3013 - Algorithms
Spring 2022
Exam 2
March 31 2022

Name: _____

READ THESE INSTRUCTIONS
• You need a scantron • Put your name on your scantron on both sides. • Do not crumple or fold your scantron. • **Answering Questions:** – Make sure you mark your scantron clearly. • Help me ... help you!
Failure to comply will result in loss of letter grade

1. (3 points) The following sorting algorithms are considered **in place** :
   A. Insertion Sort, Heapsort
   B. Bubble sort, Selection Sort
   C. All of the Above
   D. None of the Above

2. (3 points) Which of the following is not a desirable property of a hash function $h(x)$?
   A. It should be computable in $O(1)$ time.
   B. The range of $h(x)$ should stay within the desired hash-table size.
   C. The range of $h(x)$ should include a wide range of integers.
   D. If $x_1, ..., x_n$ are the items to be hashed, then the numbers $h(x_1), ..., h(x_n)$ should be uniformly distributed over the integers.

3. (3 points) If a separate-chaining hash table has load factor = 5, then the average length of a chain equals
   A. 5.
   B. $log\, 5$.
   C. $5\ log\, 5$.
   D. $log(log\, 5)$.

4. (3 points) Perfect hashing:
   A. may be applied to static hash tables.
   B. means there are no collisions when retrieving data from the hash table.
   C. represents one of the most efficient ways of retrieving data.
   D. all of the above

5. (3 points) The worst case running time $T(n)$ for inserting n elements into an initially-empty heap is
   A. $T(n) = O(n^2)$.
   B. $T(n) = O(n\ log\ n)$.
   C. $T(n) = O(n)$.
   D. $T(n) = O(n\ log\ n)$.

6. (3 points) The worst case running time $T(n)$ for popping an element from a binary heap of size n is
   A. $T(n) = O(1)$.
   B. $T(n) = O(log\ n)$.
   C. $T(n) = O(n)$.
   D. $T(n) = O(n\ log\ n)$.

7. (3 points) Which of the following algorithms does not require a heap for its efficient implementation?
   A. Huffman's algorithm
   B. Dijkstra's algorithm

C. Kruskal's algorithm

D. Prim's algorithm

8. (3 points) Which of the following graph problems cannot be solved in time that is linear with respect to the sum of the number of vertices and edges in the graph (i.e. $O(m + n)$).

   A. determining if a simple graph is connected

   B. determining if a simple graph is bipartite

   C. determining a minimum spanning tree for a connected weighted graph

   D. determining a topological sort of the vertices for a directed acyclic graph

9. (3 points) Let $G = (V, E)$ be the undirected graph whose edges are $(a, b), (b, c), (c, d), (a, d)$. If T is the depth-first spanning tree of G rooted at vertex a, it follows that T has branch(es).

   A. 1

   B. 2

   C. 3

   D. 4

10. (3 points) The worst case running time $T(n)$ for inserting n elements into an initially-empty binary search tree is:

    A. T(n) = $O(n^2)$.

    B. T(n) = $O(n \log n)$.

    C. T(n) = $O(n)$.

    D. T(n) = $O(n \log n)$.

11. (3 points) Binary search tree T is said to be balanced when, for every node n in T,

    A. n's left and right subtrees have equal height.

    B. n's left and right subtrees have equal size.

    C. n's left and right subtrees have heights that differ by at most one.

    D. n's left and right subtrees have sizes that differ by at most one.

12. (3 points) If numbers from the set $1, ..., n$ are selected at random (without replacement) and inserted into an initially-empty binary search tree, then the big-O expression that best describes the average (taken over all possible resulting trees) height of the resulting tree is:

    A. $O(n)$.

    B. $O(\log n)$.

    C. $O(n \log n)$.

    D. $O(n^2)$.

13. (3 points) Which of the following sorting tasks would not be appropriate for Counting Sort?

