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 Zachary Schallenberger

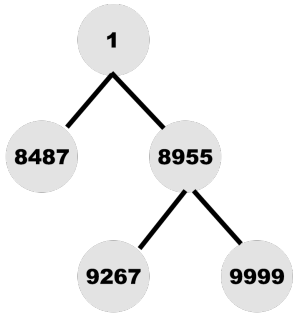
Question 1: A company uses a ticket system for customer service. Each ticket is given an urgency score when it is entered into the system. For example, a VIP customer would receive a higher urgency score than a regular customer. Assume that the urgency scores range from 1 to 10,000. The company's customer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

I would use a tree data structure. I would choose to do this because trees provide hierarchical sorting which would allow them to store tickets with higher "urgency scores" towards the top of the tree, and ones with lower "urgency scores" at the bottom.

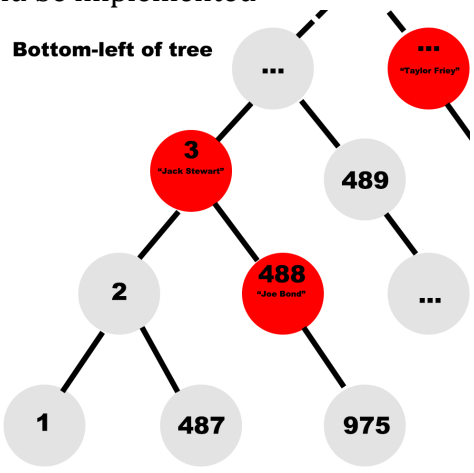
b) Describe one way in which this data structure could be implemented and draw a picture of that data structure.

One way this would work, is for example if you only had 5 tickets in the system and one of them had a score of 1 (assuming that is high) and the others were within the 8,000 - 10,000 range (assuming that is low), the ticket with a score of 1 would still be at the top of the tree. When a new ticket is entered into the system, it is given its "urgency number" and it would then trickle down the tree starting at the top and move to the left or the right depending on if its number is greater than or less than the node it is being compared to until it eventually finds its spot in the tree



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

Another way to utilize the tree data structure is to have a complete, finite number of nodes of however many tickets are to be sold, and store a boolean and string on each node to determine who the ticket belongs to and whether or not the ticket has been purchased. Once purchased, the boolean would flip to "True" and the string would become the name of the ticket holder. Then, when searching for the next ticket with the highest priority, the tree would be parsed from left —> right with the bottom-left node being 1, and the bottom-right node being the highest number of tickets.



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 myFunction(theString, theCharacter):
    theString = theString.lower();
    theCharacter = theCharacter.lower();
    count = 0;
    for character in theString:
        if (character == theCharacter):
            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:

Explanation of best case time complexity:

NOTE: To be honest, I never really got a great grasp on "Time Complexity" and I don't even know how to answer these questions. I'm sure I could look it up online and find some resources to better help understand it in order to answer these questions, but from my own personal knowledge, I don't feel like I'm capable of answering either of these questions

Worst case time complexity of algorithm:

Explanation of worst case time complexity:

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)*	
Belgrade Community Library	Volunteer Mentor — Teaching "Scratch" to kids interested in CS	3 hours/week for 2 months	≈ 24 hours total
A.M.E.N Free Health Clinic	Spanish Interpreter	8 hours	≈ 8 hours total
Tyler Technologies	Software Support Internship	40 hrs/week for 3 months	≈ 480 hours total
Tyler Technologies	User-Center Design Intern	20 hrs/week for 8 months	≈ 640 hours total
Tyler Technologies	Part-Time Software Developer	24 hrs/week for 1.5 years	≈ 1728 hours total
BMW Manufacturing Co., LLC	Customer Orientation Co-Op	40 hrs/week for 10 months	≈ 1600 hours total
Ford Motor Company	Product Design Internship	40 hrs/week for 6 months	≈ 960 hours total
NSF / DoD / Auburn University	Undergraduate Research Assistant (REU)	40 hrs/week for 3 months	≈ 480 hours total
MSU / UoM	Hackathons / Business Venture Competitions	≈ 54 hours	

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithm bias is the intentional (or unintentional) bias that is integrated within a developed algorithm.

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

A potential example of how algorithm bias could be manifested in college admissions software is where an algorithm is designed to find the best fit students to be admitted to the university. The algorithm could be created and coded to try and accept students to meet "diversity goals" that the university may be trying to achieve. This bias could be manifested by overlooking students' qualifications and basing their admissions purely on whether or not they fit a minority group to meet the university's goals

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:

APIs are now considered "open-source" and allow for many newer and better implementations to be created as a result.

Second possible impact:

Less APIs are released or created because any time or work that is put into the code of an API can now be considered "open-source" and available for others to take and use for their own products without infringing copyright law. Companies would lose protection over rights to their code used in APIs as a result.

Third possible impact:

Smaller developers and companies would have more access to industry-standard code for use on their own projects since APIs are no longer considered protected from copyright infringement law.

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:

If an autonomous car was presented with two (and only two) options of either harming the passenger(s), or pedestrian(s), the software would have to make a decision to harm someone

Second type of harm:

No matter how well the software is coded, there will always be risk of harm to any individuals involved with the self-driving technology (passengers or pedestrians). Moving vehicles can be incredibly dangerous and when paired with software, the software can then become liable for any harm done to anyone involved

Third type of harm:

The creators of the software could be held liable for any exploitations of the code done by hackers with malicious intentions (i.e., taking over the vehicle remotely, confusing the vehicles's sensors and technologies with jamming technology, etc…)

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 plan on leaving my current position as a Software Developer at Tyler Technologies to pursue my new career as an IT professional for Ford Motor Company following graduation (I have already applied and received/ accepted an offer for this position). The program I will be starting is called the "Ford College Graduate" (FCG) program. It is designed for recent graduates to work three, 1-year rotations of full-time positions within the company and then roll into a full-time position at the end of the 3-year program. For IT, the positions can range from anything like Software Development/Architecture to Product Design to Product Management, etc. FCGs are given a list of around 200 different positions and list their top 8 choices and Ford assigns a position accordingly. I should be receiving my assignment within the following months. I will also be given the opportunity to go to graduate school (paid for by Ford) starting in Fall 2022. I have not decided where or what I will be pursuing in graduate school, but will likely take advantage of this opportunity.

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)*

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)*
EGEN 310 - Multidisciplinary Engineering	3 hrs/week for 14 weeks ≈ 42 hours
BGEN 194 - Business and Entreprenuership	2 hrs/week for 14 weeks ≈ 28 hours

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 (also have used Mercurial)

Non-trivial feature 1:

Allows browser-based-development using VS code in the browser by pressing the "." key when viewing any repository on Github.com

Non-trivial feature 2:

Allows for control of different branches. When developing an app with other developers for our startup, Freats LLC, we all had different branches for each developer and when finished with implementing a new feature, we would merge our branch with the development branch to determine merging conflicts and allow for other developers to view and test the code and finally merge the development branch with the production branch before pushing the code to the app stores.

Non-trivial feature 3:

Allows for reverting "commits" this is useful for when a mistake has been made in the code and accidentally pushed to the branches, I would be able to revert the commit to an earlier version to eliminate the errors

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)*
Web Development certification - Google	≈ 40 hours
Self-taught Blender 3D hobbiest	≈ 400 hours
Went on trip with CS department to Portland to look at companies	≈ 120 hours
Attended NRF conference in NYC	≈ 120 hours

Best wishes wrapping up the semester and in the future!