Cutting-edge AI applications

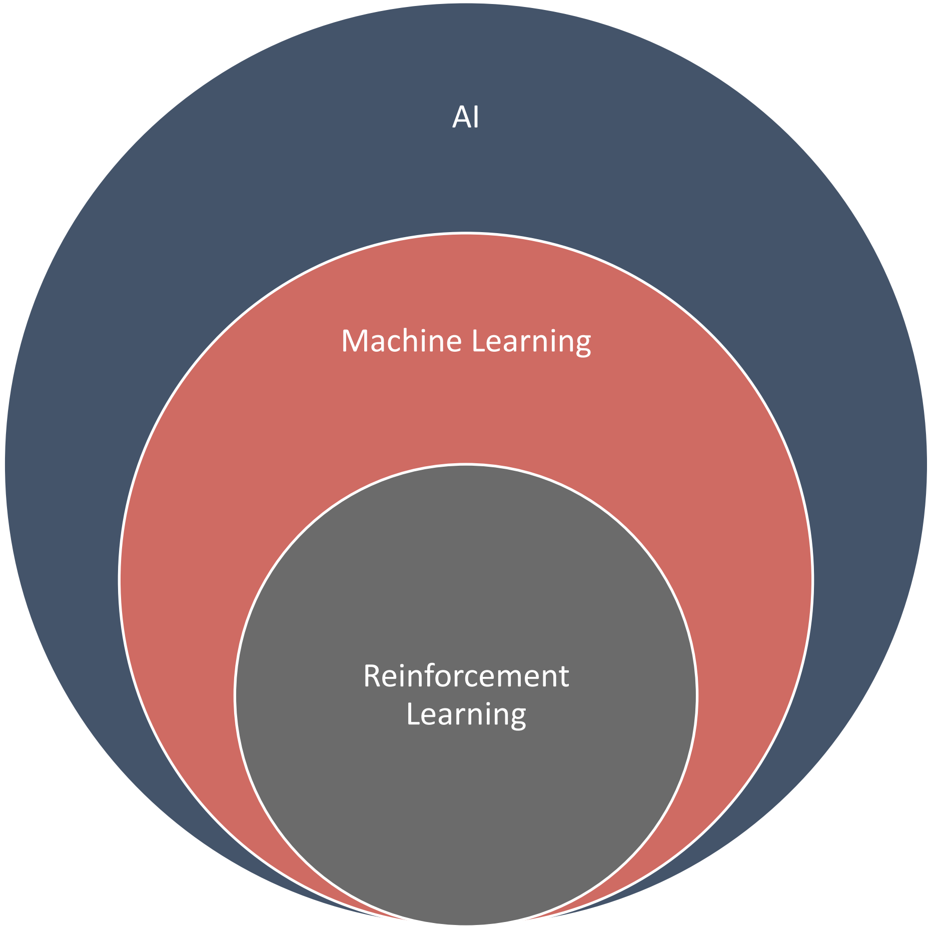
Objectives

- Upon completion of this course, you will be able to:
  - Understand the concepts and applications of reinforcement learning;
  - Understand the concepts and applications related to the GAN;
  - Understand the concepts and applications related to knowledge graph;
  - Understand the concepts and applications of intelligent driving.

