# Algorithms and Applications in Social Networks
## HW #1

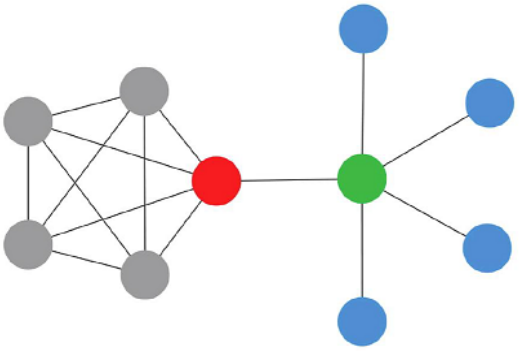
**Instructions:** Implementation should be done using Python and NetworkX library. Please submit your code in .py files (file per question) or .ipynb file (Jupyter Notebooks).
The theoretical part of the question should be submitted in a PDF file.
Do not forget to write IDs of all members in the team (pair). Submit only once per team!
Please ZIP all files together, name the file HW1_<student_id>.zip and upload it to Moodle.

### Question #1:

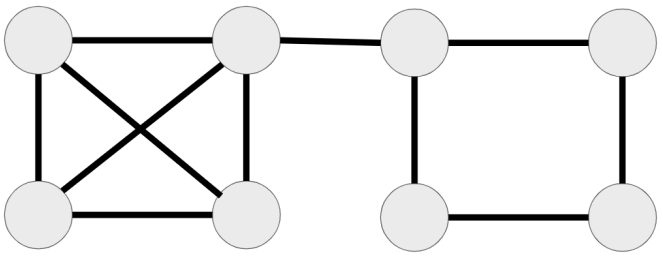
a. Implement the Watts–Strogatz model. Write a function that gets n, k and p returns a random graph according to the model.
b. Implement a function that computes the clustering coefficient of a given graph.

### Question #2:

a. Implement the Degree, Betweenness and Closeness centrality measures.
b. Run these measures on a random Gnp network with n=22 and p=0.3 and report top-3 nodes according to each of the measures.
c. Visualize this network using different centrality measures by changing node sizes based on the centrality measure value of each node.
d. Compute (manually) each of the centrality measures for red, green, blue and grey nodes.



e. Compute (manually) each of the centrality measures for the following graph:



Find the nodes that are symmetric (you can do it before the computation).

**Question #3:**

a. Implement check_balance(G) function that checks balance (according to “Theory of Structural Balance”) of a G. Explain your implementation decision.
b. Think about a real-world example of a signed social network (up to 10 nodes) that is balanced according to the “Theory of Structural Balance”. Present the network, explain the nodes and the edges. Show (by splitting it into two coalitions of by completing it) that the graph is balanced.
c. Visualize the network from (b) using different colors for positive and negative edges. Run the algorithm implemented in (a) to demonstrate that the network is balanced.
d. Find a number N>3 (one example is enough) for which a complete graph with N nodes is balanced and has three times more “+” edges than “-” edges.
e. Find a number N>3 (one example is enough) for which a complete graph with N nodes is balanced and has three times more “-” edges than “+” edges.

**Question #4:**

There is a random graph generated using the Erdős–Rényi model, with parameters N = 20 and p = 0.5. What is the expected number of triangles in this graph?

**Question #5:**

A group of n people are connected to each other, and using 2 ways of communications – phone and mail. Prove that they can decide to use only one of these two ways and still all of them will be reachable to each other (not necessarily directly connected).

**Question #6:**

There is a group of 6 people (some of them know each other). Prove that we can take three of them such that all of them know each other or do not know each other.