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 Christian Hess

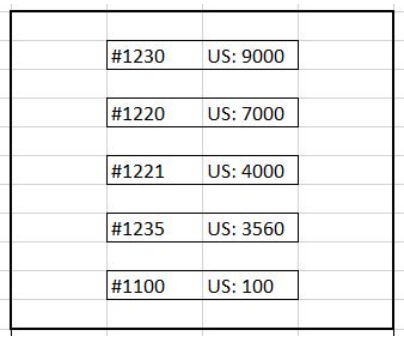
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer 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 would best model this situation is a priority queue. When a customer service ticket is submitted, the ticket is added to the queue, but the urgency score affects where the ticket is enqueued in the binary heap. For example if a VIP with an 10,000 urgency score submits a ticket, there ticket will be first in the queue, or at the head of the binary heap. That ticket is then removed from the queue, and the next largest urgency score replaces it at the front of the queue, or at the head of the binary heap.

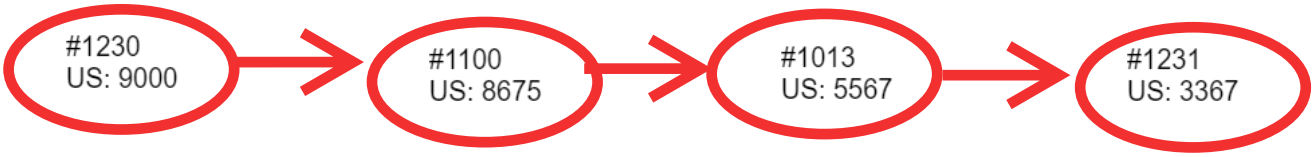
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

The first way I would implement this data structure would be using a two dimensional array. The array would hold arrays of size two which would contain a ticket number and the urgency score associated with the user who submitted the ticket. The array would be sorted by the urgency score in descending order with the largest urgency scores at the beginning of the array. The company then just needs to remove the first element of the array and find the associative ticket number.



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

The next way I would implement this data structure is with a singly linked list. Similar to the array implementation, each node of the linked list will hold a ticket number and the urgency score associated with the user who submitted the ticket. When a new ticket is added to the queue, it will be inserted into the linked list based on the users urgency score. With the linked list, all the company needs to do is pop the first node off of the list and service the ticket associated with the first node in the list.



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 count_ch_in_string(string, character):
    count  = 0
    for ch in string.lower():
        if ch == character:
            count += 1

    return count


string = "Hello, lovely weather we're having"
char = 'h'

print(count_ch_in_string(string, char))
```

Output: 3

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:

Θ(k)

Explanation of best case time complexity:

The best case scenario is when each k being inserted into the linked list is less than the value of the first node in the list. For example the linked list is 5,6,7,8,9 and the k elements we want to add are 4,3,2,1. Each k will replace the head of the linked list without requiring any traversal of the linked list. This will require strictly k operations.

Worst case time complexity of algorithm:

Θ(kn)

Explanation of worst case time complexity:

The worst case scenario is when each k is greater than the last element in the linked list. For example, the linked list is 5,6,7,8,9 and the k elements we want to add are 10,11,12. Each insertion of a kth element will require a full traversal of the linked list (n) to insert each k element at the tail.

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)*
Alpha Sigma Phi	Philanthropy, Community Service	100

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithm bias is favoritism or exclusion within an algorithm. Bias in an algorithm may produce unfair results for certain groups of people, or may favorite a specific group of people. Algorithm bias can occur from data selection, data used to train an algorithm, or a sundry of other actions.

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

While having racial quotas is technically illegal in college admissions, many schools strive to have racial diversity in their schools. If they have software that is taking into account race and overall diversity of the school, some individual students may be excluded from a university because of their race. For example, if an admissions algorithm is programmed select a minority applicant on every third admission, students may be excluded from the college when they may have greater qualifications than a minority student.

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:

The first impact of this win is creating honesty in the industry. With Oracle winning this lawsuit, it sets an industry precedent of honesty. It demonstrated that even a company as large as Google can't get away with using copyrighted information without repercussions.

Second possible impact:

The second impact this decision has on the industry is justice. Whether Google used Oracle's code maliciously or they were simply oblivious to the effects of their actions, it demonstrates that any company get caught for doing such things. Even small companies should strive to be original in their work and not resort to stealing intellectual property.

Third possible impact:

The third impact of this win is creating honest collaboration in the industry. Companies need to collaborate in order to improve user experiences and create compatibility between different applications. However, using a companies code without crediting or paying them is the wrong way to go about collaboration. Make different technologies work together, but credit the people/companies that make it possible to do so.

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:

One type of harm that can come from self-driving cars, that has unfortunately already happened is death. The software in these vehicles is far from perfect and they are not 100% accurate at avoiding pedestrians. Likely, the most crucial harm that these cars can cause is death. Until the software is perfected, which seems impossible, one harm that can occur is loss of human life.

Second type of harm:

The next type of harm that these autonomous cars can cause is to the driver. Once again, the software isn't perfect at identifying road conditions or driving. Suppose road conditions have been completely dry throughout a 3 hour drive. However, near the end of a drive is a canyon and temperatures have dropped significantly throughout the day. I doubt an autonomous car could identify a patch of black ice on a curve, which would likely result in injury or death of a passenger.

Third type of harm:

The third type of harm that could occur from self-driving cars is on a larger scale. These cars function solely because of computers which means they are at risk of cyber attacks. Should a foreign malicious entity hack into these vehicles, it could be catastrophic for passengers.

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 consists of lots of adventure followed by a lot of work. Following graduation, I am rafting the Grand Canyon with my father for a month. After that, I will be going back to Nevada to enjoy the remainder of the summer, and go on a month long backpacking trip with a high school friend. In September I am going to work as an implementation consultant for Fast enterprises. I applied to Fast, Snowflake, and Atrium following the Fall 2021 career fair and received an offer from Fast. Come September, I will be moving to new city and working full time for Fast for the foreseeable future.

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)*
Alpha Sigma Phi	1000

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)*
Group projects	100
Fraternity Executive Board	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:

One unique feature of Git is branching capabilities. Users can easily create a branch of the main branch of a project. With this branch, a user can implement functionality and test their changes without ever touching the main branch. Once the branch has been reviewed and tested adequately, Git makes it very easy to merge the updated branch into the main branch and make the changes available to other collaborators.

Non-trivial feature 2:

Another unique feature of Git is it's popularity. Git is the most popular version control system for a reason. The amount of resources and 3rd party Git applications make the system very attractive. For example, GitHub Desktop and GitKraken are both GitGUI's that make version control of projects as simple and comprehendible as possible.

Non-trivial feature 3:

Another feature of Git that makes it superior is attention to detail and the amount of information it provides users. When it comes to version control, Git checks all the boxes. Users can see any change made to any file in a change list, revert to older project versions, or just older version of specific files, all while providing users with flexibility and code security.

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)*
Personal Website	10

Best wishes wrapping up the semester and in the future!