Artificial Intelligence Definition and History

J. B. Pollack

Basic definition

- Circular Definition:
  - AI is the design and study of computer programs that behave intelligently

Marvin Minsky
Founding Father

- "The engineering of intelligent artifacts"
  - What about scientific questions?
  - What about moral questions?
  - What about Human intelligence?

Roger Schank
Founding Nephew

- Artificial Intelligence is what me and my friends work on, and that's not anything written in FORTRAN, or anything that Noam Chomsky does...

- What is in/out of the field depends on fashion?

Dreyfus, Searle, Penrose Anti-AI Philosophers

- AI is a non-sequitor, an impossibility
  - computers can't have common-sense
  - computers can't be conscious
  - computers can't really understand
  - god didn't create computers
  - they'll never be subject to evolution
  - Godel proved machines are incomplete
  - They don't use quantum phenomena right

AI as Alchemy -- Pre-scientific

- AI is a science in a very early phase, like alchemy, where no agreed upon methods of experimentation and validation exist, and credits assigned by political influence rather than by normative means

Lets Backtrack...

What is Intelligence????

- That which separates man from beast?
  - actually dogs are pretty smart
- A facet of survival and reproduction?
  - bacteria, ants are better
- Specific abilities which people have?
  - and computers don't or can't?
    - Once an ability is "defined well enough" a computer program can be built to specifiation. Addition, time-sharing, Gameplaying, theorem proving, were all seen as tests for AI.

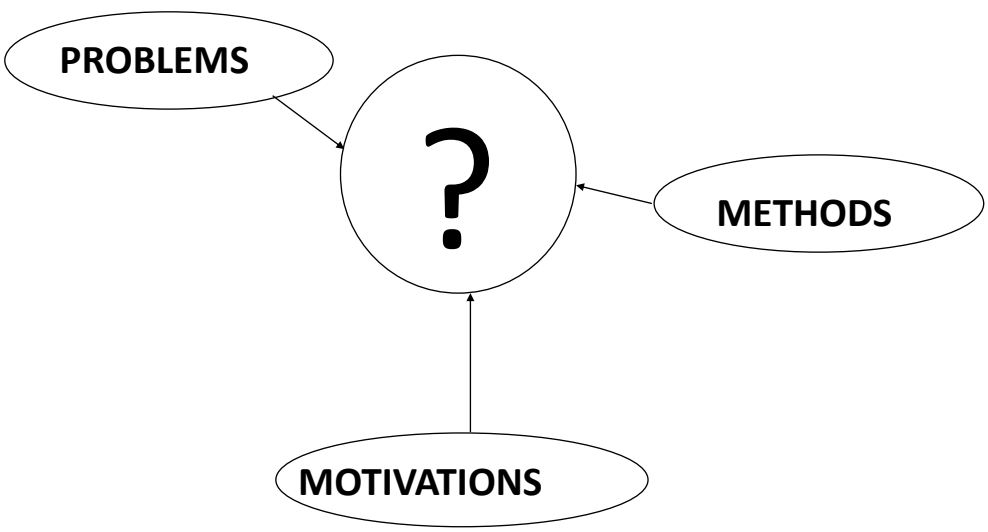
Mind is as Mind does

- Laundry List Approach:
  - Flexible Attention
  - Problem Solving
  - Mathematics
  - Gameplaying
  - Communication
  - Tool Design
  - Search (for food, mates)
    - Any element can be simulated quite well!

