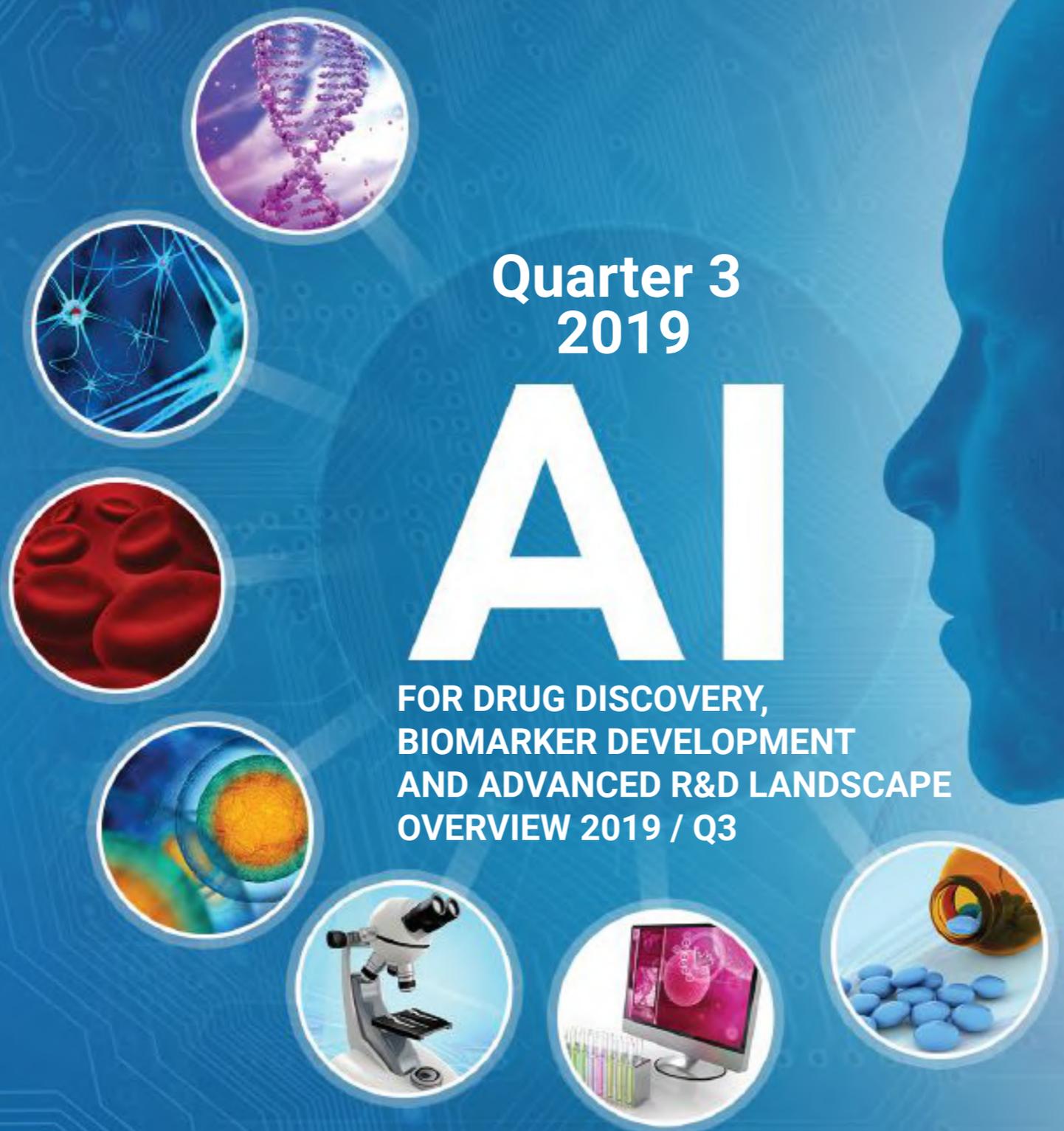


Companies - 200  
Corporations - 70  
R&D Centers - 35  
Investors - 460

Quarter 3  
2019

# AI

FOR DRUG DISCOVERY,  
BIOMARKER DEVELOPMENT  
AND ADVANCED R&D LANDSCAPE  
OVERVIEW 2019 / Q3



[www.ai-pharma.dka.global](http://www.ai-pharma.dka.global)

# Table of Contents

<b>AI for Drug Discovery Infographic Summary and Mind Maps</b>	3
<b>Executive Summary</b>	20
<b>Landscape of AI for Drug Discovery and Advanced R&amp;D Q3 2019</b>	28
30 Leading Companies in AI for Drug Discovery Sector	30
30 Leading Investors in AI for Drug Discovery Sector	31
List of 200 AI-companies	32
List of 460 Investors	35
List of 70 BioPharma, Chemical and Tech Corporations	41
List of 35 Leading R&D centers	48
Regional Comparison: USA, UK, Europe and Asia-Pacific	50
15 Most Innovative R&D Approaches of AI in Biopharma	52
<b>Pharma AI Deals</b>	85
<b>Declining R&amp;D Efficiency of Biopharma Corporations</b>	92
<b>“AI-Friendly” CEOs and Board Members of Pharma and Tech Corporations</b>	102
<b>Top-35 AI for Drug Discovery Conferences 2019-2020</b>	110
<b>Industry Developments 2019 / Q3</b>	118
<b>Appendix</b>	
Overview of Proprietary Analytics by Pharma Division of Deep Knowledge Analytics	130
<b>Enhanced Analysis of 30 Leading AI Companies</b>	139
<b>Disclaimer</b>	145

**AI for Drug Discovery,  
Biomarker Development  
and Advanced R&D  
Landscape / 2019 Q3**

**AI Companies - 200  
Investors - 460  
Corporations - 70**



AI for Drug Discovery,  
Biomarker Development  
and Advanced R&D  
Landscape / 2019 Q3

AI Companies - 200  
Investors - 460  
Corporations - 70

Regional Position

Investors  
AI Companies  
Corporations



Canada

Other Regions

China

Asia

EU

UK

# Diversification of AI for R&D and Drug Discovery Process 2019 Q3

## Companies

### Design Preclinical Experiments

### Preclinical Experiment Execution

### Data Aggregation & Analysis

### Drug Design

### Clinical Trial Design, Optimization, Recruitment

### Repurposing Existing Drugs

### Researching Mechanisms of Disease

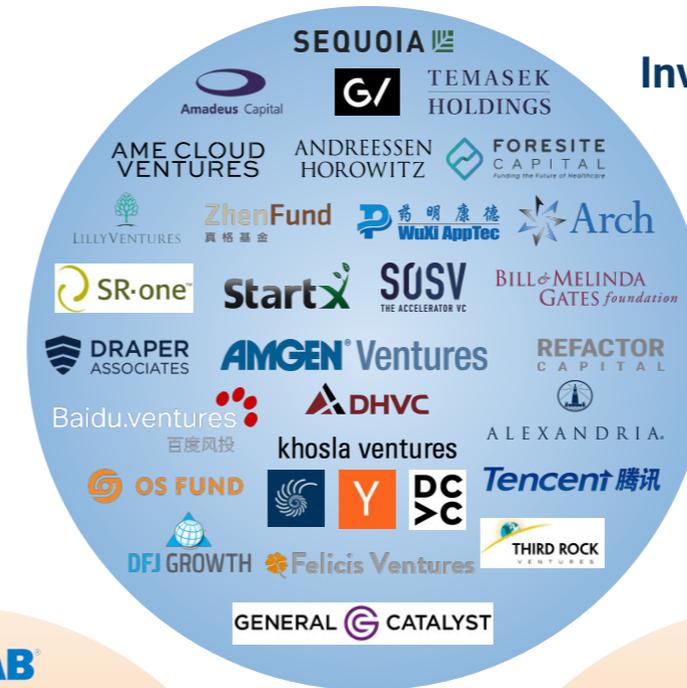


# Leading Companies - Advanced AI in Healthcare and Drug Discovery 2019 / Q3

## AI-Companies



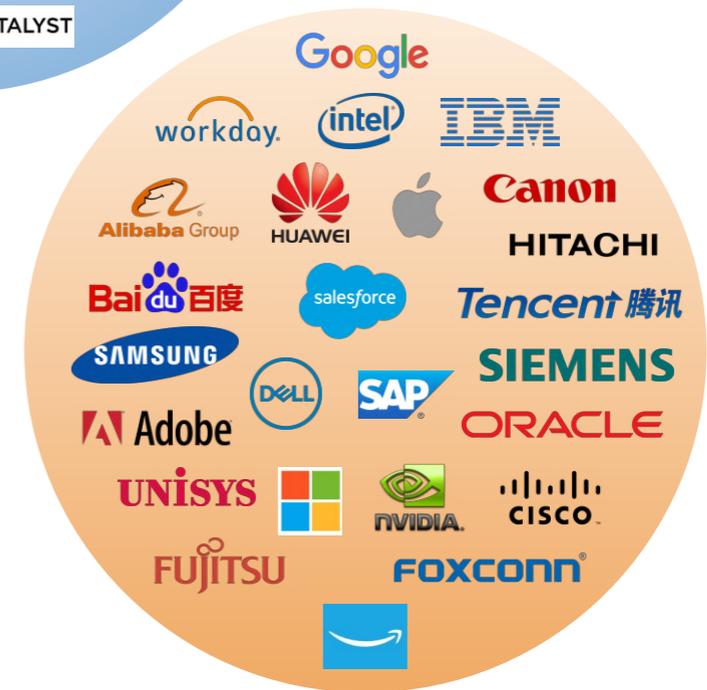
## Investors



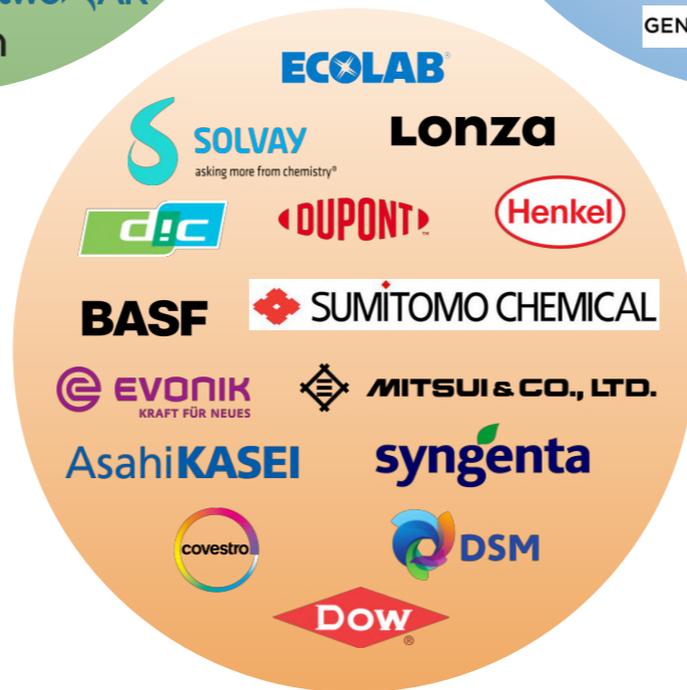
## Pharma Corporations



## Tech Corporations



## Chemical Corporations



# Pharma AI Deals Structure 2019 / 30 Pharma Corporations

AI Companies				Pharma Corporations	Pharma Corporations	AI Companies				

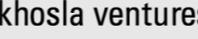
# Tech AI Deals Structure 2019

AI Companies	Tech Corporations	Tech Corporations	AI Companies
Atomwise Better medicines faster. XtalPi	Tencent 腾讯	Adobe	Atomwise Better medicines faster.
XtalPi	Alibaba Group	salesforce	color
XtalPi	amazon	DELL	virtustream
Atomwise Better medicines faster.	Baidu 百度	Apple	SCHRÖDINGER
IBM Watson™	IBM	intel	OKYNDI
XtalPi	Google	Microsoft	NOVARTIS
Insilico Medicine 英科智能	NVIDIA	FUJITSU	
	FOXCONN®	UNISYS	
	ORACLE®	SIEMENS	
	CISCO	SAMSUNG	
	anion	SAP	
	HUAWEI	workday.	
	HITACHI		

# Chemical AI Deals Structure 2019

AI Companies	Chemical Corporations	Chemical Corporations	AI Companies
NURITAS Life-changing Discoveries	BASF	Henkel	
	AsahiKASEI	YAVJOS *systeme mit einem geis	
	difc	ECOLAB®	
	syngenta	DSM	
	Lonza	MITSUBI & CO., LTD.	
	covestro	EVONIK KRAFT FÜR NEUES	
	DU PONT	Sumitomo	
	DOW		

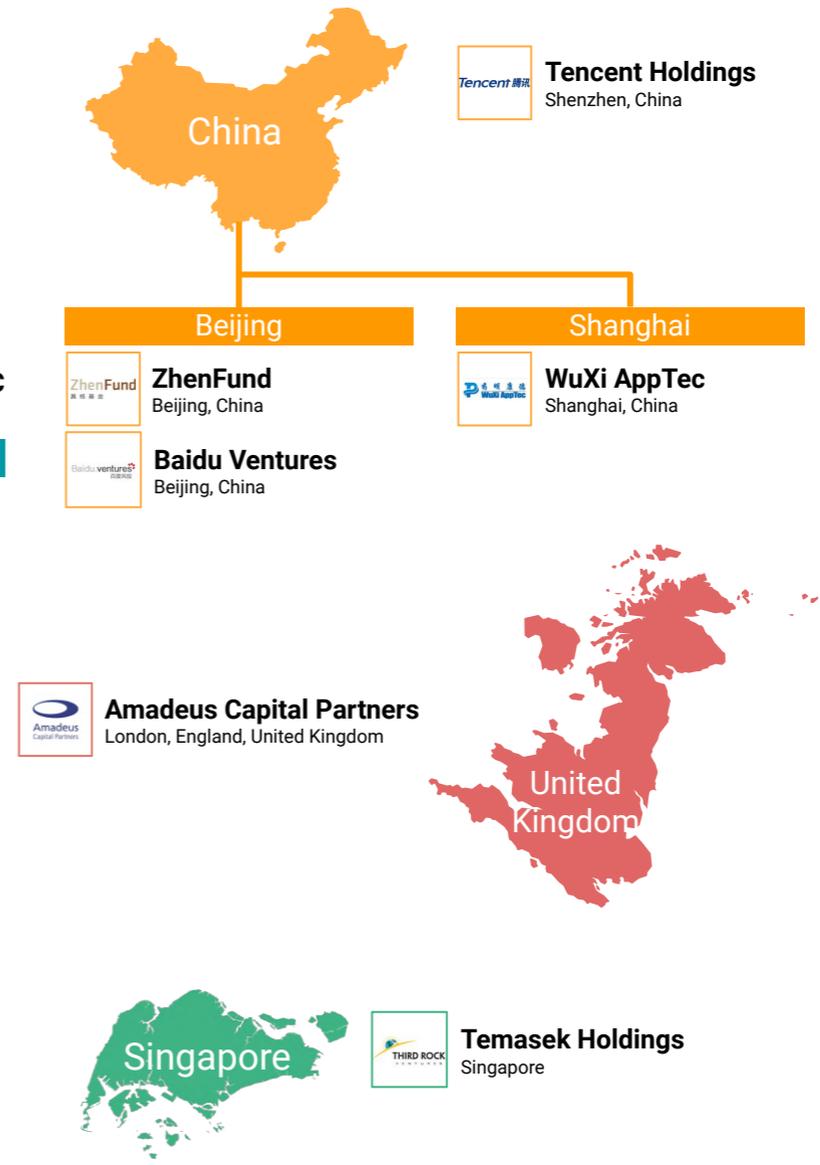
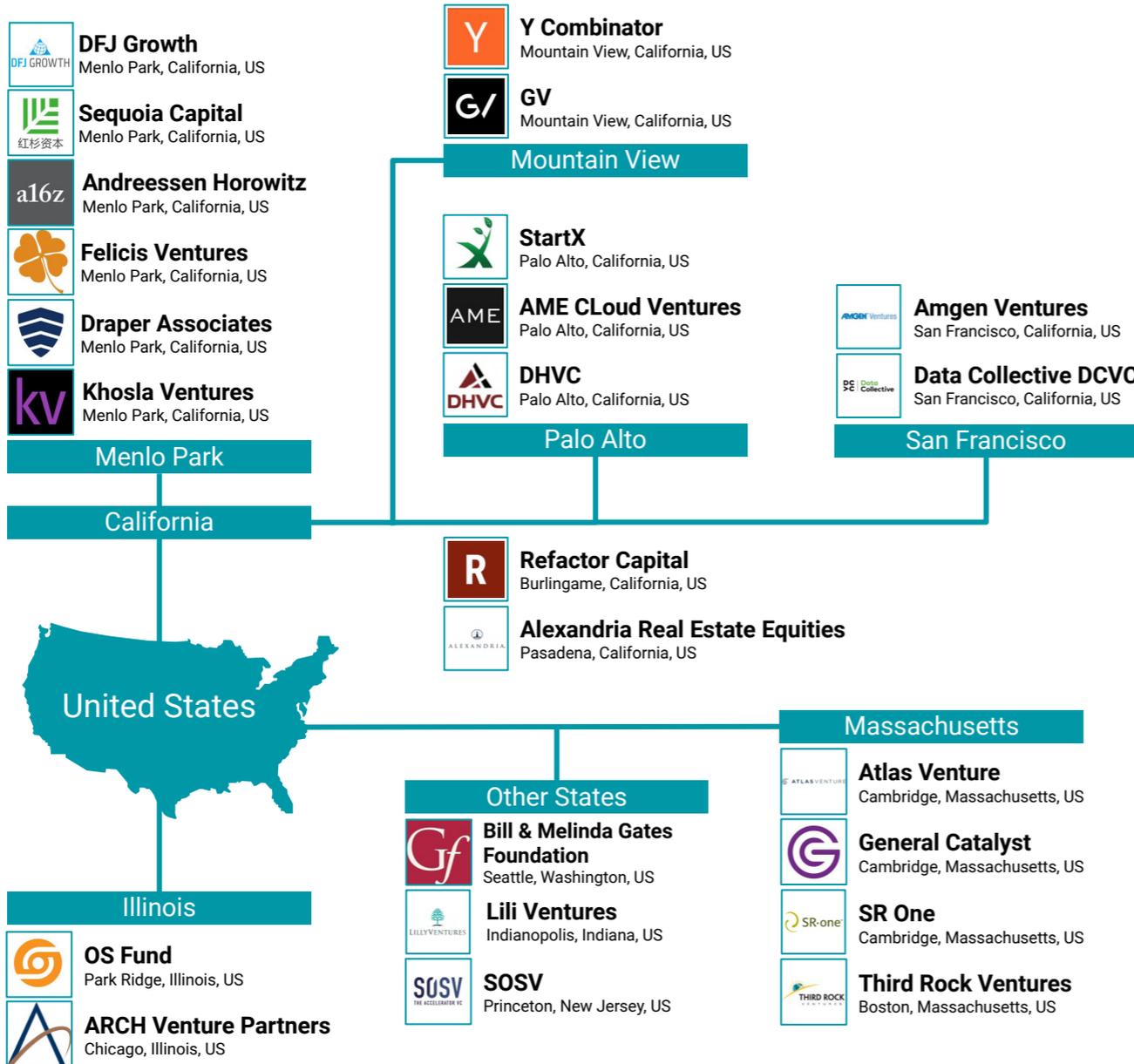
# Top-30 Investors in AI Companies

Top AI Companies		Investments overall	INVESTORS		Investments overall	Top AI Companies		
	 Atomwise	9	 Y Y combinator	 SEQUOIA Sequoia Capital	9	 XtalPi	 WuXiNextCODE	
 NIMBUS THERAPEUTICS	 Numerate	9	 ATLAS VENTURE Atlas Venture	 OS Fund	8	 Atomwise	 twoAR	
SCHRÖDINGER.	 Insitro	8	 GV GV	 DCVC Data Collective DCVC	8	 Atomwise	 RECURSION pharmaceuticals	
 Atomwise	 RECURSION pharmaceuticals	8	 AME AME Cloud Ventures	 SOSV THE ACCELERATOR VC SOSV	8			
	 XtalPi	7	 ZhenFund 真格基金 Zend Fund	 BILL & MELINDA GATES foundation Bill & Melinda Gates Foundation	7	 RECURSION pharmaceuticals	SCHRÖDINGER.	 NIMBUS THERAPEUTICS
		6	 Amadeus Capital Partners Amadeus Capital Partners	 khosla ventures Khosla Ventures	6	 deep genomics	 Atomwise	
SCHRÖDINGER.	 Insilico Medicine 英科智能	6	 药明康德 WuXi AppTec WuXi AppTec	 ANDREESSEN HOROWITZ Andreessen Horowitz	6	 Insitro	 twoAR	
	 NIMBUS THERAPEUTICS	6	 SR·one™ SR One	 StartX StartX	6	 twoAR		

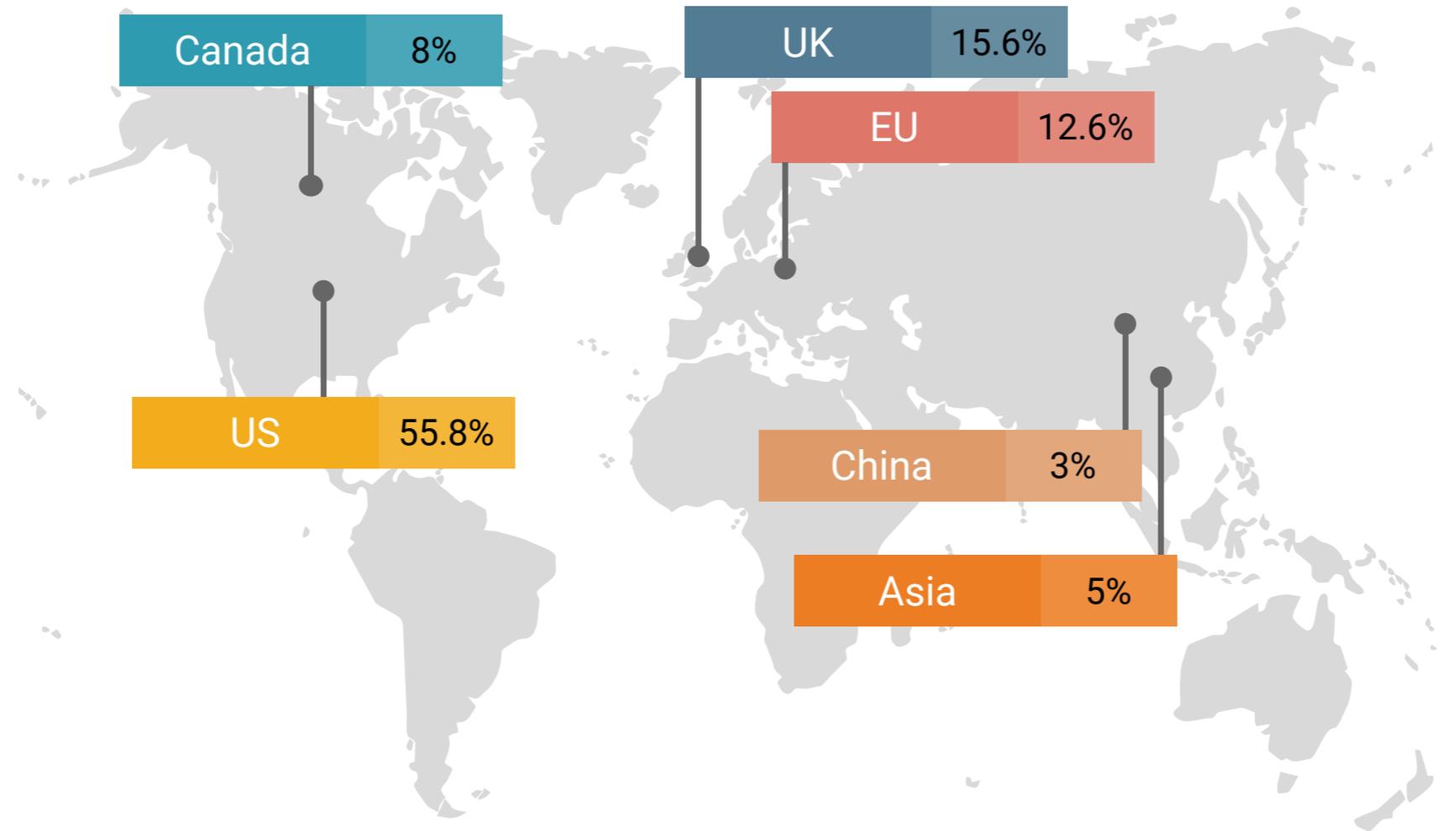
# Top-30 Investors in AI Companies

Top AI Companies		Investments overall	INVESTORS		Investments overall	Top AI Companies	
		4	 Felicis Ventures	 Draper Associates	4		
		4	 General Catalyst	 Amgen Ventures	4	 GNS HEALTHCARE	
		4	 Refactor Capital	 Alexandria Real Estate Equities	4	 GNS HEALTHCARE	
		4	 Lilly Ventures	 Tencent Holdings	4		 
		3	 ARCH Venture Partners	 Temasek Holdings	4		
		3	 DFJ Growth	 DHVC	3		
		3	 Third Rock Ventures	 Baidu Ventures	2		

# Top-30 AI for Drug Discovery Investors

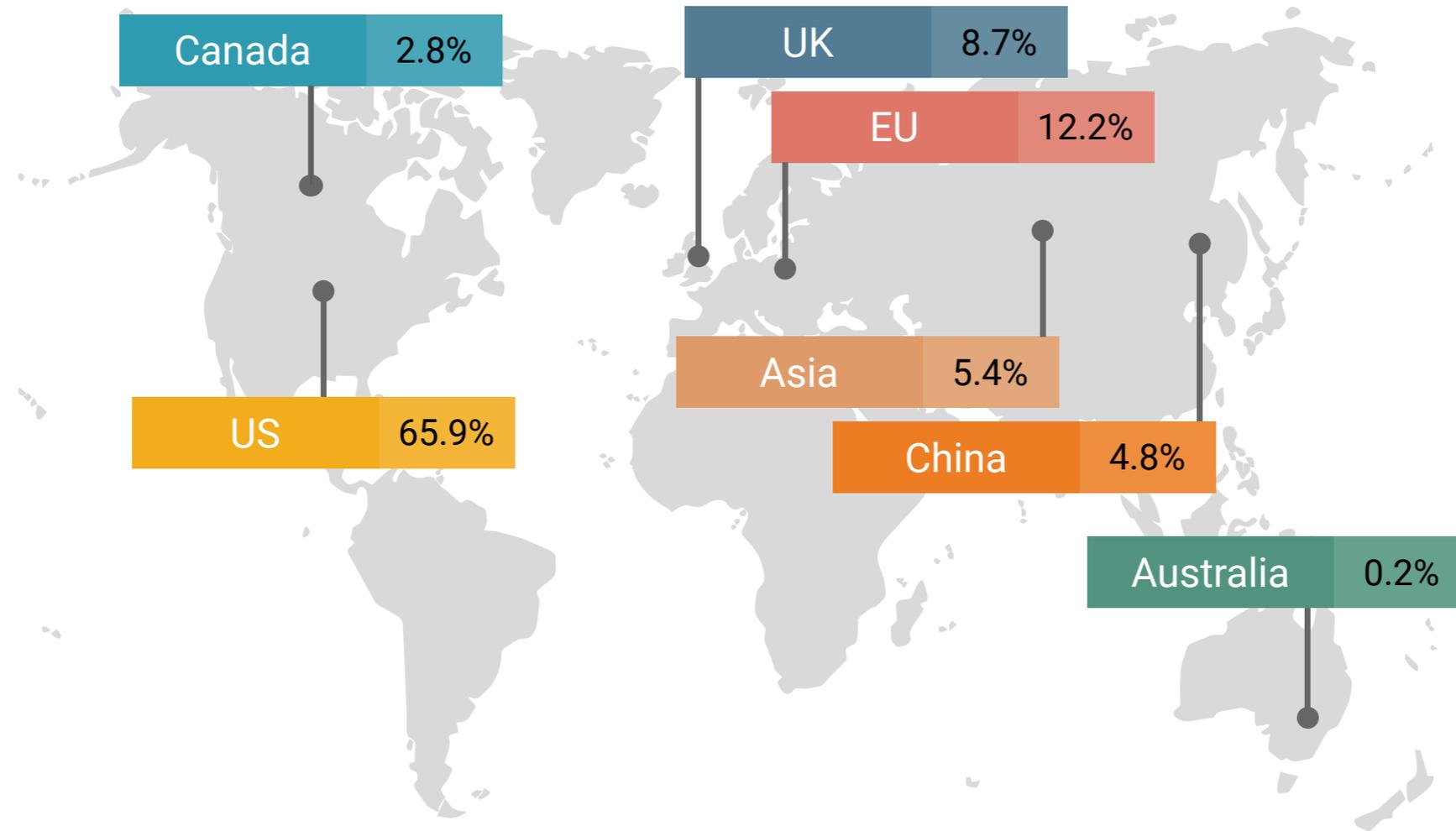


## 200 AI Companies: Regional Proportion



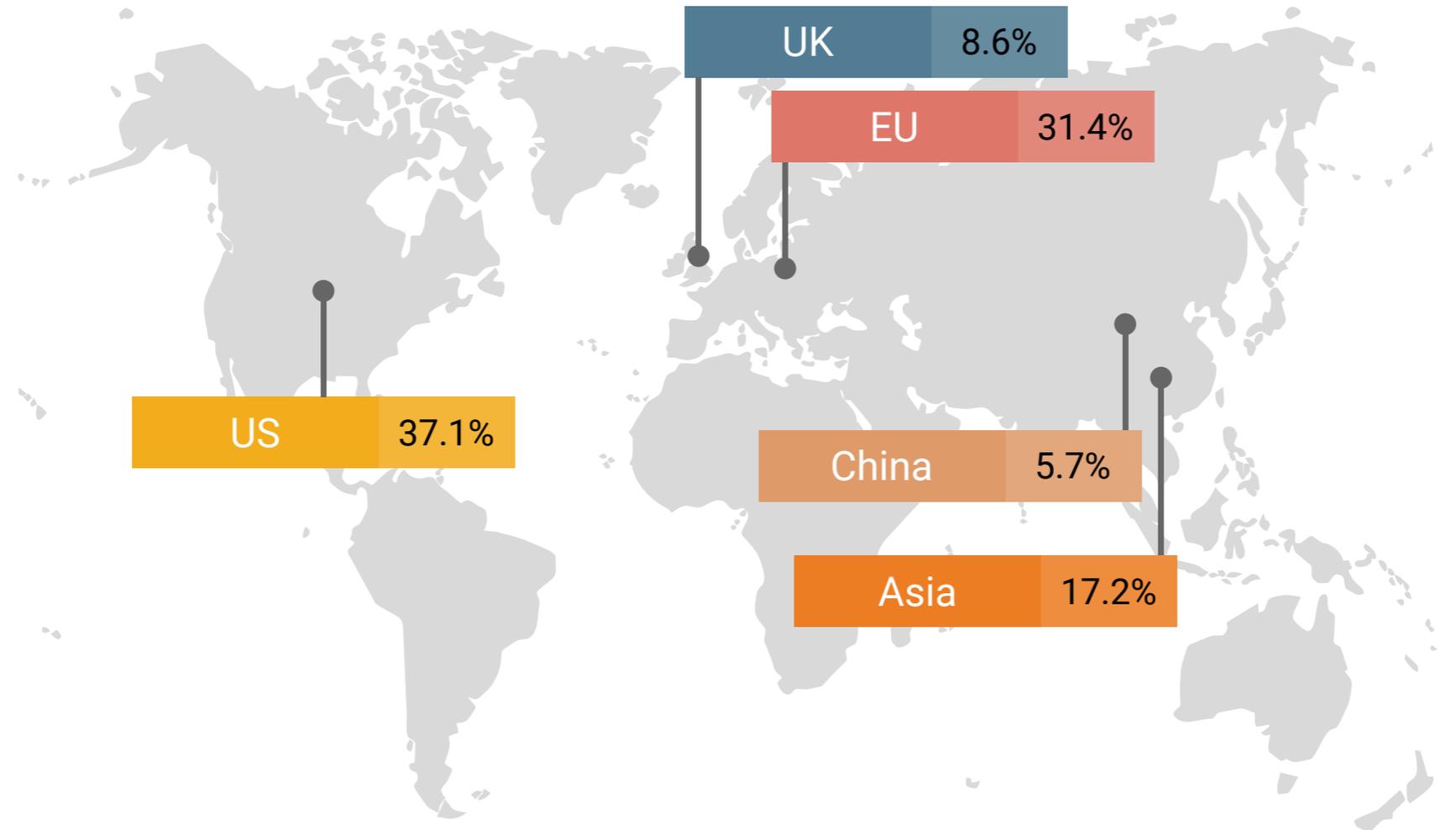
The US is still firmly in the lead in terms of its proportion of AI for Drug Discovery companies. Interestingly, Asia currently has the fifth-lowest proportion of AI for Drug Discovery companies. However, Asia-Pacific region has begun to aggressively increase its activity in the space in terms of investments into foreign companies (largely US-based companies), and we 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. Comparing to the Q1 distribution, we can observe the significant increase in the number of the US companies.

## 460 Investors: Regional Proportion



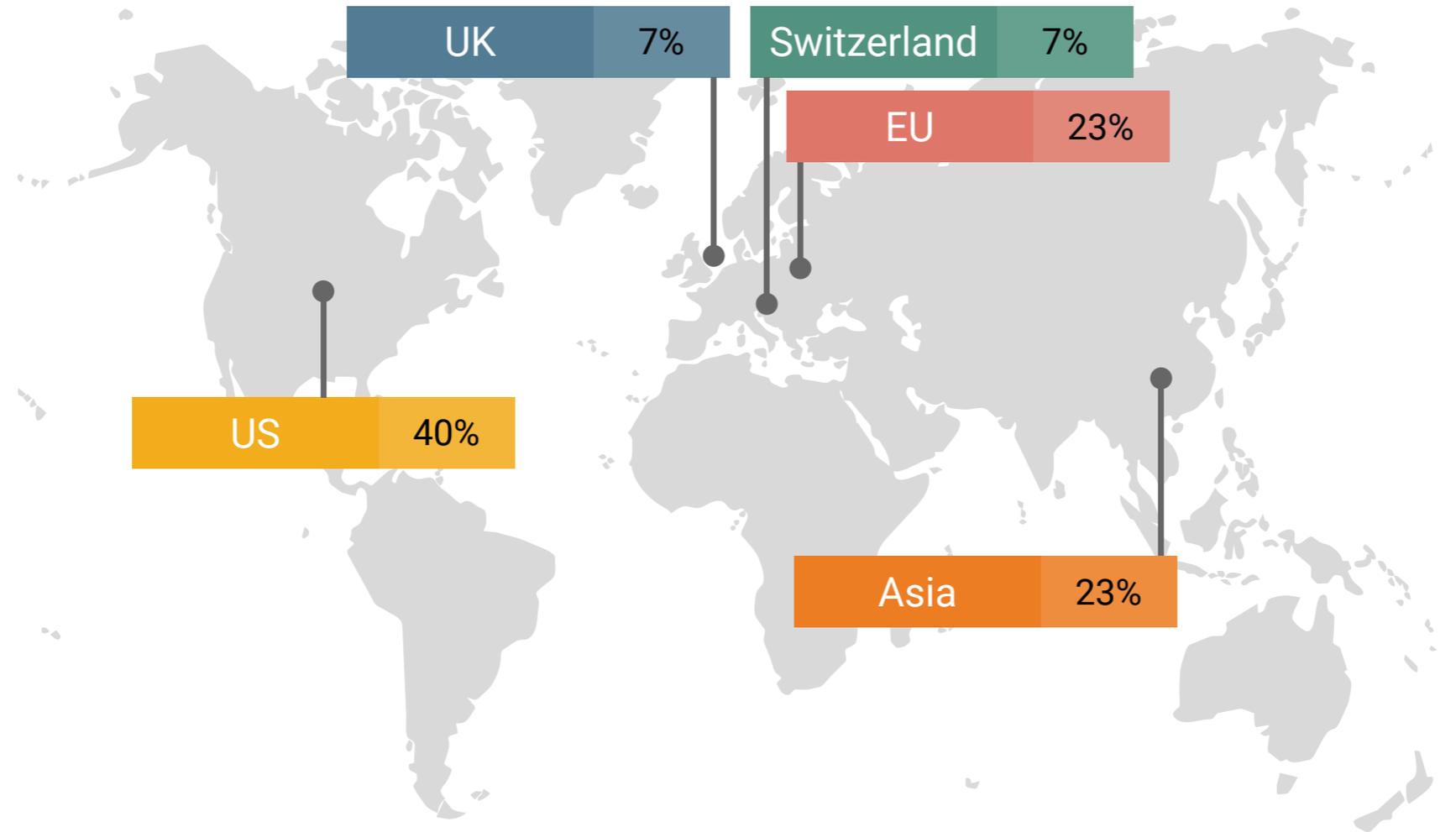
The United States continues to lead the rest of the world in terms of artificial intelligence for companies and funds that invest in Drug Discovery. This is reasonable, given that more than a half of the world's AI for Drug Discovery companies have their headquarters in USA. Comparing with previous periods of 2019, we can observe significant growth of the number of investors in the USA and EU. Thus, together with UK these regions are leaders by the number of investors in AI in Drug Discovery companies. A total number of investors in the world that give money to the development of the above mentioned industry has increased in Q3 by 15% comparing with Q2 2019.

## 35 Leading R&D Centers: Regional Proportion



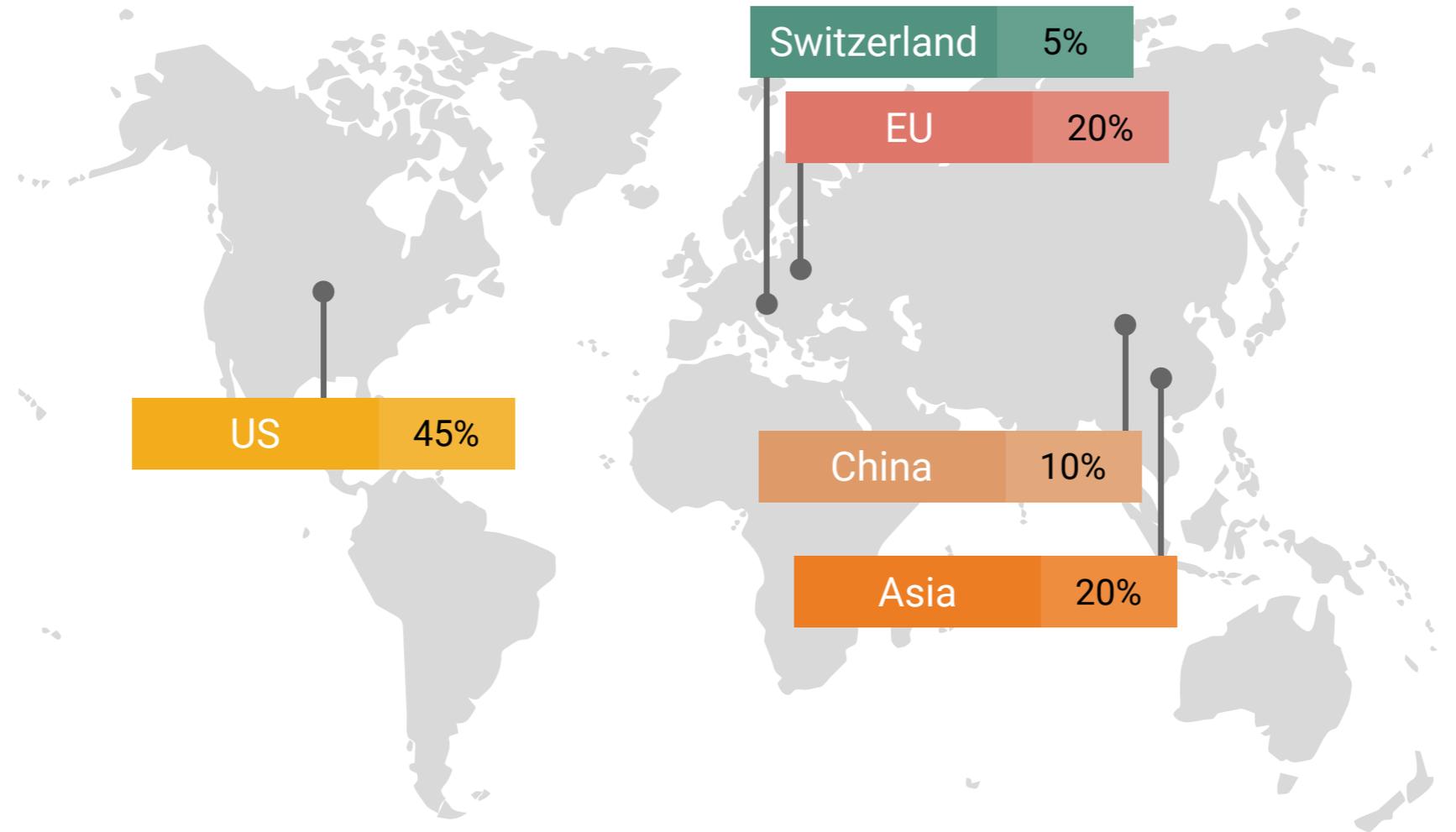
Following the trend from our previous reports the map indicates that the US leads the world in terms of the number of R&D Centers focused on AI for Drug Discovery. This is sensible within the context of the recent increase in the number of investors that invest in AI for Drug Discovery space within the territory of United States. The same trend can be observed in European Union as it demonstrates second biggest figure of investors' part in the world that results in second biggest share of Leading R&D Centers.

