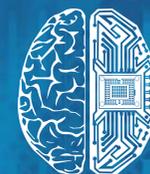
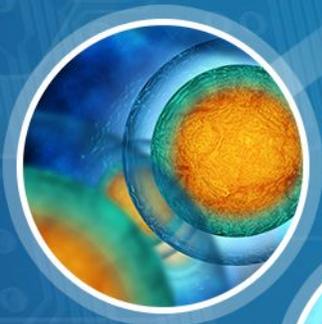


Companies - 150
Corporations - 50
R&D Centers - 30
Investors - 350

AI

FOR DRUG DISCOVERY,
BIOMARKER DEVELOPMENT
AND ADVANCED R&D
LANDSCAPE OVERVIEW 2019 / Q1



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AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview 2019 / Q1

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AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2019 Q1

Companies - 150
Investors - 350
Corporations - 50

Drug Discovery

Advanced R&D

Investors
AI Companies
Corporations



Biomarker Development

Diversification of AI for R&D and Drug Discovery Process 2019 Q1

Companies - 150
Investors - 350

Companies

Investors

Data Aggregation & Analysis

Drug Design

Clinical Trial Design, Optimization, Recruitment

Repurposing Existing Drugs

Researching Mechanisms of Disease

Design Preclinical Experiments

Preclinical Experiment Execution

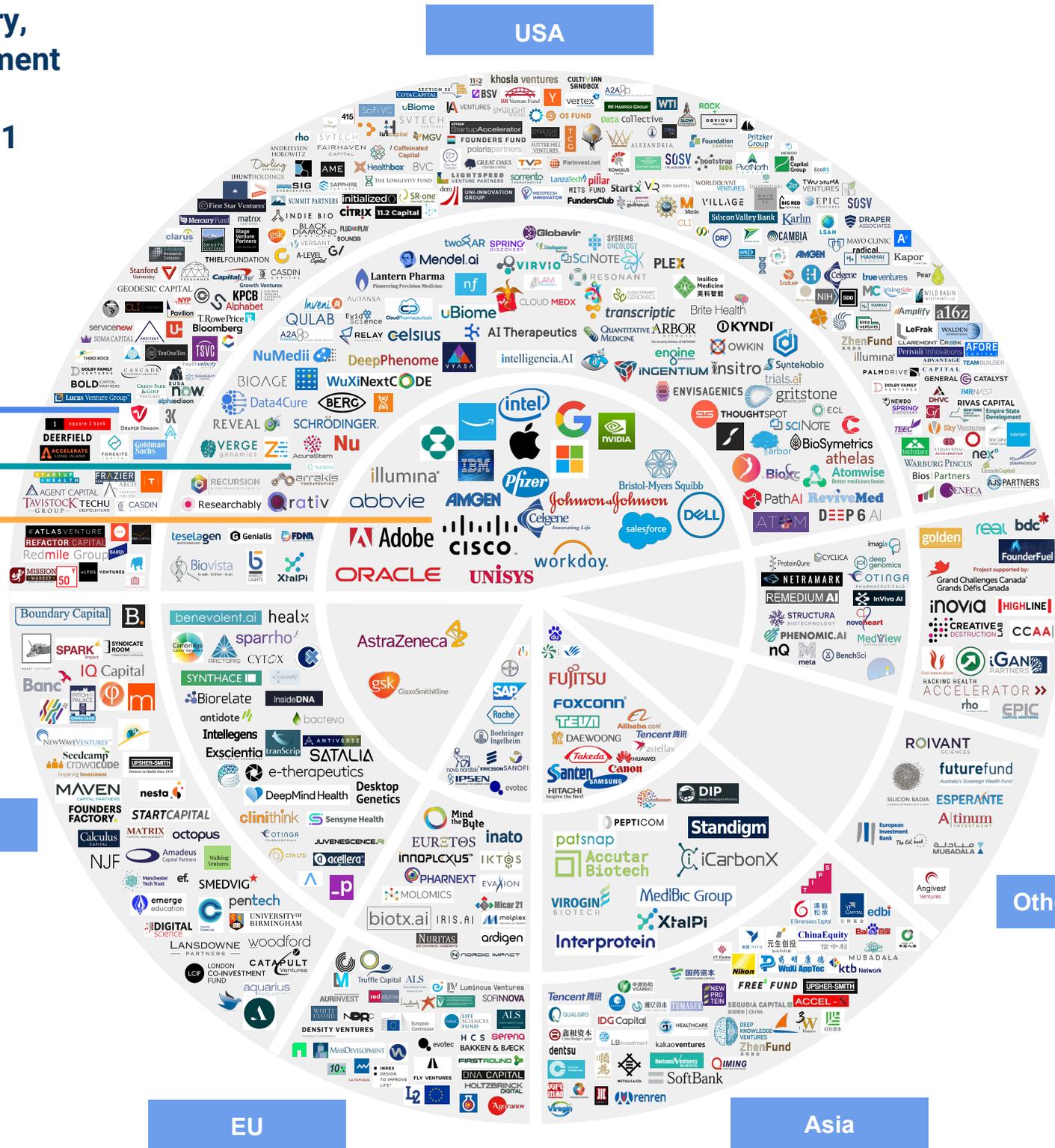


AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2019 Q1

Companies - 150
Investors - 350
Corporations - 50

Regional
Position

Investors
AI Companies
Corporations



Canada

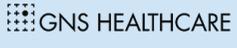
UK

Other Regions

EU

Asia



AI Companies			Pharma Corporations	Tech Corporations	AI Companies			
 Insilico Medicine 英科智能	 Exscientia DRIVEN BY KNOWLEDGE	 CloudPharmaceuticals	 gsk	 Pfizer	 SANOFI	 Tencent 腾讯	 XtalPi	 Atomwise Better medicines faster.
 CYCLICA	 Atomwise Better medicines faster.	 Numerate	 MERCK	 Alibaba Group	 XtalPi	 amazon	 XtalPi	
 Biovista to seek - to know - to act	 XtalPi	 Roche	 BAYER	 Roche	 SANOFI	 Baidu 百度	 Atomwise Better medicines faster.	
 Exscientia DRIVEN BY KNOWLEDGE	 SCHRODINGER	 RECURSION PHARMACEUTICALS	 NOVARTIS	 IBM	 IBM Watson™	 Google	 XtalPi	
 Biovista to seek - to know - to act	 Numerate	 NuMedii	 Boehringer Ingelheim	 DAEWOONG	 NVIDIA.	 AiCure	 Atomwise Better medicines faster.	 CYCLICA
	 BenevolentAI	 Johnson & Johnson	 Roche	 Canon	 Insilico Medicine 英科智能	 SCHRODINGER®		
	 AiCure	 GNS HEALTHCARE	 药明康德 WuXi AppTec	 HUAWEI				
	 Insilico Medicine 英科智能	 BERG	 AstraZeneca	 intel				
		 astellas	 Bristol-Myers Squibb	 HITACHI				
		 Celgene Innovating Life	 AMGEN	 SAMSUNG				
		 illumina®		 SIEMENS				

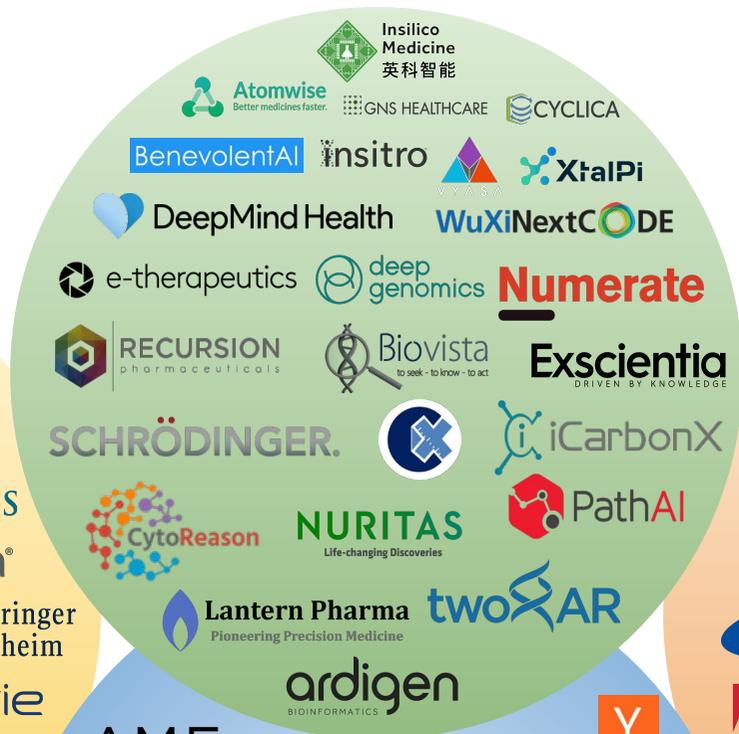
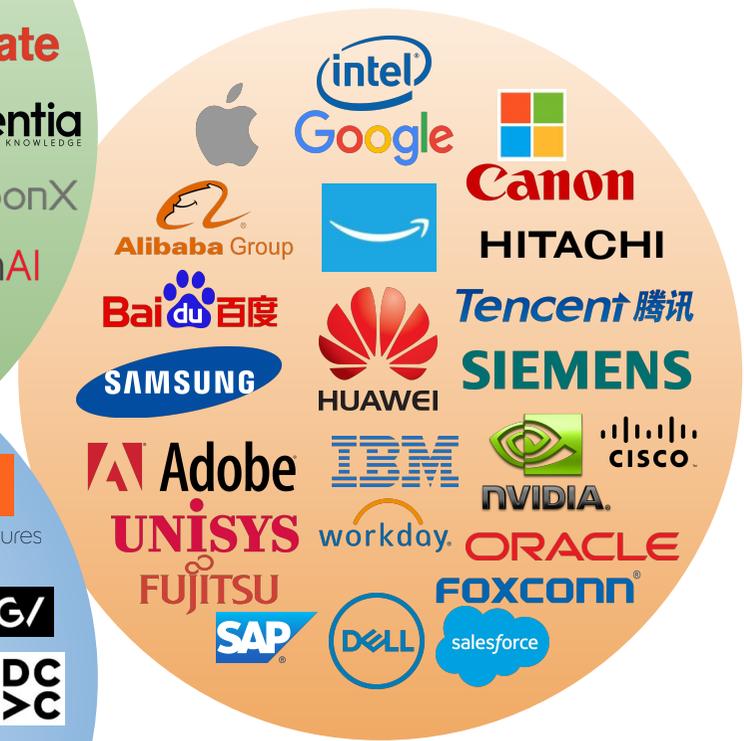
Leading Companies - Advanced AI in Healthcare and Drug Discovery / 2019 Q1

AI-Companies

Pharma Corporations



Tech Corporations

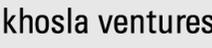


Investors

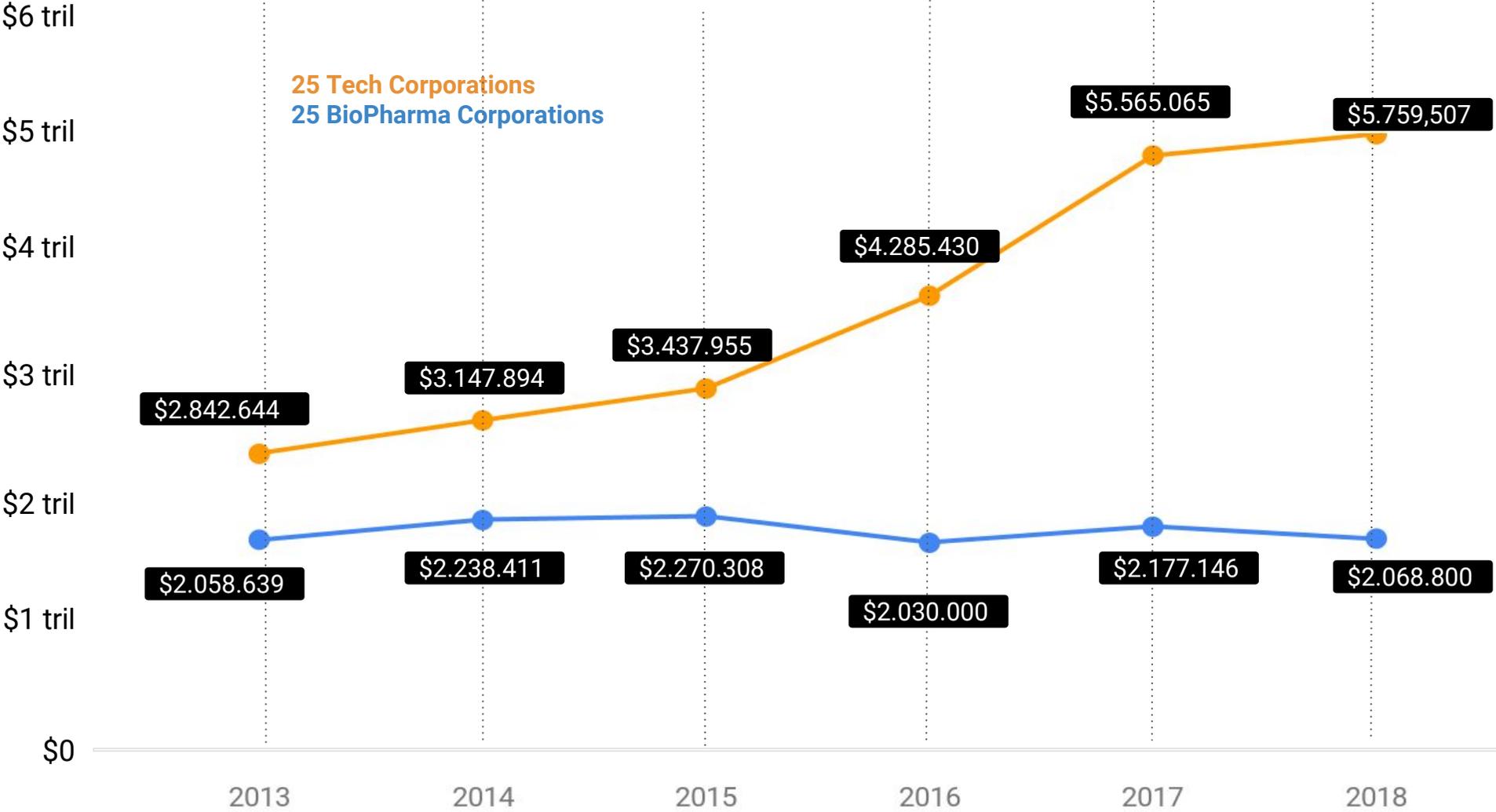


Top-20 Investors in AI Companies

Top AI Companies ← Investments overall — INVESTORS — Investments overall → Top AI Companies

Top AI Companies	Investments overall	INVESTORS	Investments overall	Top AI Companies
 Atomwise	9	 Y combinator	 SEQUOIA Sequoia Capital	 XtalPi
	8	 SOSV	 OS Fund	 Atomwise
SCHRÖDINGER.	8	 GV	 DCVC Data Collective DCVC	 Atomwise
 Atomwise	8	 AME AME Cloud Ventures	 ZhenFund 真格基金 ZhenFund	 XtalPi
 Atomwise	6	 khosla ventures Khosla Ventures	 ANDREESSEN HOROWITZ Andreessen Horowitz	 Insitro
	6	 Amadeus Capital Partners Amadeus Capital Partners	 药明康德 WuXi AppTec	 Insilico Medicine 英科智能
 PathAI	5	 General catalyst	 StartX StartX	 XtalPi
 PathAI	4	 REFACTOR CAPITAL Refactor Capital	 Founders fund	 RECURSION pharmaceuticals
	4	 Felicis ventures	 DRAPER ASSOCIATES Draper associates	 Atomwise
 WuXiNextCODE	3	 AMGEN Ventures Amgen ventures	 500 500 startups	

Combined Capitalization of 25 Tech Corporations vs 25 BioPharma Corporations



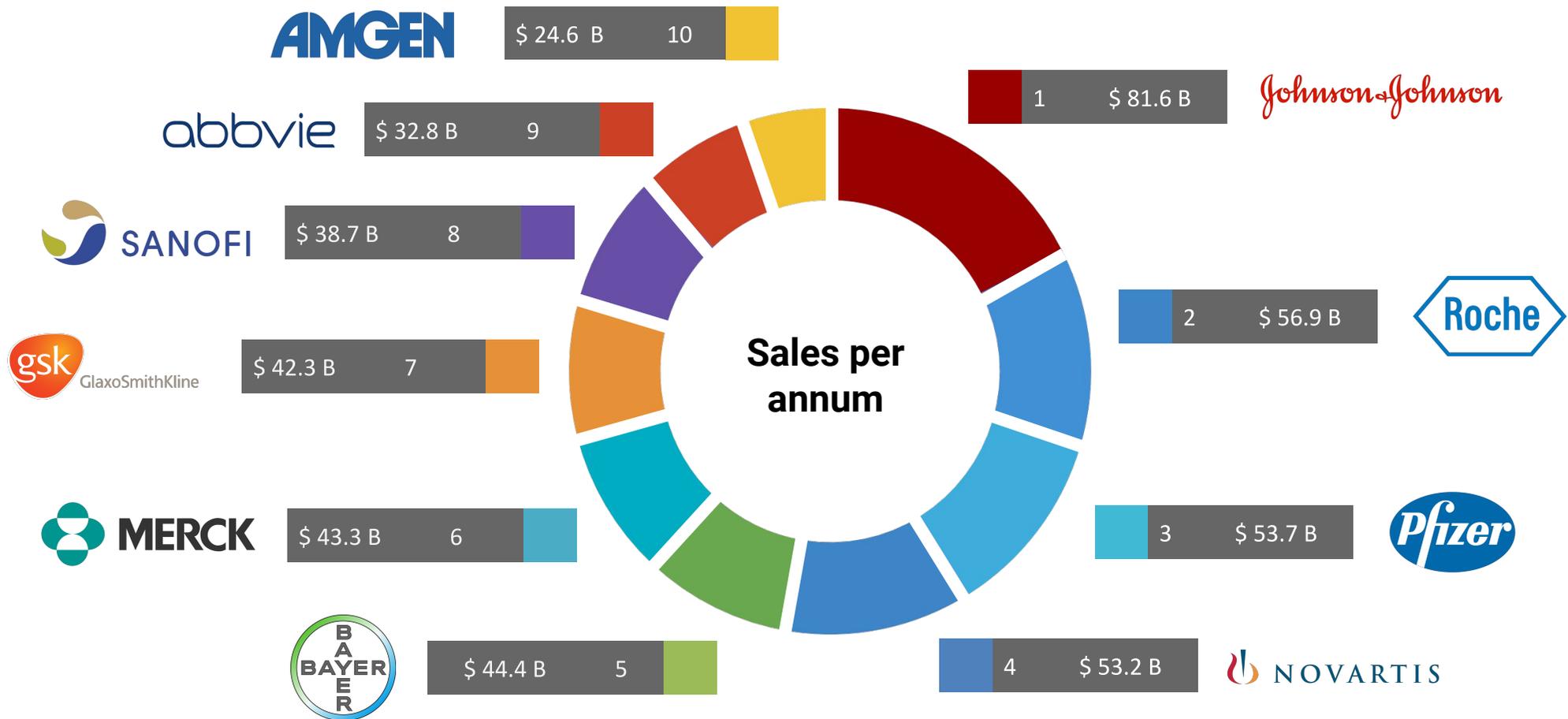
As can be seen in the figure above, the combined capitalization of the 25 BioPharma corporations profiled in this report has remained on the same level for the past 5 years while the capitalization of the 25 IT & Tech corporations profiled in this report is growing significantly. This can be considered as evidence that the BioPharma industry is stagnating in general, while the IT & Tech industry is progressing. This is why it is so notable that the number of IT corporations has already matched the number of BioPharma corporations active in this subsector.

