

## ARTIFICIAL INTELLIGENCE

DISRUPTIVE INDUSTRY REVIEW

AUGUST 2017

# ABOUT THIS ARTIFICIAL INTELLIGENCE INDUSTRY REVIEW

In addition to traditional financial analysis, OLMA Next Fund undertakes reviews of certain industries and businesses that are of interest for current and future potential investments. These reviews are for internal use by OLMA partners and analysts to provide them with insight into those industries and businesses, and relevant links to other information resources to assist them to perform their own analyses.

OLMA Next is pleased to share its review of the promising Artificial Intelligence industry and hope it will shed light on the industry's revolutionary technologies that are impacting all fields related to human perception, thought and decisions and perhaps the destiny of human life on earth.

## OLMA NEXT Select: Eight Publicly Available AI Industry Research Studies

OLMA Next has selected the following publicly available research reports for readers who desire more detailed analysis of aspects of the AI Industry:

- Artificial intelligence: The next digital frontier?, McKinsey Global Institute, June 2017.
- Why Artificial Intelligence is the Future of Growth, Accenture, Mark Purdy and Paul Daugherty, September 2016.
- Sizing the prize: What's the real value of AI for your business and how can you capitalise?, PwC, June 27, 2017.
- Artificial Intelligence Market Forecasts: Executive Summary, Tractica, 2Q 2017.
- Thematic Investing: Robot Revolution – Global Robot & AI Primer, Bank of America Merrill Lynch, December 16, 2015.
- AI-Ready or Not: AI-READY OR NOT: Artificial Intelligence Here We Come!, Weber Shandwick & KRC Research, October 2016.
- Cognitive technologies: The real opportunities for business Deloitte Review Issue 16, Deloitte University Press, David Schatsky, Craig Muraskin, Ragu Gurumurthy, January 26, 2015.
- WCP Issues M&A Report on Artificial Intelligence Sector, Woodside Capital Partners Industry Reports, January 19, 2017.

## OLMA Next Fund

OLMA Next is contemplating the launch of a fund that will focus on current and future disruptive market leaders. With its combination of youth and experience, OLMA Next plans to scrutinize high performing businesses in developed and emerging markets.

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# ARTIFICIAL INTELLIGENCE: THE NEXT BIG THING?

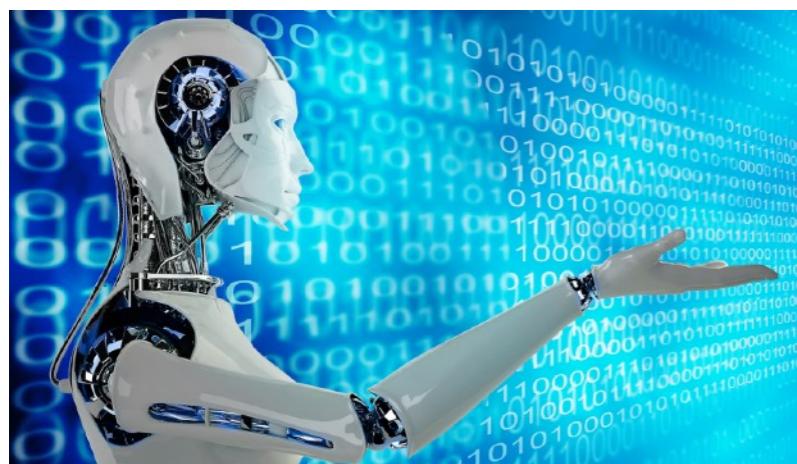


The exponential increase of the power of computer processors and the accumulation of collections of “Big Data” over recent decades have provided the entry point for Artificial Intelligence to have a growing impact on every aspect of life throughout the entire world.

For business, AI promises not only to help to reduce labour costs but also to create new opportunities and assist companies to strategize, evaluate options, calculate probabilities and make smarter decisions. Artificial Intelligence is a new “revolution” that will rival the agriculture and industrial revolutions of previous millennia for influence.



*The Oxford Dictionary defines Artificial Intelligence (AI) as the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.*



*“Often people only think of AI boosting growth by substituting humans, but actually huge value is going to come from the new goods, services and innovations AI will enable.”*

David Autor - Professor of Economics, MIT

## Key Figures and Facts

**\$8B** TOTAL REVENUE FOR AI TECHNOLOGY MARKET IN 2016

**\$47B** TOTAL REVENUE FOR AI TECHNOLOGY MARKET IN 2020

**62.9%** EXPECTED AI MARKET CAGR FROM 2016 TO 2022

**\$20B TO \$30B** INVESTMENT BY TECH GIANTS IN AI IN 2016

**550** AI STARTUPS FUNDED IN 2016

**\$5B** FUNDING FOR AI STARTUPS IN 2016

**\$12.45B** TOTAL AI STARTUP FUNDING OVER THE PAST FIVE YEARS

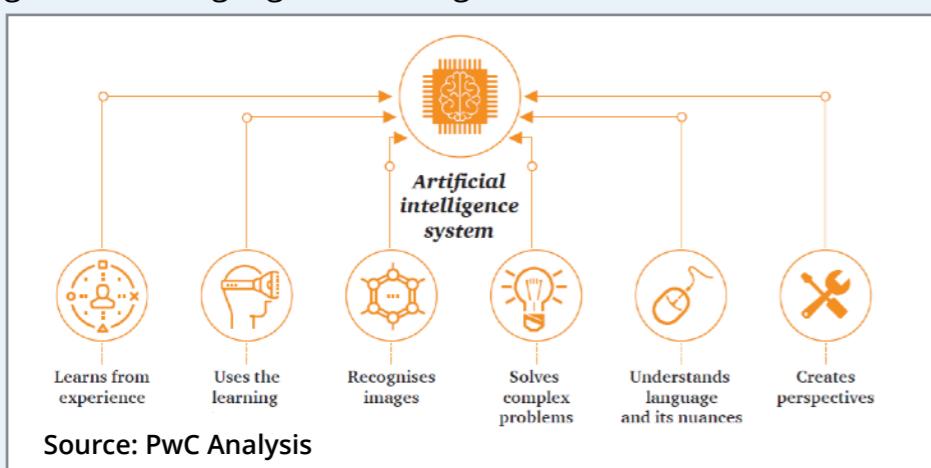
# SUMMING UP: THE MACHINES WISE UP

## The Development of AI Technology

Until recently, anthropomorphic robots like C-3PO, the Terminator or RoboCop represented the pop culture image of Artificial Intelligence (AI). Hollywood provided them with expressions that imitated human behavior and evoked emotions such as kindness, humor and fear. Now, after decades of confinement to science fiction circles and research institutes, AI and its various component technologies have made their real-life debut in many forms such as the entertainment and search assistants Siri, Google Home and Amazon Alexa.

In just the past five years AI has emerged as a grand Fountain of hundreds of products and services that will transform life at work, home and leisure worldwide. Businesses now vie to incorporate AI in all manner of products from consumer to industrial and happily use the term AI as a marketing hook in mass market product advertising: *"Our AI is better than their AI!"*. Although consumers are becoming familiar with the technology, applications of AI are present in many aspects of life with neither the consumer's awareness nor consent.

Previously most AI applications provided intelligent prediction tools for better decision-making by using data that businesses already generate such as sensors that track industrial operations. Artificial Intelligence is now a broad term that encompasses many diverse technologies and sub-technologies. Some of the most promising AI technologies are Machine Learning and its subset Deep Learning, Natural Language Processing, and Autonomous Robots.



## The Perfect Storm: Big Data Arrives

Big Data is the partner that "feeds" AI, enabling learning processes for it to "grow up". A report by the McKinsey Global Institute states that *"billions of gigabytes every day, [are] collected by networked devices ranging from web browsers to turbine sensors."* Industrial machinery is increasingly being directly connected to the Internet. IT network specialist Cisco reports that *"Over the next five years, global IP networks will support up to 10 billion new devices and connections, increasing from 16.3 billion in 2015 to 26.3 billion by 2020."* These connections will soon be (if they are not already) subject to AI driven systems.

## ThoughtWorks®



## The Technology of Technologies

Combined with Big Data, AI has become a technology of technologies that already directly affects business models as well as the governments that regulate them. Business opportunities from AI promise to lower service and worker costs, provide better quality and consistency for products and services, and improve service in many fields such as education and medical treatment. In a recent report, McKinsey Global Institute estimated that *"about half of all the activities people are paid to do in the world's workforce could potentially be automated by adapting currently demonstrated technologies... almost \$15 trillion in wages."* It is predicted by many that AI has the potential to double annual economic growth rates of developed countries by 2035.

# SUMMING UP: GROWTH, CHALLENGES, RISKS

## GROWTH IN AI INVESTMENT AND ACQUISITIONS

Tech industry giants like Apple, Baidu, Google, IBM, Intel, Salesforce and Yahoo have been making large direct investments in their own AI projects and racing to acquire new AI startups and talent. Traditional industrials such as Ford, GE and Samsung have also entered the race. Total spending by these players for AI in 2016 is estimated between \$20 billion and \$30 billion with about 10% of that on acquisitions.

Venture capitalists are also ramping up their investments in AI startups. More than 550 AI startup ventures received more than \$5 billion total investments in 2016, up from \$589 million in 2012.

## CHALLENGES, RISKS OF AI TECHNOLOGY

AI presents the world, governments, businesses and citizens with challenges. Although the AI revolution has the potential to greatly improve the lives of millions around the world, it will negatively impact many. However, AI is also influencing and changing social interactions on a personal level and at work and it shows potential for bringing people together from diverse cultures in new ways.

Changes to the job market and occupations are a primary concern. Although America's new president talks of restoring jobs for America's coal mining industry, the reality is that the next generation of coal miner, to the extent they are needed, will look more like the Terminator. The human worker will be a "monitor" for his or her "avatar" deep underground. They might even become "Friends".

Artificial Intelligence is seen by many to present the potential to fundamentally change society at the level of agricultural and industrial revolutions of past millennia. Some tech and science leaders such as Elon Musk, Bill Gates and Stephen Hawking have sounded warnings about the disruptions to society such as loss of jobs and entire occupations, and other ethical and social changes.

The alarmists also worry about the existential problem presented by Artificial General Intelligence (AI that performs at human levels), and Artificial Super Intelligence (AI that surpasses humans) and might decide humans are a "nuisance". What happens when the AI coal miner begins to wonder "*why is coal even needed...*"?

The great challenge is to manage this transition and to harness benefits and mitigate problems during the AI Revolution.

## PLAYERS



## To BE OR NOT TO BE

There are those that believe AI represents existential issues for humanity. Elon Musk Tweeted, "In the end the machines will win." He believes AI is "*a fundamental risk to the existence of human civilization, in a way that car accidents, airplane crashes, faulty drugs, bad food were not.*"

Musk and Google Deepmind cofounder Mustafa Suleyman together with 116 other experts from 26 countries recently put out a press release appealing to the United Nations for a global ban on "killer robots". They stated that "*We do not have long to act. Once this Pandora's box is opened, it will be hard to close.*"



# MILESTONES IN ARTIFICIAL INTELLIGENCE DEVELOPMENT

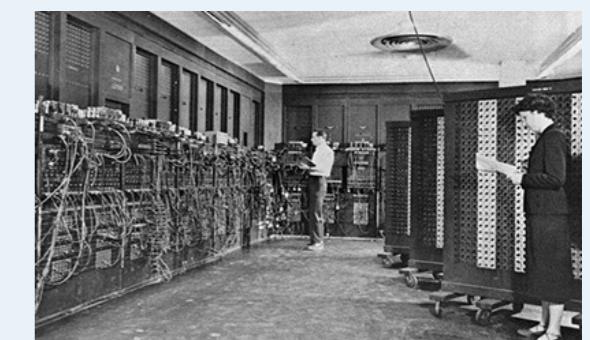
The first electrical-programmable computers were built in the 1940s. Over the ensuing decades hardware and software inventions and developments enabled increasingly sophisticated and complex calculations and user interactions.

Developers dreamed of building a “thinking machine” that might imitate human reason but only recently the convergence of technologies enabled researchers to begin to fulfill that dream. IBM introduced one of the first computers in 1953 and the IBM name for years was synonymous with

the industry, but its position declined in the 80s with the rise of Apple and Asian hardware competitors.

