



Programme syllabus

Master's Programme, Machine Learning, 120 credits

Masterprogram, maskininlärning

120.0 credits

Valid for students admitted to the education from autumn 19 (HT - Autumn term; VT - Spring term).

This is a translation of the Swedish, legally binding, programme syllabus.

Programme objectives

Machine Learning is an area within Computer Science where computer systems are designed to learn from large sets of examples, similarly to the learning strategies of biological systems (like humans). Recently, Machine Learning has gained great importance for the design of search engines, robots, and sensor systems, and for the processing of large scientific data sets.

The focus of the Master's programme in Machine Learning is on mathematical foundations and methods for Machine Learning. These application areas include topics such as computer vision, speech communication, robotics, information retrieval and/or computational biology.

Knowledge and understanding

A student at the programme of Machine Learning will be able to:

- present a good knowledge of mathematical methods for Machine Learning, as well as how these are applied in a number of application domains,
- understand different Machine Learning problems deeply enough to select and apply suitable methods and computer tools to solve them,
- formulate and approach new Machine Learning problem settings in a scientific manner, in a creative, critical and systematic way.

Skills and abilities

A Master of Science in Machine Learning will be able to:

- work out solution strategies to different Machine Learning problems, knowing the capabilities and limitations of different methods and tools,
- work efficiently in a teamwork environment in groups with people from different scientific and engineering background,
- communicate with scientists and people active in engineering development in a competent manner both orally and in writing,
- follow and participate in research and development related to the chosen track.

Ability to make judgements and adopt a standpoint

A Master of Science in Machine Learning will be able to:

- critically judge a problem and in an independent manner acquire the information and knowledge that is necessary to establish a qualified opinion,

- formulate and approach new Machine Learning problem settings in a scientific manner; in a creative, critical and systematic way,
- identify the need for further knowledge in the field and take responsibility for keeping her/his personal knowledge up to date.

In addition to this the similar objectives for master degree defined in the Higher Education Ordinance are applicable.

Extent and content of the programme

Machine Learning is a two-year (120 ECTS credits) master programme on the advanced level (second cycle). The instruction language is English.

The curriculum consists of:

- mandatory courses,
- courses within Machine Learning: Application domains,
- courses within Machine Learning: Theory.

Eligibility and selection

General admission requirements and the following special admission requirements must be fulfilled in order to be admitted:

a Swedish or foreign degree equivalent to Bachelor's degree of 180 ECTS credits, with a level in Mathematics and Computer Science equal, or higher, than that of the following courses at KTH: SF1624 Algebra and geometry, SF1625 Calculus in one variable, SF1626 Calculus in several variables, SF1901 Probability theory and statistics, DD1337 Programming and DD1338 Algorithms and Data Structures.

Selection

If the number of applicants exceeds the number of places there will be a selection from the following criterias:

1. Evaluation of university
2. Grades from previous study
3. Motivation to study.

The evaluation scale is 1-75.

Implementation of the education

Structure of the education

Each academic year consists of two semesters which are 20 weeks each, and each semester is further divided into two study periods.

The first semester in the programme is dedicated to the compulsory courses. The second and the third semester consist of the courses within the two tracks and the elective courses. The last semester is dedicated to the degree project.

Courses

The programme is course-based. Lists of courses are included in [appendix 1](#).

After each course a student evaluation is performed and then analysed by the course leader in the course analysis document, which is normally published on the web.

Grading system

Courses in the first and the second cycle are graded on a scale from A to F. A-E are passing grades, A is the highest grade. The grades pass (P) and fail (F) are used for courses under certain circumstances.

The grading scale is found in the course syllabus.

Conditions for participation in the programme

Participation requires admission to courses within the programme and course registration.

For further studies, special admission requirements for the course are to be fulfilled. Special admission requirements are listed in the respective course syllabus.

Degree project

The degree project is the final part of the education. The project work may begin when special admission requirements for the course are fulfilled.

Degree

Master of Science.

Requirements for the Degree of Master of Science

The student can apply for a degree of Master of Science after completion of the programme. The programme is designed so that students, when they graduate, have fulfilled national requirements for a degree. This means that the students have completed courses comprising 120 ECTS credits, of which at least 90 ECTS credits are second cycle, and at least 60 ECTS credits (including a 30 ECTS credits degree project) constitute in depth studies in the main field of study.

