# ICS3U: Flowcharts

Pseudocode is a way of describing an algorithm using words or mathematical-like notation. **Flowcharts** are graphical depictions of an algorithm, that can help make the sequence of steps clearer. They use standardized symbols to represent different actions, and connect actions using a logical sequence that reflects the *flow* of a given algorithm.

There are many different symbols, but the ones most commonly seen in this course are shown below.
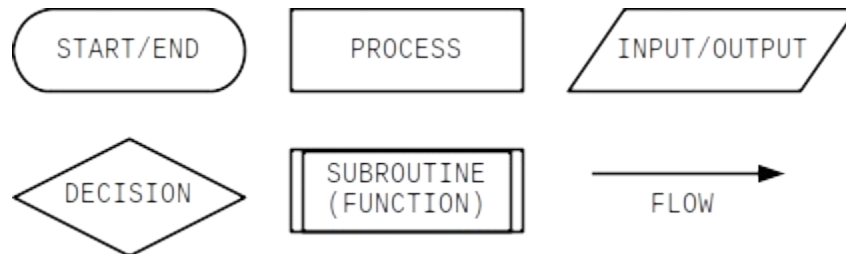
- START/END: Indicates either the beginning or the conclusion of the algorithm. Every flowchart should contain exactly one START and at least one END symbol.
- PROCESS: Indicates an operation that changes the value or the form of data, such as a computation or an assignment.
- INPUT/OUTPUT: Used when data is received from (input) or presented to (output) the user.
- DECISION: Shows two possible paths, depending on some condition, which is usually phrased as a Yes/No question. Each path is labelled Yes or No to show the direction corresponding to each answer.
- SUBROUTINE (FUNCTION): Used to indicate a pre-defined process that can be called as part of the algorithm.
- FLOW: Shows which step the algorithm moves on to once the current step is finished.

Consider an algirothm for displaying the first ten perfect squares: 1, 4, 9, 16, ..., 100. Pseudocode for such an algorithm is below.

1. SET $n \leftarrow 1$
2. WHILE $n \leq 10$:
   A. OUTPUT $n \times n$
   B. SET $n \leftarrow n+1$

The algorithm begins counting at one, then checks whether the current value of the counter is ten or less. If so, it calculates the square of the counter's value before incrementing the counter by one. This comparison-calculation-increment cycle is repeated until the counter finally exceeds ten, and the algorithm terminates.

A flowchart depicting the same algorithm is shown at the right.
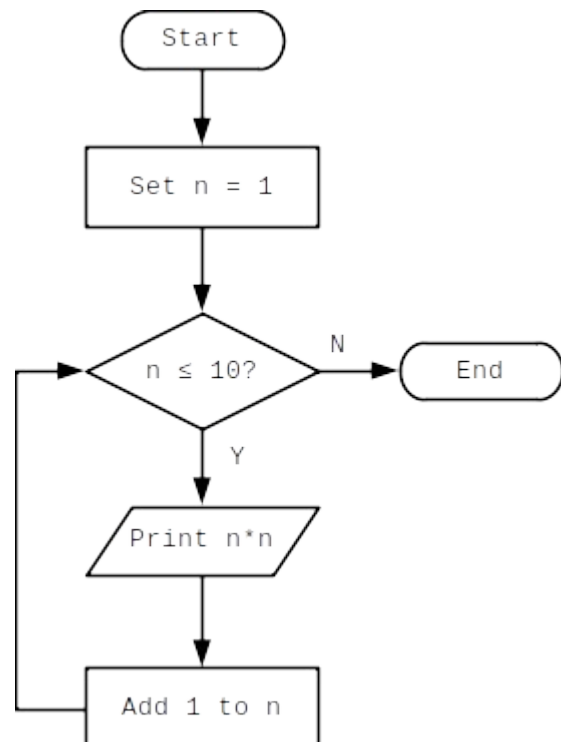
There is exactly one START and one END in this flowchart. The two PROCESSes are setting a counter and incrementing the value of the counter by one. A DECISION occurs when comparing the value of the counter to 10. If the value is less than or equal to ten, then the algorithm OUTPUTs the square and increments the counter. If not, then the algorithm ENDs.

Note that there is no separate symbol for a "loop" in a flowchart. It is indicated by an arrow which leads back to a previously-encountered PROCESS, DECISION or OUTPUT. Also note that there are exactly two arrows leading out from the DECISION, and that they are labelled Yes or No in response to the question asked.

Here is another example. Both the pseudocode and the flowchart describe an algorithm that obtains an integer, n, from the user and displays all even values between 1 and n.

1. GET n
2. SET $k \leftarrow 1$
3. WHILE $k \leq n$:
   A. IF k is divisible by 2:
      OUTPUT k
   B. SET $k \leftarrow k+1$

See if you wan work through the logic in both the pseudocode and the flowchart. Try a small value, like $n=6$, and see if you get the correct output (2, 4 and 6) from each representation.

As yo udevelop programs in this course, there will be times when it might be easier to start with a well-defined idea about how the code should work before writing any code. In these cases, using pseudocode or a flowchart can help organize your thoughts and make the actual coding easier.