Network Theory and Degree Distributions

Network Science '22: Assignment 1

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Objectives

1. Get acquainted with the software tools to be used
2. Create simple networks
3. Learn how to compute and visualise degree distributions
4. Gain intuition on the typical properties of the degree distributions

A01.1 Building and visualising networks

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Task: *Build and visualise the following networks*

1. Star network
2. Fully-connected
3. One-dimensional lattice with periodic boundary conditions where each node i has degree $k_i = 2$

Parameters: Build each network with $N = 32$ nodes. Note that these networks are undirected and unweighted.

A01.1 Hints

It is highly recommended to use Python's library `networkx`

- Build manually the networks by creating objects of the type "`Graph`"
- To display the networks, use the function `draw( )`

A01.2 Global properties

A01.2-3 Datasets provided

Datasets provided:

- Zachary Karate Club: Nodes represent members of the club and Edges represent a tie between two members **[1]**
- NetSci collaborations: Nodes represent scientists working in network science and Edges represent co-authorship of at least one paper published up until early 2006 **[2]**
- Facebook friendships: Nodes represent Facebook users and Edges represent their friendship relations collected from survey participants **[3]**

A01.2 Datasets provided

[1] W. W. Zachary, An information flow model for conflict and fission in small groups, Journal of Anthropological Research, 33 (1977), pp. 452–473
[2] M. E. J. Newman, Finding community structure in networks using the eigenvectors of matrices, Physical Review E, 74 (2006)
[3] J. Leskovec and J. J. Mcauley, Learning to discover social circles in ego networks, in Advances in Neural Information Processing Systems, 2012, pp. 539– 547.

A01.2a Global properties

For each one of the networks provided, compute the following network measures

1. Compute the average degree $\langle k \rangle$ and the density δ of the networks.
2. Write a function `max_degree` that takes a network as its argument, and returns two values: the id/name/label of the node with the largest degree, and the value of its degree. *Test it on the datasets given*

A01.2b Degree Distributions

For the same networks, compute and plot the degree distribution

1. Select axis scales (lin-lin / lin-log / log-log) that allow you to visualise better the distributions
2. **Remember to bin the data accordingly to the scales selected**

A01.2 Hints

- for the function `max_degree`, return a 2-tuple
- To compute the distribution, use the function "`hist`" from the package `matplotlib`
- To such a function, you can specify the set of bins with the (optional) parameter '`bins`'. The parameter can be either
  - **an integer**: in this case, it determines the number of bins
  - **an array of numbers**: in this case, it specifies the bins themselves
- **You must set** `density=True`

IMPORTANT:
submissions MUST be standardised according to the following guidelines

Assignment submission

- only ONE file per person (.ipynb, .html, .pdf)
- file name MUST be `LASTNAME_FIRSTNAME_EX#.ipynb`
- we do NOT run your code: all results AND the code generating them must be clearly shown in the file
- if collaborating, BOTH students submit the same document and put a comment at the top of the notebook stating the collaboration

Not following these guidelines results in a FAIL

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