Montana State University Computer Science Department

Graduating Senior Exam

Spring Semester 2022, 80 minutes.

Your performance helps us assess how well we are meeting our stated learning outcomes for computer science majors. To pass this exam, spend at least 45 minutes in order to provide a carefully reasoned answer to each question. This information will help us make improvements.

Name Kolson Mendelsohn

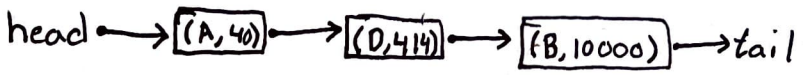
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer service team needs a way to find the most urgent ticket in the system and remove it when it has been addressed. New tickets can arrive at any time.

a) What simple data structure would best model this situation? Explain.

A Queue... more specifically, a priority queue. Queues and stacks are both effective data structures when dealing with a customer/transaction based system. In this case, a priority queue would allow us to implement the urgency system while maintaining the typical FIFO setup of a customer/transaction based system.

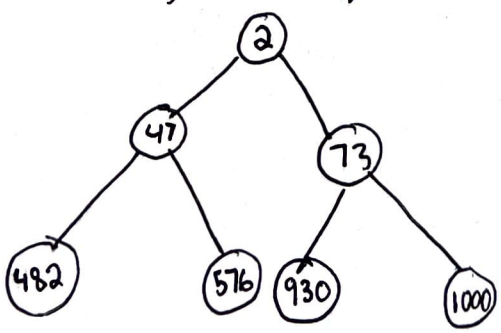
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

A priority queue could be implemented using a linked list where each node is a customer/purchase and the associated priority.



c) Describe a second way in which this data structure could be implemented and draw a picture of that data structure.

A priority queue could also be implemented using a min-heap (assuming lower urgency number equates to higher priority)



Question 2: Write a function in a language of your choice that has two parameters: a string and a character. The function should return the number of times that the character occurs in the string.

Your language of choice (e.g. Python): Python

Your solution:

```
def char_count(string, character):
    count=0
    for i in range(0, len(string)):
        if string[i] == character:
            count += 1
    return count
```

Question 3: Consider a singly linked list that contains **n** floating point numbers and is maintained in ascending order. An additional **k** floating point numbers will be added to the list, one at a time. You may assume that **k << n**.

Best case time complexity of algorithm:

$\Theta(n)$

Explanation of best case time complexity:

In the best case scenario, the list of k floating point numbers will already be sorted. This means that inserting the new elements into the linked list will be defined entirely by the length of the list for time complexity. In other words, the time it takes to complete the process will increase linearly relative to the number of elements being inserted.

and all be less than the current list

Worst case time complexity of algorithm:

$\Theta(n^2)$

Explanation of worst case time complexity:

In the worst case scenario, the list of numbers will be unsorted and inserted into the singly linked list in various locations. Not only would the time depend on the length of the list of new numbers, but it would also depend on the length of the singly linked list. As the singly linked list grows, the time it takes to traverse it grows linearly. Therefore, two linear operations for each element results in $\Theta(n^2)$ time complexity.

Question 4: List any extracurricular community involvement (e.g. the Gallatin Valley Food Bank or coaching), extracurricular university involvement (e.g. Engineering Ambassadors, Swing Cats, AWC or ACM) or paid internships (e.g. Workiva intern or Undergraduate Course Assistant) that you were involved with during your time at MSU. For each activity, (1) **provide** the name of the organization, (2) **describe** briefly your main activities and (3) **estimate** the total number of hours you spent.

Organization	*Main Activities*	*Hours Spent (estimate)*
Air Force ROTC	Cadet Leadership	20/week
Montana State ResLife	Housing Ambassador	20/week

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias is any programming component that has a specific or deliberate adverse effect on any specific group of people.

b) Provide a hypothetical example of how algorithmic bias could manifest itself in college admissions software.

A college admissions system that sorts applicants by gender and then examines/admits applicants from the beginning of the list. This would have a bias against certain gender groups who may be sorted to the rear of the list.

Question 6: In 2010 Oracle sued Google claiming copyright and patent infringement for 11,500 lines of Java API copied code. Google used this small subset of code from the JAVA API for their mobile platform operating system. Pick a side (Google or Oracle) to win this lawsuit and explain 3 possible impacts to the computing industry of this win.

Side you choose to win: Oracle

First possible impact:
Opens the door for companies to copyright all of their code which would eventually lead to no further possible software development.

Second possible impact:
Invites other companies to inspect Google code and potentially file further lawsuits.

Third possible impact:
Could lead to development delays in Google products that would likely have ripple effects to this day.

Question 7: In the ACM Code of Ethics and Professional Conduct, one ethical principle stated is to ***avoid harm***. Describe three different types of harm that the software of an autonomous, self-driving car might cause.

First type of harm:
Physical harm to humans or animals that the car either can't identify or is unable to react to.

Second type of harm:
Harm to the environment in circumstances that a car has not been programmed to handle or is unable to react to.

Third type of harm:
Emotional or mental harm to individuals that are triggered by (PTSD or otherwise) certain driving habits/styles.

Question 8: Describe your one-year plan following graduation. If you plan to work, list where you have applied (the company and the position) and mention whether you have received any offers. If you plan to go to graduate school, list where you have applied (the school and the area of study) and mention whether you have received any acceptances.

One year after I graduate, I will be attending Air Force Pilot Training. I have no immediate plans to fill the gap between graduation and pilot training.

Question 9: List any organized social activities that you were involved with during your time at MSU. For each activity, (1) **provide** the name of the organization, (2) **estimate** the total number of hours you spent.

Organization Name	*Hours Spent (estimate)*
None	—

Question 10: List any activities that you were involved with during your time at MSU that prepared you to work more effectively with teammates whose backgrounds are significantly different than your own. For each activity, (1) **describe** the activity and (2) **estimate** the total number of hours you spent.

Activity Description	*Hours Spent (estimate)*
Air Force RoTC	20/week
Residence Life	20/week

Question 11: Name the most sophisticated version control system that you use and describe three nontrivial features it has.

Name of most sophisticated version control system:

Git

Non-trivial feature 1:

Pull requests

Non-trivial feature 2:

Mirroring

Non-trivial feature 3:

Branching

Question 12: During your time at MSU, list any major non-classroom, non-paid activities that you engaged in to help prepare for your computer science career. For example, you might have taught yourself a programming language or attended a workshop on a CS topic. For each activity, **estimate** the number of hours spent.

Activity Description	*Hours Spent (estimate)*
Attended AI Symposium	2
Tutoring (Non-paid)	40

Best wishes wrapping up the semester and in the future!