[Appendix 1 - Course list](#)

[Appendix 2 - Programme syllabus descriptions](#)



Appendix 1: Course list

Master's Programme, Machine Learning, 120 credits (TMAIM), Programme syllabus for studies starting in autumn 2019

General courses

Year 1

Mandatory courses (31.5 credits)

Course code	Course name	Credits	Edu. level
DA2205	Introduction to the Philosophy of Science and Research Methodology	7.5	Second cycle
DD2301	Program Integrating Course in Machine Learning	3.0	Second cycle
DD2380	Artificial Intelligence	6.0	Second cycle
DD2421	Machine Learning	7.5	Second cycle
DD2434	Machine Learning, Advanced Course	7.5	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
DD2257	Visualization <i>Included in Application Domain Visualization</i>	7.5	Second cycle
DD2401	Neuroscience <i>Included in Application Domain, Computational Biology</i>	7.5	Second cycle
DD2402	Advanced Individual Course in Computational Biology <i>Included in Application Domain, Computational Biology</i>	6.0	Second cycle
DD2410	Introduction to Robotics <i>Included in Application Domain, Robotics</i>	7.5	Second cycle
DD2411	Research project in Robotics, Perception and Learning <i>Included in Application Domain, Robotics</i>	15.0	Second cycle
DD2418	Language Engineering <i>Included in Application Domain Language Processing; Speech & Text</i>	6.0	Second cycle
DD2420	Probabilistic Graphical Models <i>Included in Theory, Machine Learning</i>	7.5	Second cycle

Course code	Course name	Credits	Edu. level
DD2423	Image Analysis and Computer Vision <i>Included in Application Domain Computer Vision</i>	7.5	Second cycle
DD2424	Deep Learning in Data Science <i>Included in Application Domain Computer Vision</i>	7.5	Second cycle
DD2425	Robotics and Autonomous Systems <i>Included in Application Domain, Robotics</i>	9.0	Second cycle
DD2429	Computational Photography <i>Included in Application Domain Computer Vision</i>	6.0	Second cycle
DD2430	Project Course in Data Science <i>Included in Application Domain</i>	7.5	Second cycle
DD2435	Mathematical Modelling of Biological Systems <i>Included in Application Domain, Computational Biology</i>	9.0	Second cycle
DD2437	Artificial Neural Networks and Deep Architectures <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
DD2438	Artificial Intelligence and Multi Agent Systems <i>Included in Application Domain, Robotic</i>	15.0	Second cycle
DD2447	Statistical Methods in Applied Computer Science <i>Included in Theory, Statistics & Probability</i>	6.0	Second cycle
DD2476	Search Engines and Information Retrieval Systems <i>Included in Application Domain Databases/Information Retrieval</i>	9.0	Second cycle
DT2112	Speech Technology <i>Included in Application Domain, Language Processing; Speech & Text</i>	7.5	Second cycle
DT2119	Speech and Speaker Recognition <i>Included in Application Domain, Language Processing; Speech & Text</i>	7.5	Second cycle
EL2320	Applied Estimation <i>Included in Theory, Mathematics</i>	7.5	Second cycle
EL2805	Reinforcement Learning <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
EQ2341	Pattern Recognition and Machine Learning <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
ID2222	Data Mining <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
ID2223	Scalable Machine Learning and Deep Learning <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
SF1811	Optimization <i>Included in Theory, Mathematics</i>	6.0	First cycle
SF2930	Regression Analysis <i>Included in Theory, Statistics & Probability</i>	7.5	Second cycle
SF2940	Probability Theory <i>Included in Theory, Statistics & Probability</i>	7.5	Second cycle

Course code	Course name	Credits	Edu. level
SF2943	Time Series Analysis <i>Included in Theory, Statistics & Probability</i>	7.5	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
DD1388	Program System Construction Using C++	7.5	First cycle
DD2352	Algorithms and Complexity	7.5	Second cycle
DD2395	Computer Security	6.0	Second cycle
DD2448	Foundations of Cryptography	7.5	Second cycle
DH2642	Interaction Programming and the Dynamic Web	7.5	Second cycle
ID2213	Logic Programming	7.5	Second cycle
ID2221	Data-Intensive Computing	7.5	Second cycle
SF2568	Parallel Computations for Large- Scale Problems	7.5	Second cycle

Supplementary information

Choose among the conditionally elective courses, so that the following conditions are fulfilled:

- at least 6 courses from Application Domains + Theory, and
- at least 2 courses from Application Domains, and also
- at least 2 courses from Theory.

Examples of possible combinations of courses:

- at least 2 courses from Application Domains, and at least 4 courses from Theory,
- at least 3 courses from Application Domains, and at least 3 courses from Theory,
- at least 4 courses from Application Domains, and at least 2 courses from Theory.

APPLICATION DOMAINS:

- DD2430.
- **Computer Vision:** DD2423, DD2424, DD2429.
- **Language Processing; Speech & Text:** DD2418, DT2112, DT2119.
- **Visualization:** DD2257.
- **Robotics:** DD2410, DD2411, DD2425, DD2438.
- **Databases/Information Retrieval:** DD2476.
- **Computational Biology:** DD2401, DD2402, DD2404, DD2435.

THEORY:

- **Mathematics:** EL2320, SF1811.
- **Statistics & Probability:** DD2447, SF2930, SF2940, SF2943.
- **Machine Learning:** DD2420, DD2437, EL2805, EQ2341, ID2222, ID2223.

