

Complex Systems  
WROCLAW UNIVERSITY OF SCIENCE AND TECHNOLOGY  
Complex network model

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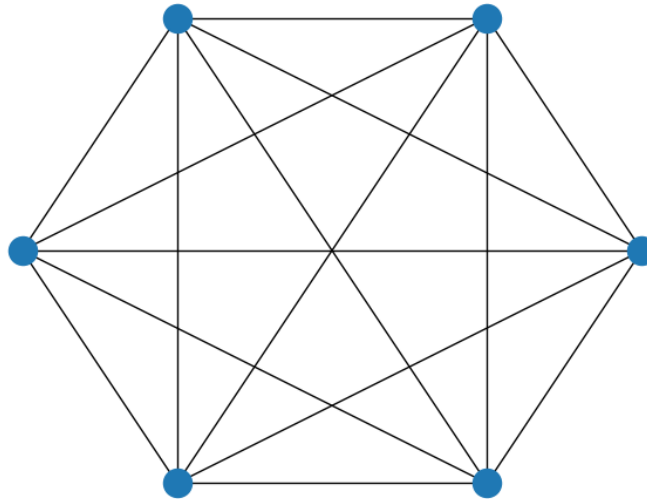
January 14, 2024

Files containing Python scripts and results of analyses are uploaded under Dropbox link:

<https://shorturl.at/cdJ37>

## 1 Visualization of a given network

Dataset of fish family was chosen from *The Network Data Repository with Interactive Graph Analytics and Visualization*, Ryan A. Rossi et. al. (<http://networkrepository.com>) 1.

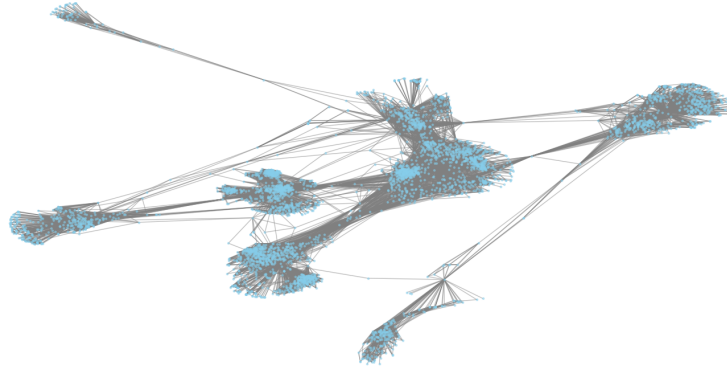


**Figure 1:** Network graph of the given data.

## 2 Visualization of social circles from Facebook (ego-Facebook).

Dataset was given by Stanford Large Network Dataset Collection by Jure Leskovec under source: J. McAuley and J. Leskovec. *Learning to Discover Social Circles in Ego Networks*. NIPS, 2012.

