Degree centrality

INTRODUCTION TO NETWORK ANALYSIS IN PYTHON

Eric Ma

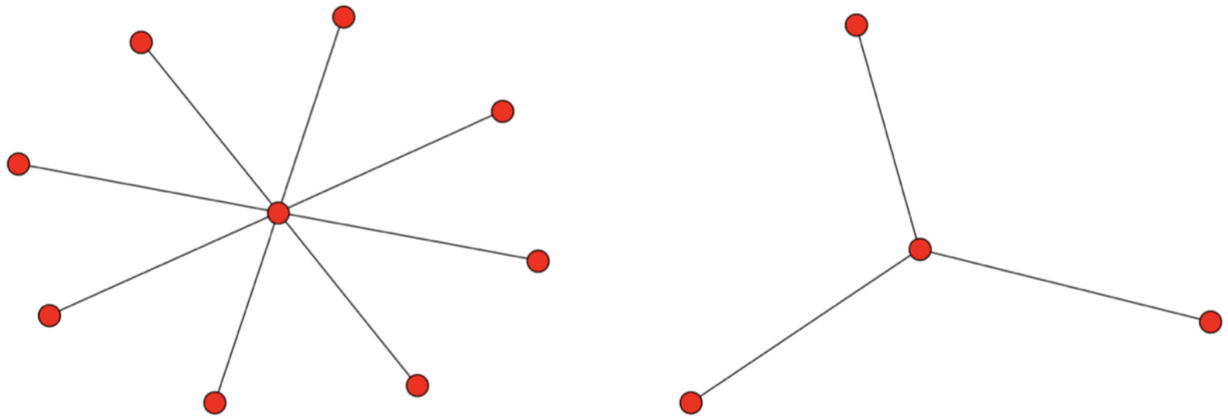
Data Carpentry instructor and author of nxviz package

Important nodes

- Which nodes are important?
  - Degree centrality
  - Betweenness centrality

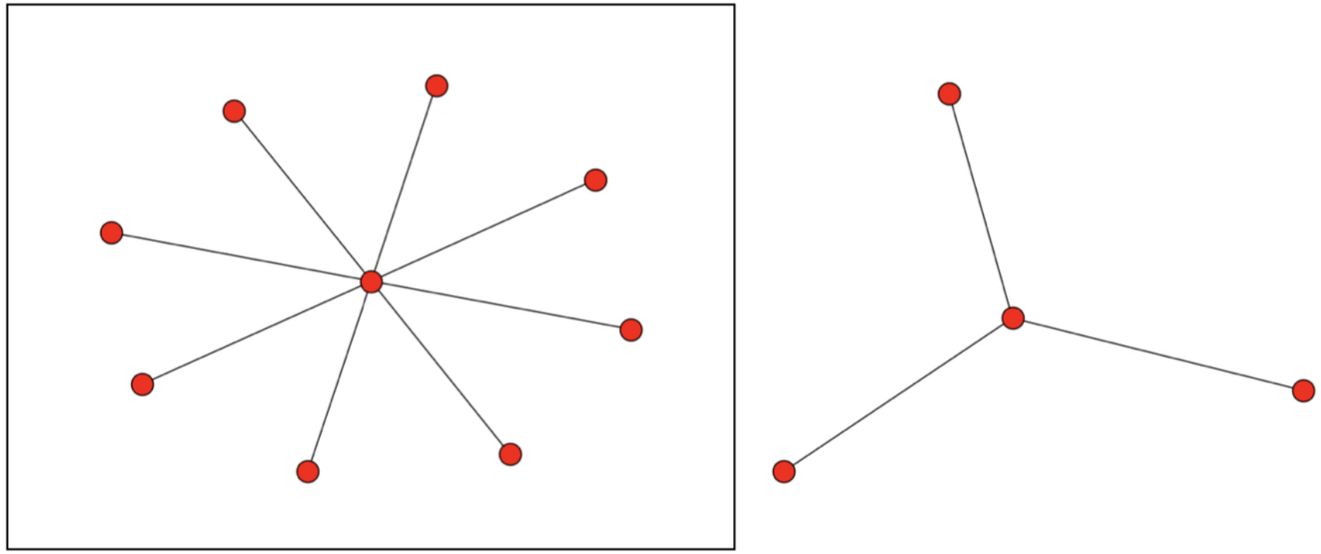
Important nodes

- Which center node might be more important?



