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 Alexander Johnston

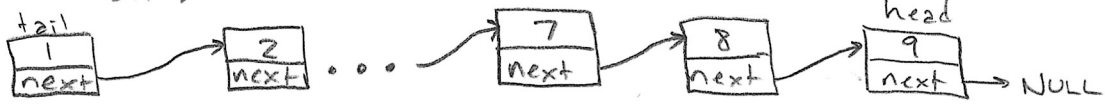
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer 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 priority queue would best model this situation, as each element in the queue (tickets) can have a priority value associated with them (urgency score). Elements are served based on their priority and can be de-queued (removed) when dealt with.

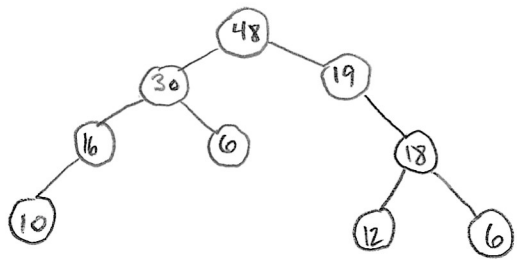
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

A priority queue could be implemented using a linked list. Each element, or node, contains a key and a pointer to the next node. The highest priority node is usually the "head" and the lowest priority node is the "tail".



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

A priority queue could also be implemented with a max binary heap. This is essentially a binary tree that is kept as a "complete" tree, and the key at the root must be kept as the maximum among all keys in the tree.



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_char(s, c):
    num = 0

    for i in range(len(s)):
        if (s[i] == c):
            num = num + 1
    return num
```

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:

If we are inserting a number at the beginning of the linked list, we do not need to traverse through all or part of the list before inserting. We would only need to check the first node, see that the number we are inserting is less than the value at that node, and insert it. This would be time complexity O(1).

Worst case time complexity of algorithm:

O(n)

Explanation of worst case time complexity:

The worst case scenario in terms of time complexity is if the number we are inserting is larger than any value in the linked list and we do not already have the location of the highest value node stored. In this case, the entire linked list would have to be traversed before insertion, which would be time complexity O(n).

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)*
None	None	None

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias refers to repeatable errors in a computer or algorithm system that creates unfair outcomes such as preferring a certain group or set of results over other results.

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

If the admissions software's purpose is to increase enrollment, it might look at the potential of students to be able to pay for their tuition. If the algorithm is also able to provide automated scholarship offers, it may tend to prefer offering scholarships to students who would normally struggle to pay for tuition. This would end up offering more scholarships to students who are low-income, vs. offering scholarships primarily based on educational merit.

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:

More robust rules are created that continue to allow smaller companies to use API code in their software, thus aiding new startups in computing and minimizing the often oppressiveness of larger companies in terms of legalities.

Second possible impact:

Computing researchers are more freely allowed to use copyrighted code in their software systems, speeding up the pace of research overall and pushing the industry forward faster.

Third possible impact:

The playing field between small and large tech companies is levelled further, facilitating more competition and innovation and thus providing better technology and electronics for consumers.

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:

Severe harm, such as bodily injury or death. The car should be smart enough to avoid pedestrians or other vehicles. However, if it is not smart enough or an error occurs, people could be injured or even die.

Second type of harm:

Unintended harm from well-intended actions. For example, if an accident is about to occur and the only two options for the car are to hit one person or hit a group of people, the car should choose the option that minimizes harm. However, this well-intended decision would still cause harm.

Third type of harm:

Damage to property or the environment. If a situation occurs where the car has to swerve to avoid an obstacle, it may end up hitting a building or other infrastructure. Even though no humans were directly injured, this is still classified as "harm" and should be avoided.

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 have applied to:

Zoot Enterprises - Solutions Developer - No offer
Workiva - Software Developer - No offer
FAST Enterprises - Implementation Consultant - Did not finish interview process
Micron - No offer / Did not finish interview process
McLaughlin Research Corporation - Electrical/Systems Engineer - SW - Offer - Declined
Naval Undersea Warfare Center - Keyport - Software Developer - Offer - Will be accepting

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)*
None	None

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)*
Collaborative design project in class	60

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 (Git)

Non-trivial feature 1:

Protected branches - restrictions can be set on how code branches are merged, including requiring code review, or only allowing certain people to work on a branch

Non-trivial feature 2:

Code Review - New code can be reviewed and viewed next to old code, and can then be merged with an existing branch

Non-trivial feature 3:

Drafted pull requests - pull requests can be created to discuss changes or work together without needing formal review until changes are finalized

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)*
Purchased Raspberry Pi to play with	12
Watched CS youtube videos	50
Wrote small programs as entertainment	2

Best wishes wrapping up the semester and in the future!