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 David Hamlin

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. Any ticket that would be inserted would be put into the queue based on urgency. Any two tickets with the same urgency would be treated as FIFO. With a priority queue, the highest "priority" (urgency in our case) will always be at the top of the queue.

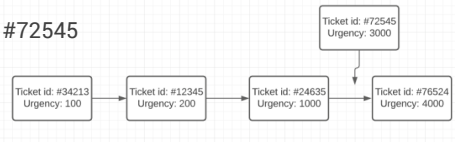
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

One way this could be implemented is with a linked list. Each node is a ticket, and a new ticket is inserted in the list based on urgency. The list is ordered from least urgent to most urgent, and when a ticket is resolved, the end node is popped.

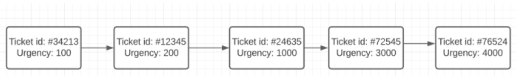
1. Existing Queue



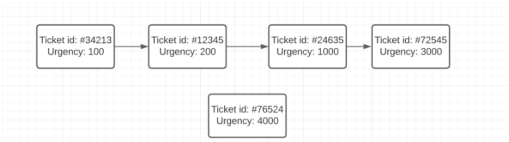
2. Add ticket #72545



3. Ticket is in correct spot



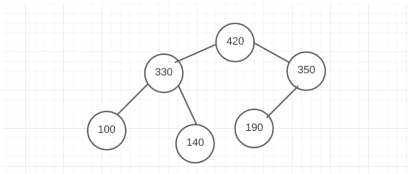
4. Pop Highest priority ticket



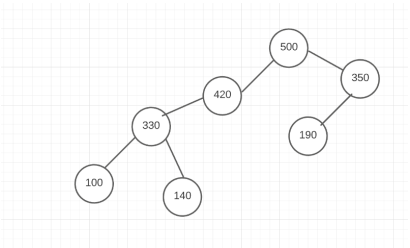
c) Describe a second way in which this data structure could be implemented and draw a picture of that data structure.

Another way this data structure could be implemented is with a heap. The root node will always be the greatest node, which will be the top of our priority queue A new ticket will be inserted into the correct spot in the heap, and then when a ticket is resolved, the top node will be popped.

1. Heap of our tickets, with the priorities being displayed



2. Inserted ticket with urgency 500, goes to the root node



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 numChars(character, sentence):
    count = 0
    for char in sentence.lower():
        print(char.lower())
        if(char.lower() in character):
            count+=1
    return count
```

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: Best case: Constant time, or Ω(1)

Explanation of best case time complexity:

Assuming that each additional floating point number is smaller than its predecessor, the best case time will mean that each element is inserted at the beginning of the linked list. That means there will by k insertations, each taking only 1 step to insert. Best case also assumes that k = 1.

Worst case time complexity of algorithm: O(n^2)

Explanation of worst case time complexity:

Assume k=n-1 floating point numbers, and each number is greater than its predecessor. For n amount of times, each number will have to iterate over n elements in the linked list to add the new number to the end, resulting in O(n^2) runtime.

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)*
Chi Alpha Campus Ministry	Member 2 years, Bible Study Leader 1 year	>1500 hrs
Journey Church	Student Ministry Leader, Led Middle School Youth Group for 2 yrs	~200 hrs
Dataminr, Inc	Software Engineer Intern, Feb 21-Current	~800 hrs
Montana State University	Undergraduate Course Assistant, 3 semesters	450 hrs

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias is where the results of an algorithm are prejudiced based on errors when analyzing the data to make decisions

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

A College admissions software may auto reject women more frequently. If the algorithm makes a decision based off of past data, the percentage of women in college was 5% fewer than the percentage of men in college, in 2005, even though in 2019, there were 2% more women in college than men. This may lead to bias in the algorithm, as the software may think that men may be a better fit for college since more men in all of history have gone to college.

source: https://www.statista.com/statistics/184272/educational-attainment-of-college-diploma-or-higher-by-gender/

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:

A Google win would set the precedent on weak copyrights for code owners, making it so code could be used by other people who it doesnt belong to more easily. This would result in big companies being able to take code from smaller companies, improve it with the vast resources, and drive the smaller companies out of business.

Second possible impact:

A Google win also would allow for greater academic and research progress. More code available to researchers with increased fair use would allow for greater technological advancement and creativity to occur.

Third possible impact:

Google's win allows java developers to not have to write their own libraries from scratch to preform functions that the API already had built in. This would increase innovation and more development in java.

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- if the car chose to hit a person instead of swerve off the road, then it would result in that person being physically harmed.

Second type of harm:

Harm to a person's private data- If the car collects data on where the person is going, the route it takes, etc, to improve the car's software, this could be a violation of privacy and harm the user by disclosing the user's private data

Third type of harm:

Harm to society- Producing self driving cars may harm the environment if self driving cars cause more people to own cars and cars to be more readily available, then people will use them more, and as a result, the environment could be harmed.

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 just accepted an offer as a Software Engineer at Dataminr, which is where I had my internship last summer. I do not plan on applying to grad school in the next year. I may apply to a couple other companies, but am pretty set on working at Dataminr.

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)*
Chi Alpha	1500
Outlaws Country Dancers	100
Venture Church	400
Journey Church	400
MSU Intramurals	50

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)*
Church youth group- Worked with people of different ages to help lead a youth group program for students	200
EGEN 310- worked with a very diverse group of students	60
WRIT 221- Lots of different majors for the group projects	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:

Can push and pull code directly from desktop application or IDE on different devices.

Non-trivial feature 2:

Can collaborate with teammates using pull requests and code review

Non-trivial feature 3:

Can access previous versions in case needed to remove a feature or view previous code.

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)*
Read a book to teach myself Go	12
Implemented scheduling software for a church. Volunteer	30
Wrote quality of life scripts for my personal computer	8
Did a LOT of leetcode	30

Best wishes wrapping up the semester and in the future!