Inference and Causality

Course Description

Statistical inference and causal analysis are crucial tools for analyzing and understanding data on a fundamental level. This course starts with an introduction to Bayesian inference and Bayesian networks which use probabilities to describe statistical problems and introduce probabilistic modelling which allows the specification of Bayesian statistical models in code. This course introduces the concepts of causality, how causality relates to correlation between variables, and discusses the fundamental building blocks of causal analysis. The effect of interventions (i.e., when the experimenter actively changes the setup from which the data are taken) are also discussed. This course then introduces the rules of do-calculus, which allow interventions to be described formally.Finally, the course discusses a wide range of typical fallacies which arise in the context of causal analysis.

Contents

1. Statistical Inference
   1. Bayesian inference
   2. Bayesian networks
   3. Probabilistic modelling
2. Introduction to Causality
   1. Correlation vs causation
   2. Granger causality
   3. Directed Acyclic Graphs (DAG)
   4. Elements of causal graphs: collider, chain, fork
   5. D – separation
3. Interventions
   1. Seeing vs doing
   2. Conditional independence
   3. Confounders & counterfactuals
   4. Causal inference vs randomized controlled trials
4. Do-calculus
   1. Front- & backdoor criterion
   2. Three rules of do-calculus
5. Fallacies

5.1 Mediation fallacy

1. Collider bias
2. Simpson's & Berkson's Paradox
3. Imputing missing values: causal vs data-driven view