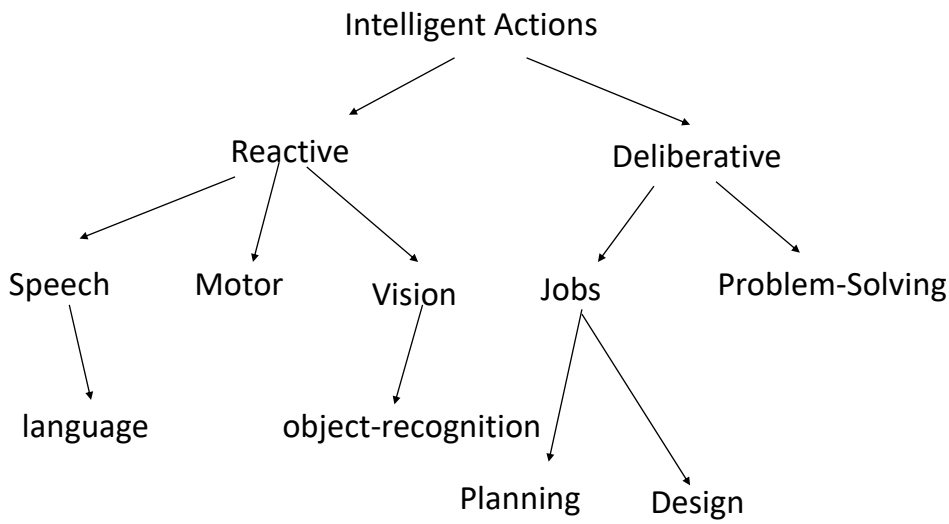
My Definition

- Intelligence is the asymptotic limit to mechanisms which perceive their environments, compress history into memory, and take actions to change their environment.
  - So a thermostat or an if-then-else statement captures a small amount of intelligence.

AI has been driven from 3 POV's

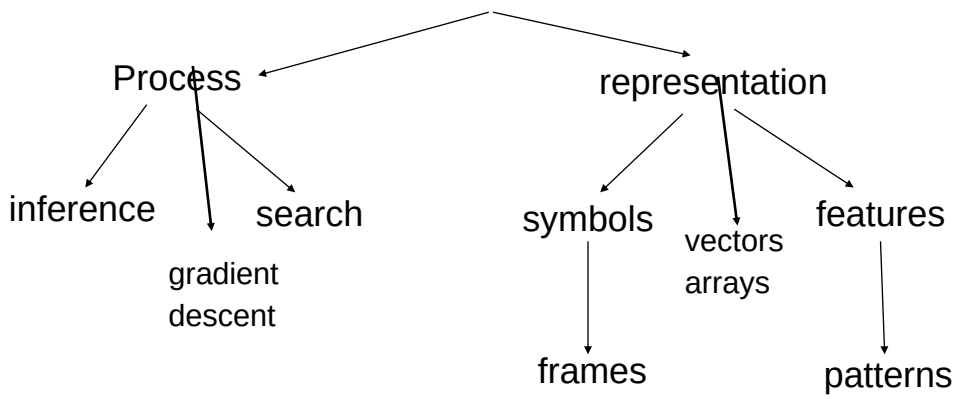


Problems



Methods

Arise when valuable for multiple problems



Motivations for AI

- Scientific
  - To understand both natural and artificial forms and their relationship
- Engineering
  - To build reliable artifacts which can coexist within human social structures
- Military
  - To build the robot army so our boys can stay home
- Commerce
  - To make money by manufacturing more mindful mass merchandise

What is an AI Technique?

- A collaboration of:
  - knowledge
  - search
  - representation
- resulting in programs which are:
  - flexible
  - extensible
  - clear
  - and maybe slower...

Roots of AI

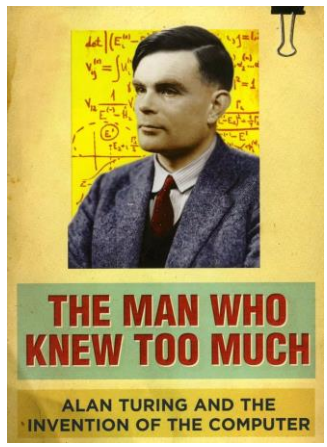
- Theories of the "Computable"
  - Turing, Church
- Logic of thought
  - Aristotle,Decartes,Boole
- Neural Nets, Automata theory
  - McCullogh, Von Neumann

If all computers calculate the same set of numbers

- First result in Theoretical CS:
  - Turing Machines
  - Register Machines (Von Neumann)
  - Lambda Calculus (Church, basis of lisp)
  - Production systems (Post, Chomsky)
- All reduce to each other, none can calculate something others cannot.
- QED: Mind is just a computer program too!

