

1

Overview

- Staff Information
- Lectures/Tutorials
- Unit Learning Outcomes
- Course Content
- Assessment
- Lecture Schedule
- Relevant Resources

The Swinburne University of Technology logo, consisting of a red rectangle with the text 'SWINBURNE' and 'UNIVERSITY OF TECHNOLOGY' separated by two small white stars.

2

Staff Information

- **A/Prof Bao Vo (Lecturer, Convenor)**
 - Email: bvo@swin.edu.au,
- **Tutors:**
 - **Hy Nguyen**
 - Email: hynguyen@swin.edu.au
 - **Dr Ru Jia**
 - Email: rjia@swin.edu.au
 - **TBA**



Lectures/Tutorials

- **Lectures**
 - **When:** Monday 18:30-20:30
 - **Where:**
 - On campus (BA302) in Weeks 1, 5, 6, and 12.
 - In Weeks 2, 3, 4, 7, 8, 9, 10, and 11: we will run an interactive session on Collaborate Ultra (on Canvas) – Live Online.



Lectures/Tutorials

- **Tutorials**
 - CL1-01: Tuesday 10:30-12:30 (ATC627)
 - CL1-02: Tuesday 8:30-10:30 (ATC627)
 - CL1-03: Thursday 14:30-16:30 (BA408)
 - CL1-04: Friday 12:30-14:30 (BA405)
 - CL1-05: Friday 16:30-18:30 (ATC627)
 - CL1-06: Monday 8:30-10:30 (EN302)
 - CL1-07: Friday 14:30-16:30 (TA306)
- **Consultation**
 - We will announce the fixed time you can meet a tutor on campus for consultations

Unit Learning Outcomes

- **Aim:** to introduce students to a range of artificial intelligence techniques
- **Learning Outcomes**
 - **Understand** a range of techniques of **intelligent systems**
 - across artificial intelligence (AI) and intelligent agents (IA);
 - from theoretical & practical perspective
 - **Apply** different AI/IA algorithms to solve practical problems
 - **Design/build** simple intelligent systems based on AI/IA concepts

Recommended Reading

- **Reading**
 - **Russell, S. & Norvig, P.** *Artificial Intelligence: A Modern Approach*. Prentice Hall, 3rd edition/4th edition, 2009
 - **Negnevitsky, M.**, 2005. *Artificial intelligence: a guide to intelligent systems*. Pearson education, 3rd edition.
 - **Wooldridge, M.** *An Introduction to Multi-Agent Systems*. John Wiley & Sons, 2002
 - Lecture slides posted on Canvas + online Internet resources...



7

Content

- **Topics**
 - Introduction to Intelligent Systems
 - Intelligent agents and multi-agent systems
 - Knowledge representation and reasoning
 - Learning and adaptation
 - Neural networks
 - Evolutionary computing
 - Collective intelligence
 - (Agent methodologies and applications)



8

Lecture Schedule (Provisional)

Week	Lecture Topic	Date
1	Topic: Overview. Definition and scope of IS (AI and IA). Philosophical aspects of AI and IA. Tutorial: Getting to know your tutor and teammates; Setting up your computing environment. Java and JADE	Mon 29/07 18:30-20:30 BA302
2	Topic: Problem-Solving Agents: Search and Constraint Satisfaction Problem. Tutorial: Choco (Constraint Solver) and JADE.	Mon 5/08 Live Online
3	Topic: Multi-agent systems. Agent interactions (encounters, games). Agent communication. Reaching agreements (negotiations). Tutorial: JADE	Mon 12/08 Live Online
4	Topic: Introduction to machine learning (ML) Tutorial: Introduction to Python & Machine Learning with Python practicals.	Mon 19/08 Live Online
5	Topic: Machine learning (ML) algorithms (DT, RF, KNN, PCA) Tutorial: Machine Learning with Python practicals & Project assignment.	Mon 26/08 BA302
6	Topic: Artificial neural networks and Deep Learning (DL) Tutorial: ML/DL with Python practicals & Project assignment.	Mon 2/09 BA302

