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INVESTMENT DIGEST

ARTIFICIAL INTELLIGENCE (AI) FOR DRUG DISCOVERY, BIOMARKER DEVELOPMENT AND ADVANCED R&D LANDSCAPE OVERVIEW 2020

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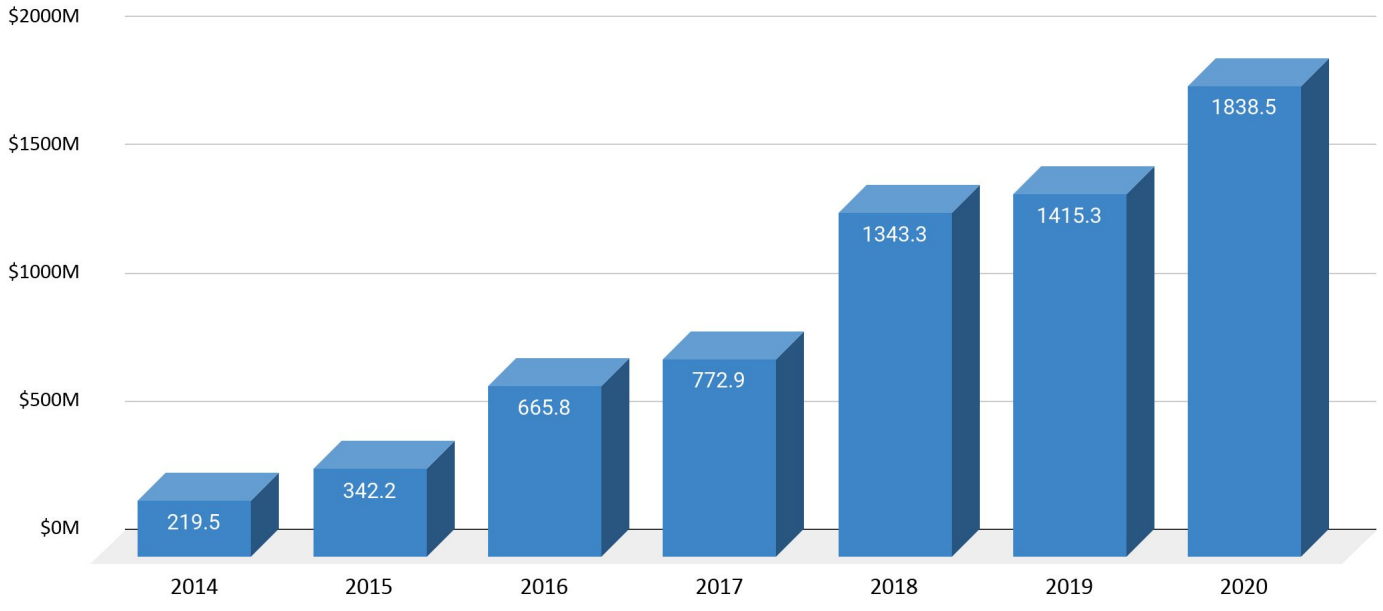
Investment Digest at a Glance

This Investment Digest is summarizing key players and observations in the private equity and venture capital ecosystem, focusing on the pharmaceutical artificial intelligence (AI). Here we have summarized information about key industry trends, 240 promising AI-driven biotech startups, and 50 leading biotech investors in this sector, outlining major investment rounds and relevant R&D partnerships illustrating the industry traction and readiness of institutional investors (big pharma/biotech) to potentially acquire most successful AI-vendors.

It is also found that the ongoing COVID19 pandemics catalyzed further interest toward pharmaceutical AI technologies, and generally created favorable investment climate in the area of pharmaceutical artificial intelligence.

This Investment Digest is based on the 130 page industry report "**AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview 2020**", which is a comprehensive overview of the pharmaceutical AI sector, including 240 AI biotechs, 600 investors, 90 pharma corporations and 35 R&D centers across the globe. The report also summarizes

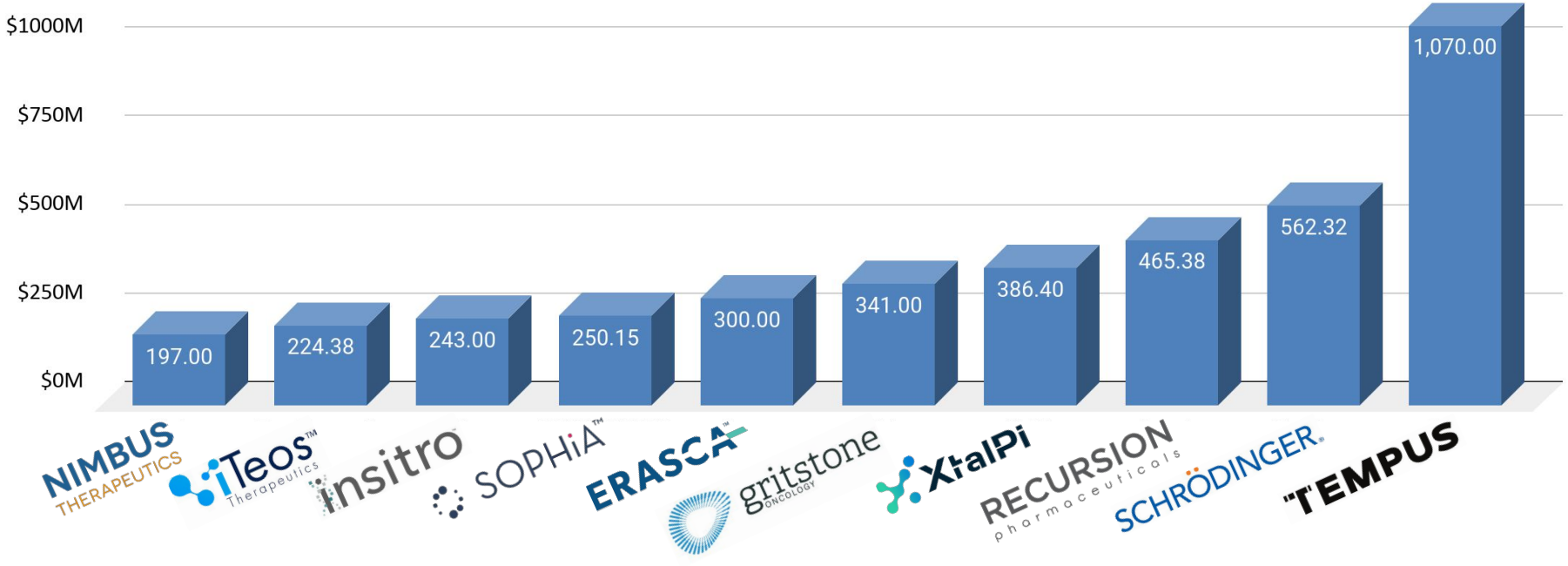
Dynamics of Investments in AI in Pharma



There has been a strong increase in the amount of capital invested in AI-driven biotechs since 2014. During the last 7 years, the annual amount of investments has increased by around 737% and $1,619M in total. In 2020, the flow of investments increased by almost 30% as compared to the previous year. The majority of the deals fall within the $1 - 64M range, with a relatively small number of “mega-deals” above the $100M mark.

Source: BioPharmaTrend

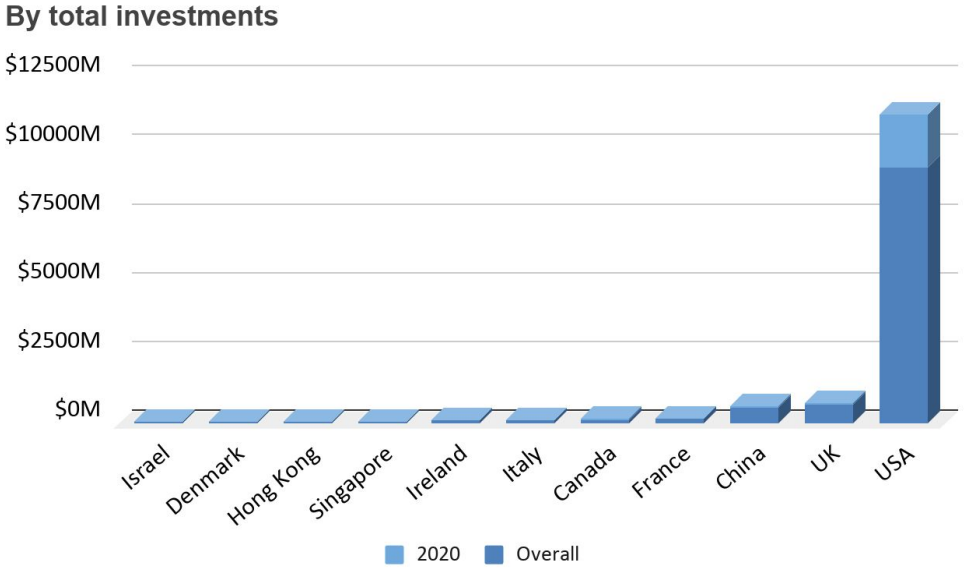
Top-10 AI Companies by Total Investments in 2020

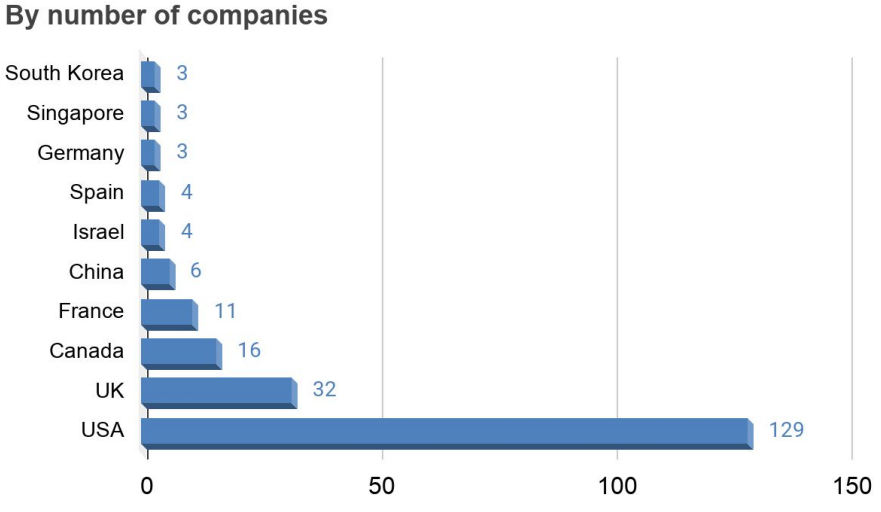


The chart shows the top 10 AI-driven drug discovery companies sorted by total funding raised by the end of 2020. Tempus, a leader in artificial intelligence and precision medicine, is now at the top of the list. With an additional $550M financing received in December 2020, the total funding raised by the company reached $1.07B. The investors included Baillie Gifford, Franklin Templeton, NEA, Novo Holdings, and funds and accounts managed by T. Rowe Price.

Source: Crunchbase

Top-10 Countries in AI for Drug Discovery Sector in 2020





The chart at the right represents the distribution of funding received by companies located in 10 countries with largest investment in AI for Drug Discovery sector by 2020. The USA is an unconditional leader with a total amount of investments of $11B overall and $1.9B in 2020. This is approximately 14 times the amount received by the companies from the UK, which is the second-most invested region with total investments of $714.43M overall and $56M raised in 2020. This tendency is repeated in the chart at the left, which shows top 10 countries by the number of companies applying AI for drug discovery.

Source: Crunchbase

Investment Landscape at a Glance (Q4 2019 — 2020)

The total amount of VC funding in AI-biotech startups increased in 2020 by around 23%, compared to 2019, approaching a total of $1.9B, which is also more than in 2015, 2016 and 2017 combined.

