CS 1571 Introduction to AI
Lecture 2

History and applications of AI

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The beginnings of AI (40s-50s).

Two streams:

(1) Neural network approach (McCulloch and Pitts 1943).
- Boolean model of a human brain.

(2) Programs capable of **simple reasoning tasks**:
- chess programs (Shannon 1950, Newell, Shaw & Simon 1958)
- checkers (Samuel 1959)
- Theorem prover in geometry (Gelernter 1959)
- Logic Theorist (Newell, Shaw & Simon 1957). Used propositional logic to prove theorems.

- **Dartmouth meeting (1956),** the name **Artificial Intelligence** adopted (due to John McCarthy)

60s.

Developments in the two streams:

(1) Neural network models for learning and recognition

- Build on McCulloch and Pitts' work (1943)
- **Objective:** replicate self-organization and subsequently phenomenon intelligence
- **Adaline networks** (Widrow, Hoff 1960)
- **Perceptrons** (Rosenblatt 1961)
- Minsky and Papert (1969) – strong critique of perceptrons, it killed the area for a decade

(2) Symbolic problem solvers:

- **General problem solver** (Newell, Simon) – think humanly
- **LISP –** AI-specific programming language
- **Micro-worlds –** focus on problem-solving in restricted worlds (e.g. blocks world)

70s. Knowledge-based system era.

- Early AI systems did not scale-up well to large applications
- The need for background knowledge

Edward Feigenbaum: **"knowledge is the power"**

Power of the system derived from the knowledge it uses

- Expert systems: obtain the knowledge from experts in the field, and replicate their problem-solving

Examples of KB systems:

- **Dendral** system (Buchanan et al.). Molecular structure elicitation from mass spectrometer readings.
- **Mycin.** Diagnosis of bacterial infections.
- **Internist** (Pople, Myers, Miller). Medical diagnosis.

80s. AI goes commercial.

AI becomes an industry

- Many tools for the design of KB systems were developed

Revival of neural network (connectionist) approach.

- **Multi-layer neural networks**
  - Modeling and learning of non-linear functions.
  - Back-propagation algorithm (learning)

Failure of AI in 80s

- High expectations in very short time
- Computational complexity: some problems are intrinsically hard
- Modeling uncertainty
- Separation of connectionist - logic approaches.

90s. Moving ahead

- **Modeling uncertainty** (a breakthrough in late 80s)
  - Bayesian belief networks, probabilistic graphical models.
  - Speech recognition.
- **Machine learning and data mining**
  - Analysis of large volumes of data
  - Finding patterns in data
  - Learning to predict, act
- **Autonomous agents** with intelligence:
  - Software agents
  - Robots

AI today (where are we?)

AI is more rigorous and depends strongly on: applied math, statistics, probability, control and decision theories

Recent theoretical advances and solutions:

- Methods for dealing with uncertainty
- Planning
- Learning
- Optimizations

Applications:

- Focus on **partial intelligence** (not all human capabilities)
- Systems with components of intelligence in a specific application area; not general multi-purpose intelligent systems

AI applications: Software systems.

- **Diagnosis of software**, technical components
- **Adaptive software systems**
  - **Examples:**
    - **Intelligent interfaces**

      (http://www.research.microsoft.com/research/dtg/))
    - **Intelligent helper applications**, intelligent tutoring systems
    - **Web applications:**
      - softbots, shopbots (see e.g. http://www.botspot.com/)

AI applications: information retrieval.

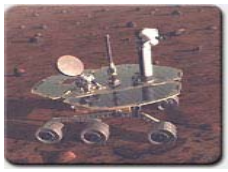
- **Web search engines**
  - Improve the quality of search
  - Rely on methods developed in AI
- **Web agents:**
    - softbots, shopbots (see e.g. http://www.botspot.com/)
- **Semantic web:**
  - From information to knowledge sharing
  - OWL

AI applications: Speech recognition.

- **Speech recognition systems:**
  - Hidden Markov models
- **Adaptive speech systems**
  - Adapt to the user (training)
  - continuous speech
  - commercially available software (e.g. IBM http://www-3.ibm.com/software/speech/)
- **Multi-user speech recognition systems**
  - Restricted (no training)
  - Customer support:
    - Airline schedules, baggage tracking;
    - Credit card companies.

