Artificial Intelligence

Report

2017/2018

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Welcome

Introduction

Welcome to another published Report of the University of Glasgow FinTech Society with title "Artificial Intelligence". In this report, we provide an entry-level and easy-to understand introduction to Artificial Intelligence, utilising its functionality and use-case within the FinTech sector. We analyse the advance of Artificial Intelligence from the early-stages of development to its current state in modern technology and we look at future applications and aspirations of this field.

About the Fintech Society

Founded in summer 2017, we are the first student-led FinTech Society in Scotland. We bring together University of Glasgow students of any degree who are interested in technological innovations that are likely to disrupt the financial services sector. We recognise the need for developing FinTech awareness among students before their graduation as a number of surveys indicate that FinTech and FinTech technologies will play a key role in a number of industries in very near future. We also aim to give members opportunities to develop useful employability skills. We believe we can achieve our goals by running a series of workshops throughout the academic year, which are characterised by students' cross-faculty collaboration, peer learning and engagement with industry professionals.

About this report

This report and presentation slides accompanying this report were created by members of the UoG FinTech Society, namely *Aleksandra Waluga, Aliou Amar, Amantle Khachana, Jiaxing Sun, Jim Brysland, Lenka Marčanová and Milo Krawiec.*

This report aims to explain in simple terms the ideas and technology that form Artificial Intelligence. Firstly, we cover the general idea of Artificial Intelligence and the history of development in this field, we then discuss the modern technology applications of AI in the FinTech space, including use cases in investment banking as well as applications of this technology in decentralized financial systems. Furthermore, we discuss the current state of Virtual Reality and Autonomous Vehicles. Lastly, we go into the future plans and developments of Artificial Intelligence in terms of both technology and applications in both industrial and academic fields.

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What is Artificial Intelligence

Definition

Artificial Intelligence (AI) is a branch of computer science that aims to create intelligent machines. An intelligent machine is a computer which perceives its environment and is capable of reacting in a "human-like" fashion. Usually the term "artificial intelligence" is often applied to machines which successfully mimic "cognitive" functions to achieve certain tasks. These functions are associated with human minds, such as learning and problem solving.

History & Intro

Artificial Intelligence (AI) has been studied for decades and is still one of the most elusive subjects in Computer Science. This is partly due to how ambiguous and large the topic is. AI can range from a system truly capable of thinking to machines using computing algorithms to play board games. Therefore, a question is posed: What is intelligence?

Intelligence can be described as:

> "The ability or inclination to perceive or deduce information, and to retain it as knowledge to be applied towards adaptive behaviors within an environment or context. [1]"

Because of the nebulous nature of this field, throughout the development of AI, research projects seemed to underestimate the complexity of what they were trying to achieve, which resulted in projects falling short on their promises and a fluctuating interest in Artificial Intelligence research. During these fluctuations the AI research fields either profited from a heavy influx of grants, or suffered a serious lack of funds. An example of the growing interest in AI would be the time following an AI-centred conference in Darthmouth College (1956) organised by scientists Marvin Minsky and John McCarthy. This event was the first AI-centred gathering and came to be known as "The Birthplace of Artificial Intelligence". It included mathematicians and scientists alike brainstorming the possibility of AI over several weeks, with many attendees going on to be the founders and pioneers of AI technology over the following decades.
However, after years of promising research and ground-breaking milestones, people realised just how complex the end-goal of a truly intelligent system is, and thus many backers withdrew their funding. This period of time came to be known as "AI winter" and occurred in the years following 1973.[4]

The Birthplace of Artificial Intelligence

The 1956 Dartmouth Artificial Intelligence (AI) conference gave birth to the field of AI, and gave succeeding generations of scientists their first sense of the potential for information technology to be of benefit to human beings in a profound way.

The project was advertised to last six to eight weeks, essentially an extended brainstorming session, with many leading researchers attending from fields such as complexity theory, language simulation, neuron nets, abstraction of content from sensory inputs, relationship of randomness to creative thinking, and learning machines. Because of the ambition of this project, interest was stirred up across the fields of computer science, mathematics, psychology, electronics, and others. At this time parties interested in computing science were already observing proof of Moore's Law, with computer processing power doubling every two years and the rate of improvement showing no signs of slowing down.

This caused people to wonder if there is a limit to what machines can achieve, and if in fact AI was that limit.

The Turing Test

In 1950, British mathematician Alan Turing published a landmark paper entitled "Computing Machinery and Intelligence" in which he explores the possibility of creating machines that are capable of thinking. He noted that the term "thinking" is tricky to define and hence Turing then went on to propose a method for evaluating whether machines can think, which came to be known as the Turing test. The test, or "Imitation Game" as it was called in the paper, was put forth as a simple assessment that could be used to prove that machines could think. The Turing test takes a simple pragmatic approach, assuming that a computer that is indistinguishable from an intelligent human actually has shown that machines can think.[2]

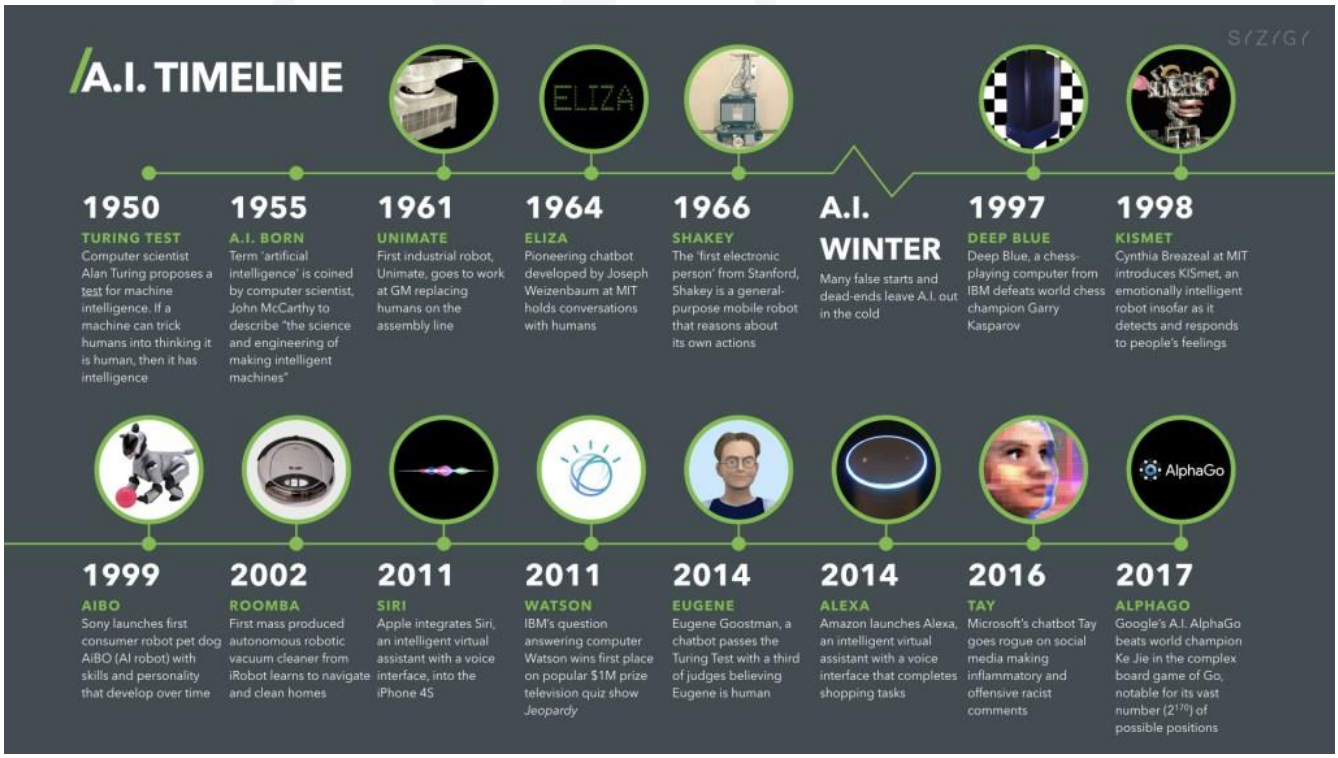
The test involves a suspicious judge which engages in open conversation separately with both a human and machine over a text-only based channel (so that speech rendering would not be a deciding factor in the outcome of the test). All parties being separated from one another, if the assessor cannot reliably tell the machine from the human, the machine is said to have passed the test.[3]

