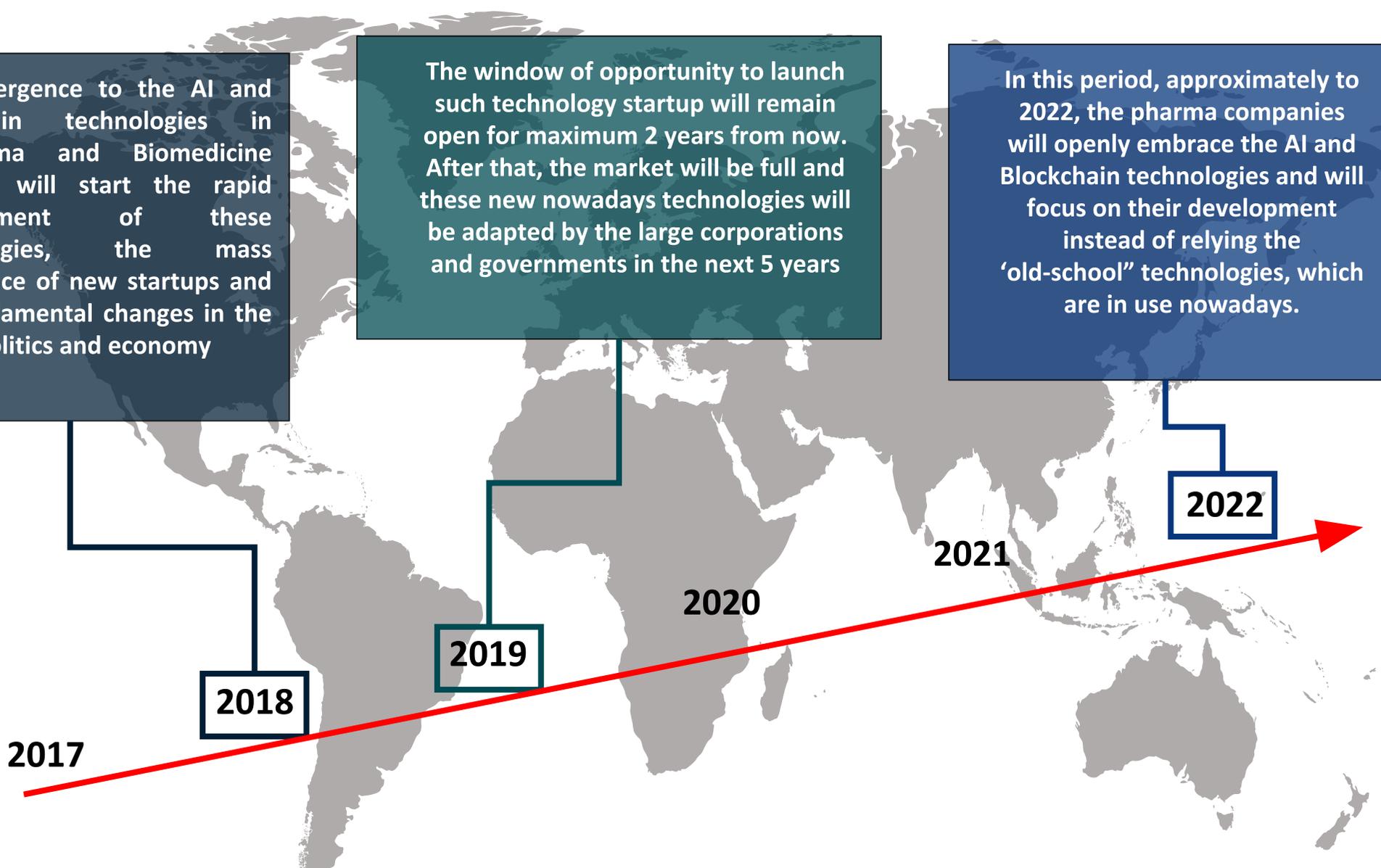
2018

2019

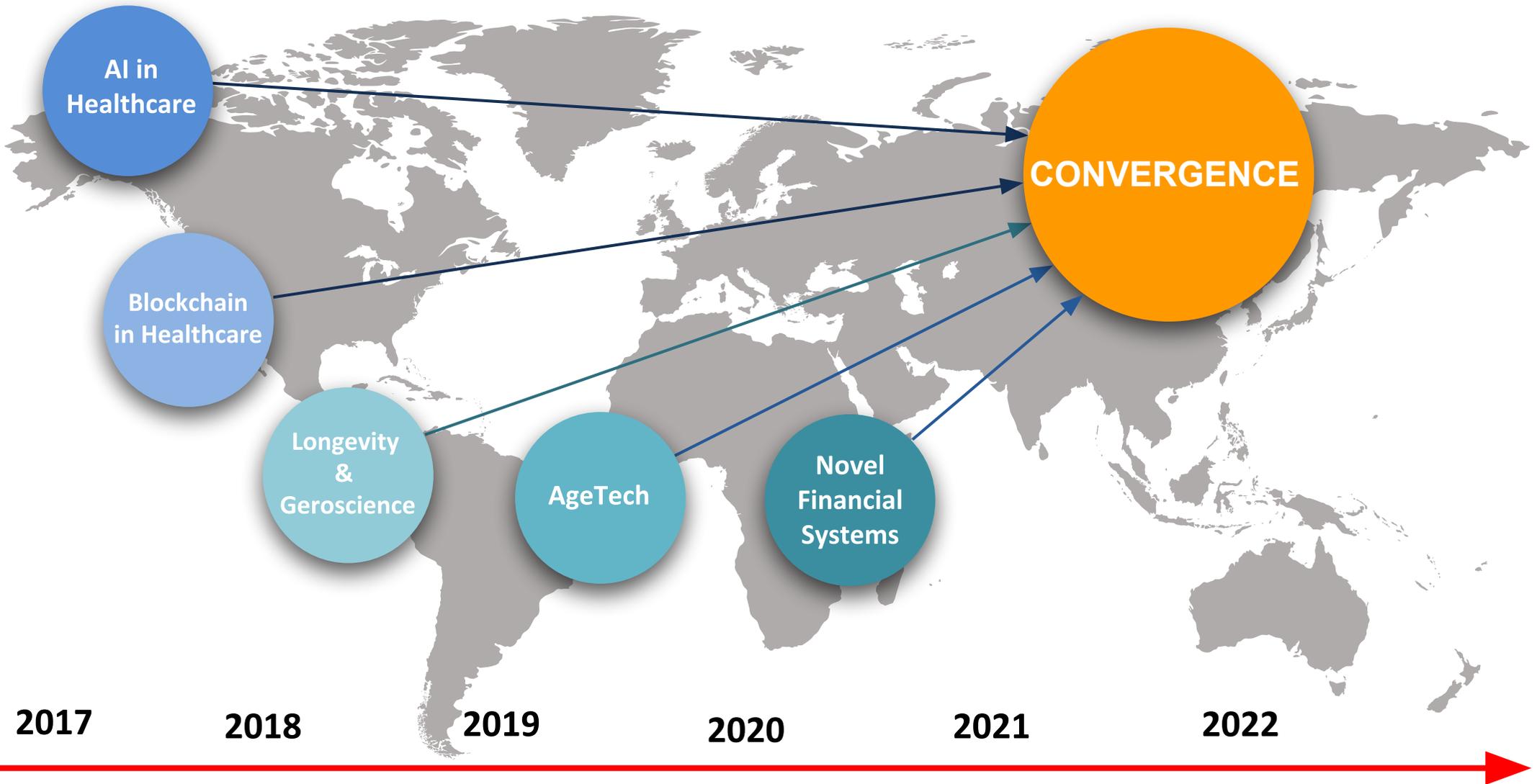
2020

2021

2022



Convergence of 5 Mega Trends



Convergence of Technological MegaTrends

5 Mega Trends to Disrupt the BioTech & Venture Capital Industry in 5 Years

Major Disruption on the Horizon

The BioPharma and BioMedicine industry is now on the edge of a major shift which will happen in 2018-2019.

There is clear evidence of this today, but due to the significant inertia pervading the BioPharma industry relating to the traditional business model of pharmaceutical companies and heavy government regulations, the capacity for the industry to translate novel trends into actual practice is significantly lacking.

We have major evidence for these emerging trends all around us, but for several specific reasons they are only recognized by a few top executives in the industry. Those executives that don't begin to recognize these trends and act accordingly will be responsible for colossal industry failures in the next 5 years.

The window of opportunity to board this departing train is 1, maximum 2 years from now and in the next 5 years the first pharma company to openly embrace AI at the C suite and board level focusing on their own development instead of relying on the "old-school" technology companies, will see its stock skyrocket.

Major Disruptive Trends:

- I. **AI in BioPharma and Healthcare**
- II. **Blockchain and Next Generation IT in Healthcare**
- III. **Longevity & Gero Science**
- IV. **Broken VC and BioPharma Business Model and Novel Financial Systems**
- V. **AgeTech**

Convergence of Technological MegaTrends

I. Artificial Intelligence

- AI in Healthcare is rising very fast. There have been several deals worth tens to hundreds of millions of dollars in just the past few months alone
- As this trend continues it will mostly be applied by existing IT corporations, with the exception of areas such as electronic health records and digital pathology where these do not have access to the data
- These advances will occur much faster than even the most optimistic scenarios, outperforming even the speed of AI development demonstrated by the big IT corporations of today - Google, Facebook, NVIDIA, Baidu, etc.
- The continuous development of software, the rise of the sharing economy, the distribution and processing power and AI, along with the convergence of all these niches causes transformation at a global scale making the right forecasting for healthcare and BioPharma in particular, needed, and where key players should switch from thinking of niche areas to a much more holistic and inclusive approach
- One of the most important patterns in this emerging area is AI in Drug Discovery, and it holds the greatest disruptive potential. It has begun to penetrate into Big Pharma's drug discovery departments at a rapid pace

II. Blockchain in Healthcare

- This will take the form of blockchain integration into healthcare governance systems, into telemedicine mobile apps for securing and transmitting personal medical information, and into systems for analyzing and optimizing healthcare business processes, among others
- The overarching trend will be blockchain as healthcare's backend
- Its speed of penetration is enormous and on the rise, and its speed of penetration into new fields that could benefit significantly from enhanced protection of data and enhanced logistical optimization, like the healthcare industry, is huge

Convergence of Technological MegaTrends

III. Longevity & Healthcare

- Longevity is another major trend, but is much more complicated than the above 2 trends
- With AI, this window of opportunity is very short. For longevity it is much longer - around 5 years
- The window of opportunity is longer for longevity, but its potential to disrupt the field is also much larger
- Because the window of opportunity is larger, there is much more time and opportunity for Pharma to begin activities within this emerging trend

IV. A Broken VC and BioPharma Business Model

- During recent years we have seen significant stagnation in the VC industry, not only in biotech but many other industries
- The industries most affected are those with big requirements for DeepTech, advanced R&D
- This stagnation is due to the outdated model of typical VC funds, which made sense 5-10 years ago, but not so much nowadays
- There is an emerging phenomenon already disrupting the typical VC industry, known as Initial Coin Offerings and Crypto Liquid Venture Funds, applying advances in blockchain and cryptocurrencies to create radically progressive and dynamic investment models
- VC funds, in the US in particular, are also beginning to recognize the disruptive potential of this new investment model
- These new investment models and instruments are in a sense like the merger of VC funds and Hedge Funds, with all their advantages and fewer of their disadvantages

Convergence of Technological MegaTrends

- VC funds sometimes have very high profits but very low liquidity. Hedge funds typically have lower profits but very high liquidity
- These new investment models have both - high profits and very high liquidity
- We can predict that 2018 will be the threshold moment when many promising biotech startups will begin receiving substantial investments in the form of angel financing and crypto fundraising

V. AgeTech

- A fifth major trend will be what can be called AgeTech - the integration of FinTech and HealthTech
- Financial services designed for the aging demographic that integrates cutting-edge FinTech services with emerging geoscience and P3 (personalized, precision and preventive) medicine therapies to deliver optimized financial and healthcare services for elderly citizens
- The aging demographic is rising rapidly and will witness enormous growth over the next 20 years.
- AgeTech services will serve to extend the healthy, productive and functional years of elderly citizens' lives and will promote them to remain in or re-enter the workforce, enhancing their lives and the economy simultaneously

"It's vital that individuals and businesses recognize the tremendous potential of this longevity revolution. Our aging population could generate the most significant opportunity of our lifetime."²¹⁶

– Andy Sieg, Head of Merrill Lynch Wealth Management

-Milken Institute, Silver to Gold

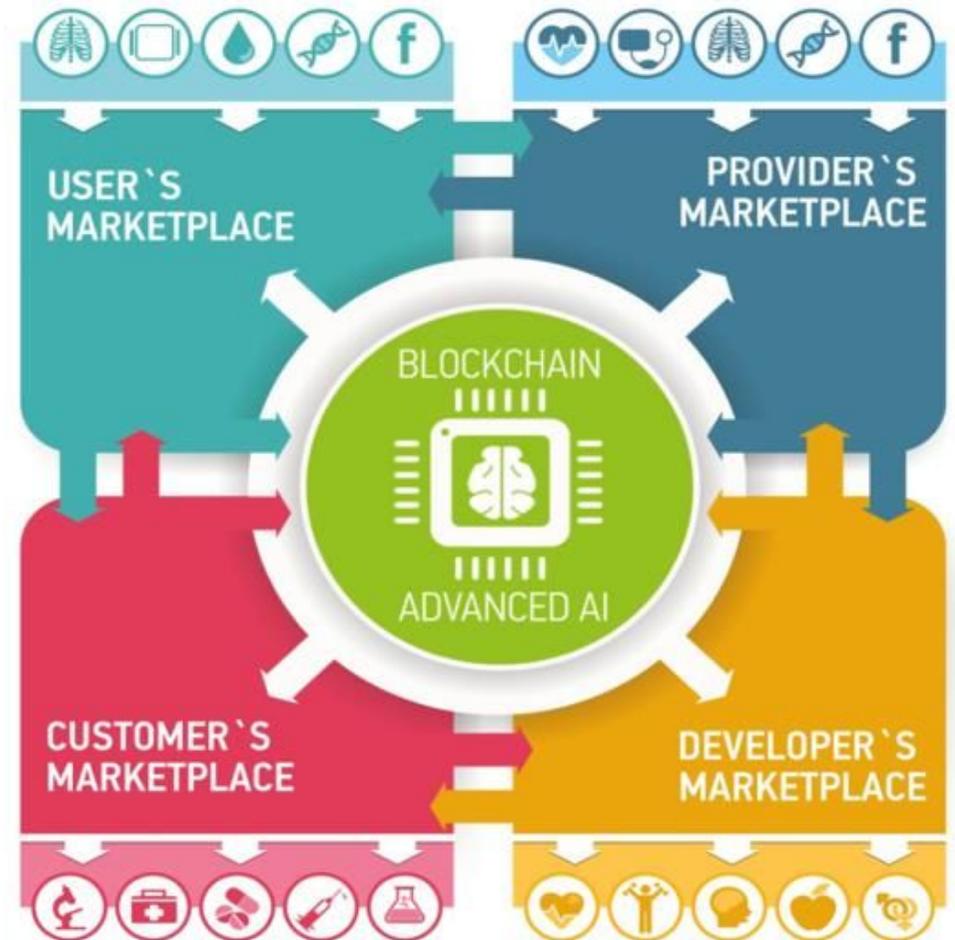
Convergence of Technological MegaTrends

VI. Conclusions

- Keep an eye on these 5 rapidly emerging trends - AI in Healthcare and Drug Discovery, Blockchain in Healthcare, Geroscience and Longevity, AgeTech and Crypto Liquid Venture Funds
- In 5 years these 5 areas will disrupt the BioMedicine and BioPharma industry nearly beyond recognition to what it is today as well as many other industries
- It is well known that professionals are unable to see these trends on a grand scale, the real transformation will happen because of convergence between all these 5 trends in combination. This convergence will further influence the acceleration at an unforeseen rate that requires deep forecasting
- The era of venture capital and unadaptable BioMedicine and BioPharma companies in this industry is coming to a close with ample opportunity for them to adapt or die making way for up and coming R&D groups and startups that take advantage of these new technologies and financing mechanisms.
- Development of the BioMedicine and BioPharma industries will be faster than anyone can imagine including the pessimists and optimists because of the convergence of these trends, the more the number of dimensions, the greater the acceleration as the industry leapfrogs into a new era.
- These megatrends will become much clearer in the next two years and we will make adjustments to these megatrends in 2018 when the picture becomes clearer and we can forecast the synergy between the rate of acceleration of these trends and of their convergence

Next Generation AI for Drug Discovery and Biomarker Development Convergence with Blockchain and Digital Medicine

- In 2018, even more extreme challengers and disruptors will arrive with the convergence of next generation AI, blockchain and precision medicine.
- Longgenesis is a revolutionary blockchain-based personalized medicine Data Marketplace platform built by Insilico Medicine and Bitfury that provides modular toolsets coupled with integrated advanced
- Artificial Intelligence systems to store, manage, and trade life data: social network data, health data and medical records.
- Longgenesis will redefine the relationships between healthcare companies and patients. By facilitating a fast and easy way to contribute or purchase data along with an integrated deep learning AI, enterprises can save much money on R&D while users will for the first time be compensated for their Life data efficiently and ethically.



Digital Health

Digital health covers a broad range of applications and areas. This includes mobile health, health information technology, wearable devices, telehealth and telemedicine, and personalized medicine.

The digital and genomic revolutions in particular hold great potential for digital health: while it took 10 months to sequence a genome in 2007, today it takes as little as just one hour.

Digital health concerns itself with the following goals:

- Reducing inefficiencies and costs
- Increasing quality of care
- Improving access
- Making medicine more personalized

Over \$16 billion have been invested in 800+ digital health companies since 2014; \$3.5 billion in the first half of 2017 alone, but no unicorns so far. Healthcare is an old industry with traditional institutions that struggle to innovate; hence the high interest in investing in up and coming, innovative startups.

This means that digital health startups need early funding for a relatively extended period of time - compared to the average apps and platforms - before they can start reaping the benefits of their work in contrast to apps and platforms.

Data also represents another challenge for these companies. The metrics of success for healthcare companies are harder to come by and usually take a long time to come by.

Digital Health

1. Digital Health Interventions:

Interventions delivered through digital technologies, such as smartphones, website, text messaging hold great potential to healthcare delivery making it more efficient, effective, accessible, and personalized. This is an area of interest particularly to insurance companies, since it can improve success rates for treatments and reduce patient readmissions.

2. Doctor-Patient Interaction:

Documentation requirements have taken over the patient encounter in many specialities. Digital solutions that streamline the documentation workload and allow doctors to give their full attention to the patient are currently being developed. Some of solutions being tested include head mounted displays that stream the doctor-patient interaction to a remote transcription center.

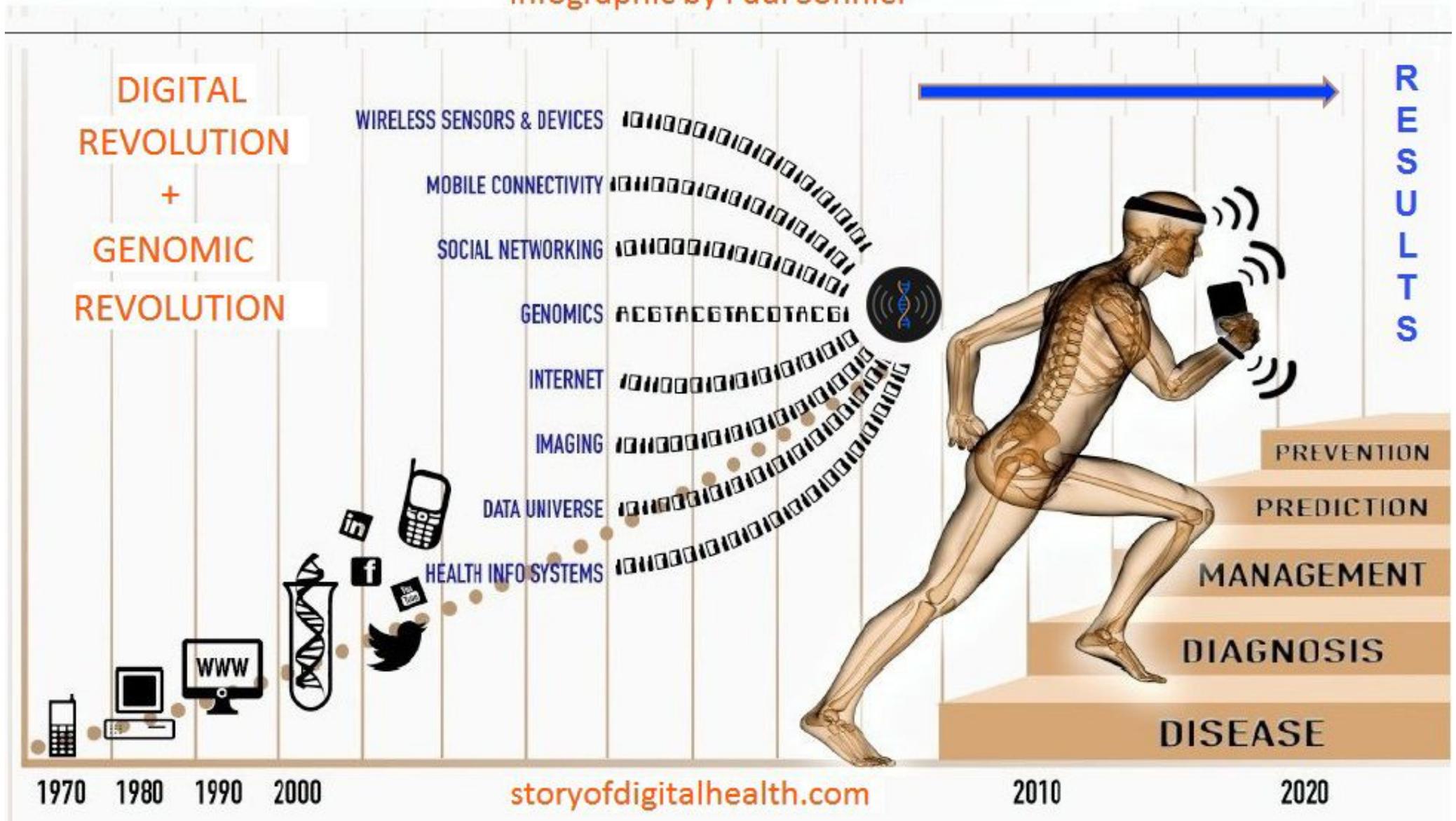
3. Big Data:

Companies have so much data that they can model the risk factors associated with a given patient or procedure, i.e. assume the likelihood of someone being readmitted or the recovery time. In another instance, looking at thousands of cases, and taking the patient's own history in context, companies can draw conclusions on whether a certain procedure might be riskier for a given patient.



THE DIGITAL HEALTH REVOLUTION

Infographic by Paul Sonnier

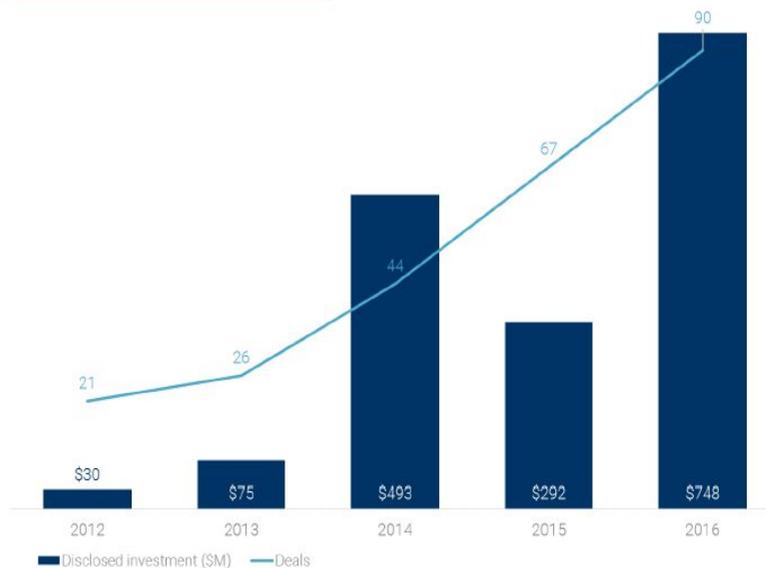


Artificial Intelligence

Much of the current commercial applications of AI concern what is known as weak artificial intelligence, aka narrow AI; think Google, Apple, or Amazon's personal assistants that use natural language processing to understand a query then do a relatively simple search, taking into consideration a few factors from your history and behavior. A truly artificially intelligent system is one that learns on its own, is capable of processing very large amounts of data and digging up associations, and imitates human behavior. We are just beginning to scratch the surface of AI in healthcare.

When talking about Artificial Intelligence in healthcare, more often than not, Big Data is the first topic that comes into discussion. Digital data is growing at an exponential rate - by 2020, the data created annually will reach 44 trillion gigabytes. Tech titans such as Google or IBM, are trying to tap the potential of patient data mining using their AI tech. It is worth noting that IDC predicts that the worldwide spend on AI and cognitive computing will reach \$46 billion by 2020.

ANNUAL FUNDING HISTORY



Alphabet, the parent company of Google, recently launched the Google Deepmind Health project. Deepmind Health is able to process hundreds of thousands of medical information entries within minutes. This will enable providers to provide better and faster health services. Google also aims to employ the same algorithms that power its search engine to genetic data in the hopes of understanding what makes people healthy.

IBM on its part, is using Watson technology to power WatsonPaths. The aim is to help physicians make informed and accurate decisions, faster, and to glean insights from electronic medical records.

AI in healthcare dominates all other industrial applications of AI in terms of equity deals, raising \$1.8B across 270 deals since 2012.

Artificial Intelligence

Real artificial intelligence is already being used to detect diseases. According to the American Cancer Society, a large number of mammograms yield false results - as much as half of healthy women are wrongly diagnosed with cancer. AI, on the other hand, is able to review and translate mammograms 30 times faster, and with a 99% accuracy rate.

This is possible because we are able to train algorithms to tell the difference between groups of pixels that represent cancer versus groups that don't. The algorithms constantly learn. Software is able to process millions of those images, or others, in a day.

Gartner predicts that by 2025, half of the population will rely on "virtual personal health assistants" powered by AI. These personal assistants would be cognizant of a user's unique medical conditions, history, and genetic makeup and able to incorporate them in its decision making. Automating primary care needs is also a great boon to the elderly demographic in particular, who typically lacks mobility. These assistants will help seniors remain independent for longer, and reduce the need for hospitalization or staying in nursing homes. Overall the progress of AI implementation in healthcare will carry great reduction in costs and time.



AI for instance will be able to accelerate drug development and make it more cost effective; by contrast, the costs of developing pharmaceuticals through clinical trials can reach billions of dollars and can take more than a decade.

Banks have embraced machine learning quickly, looking more like IT firms with each passing day, but the executives of pharma have been less agile. Top managers are avoiding risk rather than showing results. They don't want to be the executive who reduced earnings by engaging in advances IT capex. However, in neglecting disruptive technological risk, they are failing to hedge properly. The same is true of countries, including the United Kingdom.

Blockchain

We have already discussed the power and importance of Blockchain technology in creating trust in the ecosystem.

Trust to share health data, which is paramount to harnessing the power of biological science and research.

We also went over the value that blockchain can offer when it comes to logistical matters, such as maintaining and unifying health records, establishing a log of accountability and transparency, as well as fighting counterfeit drugs.

All of those advances are a great boon to the longevity industry.

But to delve deeper into the effects of blockchain on longevity, there has been accumulating evidence that suggests that aging is linked to genetic and epigenetic alterations.

Epigenetic, by definition, describes the study of changes in gene expression that do not involve changes to the underlying DNA sequence, instead arising from nongenetic influences on gene expression.

Given the reversible nature of epigenetic mechanisms, they provide promising avenues for therapeutics against age-related decline and disease.

Looking at epigenetic data, deep learning algorithms can predict the risk of a disease in time to prevent it.

However, ensuring security and privacy in transmitting and storing personal epigenetic profiles will require building a new and open data ecosystem.

Blockchain has the potential to do just that.

1 Health organizations direct information to the blockchain

Health organizations provide service two patients

Clinical data is tracked in existing Health IT systems

Standard data fields and a patients public ID are redirected to the blockchain via APIs

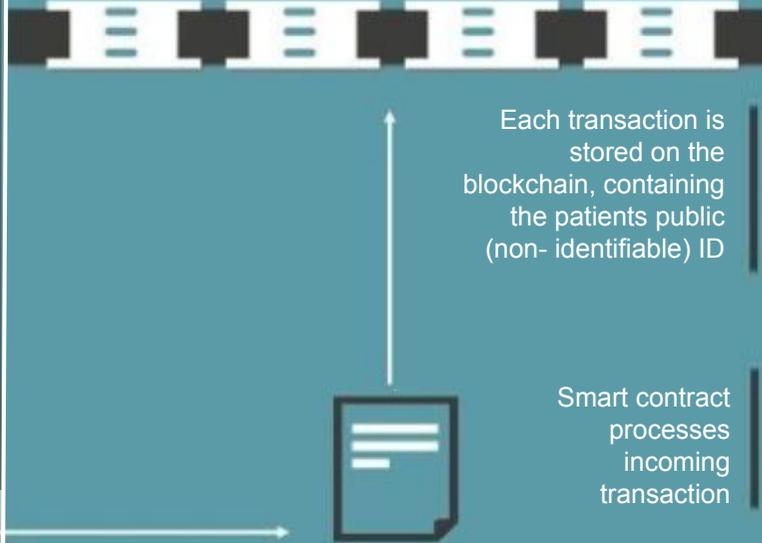


2 Transactions are completed and uniquely identified

Blockchain

Each transaction is stored on the blockchain, containing the patients public (non-identifiable) ID

Smart contract processes incoming transaction



3 Health organizations and institutions can directly query the blockchain

Health organizations and institutions submit their queries via APIs

Non-identifiable patient information (e.g. age, gender, illness) is viewable

Data can be analyzed to uncover new insights

Blockchain



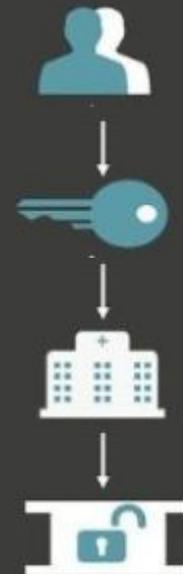
4 Patients can share their identity with health organizations

The patients private key links their identity To blockchain data

The private key can be shared with new health organizations

With the key organizations can then uncover the patients data

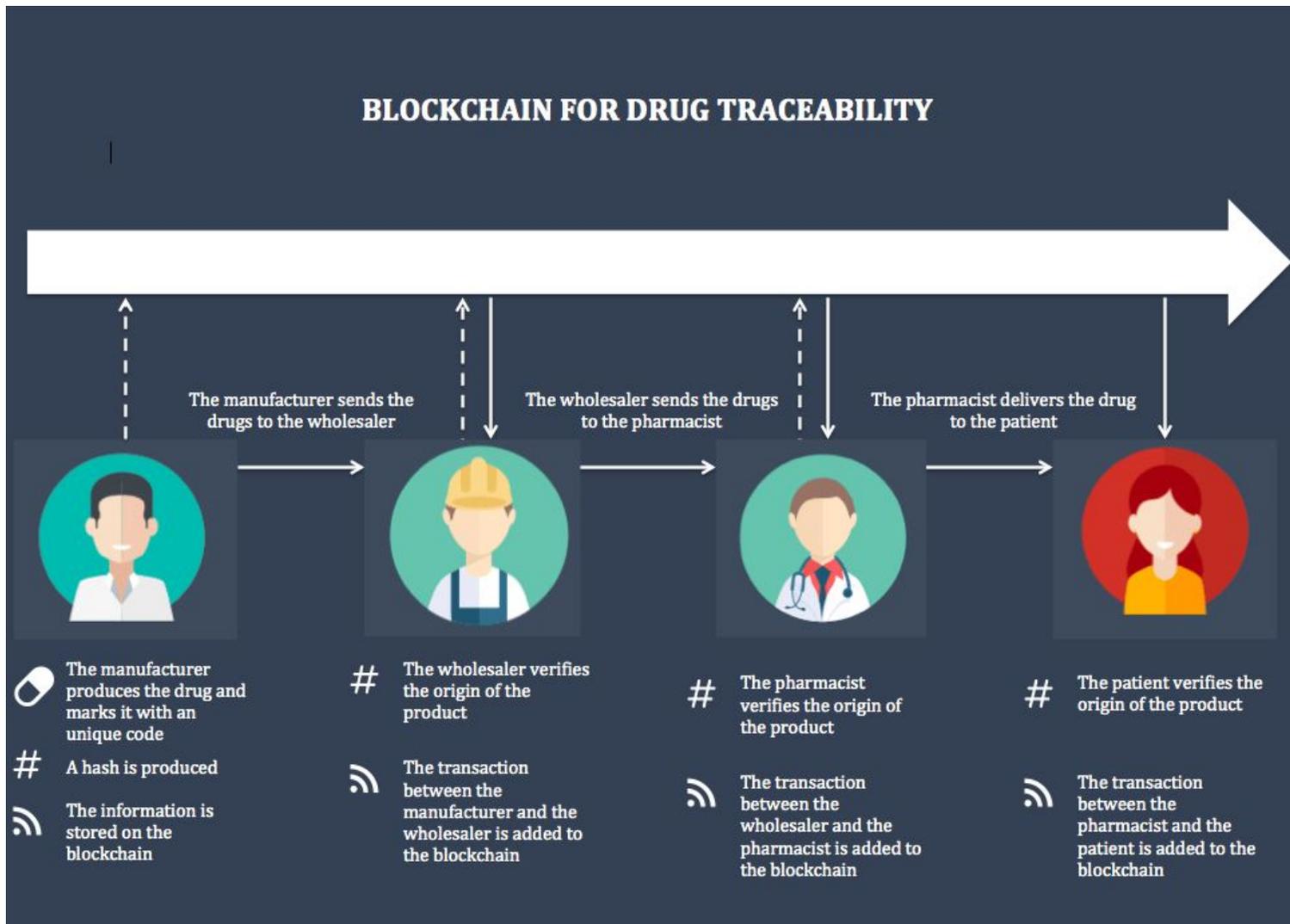
Data remains non-identifiable to those without the key



Blockchain will enable secure and verifiable sensitive data storage and sharing, while allowing patients to choose to share their individual data with relevant parties such as doctors and researchers, as well as for clinics to access non-identifiable patient data through queries via APIs.

Each patient is assigned their **private key** to enable sharing of their data which remains unidentifiable to anyone from the outside without the key.

Blockchain



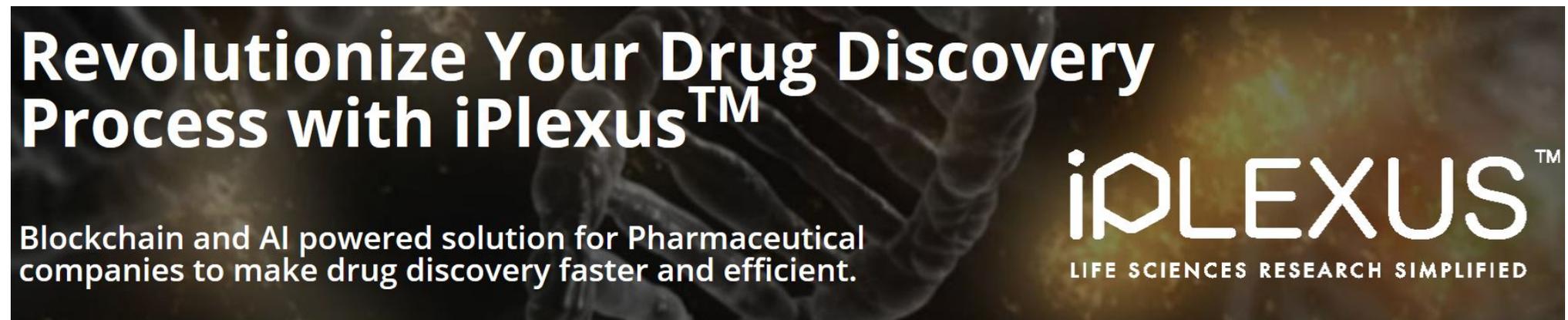
Another interesting use-case for blockchain in the BioPharma industry is utilizing distributed ledgers to record where a drug has come from and where it has been received as an immutable and transparent mechanism for ensuring drug traceability so as to avoid fraud.

Blockchain: Combined AI & Blockchain Platforms for Drug Discovery are on the Horizon

In May 2018, Innoplexus announced the launch of iPlexus, an AI and blockchain-based platform to democratize drug discovery. The project aims to give researchers a blockchain and AI-driven platform for posting and using unpublished data from both successful and failed experiments, with IP being secured on the blockchain so as to be immutable and transparent. Meanwhile, AI will perform analysis of the data uploaded to the blockchain in order to rank it in terms of its value for drug development R&D.

In an associated press release Gunjan Bhardwaj, CEO of Innoplexus AG, stated:

"Our mission at Innoplexus is to democratize the drug discovery process. We believe that cutting-edge technologies like AI and blockchain are the key to making this possible. After over 6 months of research, we believe that the new iPlexus is a major step forward for the preclinical trial industry and will solve many of the problems that are slowing the industry down. By overcoming these challenges, we will make drug discovery more efficient and bring down the consumer price of drugs."

The advertisement banner features a dark background with a faint, glowing molecular structure. The text is white and bold. On the left, it reads "Revolutionize Your Drug Discovery Process with iPlexus™". On the right, the iPlexus logo is displayed, consisting of the word "iPLEXUS" in a stylized font with a small "i" and a trademark symbol, followed by the tagline "LIFE SCIENCES RESEARCH SIMPLIFIED" in a smaller, all-caps font.

Revolutionize Your Drug Discovery Process with iPlexus™

Blockchain and AI powered solution for Pharmaceutical companies to make drug discovery faster and efficient.

iPLEXUS™
LIFE SCIENCES RESEARCH SIMPLIFIED

Source: <https://www.prnewswire.com/news-releases/new-blockchain-and-ai-based-platform-to-revolutionize-drug-discovery-300654106.html>

83% of Surveyed Pharma Executives Expect Blockchain to be Adopted in the BioPharma Industry within Next 5 Years

A 2017 survey conducted by The Pistoia Alliance, an international nonprofit that works to lower barriers to innovation in life sciences R&D, among senior pharmaceutical executives found that industry interest in blockchain has increased dramatically in recent years, with 83% of respondents stating that they expected blockchain to be widely adopted in the pharmaceutical and life sciences industry in the next five years.

In an associated press release, Pistoia Alliance President Steve Arlington stated:

"We are entering a future where individuals have cheap and ready access to their genomic profile or ancestral history, for as little as \$100. The potential of this data to advance research and development efforts is huge. But this potential will only be realised if the industry can work out how to safely and securely store and share sensitive data. Right now, blockchain is a technology originally created for use in the financial services industry, but by working together, the life sciences industry can take advantage of its secure attributes. The Pistoia Alliance was formed to foster collaboration between the life sciences industry and its stakeholders in other sectors – our aim is to support our members' blockchain initiatives and provide a forum for such partnership."

Pistoia Alliance consultant Nick Lynch added:

"The dynamics of power are changing and patients today have become more empowered – we are seeing a shift to a transformative age of 'the patient will see you now'. In the future, patients will even have the possibility of monetising access to their personal data, giving individual companies access to 'blocks' of their data for research purposes. This shift – where patients have access to and control over how their data is used – is changing the entire model of healthcare from early R&D all the way to frontline delivery. Ultimately, patients will want to manage their personal data the way they manage their bank accounts. The life sciences industry must collaboratively explore solutions that enable patients to do this, while ensuring they retain access to data for their own R&D efforts."

Source:

<http://www.drugdiscoverytoday.com/view/46077/83-of-life-science-leaders-believe-blockchain-will-be-adopted-within-five-years-finds-survey-from-the-pistoia-alliance/>

P3 medicine

Precision, preventive, and personalized medicine, also known as P3 medicine, represents the next evolutionary step from reactive disease care. In contrast to the latter, P3 covers three functions: the early detection of factors responsible for diseases (predictive), reducing the likelihood of diseases (preventive), and therapy that focuses uniquely on each patient (personalized).

P3 medicine is made possible thanks to the convergence of three trends:

One is the advances in systems medicine - a field of study that looks at the systems of the human body as part of an integrated whole that are affected by biochemical, physiological, and environment factors - particularly its increased ability to understand the complexity of diseases.

Two is our increased ability to collect, store, and analyze data.

And three, an ever easier access to information afforded to consumers about their own health data, leading to a rise in their active interest in managing their health.

The human genome is made up of about 25,000 genes, but some genes may not be fully expressed, some genes share multiple responsibilities, and each gene encodes multiple proteins, all of which produces very complex interactions. This is where supercomputers come in.

They are able to model biological networks and simulate the functioning of these networks to identify any perturbation, or disease, and the therapies most likely to 'fix' the network.

P3 medicine is much more effective than the medicine we know today. While the current status is marked by increasing healthcare costs, the promise of P3 is that it could lead to better health for consumers and an industry that is more efficient financially.

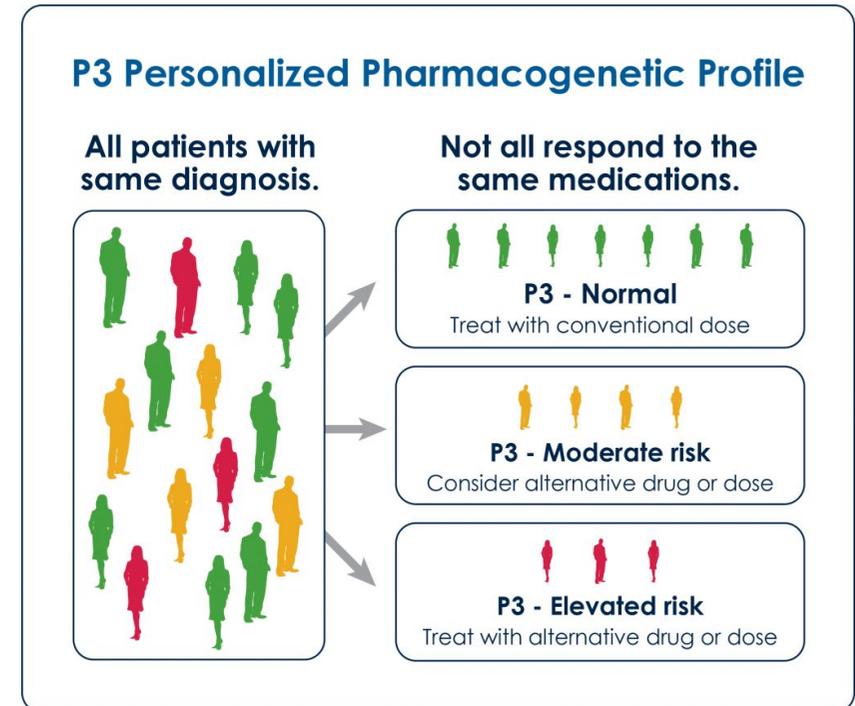
P3 Medicine

Personalized medicine is an interdisciplinary field that is entering the market with a promise to revolutionize the industry. Personalized medicine can be defined as an approach in healthcare that creates therapies based on individual characteristics of the patients.