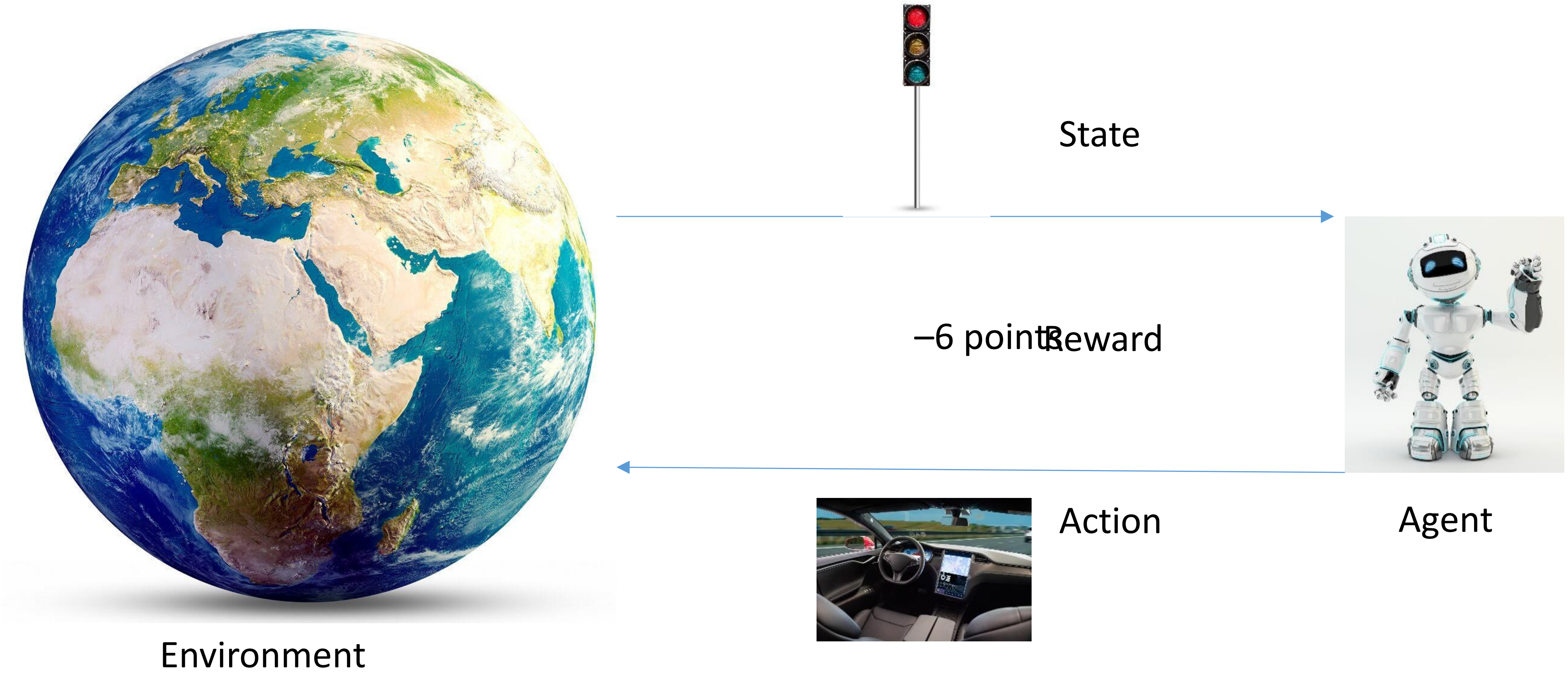
Contents

Reinforcement Learning

- Reinforcement learning (RL) is a branch of machine learning that emphasizes how to act based on the environment in order to maximize the expected benefits.



Environment Sensing

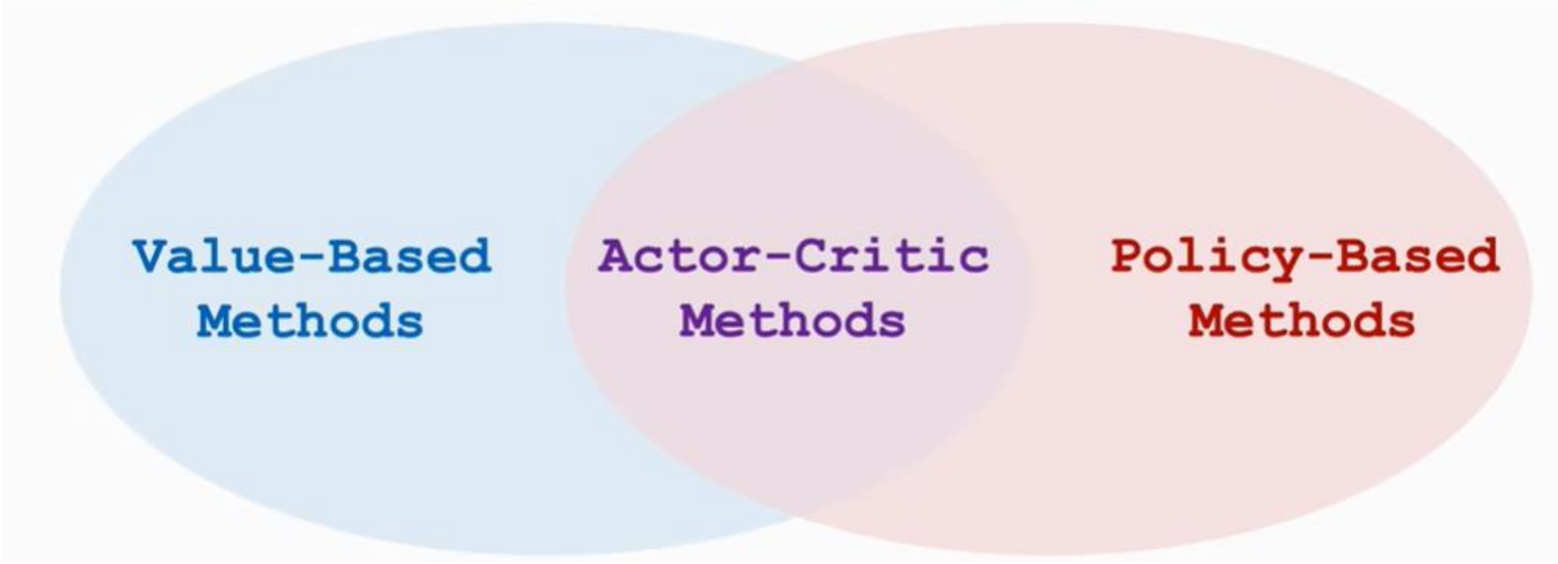


Basic Concepts in Reinforcement Learning

- Two objects:
  - Agent
  - Environment
- Main elements:
  - Action: performed at the current moment based on the status.
  - Policy: makes decisions based on the status and controls the agent to perform actions.
  - Reward: provided by the environment based on the current action.
  - Return: sum of rewards at all moments.