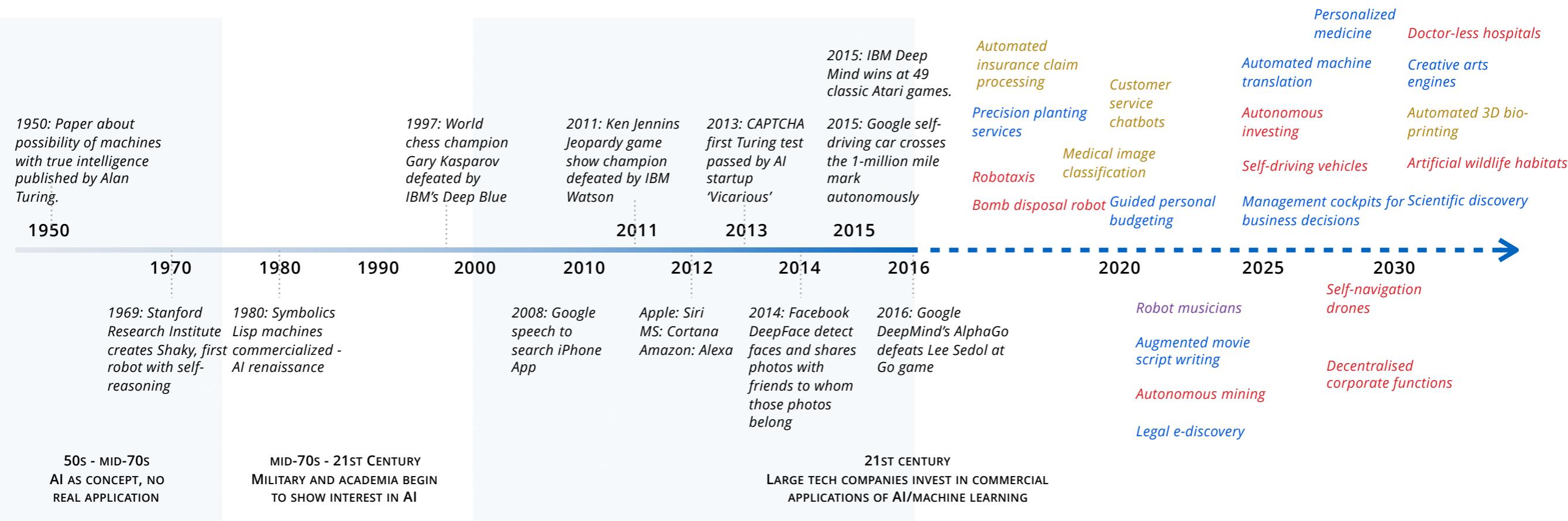
This decade, AI has entered a new phase of accelerated growth that has been driven by three factors:

- major advances in computing power,
- distributed computer processing capabilities through worldwide networks of computers,
- the ability to collect, store and save enormous amounts of data (“Big Data”).



**ENIAC - 1946**

## THE RISE OF “THINKING MACHINES” LEADING TO AND THROUGH THE ARTIFICIAL INTELLIGENCE MILLENNIUM



# PROGRESSION OF ARTIFICIAL INTELLIGENCE

Author Tim Urban provided a light and clear explanation of the progression of AI developments in his article "*The AI Revolution: The Road to Superintelligence*". He analyzed and illustrated the commonly accepted stages of advances in AI technology:

**Narrow AI** solves a narrowly defined task with a degree of perceived intelligence. All current AI applications such as Siri and Alexa, as well as game playing computers and intelligent industrial robots are forms of Narrow AI.

**Artificial General Intelligence (AGI)** would be able to perform with average human intelligence. The Terminator and 3-CPO are examples that approach AGI.

**Artificial Super Intelligence (ASI)** would exceed the capabilities of any human being. The consequences of emergence of ASI, an event known as the "Singularity", might only be imagined in true science fiction.

## Big Data Enters the Stage

Look around a crowd, a subway car, a busy park, a school cafeteria – at the dozens who are glued to their devices, poking away at the screen, reading, smiling, playing, studying, buying, gambling. Each device is a data vacuum collecting shopping habits and political persuasions, tallying purchases and personal interests. These personal users are just a fraction of the data sources that include business IT systems, sensors and other sources that feed the "Big Data" explosion.

A study by IDC predicts that the "*the digital universe will grow by a factor of 10 – from 4.4 trillion gigabytes to 44 trillion*" from 2013 to 2020, more than doubling every two years. In addition, IDC demonstrates that the balance between emerging and mature economies in the same period will shift from a 60% share of data growth from mature markets to 60% for emerging markets.

In a recent interview in Wired, former Microsoft engineer and now Baidu CEO Qi Lu forecast that China will be the Big Data giant if only due to its huge population. But he also stated that "*most places in the world have much more in common with the tiny homes of the Chinese than the sprawling North American McMansions.*"

## Rights Levels for Artificial Intelligence Solutions: Human vs Machine

### Augmented intelligence

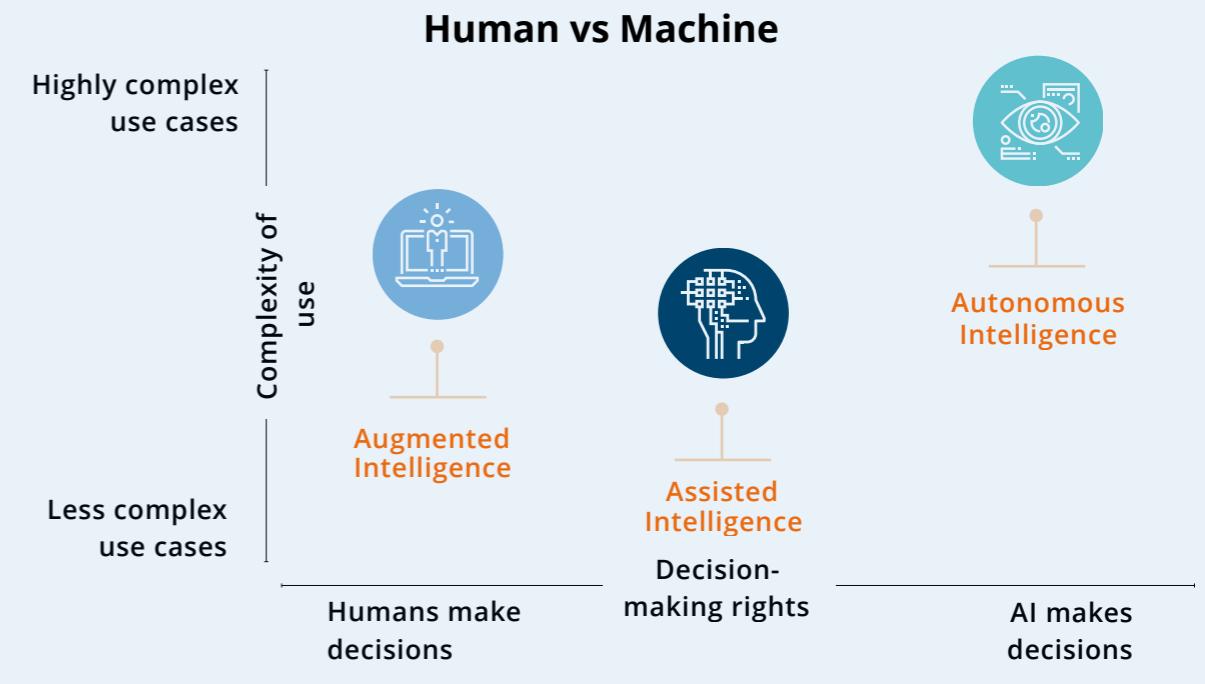
AI enhances human abilities to accomplish tasks faster or better. The human makes key decisions, but AI executes the tasks on behalf of the human. The human retains sole decision rights.

### Assisted intelligence

The human and AI learn from each other. They together define their respective responsibilities and they share decision rights.

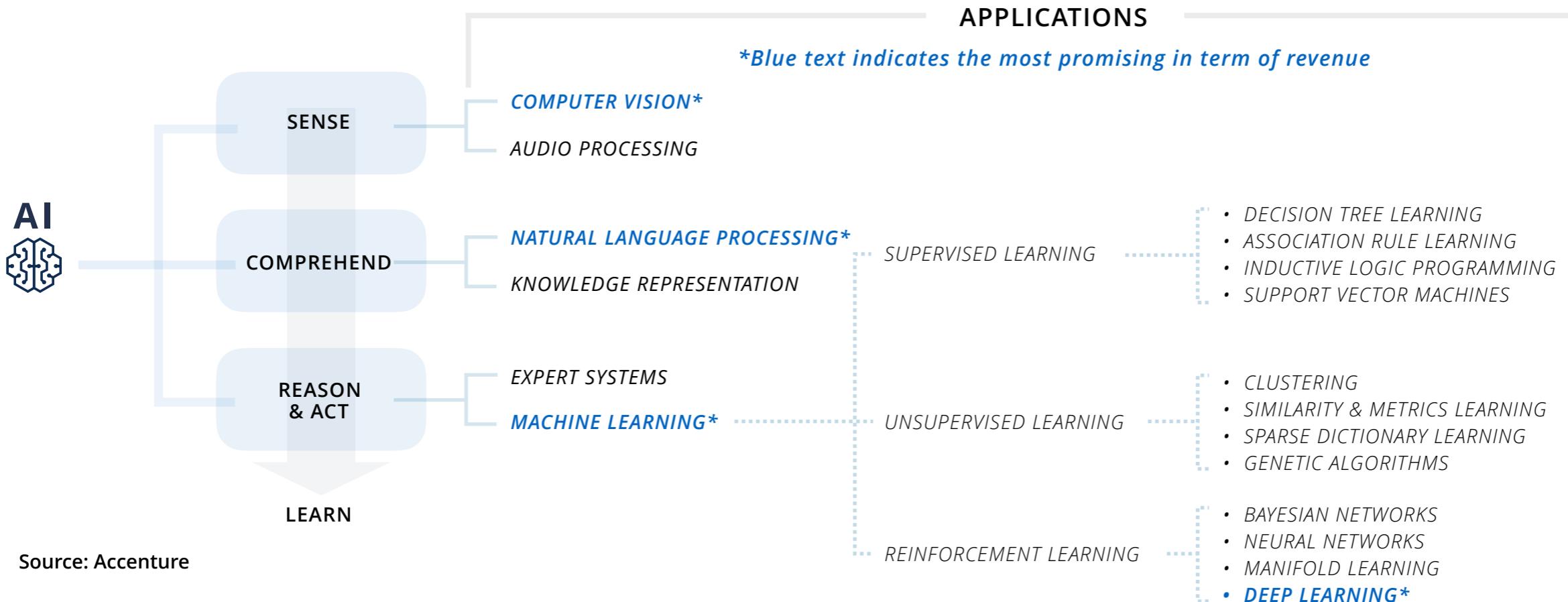
### Autonomous intelligence

AI provides adaptive and continuous operation and may have decision authority. AI does so only after human trusts AI or the human is a liability to efficiency. AI has decision rights.



# COGNITIVE TECHNOLOGIES OF ARTIFICIAL INTELLIGENCE

An Accenture Technology report in 2016, *"Turning artificial intelligence into business value. Today"*, provided the models below to explain the means through which businesses can generate value from Artificial Intelligence technology and applications.



## Accenture sorted business tasks into four activity models for Artificial Intelligence solutions:

### Efficiency model

This AI model identifies criteria, procedures and rules for routine activities. The principal goal is to provide reliable, low-cost performance.

### Expert model

This AI model requires the presence of specialized experience and knowledge, for instance engineering, legal, financial advisory or medical. The role of AI is to expand human sensory ability and decision making. AI provides analytical support and may offer recommendations and implementation support.

### Effectiveness model

This AI model aims to enhance the capability of workers and companies to make better use of their potential to achieve desired results. This model typically requires comprehensive knowledge of the industry, company and business operations. Success requires management coordination and communication and involves a broad range of integrated business activities such as administration, management, or sales. AI technology operates as a personal assistant on behalf of the human user.

### Innovation model

This AI model provides solutions to enhance creativity and formation of ideas for humans especially in fields such as biomedical research, fashion design, culinary arts and music. Humans make decisions and act while AI helps to identify alternatives and optimize recommendations.

# AI APPLICATION TECHNOLOGIES: MACHINE LEARNING & DEEP LEARNING

**Machine Learning** is the ability to learn without explicit programming. Machine Learning consists of algorithms that can learn from and make predictions from data sets. It is the basis of many implementations of existing weak AI systems.

With the rise in Big Data, **Machine Learning** has become particularly important for solving problems in areas such as:

- Computational finance – for credit scoring and algorithmic trading;
- Image processing and computer vision;
- Energy production – for price and load forecasting;
- Automotive, aerospace, and manufacturing – for predictive maintenance.

Industry-specific uses that combine large volumes of data and frequency of use present the largest opportunity. They represent areas for prioritization for use of **Machine Learning**. Some of the high-opportunity use cases include personalised and targeted advertising; autonomous vehicles; price optimisation, travel and logistics routing and scheduling based on real time data; prediction of personalised health outcomes; and optimisation of retail merchandising strategy.

**Deep Learning** and classic **Machine Learning** combined will represent 67% of the AI market by 2025. Globally, about 45% of all work activity that generates \$14.6 trillion of wages have the potential to be automated by adapting currently demonstrated technology.

