MONASH University
Information Technology

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FIT5047 – Intelligent Systems

Introduction to Artificial Intelligence Chapter 1

What is Intelligence?

An entity is intelligent if

- **It can communicate**
- **It has internal knowledge**
- **It has world knowledge**
- **It has intentions and plans to fulfill these intentions**
- **It has creativity**

FIT5047 Intelligent Systems

This unit introduces the main problems and approaches to designing intelligent software systems including

- **automated search methods**
- **knowledge representation and reasoning**
- **reasoning under uncertainty**
- **machine learning paradigms**
- **(recommender systems)**

What is Artificial Intelligence (AI)?

- ***AI is the study of mental faculties through the use of computational models***

  Charniak and McDermott, 1985

- ***AI is the study of how to make computers do things that (at the moment) humans do (better)***

  Rich and Knight, 1991

- ***AI is the science of making computers act like the ones in the movies***

  Anonymous

AI is 20 years away

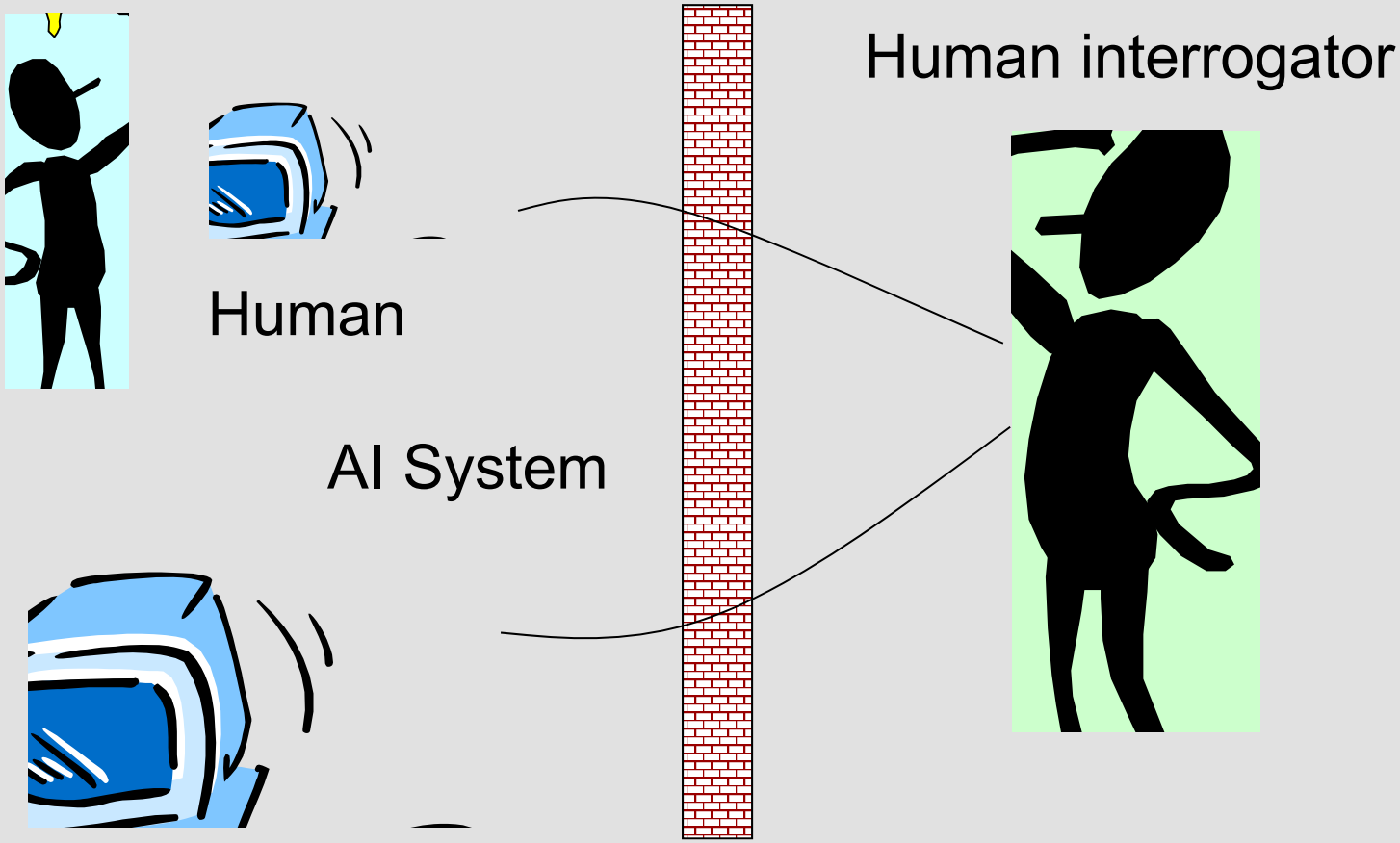
Goals of AI Practitioners

- **Find out about the nature of intelligence**
- **Build an intelligent machine**

Build systems that	
Think like humans	Think rationally
Act like humans	Act rationally

Acting Humanly: The Turing Test (I)

Turing test (1950)



Acting Humanly: The Turing Test (II)

Turing (1950)

- **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**

☺ **Suggested major components of AI: knowledge, reasoning, language understanding, learning**

☹ **Not reproducible, constructive, or amenable to mathematical analysis**

Acting Rationally

- **Rational behaviour: doing the right thing**
  - The right thing: that which is expected to maximize goal achievement, given the available information
- **Aristotle (Nicomachean Ethics):**
  Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good

