Artificial Intelligence: Introduction

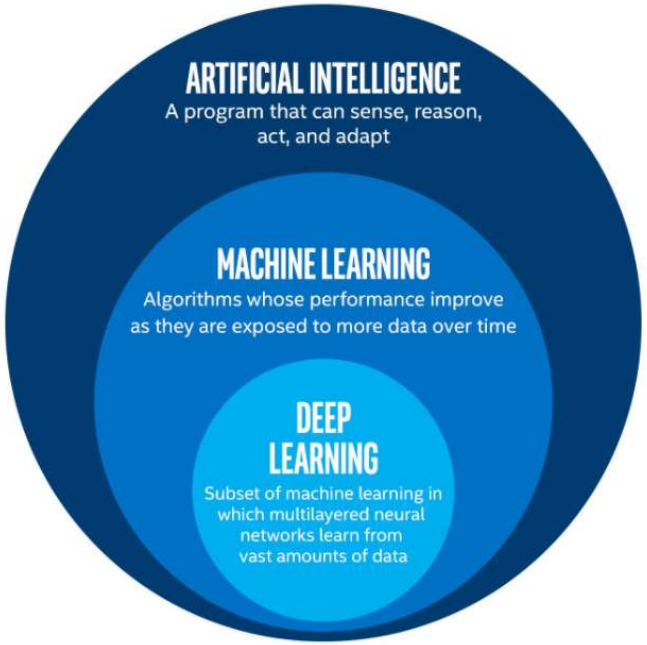
- Russell & Norvig, chap. 1 & 26

Today

1. Recent Breakthroughs
2. Important Questions
   a) What is artificial intelligence?
   b) What is intelligence?
   c) Is there a test for intelligence?
3. What do we do in AI?
4. History of AI

1. Why is every one is talking about AI these days?

- Major breakthroughs in many AI topics
- Thanks to a technique called Deep Learning



https://towardsdatascience.com/cousins-of-artificial-intelligence-dda4edc27b55

Recent Breakthroughs

- Speech Recognition & Machine Translation (2010+)

- *Google now*

- *Google Translate*

- *Skype Translator*

- Image Recognition & Computer Vision (2012+)
- Natural Language Processing (2014+)
- …

Figures from Yoshua Bengio, 2015

Recent Breakthroughs

- Speech Recognition & Machine Translation (2010+)
- Image Recognition & Computer Vision (2012+)

Google Photos

- *Object recognition*
- *Self driving cars*
- *Airport Screening*

- Natural Language Processing (2014+)
- …

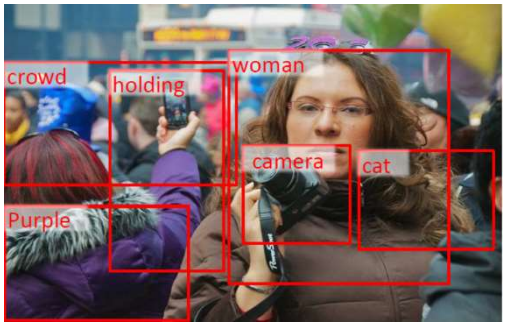
Figures from Yoshua Bengio, 2015 and https://qz.com/1371531/deep-learning-algorithms-are-being-used-to-detect-lithium-ion-batteries-in-airport-luggage/

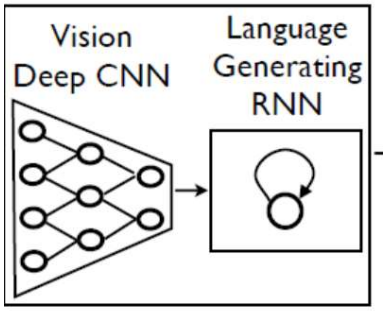
Recent Breakthroughs

- Speech Recognition & Machine Translation (2010+)
- Image Recognition & Computer Vision (2012+)
- Natural Language Processing (2014+)

Joe went to the kitchen. Fred went to the kitchen. Joe picked up the milk.
Joe travelled to the office. Joe left the milk. Joe went to the bathroom.
Where is the milk now? A: office
Where is Joe? A: bathroom
Where was Joe before the office? A: kitchen

- *Question Answering*





Machine-generated (but turker prefered)	a bicycle is parked next to a river
Human-annotated (but turker not prefered)	a bike sits parked next to a body of water

- *Image Captioning (deep vision + deep NLP)*

Figures from Yoshua Bengio, 2015

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What is artificial intelligence?