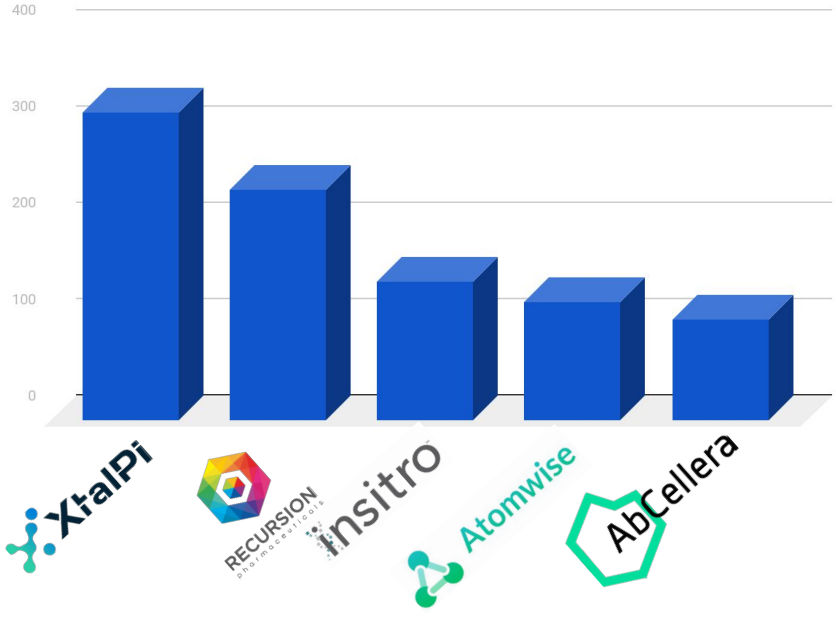
There is an increasing number of late-stage mega-rounds (e.g. B, C), including hundreds of millions. The apparent trend is sector consolidation, where a number of AI-startups have achieved substantial leadership and grown in resources and technology, while others have lagged behind and had to focus on niche service-oriented segments of drug discovery. Several AI startups also went out of business.

Some of the major deals included:

- insitro with their $143 million (Series B);
- XtalPi with $319 million (Series C);
- Atomwise with $123 million (Series B);
- Recursion Pharmaceuticals with $239 million (series D);
- AbCellera with the sum of $105 million (Series B).

An important driver of growth for the sector is a substantial shift in Big Pharma's interest in AI technology from "nice to try" to "strategically important". Such increasing market demand will drive more exits in future, and is important for heating up the investor's interest in this sector.

Top 5 Investment Deals in 2020 (in million US dollars)



AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2020

AI Companies - 240
Investors - 600
Corporations - 90

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AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2020

AI Companies - 240
Investors - 600
Corporations - 90

Asia

Canada

EU

China

AI Companies

Investors

Corporations

Pharma

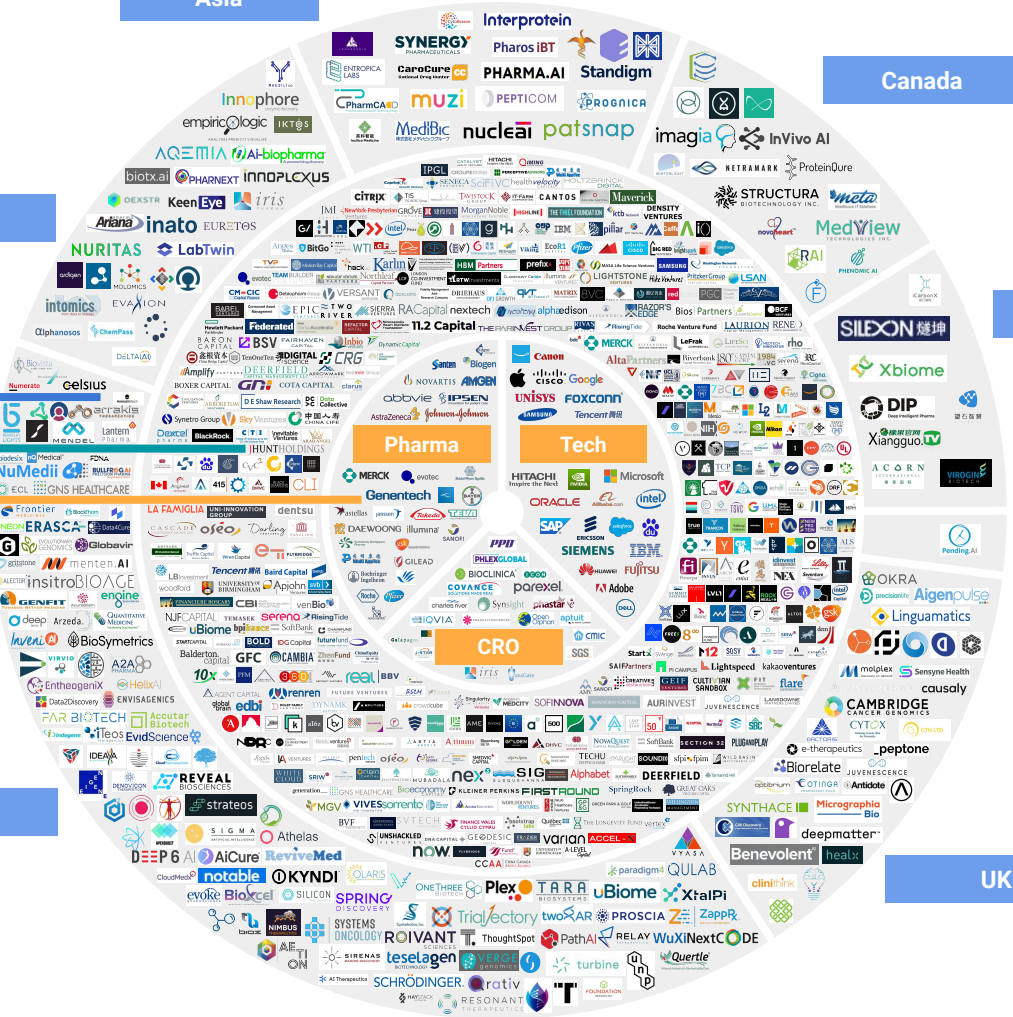
Tech

CRO

Australia

US

UK



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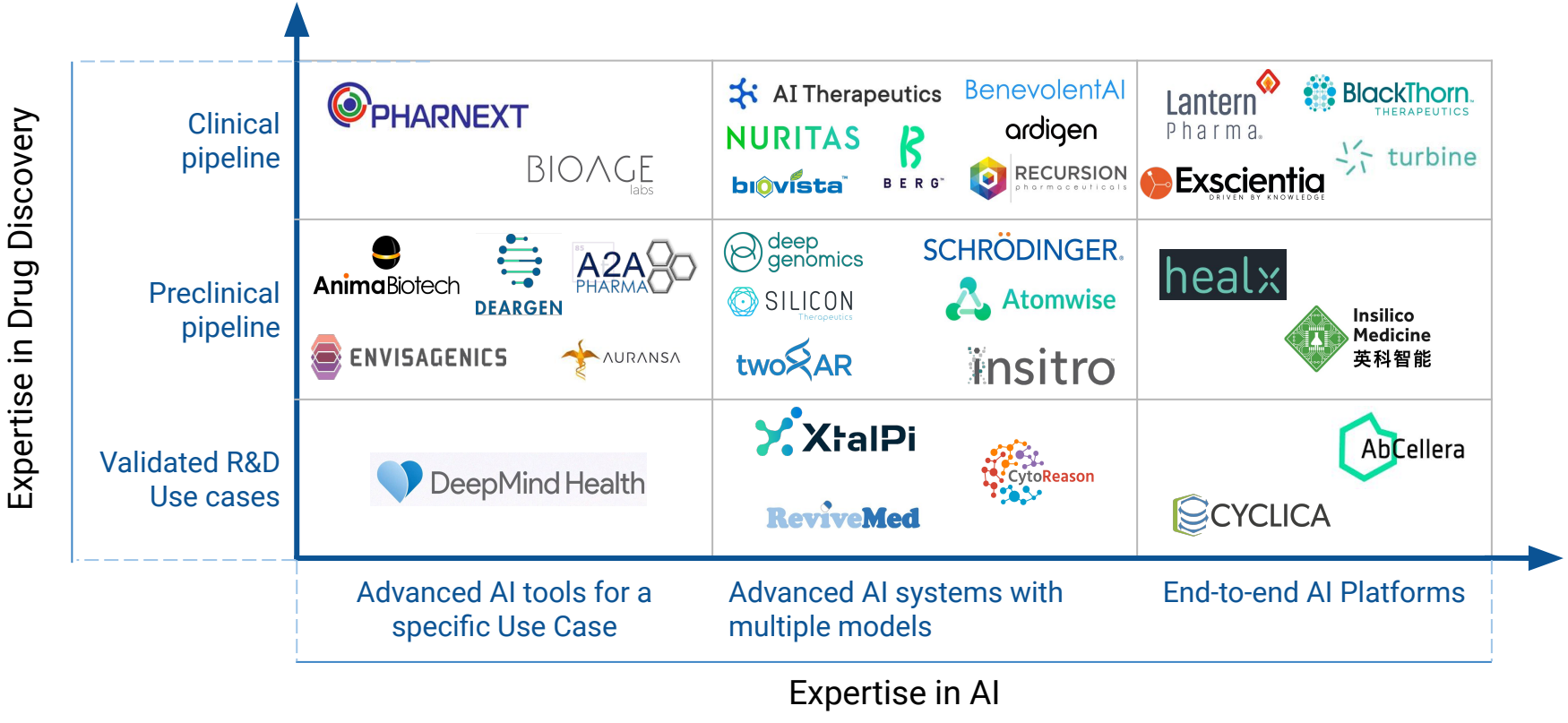
30 Leading Companies in AI for Drug Discovery Sector

1	Acellera
2	Ardigen
3	Atomwise
4	Benevolent.AI
5	Biovista
6	C4X discovery
7	Cyclica
8	CytoReason
9	Deep Genomics
10	DeepMind Health
11	e-Therapeutics
12	Exscientia
13	GNS Healthcare
14	iCarbonX
15	Insilico Medicine
16	Insitro
17	Lantern Pharma
18	Nimbus Therapeutics
19	Numerate
20	Nuritas
21	PathAI
22	Pharnext
23	Recursion Pharmaceuticals
24	Saama Technologies
25	Schrödinger
26	Turbine.AI
27	twoXAR
28	Vyasa Analytics
29	WuXi NextCODE
30	XtalPi

Comparison of Top-33 Leading AI for Drug Discovery Companies
Expertise in Drug Discovery R&D / AI



50 Leading Investors in Pharmaceutical AI

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50 Leading Investors in AI for Drug Discovery Sector

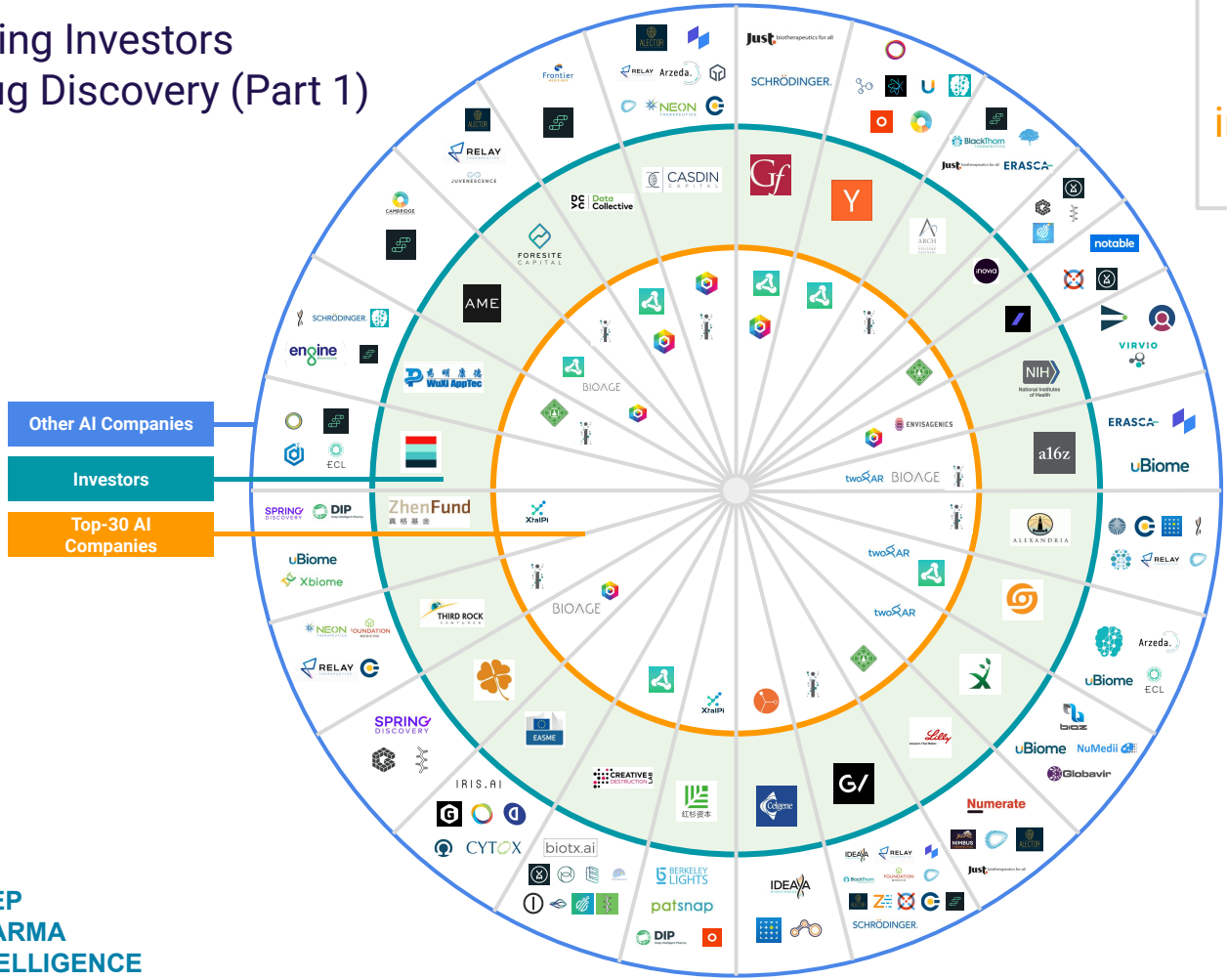
1	GV
2	Casdin Capital
3	Creative Destruction Lab
4	Y Combinator
5	Alexandria Venture
6	WuXi AppTec
7	Andreessen Horowitz
8	EASME - EU Executive Agency for SMEs
9	Lilly Asia Ventures
10	OS Fund
11	AME Cloud Ventures
12	ARCH Venture Partners
13	Felicis Ventures
14	National Institutes of Health
15	StartX (Stanford-StartX Fund)
16	Third Rock Ventures
17	ZhenFund
18	500 Startups
19	Bill & Melinda Gates Foundation
20	Celgene
21	Data Collective DCVC
22	F-Prime Capital
23	Foresite Capital
24	Founders Fund
25	Inovia Capital
26	Intel Capital
27	Khosla Ventures
28	Perceptive Advisors
29	SoftBank Vision Fund
30	UK Innovation & Science Seed Fund

