Networks and Graphs (and surfaces)

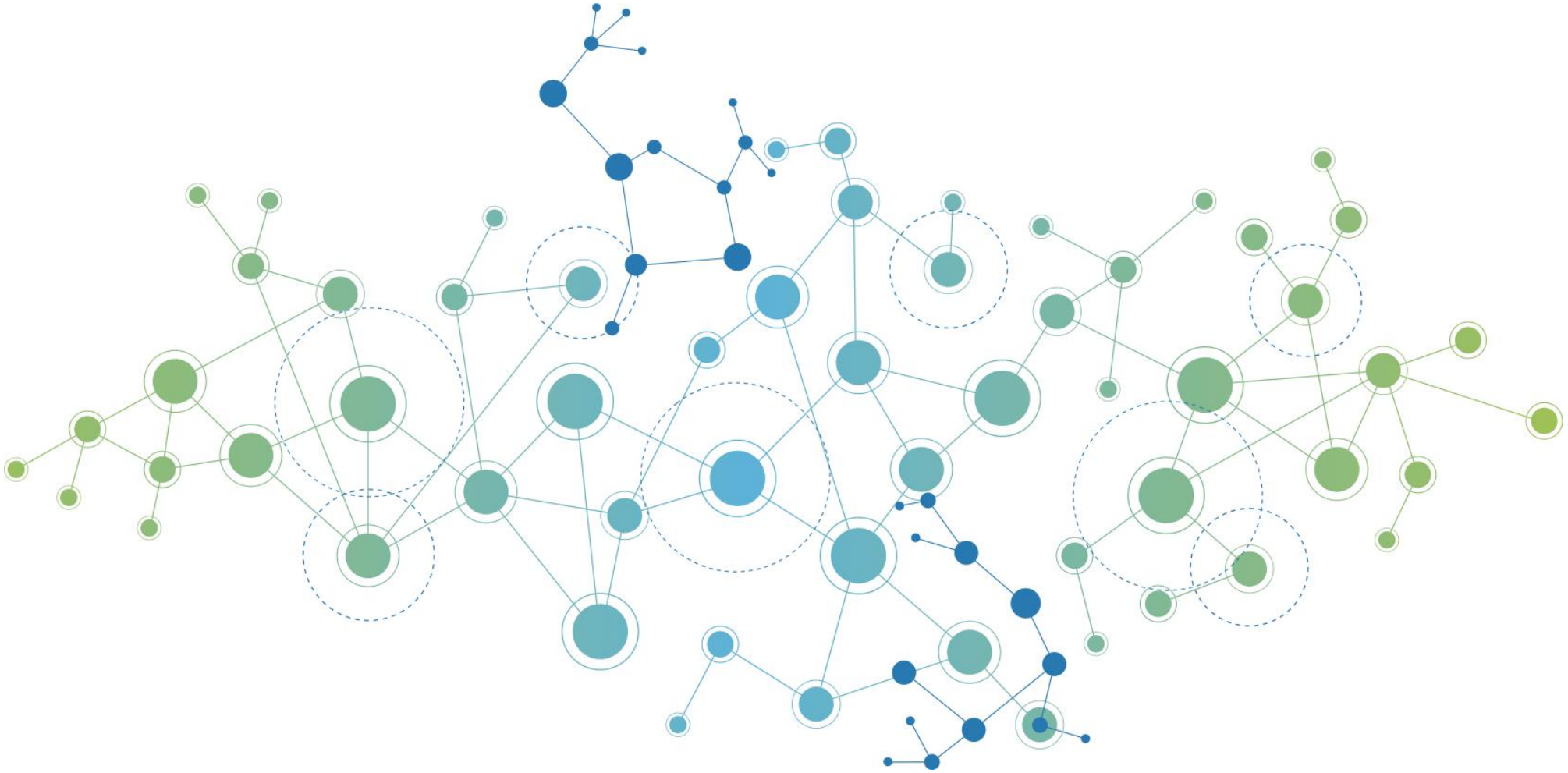
10.18.24

What’s a graph?