Personalized medicine is used in conjunction with the precision and preventive medicine to form the P3 Medicine. The core ideas of the P3 approach are:

- Take **personal** traits of the patient into the consideration
- **Predict** diseases before they do any substantial damage
- **Prevent** diseases when possible, rather than to treat them

P3 Medicine stands as a key enabler in the longevity technology framework that ties multiple innovations in a single industry,



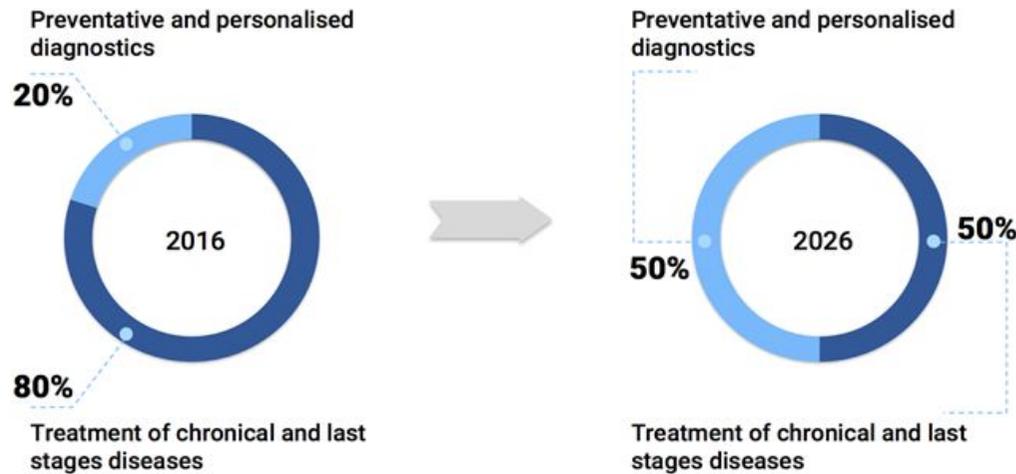
Source: <http://arcpointos.com/pharmacogenetics-testing/>

P3 Medicine mirrors another notable trend in modern healthcare, gene therapy. While the latter is using advancements in genetics and related fields in order to treat diseases by altering patient's genome, P3 looks to learn from one's genetics instead of altering it. This approach can be seen as a safer and less invasive one.

The strongest point of P3 medicine from the longevity perspective is the fact that it is **already being partially implemented** while having enormous potential for further development.

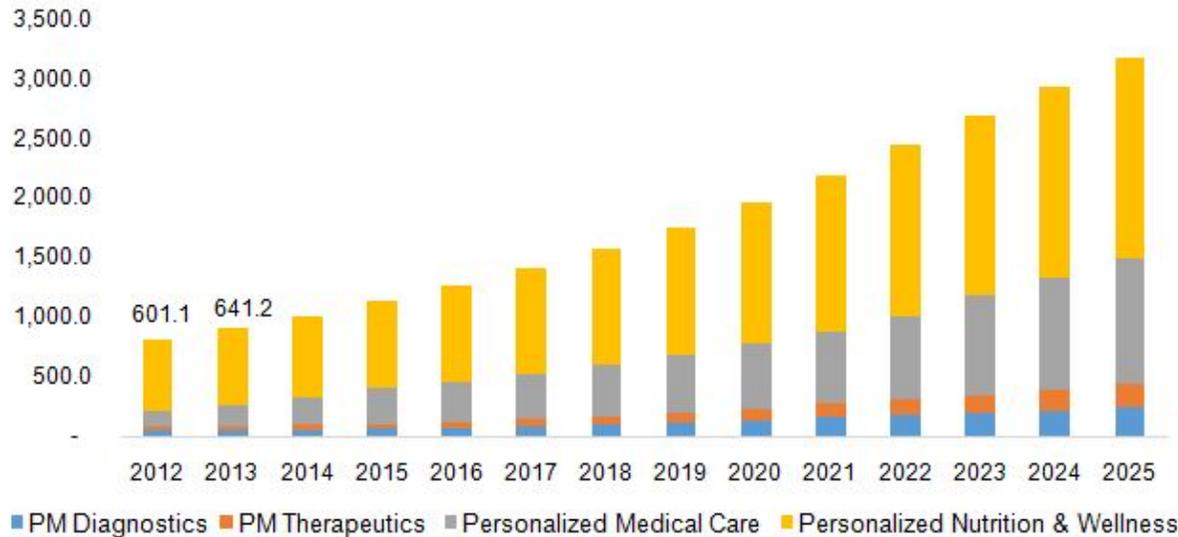
P3 market is expected to develop significantly over the course of the next ten years. This is because P3 Medicine is a complex structural change for the healthcare industry that heavily relies on other **emerging technologies** that are also expected to be fully developed in ten years.

P3 medicine



It is expected that personalized and preventive approaches in the treatment of chronic diseases will become the prevalent one by 2026.

The changes in healthcare systems together with emerging technologies will double the P3 medicine market by 2022.



Source:
<https://www.grandviewresearch.com/industry-analysis/personalized-medicine-market>

AgeTech

*“We need a seismic shift from collective responsibility for retirement to individual responsibility.”
~ Laurence D. Fink*

AgeTech is the amalgamation of Fintech and Healthtech. Age-friendly banks use technology to attract and protect vulnerable older customers.

A person's financial decision-making ability peaks roughly in their mid-50s, and begins to deteriorate afterwards. Elderly people in general struggle with day-to-day banking activities, are more susceptible to poor investment choices and financial fraud; the average age of victims of mass-marketing scams is 75.

Barclays for instance uses voice recognition to help customers who have trouble with passwords. Other fintech solutions for the elderly focus on mobile technology: the devices currently found on the market aren't friendly to the elderly populations. A revolution in AgeTech then is very much dependant on the spread of mobile devices that are easy to use for old people. Only then will banks be able to unlock mobile banking for that demographic.

More significantly, algorithms are helping banks spot any alarming changes in behavior - such as spending patterns - which could signal trouble.

Managing people's money can shed light on their health

A much more intriguing pattern is emerging: banks are well placed to spot elderly individuals who are at risk. A decline in financial management skills can be an early sign of health problems, dementia for example. Banks will be able to refer a person to a doctor. In addition to spotting financial abuse, some banks are currently training their staff to spot dementia.

AgeTech and the Shifting Retirement Landscape



Commenting on the changing retirement landscape in a 2013 speech to NYU Stern MBA students entitled *Longevity in the Age of Twitter*, Laurence D. Fink, CEO of BlackRock and an NYU Trustee raised the spectre of the Silver Tsunami:

“When I was growing up, the U.S. was launching the Great Society, which sought to summon the resources of government to wipe out poverty. Today, the generation that came of age with the Great Society is headed for retirement and giving you a Grey Society – where we will need to summon up even greater resources just to meet their needs.”

Turning to the role of technology in managing senior finances:

*“ We need a seismic shift from collective responsibility for retirement to **individual** responsibility. ”*

By adapting to the changing biological reality of each individual’s as they age, the growth of AgeTech hands back to old people their former individual decision making capacity, putting the wisdom of individual life experience back behind the grey pound.

Objective forecasting for 2018 - 2022 (applying TRLs)

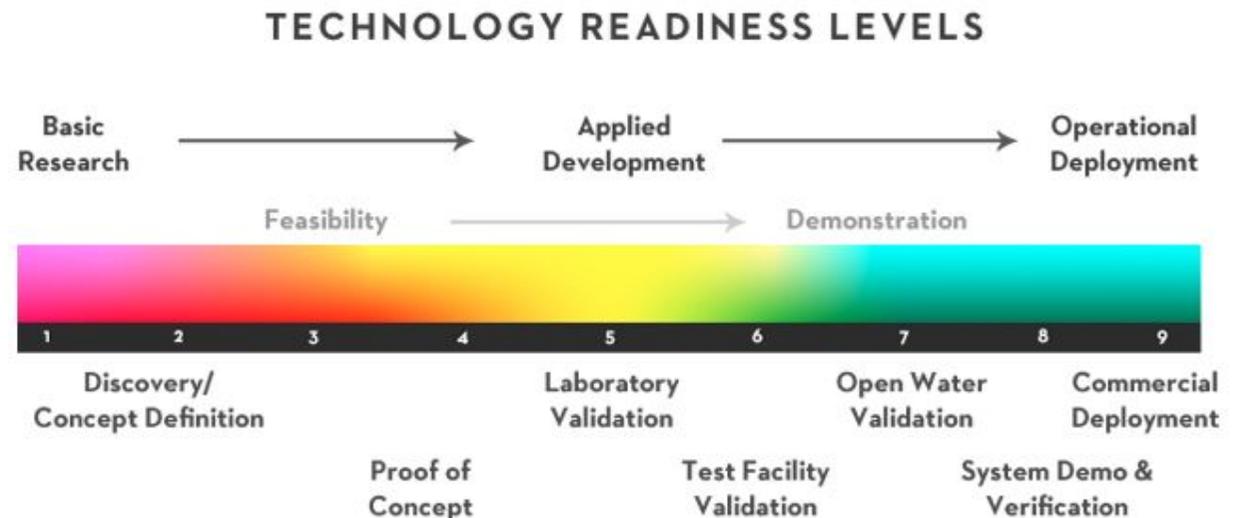
Technology readiness levels (TRLs) enable the gauging of the maturity of Critical Technology Elements (CTEs) determined during a Technology Readiness Assessment (TRA) that examines program concepts, technology requirements, and demonstrated technology capabilities.

TRL use a ranking 1 - 9, with 9 being the most mature technology, with specific TRL levels being assigned to specific technologies by a group of scientific experts familiar with each specific technology. The use of TRLs enables consistent, uniform discussions of technical maturity across different types of technology.

In the coming years, TRLs can underpin efforts to shed light on the most important technologies, but also those that are at present furthest away from their practical application; therefore enabling the right timing and focus to ensure the accomplishment of specific endpoints with regard to each emerging technology, and the interactions that are possible between technologies that are currently at different points on the TRL scale, but can be expected to merge in level over the coming few years.

Using TRLs can expedite progress in the coming 5 years by employing TRLs to provide an objective lens through which various technologies are viewed.

In the same way that using this scale has benefited the aerospace industry, it can bolster the efforts of the life sciences industry in the coming years.



Exponential acceleration of further progress

We have barely scratched the surface when it comes to the applications of technology in healthcare.

Technology grows exponentially: according to Moore's Law, computer processing speed doubles every 18 months. Although the healthcare industry is typically slow to progress, the growth driven by innovative tech should accelerate the progress exponentially.

Another factor enabling this acceleration is the growth of outside players: big and small companies looking to capitalize on gaps in the market will drive advances in diagnostics and treatments faster than traditional medical institutions. According Mary Meeker's latest report, venture capitalists in Silicon Valley are increasingly hiring bio experts to help guide their investments.

Artificial Intelligence, for instance, is expected to reach \$6.6 billion in 2021, at a compound annual growth rate of 42%. By 2020, it is expected that conditions such as cancer and diabetes will be diagnosed in minutes using cognitive systems. By 2025, AI systems are expected to be implemented in 90% of the U.S., and 60% of the global hospitals and insurance companies will have implemented AI systems, which will be able to deliver quality care to 70% of patients at a reduced cost.

Innovation in immunotherapy, such as checkpoint inhibitors - a type of drug that boosts the immune response against cancer cells - is growing at 139% CAGR. Scientists are still trying to nail down an algorithm for its effective use. Once realized, the market for checkpoint inhibitors could reach \$21.1 billion by 2020.

Now that the media hype dust has settled, 3D Printing for organ or tissue repair carries huge potential in healthcare. The 3D printing business for healthcare is expected to reach approximately \$6 billion in 2025.

Conclusion

The whole will become bigger than the sum of its parts when the following 5 technology megatrends converge:

- AI in biomedicine
- The adoption of blockchain
- Progress in longevity and geroscience
- New financial systems and AgeTech.

These megatrends are going to converge **very fast** in the coming 5 years. Therefore the window for startups to enter this new market will be closing swiftly over the course of the next few years. By 2022, the big companies will openly begin to embrace these new trends, whereupon the leaders of the AI for Drug Discovery race (whether they are startups, BioPharma corporations or IT/Tech corporations) will adapt to work with the transformed industries.

“Given the increasing cost of drug discovery, development and clinical evaluation, it is clear that the clinical translation of geroprotective interventions will be increasingly led by the private sector, and by parties who have the resources to sustain the increasing financial burden of bringing truly effective longevity therapeutics to market.” - Dmitry Kaminskiy, Managing Partner of Deep Knowledge Ventures

Section III

**Comparative Industry Analysis
& Classification Framework
(Investor and M&A Guide)**

Section III: Comparative Industry Analysis & Classification Framework (Investor and M&A Guide) is devoted to an in-depth comparative and quantitative analysis of the entire AI for Drug Discovery landscape, specifically tuned for investors and business analysts who wish to gain a deeper understanding of the industry in Q2 of 2018.

- **Chapter XI: Classification/Ratings of AI for Advanced R&D and Drug Discovery Companies** performs a quantitative analysis of many of the AI for Drug Discovery companies covered and profiled in this report using a variety of tangible metrics that can be used to acquire an understanding of their level of scientific validation and industry activity, including the proportion of AI specialists among their total staff, number of publications, number of patents, etc. It then uses these metrics to rank AI for Drug Discovery companies side by side, and to build a classification framework by which these companies can be better categorized according to their specific focus, application and industry segmentation.
- **Chapter XII: 2010 - 2016 - Investment Rounds, M&A Deals and Notable Events** summarizes some of the most notable investment rounds, M&As and other notable events from 2010-2016, including but not limited to Benevolent AI's \$87M raise, ThoughtSpot's \$100M raise and Meta's \$23M raise.
- **Chapter XIII: 2017 - Investment Rounds, M&A Deals and Notable Events** summarizes some of the most notable investment rounds, M&As and other notable events in 2017, including but not limited to Exscientia's €250M raise, AICure's \$15M raise and Insilico Medicine's \$10M raise.
- **Chapter XIV: Q1 2018 - Investment Rounds, M&A Deals and Notable Events** summarizes some of the most notable investment rounds, M&As and other notable events in Q1 of 2018, including but not limited to AtomWise's \$45M raise, XtalPi's \$15M raise, and twoXAR's \$10M raise.
- **Chapter XV: Q2 2018 - Investment Rounds, M&A Deals and Notable Events** summarizes the major investments, M&As and other notable events (e.g. joint ventures, public announcements, etc.) that have occurred within the AI for Drug Discovery space specifically in Q2 of 2018, including but not limited to ThoughtSpot's \$145M raise, Benevolent.AI's \$115M raise, Celsius Therapeutics' \$65M raise, and Datavant's \$40.5M raise

Chapter XI

Comparison of Leading AI Companies

Methodology

This chapter aims to better contextualize the AI for Drug Discovery company landscape by comparing some of the industry's leading companies side by side according to several tangible metrics. In order to ascertain each company's degree of scientific validation, we have analyzed several parameters including:

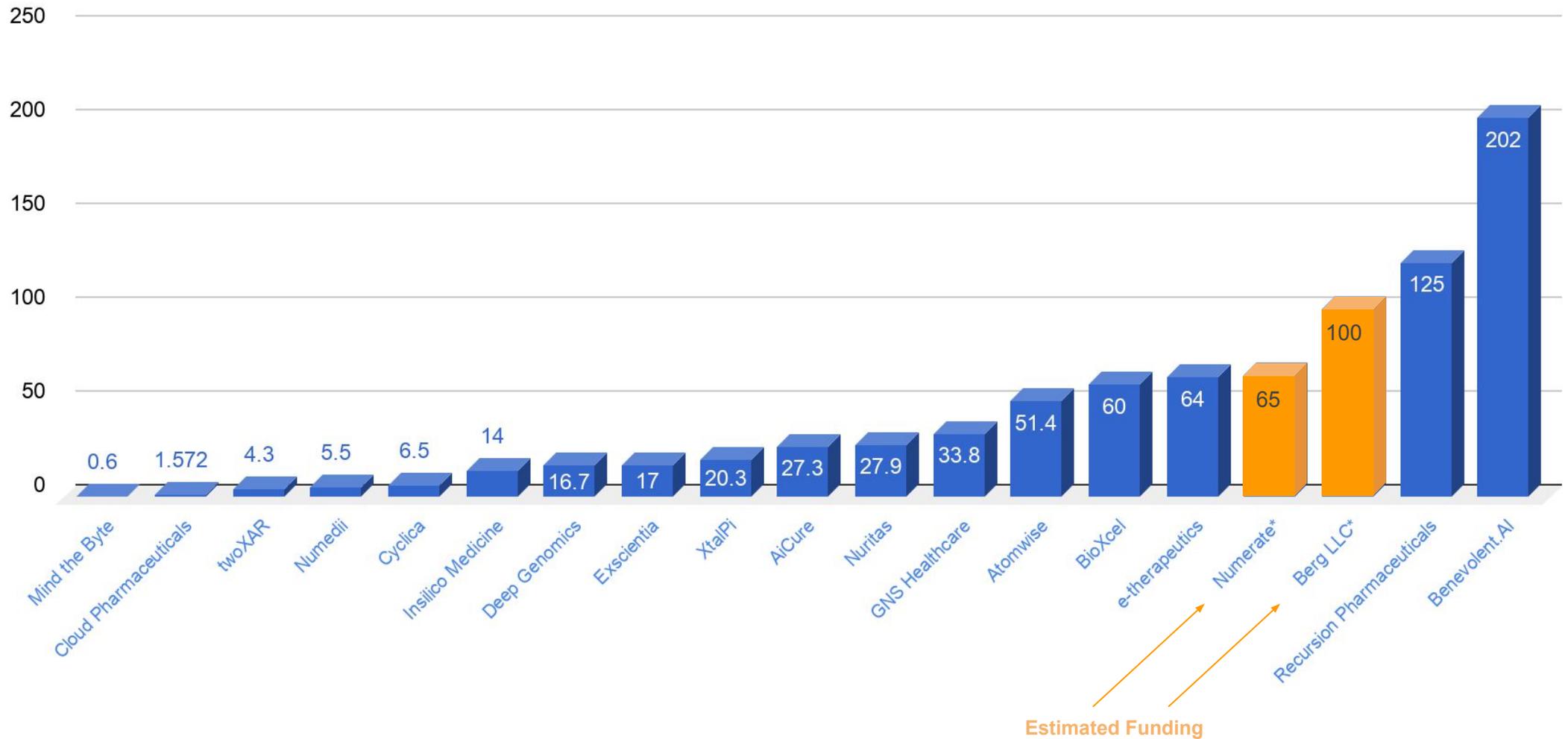
- Level of funding
- Number of scientific publications
- Number of patents
- Ratio of AI experts vs. Life Sciences experts vs. Administrative staff
- Number of public talks at AI for Drug Discovery conferences
- Type of AI utilized (e.g. core AI or complimentary AI; DL and GANs vs. legacy ML, etc.)
- Number of distinct types of AI utilized by company in their R&D process
- Publicly-disclosed AI applications
- Number of distinct forms of research activity (e.g. Data Mining, Biology Research, Compound Generation, Compound Binding, ADME/Toxicity Prediction, Drug Development Biomarker Discovery)

Types of AI for Drug Discovery Companies:

- **Core AI:** Developing AI as a core technological advantage and know-how (Insilico Medicine, BenevolentAI, Numerate etc). Companies in this category typically have state-of-the-art AI technology at the core of their R&D activities and IP, including sophisticated, state-of-the-art and proprietary DL architectures, GANs+RL, etc.
- **Complimentary AI:** Applying AI as a tool to complement primary area of activity and expertise in biology/chemistry (Recursion Pharmaceuticals, Berg Health, Cloud Pharmaceuticals, etc). Companies in this category develop AI resources on top of existing primary expertise in experimental chemistry/biology/drug discovery and can have various levels of AI sophistication, but typically without advanced AI know-how (simpler symbolic AI methods, statistics/cheminformatics/bioinformatics with elements of ML, legacy ML algorithms, less sophisticated DL architectures etc.).

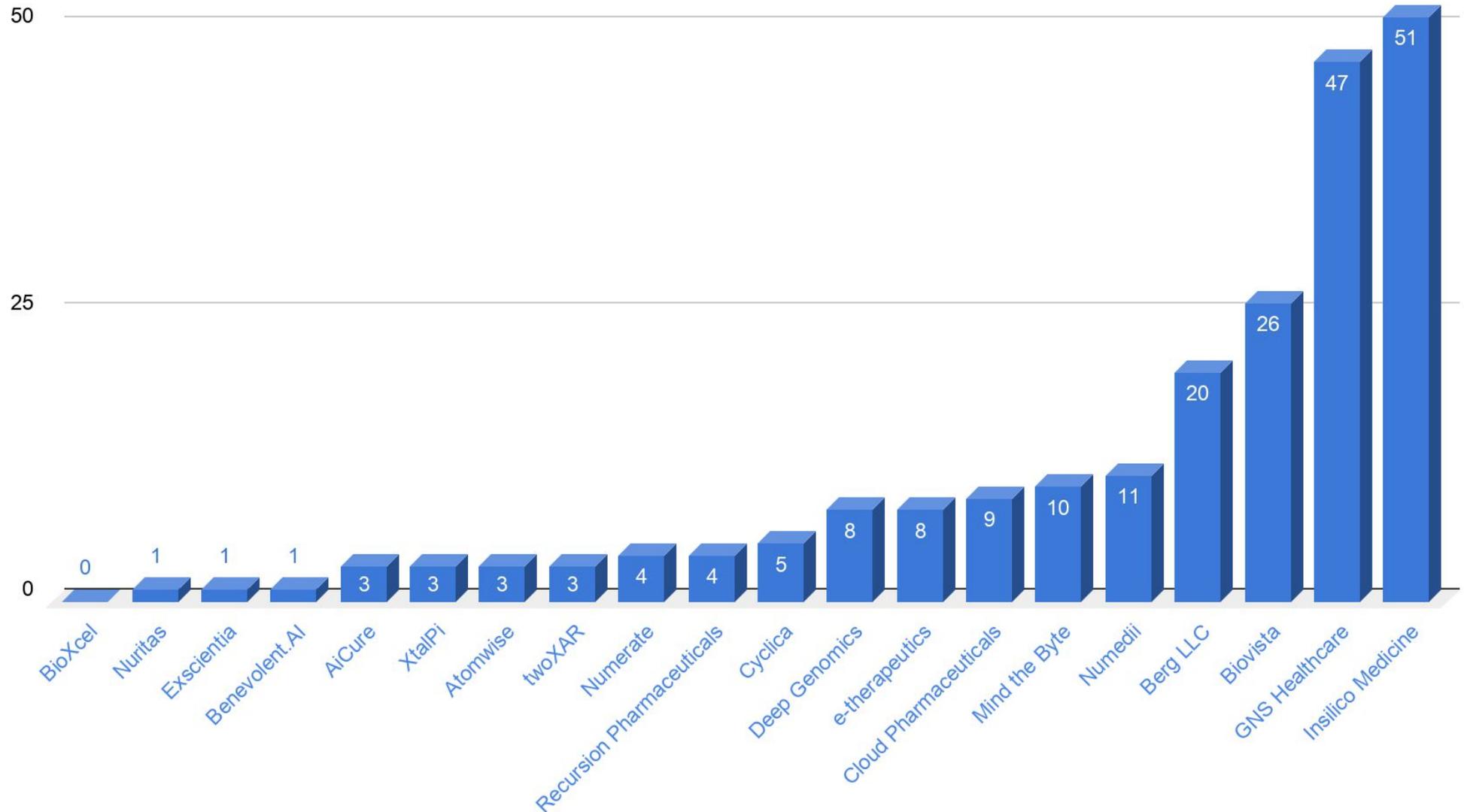
Comparison of Top-20 AI for Drug Discovery Companies

Funding, \$m *(as of 1 July 2018)*



Comparison of Top-20 AI for Drug Discovery Companies

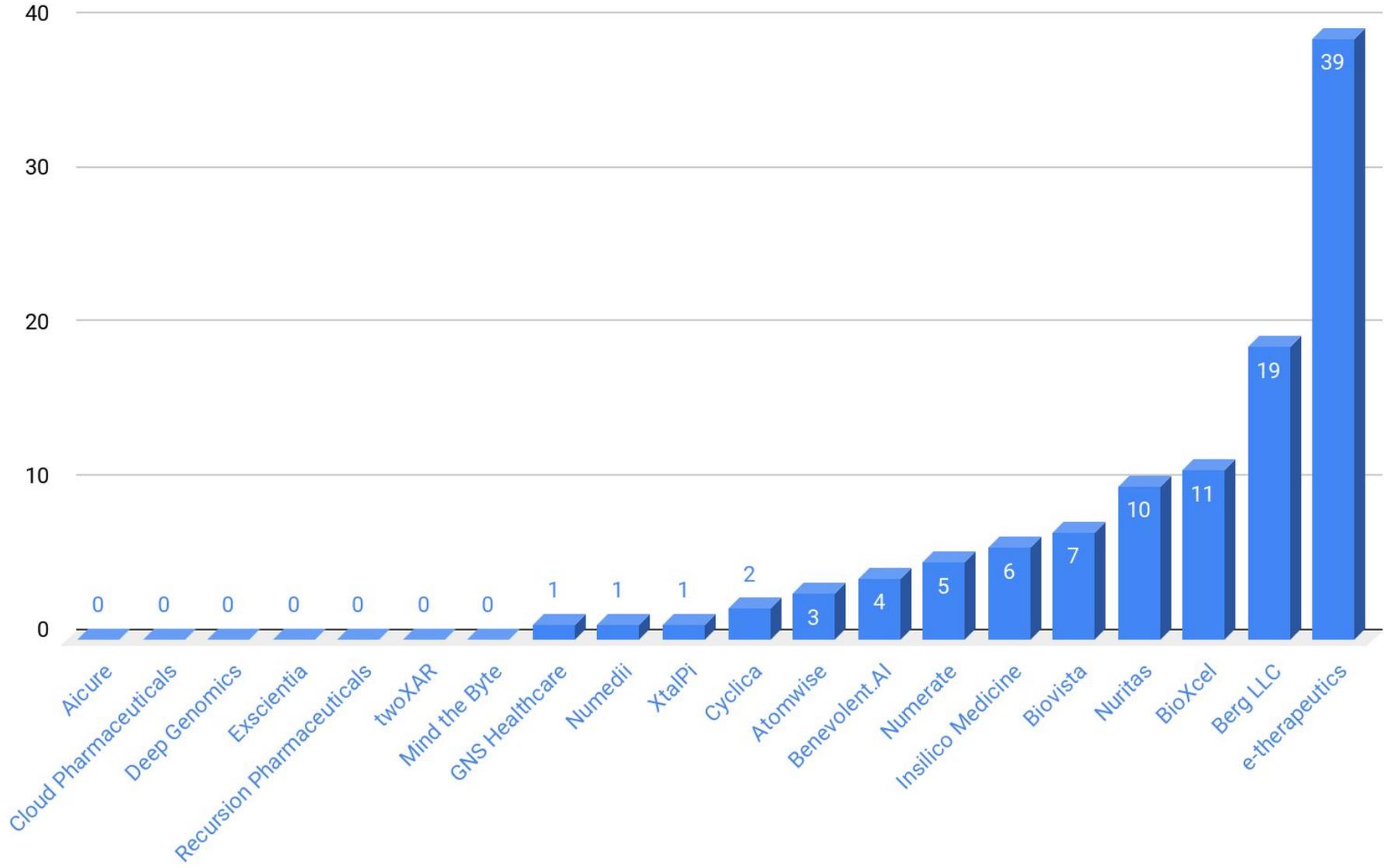
Number of Scientific Publications



Source: Company Website and PubMed

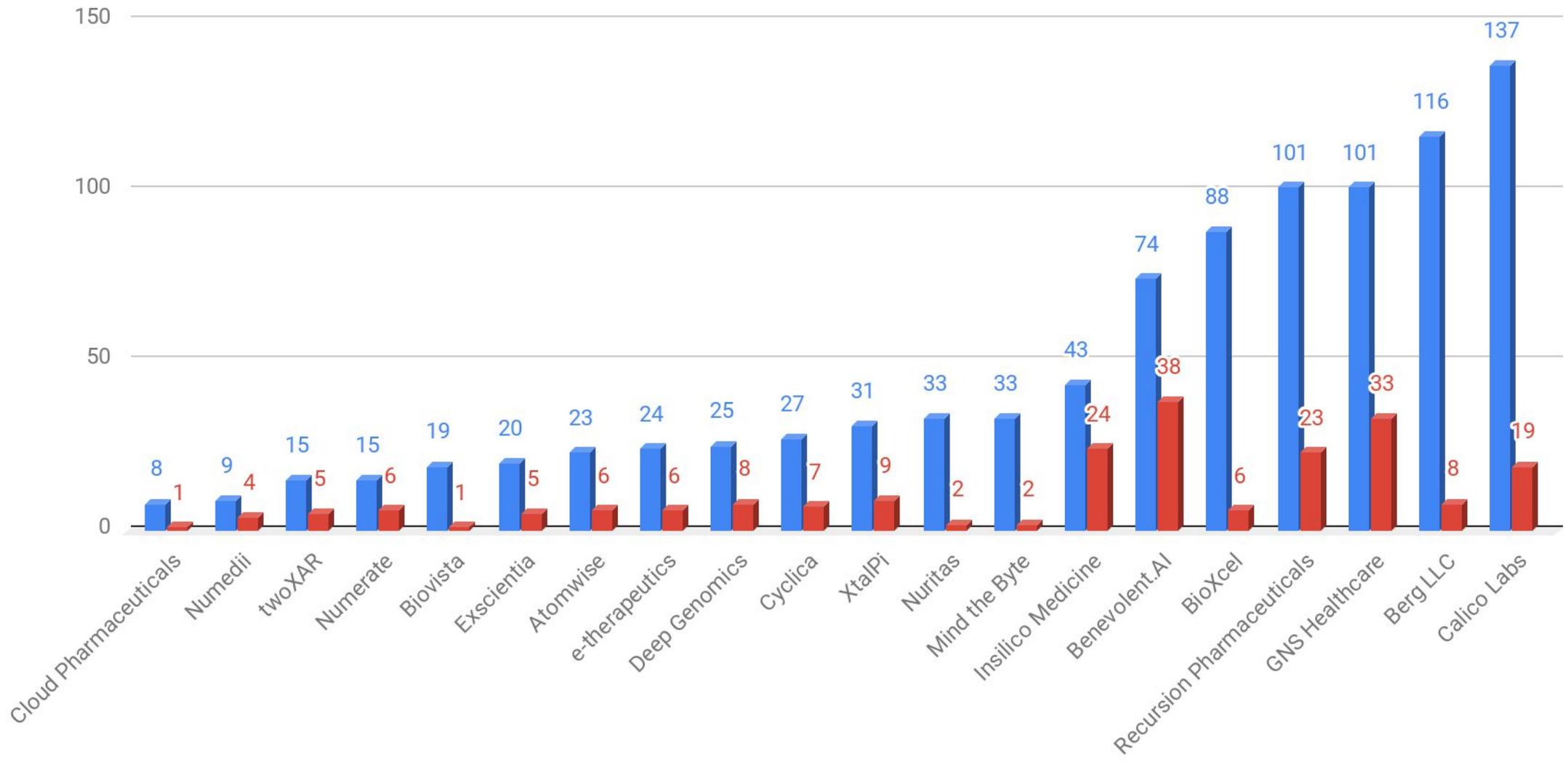
Comparison of Top-20 AI for Drug Discovery Companies

Number of Patents

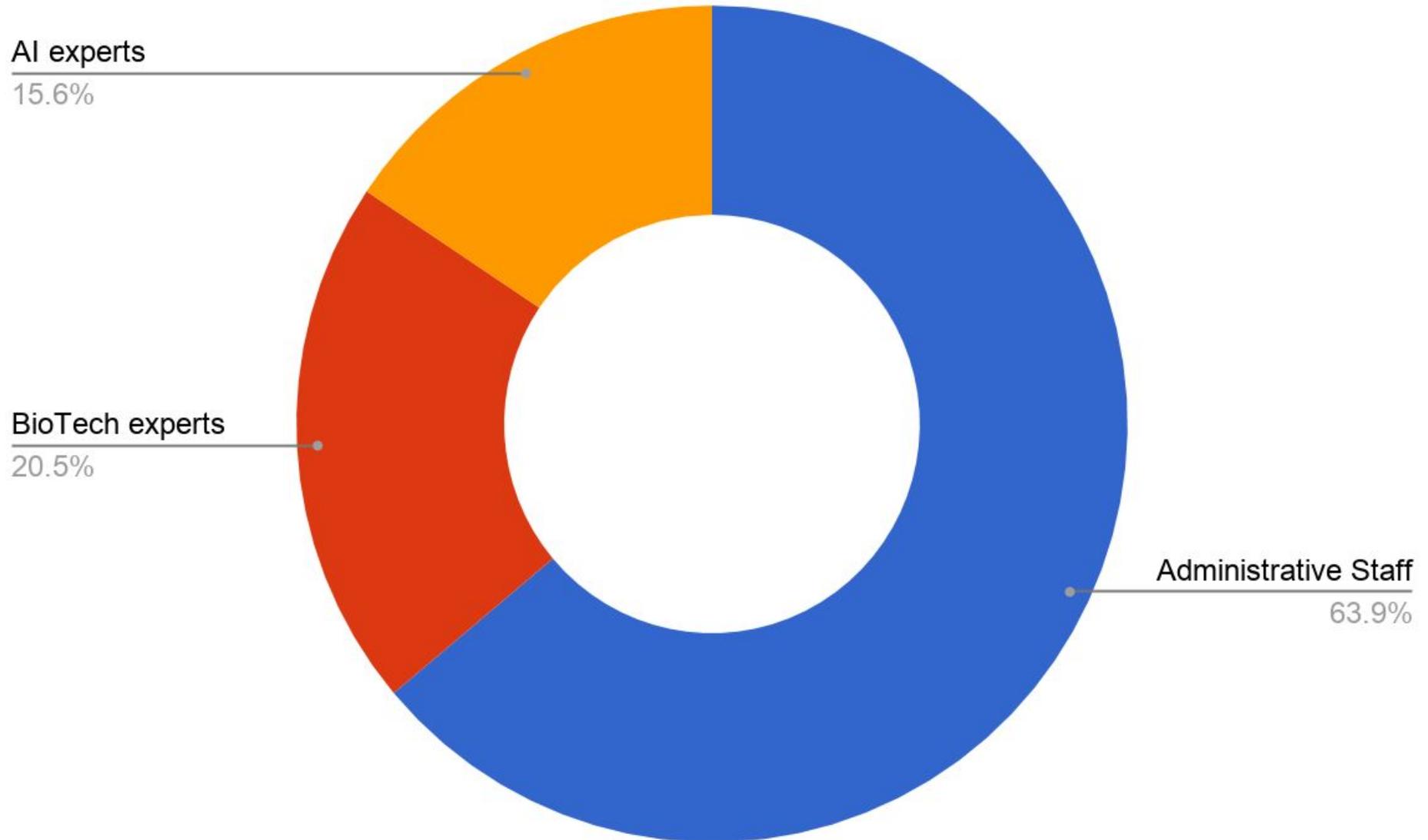


Comparison of Top-20 AI for Drug Discovery Companies

Total Number of Employees / AI experts

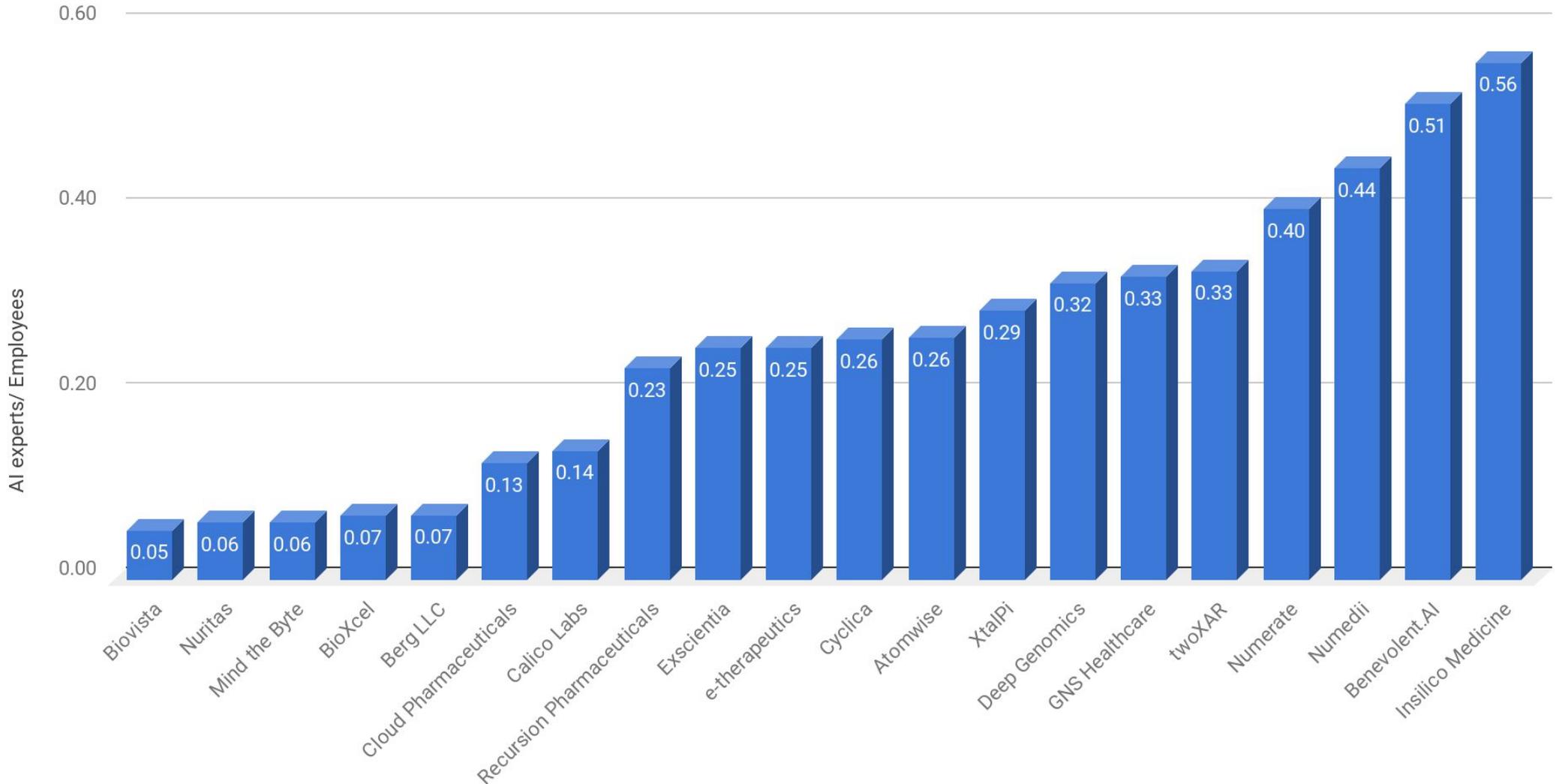


AI experts vs BioTech experts vs Administrative Staff



Comparison of Top-20 AI for Drug Discovery Companies

True AI companies
The ratio: **AI experts vs**
Total Number of Employees



Source: According to LinkedIn

Comparison of Top-20 AI for Drug Discovery Companies

Company	Scientific publications covering AI for Drug Discovery	Number of AI experts in the team / total number of employees	Public talks on AI for Drug Discovery	Validation
Atomwise	+	11/13	+	n/a
Benevolent.AI	+	18/74	+	n/a
Deep Genomics	+	10/26	-	n/a
Exscientia	+	2/12	+	+
GNS Healthcare	+	21/98	-	n/a
Insilico Medicine	+	24/43	+	+
NuMedii	+	4/9	+	+
Numerate	-	4/15	+	+
Recursion Pharmaceuticals	+	85/12	+	+
twoXAR	+	1/15	+	+

Comparison of Top-20 AI for Drug Discovery Companies

Company	Scientific publications covering AI for Drug Discovery	Number of AI experts in the team / total number of employees	Public talks on AI for Drug Discovery	Validation
Berg LLC	-	3/11	+	n/a
Mind the Byte	-	2/33	+	n/a
Biovista	+	1/19	+	+
AiCure	-	9/43	+	+
Cloud Pharmaceuticals	+	1/8	+	n/a
e-therapeutics	+	4/25	+	n/a
Nuritas	-	2/33	+	+
XtalPi	-	1/25	+	n/a
Cyclica	-	7/27	+	+
BioXcel	-	4/88	+	+

Comparison of Top-20 AI for Drug Discovery Companies

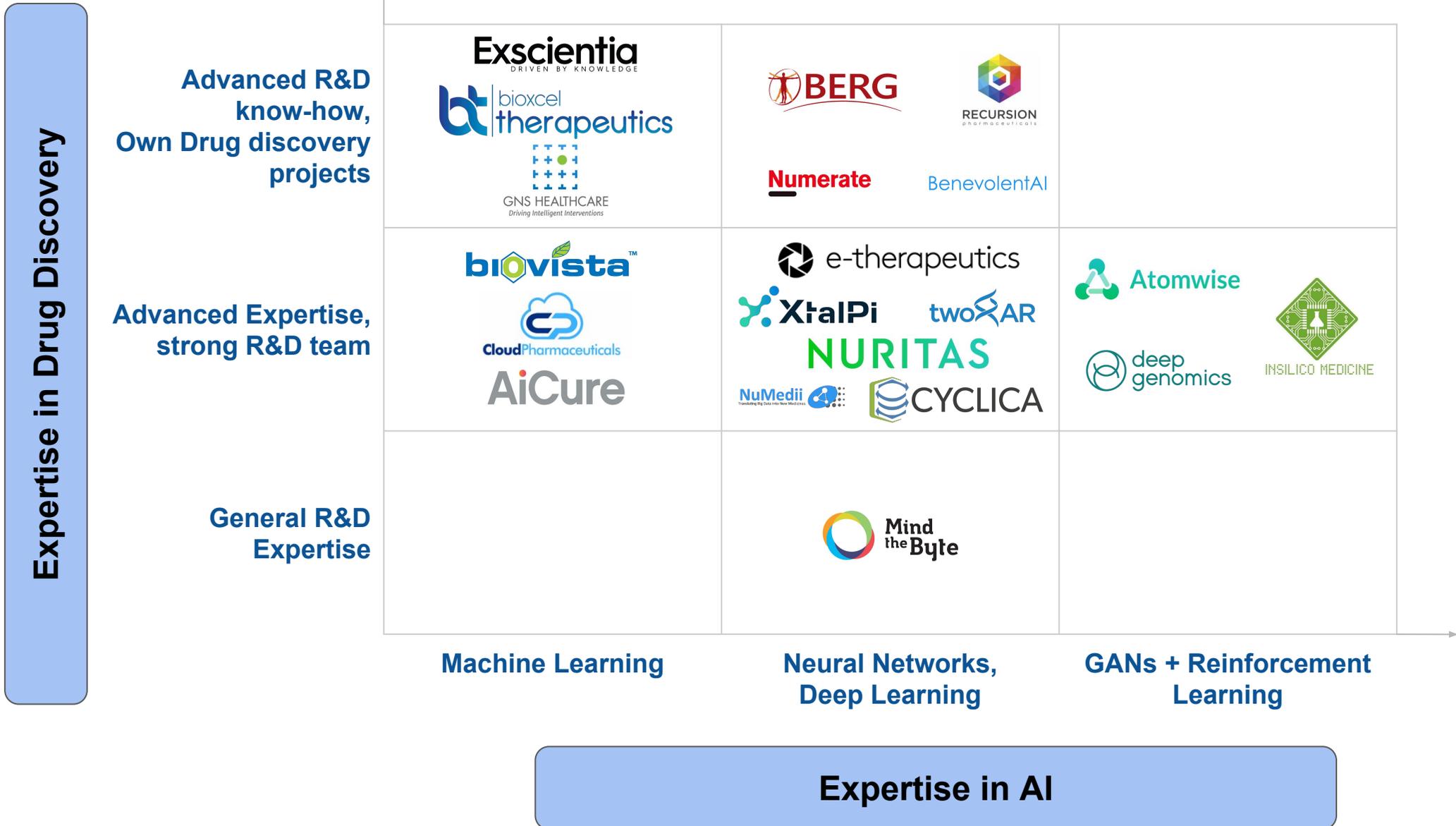
Companies	Computation method	Data Type
Atomwise	DL	Chemical notations; QSAR
Benevolent.AI	ML, DL, symbolic AI	Text; images; EHRs; omics
Deep Genomics	n/a	n/a
Exscientia	ML	Chemical notations; high-content screening; SAR
GNS Healthcare	ML	n/a
Insilico Medicine	DL, GANs, GANs + RL, symbolic AI	Omics; EHR
NuMedii	Big data analysis, DL, ML	Raw human, biological, pharmacological and clinical data, normalized and annotated.
Numerate	AI, cloud computing	Chemical notations; screening; high-content screening;
Recursion Pharmaceuticals	n/a	Images, high content screening data
twoXAR	n/a	Omics data, high content screening

