Topics in Actuarial Science
Copula and Dependence Modeling
ACTSC 991, Winter 2014

Instructor:	Ruodu Wang, M3 3122, ext.31569, wang@uwaterloo.ca
Lectures:	5:30 – 6:50 Tuesdays and Thursdays, M3 3103.
Tutorials:	N/A.
Office hours:	3:30 – 4:30 Tuesdays and Thursdays, or by appointment.
Ideal audience:	Ph.D. students and Master's students interested in research.

Reference

The lecture be based on selected topics from the following sources:

(i) Nelsen, R. (2006). An Introduction to Copulas. Second Edition. Springer Series in Statistics.

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

(iii) Denuit, M.; Dhaene, J.; Goovaerts, M.; Kaas, R. (2005). Actuarial Theory for Dependent Risks. Wiley.

(iv) Selected research papers.

- You are not required to purchase those books. The key concepts will be available through the course.

- You are expected to read some research papers by yourself.

Main objectives of the course

The course consists of a traditional learning part (first 2/3) and a research development part (last 1/3). We will study

- the general framework of dependence modeling.

- the complete theory of copulas, including both the probability theory and statistical inference of copulas, with a focus on the probability aspect.

- some recent research development in dependence modeling.

- relevance of dependence modeling in financial risk management.

- ongoing research projects in the area.

The studenets are expected to learn

- modern theory of dependence modeling and risk management techniques.

- to read and present research papers/talks.

- to develop their own interest and ability of conducting research and scentific writing.

The technical/mathematical level of the course is designed to be high (Ph.D. level) but students with less mathematical background are also welcome and expected to be able to survive.

Assignments

There will be two assignments. Assignments should be handed in to the instructor by the end of the class on the due day.

In-class presentation

Each student is expected to give one or two oral presentations/seminars on research topics during the lectures. The typical length of each presentation is about 30 minutes which also depends on the number of students enrolled in the class.

Midterm

There will be one midterm for the first 2/3 of the course.

Project

There will be one final project concerning the study of some research topics. (It is like a review paper or an application paper.)

Course Evaluation Breakdown

(1) Assignments 20%;

(2) Midterm 30%;

(3) In-class presentation 20%;

(4) Final Project 30%.

Course Topics and Tentative Schedule

	Time	Topics	Format
Part I **Introduction**	Lectures 1-2	Introduction Multivariate distributions Elliptical distributions Risk aggragation	Lectures
Part II **Probabilistic theory** **of copulas**	Lectures 3-7	Introduction to copulas Bivariate copulas Dependence concepts Construction of copulas Achimedian copulas Dependence measures	Lectures & presentation
Part III **Statistical inference** **and simulation of copulas**	Lectures 8-10	Empirical copula Parametric MLE Pseudo parametric MLE Non-parametric methods Simulation	Lectures & presentation
Part IV **General dependence modeling** **concepts**	Lectures 11-12	Stochastic orders Complete mixability Postive dependence Negative dependence	Lectures & presentation
Part V **Dependence modeling for** **financial risk management**	Lectures 13-15	Risk management techniques Model uncertainty Extreme scenarios Financial data analysis Credit risk models	Lectures & seminars
Lecture 16: Midterm			
Part VI **Development in research**	Lectures 17-24	Vine copulas New construction of copulas Advanced statistical inference Development in modeling Risk aggregation questions	Seminars

Notes

Course webpage: All the course materials will be posted on the D2L course webpage
https://learn.uwaterloo.ca/.

Attendance to classes is strongly recommended. If you missed, it is your own responsibility to get known of all the mathematical knowledge and announcements made in classes. Unless you have legitimate excuse for your absence, it will be impossible to get a copy, from the instructor afterwards, of those course materials you missed.

Collaboration. You may discuss assignments, but you should write up solutions separately, without access to any other students' solutions, unless the assignment is specifically set as a group assignment. Rules for group assignments will be explained when they are assigned.

Requests for re-grading an exam must be made within one week after the grades have been posted on course webpage. To have your assignment/exam considered for re-grading, the assignment/exam must be written in ink. Note that the instructor reserves the right to re-grade the entire exam and raise or lower the grades originally assigned.

Missed an exam. If you missed the midterm or the final exam without a legitimate excuse, you get zero grade. If you know that you are going to be absent, you should ask the instructor in advance for the permission. Examples of an excused absence include participation in the University sponsored activities (e.g. varsity sport, debate team), observance of officially designated religious holidays, serious personal problems (illness, etc) and matters relating to students' academic training (e.g. graduate or professional school interviews). Conflicts arising from personal travel plans or social obligations do not qualify as excused absences.

Illness. If an illness prevents you from completing an examination, the University's rules stated in the Accommodation for Illness Policy will apply; see the following link
http://www.registrar.uwaterloo.ca/students/accom_illness.html.

It is your responsibility to familiarize yourself with this policy. To be excused for your absence due to illness, the student need to present a "Verification of Illness Form" filled out and signed by a physician (automatically done if you go to the campus clinic) to your instructor within 3 working days of the exam. You also need to send an email to the instructor within 24 hours of the exam to let us know that you were unable to write the exam. You should be aware that presenting the Verification of Illness Form within the above deadlines does not guarantee that you will be excused from the exam.

No make-up exams. If you missed the midterm and your absence is well excused, the weight of the midterm will be shifted to the final exam. There are no make-up midterm. If you miss the final exam and present satisfying evidence as above, a make-up exam will be given to you. You will receive a 24-hour notice by email (using the email address that you used to let us know about your absence from the exam) giving you the time and location of the make-up final exam. The make-up final exam will be scheduled at a time that does not conflict with your other exams. An INC grade is only given in very exceptional circumstances, when a student is unable to write exams in the remaining exam period (and has documented evidence of that), had maintained an average of at least 70% in the course, and had missed no midterm.

UW Academic Policies

Persons with Disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132 collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with OPD at the start of each academic term.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70 - Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm.

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., 2 plagiarism, cheating) or about rules for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. When misconduct has been found to have occurred, disciplinary penalties will be imposed under Policy 71-Student Discipline. For information on categories of offenses and types of penalties, students should refer to Policy 71-Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm.

Avoiding Academic Offenses: Most students are unaware of the line between acceptable and unacceptable academic behavior, especially when discussing assignments with classmates and using the work of other students. For information on commonly misunderstood academic offenses

and how to avoid them, students should refer to the Faculty of Mathematics Cheating and Student Academic Discipline Policy, http://www.math.uwaterloo.ca/navigation/Current/cheating policy.shtmlhttp://www.math.uwaterloo.ca/navigation/Current/cheating policy.shtml.

Appeals: A student may appeal the finding and/or penalty in a decision made under Policy 70 - Student Petitions and Grievances (other than regarding a petition) or Policy 71 - Student Discipline if a ground for an appeal can be established. Read Policy 72 - Student Appeals,

http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.