Artificial Intelligence

Introduction

"Artificial Intelligence - A Modern Approach", Chapter 1

Slides by Carlos Grilo

Object and goals

- Object
  - Intelligent entities
- Goals
  - Understand how they operate
  - To build intelligent entities

Approaches to AI

	Human	Rational
Think	The exciting new effort to make computers think... (Haugeland 1985)	The study of computations that make it possible to perceive, reason and act (Winston 1992)
Act	The study of how to make computers do things at wich at the moment people are better (Rich & Knight 1992)	The study and construction of rational agents (Russell & Norvig 1995)

"By distinguishing between *human* and *rational* behavior, we are not suggesting that humans are necessarily "irrational" in the sense of "emotionally unstable" or "insane". One merely need note that we are not perfect: not all chess players are grandmasters; and, unfortunately, not everyone gets an A on the exam."

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Thinking humanly

- Goal: simulation of the human way of reasoning
- Needs scientific theories about the human brain activity (cognitive science & cognitive neuroscience)
- One needs to define the abstraction level at which human reasoning should be modeled (circuits ←→ knowledge)
- Historical real example of this approach: the General Problem Solver Herbert Simon, J. C. Shaw and Allen Newell (1957)

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Acting humanly

- Goal: simulation of the human behavior
- Question: How can we verify if the goal has been reached?
- Turing test (Alan Turing, Computing Machinery and Intelligence, 1950)
  - Designed to provide a satisfactory operational definition of intelligence
  - A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer

Acting humanly

- Turing suggested that a machine should have the following capabilities in order to pass the test:
  - Automated reasoning
  - Knowledge representation
  - Machine learning
  - Natural language processing

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And me,

Am I not rational?

Thinking rationally

- Goal: to build agents that generate irrefutable reasoning (logic reasoning)

- Problems with the usage of logic:
  - It's not easy to represent informal knowledge formally, as logic demands
    - **Example**: it's difficult to represent uncertainty
  - It can be impractical to solve real problems
  - Not all intelligent behavior is logical…

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Acting rationally

- Goal: to build agents that perform tasks in a rational way
- A rational agent acts so as to achieve the best possible outcome or, when there is uncertainty, the best expected outcome
- Differences between acting and thinking rationally:
  - Sometimes there is no probably "right" thing to do but something must still be done
  - In some situations there is no time to think: one can only react (ex.: react to the contact with a very hot surface)

AI foundations

- Philosophy: Aristoteles, Decartes, dualism, materialism, theories about knowledge, empirism, connection between knowledge and action
- Mathematics: computation, logic, probability, decision theory
- Psychology: behaviorism, cognitive psychology
- Computational linguistics: useful for the representation of knowledge and in the study of natural language; how to deal with language ambiguity?
- Computer engineering, neuroscience, economics…

AI foundations: Mathematics

- Mathematical algorithms (Al-Khowarazmi, 9th century)
- Logic, logic inference
- Studies about the impossibility of asserting the truth of some statements
- Turing machine (capable of excuting any “computable” function)
- Impossibility of dealing with certain problems (dimension)
- Probability theory
- Decision theory

AI foundations: Psychology

- Introspection (reasoning processes)
- Behaviourism – only observable behavior should be studied (good results with animals…)
- Cognitive psychology – views the brain as an information processing device

“Ziped” history of AI

- 1943 – 1956: Gestation and birth
  - 1943 – W. McCulloch and W. Pitts proposed a model of artificial neurons
  - 1949 – Donald Hebb, “The Organization of Behvior”, Hebb’s rule
  - 1950 – Alan Turing, “Computing Machinery and Intelligence”, opened the doors to the field that would be called AI; The “Imitation Game” later called Turing test
  - C. Shannon and A. Turing were already writing programs to play chess (even without access to computers…)
  - During the 1950s, A. Newell and H. Simon developed a program capable of proving mathematical theorems
  - In 1956 there was a workshop where the name “Artificial Intelligence” was born

“Ziped” history of AI

- 1952 – 1969: Early entusiasm, great expectations
  - In this period many problems were solved whose resolution by computers was considered to be impossible
  - A. Samuel developed a program that learned to play checkers at strong amateur level (being able to beat him also)
  - The Lisp programming language was created in this period
  - A. Newell and H. Simon developed the *General Problem Solver* having the goal of simulating human reasoning in the resolution of simple problems

“Ziped” history of AI

- 1952 – 1969: Early entusiasm, great expectations
  - 1962 – Frank Rosenblatt, “Principles of neurodynamics”, where perceptrons were “created”
  - Time Sharing (DEC)
  - Microworlds (problems solved in a controlled environment)
    - Most notable example: Blocks world

“Ziped” history of AI

- 1966 – 1974: A dose of reality
  - In 1958, H. Simon predicted that within 10 years a computer would be chess champion and a significant mathematical theorem would be proved by a computer!!
- However...
  - Programs knew nothing about their subject matter; They succeded by simple syntatic manipulations
    - Example: by simple syntatic manipulation, the sentence “The spirit is willing but the flesh is weak” was translated as “The vodka is good but the meat is rotten”…
  - The methods able to solve simple problems were not able to solve general and difficult problems

“Ziped” history of AI

- 1966 – 1974: A dose of reality
  - Computers had not enough computational power to solve “larger” problems
  - Difficulties due to computational limitations – genetic algorithms (“good” idea, but impossible to verify with existent hardware)
  - “Perceptrons” book (Minsky and Papert, 1969) that, among other things, address perceptron limitations
  - Strong decrease in AI research funding (the so called “AI Winter”)
  - (Only) in 1997 a computer beated the human chess world champion

“Ziped” history of AI

- 1969 – 1979: Knowledge based systems
  - It was realized the necessity of using knowledge about the problem to solve in order to achieve better results
  - Expert systems: systems intended to simulate the reasoning of an expert in a given area
    - Examples: Dendral (molecular structures identification), MyCin (bacteria identification)
  - Expert systems led to a strong effort in the development of knowledge representation methods
  - Creation of the Prolog programming language

“Ziped” history of AI

- 1980 – Present: AI becomes an industry
  - AI starts to pay: expert systems, robotics, vision systems
- 1986 – Present: The return of neural networks
  - It started mainly due to the Back-propagation algorithm
- 1987 – Present: AI adopts the scientific method
  - It is now more common to build on existing theories than to propose brand-new ones, to base claims on rigorous theorems or hard experimental evidence rather than on intuition, and to show relevance to real-world applications rather than toy examples

Some, just a few, AI applications

- Systems control
- Automated driving (especial case of systems control)
- Speech, image, writing recognition
  - Written/(online) speech translation
  - Failure detection
  - Disease diagnostics (isn’t a disease a failure?)
  - Robotics
  - Programs that win to the chess world champion
  - There is no more space in this slide...

Questions

- Is a program with 200 IQ more intelligent than humans?
- There are problems that are not tractable by computers because they demand too much resources and others that are probably impossible to solve. Is AI impossible?

Questions

- Turing test:
  - Does imitating a human actually prove intelligence?
  - Does it prove that the machine is sentient?
  - Is intelligence possible without passing the Turing test?