There have been many attempts at passing the test, with AI systems developers claiming success time and time again, however each claim has been heavily criticized in the academic society, with many factors of the testing process being questioned. With this in mind it is the general consensus that the Turing test has not yet been passed by any machine in modern time.

AI Winter

Following the major interest influx into AI research up to the 1970s, there was growing pessimism from the public and strong criticism from the US Congress regarding the proof of concept of AI after millions have been spent funding research. The AI field had little to show to justify the amounts spent, and researchers fell short on their promises to deliver "intelligent" machines" in their initial time periods.

A major part in the cause of the AI winter was when in 1973, professor Sir James Lighthill was asked by Parliament to evaluate the state of AI research in the United Kingdom. His report, now called the Lighthill report[6], criticized the failure of AI to achieve its "grandiose objectives"[6] and claimed that nothing of significant value can be achieved in the field of AI. The report led to the near-complete dismantling of AI research in England and major cuts in funding across the globe. Upon reviewing this report, John McCarthy flew to the UK and a debate was held between McCarthy and Lighthill, this came to be known as the Lighthill Debate (1973), which was broadcasted in the BBC "Controversy" series[5]. Unfortunately, McCarthy's efforts in the debate yielded no significant results in retaining funds within the AI research field.



Timeline graph of AI [42]

Robo-advisors

What it is?

Robo-advisors are software solutions created to provide financial advice and handle portfolio management with moderate to minimal human intervention. The first few of them were launched during the 2008 financial crisis. Robo-advisors have seen a massive growth in usage and it is predicted that approximately 10% of all global assets under management by 2020 will be managed by them.

Robo-advisors then are basically automated investment services that use algorithms to manage and allocate people's assets by analysing their financial status, risk and goals to recommend the best portfolio of stocks available based on that data. There are different types of robo advisors: those who are fully automated and those who are hybrid. Fully automated ones operate in a standalone manner while hybrid ones combine the power of algorithms with human input.

A true robo-advisor is completely automated and requires little to no human interaction. When signing up to these, you usually need to provide some information like the number of years left before retirement, comfort at risk and level of investing experience. These platforms are good for people who are just getting started with investing and who are comfortable with technology taking care of their financial advice. Fees are lower than other types of financial advisors, minimum balance need is lower and letting technology take over can also help prevent human error. Best examples of fully automated robo advisors are Betterment's normal plan and Wealthfront.

Hybrid represents the most widely used model because at this stage algorithms aren't perfect yet for a truly automated financial advisor. Most of the bigger players use their algorithms and pair them with human financial advisors. Betterment, which is one of the leaders in the sector, uses this strategy for its premium plan for example. Even though they are the best type of advisors, they usually charge higher fees (examples include Vanguard and Personal Capital) and have higher minimum balance requirements. Hybrids are good for people who enjoy the automation robo advisors provide but also want to have access to humans (goals, changing circumstances etc..).[7]

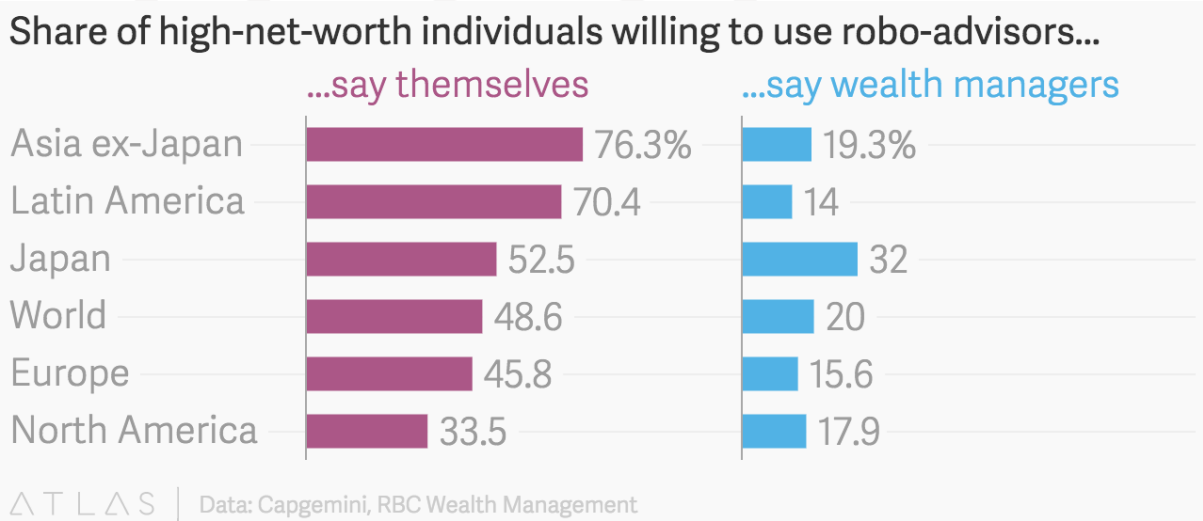
Why Robo-advisors?

But why would people use robo advisors over human financial advisors? What are the advantages? Well the most important advantage probably is the lower fees robo advisors charge. This allows robo advisors to be easily marketed among tech savvy generation like the millennials and, soon, the generation Z. Robo advisors can

charge lower fees mostly because of the cost cuts thanks to the automation of transaction processes. Another advantage of robo advisors is that they usually come with state of art algorithms that are based on Nobel Prize theories like Betterment algorithms. Lower costs and time, paired with low minimum balance to start investing, allow robo advisors to expand the market of financial advice to a wider client base rather than serving only investors who have a certain amount of money to invest.