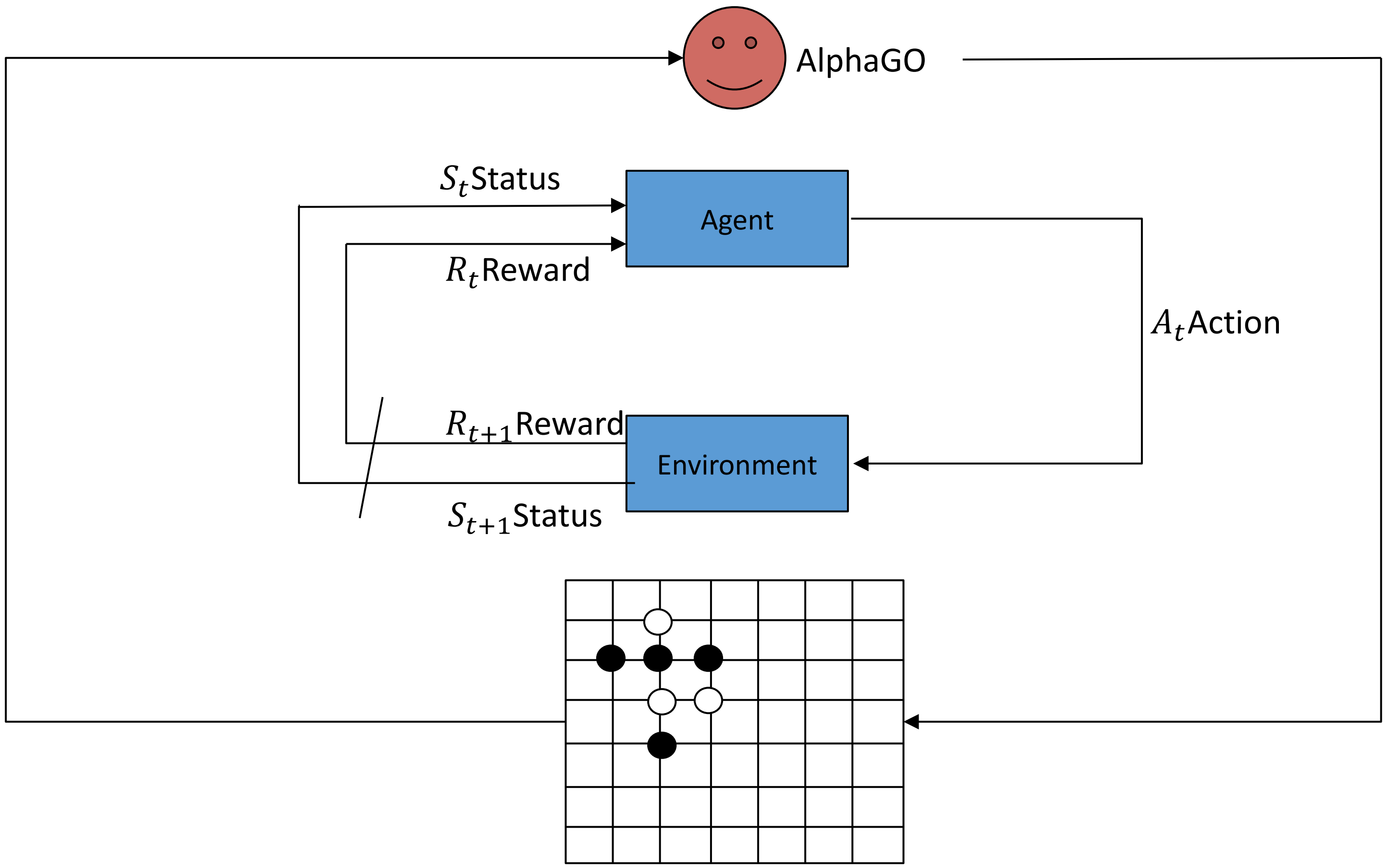
Classification of Reinforcement Learning Algorithms

- The reinforcement learning algorithms can be divided into two directions based on the process of finding the optimal policy:
  - Direct solution: The optimal policy function is optimized during the interaction with the environment.
  - Indirect solution: This type of algorithms are the most common algorithms. They indirectly calculate other indicators and deduce the optimal policy based on the results of these indicators.



Reinforcement Learning Model - Go

What is the situation?
Who is winning?



