

## **Master's Programme in Statistics and Machine Learning**

Master's Programme in Statistics and Machine Learning  
120 credits

F7MSL

Valid from: 2022 Autumn semester

**Determined by**

Board of the Faculty of Arts and Sciences

**Date determined**

2017-11-24

**Revised by**

Course and Programme Syllabus Board at the Faculty of Arts and Sciences

**Revision date**

2019-06-13; 2020-06-08; 2020-09-01; 2021-06-28

**Registration number**

LiU-2017-02005; LiU-2019-02290; LiU-2021-02844

**Offered first time**

Autumn semester 2018

**Offered for the last time**

**Replaced by**

## Introduction

The rapid IT development has led to the overwhelming of society with enormous volumes of information generated by large or complex systems. Information can be stored in large databases, it can come in a streaming manner or it can be a result of the interaction between the system and the learning environment. This advanced level programme meets the challenges of learning from these complex information volumes by means of models and algorithms which enable for efficient prediction, analysis and decision making. Statistical modelling and analysis is integrated with machine learning, data mining and data management into a solid basis for professional work with the information modelling and analysis of data in large or complex systems. The program also provides excellent qualifications for a career in research. The programme leads to master degree in Statistics.

## Aim

### **National Qualifications according to the Swedish Higher Education Act**

#### **Knowledge and understanding**

For a Degree of Master (120 credits) the student shall

- demonstrate knowledge and understanding in Statistics, including both broad knowledge of the field and a considerable degree of specialised knowledge in certain areas of the field as well as insight into current research and development work, and
- demonstrate specialised methodological knowledge in Statistics.

Specialized knowledge in machine learning shall include modern powerful techniques for classification and regression, prediction, methods for statistical simulation and optimization, Bayesian methods and methods for analysis of large databases.

#### **Competence and skills**

For a Degree of Master (120 credits) the student shall

- demonstrate the ability to critically and systematically integrate knowledge and analyse, assess and deal with complex phenomena, issues and situations even with limited information
- demonstrate the ability to identify and formulate issues critically, autonomously and creatively as well as to plan and, using appropriate methods, undertake advanced tasks within predetermined time frames and so contribute to the formation of knowledge as well as the ability to evaluate this work
- demonstrate the ability in speech and writing both nationally and internationally to report clearly and discuss his or her conclusions and the knowledge and arguments on which they are based in dialogue with different audiences, and

- demonstrate the skills required for participation in research and development work or autonomous employment in some other qualified capacity.

### **Judgement and approach**

For a Degree of Master (120 credits) the student shall

- demonstrate the ability to make assessments in statistics informed by relevant disciplinary, social and ethical issues and also to demonstrate awareness of ethical aspects of research and development work
- demonstrate insight into the possibilities and limitations of research, and especially research in statistics its role in society and the responsibility of the individual for how it is used, and
- demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.

### **Local aims**

Upon completing the programme the students shall be able to:

- model information volumes that are generated by large or complex systems
- select a suitable model in a given context
- extract and organize large volumes of complexly structured data
- explore, summarize and present large and complex data sets by static, interactive and dynamic graphical facilities
- use advanced software to analyse large or complex data volumes
- implement models suitable for data analysis, prediction and decision making in some computer language
- combine data information with other sources of prior information to improve inference and prediction performance
- give examples of application areas where it is required to model information volumes that emerge from large or complex systems.
- uncover and statistically verify previously unknown patterns and trends in the data
- present a written thesis with a theoretical or an applied study of large or complex systems or data sets by means of methods from statistics and machine learning.

## Content

The programme is organized as an education in data analytics that is relevant in different application areas. The profile in data analytics is created as a synergy of courses in statistics, machine learning and computer science. The programme comprises introductory, obligatory, complementary, profile courses and a master thesis.

Introductory courses are offered to prepare the students for the programme's other courses. Obligatory courses contain theoretical and practical tools that are necessary for solving various analytical problems. Profile courses are courses in Statistics that include models and methods which give a deeper probabilistic understanding of machine learning and data analysis. Complementary courses have diverse nature connected to statistics or machine learning and directed towards a specific application area or an advanced methodological domain. During semester 3, a possibility to exchange semester is given.

Master thesis covering 30 ECTS makes it possible for the students to apply their theoretical and practical knowledge in order to solve a relevant practical data analysis problem or going deeper into a research-oriented project.

The heading "Curriculum" contains a list of courses included in the programme. The course syllabuses for these describe in more detail the contents, teaching and working methods, and examination.

## Teaching and working methods

Ordinary courses have lectures, seminars, and computer exercises. The lectures are devoted to presentations of theories, concepts, and methods. The seminars comprise presentations and discussions of assignments. The computer exercises provide practical experience of data analysis and other methods taught in the programme. The courses that are named projects have supervision only.

The course syllabuses describe in more detail the contents, teaching and working methods, and examination.

## Entry requirements

- Bachelor's degree equivalent to a Swedish Kandidatexamen in one of the following subject areas:
  - statistics
  - mathematics
  - applied mathematics
  - computer science
  - engineeringor a similar degree
- Completed courses with passing grade in following subjects:
  - calculus
  - linear algebra
  - statistics
  - programming
- English corresponding to the level of English in Swedish upper secondary education (Engelska 6)  
Exemption from Swedish

## Threshold requirements

The student must have at least 6 ECTS credits from passed courses of the first semester, in order to get access to the second semester of the programme.