GLOBAL SALES: >\$1 Trillion

GLOBAL R&D: >\$150 Billion

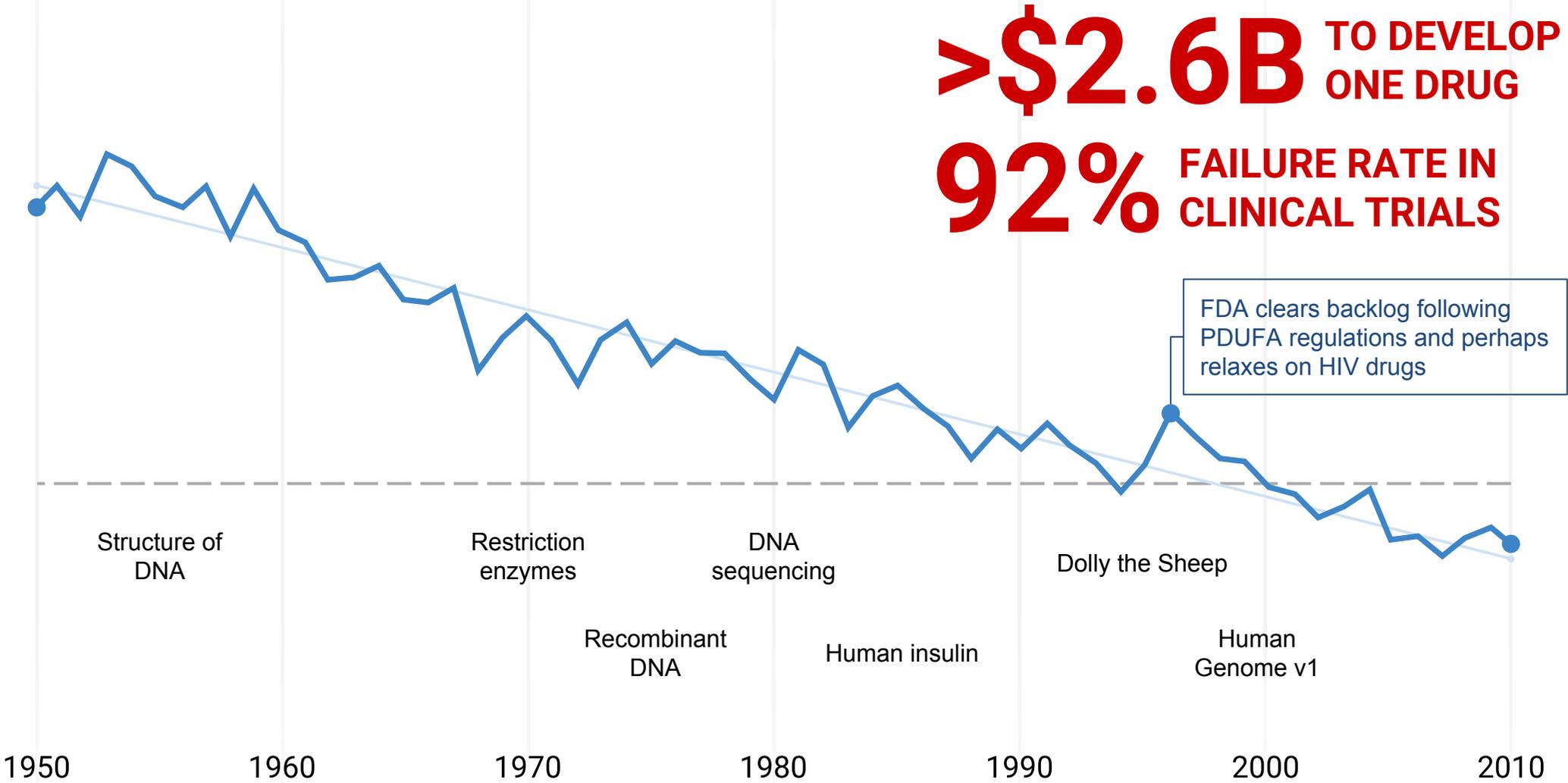
AI in Healthcare by 2024: >\$50 Billion

AI for Drug Discovery by 2024: >\$10 Billion



Pharma Efficiency is Declining Steadily

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

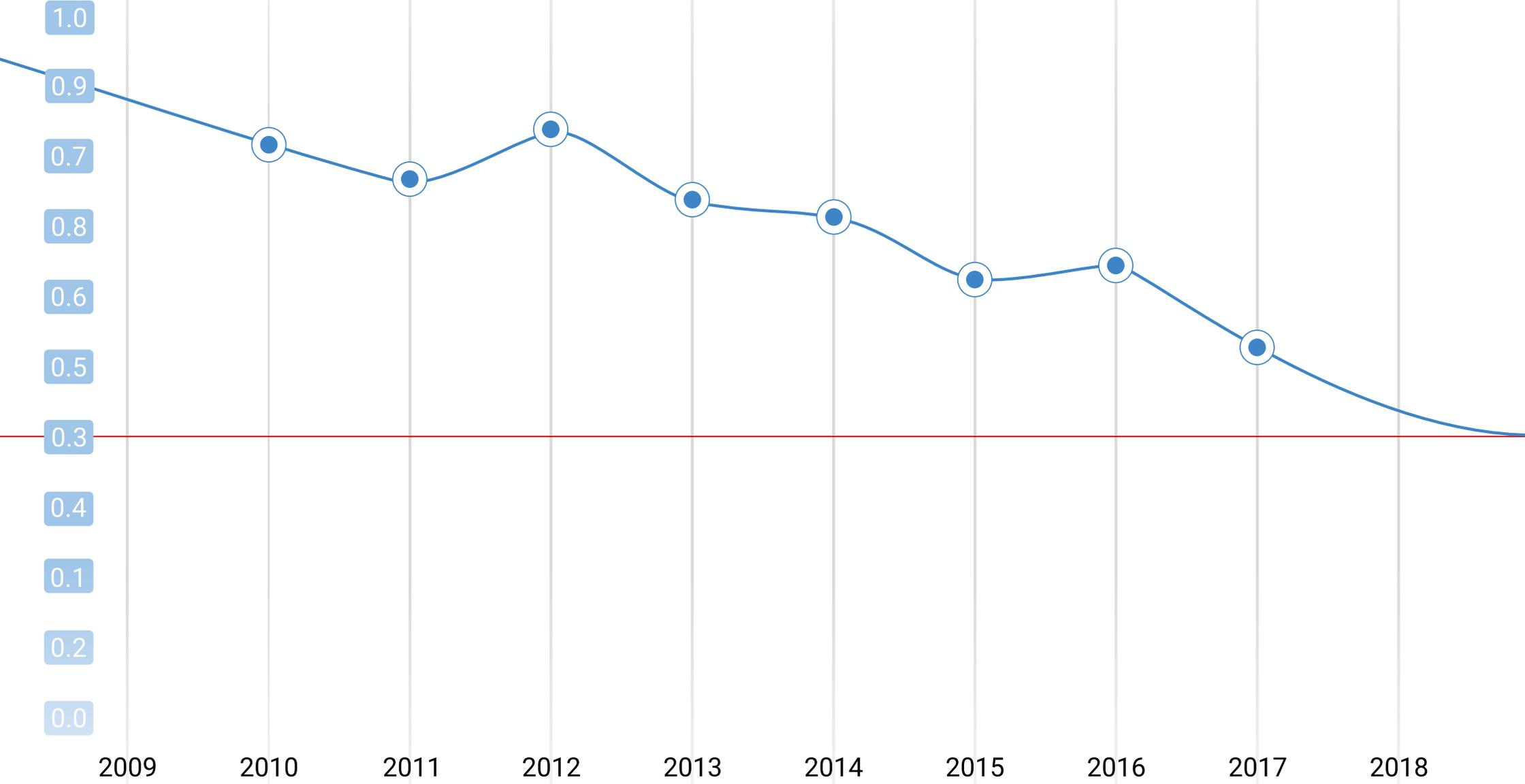


Bernstein Research: The Long View - R&D Productivity, 2010

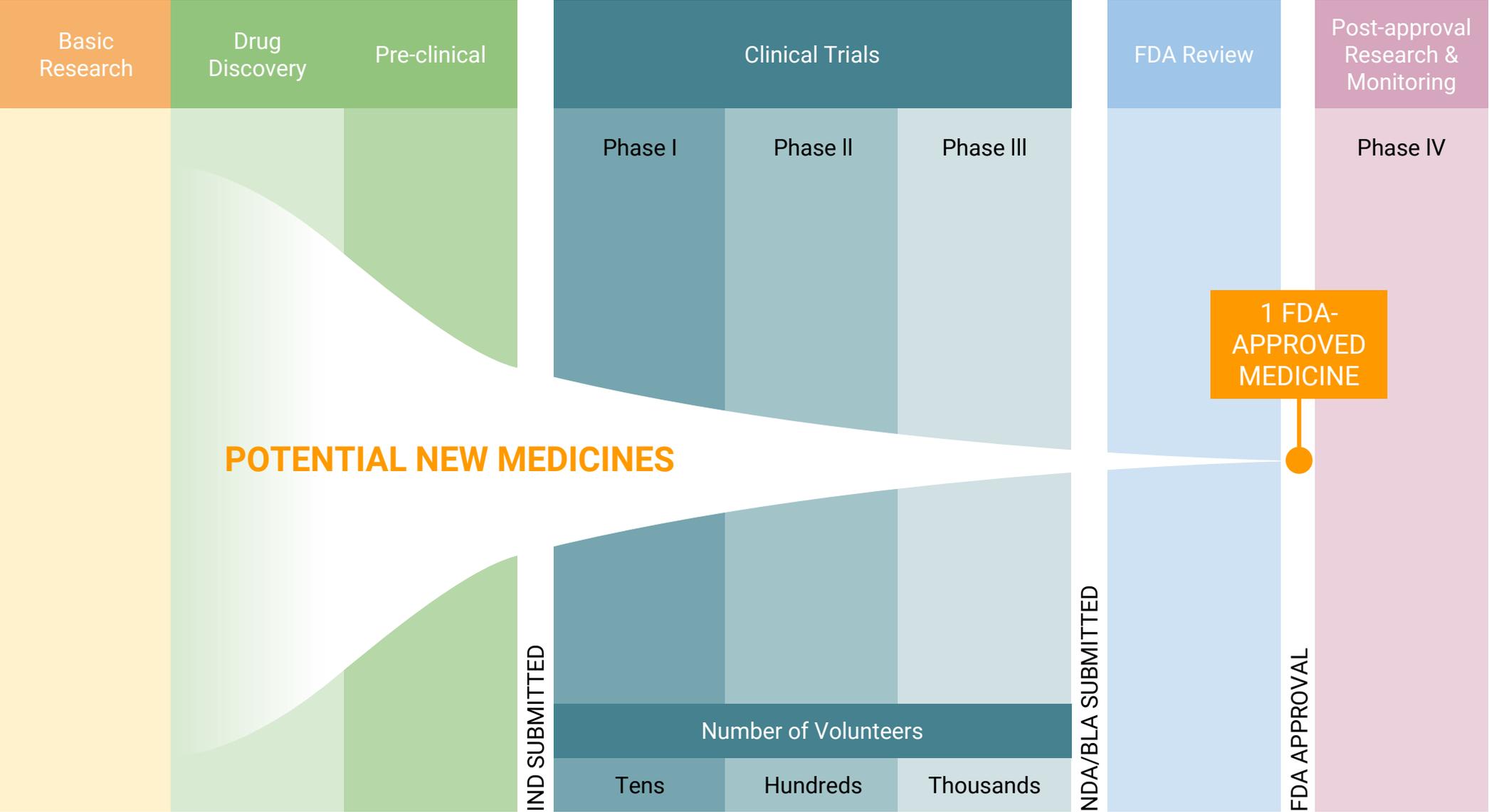
59 NEW DRUGS launched in 2018

Efficiency of Pharma R&D is Declining Steadily

Number of drugs developed per billion US\$ spend on R&D



Biopharmaceutical R&D Process / **Low Efficiency**



Sources Biopharmaceutical Research & Development, PRMA

phrma-docs.phrma.org pdf

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

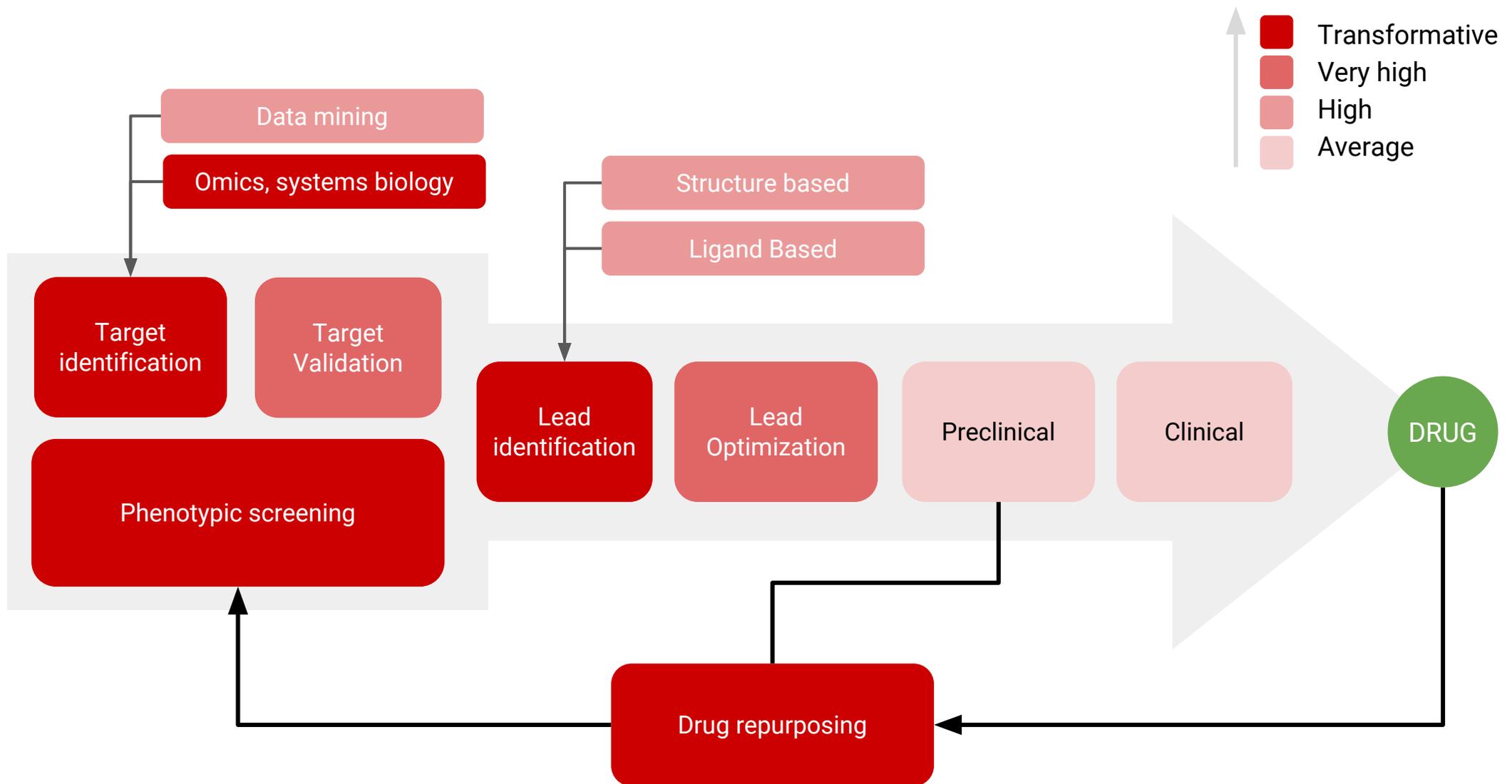
Repurposing of Existing Drugs

- 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

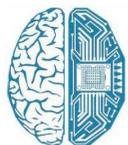
Aggregation and Synthesis of Information

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

The "Heat Map" of AI Potential Value for Various R&D Areas



Executive Summary



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Executive Summary

This 108–page report marks the fourth installment in a series of reports on the topic of the Artificial Intelligence in Drug Discovery Industry that Deep Knowledge Analytics have been producing for more than 1 year now. We released the first edition of these reports, entitled “[AI for Drug Discovery Landscape Overview 2017](#)”, in the end of 2017, followed by “[AI for Drug Discovery & Advanced R&D Q1 2018](#)” in the first quarter of 2019, “[AI for Drug Discovery & Advanced R&D Q2 2018](#)” in the second quarter of 2018, and “[AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview 2018/Q4](#)” in the fourth quarter of 2018.

The present edition consists of an updated overview of the state of the industry in Q1 of 2019, tuned to the latter half of 2019 and including extended coverage of major events in Q1 of 2019. It revisits the major insights, trends, data analytics, conclusions and forecasts of our previous report, analyzing which trends and conclusions are still on track, which ones have changed course, and which ones have been usurped by entirely new insights, trends and conclusions.

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 150 AI-companies, 350 investors, 25 biopharma corporations, 25 IT & Tech corporations, 20 industry-specific conferences and 20 journalists covering the AI for Drug Discovery topic.
4. **Industry Developments - Q1 2019** outlines an overview of major industry developments in Q1 of 2019, including some of the key initiatives, investment deals and M&A activity. A number of observations are discussed, illustrating the industry’s ascending growth trend, China’s continuing effort to develop innovative potential in the application of AI for drug discovery. It is also outlined how other countries in Asian region (e.g. South Korea) are building presence in the industry.
5. **Top 100 AI Leaders in Advanced Healthcare and Drug Discovery**
6. **Top-20 AI for Drug Discovery Conferences in 2019**
7. **Appendixes**
 - Overview of Proprietary Analytics by Pharma Division of Deep Knowledge Analytics
 - Overview of the “AI for Drug Discovery & Advanced R&D Q1 2019” report.

Executive Summary: Key Trends

Expanding upon the key observations in our previous Reports with new knowledge and analytics of Q1 2019, we can now better distinguish several major industry trends that will be shaping the market of AI in Drug Discovery in 2019 and beyond:

The industry continues “heating 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 industry’s growth dynamics is largely influenced by the more active participation of largest pharmaceutical corporations in the AI-related investment and M&A deals, as can be seen in the “BioPharma Corporations Onboarding AI for Drug Discovery” section of this report. Besides, the number of research collaborations between pharma companies and AI-expertise vendors is rapidly increasing (7 in 2016, 19 in 2017, 20 in 2018 and 30 in 2019).

IT and Tech corporations are becoming stronger competitors to Pharma Corporations in the AI race, leveraging their “natural” advantage in computational infrastructures, AI technology and already acquired AI/Data Science talent. As can be seen in “BioPharma Corporations Onboarding AI for Drug Discovery”, the number of IT and Tech corporations active in this area is steadily growing. It is noteworthy that IT and Tech corporations started investing and acquiring AI-driven healthcare as early as 2016-2017, while pharma giants were still skeptical – a phenomenon, referred to in our first three Reports as the “Big Gap”. While our most recent analysis indicated that the “Big Gap” was narrowing due to rapidly increasing attention and activity of pharmaceutical companies with regards to AI prospects, the year 2019 will mark a challenge in the ability to innovate, transform and adopt AI at scale faster. Given the exponential nature of the AI-driven progress and rather limited available market of top AI-talent, time will be a crucial parameter for the competitive differentiation between future front runners and those lagging behind. It should be noted that IT and Tech corporations have in general more flexible approach to innovation and business models, compared to more conservative pharmaceutical companies – it will be an important advantage in the pharmaceutical AI race.

Geographic diversity is increasing in the Pharma AI industry, with more countries joining the pharmaceutical AI race. Historically the US has been dominating the space of pharmaceutical AI - both in terms of companies, investments and industry conferences. Now, however, we are seeing an increased level of activity from the UK and EU, particularly in the form of government initiatives. We are also seeing a dramatic increase in activity from the Asia-Pacific region generally, and from China in particular. We are now seeing industry involvement and a profusion of AI for Drug Discovery-themed events and conferences in the UK, Germany and Switzerland. Meanwhile, the number of investors based in the Asia-Pacific region, including China and Singapore, are also beginning to increase significantly, with a slew of large investment rounds occurring in the first quarter of 2019 alone.

Executive Summary: Key Trends

Global shortage of AI talent will be a challenge for the pharma industry, as was noted in our reports. The majority of talented AI specialists, in general, have been acquired by traditional IT-corporations and have been applied for purposes other than AI in healthcare, creating a lack of enough specialists to support the activities of AI for Drug Discovery companies in particular.

The shortage of pharmaceutical AI talent is a notorious issue, and not only large pharmaceutical companies will be increasingly competing for the scarce resource, but also specialized AI-driven drug discovery companies cannot fully fill gaps of AI talent, with only 15.6% of their staff being AI-experts, on average. One of the central aims of this report is to derive actionable ideas of minimizing the negative effect of this talent gap.

Deep learning (DL) family of algorithms become a major technology differentiator in the pharmaceutical AI race. Deep Learning in general and Generative Adversarial Networks (GANs) in particular are being increasingly regarded as a “golden standard” of innovation in the pharmaceutical AI space.

Valuation of the industry will be growing substantially, yet uncertainties might delay the process in time. The total valuation of the AI for Drug Discovery sub-sector grew approximately 1.5 - 2x during the first quarter of 2019. Notably, this appears to be a result of the general growth in the number of active business players, rather than an increase in the value of innovation and new products as a result of a specific practical AI breakthrough. No AI-derived drug has been approved by the FDA or even validated in clinical trials yet, although we expect first milestones to be reached by the end of 2020. It is reasonable to predict that first practical results, stipulated directly by the AI adoption, will bring a significant expansion of the total sub-sector capitalization – on the order of 5-10x.

On the other hand, the anticipated global financial crisis may somewhat hinder the industry’s exponential growth dynamics, delay the AI adoption at scale, as well as the emergence of the first AI-derived blockbuster drugs.

Executive Summary: Geography

China is building up muscles in the Pharma AI race:

The entry of Chinese investors in the broader biotech and drug industry landscape mounted significantly in 2019, rising 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. Furthermore, the Chinese government has recently shown significant interests in building up their AI industry, and in prioritizing AI in healthcare in particular. In an AI Strategic Plan released in July 2017, they outlined their intentions to catch up in the AI race by 2020, make major breakthroughs by 2025 and become the world leader in AI by 2030.

Chinese IT and Tech corporations, such as Alibaba, Baidu and Tencent, have made significant investments and acquisitions in the area of pharmaceutical and healthcare AI, while also the number of Chinese investors active in this area is steadily increasing. This trend was noted in our last report Q4 2018 and can be further confirmed throughout Q1 observations.

Among notable examples, there is a leading Chinese IT-giant Tencent, which led a \$155 million round for AI-driven healthcare company iCarbonX and also co-invested with Google and Sequoia China in a \$15 million round for XtalPi, a startup applying AI, cloud computing and quantum physics to drug discovery.

Chinese IT-corporation Alibaba has also entered the AI for healthcare space with the launch of the "ET Medical Brain", a platform leveraging company's massive computational resources to generate new medical applications of AI.

Similarly, in Q1 2019, Sequoia Capital China led a \$115 Series B investment round into Chinese AI for Drug Discovery company Deep Intelligent Pharma (DIP). And in Q1 2019 Ping An Good Doctor (backed by Softbank), the biggest online health care services provider in China, announced their plans to build 'hundreds of thousands' of its telephone booth-sized, unstaffed AI-assisted clinics and roll these out across the country within the next years.

In 2019, prominent Chinese pharma company Wuxi AppTec invested in AI for Drug Discovery company Insilico Medicine together with Pavilion Capital (a VC firm owned by the Singaporean government), as well as several Western VC firms including BOLD Capital Partners and Juvenescence Limited.

Among top drivers of China's march in the pharmaceutical AI race, there is, firstly, the ability to generate massive amounts of real-time medical data from more than 1 billion local population, stimulated by rather flexible privacy laws. Secondly, the market of Chinese AI and data science talent is rapidly growing – due to proactive government programs, and "reverse migration" of highly skilled and educated Chinese professionals from the US, UK and EU.

However, China is lagging behind the Western world in terms of core pharmaceutical and biotech innovation, which will be limiting the speed of progress in the global pharmaceutical AI race. Another limiting factor is less stringent IP protection laws, compared to Western countries – newly generated innovation in pharmaceutical AI might be diffusing to competitors.

Executive Summary: Business Activity

Overall, the business activity has been steadily increasing in the pharmaceutical AI space over Q1 2019, judging by an increased number of transactions and partnership announcements in this period, compared to what was covered in our Q1 Report.

More than 5 new collaborations were announced between leading pharmaceutical companies and AI-driven vendors, including Pfizer and Atomwise (September), Bayer and Cyclica (November), Merck and Cyclica (December), Novo Nordisk and e-Therapeutics (December), InveniAI and Kyowa Hakko Kirin (December) and others.

There is, also, a number of notable transactions, including a \$95 M round by Berkley Lights (October), a \$46 M series B round by XtalPi (October), a \$30 M fundraising deal by Nuritas (November), a \$18 M round by Spring Discovery (December), a \$25.6 M round by Synthace (December), and the acquisition of UK-based Kinetic Discovery by AI-driven Exscientia – a move aimed at bringing additional biophysics and modelling expertise on board.

Some of the leading pharmaceutical companies are seriously moving towards adopting AI at scale, as reflected in a recent Pfizer's statement that it has over 150 separate AI projects underway, and in Bayer's resolution to use AI to accelerate patient safety data analysis to detect drug-related side effects through its pharmacovigilance systems.

Notwithstanding the skyrocketing growth dynamics in the pharmaceutical AI space over the Q1, the shortage of AI talent remains among the key obstacles for pharmaceutical and biotech companies focused on AI adoption. In order to understand better the intricate market of AI talent, we have included a new chapter "Top 100 AI Leaders in Drug Discovery and Advanced Healthcare", which is aimed at understanding a typical profile of an accomplished professional in the space, their skill-sets, typical backgrounds, and career paths. The list of TOP 100 AI Leaders offers a "bird's view" on the global leadership scene in the area of adopting ML/AI-driven methods in drug discovery and healthcare and can serve as a benchmark tool for shaping successful talent acquisition strategies.

Executive Summary: Conferences

“The chapter “Top-20 AI for Drug Discovery Conferences in 2019” is also a new addition to this report. 20 conferences have been included, based on the following criteria:

- The event must be well attended, with a large number of speakers as well as participants.
- It must include at least one panel on the *application* of AI to drug discovery.
- Speakers must include pharmaceutical corporations (e.g., Johnson & Johnson, Merck, etc.) and/or technology corporations (such as IBM or Microsoft) in order to be relevant. Such corporations are the main engines driving the development of AI in drug discovery and the primary end-users of technologies currently being developed by AI startups.

This report also contains an updated and expanded review and analysis of the declining R&D efficiency of pharmaceutical companies, outlining important drivers of change, both negative and positive.

Finally, 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.

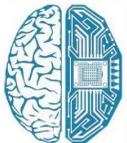
Executive Summary: Major Conclusions for Q1 2019

The industry continues its rapid development after a major breakthrough in 2018 with another series of collaborations and investments announced in Q1 2019. More and more investors are getting interested in AI for Drug Discovery companies, as can be seen in an expanded list of investors of the report. 350 investors were identified in the first quarter of 2019, 30 more than in Q4 2018. A growing interest in the industry was reported from companies, corporations and R&D centers as well. The list of companies and corporations was expanded by 20 entities, and 10 new centers were recorded in the R&D sphere of the industry compared to the last quarter of 2018, which speaks to further growth of the market. Regional proportion remained almost the same, despite an increased number of entities and a growing interest from China. It would be interesting to observe future development in this regard.

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 definitely not increasing. Pharma companies need to consider new approaches in their R&D process, such as the development of artificial intelligence and implementation of experience of biotech startups. This brings us to an issue which is of profound concern to everyone - a growing race for AI talent.

Over the last several years, the pharmaceutical and healthcare organizations have developed a strong interest in applying artificial intelligence (AI) in various areas. 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. 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. Some might argue that the focus should perhaps be on the collaboration with academia to avoid a “brain-drain”, which is a harmful phenomenon, with far-reaching negative implications for both science and educational process.

Landscape AI for Drug Discovery and Advanced R&D Q1 2019



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AI for Drug Discovery and Advanced R&D Landscape Q1 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:

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

Our aim is to list them and, where applicable, to classify them according to application, industry segmentation, and regional location. Companies, for instance, are categorized according to industry segmentation (i.e. focusing on Drug Discovery, Biomarker Development, or Advanced R&D, respectively), while investors are classified according to their regional location and the companies in which they invested. Mentioned categorization can be seen on mind maps and infographics.

These lists have been extended in comparison to our previous report (AI for Drug Discovery, Biomarker Development and Advanced R&D Q4 2018) in order to include those companies, investors and entities that rose into prominence in Q1 of 2019. We have added, 5 AI companies and 60 investors.

