UNIVERSITY OF DAYTON
Department of Computer Science
CPS 530 - Algorithm Design
Fall 2024 Assignment 1 (100 pts)
Due: September 30, 2024 by 11:55pm

(50 pts)

1. Implement Gale-Shapley Algorithm for computing Stable Marriage Assignment in any language, such as ***Python, Java, C++ or MATLAB,*** using the approach and data structures described in the first two Chapters of the Kleinberg and Tardos text. The input file should include number of subjects, n, preference list for men and women one line for each.

$$n$$
$$m_1: w_{11}, w_{12}, \ldots, w_{1n}$$
$$\ldots$$
$$\ldots$$
$$m_n: w_{n1}, w_{n2}, \ldots, w_{nn}$$
$$w_1: m_{11}, m_{12}, \ldots, m_{1n}$$
$$\ldots$$
$$\ldots$$
$$w_n: m_{n1}, m_{n2}, \ldots, m_{nn}$$

   a) Write a function to create preference lists for men and women. Function should take number of men (women), say n, create preferences and output them.
   b) Write a function to check if there are any unstable pairs in a given match set and preference lists. Turn in sample inputs and corresponding outputs in separate files.
   c) Implement Gale-Shapley algorithm and run 5 times for n = 10 with different input files and plot the variation in the running time.
   d) Run the algorithm implemented 5 times for n = 10 with the same input file and plot the variation in the running time.
   e) Run the algorithm implemented 5 times for n = 10, 15, 20, 50, 100, and plot the average running time as a function of the problem input size (n).
   f) Run the algorithm implemented 5 times for n = 10 with the same preference lists, let a different man start proposing and output the matches created.

2. **(20 pts)**
   a. Run Gale-Shapley Algorithm manually (not your implementation) and show your steps using the preference lists tables below. Are there any unstable pairs in the final match?

   b. Modify Gale-Shapley Algorithm such that women will propose instead of men. Show the final match.

men's preference list

	1st	2nd	3rd	4th	5th
Victor	Bertha	Amy	Diane	Erika	Clare
Wyatt	Diane	Bertha	Amy	Clare	Erika
Xavier	Amy	Erika	Bertha	Diane	Clare
Yancey	Amy	Erika	Clare	Bertha	Diane
Zeus	Bertha	Amy	Erika	Clare	Diane

women's preference list

	1st	2nd	3rd	4th	5th
Amy	Xavier	Victor	Wyatt	Yancey	Zeus
Bertha	Xavier	Wyatt	Yancey	Victor	Zeus
Clare	Yancey	Zeus	Xavier	Wyatt	Victor
Diane	Victor	Zeus	Yancey	Xavier	Wyatt
Erika	Xavier	Wyatt	Zeus	Yancey	Victor

(15 pts)

3. Do Problem 3 in Chapter 2 on page 67 of the Kleinberg and Tardos text (given below). Provide a "clear" explanation in each case.

Take the following list of functions and arrange them in ascending order of growth rate. That is, if function $g(n)$ immediately follows function $f(n)$ in your list, then it should be the case that $f(n)$ is $O(g(n))$.

$$f_1(n) = n^{2.5}$$
$$f_2(n) = \sqrt{2n}$$
$$f_3(n) = n + 10$$
$$f_4(n) = 10^n$$
$$f_5(n) = 100^n$$
$$f_6(n) = n^2 \log n$$

(15 pts)

4. Do Problem 1 in Chapter 3 on page 107 of the Kleinberg and Tardos text (given below). Look at solved exercise 1 on page 104 as an example.

   Consider the directed acyclic graph G in Figure 3.10 below. How many topological orderings does it have?

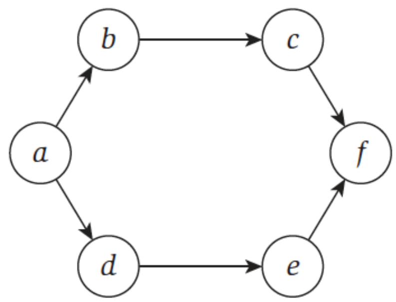

Figure 3.10 How many topological orderings does this graph have?

<u>NOTE:</u> You can write your answers for the questions 2 through 4 on paper, scan and create a pdf file.

TURNIN:

- Bundle your source code, sample inputs/results, timing plots and answers of each question as a single zip archive, name it using ”lastname-firstname” format, and submit to Isidore by the deadline. Any late date after the deadline, up to 5 days, will cost you 10 points/day. No submission will be accepted after 5 days after the deadline.

- Make sure you submit all the required items. You are responsible what you are submitting. No missing part of the homework can be resubmitted after the deadline.