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 Elliott Pryor

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.

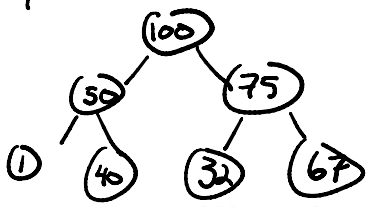
a) What simple data structure would best model this situation? Explain.

Priority Queue. We want a queue for first in, first off / overall functionality (more fair). Priority queue provides us with a way to prioritize VIPs (dequeue high pro first)

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

O(log n) ← re-rooting O(log n)

Max heap, deque the root of heap. Insert into correct order based on priority.



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

O(n) O(1)

linked list. Insert in sorted order, remove from tail

tail → 100 → 75 → 67 → 50 → 40 → 32 → 1

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 f(s, c):
    return s.count(c)
```

or

```
def f(s, c)
    t = 0
    for x in s
        t += x == c
    return t
```

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: $O(k)$

Explanation of best case time complexity:

K numbers are also in ascending order, with the max being smaller than the smallest in the list.

So the next number always goes at next spot



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

Explanation of worst case time complexity:

Exact opposite. Next number has to go at very front of list (must traverse through entire list)

iter	time
1	n
2	n+1
⋮	
k	n+k-1

k^2

n * Worst Case Insertion Sort

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)*
Engineers Without Borders	Co President, Committee lead	Avg. 5hr/week. 4AY
Research: Yaw, Money	Scheduling alg	1 Summer: 30hr/week ~120
Research: Sheppard	Variable Elecomp/Bayes Net	5hr/week 2AY
ACM ICPC	Coding Competition	40hr total
Novetta Intern	NLP development	40hr/week ~160

Question 5: IEEE P7003 defines the Algorithmic Bias Standard.

a) Describe briefly what algorithmic bias is.

Subjective or Systematic errors that lead to results/outcomes not representative of the population or that are unfair /go against legislation on protected characteristics.

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

A dataset of student race and gender in CS measuring GPA based on historic records. The alg aims to admit students who are likely to succeed. Since white, male students are significantly over-represented the alg may admit white, male students at an unfair rate due to historic over representation.

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:

parts of JAVA API becomes not patentable / copywrite

Second possible impact:

Sets precedent for open API, all languages are public and not intellectual property.

Third possible impact:

Reduction in investing in new languages as they cannot be sold as easily.

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:

Cause a crash - injuring humans.

Second type of harm:

Economic - no need for taxi or semi drivers (loss of job)

Third type of harm:

Responsibility - who is responsible for an accident? The owner was not driving, but company did not have control.

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.

Either work or grad school

Work - Accenture Federal or Epic

Grad School - PhD at University of Virginia (UVA)

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)*
Engineers Without Borders	5hr/week 4AY

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)*
Engineers without borders	5hr/wk
Honors College	4 seminar courses 16 credits

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 / GitHub

Non-trivial feature 1: Pull request

Non-trivial feature 2: forks

> allow code to be shared easily and collaborate with others

Non-trivial feature 3: Branches - managing/developing individual features separately

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)*
ACM ICPC competition	40
Seminar Talks	1 hr/week, 2 AY

Best wishes wrapping up the semester and in the future!