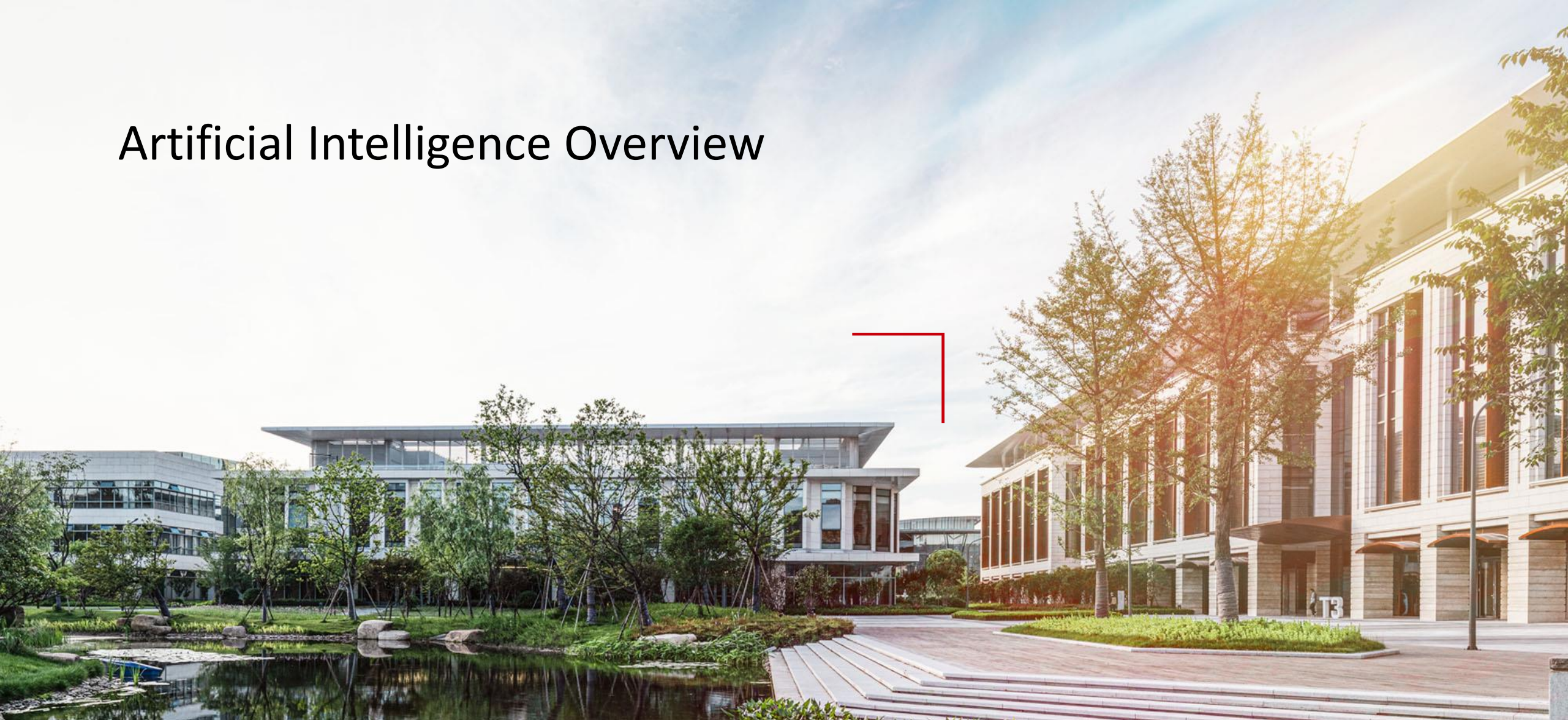# Artificial Intelligence Overview

Objectives

- Upon completion of this course, you will understand:

  □ Basic concepts of AI

  □ AI technologies and development history

  □ Application technologies and fields of AI

  □ Huawei's AI development strategy

  □ AI development trends

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Contents

Insights from Prominent Computer Scientists

"I propose to consider the question, 'Can machines think?'"

— Alan Turing, 1950

"...making a machine behave in ways that would be called intelligent if a human were so behaving."

— John McCarthy et al., 1956

"Artificial intelligence is the science of making machines do things that would require intelligence if done by men."

— Marvin Minsky

What is intelligence?

- According to the theory of multiple intelligences proposed by Professor Howard Gardner, multiple intelligences are manifested by eight capabilities:

  - Linguistic-verbal intelligence

  - Logical-mathematical intelligence

  - Visual-spatial intelligence

  - Bodily-kinesthetic intelligence

  - Musical-rhythmic and harmonic intelligence

  - Interpersonal intelligence

  - Intrapersonal intelligence

 - Naturalistic intelligence

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What Is Artificial Intelligence?

- "Artificial" in artificial intelligence (AI) means that it is designed by and is created for humans.

- AI is a scientific discipline that studies and develops theories, techniques, and application systems used to simulate and extend human intelligence. The term was first coined by John McCarthy in 1956, who defined it as the "science and engineering of making intelligent machines, especially intelligent computer programs". The very premise of AI technology is to enable machines to learn from collected data, and make human-like decisions.

- Today, AI has become an interdisciplinary course that involves various fields.
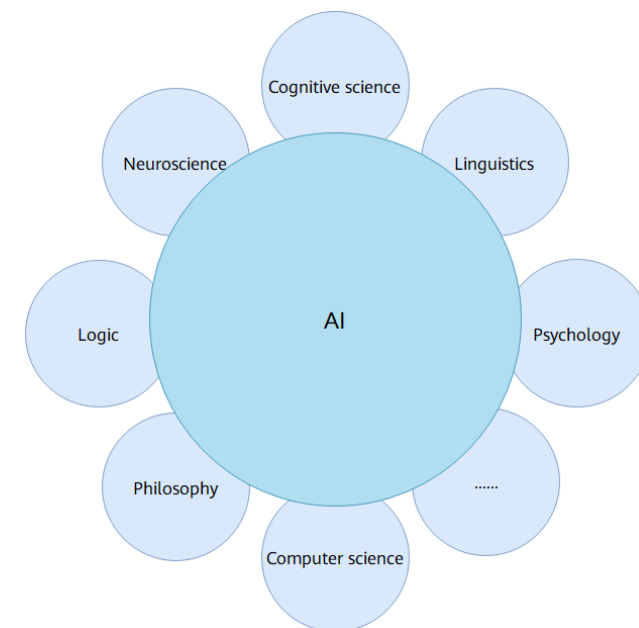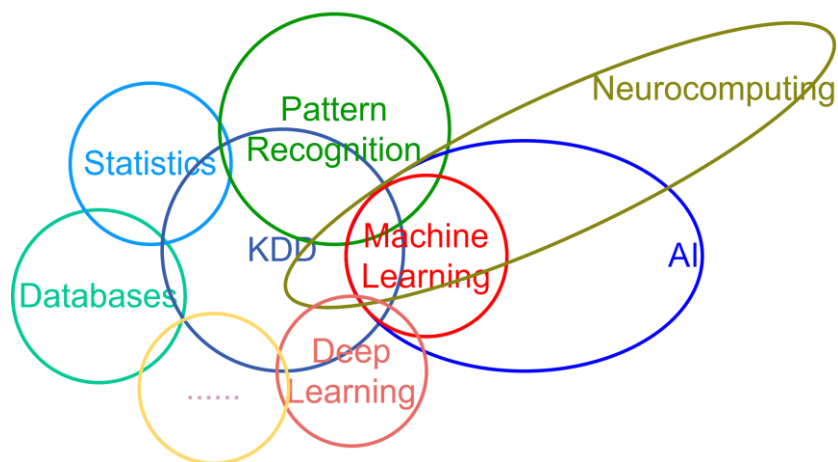
Relationship Between AI, Machine Learning, and Deep Learning