50 Leading Investors in AI for Drug Discovery Sector

31	8VC
32	Alexandria Real Estate Equities
33	Vertex Ventures
34	Atlas Venture
35	Baidu Ventures
36	Baillie Gifford
37	General Catalyst
38	IA Ventures
39	Johnson & Johnson Innovation
40	Luminous Ventures
41	Mubadala Capital | Ventures US
42	Nextech Invest
43	Obvious Ventures
44	Qiming Venture Partners
45	RA Capital Management
46	Refactor Capital
47	Sequoia Capital
48	SOSV
49	Tencent Holdings
50	Two Sigma Ventures

50 Leading Investors
AI in Drug Discovery (Part 1)

Portfolios of leading biotech investors include startups from the list of Top 30



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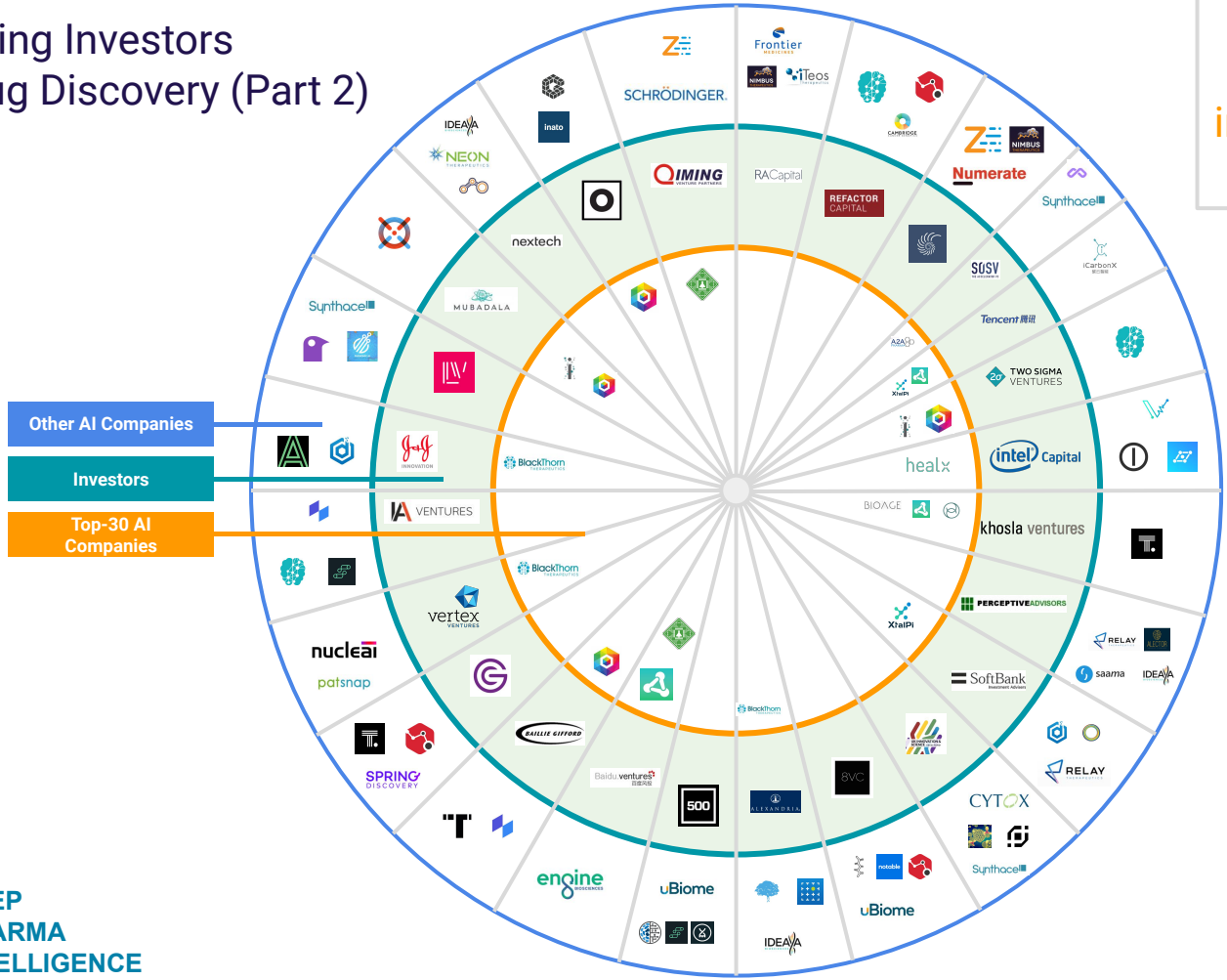
50 Leading Investors
AI in Drug Discovery (Part 2)

Portfolios of leading biotech investors include startups from the list of Top 30



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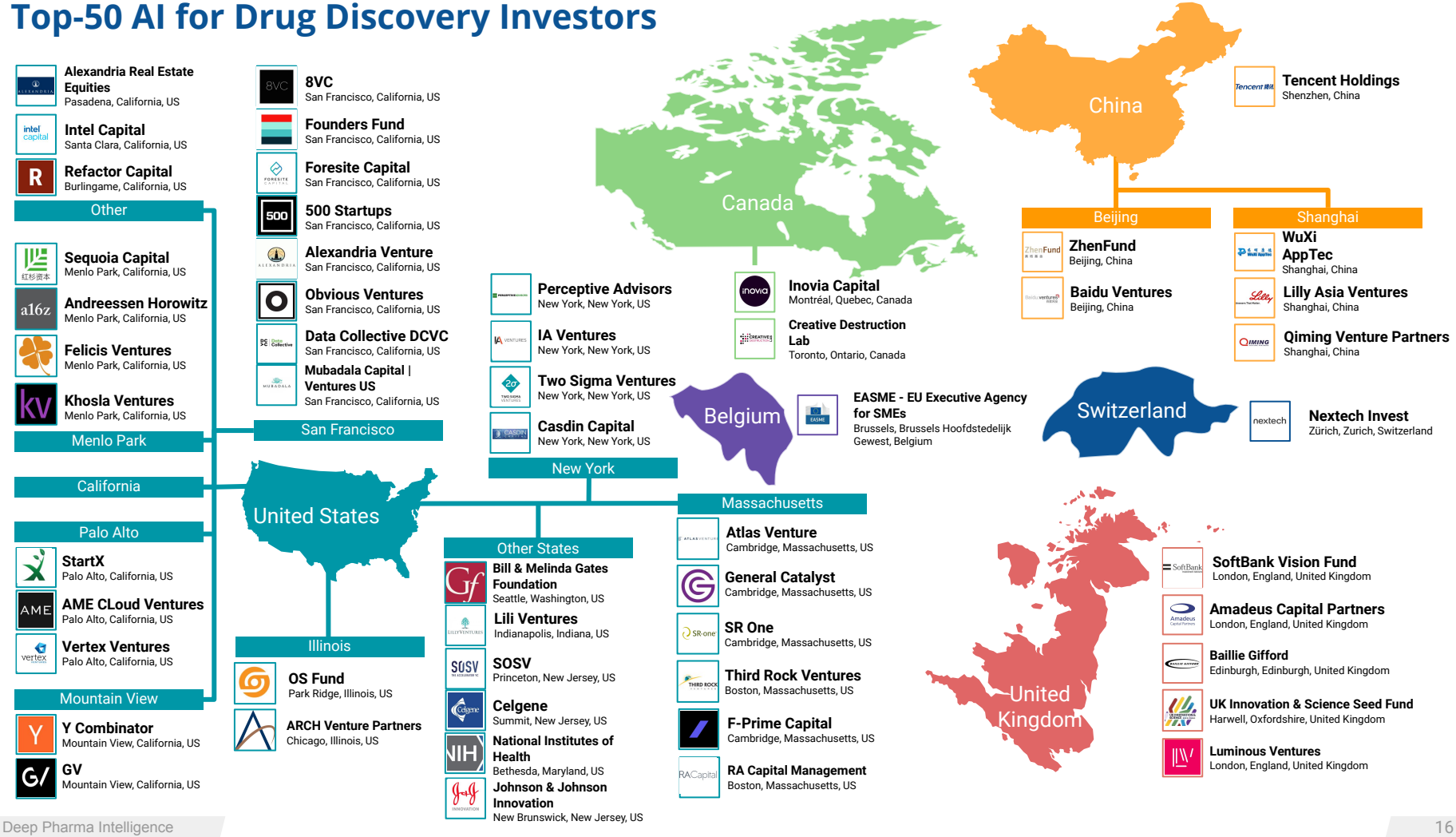
Top-50 AI for Drug Discovery Investors



Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
GV	13 AI for Drug Discovery Companies	24	Alector, BlackThorn Therapeutics, Celsius Therapeutics, Flatiron Health, Foundation Medicine, Gritstone Oncology, Ideaya Biosciences, Insitro, Relay Therapeutics, Owkin, Schrödinger, Strateos, ZappRx
Casdin Capital	10 AI for Drug Discovery Companies	11	Alector, Arzeda, Celsius Therapeutics, Flatiron Health, Foundation Medicine, Gritstone Oncology, Insitro, Neon Therapeutics, Recursion Pharmaceuticals, Relay Therapeutics
Creative Destruction Lab	10 AI for Drug Discovery Companies	10	Atomwise, BenchSci, Biotx.ai, Deep Genomics, Entropica Labs, Kyndi, NetraMark, Phenomic AI, ProteinQure, WinterLight Labs
Y Combinator	9 AI for Drug Discovery Companies	14	Athelas, Atomwise, Cambridge Cancer Genomics, CloudMedX, PostEra, Reverie Labs, Strateos, uBiome, Verge Genomics
Alexandria Venture	8 AI for Drug Discovery Companies	11	Relay Therapeutics, TARA Biosystems, BlackThorn Therapeutics, Celsius Therapeutics, GNS Healthcare, Gritstone Oncology, Ideaya Biosciences, Insitro
WuXi AppTec	7 AI for Drug Discovery Companies	8	Engine Biosciences, Insilico Medicine, Insitro, Schrödinger, Strateos, Verge Genomics, Ideaya Biosciences
Andreessen Horowitz	6 AI for Drug Discovery Companies	9	BioAge Labs, Erasca, Flatiron Health, Insitro, TwoXAR, uBiome
EASME - EU Executive Agency for SMEs	6 AI for Drug Discovery Companies	6	Accutar Biotech, Cytox, Genialis, Iris.ai, Mind the Byte, omicX
Lilly Asia Ventures	6 AI for Drug Discovery Companies	9	Alector, Gritstone Oncology, Insilico Medicine, Just Biotherapeutics, Nimbus Therapeutics, Numerate
OS Fund	6 AI for Drug Discovery Companies	9	Arzeda, Atomwise, Emerald Cloud Lab, TwoXAR, uBiome, Verge Genomics

