Faculty of Health, Science and Technology
Mathematics

Syllabus

Mathematical methods of modern statistics and simulation

Course Code:	MAAD34
Course Title:	Mathematical methods of modern statistics and simulation *Matematiska metoder för modern statistik och simulering*
Credits:	7.5
Degree Level:	Master's level
Progressive Specialisation:	Second cycle, has only first-cycle course/s as entry requirements (A1N)

Major Field of Study:
MAA (Mathematics)

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology 2024-02-18, and is valid from the Autumn semester 2024 at Karlstad University.

Prerequisites
Mathematics 90 ECTS credits, with 30 ECTS credits at the G2F level, and upper secondary level English 6, or equivalent

Learning Outcomes
Upon completion of the course, students should be able to:
- calculate sample mean and sample variance for a given data set,
- perform principal component analysis,
- model phenomena with standard distributions (for instance Poisson, exponential, and normal distribution),

- use conditional probability and Bayes' theorem,
- calculate point and interval estimates for relevant parameters,
- implement (in for instance R or Python) procedures for parameter estimates, and
- carry out hypothesis testing.

Content
Module 1: Statistical data analysis

A. Theory
Probability, conditional probability, Bayes' theorem, discrete and continuous random variables, probability function, distribution function, density function, averages, dispersion measures, multidimensional random variables, dependence measures.

B. Practice
Data processing with programming or statistical software, data reduction, sparsity and compression, principal component analysis, cluster analysis, machine learning.

Module 2: Statistical inference

A. Theory
Random sample, sample distributions (t and F distributions), methods for parameter estimation (least squares method, maximum likelihood method), calculation of point and interval estimates for relevant parameters, variance analysis (ANOVA) and variance reduction.

B. Practice
Inverse transform sampling, implementation of parameter estimates with controlled variance, comparison of estimates based om maximum likelihood method (or other methods for parameter estimation) and estimates based on machine learning.

Reading List
See separate document.

Examination
Assessment is based on individual written hand-in assignments and a seminar.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades
One of the grades Distinction (VG), Pass (G), or Fail (U) is awarded in the examination of the course.

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate
A course certificate will be provided upon request.

Additional information

The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.