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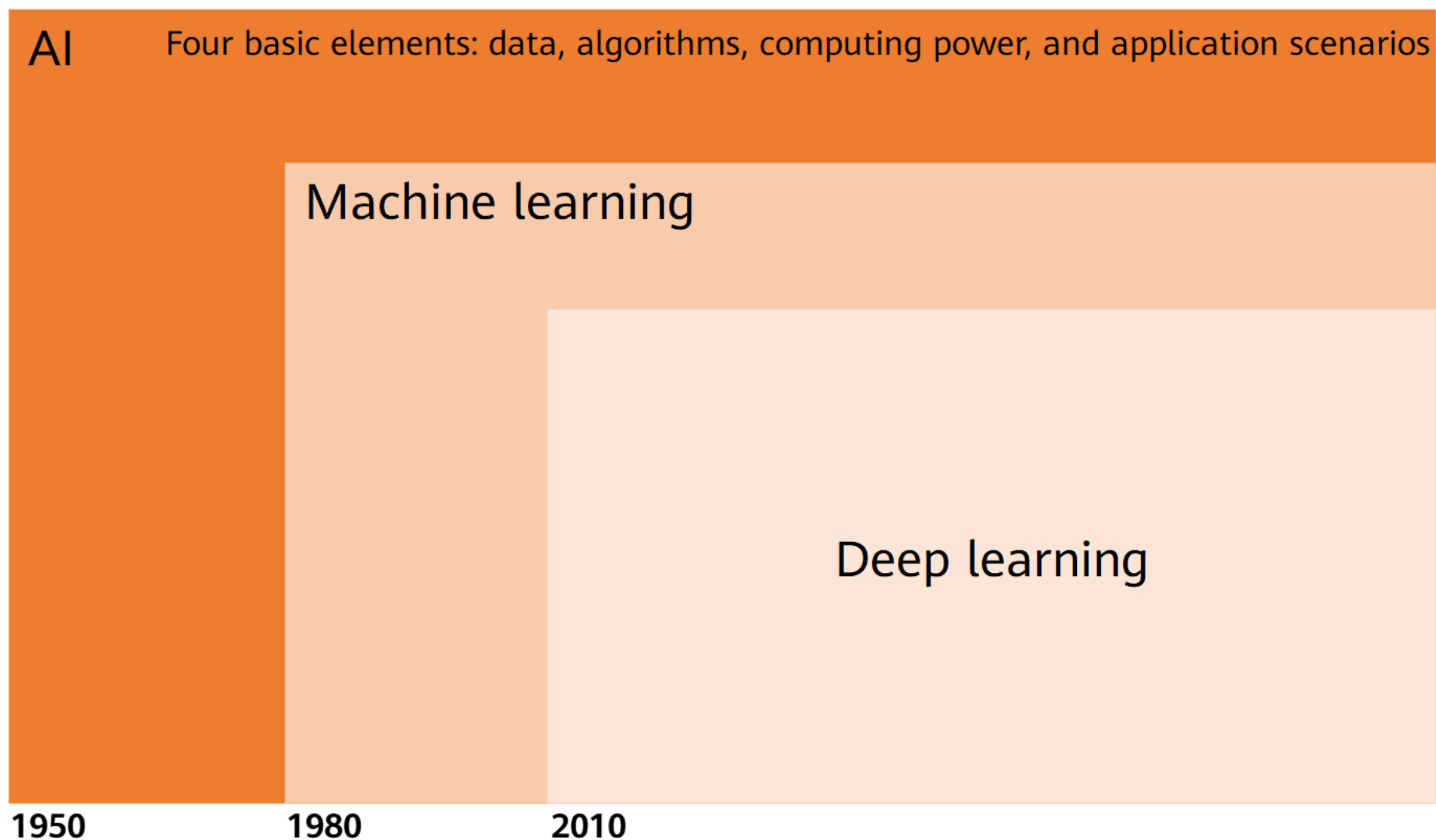
Relationship Between AI, Machine Learning, and Deep Learning

- AI is a scientific discipline that studies and develops theories, techniques, and application systems used to simulate and extend human intelligence.

- Machine learning (ML) refers to the ability of computers to learn, simulate, or implement human behavior to acquire new knowledge or skills, and continuously update existing knowledge structures to improve performance.

- Deep learning (DL) is a research field in ML and originates from artificial neural network (NN) studies. Multilayer perceptron (MLP) is a deep learning structure. Deep learning uses higher level features derived from the lower level features to form a hierarchical representation, in which it simulates the mechanisms of the human brain to interpret data, such as images, voice, and text.

Major Schools of AI - Symbolism

- Symbolicism, also called logicism, psychologism, or computerism, refers to the symbolic AI that is derived from mathematical logic.

- It suggests the basic cognition units of humans are symbols, and human cognition is a reasoning process based on various symbols. As humans and computers are both physical symbol systems, computers can be used to simulate intelligent human behaviors.

- This theory, proposed by McCarthy et al in 1956, first used the term "artificial intelligence" and made dominant contributions to the field's development, especially the success of expert systems.
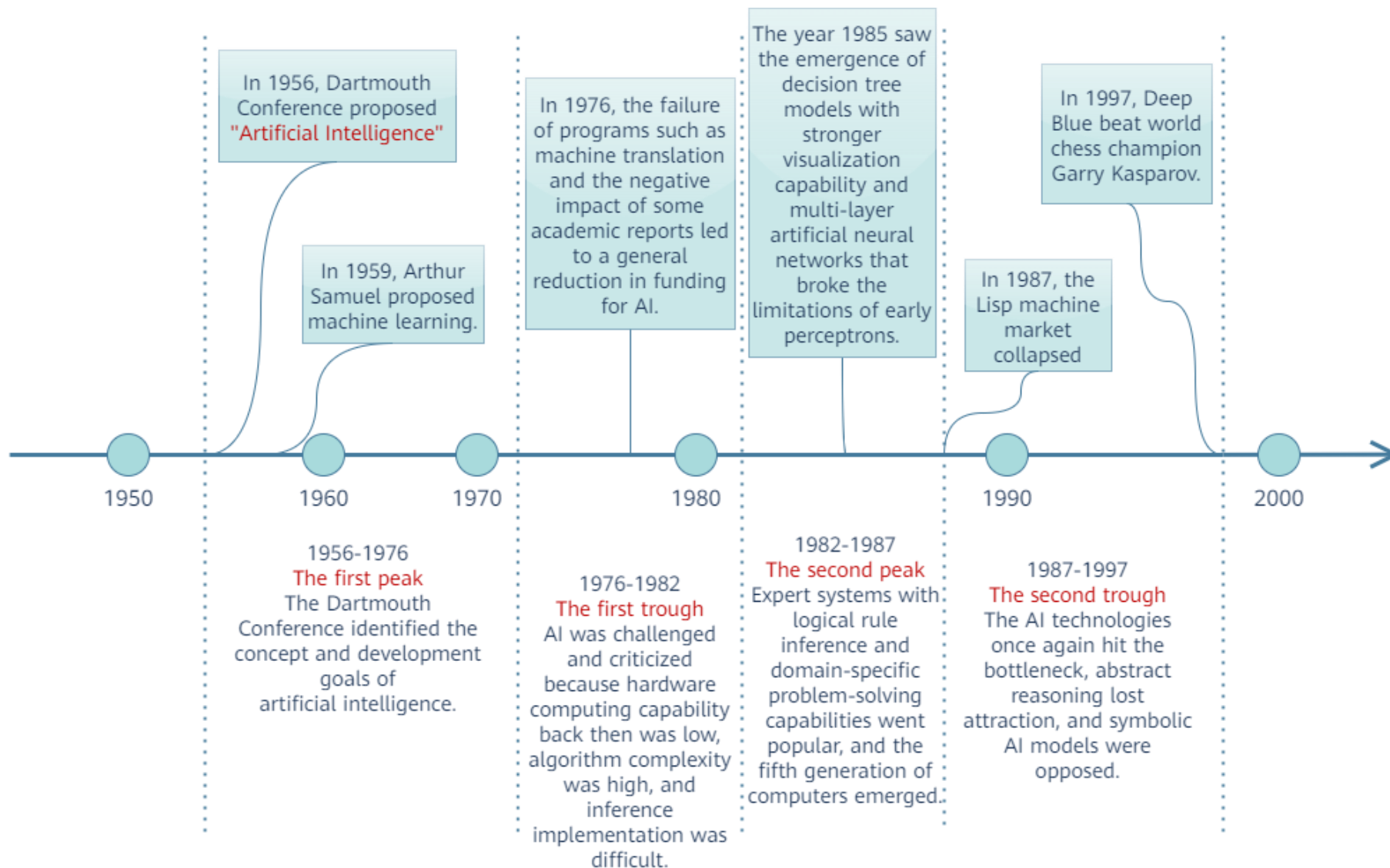
Major Schools of AI - Connectionism

- Connectionism, also known as bionicsism or physiologism, argues AI originates from bionics, that is, it is the study of human brain.

- Researchers believe the neuron, and not symbol processes, is the basic thinking unit. Connectionism starts with neurons and studies NNs and brain models, to create a new development path for AI.

- The McCulloch-Pitts (MP) neuron model was proposed in 1943. However, the study of brain models was limited due to biological prototypes and technical conditions in the 1970s and 80s. It was not until the proposal of hardware-simulated neural networks that the trend of connectionism reemerged again.

- Nowadays, the artificial neural network (ANN) is a common technique but its complexity and scale has brought many interpretability problems.

Major Schools of AI - Actionism

- Actionism is also known as evolutionism or cyberneticsism and states that AI originates from cybernetics.

- It suggests intelligence depends on perception and actions, and that intelligence does not require knowledge, representation, or reasoning. AI can evolve like human intelligence, and intelligent behavior can only be manifested in the real world by interacting with the surrounding environment.

- Early research on actionism focused on simulating intelligent behavior of people in the control process. It led to the birth of intelligent control and robotics in the 1980s.

AI Development History (1)

In 1956, Dartmouth Conference proposed "Artificial Intelligence"

In 1959, Arthur Samuel proposed machine learning.

In 1976, the failure of programs such as machine translation and the negative impact of some academic reports led to a general reduction in funding for AI.

The year 1985 saw the emergence of decision tree models with stronger visualization capability and multi-layer artificial neural networks that broke the limitations of early perceptrons.

