

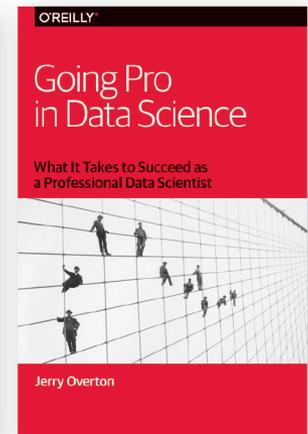
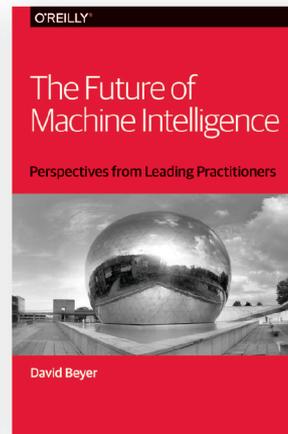
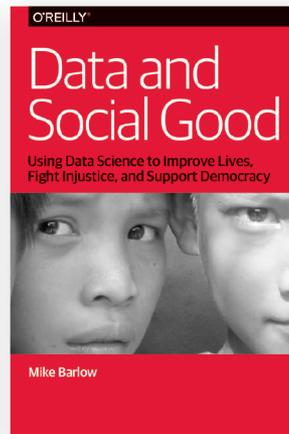
The New Artificial Intelligence Market

A Data-Driven Analysis of Industries and Companies Adopting AI



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Aman Naimat

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THE NEW ARTIFICIAL INTELLIGENCE MARKET

by Aman Naimat

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Table of Contents

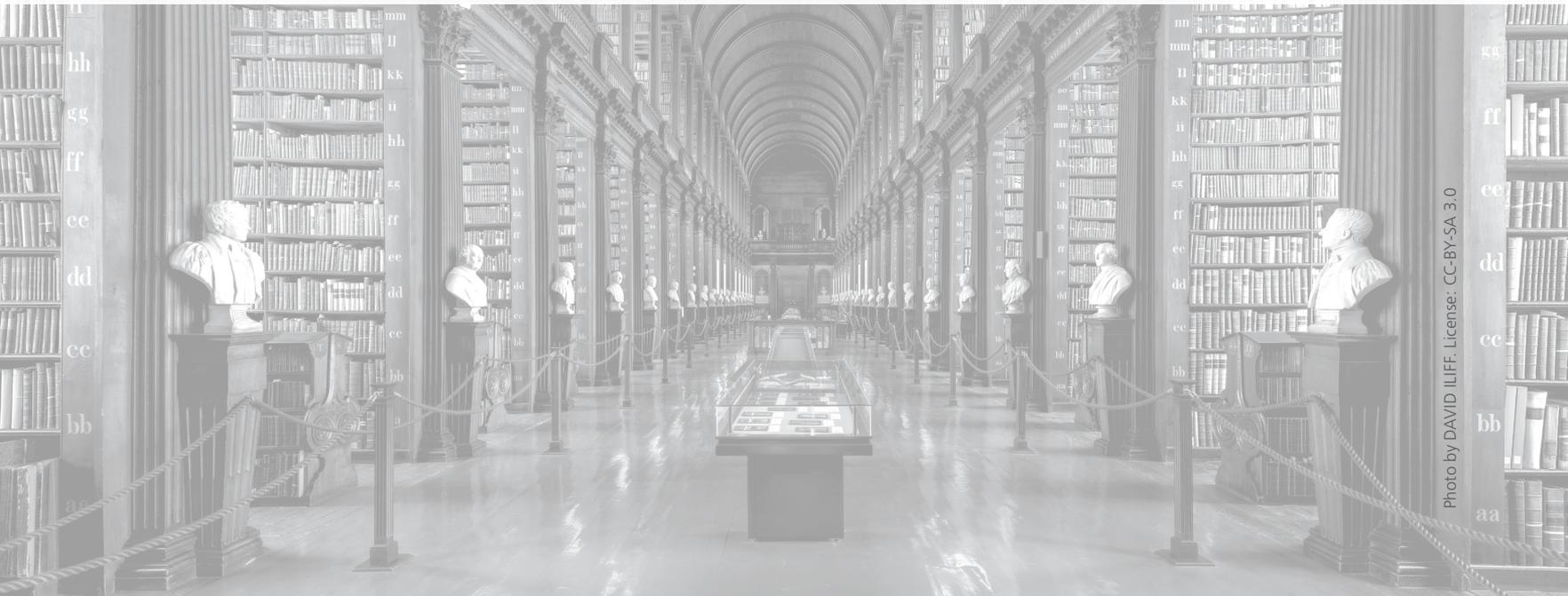
The New Artificial Intelligence Market	1
The Primordial Soup for Artificial Intelligence	3
A Word of Caution.....	4
Research for this Report	5
Investment in AI by Industry.....	6
Investment in AI by Company	8
Use Cases of AI	10
Adoption of Technologies in AI-Mature Companies	12
Summary	17



THE NEW ARTIFICIAL INTELLIGENCE MARKET

**THIS REPORT
COVERS AI AND
ITS ADOPTION BY
INDUSTRY**

THE GOAL IS TO CREATE A LANDMARK that can be used to study the future growth of AI and provide insight into what's happening right now in the world around AI.