- No standard definition of AI among those working in the field
- AI has even been defined as:

"… the collection of problems and methodologies studied by artificial intelligence researchers."
- Luger and StubbleField

Other Definitions

Machines that **think/act like humans**

- *The exciting new effort to make computers think… machines with minds, in the full and literal sense* (Haugeland, 1985)
- *The art of creating machines that perform functions that require intelligence when performed by people* (Kurzweil, 1990)
- *The study of how to make computers do things at which, at the moment, people are better*. (Rich and Knight, 1991)

Machines that **think/act intelligently**

- *The study of mental faculties through the use of computational models* (Charniak and McDermott, 1985)
- *A field of study that seeks to explain and emulate intelligent behavior in terms in terms of computational processes (Schalkoff, 1990)*
- *---> The study of the computations that make it possible to perceive, reason, and act* (Winston, 1992)

Approaches to AI: Engineering VS Cognitive Approach

- Engineering Approach:
  - Tries to find optimal solutions
  - No matter how (not necessarily what human do)

- Cognitive Approach:
  - Tries to understand the process
  - Tries to reproduce human behavior (even if wrong result)

Approaches to AI: Weak VS Strong AI

- Weak AI :
  - A system whose capabilities are **not** intended to match or exceed the capabilities of human beings.

  - A system that can perform **a specific** intellectual task as well as a human would

- Strong AI:

  - typically used in science fiction
  - A system that matches or exceeds human intelligence in **any** intellectual task – "general intelligence"
  - A system that could have: consciousness, self-awareness, the ability to *feel* sentiments, …

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What is Intelligence, Anyways?

- are you intelligent if you:
  - can do complex arithmetic quickly?
    - humans are bad at it
    - … but computers are good at it
  - can recognize a face in a picture?
    - humans are good at it
    - but *<up until a few years ago>* hard to automate in a computer
  - hold a 15 min. conversation?
    - humans are good at it
    - … but really hard to automate in a computer

What is Intelligence?

- intellectual vs physical capabilities
  - a dog has a more acute sense of smell…
  - a bat can see at night…
- reflex vs planned/reasoned action
  - *when the female wasp returns to her burrow with food, she first deposits it on the threshold, checks for intruders inside, and only then, if the coast is clear, carries her food inside.*
  - but that's **instinctual** behavior
  - if the food is moved a few inches away while she is inside: on emerging, she will repeat the whole procedure as often as the food is displaced.
- awareness of existence (consciousness of itself)
  - if a system passes a test for intelligence but is not aware of it, is it intelligent?
  - but the only way to *really* know if a machine is thinking is to *be* the machine…

source of picture http://upload.wikimedia.org/wikipedia/en/8/85/Cicada_Killer_Wasp.jpg

Is Deep Blue Intelligent?

- In 1996 and 1997 IBM's Deep Blue beat the human chess champion Kasparov in a six-games match.
- But Deep Blue uses:
  - plain brute force technique
  - on a massively parallel supercomputer
  - can explore 200,000,000 positions per second (Kasparov can examine 3/sec)
- Today, emphasis on more *intelligent* chess programs
- in Nov. 2006, Deep Fritz vs. Kramnik, ran on an ordinary Intel Core 2 Duo CPUs

source of image:
http://upload.wikimedia.org/wikipedia/en/c/c6/P11_kasparov_breakout.jpg

Is Chess Playing Intelligent?

"Chess is far easier than innumerable tasks performed by an infant, such as understanding a simple story, recognizing objects and their relationships, understanding speech, and so forth. For these and nearly all realistic AI problems, the brute force methods in Deep Blue are hopelessly inadequate."

– David Stork

Is Watson Intelligent?

- In 2011, IBM's Watson competed on *Jeopardy!*
- Watson beat Brad Rutter, the biggest all-time money winner on *Jeopardy!*, and Ken Jennings, the record holder for the longest championship streak
- Watson received the first prize of $1 million
- Watson is a question answering system... "an application of advanced Natural Language Processing, Information Retrieval, Knowledge Representation and Reasoning, and Machine Learning technologies to the field of open domain Question Answering"

source: http://en.wikipedia.org/wiki/Watson_%28artificial_intelligence_software%29

Is AlphaGo Intelligent?

