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 Joshua Anderson

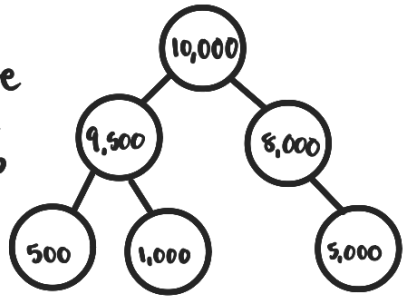
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer 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.

I would choose a heap because it'll allow us to sort by urgency and sorts relatively quick at O(nlogn)

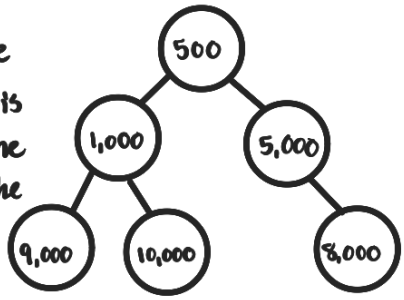
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

One implementation could be a Max Heap where the most urgent tickets are towards the root. When you remove the most urgent ticket, swap it with the most recently added ticket, pop it off, and then resort the Max Heap to find the next most urgent ticket.



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

Another implementation could be a Min Heap where the least urgent tickets are towards the root. In this case, in order to remove a node you could just pop one of the bottom right branch tickets since they'll be the most urgent. One problem with this implementation is that it doesn't guarantee that'll you'll get the most urgent ticket. To balance this out though, since you take from the bottom, you'll have to sort the tree less.



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 countoccurrence (str, char):
    return str.count(char)
```

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:

$O(k \cdot 1)$

Explanation of best case time complexity:

The best case would be if the added k nodes are in descending order and all are less than the current n nodes that are in ascending order.

Ex: n = 5 → 6 → 7 n+k[0] = 3 → 5 → 6 → 7 ← In order to add every node in k, you just add it to the front of n nodes already in the list.

k = 3 → 2 → 1 k = 2 → 1

n+k = 1 → 2 → 3 → 5 → 6 → 7

Worst case time complexity of algorithm:

$O(k \cdot n)$

Explanation of worst case time complexity:

The worst case would be if the added k nodes are in ascending order and all are greater than the current n nodes that are in ascending order.

Ex: n = 5 → 6 → 7 n+k[0] = 5 → 6 → 7 → 8 ← In order to add every node in k, you have to traverse the n nodes already in the list.

k = 8 → 9 → 10 k = 9 → 10

n+k = 5 → 6 → 7 → 8 → 9 → 10

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)*
University Student Housing	Resident Advisor. Mentored 50+ freshmen students.	1500+ hrs
Undergrad Course Assistant	CSCI 127. Led a weekly lab and graded assignments.	80 hrs
CS Success Center Tutor	Helped students with CS questions weekly.	48 hrs
Zoot Enterprises Intern	Microservices. Created data provider connections.	500 hrs

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias is the use of a specific algorithm(s) in software in order to target an unfair outcome.

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

Algorithmic bias could find itself in college admissions software where an algorithm sends targeted marketing to prospective students of a specific race or ethnicity, thus making it unfair for those not of the specified race or ethnicity to receive marketing.

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:

Copyright laws on code and APIs specifically would stricten.

Second possible impact:

Google's mobile platform would have been halted or needed to be redone.

Third possible impact:

Larger corporations would have a stronger monopoly on the market since they would have more control over who could use their software/code.

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. The software of the autonomous, self-driving car could malfunction leading to a car wreck which could injury or kill many individuals.

Second type of harm:

Mental harm. Nowadays, anxiety is a big problem in society. With the software of autonomous, self-driving cars, users are less in control. This could make a extremely difficult task for anyone not willing to trust the software. Thus, eliminating the use of a car for that individual which isn't really plausible in today's society.

Third type of harm:

Behavioral harm. The more common the software becomes, the more miss-use of it will occur. For example, drivers might be more willing to sleep or not pay attention to the road if they have access to the software.

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.

My plan after graduation is to work.

Places Applied:

Sofi - Full Stack Software Engineer - No Offer
Zoot Enterprises - Microservices Developer - Full Time Offer *accepted

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)*
LEGO Robotics League Comp Volunteer	8 hrs
Yellowstone Royale Volunteer	6 hrs
Hyalite Hall Events (too many to list)	200+ hrs

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)*
Resident Advisor	1500+ hrs
EGEN 310 Project	20 hrs
Mental Health Training w/ CPS	12 hrs

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:

GitHub

Non-trivial feature 1:

Setting up an upstream that differs from repository you push/commit to.

Non-trivial feature 2:

Merges. Having to go into different apps to workout merges.

Non-trivial feature 3:

Commit then push. To someone new to Git, this is confusing at first.

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)*
Hackerrank Activities	20 hrs
Taught myself C# for Capstone Project	8 hrs
Learned Linux on my own system	8 hrs

Best wishes wrapping up the semester and in the future!