The fact that robo advisors are expanding financial advice doesn't mean that they don't come with drawbacks. For example, even though robo advisors are based on award winning theories, they haven't been tested properly because of their relatively young age (they started appearing from 2008 onwards) so we don't really know how they would react to a crisis such as the 2008 financial crisis. Furthermore, robo-advisors lack that human level interaction that the most sceptical, like high-net-worth will seek for, from having a personalized advice considering personal situations and flexibility to face to face meetings.

Even though there are disadvantages, the robo-advising market is getting bigger and bigger. The graph below indicates that, by showing the percentage of high net worth people who are willing to invest themselves through robo-advisors rather than with human financial advisors in different areas of the world.



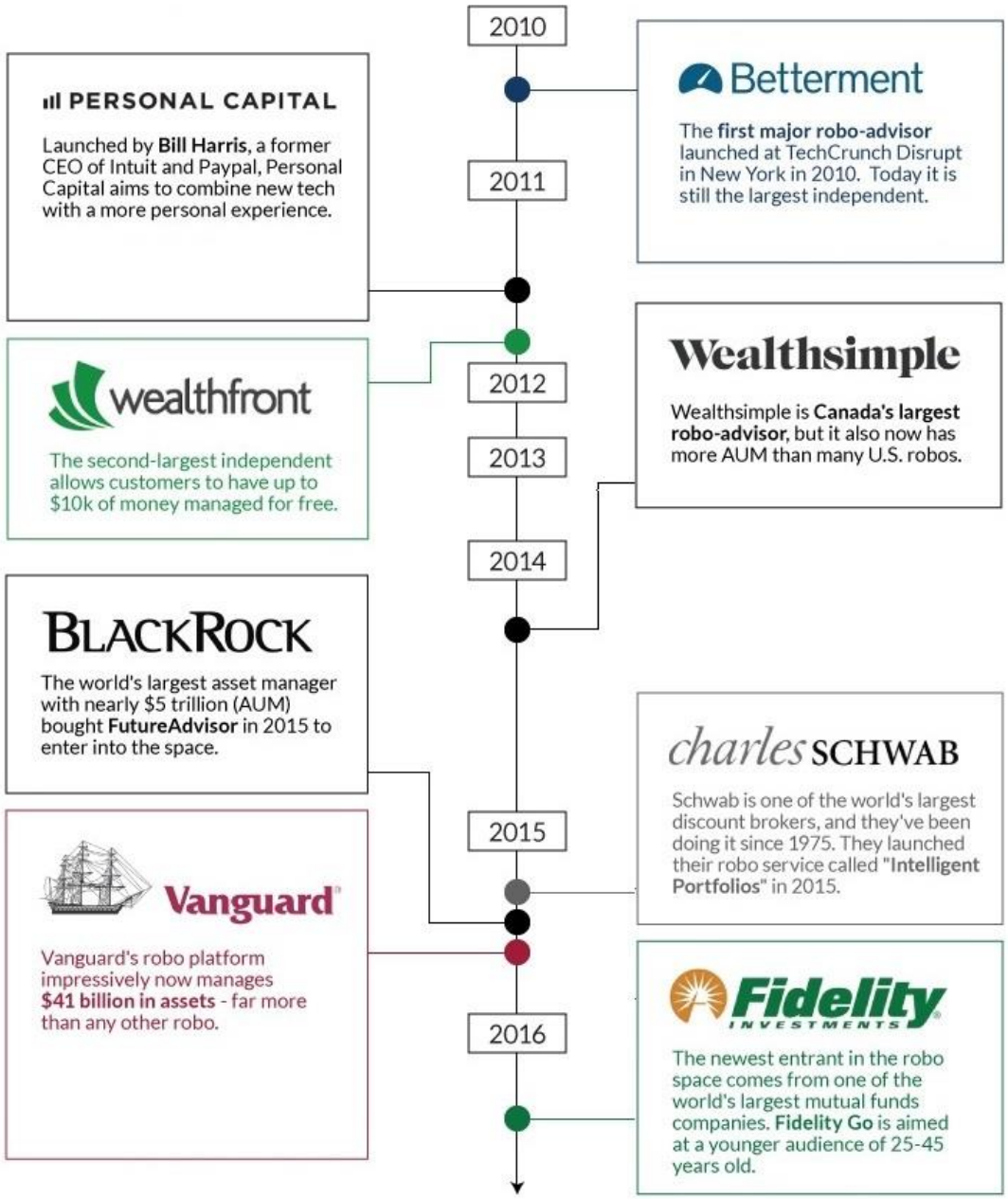
The growth in the market is also shown by the growth in asset under management of robo advisors. In fact, it is predicted that robo advisors could manage a massive amount of $2.2 trillion by 2020. This graph illustrates the main players in the field and their assets under management, from start-ups like Betterment and Wealthfront to old guards like Vanguard and Fidelity Investments.
In fact, VC are pouring money into robo advising start-ups, the most recent being the French start-up Yomoni raising $54 million.[8]

THE ROBO-ADVISOR ARMS RACE

Can upstart robo-advisors compete against scale?

Robo-Advisor Launch Timeline

(AUM) 2016



Robo-advisors could be managing as much as $2.2 trillion by 2020

Artificial Intelligence & Blockchain

DeepBrain Chain

Video: https://www.deepbrainchain.org/pc/indexEnglish.html

To recap from one of our earlier workshops, what is a blockchain? A blockchain is a digital and decentralised public ledger of all recorded cryptocurrency transactions Constantly growing as 'completed' blocks (the most recent transactions) are recorded and then added to it in chronological order, it allows market participants to keep track of digital currency transactions without central record keeping. Each node (a computer connected to the network) gets a copy of the blockchain from the 'genesis block' to the current block, which is downloaded automatically. There is a financial incentive for keeping the network up for the 'miners'.

DeepBrain Chain's vision is to provide a private, safe and low-cost decentralised artificial intelligence computing platform to AI companies using blockchain technology.

What problem is being solved here? From 2012-2016 there were over 5154 new AI companies created with venture funding of $22.4 billion.[9] The era of AI is coming.

High performing artificial intelligent products go through extremely vigorous training methods to develop their product to the highest level. AI development requires large resources of computing power due to the fact AI products train models by neural network calculation which act as a statistical learning model inspired by biological neural networks (central nervous systems such as the brain). These networks are represented as systems of interconnected "neurons", which send messages to each other. The connections within the network can be systematically adjusted based on inputs and outputs, making them ideal for supervised learning. The larger number of users using the product results from larger computational costs for the firms.

The computing power needed to develop these neural networks is extremely expensive and has been a big problem within the artificial intelligence industry.
AI companies are troubled with the decision if they will extensively test the product in order to create a greater AI for the market or limit testing to save costs. This creates a barrier to entry within the industry for small-medium AI firms while companies like Googles acquired 'Deepmind' have the financial support of the technology giant. For example, one game of Deepminds "AlphaGO" costs

$3,000[9]. AlphaGO has been trained to be skilled at the board game "GO" and managed to beat the world number one ranked player, Ke Jie in a best of three matches.