- GO was always considered a much harder game to automate than chess because of its very o high a branching factor (35 for chess vs 250 for Go!)
- In 2016, AlphaGo beat Lee Sedol in a five-game match of GO.
- In 2017 AlphaGo beat Ke Jie, the world No.1 ranked player at the time

- AlphaGo uses a Monte Carlo tree search algorithm to find its moves based on knowledge previously "learned" by deep learning

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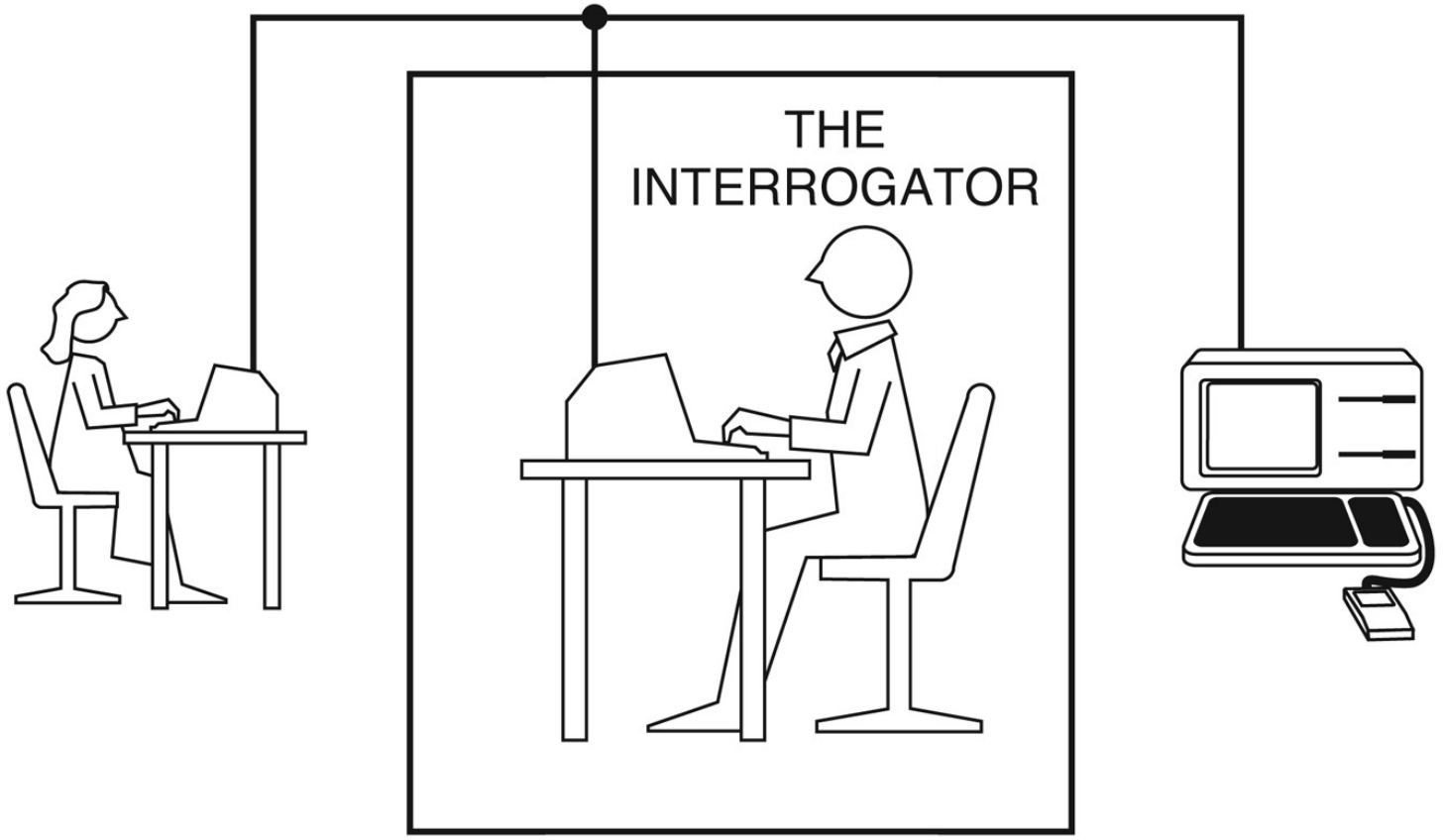
A Test for Intelligence…

- The Turing Test
  - The "imitation game"
  - Proposed by Alan Turing in 1950
  - If a human interrogator cannot tell the computer and human apart, then the computer is intelligent
  - Measures the intelligence of a computer vs. a human
  - Turing predicted that by 2000, a machine might have a 30% chance of fooling a person for 5 minutes