## 30 Pharma Corporations Applying Advanced AI in Healthcare and Drug Discovery



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 the number of AI companies, the volume of investments and number of industry specialized conferences, in 2019 we are seeing an increased level of activity from the UK, Switzerland and China.

## 40 Leading Tech and Chemical Corporations: Regional Proportion

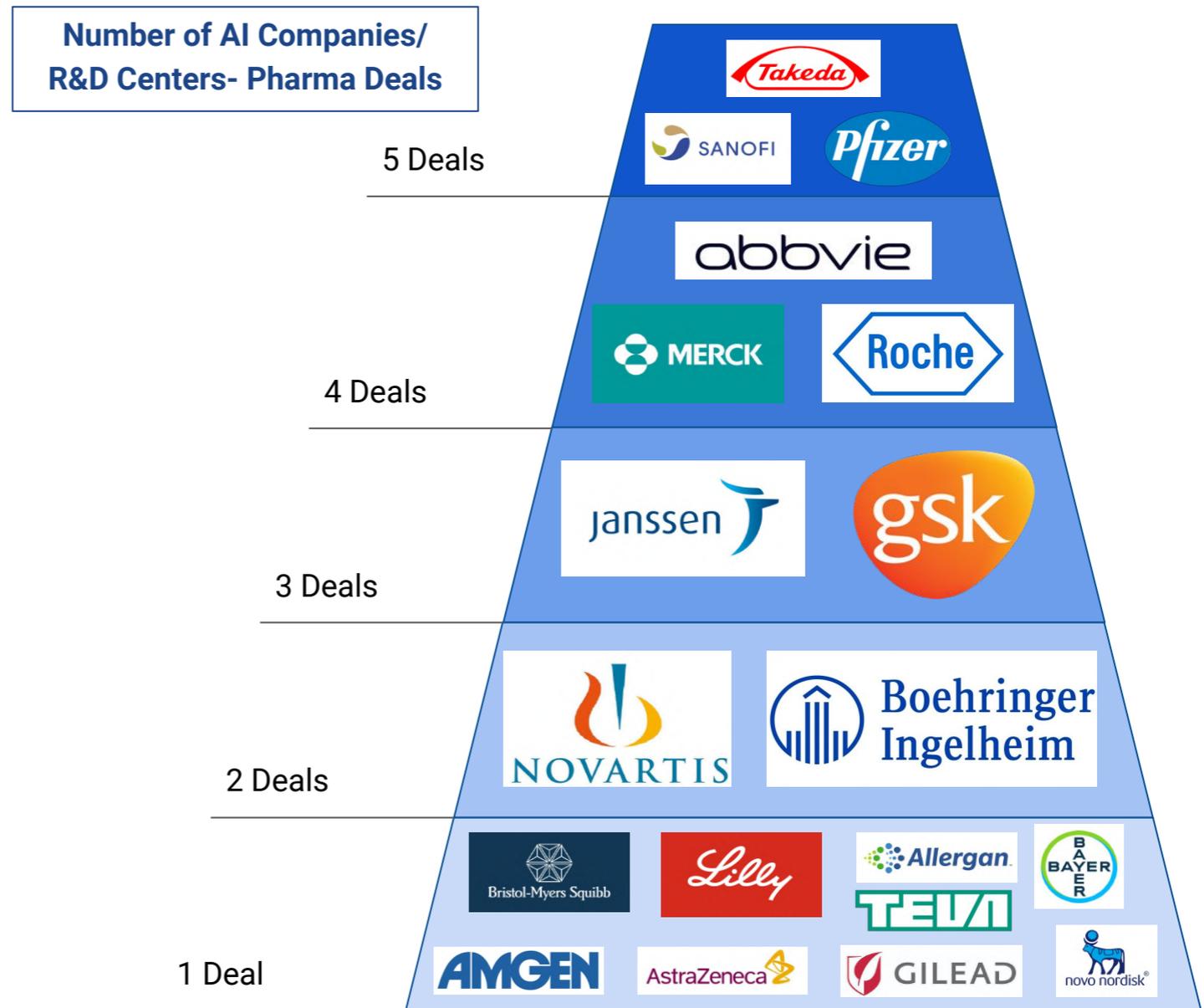


The US is the leader according to the number of tech corporations applying advanced AI in healthcare and drug discovery. EU leads the world in terms of the number of Chemical Corporations. The second biggest figure can be observed in Asia while the US is in the third place. This is sensible within the context of the recent increase in the chemical industry in EU that overweight the US and Asian markets of chemical substances and related products. A lot of these chemical corporations are participating in cooperations and partnerships that are aimed at drug discovery and are related to pharmaceutical issues.

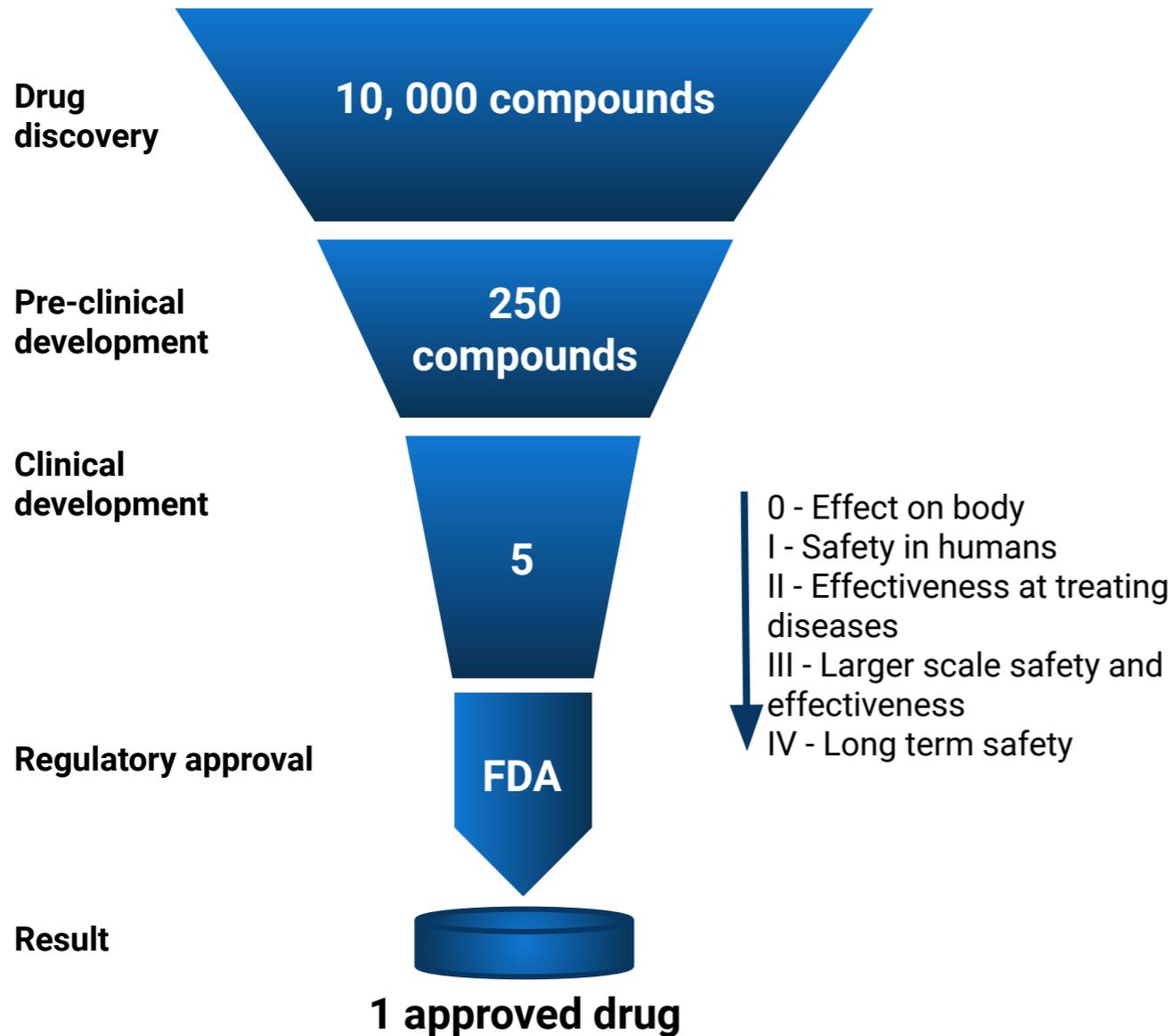
# Executive Summary

# Cooperation Between Different AI-Related Pharma Fields

Till the second half of 2019 number of international AI companies has increased to almost 200 worldwide. The same rapid growth trend can be observed among influencers, investors, R&D centers, outsourcing groups and private researchers who work on AI using in Pharmaceuticals. The most popular investigations' directions of AI drug discovery startups are first screening, leading molecule identification, preclinical testing, drug candidate selection, target identification, target validation. Biopharma related companies constantly try to apply developed AI algorithms to multiple drug research and discovery areas at once. Main focus of AI research for today is concentrated on small molecules' libraries.



# Pharma Efficiency is Declining Steadily



**> 10 years**  
**>\$2.6 bln**  
**1 new drug**

It takes on average over 10 years to bring a new drug to market. As of 2014, according to Tufts Center for the Study of Drug Development (CSDD), the cost of developing a new prescription drug that gains market approval is approximately \$2.6 billion. This is 145% increase, correcting for inflation, comparing to the same report made in 2003.

The pharmaceutical industry is in a terminal decline, with return on investment (ROI) projected to hit zero by 2020. The returns on new drugs that do get to market do not justify the massive investments that Pharma currently puts into R&D anymore.

Source

[Endpoints News](#)

[ePharmacology](#)

# 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

## 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

## Design and Processing of 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

## Repurposing of 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

## Aggregation and Synthesis of Information

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

# Executive Summary

This 145-page “AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview 2019 / Q3” report marks the **eighth installment** in a series of reports on the topic of the Artificial Intelligence using in Drug Discovery industry, that Deep Knowledge Analytics have been producing since 2017.

These reports are released regularly on quarterly basis. The main aim of their creation is to provide a wide, comprehensive overview of the industry landscape. This overview highlights trends and correlations in a form of informative mind maps and infographics as well as benchmarks the performance of key players, that form space and relations within the industry. This is an overview analysis to help the reader understand what is happening in the industry nowadays and possibly give an idea of what is waiting for it in the nearest future.

The present edition consists of an updated overview of the industry state in Q3 of 2019, tuned to the latter half of 2019 and including extended coverage of major events in Q3 of 2019. It revisits the major insights, data analytics and forecasts of our previous report, analyzing existing trends and conclusions that are still on track, which ones have changed their course, and which ones have been usurped by entirely new realities of our changing world.

The report is structured into the following sections:

1. [Infographic Summary](#) - provides a set of mind maps and diagrams visualizing key trends and analytics.
2. [Executive Summary](#) - presents a bird’s view of the report, key observations and conclusions.
3. [AI for Drug Discovery Landscape Overview](#) aggregates, lists and categorizes 200 AI-companies, 460 investors, 25 biopharma corporations, 25 IT & Tech corporations, 35 industry-specific conferences and 35 R&D centers covering the AI for Drug Discovery topic.
4. [Industry Developments - Q3 2019](#) outlines an overview of major industry developments in Q3 of 2019, including some of the key initiatives, investment deals and M&A activity.
5. [Declining R&D Efficiency of Biopharma Corporations](#)
6. [AI Friendly CEOs and Board Members of Pharma and Tech Corporations](#)
7. [Pharma AI Deals](#)
8. [Top-35 AI for Drug Discovery Conferences 2019-2020](#)
9. [Appendixes](#)

[Overview of Proprietary Analytics by Pharma Division of Deep Knowledge Analytics](#)

[Overview of the “Comparative Industry Analysis and Classification Framework” and “Comparison of 25 Leading AI Companies” reports.](#)

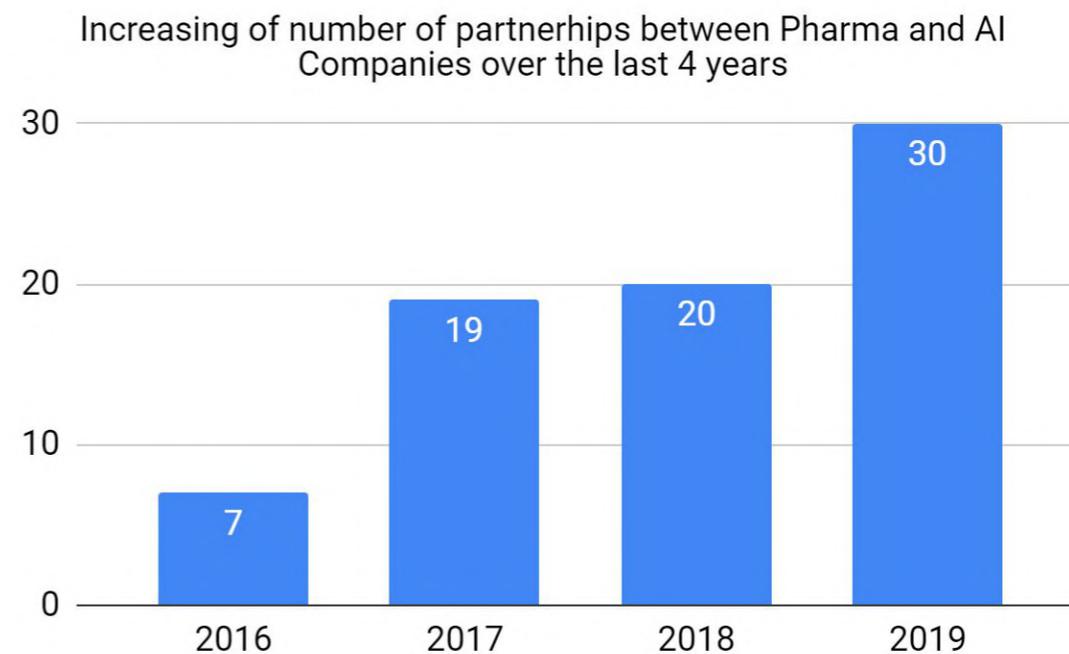
## Executive Summary: Key Trends

Expanding upon the key observations in our previous reports with new knowledge and analytics of Q2 2019, we can now better distinguish main trends within the industry in Q3 that will be shaping the market of AI in Drug Discovery in 2019 and beyond.

Following a long lasting period of skepticism in 2018 and previous years **the industry continues the “heating up” trend** observed in Q2 also in Q3. This trend mainly consists of substantial increase in the volume of investments, financial support and the number of joint ventures in Q3 of 2019. The industry’s growth dynamics is mainly influenced by the more active participation of largest pharmaceutical corporations in the AI-related investment and research collaborations. The number of research collaborations between pharma companies and AI-expertise vendors continues to increase rapidly.

Despite the fact that **IT and Tech corporations are still becoming stronger competitors to Pharma Corporations in the AI race**, they more readily agree to make co-operations and other forms of partnership in order to leverage their computational infrastructures and high-tech opportunities with enormous experience of BioPharmaceutical companies, their gigantic collections of various data and novel approaches. AI here helps to discover new drugs, molecules, repurpose already existing drugs, find new targets that influence the illness ongoing etc. Most interest of such AI Companies lies in shortening of time needed to get income from newly discovered drug, ability to co-own important scientific discoveries and intellectual property obtained from the partnership and ability to continue developing of new algorithms that will help these companies to leave their mark on medical history.

As 2019 marks a challenge in the ability to innovate, transform and adopt AI at scale faster, the so-called “Big Gap” continues narrowing due to rapidly increasing attention and activity of pharmaceutical companies with regards to AI prospects. Even tech giants like Google and Tencent are willing to expand their super-platforms to the area of pharmaceutical research. Having much bigger expertise of building and integrating super-platforms, currently they are conducting significant M&As and gaining some expertise in the area of the drug discovery, which would enable in the nearest future their expansion in this area. At the same time, the number of the deals between BioPharma corporations and AI companies aiming at the application of AI in drug discovery increased comparing with the same period in 2018.



# Executive Summary: Key Trends

**Global shortage of AI talent** continues to be a serious challenge for Biopharma industry, repeating the trend from our previous reports. However it should be noted that there is an increase in number of training courses and overall representing of AI-related directions in education programmes worldwide. Big pharmaceutical companies invest huge amounts of money in preparing of such specialists. But still the majority of talented AI professionals have been acquired by traditional IT-corporations and have been applied for purposes other than AI in healthcare. Therefore a lack of experienced specialists to support the activities of AI for Drug Discovery companies in particular is still a matter of today's reality. Consequently large pharmaceutical companies continuously increase competing for the talented AI specialists as a valuable resource. Even specialized AI-driven drug discovery companies cannot fulfill gaps of AI talents as only 15.6% of their staff being AI-experts.

**Technologies, based on Deep learning (DL) algorithms will hold their leading position in the pharmaceutical AI race.** Generative Adversarial Networks (GANs) and their variants are being increasingly regarded as a "golden standard" of innovation in the pharmaceutical AI space.

**Lack of available quality data is still a challenge for Investigations in AI and cooperating between AI and non-AI companies.** The significant bottleneck in the AI applications for drug discovery purposes is the need to have correctly prepared, systematized and properly linked data that is ready to processing or is at least easy to manipulate with. Such types of data are quite scarce for the life sciences industry. A lot of research data in drug discovery is poorly validated and provided under a strict code of secrecy due to the high level of competition between drug makers. This is an issue unless there exists a well trained AI that is able to operate with unsorted collected information. This means that as AI technologies evolve the weight of problems with unsorted information will decrease.

**Valuation of the industry is thought to show substantial growth**, that, however, can be delayed in time. This appears to be a result of the general growth in the number of active business players, rather than an increase in the new products' value.. No AI-derived drug has been approved by the FDA or validated in clinical trials so far. Despite this fact first milestones are expected to be reached by the end of 2020. On the other hand, the anticipated global financial crisis may hinder the industry's growth dynamics, delay the AI adoption at scale, as well as the emergence of the first AI-derived blockbuster drugs.

**AI-friendly decision makers in pharmaceutical companies will become a great advantage in the competition for faster and cheaper development of new drugs.** According to a [recently conducted research](#), US, Japan and Germany are the countries with the biggest concentration of AI-friendly decision makers. About 46% of them work in pharmaceutical industry, while only 3% are dealing with both AI and Pharma. In such more efficient application of AI technologies are expected to be observed and it will bring faster and more noticeable results.

# Executive Summary: Geography

**AI builds up a new era of Pharma Industry.** Nowadays it is hard to single out particular region which dominates the field of AI in Pharma, because more and more countries take part in the global pharmaceutical AI race. In the beginning of AI implementation US was a pioneer and then the main player with the greatest number of companies using AI to force R&D, research centres and institutes, and investments. Nevertheless we observe the increased level of the UK and EU activity through big corporations that use AI to reorganise drug discovery and in launching government initiatives. It is important to note about great increase in activity from the Asia-Pacific region generally, and particular from China - AI superpower.

China has at least ten privately owned AI startups valued at more than US\$1 billion. The number of investments made by this country is significant, for instance, Chinese state has promised to invest \$5 billion in AI, Tianjin, one of the biggest municipalities, is going to invest \$16 billion in its local AI industry and the Beijing authorities will build \$2.12 billion AI development project. Moreover, the start of AI investments in 2019 was impressive as Chinese investors in the biotech and drug industry landscape have raised to \$1.4 billion of investments into US-based biotech and drug firms compared to just \$125.5 million during the same period the previous year.

The Chinese government has a big interest in building up their AI industry worth almost \$150 billion. According to the AI Strategic Plan released in July 2017, it was announced that there is a plan to make China and its industries world AI leaders by 2030. The analysis of the the Asia-Pacific region has shown that main forcers of AI implementation include Saama Technologies, Inc., a leading clinical data analytics company, announced a collaboration with researchers at the Tufts Center for the Study of Drug Development to ascertain how biopharmaceutical companies optimize automation and information technologies, including machine learning and neural networks, to support the research and development of new therapeutics. XtalPi provide a huge number of talent to work with machine learning, create drug discovery and development applications that predict the properties of small molecules. Another innovators of Asian AI industry are Cytlimic and Fujitsu that offer software for predicting how well compounds will bind with each other and proteins.

The UK and EU activity in the pharmaceutical AI race is mainly boosted by Novartis that announced an important step in reimagining medicine by founding the Novartis AI innovation lab and by selecting Microsoft Corp. as its strategic AI and data-science partner for this effort. Furthermore, GlaxoSmithKline has announced a few deals with companies such as Exscientia, Insilico Medicine, Insilico Biotechnology to use new computer modelling systems. BenevolentAI, a global leader in the application of AI for scientific innovation, also has several high-profile research collaborations, including AstraZeneca, and licensed in a group of drugs to develop from Janssen in 2016. This all demonstrate that Pharma is increasingly turning to AI to transform the drug discovery process.

# Executive Summary: Business Activity

The business activity has been increasing in the pharmaceutical AI space over Q3 2019, judging by an increased number of transactions and partnership announcements in this period.

The most significant deals and collaborations having happened in Q3 of 2019 are the following:

- Sensyne Health - Bayer: Sensyne Health signed collaboration agreement with Bayer to accelerate the development of new treatments for Cardiovascular Disease using clinical AI;
- Celsius Therapeutics - Janssen: Celsius Therapeutics started collaboration with Janssen to identify response biomarkers for Ulcerative Colitis by applying Single-Cell Genomics and Machine Learning Platform at unprecedented scale in large Phase 2 Clinical Study;
- Novo Nordisk - e-Therapeutics: Novo Nordisk extended a collaboration with e-Therapeutics to deploy its AI-based drug discovery technology to find new biological targets and therapies for type 2 diabetes;
- BenevolentAI - Neuropore Therapies: Neuropore Therapies and BenevolentAI entered strategic collaboration to discover novel therapeutics through the application of AI;
- Schrödinger - AstraZeneca: Schrödinger announced a collaboration with AstraZeneca to deploy Schrödinger's advanced computing platform to help accelerate drug discovery efforts by improving the design of compounds to identify potential new therapeutic candidates;
- BenevolentAI - Novartis: BenevolentAI announced that it has signed a framework collaboration agreement with Novartis to leverage BenevolentAI's technology platform to interrogate clinical trial and experimental data;
- Novartis - Microsoft: Novartis and Microsoft signed 5-year partnership that aims to provide an AI solution to use the masses of data generated from laboratory experiments, clinical trials, and manufacturing plants managed by Novartis;
- BenevolentAI - Temasek: BenevolentAI announced \$90 million investment from Temasek. The funding will be used to scale and further develop the Benevolent Platform for drug discovery.

The kind of partnerships like these provide a huge effect on Pharma industry development and needed in case if company pretend to be leader in this competition. As big Pharma and Tech corporations want to leverage AI and machine learning in their line of business to transform the way medicines are discovered and developed, such deals will confirm their commitment towards the application of AI.

# Executive Summary: Conferences and Declining Efficiency of R&D in Pharma Corporations

The chapter “Top-35 AI for Drug Discovery Conferences in 2019” is an updated addition to this report. Its purpose is to enable academics, investors, scientists, politicians, and technologists, as well as interested general public, to participate more readily in the emerging industry by identifying affordable events at venues near to them.

35 conferences have been included, based on the following criteria:

- Well attended, with a large number of speakers as well as participants.
- Include at least one panel on the application of AI in Pharma Industry.
- Include speakers from pharmaceutical corporations (e.g., Bayer, Novartis, Sanofi etc.) and/or tech corporations (such as SAP, Google or Nvidia). These corporations are the main driving force behind the development of AI in Pharma and are the primary end-users of technologies, developed by AI startups.

Thus, the report includes an updated and expanded list of the top AI in drug discovery and healthcare conferences, together with illustrative event analytics – a resource that would be useful both for planning activities, as well as making sense of the industry's top places to maintain constructive discussions on a broad range of AI topics.

The chapter “Declining R&D Efficiency of Biopharma Corporations” provides an overview of the major sources of declining productivity of Pharma corporations. The major conclusions of this chapter include:

- Costs of R&D per drug are currently growing exponentially, yet sales per asset are definitely not increasing. This is one of the major challenges for companies operating in this industry.
- In the nearest future, pharmaceutical corporations will have to embrace a more venture fund-like approach, given its naturally inherent risk of failure.
- One opportunity to pharma is to use solutions of young pharma AI startups by making acquisitions.
- To respond to the mentioned challenges, the business model of pharma has to be changed to favor more agile early stage drug discovery, a much larger number of initial pool of projects (with minimal investment, via outsourcing, partnering, or VC funds), and an efficient process of project prioritization.

# Executive Summary: Major Conclusions for Q3 2019

- The rapid development of the industry continues, following the trend mentioned in our previous report about Q2 2019 after breakthrough in 2018. Now not only private investors are getting interested in AI for Drug Discovery companies, but the Biopharmaceutical companies are looking for cooperation with AI startups on their own and are ready to invest in them as it is shown in this report. In Q3 2019 460 investors were identified. This is 60 more than in Q2 2019 and 110 more than in Q1 2019. Companies, Corporations and R&D Centers demonstrated growing interest in the industry as well. 25 Pharma corporations applying AI for drug discovery and 25 Tech corporations applying advanced AI applications in healthcare are highlighted in this report which speaks to further growth of the market.
- Declining R&D efficiency of Biopharma Companies remains a major concern among all parties in the industry with a continuous decline recorded during the last 8 years. Costs of R&D per drug are growing exponentially, yet sales per asset are not showing the trend to increasing. Pharma companies need to consider new approaches in their R&D field, such as the development of AI algorithms for better data processing in order to discover new drugs, their components and improve already existing ones or implementation of biotech startups' experience. This brings us to an issue which is of profound concern to everyone - a growing race for AI talent.
- Pharmaceutical and healthcare companies have developed a strong interest in applying AI in many different areas over the last several years. The demand for the ML/AI technologies, as well as for ML/AI talent, is growing in pharmaceutical and healthcare industries and driving the formation of a new interdisciplinary field – data-driven drug discovery/healthcare. The overall success of all the companies in the industry depends strongly on the presence of highly skilled interdisciplinary decision makers, able to streamline, organize and guide in this direction. For Big Pharma companies that are fighting to survive it will be extremely important to hire top AI specialists as well as prepare and support special training courses within academia field to meet this need in the nearby future. The USA and Great Britain remain home for the largest number of top experts. However, it should be noted that China has the potential to substantially alter these statistics in the coming years due to reverse migration of top AI experts from the USA. It will also be a challenge to poach AI experts from academia, where most of them work and where they are clearly comfortable.

# Landscape of AI for Drug Discovery and Advanced R&D Q3 2019

# AI for Drug Discovery and Advanced R&D Landscape Q3 2019

The present section 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:

- 30 Leading Companies in AI for Drug Discovery Sector
- 30 Leading Investors in AI for Drug Discovery Sector
- 200 companies applying AI for Drug Discovery & Advanced R&D
- 460 investors in AI for Drug Discovery companies
- 35 leading AI for Drug Discovery R&D centers
- 25 IT and Tech corporations embracing AI for Drug Discovery and advanced AI in Healthcare
- 30 Biopharma corporations applying AI for Drug Discovery
- 15 Chemical corporations applying AI for Drug Discovery

Our aim is to make a list of Companies, Investors, R&D Center, Conferences and Media for which AI was mentioned to be used in Drug Discovery or that are somehow related to this field. In addition we intended to classify them where applicable, according to application, industry segmentation, and regional location in the world. Companies, for instance, are categorized according to segment of industry they are related to. For example following this logic, Companies are classified to those focused on Drug Discovery, Biomarker Development, or Advanced R&D. At the same time such category as Investors are classified according to their regional location and the companies in which they invested money and gave their financial support. Mentioned categorization is visualized to create a holistic picture of the understanding of information contained in the report and can be clearly seen on mind maps and infographics.

These lists have been extended in comparison to our previous reports (“AI for Drug Discovery”, “Biomarker Development” and “Advanced R&D Q2 2019”) in order to include those companies, investors and entities that rose into prominence in Q3 of 2019. Namely, among the added constituents that influenced the appearance of our infographics and mind maps there should be mentioned 30 new AI-related companies specialising in AI for Drug Discovery, updated top of R&D centers, 60 new investors. Also 20 new Pharma & Chemical Corporations, 5 companies and 10 investors were added to our Top-lists.

What is more, the AI in Drug Discovery industry is constantly growing nowadays, as well as the number of deals the aim of which is to enable collaboration between corporations, AI-companies and startups for the purpose of the AI usage in the sphere of discovery of new modern drugs, molecules and targets. That is why in the next chapter the major deals on this topic are reviewed and analyzed.

# 30 Leading Companies in AI for Drug Discovery Sector

1	Acellera
2	Ardigen
3	Atomwise
4	Benevolent.AI
5	Biovista
6	C4X discovery
7	Cyclica
8	CytoReason
9	Deep Genomics
10	DeepMind Health
11	e-Therapeutics
12	Exscientia
13	GNS Healthcare
14	iCarbonX
15	Insilico Medicine

16	Insitro
17	Lantern Pharma
18	Nimbus Therapeutics
19	Numerate
20	Nuritas
21	PathAI
22	Pharnext
23	Recursion Pharmaceuticals
24	Saama Technologies
25	Schrödinger
26	Turbine.AI
27	twoXAR
28	Vyasa Analytics
29	WuXi NextCODE
30	XtalPi

## 30 Leading Investors in AI for Drug Discovery Sector

1	Alexandria Real Estate Equities
2	Amadeus Capital Partners
3	AME Cloud Ventures
4	Amgen Ventures
5	Andreessen Horowitz
6	ARCH Venture Partners
7	Atlas Venture
8	Baidu Ventures
9	Bill & Melinda Gates Foundation
10	Data Collective DCVC
11	DFJ Growth
12	DHVC (Digital Horizon Capital)
13	Draper Associates
14	Felicis Ventures
15	General Catalyst

16	GV
17	Khosla Ventures
18	Lili Ventures
19	OS Fund
20	Refactor Capital
21	Sequoia Capital
22	SOSV
23	SR One
24	StartX
25	Temasek Holdings
26	Tencent Holdings
27	Third Rock Ventures
28	WuXi AppTec
29	Y Combinator
30	ZhenFund

# 200 Companies Applying AI for Drug Discovery and Advanced R&D

1. A2A Pharmaceuticals
2. AccutarBio
3. Acellera
4. AcuraStem
5. Aetion
6. AiCure
7. Alector
8. Alphanosos
9. Antidote
10. Antiverse
11. Arbor Biotechnologies
12. Arctoris
13. Ardigen
14. Ariana Pharma
15. Arrakis Therapeutics
16. Arzeda
17. Athelas
18. ATOM
19. Atomwise
20. Auransa
21. Bactevo
22. BenchSci
23. BenevolentAI
24. Berg LLC
25. Berkeley Lights
26. BioAge Labs
27. Biodesix
28. Biorelate
29. BioSymetrics
30. Biotx.ai
31. Biovista
32. BioXcel
33. Bioz
34. BlackThorn Therapeutics
35. BriteHealth
36. BullFrog AI
37. C4X discovery
38. Cambridge Cancer Genomics
39. Causaly
40. Celsius Therapeutics
41. Chempass
42. Clinithink
43. Cloud Pharmaceuticals
44. CloudMedX
45. Collective Scientific
46. Concerto HealthAI
47. Cotinga Pharmaceuticals
48. Cyclica
49. CytoReason
50. Cytos
51. Data2Discovery
52. Data4Cure
53. Datavant
54. Deep 6 AI
55. Deep Genomics
56. Deep Intelligent Pharma
57. DeepLens
58. DeepMind Health
59. DeepPhenome
60. Desktop Genetics
61. Dristi.ai
62. E-therapeutics
63. Elucidata
64. Emerald Cloud Lab
65. Engine Biosciences
66. Envisagenics
67. Erasca
68. Euretos
69. Evaxion Biotech
70. EvidScience
71. Evolutionary Genomics
72. Exscientia

# 200 Companies Applying AI for Drug Discovery and Advanced R&D

- |                        |                           |                          |
|------------------------|---------------------------|--------------------------|
| 73. FDNA               | 97. InveniAI              | 121. Mozi                |
| 74. Fetch Biosciences  | 98. InVivo AI             | 122. Nanna Therapeutics  |
| 75. GenFit             | 99. Iris.ai               | 123. Neon Therapeutics   |
| 76. Genialis           | 100. iTeos Therapeutics   | 124. NetraMark           |
| 77. Globavir           | 101. Juvenescence AI      | 125. Nference            |
| 78. GNS Healthcare     | 102. Keen Eye             | 126. Nimbus Therapeutics |
| 79. Gritstone Oncology | 103. Kite Pharma          | 127. Notable             |
| 80. GTN Limited        | 104. KYAN Therapeutics    | 128. Novoheart           |
| 81. Healx              | 105. Kyndi                | 129. nQ Medical          |
| 82. HelixAI            | 106. LabTwin              | 130. Nucleai             |
| 83. iCarbon X          | 107. LAM Therapeutics     | 131. NuMedii             |
| 84. Ideaya Biosciences | 108. Lantern Pharma       | 132. Numerate            |
| 85. Iktos              | 109. Linguamatics         | 133. Nuritas             |
| 86. Imagia             | 110. Longenesis           | 134. OccamzRazor         |
| 87. Inato              | 111. MAbSilico            | 135. Owkin               |
| 88. Indegene           | 112. Massive Bio          | 136. PathAI              |
| 89. Ingentium          | 113. MediBIC Group        | 137. PatSnap             |
| 90. Innoplexus         | 114. MedView Technologies | 138. Pepticom            |
| 91. Inside DNA         | 115. Mendel.ai            | 139. Peptone             |
| 92. Insilico Medicine  | 116. Meta                 | 140. Percayai            |
| 93. Insitro            | 117. Micar21              | 141. Perceiv Research    |
| 94. Intellegens        | 118. Mind the Byte        | 142. Pharnext            |
| 95. Intelligencia.AI   | 119. Molomics Biotech SL  | 143. Pharos iBT          |
| 96. Interprotein       | 120. Molplex              | 144. Phenomic AI         |

# 200 Companies Applying AI for Drug Discovery and Advanced R&D

- |                                |                                 |                         |
|--------------------------------|---------------------------------|-------------------------|
| 145. Plex Research             | 164. Sangamo BioSciences        | 183. TeselaGen          |
| 146. Precisionlife             | 165. Satalia                    | 184. ThoughtSpot        |
| 147. Prognica Labs             | 166. Schrodinger                | 185. Transcriptic       |
| 148. Proscia                   | 167. sciNote                    | 186. TrialJectory       |
| 149. ProteinQure               | 168. SEngine Precision Medicine | 187. Trials.ai          |
| 150. Qrativ                    | 169. Sensyne Health             | 188. Turbine            |
| 151. Quantitative Medicine     | 170. Sigma Technologies         | 189. TwoXAR             |
| 152. Quertle                   | 171. Sirenas                    | 190. uBiome             |
| 153. Qulab                     | 172. Sophia Genetics            | 191. Unnatural Products |
| 154. Recursion Pharmaceuticals | 173. Sparrho                    | 192. Verge Genomics     |
| 155. Relay Therapeutics        | 174. Spring Discovery           | 193. VERISIM Life       |
| 156. Remedium AI               | 175. Standigm                   | 194. Virogin            |
| 157. Researchably              | 176. Structura Biotechnology    | 195. Virvio             |
| 158. Resonant Therapeutics     | 177. Synergy Pharma             | 196. Vyasa Analytics    |
| 159. Reveal Biosciences        | 178. Syntekabio                 | 197. WinterLight Labs   |
| 160. Reverie Labs              | 179. Synthace                   | 198. WuXi NextCODE      |
| 161. ReviveMed                 | 180. Systems Oncology           | 199. XtalPi             |
| 162. Roivant Sciences          | 181. TARA Biosystems            | 200. ZappRx             |
| 163. Saamo                     | 182. Tempus                     |                         |

# 460 Investors - AI for Drug Discovery and Advanced R&D

1. 415
2. 10x Group
3. 11.2 Capital
4. 180 degree capital
5. 1984 Ventures
6. 360 Capital Partners
7. 3W Partners
8. 500 Startups
9. 5AM Ventures
10. 6 Dimensions Capital
11. 8VC
12. A-Level Capital
13. Abstract Ventures
14. Accel X
15. Access Industries
16. Advantage Capital
17. Afore Capital
18. Agent Capital
19. AJS Investments
20. Alan Cohen
21. Alchemist Accelerator
22. Alexa Fund
23. Alexandria Real Estate Equities
24. Alexandria Venture Investments
25. AllBright
26. Alpha Edison
27. Alphabet
28. ALS Investment Fund
29. Alta Partners
30. Altitude Life Science Ventures
31. Altos Ventures
32. Amadeus Capital Partners
33. AME Cloud Ventures
34. Amgen Ventures
35. Amplify Partners
36. Andreessen Horowitz
37. Angivest Ventures
38. Aquarius Equity Partners
39. Arab Angel Fund
40. Arboretum Ventures
41. ARCH Venture Partners
42. Arkitekt Ventures
43. ArrowMark Partners
44. Artis Ventures (AV)
45. Asset Management Ventures (AMV)
46. Atinum Investment
47. Atlas Venture
48. Aurinvest
49. B Capital Group
50. Babel Ventures
51. Baidu Ventures
52. Baillie Gifford
53. Baird Capital
54. Bakken & Baeck
55. Balderton Capital
56. Baron Capital Management
57. Basis Set Ventures (BSV)
58. BDC Venture Capital
59. Beast Ventures
60. Better Ventures
61. Bill & Melinda Gates Foundation
62. Bill Tai
63. Bioeconomy Capital
64. Biomatics Capital Partners
65. Bios Partners
66. Biotechnology Value Fund
67. Bioverge
68. Black Diamond Ventures
69. Bloomberg Beta
70. Blue Bear Ventures
71. Bold Capital Partners
72. Bootstrap Labs
73. Boundary Capital Partners LLP
74. BR Ventures
75. Builders VC
76. Caffeinated Capital
77. Cambia Health Solutions
78. Canaan Partners
79. Cantos
80. Capital One Growth Ventures
81. Carrick Capital Partners
82. Cascade Investment
83. Casdin Capital
84. Catapult Ventures

# 460 Investors - AI for Drug Discovery and Advanced R&D

85. Cathay Innovation
86. Celgene
87. China Bridge Capital
88. China Canada Angel Alliance
89. China Equity
90. China Life Healthcare Fund
91. Citrix Startup Accelerator
92. Citrix Systems
93. City Hill Ventures
94. Civilization Ventures
95. Clal Biotechnology Industries
96. Claremont Creek Ventures
97. CLI Ventures
98. CM-CIC Capital Finance
99. Conversion Ventures LLC
100. Cormorant Asset Management
101. Cosine
102. Cota Capital
103. Creative Destruction Lab
104. CRG L.P.
105. CRV
106. Cultivian Sandbox Ventures
107. Curative ventures
108. Daniel Curran
109. Darling Ventures
110. Data Collective DCVC
111. DCM Ventures
112. Deep Knowledge Ventures
113. Deerfield
114. Deerfield Capital Management
115. Density Ventures
116. Dentsu
117. Dexcel Pharma
118. DFJ
119. DFJ Growth
120. DHVC (Digital Horizon Capital)
121. Digital Science
122. DNA Capital
123. Dolby Family Ventures
124. Dorm Room Fund
125. Draper Associates
126. Draper Dragon
127. Driehaus Capital Management
128. Dynamic Capital
129. EASME - EU Executive Agency for SMEs
130. EcoR1 Capital
131. EDBI
132. Emerald Development Managers
133. Emerge Education
134. Endeavour Vision
135. Endure Capital
136. Enterprise Ireland
137. Entrepreneur First (ef.)
138. EPIC Capital
139. EPIC Ventures
140. Esperante Ventures
141. Euclidean Capital
142. European Investment Bank (EIB)
143. European Union
144. Evotec
145. F-Prime Capital
146. Fairhaven Capital Partners
147. Farzad (Zod) Nazem
148. Felicis Ventures
149. Fenox Venture Capital
150. Fifty Years
151. Finance Wales
152. Financière Boscary
153. Finorpa
154. First Round
155. First Round Capital
156. First Star Ventures
157. Flare Capital Partners
158. Fly Ventures
159. Flybridge Capital Partners
160. Fond Vives II
161. Foresite Capital
162. Foundation Capital
163. Foundation for Technological Innovation (FIT)
164. Founders Factory
165. Founders Fund
166. FREES FUND
167. FUND+

