Artificial Intelligence Foundation – JC3001

Lecture 1: Introduction to Artificial Intelligence

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Material adapted from:
Russell and Norvig (AIMA Book): Chapter 1
Herbert and Lewicki (CMU)

Objectives

- Introduce criteria for the course
- Introduce the field of AI
- Motivate to the importance of the field
- Describe the history of AI and the current state of the art

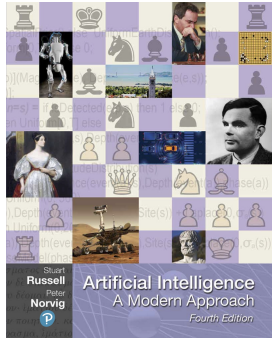
Outline

1 Course Admin

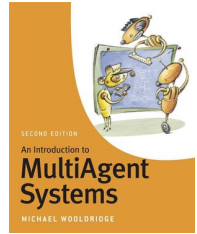
- Course Admin
- (Artificial) Intelligence

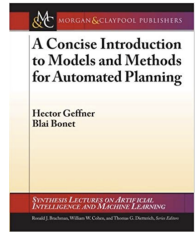
- My Aberdeen:
  - Course Information
  - Lectures
  - Assessments
- MS Teams (by arrangement, so please email to schedule an appointment):
  - Quick Q&A
  - Group discussions
- The Course Team (in alphabetical order):
  - Prof. Aladdin Ayesh
  - Dr. Binod Bhattarai
  - Dr. Gideon Ogunniye

- Artificial Intelligence:A modern approach (AIMA) Russell and Norvig, 4th ed, 2021
  - Most classes derived from AIMA
  - `http://aima.cs.berkeley.edu`—Additional Material



- An Introduction to MultiAgent Systems, 2nd ed, 2009
  Michael Wooldridge
- A Concise Introduction to Models and Methods for Automated Planning
  Hector Geffner and Blai Bonet





There are two assessments each contributes to the final grade:

- Assignment
- Examination

Final grade:

$$G = w_A * A + w_E * E$$

- For the assignment you will write an essay or a report.
- The assignment specification will outline the details of the tasks and the sections of the report to be completed, and will give the evaluation criteria.
- The specification will be released in **Week 4** with a deadline in **Week 10**.
- Late submissions will be subject to the Penalties for Late Submission of Coursework as outlined in the Student Handbook.

- What you **can** do:
  - Discuss lecture and textbook materials
  - Discuss how to approach assignments
- What you **cannot** do:
  - Share ideas in any written form
- Plagiarism will not be tolerated and will be **escalated** according to the University's Code of Practice

The course is divided into 6 parts and will be delivered in 4 sections:

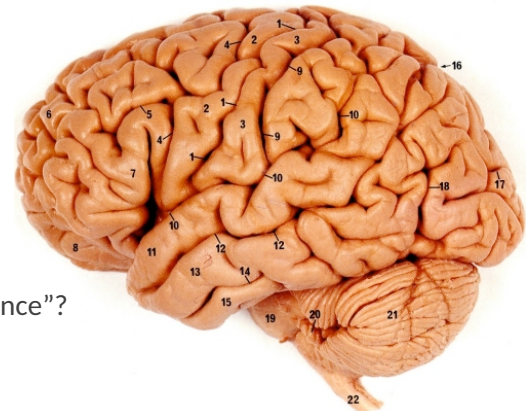
- **Section 1** to be delivered in **weeks 1-3** and covers the first two parts: Introduction and Search algorithms
- **Section 2** to be delivered in **weeks 3-6** and covers part 3 on Reasoning and Uncertainty
- **Section 3** to be delivered in **weeks 6-9** and covers part 4 on Planning.
- **Section 4** to be delivered in **weeks 9-12** and covers parts 5 and 6 Learning, ethics and course conclusion.

Next slide shows the topics covered in each part.

- Part 1: Introduction
  1. Introduction to AI
  2. Agents
- Part 2: Problem-solving
  1. Search 1: Uninformed Search
  2. Search 2: Heuristic Search
  3. Search 3: Local Search
  4. Search 4: Adversarial Search
- Part 3: Reasoning and Uncertainty
  1. Reasoning 1: Constraint Satisfaction
  2. Reasoning 2: Logic and Inference
  3. Probabilistic Reasoning 1: BNs
  4. Probabilistic Reasoning 2: HMMs
- Part 4: Planning
  1. Planning 1: Intro and Formalism
  2. Planning 2: Algos and Heuristics
  3. Planning 3: Hierarchical Planning
  4. Planning 4: Stochastic Planning
- Part 5: Learning
  1. Learning 1: Intro to ML
  2. Learning 2: Regression
  3. Learning 3: Neural Networks
  4. Learning 4: Reinforcement Learning
- Part 6: Conclusion
  1. Ethical Issues in AI
  2. Conclusions and Discussion

Outline

- Course Admin
- (Artificial) Intelligence



- What is “intelligence”?