Comparison of Top-20 AI for Drug Discovery Companies

Companies	Computation method	Data Type
Berg LLC	DL	Human Data
Mind the Byte	Big Data	protein ligand interactions
Biovista	ML	correlations between drugs, molecular targets, pathways, adverse events and diseases
AiCure	ML	n/a
Cloud Pharmaceuticals	legacy ML, cheminformatics	Chemical notations
e-therapeutics	Big Data	Chemical notations
Nuritas	DL	n/a
XtalPi	Quantum physics; machine learning; cloud computing	n/a
Cyclica	AI	Chemical notations
BioXcel	ML	n/a

Comparison of Top-20 AI for Drug Discovery Companies

Expertise in AI for Drug Discovery R&D / AI



Comparison of Top-20 AI for Drug Discovery Companies

Expertise in AI for Drug Discovery Chemistry / Biology



Expertise in Biology

Classification of AI applications for R&D and Drug Discovery process

Data Mining	Biology Research	Drug Discovery			Drug Development	Biomarker Discovery
		Compound Generation	Compound Binding	ADME/Tox Predictions		
		 Atomwise Better medicines faster.	 Atomwise Better medicines faster.			
 benevolent.ai				 benevolent.ai		
 deep genomics						 deep genomics
		 e ^x scientia	 e ^x scientia	 e ^x scientia		
					 GNS HEALTHCARE Driving Intelligent Innovation	
	 INSILICO MEDICINE	 INSILICO MEDICINE	 INSILICO MEDICINE	 INSILICO MEDICINE	 INSILICO MEDICINE	 INSILICO MEDICINE
						 NuMedii
		 Numerate		 Numerate		
		 RECURSION pharmaceuticals				
	 twoXAR	 twoXAR				

Classification of AI applications for R&D and Drug Discovery process

Data Mining	Biology Research	Drug Discovery			Drug Development	Biomarker Discovery
		Compound Generation	Compound Binding	ADME/Tox Predictions		
						
						
						
						
						
						
						
						
						
						

Competitive Landscape

Hypothesis Knowledge Discovery	Target ID Biology	Compound Generation	Compound Binding	ADME Tox	Clinical Trials	Personalized Medicine	Real World Insights
 INSILICO MEDICINE BenevolentAI  IBM Watson  SPARKBEYOND nference	 INSILICO MEDICINE  IBM Watson twoAR NuMedii BIOAGE Standigm BERG  deep genomics  RECURSION PHARMACEUTICALS WuXiNextCODE healx  iCarbonX 碳云智能	 INSILICO MEDICINE BenevolentAI inSili.com	 INSILICO MEDICINE Exscientia DRIVEN BY KNOWLEDGE  Atomwise  CYCLICA SCHRÖDINGER  XtalPi	 INSILICO MEDICINE Exscientia DRIVEN BY KNOWLEDGE Numerate	 INSILICO MEDICINE BenevolentAI  IBM Watson  SPARKBEYOND WuXiNextCODE  DEEP 6  Mendel.ai  trials.ai  OWKIN	 INSILICO MEDICINE  IBM Watson  FOUNDATION MEDICINE  flatiron  freenome GRAIL verily  iCarbonX 碳云智能 Over 1000 companies worldwide	 INSILICO MEDICINE  IBM Watson nference  Qrative  iCarbonX 碳云智能  SPARKBEYOND

10 Companies in Data Mining Companies

Company Name	Technology Abstract	Total Raised, \$m	Product focus	Field Focus
BenchSci	Decode open- and closed-access data on reagents such as antibodies and present published figures with actionable insights. Allows researchers to: Reduce time, money, and uncertainty in planning experiments.	9.7	biologics	biology
BenevolentAI	Evolved from text mining and semantic linking into knowledge graphs. Recent small efforts into DL and computational chemistry mostly for PR.	202	various	chemistry / biology
Biorelate	Create curated databases from the analysis of published scientific literature. Allows researchers to: Extract structured biological knowledge to power drug discovery applications.	0.13		
BioSymetrics	Process raw phenotypic, imaging, drug, and genomic data sets. Allows researchers to: Integrate rapid analytics and machine learning capabilities into existing business processes to improve care, enhance discoveries, gain insight into business, and enable fast data-driven decisions.	0	small molecules	biology
Datavant		40.5	-	-
Euretos	Direct access to the cloud based Euretos discovery platform via user friendly application; - API Integration of the discovery platform in your company's IT environment/workflows; - Integration of company proprietary data and public data in a secure environment.	0	-	-
FDNA	Link phenotypic traits to genetic mutations. Allows researchers to: Discover new clinical signs, symptoms, and genes for biomarkers, and access data to develop, test, and market precision Medicines.	0	therapies	biology
GNS Healthcare	GNS moves beyond analytical and machine learning approaches that rely on data correlations to match treatments to patients.	54.2	therapies	biology
IBM Watson Health		40	various	chemistry / biology
Nference	nferX - uses state-of-the-art Neural Networks - (shallow and deep learning models) for real-time, automated extraction of knowledge from the commercial, scientific, and regulatory body of literature.	3	-	-

10 Companies in Biology Research

Company Name	Technology Abstract	Total Raised, \$m	Product focus	Field Focus
Berg Health	Analyze data from patient samples in both healthy and diseased states to generate novel biomarkers and therapeutic targets. Allows researchers to: Generate therapeutic targets from biological data in an unbiased way, and implement personalized medicine at scale.	1.3	various	biology
e-Therapeutics	Analyze complex networks of molecular interactions in cells utilizing big data, and AI-powered analysis to come up with novel drug candidates for in-licensing.	66.8	small molecules	chemistry-biology
Engine Biosciences	Uncover gene interactions and biological networks underlying diseases, and test therapies that target them. Allows researchers to: Make analyses and predictions for precision medicine applications.	10	biologics	
Envisagenics	Analyze RNA data from patients to identify new biomarkers and drug targets. Allows researchers to: Accelerate discovery of RNA therapeutics.	4.1	biomarkers	
Euretos	Direct access to the cloud based Euretos discovery platform via user friendly application; - API Integration of the discovery platform in your company's IT environment/workflows; - Integration of company proprietary data and public data in a secure environment.	0	-	-
FDNA	Link phenotypic traits to genetic mutations. Allows researchers to: Discover new clinical signs, symptoms, and genes for biomarkers, and access data to develop, test, and market precision medicines.	0	therapies	
Insilico Medicine	Comprehensive DL pipeline. Biology: Signaling pathways, DNNs for target ID and HTS analysis. Chemistry: GANs-RL for novel molecule generation..	14	small molecules	chemistry-biology
Mind the Byte	Our prototype system is able to discriminate binders and non-binders from docking results based on AI with striking results. It uses AI to minimize the conformational energies and extracts interaction patterns from the Protein Data Bank.	0.58	small molecules	chemistry
Resonant Therapeutics	Assess and prioritize a library of drug candidates derived from analyzing tumor microenvironments. Allows researchers to: Simultaneously discover novel targets and functional antibodies for cancer.	1.96	biologics	biology
ReviveMed	Our platform for the first time enables the rapid, high- throughput, and cost-effective application of metabolic data to discover new disease mechanisms for drug discovery and, simultaneously metabolomic biomarkers.	1.5	various	biology

10 Companies in Early Drug Discovery

Company Name	Technology Abstract	Total Raised, \$m	Product focus	Field Focus
Arbor Biotechnologies	Arbor's platform employs a diverse set of technologies and techniques – including artificial intelligence, genome sequencing, gene synthesis and high-throughput screening – for accelerating the discovery of proteins for improving human health and sustainability.	27.8	biologics	
Atomwise	AtomNet is the first drug discovery algorithm to use a deep convolutional neural network. It excels at understanding complex concepts as a combination of smaller and smaller pieces of information. AtomNet has been predicting new potential treatments for two years. It has already explored questions in cancer, neurological diseases, antivirals, antiparasitics, and antibiotics.	51.57	small molecules	chemistry
BenevolentAI	Evolved from text mining and semantic linking into knowledge graphs. Recent small efforts into DL and computational chemistry mostly for PR.	202	various	chemistry-biology
Berg Health	Analyze data from patient samples in both healthy and diseased states to generate novel biomarkers and therapeutic targets. Allows researchers to: Generate therapeutic targets from biological data in an unbiased way, and implement personalized medicine at scale.	1.3	various	biology
Biovista	Drug repositioning specialist Biovista Inc. has tapped Hewlett Packard Enterprise Co. (HPE) to add greater computing power to Project Prodigy, a personalized medicine platform that leverages artificial intelligence (AI) to help doctors identify novel drugs for hard-to-treat patients.	0	therapies	chemistry-biology
BioXcel	Find applications for existing approved drugs or clinically validated candidates. Allows researchers to: Develop a pipeline of product candidates in immuno-oncology, neuroscience, and rare diseases.	60	small molecules	
CloudPharmaceuticals	We use a proprietary design process that combines AI and cloud computing to search virtual molecular space and applies along sophisticated molecular modeling to design novel drugs that are well-qualified for development from the outset and have original composition of matter IP.	1.5	small molecules	chemistry
Cyclica	Provide insight and analysis into a drugs' polypharmacology via its AI-powered platform LignadExpress utilizing structure based drug discovery approach.	6.5	small molecules	chemistry
Deep Genomics	Search 69 billion molecules with the goal of generating a library of 1,000 compounds to manipulate cell biology. Allows researchers to: Unlock new classes of antisense oligonucleotide therapies.	16.7	small molecules	chemistry-biology
e-Therapeutics	Analyze complex networks of molecular interactions in cells utilizing big data, and AI-powered analysis to come up with novel drug candidates for in-licensing.	66.8	small molecules	chemistry-biology

10 Companies in Drug Development

Company Name	Technology Abstract	Total Raised, \$m
AiCure	Visually confirm medication ingestion via smartphone. Allows researchers to: Improve medication adherence in clinical trials.	27.3
Antidote	Make sense of unorganized and unstructured data about clinical trials. Allows researchers to: Enrol more patients in appropriate trials.	28.9
Athelas	Analyze cancer biomarkers in 60 seconds from a drop of blood using an at-home device slightly bigger than an Amazon Echo. Allows researchers to: Optimize oncology drug development with a biomarker monitoring platform and millions of patient datapoints.	3.62
BenchSci	Decode open- and closed-access data on reagents such as antibodies and present published figures with actionable insights. Allows researchers to: Reduce time, money, and uncertainty in planning experiments.	9.7
Berkeley Lights	Automate selection, manipulation, and analysis of cells. Allows researchers to: Expedite development of cell lines and automate manufacturing of cellular therapeutics	86.2
Brite Health	Analyze structured and unstructured clinical trial participant data. Allows researchers to: Reduce clinical trial dropout rates through personalized communication.	0
BullFrog AI	BullFrog AI platform is based on a graph analytics tool designed to discover patterns and relationships in large scale and complex data sets. It harnesses valuable clinical data to solve challenges with patient targeting in clinical development.	0
Deep 6 AI	Analyze medical records to find patients for clinical trials. Allows researchers to: Accelerate patient recruitment to complete clinical trials faster.	0.24
Desktop Genetics	Determine biological variables influencing CRISPR guide design. Allows researchers to: Improve activity and reduce experimental bias in the selection of guides for CRISPR libraries.	6.8
GNS Healthcare	GNS moves beyond analytical and machine learning approaches that rely on data correlations to match treatments to patients. We reverse engineer the complex causal mechanisms that determine which therapies will produce the best outcomes for each patient	54.2

5 Companies in Biomarker Discovery

Company Name	Technology Abstract	Total Raised, \$m
Bioage Labs	Analyze omics data related to aging. Allows researchers to: Develop biomarkers and drugs that impact human aging.	10.9
Cotinga Pharmaceuticals	CHEMSAS® is a multi-staged computational platform technology based upon a hybrid of machine learning technologies and proprietary algorithms that allows prediction of biological activity from molecular structures. COTI-2 and COTI-219 are the first compounds derived with the benefit of CHEMSAS to be developed by Cotinga. ROSALINDTM is a simulation platform designed to provide better personalized treatment options based on the genetic profile of the patient's cancer.	0
Envisagenics	Analyze RNA data from patients to identify new biomarkers and drug targets. Allows researchers to: Accelerate discovery of RNA therapeutics.	4.1
Euretos	Direct access to the cloud based Euretos discovery platform via user friendly application; - API Integration of the discovery platform in your company's IT environment/workflows; - Integration of company proprietary data and public data in a secure environment.	0
Imagia	Analyze radiological images to produce clinically actionable information. Allows researchers to: Predict a patient's disease progression and treatment response, for clinical trial stratification and companion diagnostics.	0

Most Promising Players

Corporations



AI companies



BenevolentAI



Chapter XII

**2010-2016 - Investment Rounds,
M&A deals and Notable Events**

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Meta	28 January 2015	\$23M	Investment	Horizon Ventures; BOE Optoelectronics; Y Combinator.	Meta's mission is to build natural machines that seamlessly unite the real world with the virtual world.
Antidote	5 February 2015	\$13.5M	Investment	Smedvig Capital; Octopus Ventures; Amadeus Capital Partners.	Antidote is accelerating the breakthroughs of new treatments by bridging the gap between medical research and the people who need them.
Atomwise	3 June 2015	\$6M	Investment	OS Fund; Khosla Ventures; Draper Associates; AME Cloud Ventures	Atomwise develops artificial intelligence systems using powerful deep learning algorithms and supercomputers for drug discovery.
Benevolent AI	26 August 2015	\$87M	Investment	Woodford Investment Management, Lundbeck, Upsher Smith Laboratories, Lansdowne Partners.	Benevolent AI develops and applies artificial intelligence to enhance and accelerate scientific innovation.
Cytox	3 April 2014	£1.5M	Investment	Seneca Partners; Wren Capital; Walking Ventures; Midven	The money allowed Cytox to extend the clinical research programme and more rapidly access potentially valuable utility claims.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Deep Genomics	18 November 2015	\$3.7M	Investment	True Ventures; Bloomberg Beta; 11.2 Capital	Deep Genomics plans to use the funds to grow its team of machine learning and genome biology experts and to further develop and validate its proprietary deep learning technology.
GNS Healthcare	8 December 2015	\$10M	Investment	Mitsui & Co; Heritage Provider Network; Celgene; Cambia Health Solutions; Alexandria Real Estate Equities; Gi Global Health Fund	The financing will be used to accelerate the development of new, cloud-based big data solutions at the intersection of precision medicine and population health.
NuMedii	26 June 2013	\$3.5M	Investment	Claremont Creek Ventures; Lightspeed Venture Partners	NuMedii raised funding to further develop its proprietary technology and prepare its first three internal drug development programs for clinical testing.
Nuritas	11 April 2014	€100K	Investment	NDRC	Nuritas combines artificial intelligence and genomics to discover and unlock natural bioactive peptides with extraordinary health benefits.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Recursion Pharmaceuticals	3 October 2016	\$12.9M	Investment	Lux Capital; Wild Basin Investments; Obvious Ventures; EPIC Ventures; Data Collective; AME Cloud Ventures	With its funding, Recursion will develop its next-generation “Platform 2.0” – to scale its endeavor from the exploration of dozens of targets and diseases per year to thousands.
Synthace	11 February 2015	£2.2M	Investment	UK Innovation & Science Seed Fund; Sofinnova Partners; Bioeconomy Capital	The new financing was used to expand automation and to further develop and disseminate its Antha language.
ThoughtSpot	19 May 2016	\$50M	Investment	Geodesic Capital; General Catalyst; Khosla Ventures; Lightspeed Venture Partners; Quentin Clark	With the investment, ThoughtSpot will fuel continued growth through three areas: global expansion, hiring, and technology advancement.
Transcriptic	17 November 2016	\$13.4M	Investment	Data Collective; ZhenFund; WuXi AppTec; Holtzbrinck Digital; Digital Science; AME Cloud Ventures	Transcriptic will utilize the new capital to drive the company’s product, team and expansion plans.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
twoXAR	19 November 2015	\$3.4M	Investment	Andreessen Horowitz; CLI Ventures; StartX	twoXAR will use these funds to expand its engineering and commercial teams and advance the progress of new and existing partnerships focused on drug candidates for metabolic and neurological diseases.
Verge Genomics	29 October 2015	\$4M	Investment	IA Ventures; Two Sigma Ventures; Slow Ventures; Refactor Capital; OS Fund; Karlin Ventures; Great Oaks Venture Capital; Draper Associates	Verge will use the proceeds to expand development on its leading algorithmic platform while advancing lead drug candidates through further preclinical proof-of-concept experiments.

AI R&D startups investments 2010-2016

AI startups	Investment description	Investor name
<p>Meta</p> 	<p>Horizons Ventures invested \$23 000 000 in 2015</p> <p>Meta secured \$23M in Series A led by Horizons Ventures, Tim Draper and Y-Combinator partners. Meta is developing augmented reality glasses. Meta glasses are the first holographic, see-through display that allow users to see, create and interact with digital objects shown in physical space.</p>	<p>Horizons Ventures</p>  <p>Horizons Ventures is a venture capital firm based in Hong Kong with a focus on disruptive and technology-focused start-ups. It manages the private investment of Sir Li Ka-shing in the technology, media and telecommunications sector.</p>
<p>Antidote</p> 	<p>Smedvig Capital invested \$13 500 000 in 2015</p> <p>Antidote is accelerating the breakthroughs of new treatments by bridging the gap between medical research and the people who need them. The Series B was led by Amadeus Capital Partners, Octopus Ventures and Smedvig Capital on February 5th, 2015.</p>	<p>Smedvig Capital</p>  <p>Smedvig Capital is a growth capital firm that invests in U.K & Nordic based businesses, with a focus on those that are technology enabled. Founded in 1996, Smedvig has invested over £800M of internal capital. It invests £2-15M in fast growing UK based businesses.</p>
<p>Atomwise</p> 	<p>Y Combinator invested \$6 000 000 in 2015</p> <p>Y Combinator-backed Atomwise scores \$6M to use deep learning for drug discovery. Instead of relying on more traditional machine learning approaches, Atomwise employs deep learning, which involves training artificial neural networks on a large quantity of data — like billions of pictures, for example — and then giving them new data to receive inferences, or predictions, in response.</p>	<p>Y Combinator</p>  <p>Y Combinator is a startup accelerator based in Mountain View, CA. Twice a year they invest a small amount of money (\$120K) in a large number of startups. The YC partners work closely with each company to get them into the best possible shape and refine their pitch to investors.</p>

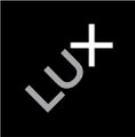
AI R&D startups investments 2010-2016

AI startups	Investment description	Investor name
<p>Benevolent AI</p> 	<p>Woodford Investment Management invested \$87 000 000 in 2015</p> <p>Benevolent AI has raised \$87M from blue-chip institutional investors and pharmaceutical companies including Woodford Investment Management, Lundbeck, Upsher Smith Laboratories, Lansdowne Partners. The company announced a major partnership with Johnson & Johnson in November 2016.</p>	<p>Woodford Investment Management</p> <p><small>woodford</small></p> <p>Woodford Investment Management LLP is authorised and regulated by the Financial Conduct Authority. The trust currently intends to conduct its affairs so that its securities can be recommended by IFAs to ordinary retail investors in accordance with the FCA's rules in relation to non-mainstream investment products and intends to continue to do so for the foreseeable future.</p>
<p>Cytox</p> 	<p>Seneca Partners invested £1 500 000 in 2014</p> <p>This money allowed Cytox to extend the clinical research programme and more rapidly access potentially valuable utility claims. The laboratory facilities and partnership would allow the company to partner with academia and industry in Europe and North America in the development of new Alzheimer's disease therapies and biomarkers.</p>	<p>Seneca Partners</p>  <p>Seneca Partners is a middle market focused investment banking and private investing firm. Their transaction and investing experience includes most industry sectors, however has strong experience in manufacturing, healthcare and business services.</p>
<p>Deep Genomics</p> 	<p>True Ventures invested \$3 700 000 in 2015</p> <p>Deep Genomics has raised \$3.7M in seed financing in a funding round led by True Ventures with participation from Bloomberg Beta and unnamed angel investors. The Toronto-based bioinformatics company plans to use the funds to grow its team of machine learning and genome biology experts and to further develop and validate its proprietary deep learning technology.</p>	<p>True Ventures</p>  <p>Founded in 2005, True Ventures is a Silicon Valley-based venture capital firm that invests in early-stage technology startups. The firm maintains a strong community that supports founders and their teams, helping True companies achieve higher levels of success and impact.</p>

AI R&D startups investments 2010-2016

AI startups	Investment description	Investor name
<p>GNS Healthcare</p> 	<p>Celgene Corporation invested \$10 000 000 in 2015</p> <p>GNS Healthcare, which has developed an analytics tool for precision medicine and population health, raised \$10 million from Celgene Corporation, Alexandria Real Estate Equities, and Gi Global Health Fund. The financing will be used to accelerate the development of new, cloud-based big data solutions at the intersection of precision medicine and population health.</p>	<p>Celgene Corporation</p>  <p>Celgene Corporation is a global integrated biopharmaceutical company primarily engaged in the discovery, development and commercialization of innovative therapies designed to treat cancer and immune-inflammatory related diseases in patients with limited treatment options.</p>
<p>NuMedii</p> 	<p>Claremont Creek Ventures invested \$3 500 000 in 2013</p> <p>NuMedii received \$3.5M in a Series A funding led by Claremont Creek Ventures and Lightspeed Venture Partners, with participation by Life Science Angels and others. NuMedii raised funding to further develop its proprietary technology and prepare its first three internal drug development programs for clinical testing.</p>	<p>Claremont Creek Ventures</p>  <p>Claremont Creek Ventures is a seed and early stage venture firm. CCV invests in companies that serve essential, broad-impact industries with innovative digital solutions that increase efficiency or create entirely new high-growth, high-margin businesses.</p>
<p>Nuritas</p> 	<p>NDRC invested €100 000 in 2015</p> <p>Nuritas Ltd is a bioinformatics technology company specialising in the discovery of peptides (chains of amino acids) with functional health or therapeutic benefits in nutrition and cosmetics. NDRC VentureLab is targeted at enabling ventures that are commercialising science, tech or intellectual property with high potential for success.</p>	<p>National Digital Research Centre</p>  <p>NDRC builds high-impact new ventures. By providing the people, time, space and investment needed at the earliest stages of dedicated commercialisation work, NDRC is creating companies worthy of commercial investment and with the ability to scale.</p>

AI R&D startups investments 2010-2016

AI startups	Investment description	Investor name
<p>Recursion Pharmaceuticals</p> 	<p>Lux Capital invested \$12 900 000 in 2016</p> <p>Recursion Pharmaceuticals raised \$12.9m to discover new drugs using artificial intelligence. The Series A round of funding was led by leading deep technology investor Lux Capital, with participation from Obvious Ventures, Epic Ventures, and more. With its funding, Recursion will develop its next-generation “Platform 2.0” – to scale its endeavor from the exploration of dozens of targets and diseases per year to thousands.</p>	<p>Lux Capital</p>  <p>Lux Capital Management is a research-driven investment firm focused on founding, seed and early stage investments in the physical and life sciences. Lux takes an active role in helping entrepreneurs build successful businesses in high growth sectors.</p>
<p>Synthace</p> 	<p>UK Innovation & Science Seed Fund invested £2 200 000 in 2015</p> <p>The firm has a growing collection of integrated technologies – including the Antha language for biology, driving an automated laboratory environment – for engineering biological systems. The new financing was used to expand automation and to further develop and disseminate its Antha language.</p>	<p>UK Innovation & Science Seed Fund</p>  <p>The UK Innovation & Science Seed Fund (formerly known as The Rainbow Seed Fund) is a £27.1m early-stage venture capital fund building and growing technology companies stemming from the UK’s research base.</p>
<p>ThoughtSpot</p> 	<p>General Catalyst Partners invested \$50 000 000 in 2016</p> <p>ThoughtSpot’s disruptive technology has garnered attention from customers and investors, including lead investor General Catalyst Partners, and Geodesic Capital. Existing investors Lightspeed Ventures and Khosla Ventures continue to support ThoughtSpot’s success through additional investments.</p>	<p>General Catalyst Partners</p>  <p>General Catalyst Partners provide the ongoing momentum that accelerates your ideas, your career, and your company toward standout success. They create the ideal conditions for growth, surround you with the right people, and offer mentorship based on deep experience.</p>

AI R&D startups investments 2010-2016

AI startups	Investment description	Investor name
<p>Transcriptic</p> 	<p>Data Collective invested \$13 400 000 in 2016</p> <p>Transcriptic will utilize the new capital to drive the company's product, team and expansion plans. The new funds will allow the company to grow its team to accommodate further growth, extend the capabilities of its innovative platform, and deliver on its vision of using its automated platform to dramatically increase research productivity.</p>	<p>Data Collective</p>  <p>Data Collective is a venture fund with a unique team of experienced venture capitalists, technology entrepreneurs and practicing engineers, investing together in seed and early stage Big Data and IT infrastructure companies.</p>
<p>twoXAR</p> 	<p>Andreessen Horowitz invested \$3 400 000 in 2015</p> <p>twoXAR will use these funds to expand its engineering and commercial teams and advance the progress of new and existing partnerships focused on drug candidates for metabolic and neurological diseases.</p>	<p>Andreessen Horowitz</p> <p>Andreessen Horowitz is a Silicon Valley-based venture capital firm with \$2.7 billion under management. They invest from seed to growth. It prefers to invest in the technology sector, biotech, and medicine companies at the intersection of computer science and life sciences.</p>
<p>Verge Genomics</p> 	<p>IA Ventures invested \$4 000 000 in 2015</p> <p>The firm was looking to change drug development for neurodegenerative diseases by using algorithms to find the gene networks contributing to those diseases and matching drugs that can affect the entire network. Verge said in a statement that it will use the proceeds to expand development on its leading algorithmic platform while advancing lead drug candidates through further preclinical proof-of-concept experiments.</p>	<p>IA Ventures</p> <p>IA Ventures is an early stage venture firm based in NYC but with investments in Los Angeles, San Francisco, Toronto and the UK. IA Ventures loves getting involved very early, often seeding companies before a dollar of revenue has been generated.</p>

Chapter XIII

**2017 - Investment Rounds,
M&A deals and Notable Events**

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Exscientia	9 May 2017	€250M	Cooperation	Sanofi	Exscientia and Sanofi will develop bispecific small molecule drugs in the high interest area of metabolic disease, including diabetes.
Antidote	7 September 2017	£11M	Investment	Merck Global Health Innovation Fund; Octopus Ventures; Smedvig Capital	This funding will accelerate the development of new capabilities for its trial matching platform, including precision medicine and EHR-matching, as well as further global expansion.
GNS Healthcare	23 August 2017	\$6M	Investment	Amgen Ventures; Alexandria Real Estate Equities	The funds will be used to further develop the company's REFS causal machine learning and simulation platform - as well as solutions across drug discovery and development, value-based drug solutions, and care management.
AiCure	17 November 2017	\$15M	Investment	Baird Capital; Tribeca Venture Partners; Biomatics Capital Partners	The investment will accelerate commercial and engineering activities. AiCure is solving the lack of patient oversight and poor adherence to therapy, a \$500 billion problem in the US alone.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Insilico Medicine	2014-2017	\$10M	Investment	Deep Knowledge Ventures; Juvenescence Limited	Insilico Medicine's primary expertise is in the many flavors of generative adversarial models, one-shot learning, reinforcement learning and meta-learning used to develop a portfolio of over 1,000 promising molecules targeting cancer and age-related diseases.
ThoughtSpot	17 August 2017	\$60M	Investment	Lightspeed Venture Partners; Capital One Growth Ventures	ThoughtSpot's funding will help with the company's debut of a new artificial intelligence product, SpotIQ.
BioAge Labs	28 July 2017	\$10.9M	Investment	Andreessen Horowitz; Pear Ventures; Felicis Ventures; Elad Gil	The company intends to use the funds to build the team, refine and test its signatures of aging, and begin in vivo evaluation of drug candidates.
PathAI	3 November 2017	\$11M	Investment	General Catalyst; 8VC; DHVC (Danhua Capital); Pillar Companies	The startup will use the funds to build out its team and develop its artificial intelligence-based technology.
Berg Health	28 August 2017	N/A	Cooperation	AstraZeneca	BERG announced a research collaboration with AstraZeneca to identify and evaluate novel targets and therapeutics to treat neurological disorders such as Parkinson's disease.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Berkeley Lights	13 June 2017	N/A	Cooperation	GlaxoSmithKline	Berkeley Lights, Inc. announced that it will deliver to GlaxoSmithKline a Beacon™ Optofluidic platform for cell line development.
Recursion Pharmaceuticals	10 October 2017	N/A	Cooperation	Takeda Pharmaceutical Co. Ltd.	Recursion will screen 250 shelved preclinical assets from Takeda in exchange for an undisclosed upfront payment and more than \$90 million in milestones, plus royalties.
Synthace	11 August 2017	£2M	Cooperation	Oxford BioMedica	The agreement is a two-year £2 million collaboration project focused on gene and cell therapy manufacturing, co-funded by the UK's innovation agency, Innovate UK.
Nimbus Therapeutics	3 October 2017	N/A	Cooperation	Celgene	Under the terms of the agreement, Celgene will receive an option to acquire each program in the alliance up through a clinical inflection point. Nimbus will receive an upfront payment and potential downstream milestone payments for each program Celgene chooses to acquire. Nimbus will retain full control of research and development activities for each program prior to the program's option point. Financial terms will remain undisclosed until Celgene acquires a program.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Calico Labs	23 March 2017	N/A	Cooperation	C4 Therapeutics	C4 Therapeutics (C4T) and Calico announced a five-year collaboration to discover, develop, and commercialize therapies for treating diseases of aging, including cancer. The partnership will pursue preclinical research and Calico will be responsible for subsequent clinical development and commercialization of resulting products that may emerge from the collaboration.

AI R&D startups investments 2017

AI startups	Investment description	Investor name
<p>Exscientia</p> 	<p>Sanofi invested 250 000 000€ in 2017.</p> <p>Exscientia and Sanofi will develop bispecific small molecule drugs in the high interest area of metabolic disease, including diabetes. Exscientia will be responsible for compound design, while Sanofi will handle the chemistry synthesis, as well as further assays, preclinical experiments and subsequent trials.</p>	<p>Sanofi</p>  <p>Sanofi is a healthcare company engaged in the research, development, manufacturing, and marketing of innovative therapeutic solutions. It covers areas such as diabetes solutions, human vaccines, innovative drugs, consumer healthcare, emerging markets, animal health.</p>
<p>Antidote</p> 	<p>Merck Global Health Innovation Fund (GHI) invested £11 000 000 in 2017</p> <p>This funding will accelerate the development of new capabilities for its trial matching platform, including precision medicine and EHR-matching, as well as further global expansion.</p>	<p>Merck Global Health Innovation Fund</p>  <p>Merck GHI is evolving corporate healthcare venture capital globally by utilizing their healthcare ecosystem strategy.</p>
<p>GNS Healthcare</p> 	<p>Amgen Ventures invested \$6 000 000 in 2017</p> <p>The funds will be used to further develop the company's REFS causal machine learning and simulation platform -- as well as solutions across drug discovery and development, value-based drug solutions, and care management.</p>	<p>Amgen Ventures</p>  <p>The firm primarily invests in the biotechnology sector with a focus on discovering and developing human therapeutics with a focus on oncology, inflammation, hematology, nephrology, metabolic disorders, neuroscience, and cardiovascular therapeutics</p>

AI R&D startups investments 2017

AI startups	Investment description	Investor name
<p>AiCure</p> 	<p>Baird Capital invested \$15 000 000 in 2017</p> <p>The investment will accelerate commercial and engineering activities. AiCure is solving the lack of patient oversight and poor adherence to therapy, a \$500 billion problem in the US alone.</p>	<p>Baird</p>  <p>Baird Capital makes venture capital, growth equity, and private equity investments in strategically-targeted sectors around the world. Baird Capital is the direct private investment arm of Robert W. Baird & Co.</p>
<p>Insilico Medicine</p> 	<p>Deep Knowledge Ventures and Juvenescence Limited invested over \$10 000 000 in 2014-2017</p> <p>Insilico Medicine's primary expertise is in the many flavors of generative adversarial models, one-shot learning, reinforcement learning and meta-learning used to develop a portfolio of over 1,000 promising molecules targeting cancer and age-related diseases. Besides AI for Drug Discovery, the company is also extremely active in the niche of applying AI for drug repurposing and AI for aging biomarker discovery.</p>	<p>Deep Knowledge Ventures</p> <p>DKV lead by Dmitry Kaminskiy is an investment fund focused on early stage companies at the intersection of AI and precision medicine and Longevity.</p>  <p>JUVENESCENCE Juvenescence Limited</p> <p>Juvenescence Limited is a VC firm focused exclusively on longevity startups, led by prominent British investor Jim Mellon.</p>
<p>ThoughtSpot</p> 	<p>Lightspeed Venture Partners invested \$60 000 000 in 2017</p> <p>ThoughtSpot's funding will help with the company's debut of a new artificial intelligence product, SpotIQ. With this technology, a computer asks thousands of questions on its own, making assumptions about what the user wants to know based on the user's profile and certain search terms. The search produces dozens of analyzed data sets in seconds.</p>	<p>Lightspeed Venture Partners</p>  <p>Lightspeed Venture Partners is a venture capital firm that is engaged in the consumer, enterprise, technology, and cleantech markets. Lightspeed is an early stage venture capital firm focused on accelerating disruptive innovations and trends in the Enterprise and Consumer sectors.</p>

AI R&D startups investments 2017

AI startups	Investment description	Investor name
<p>BioAge Labs</p> 	<p>Andreessen Horowitz invested \$10 900 000 in 2017</p> <p>The company intends to use the funds to build the team, refine and test its signatures of aging, and begin in vivo evaluation of drug candidates. BioAge Labs initially targets specific diseases where aging is causal. However, its ultimate goal is to combat the suffering and disability caused by all aging-related diseases, and to restore both the quality and quantity of life in old age.</p>	<p>Andreessen Horowitz ANDREESSEN HOROWITZ</p> <p>Andreessen Horowitz LLC is a venture capital firm specializing in investing in seed, start-ups, early, mid stage, growth, and late stage. It prefers to invest in business and technology sector with a focus on software, cloud computing, enterprise software and data-storage, software related biology, biotech, and medicine companies at the intersection of computer science and life sciences with a focus on digital therapeutics, cloud technology in biology, and computational medicine.</p>
<p>PathAI</p> 	<p>General Catalyst Partners invested \$11 000 000 in 2017</p> <p>PathAI, a Cambridge, MA-based company developing A.I. software aim at helping pathologists be more efficient and accurate in diagnosing disease. The startup will use the funds to build out its team and develop its artificial intelligence-based technology.</p>	<p>General Catalyst Partners </p> <p>General Catalyst Partners is a private equity and venture capital firm. The firm seeks to invest in technology with a focus on advanced materials, clean energy solutions, cyber security and biosecurity and more.</p>

AI R&D startups cooperations 2017

AI startups	Deal description	Partner Organization
<p>Berg Health</p> 	<p>On 28th August 2017 BERG announced a research collaboration with AstraZeneca to identify and evaluate novel targets and therapeutics to treat neurological disorders such as Parkinson's disease. AstraZeneca will provide BERG with its curated library of central nervous system (CNS) optimized fragments. BERG will employ AstraZeneca's fragment library to assist in discovering drug candidates for therapeutic development. BERG's current clinical pipeline consists of therapeutics as well as companion and disease diagnostics that support clinical development in the areas of oncology, neurology and endocrinology.</p>	<p>AstraZeneca</p>  <p>AstraZeneca is a global, science-led biopharmaceutical company that focuses on the discovery, development and commercialisation of prescription medicines. Its purpose is to push the boundaries of science to deliver life-changing medicines. AstraZeneca focuses on three main therapy areas: Oncology, Cardiovascular & Metabolic Disease (CVMD) and Respiratory – and it is also selectively active in the areas of autoimmunity, neuroscience and infection.</p>
<p>Berkeley Lights</p> 	<p>On 13th June 2017 Berkeley Lights, Inc. announced that it will deliver to GlaxoSmithKline a Beacon™ Optofluidic platform for cell line development. The Beacon platform innovates various processes within drug discovery and development, reducing lead times and increasing capacity by transforming currently fragmented microfluidic workflows into automated nanofluidic workflows.</p>	<p>GSK</p>  <p>A science-led global healthcare company with a special purpose: to help people do more, feel better, live longer. GSK aims to bring differentiated, high-quality and needed healthcare products to as many people as possible, with its 3 global businesses, scientific and technical know-how and talented people.</p>
<p>Recursion Pharmaceuticals</p> 	<p>On 10th October 2017, Recursion entered a collaboration with Takeda Pharmaceutical Co. Ltd. to discover rare disease candidates for Takeda's TAK-celerator pipeline. Recursion will screen 250 shelved preclinical assets from Takeda in exchange for an undisclosed upfront payment and more than \$90 million in milestones, plus royalties.</p>	<p>Takeda</p>  <p>As a global pharmaceutical leader, Takeda focuses on solving unmet needs where it can make a real difference and on putting patients first. Its therapeutics focus is oncology, gastroenterology, and the central nervous system, as well as vaccines.</p>

AI R&D startups cooperations 2017

AI startups	Deal description	Partner Organization
<p>Synthace</p> 	<p>On 11th August 2017, Oxford BioMedica announced it has agreed, as lead partner, to enter into a collaboration agreement with a consortium of partners, including the Cell and Gene Therapy Catapult, Stratophase Ltd and Synthace Ltd. The agreement is a two-year £2 million collaboration project focused on gene and cell therapy manufacturing, co-funded by the UK's innovation agency, Innovate UK.</p>	<p>Oxford BioMedica</p>  <p>Oxford BioMedica is a leading gene and cell therapy company focused on developing life changing treatments for serious diseases. Oxford BioMedica is based across several locations in Oxfordshire, UK and employs more than 250 people.</p>
<p>Nimbus Therapeutics</p> 	<p>On 3rd October 2017, Nimbus Therapeutics announced the initiation of a long-term strategic alliance with Celgene Corporation in immunology. Under the terms of the agreement, Celgene will receive an option to acquire each program in the alliance up through a clinical inflection point. Nimbus will receive an upfront payment and potential downstream milestone payments for each program Celgene chooses to acquire. Nimbus will retain full control of research and development activities for each program prior to the program's option point. Financial terms will remain undisclosed until Celgene acquires a program.</p>	<p>Celgene</p>  <p>Celgene Corporation is an integrated global pharmaceutical company engaged primarily in the discovery, development and commercialization of innovative therapies for the treatment of cancer and inflammatory diseases through gene and protein regulation.</p>
<p>Calico Labs</p> 	<p>On 23 March 2017, C4 Therapeutics (C4T) and Calico announced a five-year collaboration to discover, develop, and commercialize therapies for treating diseases of aging, including cancer. The partnership will pursue preclinical research and Calico will be responsible for subsequent clinical development and commercialization of resulting products that may emerge from the collaboration.</p>	<p>C4 Therapeutics</p>  <p>C4 Therapeutics is pioneering a new class of drugs. C4's technology platform produces small molecule drugs that harness machinery already present in cells to selectively target disease-relevant proteins for degradation.</p>

Chapter XIV

**Q1 2018 - Investment Rounds, M&A deals
and Notable Events**

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Atomwise	7 March 2018	\$45M	Investments	Monsanto Growth Ventures	Atomwise partnered with Monsanto in 2017 to help the agtech company find a quicker and more cost-effective way to bring new crop protection products to market.
twoXAR	19 March 2018	\$10M	Investments	SoftBank Ventures; Andreessen Horowitz Bio Fund; OS Fund	The proceeds will be used to build the company's drug pipeline through partnerships and accelerate preclinical development of existing candidates.
XtalPi Inc	January 2018	\$15M	Investments	Alphabet Inc; Tencent Holdings Ltd; Sequoia Capital China	The funding will be used to develop new computational models built on big data generated from XtalPi's high-precision computing platform and to expand its business into adjacent areas along the pharmaceutical value chain. The investment will also support the construction of a prediction-driven research lab.
Berkeley Lights	January 2018	N/A	Cooperation	Pfizer Inc.	A research collaboration and license agreement focused on optimizing BLI's proprietary Beacon™ Optofluidic platform with the goal of helping to accelerate Pfizer's monoclonal antibody (mAb) discovery and gene editing workflows.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Sirenas	12 February 2018	N/A	Cooperation	Bristol-Myers Squibb	A multi-target research collaboration agreement with Bristol-Myers Squibb to deploy Sirenas' drug discovery platform against certain undisclosed challenging therapeutic targets to identify potential drug candidates. Sirenas will receive an undisclosed up-front payment, funding for research activities and potential success fees from Bristol-Myers Squibb.
Nuritas	9 February 2018	N/A	Cooperation	Nestlé	As part of the collaboration, Nuritas will deploy its technology platform, which uses artificial intelligence and DNA analysis to predict, unlock and validate highly efficacious peptides, exclusively from natural food sources.

Investment round Q1 2018 / Atomwise

On **7th March 2018 Monsanto Growth Ventures**, the venture capital arm of Monsanto Co. was the lead investor in **Atomwise**, artificial intelligence startup's **\$45 million** Series A raise. Atomwise partnered with Monsanto in 2017 to help the agtech company find a quicker and more cost-effective way to bring new crop protection products to market. Terms of that partnership were not disclosed.

Monsanto Growth Ventures (MGV) led the Series A round with DCVC (Data Collective) and B Capital Group. Y Combinator, Khosla Ventures, DFJ, Baidu Ventures, Tencent and Dolby Family Ventures participated. The oversubscribed round brings Atomwise's total capital raised to more than \$51 million.

Monsanto Growth Ventures, DCVC (Data Collective), and B Capital Group led the raise in support of Atomwise's mission to become the preferred artificial intelligence partner for the world's leading pharmaceutical, biotech, and agrochemical companies.

Atomwise has struck partnerships with four of the top-ten U.S. pharma companies, multiple biotech firms, and over forty major research universities. All told, Atomwise has over fifty distinct molecular discovery programs. The Atomwise approach demonstrates a new model for a pharmaceutical industry that is facing a crisis of declining productivity, spending more on research each year, yet achieving fewer breakthroughs per dollar. Atomwise has brought the power of artificial intelligence to breakthrough research on deadly viruses, several forms of cancer, neurodegenerative diseases, metabolic diseases, life-threatening bacteria, endemic parasites, and crop-blighting fungi in agriculture. With this funding, Atomwise is ready to help hundreds of organizations discover compounds that could become tomorrow's blockbusters.

