

## COS30018 - Intelligent Systems: Week 1

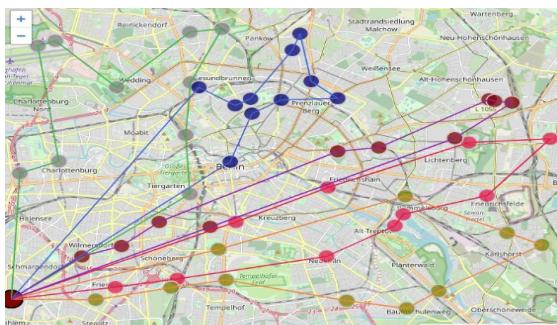
### Introduction to Intelligent Systems

## What is an intelligent system - Examples



aka. **AI systems**

# What is an intelligent system - Examples



## What is an intelligent system?

### • What is intelligence?

- Intelligence can be characterized by the capability of
  - Reasoning
  - Problem solving



- **What is intelligence?**

- Intelligence can be characterized by the capability of
  - Reasoning & Problem solving
  - Learning & adapting



- **What is intelligence?**

- Intelligence can be characterized by the capability of
  - Reasoning & Problem solving
  - Learning & adapting
  - Performing **complex tasks**



## What is an intelligent system?

- Programming computers to **solve tasks that would require intelligence for people to solve** (Minsky's definition of AI)

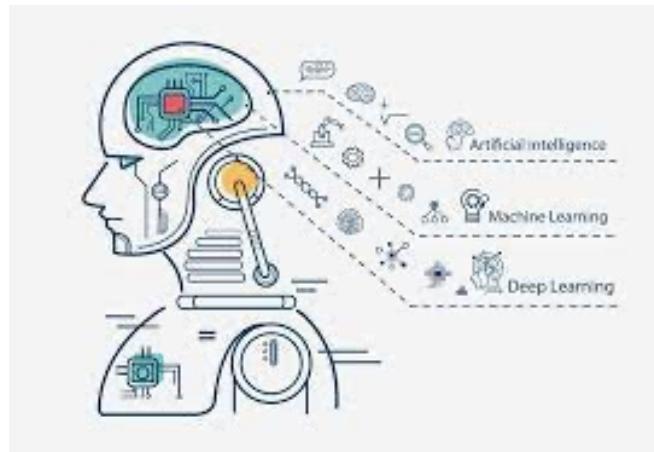


## What is an intelligent system?

- Programming computers to **solve tasks that would require intelligence for people to solve** (Minsky's definition of AI)
- A truly intelligent system **adapts itself to deal with changes in problems** (automatic learning)
  - Few machines can do that at present



