جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Special Topics in Statistics - STAT 390

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	STAT 390
Course Title	Special Topics in Statistics
Academic Semester	Spring
Academic Year	2019/2020
Semester Start Date	01/26/2020
Semester End Date	05/13/2020
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Sun Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Raphael Georges Huser	raphael.huser@kaust.edu.sa	+966128080682	4125, 1, Al-Khawarizmi (bldg. 1)	TBA

Teaching Assistant(s)

Name	Email
TBA	TBA

Course Information

Comprehensive Course Description	This advanced statistics course is an introduction to the statistical dependence modeling with copulas. Topics covered include: (a) *Prelude: Multivariate Modeling*: Random vectors and their distributions, The correlation coefficient and misconceptions, The multivariate normal distribution, Extensions of multivariate normality; (b) *Copula fundamentals*: Standardization of random vectors to a common scale, Probability integral transform, Definition of copulas, Basic properties, Copula (conditional) CDF and PDF, Some simple copula families, The copula package in R, Sklar's Theorem, Fréchet-Hoeffding bounds, The invariance principle, Survival copulas and copula symmetries, Measures of association (Pearson's correlation, Concordance, Spearman's rho, Kendall's tau, Blomqvist's beta, Tail dependence coefficient, Tail order, Tail dependence functions), Measures of bivariate asymmetry, Simulation algorithms, Rosenblatt transform and conditional sampling; (c) *Copula constructions and models*: Fundamental copulas, Copula constructions and transformations (implicit copulas, rotated copulas, Khoudraji's device, Mixtures of copulas), Elliptical copulas, Archimedean copulas and asymmetric extensions, Extreme-Value copulas and max-domains of attractions, Factor copulas, Vine copulas, Copulas of discrete random vectors; and (d) *Inference:* Estimation (parametric assumption, nonparametric assumption, etc.), Graphical diagnostics (pseudo-observations and normal scores), Hypothesis tests (independence, exchangeability, radial symmetry, extreme-value dependence, goodness-of-fit tests), Model selection. Additional modern special topics will also be discussed.
Course Description from Program Guide	
Goals and Objectives	By the end of the course, the students will be able to: 1. understand the concept and theory of copulas; 2. know the most widely-used copula parametric families, and their theoretical properties; 3. apply the concepts of copula modeling and inference to real datasets.
Required Knowledge	STAT 220, STAT 230, STAT 250

Reference Texts	References: 1. Hofert, M., Kojadinovic, I., Mächler, M. and Yan, J. (2018). Elements of Copula Modeling with R. Springer 2. Nelsen, R. B. (2006). An Introduction to Copulas. New York: Springer 3. Joe, H. (1997). Multivariate Models and Dependence Concepts. Chapman & Hall/CRC 4. Joe, H. (2014). Dependence Modeling with Copulas. Chapman & Hall/CRC 5. Czado, C. (2019). Analyzing Dependent Data with Vine Copulas. Springer 6. Durante, F. and Sempi, C. (2016). Principles of Copula Theory. Chapman & Hall/CRC 7. Kojadinovic, I. and Yan, J. (2010). Modeling multivariate distributions with continuous margins using the copula R package. Journal of Statistical Software 34, 1-20.
Method of evaluation	**50.00**% - Scientific review article presentation **50.00**% - Course Project(s)
Nature of the assignments	There are two types of assignments: 1. **Paper presentations:** Each student will have to present *several* scientific papers in class, assigned by the instructor. The total grade for all paper presentations will be worth 50% of the final grade. 2. **Project:** Each student will have to conduct an individual project during the whole semester, where copula models and methods will have to be applied to a real dataset using the statistical software R. Each student will have to write a project report (due near the end of the semester), and to present the results of the project in class. More details will be given in class. The total grade for the project will be worth 50% of the final grade.
Course Policies	1. Class notices and course related information will be posted periodically on Blackboard. Please check regularly for important information. Also, there may be important email communications. 2. Project: A project, done individually, will be due near the end of the semester. More details will be given as the semester progresses. Late projects will not be accepted. 3. Grades will be posted on Blackboard and may be disputed only within 48 hours.
Additional Information	

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Sun 01/26/2020 Wed 01/29/2020	Semester starts Sun: Prelude: Multivariate Modeling (Examples, Random vectors and their distributions, The correlation coefficient as a measure of association), The multivariate Normal distribution) Wed: Prelude: Multivariate Modeling (Extending multivariate normality)
2	Sun 02/02/2020 Wed 02/05/2020	Sun: Copula fundamentals (Standardization of random vectors, Definition of copulas, The copula package in R, Sklar's Theorem) Wed: Copula fundamentals (Some more advanced properties, survival copulas and copula symmetries, Measures of association)
3	Sun 02/09/2020 Wed 02/12/2020	Sun: Copula fundamentals (Measures of association, Measures of bivariate asymmetry, Simulation algorithms) Wed: Copula constructions and models (Fundamental copulas, Copula constructions and transformations, Elliptical copulas)
4	Sun 02/16/2020 Wed 02/19/2020	Paper presentations 1
5	Sun 02/23/2020 Wed 02/26/2020	Sun: Copula constructions and models (Archimedean copulas, and asymmetric extensions) Wed: Copula constructions and models (Extreme-value copulas, Factor copulas)
6	Sun 03/01/2020 Wed 03/04/2020	Sun: Copula constructions and models (Vine copulas) Wed: Copula constructions and models (Vine copulas, copulas for discrete random vectors)
7	Sun 03/08/2020 Wed 03/11/2020	Paper presentations 2
8	Sun 03/15/2020 Wed 03/18/2020	Sun: Inference (Parametric estimation and nonparametric estimation) Wed: Inference (Estimation for special cases: extreme-value copulas, vine copulas, factor copulas)
9	Sun 03/22/2020 Wed 03/25/2020	Sun: Mid-semester break Wed: Inference (Graphical diagnostics, Hypothesis tests)
10	Sun 03/29/2020 Wed 04/01/2020	Presentation of the Instructor's own work (recent publications) related to copulas.
11	Sun 04/05/2020 Wed 04/08/2020	Sun: Inference (Model selection) Wed: Inference in practice (examples, how to handle ties, time-varying copulas, etc.)
12	Sun 04/12/2020 Wed 04/15/2020	Paper presentations 3
13	Sun 04/19/2020 Wed 04/22/2020	Special topic
14	Sun 04/26/2020 Wed 04/29/2020	Special topic
15	Sun 05/03/2020 Wed 05/06/2020	Special topic
16	Sun 05/10/2020 Wed 05/13/2020	Project presentations Semester ends

Note

The instructor reserves the right to make changes to this syllabus as necessary.