Brains (adult cortex)

- surface area: 2500 cm^2
- squishy
- neurones: 20 billion
- synapses: 240 trillion
- neurone size: 15 um
- synapse size: 1 um
- synaptic OPS: 30 trillion

Computers (Intel Haswell)

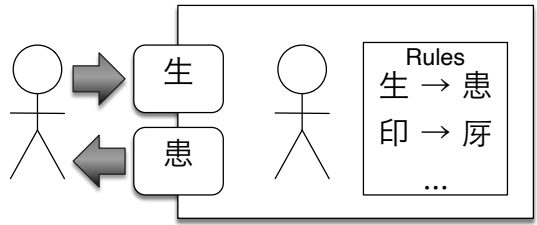
- surface area: 82 mm^2
- crystalline
- transistors: 1.3 billion
-
- transistor size: 15 nm
-
- FLOPS: 211 billion

What is AI for you?

- High-level ("human") reasoning requires little computation
- Sensorimotor reasoning is comparatively much harder
  - Chew gum and walk at the same time is harder than chess
- Possible explanations
  - Evolution "implemented" harder skills over millennia
  - Unconscious processes much harder to reverse engineer

Chinese Room Thought Experiment

- Chinese speaker outside
- Non-Chinese speaker inside, plus a rulebook
- Does the Non-Chinese speaker “understand” Chinese?
- Strong AI vs. Weak AI



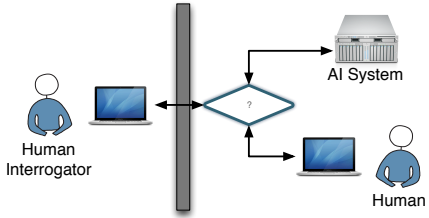
Argument articulated by John Searle in "Minds, Brains, and Programs"

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

Acting humanly: The Turing test

Turing (1950) “Computing machinery and intelligence”:

- “Can machines think?” → “Can machines behave intelligently?”
- Operational test for intelligent behaviour: the Imitation Game
- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Suggested major components of AI: knowledge, reasoning, language understanding, learning



- 1960s “cognitive revolution”: information-processing psychology replaced prevailing orthodoxy of behaviourism
- Requires scientific theories of internal activities of the brain
  - What level of abstraction? “Knowledge” or “circuits”?
  - How to validate? Requires
    1. Predicting and testing behaviour of human subjects (top-down) or
    2. Direct identification from neurological data (bottom-up)
- Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI
- Both share with AI the following characteristic:
  the available theories do not explain (or engender) anything resembling human-level general intelligence
- Hence, all three fields share one principal direction!

- Normative (or prescriptive) rather than descriptive
- Aristotle: what are correct arguments/thought processes?
- Several Greek schools developed various forms of logic:
  - notation and rules of derivation for thoughts;
  - may or may not have proceeded to the idea of mechanisation
- Direct line through mathematics and philosophy to modern AI
- Problems:
  1) Not all intelligent behaviour is mediated by logical deliberation
  2) What is the purpose of thinking? What thoughts should I have out of all the thoughts (logical or otherwise) that I could have?

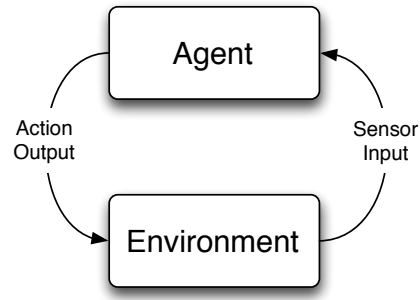
- Rational behaviour: doing the right thing
- The right thing: that which is expected to maximise goal achievement, given the available information
- Doesn't necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action

Acting Rationally: Rational agents

- An agent is an entity that perceives and acts
- This course is about designing rational agents
- Abstractly, an agent is a function from percept histories to actions:

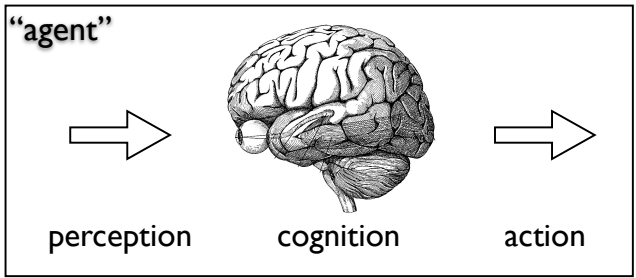
$$f : P_* \mapsto A$$

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- Caveat: computational limitations make perfect rationality unachievable
- So, our goal in AI is to design best program for given machine resources



Three key steps of a knowledge-based agent (Craik, 1943):

