Overview of Artificial Intelligence

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1

AI Application Scenarios

Driverless car **Smart home** **Virtual reality** **Augmented Reality**
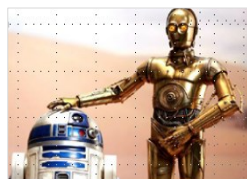
Intelligent robot **Smart investment adviser** **Intelligent healthcare**

Page 2 **HUAWEI**

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.

Page 3 **HUAWEI**

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.

Page 4   HUAWEI

Computer Vision (cont.)

- **Image Localization**: **locate single object** in an image

- **Object Detection**: **locate and classify (determine the type/class) multi objects** in an image
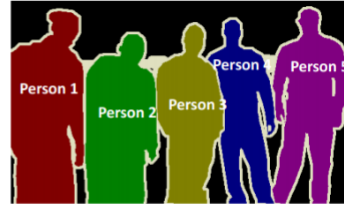
Image Localization

Object Detection

https://www.analyticsvidhya.com/blog/2019/04/introduction-image-segmentation-techniques-python/

Page 5   HUAWEI

Computer Vision (cont.)

- **Image Segmentation**: group image pixels into segments (set of pixels) that share similar properties
  - **Semantic Segmentation**: determine the class of every pixel. Every class has different color
  - **Instance Segmentation**: determine the class of every pixel where every objects of the same class have different colors

Semantic Segmentation   Instance Segmentation

https://www.analyticsvidhya.com/blog/2019/04/introduction-image-segmentation-techniques-python/

   Page 6   **HUAWEI**

Computer Vision (cont.)

Semantic Segmentation	Classification + Localization	Object Detection	Instance Segmentation
GRASS, CAT, TREE, SKY	CAT	DOG, DOG, CAT	DOG, DOG, CAT
No objects, just pixels	Single Object	Multiple Object	

This image is CC0 public domain

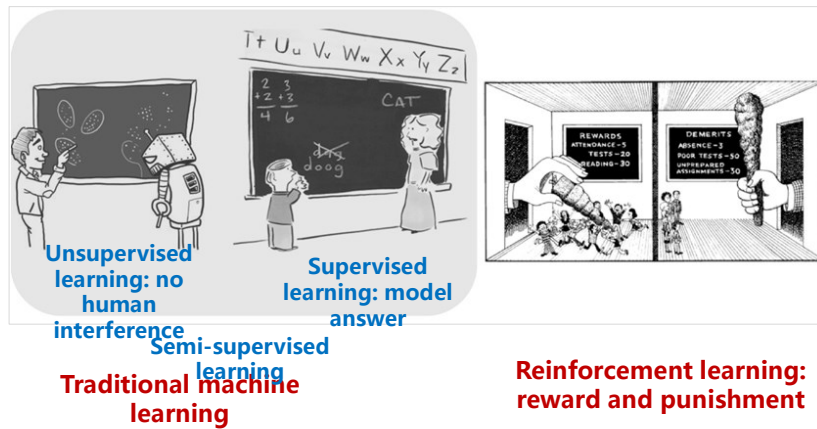Source : cs231n.stanford.edu

   Page 7   **HUAWEI**

4

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
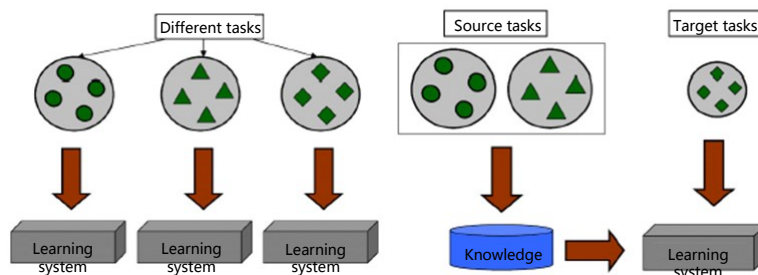
Machine Learning

◆ 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 (cont.)

Unsupervised learning: no human interference

Supervised learning: model answer

Semi-supervised learning

Traditional machine learning

Reinforcement learning: reward and punishment

Page 10   **HUAWEI**

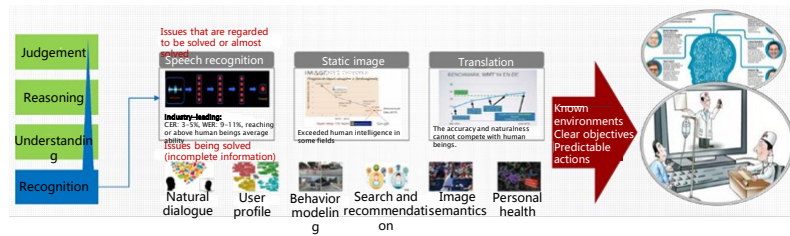
Machine Learning (cont.)

