# Overview of Artificial Intelligence

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# Objectives

- After completing this course, you will be able to:
  - Understand the development of Artificial Intelligence (AI).
  - Master AI technologies and related concepts.
  - Understand the justice and equity in the era of AI.
  - Understand the man-machine relationship and AI governance in the era of AI.

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1. The Past of AI
2. What Is AI?
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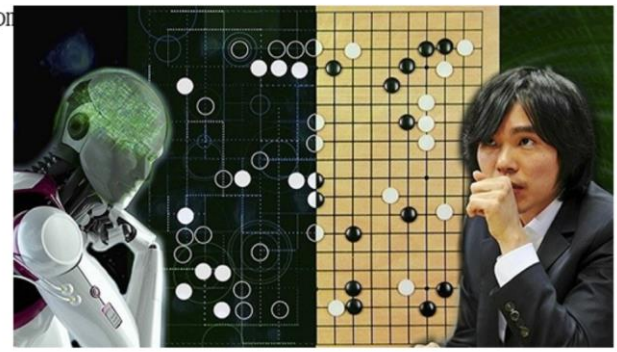
## The Rise of AI

- In March 2016, AlphaGo defeated Lee Sedol, a South Korean 9-dan professional Go player, by 4-1. This reshaped people's opinion on AI and unveiled its overwhelming developr



- Introduction to AlphaGo:
  - On January 27, 2016, Nature, an international top journal, reported that AlphaGo, a computer Go program developed by Google, defeated Fan Hui, a 2-dan professional player who once won the European Professional Go Championship by 5-0 without handicap. This was an unprecedented breakthrough in the AI field of Go matches. It was also the first time that a computer Go program had beaten a professional human player on a full-sized board without handicap.
  - From March 9 to 15, 2016, AlphaGo versus Lee Sedol, a five-game Go match between the world champion Lee Sedol and AlphaGo, played in Seoul, South Korea. The match used Chinese chess rules. Finally, AlphaGo won the match by 4:1.
  - From 29 December 2016 to 4 January 2017, AlphaGo, under the account name Master, won 60 straight online games against human professional Go players on the Tygem Go server and Fox Go server.
  - From May 23 to 27, 2017, AlphaGo Zero won the world championship Ke Jie with a total score of 3:0 in Wuzhen, China. In the team Go match held on 26 May, AlphaGo defeated five world champion players, Chen Yaoye, Tang Weixing, Zhou Ruiyang, Shi Yue, and Mi Yuting.

## Dartmouth Workshop: Birth of AI


- In August 1956, some scientists and mathematicians gathered at Dartmouth College, discussing about how to make machines simulate human learning and any other feature of intelligence. They were John McCarthy (creator of the Lisp programming language), Marvin Minsky (AI and cognitive scientist), Claude Shannon (father of information theory), Allen Newell (computer scientist), and Herbert A. Simon (winner of the Nobel Prize in Economic Sciences).
- The workshop ran for two months. No consensus was reached, but they picked the name artificial intelligence for the field they discussed about. Then, they [illegible] 1956 marked the birth of AI.





- The workshop pointed that every aspect of learning or any other feature of intelligence should in principle be so precisely described that a machine can be made to simulate it.
- The study of AI can be traced back to explorations on mathematical logics done by Aristotle (theory of the syllogism), Gottfried Wilhelm Leibniz (symbolic logic, which enabled people to perform calculation and inference in a quantitative way, laying the foundation for mathematical logic), George Boole (Boolean algebra), Gottlob Frege, Bertrand Russell, Kurt Gödel, McCulloch-Pitts model, and Alan Turing's computing machinery and intelligence.
- Optimistic predictions of AI:
  - 1958, H. A. Simon and Allen Newell: "within ten years a digital computer will be the world's chess champion" and "within ten years a digital computer will discover and prove an important new mathematical theorem."
  - 1965, H. A. Simon: "machines will be capable, within twenty years, of doing any work a man can do."
  - 1967, Marvin Minsky: "Within a generation ... the problem of creating 'artificial intelligence' will substantially be solved."
  - 1970, Marvin Minsky: "In from three to eight years we will have a

machine with the general intelligence of an average human being."

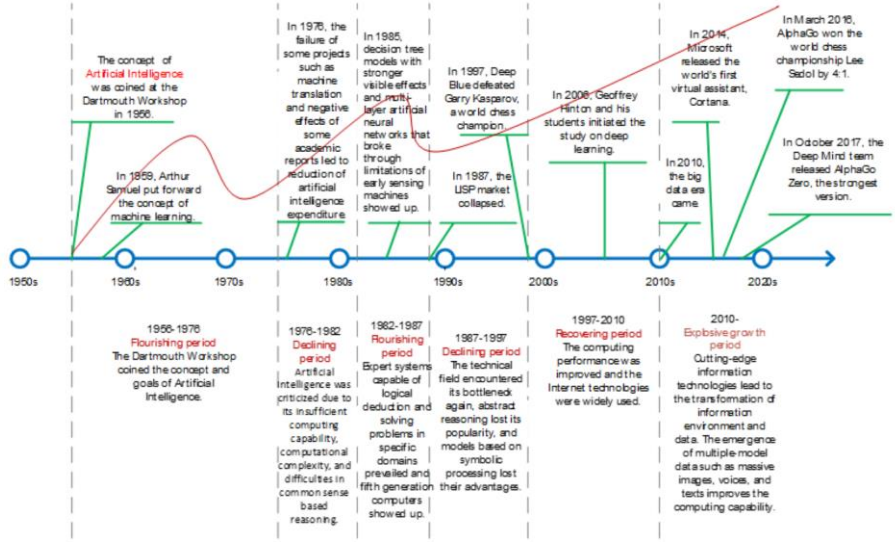
## The Dartmouth College Artificial Intelligence Conference: The Next Fifty Years

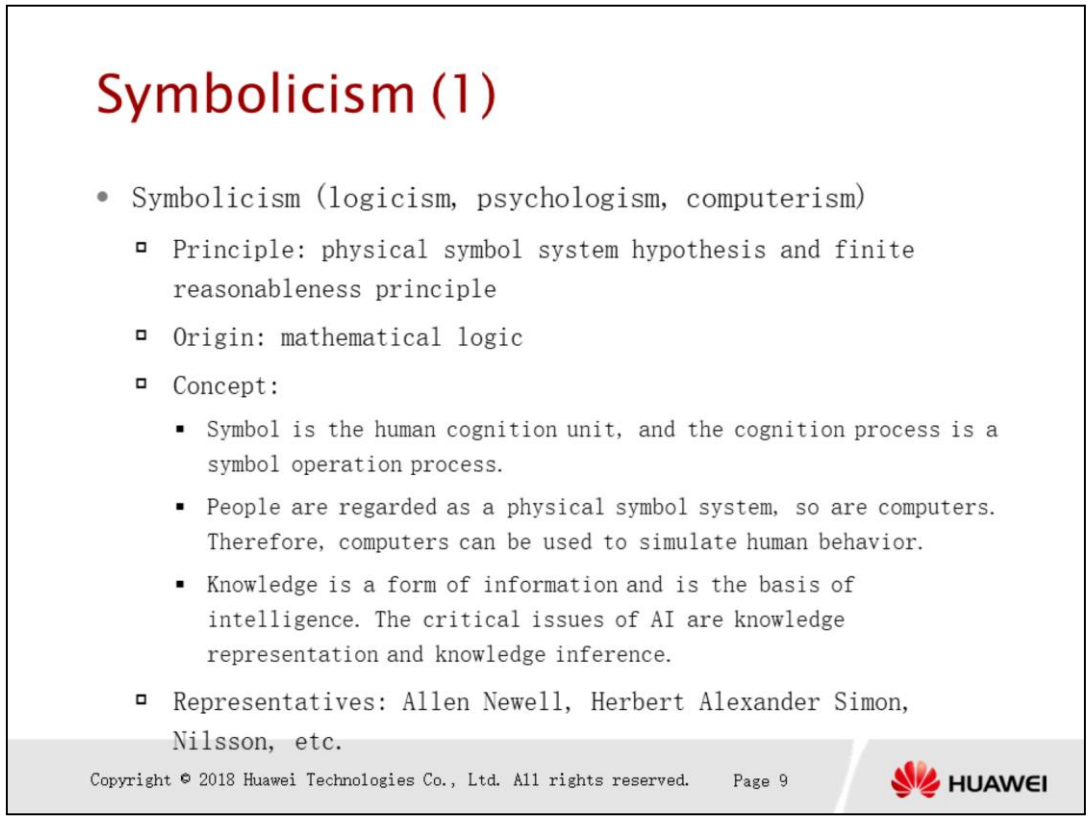
- Participants of Dartmouth Workshop reunited in 2006, after 50 years of the Dartmouth Workshop.