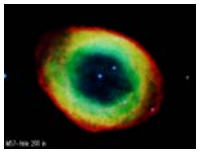
Applications: Space exploration

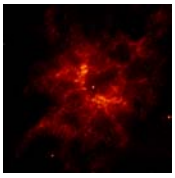
Autonomous rovers, intelligent probes



Telescope scheduling

Analysis of data

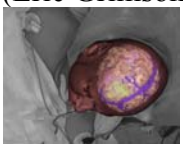




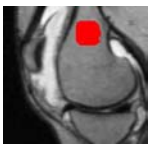
AI applications: Medicine.

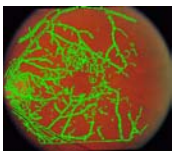
- **Medical diagnosis:**
  - Pathfinder. Lymph-node pathology.
  - QMR system. Internal medicine.
- **Medical imaging**

  http://www.ai.mit.edu/projects/medical-vision/
  - Image guided surgery (Eric Grimson, MIT)



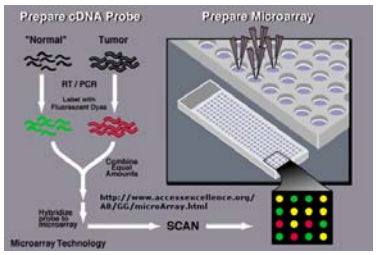
  - Image analysis and enhancement

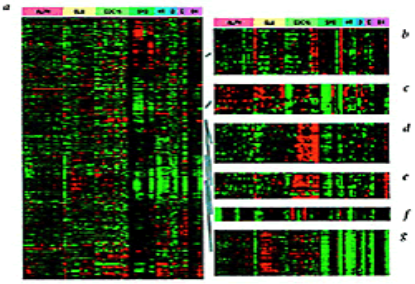




AI applications: Bioinformatics.

- **Genomics and Proteomics**
  - Sequence analysis
  - Prediction of gene regions on DNA
  - Analysis of micro-array and proteomic MS profiles: find genes, proteins (peptides) that characterize a specific disease
  - Regulatory networks





Example of a microarray used in gene sequencing

AI applications: Transportation.

Autonomous vehicle control:

- ALVINN (CMU, Pomerleau 1993) .
  - Autonomous vehicle
  - Driving across US
- DARPA challenge (http://www.darpa.mil/grandchallenge/)
  - Drive across Mojave desert
  - 2004 – no vehicle finished the course
  - 2005 – 5 vehicles finished
    - Won by a Stanford team
  - 2007 - DARPA Urban Challenge (October/November 2007)

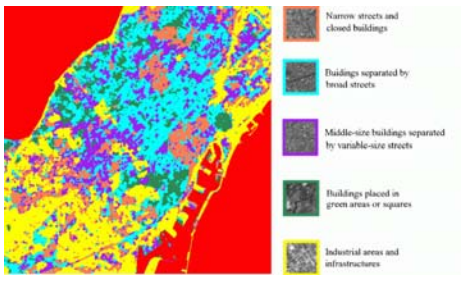
AI applications: Transportation.

- **Vision systems:**
  - Automatic plate recognition

  - Pedestrian detection (Daimler-Benz)

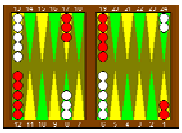
  - Traffic monitoring
- **Route optimizations**

Classification of images or its parts



AI applications: Game playing.

- **Backgammon**
  - TD-backgammon
    - a program that learned to play at the championship level (from scratch).
    - reinforcement learning



- **Chess**
  - Deep blue (IBM) program beats Kasparov.

- **Bridge**

- **Etc.**

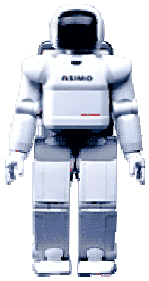
AI applications.

- **Robotic toys**
  - Sony's Aibo

(http://www.us.aibo.com/)

- **Humanoid robot**
  - Honda's ASIMO

(http://world.honda.com/robot/)



Other application areas

- **Text classification, document sorting**:
  - Web pages, e-mails
  - Articles in the news
- **Video, image classification**
- **Music composition, picture drawing**
- **Entertainment** ☺

Topics

- **Problem solving and search.**
  - Formulating a search problem, Search methods, Combinatorial and Parametric Optimization.
- **Logic and knowledge representations.**
  - Logic, Inference
- **Planning.**
  - Situation calculus, STRIPS, Partial-order planners,
- **Uncertainty.**
  - Modeling uncertainty, Bayesian belief networks, Inference in BBNs, Decision making in the presence of uncertainty.
- **Machine Learning.**
  - A little