



## DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

### **DIT382 Algorithms for Machine Learning and Inference, 7.5 credits**

Algoritmer för maskininlärning och slutledning, 7,5 högskolepoäng

*Second Cycle*

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#### **Confirmation**

This course syllabus was confirmed by Department of Computer Science and Engineering on 2020-12-18 and was last revised on 2023-11-14 to be valid from 2025-01-20, spring semester of 2025.

*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) Computer Science, Master's Programme (N2COS), 2) Mathematical Sciences, Master's Programme (N2MAT), 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*

Computer Science

*Specialization*

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-Oriented, 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 multivariate calculus.

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 (5), Pass with credit (4), Pass (3) and Fail (U)

**2. Assignments** (*Inlämningsuppgifter*), 3 credits

Grading scale: Pass with distinction (5), Pass with credit (4), Pass (3) and Fail (U)

**Form of teaching**

Lectures and homework assignments.

*Language of instruction:* English

**Assessment**

The course is examined by assignments and a 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 (5), Pass with credit (4), Pass (3) and Fail (U).

The grading scale comprises Fail (U), 3, 4 or 5.

To pass the course, all mandatory components must be passed. To earn a higher grade than Pass, a higher weighted average from the grades of the components is required.

**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.