Introduction to Machine Learning

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Machine Learning

- When we design an AI system to solve a complex problem, sometimes we have to face three problems:
  - We can not anticipate all the possible situations that can arise
  - We can not anticipate future changes in the environment of the system
  - There are tasks too complex to be programmed
- For example, the designers of a robotic vacuum cleaner cannot:
  - Program the map of all possible houses
  - Assume that the robot will always be cleaning the same house
  - Program all possible shapes and sizes of objects and furniture
  - ...

Machine Learning

- A straightforward solution would be to design the system to be able to solve these problems by itself (able to learn)
- Learning represents the dynamic part of intelligence, we want systems that:
  - Adapt to the environment
  - Acquire new capabilities/knowledge
  - Solve problems better
  - Learn from experience/mistakes
  - Predict the outcome of their future actions
- *Machine learning* studies the methods to give these capabilities to AI programs (and also to non AI programs)

Basis/Influences

- Models of intelligence
  - Cognitive Psychology: Psychological basis, the process of human learning.
  - Neurobiology: Physiological basis, the brain, the neuron.
- Knowledge/concepts
  - Cognitive Psychology: What is a concept? Why we use the concepts we use? How do we represent them internally? How do we organize them?
  - Mathematical Logic: Learning of symbolic models/Use of prior knowledge
  - Statistics: Learning of probabilistic models/Data Uncertainty
  - Optimization: Learning as function approximation

Goals

- The goal of ML is not to model/understand human learning

- We need methods able to extend the capacity of programs (agents)
  - Methods that help agents to reach beyond their initial programming
  - Methods that allow agents to adapt to new environments
  - Methods that help to automatically create models for complex tasks
  - Methods that allow to discover patterns that can be used to solve new tasks

Does it work?

Does Machine Learning Really Work? Tom Mitchell. AI Magazine 1997

- Tasks very difficult to program
  - Machine perception: Vision/Image recognition, Voice recognition, ...
  - Robotics
  - Human computer interfaces
- Adaptable applications
  - Intelligent interfaces
  - Spam filters/Documents filtering
  - Personalization, recommender systems
- Data mining (Intelligent Data Analysis, Knowledge Discovery)
  - Business: Finance, marketing, user profiling, ...
  - Scientific data: bioinformatics (microarray data, genomic data, drug discovery, ...), geological data, satelite data, astronomical probes/telescopes, ...
  - Internet: Web logs, social networks, text/documents, ...

Types of machine learning

Characteristics:

- Supervised vs unsupervised
- Basic Knowledge vs Structured Knowledge
- Inductive vs deductive
- Symbolic vs conexionist

Types of machine learning

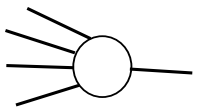
- **Inductive Learning:** Models are built from the *generalization* of examples. We look for patterns that explain the common characteristics of the examples.

All objects dropped by Galileo from Pisa tower fell at the same speed

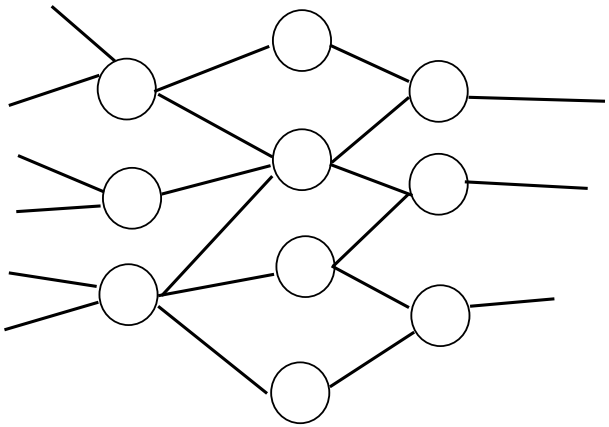
So, any object fall at the same speed dropped from anywhere

Types of machine learning

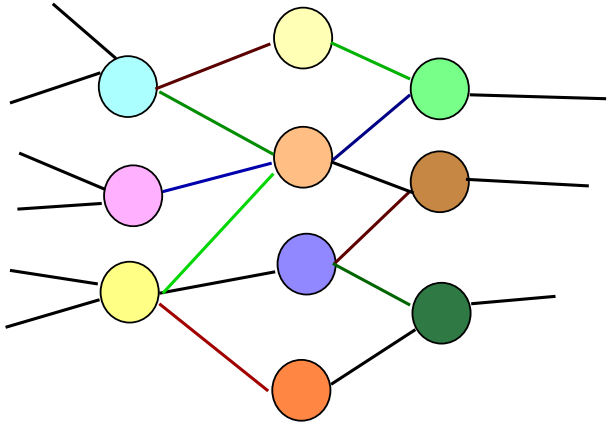
- **Conexionist learning:** Generalization is performed by the adaptation mechanisms of artificial neural networks.



I am a neuron



I am a neural network



I am a neural network trained to solve a problem

Types of machine learning

- **Reinforcement Learning:** Models are learned by trial and error playing with the environment and receiving feedback of our actions

Types of machine learning

- **Deductive Learning:** Deduction is applied to obtain generalizations from a domain theory, a solved example and its explanation.

A Drink container is something that can hold liquid, the liquid can be hot or cold, it can be grasp because of its cillindrical or conical shape or because it has a handle, it can have one or two openings on the top end, and can be put on any horizontal surface

This is a tea cup, and is a drink container because can contain a hot liquid, has a handle. is on a table and has a top opening

So a drink container is anything that has a handle can contain hot liquid, can lie on a table and has a top opening

Types of machine learning

- **Analogical Learning:** Solutions to new problems are found by finding their similarities with known problems and adapting their solutions.