

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

Comparative Industry Analysis and Classification Framework September 2019



**DEEP
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PHARMA DIVISION**

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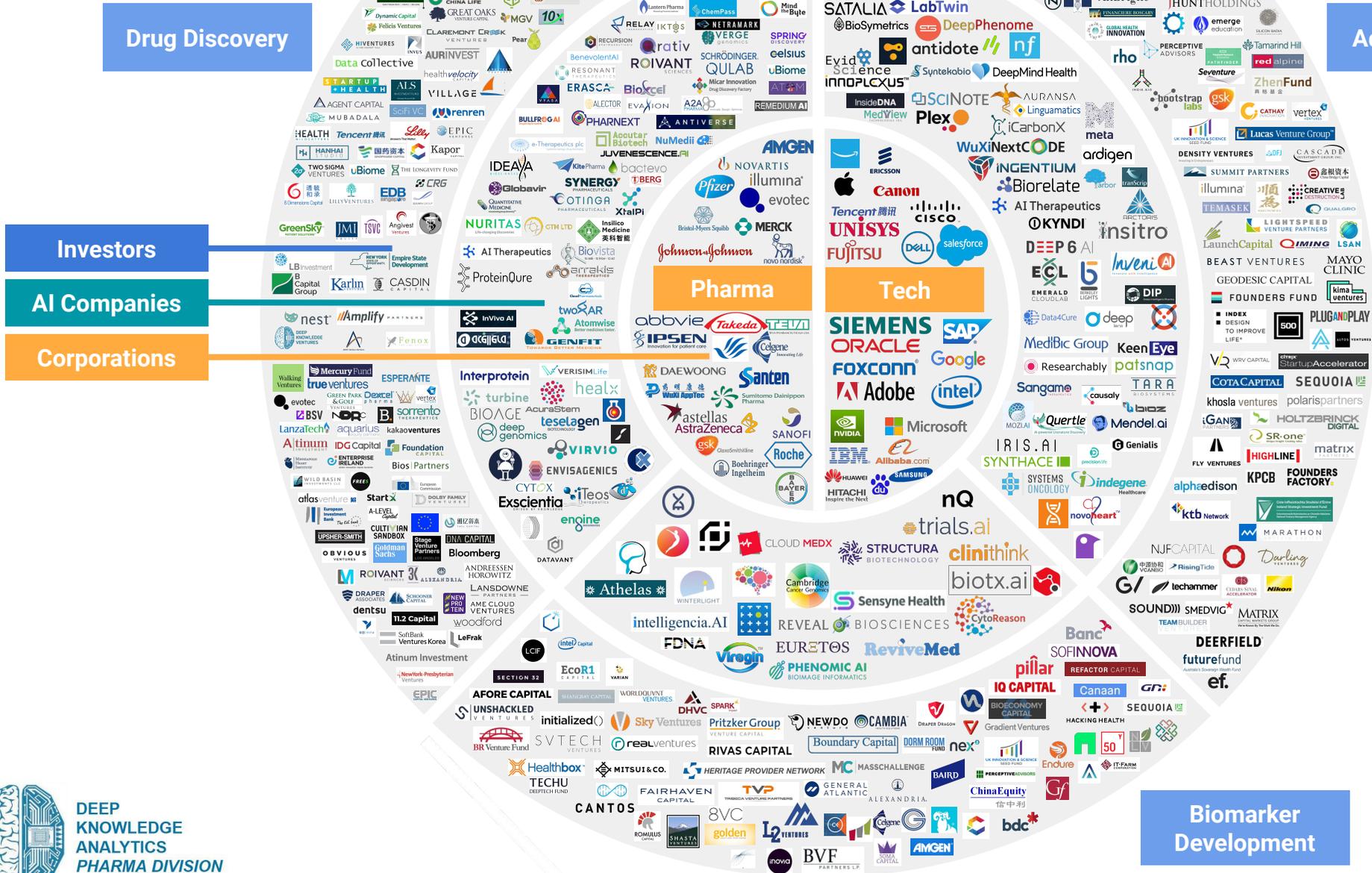
AI for Drug Discovery, Biomarker Development and Advanced R&D September 2019

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

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AI for Drug Discovery, Biomarker Development and Advanced R&D Landscape / 2019 Q2

AI Companies - 170
Investors - 400
Corporations - 50



Drug Discovery

Advanced R&D

Investors
AI Companies
Corporations

Pharma

Tech

Biomarker Development



Diversification of AI for R&D and Drug Discovery Process 2019 Q2

AI Companies - 170
Investors - 400

Companies

Investors

Design
Preclinical
Experiments



Preclinical
Experiment
Execution



Data
Aggregation &
Analysis



Drug Design



Clinical Trial
Design,
Optimization,
Recruitment



Repurposing
Existing Drugs



Researching
Mechanisms
of Disease



Introduction

Comparative Industry Analysis & Classification Framework delivers a comparison of 25 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.

Funding: by comparing the levels of funding that each company has acquired compared to its level of scientific validation (according to number of patents, publications and ratio of AI experts), it can deliver a sense for the ratio of efficiency of funding compared to the generated technical and scientific IP of each company.

Classification of Combined AI and Biochemistry Expertise: this section classifies each of the top 25 AI-companies according to their use of AI as a core part of their R&D operations, and their levels of expertise in biology and chemistry.

Classification of AI Expertise: this section presents a classification framework that categorizes companies according to major levels of AI asset classes, and applications of specialized AI-techniques. This framework takes into account the total ratio of AI specialists, the number of separate AI applications, the number of visible AI applications, and whether or not they are utilizing Deep Learning as a part of their products, services or core R&D.

This comparative analysis is an add-on to our *AI for Advanced R&D and Drug Discovery Q2 2019* report, 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 1 year now.

Goal and Applications of the Analytical Report

This report provides enhanced analysis of Leading AI-companies sophisticated, comprehensive and precise understanding of the challenges and opportunities, as well as what businesses such as pharma corporations and private biotech companies need to do in order to benefit, to enable investors, corporations and other industry participants to develop effective short and long-term strategies.

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

The analytical report analyzes and benchmarks the activities of 25 the most promising AI-companies. Also, the report is supplemented with a qualitative analysis and comparison of the best 25 companies.

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

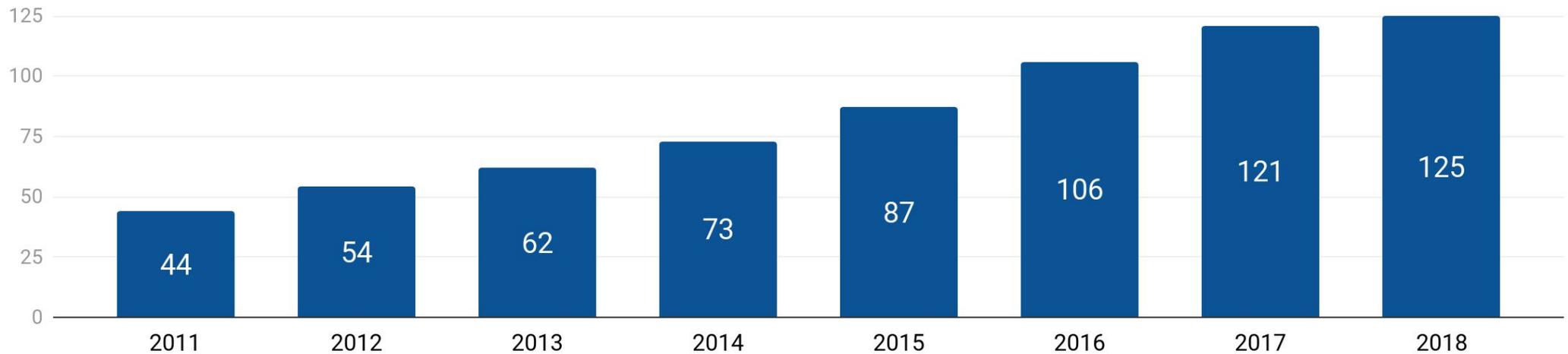
The findings of the report can be used for:

