Computer Science · Revision

Algorithms Notes

Computational thinking, searching and sorting. Be ready to trace these by hand and to compare them.

Computational thinking

Skill	Meaning
Decomposition	Breaking a problem into smaller parts
Abstraction	Removing unnecessary detail
Algorithmic thinking	Designing clear steps to solve the problem

Linear search

Check each item in turn until you find the target or reach the end. It works on unsorted lists, but is slow on large ones.

```
for i = 0 to items.length - 1
    if items[i] == target then
        return i
    endif
next i
return -1
```

Binary search

The list **must be sorted**. Check the middle item, then discard the half that can't contain the target. Repeat.

Find 23 in [2, 5, 8, 12, 16, 23, 38]:

middle = 12
23 is bigger, so keep [16, 23, 38].

middle = 23
Found it, after 2 comparisons.

Bubble sort

Compare neighbouring items and swap them if they're in the wrong order. Repeat passes until a full pass makes no swaps.

Pass	List after the pass
Start	5, 3, 8, 1
1	3, 5, 1, 8
2	3, 1, 5, 8
3	1, 3, 5, 8

A fourth pass makes no swaps, so the list is sorted.

Common slip: one *pass* is the whole way through the list, not a single swap.

Insertion sort

Take each item in turn and insert it into the correct place in the sorted part on the left.

Step	List
Start	**5**, 3, 8, 1
Insert 3	**3, 5**, 8, 1
Insert 8	**3, 5, 8**, 1
Insert 1	**1, 3, 5, 8**

Merge sort

Keep splitting the list in half until each part has one item, then merge the parts back together in order.

Stage	Lists
Split	[6, 2] [7, 4]
Split	[6] [2] [7] [4]
Merge	[2, 6] [4, 7]
Merge	[2, 4, 6, 7]

Which should you use?

Algorithm	Good	Not so good
Linear search	Simple, works on unsorted data	Slow on long lists
Binary search	Very fast on long lists	List must be sorted first
Bubble sort	Simple, uses little memory	Slow on long lists
Insertion sort	Simple, good on short or nearly sorted lists	Slow on long lists
Merge sort	Fast on long lists	Uses more memory, more complex

Trace tables

Write one column per variable and add a new row whenever a value changes. Tracing this code, where total starts at 0:

```
for i = 1 to 3
    total = total + i
next i
```

i	total
1	1
2	3
3	6

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