Artificial Intelligence

COMP3431
http://www.cse.unsw.edu.au/~cs3431

Lecturer

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Timetable

	Monday	Tuesday	Wednesday	Thursday	Friday
09:00 - 10:00					Tut CivEng G6 (**Colm**)
10:00 - 11:00					Tut CivEng G6 (**Jingying**)
11:00 - 12:00			Tut CivEng G6 (**Victor**)		Tut CivEng G6 (**Jingying**)
12:00 - 1300			Tut CivEng G8 (**Anna**)	Tut Business 130 (**Adam**)	Lecture CLB7
13:00 - 14:00			Tut CivEng G8 (**Anna**)	Tut Business 130 (**Adam**)	
14:00 - 15:00		Lecture CLB7			Tut Business 119 (**Lina**)
15:00 - 16:00					Tut Business 119 (**Lina**)
16:00 - 17:00		Tut Mathews 310 (**Oliver**)	Tut CivEng G6 (**Matt**)		Tut Business 119 (**Anchit**)
17:00 - 18:00		Tut Mathews 232 (**Oliver**)	Tut CivEng G6 (**Matt**)		Tut Business 119 (**Anchit**)
18:00 - 19:00		Tut Mathews 232 (**Gal**)			
19:00 - 20:00		Tut Mathews 232 (**Gal**)			

Course Outline

- Introduction & History

- AI Programming

- Search and Problem Solving

- Knowledge Representation and Reasoning

- Machine Learning

- Natural Language

- Robotics & Computer Vision

Texts & References

Recommended Text:

- David L. Poole and Alan K. Mackworth Artificial Intelligence: *Foundations of Computational Agents*, 2nd Edition

Additional reference material

- 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.

Assessment

- Assignments: 2 x 20 = 40%

  - Prolog programming

  - Application of an AI toolkit

- Exam: 60%

Assessment

- Assessment will consist of:

  - Assignments 2 x 20 = 40%

  - Final Exam 60%

- To pass, 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

Related Courses

- COMP3431 Robotic Software Architecture

- COMP4418 Knowledge Representation and Reasoning

- COMP9417 Machine Learning and Data Mining

- COMP9444 Neural Networks and Deep Learning

- COMP9517 Machine Vision

- 4th Year Thesis topics (incl RoboCup)

What is AI?

"... to investigate the fundamental laws of those operations of the mind by which reasoning is performed; to give expression to them in the symbolical language of a Calculus, and upon this foundation to establish the science of Logic and construct its method; to make that method itself the basis of a general method for the application of the mathematical doctrine of Probabilities; and, finally, to collect from the various elements of truth brought to view in the course of these inquiries some probable intimations concerning the nature and constitution of the human mind.

George Boole (1854)
An Investigation of the Laws of Thought

Artificial Intelligence:
The First 2,400 years

- Logic (Aristotle c. 350BC, Boole 1848, Frege 1879, Tarski 1935)

- Formal algorithms (Euclid c. 300BC)

- Probability theory (Pascal 17th C, Bayes 18th C)

- Utility theory (Mill 1863)

- Dynamical systems (Poincare 1892)

- Structural linguistics (Saussure 1916, Bloomfield 1933)

- Formal systems (Gödel 1929, Turing 1936)

- Neural networks (McCullogh & Pitts 1943)

- Cybernetics/Control theory (Wiener 1948)

- Game theory (von Neumann & Morgernstern 1947)

- Decision theory (Bellman 1957)

- Formal linguistics (Chomsky 1957)

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

- What is mind ? -- > mind is like a machine

- 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

- 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

- Humans and other animals are information processing machines

- Introspection

- Experiments

- What is intelligence?
(http://www.iqtest.com/)

- What is learning, memory, problem solving?