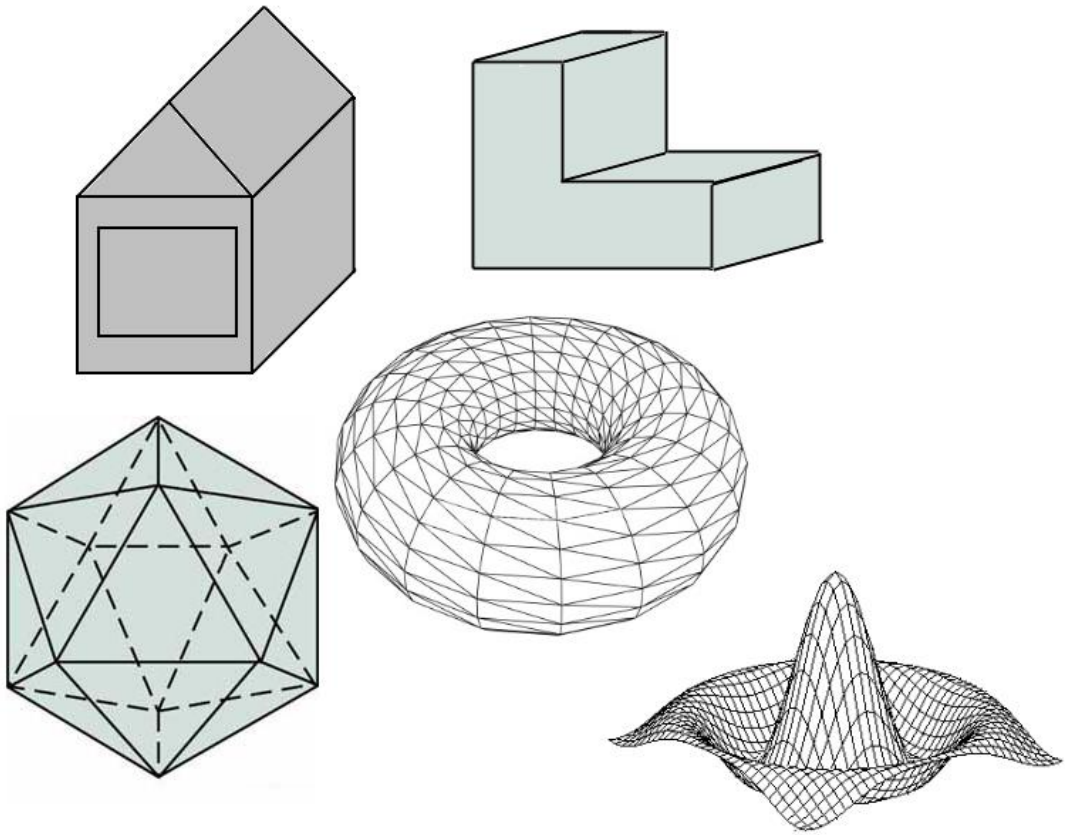
- Nodes/vertices: components of a network
- Edges: relationship between nodes
  - Can be binary, weighted, and/or directed

- Communities: clusters that group similar nodes

Examples of graph data?



