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COS30019: Introduction to Artificial Intelligence

Introduction

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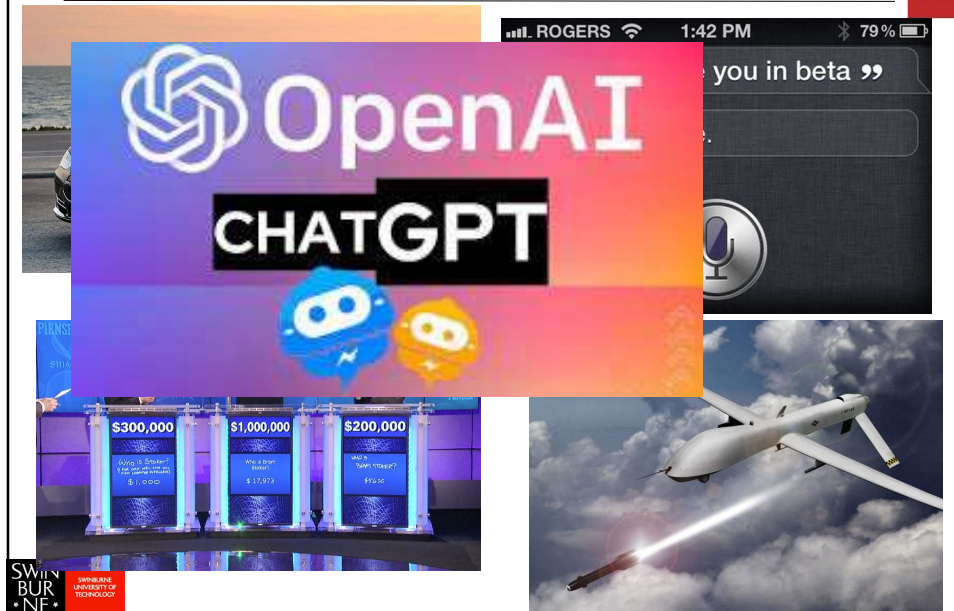
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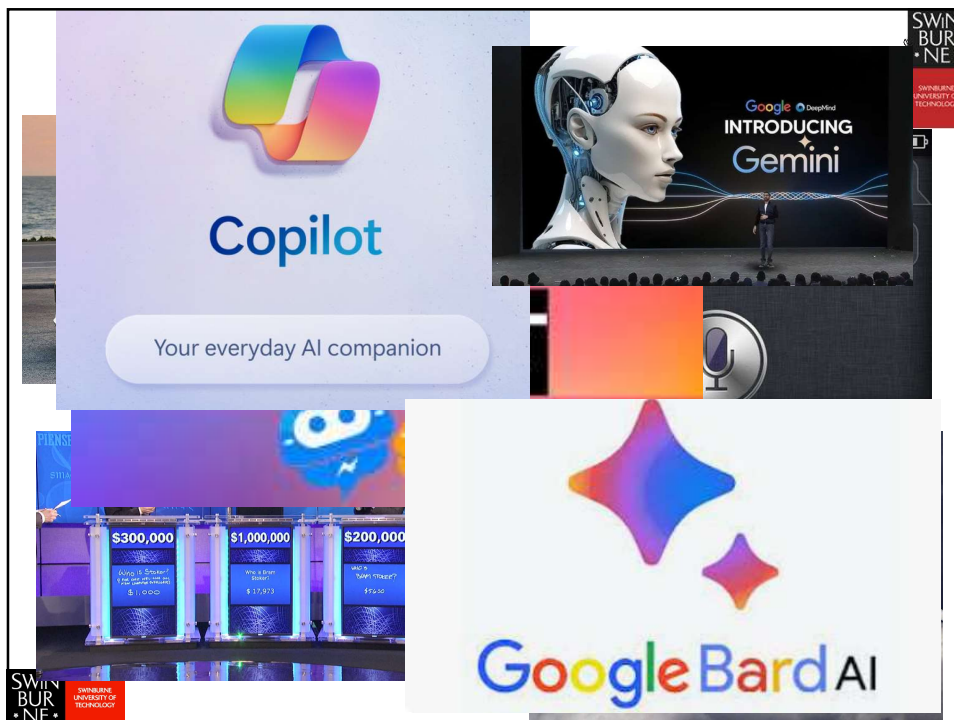
AI – A pop-culture view

