
Louvain method: Finding communities in large networks

A Multi-Level Aggregation Method for optimizing modularity

Two C++ codes, the [original](#) and an [updated](#) versions, are freely available for download. More information can be found in the readme file included in both distributions and [here](#). A preliminary matlab version can be obtained on demand.

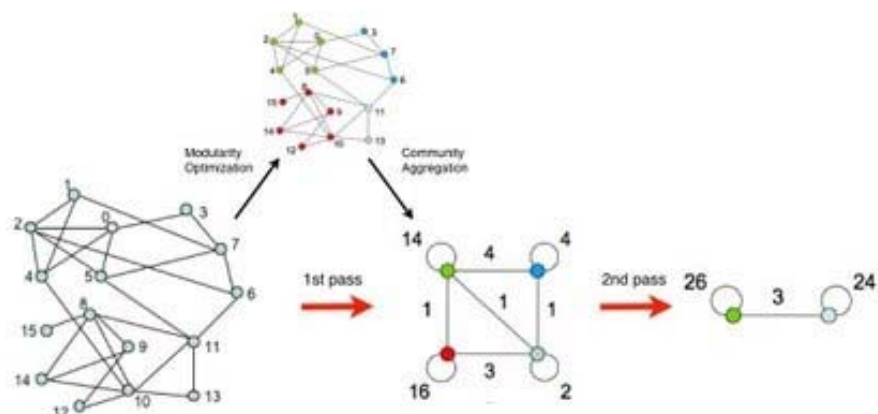
Details about our method can be found [here](#).

This project has been developed by [Vincent Blondel](#), [Jean-Loup Guillaume](#), [Renaud Lambiotte](#), and Etienne Lefebvre

In the last few years, there have been many attempts to uncover communities in large networks. By large, we mean systems composed of millions of nodes, which cannot be visualized nor analyzed at the level of single nodes and therefore require a coarse-grained description.

Our method, that we call Louvain Method (because, even though the co-authors now hold positions in Paris, London and Louvain, the method was devised when they all were in Louvain), outperforms other methods in terms of computation time, which allows us to analyze networks of unprecedented size (e.g. the analysis of a typical network of 2 million nodes only takes 2 minutes). The Louvain method has also been shown to be very accurate by focusing on ad-hoc networks with known community structure. Moreover, due to its hierarchical structure, which is reminiscent of renormalization methods, it allows to look at communities at different resolutions.

The method consists of two phases. First, it looks for "small" communities by optimizing modularity in a local way. Second, it aggregates nodes of the same community and builds a new network whose nodes are the communities. These steps are repeated iteratively until a maximum of modularity is attained.



The output of the program therefore gives several partitions. The partition found after the first step typically consists of many communities of small sizes. At subsequent steps, larger and larger communities are found due to the

aggregation mechanism. This process naturally leads to hierarchical decomposition of the network.

This is obviously an approximate method and nothing ensures that the global maximum of modularity is attained, but several tests have confirmed that our algorithm has an excellent accuracy and often provides a decomposition in communities that has a modularity that is close to optimality.

The method was first published in: [Fast unfolding of communities in large networks](#), Vincent D Blondel, Jean-Loup Guillaume, Renaud Lambiotte, Etienne Lefebvre, Journal of Statistical Mechanics: Theory and Experiment 2008 (10), P1000

For more information, or comments, please send an email to [Jean-Loup Guillaume](#), [Vincent Blondel](#) or [Renaud Lambiotte](#). For specific comments concerning the code or if you find any bug, contact [Jean-Loup Guillaume](#).