Foundations of AI
Linguistics

- Language use fits into the 'information processing machine' model

- Chomsky hierarchy

- Natural language processing

Foundations of AI
Neurobiology & Psychiatry

- Information processing in biological systems

- Nervous System

  - Molecular level (effects of drugs)

  - Cell circuit level

- Learning from disorders

- Brain scans (EEG/MEG/PET/MRI)

Foundations of AI
Cybernetics

- Intelligent behaviour as a control system

- Feedback mechanisms

- Predictive models

- Links to electrical and mechanical engineering

  - Mechatronics

Foundations of AI
# Computer Science

- Thought as computation

- Implementation of algorithms on a computer make theories operational

- Build computers and robots fast enough to make AI applications

Thought as Calculation

The only way to rectify our reasonings is to make them as tangible as those of the Mathematicians, so that we can find our error at a glance, and when there are disputes among persons, we can simply say: "Let us calculate", without further ado, to see who is right

Liebnitz (1685)
The Art of Discovery

Turing's Imitation Game
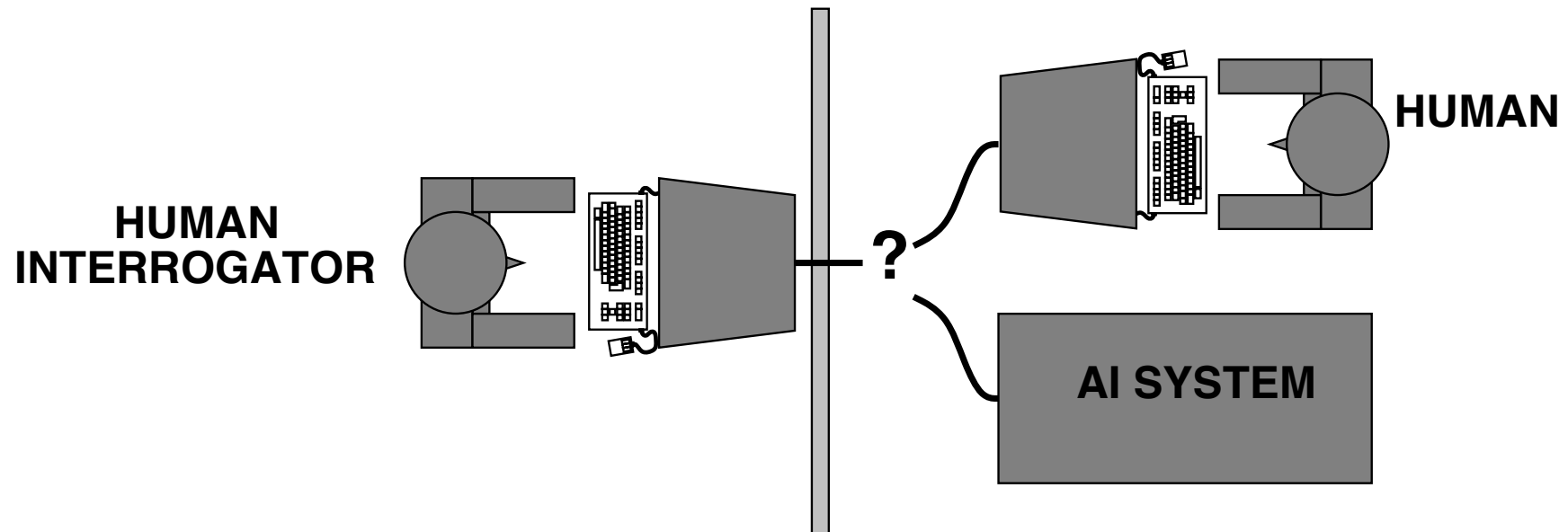
I believe that in about fifty years time [2000] it will be possible to programme computers with a storage capacity of about 10^9 to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after five minutes of questioning.