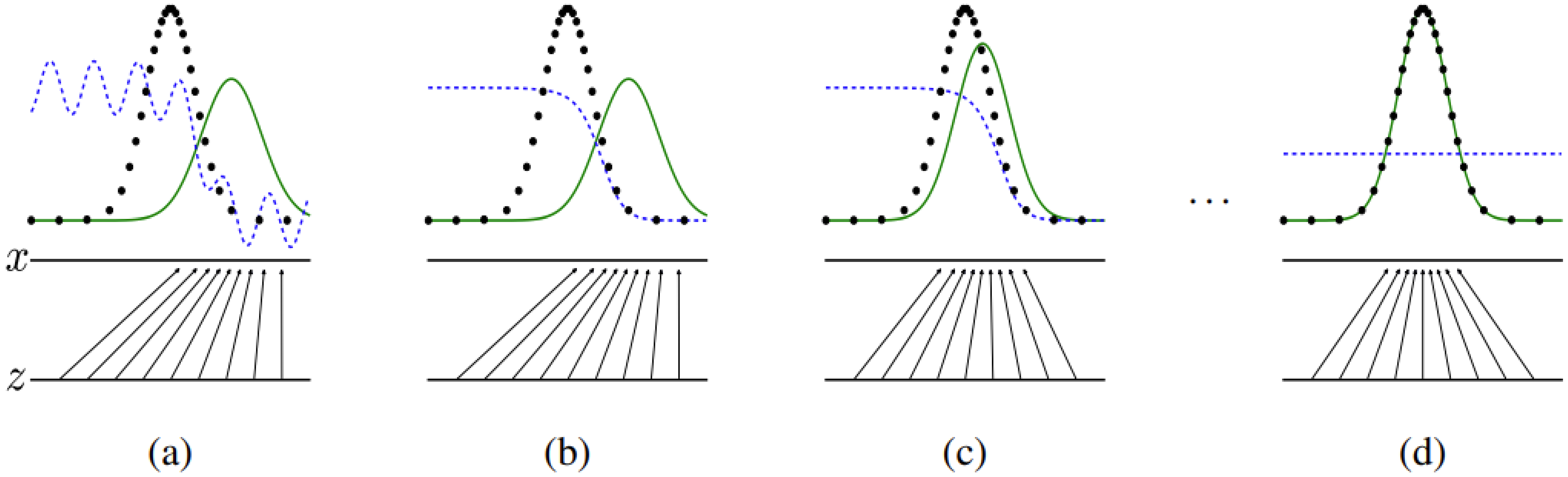
Where to place the go?

Contents

Generative Adversarial Network (GAN)

- A GAN is a class of frameworks that trains generator G and discriminator D to compete in a game. The game between the two makes the discriminator D unable to distinguish whether the sample is a fake sample or a real sample.
  - The generator G generates "fake" images that look like the images for training.
  - The discriminator D determines whether the images output by the generator are real images or fake images.
- GANs are used in scenarios such as image generation, text generation, speech enhancement, and image super-resolution.

GAN Training Process

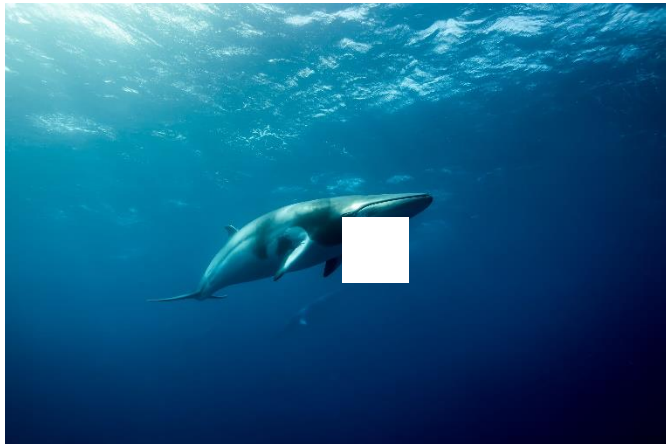


GAN Application

- Image dataset generation
- Image-to-image conversion
- Resolution enhancement, making photos clearer
- Text-to-image conversion

GAN - Photo Repair

- If an area in a photo is faulty (for example, colored or erased), GAN can repair the area and restore it to its original state.



