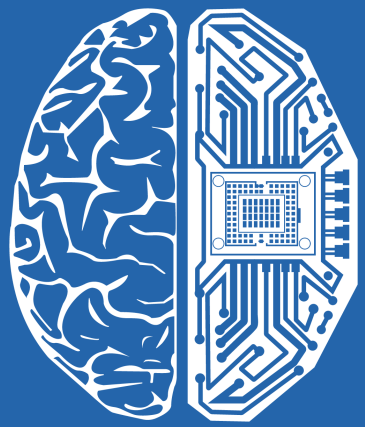
Overview of Proprietary Analytics



DEEP KNOWLEDGE ANALYTICS
PHARMA DIVISION

www.ai-pharma.dka.global

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. It serves as the main source of market intelligence and investment analytics for AI-Pharma, a specialized hybrid investment 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.

Analytical Reports Deliverables and Proposition for Cooperation

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 IT and Tech Corporations and is becoming crucially important for Pharma Corporations as well.This is why the knowledge and incorporation of AI and DL is of essential importance for the pharma corporations if they plan to maintain their positions and stay competitive. Deep industry analytics based on tangible, quantifiable metrics is crucial for big market players to become leaders, whereas for new players it is an opportunity to jump to the next stages.

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?**

Currently Deep Knowledge Analytics Pharma Division has in pipeline 8 ongoing proprietary special case studies delivering practical answers and insights to these specific questions in order to optimize the short and long-term strategies of biopharma corporations and other entities 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 implementation of AI in Drug Discovery sector 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.

Proprietary Analytical Reports 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;
- Quantifiable comparative/competitive analysis of key market players in the AI for Drug Discovery and Biomarker Development sector.

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.

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

Companies - 150
Investors - 350
Corporations - 50

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

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:

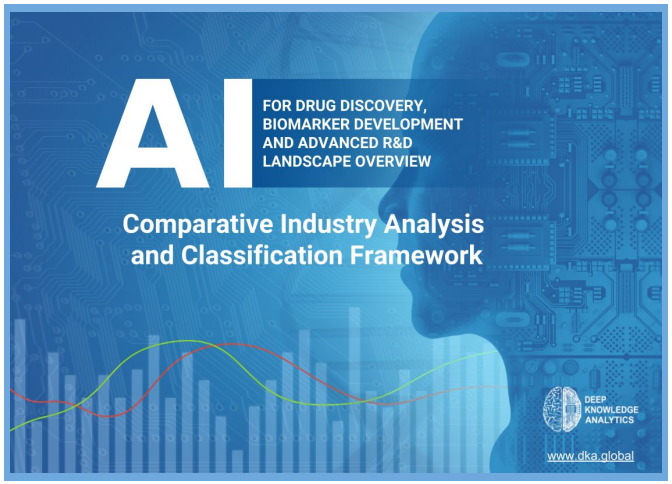
- Conduct customised case studies, research and analytics for internal (organizational) use, tailored to the precise needs of specific clients;
- Perform customised solutions using specialised software, industry and technology databases, interactive IT-platforms.
- Provide customized competitive analytics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

Methodology Summary

General approach of data analysis looks as follow: sourcing the data, cleaning data, data filtering, exploratory data analysis, data modeling, deriving results and recommendations development. The initial data for the reports has been selected from multiple sources including: companies websites, Google News, top pharmaceutical and healthcare AI conference program lists, databases. Researches are based on the analysis of the descriptive criteria and formal numerical metrics. To achieve purposes of analysis following methods were used:

Tangible metrics for predictive analysis	using historic data and advanced algorithms to generate accurate forecast and recommendations
Quantitative evaluation of institutions and trends	evaluating performance, assessing financial instruments, and making predictions, techniques of measuring data: regression analysis, linear programming, factor analysis, and data mining
Ranking	choosing proprietary criterias for ranking
Behavioral analysis	understanding of behavior and strategies of market leaders
Technological and financial expertise	profound combination of both finance and technology
Polyfactor models, quantitative and qualitative methods	describing the associations among sets of manifest variables, referred to as indicators or items across different categories (groups) and particular time horizon

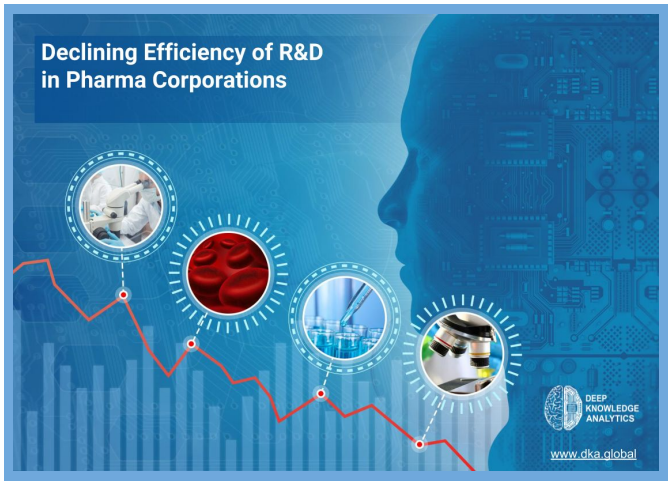
Deep Knowledge Analytics Pharma Division: Upcoming Proprietary Reports Q2 2019



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 Investment Funds

Enhanced Analysis of Most Promising AI-companies as the Best Investment Targets for AI-Pharma Index Hedge Fund

Deep Knowledge Analytics Pharma Division: Upcoming Open Access Reports Q2 2019

Pharma AI Deals:
Corporations and Startups

AI for Drug Discovery and Advanced R&D Landscape Overview 2019/Q2

Corporations Applying AI for Drug Discovery and Advanced Healthcare

Most Advanced Technologies in Drug Discovery and Biomarker Development Trends Overview

AI FOR DRUG DISCOVERY, BIOMARKER DEVELOPMENT AND ADVANCED R&D LANDSCAPE OVERVIEW

Comparative Industry Analysis and Classification Framework

1 June 2019

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Deliverables of the Report

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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:

- Enhanced comparative analysis of the perspectives of AI for Drug Discovery and Biomarker Development industry regarding to recent trends and future prospects
- Tangible short-term and long-term forecasts, including an overview of novel biopharma tools and methods that will be relevant in the market by 2022-2025
- Comparative analysis of key investors in the AI for Drug Discovery and Biomarker Development industry with derived classification metrics
- Dynamics of the number of investments in AI for Drug Discovery Companies and the number of AI companies and tangible forecast on future periods.

This comparative analysis is an add-on to our 110-page Q1 2019 report released in April 2019, which marked the fourth installment in a series of reports on the topic of the Artificial Intelligence in Drug Discovery Industry that Deep Knowledge Analytics has been producing for more than 2 years now. Its overall goal is to identify the leaders of the industry and to provide a framework for independent and reasonable assessment, and a framework for effective companies comparison