In 1987, the Lisp machine market collapsed

In 1997, Deep Blue beat world chess champion Garry Kasparov.

1950   1960   1970   1980   1990   2000

1956-1976
The first peak
The Dartmouth Conference identified the concept and development goals of artificial intelligence.

1976-1982
The first trough
AI was challenged and criticized because hardware computing capability back then was low, algorithm complexity was high, and inference implementation was difficult.

1982-1987
The second peak
Expert systems with logical rule inference and domain-specific problem-solving capabilities went popular, and the fifth generation of computers emerged.

1987-1997
The second trough
The AI technologies once again hit the bottleneck, abstract reasoning lost attraction, and symbolic AI models were opposed.

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AI Development History (2)

2006
Geoffrey Hinton, who developed the backpropagation algorithm, began working on deep learning with his students.

2010
The advent of the big data era

2014
Microsoft launched world's first personal intelligent assistant Cortana.

2016
AlphaGo won the world champion Go player Lee Sedol by 4-1.

2018
The Transformer-based BERT natural language processing (NLP) model attracted much attention.

2022
Google Research launched diffusion models Imagen and DreamBooth.

2000   2010   2020   2022

1997-2010
Recovery
Computing performance improved. Internet technologies gained popularization rapidly.

2010-
Booming
The new generation of information technology has led to the transformation of information environment and data. Massive multi-modal data, such as images, speech, and texts, are emerging continuously. Computing performance is increasing, and various models are becoming mature.

2017
The DeepMind team introduced AlphaGo Zero, an improved version of AlphaGo.

2020
The OpenAI team released the GPT-3 NPL model trained on massive amounts of data.

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Types of AI

- Strong AI:

  □ This hypothesis aims to create intelligent machines that replicate human functions, such as reasoning and problem-solving, and are perceptive and self-conscious. Strong AI will be able to think independently and teach itself to solve new problems, and have its own values and worldviews, and will even have the same instincts as creatures, such as survival and safety needs. In a sense, strong AI can be seen as a new species.

- Weak AI:

  □ Weak AI aims to build intelligent machines that can perform specific tasks but rely heavily on human interference. These machines may seem intelligent but are not self-conscious.

AI Industry Ecosystem

- Data, algorithms, computing power, and application scenarios are the basic elements of AI applications. We must combine AI with premium cloud computing, big data, and IoT to facilitate our intelligent society.
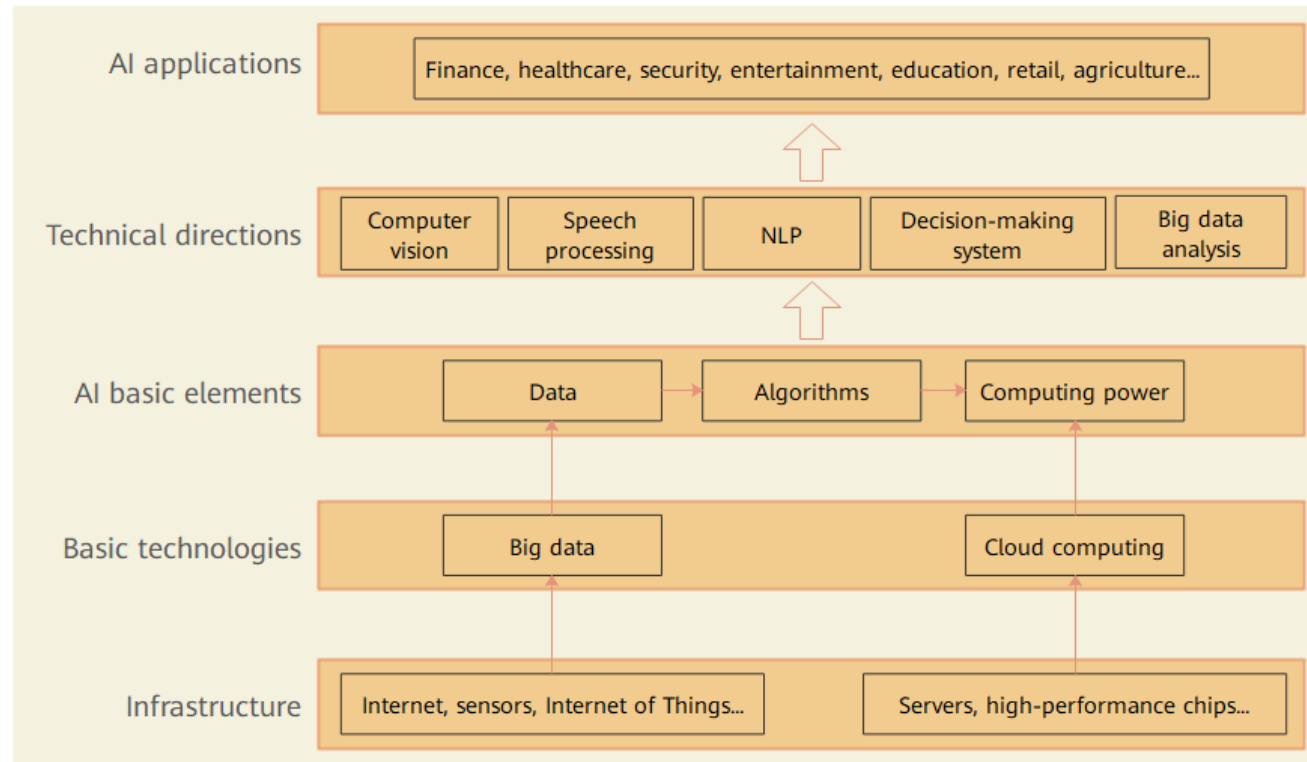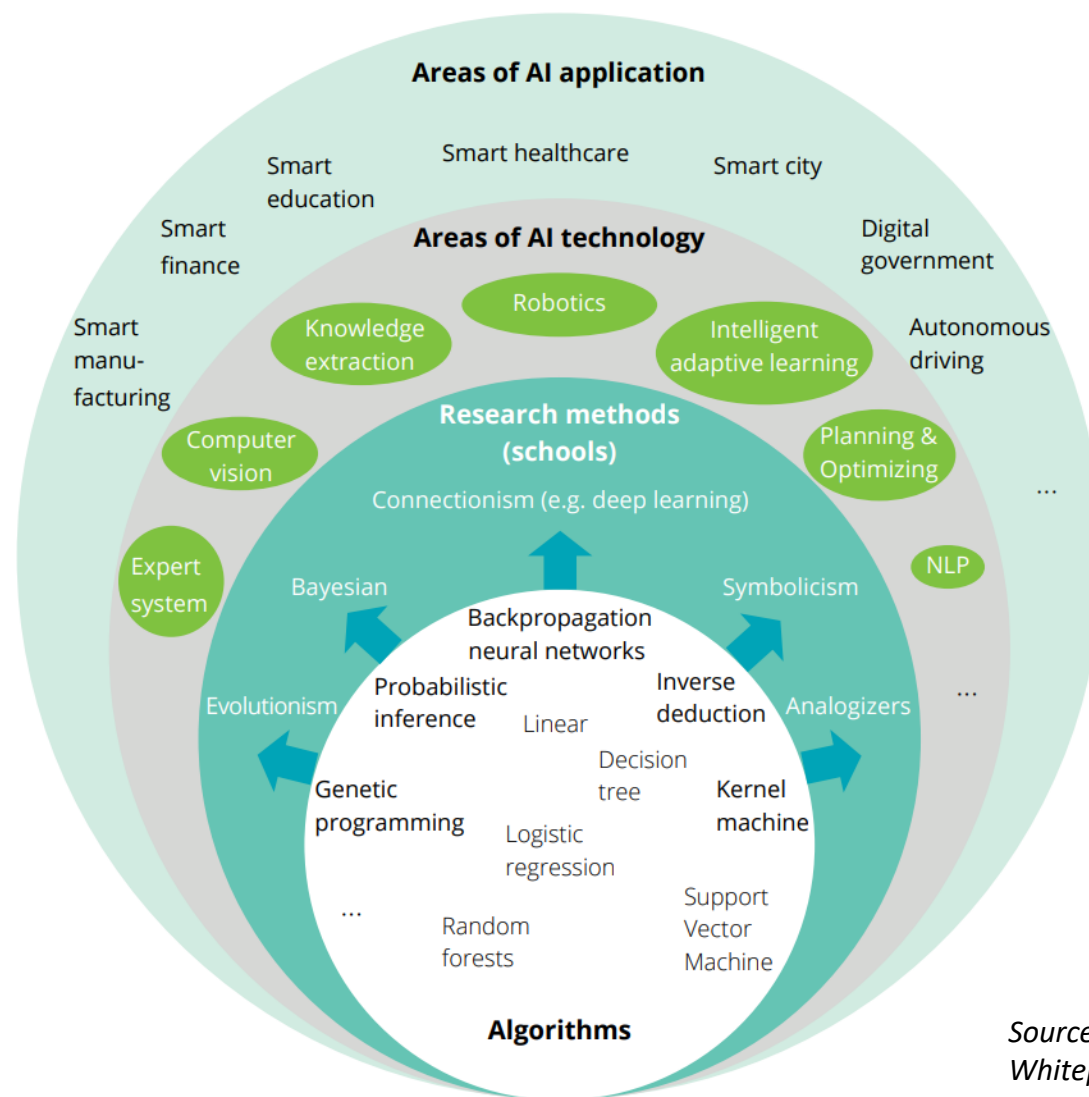
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1. AI Overview

2. **Application Fields of AI**

3. Huawei's AI Development Strategy

4. Controversies Over AI and Its Future

Popular AI Subfields

Content review

Object detection

Autonomous driving

Machine translation

Medical imaging

Intelligent customer service

Recommender system

......