# What is an intelligent system?

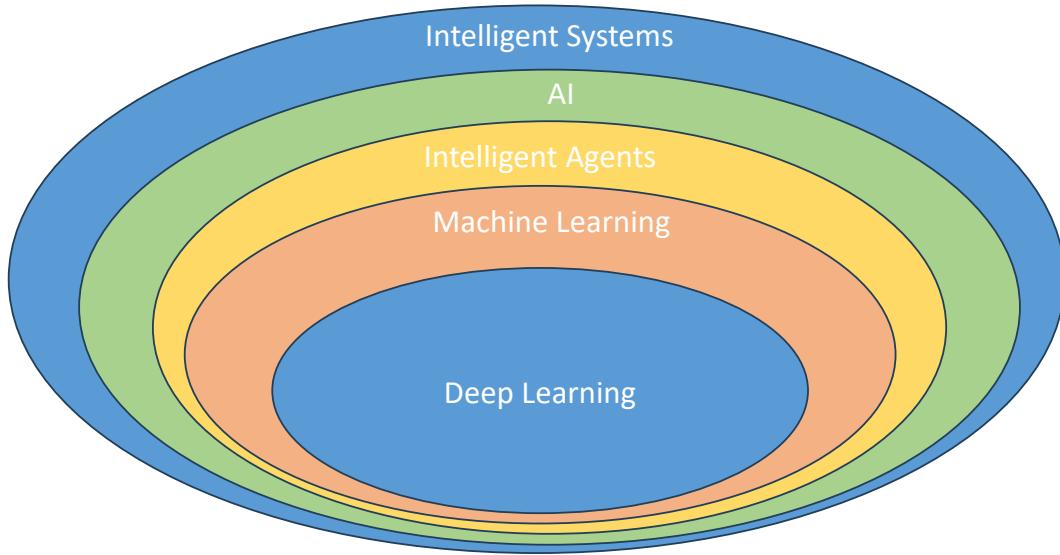


- Intelligent systems display **machine-level intelligence, reasoning, often learning**, not necessarily self-adapting

Intelligent  
systems vs AI  
vs Machine  
Learning vs ...

- A plethora of terminologies:
  - Intelligent systems (**IS**)
  - Artificial Intelligence (**AI**)
  - Intelligent agents (**IA**)
  - Machine learning (**ML**)
  - Cognitive computing
  - Computational intelligence,  
machine intelligence,  
soft computing, etc.

# IS vs AI vs IA vs ML vs DL vs ...



## Artificial Intelligence (AI)

Philosophically, scientists consider four main paradigms:

- AI as a system that **thinks like a human**
- AI as a system that **thinks rationally**
- AI as a system that **acts like a human**
- AI as a system that **acts rationally**

# Artificial Intelligence (AI)

Philosophically, scientists consider four main paradigms:

AI as a system that **acts rationally** =  
**Intelligent Agents (IA)**

- AI as a system that **acts rationally**

## Recent Achievements of Intelligent Systems

- Google DeepMind -  
<https://www.youtube.com/watch?v=TnUYcTuZJpM>



## Recent Achievements of Intelligent Systems

- Driverless Cars -  
<https://www.youtube.com/watch?v=TsaES--OTzM>



## Recent Achievements of Intelligent Systems

- IBM Watson -  
[https://www.youtube.com/watch?v=\\_Xcmh1LQB9I](https://www.youtube.com/watch?v=_Xcmh1LQB9I)  
<http://www.youtube.com/watch?v=Dyw04zksfXw>



## Recent Achievements of Intelligent Systems

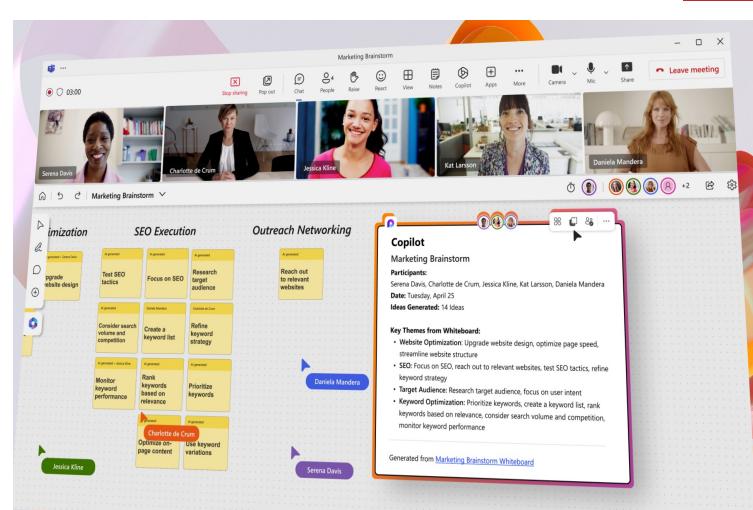
- OpenAI's ChatGPT/ Google's Gemini/ Meta's Llama 3... -  
<https://research.aimultiple.com/chatgpt-use-cases/>  
<https://www.youtube.com/watch?v=3Ud-BMOClI>



