Unit 4, Week 3

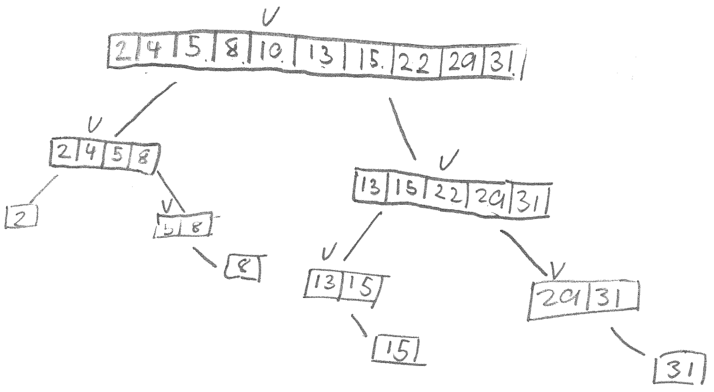
Answer these questions on a separate piece of paper.

Binary Search Algorithm

1. Draw a binary search tree showing how to search for a given number in the following array, using the pseudocode specified.

Index	1	2	3	4	5	6	7	8	9	10
Item	2	4	5	8	10	13	15	22	29	31

```
def binary_search(array, target):
    L = len(array)
    if L == 0:
        return -1
    pivot = L // 2
    if array[pivot] == target:
        return pivot
    elif array[pivot] < target:
        result = binary_search(array[pivot+1:L], target)
        if result == -1:
            return -1
        else:
            return pivot + 1 + result
    else:
        return binary_search(array[0:pivot], target)
```



2. What does a return value of -1 signify?

Value Not Found

3. State which items could take the longest to find using this tree.

8, 15, 31

4. What must be true about the array for all items to take the same amount of time to find?

One element in length

5. For each of the arrays below, explain why binary search does not work:

(a)

Index	0	1	2	3	4
Item	1	2	2	3	5

Duplicate Elements

(b)

Index	0	1	2	3	4
Item	3	2	4	9	1

Unordered

Sorting Algorithms

6. Considering MergeSort and QuickSort:

a. Which algorithm requires the most storage space?

Both have a worse case space complexity of O(n)
Quicksort has a better avg case, O(log n)

b. Which algorithm is the most efficient for **any** given data set? Why?

Mergesort, always has the same number of ops for the same sised input array, O(n log n)

Quicksort can be slower if the array structure results in imbalenced partitions, $O(n^2)$

c. Which algorithm chooses a random pivot to divide the data? Why does it do this?

Quicksort

Random Pivot minimises the chance of encountering the worse case TC

Split the array into values smaller/larger than the Pivot

d. Which algorithm best describes the following pseudocode:

```
function sort(array)
    if length(array) ≤ 1
        return array

    pivot = choose pivot element from array
    left = empty array
    right = empty array

    for each element in array
        if element < pivot
            append element to left
        else if element > pivot
            append element to right
        else
            // do nothing, element equal to pivot

    left = sort(left)
    right = sort(right)

    return concatenate(left, pivot, right)
```

Quicksort

e. Write a one line description for each sorting algorithm.

Mergesort devides the array into halves recursively
until the problem is trivial, sorts them and merges

Quicksort partitions the array into elements less
than and greater than the pivot then recursively
sorts the partitions