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AI – in real life



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What is AI? (Informally)



- Different people can define AI differently
- Most popular definitions:
 - “Artificial intelligence is a constellation of many different technologies working together to enable machines to sense, comprehend, act, and learn with **human-like** levels of intelligence.”
(Accenture)
 - Artificial intelligence is the **simulation of human intelligence** processes by machines, especially computer systems/AI refers to systems or machines that **mimic human intelligence** to perform tasks and can iteratively improve themselves based on the information they collect.
(SAS/Oracle)
 - AI refers to systems that acts **rationally** (aka. Intelligent agents): any system that perceives its environment and takes actions that maximize its chance of achieving its goals
(AI textbooks)



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What Some Smart People are Saying About AI



Steve Wozniak
Apple co-founder

“The future is scary and very bad for people.” [1]

AI is a “demon” that is “potentially more dangerous than nuclear weapons” [2]



Elon Musk
Tesla chief executive



Bill Gates
Microsoft co-founder

“I don’t understand why some people are not concerned” [3]

“... full artificial intelligence could spell the end of the human race” [4]



Stephen Hawking
British theoretical physicist



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What about Australian industry?



- **Suncorp Group Ltd.** (ASX15) worked with us to understand the role of intelligent agents in future-generation markets for financial services/products
- **Data61** and **Defence Science and Technology** are working with us to create AI-based antifragile and resilient cyber-defence systems
- **SmartSat CRC (Airbus, SAAB, Leonardo, Ascension, ... + UniSA, Swinburne, Deakin,...)** are working with us on a project to develop *SpaceCraft Autonomy and Onboard AI for Next Generation Space Systems (SCARLET- α)*.



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Why study AI (from an academic perspective)



- It provides the core knowledge of computer science
- You'll learn to analyse problems and learn about techniques/algorithms to solve real-world problems
- It paves the way to understanding various sorts of intelligence (in both humans and machines)
- It is also fun (and different to most other subjects)



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Why study AI? (from a career perspective)



- The global AI market value is expected to reach \$267 billion by 2027.
(Fortune Business Insights)
- The total contribution of AI to the global economy is expected to hit \$15.7 trillion by 2030.
(PwC Global)
- AI will help boost the GDP of local economies, with China expected to record the greatest gains of 26% by 2030.
(PwC Global)
- The most in-demand AI job of 2023 can pay over \$200,000 and offers remote opportunities
(CNBC, Nov 2023)
- Searches for generative AI jobs on Indeed have increased almost 4,000% in the last year, and openings for generative AI jobs are up 306% over the same period.
(CNBC, Nov 2023)



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What is Artificial Intelligence



■ Different definitions due to different criteria

□ Two dimensions:

- Thought processes/reasoning vs. behavior/action
- Success according to human standards vs. success according to an ideal concept of intelligence: rationality.

Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

- Each definition falls under a **PARADIGM** in which AI can be built



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Systems that **act like humans**



- AI is the art of creating machines that perform functions that require intelligence when performed by humans
- **Methodology**: Take an intellectual task at which people are better and make a computer do it
- **Turing test**

- Prove a theorem
- Play chess
- Plan a surgical operation
- Diagnose a disease
- Navigate in a building

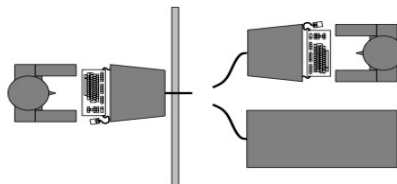


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Systems that **act like humans**



- When does a system behave intelligently?
 - ☐ Turing (1950) *Computing Machinery and Intelligence*
 - ☐ Operational test of intelligence: imitation game



- ☐ Test still relevant now yet might be the wrong question.
- ☐ Requires the collaboration of major components of AI: knowledge, reasoning, language understanding, learning, ...



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Systems that think like humans



- How do humans think?
 - Requires scientific theories of internal brain activities (cognitive model):
 - Level of abstraction? (knowledge or circuitry?)
 - Validation?
 - Predicting and testing human behavior
 - Identification from neurological data
 - Cognitive Science vs. Cognitive neuroscience.
- Both approaches are now distinct from AI
- Share that the available theories do not explain anything resembling human intelligence.
 - Three fields share a principal direction.

