UNIVERSITY OF GOTHENBURG

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

DIT381 Algorithms for Machine Learning and Inference, 7.5 credits

Algoritmer för maskininlärning och slutledning, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Computer Science and Engineering on 2017-12-19 and was last revised on 2019-12-02 to be valid from 2021-01-18, spring semester of 2021.

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

Position in the educational system

The course is offered within several programmes. It is also a single subject course at the University of Gothenburg.

The course can be part of the following programmes: 1) Mathematical Sciences, Master's Programme (N2MAT), 2) Computer Science, Master's Programme (N2COS), 3) Applied Data Science Master's Programme (N2ADS), 4) Game Design & Technology Master's Programme (N2GDT) and 5) Software Engineering and Management Master's Programme (N2SOF)

Main field of studies	*Specialization*
Computer Science	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

To be eligible to the course, the student should have a bachelor degree. In particular, the student must have acquired the following knowledge:

- 7.5 credits of programming (e.g., DIT440 Introduction to Functional Programming, DIT042 Object-Oriented Programming, DIT012 Imperative Programming with Basic Object-Orientation, or equivalent)

- 7.5 credits of data structures (e.g., DIT961 Data Structures, DIT181 Data Structures and Algorithms, or equivalent)
- 7.5 credits of basic probability and statistics (e.g., MSG810 Mathematical Statistics and Discrete Mathematics, DIT861 Statistical Methods for Data Science, or equivalent)
- 7.5 credits of linear algebra (e.g., MMGD20 Linear Algebra, or equivalent)
- 7.5 credits of calculus (e.g., MMGD30 Calculus, or equivalent)

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

After completion of the course the student should be able to:

Knowledge and understanding

- explain a representative set of available methods for machine learning

Competence and skills

- implement and analyze machine learning algorithms
- apply sound mathematical principles to the inference of hypotheses from empirical data and models on scientific grounds

Judgement and approach

- choose appropriate methods and apply them to specific inference problems, based on a solid understanding of scientific literature in the field
- evaluate the methods qualitatively and quantitatively, and recognize their strengths as well as their limitations

Course content

This course will discuss the theory and application of algorithms for machine learning and inference, from an AI perspective. In this context, we consider as learning to draw conclusions from given data or experience which results in some model that generalises these data. Inference is to compute the desired answers or actions based on the model.

Algorithms of this kind are commonly used in for example classification tasks (e.g., character recognition, or to predict if a new customer is creditworthy) and in expert systems (e.g., for medical diagnosis). A new and commercially important area of application is data mining, where the algorithms are used to automatically detect interesting information and relations in large commercial or scientific databases.

The course intends to give a good understanding of this crossdisciplinary area, with a sufficient depth to use and evaluate the available methods, and to understand the

scientific literature. During the course we may discuss potential problems with machine learning methods, for example, bias in training data and safety of autonomous agents.

The following concepts are covered:

- Bayesian learning: likelihood, prior, posterior.
- Supervised learning: Bayes classifier, Logistic Regression, Deep Learning (Standard and CNN), Support Vector Machines, regression models, K-nn models.
- Unsupervised learning: Clustering algorithms, EM algorithm, Mixture models,
- Kernel methods,
- Temporal machine learning models (for example RNN)

Sub-courses

1. **Written hall examination** *(Skriftlig salstentamen),* 4.5 credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)
2. **Assignments** *(Inlämningsuppgifter),* 3 credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)

Form of teaching

Lectures and homework assignments.

Language of instruction: English

Assessment

The course is examined by individual homework assignments and an written hall examination.

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).
A Pass grade (G) for the entire course requires at least a Pass grade for all sub-courses.
To be awarded Pass with Distinction (VG) for the full course, the grade VG must be

obtained on both the sub-courses.

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 DIT380, 7.5 credits. The course cannot be included in a degree which contains DIT380. Neither can the course be included in a degree which is based on another degree in which the course DIT380 is included.

The course cannot be included in a degree which contains DIT866.