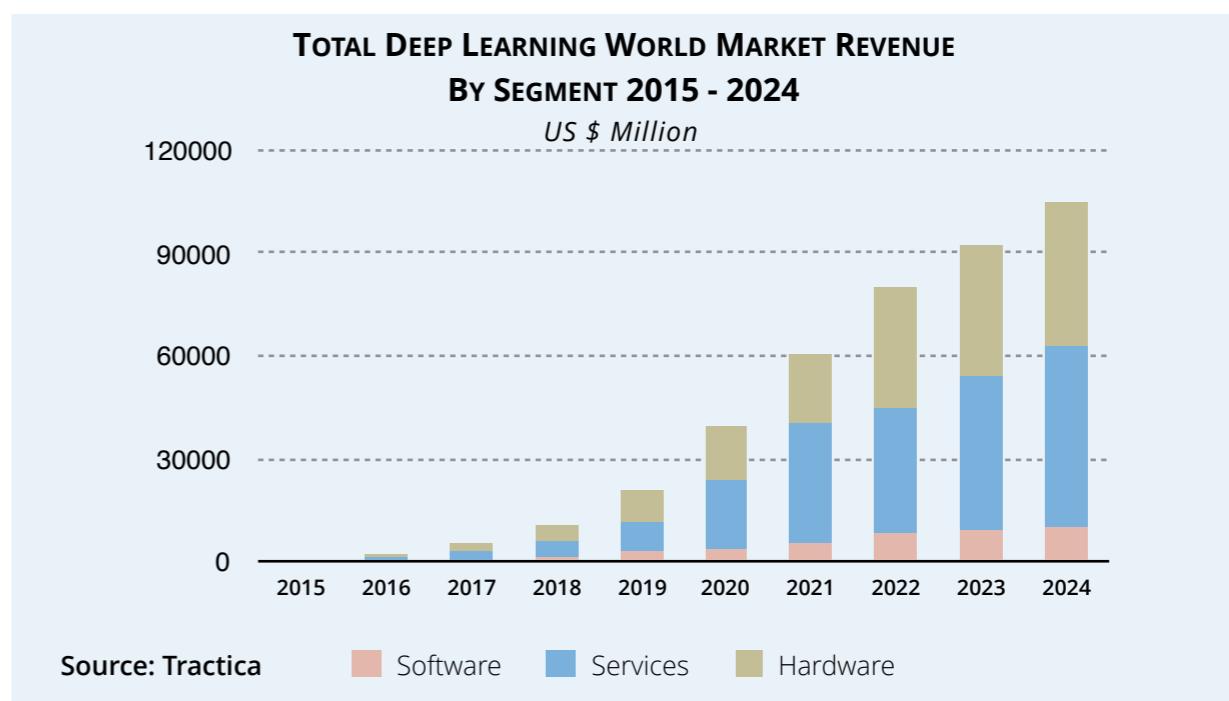
*"Machine learning [a subfield of AI] is a core, transformative way by which we're rethinking how we're doing everything."*

Sundar Pichai - Google Chief Executive Officer

**Deep Learning** is subset of **Machine Learning** that is inspired by nervous systems. Like neural networks, signals at each layer are transformed by processing units (an artificial neuron) with parameters that are 'learned' through training. It is called "deep" because it has more layers than simple **Machine Learning** that allow for more complex processing. **Deep Learning** is the newest, fastest advancing and fastest growing field of AI and it should eventually become integral to almost all AI applications.

**Deep Learning** has recently provided several major advances in AI. For example, in 2015, Google's large-scale speech recognition almost doubled its performance thanks to the application of **Deep Learning** techniques. Most AI applications will use **Deep Learning** or a combination of **Deep Learning** and related technologies like **Machine Learning**, Computer Vision, Natural Language Processing or Machine Reasoning.

In its Artificial Intelligence Market Forecast (2Q 2017), AI advisory service Tractica predicts that **Deep Learning** and classic **Machine Learning** combined will represent 67% of the AI market by 2025. Tractica expects that **Deep Learning** will be the largest AI technology in terms of revenue. In a separate **Deep Learning** Report in 2Q 2016, Tractica estimated that revenues from **Deep Learning** will grow from \$109 million in 2015 to \$10.4 billion by 2024, a compound annual growth rate of 65.8%. This would represent over 40% of the overall AI market by 2024.



# AI APPLICATION TECHNOLOGIES: NATURAL LANGUAGE PROCESSING

**Natural Language Processing (NLP)** is one of the most interesting fields of AI. Google estimates that about 20% of mobile device queries are by voice but the share is rapidly increasing. Major tech players such as Apple (Siri), Google (Home), and Amazon (Alexa) have invested heavily in their network devices that use Natural Language Processing voice input technologies.

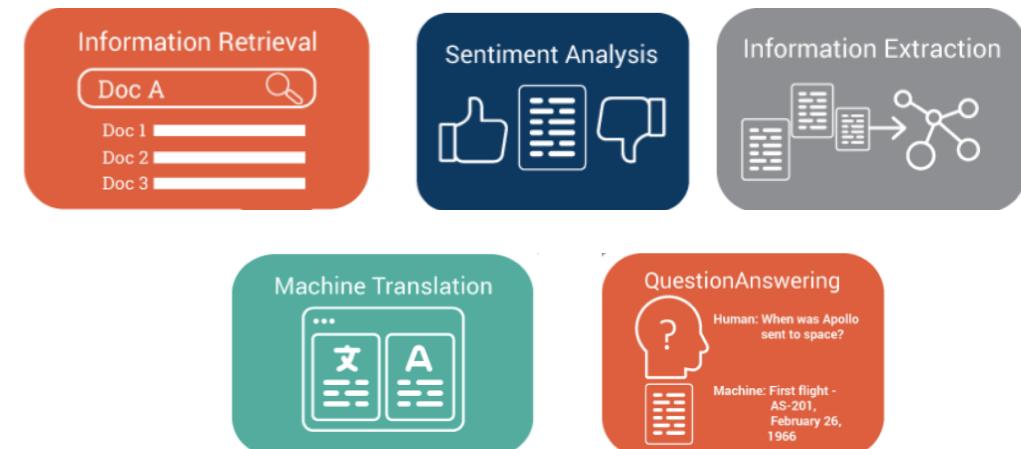
Natural Language Processing not only enables voice-to-text, but enables computers to interpret language. However, aspects of language interpretation such as emotional expressions, the complex and abstract relations between words, and syntax and context present challenges.

NLP is not only useful in popular consumer devices, but is also important for narrow applications. For instance, IPsoft's Amelia AI platform uses **Natural Language Processing** to support remote maintenance engineers. Amelia digests maintenance manuals, and then can diagnose problems and suggest solutions.

In a 2016 report on **NLP**, Tractica forecast that revenue from direct and indirect application of **NLP** will grow from \$116 million in 2016 to \$620 million by 2025.

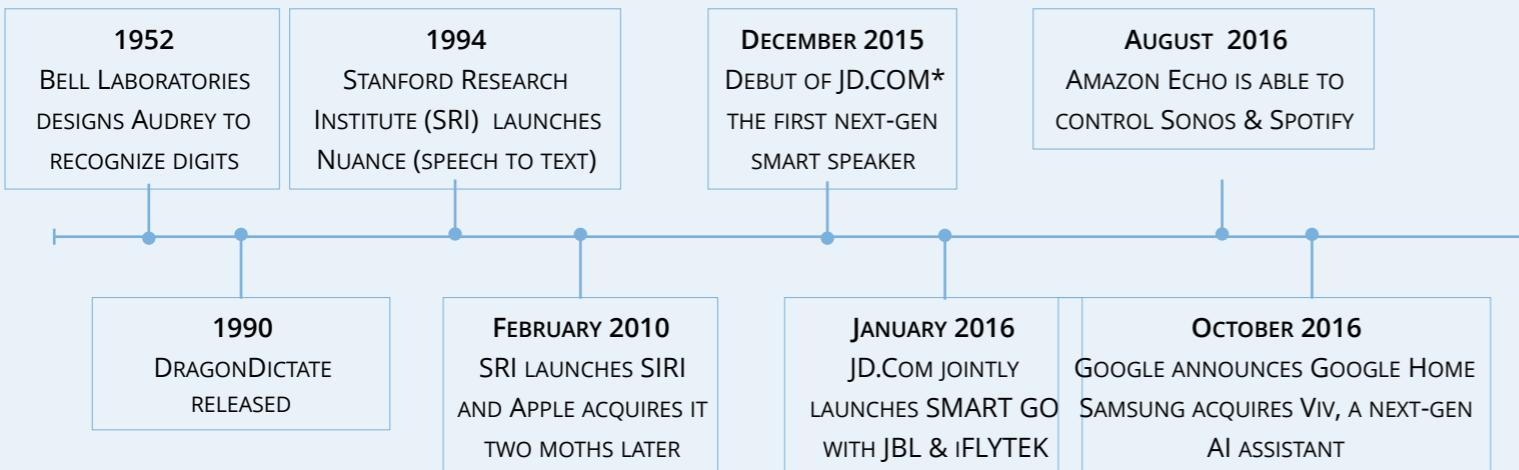
Tractica further found that "*Companies like Amazon, Apple, Baidu, Facebook, Microsoft, Nuance, and Google are pushing ahead with their research into NLP. These companies and others like AT&T, 3M, and IBM are spending significant sums of money to acquire NLP companies, recruit NLP talent, and mine terabytes of crowdsourced content.*"

## PRINCIPAL NATURAL LANGUAGE PROCESSING TECHNOLOGIES

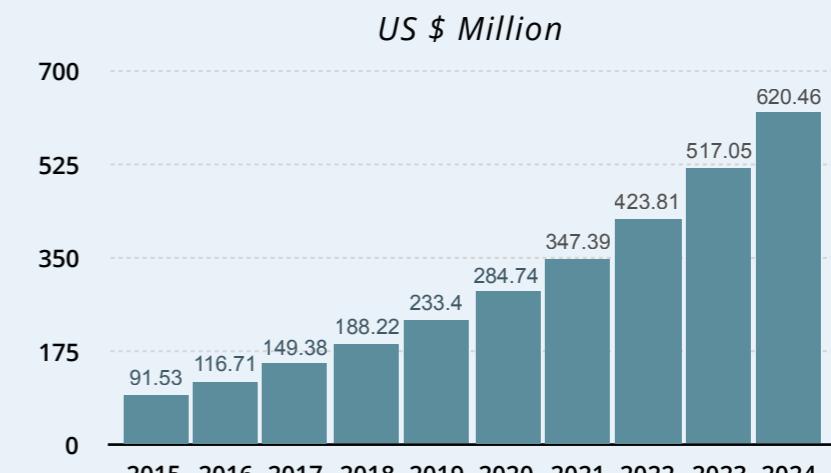


Source: Ontotext

## GLOBAL AND CHINESE TECH GIANTS: VOICE ASSISTANT AND SMART HOME PRODUCTS



## NORTH AMERICA NLP MARKET REVENUES



Source: Tractica

# AI APPLICATION TECHNOLOGIES: SMART MACHINES - AUTONOMOUS ROBOTS

**Smart machines** are a group of AI technologies that include virtual reality assistants such as Alexa and Siri, intelligent agents such as automated online assistants, expert systems, embedded systems for monitoring and control and autonomous robots (the most promising category in terms of revenues and growth).

In a 2016 report BCC Research stated that “*the global market for smart machines reached \$6.6 billion in 2015. The market should reach \$7.4 billion in 2016 and nearly \$15.0 billion in 2021, at a compound annual growth rate (CAGR) of 15.0% from 2016 to 2021.*”

Robots have become ubiquitous in industry for decades, and adept at tasks previously performed by humans such as auto or electronics assembly, but they operate based upon a continuous programmed instruction set. **Autonomous Robots** have a degree of freedom of operation and decision-making that becomes necessary when the human is distant in time and space, for instance undersea, in the arctic, or even on Mars.

**Autonomous Robots** are no longer science fiction fantasy – they already make the global economy more efficient: factory robots on production lines, virtual assistants to respond to consumer inquiries, or self-driving systems that help safely operate vehicles.

AI-CD β is an advanced example. It is the world's first AI creative director and McCann Japan's newest employee. AI-CD β gives creative direction to produce advertisements. It even uses a brush attached to its robotic arm to illustrate with text and drawings. It did lose a creative battle over creating a spot against a human counterpart, Mitsuru Kuramoto in fall 2016, though narrowly.

The **Autonomous Robot** industry is a key partner with the Internet of Things (IoT), which will result in devices that communicate and transmit data to other devices and hubs, and to platforms for analysis by AI.

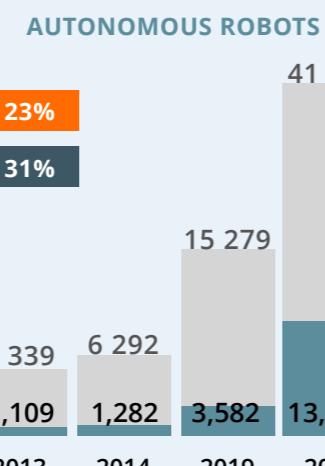
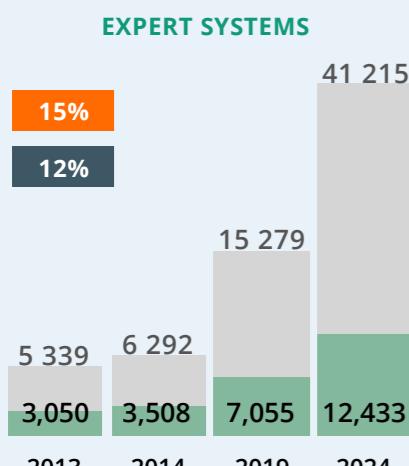
This synergy results in predictions of high market growth, up to 30% annually by 2022. This will bring **Autonomous Robot** revenues into the top three AI industrial applications.

