

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 development.

Dartmouth Workshop: Birth of AI



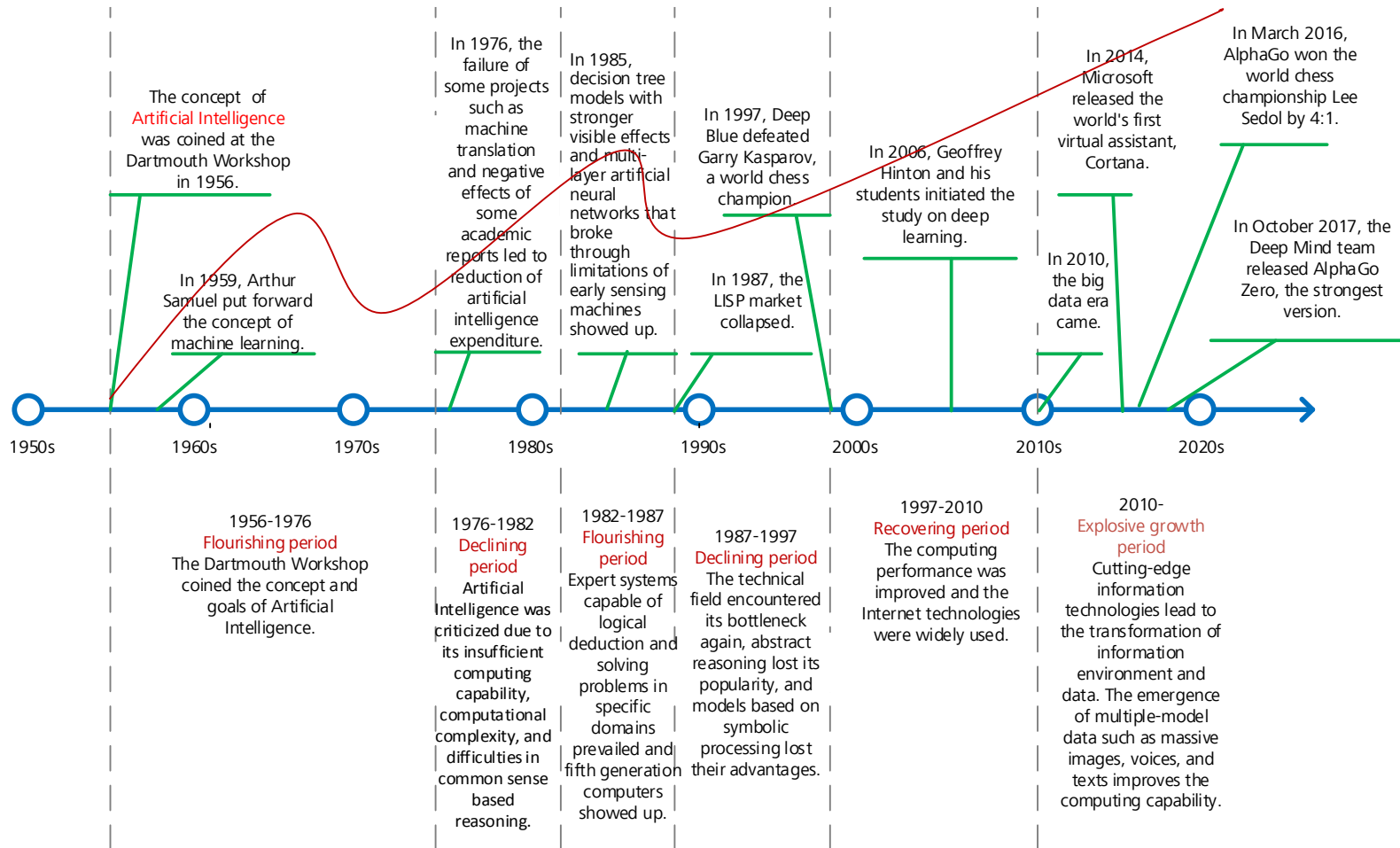
- ◆ In August 1956, some scientists and mathematicians gathered at Dartmouth College, discussing about how to make machines simulate human learning and any other feature of intelligence. They were John McCarthy (creator of the Lisp programming language), Marvin Minsky (AI and cognitive scientist), Claude 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, **the year 1956 marked the birth of AI.**

The Dartmouth College Artificial Intelligence Conference: The Next Fifty Years

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



AI Development History

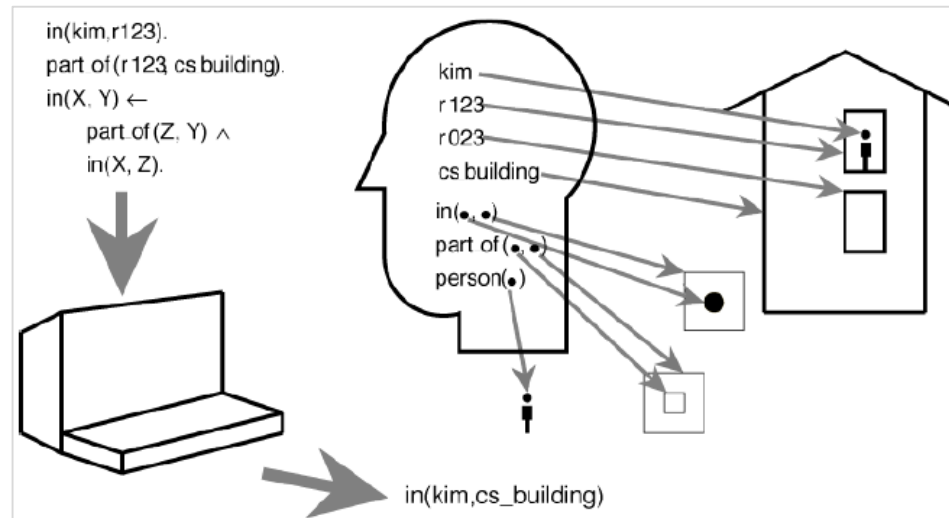


Symbolicism (1)

- ◆ Symbolicism (logicism, psychologism, computerism)
 - Principle: physical symbol system hypothesis and finite reasonableness principle
 - Origin: mathematical logic
 - Concept:
 - Symbol is the human cognition unit, and the cognition process is a symbol operation process.
 - People are regarded as a physical symbol system, so are computers. Therefore, computers can be used to simulate human behavior.
 - Knowledge is a form of information and is the basis of intelligence. The critical issues of AI are knowledge representation and knowledge inference.
- ◆ Representatives: Allen Newell, Herbert Alexander Simon, Nilsson, etc.