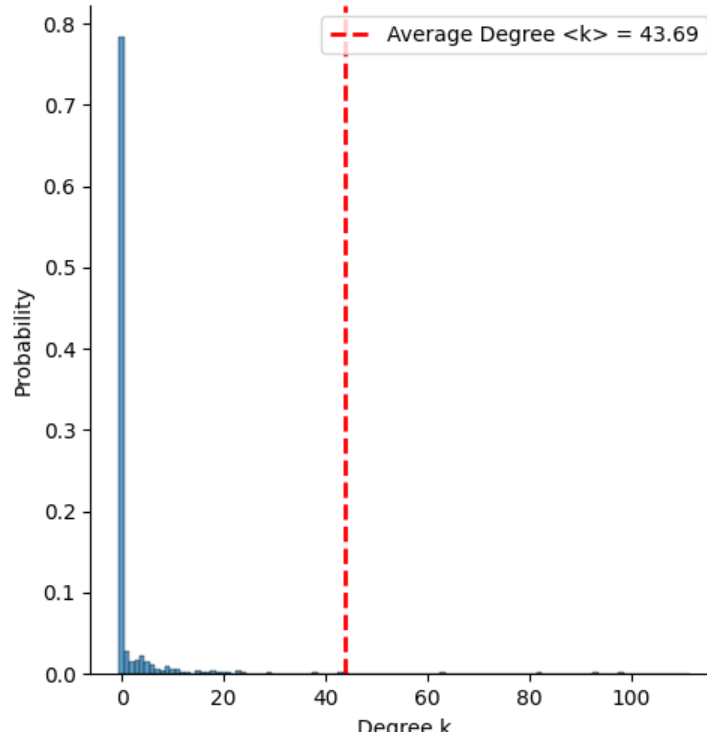
## 2.1 Network graph



**Figure 2:** Network graph of the ego-Facebook data

## 2.2 Degree distribution $P(k)$ and an average degree $\langle k \rangle$

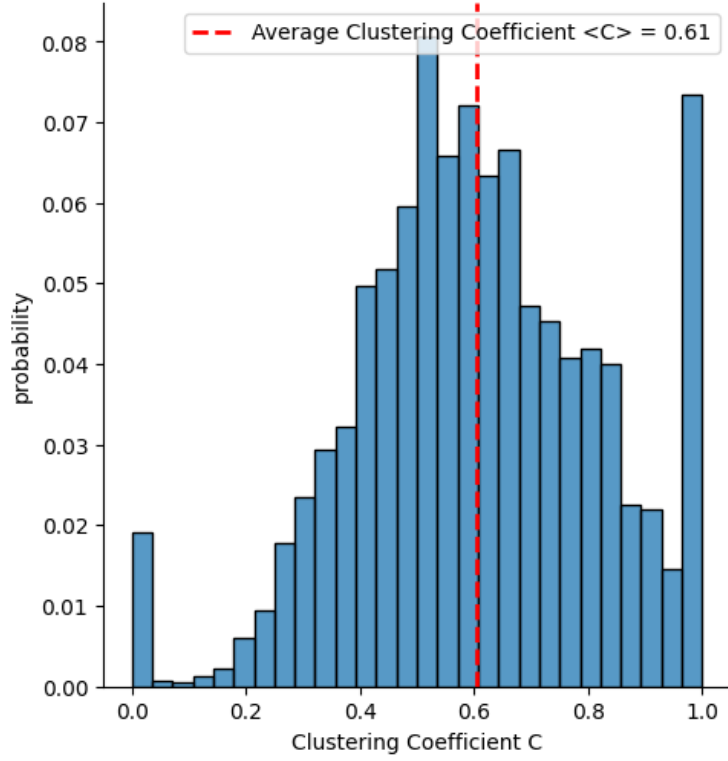
Degree distribution was computed using *networkx* package method called *degree\_histogram* and average degree was computed by simple averaging over distribution values.



**Figure 3:** Degree distribution  $P(k)$  with average degree  $\langle k \rangle$  marked.

## 2.3 Distribution of clustering coefficients and an average clustering coefficient

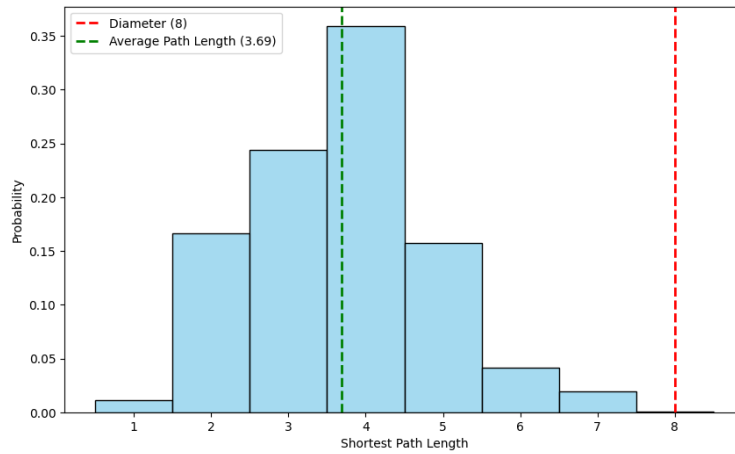
Distribution of clustering coefficient was derived and normalized using *networkx* method called *clustering*, average value was computed by simple averaging over distribution values.



**Figure 4:** Distribution of clustering coefficients and with average clustering coefficient marked.

## 2.4 Distribution of the shortest paths, the diameter, and the average path length.

The distribution was derived by firstly getting all pairs of nodes in the graph using networkx method *all\_pairs\_shortest\_path\_length* and then extracting the shortest path lengths. Diameter was calculated using another networkx method called *diameter* and average path length was computed using networkx *average\_shortest\_path\_length* method.

