ANR CODDDE meeting

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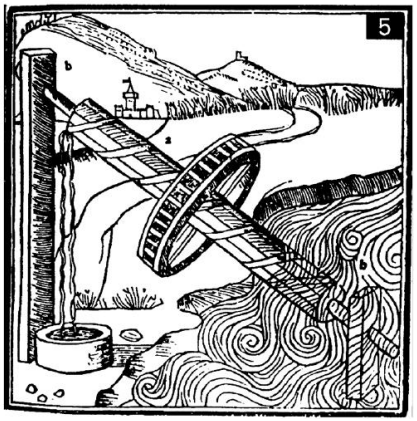
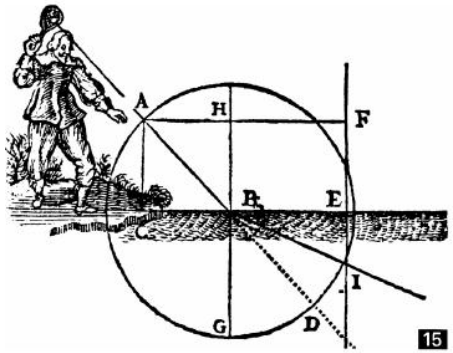
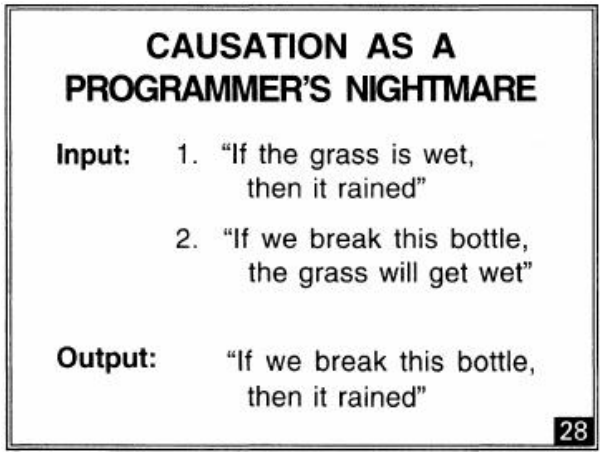
Introduction on Causality

Goals:

- Understand and model a system
- Predict behavior
- Formalize causal knowledge







Introduction on Causality

What is causality

- Set of causes and effects explaining a certain system behavior
- Historical
  - Aristotle, Galileo, Newton, David Hume, Pearson, Fisher, . . . ,
  - Judea Pearl (UCLA)
  - Peter Spirtes & Clark Glymour & Richard Scheines (CMU)

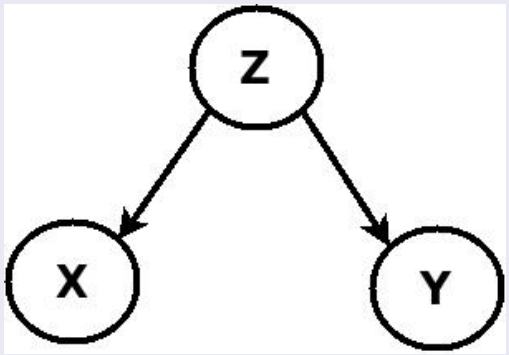
Why causality

- Complex systems: Interdependencies, Spurious associations
- Stable under interventions: Can predict the impact of change

Introduction on Causality

Correlation is not causation

Two parameters, X and Y, correlated



Spurious associations and latent variables

- People with yellow teeth higher probability to have lung cancer
- Windshield wiper and accidents

Causal model

Definitions

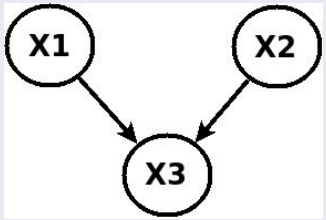
- *System:* $\{X_1, \ldots, X_p\}$
- *Causal study*: Understand the system causal dependencies:
  $\Rightarrow$ Causal model

Representations

- Structural equation models:

$$X_i := f_i(\prod_{j \neq i} X_j) + \epsilon_i$$

- Graphical representations



Causal model inference

Manual intervention

- Intervention
- Random experiments

Passive observation

- Suppose a model generating the observed system: hypothesis
- Infer such model through test relying on hypothesis
- *Constraints*: Determinism, time scale, model granularity

