Artificial Neural Networks

2025 - 2026

Is part of the next programmes:

- M0012004 Master of Computer Science: Software Engineering
- M0012005 Master of Computer Science: Data Science and Artificial Intelligence
- M0012006 Master of Computer Science: Computer Networks
- M0048004 Master of Computer Science: Software Engineering
- M0048005 Master of Computer Science: Data Science and Artificial Intelligence
- M0048006 Master of Computer Science: Computer Networks
- U0001008 Courses open to exchange students in Sciences

Course Code:	2500WETANN
Study Domain:	Computer Science
Semester:	2E SEM
Contact Hours:	48
Credits:	6

Study Load (hours):	168
Contract Restrictions:	No contract restriction
Language of Instructions:	ENG
Lecturer(s):	T José Antonio Oramas Mogrovejo
Examperiod:	exam in the 2nd semester

1. Prerequisites *

speaking and writing of:

- English

reading and comprehending of:

- English

general notion of the basic concepts of

Since the "Deep Learning" boom started in 2012, learning-based representations commonly obtained through deep neural networks have experienced a constantly increasing development. In addition, this family of learning algorithms have been deployed in several applications including, image refinement, super-resolution, data compression, audio synthesis, text translation, medical image analysis, etc. This course aims at providing the student with sufficient foundations on the inner-workings of artificial neural networks so that the student is capable of, one the one hand, conducting fundamental research around them, or, on the other hand, deploying them effectively in end-user products.

specific prerequisites for this course

The student is expected to be familiar with concepts related to:

- Artificial Intelligence
- Machine Learning
- Linear Algebra

- Calculus

2. Learning outcomes *

- Students will gain familiarity with relevant fundamental/theoretical aspects behind the design and training of Deep Neural Networks. This will allow the identification of strengths and weaknesses of a given model.
- Students will get familiarity with different neural network architectures for addressing different type of problems.
- Students will be familiar with critical aspects to consider when deploying a neural network for practical applications.
- Students will build the foundations to allow them proper understanding of manuscript published in scientific conferences and journals.
- Students will get hands-on experience with practical aspects regarding the implementation of Neural Networks.

3. Course contents *

The course will cover the following topics:

- Multi-layer Perceptron
- Shallow-Deep Neural Networks
- Convolutional Neural Networks
- Learning and Optimization
- Transfer Learning
- Modeling Sequences with Neural Networks
- Deep Generative Neural Networks
- Interpretation and Explanation of Deep Neural Networks.
- Revision of recent nominal papers

4. International dimension *

- This course stimulates international and intercultural competences.

- Students use course materials in a foreign language.
- The lecturer invites international guest lecturers.
- Students give presentations in a foreign language.

5. Teaching method and planned learning activities

5.1 Used teaching methods *

Class contact teaching

- Lectures
- Practice sessions
- Guest lectures
- Laboratory sessions

Personal work

- Exercises

Assignments

- Individually
- In group

5.2 Planned learning activities and teaching methods

Recordings of the lectures will be made available in two groups. First group will be released after the first half of the topics have been discussed in class. The second group will be released after the last topic has been discussed.
Recordings of specific sessions can be provided in advanced given that valid justifications for not attending the corresponding session are provided.

5.3 Facilities for working students *

Classroom activities

- no specific facilities
- Lectures: recording available via video link on Blackboard

Individual work

- In group: individual alternative assignment possible

Others

See above for details regarding recordings released via Blackboard

6. Assessment method and criteria *

6.1 Used assessment methods *

Examination

- Written examination without oral presentation
- - Closed book
- - Open-question
- - Exercises

Continuous assessment

- Participation in classroom activities

Other assessment methods

- Project
- Presentation

6.2 Assessment criteria *

The evaluation of the course is composed by three parts:

- The **theoretical part:** evaluated via a written exam, aims at evaluating theoretical knowledge and critical analysis of the student regarding the topics

covered in the lectures.

- The **practical part:** evaluated via a single assignment to be submitted towards the end of the course, assesses the development skills and critical analysis of the student when implementing a neural network.
- The **research part:** evaluated through the oral presentation of a scientific paper, assesses the understanding capabilities and critical analysis of the student of the assigned scientific manuscript.

The parts contribute to the total grade in the following manner: theoretical (60%), practical (25%) and research (15%).
Since these three parts assess complementary sets of skills, the student should obtain a grade of 10/20 or higher on each of the parts to successfully pass the course.
Partial exemptions are possible, parts of the exam that are passed during the first exam period do not need to be retaken during the second. This exemption is only applicable during the same academic year.
During the second exam period the theoretical part has the same form and complexity. For the research part a new scientific paper is assigned to the student for analysis and presentation. For the practical part, the development of a new project or an extension to the original would be required.
The use of technology based on generative models, usually referred to as "Generative AI" in popular media, is not permitted for the assignments of this course

7. Study material

7.1 Required reading *

Topics discussed in the theory lectures are taken from the the following textbooks and scientific papers published in the following venues:
Reference Textbooks

- **Dive into Deep Learning**, Zhang, Zachary, Li & Smola, 2020.
- **Deep Learning**, Goodfellow, Bengio & Courville. An MIT Press book. 2016

Note: both manuscript are freely available online

Scientific Articles (Journals/Conferences)

- IEEE Transactions on Pattern Recognition and Machine Intelligence (TPAMI)

- Journal of Machine Learning Research (JMLR)
- International Conference on Learning Representations (ICLR)
- Neural Information Processing Systems (NeurIPS)
- IEEE Transactions on Neural Networks and Learning Systems (TNNLS)
- International Conference on Machine Learning (ICML)
- Computer Vision and Pattern Recognition (CVPR)
- Etc.

7.2 Optional reading

The following study material can be studied voluntarily :

At the end of the slides of each lecture a list of specific scientific references is included. It is advised to review these references as they complement the content discussed in the lectures
Most of these listed articles have open access versions publicly available in the Web.

8. Contact information *

For questions concerning the theory lectures, contact
- José Oramas Mogrovejo, email: Jose.Oramas@uantwerpen.be, The Beacon (S.BC) 702 2000 Antwerpen

For questions concerning the practical sessions, contact
- Arian Sabaghi, email: Arian.Sabaghikhameneh@uantwerpen.be
- Thomas Dooms, email: Thomas.Dooms@uantwerpen.be
- Fabian Denoodt, email: Fabian.Denoodt@uantwerpen.be

For questions concerning the projec, contact
- Arian Sabaghi, email: Arian.Sabaghikhameneh@uantwerpen.be

9. Tutoring

- It is suggested to take this course during the first year of the master program in order to take advantage of knowledge acquired in this course for future courses.
- Continuous review of suggested reading materials listed at the end of each session is recommended for a richer view of the contents discussed in the course.
- There is significant sequential dependency among the covered topics. Therefore, it is advise to follow a gradual study of the topics and avoid skipping topics as this will hinder the understanding of later concepts.
- At the end of the slides of each lecture a list of specific scientific references is included. It is advised to review these references as they complement the content discussed in the lectures.