

ADSSE 2023 Answers

Question 1

- a) False
- b) True
- c) False
- d) True
- e) False
- f) True
- g) False
- h) True
- i) False
- j) True

[1 mark for each correct part]

Question 2

- a) $\Theta(\sqrt{n} \lg n)$
- b) $\Theta(n^3)$
- c) $\Theta(n^3)$
- d) $\Theta(n^2 \lg n)$
- e) $\Theta(n)$

[2 marks for each part]

Question 3

- a) The key at each node is less than or equal to that of its parent. [2 marks]
- b) Yes [2 marks]
- c)

```
PARENT(i)
```

```
1 return  $\lfloor i/2 \rfloor$ 
```

```
LEFT(i)
```

```
1 return  $2i$ 
```

```
RIGHT(i)
```

```
1 return  $2i + 1$  [1 mark each]
```

- d) 1. Parent can be implemented by shifting binary representation of i one bit to the right. [1 mark]
- 2. Left can be implemented by shifting binary representation of i one bit to the left. [1 mark]
- 3. Right can be implemented by shifting binary representation of i one bit to the left and then adding 1 as the low-order bit. [1 mark]

Question 4

- a) C
- b) B
- c) A
- d) B
- e) A

[2 marks each]

Question 5

- a) 5 7 9
- b) 3 blocks per grid, 1 thread per block
- c) CPU memory

- d) device memory
- e) 27-29

[2 marks for each part]

Question 6

- a) {4,2,1,3,4,7,5,6,8,9}
- b) 5
- c) $O(n)$
- d) Anything strictly less than linear. For example, $\omega(1)$ or $\omega(\sqrt{n})$.
- e) r

[2 marks for each part]

Question 7

- a) Theta(n). Occurs when all the data is hashed to the same slot.
- b) $O(1)$. Occurs when the hash function is chosen so that we have simple unified hashing and the chains are all approximately the same length.
- c) $O(n)$. Occurs when the searched element is not present in the list.
- d) n/m
- e) Simple unified hashing is when any given element in the data is equally likely to be hashed to any of the slots in a hash table. In this case, the expected length of a chain on a slot is equal to the load factor.

[2 marks for each correct part]

Question 8

- a) Product backlog is the model of the work to be done, ordered list of product requirements, includes user stories, features, bug fixes, visible to everyone but only changed by product owner. [2 marks]
- b) Sprint is a time-boxed iteration lasting 1 week to 1 month. Starts with a planning event, ends with a sprint review and retrospective. At end of each sprint, software should be integrated, tested, documented and potentially releasable. [2 marks]
- c)
 - i. Product owner represents product's stakeholders, responsible for the product backlog, defines product in user-centric terms, adds user stories to product backlog and prioritizes them, focuses on business side, not the scrum master. [2 marks]
 - ii. The development team delivers a potentially releasable product after each sprint, consists of 3 to 9 members, is self-organising, facilitated by scrum master. [2 marks]
 - iii. Scrum master removes obstacles to the team achieving its goals, ensures scrum framework is followed, helps product owner maintain product backlog, helps team determine when job is done, coaches team, promoting self-organization, not a manager. [2 marks]

Question 9

- a) i. Factory method is Creational. ii. Singleton is Creational. iii. Decorator is Structural. [3 marks]
- b) Where a client sends messages to objects whose types are as high up in the inheritance hierarchy as possible. It is then easy to define new subclasses that a client can use without having to change the client, which reduces coupling between components. [3 marks]
- c) Inheritance is where objects of a subclass inherit functionality from superclasses; composition is where an object gains functionality by virtue of having a member of a class that provides

that functionality. Inheritance is sometimes called “white-box reuse” because the subclass knows something about the internals of its superclasses. Composition is generally considered preferable because inheritance breaks encapsulation and increases coupling, whereas composition does not. [4 marks]

Question 10

Needs a description of the randomized select algorithm. Worst-case time is $\Theta(n^2)$.

```
PARTITION( $A, p, r$ )
1  $x = A[r]$ 
2  $i = p - 1$ 
3 for  $j = p$  to  $r - 1$ 
4     if  $A[j] \leq x$ 
5          $i = i + 1$ 
6     exchange  $A[i]$  with  $A[j]$ 
7 exchange  $A[i + 1]$  with  $A[r]$ 
8 return  $i + 1$ 
```

```
RANDOMIZED-PARTITION( $A, p, r$ )
1  $i = \text{RANDOM}(p, r)$ 
2 exchange  $A[r]$  with  $A[i]$ 
3 return PARTITION( $A, p, r$ )
```

```
RANDOMIZED-SELECT( $A, p, r, i$ )
1 if  $p == r$ 
2     return  $A[p]$ 
3  $q = \text{RANDOMIZED-PARTITION}(A, p, r)$ 
4  $k = q - p + 1$ 
5 if  $i == k$  // the pivot value is the answer
6     return  $A[q]$ 
7 elseif  $i < k$ 
8     return RANDOMIZED-SELECT( $A, p, q - 1, i$ )
9 else return RANDOMIZED-SELECT( $A, q + 1, r, i - k$ )
```