GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2026-2027

Introduction to Machine Learning (C004667)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings in academic year 2026-2027

A (semester 1)	English	Gent

Lecturers in academic year 2026-2027

Saeys, Yvan	WE02	lecturer-in-charge

Offered in the following programmes in 2026-2027	**crdts**	**offering**
Bachelor of Science in Computer Science	6	A
Bachelor of Science in Mathematics	6	A
Bachelor of Science in Physics and Astronomy	6	A

Teaching languages

English

Keywords

Machine learning, supervised learning (classification and regression), unsupervised learning (clustering, dimensionality reduction), model setup and evaluation

Position of the course

Machine learning techniques represent the most important and most widely used category of techniques within the larger domain of artificial intelligence. Machine learning techniques allow the automatic construction of models from data, and in this way facilitate the automation of tasks such as creating predictions or descriptions based on data. These techniques are paramount in our society and are used for a variety of problems, including weather prediction, face recogintion, language models and analysis of large datasets. Getting an understanding on how these models work and how they can be used to tackle real-world problems is an essential competence of any modern data scientist.

Contents

- Introduction to machine learning
  - Overview of the major data types
  - Overview of the major types of learning problems
  - Bias-Variance tradeoff
  - Key elements of learning problems
  - Illustration using practical examples
- Model setup and evaluation
  - Train-test splitting, cross-validation
  - Evaluation metrics
  - Imbalanced data
  - Experimental design
- Supervised learning
  - Linear models (LDA, SVM (including kernels), linear regression)
  - Tree based models (decision and regression trees, ensembles of trees: Random Forest, Gradient boosting)
  - Ensemble models (bagging, boosting)
  - Naive Bayes
  - Neural networks
    - Essentials of MLPs: model architecture, backpropagation, loss functions, optimizers, training procedures

- Unsupervised learning
  - Clustering methods
    - Hierarchical clustering, K-Means, Gaussian mixture models, density-based clustering, Self-organizing maps, spectral clustering/graph clustering
    - Validation of clustering results
      - Evaluation metrics
      - Statistical frameworks
  - Dimensionality reduction methods
    - PCA, MDS, tSNE, autoencoder
- Feature selection
- Troubleshooting/debugging ML models

Initial competences

Basic knowledge of data structures and algorithms, basic knowledge of probabilities and distributions, and basic programming experience in Python.

Final competences

1 Explain the differences among the main styles of learning: supervised, unsupervised and reinforcement learning. [Familiarity]
2 Explain concepts of overfitting, underfitting, bias–variance trade-off, and apply validation techniques such as cross-validation. [Assessment, Usage]
3 Implement simple algorithms for supervised learning and unsupervised learning. [Usage]
4 Analyze and prepare datasets using common data preprocessing techniques (e.g., normalization, handling missing values, encoding categorical variables). [Usage]
5 Determine which learning algorithm is appropriate for a particular problem. [Usage]
6 Compare and contrast the properties of different learning algorithms (e.g. linear models, tree-based models, ensemble models, neural networks). [Assessment]
7 Design a complete workflow to compare and evaluate the performance of basic machine learning models on a real-world problem. [Assessment]
8 Identify common data issues such as bias, noise, imbalance, and leakage. [Assessment]
9 Be able to read and interpret scientific literature in the domain of machine learning. [Familiarity]

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Practical

Study material

Type: Handouts

Name: Lecture material'
Indicative price: Free or paid by faculty
Optional: no
Additional information: Lecture material will be made available through Ufora

References

Christopher M. Bishop “Pattern Recognition and Machine Learning” (2006)

Course content-related study coaching

Personal contact with the lecturer, by e-mail or by appointment

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Written assessment with open-ended questions

Examination methods in case of permanent assessment

Oral assessment, Skills test, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Calculation of the examination mark

The exact distribution of points between continuous assesment and the final examination, and the minimum requirements for each component in order to pass the overall course, will be announced at the beginning of the semester.