Neo platform

DBC is built on the decentralised smart computing system NEO. Similar to Ethereum, Neo has the ability to offer 'smart contracts' which are a computer program that directly controls the transfer of digital currencies or assets between parties under certain conditions. A smart contract not only defines the rules and penalties around an agreement in the same way that a traditional contract does, but it can also automatically enforce those obligations allowing trust between two people without the need for a third party.
This will allow DBC the ability to manage resources within the network efficiently, allowing for all data to be open, transparent, non-temperable and achieving privacy through cryptography.
Overall Architecture:
Deep brain chain makes use of thousands of nodes on its network that allow the AI companies to make use of its decentralised computational power in return for DBC coin.

What is a node?

In a communications network, a network node is a connection point that can receive, create, store or send data along distributed network routes. Nodes give DBC the resources to power AI products and in return for staking power to the DBC network, they are rewarded in DBC coin which currently has a market cap of $118,000,000 at $0.13 a share.
Miners' main income DBC comes from mining through staking computational power to the network.

DBC mining mechanism

The total number of DBC tokens produced by mining will be 5 billion. Every 5 years, the number of DBC obtained from mining will be halved. In the first 5 years, there will be a total of 2.5 billion tokens. In other words, 500 million pieces will be dug out each year initially. This creating a cap on the supply which creates a certain scarcity within the token with the aim of future price appreciation. It is common for utility tokens to have much higher supplies than cryptocurrencies like bitcoin which are deemed as a "store of value" as there needs to be enough liquidity in the token market for daily use without extreme volatility making them unusable.

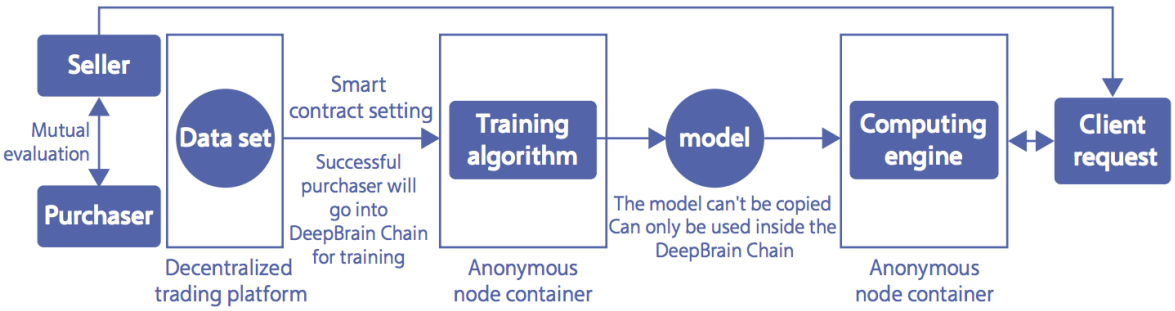
Aside from supplying cheap computer power for AI companies, DeepBrain Chain in the future plan on creating a trading platform for various AI instruments. Creating

a marketplace for AI companies to buy or sell AI data and algorithms cheaply, such instruments are used extensively during the development cycle of AI products.

Data Privacy protection

AI creators can sell their own data on DBC whilst keeping users privacy.
DBC makes it so the buyers on the trading platform cannot receive data directly; instead, the data is sent directly to the anonymous node container of DBC to be trained, and the trained model will be sent directly to the anonymous node container that the computing engine is working on.
Data buyers cannot copy data from the node outside the process of training and using the model, protecting the seller from getting their work stolen. Sellers can also verify whether the anonymous node container has cheated by client request. Then the seller and the buyer will score each other creating a feedback database. (4,3 graphic)

4.3 Data privacy protection



Virtual reality

Virtual Reality is the term for a three-dimensional, computer generated environment which can be explored and interacted with by a person. The more somebody feels like they are inside, or part of, a 3D computer generated environment, the more they are immersed in that virtual world[14].

If an implementation of virtual reality manages to get the combination of hardware, software and sensory synchronicity just right it achieves something known as a *sense of presence*. Where the subject really feels like they are present in that environment [15].

There are many different types of virtual reality systems but they **all share the same characteristics** such as the ability to allow the person to **view three-dimensional images**. These images appear life-sized to the person [15].

Plus, they change as the person moves around their environment which corresponds with the change in their field of vision. The aim is for a seamless join between the person's head and eye movements and the appropriate response, e.g. change in perception [14]. This ensures that the virtual environment is both realistic and enjoyable. The aim is for a natural, free-flowing form of interaction which will result in a memorable experience [15].
Computer games therefore qualify as virtual reality, although they provide little immersion. What more readily springs to mind when we think of virtual reality is someone wearing some headgear, such as the Oculus Rift, to provide them with visual and auditory immersion; partial immersion in their virtual reality [16]. Complete (or at least almost complete) immersion is also possible using a Computer Automated Virtual Environment, which is essentially a room with floors and walls made of screens displaying 3D images. VR will be about more than games. Some of other examples are Facebook's Oculus Rift, Samsung's Gear VR, Microsoft's HoloLens, Sony's Project Morpheus and the wild card – the low-tech, low-cost Google Cardboard – are in the market or on the horizon [17].

The Samsung Gear VR

The Samsung Gear VR is designed to work with Samsung's flagship smartphones. The device can be calibrated using the wheel at the top of the headset. A trackpad is located on the right of the device and back button is located just above it. Volume can be adjusted through the volume rockers also found on the right-hand side [19]. Some of the major goals Samsung set for this project regarding hardware were: that their headset could support MTP (Motion to Photon) latency less than 20 ms. The lenses field of view are 96˚ for the first three models and 101˚ for the R323. Moreover, it cooperates with Oculus Home which is the main facility to download and use content on the Samsung Gear VR. Oculus Home is also the main line for

software distribution on the Gear VR. Apart from a classic usability for gaming. It can be also used for anyone who has ever tried to meditate knows the problem: After a few breaths, the thought scrapes off. One should accept it and then put the attention back to the breathing. Easier said than done. Various apps for the Oculus Rift and the Gear VR support the meditation beginner [18].

MicrosoftHoloLens

Video: https://www.youtube.com/watch?time_continue=18&v=7Xv8A9vqeBw

MicrosoftHoloLens, known under development as **Project Baraboo,** is a pair of mixed reality smart glasses developed and manufactured by Microsoft. HoloLens gained popularity for being one of the first computers running the Windows Mixed Reality platform under the Windows 10 operating system. The HoloLens can trace its lineage to Kinect, an add-on for Microsoft's Xbox gaming console that was introduced in 2010. A collection of applications will be provided for free for developers purchasing the Microsoft HoloLens Developer Edition [20].