Important nodes

Which center node might be more important?



Degree centrality

- Definition:

$$\frac{\text{Number of Neighbors I Have}}{\text{Number of Neighbors I Could Possibly Have}}$$

- Examples of node with high degree centrality:
  - Twitter broadcasters
  - Airport transportation hubs
  - Disease super-spreaders

Number of neighbors

```
G.edges()
```

```
[(1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (1, 7), (1, 8), (1, 9)]
```

```
G.neighbors(1)
```

```
[2, 3, 4, 5, 6, 7, 8, 9]
```

```
G.neighbors(8)
```

```
[1]
```

```
G.neighbors(10)
```

```
NetworkXError: The node 10 is not in the graph.
```

Degree centrality

```
nx.degree_centrality(G)
```

```
{1: 1.0,
 2: 0.125,
 3: 0.125,
 4: 0.125,
 5: 0.125,
 6: 0.125,
 7: 0.125,
 8: 0.125,
 9: 0.125}
```

Let's practice!

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Graph algorithms

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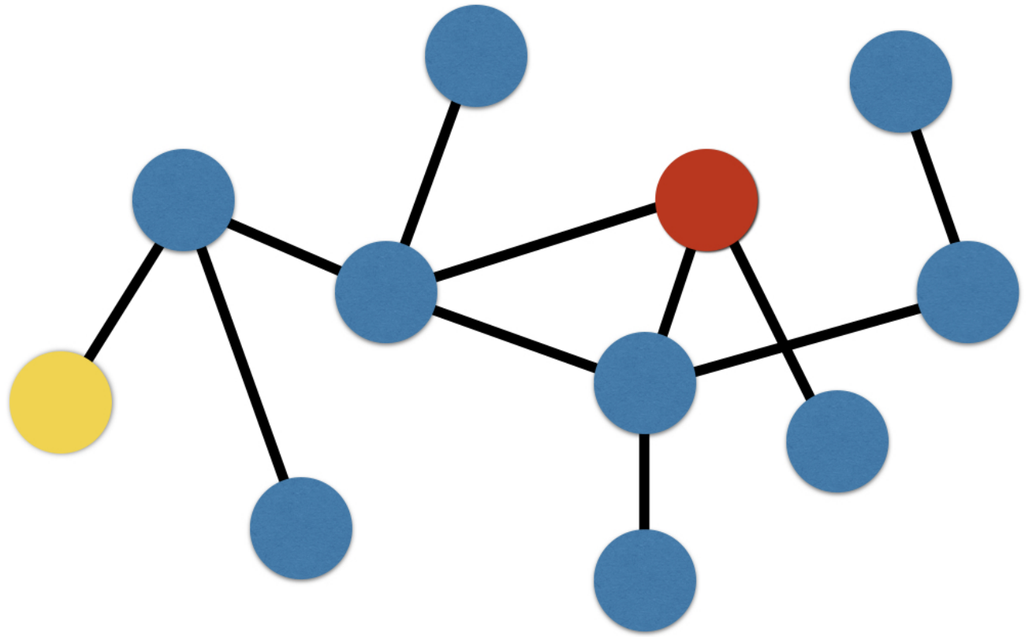
Finding paths

- Pathfinding is important for
  - Optimization: e.g. shortest transport paths
  - Modeling: e.g. disease spread, information passing
- Algorithm: Breadth-first search