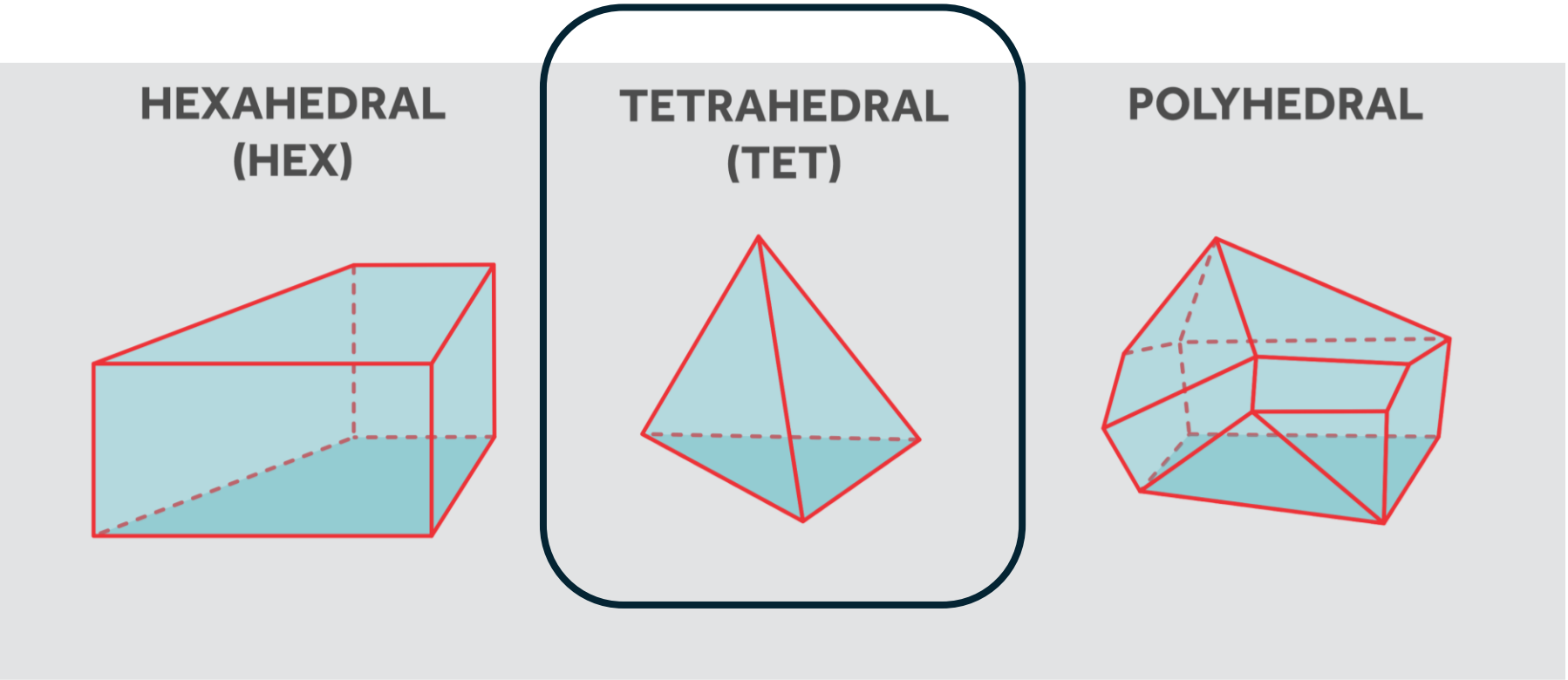
Meshes/Surfaces are networks



Nodes=vertices

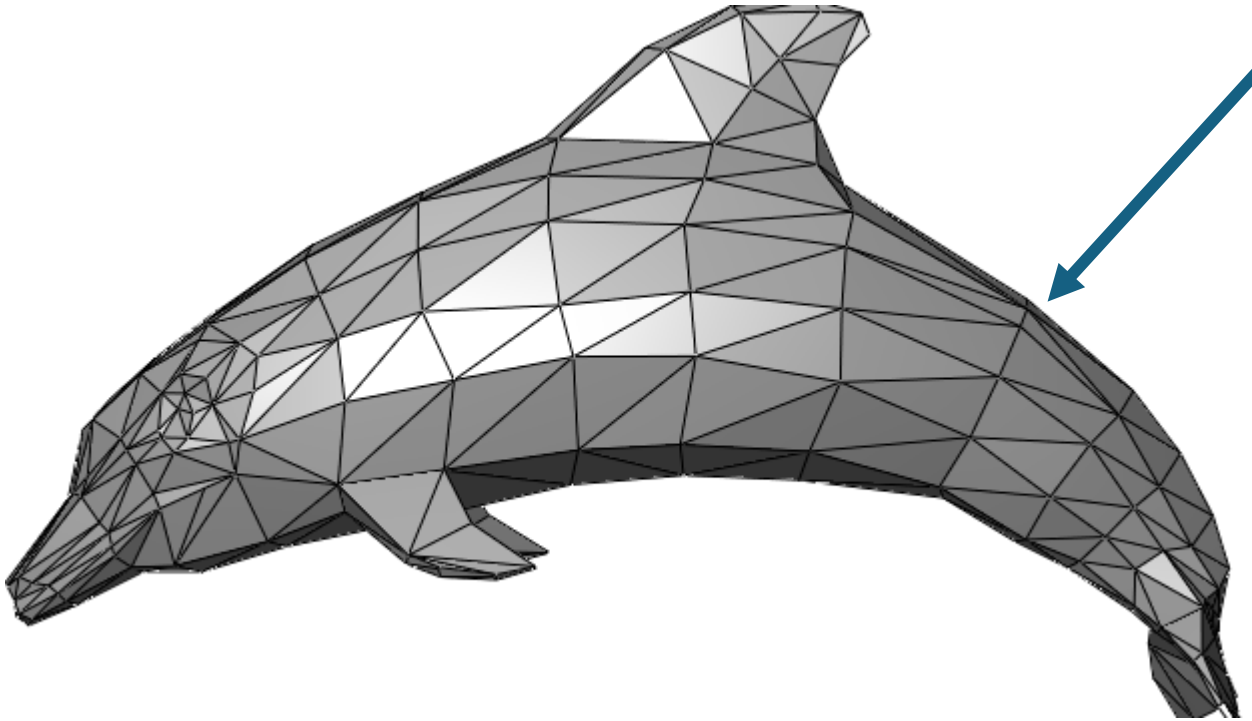
Mesh structures

Most common



Triangular Surfaces

- 3d tetrahedron=dense volumes
- Triangular tessellation = surfaces



Defined by triangles:
3 nodes + 3 edges

(Tri) Surface Data (in 3d)

For n nodes and m edges

1. A list of coordinates for each vertex: (n x 3)

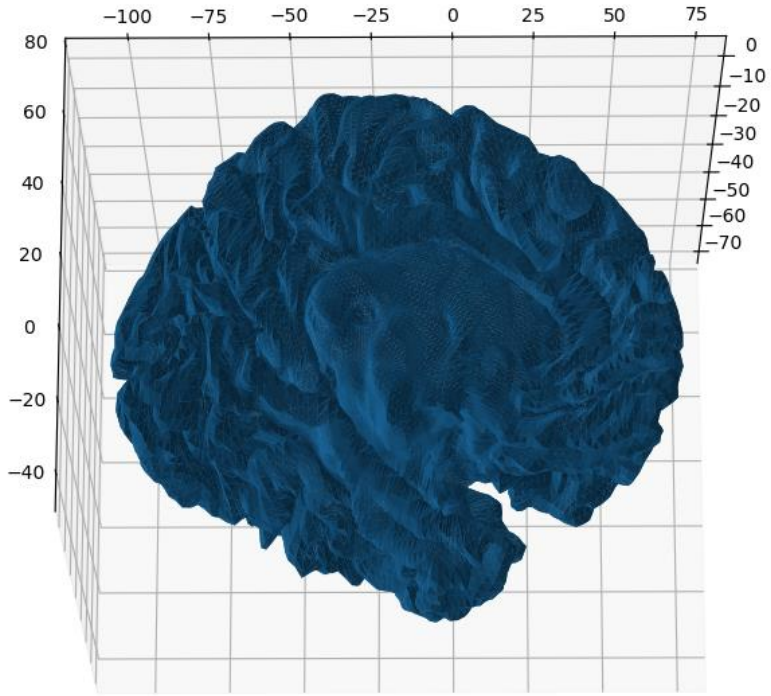
2. A list of edges: (m x 3). Each row has the node numbers
   - [vertex1 , vertex 2, vertex 3]