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
AME Cloud Ventures	5 AI for Drug Discovery Companies	11	Atomwise, BioAge Labs, Cambridge Cancer Genomics, Recursion Pharmaceuticals, Strateos
ARCH Venture Partners	5 AI for Drug Discovery Companies	10	Arbor Biotechnologies, BlackThorn Therapeutics, Erasca, Insitro, Just Biotherapeutics
Felicis Ventures	5 AI for Drug Discovery Companies	10	BioAge Labs, LabGenius, ProteinQure, Recursion Pharmaceuticals, Spring Discovery
National Institutes of Health	5 AI for Drug Discovery Companies	6	Envisagenics, Recursion Pharmaceuticals, Sangamo BioSciences, SEngine Precision Medicine, Virvio
StartX (Stanford-StartX Fund)	5 AI for Drug Discovery Companies	7	Bioz, Globavir Biosciences, NuMedii, TwoXAR, uBiome
Third Rock Ventures	5 AI for Drug Discovery Companies	11	Celsius Therapeutics, Foundation Medicine, Insitro, Neon Therapeutics, Relay Therapeutics
ZhenFund	5 AI for Drug Discovery Companies	8	Deep Intelligent Pharma, Spring Discovery, uBiome, Xbiome, XtalPi
Sequoia Capital China	5 AI for Drug Discovery Companies	8	Athelas, Berkeley Lights, Deep Intelligent Pharma, PatSnap, XtalPi
Bill & Melinda Gates Foundation	4 AI for Drug Discovery Companies	5	Atomwise, Just Biotherapeutics, Recursion Pharmaceuticals, Schrödinger
Celgene	4 AI for Drug Discovery Companies	5	Arrakis Therapeutics, Exscientia, GNS Healthcare, Ideaya Biosciences

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
Data Collective DCVC	4 AI for Drug Discovery Companies	12	Atomwise, Frontier Medicines, Recursion Pharmaceuticals, Strateos
F-Prime Capital	4 AI for Drug Discovery Companies	5	BenchSci, Insilico Medicine, Notable, Owkin
Foresite Capital	4 AI for Drug Discovery Companies	10	Alector, Insitro, Juvenescence AI, Relay Therapeutics
Founders Fund	4 AI for Drug Discovery Companies	6	Datavant, Emerald Cloud Lab, Roivant Sciences, Strateos
Inovia Capital	4 AI for Drug Discovery Companies	7	BenchSci, LabGenius, Phenomic AI, ProteinQure
Intel Capital	4 AI for Drug Discovery Companies	4	Healx, Kyndi, Reveal Biosciences, VERISIM Life
Khosla Ventures	4 AI for Drug Discovery Companies	8	Atomwise, BioAge Labs, Deep Genomics, ThoughtSpot
Perceptive Advisors	4 AI for Drug Discovery Companies	4	Alector, Ideaya Biosciences, Relay Therapeutics, Saama
SoftBank Vision Fund	4 AI for Drug Discovery Companies	5	Datavant, Relay Therapeutics, Roivant Sciences, XtalPi
UK Innovation & Science Seed Fund	4 AI for Drug Discovery Companies	6	Antiverse, Cytox, Desktop Genetics, Synthace

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
8VC	4 AI for Drug Discovery Companies	6	Notable, PathAI, ProteinQure, uBiome
Alexandria Real Estate Equities	4 AI for Drug Discovery Companies	5	Arbor Biotechnologies, BlackThorn Therapeutics, GNS Healthcare, Ideaya Biosciences
500 Startups	4 AI for Drug Discovery Companies	5	Massive Bio, Strateos, uBiome, BenchSci
Baidu Ventures	3 AI for Drug Discovery Companies	4	Atomwise, Engine Biosciences, Insilico Medicine
Baillie Gifford	3 AI for Drug Discovery Companies	5	Flatiron Health, Recursion Pharmaceuticals, Tempus
General Catalyst	3 AI for Drug Discovery Companies	6	PathAI, Spring Discovery, ThoughtSpot
Vertex Ventures	3 AI for Drug Discovery Companies	6	Nucleai, PatSnap, BlackThorn Therapeutics
IA Ventures	3 AI for Drug Discovery Companies	4	Flatiron Health, Strateos, Verge Genomics
Johnson & Johnson Innovation	3 AI for Drug Discovery Companies	4	Aetion, BlackThorn Therapeutics, Datavant
Luminous Ventures	3 AI for Drug Discovery Companies	4	Phenomic AI, Sparrho, Synthace

Top-50 Investors in AI Companies

INVESTORS	AI Companies	Investments overall	
Mubadala Capital | Ventures US	3 AI for Drug Discovery Companies	5	Insitro, Owkin, Recursion Pharmaceuticals
Nextech Invest	3 AI for Drug Discovery Companies	4	Arrakis Therapeutics, Ideaya Biosciences, Neon Therapeutics
Obvious Ventures	3 AI for Drug Discovery Companies	8	Inato, LabGenius, Recursion Pharmaceuticals
Qiming Venture Partners	3 AI for Drug Discovery Companies	3	Insilico Medicine, Schrödinger, ZappRx
RA Capital Management	3 AI for Drug Discovery Companies	3	Frontier Medicines, iTeos Therapeutics, Nimbus Therapeutics
Refactor Capital	3 AI for Drug Discovery Companies	4	Cambridge Cancer Genomics, PathAI, Verge Genomics
Atlas Venture	3 AI for Drug Discovery Companies	9	Nimbus Therapeutics, Numerate, ZappRx
SOSV	3 AI for Drug Discovery Companies	10	A2A Pharmaceuticals, MendelAI, Synthace
Tencent Holdings	3 AI for Drug Discovery Companies	6	Atomwise, iCarbonX, XtalPi
Two Sigma Ventures	3 AI for Drug Discovery Companies	5	Recursion Pharmaceuticals, Verge Genomics, Antiverse

AI for Drug Discovery Market Timeline

The first AI approaches

- The first scalable AI approaches for Drug Discovery and Advanced R&D were developed and several industry players with forward-thinking executives started launching pilot collaborations and making small investments.
- However, only few market players believed in the technology.

Criticism

- Because AI is still a young approach within the life sciences, many pilot projects failed, creating a lot of criticism towards the use of deep learning for Drug Discovery and Advanced R&D.
- Since then the race for the acquisition of the best, AI startups began.
- Testing of the technology began.

Market cap growth

- Capitalization of the industry was continuously growing.
- Many bets of early investors appeared to be justified.
- Over the next several years, we can expect to see VC firms and subsidiary funds focused exclusively on the AI for Drug Discovery subsector, and funds that invest in a maximally-diverse number of AI for Drug Discovery companies.

Transition from quantity to quality

- It is going to be an important milestone in transitioning from the quantity of AI-related collaborations, investments, and M&As to qualitative gains — first practical validations of previously conducted research might be appearing during this year.
- Competition for the most successful pharma AI companies will increase drastically.

Intensive competition

- Pretty much all big players in pharma industry are concerned with AI adoption, the tech has become a strategic priority, among other things.

AI in Pharma Publicly Traded Companies

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AI in Pharma Publicly Traded Companies

Despite the crisis, publicly traded companies present rapid growth with reached **$28.7B of cumulative capitalization or 293.2% Growth**

4 companies announced closing of IPO: Relay Therapeutics, Berkeley Lights, Lantern Pharma, Schrodinger

The largest companies by market capitalization are C4X discovery. Schrodinger, Berkeley Lights. Relay Therapeutics

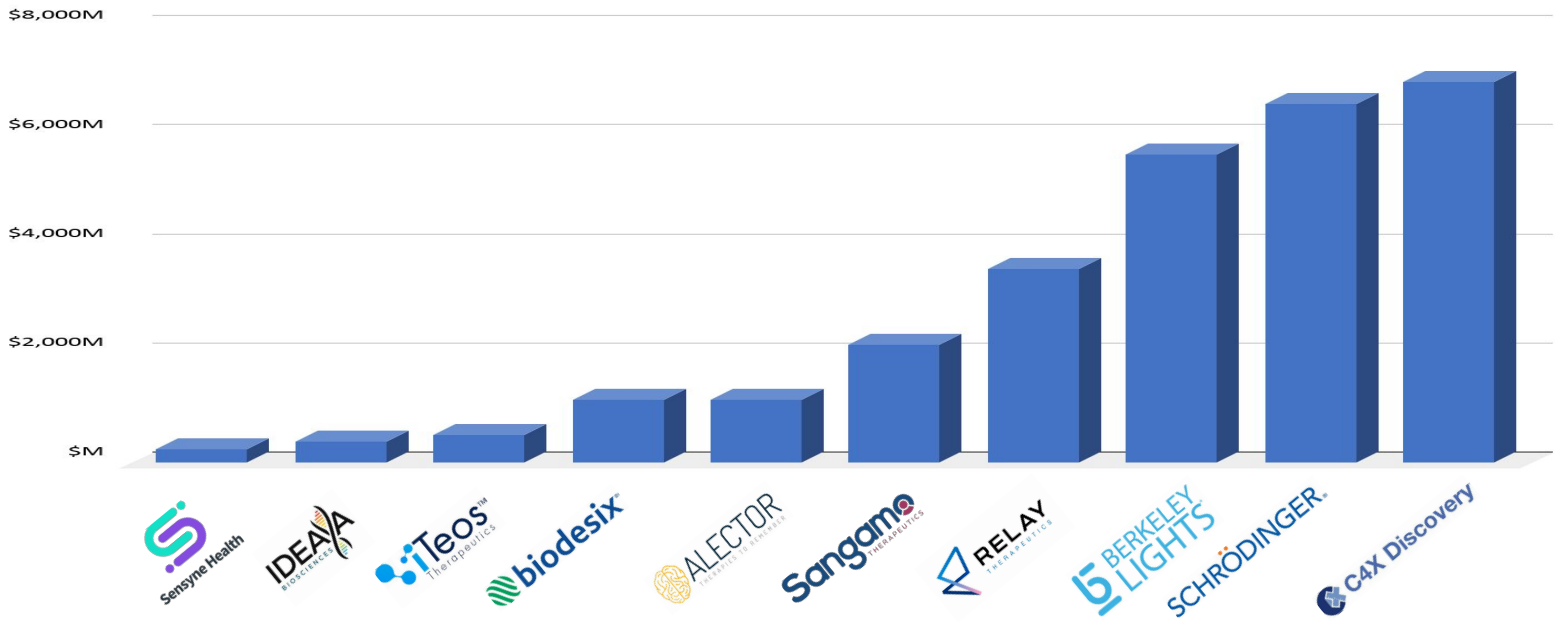
.

Novoheart Holdings has been acquired by Novomed Limited and delisted from TSX Venture Exchange.

Technologically publicly traded AI in pharma companies are similar to other companies in the sector (which reached series B or C funding rounds), which means that their market capitalization growth can be an approximation of the dynamics of the whole sector.

Source: Yahoo Finance

Top-10 Public AI Companies by Market Capitalization in 2020



The chart presents the top 10 AI-driven drug discovery public companies sorted by Market Capitalization by the end of 2020. C4X discovery, specialized in molecular drug discovery and located in the UK, is a leader of the list. With the rapid growth in the second half of 2020, the company increased its capitalization by 121%. Most of the companies had positive stock dynamics and the biggest growth was performed by eTherapeutics, Schrodinger, and the previously mentioned C4X discovery..