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

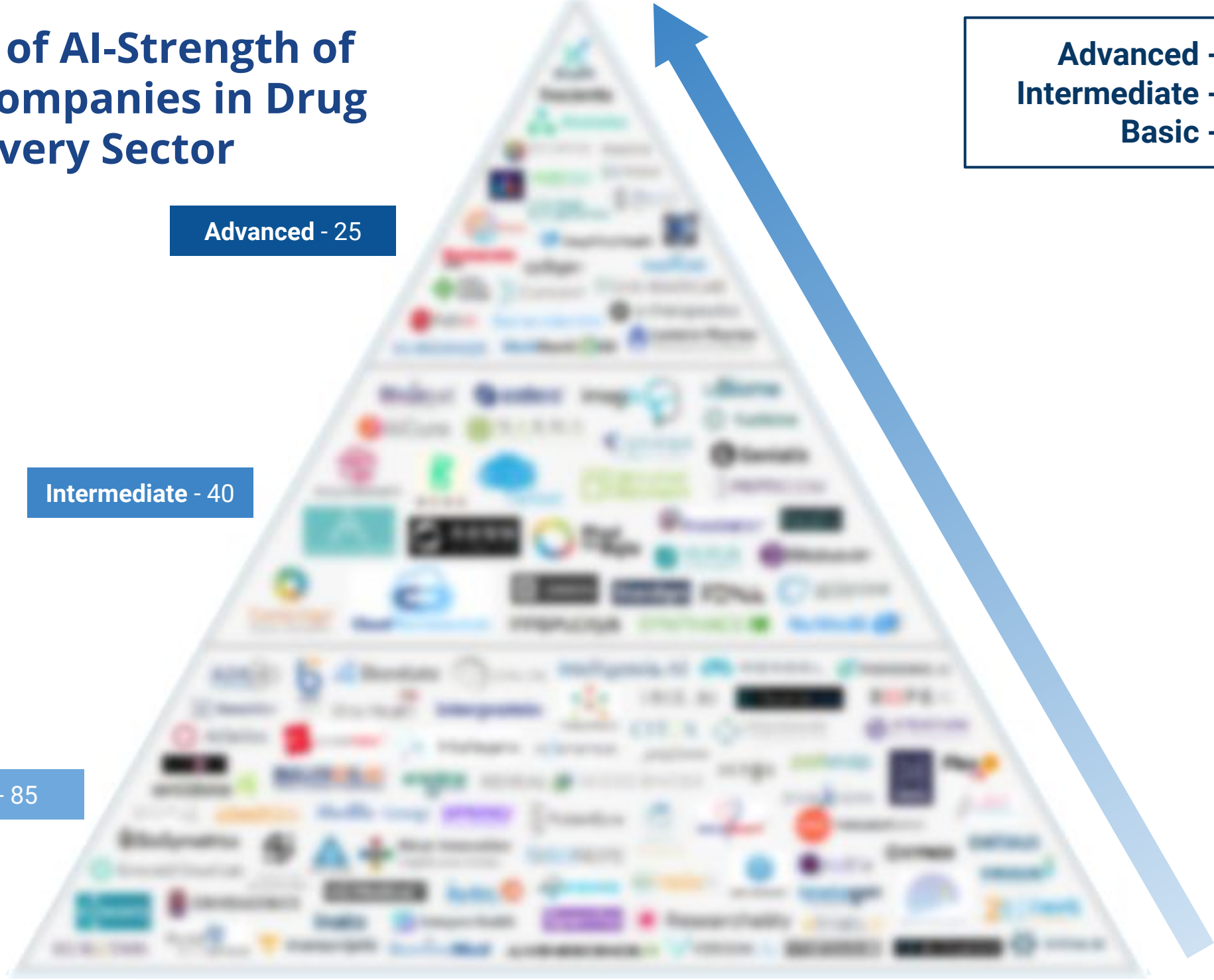
Comparative Industry Analysis & Classification Framework
Comparison of 25 Leading AI for Drug Discovery Companies

Level of AI-Strength of 150 Companies in Drug Discovery Sector

Advanced - 25

Intermediate - 40

Basic - 85



Advanced - 25
Intermediate - 30
Basic - 95

“Advanced AI” Group

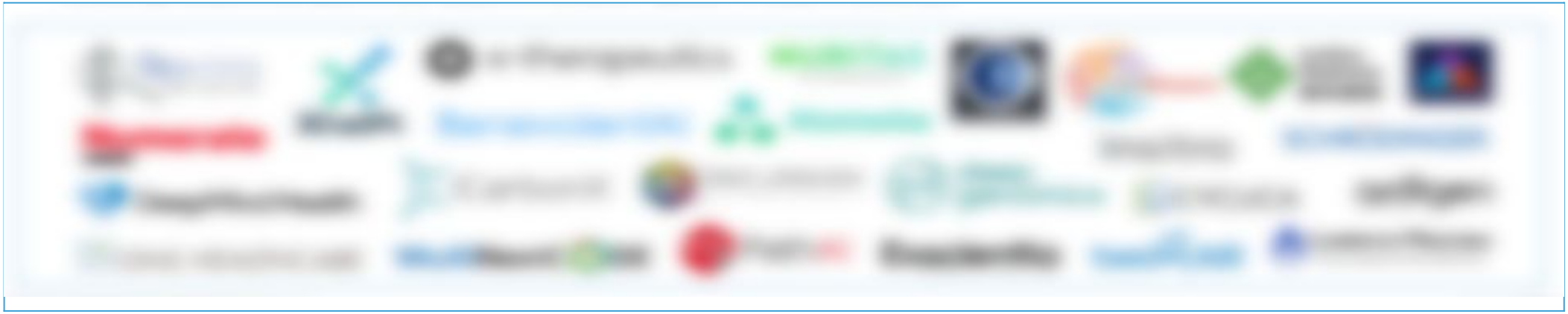
The companies in this section are active in the field of Drug Discovery and basic research. The following criteria have been used to attribute companies to the list of top 25 AI companies in Drug Discovery,

1. **Significant amount of patents and peer-reviewed articles in the domain of pharmaceutical research and AI technologies:** companies in this category are demonstrating significant advances in the application of AI to drug discovery tasks, which is reflected in a high number of research publications, public presentations and press-releases, patents. They usually have strong expertise both in drug discovery and development and in theoretical and practical aspects of AI technology.

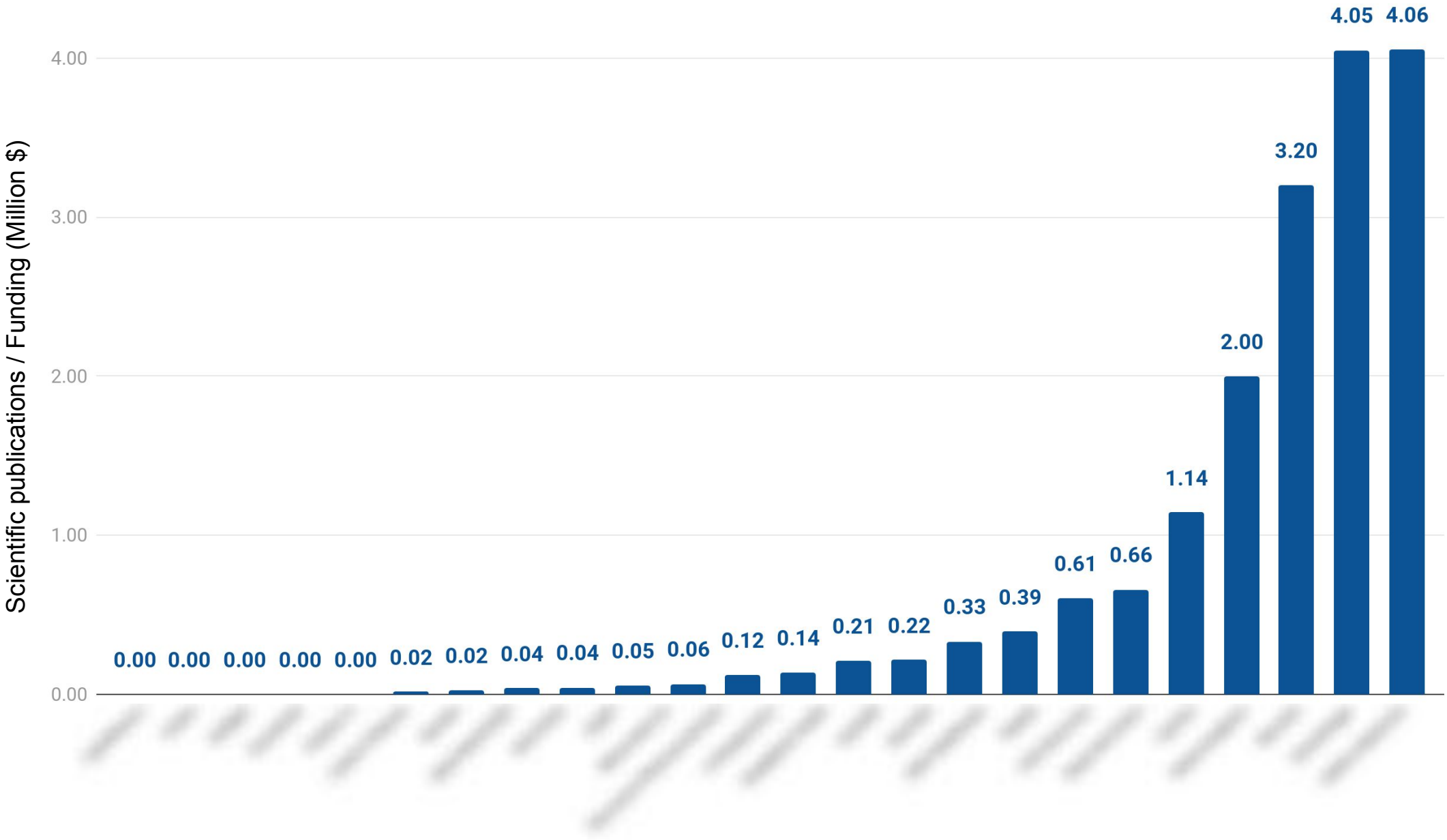
2. **High ratio of AI specialists to other employees**: companies in this category typically have a decent number of employees with background in AI/ML/DL, which allows generating unique know-how and intellectual property. Importantly, these companies have strong interdisciplinary teams uniting AI and life science experts.