IN 2004, IN THE MAZE-LIKE aisles of Stanford’s computer science department, I spoke to a man who resembled Santa Claus. This bearded man was John McCarthy, who coined the term *Artificial Intelligence* in the 1950s and was one of the founding fathers of Artificial Intelligence, along with Marvin Minsky. McCarthy spearheaded the effort for some time, including creating the language Lisp for the purpose of AI, among other innovations like time-sharing for computers, garbage collection, and lambda calculus. I was a graduate student studying natural language processing, and AI wasn’t as cool as it is today. Neither was natural language processing. It was far from the awe-inspiring concept it has become. But the thawing of the so-called AI winter was starting.

On that day in 2004, I stared at an old thermostat in the room, and my conversation with John McCarthy moved from the inability of relational databases to be introspective to AI. The thermostat was the boring kind found in every university and hospital. John, however, believed that thermostats could “think” and “have emotions” and “beliefs”, as described in

his essay found at <http://stanford.io/2a/WwVr>. He was disappointed at the state of the affairs of AI—or databases, for that matter. I don’t know if the founders of Nest know of or were motivated by his thinking on thermostats when they invented their beautiful device, but every time I look at a Nest, I remember John McCarthy and how quickly we moved from a dumb thermostat in that office to the one from Nest. While I am not sure how much my Nest “believes” in things, it certainly does a good job at managing its narrow task. It has models that predict the future and goals—set by me—that drive its behavior. It may not be everything we think as AI, but in only a few years, the thermostat moved a lot closer to McCarthy’s vision.

Professor John McCarthy passed away in 2011. Quite rapidly, AI moved from the labs of computer science departments and failed research attempts into the real world. The question I often ponder, along with everyone in the field, is whether AI is here to stay or if we are susceptible to another AI winter. The majority of people involved in AI are quite pragmatic and

THE NEW ARTIFICIAL INTELLIGENCE MARKET

looking to solve practical problems, which gives me confidence. I appreciate every Watson commercial that I see on TV because IBM is investing valuable marketing dollars in popularizing the AI vision, but I also get nervous about the possibility of over-promise and under-delivery by this very nascent technology.

Everyone is jumping into the fray. The CEO of Google recently announced that AI and machine learning will be the central component in all of their products. They are actually trailing companies like Amazon, which have already released really smart home products like Echo and Alexa based on AI and natural language understanding.

I remember how quickly we moved from a dumb thermostat in that office to the one from Nest

This report aims to cover the current market of AI and its commercial adoption beyond the academic labs into industry. We are at the cusp of mass adoption of AI. Big market predictions are being thrown around, and we must ground where we are with data. The goal is to create a landmark that can be used to study its future growth, though I do try to provide some color along with data on what is happening in the current business world around AI. The backing data provided is meant to be stand-alone and my comments are just one interpretation. The goal of the report is to provide guidance to industry on how their peers are adopting AI, and its general direction and use cases. The report makes no claims of predicting AI's future, and the scope of the project is restricted to companies operating in the U.S.

The Primordial Soup for Artificial Intelligence

AI REALLY JUMPED INTO MAINSTREAM industry in 2011 and 2012—ironically, right after the death of its founding fathers, McCarthy and Minsky. Turns out, there were many material reasons for AI to sprout around this time and many foundational technologies came together to create this perfect storm. The following are some technological innovations and market conditions that made AI accessible to mainstream developers and companies around the world:

Big data Infrastructure

The original MapReduce paper by Google spawned projects like Hadoop, which provided the infrastructure required for cheap, massive data processing required by AI.

Cloud computing

This advancement provided the ability for a graduate student to hire 100-node machines for a data processing job for a mere \$1000, something that would have previously required \$100 million in investments to build.

Massive amounts of data

Open source crawlers like Nutch have made knowledge accessible on the Internet. Also, copies of most pages found on the Internet are easily available to everyone thanks to open source repositories like commoncrawl.

Watson and Siri

While not always impeccable, both Watson and Siri should be credited for popularizing AI and making it approachable to the masses.

Venture funding

Since 2009, over \$10B of venture funding has been invested in the big data infrastructure required to build today's AI applications.

Qualified people

The number of people who can perform the various tasks for AI development, from data processing to data science, has grown tenfold.

A Word of Caution

BEFORE I DIVE INTO THE current state of AI in the business world, I would like to point out that most technologies available today are still far from a generalized AI. I define *generalized AI* as a system that can reason about the world, understand general problems, and solve them at super-human or even human-level intelligence. The main argument against modern peddlers of AI is that most are trivial bag-of-words models (aka *counting words*) being passed off as AI—they cannot think or do anything labeled as *cognition*. Please refer to these series of blogs by an AI researcher (<http://bit.ly/2aCfYyN>) on why we should not peddle our current AI as the AI promised to us in the 1960s. There are claims that Google DeepMind is generalizable and in theory it looks like one, but to me, it's still just playing games, and we haven't seen any other application.

