Overview of Artificial Intelligence

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Objectives

◆ After completing this chapter, 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.

Page 1

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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

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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.

https://en.wikipedia.org/wiki/Go_(game)
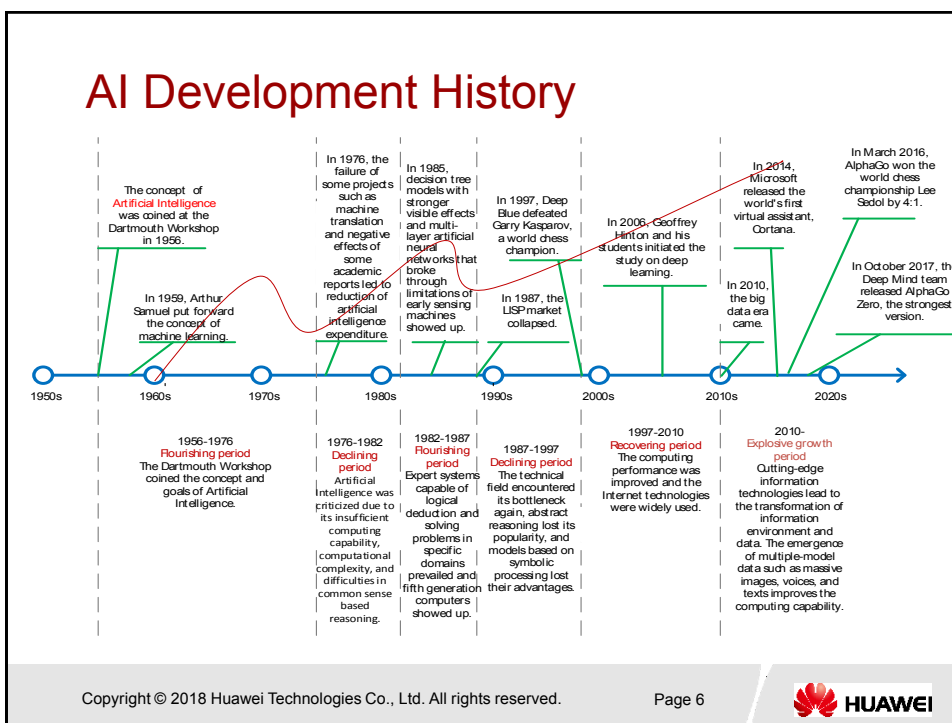
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Dartmouth Workshop: Birth of AI

- 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.**

Page 4

The Dartmouth College Artificial Intelligence Conference: The Next Fifty Years

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

- Participants 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
  - Ray Solomonoff: inventor of algorithmic probability

Page 5

3

AI Development History

The concept of Artificial Intelligence was coined at the Dartmouth Workshop in 1956.

In 1959, Arthur Samuel put forward the concept of machine learning.

In 1976, the failure of some projects such as machine translation and negative effects of some academic reports led to reduction of artificial intelligence expenditure.

In 1985, decision tree models with stronger visible effects and multi-layer artificial neural networks that broke through limitations of early sensing machines showed up.

In 1987, the LISP market collapsed.

In 1997, Deep Blue defeated Garry Kasparov, a world chess champion.

In 2006, Geoffrey Hinton and his students initiated the study on deep learning.

In 2010, the big data era came.

In 2014, Microsoft released the world's first virtual assistant, Cortana.

In March 2016, AlphaGo won the world chess championship Lee Sedol by 4:1.

In October 2017, the Deep Mind team released AlphaGo Zero, the strongest version.

1950s — 1960s — 1970s — 1980s — 1990s — 2000s — 2010s — 2020s

1956-1976
Flourishing period
The Dartmouth Workshop coined the concept and goals of Artificial Intelligence.

1976-1982
Declining period
Artificial Intelligence was criticized due to its insufficient computing capability, computational complexity, and difficulties in common sense based reasoning.

1982-1987
Flourishing period
Expert systems capable of logical deduction and solving problems in specific domains prevailed and fifth generation computers showed up.

1987-1997
Declining period
The technical field encountered its bottleneck again, abstract reasoning lost its popularity, and models based on symbolic processing lost their advantages.

1997-2010
Recovering period
The computing performance was improved and the Internet technologies were widely used.

2010-
Explosive growth period
Cutting-edge information technologies lead to the transformation of information environment and data. The emergence of multiple-model data such as massive images, voices, and texts improves the computing capability.

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Mainstream AI Theories
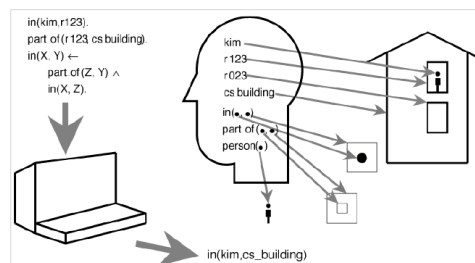
- Many theories emerged during AI development:
  - Symbolicism
  - Connectionism
  - Actionism
- All these have facilitated the development of AI.