9

Lecture Schedule (Provisional)

Week	Lecture Topic	Date
7	Topic: Computational intelligence. Genetic algorithm and evolutionary computing. Tutorial: ML/DL with Python practicals & Project assignment.	Mon 16/09 Live Online
8	Topic: Computational intelligence. Fuzzy systems. PSO/ACO. Tutorial: EC/GA with PyGad & Project assignment	Mon 23/09 Live Online
9	Topic: Advanced topic 1: Reinforcement learning. Tutorial: Project assignment.	Mon 30/09 Live Online
10	Topic: Advanced topic 2: Knowledge Representation and Reasoning (KRR) & Expert Systems (ES) or Distributed Constraint Optimization Problems (DCOP). Tutorial: Project assignment.	Mon 7/10 Live Online
11	Topic: Advanced topic 3: Natural Language Processing (NLP). Tutorial: Project assignment.	Mon 14/10 Live Online
12	Topic: Future directions of AI and IA – selected topics and examples. Review of the subject. Sample examination. Tutorial: Project assignment.	Mon 21/10 BA302 (Project Assignment due Sunday 29/10)

10

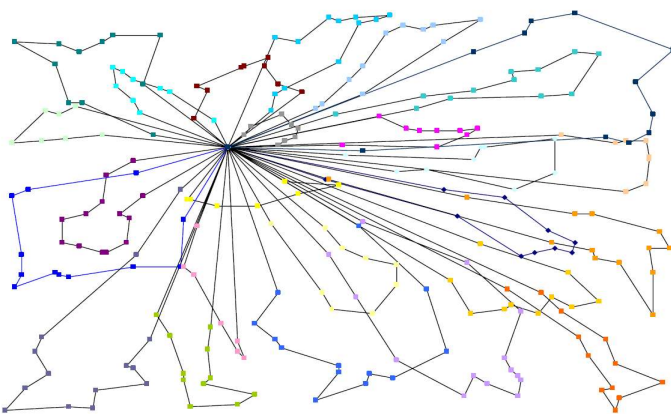
Assessment

- **Project:** Design and implementation of a simple intelligent system to solve a practical problem
 - **Agent-based or Machine Learning system** – built using IS principles/algorithms
 - **Working software** - demonstration
 - **Short project report** (summary of work, architecture, interaction, algorithm/s, result analysis, example)
 - **Video if applicable** (s/w demo)
 - **Assignment Release:** on Canvas
 - **Assignment Progress:** will be **checked** by your tutor **starting Week 3!**
 - **If you choose Option B, you will have Weekly Tasks due in Week 3!**
- **Continuous Oral Defense:** Individual Q&A (about the subject matter covered in the lectures)

11

Project Option A/Topic 1 – Delivery Vehicle Routing System

- **Project:** Design and implementation of a simple delivery vehicle routing system involving delivery agents and a master routing agent whose job is to find the optimal routes for the delivery vehicle agents to get their parcels to the receivers.

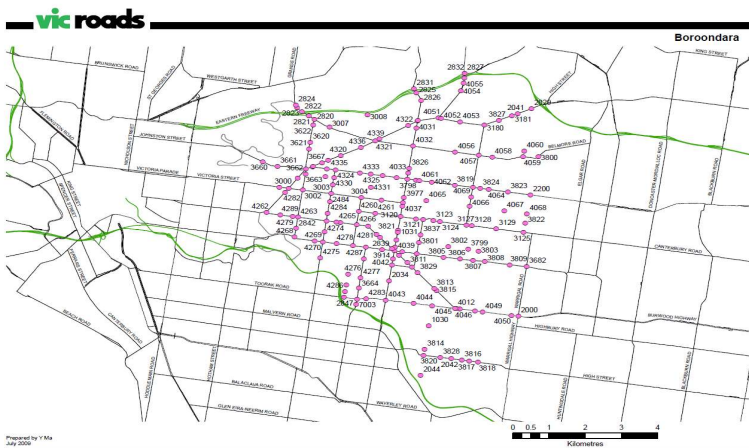


- Interaction Protocols
- Search/optimization
- Dynamic adaptation
- Automated negotiation