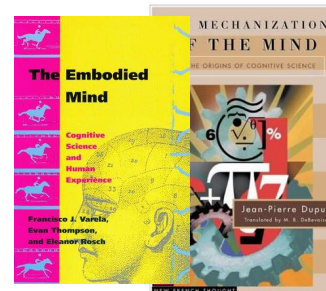
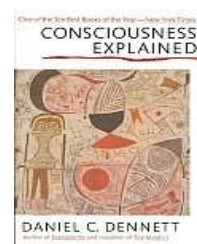


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Systems that think like humans



- Some references;
 - Daniel C. Dennet.
Consciousness explained.
 - M. Posner (edt.)
Foundations of cognitive science
 - Francisco J. Varela et al.
The Embodied Mind
 - J.-P. Dupuy. The mechanization of the mind



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Systems that think rationally



■ Capturing the laws of thought

- ☐ Aristotle: What are 'correct' argument and thought processes?
 - ☐ Correctness depends on irrefutability of reasoning processes.
- ☐ This study initiated the field of logic.
 - ☐ The logicist tradition in AI hopes to create intelligent systems using logic programming.
- ☐ Problems:
 - ☐ Not all intelligence is mediated by logic behavior
 - ☐ What is the purpose of thinking? What thought should one have?



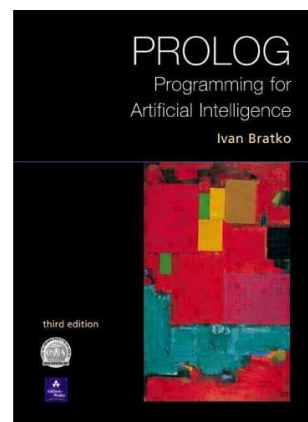
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Systems that think rationally



■ A reference;

- ☐ Ivan Bratko, Prolog programming for artificial intelligence.



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Systems that **act rationally**



- Rational behavior: “doing the right thing”
 - The “Right thing” is the course of action that is expected to *maximize goal achievement given the available information*.
- Can include thinking, yet in service of rational action.
 - Action without thinking: e.g. reflexes.



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Systems that **act rationally**



- Two advantages over previous approaches:
 - More general than law of thoughts approach
 - More amenable to scientific development.
- Yet rationality is only applicable in *ideal* environments.
- Moreover, rationality is not a very good model of reality.



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Some other terminologies



■ Strong AI vs Weak AI

- ☐ Weak AI:
 - ☐ Machines that can be made to act as *if* they were intelligent.
- ☐ Strong AI:
 - ☐ Machines that act intelligently with real, conscious minds.

■ Narrow AI vs Artificial General Intelligence (AGI)

- ☐ Narrow AI:
 - ☐ Machine that is focused on one narrow (intellectual) task.
- ☐ AGI:
 - ☐ Machine with the ability to apply intelligence to any problem, rather than just one specific problem.



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Foundations of AI



■ Different fields have contributed to AI in the form of ideas, viewpoints and techniques.

- ☐ *Philosophy*: Logic, reasoning, mind as a physical system, foundations of learning, language and rationality.
- ☐ *Mathematics*: Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability.
- ☐ *Psychology*: adaptation, phenomena of perception and motor control.
- ☐ *Economics*: formal theory of rational decisions, game theory.
- ☐ *Linguistics*: knowledge representation, grammar.
- ☐ *Neuroscience*: physical substrate for mental activities.
- ☐ *Control theory*: homeostatic systems, stability, optimal agent design.



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A brief history



- What happened after WWII?
 - 1943: Warren Mc Culloch and Walter Pitts: a model of artificial boolean neurons to perform computations.
 - First steps toward connectionist computation and learning (Hebbian learning).
 - Marvin Minsky and Dann Edmonds (1951) constructed the first neural network computer
 - 1950: Alan Turing's "Computing Machinery and Intelligence"
 - First complete vision of AI.



