Definitions & basic recap

INTERMEDIATE NETWORK ANALYSIS IN PYTHON



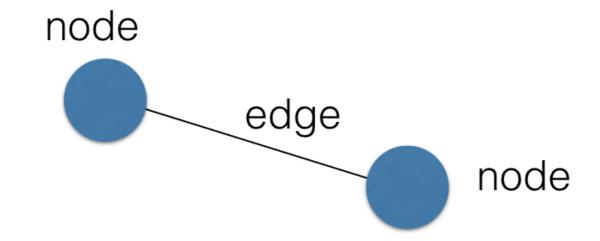
Eric Ma

Data Carpentry instructor and author of nxviz package



Network/Graph

- Network = Graph = (nodes, edges)
- Directed or Undirected
 - Facebook: Undirected
 - Twitter: Directed
- networkx : API for analysis of graphs



Basic NetworkX API

```
import networkx as nx
G
<networkx.classes.graph.Graph at 0x10b192da0>
G.nodes()

['customer1', 'customer3', 'customer2']
```



Basic NetworkX API

len(G.nodes())

3

len(G.edges())

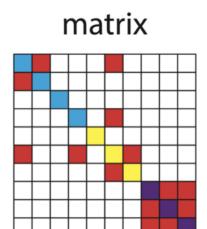
2

type(G)

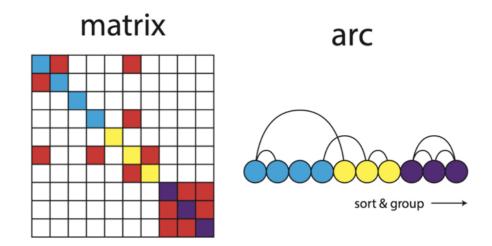
networkx.classes.graph.Graph



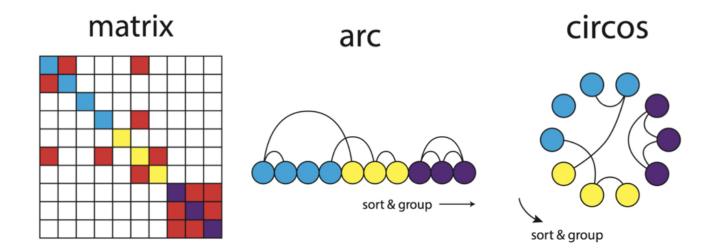
- nxviz: API for creating beautiful and rational graph viz
- Prioritize placement of nodes



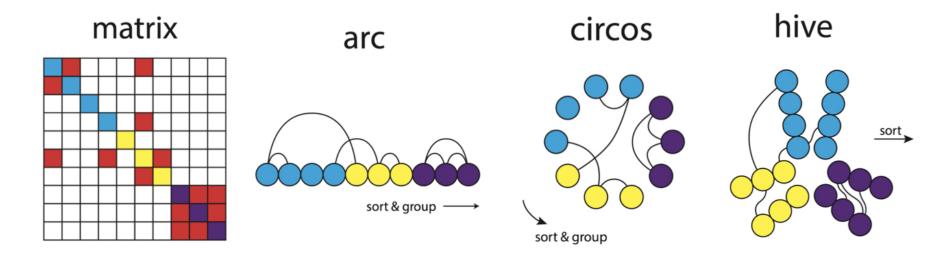
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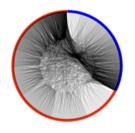


- nxviz: API for creating beautiful and rational graph viz
- Prioritize placement of nodes



Basic nxviz API

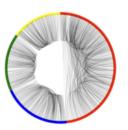
```
import nxviz as nv
import matplotlib.pyplot as plt
c = nv.CircosPlot(G)
c.draw()
plt.show()
```

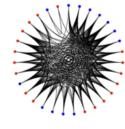












Let's practice!

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Bipartite graphs

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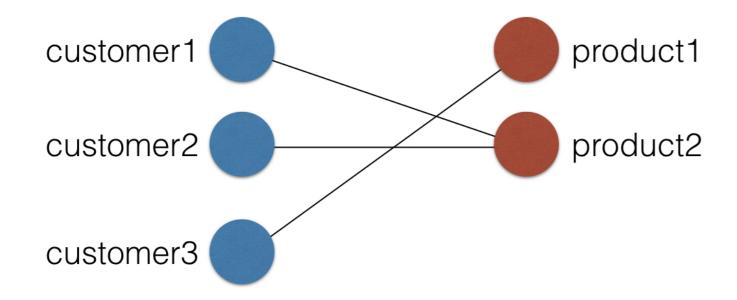


Bipartite graphs

- A graph that is partitioned into two sets
- Nodes are only connected to nodes in other partitions
- Contrast: "unipartite"