## Intelligent systems in business

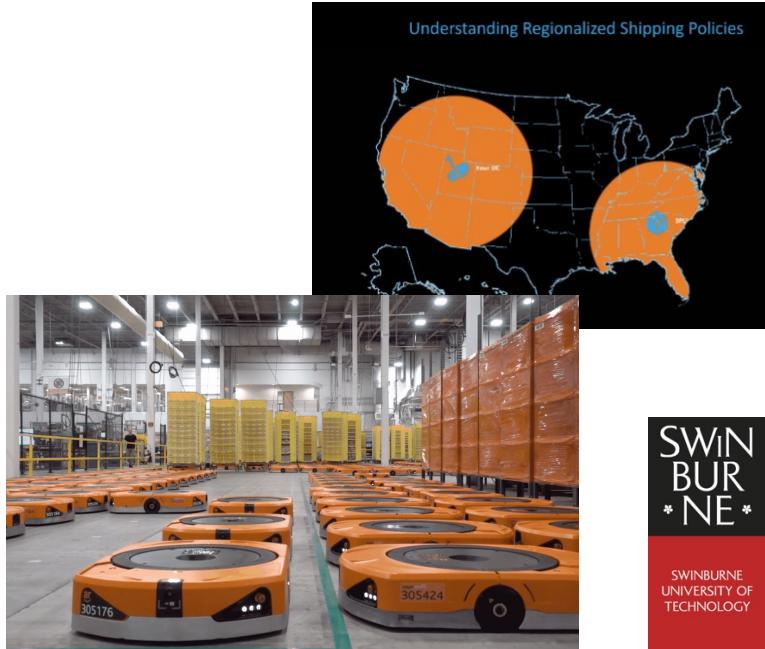
- **Microsoft 365 Copilot:**

- Combines the power of large language models (LLMs) with your data in the Microsoft Graph and the Microsoft 365 apps
- Turns your words into a powerful productivity tool



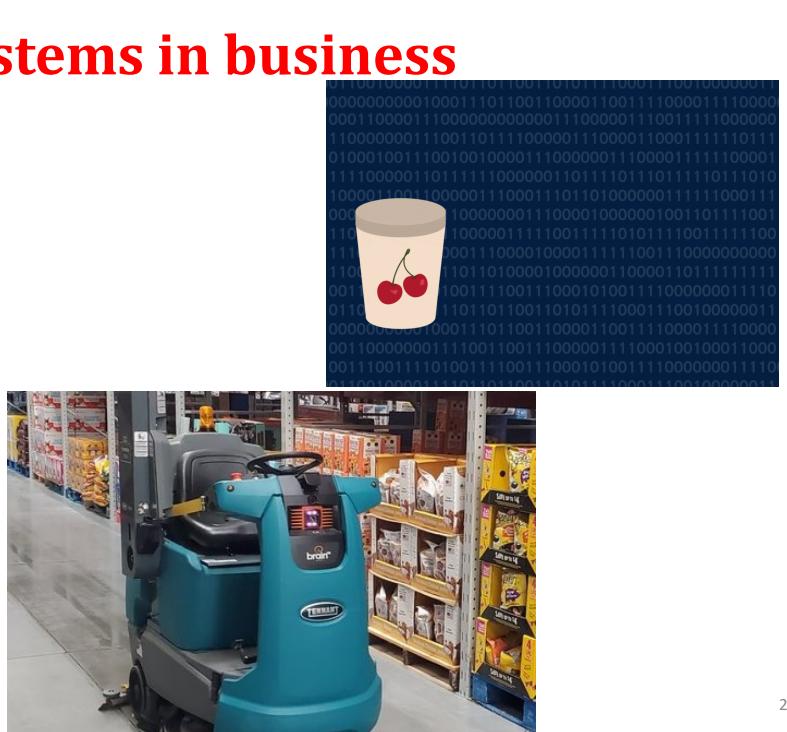
# Intelligent systems in business

- **Amazon** is using AI to speed up deliveries:
- Amazon's "regionalization": ship products to customers from warehouses closest to them
- AI-enabled technology to analyze data and patterns in order to predict what products will be in demand and where



