Stockholm University

Course Description
Probability Theory,
AN, 7.5 hp
Department of Statistics
Fall, 2019

1. Contents of the Course

This course covers the following areas of probability theory: axiomatic foundations, random variables and their density/mass functions; transformations and expectations; multiple random variables: joint and marginal distributions; hierarchical models; inequalities; properties of random samples: convergence, sampling from normal distribution; the Delta method.

2. Intended learning outcomes

After the course, the students should be able:

- To understand axioms of Probability theory and perform probability calculations that are at the base of multivariate/hierarchical model building; to know different types of convergence and their hierarchy;
- To be able to visualize basic concepts of probability theory using Matlab

3. Literature and plan for the lectures

Text book:

> Casella G. & Berger R. L. *Statistical Inference*. Chapters 1-5; Second Edition, Duxbury Press (Thomson Learning Academic Resource Center), 2007

The course covers the text book sections that are listed in the Table below. It comprises of 12 lectures (L1-L12), 3 (three) computer sessions (C1-C3) and 4 (four) exercise sessions (E1-E4).

Week/Date	Time/Place	Topic	Reading	Assignment
W40 (03/10): L1 (AA)	13.00-15.30 B705	Introduction and overview of the course. Basics of probability theory: conditional probability, random variables and distribution functions	1.1-1.4	1.4, 1.7, 1.12, 1.18, 1.29, 1.30, 1.34, 1.39, 1.44
W41 (07/10): L2 (AA)	13.00-15.30 B705	Random variables and distribution functions (cont), density and mass functions	1.3-1.6	1.47, 1.51, 1.53, 1.54
W41 (08/10): L3 (AA)	10.00-12.30 B705	Functions of a random variable, expected values, variances, moments and moment generating functions	2.1-2.3	2.2, 2.3, 2.8, 2.11, 2.14(a), 2.23, 2.24, 2.19, 2.30, 2.33, 2.36, 2.39
W41 (09/10): L4 (AA) E1 (B315) (AC&OO)	09.00-11.30 B705 13.00-15.00	Exponential families; Joint and marginal distributions	3.3-3.5 4.1	3.3, 3.8, 3.9, 3.13, 3.28, 3.33(i), 3.40
W41 (10/10): L5 (AA)	10.00-12.30 B705	Conditional distributions and independence	4.1-4.2	4.1, 4.5, 4.10,
W42 (14/10): L6 (AA) E2 (D220) (AC&OO)	10.00-12.30 B705 14.00-16:00	Bivariate transformations and hierarchical models	4.3-4.4	4.15, 4.16(a) 4.19, 4.20, 4.27
W42 (15/10): L7 (AA)	13.00-15.30 B705	Hierarchical models (cont.) and mixture distributions	4.3-4.4	4.31, 4.32(b), 4.34(a)
W42 (16/10): L8 (AA)	09.00-11.30 B705	Covariance and correlation. Multiple random variables and multivariate distributions. Inequalities.	4.5, 4.7	4.30, 4.55, 4.63
W42 (17/10) E3 (AC&OO)	12.00-14:00 E420			
W42 (18/10): L9 (AA)	9.00-11.30 B705	A random sample and its properties. Sums of random variables from a random sample	5.1-5.2	
W43 (21/10): L10 (AA) E4(E413) (AC&OO)	10.00-12.30 B705 14.00-16:00	Sampling: direct/indirect. Central limit theorem	5.3, 5.6	5.17, 5.18, 5.29, 5.30, 5.31, 5.34
W43 (22/10): L11 (AA)	10.00-12.30 B705	Various types of convergence, Delta method	5.5	
W43 (26/10): L12 (AA)	09.00-11.30 B705 13:00-14:00	Exercises, exam preparation Questions: AC & OO	all	
W42 (10/10): C1 (AC&OO)	14.00-16.00 B319	Exploring probability distributions with Matlab		
W42 (18/10): C2 (AC&OO)	13.00-15.00 B319	Exploring probability applications with Matlab		
W43 (22/10): C3 (AC&OO)	14.00-16.00 B319	Exploring probability applications with Matlab		