12

Project Option A/Topic 2 – Traffic Flow Prediction System

- **Project:** Design and implementation of a simple machine learning system for predicting traffic flow using real-world datasets from VicRoads or other road and traffic management authorities



- Machine learning
- Deep learning
- Traffic flow prediction

13

Project Option B – Stock Price Prediction System

- **Project:** Design and implementation of a simple machine learning system for predicting stock price of companies on the stock market using real-world datasets.
- You are going to work in a project led by a teaching staff. The project leader will give you starting code for this project. It is quite poor (in terms of programming and performance). We will give you weekly tasks to do to improve this code base (and in the process, you will learn about things such as data processing and deep learning).

- Machine learning
- Deep learning
- Stock price prediction

14

Project Option C –

Mitigating Large language Models (LLMs) hallucination



Project: With the advent of many powerful large language models (LLMs), including OpenAI's GPTs, Google's Gemini and Meta's Llama 3, a key challenge remains due to these models generating content that appears factual but is ungrounded, aka "hallucination." The aim of the project is for the team to learn one or two hallucination mitigation techniques and reproduce them on an open-source LLM to investigate their efficacy.

- If you join this project, you will work under the supervision of your project leader who is a teaching staff of this unit and within a team of students (between 3 and 5 students).

- Machine learning
- NLP
- Large language Models
- Generative AI

15

Other Resources

- **Google OR-Tools/Vehicle Routing Problem:**
<https://developers.google.com/optimization/routing/vrp>
- **Larry's page on Traffic Flow Prediction with Neural Networks(SAEs, LSTM, GRU):**
<https://github.com/xiaochus/TrafficFlowPrediction>
- **Google Machine Learning Crash Course:**
<https://developers.google.com/machine-learning/crash-course/>
- **AUTOMATED NEGOTIATING AGENT COMPETITION (ANAC):**
<https://www.ijcai-18.org/anac/index.html>
<http://web.tuat.ac.jp/~katfujii/ANAC2018/>
- **JADE tutorials, documentation and guidelines** from
<https://jade.tilab.com/documentation/tutorials-guides/>
- "A Comprehensive Survey of Hallucination Mitigation Techniques in Large Language Models" by Tonmoy et al.
<https://arxiv.org/abs/2401.01313>



16

TODO this week (for you)

- **Form a team (if you choose Option A)**
 - **Team members can be from different tutorials**
 - To help your tutor easily recognise the members of the team, please fill in the **Team Page** on Canvas.
 - If you can't find a team for yourself, please talk to us ASAP
 - Feel free to use the **Discussion Board** on **Canvas**
 - Discuss within your team to choose a topic
 - Teams are to be finalised next week (or Week 3 the latest)
 - Topic is to be finalised in Week 3 (with your tutor's approval)!
- **You can also choose Option B: You will work in a team with your tutor and complete weekly Tasks (first Task is due in Week 3).**

17

TODO this week (for you)

- **If you want to register for Option C:**
 - **Send an email to bvo@swin.edu.au to register your intention in Week 1**
 - No registration email can be sent after Week 1.
 - If you are not selected, you will be informed within 72 hours of your email so that you can decide on Option A and Option B.
 - If you are selected, you will be informed no later than Sunday 4 August 2024 of your team and the next steps.