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

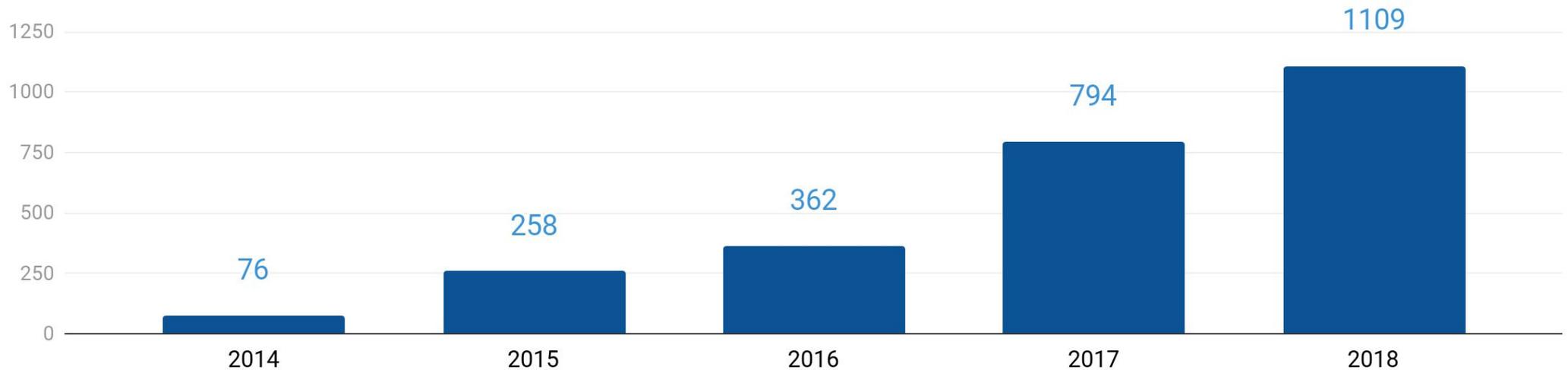
Organizations, who has an early access to our analytics will have deep expertise on how their strategic agendas can be optimized and stabilized in order to benefit and choose the best attractive companies for investments in AI-Pharma industry.

Amount of AI for Drug Discovery Companies & Amount of Investments in AI for Drug Discovery Companies

Number of AI Companies in Drug Discovery Sector

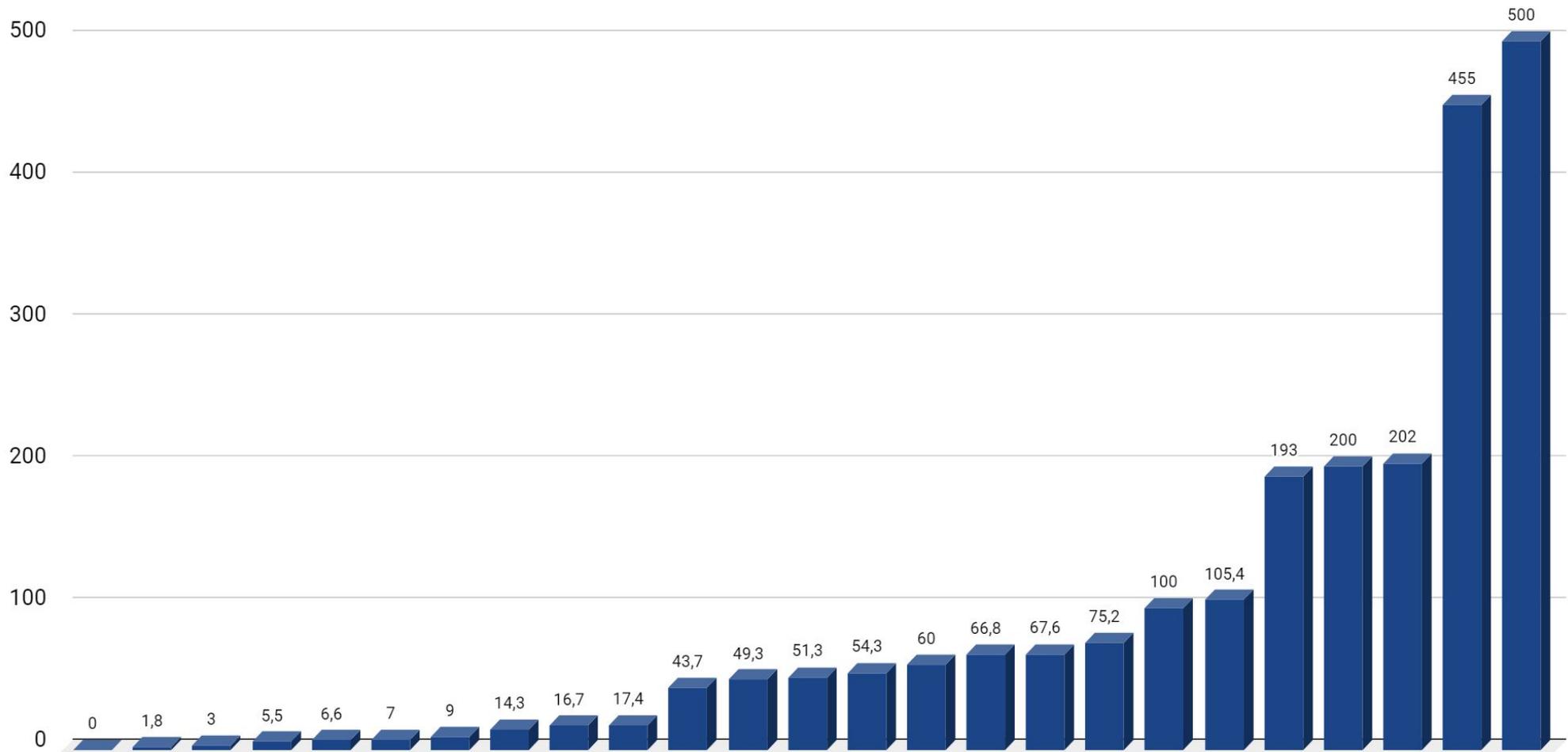


Amount of Investments in AI for Drug Discovery Companies (in millions USD) per Year



