Introduction to Structural Causal Models

Daniel Saggau

May 2021

Overview

- Foundations of SCMs
  - Assumptions
  - Comparing Causal Tools
- Pearl's Causal Hierachy
  - Prediction
  - Intervention
  - Counterfactuals
- Graphical Models
- Causality and Time

Assumptions SCM

- Mechanisms independent/autonomous
- Set of equations (assignments $' :=')$
- Observational Data
- Endogenous and Exogenous Variables
- Latent noise variables to simulate joint distribution
- Noise terms $U_1..U_i$ (joint) independence

Graphical Example

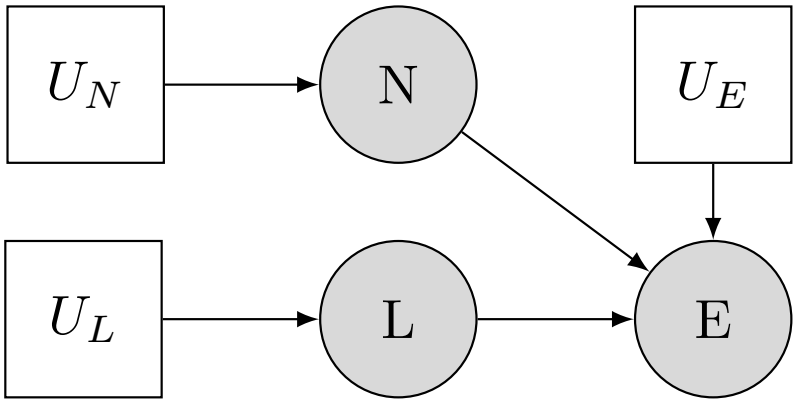

Figure 1: Structural Causal Model

$\{U_N\}$ - Numeric Ability
$\{U_L\}$ - Literary Ability
$\{U_C\}$ - Quality of the Student
$\{A\}$ - Math Test
$\{E\}$ - English-Test
$\{C\}$ - GPA

Mathematical Example

$N := f_N(U_N)$
$L := f_L(U_L)$
$E := f_E(N, L, U_E)$

$\{U_N\}$ - Numeric Ability
$\{U_L\}$ - Literary Ability
$\{U_E\}$ - Quality of the Student
$\{N\}$ - Math Test
$\{L\}$ - English-Test
$\{E\}$ - GPA

Pearl's Causal Hierachy

Table 1: Pearls Hierachy of Causation (2009)

Method	Action	Example	Usage
Association $P(a\|b)$	Co-occurrence	What happened...	(Un-)Supervised ML, BN, Reg.
Intervention $P(a\|do(b), c)$	Do-manipulation	What happens if ...	CBN,MDP,RL
Counterfactual $P(a_b\|a', b')$	Hypotheticals	What would have happened if...	SCM ,PO

Questions for Discussion

Do you have any concepts that are still unclear to you?