Atomwise has delivered significant research results since its seed funding in 2015. Dozens of its discovery programs have achieved success in the hands of its partners, contrasting with an industry that typically has extremely high rates of failure for comparable work.

Sources: <https://www.businesswire.com/news/home/20180307005638/en/Atomwise-Raises-45-Million-Series-Preferred-Artificial>



Investment round Q1 2018 / twoXAR

On **19th March twoXAR**, an artificial intelligence (AI)-driven biopharmaceutical company, announced that it has raised **\$10 million** in Series A financing led by **SoftBank Ventures**, a SoftBank Group early stage venture capital arm. Joining SoftBank Ventures is the Andreessen Horowitz Bio Fund and OS Fund. The proceeds will be used to build the company's drug pipeline through partnerships and accelerate preclinical development of existing candidates. With this financing, JP Lee, Managing Director at SoftBank Ventures, and Vijay Pande, PhD, General Partner at Andreessen Horowitz, have been appointed to the twoXAR Board of Directors.



The company's AI-driven discovery platform has the potential to transform the identification of new medicines and dramatically improve the success rates of preclinical development. The twoXAR team has already established a number of collaborations with global biopharmaceutical leaders and demonstrated how candidates identified by their technology translate to successful in vivo studies.

Using its proprietary AI-driven platform, twoXAR rapidly identifies drug candidates for in vivo testing in weeks rather than years and has demonstrated in vivo success rates significantly greater than those of traditional approaches across therapeutic areas including diseases such as liver cancer, rheumatoid arthritis, and type 2 diabetes. twoXAR is building a pipeline of novel, proprietary drug candidates through partnerships with biopharmaceutical companies, drug developers, and investors.

twoXAR's approach to developing their pipeline through partnerships and spin-outs enables them to apply their technology broadly across therapeutic areas, put drug development in the hands of expert drug developers, and create a portfolio of drug programs that significantly increases the probability of a twoXAR-discovered treatment benefiting patients. twoXAR previously raised \$4.3 million in seed financing from investors including Andreessen Horowitz, CLI Ventures, and the Stanford-StartX Fund.

Sources: <https://www.businesswire.com/news/home/20180319005411/en/SoftBank-Ventures-Leads-10M-Investment-AI-Driven-Drug>

Investment round Q1 2018 / XtalPi

In **January 2018** **Alphabet Inc's** Google, **Tencent Holdings Ltd** and **Sequoia Capital China** have joined a **\$15 million** B series funding round for Boston- and Shenzhen-based artificial intelligence (AI) pharmaceutical firm **XtalPi Inc.**

This funding will be used to develop new computational models built on big data generated from XtalPi's high-precision computing platform and to expand its business into adjacent areas along the pharmaceutical value chain. The investment will also support the construction of a prediction-driven research lab.

XtalPi uses AI, cloud computing and quantum physics to improve drug design processes. The deal is the first co-investment by Google and Tencent since the two companies revealed that they have signed a patent sharing agreement, paving the way for cooperation between the two firms. To give an idea of its computing focus XtalPi has built an elastic HPC (high performance computing) cloud that can deploy up to one million cores across AWS, Tencent cloud, Google Cloud and Alibaba Cloud.

The startup previously raised a \$5 million Series A round by Tencent in late 2015, prior to that, social network Renren led its seed investment. It counts ZhenFund and FreeS Fund as other investors. This new round — which takes XtalPi to \$20 million from investors to date — will go towards using big data from XtalPi's high-precision computing platform to develop new computational models. It will also help expand its footprint into new segments in the pharma industry.

XtalPi said it is working on a “prediction-driven research lab” that will combine its R&D with lab technology to get more precise and rounded results and predictions.



Source: <https://techcrunch.com/2018/01/23/xtalpi-google-tencent-sequoia-china/>

AI R&D startups cooperations Q1 2018

Berkeley Lights and Pfizer

In **January 2018 Berkeley Lights** announced that it has entered into a research collaboration and license agreement with **Pfizer Inc.** focused on optimizing BLI's proprietary Beacon™ Optofluidic platform with the goal of helping to accelerate Pfizer's monoclonal antibody (mAb) discovery and gene editing workflows.

Through the collaboration, the companies will combine BLI's platform – which utilizes a light-based, nano-fluidic method to select, characterize, culture and export single cells – with Pfizer's expertise in gene editing, sequencing, and molecular biology, as well as B-cell screening, to help advance the research aims and influence the development of the Beacon platform.

Berkeley Lights, Inc. (BLI) develops and commercializes platforms on which many bio-pharmaceutical, genomic, and cellular therapy applications will run. BLI launched its first commercial platform, the Beacon, in December 2016.

The Beacon platform is capable of screening thousands of plasma B-cells or gene edited cells in an automated fashion, speeding up a traditionally time-consuming, manual process to just a few days. Cell characterizations are performed through a variety of serial or multiplex fluorescence assays to determine antigen specific binding to membrane bound targets on live cells, relative affinity, and functional response with reporter cells. Individual cells with the desired characteristics are selected and exported for genomic profiling or further manipulation.

Through this program Berkeley Lights plans to deliver a new level of speed and precision that, the startup believes, is unattainable with other methods. This program enables a thorough evaluation of multiple areas within their development process to further optimize plasma b-cell and gene editing workflows.



Source: <https://www.prnewswire.com/news-releases/berkeley-lights-announces-research-collaboration-and-license-agreement-with-pfizer-300577279.html>

AI R&D startups cooperations Q1 2018

Sirenas and Bristol-Myers Squibb

On **12th February 2018** **Sirenas** announced that it has entered into a multi-target research collaboration agreement with **Bristol-Myers Squibb** to deploy Sirenas' drug discovery platform against certain undisclosed challenging therapeutic targets to identify potential drug candidates. Sirenas will receive an undisclosed up-front payment, funding for research activities and potential success fees from Bristol-Myers Squibb. In addition, Bristol-Myers Squibb has an option to license compounds identified from the collaborative efforts under a separate agreement that will include potential milestones and royalties paid to Sirenas.



Sirenas has built a remarkably effective platform that combines powerful computational approaches, deep natural product expertise, and state of the art synthesis to rapidly deliver new drug candidates. Due to Sirenas' expertise in the field, the company has formed research partnerships including the Bill and Melinda Gates Foundation and the California Institute for Biomedical Research to advance ATLANTIS™ and its emerging pipeline of immunomodulatory programs.

The research collaboration leverages Sirenas' expertise in applying ATLANTIS™, its data mining technology, to identify such potential drug candidates derived from Sirenas' proprietary chemical library isolated from global microbiome collections. ATLANTIS™ uses machine learning and "big data" approaches to uncover the complex relationships between natural small molecule metabolites and disease relevant biological assays. ATLANTIS™ provides rapid insights into the therapeutic potential, chemical novelty, structure activity relationships and global distribution of each metabolite. This functionality enables the uncovering of therapeutic leads from a previously hidden, rich pool of privileged chemistry that can be leveraged to help tackle the greatest unmet disease needs.

Sirenas believes science-focused biopharma companies can benefit from its innovative approaches to access breakthrough chemistry in delivering drug candidates for difficult biological targets. The collaboration with Bristol-Myers Squibb will help to identify potential new therapies to treat the world's highest unmet medical needs.

Source: <https://www.prnewswire.com/news-releases/sirenas-enters-into-multi-target-collaboration-with-bristol-myers-squibb-300596468.html>

AI R&D startups cooperations Q1 2018

Nuritas and Nestlé

On **9th February 2018 Nuritas** announced its collaboration with food giant **Nestlé** to discover bioactive peptide networks within natural food sources. As part of the collaboration, Nuritas will deploy its award-winning and novel technology platform, which uses artificial intelligence (AI) and DNA analysis to predict, unlock and validate highly efficacious peptides, exclusively from natural food sources. The Nuritas platform will help to cut the time and cost of discovering new ingredients for health promotion, disease prevention and medicines.



Nuritas is a rapidly growing, award-winning digital biotechnology and R&D company which has created remarkable interest globally for its peptide-finding platform capabilities. Nuritas has received global recognition for the impact its innovative technology will have on the future of food and health. This includes winning the overall Innovation Award at the Forbes Reinventing America Summit in 2015, the Nutrition Capital Network Venture competition in October 2016 and support from EU Horizon 2020 in 2016 for a peptide that carries the potential to prevent prediabetic patients from developing diabetes.

The Nuritas platform will help to cut the time and cost of discovering new ingredients for health promotion, disease prevention and medicines. For its part, Nestlé will use its considerable scientific know-how and applications expertise to validate the efficacy of these new discoveries within the target applications.

The results of Nuritas's research could lead to the discovery of new food components to help prevent, manage and even cure deadly diseases.

Founded in 2014, Nuritas boasts some pretty well-known funders from previous rounds, including Bono and The Edge from U2, and Salesforce CEO Marc Benioff. In December, it emerged that the company secured €16m Series A funding led by Chicago-based Cultivian Sandbox Ventures, bringing its total investment to date to approximately €25m.

Sources: <http://www.nuritas.com/nestle-and-nuritas-to-work-together-on-discovery-of-food-derived-bioactive-peptides-through-artificial-intelligence/>
<https://www.siliconrepublic.com/machines/nuritas-nestle-ai-dna-analysis-food-health>

Chapter XV

**Q2 2018 - Investment Rounds, M&A Deals
and Notable Events**

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
BenevolentAI	19 April 2018	\$115M	Investments	Woodford Investment Management	The company will use the funds to significantly scale its drug development activities, broaden the disease areas on which it focuses, and extend its AI platform capabilities. A portion of the funds will be used to extend BenevolentAI's capabilities into other science-based industries underpinning many of the world's most valuable markets such as advanced materials, agriculture, and energy storage.
BenchSci	2 May 2018	\$8M	Investments	iNovia Capital; Gradient Ventures; Golden Venture Partners, Afore Capital, Real Ventures, and Radical Ventures	The funds will be used by BenchSci to expand its team of engineers and scientists, implement new sales and marketing programs to drive new customer acquisition, and scale its AI technology used by researchers to accelerate biomedical discoveries.
GTN	May 2018	£2.1	Investments	Octopus Ventures; Pentech; Entrepreneur First	N/A

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Celsius Therapeutics	May 2018	\$65M	Investments	Third Rock Ventures; GV; Heritage Provider Network; Casdin Capital; Alexandria Venture Investments	N/A
Datavant	April 2018	\$40.5M	Investments	Roivant Sciences; Travis May	N/A
OWKIN	May 2018	\$5M	Investments	GV	The company will use the new funding to continue the development of Socrates, strengthen strategic partnerships, and support internal growth.
ThoughtSpot	8 May 2018	\$145M	Investments	Lightspeed Venture Partners; Khosla Ventures; General Catalyst; Sapphire Ventures; Future Fund	ThoughtSpot will continue to innovate its next-generation analytics platform, accelerate global business growth, including expansion in EMEA and APAC, and grow its R&D centers in Palo Alto, Seattle, Dallas, and Bangalore.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Recursion Pharmaceuticals	5 June 2018	\$20.5M	Investments	Square 1 Bank	The funding will allow Recursion to expand its platform to enable target discovery and new chemical entity discovery as well as identify potential treatments in new indication areas like inflammation, immuno-oncology, infectious disease, and aging.
ReviveMed Inc	18 April 2018	\$1.5M	Investments	Rivas Capital; TechU, Team Builder Ventures, WorldQuant Ventures	The financing will allow the company to continue scaling the platform and begin building its internal drug discovery pipeline.
Insilico Medicine	11 June 2018	N/A	Investments	WuXi AppTec; Pavilion Capital; Juvenescence; Bold Capital Partners	The funding is intended to enhance Insilico Medicine's work in the innovative approaches to the generation of novel molecules using a variety of machine learning and deep learning techniques, as well as to expand a variety of the biomarker discovery initiatives.
Boehringer Ingelheim	May 2018	N/A	Cooperation	Bactevo	Boehringer Ingelheim announced a partnership with Bactevo to use its Totally Integrated Medicines Engine platform to identify novel small molecule lead compounds.

AI Company Name	Date	Amount	Type of Deal	Industry/Academia partner	Description
Cloud Pharmaceuticals	30 May 2018	N/A	Cooperation	GlaxoSmithKline	GSK announced a partnership to use AI for the design of novel small-molecule drugs with Cloud Pharmaceuticals.
Hitachi	March 2018	N/A	Cooperation	Mitsubishi Tanabe Pharma	Mitsubishi Tanabe Pharma partnered with Hitachi to optimize clinical trial planning with AI.
XtalPi	May 2018	N/A	Cooperation	Pfizer	Pfizer announced a partnership with XtalPi to combine quantum mechanics and machine learning to predict the properties of drugs.
Deep Genomics	April 2018	N/A	Cooperation	Wave Life Sciences	Wave Life Sciences and Deep Genomics announced their collaboration to discover novel therapies for genetic neuromuscular disorders. Under the collaboration, the companies will analyze and test oligonucleotides against potential therapeutic targets within multiple genes implicated in neuromuscular disorders.

Investment round Q2 2018 / BenevolentAI

On **19th April 2018 BenevolentAI** announced that it has raised **\$115 million** from new and existing investors at a pre-money valuation of \$2 billion in one of the largest funding rounds in the AI pharmaceutical sector. The majority of investors are from the United States, expanding the Company's global investor footprint. The balance of raised funds came from existing investors, including **Woodford Investment Management**. To date, the company has raised more than \$200m of funding since 2013. Credit Suisse acted as the sole placement agent.

The logo for BenevolentAI, consisting of the company name in white text on a blue rectangular background.

BenevolentAI is applying artificial intelligence to develop new medicines for hard to treat diseases. It is the first fully integrated AI company with pharmaceutical discovery and clinical development capabilities. BenevolentAI's technology aims to accelerate the journey from inventive ideas to medicines, lower costs and decrease failure rates associated with traditional drug discovery. The company's AI technology is being used to develop treatments to unmet patients' needs across a wide range of diseases, including Motor Neuron Disease, Parkinson's Disease, Glioblastoma and Sarcopenia.

BenevolentAI has already made progress in accelerating drug development, including the initiation of over 20 research and development programmes to date. The company will use the funds to significantly scale its drug development activities, broaden the disease areas on which it focuses, and extend its AI platform capabilities. A portion of the funds will be used to extend BenevolentAI's capabilities into other science-based industries underpinning many of the world's most valuable markets such as advanced materials, agriculture, and energy storage.

BenevolentAI will continue developing its core "AI brain" as well as different arms of the company that are using it specifically to break new ground in drug development and more. Other areas where the startup hopes to move into over the coming months and years include agriculture, veterinary science, and other categories that sit alongside those BenevolentAI is already tapping.

Source: <https://benevolent.ai/news/announcements/benevolentai-raises-115m-for-ai-enabled-drug-development/>

Investment round Q2 2018 / BenchSci

On **2nd May 2018 BenchSci**, an AI-powered search engine for biological products, announced that it has raised **US\$8 million** in Series A financing. The round was led by **iNovia Capital** with participation from Google's AI-focused venture fund, Gradient Ventures, and return investors Golden Venture Partners, Afore Capital, Real Ventures, and Radical Ventures. Using BenchSci, researchers can find reliable antibodies 24x faster and 75% cheaper than current methods. It now powers discoveries in 7 of the top 10 pharma companies and 910 academic institutions. The company launched out of beta in July 2017, and since that time has analyzed data on more than 4 million commercial antibodies.



As a Canadian technology startup founded by four immigrants, BenchSci prides itself on its diverse workplace and is continuing to expand its team with diverse talent. In 2017, BenchSci tripled its employee count, and plans to add 16 new team members in 2018. The funds will be used by BenchSci to expand its team of engineers and scientists, implement new sales and marketing programs to drive new customer acquisition, and scale its AI technology used by researchers to accelerate biomedical discoveries.

BenchSci's technology provides a unique value proposition for this market, enabling academic researchers to spend less time searching for antibodies and more time working on their experiments. Led by Liran Belenzon, CEO and co-founder, BenchSci accelerates biomedical discoveries via Artificial intelligence driven technology that helps researchers find reliable antibodies faster.

BenchSci has also established partnerships with many of the top scientific publishers, including Springer Nature, Wiley, Karger, the American Medical Association, FASEB, and ASPET.

Source: <https://www.benchsci.com/press/series-A/>

Investment round Q2 2018 / GTN

In **May 2018** drug discovery startup **GTN** has raised **£2.1 million** in Seed funding in a round led by Octopus Ventures and Pentech to transform the industry. Existing investor Entrepreneur First also contributed to the round, which will be used to build on GTN's drug discovery technology. GTN's technology can allegedly predict molecular properties such as binding energy and toxicity. The company is currently running collaborations with global pharmaceutical companies and also has strong partnerships with research bodies including the Francis Crick Institute.



GTN, a female-led company, has developed technology called Generative Tensorial Networks. It combines and builds upon techniques from machine learning and quantum physics to simulate, filter and discover new molecules. The company says this will help bring efficiencies to the drug development cycle, discovering much-needed medicines for patients with cancer, autoimmune and infectious diseases.

GTN uniquely combines multiple scientific disciplines, including quantum physics, biochemistry and deep learning to revolutionise medicine discovery. GTN is currently recruiting for a number of roles within the Machine Learning, Computational Chemistry and Drug Discovery fields.

Cofounder and CEO Professor Noor Shaker commented on the funding round in a statement that “interdisciplinary solutions are key to solving some of the most fundamental challenges in one of the world’s most important and commercially valuable targets for scientific R&D.”

Source: <https://www.uktech.news/news/drug-discovery-startup-gtn-lands-2-1m-seed-from-octopus-ventures-20180504>

Investment round Q2 2018 / Celsius Therapeutics

In **May 2018 Celsius Therapeutics**, a company translating single-cell genomic insights into precision therapeutics for autoimmune diseases and cancer, launched with a **\$65 million** Series A financing led by Third Rock Ventures with participation from GV (formerly Google Ventures), Heritage Provider Network, Casdin Capital, Alexandria Venture Investments and other key investors. Celsius is charting a new course of target and drug discovery by understanding the specific cells, among many others, that are key players in disease and by identifying the genes that are triggering their malfunction.



For the first time, with the approaches discovered by Aviv and Celsius' other founders, the company will combine massive datasets of unprecedented size and complexity with sophisticated machine learning algorithms. Celsius will be able to distinguish the specific cells, among many others, that play a key role in disease and identify the genes that are triggering their malfunction. This approach will allow the company to more efficiently identify specific targets for treating diseases in specific patients and ultimately develop medicines for those targets.

Celsius' fundamentally new approach aims to combine the power of single-cell genomic sequencing with computational algorithms to discover first-in-class precision therapies that have a transformative impact on the lives of patients with autoimmune diseases and cancer. To do this, the company applies a systematic approach, starting with single-cell sequencing on defined patient samples to identify and understand the individual cells and their interactions that cause disease. By analyzing single cells, Celsius' approach has the potential to understand the causes of disease at an entirely new level of resolution that overcomes limitations of traditional genomic sequencing approaches. Celsius believes this approach could be the key to bring precision medicines to autoimmune diseases for the first time.

Celsius has licensed key technologies from the Broad Institute based on the work of Drs Regev and Kuchroo, including non-exclusive licenses to single-cell technologies and an exclusive license to early stage therapeutic programs.

Source: <https://hitconsultant.net/2018/05/16/celsius-therapeutics-funding/>

Investment round Q2 2018 / Datavant

In **April 2018 Datavant**, the leader in helping healthcare organizations safely link their data to improve medical research and patient care, announced that it has acquired Universal Patient Key (UPK), the leading provider of HIPAA-compliant de-identification services for healthcare data. In addition to announcing the acquisition of UPK, Datavant announced as well the completion of a **\$40.5 million** financing round, led by Roivant Sciences and Travis May.



UPK has created a suite of software products that de-identify structured and unstructured health data through HIPAA-compliant methodologies. By using UPK's industry-leading software and services, healthcare stakeholders can securely share patient-level healthcare data while minimizing the risk of unauthorized access and patient re-identification. These services enable the shared use of longitudinal, real-world evidence to further medical research, improve health outcomes, and reduce the cost of delivering care, while at the same time protecting the anonymity of individual patients. Datavant helps data owners manage the privacy, security, compliance, and trust required to enable safe data sharing.

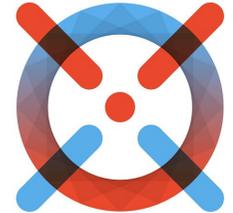
Datavant is a San Francisco-based company dedicated to organizing the world's healthcare data. Datavant helps data owners manage the privacy, security, compliance, and trust required to enable safe data sharing. Datavant's vision is backed by Roivant Sciences, SoftBank Vision Fund, and Founders Fund.

Datavant organizes and structures the world's healthcare data for use in clinical trial decision making. Datavant combines patient level clinical trial and real world evidence to help pharma companies improve the design and interpretation of clinical trials.

Sources: <https://www.prnewswire.com/news-releases/datavant-acquires-universal-patient-key-and-closes-40m-financing-round-300638719.html>

Investment round Q2 2018 / OWKIN

OWKIN announced in **May 2018** that it adds **\$5 million** to its Series A to build the first data-driven machine learning platform for medical research. OWKIN is a machine learning platform for medical research. The company hopes that its predictive analysis platform will enable doctors to effectively understand patient and tumor heterogeneity. After Owkin picked up \$11 million in January, this new raise brings the company's Series A funding to \$16 million and its total funding to \$18.1 million.



OWKIN Socrates is the first data-driven machine learning platform for medical research. It is designed to augment medical researchers' skills and recapture the excitement of research and exploration. Socrates will help researchers in academia, hospitals and the pharmaceutical industry. The platform is smart and will allow researchers to become machine teachers, without needing to understand the mathematics behind the scene. The platform learns while the researchers discover, improving its global, collective intelligence. The underlying machine learning technology is a unique integration of models built upon medical images, genomics and clinical data, allowing for the discovery of biomarkers and mechanisms associated with diseases and treatment outcomes.

Owkin uses artificial intelligence and machine learning to organize, validate, predict, and compare information. It then builds mathematical models and algorithms to interpret biostatistics data and patient profiles. Owkin aims to help the companies find biomarker patterns, design drugs, predict drug responses to design precision clinical trials, and help the right medication get to the target demographic.

The company will use the new funding to continue the development of Socrates, strengthen strategic partnerships, and support internal growth.

Sources:

<http://www.alleywatch.com/2018/05/owkin-adds-another-4-9m-to-its-series-a-to-build-the-first-data-driven-machine-learning-platform-for-medical-research/>
<https://www.mobihealthnews.com/content/alphabets-qv-invests-5-million-ai-startup-owkin>

Investment round Q2 2018 / ThoughtSpot

On **8th May 2018** **ThoughtSpot**, the leader in search and AI-driven analytics for the enterprise, announced it has successfully closed **\$145 million** in Series D funding. The funding was oversubscribed with strong participation from both existing as well as new investors. ThoughtSpot connects with any on-premise, cloud, big data, or desktop data source, deploying 85 percent faster than legacy technologies.



Since its founding in 2012, ThoughtSpot has raised \$306 million in total funding. With the new funding, ThoughtSpot will continue to innovate its next-generation analytics platform, accelerate global business growth, including expansion in EMEA and APAC, and grow its R&D centers in Palo Alto, Seattle, Dallas, and Bangalore. With ThoughtSpot, business leaders and frontline workers alike have made more than 3 million data informed decisions per year. With ThoughtSpot's next-generation analytics platform, business people can use Google-like search to easily analyze complex, large-scale enterprise data and get trusted insights to questions they didn't know to ask, automatically - all with a single click.

The company's record breaking year and notable market accolades, including being named a Visionary in the Gartner Magic Quadrant for Analytics & Business Intelligence, the #1 Best Big Data Company & CEO to Work for by Glassdoor, and a Top Company: Startup by LinkedIn, demonstrate global recognition for the company's solution.

In 2017, the company opened two new R&D centers, while substantially bolstering its presence in Palo Alto, where the company is headquartered. ThoughtSpot has opened an office in Bangalore, India, to innovate business intelligence in the cloud; as part of this effort, the company invested \$10M in the region. The second R&D center opened in Seattle to build artificial intelligence solutions, including the company's recently released AI-driven analytics engine, SpotIQ. The third center opened in Dallas, and will support enterprise expansion. The new funding will enable ThoughtSpot to continue to invest heavily in these engineering centers and fuel the company's ability to disrupt the analytics market.

Source: <https://www.businesswire.com/news/home/20180508006250/en/ThoughtSpot-Raises-145M-Oversubscribed-Series-Funding-Enterprise>

Investment round Q2 2018 / Recursion Pharmaceuticals

On **5th June 2018** Square 1 Bank, a division of Pacific Western Bank, announced that it has provided a **\$20.5 million** credit facility to existing client **Recursion Pharmaceuticals**, an innovative biotechnology company specializing in artificial intelligence enabled drug discovery. Recursion combines experimental biology and bioinformatics with artificial intelligence in a massively parallel system to quickly and efficiently identify treatments for any disease which can be modeled at the cellular level. Recursion is backed by several leading investors including Lux Capital, Data Collective Venture Capital, Mubadala Investment Company, and Obvious Ventures.



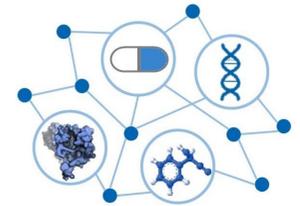
Recursion's ultimate vision is to leverage technology to build a robust and reliable map of human cellular biology, which would enable a radical shift in the pace and scale at which new treatments could benefit patients. By applying advanced machine learning algorithms to a rapidly-growing dataset of more than one petabyte of relatable biological images, the company is able to discover new chemical entities, predict mechanisms of action, reveal previously undiscovered biology, and map compounds to any disease that can be modeled in human cells.

Using a parallel approach and leveraging the speed of automation and the power of machine learning, Recursion aims to bring treatments to the clinic much faster and at a lower cost than previously possible. With Square 1's non-dilutive funding option, Recursion Pharmaceuticals is able to expand its platform to enable target discovery and new chemical entity discovery as well as identify potential treatments in new indication areas like inflammation, immuno-oncology, infectious disease, and aging. These initiatives support its ambitious goal of finding 100 new treatments by 2025.

Source: <https://www.streetinsider.com/Press+Releases/Square+1+Bank+Announces+Credit+Facility+to+Recursion+Pharmaceuticals/14273213.html>

Investment round Q2 2018 / ReviveMed

On **18th April 2018 ReviveMed Inc.** announced it has closed an oversubscribed seed round of **\$1.5 million** to advance its artificial intelligence (AI)-driven platform that unlocks the value of metabolomics data for drug discovery and development. Rivas Capital led the round, which also included participation from several institutional investors including TechU, Team Builder Ventures, and WorldQuant Ventures. ReviveMed is a pioneer in the intersection of artificial intelligence and metabolomics.



ReviveMed's platform consists of a proprietary AI algorithm which utilizes a comprehensive knowledge-based graphical database of metabolites to understand their interactions with proteins and their associations with diseases. ReviveMed can specifically discover molecular mechanisms leading to a disease from tissues and biofluid metabolites. Using this platform ReviveMed has the potential to enable the discovery of drugs, and simultaneously find the biomarkers that identify exactly which patients will benefit from the drug.

The financing will allow the company to continue scaling the platform and begin building its internal drug discovery pipeline. ReviveMed's initial internal discovery program is in metabolic diseases and focused specifically on non-alcohol fatty liver disease (NASH).

ReviveMed is a pioneer in the intersection of artificial intelligence and metabolomics. ReviveMed uniquely overcomes the difficulties of identifying a large set of metabolites for each patient, based on technology developed at The Fraenkel Lab at MIT and published in Nature Methods. It further translates metabolomic data into novel therapeutic insights for drug and drug response biomarker discovery. Currently, ReviveMed is collaborating with tier-one pharmaceutical companies to support their drug discovery programs and in pursuing internal drug discovery, initially focused on metabolic diseases.

Sources: <http://www.revive-med.com/2018/04/18/seed-fund-press-release/>

Investment round Q2 2018 / Insilico Medicine

On **11th June 2018 Insilico Medicine**, a Baltimore-based next-generation artificial intelligence company specialized in the application of deep learning for target identification, drug discovery and aging research, announced the completion of a strategic round of funding led by WuXi AppTec's Corporate Venture Fund. The strategic investment was conditional upon the successful experimental validation of Insilico Medicine's Generative Adversarial Networks (GAN) and Reinforcement Learning (RL)-based drug discovery pipeline and is intended to closely integrate Insilico Medicine's cutting-edge artificial intelligence technology with WuXi AppTec's laboratory infrastructure and expertise in drug discovery.



The round was led by WuXi AppTec's Corporate Venture Fund and includes Pavilion Capital, a subsidiary of Temasek Holdings, BOLD Capital Partners, the venture capital fund investing in exponential technologies co-founded by Peter Diamandis, and Juvenescence. The transaction has been a joint effort between WuXi AppTec's Corporate Venture Fund and WuXi AppTec's Research Services Division, which has been focused on investing in and collaborating with highly-disruptive technologies and companies globally.

The funding is intended to enhance Insilico Medicine's work in the innovative approaches to the generation of novel molecules using a variety of machine learning and deep learning techniques, as well as to expand a variety of the biomarker discovery initiatives.

Insilico Medicine is an artificial intelligence company headquartered at the Emerging Technology Centers at the Johns Hopkins University Eastern campus in Baltimore, with R&D and management resources in Belgium, Russia, UK, Taiwan and Korea sourced through hackathons and competitions. The company and its scientists is dedicated to extending human productive longevity and transforming every step of the drug discovery and drug development process through excellence in biomarker discovery, drug development, digital medicine and aging research.

Source:

<https://www.prnewswire.com/news-releases/wuxi-apptec-leads-strategic-investment-in-insilico-medicine-to-accelerate-drug-discovery-using-next-generation-artificial-intelligence-300663758.html>

M&A Deals Q2 2018

In May 2018, **Boehringer Ingelheim** announced a partnership with **Bactevo** to use its Totally Integrated Medicines Engine platform to identify novel small molecule lead compounds. Enabled by advance machine learning, Bactevo claims that its Totally Integrated Medicines Engine platform (TIME) will be able to bring about a paradigm shift in the speed, efficiency and quality of drug discovery, as well as dramatically enhanced safety profiling. In addition to working with partners to develop novel first-in-class medicines, Bactevo is also developing breakthrough medicines for the treatment of diseases that involve defects in mitochondrial function, such as MELAS and LHON. It is also targeting diseases of the central nervous system, such as Parkinson's, Alzheimer's and Amyotrophic Lateral Sclerosis (ALS). Bactevo will receive upfront payments and research funding, although that specific amount was not disclosed. The tech group could also be eligible to receive payments for certain research, development and commercialisation milestones.

On 30th May 2018, **GlaxoSmithKline** (GSK) announced a partnership to use AI for the design of novel small-molecule drugs with **Cloud Pharmaceuticals**. Cloud Pharmaceuticals will design novel small-molecule agents to GSK specified targets. Cloud Pharmaceuticals will use its proprietary AI-driven process to design the molecules. Cloud Pharmaceuticals is a leader in the computational design of new drugs and subsequent rapid, information-driven drug development. It accelerates the drug discovery and design process in a way that delivers tangible results and true value for its partners.

In March 2018, **Mitsubishi Tanabe Pharma** partnered with **Hitachi** to optimize clinical trial planning with AI. Mitsubishi Tanabe Pharma will apply Hitachi's digital technology such as artificial intelligence to make clinical trials more efficient. The partnership focuses on cutting the time spent on searching and collecting information from medical papers and ClinicalTrials.gov in the planning stage of clinical trials. A test run since the idea's inception in 2017 has confirmed that the approach can shorten the time spent on information search and collection by about 70%.

Sources: http://www.pmlive.com/blogs/digital_intelligence/archive/2018/may/boehringer_partners_with_bactevo_on_drug_discovery_1235384
<https://www.businesswire.com/news/home/20180530006184/en/Cloud-Pharmaceuticals-forms-Drug-Design-Collaboration-GSK>
<https://www.fiercebiotech.com/cro/mitsubishi-tanabe-hitachi-join-forces-ai-enabled-clinical-trials>

M&A Deals Q2 2018

In May 2018 **Pfizer** announced a partnership with **XtalPi** to combine quantum mechanics and machine learning to predict the properties of drugs. Pfizer and XtalPi are collaborating in crystal structure prediction and screening—using computer models to determine the potential molecular stability of an organic compound—and are looking to advance their work in drug design and solid-form selection. XtalPi's algorithms are supported by cloud computing, employing an elastic cluster of servers across AWS, Tencent Cloud, Google Cloud and Alibaba Cloud that can deploy up to 1 million cores in seconds.

In April 2018 **Wave Life Sciences** and **Deep Genomics** announced their collaboration to discover novel therapies for genetic neuromuscular disorders. Under the collaboration, the companies will analyze and test oligonucleotides against potential therapeutic targets within multiple genes implicated in neuromuscular disorders. The analysis will use Deep Genomics' machine learning platform to identify cause and effect relationships specific to neuromuscular-related targets that involve splicing regulation. Wave's propriety chemistry platform will be used to validate targets and elucidate the implications of target intervention across different phenotypes, with the goal of expanding Wave's pipeline of rationally designed oligonucleotides. The collaboration was built on Wave's ongoing research and development in splice correction programs, including its lead DMD program, WVE-210201, an investigational therapy targeting exon 51 currently in a global Phase 1 clinical trial. Wave's next DMD program, targeting exon 53, is expected to initiate clinical trials in Q1 2019.

Sources: <https://www.fiercebiotech.com/cro/pfizer-launches-new-collaboration-xtalpi-for-ai-drug-modeling>
<https://globenewswire.com/news-release/2018/04/10/1467697/0/en/Wave-Life-Sciences-and-Deep-Genomics-Form-Collaboration-to-Discover-Novel-Therapies-for-Genetic-Neuromuscular-Disorders.html>

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100 Companies
Applying AI
for Drug Discovery
and Advanced R&D

100 companies Applying AI for Drug Discovery and Advanced R&D

1. AccutarBio	34. e-therapeutics	67. NuMedii
2. Acurastem	35. Emerald Cloud Lab	68. Numerate
3. AiCure	36. Engine Biosciences	69. Nuritas
4. Antidote	37. Envisagenics	70. Owkin
5. Arbor Biotechnologies	38. Euretos	71. PathAI
6. Athelas	39. EvidScience	72. Pepticom
7. ATOM	40. exscientia	73. Peptone
8. Atomwise	41. FDNA	74. Pharnext
9. Bactevo	42. Globavir	75. Phenomic AI
10. BenchSci	43. GNS Healthcare	76. Plex Research
11. BenevolentAI	44. GTN	77. ProteinQure
12. Berg LLC	45. Healx	78. Qrativ
13. BioAge Labs	46. HelixAI	79. Quantitative Medicine
14. Biorelate	47. IBM Watson Health	80. Recursion Pharmaceuticals
15. BioSymetrics	48. Iktos	81. Resonant Therapeutics
16. Biovista	49. Imagia	82. Reveal Biosciences
17. BioXcel	50. Inato	83. Reverie Labs
18. Brite Health	51. Innoplexus	84. ReviveMed
19. BullFrog AI	52. Insilico Medicine	85. sciNote
20. C4X discovery	53. Insitro	86. Sparrho
21. Cambridge Cancer Genomics	54. Intellegens	87. Spring Discovery
22. Celsius Therapeutics	55. Iris.ai	88. Standigm
23. Clinithink	56. Juvenescence AI	89. Structura Biotechnology
24. Cloud Pharmaceuticals	57. Kyndi	90. Synthace
25. CloudMedX	58. Lantern Pharma	91. TeselaGen
26. Cotinga Pharmaceuticals	59. MediBIC Group	92. ThoughtSpot
27. Cyclica	60. Mendel.ai	93. Transcriptic
28. CytoReason	61. Meta	94. Trials.ai
29. Cytos	62. Micar21	95. TwoXAR
30. Datavant	63. Mind the Byte	96. Verge Genomics
31. Deep 6 AI	64. nference	97. Virogin
32. Deep Genomics	65. Novoheart	98. Virvio
33. Desktop Genetics	66. nQ Medical	99. WinterLight Labs
		100. XtalPi

AccutarBio employs artificial intelligence to revolutionize drug discovery. AccutarBio's philosophy is to derive a data-driven principle that has the power of explaining physical and chemical nature of biological systems, which it harnesses to accelerate drug discoveries.

Web site:	https://www.accutarbio.com/
Number of Employees:	N/A
Founded in:	2015
Based in:	China
Founders:	Dr. Jie Fan
Funding To Date:	N/A
Investors:	IDG Capital, YITU Tech, and ZhenFund

Acurastem



AcuraStem harnesses advanced cellular reprogramming and artificial intelligence technologies to transform the standard of care for neurodegenerative diseases through patient-specific treatment.

Web site:	https://acurastem.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	N/A
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A



AiCure's intelligent medical assistant, IMA, leverages a visual recognition platform to monitor patient progress. IMA provides visual dose confirmation, interactive patient support and engagement, and visual diagnostic capabilities. The platform has been validated to improve patient behavior in randomized controlled trials. In clinical research, AiCure is increasing the probability of trial success and introducing more objective clinical endpoints. In population health, AiCure is enabling intelligent decision-making and improving health outcomes. By 2020, there will be a one million nurse shortage in the US. AiCure is striving to help fill this gap. In clinical research, approximately one quarter of clinical trials fail due to a lack of patient oversight, contributing to over \$40 billion in annual losses. AiCure is seeking to accelerate better medications into the market.

Web site:	http://aicure.com/
Number of Employees:	11-50
Founded in:	2010
Based in:	United States
Founders:	Adam Hanina, Laura Shafner
Funding To Date:	\$27.3M
Investors:	Pritzker Group Venture Capital, Baird Capital, Tribeca Venture Partners, Biomatics Capital Partners, New Leaf Venture Partners

Antidote



Antidote is a digital health company focused on accelerating and improving medical research. By combining proprietary technologies, data, and well-established business models, the company is transforming the way patients and researchers connect, so that breakthroughs happen faster. Antidote was launched as TrialReach in 2010 and rebranded to Antidote in 2016. The company is based in the US and the UK.

Web site:	http://antidote.me/
Number of Employees:	11-50
Founded in:	2010
Based in:	United Kingdom
Founders:	Eithan Ephrati, Jessica Mann, Pablo Graiver
Funding To Date:	\$28.9M
Investors:	Smedvig Capital, Octopus Ventures, Amadeus Capital Partners, Merck Global Health Innovation Fund

Arbor Biotechnologies



Arbor Biotechnologies is an early stage life sciences company pushing the boundaries of biodiscovery. Using artificial intelligence, genome sequencing, gene synthesis and high-throughput screening, they are accelerating the discovery of proteins for improving human health and sustainability.

Web site:	https://arbor.bio/
Number of Employees:	2-10
Founded in:	2016
Based in:	United States
Founders:	David Scott, David Walt, Feng Zhang, Winston Yan
Funding To Date:	\$31.5M
Investors:	N/A

Athelas utilizes deep learning and computer vision to rapidly analyze tissue samples for diagnostics. The product is used for immune monitoring, blood counts, and parasite diagnostics.

Web site:	http://athelas.com/
Number of Employees:	N/A
Founded in:	2016
Based in:	United States
Founders:	Tanay Tandon
Funding To Date:	\$3.6M
Investors:	Y Combinator, Sequoia Capital, Liquid2 Ventures, Initialized Capital Dorm Room Fund, Fifty Years

ATOM uses AI to better predict how molecules will behave in the body. It allows researchers to accelerate development of more effective therapies.

Web site:	https://atomsience.org/
Number of Employees:	11-50
Founded in:	2017
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

Atomwise



Atomwise develops artificial intelligence systems using powerful deep learning algorithms and supercomputers for drug discovery. Atomwise uses Deep Learning Neural Networks to help discover new medicines. Atomwise achieves the world's best results for new drug hit discovery, binding affinity prediction, and toxicity detection. It predicts drug candidates for pharmaceutical companies, startups, and research institutions.

Web site:	http://atomwise.com/
Number of Employees:	1-10
Founded in:	2016
Based in:	United States
Founders:	Abraham Heifets, Alexander Levy, Dr. Izhar Wallach
Funding To Date:	\$51.3M
Investors:	Tencent Holdings, Y Combinator, Creative Destruction Lab, Khosla Ventures , Draper Associates, DFJ, B Capital Group, Baidu Ventures, OS Fund, Dolby Family Ventures, DFJ Growth, AME Cloud Ventures

Bactevo



Bactevo is a Cambridge UK-based company utilising its proprietary molecular engineering technologies. Bactevo is a 21st century drug discovery company addressing diseases for which others are failing to provide effective treatments in mitochondrial, neurodegenerative, cardiovascular/metabolic, joint/tissue disease and cancer.

Web site:	http://www.bactevo.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United Kingdom
Founders:	N/A
Funding To Date:	N/A
Investors:	New Wave Ventures

BenchSci



BenchSci is a reagent intelligence platform that transforms published data into experiment-specific recommendations. For biomedical researchers who are starting experiments, BenchSci is a reagent intelligence platform that transforms published data into experiment-specific recommendations to reduce time, money, and uncertainty in planning materials and methods. Unlike PubMed, Google Scholar, reagent directories, and vendors, BenchSci uses machine learning to decode open- and closed-access data and present published figures with actionable insights.

Web site:	http://benchsci.com/
Number of Employees:	11-50
Founded in:	2015
Based in:	Canada
Founders:	David Q. Chen, Elvis Wianda, Liran Belenzon, Tom Leung
Funding To Date:	CA\$10.3M
Investors:	Creative Destruction Lab, Real Ventures, iNovia Capital, Afore Capital, Golden Ventures, Gradient Ventures, Radical Ventures

BenevolentAI is one of the largest private AI companies in the world and the global leader in the development and application of AI for scientific innovation. The company is applying artificial intelligence to develop new medicines for hard to treat diseases. It is the first fully integrated AI company with pharmaceutical discovery and clinical development capabilities. BenevolentAI's advanced technology is disrupting the pharmaceutical industry by lowering costs, decreasing failure rates and increasing the speed at which medicines are delivered to patients. The company's AI technology is being used to develop treatments to unmet patients' needs across a wide range of diseases, including Motor Neuron Disease, Parkinson's Disease, Glioblastoma and Sarcopenia.

Web site:	http://benevolent.ai/
Number of Employees:	101-250
Founded in:	2013
Based in:	United Kingdom
Founders:	Brent Gutekunst, Ivan Griffin, Ken Mulvany, Michael Brennan
Funding To Date:	\$202M
Investors:	Woodford Investment Management, Lundbeck, Lansdowne Partners, Upsher Smith Laboratories

Berg LLC



BERG is a Boston-based BioPharma company focused on taking a bold “back to biology” approach to therapeutic discovery using its unique AI-based Interrogative Biology® platform. This platform combines patient biology and artificial intelligence-based analytics to engage the differences between healthy and disease environments. The patient’s own biology drives the platform’s results and guides it in the discovery and development of drugs, diagnostics and healthcare applications. Its platform utilizes patient population health data to bring actionable Patient Intelligence™ to precision medicine applications. This means faster discovery and development of treatments, more effective precision treatments for individuals as well as a reduction in costs to the healthcare systems.

Web site:	http://berghealth.com/
Number of Employees:	251-500
Founded in:	2006
Based in:	United States
Founders:	Niven R Narain
Funding To Date:	\$1.3M
Investors:	N/A

BioAge Labs



BIOAGE has a diverse team of computational biologists and medical scientists with expertise in aging and translational research. BIOAGE shares the vision that a synergy of machine learning approaches, high throughput human omics data, and new experimental approaches will make it possible to discover therapies that address unmet medical needs in an aging population.