    A. sorting millions of products by their 15-digit serial numbers

    B. sorting millions of employees by their ages

    C. sorting each day of the calendar year by the high temperature (in Celsius rounded to the nearest integer degree) recorded in the city of Long Beach on that given day

    D. sorting each vehicle registered in the state of California by the year it was manufactured

14. (3 points) Quicksort is guaranteed to run in time $O(n \log n)$ so long as the pivot is
    A. randomly selected.
    B. set to the median of the first, middle, and last array element.
    C. set to the median of the array.
    D. none of the above

15. (3 points) When following Kruskal's algorithm, the greedy choice is to
    A. remove the edge of greatest cost from the graph so long as its removal does not disconnect the graph.
    B. add the edge of least cost to the forest so long as its addition does not create a cycle.
    C. add the vertex having least connection cost to the current tree.
    D. remove the vertex having greatest connection cost from the tree.

16. (3 points) Which of the following greedy algorithms has an implementation that most resembles that of Dijkstra's algorithm?
    A. Kruskal's algorithm
    B. Prim's algorithm
    C. Huffman's algoirthm
    D. Floyd-Warshall algorithm

17. (3 points) When following Huffman's algorithm, the greedy choice is to:
    A. select the two probabilities of least value for merging.
    B. select the two probabilities of greatest value for merging.
    C. add the codeword of shortest length to the code being constructed.
    D. remove the codeword of greatest length from the code being constructed.

18. (3 points) In dynamic-programming "memoization" refers to
    A. storing the dynamic-programming recurrence in a static array so that it may be applied at each level of recursion.
    B. storing solutions to smaller subproblems for future look up when solving larger subproblems.
    C. the ability of a dynamic-programming algorithm to remember the current location in the recursion tree.
    D. the ability to remember dynamic-programming recurrences for a comprehensive exam.

19. (3 points) Which of the following is false in the case of a spanning tree of a graph G?
    A. It is tree that spans G
    B. It is a subgraph of the G
    C. It includes every vertex of the G
    D. It can be either cyclic or acyclic

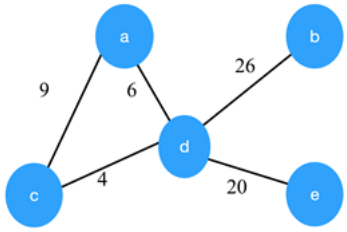
20. (3 points) Every graph has only one minimum spanning tree.
    A. True
    B. False

21. (3 points) Consider a complete graph G with 4 vertices. The graph G has _____ spanning trees.

    A. 15
    B. 8
    C. 16
    D. 13

22. (3 points) The travelling salesman problem can be solved using _____ ?

    A. A spanning tree
    B. A minimum spanning tree
    C. Bellman – Ford algorithm
    D. DFS traversal

23. (3 points) Consider the graph shown below. Which of the following are the edges in the MST of the given graph? 

The edges in the MST of the given graph is (a-d)(d-c)(d-b)(d-e)

    A. (a-c)(c-d)(d-b)(d-b)
    B. (c-a)(a-d)(d-b)(d-e)
    C. (a-d)(d-c)(d-b)(d-e)
    D. (c-a)(a-d)(d-c)(d-b)(d-e)

24. (3 points) Which of the following is false?

    A. Spanning trees do not have any cycles
    B. MST have n – 1 edges if the graph has n edges
    C. Edge e belonging to a cut of the graph if has the weight smaller than any other edge in the same cut, then the edge e is present in all the MSTs of the graph
    D. Removing one edge from the spanning tree will not make the graph disconnected

25. (3 points) Recursion is a method in which the solution of a problem depends on _____

    A. Larger instances of different problems
    B. Larger instances of the same problem
    C. Smaller instances of the same problem
    D. Smaller instances of different problems

26. (3 points) Which of the following problems can't be solved using recursion?

    A. Factorial of a number
    B. Nth fibonacci number
    C. Length of a string
    D. Problems without base case

27. (3 points) Recursion is similar to which of the following?