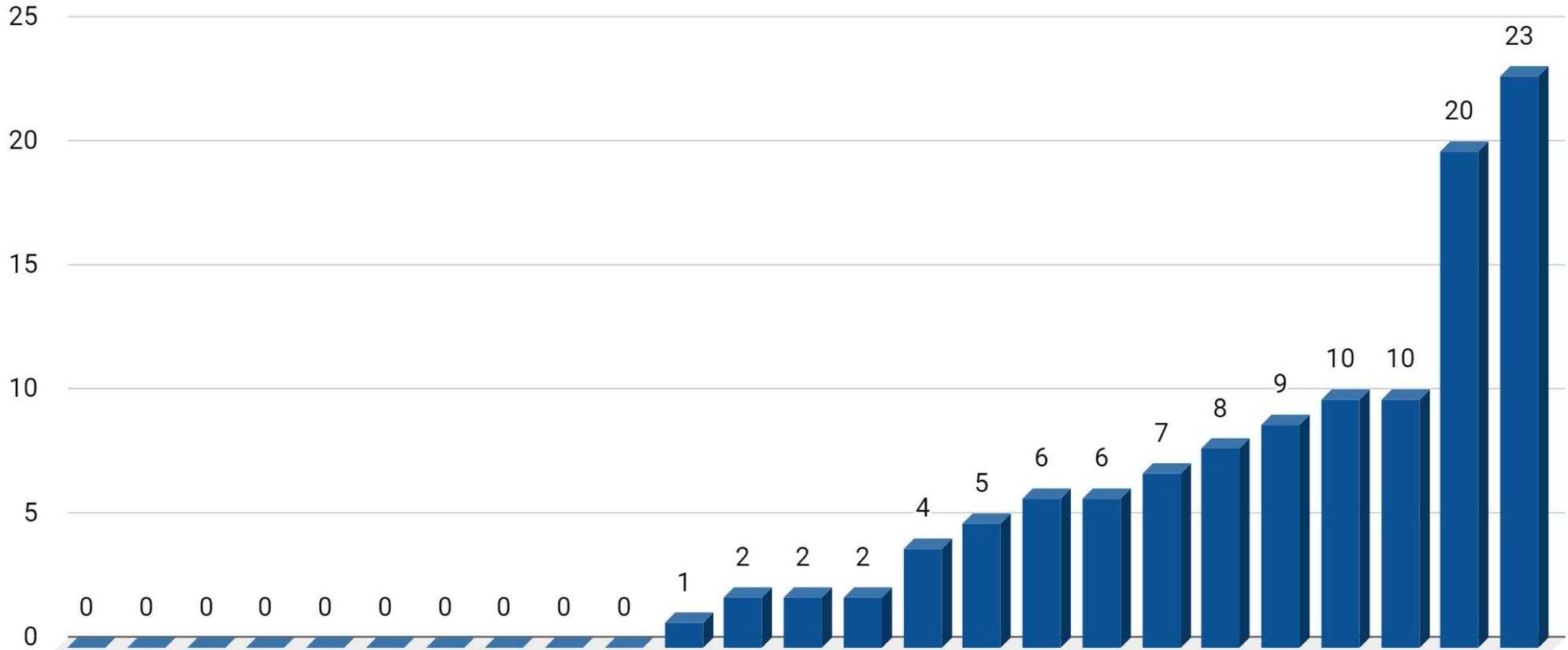
Comparison of Top-25 AI for Drug Discovery Companies

Funding, in millions USD



Comparison of Top-25 AI for Drug Discovery Companies

Number of Patents



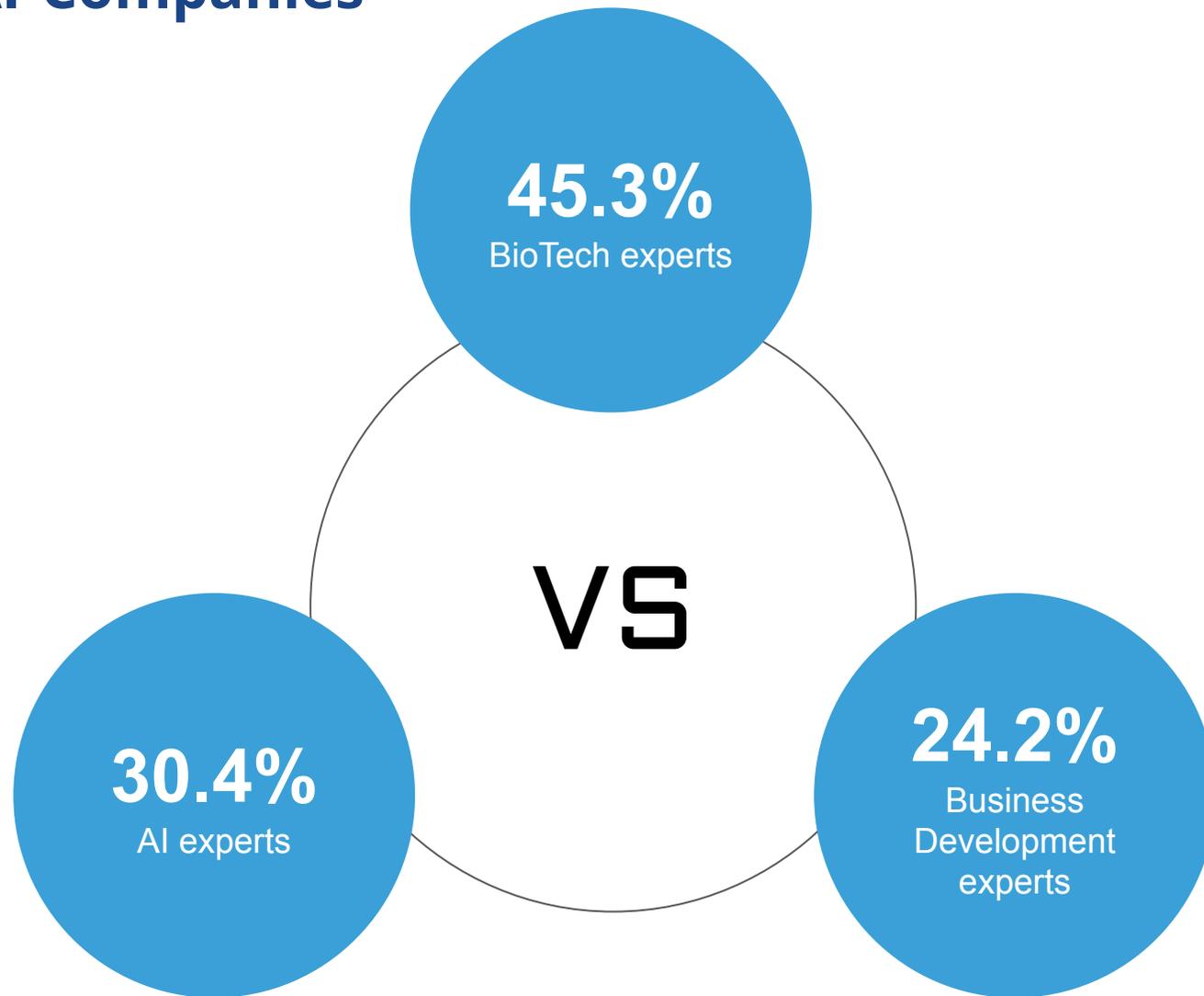
Comparison of Top-25 AI Companies: Level of Scientific Validation

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
Amgen	-	18/65	+	N/A
Amgen	+	6/30	+	N/A
Amgen	+	34/150	+	N/A
Amgen	+	1/18	+	+
Amgen	-	5/50	+	+
Amgen	-	7/26	+	+
Amgen	+	3/20	+	+
Amgen	+	11/33	-	N/A
Amgen	+	314/683	+	N/A
Amgen	+	5/23	+	N/A
Amgen	+	4/26	+	+
Amgen	+	26/101	-	N/A
Amgen	-	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
Amgen	+	16/46	+	+
Novartis	-	7/21	+	-
Genentech	-	2/7	+	+
Roche	-	4/16	+	+
Novo Nordisk	-	4/43	+	+
Novartis	+	58/25	+	+
Novartis Pharmaceuticals	+	14/105	+	+
Amgen	+	37/370	+	-
Novartis	+	4/18	+	+
Novartis	-	3/11	+	-
Novartis	+	13/232	+	+
Novartis	-	3/33	+	-