The Turing Test



- A human mediates between the interrogator and the machine

The Turing Test

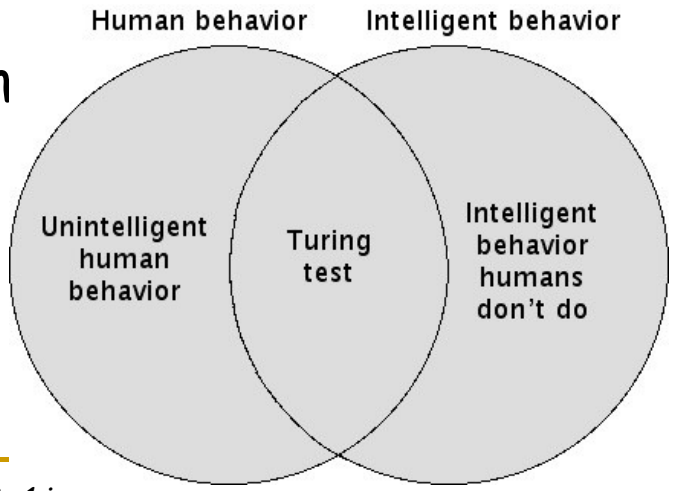
- Some capabilities required to pass the Turing test:
  - Natural Language Processing (NLP) to communicate
  - Knowledge Representation to store knowledge
  - Automated Reasoning to infer new knowledge
  - Machine Learning
  - …

Arguments For the Turing Test

- Objective notion of intelligence
- Prevents us from arguments about the computer's consciousness
- Eliminates bias in favor of humans
- …

Arguments Against Turing Test

- Not reproducible
- Not constructive
- Machine intelligence designed w.r.t. humans
  - test is anthropomorphic. It only tests if the subject *resembles* a human being.
  - unnecessarily restrict machines
  - ex: x-ray vision, fast computation



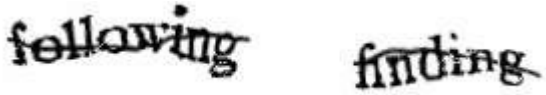
source of image: http://en.wikipedia.org/wiki/Image:Weakness_of_Turing_test_1.jpg

Did anyone pass the Turing Test yet?

- The Long Bets Foundation has $20,000 bet between
  - Mitchell Kapor, founder of Lotus Development, and
  - Ray Kurzweil, inventor
  - Kapor bets that "By 2029 no computer - or "machine intelligence" - will have passed the Turing Test. "
- After more than 60 year ... <drum roll please> ... In 2014, the news reported that a chatbot passed the Turing Test!
- But, Kurzweil himself is not convinced... because the test had restrictions...
  - the chatbot claimed to be a 13-year-old, and
  - one for whom English is not a first language

Current Turing Test

CAPTCHA:



- **C**ompletely **A**utomated **P**ublic **T**uring test to tell **C**omputers and **H**umans **A**part
- the system asks a user to complete a test which the computer is able to generate and grade, but not able to solve.
- Because computers are unable to solve the CAPTCHA, any user entering a correct solution is presumed to be human.
- also known as **reverse Turing test**, because it is:
  - given by a machine and targeted to a human
  - in contrast to the Turing test that is given by a human and targeted to a machine.

source of image:
http://upload.wikimedia.org/wikipedia/commons/b/b6/Modern-captcha.jpg

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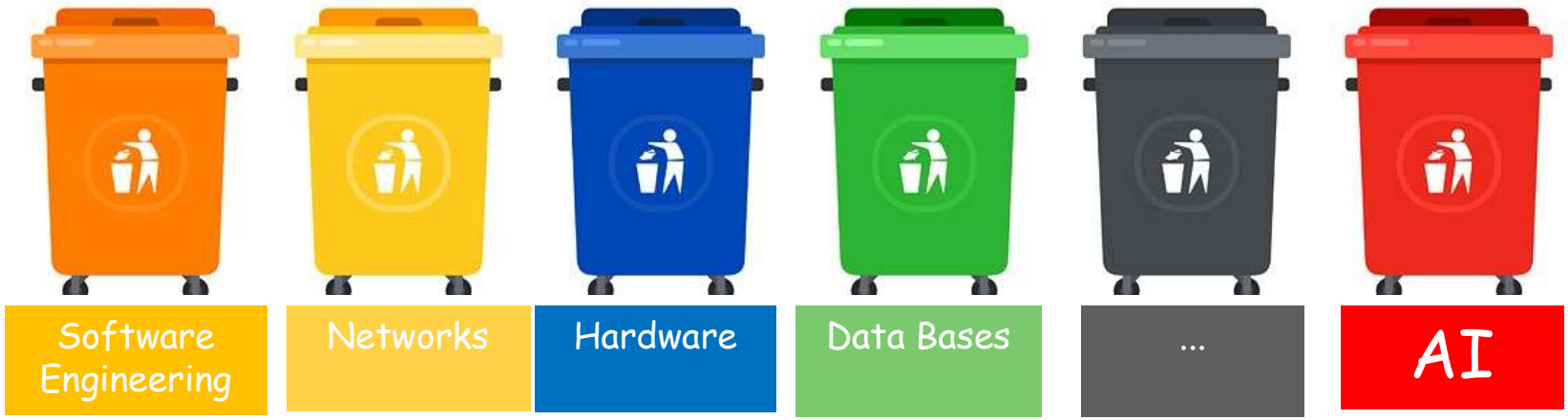
AI: the *"I don't know how to solve it"* bucket…