## AUTONOMOUS ROBOT MARKET ESTIMATE

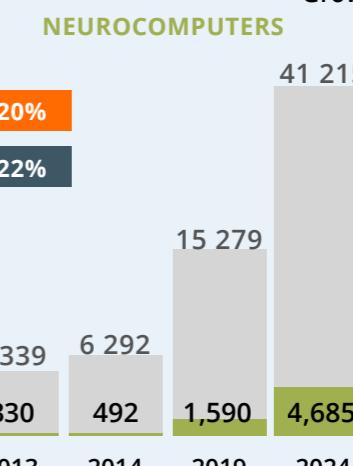
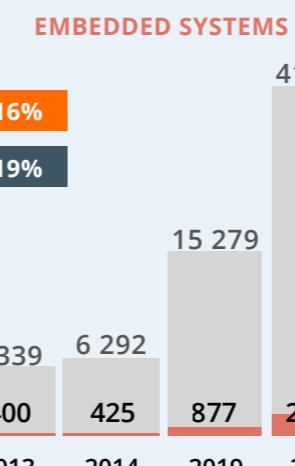
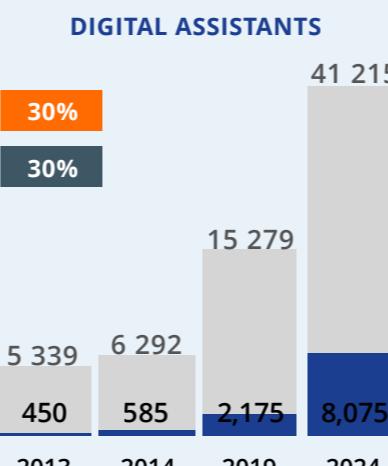
|  | 2018 to 2030<br>(in billion \$) |
|--|---------------------------------|
| Robo-advisor > 2020                      | > 255                           |
| Autonomous car > 2030                    | > 87                            |
| Artificial Intelligence analytics > 2020 | > 70                            |
| Logistics, packaging, materials > 2020   | > 31                            |
| Industrial robots > 2025                 | > 24                            |
| Surgery > 2022                           | > 18                            |
| Personal care-bots > 2020                | > 17.4                          |
| Agricultural robots > 2018               | > 16.3                          |
| Drones > 2025                            | > 14                            |
| Domestic robots > 2018                   | > 12.2                          |
| Entertainment and leisure > 2018         | > 7.6                           |
| Military > 2018                          | > 7.5                           |
| Exoskeletons > 2021                      | > 2.1                           |
| Rehabilitation > 2021                    | > 1.1                           |

Source: Statistica

Source: BCC Research



## AUTONOMOUS ROBOTS TO SURPASS EXPERT SYSTEMS: FORECAST SHARE OF THE SMART MACHINE MARKET



Growth rate 2019-2024  
Growth rate 2014-2019  
Total

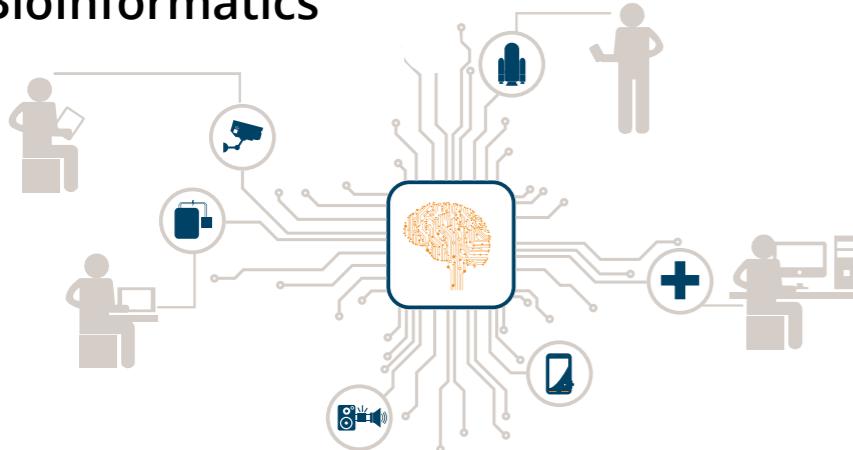
# AI APPLICATION TECHNOLOGIES: BRAIN-COMPUTER INTERFACES

Ray Kurzweil, noted futurist and inventor and now Director of Engineering at Google, anticipates a co-operative human-AI future that would result from a merger of the human brain with computer networks to form a hybrid artificial intelligence. Kurzweil believes that "*in the 2030s we're going to connect directly from the neocortex to the cloud*". In a 2010, Kurzweil evaluated 147 predictions that he made in his 1999 book, *The Age of Spiritual Machines*. Of those predictions, Kurzweil determined that 78% were "entirely correct" as of the end of 2009, and 8% were "essentially correct."

SpaceX and Tesla CEO Elon Musk is backing a brain-computer interface venture called Neuralink. Neuralink is still in the early stage of development but is said to be planning to create devices that can be implanted in the human brain to help human beings merge with software and keep pace with advancements in artificial intelligence. These enhancements could improve memory or allow for direct interface with computing devices. *The Wall Street Journal* confirmed that Neuralink is exploring a possible investment from Founders Fund, a venture capital firm founded by Peter Thiel, a PayPal co-founder (along with Elon Musk).

Braintree co-founder Bryan Johnson has funded Kernel with more than \$100 million he earned from his \$800 million sale of Braintree to PayPal. Kernel is trying to enhance human cognition with a growing team of neuroscientists and software engineers. They are working towards reversing the effects of neurodegenerative diseases and eventually making brains faster, smarter and more wired.

## BioInformatics



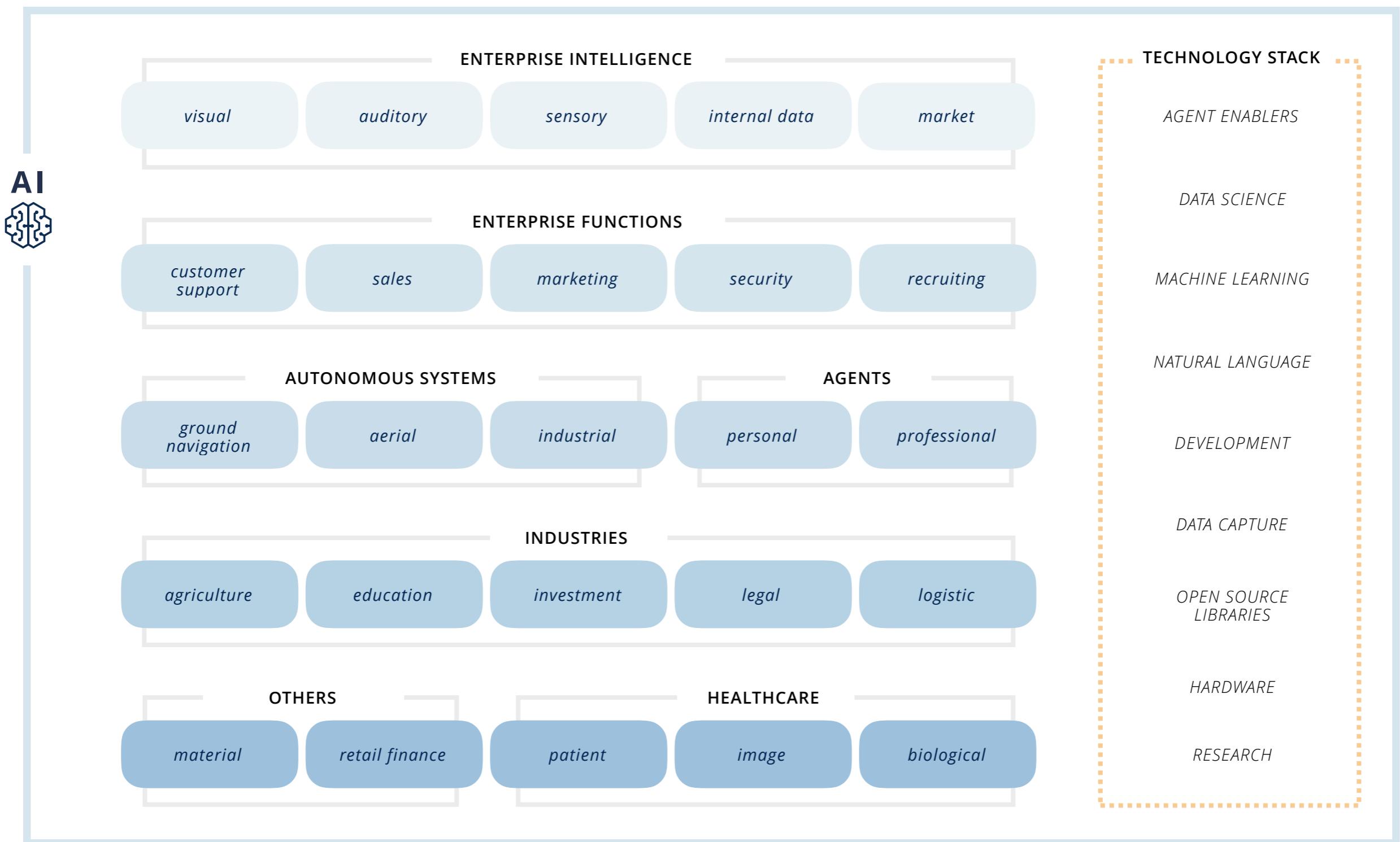
*"While Tesla and Space X aim to redefine what future humans will do – Neuralink, Elon Musk latest venture plans to redefine what future humans will be."*

*[waitbutwhy.com](http://waitbutwhy.com) - June 2017*

## EMERGING BCI TECHNOLOGY COMPANIES



# THE AI BUSINESS ECOSYSTEM



Source: Shivon Zilis and James Cham

# VISION OF POSSIBILITIES: ADDED VALUE OF ARTIFICIAL INTELLIGENCE

## AI is a new factor of production that can lead to significant growth opportunities for developed economies

According to an Accenture survey that focused on the twelve most developed economies, five of them demonstrate the potential to enlarge their annual economic growth rates by 2035. For instance, the United States benefits from the economic potential of Artificial Intelligence because of its powerful entrepreneurial business climate and progressive infrastructure position.

The Accenture research predicts a relative improvement in gross value added (GVA) growth in the United States, thus expecting a change from 2.6% to 4.6% throughout the period of 2035 - a level not seen since the economic peak in the 1980s. Accenture further states that this will translate to an additional US\$8.3 trillion GVA in 2035 - equivalent to the combined GVA of the eleven most developed economies. Japan, on the other hand, could triple its GVA growth throughout the same period. Hence, GVA could increase from 0.8% to 2.7%. Accenture believes that Sweden, Netherlands, Germany and Austria could expect their annual economic growth rates to double.

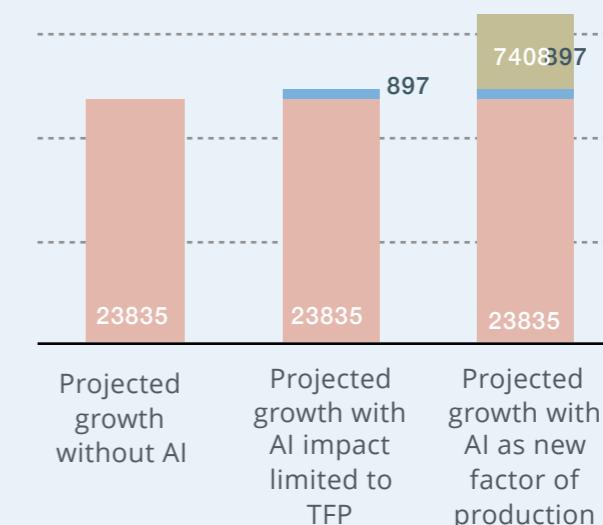
Bank of America Merrill Lynch (BAML) estimates that there is a high chance of lifting productivity levels by 30% and cutting manufacturing labor cost by approximately 18% and 33% in several industries by adopting Artificial Intelligence and robots over the coming decade.

When it comes to the world's largest economies (G19 plus Nigeria), Accenture believes automation could potentially improve the growth of productivity by 40% by 2035 and add an additional 1.1 billion to 2.3 billion full-time employees. It also predicts significant national growth due to AI in developed economies.

## UNITED STATES GROSS VALUE ADDED (GVA) IN 2035

US \$ billion

- Additional AI-Induced Growth
- AI-Induced TFP
- United States GVA



Source: Accenture

Source: Accenture and Frontier Economics

## REAL GROSS VALUE ADDED (GVA)

% growth

- Baseline
- AI Steady State



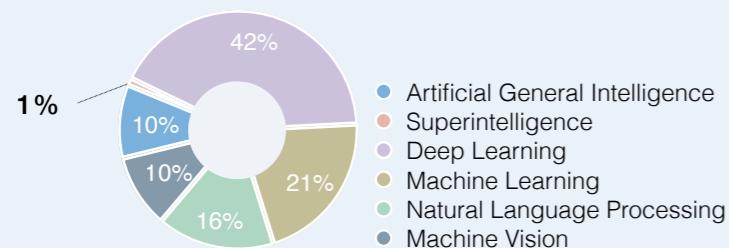
# VISION OF POSSIBILITIES: GLOBAL REVENUE GROWTH

## Exponential growth for AI industry revenue

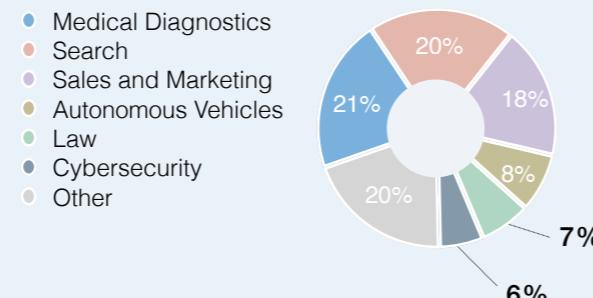
AI revenues are still relatively small at \$1.4 billion in 2016, however, industry analysts predict very rapid growth. Tractica, the market intelligence firm, believes that by 2025 AI revenues from AI software applications, indirect and direct, will reach \$59.8 billion, a 52% growth rate over the next nine years.

Artificial Intelligence has numerous sub-fields such as Artificial General Intelligence, Natural Language Processing, Deep Learning and others and each is experiencing its own growth and investment pattern. A report from Research and Markets shows that the Natural Language Processing expects the largest CAGR from 2016 to 2022, followed by Deep Learning technology.