Symbolicism (2)

Symbolicism



Representatives



John McCarthy
(1927-2011)



Allen Newell
(1927-1992)



Herbert Simon
(1916-2001)



Edward Feigenbaum
(1936-)

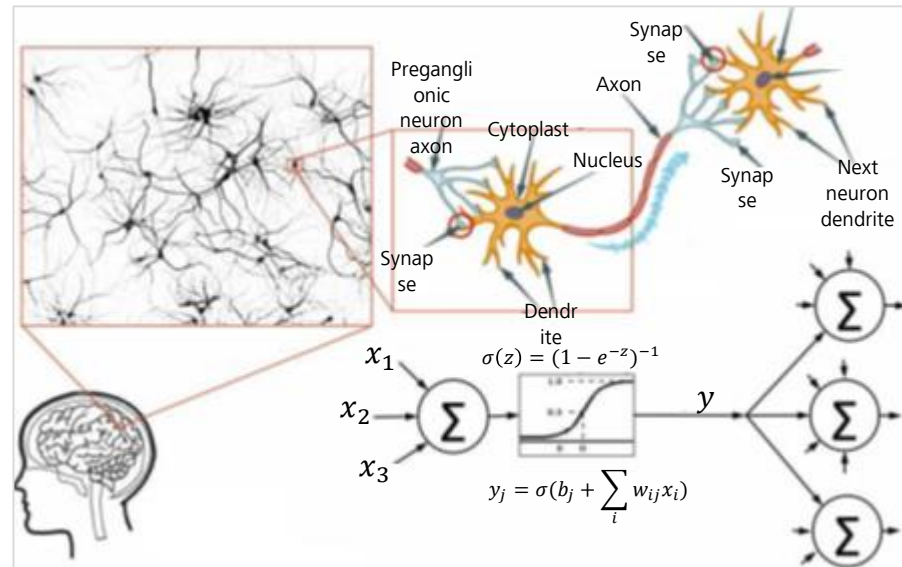
Connectionism (1)

◆ Connectionism

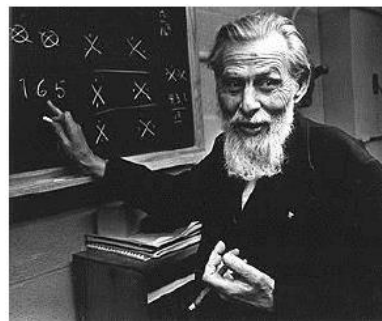
- Principle: neural network, connection mechanism and learning algorithm between neural networks
- Origin: bionics, especially the study of the human brain model
- Concept:
 - ▣ Neuron, instead of the symbol operation process, is the basic thinking unit.
 - ▣ Human brain differs from computers, and the 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



Representatives



Warren S. McCulloch
(1898-1969)



Walter H. Pitts
(1923-1969)



Marvin Minsky
(1927-2016)