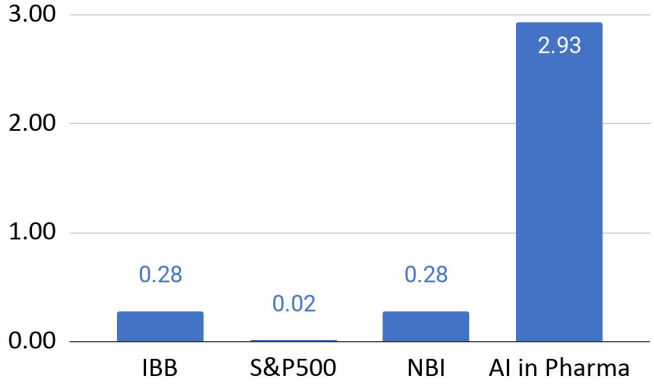
Source: Yahoo Finance

AI in Pharma Market Capitalization

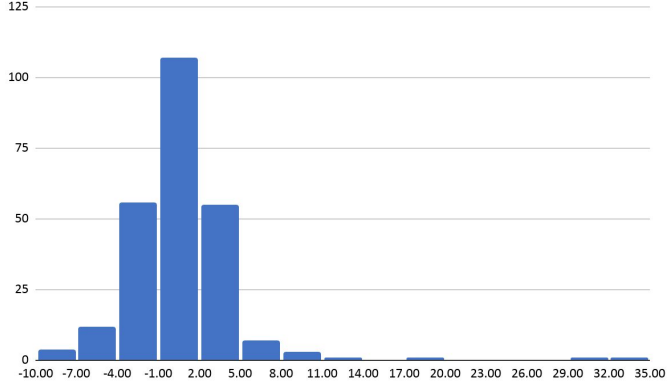
AI in pharma corporations market capitalization growth strongly outperforms the market as a whole (represented as S&P500 index), as well as general biotech industry indices (IBB and NBI), although AI in pharma stock market segment is more volatile compared to them (as measured by standard deviation).
Interestingly, distribution of the returns of the AI in pharma stock market segment is right-skewed, what differentiates it from the vast majority of stock indices and segments. It means that rare extraordinary positive events play a large role in the dynamics of the market capitalization of the segment, which can be described as the presence of “anti-black swans”. Many other indices are, contrary, characterized by negative skewness, what means that extraordinary negative events are more likely.
Distribution of AI in pharma stock returns is definitely not normal (curstosis exceeds 4.7).

Index	Correlation with AI in Pharma market	Average daily return in 2020	Average daily volatility in 2020	Skewness	Curtosis
AI in Pharma	-	0.55	4.01	2.64	17.22
IBB	0.83	0.12	2.13	-0.15	3.11
S&P500	0.72	0.03	2.31	-0.97	8.56
NBI	0.84	0.12	2.16	-0.19	3.40

Market capitalization growth



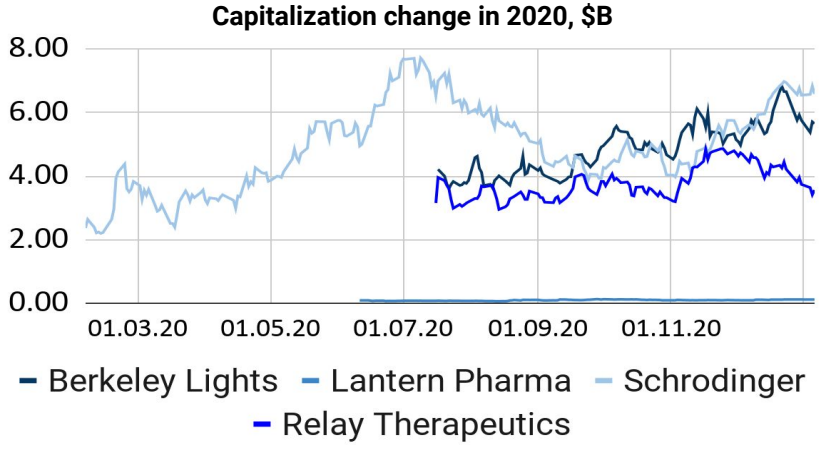
AI in pharma stock returns histogram



AI in Pharma IPOs in 2020

Despite the crisis, all new public companies announced successful closing of the IPO. They show volatile but steady growth, although net income of all corporations remains negative. All IPOs took place in the USA in summer. All companies have beta smaller than 1 (although positive) which means that AI in pharma stock prices move in accordance with general market movements, yet the degree of these movements is lower (although volatility as measured by standard deviation can be relatively high).

Major negative market events in 2020 did not affect significantly AI in pharma sector.



Name	Country	Funding Amount. M$	Investments in 2020 (M$)	IPO Date	Capitalization (M$)	ROA	ROE	Profit margin	Operating margin	EV/EBITDA	Net income
Lantern Pharma	USA	8.7	-	15.06.20	114.1	N/A	N/A	0.0	0.0	-25.4	-111.6
Schrödinger	USA	562.3	346.5	05.02.20	5830	-0.0781	-0.0604	-0.1992	-0.5172	-107.91	-20.093
Berkeley Lights	USA	208.4	50.9	21.07.20	5746	N/A	N/A	-55.63	-53.81	-225.63	-32.92
Relay Therapeutics	USA	520.0	40.0	16.07.20	3660	N/A	N/A	0	0	-26.25	-111.601

Source: Yahoo Finance, Crunchbase

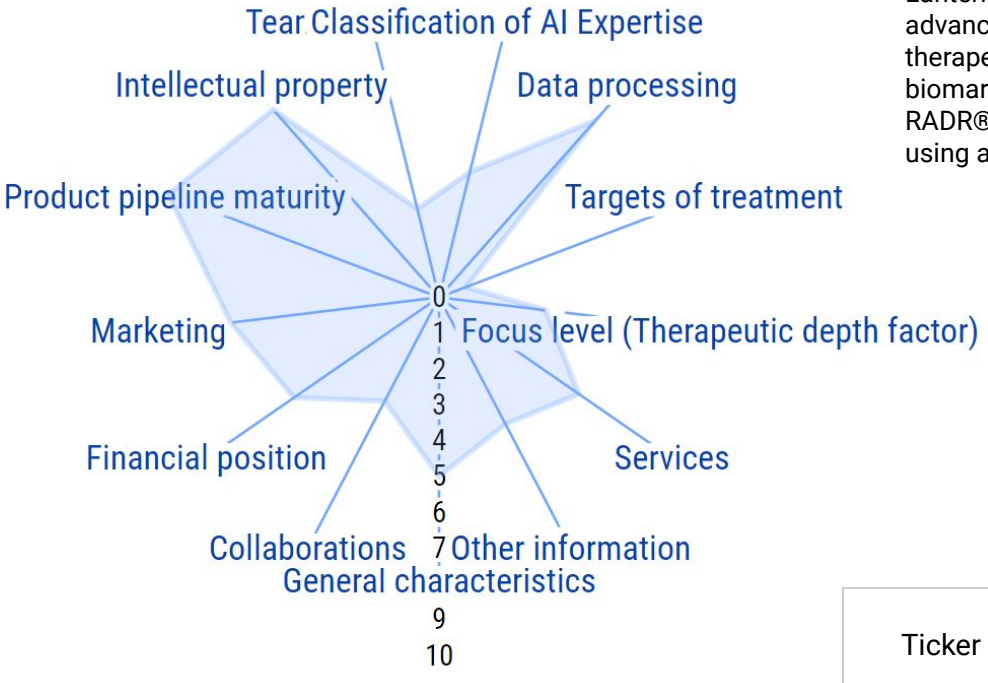
Schrödinger

Schrödinger's industry-leading computational platform facilitates the research efforts of biopharmaceutical and industrial companies, academic institutions, and government laboratories worldwide. Schrödinger also has wholly-owned and collaborative drug discovery programs in a broad range of therapeutic areas.

Ticker	Mean daily return	Volatility of daily returns	Growth after IPO	Capitalization (B$)
SDGR	0.45%	4.19%	178.18%	6.58

Source: Yahoo Finance, Crunchbase

Lantern Pharma

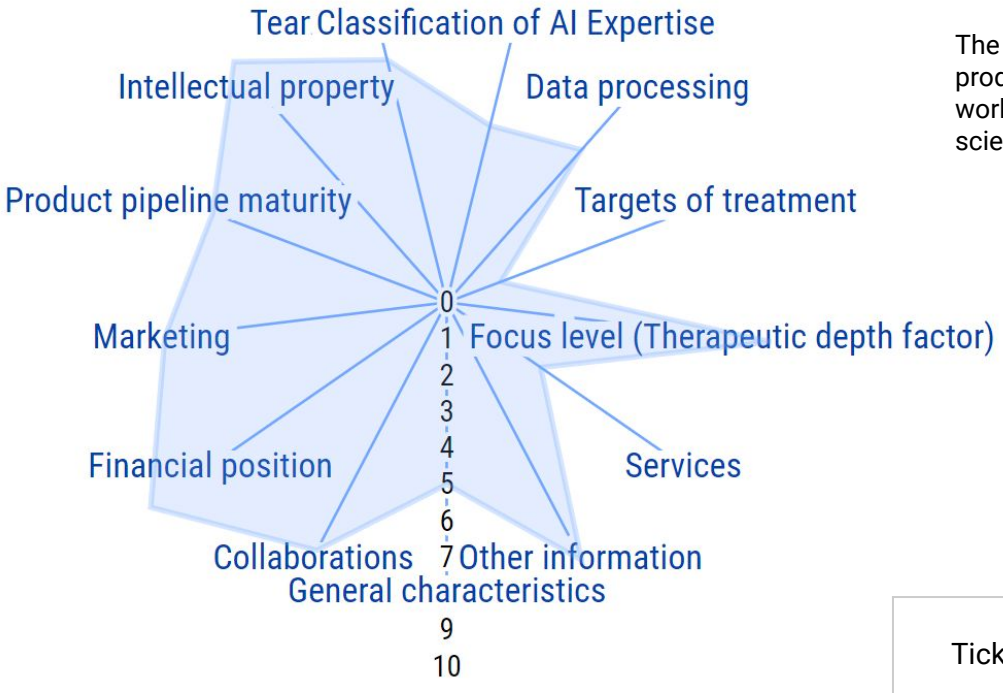


Lantern Pharma is a life science company leading the charge in advancing and accelerating the development of precision oncology therapeutics using A.I., genomics and machine learning to analyze biomarker signatures to develop personalized drug therapies.
RADR® Precision Medicine platform analyzes genetic biomarker data using advanced machine learning algorithms to stratify trial patients.

Ticker	Mean daily return	Volatility of daily returns	Growth after IPO	Capitalization (B$)
LTRN	0.17%	5.71%	27.09%	0.12

Source: Yahoo Finance, Crunchbase

Berkeley Lights

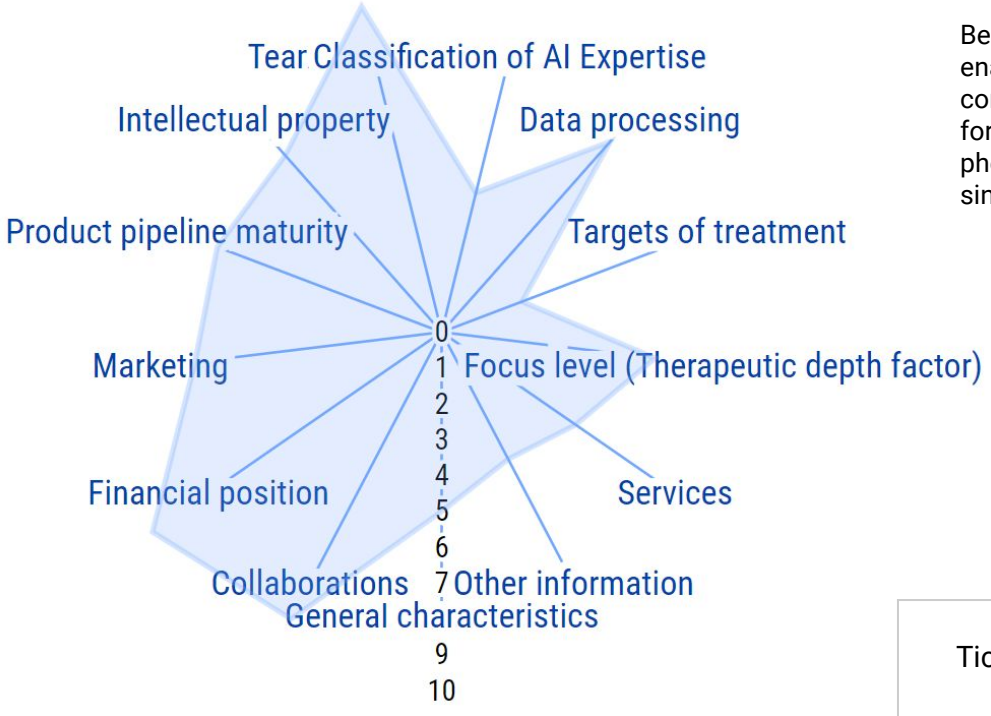


The Berkeley Lights Platform accelerates the use of cell-based products. Their proprietary technology – automation, optimized workflows, software, consumables, assay reagents – enables scientists to find the best cells, the first time they look.

