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Overview

- What is an intelligent system?
- Significance of intelligent systems in business
- Characteristics of intelligent systems
- Intelligent agents

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What is an intelligent system?

- **What is intelligence?**
  - Intelligence can be characterized by the ability to
    - Reason & Problem-solve

3

What is an intelligent system?

- What is intelligence?
  - Intelligence can be characterized by the ability to
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    - Learn & Adapt

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What is an intelligent system?

- What is intelligence?
  - Intelligence can be characterized by the ability to
    - Reason & Problem-solve
    - Learn & Adapt
    - Perform complex tasks

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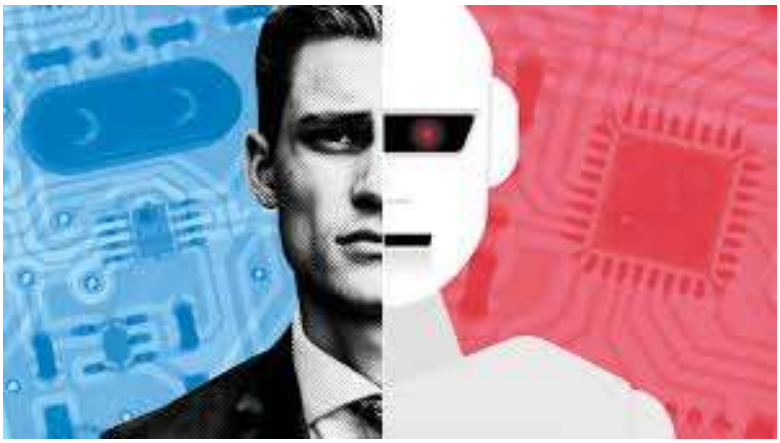
What is an intelligent system?

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



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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

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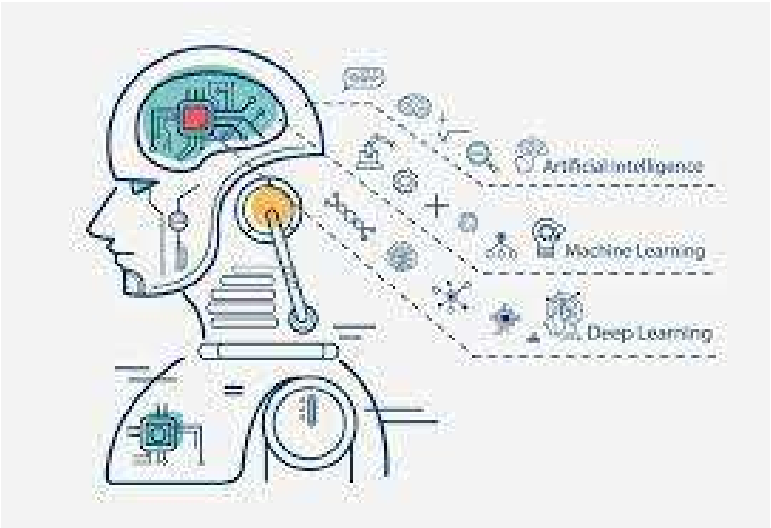
What is an intelligent system?



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

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Intelligent systems vs AI vs Machine Learning vs …

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

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- AI is an umbrella buzzword that covers almost every paradigms for building systems that are intelligent

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  - Compu
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- AI is an u
  paradigr

Philosophically, scientists considers 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**

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  - Computational intelligence, machine intelligence, soft computing, etc.
- IA is a popular paradigm of AI (systems that act rationally)

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- ML is a subfield of AI

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- Cognitive computing refers to technology platforms that enable computers to mimic the way human mind works

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  - Cognitive computing
  - Computational intelligence, machine intelligence, soft computing, etc.
- Computational intelligence and soft computing are a few other AI paradigms

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  - Machine learning (ML)
  - Cognitive computing
  - Computational intelligence, machine intelligence, soft computing, etc.
- Machine intelligence was sometimes used as a terminology in place of AI