3. (Opt). Coloring: can be specified for vertex or triangle

   If vertex-specified, triangles are colored by interpolation

Trisurf in matplotlib

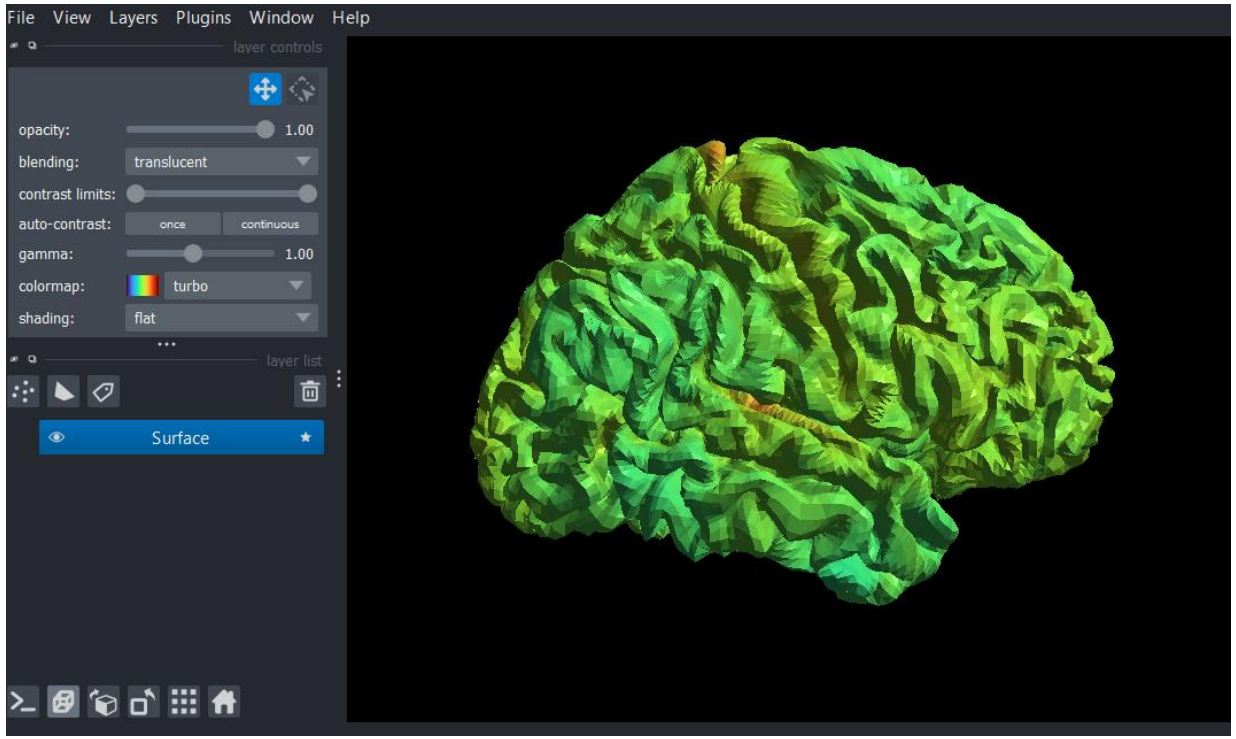
- Load in data using the script: Load_Data_10.18
- Just specify X,Y,Z vertices and triangles




```
ax = fig.add_subplot(111, projection='3d')
ax.plot_trisurf(vertL[:,0],vertL[:,1],vertL[:,2],triangles=triL)
```

