SF3961 – Statistical Inference 15 hp — 2015/16

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Examiner: Henrik Hult

Course description: The purpose of this course is to cover important topics in the theory of statistics in a thorough and general fashion. The course spans over classical inferential techniques including tests of hypothesis, point estimates, and confidence intervals as well as the Bayesian paradigm where one treats all unknown quantities as random variables and constructs a joint probability distribution for all of them. Fundamental concepts are presented from the classical and Bayesian viewpoints in parallel, for better comparison and understanding. Students will practice by studying applications and solving problems related to the theory.

Room: All meetings will take place in room 3418 in the Mathematics Department (KTH), Lindstedtsv. 25, 4th floor

1. **Introduction** (Henrik)
   Key concepts: Classical and Bayesian paradigm, Exponential families, Conjugate priors, Location scale families.
   Theory meeting: Nov 12, 13.15-14.00,
   Homework meeting: Nov 26, 13.15-15.00,
2. **Sufficient statistics** (Henrik)
   Key concepts: Sufficient statistics, Minimal sufficient statistics, Complete statistics, Ancillary statistics
   Theory meeting: Nov 26, 15.15-16.00,
   Homework meeting: Dec 10, 12.15-14.00,
3. **Decision theory** (Henrik)
   Key concepts: Bayes risk, Minimax theory, Neyman-Pearson's Lemma
   Theory meeting: Dec 10, 14.15-15.00,
   Homework meeting: Dec 21, 13.15-15.00,
4. **Point estimation** (Tatjana)
   Key concepts: Classical and Bayesian point esimation, UMVUE, Cramér-Rao, Rao-Blackwell
   Theory meeting:
   Homework meeting:
5. **Hypothesis Testing** (Tatjana)
   Key concepts: Hypothesis testing simple and interval hypothesis, Unbiased tests, Interval estimation, Location-scale pivotal quantities, Credibility intervals
   Theory meeting:
   Homework meeting:
6. **Classical-Bayesian Discussion** (Henrik)
   Discussion meeting:
7. **Computational Methods** (Jimmy/Henrik)
   Key concepts: EM-algorithm, Bootstrap, MCMC
   Theory meeting:
   Homework meeting:

Prerequisites: A minimal requirement is a basic course in statistics such as SF1901 and an advanced level course in probability (SF2940), but a graduate course in probability (SF3940) and teaching experience in statistics is recommended.

Format: The course will consist of two-week cycles with one theory lecture (45 min) the first week and one homework presentation meeting (90 min) the second week.

Literature: The course is based on lecture notes and the books

G. Casella and R. Berger: *Statistical Inference*, 2nd Ed, Duxbury, 2001.
M. Schervish, *Theory of Statistics*, Springer, 1995.

Aim: After completing the course students are expected to

- explain the classical and Bayesian paradigms and contrast the two
- have a good understanding of sufficient statistics and related concepts
- outline the foundations of statistical decision theory, both classical and Bayesian
- explain the notion of point estimation, the Cramér-Rao lower bound and the Rao-Blackwell theorem
- explain the main results and applications of hypothesis testing
- have thorough knowledge of computational methods in statistics, such as the EM-algorithm, the Bootstrap, and Markov Chain Monte Carlo
- be able to solve problems and discuss research related questions, related to the theory

Examination: The examination will be done as a combination of homework and oral exam.