



# EP231U Fundamentals of Applied Machine Learning 5.0 credits

## Grunderna i tillämpad maskininlärning

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

## Establishment

The head of school at the school of electrical engineering and computer science has 13/10/2020 determined to establish this official course syllabus to apply from autumn term 2020, registration number: J-2020-2458.

## Grading scale

P, F

## Education cycle

Second cycle

## Main field of study

Computer Science and Engineering

## Specific prerequisites

- Knowledge in the equivalent IX1304 of one variable calculus Mathematics 7.5 credits

- Knowledge in linear algebra equivalent SF1672 Linear Algebra 7.5 credits
- Knowledge in probability theory equivalent SF2940 Probability Theory 7.5 credits
- Knowledge in Programming equivalent DD1315 programming and Matlab 7.5 credits
- The upper secondary course English B/6

## Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

## Intended learning outcomes

After passing the course, the student shall be able to

- summarise machine learning in a graphics rendering system, justify its components and discuss the problems that can arise
- apply different existing supervised and unsupervised machine learning methods for given amounts of data and assess and review their result
- explain different machine learning methods and contrast their positive and negative features
- interpret existing implementations of different machine learning methods and adapt them for specific situations
- discuss ethical dimensions of machine learning methods, development and application.

## Course contents

### **Introduction and motivation**

Survey of motivating applications, good and bad

Course plan and assignment structure

Presentation of learning and modelling: Machine learning in a graphics rendering system

Example: Nearest neighbor classification

Parameters and hyperparameters

Training, validation and testing

Partitioning data: Hold out, the bootstrap, K-fold CV, LOOCV, etc.

Performance metrics: Confusion table, accuracy, precision, and recall

### **Supervised learning 1**

Probabilistic classification and regression

Incorporating notions of risk in classification and regression

Bayesian classification: Linear discriminant analysis

Bayesian classification: Quadratic discriminant analysis

Bayesian classification: Naive Bayes

### **Supervised learning 2**

Parameter estimation

Least squares regression

Regularization: LASSO, ridge regression

Bayesian regression

Logistic regression

## **Unsupervised learning 1**

What is unsupervised learning?

The curse of dimensionality

Principal component analysis

Multidimensional scaling

Overview of K-means

## **Unsupervised learning 2**

Hierarchical clustering

Density based clustering

Anomaly detection, outliers (Isolation forest)

Gaussian mixture models

Deterministic or probabilistic clustering

## **Working with time series**

Motivating examples

Transformation between time and frequency domains

Autoregressive modelling

Autoregressive moving average modelling

## **Data representation and feature engineering**

Development of distinctive features

Selection of distinctive features

Joint optimisation of feature engineering and classification

## **Machine learning pipeline**

AutoML tools

Pitfalls with standard methods

Data augmentation and other tricks

The responsibilities of the engineer and user

Interpreting models, explaining decisions

Correlation and causalities: machine learning is not magic

## **Specialisation: Reinforcement learning (RL)**

Overview of applications in reinforcement learning

Fundamentals of reinforcement learning

Q-learning

## **Examination**

- LAB1 - Laboratory work, 4.0 credits, grading scale: P, F
- PRO1 - Project, 1.0 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

## **Ethical approach**

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.

- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.