

Introduction

Contents of the course

- [#Supervised-learning](#) ^[1]
- [#Unsupervised-learning](#) ^[2]
- [#Reinforcement-learning](#) ^[3]

Note

There are [other learning techniques](#).

Machine Learning

? What is machine learning?

Machine learning is the study of computer [#algorithms](#) that improve automatically through experience. It is seen as a part of artificial intelligence.

” Quote

Machine learning is the science of getting computers to act without being explicitly programmed.

A. Samuel

” Quote

Machine learning is concerned with the automatic discovery of regularities in data through the use of computer [#algorithms](#) and with the use of these regularities to take actions.

Christopher M. Bishop

” Quote

The goal of machine learning is to develop methods that can automatically detect patterns in data, and then to use the uncovered patterns to predict future data or other outcomes of interest.

Kevin P. Murphy

” Quote

Machine learning is about predicting the future based on the past.

Hal Daume III

Quote

A computer program is said to learn from experience E with respect to some class of **#tasks** T and performance measure P , if its performance at **#tasks** in T , as measured by P , improves with experience E .

T. Mitchell

TL;DR

Machine learning is the study of **#algorithms** that

- improve their performance P
- at some **#task** T
- with experience E

? When is machine learning used?

Machine learning is used when:

- Human expertise does not exist [\[1\]](#)
- Humans can't explain their expertise [\[2\]](#)
- Models must be customised [\[3\]](#)
- Models are based on huge amounts of data [\[4\]](#)

Machine learning isn't always useful [\[5\]](#)

1. navigating on Mars ↩
2. speech recognition ↩
3. personalised medicine ↩
4. genomics ↩
5. there is no learning in calculating a payroll ↩

A well-defined learning **#task** is given by a triplet $\langle T, P, E \rangle$.

Example





Example



Example



Artificial Intelligence



Definition

Programs with the ability to learn and reason like humans



Quote

Our ultimate objective is to make programs that learn from their experience as effectively as humans do.

John McCarthy

Deep Learning



Definition

Subset of machine learning in which artificial neural networks adapt and learn from vast amounts of data



Quote

Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction

Nature ^[1]

1. www.nature.com/articles/nature14539 ↩

Deep learning means using a neural network with several layers of nodes between input and output. The series of layers between input and output compute relevant features automatically in a series of stages, just as our brains seem to.

Deep Learning Revolution - Why Now?

- Flood of available data
- Increased computational power
- Growing number of machine learning **#algorithms** and theory developed by researchers
- Increased support from the industry

The Learning Process

- Measuring devices
 - Sensors
 - Cameras
 - Databases
- **#Preprocessing**
 - Noise filtering
 - **#Feature-extraction**
 - **#Normalisation**
- **#Dimensionality-reduction**
 - **#Feature-selection**
 - **#Feature-projection**
- Model learning
 - **#Classification**
 - **#Regression**
 - **#Clustering**
 - Description
- Model testing loop
 - **#Cross-validation**
 - **#Bootstrapping**
- Analysis results

Data, features, and models

Every item in the dataset is turned into a vector in some way. We then choose the **#features** of these items which are also represented with vectors and could be thought of as the questions we can ask about the different items in the dataset.

Example

We could represent an apple with the features `[red, round, leaf, 85g]` and a banana with the features `[yellow, curved, no leaf, 120g]`. We would then choose which of these features should hold the most weight in our model.

Training and test data, generalisation

i Idea

Training data and test set should belong to the same "data distribution"

More technically, using a probabilistic model of learning, there is some probability distribution over example/label pairs called the "data generating distribution". Both the training data *and* the test set are generated based on this distribution

Example

If a large amount of our training set contains red apples, then a proportionally large amount of our test set^[1] should contain red apples.

1. depending on the size of the training and test sets ↩

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1. [Lazy vs. Eager Learning](#) ↩
 2. [Unsupervised Learning](#) ↩
 3. [Reinforcement Learning](#) ↩