

Introduction

Murray Shanahan

Overview

- What is artificial intelligence?
- Aims and contents of the course
- History of AI
- The state of the art

What Is Artificial Intelligence?

- Most interesting things are hard to define (except in mathematics). However, it's useful to make the attempt
- *Artificial intelligence* is the study of how to program computers and robots to carry out tasks considered to require intelligence in humans
- This is somewhat circular. So ...
- *Intelligence* is the ability to make good decisions and attain goals in a large variety of environments
- Much of AI concerns systems are *specialised* for particular tasks. But the grand aim is human-level *general* artificial intelligence

Course Aims

- By the end of the course you should have a broad understanding of
 - the nature of the field of artificial intelligence
 - the major methodological approaches
 - the state-of-the-art and current challenges
- You should also have acquired the practical ability to deploy a number of AI techniques
 - search
 - planning
 - knowledge representation
 - learning
- And you should be familiar with the fundamental concepts and the basic terminology deployed in the field

The Content of the Course

MS = Murray Shanahan, FT = Francesca Toni

- Introduction (MS)
- AI methodologies (MS)
- Search (MS)
- Planning (MS)
- An application: the semantic web (FT)
- Knowledge representation (FT)
- Machine learning (FT & MS)

AI hype

A New AI Spring?

- Interest in AI tends to go in cycles of hype and disappointment
- There were “AI Winters” in the late 1970s and late 1980s / early 1990s
- Lately AI has been getting a lot of attention again
 - Investment
 - Media
 - Movies

Investment in AI

- Google buys DeepMind for £400,000,000
- Google buys six robotics companies, including Boston Dynamics
- Facebook and Baidu set up AI labs and hire machine learning gurus



AI in the Media



Stephen Hawking



Elon Musk

“Success in creating AI would be the biggest event in human history. Unfortunately, it might also be the last, unless we learn how to avoid the risks.”

“Hope we’re not just the biological boot loader for digital superintelligence. Unfortunately, that is increasingly probable.”

AI in the Movies



Ex Machina



Transcendence



Her

AI history

The Origins of AI: Turing

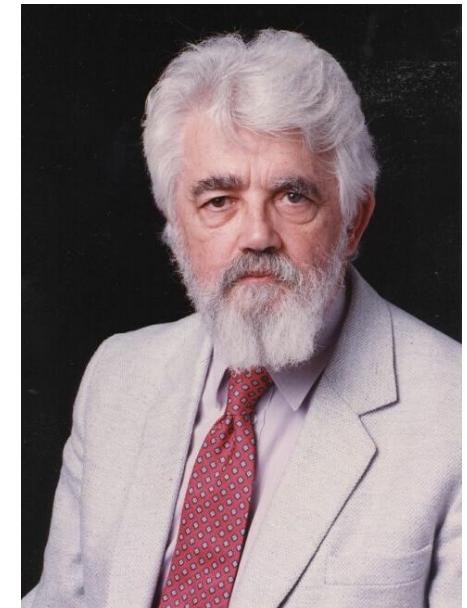
- But the birth of AI coincides with the birth of the digital computer. British mathematician Alan Turing inaugurated the field in his 1950 paper “Computing Machinery and Intelligence”. In the paper, he asks the question “Can a machine think?”
- Instead of answering the question directly, he replaces it with (roughly) the question “Could a machine playing a question-answer game fool a human into thinking it was not a machine?”
- This is the famous *Turing Test*
- Turing believed this was possible, and the paper confronts many counter-arguments



Alan Turing

The Origins of AI: McCarthy

- The term “artificial intelligence” was coined by U.S. computer pioneer John McCarthy
- McCarthy organised the *Dartmouth Conference* in 1956, which signalled the start of AI as a field
- He initiated one of the major AI methodologies – the *logic-based* approach, in which a system makes decisions based on symbolic reasoning with sentences of formal logic
- McCarthy invented the functional programming language *LISP*
- He also invented the *situation calculus* and discovered the *frame problem* (more on this in later lectures)