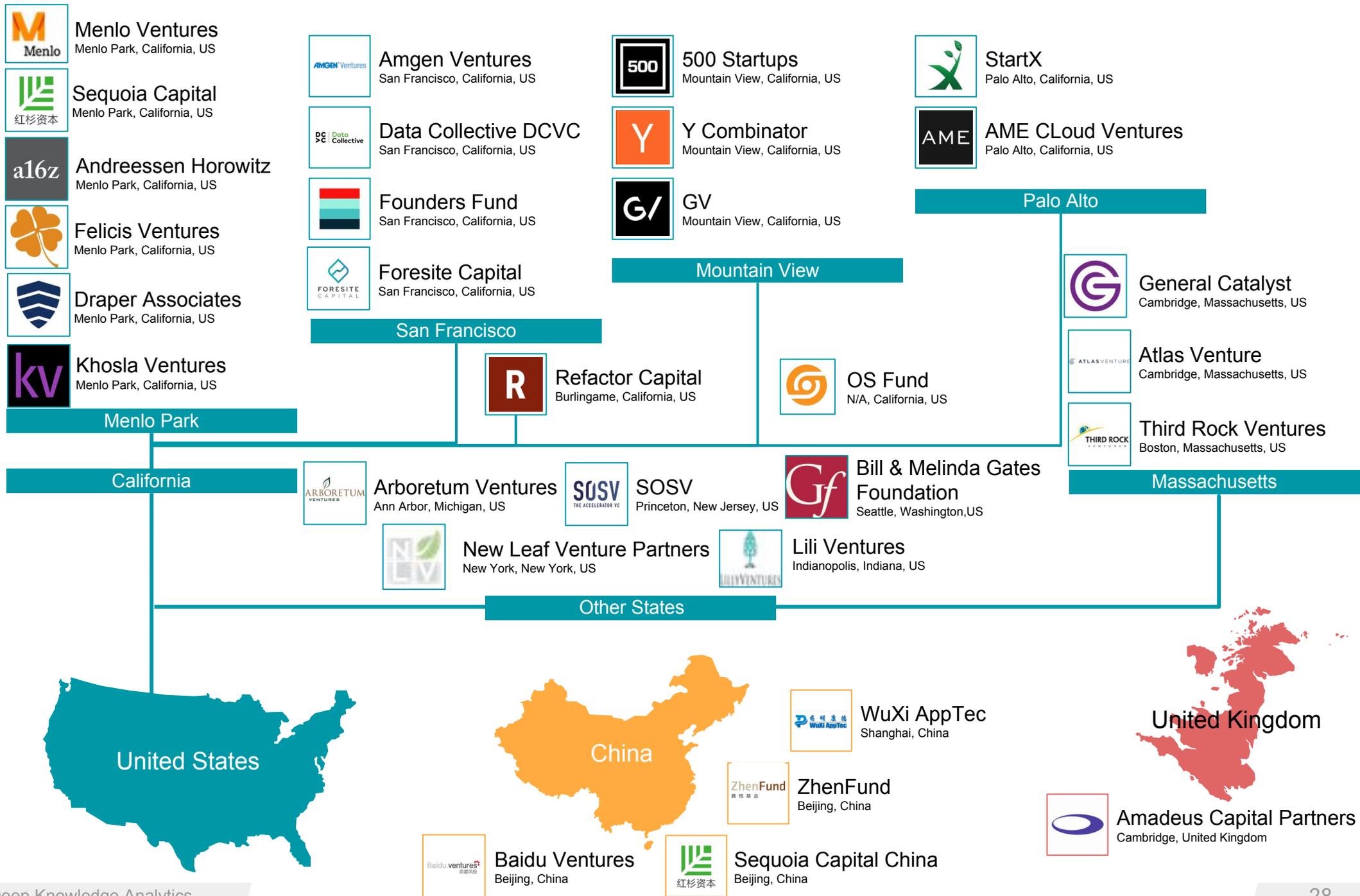
25 Leading Companies in AI for Drug Discovery Sector

1	Ardigen	14	Insilico Medicine
2	Atomwise	15	Insitro
3	Benevolent.AI	16	Lantern Pharma
4	Biovista	17	Numerate
5	C4X discovery	18	Nuritas
6	Cyclica	19	PathAI
7	CytoReason	20	Recursion Pharmaceuticals
8	Deep Genomics	21	Schrödinger
9	DeepMind Health	22	twoXAR
10	e-therapeutics	23	Vyasa Analytics
11	Exscientia	24	WuXi NextCODE
12	GNS Healthcare	25	XtalPi
13	iCarbon X		

30 Leading Investors in AI for Drug Discovery Sector

1	500 Startups	16	GV
2	Amadeus Capital Partners	17	Khosla Ventures
3	AME CCloud Ventures	18	Lilly Ventures
4	Amgen Ventures	19	Menlo Ventures
5	Andreessen Horowitz	20	New Leaf Venture Partners
6	Arboretum Ventures	21	OS Fund
7	Atlas Venture	22	Refactor Capital
8	Baidu Ventures	23	Sequoia Capital
9	Bill & Melinda Gates Foundation	24	Sequoia Capital China
10	Data Collective DCVC	25	SOSV
11	Draper Associates	26	StartX
12	Felicis Ventures	27	Third Rock Ventures
13	Foresite Capital	28	WuXi AppTec
14	Founders Fund	29	Y Combinator
15	General Catalyst	30	ZhenFund

Top-30 AI for Drug Discovery Investors



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

1. A2A Pharmaceuticals
2. AccutarBio
3. Acellera
4. AcuraStem
5. AiCure
6. Antidote
7. Antiverse
8. Arbor Biotechnologies
9. Arctoris
10. Ardigen
11. Arrakis Therapeutics
12. Athelas
13. ATOM
14. Atomwise
15. Auransa
16. Bactevo
17. BenchSci
18. BenevolentAI
19. Berg LLC
20. Berkeley Lights
21. BioAge Labs
22. Biorelate
23. BioSymetrics
24. Biotx.ai
25. Biovista
26. BioXcel
27. Brite Health
28. C4X discovery
29. Cambridge Cancer Genomics
30. Causaly
31. Celsius Therapeutics
32. Clinithink
33. Cloud Pharmaceuticals
34. CloudMedX
35. Collective Scientific
36. Concerto HealthAI
37. Cotinga Pharmaceuticals
38. Cyclica
39. CytoReason
40. Cyttox
41. Data4Cure
42. Datavant
43. Deep 6 AI
44. Deep Genomics
45. Deep Intelligent Pharma
46. DeepMind Health
47. DeepPhenome
48. Desktop Genetics
49. Dristi.ai
50. E-therapeutics
51. Emerald Cloud Lab
52. Engine Biosciences
53. Envisagenics
54. Euretos
55. Evaxion Biotech
56. EvidScience
57. Evolutionary Genomics
58. Exscientia
59. FDNA
60. Genialis
61. Globavir
62. GNS Healthcare
63. Gritstone Oncology
64. GTN Limited
65. Healx
66. HelixAI
67. iCarbon X
68. Iktos
69. Imagia
70. Inato
71. Indegene
72. Ingentium
73. Innoplexus
74. Inside DNA
75. Insilico Medicine

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

76.	Insitro	101.	Numerate	126.	Sensyne Health
77.	Intellegens	102.	Nuritas	127.	Sparrho
78.	Inteligencia.AI	103.	Owkin	128.	Spring Discovery
79.	Interprotein	104.	PathAI	129.	Standigm
80.	InveniAI	105.	PatSnap	130.	Structura Biotechnology
81.	InVivo AI	106.	Pepticom	131.	Syntekabio
82.	Iris.ai	107.	Peptone	132.	Synthace
83.	Juvenescence AI	108.	Pharnext	133.	Systems Oncology
84.	Kyndi	109.	Phenomic AI	134.	TeselaGen
85.	LAM Therapeutics	110.	Plex Research	135.	ThoughtSpot
86.	Lantern Pharma	111.	ProteinQure	136.	TranScrip
87.	MediBIC Group	112.	Qrativ	137.	Transcriptic
88.	MedView Technologies	113.	Quantitative Medicine	138.	Trials.ai
89.	Mendel.ai	114.	Qulab	139.	Turbine
90.	Meta	115.	Recursion Pharmaceuticals	140.	TwoXAR
91.	Micar21	116.	Relay Therapeutics	141.	uBiome
92.	Mind the Byte	117.	Remedium AI	142.	Verge Genomics
93.	Molomics Biotech SL	118.	Researchably	143.	VERISIM Life
94.	Moplex	119.	Resonant Therapeutics	144.	Virogin
95.	Mozi	120.	Reveal Biosciences	145.	Virvio
96.	NetraMark	121.	Reverie Labs	146.	Vyasa Analytics
97.	Nference	122.	ReviveMed	147.	WinterLight Labs
98.	Novoheart	123.	Satalia	148.	WuXi NextCODE
99.	nQ Medical	124.	Schrodinger	149.	XtalPi
100.	NuMedii	125.	sciNote	150.	ZappRx

1. 415
2. 10x Group
3. 11.2 Capital
4. 1984 Ventures
5. 3W Partners
6. 500 Startups
7. 6 Dimensions Capital
8. 8VC
9. A-Level Capital
10. Accel X
11. Advantage Capital
12. Afore Capital
13. Agent Capital
14. AJS Investments
15. Alan Cohen
16. Alchemist Accelerator
17. Alexa Fund
18. Alexandria Real Estate Equities
19. Alexandria Venture Investments
20. AllBright
21. Alpha Edison
22. Alphabet
23. ALS Investment Fund
24. Altos Ventures
25. Amadeus Capital Partners
26. AME Cloud Ventures
27. Amgen Ventures
28. Amplify Partners
29. Andreessen Horowitz
30. Angivest Ventures
31. Aquarius Equity Partners
32. Arab Angel Fund
33. Arboretum Ventures
34. ARCH Venture Partners
35. Arkitekt Ventures
36. Atinum Investment
37. Atlas Venture
38. Aurinvest
39. B Capital Group
40. Baidu Ventures
41. Baird Capital
42. Bakken & Baeck
43. Balderton Capital
44. Baron Capital Management
45. Basis Set Ventures
46. BDC Venture Capital
47. Beast Ventures
48. Bill & Melinda Gates Foundation
49. Bill Tai
50. Bioeconomy Capital
51. Biomatics Capital Partners
52. Bios Partners
53. Biotechnology Value Fund
54. Black Diamond Ventures
55. Bloomberg Beta
56. Bold Capital Partners
57. BootstrapLabs
58. Boundary Capital Partners LLP
59. BR Ventures
60. Caffeinated Capital
61. Cambia Health Solutions
62. Canaan Partners
63. Capital One Growth Ventures
64. Cascade Investment
65. Casdin Capital
66. Catapult Ventures
67. Cathay Innovation
68. Celgene
69. China Bridge Capital
70. China Canada Angel Alliance
71. China Equity
72. China Life Healthcare Fund
73. Citrix Startup Accelerator
74. Citrix Systems
75. Civilization Ventures
76. Claremont Creek Ventures
77. CLI Ventures
78. Cosine
79. Cota Capital
80. Creative Destruction Lab
81. CrunchFund
82. CRV
83. Cultivian Sandbox Ventures
84. Daniel Curran
85. Darling Ventures
86. Data Collective DCVC
87. DCM Ventures

88.	Deep Knowledge Ventures	118.	Fifty Years	148.	Health Wildcatters
89.	Deerfield	119.	Finance Wales	149.	Healthbox
90.	Density Ventures	120.	Financière Boscary	150.	Heritage Provider Network
91.	Dentsu	121.	First Round	151.	Hewlett Packard Pathfinder
92.	DFJ	122.	First Star Ventures	152.	HIGHLINEvc
93.	DFJ Growth	123.	Fly Ventures	153.	Holtzbrinck Digital
94.	DHVC (Digital Horizon Capital)	124.	Foresite Capital	154.	Horizons Ventures
95.	Digital Science	125.	Foundation Capital	155.	IA Ventures
96.	DNA Capital	126.	Founders Factory	156.	IDG Capital
97.	Dolby Family Ventures	127.	Founders Fund	157.	iGan Partners
98.	Dorm Room Fund	128.	FREES FUND	158.	Illumina Ventures
99.	Draper Associates	129.	Future Fund	159.	INDEX: Design to Improve Life
100.	Draper Dragon	130.	General Catalyst	160.	IndieBio
101.	Dynamk Capital	131.	Geodesic Capital	161.	Initialized Capital
102.	EcoR1 Capital	132.	Gi Global Health Fund LP	162.	iNovia Capital
103.	EDBI	133.	GlaxoSmithKline	163.	IQ Capital
104.	Emerge Education	134.	GM&C Life Sciences Fund	164.	Ireland Strategic Investment Fund
105.	Endure Capital	135.	Golden Ventures	165.	IT-Farm
106.	Enterprise Ireland	136.	Goldman Sachs	166.	J. Hunt Holdings
107.	Entrepreneur First	137.	Goodman Capital	167.	Jiantou Huawei Investment
108.	EPIC Capital	138.	GPG Ventures	168.	JMI Equity
109.	EPIC Ventures	139.	Gradient Ventures	169.	Juvenescence
110.	Esperante Ventures	140.	Great Oaks Venture Capital	170.	Kakao Ventures
111.	European Investment Bank (EIB)	141.	Green Park & Golf Ventures	171.	Kapor Capital
112.	European Union	142.	GreenSky Capital	172.	Karlin Ventures
113.	Evotec	143.	GV	173.	KdT Ventures
114.	Fairhaven Capital Partners	144.	Hack VC	174.	Khosla Ventures
115.	Farzad (Zod) Nazem	145.	Hacking Health Accelerator	175.	Kima Ventures
116.	Felicis Ventures	146.	Hanhai Studio	176.	Kleiner Perkins
117.	Fenox Venture Capital	147.	Health Velocity Capital	177.	Konstantin von Unger

- | | | | | | |
|------|--|------|--------------------------------------|------|--------------------------------|
| 178. | Korea Tech Incubator Program For Startup | 207. | Midven | 237. | Perceptive Advisors |
| 179. | KTB Network | 208. | Minneapolis Heart Institute Ventures | 238. | Perivoli Innovations |
| 180. | La Famiglia | 209. | Mission and Market | 239. | Pi Campus |
| 181. | Lane Bess | 210. | MIT delta v | 240. | Pillar Companies |
| 182. | Lansdowne Partners | 211. | MITS Fund | 241. | Pitch@Palace |
| 183. | Lanza Tech Ventures | 212. | Mitsui & Co | 242. | PivotNorth Capital |
| 184. | LaunchCapital | 213. | Monsanto Growth Ventures (MGV) | 243. | Plug and Play |
| 185. | LB Investment | 214. | Mubadala Investment Company | 244. | Polaris Partners |
| 186. | LeFrak | 215. | National Institutes of Health | 245. | Pritzker Group Venture Capital |
| 187. | Life Sciences Angel Network | 216. | NDRC | 246. | Qiming Venture Partners |
| 188. | Lightspeed Venture Partners | 217. | Nest.Bio Ventures | 247. | Qualgro VC |
| 189. | Lilly Ventures | 218. | Nesta Ventures | 248. | Quentin Clark |
| 190. | Linden Mobile Ventures | 219. | New Leaf Venture Partners | 249. | Radical Ventures |
| 191. | Liquid 2 Ventures | 220. | New Wave Ventures | 250. | Real Ventures |
| 192. | London Co-Investment Fund | 221. | New York Presbyterian Ventures | 251. | Redalpine Venture Partners |
| 193. | Lucas Venture Group | 222. | New York State | 252. | Refactor Capital |
| 194. | Luminous Ventures | 223. | NewDo Venture | 253. | Renren Inc. |
| 195. | Lundbeck | 224. | Nex Cubed | 254. | Rho Canada Ventures |
| 196. | Lux Capital | 225. | Nikon | 255. | Rising Tide |
| 197. | Manchester Tech Trust Angels | 226. | NJF Capital | 256. | Rivas Capital |
| 198. | Marathon Venture Capital | 227. | Nordic Impact | 257. | Rock Health |
| 199. | Masa Life Science Fund | 228. | NPIF Maven Equity Finance | 258. | Roivant Sciences |
| 200. | MassChallenge | 229. | Obvious Ventures | 259. | Romulus Capital |
| 201. | Matrix Capital Management | 230. | Orbimed | 260. | Sapphire Ventures |
| 202. | Mayo Clinic | 231. | OS Fund | 261. | Schooner Capital |
| 203. | MedTech Innovator | 232. | Otium Capital | 262. | SciFi VC |
| 204. | Menlo Ventures | 233. | Parinvest | 263. | Sea Lane Ventures |
| 205. | Merck Global Health Innovation Fund | 234. | Pavilion Capital | 264. | Section 32 |
| 206. | Mercury Fund | 235. | Paxion Capital Partners | 265. | Seedcamp |
| | | 236. | Pear Ventures | 266. | Seneca Partners |

267. Sequoia Capital
268. Sequoia Capital China
269. Seraph Group
270. Serena Capital
271. ServiceNow
272. Shangbay Capital
273. Shasta Ventures
274. Shunwei Capital
275. Silicon Badia
276. Silicon Valley Bank
277. Singularity University Ventures
278. Sinopharm Capital
279. Sky Ventures Group
280. Slow Ventures
281. Smedvig Capital
282. Sofinnova Partners
283. SoftBank
284. Softbank Ventures Korea
285. Soma Capital
286. Sorrento Therapeutics
287. SOSV
288. Sound Ventures
289. SPARK Impact
290. Square 1 Bank
291. SR One
292. Stage Venture Partners
293. Stanford University Venture Fund
294. Starlight Ventures
295. Start Capital
296. StartUp Health
297. SStartX (Stanford-StartX Fund)
298. Summit Partners
299. Susa Ventures
300. Susquehanna International Group
301. SV Angel
302. SV Tech Ventures
303. T. Rowe Price
304. Tavistock Group
305. Team Builder Ventures
306. Techammer
307. Techstars
308. TECHU
309. Temasek Holdings
310. Tencent Holdings
311. TenOneTen Ventures
312. The Cedars-Sinai Accelerator
313. The Longevity Fund
314. Third Kind Venture Capital
315. Third Rock Ventures
316. Travis May
317. Tribeca Venture Partners
318. True Ventures
319. Truffle Capital
320. TSVC
321. Two Sigma Ventures
322. uBiome
323. UK Innovation & Science Seed Fund
324. Uni-Innovate Group
325. University of Birmingham
326. Unshackled Ventures
327. UpHonest Capital
328. Upsher Smith Laboratories
329. Vanguard Atlantic
330. Varian
331. Vertex Ventures
332. Vertex Ventures Southeast Asia & India
333. Village Global
334. VisVires New Protein
335. Walden Riverwood Ventures
336. Walking Ventures
337. Western Technology Investment
338. White Cloud Capital
339. WI Harper Group
340. Wild Basin Investments
341. Woodford Investment Management
342. WorldQuant Ventures LLC
343. Wren Capital
344. WuXi AppTec
345. Y Combinator
346. Yael Capital Management Limited
347. YF Capital (Yunfeng Capital)
348. Yitu Technology
349. ZhenFund
350. Zhongyuan Union Cell & Gene Eng

25 Pharma Corporations Applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
1. AbbVie	United States	abbvie.com
2. Amgen	United States	amgen.com
3. Astellas Pharma	Japan	astellas.com
4. Astrazeneca	United Kingdom	astrazeneca.com
5. Bayer	Germany	bayer.com
6. Boehringer Ingelheim	Germany	boehringer-ingelheim.com
7. Bristol-Myers Squibb	United States	bms.com
8. Celgene	United States	celgene.com
9. Daewoong Pharmaceutical	South Korea	daewoong.com
10. Evotec	Germany	evotec.com
11. GSK	United Kingdom	gsk.com
12. Illumina	United States	illumina.com
13. Ipsen	France	ipсен.com
14. Johnson & Johnson	United States	inj.com
15. Merck	United States	merck.com

25 Pharma Corporations applying AI for Drug Discovery

COMPANY NAME	BASED IN	WEBSITE
16. Mitsubishi Tanabe Pharma	Japan	mt-pharma.co.jp
17. Novartis	Switzerland	novartis.com
18. Novo Nordisk	Denmark	novonordisk.com
19. Pfizer	United States	pfizer.com
20. Roche	Switzerland	roche.com
21. Sanofi	France	m-en.sanofi.com
22. Santen	Japan	santen.com
23. Sumitomo Dainippon Pharma	Japan	ds-pharma.com
24. Takeda	Japan	takeda.com
25. Teva Pharmaceutical	Israel	tevapharm.com

25 Tech Corporations Applying Advanced AI Applications in Healthcare

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

25 Tech Corporations Applying Advanced AI Applications in Healthcare

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

New Tech Corporations Applying AI in Advanced Healthcare and Drug Discovery

New 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. This includes the following:

- Adobe partnership with Atomwise, the company which uses Deep Learning and Artificial Intelligence to shorten the process of discovering new drugs;
- Salesforce collaboration with Color Genomics, AI company for analyzing employees health; Dell Technologies cooperation with Virustream that also uses AI in its activities;
- Foxconn new data venture with Advocate Aurora Health in order to combine its technology products with the health system's population health expertise;
- Fujitsu announcement of a new collaborative project with Kyoto University with the aim to create an AI system that is capable of both diagnosing a patient and making treatment suggestions.

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.

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

R&D CENTERS	LOCATION
Astellas Drug Discovery Research Centre	Japan
Babraham Research Campus	UK
BioMed Taiwan	Taiwan
BioVentureHub	Sweden
Cambridge Clinical Trials Unit (CCTU)	UK
Center for Computational Health - IBM Research	US
Centre for Drug Discovery Science (CDDS)	UK
Centre for Drug Research and Development	Canada
China R&D Center (CRDC) - Pfizer	China
Chinese Thoracic Oncology Group (CTONG)	China
Clinical Trials Centre, The University of Hong Kong	Hong Kong
Clinical Trials Unit Freiburg	Germany
Drug Discovery Oxford	UK
Insilico Medicine R&D center	Taiwan
Janssen Pharmaceutical Companies of Johnson & Johnson	US
Japan Agency for Medical Research and Development	Japan
Johnson & Johnson Pharmaceutical Research and Development	China
Korea Pharmaceutical and Bio-Pharma Manufacturers Association	South Korea
La Jolla Laboratories	US

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

R&D CENTERS

LOCATION

Mayo Clinic's Center for Clinical and Translational Science (CCaTS)

US

Merck Exploratory Science Center (MESOC)

US

Merck Serono Pharmaceutical R&D Co., Ltd

China

Pande Lab - Stanford University

US

Ritsumeikan Research Center for Drug Discovery and Development Science

Japan

Roche Innovation Center Copenhagen

Danmark

Sanofi Pasteur R&D Centre

Canada

Shanghai Clinical Research Center (SCRC)

China

The Development Center for Biotechnology

Taiwan

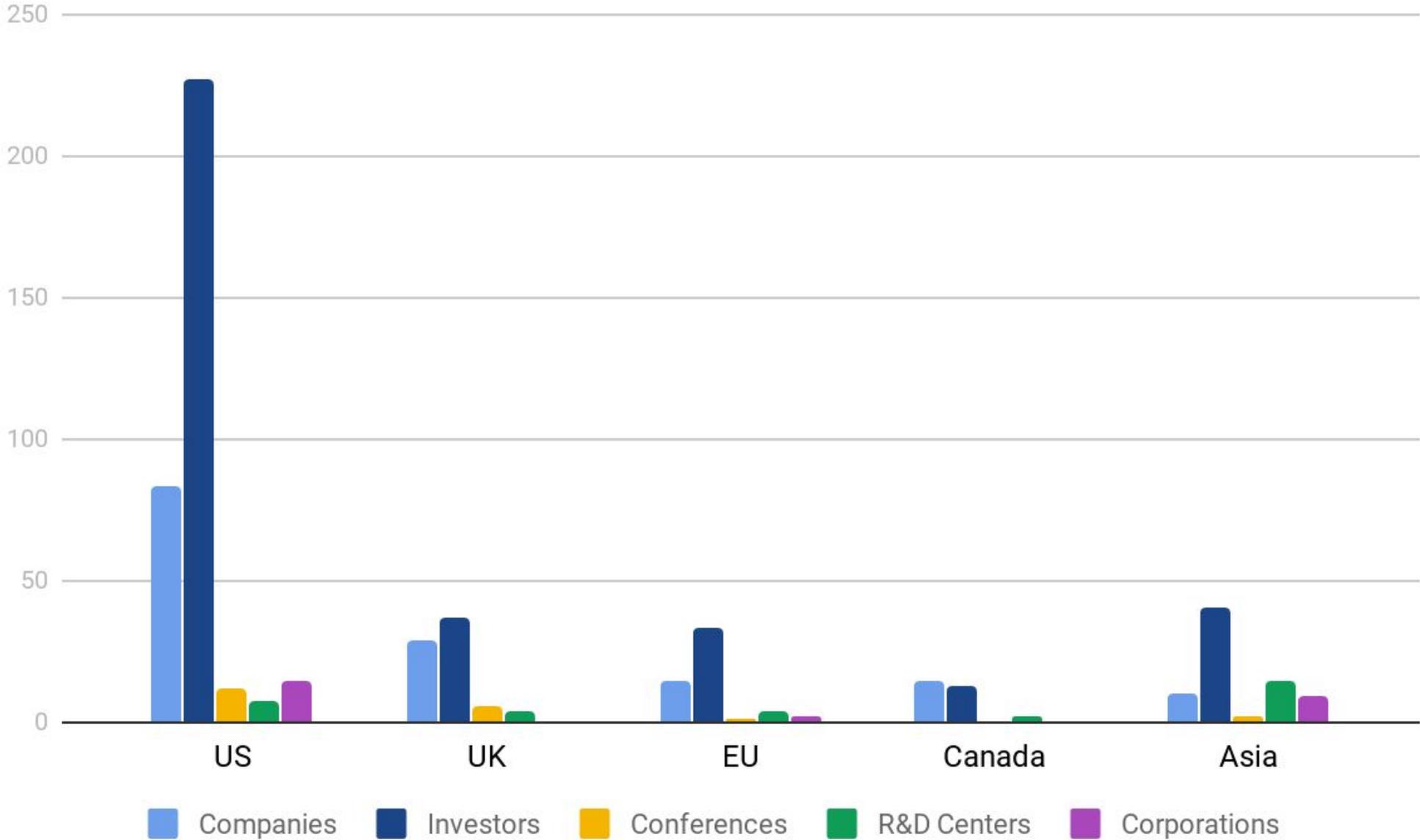
The Swedish Center for Research and Innovation (SCRI)

Sweden

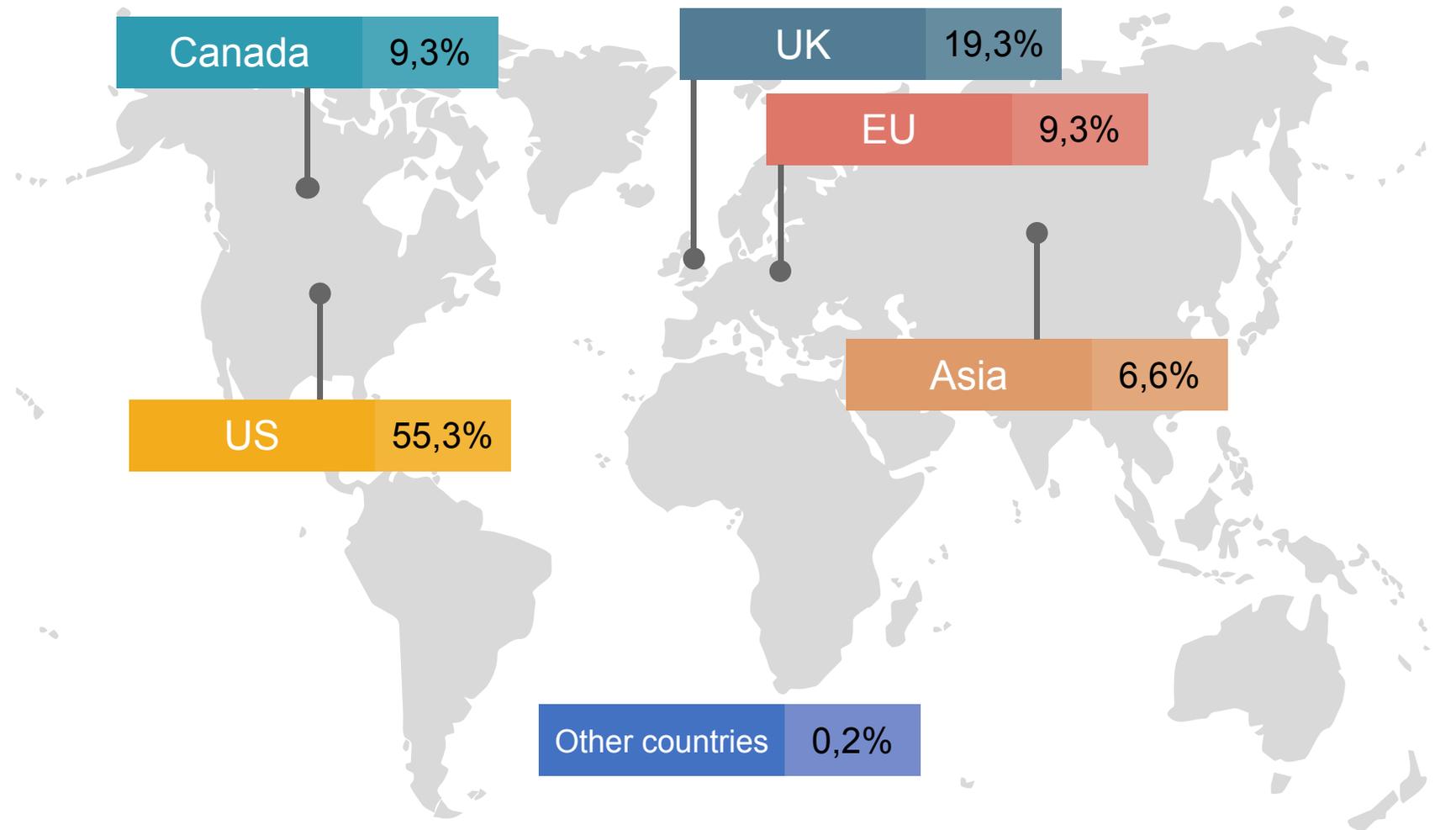
Warren Family Research Center for Drug Discovery and Development

