OCR Computer Science AS Level

2.3.1 Sorting Algorithms

Concise Notes

Specification:

- Standard algorithms
    - Bubble sort
    - Insertion sort

Sorting Algorithms

- Take a number of elements in any order and output them in a logical order
- This is usually numerical or lexicographic (phonebook style ordering)
- Most output elements in ascending order, but can typically be slightly altered or their output reversed in order to produce an output in descending order

Bubble Sort
- Makes comparisons and swaps between pairs of elements
- The largest element in the unsorted part of the input is said to "bubble" to the top of the data with each iteration of the algorithm
  - Starts at the first element in an array and compares it to the second
  - If they are in the wrong order, the algorithm swaps the pair
  - The process is then repeated for every adjacent pair of elements in the array, until the end of the array is reached
- This is one pass of the algorithm
- For an array with n elements, the algorithm will perform n passes through the data
- After n passes, the input is sorted and can be returned

```
A = Array of data

    for i = 0 to A.length - 1:
        for j = 0 to A.length - 2:
            if A[j] > A[j+1]:
                swap A[j] and A[j+1]
    return A
```

- Can be modified to improve efficiency
- A flag recording whether a swap has occurred is introduced
- If a full pass is made without any swaps, then the algorithm terminates
- With each pass, one fewer element needs comparing as the n largest elements are in position after the nth pass
- Bubble sort is a fairly slow sorting algorithm, with a time complexity of $O(n^2)$

Insertion Sort
- Places elements into a sorted sequence
- In the ith iteration of the algorithm the first i elements of the array are sorted
  - Warning: although the i elements are sorted, they are not the i smallest elements in the input!
- Stars at the second element in the input, and compares it to the element to its left
- When compared, elements are inserted into the correct position in the sorted portion of the input to their left
- This continues until the last element is inserted into the correct position, resulting in a fully sorted array
- Has the same time complexity as bubble sort, $O(n^2)$

A = Array of data

```
for i = 1 to A.length - 1:
    elem = A[i]
    j = i - 1
    while j > 0 and A[j] > elem:
        A[j+1] = A[j]
        j = j - 1
    A[j+1] = elem
```