Popular AI subfields

Integrated circuit design

Machine learning

Computer vision

NLP

Big data

Expert system

Database technology

......

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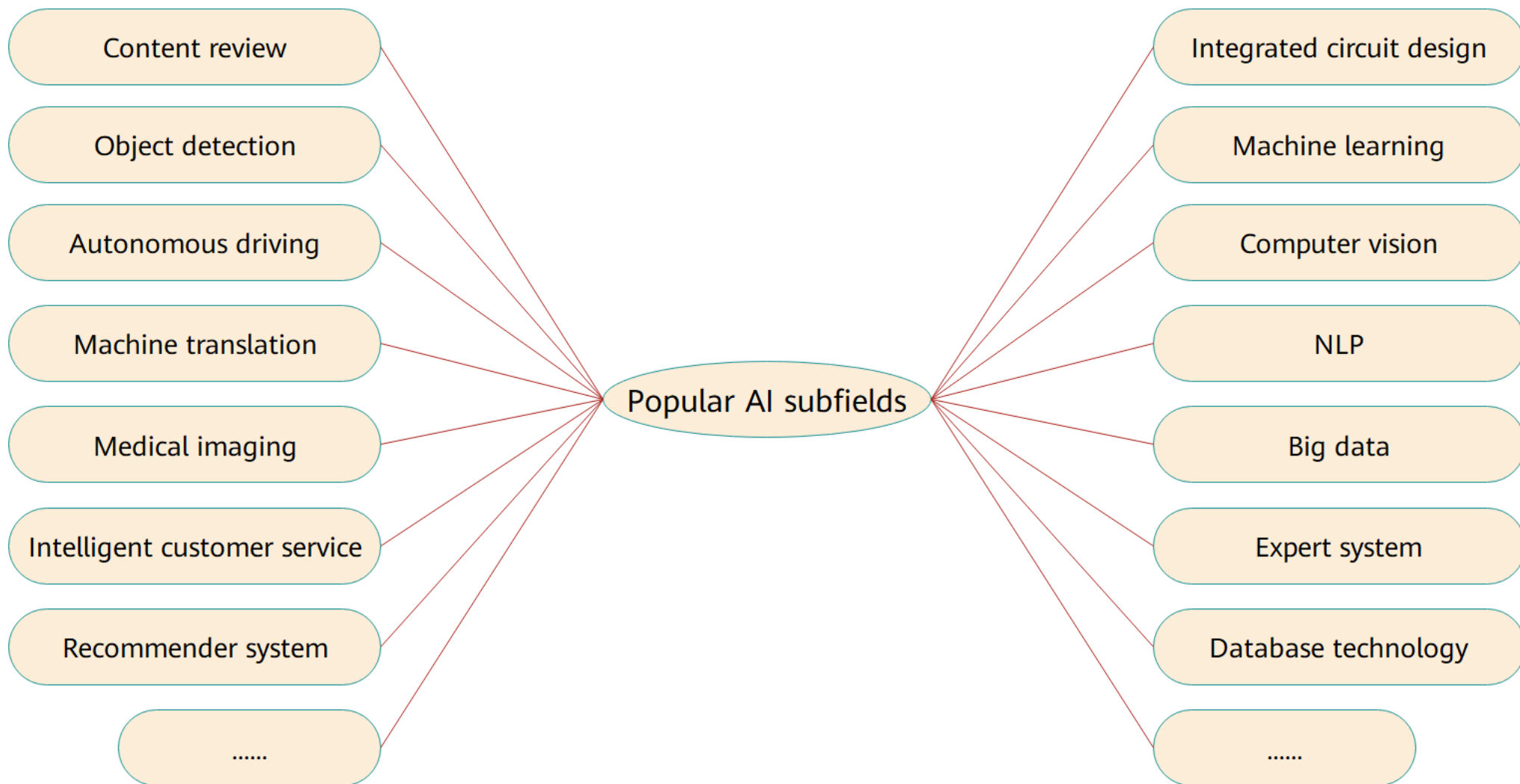
AI Technology and Application Fields

Source: Deloitte Global Artificial Intelligence Industry Whitepaper

Distribution of AI Application Technologies in China

- Computer vision, robotics, natural language processing (NLP), machine learning, and biometric recognition are the most popular technology fields for China's AI enterprises.

- Currently, the directions of general AI

  technologies are:

  - Computer vision
    - The study to make computers see things

      fast and accurately.

  - NLP
    - The study making computers understand

      and use natural languages.
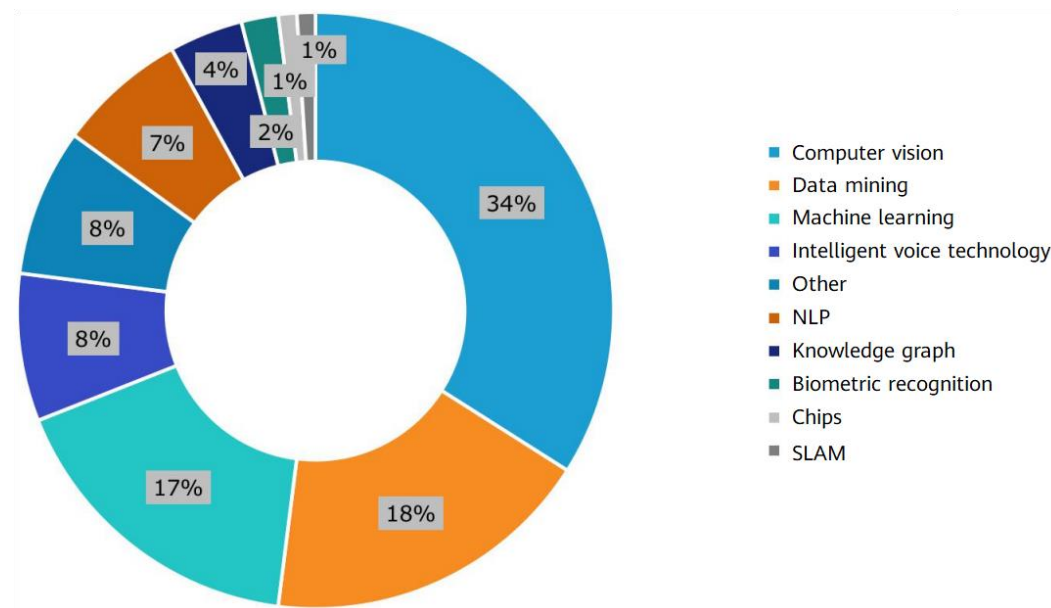
Source: EqualOcean 2022 China AI chips Industry Research

Smart Mining

Scenario 1: Mining chamber that houses important devices such as power and communications devices
Goal: Automatic inspection and unattended operation.

Challenge 1: The chamber environment needs to be monitored 24/7.

Challenge 2: Manual inspection must be performed periodically.

Scenario 2: Underground video surveillance system

	Challenges
Coal conveyor belt	The length of the coal conveying belt exceeds 20 km. Manual inspection is time-consuming and insecure. Multiple belts need to work together to prevent coal accumulation.
Violation activities	Monitoring of personnel violations, such as not wearing safety helmets, smoking, passing under equipment, walking in roadways, and sitting on belts.
Violation operations	Gas drainage, water exploration and drainage.

Solution for scenario 1: Automatic inspection robot

Video surveillance: Machine vision-based video surveillance for 24-hour monitoring of sensitive areas

Sound detection: AI sound detection techniques to intelligently monitor devices

Scenario 2

Belt tear monitoring

Belt deviation monitoring

Belt cleanliness monitoring

AI Safeguards Nature – A Protective Umbrella for Biodiversity in Chile

- The AI-powered "Nature Guardian" project has landed in the Nahuelbuta mountain range to study and protect the Darwin's fox. The "Nature Guardian", an acoustic monitoring system developed by the rainforest conservation organization Rainforest Connection (RFCx), has been deployed in several projects and is working effectively.

- It consists of solar devices equipped with microphones and antennas. These devices collect sound data from the surrounding environment and transmit it to the cloud through wireless networks for AI to analyze. Each device covers 3 square kilometers and runs around the clock.

- The "Nature Guardian" monitors gunshots from poachers, trucks and saws from illegal loggers, and cries from different animals to provide data for research.

- Trained AI analysis can identify the sounds of different animals, enabling experts to study the distribution and behavior of specific species and better implement environmental protection through adaptive management.