# 460 Investors - AI for Drug Discovery and Advanced R&D

168. Fusion Fund
169. Future Fund
170. General Atlantic
171. General Catalyst
172. Generation Investment Management
173. Geodesic Capital
174. Gi Global Health Fund LP
175. GlaxoSmithKline
176. GM&C Life Sciences Fund
177. GNI Group
178. GNS Healthcare
179. Golden Ventures
180. Goldman Sachs
181. Goodman Capital
182. GPG Ventures
183. Gradient Ventures
184. Great Oaks Venture Capital
185. Green Park & Golf Ventures
186. GreenSky Capital
187. Grove Ventures
188. GV
189. Hack VC
190. Hacking Health Accelerator
191. Hanhai Studio
192. HBM Partners
193. Health Velocity Capital
194. Health Wildcatters
195. Healthbox
196. Heritage Provider Network
197. Hewlett Packard Pathfinder
198. HIGHLINEvc
199. Hillhouse Capital Group
200. Hiventures Investment Fund
201. Holtzbrinck Digital
202. Horizon Healthcare Services
203. Horizons Ventures
204. Hyperplane Venture Capital
205. IA Ventures
206. IDG Capital
207. Idinvest Partners
208. iGan Partners
209. Illumina Ventures
210. Inbio Ventures
211. INDEX: Design to Improve Life
212. IndieBio
213. Industry Ventures
214. Initialized Capital
215. Innovate UK
216. iNovia Capital
217. Intel Capital
218. Invoke Capital Partners
219. Invus
220. IQ Capital
221. Ireland Strategic Investment Fund
222. IT-Farm
223. J. Hunt Holdings
224. Jiantou Huawen Investment
225. JMI Equity
226. Johnson & Johnson Innovation
227. Johnson & Johnson Innovation – JJDC
228. Juvenescence
229. Kakao Ventures
230. Kapor Capital
231. Karlin Ventures
232. KdT Ventures
233. Khosla Ventures
234. Kima Ventures
235. Kleiner Perkins (KPCB)
236. Konstantin von Unger
237. Korea Tech Incubator Program
238. KTB Network
239. La Famiglia
240. Lakestar
241. Lane Bess
242. Lansdowne Partners
243. Lanza Tech Ventures
244. LaunchCapital
245. Laurion Capital Management
246. LB Investment
247. LeFrak
248. Life Sciences Angel Network
249. Lifeforce Capital
250. Lightspeed Venture Partners
251. Lightstone Ventures

# 460 Investors - AI for Drug Discovery and Advanced R&D

- 252. Lilly Asia Ventures
- 253. Lilly Ventures
- 254. Linden Mobile Ventures
- 255. Liquid 2 Ventures
- 256. London Co-Investment Fund (LCIF)
- 257. Lucas Venture Group
- 258. Luminous Ventures
- 259. Lundbeck
- 260. Lux Capital
- 261. Manchester Tech Trust Angels
- 262. Marathon Venture Capital
- 263. Masa Life Science Fund
- 264. MassChallenge
- 265. Matrix Capital Management
- 266. Mayo Clinic
- 267. McKesson Ventures
- 268. MedTech Innovator
- 269. Menlo Ventures
- 270. Merck Global Health Innovation Fund
- 271. Mercury Fund
- 272. Midven
- 273. Minneapolis Heart Institute Ventures
- 274. Mission and Market
- 275. Mission Bay Capital
- 276. MIT delta v
- 277. MITS Fund
- 278. Mitsui & Co
- 279. Monsanto Growth Ventures (MGV)
- 280. Morgan Noble
- 281. MPM Capital
- 282. MRL Ventures Fund
- 283. Mubadala Investment Company
- 284. National Institutes of Health
- 285. NDRC
- 286. Nest.Bio Ventures
- 287. Nesta Ventures
- 288. New Enterprise Associates
- 289. New Leaf Venture Partners (NLV)
- 290. New Wave Ventures
- 291. New York Presbyterian Ventures
- 292. New York State of Opportunity
- 293. NewDo Venture
- 294. Nex Cubed
- 295. Nextech Invest
- 296. Nikon
- 297. NJF Capital
- 298. Nordic Impact
- 299. Northpond Ventures
- 300. Novaquest Capital Management
- 301. Novo Holdings
- 302. NPIF Maven Equity Finance
- 303. Obvious Ventures
- 304. Orbimed
- 305. OS Fund
- 306. Oséo
- 307. Otium Capital
- 308. Oxeon Partners
- 309. Parinvest
- 310. Partner Fund Management
- 311. Pavilion Capital
- 312. Paxion Capital Partners
- 313. Pear Ventures
- 314. Perceptive Advisors
- 315. Perivoli Innovations
- 316. Pfizer Venture Investments
- 317. Pi Campus
- 318. Pillar Companies
- 319. Pitch@Palace
- 320. PivotNorth Capital
- 321. Plug and Play
- 322. Polaris Partners
- 323. PP Capital
- 324. Premier Partners
- 325. Pritzker Group Venture Capital
- 326. Qiming Venture Partners
- 327. QTV Financial
- 328. Qualgro VC
- 329. Quentin Clark
- 330. Radical Ventures
- 331. Razor's Edge Ventures
- 332. Real Ventures
- 333. Redalpine Venture Partners
- 334. Refactor Capital
- 335. Reneo Capital Management

# 460 Investors - AI for Drug Discovery and Advanced R&D

- 336. Renren Inc.
- 337. Rev1 Ventures
- 338. Revolution
- 339. Rho Canada Ventures
- 340. Right Side Capital Management
- 341. Rising Tide
- 342. Rising Tide Fund Managers
- 343. Riva Capital
- 344. Riverbank Capital Securities
- 345. Robin Hood Ventures
- 346. Roche Venture Fund
- 347. Rock Health
- 348. Roivant Sciences
- 349. Romulus Capital
- 350. S.R.I.W
- 351. Sanofi
- 352. Sapphire Ventures
- 353. Schooner Capital
- 354. Schrodinger
- 355. SciFi VC
- 356. Sea Lane Ventures
- 357. Section 32
- 358. Seedcamp
- 359. Seneca Partners
- 360. Sequoia Capital
- 361. Sequoia Capital China
- 362. Seraph Group
- 363. Serena Capital
- 364. ServiceNow
- 365. Seventure Partners
- 366. SFPI-FPIM
- 367. Shangbay Capital
- 368. Shasta Ventures
- 369. Shunwei Capital
- 370. Sierra Ventures
- 371. Silicon Badia
- 372. Silicon Valley Bank
- 373. Singularity University Ventures
- 374. Sinopharm Capital
- 375. Sky Ventures Group
- 376. Slow Ventures
- 377. Smedvig Capital
- 378. Sofinnova Partners
- 379. SoftBank
- 380. Softbank Ventures Korea
- 381. Soma Capital
- 382. Sorrento Therapeutics
- 383. SOSV
- 384. Sound Ventures
- 385. SPARK Impact
- 386. Square 1 Bank
- 387. SR One
- 388. Stage Venture Partners
- 389. Stanford University Venture Fund
- 390. Starlight Ventures
- 391. Start Capital
- 392. StartUp Health
- 393. StartX (Stanford-StartX Fund)
- 394. Summit Partners
- 395. Susa Ventures
- 396. Susquehanna International Group (SIG)
- 397. Sustainable Conversion Ventures
- 398. SV Angel
- 399. SV Tech Ventures
- 400. Swisscom Ventures
- 401. T. Rowe Price
- 402. Tamarind Hill
- 403. Tavistock Group
- 404. TCP Venture Capital
- 405. Team Builder Ventures
- 406. Techammer
- 407. Techstars
- 408. TECHU
- 409. Temasek Holdings
- 410. Tencent Holdings
- 411. TenOneTen Ventures
- 412. The Cedars-Sinai Accelerator
- 413. The Longevity Fund
- 414. Third Kind Venture Capital
- 415. Third Rock Ventures
- 416. Trancos Ventures
- 417. Travis May
- 418. Tribeca Venture Partners
- 419. True Ventures

## 460 Investors - AI for Drug Discovery and Advanced R&D

- 420. Truffle Capital
- 421. TSVC
- 422. Tuesday Capital
- 423. Two River
- 424. Two Sigma Ventures
- 425. uBiome
- 426. UCB Pharma
- 427. UK Innovation & Science Seed Fund
- 428. UL Ventures
- 429. Uni-Innovate Group
- 430. University of Birmingham
- 431. Unshackled Ventures
- 432. UpHonest Capital
- 433. Upsher Smith Laboratories
- 434. Vanguard Atlantic
- 435. Varian
- 436. VenBio Partners
- 437. Vertex Ventures
- 438. Vertex Ventures HC
- 439. Vertex Ventures Southeast Asia & India
- 440. Viking Global Investors
- 441. Village Global
- 442. VisVires New Protein
- 443. Walden Riverwood Ventures
- 444. Walking Ventures
- 445. Washington Research Foundation.
- 446. Wellington Management
- 447. Western Technology Investment
- 448. White Cloud Capital
- 449. WI Harper Group
- 450. Wild Basin Investments
- 451. Woodford Investment Management
- 452. WorldQuant Ventures LLC
- 453. Wren Capital
- 454. WuXi AppTec
- 455. Y Combinator
- 456. Yael Capital Management Limited
- 457. YF Capital (Yunfeng Capital)
- 458. Yitu Technology
- 459. ZhenFund
- 460. Zhongyuan Union Cell & Gene Eng

# 30 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
1. AbbVie	United States	<a href="http://abbvie.com">abbvie.com</a>
2. Agios Pharmaceuticals	United States	<a href="http://agios.com">agios.com</a>
3. Amgen	United States	<a href="http://amgen.com">amgen.com</a>
4. Astellas Pharma	Japan	<a href="http://astellas.com">astellas.com</a>
5. Astrazeneca	United Kingdom	<a href="http://astrazeneca.com">astrazeneca.com</a>
6. Bayer	Germany	<a href="http://bayer.com">bayer.com</a>
7. Biogen	United States	<a href="http://biogen.com">biogen.com</a>
8. Boehringer Ingelheim	Germany	<a href="http://boehringer-ingelheim.com">boehringer-ingelheim.com</a>
9. Bristol-Myers Squibb	United States	<a href="http://bms.com">bms.com</a>
10. Celgene	United States	<a href="http://celgene.com">celgene.com</a>

# 30 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
11. Illumina	United States	<a href="http://illumina.com">illumina.com</a>
12. Ipsen	France	<a href="http://ipсен.com">ipсен.com</a>
13. Janssen Pharmaceuticals	Belgium	<a href="http://janssen.com">janssen.com</a>
14. Johnson & Johnson	United States	<a href="http://inj.com">inj.com</a>
15. Merck	United States	<a href="http://merck.com">merck.com</a>
16. Mitsubishi Tanabe Pharma	Japan	<a href="https://www.mt-pharma.co.jp/">https://www.mt-pharma.co.jp/</a>
17. Novartis	Switzerland	<a href="http://novartis.com">novartis.com</a>
18. Novo Nordisk	Denmark	<a href="http://novonordisk.com">novonordisk.com</a>
19. Daewoong Pharmaceutical	South Korea	<a href="http://daewoong.com">daewoong.com</a>
20. Evotec	Germany	<a href="http://evotec.com">evotec.com</a>

# 30 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
21. Genentech	United States	<a href="http://gene.com">gene.com</a>
22. Gilead Sciences	United States	<a href="http://gilead.com">gilead.com</a>
23. GSK	United Kingdom	<a href="http://gsk.com">gsk.com</a>
24. Pfizer	United States	<a href="http://pfizer.com">pfizer.com</a>
25. Roche	Switzerland	<a href="http://roche.com">roche.com</a>
26. Sanofi	France	<a href="http://m-en.sanofi.com">m-en.sanofi.com</a>
27. Santen	Japan	<a href="http://santen.com">santen.com</a>
28. Sumitomo Dainippon Pharma	Japan	<a href="http://ds-pharma.com">ds-pharma.com</a>
29. Takeda	Japan	<a href="http://takeda.com">takeda.com</a>
30. Teva Pharmaceutical	Israel	<a href="http://tevapharm.com">tevapharm.com</a>

# 15 Chemical Corporations Applying AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
1. Asahi Kasei	Japan	<a href="http://asahi-kasei.co.jp">asahi-kasei.co.jp</a>
2. BASF	Germany	<a href="http://basf.com">basf.com</a>
3. COVESTRO	Germany	<a href="http://covestro.com">covestro.com</a>
4. DIC	Japan	<a href="http://dic-global.com">dic-global.com</a>
5. The Dow Chemical Company	United States	<a href="http://dow.com">dow.com</a>
6. DSM	The Netherlands	<a href="http://dsm.com">dsm.com</a>
7. DUPONT	United States	<a href="http://dupont.com">dupont.com</a>
8. ECOLAB	United States	<a href="http://de-at.ecolab.com">de-at.ecolab.com</a>
9. EVONIK INDUSTRIES	Germany	<a href="http://corporate.evonik.de">corporate.evonik.de</a>
10. Henkel	Germany	<a href="http://henkel.com">henkel.com</a>
11. Lonza	Switzerland	<a href="http://lonza.com">lonza.com</a>
12. MITSUI CHEMICALS	Japan	<a href="http://mitsuichem.com">mitsuichem.com</a>
13. Solvay	Belgium	<a href="http://solvay.de">solvay.de</a>
14. SUMITOMO CHEMICAL	Japan	<a href="http://sumitomo-chem.co.jp">sumitomo-chem.co.jp</a>
15. SYNGENTA	Switzerland	<a href="http://syngenta.com">syngenta.com</a>

# 25 Tech Corporations Applying Advanced AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
1. Adobe	United States	<a href="https://adobe.com">adobe.com</a>
2. Alibaba	China	<a href="https://alibaba.com">alibaba.com</a>
3. Amazon	United States	<a href="https://amazon.com">amazon.com</a>
4. Apple	United States	<a href="https://apple.com">apple.com</a>
5. Baidu	China	<a href="https://baidu.com">baidu.com</a>
6. Canon	United States	<a href="https://usa.canon.com">usa.canon.com</a>
7. Cisco	United States	<a href="https://cisco.com">cisco.com</a>
8. Dell Technologies	United States	<a href="https://delltechnologies.com">delltechnologies.com</a>
9. Foxconn Technology	Taiwan	<a href="https://foxconn.com">foxconn.com</a>
10. Fujitsu	Japan	<a href="https://fujitsu.com">fujitsu.com</a>
11. Google	United States	<a href="https://google.com">google.com</a>
12. Hitachi	Japan	<a href="https://hitachi.com">hitachi.com</a>
13. Huawei	China	<a href="https://huawei.com">huawei.com</a>
14. IBM	United States	<a href="https://ibm.com">ibm.com</a>
15. Intel	United States	<a href="https://intel.com">intel.com</a>

## 25 Tech Corporations Applying Advanced AI in Healthcare

COMPANY NAME	BASED IN	WEBSITE
16. Microsoft	United States	<a href="https://microsoft.com">microsoft.com</a>
17. Nvidia	United States	<a href="https://nvidia.com">nvidia.com</a>
18. Oracle	United States	<a href="https://oracle.com">oracle.com</a>
19. Salesforce	United States	<a href="https://salesforce.com">salesforce.com</a>
20. SAP	Germany	<a href="https://sap.com">sap.com</a>
21. Samsung Electronics	South Korea	<a href="https://samsung.com">samsung.com</a>
22. Siemens	Germany	<a href="https://siemens.com">siemens.com</a>
23. Tencent	China	<a href="https://tencent.com">tencent.com</a>
24. Unisys	United States	<a href="https://unisys.com">unisys.com</a>
25. Workday	United States	<a href="https://workday.com">workday.com</a>

# Tech Corporations Applying Advanced AI in Healthcare and Drug Discovery

More tech corporations are constantly coming to the healthcare industry. What differentiates them from other newcomers is that these companies are already using or are going to use in the immediate future AI-related solutions for Drug Discovery.

A number of Tech Corporations announced partnerships with AI companies and institutions in the field of Drug Discovery and Healthcare. The most notable of these deals are the following:

- Chinese technology powerhouse Alibaba has teamed up with British pharmaceutical giant AstraZeneca to deliver smart healthcare services through the use of artificial intelligence (AI) and the internet of things in China. For a start, the partnership with Alibaba will enable more than one million Chinese patients to learn more about disease prevention and healthcare services by scanning the AliHealth traceability code on drug packages this year.
- AstraZeneca joined Chinese tech giant Tencent in signing a Memorandum of Understanding (MoU) for strategic cooperation. According to the agreement, the two companies will harness the power of big data-driven internet technologies to more accurately and effectively crack down on the online sale of counterfeit drugs, and will work together to build a new model for online drug safety management as part of a larger "Smart Healthcare" push.
- Hewlett Packard Enterprise (HPE) will collaborate with Biovista to advance Biovista's Project Prodigy Big Data AI healthcare platform applied in the personalized medicine vertical. Advances from the HPE-Biovista collaboration will be used initially within the context of Biovista's existing collaboration with Sarah Bush Lincoln Health Center (SBL), a hospital and healthcare organization that is home to more than 300,000 provider office visits per year.

Others decided to dive into the industry by themselves, e.g. SAP launched Intelligent Enterprise for Healthcare that uses intelligent technologies, such as artificial intelligence (AI), machine learning (ML), and the Internet of Things capabilities (IoT), and real-time, in-memory analytics to achieve operational and clinical excellence in care delivery. Oracle is planning Healthcare's digital transformation, its Autonomous Database takes out much of the human effort required in data ingestion and matching, while also ensuring its platforms meet global requirements for security and privacy. Furthermore, a number of Oracle's AI applications are ready to make the difference in the business. Cisco's digital technologies, including the Internet of Things (IoT), help to accelerate life sciences R&D and manufacturing. Cisco also expressed interest in AI diagnosis-focused algorithms. Workday introduced AI Maturity Model that is poised to transform medicine and healthcare. Unisys unveiled Artificial Intelligence Center of Excellence to help its clients build Advanced Data Analytics Capabilities. They are also using AI solutions in regard to research field engineering services to improve potential new cures.

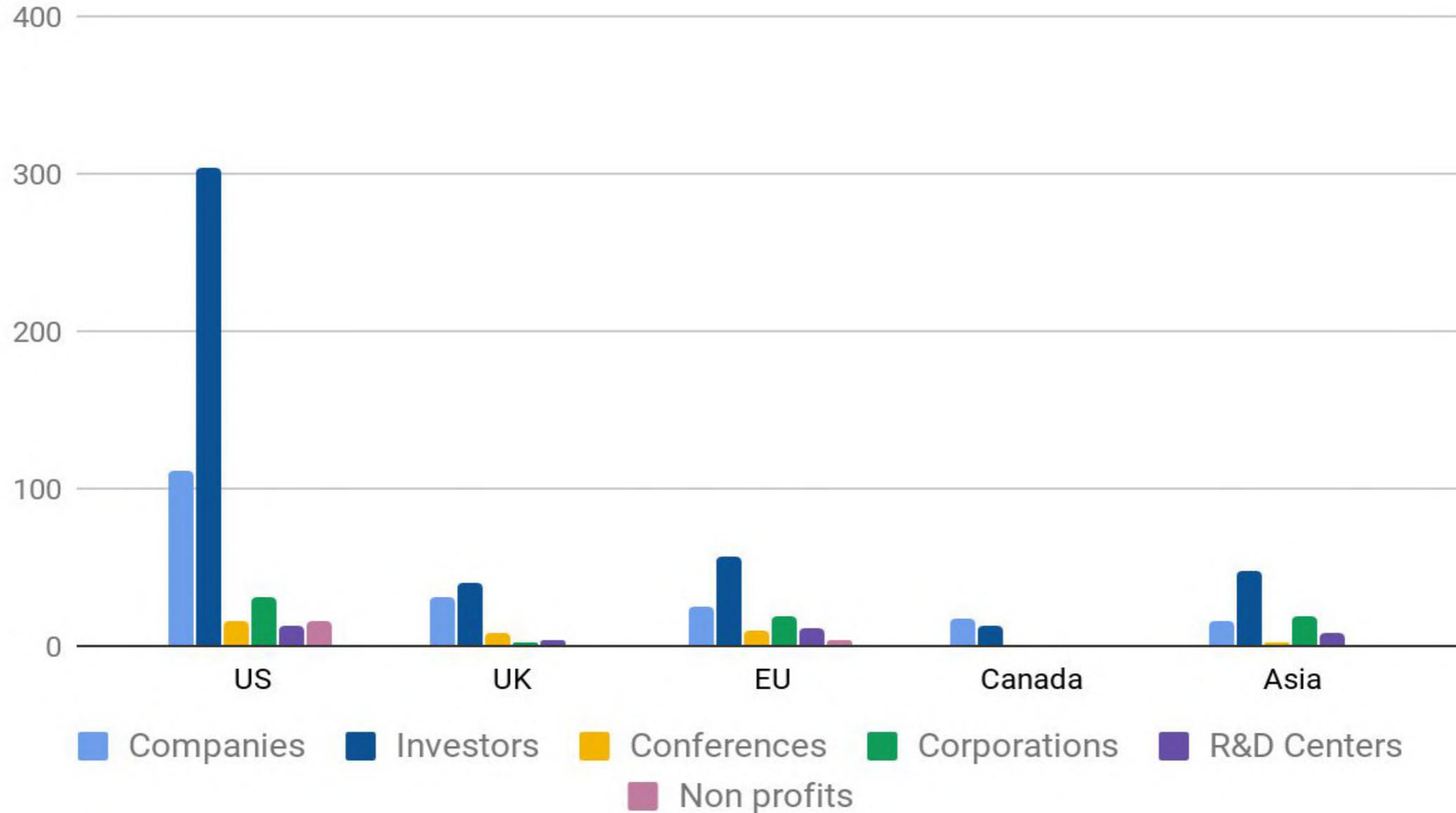
## 35 Leading AI R&D Centers in Drug Discovery and Advanced Healthcare

R&D CENTERS	LOCATION
Bioinformatics and Drug Design Group, Department of Pharmacy, National University of Singapore	Singapore
Center for Computational and Integrative Biology, Rutgers University-Camden	US
Center for Computational Health - IBM Research	US
Center for Computational Science University of Miami	US
Centre for Drug Discovery Science (CDDS)	UK
Centre for Excellence in Brain Science and Intelligence Technology, Institute of Automation, CAS	China
College of Life Sciences, University of Dundee	UK
CUHK-SDU Reproductive Genetics Joint Laboratory, School of Biomedical Sciences, the Chinese University of Hong Kong	China
CureMatch Inc	US
Department of Bio and Health Informatics, Technical University of Denmark	Denmark
Department of Biostatistics, Boston University Schools of Medicine and Public Health	US
Department of Chemistry and Applied Biosciences Institute of Pharmaceutical Sciences	Switzerland
Department of Pharmacological Sciences	US
Drug Discovery Institute	US
ETH Zurich (Swiss Federal Institute of Technology in Zurich)	Switzerland
German Cancer Consortium (DKTK)	Germany
German Cancer Research Center, (Deutsches Krebsforschungszentrum, DKFZ)	Germany

# 35 Leading AI R&D Centers in Drug Discovery and Advanced Healthcare

R&D CENTERS	LOCATION
Icahn School of Medicine at Mount Sinai	US
In Silico Biosciences, Inc.	US
Institute for Molecular Medicine Finland, University of Helsinki	Finland
Institute for Research, Development and Innovation (IRDI) International Medical University	Malaysia
International Center for Health Information Technology (ICHIT)	Taiwan
International Centre for Genetic Engineering and Biotechnology (ICGEB)	Italy
Japan Biological Informatics Consortium (JBIC)	Japan
Machine Learning Group, Université Libre de Bruxelles	Belgium
Molecular Health GmbH	Germany
Mount Sinai Center for Bioinformatics	Switzerland
National Center for Advancing Translational Sciences (NCATS)	US
National Institute of Advanced Industrial Science and Technology (AIST)	Japan
NIHR Sheffield Biomedical Research Centre	UK
Novo Nordisk Foundation Center for Protein Research, University of Copenhagen	US
Pande Lab - Stanford University	US
SIB Swiss Institute of Bioinformatics	Switzerland
The Development Center for Biotechnology	Taiwan
Warren Family Research Center for Drug Discovery and Development	US

# Regional Comparison of AI for R&D and Drug Discovery Organizations 2019 / Q3



# AI for Drug Discovery and Advanced R&D Reports Produced by Deep Knowledge Analytics in Q3 2019

In this chapter, we described the dynamics of the industry landscape and analyzed its main players - investors, companies and R&D centres. To better understand the main trends of the industry, described in the executive summary, we include the most relevant information and main conclusions from the reports, made by Deep Knowledge Analytics in the second quarter of 2019. They include the information on the main trends and explain them using qualitative and quantitative matrices.

The featured reports include:

- [Pharma AI Deals](#) - describes the methodology and general classification comparison of the major partners in the field of usage of AI for Drug Discovery. The report itself includes the major 50 deals that were made during the last 3 years and their main goals. It shows how the major race between Pharma and Tech corporations for the segment of AI in Drug Discovery evolves;
- [Declining R&D Efficiency of Biopharma Corporations](#) - provides enhanced analysis of resource effectiveness and reveals the methods to overcome the burden of declining Eroom's Law trend. This is a proprietary report explaining the problem of the declining efficiency from different angles and shows how the Pharma corporations are dealing with decreasing productivity;
- [AI Friendly CEOs and Board Members of Pharma and Tech Corporations](#) - identifies and provides a "bird's view" on the global leadership scene in the area of adopting AI-driven methods in drug discovery and healthcare. It continues the discussion on the necessity of AI in Drug Discovery knowledge in Pharma and Tech corporations and shows, which companies are succeeding in this sense;
- [Top-35 AI for Drug Discovery Conferences 2019-2020](#) - represents the top 35 conferences that accumulate people from the industry of Artificial Intelligence usage in drug discovery. It includes well attended events with presented academia and AI startup community. The conferences are featured in chronological order, so that interested parties can use the report as a guide on which conferences to attend.

# 15 Most Innovative R&D Approaches of AI in Biopharma

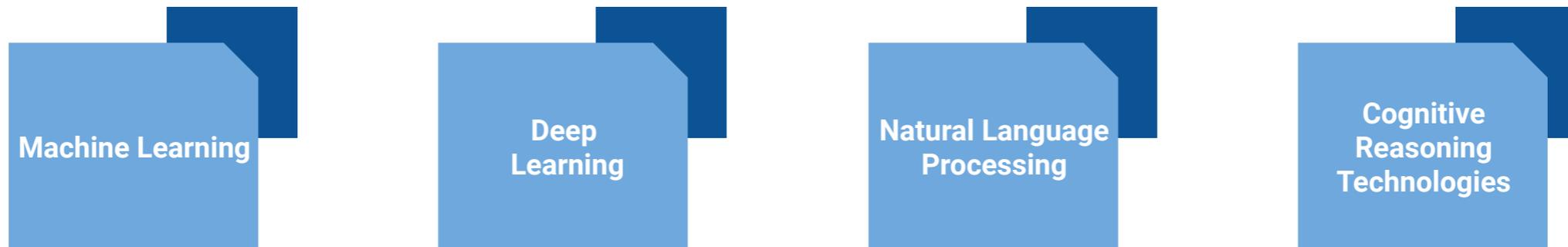
# Introduction to Most Innovative R&D Approaches of AI in Biopharma

The industry of AI in Biopharma continues growing up after a long period of skepticism, which is reflected in a substantial increase in the volume of investments and the number of joint ventures in 2019 compared to 2018 and earlier years. The difference between Pharma and Biopharma fields is that biopharma medicines and drug products are manufactured in living organisms like bacteria, yeast and mammalian cells. The prefix “bio” refers to how drugs are produced. Biopharma is the subset of drugs produced by biological methods. Pharmaceutical drugs cover biological means as well as chemical synthesis.

The Biopharma industry’s growth dynamics is largely influenced by the more active participation of largest pharmaceutical corporations in the AI-related investment and research collaborations. Despite some Pharma corporations still being critical about AI applications, the number of researches, scientific publications in the field of AI in Biopharma and research collaborations between pharma companies and AI-expertise vendors is rapidly increasing.

Nevertheless research in AI is facing challenges today, but the demand for the ML/AI technologies, as well as for ML/AI talent, is growing in pharmaceutical and healthcare industries and driving the formation of a new interdisciplinary field – data-driven drug discovery/healthcare. The overall success of all the companies in the industry depends strongly on the presence of highly skilled interdisciplinary leaders, able to innovate, organize and guide in this direction. It will be crucial to hire top AI experts, especially for Big Pharma companies that are fighting to survive.

Trending and most innovative R&D approaches of top AI in Biopharma companies include application of:

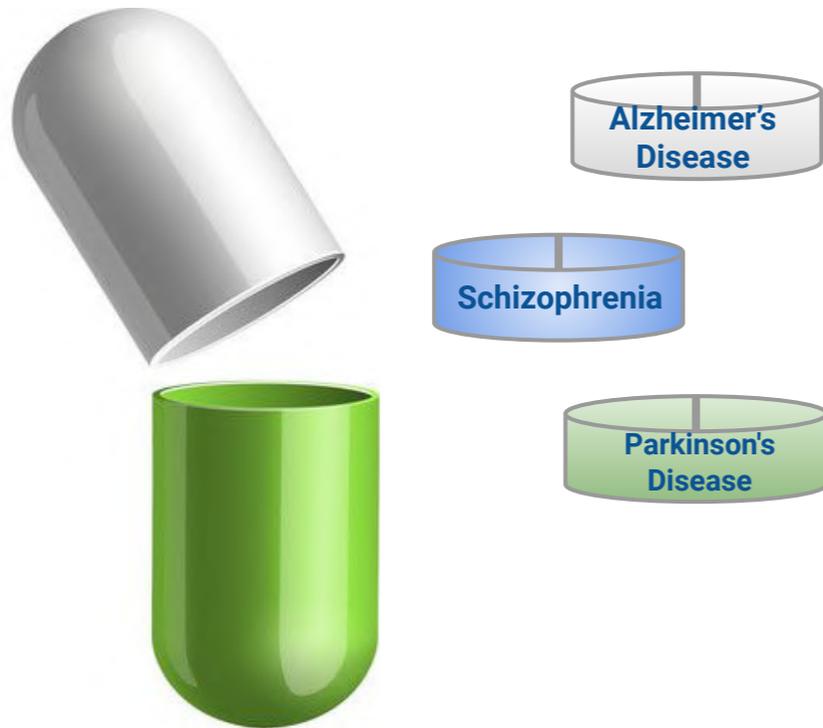


# Most Innovative R&D Approaches of AI in Biopharma. **Abbvie**

**abbvie** AbbVie is a global, research-based biopharmaceutical company formed in 2013 following separation from Abbott. The company's mission is to use its expertise, dedicated people and unique approach to innovation to develop and market advanced therapies that address some of the world's most complex and serious diseases.

There is not much information about use of artificial intelligence in drug discovery by AbbVie. But it does have a confidential project listed with Atomwise. Also, in September 2016, together with its partner AiCure, AbbVie announced how its AI-based patient monitoring platform improved adherence in an AbbVie phase 2 schizophrenia trial.

## Main focus areas:



Source

Crunchbase

## The way AI is used:

- to visually confirm medication ingestion;
- to increase medication adherence in patients;
- to use data to assess effectiveness of treatment.

## Cooperation:

- AiCure
- Mission Therapeutics



# How **Abbvie** Uses AI in R&D?

**abbvie** Abbvie and Mission Therapeutics collaboration is aimed on developing DUB inhibitors that promise to treat two currently incurable conditions, Parkinson's and Alzheimer's diseases. With over 50 million Americans struggling Alzheimer's and dementia, this AI partnership will bring treatment closer and hope for many.

1. Abbvie cooperates with another AI-specialized company AiCure, a clinically-validated artificial intelligence company that visually confirms medication ingestion on smartphones, announced that study results presented today during the International Society for CNS Clinical Trials and Methodology (ISCTM) Scientific Sessions confirm that use of the AiCure Platform significantly increases medication adherence in patients with schizophrenia, as measured by drug concentration levels.



2. The sub-study was part of a larger Abbvie, Phase 2, multicenter, randomized, double-blind, placebo-controlled, dose-ranging, parallel-group, study in nonsmoking subjects with schizophrenia who were clinically stable. Subjects were enrolled and randomized to placebo or ABT-126. The AiCure platform was introduced into 10 of 31 US sites; subjects were monitored either by AiCure or by modified Directly Observed Therapy (mDOT) at least 3 times per week. In addition, adherence was measured by review of returned study drug blister and scheduled pharmacokinetic sampling.
3. Results: cumulative adherence, measured by study drug concentrations above the LLOQ (minimum required therapeutic level), were higher through 24 weeks for subjects monitored using the AiCure platform (89.7%) compared with subjects monitored using mDOT (71.9%). This research adds to the growing body of scientific evidence showing the advantages of using AI to increase statistical power and reduce sample size in clinical trials, thereby decreasing costs and accelerating drug development.

Source

[AiCure](#)

[Blog.Benchsci](#)

[Healthcare Weekly](#)

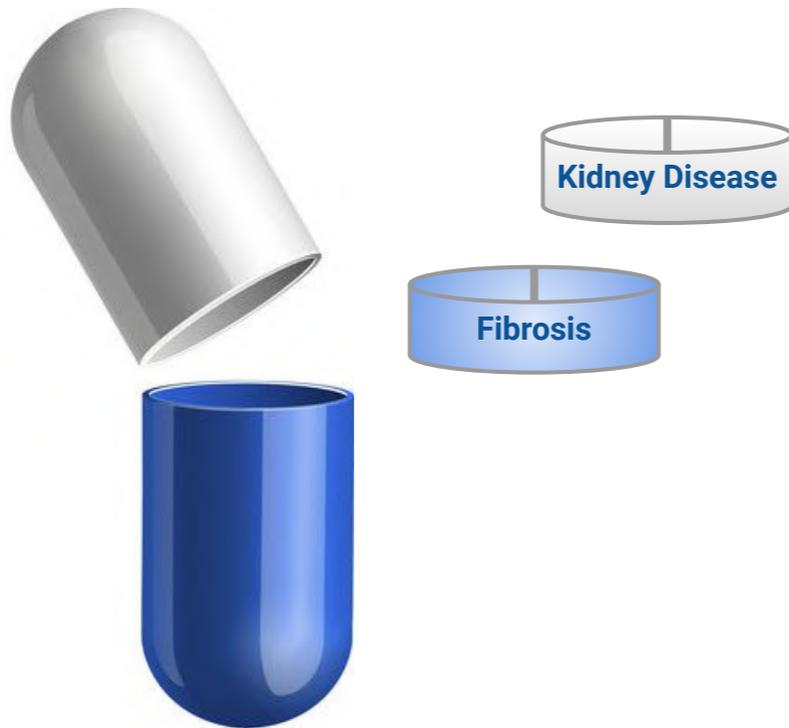
# Most Innovative R&D Approaches of AI in Biopharma. **AstraZeneca**



AstraZeneca is a global, science-led biopharmaceutical company, its innovative medicines are used by millions of patients worldwide. Jim Weatherall, Vice President in AstraZeneca, said that data science and AI has the potential to transform the way they develop new medicines – turning yesterday's science fiction into today's reality with the aim of enabling the translation of innovative science into life-changing medicines.

At AstraZeneca, they are using AI to combine information from multiple sources researchers hope to draw more accurate conclusions than if they analysed science literature by hand. AI also has the potential to find patterns in these graphs revealing previously unexplored hypotheses.

## Main focus areas:



## The way AI is used:

- to build disease understanding through knowledge graphs to integrate genomic, disease, drug and safety information;
- to identify new targets for novel medicines;
- for fast, accurate image analysis.

## Cooperation:

- Schrödinger

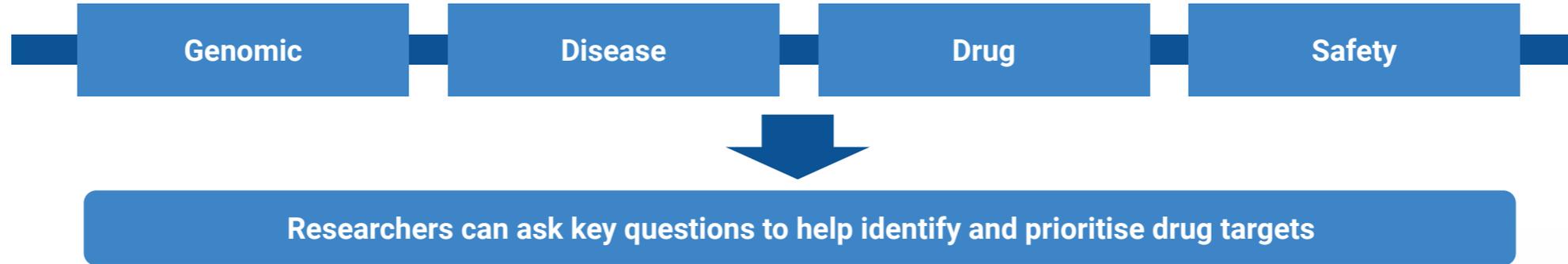


# How AstraZeneca Uses AI in R&D?



AstraZeneca focuses on the discovery, development and commercialisation of prescription medicines, primarily for the treatment of diseases in three therapy areas - Oncology, Cardiovascular, Renal & Metabolism and Respiratory. The company has turned to AI to cut development costs by improving the efficiency of repetitive tasks and engendering better-informed decision.

1. The knowledge graphs are used to give their scientists the information they need about genes, proteins, diseases and compounds and how they relate to each other. Using AI to combine information from multiple sources they hope to draw more accurate conclusions than if researchers analysed science literature by hand. AI also has the potential to find patterns in these graphs revealing previously unexplored hypotheses. The company's knowledge graphs integrate:



2. Discovering a potential drug molecule requires several years of detailed scientific research. AI is enabling us to rapidly generate novel ideas for molecules to make and rank these ideas using predictions based on large data sets available to us. Having identified promising molecules, the next step is to synthesise the molecules in the laboratory. AI is starting to help here too – the science of synthesis prediction is rapidly evolving and scientist will soon be able to use AI to help deduce the best way to make a molecule in the shortest time.
3. AI systems are trained to assist pathologists in analysing samples accurately and more effortlessly. This has the potential to cut analysis time by over 30%. For one of their AI systems, they implemented an approach inspired from how some self-driving cars understand their environment. They trained the AI system to score tumour cells and immune cells for a biomarker, called PD-L1, which has potential to help inform immunotherapy-based treatment decisions for bladder cancer.

Source

[AstraZeneca](#)

[TechCrunch](#)

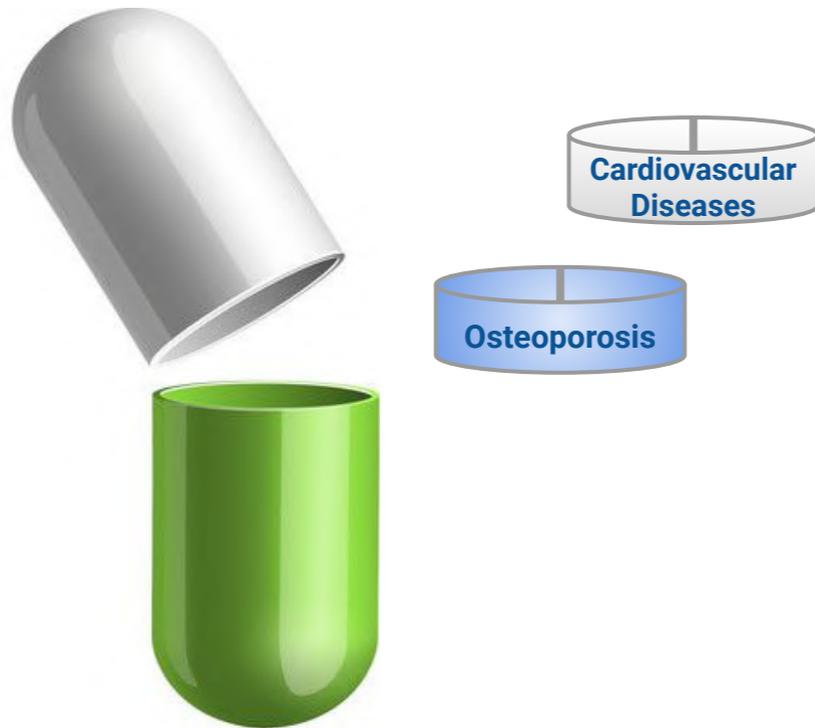
# Most Innovative R&D Approaches of AI in Biopharma. Amgen



Amgen is one of the world's leading biotechnology companies. Amgen is committed to unlocking the potential of biology for patients suffering from serious illnesses by discovering, developing, manufacturing and delivering innovative human therapeutics. This approach begins by using tools like advanced human genetics to unravel the complexities of disease and understand the fundamentals of human biology.