    A. Switch Case
    B. Loop
    C. If-else
    D. if elif else

28. (3 points) In recursion, the condition for which the function will stop calling itself is _____

    A. Best case
    B. Worst case
    C. Base case
    D. There is no such condition

29. (3 points) What will happen when the below code snippet is executed?

```
void my_recursive_function()
{
  my_recursive_function();
}
int main()
{
  my_recursive_function();
  return 0;
}
```

    A. The code will be executed successfully and no output will be generated
    B. The code will be executed successfully and random output will be generated
    C. The code will show a compile time error
    D. The code will run for some time and stop when the stack overflows

30. (3 points) What is the output of the following code?

```
void my_recursive_function(int n)
{
   if(n == 0)
   return;
   cout<<n<<" ";
   my_recursive_function(n-1);
}
int main()
{
   my_recursive_function(10);
   return 0;
}
```

    A. 10
    B. 1
    C. 10 9 8 . . . 1 0
    D. 10 9 8 . . . 1

31. (3 points) What is the base case for the following code?

```
void my_recursive_function(int n)
{
    if(n == 0)
    return;
    cout<<n<<" ";
    my_recursive_function(n-1);
}
int main()
{
    my_recursive_function(10);
    return 0;
}
```

A. $return$
B. $cout << n << " ";$
C. $if(n == 0)$
D. my_recursive_function$(n-1)$

32. (3 points) How many times is the recursive function called, when the following code is executed?

```
void my_recursive_function(int n)
{
    if(n == 0)
    return;
    cout<<n<<" ";
    my_recursive_function(n-1);
}
int main()
{
    my_recursive_function(10);
    return 0;
}
```

A. 9
B. 10
C. 11
D. 12

33. (3 points) What does the following recursive code do?

```
void my_recursive_function(int n)
{
    if(n == 0)
    return;
    my_recursive_function(n-1);
    cout<<n<<" ";
}
int main()
{
    my_recursive_function(10);
    return 0;
}
```

A. Prints the numbers from 10 to 1
B. Prints the numbers from 10 to 0
C. Prints the numbers from 1 to 10
D. Prints the numbers from 0 to 10

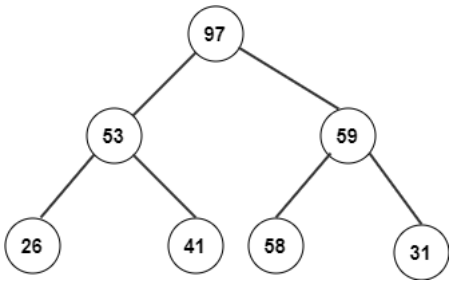
34. (3 points) Which of the following statements is true?
A. Recursion is always better than iteration
B. Recursion uses more memory compared to iteration
C. Recursion uses less memory compared to iteration
D. Iteration is always better and simpler than recursion

35. (3 points) What is the output of the following code?

```
int cnt = 0;
void my_recursive_function(char *s, int i)
{
    if(s[i] == '\0')
      return;
    if(s[i] == 'a' || s[i] == 'e' || s[i] == 'i' || s[i] == 'o' || s[i] == 'u')
    cnt++;
    my_recursive_function(s,i+1);
}
int main()
{
    my_recursive_function("thisisrecursion",0);
    cout<<n<<" ";
    return 0;
}
```

A. 6
B. 9
C. 5
D. 10

36. (3 points) Consider the following heap after buildheap phase. What will be its corresponding array?



A. 26,53,41,97,58,59,31
B. 26,31,41,53,58,59,97
C. 26,41,53,97,31,58,59
D. 97,53,59,26,41,58,31

37. (3 points) It is possible to have gaps in the array holding data for a binary heap:
A. True

B. False

38. (3 points) A binary heap is always structured like a complete tree:
    A. True
    B. False

39. (3 points) In binary tree sort, we first construct the BST and then we perform _____ traversal to get the sorted order.
    A. inorder
    B. postorder
    C. preorder
    D. level order

40. (3 points) When is linear searching used?
    A. For small number of items
    B. When performing a single search in an unordered list
    C. Used all the time
    D. Used when items are ordered since its faster

41. (3 points) What is the best case for linear search?
    A. $O(n\ log\ n)$
    B. $O(log\ n)$
    C. $O(n)$
    D. $O(1)$

42. (3 points) What is the worst case for linear search?
    A. $O(n\ log\ n)$
    B. $O(log\ n)$
    C. $O(n)$
    D. $O(1)$

