

Causal order

- “cause” and “effect”
- X/Y system
 - Indirect effects
 - Causally spurious effects
 - Signed effects
- Possible, improbable, impossible causal flows
- Causal order is solved by our knowledge of the real world

Rules of Causal Order

RULE #1 “*after cannot cause before*”

- $X \rightarrow Y$ if Y starts after X freezes
- $X \rightarrow Y$ if X is linked to a well-known sequence
- If during some span of time X never changes and Y sometimes changes, $X \rightarrow Y$. If neither X nor Y can change, $X \leftrightarrow Y$
- If X is relatively stable, hard to change, or fertile, while Y is relatively volatile, easy to change, or has few consequences, $X \rightarrow Y$

Path Diagrams

- Path is a route following one-way arrows without retracing any steps
 - Ordered or recursive`
 - Partial orders or ordered blocks or block recursive

Prior → independent → intervening → dependent → consequent

- Exogenous/endogenous variables

Rules of Causal Order

RULE #2

If there is a path starting from X and returning to it without retracing any steps, X and all the variables on the path form a loop. Variables in a loop have no order.

Causation

- Do correlations imply causal effects?
- A correlation is spurious to the extent that the cross-sectional slope differs from the true causal effects
 - Sampling bias, random sampling variation, bad measurements
 - Prior variables can produce spuriousity if they have a direct or indirect effect on both variables
 - What is spurious is your estimate of the causal impact of manipulating the independent variable

Rules of Causal Order

RULE #3

If a prior variable has a causal path to the independent variable and a causal path to the dependent variable, it will contribute a statistical association between them that is causally spurious.

Rules of Causal Order

RULE #4

Reversing poles for one variable reverses the signs of each of its relationships. Reversing polarities for both variables leaves the sign of their relationship unchanged.

Rules of Causal Order

RULE #5 “the sign rule”

The sign of a path is given by multiplying the sign of its arrows. A path of non-zero arrows will be positive unless it contains an odd number of negative arrows.

- A path containing 0 anywhere has a value of 0
- Inserting any number of positive links has no effect on a chain’s sign
- Inserting a single negative link anywhere reverses the sign of a chain

Causal mechanisms

- Consistent or reinforcers
- Inconsistent or suppressors

Rules of Causal Order

RULE #6

A system is inconsistent if at least one pair of variables has both positive and negative signs among its direct, indirect, and spurious effects. Otherwise, it is consistent. If a system is consistent, all negative arrows can be eliminated by reversing polarities.