18



19

Overview

- **What is an intelligent system (IS)?**
 - Examples of IS
 - Differentiate IS from related concepts (e.g., AI, intelligent agents, machine learning, ...)
- **Significance of intelligent systems in business**
- **Characteristics of intelligent systems**
- **Intelligent agents**



20

What is an intelligent system - Examples

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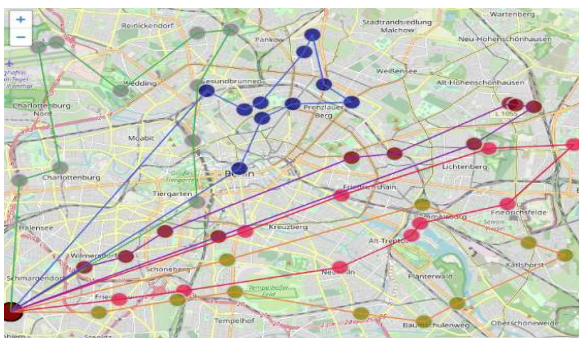


21

What is an intelligent system - Examples

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22

What is an intelligent system?

• What is intelligence?

- Intelligence can be characterized by the ability to
 - Reason & Problem-solve




What is an intelligent system?

• What is intelligence?

- Intelligence can be characterized by the ability to
 - Reason & Problem-solve
 - Learn & Adapt



What is an intelligent system?

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

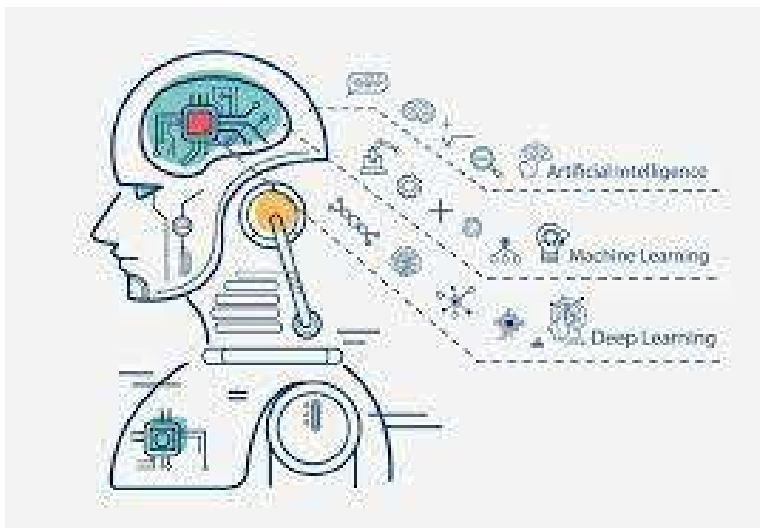


What is an intelligent system?

- 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

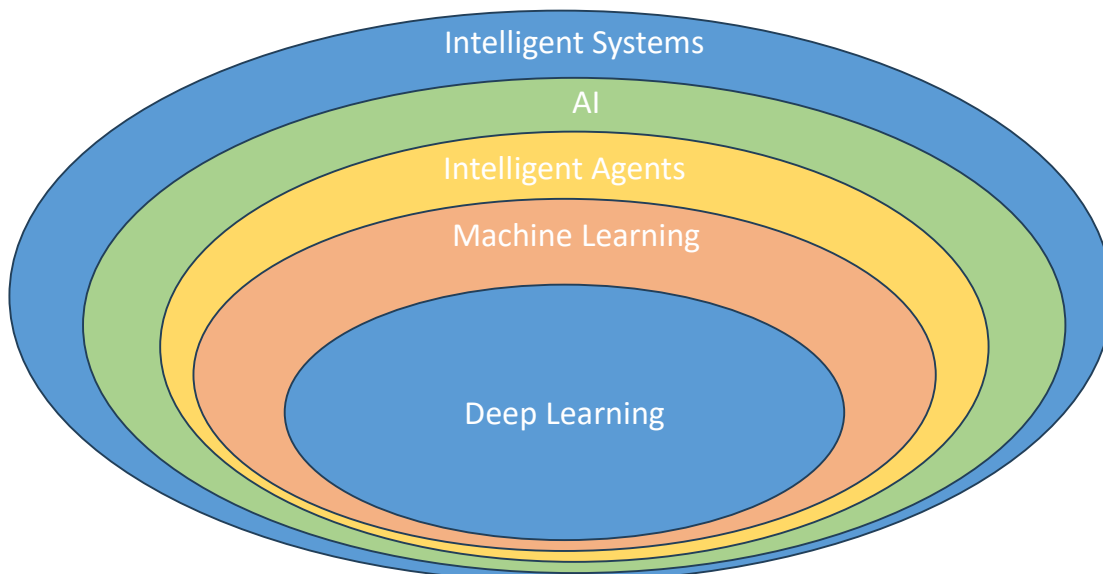
Intelligent systems vs AI vs Machine Learning vs ...

