Lecture 1
Introduction to AI

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Questions?

- What is intelligence?
- What makes it artificial?
- What can we use it for?
- How does it work? How to create it?
- How to control / repair / improve it?
- What are the consequences?
- Do we need to be afraid of it?
- What can we do?

Good to know

- Slides in English
- Vox Populi
- Requirements: later today

Administration

- Contact
  - Instructor: Kristóf Karacs
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  - TAs
    - Attila Stubendek, Attila Sulyok
      room 224,   stubendek.attila@itk.ppke.hu
                         sulyok.a.attila@gmail.com
- Web
  - http://users.itk.ppke.hu/~karacs/AI/
- Lectures
  - Mon 12:15am, Jedlik Lecture hall
- Seminars
  - Group 1: Wed 8:15am, room 322
  - Group 2: Wed 13:15pm, room 220
  - Group 3: Tue 12:15pm, room 220

What is intelligence?

intelligere: to comprehend, to perceive

- Sense
- Reason rationally
- Learn and discover
- Compete
- Communicate and cooperate

What is AI? (1)

- "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)
- "The exciting new effort to make computers think ... machines with minds, in the full and literal sense" (Haugeland, 1985)
- "The study of mental faculties through the use of computational models" (Charniak and McDermott, 1985)
- "The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)
- "A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990)
- "The study of how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)
- "The study of the computations that make it possible to perceive, reason, and act" (Winston, 1992)
- "The branch of computer science that is concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)

Russell Beale
(University of Birmingham)

- "AI can be defined as the attempt to get real machines to behave like the ones in the movies."

John McCarthy
(Stanford)

- "It is the science and engineering of making *intelligent* machines, especially intelligent computer programs.

- It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable."
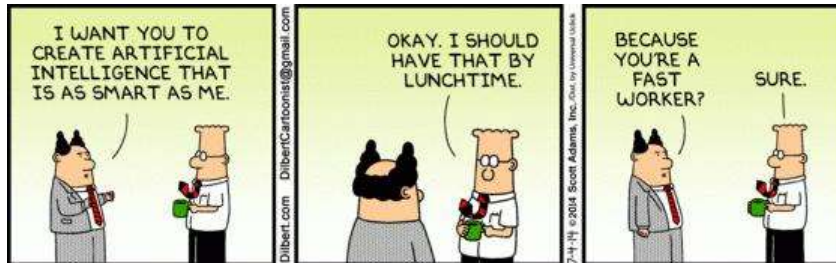
Ray Kurzweil (Google)

- "Artificial intelligence is the ability to perform a task that is normally performed by natural intelligence, particularly human natural intelligence."

Elaine Rich (University of Texas at Austin)

- "Artificial Intelligence is the study of how to make computers do things at which, at the moment, people are better."

What is AI? (2)

> "The synthesis and analysis of computational agents that act intelligently."

- Science and engineering

  - *Understanding principles that make intelligent behavior possible in natural or artificial systems*

  - *Specifying methods for the design of useful, intelligent artifacts*

  [Poole - Mackworth: Artificial Intelligence, Cambridge University Press, 2010]

What is AI? (3)

"Intelligence measures an agent's ability to achieve goals in a wide range of environments."

- Implicitly includes

  - *ability to learn and adapt*
  - *to understand*

[S. Legg – M. Hutter, A formal measure of machine intelligence, Benelearn Conference, 2006]
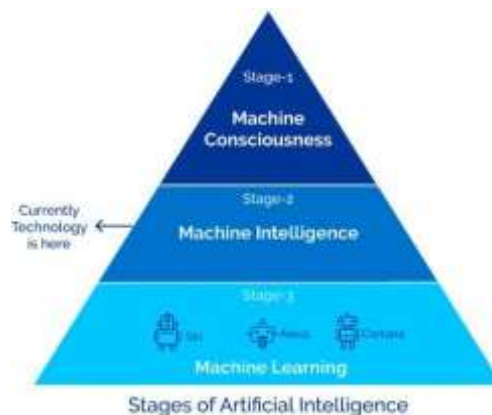
What is AI? (4)

- Study of the principles by which
  - knowledge is acquired and used,
  - goals are generated and achieved,
  - information is communicated,
  - collaboration is achieved,
  - concepts are formed,
  - languages are developed.