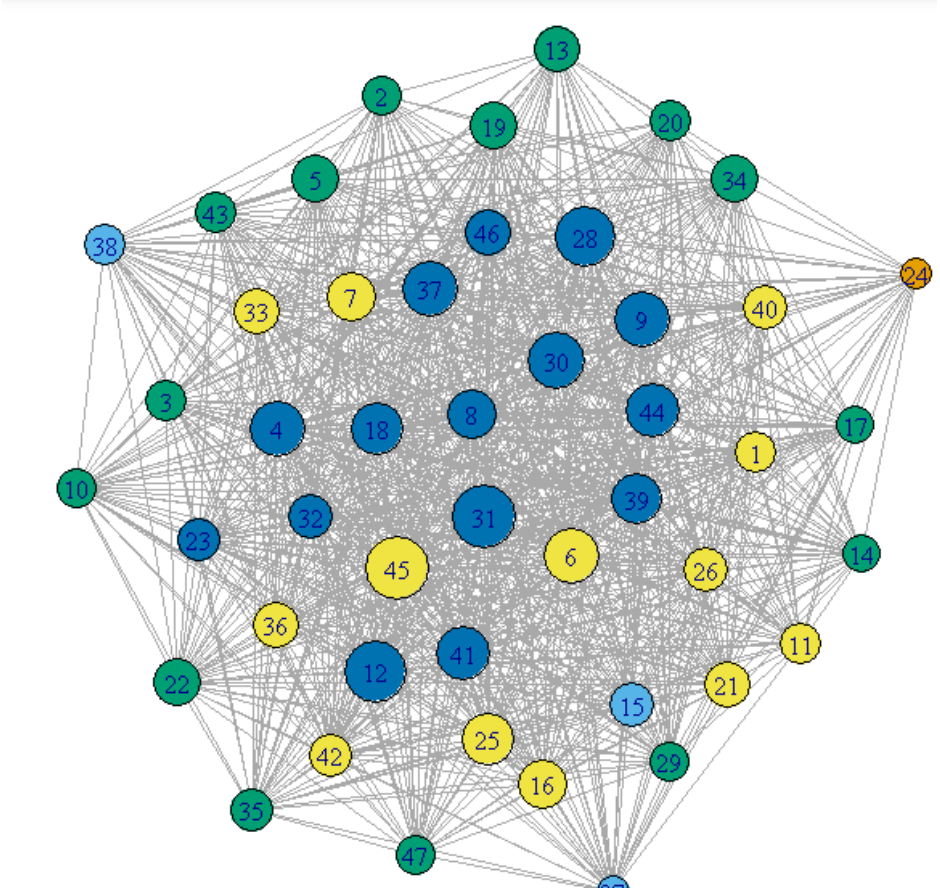
Colored surfaces in napari

```
viewer = napari.Viewer()
viewer.add_surface((vertL, triL, myL/np.max(myL)), colormap='turbo')
napari.run()
```



Other graphs…

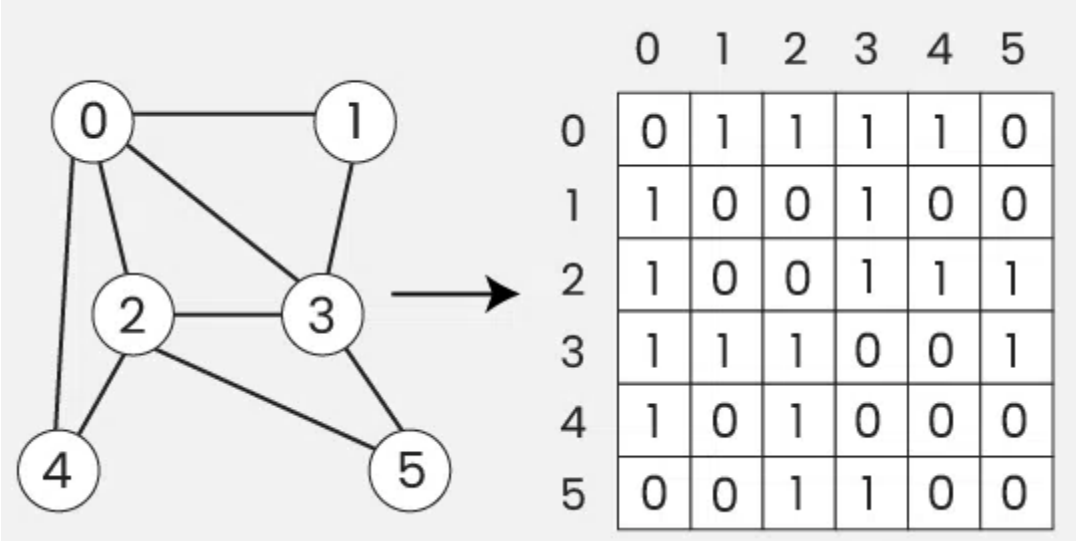
What do I want to measure with graph data?