Web site:	http://bioagelabs.com/
Number of Employees:	N/A
Founded in:	2015
Based in:	United States
Founders:	Kristen Fortney
Funding To Date:	\$10.9M
Investors:	Andreessen Horowitz, Felicis Ventures, Caffeinated Capital, AME Cloud Ventures, Pear Ventures

Biorelate is a venture-backed AI start-up with a mission to curate truths in biomedicine. Biorelate provides biomedical knowledge databases curated from published literature to pharmaceutical and biotechnology companies and academic institutes. Biorelate is based in Manchester Science Park.

Web site:	http://biorelate.com/
Number of Employees:	N/A
Founded in:	2014
Based in:	United Kingdom
Founders:	Daniel Jamieson
Funding To Date:	£100K
Investors:	GM&C Life Sciences Fund, Catapult Ventures

BioSymetrics



BioSymetrics is a biomedical AI company that has pioneered proprietary Machine Learning (ML) methods to optimize innovation in BioPharma, precision medicine, diagnostics, and medical discovery. Its technology platform, Augusta™, performs advanced data pre-processing and integrated ML on complex biomedical data types and large-scale datasets. Augusta can work from siloed or raw data, and enable integration of multiple biological, clinical, genomics, metabolomic, lab testing, and drug development data types, for analytics at unprecedented speed and accuracy. Augusta is deployable anywhere (no data transfer needed) and provides scalable architecture for enterprise and cloud computing applications.

Web site:	http://biosymetrics.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

Biovista



Biovista delivers custom drug repositioning, drug de-risking and clinical hold solutions for the Biopharma Industry. Biovista also develops powerful platform technologies for Life science and Biotechnology companies. Biovista has an ongoing R&D program to develop new and improve existing products and services.

Web site:	http://biovista.com/
Number of Employees:	N/A
Founded in:	2005
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

BioXcel is a BioPharmaceutical company pioneering the application of big data analytics and machine learning-based artificial intelligence integrated with drug development expertise, its R&D Engine, to advance the next wave of medicines and significantly improve the clinical and regulatory success of drug development.

Web site:	http://bioxcel.com/
Number of Employees:	101-250
Founded in:	2005
Based in:	US
Founders:	N/A
Funding To Date:	\$60M
Investors:	N/A

Brite Health



Brite Health provides an AI platform for clinical trials. Brite Health's patient-first mobile platform and intelligent site dashboard together support each patient's complex journey through the clinical trial and its care journey post-market. The patient application notifies patients about their tasks and site visits at the right moment and informs them every step of the way through personalized conversations and curated content. The site dashboard allows site staff to monitor patient adherence and engagement in real-time, and intervene in a timely manner to prevent dropouts.

Web site:	http://britehealth.co/
Number of Employees:	1-10
Founded in:	2015
Based in:	United States
Founders:	Niousha Zadeh, Sanaz Motahari
Funding To Date:	\$240M
Investors:	Plug and Play, Unshackled Ventures

BullFrog AI



BullFrog AI utilizes a proprietary deep machine learning/AI platform to harness valuable clinical data to solve challenges with patient targeting in clinical development. The platform is based on a graph analytics tool designed to discover patterns and relationships in large scale and complex data sets. The technology has been in development for seven years at The Johns Hopkins University Applied Physics Laboratory and has proven to be incredibly robust, scalable, and precise.

Web site:	https://www.bullfrogai.com/
Number of Employees:	2-10
Founded in:	2017
Based in:	United States
Founders:	Vin Singh
Funding To Date:	N/A
Investors:	N/A

C4X discovery



C4X Discovery brings a new dimension to drug discovery. Using its unique NMR-based technique to determine 3D molecular structures with high accuracy, C4X Discovery is focused on optimising the design and development of medicines and partnering with the pharmaceutical sector to generate better, safer products. C4X Discovery is able to determine the bioactive 3D structures of a variety of biologically important molecules, including drugs, naturally occurring ligands and enzyme cofactors, and does this independently of traditional methods such as computational modelling and X-ray crystallography. C4X Discovery is applying its unique technology to improve the efficiency of the drug discovery process, both in partnership with the pharmaceutical industry and across its own pipeline of high-value therapeutic targets.

Web site:	https://www.c4xdiscovery.com/
Number of Employees:	N/A
Founded in:	2007
Based in:	United Kingdom
Founders:	Charles Blundell
Funding To Date:	£5,000,000
Investors:	Aquarius Equity Partners

Cambridge Cancer Genomics



Cambridge Cancer Genomics is using blood tests to guide smarter cancer therapy. Currently, cancer patients have to wait up to 6 months to know whether their chemotherapy is working. In the interim, patients suffer the side effects of such treatments. Using simple blood draws, Cambridge Cancer Genomics shortens the time required to know whether treatment is working, buying the clinician more time to alter treatment and reduce unnecessary side effects. In addition, Cambridge Cancer Genomics can identify relapse an average of 7 months earlier than standard practice. Over time, it will be able to better predict the best therapeutic strategy for cancer patients before they even begin treatment.

Web site:	http://ccg.ai/
Number of Employees:	1-10
Founded in:	2016
Based in:	United Kingdom
Founders:	Evaline Tsai, Harry Clifford, John Cassidy, Nirmesh Patel
Funding To Date:	\$4.1M
Investors:	Pi Campus, Endure Capital, NewDo Venture, Y Combinator

Celsius Therapeutics



Celsius Therapeutics is a community of scientists, technologists, clinicians and drug hunters leveraging single-cell RNA sequencing and genomic analysis to develop life-changing medicines. Its common goal is to markedly improve human health by integrating data, experience and insight.

Web site:	http://www.careskore.com/
Number of Employees:	11-50
Founded in:	2018
Based in:	United States
Founders:	Aviv Regev
Funding To Date:	\$65M
Investors:	Third Rock Ventures, Casdin Capital, GV

Clinithink, a London, UK-based healthcare software company. Led by CEO Chris Tackaberry, Clinithink has developed cloud-based text processing capability that can be used to support data analytics, coding and decision support in healthcare applications. Its patent-pending Clinical Language Indexing software (CLiX) uses Natural Language Processing (NLP) to construct coded output from physicians' notes using industry data standards (ICD-9, ICD-10, and SNOMED CT).

Web site:	https://clinithink.com/
Number of Employees:	11-50
Founded in:	2009
Based in:	United Kingdom
Founders:	Chris Tackaberry, Peter Johnson
Funding To Date:	N/A
Investors:	Vanguard Atlantic, Finance Wales

Cloud Pharmaceuticals



Cloud Pharmaceuticals is committed to improving health and well-being through the computational design and rapid development of new therapies. Cloud Pharmaceuticals uses a proprietary design process that combines artificial intelligence and cloud computing to search virtual molecular space and applies along sophisticated molecular modeling to design novel drugs that are well-qualified for development from the outset and have original composition of matter IP. The process enables faster drug development progress at lower cost and a higher success rate and better targeting of hard-to-drug indications. Their approach amplifies the power of cloud computing and AI to radically improve drug discovery and design. Cloud Pharmaceuticals partners at all stages of drug development – from discovery through the clinic – and are building an extensive product pipeline that spans a wide range of indications.

Web site:	http://cloudpharmaceuticals.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	United States
Founders:	Ed Addison, Lawrence Husick, Shahar Keinan
Funding To Date:	\$1.5M
Investors:	National Science Foundation

CloudMedx Inc



CloudMedx is a Clinical AI Computing platform that uses healthcare specific NLP and Machine learning to generate real-time clinical insights at all points of care to improve patient outcomes. The award winning technology is run by experts in machine learning, neuroscience, medicine, and data science and brings unprecedented scale and simplicity to the application of brain-inspired clinical algorithms to healthcare. CloudMedx utilizes evidence based algorithms and deep learning for making sense of a wide variety of structured and unstructured data that is stored in clinical workflows. Through its algorithms and technology clinical partners at all levels can derive meaningful and real-time insights from their data and intervene at critical junctures of patient care. Trusted by some of the best performing provider organizations in the country, CloudMedx is passionate about bringing a comprehensive and adaptive platform to healthcare.

Web site:	http://www.cloudmedxhealth.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	United States
Founders:	Sahar Arshad, Tashfeen Suleman
Funding To Date:	\$5.3M
Investors:	SV Tech Ventures, China Equity, Draper Associates, Draper Dragon, Data Collective, Tencent Holdings, Y Combinator, FundersClub

Cotinga Pharmaceuticals



Cotinga Pharmaceuticals is a biopharmaceutical company focused on developing treatments for a broad range of cancers by targeting the fundamental mechanisms driving cancer cell survival. The company applies Cotinga's proprietary technologies and oncology expertise to develop drug candidates that inhibit major mechanisms implicit in cancer cell survival and growth. Cotinga's drug candidates have demonstrated the ability to target key pathways and prevent cancer cells from thriving and replicating.

Web site:	http://cotingapharma.com/
Number of Employees:	N/A
Founded in:	1999
Based in:	Canada
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

Cyclica



Cyclica operates in the exciting intersection of Technology and Life Sciences/Healthcare. Cyclica enhances drug discovery by harnessing big data and predictive analytics through its patented cloud based platform, Ligand Express. Cyclica harnesses biophysics, biological data, and artificial intelligence to help pharmaceutical companies navigate the drug discovery pipeline by assessing the safety and efficacy of drugs. Whether pre-clinical, clinical, or FDA approved, Cyclica's patented, drug-centric, structure-based and AI-augmented platform, Ligand Express, offers novel insight and analysis into a drugs' polypharmacology.

Web site:	http://cyclicarx.com/
Number of Employees:	11-50
Founded in:	2013
Based in:	Canada
Founders:	Jason Mitakidis
Funding To Date:	\$7M
Investors:	StartUp Health, GreenSky Capital, EPIC Capital, China Canada Angel Alliance, Hanhai Studio.

CytoReason



Founded in 2016 by bioinformatics visionaries and digital health experts, CytoReason's vision is to use the most recent accomplishments in computer science to improve people's lives where it matters the most – their health. CytoReason combines immunology domain expertise with state-of-the-art artificial intelligence technology to accelerate breakthroughs that are hidden in the massive amounts of data. Its mission is to scale the creative part of bioinformatics, empowering biologists, researchers and business analysts with a machine that constantly analyzes data and surfaces discoveries automatically.

Web site:	http://www.cytoreason.com/
Number of Employees:	11-50
Founded in:	2016
Based in:	Israel
Founders:	David Harel, Elina Starosvetsky, Ksenya Kveler, Renaud Gaujoux, Shai Shen-Orr, Yuval Kalugny
Funding To Date:	N/A
Investors:	N/A

Cytox has developed a simple genetic based blood test for the assessment of risk and diagnosis of Alzheimer's Disease in the very early stages. Alzheimer's Disease affects over 26 million people worldwide and is a growing condition as people live longer. There is currently no cure for Alzheimer's Disease, but there are large international initiatives underway to find treatments with many drugs in clinical development. Cytox is commercially launching their tests in conjunction with Affymetrix (part of Thermo Fisher Scientific) to support Pharmaceutical and Biotechnology companies developing novel therapeutics.

Web site:	cytoxgroup.com
Number of Employees:	1-10
Founded in:	2004
Based in:	United Kingdom
Founders:	Zsuzsanna Nagy
Funding To Date:	£10.3M
Investors:	Seneca Partners, Walking Ventures, GM&C Life Sciences Fund, Nesta Ventures, Midven, University of Birmingham, UK Innovation & Science Seed Fund, Wren Capital, Masa Life Science Fund, Esperante Ventures

Datavant



Datavant connects healthcare data to eliminate the silos of healthcare information that hold back innovative medical research and improved patient care. Datavant helps data owners manage the privacy, security, compliance, and trust required to enable safe data sharing. Datavant's vision is backed by Roivant Sciences, Softbank, and Founders Fund, and combines technical leadership and healthcare expertise. Datavant is located in the heart of San Francisco's Financial District.

Web site:	http://datavant.com/
Number of Employees:	11-50
Founded in:	2017
Based in:	United States
Founders:	Travis May
Funding To Date:	\$40.5M
Investors:	Founders Fund, Roivant Sciences.

Deep 6 AI



Deep 6 AI finds patients for clinical trials in minutes rather than months. Using artificial intelligence on clinical data, Deep 6 AI's software accelerates patient recruitment exponentially, getting life-saving cures to people faster. Deep 6 AI got its start by beating out some of the biggest names in analytics in a U.S. government-sponsored contest. This led to a contract with the U.S. intelligence community, which is perhaps the most complex data environment in the world. Since 2016, Deep 6 AI has focused exclusively on healthcare, participating in the Techstars Healthcare Accelerator in partnership with Cedars-Sinai, the Healthbox modified-accelerator program, and Stanford's StartX Accelerator.

Web site:	http://deep6.ai/
Number of Employees:	11-50
Founded in:	2015
Based in:	United States
Founders:	Brian Dolan, Wout Brusselaers
Funding To Date:	N/A
Investors:	Techstars, The Cedars-Sinai Accelerator

Deep Genomics



Deep Genomics is using artificial intelligence to build a new universe of life-saving genetic therapies. The future of medicine will rely on artificial intelligence, because biology is too complex for humans to understand. At Deep Genomics, its geneticists, molecular biologists and chemists develop new ways of detecting and treating disease using their biologically accurate artificial intelligence technology.

Web site:	http://deepgenomics.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	Canada
Founders:	Andrew Delong, Brendan Frey, Hannes Bretschneider, Hui Yuan Xiong
Funding To Date:	\$16.7M
Investors:	Creative Destruction Lab, Khosla Ventures, True Ventures , 11.2 Capital Bloomberg Beta

Desktop Genetics



Desktop Genetics is an international biotechnology company established in 2012 to help researchers discover and treat the root genetic causes of human disease. Today, Desktop Genetics is a recognised leader in genome editing technology, staffed by dedicated team of genome editing experts, bioinformaticians and data scientists, driven by the real-world impact of CRISPR technology. Desktop Genetics' tools and technologies are used by over 1800 organisations all over the world, and its projects contribute directly to several key partnerships to bring CRISPR into the clinic. The company has received awards from Fast Company, Kairos 50 and SxSW Interactive

Web site:	http://desktopgenetics.com/
Number of Employees:	11-50
Founded in:	2012
Based in:	United Kingdom
Founders:	Edward Perello, Riley Doyle, Victor Dillard
Funding To Date:	\$6.8M
Investors:	Illumina, SyndicateRoom, IQ Capital Partners LLP, London Co-Investment Fund, Boundary Capital Partners LLP, UK Innovation & Science Seed F

e-Therapeutics



e-Therapeutics plc
The Network Pharmacology Company

e-Therapeutics plc is a drug discovery and development company. It has developed proprietary computational systems to swiftly and accurately analyse and predict how medicines interact with cells in the body in hopes of optimizing the probability of identifying drug candidates with desirable efficacy and minimal side effects.

Web site:	http://www.etherapeutics.co.uk/
Number of Employees:	11-50
Founded in:	2003
Based in:	United Kingdom
Founders:	N/A
Funding To Date:	\$66.8M
Investors:	Octopus Ventures



Emerald Cloud Lab was founded by scientists, for scientists. Their vision is to build a system that sweeps aside the daily grind scientists face in the laboratory and allows the day-to-day work to center on orchestrating science. There is transformative potential in a world where scientific ideas have a more direct route to realization and where progress in science and medicine is driven more by the strength of their ideas than their labor in the lab. Succeeding in this mission has the chance to provide unprecedented leverage and autonomy to scientists worldwide and in doing so to accelerate the rate of progress in pharmaceutical research, materials science, medical diagnostics, and agriculture.

Web site:	http://emeraldcloudlab.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United States
Founders:	N/A
Funding To Date:	\$13.5M
Investors:	N/A

Engine Biosciences



Engine Biosciences is a biotech company that applies machine learning to genomics for drug discovery. Engine Biosciences is a venture-backed San Francisco- and Asia-based technology company pioneering network biomedicine. The company's proprietary and patented technologies oriented around deciphering the complexity of biology networks include both high-throughput wet lab experimentation and artificial intelligence algorithms for drug discovery and cellular reprogramming. This platform, developed through several years of research by their scientific founding and leadership team who include faculty members at MIT, Harvard, Mayo Clinic, and UCSD, dramatically accelerates and reduces costs of the R&D process for new medical therapies. Engine Biosciences is actively applying the platform internally and with partners across a range of disease indications.

Web site:	http://enginebio.com/
Number of Employees:	1-10
Founded in:	N/A
Based in:	United States
Founders:	Jeffrey Lu, Timothy Lu
Funding To Date:	\$10M
Investors:	DHVC (Danhua Capital), Dimensions Capital, WI Harper Group, Baidu Ventures, EDBI, Goldman Capital, WuXi AppTec, Nest.Bio Ventures

Envisagenics



Envisagenics is a bioinformatics spinout from Cold Spring Harbor Laboratory translating NextGen sequencing data for RNA therapeutics discovery into BioPharma R&D intelligence. Envisagenics focus on the discovery of RNA therapeutics. Over 30 million people in the US suffer from genetic diseases or cancer that could be caused by mutations affecting RNA splicing. 370 human diseases are known to be caused by splicing errors, and more remain to be discovered.

Web site:	http://envisagenics.com/
Number of Employees:	1-10
Founded in:	2014
Based in:	US
Founders:	Maria Luisa Pineda, Martin Akerman
Funding To Date:	\$4.6M
Investors:	National Institutes of Health, Grand Central Tech, Dynamk Capital, Cosine, SV Angel, Dolby Family Ventures, Third Kind Venture

Euretos provides an AI platform mainly used by pre & early-clinical researchers for in-silico discovery & validation of targets and biomarkers. The platform enables a systems biology approach where researchers discover how x-omics molecular mechanisms influence cell and tissue functions, and in turn mediate phenotypes and disease pathology. Euretos supports their customers through: - AI/systems biology driven research consulting, involving cutting edge approaches such as machine learning; - Direct access to the cloud based Euretos discovery platform via user friendly application; - API Integration of the discovery platform in your company's IT environment/workflows; - Integration of company proprietary data and public data in a secure environment.

Web site:	https://www.euretos.com/
Number of Employees:	11-50
Founded in:	2012
Based in:	The Netherlands
Founders:	Arie Baak
Funding To Date:	N/A
Investors:	N/A

Evid Science



Evid Science represents the next generation of comparative effectiveness analysis in healthcare and pharmaceuticals. Leveraging cutting edge research in Artificial Intelligence and Machine Learning, Evid Science is building the largest database of therapy evidence in the world to answer any comparative cost and outcomes questions, on-the-fly, in seconds.

Web site:	http://evidscience.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United States
Founders:	N/A
Funding To Date:	\$500K
Investors:	N/A

Exscientia is applying AI and big data processing to accelerate drug discovery and development. Exscientia is the first company to automate drug design, surpassing conventional human endeavour. Its AI driven systems actively learn best practice from vast repositories of discovery data and are further enhanced with knowledge acquired from seasoned drug hunters. With better information to hand than any researcher could acquire individually, its knowledge-driven systems design millions of novel, project-specific compounds and pre-assess each for predicted potency, selectivity, ADME and other key criteria. From this, a selection of the best, information-rich compounds are selected for synthesis and assay.

Web site:	http://exscientia.co.uk/
Number of Employees:	11-50
Founded in:	2012
Based in:	United Kingdom
Founders:	Andrew Hopkins
Funding To Date:	\$17M
Investors:	Frontier IP Group plc



FDNA develops innovative digital health solutions, using proprietary facial analysis technology to transform facial images into meaningful and actionable genetic information, accessible to healthcare professionals anywhere, anytime. FDNA's mission is to save lives and improve the quality of life of patients with rare, or difficult-to-diagnose genetic syndromes. FDNA has developed Face2Gene - a genetic search and reference mobile application, powered by the Facial Dymorphology Novel Analysis technology. Face2Gene is a robust application that can seamlessly integrate into a clinicians workflow, providing a powerful time-saving tool that delivers relevant, accurate and insightful information to enhance clinical confidence in the evaluation of rare-disease patients.

Web site:	http://fdna.com/
Number of Employees:	11-50
Founded in:	2011
Based in:	United States
Founders:	Lior Wolf, Moti Shniberg
Funding To Date:	N/A
Investors:	N/A

Globavir Biosciences is a San Francisco Bay Area based company committed to the development of therapeutics and diagnostics for the treatment of global infectious diseases. Globavir's development strategy harnesses the advantages offered by the 505(b)2 regulatory pathway, allowing for rapid development of new therapies. Globavir is focused on the treatment of dengue virus infection, a potentially lethal disease infecting 390 million patients annually. Through the combination of its proprietary diagnostic technology and advanced therapeutic candidates, Globavir is ideally positioned to rapidly impact the clinical landscape for Dengue patients. Globavir's platform discovery technologies have further identified candidate compounds with efficacy in additional viral indications, including West Nile, Japanese Encephalitis, Ebola, Marburg, and Hunta viruses.

Web site:	http://globavir.com/
Number of Employees:	11-50
Founded in:	2011
Based in:	United States
Founders:	Shalabh Gupta, Vijay Pande
Funding To Date:	\$5.5M
Investors:	Stanford-StartX Fund, Sorrento Therapeutics.

GNS Healthcare



GNS Healthcare is a big data analytics company focuses on discovering what works in the healthcare industry and for whom. They focus on advancing and applying industrial-scale data analytics to empower key healthcare stakeholders to solve complex care, treatment and cost challenges. They are a multi-disciplinary group of physicists, actuaries, geneticists, engineers, business people, and computer scientists, passionate about extracting the evidence of what works in healthcare and for whom.

Web site:	http://gnshealthcare.com/
Number of Employees:	101-250
Founded in:	2000
Based in:	United States
Founders:	Colin Hill, Iya Khalil
Funding To Date:	\$48.7M
Investors:	Amgen Ventures, Cambia Health Solutions, Mitsui & Co, Celgene, Heritage Provider Network, Alexandria Real Estate Equities

GTN Limited



Bringing a single new drug to the market costs \$2.9bn, often delivering an intervention that barely differs from those already in the market. Projections into the future are not promising, with an expected 50% drop in R&D output every nine years. GTN is searching the astronomically large space of drug-like molecules with its unique patented technology, Generative Tensorial Networks. Its software combines and builds upon techniques from machine learning and quantum physics to simulate, filter and search for molecules, halving development costs and discovering molecules entirely hidden from view.

Web site:	http://gtn.ai/
Number of Employees:	11-50
Founded in:	2017
Based in:	United Kingdom
Founders:	Noor Shaker, Vid Stojevic
Funding To Date:	£2.1M
Investors:	Octopus Ventures, Pentech Ventures

Healx is a biotechnology company that develops and offers new therapeutic solutions for patients with rare diseases. The company offers Rareomics, a tool that helps researchers, charities, and individuals keep up with the latest scientific literature on many rare diseases. It also offers Rarepurposing that helps identify existing drug candidates which can help improve the quality of life of patients with rare diseases.

Web site:	http://healx.io/
Number of Employees:	1-10
Founded in:	2014
Based in:	United Kingdom
Founders:	Andreas Bender, David Brown, David Cavalla, Tim Guilliams
Funding To Date:	£1.5M
Investors:	Amadeus Capital Partners, Pitch@Palace

HelixAI is a platform for the creation of voice activated virtual assistant for the laboratory sciences. HelixAI wants to bring voice technology to the sciences. Their platform can be used to create personalized virtual assistants for individual labs that can be accessed through any of the Amazon Echo family of smart speaker devices. HelixAI virtual assistants can be used to help scientists complete many daily tasks in a hands free way.

Web site:	http://askhelix.io/
Number of Employees:	N/A
Founded in:	2017
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

IBM Watson Health



IBM Watson Health's purpose is to empower leaders, advocates and influencers in health through support that helps them achieve remarkable outcomes, accelerate discovery, make essential connections and gain confidence on their path to solving the world's biggest health challenges.

Web site:	https://www.ibm.com/watson/health
Number of Employees:	N/A
Founded in:	2015
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

Iktos is a French start-up company which develops a truly innovative and disruptive artificial intelligence technology for ligand-based de novo drug design, focusing on MPO (multi parametric optimization). Its innovative algorithm is based on state of the art deep learning models, called generative models, and enables to design new, druggable and synthesizable molecules under the constraint of a given blueprint, with unprecedented speed and performance.

Web site:	http://iktos.ai/
Number of Employees:	1-10
Founded in:	2016
Based in:	France
Founders:	Icolas Do Huu, Quentin Perron, Yann Gaston-Mathe
Funding To Date:	N/A
Investors:	AGORANOV

Imagia



Imagia focuses on AI-driven personalized care solutions across healthcare & bioscience industries. Their research scientists, engineers, clinicians, and colleagues work with hospitals, healthcare professionals and AI scientists to integrate impactful solutions in routine clinical workflows, and help patients access treatment as quickly and accurately as possible.

Web site:	http://imagia.com/
Number of Employees:	11-50
Founded in:	2015
Based in:	Canada
Founders:	Alexandre Le Bouthillier
Funding To Date:	N/A
Investors:	BDC Venture Capital, Real Ventures, Hacking Health Accelerator

Inato automates data structuring and analysis, cross checks data sources, and provides insights on this data. With a unique tool for collecting and analyzing data used in clinical trials, Inato's AI-powered platform lets pharmaceutical companies drastically reduce drug development costs. By accelerating clinical trials, Inato helps new therapies arrive to patients faster, and at lower prices

Web site:	https://inato.com/
Number of Employees:	1-10
Founded in:	2016
Based in:	France
Founders:	Kourosh Davarpanah, William Pambrun
Funding To Date:	€1.3M
Investors:	Serena Capital, Kima Ventures, Fly Ventures

Innoplexus is a technology and product development company focussed on solving challenges in life sciences and pharmaceuticals. Five years ago Innoplexus set out to create self-service products to transform the decision-making in enterprises. Today its products are helping organisations move to continuous decision making by generating insights from structured and unstructured private and public data.

Web site:	http://innoplexus.com/
Number of Employees:	101-250
Founded in:	2011
Based in:	Germany
Founders:	Gunjan Bhardwaj
Funding To Date:	\$3M
Investors:	HCS Beteiligungsgesellschaft

Insilico Medicine



Insilico Medicine is a company dedicated to finding novel solutions for aging and age-related diseases using advances in genomics and big data analysis. Their mission statement and their pledge to their investors, friends and families: “Through excellence in knowledge management, machine learning and bioinformatics, relentless pursuit for new drug, omics and clinical outcomes data, development of reliable in silico drug screening methods, novel validation approaches and strong international partnerships in personalized medicine we strive to find real working solutions to cure and prevent age-related diseases and aging itself.”

Web site:	http://insilicomedicine.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	United States
Founders:	Alex Zhavoronkov
Funding To Date:	\$21M
Investors:	Deep Knowledge Ventures, Bold Capital Partners, WuXi AppTec, A-Level Capital, Pavilion Capital, Juvenescence

Over the past decades, developing drugs has become increasingly more difficult and expensive, leaving many patients with significant unmet need. A constellation of technologies now allows Insitro to construct, perturb, and observe biological model systems in the laboratory, allowing the generation of biomolecular data at unprecedented breadth and scale. At the same time, the tools of data science and machine learning are now solving problems previously thought to be decades away from solution.

Insitro aims to combine these technologies to develop a new approach to drug development that might help cure more people, sooner, and at a much lower cost.

Web site:	http://www.insitro.com/
Number of Employees:	1-10
Founded in:	2018
Based in:	United States
Founders:	Daphne Koller
Funding To Date:	N/A
Investors:	N/A

Intellegens



Intellegens is a spin out of the University of Cambridge to develop and commercialise novel artificial intelligence (AI) software. Intellegens has developed proprietary algorithms which allow neural networks to be trained on a fragmented or incomplete database. Intellegens has already successfully deployed its code in two diverse applications: drug discovery and material design, where it has significantly cut customers' costs by reducing the number of experiments thereby shortening development cycles and offering accelerated time-to-market. The company was founded by Dr Gareth Conduit, a Royal Society Fellow at the Cavendish Laboratory, and Ben Pellegrini, an expert in big data and cloud-based platforms.

Web site:	https://intellegens.ai/
Number of Employees:	1-10
Founded in:	2017
Based in:	United States
Founders:	Dr Gareth Conduit
Funding To Date:	N/A
Investors:	N/A

Iris is an AI Science Assistant, helping R&D double productivity when seeking out new opportunities in published research. Iris.ai is your Research assistant, drastically increasing performance of R&D teams in mapping out existing knowledge (published research, patents, internal R&D content). Moving beyond limiting keywords, endless result lists and the biased citation, Iris.ai is the perfect AI assistant for cross-disciplinary early stage research projects.

Web site:	https://iris.ai/
Number of Employees:	1-10
Founded in:	2015
Based in:	Norway
Founders:	Anita Schjøll Brede, Jacobo Elosua, Maria Ritola, Victor Botev
Funding To Date:	\$2.4M
Investors:	Founders Factory, Nordic Impact, Bakken & Baeck, INDEX: Design to Improve Life

Juvenescence AI

JUVENESCENCE.AI

Juvenescence AI works along and provides its partners with operational support. We combine advances in state-of-the-art technologies, such as AI, with classical development expertise in order to prioritise and progress compounds from Insilico Medicine Inc's end, to automate our drug discovery pipeline through to the clinical proof of concept.

Web site:	http://www.juvenescence.ai/
Number of Employees:	N/A
Founded in:	2018
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	Juvenescence

Kyndi is an artificial intelligence company building the first Explainable AI platform for critical government and commercial institutions. Kyndi transforms business processes by offering auditable AI solutions. Its products exist because critical organizations cannot use 'black box' machine learning when they are required to explain the reason for any decision.

Web site:	https://kyndi.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	United States
Founders:	Arun Majumdar, Paul Tarau, Ryan Welsh, Shafe Ramsey
Funding To Date:	\$8.5M
Investors:	PivotNorth Capital, Darling Ventures, Citrix Systems, Creative Destruction Lab, J. Hunt Holdings

Lantern Pharma



Lantern Pharma

Pioneering Precision medicine

Lantern Pharma Inc is a multinational drug development company that harnesses the power of technology to identify patient subgroups that respond best to new drug therapeutics and bring them to the market in a timely and cost sensitive manner. Lantern's vision is to be the global leader in 3R adaptive reuse: Rescuing, Repurposing and Revitalizing of shelved oncology drugs based on widespread adoption of its RADR A.I. platform.

Web site:	http://lanternpharma.com/
Number of Employees:	11-50
Founded in:	2013
Based in:	United States
Founders:	Arun Asaithambi, Gregory Tobin, Peter Nara
Funding To Date:	\$5.5M
Investors:	Green Park & Golf Ventures, Health Wildcatters, Bios Partners

MediBIC Group

MediBic Group

MediBIC is a leading biotechnology company in Japan specializing in Pharmacogenomics (PGx). They support drug discovery & development for personalized medicine by providing project planning, IRB, and data analysis services.

Web site:	http://www.medibic.com/en/
Number of Employees:	N/A
Founded in:	2000
Based in:	Japan
Founders:	Yasuhiro Hashimoto
Funding To Date:	\$7.1M
Investors:	N/A

Mendel.ai



Mendel.ai automates matching cancer patients to clinical trials through personal medical history and genetic analysis. Mendel finds the latest treatment for your cancer using Artificial Intelligence and Genetics.

Web site:	http://mendel.ai/
Number of Employees:	1-10
Founded in:	2016
Based in:	United States
Founders:	Karim Galil, Ruchi Deshpande, Wael Salloum
Funding To Date:	\$2M
Investors:	SOSV, DCM Ventures, LaunchCapital, Indie Bio, BootstrapLabs

Meta



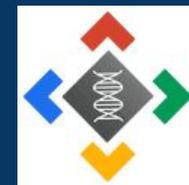
Meta offers users a total augmented reality (AR) experience:

- See, create, and interact with virtual objects and apps inserted in the real environment
- Display with wearable glasses
- Control with hand gestures

Meta's goal is to lead the next evolution of personal computing through augmented reality, replacing desktops, laptops, tablets, and smartphones with a more natural-to-use system set entirely in a pair of glasses.

Web site:	http://www.metavision.com/
Number of Employees:	11-50
Founded in:	2012
Based in:	United States
Founders:	Ben Sand, Meron Gribetz, Raymond Lo
Funding To Date:	\$73M
Investors:	DHVC (Danhua Capital), Horizons Ventures, Gaorong Capital, GQY, Bold Capital Partners, Presence Capital, Comcast Ventures, InnoSpring Seed Fund, Lenovo, BOE Technology Group, Westcott LLC, Zappos, Fenox Venture Capital, VTF Capital, Zillionize Angel, Eniac Ventures

Micar21



Micar Innovation - Drug Discovery Factory for novel molecules (structure based in silico drug design & AI - platform Micar21) . Micar21 successfully integrated the state-of-art in silico and experimental approaches and already identified new promising drug candidates. Their drug discovery program targets different type of diseases with an application to both human and veterinary medicine.

Web site:	http://micar21.com/
Number of Employees:	1-10
Founded in:	2016
Based in:	Bulgaria
Founders:	Dimitar Dimitrov, Filip Fratev
Funding To Date:	N/A
Investors:	N/A

Mind the Byte



Mind the Byte is a bioinformatics company that develops and provides software for computational drug discovery using Big Data and Machine Learning (AI) approaches. Mind the Byte works with partners on a consultancy basis or offer an easy to use Software as a Service (SaaS) package to allow clients to apply the High-performance computing platform on a flexible pay-per-use basis without investment in hardware or software licenses. Mind the Byte has developed a versatile set of applications using cloud computing which lowers the entry barrier to the technology. Mind the Byte is an Amazon Web Services technology partner - a seal of quality that has only been awarded to five companies in this sector – to ensure security and reliability.

Web site:	http://mindthebyte.com/
Number of Employees:	1-10
Founded in:	2011
Based in:	Spain
Founders:	Alfons Nonell-Canals
Funding To Date:	€584.1K
Investors:	Crowdcube, EASME - EU Executive Agency for SMEs

Powered by its artificial intelligence software platform, nferX, nference's mission is to synthesize the exponentially growing biomedical knowledge. nferX uses state-of-the-art neural networks (shallow and deep learning models) for real-time, automated extraction of knowledge from the commercial, scientific and regulatory body of literature. The platform enables a diverse set of applications ranging from R&D to commercial strategy and operations in the life sciences ecosystem. The long-term goal of the nferX platform is to become the connecting fabric of the various silos of information that exist across health care. Founded by Murali Aravamudan and Venky Soundararajan, Ph.D., nference is led by a multidisciplinary team of serial entrepreneurs from the tech and biotech worlds and PhDs in Biology/Genomics from MIT and Harvard Medical School.

Web site:	http://nference.ai/
Number of Employees:	51-100
Founded in:	2013
Based in:	United States
Founders:	Venky Soundararajan
Funding To Date:	\$14M
Investors:	Matrix Partners, Matrix Capital Management

Novoheart



Novoheart is a global stem cell biotechnology company pioneering an array of next-generation human heart tissue prototypes. It is the first and only company in the world to have engineered miniature living human heart pumps that can revolutionize drug discovery, helping to save time and money for developing new therapeutics. Also known as 'human heart-in-a-jar', Novoheart's bio-artificial human heart constructs are created using state-of-the-art and proprietary stem cell and bioengineering approaches and are utilized by global pharmaceutical and biotech companies for accurate preclinical testing as to the effectiveness and safety of new drugs, maximizing the successes in drug discovery whilst minimizing costs and harm caused to patients.

Web site:	http://novoheart.com/
Number of Employees:	N/A
Founded in:	1964
Based in:	Canada
Founders:	Kevin Costa, Ronald Li
Funding To Date:	N/A
Investors:	N/A

nQ Medical is a Neurotechnology company allowing Data Defined Disease Management via typing signatures; a passive, frictionless, non-invasive monitoring modality.

Web site:	http://nq-medical.com/
Number of Employees:	1-10
Founded in:	2017
Based in:	United Kingdom
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

NuMedii



NuMedii discovers and de-risks effective new drugs by translating Life Sciences Big Data into therapies with a higher probability of therapeutic success. The Company's proprietary and dynamic Big Data technology, developed in Atul Butte's lab at Stanford University and licensed exclusively to NuMedii, consists of hundreds of millions of raw human, biological, pharmacological and clinical data points that the company has normalized and annotated. The company integrates these data with proprietary network-based algorithms to find both drug candidates and biomarkers predictive of efficacy for diseases.

Web site:	http://numedii.com/
Number of Employees:	11-50
Founded in:	2008
Based in:	United States
Founders:	Atul Butte, Gini Deshpande, Joel Dudley
Funding To Date:	\$5.5M
Investors:	Lightspeed Venture Partners, TSVC, Claremont Creek Ventures, Seraph Group, StartX (Stanford-StartX Fund)

Numerate

The logo for Numerate, featuring the word "Numerate" in a red, sans-serif font with a horizontal line underneath the "u".

Numerate is a group of cutting-edge scientists and engineers trying to solve very difficult problems at the interface of data science, machine learning, cloud scale analytics and medicinal chemistry. Numerate has developed a computational platform that can predict how a potential drug will behave in the lab and the body. Numerate uses this platform to process large spaces of chemistry while searching for therapies for some of the world's most important diseases, such as, obesity, heart failure, Alzheimer's, and Huntington's disease. Their platform makes the drug development process cheaper, faster, and results in higher success rates than traditional approaches.

Web site:	http://numerate.com/
Number of Employees:	11-50
Founded in:	2007
Based in:	United States
Founders:	Brandon Allgood, Nigel Duffy
Funding To Date:	\$8.2M
Investors:	Atlas Venture, Foundation Capital, Lilly Ventures, Lanza Tech Ventures

Nuritas is revolutionising the discovery of novel, natural and scientifically proven active ingredients that can manage and improve human health. The company’s disruptive computational approach to discovery uses artificial intelligence and genomics to, for the first time ever, rapidly and efficiently predict and then provide access to the most health-benefiting components hidden within food, called bioactive peptides.

Web site:	http://nuritas.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	Ireland
Founders:	Nora Khaldi
Funding To Date:	€23.9M
Investors:	Enterprise Ireland, NDRC, European Union, Cultivian Sandbox Ventures, New Protein Capital

Owkin



OWKIN is the AI startup that uses machine learning to augment medical and biology research. Its proprietary platform, OWKIN Socrates, uses machine learning technology to integrate biomedical images, genomics and clinical data to discover biomarkers and mechanisms associated with diseases and treatment outcomes. OWKIN develops scientific collaborations with top-tier medical institutions and partners with leading pharmaceutical companies. OWKIN has developed a state-of-the-art federated learning technology in healthcare to overcome the data sharing problem, building collective intelligence from distributed data at scale while preserving data privacy and security.

Web site:	http://owkin.com/
Number of Employees:	11-50
Founded in:	2016
Based in:	United States
Founders:	Gilles Wainrib, Thomas Clozel
Funding To Date:	\$18.1M
Investors:	GV, Otium Capital, Plug and Play, NJF Capital, Cathay Innovation.

PathAI



PathAI's services solve the most challenging pathology problems faced by the research and pharmaceutical industry. The PathAI platform provides end-to-end automation for reliable, scalable, and cost-effective long-term solutions. Their solutions make discovery scalable. PathAI's team will work with you to solve your most critical pathology analysis problems.

Web site:	http://pathai.com/
Number of Employees:	11-50
Founded in:	2016
Based in:	United States
Founders:	Aditya Khosla, Andrew Beck
Funding To Date:	\$15.2M
Investors:	Pillar Companies, General Catalyst, DHVC, 8VC, Fairhaven Capital Partners, Refactor Capital, KdT Ventures.

Pepticom



Pepticom is a unique Artificial Intelligence (AI) platform company with disruptive technology for peptide discovery. The platform is based on research carried out in the Hebrew University and extensively developed further by the company. Pepticom's disruptive technology allows for the discovery of quantity and quality innovative peptides and other molecules at a fraction of the time and cost of the traditional laboratory discovery methods. The peptide discovered can be used as drugs, in agriculture and animal well-being. Pepticom is engaged in various discovery projects such as ADAMA in the field of agriculture and with other big companies in the Pharmaceutical field.

Web site:	http://pepticom.com/
Number of Employees:	1-10
Founded in:	2011
Based in:	Israel
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

Peptone



Peptone accelerates protein lead design and optimisation through AI. The science behind sequence-structure-function relationships in proteins is not fully understood. Thus, rational protein design and enhancement rely on combinatorial mutagenesis, which in turn demands extensive structural biochemistry training and specialised experimental pipelines. Because of its complexity and time-consuming character, protein engineering is the dominant part of R&D budgets in life sciences. Peptone accelerates the lengthy process of protein lead optimisation and design through AI coupled with experimental cross-validation.

Web site:	http://peptone.io/
Number of Employees:	1-10
Founded in:	2016
Based in:	The Netherlands
Founders:	Emanuele Paci, Kamil Tamiola, Matthew Heberling
Funding To Date:	\$350K
Investors:	Founders Factory

Pharnext



Pharnext SAS, a BioPharmaceutical company, engages in the development of treatments for severe neurological diseases. The company specializes in drug repositioning. Its target pathologies include Charcot-Marie-Tooth disease; and diabetic and toxic peripheral neuropathies, as well as severe neurodegenerative diseases in general and peripheral neuropathies. The company was founded in 2007 and is based in Paris, France.

Web site:	https://www.pharnext.com/fr/
Number of Employees:	11-50
Founded in:	2007
Based in:	France
Founders:	Philippe Pouletty, Serguei Nabirotkin
Funding To Date:	\$19.9M
Investors:	Truffle Capital, Aurinvest

Phenomic AI



Phenomic AI develops computer vision tools for a faster and more accurate analysis of microscopy data. Founded by an international team of researchers at the University of Toronto and the Institute of Cancer Research in London, they were among the first researchers to develop deep learning based techniques for microscopy data. They have previously demonstrated the success of this approach on analyzing genome wide screens, mechanism of action profiling, and metastases detection in histopathology. They're now using their approach to enable discovery of the next generation of therapies against cancer. At Phenomic AI they're developing deep learning solutions to accelerate drug discovery. What sets them apart is their ambition to seamlessly integrate AI with experiments; Imagine biologists receiving real time deep learning driven analysis of compound screens, medicinal chemists linked to reinforcement learning algorithms suggesting the next synthesis they should perform, and diagnostic data feeding directly into formulations and treatment regimens in the clinic.

Web site:	http://phenomic.ai/
Number of Employees:	1-10
Founded in:	2017
Based in:	Canada
Founders:	Oren Kraus, Sam Cooper
Funding To Date:	\$1.5M
Investors:	Creative Destruction Lab

Plex Research



Plex Research is the Boston area startup that's transforming the humble search bar into a drug discovery powerhouse. Its search engine will scour all the world's biomedical research data, and find the bit you were looking for.

Web site:	http://plexresearch.com/
Number of Employees:	N/A
Founded in:	2017
Based in:	United States
Founders:	Douglas Selinger
Funding To Date:	N/A
Investors:	N/A

ProteinQure



ProteinQure uses AI to design protein drugs through reinforcement learning. It allows researchers to target a wider array of binding sites, target diseases with high specificity, and create compounds that are easier to synthesize and test.

Web site:	https://proteinqure.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	Canada
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A

Qrativ is reinventing the way treatments for diseases with unmet medical need are discovered and developed. Formed by Mayo Clinic and nference, Qrativ combines nference’s knowledge synthesis platform, and Mayo Clinic’s medical expertise and clinical data to enable systematic drug proposing. Starting in the early stages of drug development, Qrativ partners can leverage the company’s drug purposing platform, Darwin.ai, to search for all possible uses of a drug candidate, including identifying potential rare disease indications and find subsets of patients who may respond favorably to a given candidate. Through these partnerships, Qrativ will aim to maximize every drug’s potential for as many patients and diseases as possible.