# Intelligent systems in business

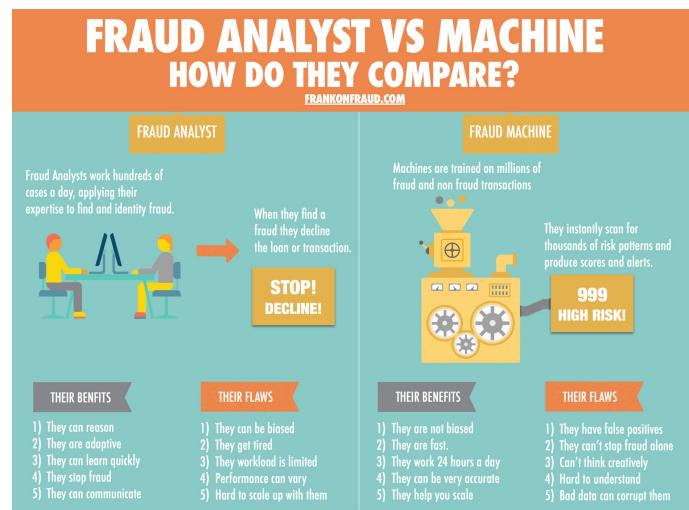
- **Walmart:**
  - Using A.I. To Make Smarter Substitutions in Online Grocery Orders
  - Using Brain Corp's Robotic Inventory Scanners



# Intelligent systems in business

- Visa, Mastercard and PayPal are using machine-learning algorithms to analyse data on customer behaviour:

- Fraud detection



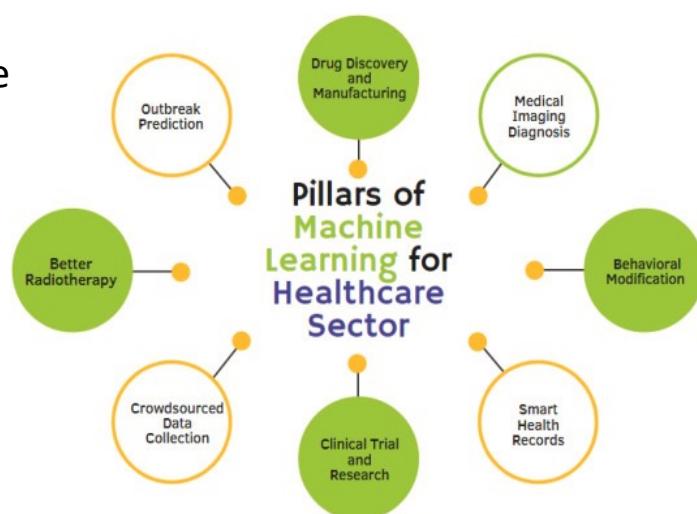
# Intelligent systems in business

- Pfizer, Genentech and Sanofi:

- using AI and machine learning to speed up their R&D efforts.
- drug discovery, diagnostics and allocation of resources

- GE HealthCare:

- digitalisation of health services



# Intelligent systems in business



THE CHINA CONNECTION

## CNBC's The China Connection newsletter: Chinese AI companies are already making money

PUBLISHED WED, JUL 30 2025 12:55 AM EDT

### KEY POINTS

- Tencent Cloud Vice President Wu Yongjian said a drop in customer service requests for a human operator shows its AI service is working.
- Engineers for AI models are now also looking for jobs at AI application companies such as startup Black Lake Technologies, CEO Zhou Yuxiang said.
- Data labeling, or annotating bits of information for better AI use, is also seeing rising demand.