John McCarthy

An AI History (Abridged) 1

- 1950: Turing's "Computing Machinery and Intelligence"
- 1950s: Grey Walter's "tortoises"
 - The first autonomous robots – valves, not transistors
- 1956: The Dartmouth conference
 - McCarthy, Minsky, Newell, Simon & Shannon set the agenda
- Late 1960s to mid 1970s:
 - Resolution rule of inference, Prolog
 - The Shakey project (A robot that worked by reason and logic)
- Early 1980s to early 1990s: Expert systems and logic programming, the "fifth generation project", default reasoning

An AI History (Abridged) 2

- Late 1980s: Neural nets revival
- Early 1990s:
 - Biologically-inspired robotics
 - Agent-based systems
- 2000s:
 - Probabilistic robotics
 - Deep learning
- 2010s:
 - Big data
 - Artificial General Intelligence (AGI) revival

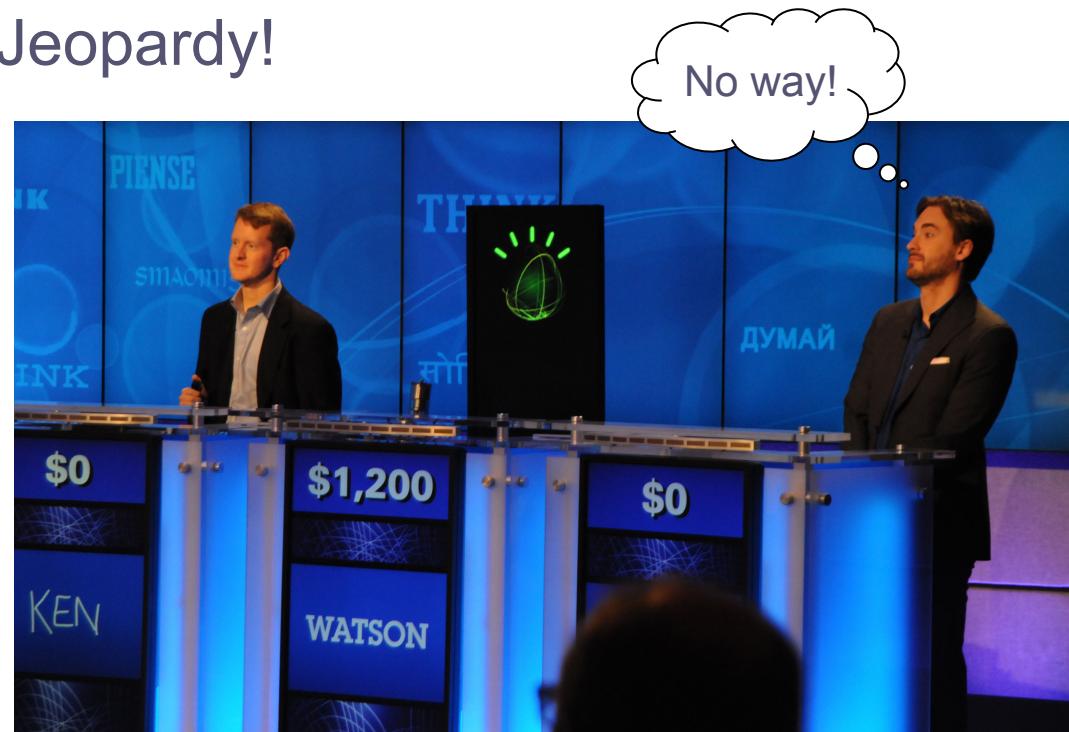
AI Landmarks 1

- 1997: IBM's Deep Blue beats the world chess champion
- Deep Blue was good at searching through many possibilities in a narrow domain



AI Landmarks 2

- 2011: IBM's Watson beats the reigning champion on the US quiz game Jeopardy!
- Impressive language understanding abilities, and capacity to sift large quantities of data



More Landmark AI Programs

- SHRDLU (early 1970s): Natural language understanding and reasoning
- Mycin (1970s): Rule-based expert system for diagnosis of diseases
- NetTalk (mid 1980s): Neural net that learned to pronounce words
- The CYC project (late 1980s onwards): A large database of “commonsense knowledge”
- Genghis (late 1980s): Hexapod robot that learned to walk
- Archon (early 1990s): Early agent-based system
- Deep Blue (1997): Defeated Garry Kasparov, world chess champion
- Self-driving cars (2007): DARPA urban challenge
- IBM Watson (2011): Defeated Jeopardy! quiz show champion
- DQN (2014): DeepMind’s deep reinforcement learning agent

