Contribution ID: **121** Type: **not specified**

Applications of machine learning methods for parameter estimation in spreading processes on hypergraphs

Monday, 16 September 2024 14:10 (20 minutes)

In spreading processes such as opinion spread in a social network, interactions within groups often play a key role. For example, we can assume that three members of the same family have higher chance to persuade a fourth member to change their opinion than three friends of the same person who do not know each other, and hence who do not belong to the same community. The other way around, in a dynamical version, the change of opinion of the individuals can lead to the split of communities, or the birth of new ones, as people prefer to join groups where they find peers with the same opinion. We can represent these phenomena on spreading processes on hypergraphs, where hyperedges (subsets of the vertex set of arbitrary size) represent the communities, and the vertices in the intersecion of two or more hyperedges act as transmitters. These kind of dynamics on random hypergraphs give rise to various statistical problems, for example, the estimate of the probability of the split of a community where opinions differ, or the rate of opinion change given the neighborhood of an individual.

In our work we use various machine learning methods, in particular, xgboost and neural networks to estimate such rates by using only cumulative statistics of the process. That is, we assume that we only know the total number of individuals representing the different opinions, and some basic statistics about the hypergraph structure, for example, the average size of communities and average size of overlaps. In our simulation study, we identify the quantities that are necessary to obtain good estimates, and the quantities that might contain some additional useful information and help improving the quality of the estimates. We also study the effect of the structure of the underlying random hypergraph by running the simulations on networks with different distribution of the community structure in the graph.

Type of presentation

Talk

Classification

Mainly application

Keywords

random hypergraph, spreading process, machine learning

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Session Classification: Machine learning I

Track Classification: Machine Learning