- A few years ago, all these were considered AI problems… now, no one thinks of them as AI
  - Optical Character Recognition
  - Speech Recognition & Synthesis
  - Information Retrieval
  - Spell Checker and Grammar Checker
  - Word Prediction
  - …

Successes of AI…

- A few years ago, all these were considered AI problems… now, no one thinks of them as AI
  - Machine Translation
  - Image Recognition
  - Optical Character Recognition
  - Speech Recognition & Synthesis
  - Information Retrieval
  - Spell checker and Grammar checker
  - Word Prediction
  - …

- A more pragmatic definition of AI today :

  "AI research is that which computing scientists do not know how to do cost-effectively today."

AI is like …

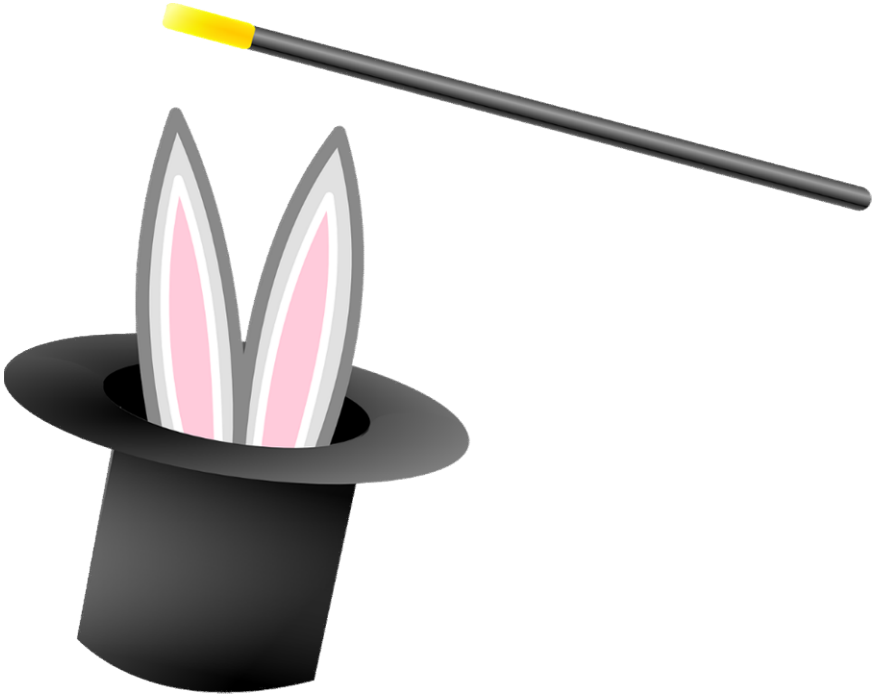
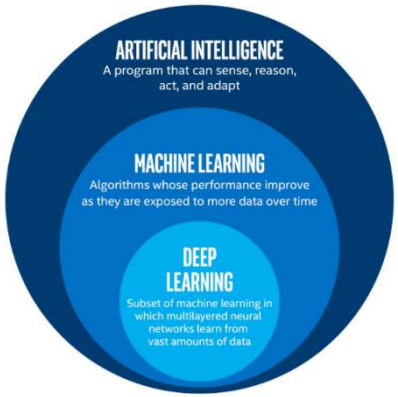


Image from: https://pixabay.com/p-25490/?no_redirect

What do we do in AI?