- If a threat is identified, the system sends a real-time alert to the ranger's mobile app, enabling the ranger to respond rapidly.

Image credit:
Buin Zoo & Nahuelbuta Foundation

Darwin's fox

Source: https://www.huawei.com/en/tech4all/stories/nature-guardians-for-biodiversity-in-chile
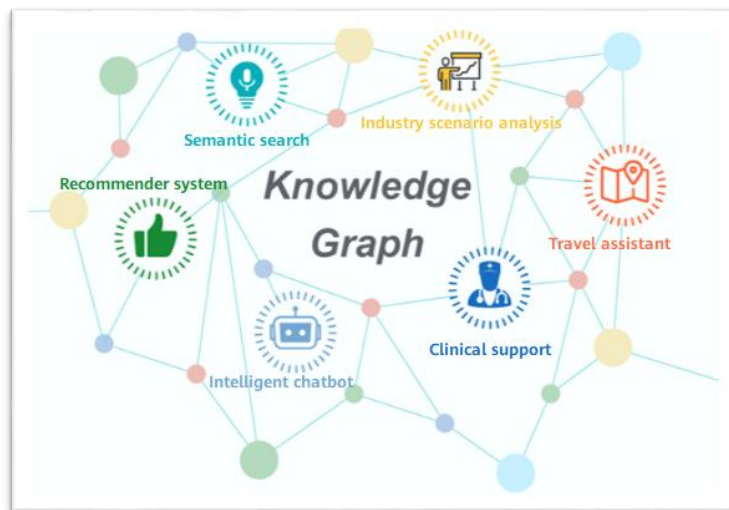
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AI Safeguards Nature – Protecting Wildlife in Greece with a Shield of Sound

NLP Application Scenarios

- The research topics of natural language processing include machine translation, text mining, and sentiment analysis. Current NLP is technically difficult and not mature enough, and due to the highly-complex semantics, machines are unable to achieve the human understanding through deep learning based on big data and parallel computing.

- Development: From shallow semantics understanding to automatic feature extraction and deep semantics understanding; from single intelligence (ML) to hybrid intelligence (ML, DL, etc.).

- Application scenarios:

Knowledge graph

```
review_en = "the movie is so boring"
inference(review_en)
```

Negative comments
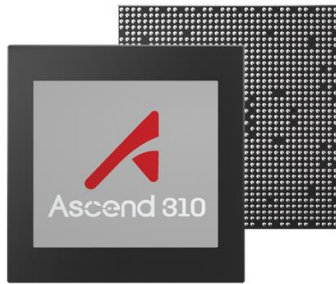
Sentiment analysis

Contents

Huawei Full-Stack All-Scenario AI Solution

Industry applications

Smart city, manufacturing, energy, transportation, finance, carrier, education, and more

Application enablement

ModelArts   HiAi Service   Third-party platform

MindX: Ascend application enablement

MindX DL
Deep learning enablement

MindX Edge
Intelligent edge enablement

ModelZoo
Preferred model library

MindX SDK
Industry SDKs

Full-pipeline toolchain

O&M tools

Ascend Community

AI framework

[M]ˢ 昇思 MindSpore

All-scenario AI framework that best manifests the computing power of Ascend AI processors

MindStudio

Fusion Director/SmartKit

hiascend.com

Heterogeneous compute architecture

CANN

Unified heterogeneous compute architecture to unleash hardware power

Hardware products

Device   Edge   Cloud

Atlas Hardware

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Ascend AI Processors Empower Smarter, Superior Computing

Ascend AI inference Chip series

Energy-efficient AI SoC

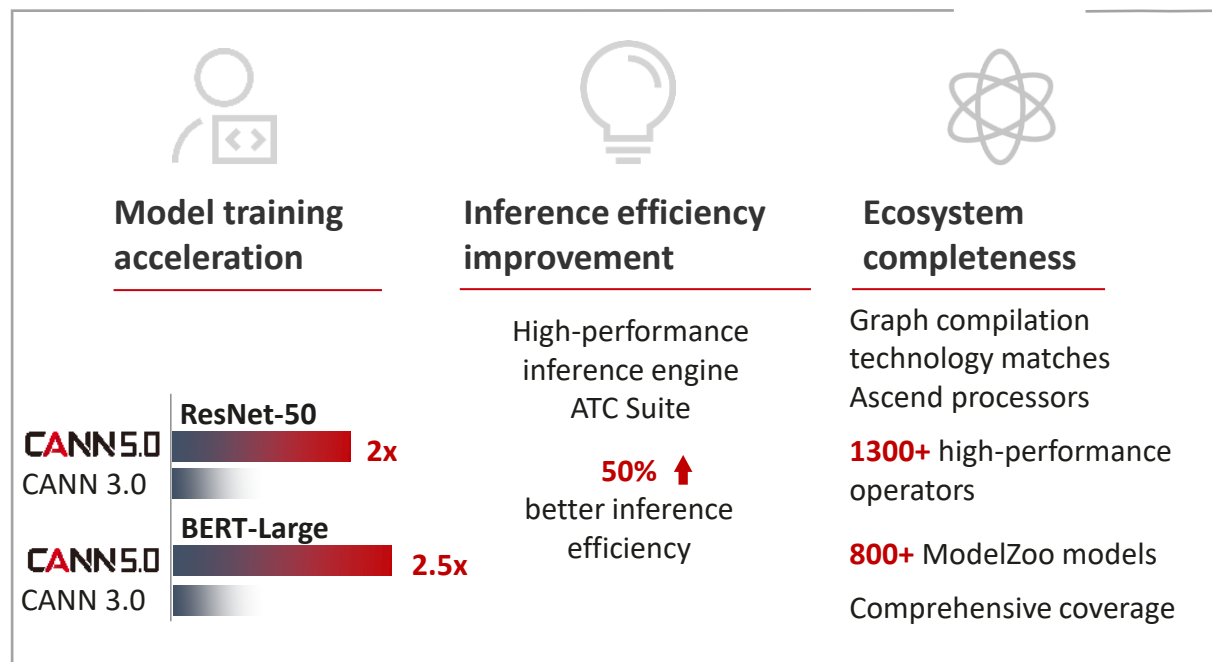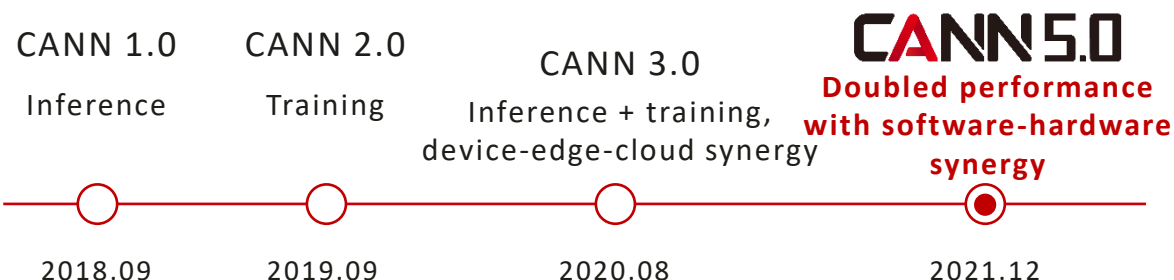**Ascend AI Training Chip series**

Powerful AI Processor

CANN Heterogeneous Computing Architecture

Software and Hardware Synergy to Double Computing Power

CANN 1.0
Inference

CANN 2.0
Training

CANN 3.0
Inference + training,
device-edge-cloud synergy

CANN 5.0
**Doubled performance
with software-hardware
synergy**

2018.09   2019.09   2020.08   2021.12

**Model training
acceleration**

ResNet-50
CANN 5.0 / CANN 3.0 — **2x**

BERT-Large
CANN 5.0 / CANN 3.0 — **2.5x**

**Inference efficiency
improvement**

High-performance
inference engine
ATC Suite

50% ↑
better inference
efficiency

**Ecosystem
completeness**

Graph compilation
technology matches
Ascend processors

1300+ high-performance
operators

800+ ModelZoo models

Comprehensive coverage

>>Support for multiple AI frameworks

[M]ˢ MindSpore   TensorFlow   Caffe

PyTorch   PaddlePaddle   ONNX

>> Continuous performance improvement

Industry-leading **ResNet-50** training speed

59.8s

28s

16s

*Test benchmark: ResNet-50 V1.5
model, ImageNet-1k dataset*

CANN 2.0   CANN 3.0   CANN 5.0

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MindSpore AI Computing Framework

AI computing center, manufacturing, finance, Internet, transportation, government, energy, university scientific research, public safety, and carrier

Ease of use

| Model/suite library | Dynamic and static graph unification | Python native expression |

Ultra-large-scale AI

| Automatic parallelism |
| Visualized cluster optimization |

AI converged computing

| Multi-scale hybrid computing |
| Higher-order differentiation |

AI security and trustworthiness

| Robustness evaluation and enhancement |
| Interpretability |

High-performance execution

| Heterogeneous acceleration | Memory overcommitment | Graph kernel fusion | On-device execution |

MindSpore IR (unified intermediate representation)

Collaborative AI across device-edge-cloud

| Adaptive lightweight deployment | High-performance inference | Distributed parallel scheduling | Lite/Micro |

The hardware abstraction layer (HAL) supports Huawei-developed and third-party processors.