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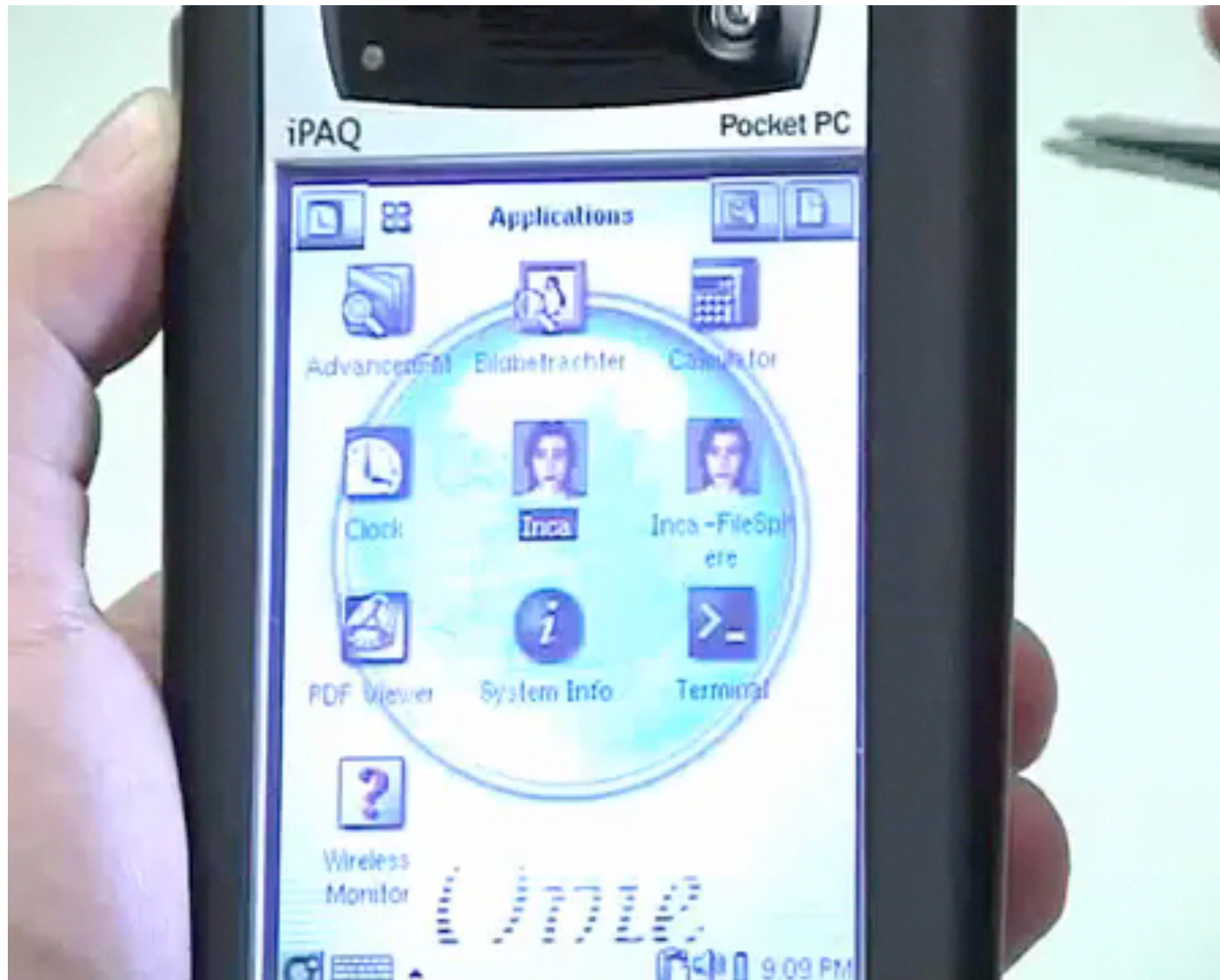...
Visitor: The trouble is, my mother's Irish.

Doctor: How long has she been Irish?

...

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

Doctor: How long has she been poodle?

Conversational Agents

The Child Machine

"Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's? If this were then subjected to an appropriate course of education one would obtain the adult brain. Presumably the child-brain is something like a note- book as one buys from the stationers. Rather little mechanism, and lots of blank sheets... Our hope is that there is so little mechanism in the child-brain that something like it can be easily programmed. The amount of work in the education we can assume, as a first approximation, to be much the same as for the human child."

Alan Turing (1950)
Computing Machinery and Intelligence

The World Brain

- "...a sort of mental clearing house for the mind, a depot where knowledge and ideas are received, sorted, summarized, digested, clarified and compared."

- "any student, in any part of the world, will be able to sit with his projector in his own study at his or her convenience to examine any book, any document, in an exact replica."

H.G. Wells (1937)
World brain: the idea of a permanent world encyclopaedia

Where has AI gone?

- More focussed on the world brain than the child machine

- Masses of data enable solving problems in ways we couldn't anticipate

  - E.g. Crowd-sourcing

  - Data centres have enormous computing power

Recent History

- Read Nils Nilsson's "The Quest for Artificial Intelligence"

  - https://ai.stanford.edu/~nilsson/QAI/qai.pdf

Agents and Autonomous Systems

- Complex behaviours in dynamic environments

- Have to integrate almost all aspects AI

- Combines computing with many other disciplines

Shakey

Freddy

Autonomous Systems