- From left: Gordon Moore (Moore's law), John McCarthy (doctor of mathematics, creator of the Lisp programming language), Marvin Minsky (developer of Robot C, the world's earliest robot that can simulate human activity), Oliver Gordon Selfridge (founder of pattern recognition and developer of the first workable artificial intelligence program), and Ray Solomonoff (inventor of algorithmic probability)

# AI Development History

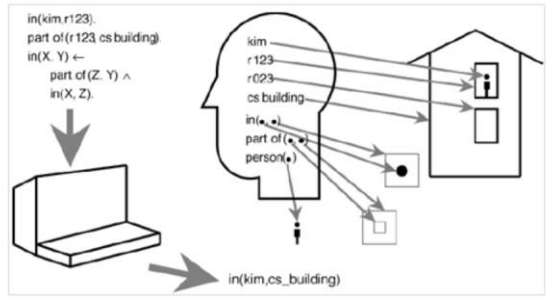





- Many theories emerged during AI development: symbolicism, connectionism, and actionism. All these have facilitated the development of AI.

# Symbolicism (2)

Symbolicism




Representatives

John McCarthy (1927-2011) | Allen Newell (1927-1992) | Herbert Simon (1916-2001) | Edward Feigenbaum (1936-)



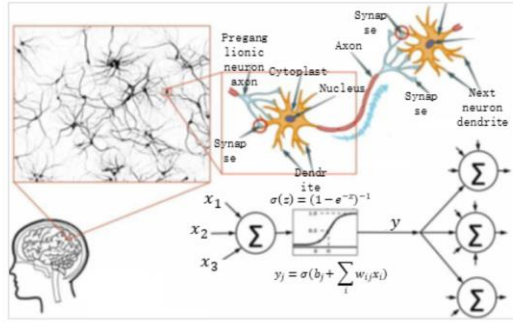

- These symbolists first adopted the term "artificial intelligence" in 1956. Later, the heuristic algorithm, expert system, and knowledge engineering theory and technology made considerable progress in the 1980s. Symbolicism has stood out for a long time and contributed greatly to the development of AI, especially the expert system. It was critical for applying AI to engineering applications. Symbolicism remained to be a mainstream even other AI theories emerged.

# Connectionism (1)

- Connectionism
  - Principle: neural network, connection mechanism and learning algorithm between neural networks
  - Origin: bionics, especially the study of the human brain model
  - Concept:
    - Neuron, instead of the symbol operation process, is the basic thinking unit.
    - Human brain differs from computers, and the human brain pattern can be used to replace the computer pattern.
  - Representatives: Warren McCulloch, Walter Pitts, John Hopfield, Rumelhart, D.E., etc.

# Connectionism (2)

Connectionism

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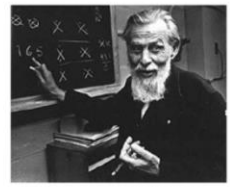


Warren S. McCulloch
(1898-1969)

Walter H. Pitts
(1923-1969)

Marvin Minsky
(1927-2016)

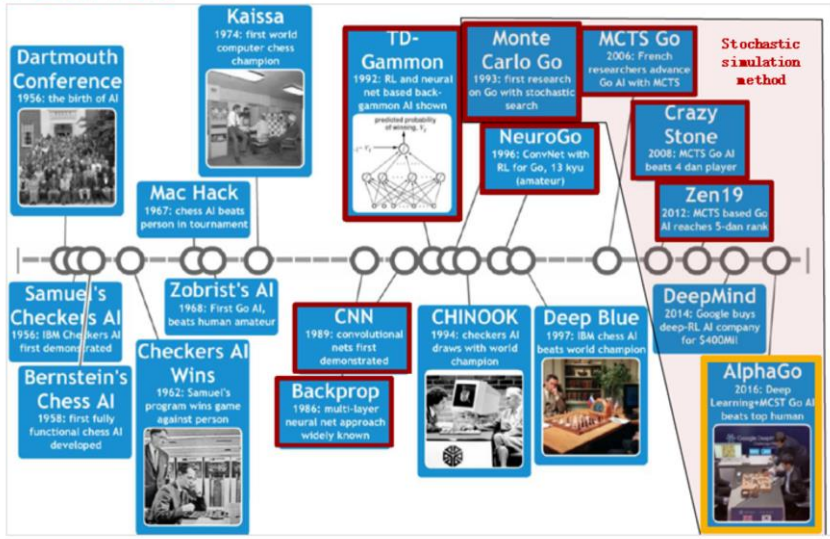
# Actionism

- Actionism (evolutionism and cyberneticsism)
  - Principle: cybernetics and perception-action control system
  - Origin: cybernetics
  - Concept:
    - Intelligence depends on perception and actions. The "perception-action" mode of intelligent behavior is proposed.
    - Intelligence requires no knowledge, representation, and inference. Artificial intelligence can evolve like human intelligence. Intelligent behavior can only interact with the surrounding environment in the real world.

# Advantages and Disadvantages of Mainstream AI Theories

| Mainstream AI Theories | Knowledge Representation | Black Box | Feature Learning | Interpretability | Requiring Large Samples | Computational Complexity | Combinatorial Explosion | Interaction With Environment | Overfitting |
|---|---|---|---|---|---|---|---|---|---|
| Symbolicism (logicism) | Strong | No | No | Strong | No | High | Many | No | No |
| Connectionism (bionicsism) | Weak | Yes | Yes | Weak | Yes | High | Few | No | Yes |
| Actionism (decision-making control) | Strong | No | No | Strong | No | Ordinary | Ordinary | Yes | No |

# History of AI Chess Games: Convergence of Mainstream Theories



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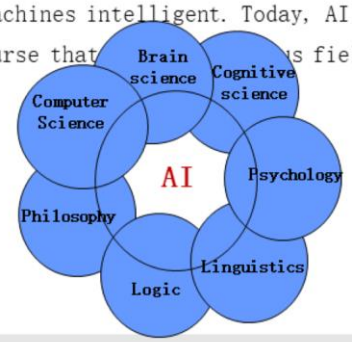
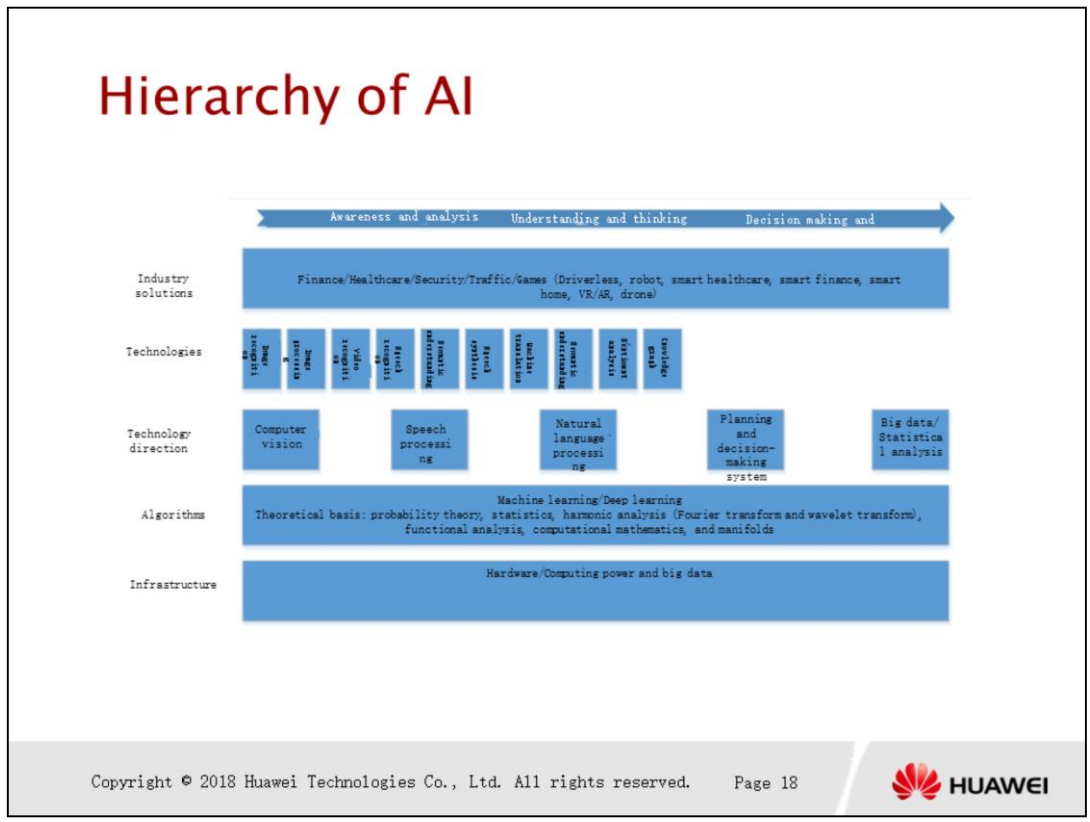
# What Is AI?