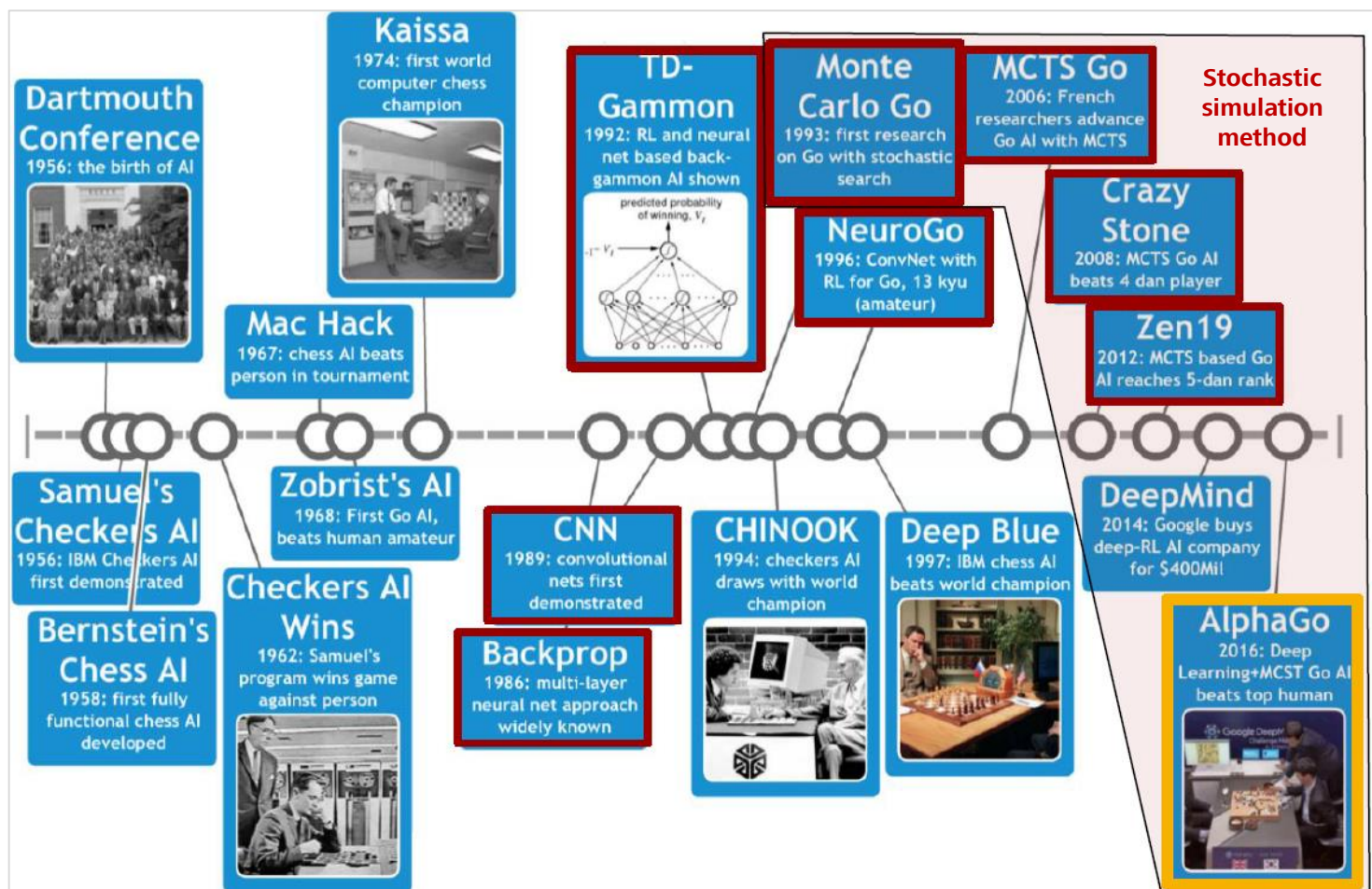
Actionism

- ◆ 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

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

History of AI Chess Games: Convergence of Mainstream Theories



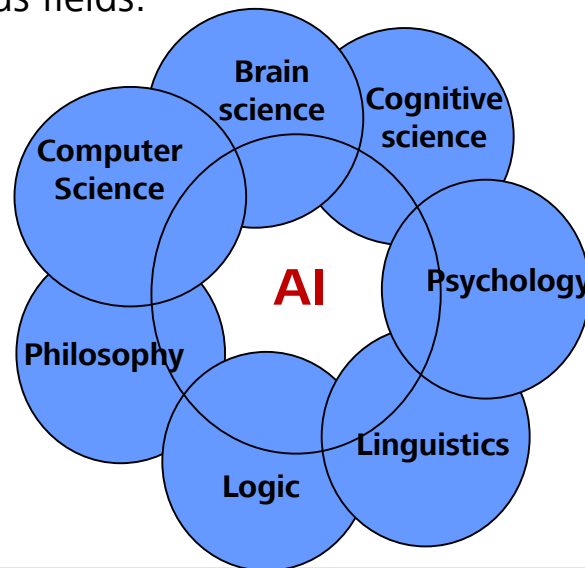


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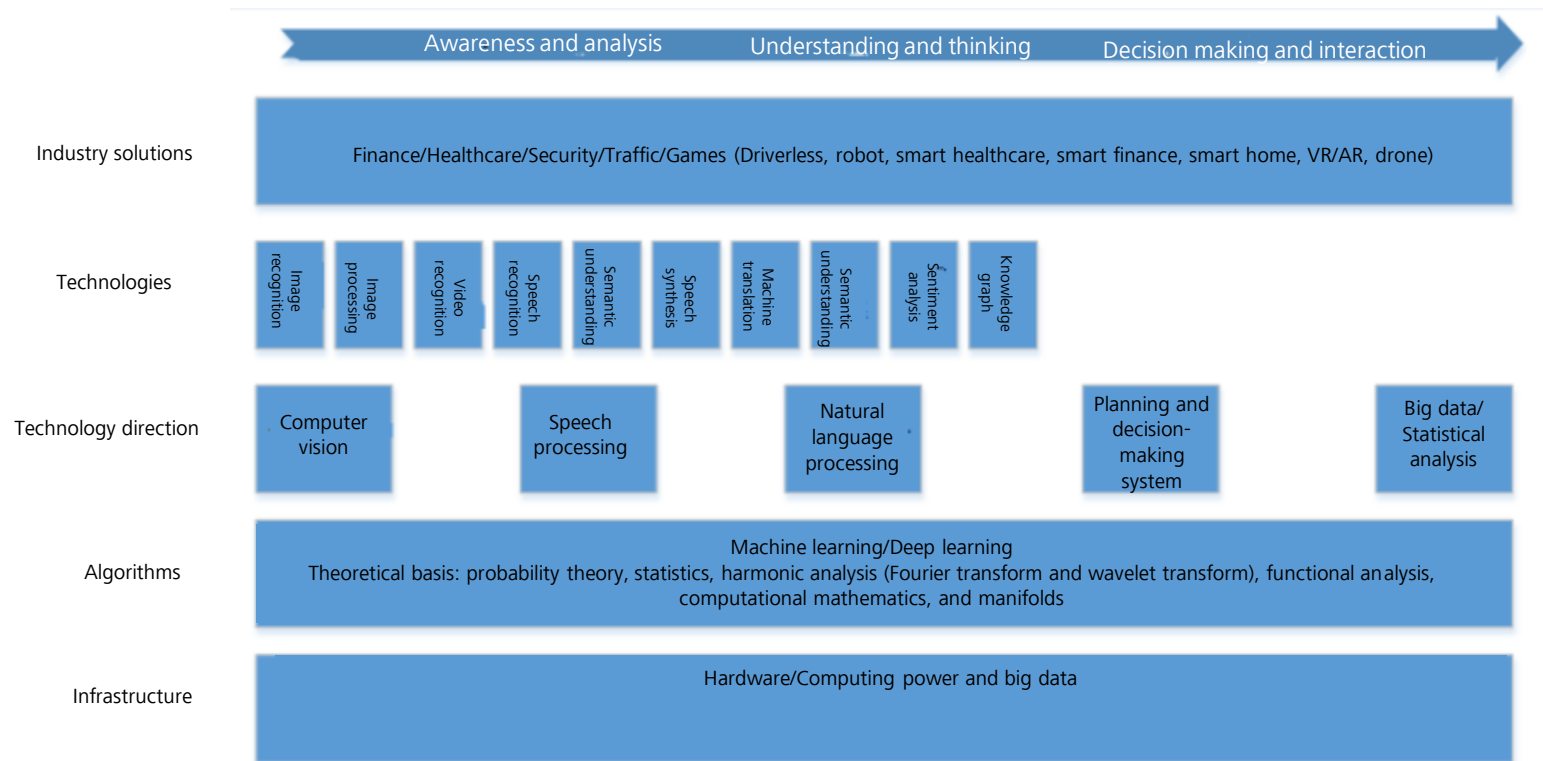
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What Is AI?