Topics at Canadian AI conference 2019

1. Automated Reasoning
2. Bioinformatics and BioNLP
3. Case-based Reasoning
4. Cognitive Models
5. Constraint Satisfaction
6. Data Mining
7. E-Commerce
8. Evolutionary Computation
9. Games
10. Information Retrieval and Search
11. Information and Knowledge Management
13. Knowledge Representation
14. Machine Learning
15. Multimedia Processing
16. Natural Language Processing
17. Neural Nets and Deep Learning
18. Planning
19. Privacy-preservi
20. Robotics
21. Uncertainty
22. User Modeling
23. Web Mining and Applications



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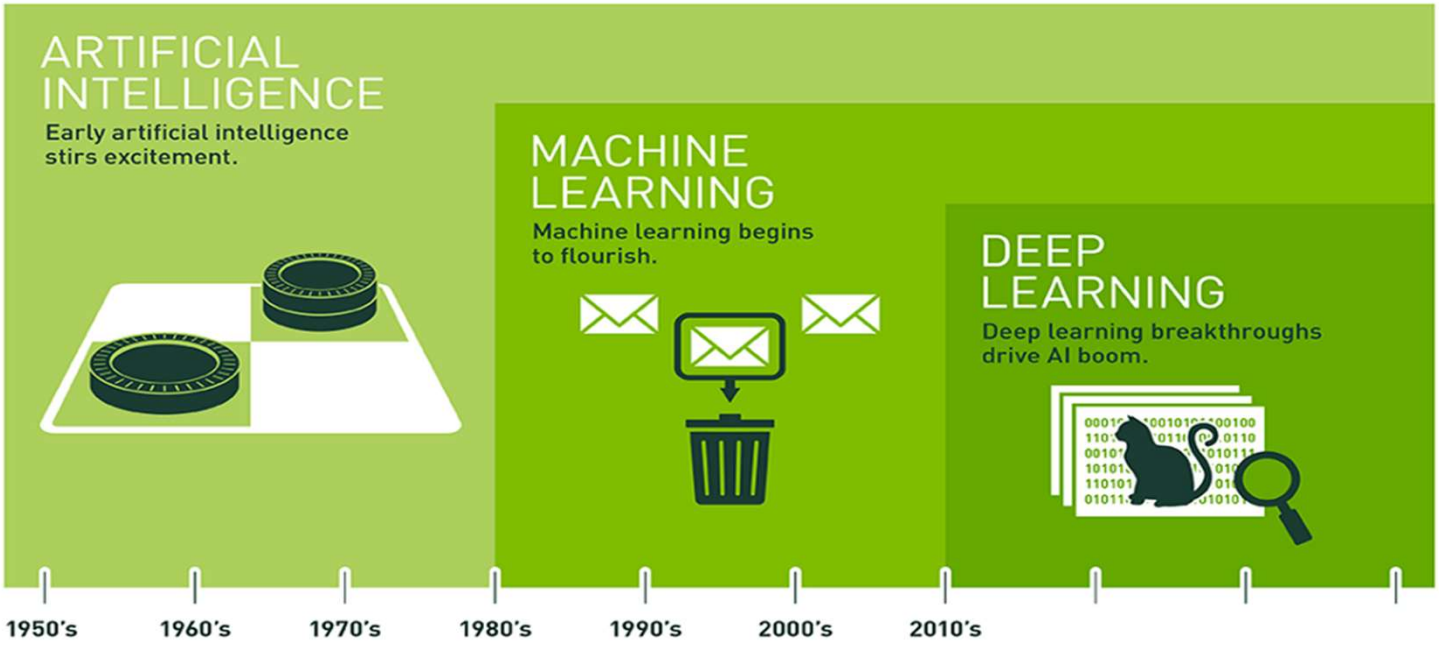
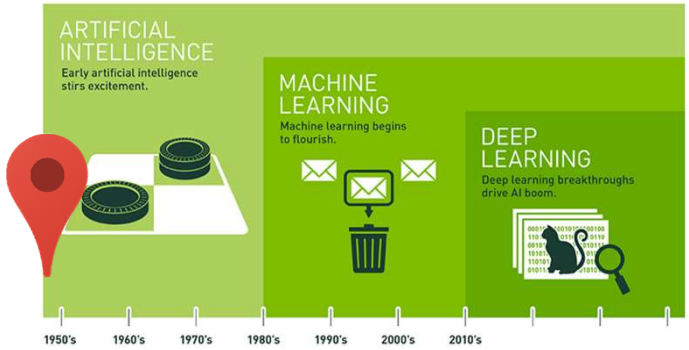


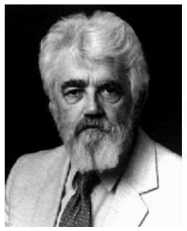
https://medium.com/machine-learning-for-humans/neural-networks-deep-learning-cdad8aeae49b