Alan Turing

- Worked on computers and code breaking in ww2
- Asked if machines could think in 1950!
  - anticipated many objections!
- Died in 1954, sadly, before...



Birth of AI

1956 Dartmouth Conference

- Newell & Simon
  - Rand Corp, CMU, general problem-solving
- Minsky
  - MIT AI Lab, Neural Machines
- McCarthy
  - Stanford, Theorem Proving, LISP
- Solomonoff
  - Independent, Founder of Learning Theory
- And Nash, Ashby, McCullogh, Shannon!!

Belief in AI is a Religion
Central Dogma: PSSH

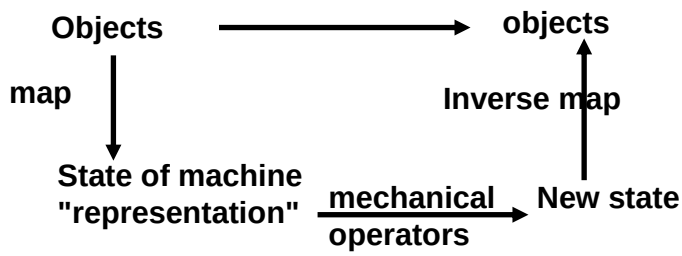
- With the right programming, computers will be able to think!
- ***Physical Symbol System Hypothesis***
- A Physical Symbol System has the necessary and sufficient means for intelligent action. (Newell & Simon 1976)

What is a physical symbol System?

- A machine which contains a collection of symbol structures and modification processes which can change those structures dynamically over time.
  - (e.g. bits in computer memory can MEAN, and programs can change their minds!)

Law of Representation

- Objects of Interest are MAPPED into bits/symbolic form, held as bits or state
- mechanical operations are performed *on the representations*
- Results hold through the inverse map



The Fifty's

- Exploration of multiple approaches
  - brain-like models
  - simple computer programs
  - automated philosophy
  - differential equations
  - polynomials

The Sixties

- Exhuberant Expectations
- Moonshot Mentality
- Wide open Field
- Good Funding during High Military Budget

Moonshot Madness?

- Creative Naming of programs
  - Logic Theorist
  - General Problem Solver
- General Approach
  - Weak methods that are domain independent
- Hot Predictions
  - Chess Master in 10 years
  - Machine Translation of Language in 5
  - Weather Prediction...

Lots was Learned, nevertheless

- AI will take time
- Domain Knowledge is very important
  - weak versus strong methods
- Lots of heuristic search algorithms
- Lots of pattern recognition mathematics

The Seventies

- Untimely end of Neural Models
- Soviet style "Five Year Plans"
  - Machine Translation
  - Speech Recognition
- Competition for funding
- Focus on Knowledge Representation
- First "Expert" Systems

The Eighties

- Heavy Commercialization
- New forms of Competition
- New Visions of Grandiosity

- IN FACT AI WAS IN A "BUBBLE" WHICH BURST IN 1986 LEADING TO "AI WINTER"
  - Just when I was looking for a faculty job!

AI industry in 1980's

- There were two attempts at making AI an "Industry"
  - Expert System Shell Companies
    - expert systems were carefully constructed collections of knowledge, together with an "inference engine". Capture knowledge of experts and allow novices to deliver it cheaper.
  - Lisp Machine Companies
    - In the era of large governement grants, special purpose computers (The first with bitmap screens and mice) were sold for $40-100K each.

Both took investments, both sectors collapsed, VC's said "Never Again!"

The Nineties

- No Explicit "AI" industry anymore
- Hidden AI inside normal commercial software
  - e.g HRBlock and Turbotax.
- World Class Backgammon and Chess
- Second wave of NN started in 1985

- First emergence of Machine Learning

- Heyday of Symbolic Approaches to Web data (spidering, semantic web)

Deep Blue (IBM) 1997

Inscrutable Conqueror

By ROBERT D. MCFADDEN MAY 12, 1997

When it was all over yesterday, when the greatest chess player in history had been crushed, the machine that had done it -- I.B.M.'s RS/ 6000 SP, alias Deep Blue -- did the magnanimous thing: it kept its monastic silence. After days of Man-versus-Machine hyperbole, those who had looked to Garry Kasparov as the last best hope could now only bemoan the coming days of ascendant computers.