3. **Direct collaborations with some of the 30 Pharma and Tech Corporations:** an important indicator for a company to be included in this category is the availability of official research collaborations with some of the top 30 Pharma and Tech corporations, where they provide advanced know-how in AI-driven drug discovery.

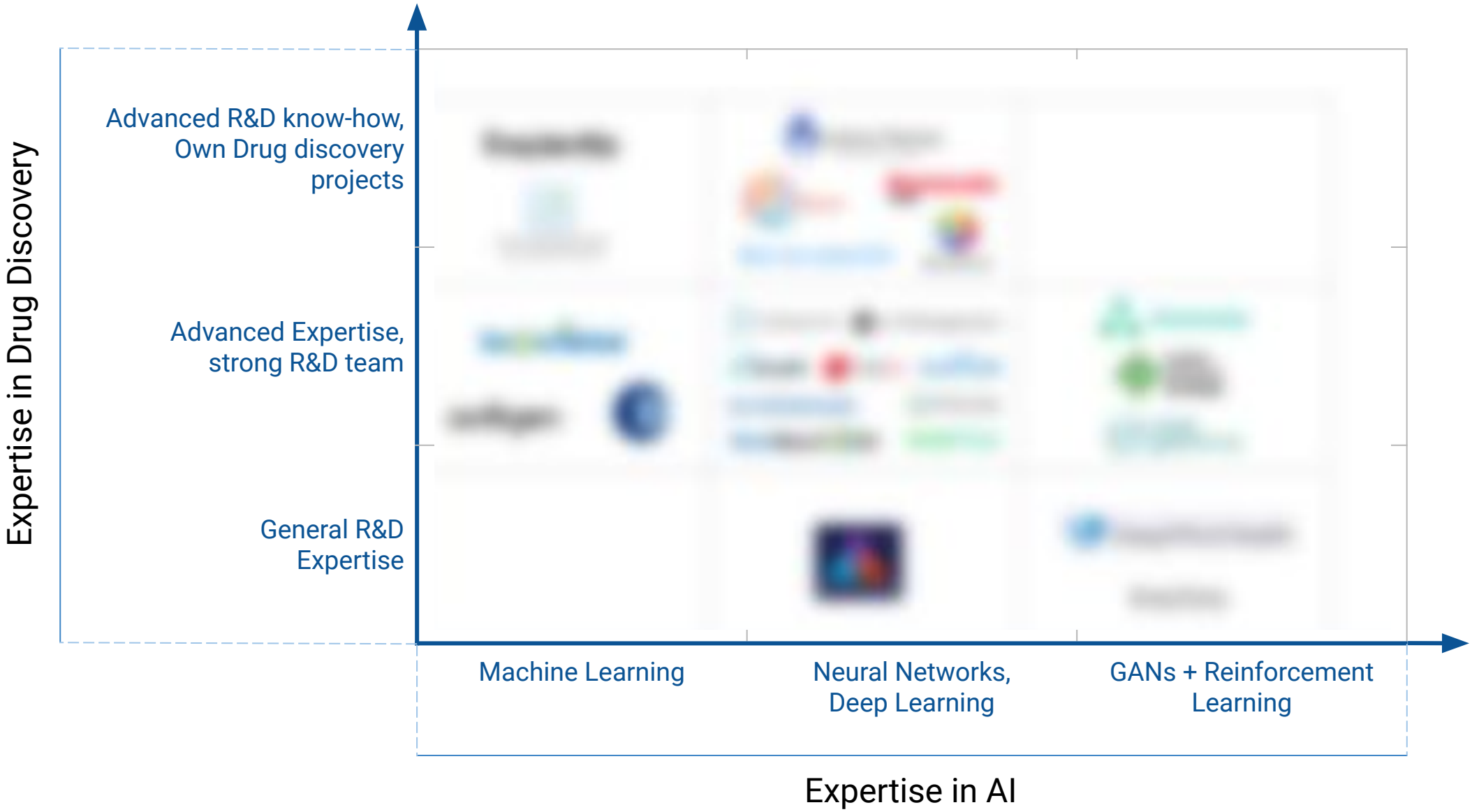
4. **High level of AI tech promotion:** companies in this category are typically active presenters in high profile public events, discussions and forums; they appear in news and media regularly. They contribute significantly to promoting AI-driven approach to drug discovery and basic biology, educating the public by specific use cases, and establishing best AI adoption practises.



Ratio of Scientific IP vs Funding



Comparison of Top-25 AI for Drug Discovery Companies
Expertise in Drug Discovery R&D / AI



Comparison of Top-25 AI Companies: Level of Scientific Validation

COMPANY	SCIENTIFIC PUBLICATIONS COVERING AI FOR DRUG DISCOVERY	NUMBER OF AI EXPERTS ON THE TEAM / TOTAL NUMBER OF EMPLOYEES	PUBLIC TALKS ON AI FOR DRUG DISCOVERY	VALIDATION
[illegible]	-	18/65	+	N/A
[illegible]	+	6/30	+	N/A
[illegible]	+	34/150	+	N/A
[illegible]	+	1/18	+	+
[illegible]	-	5/50	+	+
[illegible]	-	7/26	+	+
[illegible]	+	3/20	+	+
[illegible]	+	11/33	-	N/A
[illegible]	+	314/683	+	N/A
[illegible]	+	5/23	+	N/A
[illegible]	+	4/26	+	+
[illegible]	+	26/101	-	N/A
[illegible]	-	22/100	+	N/A

Comparison of Top-25 AI Companies: Level of Scientific Validation

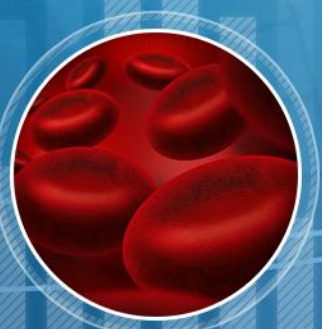
COMPANY	SCIENTIFIC PUBLICATIONS COVERING AI FOR DRUG DISCOVERY	NUMBER OF AI EXPERTS ON THE TEAM / TOTAL NUMBER OF EMPLOYEES	PUBLIC TALKS ON AI FOR DRUG DISCOVERY	VALIDATION
[illegible]	+	16/46	+	+
[illegible]	-	7/21	+	-
[illegible]	-	2/7	+	+
[illegible]	-	4/16	+	+
[illegible]	-	4/43	+	+
[illegible]	+	58/25	+	+
[illegible]	+	14/105	+	+
[illegible]	+	37/370	+	-
[illegible]	+	4/18	+	+
[illegible]	-	3/11	+	-
[illegible]	+	13/232	+	+
[illegible]	-	3/33	+	-

Key Points of Analytical Report “Comparative Industry Analysis”

- **Comparative Industry Analysis & Classification Framework** delivers a comparison of 20 leading AI for Drug Discovery companies according to their number of patents, scientific publications, ratio of AI experts to total number of employees, levels of core AI in R&D, levels of specialized AI expertise (e.g. advanced deep learning vs. basic machine learning), levels of expertise in biology and computational chemistry, partnerships with leading Pharma and Tech corporations, in conjunction with their overall levels of funding and other metrics to deliver tools for a realistic and quantitative comparison of present-day and future value of the companies, which could be used to support more effective due diligence processes.
- AI for Drug Discovery, Advanced Healthcare and Biomarker Development sector of BioPharma industry is developing very intensively. Now it includes about 150 companies that provide services for different stages of drug discovery process. However, many of these companies struggle to deliver essential results. Whereas there are about 20 leading AI-companies in the industry which with high probability will be capable to succeed in at least some specific domains of pharmaceutical R&D process.
- Most of the 150 AI-companies operating in the AI for Drug Discovery space on average have 15% of the stuff which can be considered as AI-experts. In the case of leading 25 AI-companies, this bar raises up to 30% of the total amount of stuff.
- 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 number of investments in AI for Drug Discovery Companies demonstrate exponential growth and the number of AI companies increased linearly.
- Pharma companies face with challenge of significant spending increase per one FDA approved drug. AI application can accelerate data analysis process and decrease time for Drug Design and Development, Prediction of Treatment results. Even 5% less overall time reducing for drugs trails can save millions of dollars for Pharma companies.
- The main part of Top AI investment funds is nowadays USA-based.

Pharma Corporations - 15
Tech Corporations - 15

Pharma AI Stock Index *Teaser*



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Deliverables of the Report

Pharma and Tech corporations demonstrate an increasing interest in AI. Applying of AI for Drug Discovery and cooperation with pharma AI companies can be a sign that a corporation has prospects for competitive advantage. Understanding of 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.

