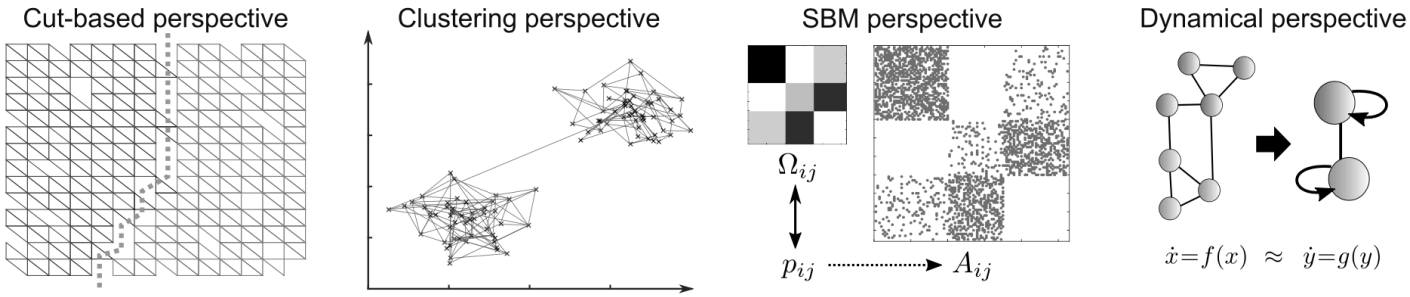
Community detection, blockmodeling & stochastic block models

Browse CDlib, NetworkX, graph-tool or other library for implementations of network community detection and graph partitioning algorithms. Select an algorithm which you will be using in the exercises below. For instance, select one of most popular algorithms such as hierarchical optimization of modularity known as Louvain algorithm, map equation algorithm called Infomap, simple label propagation algorithm, hierarchical clustering based on edge betweenness, Markov clustering algorithm, (degree-corrected) stochastic block model etc.



I. Community detection in small social networks

You are given three small social networks with known sociological partitioning of nodes.

- Zachary karate club network with 2 groups (karate_club.net)
- Lusseau bottlenose dolphins network with 2 groups (dolphins.net)
- US college football network with 12 conferences (american_football.net)

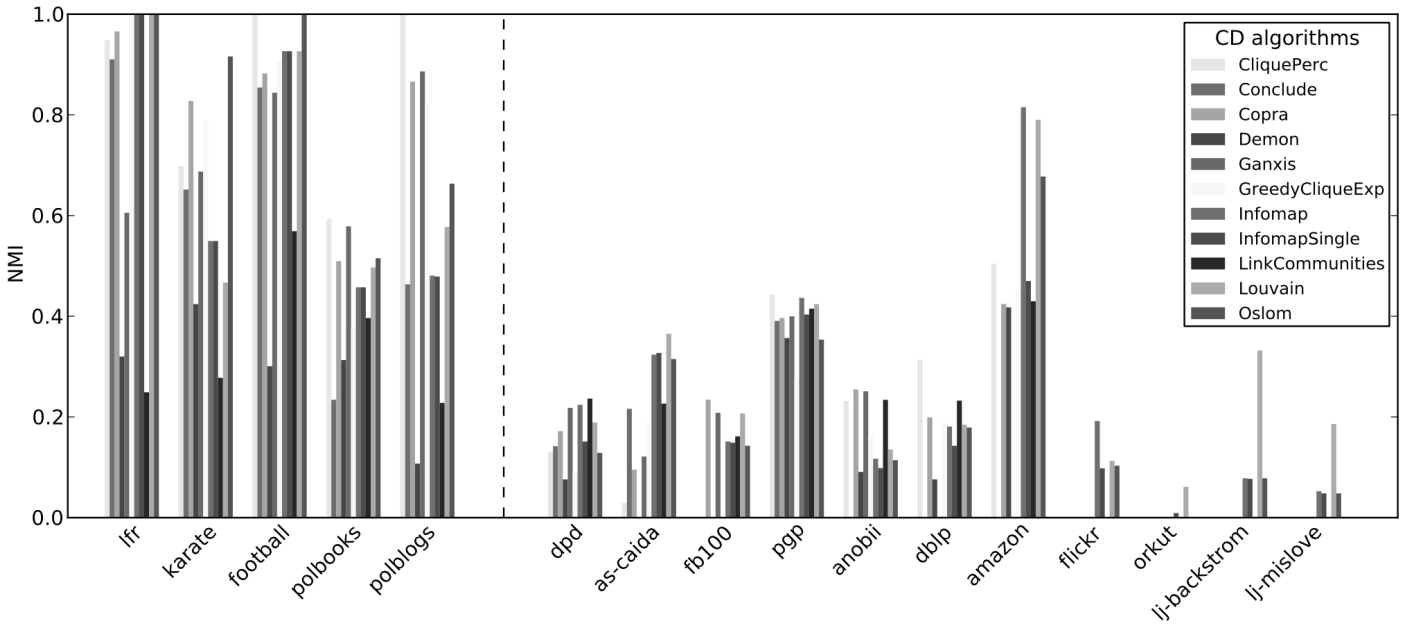
(code) Apply the algorithm to small social networks and test whether the revealed communities coincide with sociological partitioning of these networks. You should apply the algorithm to each network multiple times and compare partitions using some standard measure such as normalized mutual information or adjusted Rand index. Since these networks are very small, you can also print out or visualize the results.