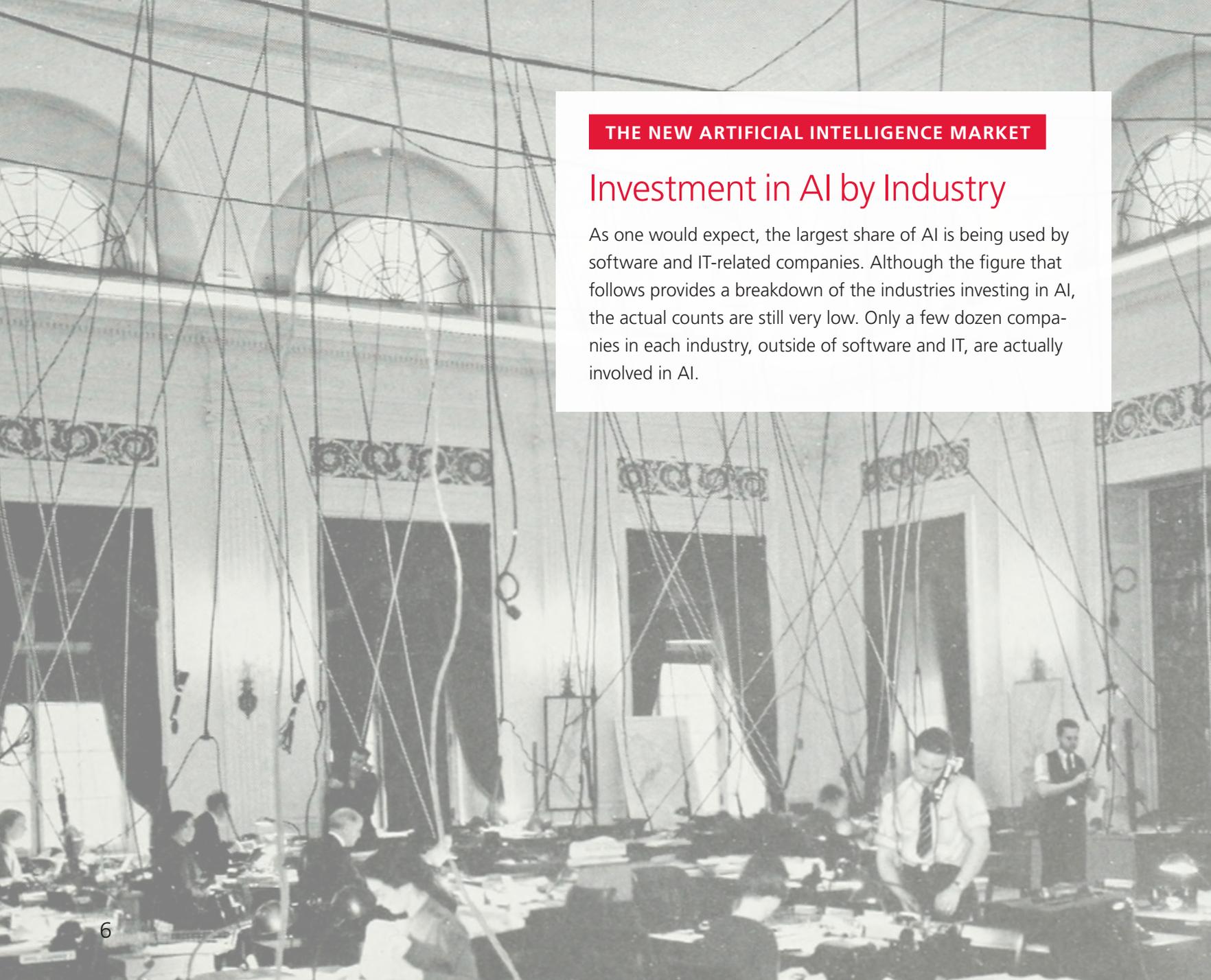
Having said that, there are pockets of technologies available that are achieving human- or super-human-level intelligence on a given human task (aka “narrow intelligence”). And it's not just a task done by a disinterested party, but a human who is very good at completing it. DeepMind beat the Go master—an achievement since, unlike Chess, Go requires human intuition and not just brute force calculations of every move. Image recognition has also reached and sometimes beat human-level performance. For example, our own AI-based engine for Spiderbook can best a good salesperson in coming up with a list of customers to target.

However, it is not the purpose of this report to argue what Artificial Intelligence is or is not'. Rather, I take a practical approach to the definition of AI and present an analysis based on self-identified businesses that claim to be using or building AI. I do not attempt to verify what people are calling AI, or discern between “good” AI or “bad” AI.

Research for this Report

TO CONDUCT RESEARCH FOR THIS report, my team used a graph-based machine learning model developed at Spiderbook that learns industry vocabularies around AI, reads the entire business Internet, and then classifies businesses into different levels of maturity and investments in AI. We canvassed almost 500,000 companies around the globe to develop a data-driven, in-depth understanding of the AI landscape and various related technologies, like cognitive computing, deep learning, machine vision, natural language understanding, and chatbots. The engine reads and understands billions of publicly available documents, including all press releases, business relationships, forums, job postings, blogs, tweets, patents, and proprietary databases that we have licensed. We use this data, which largely represents the business Internet, to create a knowledge graph that represents how companies are inter-linked and who is using what products or has employees with given skills. On top of this knowledge graph, we performed network-based machine learning to create a near-real-time snapshot of a company's priorities, projects, and investments. Let's dive into the results.

