CISC-235*
Test #3
March 23, 2017

Student Number (Required) ______________________

Name (Optional) ________________________________

This is a closed book test. You may not refer to any resources.

This is a 50 minute test.

Please write your answers in ink. Pencil answers will be marked, but will not be re-marked under any circumstances.

The test will be marked out of 50.

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“We all want to forget something, so we tell stories”

Happy birthday to Akira Kurosawa
Question 1 (12 marks):

Create a hashing function for playing cards. Each card is represented by a pair (X,Y) where X is a number in the range 1 to 13, and a Y is a letter which is either “C”, “S”, “H”, or “D”. You can use this pair as the key.

a) [4 marks] Create your hashing function and explain your reasoning.

b) [4 marks] How will you handle collisions? Explain your choice.

c) [4 marks] What criteria would you use when choosing the size of your hash table?
Question 2 (12 marks):

Here is a collision resolution method that combines chaining with open addressing. In this method we resolve collisions with chaining, but each chain is allowed to contain at most 2 values. If we try to insert a value into a location where the chain is full, we use linear probing to find the next address where the chain has length < 2.

a) [4 marks] Show the result of inserting these values:

3, 23, 14, 6, 13, 24, 25, 17, 4

into this hash table using \( h(k) = k \mod 10 \)

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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(This question continues on the next page.)
b) [4 marks] How would you handle the “delete” operation, so as to guarantee that “search” would function properly?

c) [4 marks] Compared to standard open addressing with linear probing, would you expect this method to have more primary clustering, less primary clustering, or about the same amount of primary clustering? Explain your answer.
Question 3 (12 marks):

Suppose you are implementing a priority queue using a Max-heap. How would you make sure that when two items have the same priority, the one that was added earlier gets to the head of the queue earlier? You may assume there is a built-in function `clock()` that returns the current system time.

Explain the modifications (if any) that you would need to make to the standard `insert()` and `remove_largest()` algorithms.
Question 4 (12 marks):

In a connected unweighted graph, the distance between two vertices is the number of edges in the shortest path that joins them. For example in this graph the distance between C and E is 3, and the distance between D and F is 2.

Explain how we can use multiple executions of Breadth First Search to compute the distance between all pairs of vertices in a connected unweighted graph.

The next page is available for use in answering this question.
Question 5 (2 marks):

Why can’t we use this for double hashing:

\[ h(k,i) = (h'(k) + \text{randint()}*i) \mod m \]

where randint() returns a random positive integer every time it is called?