Ascend/Kunpeng/Kirin/GPU/CPU/...

Key Features

Ease of use
Models for popular scenarios, Python native expression, and dynamic and static graph unification.
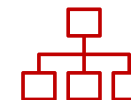
All-scenario AI
Diversified computing power, collaborative systems, and smart devices over edge and cloud.

High-performance execution
Full-stack collaborative acceleration and Ascend-affinitive execution engine to maximize performance.
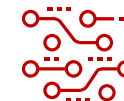
Ultra-large-scale AI
Distributed parallel training of ultra-large trillion-parameter models, with a series of pre-trained influential models available.

AI converged computing
X-fold acceleration of AI+scientific computing converged applications for electromagnetic, biopharmaceutical, and other usages.
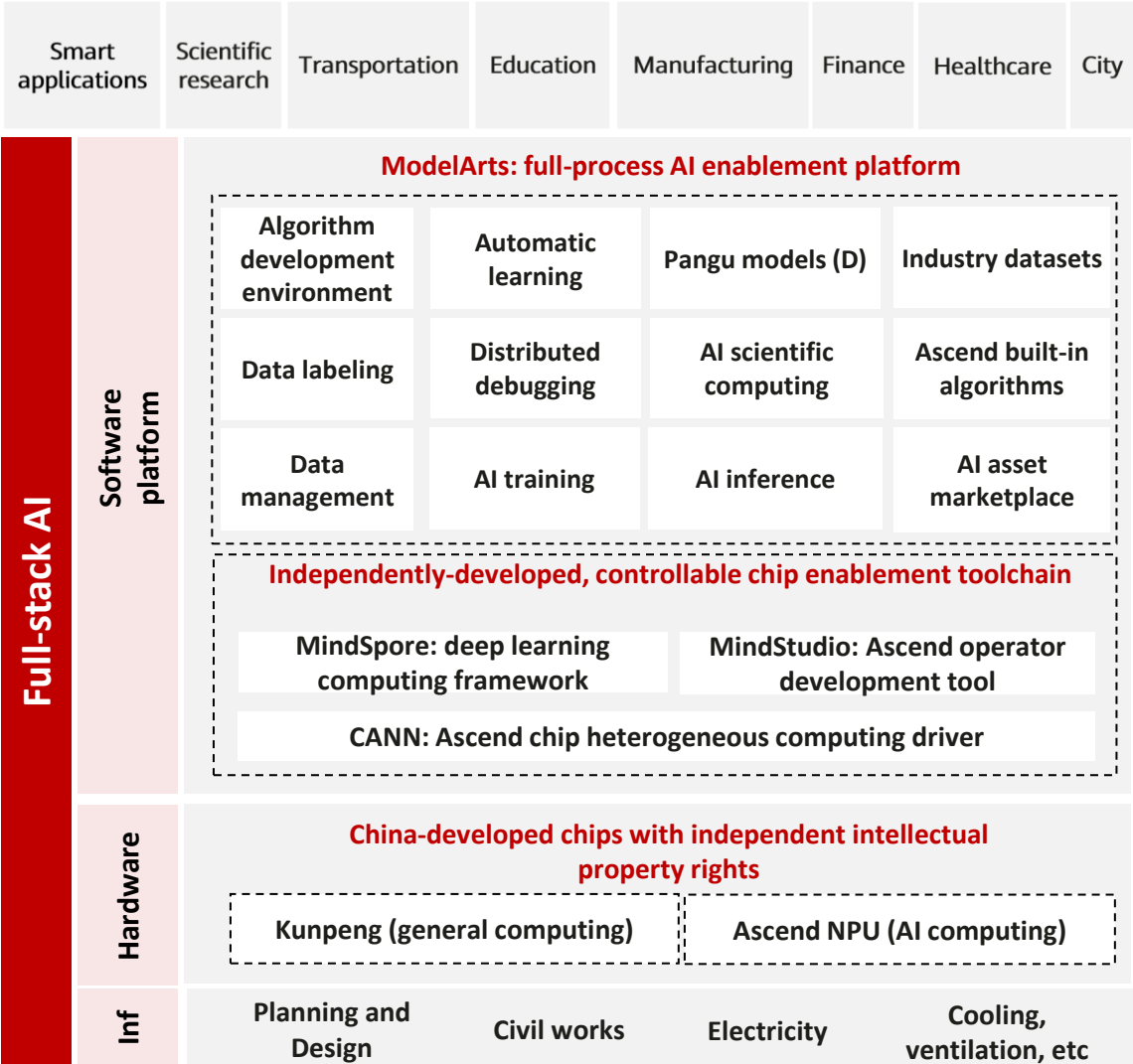
AI security and trustworthiness
Secure and trustworthy training, evaluation, and deployment of models.
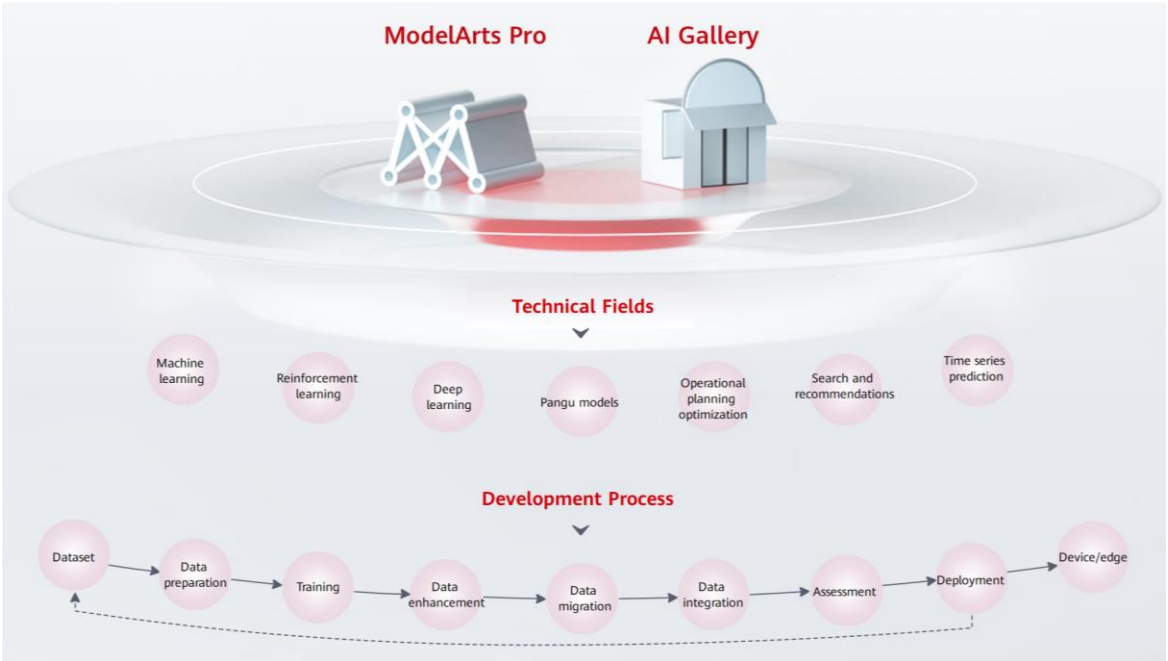
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ModelArts: Ascend-based Full-Stack Independence and Controllability

Independent and controllable AI technology stack

Smart applications	Scientific research	Transportation	Education	Manufacturing	Finance	Healthcare	City

Full-stack AI

Software platform

ModelArts: full-process AI enablement platform

Algorithm development environment	Automatic learning	Pangu models (D)	Industry datasets
Data labeling	Distributed debugging	AI scientific computing	Ascend built-in algorithms
Data management	AI training	AI inference	AI asset marketplace

Independently-developed, controllable chip enablement toolchain

MindSpore: deep learning computing framework	MindStudio: Ascend operator development tool

CANN: Ascend chip heterogeneous computing driver

Hardware

China-developed chips with independent intellectual property rights

Kunpeng (general computing)	Ascend NPU (AI computing)

Inf

Planning and Design	Civil works	Electricity	Cooling, ventilation, etc

ModelArts is a one-stop AI development platform that offers tools to help developers and data scientists of all skill sets build, train, and deploy models (cloud to edge), and manage full-lifecycle AI workflows. The platform makes it easier to develop AI by providing key capabilities, including data preprocessing and auto labeling, distributed training, automated model building, and one-click workflow execution.

ModelArts Pro: Enterprise-Grade Development Platform for Specific Industry Needs

ModelArts Pro   **AI Gallery**

Technical Fields

Machine learning · Reinforcement learning · Deep learning · Pangu models · Operational planning optimization · Search and recommendations · Time series prediction

Development Process

Dataset → Data preparation → Training → Data enhancement → Data migration → Data integration → Assessment → Deployment → Device/edge

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MindX: Application Enablement with Ascend

MindX: Ascend application enablement

MindX DL Deep learning enablement	MindX Edge Intelligent edge enablement	**MindX SDK** Industry application development kit	ModelZoo **800+** high-performance pre-trained models **110+** reference designs

MindX SDK: Accumulated industry knowledge to simplify application development

Video analysis SDK

mxVision

Smart manufacturing SDK

mxManufacture

Search clustering SDK

mxIndex

Shorten development time

Traditional application development

SDK-based development

Scenario -specific SDKs

OCR, customer service, voice...