Intelligent agents

- act according to the circumstances and its goals
- adapt to dynamic environments and goals
- learn from experience
- are aware of their own limitations (sensors, memory, speed, etc.)

Levels of intelligence

Stage-1
Machine Consciousness

Currently Technology is here →
Stage-2
Machine Intelligence

Stage-3
Machine Learning

Stages of Artificial Intelligence

Levels of intelligence

- Difficulty levels for humans and machines

- Playing team sports, driving a car
- Playing chess or go
- Recognizing a cat
- Solving partial differential equations
- Solving logic puzzles

Old captchas

Newer captchas
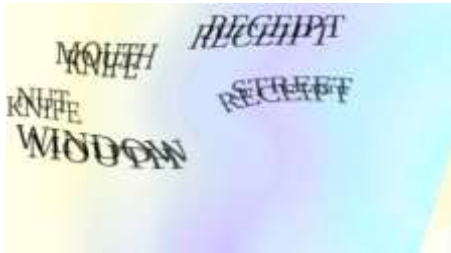
Minimum requirements

- Assignments: 50%
- Seminar tests: passing 60% of all
- Project (code and documentation): 50%
- Midterm exam: 40%

Grade composition

- Project   30%
  - Proposal   2%
  - Code   18%
  - Documentation 10%
- Midterm   30%
- Final   40%

- Activity, presentations   + 10%
- Competition (for top positions) + 20%
- Worked out problems   + 10%

Grading

- Grades
  - 5: 87.5%-
  - 4: 75.0%-
  - 3: 62.5%-
  - 2: 50.0%-

- Grade offer requirements
  - Min. 75% at the midterm
  - Project presentation on the last week of the semester

Presentation

- Optional
- 5 minutes
- Topics
  - Anything AI related you find interesting and think that it may be interesting to others
  - Some topics are posted on the website

Project work

- Goal: Demonstrating the use of some AI techniques
- Self defined or Challenge-type
- Proper documentation according to the rules outlined on the website
- Project submission deadlines
  - Proposal: February 27
  - First prototype: March 27
  - Final version: May 10

Project work

- Start thinking about it now, to come up with your own!

Sample project ideas

- Visual scene understanding
- Reading sheet music
- Predicting structure of protein fragments
- Object detection
- Bongard problems
- Captcha solver
- Intelligent vacuum cleaner
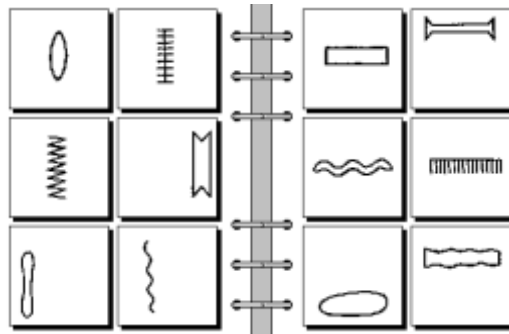- Route searching for a carpooling system

Bongard problems

- Mikhail Moiseevich Bongard, 1967

- Given 2 x 6 figures
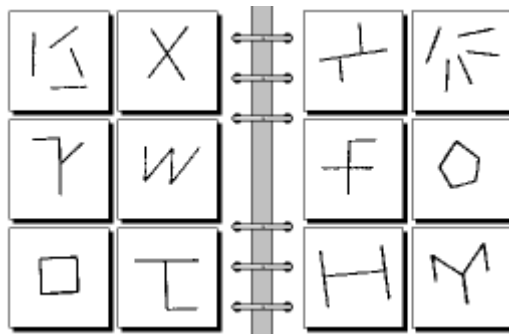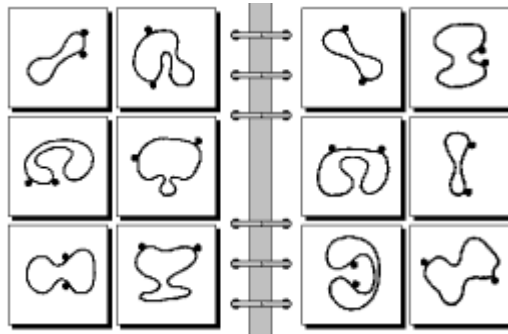- Task: describe what is common in one set not shared with the other set
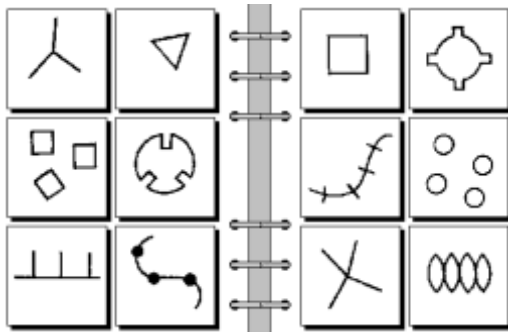
Bongard problem #6
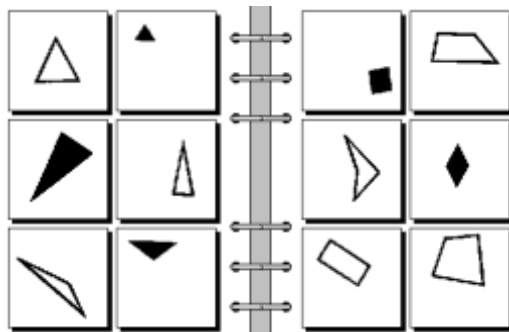
Bongard problem #7