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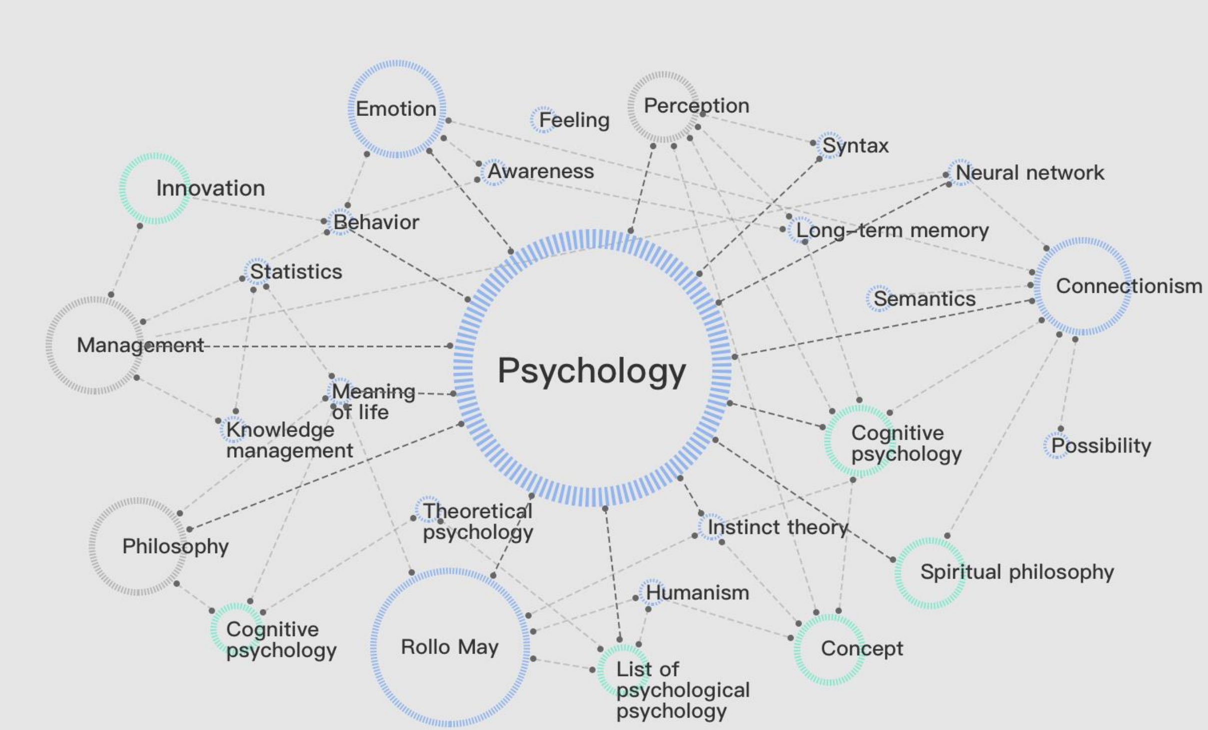
Basic Concepts

- Knowledge graph is essentially a knowledge base of the semantic network. It describes various concepts, entities, and relationships in the real world in a structured manner to form a huge semantic network. Nodes in the network are entities, and each edge represents a property of entities or the relationship between entities.

- Entity: an object that exists in the real world and can be distinguished from other objects.
- Property: The nature and relationship of a specific object are called the properties of the object.
- Concept: a set of entities with the same features.
- Ontology: a set of abstract concepts used to describe the common features of all the things in a domain and the relationships between them.



History of Knowledge Graph

- Knowledge graph is a relatively mature application "fruit" of knowledge engineering in the current stage of AI development.
- Five phases of knowledge engineering:
  - Pre-knowledge engineering period (1950s–1970s)
  - Expert system period (1970s–1990s)
  - World Wide Web 1.0 period (1990s–early 21st century)
  - Swarm intelligence period (2000–2006)
  - Knowledge graph period (2006–present)
- In the knowledge graph period, the vigorous development of large-scale structured encyclopedia websites and the continuous progress of text information technology provide conditions for obtaining large-scale knowledge.
- Google took the lead in applying knowledge graphs to search engines in 2012, successfully improving users' search quality and experience.

Process for Constructing a Knowledge Graph

- The general knowledge graph construction process is as follows:

Determining the domain

- Determine the target domain of the knowledge graph.

Understanding the domain

- Fully understand the target domain of the knowledge graph.
- Knowledge system construction

