MONASH University
Information Technology

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FIT5047: Fundamentals of AI

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, which should be consistent with such intentions**
- **It has creativity**

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

- **automated search methods**
- **knowledge representation and reasoning**
- **reasoning under uncertainty**
- **machine learning paradigms**

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

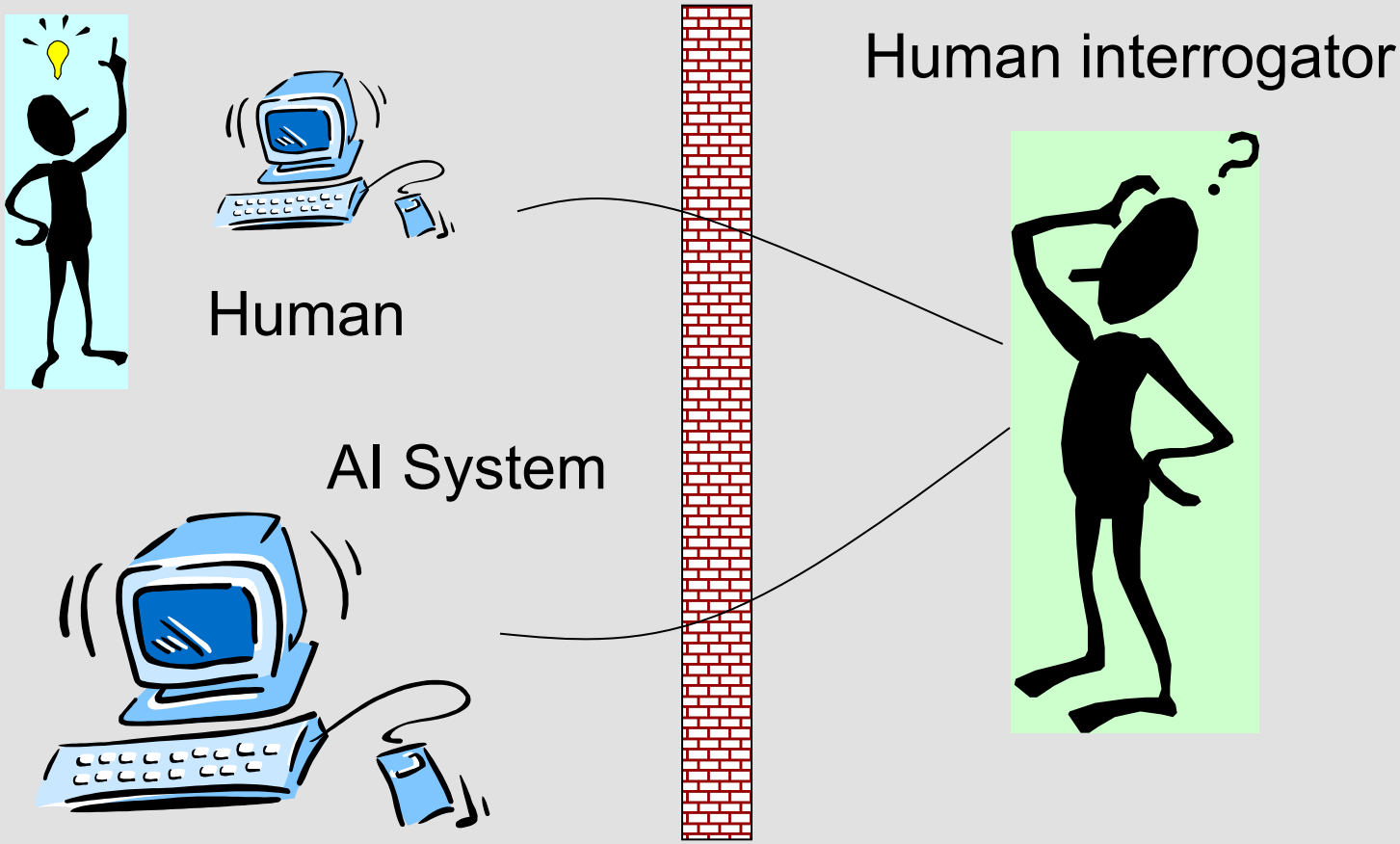
Goals of AI practitioners

- **Find out about the nature of intelligence**
- **Build intelligent machines**

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*

☺ **Suggested major components of AI: knowledge, reasoning, learning, communication/understand**

☹ **Not reproducible, not constructive, and not amenable to mathematical analysis**

Acting rationally

- **Rational behaviour: doing the best/right thing**
  - The right thing: that which is expected to maximize goal achievement, given the available information

- **Aristotle (Nicomachean Ethics):**
  Every art and 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(s) 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**
- **Decoding**
- **Inference**
- **Controlling combinatorial explosion**
- **Planning**
- **Indexing**
- **Prediction and recovery**
- **Dynamic modification**
- **Generalization**
- **Curiosity**
- **Creativity**

Subfields of AI

- **Methods**
  - Knowledge Representation (Logic, Bayes Nets, Semantic nets)
  - Reasoning (Logic, Bayes Nets, Spreading activation)
  - Planning / decision making (Goal-based planning, MDPs)
  - Search (A*, simulated annealing, genetic algorithms)
  - Machine Learning (Artificial neural networks, decision trees, Naïve Bayes, Reinforcement learning)
- **Applications**
  - Decision support/making systems
  - Data mining/science
  - Game playing
  - Robotics, Vision, NLP
  - Optimisation
  - Nowadays, pretty much anything!

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 no scaling up (high computational complexity)**
- **1974 Neural networks research almost disappears**
- **1969-79 Knowledge-based systems**
- **1980 AI becomes an industry:**
  Expert systems, vision systems, robotics
- **1986 Neural networks return to popularity**
- **1987 Probability is back; increase in technical depth**
  - "Nouvelle AI": ALife, Genetic Algorithms, soft computing
- **1995 Increase interest in agent-based systems**
- **2001 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)**

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 here

- **Learn what some of the key problems in AI are**
- **Learn some 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
  - A. Turing (1950) Computing machinery &intelligence. *Mind*, 59, 433-460. Reprinted many times (e.g., 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 (LN2)**
  - Intelligent Agents