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 __Caden Senitte_____

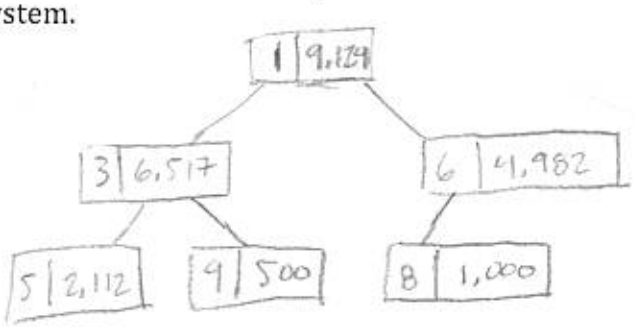
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer 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 simple data structure that would best model this situation would be a priority queue. This would be the best option because we would be able to pass in key value pairs and index through the queue based on the priority, or in this case, the urgency score of each ticket.

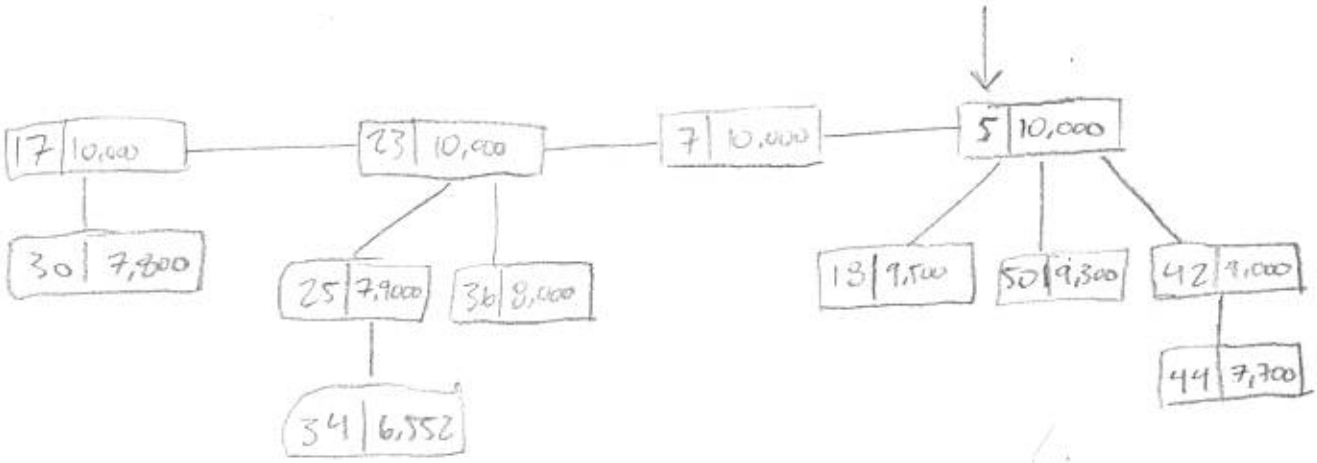
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

On way in which this data structure of a priority queue could be implemented is through a binary heap. This could be represented as a complete tree with parent, child, and weighted nodes. Using either a heap sort algorithm or Dijkstra's algorithm, we would be able to implement and execute the priority queue for the ticketing system.



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

Another way that this data structure could be implemented is through a Fibonacci heap. This is set up somewhat similar to the last structure, except the time complexity differs and there are more possibilities for the tree/graph



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 question(word, character):
    count = 0
    for i in range(len(word)):
        if word[i] == character:
            count += 1
    print(count)

question("i live in hawaii", "i")
```

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(1)

Explanation of best case time complexity:

The best case time complexity of the linked list algorithm is O(1) because we are adding k to the list and it is one at a time and linear, therefore the best and worst cases are going to both be linear.

Worst case time complexity of algorithm: O(1)

Explanation of worst case time complexity:

The worst case time complexity of the linked list algorithm is O(1) because we are adding k to the list and it is one at a time and linear, therefore the best and worst cases are going to both be linear.

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)*
ACM	Served as Treasurer for 2020-2021	25
Cru	Served as community group leader and mentor 2018-2022 Co-Student President 2021-2022	350
TechLink Systems Admin Intern	Worked alongside development Team in troubleshooting and testing. Built and maintained company systems through lifecycle. Helped choose a new database system for economic research team. Rebuilt the Technology Transfer Office's website.	530

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias is error in a system or artificial intelligence that treats people unfairly for attributes such as race, gender, etc.

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

Let's say that for a college admission's software program, the algorithm is meant to take in the applicant's information and suggest either to admit them to, or deny them from the university. However, this software algorithm was modeled after a military admissions software for Special Forces programs. The algorithm is used to predicting and admitting more men into the program than women, based on certain criteria. If given time and a bad base data set, we could see this algorithm begin to admit more men into the college than women.

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: Google

First possible impact: Allows open-source to remain open-source. Would be a big win for developers and innovation. Opens the door for new technologies from anyone and anywhere as opposed to more monopolies.

Second possible impact: Would be a big win for consumers to have larger say on new technologies. Especially, if there is algorithmic bias present, it would make it easier for someone to challenge that technology in court.

Third possible impact: Sets precedent for future cases involving the grey line of what can be considered copywrite-able and what cannot.

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 obvious one is, what if there is a bug? What if the software has an unintended error while driving? This can cause major physical harm to drivers and pedestrians.

Second type of harm: Financial/Economic harm. If autonomous vehicles took over the roads, there would be an enormous shortage of jobs and economic cash flow. Almost 10% of the United States workforce is in the transportation industry. This would

centralize and monopolize that industry and leave a large portion of the American economy in a few people's hands as opposed to keeping hard-working people on the roads with jobs.

Third type of harm Psychological harm: If autonomous vehicles became a normality in our culture, there would be a huge shift in how people's brains work and think about everyday things. We already live in a society where many people feel entitled and lack work ethic. Just think the harm to society that being driven around all day would do for people's minds.

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 one-year plan following graduation is to begin working. I applied to Software Engineer positions at Zoot and onX, both of which were denied due to timing. I applied for a Cloud DevOps Engineer position with the United States Geological Survey and was offered the position if I held out on other offers until this spring. I couldn't afford to do that, and at the same time had applied to Atrium AI and was offered a position as a software developer in the new-hire program. I begin work this summer at Atrium here in Bozeman and am extremely excited for it.

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)*
ACM	25
Cru	300

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)*
ACM	25
Cru	300

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: Collaboration. With git, I am able to easily collaborate with team members on a single repo or branches without having to worry about code missing or conflicting.

Non-trivial feature 2: Sharing data. I am able to allocate more space on different branches for more complex tasks or versions.

Non-trivial feature 3: It's scalable. I am able to scale projects from nothing into something quite large which wouldn't be possible without the many features and tools that Git and Github have to offer.

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)*
ACM	25

Best wishes wrapping up the semester and in the future!