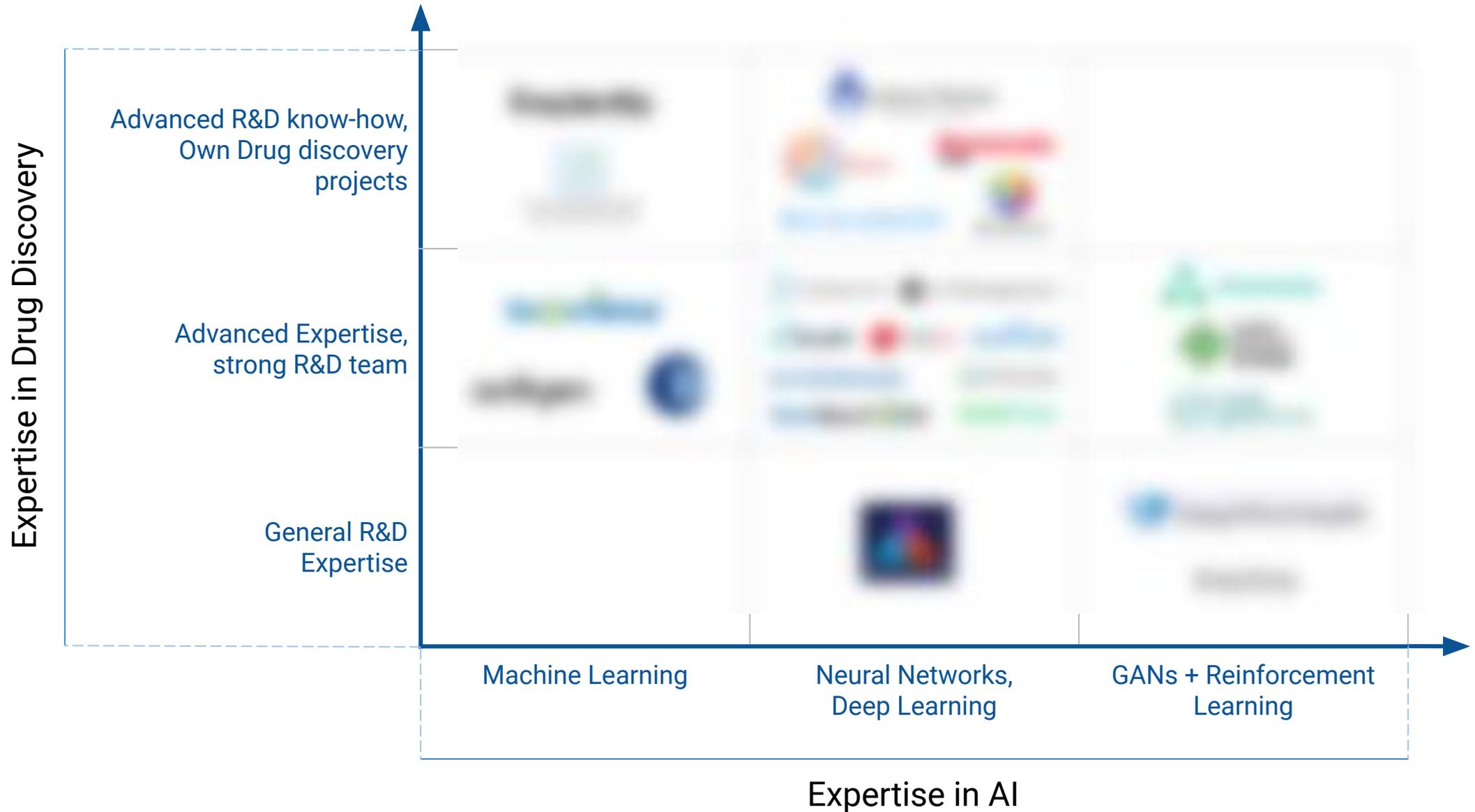
AI Experts vs BioTech Experts vs Business Development Experts In Top-25 AI-Companies



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. We might consider that the most balanced companies should be proportioned as 33% - AI experts, 45% Biotech experts, 24% - Business development specialists.

Comparison of Top-25 AI for Drug Discovery Companies

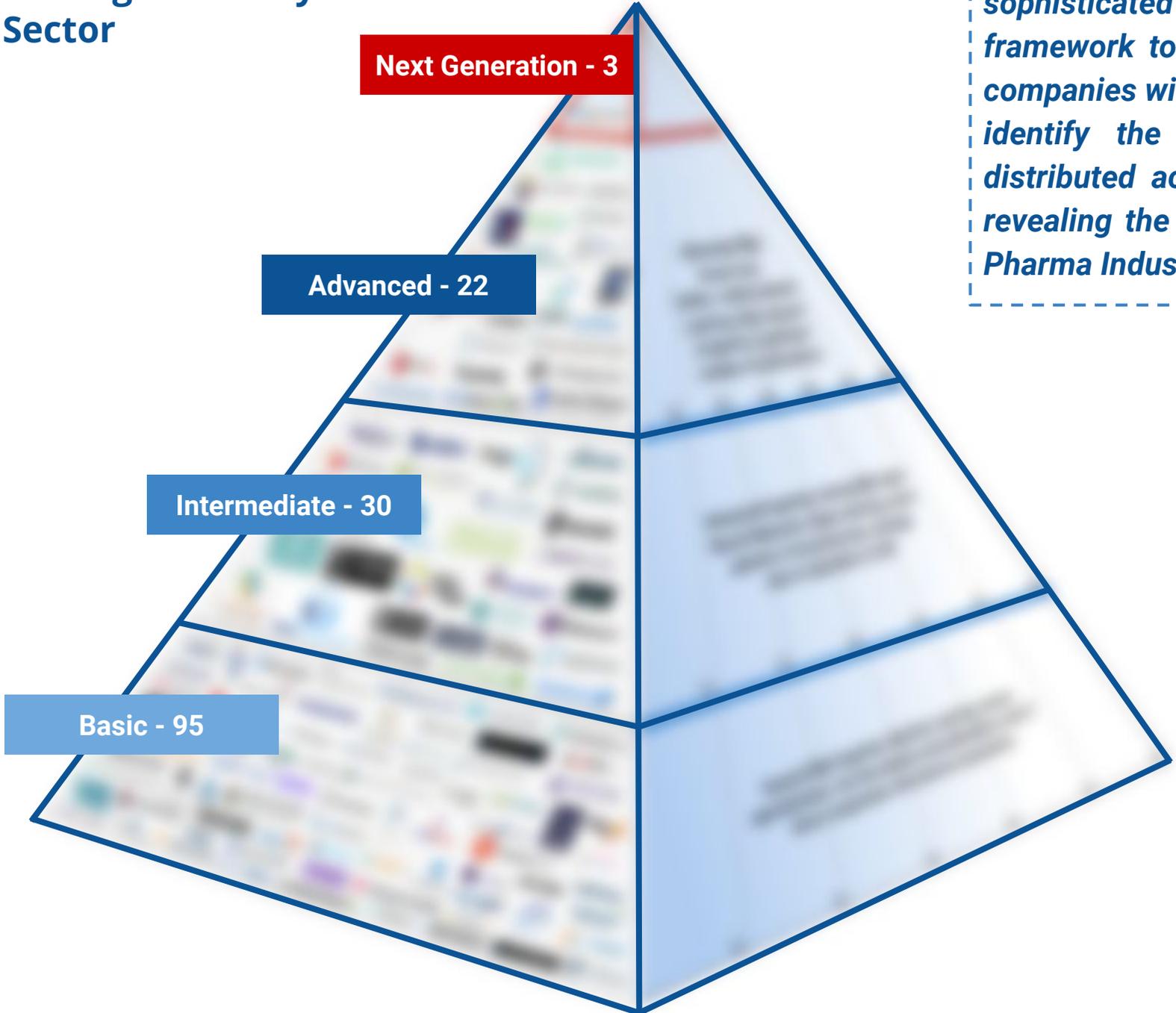
Expertise in Drug Discovery R&D / AI



Classification of AI Applications for R&D and Drug Discovery Process

Hypothesis Knowledge Discovery	Target ID Biology	Compound Generation	Compound Binding	ADME Tox	Clinical Trials	Personalized Medicine	Real World Insights