Creating graphs

- Matrix-based: easiest for small N
- nx.from_numpy_array

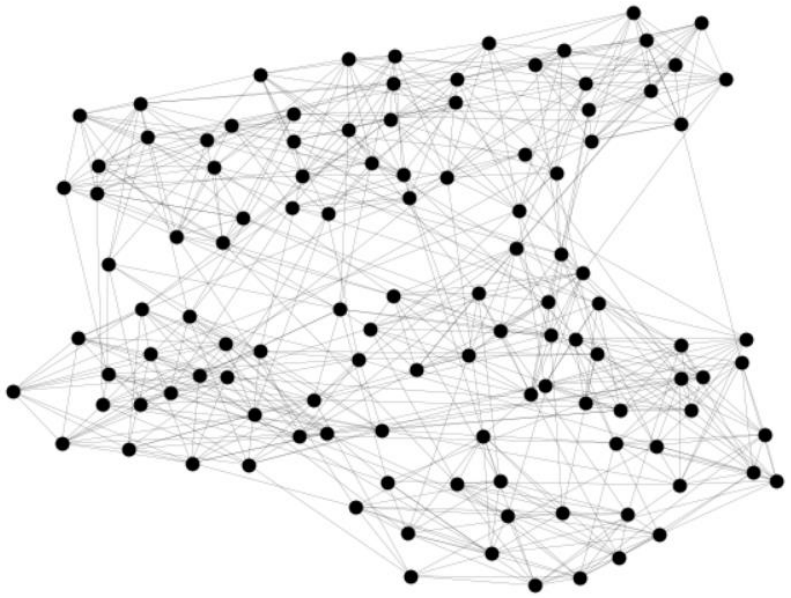
- Node-based: necessary when there are many nodes, high sparsity
- nx.from_edgelist
  - Same way that surfaces are stored: edge-lists



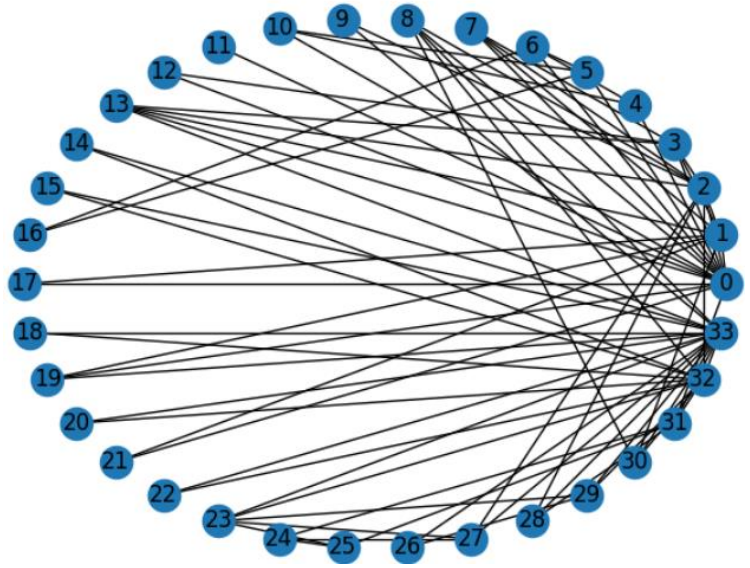
	0	1	2	3	4	5
0	0	1	1	1	1	0
1	1	0	0	1	0	0
2	1	0	0	1	1	1
3	1	1	1	0	0	1
4	1	0	1	0	0	0
5	0	0	1	1	0	0