AI is but one of a series of emerging digital capabilities Amgen is advancing to improve how they do a whole host of activities across the company – from drug discovery and patient identification to optimized interactions with physicians. Other technologies that company is leveraging include digital automation, natural language processing, advanced analytics.

## Main focus areas:



Source

Wired

## The way AI is used:

- to boost the accuracy of risk predictions;
- to provide personalized approach to patient care;
- to support compliance via real-time answers with accuracy, consistency;
- to use data to determine the most effective treatment.

## Cooperation:

- Owkin

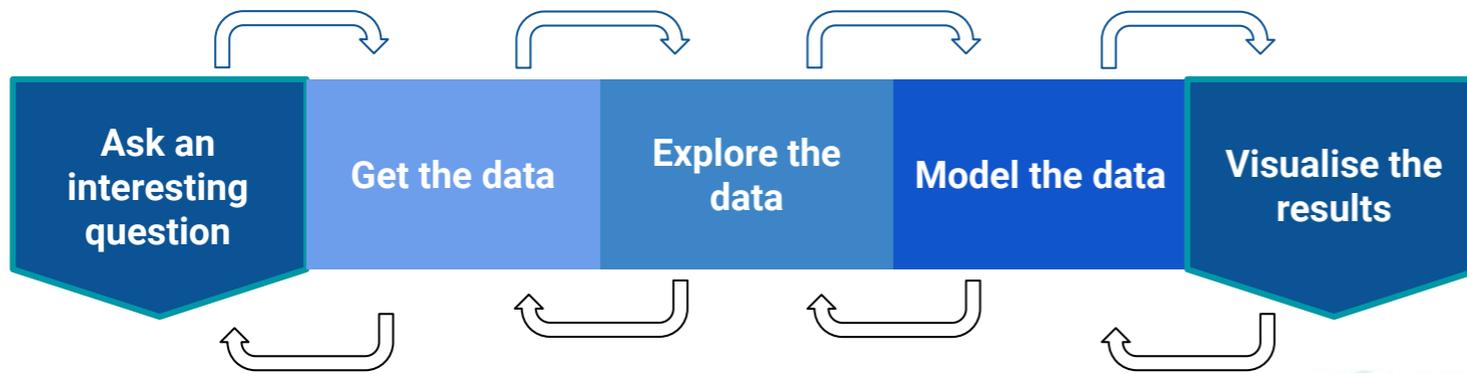


# How Amgen Uses AI in R&D?



Amgen is piloting a process using AI that has the potential to greatly enhance its ability to trend and find patterns in manufacturing deviations and to prevent their recurrence. The AI tool will replace a manual, labor-intensive process with one that can look across large data sets and find correlations between obscure signals and events which the previous system could have missed.

1. While large company manufacturing, purifying, and packaging biotech drugs, a huge amount of diverse data is generated, not all of which is digitized. The focus of Amgen is the application of data science specifically in quality operations, using a data science process:



Quality data sciences creates solutions that unlock and leverage data. These solutions will efficiently provide insights and intelligence for the Quality Operation. This involves:

- 1) Ensuring data access;
- 2) Application of appropriate analysis methods to unlock information;
- 3) Meaningful visualisation

2. Amgen have created a project team to look for a system algorithm that could replicate and perhaps improve upon the manual process. The goal was to think big but start small and build a product that could be deployed across the manufacturing network. Using an **agile development approach** and **natural language processing (NLP)** tools, the team developed a consistent algorithm that was able to reasonably replicate the manual process.

NLP is described as an AI technology that turns text into numbers, which can be read by a computer and used to identify similar records. Each record has a series of numbers associated with it that can be analyzed to create similarity scores. The records can then be clustered together. Those clusters can then be given to an subject matter expert, who can decide if there is trending and if action should be taken. Feedback can then be given to the algorithm, which can be adjusted.

Source

Wired

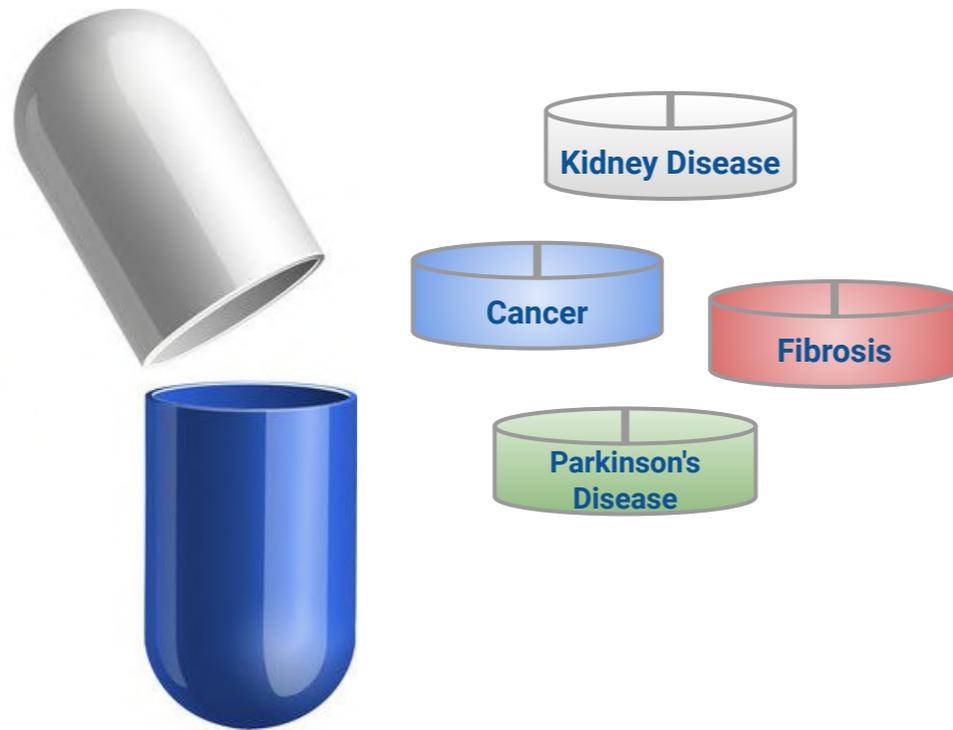
Pharmaceutical Online

# Most Innovative R&D Approaches of AI in Biopharma. **BenevolentAI**

**BAI** BenevolentAI is the global leader in the application of AI for scientific innovation. The company's aim is to accelerate the journey from inventive ideas to medicines for patients by developing AI to generate new treatments for some of the world's 8,000 untreated diseases. BenevolentAI integrates AI technologies at every step of the drug discovery process: from early discovery to late stage clinical development.

The company has developed the Benevolent Platform™ - a leading computational and experimental discovery platform that allows our scientists to find new ways to treat disease and personalise medicines to patients. The Benevolent Platform™ focuses on three key areas: Target Identification, Molecular Design and Precision Medicine.

## Main focus areas:



## The way AI is used:

- to force the discovery of drug patterns;
- to collect more diverse data;
- to identify specific target;
- in molecular design;
- in patient stratification.

## Cooperation:

- Neuropore Therapies
- Novartis



Source

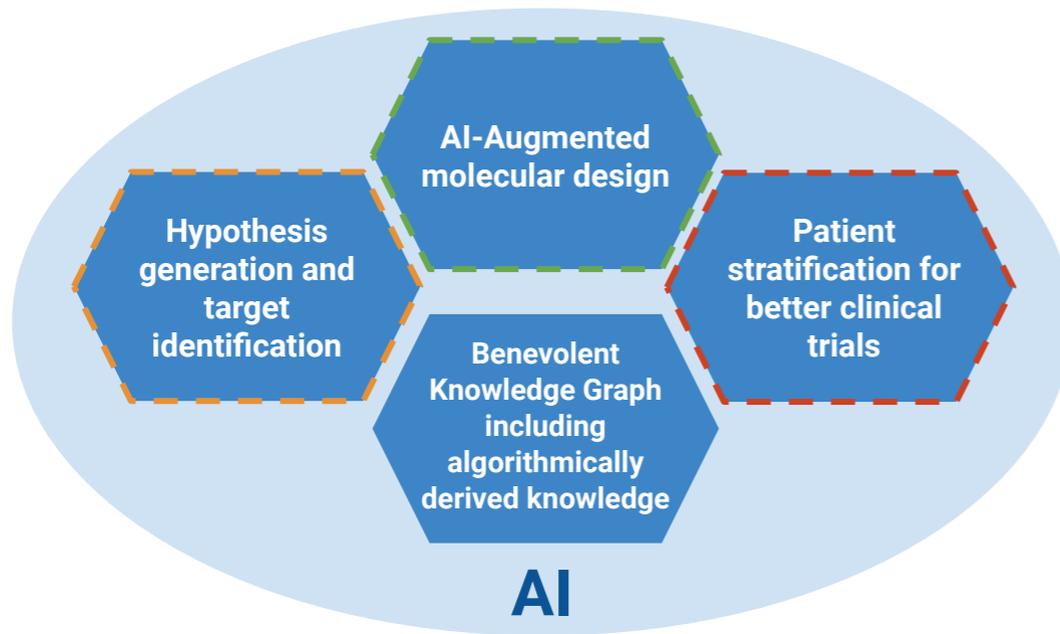
Wired

Benevolent.ai

# How BenevolentAI Uses AI in R&D?

**BAI** The Benevolent Platform™ of computational and experimental technologies and processes, draws on vast quantities of mined and inferred biomedical data and is built and used by their world-class scientists, researchers, and technologists, working side-by-side, to improve and accelerate every steps of the drug discovery process.

1. BenevolentAI uses AI to mine and analyse biomedical information, from clinical trials data to academic papers. The company's approach:



2. BenevolentAI has spent the last five years developing a knowledge pipeline that pulls data from various structured and unstructured biomedical data sources and **curates and standardizes this knowledge via a data fabric**.

This is fed into our proprietary **knowledge graph** which extracts and contextualises the relevant information.

The knowledge graph is made up of a vast number of contextualised, machine curated relationships between diseases, genes, drugs and with over 20 types of biomedical entities.

3. Relation inference AI models help to predict **potential non-obvious disease targets** that may be overlooked. Their specific expression based models help to identify proteins, genes that express differently in a disease and healthy cell.
4. By leveraging advanced AI, the **EvoChem** product designs de novo compounds based on multiparametric optimisations with a scoring function that factors in all the properties the company is seeking to optimise for that molecule.
5. Company applies ML models to identify patient groups by the molecular signature of their disease and design, allowing to run faster clinical trials.

Source

[Wired](#)

[Benevolent.ai](#)

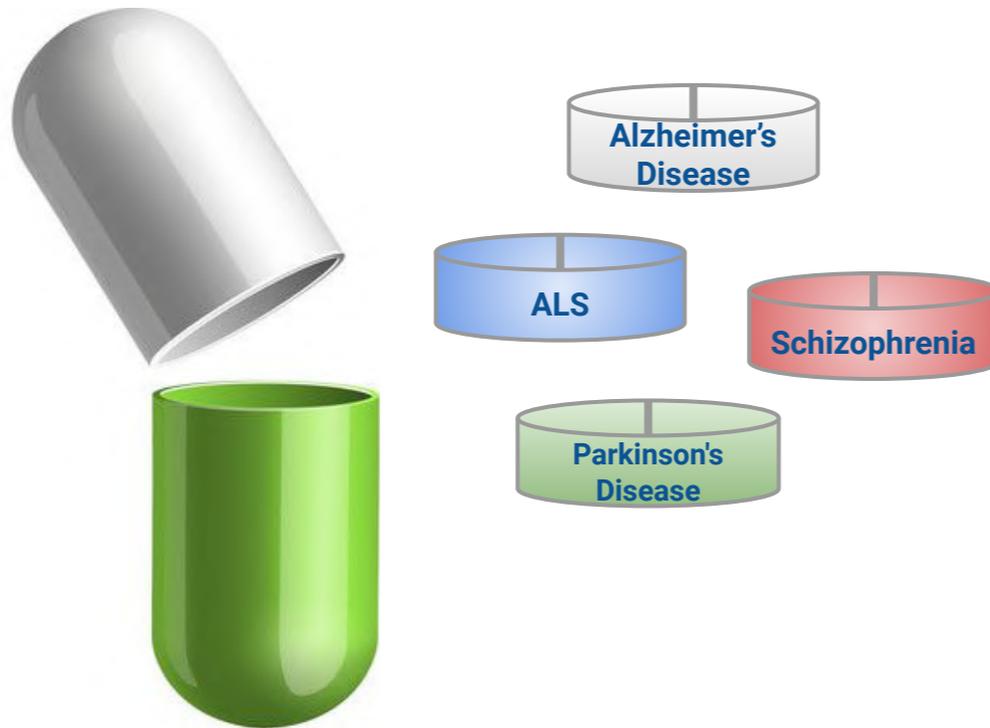
# Most Innovative R&D Approaches of AI in Biopharma. **Boehringer Ingelheim**



Boehringer Ingelheim is one of the world's largest pharmaceutical companies, and the largest private one. The company's key areas of interest are: respiratory diseases, metabolism, immunology, oncology and diseases of the central nervous system.

The focus of the company's AI-related activity is in doing so is on diseases for which no satisfactory treatment option exists to date. The company therefore concentrates on developing innovative therapies that can extend patients' lives. In animal health, Boehringer Ingelheim stands for advanced prevention.

## Main focus areas:



## The way AI is used:

- to boost the efficiency speed;
- to reduce the time needed to discover a new drug;
- to improve the quality of discovered drugs and molecules.

## Cooperation:

- Bactevo
- Bi X



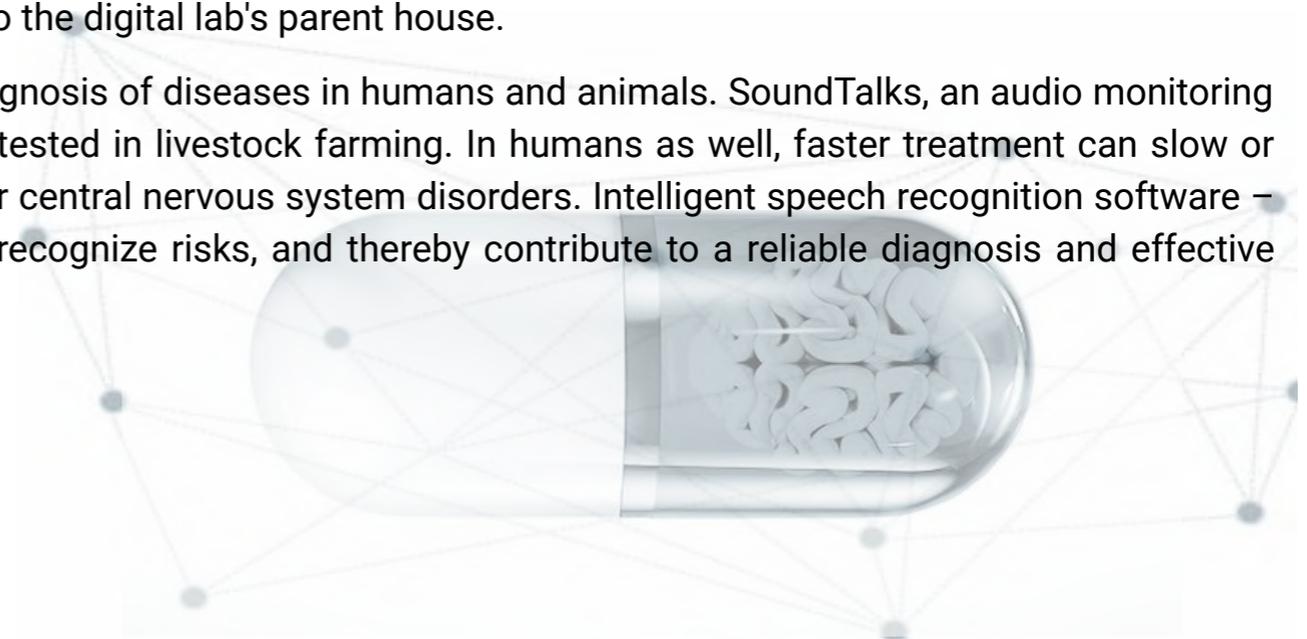
# How Boehringer Ingelheim Uses AI in R&D?



Boehringer  
Ingelheim

Boehringer Ingelheim has partnered with UK-based AI tech company Bactevo to speed up its drug discovery efforts. In this collaboration, Boehringer will leverage Bactevo's AI-powered platform – Totally Integrated Medicines Engine platform (TIME) – to boost the efficiency, speed, and quality of drug discovery from small molecule lead compounds. As a result they obtain the reduction of time to take drugs to market for treatment of conditions caused by defects in mitochondrial function. It essentially brings together the powerful drug research experience at Boehringer and state of the art TIME drug discovery platform to discover new medicines for ALS, Parkinson's disease and Alzheimer's disease.

1. With the founding of BI X as independent subsidiary Boehringer Ingelheim will focus on breakthrough innovative digital solutions in healthcare from idea to pilot. The start-up will work closely together with all three business units of the company - Human Pharma, Animal Health and Biopharmaceuticals. It will provide a platform for collaborating with specialists in the field of data science, agile software development and user experience design.
2. BI X will develop prototypes for new products and solutions and test them together with the company's business units in pilot phases. The business units will then use the successfully developed new products and solutions themselves and bring them to the market. This approach is to ensure that knowledge and experience accrued at BI X are being quickly integrated into the digital lab's parent house.
3. Analytical algorithms in audio tools can lead to advances in the earlier diagnosis of diseases in humans and animals. SoundTalks, an audio monitoring system for the early detection of respiratory diseases, is currently being tested in livestock farming. In humans as well, faster treatment can slow or even halt the progression of a disease – which is essential, particularly for central nervous system disorders. Intelligent speech recognition software – via smartphone, for example – will be able to analyze speech patterns, recognize risks, and thereby contribute to a reliable diagnosis and effective therapy.



Source

[eHealth News](#)

[pmlive](#)

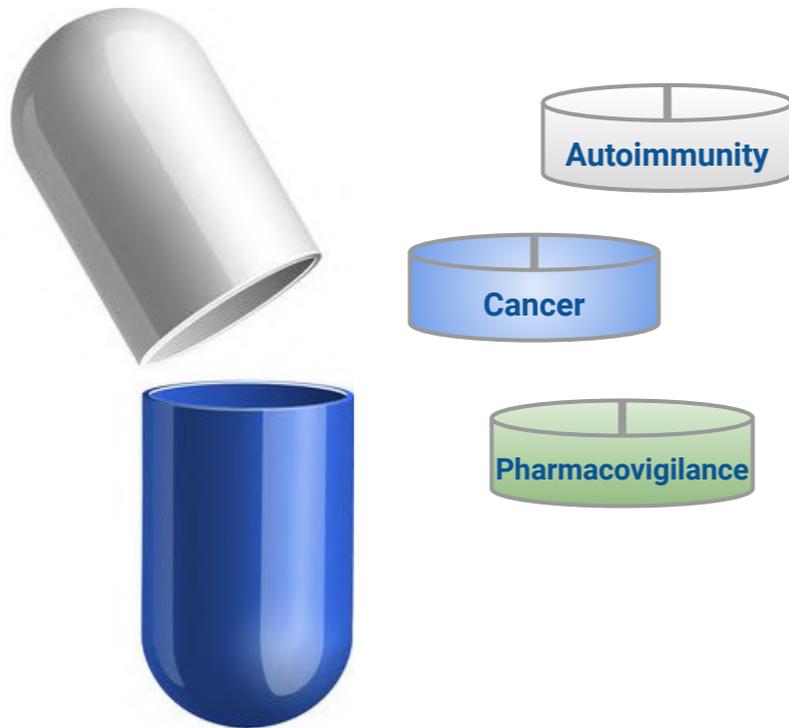
# Most Innovative R&D Approaches of AI in Biopharma. Celgene



Their vision as a company is to build a major biopharmaceutical corporation while focusing on the discovery, the development, and the commercialization of products for the treatment of cancer and other severe, immune, inflammatory conditions. There are more than 300 clinical trials at medical centers using compounds from Celgene. The company is transforming pharmacovigilance (PV) to drive the new era of patient safety.

Pharmacovigilance detects, assesses, and prevents adverse events (AEs) and other drug-related problems by collecting, evaluating, and acting upon AEs. The value of using AI methodologies in PV is compelling; however, as PV is highly regulated, acceptability will require assurances of quality, consistency, and standardization.

## Main focus areas:

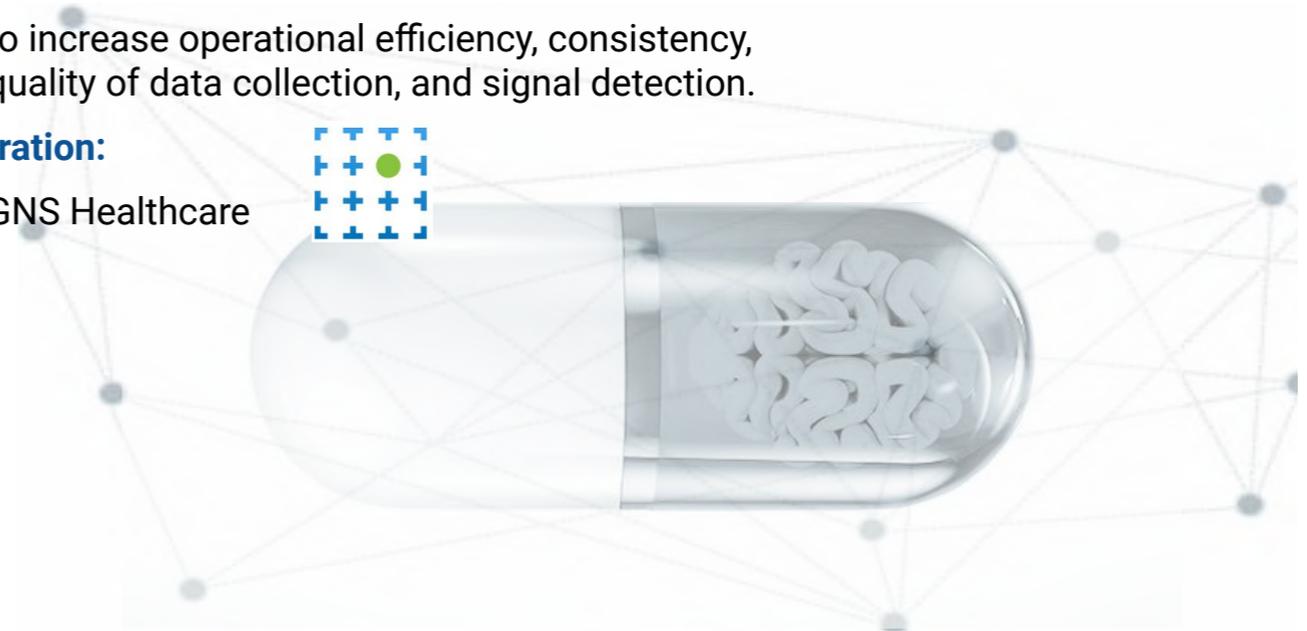


## The way AI is used:

- to speed up the discovery of drug candidates for for cancer and autoimmune diseases;
- to identify and standardize PV knowledge elements;
- to develop, review and validate cognitive services;
- to increase operational efficiency, consistency, quality of data collection, and signal detection.

## Cooperation:

- GNS Healthcare

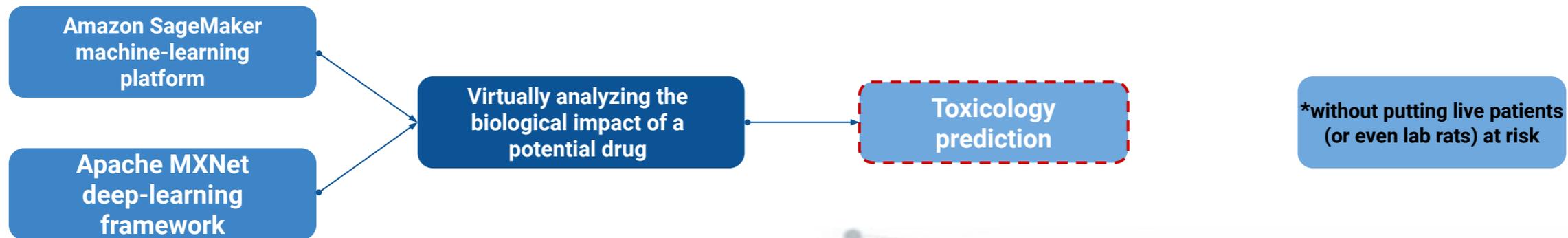


# How Celgene Uses AI in R&D?



Celgene force boost AI implementation in drug discovery particularly machine learning and deep learning. Machine learning involves computing techniques that analyze vast amounts of data to find understanding that might be too abstract and time consuming for humans. Deep learning takes that even further, using code that attempts to mimic the brain's ability to recognize patterns in unstructured data.

1. In the past, researchers relied on imperfect image-processing algorithms to analyze cancer cells, and then they corrected them by hand. With tens of thousands of cells, this required a huge expenditure of time and effort. But using deep learning, images can be processed almost instantaneously with much better results. For these analyses use:



2. Pharmaceutical research revolves heavily around exceedingly complex algorithms to predict how certain compounds will interact with the human body. To this end, Celgene uses high-performance **Amazon EC2 P3** instances powered by NVIDIA Tesla V100 Tensor Core GPUs (graphics processing units) to process the complexity. These NVIDIA GPUs have thousands of cores that accelerate the training of machine-learning models (which can, for instance, test the effectiveness of a drug at faster and more accurate rates). The results have been game changing: **A model that once took two months to train can now be trained in four hours.**
3. AI is used to identify areas across the pharmacovigilance (PV) value chain that can be augmented by cognitive service solutions using the methodologies of contextual analysis and cognitive load theory. It will also provide a framework of how to validate these PV cognitive services leveraging the acceptable quality limit approach.

Source

Springer

Labiotech

AWS Amazon

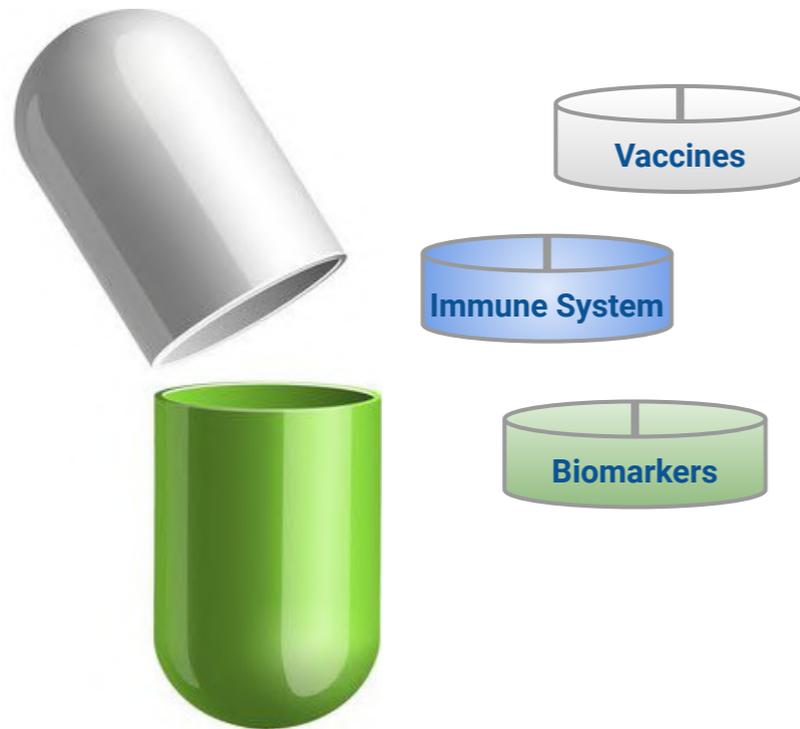
# Most Innovative R&D Approaches of AI in Biopharma. **GSK**



GlaxoSmithKline has 3 global businesses - Pharmaceuticals, Vaccines, Consumer Healthcare - that research, develop and manufacture innovative pharmaceutical medicines, vaccines and consumer healthcare products. Their R&D approach focuses on science related to the immune system, use of genetics and advanced technologies.

GlaxoSmithKline has many deals with different companies such as Exscientia, Insilico Medicine, Insilico Biotechnology to use new computer modelling systems to bring differentiated, high-quality and needed healthcare products.

## Main focus areas:



## The way AI is used:

- to improve the discovery of drugs, biomarkers, and new vaccines;
- to interpret and understand genetics and genomic data;
- to understand the effect of interventions on diseases.

## Cooperation:

- Exscientia
- Insilico Medicine



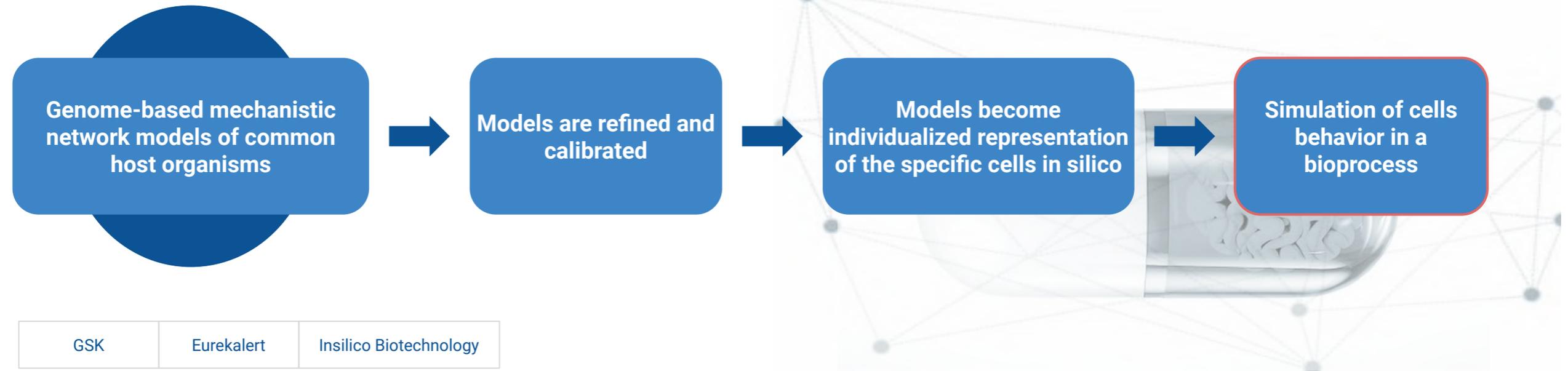
# How GSK Uses AI in R&D?



The goal of GSK is to achieve a sustainable flow of meaningful new treatments, utilising modalities such as small molecules, antibodies, antibody drug conjugates and cells, either alone or in combination. Their research focuses on science related to the immune system and human genetics, while leveraging advanced technologies including functional genomics, AI and machine learning.

1. According to the GSK and Exscientia collaboration, AI enabled platform will be applied and combined 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.
2. GSK evaluates Insilico Medicine technology in the identification of novel biological targets and pathways of interest to GSK to enhance its drug discovery process.
3. GSK uses Insilico' Biotechnology technology platform to analyse predictive simulations of cell responses. As a result an almost unlimited number of scenarios will be generated and utilized to significantly reduce the number of experiments necessary during bioprocess development. This has the potential to cut down the time taken to research Vaccine manufacturing processes and could therefore speed up the time-to-market for candidate Vaccines in GSK's research portfolio.

Insilico's technology is built around Insilico Cells™:



# Most Innovative R&D Approaches of AI in Biopharma. **Gilead**



Gilead is focused on developing and delivering medications that advance the treatment of life-threatening diseases. The commercial success of their products provides them with the resources to generate new clinical data defining their profiles and supports their development of new therapeutic advancements. As they bring new products into clinical development, their goal remains the same – to discover, develop and commercialize therapeutics that advance patient care.

In spring 2019 Gilead and insitro announced that the companies have entered into a strategic collaboration to discover and develop therapies for patients with nonalcoholic steatohepatitis (NASH).

## Main focus areas:



Source

Gilead

## The way AI is used:

- to create disease model;
- to discover new targets that influence disease progression and regression.

## Cooperation:

- insitro

**insitro**

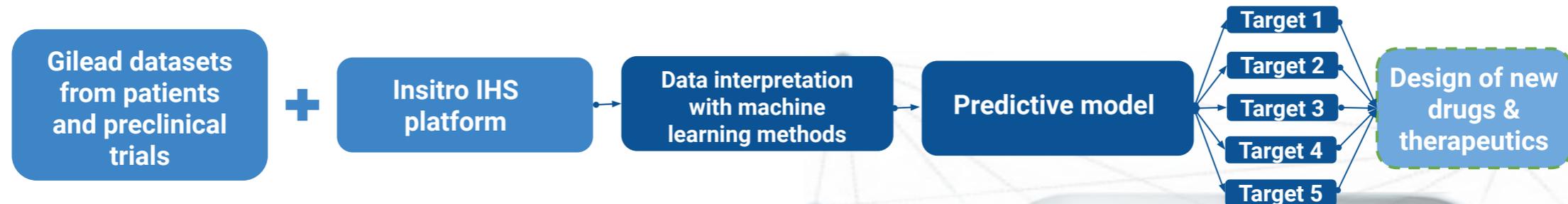


# How Gilead Uses AI in R&D?



According to John McHutchison, the company's Head of Research and Development, Gilead is committed to researching and developing treatments for patients living with NASH, particularly those with advanced fibrosis who have the greatest unmet need. Gilead is able to utilize deep learning to explore the scientific underpinnings of the biology and clinical spectrum of NASH, with the goal of accelerating the development of highly effective treatment options for patients with this disease.

1. The startup's insitro Human platform combines AI with human genetics and genomic data to provide insights into the disease's makeup and progression, propose forms of treatment and predict patient responses to those therapies. With that information, Gilead is planning to chemically develop up to five of the proposed treatments for NASH.
2. By generating high-throughput, functional genomic data sets that align with patient data, and interpreting those data via novel machine learning methods, insitro builds predictive models that can accelerate target selection and the design of effective therapeutics. The company is building a high-throughput bio-data factory based on state-of-the-art technologies from bioengineering, allowing the creation of large data sets that enable cutting edge machine learning methods to be brought to bear on key bottlenecks in drug development.



3. The insitro Human (ISH) platform applies machine learning, human genetics and functional genomics to generate and optimize unique in vitro models and drive therapeutic discovery and development. The ISH platform provides insights into disease progression, suggest candidate targets, and predict patient responses to potential therapeutic interventions. Gilead can advance up to five targets identified through this collaboration and is responsible for chemistry and development against these targets.

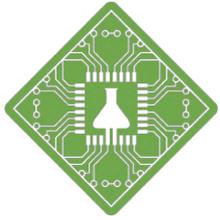
Source

[Wire](#)

[GEN](#)

[Beckershospitalreview](#)

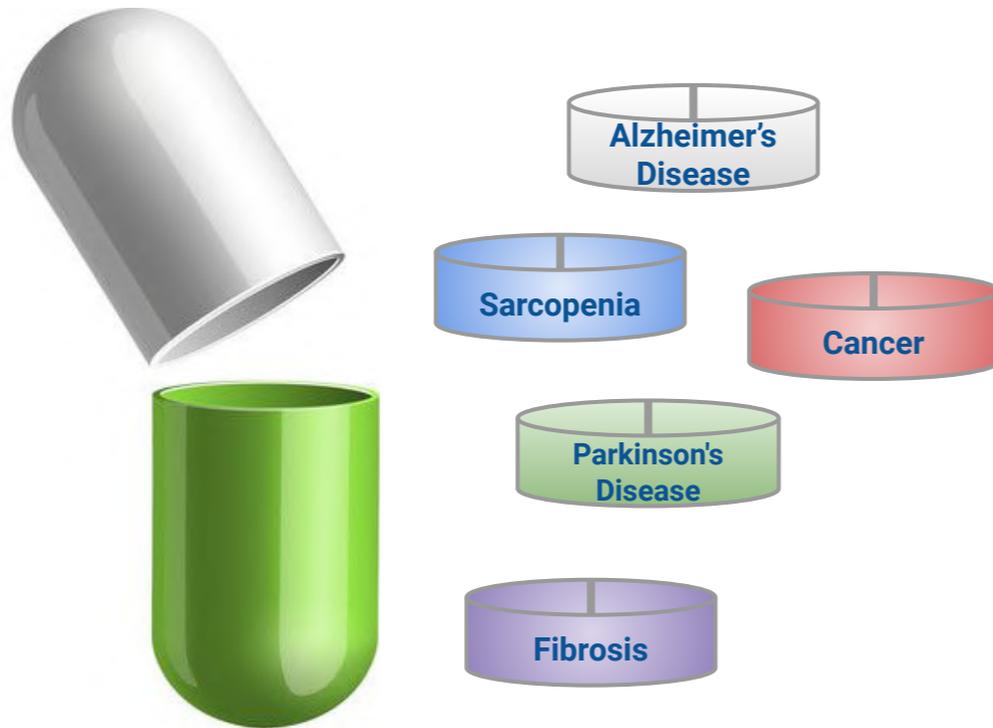
# Most Innovative R&D Approaches of AI in Biopharma. **Insilico Medicine**



Insilico Medicine, Inc. is a bioinformatics company located at the Emerging Technology Centers at the Johns Hopkins University Eastern campus in Baltimore. It utilizes advances in genomics, big data analysis and deep learning for in silico drug discovery and drug repurposing for age-related diseases. The company pursues internal drug discovery programs and geroprotector discovery and provides services to pharmaceutical companies.

Combining genomics, big data analysis, and deep learning, the company has been using artificial intelligence algorithms to potentially discover the next world-changing drug.

## Main focus areas:



## The way AI is used:

- to cheaper and faster discover of drug molecules;
- to imagine new molecules with drug-like properties;
- to find new drug candidates, biological targets and molecules;
- to validate the targets, using novel chemistry.

## Cooperation:

- BioTime 
- Juvenescence AI Limited 
- Bitfury 

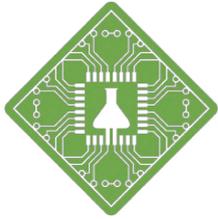


Source

EurekaAlert

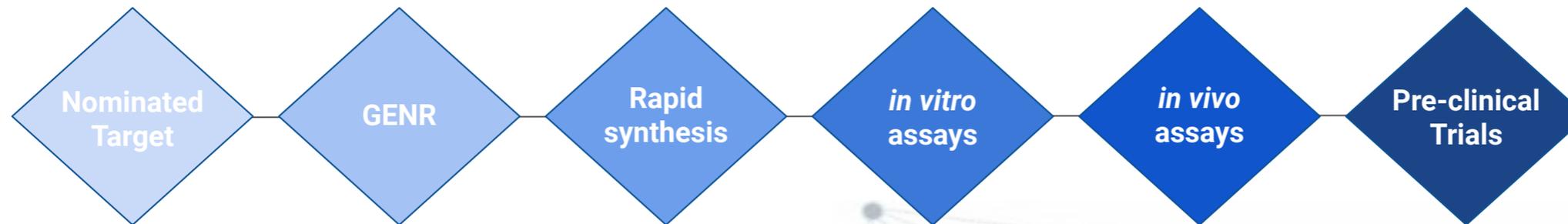
Insilico

# How Insilico Medicine Uses AI in R&D?



Next-generation AI developed by Insilico Medicine can be used to validate, assess and improve the quality of biological samples as well as learn using large volumes of heterogeneous data without human intervention. Multiple new methodologies including the feature importance, deep feature selection and deep pathway analysis among the others can provide the biologically-relevant interpretation of the inner workings of the AI systems.

1. Since 2016, Insilico Medicine researchers have been working to get GANs (Generative Adversarial Networks consisting of two distinct neural networks) to “imagine” new molecules with drug-like properties. In 2017, they combined this with another type of groundbreaking A.I. in the form of Reinforcement Learning. Reinforcement Learning is built around the notion of A.I. agents which use trial-and-error to maximize some kind of reward.