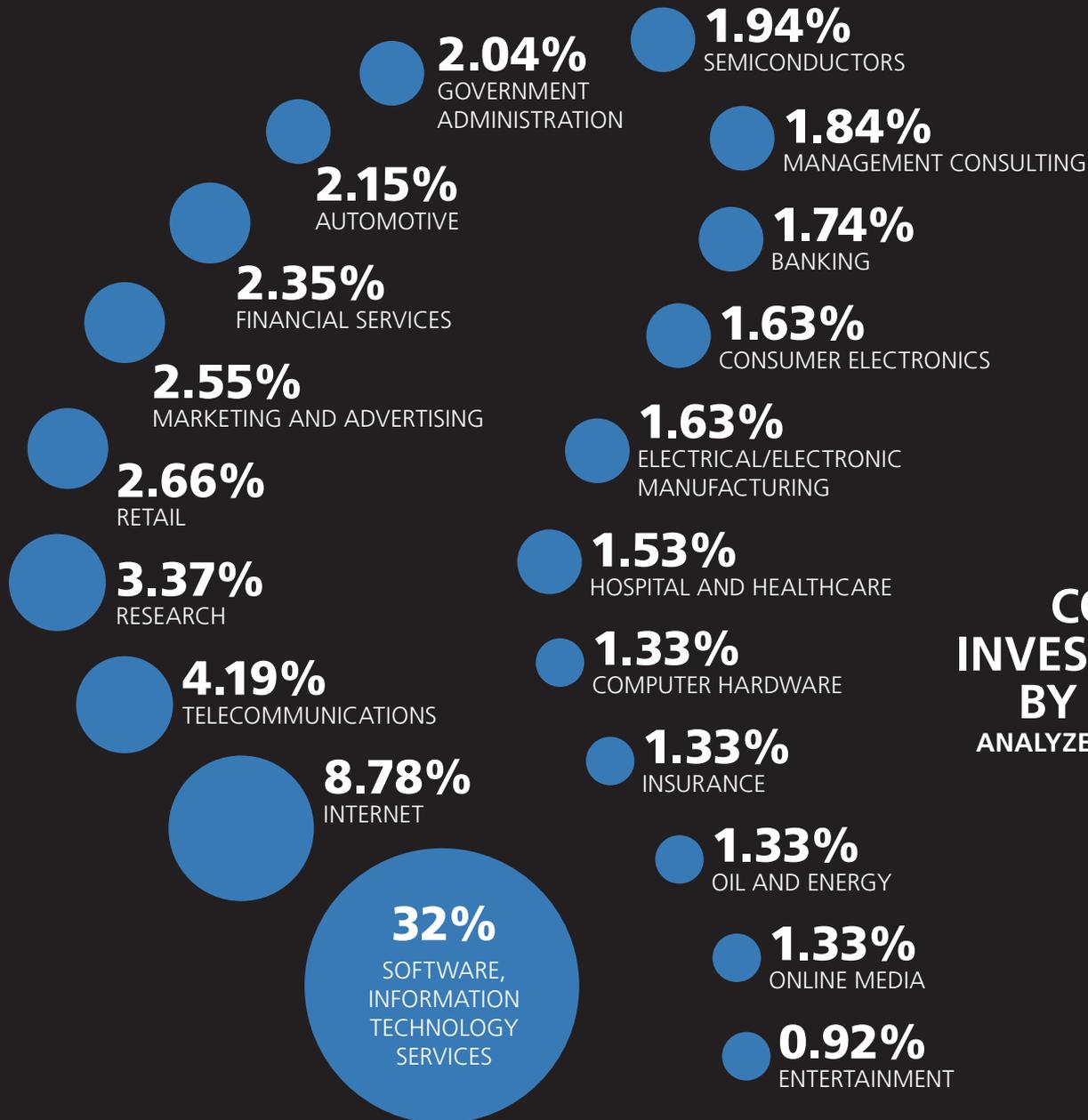




THE NEW ARTIFICIAL INTELLIGENCE MARKET

Investment in AI by Industry

As one would expect, the largest share of AI is being used by software and IT-related companies. Although the figure that follows provides a breakdown of the industries investing in AI, the actual counts are still very low. Only a few dozen companies in each industry, outside of software and IT, are actually involved in AI.



COMPANIES INVESTING IN AI BY INDUSTRY

ANALYZED BY SPIDERBOOK

Investment in AI by Company

There are only 1,500 companies in North America that are doing anything related to AI today, even using its narrow, task-based definition. That means less than one percent of all medium-to-large companies across all industries are adopting AI.

The table on the following page shows some of the companies that are actively investing in AI, organized by industry.

Even though less than one percent of companies in any industry are adopting AI, the companies that are adopting it seem to be the leaders of their industry. They are household names and the biggest, most successful companies in their fields. It's hard to discern the causal reason for this finding: is it because they are paranoid of their leadership positions? Or do they have extra resources to try out any new ideas, not just AI? Or perhaps these are the early adopters, laying out the groundwork for others in their respective industries to follow?

Top Companies Investing in AI

The following list shows the companies investing the most in AI, and talking about it as a core strategic driver for their business. There are the usual suspects, such as Google and Facebook, but also companies like MITRE Corporation, a nonprofit that operates federally funded research and development centers, that aren't household names:

1. Google
2. Facebook
3. Rocket Fuel
4. IBM
5. Amazon
6. Yahoo
7. Intel
8. Microsoft
9. Deloitte
10. MITRE
11. Baidu
12. LinkedIn
13. Apple
14. Cylance
15. Lockheed Martin
16. NASA
17. Sentient Corporation
18. Electronic Arts

