Statistical Inference for Causal Effects
in Experiments and Observational Studies

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causinf.tex
Causal Inference

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Global contents of the course
Causal inferences play a predominant role in science. Yet the problems encountered in the process of trying to attain causal explanations are often severe, especially in the social and behavioral sciences. Basic elements of causal inference and the consequences for experimental and non-experimental research designs are covered in the course. Causal inference in observational studies and up-to-date statistical methods available in the search for causal knowledge in the social sciences and other disciplines will be emphasized.

Key references
For a solid study of the potential-outcome framework of causal inference, three books are very useful: The first book contains selected work of Donald Rubin and colleagues, the second provides a uniform treatment of the subject (partly no easy reading though — see, however, the last chapter: Planning an observational study), and the third book is a more recent and general one, covering the counterfactual approach, causal graphs, and instrumental variable modeling.


Practical guidelines for causal effect estimation can be found in the following important paper, published last year.

Provisional setup of the course

A selection will be made from the references listed below. An asterisk [*] behind a reference, along with the number of pages shown in the margin, indicates that this material might be part of the course. The other listed literature can be viewed as additional reading material. It should be noted that the size of the course is restricted to seven lectures only.

Lecture 1a
The scientific method; descriptive, relational and experimental orientations; the roots of causal inference; some historical background and current questions; general statistical aspects; basics of controlled experiments and observation studies; pitfalls of causal inference.


Lecture 1b
Design of experiments; randomization; controlled experiments, quasi-experiments, and observational studies.


**Lecture 2**
Planning and analysis of observational studies; controlling bias in observational studies; matching, stratification and covariance adjustment.


Lecture 3
Rubin’s causal model — or the potential-outcome model —, missing values, and counterfactuals.


Lecture 4
Matching, stratification, and covariance adjustment.


Lecture 5
Propensity scores; logistic regression; propensity score stratification.

• Rosenbaum, P.R., & Rubin, D.B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70*, 41–55. *


Lecture 6
Hidden bias and sensitivity analysis; average causal effect estimation revisited.


Lecture 7
Quantifying the impact of confounders on regression coefficients; from association to causation via regression and structural equation modeling.


**Lecture 8**
Practical guidelines for causal effect estimation


**Lecture 9**
Instrumental variables, structural equation modeling, causal inference in the social sciences.


**Lecture 10**
Epidemiologic principles of causation; statistical inference for causal effects. Second hour: *The memory of water*. A videotape of the BBC television program *Horizon* on testing the effect of homeopathic treatment.


Lecture 11


Valid causal inferences are of paramount importance both in medical and social research and in public policy evaluation. Unbiased estimation of causal effects in a nonrandomized or imperfectly randomized experiment (such as an observational study) requires considerable care to adjust for confounding covariates. A graphical causal model is a powerful and convenient tool that you can use to remove such confounding influences and obtain valid causal inferences. This paper introduces the CAUSALGRAPH procedure, new in SAS/STAT® 15.1, for analyzing graphical causal models. The procedure takes as its input a graphical causal model to remove such confounding influences and obtain valid causal inferences. This paper introduces the CAUSALGRAPH procedure, new in SAS/STAT® 15.1, for analyzing graphical causal models. The procedure takes as its input a graphical causal model to remove such confounding influences and obtain valid causal inferences. This paper introduces the CAUSALGRAPH procedure, new in SAS/STAT® 15.1, for analyzing graphical causal models. The procedure takes as its input a graphical causal model to remove such confounding influences and obtain valid causal inferences. This paper introduces the CAUSALGRAPH procedure, new in SAS/STAT® 15.1, for analyzing graphical causal models. The procedure takes as its input a graphical causal model to remove such confounding influences and obtain valid causal inferences. This paper introduces the CAUSALGRAPH procedure, new in SAS/STAT® 15.1, for analyzing graphical causal models. The procedure takes as its input a graphical causal model to remove such confounding influences and obtain valid causal inferences. This paper introduces the CAUSALGRAPH procedure, new in SAS/STAT® 15.1, for analyzing graphical causal models. The procedure takes as its input a graphical causal model to remove such confounding influences and obtain valid causal inferences.