Montana State University Computer Science Department

Graduating Senior Exam

Fall Semester 2021, 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 *Bowen Kruse*

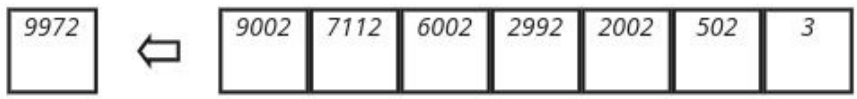
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer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

The data structure that best models this situation is a priority queue. The priority value in this situation would be the urgency score, thus those with most urgent tickets would be addressed or 'dequeued' first. Furthermore either of the below implementations would allow easy insertion or creation of new tickets.

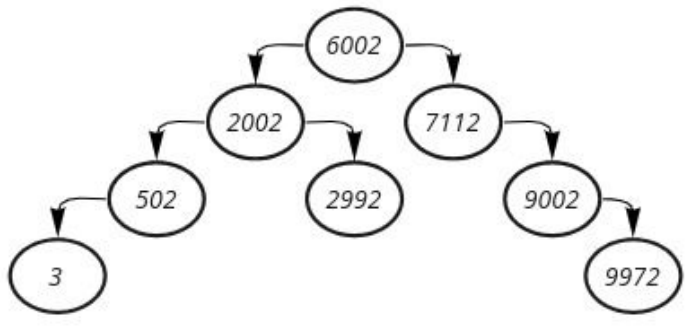
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

A priority queue for this situation could be implemented as a sorted array, in descending order. By popping off the first value of the array the ticket with the highest urgency score would be first accessed. However, each insertion would then need to be inserted in correct order.



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

A second way to implement a priority queue for this situation would be to create a binary search tree in which the keys of the nodes are the urgency scores while the nodes themselves are the tickets. Because of the nature of binary search trees, the tickets with the highest urgency scores will be at the bottom right of the three



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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 charCount(aString, aCharacter):
    charCount = 0
    for i in aString:
        if i == aCharacter:
            charCount += 1
    return charCount
```

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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:

Consider a list of k floating point numbers called T. Assuming that T has only one element x, and x <= the first element of a singly linked list called S of length n. Then the only operation to insert one number from T into S would simply be the time it takes to insert each element of T one at a time. Thus the best case complexity is O(1).

Worst case time complexity of algorithm:

O(n+k log n+k)

Explanation of worst case time complexity:

Assuming that "maintained in ascending order" allows us to first insert and then sort, we insert all k elements in O(k) time and then sort this linked list of size n + k using merge sort O(n+k log n+k) thus total worst cast time is O(n+k log n+k).

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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	*Attending meetings/events*	50
AWC	*Attending meetings/events*	15
Students Against Sexual Abuse	*Attending meetings/events*	25
Undergraduate Course Assistant	*Run labs, office hours, exam review sessions, and grade assignments*	150
BNSF Railway - internship	*Build and deploy web apps*	450

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias is the collective result of repeated errors in an algorithm that favors one group over another.

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

An algorithm used in a universities admissions office assigns applications 'admissibility' scores based on submitted materials. The algorithm compares applications to passed applications, though this university has been historically 98% white. Because the algorithm itself is a bit of a 'black-box' developers had no idea it would include the color of the applicants skin and socioeconomic status in its decision.

This leads to the systematic exclusion of minorities and other demographics.

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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:

Reinforce the idea that open standards encourage development of more innovative and cooperative platforms and services.

Second possible impact:

Set legal precedence that will protect future interoperability and integration in the future of software development and maintenance.

Third possible impact:

One of the current trends in software development is the creation of platforms and services that are well equipped to communicate with existing and soon to be created concepts. This will encourage that trend to continue.

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:

Bodily harm: when an error or decision by an autonomous vehicle results in what otherwise would have not been injury or death to a human.

Second type of harm:

Occupational harm: the widespread acceptance and use of autonomous cars will have a significant effect on how the world moves. Occupations that involve driving others or goods will be made redundant.

Third type of harm:

Making the transportation system vulnerable: any device connected to a network or platform is vulnerable to cyber attacks. By further releasing full control over the vehicle to a computer, we potentially release full control over to attackers.

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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.

1. *Graduate - December 17 2021*
2. *Move to Texas - January 12-13, 2022*
3. *Start Job at BNSF Railway (Offer accepted October 2021) - January 31, 2022*
4. *Begin considering schools in Fort Worth Area for Masters programs December 2022*

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	50
AWC	15
Students Against Sexual Abuse (SASA)	25

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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)*
Study Abroad	*Two semesters*
Hackathons	*50*

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:

Github's popularity has allowed it to amass a huge amount of third-party plugins that enable all kinds of awesome services like repository security monitoring and many more. While this may not be a specific feature of Github, the amount of other platforms and services a service can interct with I think is a significant attribute.

Non-trivial feature 2:

Gists: Gist is a platform where users can create Gists, which are almost like prototyping instances. On Gist you can share files, patches, or even entire apps.

Non-trivial feature 3:

File searching: in larger repositories locating a snippet of code or certain files can be difficult. Luckily Github provides a Fuzzy file finder, so that users can search any repository.

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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)*
IBM Applied AI Professional Certificate	*50*
Google IT Support Specialization	*40*
TensorFlow Developer Certificate	*140*
Building a personal portfolio website	*30*
Building UI's for program assignments	*70*

Best wishes wrapping up the semester and in the future!

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