STOCKHOLM UNIVERSITY
Department of Statistics
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Spring semester 2025

ST5501
Theory and Methodology of Statistical Science, 7.5 ECTS. (Statistisk vetenskapsteori och metod, AN, 7.5 hp)

Course description

Contents
The course covers some basic epistemological views on empirically based knowledge as well as statistical problem solving and modelling from an applied point of view. A pervading theme in the course is the role of models in empirical sciences. The course takes as a starting point some basic epistemological views on knowledge, for example, how scientific knowledge is generated and how it changes. Different classical epistemological approaches are related to different statistical methods (e.g. hypothesis testing, Bayesian statistics, likelihood methods) in order to highlight the relationship between philosophical questions about science, statistical inference and proofs/results. In addition, ethical aspects of empirical research are discussed.
The course aims at giving a deeper understanding of experimental and non-experimental research methods, especially with respect to validity, causal conclusions, control of sources of random errors and handling of confounders. Tools for examining epistemological assumptions behind different statistical methods are discussed in the course.

Learning outcome
After the course, the student is expected to be able to
□□give an account of some important epistemological viewpoints and their relationships to statistical methods,

□□discuss the advantages and disadvantages of some experimental and non-experimental methods for analysing some specific problems, especially with respect to validity, causal conclusions, control of sources of error and handling of confounders.

Course literature
As central starting point, we use:
Nyquist, Hans, compendium, Stockholm University. Will be avaialable at Athena.

□□SOH: Hansson SO (2007). The Art of doing science. Department of Philosophy and the History of Technology, Royal College of Stockholm. Will be available at Athena; the original Swedish version, “Konsten att vara vetenskaplig”, will also be available at Athena.

Freedman D.A. (1985). Statistics and the scientific method. In *Cohort analysis in social research* (Mason, W.M and Fienberg, S.E. eds.) will also be available at Athena.

Material related to the lectures may be distributed during the course.

There is a large number of additional texts the student may consult for deeper studies, examples include:

Gelman A, Shalizi CR (2013). Philosophy and the practice of Bayesian statistics. *British Journal of Mathematical and Statistical Psychology* **66**, 8–38.
Häggström O (2016). The need for nuance in the null hypothesis significance testing debate. *Educational and Psychological Measurement* to appear (online available). Author version at:http://www.math.chalmers.se/~olleh/NHST-nuance-revision.pdf.
Lehmann EL (1993). The Fisher, Neyman-Pearson theories of testing hypotheses: one theory or two? *J Am Stat Assoc* **88**, 1242-1249.
Pawitan Y (2001). *In all likelihood. Statistical modelling and inference using likelihood.* Clarendon press, Oxford.
Romeijn JW (2014). *Philosophy of Statistics.* The Stanford Encyclopedia of Philosophy, Edward N. Zalta (ed.), http://plato.stanford.edu/archives/fall2014/entries/statistics/.
Royall R (1997). *Statistical evidence – a likelihood paradigm.* Monographs on Statistics and Applied Probability 71. Chapman & Hall.
Stigler S (2008). Fisher and the 5% level. *Chance* **21** (4), 12.
Wasserstein RL, Lazar NA (2016). The ASA's statement on p-values: context, process, and purpose. *The American Statistician* **70**, 129-133.
American Statistical Association (1999). “Ethical guidelines for statistical practice”. http://www.amstat.org/about/ethicalguidelines.cfm.
Bretz F, Hothorn T, Westfall P (2010). *Multiple Comparisons Using R*. CRC Press.
Fisher RA (1949). *Design of experiments. 5th ed.* Oliver and Boyd, Edingburgh.
Jackson M, Cox DR (2013). The principles of experimental design and their application in sociology. *Annu Rev Sociol* **39**, 27-49.
Montgomery DC (2013). *Design and analysis of experiments.* 8th ed. Wiley. Chapter 1.
Pawitan Y, Sjölander A (2014). Dealing with multiple comparisons: To adjust or not to adjust. *Qvintensen* **2/2014**, 11-14.
Pearl J, Glymour M, Jewell NP (2016). *Causal Inference in Statistics: A Primer*. Wiley, Chichester, UK.
Rosenbaum PR (2010). *Design of Observational Studies*. Springer Series in Statistics.
Rothman KJ (1990). No Adjustments Are Needed for Multiple Comparisons. *Epidemiology* **1**, 43–46.

Note that some of the literature above can be accessed via SUs library (free of charge for SU students).

Teaching format
There are 8 lectures.

Examination
The course is examined by a written examination at the end of the course and two home assignments to be handed in at the same time as the written exam: **June 4.**

Grading criteria
On each home assignment, a maximum of 20 points can be achieved. Problems will be both pure discussion problems and problems for data analysis plus discussion. For the data analysis, one of the program packages SAS or R should be used.

In the written exam, a maximum of 60 points can be achieved. Problems in the exam can be discussion problems, discussion of case studies and some interpretation of statistical results. No literature or other facilities are allowed to be used during the exam.
To pass the course, a minimum of 10 points need to be achieved on each home assignment and a minimum of 30 points need to be achieved on the written exam. The sum of credit points from the two home assignments and from the written exam defines the grade (possible maximum 100 points).

Grades are given on a seven-point rating scale:
A. Excellent 90-100 points
B. Very good 80-89 points*
C. Good 70-79 points*
D. Satisfactory 60-69 points*
E. Adequate 50-59 points*
Fx. Inadequate None of the criteria for A-E but at least 40 points
F. Totally Inadequate Anything less than 40 points

*and additionally the minimum requirements for the home assignments and the written exam.

All the credit points from the assignments need to be achieved at this period of teaching.
No credit points from the assignments achieved at this semester can be transferred to the next time the course will be given.
Students who get less than 10 points on an assignment or who fail to submit it before hand-in date are given one opportunity to re-submit it until a second hand-in date but can then get a maximum of only 15 points for this assignment. The later second hand-in date is **June 18**. The examiner will advise the student about the need to re-submit such that there are at least 7 days to perform the re-submission.

The hand-in assignments are executed individually. The written examination is to be done individually. For both assignments and written examination, plagiarism of all types is prohibited. Text matching software may be used.
AI: The use of AI tools is permitted as an aid during the learning process but not to produce material for any kind of examination. Any type of plagiarism is prohibited which includes AI-generated text. The use of AI tools for the improvement of an originally self-written text is not permitted. Text matching software and AI-generated text detectors are used by the department. Read ”Guidelines for disciplinary matters at Stockholm University”
https://www.su.se/medabarteta/organisation- styrning/styrdokument-regelboken /utbildning/regler-och handl¨aggningsordning-f¨or-disciplin¨arenden-1.605869

The written examination is to be done individually.. Special tools may, if necessary, be allowed upon request and after approval of the examiner. Students who need special support and tools should contact the department’s student counsellor as soon as possible, no later than 3 weeks before the exam. More information regarding examination regulations is available on the department and Stockholm University webpages.

Lecturer, course coordinator and examiner:
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Information
Further information and updates will be announced in Athena