



COMMONWEALTH OF AUSTRALIA

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# FIT3080 – 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**

# 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 an intelligent machine

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

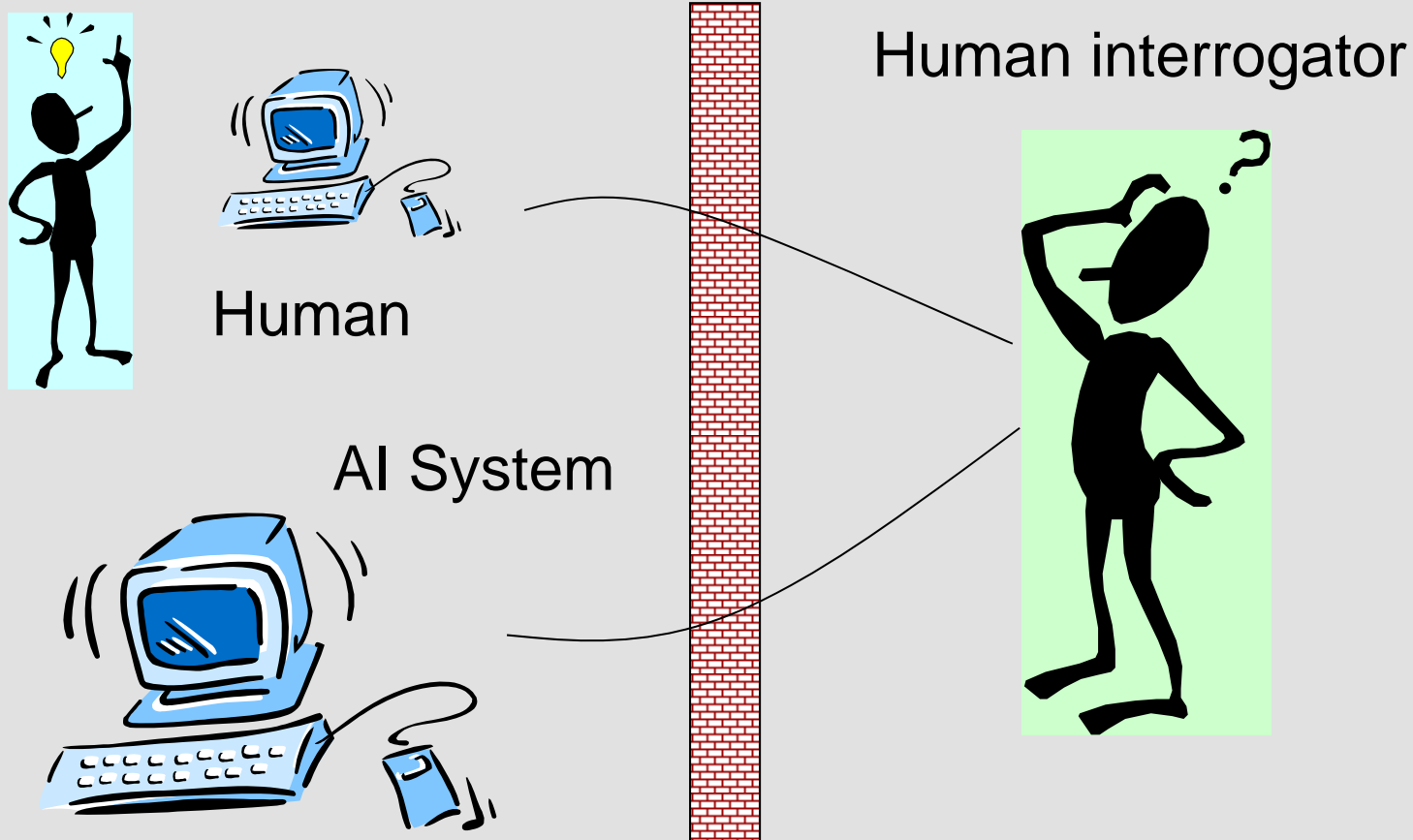
# Acting Humanly: The Turing Test (I)

## 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

# Acting Humanly: The Turing Test (II)

## Turing test (1950)



# 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  
→ 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
  - 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 (Semantic nets, Logic, Bayesian Networks)
- Reasoning (Spreading activation, Logic, Bayesian Networks)
- Planning
- Search (A\*, simulated annealing)
- Machine Learning (Artificial Neural Networks, decision trees, Naïve Bayes, Minimum Message Length Principle)

- **Applications**

- Natural Language Processing (NL Understanding, NL Generation, machine translation, sentiment analysis, discourse summarization)
- 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**
- **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**

# State of the Art

- **Logistics planning (1991)**
- **Game playing – Deep Blue defeated the reigning world chess champion Garry Kasparov (1997)**
- **Autonomous planning and scheduling (1999, 2004, 2008)**
- **Robotic vehicles – autonomous driving (2006, 2007)**
- **Robotics – Roomba (2002), packBot (2002)**
- **Machine translation (2007)**
- **Spam fighting – machine learning**
- **Winning Jeopardy – Watson (2011)**
- **Speech recognition – in restricted domains**

# Reading

- **Russell, S. and Norvig, P. (2010), *Artificial Intelligence – A Modern Approach* (3<sup>rd</sup> 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. *Comm ACM*, 19. Reprinted in Boden
  - M. Boden (1977), *Artificial Intelligence and Natural Man*. Basic Books Inc.



# Next Lecture Topic

- **Lecture Topic 1b**
  - Intelligent Agents