- **Artificial Intelligence (AI)** is a technical science that studies and develops theories, methods, technologies, and applications for simulating and extending human intelligence. This term was first coined by John McCarthy in 1956. McCarthy defined the subject as the "science and engineering of making intelligent machines, especially intelligent computer programs". The purpose of AI is to enable machines to think like people and to make machines intelligent. Today, AI has become an interdisciplinary course that [illegible]s fields.

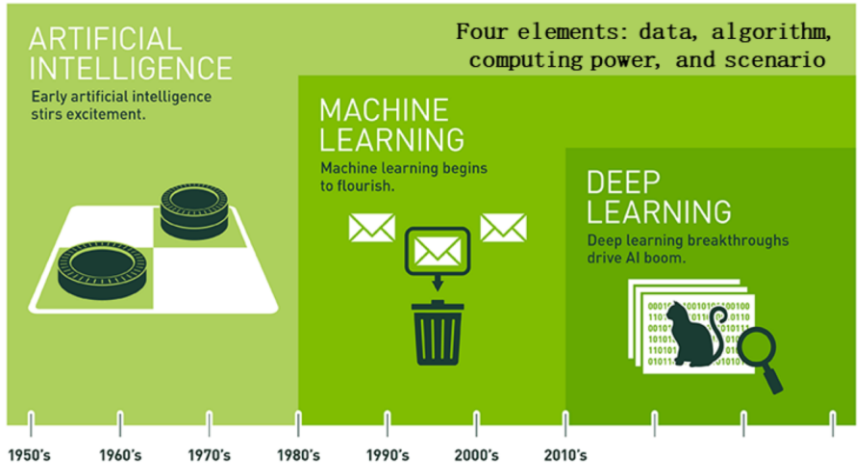





- Infrastructure layer: As AI develops, the infrastructure development each time greatly promoted the evolution of algorithms and technologies. Computers grew up in the 1970s and gained popularity in the 1980s. The 1990s witnessed the improvement of computers' computing speed and storage capacity, as well as the rise of the Internet. All these contributed a lot to AI's development. In the 21st century, the emergence of large-scale clusters, the accumulation of big data, and the rise of GPU and heterogeneous/low power consumption chips enhanced the computing power. As a result, deep learning came into being, pushing AI to a new height. Mass training data is an important driving force for the development of AI.
- Algorithm layer: Machine learning uses algorithms to teach computers to obtain information from data like human beings. Deep learning, as a subset of machine learning, uses more parameters and more complex models. This enables the models more intelligent and to better understand data.
- Computer vision: In 1966, Marvin Minsky, an AI scientist, asked his students to write a program, attaching a camera to a computer and having it "describe what it saw". This is the earliest description of the computer vision task. Computer vision uses three-dimensional reconstruction and priori knowledge base, methods for people to see the world. Computer vision has been applied to the security protection field, as well as the financial field (face recognition), e-commerce field (commodity photographing and search), healthcare field (intelligent image diagnosis), and robot/self-driving car

field (visual input system).

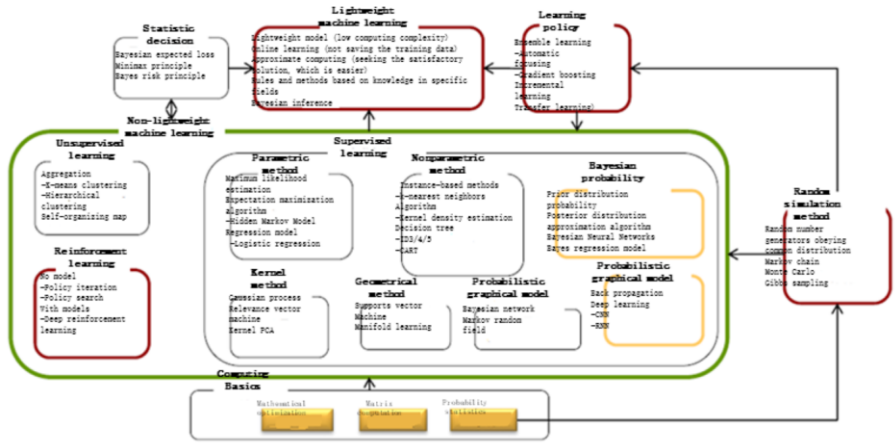
# Relationship Between AI, Machine Learning, and Deep Learning



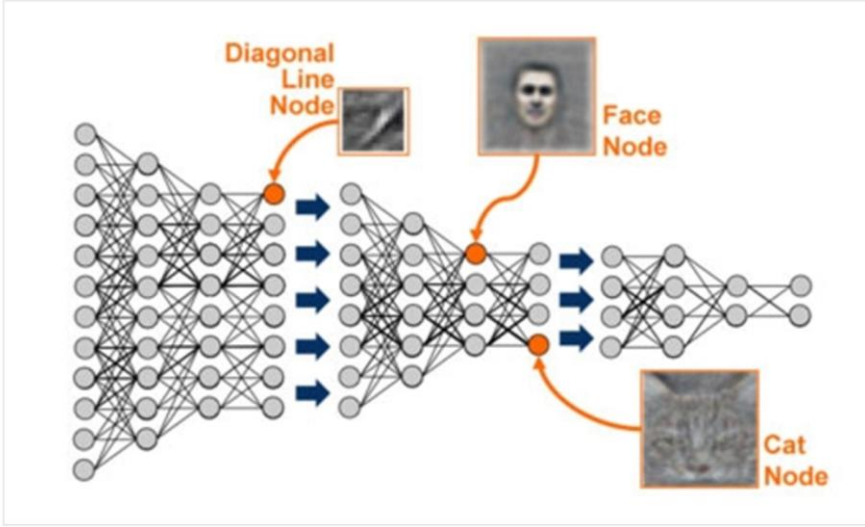
# Relationship Between AI, Machine Learning, and Deep Learning

- AI is a technical science that studies and develops theories, methods, and applications for simulating and extending human intelligence.
- Machine learning specializes in how computers simulate or implement human learning behavior to acquire new knowledge or skills, and reorganize existing knowledge structures to improve their performance continuously. It is a subset of artificial intelligence. Any system without learning ability can hardly be considered a real intelligent system.
- Deep learning is developed based on the study of artificial neural networks (ANNs). The multilayer perceptron (MLP) with multiple hidden layers has a deep learning structure. Deep learning is a new field of machine learning. It aims to establish a neural network that simulates the human brain to analyze and interpret data, such as images, sounds, and texts.

# Key Technologies of Machine Learning



## Deep Learning

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- Deep learning is model (attribute or feature) formed by identifying and collecting a large amount of data and is used to identify new data, such as medical applications.
- Disadvantages:
  - Deep learning is data-driven and hard to explain for lack of related theories.
  - Deep neural networks are complex and require large-scale data training.
  - Deep learning is only suitable for perception and is not suitable for cognition and inference.