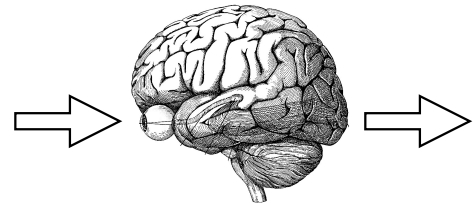
- the stimulus must be translated into an internal representation
- the representation is manipulated by cognitive processes to derive new internal representations
- these in turn are translated into action



All AI problems require some form of representation

- chess
- board
- maze
- text
- object
- room
- sound
- visual scene

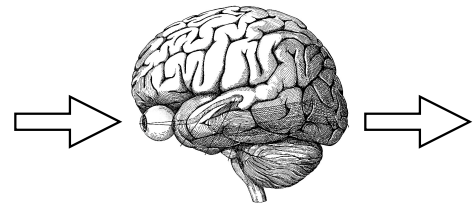
Sometimes the representation is the output.
E.g., discovering “patterns“



A major part AI is representing the problem space to allow efficient search for the best solution(s).

The output action can also be complex

- next move
- text
- label
- actuator
- movement



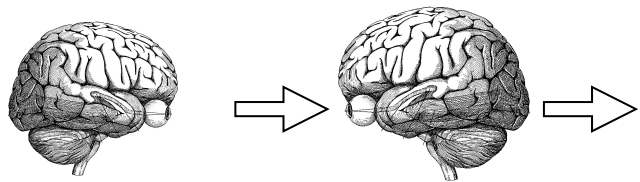
From a simple chess move
to a motor sequence
to grasp an object

What do you do once you have a representation? This requires a goal.

chess board	find best move
maze	shortest path
text	semantic parsing
object	recognition
room	object localisation
sound	speech recognition
visual scene	path navigation

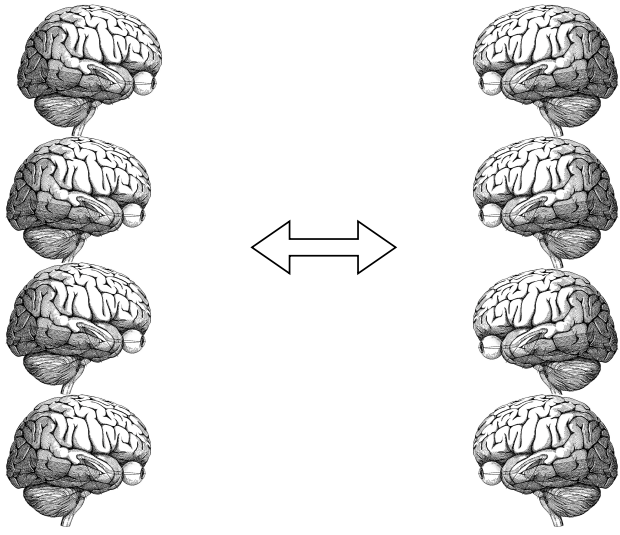
Rational behaviour:
choose actions that maximise
goal achievement
given available information

What if your world includes another agent?

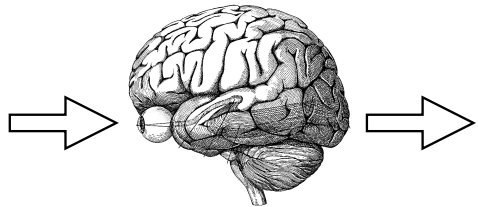


- strategic game play
- auctions
- modelling other agents
- uncertainty: chance and future actions

Rational behaviour:
How do we choose moves/actions to win?
Or guarantee fairest outcome?



Reasoning can be thought of as constructing an accurate world model

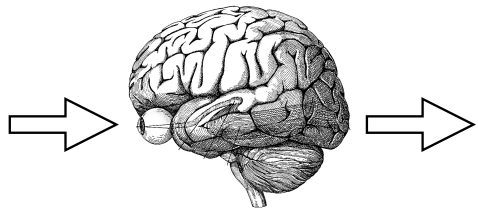


- facts
- observations
- "wet ground"

- logical consequences
- inferences
- "it rained" or "sprinkler"?

Rational inference:
What can be logically inferred given available information?

Most facts are not concrete and are not known with certainty.



- facts / observations
- “fever‘
- “aches”
- platelet count = N

- inferences
- What disease?
- What causes?

Probabilistic inference:
How do we give
the proper weight
to each observation?
What is ideal?

What if your world is changing? How do we maintain an accurate model?

- chess board
- maze
- text
- object
- room
- sound
- visual scene

Learning:
adapt internal representation so that it is as accurate as possible

Can also adapt our models of other agents.

What do you think is possible with current AI?

- Course Admin
- Assessment
- A gentle introduction to AI
  - What is AI?
  - Foundational issues in AI

Any Questions.