

# CSE 373 18AU: Practice Exam

Name:

UW email address:

## Instructions

- **Do not start the exam until told to do so.**
- You have 110 minutes to complete the exam.
- This exam is closed book and closed notes.
- You may not use a calculator, cell phone, or any other electronic devices.
- Write your answers neatly in the provided space.  
Be sure to leave some room in the margins: we will be scanning your answers.
- If you need extra space, use the back of the page.
- If you have a question, raise your hand.
- **Unless specified, when asked for a runtime give the worst-case tight big- $\mathcal{O}$  bound.**

Question	Points	Question	Points	Question	Points
1	4	3	8	5	5
2	6	4	8	6	6
Total:	10	Total:	16	7	8
				8	6
				Total:	25

## Advice

- Read questions carefully. Understand a question before you start writing.
- Write down thoughts and intermediate steps so you can get partial credit.
- The questions are ordered roughly in the increasing order of difficulty.
- Relax. You are here to learn.

## Warmup

This part will test some of the basic concepts in the course. This section has multiple choice questions, and short-answer questions.

1. For each of the following questions, choose the best (most correct) option, unless stated otherwise explicitly. (*1 point per question.*)
  - (i) How many MSTs can a graph have?
    - A. 0
    - B. 1
    - C. 0 or 1
    - D. 0 or 1 or more (depends on the graph)
  - (ii) Stack is also called as
    - A. Last in first out
    - B. First in last out
    - C. Last in last out
    - D. First in first out
  - (iii) To represent hierarchical relationship between elements, which data structure is suitable?
    - A. Dequeue
    - B. Priority
    - C. Tree
    - D. Graph
  - (iv) Which of the following is a good criteria to resize an open addressing hash table that uses quadratic probing for resolving collisions.
    - A.  $0 \leq \lambda < 0.25$
    - B.  $0.25 \leq \lambda < 5$
    - C.  $0.5 \leq \lambda < 0.75$
    - D.  $0.75 \leq \lambda < 1$

### 2. Short answer questions

Use the provided underlined space on the right to write your answer.

- (i) (*5 points*) Give worst-case tight big- $\mathcal{O}$  bound for the following.

a. Insertion sort

a. \_\_\_\_\_

b. Merge sort

b. \_\_\_\_\_

c. Heap sort

c. \_\_\_\_\_

d. Quick sort

d. \_\_\_\_\_

e. Selection sort

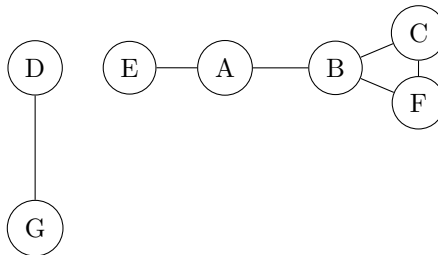
e. \_\_\_\_\_

- (ii) (1 point) Consider the following disjoint set. Suppose we do `union(1, 2)` using union-by-rank optimization. In the resulting union tree, how many nodes would point directly to node 4?



(ii) \_\_\_\_\_

- (iii) Consider the *undirected, unweighted* graph below.



- What is the maximum *degree* of the graph?  
a. \_\_\_\_\_
- Are there any cycles? If so, where?  
b. \_\_\_\_\_
- What is the maximum length simple path in this graph?  
c. \_\_\_\_\_
- What is the one edge that you could add to the graph that would increase the length of the maximum length simple path of the new graph to 6?  
d. \_\_\_\_\_
- What are the *connected components* of the graph?  
e. \_\_\_\_\_

## Basic

This part will test your ability to apply basic techniques covered in lecture and reinforced through sections and homeworks. Remember to show your work and justify your claims.

3. For each of the following questions, choose the best option (most correct).
- (i) (1 point) Dijkstra's algorithm will always return an incorrect path if the graph contains negative-length edges. Is this statement true or false?
    - A. True
    - B. False
  - (ii) (2 points) Suppose you have an directed graph containing  $|V|$  nodes. What is the maximum number of edges you can add to this graph while maintaining it acyclic? (Assume that you are not allowed to add parallel edges.)
    - A.  $|V|$
    - B.  $|V|(|V| - 1)/2$
    - C.  $|V|(|V| + 1)/2$
    - D.  $|V|^2$
  - (iii) (2 points) If you insert 16 elements in an empty BST, what are the possible heights of the resulting BST?

True or False

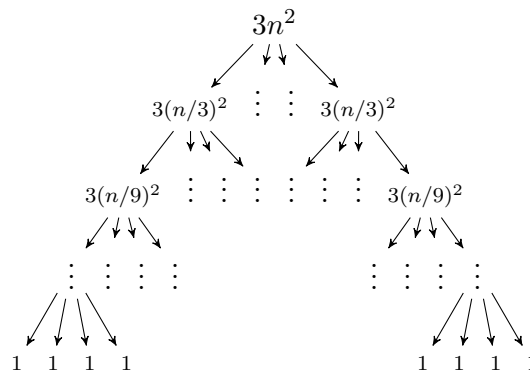
- (iv) (1 point) We can always sort some list of length  $n$  in  $\mathcal{O}(n)$  time.
  - A. True
  - B. False
- (v) (1 point) Iterating over a list using the iterator is always faster than iterating by repeatedly calling the `get()` method.
  - A. True
  - B. False
- (vi) (1 point) Dijkstra's algorithm will always return the incorrect result if the graph contains negative-length edges.
  - A. True
  - B. False

## 4. Tree recurrence

(i) (4 points) Draw the first three levels of the recurrence tree for this following recurrence

$$T(x) = \begin{cases} 1 & \text{if } x = 1 \\ T(n/2) + T(n/3) + n & \text{otherwise} \end{cases}$$

(ii) (4 points) Write the recurrence for this following recurrence tree





7. Frodo and Sam are on their way to Mordor to destroy the ring, and along their path they have to pass through several human villages on their way, some of which are now deserted and likely Orc territory. They learn that there are some paths that are being heavily guarded by Orcs, and they want to avoid those paths at all costs. Friendly spies tell Frodo and Sam that they should avoid the road between two deserted villages, as it is more likely be monitored by Orcs.

(i) (*4 points*) How would you represent a graph to capture this problem.

- What are your vertices and edges?
- What information would you store for each vertex and each edge?
- Is the graph directed/undirected, weighted/unweighted?
- Are there any self-loops? Parallel edges?

(ii) (*4 points*) How should Frodo and Sam find the shortest and safest path to Mordor? State the runtime of your solution.

8. (*6 points*) Suppose you have a bunch of computers networked together (haphazardly) using wires. You want to send a message to every other computer as fast as possible. Unfortunately, some wires are being monitored by some shadowy organization that wants to intercept your messages.

After doing some reconnaissance, you were able to assign each wire a “risk factor” indicating the likelihood that the wire is being monitored. For example, if a wire has a risk factor of zero, it is extremely unlikely to be monitored; if a wire has a risk factor of 10, it is more likely to be monitored. The smallest possible risk factor is 0; there is no largest possible risk factor.

Implement an algorithm that selects wires to send your message such that (a) every computer receives the message and (b) you minimize the total risk factor. The total risk factor is defined as the sum of the risks of all of the wires you use.