History of AI

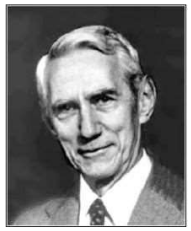


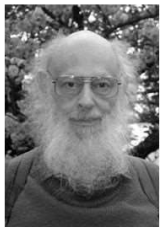
- 1940-1956
  - 1943: early work in neural networks… but just a theory, no real implementation
  - 1950: Alan Turing describes the Turing test
  - 1956: The Darmouth workshop
    - get-together of the big guys: McCarthy, Minsky, Shannon & others
    - the term "Artificial Intelligence" is first adopted

Dartmouth Conference: The Founding Fathers of AI


John McCarthy


Marvin Minsky


Claude Shannon


Ray Solomonoff

Alan Newell

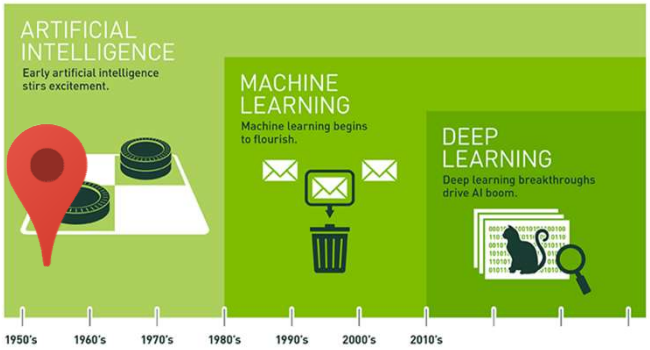
Herbert Simon

Arthur Samuel

And three others…
Oliver Selfridge (Pandemonium theory)
Nathaniel Rochester (IBM, designed 701)
Trenchard More (Natural Deduction)

https://www.linkedin.com/pulse/goedels-incompleteness-theorem-emergence-ai-eberhard-schoeneburg/

History of AI

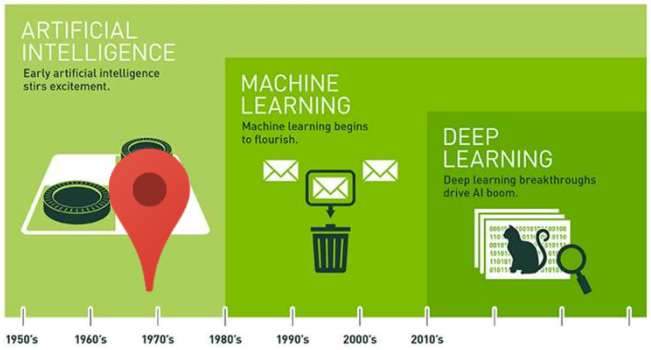


- The rise of AI (~1956 - 70s)
  - The era of GOFAI: Good Old Fashioned AI
  - Symbolic computation rather then numeric computation
    - `cold`, `hot` rather than `25.5°C`
    - `onTop(red)` rather than `position[1,0,0] = 50cm`
  - Development of AI-specific programming languages:
    - 1958: John McCarthy develops LISP
    - 1972: Colmeraurer develops Prolog

Unrealistic predictions

- In 1950, Turing predicted that 50 years later (in 2000)
  - it will be possible to program a computer with ~100 Mb memory to pass the Turing Test 30% of the time, with 5 minute conversations.
  - It will be natural to speak of computers 'thinking'.
  - --> we still can't do that
- Machine Translation:
  - In the 1950s, after World War II, we could translate automatically a few sentences from Russian to English.
  - Prediction: "Within three to five years, machine translation will be a solved problem."
  - --> we still can't do that
- All this, lead to the First AI Winter…

History of AI



- First major *AI Winter*…
- late 60s - early 70s
  - 1966: the ALPAC report kills work in machine translation
  - 1969: Minsky & Papert's book on the limits of perceptrons kills work in neural networks
  - 1973: following the Lighthill report, the British government stops funding research in AI due to no significant results

