COMP3411/9414: Artificial Intelligence

1a: Foundations

Course Materials through OpenLearning

Instructions on how to access the course materials are given here:

- `http://www.cse.unsw.edu.au/~cs3411/`
- `http://www.cse.unsw.edu.au/~cs9414/`

Lecturer-in-Charge

- Alan Blair
- `blair@cse.unsw.edu.au`
- K17-412C
- 9385-7131

Course Schedule

- Lecture Friday 10-1 in John Clancy Auditorium
- Friday tutorials begin in Week 1
- Mon, Tue, Wed, Thu tutorials begin in Week 2
- Prolog Labs (optional) start Friday of Week 1 and continue until Week 5

Planned Topics

- AI, Tasks, Agents & Prolog
  - What is AI?
  - Classifying Tasks
  - Agent Types
  - Prolog Programming
- Logic & Uncertainty
  - Logical Agents
  - First Order Logic
  - Uncertainty
- Solving Problems by Search
  - Path Search
  - Heuristic Path Search
  - Games
  - Constraint Satisfaction
- Learning
  - Learning and Decision Trees
  - Perceptrons & Neural Networks
  - Reinforcement Learning

What To Do (This Week)

- sign up to OpenLearning (through Moodle)
- work through this week's Learning Activities
- set up and log into your CSE account
- start working through the Prolog Exercises

Prolog Lab Schedule

Day / Time	Weeks	Labs
Friday 4-8	1-5	J17 302 (Flute) + J17 304 (Oboe)
Monday 4-8	2-5	J17 302 (Flute) + J17 304 (Oboe)
Wednesday 4-6	2-5	J17 302 (Flute) + J17 304 (Oboe)
Thursday 10-12	2-5	J17 302 (Flute) + J17 302 (Strings)
Thursday 12-2	2-5	J17 302 (Flute) + J17 304 (Oboe)

Prolog Labs are not compulsory. You can attend at any time(s) that suit you. Lab Consultants will be there to help you if you have questions.

Why Prolog?

- very useful for AI and search
- good for you to see an example of a non-imperative language
- logic programming languages like Prolog have recently had a resurgence of popularity in the computing industry

Resources

Recommended Text:

- Stuart Russell and Peter Norvig, *Artificial Intelligence: a Modern Approach*, 3rd Edition, Prentice Hall, 2009.
- Ivan Bratko, *Programming in Prolog for Artificial Intelligence*, 4th Edition, Pearson, 2013.

Reference Text:

- Nils J. Nilsson, *Artificial Intelligence: a New Synthesis*, Morgan Kaufmann, 1998.
- Valentino Braitenberg, *Vehicles: Experiments in Synthetic Psychology*, MIT Press, 1984.

Assessment

Assessment will consist of:

Assignments	40%
Written Exam	60%

In order to pass the course, you must score

- at least 16/40 for the assignments
- at least 24/60 for the exam
- a combined mark of at least 50/100

Assignments

The assignments may, for example, involve writing a program to:

- enable an agent to act in a simulated environment
- solve a problem using search techniques
- play a game
- apply a machine learning algorithm

Plagiarism

- ALL work submitted for assessment must be your own work
- for an individual assignment, collaborative work in the form of "think tanking" is encouraged, but students are not allowed to derive code together as a group during such discussions
- in the case of a group assignment, code must not be obtained from outside the group
- plagiarism detection software may be used on submitted work
- UNSW Plagiarism Policy:
  `https://student.unsw.edu.au/plagiarism`

Related Courses

- COMP9417 Machine Learning and Data Mining
- COMP4418 Knowledge Representation and Reasoning
- COMP3431 Robotic Software Architecture
- COMP9517 Machine Vision
- COMP9444 Neural Networks and Deep Learning
- 4th Year Thesis topics

Foundations of AI

- Philosophy (428 B.C — present)
- Mathematics (c. 800 — present)
- Psychology (1879 — present)
- Linguistics (1957 — present)
- Computer engineering (1940 — present)
- Biocybernetics (1940's — present)
- Neurology (1950's – present)

Foundations of AI - Philosophy

- Philosophy / Arts
  - what is mind ? $\rightsquigarrow$ mind is like a machine
  - it operates on knowledge encoded in an "internal language"
  - thought and reasoning can be used to arrive at the right actions
  - what is consciousness ?

