CW1 Algorithms (COMP0005)

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**Question 1**

1.a) The complexity of an unsuccessful search for the given algorithm is its asymptotically worst case, constant . Unsuccessful search implies the absence of the ‘key’ or a particular element in a given array . Subsequently, the number of comparisons made is equivalent to the length of the array. The algorithm will compare each element iterating to to ‘key’, hence the expected number of comparisons made is , meaning the time complexity of the given unsuccessful search is however the constants are ignored due to its insignificance at large numbers of n, hence O(n).

1.b) The asymptotic time complexity (worst case) for a successful search for the given algorithm is when the element that is searched for is the last element of the array . In that case, the algorithm would need to make comparisons, with the last element resulting in returning index of the ‘key’. Ergo, time complexity is or just .

1.c) The average number of comparisons made is , where is the number of elements in array .

**Question 2**

2.a) Yes, since,

2.b) A similar statement would still be true for an arbitrary value of a:

**Question 3**

Given an array , such that all appear before , the following pseudocode describes a search algorithm to return the smallest index of an element , such that . The function takes in the following parameters:

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

Calculating the time complexity of the SEARCH algorithm:

Length of the array after the first iteration , where is the length of the array . Subsequently, after some iterations, the length of the array equates to , which eventually, at some value of becomes . Therefore,

Thus,

The “if”, “else” statements at lines 4, 5, 7, 9, 11 all take constant time to execute. Conclusively, since the algorithm is a variation of the binary search algorithm, it follows that the asymptotic running time complexity of the SEARCH algorithm is . Full implementation of the given algorithm in Python language can be viewed below:

A screenshot of a cell phone

Description automatically generated

**Question 4**

4.1) has complexity

4.2) has complexity

4.3) has complexity of

4.4) has complexity of

4.5) has complexity of

4.6) has complexity of )