- **Transfer Learning:** the reuse of a pre-trained model on a new related problem
- Advantages:
    - Less training time
    - Better performance of neural networks
    - Less a mount of data

(a) Traditional machine learning

(b) Transfer learning

Page 11   **HUAWEI**

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.
  - ➢ 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.

Page 12   HUAWEI

Contents

Page 13   HUAWEI

7

Brain-like Research in the World

The US	EU	Japan	China
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)	**Human Brain Project:** Study on information communication technologies and healthcare in the future (initiated in 2013, EUR1 billion)	**Brain/Minds:** Study on a marmoset's brain to look into the brain functions and diseases (initiated in 2014, US$270 million)	**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.)
SyNAPSE: • 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)	**Human Brain Project:** • 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	**Brain/Minds:** • Brain function locating using the functional MRI and other technologies • Collection and analysis of related research information, such as brain imaging	**Local brain project** • 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
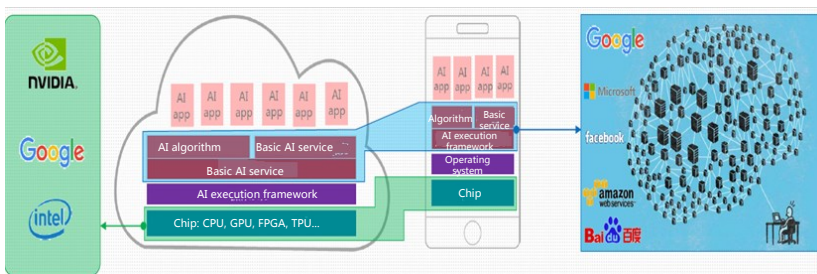
- ◆ AI might lead to a change in chip architectures, which will further reshape the industry landscape. NVIDIA, Google, and Intel are competing for the dominant place in the future.

- ◆ 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.**

8

Contents

1. The Past of AI

2. What Is AI?

3. The Present and Future of AI

4. Development and Strategic Planning of the AI Industry

5. **Justice and Equity in the Era of AI**

6. Man-Machine Relationship and AI Governance

7. AI Society in the Future

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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.

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9

Self-driving Legislation

- In 2013, the U.S. National Highway Traffic Safety Administration (NHTSA) issued the Federal AutomatedVehicles Policy. 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.

- 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.**

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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.

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10

Data Protection

- ◆ Legislation protection:
  - ➢ Since the Swedish Data Protection Act, the first personal data protection act, was issued in 1973.
  - ➢ In 2012, Decision of the Standing Committee of the National People's Congress on Strengthening Information Protection on Networks was passed.
- ◆ 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.

Page 20   **HUAWEI**

Is the Algorithm Fair by Default?

- ◆ The algorithm model and input data, which determine the prediction results, are two main sources of algorithm discrimination. The following is example:
  - ➢ 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.

Page 21   **HUAWEI**

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?
- ...

Page 22   HUAWEI

Contents

1. The Past of AI
2. What Is AI?
3. The Present and Future of AI
4. Development and Strategic Planning of the AI Industry
5. Justice and Equity in the Era of AI
6. **Man-Machine Relationship and AI Governance in the Era of AI**
7. AI Society in the Future

Page 23   HUAWEI

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**.

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Classification of Intelligent Robots

- 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

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Man-Machine Relationship

- ➤ 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.

Page 26   HUAWEI

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.

Page 27   HUAWEI

14

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.

　　　Page 28　　　 HUAWEI

Contents

1. The Past of AI

2. What Is AI?

3. The Present and Future of AI

4. Development and Strategic Planning of the AI Industry

5. Justice and Equity in the Era of AI

6. Man-Machine Relationship and AI Governance in the Era of AI
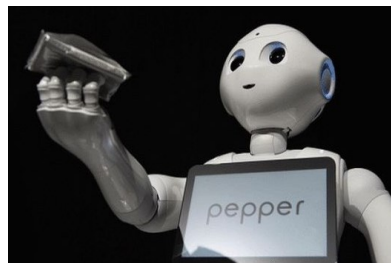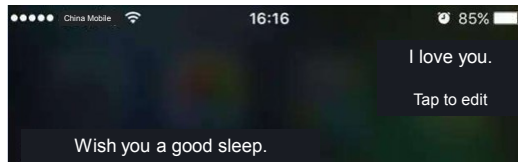
7. **AI Society in the Future**

　　　Page 29　　　 HUAWEI

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Robot Colleagues

ASIMO

Waiter

Soul Mate

Baymax

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

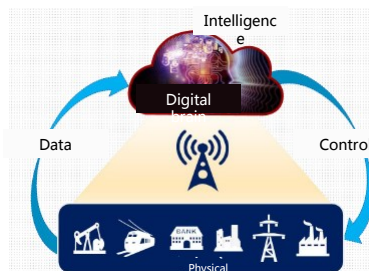I love you.
Tap to edit

Wish you a good sleep.

Siri

16

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.

Page 32

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.

Page 33

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. Symbolism

   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

Thank You

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