Foundations of AI - Mathematics

- Philosophy
- Mathematics / Physics / Statistics / Logic
  - tools to manipulate logical statements
  - tools to manipulate probabilistic statements
  - algorithms and their analysis
  - complexity issues
  - dynamical systems / RNNs
  - statistical physics / Hopfieled nets
  - methods for pattern recognition
  - models using differential equations, statistics, etc.

Foundations of AI - Psychology

- Philosophy
- Mathematics
- Psychology / Cognitive Science
  - humans and animals are information processing machines
  - introspection
  - experiments
  - what is intelligence ?
    (`http://www.iqtest.com/`)
  - what is learning and memory ?

Foundations of AI - Linguistics

- Philosophy
- Mathematics
- Psychology
- Linguistics / Computational Linguistics / Formal Languages
  - language use fits into the 'information processing machine' model
  - Chomsky hierachy
  - natural language processing

Foundations of AI - Engineering

- Philosophy
- Mathematics
- Psychology
- Linguistics
- Computer Engineering
  - build computers and robots fast enough to make AI applications and simulations possible
  - links to mechanical engineering

Foundations of AI - Neurobiology

- Philosophy
- Mathematics
- Psychology
- Linguistics
- Computer Engineering
- Biocybernetics and Neurobiology
  - molecular level
  - single cell recordings
  - cell circuit level
  - information processing in biological systems

Foundations of AI - Neurology

- Philosophy
- Mathematics
- Psychology
- Linguistics
- Computer Engineering
- Biocybernetics / Neurobiology
- Neurology / Psychiatry
  - drugs
  - learning from disorders
  - brain scans (EEG/MEG/PET/MRI)

Foundations of AI

- Philosophy
- Mathematics
- Psychology
- Linguistics
- Computer Engineering
- Biocybernetics / Neurobiology
- Neurology / Psychiatry

AI is a central topic of current interdisciplinary scientific investigation.

Theories about Intelligence

- 380BC Plato (Rationalism - innateness)
- 330BC Aristotle (Empricism - experience)
- 1641 Descartes (mind-body Dualism)
- 1781 Kant (Critique of Pure Reason)
- 1899 Sigmund Freud (Psychology)
- 1953 B.F. Skinner (Behaviourism)

Rationalism vs. Empiricism

Artificial Intelligence in Literature

- Greek Mythology (Pygmalion, Talos)
- 1580 Rabbi Loew (Golem, a clay man brought to life)
- 1818 Mary Shelley (Frankenstein)
- 1883 Carlo Collodi (Pinocchio)
- 1920 Karel Capek (Rossum's Universal Robots)
- 1950 Isaac Asimov (Three Laws of Robotics)
- 1951 Osamu Tezuka (Astro Boy)

Robots - Good or Evil?

Artificial Intelligence Origins

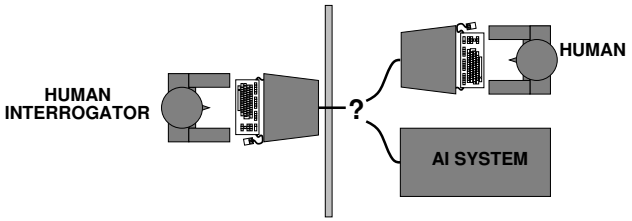
- 1642 Blaise Pascal (mechanical adding machine)
- 1694 Gottfried Leibniz (mechanical calculator)
- 1769 Wolfgang von Kempelen (Mechanical Turk)
- 1837 Charles Babbage & Ada Lovelace (Difference Engine)
- 1848 George Boole (the Calculus of Logic)
- 1879 Gottlob Frege (Predicate Logic)
- 1950 Turing Test
- 1956 Dartmouth conference

What is Intelligence?

Turing Test

- proposed by Alan Turing in 1950
- a human interrogates/converses with the computer via a teletype
- the aim is for the computer to **imitate** a human well enough to fool the human interrogator

Turing Test



Turing thought a computer would pass this test by end of the 20th century.

The Loebner Prize (Turing test) competition is held each year.

The "Total Turing Test" allows physical objects to be passed to the machines as well as characters via the teletype.