## PROJECTED AI REVENUE SHARE BY TECHNOLOGY

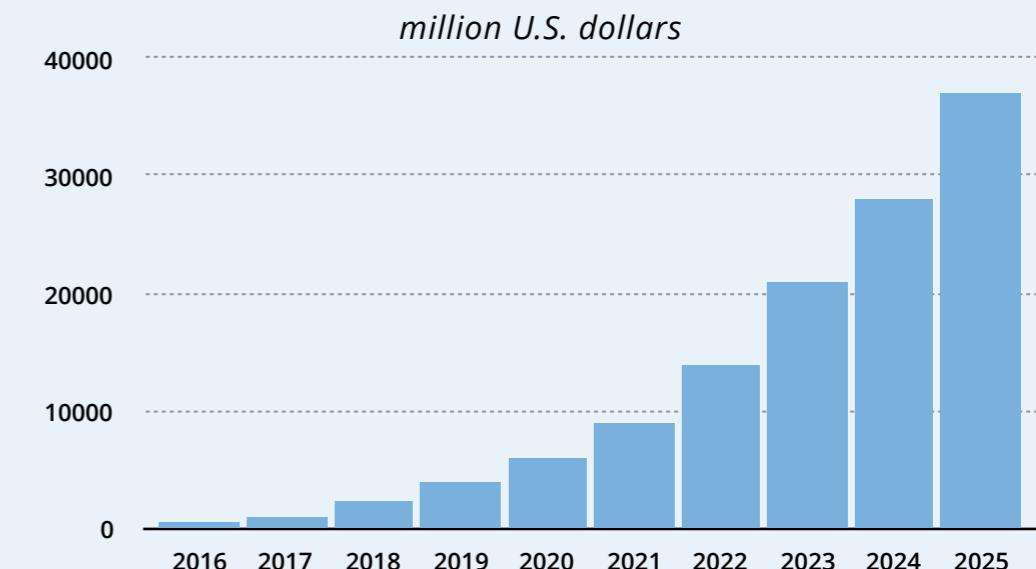


## PROJECTED AI REVENUE BY VERTICAL 2017 - 2025



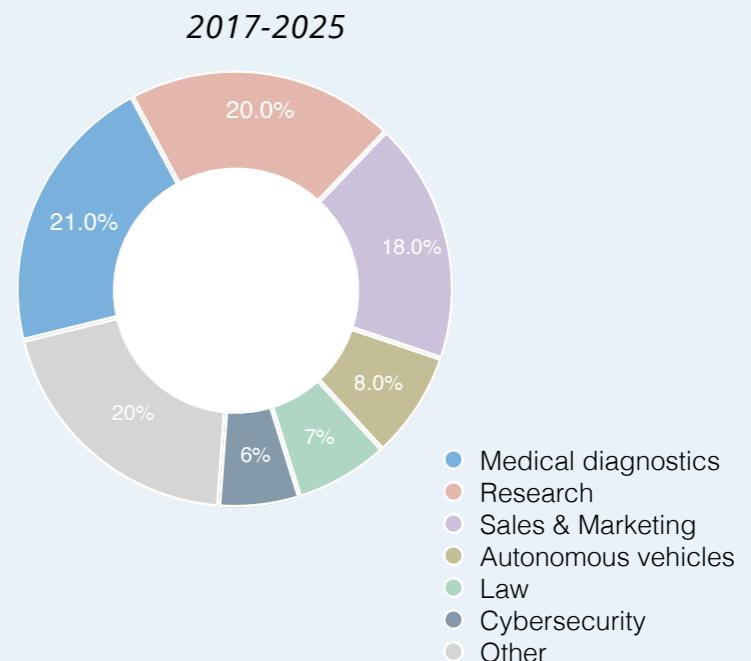
Source: CB Insights

## AI MARKET REVENUES WORLDWIDE



Source: Tractica

## AI PROJECTED AI REVENUE BY MARKET



Source: Tractica

# VISION OF POSSIBILITIES: GLOBAL INVESTMENTS IN AI

A McKinsey report states that Machine Learning and Deep Learning applications attract about 60% of investment. According to IDC Research, industries that currently invest the most AI systems are banking, retail, healthcare and product manufacturing.

Global investment for Artificial Intelligence has and will come from several sources:

- Direct investment by industrial and IT companies in their own projects;
- Acquisition and further development of established AI businesses;
- Venture capital funding of AI Startups.

## Direct investment in own projects

McKinsey also found that tech giants like Amazon, Apple, Google and Baidu spent 90% of their estimated \$20 billion to \$30 billion AI investments on R&D and deployment and the remainder on acquisitions. Tech leaders are also investing in top AI talent with laboratories such of Facebook's new Paris AI Research lab, Microsoft's Machine Learning and Artificial Intelligence research division, and a recent Google investment in the Montreal Institute for Learning Algorithms.

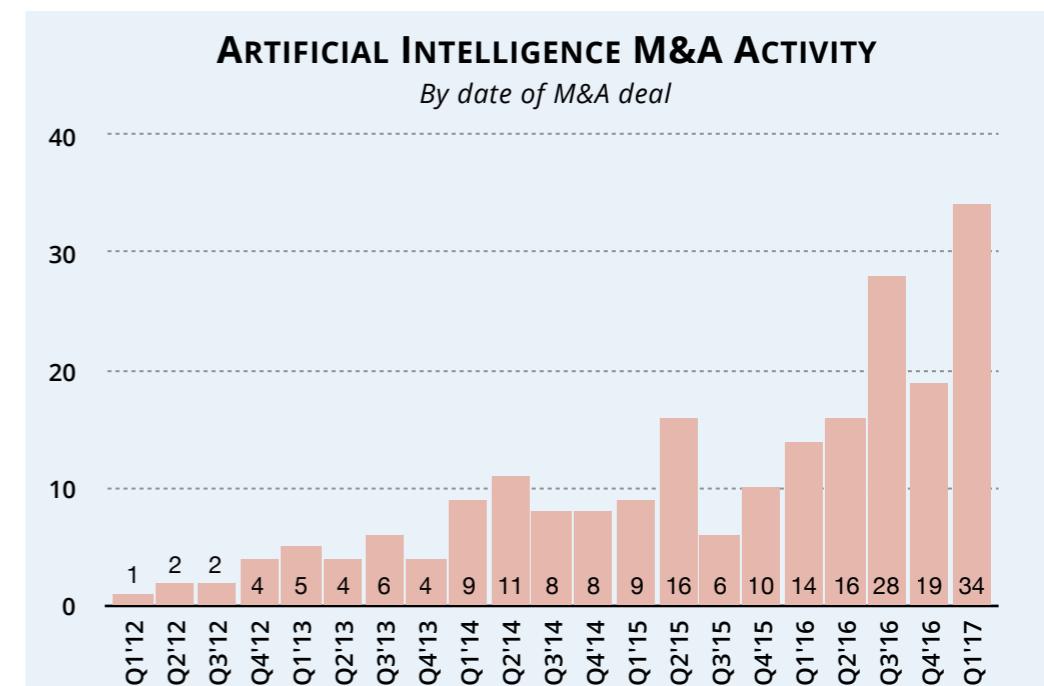
## Acquisitions of established AI businesses

More than 200 private AI companies have been bought since 2012 and there have been over thirty acquisitions in early 2017. In 2014 and 2015 alone, eight major global tech firms made at least 26 acquisitions totaling \$5 billion of companies developing AI technology.

Application industry leaders such as Apple, Facebook, Google, IBM, Intel, Microsoft, Salesforce and Yahoo have been competing for acquisition of startup AI companies. However, industrial competitors from diverse industries such as Ford, GE, Monsanto and Samsung are also seeking AI companies that have experience in their fields.

## Google vs Apple on AI investment and development

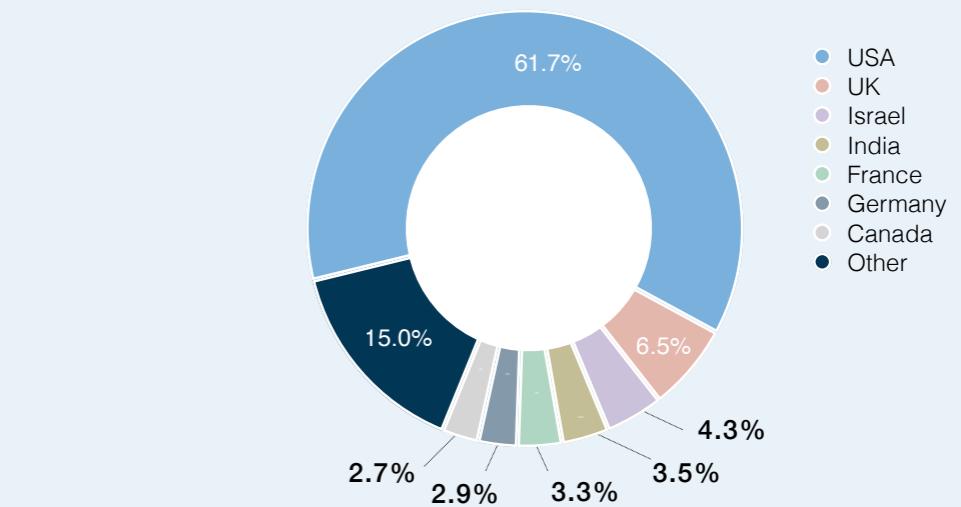
*"Apple also is not likely to talk as loudly about AI as Google does. As a software and services company, Google would be expected to focus on AI.. Apple is mainly a hardware company (albeit increasingly a services company). It's more likely to focus on functionalities that AI helps improve, rather than dwelling much on technical underpinnings. Google has on numerous occasions released products that were technically impressive but betrayed a woeful misunderstanding of what people might find useful (Google Wave, Google Glass)." MARK SULLIVAN - Fast Company*



Source: CB Insights

## GLOBAL AI DEAL SHARE BY COUNTRY

2016



Source: CB Insights

# VISION OF POSSIBILITIES: VENTURE CAPITAL FUNDING

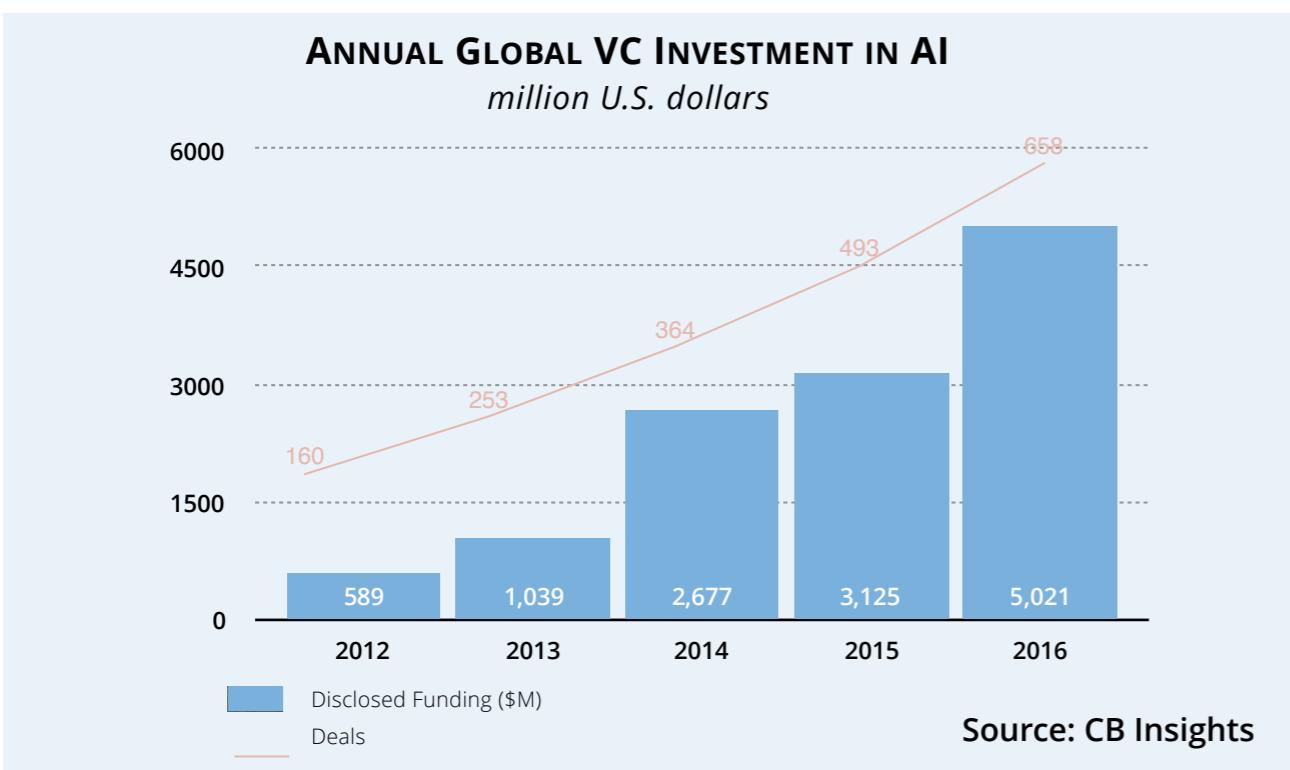
## Startup investors and acquirers

The McKinsey report also estimates that venture capital, private equity, seed capital and grants in 2016 totaled \$6 billion to \$9 billion. CB Insights estimates total funding for 550 AI startups in the United States in 2016 at about \$5 billion, up from \$589 million in 2012.

The top five venture capital investors in AI as measured by number of deals and size of placements have been Data Collective, Google Ventures, Intel Capital, Khosla Ventures and New Enterprise Associates.

AI ventures are increasing their share of the venture capital budget. According to Ernst and Young, global venture capital investment of \$46.6 billion in 2010 doubled to \$86.7 billion in 6,507 deals in 2014 while venture investment in AI tech increased eight-fold.