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Recent Achievements of Intelligent Systems

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

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Recent Achievements of Intelligent Systems

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

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Recent Achievements of Intelligent Systems

- IBM Watson -
  https://www.youtube.com/watch?v=_Xcmh1LQB9I
  http://www.youtube.com/watch?v=Dyw04zksfXw

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Recent Achievements of Intelligent Systems

- OpenAI's ChatGPT/ Google's Bard AI/ … -
  https://research.aimultiple.com/chatgpt-use-cases/
  https://www.youtube.com/watch?v=3Ud-BMOCkDI

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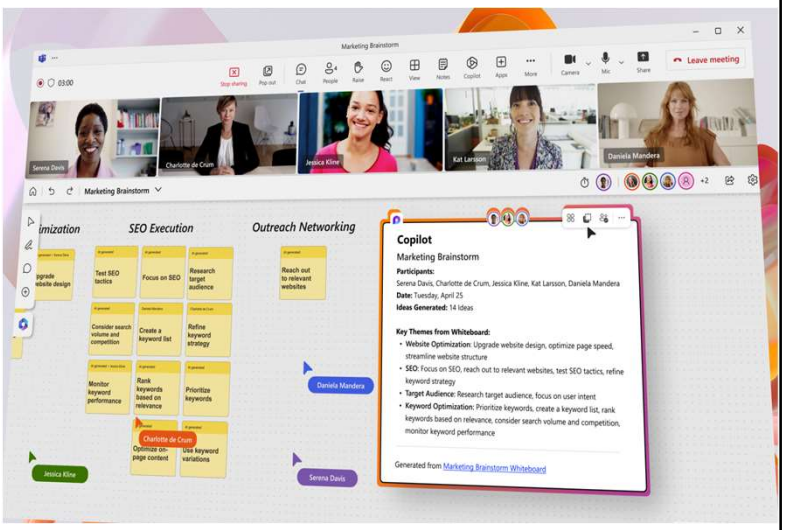
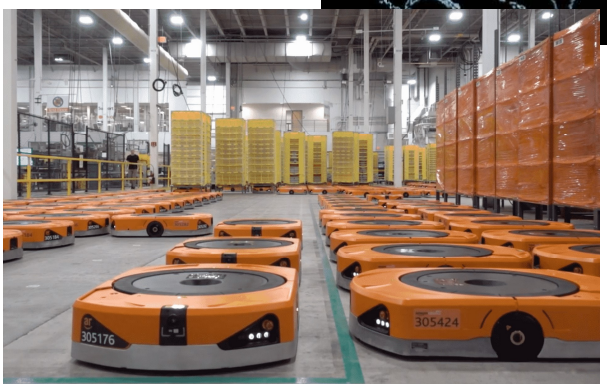
Intelligent systems in business

- **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

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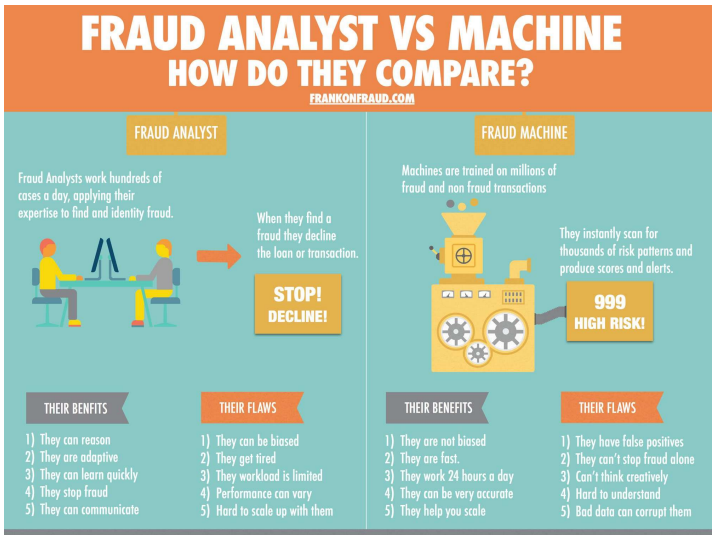
Intelligent systems in business

