

**UNIVERSITY OF DAYTON**  
**Department of Computer Science**  
**CPS 530 - Algorithm Design**  
**Fall 2021 Assignment 1 (100 pts)**  
**Due: September 29, 2021 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.

$$\begin{array}{c} n \\ m_1: w_{11}, w_{12}, \dots, w_{1n} \\ \dots \\ m_n: w_{n1}, w_{n2}, \dots, w_{nn} \\ w_1: m_{11}, m_{12}, \dots, m_{1n} \\ \dots \\ w_n: m_{n1}, m_{n2}, \dots, m_{nn} \end{array}$$

- 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 the output, explicitly checking to see that it is a stable match (It requires a separate function to check). Turn in sample inputs and corresponding outputs in separate files.
- c) Run the algorithm on several instances of the problem for  $n = 10$  with different input files and plot the variation in the running time.
- d) Run the algorithm on several instances of the problem for  $n = 10$  with the same input file and plot the variation in the running time.
- e) Run the algorithm on problem instances with  $n = 10, 15, 20, 50, 100$ , and plot the average running time as a function of the problem input size ( $n$ ).
- f) Run the algorithm on several instances of the problem for  $n = 10$  with the same input file, let a different man start proposing and output the matches.

## 2. (20 pts)

- Run Gale-Shapley Algorithm and show your steps using the preference lists tables below. Are there any unstable pairs in the final match?
- Modify Gale-Shapley Algorithm such that women will propose instead of men. Show the final match.
- Compare and discuss the matches produced above in terms of men-optimality/women-pessimality and women-optimality/men-pessimality.

men's preference list					
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>
Victor	Bertha	Amy	Diane	Erika	Clare
Wyatt	Bertha	Amy	Diane	Erika	Clare
Xavier	Bertha	Erika	Clare	Diane	Amy
Yancey	Amy	Diane	Clare	Bertha	Erika
Zeus	Bertha	Diane	Amy	Erika	Clare

women's preference list					
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>
Amy	Zeus	Victor	Wyatt	Yancey	Xavier
Bertha	Xavier	Wyatt	Yancey	Victor	Zeus
Clare	Wyatt	Xavier	Yancey	Zeus	Victor
Diane	Wyatt	Xavier	Yancey	Zeus	Victor
Erika	Yancey	Wyatt	Zeus	Xavier	Victor

## (15 pts)

- 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  $O(g(n))$ .

$$f_1(n) = n^{2.5}$$

$$f_2(n) = \sqrt{2n}$$

$$f_3(n) = n + 10$$

$$f_4(n) = 10^n$$

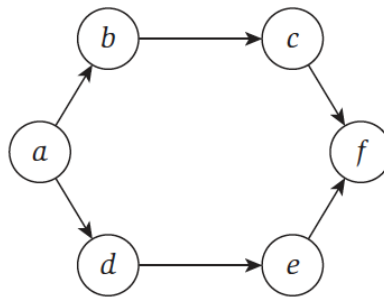
$$f_5(n) = 100^n$$

$$f_6(n) = n^2 \log n$$

**(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.

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



**Figure 3.10** How many topological orderings does this graph have?

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.