2. Insilico Medicine has developed GENTRL (Generative Tensorial Reinforcement Learning), a new artificial intelligence system for drug discovery that dramatically accelerates the process from years to days (from 3 years to 21 days before first synthesis and trials). In the industry’s first successful experimental validation of such AI technology for drug discovery in cells and animals, Insilico successfully tested the technology by creating a series of entirely new molecules capable of combating disorders like fibrosis.
3. The system bucks the standard brute-force approach for AI drug development, which involves screening millions of potential molecular structures looking for a viable fit, in favor of a creative AI algorithm that can imagine potential protein structures based on existing research and certain preprogrammed design criteria. Insilico's system initially produced 30,000 possible designs, which the research team whittled down to six that were synthesized in the lab, with one design eventually tested on mice to promising results.

Source

[Biospace](#)

[Digital Trends](#)

[Business Insider](#)

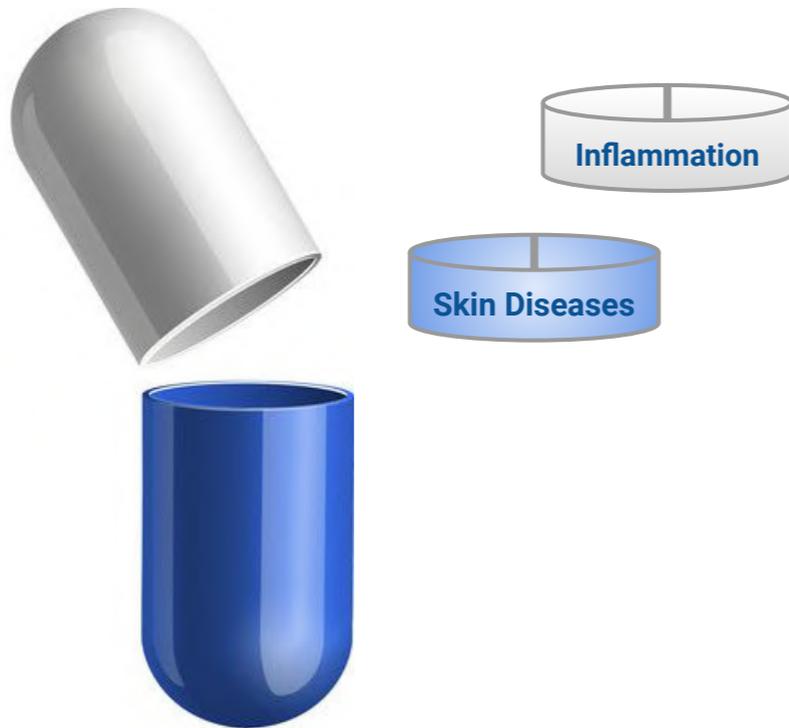
# Most Innovative R&D Approaches of AI in Biopharma. **Nuritas**

## **NURITAS**

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.

Their bioactive peptides provide patented innovative solutions to companies needing new therapeutic options to deal with significant unmet medical needs. The Bioactive Peptides they discover have the potential to offer new and innovative treatments for many of the illnesses that are becoming more prevalent as the world population continues to expand and age.

### **Main focus areas:**



### **The way AI is used:**

- to target, predict and unlock novel bioactive peptides;
- to deliver highly specific, efficient and life-changing health solutions;

### **Cooperation:**

- BASF

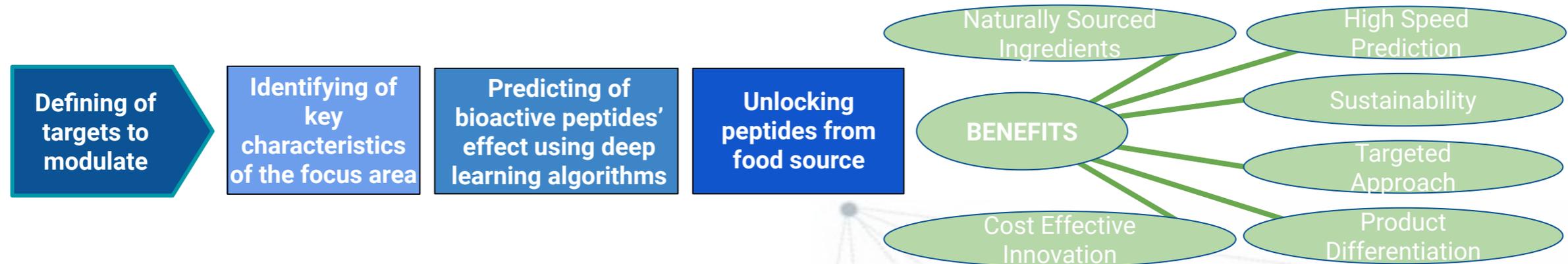


# How Nuritas Uses AI in R&D?

## NURITAS

At Nuritas, they recognise the vast untapped potential that exists in naturally occurring Bioactive Peptides. Their unique discovery platform targets, predicts and unlocks these natural ingredients to provide new solutions and opportunities for their partners across a wide range of application areas. Together with their partners, they are changing the lives of billions of people worldwide.

1. They begin the discovery process by precisely defining the health condition and targets they wish to modulate. They then use proprietary search tools to identify the characteristics specific to their area of focus. The most up-to-date academic and scientific knowledge is used to maximise the efficiency and effectiveness of prediction algorithms.



2. Having begun the discovery process as above, Nuritas takes advantage of multiple proprietary AI algorithms, including deep learning. Using these, they are now uniquely able to predict which novel food-derived bioactive peptides deliver the pre-determined effect that they are seeking. This cuts out many thousands of hours of trial and error.
3. After targeting and predicting high potential Bioactive Peptides, Nuritas unlocks them from within the food source for their pre-defined therapeutic use.
4. Their library of plant and animal derived Bioactive Peptides have gone through hundreds of millions of years of selective evolution to become the most potent repairers, healers and protectors.

Source

Nuritas

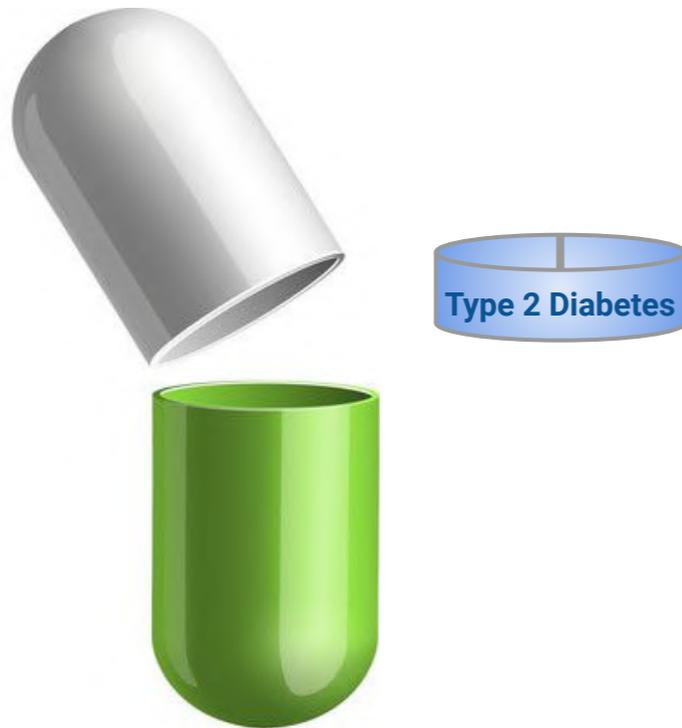
# Most Innovative R&D Approaches of AI in Biopharma. **Novo Nordisk**



Novo Nordisk is a global healthcare company with more than 95 years of innovation and leadership in diabetes care. This heritage has given us experience and capabilities that also enable us to help people defeat other serious chronic diseases: haemophilia, growth disorders and obesity. At Novo Nordisk, they are driving change to defeat diabetes and other serious chronic diseases.

Novo Nordisk cooperates with e-Therapeutics to use its AI-based drug discovery technology to find new therapies for type 2 diabetes. e-Therapeutics uses a suite of powerful computational tools to augment and interrogate the vast amount of biological information currently available in both public and private databases.

## Main focus areas:



## The way AI is used:

- to identify novel intervention strategies;
- to find new biological pathways and compounds;
- tease out previously unknown disease processes and pathways;
- to form the basis for new therapies.

## Cooperation:

- e-Therapeutics  e-therapeutics

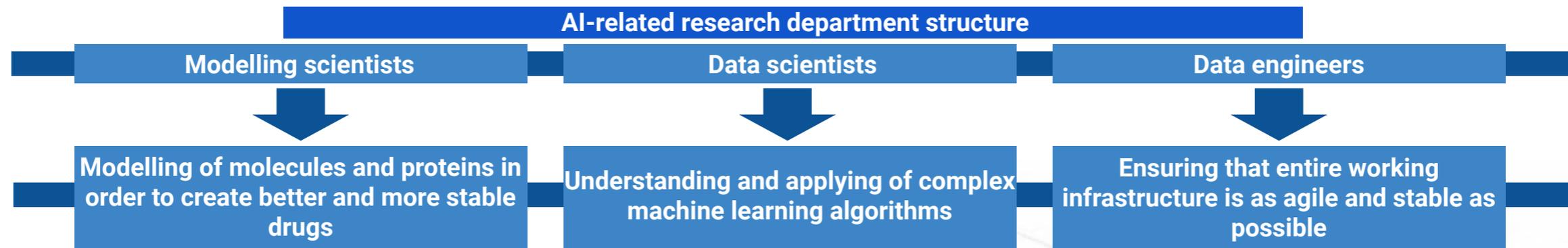


# How Novo Nordisk Uses AI in R&D?



The company said this approach more realistically reflects the true complexity of disease with its multiple and often interconnected cellular pathways. Novo Nordisk already has a research centre in Oxford, where visiting researchers are working with Oxford University academics to advance development of therapies for type 2 diabetes.

1. Using techniques such as machine learning and state of the art data analysis, e-Therapeutics creates and analyses network models of disease to identify likely proteins that could be disrupted to treat diseases. Company's scientists use AI to improve and accelerate active pharmaceutical ingredient (API) and drug product (DP) designs of new peptides and biologics. They have access to advanced state-of-the-art protein modelling software and are applying data science tools and prediction models to a variety of biological and chemical data, including high-throughput analytical data and images.



2. Novo Nordisk is the first pharma partner to sign up to use the GAIN platform, which taps into genome-wide association study (GWAS) data to find mutations in DNA linked to disease traits and – according to the UK company – bridges the gap between genetic susceptibility and disease mechanism. While many gene variants discovered using GWAS studies often don't map to a plausible biological mechanism, e-Therapeutics says its “network biology” approach can improve the hit rate.
3. Using GAINs, the company will be able to interrogate genomics data from patients with complex, polygenic disease and shed new light on important and novel biological pathways for particular groups of patients.

Source

Novo Nordisk

Pharma Forum

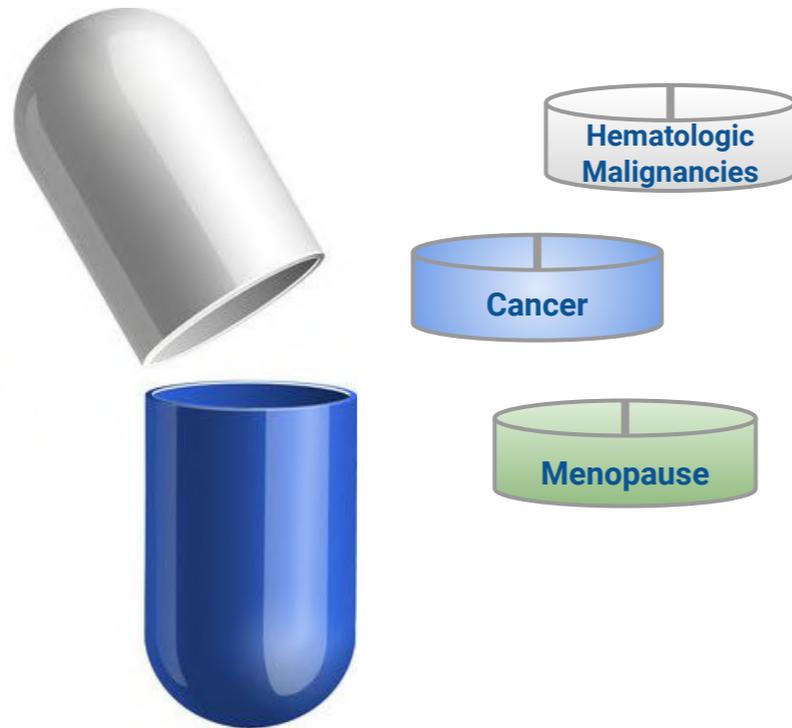
# Most Innovative R&D Approaches of AI in Biopharma. Pfizer



Pfizer is a leading research-based biopharmaceutical company. They apply science and their global resources to deliver innovative therapies that extend and significantly improve lives. The company's products are the results of 1500 scientists overseeing more than 500,000 lab tests and over 36 clinical trials before the first prescription.

Pfizer in late 2016 announced 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. Based on their research, this appears to be one of the first significant uses of Watson for drug discovery.

## Main focus areas:



## The way AI is used:

- to uncover new information or insights related to patient needs;
- to analyze massive volumes of disparate data sources, including licensed and publicly available data;
- to discover new drug targets and alternative drug indications.

## Cooperation:

- IBM Watson

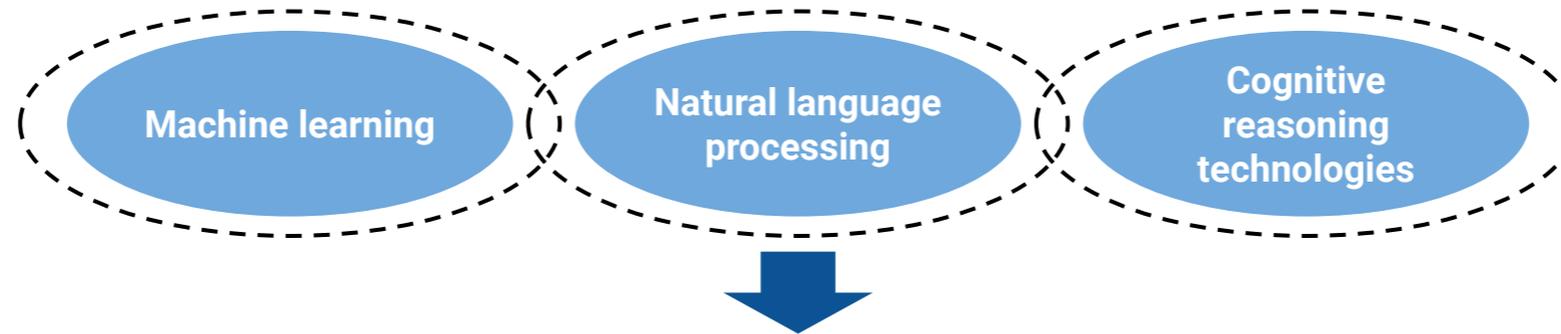


# How Pfizer Uses AI in R&D?



Pfizer is among the healthcare companies investing heavily in AI and teamed with IBM Watson to identify better targets for cancer during the discovery phase and Concerto HealthAI to apply real-world datasets and artificial intelligence techniques to develop new and more precise treatment options for patients with solid tumors and hematologic malignancies.

1. Pfizer is one of the first organizations worldwide to deploy Watson for Drug Discovery, and the first to customize the cloud-based cognitive tool:



**to support the identification of new drug targets, combination therapies for study, and patient selection strategies in immuno-oncology**

2. Pfizer uses newly launched Watson for Drug Discovery, a cloud-based offering that aims to help life sciences researchers discover new drug targets and alternative drug indications. The average researcher reads between 200 and 300 articles in a given year, while Watson for Drug Discovery has ingested 25 million Medline abstracts, more than 1 million full-text medical journal articles, 4 million patents and is regularly updated. Watson for Drug Discovery can be augmented with an organization's private data such as lab reports and can help researchers look across disparate data sets to surface relationships and reveal hidden patterns through dynamic visualizations.
3. AI systems are used in progressive ways to analyze data, to uncover new information or insights related to patient needs.

Source

Pfizer	Medtechdive	Pfizer
--------	-------------	--------

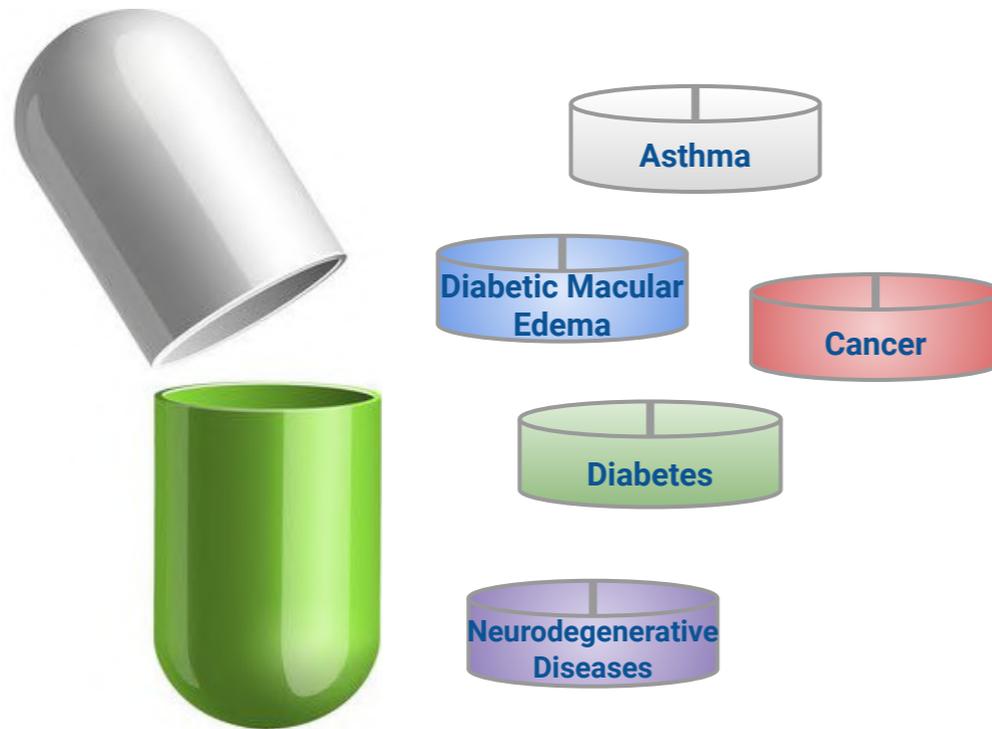
# Most Innovative R&D Approaches of AI in Biopharma. Roche



To intensify its focus on healthcare, Roche divests two businesses: fragrances and flavours, and vitamins and fine chemicals. As a research-driven company committed to innovation, the Group's Pharmaceuticals and Diagnostics Divisions supply products spanning the healthcare spectrum, from the early detection and prevention of disease to diagnosis and treatment.

Sensors, wearables, IOT, blockchain, high performance compute, Machine Learning and Deep Learning are drivers and enablers of digital transformation of Roche's entire Pharma value chain. AI is expected to have a dramatic impact on medicine that Roche provides.

## Main focus areas:



## The way AI is used:

- to improve the ability to diagnose disease;
- to select the best treatments for individual patients;
- to De novo compound design;
- to better target selection.

## Cooperation:

- Owkin

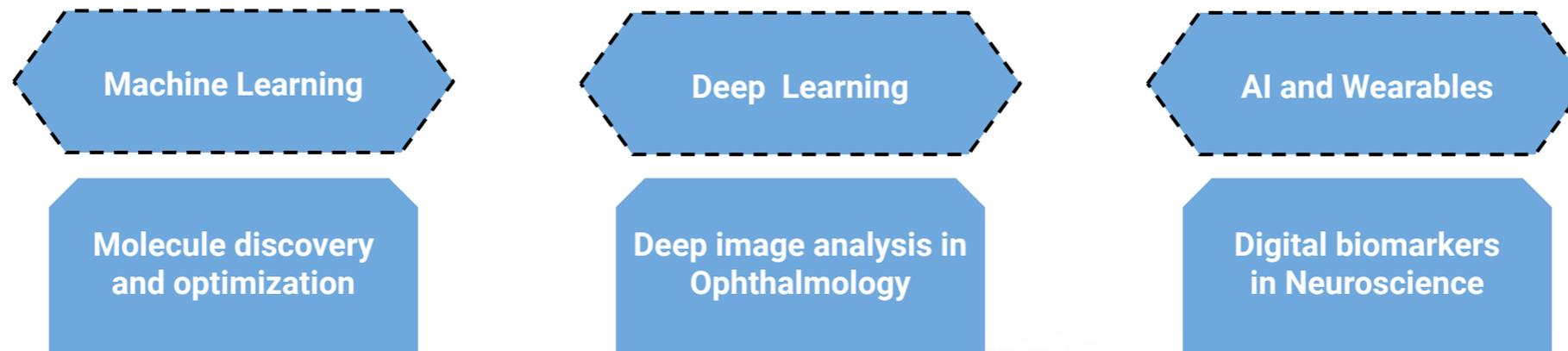


# How Roche Uses AI in R&D?



With the advent of more sophisticated digital technologies, personalised healthcare is entering a new phase, expanding from companion diagnostics to a more complex, holistic view of patient health generated from a wide variety of data sources. Combining and standardising data, using AI and algorithms to make sense of it all, enhance the way Roche can develop and bring medicines to patients in a much more targeted fashion.

1. Examples of transformative digital use cases across different areas, modalities and pipeline phases:



2. AI could revolutionise the way ophthalmologists diagnose diabetic macular edema (DME), a complication of diabetes that causes a thickening of the retina that can lead to irreversible blindness if left untreated. The best way to prevent DME is through regular eye exams that use a technique called colour fundus photography (CFP) and optical coherence tomography (OCT). The company's researchers use deep learning to teach computers how to estimate macular thickness from CFP images, making DME diagnosis easier, so they gave their computers a large set of CFP and OCT data from participants in two large DME clinical trials to train on.

The deep learning system examined a total of 17,997 CFP images from ~700 patients and compared them with corresponding OCT thickness measurements. Deep learning could even do a reliable job of predicting the actual OCT measurement of the macula's thickness from a CFP image if it was of sufficient quality.

Source

Roche

Roche

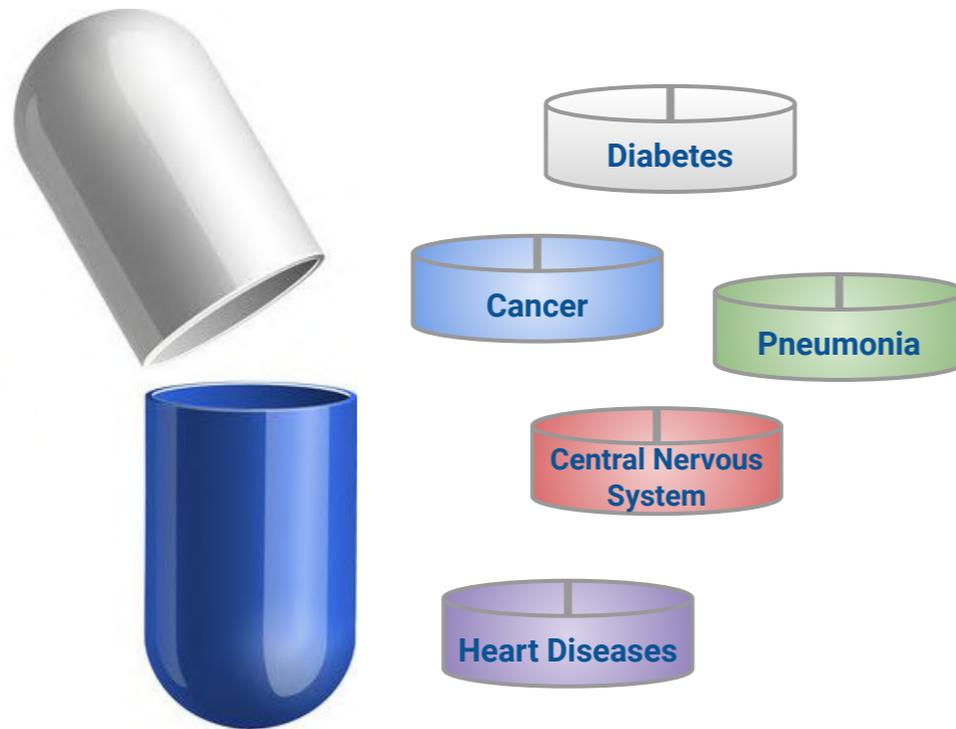
# Most Innovative R&D Approaches of AI in Biopharma. **Sanofi**



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, etc. Its products includes prescriptions and over-the-counter drugs for thrombosis, cardiovascular disease, diabetes, central nervous system disorders, oncology and internal medicine, vaccines.

Sanofi and Google apply artificial intelligence (AI) across diverse datasets to better forecast sales and inform marketing and supply chain efforts. Using AI will take into account real-time information as well as geographic, logistic and manufacturing constraints to help the accuracy of these complex activities.

## Main focus areas:



## The way AI is used:

- to provide remote connection between patients and doctors;
- to diagnose diseases at early stage;
- to decentralize clinical trials;
- to improve marketing strategies.

## Cooperation:

- Google



# How Sanofi Uses AI in R&D?



Big data and a better understanding of the human genome are also providing medical professionals with better tools to make faster, more accurate diagnoses and deliver more personalized treatments. Large, multinational databases of clinical data called patient registries can also play a key role in the study of rare diseases. Additionally, Sanofi IT will be modernizing its infrastructure by migrating some existing business applications to Google Cloud Platform (GCP).

## Mouthlab

1. MouthLab is a single, noninvasive device that measures more than 10 different health indicators in less than a minute. The AI-powered system uses the patient's mouth and hand to measure in real-time vital health signs typically monitored at the doctor's office, including respiratory rate, pulse, electrocardiogram, blood oxygen saturation, temperature, blood pressure, and several lung functions. In addition, the device connects to the cloud, so patient data is accessible in real time to physicians and caregivers. By making this data easily available, Sanofi aims to reduce hospitalizations, patient costs and risks.

## Wavy Assistant

2. Wavy Assistant delivers continuous real-time heart health monitoring using voice and AI solutions. After a patient's data is collected and analyzed, Wavy can provide advice tailored to that individual. Our heart health monitoring solution uses a smart home speaker as its main user interface, which allows customers to interact with their heart health easily through a natural conversation instead of a mobile app. If the system detects something is wrong, Wavy instantly sends an emergency signal to designated doctors, friends and family. It can also trigger an immediate alert during emergency situations. Almost all heart attacks and strokes happen at home and most of the damage occurs because the emergency services are called too late.

## LIFEdata

3. LIFEdata is an intuitive, easy to use AI platform that automates personally tailored conversational experiences across all channels. In terms of user experience, healthcare is no different than any other industry.

Source

Sanofi

# How Sanofi Uses AI in R&D?



## ChatbotPack.com

4. Computers that understand humans through text and voice are Sanofi's solution for healthcare with many applications. Voice technologies are used to detect, e.g. flu—or a general decline in condition—before it gets worse (e.g. pneumonia). A device in the elderly person's home can analyze changes in a person's voice and detect symptoms early on. It helps homecare and home nurses to detect their patients' illness before they need hospital care.

## Mentalab

5. Mentalab combines a wearable patch that can measure electrocardiogram biosignals continuously, with a cloud-based analysis service to diagnose and monitor cardiac and respiratory conditions. The patch can be applied by patients directly, and worn throughout their daily activities, while data is transmitted and analyzed seamlessly. In site-less clinical trials, this solution can increase patient engagement and participation rates.

## NeuroAdvise

6. NeuroAdvise is a clinical decision support tool available as a mobile application that helps physicians make better clinical decisions. Our system can archive all demographic and clinical patient-related information in a classified manner. Data is currently stored without patient identity according to time and date. NeuroAdvise algorithms are simulations of a clinician's mental diagnostic process and most of the important diagnostic factors are included in its comprehensive database. It only takes a few seconds for the user to access the list of differential diagnosis, which are sorted in order of probability and unique for each patient. The system is flexible with unlimited capacity for adding new symptoms, disorders and diagnostic tests.

## CART

7. A ring-design cardio tracker, or CART, can provide continuous monitoring of vital signs in real-world clinical trials and can be worn easily in daily life.

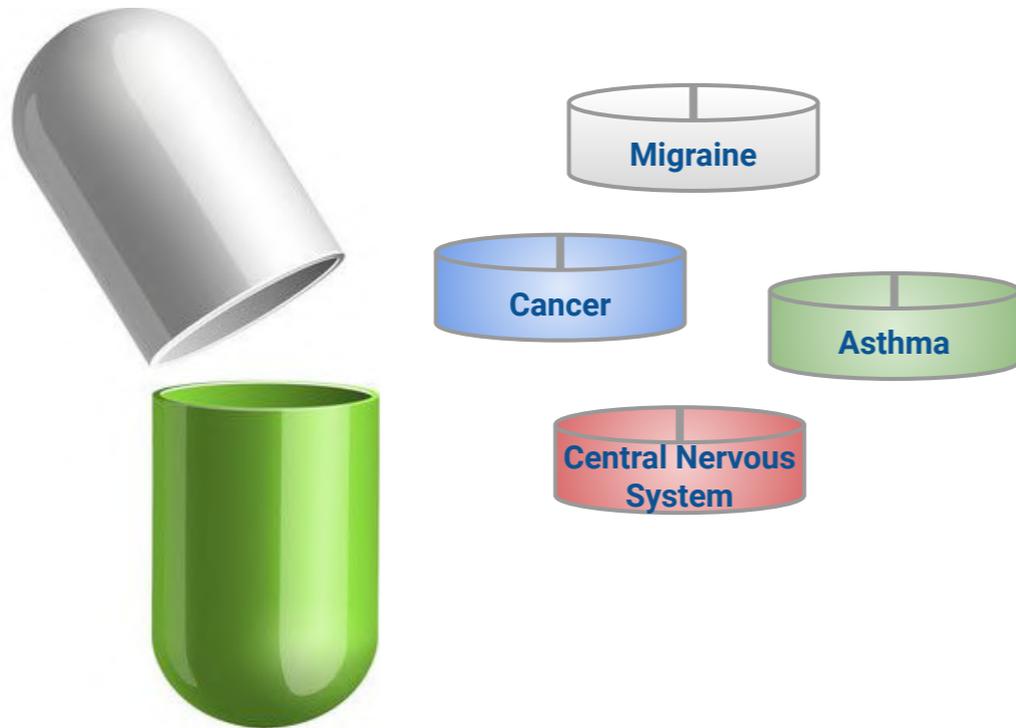
# Most Innovative R&D Approaches of AI in Biopharma. **Teva**



Teva is investing in both original biologic medicines and in biosimilars (highly similar versions to specific innovator biologics) to help patients around the world. We are focusing on treatments for the central nervous system, respiratory conditions, and in the field of oncology. Teva uses the help of AI for development of 'Single device location-algorithm pair' for optimal treatment of impaired mobility resulting from ageing and chronic disease as well as for digital technology, including body worn sensors.

In cooperation with IBM Research, Teva focuses on two key healthcare areas: the discovery of new treatment options and improving chronic disease management.

## Main focus areas:



## The way AI is used:

- to improve chronic disease management;
- to discover new treatment options;
- to repurpose already existing drugs.

## Cooperation:

- IBM Research



Source

Startuphub

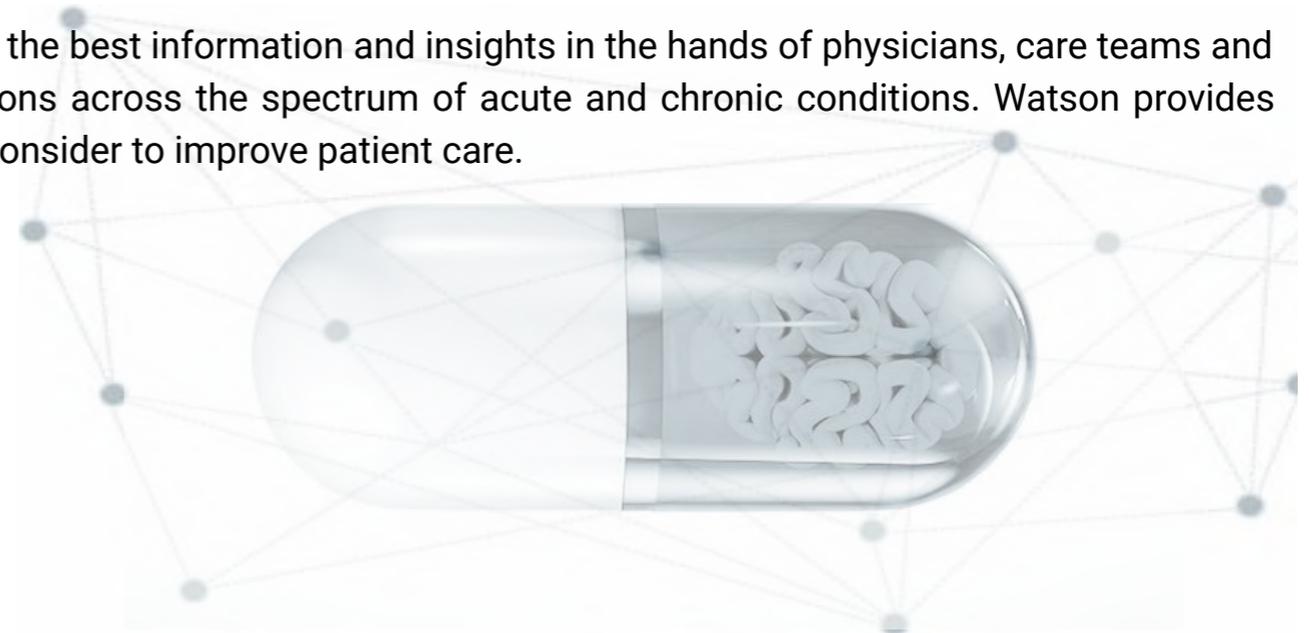
7wdata

# How Teva Uses AI in R&D?



In cooperation with IBM Research, Teva focuses on two key healthcare areas: the discovery of new treatment options and improving chronic disease management. Teva's AI projects are based on the IBM Watson Health Cloud, that is a health-data enabled platform-as-a-service which is designed to help healthcare organizations derive individualized insights and obtain a more complete picture of the many factors that can affect people's health based on machine learning.

1. Teva has chosen the IBM Watson Health Cloud as a preferred global technology platform and managed to build solutions designed to help millions of individuals worldwide with complex and chronic conditions such as asthma, pain, migraine and neurodegenerative diseases. In addition, a joint Teva-IBM Research team will deploy Big Data and machine learning technology to create disease models and advanced therapeutic solutions.
2. Watson is a groundbreaking cognitive computing platform that represents a new era of computing based on its ability to interact in natural language, process vast amounts of Big Data to uncover patterns and insights, and learn from each interaction. The Watson Health Cloud provides an open development platform for physicians, researchers, insurers and companies focused on creating health and wellness solutions.
3. IBM's Global Business Services works closely with a Teva Analytics team to assess the data and the analytics model requirements for the Real World Evidence e-health solution.
4. By building on the Watson Health Cloud, Teva is in a unique position to put the best information and insights in the hands of physicians, care teams and patients, to empower treatment optimization for individuals and populations across the spectrum of acute and chronic conditions. Watson provides Teva with better insights, real-time feedback and options for clinicians to consider to improve patient care.



Source

7wdata

Teva

# Pharma AI Deals



# Corporation and AI-companies Participating in the Pharma AI Deals

**Pharma Partners**

Logos of pharmaceutical companies participating in the deals, including: Abbvie, Santen, Bayer, Vertex, Sanofi, AstraZeneca, Charles River, Lilly, Pfizer, Novo Nordisk, Biovista, Crystal Genomics, GSK, Bristol-Myers Squibb, GNS Healthcare, Boehringer Ingelheim, Merck, Roche, Takeda, WuXi AppTec, Lundbeck, Celgene, Janssen, Gilead, Aptalis, Kyowa Kirin, Nestlé, and BASF.

**AI and Biotech Partners**

Logos of AI and biotech companies participating in the deals, including: Amgen, Nanna Therapeutics, Genialis, Atomwise, Berkeley Lights, Arbor, BenevolentAI, C4 Therapeutics, Concerto HealthAI, BERG, Cloud Pharmaceuticals, Insitro, CytoReason, Wave Life Sciences, Exscientia, Cyclica, NuMedii, IKTOS, Genentech, WuXiNextCODE, e-therapeutics, Intellegens, XtalPi, Insilico Medicine, Recursion Pharmaceuticals, Inveni AI, Numerate, Sirenas, Nuritas, Researchably, Standigm, Transcriptic, Two SAR, Hewlett Packard Enterprise, Alibaba, and Tencent.

**Tech Partners**



# Methodology

In order to identify major **50 Pharma AI deals**, an initial pool of **100 companies** was identified. The companies, as well as the respective deals of the companies satisfy the **following criteria**:

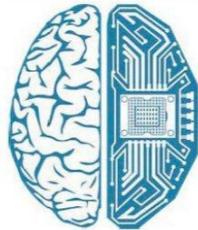
- **Parties criteria** - the companies participating in the deal represent Pharma, Biotech, Tech and related industries and actively participate in them; besides, the companies are involved in AI, Drug Discovery and related activities;
- **Object criteria** - the deals aim to develop a partnership, discover a new product or deliver a new technology related to the usage of AI in the Pharma or Biotech fields;
- **Time criteria** - the deals were conducted during the last 3 years, starting from 1 January 2017.

From the initial pool of the deals, the major ones in terms of the budget were identified and consequently divided into the categories for further analysis. **The categories featured in this report include:**

- **True partnership** - a partner to deliver tangible drug or product;
- **Kicking the tires** - general partnership, not including the cooperation at a specific project;
- **Saving costs and operational efficiency** - partnership to solve a specific problem a company faces;
- **Reputational partnership** - cooperation aiming at improving reputation of a company.



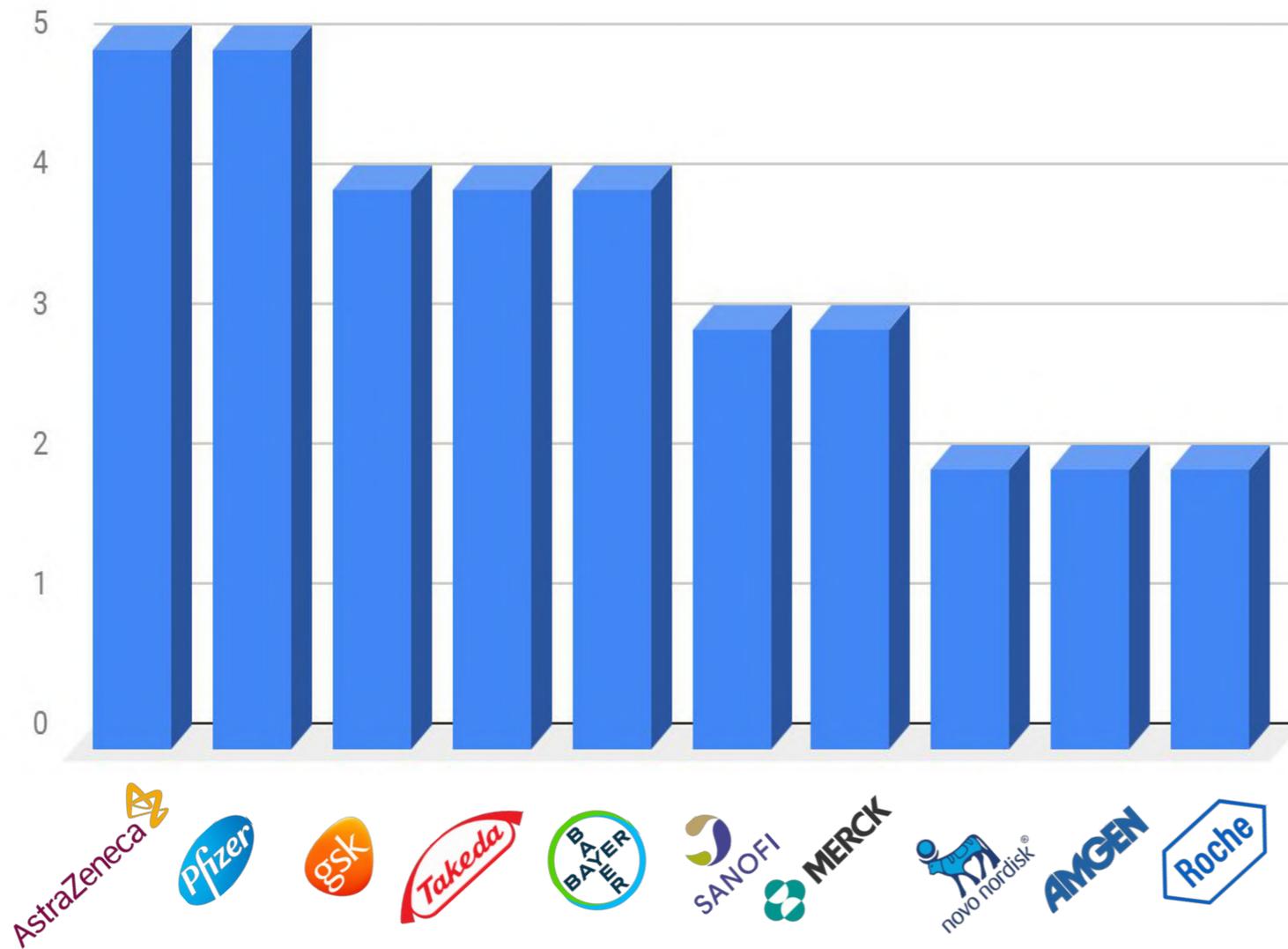
# Deal Classification Framework: an Overview

<b>Deal Metrics</b>	Region	Reports on results	Press Coverage (high, low)	Availability of Milestone Payments
	Specific R&D service focus	Deal Budget	Deal Length, years	Specific product development focus
<b>AI Startup parameters</b>	Business/marketing team	Company founding date	Number of previous similar collaborations	 <b>DEEP KNOWLEDGE ANALYTICS PHARMA DIVISION</b>
	Unique product/service offering	Research team	History of research publications	
<b>Lead company parameters</b>	Main industry (Pharma/ Biotech/ High Tech)	Own programs in AI research	<p>Each of the parties of the deals can be characterized by a number of metrics, which are different for lead companies and AI startups. For instance, while analyzing the startups, it is important to take into account the composition of the research team and their number of publications. This is an implicit indicator of the startup team's experience and knowledge of the topic. On the other hand, the lead companies should rather be analyzed on the level of the firm itself and its R&amp;D activities.</p>	
	Both Sexes Life Expectancy	Number of previous deals with AI vendors		

# Pharma AI Deals Structure 2019 / 30 Pharma Corporations

AI Companies				Pharma Corporations	Pharma Corporations	AI Companies				

# Top 10 Leading Corporations by The Number of Pharma AI Deals



The biggest number of significant deals on the topic of AI in Drug Discovery was concluded by **AstraZeneca and Pfizer**.