Year 2

Mandatory courses (93.0 credits)

Course code	Course name	Credits	Edu. level
DA233X	Degree Project in Computer Science and Engineering, specializing in Machine Learning, Second Cycle	30.0	Second cycle
DD2301	Program Integrating Course in Machine Learning	3.0	Second cycle
SF288X	Degree Project in Optimization and Systems Theory, Second Cycle	30.0	Second cycle
SF299X	Degree Project in Mathematical Statistics, Second Cycle	30.0	Second cycle

Conditionally elective courses

Course code	Course name	Credits	Edu. level
DD2257	Visualization <i>Included in Application Domain Visualization</i>	7.5	Second cycle
DD2401	Neuroscience <i>Included in Application Domain, Computational Biology</i>	7.5	Second cycle
DD2402	Advanced Individual Course in Computational Biology <i>Included in Application Domain, Computational Biology</i>	6.0	Second cycle
DD2404	Applied Bioinformatics <i>Included in Application Domain, Computational Biology</i>	7.5	Second cycle
DD2410	Introduction to Robotics <i>Included in Application Domain, Robotics</i>	7.5	Second cycle
DD2411	Research project in Robotics, Perception and Learning <i>Included in Application Domain, Robotics</i>	15.0	Second cycle
DD2418	Language Engineering <i>Included in Application Domain, Language Processing; Speech & Text</i>	6.0	Second cycle
DD2420	Probabilistic Graphical Models <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
DD2423	Image Analysis and Computer Vision <i>Included in Application Domain Computer Vision</i>	7.5	Second cycle
DD2424	Deep Learning in Data Science <i>Included in Application Domain Computer Vision</i>	7.5	Second cycle
DD2425	Robotics and Autonomous Systems <i>Included in Application Domain, Robotics</i>	9.0	Second cycle
DD2429	Computational Photography <i>Included in Application Domain Computer Vision</i>	6.0	Second cycle
DD2430	Project Course in Data Science <i>Included in Application Domain</i>	7.5	Second cycle
DD2435	Mathematical Modelling of Biological Systems	9.0	Second cycle

Course code	Course name	Credits	Edu. level
	<i>Included in Application Domain, Computational Biology</i>		
DD2437	Artificial Neural Networks and Deep Architectures <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
DD2438	Artificial Intelligence and Multi Agent Systems <i>Included in Application Domain, Robotics</i>	15.0	Second cycle
DD2447	Statistical Methods in Applied Computer Science <i>Included in Theory, Statistics & Probability</i>	6.0	Second cycle
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EL2805	Reinforcement Learning <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
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ID2223	Scalable Machine Learning and Deep Learning <i>Included in Theory, Machine Learning</i>	7.5	Second cycle
SF1811	Optimization <i>Included in Theory, Mathematics</i>	6.0	First cycle
SF2930	Regression Analysis <i>Included in Theory, Statistics & Probability</i>	7.5	Second cycle
SF2940	Probability Theory <i>Included in Theory, Statistics & Probability</i>	7.5	Second cycle
SF2943	Time Series Analysis <i>Included in Theory, Statistics & Probability</i>	7.5	Second cycle

Recommended courses

Course code	Course name	Credits	Edu. level
DD1388	Program System Construction Using C++	7.5	First cycle
DD2352	Algorithms and Complexity	7.5	Second cycle
DD2395	Computer Security	6.0	Second cycle
DD2448	Foundations of Cryptography	7.5	Second cycle
DH2642	Interaction Programming and the Dynamic Web	7.5	Second cycle
ID2213	Logic Programming	7.5	Second cycle

Course code	Course name	Credits	Edu. level
ID2221	Data-Intensive Computing	7.5	Second cycle
SF2568	Parallel Computations for Large- Scale Problems	7.5	Second cycle

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- at least 4 courses from Application Domains, and at least 2 courses from Theory.

APPLICATION DOMAINS:

- DD2430.
- **Computer Vision:** DD2423, DD2424, DD2429.
- **Language Processing; Speech & Text:** DD2418, DT2112, DT2119.
- **Visualization:** DD2257.
- **Robotics:** DD2410, DD2411, DD2425, DD2438.
- **Databases/Information Retrieval:** DD2476.
- **Computational Biology:** DD2401, DD2402, DD2404, DD2435.

THEORY:

- **Mathematics:** EL2320, SF1811.
- **Statistics & Probability:** DD2447, SF2930, SF2940, SF2943.
- **Machine Learning:** DD2420, DD2437, EL2805, EQ2341, ID2222, ID2223.

Year 3



Appendix 2: Specialisations

Master's Programme, Machine Learning, 120 credits (TMAIM), Programme syllabus for studies starting in autumn 2019

This programme has no specialisations.