Data acquisition

- Structured data
- Semi-structured data
- Unstructured data

Information extraction

- Property Extraction
- Relationship extraction
- Entity extraction

Knowledge mapping and fusion

- Knowledge mapping
- Knowledge fusion

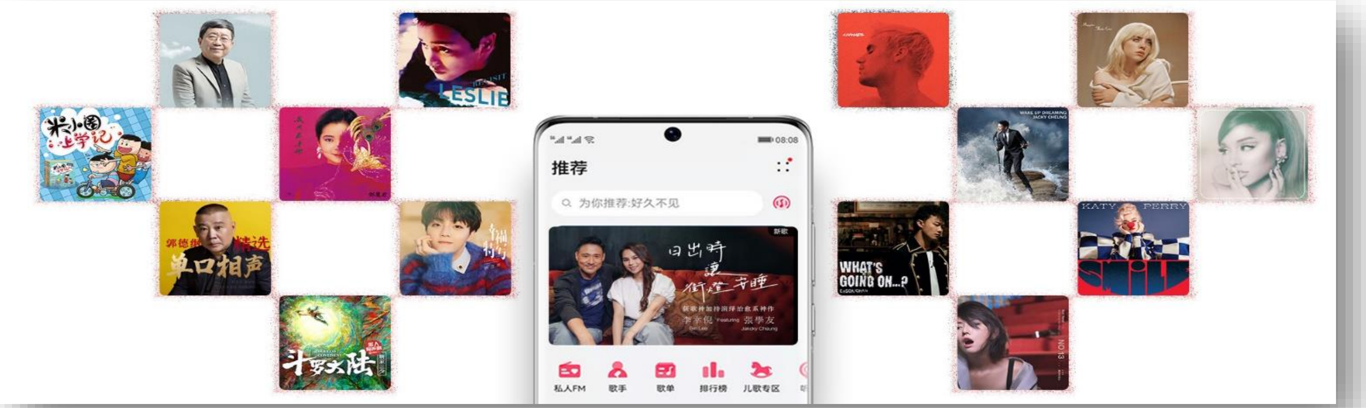
Knowledge processing and reasoning

Knowledge graph application

Knowledge Graph Application Scenario (1)

The common application scenarios are as follows:

Precise recommendation



Music apps accurately recommend songs that you like to listen to.

Semantic search

Exact keyword matching by the Petal search engine

Intelligent Q&A

Huawei Xiaoyi
Apple Siri
Microsoft Cortana
Baidu Xiaodu

Retrieval technology
Knowledge graph
Deep learning

The graph technology applies to the intelligent Q&A robots of major vendors.

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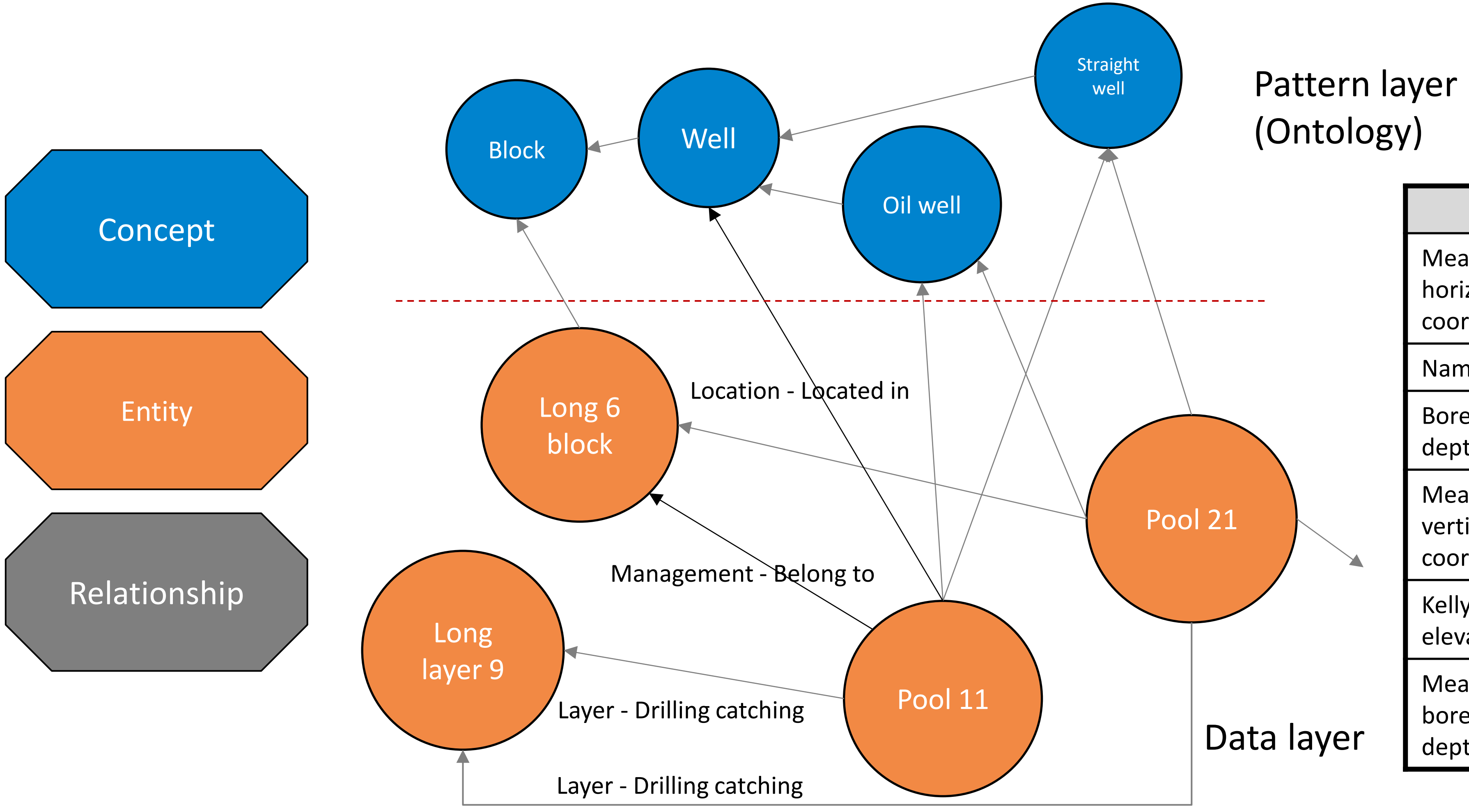
Knowledge Graph Application Scenario (2)