Applications available at launch include:

- Holograms, a catalogue of a variety of 3D objects that users can place and scale around them; ranging from tigers and cats to space shuttles and planets.
- HoloStudio, a full-scale 3D modelling application by Microsoft with 3D print compatibility.
- An implementation of the Skype telecommunications application by Microsoft. Any user with Skype on his or her regular devices like PC, Mobile etc. can dial user on HoloLens and communicate with each other. With Video call. On, the user on PC will see the view HoloLens user is seeing and HoloLens user will see view captured by PC / Mobile device user camera.
- HoloTour, an audio-visual three-dimensional virtual tourism application.
- Fragments, a high-tech crime thriller adventure game developed by Microsoft and Asobo Studio, in which the player engages in crime-solving.
- Young Conker, a platform game developed by Microsoft and Asobo Studio, featuring a young version of Conker the Squirrel.
- RoboRaid (previously code-named "Project X-Ray"), an augmented-reality first-person shooter game by Microsoft in which the player defends against a robot invasion, aiming the weapon via gaze, and shooting via the Clicker button or an air tap.
- Actiongram, an application for staging and recording short video clips of simple mixed-reality presentations using pre-made 3D virtual assets, will be released in summer 2016 in the United States and Canada.

Other applications announced or showcased for HoloLens include:

- An interactive digital human anatomy curriculum by Case Western Reserve University and Cleveland Clinic
- Architectural engineering software design tools, SketchUp Viewer by Trimble Navigation was the first commercially available HoloLens application

- OnSight and Sidekick, software projects developed by a collaboration between NASA and Microsoft to explore mixed reality applications in space exploration
- *Galaxy Explorer*, an educational application about the Milky Way in development by Microsoft Studios, pitched and chosen by the developer community via the *Share Your Idea*campaign, and to be open-sourced upon completion
- A spacecraft design/visualization application in development by NASA's Jet Propulsion Laboratory (JPL) [21]

PlayStation VR

The **PlayStation VR**, known by the codename **Project Morpheus** during development, is a virtual reality headset developed by Sony Interactive Entertainment, which was released in October 2016.
It was designed to be fully functional with the PlayStation 4 home video game console. In certain games and demos for the VR, the player wearing the headset acts separately from other players without the headset. The PlayStation VR system can output a picture to both the PlayStation VR headset and a television simultaneously, with the television either mirroring the picture displayed on the headset, or displaying a separate image for competitive or cooperative gameplay. PlayStation VR works with either the standard DualShock 4 controller or the PlayStation Move controllers [25].

Oculus VR

Oculus VR a virtual reality headset designed for video gaming, and launched a Kickstarter campaign in August to make virtual reality headsets available to developers. The consumer product was released on March 28, 2016 with an all-new design incorporating specialized VR displays, positional audio, and infrared tracking system [23].
Apart from gamer's using it can be used as additional tool for drones. Drone maker Parrot has a fix for its quadcopter drone, known as Bebop. It uses Oculus Rift to see what the drone sees through its 180-degree fish-eye lens. This gives a first-person perspective, rather than squinting at a monitor, to give a direct view of something like inspecting a construction site [24].
Moreover, Virtual Reality can enhance current eLearning by making it 3D and interactive. Rather than a group of learners all looking at 2D images of course-content on an interactive whiteboard, they can experience the content of this lesson as occupying space in their classroom and thereby become immersed in learning. Google has been seeding elementary schools with over 100,000 virtual reality headsets and lesson plans [15]. Kids are able to go on a virtual reality field trip to, say, and the surface of the moon. Some of the educational projects already unveiled – the British Museum's use of VR to transport visitors back to the bronze age; Irish start up VR Education's VR app based on the Apollo 11 moon landing; David Attenborough's work with a special VR exhibit at London's Natural History

Museum; and NASA's PlayStation VR demo of how VR could help its operators practise using robotic arms on the International Space Station – are among the more convincing arguments for modern VR being about more than just games or gimmicks [15]. One recent example was a doctor [who] practised surgery on a tiny baby's heart. He took scans of the heart, uploaded them to the computer and toured it with this little virtual reality headset, was able to plan out his surgery ahead of time, and saved the baby [15].

A virtual environment **should provide the appropriate responses** – in real time- as the person explores their surroundings. The problems arise when there is a delay between the person's actions and system response or latency which then disrupts their experience. The person becomes aware that they are in an artificial environment and adjusts their behaviour accordingly which results in a stilted, mechanical form of interaction [14].
There are a range of systems that are used for this purpose, such as headsets, Omni-directional treadmills and special gloves. These are used to actually stimulate our senses together in order to create the illusion of reality [15].

Brains are evolved to provide us with a finely synchronised and mediated experience. If anything is even a little off we can usually tell. This is where you'll hear terms such as *immersiveness* and *realism* enter the conversation [16]. These issues that divide convincing or enjoyable virtual reality experiences from jarring or unpleasant ones are partly technical and partly conceptual. Virtual reality technology needs to take our physiology into account. For example, the human visual field does not look like a video frame [17]. We have (more or less) 180 degrees of vision and although you are not always consciously aware of your peripheral vision, if it were gone you'd notice. Similarly, when what your eyes and the vestibular system in your ears tell you are in conflict it can cause motion sickness [16]. Which is what happens to some people on boats or when they read while in a car.

- ✓ How virtual reality affects the brain:
  https://www.youtube.com/watch?v=QlyL_qCMO5M

Autonomous Vehicles (AVs)

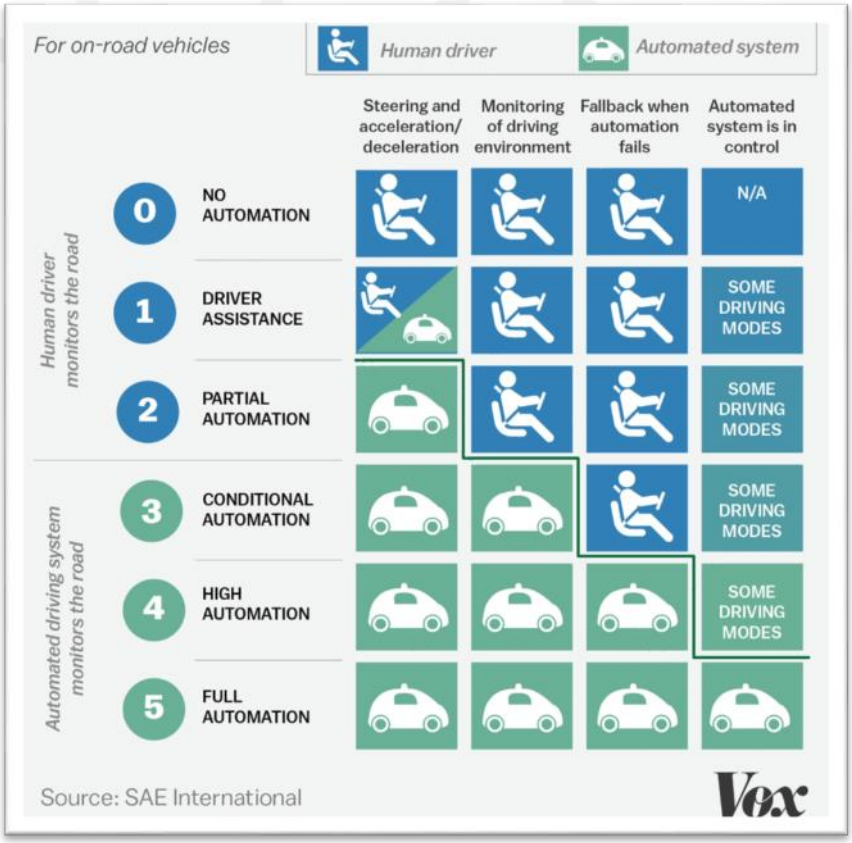
What it is?