It will deliver:

- Specific analysis of stock dynamics of pharma and tech AI corporations with reference to their relation to AI for Drug Discovery industry
- Forecasts on the 3-5 years with extrapolation of possible scenarios of the indices development
- Analysis of the specifics of the stock indices aggregated based on these corporations
- Deep analysis of relation between pharma and tech composite indices to the most relevant stock indices

Pharma AI Stock Index

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Corporations and Market Analysis Framework

General characteristics of corporations

Stock indices indicators

Factors influencing stock indices dynamics

Future prospects

Non-financial indicators of corporations

Financial position of corporations

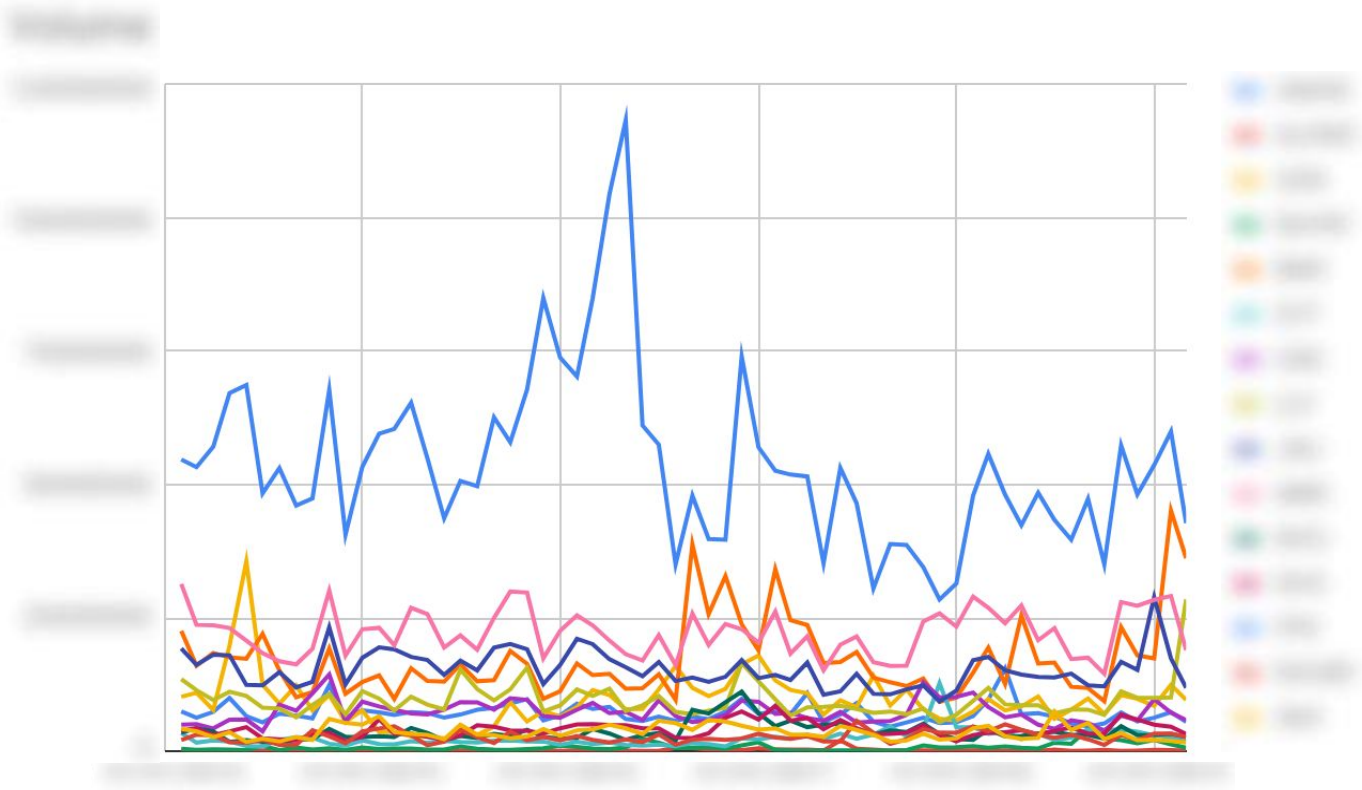
Scientific results

15 Pharma Corporations Applying AI for Drug Discovery and 15 Tech Corporations Applying Advanced AI Applications in Healthcare

Pharma Corporations	Tech Corporations
1. Amgen	1. Alibaba
2. Astellas Pharma	2. Amazon
3. Astrazeneca	3. Apple
4. Bayer	4. Baidu
5. Boehringer Ingelheim	5. Canon
6. Bristol-Myers Squibb	6. Google
7. Evotec	7. Hitachi
8. GSK	8. Huawei
9. Eli Lilly	9. IBM
10. Johnson & Johnson	10. Intel
11. Merck	11. Microsoft
12. Novartis	12. Nvidia
13. Pfizer	13. Samsung Electronics
14 Roche	14. Siemens
15. Sanofi	15. Tencent

Pharma Corporations Market Cap Dynamics

Market capitalization of 15 pharma corporations dynamics

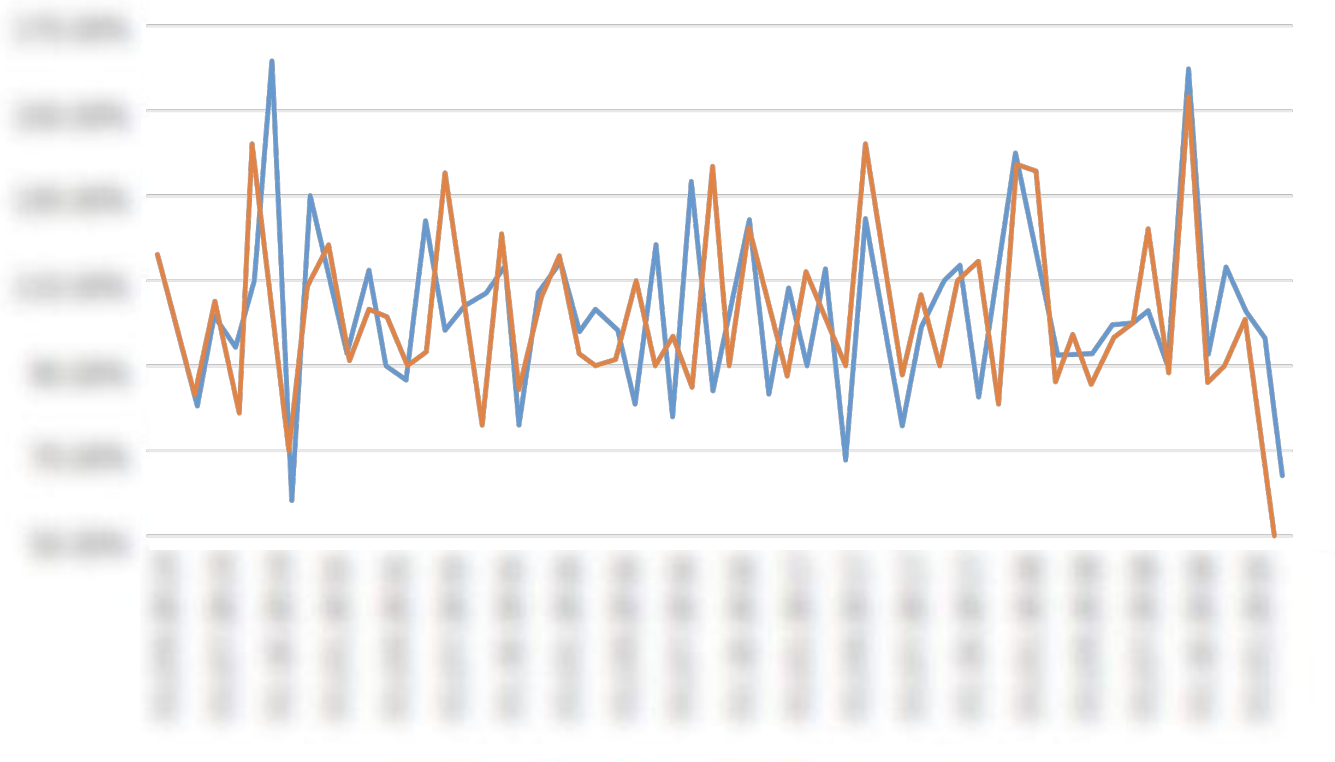


Pharmaceutical sector has an accelerated growth pace, but it is still slower than the other two large healthcare segments, medical equipment and healthcare services. Pharma corporations worldwide are expected to grow by 160% between 2017 and 2030. Pharmaceutical market growth is boosted by the following factors:

- Population aging and sedentary lifestyles leading to increased chronic disease prevalence
- Industrialized data services in R&D enabling the use of clinical trial data in trial simulations
- High urban pollution levels increasing the incidence of conditions like asthma

Dynamics of the Pharma AI Stock Index and Tech Index

The dynamics of capitalization growth of 15 pharma companies' stocks and 15 tech companies' stocks.