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

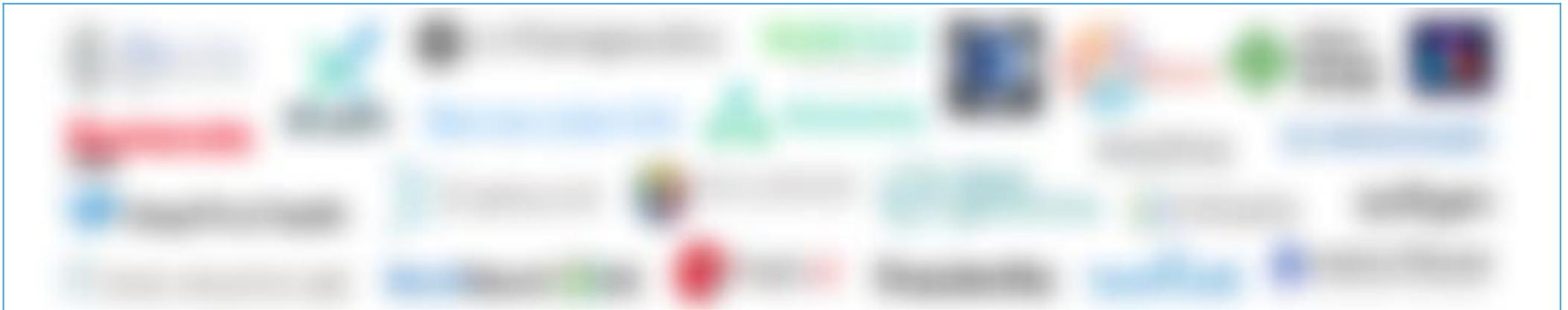


DKA Pharma Division has developed a sophisticated multidimensional analytical framework to benchmark the full scope of companies within the global AI in Pharma, to identify the Top-25 Leading companies distributed across distinct market sectors, revealing the untapped bottom of the AI in Pharma Industry iceberg.

“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,

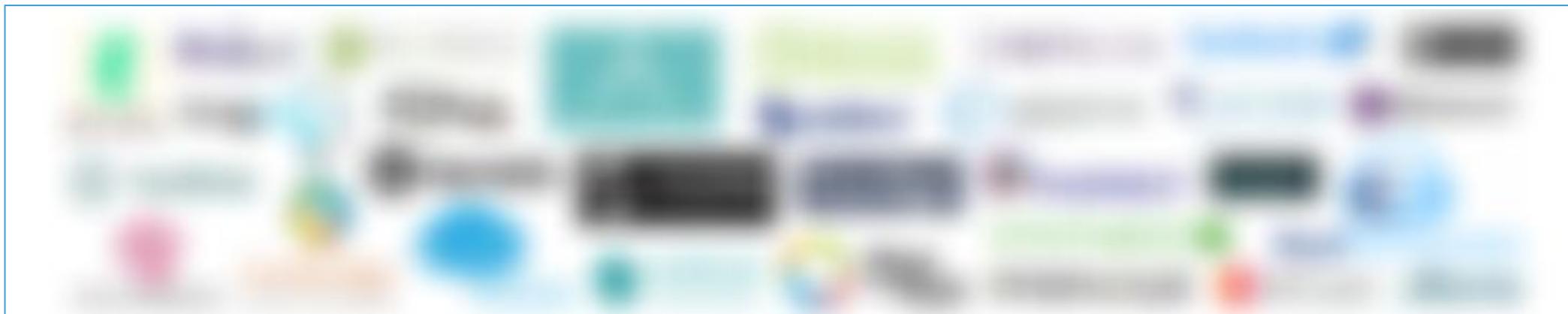
1. **Significant amount of patents and peer-reviewed articles in the domain of pharmaceutical research and AI technologies:** companies in this category are demonstrating significant advances in the application of AI to drug discovery tasks, which is reflected in a high number of research publications, 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 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.



“Intermediate AI” Group

The companies in this group still have significant know how in the AI for drug discovery domain, they were chosen based on the following criteria:

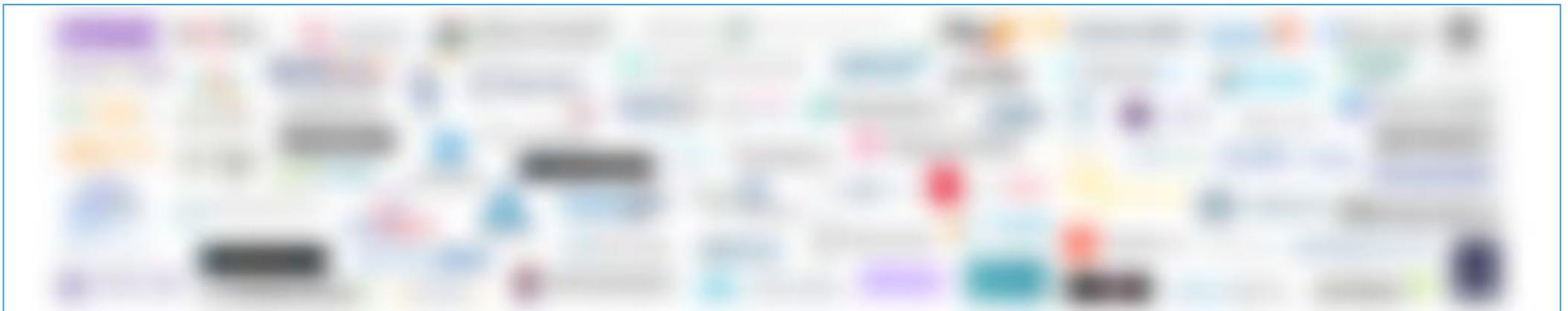
1. **Intermediate number of articles and patents:** their expertise is primarily in drug discovery or basic research, and they develop augmenting capacities in the AI-related technologies to boost core workflows.
2. **The ratio of AI specialist to other employees is average:** companies in this category typically have small-to-medium teams of AI experts collaborating with a core team of chemists/biologists.
3. **Direct collaborations with 30 Pharma and Tech Corporations:** companies in this category are supposed to have research collaborations with some of the 30 Pharma and Tech corporations, which is an indicator of a decent level of research capabilities.
4. **Average level of AI tech promotion:** companies in this list have a lower level of overall public presence and media coverage, compared to the “Advanced” Group. They participate in several top events regularly.