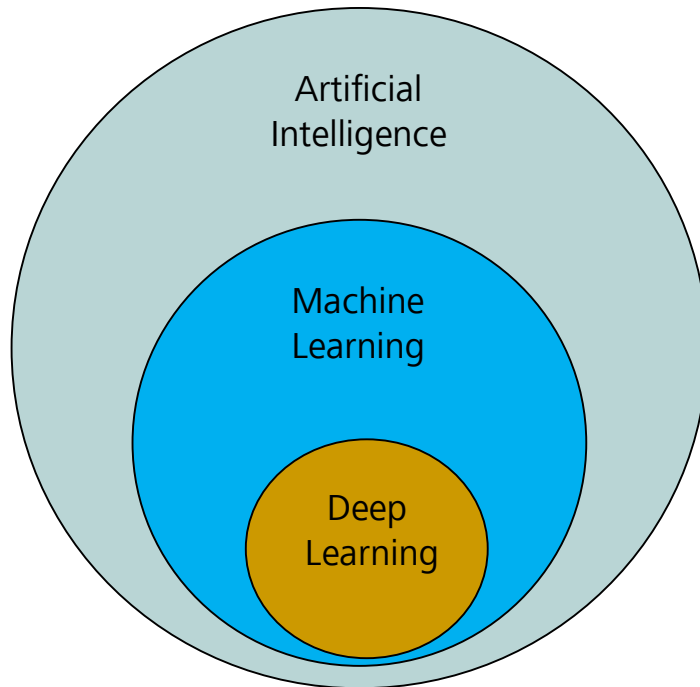
- ◆ **Artificial Intelligence (AI)** is a technical science that studies and develops theories, methods, technologies, and applications for simulating and extending human intelligence. This term was first coined by John McCarthy in 1956. McCarthy defined the subject as the "science and engineering of 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 involves various fields.



