GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Machine Learning in Photonics (E901130)

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

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2025-2026

A (semester 2)	English	Gent	seminar
			lecture
			practical

Lecturers in academic year 2025-2026

Ferranti, Francesco	VUB	lecturer-in-charge

Offered in the following programmes in 2025-2026	**crdts**	**offering**
Master of Science in Photonics Engineering	4	A

Teaching languages

English

Keywords

Position of the course

Contents

- Introduction to supervised, unsupervised and reinforcement learning
- Interpolation and regression techniques
- Pre-processing techniques (e.g., smoothing, cosmic spike removal, baseline correction)
- Classification techniques
- Dimensionality reduction and clustering techniques
- Sampling techniques
- Modeling of multi-output complex frequency/wavelength-dependent response
- Electromagnetics, optics and biophotonics as application domains
- Introduction to these application domains and links among them
- Design and data analysis
- Practice examples (e.g., photonic sensors, optical imaging, biophotonic data classification.)

Initial competences

Final competences

Learning various concepts, methods, and key technologies relevant in the supervised and unsupervised machine learning areas. This knowledge is general purpose and students will practically apply it to a set of very relevant photonic applications, namely electromagnetic and optical designs, and data analysis for biophotonics. Optics will be presented as part of electromagnetics, showing connections between full-wave, diffractive and refractive (geometrical optics) solutions. Design can include data preparation, optimization and tolerance analysis as practical activities. Biophotonic data will be used for classification problems and the importance of pre-processing techniques will be shown (e.g., for Raman spectroscopy data). Electromagnetics and biophotonics connections will be shown for example when using nanostructures for Surface Enhanced Raman spectroscopy. Students will acquire insight, skills and experience in solving photonic/optical design and data analysis problems using machine learning techniques.

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

Extra information on the teaching methods

24 contact hours Lecture
12 contact hours Seminar, Exercises or Practicals

Study material

None

References

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

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

Oral assessment, Written assessment, Assignment

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

Oral assessment, Written assessment, Assignment

Examination methods in case of permanent assessment

Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible

Extra information on the examination methods

The final exam will be based on the evaluation of a project assignment and of an oral discussion on the project report. During semester: graded project reports; graded lab sessions; graded homework.

Calculation of the examination mark

Special conditions: lab exercises + projects + homework: 1/3. examination: 2/3 (50% final project, 50% oral exam).

Facilities for Working Students

[1] Deep learning, Goodfellow - Bengio - Courville, The Mit Press, 2017
[2] The Elements of Statistical Learning, Data Mining, Inference, and Prediction, Trevor Hastie , Robert Tibshirani , Jerome Friedman, 2009
[3] Kevin P. Murphy, "Machine Learning, a Probabilistic Perspective", MIT Press, 2012
[4] Christopher M. Bishop, Pattern recognition and machine learning, Springer, 2006
[5] Yaser Abu-Mostafa et al.,"Learning from data", AMLbook.com, 2012
[6] Scientific literature