Web site:	http://qrativ.bio/
Number of Employees:	11-50
Founded in:	2017
Based in:	United States
Founders:	Murali Aravamudan, Venky Soundararajan
Funding To Date:	\$8.3M
Investors:	Matrix Partners, Mayo Clinic, Matrix Capital Management

Quantitative Medicine



Quantitative Medicine is a biomedical analytics and computational biology company offering a novel drug discovery platform which dramatically reduces the time, cost and financial risk of discovering new therapeutic drugs by predicting: the main effects of drugs on target molecules that mediate disease; the effects of drugs on other molecules or pathways in the body that could mediate adverse effects; as well as the interaction of these with underlying genetic variations. The platform identifies similarities in relationships of drug candidates screened against a diverse matrix of pathogenic, cellular, molecular and/or systems biology targets. By iteratively adding new data from other existing research or additional experiments, the predictive model is improved. More accurate predictions can be made for previously unobserved effects of putative compounds on target molecules.

Web site:	http://qtmed.com/
Number of Employees:	1-10
Founded in:	2012
Based in:	United States
Founders:	Joshua D. Kangas PhD, Robert Murphy PhD, Scott R. Bodine
Funding To Date:	\$563K
Investors:	N/A

Recursion Pharmaceuticals



Recursion Pharmaceuticals is a biotechnology company based in Salt Lake City. Recursion combines experimental biology, automation, and artificial intelligence in a massively parallel system to quickly and efficiently identify treatments for any disease which can be modeled at the cellular level. From its initial and continued focus on drug repurposing to treat rare diseases, Recursion has broadened its platform to probe rich data from high-throughput automated screens for a number of indications, including aging, inflammation, infectious disease, and immunology. Recursion is aggressively leveraging technology to build a robust and reliable map of human cellular biology, which will enable a radical shift in the pace and scale at which new treatments will benefit patients.

Web site:	http://recursionpharma.com/
Number of Employees:	51-100
Founded in:	2013
Based in:	United States
Founders:	Blake Borgeson, Chris Gibson, Dean Li
Funding To Date:	\$105.4M
Investors:	Felicis Ventures, Data Collective, Lux Capital, Square 1 Bank, Bill & Melinda Gates Foundation, Menlo Ventures, CRV, Lux Capital, EPIC Ventures

Resonant Therapeutics



Resonant Therapeutics's platform allows for the simultaneous discovery of novel targets and high affinity, functional antibodies with unprecedented speed. Using novel insights into the tumor microenvironment and the immune system, their platform identifies targets and therapeutic candidates for any patient derived tumor tissue or cell line, including cancer stem cells. The platform is extensible to other microenvironment regulated disease. They have created a pipeline of candidates with potent, direct anti-tumor activity, initially in breast and ovarian cancers. Their antibodies are expected to work as a monotherapy or in synergistic combination with emerging immunotherapies.

Web site:	http://resonantrx.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United States
Founders:	N/A
Funding To Date:	\$1.9M
Investors:	Mercury Fund

Reveal Biosciences



Reveal brings AI into pathology to diagnose disease from large whole slide microscope images. This is a new class of diagnostics offering fundamental improvements to reach, cost, speed, accuracy and scale in how disease is diagnosed. Reveal's computational pathology technology combines a histopathology laboratory with machine learning models applied to tissue biology problems. The computer aided characterization and diagnosis products locate and measure cells, tissue and tissue architecture needed to generate diagnostic assessment that can truly impact healthcare.

Web site:	https://www.revealbio.com/
Number of Employees:	11-50
Founded in:	2012
Based in:	United States
Founders:	Casey Laris, Claire Weston
Funding To Date:	N/A
Investors:	N/A

Reverie Labs



Reverie Labs optimizes potential medicines using machine learning. Reverie Labs accelerates preclinical drug development by applying machine learning to lead generation & optimization. Using recently-developed machine learning techniques, Reverie Labs has developed best-in-class structure-based predictive models for potency and ADME/PK properties of small molecules. Reverie Labs has developed a multi-objective molecular optimizer that applies evolutionary algorithms to conceive new molecules that optimize for many ADME/PK properties simultaneously while maintaining potency and synthesizability.

Web site:	https://www.reverielabs.com/
Number of Employees:	1-10
Founded in:	2017
Based in:	United States
Founders:	Ankit Gupta, Connor Duffy, Jonah Kallenbach
Funding To Date:	N/A
Investors:	Y Combinator, First Round Capital

ReviveMed



ReviveMed is a precision-medicine platform that leverages the data from small molecules or metabolites. ReviveMed unlocks the value of metabolomic data, and translates them into actionable therapeutic solutions. Using the company's proprietary database and machine-learning algorithm, it reduces the need for costly and time-consuming experiments to identify a large set of metabolites, and integrate these data with other large-scale molecular datasets such as genomics and proteomics.

Web site:	http://revive-med.com/
Number of Employees:	1-10
Founded in:	2016
Based in:	United States
Founders:	Ernest Fraenkel, Leila Pirhaji
Funding To Date:	\$1.5M
Investors:	TechU Angels, Team Builder Ventures, Rivas Capital, MassChallenge, WorldQuant Ventures LLC, MIT delta v

SciNote is a top-rated platform for researchers in academia or industry, who need electronic lab notebook, inventory management and project management functionalities. Trusted by more than 25.000 scientists in more than 100 countries around the World. Including world's Top Research Institutes such as: Imperial College London, Seattle University, The University of Memphis, National Institutes of Health and many others.

Web site:	http://scinote.net/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United States
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A



Sparrho's blend of machine learning and human expert curation helps you stay on top of the science that matters to you. With 60 million+ papers and patents from 45k+ journals and preprint servers, Sparrho's content is enhanced by world-class researchers from 1,500+ universities in 150+ countries. Sparrho is democratising scientific knowledge, making it more accessible, searchable and shareable.

Web site:	http://sparrho.com/
Number of Employees:	11-50
Founded in:	2013
Based in:	United Kingdom
Founders:	Niluka Satharasinghe, Vivian Chan
Funding To Date:	\$3M
Investors:	Pitch@Palace, Entrepreneur First, White Cloud Capital, AllBright, Beast Ventures

Spring Discovery



Spring Discovery's machine learning-based experimentation platform solves this. They're applying a novel computational approach to one of the most important problems in the world: battling aging and disease.

Web site:	www.springdisc.com/
Number of Employees:	N/A
Founded in:	N/A
Based in:	United States
Founders:	Ben Kamens
Funding To Date:	\$4.3M
Investors:	General Catalyst, Caffeinated Capital, The Longevity Fund, First Round, Sea Lane Ventures

Standigm applies cutting-edge AI technologies to drug discovery. AI and biology experts team up to build a real-world AI model for the pharmaceutical industry. Standigm currently focuses on predicting new indications for existing drugs, called drug repositioning through the deeply trained AI model with molecular features of drug responses and drug uses. Standigm generated tens of drug candidates for cancers, Parkinson’s disease (PD), autism, fatty liver diseases (NASH) and more. Standigm promises practical benefits on time and cost in pharmaceutical industry by eliminating some of the uncertainty in the drug discovery process.

Web site:	http://standigm.com/
Number of Employees:	11-50
Founded in:	2015
Based in:	South Korea
Founders:	Jinhan Kim, Sang Ok Song, So Jeong Yun
Funding To Date:	\$3.7M
Investors:	Kakao Ventures, LB Investment, Atinum Investment, Korea Tech Incubator Program For Startup

Structura Biotechnology



Structura builds software that enables fast, accurate and automated electron cryo-microscopy (cryo-EM) for drug discovery and research. Structura Biotechnology works closely with pharmaceutical companies and research labs globally. Their flagship product, the cryoSPARC System™, is a commercial software product that processes cryo-EM data to provide high-resolution 3D structures of proteins and complexes. The patent-pending algorithms underlying cryoSPARC™ enable reconstructions of research and drug targets within minutes of collecting microscope data, and without the need for prior knowledge or guesswork.

Web site:	http://structura.bio/
Number of Employees:	N/A
Founded in:	2016
Based in:	Canada
Founders:	Ali Punjani, Marcus Brubaker
Funding To Date:	N/A
Investors:	N/A

Synthace's goal is to raise universal bioscience productivity, enabling people to better engineer biology for health, food, energy and manufacturing. Central to its technology is Antha, an operating system for biology that enables ease of designing and optimizing biological unit operations that are linked into executable workflows that are reliable, shareable and saleable. Antha spreads biological information in a repeatable way, linking lab equipment, protocols and processes, thereby allowing vast and speedy development, enhancing productivity for any bioscience.

Web site:	http://synthace.com/
Number of Employees:	11-50
Founded in:	2011
Based in:	United Kingdom
Founders:	Sean Ward
Funding To Date:	\$19.6M
Investors:	SOSV, Sofinnova Partners, Amadeus Capital Partners, White Cloud Capital, 1.2 Capital, Bioeconomy Capital, UK Innovation & Science SeedF

TeselaGen is building a rapid prototyping system for fast bio-based construction of sustainably sourced chemicals, therapeutic medicines, and novel vaccines. Their customers are BioPharmaceutical and bioindustrial companies like Amgen and Genomatica. Their bioCAD/CAM system is based on technology exclusively licensed from Lawrence Berkeley National Lab and is being beta tested by hundreds of users.

Web site:	http://teselagen.com/
Number of Employees:	1-10
Founded in:	2011
Based in:	United States
Founders:	Michael Fero, Nathan Hillson
Funding To Date:	N/A
Investors:	N/A

ThoughtSpot



ThoughtSpot's AI-Driven analytics platform puts the power of a thousand analysts in every business person's hands. With ThoughtSpot, you can use search to easily analyze your data or automatically get trusted insights pushed to you with a single click. ThoughtSpot connects with any on-premise, cloud, big data, or desktop data source and deploys 85 percent faster than legacy technologies. BI & Analytics teams have used ThoughtSpot to cut reporting backlogs by more than 90 percent and make more than 3 million decisions - and counting. ThoughtSpot's customers include Amway, Bed Bath and Beyond, BT, Capital One, Celebrity Cruises, Chevron Federal Credit Union, De Beers, Insurethebox and Scotiabank.

Web site:	http://thoughtspot.com/
Number of Employees:	101-250
Founded in:	2012
Based in:	United States
Founders:	Abhishek Rai, Ajeet Singh, Amit Prakash, Priyendra Deshwal, Sanjay Agrawal, Shashank Gupta, Vijay Ganesan
Funding To Date:	\$295.7M
Investors:	Lightspeed Venture Partners, Khosla Ventures, General Catalyst, Sapphire Ventures, Geodesic Capital, Sapphire Ventures, Future Fund

Transcriptic



Transcriptic is a SaaS-based biotechnology company providing robotic solutions for biology labs. Founded in 2012, Transcriptic has developed the first robotic cloud lab platform for on-demand life science research. It's powered by the Transcriptic Common Lab Environment (TCLE) a scalable, digital infrastructure that integrates laboratory processes, instruments and IoT technologies into a single user interface. Researchers can carry out scalable, reproducible and rapid experimentation from anywhere in the world.

Web site:	http://transcriptic.com/
Number of Employees:	10-50
Founded in:	2012
Based in:	United States
Founders:	Max Hodak
Funding To Date:	\$26.8M
Investors:	Y Combinator, 500 Startups, GV, Silicon Valley Bank, Founders Fund, Data Collective, ZhenFund, AME Cloud Ventures, IA Ventures

Trials.ai leverages Artificial Intelligence to help organizations manage clinical trials, better. Rather than building a siloed system filled with endless spreadsheets, unnecessary data entry points, and confusing charts and graphs, their cloud-based platform is lean, flexible, and straightforward, utilizing A.I to assist you along the process. By leveraging A.I, Trials.ai automate repetitive tasks, validate compliance and data quality, increase patient retention, and improve protocol adherence.

Web site:	http://trials.ai/
Number of Employees:	1-10
Founded in:	2015
Based in:	United States
Founders:	Kim Walpole, Michael Nicoletti
Funding To Date:	N/A
Investors:	Nex Cubed

twoXAR is an artificial intelligence-driven drug discovery company. They leverage their computational platform to identify promising drug candidates, validate & de-risk them through preclinical studies, and progress candidates to the clinic through industry and investor partnerships. twoXAR is financially backed by Andreessen Horowitz and the Stanford-StartX Fund and engaged in collaborations with leading academic research and BioPharma R&D organizations.

Web site:	http://twoxar.com/
Number of Employees:	11-50
Founded in:	2014
Based in:	United States
Founders:	Andrew A. Radin, Andrew M. Radin
Funding To Date:	\$14.3M
Investors:	Andreessen Horowitz, Stanford-StartX Fund, Softbank Ventures Korea, OS Fund, CLI Ventures

Verge Genomics



Verge Genomics is looking to find cures for brain diseases. Alzheimers, ALS, and Parkinsons are complex diseases that usually involve a network of genes, as opposed to a single gene.

Web site:	http://vergegenomics.com/
Number of Employees:	11-50
Founded in:	2015
Based in:	United States
Founders:	Alice Zhang, Jason Chen
Funding To Date:	\$36.1M
Investors:	DFJ, IA Ventures, OS Fund, WuXi AppTec, Agent Capital, ALS Investment Fund, Y Combinator, Draper Associates, Two Sigma Ventures

Virogin Biotech Ltd is a biological drug development focused on innovative anti-cancer oncolytic viruses. Built on 20+ years of oncolytic virus research by co-founder, Dr. William Jia, Virogin has established a research team of world-class scientists and industry professionals. The team members are specialized in recombinant viruses, tumor immunology, and tumor animal models. More recently, Virogin has assembled an excellent Investigational New Drug (IND) development team that includes published and experienced experts in all areas of IND development, from manufacturing to regulatory filing as well as clinical studies.

Web site:	https://ca.virogin.com/index.php
Number of Employees:	N/A
Founded in:	N/A
Based in:	China
Founders:	N/A
Funding To Date:	N/A
Investors:	N/A



Virvio is a pre-clinical biotherapeutic discovery company and world leader in computationally designed protein scaffolds called "mini-binders". Its platform generates mini-binder leads having antibody-like affinity and specificity yet also possessing the hyper-stability and manufacturability of small-molecule drugs. Mini-binders are small structured proteins designed completely de novo to meet the requirements of the molecular target and indication.

Web site:	http://virvio.com/
Number of Employees:	N/A
Founded in:	2015
Based in:	United States
Founders:	Christopher Pirie, David Baker
Funding To Date:	\$209K
Investors:	NIH

WinterLight Labs



Winterlight Labs builds technology that can quickly and accurately detect signs of cognitive impairment from a sample of speech. WinterLight Labs develops a novel AI technology that can quickly and accurately quantify speech and language patterns to help detect and monitor cognitive and mental diseases. WinterLight Labs is developing a proprietary AI diagnostic platform that can objectively assess and monitor cognitive health. The platform can analyze natural speech to detect and monitor dementia, aphasia, and various cognitive conditions. Using a short one-minute sample of speech, WinterLight can characterize the speaker's cognitive, acoustic and linguistic state, including lexical diversity, syntactic complexity, semantic content, and articulation.

Web site:	http://winterlightlabs.com/
Number of Employees:	1-10
Founded in:	2015
Based in:	Canada
Founders:	Frank Rudzicz, Kathleen Fraser, Liam Kaufman, Maria Yancheva
Funding To Date:	\$500K
Investors:	Creative Destruction Lab



XtalPi is a pharmaceutical technology company that is reinventing the industry’s approach to drug research and development with its Intelligent Digital Drug Discovery and Development (ID4) platform. Through its tightly interwoven quantum mechanics, artificial intelligence, and high-performance cloud computing algorithms, the ID4 platform enables pharmaceutical companies to increase their efficiency, accuracy, and success rate at critical stages of drug R&D. By accelerating the pace of drug discovery and development, XtalPi aims to contribute to a healthier society worldwide.

Web site:	http://xtalpi.com/
Number of Employees:	51-100
Founded in:	2014
Based in:	United States
Founders:	Jian Ma, Lipeng Lai , Shuhao Wen
Funding To Date:	\$20.3M
Investors:	Tencent Holdings, ZhenFund, Sequoia Capital China, FREES FUND, Renren Inc, Alphabet

20 Leading R&D centers

Research and Development Centers

Name	About	website	Country	Mission
<p>1. La Jolla Laboratories</p> 	<p>Pfizer is a research-based, global BioPharmaceutical company. Pfizer is using IBM's AI technology on its immuno-oncology research, a strategy of using a body's immune system to help fight cancer. The campus includes dedicated facilities for pharmaceutical sciences, analytical chemistry, medicinal chemistry, X-ray crystallography, pharmacology, chromatography, drug safety evaluation, and pharmacokinetics, dynamics and metabolism. La Jolla's success is the ability to bring together new findings and technologies from a variety of scientific disciplines and apply them to the challenges typically faced in drug discovery efforts.</p>	<p>https://www.pfizer.com/science/research-development/centers/ca_la_jolla</p>	<p>US</p>	<p>The scientists based in La Jolla focus on two areas of research and development: discovering and developing new medicines to treat many forms of cancer; and, discovering novel prophylactic and therapeutic vaccines for the prevention and treatment of significant human maladies (in the areas of cancer and central nervous system diseases).</p>
<p>2. Merck Exploratory Science Center (MES C)</p> 	<p>The Merck Exploratory Science Center (MES C) is focused on exploring the causes of some of the most challenging diseases. The MES C is made up of approximately 40 accomplished researchers with diverse scientific backgrounds but one common goal: to bring together biology, chemistry, technology and drug discovery under one roof to ultimately help MRL's global network of researchers to discover and develop new and innovative medicines and vaccines.</p>	<p>https://www.merck.com/about/featured-stories/cambridge-mrl.html</p>	<p>US</p>	<p>The company focuses on discovering and developing therapies to improve patients' lives and aims to explore emerging areas of disease biology to uncover new opportunities for drug discovery research.</p>
<p>3. Roche Innovation Center Copenhagen</p> 	<p>Roche Innovation Center Copenhagen is a leader in the rapidly emerging field of RNA-targeted drugs, where it is exploiting its proprietary Locked Nucleic Acid (LNA) platform to discover important novel medicines across multiple therapeutic areas. Roche Group plans to use the GNS REFS™ (Reverse Engineering and Forward Simulation) causal machine learning and simulation platform to find and validate potential new drug candidates.</p>	<p>http://www.roche.dk/</p>	<p>Danmark</p>	<p>RICC is investing in its drug discovery and technology platform, bringing together a multidisciplinary team of scientists with experience, talent and commitment to deliver broadly on the promise of RNA medicines.</p>

Research and Development Centers

Name	About	website	Country	Mission
<p>4. Sanofi Pasteur R&D Centre</p> 	<p>Sanofi Pasteur, the vaccine division of Sanofi, opened a new vaccine research and development centre in Canada. Sanofi Pasteur produces nearly one billion doses of vaccines per annum for about 20 infectious diseases. It is also developing vaccines targeting chlamydia, tuberculosis and pneumococcal. One of the largest drug discovery collaborations and strategic leasing agreements were announced this year between pharmaceutical maker Sanofi and artificial intelligence driven drug discovery company Exscientia.</p>	<p>http://www.sanofipasteur.ca/node/17302</p>	<p>Canada</p>	<p>The centre focuses mainly on the development of vaccines for cancer and paediatric ailments.</p>
<p>5. Johnson & Johnson Pharmaceutical Research and Development</p> 	<p>The Johnson & Johnson's businesses span across three sectors in China: consumer; pharmaceuticals; medical devices and diagnostics. The Asia division plans to invest in open innovation through more research partnerships and collaborative efforts that connect the medical and academic communities to its R&D centers. Johnson & Johnson reached a deal to BenevolentAI which has the right to develop, manufacture and commercialize a select number of novel clinical stage drug candidates from Johnson & Johnson.</p>	<p>https://jllabs.jnjinnovation.com/locations/jlabs-shanghai</p>	<p>China</p>	<p>The company's therapeutic areas include neuroscience, cardiovascular and metabolic disease, immunology, oncology and virology. A special focus will be placed on diseases with specific, high unmet needs in the region.</p>
<p>6. Centre for Drug Research and Development</p> 	<p>The Centre for Drug Research and Development is a global bridge that translates discoveries into innovative therapeutic products and improved health outcomes. CDRD has amassed strategic partnerships with over 50 affiliated universities and research institutes, 26 Canadian health sciences SMEs/entrepreneurs, six top global pharmaceutical companies, eight of the world's leading translational research centres, and three patient-focused foundations.</p>	<p>http://www.cdrd.ca/about/</p>	<p>Canada</p>	<p>CDRD is strategically focused on the following therapeutic areas, but will opportunistically support projects in any area given they meet the criteria above: Oncology (including immunotherapy/immunology), Anti-Infectives, Regenerative Medicine/Fibrosis, Neuroscience, Other Indications</p>

Research and Development Centers

Name	About	website	Country	Mission
<p>7. Warren Family Research Center for Drug Discovery and Development</p> 	<p>The Warren Family Research Center for Drug Discovery and Development is a collaborative program well aligned with the University's overarching Catholic mission through its focus on the discovery and development of new therapeutic leads for the treatment of unmet clinical needs in a number of areas including cancer, infectious diseases, and a number of rare diseases. The Center brings together chemical and biological expertise and technologies through partnerships with researchers within the University's biomedical research centers.</p>	<p>https://drugdiscovery.nd.edu/</p>	<p>US</p>	<p>The mission of this premier drug discovery and development center is to organize the products and byproducts of past, current, and future chemical research to create the Notre Dame Chemical Compound Collection and to promote biological evaluation of these entities through internal collaborations and external partnerships.</p>
<p>8. Ritsumeikan Research Center for Drug Discovery and Development Science</p> 	<p>Research Center for Drug Discovery and Development Science conducts individual research in each of the fields of drug discovery and drug formulation technology. In addition, the Center conducts research and development activities through government-industry-academia partnerships, with an eye toward overall "drug manufacturing," from drug discovery to formulation.</p>	<p>http://en.ritsumei.ac.jp/research/organizations/research-center-drug-discovery/</p>	<p>Japan</p>	<p>The centre's focus is on two consortiums ("drug discovery" and "drug formulation") as their pillars.</p>
<p>9. Astellas Drug Discovery Research Centre</p> 	<p>Astellas Pharma is a global pharmaceutical company with a simple vision to produce exceptional medicines that change tomorrow for patients in need. Scientists strive to discover new chemical compounds with the potential to influence the biological processes that cause diseases. Astellas understands that new scientific discoveries combined with advances in technology are deepening our understanding of disease and creating an array of potential new medical solutions.</p>	<p>https://www.astellas.eu/rd/research-development/</p>	<p>Japan</p>	<p>Their vision is to be on the forefront of this changing healthcare environment, turning innovative science into valuable new treatment options for patients.</p>

Research and Development Centers

Name	About	website	Country	Mission
<p>10. Drug Discovery Oxford</p> 	<p>Oxford has all the necessary expertise on site to drive a drug discovery programme from target identification to preclinical candidate selection, and then on through all phases of clinical trials. This draws on key competencies from the Department of Chemistry, including a strong, broad-based and vigorous synthetic chemistry community with expertise in natural product synthesis, asymmetric synthesis and high-speed parallel assay synthesis, in silico modelling, screening and informatics, molecular imaging, radiochemistry, peptide and protein chemistry, carbohydrate chemistry, molecular biology, enzymology and proteomics.</p>	<p>http://drugdiscovery.chem.ox.ac.uk/</p>	<p>UK</p>	<p>The Drug Discovery showcases the University of Oxford's involvement in drug discovery and provides useful links to resources in this area. It looks at the wide range of disease areas that the researchers study, provides case studies of exciting new fundamental research, and explains the histories behind their most successful spin-outs.</p>
<p>11. Babraham Research Campus</p> 	<p>The Babraham Research Campus is considered to be one of the UK's leading campus' to support early-stage bioscience enterprise and is distinct in its co-location of bioscience companies with the Babraham Institute. World class research and business come together to promote innovation and strengthen links between academia and the commercial world. The Babraham Research Campus is managed and developed by Babraham Bioscience Technologies Ltd (BBT).</p>	<p>https://www.babraham.com/</p>	<p>UK</p>	<p>The aim is to create an environment where companies can focus on developing their science and building their business in a supportive and highly networked community, helping to create new medicines, jobs and growth, and maximising the impact of UK science.</p>
<p>12. Janssen Pharmaceutical Companies of Johnson & Johnson</p> 	<p>At Janssen Research & Development the biotherapeutics organization works to translate scientific discoveries into medicines that will continue to make significant contributions to human health. The strategy is to bring innovative, effective and safe treatments forward in six therapeutic areas: cardiovascular and metabolism, immunology, infectious diseases and vaccines, neuroscience, oncology, and pulmonary hypertension.</p>	<p>http://www.janssen.com/</p>	<p>US</p>	<p>At Janssen, a key goal is developing and implementing new approaches to make the clinical trial process better and faster for all stakeholders: patients, trial sites/investigators and the healthcare industry at large.</p>

Research and Development Centers

Name	About	website	Country	Mission
<p>13.Chinese Thoracic Oncology Group (CTONG)</p> 	<p>This collaborative group is a research-based, non-profit academic group that is composed of medical units with certain chest tumor diagnosis and treatment capabilities in China and that promotes the development of chest prevention and treatment in China through multi-center clinical trials.</p>	<p>http://www.ctongonline.com/webhtml/Default.aspx</p>	<p>China</p>	<p>The goal of the collaboration group is to design and conduct multi-center clinical trials in the field of thoracic tumors, especially lung cancer research, to provide high-level evidence-based medical evidence for clinical practice of thoracic tumors, and to promote the standardization and modernization of thoracic tumor medical treatment and research activities in China. And internationalization, improve the diagnosis and treatment of thoracic cancer in China and its international status.</p>
<p>14.The Development Center for Biotechnology</p> 	<p>The Development Center for Biotechnology (abbreviation: Biotechnology Center, DCB) was founded in 1984 and is a non-profit organization established jointly by the government and the private sector. The Biotechnology Center, with its “best partner in the biotechnology industry”, has played the role of the “best in fostering” role in the value chain of the biotechnology and pharmaceutical industry in China. After the pre-clinical development and value-adding of innovative technologies or lead drugs through the Center, they are transferred to the third-biggest biotechnology and pharmaceutical manufacturer, and further commercialization of research and development results.</p>	<p>http://www.dcb.org.tw/home.php</p>	<p>Taiwan</p>	<p>The purpose of the Biotechnology Center is to cooperate with production, government, research, and research institutions, construct important environmental facilities required for the biotech and pharmaceutical industry, develop key biotechnologies, and cultivate professional talents to accelerate the development of China's biotechnology industry as the main task.</p>

Research and Development Centers

Name	About	website	Country	Mission
<p>15.Korea Pharmaceutical and Bio-Pharma Manufacturers Association</p> 	<p>The Korea Pharmaceutical and Bio-Pharma Manufacturers Association was founded in October 1945 with the name of Chosun Pharmaceutical Manufacturers Association at first, and as of 2015, it has 202 pharmaceutical companies as its members. The KPBMA is the largest pharmaceutical industry organization in Korea, with a membership that includes 175 domestic pharmaceutical firms and 27 multinational corporations. To achieve its goal of 'improving national healthcare through the sound development of the pharmaceutical industry,' it plays a variety of roles such as policy-supporting activities, educations, and supporting to member companies. Internationally, it cooperates with the international pharmaceutical organizations as a member of IFPMA (International Federation of Pharmaceutical Manufacturers & Associations) and WSMI (World Self-Medication Industry).</p>	<p>http://kpma.or.kr/english/index</p>	<p>South Korea</p>	<p>The goal is improving national healthcare through the sound development of the pharmaceutical industry</p>
<p>16.Pande Lab - Stanford University</p>	<p>Pande Lab use computer simulation, statistical mechanics, and Bayesian statistics to tackle challenging problems in chemical biology, biophysics, and biomedicine.</p>	<p>https://pande.stanford.edu/</p>	<p>US</p>	<p>The goal is to push the limits of computational and theoretical methods and applying them to important problems in biophysics and biophysical chemistry.</p>
<p>17. Center for Computational Health - IBM Research</p> 	<p>The Center for Computational Health at IBM Research work on developing cutting-edge methodologies to derive insights from diverse sources of health data, to support use cases in personalized care delivery and management, real world evidence, health behavior modeling, cognitive health decision support, and translational informatics.</p>	<p>https://researcher.watson.ibm.com/researcher/view_group.php?id=6743</p>	<p>US</p>	<p>The center pursue research in the application of data science to healthcare across the entire continuum from the health of individuals, to that of populations, to the healthcare system itself.</p>

Research and Development Centers

Name	About	website	Country	Mission
<p>18. The R&D Centre China LTD (RRDCC)</p> 	<p>The R&D Centre China LTD (RRDCC) was established in 2004 in Zhangjiang Hi-Tech Park in Shanghai as a pioneer in Pharmaceutical R&D in China. It is now a Roche Centre of Excellence contributing to the drug discovery in the areas of Oncology, Virology and Metabolic Diseases. The Development Centre is the first comprehensive Clinical Development Organisation in Asia Pacific (excluding Japan) of Roche. It is capable to design, conduct and analyse clinical studies to meet the registration needs – currently the only pharmaceutical company with this capability in China.</p>	<p>http://www.roche.com.cn/</p>	<p>China</p>	<p>The RRDCC is dedicated to develop new medicines for China and the rest of the world.</p>
<p>19. China R&D Center (CRDC) - Pfizer</p> 	<p>CRDC supports Pfizer's global biological and chemical pharmaceutical R&D programs across clinical development pipeline, and serves as an important hub of Pfizer global and Asia-Pacific R&D activities. As such, CRDC is an integral part of Pfizer's global R&D site network, providing support across many R&D disciplines, including clinical drug development, medical, regulatory and safety.</p>	<p>http://www.pfizer.com.cn/(S(syf5z355lzdweeigrwarzprw))/research/about_china_r_d_center_en.aspx</p>	<p>China</p>	<p>CRDC's aspiration is to help accelerate China's transition to an innovative economy by catalyzing the upgrade of local R&D capabilities, systems, technologies/IP, and culture, to address unmet medical needs, and create a world-class BioPharmaceutical R&D ecosystem for China, as part of the global R&D community.</p>
<p>20. Merck Serono Pharmaceutical R&D Co., Ltd</p> 	<p>As one of Merck Serono's four global R&D hubs, the R&D Beijing Hub will not only increase the level of China's Research and Development, but will also work closely with global R&D institutes, increase global product development efforts, and expand global R&D expertise and capability. This strategy has also become the company's key driver for further innovation, driving Merck Serono to achieve its ultimate mission of Living Science, Transforming Lives.</p>	<p>http://www.merck-china.com/en/company/beijing_merck_pharma_china/beijing_merck_pharma.html</p>	<p>China</p>	<p>The R&D Beijing Hub aims to stimulate innovation, introducing new products to Asia paralleling market timelines in the West, and leading research and development into new treatment solutions for critical diseases in Asia.</p>

15 BioPharma Corporations Using Artificial Intelligence for Drug Discovery

15 BioPharma Corporations and advanced AI in Healthcare

Name	About	website	Country	Practical applications and uses of AI
Pfizer 	<p>Pfizer is a research-based, global BioPharmaceutical company. The Company applies science and its global resources to improve health and well-being at every stage of life. Pfizer develops and produces medicines and vaccines for a wide range of conditions.</p>	https://www.pfizer.com/	United States	<p>Pfizer announced in late 2016 a collaboration that will utilize IBM Watson for Drug Discovery. Pfizer is using IBM's AI technology on its immuno-oncology research, a strategy of using a body's immune system to help fight cancer.</p>
Astrazeneca 	<p>AstraZeneca is global innovation-driven BioPharmaceutical company specialising in the discovery, development, manufacturing and marketing of prescription medicines that make a meaningful difference in healthcare.</p>	http://www.astrazeneca.com/	United Kingdom	<p>In February 2018, AstraZeneca announced a partnership with Alibaba to apply technology including artificial intelligence to patient diagnosis and treatment.</p>
Sanofi 	<p>Sanofi is a healthcare company engaged in the research, development, manufacturing, and marketing of innovative therapeutic solutions.</p>	http://m-en.sanofi.com/	France	<p>Sanofi - Exscientia partnership announced in May 2017, focuses on finding bispecific small molecule drugs for metabolic diseases such as diabetes and their comorbidities.</p>
Roche 	<p>Roche was one of the first companies to bring targeted treatments to patients. Roche Holding AG is the owner of F. Hoffmann-La Roche Ltd., a provider of in-vitro diagnostics and drugs for cancer and transplantation.</p>	http://www.roche.com/	Switzerland	<p>Genentech plans to use the GNS REFS™ causal machine learning and simulation platform to find and validate potential new drug candidates.</p>
GSK 	<p>GSK is a UK-based pharmaceutical and healthcare company focusing on research to develop and distribute treatments for HIV/AIDS, TB, and malaria.</p>	http://www.gsk.com/	United Kingdom	<p>GSK created an in-house artificial intelligence unit. And it has partnered with startups including Exscientia and Insilico Medicine.</p>

15 BioPharma Corporations and advanced AI in Healthcare

Name	About	website	Country	Practical applications and uses of AI
<p>Novartis</p> 	<p>Novartis is a global healthcare company based in Switzerland that provides solutions to address the evolving needs of patients worldwide. Their mission is to discover new ways to improve and extend people's lives.</p>	<p>http://www.novartis.com/</p>	<p>Switzerland</p>	<p>In January 2018, Novartis partnered with McKinsey's QuantumBlack to analyze clinical trial operations with machine learning.</p>
<p>Illumina</p> 	<p>Illumina has the goal to apply innovative technologies and revolutionary assays to the analysis of genetic variation and function, making studies possible that were not even imaginable just a few years ago.</p>	<p>https://www.illumina.com/</p>	<p>United States</p>	<p>Illumina uses big data techniques such as AI to process the sequencing information that comes into Illumina's cloud, and as a way to keep tabs on how its instruments are doing out in the field.</p>
<p>Merck</p> 	<p>Merck is a global healthcare leader working to help the world be well. Merck is known as MSD outside the United States and Canada. It is currently one of the world's seven largest pharmaceutical companies by market capitalization and revenue.</p>	<p>http://www.merck.com/</p>	<p>United States</p>	<p>Merck struck an early partnership with Numerate, announced in March 2012. The collaboration focuses on generating novel small molecule drug leads for an unnamed cardiovascular disease target.</p>
<p>Johnson & Johnson</p> 	<p>Johnson & Johnson engages in the research and development, manufacture, and sale of a range of products in the healthcare field.</p>	<p>http://www.jnj.com/</p>	<p>United States</p>	<p>In January 2018, Johnson & Johnson announced a partnership between Janssen and WinterLight Labs to try predicting dementia and neurodegenerative diseases from voice samples obtained through Janssen clinical trials.</p>
<p>Bayer</p> 	<p>Bayer is a global enterprise with core competencies in the fields of health care, nutrition and high-tech materials.</p>	<p>http://bayer.com/</p>	<p>Germany</p>	<p>There is evidence of Bayer's interest in AI in its 2016 Grants4Apps Accelerator.</p>

15 BioPharma Corporations and advanced AI in Healthcare

Name	About	website	Country	Practical applications and uses of AI
Amgen 	<p>Amgen is one of the world's leading biotechnology companies. Amgen is a values-based company, deeply rooted in science and innovation to transform new ideas and discoveries into medicines for patients with serious illnesses.</p>	https://www.amgen.com/	United States	<p>Amgen is an investor in precision medicine startup GNS Healthcare. In May 2018, MIT announced that Amgen was a member of its Machine Learning for Pharmaceutical Discovery and Synthesis Consortium.</p>
Astellas Pharma 	<p>Astellas Pharma is a global pharmaceutical research & development company. Astellas is committed to turning innovative science into medical solutions that bring value and hope to patients and their families.</p>	https://www.astellas.com/	Japan	<p>In December 2015, Astellas and Biovista announced a partnership around drug repurposing. And in January 2016 Astellas and NuMedii announced a similar repurposing collaboration.</p>
Boehringer Ingelheim 	<p>Boehringer Ingelheim is a group of companies dedicated to researching, developing, manufacturing and marketing novel products of high therapeutic value for human and veterinary medicine. It is one of the world's 20 leading pharmaceutical companies.</p>	https://www.boehringer-ingelheim.com/	Germany	<p>In May 2018 Boehringer had partnered with Bactevo to use its "Totally Integrated Medicines Engine" platform to identify novel small molecule lead compounds.</p>
Bristol-Myers Squibb 	<p>Bristol-Myers Squibb is a global BioPharmaceutical company focused on discovering, developing and delivering innovative medicines for patients with serious diseases</p>	https://www.bms.com/	United States	<p>Bristol-Myers Squibb partnered with Sirenas to apply its proprietary drug discovery platform against a series of undisclosed but challenging therapeutic targets.</p>
Evotec 	<p>Evotec is a drug discovery alliance progressing innovative product approaches with leading pharmaceutical and biotechnology companies.</p>	https://evotec.com/	Germany	<p>Evotec has a partnership with Exscientia. Evotec announced a collaboration in 2016 and an investment in 2017. The partnership focuses on creating bispecific small molecule immuno-oncology therapies.</p>

15 Tech Corporations Interested in Advanced AI Applications in Healthcare

15 IT Corporations and advanced AI in Healthcare

Name	About	website	Country	Practical applications and uses of AI
<p>Alibaba</p> 	<p>Alibaba is a Chinese e-commerce company operating online marketplaces for both international and domestic China trade.</p>	<p>http://www.alibaba.com/</p>	<p>China</p>	<p>Alibaba is charting ways to push the application of AI in diagnostics and healthcare to make medical treatment more accessible, timely, and affordable. Alibaba Cloud is actively working on AI-powered solutions to tackle healthcare problems in China and globally</p>
<p>Amazon</p> 	<p>Amazon is an e-commerce retailer formed originally to provide consumers with products in two segments. It offers users with merchandise and content purchased for resale from vendors and those offered by third-party sellers.</p>	<p>http://amazon.com/</p>	<p>United States</p>	<p>Amazon Web Services and Merck announced a developer competition to that plans to harness artificial intelligence for diabetics.</p>
<p>Apple</p> 	<p>Apple is a multinational corporation that designs, manufactures, and markets consumer electronics, personal computers, and software.</p>	<p>http://www.apple.com/</p>	<p>United States</p>	<p>Lattice, the "dark data" startup Apple snapped up that have aspirations in the healthcare space.</p>
<p>Google</p> 	<p>Google is a multinational corporation that is specialized in internet-related services and products.</p>	<p>http://www.google.com/</p>	<p>United States</p>	<p>Google bought AI startup DeepMind in 2014 and has ended up focusing most of that company's energies in the healthcare space.</p>
<p>Huawei</p> 	<p>Huawei Technologies provides infrastructure application software and devices with wireline, wireless, and IP technologies.</p>	<p>http://huawei.com/</p>	<p>China</p>	<p>Huawei Technologies plan to develop processors optimized for artificial intelligence workloads, moves that will put them into competition with the likes of Intel, Google, Nvidia and Advanced Micro Devices.</p>

15 IT Corporations and advanced AI in Healthcare

Name	About	website	Country	Practical applications and uses of AI
IBM 	IBM is an IT technology and consulting firm providing computer hardware, software, and infrastructure and hosting services.	http://www.ibm.com/	United States	IBM developed machine learning models to analyze correlations between diseases and side effects commonly caused by the medications used to treat them.
Microsoft 	Microsoft is a software corporation that develops, manufactures, licenses, supports, and sells a range of software products and services.	http://www.microsoft.com/	United States	Microsoft's Project Hanover is using ML technologies in multiple initiatives, including a collaboration with the Knight Cancer Institute to develop AI technology for cancer precision treatment, with a current focus on developing an approach to personalize drug combinations for Acute Myeloid Leukemia (AML).
Canon 	Canon is a manufacturer of business and consumer imaging products.	https://www.usa.canon.com/internet/portal/us/home	United States	In April 2018 NVIDIA and Canon Medical Systems partnered to accelerate Deep Learning in Healthcare.
Nvidia 	Nvidia manufactures integrated circuits for use in motherboard chip-sets, graphic processing units, and game consoles.	http://www.nvidia.com/	United States	GE Healthcare and graphics firm NVIDIA combined artificial intelligence with imaging devices, accelerating the speed at which healthcare data can be processed.
Samsung Electronics 	Samsung Electronics is a South Korean multinational electronics company engaged in consumer electronics, information technology and mobile communications, and device solutions businesses worldwide.	http://www.samsung.com/us	South Korea	Samsung wants to add artificial intelligence to stroke diagnosis in ambulances.