Autonomous vehicles (AVs) involve the application of augmented technological capabilities to cars, buses and trucks. The technology to power self-driving cars has been advancing quickly and is steadily becoming ready for rapid deployment. Although the wide-scale adoption of driverless cars is certain to bring disruptive social, economic and environmental changes, the era of fully autonomous cars is

still in its infancy. Nevertheless, the optimism that it is the wave of the future is already pervasive.

Five Levels of Driving Automation

The Society of Automotive Engineers defined a five-level classification of self-driving capabilities. The levels range from 'no automation' to 'full automation', with a key distinction between levels 2 and 3, where the human-centred autonomy begins to develop into full autonomy.[26] The existing automatic driver aids like lane-keeping systems, adaptive cruise control, auto-parking systems, emergency braking, and satellite-navigation systems is what can be classified as level 1 automation. Some luxury brands including Mercedes-Benz and BWM began to present level 2 features, such as speed control and automated steering. Level 3 vehicles will still require a certain degree of driver intervention, and the cars with such 'conditional automation' are still in a testing stage. Levels 4 and 5 will be autonomous enough to reduce the human role in driving from little to no involvement at all. To achieve the full autonomy, a range of sophisticated technologies is required, including a combination of cameras, sensors, radar, light detection and ranging systems (LIDAR), high-performance GPS, as well as artificial intelligence and machine learning systems – all of which are employed to analyse real-time information and enable the vehicle to adapt to constantly changing circumstances.[27]



~ The 5 levels of driving automation.[28] ~

Key Technologies of Intelligent Vehicles

Self-driving vehicles can thus be broken down into five core components [29]:

- ✓ **Computer vision**: using cameras as a substitute for human eyes to image lanes and the position of moving and static objects relative to the vehicle;
- ✓ **Sensor fusion**: integrating data from sensors (radar, lasers) and camera images to compose a comprehensive understanding of the car's surroundings; a variety of sensors is employed because of the different measurements (distance, velocity) and conditions (adverse weather) in which they excel, eventually to obtain a richer model of the environment;
- ✓ **Localization**: for autonomous driving purposes, highly sophisticated mathematical algorithms are used to localise the vehicle within a 1-2 centimetres accuracy (compared to 1-2 metres offered by the common GPS);
- ✓ **Path planning**: a trajectory charting in accordance with safety, comfortability, rules of the ground, vehicle dynamics for manoeuvring in the modelled environment context;
- ✓ **Motion control**: the vehicle executing commands (turning the steering wheel, hitting throttle or brake) necessary to follow the trajectory set in the path planning block.

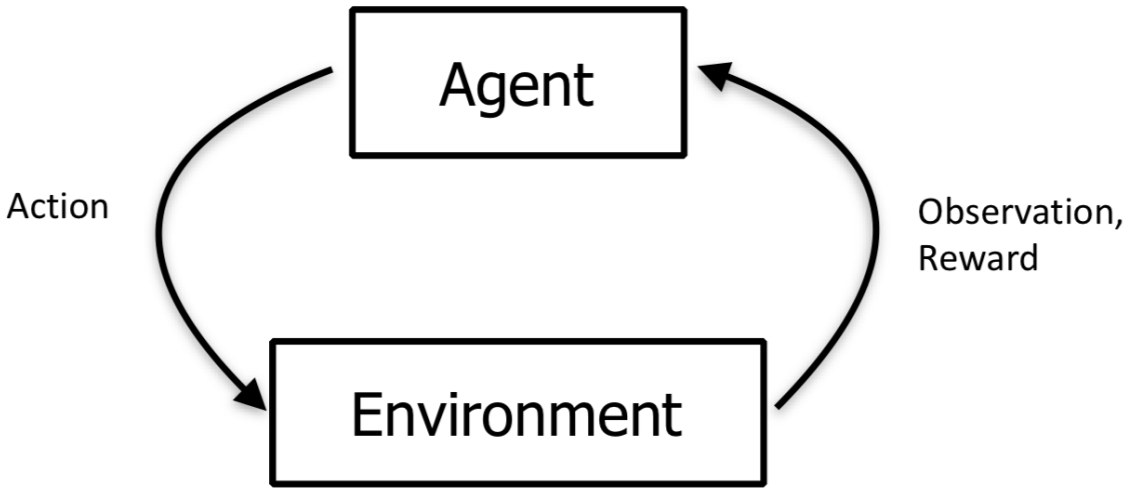
~ Key technologies of intelligent vehicles.[30] ~

Since the cameras and sensors need to instantly process a huge amount of information to ensure absolute safety, AVs require advanced algorithms, high-

performance computing and deep learning systems to adapt to changing scenarios. This essentially means that software is the key element in any self-driving vehicle, and in order to achieve full autonomy in driving, the computers have to be trained to interpret the real world more intelligently.[31]

Reinforcement Learning

Humans as sentient, cognitive beings can comprehend, reason and take appropriate to a situation actions, whereas AVs are only programmed to do specific things in specific scenarios.[32] Nonetheless, there exists a technology that could train machines to perform a new task without the need for manual programming.
Currently, self-driving vehicles often fail in more complex situations involving interaction with human drivers, like four-way stops or roundabouts. To teach their vehicles how to drive in such challenging situations, carmakers are exploring the reinforcement learning technology. This approach is inspired by animals' trial-and-error cognitive process, based on repeating a behaviour that led to a positive outcome. This has been considered a powerful yet difficult to scale idea until the 2016 superhuman victory of AlphaGo, a programme trained using reinforcement learning.[33]
Reinforcement learning is based on the reward hypothesis, which holds that all goals can be defined by the maximisation of expected cumulative reward. In the case of AVs for example, a positive reward will be issued for following the desired trajectory, and a negative reward for crashing. The goal of this mechanism is to teach a machine to select actions that maximise total future reward.[34]



~ Sequential decision-making in reinforcement learning.[35] ~

In order for an agent to become skilled in behaving optimally in all possible states, it must be exposed to as many of those conditions as possible. Unlike in traditional