The range of venture capital investors and targets in the chart at right demonstrates the potential influence of AI in virtually every industry.



## MOST ACTIVE CORPORATE INVESTORS IN AI

2011 - 2016

| INVESTOR                        | RANK | SELECT INVESTMENTS  |
|---------------------------------|------|---|
| INTEL CAPITAL                   | 1    | DataRobot prelert lumia MAANA incoming saffron<br>PERFANT emotient Reflektion Parallel Machines PA<br>MindMeld smartzip api.ai Indisys: COLDLIGHT |
| GOOGLE VENTURES                 | 2    | BUILDING ROBOTICS clarifai KENSHO FRAMED ZEPHYR Unbabel<br>tamr MindMeld Orbital Insight Predilytics  |
| GE VENTURES                     | 3    | SIGHT MACHINE ARTERYS AYASDI BITSTEW SYSTEMS MedAware<br>Manufacturing Analytics PingThings stem Predixion MAANA                                  |
| SAMSUNG VENTURES                | 4    | vicarious sentiance Maluuba iDIBON jibo<br>MindMeld ai AUTOMATED INSIGHTS   |
| BLOOMBERG BETA                  | 4    | deep genomics ocontext relevant AVISO howdy. DOMINO<br>Orbital Insight DigitalGenius DIFFBOT  |
| IN-Q-TEL                        | 6    | MindMeld CYLANCE select INTERSET<br>Digital Reasoning DOMINO  |
| TENCENT                         | 7    | DIFFBOT CLOUDMEDX SI SCALED INFERENCE iCarbonX skymind  |
| NOKIA GROWTH PARTNERS           | 8    | rocketfuel WorkFusion rapidminer indix.<br>BUILDING ROBOTICS NEURA insideSALES CrowdFlower  |
| MICROSOFT VENTURES              | 8    | clarifai Predilytics Welltok tempo  |
| QUALCOMM VENTURES               | 8    | DigitalGenius insideSALES sense   |
| SALESFORCE VENTURES             | 8    | NEURA BI-BEATS medlanes pricemethod   |
| AXA STRATEGIC VENTURES          | 8    | ocontext relevant DataRobot Skycure Captricity  |
| NEW YORK LIFE INSURANCE COMPANY | 8    |   |

Source: CB Insights

# FUNDRAISING FOR AI VENTURES - SAMPLE INVESTMENTS

| Company             | Industry                  | Mission   | Founded | Capital Raised | Recent Investors   |
|---------------------|---------------------------|---|---------|----------------|--|
| Appier              | Sales Assistant           | Optimizes cross-device marketing by predicting the best time and device to reach customers                        | 2012    | \$48.5m        | Pavilion Capital, Sequoia Capital                                |
| Atomwise            | Pharmaceutical Research   | AtomNet, Deep Learning for small molecule discovery to improve success rates for drug discovery programs          | 2012    | \$6.4m         | Khosla Ventures, Draper Fisher, Y Combinator                     |
| Brain Corp          | Autonomous Robots         | Self-driving technology to enable robots to perceive the environment, learn to control their motion, and navigate | 2009    | \$125m         | SoftBank   |
| BrainCo             | Self improvement          | Wearables that help people improve attention level and work efficiency  | 2015    | \$5.5m         | Boston Angel Club, Han Tan Capital, Wandai Capital               |
| Butterfly Network   | Medical Diagnostics       | Deep Learning combined with ultrasound imaging for diagnosis and monitoring                                       | 2014    | \$100m         | Aeris Capital, Jonathan Rothberg                                 |
| Caruma Technologies | Autonomous Vehicles       | Intelligent connected vehicle platform for autonomous driving vehicles to improve safety                          | 2015    | \$2m           | Q Venture Partners, Angels                                       |
| Conversica          | Sales Assistant           | Cloud-based natural conversational AI platform  | 2007    | \$56m          | Providence Strategic Growth, Kennet Partners, Toba Capital       |
| Deep Genomics       | Medical Diagnostics       | Applies Machine Learning and genome biology to predict the effects of genome changes                              | 2015    | \$3.7m         | True Ventures, Bloomberg Beta, Eleven Two Capital                |
| Dreem               | Healthcare                | Sleep solution that monitors, analyzes, and acts on the brain to enhance sleep                                    | 2016    | \$22m          | MAIF, Angels   |
| Drive.ai            | Autonomous Vehicles       | Simulates unusual driving conditions using Deep Learning to navigate real-time on different types of roads        | 2015    | \$112m         | NEA, GGV Capital   |
| Freenome            | Medical Diagnostics       | Non-invasive screening to detect cancer and other diseases  | 2015    | \$70.5m        | Andreessen Horowitz  |
| Kernel              | Healthcare                | BCI technologies to understand and treat neurological diseases  | 2016    | \$100m         | Braintree founder Bryan Johnson                                  |
| MindMaze            | Healthcare/Entertainment  | Virtual reality headset that uses neuroscience and machine learning for healthcare and entertainment              | 2012    | \$100m         | Hinduja Group  |
| Neurable            | Brain-computer interfaces | Brain-computer interfaces for next-generation computing platforms   | 2016    | \$2m           | Angels led by Barry Shin, Boss Syndicate                         |
| Neuroolutions       | Rehabilitation            | Platform of devices based on BCI technology to restore function to patients disabled due to neurological injury   | 2007    | \$1.25m        | BioGenerator, an evergreen investor                              |
| NeuroPace           | Healthcare                | BCI medical device that can monitor and respond to brain activity to treat epilepsy                               | 1997    | \$180m         | New Enterprise Associates, InterWest Partners, Johnson & Johnson |
| Persado             | Sales Assistant           | Maps emotions to generate natural language content to emotionally connect with consumers                          | 2012    | \$66m          | Goldman Sachs, StarVest Partners, Bain Capital Ventures          |
| StackPath           | Web Services              | AI based intelligent web services platform to improve speed, security and scale                                   | 2015    | \$180m         | ABRY Partners  |
| ViSenze             | Shopping Assistant        | Visual search by image to convert images from shoppers into product searches                                      | 2012    | \$14m          | Empire Capital, Rakuten, WI Harper Group                         |

# FUNDRAISING FOR AI VENTURES - CB INSIGHTS TOP 100 STARTUPS

*"These 100 startups on our list have raised \$3.8B in aggregate funding across 263 deals since 2012." CB Insights 2017*



## 100 STARTUPS USING ARTIFICIAL INTELLIGENCE TO TRANSFORM INDUSTRIES

### CONVERSATIONAL AI/ BOTS



### VISION



### AUTO



### ROBOTICS



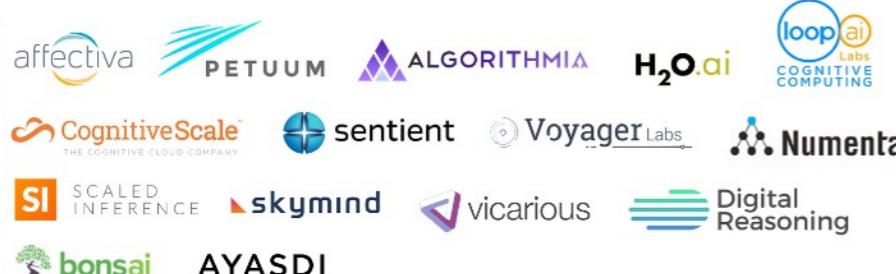
### CYBERSECURITY



### BUSINESS INTELLIGENCE & ANALYTICS



### CORE AI



### AD, SALES, CRM



### HEALTHCARE



### FINTECH & INSURANCE



### OTHER



# CHALLENGES FOR AI: AI WILL DESTROY JOBS

## But it will create new occupations

AI has extended information technology to perform tasks that have previously been performed by humans. AI enables organizations to change relationships between production factors such as speed, cost, and quality for the better.

The McKinsey Global Institute examined the potential to automate 2,000 work activities in 800 occupations of the global economy. The report showed that half of worker tasks might be automated through implementation of demonstrated AI technology. It found that Deep Learning is well suited to develop seven out of eighteen capabilities required in many work activities. This replacement could affect \$16 trillion of wages worldwide. Although the McKinsey analysis showed that less than 5% of all occupations could be entirely automated with existing AI technology, more than 30% could be replaced by AI in 60% of occupations.

University of Oxford researchers Carl Frey and Michael Osborne estimated that 35% of UK jobs had a high risk of automation over the next 10-20 years. Similar research at the Bank of England suggests that up to fifteen million jobs in the UK could be at risk from automation over that same time frame.

The majority of workers surveyed by McKinsey (82%) across many markets expected that jobs will be lost due to AI. Two-thirds expected that their own jobs would be sacrificed to AI and just 25% did not foresee that possibility.

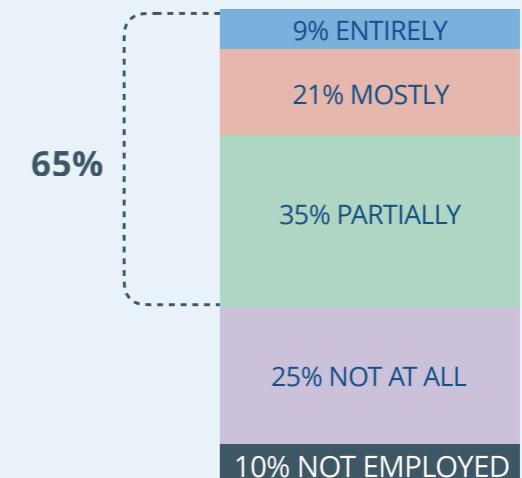
Robots and AI technologies are already displacing many jobs in numerous sectors especially manufacturing. China has probably installed the most industrial robots of any other country – about 30 robots per 10,000 workers. Tens of thousands of workers have “*been made redundant*” by robotics in a single Foxconn factory.

Artificial Intelligence has the potential to make capital and labor more efficient so that rather than AI replacing a worker, that worker becomes more efficient, thus generating economic growth on the macro and micro levels. AI may offer workers new tools for development and potentially better work (e.g. the coal miner example). AI has the potential to boost labor productivity by up to forty percent in 2035 in the majority of developed countries.

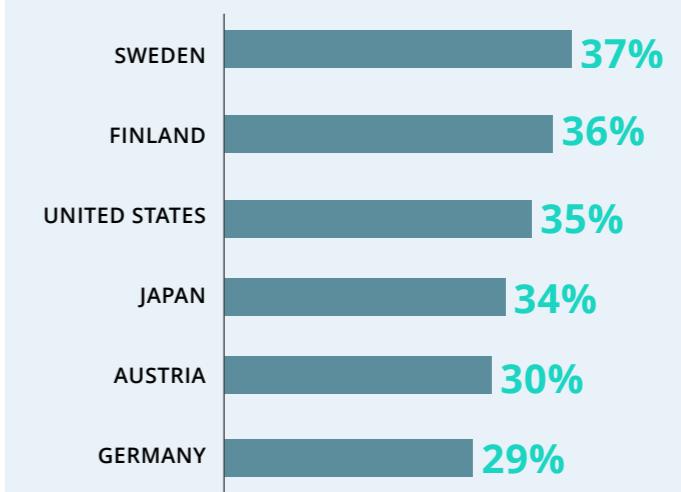
A Barclays Bank survey of manufacturers in 2015 and its own economic modelling resulted in the estimation that “£1.24bn in automation investment could raise the overall value added by the manufacturing sector to the UK economy by £60.5bn over the next decade.”

It is likely that AI will change the nature of work rather than the jobs, and AI will also create new types of jobs. AI has the potential to improve working conditions for workers who can make a transition to an AI assisted job. However, workers will require re-training to make the transition.

