Causality

# Introduction

## Functional Causal Models

We have seen Bayesian networks to represent causal relationships.

A functional causal model consists of a set of equations of the form x\_i = f\_i(pa\_i, u\_i). A set of these equations in which each equation represents an autonomous mechanism is a structural model. If each variable appears on the lhs in a distinct equation, it is a (structural) causal model.

Drawing arrows reveals a causal diagram, which is semi-Markovian if it acyclic, and additionally Markovian if the error terms are jointly independent. Then (Thm. 1.4.1) each variable X\_i is independent of all its non-descendants given its parents.

We have three types of queries: predictions, interventions, counterfactuals, requiring increasing levels of detail.

Causal-Functional specification has advantages over Bayesian specification. All conditional dependencies are more stable, the specification is more meaningful and natural, judgemental assumptions are simplified and more reliable, and only few mechanism change when the system undergoes change.

This functional specification helps in specifying the resulting distribution of an intervention. The functional specification offers greater flexibility and generality than a stochastic model. It can be extended to cyclic models, is more readily comprehended, and the analysis of causal effects is greatly simplified. Lastly, we can analyze context-specific actions and policies.

Most counterfactuals cannot be defined in stochastic networks, e.g. the probability that Joe dies would he have not been treated. Quite a difficult subject, no stochastic network can answer it because information is missing because the variables U are not in the model. In structural models, we can use three steps: abduction, action, prediction.

Different kinds of parameters: probabilistic parameters, statistical parameters (e.g. expectation) and causal parameters.

Different kinds of assumptions: statistical assumption (e.g. constraint on distribution), causal assumption (e.g. f\_i is linear).

Different kinds of concepts: statistical concepts, causal concepts.

Two main mental barriers: causal analysis with untested judgmental assumptions and new required notation.

# A Theory of Inferred Causation

Main questions in Chapter 2:

1. What clues prompt people to perceive causal relationships in uncontrolled observations?

2. What assumptions would allow us to infer causal models from these clues?

3. Would the models inferred tell us anything useful about the causal mechanisms that underly the observations?