43. (3 points) What is the advantage of recursive approach than an iterative approach?
    A. Consumes less memory
    B. Less code and easy to implement
    C. Consumes more memory
    D. More code has to be written

44. (3 points) Which of the following algorithms solves the unweighted single source shortest path problem?
    A. breadth first search
    B. depth first search
    C. Dijkstra's algorithm
    D. Kruskal's algorithm
    E. Prim's algorithm

45. (3 points) Which sorting algorithm has the same average and worst-case time bounds (in Big-Oh) as heapsort?
    A. insertion sort
    B. mergesort
    C. quicksort
    D. shellsort
    E. none of the above

46. (3 points) How much extra space is used by heapsort?
    A. $O(n \log n)$
    B. $O(\log n)$
    C. $O(n^2)$
    D. $O(1)$
    E. none of the above

47. (3 points) A node with key 8 has a left child with key 10. Which of the following objects could this node be found in?
    A. binary search tree
    B. max heap
    C. min heap
    D. two of the above
    E. none of (a), (b), and (c)

48. (3 points) Which data structure is used by the compiler to implement recursion?
    A. hash table
    B. priority queue
    C. queue
    D. search tree
    E. stack

49. (3 points) 6, 8, 4, 3, and 1 are inserted into a data structure in that order. An item is deleted using only a basic data structure operation. If the deleted item is a 1, the data structure cannot be a:
    A. hash table
    B. priority queue
    C. queue
    D. search tree
    E. stack

50. (3 points) Jobs sent to a printer are generally placed on a
    A. binary search tree
    B. hash table
    C. priority queue

D. queue

E. stack

51. (3 points) Linked lists are used in

A. double hashing

B. linear probing

C. quadratic probing

D. separate chaining

E. all of the above

52. (3 points) Primary clustering occurs in

A. linear probing

B. quadratic probing

C. separate chaining

D. all of the above

E. none of (a) , (b), and (c)

53. (3 points) Rehashing can be used in

A. linear probing

B. quadratic probing

C. separate chaining

D. all of the above

E. none of (a), (b), and (c)

54. (3 points) In a separate chaining hash table with load factor = 0:8, what is the average length of a list?

A. 0.8

B. 1.0

C. 1.25

D. there is not enough information

E. there is enough information, but none of the above are correct

55. (3 points) Which of the following costs are equal in a probing hash table?

A. insertion and successful search

B. insertion and unsuccessful search

C. successful search and unsuccessful search

D. insertion, successful search, and unsuccessful search

E. none of the above

56. (3 points) Which of the following data structures requires more than constant average time for insertions?

A. hash table

B. queue

C. search tree

D. stack

E. all of the above have constant time insertion algorithms

57. (3 points) What is the range of values computed by the hash function H ash(X) = X mod 100?

A. 0 to 99

B. 0 to 100

C. 1 to 99

D. 1 to 100

58. (3 points) How are elements deleted in linear probing?

A. deletion is not allowed

B. they are changed to zero

C. they are marked deleted

D. unchecked deallocation

E. none of the above

59. (3 points) The following items are inserted into an AVL tree: 1, 2, 3, 8, 6. How many rotations are performed?

A. no rotations

B. 1 single rotation only

C. 1 double rotation only

D. 1 single rotation and 1 double rotation

E. none of the above

60. (3 points) The following items are inserted into a binary search tree: 8, 3, 4, 9, 5, 6, 2, 1, 7. Which item is placed at a root?

A. 1

B. 4

C. 8

D. 9

E. none of the above

61. (3 points) The following items are inserted into a binary search tree: 3, 6, 5, 2, 4, 7, 1. Which node is the deepest?

A. 1

B. 3

C. 4

D. 7

E. none of the above

62. (3 points) Which of the following statements is true about deleting the root of a binary search tree?

A. the root pointer always changes

B. the root pointer changes if it does not have two children

C. if the root has two children, its item is replaced by the largest element in the right subtree

D. all of the above

E. none of (a), (b), and (c)

63. (3 points) For an insertion of a single item into an n-item AVL tree, the maximum number of rotations (double rotations count as one rotation) is:

A. 1

B. 2

C. approximately $log\ n$

D. approximately $1:44\ log\ n$

E. none of the above