US

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

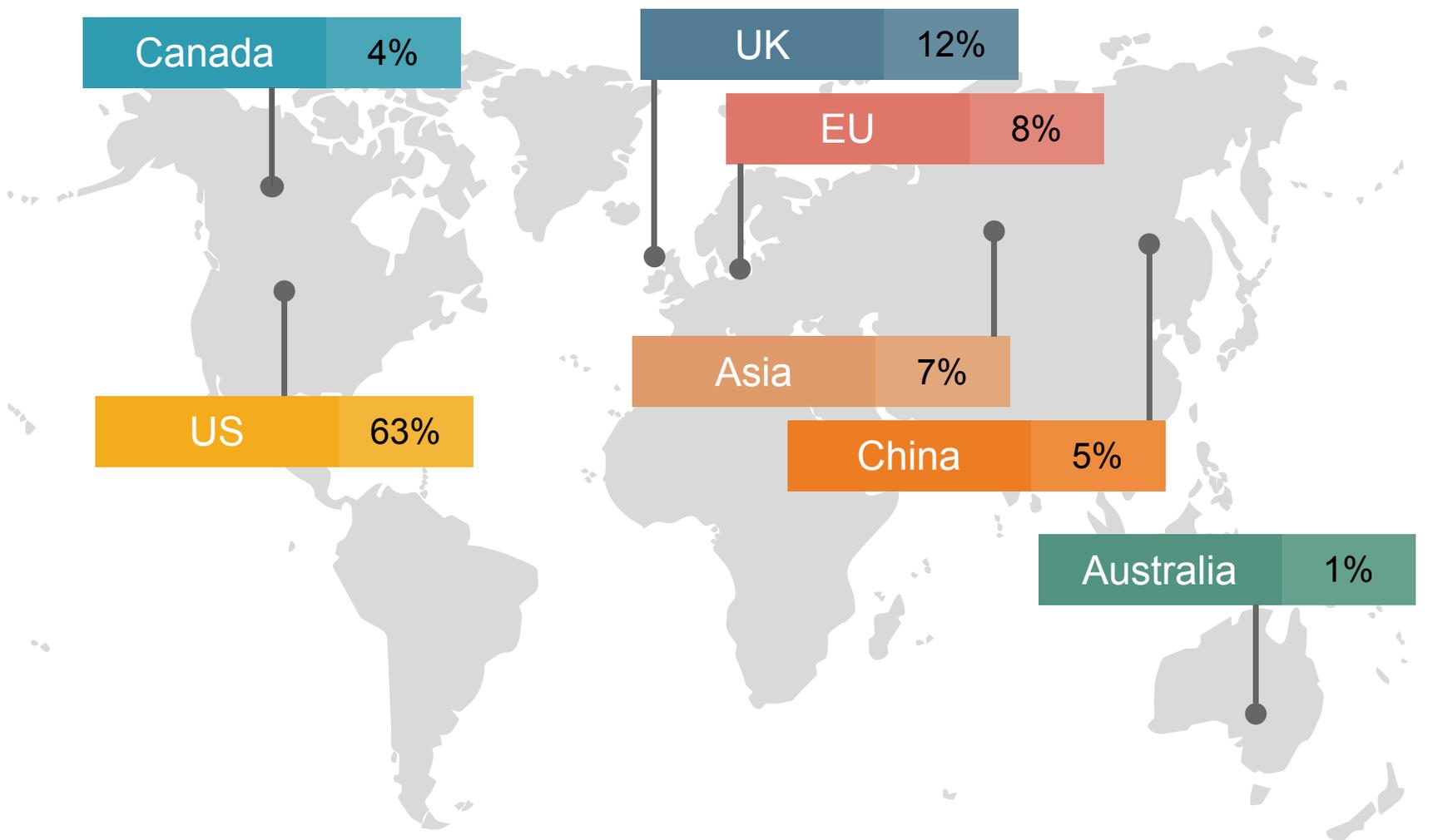


150 AI Companies: Regional Proportion



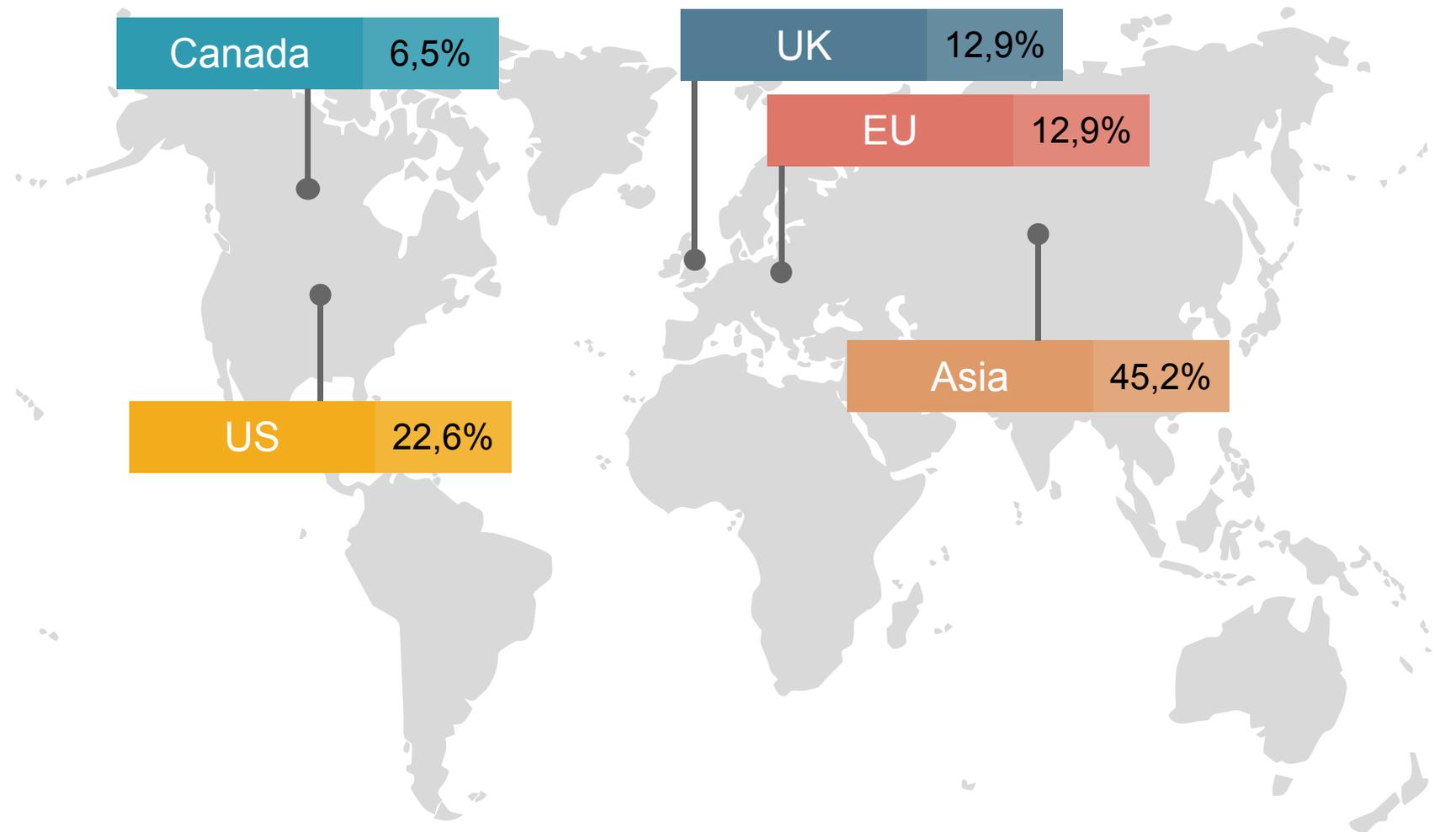
The US is still firmly in the lead in terms of its proportion of AI for Drug Discovery companies. Interestingly, Asia currently has the fifth-lowest proportion of AI for Drug Discovery companies. However, Asia-Pacific region has begun to aggressively increase its activity in the space in terms of investments 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.

350 Investors: Regional Proportion



The United States continues to lead the rest of the world in terms of artificial intelligence for investors in Drug Discovery. This is reasonable, given that they also have the largest share of AI for Drug Discovery companies. Nevertheless, it is interesting to note that, although the Asia-Pacific region is home to the second largest share of investors in this space, the UK has now risen to it, dividing equally the position No. 2, which previously occupied No. 3 position in this regard in our previous reports.

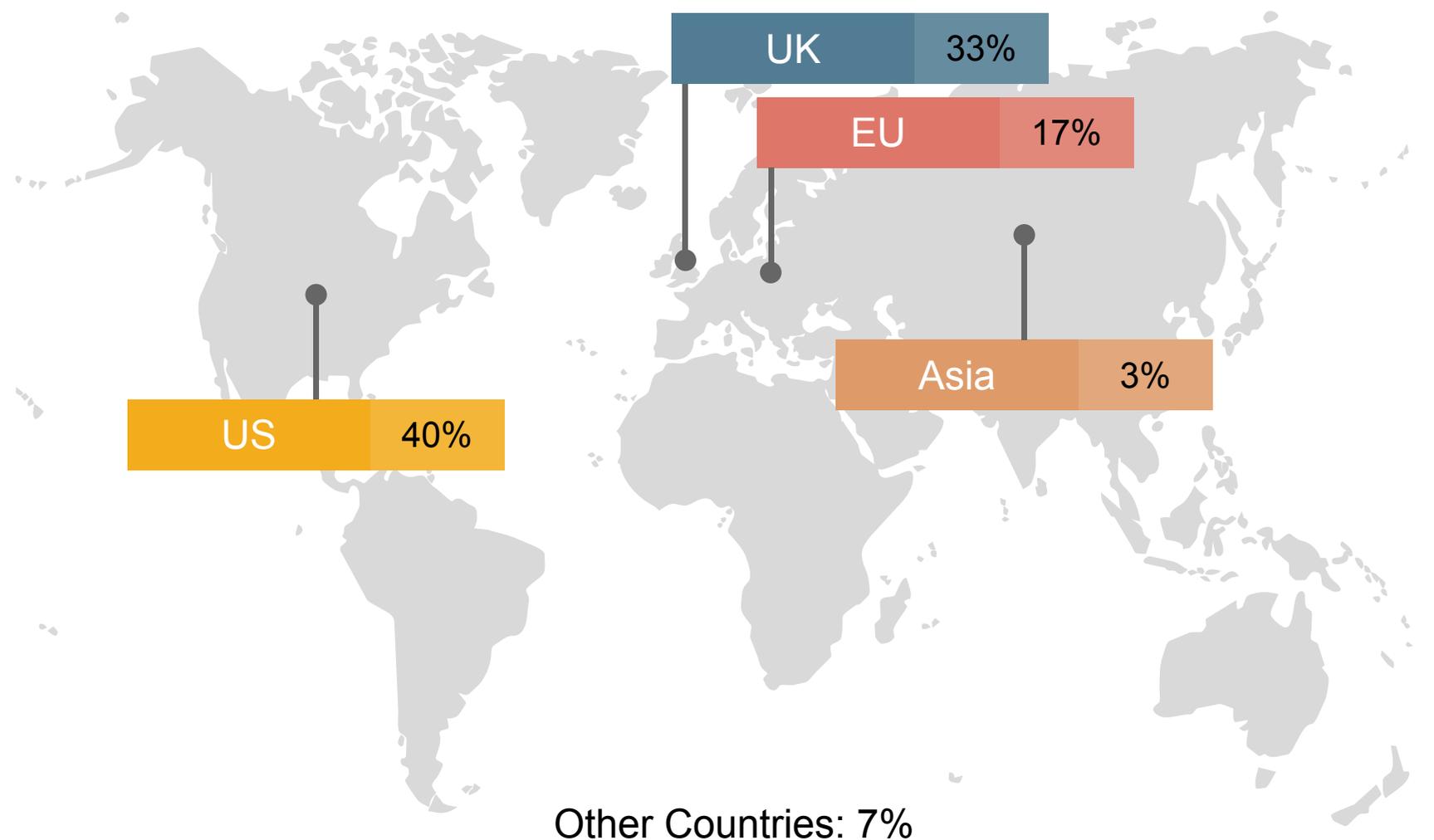
30 Leading R&D Centers: Regional Proportion



Whereas data in our previous reports indicated that the US leads the world in terms of the number of R&D Centers focused on AI for Drug Discovery, Asia has now surpassed them. This is sensible within the context of the recent increase in the number of Chinese investors entering the AI for Drug Discovery space, and the Chinese government's recent commitment to lead the world in AI by the year 2030.

Top-30 Conferences

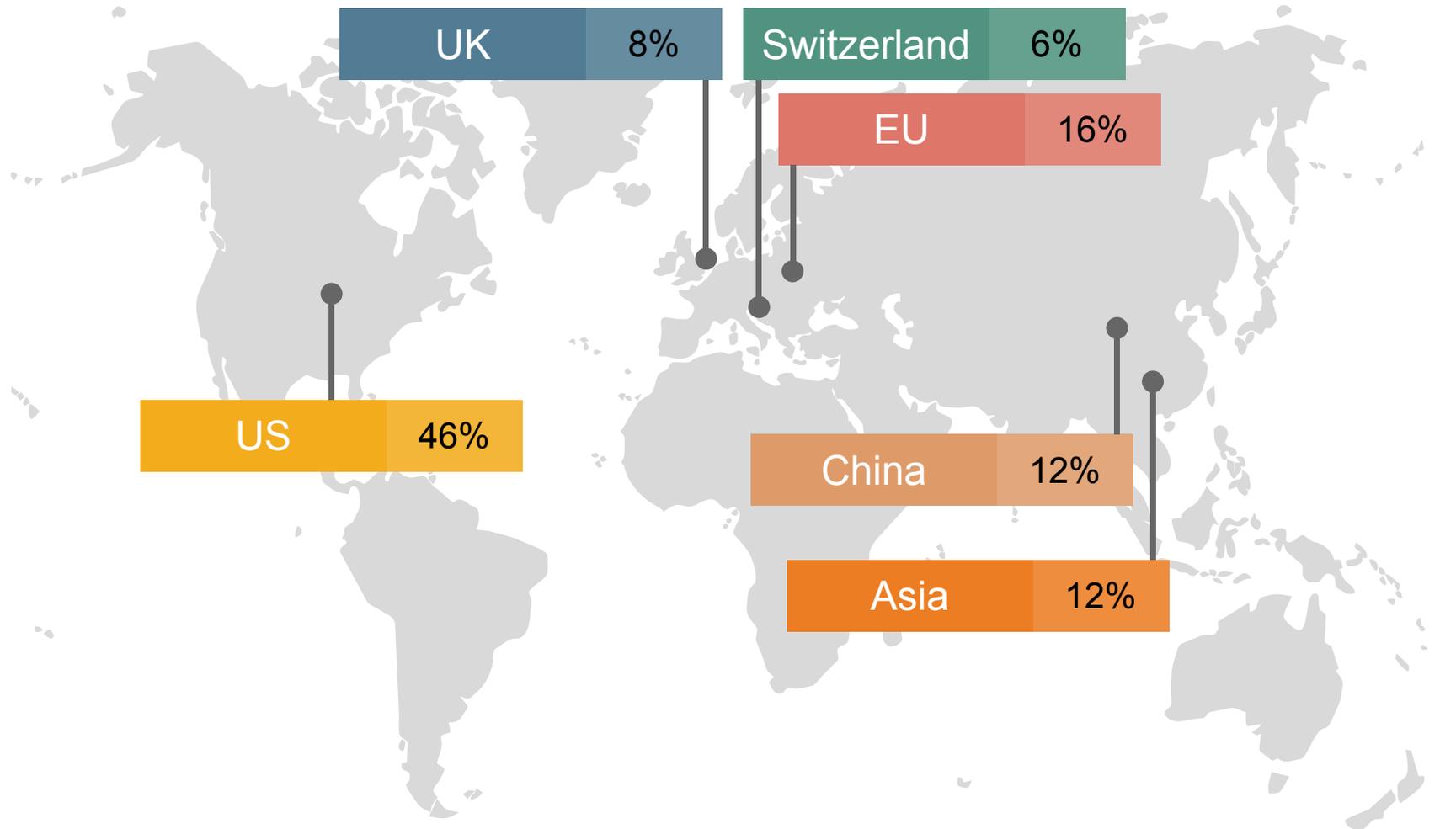
on AI for R&D and Drug Discovery 2019-2020



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

50 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.

Declining R&D Efficiency of Biopharma Corporations

(Based on “Unlocking R&D productivity Measuring
the return from pharmaceutical innovation 2018” Deloitte Report)

Executive Summary

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.

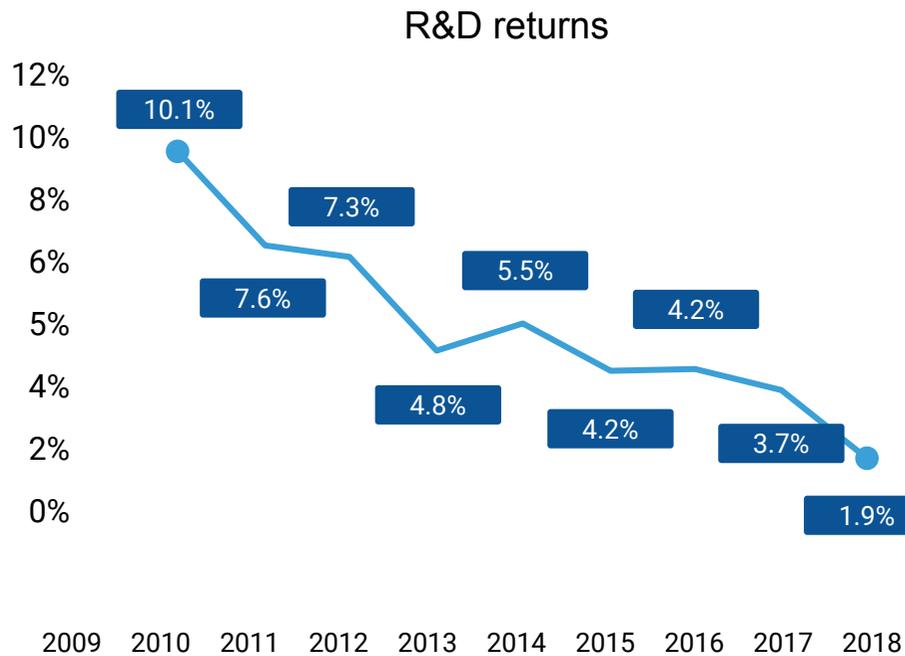
The solution to the problem is changing the business model of pharma to favor more agile early stage drug discovery, a much larger number of initial pool of projects (with minimal investment, via outsourcing, partnering, or VC funds), and an efficient process of project prioritization. In this sense, 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 Companies

	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 companies 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.

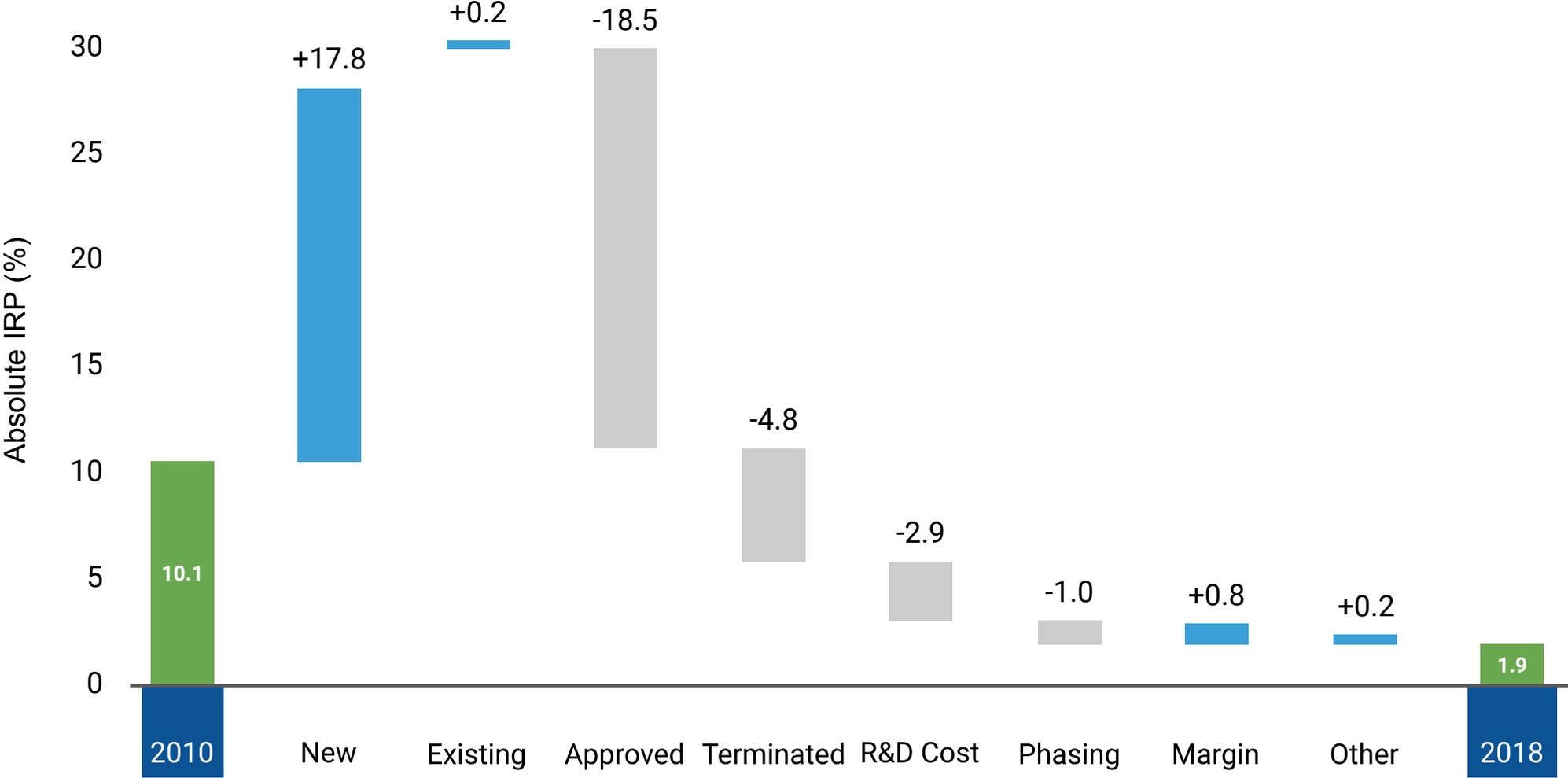
Smaller, more specialized companies become more competitive since they have higher projected pipeline values.

Pharma companies 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.

