

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

Credits 6.0 Study time 180 h Contact hrs 40.0 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 2)	English	group work	5.0 h
		seminar: practical PC	20.0 h
		room classes	
		demonstration	2.5 h
		lecture	10.0 h

Lecturers in academic year 2018-2019

Dambre, Joni TW06 lecturer-in-charge

Offered in the following programmes in 2018-2019

	crdts	offering
<a href="#">Master of Science in Business Engineering (main subject Data Analytics)</a>	6	A
<a href="#">Master of Science in Business Engineering (main subject Operations Management)</a>	6	A
<a href="#">Master of Science in Marketing Analysis</a>	4	A

Teaching languages

English

Keywords

Deep learning, artificial neural networks, artificial intelligence

Position of the course

Deep learning is one of the most successful techniques in artificial intelligence (machine learning) today. Like all techniques in machine learning, deep learning builds a model from example data. It does this by modeling the world in terms of a hierarchy of concepts, with each concept defined in terms of its relation to simpler concepts. This approach avoids having to formally specify all of the knowledge that the system needs. In this course, we give the students a solid understanding and hands-on experience of the possibilities of deep learning for practical applications in industry and marketing. After following this course, you are ready to use deep learning in practice, to understand and re-implement state-of-the-art techniques and adapt them to the needs of your application.

Contents

Deep learning builds on machine learning and artificial neural networks, hence, this course starts out with a summary of the basic concepts of machine learning and an in-depth explanation of ANNs, including convolutional neural networks and recurrent neural networks.

This course stresses:

- 1 The benefits of neural networks over other learning algorithms
  - 2 The benefits of "deep" neural networks over "shallow" architectures
  - 3 The practical steps in designing a suitable neural network for a given application
- We apply simple and advanced neural network architectures to cases with economical relevance. We use deep learning on different types of data sets, such as: image processing, NLP (natural language processing), or time series prediction. Case studies will be performed in Python, using common libraries such as scikit-Learn, Keras and TensorFlow or PyTorch.

After an exploration of the different techniques through dedicated assignments, we proceed to tackle a more realistic (difficult) problem on a large and complex data set.

## Initial competences

Programming skills (preferably in Python)

Basic mathematics:

- linear algebra: matrices,
- calculus: derivatives,
- geometry: vectors and inner products

## Final competences

- 1 Determining when and how to use Deep Learning for solving complex problems with economical relevance (marketing and/or R&D).
- 2 Using Deep Learning with complex data (e.g., images, audio, video, text) by combining multiple data streams and multiple models with other techniques from machine learning.
- 3 Systematic design and optimization of deep neural network architectures and analysis of their performance, reliability and robustness.
- 4 Understanding scientific literature about applications of Deep Learning. Validating the results of one's own research in comparison with the state-of-the-art for similar problems.

## 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

Guided self-study, demonstration, group work, lecture, seminar: practical PC room classes

## Extra information on the teaching methods

The concepts discussed in class are demonstrated in Jupyter notebooks, which can be altered by the students in order to get an active understanding.

In three graded programming assignments, students have to apply these concepts to unseen data sets. The results are discussed collectively in class, as well as individually, per group.

Additional for students Master of Business Engineering

In the second part of the semester, an advanced problem is addressed in groups.

Group progress feedback is provided. The final results are presented at the end of the semester.

## Learning materials and price

Learning materials: slides, Jupyter notebooks, a selection of online sources for specific topics.

Scientific papers:

- Bengio, Yoshua; LeCun, Yann; Hinton, Geoffrey (2015). "Deep Learning". *Nature* **521**: 436-444.

## References

Goodfellow I, Bengio Y., Courville A. (2016), "Deep Learning", MIT Press.

## Course content-related study coaching

Numerous exercises are being solved during sessions. In addition there are specific graded assignments as well as an advanced assignment (both to be solved in teams). Students receive coaching in the process of solving the assignments and feedback afterwards (collectively, by team and individually).

## Evaluation methods

continuous assessment

## Examination methods in case of periodic evaluation during the first examination period

Oral examination

## Examination methods in case of periodic evaluation during the second examination period

Oral examination

## Examination methods in case of permanent evaluation

Participation, assignment, report

## Possibilities of retake in case of permanent evaluation

examination during the second examination period is possible in modified form

## Extra information on the examination methods

There are three graded assignments in group and one advanced assignment in group.

Peer assessment will be used to monitor whether each group member contributes sufficiently to the final result. In extreme cases, this will lead to a score that deviates from the group score.

The oral examination (with written preparation) assesses whether each individual student has acquired the necessary understanding and practical knowledge.

#### Calculation of the examination mark

Students Master of Business Engineering

NPE (70%), oral examination (30%)

For each of both parts a score of at least 9/20 must be obtained. If this is not the case, the final score will be reduced to at most 7/20.

Students Master of Marketing Analysis

Individual exercises and group work (50%)

Oral interrogation: 50%

For each of both parts a score of at least 9/20 must be obtained. If this is not the case, the final score will be reduced to 7/20.