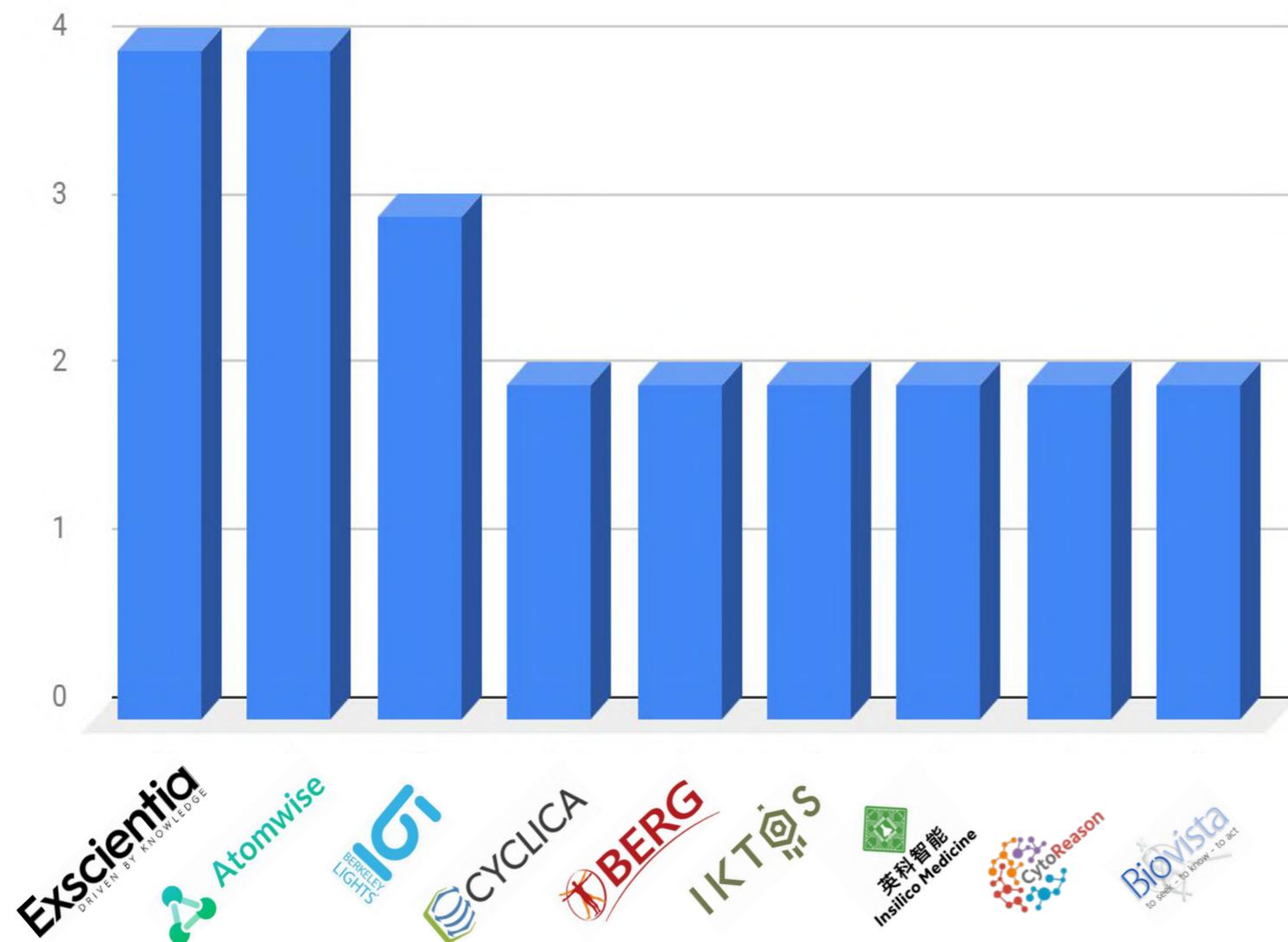
## Implications

These are both big Pharma corporations showing their **commitment in implementing innovations** with the help of AI and invest significant funds in the deals on this matter.

The most common type of deals are **true partnerships and saving the costs deals**.

It becomes more popular among pharma corporations facing **the problem of declining R&D efficiency**.

# Top AI and Tech Partners by the Number of Pharma AI Deals



## Implications

The **biggest number** of AI in Drug Discovery deals was conducted by **Exscientia**.

The company engages in **small molecule drug discovery, selective single target molecules, bispecific small molecules, and phenotypic drug design**.

All of the deals concluded with this company were categorized as the ones aiming at **saving costs and increasing operational efficiency** due to the character of the services provided.

# Declining R&D Efficiency of Biopharma Corporations

(Based on “Unlocking R&D productivity Measuring  
the return from pharmaceutical innovation 2018”  
from the Deloitte Centre for Health Solutions)

# Introduction to Declining Efficiency of Biopharma Corporations

Efficiency of R&D in drug discovery of biopharma declines for many decades and this trend (known as Eroom's Law) does not stop. Costs of R&D per drug are growing exponentially, yet sales per asset are definitely not increasing. Actually, sales per asset even contribute to the trend, since an average asset brings less revenue. R&D spending continues to increase. Late-stage R&D continues to be inherently risky. The share of oncology assets in late-stage pipelines is growing and becoming the greatest.

While big pharma has warmed to external sources of innovation from biotech, they continue to pursue a strategy that stresses large-scale, narrowly-focused research, rather than breadth of opportunity. The high-quality, low-volume, high-cost strategy makes corporations particularly vulnerable to the failure rate. As a result, limited output has left the industry dependent on monopolistic pricing and a target for potentially devastating political intervention. Under the current business model, pharma cannot reign-in drug prices without accelerating the decline that Stott has documented.

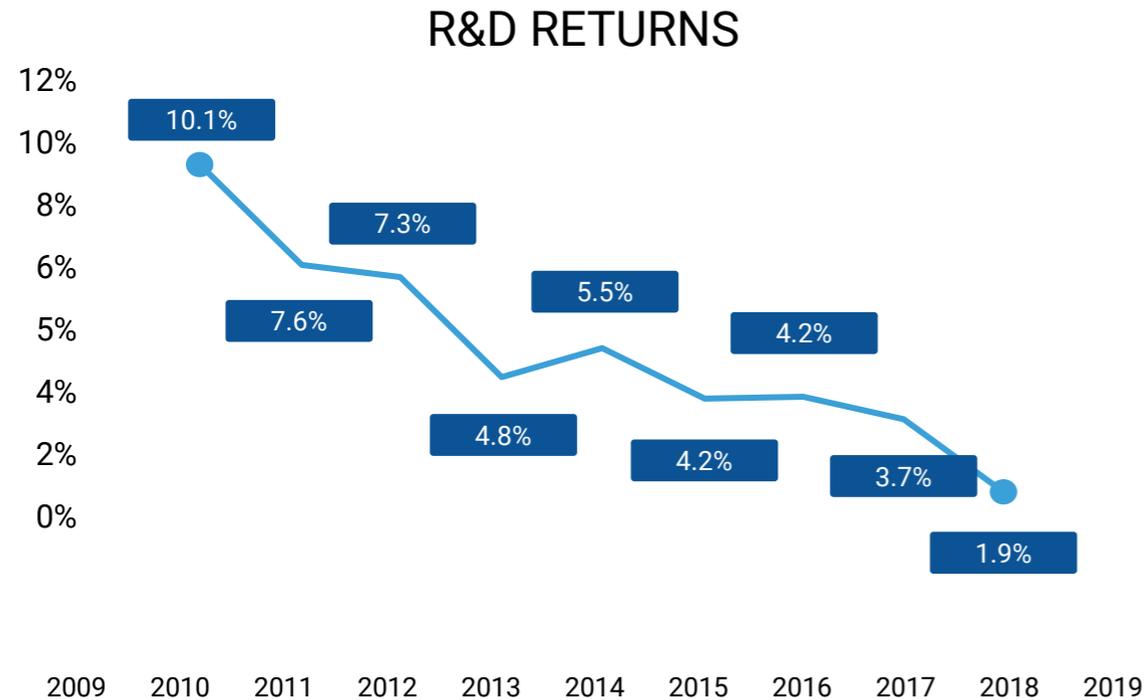
The solution to the problem is changing the business model of pharma to favor more agile early stage drug discovery, a much larger number of initial pool of projects (with minimal investment, via outsourcing, partnering, or VC funds), and an efficient process of project prioritization. In this sense, pharmaceutical corporations will have to embrace a more venture fund-like approach, given its naturally inherent risk of failure.

Development of AI for drug discovery may cause an additional boost in productivity and bring innovation for big pharma corporations. One opportunity to pharma is to use solutions of young pharma AI startups by making acquisitions. Some corporations that already apply AI for drug discovery have already shown positive changes in financial indicators.

However, it is very likely that negative trends can be overcome only by a combination of technological and managerial innovations in the industry.

# Declining R&D Efficiency of Biopharma Corporations

	2010	2018
The cost to bring an asset to market	\$1,188M	\$2,168M
Forecast peak sales per asset	\$816M	\$407M



Efficiency of R&D in drug discovery of biopharma corporations continued to decline in the last 8 years.

Costs of R&D per drug are growing exponentially, yet sales per asset are definitely not increasing. Actually, sales per asset even contribute to the trend, since an average asset brings less revenue.

R&D spending continues to increase. Late-stage R&D continues to be inherently risky. The share of oncology assets in late-stage pipelines is growing and becoming the greatest.

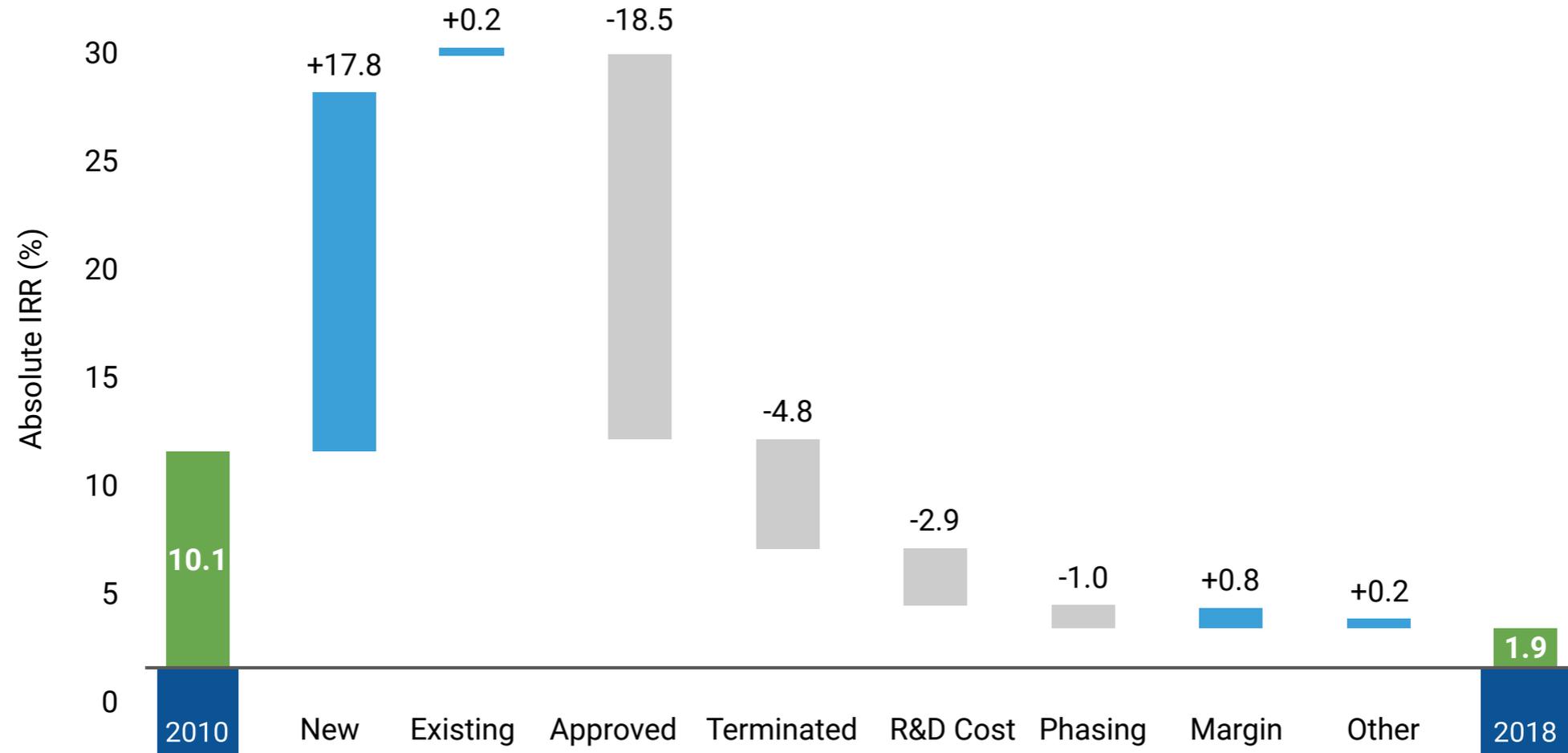
Clinical cycle times have also continued to increase, which contributes to the negative trend.

Smaller, more specialized corporations become more competitive since they have higher projected pipeline values.

Pharma corporations need to consider new approaches in their R&D process, such as the development of artificial intelligence and implementation of experience of biotech startups.

There is, however, some progress in de-risking and increasing returns from existing late-stage pipeline assets.

# Declining R&D Efficiency of Biopharma Corporations: Drivers of Change



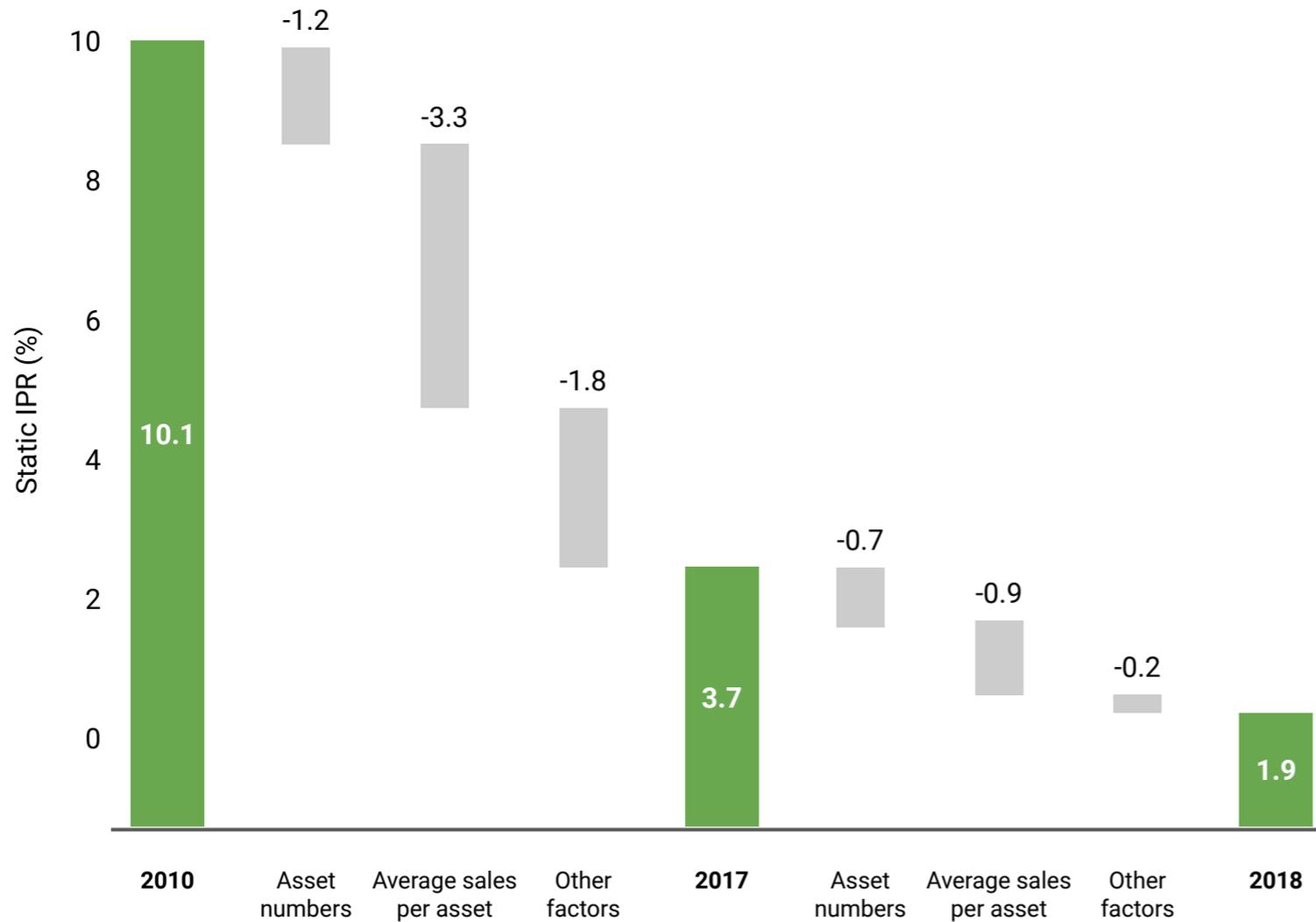
The figure above shows the key drivers of change between 2010 and 2018 years. We can see the drastic decrease in absolute IRR between those years, namely, starting with the indicator of 10.1% in 2010, it has fallen to the value of 1.9%. Also, the graph demonstrates, that R&D costs have led to a decline in projected returns of 2,9 percentage points. The figure shows also impact of different factors on the IRR. As we can see, the development of new drugs was the main driver of change.

Source

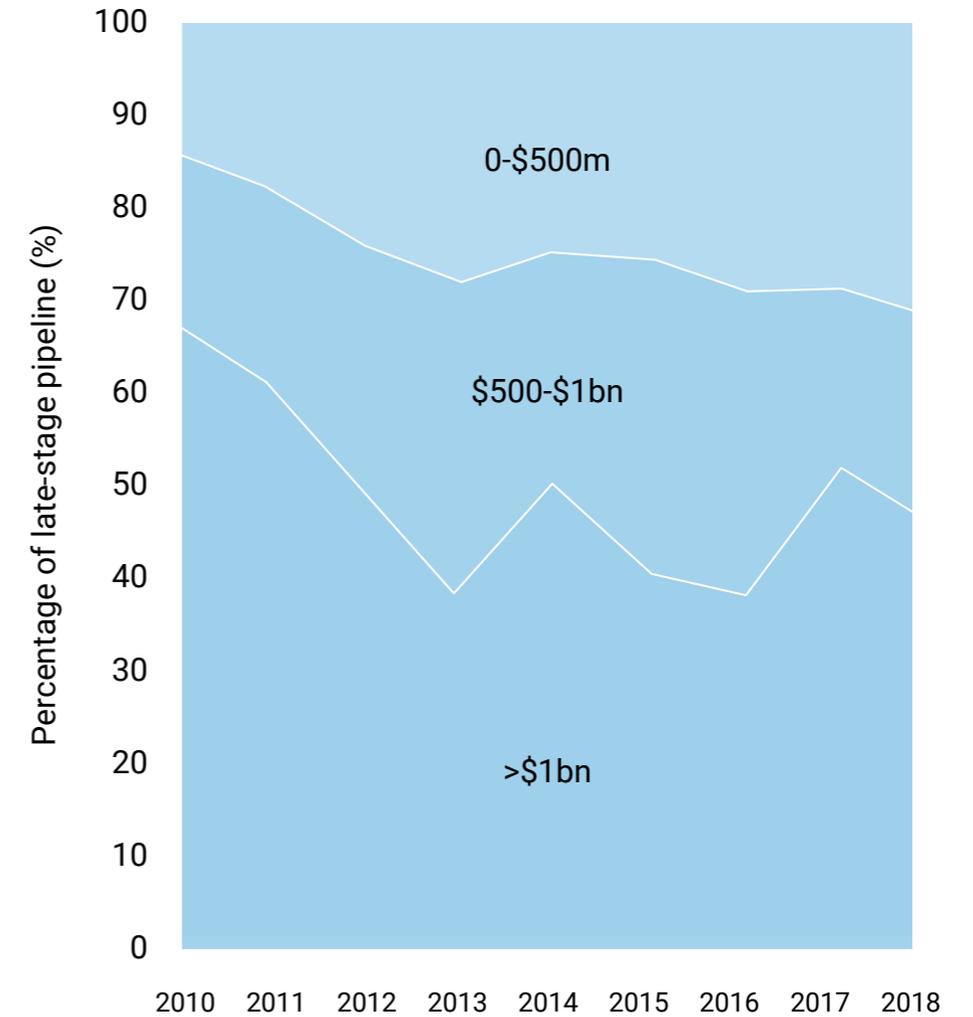
[Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte](#)

# Declining R&D Efficiency of Biopharma Corporations

OVERALL IMPACT OF PIPELINE FACTORS ON CHANGE IN IRR



PROPORTION OF FORECAST PEAK SALES

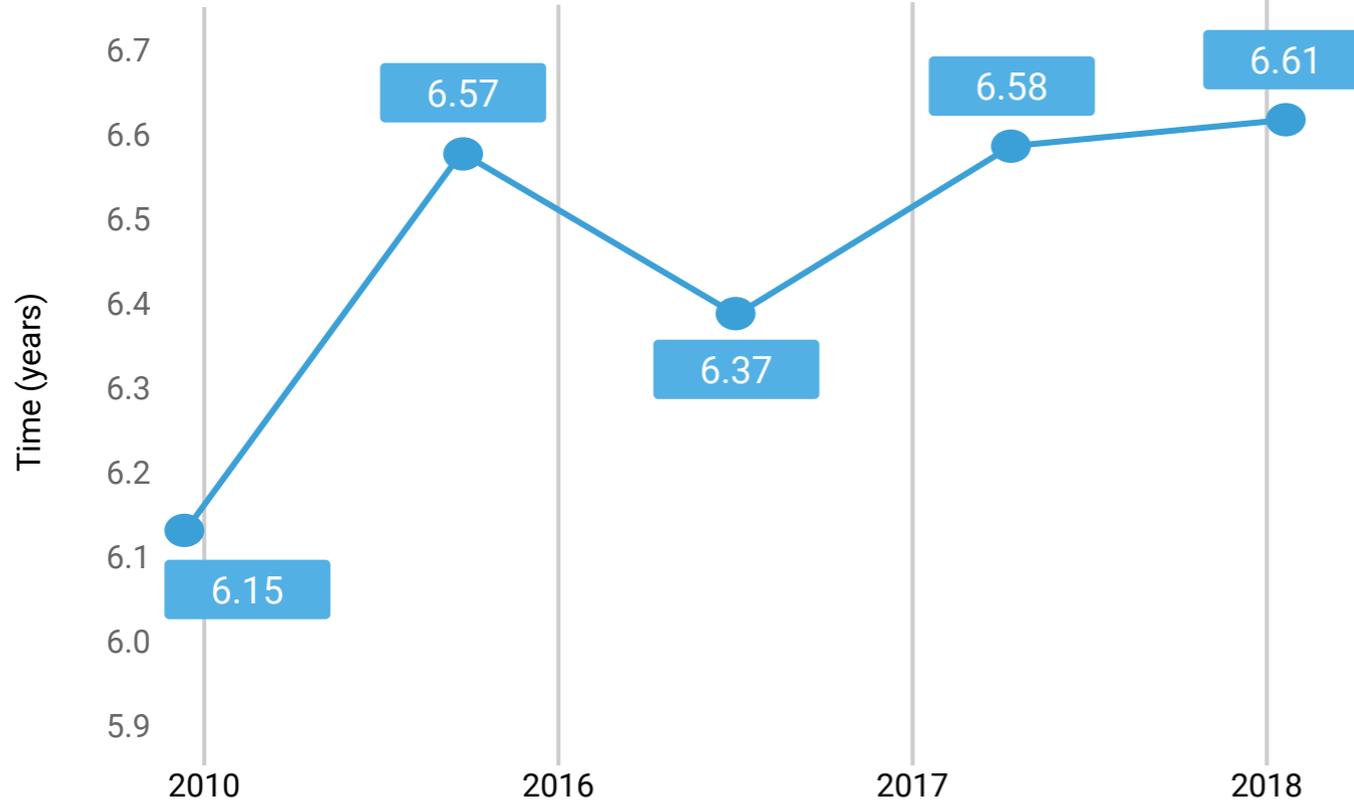


Source

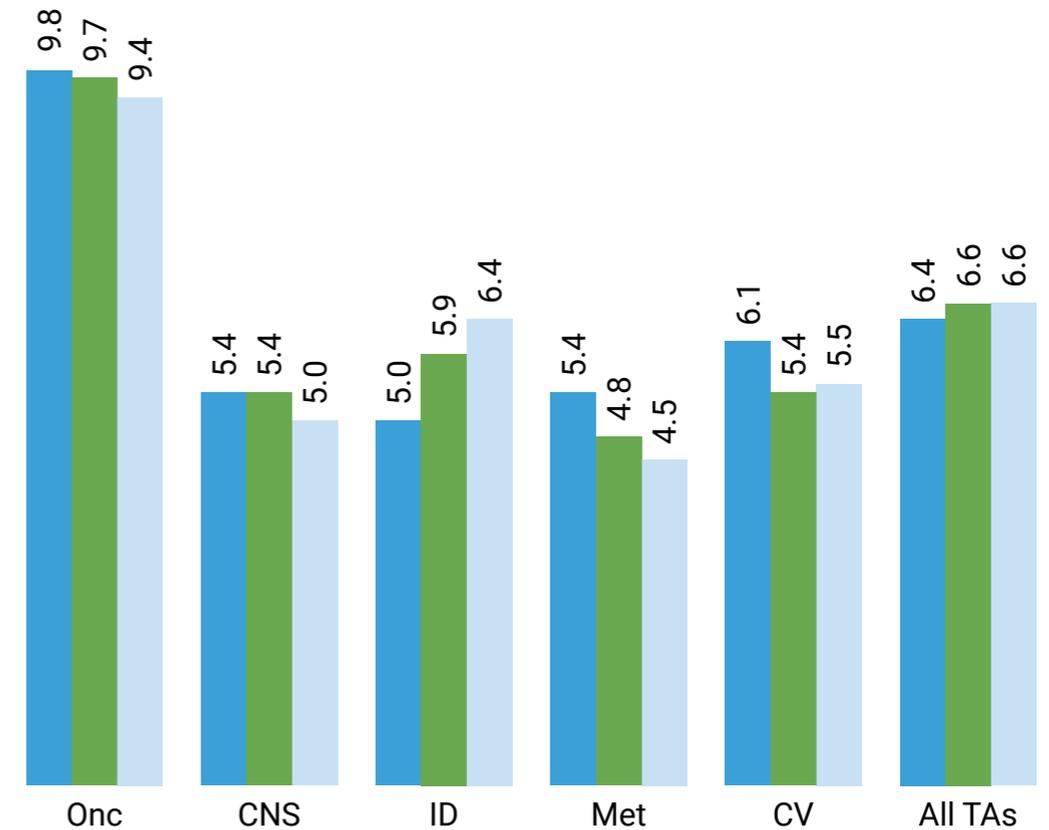
[Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte](#)

# Clinical Cycle Time

CLINICAL CYCLE TIME



CLINICAL CYCLE TIME BY THERAPY AREA



Onc - oncology;  
 CNS - central nervous system;  
 ID - infectious disease;  
 Met - metabolic therapy;  
 CV - cardiovascular;  
 All TAs - all therapy areas.

2016  
 2017  
 2018

The average clinical cycle time saw a 7.48% increase over the last 8 years, or 5 and a half months. Clinical cycle time for drugs targeting infectious diseases saw the sharpest rise over the last 3 years.

Source [Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte](#)

# Influence of AI Implementation

NET INCOME OF TOP-15 corporations USING AI (\$B)

COMPANY	2013	2014	2015	2016	2017	2018	Chart	Tendency
Amgen	5.08	5.16	6.94	7.72	1.98	8.93		+
Astellas Pharma	0.88	0.88	1.24	1.61	1.95	1.55		+
AstraZeneca	2.56	1.23	2.83	3.50	3.00	2.05		-
Bayer	3.62	3.89	4.66	5.14	8.33			+
Boehringer Ingelheim	1.72	1.36	2.05	2.40	-0.30			-
Bristol-Myers Squibb	2.56	2.00	1.57	4.46	1.01	4.95		+
Evotec	-0.03	0.09	0.02	0.03	0.03	0.07		+
GSK	8.81	4.67	12.88	1.24	1.97	4.84		+
Eli Lilly	4.685	2.391	2.408	2.738	-0.204	3.232		+
Johnson & Johnson	13.83	16.32	15.41	16.54	1.30	15.30		+
Merck	4.40	11.92	4.44	3.92	2.39	6.22		+
Novartis	9.18	10.21	17.78	6.71	7.70	12.61		+
Pfizer	22.00	9.14	6.96	7.22	21.31	11.15		+
Roche	11.30	9.54	9.06	9.73	8.83	10.87		+
Sanofi	4.94	5.84	4.76	5.21	9.53	5.09		-

- The year the company started to use AI in drug development

The table on the left shows the net income of top-15 corporations, with an adjustment on using AI. It's easy to see, that almost every company faced a negative trend in net income. However, after starting to use AI in drug discovery, net income starts to show a considerable. So applying AI for DD positively influences net income of pharma corporations.

Some financial information has not been published yet (for Bayer and Boehringer Ingelheim in 2018).

# The Reasons for Declining Efficiency of R&D

**Rise in costs** of R&D outpaces increase in sales

**Increasingly exigent requirement** to the efficacy, safety, and quality of new drugs

The **shortening of the lifespan** of drugs mainly because of antimicrobial resistance

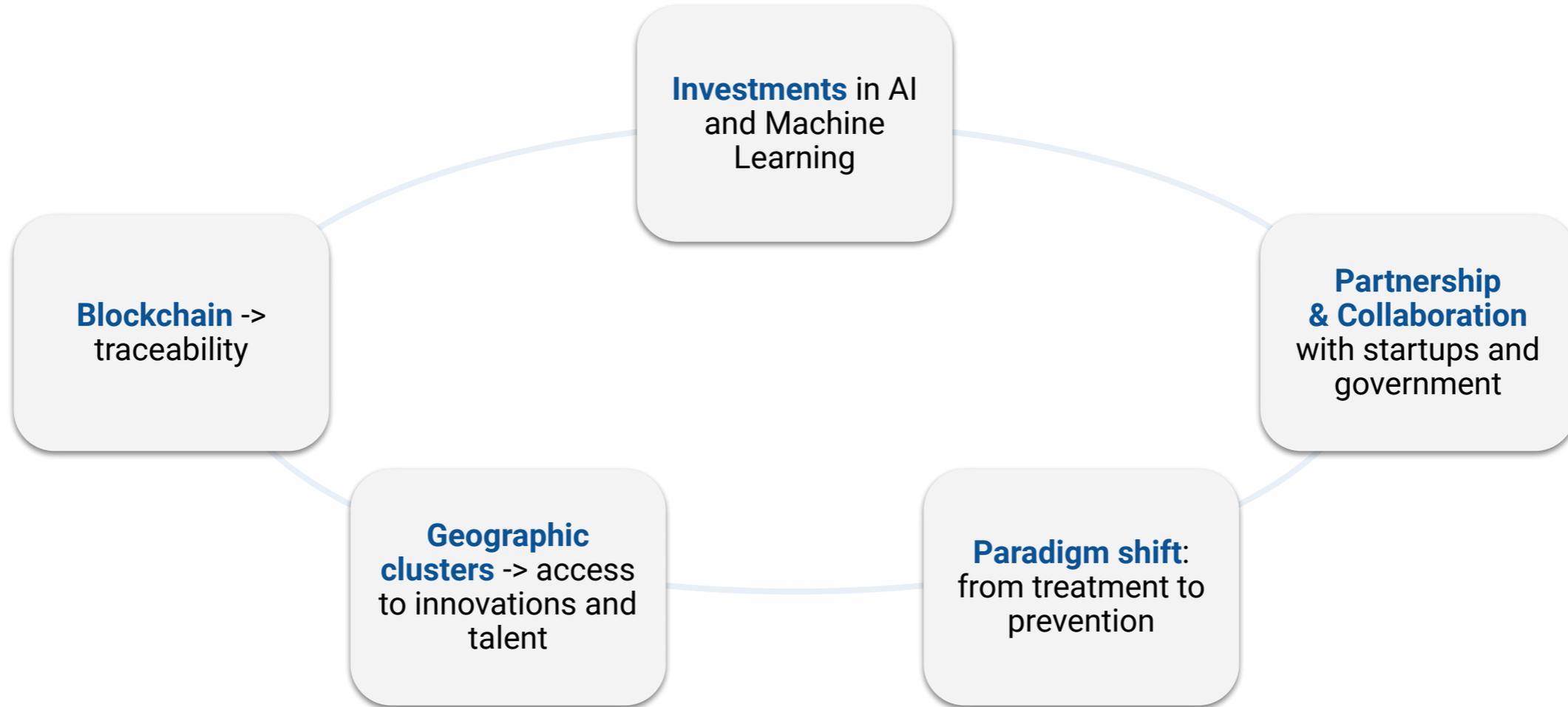
**Small incremental benefit** is not enough to convince payers to switch to new, more effective drugs

**95 % commercial failure rate**

**Growing level of scrutiny** from political entities and public regarding drug prices

**Failed to produce “blockbusters”** - Pharma have been left with complex diseases who cores carry many ramifications

# Way to "Fix" – Technology-Based Solutions



The main obstacle:

***Pharma is conservative by nature. It will take time to develop the industry.***

# Proprietary Analytical Report “Declining Efficiency of R&D in Pharma Corporations” Summary

**This chapter is a brief summary of a proprietary analytical report [“Declining Efficiency of R&D in Pharma Corporations”](#) by Deep Knowledge Analytics Pharma Division.**

The goal of this report is to provide deep analysis of the prospects of pharma industry considering declining efficiency of R&D. Besides, it includes **practical guide** to the way for assembling the best possible solutions to deal with the declining efficiency of R&D. Analytical report comprises analysis of key market players in pharma industry for the specific understanding of how they should deal with the risk which arises while declining efficiency.

According to this purpose, the main reasons for declining trend in pharma industry were analyzed based on the tangible indicators. As a result, analytical report provides some recommendations for pharma corporations concerning the issue of finding the solutions to deal with this negative trend. It was also analyzed what strategic areas are appropriate for immediate AI adoption. Thus, quantitative analysis was enhanced by a qualitative one. The system of metrics and criteria can be applied for the forecasting and predictive analytics in order to understand which companies could be successful and which ones will not survive from the pressure of reducing efficiency. Thus, future prospects of pharma corporations regarding the evidence of R&D efficiency are described. Moreover, analytical report includes specific methods of how these prospects can be changed. These implications can be extremely useful for every institution operating in the field of AI for Drug Discovery. Except this, the possible impact of AI on the declining efficiency trend was investigated. These implications may be helpful regarding the usage of AI to deal with negative efficiency trends in biopharma industry.

## **The results of the report can be applied for:**

- Complex and deep analysis of the pharma industry
- Optimizing the short and long-term strategies of biopharma corporations and other institutions related to the industry
- Determination of the most promising development directions for the pharma corporations’ in order to maximize profits
- Risk assessment of the sector
- Predicting future dynamics and prospects of pharma industry
- Investigating the reasons for declining efficiency of R&D and suggesting solutions to deal with it

**The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to surpass the challenges and to utilize the opportunities related to these novel AI for Drug Discovery investment trends.**

# “AI-Friendly” CEOs and Board Members of Pharma and Tech Corporations



# Introduction to “AI-Friendly” CEOs and Board Members of Pharma and Tech Corporations Report

Over the last few years, there was a tendency that has shown a decline in the pharmaceutical industry. This is connected to the numerous facts, starting from the R&D inefficiency and ending with the world markets landscape.

Therefore, pharmaceutical companies have a strong interest in improving their positions. For this purpose, they use AI in various areas of their activity, namely, medical image analysis and elaboration of electronic health records (EHRs), building disease ontologies, preclinical drug discovery, and clinical trials. In such conditions, the demand for the ML/AI talent, as well as for ML/AI technologies, is growing in pharmaceutical and healthcare industries and driving the formation of a new interdisciplinary field – data-driven drug discovery/healthcare. This is, undoubtedly, one of the key options for the further development of the pharmaceutical industry.

Progress accelerates at the same time as people with the background in the field of AI occupy leadership positions in top companies. Main market trends are driving the growth in the AI implementation in pharmaceutical and tech research, but the overall success depends strongly on the presence of highly skilled interdisciplinary leaders. They must be able to innovate, organize and guide in this direction.