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4

Symbolicism

- ◆ 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.

Page 8 HUAWEI

Symbolicism (cont.)

Symbolicism

in(kim,r123).
part of(r123, cs building).
in(X, Y) ←
    part of(Z, Y) ∧
    in(X, Z).

kim
r123
r023
cs building
in(•,•)
part of(•,•)
person(•)

in(kim,cs_building)

Representatives

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

Page 9 HUAWEI

Connectionism

◆ 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.

Page 10   **HUAWEI**

Connectionism (cont.)
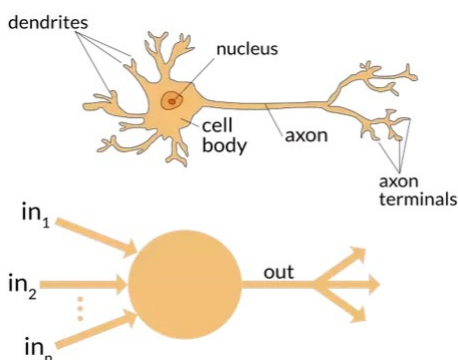
◆ Biological neuron consists of four major parts
  ◆ **Cell Body (Soma)** : signal processing
  ◆ **Dendrites** : receive signals
  ◆ **Axon** : output
  ◆ **Synapse (Axon Terminals):** connect the axon and the dendrite of the other neurons

https://www.quora.com/What-is-the-differences-between-artificial-neural-network-computer-science-and-biological-neural-network

Page 11   **HUAWEI**

Connectionism (cont.)

Connectionism
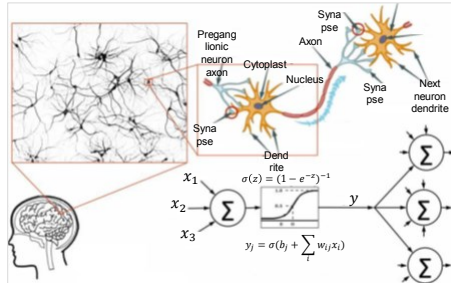
Representatives
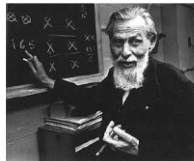
Warren S. McCulloch (1898-1969)   Walter H. Pitts (1923-1969)   Marvin Minsky (1927-2016)

Connectionism (cont.)

Artificial Neural Network

(a) Brain   (b) Neuron network

input layer   hidden layer   output layer

https://www.researchgate.net/figure/Neuron-networks-a-brain-b-neural-network-c-neuron-connecting-structure-d-neuron_fig1_320567646

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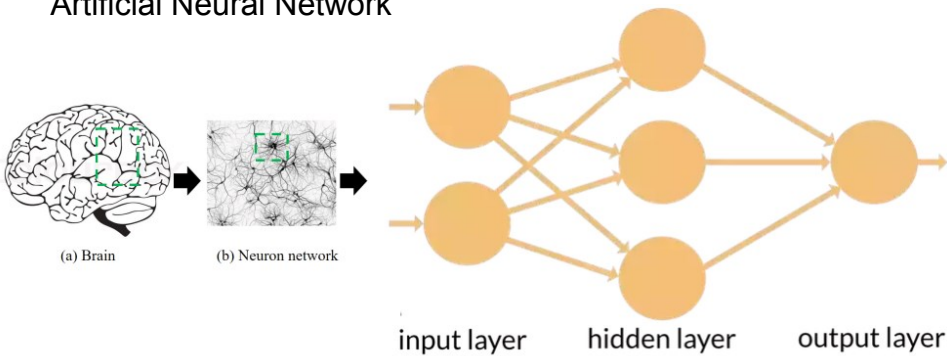
Actionism

◆ 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.

Page 14   HUAWEI

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

Page 15   HUAWEI

History of AI Chess Games:
Convergence of Mainstream Theories
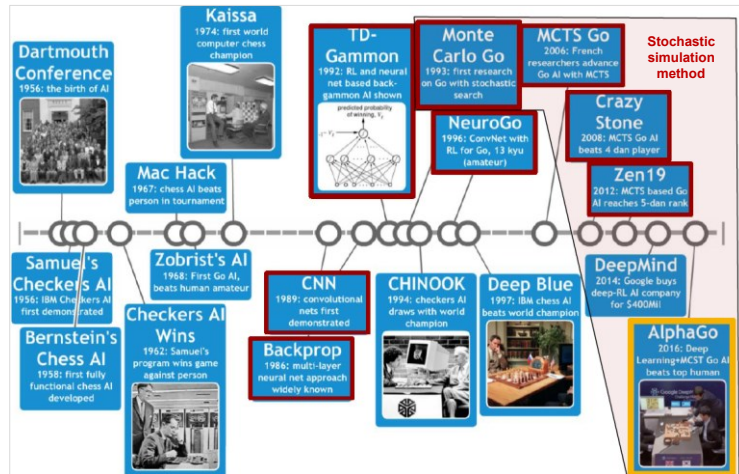
Page 16

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
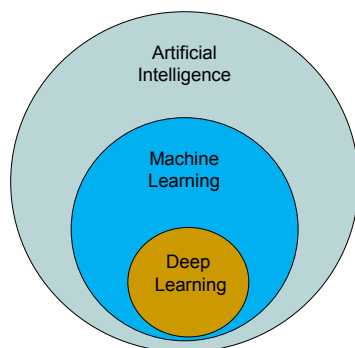
7. AI Society in the Future

Page 17

9

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.

