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 2026-2027

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

Lecturers in academic year 2026-2027

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

Offered in the following programmes in 2026-2027	**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 Chemical Engineering	6	B
Master of Science in Chemical 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, deep learning, probabilistic and Bayesian models, Gaussian processes, design and analysis of AI systems, AI and society

Position of the course

The objective of this course is to provide theoretical and practical insights into the use of contemporary machine learning in advanced practical applications. It also offers a broad perspective on recent evolutions in the field and a critical analysis of their impact on people and society. A theoretical framework is offered better understand the benefits and limitations of each technique, but the focus is on understanding how to correctly apply machine learning in practice. This course comes with a hands-on component, in which you learn to apply techniques, design multi-component AI-systems and learn to analyse their performance.

For the application of machine learning models, the Python programming language is used. Students are therefore expected to be fluent in Python programming and have previous experience with the Machine learning library Scikit Learn.

Contents

- Brief historical overview and revision of the most important fundamental concepts of machine learning
- Advanced unsupervised learning techniques for clustering, dimensionality reduction and density estimation
- Deep learning: theory and practical network design, transfer learning, deep unsupervised and self-supervised learning, attention and transformers, introduction to recent technologies for large language models and image generation
- Advanced probabilistic and Bayesian techniques, Gaussian processes, variational learning
- Risks and pitfalls of powerful deep learning: algorithmic bias, overconfidence, (lack of) explainability, unfairness (and techniques to address them)
- Impact of recent evolutions in AI on society, ethical and legal considerations

Initial competences

Mathematics: calculus, linear algebra, analytic geometry, probability theory and statistics (all at university level).
Theoretical and mathematics-based basic knowledge on Machine learning, as provided by UGent's Computer Science engineering bachelor course " Artificial Intelligence E016350 (or the 3-credit B-session adopted in other engineering bachelors), including basic experience with the machine learning library **Scikit Learn**.
A good practical proficiency of **Python programming**: fluent use of common libraries such as numpy or pandas.

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 take place on-campus. Recordings Are made available through Ufora after each lecture. In-class discussions are not recorded. Livestreaming is not available.
The NPE will consist of a number of hands-on assignments which will have to be made individually or in groups. Coaching is provided in-person on-campus during hands-on lecture hours or online (through MsTeams). In-depth feedback is provided collectively during lectures.

Study material

Type: Slides

Name: Lecture slides
Indicative price: Free or paid by faculty
Optional: no

Language : English
Available on Ufora : Yes

Type: Audiovisual Material

Name: Lecture recordings
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

Type: Other

Name: Jupyter notebooks and code examples used in lectures and hands-on assignments
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

References

References to recent and online available sources will be given during lectures and made available through Ufora if necessary.

Course content-related study coaching

By the teachers and the assistants, before, during or after contact sessions, by appointment or through MsTeams chat.

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

Skills test, Participation, 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 integer 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 the exam but not for the course, you do not have to retake the exam. If you passed for NPE but not for the course, you only have to retake the exam.
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, you can only obtain an NPE score correction for NPE in resit.
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).

Overall, you still 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 integer score that is smaller than 9/20).

Facilities for Working Students

Lecture recordings are made available after each theory lecture. Attendance for most of the hands-on lecture blocks is optional. The planning of hands-on assignments is announced at the start of the term and enough time is provided to allow planning for the assignments themselves. Only in very exceptional cases, a deadline extension can be allowed. In this case the extension must be requested and well motivated as soon as possible and before the start of the assignment. A deadline can never be postponed beyond the lecture in which collective feedback on the assignment is given.