Networked Experiments

Causal Inference

- Randomized Controlled Trial
  - A/B : assumes treatment of i does not affect outcome of j
    - no interference
- Experiments over networks
  - Knowledge diffusion
  - Aral: networked experiments survey
  - All of these break interference

Potential Outcomes

- Finite population

$z = (z_1, \ldots, z_{N_V})^T \in \{0,1\}^{N_V}$ treatment assignment vector

$p_z = P(Z = z)$ prob. of treatment under experimental design

$O_i(z)$ denote outcome of i under treatment z.

Assume $O_i(z)$ continuous

Evaluate treatment based on observed $O_1(z), \ldots, O_{N_v}(z)$

fundamental quest: observing outcomes under different treatments

	$z_i = 0$	$z_i = 1$	$z_i = 0$	$z_i = 0$
1	$O_1(0)$	$O_1(1)$	$O_1(0)$	//
2	$O_2(0)$	$O_2(1)$	//	$O_2(1)$
	Ideal		Real	

SUTVA: $O_i(z) = O_i(z_i)$ independence to others

unit level casual effect $O_i(1) - O_i(0)$

average treatment effect $\tau_{ATE} = \frac{1}{N_w} \sum_{i=1}^{N_v} (O_i(1) - O_i(0))$

Q: Is it estimable?

Framework: - define unbiased estimator

- mean, variance, CLT

$$\hat{\tau}_{ATE} = \frac{1}{N_v} \sum_{i=1}^{N_v} \left[\frac{z_i O_i(1)}{N_t/N_v} - \frac{(1-z_i) O_i(0)}{N_c/N_v} \right]$$

- we can get bias + variance for this

- variance not in general estimable

and additional assumptions needed.

or construct bounds

In general SUTVA is not appropriate

Network Exposure Models

- exposure maps: assume there is some finite # of exposures K

$$f(z, x_i) = c_k \quad k \in [K]$$

z: treatment vector; x_i: neighbors imposing interference

Generalization $\frac{1}{N_v} \sum_{i=1}^{N_v} [O_i(1) - O_i(0)]$

- each potential outcome $O_i(1), \ldots, O_i(K)$

  → Assumes only faced with one exposure

  → induces prob. dist. over treatment exposure