Overview

Lecture 1: Introduction

Topics:

- What will the course cover?
- How are labs and examination handled?
- What do we mean by a "Learning Machine"?
- What can learning algorithms be used for?
- Supervised vs Unsupervised learning?
- What is a Nearest neighbour classifier?

Related reading: Chapter 2 from An Introduction to Statistical Learning (Springer, 2013)

Lecturer: Atsuto Maki, Giampiero Salvi, Örjan Ekeberg

Lecture 2: Decision Trees

Topics:

- What is a Decision Tree?
- When are decision trees useful?
- How can one select what questions to ask?
- What do we mean by Entropy for a data set?
- What do we mean by the Information Gain of a question?
- What is the problem of overfitting? Minimizing training error?
- What extensions will be possible for improvement?

Related reading: Chapter 8.1 from An Introduction to Statistical Learning (Springer, 2013)

Lecturer: Atsuto Maki

Lecture 3: Challenges in ML

Topics:

- Concepts of prediction errors
- Model complexity and overfitting

Cross-Validation
The curse of dimensionality
The bias-variance trade-off

Supplementary materials from PRML publicly available here .

Related reading: Chapter 2, 5.1 and 6.4 from An Introduction to Statistical Learning (Springer, 2013)

Lecturer: Atsuto Maki

Lecture 4: Regression

Linear regression
RANSAC
Nearest Neighbours regression
Parametric / non-parametric
Linear regression + regularization
Ridge regression
Lasso

Related reading: Chapter 3.1, 3.2, 3.5 and 6.2 from An Introduction to Statistical Learning (Springer, 2013)

Lecturer: Atsuto Maki

Lecture 5: Probabilistic Reasoning

Topics:

- introduction to probabilistic machine learning
- probability theory foundations
- common distributions
- probabilistic classification

Related reading: Prince, S.J.D., Part I (Chapters 2, 3, 5)

Lecturer: Giampiero Salvi

Lecture 6: Learning as Inference

Topics:

- probability estimation assumptions
- maximum likelihood estimate for regression

- MLE for classification, continuous and discrete case
- Naïve Bayes classifier
- Logistic regression

Related reading: Chapter 4, Prince book. Optional Bishop, C. M. Pattern Recognition and Machine Learning

Lecturer: Giampiero Salvi

Lecture 7: Priors and Latent Variables

Topics:

- maximum a posteriori estimate
- Bayesian non-parametric methods
- Model selection and Occam's Razor
- unsupervised learning
- K-means
- Expectation Maximization

Related reading: Prince: 7.1-7.4, 8.1, 9.1

Lecturer: Giampiero Salvi

Lecture 8: Support Vector Machines

Topics:

- Classification with Hyperplanes
- Incremental Learning
- Structural Risk
- Structural Risk Minimization
- Support Vector Machines
- Kernels
- Dealing with Overlapping Classes

Related reading: Chapter 9 from An Introduction to Statistical Learning.

Lecturer: Örjan Ekeberg

Lecture 9: Artificial Neural Networks

Topics:

- SVM continued

- Multi-layered Networks
- BackPropagation Learning
- Deep Neural Networks

Supplementary reading: Chapter 7 from Raul Rojas; Neural Networks - a Systematic Introduction.

Lecturer: Örjan Ekeberg

Lecture 10: Ensemble Methods

Topics:

Why combine classifiers?
Bagging
Decision Forests
Boosting

Related reading: Chapter 8.2 from An Introduction to Statistical Learning (Springer, 2013)

Lecturer: Atsuto Maki

Lecture 11: Dimensionality Reduction

Topics:

Principal Component Analysis (PCA)
Concept of subspace
Similarity measures
Subspace methods
Fisher's criterion

Related reading: Chapter 10.2 and 4.4 from An Introduction to Statistical Learning (Springer, 2013)

Lecturer: Atsuto Maki

Lecture 12: Summary

Three mini lectures