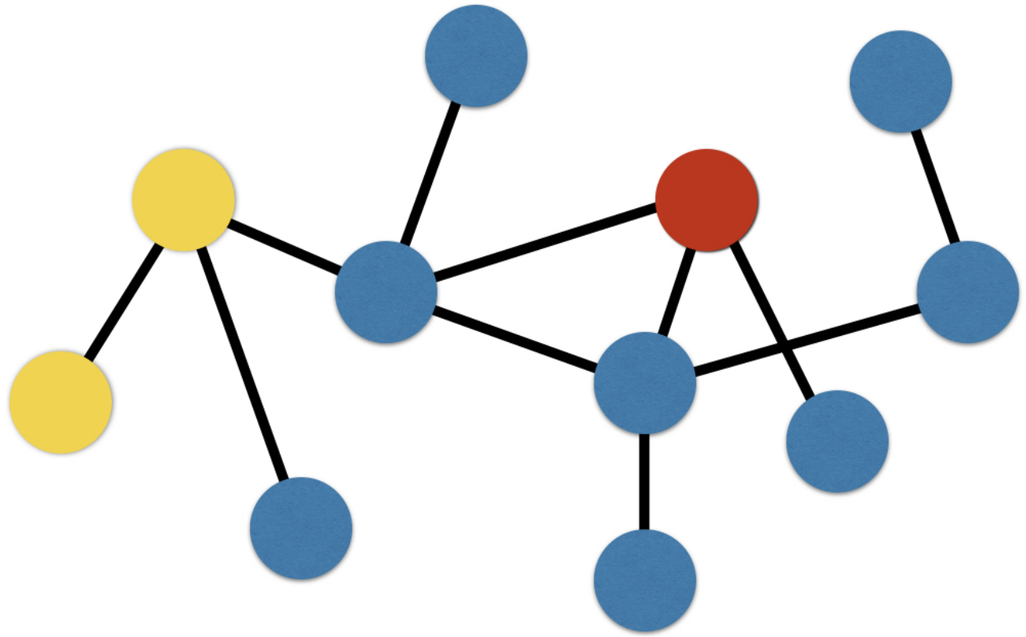
Breadth-first search (BFS)

- Example: Shortest path between two nodes



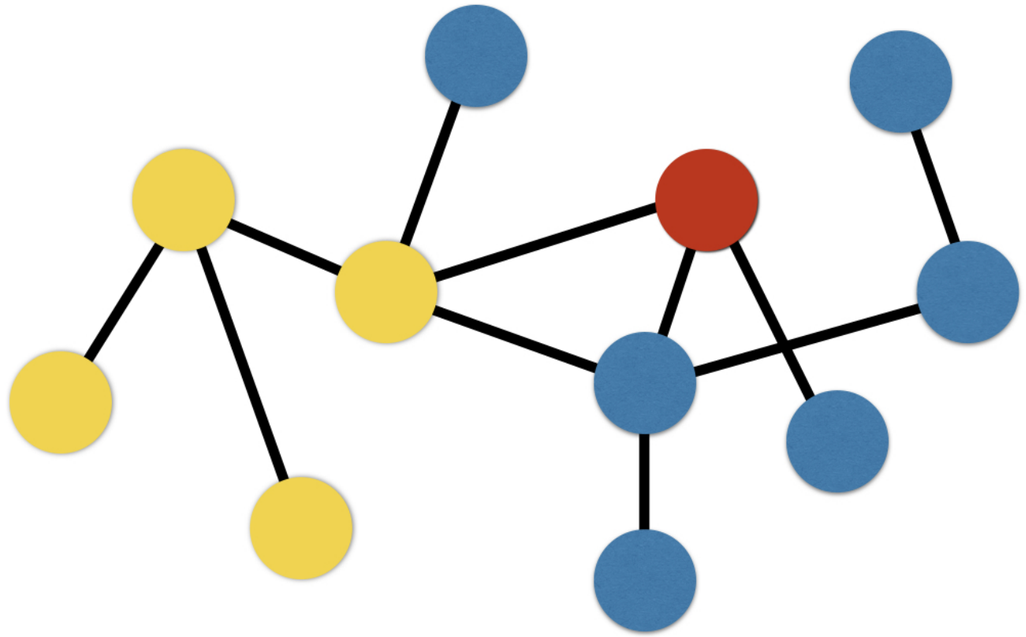
Breadth-first search (BFS)