As we can see, there is no general trend or consistent path that both indices follow. Rises and falls are explained by different tech inventions and breakthroughs or, vice versa, various unfortunate events. However, there were several significant increases and declines. First one happened at the end of Summer 2014 and was caused by a series of major technological breakthroughs in pharma, such as neuromorphic chips, brain mapping, genome editing, etc. Nevertheless, this rapid increase was followed by the catastrophic decline in October 2014. This shock was provoked by several events, like US treasury freeze, worries about US airstrikes in Syria, Hong-Kong protests and Ebola virus spread.

Both indices are vulnerable to random social and scientific events and can hardly be predicted

Correlation between Indices

Correlations of the main indices

	Pharma index	Tech index	Combined index
Pharma index			
Tech index			
Combined index			
S&P Pharmaceuticals Select Industry Index			
Dow Jones U,S, Select Pharmaceuticals Index			
S&P/TSX Venture Pharmaceuticals, Biotechnology & Life Sciences (Industry Group) Index (CAD)			
NASDAQ Biotechnology Index			
Dow Jones			
S&P 500			
Nasdaq			
NYSE			
Russel 2000			

According to our calculations, the Pharma AI stock index is highly correlated with tech index. At the same time, the tech index is uncorrelated with NASDAQ Biotechnology Index and Dow Jones U.S. Select Pharmaceuticals Index, which includes the major part of traditional Pharma companies. This proves that investment analysis of Pharma corporations, which are applying AI drug discovery, should be conducted separately from the traditional pharma market.

Besides, the correlation between the technical index and the combined index is higher than between Pharma AI stock index and the combined one. Thus, the influence of fluctuations in the tech stock is bigger than the one in the Pharma stock.

Key Points of Analytical Report “Pharma AI Stock Index”

- The combined capitalization of the 15 BioPharma corporations profiled in this report has remained at the same level during the last 5 years. For the past 5 years, the capitalization of 15 IT & Tech corporations profiled in this report is steadily growing.
- As for the close price dynamics, most of the companies’ stocks that we accounted for still do show significant increases. This is connected with existing industry burdens such as government pricing pressure, poor clinical trial results, increased litigation, competition, FDA scrutiny in the US, domestic price controls, and the gradual shift locally to generic drugs.
- At the same time, three of the profiled companies, Amgen, Eli Lilly, and Johnson & Johnson, leaders with blockbuster drugs in pipeline, stand out due to strong cash flow and faster growth comparing to traditional pharma. Keeping other things fixed, when tech stock increases by 1%, pharma AI stock index increases by 0,5% on average. The results turned out to be statistically significant at all significance level, so we can conclude that Pharma AI stock is less volatile and 48% less likely to respond towards movement in the technical market.
- Pharma Index is highly correlated with NASDAQ Biotechnology Index (25%) and NASDAQ itself (28%). This can be explained by the fact that all these three indices are often affected by similar factors of the external environment.
- The optimal portfolio in Pharma Industry is composed of the stocks of Astellas Pharma, Bayer, Eli Lilly, Evotec, Johnson&Johnson and Merck.
- 6 critical risks facing the pharmaceutical industry include increased competition from generic drugs, legal liability for opioid addiction, global quality control, patent cliffs, product liability and not keeping up with technology.

Declining Efficiency of R&D in Pharma Corporations

Teaser

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Deliverables of the Report

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.

It will deliver:

- Complete assessment of the pharma industry prospects regarding declining efficiency of R&D
- Tangible forecasts on the 3-5 years horizon, providing an overview of novel biopharma tools and methods that will be market-ready by 2022-2025 and can stop or even revert the negative trend
- Practical guide to the optimized way for assembling the best possible tools and solutions to deal with the declining efficiency of R&D
- Analysis of key market players in pharma industry for the specific understanding of how they are going to deal with the risk of declining efficiency

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.

Declining Efficiency of R&D in Pharma Corporations

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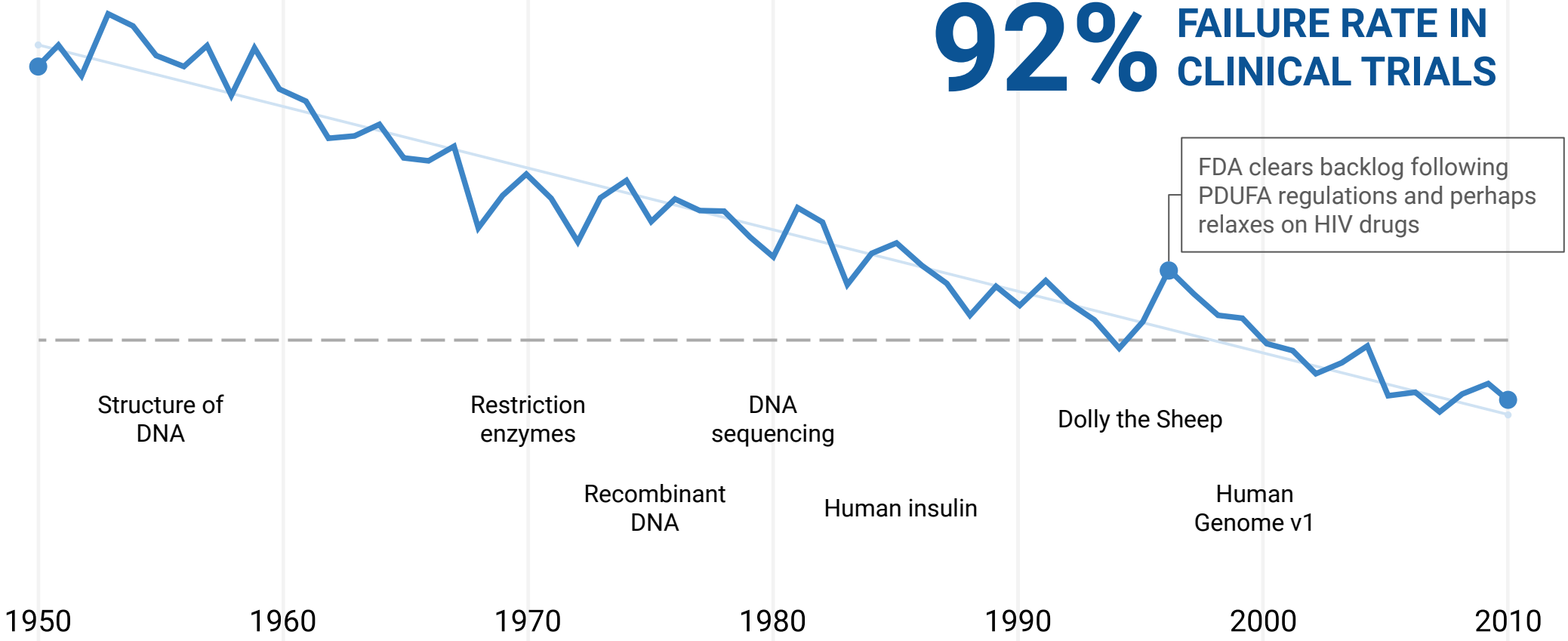
Pharma Efficiency is Declining Steadily

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

>$2.6B TO DEVELOP ONE DRUG

92% FAILURE RATE IN CLINICAL TRIALS



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

59 NEW DRUGS launched in 2018

Why Productivity of R&D in Pharmaceutical Industry is Declining?

Market opportunity is growing

Drug value is stable and high

Sales are growing, and revenues as well

Innovation and R&D is, in fact, efficient and disruptive. Pharma constantly launches blockbusters

(e.g. Sovaldi/Harvoni, Keytruda, Kalydeco are some of the recent blockbusters, which had a transformative impact on medicine, with decent revenues streams)

WHY THE PRODUCTIVITY and PROFITS are falling?

The cumulative cost of R&D is growing **too fast**, **mainly** because of high failure rate at late projects.

X

Less than 10% success rate of commercial launch is inevitably leading to decline in profit, no matter how much money pharma is making, considering that the cost of R&D for one project might well go beyond a billion dollar ceiling.