- 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

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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
  - Finding solutions through processes similar to natural evolution
  - has the ability to interact and deal with other agents (including humans)
- Recent trend:
  - More sophisticated Interaction with the user through:
    - natural language understanding
    - speech recognition and synthesis
    - image analysis

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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
- Recent trend:
  - More sophisticated Interaction with the user through:
    - natural language understanding
    - speech recognition and synthesis
    - image analysis

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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

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Characteristics of intelligent systems

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  - Learning from experience (or training)
  - Dealing with imprecise expressions of facts
  - Finding solutions through processes similar to natural evolution
- Fuzzy logic
  - Fuzzy systems
  - Rough set theory
- R
  - natural language understanding
  - speech recognition and synthesis
  - image analysis

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Characteristics of intelligent systems

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  - Finding solutions through processes similar to natural evolution
- Soft computing/computational intelligence
  - 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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- Multi-agent systems
  - Agent communication
  - Automated negotiation
  - Natural language processing (NLP)
  - NL-based conversational agents

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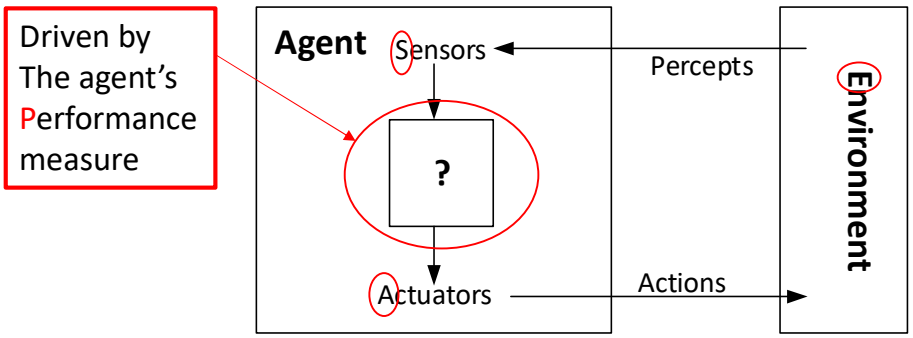
Review of intelligent agent (IA) concept

- **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

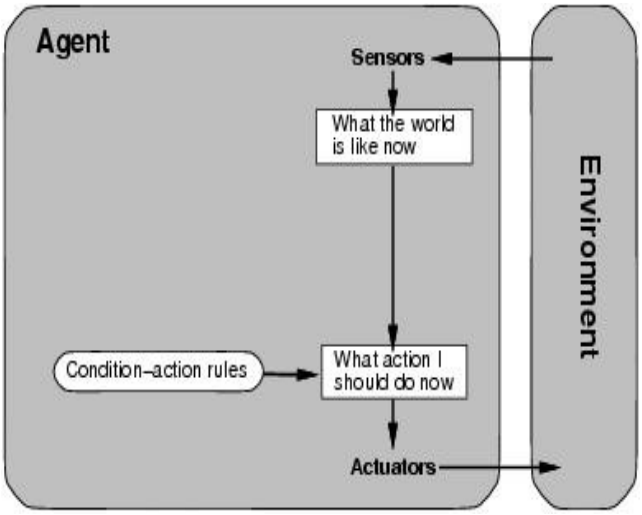
- **Sensing's Percept** – Video, sonar, speedometer, laser, odometer, engine sensors, microphone, GPS, …
- **Actions** – steer, accelerate, brake, horn, indicator, …
- **Performance measures** – Maintain safety, reach destination, obey laws, provide passenger comfort, …
- **Environment –** urban streets,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



