

SWINBURNE

SWINBURNE UNIVERSITY OF TECHNOLOGY

COS30019: Introduction to Artificial Intelligence

Introduction

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What is AI? (Informally)

- You may have encountered it yourself ☺
 - At leats in the movies
 - Driverless aircrafts & vehicles
 - SIRI (iPhones, iPads)
 - Direct product of SRI International's Artificial Intelligence Center
 - Raised US\$24million through venture capitalists before acquired by Apple
 - MS Cortana, Amazon Alexa, Google Assistant/Now, Samsung Bixby
 - Robo-advisor
 - People give software real money to invest on their behalf
 - <https://www.forbes.com/sites/llkerkoksai/2020/04/18/how-ai-is-expanding-the-applications-of-robo-advisory/?sh=78d7d4f055c3>

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AI – A pop-culture view

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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 is AI? (Informally)

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AI – in real life

A young *science* (~ 60 years old)

- Exciting and dynamic field, lots of uncharted territory left
- Impressive success stories
- "Intelligent" in specialized domains
- Many application areas

Face detection

Formal verification

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AI – in real life

Drones. Disinfecting robots. Supercomputers. The coronavirus outbreak is a test for China's tech industry

By Michelle Toh and Serenitie Wang, CNN Business
Updated 1935 GMT (0335 HKT) February 24, 2020

Hong Kong (CNN Business)— China has spent decades nurturing its tech sector. Now, faced with a massive public health crisis, Beijing is pushing its tech companies to join the fight against the novel coronavirus.

The country's tech giants have responded to the outbreak by deploying autonomous vehicles to bring supplies to medical workers, fitting drones with thermal cameras to improve detection of the virus and lending their computing power to help develop a vaccine.



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AI in Healthcare (Google IO)

Diagnosing diabetic retinopathy



Image of retina



<https://www.recode.net/2018/5/8/17332380/google-io-2018-ai-assistant-phone-conversations>



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AI in Healthcare (Google IO)

Predicting cardiovascular risk



Image of retina



Age



Biological sex



Smoking



A1C



BMI



Systolic blood pressure



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AI in Healthcare (Google IO)

Helping doctors predict medical events

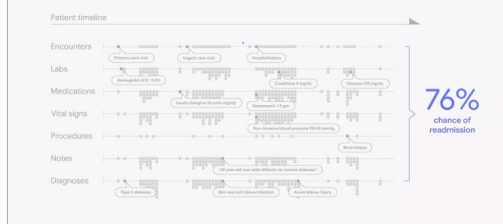
Is my patient likely to get better?
Is my patient likely to go home soon?
Is my patient likely to get sick again?



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AI in Healthcare (Google IO)

Predicting medical events



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AI – in real life



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What Some Smart People are Saying About AI

Steve Wozniak
Apple co-founder

Elon Musk
Tesla chief executive

Bill Gates
Microsoft co-founder

Stephen Hawking
British theoretical physicist

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

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

"I don't understand why some people are not concerned" [3]

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

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Further food for thought

- <http://www.globalresearch.ca/artificial-intelligence-frankenstein-or-capitalist-money-machine/5576427>
- <http://www.smartcompany.com.au/technology/83518-elon-musk-says-the-world-faces-a-dangerous-situation-with-artificial-intelligence/>
- <http://www.popsi.com.au/robots/artificial-intelligence/will-artificial-intelligence-ever-actually-match-up-to-the-human-brain-,452463>
- <http://www.zdnet.com/article/artificial-intelligence-in-the-real-world-what-can-it-actually-do/>

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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
- **AARNET** and **Zimbani** worked with us to commercialise **Smart Cloud Broker** – an automated tool to assist your organisation to purchase and utilise cloud services more optimally.

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Why study AI

- 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 artificial intelligence (AI)?

- 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)
- 37% of organizations surveyed by Gartner in 2019 now use AI in the workplace. (Gartner)
- 75% of commercial enterprise apps will use AI by 2021 (International Data Corporation - IDC)
- Demand for AI talent has doubled in the last two years. Technology and financial service companies are currently absorbing 60% of AI talent (MMC Ventures, 2019)

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AI key statistics

Two-third of senior decision-makers agree that AI is fundamental to the success of their organization's strategy

By 2022, those currently or planning to use AI technology anticipate a **39%** boost to their organization's revenue, on average

7 in 10 organizations that have replaced, or plan to replace, roles with technology will retain or redeploy those who are displaced

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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**

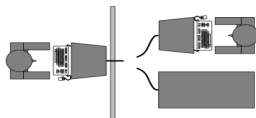
- Prove a theorem
- Play chess
- Plan a surgical operation
- Diagnose a disease
- Navigate in a building

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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?

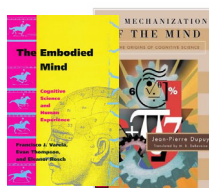
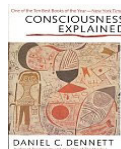
- Requires scientific theories of internal brain activities (cognitive model):
 - Level of abstraction? (knowledge or circuitry?)
 - Validation?
 - Predicting and testing human behavior
 - Identification from neurological data
 - Cognitive Science vs. Cognitive neuroscience.
- Both approaches are now 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**

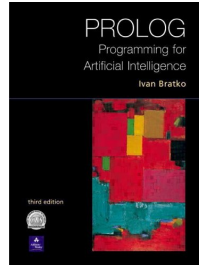
■ Capturing the laws of thought

- 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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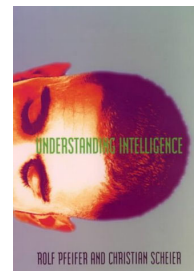
Systems that act rationally

- 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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Systems that act rationally

- A reference:
 - Rolf Pfeifer and Christian Scheier. [Understanding Intelligence](#). MIT Press, 1999.



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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)
 - Dartmouth 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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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



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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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AI units at Swinburne



- | | |
|--|--|
| <ul style="list-style-type: none"> ■ COS30019 – IAI <ul style="list-style-type: none"> □ An introductory unit □ Focus is on the concept, design and development of intelligent agents (IA) <ul style="list-style-type: none"> □ Systems that act rationally □ Focus is on the fundamental theories (e.g., logic, probability) and algorithms (e.g., tree- and graph-based search, inference engine, AI planning) to understand and build intelligent systems ■ COS30002 – Artificial Intelligence for Games <ul style="list-style-type: none"> □ Discuss and implement software development techniques to create AI behaviour in games □ Understand and utilise a variety of graph and path planning techniques □ Create realistic movement for agents using steering force models □ Create agents that are capable of planning actions in order to achieve goals | <ul style="list-style-type: none"> ■ COS30018 – Intelligent Systems (IS) <ul style="list-style-type: none"> □ Look at various techniques and algorithms to design and develop intelligent systems □ Focus is on evaluating intelligent systems, and in particular, their suitability for specific applications □ Focus is on applying various tools/techniques available for developing intelligent systems |
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