

ARTIFICIAL INTELLIGENCE 2006

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Talk

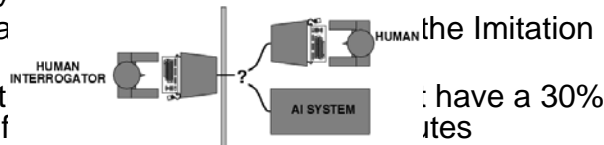
- What is AI?
- A brief history
- Use in Industry
- My work
- Future

What is AI?

- AI – a science/engineering of intelligence
 - In analogy to aeronautical engineering/flying
 - computer produces an “intelligent result”
- AI – model of “human/cognitive” system
 - Is done as a theory of human intelligence
 - computer mimics human intelligence

Acting humanly: Turing Test

- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" → "Can machines behave intelligently?"
- Operationa
Game
- Predicted t
chance of f
- Anticipated all major arguments against AI in following
50 years
- Loebner Prize
[://www.loebner.net/Prizef/loebner-prize.html](http://www.loebner.net/Prizef/loebner-prize.html)



Thinking humanly: cognitive modeling

- 1960s "cognitive revolution": information-processing psychology Newell and Simon GPS
- Requires scientific theories of internal activities of the brain
- -- How to validate? Requires
 - 1) Predicting and testing behavior of human subjects (top-down)
 - or 2) Direct identification from neurological data (bottom-up)

Thinking rationally: "laws of thought"

- Several Greek schools developed various forms of *logic: notation and rules of derivation* for thoughts; may or may not have proceeded to the idea of mechanization
- Direct line through mathematics and philosophy to modern AI -Boole
- Kleene, Church, Turing – McCarthy, Robinson

AI prehistory

- Philosophy Logic, methods of reasoning, mind as physical system foundations of learning, language, rationality
- Mathematics Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability
- Economics/OR utility, decision theory
- Neuroscience physical substrate for mental activity
- Psychology phenomena of perception and motor control, experimental techniques
- Computer Science building fast computers, algorithms
- Linguistics knowledge representation, grammar

Abridged history of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1950s Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1965 Robinson's complete algorithm for logical reasoning
- 1969—79 Early development of knowledge-based systems
- 1970 Industrial Robotics – painting/welding
- 1980 AI industry -Symbolics
- 1985 The emergence of modern learning
- 2003 iRobot – roomba- everyday robotics

State of the art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997 -IBM
- Proved a mathematical conjecture (Robbins conjecture) unsolved for decades -OTTER
- In 1995 No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego) CMU
- In 1998 720,000 industrial robots (UNIMATE 1963)
- 2003 ASE NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft EOS1
- Roomba- 2003 credible home robot

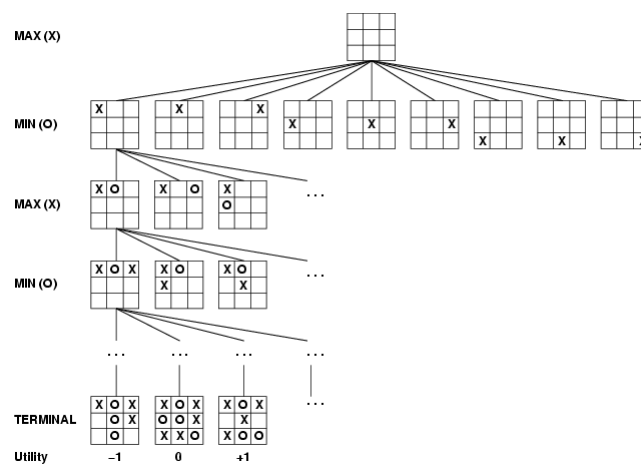
Achievements

- LISP, Time Sharing
- Games – early spacewar games 1962 first computer video game PDP1
- Intellectual Games – mastery in Chess, checkers, othello, backgammon, scrabble-
– But not(yet) Go or Poker
- MACSYMA –Mathematica, MATLAB
- DENDRAL(chemistry, medicine ... experts)
- Robotics
- Speech and Handwriting recognition

Basic Methods

- Logic – “All men are mortal “
 - Formal, with inference rules -McCarthy
- Heuristic – search, ad-hoc – domain specific rules – Michie, Nilsson, Pohl
- Learning – adaptive – Haussler, Warmuth
- Knowledge Frameworks(KE, Productions)
 - Minsky, Schank

Game Tree alpha-beta



Heuristic search

- Let us suppose that we have one piece of information: a heuristic function
 - $h(n) = 0$, n a goal node
 - $h(n) > 0$, n not a goal node
 - we can think of $h(n)$ as a “guess” as to how far n is from the goal

```
Best-First-Search(state,h)
nodes <- MakePriorityQueue(state, h(state))
while (nodes != empty)
  node = pop(nodes)
  if (GoalTest(node) succeeds return node
  for each child in succ(node)
    nodes <- push(child,h(child))
return failure
```

Michie 8-puzzle

- 8-puzzle: $h(n)$ = tiles out of place
- 1 2 3
- 8 4
- 7 6 5 goal

- $N!$ For N sliding tiles

1	2	3
8	6	
7	5	4

Search Performance

Heuristic 1:
Tiles out of place

Heuristic 1:
Manhattan distance*

Search Algorithm	expanded	solution length	expanded	solution length
Iterative Deepening			1105	9
hill-climbing	2	no solution found	10	8-Square 9
best-first	495	24	9	9

*Manhattan distance = total number of horizontal and vertical moves required to move all tiles to their position in the goal state from their current position.

3	2	5
	7	1
4	6	8

$$h1 = 7$$

$$h2 = 2+1+1+2+1+1+1+0=9$$

0	1	2
3	4	5
6	7	8

=> Choice of heuristic is critical to heuristic search algorithm performance.

My Work

- BIDIRECTIONAL SEARCH -1969-
- Focused Search G node – with Politowski 1984
- Piecewise search – with Ratner 1985
- Pohl-Warnsdorf method – Hamiltonians
- A* adversary analysis- 1969-
- Regular degree 3 recursively described adversaries – with Stockmeyer 2004

Games

- Games – Laird – games are a testbed for comprehensive AI – such as characters in FAÇADE – or opponents and teammates in Madden Football – Why?
- Funge – has a textbook will teach here next quarter

Ikuni - Funge

- John Funge is a co-founder and one of the lead scientists at a new Silicon Valley based company (ikuni) focusing on AI effects for computer entertainment. John successfully developed a new approach to high-level control of characters in games and animation. John is the author of numerous technical papers and two books on Game AI, including his new book [Artificial Intelligence for Computer Games: An Introduction](#).
- His current research interests include computer games, machine learning, knowledge representation and new democratic methods.

A Real Psychiatrist

- ELIZA – Weizenbaum
- Why – Colby – needed for autism, prisoners , ...
- Why not – Weizenbaum – alien and unfeeling – lacking human empathy
- Passing T-Test still seems 50 years off

Conclusions

- AI has been very successful and in many instances(robotics, speech) developed as a separate discipline
- Assisted expertise such as Chemistry experts systems (Wipke) and math experts – MATLAB , mathematica
- Failures – general AI, common sense reasoning – (Emperor's new mind – Penrose)
- Is it desirable?