Extract from Turing paper

Interrogator: In the first line of your sonnet which reads 'Shall I compare thee to a summer's day', would not 'a spring day' do as well or better?

Witness: It wouldn't scan.

Interrogator: How about 'A winter's day' – That would scan all right.

Witness: Yes, but nobody wants to be compared to a winter's day.

Interrogator: Would you say Mr. Pickwick reminded you of Christmas?

Witness: In a way.

Interrogator: Yet Christmas is a winter's day, and I do not think Mr. Pickwick would mind the comparison.

Witness: I don't think you're serious. By a winter's day one means a typical winter's day, rather than a special one like Christmas.

Eliza Session

Doctor: What brought you here to see me today?

Visitor: Oh, nothing much. I'm feeling a bit tired, that's all.

Doctor: Why do you think you're feeling a bit tired?

Visitor: Well, I've been traveling a lot, and away from home.

Doctor: Tell me more about your family.

Eliza Session

Visitor: The trouble is, my mother's ill.

Doctor: How long has she been ill?

...

Visitor: The trouble is, my mother's Irish.

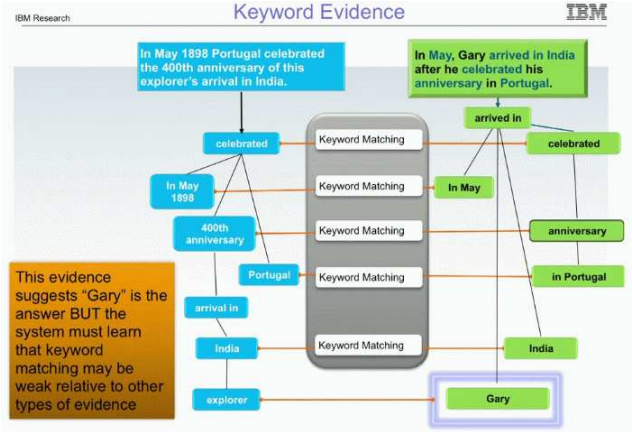
Doctor: How long has she been Irish?

...

Visitor: The trouble is, my mother's poodle.

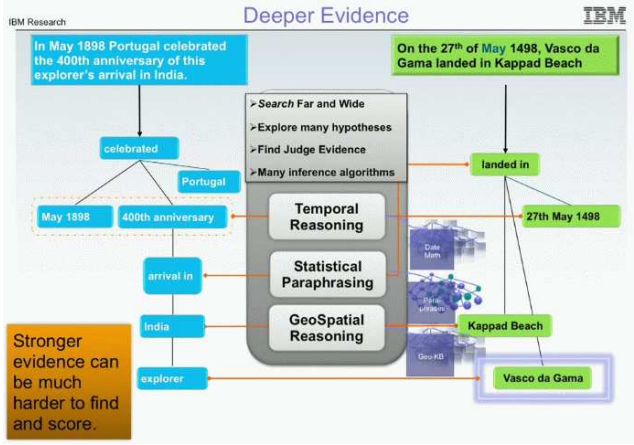
Doctor: How long has she been poodle?

IBM Watson DeepQA



YouTube: "Building Watson - A Brief Overview of the DeepQA Project"

IBM Watson DeepQA



YouTube: "Building Watson - A Brief Overview of the DeepQA Project"

Critiques of Turing Test (or AI in general)

- Misplaced emphasis on abstract reasoning rather than low-level perception and behaviour
  - Intelligence Without Reason (Brooks 1991)
- General Intelligence vs. Specific Modules
  - "How the Mind Works" (Pinker, 1997)
- Philosophical Objections to AI
  - Gödel's Theorem, Undecidability (Lucas 1961, Penrose 1989)
  - Chinese Room (Searle 1980)
  - "What Computers (Still) Can't Do" (Dreyfus 1972,1993)

Chess, Vision - Easy or Hard?

State of the art

Which of the following can be done at present?

- Play a decent game of table tennis (ping-pong)
- Drive in the center of Cairo, Egypt
- Drive along a curving mountain road
- Play games like Chess, Go, Bridge, Poker
- Discover and prove a new mathematical theorem
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish (or Chinese) in real time

Summary

- Artificial Intelligence has a long history in diverse areas of science as well as philosophy and literature
- Debates continue over the definition of Intelligence
- Significant progress has been made, but many challenges remain.