Sources Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte

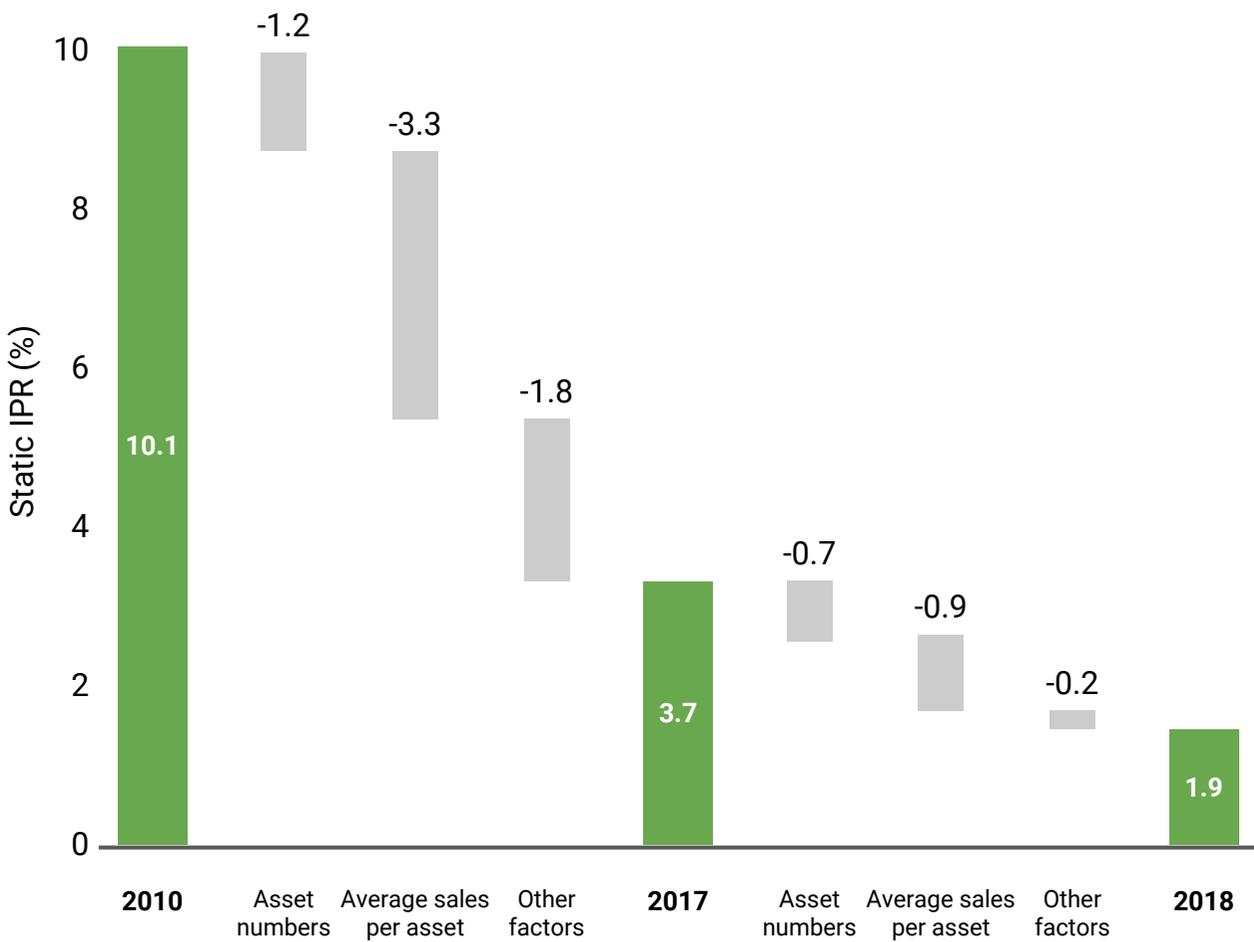
Declining R&D Efficiency of Biopharma Companies: Drivers of Change



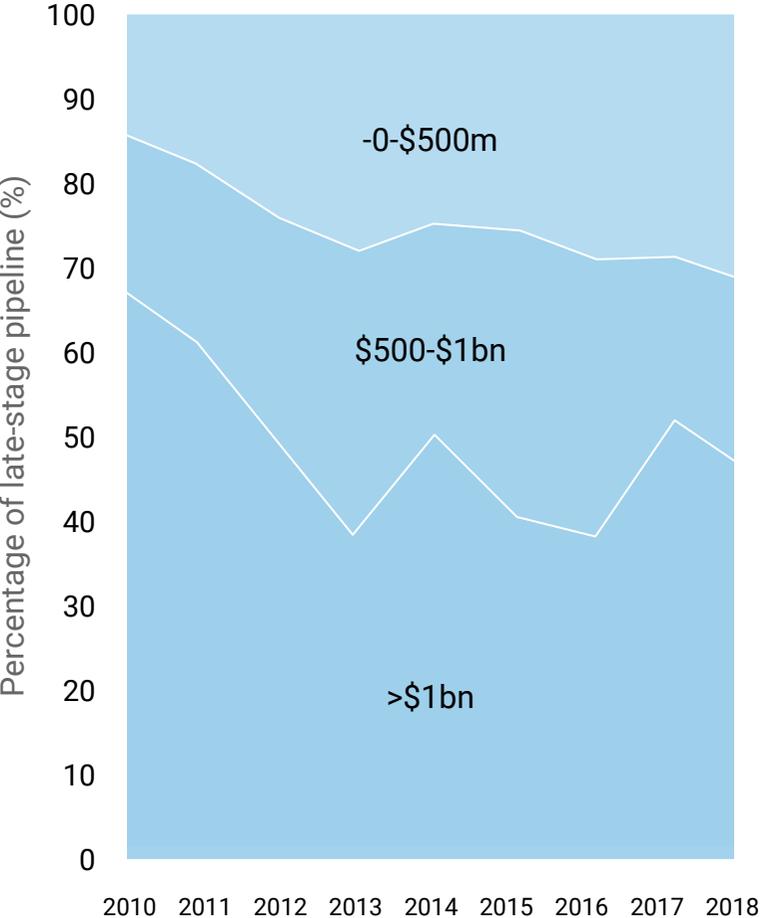
Sources: Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte

Declining R&D Efficiency of Biopharma Companies

Overall impact of pipeline factors on change in IRR

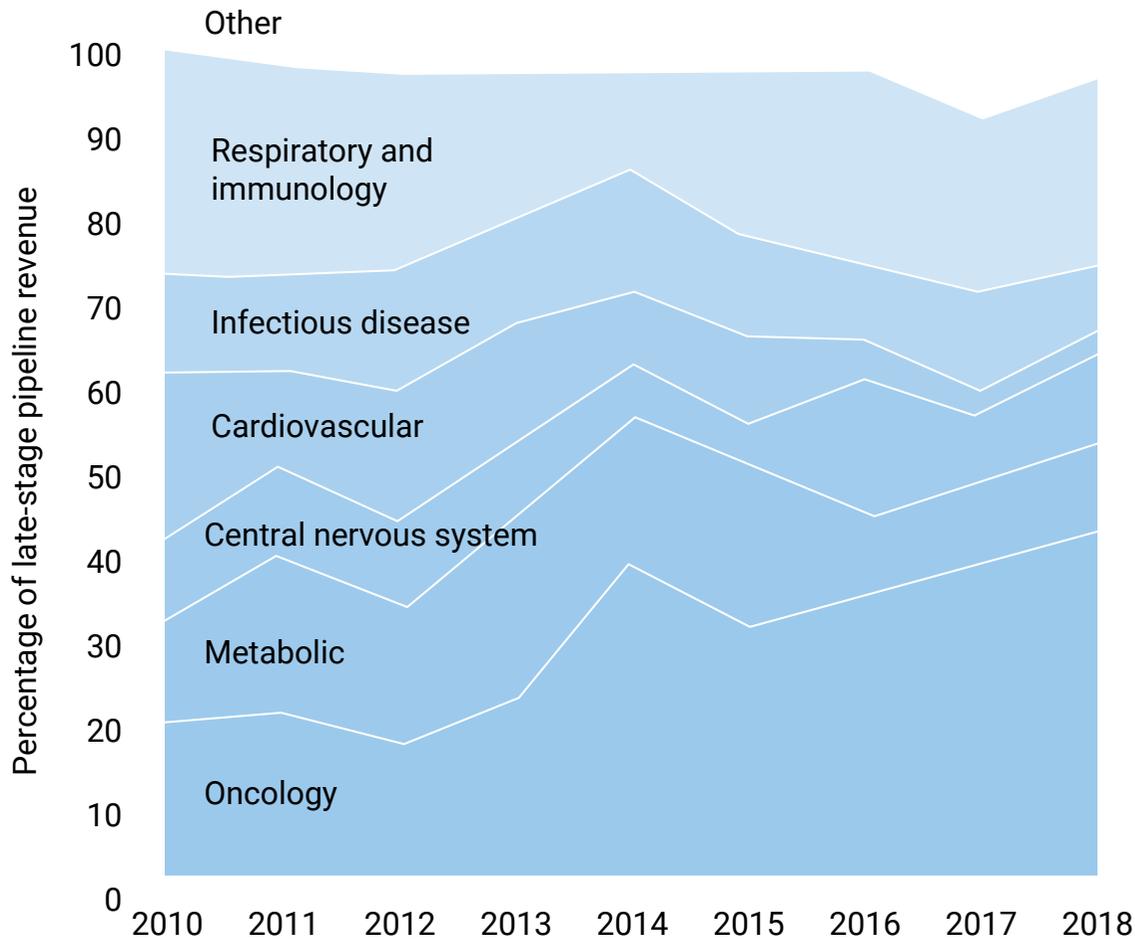


Proportion of forecast peak sales



Sources: Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte

Late-stage Pipeline Composition by Therapeutic Area



The share of oncology is, predictably, increasing over the last 6-7 years. Now oncology assets are representing about 40% of late-stage pipelines. But it should be noted that this growth is due to the decrease in the revenues from other therapy areas since the absolute value of revenues from oncology assets is decreasing. This shift is associated with the move to immuno-oncology drugs.

Revenues from central nervous system assets remain relatively stable, but in the long run their growth can outperform other areas because of population aging. It is, however, unclear whether neurodegenerative diseases may outweigh oncology.

The share of revenues from cardiovascular assets decreases dramatically what means even more intensive decrease in the absolute value of the revenues.

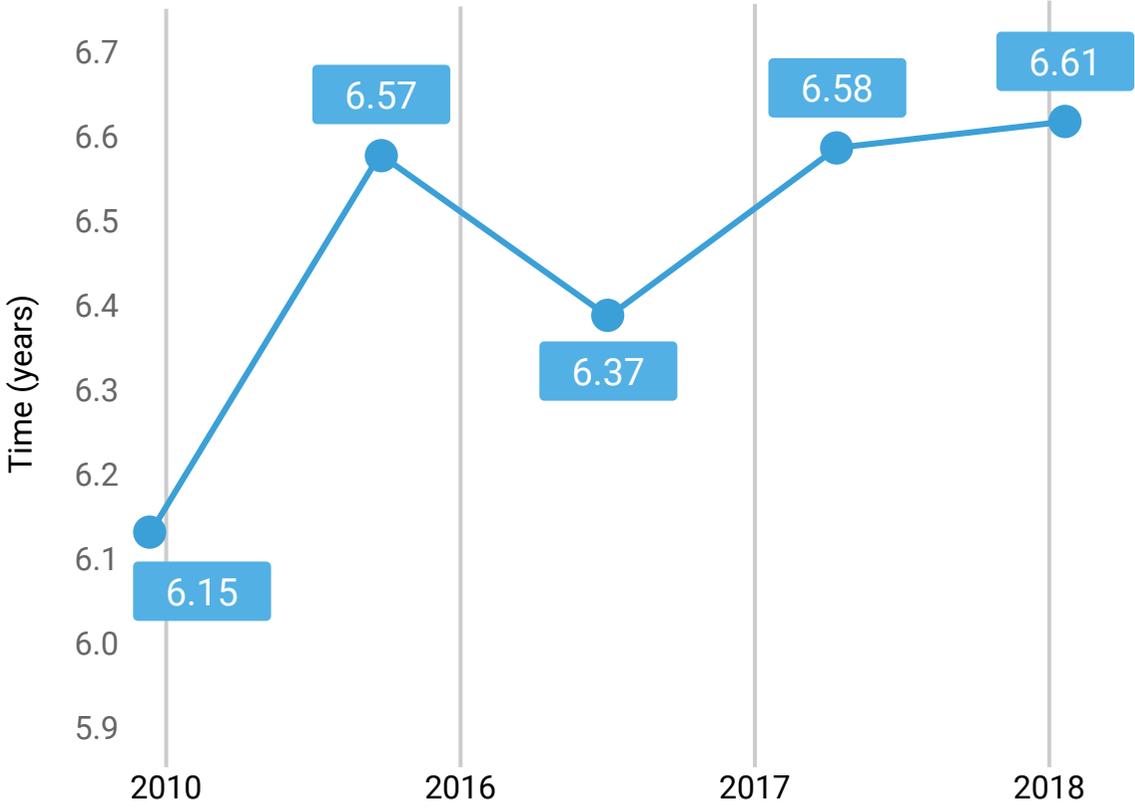
Clinical cycle for almost every category also continues to lengthen, but this trend is the most obvious in oncology. It can be explained by the fact that clinical cycle here is very complex what is associated with developing cancer therapies. It is partly driven by an insufficient number of patients willing to take part in clinical trials.

As the share of oncology assets grows, it affects the length of the clinical cycle significantly.

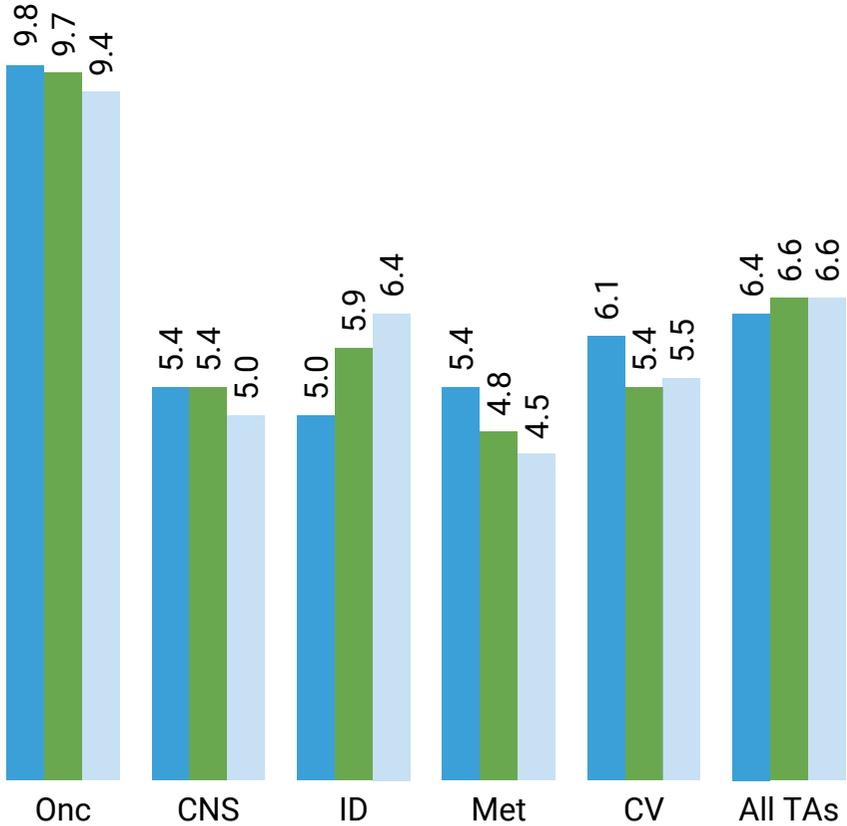
Sources: Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte

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

Sources: Unlocking R&D productivity Measuring the return from pharmaceutical innovation 2018 by Deloitte

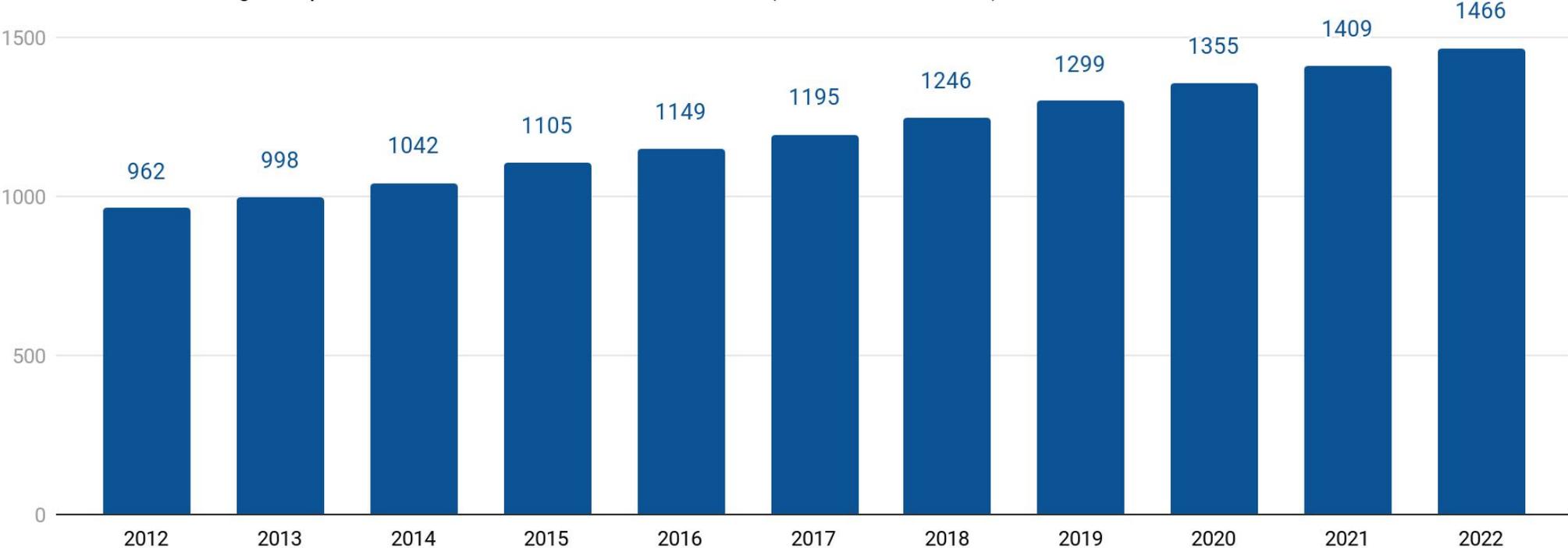
Revenues and New Entities

Annual revenues of the global pharmaceutical market as well as number of new chemical and biological entities are increasing, but it does not lead to positive shifts of trends of returns and efficiency. Growing revenues are connected with growing costs, and despite the fact that the number of assets grows, every single asset brings less return. What is also important, the growth of revenues is linear, whereas the growth of costs of R&D per asset is exponential, what means that sooner or later the revenues will not be able to cover the costs.

Geographical distribution of the intensity of drug development shows that stagnation is the most obvious in Europe, but developing countries demonstrate essential to progress.

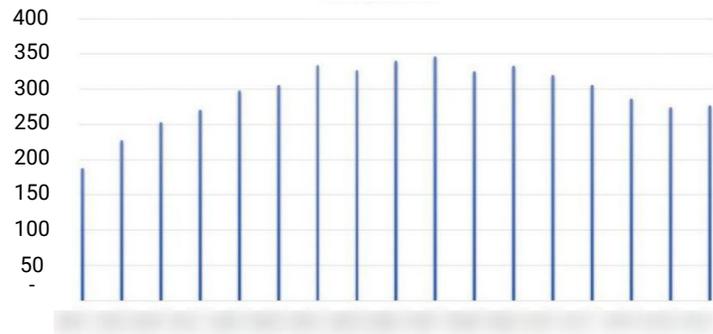
Average annual revenue growth over the last 6 years was about 4.5%.

Annual revenue of the global pharmaceutical market from 2012 to 2022 (in billion U.S. dollars)



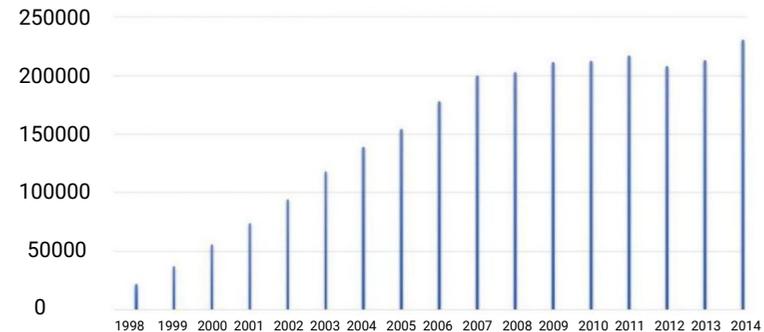
Sales Performance

Average revenue per drug each year from 1998 to 2014 \$ million



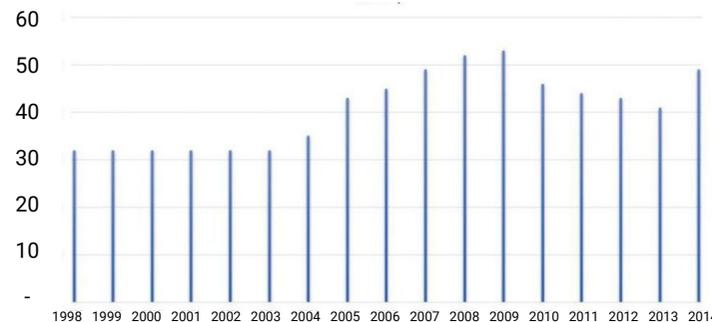
The graph above shows, how average revenue per drug was stably growing from 1998 up to 2007. Starting from 2008, a clear decline till 2013 can be seen, which was stabilized in 2014.

Annual pharmaceutical industry sales from 1998 to 2014 \$ million



This diagram demonstrates, that from 1998 to 2014 annual pharmaceutical industry sales were strongly growing, with a slight decline in 2012.

The number of drugs that sold \$1 billion or more in each year from 1998 to 2014



The figure above shows a general growth of number of drugs, which sold \$1 billion or more, with a slight decrease during 2010-2013 years and with a further increase in 2014.

Source

EvaluatePharma [®], November, 2015, Evaluate LTD., www.evaluate.com

Influence of AI Implementation

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

COMPANY	2013	2014	2015	2016	2017	2018	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 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.

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

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

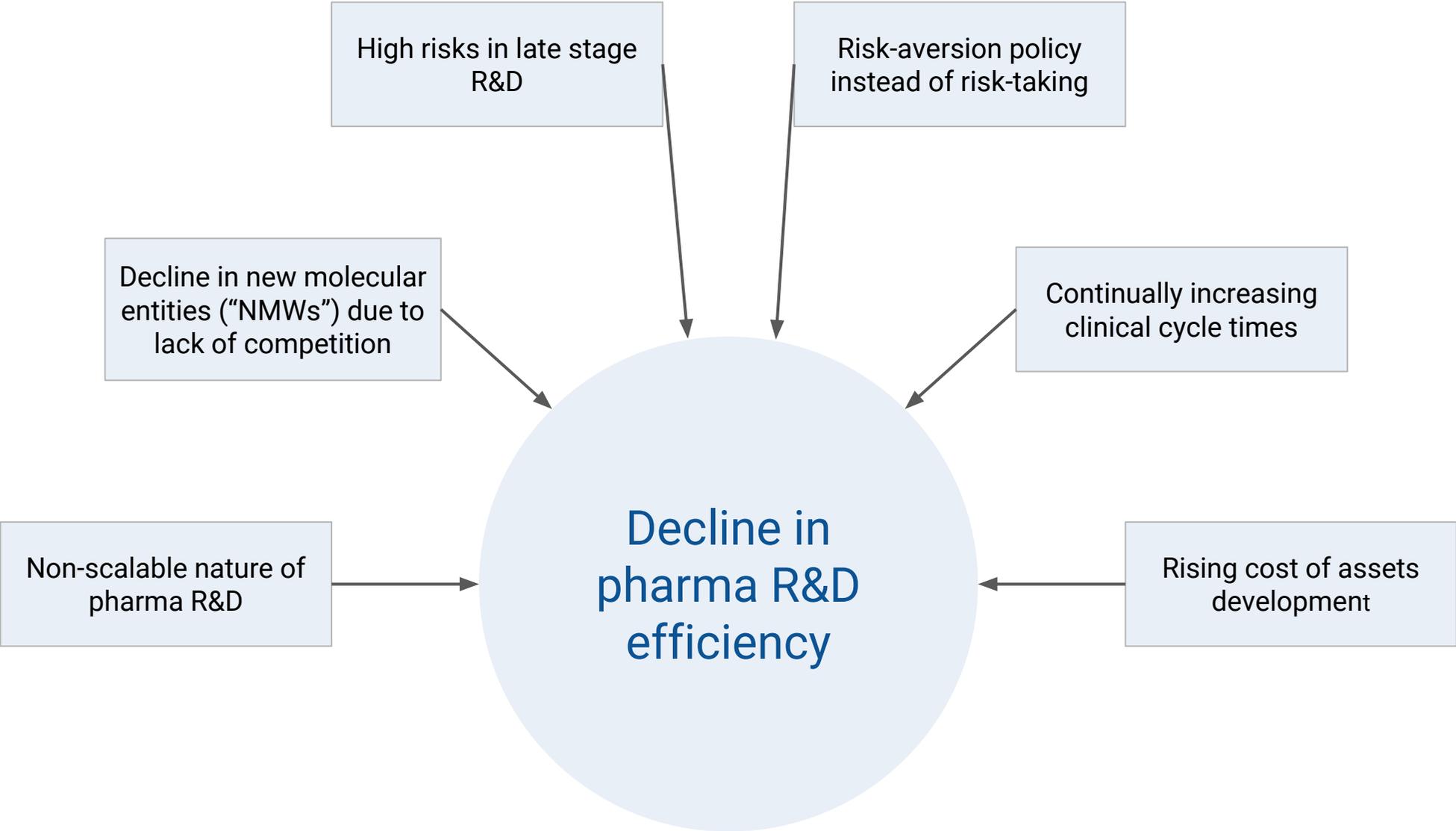
Small incremental benefit are not enough to convince payers to switch to new, more effective drugs.

95 % commercial failure rate

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

Pharma have failed produce "blockbusters"
Pharma have been left with complex diseases who cores carry many ramifications

Main Trends of R&D Efficiency



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.

Top-100 AI Leaders in Advanced Healthcare and Drug Discovery



Introduction

Over the last several years, the pharmaceutical and healthcare organizations have **developed a strong interest** toward applying artificial intelligence (AI) in **various areas**, ranging from medical image analysis and elaboration of electronic health records (EHRs), to more basic research like building disease ontologies, preclinical drug discovery, and clinical trials. 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.

Consequently, there is a growing number of AI-driven startups and emerging companies offering technology solutions for drug discovery and healthcare. In most cases, AI-driven startups are born within the cradle of academic institutions, where early concepts and prototypes are developed and validated – prior to getting funded by venture capitalists.

Another important source of advanced AI expertise for drug discovery and healthcare comes from largest technology corporations (Google, Microsoft, Tencent, etc), which are increasingly focusing on applying their technological resources for tackling health-related challenges, or providing technology platforms on project-based or rent-based conditions for conducting research analytics by life science professionals.

Some of the leading pharmaceutical giants, like GSK, AstraZeneca, and Novartis, are already making steps towards aligning their internal research workflows, hiring ML/AI/Data Science talent, and shaping development strategies to start embracing AI-driven digital transformation at scale. However, the pharmaceutical industry at large is still **lagging behind in adopting AI**, compared to more traditional consumer industries – finance, retail etc.