- 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.



29

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



30

Artificial Intelligence (AI)

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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

31

Artificial Intelligence (AI)

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Philosophically, scientists considers four main paradigms:

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- AI as a system that **thinks** rationally
- AI as a svstem that **acts** like a human
- AI as a system that **acts** rationally =
Intelligent Agents (IA)

32

Recent Achievements of Intelligent Systems

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



33

Recent Achievements of Intelligent Systems

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



34

Recent Achievements of Intelligent Systems

- IBM Watson -
<https://www.youtube.com/watch?v=Xcmh1LQB9I>
<http://www.youtube.com/watch?v=Dyw04zksfXw>



35

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-BMOckDI>

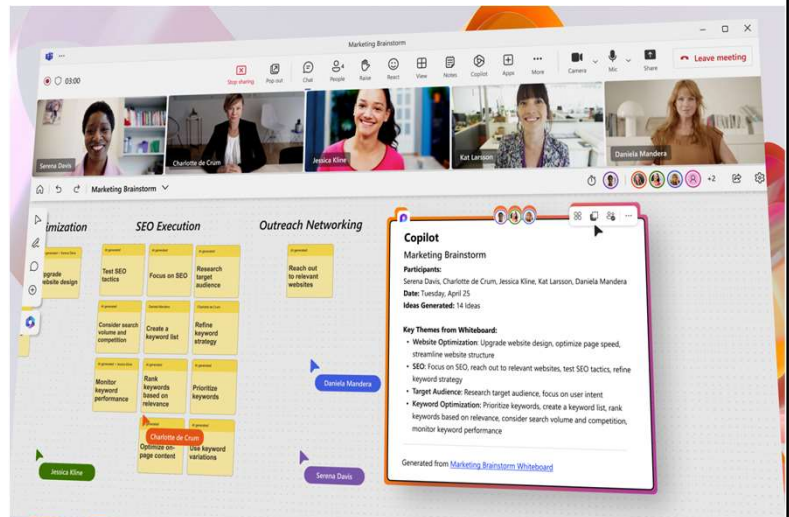


36

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



37

37

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



38

Intelligent systems in business

- **Walmart:**

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

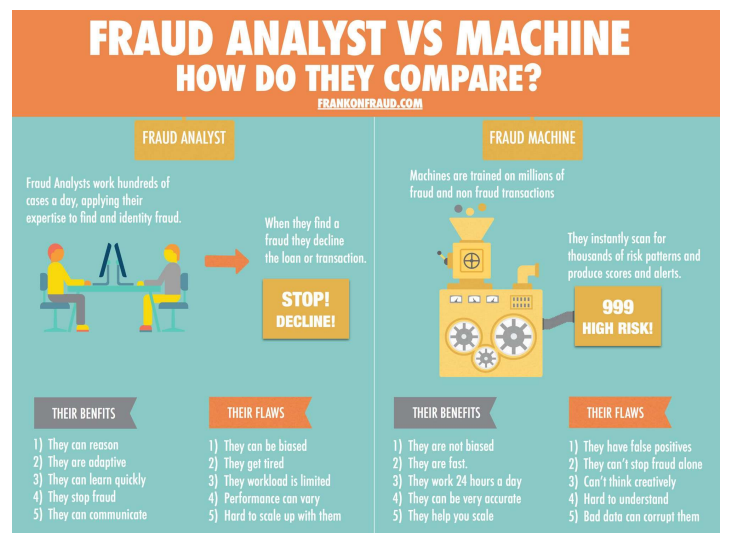


39

39

Intelligent systems in business