Ticker	Mean daily return	Volatility of daily returns	Growth after IPO	Capitalization (B$)
BLI	0.25%	4.83%	34.15%	5.65

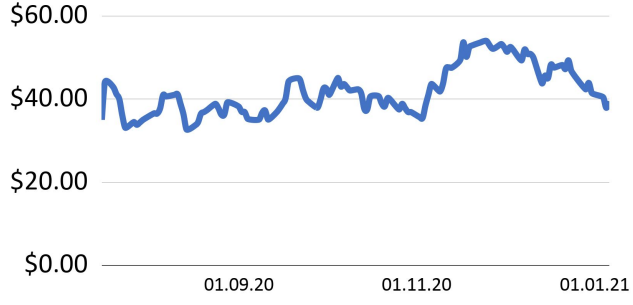
Source: Yahoo Finance, Crunchbase

Relay Therapeutics



Berkeley Lights is a leading Digital Cell Biology company focused on enabling and accelerating the rapid development and commercialization of biotherapeutics and other cell-based products for the customers. The Berkeley Lights Platform captures deep phenotypic, functional and genotypic information for thousands of single cells in parallel.

Stock price



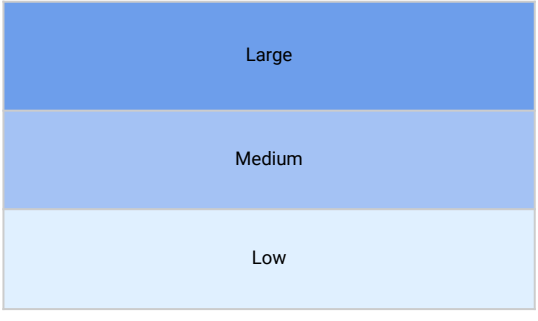
Ticker	Mean daily return	Volatility of daily returns	Growth after IPO	Capitalization (B$)
RLAY	0.10%	4.53%	12.90%	3.56

Source: Yahoo Finance, Crunchbase

AI in Pharma Corporations Financials

Company	Capitalization (M$)	Mean daily return	Volatility of daily returns	IBB Beta	S&P500 Beta	Total funding amount (M$)	Operating margin	EV/EBITDA	Net income (M$)
Acorn International	1071.10	0.06%	4.11%	0.55	0.34	99.80	1.58%	4.11	7.79
Alector	1165.66	-0.04%	5.10%	0.77	0.60	194.50	-780.36%	-4.8	-168.58
Berkeley Lights	5651.56	0.25%	4.79%	0.69	0.17	208.50	-53.81%	-225.63	-32.92
Biodesix	514.11	0.90%	7.73%	0.03	-0.27	188.80	-81.88%	-25.84	-33.34
C4X discovery	3695.29	0.46%	34.51%	0.92	0.47	6.81	0.00%	-6.53	N/A
Cotinga Pharmaceuticals	5.95	0.69%	5.31%	-0.04	-0.03	4.20	N/A	-0.44	N/A
DeepMatter Group	2388.65	-0.01%	5.75%	0.10	0.09	N/A	-180.69%	-8.02	-2.53
eTherapeutics	9748.65	0.68%	3.87%	1.10	0.97	66.80	-1335.74%	-18.31	-3.41
Evolutionary Genomics	9.22	-0.09%	4.94%	0.29	0.06	1.50	-6428.32%	-9.59	-255.41
GenFit	199.74	-0.56%	2.90%	0.22	0.19	95.70	0.00%	-2.71	-65.14

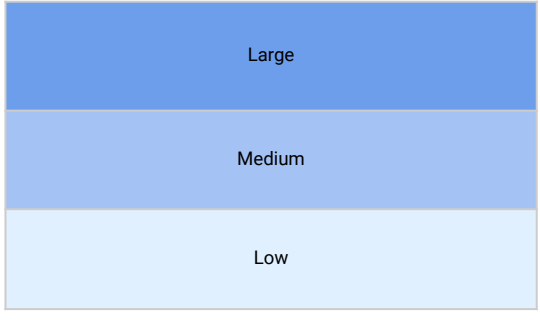
Market capitalization of some AI in pharma corporations (such as C4X discovery) reaches 6 billion USD, whereas other companies are priced in the range of dozens of millions of dollars - the difference in the valuation is immense. There is no strong correlation between operating margin or net income and market capitalization - the valuation of the corporations still being unprofitable can exceed billion of dollars.
Some corporations, such as Acorn International, have managed to achieve positive operating margin, yet such cases are mostly exceptions.



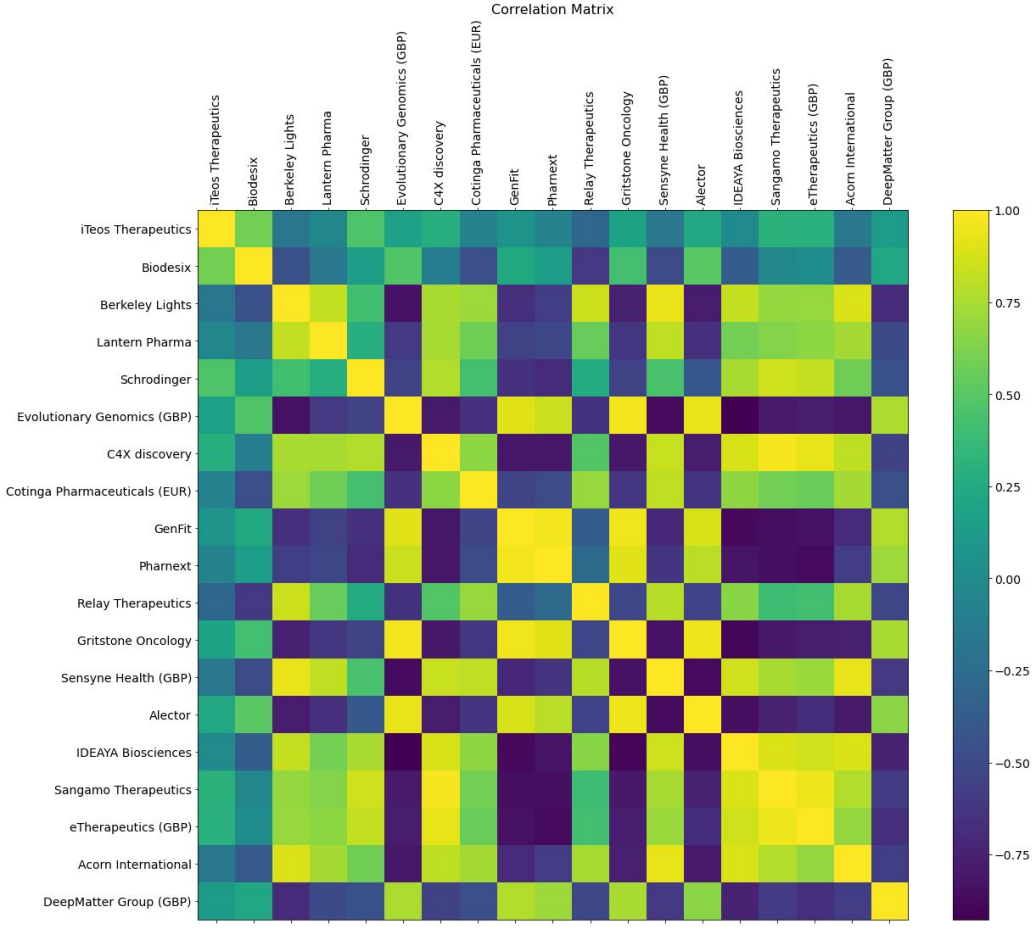
AI in Pharma Corporations Financials

Company	Capitalization (M$)	Mean daily return	Volatility of daily returns	IBB Beta	S&P500 Beta	Total funding amount (M$)	Operating margin	EV/EBITDA	Net income (M$)
Gritstone Oncology	209.45	-0.17%	5.78%	0.79	0.75	341.00	-3000.64%	-2.05	-94.43
IDEAYA Biosciences	396.80	0.20%	4.73%	0.00	0.07	140.00	-461.50%	-3.37	-40.14
iTeos Therapeutics	1159.63	0.49%	4.76%	0.49	1.21	224.40	0.00%	-27.67	-23.30
Lantern Pharma	118.13	0.17%	5.76%	0.59	0.30	8.70	0.00%	-25.35	-2.45
Pharnext	66.06	-0.20%	5.09%	1.92	1.89	45.70	-624.01%	-3.63	-23.31
Relay Therapeutics	3560.70	0.10%	6.43%	0.95	1.55	520.00	0.00%	-26.25	-111.60
Sangamo Therapeutics	2175.37	0.26%	3.60%	0.78	0.42	93.20	-57.49%	-24.92	-101.59
Schrodinger	6584.83	0.45%	4.43%	0.34	0.04	562.30	-51.72%	-107.91	-20.09
Sensyne Health (GBP)	23824.79	0.25%	6.79%	0.57	0.19	37.48	-1026.29%	-6.63	-21.84

AI in pharma corporations tend to be more volatile than average publicly traded company, although it is compensated by higher returns. For most of the corporations, daily returns are positive and abnormal compared to the market. More volatile stocks are usually characterized by higher betas (both calculated for IBB index and for S&P500). Moreover, higher volatility tends to imply smaller current financial indicators. AI in pharma segment is definitely a segment of growth stocks with the investors focused on the prospects of the companies rather than on the dividends.



Correlation Analysis of AI in Pharma Stocks



Unsurprisingly, most of the AI in pharma stocks are positively correlated. However, there are several companies which tend to move in the opposite direction relative to the market, namely: GenFit, Pharnext, Evolutionary Genomics, and Alector.

A typical correlation coefficient of 2 AI in pharma stocks lies in the range of 0.5-0.75, although it can achieve the value of -0.8. Correlated stocks tend to be the stocks of similar companies in terms of the product and the technology.

The most volatile AI in pharma stocks tend to be C4X discovery, Berkeley Lights, Schrodinger, GenFit, Relay Therapeutics, Sensyne Health (GBP), most of each are the companies which made IPO recently. High volatility is predominantly compensated by abnormal returns.

Although almost all corporations are still characterized by negative profit margins, stock dynamics demonstrates that investors believe in their prospects.

The stocks are correlated to some extent with biotech indices (corresponding betas are in the range 0.2-0.6), whereas the correlation with total market is predominantly low.