The above three main trends are driving the growth in the AI implementation in pharmaceutical and advanced healthcare research, but the overall success depends strongly on the presence of highly skilled interdisciplinary leaders, able to innovate, organize and guide in this direction.

This chapter is a summary of analytical reports “Top-100 AI Leaders in Drug Discovery and Advanced Healthcare” and “Top-30 Women AI Leaders in Drug Discovery and Advanced Healthcare”, which are available on our website: <https://www.ai-pharma.dka.global/ai-leaders>; <https://www.ai-pharma.dka.global/top-30-women>.

The Existing Challenge of Hiring Top ML/AI Talent in Pharmaceutical Setting

It comes as no surprise that talent acquisition and team building appears to be among the most challenging parts in the whole strategy of AI adoption by pharmaceutical companies and drug discovery organizations. All the complexity, in this case, arises from the fact that drug discovery and healthcare are the complex areas of knowledge requiring years of theoretical training and practical experience to understand how to model them in the ML/AI-driven fashion. In other words, it is not possible to efficiently apply ML/AI skills for this kind of tasks without a certain level of domain expertise to understand data semantics, proper features, and general ontologies. This is, indeed, very different from “traditional” AI tasks, like the image processing, where the object of modeling is easily understandable without deep expertise (images are simply matrices of pixels with color attributes). In contrast, to comprehend datasets from, say, gene expression studies in the context of identifying novel biological modulators, or genetic polymorphism in the context of studying various types of pathogenesis in species, requires deep knowledge in biology, genetics, etc.

In the same time, the ML/AI in itself is a complex multidisciplinary domain of knowledge, requiring strong foundations in Statistics and Probability Theory, Calculus and Linear Algebra, Data Analytics and specialized topics like Graph Theory, advanced programming skills, and hands-on experience in developing, training and deploying ML models in distributed environments (clouds).

In addition to the above technical and research “hard” skills, a number of “soft” skills is usually sought to complement a portrait of an “ideal candidate” for leadership roles to adapt AI in pharmaceutical organizations. They include leadership, project/product management experience, executive experience, or experience running industrial-grade projects.

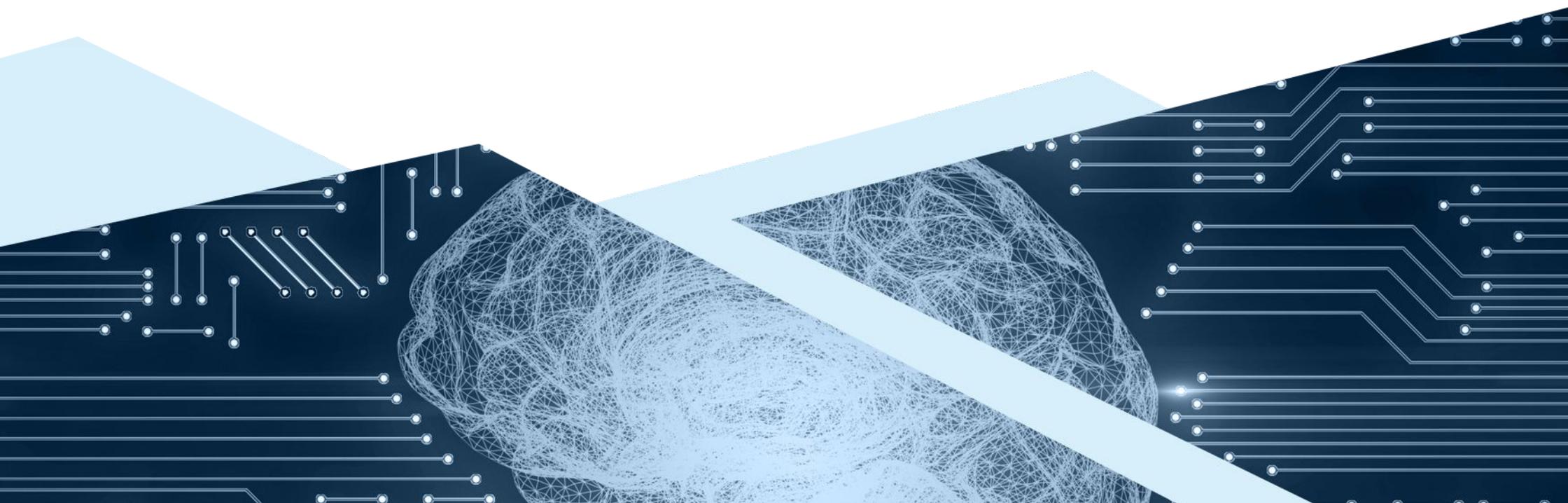
The above unique set of requirements explains well substantial scarcity of highly skilled talent in this area, and in the same time, it conditions highest “price tags” for specialist of this kind: we predict that AI specialists with substantial domain expertise in Life Sciences will become some of the most highly paid employees in the world within several years.

More practically, pharma organizations will be attempting to solve the need of “dual” expertise in ML/AI and Life Sciences by creating highly interdisciplinary teams bringing together experts from ML/AI and Life Sciences and making them communicate and collaborate closely. Yet, even this scenario requires a leader, or a group of leaders, with strong foundations in both areas to create an integral vision of a project and make sure both “camps” collaborate efficiently.

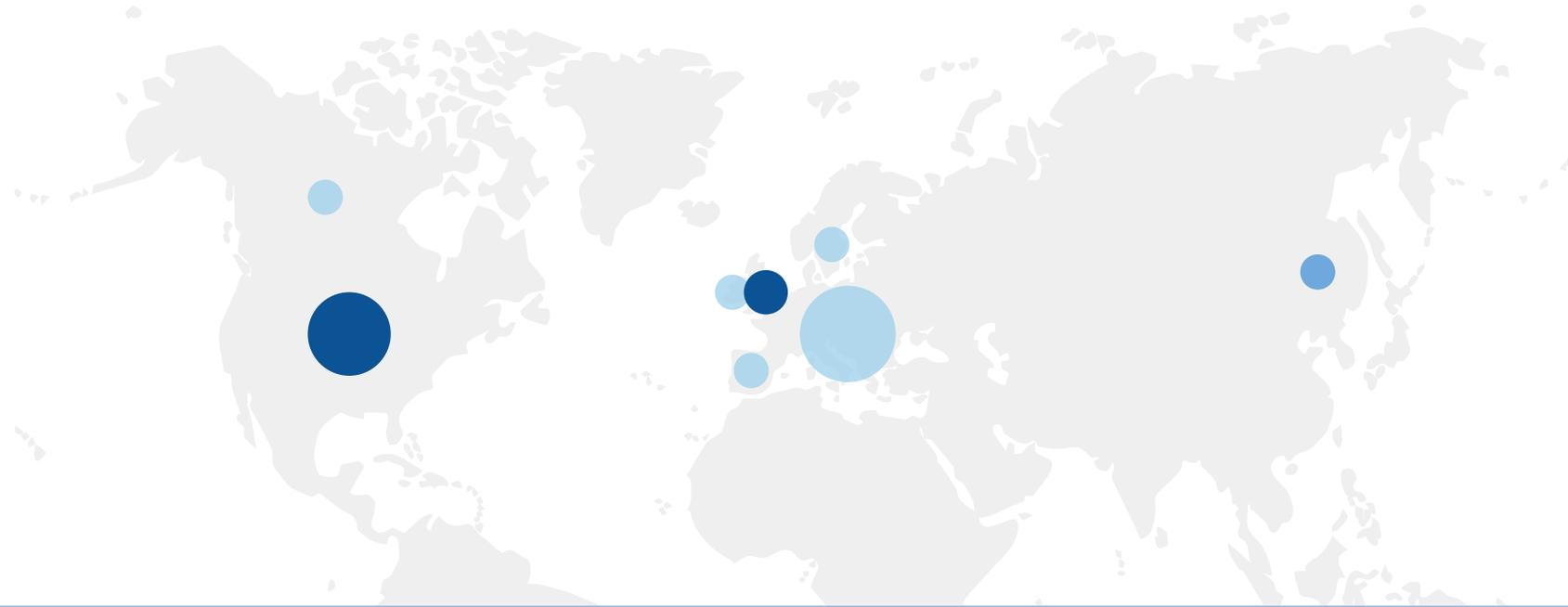
The Goal of the Report

In order to understand how to build efficient interdisciplinary teams able to deliver meaningful milestones on the road to the AI-driven transformation of drug discovery and healthcare organizations, it is crucial to analyze the existing examples of accomplished leaders in this area, their backgrounds, technical skill-sets, strengths, competencies, roles in the organizations, and types of impact they have on the industry in general.

The current report summarizes the TOP 100 most innovative and entrepreneurial AI leaders, who has been contributing largely towards data-driven transformation of the pharmaceutical and healthcare industries. It has a goal of providing a “bird’s view” on the global leadership scene in the area of adopting ML/AI-driven methods in drug discovery and healthcare to serve as a benchmark tool for shaping successful talent acquisition strategies.

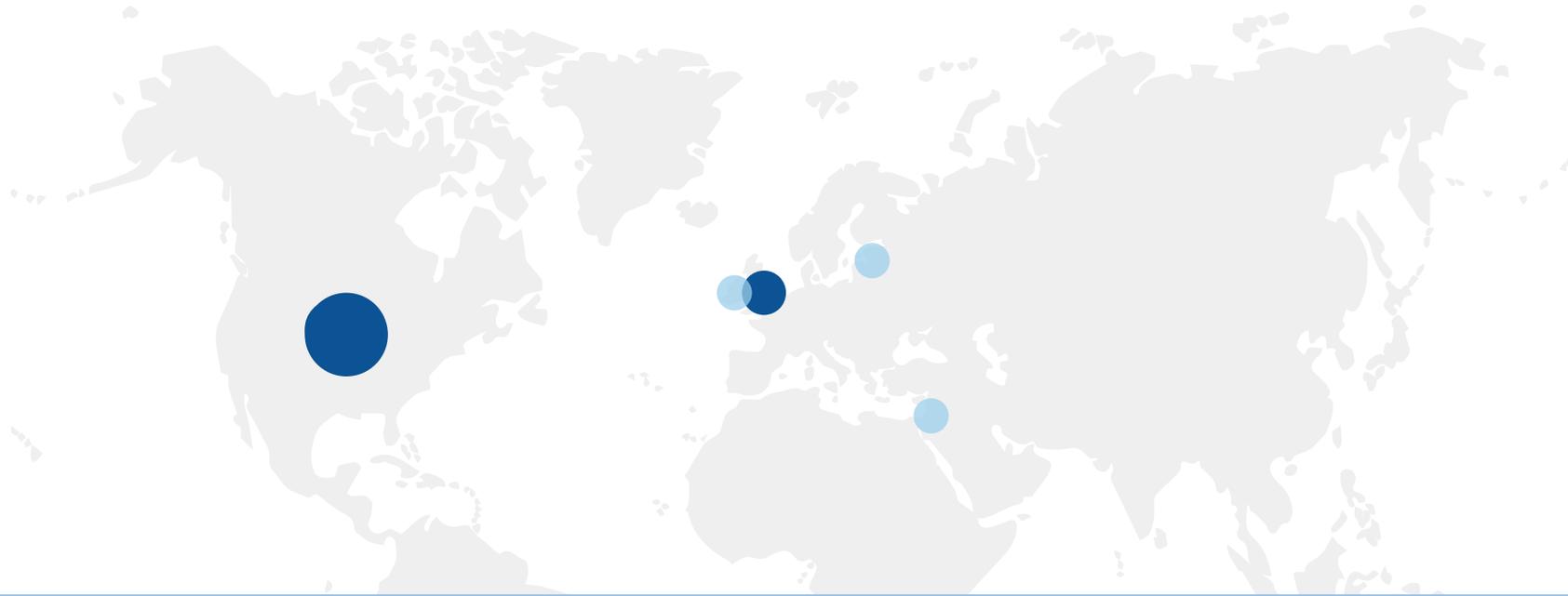


Top-100 AI Experts in Drug Discovery Distribution by Countries



This diagram illustrates the location of the top AI leaders in pharma and healthcare across the globe. 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.

Top-30 Women AI Experts in Drug Discovery Distribution by Countries



USA



UK



Estonia



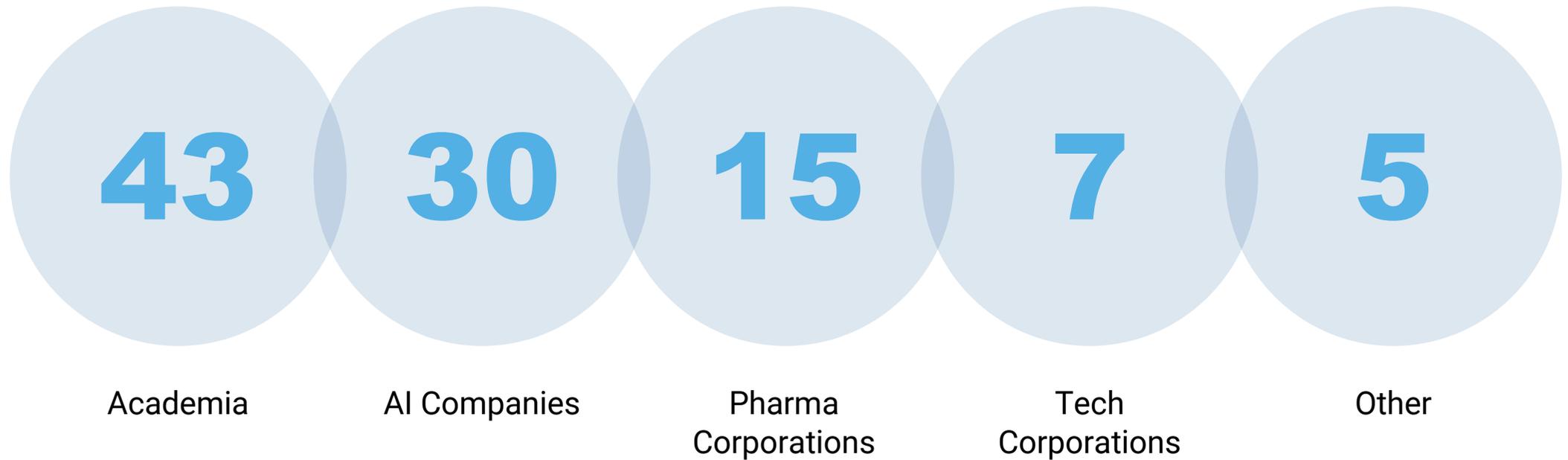
Israel



Ireland

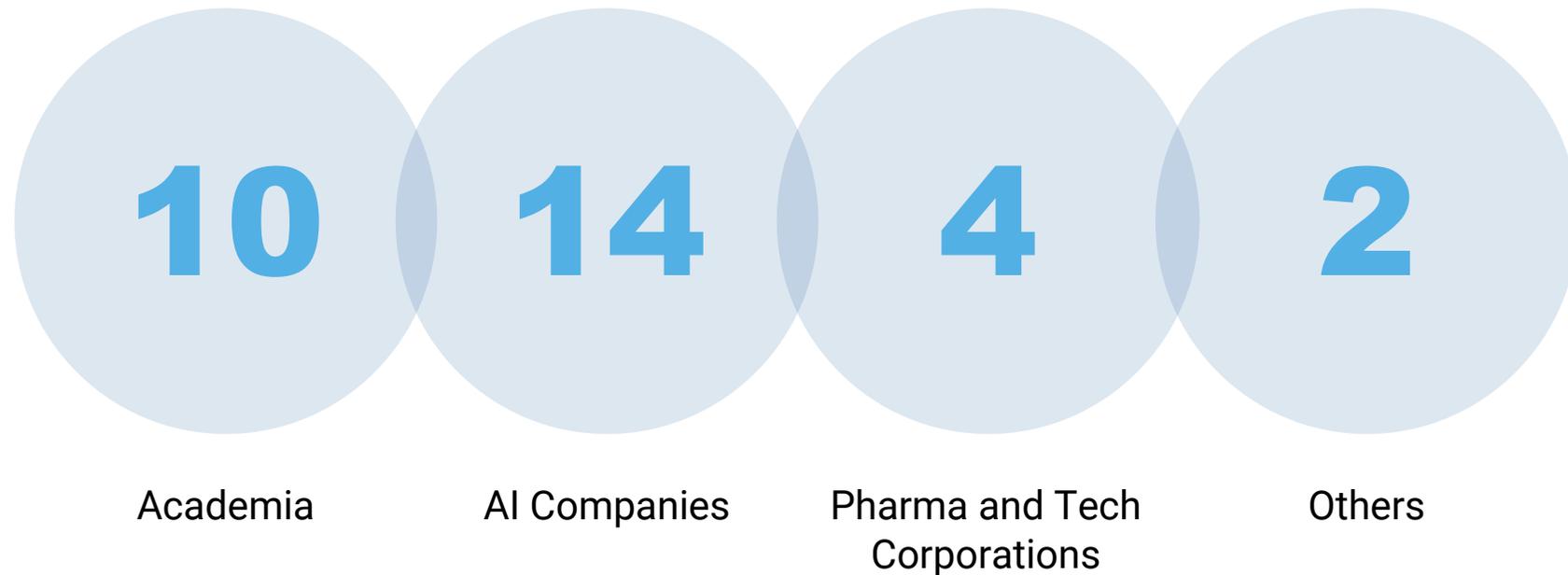
This diagram illustrates location of the top women AI leaders in pharma and healthcare across the globe. USA and Great Britain remain home for the largest number of top women experts. However, it should be noted that China has a potential to substantially alter this statistics in the coming years due to reverse migration of top women AI experts from the USA.

Top-100 AI Experts in Drug Discovery Distribution by Organization Type



Academia has traditionally been home to the most of the top research minds in the area of pharmaceutical and healthcare AI, which is in accordance with the current statistics. A major part of top AI experts also involved in entrepreneurship and run their own AI companies. The remaining list of top experts is distributed between pharma corporations, technology corporations, and various uncategorized companies.

Top-30 Women AI Experts in Drug Discovery Distribution by Organization Type



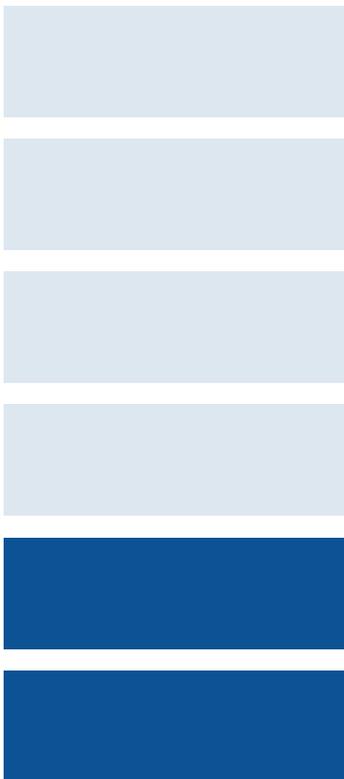
Academia has traditionally been home to most of the top research minds in the area of pharmaceutical and healthcare AI, which is in accordance with the current statistics. A major part of top women AI experts also involved in entrepreneurship and run their own AI companies. The remaining list of top experts is distributed between pharma corporations, technology corporations, and non-profit projects.

Top-100 AI Experts in Drug Discovery

Distribution by Primary Activity

Business Roles

17%



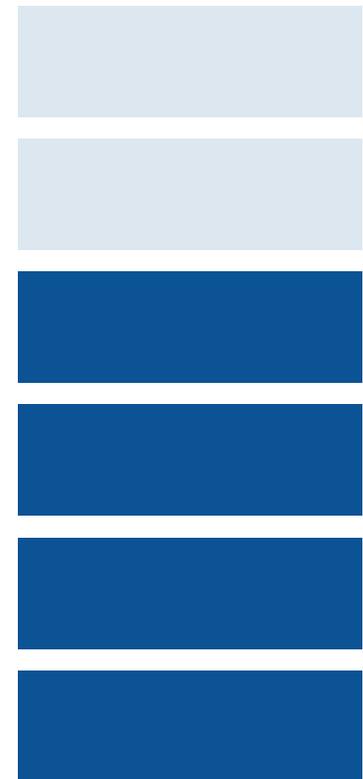
AI Research/Technology

46%



Life Sciences
Research/Technology

37%



Top-30 Women AI Experts in Drug Discovery Distribution by Primary Activity

Business Roles

56%



AI Research/Technology

27%



Life Sciences
Research/Technology

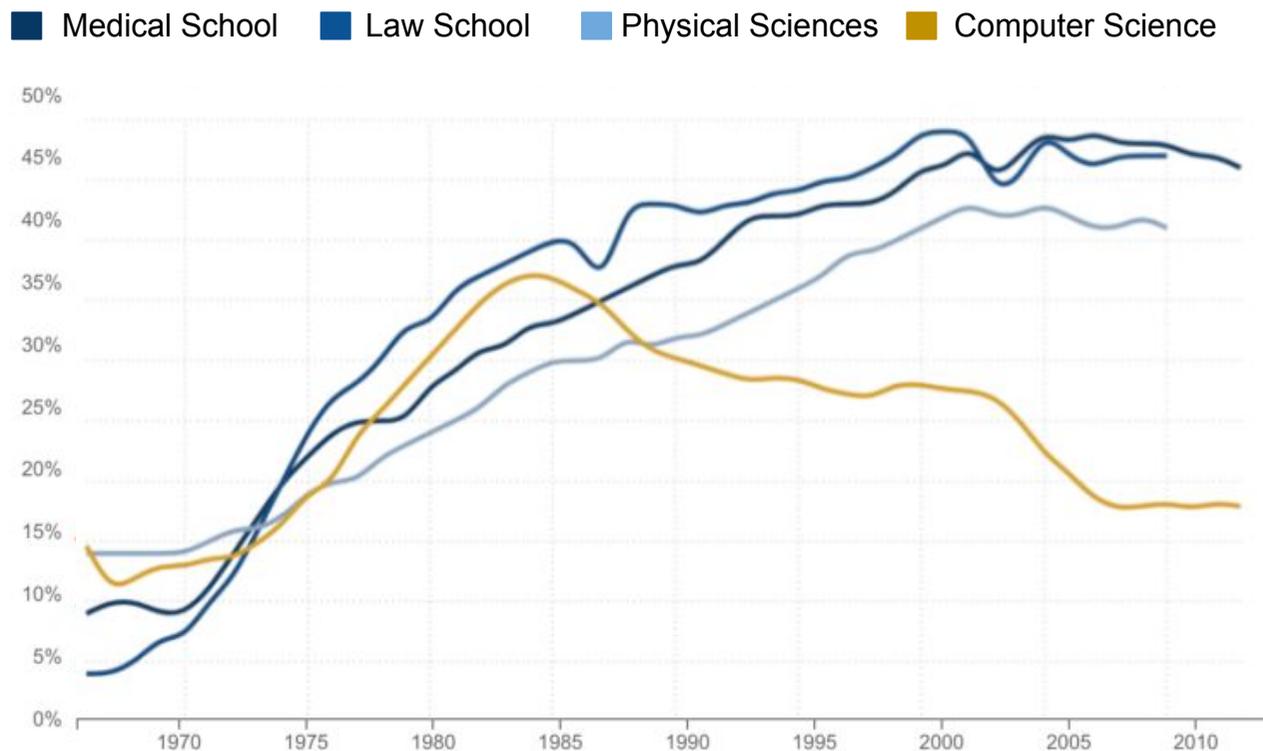
17%



Women in Deep Tech

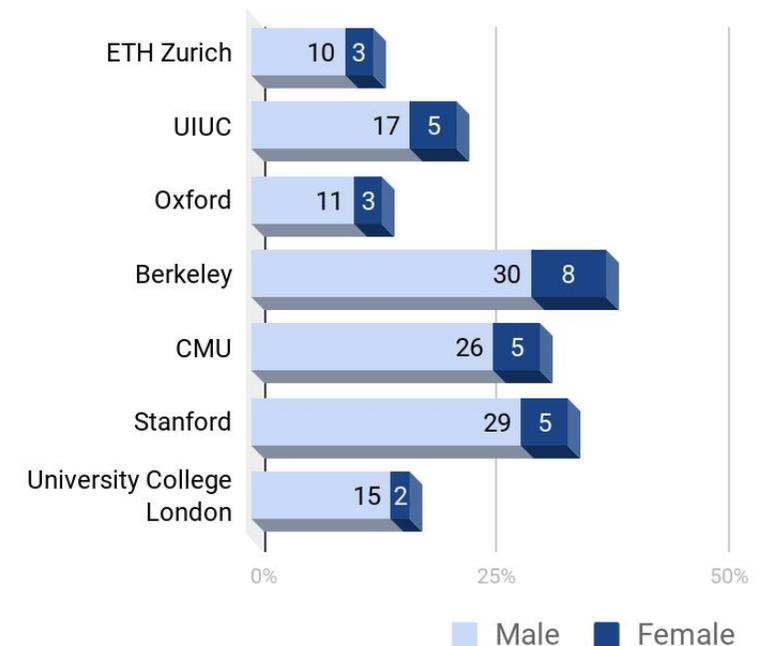
In the long run, the share of women in computer sciences declined. Now we can observe sorrowful consequences of this trend in deep tech industry. But the opportunity is to use the current AI boom to engage more women. The growth of involvement of women in physics, presented on the graph, is an example of positive shifts that we need to implement in AI sector.

% OF WOMEN MAJORS, BY FIELD



Source: National Science Foundation, American Bar Association, American Association of Medical Colleges
Credits: Quoctrung Bui/NPR

AI PROFESSORS BY GENDER



Source: aiindex.org

Key Report Observations

Where do TOP-100 AI leaders reside?

It might come as no surprise that the US and UK still remain home for the largest number of top AI experts in pharmaceutical and healthcare R&D sectors with 68% and 31% of list TOP 100 list participants residing there, respectively (see Distribution by Countries). Being major innovation hubs, San Francisco, Boston, New York and London are topping the list of cities with the largest numbers of TOP 100 AI leaders working there.