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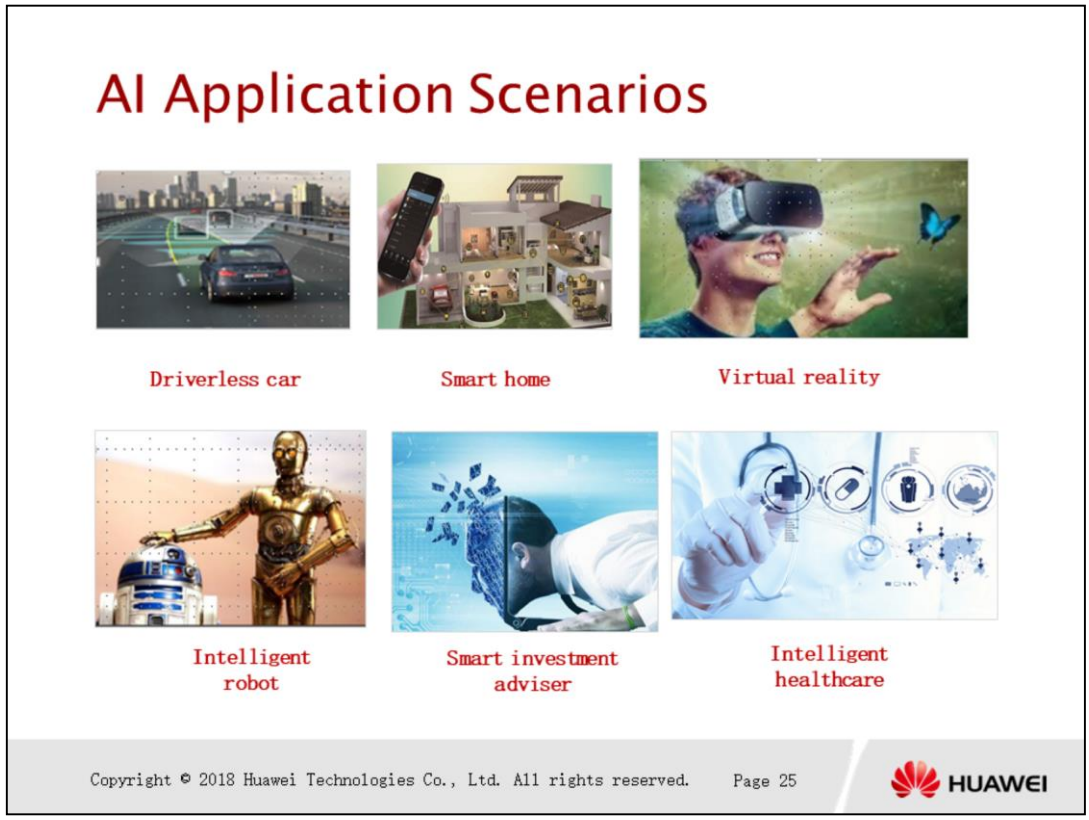
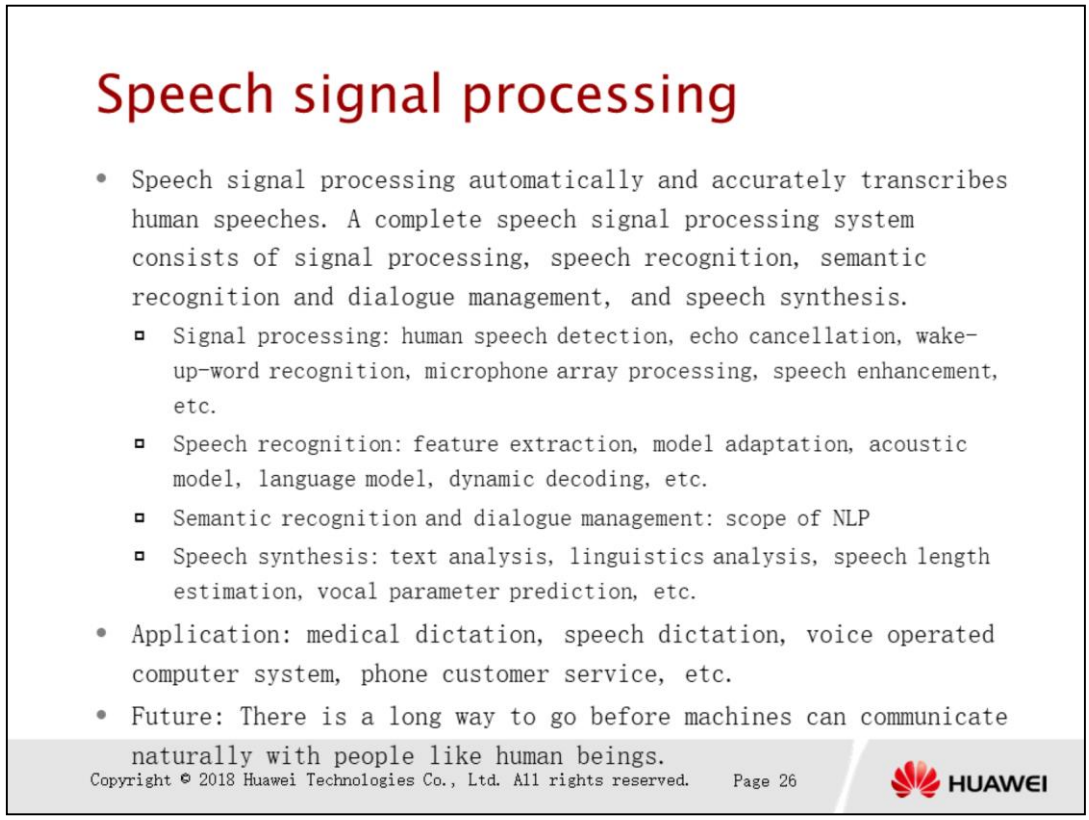



- Today, the development of AI has broken through a certain threshold. Today, AI improves the performance and efficiency in different vertical fields. The accuracy of computer vision, speech recognition, and NLP is also improved. AI application scenarios gradually play an important role in the real business world.




- Signal processing:
  - Human speech detection: effectively detects the time when the human speech starts and ends, and distinguishes the human speech from the background sound.
  - Echo cancellation: eliminates the interference from the speaker without pausing the played music.
  - Wake-up-word recognition: a way for humans to interact with machines
  - Microphone array processing: locates the sound source, enhances the signal in the speaker direction, and suppresses the noise signal in other directions.
  - Speech enhancement: further enhances the speech area and suppresses the noise area, effectively reducing the attenuation of far-field speeches. Handheld devices are used in the near-field communication (NFC) scenario, while vehicle-mounted and smart home devices are used in far-field scenarios.
- Speech recognition: Many cutting-edge researches focus on solving the cocktail party problem in addition to far-field identification.
- Speech synthesis: Speeches synthesized using current technologies are more clear and intelligible. However, the machine accent is still obvious. Current researches are focusing on how to make synthesized speech more

natural and more expressive, and how to naturally and smoothly synthesize multiple languages.

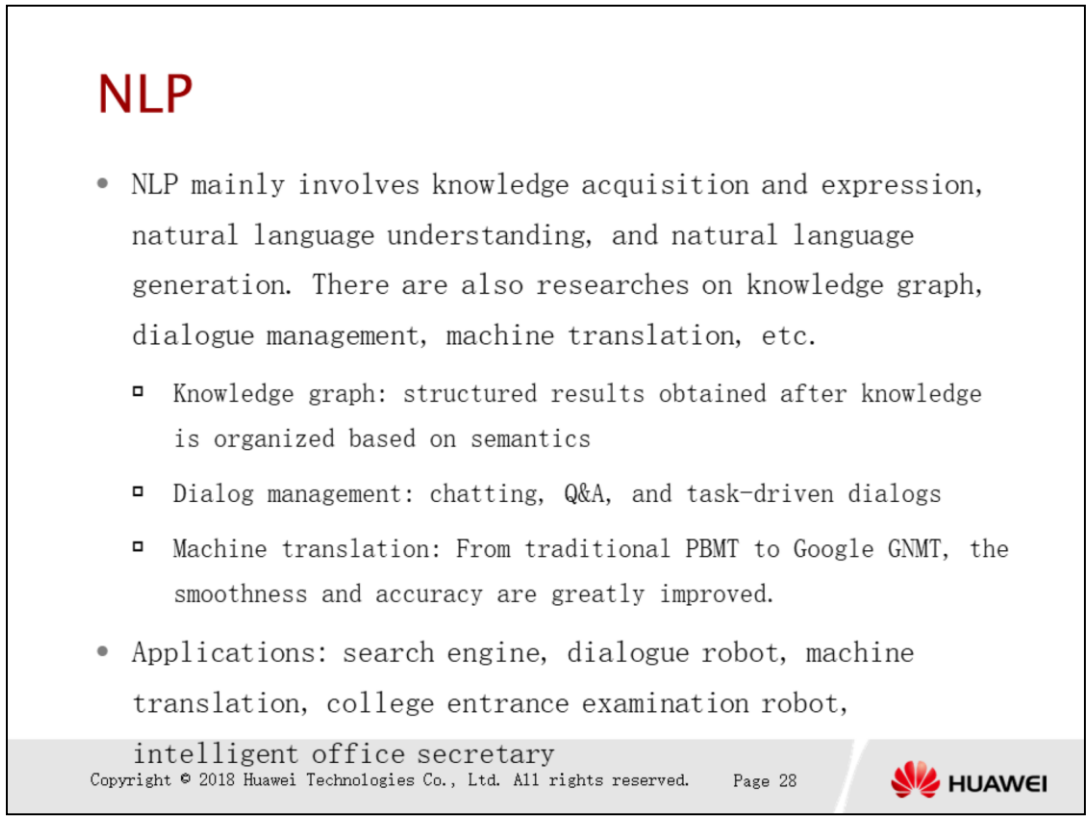
# Computer Vision

- Computer vision deals with how computers can be made to identify objects, scenes, and activities from images, including image processing, recognition, detection, analysis, and understanding.
  - Image processing: noise cancellation, deblurring, super-resolution processing, filter processing, etc.
  - Image recognition: image pre-processing, image segmentation, feature extraction, and judgment and matching. Image recognition can be used for classification, location, detection, and segmentation.
  - Image understanding: interaction between images and texts. Image understanding can be used to perform text-based image search, image description generation, image Q&A, etc.
- Applications
  - Medical image analysis is used to facilitate disease prediction, diagnosis, and treatment.
  - Identifying suspects in security and surveillance fields
  - Shopping-goers can take photos of products with smartphones to obtain more information.
- Future: Computer vision is expected to enter an advanced stage of independent understanding, and analysis and decision making, truly endow machines with the ability to watch, and play a bigger role in [illegible].