“Basic AI” Group

Companies in this group were chosen based on the following criteria:

1. **Low but non-zero number of research articles and patents:** these companies have a small number of research publications and/or patents covering only essential aspects of their technology. Typically, companies in this group are at the prototype or early validation stage of their technology/approach.
2. **The ratio of AI specialist to other employees is below average:** companies in “Basic” Group typically have a small number of AI-experts. They typically have early startup-like organizational structures, bootstrapping resources and human talent.
3. **Absence of officially announced collaborations with top 30 Pharma and Tech corporations:** companies in this list are typically in their early stage of development, and not yet established research ties with leading pharmaceutical or technological brands. Occasional companies in this list might just have entered in such collaborations lately, or are in the process of negotiation, though.
4. **Weak AI technology promotion:** companies in this list typically have small presence in media, public events and official forums. Their marketing teams are small, with the majority of resources allocated to developing core technological know-how.



Methodology

The infographic dashboard below displays geographical distribution of top-20 investors into AI-driven advanced healthcare and drug discovery companies. Top-20 Investors are mainly based in the U.S., followed by Chinese, United Kingdom and European Union companies.

The infographics outlines the Top-20 investors in Top-150 AI companies operating in the field of drug discovery and similar industries during 2012-2019. The header displayed at the top of the given infographic shows the key investors, the number of investments deals they made, and the top AI-powered biopharmaceutical and biotechnology companies that obtained funding/assistance.

Data on seed rounds, private equity, corporate rounds, venture funding, grants, as well as other types of funding rounds and non-equity assistance were collected and analysed according to various parameters set forth in Deep Knowledge Analytics evaluation criteria methodology. The Top-20 leading investors in AI for drug discovery and advanced health sector have been selected based primarily upon the following criteria:

- Number of investments (from 3 to 9) made in 150-AI Companies, specializing in Drug Discovery;
- The potential for equity and non-equity financing (lead investors in seed/venture rounds);
- Investors overall background, intangible assets and philosophy.

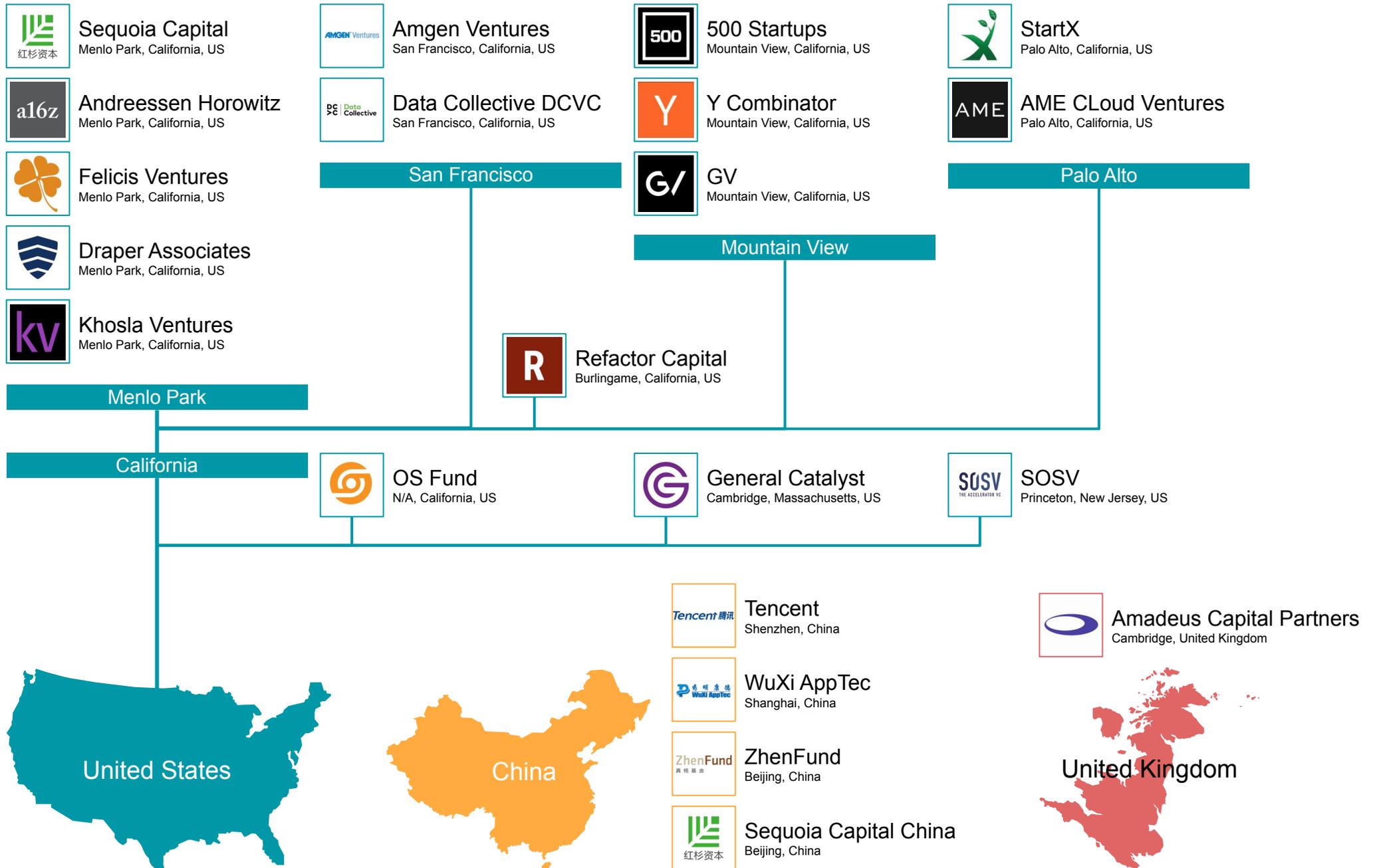
Within the framework of the given research, data related to over 500 investment deals, concluded by 320 private and corporate investors, were collected. The share of deals concluded in 2018 constituted circa 27% of the total number of investments.

The data table shows the top investors in top 25 biotech, biopharmaceutical research and development and advanced healthcare. The basic criteria underpinning the selection of the top investors in the aforementioned industries were as follows:

- Minimum 2 investments in top 25 companies;
- The volume of funding/financing;
- Investors' intangible assets/capacities.

The trend is that investors keep investing several times in the same companies due to established partnerships and business models that gained credibility.

