



LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Kvantitativ riskanalys med copulas Quantitative Risk Management Using Copulas

FMSN65, 7,5 credits, A (Second Cycle)

Valid for: 2023/24

Faculty: Faculty of Engineering, LTH

Decided by: PLED I

Date of Decision: 2023-04-14

General Information

Elective for: F5, F5-fm, I5-fir, Pi5, R5

Language of instruction: The course will be given in English

Aim

Advanced dependence modelling in multivariate data analysis is an important and challenging subject with important applications in finance, environmental studies and insurance. 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 copulas and analysing multivariate extreme value data.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

- 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

Competences and skills

For a passing grade the student must

- handle 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

For a passing grade the student must

- always check the prerequisites 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.

Contents

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.

Some 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 CFG and Pickand's non-parametric estimators.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Assessment: Written exam and computer labs with written reports.

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.

Parts

Code: 0121. **Name:** Written Examination.

Credits: 6. **Grading scale:** TH. **Assessment:** Written examination.

Code: 0221. **Name:** Laboratory Work.

Credits: 1,5. **Grading scale:** UG. **Assessment:** Computer exercises and written report.

Admission

Admission requirements:

- FMSF20 Mathematical Statistics, Basic Course or FMSF25 Mathematical Statistics - Complementary Project or FMSF32 Mathematical Statistics or FMSF45 Mathematical Statistics, Basic Course or FMSF50 Mathematical Statistics, Basic Course or FMSF55 Mathematical Statistics, Basic Course or FMSF70 Mathematical Statistics or FMSF75 Mathematical Statistics, Basic Course or FMSF80 Mathematical Statistics, Basic Course

Assumed prior knowledge: FMSN55 Statistical Modelling of Extreme Values

The number of participants is limited to: No

The course overlaps following course/s: FMSN15, MASM23, MASM33

Reading list

- Jan Beirlant, Yuri Goegebeur, Johan Segers, Jozef Teugels: Statistics of Extremes: Theory and Applications. Wiley, 2004, ISBN: 978-0471976479.
- Jan-Frederik Mai and Matthias Scherer: Simulation copulas, stochastic models, sampling algorithms, and applications. Imperial College Press, 2017, ISBN: 978-1848168749.

Contact and other information

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Course coordinator: Docent Nader Tajvidi, nader.tajvidi@matstat.lu.se

Course administrator: Susann Nordqvist, expedition@matstat.lu.se

Course homepage:

<https://www.maths.lu.se/utbildning/civilingenjoersutbildning/matematisk-statistik-paa-civilingenjoersprogram/>

Further information: The course is also given at the faculty of science with the course code MASM33.