Custom Exam

Wednesday, April 6, 2022 2:08 PM

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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.

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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 linked list would be the best model for this situation because it allows us to add and remove tickets at anytime. Additionally, the elements with the highest urgency can be at the head of the list to ensure that VIP customers are helped first.

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

There's a queue with 5 customers, as shown on the right. Customers with an urgency rating of 1 are VIP, while those with rating 2 are not. Let's say that first a new VIP customer needs to be added to the queue. Shortly after, the first VIP customer is helped and needs to be removed from the queue. Then, a non VIP customer is added.

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

The example above uses a singly linked list, meaning that each element only links to the next element in the list. However, this data structure can also be doubly linked and can reference both the previous and next element

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 character_in_String(String, character):
    num = 0
    for i in string:
        if (i == character):
            num = num + 1
    return num

Print (character_in_String("Hello, Kajia", "a"))
```

Output: 2

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:

$O(n)$

Explanation of best case time complexity:

Elements sorted in descending order will give a best case time complexity of $O(n)$ because it will take $O(1)$ time for comparing the elements and $O(1)$ to insert the new element.

Worst case time complexity of algorithm:

$O(n^2)$

Explanation of worst case time complexity:

Elements sorted in ascending order will give $O(n)$ because for the nth element insert, $(n-1)$ comparisons are needed.

$$\frac{n(n-1)}{2} = O(n^2)$$

And to add elements, the time complexity is $O(n)$, so $O(n^2) + O(n) = O(n^2)$.

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)*
National Society of Leadership and Success	meetings, leadership discussion, keynotes	15 hours
Association for Women in Computing	Meetings, workshops	8 hours
Hapner Desk Clerk	Front desk help	100+ hours
Human Interaction lab	Research	1500+ hours
REU - Cybersecurity	Research	400+ hours
Longfellow Elementary School Outreach	Presentation, guided use of immersive technology	2 hours

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias alludes to systematic and unfair discrimination against characteristics like sex, gender preferences, and race due to uninformed or unsatisfactory dataset usage when training the algorithm.

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

College admissions software is useful for facilitating the selection process by saving time and money, in addition to providing further insights for the potential candidates. Typically, a variety of information is collected by this type of software such as race, gender, income, past grades, and more. However, many of these algorithms were probably trained using data that may inadvertently favor a particular demographic. This could lead to excluding those not properly represented in the original data, preventing them from being accepted by the college.

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:

The legitimacy of Fair Use Copyright in the computing industry is supported, which can speed up developing processes by reusing select pieces of code in appropriate contexts, thus promoting innovation.

Second possible impact:

The winner of this case will influence how future technology develops because a better understanding of the extent to which Fair Use applies will be obtained. This developers can take additional precautions to protect their code if needed.

Third possible impact:

Industries continue to grow, rather than getting held back by restrictions and technicalities.

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:

Although autonomous cars are gaining popularity, they are not yet commonplace. There could be confusion and lack of direction for handling any mistakes or errors caused by these cars, which could lead to unregulated legal action.

Second type of harm:

Too much trust can be a bad thing. Some users may rely too heavily on the car and may not be able to intervene quickly enough when needed to prevent an accident.

Third type of harm:

It is inevitable that new technology will contain bugs. Unexpected system behavior may occur, possibly resulting in damage, injury, and even death to those in and around the vehicle.

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.

I am already registered for classes and accepted to the Computer Science graduate program at MSU. I'll be taking the computability and advanced algorithms classes in addition to a couple of thesis credits this fall.

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)*
Career Fair	1 hour
Catapulta	1 hour

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)*
N/A	

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:

Collaborative Coding - we can use merge to integrate code from different developers, while also enforcing restrictions with protected branches.

Non-trivial feature 2:

Project management - beyond just tracking changes with version control, you can track milestones, bugs, and visually see your contributions not only for the specific project, but also to Github.com in general.

Non-trivial feature 3:

Client Apps - you can access github on a variety of devices including mobile smartphones, macOS, and windows. I happen to have all 3 so this is useful.

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)*
Grace Hopper 2020	5 hours
Taught myself Python	20 hours
(I'm a transfer student & never took a class for this)	
Taught myself LaTeX	4 hours
Created a UX Portfolio	3 hours

Best wishes wrapping up the semester and in the future!