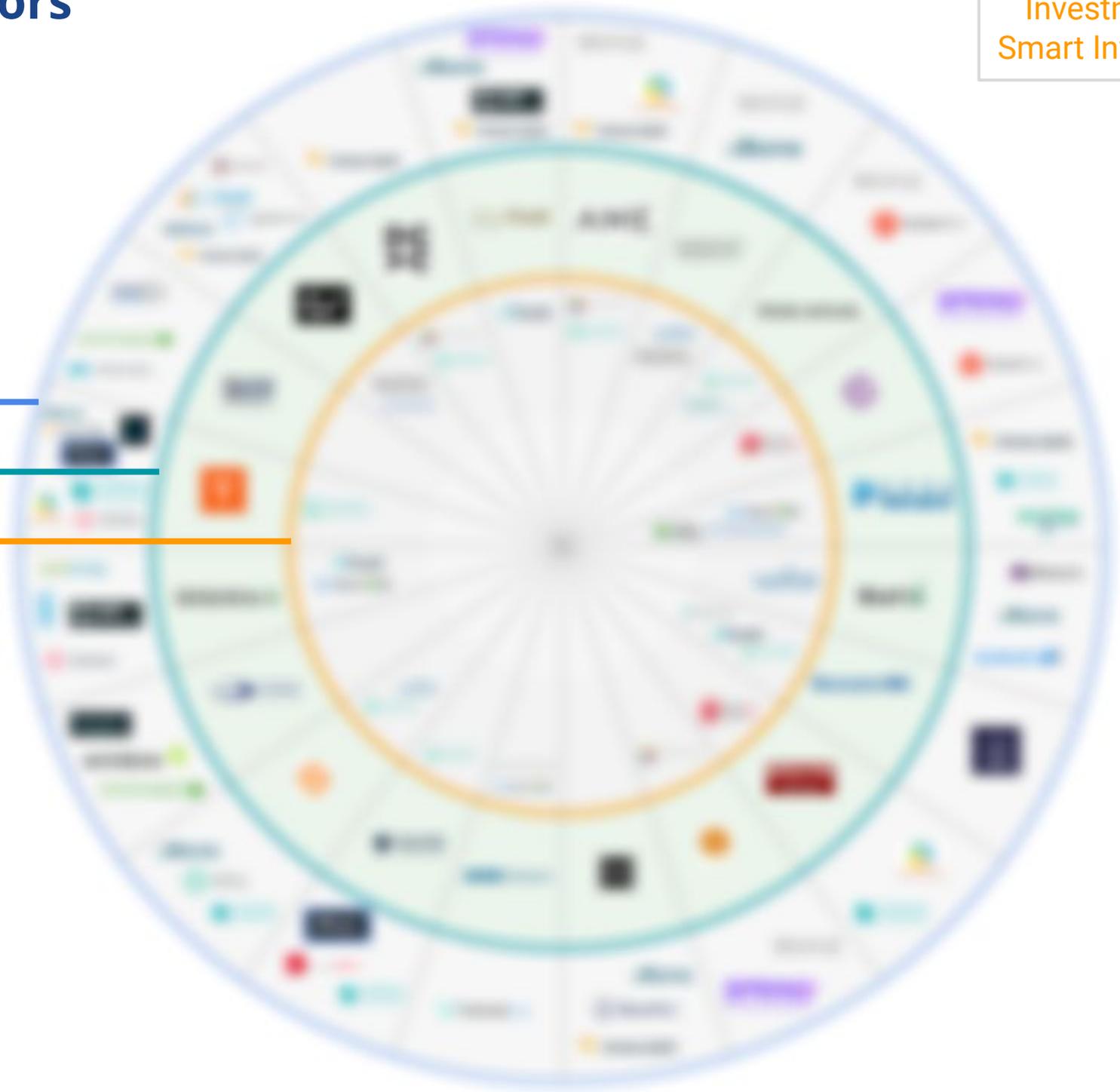
Top-20 AI for Drug Discovery Investors



Top-20 Investors AI in Drug Discovery

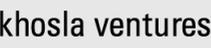
Investments vs
Smart Investments

- Other AI Companies
- Investors
- Top-25 AI Companies



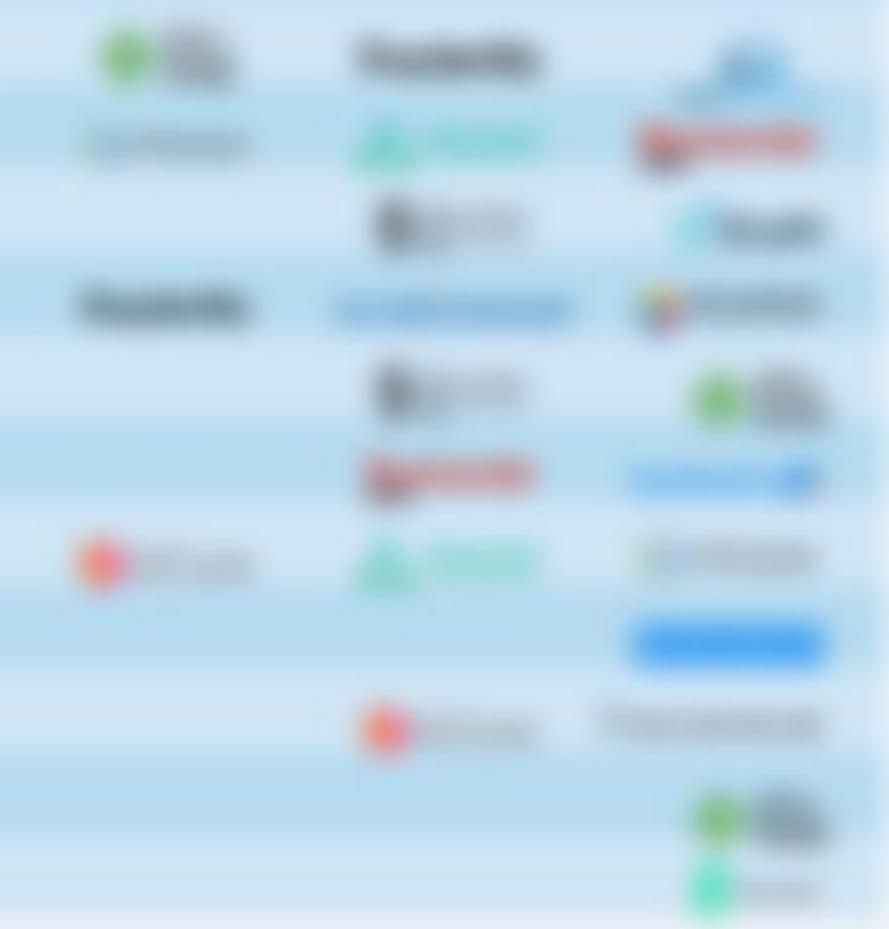
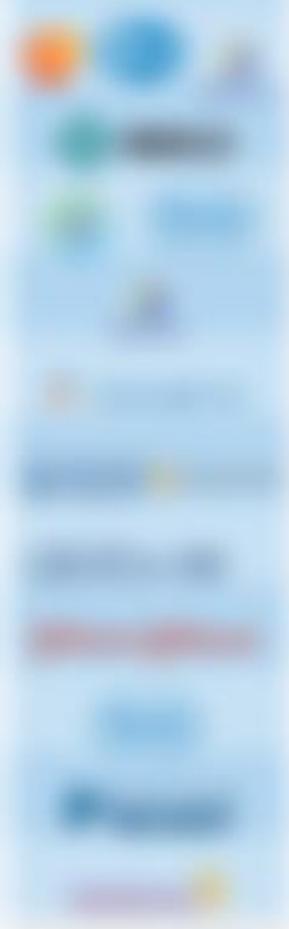
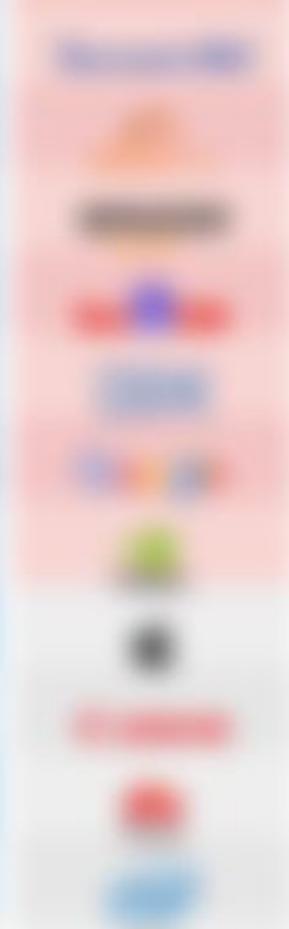
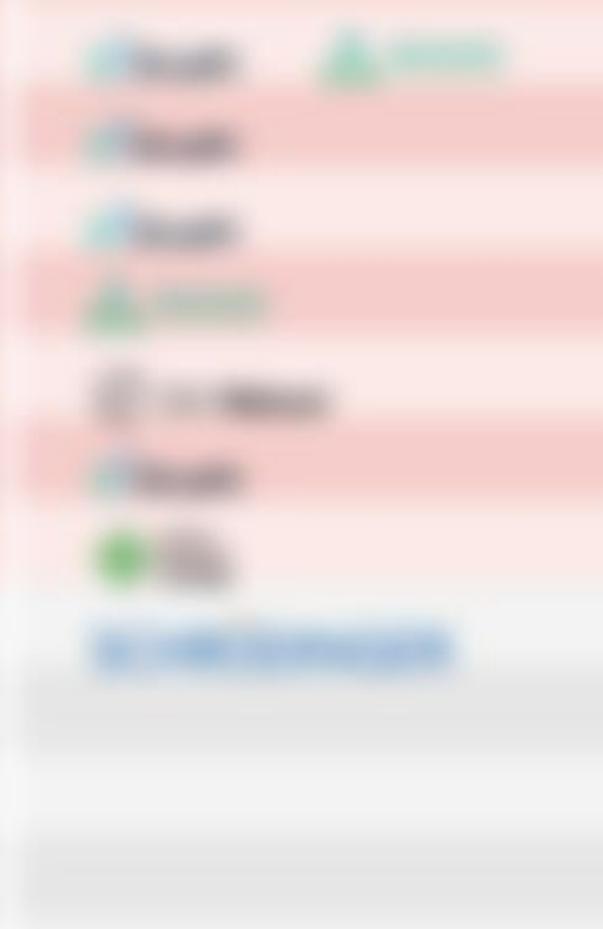
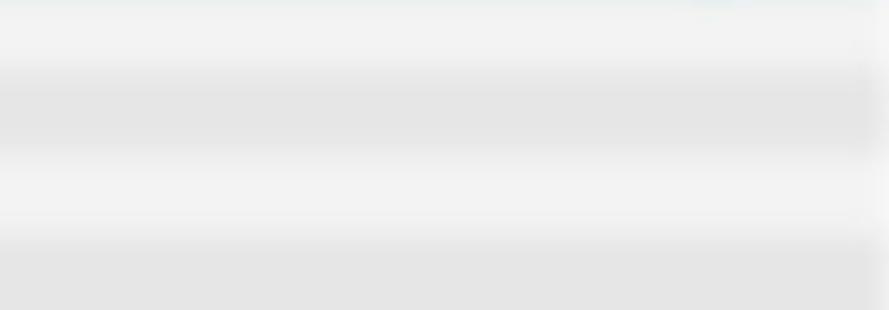
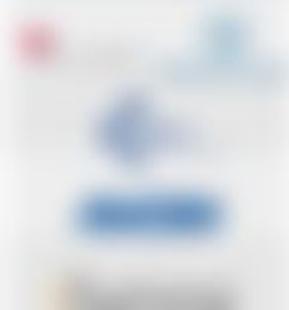
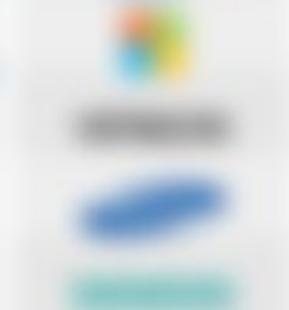
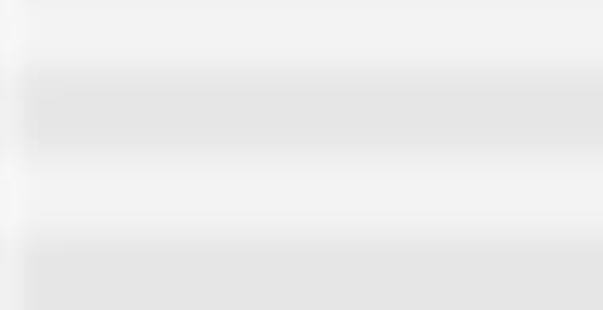
Top-20 Investors in 150 AI-Companies

