GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2023-2024

Machine Learning (E061330)

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

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2023-2024

A (semester 1)	Dutch	Gent	group work	30.0h
			lecture	30.0h
B (semester 1)	English	Gent	lecture	
			independent work	

Lecturers in academic year 2023-2024

Dambre, Joni	TW06	lecturer-in-charge
Dhaene, Tom	TW05	co-lecturer

Offered in the following programmes in 2023-2024	crdts	offering
Bridging Programme Master of Science in Bioinformatics(main subject Engineering)	6	B
Bridging Programme Master of Science in Computer Science Engineering	6	B
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	B
Master of Science in Bioinformatics(main subject Engineering)	6	B
Master of Science in Industrial Engineering and Operations Research(main subject Manufacturing and Supply Chain Engineering)	6	B
Master of Science in Industrial Engineering and Operations Research(main subject Transport and Mobility Engineering)	6	B
European Master of Science in Nuclear Fusion and Engineering Physics	6	B
Master of Science in Biomedical Engineering	6	B
Master of Science in Biomedical Engineering	6	B
Master of Science in Computer Science Engineering	6	A
Master of Science in Computer Science Engineering	6	B
Master of Science in Industrial Engineering and Operations Research	6	A, B
Master of Science in Photonics Engineering	6	B
Exchange Programme in Bioinformatics (master's level)	6	B

Teaching languages

English, Dutch

Keywords

Machine learning, regression, classification, Baysian networks, clustering, PCA, kernel techniques, support vector machines, random forest, neural networks, deep learning, gaussian processes, robotics, reinforcement learning

Position of the course

The objective of this course is to provide theoretical and practical insights into the use of machine learning in practical applications. First, the fundamental principles of machine learning and learning theory are introduced in the context of linear models. The major historical families of machine learning techniques are addressed and selected state-of-the-art advanced methods are highlighted. The theoretical background is given in order to understand the benefits and limitations of each technique, but the emphasis of the course is on the practical use of the different techniques. This is achieved through a number of supervised PC-labs as well as a project in the form of a machine learning competition.
For the applied parts of this course, the Python programming language is used.

Contents

- Introduction to machine learning: types of problems, types of techniques, types of data, introduction to learning theory, approximation versus generalisation, features and feature selection, uncertainty and overfitting, problem and model analysis, ensembles
- Unsupervised learning: clustering, dimensionality reduction, approximating probability density functions, Gaussian mixture models
- Rule-based techniques: decision trees and random forrests
- Model-based techniques: linear regression and classification, logistic regression, neural networks
- Similarity-based techniques: KNN, kernel techniques, SVM
- Probabilistic and Bayesian approaches, maximal likelihood and expectation maximization
- State-of-the-art topical examples, e.g.: convolutional neural networks, natural language processing, biomedical applications
- Hands-on application to real-world problems

Initial competences

ICT: **Being able to program in Python is a necessary prerequisite for this course!**
Mathematics: calculus, linear algebra, analytic geometry, probability theory and statistics (all at university level).

Final competences

1 Understand the fundamental principles and challenges of machine learning.
2 Understand the mathematical background of some common and advanced machine learning models.
3 Implement simple machine learning models and correctly apply machine learning libraries for more advanced techniques.
4 Analyse a new machine learning problem and address it by correctly applying the principles of machine learning and selecting suitable common machine learning models.
5 Understand and critically evaluate the techniques presented in scientific literature on machine learning.

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

Group work, Lecture, Independent work

Extra information on the teaching methods

The lectures will take place on-campus. Recordings and/or live streaming will be provided only when supported by the equipment of the lecture room.
The NPE will consist of assignments (labs) which will have to be made individually or in groups.
Coaching is provided on-campus during lecture hours or online (through MsTeams).

Learning materials and price

Presentation materials.
Free online boek.

References

- Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press, 2012
- Sebastian Raschka, "Python Machine Learning", 3rd edition, Packt Publishing, 2019
- Yaser Abu-Mostafa et al.,"Learning from data", AMLbook.com, 2012
- Kevin P. Murphy, "Machine Learning, a Probabilistic Perspective", MIT Press, 2012
- Christopher M. Bishop, “Pattern recognition and machine learning”, Springer (2006)
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, “The elements of statistical learning theory”, Springer (2003) (freely available online)
- Richard S. Sutton, Andrew G. Barto, “Reinforcement learning: an introduction”, MITpress (1998) (freely available online)

Course content-related study coaching

By the teachers and the assistants, before, during or after contact sessions, by appointment or via the e-learning system.

Assessment moments

end-of-term and continuous assessment

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

Written assessment

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

Written assessment

Examination methods in case of permanent assessment

Participation, Peer and/or self assessment, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

The exam consists of a written examination (closed book). It consists of several short questions to test knowledge and understanding (multiple choice or open questions with very short answers), as well as a few questions that evaluate deeper understanding.
The NPE for this course consists of multiple graded assignments (individual or in groups) in which students apply the principles from the theory lectures and deepen their understanding.
The second exam period only consists of individually graded work.

Calculation of the examination mark

The final score for the course is a weighted average, consisting of 35% NPE (evaluation during the semester), and 65% PE (exam).
Participation to the NPE assignments is mandatory in order to succeed.
You need to obtain a score of at least 9/20 on each of both parts (NPE and PE) in order to obtain a credit. Students who do not fulfill the second condition but for whom the calculated score would be 9/20 or more, will receive a truncated score of 8/20 (i.e., the largest score that is smaller than 9/20).

Resit:

If you failed for the course in first session, the ratio between practical work and exam remains the same in resit. If you passed for either the exam or the NPE you do not retake that in resit.
The resit exam covers the same materials as the first session exam.
Since a resit assignment for NPE can never cover all aspects of the practical work during the semester, this assignment only allows for a score correction. You will receive an individual assignment to assess your practical skills. This will allow you to correct your NPE score of the first session: your final score for NPE will be calculated as 0.6*(score NPE first session)+0.4*(score NPE resit).