## THE POTENTIAL FOR AI TO REPLACE OCCUPATIONS *of global consumers*



## INCREASE IN LABOR PRODUCTIVITY *in an AI world*



Source: Weber Shandwick & KRC Research

# CHALLENGES FOR AI: TRUST - ARE CONSUMERS READY FOR AI

## Psychological adoption

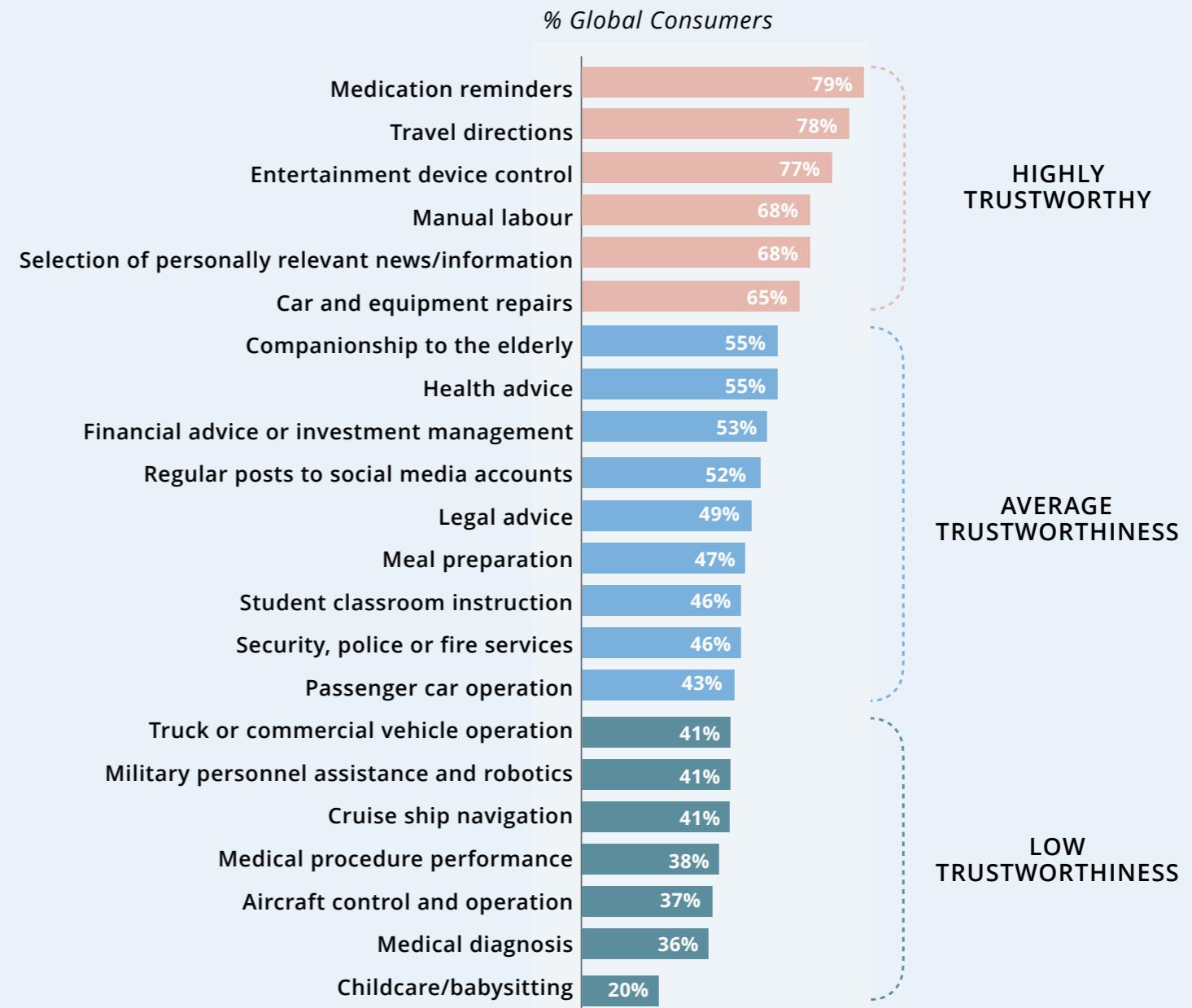
Global consumers trust devices that use AI for many tasks in life but often do not realize the significance of the AI involved. More than two-thirds of consumers use and trust devices that use AI for entertainment (such as Amazon Alexa), to obtain information (Siri), travel directions (Google Maps), medication reminders, news filters and household labour. AI enabled devices are used and trusted by more than 50% of consumers financial guidance, elder care, health advice, and social media content creation. Other AI aided tasks that have an average level of trustworthiness include legal advice, security, police or fire services, meal preparation and education.

However, many consumers feel that certain tasks are too risky to trust AI such as medical procedures, piloting of aircraft, medical diagnostics and childcare. However, these consumers do not realize that these tasks are already successfully handled by AI, for instance aircraft autopilot systems and ship navigation systems.

Overall, Chinese consumers most trust AI for many tasks and UK consumers are the least trusting. Consumers in Canada, the UK and China are most trusting of AI-aided travel directions. Consumers in the United States and Brazil most trust AI for medication reminders. American consumers also cite AI-assisted entertainment as their most trusted AI application.

**Source:** Abstract from AI-Ready or Not: AI-READY OR NOT:  
Artificial Intelligence Here We Come!, Weber Shandwick  
& KRC Research, October 2016

## CONSUMER TRUST OF TASKS WITH AI COMPONENTS



Source: Weber Shandwick & KRC Research

# CHALLENGES FOR AI: PRIVACY, ETHICS, SAFETY

Although job replacement is the #1 social concern about AI, there is a growing realization that on the level of society and the world, Artificial Intelligence presents challenges for entire social systems that govern the relationships between populations, social classes, governments and industry.

The rise of AI is seen to present the potential to fundamentally change society at the level of agricultural and industrial revolutions of past millennia. There are now active public discussions about a need to develop an entirely new world order to deal with this challenge.

## Privacy

The collection of data from every individual begins even before birth with medical tests on the mother such as genetic screening and ultrasound. This first data initiates a unique personal identification signature in the Big Data cloud that increasingly can be tied to daily activities from specific shopping purchases to mobile phone conversations. These activities also provide geolocation information.

With the use of AI, this data could be used (or misused) to provide psychological profiles including behavior prediction. Even with current technology, Google search users are no longer surprised when a search for "refrigerators" results in ads for refrigerators on Facebook.

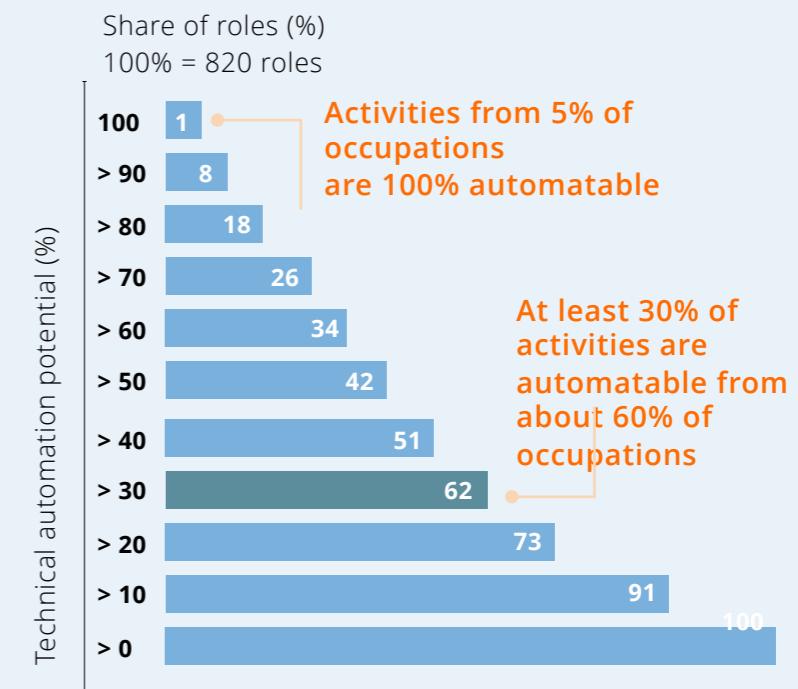
## Ethics

Science fiction author Isaac Asimov laid out "*Three Laws of Robotics*" in 1942, which began with "*1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.*"

Ethical concerns about AI have grown with the technology into two fields of research: roboethics, which applies to AI use relating to humans and their institutions, and "machine ethics", the study of "robot rights" as they become increasingly "intelligent". In some industries like healthcare and finance, professional ethics codes might serve as the basis for AI ethics codes.

## AUTOMATION POTENTIAL FOR OCCUPATIONS IN THE UNITED STATES USING DEMONSTRATED TECHNOLOGY

### EXAMPLE OCCUPATIONS



Source: McKinsey Global Institute

## Safety

Even at the level of Narrow AI, self-driving cars present serious safety concerns. So far, only four American states regulate self-driving vehicles: California, Florida, Michigan and Nevada. Ontario (Canada), France and Switzerland and the United Kingdom have also passed regulations to enable tests on public roads of self-driving cars. However, such laws do not cover some issues such as blame and financial responsibility for test self-driving vehicles. A key question presented by self-driving cars and autonomous robots is "*how reliable is the code and testing process – is the system really safer than a human operator?*"

# GLOBAL CHALLENGE: THE “SINGULARITY”

**The Singularity** is a term popularized by Ray Kurzweil in his 2005 book *“The Singularity Is Near: When Humans Transcend Biology”* and derived from the 1993, *“The Coming Technological Singularity”*, by Vernor Vinge. The Singularity is an event, a future day when exponential development of Artificial Intelligence and its various technologies produces machine intelligence that exceeds all human intelligence combined. Beyond that date, Kurzweil believes the entire future of the universe becomes unpredictable.

The path to the Singularity, which Kurzweil and others believe is inevitable, began with Narrow AI applications such as the ability to play strategic games and perform language translation. Narrow AI has enabled commercial applications such as information search, travel planning, shopper targeted ads and recommendations. However, the next step is Artificial General Intelligence (AGI) which promises intelligent human-like behavior. Although a broad chasm still separates the Narrow AI applications of today from the difficult challenge of AGI, research is making headway.

The consensus of private-sector experts such as Kurzweil, with which the America’s National Science and Technology Council Committee on Technology concurs, is that General AI will not be achieved for decades. However, tech and science giants Elon Musk, Bill Gates and Stephen Hawking have issued their own warnings about Artificial Intelligence.

The final step towards the Singularity is Artificial Superintelligence (ASI). Oxford philosopher and leading AI thinker Nick Bostrom defines superintelligence as *“an intellect that is much smarter than the best human brain in practically every field, including scientific creativity, general wisdom and social skills.”* Artificial Superintelligence ranges from computers just a bit smarter than human to trillions of times smarter. This will bring the world’s tipping point, the Singularity.

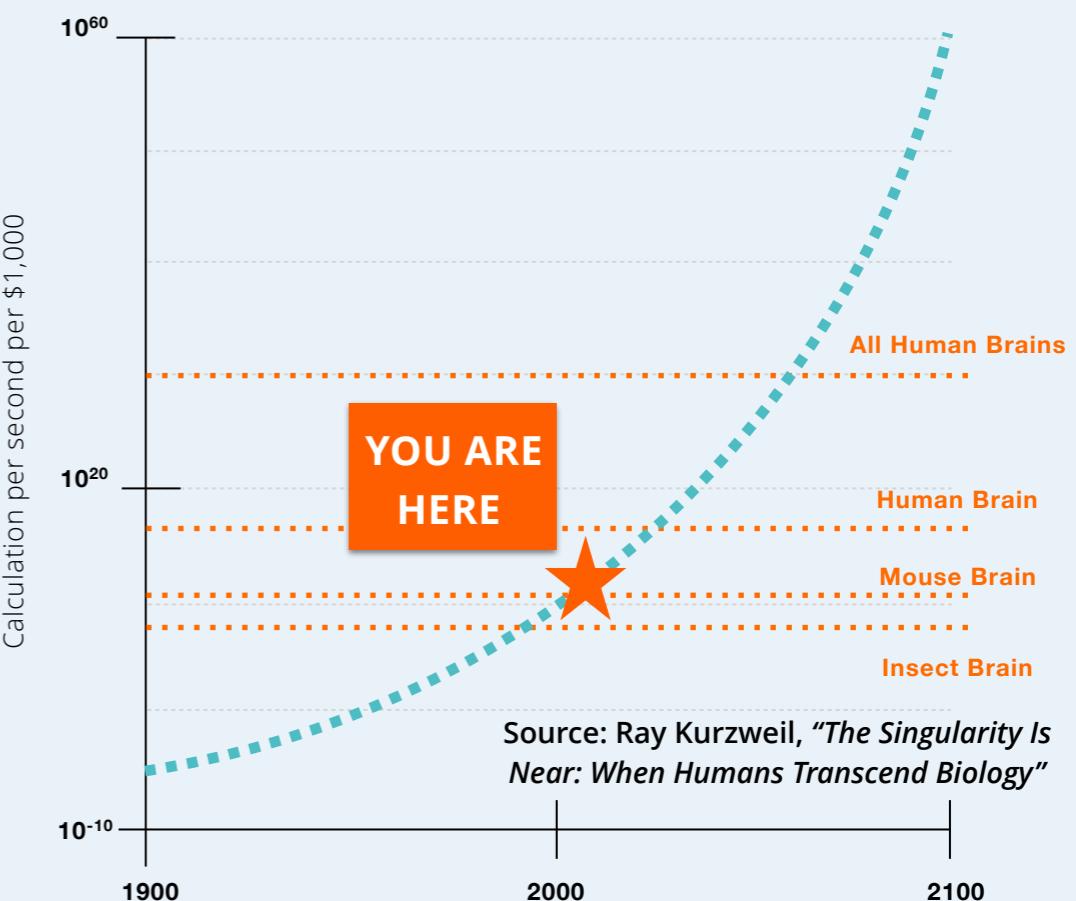
*“So the world’s \$1,000 computers are now beating the mouse brain and they’re at about a thousandth of human level. This doesn’t sound like much until you remember that we were at about a trillionth of human level in 1985, a billionth in 1995, and a millionth in 2005. Being at a thousandth in 2015 puts us right on pace to get to an affordable computer by 2025 that rivals the power of the brain.”*

Tim Urban — [WaitButWhy.com](http://WaitButWhy.com)

*“We are on the edge of change comparable to the rise of human life on Earth.”* — Vernor Vinge

## EXPONENTIAL GROWTH OF COMPUTING

*Twentieth through twenty first century*



*“The development of full artificial intelligence could spell the end of the human race ... It would take off on its own, and re-design itself at an ever increasing rate ... Humans, who are limited by slow biological evolution, couldn’t compete, and would be superseded.”* — Stephen Hawking 2014