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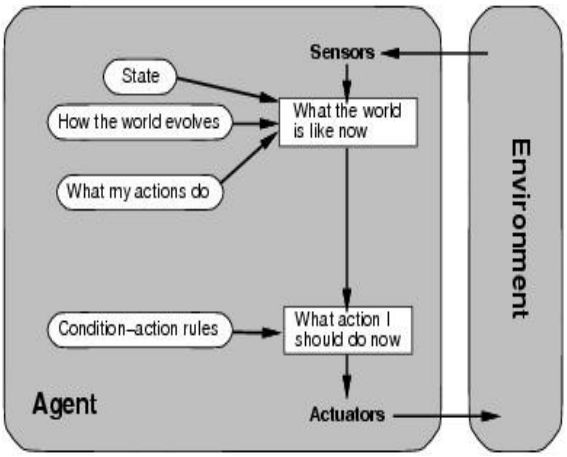
Agent types; reflex and state

- 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*



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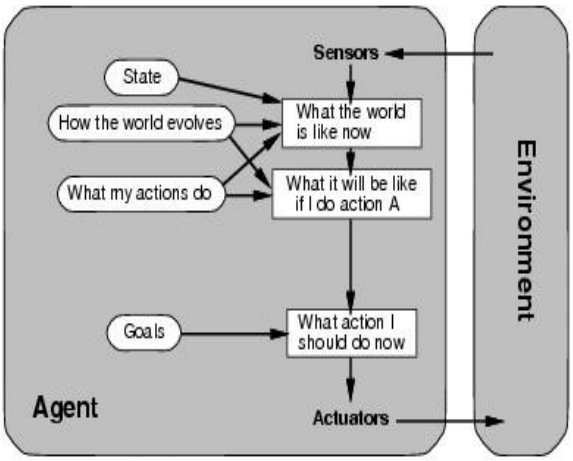
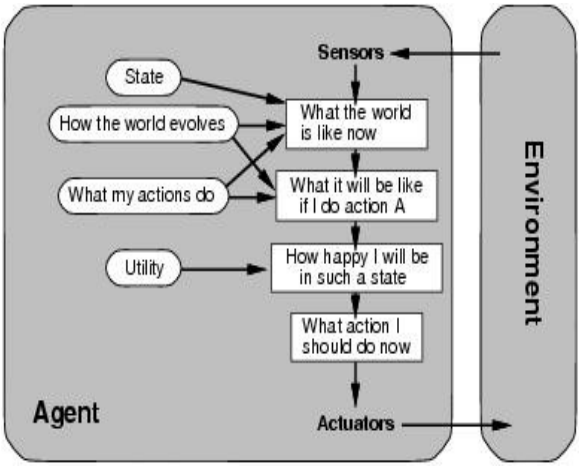
Agent types; goal-based

- 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.



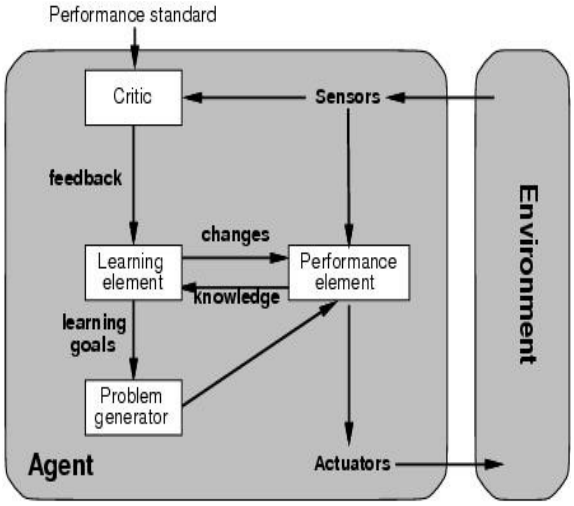
Agent types; utility-based

- 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.



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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 a basic agent type with the learning capability)*
-

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