Source forbes.com

Solutions: Increasing the Pharma Efficiency

Drug Discovery

New drugs on the market

3 bottleneck

R&D is unpredictable, slow and expensive	Outdated clinical trials model	Lack of flexibility, analytical power and urgency
• [illegible] • [illegible] • [illegible]	• [illegible] • [illegible] • [illegible] • [illegible]	• [illegible] • [illegible] • [illegible]

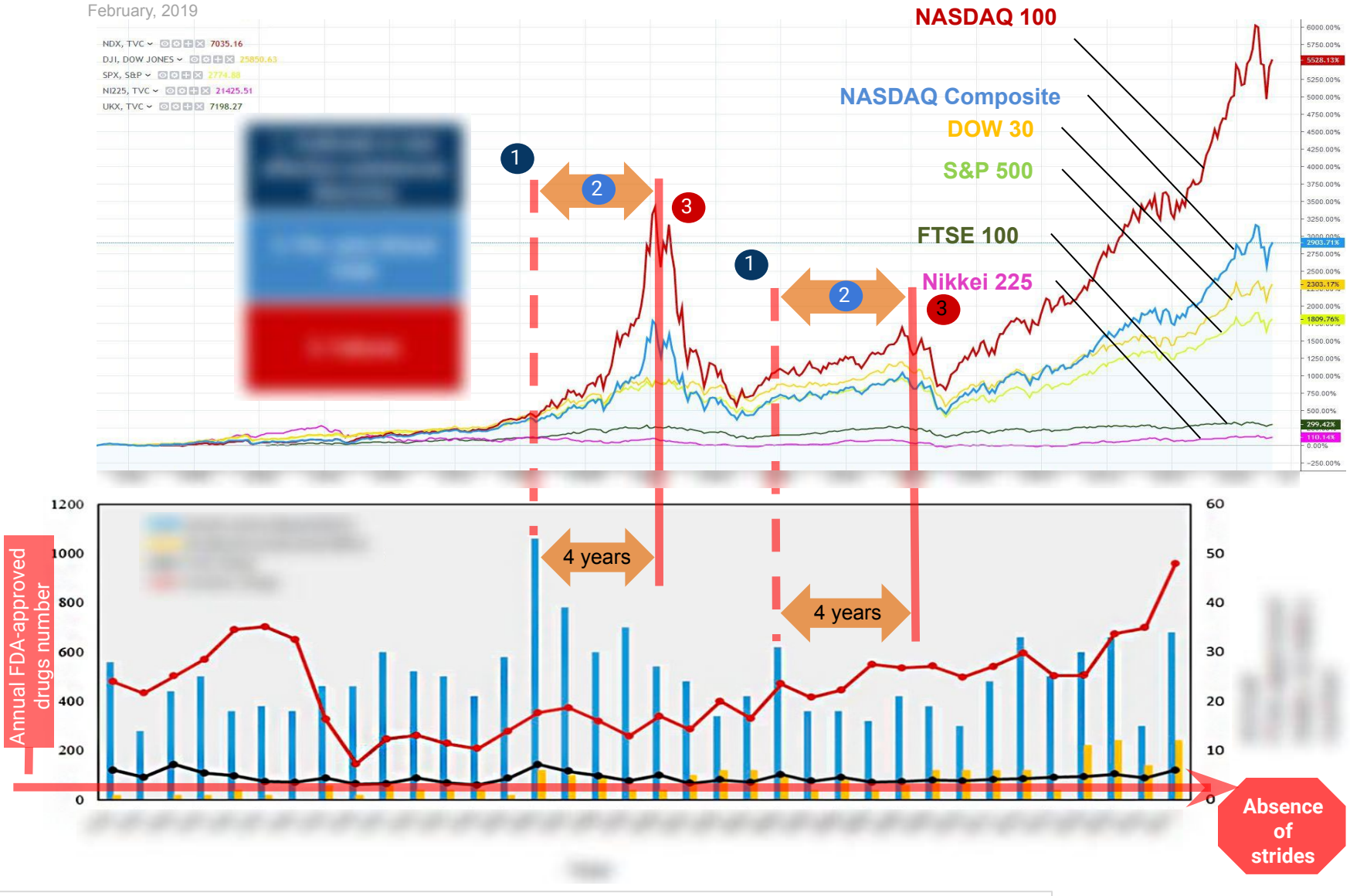
10 Underappreciated Risks Facing Pharmaceutical Companies

RISK	IMPACT	PROBABILITY	ORIENTATION
[illegible]	High	High	External
[illegible]	High	High	External
[illegible]	Moderate	High	External
[illegible]	Moderate	Moderate	External
[illegible]	Moderate	Low	Internal
[illegible]	Moderate	Low	External
[illegible]	Low	Low	Internal
[illegible]	Low	Low	Internal
[illegible]	Low	Low	External
[illegible]	Low	Very Low	External

Sources fitchsolutions.com

Pharmaceutical R&D Breakdown Overview

SEARCHING FOR CORRELATION BETWEEN MAIN STOCK MARKET INDICES AND PHARMA PRODUCTION



Sources adapted from tradingview.com, Zhong H. et al., Pharmaceutics, 2018 (doi:10.3390/pharmaceutics10040263)

Key Points of Analytical Report “Declining Efficiency of R&D in Pharma Corporations”

- Efficiency of R&D in drug discovery of biopharma declines for many decades and this trend (known as Eroom`s Law) does not stop. Costs of R&D per drug are growing exponentially, yet sales per asset are definitely not increasing. Actually, sales per asset even contribute to the trend, since an average asset brings less revenue. R&D spending continues to increase. Late-stage R&D continues to be inherently risky. The share of oncology assets in late-stage pipelines is growing and becoming the greatest.
- While big pharma has warmed to external sources of innovation from biotech, they continue to pursue a strategy that stresses large-scale, narrowly-focused research, rather than breadth of opportunity. The high-quality, low-volume, high-cost strategy makes corporations particularly vulnerable to the failure rate. As a result, limited output has left the industry dependent on monopolistic pricing and a target for potentially devastating political intervention. Under the current business model, pharma cannot reign-in drug prices without accelerating the decline that Stott has documented.
- The solution to the problem is changing the business model of pharma to favor more agile early stage drug discovery, a much larger number of initial pool of projects (with minimal investment, via outsourcing, partnering, or VC funds), and an efficient process of project prioritization. In this sense, pharmaceutical corporations will have to embrace a more venture fund-like approach, given its naturally inherent risk of failure.
- Development of AI for drug discovery may cause an additional boost in productivity and bring innovation for big pharma corporations. One opportunity to pharma is to use solutions of young pharma AI startups by making acquisitions. Some corporations that already apply AI for drug discovery have already shown positive changes in financial indicators.
- However, it is very likely that negative trends can be overcome only by a combination of technological and managerial innovations in the industry.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Top-20 AI
in Drug Discovery
Investors

Summary
Deliverables of the Report

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.

It will deliver:

- Comprehensive analysis of the lead investors` strategies in the AI for Drug Discovery and Biomarker Development industry regarding to development trends in particular fields.
- Classification of investors by region, investment type, sector etc. to define optimal portfolio of economic agents
- Forecast on future dynamics and prospects of AI for Drug Discovery investors, their behaviour in the market and assessment of future success of business performance
- Analysis of a investor's current position in the AI for Drug Discovery investment landscape

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-20 AI in Drug Discovery Investors

Table of Contents

Investors Ranking Framework

Top-20 AI for Drug Discovery Investors

Sequoia Capital
Menlo Park, California, US

Andreessen Horowitz
Menlo Park, California, US

Felicis Ventures
Menlo Park, California, US

Draper Associates
Menlo Park, California, US

Khosla Ventures
Menlo Park, California, US

Amgen Ventures
San Francisco, California, US

Data Collective DCVC
San Francisco, California, US

San Francisco

500 Startups
Mountain View, California, US

Y Combinator
Mountain View, California, US

GV
Mountain View, California, US

Mountain View

StartX
Palo Alto, California, US

AME CLoud Ventures
Palo Alto, California, US

Palo Alto

Refactor Capital
Burlingame, California, US

Menlo Park

California

OS Fund
N/A, California, US

General Catalyst
Cambridge, Massachusetts, US

SOSV
Princeton, New Jersey, US

Tencent
Shenzhen, China

WuXi AppTec
Shanghai, China

ZhenFund
Beijing, China

Sequoia Capital China
Beijing, China

Amadeus Capital Partners
Cambridge, United Kingdom

Top-20 Investors in 150 AI-Companies

Top AI Companies		Investments overall	INVESTORS		Investments overall	Top AI Companies	
	Atomwise	9	Y combinator	Sequoia Capital	9	XtalPi	WuXiNextCODE
		8	SOSV	OS Fund	8	Atomwise	twoXAR
SCHRÖDINGER	insitro	8	GV	Data Collective DCVC	8	Atomwise	RECURSION
Atomwise	RECURSION	8	AME Cloud Ventures	ZhenFund	7	XtalPi	
Atomwise	deep genomics	6	Khosla Ventures	Andreessen Horowitz	6	insitro	twoXAR
		6	Amadeus Capital Partners	WuXi AppTec	5	Insilico Medicine 英科智能	WuXiNextCODE SCHRÖDINGER
	PathAI	5	General catalyst	StartX	4	twoXAR	
	PathAI	4	Refactor Capital	Tencent	4	Atomwise	XtalPi iCarbonX
		4	Felicis ventures	Draper associates	4	Atomwise	
	WuXiNextCODE GNS HEALTHCARE	3	Amgen ventures	500 startups	3		