Hierarchy of AI



Relationship Between AI, Machine Learning, and Deep Learning

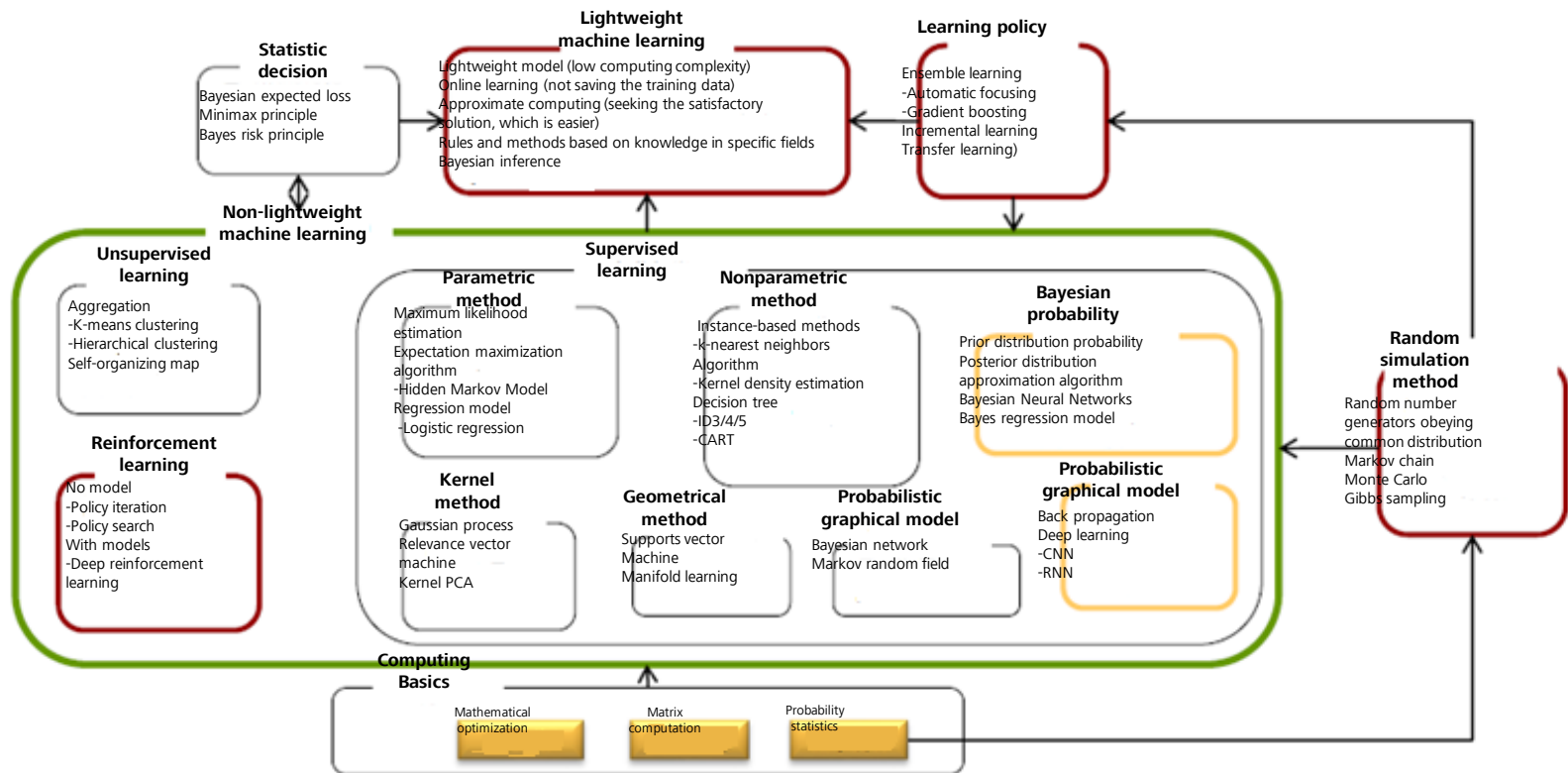


Four elements: data, algorithm, computing power, and scenario

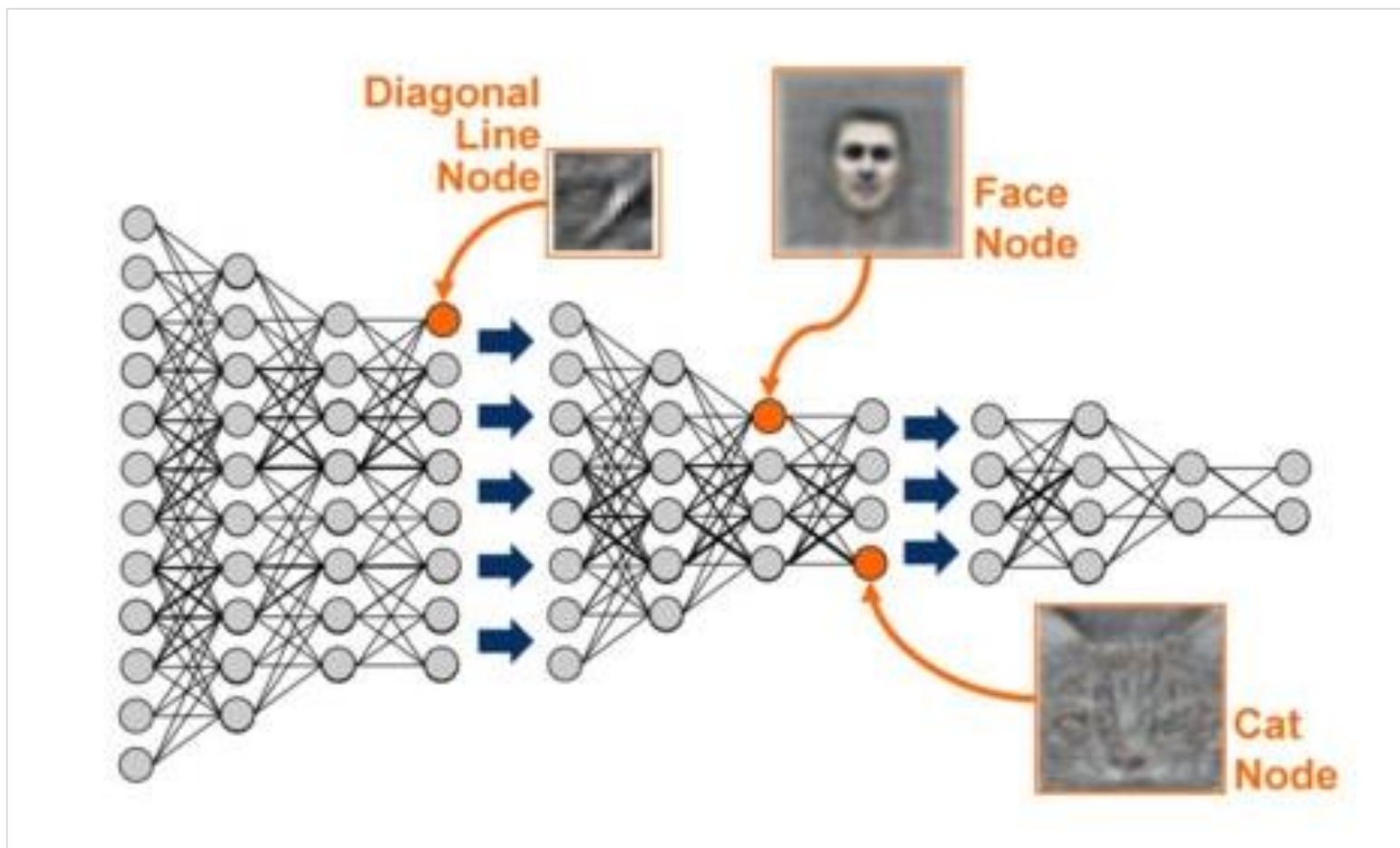
Relationship Between AI, Machine Learning, and Deep Learning

- ◆ 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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AI Application Scenarios



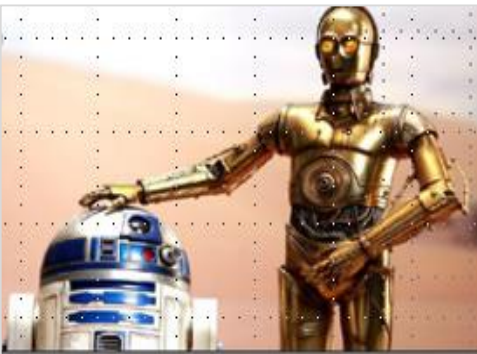
Driverless car



Smart home



Virtual reality



Intelligent robot



**Smart investment
adviser**



**Intelligent
healthcare**

Speech signal processing

- ◆ Speech signal processing automatically and accurately transcribes human speeches. A complete speech signal processing system consists of signal processing, speech recognition, semantic recognition and dialogue management, and speech synthesis.
 - Signal processing: human speech detection, echo cancellation, wake-up-word recognition, microphone array processing, speech enhancement, etc.
 - Speech recognition: feature extraction, model adaptation, acoustic model, language model, dynamic decoding, etc.
 - Semantic recognition and dialogue management: scope of NLP
 - Speech synthesis: text analysis, linguistics analysis, speech length estimation, vocal parameter prediction, etc.
- ◆ Application: medical dictation, speech dictation, voice operated computer system, phone customer service, etc.
- ◆ Future: There is a long way to go before machines can communicate naturally with people like human beings.

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 scenarios such as driverless cars and smart home.

