Assignment 2 : Design and Analysis of Algorithms

Due date : April 28,2016

General instructions :

- You may write your own code entirely or you may use snippets of code or libraries from some other sources, in such cases you are expected to clearly cite the source. It may especially be useful to use existing libraries for graph processing.
- You are expected to have a decent understanding and working knowledge of the code and should be comfortable showing a demo as well as giving an overview of different portions of the code.
- Marks will be awarded individually based on your overall understanding of the specific problems as well as related background.
- It may be useful for a member of a group to focus on one question. You can consult with other members, however it would be easier to show a demo/answer questions if you individually focus on one question. You will in any case be expected to have an understanding of the solutions to the other questions also.

Problems

The graph in the file bcsstk08.mtx needs to be used for question 1 and 2. This graph was downloaded from `https://www.cise.ufl.edu/research/sparse/matrices/list_by_id.html`. It is in Matrix Market format which is similar to edge list format, except that the first few lines are comments (these lines begin with a %), the first non-comment line contains number of rows and columns and the third entry is the number of edges. Each line contains an edge in the format
startId endId edgeWeight
For more details on Matrix Market format you may refer to `http://math.nist.gov/MatrixMarket/index.html`.

1. Compute the diameter of the largest **strongly connected component** of that graph. Recall that diameter is the length of longest shortest path.
2. In the same graph, ignore the edge directions, for the resulting undirected graph find the largest connected component and determine the minimum spanning tree.

3. Consider a set of employees and task preferences. Suppose the employees give a ranking of task preferences as stored in file taskPreferences.txt. Assume each employee has given upto a maximum of 4 preferences. For example if entry in row i column j is 2, it means that employee i opted for job j as his/her second preference.

   Compute the following :

   (a) If no employee is to be allocated a task lower than his/her second preference what is the maximum number of tasks that can be allocated.

   (b) Compute the best assignment of tasks to employees (if there exists one) such that most of employees get tasks among their top preferences. The overall measure of goodness of task assignment is the average preference = sum of preferences/number of employee-job allocations. Additionally the following criteria should be met :

   - An employee is assigned at least one task.
   - No employee is assigned more than two tasks.
   - All tasks are assigned to some employee.

4. Implement a branch and bound strategy for the following instance of the 0/1 knapsack problem. Recall that in a 0/1 knapsack problem, an object is fully selected or not. The weights and values are stored in the files p07_w_modified.txt and p07_p_modified.txt respectively. Assume the knapsack capacity is 800. This data was downloaded from `http://people.sc.fsu.edu/~jburkardt/datasets/knapsack_01/knapsack_01.html`. However the data was modified, also the capacity is different. Hence the solution to this problem with modified data would be different as compared to the one reported on this website.