EP234U Fundamentals of Applied Machine Learning 5.0 credits

Grunderna i tillämpad maskininlärning

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

Establishment

Course syllabus for EP234U valid from Spring 2022

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.

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

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.