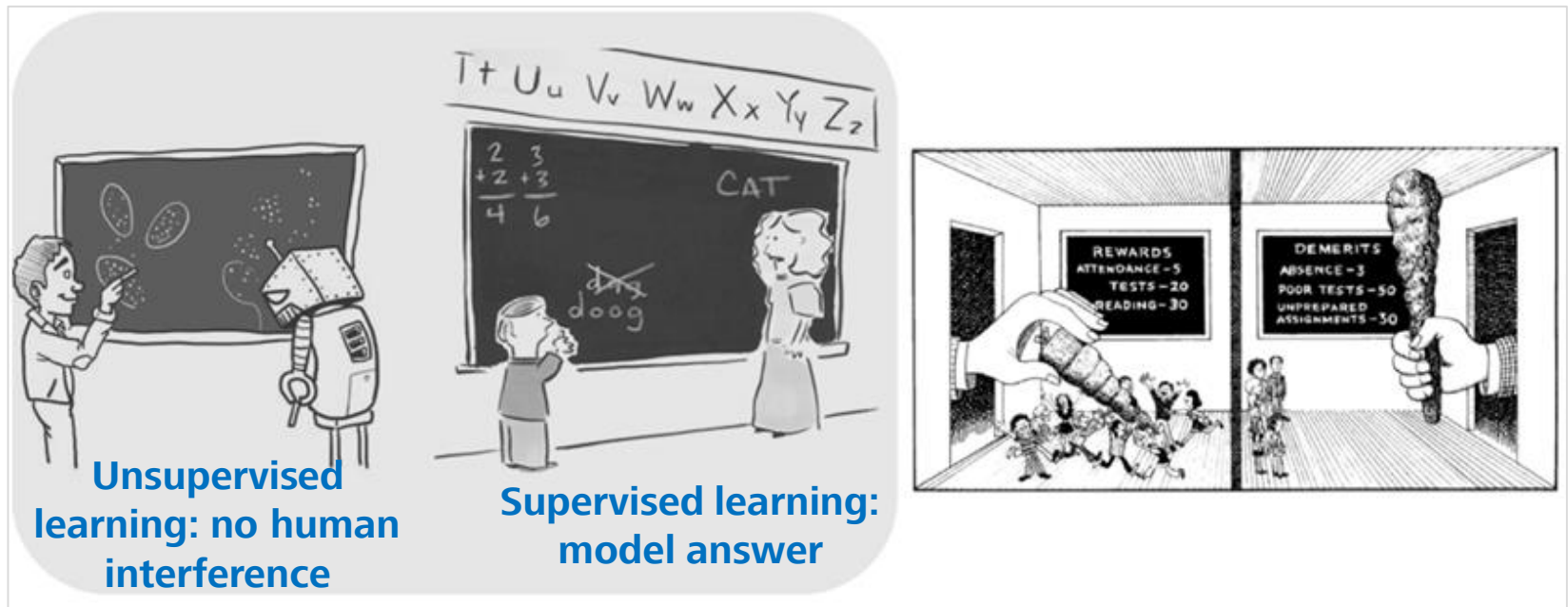
NLP

- ◆ NLP mainly involves knowledge acquisition and expression, natural language understanding, and natural language generation. There are also researches on knowledge graph, dialogue management, machine translation, etc.
 - Knowledge graph: structured results obtained after knowledge is organized based on semantics
 - Dialog management: chatting, Q&A, and task-driven dialogs
 - Machine translation: From traditional PBMT to Google GNMT, the smoothness and accuracy are greatly improved.
- ◆ Applications: search engine, dialogue robot, machine translation, college entrance examination robot, intelligent office secretary

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

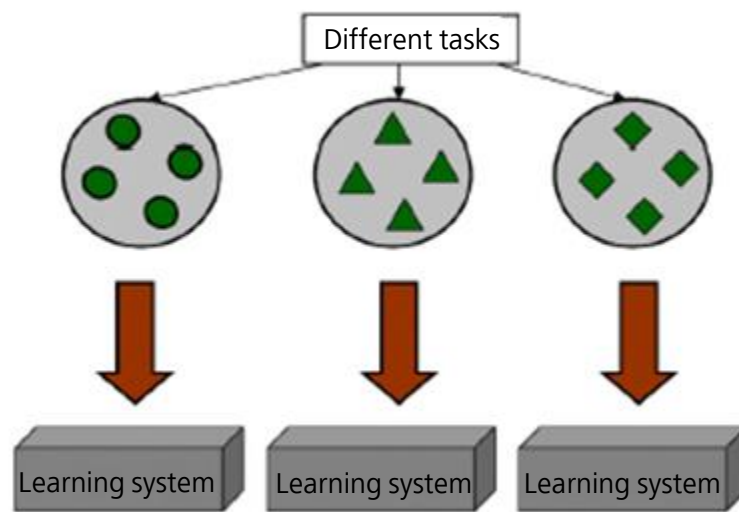
Machine Learning (2)



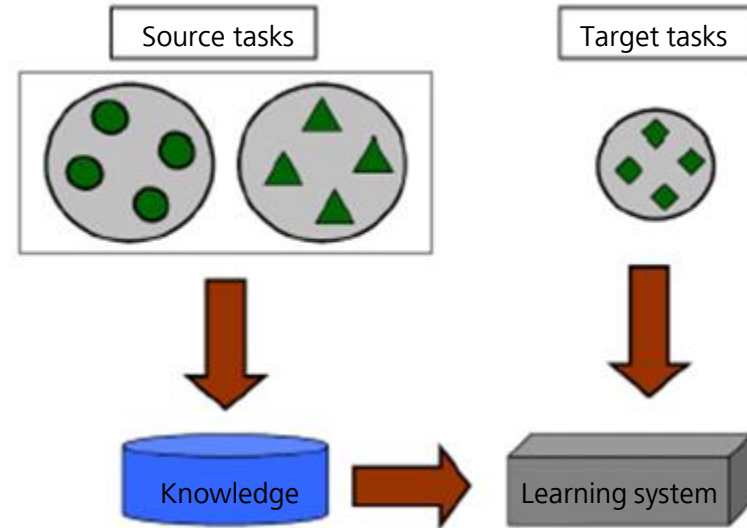
Traditional machine learning

**Reinforcement learning:
reward and punishment**

Machine Learning (3)