AI in the Noughts

- Focus on Real World problems
- Internet Robots
- Massive Text Databases
- Management of Large SW projects
- DARPA Competitions
- EG Self-driving Cars (Autonomous Vehicles)
- Renewed power of Neural Net Learning Models
- Checkers is "Solved"
- ML becomes focus of large corporations intent on software improvement.

2006 50th anniversary of Dartmouth

- Paroxysm of self-examination
- 50 Anniversary Conferences
  - Dartmouth/AAAI
  - ai50.org
  - Bremen
- China, Japan, Spain,...
- Publication of (my) attack on business as usual "Mindless Intelligence" at http://Ectomental.com

AI in the Dimes (2010-)

- Neural Net learning has scaled (Deep Learning)
  - management of training sets
  - management of gradients
  - heavy use of GPU's
- Jeopardy and Go fall to machines
- Applications to HUGE datasets collected online
  - Google Translate
  - What's Playing (Song recognition)
  - Speech-to-text
  - Image classification and recognition of "Cats".

Every Commercial Success is hailed as "The" dawn of AI

Watson (IBM 2011)

Computer Wins on 'Jeopardy!': Trivial, It's Not

Carol Kaelson/Jeopardy Productions Inc., via Associated Press

Two "Jeopardy!" champions, Ken Jennings, left, and Brad Rutter, competed against a computer named Watson, which proved adept at buzzing in quickly.

By JOHN MARKOFF
Published: February 16, 2011

YORKTOWN HEIGHTS, N.Y. — In the end, the humans on "Jeopardy!" surrendered meekly.

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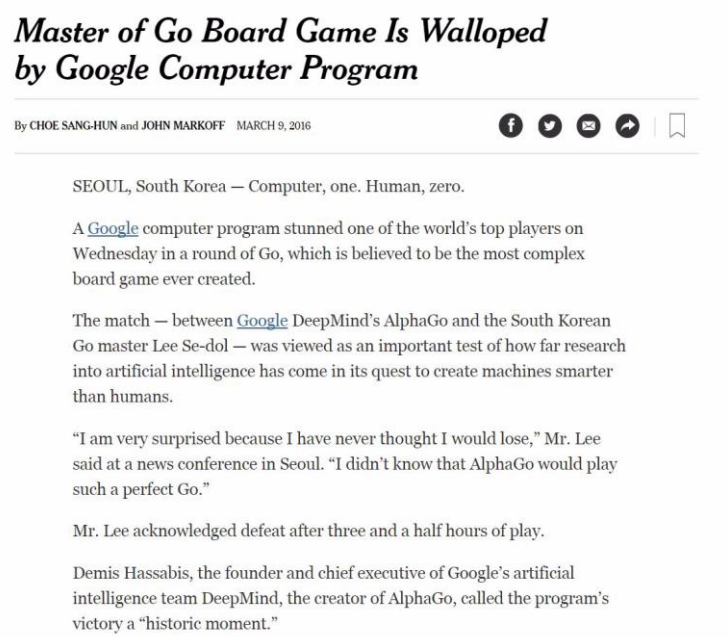
Back Story With John Markoff

Facing certain defeat at the hands of a room-size I.B.M. computer on Wednesday evening, Ken Jennings, famous for winning 74 games in a row on the TV quiz show, acknowledged the obvious. "I, for one, welcome our new computer overlords," he wrote on his video screen, borrowing a line from a "Simpsons" episode.

Multimedia

Alphago (Google 2016)



Master of Go Board Game Is Walloped by Google Computer Program

By CHOE SANG-HUN and JOHN MARKOFF MARCH 9, 2016

SEOUL, South Korea — Computer, one. Human, zero.

A Google computer program stunned one of the world's top players on Wednesday in a round of Go, which is believed to be the most complex board game ever created.

The match — between Google DeepMind's AlphaGo and the South Korean Go master Lee Se-dol — was viewed as an important test of how far research into artificial intelligence has come in its quest to create machines smarter than humans.