Bipartite graphs: Example





Bipartite graphs in NetworkX

```
import networkx as nx
G = nx.Graph()
numbers = range(3)
G.add_nodes_from(numbers, bipartite='customers')
letters = ['a', 'b']
G.add_nodes_from(letters, bipartite='products')
```

Bipartite graphs in NetworkX

```
G.nodes(data=True)
```

```
[(0, {'bipartite': 'customers'}),
  (1, {'bipartite': 'customers'}),
  (2, {'bipartite': 'customers'}),
  ('b', {'bipartite': 'products'}),
  ('a', {'bipartite': 'products'})]
```

Degree centrality

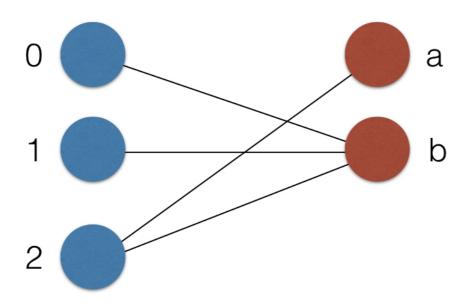
• Definition:

number of neighbors number of possible neighbors

Number of possible neighbors depends on graph type

Bipartite centrality metrics

• Denominator: number of nodes in opposite partition, rather than all other nodes



Filtering graphs

```
cust_nodes = [n for n, d in G.nodes(data=True) if
                  d['bipartite'] == 'customers']
cust_nodes
[(0, {'bipartite': 'customers'}),
 (1, {'bipartite': 'customers'}),
 (2, {'bipartite': 'customers'})]
nx.bipartite.degree_centrality(G, cust_nodes)
{0: 0.5,
1: 0.5,
2: 1.0,
 'a': 0.333,
 'b': 1.0}
```



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Bipartite graphs and recommendation systems

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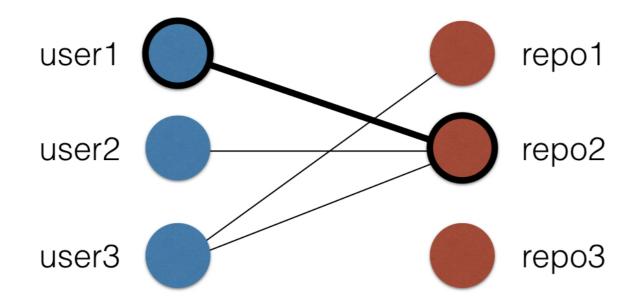
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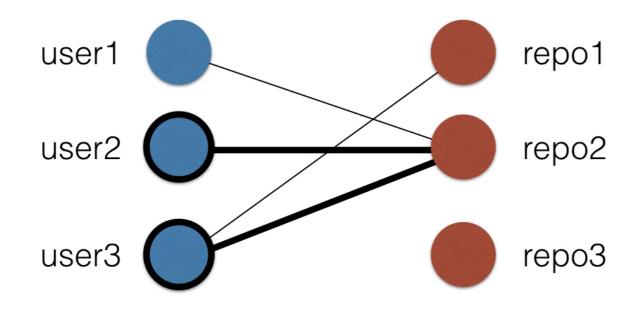
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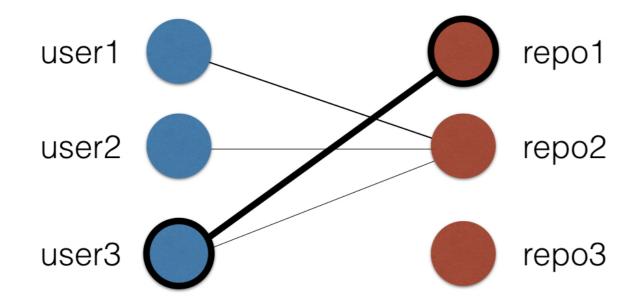




- Previously: Recommended users to connect with one another
- Graph: "unipartite" (or users-only) version
- Now: "bipartite" or (repo-users) version
- Recommending repositories for users to work on







Code: Node sets

```
G.nodes(data=True)
[('repo3', {'bipartite': 'repositories'}),
 ('repo1', {'bipartite': 'repositories'}),
 ('user1', {'bipartite': 'users'}),
 ('user2', {'bipartite': 'users'}),
 ('repo2', {'bipartite': 'repositories'}),
 ('user3', {'bipartite': 'users'})]
G.edges()
[('repo1', 'user3'),
 ('user1', 'repo2'),
 ('user2', 'repo2'),
 ('repo2', 'user3')]
```



Code: Node sets

```
user1_nbrs = G.neighbors('user1')
user1_nbrs
```

['repo2']

```
user3_nbrs = G.neighbors('user3')
user3_nbrs
```

```
['repo2', 'repo1']
```

Code: Node sets

```
set(user1_nbrs).intersection(user3_nbrs)

{'repo2'}

set(user3_nbrs).difference(user1_nbrs)

{'repo1'}
```



Let's practice!

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