Big Pharma’s Focus on AI

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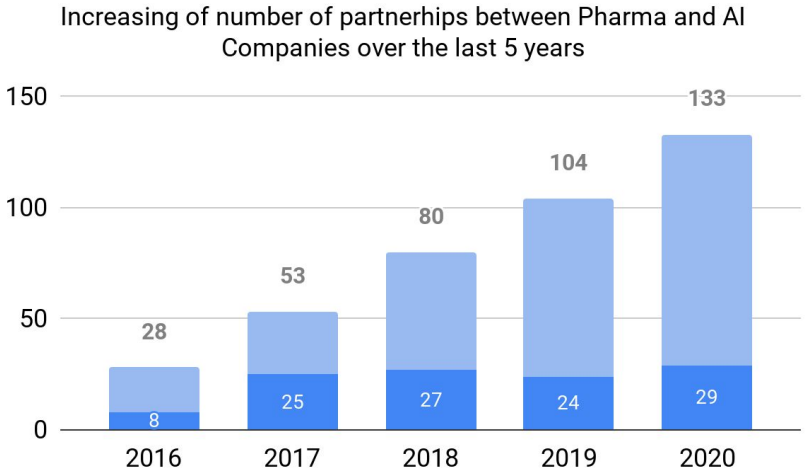
A Growing Number of Collaborations Involving AI for Drug Discovery

Summarizing industry observations over the last five years, we can observe a fundamental shift in perception of top executives at leading pharmaceutical organizations about the need of advanced AI technologies. Since 2015, there has been an obvious shift in the perception from skepticism and cuasious interest, all the way to a realization of a strategic role AI has to play in the emerging “data-centric” model of innovation. This change in perception was underpinned by a number of factors:

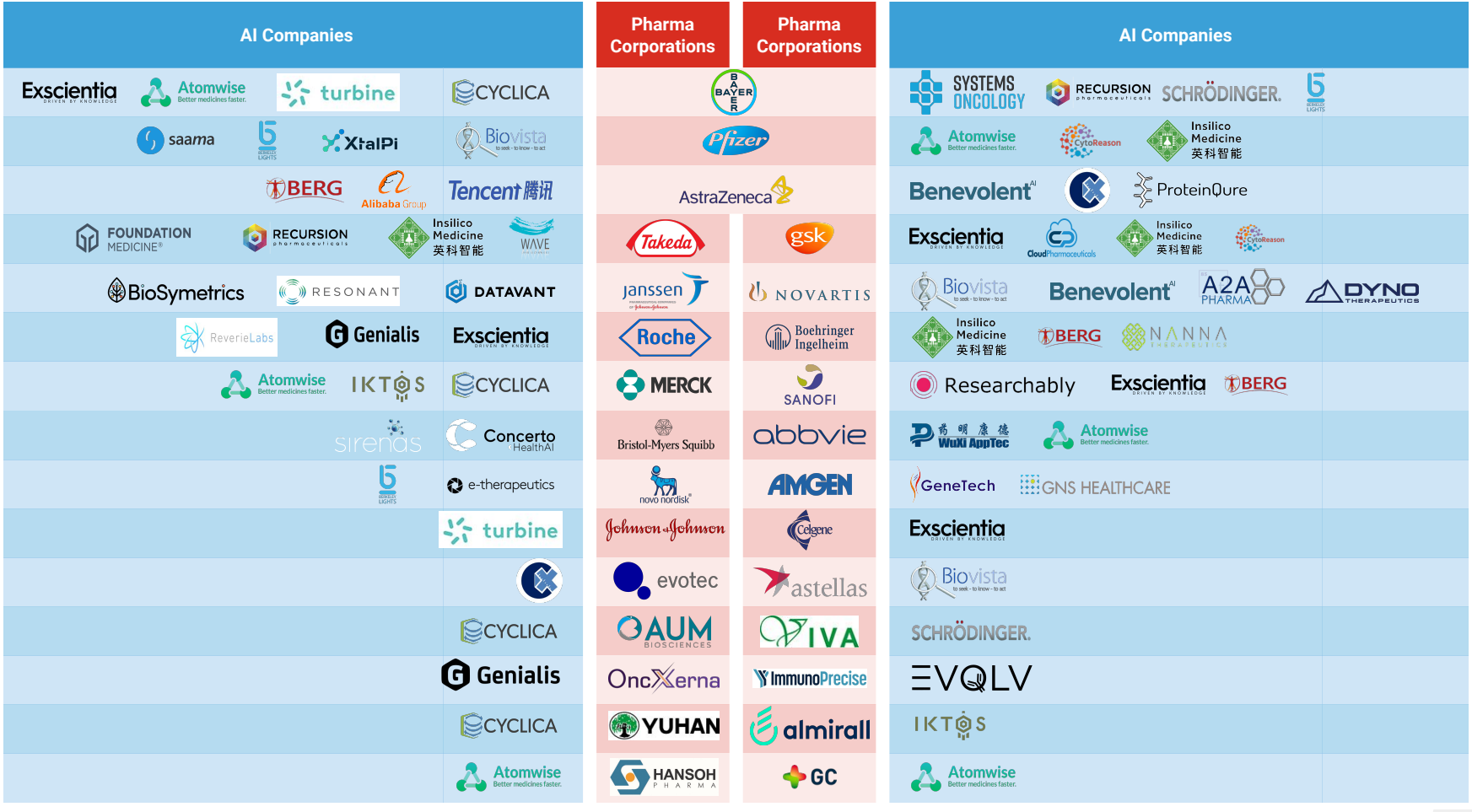
- a wave of proof-of-concept studies and research breakthroughs in a wide range of AI application use cases;
- A number of commercial successes and successfully reached milestones, involving AI as a central element of research
- Substantial advances in democratizing AI technology, where machine learning and deep learning algorithms become available at scale to non-AI experts.
- Substantial increase in the overall understanding of AI “mechanics”, due to increasing efforts in the education and professional development with a focus on AI-driven tools and approaches.

Pharmaceutical companies of all sizes start competing for AI-expertise, talent, and partnerships. In this report we summarize some of the most high-profile such collaborations, involving top-20 pharma giants. Even though, we can see a clear uprising trend in the number of collaborations, focused on AI-drug design, and other aspects of data mining and analytics.

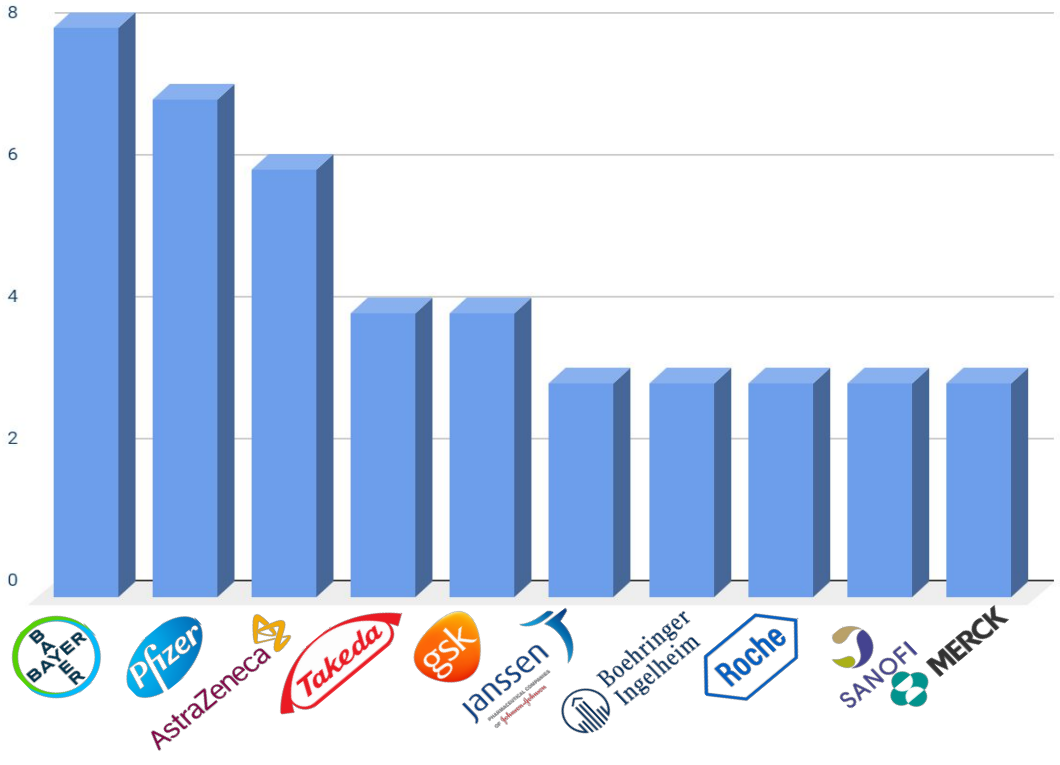


The rising interest of leading pharma and contract research organizations towards AI-driven biotech startups is a major driver for the area to become more attractive for investors, since the industry is becoming well-suited for successful exit strategies in future.

Pharma AI Deals Structure 2020



Top-10 Leading Corporations by The Number of Major Pharma AI Deals



The leading players by the amount of major industry partnerships are **Bayer, Pfizer and AstraZeneca.**

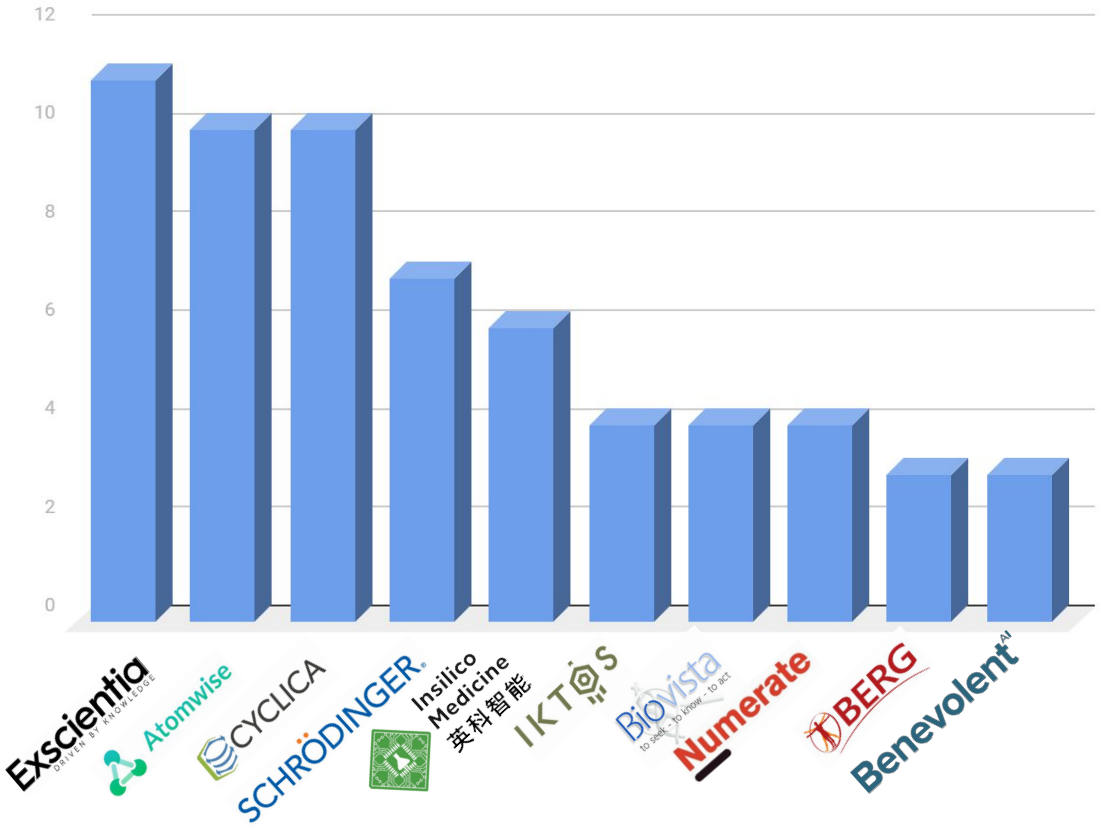
Implications

These companies demonstrate increasing commitment to probing the grounds in the AI space — by investing into internal programs, as well as partnering with external AI vendors to pilot programs in drug discovery and other research areas.

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

The leading big pharma brands are increasingly open to partnerships with AI startups and biotechs to get competitive edge, and mitigate **the problem of declining R&D efficiency**.

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



Implications

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

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

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

Key Takeaways

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Major Observations for 2020: **Key Business Takeaways**

1. **The segment of pharmaceutical AI continues consolidation** with the increasing number of later stage mega-rounds, including those of Insitro ($143M), Recursion Pharmaceuticals ($239M), XtalPi ($319M) and others. The AI startups pack is clearly differentiating into the leaders, who developed substantial resources, financial leverage, and technological advantage, and others lagging behind -- companies with less resources or less mature technology and scientific assets. The latter are usually focused on narrow therapeutic or technological niches, and are following service-oriented business models.

2. **Pharmaceutical AI sector is "heating up"**, and becomes a lucrative area for specialized biotech investors as well as investor organizations just entering the pharma space with a goal of including high-risk/high-return companies in their investment portfolios. This is backed by several observations, including an overall increasing investment activity in this sector in 2020, the increasing rush among leading pharma and contract research organizations (CROs) to compete for partnerships with AI-driven companies, and the increasing amount of proof-of-concept breakthroughs, confirming that AI technology has achieved substantial maturity to be able to bring tangible value for drug discovery -- far beyond a simple optimization gain.

3. **Big pharma and contract research organizations increasingly compete for AI partnerships**, and continue building in-house AI workflows -- driven by rapidly emerging evidence of the AI tech feasibility and innovation potential. A number of highly notable proof-of-concept results has been announced in 2019-2020.

4. **COVID-19 pandemics appears to be a positive catalyst for the acceleration of the AI adoption** by the pharmaceutical organizations. This is primarily stipulated by the necessity to rapidly process vast amounts of data, and come up with innovations under strict deadlines. Therefore, this urgency pushed companies and investors into more opportunistic projects than ever before.