Bongard problem #87
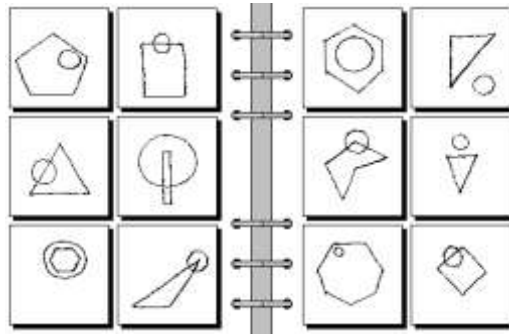
Bongard problem #20

Bongard problem #91

Bongard problem #116

Typical problems

- Exponential blow-up

- Representation of information

Methods

- Analytical
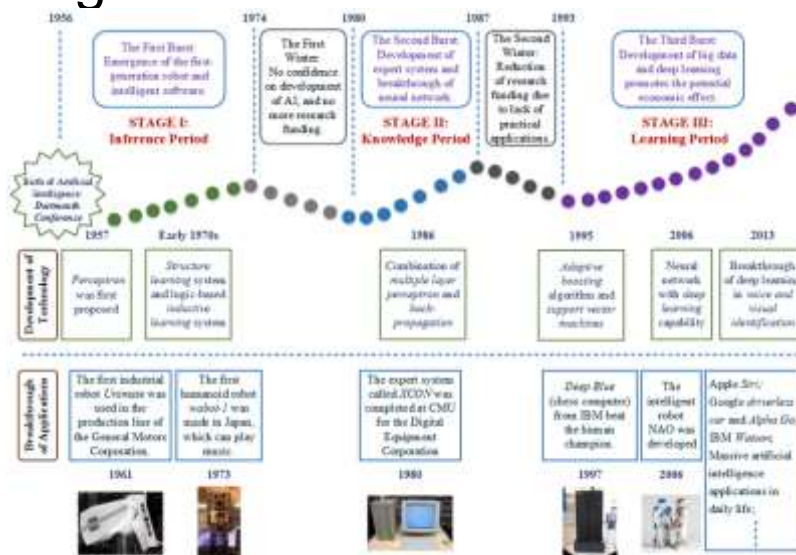- Empirical

- Hybrid

Early milestones

- 1950. Turing test
- 1955. GPS by H. Simon and A. Newell
- 1956. The term "AI" was born at a conference organized by John McCarthy in Dartmouth College, Hanover, NH

