Community Detection using Stability Optimisation

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As part of a growing interest in network science, the field of community detection attracted a lot of interest in the past decade considering community structures as important features of real-world networks. Most community detection algorithms rely on modularity (Newman, 2004a) and effort has mainly been put into finding efficient algorithms able to deal with larger and larger networks. Yet modularity methods have several well-understood drawbacks (Fortunato & Barthélemy 2007) and the task of measuring partitions quality has received less attention. Recently, stability (Delvenne et al, 2010) was introduced as a new quality measure for community partitions. Stability exploits the relationship between graphs and Markov chains and is based on a clustered auto-covariance matrix that provides the probability to end up in a community *c2* after *t* steps starting from a community *c1*.

Our recent work investigated the use of stability as an optimisation function. We first show how stability can be expressed in terms of modularity and then adapt some modularity optimisation techniques to work with stability optimisation. We then present a greedy agglomerative hierarchical algorithm similar to Newman's fast algorithm (Newman, 2004b) using stability as optimisation function and using the Markov time (steps) as a resolution parameter.
The algorithm has been tested against several networks commonly found in the literature and against generated networks. To enable performance comparison its results are compared to those of several modularity optimisation algorithms. The results demonstrate a good accuracy overall compared to other approaches. They also show that the classification converges towards stable communities over time from where a deeper analysis can be performed to uncover hierarchies of stable partitions.

References

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