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



40

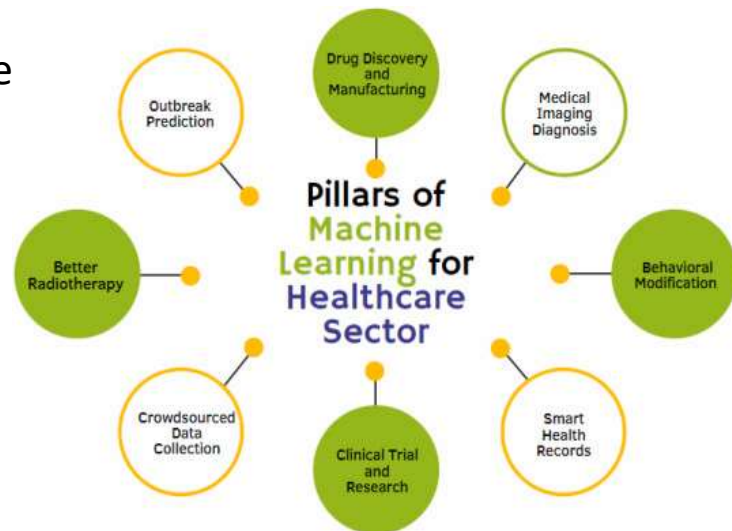
Intelligent systems in business

- **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



41

41

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

42

42

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

43

43

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

44

44

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

- Fuzzy systems
- Rough set theory

- Finding solutions through
 - natural language understanding
 - speech recognition and synthesis
 - image analysis

45

45

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**

• 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)
- ...

46

Characteristics of intelligent systems

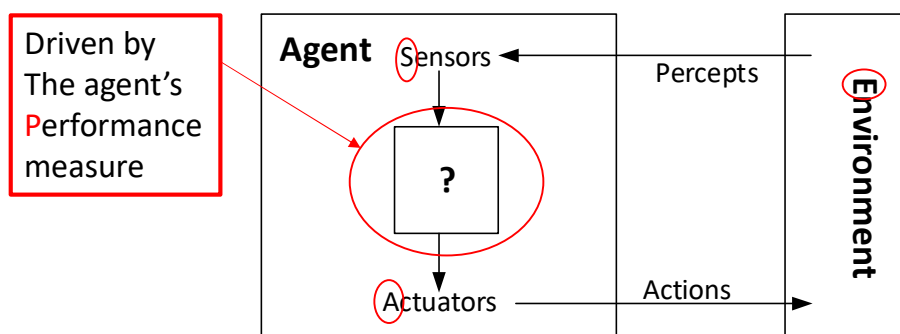
- Possess one or more of these:
 - Capability to extract and store knowledge
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 - Learning from experience (or training)
 - Dealing with imprecise expressions of facts
 - Finding solutions through processes similar to natural evolution
 - has the ability to **interact and deal with other agents** (including humans)
- Recent trends:
 - More sophisticated:
 - natural language processing
 - speech recognition
 - image and vision
 - Multi-agent systems
 - Agent communication
 - Automated negotiation
 - Natural language processing (NLP)
 - NL-based conversational agents

