Connecting communities via the block model

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Workshop Summary

The block model is one of the most studied models of network with community structure. This model has been studied since the 1970s in different communities - in statistics under the name of stochastic block model, in computer science under the name of planted partition problem and in combinatorics under the name of inhomogeneous random graphs.

Recent years have seen strengthening connections between the different communities studying the block model which include in addition to the statistics, combinatorics and computer science communities, the information theory, optimization and statistical physics communities. This has led to new conjectures, novel techniques and results.

The goal of the proposed workshop is to leverage the newly established connections and techniques to study new challenges involving inference of combinatorial structures both in the context of network models and beyond. Some of the thematics covered are

- *Statistical vs. computational tradeoffs.* The block model serves as a fertile ground to study the interplay between statistical and computational barriers in graphical inference. Starting from 5 communities, there seem to be a region of parameters where detecting communities in the SBM is statistically possible but computationally hard. On the other hand, recovering exactly communities does note seem to exhibit such gaps for linear size communities. Understanding better such phenomena would benefit from a diversified workshop.
- *Algorithms.* The phase transitions identified for block models in the recent years have given raise to a new challenge for algorithms: achieving efficiently the thresholds. This has already brought to lights new powerful algorithms, such as nonbacktracking operators, while it allowed to benchmark existing ones. More algorithmic developments are expected to emerge from this quest.
- *Beyond block models.* The SBM is a canonical model for community detection, and its extensions allow to capture various important questions in complex networks and machine learning. The workshop will also focus on extensions of the basic model, such as graphons and low-rank approximation models, and more generally on the inference of combinatorial structures.

A closely related workshop will be held in Paris in May 2016 (http://www.msr-inria.fr/conferences-workshops/workshop-on-networks-learning-information-and-complexity/) and the organizers would like to request to hold a followup workshop in May 2017.

2 Summary of the workshop

The workshop brought together mathematicians, statistical physicists and computer science to study the block model and related inference in "planted" problems.

Each day started with two talks before lunch followed by working groups after lunch. The talks included introductory talks on the block model and some of the remaining challenges (Abbe, Moore). Other talks discussed extension to other planted problems (Montanari, Mossel, Zdeborova) and related spectral graph problems (Trevisan, Srivastava, Massoulié). Finally, Perry and Wein gave an introductory perspective on Approximate Message Passing and Replica. The use of white board and the relaxed schedule resulted in very active discussions during and after the talks. Open problems presented in talks were some of the more popular problems for group activities.

The main effort in the group activity involved a spatial variant of the block model, community detection via discrete message passing algorithms and phase transition for tensor problems.

Many of the participant expressed their interest in future work on the problems they worked on.

3 Research directions

A few themes were investigated:

- Non-mean field planted models, taking into account geometric attributes for the local interactions;
- Discrepancies between Bayesian and Maximum Likelihood approaches;
- Simple iterative procedure to extract communities;
- Interplay between block models and Spiked Wigner models.

Some of these are currently being pursued by the groups with new collaborations.