# CASE STUDY: NVIDIA, THE FUTURE “GOOGLE” OF AI?

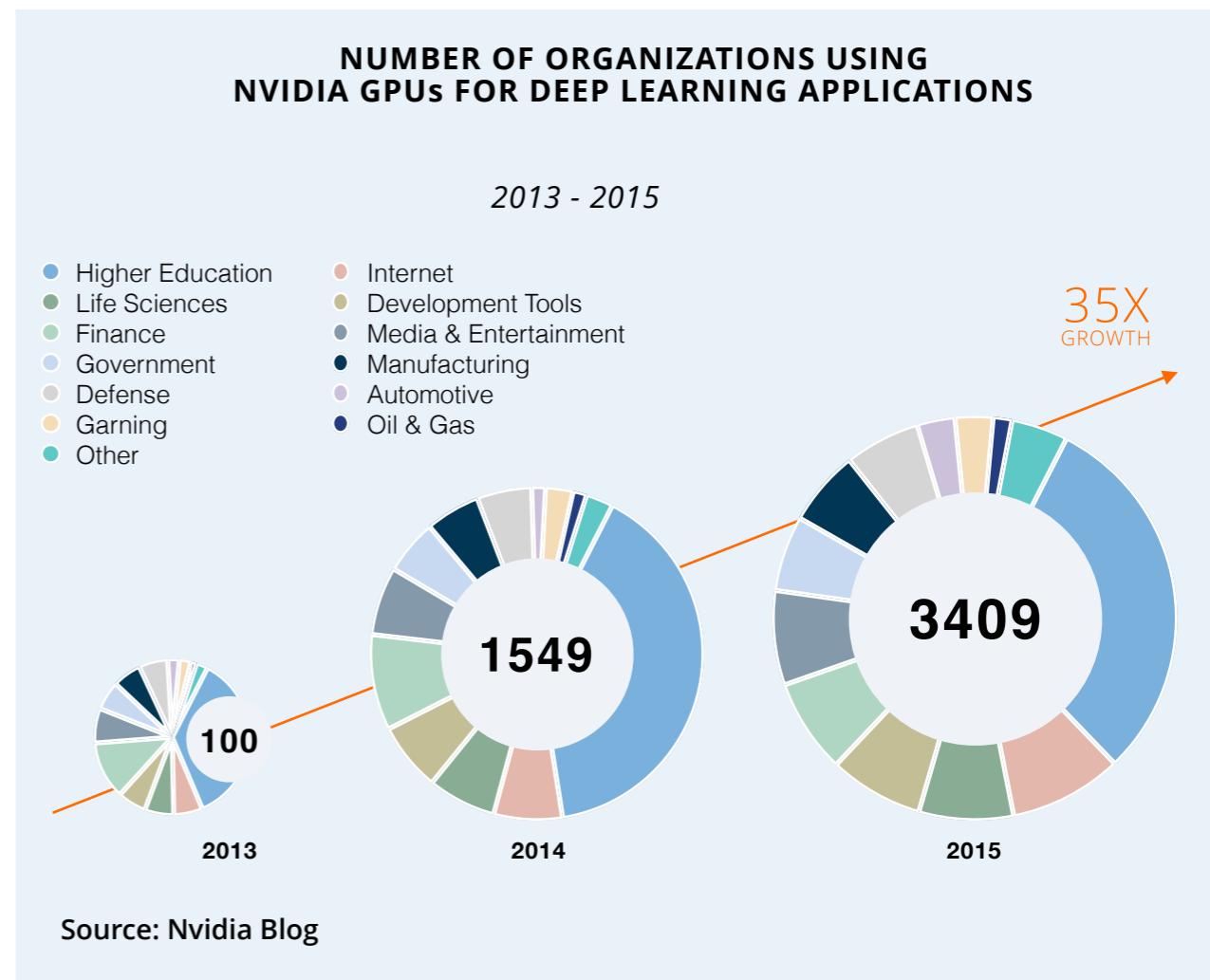
**Nvidia**, a Silicon Valley producer of the graphics processing units (GPU) that drive high-speed and quality displays, saw a hundred-fold increase the number of its customer companies from 2013 to 2015. Although gaming is a big market for **Nvidia** GPUs, its chips have been deployed in supercomputer centers and by researchers and scientists to run high performance applications with AI components.

The increase in use of the type of GPU sold by **Nvidia** provides a rough indicator of the application of AI in an industry. Higher education is **Nvidia's** biggest market (see chart at right).

Over the past five years, **Nvidia** shares increased by +487% while the NASDAQ index grew by 95%. Most remarkably, in the past year **Nvidia** shares rose by 178% as compared to just 2% growth for NASDAQ.

It is also interesting to note that the price of **Nvidia** shares experienced a highly unusual one-day surge of +29.7% when the company released an earnings report on November 11, 2016. With such a large company, a sharp increase in share price is rare except following a major announcement like an acquisition. However, in this case, it appears that Wall Street had underestimated the effect that the increase in AI applications for **Nvidia** GPUs would have on its earnings.

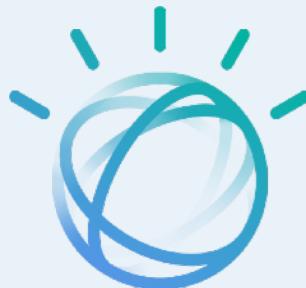
“The **NVIDIA Deep Learning Institute (DLI)** offers hands-on training for developers, data scientists, and researchers looking to solve the world’s most challenging problems with deep learning. Through self-paced online labs and instructor-led workshops, DLI provides training on the latest techniques for designing, training, and deploying neural networks across a variety of application domains.”



“**Nvidia Inception** nurtures dedicated and exceptional startups who are revolutionizing industries with advances in AI and data science. This virtual accelerator program helps startups during critical stages of product development, prototyping, and deployment...NVIDIA invests in next-gen AI leaders through its **GPU Ventures** program”



# CASE STUDY: WATSON, IBM'S PROMISING PIVOT



Five years ago, IBM launched **Watson**, a broad system of AI solutions. **Watson** is named after the late Thomas Watson Sr, the CEO who built IBM into a global business power. **Watson** demonstrated its AI powers when it defeated two human champions on the Jeopardy TV game show.

**Watson** processes information at a rate of eighty teraflops (trillion floating point operations) per second to emulate or even outpace human ability to answer questions. **Watson** uses more than six million logic rules to simultaneously process data on its ninety servers.

Instead of selling **Watson** as single broad solution, IBM split it into different AI field specific solutions, each of which can be purchased to handle a specific business conundrum. It now offers over forty different less ground-breaking but more pragmatic **Watson** services such as language recognition solutions.

The possibilities for application of Watson's underlying AI technology are enormous. **Watson** can run complex analytics and data extraction on huge volumes of data. For example, it could be the foundation for a search engine that would have far greater potential than any other technology. **Watson-like** AI technology can be found behind Siri (Apple) or Alexa (Amazon) as well as many other new cloud-based services.

However, even though IBM was a precursor in AI, it has not able to take advantage of its edge on competition. Despite a strong PR campaign, IBM's inconsistent strategy put off many large investors. On May 5, 2017, Warren Buffett's Berkshire Hathaway announced it had sold nearly a third of its stake in IBM. The same day, IBM shares fell 3% to \$154.45. Berkshire Hathaway has sold over thirty million shares from the 81 million shares it held at the end of 2016.

*"I would think the biggest value will come in when Watson actually replaces human labor, and machines don't come round annually and ask for higher wages, and they don't need health care, and maybe a little maintenance."*

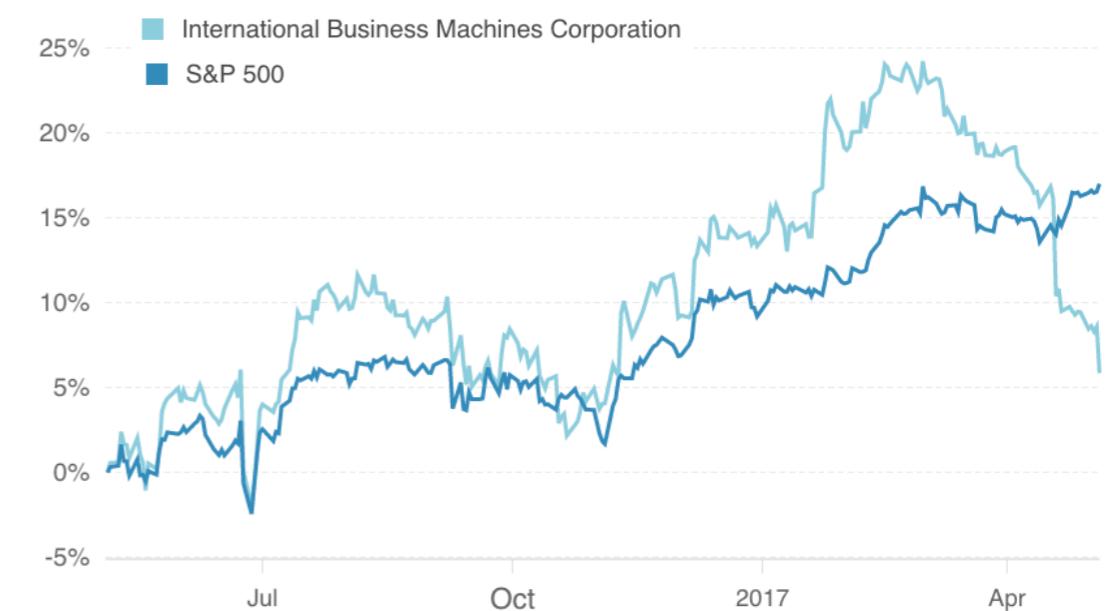
Warren Buffet for CNBC - May 2017



Source: IBM Image Gallery

**WATSON CONQUERS JEOPARDY (2011)**

## IBM COMMON STOCK (NYSE: IBM)



Source: Google Finance

# CASE STUDY: MONSANTO AND AMERICAN FARMING

## Climate Fieldview

American and Canadian farmers use the AI driven **Climate Fieldview** app to determine where to plant crops such as soybeans or corn, or determine areas to irrigate or apply fertilizer and chemicals. **Climate Fieldview** tracks local temperature, erosion records, rain forecasts, soil quality, and other farm data using field sensors and a grid of 10x10 meter parcels that have been mapped for the entire North American continent excluding Mexico. The on-farm sensors stream soil, weather and other data to the company's Big Data archive.

An advanced **Climate Fieldview** app brings in other data and provides broader functions that for instance allow using changes in locally predicted crop yields to help farmers receive supplemental crop insurance coverage if necessary. This USDA approved hassle-free, streamlined and cheaper automated claim process benefits both farmers and insurers.

**Climate Fieldview** is a product of Silicon Valley startup Climate Corporation, which was founded by two Google employees in 2006. Agribusiness giant Monsanto purchased Climate Corporation in 2013. Following that purchase Climate Corporation purchased other agriculture technology startups including Ames, Iowa based Solum and Chicago based 640 Labs.

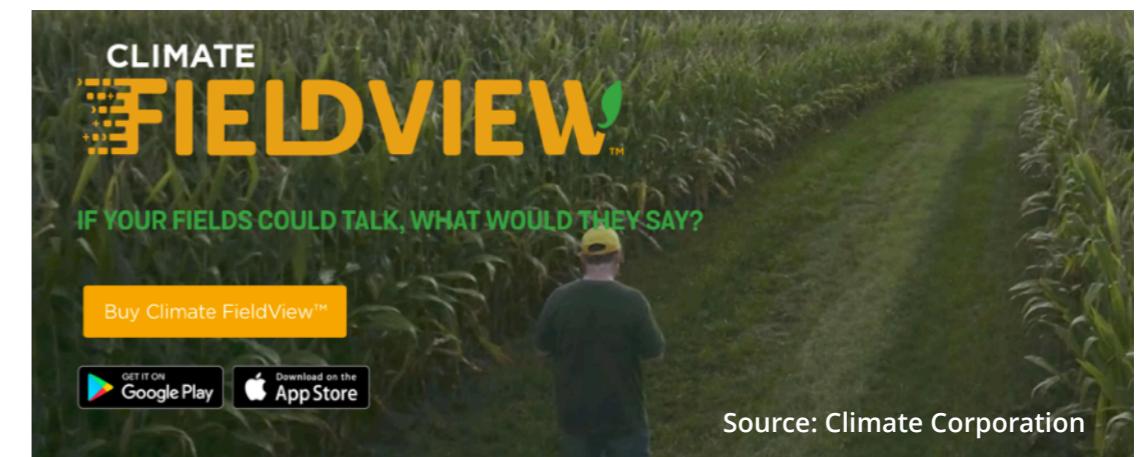
Climate Corporation also provides third-party developers with an API to access its software infrastructure to assist development of additional applications to enhance its service.

After the **Climate Fieldview** launch in the USA, Brazil and Eastern Canada in 2016, and Western Canada in 2017, the company plans to launch in Australia, Europe, South Africa and Argentina in the next few years.

The use of **Climate Fieldview** results in higher yields for each parcel of a farm, and better financial efficiency for the farmer. According to the U.S. Department of Agriculture, the use of Artificial Intelligence has helped farmers to produce the largest crops in America's history.

**Source:** Abstract from Strategy+Business

Monsanto paid \$930 million for Climate Corporation in 2013. This gave it better exposure and legitimacy. The acquisition also provided Climate with the means to continuously improve its technology. It also enabled Monsanto to provide services for better forecasting models and accuracy from the data it streams from field sensors and farm machinery. This has made Monsanto the Amazon.com for agriculture products and services.



**CLIMATE  
FIELDVIEW™**

IF YOUR FIELDS COULD TALK, WHAT WOULD THEY SAY?

Buy Climate FieldView™

GET IT ON  
Google Play      Download on the  
App Store

Source: Climate Corporation

*"AI is generating new approaches to business models, operations, and the deployment of people that are likely to fundamentally change the way business operates. And if it can transform an earthbound industry like agriculture, how long will it be before your company is affected?."*

Anand Rao - Partner at PwC Analytics

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**COVER PHOTO:** [Nvidia Cool Stuff](#)

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