Particular attention should be given to China. While formally it has a small count of participants from the TOP 100 AI leaders list (only 2), the real potential of this country in data-driven pharmaceutical and healthcare research is among the biggest. The currently underrepresented position of China is explained by a relatively recent explosion of the AI talent in this country, while the list of TOP 100 AI leaders has an emphasis of the historical achievements (USA and UK historically were home to many pioneering advances in the field) and currently recognized leadership positions (rather, than potential for the future). Secondly, all Chinese experts working in Western offices of Chinese companies and residing in the USA or UK were associated with those countries to increase their score.

We predict that these 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.

Key Report Observations

Where do TOP-100 AI leaders work?

It was found that the majority of the TOP 100 list participants work in academia (43%), which is predictable – academia has traditionally been a cradle of the innovative thought not only in drug discovery, but also in the theoretical and practical aspects of ML/DL/AI in the context of the application for drug discovery and biomedical research. The impact of AI leaders in this category is usually characterized by:

- High number of peer-reviewed publications
- High level of citation (high h-index and i10-index, RG score in ResearchGate – if applicable)
- Pioneering roles in a particular area of theoretical or engineering aspect of ML/AI for drug discovery
- Availability of a notable theoretical breakthrough, technical invention, or widely adopted commercial model

Founders and top research executives of the AI-driven drug discovery startups constitute the second largest group (30%) of leaders in the TOP 100 list. The abundance of the emerging companies in this area is a consequence of an increasing demand for the AI-driven solutions from the side of pharmaceutical companies. Those AI leaders who advance the industry through their entrepreneurial ambitions are usually characterized by the following set of demonstrated abilities:

- Outstanding business leadership in the area of introducing AI for drug discovery/biotech/healthcare
- High level of interdisciplinary expertise in both hi-tech and life sciences to realize an integral vision of their projects
- Publicly active position, thought leadership activity

Key Report Observations

15% of the AI-leaders in the TOP 100 list work in the largest pharmaceutical companies, which reflects a somewhat slow change in the perception of “big pharma” regarding ML/AI-related opportunities. However, we expect a substantial expansion of this category in the nearest time – as pharma becomes more striving for AI-talent and leadership. Leaders in this category include top pharmaceutical executives, who possess substantial influence on the fate of adopting ML/AI-driven strategy in their organizations and already made practical steps towards this vision.

Typical features of the participants in this group include:

- C-level executive role, or leading research role in some of the largest pharmaceutical companies
- Strong background in digital technologies, cheminformatics/bioinformatics
- Strong technology leadership ability
- Knowledge of ML/AI (either career major, or as an additional training)

The rest of the leaders in the TOP 100 list are from the world’s largest non-pharma technology corporations, like Google, and Tencent (7%), and companies in various uncategorised industries (5%).

Particular attention should be given to the segment “Technology Corporations” as these companies have already developed the strongest capabilities in the ML/AI available on the planet, with best-in-class IT-infrastructures. Now they are increasingly attempting to shift their focus to healthcare, drug discovery and even basic pharmaceutical research, hoping to leverage the unmatched AI expertise in a “foreign”, but very promising for the market. At this moment, technology giants are not able to enter the medicines R&D market on a meaningful scale, but things are changing rapidly. We expect that large technology corporations might, at some point in time, substantially increase the competitive pressure on the currently dominating pharma and biotech organizations. In this case, the ML/AI technologies serve as a sort of “democratizing” factor, allowing a non-pharma corporation enter pharmaceutical R&D market.

Concluding the review of the TOP 100 list, it becomes obvious that successful AI-leaders in pharmaceutical/healthcare fields originate from a variety of quite different backgrounds and fields of specialization, and they have a wide range of possible roles to play in the projects, ranging from purely scientific ones to entrepreneurship and general management. It suggests that any successful AI talent acquisition strategy, aimed at an organization-wide AI adoption, has to include a wide range of different roles and departments, and not be limited to only hiring highly-specific staff to augment R&D or IT departments.

The Coming Race for AI talent

Considering a rapidly increasing realization that AI-based technologies are a transformative opportunity for the pharmaceutical organizations, it is easy to predict the coming frantic race for the AI talent, especially, with experience in Life Sciences – demand for this type of expertise will be growing **to far outpace supply for years to come**.

An additional constraint in the AI talent acquisition strategy will be conditioned by the growing external competition for the available talent – as large technology giants, like Google, Microsoft, Tencent, and Amazon are increasingly focusing on the Life Sciences and healthcare. Hence, pharmaceutical giants will be competing for the available talent not only with closest pharma competitors, but also with a growing pool of pharmaceutical AI-startups, and increasingly – with global technology corporations.

To gain momentum and set themselves for a long-term AI-driven growth, pharmaceutical corporations will have to focus on the most efficient talent acquisition strategies:

- 1. Focus on collaboration with academia:** Closer and more flexible types of collaboration with academia, since academic institutions are not only a cradle of innovation in the AI, but also the main source of scientific talent. Engaging with talented PhD-level specialists early in their career is a crucial aspect to set them for work in pharmaceutical industry, rather than letting them drift away towards careers in technology corporations. This strategy should be wisely balanced to avoid a **“brain drain” from academia** – a harmful phenomenon, with far-reaching negative implications for both science and educational process.
- 2. M&A Strategy:** Setting focus on the merger and acquisition (M&A) activity is an important component of AI-talent acquisition work. The growing wave of AI-driven drug discovery and healthcare startups are yielding highly skilled teams with strong understanding in both ML/AI and Life Sciences. We anticipate that the most successful startups in this area will soon become lucrative targets for M&A by pharmaceutical and technology corporations.
- 3. Increasing intrapreneurship culture:** Creating intrapreneurship programs and business incubators will have to become an important element of an AI-talent acquisition strategy by pharmaceutical corporations. Companies like Google are well-known for outstanding conditions for internal innovators and intrapreneurs. Pharmaceutical companies, being notoriously conservative, will have to embrace more agile strategies regarding internal innovation and intrapreneurship.

Top-20 AI for Drug Discovery Conferences in 2019

Introduction

The following is an early edition of our global guide to conferences pertaining to artificial intelligence in drug discovery officially announced for 2019.

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.

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

- The event must be well attended, with a large number of speakers as well as participants.
- It must include at least one panel on the *application* of AI to drug discovery.
- Speakers must include pharmaceutical corporations (e.g., Johnson & Johnson, Merck, etc.) and/or technology corporations (such as IBM or Microsoft) in order to be relevant. Such corporations are the main engines driving the development of AI in drug discovery and the primary end-users of technologies currently being developed by AI startups.

The conferences we identify also have the following in common:

- They all include AI startups.
- They all include scientists and scholars who are helping AI specialists to develop efficient technologies so that academia is well represented.
- The vast majority take a place in the US or UK, however several of them will be in Asia, mainly Singapore and China.

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

Top-20 AI for Drug Discovery Conferences in 2019

NAME	WEBSITE	DATE	REGION
2nd AI Pharma Innovation: Drug Discovery Summit 2019	ai-drugdiscovery.com	February 27-28	US
3rd Annual Artificial Intelligence in Drug Development Congress	oxfordglobal.co.uk	September	UK
The AI Application Summit Biopharma	aiapplicationssummit.com	October 25-26	US
Advanced Machine Learning And Artificial Intelligence For Drug Discovery And Development	drugdiscoverydevelopmentforum.com	May 28-29	UK
Healthcare & Medical Research Conference Sessions	nvidia.com	March 18-22	US
WuXi Global Forum 2020	wxpress.wuxiapptec.com	January	US
6th International Conference on Accelerating Biopharmaceutical Development (AccBio 2019)	aiche.org	February 17-20	US
ManuPharma 2019	manupharma.wbresearch.com	December	UK
AI Innovations For Life Science Summit West	aiinnovationsummit.com	13-14	US
Ai4 Healthcare	ai4.io	November 11-12	US
AI Applications for Drug Discovery and Development	lifesciences.knect365.com	September 10-19	US
Phar-East	terrapinn.com	March 18-20	Singapore
Intelligent Health AI	intelligenthealth.ai	September 11-12	Switzerland
AI Med Europe	aimed.events	September 17-19	UK
BioData World West 2019	terrapinn.com	October 10-11	US
Precision Medicine World Conference 2019	pmwcintl.com	January 20-23	US
JPMorgan	jpmorgan.com	2020	US
Pharma AI & IoT 2019	pharmaphorum.com	TBD	UK
Deep Learning in Healthcare Summit	re-work.co	May 23-24	US
Global AI Empowered Healthcare China Summit 2019	aiemhe.com	March 28	China

2nd AI Pharma Innovation: Drug Discovery Summit 2019

www.ai-drugdiscovery.com

27-28 February 2019 | Location: USA | Price: \$2,699

18 speakers (e.g. Takeda, GSK, Berg, Amgen, Eli Lilly, Numerate, Genentech etc)

Attending: Pharma Corporations, Academia, AI Companies

The AI Application Summit Biopharma

www.aiapplicationssummit.com

25-26 October 2019 | Location: USA | Price: Approx \$2,000

43 Speakers in 2019 (e.g. Pfizer, NuMedii, Sanofi, Numerate, Berg, Merck, twoXAR, WuXi AppTec, Insilico Medicine, etc)

Attending: Pharma Corporations, Academia, AI Companies

3rd Annual Artificial Intelligence in Drug Development Congress

www.oxfordglobal.co.uk

September 2019 | Location: UK | Price: TBD

Speakers: TBD (e.g. from 2019: AstraZeneca, Takeda, Pfizer, GSK, Janssen, Merck, Roche, Boehringer Ingelheim, Berg Health, Insilico Medicine etc)

Attending: Government agencies, Pharma Corporations, Academia, AI Comp

Healthcare & Medical Research Conference Sessions

www.nvidia.com

18-22 March 2019 | Location: USA | Price: \$1,700-2,000

Speakers: TBD

Attending: TBD

Advanced Machine Learning And Artificial Intelligence For Drug Discovery And Development

www.drugdiscoverydevelopmentforum.com

28-29 May 2019 | Location: UK | Price: \$1,700

Speakers: TBD (already in the list: Roshe, GSK, Novartis etc)

Attending: Pharma Corporations, Academia, AI Companies



WuXi Global Forum 2020 www.wxpress.wuxiapptec.com

January 2019	Location: USA	Price: TBD
Speakers: TBD (e.g. from 2019: WuXi AppTec, Johnson & Johnson, BenevolentAI, Google Ventures etc)		
Attending: Pharma Corporations, Academia, AI Companies		

ManuPharma 2019 www.manupharma.wbresearch.com

December 2019	Location: UK	Price: TBD
Speakers: TBD (already in the list: Novartis, Takeda, Roche, GSK, Boehringer Ingelheim, GSK, Johnsson & Johnsson, Merck, Eli Lilly etc)		
Attending: Pharma Corporations, Academia, AI Companies		

6th International Conference on Accelerating Biopharmaceutical Development (AccBio 2019) www.aiche.org

17-20 February 2019	Location: USA	Price: Approx \$3,000
28 Speakers (e.g. Amgen, Pfizer, Merck, Sanofi, Just BioTherapeutics, Biogen, Optera Therapeutics etc)		
Attending: Pharma Corporations, Academia, AI Companies		

Ai4 Healthcare www.ai4.io

11-22 November 2019	Location: USA	Price: \$1,200
40+ Speakers (e.g. Sanofi, Pfizer etc)		
Attending: Government agencies, Pharma Corporations, Academia, AI Companies		

AI Innovations For Life Science Summit West www.aiinnovationsummit.com

13-14 June 2019	Location: USA	Price: TBD
Speakers: TBD		
Attending: TBD		

AI Applications for Drug Discovery and Development

www.lifesciences.knect365.com

10-11 September 2019 | Location: USA | Price: TBD

30+ speakers (e.g. MIT, Sanofi, Takeda, GSK etc)

Attending: Pharma and Tech Corporations, Academia, AI Companies

AI Med Europe

www.aimed.events

17-19 September 2019 | Location: UK | Price: TBD

350+ Speakers (e.g. Google, HP, Pfizer, Benevolent Bio etc)

Attending: Pharma and Tech Corporations, Academia, AI Companies

Phar-East

www.manupharma.wbresearch.com

18-20 March 2019 | Location: Singapore | Price: Approx \$3,000

125 Speakers (e.g. Samsung etc)

Attending: Pharma and Tech Corporations, Academia, AI Companies

BioData World West 2019

www.terrapinn.com

10-11 October 2019 | Location: USA | Price: \$1,800

270+ Speakers (e.g. Numerate, Recursion Pharmaceuticals, Pfizer, IBM, MIT, GSK etc)

Attending: Government agencies, Pharma and Tech Corporations, Academia, AI Companies

Intelligent Health AI

www.intelligenthealth.ai

11-12 September 2019 | Location: Switzerland | Price: \$450

100 Speakers (e.g. IBM, Bosch, GSK, Roche, Novartis etc)

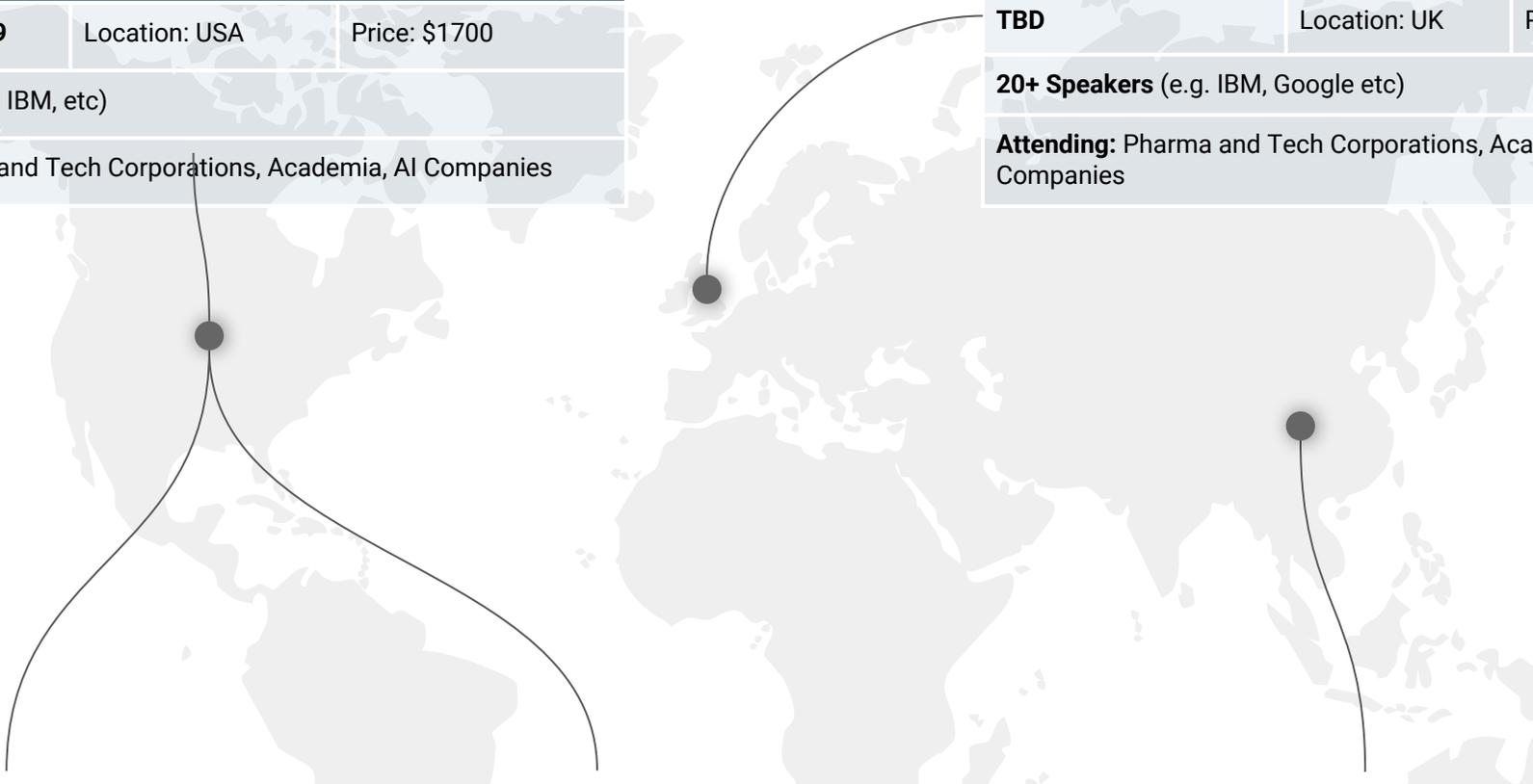
Attending: Pharma and Tech Corporations, Academia, AI Companies

Precision Medicine World Conference 2019 www.pmwintl.com

20-23 January 2019	Location: USA	Price: \$1700
450+ speakers (e.g. IBM, etc)		
Attending: Pharma and Tech Corporations, Academia, AI Companies		

Pharma AI & IoT www.pharmaphorum.com

TBD	Location: UK	Price: \$1,250
20+ Speakers (e.g. IBM, Google etc)		
Attending: Pharma and Tech Corporations, Academia, AI Companies		



JPMorgan www.jpmorgan.com

2020	Location: USA	Price: TBD
Speakers: TBD		
Attending: Government agencies, Pharma and Tech Corporations, Academia, AI Companies		

Deep Learning in Healthcare Summit www.re-work.co

23-24 May 2019	Location: USA	Price: TBD
90 Speakers (e.g. Philips Cambridge Innovation Labs, FDA etc)		
Attending: Pharma and Tech Corporations, Academia, AI Companies		

Global AI Empowered Healthcare China Summit 2019 www.aiemhe.com

28 March 2019	Location: China	Price: \$800
Speakers: TBD (already in the list: Microsoft, Insilico Medicine etc.)		
Attending: Pharma and Tech Corporations, Academia, AI Companies		

Industry Developments

Q1 2019

Industry Developments Q1 2019

JAN

- Iqvia acquired UK-based Linguamatics as part of the company's commitment to deliver value from AI and ML. Linguamatics also helps Sanofi to sort through massive amounts of genomic data and published medical literature a quest to find new biomarkers for multiple sclerosis.
- Novartis and the University of Oxford's Big Data Institute have announced that they are to establish a five-year research alliance using artificial intelligence to understand complex diseases and improve drug development. Using the BDI's latest statistical machine learning technology and experience in data analysis, combined with Novartis' wealth of clinical expertise and clinical trial data, the alliance expects to predict how patients will respond to existing and new medicines.
- Exscientia, leading AI-driven drug discovery company, announces it has raised US\$26 million in a Series B financing round. This will be used to scale the company's pipeline and advance selected programmes towards clinical development. The round included participation from new investors Celgene Corporation and specialist healthcare investor GT Healthcare Capital Partners, as well as existing investor Evotec AG.
- Numerate, Inc., a data-driven drug design company applying AI to transform drug discovery, announced a multi-target research collaboration with Lundbeck Pharmaceutical to identify clinical candidates for the treatment of disorders in the central nervous system, including depression, psychosis, seizure and neurodegenerative disorders.
- Juvenescence Ltd, a biopharmaceutical company focused on modifying aging and age-related disease, is pleased to announce the close of the first tranche of its Series B financing, in the amount of \$46 million.
- San Francisco-based Atomwise announced it had formed the partnership with Wilmington, Massachusetts-based Charles River Laboratories. The deal is potentially worth up to \$2.4 billion for the technology company in royalties. Under the agreement, Atomwise will receive technology access fees, milestone payments and royalties from clients while supporting hit discovery, hit-to-lead and lead optimization.

FEB

- During the 10th Annual Summit for Clinical Ops Executives in Orlando, FL, Saama Technologies unveiled 3 new machine learning-based capabilities, expanding the functionality of its analytics cloud to overcome obstacles historically associated with clinical development.
- Insilico Medicine, one of the world's leading artificial intelligence (AI) companies in the field of deep learning for drug discovery, hosts MolHack 2019 in Taiwan, an online hackathon from February 25th to March 31st with a focus of "Deep Learning for Small Molecule Generation".
- Pharmaceutical Product Development, LLC (PPD) and Happy Life Tech (HLT) of China have signed an exclusive agreement to develop a distinctive service offering for the China drug-development market delivering data science-driven clinical trials and real-world evidence of drug products' effectiveness, safety and value. HLT contributes an unparalleled ability to generate AI-enabled solutions and its growing network of prominent physicians and more than 100 leading hospitals in 22 Chinese provinces.
- Insilico Medicine, a Rockville-based company developing the end-to-end drug discovery pipeline utilizing the next generation AI, announces its partnership with a new Centre for Doctoral Training (CDT) at the University of Oxford, supported by EPSRC.
- Ben-Gurion University of the Negev (BGU) has developed a new AI platform for monitoring and predicting progression of neurodegenerative diseases to help identify markers for personalized patient care and improve drug development. The platform will initially be used for amyotrophic lateral sclerosis (ALS) and ultimately for Alzheimer's, Parkinson's and other neurodegenerative diseases.
- GlaxoSmithKline Plc will pay Germany's Merck KGaA as much as 3.7 billion euros (\$4.2 billion) to get access to a promising immune-oncology treatment that the drugmakers see as a key to bringing the next wave of cancer therapies to patients.
- Medicxi Ventures is going to invest €40M in Orexia and Inexia, two new virtual companies spun out of Sosei Heptares, developing drugs for neurological diseases such as narcolepsy.

MAR

- Bristol-Myers Squibb and Concerto HealthAI, a company that specialized in oncology-specific real-world data (RWD) and advanced artificial intelligence (AI)-enabled insight solutions for real-world evidence (RWE) generation, announced a multi-year strategic agreement that will cover a diverse range of cancers, integrate multiple data sources, and apply AI and machine learning to accelerate clinical trials, enable robust protocol design, and generate insights for precision oncology treatment and improved patient outcomes.
- AI drug R&D firm Exscientia announces that it expands into Japan. Its subsidiary, Exscientia K.K., is headquartered in Osaka, Japan, and led by Dr. Daisuke Tanaka, an experienced medicinal chemist who previously was director of the Innovative Chemistry Group at Sumitomo Dainippon Pharma. It plans to deliver business development and project support in Japan as well as providing a strategic base extending across the broader Asia region, including China, Singapore and South Korea.
- Merck KGaA, Darmstadt, Germany, announces its collaboration with Iktos, a French start-up company specialized in artificial intelligence (AI) for new drug design, to further accelerate its drug discovery capabilities.
- Ono Pharmaceutical, a Japanese pharmaceutical R&D company, and twoXAR, an artificial intelligence (AI)-focused biopharmaceutical company, announced that the companies have signed a drug discovery research collaboration to jointly discover and develop novel, efficacious treatments to address unmet medical needs in a specific neurological disease.
- The new investment round, which was led by Mirae Asset Venture Investment and Mirae Asset Capital, brings South Korea startup Standigm's total financing to \$15 million. Other backers include Kakao Ventures, Atinum Investment, DSC Investment, LB Investment, Wonik Investment Partners, as well as Mirae Asset Venture Investment and Mirae Asset Capital. It will allow Standigm to scale the AI technology platforms and advance its drug discovery pipelines toward license-out.
- Celgene has partnered with Exscientia, an artificial intelligence startup aiming to reduce the time it takes to bring new drug treatments to market by as much as four years. The collaboration will use AI for three therapeutic programmes in the areas of oncology and autoimmunity.

MAR

— Erasca, a company dedicated to advancing exceptional scientific approaches to erase cancer, has closed an extension to its Series A financing round, bringing the total raised to \$64 million. Proceeds of the financing will support the company's efforts to potentially in-license new investigational compounds in development, while also accelerating the buildout of Erasca's AI platform that will drive discovery and development of a new generation of oncology drugs designed to not just treat, but actually, cure, cancer.

— InveniAI Corporation, a global leader pioneering the application of AI and ML to transform innovation across healthcare and other industries, was featured in a Microsoft-sponsored AI for Change series that showcases companies making a transformative impact in their industry with AI technology.

— Owkin, a company which builds machine learning technologies and infrastructure to enable breakthrough medical research, announced a funding round led by F-Prime Capital and Eight Roads Ventures. The round was joined by GV, Cathay Innovation and NJF Capital.

— Oxford BioMedica announced it had inked a two-year research-and-development collaboration with Microsoft Research. The goal is to improve the yield and quality of next-generation gene therapy vectors—typically viruses—using AI and machine learning.

— Healx has announced a collaboration with Boston Children's Hospital and Barth Syndrome Foundation (BSF) to advance promising therapeutic compounds to treat Barth syndrome.

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).

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.

INCREASED AMOUNT OF INVESTMENTS

2017 and 2018 showed significant growth of investments. Comparing to 2015 and 2016, when AI R&D startups raised \$231M and \$230M accordingly, 2017 showed significant growth to \$469M. The industry saw a total of \$455M in Q2 of 2018, compared to \$159M in Q1 2018. This is almost as much as was raised in all of 2017 combined (\$468M).

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.

Trends of Investment and M&A Deals

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

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

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

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. We are expecting that in 2019 leading pharmaceutical companies will start adopting AI at scale, rather than follow a project-oriented path, as in previous years. The strategic importance of AI has become obvious to most organizations within the biopharma industry, and a majority of them will be looking for ways to rapidly progress in this direction.

2013-2015

2016-2017

2018

2019

Appendix I

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?**
- **What are future prospects of pharma corporations regarding the evidence of R&D efficiency and how these prospects can be changed?**
- **What are the major threats and opportunities facing investors in AI for Drug Discovery 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.

Approaches

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 Q2 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 and assessment 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-20 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?**

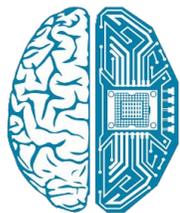
This is a 40+ page report delivering practical answers to these specific questions in order to optimize the short and long-term strategies of biopharma companies, investors and other institutions related to the industry, with a new updated edition being released each quarter, incrementally increasing 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

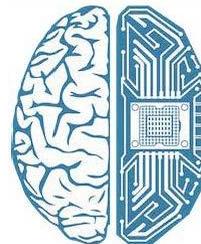
The parties who gain early access to this report will have deep expertise on how their strategic agendas can be optimized and stabilized in order to surpass the challenges and to utilize the opportunities related to these novel AI for Drug Discovery investment trends.

