

## Complex Networks (CN)

### A2: Community structure of complex networks

#### Objective

Provide hands-on experience in identifying communities within complex networks.

#### Description

##### 1. Choose a Network

- Select a biological network that you find interesting, and which consists of hundreds of nodes (at least 200 nodes).
- Note: network repositories like [Network Repository](#), [Stanford Biomedical Network Dataset Collection \(BIOSNAP\)](#), [Netzschleuder](#), provide numerous datasets of biomedical interest (among many other topics).
- Choose a network in which you think that communities are going to be meaningful

##### 2. Community detection

- Compare the performance of three community detection algorithms: one of them should be based on modularity maximization (Louvain, Leiden, Greedy). The other two algorithms should be Infomap and the degree corrected stochastic block model.
- Briefly explain the rationale behind each algorithm you choose and why it is appropriate for your network.

##### 3. Analysis of detected communities

- Visualize the community structures.
- Analyze the communities detected by the algorithms.
- If there exists a reference partition for your network (or labelling of the nodes that could classify them), compare it with your partitions.
- Discuss the characteristics of the main communities. For example, are there any notable nodes (like hubs), patterns, or substructures?
- If applicable, try to interpret these communities in the context of your network (e.g., functional modules in biological networks).

##### 4. Conclusion

- Summarize your findings and insights gained from this exercise.
- Reflect on the effectiveness of community detection algorithms in analyzing complex networks.

#### Delivery

- This is an assignment to be done in pairs.

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- The delivery must consist of a **single zip file** that contains your **Jupyter notebook** (with all the code, visualizations, analysis), the **data** and a brief PDF report. The name of the file must be of the form:
  - A2-Group\_Names\_Surnames.zip
- Ensure your notebook can be run irrespective of the folder in which it is located in our system, and that all necessary files are included. Use the solution you prefer: using relative paths to the data; checking the path in which the notebook is to set the right path to the data; using the data from a URL; downloading the data within the code; etc. In any case, please test it before the delivery.
- In the brief report, describe:
  - The network you have chosen and its relevance (if different from A1).
  - Key insights from the community detection method.
  - Observations from the results.