15 IT Corporations and advanced AI in Healthcare

Name	About	website	Country	Practical applications and uses of AI
Siemens AG 	<p>Siemens is a multinational engineering and electronics company involved in the fields of industry, energy, transportation and healthcare.</p>	<p>https://www.siemens.com/global/en/home.html</p>	<p>Germany</p>	<p>Siemens Healthineers is using artificial intelligence to transform care delivery and expanding precision medicine.</p>
Baidu 	<p>Baidu is a Chinese multinational technology company specializing in Internet-related services and products, and artificial intelligence, headquartered at the Baidu Campus in Beijing's Haidian District. It is one of the largest internet companies.</p>	<p>http://www.baidu.com/</p>	<p>China</p>	<p>Baidu is looking to use artificial intelligence algorithms for drug discovery technology so it can significantly shorten the process of analysing big data and make big decisions simple.</p>
Tencent 	<p>Tencent Holdings Limited is a Chinese multinational investment holding conglomerate whose subsidiaries specialize in various Internet-related services and products, entertainment, AI and technology both in China and globally.</p>	<p>https://www.tencent.com/en-us/</p>	<p>China</p>	<p>In 2018 was announced that Medopad has teamed up with Tencent to develop artificial intelligence enabling clinical decision support software and medical chatbots.</p>
Intel 	<p>Intel is the world's second largest and second highest valued semiconductor chip makers based on revenue after being overtaken by Samsung and is the inventor of the x86 series of microprocessors, the processors found in most personal computers. Intel supplies processors for computer system manufacturers such as Apple, Lenovo, HP, and Dell.</p>	<p>http://www.intel.com/</p>	<p>United States</p>	<p>Kyoto University Graduate School of Medicine, one of Asia's leading research-oriented institutions, has chosen Intel® Xeon® Scalable processors to power its clinical genome analysis cluster and its molecular simulation cluster.</p>
Hitachi 	<p>Hitachi is engaged in the manufacture and sale of electronic and electrical products worldwide. Hitachi is a highly diversified company that operates eleven business segments.</p>	<p>http://www.hitachi.com/</p>	<p>Japan</p>	<p>Mitsubishi and Hitachi joined its forces to use AI to hasten drug R&D. Using Hitachi's advanced digital technology, to shorten the development period for news drugs.</p>

220 Investors AI for Drug Discovery

220 Investors AI for Drug Discovery

1.	11.2 Capital	37.	Cambia Health Solutions	73.	Faridan
2.	500 Startups	38.	Capital One Growth Ventures	74.	Felicis Ventures
3.	6 Dimensions Capital	39.	Casdin Capital	75.	Fenix Venture Capital
4.	8VC	40.	Cathay Innovation	76.	Fifty Years
5.	A-Level Capital	41.	Celgene	77.	Finance Wales
6.	Accelerate Long Island	42.	China Equity	78.	Fly Ventures
7.	Advantage Capital	43.	Citrix Systems	79.	Foundation Capital
8.	Afore Capital	44.	Claremont Creek Ventures	80.	Founders Factory
9.	Agent Capital	45.	CLI Ventures	81.	Founders Fund
10.	AGORANOV	46.	Comcast Ventures	82.	FREES FUND
11.	Alexandria Real Estate Equities	47.	Creative Destruction Lab	83.	Frontier IP Group plc
12.	AllBright	48.	Crowdcube	84.	FundersClub
13.	Alphabet	49.	CRV	85.	Gaorong Capital
14.	ALS Investment Fund	50.	Cultivian Sandbox Ventures	86.	General Catalyst
15.	Amadeus Capital Partners	51.	Danhua Capital	87.	Geodesic Capital
16.	AME Cloud Ventures	52.	Darling Ventures	88.	GM&C Life Sciences Fund
17.	Amgen Ventures	53.	Data Collective	89.	Golden Venture Partners
18.	Andreessen Horowitz	54.	DCM Ventures	90.	GQY
19.	ARCH Venture Partners	55.	Deep Knowledge Ventures	91.	Gradient Ventures
20.	Atlas Venture	56.	DFJ Growth	92.	Grand Central Tech
21.	Aurinvest	57.	Digital Science	93.	Grand Challenges Canada
22.	B Capital Group	58.	Dolby Family Ventures	94.	Great Oaks Venture Capital
23.	Baidu Ventures	59.	Dorm Room Fund	95.	GreenSky Capital
24.	Baird Capital	60.	Draper Associates	96.	GV
25.	Bakken & Baeck	61.	Draper Dragon	97.	Hacking Health Accelerator
26.	BDC Venture Capital	62.	Dynamk Capital	98.	Hanghai Studio
27.	Beast Ventures	63.	EDBI	99.	Health Wildcatters
28.	Bioeconomy Capital	64.	Empire State Development	100.	Healthbox
29.	Biomatics Capital Partners	65.	Endure Capital	101.	Heritage Provider Network
30.	Bios Partners	66.	Eniac Ventures	102.	Hewlett Packard Pathfinder
31.	Bloomberg Beta	67.	Enterprise Ireland	103.	Horizons Ventures
32.	BOE Technology Group	68.	Entrepreneur First	104.	IA Ventures
33.	Bold Capital Partners	69.	EPIC Capital	105.	Illumina
34.	BootstrapLabs	70.	EPIC Ventures	106.	Indie Bio
35.	Boundary Capital Partners LLP	71.	European Union	107.	Initialized Capital
36.	Caffeinated Capital	72.	Fairhaven Capital Partners	108.	InnoSpring Seed Fund

220 Investors AI for Drug Discovery

109.	iNovia Capital	146.	New Protein Capital	183.	Square 1 Bank
110.	IQ Capital Partners LLP	147.	New Wave Ventures	184.	StartUp Health
111.	J. Hunt Holdings	148.	NewDo Venture	185.	StartX
112.	Juvenescence	149.	NJF Capital	186.	Sutter Hill Ventures
113.	Karlin Ventures	150.	Obvious Ventures	187.	SV Angel
114.	KdT Ventures	151.	Octopus Ventures	188.	SV Tech Ventures
115.	Khosla Ventures	152.	OS Fund	189.	SyndicateRoom
116.	Kima Ventures	153.	Otium Capital	190.	Techammer
117.	Kleiner Perkins Caufield & Byers	154.	Palm Drive Capital	191.	TechU Angels
118.	Lansdowne Partners	155.	Pavilion Capital	192.	Tencent Holdings
119.	Lanza Tech Ventures	156.	Pear Ventures	193.	The Thiel Foundation
120.	LaunchCapital	157.	Pentech Ventures	194.	Third Kind Venture Capital
121.	LB Investment	158.	Perivoli Innovations	195.	Third Rock Ventures
122.	Lenovo	159.	Pillar Companies	196.	TIPS
123.	Lightspeed Venture Partners	160.	Pitch@Palace	197.	Tribeca Venture Partners
124.	Lilly Ventures	161.	PivotNorth Capital	198.	True Ventures
125.	Liquid2 Ventures	162.	Plug and Play	199.	Truffle Capital
126.	London Co-Investment Fund	163.	Presence Capital	200.	TSVC (formerly TEEC Angel Fund)
127.	Lundbeck	164.	Pritzker Group Venture Capital	201.	Two Sigma Ventures
128.	Lux Capital	165.	Real Ventures	202.	UK Innovation & Science Seed Fund
129.	Masa Life Science Fund	166.	Refactor Capital	203.	Uni-Innovate Group
130.	MassChallenge	167.	Renren Inc.	204.	Unshackled Ventures
131.	Matrix Partners	168.	Rivas Capital	205.	Upsher Smith Laboratories
132.	Mayo Clinic	169.	Rough Draft Ventures	206.	Vanguard Atlantic
133.	Menlo Ventures	170.	Seneca Partners	207.	VTF Capital
134.	Merck Global Health Innovation Fund	171.	Sequoia Capital	208.	Warburg Pincus
135.	Mission and Market	172.	Seraph Group	209.	Westcott LLC
136.	MIT delta v	173.	Serena Capital	210.	White Cloud Capital
137.	MITS Fund	174.	ServiceNow	211.	WI Harper Group
138.	Mitsui & Co	175.	Silicon Badia	212.	Wild Basin Investments
139.	Monsanto Growth Ventures (MGV)	176.	Silicon Valley Bank	213.	Woodford Investment Management
140.	Mubadala Investment Company	177.	Slow Ventures	214.	WorldQuant Ventures LLC
141.	National Institutes of Health	178.	Smedvig Capital	215.	Wren Capital
142.	National Science Foundation	179.	Sofinnova Partners	216.	WuXi AppTec
143.	Nest.Bio Ventures	180.	Softbank Ventures Korea	217.	Y Combinator
144.	Nesta Ventures	181.	Sorrento Therapeutics	218.	Zappos
145.	New Leaf Venture Partners	182.	SOSV	219.	ZhenFund
				220.	Zillionize Angel

11.2 Capital



Summary:	11.2 Capital is an early stage venture capital fund that invests in breakthrough technologies in software, hardware, and healthcare.
Number of Investments:	23
Headquarters:	United States
Web Site:	http://www.112capital.com
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Deep Genomics



500 Startups

500

Summary:	500 Startups is a global venture capital seed fund with a network of startup programs headquartered in Silicon Valley with over \$350M in committed capital across 4 main funds and 13 micro funds.
Number of Investments:	1694
Headquarters:	United States
Web Site:	https://500.co/
Year Founded:	2010
Total Fund Raised:	\$529.5M
Stages:	Early Stage Venture, Seed
Invested in:	Transcriptic



6 Dimensions Capital



6 Dimensions Capital

Summary:	6 Dimensions Capital is a healthcare focused investment firms with an in-depth focus and extensive coverage across China and the US.
Number of Investments:	16
Headquarters:	China
Web Site:	http://6dimensionscapital.com/en/home/
Year Founded:	N/A
Total Fund Raised:	\$844M
Stages:	N/A
Invested in: Engine Biosciences	



8VC

8VC

Summary:	8VC seeks to enable industry transformation. In a wave of creative destruction, they believe emerging platforms will replace the decades old technology infrastructure behind many industries, promoting greater innovation and global prosperity.
Number of Investments:	76
Headquarters:	United States
Web Site:	http://www.8vc.com/
Year Founded:	2015
Total Fund Raised:	\$1.2B
Stages:	N/A
Invested in: PathAI	



A-Level Capital



Summary:	A-Level Capital, LLC is a student-led venture capital fund based in Baltimore, Maryland. The firm invests in Johns Hopkins University student and young alumni founded companies.
Number of Investments:	16
Headquarters:	United States
Web Site:	http://www.alevelcapital.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Insilico Medicine	



Accelerate Long Island



Summary:	Accelerate Long Island is a unique collaboration among Long Island's world class research institutions and its business community to commercialize research and create an entrepreneurial ecosystem.
Number of Investments:	6
Headquarters:	United States
Web Site:	http://www.acceleratedli.org/
Year Founded:	2011
Total Fund Raised:	\$500K
Stages:	Debt
Invested in: Envisagenics	



Advantage Capital



Summary:	Advantage Capital provides equity and debt financing to established and emerging companies located in communities underserved by conventional sources of capital.
Number of Investments:	109
Headquarters:	United States
Web Site:	http://www.advantagecap.com/
Year Founded:	1992
Total Fund Raised:	\$346M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: Recursion Pharmaceuticals	



Afore Capital

AFORE CAPITAL

Summary:	Afore Capital is a venture fund that focuses on pre-seed stage exclusively and is based in the San Francisco Bay Area.
Number of Investments:	25
Headquarters:	United States
Web Site:	http://afore.vc/
Year Founded:	2016
Total Fund Raised:	\$47M
Stages:	Seed
Invested in: BenchSci	



Agent Capital



Summary:	Agent Capital is a healthcare venture capital firm focused on investing in novel, differentiated therapeutics and treatments that address unmet patient needs.
Number of Investments:	7
Headquarters:	United States
Web Site:	https://www.agentcapital.com/
Year Founded:	2016
Total Fund Raised:	\$57.8M
Stages:	N/A
Invested in: Verge Genomics	



Agoranov



Summary:	Agoranov is a public Science & Tech incubator that provides mentorship, office space, funding, and consultancy services to startups. The company is based in Paris.
Number of Investments:	262
Headquarters:	France
Web Site:	http://www.agoranov.com/
Year Founded:	2000
Total Fund Raised:	N/A
Stages:	N/A
Invested in:	Iktos



Alexandria Real Estate Equities



ALEXANDRIA®

Summary:	Alexandria Real Estate Equities, Inc. is an urban office REIT uniquely focused on collaborative life science and technology campuses in AAA innovation cluster locations.
Number of Investments:	37
Headquarters:	United States
Web Site:	http://www.are.com/
Year Founded:	1994
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture
Invested in: GNS Healthcare	



AllBright

AllBright.

Summary:

AllBright is a unique funding, education and support network designed to provide the support and finance needed for female-led leaders to thrive.

Number of Investments:

4

Headquarters:

United Kingdom

Web Site:

<https://www.allbrightcollective.com/>

Year Founded:

2016

Total Fund Raised:

N/A

Stages:

N/A

Invested in: Sparrho



Alphabet



Summary:	Alphabet Inc. is the holding company for Google and several Google entities, including Google X, Google Ventures, Google Capital, Calico, and its Life Sciences efforts.
Number of Investments:	5
Headquarters:	United States
Web Site:	https://abc.xyz/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	N/A
Invested in: XtalPi	



ALS Investment Fund

ALS

INVESTMENT FUND

Investing. For you. For life.

Summary:

The ALS Investment Fund supports and finances biotech companies that develop drugs and diagnostics for the disease ALS (also called Lou Gehrig's disease). ALS Investment Fund invests globally, but its focus is on Europe and the US.

Number of Investments:

4

Headquarters:

The Netherlands

Web Site:

<http://www.alsinvestmentfund.com/>

Year Founded:

1997

Total Fund Raised:

N/A

Stages:

N/A

Invested in: Verge Genomics



Amadeus Capital Partners



Summary:	Amadeus Capital is a global technology investor that invests in technology companies at all stages, from seed to venture buyout; it also buys stakes from other investors or founders, to ensure that companies and entrepreneurs have the runway they need to succeed.
Number of Investments:	163
Headquarters:	United Kingdom
Web Site:	https://www.amadeuscapital.com/
Year Founded:	1997
Total Fund Raised:	\$513.5M
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Antidote



AME Cloud Ventures

AME

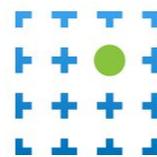
Summary:	AME Cloud Ventures invests in seed to later-stage tech companies that build infrastructure and value chains around data.
Number of Investments:	188
Headquarters:	United States
Web Site:	http://www.amecloudventures.com/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Atomwise



Amgen Ventures



Summary:	Amgen Ventures is a California-based investment firm focused on early- and late-stage biotechnology companies.
Number of Investments:	65
Headquarters:	United States
Web Site:	http://www.amgen.com/
Year Founded:	2004
Total Fund Raised:	N/A
Stages:	Early Stage Venture
Invested in:	GNS Healthcare



GNS HEALTHCARE
Driving Intelligent Interventions

Andreessen Horowitz

a16z

Summary:	Andreessen Horowitz is a Silicon Valley-based venture capital firm with \$2.7 billion under management. They invest from seed to growth.
Number of Investments:	615
Headquarters:	United States
Web Site:	https://a16z.com/
Year Founded:	2009
Total Fund Raised:	\$6.6B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	BioAge Labs

BIOAGE

ARCH Venture Partners



Summary:	ARCH invests primarily in companies co-founded with leading scientists and entrepreneurs, concentrating on bringing to market innovations
Number of Investments:	278
Headquarters:	United States
Web Site:	www.archventure.com
Year Founded:	1986
Total Fund Raised:	\$2.3B
Stages:	Early Stage Venture, Late Stage Venture, Private Equity
Invested in:	Arbor Biotechnologies



Atlas Venture



Summary:	Atlas Venture creates and invests in biotech startup companies in the U.S. with seed and early stage venture investments.
Number of Investments:	485
Headquarters:	United States
Web Site:	https://atlasventure.com
Year Founded:	1980
Total Fund Raised:	\$2.2B
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Numerate



Aurinvest

AURINVEST

Summary:	Aurinvest is a venture capital fund created at the end of 2011. It is managed and primarily funded by more than fifty entrepreneurs and business leaders, alongside with institutional investors.
Number of Investments:	27
Headquarters:	France
Web Site:	http://aurinvest.com/
Year Founded:	2001
Total Fund Raised:	N/A
Stages:	Early Stage Venture
Invested in: Pharnext	



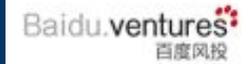
B Capital Group



Summary:	B Capital Group backs brash entrepreneurs building the next generation of groundbreaking technology companies.
Number of Investments:	21
Headquarters:	United States
Web Site:	https://www.bcapgroup.com/
Year Founded:	2015
Total Fund Raised:	\$360M
Stages:	N/A
Invested in: Atomwise	



Baidu Ventures



Summary:	Baidu Ventures aims to back artificial intelligence, virtual reality, and augmented reality projects.
Number of Investments:	31
Headquarters:	China
Web Site:	http://bv.ai/
Year Founded:	2016
Total Fund Raised:	\$517.3M
Stages:	Early Stage Venture, Venture
Invested in: Atomwise	



Baird Capital

Baird Capital 

Summary:	Baird Capital makes venture capital, growth equity, and private equity investments in strategically-targeted sectors around the world.
Number of Investments:	108
Headquarters:	United States
Web Site:	http://bairdcapital.com/
Year Founded:	1919
Total Fund Raised:	\$766M
Stages:	Debt, Early Stage Venture, Late Stage Venture
Invested in:	AiCure



Bakken & Bæck

BAKKEN & BÆCK

Summary:	Bakken & Bæck is a small, passionate team that helps startups and established companies plan, design and build digital products.
Number of Investments:	2
Headquarters:	Oslo, Norway
Web Site:	https://bakkenbaeck.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Iris.ai	

IRIS.AI

BDC Venture Capital



Summary:	BDC Venture Capital is a venture capital investment firm investing directly in Canadian tech companies.
Number of Investments:	387
Headquarters:	Canada
Web Site:	https://www.bdc.ca/en/bdc-capital/venture-capital/about-us/pages/default.aspx
Year Founded:	1975
Total Fund Raised:	\$355M
Stages:	Early Stage Venture, Late Stage Venture, Seed, Venture
Invested in:	Imagia



Beast Ventures



Summary:	Beast Ventures invests in seed stage technology companies in the United States and European Neighbourhood.
Number of Investments:	2
Headquarters:	United Kingdom
Web Site:	http://www.beast.vc/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Sparrho	



Bioeconomy Capital



Summary:	Bioeconomy Capital is a venture capital firm specializing in early stage. It seeks to invest in industrial biotechnology, which includes materials, chemicals, and enzymes. It primarily invest in technologies that enable biological engineering and production; and companies that use those technologies to produce goods and services.
Number of Investments:	8
Headquarters:	N/A
Web Site:	http://www.bioeconomycapital.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Synthace	



Biomatics Capital Partners



Summary:	Biomatics Capital Partners is a Seattle-based healthcare and life sciences venture firm.
Number of Investments:	14
Headquarters:	United States
Web Site:	https://www.biomaticscapital.com/
Year Founded:	2016
Total Fund Raised:	\$200M
Stages:	Early Stage Venture
Invested in: AiCure	



Bios Partners

Bios | Partners

Summary:	Bios Partners is a venture capital firm based in Dallas/Ft. worth focused on investment in innovative early-stage and growth-stage biotech and medical device companies.
Number of Investments:	5
Headquarters:	United States
Web Site:	http://biospartners.com
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Lantern Pharma	



Bloomberg Beta

Bloomberg
BETA

Summary:	Bloomberg Beta is an early-stage venture fund backed by Bloomberg that invests in startups making work better, focusing on machine learning.
Number of Investments:	135
Headquarters:	United States
Web Site:	https://github.com/Bloomberg-Beta/Manual
Year Founded:	2013
Total Fund Raised:	\$150M
Stages:	Early Stage Venture, Seed
Invested in: Deep Genomics	



BOE Technology Group



Summary:	BOE Technology Group Co., Ltd is a supplier of display products and solutions. After research development and technology accumulation for years, BOE has boasted core technologies in TFT-LCD field. The number of BOE independent application for new patent reaches more than 500.
Number of Investments:	4
Headquarters:	China
Web Site:	http://boe.com.cn/
Year Founded:	1993
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Meta	



Bold Capital Partners



Summary:

Bold Capital Partners is investing in exponential transformation.

Number of Investments:

33

Headquarters:

United States

Web Site:

<http://www.boldcapitalpartners.com/>

Year Founded:

2015

Total Fund Raised:

N/A

Stages:

Early Stage Venture

Invested in: Meta, InSilico Medicine



BootstrapLabs



Summary:	BootstrapLabs is a leading Venture Capital firm based in Silicon Valley and focused on Applied Artificial Intelligence.
Number of Investments:	25
Headquarters:	United States
Web Site:	https://bootstraplabs.com/
Year Founded:	2008
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in: Mendel.ai	



Boundary Capital Partners LLP



Summary:	Boundary Capital is a venture capital company focusing on early stage growth companies, primarily in the technology space.
Number of Investments:	15
Headquarters:	United Kingdom
Web Site:	http://www.boundarycapital.com/
Year Founded:	2009
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Desktop Genetics	



Caffeinated Capital

CAFFEINATED CAPITAL

Summary:	Caffeinated Capital is an early-stage venture capital firm based in San Francisco, California. Caffeinated Capital partners with unbreakable founders innovating in the biggest markets.
Number of Investments:	52
Headquarters:	United States
Web Site:	http://caffeinatedcapital.com/
Year Founded:	2009
Total Fund Raised:	\$92M
Stages:	Early Stage Venture, Seed
Invested in:	BioAge Labs

BIOAGE

Cambia Health Solutions

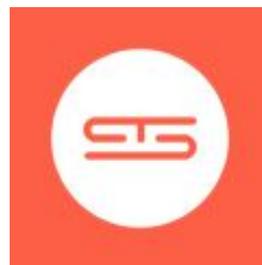


Summary:	Cambia Health Solutions, headquartered in Portland, Oregon, is dedicated to transforming health care. Cambia Health Solutions is a family of over 20 companies that work together to make the health care system more economically sustainable and efficient for people and their families.
Number of Investments:	28
Headquarters:	United States
Web Site:	https://www.cambiahealth.com/
Year Founded:	1996
Total Fund Raised:	N/A
Stages:	N/A
Invested in: GNS Healthcare	

Capital One Growth Ventures



Summary:	Capital One Growth Ventures is an investment firm focused big data technologies, payments, security, and financial technologies.
Number of Investments:	15
Headquarters:	United States
Web Site:	https://growthventures.capitalone.com/
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	N/A
Invested in: ThoughtSpot	



Casdin Capital



Summary:	Casdin Capital, LLC is an investment firm focused on the life sciences and healthcare industry.
Number of Investments:	32
Headquarters:	United States
Web Site:	https://www.casdincapital.com/
Year Founded:	2011
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture

Invested in: Celsius Therapeutics



Cathay Innovation



Summary:	Cathay Innovation is the global venture capital fund supporting digital entrepreneurs by bridging USA, Europe and China simultaneously.
Number of Investments:	20
Headquarters:	United States
Web Site:	http://www.cathayinnovation.com/
Year Founded:	2015
Total Fund Raised:	\$320M
Stages:	Early Stage Venture, Late Stage Venture
Invested in: OWKIN	



Celgene



Summary:	Celgene discovers, develops and commercializes innovative therapies to treat cancer and immune-inflammatory-related diseases.
Number of Investments:	49
Headquarters:	United States
Web Site:	http://www.celgene.com/
Year Founded:	1986
Total Fund Raised:	N/A
Stages:	N/A
Invested in: GNS Healthcare	

China Equity

ChinaEquity

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Summary:	ChinaEquity is China's leading private merchant bank engaging in VC, PE, Direct investments as well as investment management.
Number of Investments:	26
Headquarters:	China
Web Site:	http://www.chinaequity.net/
Year Founded:	1999
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: CloudMedX	



Citrix Systems



Summary:

Citrix aims to power a world where people, organizations and things are securely connected and accessible to make the extraordinary possible. Its technology makes the world's apps and data secure and easy to access, empowering people to work anywhere and at any time.

Number of Investments:

30

Headquarters:

United States

Web Site:

<https://www.citrix.com/>

Year Founded:

1989

Total Fund Raised:

N/A

Stages:

N/A

Invested in: Kyndi



Claremont Creek Ventures



Summary:	Claremont Creek Ventures, a seed- and early-stage venture capital firm, invests in various industries, including healthcare and energy.
Number of Investments:	74
Headquarters:	United States
Web Site:	https://claremontcreek.com/
Year Founded:	2005
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	NuMedii



CLI Ventures



Summary:	CLI Ventures typically invests at early to late stages of companies in the U.S. and China.
Number of Investments:	23
Headquarters:	United States
Web Site:	http://www.cli.ventures/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	twoXAR



Comcast Ventures



Summary:	Comcast Ventures invests in innovative businesses that represent the next generation of entertainment, communications and digital technology by partnering with entrepreneurs who have the vision, passion and tenacity to succeed.
Number of Investments:	257
Headquarters:	United States
Web Site:	https://www.comcastventures.com/
Year Founded:	1999
Total Fund Raised:	\$600M
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Meta	



Creative Destruction Lab



Summary:	The Creative Destruction Lab is a seed-stage program for massively scalable, science- and technology-based ventures. It employs a unique, objectives-focused coaching process to help founders commercialize advances in science and technology. The program pairs startups with exited entrepreneurs and star scientists in areas such as artificial intelligence, quantum computing, healthcare, blockchain, energy, and cleantech.
Number of Investments:	193
Headquarters:	Canada
Web Site:	https://www.creativedestructionlab.com/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Kyndi



Crowdcube



Summary:	Crowdcube enables individuals to invest or loan in small companies in return for equity or an annual return.
Number of Investments:	686
Headquarters:	United Kingdom
Web Site:	https://www.crowdcube.com/
Year Founded:	2010
Total Fund Raised:	£13M
Stages:	N/A
Invested in: Mind the Byte	



CRV



Summary:	CRV has been a leading investor in early-stage technology companies for almost half a century, backing nearly 400 startups in its history.
Number of Investments:	443
Headquarters:	United States
Web Site:	https://www.crv.com/
Year Founded:	1970
Total Fund Raised:	\$2B
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: Recursion Pharmaceuticals	



Cultivian Sandbox Ventures



Summary:	Cultivian Sandbox is a venture capital firm focused on building next-generation disruptive agriculture and food technology companies capable of generating superior returns. As early investors and active board members, Cultivian Sandbox Ventures employs a hands-on approach to building companies and are often directly involved in setting company strategy, recruiting key executives, and raising additional capital.
Number of Investments:	20
Headquarters:	United States
Web Site:	http://cultiviansbx.com/
Year Founded:	2008
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture
Invested in:	Nuritas



Danhua Capital



Summary:	DHVC (Danhua Capital) is a California-based venture capital fund investing primarily in early-stage technology companies.
Number of Investments:	138
Headquarters:	United States
Web Site:	http://danhuacap.com/
Year Founded:	2013
Total Fund Raised:	\$434.5M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	PathAI



Darling Ventures



Summary:

Darling Ventures has one goal, to help founders succeed in taking their startup from vision to mind blowing reality. They build relationships for the long term and just like their portfolio companies, they believe in the power of doing things differently. Darling Ventures dreams big but also take the time to work the details alongside its founders.

Number of Investments:

13

Headquarters:

United States

Web Site:

<https://darlingventures.com/>

Year Founded:

2013

Total Fund Raised:

N/A

Stages:

Seed

Invested in: Kyndi



Data Collective



Data
collective

Summary:	Data Collective is a venture fund with a unique team of experienced venture capitalists, technology entrepreneurs and practicing engineers, investing together in seed and early stage Big Data and IT infrastructure companies.
Number of Investments:	289
Headquarters:	United States
Web Site:	https://www.dcvc.com/
Year Founded:	2011
Total Fund Raised:	\$637M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Atomwise



DCM Ventures



Summary:	DCM Ventures assists entrepreneurs building world-class companies that will ultimately change how institutions and people use and live with technology.
Number of Investments:	408
Headquarters:	United States
Web Site:	https://www.dcm.com/
Year Founded:	1996
Total Fund Raised:	\$3.2B
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Mendel.ai



Deep Knowledge Ventures



Summary:	Deep Knowledge Ventures is based in Hong Kong and has teams in London, Amsterdam, and San Francisco. The fund primarily invests in healthcare, artificial intelligence, big data and fintech.
Number of Investments:	8
Headquarters:	Hong Kong
Web Site:	www.dkv.global
Year Founded:	2014
Total Fund Raised:	\$100M
Stages:	Early Stage Venture Fund
Invested in:	Insilico Medicine, Juvenescence AI



IN SILICO MEDICINE

DFJ Growth



Summary:	DFJ Growth is a late-stage global venture capital firm that provides capital to companies in seed-, early-, and growth-stages
Number of Investments:	80
Headquarters:	United States
Web Site:	http://www.dfj.com/
Year Founded:	2006
Total Fund Raised:	\$1.3B
Stages:	Early Stage Venture, Late Stage Venture, Private Equity
Invested in:	Helix



Digital Science



Summary:	Digital Science is a technology company serving the needs of scientific research. They provide software that makes the research process simpler and more efficient so that everyone can work smart and discover more.
Number of Investments:	19
Headquarters:	United Kingdom
Web Site:	https://www.digital-science.com/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Transcriptic	



Dolby Family Ventures



Summary:	Dolby Family Ventures is an early stage venture firm focused on building great technology companies. They partner with best-in-class innovators and strong investment syndicate partners at the seed stage of a company's development. Unlike many seed investors, Dolby Family Ventures intends to continue to invest across future rounds in its successful portfolio companies.
Number of Investments:	53
Headquarters:	United States
Web Site:	http://www.dolbyventures.com/
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Atomwise



Dorm Room Fund



Summary:	Dorm Room Fund is the strongest community of entrepreneurial students in the nation. Built by students and powered by First Round, Dorm Room Fund provides founders with a strong network of investors, world-class mentors, and a \$20,000 check.
Number of Investments:	123
Headquarters:	United States
Web Site:	https://dormroomfund.com/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Athelas	



Draper Associates

**Summary:**

Draper Associates, founded in 1985, is a seed-stage venture capital firm that encourages entrepreneurs to drive their businesses to greatness, to transform industries with new technologies, and to build platforms for extraordinary growth, jobs, and wealth creation.

Number of Investments:

212

Headquarters:

United States

Web Site:

<http://www.draper.vc/>

Year Founded:

1969

Total Fund Raised:

\$190M

Stages:

Debt, Early Stage Venture, Late Stage Venture, Seed

Invested in: Atomwise

Draper Dragon



Summary:	DFJ DragonFund was the joint venture between the internationally recognized venture capital firm Draper Fisher Jurvetson and Draper Dragon.
Number of Investments:	6
Headquarters:	United States
Web Site:	http://www.draperdragon.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	Early Stage Venture
Invested in: CloudMedX	



Dynamk Capital



Summary:	Dynamk Capital is focused on identifying innovative companies with disruptive tools, technologies and services in the life sciences sector.
Number of Investments:	3
Headquarters:	United States
Web Site:	http://www.dynamk.vc/
Year Founded:	2016
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Envisagenics



EDBI



Summary:	EDBI is a Singapore-based global fund with investments in the knowledge and innovation-intensive sectors.
Number of Investments:	59
Headquarters:	Singapore
Web Site:	https://www.edbi.com/
Year Founded:	1991
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture
Invested in: Engine Biosciences	



Empire State Development



Summary:	Empire State Development (ESD) is New York's chief economic development agency. The mission of ESD is to promote a vigorous and growing economy, encourage the creation of new job and economic opportunities, increase revenues to the State and its municipalities, and achieve stable and diversified local economies
Number of Investments:	6
Headquarters:	United States
Web Site:	https://esd.ny.gov/
Year Founded:	1968
Total Fund Raised:	\$20M
Stages:	N/A
Invested in: Envisagenics	



Endure Capital



Summary:	Endure Capital is an early stage investment fund headed by entrepreneurs looking for startup teams.
Number of Investments:	26
Headquarters:	United States
Web Site:	https://endurecap.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in: Cambridge Cancer Genomics	



Eniac Ventures



Summary:	Eniac Ventures leads seed rounds in bold founders who use code to create transformational companies. Armed with over 80 years of combined experience building its own companies, Eniac Ventures is your active partners and consider it a member of your founding team. Providing capital is just the first step, when it leads your seed round Eniac Ventures provides the industry's most comprehensive support through its Platform and hands on approach.
Number of Investments:	152
Headquarters:	United States
Web Site:	http://eniac.vc/
Year Founded:	2010
Total Fund Raised:	\$169.5M
Stages:	Debt, Early Stage Venture, Late Stage Venture, Seed
Invested in:	Meta



Enterprise Ireland



Summary:	Enterprise Ireland is the government agency responsible for the development and promotion of the indigenous business sector.
Number of Investments:	508
Headquarters:	Ireland
Web Site:	https://enterprise-ireland.com/en/
Year Founded:	1998
Total Fund Raised:	€175.2M
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Nuritas	



Entrepreneur First



Summary:	Entrepreneur First is a company builder that invests in individuals “pre-team, pre-idea” to help create new technology startups. Entrepreneur First selects purely on the basis of technical talent, so entrepreneurs would be able to apply before they have a team or an idea. Their intensive 6-month program is designed to give you the best possible support in the first 200 days of your startup’s life.
Number of Investments:	84
Headquarters:	United Kingdom
Web Site:	https://www.joinef.com/
Year Founded:	2011
Total Fund Raised:	£48.5M
Stages:	Seed
Invested in: Sparrho	



EPIC Capital



Summary:	The Epic Canadian Healthcare Fund LP is a five year fund that invests in unique private Canadian healthcare companies generally unavailable to the investing public that offer the potential for outsized returns.
Number of Investments:	5
Headquarters:	Canada
Web Site:	http://epiccapitalmanagement.ca/epic-healthcare-funds-lp-i/
Year Founded:	2000
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Cyclica	



EPIC Ventures

**Summary:**

EPIC Ventures is a premier early stage software and Internet infrastructure venture firm whose mission is to back entrepreneurs and companies positioned to lead the information economy of tomorrow. EPIC Ventures brings the collective operational and financial experience of its partnership, its world class advisors, and its extensive network of technology industry contacts to engage and ensure its portfolio's success.

Number of Investments:

122

Headquarters:

United States

Web Site:

<http://www.epicvc.com/>

Year Founded:

1994

Total Fund Raised:

\$120M

Stages:

Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed

Invested in: Recursion Pharmaceuticals



European Union



Summary:	The European Union occasionally makes investments.
Number of Investments:	35
Headquarters:	United Kingdom
Web Site:	http://europa.eu/
Year Founded:	2002
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Nuritas	



Fairhaven Capital Partners

FAIRHAVEN
CAPITAL

Summary:	Fairhaven Capital (previously TD Capital) is a Cambridge, MA based venture capital firm investing in early stage technology startups.
Number of Investments:	60
Headquarters:	United States
Web Site:	http://fairhavencapital.com/
Year Founded:	2001
Total Fund Raised:	\$250M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	PathAI



Faridan



Summary:	Game changing science and technology are the heart of Faridan's investment strategy. Cross-disciplinary teams are the soul of their investment strategy. Upgrading human health is Faridan's end goal.
Number of Investments:	N/A
Headquarters:	United States
Web Site:	http://www.faridan.com/
Year Founded:	2016
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Arbor Biotechnologies	



Felicis Ventures



Summary:	Felicis Ventures is a boutique VC firm that backs iconic companies reinventing existing markets and creating frontier technologies.
Number of Investments:	365
Headquarters:	United States
Web Site:	https://www.felicis.com/
Year Founded:	2006
Total Fund Raised:	\$438.6M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: BioAge Labs	

BIOAGE

Fenox Venture Capital



Summary:	Fenox Venture Capital is a Silicon Valley-based venture capital firm founded by an exceptional team of seasoned entrepreneurs and proven international business leaders. Fenox VC works with emerging technology companies worldwide and specializes in assisting entrepreneurs in North America achieve global expansion in Asian, European, and Middle Eastern markets.
Number of Investments:	111
Headquarters:	United States
Web Site:	http://www.fenoxvc.com/
Year Founded:	2011
Total Fund Raised:	\$610M
Stages:	Early Stage Venture, Seed
Invested in: Meta	



Fifty Years

50^Y

Summary:	Fifty Years is an early stage VC fund backing entrepreneurs solving the world's biggest problems.
Number of Investments:	25
Headquarters:	United States
Web Site:	http://www.fifty.vc/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Athelas	



Finance Wales



Summary:	Finance Wales was formed in 2001 by the Welsh Assembly Government. Finance Wales is an independent company, providing commercial funding to Welsh SMEs. They invests in private and public funds, including EU funds.
Number of Investments:	76
Headquarters:	United Kingdom
Web Site:	www.financewales.co.uk
Year Founded:	2001
Total Fund Raised:	£136M
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Clinithink

clinithink

Fly Ventures



Summary:	Fly Ventures is a Berlin-based VC firm investing in seed stage companies across Europe. Its focus is on software companies leveraging machine learning to drive business automation. Fly is led by a team of engineers, product designers, and investors, uniquely positioned to help founders build technologically outstanding businesses with global ambitions.
Number of Investments:	14
Headquarters:	Germany
Web Site:	https://www.fly.vc/
Year Founded:	2016
Total Fund Raised:	\$41M
Stages:	Seed
Invested in:	Inato

The logo for Inato, consisting of the word 'inato' in a white, lowercase, sans-serif font centered within a dark blue square.

Foundation Capital



Summary:	Foundation Capital is a venture capital firm made up of former entrepreneurs who set out to create the firm they wanted as founders.
Number of Investments:	471
Headquarters:	United States
Web Site:	http://foundationcapital.com/
Year Founded:	1995
Total Fund Raised:	\$3.1B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Numerate

Founders Factory



Summary:	Founders Factory was established to help early stage companies rapidly become viable and sustainable businesses. They have a blend of what early stage companies require: expedited pre-seed funding, agile technology development, lean acceleration and world class mentors.
Number of Investments:	25
Headquarters:	United Kingdom
Web Site:	https://foundersfactory.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Iris.ai	

IRIS.AI

Founders Fund



Summary:	Founders Fund is a San Francisco based venture capital firm investing in companies building revolutionary technologies.
Number of Investments:	380
Headquarters:	United States
Web Site:	https://foundersfund.com/
Year Founded:	2005
Total Fund Raised:	\$3.4B
Stages:	Debt, Early Stage Venture, Grant, Late Stage Venture, Private Equity, Seed
Invested in: Transcriptic	



FREES FUND



Summary:	FREES FUND is a venture capital firm that provides both early and growth stage investment to technology startups in both China and the U.S.
Number of Investments:	35
Headquarters:	China
Web Site:	https://www.freesvc.com/
Year Founded:	2015
Total Fund Raised:	CN¥920M
Stages:	Early Stage Venture, Late Stage Venture
Invested in:	XtalPi



Frontier IP Group plc

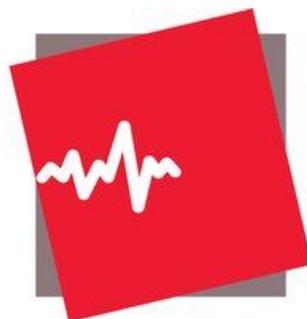


Summary:	Frontier IP specialises in the commercialisation of Intellectual Property (IP). Frontier IP establishes partnerships with individual universities and research institutions to assist with their spin-out and licensing activities and help maximise the commercial value of technologies emerging from their research programmes.
Number of Investments:	9
Headquarters:	United Kingdom
Web Site:	http://www.frontierip.co.uk/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Exscientia	

FundersClub



Summary:	FundersClub focuses on Seed and early stage investments. Investments include Coinbase, Instacart, Flexport, Le Tote, Teespring, Memebox, GitLab.
Number of Investments:	337
Headquarters:	United States
Web Site:	https://fundersclub.com/
Year Founded:	2012
Total Fund Raised:	\$1.3M
Stages:	Early Stage Venture, Seed
Invested in: CloudMedX	



Gaorong Capital



Summary:

Investors of Gaorong Capital include world-class sovereign wealth funds, university endowment funds, family foundations, pension funds and fund of funds, as well as successful entrepreneurs, including founders and managements of Tencent, Alibaba, Baidu, JD, Xiaomi, Focus Media and VIPShop. They will provide with valuable industry resources, entrepreneurial experience, and global perspectives.

Number of Investments:

54

Headquarters:

China

Web Site:

<http://www.gaorongvc.com/>

Year Founded:

2013

Total Fund Raised:

\$487.8M

Stages:

N/A

Invested in: Meta



General Catalyst

**Summary:**

General Catalyst provides the ongoing momentum that accelerates your ideas, your career, and your company toward standout success. They create the ideal conditions for growth, surround you with the right people, and offer mentorship based on deep experience. General Catalyst works with you side by side, for the whole journey. And when it really counts, they'll challenge you in ways that help you achieve true leadership and scale.

Number of Investments:

587

Headquarters:

United States

Web Site:

<http://generalcatalyst.com/>

Year Founded:

2000

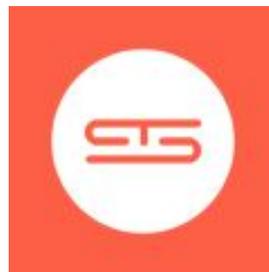
Total Fund Raised:

\$5B

Stages:

Early Stage Venture, Late Stage Venture, Seed

Invested in: ThoughtSpot



Geodesic Capital



Summary:	Geodesic Capital is a venture capital firm that provides mid- and later-stage investments to firms in the consumer technology industry. It was founded in 2015 by John Roos and Ashvin Bachireddy and is based in California.
Number of Investments:	13
Headquarters:	United States
Web Site:	http://www.geodesiccap.com/
Year Founded:	2015
Total Fund Raised:	\$335M
Stages:	Late Stage Venture, Venture
Invested in:	ThoughtSpot



GM&C Life Sciences Fund



Summary:	Managed by Catapult Ventures, the GM&C Life Sciences Fund is a seed and early stage venture capital fund targeting life sciences businesses located in the Greater Manchester and Cheshire & Warrington region. The Fund is managed by Catapult Venture Managers.
Number of Investments:	22
Headquarters:	United Kingdom
Web Site:	http://www.gmclifesciencesfund.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Biorelate



Golden Venture Partners



Summary:	Golden Ventures is a leading seed-stage venture capital fund, investing across North America. They back bold teams and their transformative ideas.
Number of Investments:	58
Headquarters:	Canada
Web Site:	https://golden.ventures/
Year Founded:	2011
Total Fund Raised:	\$110.9M
Stages:	Early Stage Venture, Seed
Invested in: BenchSci	



GQY



Summary:

Ningbo GQY Video & Telecom Joint Stock Co., Ltd. is the first research and development, production and sale of large-screen display system of high-tech companies, products are mainly used in public security, military, transportation, government, energy, broadcasting and other large enterprises and the market share in the domestic leading position.

