UNIVERSITY OF APPLIED SCIENCES UTRECHT

Applied Artificial Intelligence

"Fencing the fields"

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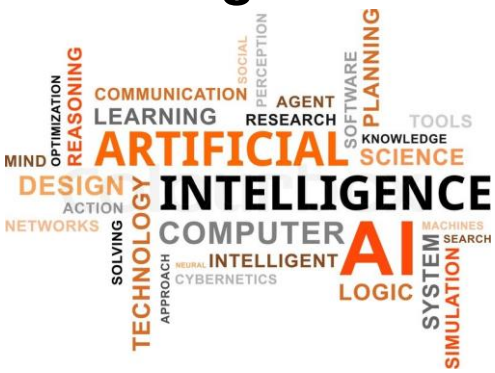

Overview

- Brief history of AI
  - Turing test
  - Chinese room
  - AI today
  - Applied AI
- Symbolic reasoning
- Machine learning

A brief history of AI

- Ancient times
  - Drive to create artificial life
    - Myths, legends, stories: Hephaistos' Golden Robots, Pygmalion's Galatea, Shelly's Frankenstein, Capek's Rossum's Universal Robots
  - Drive to understand mind / reasoning
    - Aristotle's syllogism, Leibniz calculus ratiocinator, Frege, Russel
- Birth of AI: 1952 paper by Alan Turing
  - Turing Test
- Dartmouth Conference 1956 (McCarthy, Minsky)
  - Neural networks (Pitt, McCullogh, Hopkins, Minsky)
  - Symbolic reasoning (Newell, Simon)

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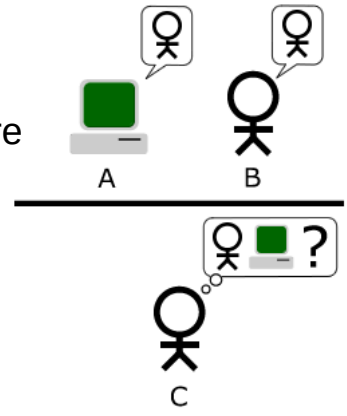
Turing test

- Test deviced to show whether a machine has intelligence
- Questioner (C) has to determine whether A and B (both pretending to be a human) are indeed humans
- Only interacting through a terminal



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A brief history of AI, continued

- The golden years (1956 – 1974)
  - Reasoning as search / General Problem Solver (Newell / Simon)
  - Natural Language Processing (Weizenbaum: ELIZA)
  - "*Within a generation ... the problem of creating 'artificial intelligence' will substantially be solved.*" (Minsky 1967)
- The first AI Winter (1974 – 1980)
  - Limited computing power, combinatoric explosion, commonsense reasoning, frame problem

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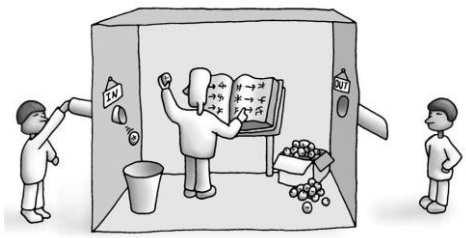
Chinese room

- Reaction to Turing Test and general AI
- Posed by John Searle in 1980
  - Machine cannot be said to *understand* the symbols it uses.
  - If symbols have no meaning to machine, it cannot be described as 'thinking'



- Strong AI vs. Weak AI
  - (narrow AI / applied AI)

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A brief history of AI, continued

- Rise of expert systems (1980 – 1987)
  - Answer questions or solve problems via logical rules
  - Rediscovery / revival of Connectionism (Hopfield, Rummelhart)
- Bust: second AI Winter (1987 – 1993)
  - New approaches in robotics (Brooks, Moravic)
    - "Elephants don't play chess"
  - Embodied AI
- Nouvelle AI (1993 – 2001)
  - Intelligent agents
  - AI behind the scenes
- Deep learning (2000 – present)

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AI today

- IBM Deep Blue defeats Kasparov (May 1997)
- DARPA grand challenge
  - 2005 – 131 miles unrehearsed autonomous driving in desert
  - 2007 – 55 miles unrehearsed autonomous driving in city
- IBM Watson wins Jeopardy (February 2011)
- Google AlphaGO defeats world champion GO (May 2016)

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Narrow AI vs. Strong AI

- Many successes of today due to increase in computing power (Moore's Law)
- Difficult challenges of 1970s still unresolved
- AI as toolbox for computational problems
  - *When AI solves a problem it becomes 'mainstream' computer science*

- Artificial General Intelligence (strong AI) still far away
  - Consciousness
  - Self-awareness
  - Sentience
  - Sapience

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Symbolic reasoning

Not exhaustive!