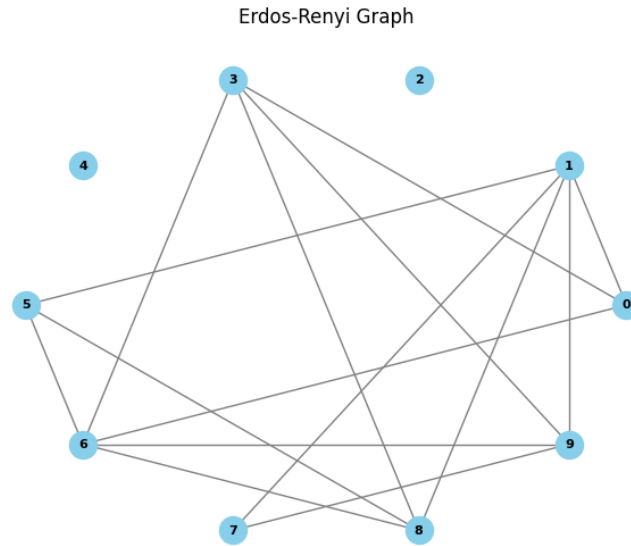


**Figure 5:** Distribution of the shortest paths, the diameter, and the average path length.

### 3 Random graphs

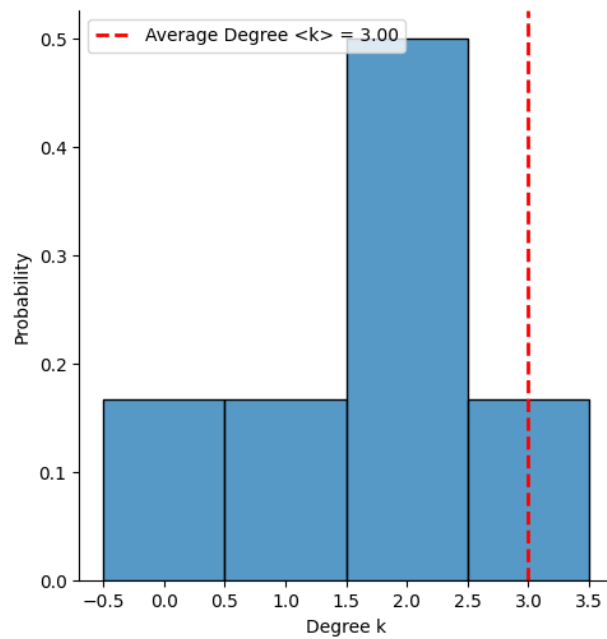
#### 3.1 Erdos-Renyi model

Erdos-Renyi model  $G(N, L)$ , in which  $N$  vertices are connected with  $L$  randomly placed edges, was implemented by creating an array called adjacent matrix and randomly connecting nodes till a given number of edges was reached.

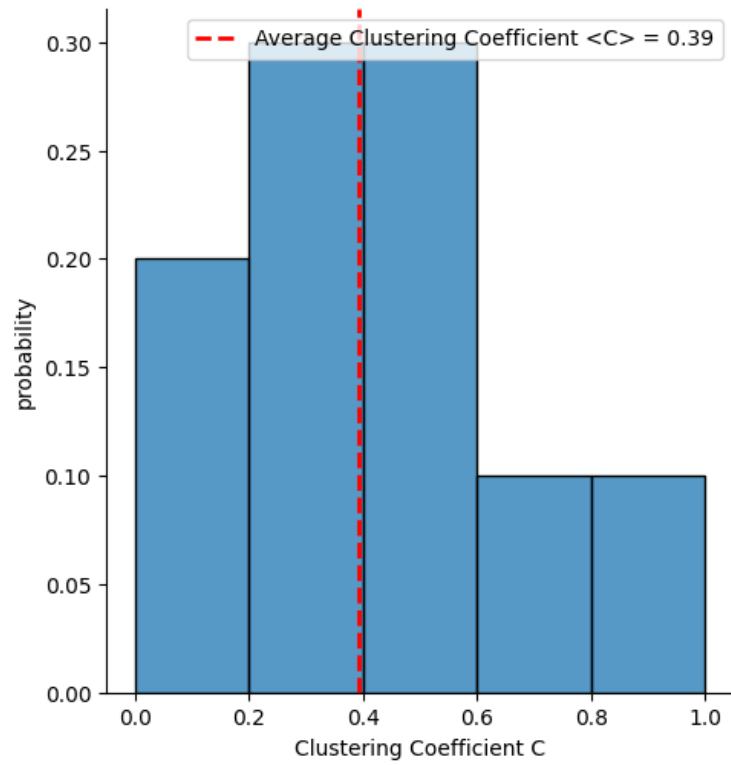


**Figure 6:** Graph of an Erdos-Renyi model network for  $N = 10$  and  $L = 15$

##### 3.1.1 Degree distribution $P(k)$ and an average degree $\langle k \rangle$ .



### 3.1.2 Distribution of clustering coefficients and an average clustering coefficient.



### 3.1.3 Distribution of the shortest paths, the diameter, and the average path length.