Visualizing Graphs

nx.springlayout



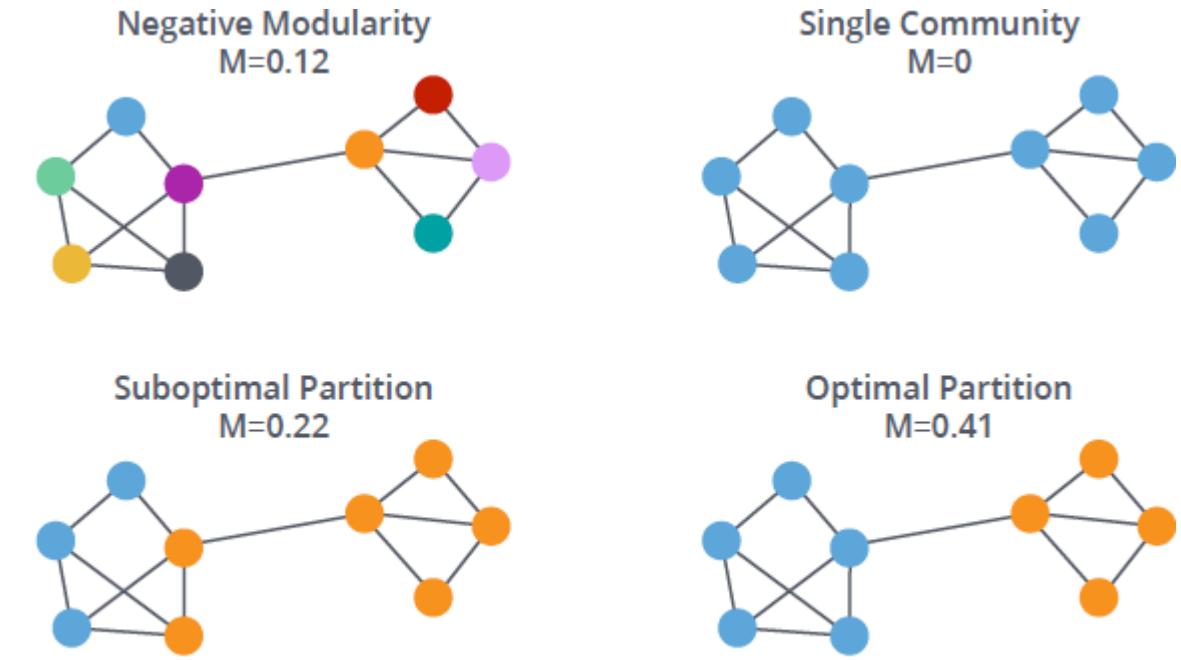
nx.draw_circular



Graph Communities

- networkx.communities

- Common algorithms:
  - Louvain (maximal modularity)
  - Bisection



Modularity

Practice

- Use the college message dataset.
- Columns: sender, receiver, time[ignore]

- Turn into a graph using G=nx.from_edgelist
- Edgelists should be a list of tuples…[(a1,b1), (a2,b2)…]

Practice

- Use the college message dataset.
- Columns: sender, receiver, time[ignore]

- Get spring-loaded positions:

pos = nx.spring_layout(G)

draw as: nx.draw_networkx_edge_labels(G, pos)

Brain Network demo

Fin