Rational Agents

- **An agent is an entity that perceives and acts**
- **Abstractly, an agent is a function from percept histories to actions:**

$$f: \mathcal{P}^* \rightarrow \mathcal{A}$$

- **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 → *bounded rationality***
  - design the best program for a given machine's resources

Autonomous Agency

- **Autonomy**
  - Ability to operate independently
- **Agency**
  - Having internal goal structure and external behaviour which generally serves to satisfy a goal structure
- **Requirements of autonomous agency**
  - Pragmatics
  - Generalization and specialization
  - Incremental learning
  - Goal-driven learning
  - Defeasibility (ability to change its mind)
  - Ability to deal with uncertainty

Problems Attacked in AI

- **Representation** (all aspects)
- **Decoding** (all aspects)
- **Inference** (gen/spec, defeasibility, uncertainty)
- **Controlling combinatorial explosion** (all aspects)
- **Planning** (pragmatics, defeasibility)
- **Indexing** (pragmatics, gen/spec, defeasibility)
- **Prediction and recovery** (learning, defeasibility)
- **Dynamic modification** (learning, defeasibility)
- **Generalization**
- **Curiosity** (all aspects)
- **Creativity** (all aspects)

Subfields of AI

- **Methods**
  - Knowledge Representation (Logic, Bayes Nets, Semantic nets)
  - Reasoning (Logic, Bayes Nets, Spreading activation)
  - Planning / decision making (Goal-based planning, Markov decision processes)
  - Search (A*, simulated annealing, genetic algorithms)
  - Machine Learning (Artificial neural networks, decision trees, Naïve Bayes, Reinforcement learning)
- **Applications**
  - Natural Language Processing (NL Understanding, NL Generation, machine translation, sentiment analysis)
  - Decision support systems
  - Data mining
  - Game playing
  - Robotics, Vision

History of AI (I)

- **1943 Perceptrons/Neural nets/Connectionism (McCulloch and Pitts 1943, Rosenblatt 1957)**
- **1950s Machine translation**
- **1950 Turing initiated AI as a research area**
- **1956 Dartmouth conference: Birth of AI**
  - Origin of *Artificial Intelligence* as a name
- **1963 Checkers playing (Samuel 1963)**
- **1963 Theorem Prover (Newell 1963)**
  - GPS - General Problem Solver (Newell, Shaw & Simon) Basic technique: Means-ends analysis
- **1964 Bayesian inference applied to authorship attribution (Mosteller and Wallace 1964)**
- **1965 Robinson's complete algorithm for logical reasoning**

History of AI (II)

- **1966-74 AI has a reality check: no world knowledge and computational complexity**
- **1974 Neural networks research almost disappears**
- **1969-79 Knowledge-based systems**
- **1980-88–now AI becomes an industry: Expert systems, vision systems, robots**
- **1988-93 "AI Winter" – failure to deliver**
- **1986–now Neural networks return to popularity**
- **1987–now Resurgence of probability; general increase in technical depth**
  - "Nouvelle AI": ALife, Genetic Algorithms, soft computing
- **1995–now Intelligent agents**
- **2001–now Big data, Deep learning**

State of the Art (I)

- **Autonomous agents**
  - Smart spaces/ambient intelligence
  - Smart personal assistants
- **Data mining (business intelligence)**
- **Machine learning applications**
  - e.g., spam fighting, disease diagnosis (probabilistic expert systems)
- **Google's search engine (page ranking)**
- **Recommender systems (directed advertising)**

Ambient Intelligence

- *A world where people are surrounded by intelligent and intuitive interfaces embedded in the everyday objects around them. These interfaces recognize and respond to the presence and behavior of an individual in a personalized and relevant way.*
  Pattie Maes, MIT
- *Ambient intelligence is the vision that technology will become invisible, embedded in our natural surroundings, present whenever we need it, enabled by simple and effortless interactions, attuned to all of our senses . . .*
  Weber et al. (2007)

Any sufficiently advanced technology is indistinguishable from magic.
Arthur C. Clarke

State of the Art (II)

- **Autonomous planning and scheduling (1991, 1999, 2004, 2008)**
- **Robotic vehicles – autonomous driving (1995, 2006, 2007, now)**
- **Robotics – Roomba (2002), packBot (2002)**
- **Game playing – Deep Blue defeated the world chess champion Garry Kasparov (1997), AlphaGo defeated the world Go champion Lee Sedol (2016)**
- **Statistical machine translation (2007)**
- **Winning Jeopardy – Watson (2011)**
- **Speech recognition – in restricted domains**

What we will do in this subject

- **Learn what some of the key problems in AI are**
- **Learn some of the key strategies for solving them**
- **Learn about typical applications**

Reading

- **Russell, S. and Norvig, P. (2010), *Artificial Intelligence – A Modern Approach* (3rd ed), Prentice Hall, Chapter 1**
- **Other references**
  - W.S. McCulloch and W. Pitts (1943) A logical calculus of the ideas immanent in nervous activity. *Bull Math Biophysics*, 5, 115-137
  - Alan Turing (1950) Computing machinery and intelligence. *Mind*, 59, 433-460. Reprinted many times (e.g., M. Boden (ed) *Philosophy of AI*, Oxford, 1990)
  - F. Rosenblatt (1957) The Perceptron. Report 85-460-1 Cornell Aeronautical Lab
  - M. Minsky and S. Papert (1969) *Perceptrons*. MIT
  - A. Newell & H.A. Simon (1976) Computer science as empirical inquiry. *Communications of the ACM*, 19. Reprinted in Boden
  - M. Boden (1977), *Artificial Intelligence and Natural Man*. Basic Books Inc.

Next Lecture Topic

- **Lecture Topic 2**
  - Intelligent Agents