- Image processing is mainly applied to filter videos.




- Knowledge graph: It can be used to answer simple factual questions, including the language knowledge graph (word context, synonym, etc.), common knowledge graph (birds can fly but rabbits cannot), and entity relationship diagram (Carol Chu is Andy Lau's wife).
- PBMT: Phrased-Based Machine Translation
- GNMT: Google Neural Machine Translation

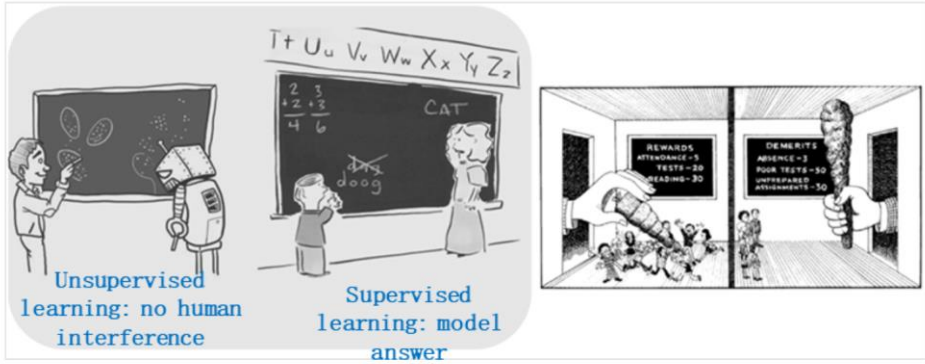
# Machine Learning (1)

- Machine learning studies how computers simulate or implement human learning behavior to acquire new knowledge or skills, and reorganize existing knowledge structures to improve their performance continuously. Machine learning is the core of AI and the fundamental way to make computers intelligent.
- Research directions:
  - Widely used in vertical fields, such as the finance, law, and healthcare fields
  - From convex optimization to non-convex optimization
  - From supervised learning to unsupervised learning and reinforcement learning
- Future: reinforcement learning and transfer learning

- An important research direction of reinforcement learning is to establish an effective simulation environment that interacts with the real world, and teach models by continuous training, action simulation, and feedback receiving.

# Machine Learning (2)



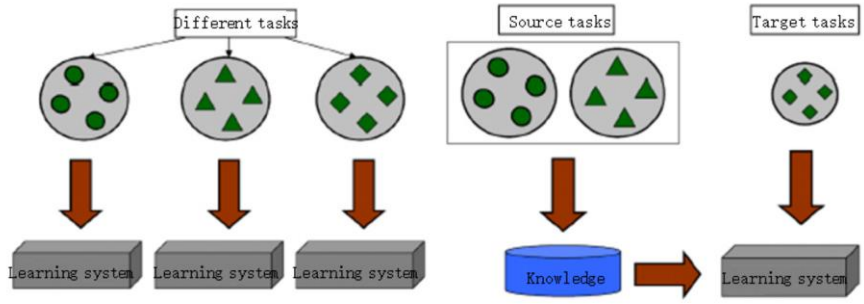

Traditional machine learning

Reinforcement learning: reward and punishment




- Reinforcement learning is a feedback system that can be modified at any time. It might be a ubiquitous learning algorithm, such as automatic driving.

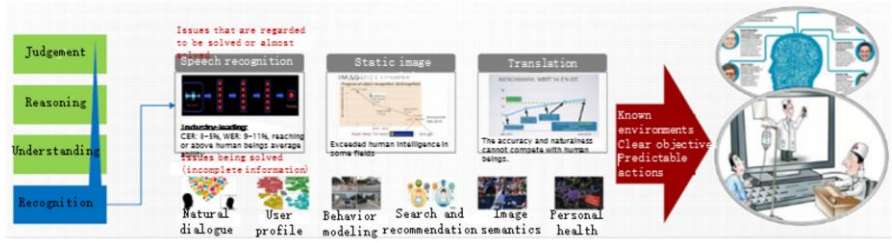
# Machine Learning (3)




(a) Traditional machine learning

(b) Transfer learning

# AI Is Still in the Initial Stage




- We should look at the status quo of AI rationally.
  - AI is still in the initial stage and applicable to scenarios with known environments, clear objectives, and predictable actions. Deep learning deals with image recognition, speech recognition, and machine translation, with AI having the same or even better recognition abilities compared with human beings. These abilities are applied in many scenarios like healthcare and public safety but are still weak in inference and cognition.
  - AI can come into use as long as it does better than human beings in a certain aspect. We do not need to wait it to exceed human intelligence.

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- Reinforcement learning cannot go without simulation environment and prior knowledge.

# Convergence: Trend of AI

- It is a trend for AI to converge the traditional machine learning, deep learning, reinforcement learning, knowledge inference, and intelligent decision-making. The next five years will see the soaring development of AI (opinion of Professor Stanford).
  - AI will develop from supervised learning to flexible learning.
  - Computer vision will be popular in the industries, such as education, healthcare, transportation, and public safety.

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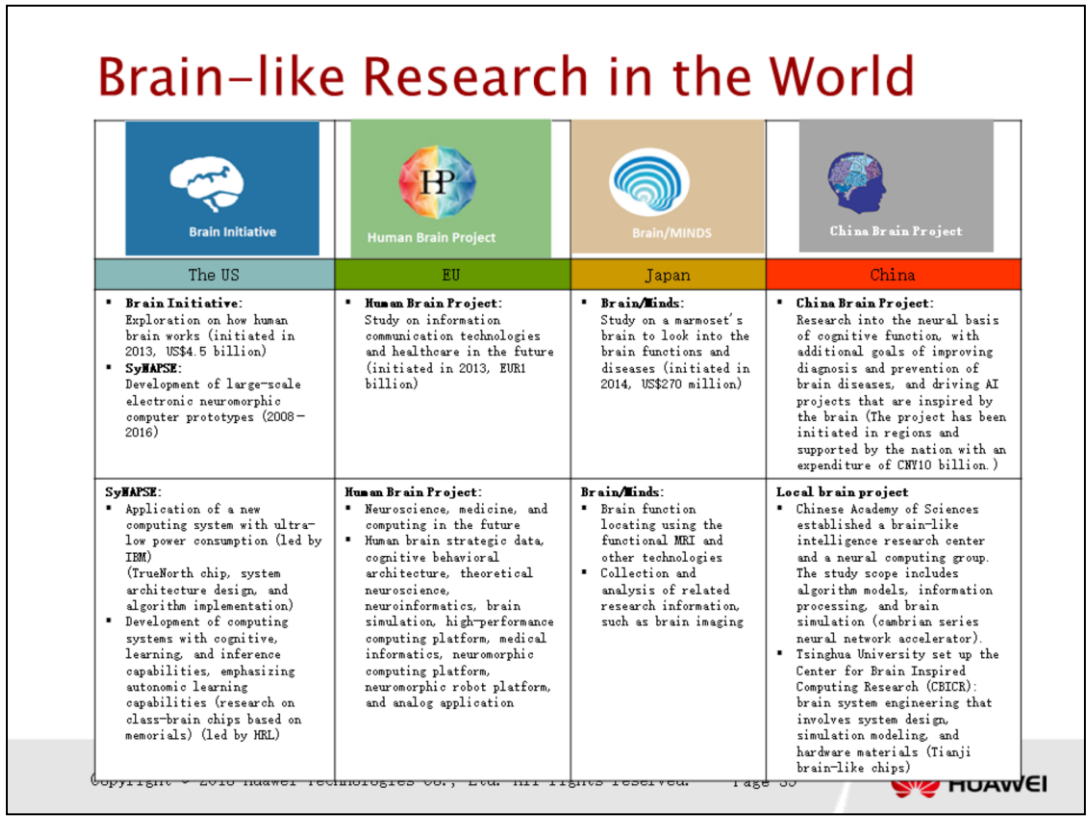
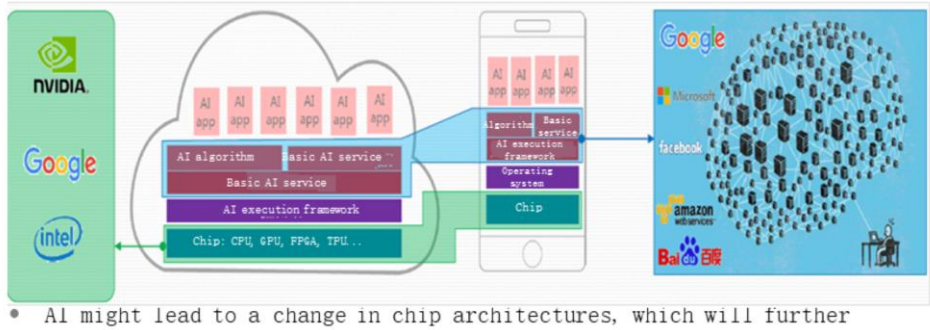



- Technical competitions that drive AI industries develop are led by giant companies. Companies outside China such as Apple, Google, Microsoft, Amazon, and Facebook are investing heavily to seize the AI market. In China, Baidu, Alibaba, Tencent (BAT) also attach critical importance to AI. Comparison of AI industries in China and the US is as follows:
  - AI companies in the US outnumber most of the nations around the globe.
  - The US has a comprehensive AI blueprint, while China constraints AI to specific fields.
  - The US has a complete talent echelon, while China does not.
  - The US has invested more heavily in AI than China does.
  - China and the US have their own advantages in the hotspot AI industries.
  - The US, as a leading industry giant, has competitive advantages.

