Foundations of Artificial Intelligence
2. Introduction: AI Past and Present

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2.1 A Short History of AI

2.2 AI Systems Past and Present

2.3 Summary

Introduction: Overview

Chapter overview: introduction
- ▶ 1. What is Artificial Intelligence?
- ▶ 2. AI Past and Present
- ▶ 3. Rational Agents
- ▶ 4. Environments and Problem Solving Methods

2.1 A Short History of AI

The Origins of AI

Before AI, philosophy, mathematics, psychology and linguistics
asked similar questions and influenced AI.

> Gestation of AI (∼1943–1956)
>
> With the advent of electrical computers, many asked:
>
> Can computers mimic the human mind?
>
> ⤳ Turing test

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60 Years of AI: 1950s

Dartmouth workshop (1956):
John McCarthy coins the term artificial intelligence
⤳ "official birth year" of the research area

early enthusiasm:

> Herbert Simon (1957)
>
> It is not my aim to surprise or shock you – but the simplest way I
> can summarize is to say that there are now in the world machines
> that think, that learn and that create. Moreover, their ability to do
> these things is going to increase rapidly until – in the visible future
> – the range of problems they can handle will be coextensive with
> the range to which the human mind has been applied.

Early Enthusiasm: General Problem Solver (GPS)

- ▶ GPS: developed in 1957 by Herbert Simon and Allen Newell
- ▶ goal: build a universal problem solving machine
  by imitating human problem solving strategies
- ⤳ first representative of "thinking humanly" approach to AI
- ▶ every formalized symbolic problem solvable in principle by GPS
- ▶ practice: GPS solves simple tasks like towers of Hanoi,
 but does not scale to realistic application problems

Video: ai02-figures/hanoi.mpeg

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60 Years of AI: 1960s and 1970s

- ▶ 1960s: "intelligent behavior" in many demonstration systems
  for micro worlds (e.g., blocks world)
- ▶ 1970s: systems for micro worlds fail to scale
- ⤳ "intelligent behavior" requires knowledge
- ⤳ knowledge-based systems

German: wissensbasierte Systeme, Mikrowelten

Micro Worlds: Blocks World (SHRDLU)

- ▶ SHRDLU understands natural language
- ▶ developed 1968–1970 by Terry Winograd at MIT AI Lab
- ▶ user dialog (via teletype) on blocks world
- ▶ graphical representation on screen

⤳ http://hci.stanford.edu/~winograd/shrdlu/
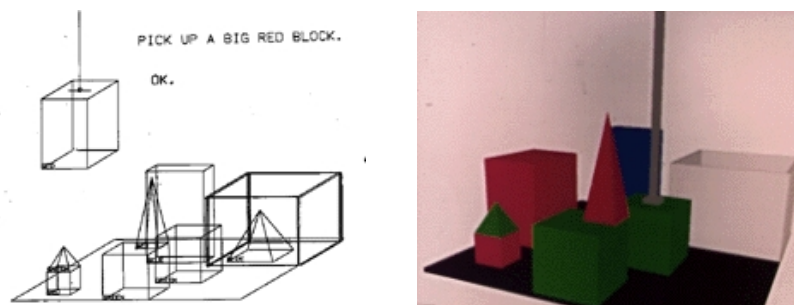
A SHRDLU Dialog