"I am very surprised because I have never thought I would lose," Mr. Lee said at a news conference in Seoul. "I didn't know that AlphaGo would play such a perfect Go."

Mr. Lee acknowledged defeat after three and a half hours of play.

Demis Hassabis, the founder and chief executive of Google's artificial intelligence team DeepMind, the creator of AlphaGo, called the program's victory a "historic moment."

the era of "deep" learning

- large and deep complex neural architectures
- extensive training sets
- millions of dollars in CPU and GPU Time
- surprisingly effective at certain tasks

Transformer Networks

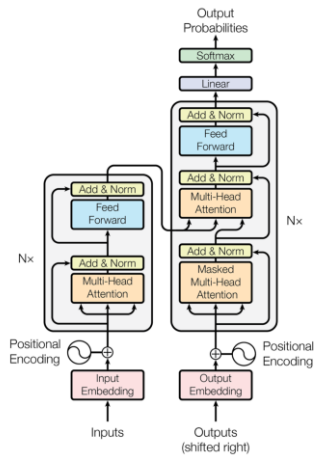


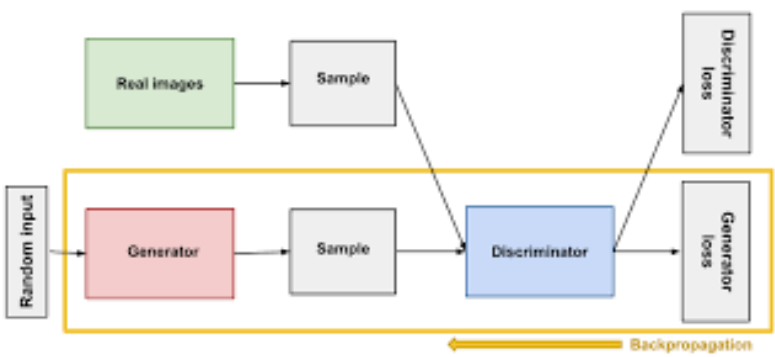
Figure 1: The Transformer - model architecture.

GPT3

- 175 billion weights, hundreds billions words
- feed it a prompt and it keeps going generating English.

- **Below is a screenplay for a film-noir hard boiled detective story by Raymond Chandler about the boy wizard Harry Potter:**
- **“Harry Potter”**
  By Raymond Chandler
- Harry Potter, Private Eye.
  Scene: A small dingy office, early morning, furniture of the Salvation Army store variety. Sordid atmosphere. Harry Potter, in ratty tweed suit, unpressed shirt, and unshined shoes, sits behind the desk looking haggard, rumpled, and embittered. In one corner of the office a torn shade rattles at the wind gusts outside. Harry has one long index finger on the butt of a .38 and he broods over a photograph. The photograph shows a gorgeous blonde wearing an evening gown. She is holding a cocktail in one hand and looking pensively at a cigarette in the other. A tear adorns her cheek. Harry looks at her for a long moment, sighs, then puts his gun down and stands. He straightens his clothes, scratches his head, then with more resolution turns around, picks up his pistol, and leaves the office. He passes through the front room and looks out the dirty window. An old woman is washing the sidewalk outside with a mop. A young man in a double breasted gray suit is leaning against the building. Harry sighs again and goes out the door. He walks up to the young man and without ceremony punches him in the jaw.

Generative Adversarial Network



nvidia stylegan

But it isn't.

- A chess master cannot tie his own shoes.
- Good in one "silo" doesn't necessarily transfer
- Advances in computer power make apps incrementally better, but don't trigger "Singularity"

Theory behind my class

- Starting in the 1950's there've been 2 principal approaches to achieving machine intelligence which oscillate in popularity:
  - Symbolic
    - logic, programming, symbol hacking
  - Numeric
    - neurons, equations, matrix manipulation
- Success in one depresses interest in the other.
  - The 70-80's saw the preeminence of Symbolic
  - Now we are in a very strong Numeric phase
    - *Some would call it a "DL Bubble"...*
- *So its important to be conversant in multiple approaches, and to be able to code new ideas yourself, even as commercial grade systems are prewritten.*