TOP COMPANIES INVESTING IN AI, BY INDUSTRY

SOFTWARE AND IT	FINANCIAL SERVICES	MANUFACTURING	AUTOMOTIVE	INDUSTRIAL AUTOMATION
Google Microsoft Amazon Facebook Mitre IBM Deloitte	Bloomberg American Express TD Ameritrade Deutsche Bank Goldman Sachs BNP Paribas	Abb National Instruments Toshiba GE	Tesla Ford GM Toyota	Bosch Siemens Rockwell Automation Honeywell
HEALTHCARE	TELECOMMUNICATIONS	RETAIL	SEMICONDUCTORS	INTERNET
GE Healthcare Nuance Mayo Clinic Siemens Healthcare McKesson Massachusetts General Hospital	Huawei Nokia BT Group Orange S.A. Nippon Verizon	Walmart Gamestop Target Rakuten Best Buy Barnes & Noble	Intel Texas instruments Microchip Technology Altera Imagination Technologies ARM Mellanox Qualcomm	Google Facebook LinkedIn Amazon

Use Cases of AI

I recently watched a panel of luminaries in AI, organized by the Milken Institute, speaking about their vision on what is going on in AI and what's now possible using such technologies. Ideas suggested by the panel were a lot more exciting—some extreme, and many more humane—than the actual applications of AI today. The ideas ranged from human disease diagnostics to farming to elderly care. However, based on our machine-intelligence-based research, the predominant applications of AI seem to be more banal and routine automation of tasks done by humans. The figure that follows quantifies how corporate budgets are being spent on specific AI-based use cases.

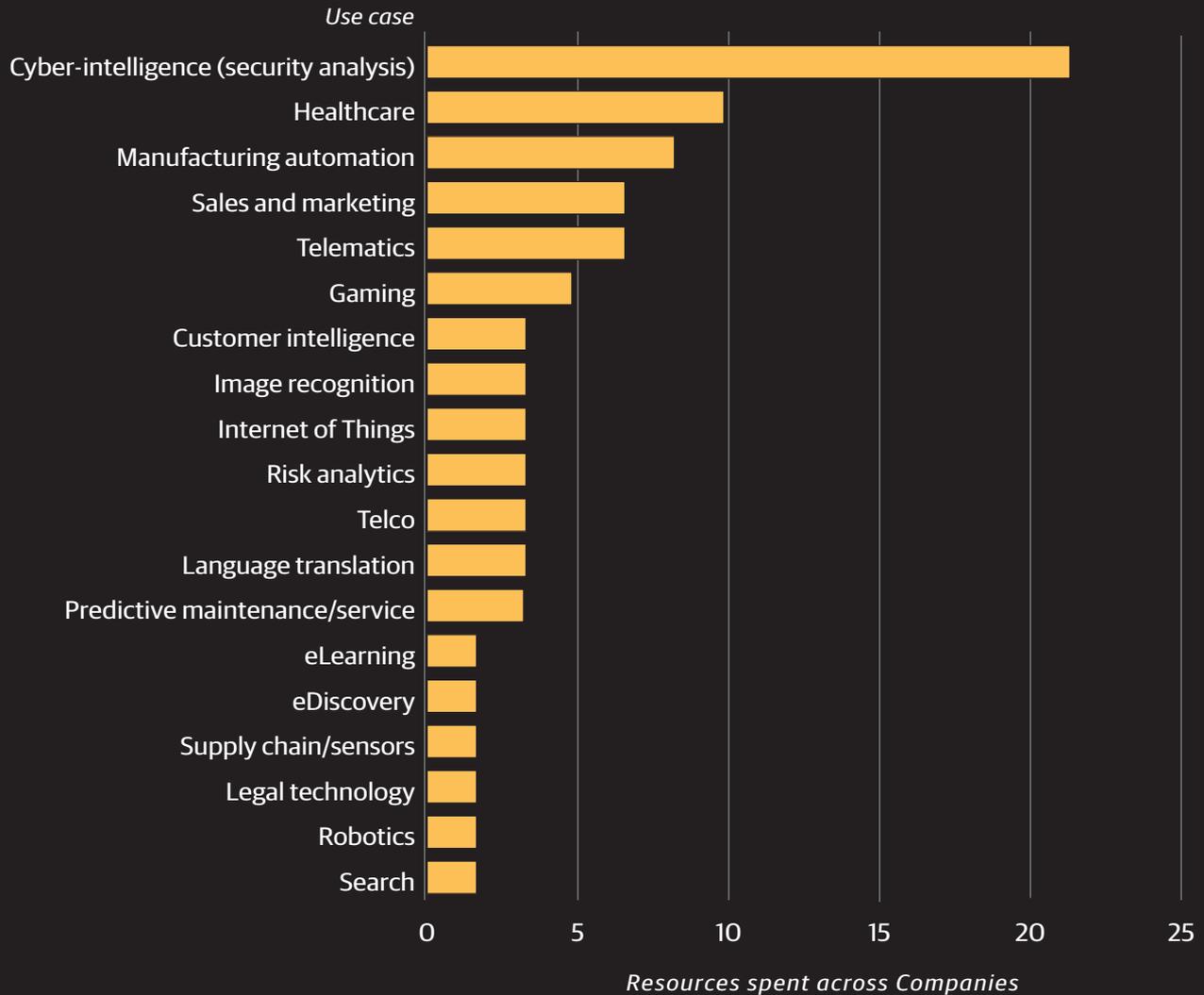
There are some novel applications in this graphic that are beyond task automation. For example, use cases like telematics, IoT, and robotics have industry-wide implications, and represent more than just human task automation.

Cyber-Intelligence and Security: A Major Driver for AI

It is also surprising to see such a wide application of AI in the world of cyber-intelligence, an area that isn't a big topic of conversation in AI circles yet, although large amounts of budgets are clearly being invested in this area.

