Module Description, available in: EN

Machine Learning

General Information

Number of ECTS Credits

3

Module code

FTP_MachLe

Valid for academic year

2022-23

Last modification

2020-02-11

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%				**X** E 100%		
Documentation	**X** E 100%				**X** E 100%		
Examination	**X** E 100%				**X** E 100%		

Module Category

FTP Fundamental theoretical principles

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

- **Math**: basic calculus / linear algebra / probability calculus (e.g., derivatives, matrix multiplication, normal distribution)
- **Statistics**: basic descriptive statistics (e.g., mean, variance, co-variance, histograms, box plots)
- **Programming**: good command of any structured programming language (e.g., Python, Matlab, R, Java, C, C++)
- **Analytics**: basic data analysis methods (data pre-processing, linear & logistic regression)

Brief course description of module objectives and content

Machine learning (ML) emerged out of artificial intelligence and computer science as the academic discipline concerned with “giving computers the ability to learn without being explicitly programmed” (A. Samuel, 1959). Today, it is the methodological driver behind the mega-trend of digitalization. ML experts are highly sought after in industry and academia alike.

This course builds upon basic knowledge in math, programming and analytics/statistics as is typically gained in respective undergraduate courses of diverse engineering disciplines. From there, it teaches the foundations of modern machine learning techniques in a way that focuses on practical applicability to real-world problems. The complete process of building a learning system is considered:

- formulating the task at hand as a learning problem;
- extracting useful features from the available data;
- choosing and parameterizing a suitable learning algorithm.

Covered topics include cross-cutting concerns like ML system design and debugging (how to get intuition into learned models and results) as well as feature engineering; covered algorithms include (amongst others) Support Vector Machines (SVM) and ensemble methods.

Aims, content, methods

Learning objectives and acquired competencies

- Students **know** the **background and taxonomy** of machine learning methods
- On this basis, they **formulate** given problems as l**earning tasks** and **select** a **proper learning method**
- Students **are able to convert** a data set into a proper **feature set** fitting for a task at hand
- They **evaluate** the chosen **approach** in a structured way using proper design of experiment
- Students **know how** to select models, and „**debug**“ features and learning algorithms if results do not fit expectations
- Students are able to leverage on the evaluation framework to **tune the parameters** of a given system and **optimize** its performances
- Students **have seen examples of different data** sources / problem types and **are able to acquire additional expert knowledge** from the scientific literature

Contents of module with emphasis on teaching content

- **Introduction** (2 weeks): Convergence for participants with different backgrounds
- **Supervised learning** (7 weeks): Learn from labeled data
  Cross-cutting topics: Feature engineering; ensemble learning; debugging ML systems
  Algorithms: e.g. SVM, ensemble learning, graphical models (Bayesian networks)
- **Unsupervised learning** (3 weeks): Learning without labels
  Algorithms: e.g., dimensionality reduction, anomaly detection, archetypal analysis
- **Special chapters** (2 weeks):
  Algorithms: e.g., reinforcement learning, recommender systems, hidden Markov / Gaussian mixture models

Teaching and learning methods

Classroom teaching; programming exercises (e.g., in Python 3)

Literature

T. Mitchell, “Machine Learning”, 1997

C. M. Bishop, “Pattern Recognition and Machine Learning”, 2006

G. James et al., “An Introduction to Statistical Learning”, 2014

K. Murphy, “Machine Learning – A Probabilistic Perspective”, 2012

Assessment

Certification requirements

Module does not use certification requirements

Basic principle for exams

As a rule, all the standard final exams for modules and also all resit exams are to be in written form

Standard final exam for a module and written resit exam

Kind of exam

written

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

1 A4 page (front and back) of handwritten notes (no book, no slides, no further notes)

Special case: Resit exam as oral exam

Kind of exam

oral

Duration of exam

30 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

1 A4 page (front and back) of handwritten notes (no book, no slides, no further notes)