NetworkX:
Network Analysis in Python

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Outline

Social Network Graphs

NetworkX

Visualization

Computing Graph Parameters

Social Network Analysis

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- Vertices in social network graphs represent *actors:* people, social entities etc.
- Edges (also called *ties* or *links*) represent various *relations* between actors.
- The standard example is the friendship relation in social networks.

Parameters of Social Network Graphs

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- We are going to get acquainted with specialized software for calculating them.

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- As we discussed earlier, the clustering coefficients tend to be quite high.
- This reflects the fact that friends of one person are much more likely to be friends also.

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Parameters of Social Network Graphs

- On the other hand, being highly clusterized, the social network happens to be tightly connected.
- The well-known theory of *six degrees of separation* (“six handshakes”) claims that any two people in the world are no more than six social connections from each other.
- In graph-theoretic terms, this means that the **diameter** of the social connections graph should be ≤ 6.

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- This makes the dataset relatively small.
- All data is of course anonymized.

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- Capable of handling big graphs (real-world datasets): 10M nodes / 100M edges and more.
- Highly portable and scalable.

Getting NetworkX

- NetworkX, along with libraries necessary for visualization, can be installed with `pip`:

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- We've renamed `networkx` to `nx` for convenience.

Defining a Graph: Manual

- In NetworkX, one can define a graph manually, by adding edges one by one.

```
mygraph = nx.Graph()


mygraph.add_edge('A','B')
mygraph.add_edge('B','C')
mygraph.add_edge('C','A')
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- Vertices can be of arbitrary type (strings, numbers, ...).

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- Graphs in NetworkX can also be *weighted*.
- In a weighted graph, each edge receives a number called its weight.
- Example: time (or cost) of driving along a road.
- Weight is added just as an optional parameter to `add_edge`:

```
mygraph.add_edge('A','B', weight=6)
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- In our example, we use SNAP's Facebook dataset (10 ego networks combined).
- In the file `facebook_combined.txt` one finds the list of edges as pairs of numbers (vertices are numbered).
- The data gets imported by the `nx.read_edgelist` method.

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- In many cases, it is very helpful to **see** how the graph looks like.
- Rendering an abstract graph to a picture is called *visualization*.
- NetworkX is capable of visualizing graphs, both in 2D and 3D.

Visualization: Small Example

- NetworkX visualizes graphs via Matplotlib (a Python library for plotting).

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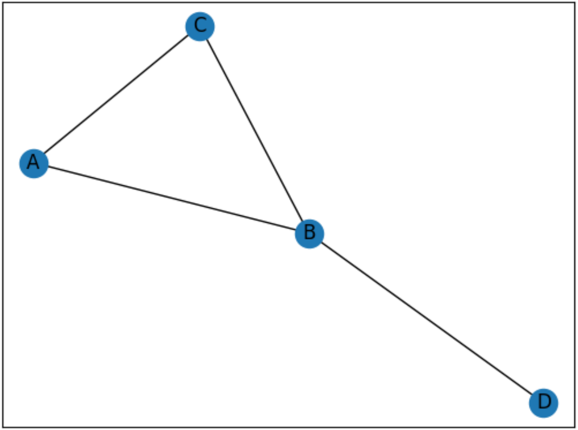
- The method is called `nx.draw_networkx`:

```
nx.draw_networkx(mygraph)
matplotlib.pyplot.savefig("mygraph.png")
```

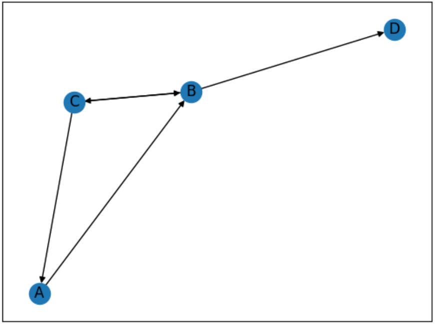
Visualization: Small Example



NetworkX output

Visualization: Small Example

This is how a directed graph is visualized. Two opposite edges between B and C are drawn as one edge with two arrows.



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Visualization of Real Data

- We remove labels, because there are too many vertices:

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nx.draw_networkx(fb_gr, with_labels=False);
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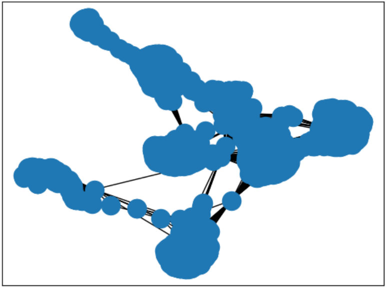
- Visualization makes clustering visible:



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- Global parameters of the graph are just functions of it.
- For example, if we wish to calculate the *average clustering coefficient* (the average value of local clustering coefficients), we just run

```
av_clust = nx.average_clustering(fb_gr)
```

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```
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```

- The calculation takes quite long... and on our data it yields 8.
- This is quite a good result, recalling that we have just a fusion of 10 ego nets, not the full Facebook graph.

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- If we need to compute several parameters of this sort, we can precompute the dictionary of eccentricities by the `nx.eccentricity` function.
- This function returns the dictionary of eccentricities, keyed by vertices.
- If we pass this dictionary to the diameter computing function, it will run much faster.

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- In directed graphs, the path should also be directed—thus, sometimes $d(a, b) \neq d(b, a)$.
- **Caveat!** If there is no path, NetworkX throws an exception.
- To be on the safe side, use `nx.has_path` before.

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- Traversal algorithms are implemented as functions which return *generators*.
- For example, `nx.dfs_preorder_nodes` returns a generator which yields the vertices of the graph in the preorder DFS traversing order.

Traversing: Example

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G = nx.Graph()

G.add_edge('A','B')
G.add_edge('B','C')
G.add_edge('C','A')
G.add_edge('B','D')
G.add_edge('D','E')
G.add_edge('E','A')

print(list(nx.dfs_preorder_nodes(G,
    source='C')))
```

Traversing: Example

This yields the following result:

```
['C', 'B', 'A', 'E', 'D']
```

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- Good luck!