There are more companies building, consulting, or using AI for cyber-intelligence than any other use case. Perhaps there are more threats in society than what's reported, since companies do not have natural incentives to publicize them. Or, perhaps this is an epiphenomena of continuous funding from the U.S. government focused on this vertical.

USE CASES OF AI BY PERCENTAGE OF RESOURCES SPENT





THE NEW ARTIFICIAL INTELLIGENCE MARKET

Adoption of Technologies in AI-Mature Companies

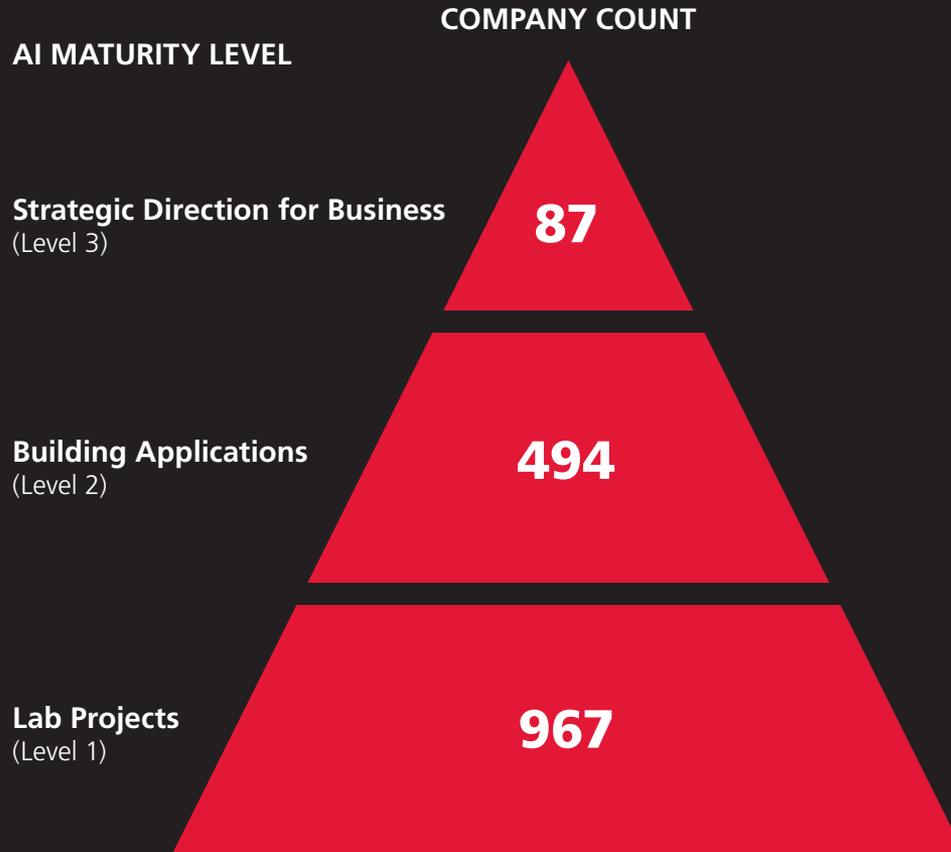
Over the last decade, there have been waves of AI-related algorithm *du jour* for solving classical problems such as classification or natural language processing. Some algorithms stick around for larger adoption, based on their efficacy and applicability to the problems, but most fade out. Latest innovations in algorithms have been in the area of deep learning, a position previously held by latent dirichlet allocation (LDA), semi-supervised learning, Latent Semantic Indexing (LSI), Support Vector Machines, and so on. Some of these technologies have become a class all their own, even though there is a lot of overlap in the problems they solve. For example, deep learning can be used for natural language understanding (NLU), cognitive computing, or even autonomous vehicles, although it's mostly used for image processing.

A breakdown of AI adoption does not provide a fair picture of the current level of AI maturity in the market. The following two figures detail how many companies are using these AI technologies beyond lab experiments (i.e., those developing applications based on it or deploying it across the company).

The second figure that follows shows subcategories of AI technologies, and the number of companies investing in those spaces.

