Short Answers

P1. (4pts, 2pts each) Q11 on page 668, Q16 on page 669

11.3 $O(N \log_2 N)$ Sorts

11. A merge sort is used to sort an array of 1,000 test scores in descending order. Which one of the following statements is true?
    a. The sort is fastest if the original test scores are sorted from smallest to largest.
    b. The sort is fastest if the original test scores are in completely random order.
    c. The sort is fastest if the original test scores are sorted from largest to smallest.
    d. The sort is the same, no matter what the order of the original elements.

16. Which is true about the quick sort?
    a. A recursive version executes faster than a nonrecursive version.
    b. A recursive version has fewer lines of code than a nonrecursive version.
    c. A nonrecursive version takes more space on the run-time stack than a recursive version.
    d. It can be programmed only as a recursive function.

11. D
16. A

P2. (4pts) Q22 on page 669

22. A very large array of elements is to be sorted. The program will be run on a personal computer with limited memory. Which sort would be a better choice: a heap sort or a merge sort? Why?

Although both of these sorting algorithms are O(n log n) time complexity, the heap sort works better with limited amount of data(aka the personal computer) and with a large array.

Merge sort: In the worst case, the number of comparisons merge sort makes is equal to or slightly smaller than ($n \lceil \lg n \rceil - 2^{\lceil \lg n \rceil} + 1$), which is between ($n \lg n - n + 1$) and ($n \lg n + n + O(\lg n)$); merge sort's worst case complexity is $O(n \log n)$

Heap sort: Although somewhat slower in practice on most machines than a well-implemented quicksort, it has the advantage of a more favorable worst-case $O(n \log n)$ runtime and is therefore more appropriate than merge sort given there is a large array of elements.

P3. (6pts, 2pts each) Q33 on page 671

33. The element being searched for *is not* in an array of 100 elements. What is the *average* number of comparisons needed in a sequential search to determine that the element is not there

a. if the elements are completely unsorted?

b. if the elements are sorted from smallest to largest?

c. if the elements are sorted from largest to smallest?

A) N comparisons = 100
B) N/2 comparisons = 50
C) N/2 Comparisons = 50

P4. (10pts, 2pts each) Q18 on page 581

18. A complete binary tree is stored in an array called `treeNodes`, which is indexed from 0 to 99, as described in this section. The tree contains 85 elements. Mark each of the following statements as true or false, and explain your answers.

a. `treeNodes[42]` is a leaf node.

b. `treeNodes[41]` has only one child.

c. The right child of `treeNodes[12]` is `treeNodes[25]`.

d. The subtree rooted at `treeNodes[7]` is a full binary tree with four levels.

e. The tree has seven levels that are full, and one additional level that contains some elements.

a)False, it has two children and therefore is not a leaf node.
b)False, it has 2 children which are the 82th and 83th nodes.
c)True, Right child equals n+1
d)False, it would only have 3 full levels below it
e)False, it would be 6 levels with some left over

P5. (11pts, 1pt each) Q1 on page 612

1. True/False. Explain your answer—in some cases drawing an example figure suffices for an explanation.
   a. A graph can have more vertices than edges.
   b. A graph can have more edges than vertices.
   c. A graph with just one vertex is connected.
   d. An edgeless graph with two or more vertices is disconnected.
   e. A graph with three vertices and one edge is disconnected.
   f. A connected graph with N vertices must have at least $N-1$ edges.
   g. A graph with five vertices and four edges is connected.
   h. An edge cannot connect a vertex to itself.
   i. All graphs are trees.
   j. All trees are graphs.
   k. A directed graph must be weighted.

a)True,consider an undirected graph with 5 vertices, it will have 4 edges
b)True, a straight line directed graph with 6 vertices will have 7 edges.
c) False, A graph is only connected when it consists of connected components which are a set of vertices that are connected to each other and their associated edges.
d) True, edges are defined as a pair of vertices which rep a connection between two vertices in the graph therefore a graph cannot be both connected and edgeless.
e) True, there is no scenario where a graph with 1 edge and 3 vertices can be complete or connected.
f) True, if there are N vertices there are N* (N-1) edges for complete directed graphs and N*(N-1)/2 edges in a complete undirected graph.
g) True.It’s not circular but it’s connected.
h)True, an edge must connect a pair of vertices.
i)False, in graphs there are no restrictions on having only one parent node.
j)True, since graphs are less restricted than trees and inherit their structure from them this is T
k) False, we can have directions on a graph without weight attached to it.