Available

Coming soon
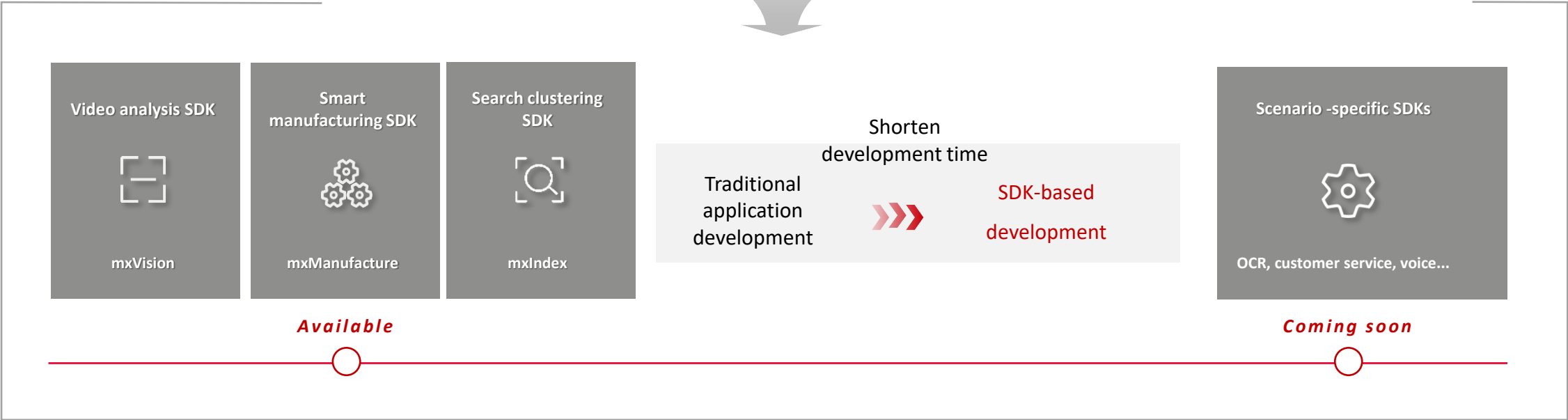
From AI+ to +AI: The Never-Ending Evolution of Best Practices

AI+

Exploring AI capabilities

| Image classification | **EfficientNet** model accuracy: 98.7%, higher than human accuracy (96%) |

| Speech recognition | **RNN-T** model accuracy: 96.8%, higher than human accuracy (94.17%) |

| Reading comprehension | **BERT** model accuracy: 90.9%, higher than human accuracy (82%) |

+AI

Powering core production systems with AI

Smart city	Smart campus
Industrial Internet	Smart healthcare
Autonomous driving	Smart finance

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4. **Controversies Over AI and Its Future**

   ▫ **Controversies Over AI**

   ▫ The Future of AI

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Controversies Over AI

- Every year we are gainin a clearer understanding of underlying AI concepts. However, many are concerned about the future of AI:

  - Do we still see and hear reality?

  - What are the ethical issues of AI?

  - Will AI take over our jobs?

  - Will our privacy be violated? How to ensure privacy security?

  - Is future AI controllable?

  - ......

Seeing Is Not Believing

- Breakthroughs in computer vision, such as photoshop and generative adversarial network (GAN), means now we can generate fake images that indistinguishable from real photos, impacting the credibility of image and video data.

- For example:

  - Weight-loss shops use Photoshop to produce fake images that show fast weight loss.

  - Lyrebird is a tool that can clone human voices based on a few minutes of recording samples. Such a tool could be exploited for malicious purposes.

  - Room pictures on rental or hotel booking platforms could be fake and generated by a GAN.

Ethical Concerns of AI

- Discrimination and stigmatization: AI can be used to impact on social justice and freedom.

- The autonomous decision-making mechanism of AI: This mechanism endangers human autonomy and the results cannot be traced or reproduced to provide effective remedies for incorrect decisions.

- Defects of AI: The objectives, methods, and decisions of AI systems cannot be interpreted.

- Damage to human dignity, minds, and bodies: Robots are vulnerable to malicious use and can be altered to make environments unsafe, while AI can expose people to deception and manipulation.

Powerful AI	→	Amazing results
AI technologies involve personal data.	may lead to →	Privacy leakage
AI technologies cover all aspects of our lives.	may lead to →	People being monitored by AI
Uncontrollability of AI	may lead to →	......
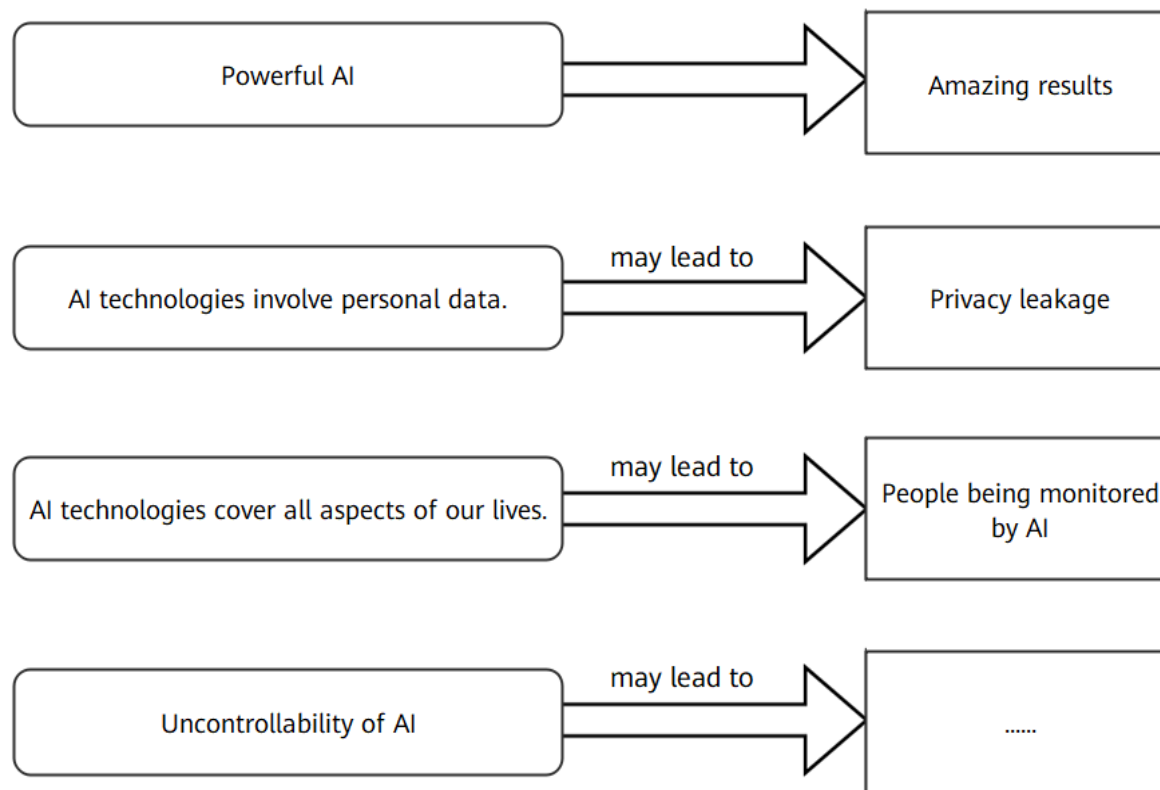
Will AI take over our jobs?

- Throughout the course of history, humans have sought ways to improve efficiency, that is, to obtain more from fewer resources. Just as sharp stones improve hunting, and steam engines reduce the demand for horses, every step towards automation has changed our society. In the AI era, what tasks will be taken over by AI?

- AI may take over:

  □ Repeatable tasks

  □ Non-creative tasks

  □ Tasks that require weak social skills

  □ Dangerous tasks

  □ ......

Privacy and Data Security

- In the era of big data and AI, we can obtain information with convenience and efficiency. However, while we are obtaining convenience, our behavior is recorded, learned, and used for different purposes. How can we protect private data?

  - 1. End users need to read privacy terms before giving consent to a mobile app to collect user information, and limit the information available to the app.

  - 2. Privacy protection laws and regulations should be developed, to implement industry code of conduct and strengthen supervision.

