Complex Networks: Quiz #5

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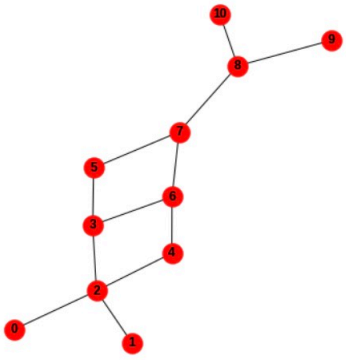
Problem 1

Make a program of computing (i) and (ii) of the following centralities (1-6). Show the code and its outputs.
(i) centrality values of all nodes in the right graph
(ii) the most central node
1. Degree centrality

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
#A = nx.adjacency_matrix(G).todense()
#A = np.array(A, dtype = np.float64)
#print("degree centrality:",list(nx.degree_centrality(G).values()))
v = list(nx.degree_centrality(G).values())
s = ("    degree centrality: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

```
    degree centrality: 0.10, 0.10, 0.40, 0.30, 0.20, 0.20, 0.30, 0.30, 0.30, 0.10, 0.10 biggest: 2
```



Answer 1

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
v = list(nx.degree_centrality(G).values())
s = ("     degree centrality: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

The result is:

```
     degree centrality: 0.10, 0.10, 0.40, 0.30, 0.20, 0.20, 0.30, 0.30, 0.30, 0.10, 0.10 biggest:
                                                                                          2
```

Problem 2

2. Betweenness centrality

Answer2

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
v = list(nx.betweenness_centrality(G).values())
s = ("     btweeenness centrality: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

The result is:

```
     btweeenness centrality: 0.00, 0.00, 0.40, 0.30, 0.12, 0.13, 0.34, 0.49, 0.38, 0.00, 0.00
                                                    biggest: 7
```

Problem 3

3. Closeness centrality

Answer3

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
v = list(nx.closeness_centrality(G).values())
s = ("     closeness centrality: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

The result is:

```
     closeness centrality: 0.29, 0.29, 0.40, 0.45, 0.42, 0.43, 0.48, 0.45, 0.37, 0.28, 0.28
                                                    biggest: 6
```

Problem 4

4. Eigenvector centrality

Answer4

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
v = list(nx.eigenvector_centrality(G).values())
s = ("     eigenvector centrality: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

The result is:

```
     eigenvector centrality: 0.16, 0.16, 0.42, 0.45, 0.33, 0.31, 0.44, 0.36, 0.20, 0.07, 0.07
                                                    biggest: 3
```

Problem 5

5. PageRank

Answer5

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
v = list(nx.pagerank(G).values())
s = ("     pagerank: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

The result is:

```
     pagerank: 0.05, 0.05, 0.16, 0.11, 0.08, 0.08, 0.11, 0.12, 0.14, 0.05, 0.05 biggest: 2
```

Problem 6

6. Katz centrality

Answer6

```
import networkx as nx
import matplotlib.pyplot as plt
import numpy as np
import pprint

G = nx.Graph()
G.add_nodes_from(range(0,10))
G.add_edges_from([(0,2),(1,2),(2,3),(2,4),(3,5),(3,6),(4,6),(5,7),(6,7),(7,8),(8,9),(8,10)])
plt.figure(figsize=(5, 5))
nx.draw_spring(G, node_size=400, node_color='red', with_labels=True, font_weight='bold')
v = list(nx.katz_centrality(G).values())
s = ("     katz centrality: "+', '.join(['%.2f']*len(v))) % tuple(v)
print(s, "biggest:", np.argmax(v))
```

The result is:

```
     katz centrality: 0.27, 0.27, 0.35, 0.33, 0.30, 0.30, 0.33, 0.33, 0.32, 0.26, 0.26 biggest: 2
```