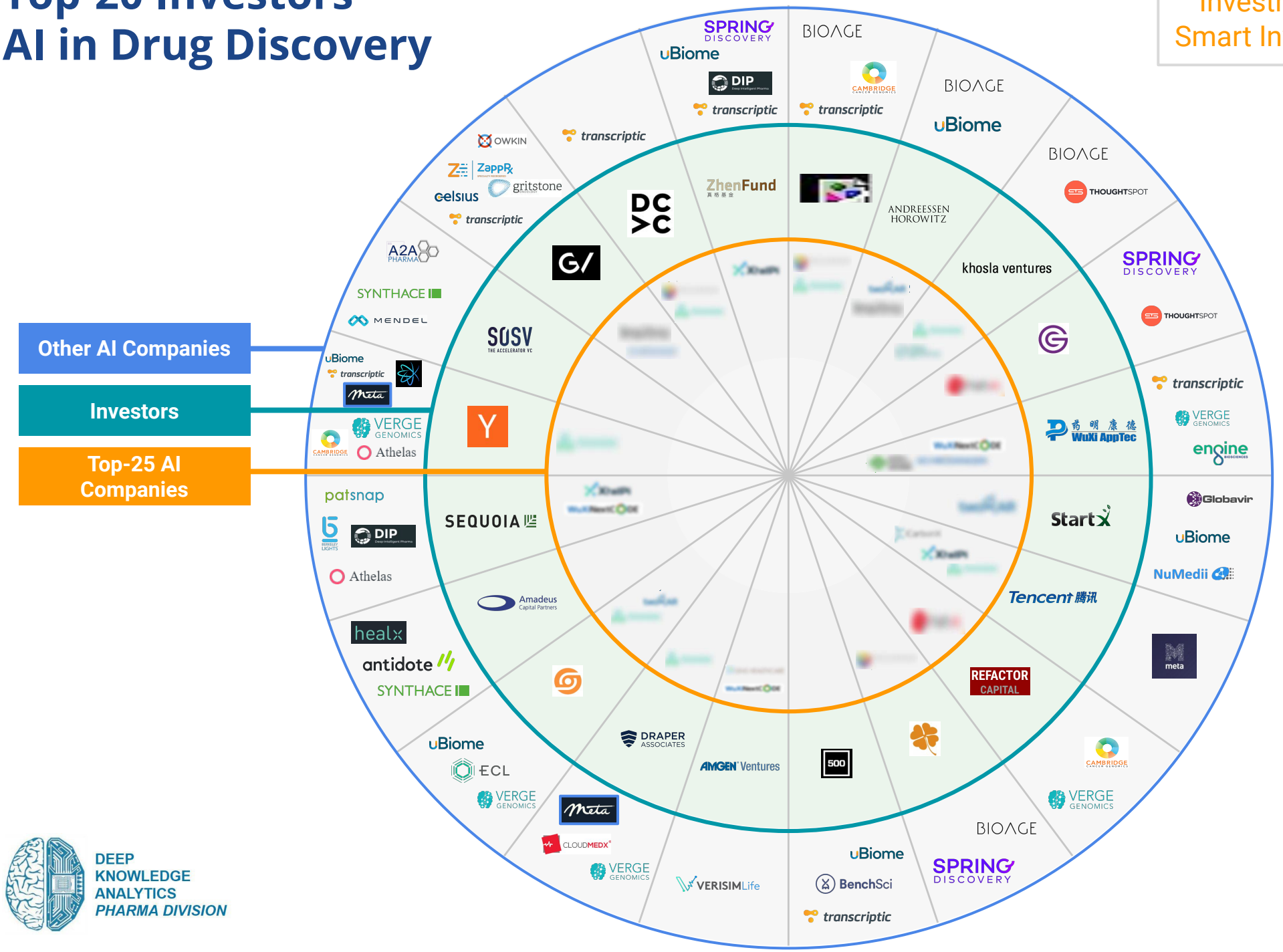
Smart 10 Investors Invested in the Top-25 AI Companies

Top AI Companies ← **INVESTORS** → Top AI Companies

Atomwise	iCarbonX	XtalPi	Tencent	WuXi AppTec	Insilico Medicine	SCHRÖDINGER	WuXiNextCODE
	twoXAR	Insitro	Andreessen Horowitz	GV	Insitro	SCHRÖDINGER	
	WuXiNextCODE	Insitro	ARCH Venture Partners	Khosla Ventures	Atomwise	deep genomics	
	RECURSION	CYCLICA	EPIC Capital	Sequoia Capital	XtalPi	WuXiNextCODE	
	RECURSION	Atomwise	Data Collective DCVC	AME Cloud Ventures	RECURSION	Atomwise	

Top-20 Investors AI in Drug Discovery

Investments vs Smart Investments



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PHARMA DIVISION

Investors Strategies

Features and elements of strategies of successful investors in AI for Drug Discovery

- Companies to invest in
- Investor`s features
- Tech expertise
- Others

What differentiates successful AI for Drug Discovery investors from unsuccessful ones? Together with common success features (diversification, quantitative metrics, deep industry analysis, risk management tools) there are some industry-specific parameters of investors behavior that contribute to the success in AI for Drug Discovery investment.

Features and elements of strategies of successful investors in AI for Drug Discovery

Key Points of Analytical Report “Top-20 AI in Drug Discovery Investment Funds”

- Top-20 AI for drug discovery investors belong predominantly to the lists of the biggest and most effective global venture and investment funds that do not specialize exclusively on biotech and pharma ventures but pay high attention to this industry. Most of the top-20 investors in AI for drug discovery are concentrated on the early stages of investment. Namely, each of the 20 funds provides early stage investment. Only 25% of investors are engaged in debt financing. However, we need to understand that the situation can be different when we observe exclusively biotech or even drug discovery investment. In this case, aforementioned investors may be relatively more conservative. Thus, the share of late-stage investments may grow. Together, these 20 firms have raised over $40 billion, with Sequoia Capital alone accounting for roughly a third of that amount. In fact, Sequoia Capital — arguably Silicon Valley’s most eminent venture capital firm, with an impressive investment record that encompasses the likes of Google, Amazon, Apple, and Cisco, just to name a few — has been heavily involved in the healthcare sector. In the future, we can expect development and growth of specialized investment in biotech sector, which can accelerate AI for drug discovery investments even more.
- 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. 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. 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.
- 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 and important investment target. The total valuation of the AI for Drug Discovery sub-sector grew approximately 1.5 - 2x during the last 6 months, which leads to the growth of investment volumes.