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A brief history (2)



- The birth of AI (1956)
 - Darmouth Workshop bringing together top minds on automata theory, neural nets and the study of intelligence.
 - Allen Newell and Herbert Simon: The logic theorist (first nonnumerical thinking program used for theorem proving)
 - For the next 20 years the field was dominated by these participants.
 - Great expectations (1952-1969)
 - Newell and Simon introduced the General Problem Solver.
 - Imitation of human problem-solving
 - Arthur Samuel (1952-) investigated game playing (checkers) with great success.
 - John McCarthy(1958-) :
 - Inventor of Lisp (second-oldest high-level language)
 - Logic oriented, Advice Taker (separation between knowledge and reasoning)



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A brief history (3)



- The birth of AI (1956)
 - Great expectations continued ..
 - Marvin Minsky (1958 -)
 - Introduction of microworlds that appear to require intelligence to solve: e.g. blocks-world.
 - Anti-logic orientation, society of the mind.
- Collapse in AI research (1966 - 1973)
 - Progress was slower than expected.
 - Unrealistic predictions.
 - Some systems lacked scalability.
 - Combinatorial explosion in search.
 - Fundamental limitations on techniques and representations.
 - Minsky and Papert (1969) Perceptrons.



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A brief history (4)



- AI revival through knowledge-based systems (1969-1970)
 - General-purpose vs. domain specific
 - E.g. the DENDRAL project (Buchanan et al. 1969)
 - First successful knowledge intensive system.
 - Expert systems
 - MYCIN to diagnose blood infections (Feigenbaum et al.)
 - Introduction of uncertainty in reasoning.
 - Increase in knowledge representation research.
 - Logic, frames, semantic nets, ...



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A brief history (5)



- AI becomes an industry (1980 - present)
 - R1 at DEC (McDermott, 1982)
 - Fifth generation project in Japan (1981)
 - American response ...
- Puts an end to the AI winter.
- Connectionist revival (1986 - present)
 - Parallel distributed processing (RumelHart and McClelland, 1986); backprop.



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A brief history (6)



- AI becomes a science (1987 - present)
 - Neats vs. scruffies.
 - In speech recognition: hidden markov models
 - In neural networks
 - In uncertain reasoning and expert systems: Bayesian network formalism
 - ...
- The emergence of intelligent agents (1995 - present)
 - The whole agent problem:
 - “How does an agent act/behave embedded in real environments with continuous sensory inputs”



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Different types of current AI systems



- **Rule-based** systems (e.g., expert systems, Mars Rover AI planner)
- **Machine learning (ML)**-based systems (e.g., IBM Watson, data analytics systems used by supermarkets, insurance and banking sector, telcos, etc.)
- **Deep learning (DL)**-based systems (e.g., those used in autonomous cars, Alpha Go, ChatGPT, etc.)



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State of the art



- Deep Blue defeated the reigning world chess champion Garry Kasparov (1997)
- Proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- Self-driving cars (and related technologies) have made their way into the real world
 - Tesla, Google, Mercedes, ...
- During the 1991 Gulf War, US force deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- Proverb solves crossword puzzles better than most humans
- Google Alpha Go beat Lee Sedol (9-dan pro) in a five-game Go match March 2016.
- A machine learning algorithm can identify tissue slides exhibiting a specific type of cancer with far greater accuracy than human epidemiologists
- **ChatGPT, Google Bard AI/Gemini, Open AI/Microsoft CoPilot**



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Ethics and AI



- **Ethical considerations** in AI:
 - ☐ Bias
 - ☐ Privacy
 - ☐ job displacement
- **Examples** of ethical issues in AI
 - ☐ facial recognition
 - ☐ algorithmic hiring
- **Potential solutions to ethical challenges**
 - ☐ European Commission (EC)'s AI Act (AIA)
 - ☐ Responsible AI
 - ☐ Transparent & Auditable AI



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Future of AI



- In your hand
 - ☐ You'll create it!
- Topic for discussion in class (tutorial)



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Summary



- Different people think of AI differently.
- Two important questions to ask are:
 - ☐ Are you concerned with thinking or behavior?
 - ☐ Do you want to model humans or work from an ideal standard?
- In this course, we adopt the view that **intelligence is concerned mainly with rational action**.
- Ideally, an **intelligent agent** takes the best possible action in a situation. We will study the problem of building agents that are intelligent in this sense.



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Further food for thought



- <https://www.forbes.com/sites/forbesbusinesscouncil/2023/07/24/artificial-intelligence-is-changing-the-world-and-your-business/?sh=6a647a432900>
- <https://builtin.com/artificial-intelligence/artificial-intelligence-future>
- <https://www.forbes.com/sites/bernardmarr/2023/06/02/the-15-biggest-risks-of-artificial-intelligence/?sh=655ed9b27066>
- <https://www.safe.ai/ai-risk>
- <https://time.com/6565026/ai-job-replacement-mit-study/>



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