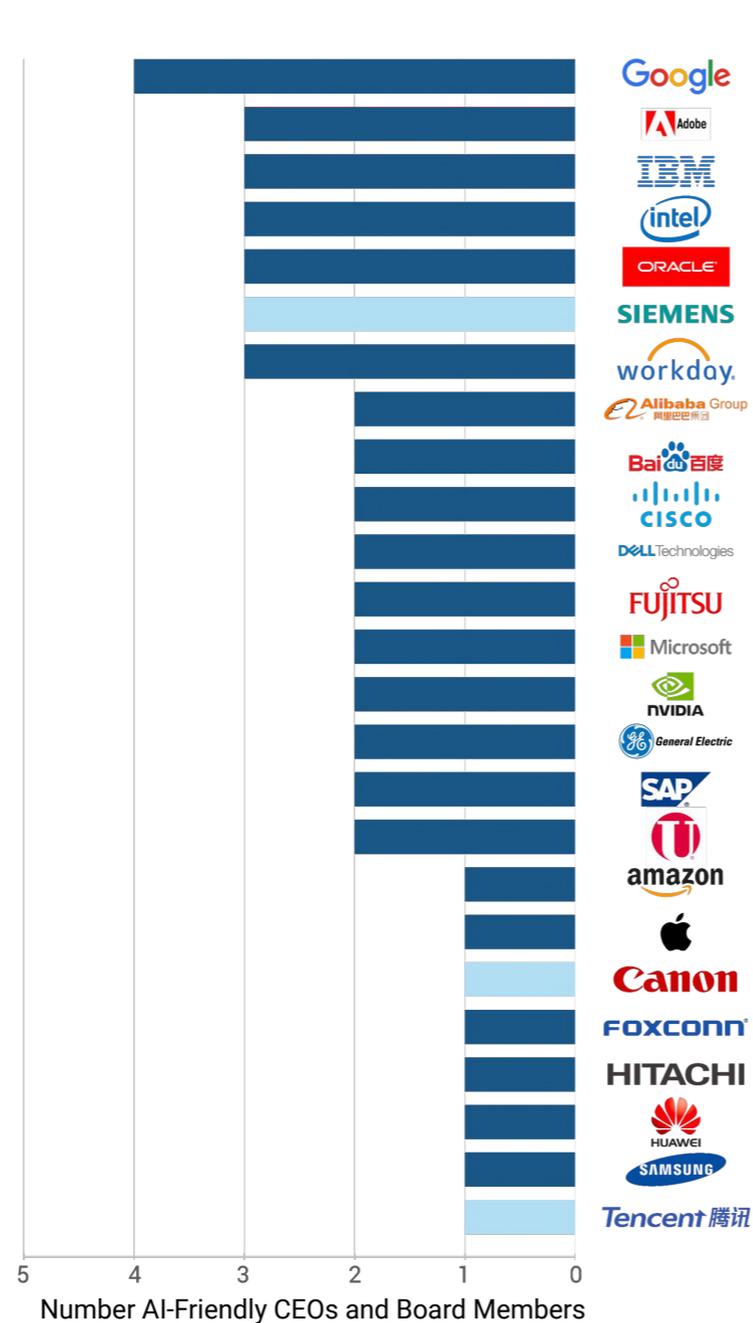
That is why, **the goal of this report** is to identify CEOs and board members, who are driving AI development in pharma and tech industries. This serves as an indicator for the companies, who are committed to using AI in their innovations processes and thus have a potential to improve their market position, comparing to their peers. To this extent, the presence of AI-friendly CEOs and Board members also indicates that the company is focused on increasing its R&D efficiency and thus is more likely to succeed in the drug discovery sector.

**The general mechanism** is as follows:

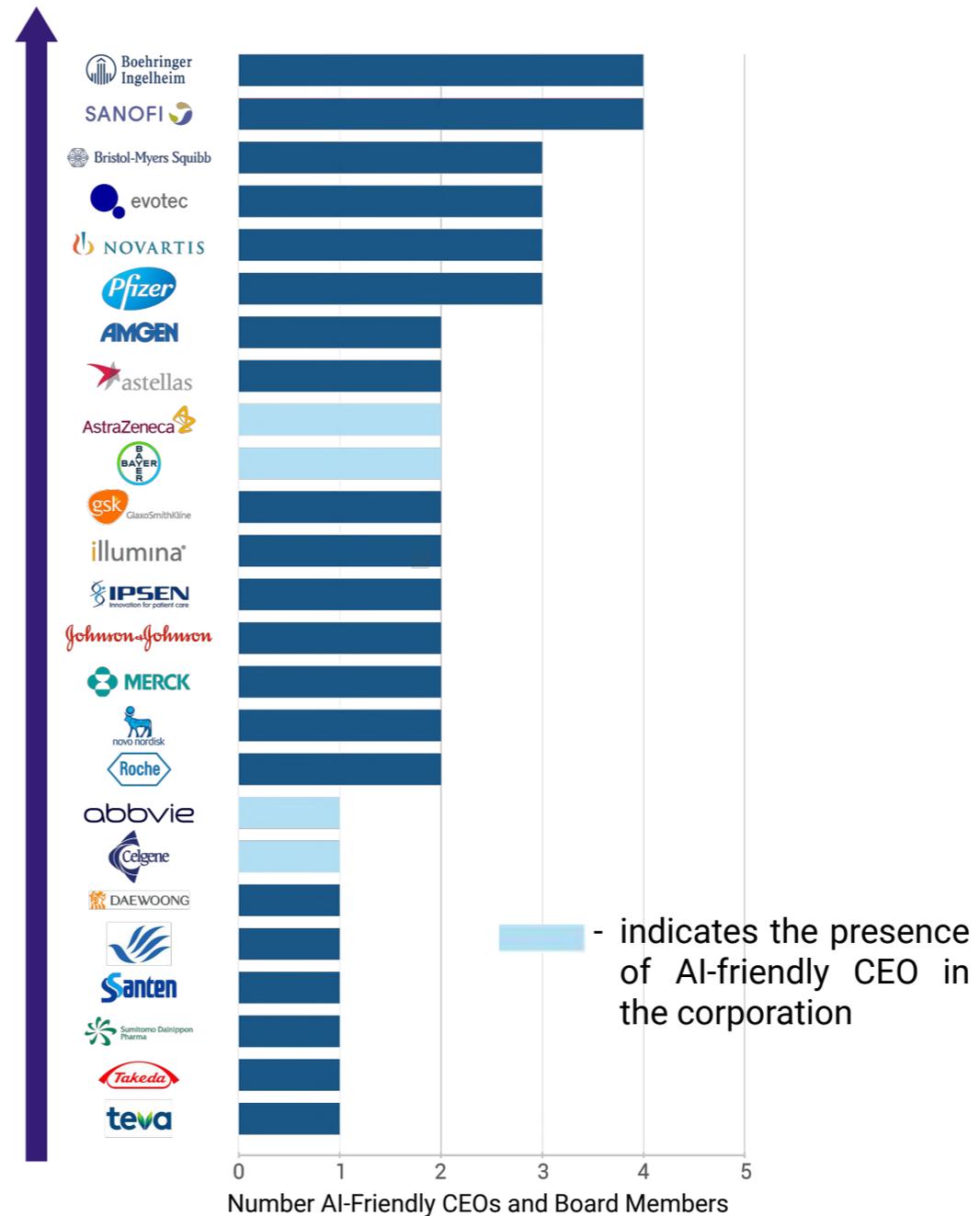
the decline of the pharmaceutical industry -> need to implement AI -> need for knowledge in the sphere of AI -> occupation of leading positions by people who have qualifications in AI -> accelerating applying of AI -> “restoration” of the pharmaceutical industry.

Thus, **the relevance** of this topic is explained by the need to advance the pharmaceutical industry, and in particular, the healthcare industry. The goal of the report is providing a “bird’s view” on the global leadership scene in the area of adopting AI-driven methods in drug discovery and healthcare to serve as a benchmark tool for indication of the most perspective pharma and tech corporations. Experience of tech corporations applying AI can be crucial in this framework.

## AI-Friendly CEOs and Board Members Distribution by Tech Corporations



## AI-Friendly CEOs and Board Members Distribution by Pharma Corporations



# Methodology for Ranking

The initial large pool of candidates (around 300) for the TOP AI-Friendly CEOs and Board Members list has been selected from multiple sources including:

Top pharmaceutical and healthcare AI conference program lists

Google Scholar

Databases

News

Pharma and Tech corporations activities

Ranking is based on the analysis of the descriptive criteria (personal page descriptions, biographies, LinkedIn and Bloomberg pages, public awards, article titles, news and PRs, and other text resources) and derived categorical metrics and formal numerical metrics (number of research citations in Google Scholar, RG score in ResearchGate, number of books/talks and articles, social media activity, number of educational diplomas in the field of AI etc).

Categorical variables are considered to be dimensions, descriptive attributes for univariate and bivariate analysis, and classification. Numerical variables are considered to be measures of the initial dataset.

To be nominated for the TOP 100 AI-Friendly CEOs and Board Members list, it was set to be a prerequisite for a candidate to have interdisciplinary technical skills and/or business/entrepreneurship/decision-making skills in both of the area of AI.

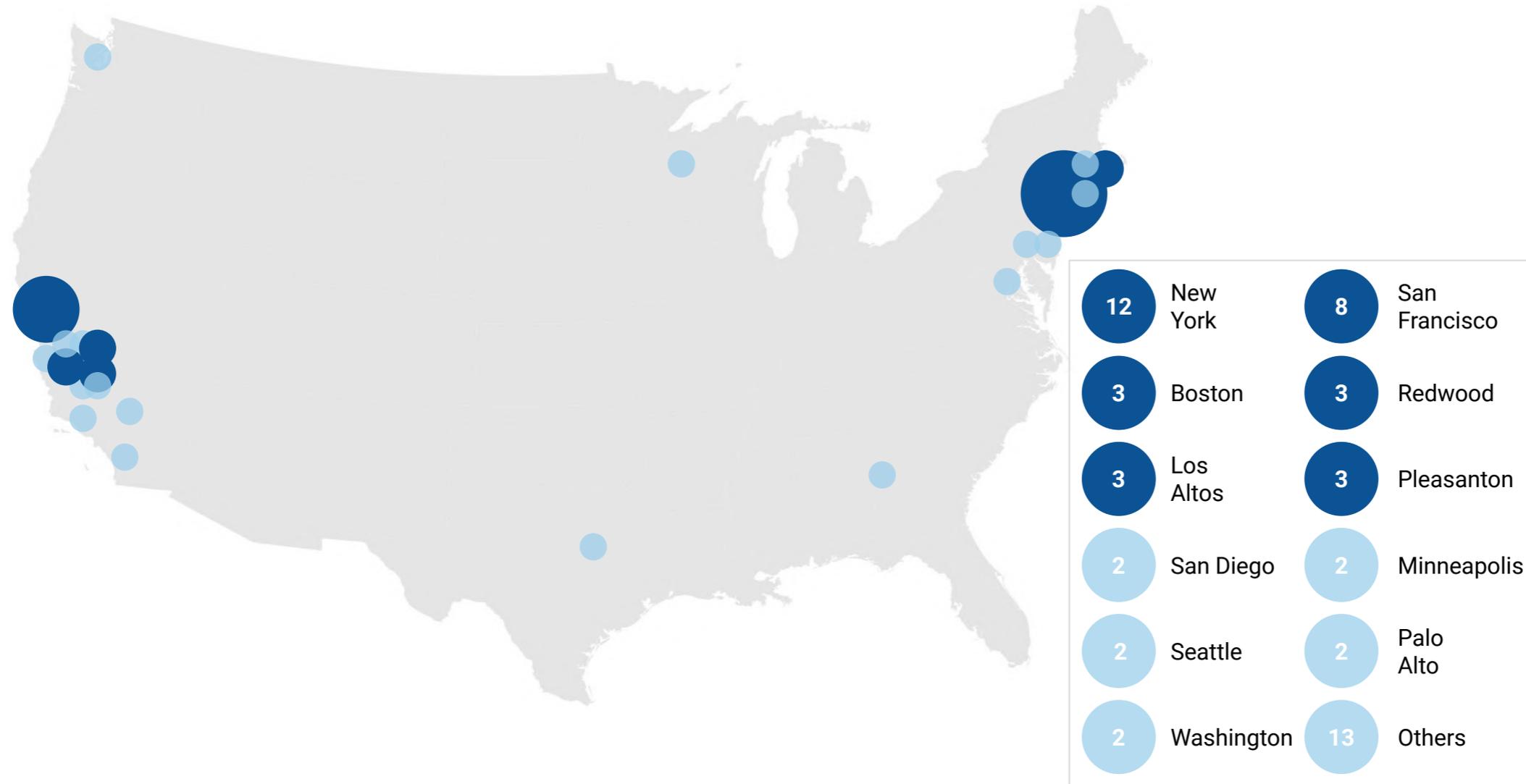
The initial pool of around 300 top candidates has been shortlisted down to the top 100 list following an iterative approach, starting with the obvious differentiating parameters (top tech or business achievements) and gradually specifying additional parameters for the final rating.

The ranking calculation model:

Is a first-order homogeneous polynomial that calculates a person's assessment variables and their relative impact weights (coefficients). Numeric variables were standardised. The weights of each variable have been logically designed to underline major contributions and impact (innovations, business achievements etc) and only augment them with less important, yet valuable, contributions (conference talks, social media activity etc).

The biggest emphasis was put on the activities of CEOs and board members in their corporations regarding AI applications and development.

# US AI-Friendly CEOs and Board Members Distribution



This map shows the geographic distribution of the AI-friendly CEOs and board members in pharma and healthcare within the United States. New York, San Francisco, Boston, Redwood, Los Altos and Pleasanton stand out as favored locations for these individuals.

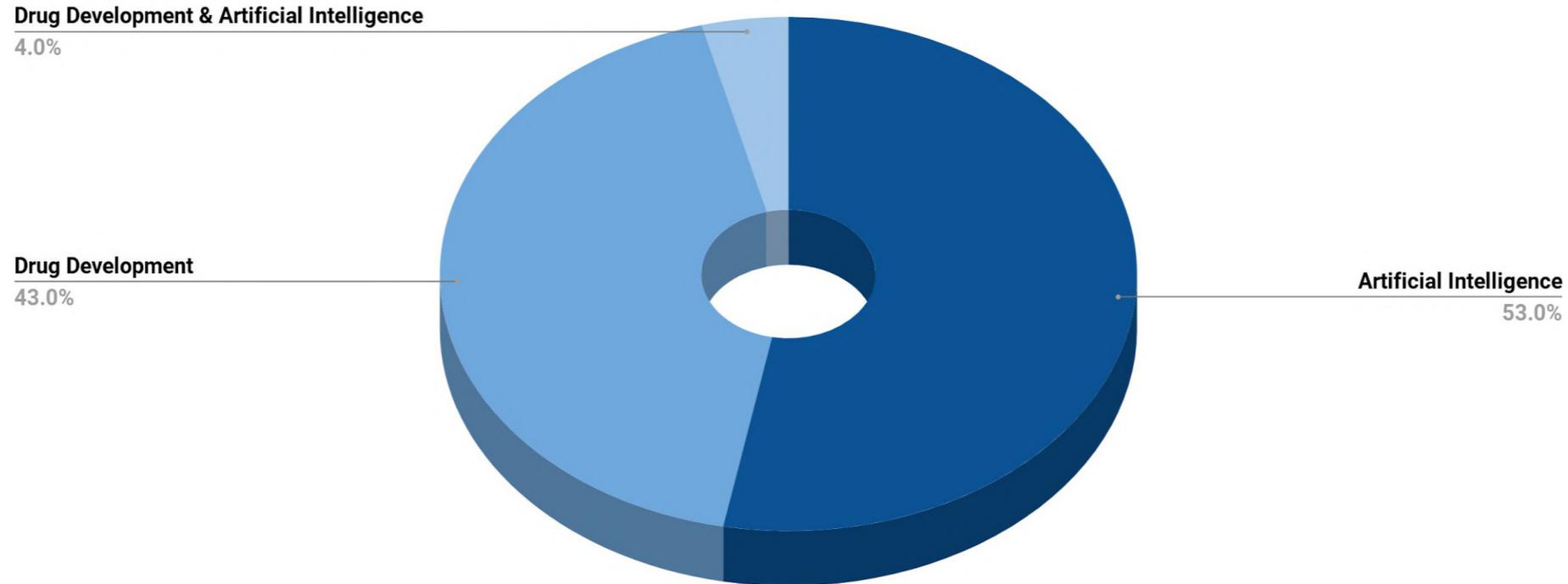
# 100 AI-Friendly CEOs and Board Members outside America

## Distribution by City



This map shows that most of the top AI-Friendly leaders in pharma and tech reside in outside of America with Tokyo being the most attractive city for this kind of experts.

# Specialization of 100 AI-Friendly CEOs and Board Members of Pharma and Tech Corporations

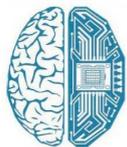


The diagram above shows that AI-friendly CEOs and Board Members are predominantly specialized in either Drug Development or Artificial Intelligence, whereas CEOs and Board Members working at the intersection of the two disciplines represent a small fraction of the total. AI for Drug Discovery companies need much higher levels of expertise in traditional biopharmaceutical science (biochemistry, biology, biomedicine, etc.) and in core AI techniques. Therefore, CEOs and Board Members which belong to this group are well-qualified and have rich experience through practice and education in both fields.

# Conclusions

- It is an axiom that CEOs and Board Members need to properly understand how applying of Artificial Intelligence in Pharma and Tech can be used to help them meet their goals. Moreover, level of implementation of AI will become a new dimension that will be used by the financial community to determine current and future market valuations of organisations.
- Simply explained, AI-friendly corporations able to demonstrate the use of AI in their domains, especially in Pharma or Healthcare, will be valued higher than their peer organisations who are not using any form of AI in their operations. We foresee that the use of AI by companies will become a standard component analyzed by fund managers to evaluate companies for investment.
- According to our research, top-100 AI-Friendly CEOs and Board Members occupy their positions in top-50 Pharma and Tech companies. 51% serve in Tech corporations and 49% of them operate in the Pharma industry. Only 4% of top-100 CEOs and Board Members have intense experience through practice and education both in Drug Development and Artificial Intelligence fields. This fact makes it possible to draw conclusions about kind of such people uniqueness.
- The geographic distribution of top-100 AI-Friendly CEOs and Board Members is characterized by their concentration in the US, Germany and Japan. Therefore, mentioned above countries are pretendents to be attractive research, innovation and business centres for AI in Pharma experts abroad, attracting and holding on to the best talents in AI, and to considerably expand their capacities in the field of AI. We predict, that this statistics may substantially change over the coming years in favor of China, firstly – due to a strong government support for AI-driven healthcare and pharma initiatives, secondly – due to relatively lower bureaucratic and regulatory barriers for “controversial” research, and thirdly – due to an emerging trend for a “reverse migration” of Chinese top experts from Western countries back to China.
- Consequently, all the information provided in this report allows leaders in Pharma and Tech to garner facts they can confidently relay to their executive teams so they can make informed decisions when thinking about AI adoption.

# Top-35 AI for Drug Discovery Conferences 2019-2020



DEEP  
KNOWLEDGE  
ANALYTICS  
PHARMA DIVISION

# Introduction to Top-35 AI for Drug Discovery Conferences 2019-2020 Report

The following report is the second edition of our global guide to conferences pertaining to Artificial Intelligence in Pharma for 2019 and 2020.

Its purpose is to enable academics, investors, scientists, politicians, and technologists, as well as interested general public, to participate more readily in the emerging industry by identifying affordable events at venues near to them.

Hereby we selected 35 conferences, which satisfy the following criteria:

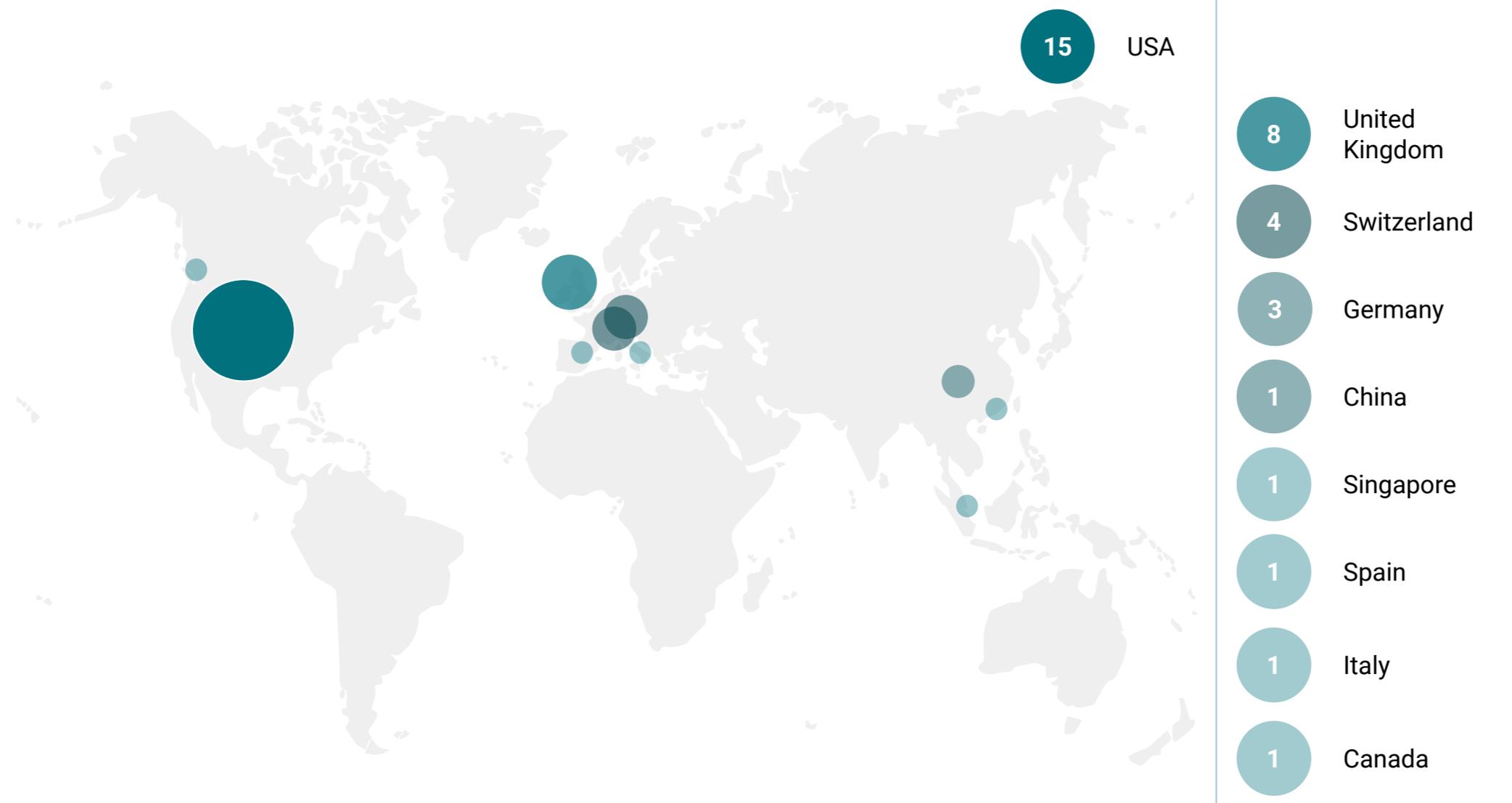
- Well attended, with a large number of speakers as well as participants.
- Include at least one panel on the application of AI in Pharma Industry.
- Include speakers from pharmaceutical corporations (e.g., Johnson & Johnson, Merck, etc.) and/or tech corporations (such as IBM or Microsoft). These corporations are the main driving force behind the development of AI in Pharma and are the primary end-users of technologies, developed by AI startups.

We also identified a few similarities between the selected conferences:

- They all include AI startups.
- They all have well-represented academia, with scholars collaborating with AI specialists to develop new efficient technologies.
- The vast majority of them take place in the US or UK, and only a few in Europe and Asia (mainly Singapore and China).

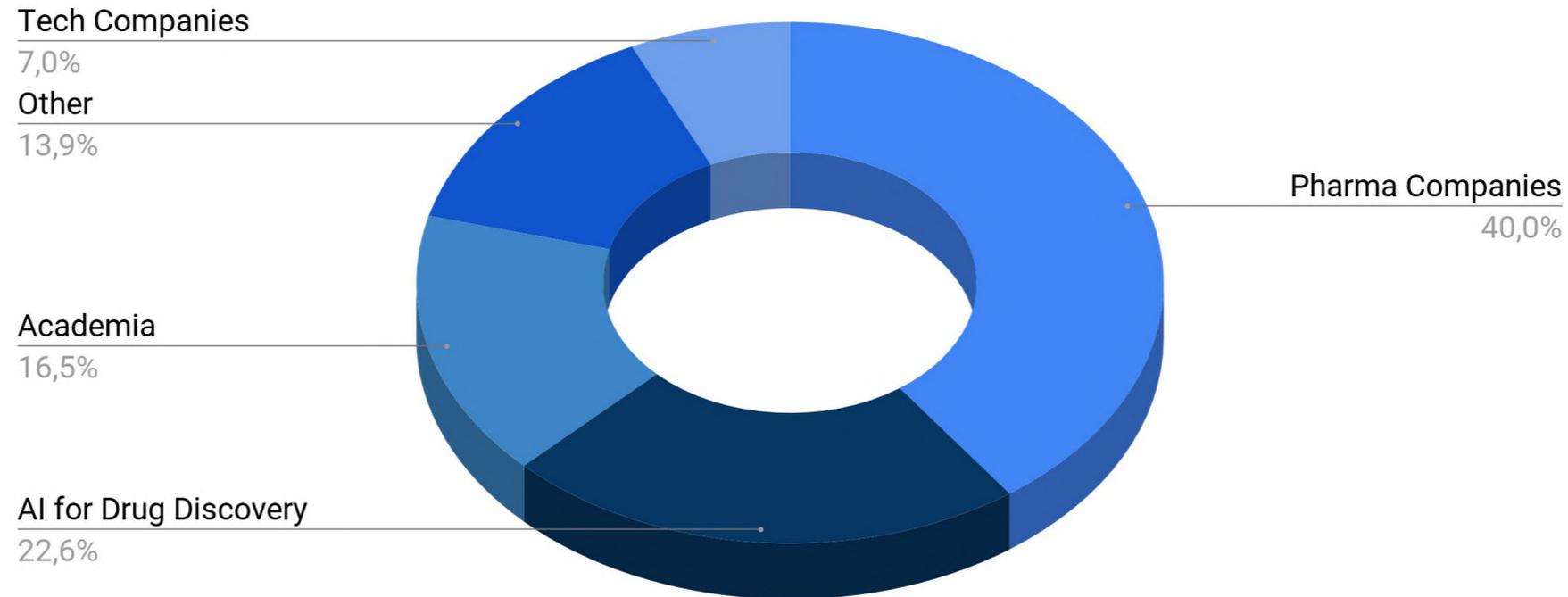
This is an experimental attempt to catalog these conferences. We expect to expand the size and scope of future editions.

# Top-35 AI in Pharma Conferences 2019-2020: Distribution by Country



The vast majority of top AI in Pharma conferences are held in the US and UK because the most advanced and richest companies are headquartered there. Furthermore, these two countries are ones of the biggest world academic and business hubs that attract the top researchers and entrepreneurs.

# Top-35 AI in Pharma Conferences 2019-2020: Distribution by Speakers Specialization



The chart shows the distribution of speakers by the companies they are working for and the industries they represent. Pharmaceutical companies account for almost half of the total number of speakers, which signifies the ever greater need to find ways to increase the efficiency of R&D activities. One way to achieve that is to look for promising partnerships with AI for Drug Discovery companies that, in turn, account for more than a quarter of the speakers. Academia speakers are represented well enough as well. They are the ones who could provide some useful information about the most recent scientific developments in Drug Discovery and Drug Development.

# Top-35 AI in Pharma Conferences in 2019 - 2020

NAME	WEBSITE	DATE	REGION
Deep Learning in Healthcare Summit	<a href="http://re-work.co">re-work.co</a>	May 23-24, 2019	US
Advanced Machine Learning And Artificial Intelligence For Drug Discovery And Development	<a href="http://drugdiscoverydevelopmentforum.com">drugdiscoverydevelopmentforum.com</a>	May 28-29, 2019	UK
Precision Medicine Leaders' Summit East	<a href="#">Website</a>	June 11-12, 2019	US
20th Annual Drug Discovery Summit	<a href="http://www.oxfordglobal.co.uk">www.oxfordglobal.co.uk</a>	June 11-12, 2019	Germany
AI Innovations For Life Science Summit West	<a href="http://aiinnovationsummit.com">aiinnovationsummit.com</a>	June 13-14, 2019	US
2019 GNS Precision Medicine Industry Forum	<a href="http://gnshealthcare.com">gnshealthcare.com</a>	June 14, 2019	US
Precision Medicine 2019: Can AI Accelerate Precision Medicine?	<a href="http://dbmi.hms.harvard.edu">dbmi.hms.harvard.edu</a>	June 18, 2019	US
Digital Biomarkers in Clinical Trials Summit	<a href="http://panagorapharma.com">panagorapharma.com</a>	June 19, 2019	Switzerland
Health Horizons Future Healthcare Forum	<a href="http://horizons.health">horizons.health</a>	June 26-27, 2019	UK
SLAS Europe 2019 Conference and Exhibition	<a href="http://slaseurope2019.org">slaseurope2019.org</a>	June 26-28, 2019	Spain
2nd Annual Pharma AI & IoT 2019	<a href="http://virtueinsight.com">virtueinsight.com</a>	July 10-11, 2019	UK
Ending Age-Related Diseases 2019	<a href="http://leafscience.org">leafscience.org</a>	July 11-12, 2019	US
Basel Life 2019	<a href="http://basellife.org">basellife.org</a>	September 9-12, 2019	Switzerland
AI Applications for Drug Discovery and Development	<a href="http://lifesciences.knect365.com">lifesciences.knect365.com</a>	September 10-11, 2019	US
Intelligent Health AI	<a href="http://intelligenthealth.ai">intelligenthealth.ai</a>	September 11-12, 2019	Switzerland
AI Med Europe	<a href="http://aimed.events">aimed.events</a>	September 17-19, 2019	UK
8th International Conference on Biostatistics and Bioinformatics	<a href="#">Website</a>	September 18-19, 2019	US

# Top-35 AI in Pharma Conferences in 2019 - 2020

NAME	WEBSITE	DATE	REGION
PHARMA AI - BSG	<a href="http://globalbsg.com">globalbsg.com</a>	September 19-20, 2019	UK
3rd Annual Artificial Intelligence in drug discovery Congress	<a href="http://oxfordglobal.co.uk">oxfordglobal.co.uk</a>	September 25-26, 2019	UK
BioData World West 2019	<a href="http://terrapinn.com">terrapinn.com</a>	October 10-11, 2019	US
11th Euro Biosensors & Bioelectronics Congress	<a href="http://biosensors.conferenceseries.com">biosensors.conferenceseries.com</a>	October 23-24, 2019	Italy
AI World Conference and Expo	<a href="http://aiworld.com">aiworld.com</a>	October 23-25, 2019	US
12th International Conference and Exhibition on Biosensors & Bioelectronics 2019	<a href="http://biosensors.conferenceseries.com">biosensors.conferenceseries.com</a>	October 25-26, 2019	Canada
3rd Global Pharma R&D Informatics and AI Congress 2019	<a href="http://global-engage.com">global-engage.com</a>	October 28-29, 2019	UK
10th World Congress on Biosensors and Bioelectronics	<a href="#">Website</a>	October 28-29, 2019	Switzerland
Drug Discovery 2019 – Looking Back To The Future	<a href="http://elrig.org">elrig.org</a>	November 5-6, 2019	UK
Ai4 Healthcare	<a href="http://ai4.io">ai4.io</a>	November 11-12, 2019	US
The AI Application Summit Biopharma	<a href="http://aiapplicationssummit.com">aiapplicationssummit.com</a>	November 11-12, 2019	US
BIT's 17th Annual Congress of International Drug Discovery Science and Technology	<a href="http://iddst.com">iddst.com</a>	November 15-17, 2019	China
ManuPharma 2019	<a href="http://manupharma.wbresearch.com">manupharma.wbresearch.com</a>	December 3-4, 2019	Germany
AIMed North America	<a href="http://aimed.events">aimed.events</a>	December 11-14, 2019	US
Precision Medicine World Conference 2020	<a href="http://pmwcintl.com">pmwcintl.com</a>	January 21-24, 2020	US
ETIM 2020	<a href="http://etim.uk-essen.de/">etim.uk-essen.de/</a>	February 28-29, 2020	Germany
Phar-East 2020	<a href="#">Website</a>	March 18-19, 2020	Singapore
Healthcare & Medical Research Conference Sessions 2020	<a href="#">Website</a>	March 23-24, 2020	US



## Basel Life



9-12 September 2019



Basel, Switzerland



[basellife.org/2019](https://basellife.org/2019)

BASEL LIFE is Europe's leading congress in the Life Sciences, showcasing cutting-edge science and technology. It brings together preeminent researchers in the field, and offers talented young scientists the possibility to present themselves. Basel is the heart of Europe's Life Sciences landscape.

Basel Life consists of:

- EMBO
- [BC]2 (BIG DATA IN MOLECULAR MEDICINE)
- The Innovation Forums
- MipTec Exhibition
- European Job Fair

Additionally, Basel Life includes **a forum on Aging, Drug Discovery and Artificial Intelligence**. During the forum, leaders in the aging, longevity, and drug discovery field will describe the latest progress in the molecular, cellular and organismal basis of aging and the search for interventions. Furthermore, the forum will include opinion leaders in AI to discuss the latest advances of this technology in the biopharmaceutical sector and how this can be applied to interventions.



11-12 November 2019



Boston, MA



[aiapplicationsummit.com](http://aiapplicationsummit.com)

The AI Applications in Biopharma Summit is the only event to convene key strategic biopharma stakeholders and data driven disruptors to discuss their experiences, obstacles, opportunities for partnerships, and strategies they have used to implement AI technologies in the discovery and drug development process.

Interest in AI driven technologies is growing fast among leaders in the biopharma industry. Over 40 industry peers discussed the practical steps for prioritizing and implementing AI technologies to achieve the greatest impact and ROI. The event enabled industry leaders to find partners to help keep the AI in Pharma movement growing and moving forward.

The Summit at a Glance:

- **AI in Research and Development:** Hear how to harness the power of AI to generate novel drug candidates, unlock ADME/Tox obstacles, and decrease the risk profile for regulatory decision-making.
- **AI in Clinical Trials:** Discover how AI can be used to influence the design and optimization of clinical trials and the recruitment and retention of patients and how getting the corporate culture right will improve business outcome conversations and results.
- **Moving from the 'Science of AI' to 'Using AI Tools in Pharma Science':** Understand from Chief Data Officers why data is the new key asset and explore real world evidence and AI and how we can take the next steps forward to start directly impacting care.

# Industry Developments Q3 2019



# Industry Developments Q3 2019

JUL

- **Kyndi**, the artificial intelligence company building the first Explainable AI platform, announced that it raised \$20 million in Series B funding led by **Intel Capital**, with participation from UL Ventures, PivotNorth Capital, and existing investors. The new funding will be used to expand the company's engineering and sales teams to meet growing customer demand in government, financial services and life sciences. Kyndi's customers include Fortune 500 pharmaceutical companies and government agencies.
- **Saama Technologies, Inc.**, a leading clinical data analytics company, announced a collaboration with researchers at **the Tufts Center for the Study of Drug Development (Tufts CSDD)** to ascertain how biopharmaceutical companies optimize automation and information technologies, including artificial intelligence such as machine learning and neural networks, to support the research and development of new therapeutics. The research will examine what areas of the R&D continuum the life sciences industry sees as most easily automated, and where these innovations are being applied. In addition, the research will examine where applications of technology solutions have the most impact, assess how contract research organizations support the adoption of these innovations, and identify areas of greatest concern and challenge.
- MIT's Research Enterprise in Singapore, **SMART**, is launching a new research group as part of Singapore's National Cell Manufacturing Initiative to overcome scientific and technical challenges in life-changing cell therapies. The new interdisciplinary research group, **Critical Analytics for Manufacturing Personalized-Medicine (CAMP)**, or SMART CAMP, will bring together 35 MIT and Singapore investigators in a complementary and integrated programme with Singapore's Agency for Science Technology and Research (**A\*STAR**) cell manufacturing effort, supported by the National Research Foundation (NRF).
- San Francisco-based **Notable Labs** announced it secured \$40 million in a Series B funding round to use its artificial intelligence platform to advance cancer drug development. The company's approach is aimed at predicting which types of patients are most likely to respond to a drug in as little as five days. The process is designed to help physicians make more informed decisions about which clinical trials will be effective with patients and can also benefit the likelihood of a trial's success by matching the right patients to the right trial. Notable noted that in a recent clinical trial, its process achieved an 84% overall accuracy rate in predicting patient response to drugs or drug combinations.

# Industry Developments Q3 2019

AUG

— **Novo Nordisk** extended a collaboration with **e-Therapeutics** to deploy its AI-based drug discovery technology to find new biological targets and therapies for type 2 diabetes. The cooperation has been provided to include functional genomics studies as well, making use of e-Therapeutics' Genome-Associated Interaction Networks (GAINs), a platform that it says can tease out previously unknown disease processes and pathways.

"Using GAINs, we are now able to interrogate genomics data from patients with complex, polygenic disease and shed new light on important and novel biological pathways for particular groups of patients," said e-Therapeutics' chief executive Dr Ray Barlow.

— **Saama Technologies, Inc.** signed a definitive agreement to acquire **Comprehend Systems, Inc.** This agreement combines Saama and Comprehend's respective industry positions as leading clinical data analytics companies. Together, Saama and Comprehend will deploy and evolve their complementary, best-in-class clinical analytics platforms. Fluid Imaging Technologies and the University of Colorado Boulder have recently entered an exclusive research agreement to determine whether the University's artificial intelligence software can identify bloodborne bacteria.

*"The Comprehend-Saama transaction creates a data analytics powerhouse with a singular vision of improving human health through the application of AI-powered solutions for actionable clinical trial insights,"* said Rick Morrison, Founder and Chairman of Comprehend.

— **Fluid Imaging Technologies** and the University of **Colorado Boulder** have recently entered an exclusive research agreement to determine whether the University's artificial intelligence software can identify bloodborne bacteria.

The collaboration will establish training set data from microscopy images for the top ten most wanted bacterial strains causing blood infections, and then train a computer to identify the bacteria automatically in tandem with Fluid Imaging Technologies' FlowCam oil immersion flow imaging microscopes.

— **Neuropore Therapies** and **BenevolentAI** entered strategic collaboration to discover novel therapeutics through the application of AI. BenevolentAI signed a cooperation with Neuropore Therapies, Inc to evaluate molecular targets implicated in progressive degenerative diseases which were identified through AI.

# Industry Developments Q3 2019

SEP

- Artificial intelligence (AI) is being harnessed by researchers to track down genes that cause disease. A **KAUST** team is taking a creative, combined deep learning approach that uses data from multiple sources to teach algorithms how to find patterns between genes and diseases.
- By using a combination of Generative Adversarial Networks (GANs) and Reinforcement Learning (RL), the team of **Insilico Medicine** researchers behind this study (documented in a paper published in Nature Biotechnology this month) have succeeded in validating the real power that AI has to expedite timelines in drug discovery and development, and to transform the entire process of bringing new drugs to market from a random process rife with dead ends and wrong turns to an intelligent, focused and directed process, that takes into account the specific molecular properties of a given disease target into account from the very first step.

**Insilico Medicine** has raised \$37M in Funding from Leading Chinese VC Firm. Lead by Qiming Venture Partners, the \$37 million Series B funding round was also joined by Eight Roads, F-Prime Capital, Lilly Asia Ventures, Sinovation Ventures, Baidu Ventures, Pavilion Capital, BOLD Capital Partners, among other investors that participated in the Series A round.

- Two studies led by **UT Southwestern** provide evidence for the impact of biology by using artificial intelligence to identify patterns of brain activity that make people less responsive to certain antidepressants. The studies include the latest findings from a large national trial (**EMBARC**) intended to establish biology-based, objective strategies to remedy mood disorders and minimize the trial and error of prescribing treatments.
- For the first time, a sophisticated computer model has been shown to accurately predict two of the most challenging side effects associated with radiation therapy for head and neck cancer. This precision oncology approach has the potential to better identify patients who might benefit from early interventions that may help to prevent significant weight loss after treatment or reduce the need for feeding tube placement. Findings was presented at the 61st Annual Meeting of the **American Society for Radiation Oncology (ASTRO)** in Chicago.
- **Arctoris Ltd**, a fully automated drug discovery platform for virtual and traditional biotechnology companies, pharmaceutical corporations and academia, today announced that it has successfully closed a seed funding round of £3.2 million to advance its novel drug discovery offering. The funding will be used to further build out the company's commercial operations and service portfolio, the latter of which enables customers to rapidly and accurately achieve drug discovery milestones from target identification to candidate characterization, as well as dataset generation for artificial intelligence (AI/ML) model validation and training.

# Industry Developments Q3 2019

SEP

- **Benevolent AI** announced that it has signed a framework collaboration agreement with **Novartis** to leverage BenevolentAI's technology platform to interrogate clinical trial and experimental data. This collaboration programme will be led by the Precision Medicine Team within Novartis Global Drug Development. The two companies will investigate indications and responder group(s) for oncology assets currently in clinical development. Under the terms of the agreement, BenevolentAI will apply its technology designed to enable better data-driven decisions to find new ways to treat disease and personalise drugs for patients. The Benevolent Platform® ingests molecular, clinical, pharmacological data and scientific literature, to derive contextual relationships in the data between genes, diseases, drugs and biological pathways leading to the proposal of novel/optimal drug targets.
- **Schrödinger** announced a collaboration with **AstraZeneca** to deploy Schrödinger's advanced computing platform to help accelerate drug discovery efforts by improving the design of compounds to identify potential new therapeutic candidates. Schrödinger's computational platform combines physics-based modeling and machine learning to enable chemists to predict the potency of a molecule binding to a target protein. This increases the likelihood that, when synthesized, compounds will have the correct properties required for further development and reduces the number of compounds that need to be synthesized.
- **BenevolentAI** announced \$90 million investment from **Temasek**, a Singapore-headquartered investment company. The funding will be used to scale and further develop the Benevolent Platform for drug discovery. The funding will be used to scale and further develop the Benevolent Platform for drug discovery and development. BenevolentAI will continue to advance its growing pipeline of internal drug development programmes and collaborations with strategic partners across its key therapeutic areas.
- **Atomwise** and **Jiangsu Hansoh Pharmaceutical Group** – the Chinese company behind this year's largest biopharma initial public offering (IPO) – have launched an up-to-\$1.5 billion collaboration to design and discover potential drug candidates for up to 11 undisclosed target proteins in cancer and "multiple" other therapeutic areas. The cooperation is intended to combine Atomwise's AI technology, medicinal chemistry, and protein structure expertise with Hansoh Pharma's fully integrated R&D, manufacturing, and commercial capabilities, with the aim of accelerating and improving drug discovery and clinical development.