Oil and Gas Knowledge Computing



Item	Value
Measured horizontal coordinate	3.81980698645996E7
Name	Pool 155
Borehole depth	2710.0
Measured vertical coordinate	5883120.49477415
Kelly bushing elevation	1571.779
Measured borehole depth	2710.0

Contents

History of Intelligent Driving

- 1995 – Navlab, Carnegie Mellon University
  - The Rapidly Adapting Lateral Position Handler (RALPH) vision system
  - Autonomous driving of 4,496 km (98.1% of the whole trip) during the long-distance driving experiment
  - Test environments included morning, night, and extreme weather conditions such as rainstorm.
- 1995 - Mercedes-Benz VITA developed by Ernst Dickmanns
  - Pioneered the 4D spatiotemporal dynamic vision model
  - Could drive at 130 km/h on highways
- 1996- ARGO autonomous, University of Parma
  - Built on a general-purpose chip and low-cost cameras
  - Autonomous driving for 94% of the 2,000 km trip, at speeds up to 112 km/h
- 1996-2000 - ATB-2 co-developed by NJUST, BIT, THU, ZJU, and NUDT
  - Developed on Mercedes-Benz Sprinter 414
  - Oriented to structured roads and off-road environments
  - Maximum speed of 74 km/h on structured roads
- 2004 - The first DARPA Grand Challenge
  - Autonomous driving of 240 km route across the Mojave Desert, USA.
  - Carnegie Mellon University's Sandstorm traveled the farthest distance, completing 11.78 km of the course.
  - Some vehicles were able to avoid obstacles but required large, expensive sensing systems.
- 2005 - The second DARPA Grand Challenge
  - The Mojave Desert 212 km off-road route was used again, but had rougher conditions.
  - Competitors were much more successful than 2004, with Stanford University's Stanley traveling the farthest in the shortest time. This challenge observed the first prototypes of intelligent driving vehicles.
- 2007 - The third DARPA Grand Challenge
  - The urban challenge of 96 km, with vehicles ranked on obeying all traffic regulations and avoiding collisions.
  - Carnegie Mellon University's car Ross ranked first.
- DARPA races foster the development of intelligent vehicles.
- 2009 - The first Intelligent Vehicle Future Challenge of China
  - The race involved obstacles, traffic lights, and hairpin turns.
  - Teams from HNU, BIT, SJTU, XJTU, and University of Parma competed in the challenge.

Intelligent Driving Will Lift Society to New Heights

Huge reductions in road accidents

- About 1.2 million people die from traffic accidents every year.
- In 2019, more than 60,000 people died from traffic accidents in China.
- 90% of traffic accidents are caused by human error.

Third living space

- "Mobile third space": Intelligent vehicles automate driving, to give drivers and passengers a multi-functional space for new entertainment, social networking, and retail scenarios.
- With an emphasis on passenger experience, consumer demand will concern industries such as media, entertainment, retail, and health. Its reported 63% of people use the time traveling to socialize, and nearly 25% want to spend the time on fitness.

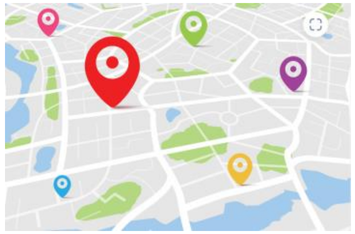
Intelligent driving

Convenient and efficient travel

- Intelligent driving enables special groups to drive on roads.
- China - 75% of roads in major cities suffer from traffic jams during peak hours, with an average traffic delay of one hour.
- Vehicle-road collaboration using an intelligent transportation system (ITS) can greatly improve traffic efficiency.
- University of Michigan estimates one shared autonomous vehicle can replace 9.34 conventional vehicles.

Manual Driving vs. Intelligent Driving

Where am I?	Where am I going?	How do I get there?
Sensing, positioning, and mapping	Navigation and map	Sensing, positioning, map, and planning and control (PnC)



Sensing & positioning	Eyes & ears	Cameras & radars
↓	↓	↓
Decision-making & planning	Brain	Central control unit
↓	↓	↓
Control	Hands & feet	Steering wheel & pedals

Three Subsystems of Intelligent Driving

Sensing → Thinking → Acting

Sensing

- Ultrasonic radar
- Millimeter-wave radar
- Camera
- Lidar
- 5G/Vehicle-to-everything (V2X)
- ......

