University of Manitoba, Department Statistics

STAT 7240 – Copula-based Dependence Models

Winter 2014

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Office hours Tuesday & Thursday 1:00 PM–2:00 PM
(or by appointment)

Lectures Tuesday & Thursday 11:30 AM–12:45 PM
Machray Hall, room 316
The first meeting is on January 9, 2014.

Course Description

Copulas are a standard tool for modelling dependence between random variables. Their appeal lies in the fact that any joint distribution can be expressed as a copula function of its marginal distributions. This representation not only provides a flexible modelling framework that separates the study of dependence from marginal analyses, but also gives rise to new classes of dependence models. These models have a wide range of applications in areas as diverse as actuarial science, biostatistics, finance, and hydrology.

This course is designed as a guided reading course on copula-based dependence models and their inference. We will review the recent literature and discuss the use of copulas in theory and applications. Topics include theoretical foundations of copulas, dependence measures, parametric copula families, copula estimation and goodness-of-fit tests.

Objectives The course will provide students with the opportunity to learn in-depth about copulas and their role in multivariate analysis. Throughout the course, the students will gain theoretical knowledge and practical skills necessary for the study of multivariate dependence.

Prerequisites STAT 4690/7200 or consent of the instructor.
A good understanding of statistical inference is essential. In addition, students are expected to have basic programming skills in R for assignments and final project.

Course Material Lecture notes define the content of the course. There is no required text. A reading list of selected papers will be provided during the course.

Recommended Texts

An Introduction to Copulas (2^{nd} edition)
R. Nelsen, Springer, 2006.

Multivariate Models and Dependence Concepts
H. Joe, Chapman & Hall/CRC, 1997.

Quantitative Risk Management: Concepts, Techniques, and Tools
A.J. McNeil, R. Frey, P. Embrechts, Princeton University Press, 2005.

Evaluation Grades will be based on students' performance in class discussions, assignments and final project.

Participation	**10 %**
Assignments	**50 %**
Final Project	**40 %**

Participation grade will be based on the quality of contributions to class discussions, not on mere attendance.

Assignment grade will consist of reading and homework assignments. There will be regular reading assignments, some of which will involve writing a brief report on a research article. Homework assignments will require mathematical derivations, programming in R and/or real data analysis. There will be 3-4 homework assignments during the term.

Final project grade will consists of a project report and an in-class presentation. Final project will require modelling dependence in real data, with possibility to include a critical analysis of a published result.

Academic Integrity

The following statement is included in this course outline to draw your attention to the academic integrity policy at the University of Manitoba.

- *Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university).*

It is your responsibility to understand the meaning and consequences of academic dishonesty. Therefore, please check:

http://www.umanitoba.ca/science/undergrad/resources/webdisciplinedocuments.html

Course Outline

Tentative topics include:

1. Preliminaries: from univariate to multivariate distributions
1. Copulas: copula functions, Sklar's theorem, properties of copulas
2. Dependence measures: concordance measures, quadrant dependence, tail dependence
3. Methods for constructing copulas
4. Parametric copula families: elliptical copulas, Archimedean copulas
5. Fitting copulas: parametric, semiparametric and nonparametric estimation
6. Copula goodness-of-fit tests: Rosenblatt's transformation, Cramér-von Mises statistic
7. Conditional copulas
8. Multivariate copulas: hierarchical copulas and vine copulas