# AI Is Reshaping the Industry Landscape




- AI might lead to a change in chip architectures, which will further reshape the industry landscape. NVIDIA, Google, and Intel are competing for the dominant place in the future.
- AI is the next major operating system. AI technology platforms will be a hot spot competed by big players. AI applications or services of vertical industries might be provided based on the technology platforms.
- Striving to be a leader of digital brains in the future becomes a strategic vision of information giants. Cloud services in the future might integrate cloud computing, big data, and AI.

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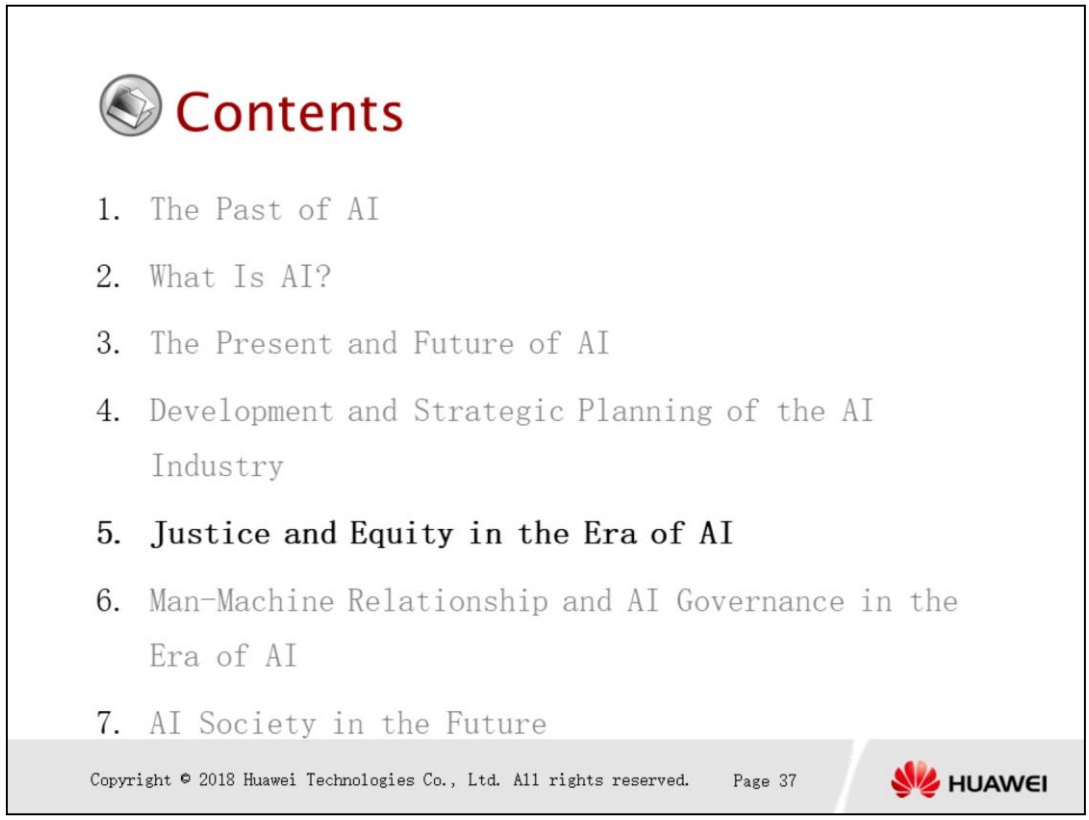
- Striving to be a leader of digital brains in the future becomes a strategic vision of information giants. Cloud services in the future might integrate cloud computing, big data, and AI. Microsoft, Google, Oracle, and Amazon are exerting their advantages to compete for the strategic highlands. There are still opportunities for us to play our role.




- The development of AI brings great challenges to the existing legal system. Legislation always lags behind technology development. In the AI field, do we need to make some forward-looking legislation layouts and how? That is a legal dilemma to be resolved by all countries around the world.

## How AI Takes Responsibilities?

- At 22:00 on Sunday (March 19, 2018, local time) in Tempe, Arizona, an Uber's self-driving test car struck a 49-year old woman, Elaine Herzberg, who was crossing the street with a bicycle. Elaine Herzberg was transported to the hospital but later died from her injuries. It was likely the first time that a human pedestrian has been killed by an autonomous vehicle.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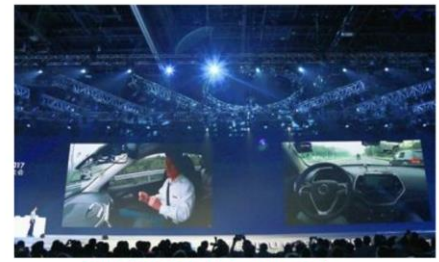
- A self-driving car has three major modules: perception, decision-making, and control modules.
  - As it was reported, Uber's modified Volvo XC90 SUV had a 360-degree 3D laser radar on the top. The laser radar could generate 3D images for static and moving objects and the laser detection was not affected by light conditions. Around the vehicle were 360-degree ultrasonic waves, millimeter-wave radar, and 7 cameras. These devices could identify other vehicles and obstacles in rainy and snowy days. In addition, the computer vision algorithm helps them recognize indicators and pedestrians. On that basis, Zhou Guang, chief scientist of Roadstar.ai, did not believe the perception module went wrong.
  - Uber's vehicles are equipped with HD laser radars, which could detect pedestrians at such a distance if the hardware functions properly. As Zhou Guang told China Makter (ID: xjbmaker), this accident was very likely caused by the malfunction of the vehicle's decision-making module. For example, it might think that the pedestrian would not enter the lane directly. However, human behavior is hard to accurately predict. That is why the accident occurred.
  - Huang Yubin, who agreed with Zhou Guang, said that there might be nothing wrong with the perception module. He thought that the decision-making module might fail to judge that a pedestrian would show up

suddenly. Huang Yubin thought that Uber's overspeed was the strangest thing. "A self-driving car would not speed up on its own. It does what people have written in programs." Huang Yubin thought that Uber's overspeed was likely to be a choice forced by road conditions. "There is a saying that it is unsafe for you to drive at a speed of 35 miles per hour when others are driving at the speed of 40 miles per hour."

- He Tao, co-founder and vice president of XPENG Motors, thought that the algorithms of current self-driving vehicles were not mature enough. Pedestrians' illegal behavior is a major cause of car accidents. However, predicting possible emergencies and solving them in algorithms is one of the missions of automatic driving. If a self-driving car fails to avoid pedestrians who violate the traffic rules, how can it deal with more complex scenarios in China?

