

1 Identification and Estimation of Treatment and Interference Effects in Observational Studies on Networks

Based on (Forastiere et al., 2021).

1.1 Background and motivation

- Interference: in experimental and observational studies, when a treatment assigned to one unit has an effect on others.
- Spillover effects: the effects of interference.
- Problem and goal: given a known network where the assignment mechanism of the treatment is unknown, estimate (1) the causal effect of individual treatment and (2) the spillover effect from treatments of others.
- Contributions of paper:
 1. A general formulization for the problem of interference in networks under the potential outcome framework.
 2. Derivation of the bias for estimators of the treatment effect when SUTVA is wrongly assumed.
 3. A joint propensity score (probability of assignment to particular individual and neighborhood treatment given observed covariates) with balancing properties, and a joint propensity score-based estimator.

1.2 Interference based on exposure to neighbourhood treatment

Notation:

- Undirected network $G = (\mathcal{N}, \mathbb{E})$ where \mathcal{N} is a set of N nodes and \mathbb{E} is a set of edges $(i, j) = (j, i)$.
- Define partition $(i, \mathcal{N}_i, \mathcal{N}_{-i})$ around node i where \mathcal{N}_i is set of N_i nodes (neighbourhood) that contains all nodes j connected to i and \mathcal{N}_{-i} is set of all other nodes not i and not in \mathcal{N}_i .
- $Z_i \in \{0, 1\}$ treatment assignment to unit i , \mathbf{Z} treatment vector for population \mathcal{N} , and $(Z_i, \mathbf{Z}_{\mathcal{N}_i}, \mathbf{Z}_{\mathcal{N}_{-i}})$ partitions for $(i, \mathcal{N}_i, \mathcal{N}_{-i})$.
- $Y_i \in \mathcal{Y}$ observed outcome of unit i , \mathbf{Y} outcome vector for population \mathcal{N} , and $(Y_i, \mathbf{Y}_{\mathcal{N}_i}, \mathbf{Y}_{\mathcal{N}_{-i}})$ partitions for $(i, \mathcal{N}_i, \mathcal{N}_{-i})$.
- $\mathbf{X}_i \in \mathcal{X}$ vector of covariates for unit i and decomposes into $\mathbf{X}_i^{\text{ind}} \in \mathcal{X}^{\text{ind}}$ (individual-level characteristics) and $\mathbf{X}_i^{\text{neigh}} \in \mathcal{X}^{\text{neigh}}$ (neighbourhood-level characteristics and aggregates of individual-level covariates).

References

- Forastiere, L., Airoidi, E. M., & Mealli, F. (2021). Identification and estimation of treatment and interference effects in observational studies on networks. *Journal of the American Statistical Association*, 116(534), 901–918. <https://doi.org/10.1080/01621459.2020.1768100>