DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DIT869 Deep machine learning, 7.5 credits

Djup maskininlärning, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Computer Science and Engineering on 2019-02-08 and was last revised on 2019-12-04 to be valid from 2020-08-31, autumn semester of 2020.

Field of education: Science 100%
Department: Department of Computer Science and Engineering

Position in the educational system

The course is offered within several programmes.

The course can be part of the following programmes: 1) Computer Science, Master's Programme (N2COS) and 2) Applied Data Science Master's Programme (N2ADS)

Main field of studies	*Specialization*
Data Science	A1F, Second cycle, has second-cycle course/s as entry requirements
Computer Science	A1F, Second cycle, has second-cycle course/s as entry requirements

Entry requirements

To be eligible to the course, the student must have a Bachelor's degree.
In particular, the student must have acquired the following knowledge:

- 15 credits of courses in programming or equivalent,
- a course including probability and statistics, such as DIT862 Statistical Methods for Data Science or MSG810 Mathematical Statistics and Discrete mathematics,
- 5 credits of linear algebra or equivalent
- 5 credits of calculus or equivalent,

- a first course in machine learning, such as DIT866 Applied Machine Learning, DIT381 Algorithms for Machine Learning and Inference, or MSA220 Statistical Learning for Big Data

Applicants must prove knowledge of English: English 6/English B or the equivalent level of an internationally recognized test, for example TOEFL, IELTS.

Learning outcomes

On successful completion of the course the student will be able to:

Knowledge and understanding

- explain the fundamental principles of supervised (and unsupervised) learning, including basic techniques like cross-validation to avoid overfitting
- describe the standard cost functions optimised during supervised training (in particular the cross entropy) and the standard solution techniques (stochastic gradient descent, back propagation, etc.)
- explain how traditional feed-forward networks are constructed and why they can approximate "almost" any function (the universality theorem)
- understand the problem with vanishing gradients and modern tools to mitigate it (e.g., batch normalisation and residual networks)
- summarise the key components in convolutional neural networks (CNNs) and their key advantages
- describe common types of recurrent neural networks (RNN) and their applications
- provide an overview of some of the many modern variations of the deep learning networks
- explain what a Markov decision problem and reinforcement learning (RL) are

Competence and skills

- make use of deep learning to solve RL using, e.g., deep q-learning
- train and apply CNNs to image applications and RNNs to applications related to time sequences such as those involved in R
- use a suitable deep learning library (e.g., TensorFlow or Torch) to solve a variety of practical applications

Judgement and approach

- argue for the benefits and limitations of generative models, transfer learning and data augmentation in situations when we have a limited amount of annotated/labelled data

Course content

The purpose with this course is to give a thorough introduction to deep machine learning, also known as deep learning or deep neural networks. Over the last few years, deep machine learning has dramatically changed the state of the art performance in various fields including speech-recognition, computer vision and reinforcement learning (used, e.g., to learn how to play Go). We focus primarily on basic principles regarding how these networks are constructed and trained, but we also cover many of the key techniques used in different applications. The overall objective is to provide a solid understanding of how and why deep machine learning is useful, as well as the skills to apply them to solve problems of practical importance.

In the course, the following broad areas will be covered:

- supervised learning by cross-entropy minimisation and cross-validation
- back propagation and stochastic gradient descent
- a suitable programming language for implementing deep learning algorithm
- feedforward neural networks and convolutional neural networks
- recurrent neural networks and long short-term memory networks
- techniques for efficient training such as momentum and batch normalisation
- modern variations of neural networks (e.g., attention and residual networks)
- transfer learning and data augmentation
- reinforcement learning, Markov decision problems, q-learning and deep q-learning
- application of convolutional neural networks on image recognition and reinforcement learning

Form of teaching

The course comprises on-line lectures (to watch before the class), active learning sessions (where we review material from the corresponding lecture), computer exercise sessions, consultation sessions, assignments, a project and tutorial sessions (primarily related to the home assignments).

Language of instruction: English

Assessment

The course is examined by attendance at compulsory activities, by written assignments and a project, out of which some are carried out individually and some in groups of normally 2-4 students. Non-attendance at a limited number of compulsory activities can be tolerated, and will typically be examined through supplementary assignments.

If a student, who has failed the same examined component twice, wishes to change examiner before the next examination, a written application shall be sent to the department responsible for the course and shall be granted unless there are special reasons to the contrary (Chapter 6, Section 22 of Higher Education Ordinance).

In cases where a course has been discontinued or has undergone major changes, the student shall normally be guaranteed at least three examination occasions (including the ordinary examination) during a period of at least one year from the last time the course was given.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
To pass the course, the student needs to attend a sufficient number of compulsory activities, and have the project and all assignments passed. The final grade is based on the performance of the student in the project and the assignments.

Course evaluation

The course is evaluated through meeting after the course between teachers and student representatives. Further, an anonymous questionnaire is used to ensure written information. The outcome of the evaluations serves to improve the course by indicating which parts could be added, improved, changed or removed.

Additional information

The course is a joint course together with Chalmers.

Course literature to be announced the latest 8 weeks prior to the start of the course.

The course replaces the course DIT868, 7.5 hec. The course cannot be included in a degree which contains DIT868. Neither can the course be included in a degree which is based on another degree in which the course DIT868 is included.