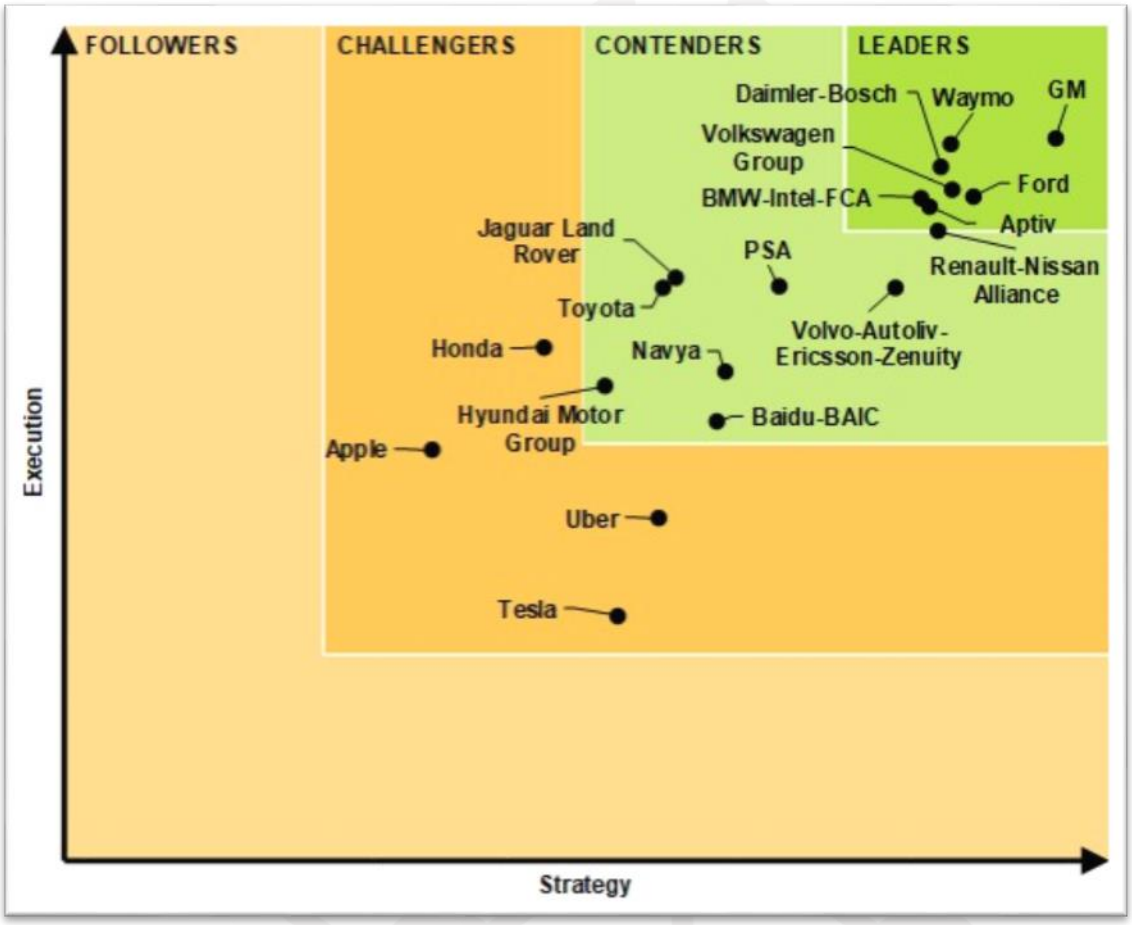
supervised learning environment, the agent in reinforcement learning has access to various scenarios only through its own actions. In effect, a chicken-and-egg problem arises – the agent needs the right experience to form a good policy, but at the same time a good policy is needed to obtain such experiences. This leads to an entire subfield of reinforcement learning that tackles the problem of 'exploration' and 'exploitation' tradeoff. Ideally, the developed technique should encourage the agent to explore its environment until it has learned enough to take informed and optimal actions.[36]
When combined with broader deep learning that utilises a vast simulated neural network to identify patterns in data, reinforcement learning should allow computers to efficiently perform even larger and more complicated tasks.[37] The hopeful goal from employing these two techniques is to create general purpose AI through generalizable learning of the optimal response to a formalised set of states and actions.[38]

Automated Driving Systems Companies Leaderboard

The pace of development in the AV sector saw a steady increase in 2017 with many companies moving from an R&D stance to production engineering. The amount of ride-hailing pilot programmes has also risen as the mobility services appear to be the primary means of deploying driverless cars, especially in the early years of commercialisation. Analysts position General Motors and Google's Waymo as the industry leaders, with Ford, Daimler and Volkswagen being strong contenders, while Tesla, Apple and Uber are lagging the most behind in the race.[39]

To dominate the self-driving car market, it is essential to possess both advanced AV technology, as well as the capability to manufacture cars with the required sensors and computing hardware on a mass scale. GM found a solution to this issue by acquiring a Silicon Valley start-up Cruise that develops driverless car software, whereas Waymo paired with Fiat Chrysler to supply minivans with built-in Waymo's hardware and sensors.[40] The growing rivalry between the two companies for the first fully autonomous car will be a heated one, with the former looking to release a fleet of taxis with no steering wheels and pedals in 2019, and the latter aiming to launch a driverless mobility service in Arizona early in 2018.[41]

Tesla, an early leader with a driver-assistance Autopilot feature rolled out in 2015, has been placed at the lowest spot in the 2017 ranking. This follows a post-fatal-accident split with Mobileye, an Israeli-based company involved in the development of the first-generation Autopilot, and rather slow and challenging process of building Tesla's own new Autopilot 2 from the ground-up.[40] The company is known for being outspoken about their plans to deliver level 5 vehicle in the near future, but at the same time its history of over-promising and underperforming is nothing new either.



~ 2017 assessment of strategy and execution for 19 companies developing automated driving systems.[43] ~

Ready for the new ride?

Researchers estimate that 250 million connected vehicles will appear on the roads by 2020 [44], bringing multifaceted benefits to consumers and society: reduced traffic accidents, improved fuel economy, curbed air pollution, freed up commute hours and free urban spaces.[45]
Major car companies and software developers make substantial progress in collision avoidance, navigation and street mapping, and governments as well begin to address relevant issues making it a high priority to produce clear regulatory rules regarding AVs. Nevertheless, there are still wider ethical and societal consideration that have to be considered before we reach full commercial deployment of driverless vehicles, which remains a major challenge before the self-driving revolution changes the transportation landscape forever.[46]

The Future of AI

With the development of deep learning (DL) technology, which is a sub-section of machine learning (ML) branch of artificial intelligence (AI), AI has raised people's attention again. More applications will be done in different industries in the future, and the market of AI will grow sharply. The main applications will be in the fields with large amount of data like finance in the recent years. Except for finance, AI will also be applied to other industries which are important in our daily life like healthcare industry. However, there are still problems waiting for people to solve to achieve artificial general intelligence, which is the final aim of artificial intelligence.

Future market size of AI

The AI market will grow sharply in the future because of the development of DL technology. Firstly, the success of DL makes investors more confident about the future of AI. The moment in March 2016 when Google Deepmind's AlphaGo machine (based on DL) beat world Go champion was a milestone in human society. It proved that DL has dramatically improved the capability of AI.