- Example: Shortest path between two nodes



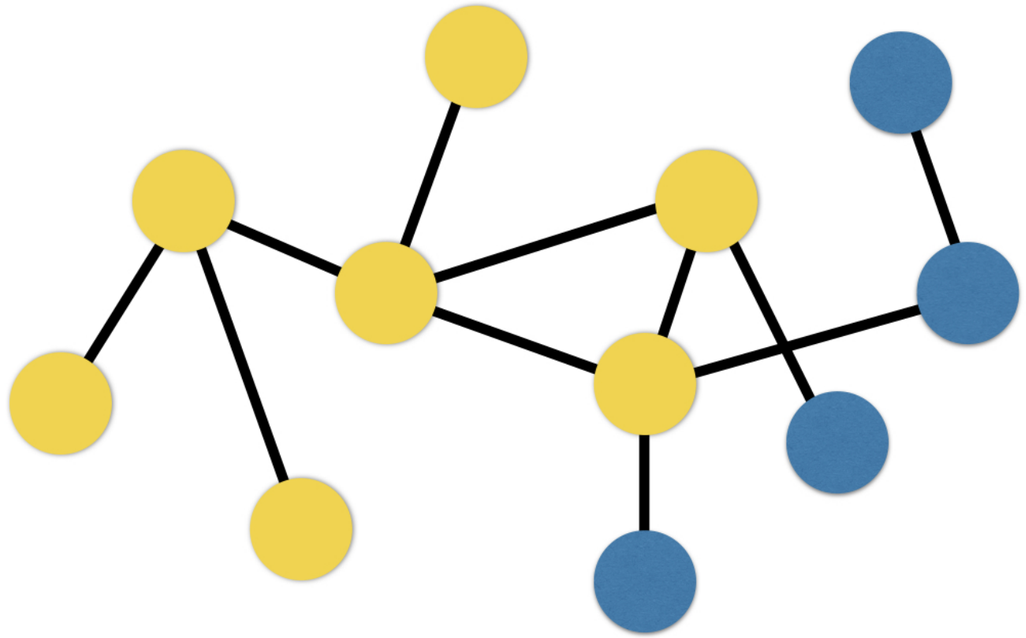
Breadth-first search (BFS)

- Example: Shortest path between two nodes



Breadth-first search (BFS)

- Example: Shortest path between two nodes



Recall: Neighbors

```
G
```

```
<networkx.classes.graph.Graph at 0x10cc08828>
```

```
len(G.edges())
```

```
57
```

```
len(G.nodes())
```

```
20
```

Recall: Neighbors

```
G.neighbors(1)
```

```
[10, 5, 14, 7]
```

```
G.neighbors(10)
```

```
[1, 19, 5, 17, 8, 9, 13, 14]
```

Let's practice!

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Betweenness centrality

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All shortest paths

- Set of paths
- Each path is shortest path between a given pair of nodes
- Done for all node pairs

Betweenness centrality

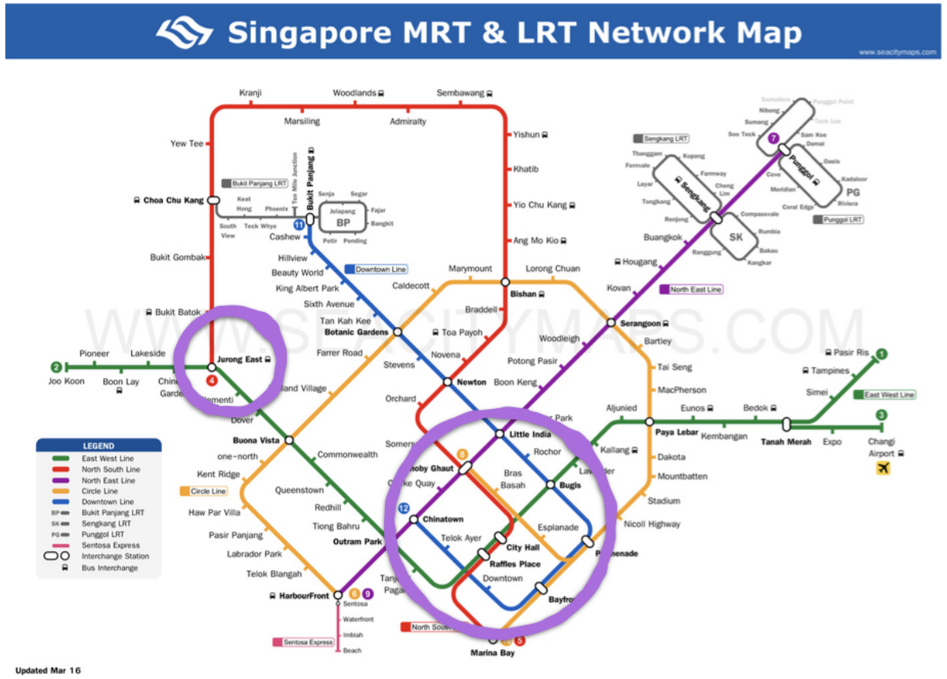
- Definition:

$$\frac{\text{num. shortest paths through node}}{\text{all possible shortest paths}}$$

- Application:
  - Bridges between liberal- and conservative-leaning Twitter users
  - Critical information transfer links

Examples

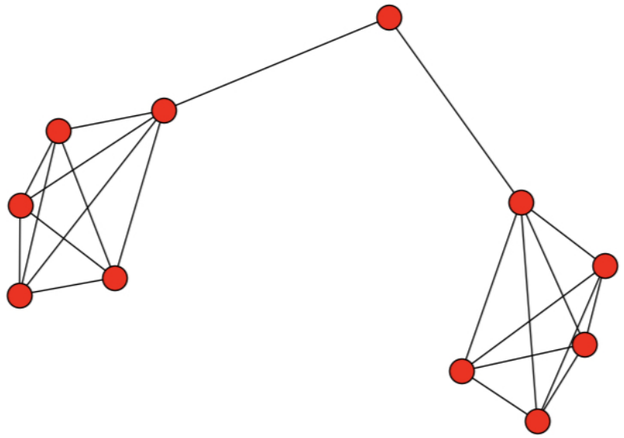
- Singapore: Raffles Place & Jurong East



[1] Source: http://www.seacitymaps.com/singapore/singapore_mrt_map.jpg

Example

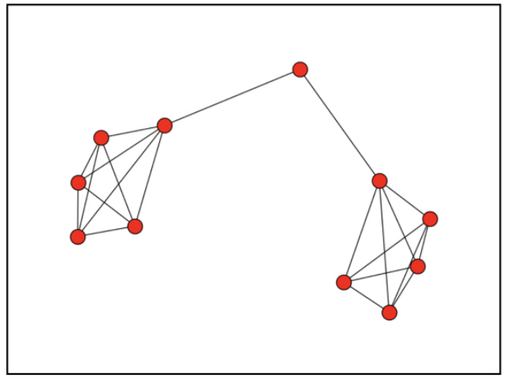
- High betweenness centrality, low degree centrality?



Betweenness centrality

```
import networkx as nx
G = nx.barbell_graph(m1=5, m2=1)
nx.betweenness_centrality(G)
```

```
{0: 0.0,
 1: 0.0,
 2: 0.0,
 3: 0.0,
 4: 0.5333333333333333,
 5: 0.5555555555555556,
 6: 0.5333333333333333,
 7: 0.0,
 8: 0.0,
 9: 0.0,
 10: 0.0}
```



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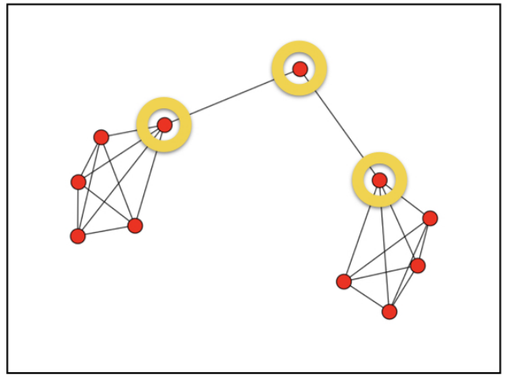

Let's practice!

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