Network Experimentation Project

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1 Introduction

There is a decision maker conducting experiments on a network environment. An 'experiment' in the context of our model is treating a node in the network. Each node responds to the treatment differently, depending on their (observable) characteristics.

The decision maker's goal is learning the optimal treatment allocation over the network by sequentially experimenting on different nodes. Because of the network setting, treating one node creates spillovers on neighboring nodes.

Finally, the distinguishing feature of our model is this: every experiment creates negative externalities on previous experiments. We model this as a cost for contaminating the treatment regime decided by a previously run experiment.

1.1 Model

There are N units (individuals, firms, locations) connected on an undirected, unweighted graph. Denote each unit on the graph by $\{1, \ldots, N\}$. The units have observable characteristics, $\{x_1, \ldots, x_N\}$ with $x_i \in \mathbb{R}^k$. The experimenter's objective depends on the observed responses of the nodes to the treatment regime, denoted $\{Y_1, \ldots, Y_n\}$ with $Y \in \mathbb{R}$. Let w_i denote the treatment assignment for node i, with $w_i \in \{0, 1\}$.

Each node's outcome depends on their characteristics, the treatment they receive and the exposure to the treatment through their neighbors. Y is assumed to be a linear function of the unit characteristics and the treatment regime.

Define the exposure for node i as e_i, which is (for simplicity) assumed to be:

$$e_i = \frac{\sum_{j \leq N} \mathbf{1}(j \in nhbd(i)) w_j}{\sum_{j \leq N} \mathbf{1}(j \in nhbd(i))}$$

We assume the response function takes the following form:

$$Y_i(w_i, e_i) = \beta^T x_i + \Gamma^T x_i e_i + \epsilon_i,$$

where $\beta, \Gamma \in \mathbb{R}^k$.