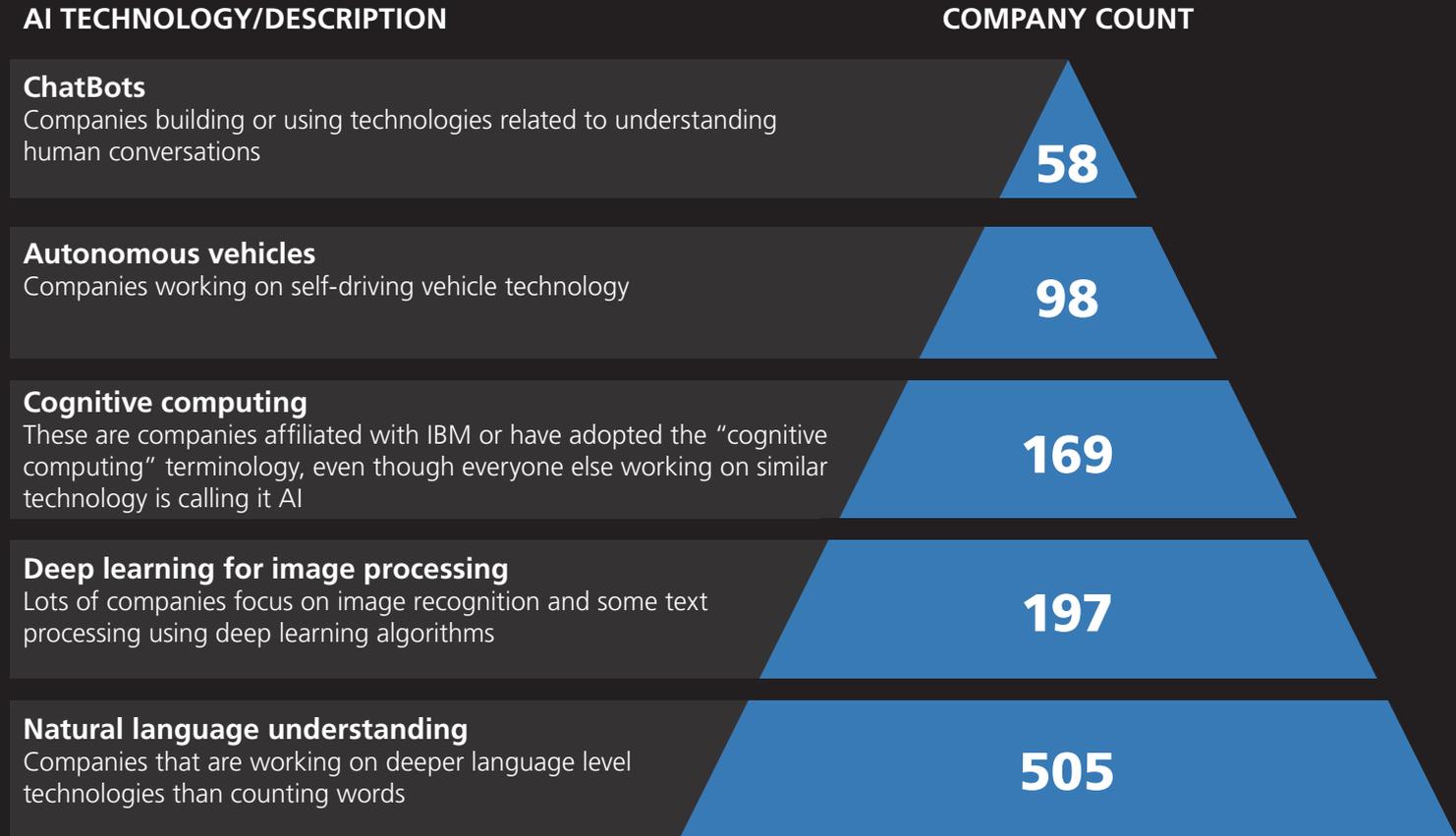
AI MATURITY LEVEL

COMPANIES ACTIVELY USING AI TECHNOLOGIES BY LEVEL OF MATURITY



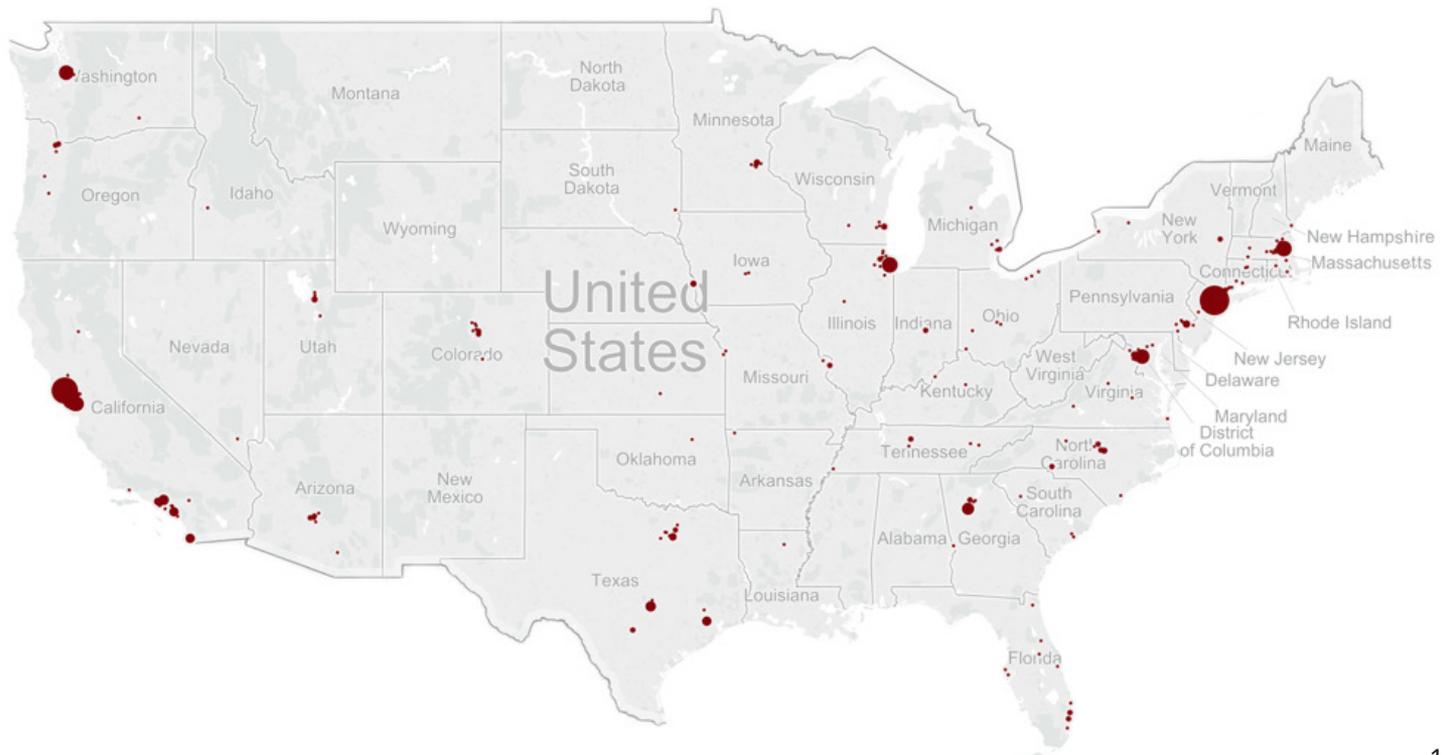
AI TECHNOLOGY SUBCATEGORIES

SUBCATEGORIES OF AI TECHNOLOGIES AND COMPANIES INVESTING



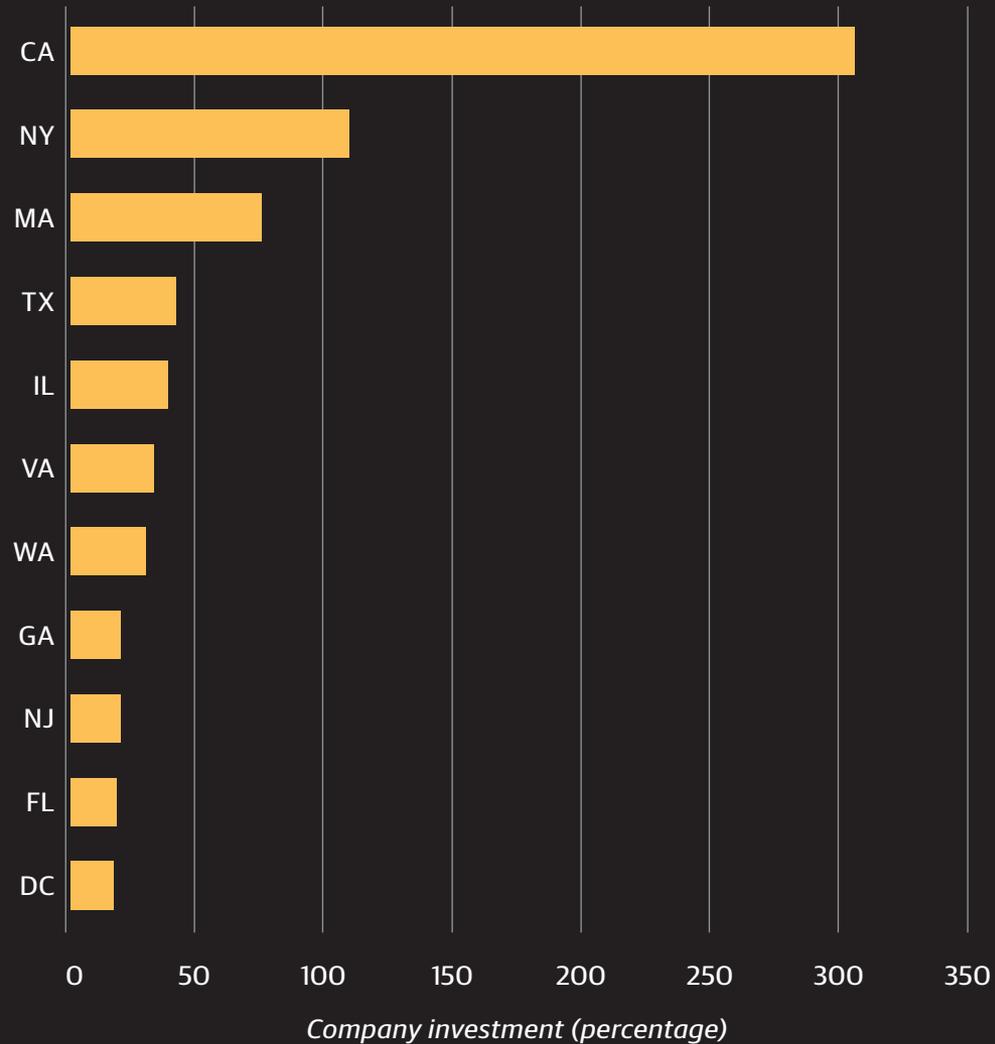
Physical Locations of AI-Oriented Companies

The physical presence of companies adopting AI is very bi-modal, even more than high-tech in general. For example, my previous report on *The Big Data Market* showed companies more geographically distributed than the companies adopting AI. Perhaps we can all guess where the singularity will arise. See the figure that follows for a state-by-state breakdown.



NUMBER OF COMPANIES INVESTING IN AI BY STATE

State



Summary

The AI winter has thawed, and it's moving into spring. While the AI movement is still very much in its infancy, the promise and recent gains around task-based AI has created a buzz. There are some focused sets of use cases like cyber intelligence, sales and marketing, and manufacturing automation that already have AI-based products in the market. Generalized problem solving and healthcare applications are topics of intense conversation, but not many companies are investing in them with their budgets.

The rise of AI was triggered roughly five years ago by government and private investments in big data technologies, cloud infrastructure, and, most importantly, the general availability of talent. Just within the last few months, major companies like Amazon, Tesla, and Google have highlighted AI as the driver for the next decade of innovation within their companies. But there is a small core set of companies adopting AI across the board, and less than 1,500 companies operating in the U.S. are investing anywhere near the space. While that is a small percentage of industry, the companies leading the movement are the biggest and brightest, and certainly have the most to gain (or lose) from AI becoming a reality.

