Faculty of Science

MASM33, Mathematical Statistics: Quantitative Risk Management using Copulas, 7.5 credits

Matematisk statistik: Kvantitativ riskanalys med Copulas, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2020-12-01 to be valid from 2020-12-01, autumn semester 2021.

General Information

The course is an elective course for second-cycle studies for a Master of Science in Mathematical statistics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Mathematical Statistics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

This course provides an introduction to parameter mixture distributions, conditional independence and asymptotic models used to construct multivariate models in higher dimensions, along with a discussion of why there is a need to separate the dependence structure from the marginal distributions.

The course has three main objectives:

1. To discuss fundamental and flexible methods for modern dependence modelling with copulas and to demonstrate how the theory can be used in

real life applications.

2. To cover the probability theory of multivariate extreme value theory and show how this can be seen as a special case of point 1 above.

3. To give an introduction to programming in R, with a focus on specialized libraries for using copulas and analysing multivariate extreme value data.

The aim of the course is that students on completion of the course should have acquired the following knowledge and skills:

Knowledge and understanding

On completion of the course, the students shall be able to:

- describe how to define copulas and their relationship to multivariate extreme value distributions,
- describe different measures of association for multivariate data,
- explain which statistical methods can be used for the analysis of copulas and extreme values.

Competence and skills

On completion of the course, the students shall be able to:

- process multivariate data for analysis of copulas and extreme values,
- fit copulas and multivariate extreme value distributions using different methods,
- validate the fitted models and make suitable modifications of the models,
- use the resulting models for prediction,
- use a statistical computer program for analysis of data,
- present the analysis and conclusions of a practical problem in a written report.

Judgement and approach

On completion of the course, the students shall be able to:

- check the prerequisites of the model before modelling multivariate data,
- evaluate the plausibility of a performed study,
- reflect over the limitations of the chosen model and estimation method, as well as alternative solutions. This is assessed in the written reports connected to the computer exercises.

Course content

The course processes:

- Multivariate distributions including, normal, students-t, spherical, elliptical and parametric mixture distributions.
- Measures of association such as: Pearson's correlation, Kendall's tau, and Spearman's rho.
- Properties of copulas; spherical, elliptical, and Archimedean copulas; simulation of copulas.
- Theoretical background for univariate extreme value theory and max-stable distributions in the bivariate case.
- Methods for constructing multivariate models in higher dimensions: copula representations, Sklar's theorem and the Fréchet-Hoeffding bounds for joint distributions.
- Statistical inference for copulas and multivariate extreme-value distributions; including multivariate peak over threshold, maximum likelihood, as well as Capéraà–Fougères–Genest (CFG) and Pickand's non-parametric estimators.

Course design

Teaching consists of lectures, home assignments, exercises, and computer exercises. Participation in computer exercises and thereby integrated teaching is compulsory.

Assessment

The examination is done by a written exam, at end of the course, and computer labs during the course.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a passing grade on the entire course, passed the written exam, and participation in compulsory parts are required. Marking scale on computer labs: Fail, Pass. The final grade is the grade on the written exam.

Entry requirements

For admission to the course English 6/B and knowledge equivalent to 90 ECTS credits within the subjects of mathematics or mathematical statistics is required. 7,5 ECTS credits must be on an advanced level, the remaining 82.5 ECTS credits may be on a basic or advanced level. Among these 90 ECTS credits knowledge equivalent to MASM15, Mathematical Statistics: Statistical Modelling of Extreme Values, 7.5 credits is required.

Further information

The course cannot be used in a degree together with MASM23 Mathematical Statistics: Statistical Modelling of Multivariate Extreme Values, 7,5 ECTS credits.

Subcourses in MASM33, Mathematical Statistics: Quantitative Risk Management using Copulas

Applies from H21

2101 Examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction
2102 Computer exercises, 1,5 hp
Grading scale: Fail, Pass
Computer exercises with written reports.