47

47

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



48

48

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**

49

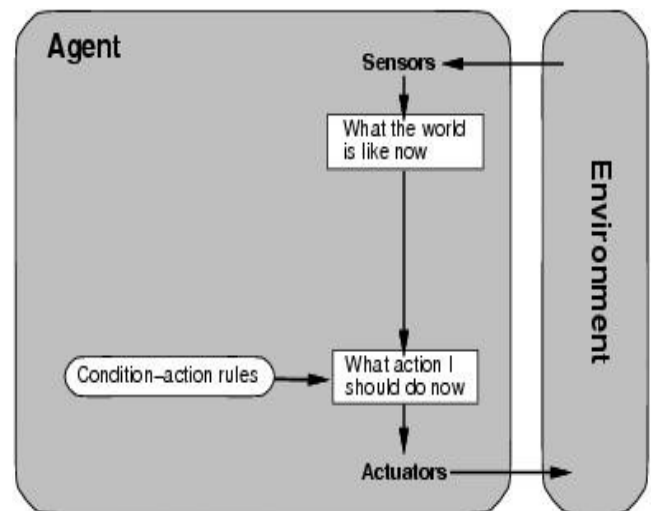
Agent Types

- 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**)*

50

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

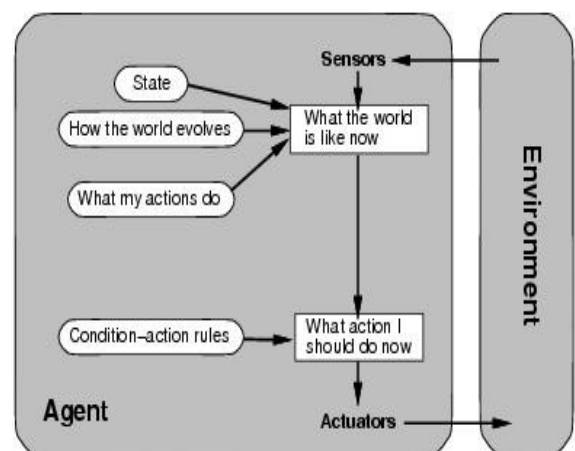


51

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.

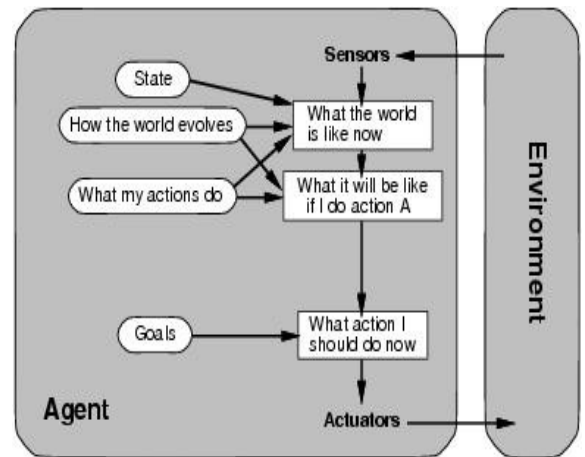
⇒ *Model of World*



52

Agent types; goal-based

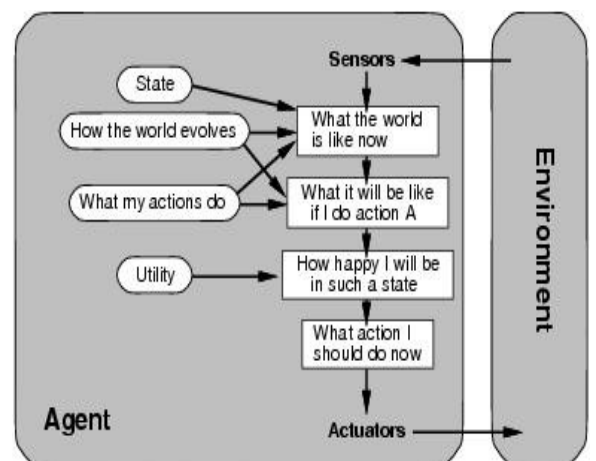
- The agent needs a goal to know which situations are *desirable*.
 - Things become difficult when long sequences of actions are required to find the goal.
- Typically investigated in **search** and **planning** research.
- Major difference: future is taken into account
- Is more flexible since knowledge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



53

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.



54

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)*
-