# Industry Developments Q3 2019

OCT

— **Novartis** announced an important step in reimagining medicine by founding the Novartis AI innovation lab and by selecting **Microsoft Corp.** as its strategic AI and data-science partner for this effort. The new lab aims to significantly bolster Novartis AI capabilities from research through commercialization and help accelerate the discovery and development of transformative medicines for patients worldwide.

Microsoft and Novartis will also collaborate to develop and apply next-generation AI platforms and processes that support future programs across these two focus areas. The overall investment will include project funding, subject-matter experts, technology, and tools.

— **ICR** collaborates with **Healx** to develop treatments for rare childhood cancer. Scientists at The Institute of Cancer Research, London, are working with Healx, a biotech company specialising in artificial intelligence (AI) to discover new possible ways of treating diffuse intrinsic pontine glioma (DIPG), an essentially untreatable brain cancer in children. Healx has previously used this approach to identify potential new treatments for rare cancers in partnership with childhood cancer charity aPODD.

— **Optibrium™**, a developer of software for drug discovery has announced the introduction of its Augmented Chemistry™ services, which provide collaborators with novel artificial intelligence technologies to supplement their skills and experience, enabling them to make more effective decisions and advance their drug discovery projects.

# Industry Developments Q3 2019

Coming back to the major industry developments in Q1 2019, one of the most prominent events was the launch of Alliance for Artificial Intelligence in Healthcare (AAIH).

The newly formed Alliance for Artificial Intelligence in Healthcare was sponsoring a panel discussion open to the public, titled “The Future of AI-Powered Healthcare,” on January 7, in association with the Digital and Medtech Medicine Showcase at the Biotech Showcase in San Francisco.

AAIH is the global advocacy organization for the advancement and use of artificial intelligence in healthcare to improve patients’ lives and create more efficient, sustainable, and accessible healthcare systems. Through investment, invention, and innovation in AI, the AAIH and its member companies and organizations are creating novel interventions and product solutions that reduce failure rates and costs while improving quality across the entire healthcare spectrum.

## AAIH Mandate and Goals:

- Develop appropriate regulations and industry guidance
- Seek engagement with appropriate stakeholders
- Interface with Government & NGO’s on growth of AI in healthcare industry
- Stimulate data sharing and open access to key findings
- Set a model and testing approach for quality control and use of standards
- Establish accreditation authority and/or affiliation with academic organizations
- Educate general populace, industry stakeholders, and government on value of AI and Machine Learning
- Prioritize and tailor forums for regulators, payors, providers, and other end-users as well as patients, the public, and media
- Produce informative and reliable industry reports

The AAIH is a coalition of technology developers, pharmaceutical companies, and research organizations who have expressed the common goal of realizing the potential for AI in healthcare to significantly improve quality of care, but who also recognize that these, and other, difficult questions must be considered.

Organization's website: <https://www.theaaih.org>

# Trends of Investment and M&A Deals

## DIVERSIFICATION

In 2015 and 2016, 26 and 22 investment rounds were conducted, and this number increased to 30 in 2017 and to 36 in 2018. There are already more than 30 rounds in 2019.

## 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 \$1,031B in 2018. This is more than twice as much as was raised in all 2017.

Amount of investments in 2019 is already higher than 1B\$.

## 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 2017-2019 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. M&A deals will continue at a fast pace driven by a need to consolidate the business and simplify collaborations and outsourcing.

## LEADERSHIP

In 2019 we can observe establishment of relatively small group of sector leaders who attract significant fraction of total investment volume.

# AI for Drug Discovery Market Timeline

The first AI approaches

- 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.
- However, only few market players believed in the technology.

2013-2015

Criticism

- 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.
- Since then the race for the acquisition of the best, AI startups began.
- Testing of the technology began.

2016-2017

Market cap growth

- Capitalization of the industry was continuously growing.
- Many bets of early investors appeared to be justified.
- 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.

2018

Transition from quantity to quality

- It is going to be an important milestone in transitioning from the quantity of AI-related collaborations, investments, and M&As to qualitative gains – first practical validations of previously conducted research might be appearing during this year.
- 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.

2019

Intensive competition

- Competition for the most successful pharma AI companies will increase drastically.
- The line between data science and health companies will blur, leading to the destruction of those companies that cannot adopt.

2020-2021

# Industry Developments 2019

One of the most prominent events in AI for Drug Discovery sector in the first quarter of 2019 was the launch of Alliance for Artificial Intelligence in Healthcare (AAIH).

## AAIH Mandate and Goals

- Develop appropriate regulations and industry guidance
- Seek engagement with appropriate stakeholders
- Interface with Government & NGO's on growth of AI in healthcare industry
- Stimulate data sharing and open access to key findings
- Set a model and testing approach for quality control and use of standards
- Establish accreditation authority and/or affiliation with academic organizations
- Educate general populace, industry stakeholders, and government on value of AI and Machine Learning
- Prioritize and tailor forums for regulators, payors, providers, and other end-users as well as patients, the public, and media
- Produce informative and reliable industry reports

The AAIH is a coalition of technology developers, pharmaceutical companies, and research organizations who have expressed the common goal of realizing the potential for AI in healthcare to significantly improve quality of care, but who also recognize that these, and other, difficult questions must be considered.

Organization's website: <https://www.theaaih.org>

# AI Success Stories in Q3 2019

Among other developments, 2019 appears to be a “proof-of-concept” year for hit discovery using AI technology.

## Insilico Medicine



First example is a landmark paper by [Insilico Medicine](#).

The first in vivo active drug candidate developed from scratch (de-novo) using GENTRL system

GENTRL system - a modular drug design platform based on generative adversarial networks (GANs) and other machine learning

A new candidate has been developed staggeringly quickly: in 46 days, including target selection

## Deep Genomics



Another big success for AI-augmented drug design is DG12P1.

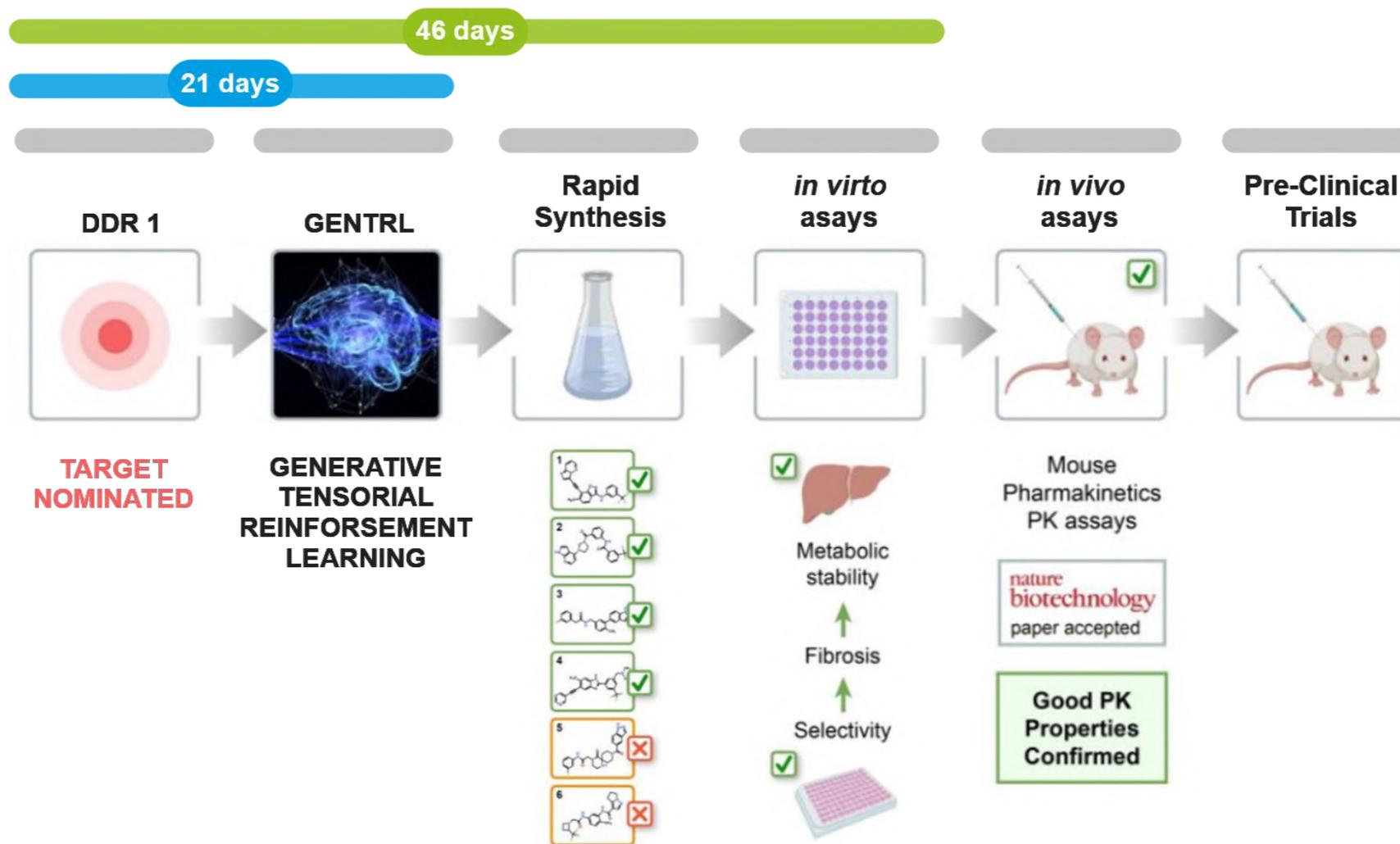
It is an oligonucleotide therapy designed by Deep Genomics via their platform AI Workbench to treat rare Wilson disease, leading to copper accumulation in the liver, brain and other vital organs.

The discovery took under 18 month from the concept to an actual clinical trials-ready drug candidate, which is way faster compared to classical approaches.

# AI Success Stories in Q3 2019

Among other developments, 2019 appears to be a “proof-of-concept” year for hit discovery using AI technology.

## DEEP LEARNING ENABLES RAPID IDENTIFICATION OF POTENT DDR1 KINASE INHIBITORS



Traditional hit-lead generation: 2-3 years  
GENTRL approach: 2 months

# Appendix

Overview of Proprietary Analytics by  
Pharma Division of Deep Knowledge Analytics



# Overview of Proprietary Analytics by Pharma Division of Deep Knowledge Analytics

The Pharma Division of Deep Knowledge Analytics encompasses deep intelligence of the pharma industry and the AI for Drug Discovery sector. AI has already become the key ingredient of success for Tech Corporations and is becoming crucially important for Big Pharma as well. It will be like oxygen for them in no time. This is why the knowledge and incorporation of AI and DL is of paramount importance for the pharma corporations if they plan to survive. Those pharma companies that are last have the potential to become first, and those of them that are downtrodden could rise up. All they need is AI and the knowledge of the market. The series of AI for Pharma reports from Deep Knowledge Analytics is there for the taking.

**The key questions regarding AI for Drug Discovery and Biomarker Development sector include:**

- **What are the major threats and opportunities facing biopharma corporations regarding AI development in the industry?**
- **What is the specifics of the stock indices aggregated based on pharma and tech corporations applying AI?**
- **What are the main reasons for declining efficiency of R&D of biopharma corporations and what are business consequences and solutions for the corporations and other participants of the industry?**
- **How can different institutions benefit from the aforementioned tendencies?**

There are a few 40+ page reports delivering practical answers to these specific questions in order to optimize the short and long-term strategies of biopharma corporations and other institutions related to the industry, with a newly updated edition being released each quarter, incrementally increasing the precision, practicality and actionability of its technological and financial analysis.

**They will deliver:**

- Concrete deep analysis of the prospects of AI for Drug Discovery and Biomarker Development industry regarding the development of the different trends;
- Tangible forecasts on the 3-5 years horizon, providing an overview of future scenarios of the development of AI in the pharma industry;
- Practical guide to the optimized way for assembling the best possible tools and solutions to deal with the industry trends;
- Analysis of key market players in the AI for Drug Discovery and Biomarker Development landscape.

**The parties who gain early access to these reports will have deep expertise on how their strategic agendas can be optimized and stabilized in order to manage the usage of AI for Drug Discovery and Biomarker Development, to surpass the challenges and to utilize the opportunities related to these novel biopharma trends.**

# Deep Knowledge Analytics Pharma Division

## Major Sectors of Expertise

AI

Deep Learning

Biomarker Development

Drug Discovery

### Our Assets



Next-generation infographics unifying big data analytics with advanced visualization



Near-term forecasts using tangible, qualitative metrics



Customised Pharma Industry analytics services for corporate and institutional clients

The **Pharma Division of Deep Knowledge Analytics** produced five case studies and analytical reports focused on AI for Drug Discovery sector in 2018, setting the gold standard for analytics on this topic. On multiple occasions, it was covered by top media such as Forbes and the Financial Times. Its opinions, insights and forecasts have been recognized and widely referenced by top executives at the level of senior Vice-Presidents of Big Pharma corporations, such as Johnson & Johnson, Merck, GSK. Recently, MIT named this division as a **top technology think-tank**, acknowledging the AI ranking framework it developed.

### Plans for 2019

**Deep Knowledge Analytics' Pharma Division** is actively increasing both its number of open-access as well as proprietary reports, and the breadth and depth of its industry-landscape and competitive analytics.

### Proprietary Analytics scheduled for Q2 2019

- New edition of Proprietary Analytical Report: Comparative Industry Analysis
- Ranking of Investment Funds
- Investment targets for AI-Pharma Fund (enhanced analysis of best AI startups)
- Declining Efficiency of R&D of Pharma Corporations
- Pharma AI Stock Index
- Pharma AI Risks
- Ranking of Pharma AI Analysts

The **Pharma Division of Deep Knowledge Analytics** aggregates the most advanced team of analysts and experts to produce customized case studies and deep industry analysis for the top executives of big pharma corporations. Its reports cover a number of converging sectors, including AI for Drug Discovery, the systemic declining efficiency of R&D of Big Pharma corporations and the rise of Tech-corporations entering healthcare and drug discovery space.

**Deep Knowledge Analytics Pharma Division** offers several services to its clients:

- Conduct customised case studies, research and analytics for internal (organizational) use, tailored to the precise needs of specific clients;
- Perform customised solutions using specialised software, industry and technology databases, interactive IT-platforms;
- Provide customized competitive analytics and development recommendations for specific companies and corporations interested in enhancing AI in Pharma assets and activities.

# Deep Knowledge Analytics "Pharma Division": Upcoming Proprietary Reports Q3 2019



Comparative Industry Analysis & Classification Framework



Pharma AI Stock Index



Top Analysts AI in Pharma



Declining Efficiency of R&D in Pharma Corporations



Top-20 AI in Drug Discovery Investors



Enhanced analysis of most promising AI-companies as the best investments targets for AI-Pharma Index Hedge Fund

# Deliverables of “Comparative Industry Analysis & Classification Framework”

AI for Drug Discovery and Biomarker Development sector has large potential to impact the whole biopharma industry essentially. Knowledge of the landscape of the market is crucial for the survival and development of every company operating in the market.

## **The key questions regarding implementation of AI for drug discovery and biomarker development include:**

- What are the major threats and opportunities facing biopharma corporations regarding AI development in the industry?
- What are the main players in AI for drug discovery field? How are they categorized and differentiated?
- How can different institutions benefit from the AI for drug discovery development?

This is a 100+ page report delivering practical answers to these specific questions in order to optimize the short and long-term strategies of biopharma corporations and other institutions related to the industry, with a new updated edition being released each month, incrementally increasing the precision, practicality and actionability of its industry analysis. Each new edition will provide a more sophisticated, comprehensive and precise understanding of the challenges and opportunities provided by the development AI in biopharma industry, as well as what businesses such as pharma corporations and private biotech companies need to do in order to benefit, rather than stagnate, from the oncoming boom of AI in the industry.

## **It will deliver:**

- Deep analysis of the prospects of AI for Drug Discovery and Biomarker Development industry regarding the development different trends
- Analysis of the most promising pharma AI companies, their opportunities, strengths and weaknesses
- Comparison of key market players
- Assessment of the future prospects of these companies

**The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to manage the usage of AI for Drug Discovery, to surpass the challenges and to utilize the opportunities related to these novel biopharma trends.**

# Deliverables of “Pharma AI Stock Index”

Pharma and Tech corporations demonstrate an increasing interest in AI. Applying AI for Drug Discovery and cooperation with pharma AI companies can be a sign that a corporation has prospects for competitive advantage. Understanding financial dynamics of such corporations is crucial for the analysis of threats and opportunities of AI for Drug Discovery industry.

## **The key questions regarding financial dynamics of pharma and tech corporations applying AI include:**

- What is the specifics of the stock indices aggregated based on these corporations?
- What is the relation of these indices to the most important, well-known and relevant stock indices and what are the reasons for that?
- How can different institutions benefit from the knowledge of dynamics of these indices?

This is a 60+ page report delivering practical answers to these specific questions in order to optimize the short and long-term strategies of investors, biopharma corporations and other institutions related to the industry, with a new updated edition being released each month, incrementally increasing the precision, practicality and actionability of its financial analysis. Each new edition will provide a more sophisticated, comprehensive and precise understanding of the reasons and consequences of financial dynamics of the aforementioned corporations, as well as what businesses such as pharma and tech corporations and private biotech companies need to do in order to benefit, rather than stagnate, from these tendencies. The report also suggests important insights for investors dealing in the related market. It is also planned to establish real-time information on the indices dynamics as well as on the statistical indicators of their relation to traditional and industrial-specific stock indices.

## **The findings of the report can be used for:**

- Developing the optimal portfolio for investing in AI for Drug Discovery industry
- Predicting future financial dynamics in the industry
- Gaining understanding of current pharma and tech markets tendencies and crucial risks
- Risk assessment and formation of future market development scenarios
- Determining what has to be done in order to benefit from these tendencies

**The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to benefit from the impact of financial dynamics of the aforementioned corporations and how to utilize the opportunities related to these financial trends. Pharma and tech corporations themselves will be able to observe their place on financial landscape regarding the sector of AI for Drug Discovery.**

# Deliverables of “Declining Efficiency of R&D in Pharma Corporations”

The decline of the R&D efficiency of biopharma corporations is perhaps the most crucial trend in the whole industry now. Today it is even more exacerbated due to the ever-increasing impact of this decline on financial indicators of pharma corporations and financial stagnation of the industry despite large technological progress.

## **The key questions regarding declining efficiency of R&D of biopharma corporations include:**

- What are the main reasons for this declining trend and what are business consequences for the corporations and other participants of the industry?
- How can pharma corporations find the solutions to deal with this negative trend?
- What are future prospects of pharma corporations regarding the evidence of R&D efficiency and how these prospects can be changed?

This is a 70+ page report delivering practical answers to these specific questions in order to optimize the short and long-term strategies of biopharma corporations and other institutions related to the industry, with a newly updated edition being released each quarter, incrementally increasing the precision, practicality and actionability of its technological and financial analysis. Each new edition will provide a more sophisticated, comprehensive and precise understanding of the challenges and opportunities provided by the decreasing efficiency of R&D in biopharma corporations, as well as what businesses need to do in order to revert this trend, rather than stagnate. It is analyzed and assessed also how are these solutions applicable and how is it likely to implement them.

## **The results of the report can be applied for:**

- Complex and deep analysis of the pharma industry
- Optimizing the short and long-term strategies of biopharma corporations and other institutions related to the industry
- Determination of the most promising development directions for the pharma corporations' in order to maximize profits
- Risk assessment of the sector
- Predicting future dynamics and prospects of pharma industry
- Investigating the reasons for declining efficiency of R&D and suggesting solutions to deal with it

**The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to manage the problem of declining efficiency of R&D in pharma corporations, to surpass the challenges and to utilize the opportunities related to these biopharma trends.**

# Deliverables of “Top-30 AI in Drug Discovery Investors”

AI for Drug Discovery and Biomarker Development industry has a large potential to impact the whole biopharma industry essentially. Knowledge of the key investors in this industry is crucial for the survival and development of every company operating in the market.

## **The key questions regarding analysis and evaluation of AI for drug discovery investors include:**

- What are the major threats and opportunities facing investors in AI for Drug Discovery industry?
- What are the main investors in AI for drug discovery field? What are their key features and similarities?
- What are their investment strategies and how can biopharma companies benefit from cooperation with them?

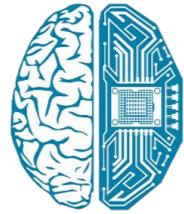
This is a 40+ page report delivering practical answers to these specific questions in order to optimize the short and long-term strategies of biopharma companies, investors and other institutions related to the industry, with a new updated edition being released each quarter, incrementally increasing the precision, practicality and actionability of capital market analysis. Each new edition will provide a more sophisticated, comprehensive and precise understanding of the challenges and opportunities for investors provided by the development AI in biopharma industry, as well as what businesses such as pharma corporations and private biotech companies need to do in order to benefit, rather than stagnate, from the strategies of these investors.

## **The results of the report can be applied for:**

- Defining the best investment strategies for the investment in AI for Drug Discovery sector
- Defining the most prospective investment funds in the industry
- Predicting future dynamics and prospects of AI for Drug Discovery investors (in order to understand which funds to invest in)
- Complex analysis of the whole industry
- Identifying inefficient investment strategies

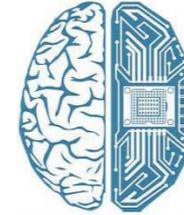
**The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to surpass the challenges and to utilize the opportunities related to these novel AI for Drug Discovery investment trends.**

# Deep Knowledge Group



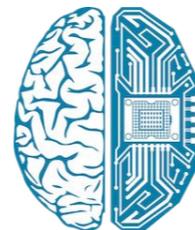
## DEEP KNOWLEDGE ANALYTICS

**Deep Knowledge Analytics** - the analytical arm of Deep Knowledge Ventures, specialising in forecasting on the convergence of technological megatrends, conducting special case studies and producing advanced industry analytical reports on the topics of Artificial Intelligence, DeepTech, GovTech, Blockchain, FinTech and Invest Tech.



## DEEP KNOWLEDGE ANALYTICS *PHARMA DIVISION*

**Deep Knowledge Analytics Pharma Division** - the leading analytical entity specifically focused on deep intelligence of the pharma industry and the AI for Drug Discovery sector. Deep Knowledge Analytics Pharma Division serves as the main source of investment intelligence and analytics for AI-Pharma, a specialized index hedge fund for the AI in Drug Discovery sector.



## DEEP KNOWLEDGE VENTURES

**Deep Knowledge Ventures** - A data-science driven investment fund focused on the synergetic convergence of specific DeepTech verticals. Investment sectors include AI, Precision Medicine, Longevity, Blockchain and Invest Tech.

# Enhanced Analysis of 30 Leading AI Companies

To get access to this specialized section  
of the analytical report please contact  
us by email [pharma@dka.global](mailto:pharma@dka.global)



# Goal and Applications of the Analytical Report

**This report aims to enhanced analysis of most promising AI-companies as the best investments targets for AI-Pharma Index Hedge Fund in order to enable investors, corporations and other industry participants to develop effective short and long-term strategies.**

To understand development line of best companies applying AI in drug discovery, bioinformatics and biotechnology it is crucial to analyze their backgrounds, technical skill-sets, strengths, competencies and types of impact they have on the industry in general. Applying AI for Drug Discovery and cooperation with pharma AI companies may indicate the prospects for competitive advantage in the market and opportunities for further growth.

Particularly, analytical report estimates activities of 30 the most promising AI-companies as the best investments targets for AI-Pharma Hybrid Index Hedge Fund Also, the report is supplemented with a qualitative analysis and comparison of the best 25 companies.

Key factors have combined to increase the capability of AI in particular: high number of AI-experts, cooperation with well-known companies, high level of funding, end-to-end clinical development, high publicity position, personalized medicine, use of unique technology.

## **The findings of the report can be used for:**

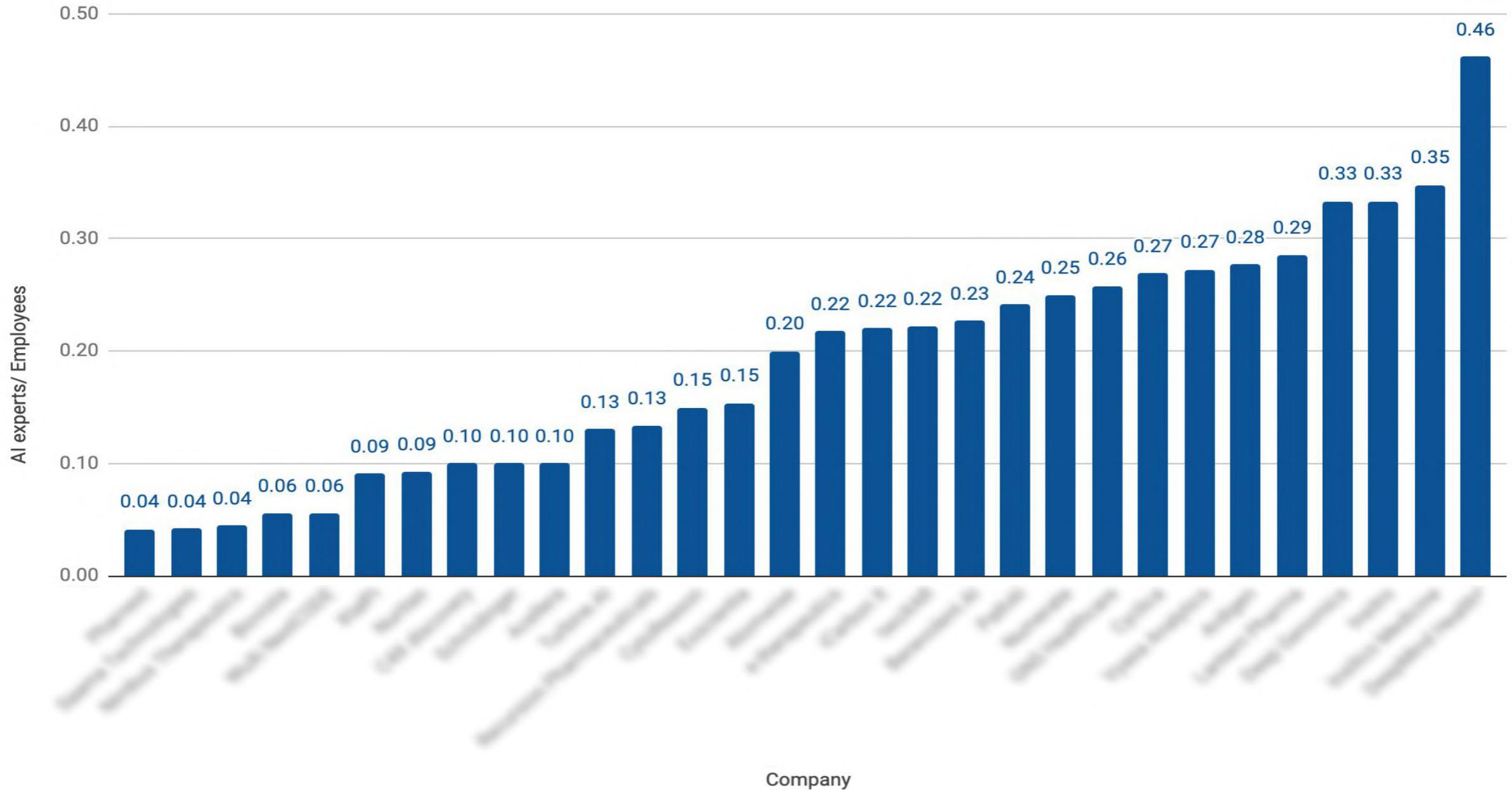
- Developing the optimal portfolio for investing in AI for Drug Discovery, Bioinformatics and Biotechnology industry
- Gaining understanding of current pharma and tech markets opportunities and crucial threats
- Determining what has to be done in order to benefit from these tendencies and tackle particular issues.

The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to benefit and choose the best attractive companies for investments in AI-Pharma industry.

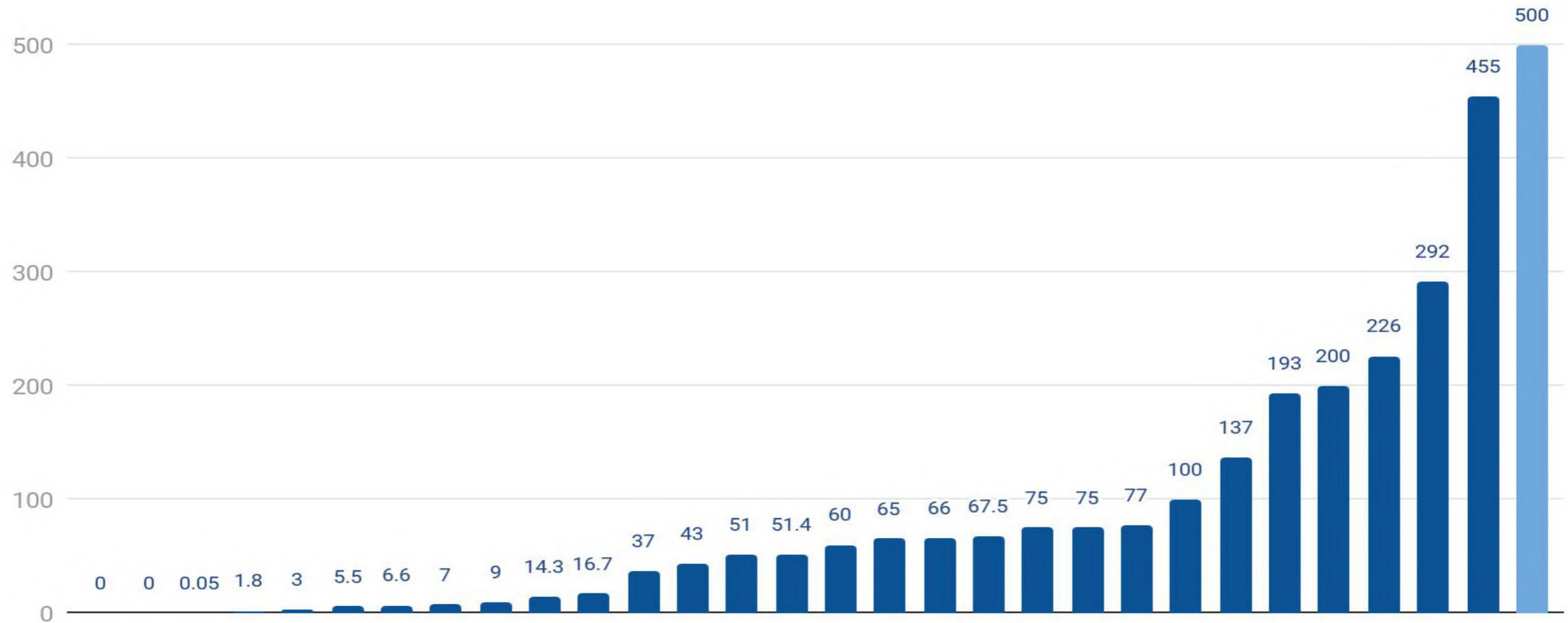
# Comparison of Top-30 AI for Drug Discovery Companies

True AI companies

The ratio: AI experts vs Total Number of Employees



# Funding of Top-30 AI for Drug Discovery Companies, in millions USD

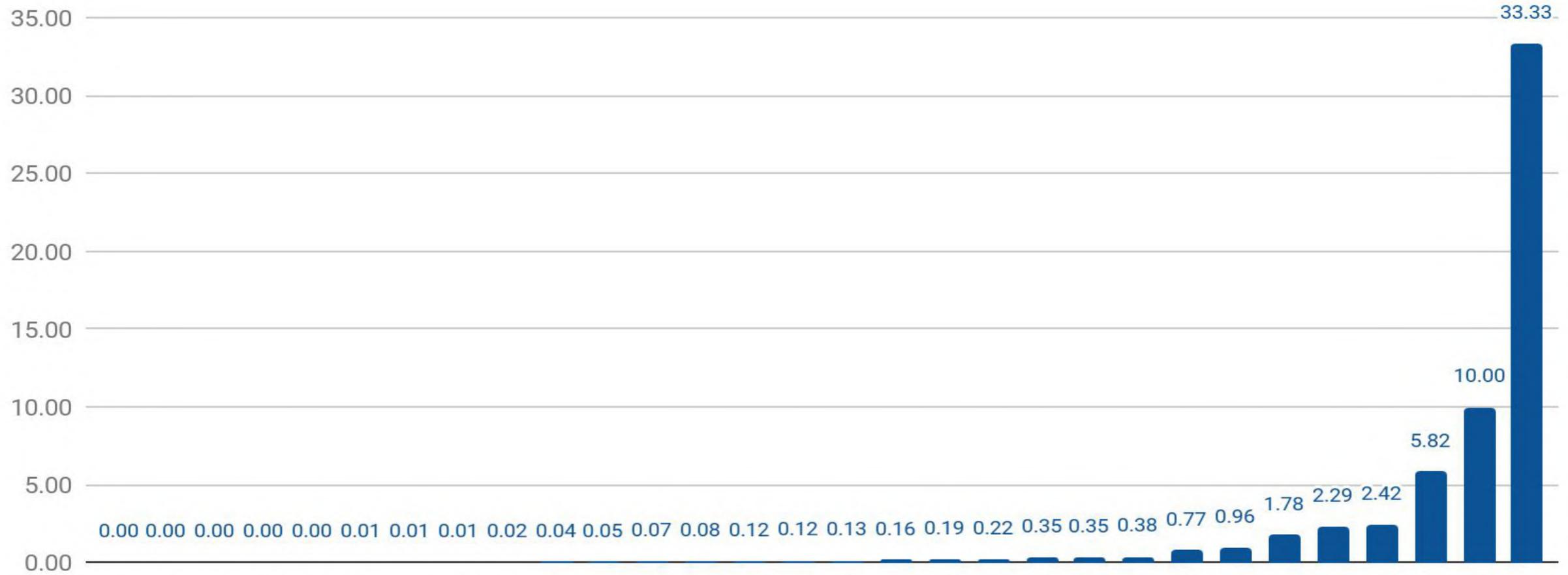


\* - approximate

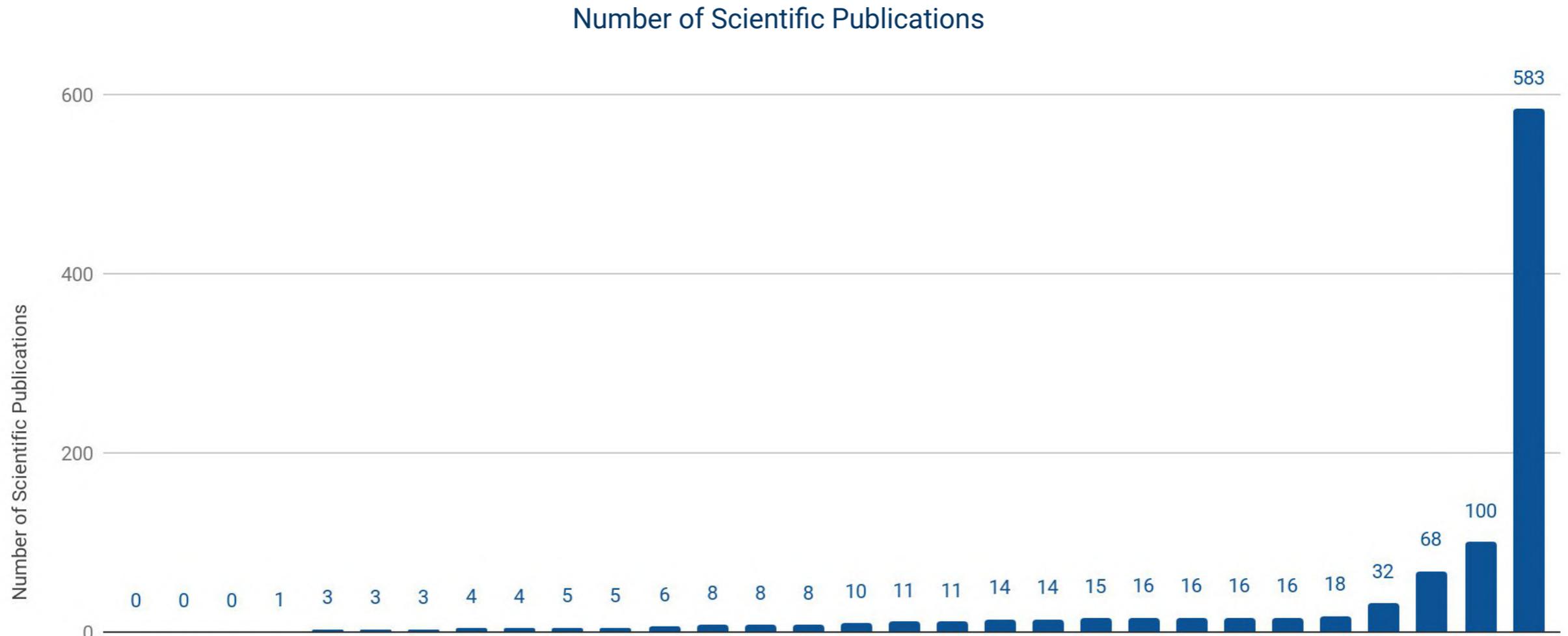
\*\* - DeepMind Funding Combined

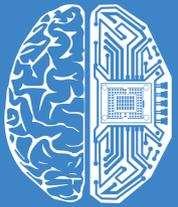
# Comparison of Top-30 AI for Drug Discovery Companies

Ratio of Scientific IP vs Funding



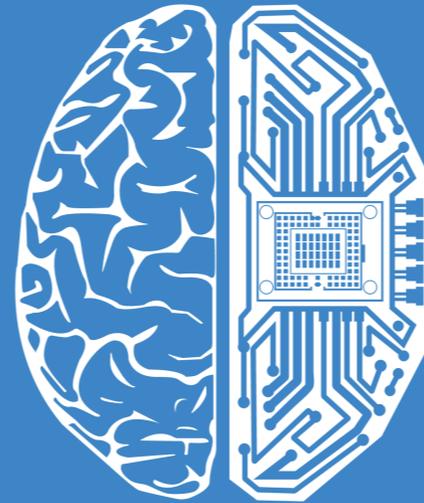
# Comparison of Top-30 AI for Drug Discovery Companies





**DEEP  
KNOWLEDGE  
ANALYTICS  
PHARMA DIVISION**

[www.ai-pharma.dka.global](http://www.ai-pharma.dka.global)



**Link to the Report: [www.ai-pharma.dka.global/AI-for-DD-2019-Q3](http://www.ai-pharma.dka.global/AI-for-DD-2019-Q3)**

**E-mail: [pharma@dka.global](mailto:pharma@dka.global)**

**Website: [ai-pharma.dka.global](http://ai-pharma.dka.global)**

#### Deep Knowledge Analytics (DKA) Disclaimer.

The information and opinions in this report were prepared by Deep Knowledge Analytics. The information herein is believed by DKA to be reliable but DKA makes no representation as to the accuracy or completeness of such information. There is no guarantee that the views and opinions expressed in this communication will come to pass. DKA may provide, may have provided or may seek to provide advisory services to one or more companies mentioned herein. In addition, employees of DKA may have purchased or may purchase securities in one or more companies mentioned in this report. Opinions, estimates and analyses in this report constitute the current judgment of the author as of the date of this report. They do not necessarily reflect the opinions of DKA and are subject to change without notice. DKA has no obligation to update, modify or amend this report or to otherwise notify a reader thereof in the event that any matter stated herein, or any opinion, estimate, forecast or analysis set forth herein, changes or subsequently becomes inaccurate. This report is provided for informational purposes only. It is not to be construed as an offer to buy or sell or a solicitation of an offer to buy or sell any financial instruments or to participate in any particular trading strategy in any jurisdiction.