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 Sarah Mantalbano

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 appears to best model the situation. The value in a node can range from 1 to 10,000 and nodes (tickets) can be removed easily by pointing past that ticket. Finding the ticket would probably require iterating through the Linked List.

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

Singly Linked List → only allow traversal in forward order



(this worst-case example has ticket of most urgency at end, so O(n) search time)

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

Doubly Linked List → allows traversal forward and backward



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): Java

Your solution:

```
Public static int countChar(String s, char c){
    int total_occ = 0; // total occurrences
    for(int i=0; i < s.length(); i++){ // iterate through string
        if (s.charAt(i)==c){ // if character at position i=c, ++
            total_occ++
        }
    }
    return total_occ;
}
```

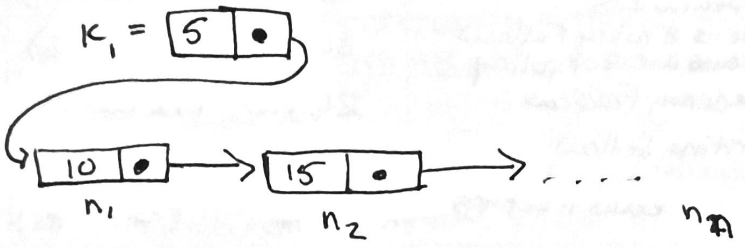
Question 3: Consider a singly linked list that contains **n** floating point numbers and is maintained in ascending order. An additional **k** floating point numbers will be added to the list, one at a time. You may assume that **k << n**.

Best case time complexity of algorithm:

O(1)

Explanation of best case time complexity: (or all k are $< n_1$) → still constant time though, O(k)

Best case occurs if k=1 and $K < n_1$, which means it replaces n_1 as the head of the list and the rest of the list follows in ascending order. That's 1 insertion.

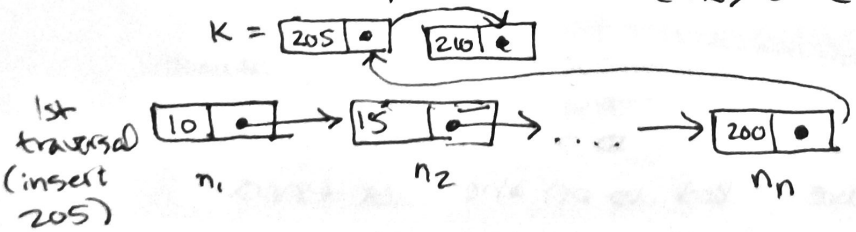


Worst case time complexity of algorithm:

O(nk)

Explanation of worst case time complexity:

Worst case happens when K values are greater than the entirety of the sorted n list. This requires n time to traverse for each k, so n*k = O(nk) time.



then traverse again (n+1) to connect 210

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)*
Zoot Enterprises	attribute development	480 hrs (3 months)
Alaska Policy Forum	write articles, policy briefs, communications, op-eds	300 hrs (4 years)
Young Voices	write op-eds, TV and radio appearances	35 hrs (6 months)
Hertog Foundation	Ideas & Policy Fellow Discuss areas of policy	36 hrs (6 weeks)
Heritage Foundation	Academy Fellow	24 hrs (12 weeks)
America's Future Foundation	writing fellow	20 hrs (6 weeks)
Bozeman Schools Foundation	attend board meetings	~20 hrs (semester)
Tau Beta Pi	member-attended ceremony	1 hr

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Algorithmic bias is a type of systematic bias (ie. not random) that causes unfair outcomes, or outcomes that conflict with anti-discrimination legislation.

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

If a college used a software to screen applications, and that software picked up on the fact that previously admitted students took many AP/IB courses, then the algorithm might selectively not admit students who didn't take AP/IB courses. This is problematic because, for many, AP/IB were not an available option and the algorithm may then exclude members of underprivileged communities.

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: API can be copied

* Most importantly, API code may be copied under fair use considerations.
* This means open-source communities can do the same, not just behemoths like Google.

Second possible impact:

* Companies can have more integrated technology (If Oracle had won, companies would have likely been more defensive over copyrights and reduced interoperability)

Third possible impact:

* Copyright protections for software would be weaker
→ competitors with more resources can snatch up code and claim it under fair use (more often)

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: EMF radiation

The sheer amount of technology in a self-driving car might increase exposure to radiation that may cause adverse health outcomes in the aggregate. (More than other common activities? Maybe not).

Second type of harm: ~~Unemployment~~ Software vulnerabilities

As with any device controlled by software, autonomous vehicles would be vulnerable to exploits. The autonomous car may be controlled, crashed purposefully, or redirected. The rams exist here because otherwise a human would be controlling the vehicle.

Third type of harm: road accidents

Self-driving cars have to plan for hundreds of scenarios that a human would react instinctively to. An AI might not make an ethical decision, especially faced with unexpected conditions. Road accidents, and perhaps some avoidable ones, may be caused by software programming decisions.

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 worked at Alaska Policy Forum for the duration of my 4-year MSU career. I have been given a verbal offer from APF to perform education research as their education policy specialist. Assuming I receive a formal offer soon, I will accept and be there until December 2022 at least.

I will reevaluate graduate school as soon as the COVID situation has died down. Economics masters or PhD.

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	:(

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)*
Boardroom Bobcats	~20 hrs

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: Distributed system
Because git is distributed (no central server), users can work simultaneously and changes can be pushed to the repository.

Non-trivial feature 2: Branching
Git branches allow users to test out and try things without screwing up the main code. Once it works, a branch can be merged with the main.

Non-trivial feature 3: Pull requests
If I want to make changes to a repository I don't have write access to, then I can author a pull request (I think of it as a suggestion) to fix the issue.
(thank you Prof. Easy for teaching this).

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.

wrote 4 pieces

Activity Description	*Hours Spent (estimate)*
WSJ Future View (not C.S.)	5
Learned a little bit of R to help w/ BF's masters	20 hrs

Best wishes wrapping up the semester and in the future!

Thank you! :)