

CSCU9YE - Artificial Intelligence



Lecture 1: Introduction to AI

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Content

- General introductions
- Modules' content and assessment
- What we will cover is a small part of AI - See timetable
- Resources for this lecture and the module in general
- Overview of AI
- What is AI?
- What is Machine Learning?
- Successful applications of AI

Module's Content and Assessment

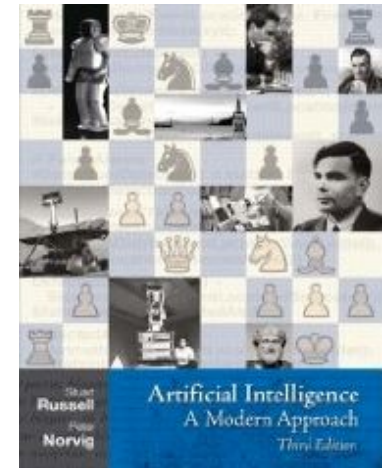
- What is Artificial Intelligence? The notion of an intelligent agent.
- Example Applications: natural language processing, robotics, games, autonomous cars.
- Problem-solving by searching, search methodologies.
- Machine learning: supervised vs. unsupervised
- Conclusions, future developments

Assessment

- Programming Assignment (50%) (teams of 2 allowed)
- Labs, attendance, not evaluated but contribute to assignment
- Examination (50%)

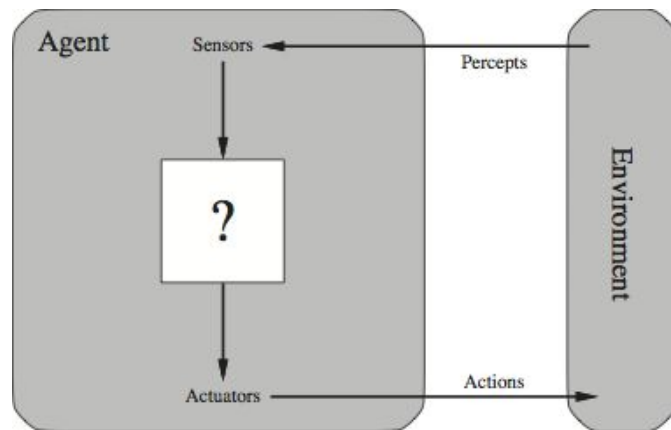
Resources

- For this lecture (Chapter 1)
 - **Artificial Intelligence: A Modern Approach**, Stuart Russell and Peter Norvig, Prentice-Hall, (Any Edition): 2nd(2003), 3rd (2010)
 - See reading list on Canvas for Books on each topic
- Links and websites
 - [AIMA Home](#)
 - AIMA [Chapters](#)



AIMA book: a unified approach to AI - Intelligent Agents

- Each such agent implements a function that maps percept sequences to actions
- The book covers different ways to represent these functions, such as reactive agents, real-time planners, and decision-theoretic systems.
- Role of learning as extending the reach of the designer into unknown environments,



AI as the study of agents that receive precepts from the environment and perform actions.

AIMA book structure - an overview of AI

Part I Artificial Intelligence

- 1 Introduction
- 2 Intelligent Agents

Part II Problem Solving

- 3 Solving Problems by Searching
- 4 Beyond Classical Search
- 5 Adversarial Search
- 6 Constraint Satisfaction Prob.

Note: we will cover aspects of the parts highlighted in red

Part III Knowledge and Reasoning

- 7 Logical Agents
- 8 First-Order Logic
- 9 Inference in First-Order Logic
- 10 Classical Planning
- 11 Planning and Acting Real World
- 12 Knowledge Representation

Part IV Uncertain Knowl. and Reasoning

- 13 Quantifying Uncertainty
- 14 Probabilistic Reasoning
- 15 Probabilistic Reasoning over Time
- 16 Making Simple Decisions
- 17 Making Complex Decisions

AIMA book structure - an overview of AI

Part V Learning

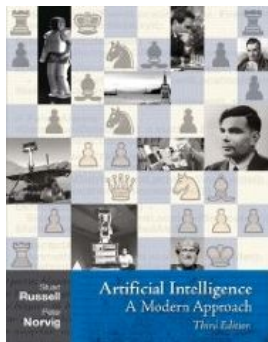
- 18 Learning from Examples
- 19 Knowledge in Learning
- 20 Learning Probabilistic Models
- 21 Reinforcement Learning

Part VI Communicating, Perceiving, and Acting

- 22 Natural Language Processing
- 23 Natural Language for Communication
- 24 Perception
- 25 Robotics