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

Investments overall	INVESTORS	Investments overall
9	 Y combinator	 Sequoia Capital
8	 SOSV	 OS Fund
8	 GV	 Data Collective DCVC
8	 AME Cloud Ventures	 ZhenFund
6	 Khosla Ventures	 Andreessen Horowitz
6	 Amadeus Capital Partners	 WuXi AppTec
5	 General catalyst	 StartX
4	 Refactor Capital	 Tencent
4	 Felicis ventures	 Draper associates
3	 Amgen ventures	 500 startups

AI for Drug Discovery Partnerships, Investments, Acquisitions

Q2 2019

AI Companies	Pharma Corporations	Tech Corporations	AI Companies
			
			

Classification of AI Applications for R&D and Drug Discovery Process

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

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

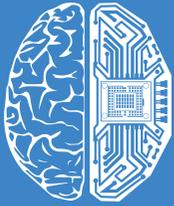
- What are the major threats and opportunities facing biopharma corporations regarding AI development in the industry?
- What are the main players in AI for drug discovery field? How are they categorized and differentiated?
- How can different institutions benefit from the AI for drug discovery development?

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

It will deliver:

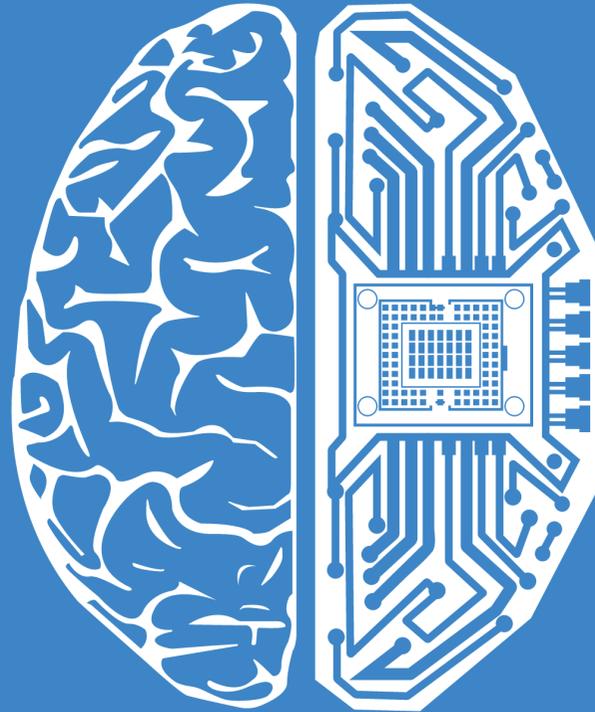
- Extensive analysis of the prospects of AI for Drug Discovery and Biomarker Development industry in terms of current trends
- 3-5-year forecasts providing information about the new game-changing biopharma instruments that will be market-ready by 2022-2025
- Practical guide to assemble the best possible tools and solutions allowing to benefit from the industry trends
- Overview of key market players in the AI for Drug Discovery and Biomarker Development 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 manage the usage of AI for Drug Discovery, to surpass the challenges and to utilize the opportunities related to these novel biopharma trends.



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