Major Observations for 2020: **Key Financial and Investment Takeaways**

1. Due to global COVID19 pandemics, **the overall biotech and drug discovery sectors are on the rise**. During 2020 we have observed multiple medium and large funding rounds for biotech and drug design companies, especially those focused on antiviral therapies and vaccines.

2. A number of successful **AI-driven companies closed large-sum late-stage venture capital rounds (B, C, and D)** over 2019-2020 and several of them are now developing clinical stage drug candidates. We expect some of them go public to 2021-2022.

3. 2020 was marked by a notable IPO in the AI-driven drug design space -- New York-based **Schrödinger closed its initial public offering in February, raising a total of $232.3 million** in proceeds – more than originally planned.

4. The year 2020 is marked by **a general "biotech IPO boom"** (non-AI sectors), catalyzed in part by the coronavirus pandemics -- directly and indirectly.

5. When some of the companies complete IPOs in the nearest future, **it will attract significant number of non-biotech investors to enter the Life Sciences sector.**

6. The growing industry traction, reflected in the increasing number of R&D partnerships between big pharma and CROs with AI-startups, is a sign that **the market is maturing for rapid increase in the M&A activity** in the nearest future.

7. Despite the crisis, publicly traded companies present rapid growth with reached **$62.8B of cumulative capitalization or 266.6% growth rate.**

Key Technology Takeaways

1. AI is regarded by some top executives at big pharma (GSK and others) as **a tool to uncover not only new molecules, but also new targets**. Ability of deep neural networks to build ontologies from multimodal data (e.g. "omics" data) is believed to be among the most disruptive areas for AI in drug discovery, alongside with data mining from unstructured data, like text (using natural language processing, NLP).

2. There is **a considerable trend for "AI democratization"** where various machine learning/deep learning technologies become available in pre-trained, pre-configured "of-the-shelf" formats, or in relatively ready-to-use formats -- via cloud-based models, frameworks, and drag-and-drop AI-pipeline building platforms (for example, KNIME). This is among key factors in the acceleration of AI adoption by the pharmaceutical organizations -- where a non-AI experts can potentially use fairly advanced data analytics tools for their research.

3. **Proof-of-concept projects keep yielding successful results** -- in research studies, and in the commercial partnerships alike. For example, companies like Recursion Pharmaceuticals and Exscientia achieved important research milestones using their AI-based drug design platforms.

Obstacles That Still Remain

1. **Global shortage of AI talent** continues to be a serious challenge for the biopharma industry, repeating the trend from our previous reports. While big pharmaceutical companies invest substantial capital in recruitment of AI specialists, still the majority of them are acquired by large tech corporations (Google, Amazon, Alibaba, Tencent, Baidu etc.) However, a growing wave of specialized university programs and courses, geared towards data science and AI application, is projected to address this issue to certain extent in the coming years.

2. **Lack of available quality data is still a challenge for the unleashing full potential of deep learning technologies.** Numerous variations of deep learning (DL) are believed to be the most lucrative area of AI for applications such as drug discovery and clinical research. The key challenge is that DL algorithms are "data-greedy", while big data in biotech is not always well-versed for modeling, or is inaccessible due to privacy reasons.

3. **Ethical, legal, and regulatory issues for AI adoption in the pharmaceutical sciences.** This set of challenges is related to the previous point, but also includes other questions -- AI explainability, patentability of AI-generated results, non-optimal regulations in various countries, slowing down the progress and adoption of AI technologies in general, and in the pharmaceutical industry in particular.

AI in the Global Context

US is a main player in AI industry. In the beginning of AI implementation, US was a pioneer and then the main player with the greatest number of companies using AI to force R&D, research centres and institutes, and investments. However, we observe the increased level of the UK and EU activity through big corporations that use AI to reorganise drug discovery and in launching government initiatives. It is also important to note a great increase in activity from the Asia-Pacific region generally, and particular from China — AI superpower.

China engages in extensive investment activity. In particular, it has promised to invest $5 billion in AI. Tianjin, one of the biggest municipalities, is going to invest $16 billion in its local AI industry, and the Beijing authorities will build $2.12 billion AI development project. China also has at least ten privately owned AI startups valued at more than US$1 billion. Moreover, China has been heavily investing in biotech R&D, although lately a serious decrease in Chinese investment in US biotech startups has been observed which can be explained by the trade conflicts between the US and China.

China plans to become the world AI leader by 2030, according to the AI Strategic Plan released in July 2017. The analysis of the the Asia-Pacific region has shown that the main forcers of AI implementation include Saama Technologies, Inc., a leading clinical data analytics company. It has announced a collaboration with researchers at the Tufts Center for the Study of Drug Development to ascertain how biopharmaceutical companies optimize automation and information technologies, including machine learning and neural networks, to support the research and development of new therapeutics. Moreover, XtalPi provides a huge number of talent to work with machine learning, create drug discovery and development applications that predict the properties of small molecules. Another innovators of Asian AI industry are Cytlimic and Fujitsu that offer software for predicting how well compounds will bind with each other and proteins.

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

About Deep Pharma Intelligence

Deep Pharma Intelligence is producing regular analytical reports on major areas of high-potential in the pharmaceutical and healthcare industries, maintaining ratings of companies and governments based on their innovation potential and business activity in the BioTech space, and providing strategic consulting and investment intelligence services to top-tier clients, including major investment funds and banks, family offices, insurance companies, government organizations, and big pharma companies among others. The company is a joint venture between the two highly specialized UK-based market intelligence hubs in Pharma / BioTech space:

Pharma Division of Deep Knowledge Analytics (PD-DKA), a specialized subsidiary of Deep Knowledge Analytics (DKA), the leading analytical entity specifically focused on deep intelligence of the high-potential areas in the pharma industry, including artificial intelligence (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 the drug discovery sector. PD-DKA's insights are frequently covered by top media such as Forbes and the Financial Times, and are acknowledged by top pharma executives.

Recently, MIT named this division a top technology think-tank, acknowledging the AI ranking framework it developed.

BPT Analytics (BiopharmaTrend) - a rapidly growing analytical portal and media resource, dedicated to tracking emerging companies (startups/scaleups), innovations, investments, and trends in the pharma and biotech space.

BiopharmaTrend's reports and articles were referenced by Deloitte, Forbes, and other high profile media and consulting companies.

BiopharmaTrend is a media partner to a number of top-tier conferences and symposia in preclinical and clinical research, and healthcare research.

Overview of Proprietary Analytics by Pharma Division of **Deep Pharma Analytics**

Deep Pharma Intelligence (DPI) is a strategic partner to the leading Life Science organizations, investment institutions (VC funds, investment banks), and governments across the globe -- in matters related to investments, strategic positioning, and policy development in the areas of pharmaceutical and biotech research, and healthcare tech.

While Deep Pharma Intelligence is regularly producing open industry reports covering high-growth sectors in the Life Sciences, including artificial intelligence (AI), digital health, and new therapies, some of the more in-depth research is only available to our clients and strategic partners under the “Proprietary Analytics” category.

Our range of proprietary services includes custom consulting projects, based on the specific customer needs, as well as a collection of pre-produced “ready-to-use” proprietary reports, produced by our research team, covering general trends and specific action ideas and strategy insights related to the most promising investment prospects (e.g. new technologies, biotech startups), M&A prospects (e.g. pipeline development targets), and strategic growth ideas (trends profiling, industry overviews etc).

Services:

- Investment landscape profiling, identifying investment ideas in the biotech/healthcare tech space.
- Preliminary due-diligence (business, science and technology, intellectual property (IP) profiling, freedom of operation assessment, legal assessment etc).
- Comprehensive due-diligence (deep business, science and technology assessment, IP and legal assessment, growth potential assessment etc).
- Infringement analysis of technology (i.e. If you plan to partner or invest in a data-analytics biotechs, or AI-development vendors, it is essential to understand their technological assets, both in terms of innovation potential and in terms of legal protection and non-infringement risk management).
- SWOT analysis of companies and technological sectors, competitive profiling.
- Industry profiling and growth strategy development for top-tier companies and governments.

Overview of Proprietary Analytics by Pharma Division of **Deep Pharma Analytics**

Proprietary Reports

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.

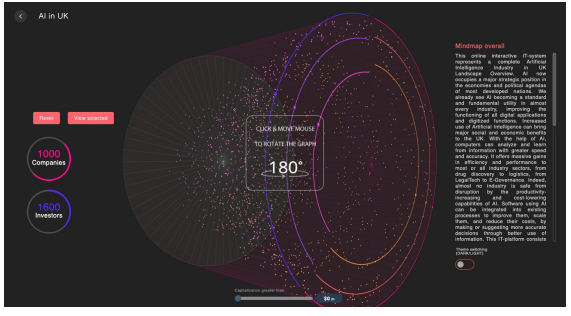
Our reports are supported by our rapidly developing data mining engine, data visualization platform and analytics dashboards.

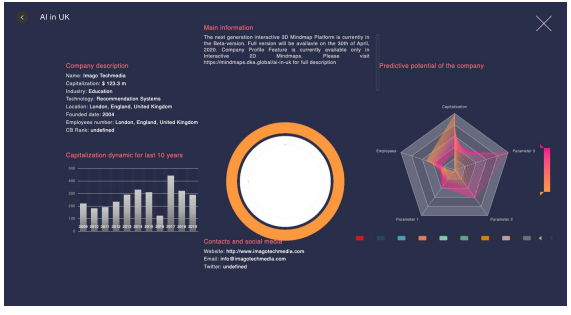
The value our reports can deliver:

- Deep analysis of the deal-making prospects in the biotech and healthcare tech space, identification of top mini-trends and larger tendencies in innovations and technology adoption (e.g. AI, blockchain, eHealth tech, longevity biomarkers, new therapeutics and therapies etc.);
- Tangible forecasts on the 3-5 years horizon, providing an overview of future scenarios of the development of various technologies in the pharma industry;
- Practical guides for adopting various technological solutions and best practises, vendor profiling and contract research strategy building;
- Analysis of key market players in the emerging and high-growth areas of the pharmaceutical and biotech industries.

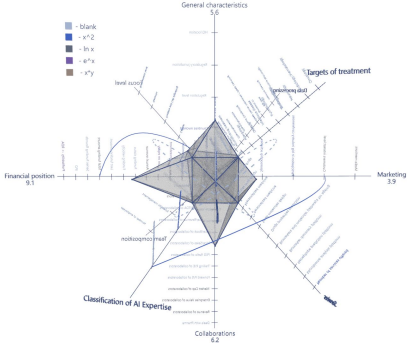
The parties who gain early access to these reports will have deep expertise on how their strategic agendas can be optimized in order to leverage novel research, new technologies, and emerging market opportunities, and stay competitive in a rapidly-changing technological environment, and taking into account shifting global priorities and trends.

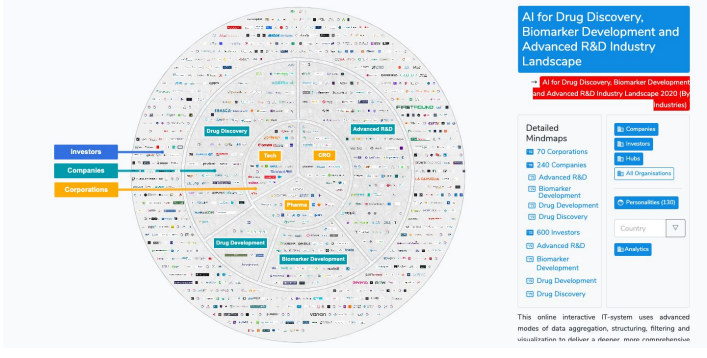
Deep Pharma Intelligence:
Upcoming Projects and Analytical Tools





3D Visualisation Prototypes





Deep Pharma Intelligence Big Data Analytics Dashboard

Deep Pharma Intelligence:
Upcoming Projects and Analytical Tools

Deep Pharma Intelligence Big Data Analytics Dashboard

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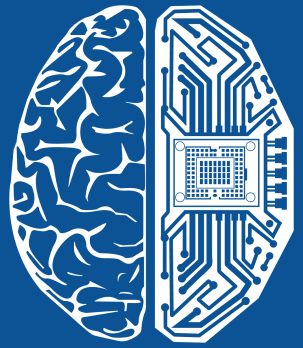

Link to Full Report: AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape Overview 2020

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