The Table is a preliminary and tentative plan for the teaching schedule. Lecturer(s) reserve(s) the right to make appropriate adjustments during the course. Current plan for lecturer allocation is reflected in the schedule with abbreviations for names: AA = Andriy Andreev; AC & OO = Azadeh Chizarifard and Oscar Oelrich

4. Examination and Grading

Exam1: Tuesday, 29th of October, 2019. Time: $15^{00} - 20^{00}$. Place: Värtasalen

Exam2: Monday, 25th of November, 2019. Time: $12^{00} - 17^{00}$. Place: Värtasalen

NOTE: Remember to sign up for the examinations at least one week before it takes place. If you have signed up correctly, you will receive a confirmation email along with your anonymous code for the examination. If you are a reregistered student with an older course code, you must contact the student expedition (expedition@stat.su.se) to sign up. If you forget to sign up for the examination, you may not take the exam.

Approved tools and aids; regulations on cheating on the exam

Table of common distributions from Casella & Berger, p. 620-627 (will be attached), calculator, dictionaries for translation and A5 hand-written (both sides) paper with no solutions or proofs (one for all, will be discussed during lectures)

The written examination is to be done individually. During the examination all forms of collaboration and discussion are not allowed. Mobile phones with calculator applications are not permitted. More information regarding examination regulations is available on the department and Stockholm University webpages.

Use of unauthorized means of assistance in examinations or in other ways attempts to mislead during exams or when study performance is to be otherwise assessed will be reported in accordance with university rules.

Students are assessed with an exam, maximum 100 points

To pass the entire course, the student must pass collect: minimum 50 points from written examination. The grade is based on the total score. If student gets "F" grade (49 points or less), one has to take re-exam. Computer labs work is not evaluated separately but material explained during the labs might be part of the final examination. The following seven criteria-referenced grades are used:

A	Excellent
B	Very Good
C	Good
D	Satisfying
E	Sufficient
F	Insufficient

A (**Excellent**): The student should be in a proper and well-structured way to apply probability theory that is not necessarily directly addressed in the course material. The student is also clearly able to present and interpret his/her results; explain concepts, methods and theories used in the implementation.

B (**Very good**): The student will correctly and in a well-structured way be able to apply the probability theory that is directly addressed in the course material. The student is also clearly able to present and interpret his/her findings; explain the concepts, methods and theories used in the implementation of probability.
C (**Good**): The student will correctly and in a well-structured way be able to apply probability theory that is directly addressed in the course material. The student should also be in a good way to present and interpret his/her findings; explain concepts, methods and theories used in the implementation of probability.
D (**Satisfying**): The student will be able to apply probability theory that is directly addressed in the course material. The student will forward in a satisfactory way to present and interpret his/her findings; explain concepts, methods and theories used in the implementation of probability.
E (**Sufficient**): The student will be able to apply probability theory directly addressed in the course material. The student, in a satisfactory way, will present and interpret his/her findings; explain the concepts, methods and theory used in the implementation of probability.
F (**Insufficient**): The student cannot correctly apply probability theory that has been considered in the course.

A single final grade for the complete course will be given according to Table 3.

Table 3: The sum of the points from the written examination and computer labs, final grade in the course

Points	Grade
91-100	A
80-90	B
66-79	C
56-65	D
50-55	E
0-49	F

Lectures: Andriy.Andreev@stat.su.se

Computer Labs: azadeh.chizarifard@stat.su.se / oscar.oelrich@stat.su.se

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The Department of Statistics is located on the 7th floor in the B building, Södra Husen. More information about the department (student office, phone numbers, schedule, etc.) can be found on the department's webpage, www.statistics.su.se. Specific course information is typically made available on Mondo and via email during the duration of the course.