Turing Test

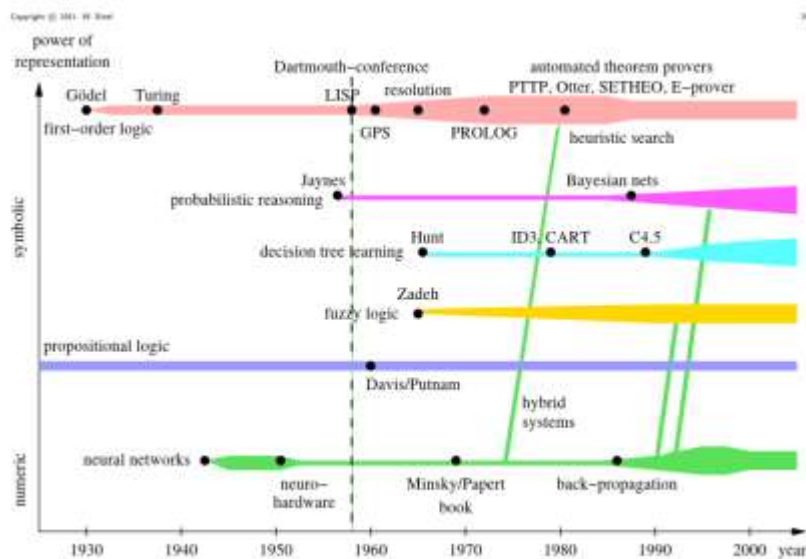

Source: Jack Copeland, alanturing.net

Stages of AI

Stages of AI

- Initial enthusiasm
- Recession
- Successes
- AI industry
- Wide-spread, sophistication

Source: Wolfgang Ertel

Source: Wolfgang Ertel

Related sciences

- Computer science / data science
  - Data mining, machine learning
- Mathematics:
  - Logic, complexity theory, probability theory
- Psychology
- Cognitive science
- Linguistics
- Biology
- Philosophy, ethics

Application areas

art, astronomy, bioinformatics,
engineering, finance, fraud detection, law,
mathematics, military, music, story writing,
telecommunications, transportation,
tutoring, video games, web search

Branches detached from AI

- Machine learning, deep learning
- Computer vision
- Speech recognition
- Optical character recognition, handwriting recognition
- Natural language processing
- Expert systems

Program

- Problem solving by search
- Search including other agents
- Logic and inference
- Search in logic representation, planning
- Inference in case of constraints
- Bayesian networks
- Fuzzy logic
- Machine learning

AI highlights (1)

- **SKICAT**: automatically classifies data from space telescopes and identifying interesting objects in the sky. 94% accuracy, way better than human *(decision trees)*
- **Deep Blue**: the first computer program to defeat human champion Garry Kasparov *(minimax search + alpha-beta-pruning + optimizations)*
- **Pegasus, Jupiter, etc.**: speech recognition systems *(Hidden Markov Models)*
- **HipNav**: a robot hip-replacement surgeon *(planning algorithms)*
- **DARPA Grand/Urban Challenge**: autonomous driving *(filtering and planning algorithms)*

AI highlights (2)

- **Deep Space 1**: NASA spacecraft that did an autonomous flyby an asteroid *(logic-based AI)*
- **Credit card fraud detection** and loan approval *(decision trees and neural networks)*
- **Chinook**: the world checker's champion *(game theory)*
- **Spam Assassin** and other spam detectors *(naïve Bayes learning)*
- **Soccer playing Aibo robots** *(reinforcement learning)*
- **Watson** *(natural language processing, knowledge aggregation)*
- **AlphaGo, AlphaZero, AlphaStar** *(deep reinforcement learning)*

Principles of academic integrity

- Projects
  - Cite all sources properly
- Assignments
  - Discuss and research the problem before you start writing
  - Do not copy cat ready solutions
  - Work on your own
  - After you start putting it into writing
    - Do not talk to others
    - Do not consult external materials

Textbooks

- S. J. Russell, P. Norvig, *Artificial Intelligence: A Modern Approach*, Third Edition, Prentice Hall, 2009
- S. J. Russell, P. Norvig, *Mesterséges intelligencia modern megközelítésben*, második kiadás, Panem, 2005
  - □ available at: tankonyvtar.hu/hu/tartalom/tamop425/0026_mi_4_4

- D. Poole, A. Mackworth, *Artificial Intelligence*, Cambridge University Press, 2010
  - □ available at: artint.info

Other resources

- I. Futó (ed.), *Mesterséges intelligencia*, Aula, 1999
- Kevin P. Murphy, *Machine Learning – A probabilistic perspective*, MIT Press, 2012
- C. M. Bishop, *Pattern Recognition and Machine Learning*, Springer Verlag, 2006

- AAAI (Association for the Advancement of Artificial Intelligence): aaai.org
- Agent portal: agent.ai