Thinking

- Sensing
- Convergence
- Positioning
- Planning
- Prediction
- Decision-making
- Control
- ......

Acting

- Drive system
- Braking system
- Steering system
- Drive train
- Security system
- Comfort system
- ....

Huawei MDC: Leading Intelligent Driving Computing Platform

Personal travel | Long-distance transportation | RoboTaxi | Campus commute | Street cleaning | Logistics | Freight transportation

Third-party scenario-specific algorithms
(from partners)

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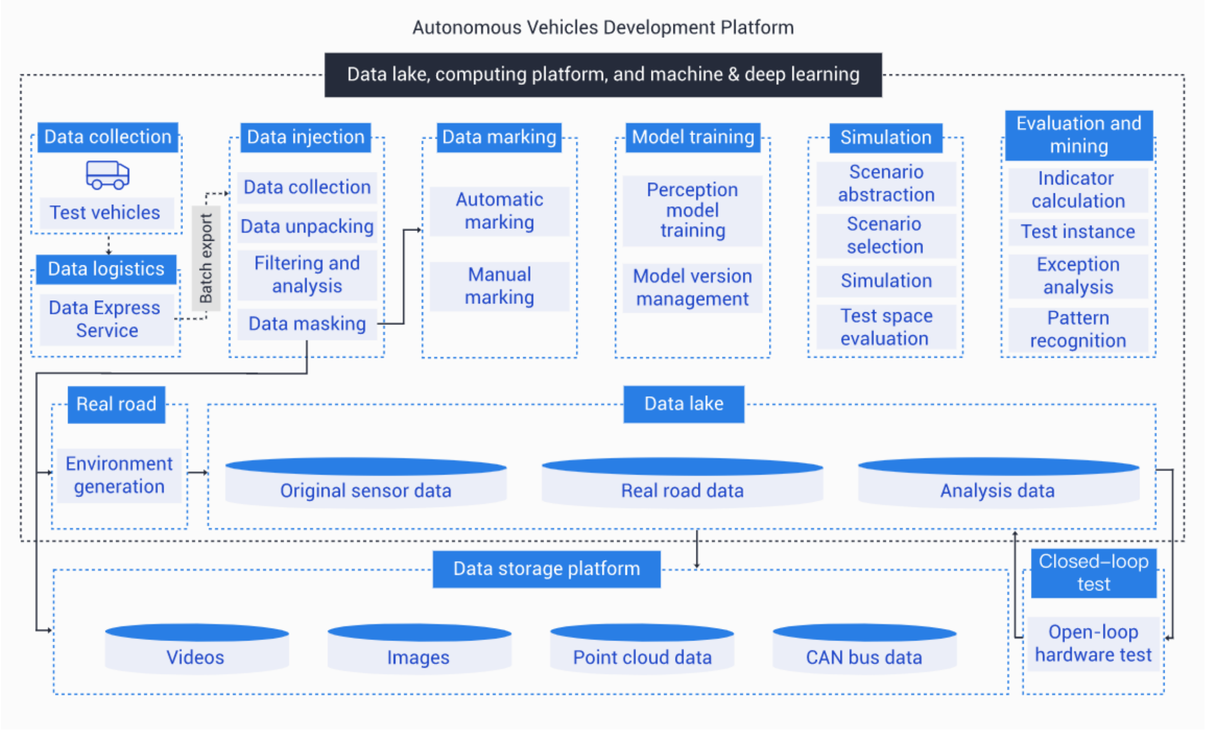
MDC Intelligent driving computing platform

Huawei hardware (CPU/AI processor) + Software (vehicle control OS platform) + Tool chain

Camera | Millimeter-wave/ ultrasonic radar | Lidar | T-BOX | GPS | Chassis-by-wire

Sensors/X-by-wire
(from partners)

Autonomous Driving Cloud Service: One-Stop Development Platform for Autonomous Vehicles



- **Data services:**
  - Data storage management, processing pipeline, overview, and playback, as well as an annotation platform
- **Training services:**
  - Training tasks, algorithm and model management, algorithm iteration, and model evaluation
- **Simulation services:**
  - Simulated scenarios, online simulations, task management, and simulation algorithms
- **Competitive advantages:**
  - **Annotation platform**
  - **Model training**
  - **Parallel simulation**

Summary

- This chapter briefly introduces concepts of several cutting-edge AI technologies: obtaining the optimal policy through reinforcement learning, the game between the generator and discriminator (GAN), the construction process and applications of knowledge graphs, and brief introduction to intelligent driving.

Quiz

1. (Multiple-answer) Which of the following scenarios can Knowledge Graph be used? (   )

   A. Search engine

   B. Product keyword search

   C. Q&A bot

2. (True or false) In intelligent driving, lidar is the only sensing device. (   )

   A. True

   B. False

Thank you.

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每个组织，构建万物互联的智能世界。

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