II. Community detection in networks with node metadata

You are given three larger networks with with some metadata associated with each node.

- Java class dependency network with 54 packages (cdn_java.net)
- WikiLeaks cable reference network with 246 embassies (wikileaks.net)
- US college Facebook social network with 66 dormitories (dormitory.net)

(code) Apply the algorithm to larger networks and test whether the revealed communities coincide with metadata associated with the nodes of these networks. You should apply the algorithm to each network multiple times and compare partitions using some standard measure.



III. Community detection in Girvan-Newman benchmark graphs

(code) Apply the algorithm to Girvan-Newman synthetic benchmark graphs with planted partition and test whether the revealed communities coincide with the planted group structure. You should apply the algorithm to graphs with varying mixing parameter μ and compare partitions using some standard measure. For which values of μ does the algorithm reveal the planted partition?

IV. Community detection in Erdös-Rényi random graphs

(homework) Apply the algorithm to Erdös-Rényi random graphs that have no group structure and test whether the algorithm is able to detect this. You should apply the algorithm to random graphs with increasing average degree $\langle k \rangle$ and compare partitions using some simple statistic. For which values of $\langle k \rangle$ does the algorithm reveal the correct partition?

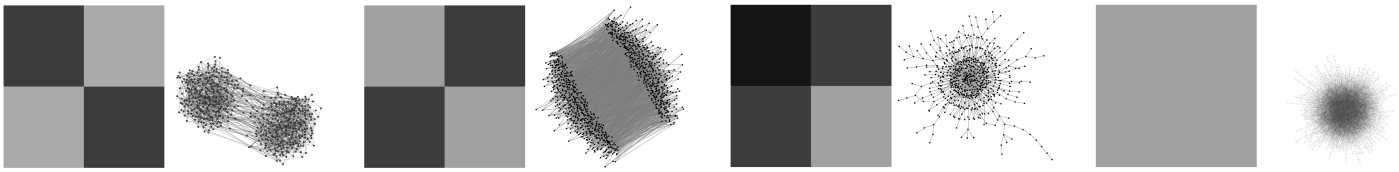
V. Blockmodeling of small social networks

You are given two small social networks with known sociological partitioning of nodes.

- Zachary karate club network with 2 groups (karate_club.net)
- Davis southern women network with 3 groups (southern_women.net)

(code) Apply the (degree-corrected) stochastic block model to small social networks and test whether the revealed clusters coincide with sociological partitioning of these networks. You should apply the algorithm to each network multiple times and compare partitions using some standard measure. Since these networks

are very small, you can also print out or visualize the results. What type of structure does the algorithm reveal in these networks?



VI. Blockmodeling of Šubelj-Bajec benchmark graphs

(homework) Apply the (degree-corrected) stochastic block model to Šubelj-Bajec synthetic benchmark graphs with planted assortative and disassortative structure, and test whether the revealed clusters coincide with the planted group structure. You should apply the algorithm to graphs with varying mixing parameter μ and compare partitions using some standard measure. For which values of μ does the algorithm reveal the planted partition?