## Characteristics of intelligent systems

- Possess one or more of these:
  - Capability to extract and store knowledge
  - Human like reasoning process
  - Learning from experience (or training)
  - Dealing with imprecise expressions of facts
  - Finding solutions through processes similar to natural evolution
  - has the ability to interact and deal with other agents (including humans)
- Recent trend (**LLMs** & Multimodal Foundation Models - **MFMs**):
  - More sophisticated interaction with the user through:
    - natural language understanding
    - speech recognition and synthesis
    - image analysis & synthesis



# Characteristics of intelligent systems

- Possess one or more of these:
  - Capability to extract and store **knowledge**
  - Human like **reasoning** process

- Knowledge representation and reasoning:
  - Logic-based
  - Rule-based expert systems
  - Constraint Satisfaction and Optimisation Problems
- More sophisticated interaction with the user through:
  - natural language understanding
  - speech recognition and synthesis
  - image analysis & synthesis

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# Characteristics of intelligent systems

- Possess one or more of these:
  - Capability to extract and store knowledge
  - Human like reasoning process
  - **Learning from experience** (or training)

- Machine learning
  - Deep learning
  - Reinforcement learning
  - Deep reinforcement learning
- More sophisticated interaction with the user through:
  - natural language understanding
  - speech recognition and synthesis
  - image analysis & synthesis

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## Characteristics of intelligent systems

- Possess one or more of these:
  - Capability to extract and store knowledge
  - Human like reasoning process
  - Learning from experience (or training)
  - Dealing with **imprecise expressions of facts**
- **Fuzzy logic** (ns)
  - Fuzzy systems
  - Rough set theory
- More sophisticated interaction with the user through:
  - natural language understanding
  - speech recognition and synthesis
  - image analysis & synthesis

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## Characteristics of intelligent systems

- Possess one or more of these:
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  - Learning from experience (or training)
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  - Finding solutions through **processes similar to natural evolution**
- **Soft computing/computational intelligence** (ns)
  - Evolutionary computing (EC)
  - Genetic algorithm (GA)/Differential Evolution (DE)
  - Particle Swarm Optimization (PSO)/Ant Colony Optimization (ACO)
  - Artificial Neural Networks (ANN)
  - ...

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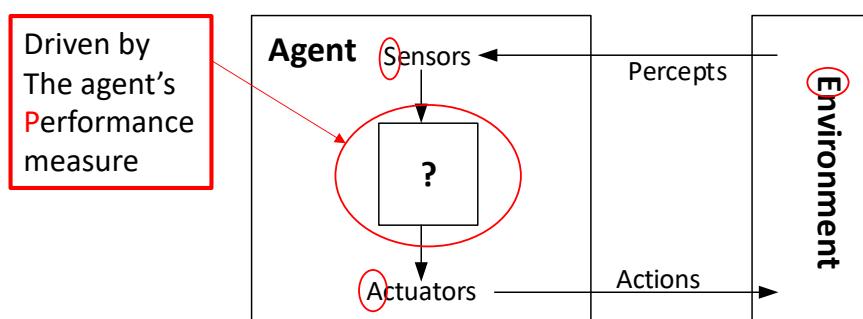
# Characteristics of intelligent systems

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  - Finding solutions through processes similar to natural evolution
  - has the ability to interact and deal with other agents (including humans)
- Recent trend - **Multi-agent systems (MAMs)**:  
  - Agent communication
  - Automated negotiation
  - More sophisticated models - through:  
    - natural language processing (NLP)
    - speed
    - image

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# Review of intelligent agent (IA) concept

- **What is an intelligent agent?**
- A computer system that is capable of *autonomous action* in some *environment* in order to meet its *design objectives*.
  - **Autonomy** – ability to act independently, exhibiting control over one's internal state



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## Example of Intelligent Agent - Self driving cars