Ph.D. work

Telecommunication networks

- System:
  - Interconnected nodes providing connection and communications
- Observations:
  - Internet traffic (TCP) with probes within the network
- Complex system
  - No assumption regarding dependencies (linear), distributions (Normality)

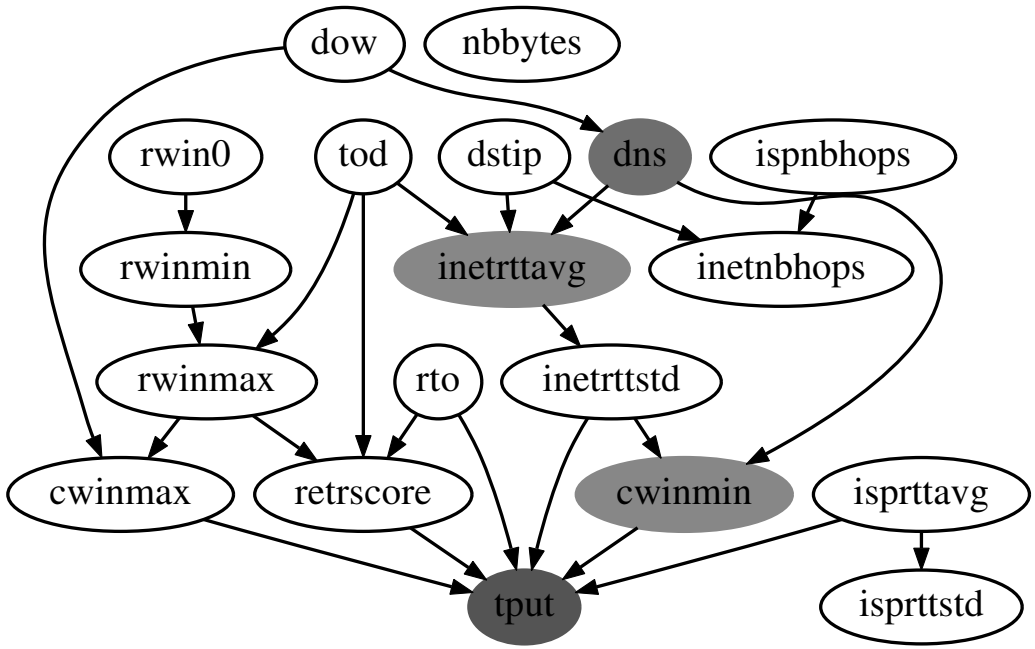
Graphical causal models

- Bayesian networks
- Directed Acyclic Graphs (DAGs)
- Graphical criteria to predict **intervention**

Ph.D. work: CDN

Goal: Understand the impact on CDN performance if choosing one DNS service instead of another

- Distribution throughput for users of DNS *a* if delay follows distribution of users of DNS *b*
- Distribution throughput for users of DNS *a* if server configurations of users of DNS *b*



Results Measure impact of DNS on CDN performance: redirection and server configuration

Study of the evolution of the mention network of Tweeter

Objective: Study the co-evolution of information diffusion and mention network

- If ***user A*** and ***user B*** share the same information: more likely to mention each other
- If ***user A*** and ***user B*** are exposed to the same information: more likely to mention each other

Approach

- Use follower network to follow information diffusion
- Use hashtags for information sharing

Twitter mention network

Twitter mention

- Dynamic interactions
- Classical approach: followers
- Different social interactions

Target model

- Structural properties
- Comparison
  - with follower network properties
  - information exposure / shared
- Use a causal approach to capture social impact (second step)

Causality as a tool to assess social bound dynamics

Goal: Impact of information diffusion on the dynamics of the mention network evolution

Why causality

- Many factors influencing social network evolution
- Many possible latent variables
- Time series (#JeSuisCharlie,...): Granger, Non deterministic dynamic systems

How

- Linguistic to capture social concepts (common / opposite interests)
- Capture of hashtags and communities as proxies

First results and open questions

Results

- Evolution of mention graph per day during on year.
- Mention network structure $\neq$ Follower network
  - Edge creation (reciprocal mention, time scale)
  - Triadic closure

Open questions

- Capture passive information exposition and active information exposition
  - Exposed information: Follower network
  - Shared information: hashtag clustering
- Capture ponctual events (Sport event, Political event)
- Introduce temporal decay in edge weights

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