The Bootstrap

Bootstrapping (Statistics) (engl. Wikipedia):

Bootstrapping is any test or metric that uses random sampling with replacement (e.g. mimicking the sampling process), and falls under the broader class of resampling methods. Bootstrapping assigns measures of accuracy (bias, variance, confidence intervals, prediction error, etc.) to sample estimates. This technique allows estimation of the sampling distribution of almost any statistic using random sampling methods.
A seminal idea

Pioneering work:


Huge impact (google scholar):

• The paper has about 22,000 citations
• The book has about 47,000 citations
• 780,000 sources when searching for 'Bootstrap' & 'statistics'

Recent paper:

• Andrew Gelman and Aki Vehtari (2020). What are the most important statistical ideas of the past 50 years?
  ▶ 'Bootstrapping and simulation-based inference' is mentioned in second place (after 'counterfactual causal inference')
General focus:

- This lecture discusses the origins of bootstrap methods pioneered by Bradley Efron in his seminal paper Efron (1979, Annals of Statistics). Besides its predecessor **Jackknife**, several **variants of bootstrap** resampling suitable for different data scenarios will be discussed. The main focus will be on the **bootstrap methodology** itself and on (asymptotic) properties of bootstrap methods. Their derivation requires **good (mathematical) knowledge of probability theory and asymptotic theory**. Students will gain insights why, how and when the bootstrap as a universal and powerful tool can be used to conduct **(valid) statistical inference**.
Course Content

Particular topics covered are:

- The Jackknife (bias-) estimator
- Efron’s (original) Bootstrap
- Parametric and non-parametric bootstrap approaches
- Asymptotic bootstrap theory (first and higher order consistency, CLT)
- Bootstrap inconsistencies
- Bootstrap confidence intervals/hypothesis tests
- Bootstrap approaches for linear regression models and time series
Literature

- Davison & Hinkley (1997). Bootstrap Methods and Their Applications
- Shao & Tu (1993). The Jackknife and Bootstrap.
Lectures:
- on campus
- mixture of slides and writing on white/black board
- two lectures per week
- Tuesday 14-16, Thursday 10-12 (both in CDI 120)
- Moodle Room

Tutorials:
- M.Sc. Maxime Faymonville
- one tutorial per week
- on campus (if possible)
- weekly exercise sheet; solutions to be handed in
- corrections if number of participants allows, otherwise two graded tests during the semester
- 40% of the total points required to be eligible for the exam

Exam:
- oral exams (if number of participants allows)