## DIT978   Advanced Software Engineering for AI/ML-Enabled Systems, 7.5 credits

Avancerad programvaruteknik för AI/ML-aktiverade system, 7,5 högskolepoäng

*Second Cycle*

### Confirmation

This course syllabus was confirmed by Department of Computer Science and Engineering on 2021-11-02 to be valid from 2023-01-16, spring semester of 2023.

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

### Position in the educational system

The course can be included in several programs. It is also given as a single subject course at the University of Gothenburg.

The course can be part of the following programmes: 1) Applied Data Science Master's Programme (N2ADS) and 2) Software Engineering and Management Master's Programme (N2SOF)

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

### Entry requirements

To be eligible for the course, the student should have a bachelor´s degree in Software Engineering, Computer Science, Computer Engineering, Information Technology, Information Systems, or equivalent.

In addition, the student should have completed courses in:

- Programming (e.g. DIT042 Object-oriented Programming, DIT012 Imperative Programming with Basic Object-orientation, DIT143 Functional Programming or equivalent)

- A basic course in machine learning (e.g. DIT406 Introduction to data science and AI, DIT821 Software Engineering for AI Systems, DIT824 Software Engineering for Data-Intensive AI Applications, or equivalent)
- A general Software Engineering course (e.g. DIT593 Software engineering principles for complex systems or equivalent) or 6 credits in one or more of the following areas of Software Engineering: Software processes and agile development, Software architecture, Software Quality Assurance or Testing, Requirements Engineering (e.g. DIT257, DIT347, DIT193, DIT344, DIT291, DIT083, DIT843, DIT046, DIT285 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**
On successful completion of the course the student will be able to:

*Knowledge and understanding*
- Explain processes and engineering practices for developing AI/ML-enabled systems, from requirements engineering to testing
- Explain typical roles in software engineering of AI/ML enabled systems as well as challenges in interdisciplinary teams consisting of Data Scientists and Software Engineers
- Explain typical requirements for AI/ML components, such as non-functional requirements, requirements on data, and contextual requirements
- Explain architectures and patterns for AI/ML-enabled systems
- Describe existing techniques to verify and explain decisions made by AI/ML-enabled systems
- Give an overview of recent research on SE for AI/ML-enabled systems

*Competence and skills*
- Read a research paper on software engineering for AI/ML-enabled systems, present it's content, and critically discuss the presented research design
- Demonstrate a software engineering approach for AI/ML-enabled systems with appropriate examples
- Assess new engineering knowledge for AI/ML-enabled systems and relate it to the knowledge presented in this course

*Judgement and approach*
- Judge the extent to which an AI/ML component needs to be safe-guarded
- Judge what verification methods are appropriate when developing an AI/ML-enabled system given the requirements o that system

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- Judge whether a model has systematic biases and discuss the consequences of these biases
- Judge fairness and potential other ethical issues of an AI/ML-enabled system
- Judge user's information needs to work with an AI-enabled system
- Judge limitations of a state-of-the-art software engineering approach for AI/ML given evidence presented in research papers

**Course content**

The course will comprise a number of themes with respect to Software engineering of AI/ML-Enabled Systems:

- Processes, Engineering Practices, and Interdisciplinary Teams
- Requirements Engineering
- Architectures
- Verification and Testing
- Analysis of Failure Cases and Debugging
- Fairness, Bias, and Ethics
- User Management and Explaining AI Decisions

*Sub-courses*

1. **Literature seminars** *(Litteraturseminarier),* 7.5 credits
   Grading scale: Pass with distinction (5), Pass with credit (4), Pass (3) and Fail (U)

**Form of teaching**

The course is provided in the form of a literature seminar, which combines reading papers, student presentations, and discussions. Students will explore one of the topics in detail and gain more summative knowledge in the other topics. An individual report is the final element of the course.

*Language of instruction:* English

**Assessment**

The examination consists of an individual presentation. In addition an active participation and contribution to discussions is required as well as an individual report.

A student who has taken two exams in a course or part of a course without obtaining a pass grade is entitled to the nomination of another examiner. The student needs to contact the department for a new examiner, preferably in writing, and this should be approved by the department unless there are special reasons to the contrary (Chapter 6 Section 22 of the Higher Education Ordinance).

If a student has received a recommendation from the University of Gothenburg for special educational support, where it is compatible with the learning outcomes of the course and provided that no unreasonable resources are required, the examiner may decide to allow the student to sit an adjusted exam or alternative form of assessment.

In the event that a course has ceased or undergone major changes, students are to be guaranteed at least three examination sessions (including the ordinary examination session) over a period of at least one year, but no more than two years, after the course has ceased/been changed. The same applies to placements and professional placements (VFU), although this is restricted to just one additional examination session.

**Grades**

The grading scale comprises: Pass with distinction (5), Pass with credit (4), Pass (3) and Fail (U).
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 meetings both during and 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 indication 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.