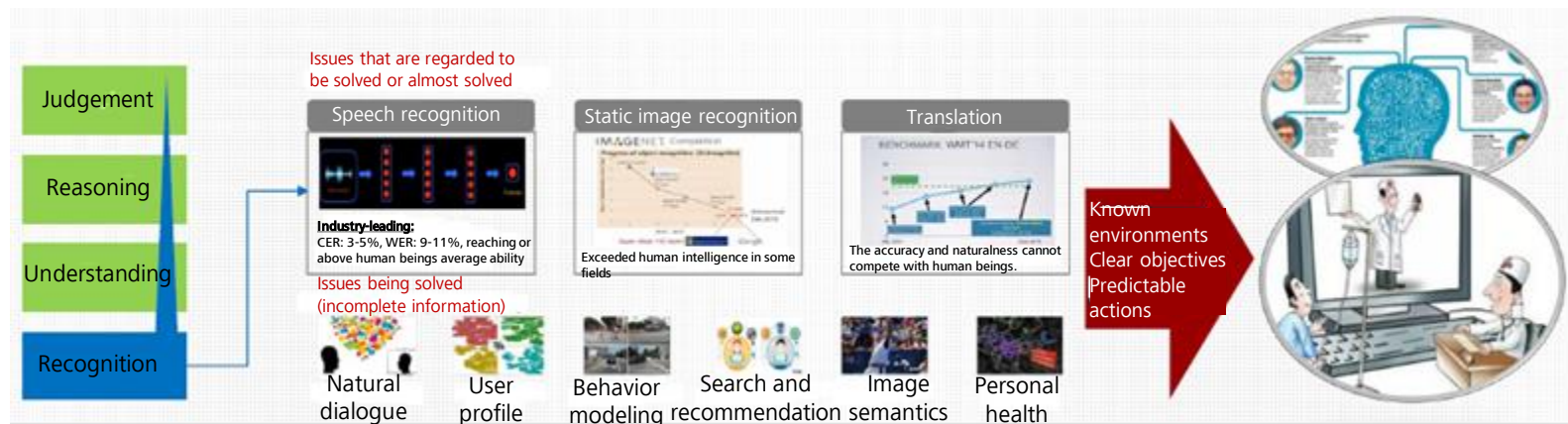


(a) Traditional machine learning



(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.

Convergence: Trend of AI

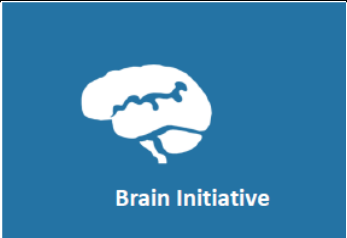


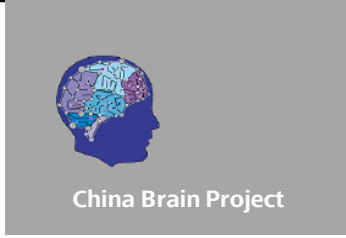
- ◆ It is a trend for AI to converge the traditional machine learning, deep learning, reinforcement learning, knowledge inference, and intelligent decision-making. The next five years will see the soaring development of AI (opinion of Professor Stanford).
 - AI will develop from supervised learning to flexible learning.
 - Computer vision will be popular in the industries, such as education, healthcare, transportation, and public safety.
 - Robots will be industrialized in 10 years.



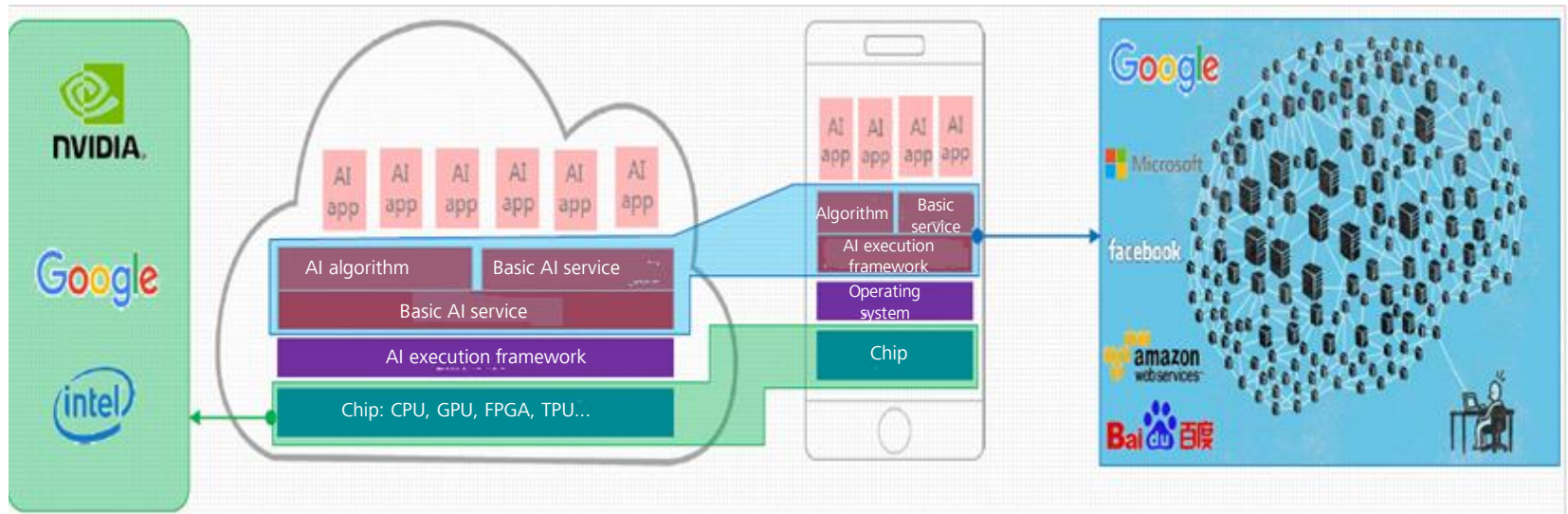
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Brain-like Research in the World