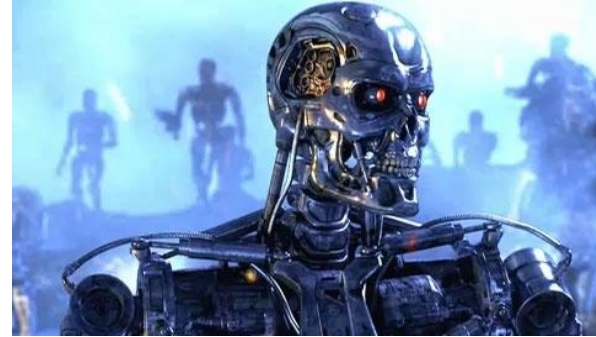
Part VII Conclusions

- 26 Philosophical Foundations
- 27 AI: The Present and Future



Science Fiction AI

- The top 20 artificial intelligence films - [in pictures](#)



What is AI?

Historically four different views. Building machines that:

1. **Thinking Humanly:** The cognitive modelling approach

- Studying how humans think
- Inside the actual workings of the human mind

3. **Thinking rationally:** The "laws of thought" approach

- Aristotle: what are correct arguments/thought processes?
- Logic: notation and rules of derivation for thoughts;

2. **Acting Humanly:** The Turing Test approach

- Turing test (1950), an operational definition of intelligence

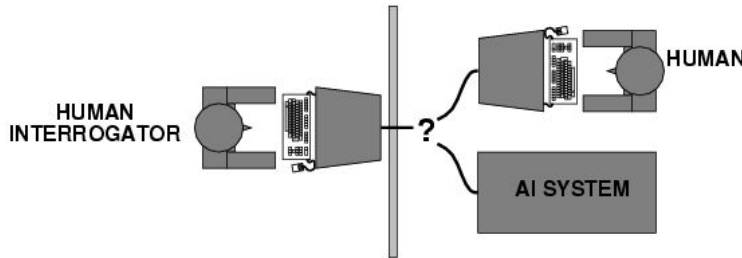
4. **Acting Rationally:** The rational agent approach

- An agent is just something that acts
- Rational agent: acts so as to achieve the best outcome



Acting humanly: Turing Test

- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game
- Suggested major components of AI: knowledge, reasoning, language understanding, learning



Acting rationally: rational agent

- **Rational** behavior: doing the right thing
- The right thing: that which is expected to maximise goal achievement, given the available information
- Doesn't necessarily involve thinking – e.g., blinking reflex – but thinking should be in the service of rational action

Foundations of AI

Philosophy

Notion that
knowledge can be
encoded in rules

Mathematics

Logic, theory of
computation,
probability

Economy

Utility theory
decision theory,
operations research

Neuroscience

Facts about how the
brain works

Cognitive Psychology

Brain as an information
processing device

Computer Engineering

Provided ever-more
powerful computers

Control theory and cybernetics

Devices that can operate
under their own control

Linguistics

Studies of how
language relate to
thought

Short history of AI

1940 - 1950: Early days

- 1943: McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing's "Computing Machinery and Intelligence"

1950 - 70: Excitement:

- 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956: Dartmouth meeting: Term "Artificial Intelligence" adopted
- 1965: Robinson's complete algorithm for logical reasoning

Short history of AI

1970 - 90: Knowledge-based approaches

- 1969—79: Early development of knowledge-based systems
- 1980—88: Expert systems industry booms
- 1988—93: Expert systems industry busts: “AI Winter”

1990 - : Statistical approaches

- Resurgence of probability, focus on uncertainty
- General increase in technical depth
- Agents and learning systems... “AI Spring”?

2000—: Where are we now?

What can AI do?

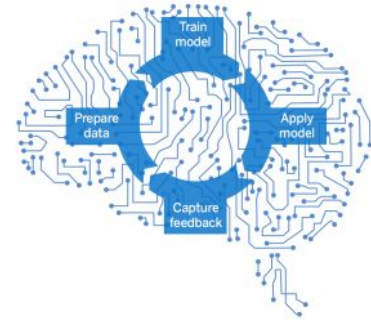
Quiz: Which of the following can be done at present?

- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ? Drive safely along a busy main road ?
- ✓ Buy a week's worth of food on the web?
- ✗ Buy a week's worth of food at an open market?
- ? Discover and prove a new mathematical theorem?
- ✗ Converse successfully with another person for an hour?
- ? Perform a surgical operation?
- ✓ Put away the dishes and fold the laundry?
- ✓ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?

Adapted from:
Dan Klein and Pieter Abbeel for
CS188 Intro to AI at UC
Berkeley. All materials
available at
<http://ai.berkeley.edu>.

What is Machine Learning?

