University of Nevada, Las Vegas Computer Science 477/677 Spring 2023

Study Guide for Third Examination April 12, 2023

1. Review answers to homework5:
   `http://web.cs.unlv.edu/larmore/Courses/CSC477/S23/Assignments/hw5ans.pdf`

2. Review answers to homework6:
   `http://web.cs.unlv.edu/larmore/Courses/CSC477/S23/Assignments/hw6ans.pdf`

3. True or False, Open if the answer is not known at this time.

   (i) _____ $\log^*(2^n) = \Theta(\log^*(n))$

   (ii) It is possible to execute the A^* algorithm on a weighted directed graph with some negative arcs, provided the heuristic satisfies certain conditions.

4. Fill in the blanks.

   (a) _____ algorithm cannot be executed if any arc has negative weight.

   (b) No shortest path algorithm can be executed on a directed graph with a _____ _____. (Two words.)

   (c) The items in any priority queue represent _____ _____. (Two words.)

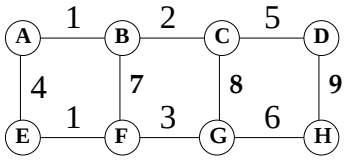
   (d) One sorting algorithm that we learned in class, _____, does not use the comparison/exchange model of computation.

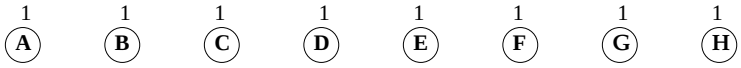
5. Using the stack algorithm, convert each infix expression to postfix. Show the stack at each step.

   (a) $a - b * c - d - e$

   (b) In this example, we use the operator $\wedge$ (present in some languages, but not in C++) which is right-associative, and has higher precedence than multiplication and lower precedence than negation.
   $a * b - d - e \wedge f \wedge -g$

6. Walk through Kruskal's algorithm, using union/find, for the following weighted graph. Be sure to watch for path compression.





7. Given an ordered list of n numbers, how would you find the median number in $O(1)$ steps?

8. Given two ordered lists of n numbers each, how would you find the median of the union of those two sets of numbers in $O(n \log n)$ time?

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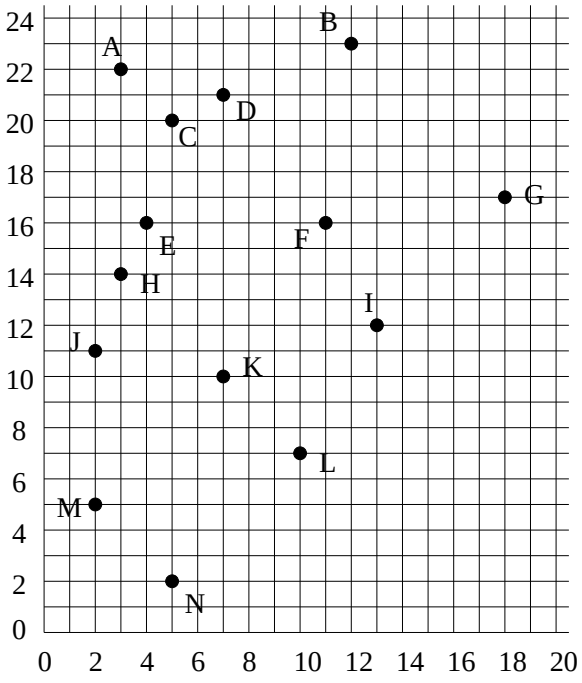
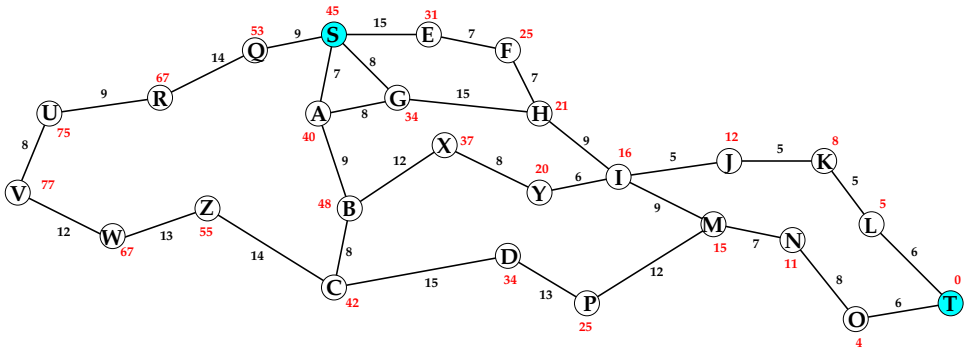
9. If you need to find the median of a list of three numbers using the comparison/exchange model of computation, the fastest method is to bubblesort the list in 3 comparisons, then pick the middle item.

   But what if you want the median of five numbers? How many comparisons do you need? (This problem arises in the BFPRT (median of medians) algorithm for median finding.)

10. The convex hull of a set of n points in the plane can be found in $O(n)$ time using the algorithm *Graham Scan*, by Ron Graham. Walk through Graham Scan for the set of points shown in the figure below. As you draw lines, do not delete previously drawn lines.



11. Walk through the A^* algorithm for the weighted graph below, where S and T are the source and target vertices.



12. (a) You are given a set of n integers $x_1, \ldots x_n$ and an integer K. Write an $O(nK)$-time dynamic programming algorithm which determines whether some subset of the integers has total K.

(b) Answer the following question. "You know that this is the the subset sum problem, which you have learned is $\mathcal{NP}$–complete. Yet, I am asking you to find a polynomial time algorithm for that problem. How can that be?"