The student must have passed at least 30 ECTS credits of the programme, including the course Machine Learning, 9 ECTS credits, in order to get access to the third semester of the programme.

The student must have passed at least 60 ECTS credits of the programme, including 6 ECTS credits from semester 3 and the course Machine Learning, 9 ECTS credits in order to get access to the fourth semester of the programme.

## Degree requirements

The student will be awarded the degree of Master of Science (120 ECTS credits) in Statistics provided all course requirements are completed and that the student fulfils the general and specific eligibility requirements including proof of holding a Bachelor's (kandidat) or a corresponding degree.

To be awarded the degree the students must have passed 90 ECTS credits of courses including 42 ECTS credits of the compulsory courses, a minimum of 6 ECTS credits of the introductory courses, a minimum of 12 ECTS credits of the profile courses, and, possibly, some amount of complementary courses. The students must also have successfully defended a master's thesis of 30 ECTS credits.

Completed courses will be listed in the degree certificate.

Course requirements to achieve a degree can be found in Appendix 2 to the Higher Education Ordinance (1993:100). Precise requirements for general degrees at first-cycle and second-cycle level can be found in LiU's current regulations.

A degree certificate will be issued by the faculty board on application by the student. A diploma supplement will be included as an appendix to the degree certificate.

## Degree in Swedish

Filosofie masterexamen med huvudområde Statistik

## Degree in English

Degree of Master of Science (120 credits) with a major in Statistics

## Specific information

### Teaching language

The teaching language is English.

### Transferred credits

Decisions about transferring credit are taken by the faculty board, or by a person designated by the board, after application from the student.

### Other information

If special circumstances prevail, the vice-chancellor may in a special decision specify the preconditions for temporary deviations from this programme syllabus, and delegate the right to take such decisions.



## Curriculum

### Semester 1 (Autumn 2023)

| Course code | Course name               | Credits | Level | Weeks          | Timetable module | ECV |
|-------------|---------------------------|---------|-------|----------------|------------------|-----|
| 732A60      | Advanced Academic Studies | 3       | A1N   | v202334-202343 | 4                | C   |
| 732A94      | Advanced Programming in R | 6       | A1N   | v202334-202343 | 1                | E   |
| 732A93      | Statistical Methods       | 6       | A1N   | v202335-202343 | 3                | E   |
| 732A98      | Visualization             | 6       | A1N   | v202335-202343 | 2                | E   |
| 732A90      | Computational Statistics  | 6       | A1N   | v202344-202402 | 2                | C   |
| 732A99      | Machine Learning          | 9       | A1N   | v202344-202402 | 1/4              | C   |

### Semester 2 (Spring 2024)

| Course code | Course name                         | Credits | Level | Weeks          | Timetable module | ECV |
|-------------|-------------------------------------|---------|-------|----------------|------------------|-----|
| 732A55      | Neural Networks and Learning System | 6       | A1F   | v202403-202412 | 2                | E   |
| 732A56      | Web programming                     | 6       | A1F   | v202403-202412 | 3                | E   |
| 732A70      | Introduction to Python              | 3       | A1N   | v202403-202412 | 4                | C   |
| 732A75      | Advanced Data Mining                | 6       | A1F   | v202403-202412 | 3                | C   |
| 732A97      | Multivariate Statistical Methods    | 6       | A1F   | v202403-202412 | 1                | E   |
| 732A54      | Big Data Analytics                  | 6       | A1N   | v202413-202422 | 3                | C   |
| 732A78      | Deep Learning                       | 3       | A1F   | v202413-202422 | 4                | C   |
| 732A91      | Bayesian Learning                   | 6       | A1F   | v202413-202422 | 2                | C   |
| 753A01      | Sports Analytics                    | 6       | A1F   | v202413-202422 | 3                | E   |

### Semester 3 (Autumn 2024)

| Course code | Course name                       | Credits | Level | Weeks          | Timetable module | ECV |
|-------------|-----------------------------------|---------|-------|----------------|------------------|-----|
| 732A63      | Probability Theory                | 6       | A1F   | v202436-202444 | 3                | E   |
| 732A80      | Time Series and Sequence Learning | 6       | A1F   | v202436-202444 | 2                | E   |
| 732A96      | Advanced Machine Learning         | 6       | A1F   | v202436-202444 | 1                | E   |
| 732A98      | Visualization                     | 6       | A1N   | v202436-202444 | 4                | E   |
| 732A66      | Decision Theory                   | 6       | A1F   | v202436-202503 | -                | E   |
| 732A76      | Research Project                  | 6       | A1F   | v202436-202503 | 4                | E   |
| 732A51      | Bioinformatics                    | 6       | A1F   | v202445-202503 | 3                | E   |
| 732A57      | Database Technology               | 6       | A1F   | v202445-202503 | 1                | E   |
| 732A81      | Text Mining                       | 6       | A1F   | v202445-202503 | 2                | E   |

### Semester 4 (Spring 2025)

| Course code | Course name                 | Credits | Level | Weeks          | Timetable module | ECV |
|-------------|-----------------------------|---------|-------|----------------|------------------|-----|
| 732A64      | Master Thesis in Statistics | 30      | A2E   | v202503-202522 | 1/2/3/4          | C   |

ECV = Elective / Compulsory / Voluntary  
\*Kursen läses över flera terminer