THE UNIVERSITY OF WESTERN AUSTRALIA

MID SEMESTER EXAMINATION
April 2019

DEPARTMENT OF COMPUTER SCIENCE & SOFTWARE ENGINEERING

DATA STRUCTURES AND ALGORITHMS CITS2200

This Paper Contains:
6 Pages
10 Questions

Time allowed: Forty five minutes

Marks for this paper total 10.
Students should answer ALL Questions.
Q1. Which one of the following is the correct recurrence for the quicksort algorithm?

(A) $T(n) = T(n^{\frac{1}{2}})$  
(B) $T(n) = 2T\left(\frac{n}{2}\right) + c\frac{n}{2}$  
(C) $T(n) = T(n-1) + cn.$  
(D) None of the above.

Q2. Which one of the following statements about the worst-case complexity of quicksort is correct?

(A) The worst-case complexity of quicksort is $O(\log n)$.  
(B) The worst-case complexity of quicksort is $O(\sqrt{n} \log n)$.  
(C) The worst-case complexity of quicksort is $O(n \log n)$.  
(D) None of the above.

Q3. Suppose $f(n)$ is $O(g(n))$, $g(n)$ is $O(h(n))$, and $h(n)$ is $O(g(n))$. Which of the following are possible functions for $f$, $g$ and $h$?

(A) $f(n) = \log^2 n, g(n) = n \log n, h(n) = n^2.$  
(B) $f(n) = n \log n, g(n) = n^2, h(n) = n^2 \log n.$  
(C) $f(n) = 5 \log n, g(n) = 10 \log n, h(n) = 5000 \log n.$  
(D) $f(n) = n^2, g(n) = n^4, h(n) = 2^n.$
Q4. Which of the following is a correct statement?

(A) $f(n)$ is $O(g(n))$ if there is a constant $c > 0$ and an integer $n_0 \geq 1$ such that, for all $n < n_0$, $f(n) \leq cg(n)$.

(B) $f(n)$ is $O(g(n))$ if there is a constant $c > 0$ and an integer $n_0 \geq 1$ such that, for all $n \geq n_0$, $f(n) \leq cg(n)$.

(C) $f(n)$ is $O(g(n))$ if there is a constant $c > 0$ and an integer $n_0 \geq 1$ such that, for all $n \geq c$, $f(n) \leq cg(n)$.

(D) $f(n)$ is $O(g(n))$ if there is a constant $c > 0$ and an integer $n_0 \geq 1$ such that, for all $n_0 \geq n$, $f(n) \leq cg(n)$.

Q5. Suppose $f(n) = 2^{5 \log n}$, $g(n) = n^2$, $h(n) = n\sqrt{n}$, $k(n) = n \log n$, $p(n) = n^2 \log n$. Which of the following is a correct ordering of these complexities in ascending order (smallest to largest)?

(A) $f(n), h(n), g(n), p(n), k(n)$.

(B) $k(n), h(n), g(n), p(n), f(n)$.

(C) $h(n), k(n), f(n), g(n), p(n)$.

(D) $p(n), k(n), f(n), g(n), h(n)$.
Q6. Consider the following figure:

Using the definition of the `Link` class from the lectures and labs, which one of the following codes transforms the first figure to the second figure?

(A) `first.successor.successor=new Link(d, first.successor.successor)`
(B) `first.successor.successor.successor=new Link(d,first.successor)`
(C) `first.successor=new Link(d,first.successor.successor)`
(D) `first.successor.successor.successor= new Link(d,first.successor.successor.successor.successor)`
Q7. Consider the following figure:

Using the definition of the Link class from the lectures and labs, which one of the following codes transforms the first figure to the second figure?

(A)

```java
char temp = first.successor.item;
first.successor.item = first.successor.successor.item;
first.successor.successor.item = temp;
first.successor.successor = first;
```

(B)

```java
char temp = first.successor.item;
first.successor.successor.item = temp;
first.successor.item = first.successor.successor.item;
first.successor.successor.successor = first;
```

(C)

```java
char temp = first.successor.item;
first.successor.item = first.successor.successor.item;
first.successor.successor.item = temp;
first.successor.successor.successor = first;
```

(D)

```java
char temp = first.item;
first.successor.successor.item = temp;
first.successor.item = first.successor.successor.item;
first.successor.successor = first;
```
Q8. Which of the following statements is true?

(A) The worst-case complexity of quicksort is $O(n \log n)$ and the worst-case complexity of mergesort is $O(n^2)$.
(B) Both quicksort and mergesort have worst-case complexities $O(n^2)$.
(C) Both quicksort and mergesort have worst-case complexities $O(n \log n)$.
(D) The worst-case complexity of quicksort is $O(n^2)$ and the worst-case complexity of mergesort is $O(n \log n)$.

Q9. Which of the following definitions of a tree is correct?

(A) Every internal node of a tree has two children;
(B) There is a unique path between a pair of nodes in a tree;
(C) The height of a tree is $O(n)$;
(D) The height of a tree is $O(\log n)$;

Q10. Which of the following statements is true?

(A) Deleting an item from a stack is an $O(n)$ operation, and deleting an item from a queue is an $O(1)$ operation.
(B) Deleting an item from a stack is an $O(1)$ operation, and deleting an item from a queue is an $O(n)$ operation.
(C) Deleting an item from a stack is an $O(n)$ operation, and deleting an item from a queue is an $O(n)$ operation.
(D) none of the above.