Number of Investments:

1

Headquarters:

China

Web Site:

<http://www.gqy.com.cn/contact/gqyen.html>

Year Founded:

1992

Total Fund Raised:

N/A

Stages:

N/A

Invested in: Meta



Gradient Ventures



Summary:	Gradient Ventures is Google's new AI-focused venture fund - investing in and connecting early stage startups with Google's resources, innovation, and technical leadership in artificial intelligence.
Number of Investments:	10
Headquarters:	United States
Web Site:	https://www.gradient.com/
Year Founded:	2017
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	BenchSci



Grand Central Tech



Summary:	Grand Central Tech is a New York-based startup accelerator specialized in seed-stage and non-equity assistance investments.
Number of Investments:	51
Headquarters:	United States
Web Site:	http://www.grandcentraltech.com
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Non Equity Assistance, Seed
Invested in: Envisagenics	



Grand Challenges Canada



Summary:	Grand Challenges Canada is dedicated to supporting bold ideas with big impact in global health.
Number of Investments:	3
Headquarters:	Canada
Web Site:	http://www.grandchallenges.ca/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Atomwise	



Great Oaks Venture Capital



Summary:	Great Oaks is an early stage venture investment firm founded by Andrew Boszhardt, Jr.
Number of Investments:	348
Headquarters:	United States
Web Site:	http://www.greatoaksvc.com/
Year Founded:	2005
Total Fund Raised:	\$80M
Stages:	Early Stage Venture, Seed
Invested in:	Verge Genomics



GreenSky Capital



Summary:	GreenSky Capital is a boutique corporate finance advisory firm based in Toronto, delivering customized financial solutions to small and medium sized businesses.
Number of Investments:	10
Headquarters:	Canada
Web Site:	https://www.greenskycapital.com/
Year Founded:	2008
Total Fund Raised:	CA\$3.3M
Stages:	N/A
Invested in: Cyclica	



Summary:	Launched as Google Ventures in 2009, GV is the venture capital arm of Alphabet, Inc. They've invested in more than 300 companies that push the edge of what's possible. In the fields of life science, healthcare, artificial intelligence, robotics, transportation, cyber security, and agriculture
Number of Investments:	570
Headquarters:	United States
Web Site:	http://www.gv.com/
Year Founded:	2008
Total Fund Raised:	\$100M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Transcriptic



Hacking Health Accelerator



Summary:	Hacking Health Accelerator exists to accelerate companies working in digital health. Put simply, they want to make healthcare better for everyone. Better means incredible change. They act as an early employee, not as an advisor or mentor. That means getting their hands dirty doing actual work. Hacking Health Accelerator supports their companies on a wide range of business issues, including product market fit, fundraising, go-to-market planning, customer development, business development and pricing.
Number of Investments:	8
Headquarters:	Canada
Web Site:	http://www.hhaccelerator.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Imagia	



Hanhai Studio



Summary:	Hanhai Studio is a cross-border business accelerator specializing in bridging opportunities between the US and China. Its focus lies in the entertainment and technology industries.
Number of Investments:	1
Headquarters:	United States
Web Site:	http://hanhaistudio.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	N/A

Invested in: Cyclica



Health Wildcatters



Summary:	Health Wildcatters is a mentor-driven seed accelerator focused on improving healthcare by supporting entrepreneurs and healthcare startups.
Number of Investments:	21
Headquarters:	United States
Web Site:	https://www.healthwildcatters.com/
Year Founded:	2013
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Lantern Pharma	

Healthbox



Summary:	Healthbox is a an innovation consulting and fund management services firm, helping organization build and sustain innovation strategies.
Number of Investments:	91
Headquarters:	United States
Web Site:	http://healthbox.com/
Year Founded:	2010
Total Fund Raised:	\$35M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Desktop Genetics



Heritage Provider Network



Summary:	Heritage Provider Network (HPN) is a limited Knox-Keene licensed organization in California that provides affordable quality care to its members. Through innovative programs and services designed specifically for the managed care environment, HPN and its medical groups have been successful in delivering the goals it set out to achieve while establishing long-standing, favorable provider relationships.
Number of Investments:	6
Headquarters:	United States
Web Site:	http://heritageprovidernetwork.com/
Year Founded:	1996
Total Fund Raised:	N/A
Stages:	N/A
Invested in: GNS Healthcare	

Hewlett Packard Pathfinder



Summary:	Hewlett Packard Pathfinder provides expansion stage capital and exceptional support to the best enterprise technology start-ups focused on Cloud, Data Centers, Big Data and Security that have received previous funding from a leading early-stage venture capital firm and have completed the initial development phase of their product or service.
Number of Investments:	19
Headquarters:	United States
Web Site:	https://www.hewlettpackardpathfinder.com/
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	N/A
Invested in: ThoughtSpot	



Horizons Ventures



Summary:	Horizons Ventures Limited, based in Hong Kong, funds especially disruptive and technology-focused start-ups.
Number of Investments:	161
Headquarters:	Hong Kong
Web Site:	http://horizonsventures.com/
Year Founded:	1999
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Meta



IA Ventures



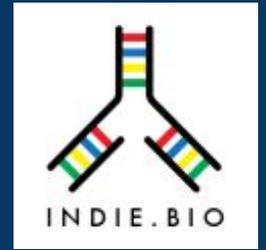
Summary:	IA Ventures is an early stage venture firm based in NYC but with investments in LA, SF, Toronto and the UK. IA Ventures loves getting involved very early, often seeding companies before a dollar of revenue has been generated. The three partners, Roger, Brad and Jesse, each do their own work, eschewing the notion of leverage from junior staff.
Number of Investments:	109
Headquarters:	United States
Web Site:	http://www.iaventures.com/
Year Founded:	2009
Total Fund Raised:	\$315M
Stages:	Early Stage Venture, Seed
Invested in:	Verge Genomics



Summary:	Illumina applies innovative technologies and revolutionary assays to the analysis of genetic variation and function.
Number of Investments:	15
Headquarters:	United States
Web Site:	https://www.illumina.com/
Year Founded:	1998
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture
Invested in:	Helix



Indie Bio



Summary:	Indie Bio is the world's first accelerator devoted to startups using biology to solve the world's largest problems.
Number of Investments:	135
Headquarters:	United States
Web Site:	https://indiebio.co/
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Mendel.ai	



Initialized Capital



Summary:	Initialized Capital is early stage VC firm focused on helping software engineers, designers and product people with their first seed checks.
Number of Investments:	74
Headquarters:	United States
Web Site:	http://initialized.com/
Year Founded:	2011
Total Fund Raised:	\$171.2M
Stages:	Early Stage Venture, Seed
Invested in: Athelas	



InnoSpring Seed Fund



Summary:	InnoSpring Seed Fund is technology seed fund backed by growth-stage venture funds including KPCB, IDG Capital, Legend Capital, NLVC etc.
Number of Investments:	43
Headquarters:	United States
Web Site:	http://www.innospringseedfund.com/
Year Founded:	2012
Total Fund Raised:	\$5M
Stages:	Seed
Invested in: Meta	



Summary:	iNova is an early stage venture capital firm that invests in category-defining technology startups. Epic companies are forged by exceptionally qualified founders; iNova supports these remarkable individuals with custom playbooks for attracting talent and scaling efficiently.
Number of Investments:	157
Headquarters:	Canada
Web Site:	https://www.inovia.vc/
Year Founded:	2001
Total Fund Raised:	CA\$425.7M
Stages:	Early Stage Venture, Seed
Invested in:	BenchSci



IQ Capital Partners LLP

IQ CAPITAL

Summary:	IQ Capital Partners is a venture capital firm that invests up to £5m in early and growth stage deep tech companies.
Number of Investments:	36
Headquarters:	United Kingdom
Web Site:	http://iqcapital.vc/
Year Founded:	2006
Total Fund Raised:	£167M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Desktop Genetics



J. Hunt Holdings

JHUNTHOLDINGS

Summary:	J. Hunt Holdings is an investment holding company that provides funds for early stage ventures. It is specialized in both domestic and international projects and investments.
Number of Investments:	82
Headquarters:	United States
Web Site:	http://jhuntholdings.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Kyndi



Juvenescence

JUVENESCENCE

Summary:	A company focussed on therapeutics for ageing and the diseases of ageing.
Number of Investments:	3
Headquarters:	United States
Web Site:	https://www.juvenescence.ltd/
Year Founded:	N/A
Total Fund Raised:	\$62.3M
Stages:	N/A
Invested in:	InSilico Medicine, Juvenescence AI



JUVENESCENCE.AI

Karlin Ventures



Summary:	Karlin Ventures, a California-based early-stage venture capital fund, invests in software, e-commerce, and advertising technology companies.
Number of Investments:	44
Headquarters:	United States
Web Site:	http://karlinvc.com/
Year Founded:	2013
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in: Verge Genomics	



KdT Ventures



Summary:	KdT Ventures is a new age seed stage venture firm, with a focus on the intersection of technology and science.
Number of Investments:	7
Headquarters:	United States
Web Site:	http://www.kdtvc.com/
Year Founded:	2017
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Private Equity, Seed
Invested in: PathAI	



Khosla Ventures

khosla ventures

Summary:	Khosla Ventures is a venture capital firm that focuses on environmentally friendly tech, internet, computing, mobile, and silicon tech.
Number of Investments:	594
Headquarters:	United States
Web Site:	https://www.khoslaventures.com/
Year Founded:	2004
Total Fund Raised:	\$2.8B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Post-Ipo, Private Equity, Seed
Invested in:	ThoughtSpot



Kima Ventures



Summary:	Kima Ventures is one of the world's most active early-stage investors, investing in 2 to 3 startups per week all over the world; providing founders with funding, network, and support for them to reach the next steps of their journey.
Number of Investments:	466
Headquarters:	France
Web Site:	https://www.kimaventures.com/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in: Inato	

The logo for Inato, consisting of the word "inato" in a white, lowercase, sans-serif font, centered within a dark blue square.

Kleiner Perkins Caufield & Byers



Summary:	Kleiner Perkins Caufield & Byers invests globally in internet start ups and operate an informational website filled with technology news.
Number of Investments:	1038
Headquarters:	United States
Web Site:	http://www.kpcb.com/
Year Founded:	1972
Total Fund Raised:	\$2.7B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Helix



Lansdowne Partners

LANSDOWNE
— PARTNERS —

Summary:	Lansdowne Partners manages assets for a diversified client base that includes some of the world's largest and most sophisticated investors.
Number of Investments:	14
Headquarters:	United Kingdom
Web Site:	https://www.lansdownepartners.com/
Year Founded:	1998
Total Fund Raised:	N/A
Stages:	Late Stage Venture, Private Equity
Invested in:	BenevolentAI

benevolent.ai

Lanza Tech Ventures



Summary:	Lanza Tech Ventures is a venture capital firm specializing in investments in early-stage companies.
Number of Investments:	4
Headquarters:	United States
Web Site:	http://lanzatechventures.com/
Year Founded:	2001
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture
Invested in: Numerate	

LaunchCapital



Summary:	LaunchCapital was founded in January 2008 with a mission to help entrepreneurs gain quick access to seed capital and mentorship.
Number of Investments:	220
Headquarters:	United States
Web Site:	https://launchcapital.com/
Year Founded:	2008
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in: Helix	



LB Investment



LB Investment

Summary:	LB Investment is a private equity and venture capital firm focused on investments in healthcare industry.
Number of Investments:	19
Headquarters:	South Korea
Web Site:	http://lbinvestment.com/
Year Founded:	1996
Total Fund Raised:	N/A
Stages:	Early Stage Venture

Invested in: Standigm

Standigm

Lenovo



Summary:	Lenovo is one of the world's leading personal technology companies, producing innovative PCs and mobile internet devices. A global Fortune 500 company, Lenovo is the world's largest PC vendor and fourth largest smartphone company.
Number of Investments:	11
Headquarters:	United States
Web Site:	https://www.lenovo.com
Year Founded:	1984
Total Fund Raised:	\$500M
Stages:	N/A
Invested in: Meta	



Lightspeed Venture Partners



Summary:	Lightspeed Venture Partners is a venture capital firm that is engaged in the consumer, enterprise, technology, and cleantech markets. It is focused in seed, early stage, later stage, expansion stage, start-up, growth companies, and incubation and has specialized in debt financing for start-up and growth companies.
Number of Investments:	641
Headquarters:	United States
Web Site:	http://lsvp.com/
Year Founded:	2000
Total Fund Raised:	\$7.6B
Stages:	Debt, Early Stage Venture, Grant, Late Stage Venture, Private Equity, Seed

Invested in: ThoughtSpot



Lilly Ventures



Summary:	Lilly Ventures has its roots in the scientific tradition of Eli Lilly and Company. Its investment philosophy drives Lilly Ventures to seek great companies with compelling life science innovations.
Number of Investments:	59
Headquarters:	United States
Web Site:	http://lillyventures.com/
Year Founded:	N/A
Total Fund Raised:	\$250M
Stages:	N/A
Invested in: Numerate	

Liquid2 Ventures



Summary:	Liquid2 Ventures provides technology startups with seed stage investments and is based in San Francisco, California.
Number of Investments:	83
Headquarters:	United States
Web Site:	http://liquid2.vc/
Year Founded:	2015
Total Fund Raised:	\$40M
Stages:	Early Stage Venture, Seed
Invested in: Athelas	



London Co-Investment Fund



Summary:	London Co-Investment Fund is a venture firm that invests in high growth tech, science, and digital startups in London.
Number of Investments:	81
Headquarters:	United Kingdom
Web Site:	http://lcif.co/
Year Founded:	2014
Total Fund Raised:	\$133M
Stages:	Early Stage Venture, Seed

Invested in: Desktop Genetics



Lundbeck

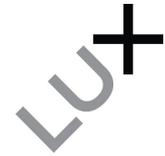


Summary:	Lundbeck is a pharmaceutical company that develops products to treat people with psychiatric and neurological disorders.
Number of Investments:	3
Headquarters:	Denmark
Web Site:	http://www.lundbeck.com/global
Year Founded:	2000
Total Fund Raised:	N/A
Stages:	N/A

Invested in: BenevolentAI

BenevolentAI

Lux Capital



Summary:	Lux Capital is based in NYC and Menlo Park investing in counter-conventional, early-stage science and tech ventures, with \$1.4B AUM across 5 funds.
Number of Investments:	175
Headquarters:	United States
Web Site:	https://www.luxcapital.com/
Year Founded:	2000
Total Fund Raised:	\$1.1B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Recursion Pharmaceuticals	



Masa Life Science Fund



Summary:	Masa Life Science Fund is a venture capital fund focused on investments in private, high-growth biotechnology, and life sciences companies.
Number of Investments:	3
Headquarters:	United States
Web Site:	http://www.mlsvfund.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	Early Stage Venture
Invested in: Cyttox	

MassChallenge



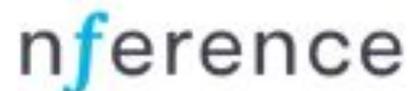
Summary:	MassChallenge is a global non-profit startup accelerator and competition with a focus on high-impact, early-stage entrepreneurs.
Number of Investments:	1392
Headquarters:	United States
Web Site:	https://masschallenge.org/
Year Founded:	2009
Total Fund Raised:	\$25.8M
Stages:	N/A
Invested in: ReviveMed	

ReviveMed

Matrix Partners



Summary:	Matrix Partners is a California-based venture capital firm focused on seed- and early-stage investments.
Number of Investments:	490
Headquarters:	United States
Web Site:	https://www.matrixpartners.com/
Year Founded:	1977
Total Fund Raised:	\$2.3B
Stages:	Early Stage Venture, Seed
Invested in:	nference



Mayo Clinic



Summary:	Mayo Clinic offers medical care services in various specialties, including diabetes and endocrinology, gastroenterology, gynecology, cancer, neurology and neurosurgery, orthopedics, pulmonology, rheumatology, nephrology, urology, and cardiology and heart surgery.
Number of Investments:	27
Headquarters:	United States
Web Site:	https://www.mayoclinic.org/
Year Founded:	1919
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Helix	



Menlo Ventures



Summary:	Menlo Ventures is a venture capital firm providing capital for seed through growth technology companies in the consumer and other sectors.
Number of Investments:	539
Headquarters:	United States
Web Site:	https://www.menlovc.com/
Year Founded:	1976
Total Fund Raised:	\$2.7B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Recursion Pharmaceuticals	



Merck Global Health Innovation Fund



**GLOBAL HEALTH
INNOVATION**

Summary:	Merck Global Health Innovation Fund (Merck GHI) is evolving corporate healthcare venture capital globally by utilizing their healthcare ecosystem strategy. This investment strategy connects innovative companies with complementary technologies to develop integrated healthcare solutions.
Number of Investments:	47
Headquarters:	United States
Web Site:	http://merckghifund.com/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Antidote	

antidote

Mission and Market



Summary:	Mission and Market is a micro-venture capital firm focused on seed investments in many areas, including big data, software-powered biotech.
Number of Investments:	11
Headquarters:	United States
Web Site:	http://m14t.com/
Year Founded:	2009
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Atomwise	



MIT delta v



Summary:	Delta v is MIT's premier venture accelerator, that prepares entrepreneurs to hit escape velocity and launch into the real world.
Number of Investments:	56
Headquarters:	United States
Web Site:	http://entrepreneurship.mit.edu/accelerator/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Grant
Invested in:	ReviveMed

ReviveMed

MITS Fund



Summary:	MITS Fund is a multi-stage investment fund that supports entrepreneurs in building new companies.
Number of Investments:	5
Headquarters:	United States
Web Site:	http://www.mitsfund.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Transcriptic	



Mitsui & Co



Summary:	Mitsui & Co., is a general trading and investment company, with interests in Iron & Steel Products.
Number of Investments:	67
Headquarters:	Japan
Web Site:	http://www.mitsui.com/jp/en/index.html
Year Founded:	1947
Total Fund Raised:	N/A
Stages:	N/A
Invested in: GNS Healthcare	

Monsanto Growth Ventures (MGV)



Summary:	Monsanto Growth Ventures, a venture capital group, offers technology-based solutions and agricultural products to improve farm productivity.
Number of Investments:	24
Headquarters:	United States
Web Site:	https://monsanto.com/company/monsanto-growth-ventures/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Atomwise



Mubadala Investment Company



Summary:	Mubadala Investment Company is a UAE-based strategic investment fund. Established and owned by the Government, the company's strategy is built on the management of long-term investments that deliver strong financial returns and tangible social benefits to the Emirate.
Number of Investments:	11
Headquarters:	United Arab Emirates
Web Site:	https://www.mubadala.com/
Year Founded:	2002
Total Fund Raised:	\$400M
Stages:	Early Stage Venture
Invested in: Recursion Pharmaceuticals	



National Institutes of Health



Summary:	National Institutes of Health is a biomedical research facility in the United States that focuses on biomedical and health-related research.
Number of Investments:	146
Headquarters:	United States
Web Site:	https://www.nih.gov/
Year Founded:	1887
Total Fund Raised:	N/A
Stages:	Grant, Seed
Invested in: Envisagenics	



National Science Foundation



Summary:	The National Science Foundation (NSF) is an independent federal agency created by the U.S. Congress in 1950.
Number of Investments:	189
Headquarters:	United States
Web Site:	https://www.nsf.gov/
Year Founded:	1950
Total Fund Raised:	\$1.5M
Stages:	Grant, Seed

Invested in: Cloud Pharmaceuticals



Nest.Bio Ventures



Summary:	Nest.Bio Ventures takes a deep science, cross-border approach to translating breakthrough science into revolutionary companies.
Number of Investments:	8
Headquarters:	United States
Web Site:	https://nest.bio/
Year Founded:	2016
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Engine Biosciences	



Nesta Ventures



Summary:	Nesta Investments is a venture capital arm of NESTA specializing in direct and fund of fund investments.
Number of Investments:	63
Headquarters:	United Kingdom
Web Site:	https://www.nesta.org.uk/project/venture-investment
Year Founded:	1998
Total Fund Raised:	£25M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: Cyttox	

New Leaf Venture Partners



Summary:	New Leaf Venture Partners is a New York- based venture capital firm focused on investments in healthcare technology companies.
Number of Investments:	140
Headquarters:	United States
Web Site:	http://www.nlvpartners.com/
Year Founded:	2005
Total Fund Raised:	\$1B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity
Invested in:	AiCure



New Protein Capital



Summary:	New Protein Capital is a Singapore-based investment company, investing in innovative solutions to address the food and feed challenges.
Number of Investments:	3
Headquarters:	Singapore
Web Site:	http://visviresnewprotein.com/
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Nuritas	



New Wave Ventures



Summary:	New Wave Ventures is a privately owned fund seeking the opportunity to invest for the long term in companies with significant growth.
Number of Investments:	16
Headquarters:	United Kingdom
Web Site:	http://www.nwventures.co.uk/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed

Invested in: Bactevo



NewDo Venture



Summary:	NewDo devotes to help ambitious startup companies to succeed at their initial stage with its fund and other strategic resources.
Number of Investments:	31
Headquarters:	United States
Web Site:	https://en.newdoventure.com/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in: Cambridge Cancer Genomics	

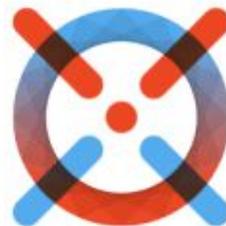


NJF Capital



Summary:	NJF Capital is an investment firm that has supported innovative technology-based businesses across the world.
Number of Investments:	26
Headquarters:	United Kingdom
Web Site:	https://njfcapital.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	Early Stage Venture

Invested in: Owkin



Obvious Ventures



Summary:	Obvious Ventures brings experience, capital, and focus to startups combining profit and purpose for a better world.
Number of Investments:	53
Headquarters:	United States
Web Site:	https://obvious.com/
Year Founded:	2014
Total Fund Raised:	\$315.4M
Stages:	Early Stage Venture, Seed
Invested in: Recursion Pharmaceuticals	



Octopus Ventures



Summary:	Octopus is a multi stage European venture capital investor backing talented teams with the potential to build big businesses.
Number of Investments:	182
Headquarters:	United Kingdom
Web Site:	https://www.octopusventures.com/
Year Founded:	1999
Total Fund Raised:	\$996.8M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: e-therapeutics	



OS Fund



Summary:	OS Fund is investing in entrepreneurs, inventors and scientists who aim to benefit humanity by rewriting the operating systems of life.
Number of Investments:	41
Headquarters:	N/A
Web Site:	https://osfund.co/
Year Founded:	N/A
Total Fund Raised:	\$100M
Stages:	N/A
Invested in: Atomwise	



Otium Capital



Summary:	Otium is an early stage European venture capital fund.
Number of Investments:	24
Headquarters:	France
Web Site:	https://otium.fr/
Year Founded:	2015
Total Fund Raised:	€200M
Stages:	Early Stage Venture, Seed
Invested in:	Owkin



Palm Drive Capital



Summary:	Palm Drive Capital is a New York-based venture capital and growth equity firm that focuses on investing in software and internet companies in the United States.
Number of Investments:	26
Headquarters:	United States
Web Site:	http://palmdrive.vc/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: CloudMedX	



Pavilion Capital



Summary:	Pavilion Capital is providing growth equity to market leading companies.
Number of Investments:	4
Headquarters:	United States
Web Site:	http://www.pavilioncapital.com/
Year Founded:	1974
Total Fund Raised:	\$50M
Stages:	N/A
Invested in: InSilico Medicine	



Pear Ventures



Summary:	Pear, formerly known as Pejman Mar Ventures, is an early stage venture fund founded by Pejman and Mar.
Number of Investments:	74
Headquarters:	United States
Web Site:	https://www.pear.vc/
Year Founded:	2013
Total Fund Raised:	\$129.2M
Stages:	Early Stage Venture, Seed
Invested in:	BioAge Labs

BIOAGE

Pentech Ventures



Summary:	Pentech Ventures invests in teams who believe they can build a category leading software company. Its areas of interest include: Artificial Intelligence and Machine Learning; Big Data; Infrastructure such as Blockchain; and verticals that are enabled via the efficient use of AI and new infrastructure approaches, such as FinServ, Health, and Enterprise Transformation.
Number of Investments:	53
Headquarters:	United Kingdom
Web Site:	https://pentech.vc/
Year Founded:	2001
Total Fund Raised:	£155.8M
Stages:	Early Stage Venture, Seed
Invested in: GTN Limited	



Perivoli Innovations

Perivoli Innovations

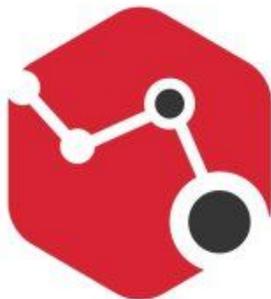
Summary:	Perivoli Innovations aim is to allocate the profits from successful investments in new technologies to The Perivoli Schools Trust which focuses on improving nursery school education in sub-Saharan Africa.
Number of Investments:	N/A
Headquarters:	United Kingdom
Web Site:	http://perivoliinnovations.com/
Year Founded:	2016
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Cyttox	

CYTOX

Pillar Companies



Summary:	Pillar Companies have been involved in building startups for many years. it wants to create the next generation of big, important, lasting technology companies.
Number of Investments:	12
Headquarters:	United States
Web Site:	https://pillar.vc/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: PathAI	



Pitch@Palace



Summary:	Pitch@Palace focuses on the benefits for entrepreneurs, as they take no stake in the participants and impose no restrictions.
Number of Investments:	385
Headquarters:	United Kingdom
Web Site:	http://pitchatpalace.com/
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	Non Equity Assistance
Invested in: Sparrho	



PivotNorth Capital



Summary:	PivotNorth Capital is a venture capital firm that invests in software companies.
Number of Investments:	38
Headquarters:	United States
Web Site:	http://www.pivotnorth.com
Year Founded:	2010
Total Fund Raised:	\$105M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Kyndi



Plug and Play

PLUGANDPLAY

Summary:	Plug and Play is a seed and early-stage investment firm focusing on technology start-ups.
Number of Investments:	773
Headquarters:	United States
Web Site:	https://www.plugandplaytechcenter.com/
Year Founded:	2006
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Owkin



Presence Capital



Summary:	Presence Capital is an investment firm that finances virtual reality and augmented reality startups.
Number of Investments:	41
Headquarters:	United States
Web Site:	https://www.presencecap.com/
Year Founded:	2015
Total Fund Raised:	\$10M
Stages:	Early Stage Venture, Seed
Invested in:	Meta



Pritzker Group Venture Capital



Summary:	Pritzker Group Venture Capital is a trusted partner helping entrepreneurs build market-leading technology companies
Number of Investments:	183
Headquarters:	United States
Web Site:	http://www.pritzkergroup.com/venture-capital/
Year Founded:	1996
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	AiCure



Real Ventures



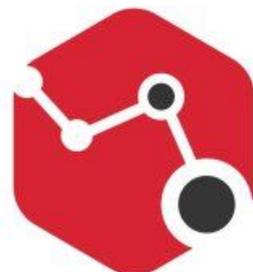
Summary:	Real is an early-stage venture capital firm that backs entrepreneurs and builds the ecosystems in which they thrive.
Number of Investments:	163
Headquarters:	Canada
Web Site:	https://realventures.com/
Year Founded:	2007
Total Fund Raised:	\$272.3M
Stages:	Early Stage Venture, Seed
Invested in:	Imagia



Refactor Capital

R

Summary:	Refactor Capital is a seed fund co-founded by David Lee of SV Angel and Zal Bilimoria of a16z.
Number of Investments:	27
Headquarters:	United States
Web Site:	https://www.refactor.com/
Year Founded:	2016
Total Fund Raised:	\$50M
Stages:	Early Stage Venture, Seed
Invested in:	PathAI



Renren Inc.



Summary:	Renren.com is an online social network service that offers an extensive interactive communication platform for Chinese users.
Number of Investments:	33
Headquarters:	China
Web Site:	http://renren-inc.com/zh/
Year Founded:	2002
Total Fund Raised:	N/A
Stages:	N/A
Invested in: XtalPi	



Rivas Capital



Summary:	Rivas Capital is an independent investment bank focused on the valuation of small and medium size businesses.
Number of Investments:	9
Headquarters:	United States
Web Site:	http://www.rivascap.com/
Year Founded:	2011
Total Fund Raised:	N/A
Stages:	N/A
Invested in: ReviveMed	

ReviveMed

Rough Draft Ventures



Summary:	Rough Draft Ventures is a student-led team that funds technology-focused university entrepreneurs in Boston, Massachusetts.
Number of Investments:	66
Headquarters:	United States
Web Site:	roughdraft.vc
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Reverie Labs	



Seneca Partners



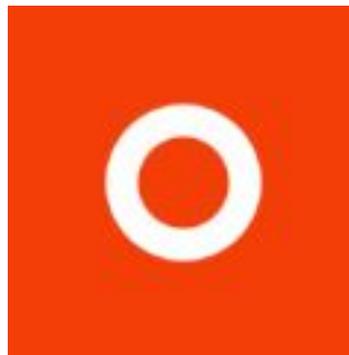
Summary:	Seneca Partners is a middle market focused investment banking and private investment firm.
Number of Investments:	14
Headquarters:	United States
Web Site:	http://senecapartners.com/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Cytox

CYTOX

Sequoia Capital



Summary:	Sequoia is a VC firm focused on energy, financial, enterprise, healthcare, internet, and mobile startups.
Number of Investments:	1589
Headquarters:	United States
Web Site:	https://www.sequoiacap.com/
Year Founded:	1972
Total Fund Raised:	\$13.9B
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Athelas



Seraph Group



Summary:	Seraph Group is an angel investor that invests between \$50,000 and \$1,000,000 in early-stage startups.
Number of Investments:	37
Headquarters:	United States
Web Site:	https://www.seraphgroup.net/
Year Founded:	2005
Total Fund Raised:	\$3.6M
Stages:	Early Stage Venture, Seed
Invested in:	NuMedii



Serena Capital



Summary:	Serena Capital caters to technology companies with seed, early, and later stage venture investments.
Number of Investments:	52
Headquarters:	France
Web Site:	http://www.serena.vc/
Year Founded:	2008
Total Fund Raised:	€306M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Inato

inato

ServiceNow

servicenow

Summary:	ServiceNow provides cloud-based solutions that define, structure, manage, and automate services for enterprise operations.
Number of Investments:	8
Headquarters:	United States
Web Site:	https://www.servicenow.com/
Year Founded:	2004
Total Fund Raised:	N/A
Stages:	N/A
Invested in:	ThoughtSpot



Silicon Badia



Summary:	Silicon Badia is a venture capital firm that invests in technology companies globally.
Number of Investments:	57
Headquarters:	Jordan
Web Site:	https://www.siliconbadia.com/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Transcriptic



Silicon Valley Bank



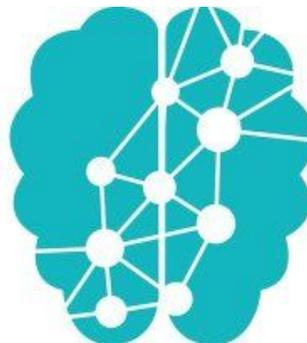
Summary:	Silicon Valley Bank works with technology, life science, cleantech, venture capital, private equity, and premium wine businesses.
Number of Investments:	513
Headquarters:	United States
Web Site:	https://www.svb.com/
Year Founded:	1983
Total Fund Raised:	N/A
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity
Invested in:	Transcriptic



Slow Ventures



Summary:	Slow Ventures invests in companies central to the technology industry and those on the edges of science, society, and culture.
Number of Investments:	366
Headquarters:	United States
Web Site:	http://www.slow.co/
Year Founded:	2009
Total Fund Raised:	\$220M
Stages:	N/A
Invested in: Verge Genomics	



Smedvig Capital



Summary:	Smedvig Capital is a growth capital firm that invests in U.K & Nordic based businesses, with a focus on those that are technology enabled.
Number of Investments:	56
Headquarters:	United Kingdom
Web Site:	http://www.smedvigcapital.com/
Year Founded:	1996
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Venture
Invested in: Antidote	



Sofinnova Partners

SOFINNOVA

Summary:	Sofinnova Partners is an independent venture capital firm based in Paris, France.
Number of Investments:	184
Headquarters:	France
Web Site:	http://www.sofinnova.fr/
Year Founded:	1972
Total Fund Raised:	\$1.9B
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Synthace

SYNTHACE 

Softbank Ventures Korea



Summary:	Softbank Ventures Korea is a Seoul-based venture capital firm that specializes in IT startup investment and corporate restructuring.
Number of Investments:	85
Headquarters:	South Korea
Web Site:	http://www.softbank.co.kr/
Year Founded:	2000
Total Fund Raised:	₩288B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: TwoXAR	



Sorrento Therapeutics



Summary:	Sorrento Therapeutics is focused on the development of proprietary drug therapeutics for addressing unmet medical needs.
Number of Investments:	3
Headquarters:	United States
Web Site:	http://sorrentotherapeutics.com/
Year Founded:	2006
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Globavir	



Summary:	SOSV is a venture capital firm that operates startup accelerators.
Number of Investments:	1154
Headquarters:	United States
Web Site:	https://sosv.com/
Year Founded:	1995
Total Fund Raised:	\$150M
Stages:	Debt, Early Stage Venture, Seed
Invested in: Mendel.ai	



Square 1 Bank

square 1 bank

Summary:	Square 1 Bank is a full-service commercial bank that provides financial services to entrepreneurs and venture capitalists.
Number of Investments:	101
Headquarters:	United States
Web Site:	https://www.square1bank.com/
Year Founded:	2005
Total Fund Raised:	N/A
Stages:	Debt, Early Stage Venture, Late Stage Venture, Post-Ipo
Invested in: Recursion Pharmaceuticals	



StartUp Health



Summary:	StartUp Health is organizing and supporting a global army of Health Transformers to improve the health & wellbeing of everyone in the world.
Number of Investments:	236
Headquarters:	United States
Web Site:	https://www.startuphealth.com/
Year Founded:	2011
Total Fund Raised:	\$7M
Stages:	Crowdfunding, Early Stage Venture, Seed
Invested in: Cyclica	



StartX



Summary:	StartX is an educational non-profit that helps Stanford's top entrepreneurs.
Number of Investments:	205
Headquarters:	United States
Web Site:	https://startx.com/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Non Equity Assistance, Seed
Invested in: TwoXAR	



Sutter Hill Ventures

SUTTER HILL
VENTURES

Summary:	Sutter Hill Ventures has financed technology-based start-ups and assisted entrepreneurs in building market-leading companies since 1962.
Number of Investments:	263
Headquarters:	United States
Web Site:	https://www.shv.com/
Year Founded:	1964
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Helix



SV Angel



Summary:	SV Angel is a San Francisco-based angel firm that helps startups with business development, financing, M&A, and other strategic advice.
Number of Investments:	829
Headquarters:	United States
Web Site:	https://svangel.com/
Year Founded:	2009
Total Fund Raised:	\$153.1M
Stages:	Crowdfunding, Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Envisagenics	



SV Tech Ventures

SVTECH
VENTURES

Summary:	SV Tech Ventures focuses primarily on companies that have successfully demonstrated their capabilities to develop advanced technologies.
Number of Investments:	19
Headquarters:	United States
Web Site:	http://www.svtechventures.us/
Year Founded:	2015
Total Fund Raised:	N/A
Stages:	Early Stage Venture
Invested in:	CloudMedX



SyndicateRoom



Summary:	SyndicateRoom connects ambitious investors with the country's most trailblazing companies.
Number of Investments:	79
Headquarters:	United Kingdom
Web Site:	https://www.syndicatoroom.com/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Desktop Genetics	



Techammer



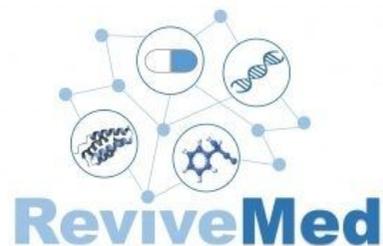
Summary:	Angel investments of Jeff Hammerbacher and Halle Tecco. Over 80 angel investments since 2008, including 13 exits.
Number of Investments:	78
Headquarters:	United States
Web Site:	http://techammer.co/
Year Founded:	2007
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Transcriptic	



TechU Angels

TECHU ANGELS

Summary:	TechU Angels is a seed investment firm founded by MIT alumni. They partner with entrepreneurs who are brave enough to challenge accepted industry norms.
Number of Investments:	9
Headquarters:	United States
Web Site:	http://techuangles.com
Year Founded:	2014
Total Fund Raised:	N/A
Stages:	N/A
Invested in: ReviveMed	



TSVC (formerly TEEC Angel Fund)



Summary:	Founded in 2010, TSVC (formerly TEEC Angel Fund) is proud to be the first deep technology-focused Chinese venture capital firm in Silicon Valley. TSVC is proud on the empathy that it brings to its strategic investments and partnerships. Part of what fulfills it about raising great companies is experiencing growing pains together and understanding the ups and downs of everyday startup life.
Number of Investments:	175
Headquarters:	United States
Web Site:	http://www.tsvcap.com/
Year Founded:	2010
Total Fund Raised:	\$30M
Stages:	Early Stage Venture, Seed
Invested in: NuMedii	



Tencent Holdings

Tencent 腾讯

Summary:	Tencent is a Chinese internet service portal offering value-added internet, mobile, telecom, and online advertising services.
Number of Investments:	299
Headquarters:	China
Web Site:	https://www.tencent.com/en-us/
Year Founded:	1998
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Atomwise	



The Thiel Foundation

THE THIEL FOUNDATION

Summary:	The Thiel Foundation supports science, technology, and long-term thinking about the future.
Number of Investments:	14
Headquarters:	United States
Web Site:	http://www.thielfoundation.org/
Year Founded:	2006
Total Fund Raised:	N/A
Stages:	Grant
Invested in: Envisagenics	



Third Kind Venture Capital



Summary:	Third Kind Venture Capital is a New York-based venture capital fund focused on early-stage investments.
Number of Investments:	58
Headquarters:	United States
Web Site:	http://www.3kvc.com/
Year Founded:	2010
Total Fund Raised:	\$44.3M
Stages:	Early Stage Venture, Seed
Invested in: Envisagenics	



Third Rock Ventures



Summary:	Third Rock Ventures invests in transformational life science companies that show high growth potential and are well-positioned to make a difference in the marketplace.
Number of Investments:	88
Headquarters:	United States
Web Site:	http://www.thirdrockventures.com/
Year Founded:	2007
Total Fund Raised:	\$1.6B
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in: Celsius Therapeutics	



TIPS



Summary:	TIPS (Accelerator Investment-Driven Tech Incubator Program for Startup) is designed to identify and nurture the most promising startups with innovative ideas and groundbreaking technologies. In order to support them when entering the global marketplace, TIPS appoints and designates successful venture founders – who are now angel investors and leaders of technological enterprises – as their incubators/accelerators.
Number of Investments:	N/A
Headquarters:	Korea
Web Site:	http://www.jointips.or.kr/about_en.php
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Standigm	

Standigm

Tribeca Venture Partners



Summary:	TVP is an early-stage venture capital firm that partners with world class entrepreneurs in the NYC area leveraging emerging technologies.
Number of Investments:	88
Headquarters:	United States
Web Site:	http://tribecavp.com/
Year Founded:	2011
Total Fund Raised:	\$171M
Stages:	Early Stage Venture, Seed
Invested in: AiCure	



True Ventures



Summary:	True Ventures is a Silicon Valley-based venture capital firm that invests in early-stage technology startups.
Number of Investments:	423
Headquarters:	United States
Web Site:	https://trueventures.com/
Year Founded:	2006
Total Fund Raised:	\$1.1B
Stages:	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Deep Genomics



Truffle Capital



Summary:	Truffle Capital is a leading independent European private equity firm originally set up for investing in technology spin-offs.
Number of Investments:	36
Headquarters:	France
Web Site:	http://truffle.com/
Year Founded:	2001
Total Fund Raised:	\$102M
Stages:	Early Stage Venture
Invested in:	Pharnext



Two Sigma Ventures



Summary:	Two Sigma Ventures invests in companies run by highly driven people with potentially world-changing ideas.
Number of Investments:	74
Headquarters:	United States
Web Site:	http://twosigmaventures.com/
Year Founded:	2012
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Verge Genomics



UK Innovation & Science Seed Fund



Summary:	UK Innovation & Science Seed Fund, an early-stage venture capital fund, offers investment.
Number of Investments:	46
Headquarters:	United Kingdom
Web Site:	https://ukinnovationscienceseedfund.co.uk/
Year Founded:	2002
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Synthace

SYNTHACE 

Uni-Innovate Group



Summary:	Uni-Innovation Group is devoted to provide complete incubation services, venture capital funds for high tech startups. In addition to this, it provides companies consultation on the Chinese market entry, and providing accurate and meticulous services for Chinese enterprises to search, purchase or merge advanced technologies overseas.
Number of Investments:	1
Headquarters:	Canada
Web Site:	http://uniinnovategroup.com/
Year Founded:	2011
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Cyclica	



Unshackled Ventures



Summary:	Unshackled Ventures is an early stage venture capital fund created in 2014 to support foreign-born entrepreneurs.
Number of Investments:	14
Headquarters:	United States
Web Site:	http://www.unshackledvc.com/
Year Founded:	2014
Total Fund Raised:	\$3.5M
Stages:	N/A
Invested in: Brite Health	



Upsher Smith Laboratories

UPSHER-SMITH

Partners in Health Since 1919

Summary:	A partner in healthcare, striving to deliver high-value, high-quality therapies and solutions that measurably improve individuals' lives.
Number of Investments:	1
Headquarters:	N/A
Web Site:	http://www.upsher-smith.com/
Year Founded:	1919
Total Fund Raised:	N/A
Stages:	N/A
Invested in: BenevolentAI	

BenevolentAI

Vanguard Atlantic



Summary:	Vanguard Atlantic Ltd. has been making private equity investments in American and European high-technology companies since 1985.
Number of Investments:	4
Headquarters:	United States
Web Site:	http://www.vanguardatlantic.com/
Year Founded:	N/A
Total Fund Raised:	N/A
Stages:	N/A
Invested in: Clinithink	

clinithink

VTF Capital



Summary:	VTF Capital is a seed-stage venture fund that finances vertical commerce and physical retail technology companies.
Number of Investments:	181
Headquarters:	United States
Web Site:	http://vtfcapital.com
Year Founded:	2012
Total Fund Raised:	\$88M
Stages:	Early Stage Venture, Seed
Invested in:	Meta



Warburg Pincus

WARBURG PINCUS

Summary:	Warburg Pincus LLC is a global private equity firm focused on growth investing.
Number of Investments:	250
Headquarters:	United States
Web Site:	http://www.warburgpincus.com/
Year Founded:	1966
Total Fund Raised:	\$74.6B
Stages:	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Invested in:	Helix



Westcott LLC



Summary:	Westcott LLC is the family office of Carl Westcott and it invests in technology start ups and real estate.
Number of Investments:	16
Headquarters:	United States
Web Site:	http://www.westcott.com/
Year Founded:	1966
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Seed
Invested in:	Meta



White Cloud Capital

WHITE
CLOUD

Summary:	White Cloud Capital offers strategic growth and venture capital for seed and early stage business ventures.
Number of Investments:	8
Headquarters:	United Kingdom
Web Site:	http://www.whcloud.com/
Year Founded:	2007
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Private Equity
Invested in: Sparrho	



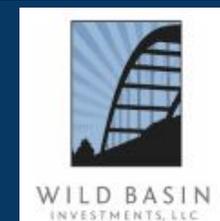
WI Harper Group



Summary:	WI Harper Group is a venture capital firm that focuses on early and expansion investments in Mainland China, Taiwan and Silicon Valley.
Number of Investments:	135
Headquarters:	United States
Web Site:	https://wiharper.com/
Year Founded:	1993
Total Fund Raised:	\$597.3M
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in: Engine Biosciences	



Wild Basin Investments



Summary:	Wild Basin Investments, LLC is a closely held investment firm located in Austin, Texas with a strong portfolio emphasis in early stage
Number of Investments:	16
Headquarters:	United States
Web Site:	https://wildbasininv.com/
Year Founded:	2007
Total Fund Raised:	N/A
Stages:	Late Stage Venture
Invested in: Recursion Pharmaceuticals	



Woodford Investment Management

woodford

Summary:	Woodford Investment Management's business is grounded in the belief that core principles are essential to how it manages money and behaves as a business.
Number of Investments:	55
Headquarters:	United Kingdom
Web Site:	https://woodfordfunds.com/
Year Founded:	N/A
Total Fund Raised:	\$1.2B
Stages:	Early Stage Venture, Private Equity
Invested in: BenevolentAI	

BenevolentAI

WorldQuant Ventures LLC



Summary: WorldQuant Ventures LLC is a leading early stage investment firm.

Number of Investments: 24

Headquarters: United States

Web Site: <http://worldquantventures.com/>

Year Founded: 2014

Total Fund Raised: N/A

Stages: N/A

Invested in: ReviveMed

ReviveMed

Wren Capital



Summary:	Wren Capital LLP is a new seed capital investment fund based in London, UK.
Number of Investments:	15
Headquarters:	United Kingdom
Web Site:	https://www.wrencapital.co.uk/
Year Founded:	2010
Total Fund Raised:	N/A
Stages:	Early Stage Venture, Late Stage Venture, Seed
Invested in:	Cytox



WuXi AppTec



Summary:	WuXi AppTec is a global pharmaceutical, biopharmaceutical, and medical device outsourcing company.
Number of Investments:	17
Headquarters:	China
Web Site:	https://www.wuxiapptec.com.cn/
Year Founded:	2000
Total Fund Raised:	\$250M
Stages:	N/A
Invested in: Engine Biosciences, InSilico Medicine	



Y Combinator



Summary:	Y Combinator is a startup accelerator based in Mountain View, California.
Number of Investments:	1833
Headquarters:	United States
Web Site:	http://www.ycombinator.com/
Year Founded:	2005
Total Fund Raised:	\$700M
Stages:	Debt, Early Stage Venture, Seed
Invested in:	Atomwise



Zappos



Summary: Zappos is an online retailer specializing in shoes and apparel.

Number of Investments: 1

Headquarters: United States

Web Site: <https://www.zappos.com/>

Year Founded: 1999

Total Fund Raised: N/A

Stages: N/A

Invested in: Meta



ZhenFund

ZhenFund
真格基金

Summary:	ZhenFund invests in TMT, Healthcare, and Education among other sectors.
Number of Investments:	238
Headquarters:	China
Web Site:	http://www.zhenfund.com/
Year Founded:	2011
Total Fund Raised:	\$300M
Stages:	Early Stage Venture, Seed
Invested in:	Transcriptic

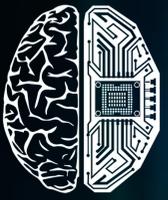


Zillionize Angel



Summary:	Zillionize invests in fast growing startups with huge potential ahead.
Number of Investments:	127
Headquarters:	United States
Web Site:	http://www.zillionize.com/
Year Founded:	2011
Total Fund Raised:	N/A
Stages:	Seed
Invested in: Meta	





DEEP
KNOWLEDGE
ANALYTICS



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