

# Seminar in Statistics: Causal Inference with Observational Data

Sara van de Geer and Jonas Peters

## § 1 Concepts relating Graphs and Distribution

### I Standard Concepts of Graphical Models (25.02.2013, J. Peters)

Patrick Gasser, Florin Gengschatz, Patrick Helbling

d-separation, conditional independences, Markov condition: Lauritzen (ask Jonas for details)

### IIa Structural Equation Models and Counterfactuals (04.03.2013, J. Peters)

Andrea Riva

Pearl: Chapter 1.4

### IIb Faithfulness and Causal Minimality (04.03.2013, J. Peters)

Steve Muller, Anja Franceschetti

Zhang and Spirtes: “Detection of Unfaithfulness and Robust Causal Inference”, *Minds & Machines* (2008) 18:239-271, p. 239–252 top

Steel: “Homogeneity, selection, and the faithfulness condition”, *Minds & Machines* (2006) 16:303-317,

## § 2 Interventional Distributions

### III Do-Statements and Simpson’s Paradox: (11.03.2013, C. Nowzohour)

Andreas Puccio, Nadine Bachmann, Martin Davtyan

Pearl: Chapter 3.1, 3.2. (in particular 3.2.3), Chapter 6.1

### IV Do-Calculus with Unobserved Variables (18.03.2013, C. Nowzohour)

Colin James Stoneking, Fabio Ghielmetti, Lukas Benedikt Herrmann

Pearl: Chapter 3.3, Backdoor and Frontdoor Criteria.

## § 3 Identifiability of Graphs

### V Constraint-Based Methods (25.03.2013, C. Nowzohour)

Gian-Andrea Peter Thanei, Andreas Luca Elsener, Zhou Syang

Markov Equivalence Class main result from Verma and Pearl: “Equivalence and Synthesis of Causal Models”, not Chapter 3.

## VI **Restricted Structural Equation Models** (08.04.2013, J. Peters)

Ioan Gabriel Bucur, Timurs Butenko

(1) Linear Non-Gaussian Models: Darrois-Skitovic theorem and proof for two variables (ask Jonas for pdf), statement for  $p$  variables from (lingam), (optional: directLingam, probably not enough time)

(2) Linear Gaussian Models with Same Error Variances: Proof for two variables, statement from Peters and Bühlmann: “Identifiability of Gaussian Structural Equation Models with Same Error Variances”, arXiv 2012, without proof.

## § 4 **Identifying Graphs (Methods)**

### VII **Constraint-Based Methods** (22.04.2013, C. Nowzohour)

Tobia Fasciati, Marco Felix Eigenmann, Shu Li

(1) PC algorithm, Spirtes et al: “Causation, Prediction and Search”, 5.1-5.4

(2) Partial Correlation as a test for conditional independence (without proofs)

### VIII **Non-parametric Independence Test** (29.04.2013, J. Peters)

Clara Valeria Pelloni, Ambra Barbara Toletti, Daniel Bruce MacKinlay

Gretton et al: “A Kernel Statistical Test of Independence”, NIPS 2007 (HSIC). Maybe better reference: Diploma thesis 3.1 and 3.3

### IX **Score-Based Methods with MEC search** (06.05.2013, C. Nowzohour)

Christina Heinze, Annette Aigner, David Josef Bürge

Likelihood with same error variances or non-same error variances. Then description of greedy DAG search and greedy equivalence search. Chickering: “Optimal Structure Identification With Greedy Search”, JMLR 2002, 507-554

### X **Bayesian Methods** (13.05.2013, J. Peters)

Jens Hauser, Caroline Anna Sophie Matthis, Anastasia Sycheva

Heckerman, Meek and Cooper: “A Bayesian Approach to Causal Discovery” Technical Report, MSR-TR-97-05, February 1997