SSW810 Special Topics in Systems Centric Software Engineering
Fall 2022
Assignment #4
Due November 3, 6:30 pm

Please submit two files: (i) a single word document demonstrating the mathematical formulation for network flow problem and the network visualization (e.g., network display of your Python scripts) and (ii) a Python file for solving the model using Gurobi optimizer and visualizing the network using NetworkX library.

The purpose of this assignment is to give you the opportunity to practice and apply concept of network flow optimization and NetworkX library into a case study. This case study represents a randomly generated water network including set of supply nodes and demand nodes.

Refer to **node.csv, link.csv, and position.csv** files on assignment #4 and address the following questions:

1- Formulate the network flow optimization model such that:
   a. Decision variables represent the flow of water from supply nodes to demand nodes
   b. Constraints represent (i) supply constraints for supply nodes (ii) demand constraints for demand nodes, (iii) capacity constraints for links, and (iv) nonnegativity constraints
   c. Objective function seeks to minimize the cumulative weighted fraction of unsupplied demand
2- Create the appropriate data structures in Python by reading node.csv and link.csv files
3- Solve the network flow model using Python and Gurobi optimizer and find the optimum solution
4- Depict the water network using NetworkX library by considering the position of nodes (read position.csv file in your program)
   a. label all nodes (e.g., node numbers: 1, 2, …)
   b. Display supply nodes as green circles
   c. Display demand nodes as blue squares
5- Find degree centrality, closeness centrality, and betweenness for the water network. Sort nodes in descending order based on 3 centrality measures
6- Remove the first 5 nodes ranked based on degree centrality. Solve the model and find the optimum solution. Compare the results with respect to part (3) and make a discussion in 5 -10 sentences.