The State of the Art

- Personal assistants (Siri, Google Now, Cortana)
 - Excellent speech recognition capabilities
 - Natural language understanding
 - Access to encyclopedic knowledge
 - Use of personal information on your device
- Self-driving cars
 - Work out the structure of the world from cameras and other sensors
 - Use this information to control a robot (a self-driving car is a kind of robot)
- Machine learning and big data
 - Modelling human behaviour for marketing, etc

Towards human-level AI

Clever! But not that Clever

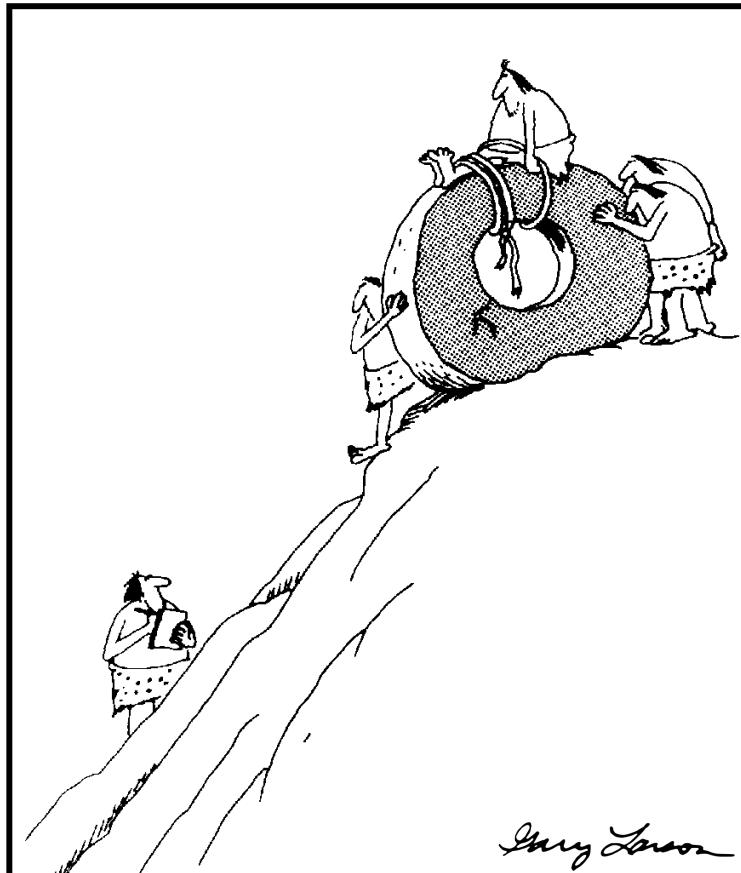
- Deep Blue was good at chess, but it couldn't make breakfast (unlike Garry Kasparov), nor could it
 - hold a decent conversation AND
 - change a lightbulb AND
 - write a computer program . . .
- Nor could it (nor can any state-of-the-art AI system) learn to carry out *completely new* tasks
- This would require artificial *general* intelligence (AGI)
- So what's missing?

Embodiment

- Apple's Siri and Google Now are disembodied
- Human intelligence is
 - embedded in a *sensorimotor loop*
 - grounded in real-time interaction with a world full of *complex physical objects* (including other people)



Creativity and Common Sense



Early experiments in transportation

- General intelligence is *adaptive*
- Learning through exploration is key to adaptation
- It requires *creativity*, the ceaseless tendency to try out new things
- General intelligence also requires *common sense*, the ability to predict the consequences of actions

Building Human-level AI

- There are various ways we might attempt to build a human-level AI
 - Engineer it from scratch
 - Copy nature (brain-inspired AI)
 - Do a bit of both (a hybrid approach)
- There are several approaches to trying to engineer human-level AI
 - Classical symbolic AI
 - Behaviour-based AI
 - Machine learning

Reading

Russell, S. & Norvig, P. *Artificial Intelligence: A Modern Approach*, 3rd Edition, Prentice Hall (2010). *Takes a traditional approach, concentrates mainly on classical AI, and is very thorough*

Poole, D. and Mackworth, A. *Artificial Intelligence: Foundations of Computational Agents*, Cambridge University Press (2010). *Not as thorough as Russell & Norvig, but covers much of the basic subject matter in fewer pages*