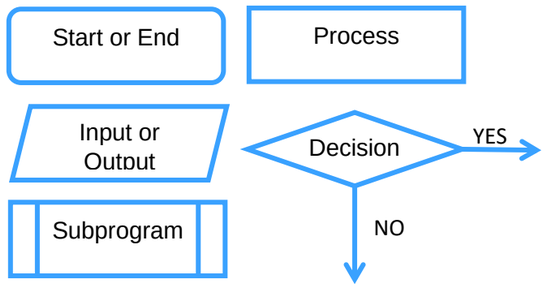
Unit 1 – Fundamentals of Algorithms

Flowcharts

- Created to represent an algorithm.
- Show the data that is input, and output.
- Show processes that take place.
- Show any decisions and repetitions that take place.
- Lines show flow through the chart.
- Shapes represent different functions



Searching Algorithms

Linear Search

1. Check the first value
2. If it is desired value
   - Stop
3. Otherwise check the second value
4. Keep Going until all elements have been checked or the value is found

Binary Search

1) Put the list in order.
2) Take the middle value.
3) Compare it to the desired value.
   a) If it is the desired value.
      i) Stop.
   b) If it is larger than the desired value.
      i) Take the list to the left of the middle value.
   c) If it is smaller than the desired value.
      i) Take the list to the right of the middle value.
4) Repeat step 3 with the new list.

Trace Tables

- Tests algorithms for logic errors which occur when the algorithm is executed.
- Simulates the steps of algorithm.
- Each stage is executed one at a time allowing inputs, outputs, variables, and processes to be checked for the correct value at each stage.

```
X = 3
Y = 1
while X > 0
      Y = Y + 1
      X = X - 1
print(Y)
```

Stage	X	Y	Output
1	3	1	
2		2	
3	2		
4		3	
5	1		
6		4	
7	0		
8			4

Key Terms

- Abstraction
  - Using symbols and variables. to represent a real-world problem with a computer program.
  - Removing unnecessary elements
  - Example - a program is to be created to let users play chess against the computer.
    - Board is created as an array(s).
    - Pieces are objects that have positions on the board
    - The shape and style of the pieces may not be required.

- Decomposition
  - Breaking down large problems into a set of smaller parts.
    - Smaller problems are easier to solve
    - Each part can be solved independently
    - Each part can be tested independently
    - The parts are combined to produce the full problem.
  - There are usually several different approaches, and not one single right way to do this.

What is an Algorithm

- An algorithm is a series of steps which can be followed to complete a task.
- A computer program may use an algorithm.
- A computer program and an algorithm are not the same thing.
- Algorithms help to work out the steps needed to solve a given problem.
- This helps us plan how to write a computer program.
- An algorithm will always finish and return an answer or perform a series of tasks that it was supposed to.

Sorting Algorithms

Bubble Sort

1) Take the first element and second element
2) Compare the two
   a) If element 1 > element 2
      i) Swap then
   b) Otherwise
      i) Do nothing
   c) Move to the next pair in the list
   d) If there are no more elements return to step (1)
   e) Otherwise, return to step (2)
3) Repeat until you have worked through the whole list without making any changes

Merge Sort

1) Split the list into individual elements.
2) Merge the elements together in pairs, putting the smallest element first.
3) Merge two pairs together, putting the smallest first.
4) Keep merging until all pairs are in order.

Comparing Algorithms

	Linear Search	Binary Search
Pros	• Works with unsorted lists • Not affected by changes to the list • Works well for small lists	• More efficient • Efficient for large lists
Cons	• Slower • Inefficient for large lists	• Does not work with unsorted lists
	Bubble Sort	**Merge Sort**
Pros	• Simplest and easiest to code • Uses less memory	• Far more efficient and faster • Consistent running time
Cons	• Slower with larger lists • Inefficient and slow	• Uses more memory • More complexed to program

Algorithm Efficiency

- Several different algorithms can solve the same problem
- Efficiency allows us to compare two different algorithms that solve the same problem.
- A more efficient algorithm is a better choice.
- The quicker the algorithm can complete its task, the more efficient it is.
- For example, an algorithm that can be executed in 10 instructions, is more efficient than one which takes 25 instructions.

Determining The Purpose of Algorithms

- There are several ways to determine the purpose of an algorithm.
- We can **dry run** the algorithm, by assigning values to its inputs, and working through to see what happens.
- **Trace Tables** allow us to record these values as the algorithm is run.
- **Visual Inspection** involves simply looking at the algorithm to determine its purpose.
- Sometimes the algorithm may follow a standard pattern which we can recognise.
- With shorter or simpler algorithms, the purpose may be obvious by simply looking at it.

Pseudocode

- Uses short English words and statements to describe an algorithm.
- Generally looks a little more structured than normal English sentences.
- Flexible.
- Less precise than a programming language.

```
IF Age is equal to 14 THEN
Stand up
ELSE Age is equal to 15 THEN
Clap
ElSE Age is equal to 16 THEN
Sing a song
ELSE
Sit on the floor
END
```

An Example Algorithm

This algorithm, written in pseudocode, follows a simple pattern for working through each letter of an input to determine if it matches a predefined word. This might form part of a hangman game

```
guess ← USERINPUT
FOR i ← 0 TO LEN(word)
  IF word[i] = guess THEN
    OUTPUT “found”
    ENDIF
ENDFOR
```