# Practice Final Exam

*Your Name:*

## Instructions

Solve each of the following problems to the best of your abilities.

Good luck!

1. Write the pseudocode for an algorithm that takes the root of a binary search tree as its only argument and returns the total number of nodes in the tree.

2. What is a template method pattern?

3. Write the pseudocode for an algorithm that takes the root of a binary search tree as its only argument and returns the minimum value stored in the tree.

4. What is the difference between the looking-glass heuristic and the character-jump heuristic?

5. What does it mean when we say that a sorting algorithm is stable?

6. Describe the strategy used by a (2,4)-tree to rearrange nodes after an insertion. I do not need to see any math or code – just a high-level explanation is sufficient.

7. What is an incidence collection of a graph?

8. Sketch out a trie that stores the words “anaconda”, “aardvark”, “ant”, “alligator”, and “antidisestablishmentarianism”.

9. What is the difference between bucket sort and radix sort?

10. What is the difference between a multimap and a map data structure?

11. Would you expect the performance of the merge sort algorithm to change if we sorted a random list of numbers versus an already sorted list of numbers? Why or why not?

12. What is the difference between a hash code and a compression function?

13. What is the “scan forward step” when searching for an element in a skip list?

14. I want to design an algorithm that can be used to calculate the shortest route from my house to the grocery store via car. It works by looking at all of the nearest intersections from my current location

and repeatedly takes the one that minimizes the distance to the store. Is this an example of a brute force, greedy, or dynamic programming algorithm?

15. Set A contains elements {2, 3, 4, 7}. Set B contains elements {1, 3, 4, 5}. What is the intersection of set A and set B?

16. What is the difference between a dense versus a sparse graph?

17. Write the pseudocode for the binary search algorithm.

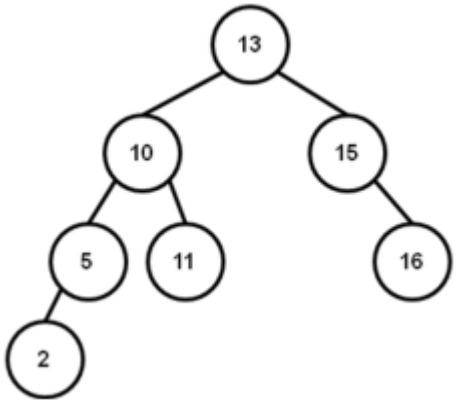
18. How does the binary search algorithm relate to a binary search tree?

19. Prove that the time complexity of the Towers of Hanoi problem is $O(2^n)$ using its recurrence relation:

$$S_0 = 1$$

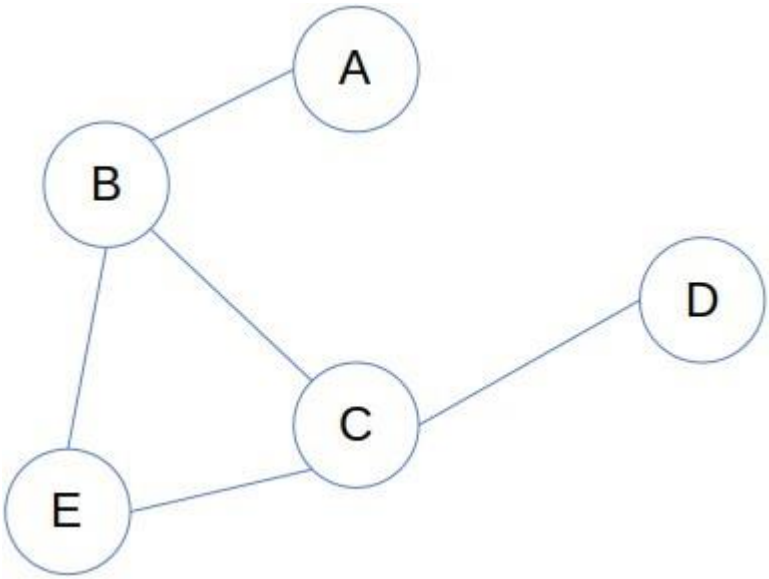
$$S_N = 2S_{N-1}$$

Consider the AVL tree shown below.




1. What is the balance factor of node 10?
2. What is the height of node 16?
3. Starting from the original tree shown above, sketch the final state of the tree after the number 14 is inserted and the tree rebalanced.
4. Starting from the original tree shown above, sketch the final state of the tree after the number 24 is inserted and the tree rebalanced.
5. Starting from the original tree shown above, sketch the final state of the tree after the number 10 is deleted and the tree rebalanced.

Consider the graph shown below. The weight of each edge is equal to one.




1. Is this a directed or undirected graph?
2. Is node B reachable from node D?
3. What is the shortest path from node A to node D?
4. Write out the edge list for the graph.
5. Write out the adjacency list for the graph.
6. Write out the adjacency map for the graph.
7. Write out the adjacency matrix for the graph.

Consider the red-black tree below. Sketch out the new tree that would result if I inserted the number 24. Note: this is something that I might ask for extra credit, but not as a regular question.