Open Access Analytical Reports by Deep Knowledge Analytics Pharma Division

Published / Q1-Q2 2019

AI for Advanced R&D and Drug Discovery Q1 2019

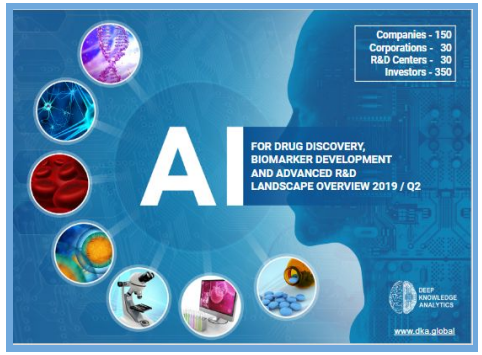
Ranking of the "AI-Friendly" CEOs and Board Members of Pharma and Tech Corporations

Top-100 AI Leaders in Drug Discovery and Advanced Healthcare

Top-30 Women AI Leaders in Drug Discovery and Advanced Healthcare

Upcoming / Q2 2019

Pharma AI Deals: Corporations and Startups



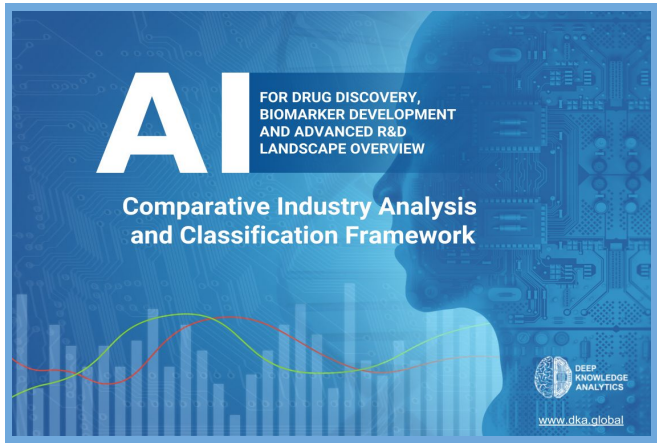
AI for Drug Discovery and Advanced R&D Landscape Overview 2019/Q2

Corporations Applying AI for Drug Discovery and Advanced Healthcare

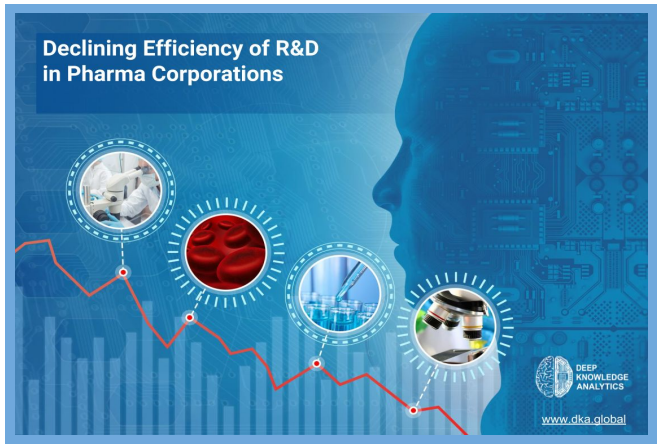
Most Advanced Technologies in Drug Discovery and Biomarker Development Trends Overview

Proprietary Analytics by Deep Knowledge Analytics Pharma Division

Published / Q1 2019



Comparative Industry Analysis & Classification Framework



Declining Efficiency of R&D in Pharma Corporations

Upcoming / Q2 2019

Pharma AI Stock Index

Top Analysts AI in Pharma

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

Proprietary Analytics Summary

Comparative Industry Analysis & Classification Framework

The amount of investments in AI for Drug Discovery Companies demonstrate exponential growth and number of AI companies increased linearly. Pharma companies face with challenge of significant spending increase per one FDA approved drugs. AI application can accelerate data analysis process and decrease time for Drug Design and Development, Prediction of Treatment results.
Across investors USA-based companies create the largest group both by total value of investments and quantity of deals.

Pharma AI Stock Index

The combined capitalization of the 15 BioPharma corporations profiled in provided report has remained at the same level during the last 5 years. During observed period, the capitalization of 15 IT & Tech corporations profiled is steadily growing.
As for the close price dynamics, most of the companies' stocks that we accounted for still do show significant increases. This is driven by existing industry burdens such as government pricing pressure, poor clinical trial results, increased litigation, competition, FDA scrutiny in the US, domestic and the gradual shift locally to generic drugs.

Declining Efficiency of R&D in Pharma Corporations

Costs of R&D per drug are growing exponentially, yet sales per asset are definitely not increasing. 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.

Top-20 AI in Drug Discovery Investors

Most of the top-20 investors in AI for drug discovery are concentrated on the early stages of investment. Only 25% of investors are engaged in debt financing.
In total, these 20 firms have raised over $40 billion, with Sequoia Capital alone accounting for roughly a third of that amount. In the future, we can expect the surge in growth of specialized investment in development of biotech sector, which can accelerate AI for drug discovery investments even more.

Top-30 Analysts AI in Pharma

The majority of the TOP 30 AI-analysts list participants work in Biopharma rather than in Tech companies. Top analysts usually have deep technological backgrounds (Computer Science, including Artificial Intelligence, Data Science, Engineering, Statistics/Math), with some acquired level of expertise in life sciences. Going into details, most analytics work in the field of Healthcare, Business management, and Data science.

Enhanced Analysis of Most Promising AI-Companies as the Best Investments Targets for AI-Pharma Index Hedge Fund

Among 25 the most promising AI-companies as the best investments targets for AI-Pharma Index Hedge Fund are companies from the USA, 15 companies are American.
By specialization, companies are divided into two groups. 14 of them are classified as AI for Bioinformatics companies, the rest deal with drug discovery.
Almost all companies use unique technologies in their performance. To reach high results and implement strategic projects AI-companies are encouraged for cooperation with well-known companies.

Analytical Reports Deliverables and Value Proposition

Comparative Industry Analysis & Classification Framework:

- Enhanced analysis of the perspectives of AI for Drug Discovery and Biomarker Development industry in accordance with prevailing trends
- Tangible short-term and long-term forecasts, including an overview of novel biopharma tools and methods that will be relevant in the market by 2022-2025
- Analysis of key market players in the AI for Drug Discovery and Biomarker Development landscape

Pharma AI Stock Index:

- Specific analysis of stock dynamics of pharma and tech AI corporations with reference to their relation to AI for Drug Discovery industry
- Forecasts on the 3-5 years with extrapolation of possible scenarios of the indices development
- Analysis of the specifics of the stock indices aggregated based on these corporations
- Deep analysis of relation between pharma and tech composite indices to the most relevant stock indices

Declining Efficiency of R&D in Pharma Corporations:

- Stress out the main reasons for this declining trend in efficiency of R&D
- Defining what are business consequences of such declining for the corporations and other participants of the industry
- Deep analysis of behavior implemented by pharma corporations to find the solutions to deal with this negative trend
- Forecasts of industry prospects regarding the evidence of R&D efficiency

Top-20 AI in Drug Discovery Investors:

- General investigation of investment strategies of different types of investors
- Forecast of future trends of investment in pharma industry
- Recommendations which can be applied for assembling the most optimal possible tools and solutions both for investors and investment-seeking companies
- Overview and comparison of key investors in AI for Drug Discovery industry

Top-30 Analysts AI in Pharma:

- Gaining understanding of current distribution of experts in the field
- Determining particular tendencies of the labour market of analysts
- Assessment of areas of the necessary focus for the specialists in the industry
- Making investment decisions on the basis of competencies of companies in the field

Enhanced Analysis of Most Promising AI-Companies as the Best Investments Targets for AI-Pharma Index Hedge Fund

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

Cooperation

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Deep Knowledge Analytics Pharma Division is primarily interested in strategic collaboration with international corporations, pharma and tech companies, NGO's and governmental organizations of progressive countries on projects and initiatives related to next-generation technologies in pharma industry and in corresponding fields of business, technology and science.

Deep Knowledge Analytics Pharma Division can engage with strategic partners via several different approaches, including:

- Conducting of customised case studies, research and analytics for internal (organizational) use, tailored to the precise needs of specific clients in pharma industry and related areas;
- Production of analytical reports for open source use (freely accessible);
- Performing of customised solutions using specialised software, industry, science and technology databases, interactive IT-platforms.

In some specific cases, if it fits the interests of Deep Knowledge Analytics' Pharma Division, we are open to considering co-sponsoring research and analytics for the production of both internal and openly-accessible industry reports and special case studies.

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is interested in strategic collaboration with pharma corporations, NGOs and governments of progressive countries on projects related to next-generation technologies in healthcare and pharma industry with high disruptive potential.

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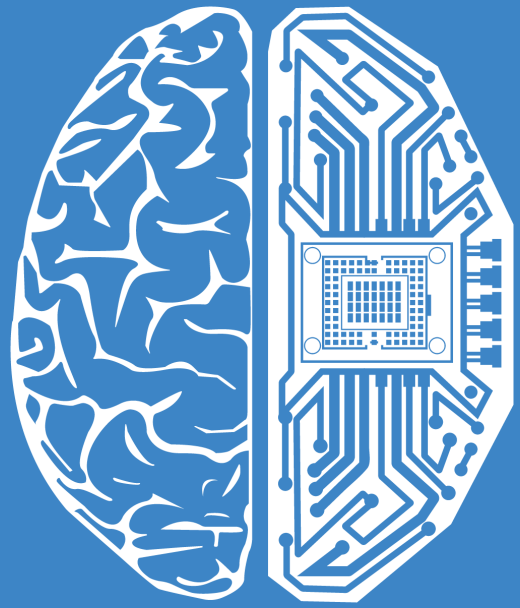

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