CSE-321 (Fall 2014) Homework 3

1-) You are required to propose a polynomial-time heuristic algorithm for the SANTA CLAUS problem defined below. Your solution should be a heuristic solution. Brute force solutions will not be evaluated. We will evaluate your solution according to its quality. You need to explain your algorithm and the rationale behind it; i.e., for each step, explain why you designed it that way. You need to write your algorithm as a pseudocode, explain the pseudocode together with your justifications for your design. In your report, you also need to make a formal computational complexity analysis of your algorithm (in terms of big-Oh etc. notation).

Subsequently, you need to write a (small) java program that implements your algorithm.

The method that you need to implement in your program takes an mXn double array A ,where A[i][j] is the happiness of kid i when toy j is given and returns an array B whose length is m where B[k] is an array list of integers whose elements are the kth kids' toys. We will test and evalute your method with our own data.

The header of the method is given below:

```
//m is the number of children and n is the number of presents.

public static ArrayList<Integer>[ ] heuristicSantaClaus(double [ ][ ] A)
```

In addition to correctness, you also need to make a performance evaluation of your algorithm as follows:

Set the number of presents to 100 000. Vary the number of kids from 1000 to 10 000 with intervals of 10 (e.g. 1000, 1010, 1020, …., 10 000). In each experiment, each A[i][j] (happiness) value is a uniformly distributed random variable between 1 and 10. For each case, make 100 experiments and plot the sample mean of the minimum total happiness value as a function of the number of kids. Show your results as a Matlab figure and also as an Excel file attached to your report. The figure should be in your report, whereas the data should be as a separate Excel file.

In your report, make a discussion about the possible real-life applications of this problem. Your report and program are equally important and will be evaluated separately.

*Upload the .java file and documentation to moodle and bring your report to room 108.

1 Santa Claus Problem

In the Santa Claus Problem (see Fig.1), or Max-Min Allocation Problem, there are m children (later called players) and n presents (items), each item can be given to only one player. Each player has an evaluation of the items, and the goal is to find an allocation that maximizes the min value of happiness of players. More formally it is defined as:

Definition 1 (Santa Claus Problem). There are m players and n items, for every $i \in [m]$ and $j \in [n]$ the input specifies $v_{ij} \geq 0$, which is i-th player's evaluation of item j. An allocation is a function $f : [n] \to [m]$, $f(j) = i$ iff item j is given to player i. Player i's happiness is defined as $\sum_{j:f(j)=i} v_{ij}$, and the goal is to find an allocation that optimizes the value

$$\max_{f} \min_{i \in [m]} \sum_{j:f(j)=i} v_{ij}$$

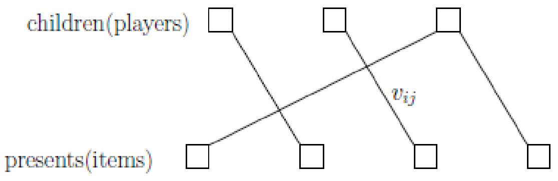

Figure 1: A Santa-Claus Instance