

**Dataset Details :**

Dataset (`socfb-UConn.mtx`) is a **Facebook social network** of the **University of Connecticut**.

Link for the dataset : <https://networkrepository.com/socfb-UConn.php>

- **Nodes (vertices)** → Facebook users → 17.2K
- **Edges** → Friendship between two users → 604.9K
- **Graph type** → Undirected, unweighted, sparse social network
- **Meaning** → If two nodes are connected, those users are friends

**Basic Structural Properties :**

Number of Nodes	17206
Number of Edges	604867
Network Density	0.004086535643794365
Average Degree	70.30884575148204
Maximum Degree	1709

**Description :**

- The observed **low network density (0.004086)** indicates that the graph is highly sparse, a defining feature of large-scale social networks.
- Despite the large number of nodes, only a very small fraction of all possible connections are realised.
- This sparsity reflects the cognitive and social constraints that limit the number of relationships an individual can maintain, consistent with sociological theories such as **Dunbar's number**.

**Degree Statistics and Distribution:**

- The large discrepancy between the average degree and the maximum degree reveals a strongly **heterogeneous topology**.
- Most users maintain a moderate number of connections, a small subset of nodes acts as highly connected hubs.
- The degree distribution follows a **heavy-tailed pattern**, indicative of broad degree variability and the presence of hubs

**Betweenness and Closeness Centrality Nodes:**

Betweenness (Node Id)	Value	Closeness (Node Id)	Value
852	0.05257772780558461	852	0.5037783375314862
14539	0.01348603465531092	14539	0.4819277108433735
10754	0.009420975446220111	10754	0.46893317702227433
13224	0.007547374315982251	13224	0.46296296296296297
16568	0.007330332504282578	16568	0.4608294930875576

**Description :****Betweenness Centrality:**

- Nodes with the highest **betweenness centrality** (notably node 852) lie on a large fraction of shortest paths between other nodes, making them critical **bridges** in the network.
- Removal of such nodes could significantly disrupt connectivity.

**Closeness Centrality:**

- Nodes with high **closeness centrality** are centrally located and can reach the rest of the network in fewer steps. These nodes are well-positioned for rapid information dissemination

**Community Structure Analysis:****Louvain Community Detection :**

Number of communities	13
Min size	3
Avg size	1323.5384615384614
Max size	4557
Modularity	0.4384469149835143

The Louvain algorithm yields a **high modularity value ( $Q = 0.438$ )**, indicating a strong and statistically significant community structure

**Label Propagation Community Detection:**

Number of communities	13
Min size	2
Avg size	1323.5384615384614
Max size	14395
Modularity	0.15437093162860344

- While Label Propagation identifies the same number of communities, it produces a substantially lower modularity value.
- The emergence of a dominant giant community suggests that the algorithm is less effective at capturing the mesoscopic structure of this network.

**Conclusion:**

- The analysed Facebook network exhibits the fundamental structural characteristics of complex social systems: sparsity, heterogeneous degree distribution, strong connectivity, high clustering, and pronounced community structure.
- The presence of influential hubs and a high-modularity partition indicates that social interactions are organised into cohesive groups interconnected by a small number of structurally central individuals

**Github repo details:**

Repo Link :

[https://github.com/karan-dev-ctrl/Network-Science\\_Python/blob/master/Final\\_NS1/NS1\\_analyses\\_PAL0343.ipynb](https://github.com/karan-dev-ctrl/Network-Science_Python/blob/master/Final_NS1/NS1_analyses_PAL0343.ipynb)