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Human: PICK UP A BIG RED BLOCK.
Computer: OK. [does it]
Human: GRASP THE PYRAMID.
Computer: I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.
Human: FIND A BLOCK WHICH IS TALLER THAN THE ONE YOU ARE
       HOLDING AND PUT IT INTO THE BOX.
Computer: BY "IT", I ASSUME YOU MEAN THE BLOCK WHICH IS
          TALLER THAN THE ONE I AM HOLDING.
Computer: OK. [does it]
Human: WHAT DOES THE BOX CONTAIN?
Computer: THE BLUE PYRAMID AND THE BLUE BLOCK.
Human: WHAT IS THE PYRAMID SUPPORTED BY?
Computer: THE BOX.
Human: HOW MANY BLOCKS ARE NOT IN THE BOX?
Computer: FOUR OF THEM.
Human: IS AT LEAST ONE OF THEM NARROWER THAN THE ONE
       WHICH I TOLD YOU TO PICK UP?
Computer: YES, THE RED CUBE.
...
```

60 Years of AI: 1980s

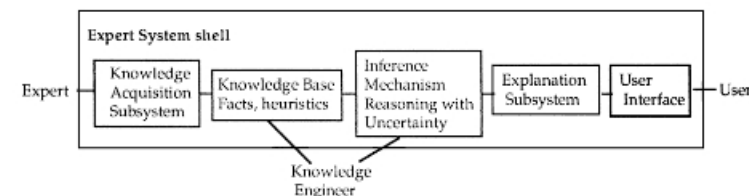1980s: AI gold rush

- ▶ commercial success of rule-based expert systems (e.g. R1)
- ▶ research boom, e.g., Fifth Generation Computer Systems project in Japan
- ▶ (second) heyday of neural networks
- ▶ end of 1980s: expert systems and other AI approaches less successful than hoped

⤳ AI winter

German: Expertensysteme, neuronale Netze, KI-Winter

Expert Systems

- ▶ knowledge acquisition: support for modeling expert knowledge
- ▶ knowledge base: database of facts and heuristic rules
- ▶ inference engine: reasoning mechanism; processes information in knowledge base to solve problems
- ▶ explanation system: explains conclusions of inference engine

German: Wissensakquise, Wissensbasis, Inferenz-Engine, Erklärungssystem

Expert Systems: R1/XCON

- ▶ **application area:** configuration of VAX computers according to customer specifications
- ▶ developed by John McDermott et al. (1978–1981)
- ▶ **input:** desired properties of the computer system
- ▶ **output:** specification of the computer system
- ▶ **inference engine:** simple forward chaining of rules

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DISTRIBUTE-MB-DEVICES-3

IF:   the most current active context is distributing massbus devices
&    there is a single port disk drive that has not been assigned to a massbus
&    there are no unassigned dual port disk drives
&    the number of devices that each massbus should support is known
&    there is a massbus that has been assigned at least one disk drive and that should support additional
     disk drives
&    the type of cable needed to connect the disk drive to the previous device on the disk drive is known

THEN: assign the disk drive to the massbus
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60 Years of AI: 1990s and 2000s

1990s and 2000s: AI comes of age
- ▶ advent of probabilistic methods
- ▶ agent-oriented approaches
- ▶ formalization of AI techniques
- ▶ better understanding of theoretical complexity
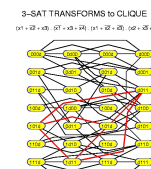- ▶ increased use of mathematical methods

Russell & Norvig (1995)
Gentle revolutions have occurred in robotics, computer vision, machine learning, and knowledge representation. A better understanding of the problems and their complexity properties, combined with increased mathematical sophistication, has led to workable research agendas and robust methods.
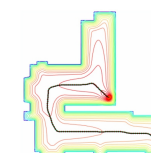
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60 Years of AI: 2010s

2010s: broad commercial viability and visibility in society
- ▶ Siri is major innovation of iPhone 4s
  "Siri: Back to the Future":
  https://www.youtube.com/watch?v=UBHgj9TuHXM
- ▶ self-driving cars are tested in real-world traffic
- ▶ AlphaGo beats leading human players
  https://www.nature.com/articles/nature16961
- ▶ debate on technological unemployment
  "Humans Need Not Apply":
  https://www.youtube.com/watch?v=7Pq-S557XQU

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60 Years of AI: Today

- ▶ many coexisting paradigms
  - ▶ reactive vs. deliberative
  - ▶ probabilistic vs. symbolic
  - ▶ often hybrid approaches
- ▶ many methods, often borrowing from other research areas
  - ▶ logic, decision theory, statistics, …
- ▶ many approaches
  - ▶ theoretical, algorithmic/experimental, system-oriented, …
- ▶ many success stories no longer count as "pure" AI
  - ▶ board games, logic programming, search methods, …

Focus on Algorithms and Experiments

Many AI problems are inherently difficult (NP-hard),
but strong search techniques and heuristics often solve
large problem instances regardless:

- satisfiability in propositional logic
  - 10,000 propositional variables or more
    via conflict-directed clause learning
- constraint solvers
  - good scalability via constraint propagation
    and automatic exploitation of problem structure
- action planning
  - 10^{100} search states and more by search
    using automatically inferred heuristics

2.2 AI Systems Past and Present

Example System (1996): Chess

Deep Blue vs. Kasparov (1996):

- first win of a chess computer
  against reigning world champion under
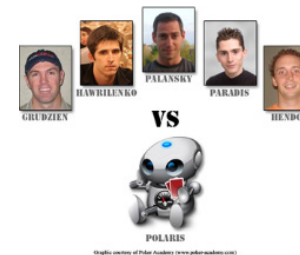 tournament conditions (time controls)

Deep Blue in Futurama:

`http://www.cc.com/video-clips/p1jk76/futurama-action-rangers`

Example System (2015): Poker

Cepheus (2015), developed at the University of Alberta,
"solves" heads-up limit Hold'em

Polaris vs. world-class players (2008)   Univ. of Alberta computer poker research group

`http://poker.cs.ualberta.ca/`

Example System (1998): Driving Cars

ALVINN (1998), developed by Dean Pomerleau et al., CMU,
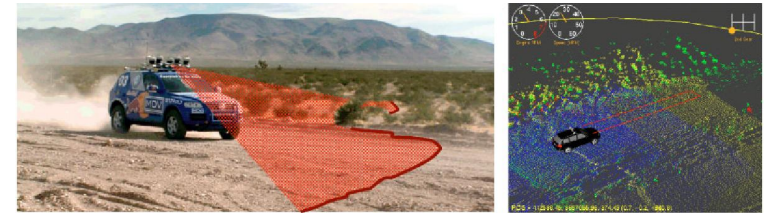keeps the lane for more than 4000 km

- ▶ semi-autonomic driving
- ▶ camera images, artificial neural networks

Example System (2005): Driving Cars

Stanley (2005) by Sebastian Thrun et al., Stanford University,
wins DARPA Grand Challenge (2'000'000 US$ prize)

- ▶ drives autonomously through Mojave desert
  (212 km, off-road)
- ▶ winning time: less than 7 hours

videos: `ai02-figures/stanley-1.avi, ai02-figures/stanley-2.wmv`

2.3 Summary

Summary

- ▶ 1950s/1960s: beginnings of AI; early enthusiasm
- ▶ 1970s: micro worlds and knowledge-based systems
- ▶ 1980s: gold rush of expert systems followed by "AI winter"
- ▶ 1990s/2000s: AI comes of age; research becomes
  more rigorous and mathematical; mature methods
- ▶ 2010s: AI systems enter mainstream