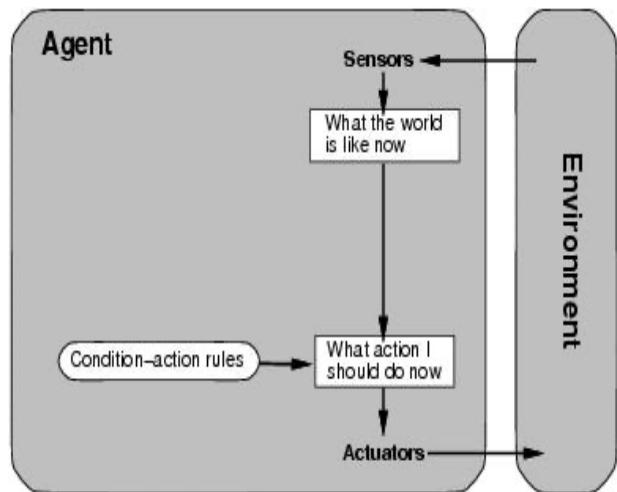
- **Sensing's Percept** – Video, sonar, speedometer, laser, odometer, engine sensors, microphone, GPS, ...
- **Actions** – steer, accelerate, brake, horn, indicator, ...
- **Performance measures** – Maintain safety, reach destination, obey laws, provide passenger comfort, ...
- **Environment** – urban streets, freeways, traffic, pedestrians, weather, customers, ...
- **PEAS**

## Agent Types

- Agent can be classified as follows based on their decision-making ability:
  - *Simple Reflex Agent*
  - *Model-based Reflex Agent*
  - *Goal-based Agent*
  - *Utility-based Agent*
  - *Learning Agent (by combining one of the above with the learning capability)*

## Agent types; simple reflex

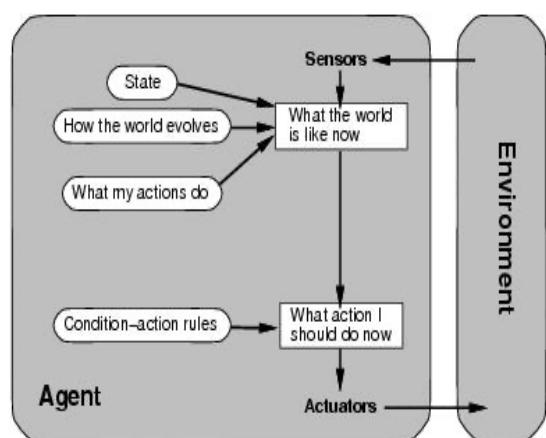
- Select action on the basis of *only the current percept*.
  - E.g. the vacuum-agent
- Large reduction in possible percept/action situations(next page).
- Implemented through *condition-action rules*
  - If dirty then suck



## Agent types; reflex and state

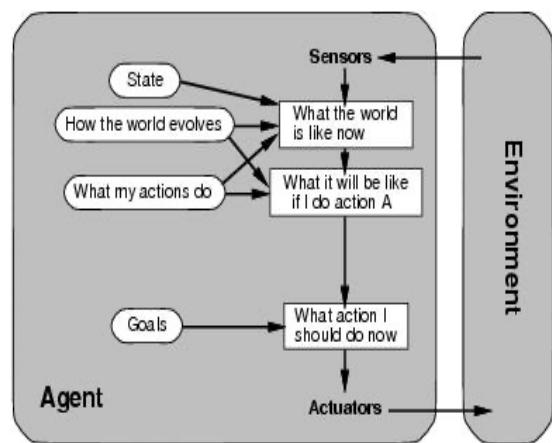
- To tackle *partially observable* environments.
  - Maintain internal state
- Over time update state using world knowledge
  - How does the world change.
  - How do actions affect world.

⇒ *Model of World*



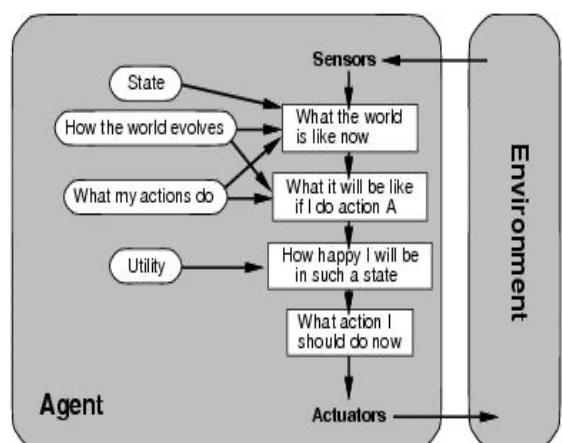
## Agent types; goal-based

- The agent needs a goal to know which situations are *desirable*.
  - Things become difficult when long sequences of actions are required to find the goal.
- Typically investigated in **search** and **planning** research.
- Major difference: future is taken into account
- Is more flexible since knowledge is represented explicitly and can be manipulated.