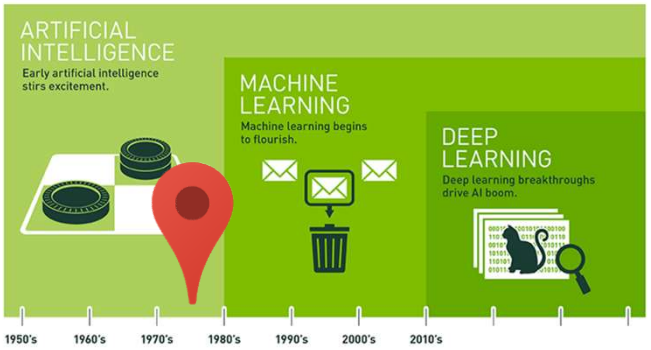
Briefing of Gerald Ford on an MT system

https://en.wikipedia.org/wiki/AI_winter#Early_episodes

History of AI

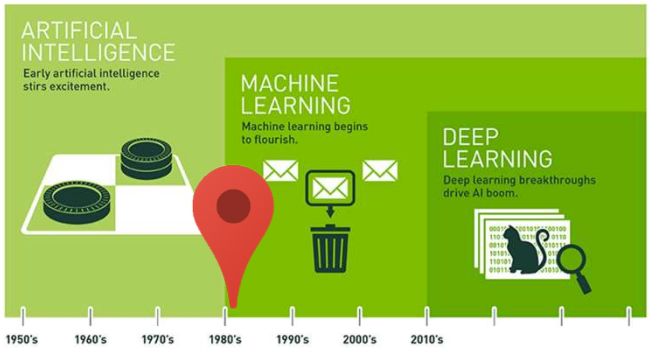
- 1970s - 1980s
- A big "hype" … Expert Systems
  - knowledge-intensive, rule-based techniques
  - Commercial expert systems
  - Decision-support systems

HUMANS need to write the rules by hand…



1972: MYCIN diagnoses blood infections as well as doctors.

History of AI

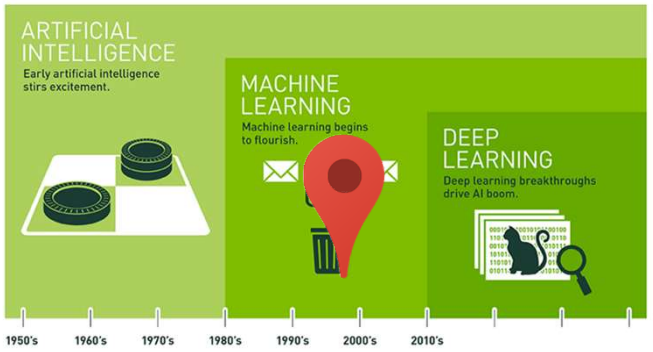


- mid 80s – mid 90s
- Another AI Winter
  - The end of Expert Systems
    - Too tedious to write rules by hand
    - Too expensive to maintain

History of AI

- 1980s-2010
- The rise of Machine Learning
  - More powerful CPUs-> usable implementation of neural networks
  - Big data -> Huge data sets are available
    - document repositories for NLP (e.g. emails)
    - billions on images for image retrieval
    - billions of genomic sequences
    - …

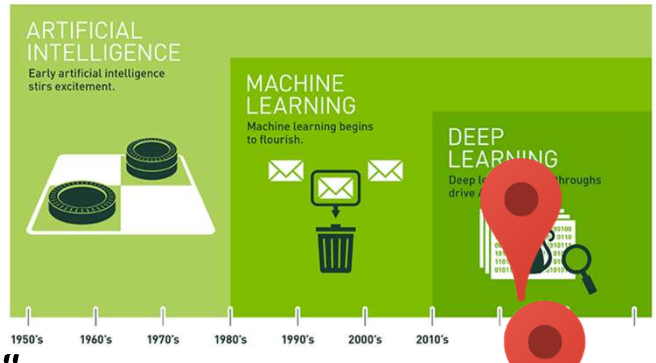
😀 Rules are now learned automatically !

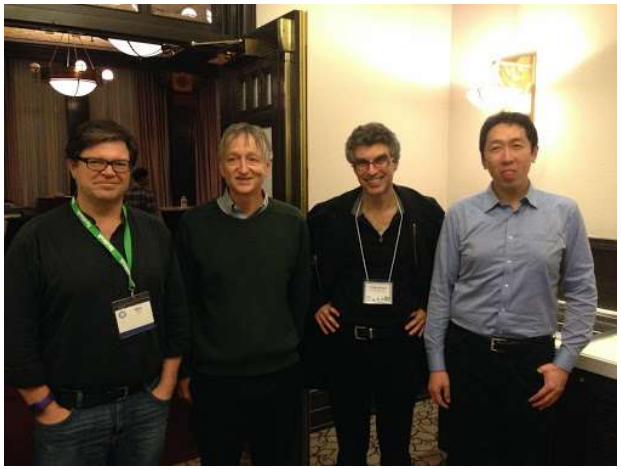


2011: Watson wins at Jeapardy!

History of AI

- 2010-today
- Deep Learning
  - Development of "deep neural networks"
  - Trained on massive data sets
  - Use of GPU for computations
  - Use of "generic networks" for many applications
    - Image recognition
    - Self driving cars
    - Machine translation
    - Speech recognition & synthesis
    - Chatbots
    - Game playing
    - …





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