Deep Knowledge Group



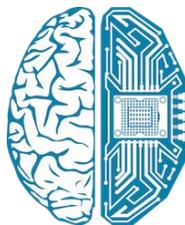
DEEP KNOWLEDGE ANALYTICS

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.

Appendix II

Comparative Industry Analysis & Classification Framework Q1 2019



The report specifically tuned to industry professionals such as investors, analysts, BioPharma/Tech executives and decision-makers, is available for purchase.

This section is devoted to an in-depth comparative and quantitative analysis of the entire AI for Drug Discovery landscape, utilizing advanced infographics and tangible parameters both for (1) ranking various AI for Drug Discovery companies according to their levels of scientific validation, clinical development, R&D and industry-application diversification, and overall prospects for future growth and for (2) classifying AI for Drug Discovery companies according to their type and number of distinct industry applications, proportion of AI specialists, number of patents and publications, use of next-generation AI technologies (e.g. GANs vs ML), and whether they utilize AI as a core component of their R&D or as a complementary element to enhance their primary, non-AI focus and business model.

AI for Drug Discovery, Biomarker Development and Advanced R&D Q1 2019

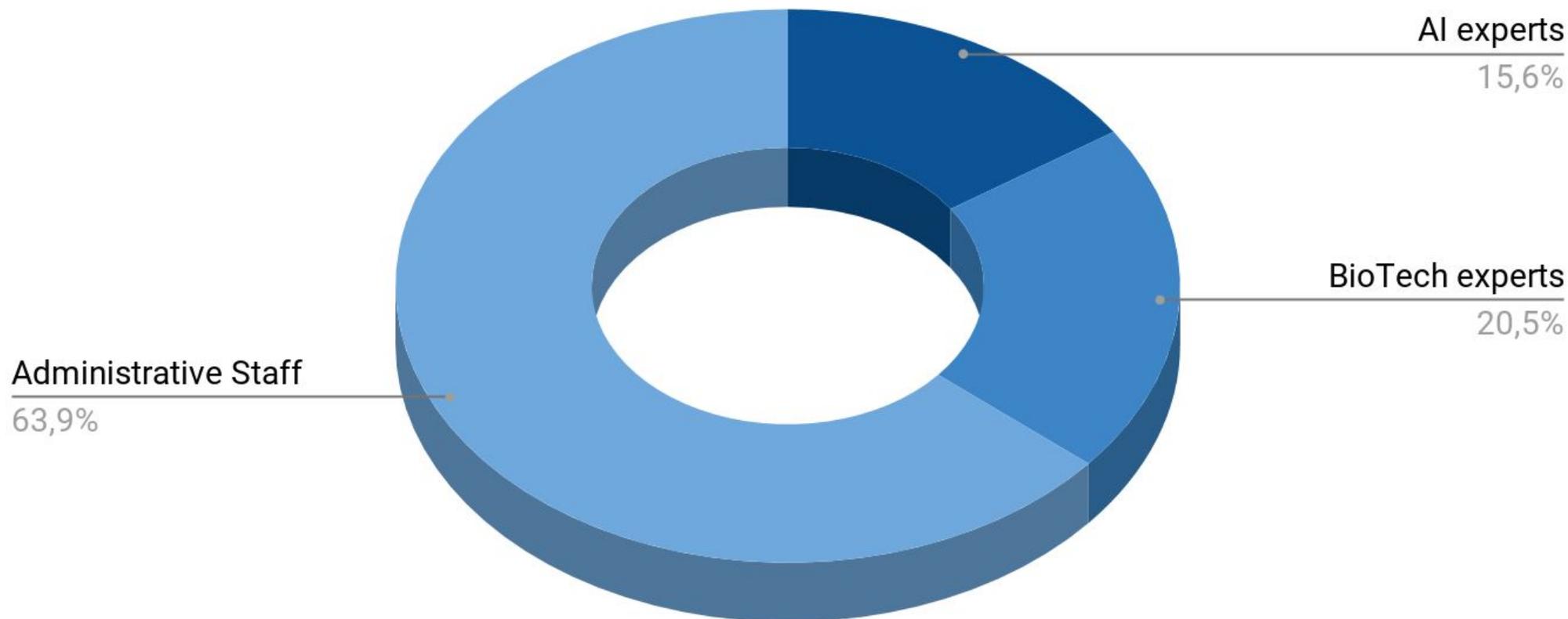
Comparative Industry Analysis & Classification Framework Comparison of 25 Leading AI for Drug Discovery Companies

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Comparison of 25 Leading AI Companies

To get access to this specialized section
of the analytical report please contact
us by email pharma@dka.global

AI Experts vs BioTech Experts vs Administrative Staff

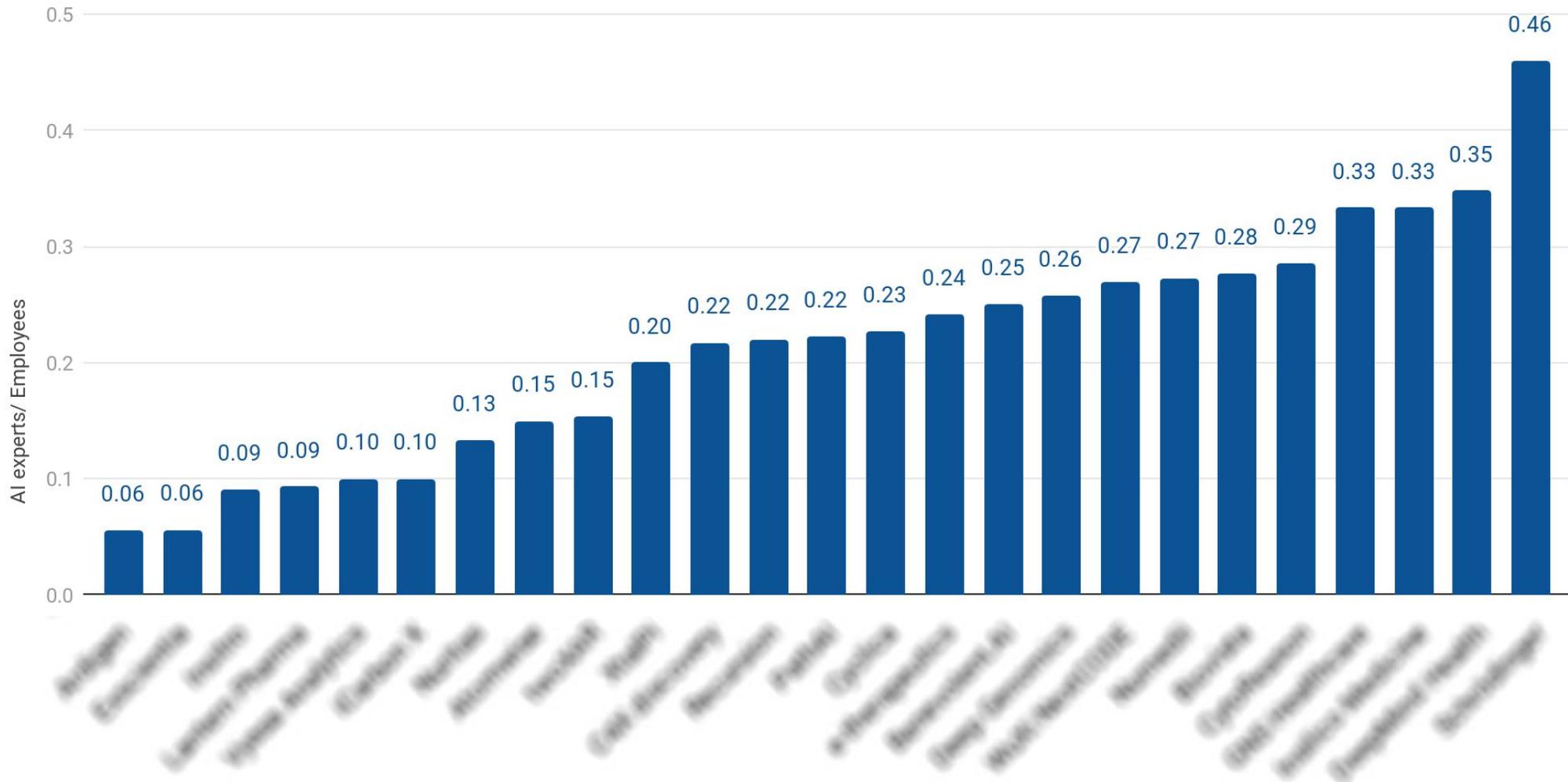


Despite the recent hype, there is an obvious lack of AI-specialists in the Drug Discovery space and therefore a lack of **“True AI”** companies in this sector. Administrative staff outnumber AI specialists at a 4:1 ratio. We are already beginning to see the effects of the coming AI talent winter.

Comparison of Top-25 AI for Drug Discovery Companies

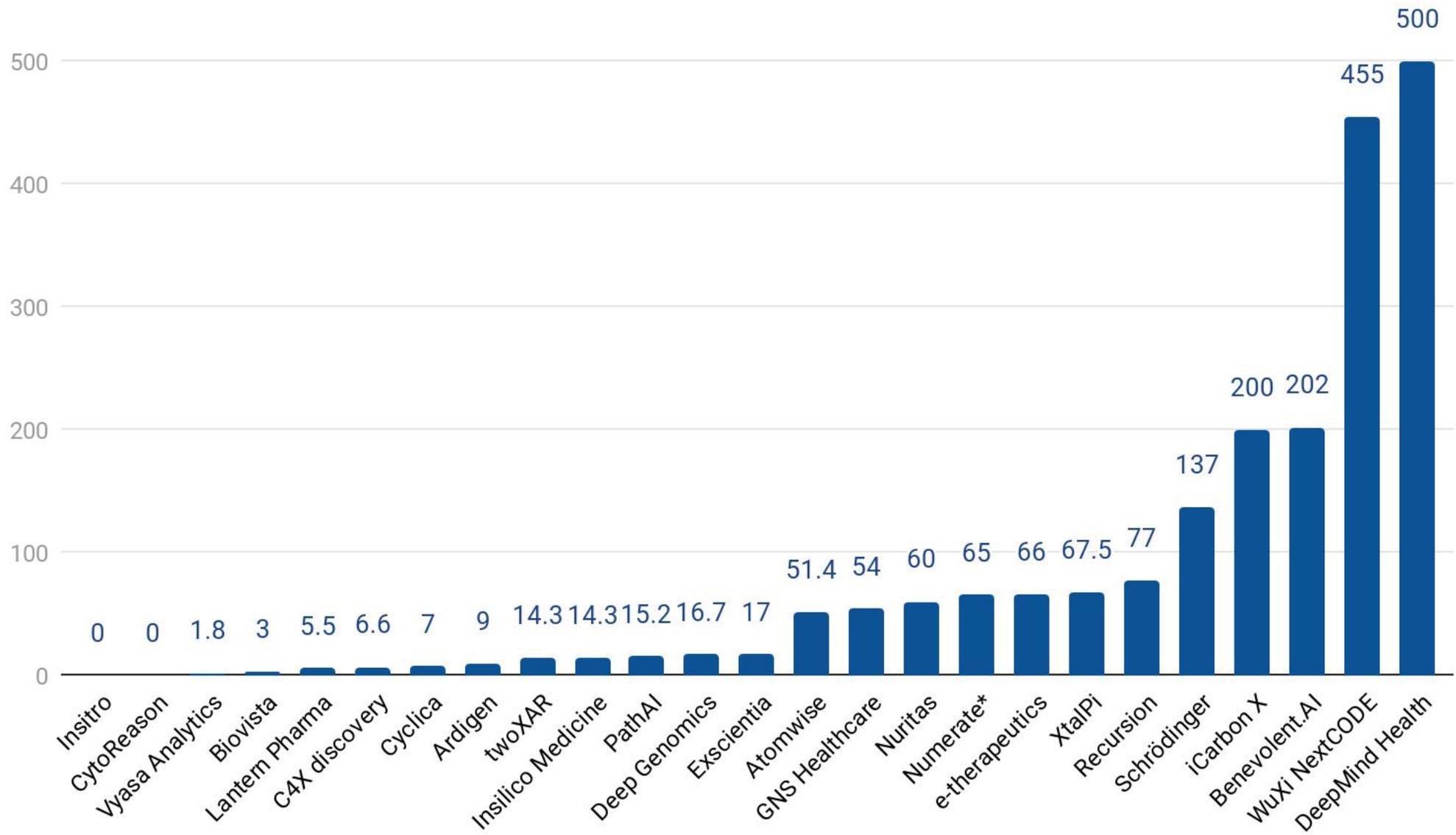
True AI companies

The ratio: AI experts vs Total Number of Employees



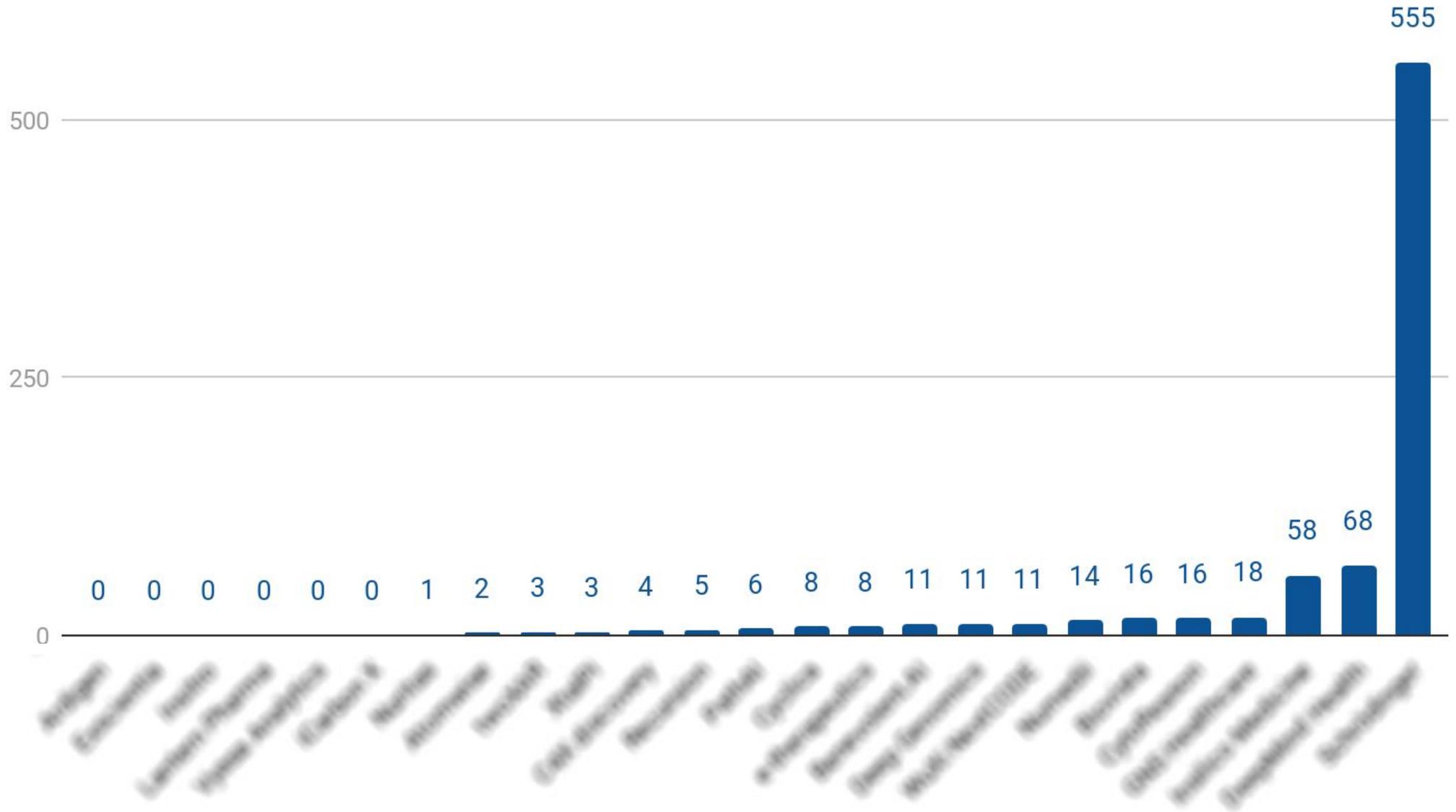
Comparison of Top-25 AI for Drug Discovery Companies

Funding, \$m



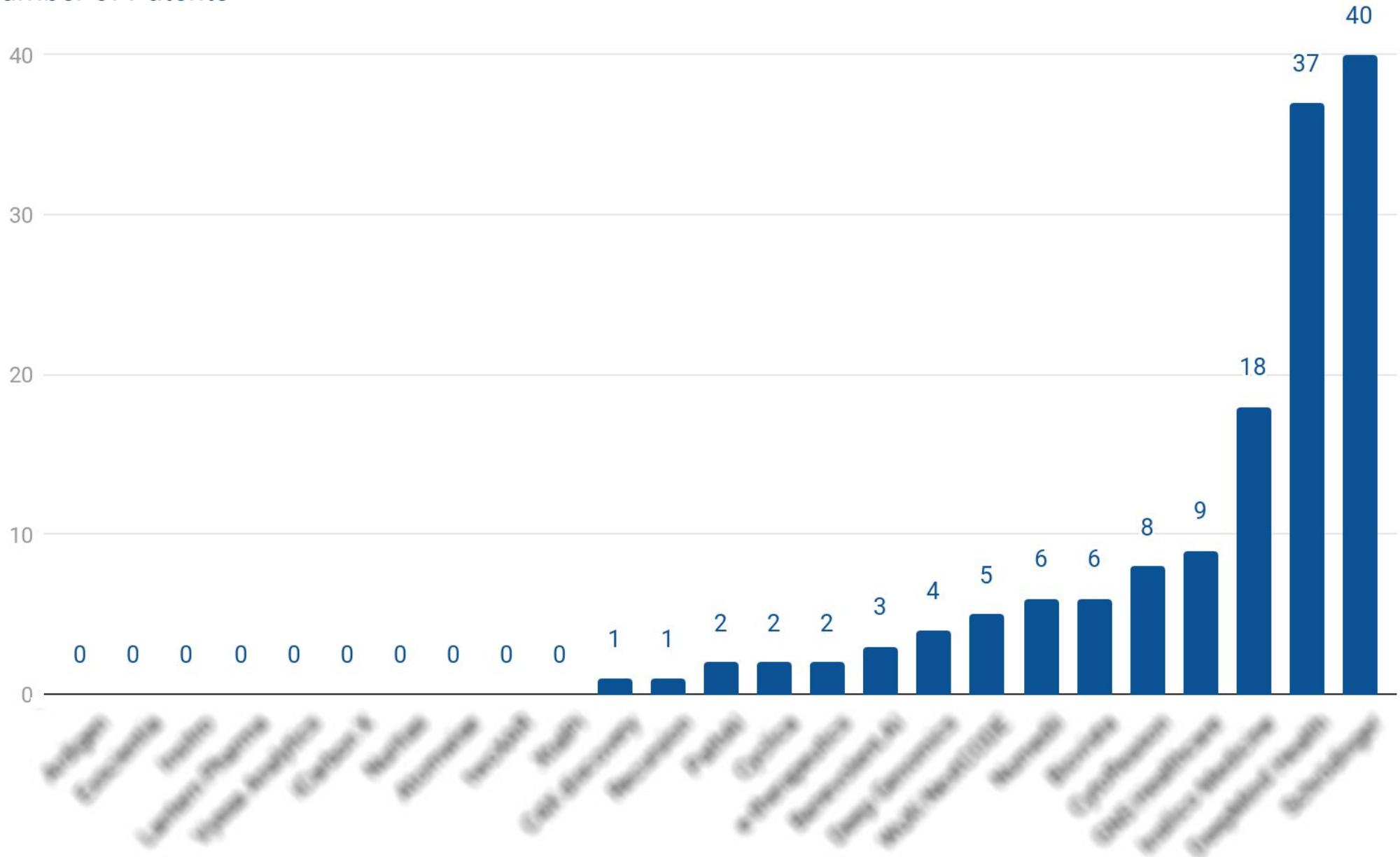
Comparison of Top-25 AI for Drug Discovery Companies

Number of Scientific Publications



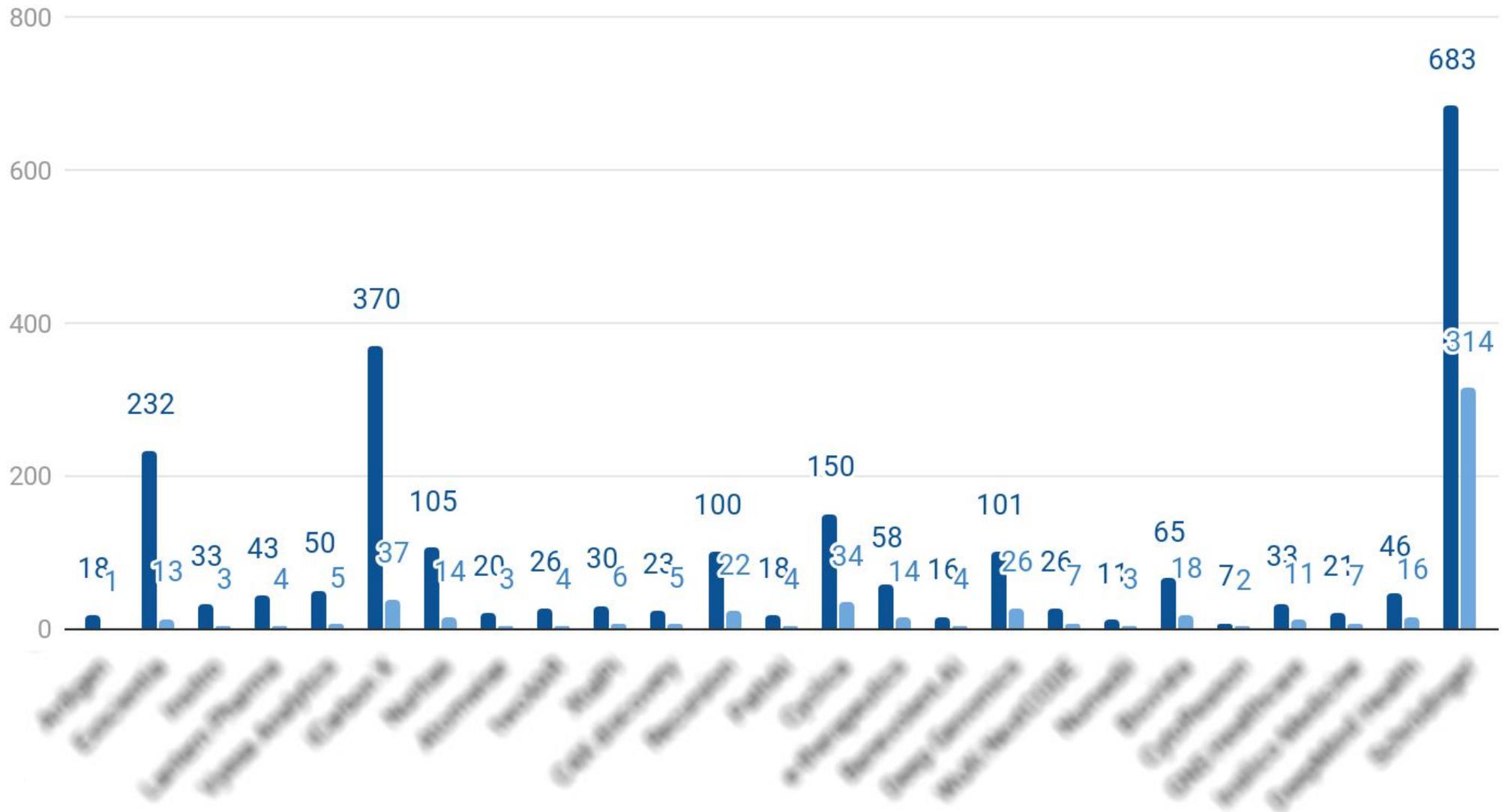
Comparison of Top-25 AI for Drug Discovery Companies

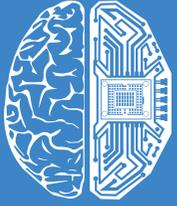
Number of Patents



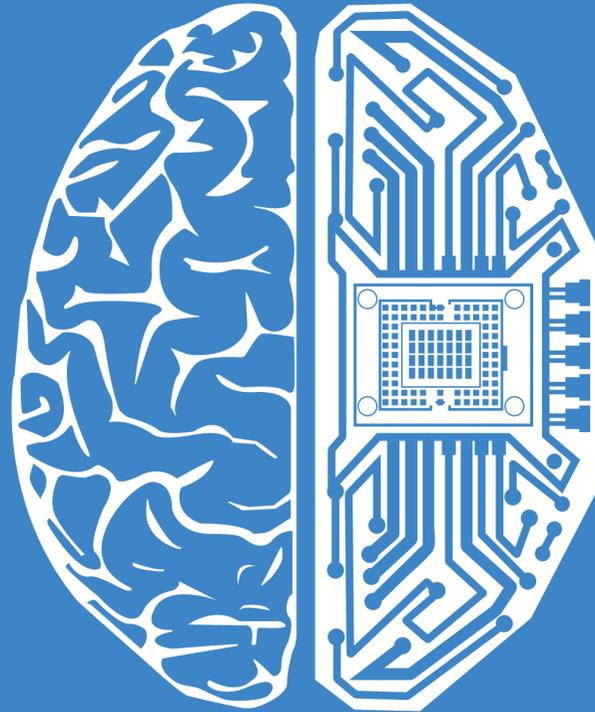
Comparison of Top-25 AI for Drug Discovery Companies

Total Number of Employees / AI experts





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KNOWLEDGE ANALYTICS**
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