GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2019-2020

Deep Learning (F000907)

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

Credits	6.0	Study time	180 h	Contact hrs	40.0 h

Course offerings in academic year 2020-2021

A (semester 2)	English
B (semester 2)	

Lecturers in academic year 2020-2021

Offered in the following programmes in 2020-2021	crdts	offering
Master of Science in Business Engineering (main subject Data Analytics)	6	A
Master of Science in Business Engineering (main subject Operations Management)	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Marketing Analysis	4	B
Exchange Programme in Computer Science (master's level)	6	A

Teaching languages

English

Keywords

Deep learning, artificial neural networks, artificial intelligence

Position of the course

Deep learning is one of the most succesful 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 business applications in industry. 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: images, text, or time series.
Case studies are performed in Python, using common libraries such as Scikit-Learn and Keras.
Only for the students in the 6 credits version of the course:
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)
Mathematics:
- linear algebra: matrix operations
- calculus: derivative, gradient
- analytic geometry: vector space, distance, inner product

Final competences

1 Determine when and how to use Deep Learning for solving complex problems with economical relevance (marketing and/or R&D).
2 Understand the structure and properties of basic neural network types (fully connected, convolutional, recurrent, dense) and their applications.
3 Be able too systematically design and optimise of standard deep neural network architectures in Keras and analyse of their performance, reliability and robustness.
4 Understand 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.
5 **Only for 6 credits version:** Use 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.

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

Demonstration, group work, lecture, seminar: practical PC room classes

Extra information on the teaching methods

Attendance to the practical sessions with group work is mandatory
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.
Only for the 6 credits version:
In the last 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.
- Chollet F. (2017), "Deep learning with Python"

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, and/or by team).

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. For teh 6 credits version there is also a final project in groups. Insufficient contribution to the group results can lead to failing for the course.
The oral examination (with written preparation) assesses knowledge and understanding of the principles of deep learning as well as practical understanding ackquired during the assignments.

Calculation of the examination mark

6 credits version:
NPE (70% - individual correction of group score is possible), oral exam (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.
4 credits version:
Individual exercises and group work (50% - individual correction of group score is possible)
Oral exam: 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 at most 7/20.