- A form of AI that allows computers to *learn* (improve their performance at specific tasks) from examples, data and experience.
- Machine learning systems can carry out complex process, by learning from data, rather than following pre-programmed rules.
- Recent advances and importance



WHAT IS MACHINE LEARNING

THE
ROYAL
SOCIETY



The Royal Society:
[Machine Learning](#)

Successful Applications of AI

- Natural language processing, voice recognition
- Computer vision, image processing
- Robotics
- Self-driving cars
- Game playing
- Decision making

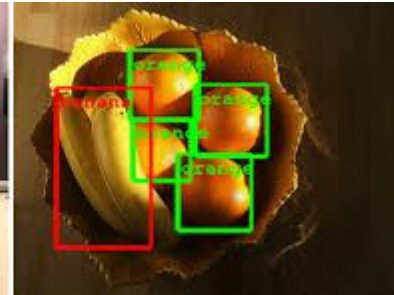
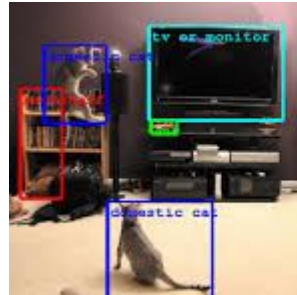
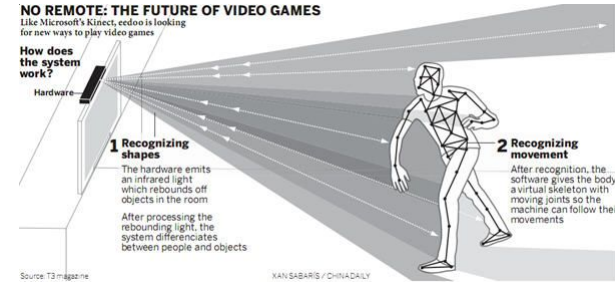
Natural Language

- Speech technologies
 - Automatic speech recognition (Alexa, Siri, Google)
 - Text-to-speech synthesis
 - Dialog systems
- Language processing technologies
 - Question answering
 - Machine translation
 - Web search
 - Text classification, spam filtering, etc...



Vision (Perception)

- Object and face recognition
- Scene segmentation
- Image classification
- Object tracking and behaviour recognition



YOLO (You Only Look Once) system :

https://www.ted.com/talksjoseph_redmon_how_a_computer_learns_to_recognize_objects_instantly

Robotics

- Robotics
 - Part mech. eng.
 - Part AI
 - Reality much harder than simulations!
- Technologies
 - Vehicles
 - Rescue
 - Soccer!
 - Lots of automation...



Robotics Demos

- The DARPA Robotics Challenge
 - <http://www.theroboticschallenge.org/>
- Football Robocup
 - <https://www.youtube.com/watch?v=6EWPkQKHfU> (5 min)
 - <https://www.youtube.com/watch?v=plB72Smu0H8>
- iRobot corporation. Roomba® Vacuum Cleaning Robot
 - <http://www.irobot.co.uk/home-robots/vacuum-cleaning>
- Self-driving car
 - <http://www.google.com/selfdrivingcar/>
- Boston Dynamics
 - Atlas: <https://www.youtube.com/watch?v=rVlhMGQgDkY>
 - Spot: <https://www.youtube.com/watch?v=M8YjvHYbZ9w>

Game Playing (board games)

DeepBlue by IBM

- 1996: Kasparov Beats Deep Blue (IBM)
- 1997: Deep Blue vs. Kasparov
- First match won against world champion
- “Intelligent creative” play
- 200 million board positions per second

AlphaGO by Google

- More complex, much more board positions
- 2016: beats a human professional GO player
- 2017: Defeats the World champion
- Highly inventive winning moves”



VIDEO GAME AI



Game Playing (Video Games)

- To generate responsive/intelligent behavior in non-player characters (NPCs)
- Games often implement classical AI techniques such as pathfinding

Decision Making

Applied AI involves many kinds of automation. Many useful Applications!

- Scheduling, e.g. airline routing, military
- Route planning, e.g. Google maps
- Medical diagnosis
- Web search engines
- Spam classifiers
- Automated help desks
- Fraud detection
- Product recommendations
- ... Lots more!



NASA's Mars Rover Curiosity: Historic Landing:
<https://www.youtube.com/watch?v=oNviFQpRvwQ>

Summary

- Historically different views of AI
 - Thinking vs. Behaviour
 - Humans vs. Ideal Standard (Rationality)
- We consider AI related to **rational action**.
- An **intelligent agent** takes the best possible action in a situation.
- **Several succesful applications of AI**: natural language processing, computer vision, self-driving car, robotics, recommender systems, decision making, game playing