			
The US	EU	Japan	China
<ul style="list-style-type: none"> ▪ Brain Initiative: Exploration on how human brain works (initiated in 2013, US\$4.5 billion) ▪ SyNAPSE: Development of large-scale electronic neuromorphic computer prototypes (2008–2016) 	<ul style="list-style-type: none"> ▪ Human Brain Project: Study on information communication technologies and healthcare in the future (initiated in 2013, EUR1 billion) 	<ul style="list-style-type: none"> ▪ Brain/Minds: Study on a marmoset's brain to look into the brain functions and diseases (initiated in 2014, US\$270 million) 	<ul style="list-style-type: none"> ▪ China Brain Project: Research into the neural basis of cognitive function, with additional goals of improving diagnosis and prevention of brain diseases, and driving AI projects that are inspired by the brain (The project has been initiated in regions and supported by the nation with an expenditure of CNY10 billion.)
<p>SyNAPSE:</p> <ul style="list-style-type: none"> ▪ Application of a new computing system with ultra-low power consumption (led by IBM) (TrueNorth chip, system architecture design, and algorithm implementation) ▪ Development of computing systems with cognitive, learning, and inference capabilities, emphasizing autonomic learning capabilities (research on class-brain chips based on memorials) (led by HRL) 	<p>Human Brain Project:</p> <ul style="list-style-type: none"> ▪ Neuroscience, medicine, and computing in the future ▪ Human brain strategic data, cognitive behavioral architecture, theoretical neuroscience, neuroinformatics, brain simulation, high-performance computing platform, medical informatics, neuromorphic computing platform, neuromorphic robot platform, and analog application 	<p>Brain/Minds:</p> <ul style="list-style-type: none"> ▪ Brain function locating using the functional MRI and other technologies ▪ Collection and analysis of related research information, such as brain imaging 	<p>Local brain project</p> <ul style="list-style-type: none"> ▪ Chinese Academy of Sciences established a brain-like intelligence research center and a neural computing group. The study scope includes algorithm models, information processing, and brain simulation (Cambrian series neural network accelerator). ▪ Tsinghua University set up the Center for Brain Inspired Computing Research (CBICR): brain system engineering that involves system design, simulation modeling, and hardware materials (Tianji brain-like chips)

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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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.



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."

Efforts in Self-driving Legislation

- ◆ In 2013, the U.S. National Highway Traffic Safety Administration (NHTSA) issued the *Federal Automated Vehicles Policy*, which stipulated the responsibilities in case of self-driving test accidents.
- ◆ In August 2016, the United Nations Education, Scientific and Cultural Organization (UNESCO) and World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) explored the possibility of robots in the *Preliminary Draft Report of COMEST on Robotics Ethics*. It suggested that people participating in the robots' invention, authorization, and distribution share the responsibility.
- ◆ On May 12, 2017, Germany passed a revised action proposed by the transport department. The system cannot completely replace the driver for driving. The driver should stay there and be able to take over the vehicle at any time. Although self-driving is controlled by the computer, the ultimate responsibility should primarily fall on the driver.
- ◆ Under the current legal framework, the robot is not liable for any damage to the third party due to its behavior or negligence.

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-recommendation engine competition.



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-semitic, 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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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.

Man-Machine Relationship and AI Governance

◆ **Man-machine relationship blueprint:**

- There are worries that robots might pose threats to human beings. However, machines and human beings can coexist by controlling AI.
- AI becomes the agent of human consciousness. Human beings extend themselves through AI.
- The virtual reality will come true in the future.

◆ **AI governance:**

- AI governance should be based on technological and industrial innovation.
- Regulators are advised to give more freedom to the market for innovation.
- Do not set too many constraints on the grounds of security.
- Strive to facilitate development and innovation.
- Encourage different entities to participate in the AI governance.



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Robot Colleagues



ASIMO



Waiter

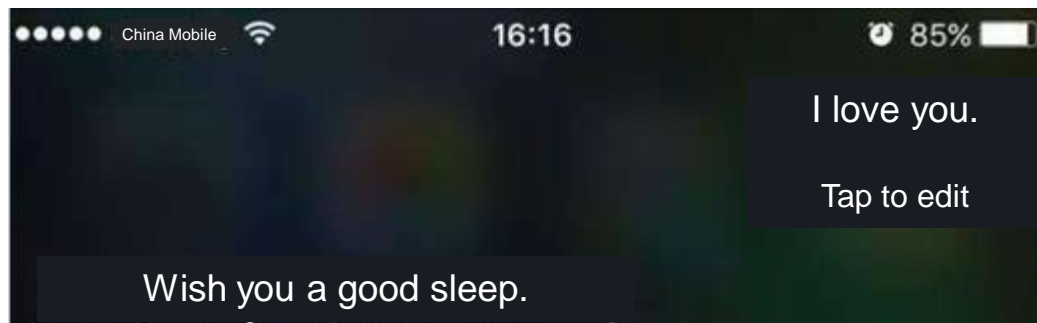
Soul Mate



Baymax



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

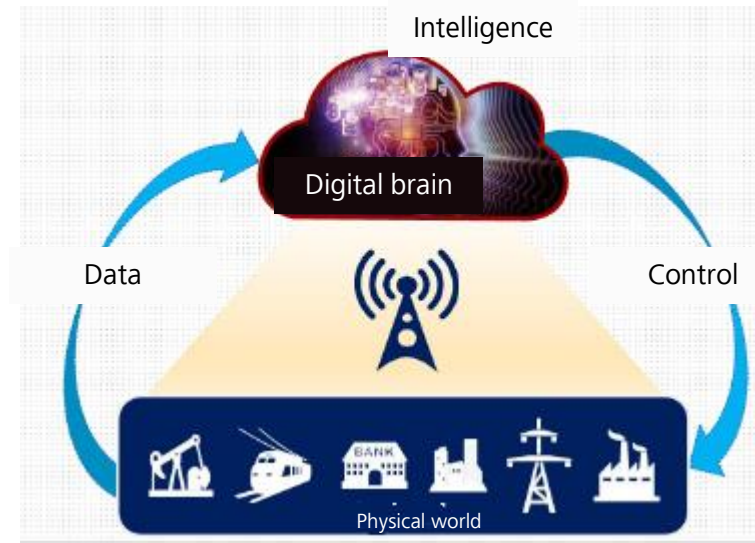


Siri

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.

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



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



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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