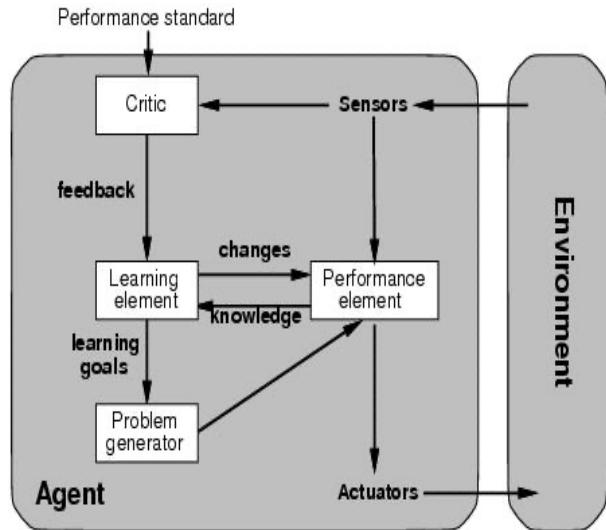
## Agent types; utility-based

- Certain goals can be reached in different ways.
  - Some are better, have a higher utility.
- Utility function maps a (sequence of) state(s) onto a real number.
- Improves on goals:
  - Selecting between conflicting goals
  - Select appropriately between several goals based on likelihood of success.



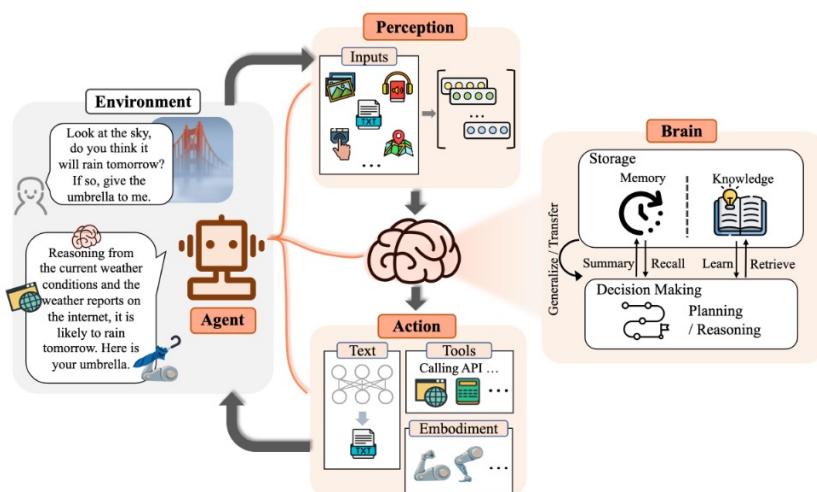
# Agent types; learning

- All previous agent-programs describe methods for selecting *actions*.
  - Yet it does not explain the origin of these programs.
  - Learning mechanisms can be used to perform this task.
  - Teach them instead of instructing them.
  - Advantage is the robustness of the program toward initially unknown environments.



# Agent types; LLM-based

## 1. The Birth of An Agent: Construction of LLM-based Agents



1.1 Brain: Primarily Composed of An LLM

Source:

<https://github.com/WooooDyy/LLM-Agent-Paper-List>

## Summary

- Four main paradigms of AI (think vs act, rational vs human-like)
  - *How you choose to view AI will define the appropriate techniques*
- Main characteristics of intelligent systems
  - *To develop a system with certain characteristics, some AI techniques will be introduced to you in this unit of study*
- Intelligent agents (IA):
  - *Four basic agent types + four advanced agent types (by combining each basic agent type with the learning capability)*
-