Page 18

Hierarchy of AI

Page 19
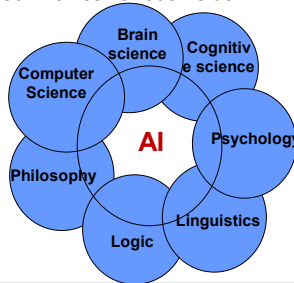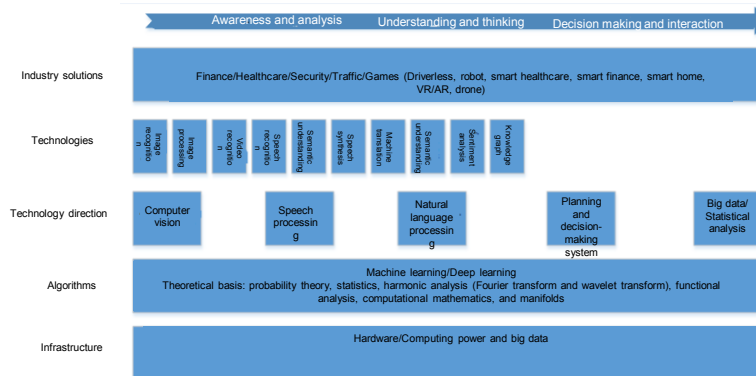
# Relationship Between AI, Machine Learning, and Deep Learning

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

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Relationship Between AI, Machine Learning, and Deep Learning (cont.)

- **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.

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Key Technologies of Machine Learning
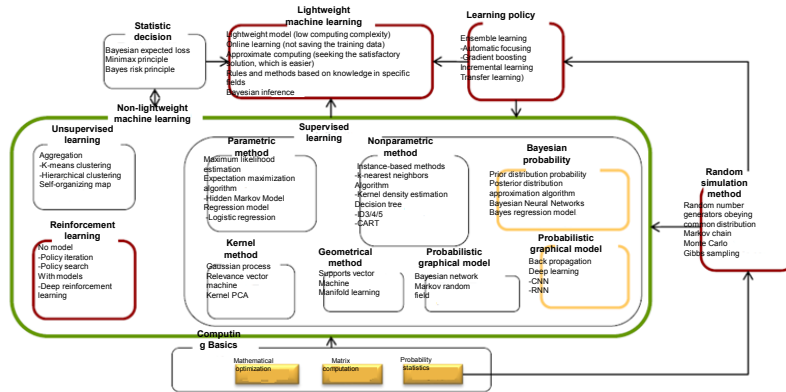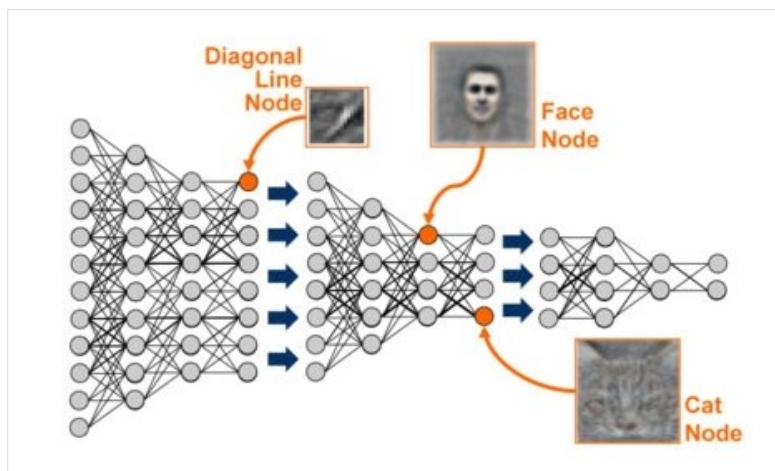
Page 22

Deep Learning

Page 23

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 24

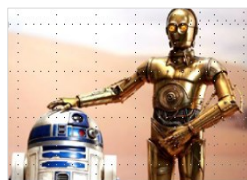# AI Application Scenarios

Driverless car   **Smart home**   **Virtual reality**   **Augmented Reality**

Intelligent robot   **Smart investment adviser**   **Intelligent healthcare**

Page 25

Thank You

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