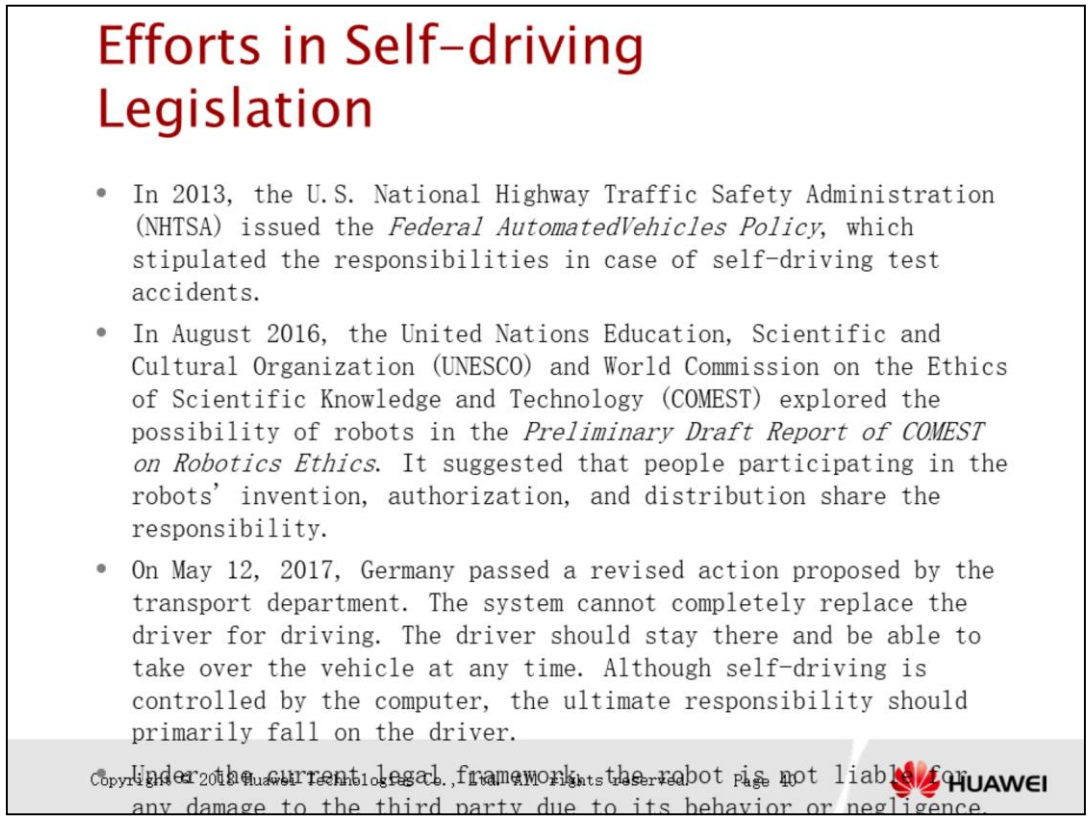
# Self-driving in China

Four Alphabus smart buses made the inaugural trial run in Shenzhen, 2 December, 2017.



Baidu CEO Robin Li took a driverless car developed by Baidu.

- Wu Shichun, founder of Plum Ventures, said, "Self-driving is an inevitable trend, but it must be constrained by standards. The deadly crash with self-driving Uber was shocking and heartbreaking. According to statistics, more than 1 million people died from traffic accidents each year. Therefore, each new technology must be tested and optimized continuously to ensure its security before it is put into wide use. An aircraft cannot be put into commercial use without an airworthiness certificate. Similarly, self-driving systems should be tested by an official authority or authoritative third party, and then drive cars on the road after obtaining a certificate. Companies cannot decide whether to put self-driving systems into the market. This applies to all emerging technologies such as robots and AI."




- In 2013, the U.S. National Highway Traffic Safety Administration (NHTSA) issued the *Federal AutomatedVehicles Policy*, which stipulated the responsibilities in case of self-driving test accidents. That is, after a vehicle is transformed into a self-driving vehicle by a third party, the original manufacturer is not responsible for any personal injury, death, or property damage caused by the self-driving test, unless there are proofs that the vehicle has defects before being transformed. For example, Google takes the full responsibility for the security when it uses Mercedes-Benz for self-driving test.

# How to Protect Privacy?

- Two researchers from the University of Texas at Austin successfully identified two people out of the nearly half million anonymized users whose movie ratings were released by online rental company Netflix, which forced the company to cancel the movie-rec ).

# Legislation Protection and Technology Application

- Legislation protection:
  - Since the Swedish Data Protection Act, the first personal data protection act, was issued in 1973, more than 110 countries and regions have enacted dedicated laws to protect personal information till December 2016.
  - In 2012, Decision of the Standing Committee of the National People's Congress on Strengthening Information Protection on Networks was passed. In 2016, the People's Republic of China Network Security Law was adopted.
- Technical application:
  - Data anonymization: It is the process of removing personally identifiable information from personal data, so that the people whom the data describes remain anonymous.

# Is the Algorithm Fair by Default?

- In many cases, algorithm-based decision making is to use the past data to predict the future. The algorithm model and input data, which determine the prediction results, are two main sources of algorithm discrimination. The following are two examples:
  - Google's image software once marked a black person as a gorilla by mistake.
  - On March 23, Microsoft's AI chatbot, Tay, was taught to be an anti-semite, sexist, and racist after it was launched. As a result, it was brought offline immediately in less than a day.

# Issues To Be Resolved

- Are the contents created by AI protected by copyright laws?
- Who will assign rights to robots?
- What rights can be assigned to robots?
- ...

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5. Justice and Equity in the Era of AI
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7. AI Society in the Future

 

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# Three Generations of Robots

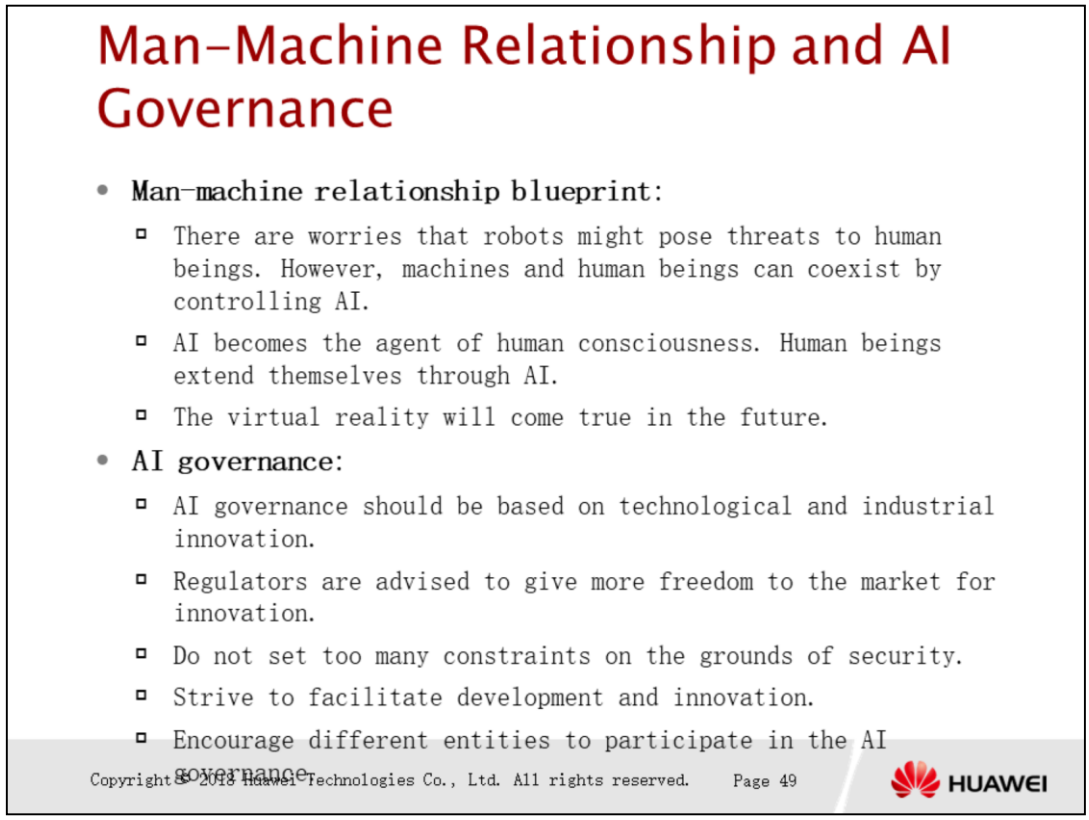
- Generation 1: Playback robot. It can repeat actions taught by humans, but is unaware of the outside environment.
- Generation 2: Robot with feelings. It has feelings similar to humans. For example, it can judge a force through the sense of force, touch, and hearing.
- Generation 3: Intelligent robot. It is the highest pursuit of robot development. An intelligent robot is expected to be able to do what people ask it to. Now it remains to be a concept.

# Classification of Intelligent Robots

- There is no unified definition of AI research in the world. Currently, intelligent machines are classified into four types:
  - "Think like people": Weak AI, such as Watson and AlphaGo
  - "Act like people": Weak AI, such as Android, iRobot, and Atlas of Boston Dynamics
  - "Think rationally": Strong AI, which is yet unavailable due to the bottlenecks in brain science
  - "Act rationally": Strong AI

# Three Laws of Robotics

- In 1942, Isaac Asimov, a well-known American science fiction author, proposed the Three Laws of Robotics.
  - 1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
  - 2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
  - 3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.




- Although AI has entered a new stage of learning (early stage), there is no need to worry about the so-called "human-computer war" robot control, because AlphaGo does not know that he is playing chess, I don't have to invent a game of chess.