[49]

Secondly, AI is a technology that can be used in many fields such as finance, medicine, education etc. Therefore, different companies from different industries will all invest to develop AI. There is a survey report has shown that 80% of enterprises are investing in AI. [47] Moreover, AI is a technology that can help company reduce cost. For example, FuKoku Mutual Life Insurance replaced 34 employees with an artificial intelligence system called Watson, which can calculate

pay-outs to policyholders. The system costs 1.7 million dollars and maintaining it will cost 128 thousand dollars. It could help the company save 1.1 million dollars per year. [48] According to the prediction of "statista", the worth of AI market value will increase from 1378 million dollars in 2016 to 59748 million dollars in 2025. [49]

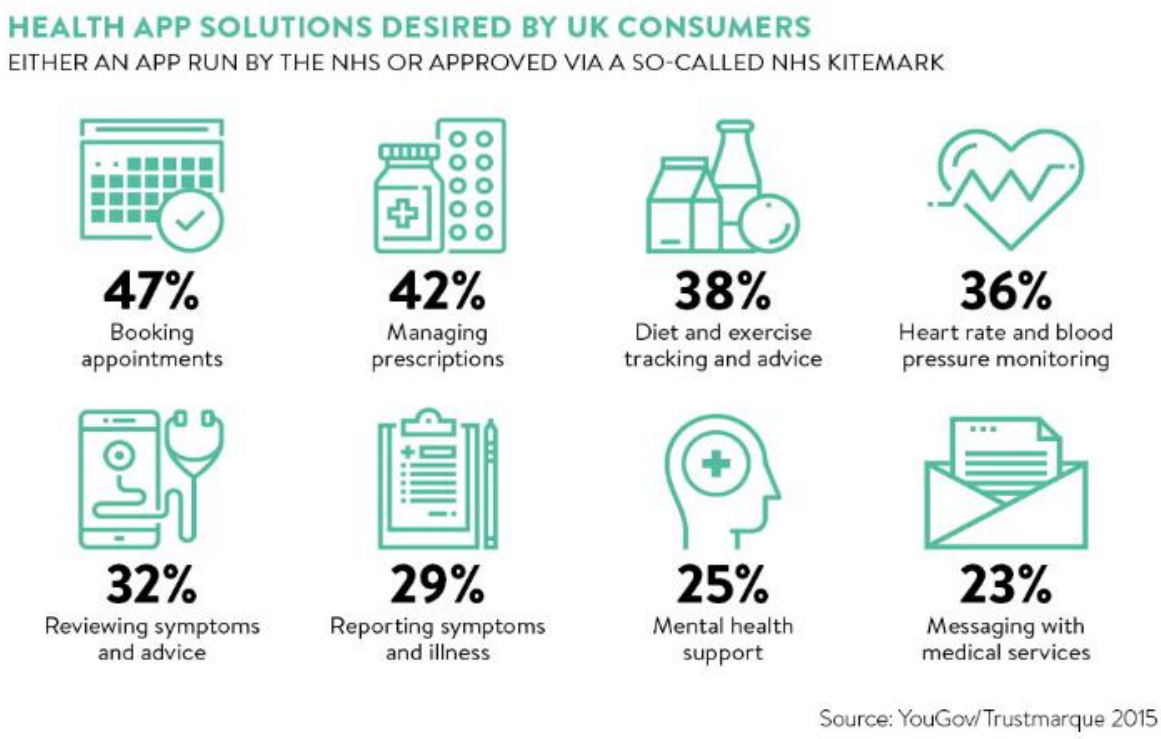
Future of AI in finance industry

Finance industry is one of the main place that AI will be applied to, and AI could make the financial service better, safer and more personalized in the future. DL is part of a broader family of ML methods based on learning data representations. In other words, DL requires large quantity of data to train the machine to make them perform better. At the same time, finance is an industry full of data and needs models and calculations to predict the future. What is more, the aim of financial activity is clear, it is making profits or managing risk. Therefore, finance industry is one of the best industry that AI could be implied to. There already have been many robot advisors now, for example, Wealthfront, Betterment and Future Advisor. However, finance industry still has a lot of room for improvement with the help of AI. Firstly, future AI applications may can not only understand the data of stock price or trades but also other source of data. Ben Goertzel hold the belief that the future applications of machine learning will be in understanding social media, news trends and other data sources. The stock market move is response to myriad human-related factors; therefore, the hope is that DL is able to enhance machine's ability to discover the trends by reading information like human. [50]

Secondly, AI can make the financial system safer in the future. Daniel mentioned that Usernames, passwords and security may no longer be the norm for user security in five years. Future security measure might require facial recognition, voice recognition or other biometric data. [51] Finally, AI can make the financial service more personalized in the future. In the traditional mode of finance, banks only provide customized service to customers with large amount of assets or deposits because of the limitation of human resource and data-handling capacity. However, with the development of technologies like natural language process (NLP) and DL, chat bot and robot advisors have been created. If these two applications could be combined in the future, it could replace the role of financial manager and provides customized financial plan for each customer.

Future of AI in the healthcare market

AI will influence the healthcare industry in three main ways. Firstly, chatbots or intelligent personal assistants are forecasted to replace simple messaging soon. It could take off the burden on medical professional regarding easily diagnosable health concerns or quickly solvable health management issues. As a result, medical professionals will get the chance to move from repetitive, monotonous tasks to the challenging, creative assignments. [52] For the patient, they will save much time and money.



Here is the data about people's demand for healthcare APP in UK, according it, the intelligent personal assistants will meet people's need and occupy large proportion of market. To the second, AI can also help doctors with the hardest cases that they are hard to make diagnoses by experience. For example, when a doctor need to distinguish cardiomyopathy from pericarditis. [53] Finally, AI will help healthcare move from traditional "one size fits all" medical solutions towards precision medicine. As the National Institutes of Health (NIH) put it, precision medicine is "an emerging approach for disease treatment and prevention that considers individual variability in genes, environment, and lifestyle for each person." To be able to ponder all those individual variations, medical professionals must gather incredible amounts of information, and the ability to analyse, store, normalize or trace that data. [54] This is what AI can help to do.

Future market trend of AI

Obviously, except for the DL technology, all the other plans or applications are all related to natural language processing and image vision. Therefore, in the future several years, most of the money, source and specialist will focus on these two areas which give machine the ability of reading, listening and talking like human.

Challenges for Artificial General Intelligence

However, even these all come true in the future, people are still far away from achieving the real artificial intelligence (also named artificial general intelligence), which is the primary goal of artificial intelligence research. AGI refers to an

intelligence of a machine that could successfully perform any intellectual task that a human being can, instead of focusing only specified tasks like playing video games or driving cars. [55] To achieve AGI, there are still many problems need to be solved. Firstly, we should still keep exploring how brain works. According to David Deutsch, an Oxford physicist widely regarded as the father of quantum computing said that we do not even understand how to define how human intelligence operates. [56] Tomaso Poggio said in the Emtech China 2018 that 10% of the difficulties can be solved through deep learning, however the rest of 90% requires future research on neuroscience and cognitive science.

Furthermore, people also need to think about how to achieve multitasking AI system, and how to support machines with adaptability to work in new situations. Finally, the development of AI also relies on the development of the computing and data storage capabilities. According to Lauren Macpherson, there are roughly 100 billion neurons and 1 quadrillion synapses in the human brain, so to map this and store all the data is impossible with current computing and data storage capabilities. [57]

Therefore, to achieve AGI there are many fields should be developed. For example, biology studies how brain works and how people create consciousness and emotion. Math helps to make algorithm more efficient. Development of IC foundry provides enhance the capability of calculation. In the past several years, the use of Gpu accelerated the development of AI. Maybe the development of quantum computers would be the next boost for the development of AI in the future. Except for these, how people regulate AI will also influence its future development.

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