- (Intelligent) Agents
- Expert systems (rule-based systems)
- Logics
- Fuzzy Logics
- Game Theory
- Ontology / Semantics

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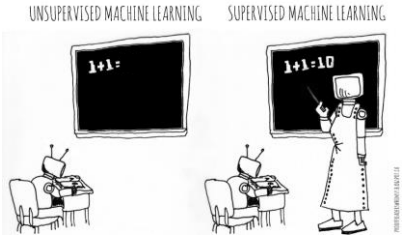
Machine learning

- ML gives “computers the ability to learn without being explicitly programmed.”
  - Input and output known; program is derived/learned
  - Evolved from pattern recognition and computational learning theory
- Supervised Learning
  - Computer is presented example inputs and desired outputs, given by a ‘teacher’; goal is to learn a general rule that maps input to output
- Unsupervised Learning
  - No labels given to the learning algorithm, leaving it on its own to find structure in its input; goal can be to detect hidden patterns or can be applied as a means to an end
- Reinforcement Learning
  - Program interacts with environment to maximise long-term reward
  - Differs from supervised learning in that it does not present correct input/output pairs, nor does it explicitly correct sub-optimal actions



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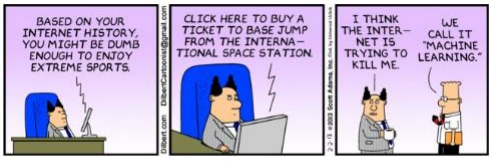
Types of Machine Learning

Not exhaustive!

- Classification (**Neural Networks**, **K-Nearest Neighbors**, Support Vector Machines)
  - supervised, put examples in right class
- Regression (K-Nearest Neighbors, Support Vector Machines)
  - supervised, continuous output, predict value/outcome based on training set
- Clustering (**K-Means**, Gaussian Mixture Models)
  - unsupervised, grouping of inputs, groups unknown at start
- Dimensionality reduction (Principal Component Analysis)
  - simplify input by mapping to lower-dimensional space
- Density estimation
  - distribution of inputs in some space
- Prediction (**Decision Trees**, **Bayesian Networks**)
  - map observations to conclusions about target values



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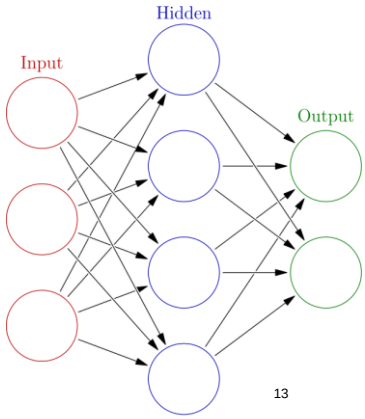
http://dilbert.com/strips/comic/2013-02-02/

Neural Networks

Week 2

- Computational model based on topology of the brain
  - Neurons & axons
- Self-learning and trained
  - Require no explicit programming
- Good for
  - Pattern recognition (classification)
  - Regression (function approximation)
  - General estimation problems (clustering)
  - Feature extraction



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Deep learning

Week 2

- Cascade of many layers of nonlinear processing units for feature extraction and transformation
- Successive layers use the output of previous layer as input
- May apply combinations of supervised (classification) or unsupervised (pattern analysis) algorithms
- Higher level features are derived from lower level features to form hierarchical representation
- Learn multiple levels of representations that correspond to different levels of abstraction

- Deep learning has been characterized as a buzzword, or a rebranding of neural networks.

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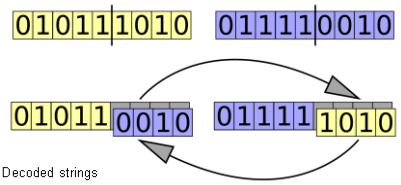
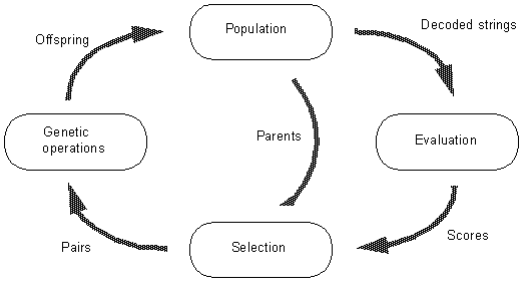
Evolutionary / Genetic Algorithms

Week 5

- Metaheuristic inspired by process of natural selection
- Commonly used for
  - Optimization solutions
  - Search problems



- Selection
- Mutation
- Crossover



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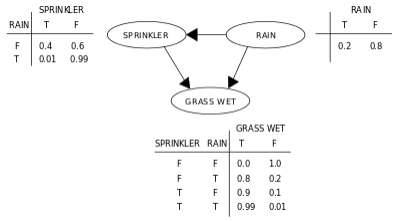
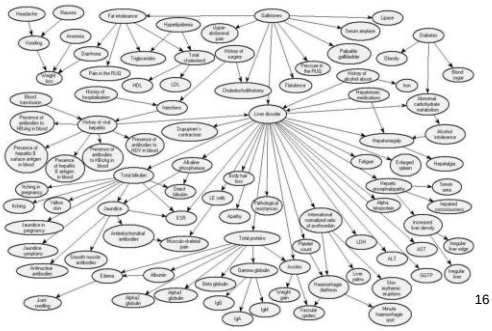
Prediction

- Bayesian Networks
  - Expressive, intuitive language
  - Powerful reasoning
- Represent (probabilistic) relation between cause and effect
- Calculate probability of effect given the availability of causes





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Conclusions

- Combination of many research fields
  - Computer science, sociology, philosophy, linguistics, economics
- Strong vs. Weak
  - Wide vs. Narrow / Philosophical vs. Applied
- AI effect: solutions by AI become mainstream
  - "AI is whatever hasn't been done yet.“ (D. Hofstadter)
- Ethics

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