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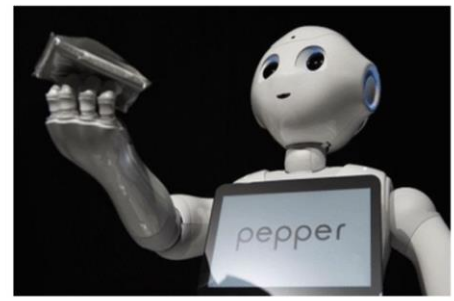
# Robot Colleagues


ASIMO

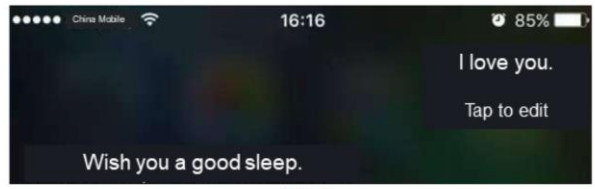
Waiter

## Soul Mate

Baymax




Pepper, a robot that can read emotions, developed in Japan



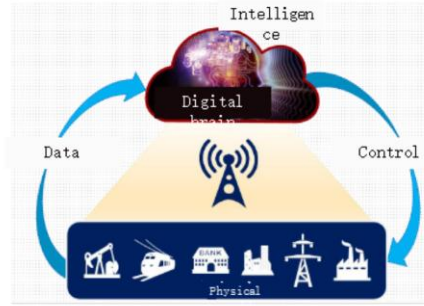

Siri

- Analysts said in a report that a machine might be able to make a conversation with human beings like a spouse by 2020.

# Opportunities and Challenges of AI: New Markets and Value Distribution


Opportunities: From efficiency to intelligence, AI will create a market larger than today's IT market (US$2 trillion), which sparks a competition in the information industry.




Challenges: In the entire industry chain, people who master intelligence will have greater say and gain more value. This is why traditional enterprises, such as GE, set up their own digital departments.

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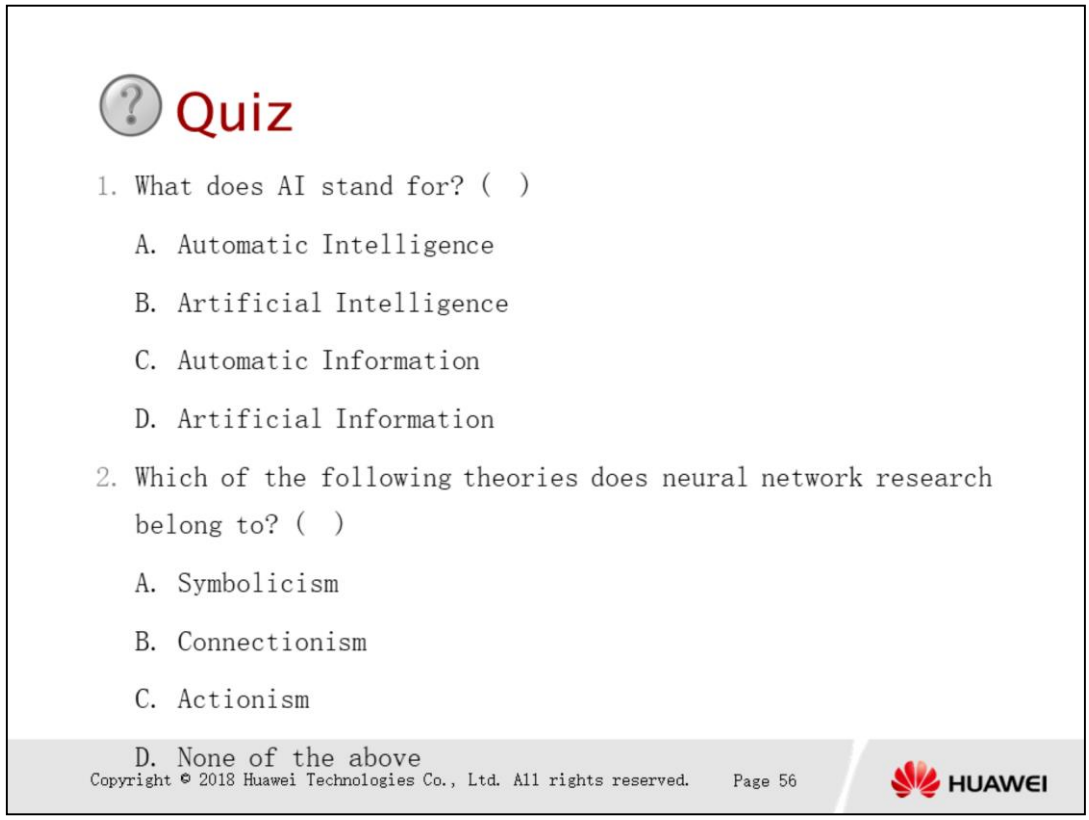
- You think your opponent is a competitor, but your opponent is an era. --Li Shanzhao

# Die Progress Unit

# Summary

- Now we've covered the past, present, and future of AI, AI technologies and development, as well as questions and problems to be thought in the AI era, such as justice and equity, man-machine relationship, and AI governance.


Quiz
1. What does AI stand for? ( )
A. Automatic Intelligence
B. Artificial Intelligence
C. Automatic Information
D. Artificial Information
2. Which of the following theories does neural network research belong to? ( )
A. Symbolicism
B. Connectionism
C. Actionism
D. None of the above
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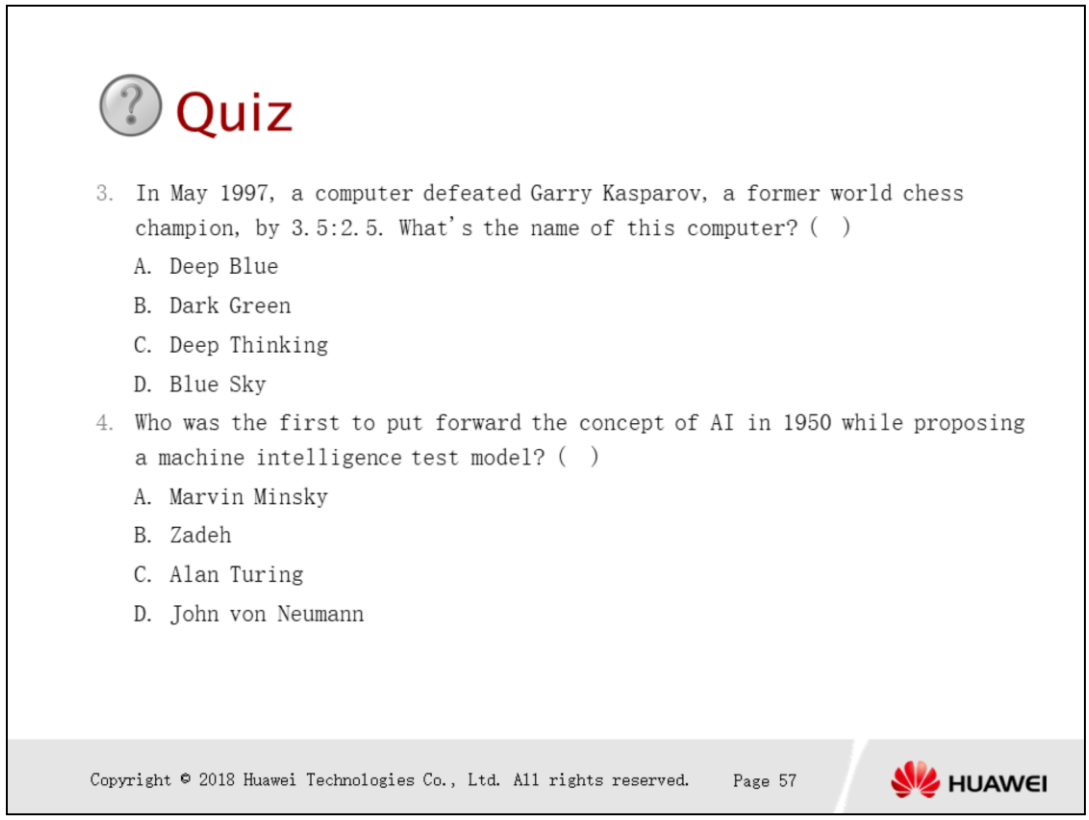
- Answer: 1.B, 2.B


Quiz
3. In May 1997, a computer defeated Garry Kasparov, a former world chess champion, by 3.5:2.5. What's the name of this computer? ( )
A. Deep Blue
B. Dark Green
C. Deep Thinking
D. Blue Sky
4. Who was the first to put forward the concept of AI in 1950 while proposing a machine intelligence test model? ( )
A. Marvin Minsky
B. Zadeh
C. Alan Turing
D. John von Neumann
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- Answer: 3. A 4.C

# More Information

- Huawei e-Learning website:
  - http://support.huawei.com/learning/Index!toTrainIndex
- Case library:
  - http://support.huawei.com/enterprise/servicecenter?lang=zh

# Thank You

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