  - 3. Confidential computing, model privacy protection, federated learning, or adversarial learning, in addition to protection frameworks, such as MindArmour, can prevent reverse attacks and protect user privacy.
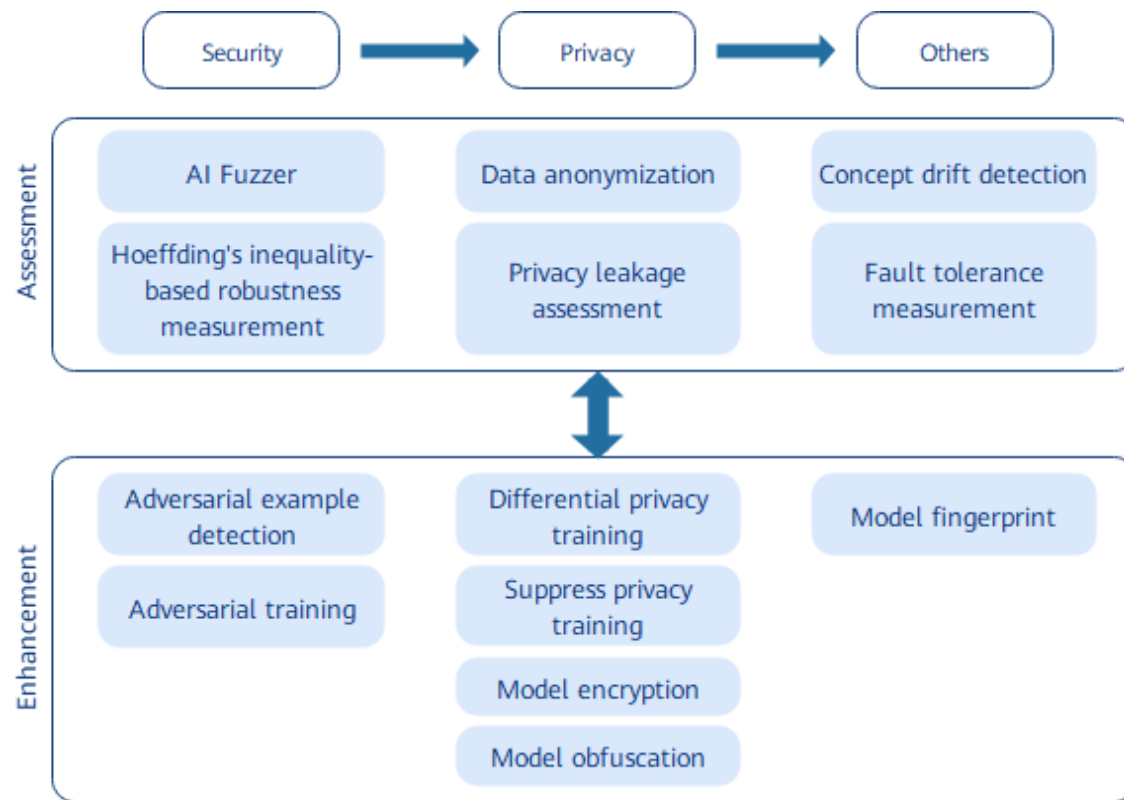
Typical application scenarios of MindArmour

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Issues to Be Resolved

- Are AI-generated content protected by copyright laws?

- Who will grant rights to robots?

- What rights can be granted to robots?

- ......

Contents

Policy Trends - United States (1)

- Executive Order - American Artificial Intelligence Initiative

  - In February 2019, the US released the *American Artificial Intelligence Initiative*, which states that the US will take various ways to improve American leadership in AI. It covers federal investment, access to federal data and computing resources, development of AI-related regulations, employment crisis response, and participation in formulation of international standards. It specifies the AI development direction of the US in the future, proposes key propositions in fields such as smart healthcare and smart city, and clearly expresses the exclusion of cross-border acquisitions of key AI technologies from competitive countries.

Federal investment

Access to federal data and computing resources

Development of AI-related regulations

Employment crisis response

Participation in international standard formulation
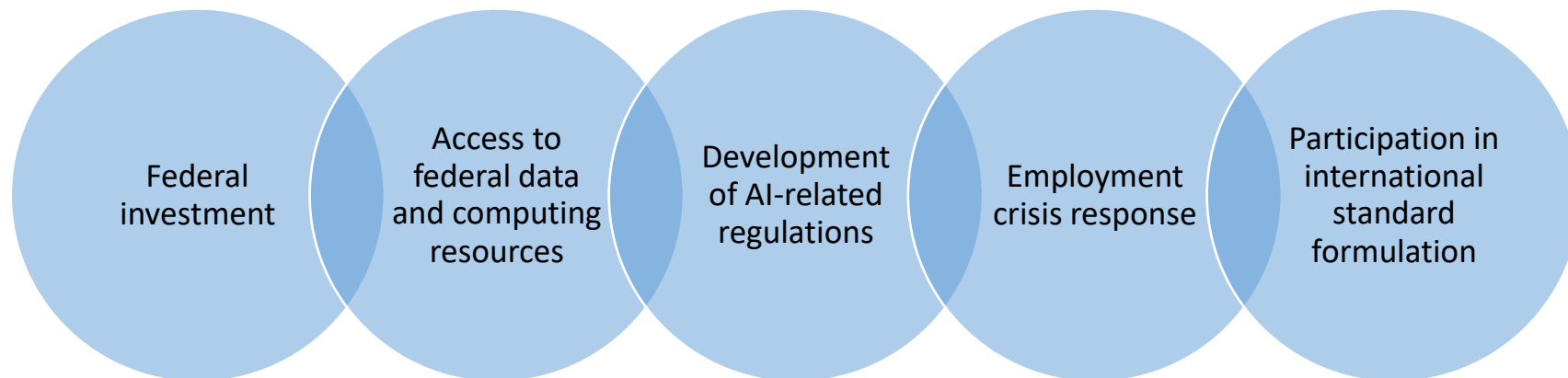
Policy Trends - United States (2)

- Main Content of *American Artificial Intelligence Initiative: Year One Annual Report*:

  1. Invest in AI Research and Development

  2. Unleash AI Resources

  3. Remove Barriers to AI Innovation

  4. Train an AI-ready Workforce

  5. Promote an International Environment Supportive of American AI Innovation

  6. Embrace Trustworthy AI for Government Services and Missions

AMERICAN ARTIFICIAL INTELLIGENCE INITIATIVE: YEAR ONE ANNUAL REPORT

Prepared by

THE WHITE HOUSE

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

FEBRUARY 2020

Policy Trends - United States (3)

- To promote technological innovation and scientific research development in the US, the US government passed the *United States Innovation and Competition Act of 2021* in June 2021. The act covers multiple topics including chips, 5G, aerospace, cyber security and AI, medical research, and American manufacturing. The act proposes to reform the National Science Foundation (NSF) and authorizes $81 billion for it to conduct research in 10 key fields including AI and computer technology. In addition, $10 billion is authorized for technology centers and innovation research institutes of universities for research in related fields.

Policy Trends - China (1)

- In July 2017, AI was first written into the government's work report. The New Generation of Artificial Intelligence Development Plan issued by the State Council proposed a three-step strategic goal:

- Step 1: By 2020, the overall technology and application of AI will be in step with globally advanced levels.

- Step 2: By 2025, achieve major breakthroughs in basic theories for AI, and be a world-leading player for technologies and applications.

- Step 3: By 2030, realize world-leading status of nationally-developed AI, technologies, and applications, ensure China is the world's primary AI innovation center, achieve tangible results in intelligent economy and intelligent society, and lay an core to become a leading innovation-style nation and an economic power.

Policy Trends - China (2)

- The Outline of the 14th Five-Year Plan for Economic and Social Development and Long-Range Objectives Through the Year 2035 of the People's Republic of China was released in March 2021, which emphasized that China "will explore the establishment of regulatory frameworks for autonomous driving, online medical care, financial technology, and intelligent delivery, and improve the relevant laws, regulations, and rules for ethical reviews". The statements reflect China's priority for and determination to overhaul AI ethics and its governance.

- The infringement on personal information is becoming more rampant, and there is an urgent need to protect personal information. To protect the rights and interests on personal information, regulate its processing, and guide its reasonable use, Personal Information Projection Low of People's Republic of China was passed on August 20th, 2021 and came into force on November 1st, 2021.

AI in More Industry Practices

- With further breakthroughs in AI in various vertical industries, AI technologies will be used in an increasing number of scenarios.

  - Smart transportation - highways, airports, railways, logistics, ports...

  - Energy - electric power, oil and gas...

  - Finance - bank, insurance, securities...

  - ......

Quiz

- 1. What are the AI application scenarios in these vertical fields? What technologies (not limited to AI) are used in these scenarios?

- 2. Based on the policy trends,summarize the core concerns for future AI development of each country.

Summary

- This course introduces the definition and development history of AI, describes the popular fields and application scenarios of AI, briefly introduces Huawei's AI development strategy, and discusses its most pressing topics and trends.

Quiz

1. (Multiple-answer question) Which of the following are Huawei's full-stack all-scenario AI solutions?

   A. ModelArts

   B. MindSpore

   C. Atlas 800 Servers

   D. ModelZoo

Recommendations

- Huawei Talent

  - https://e.huawei.com/en/talent/#/home

- Ascend official website

  - https://www.hiascend.com/

- MindSpore

  - https://mindspore.cn/

- Huawei Cloud

  - https://www.huaweicloud.com/

Thank you.

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