ARTIFICIAL INTELLIGENCE
2008

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TIM October, 2008
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?"
- Operational test for intelligent behavior: the Imitation Game
- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Loebner Prize
  ://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
Search Performance

Heuristic 1:
Tiles out of place

Heuristic 1:
Manhattan distance*

*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.

\[ h_1 = 7 \]
\[ h_2 = 2+1+1+2+1+1+1+0=9 \]

=> 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?