Introduction

What is a flowchart?

    A flowchart is a schematic representation of an algorithm or a process or a program.
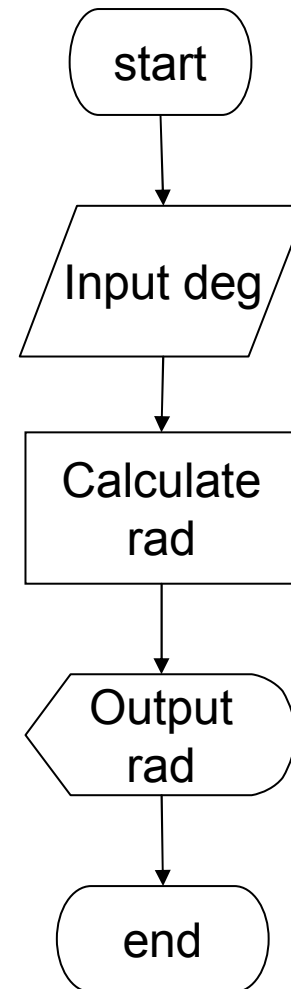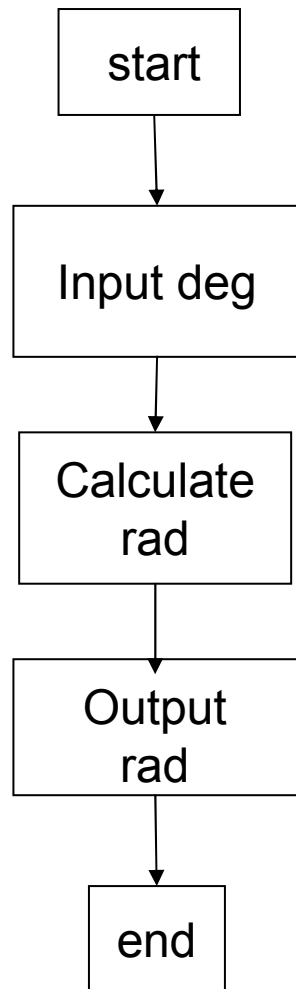
Why should a flowchart be produced before a computer program?

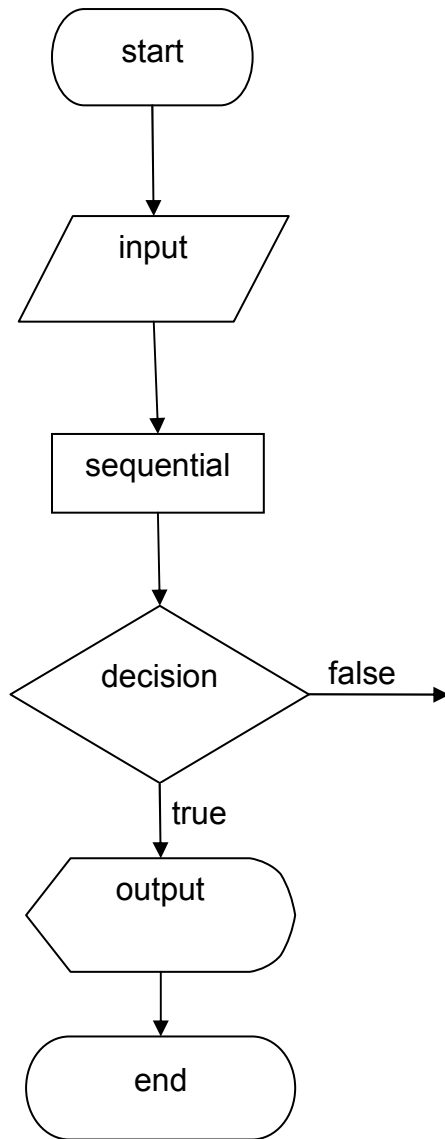   Planning ahead

    Team work

    To learn the order of instructions in computer programming

Use rectangular boxes or flowchart symbols?

```
start          start

Input deg      Input deg

Calculate      Calculate
rad            rad

Output         Output
rad            rad

end            end
```

Flowchart Symbols:

input: CPU takes data from outside

output: CPU sends data to outside

sequential: computing within CPU/memory

decision: conditional instructions

Rules:

•Those flowchart symbols should be used in the coursework of this module.

• **start** has one output, no input

• **input**, **sequential** and **output** have one input and one output

• **decision** has one input and more than one output.

• **end** box has one input, no output.

• There must be one **start** and one **end** in the flowchart. All flow paths should end at the **end** box.
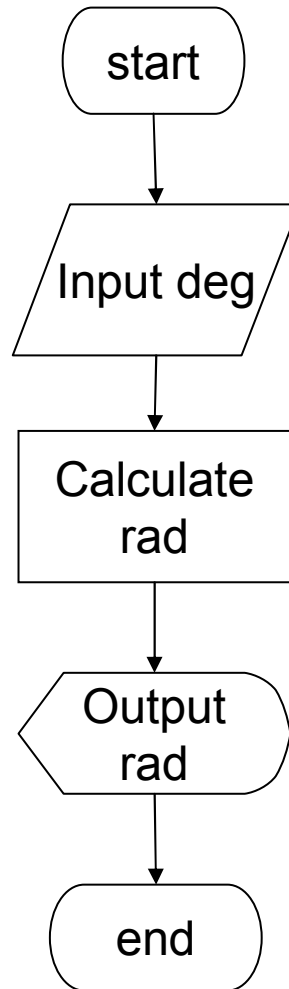
How to design a flowchart?

- Use sequence of the events
- Use experiences learnt from examples

  How you write software should be based on how the CPU (central processing unit) works. We do no know much about the architecture of CPU, so we learn from examples.

Sequence of events

Q. Write a flowchart for a program, which converts an angle in degrees to radians.

```
        ( start )
            |
            v
       / Input deg /
            |
            v
       +-----------+
       | Calculate |
       |    rad    |
       +-----------+
            |
            v
       < Output
          rad  >
            |
            v
        (  end  )
```

deg and rad are two variables, which are the names given to two memory locations for storing data.
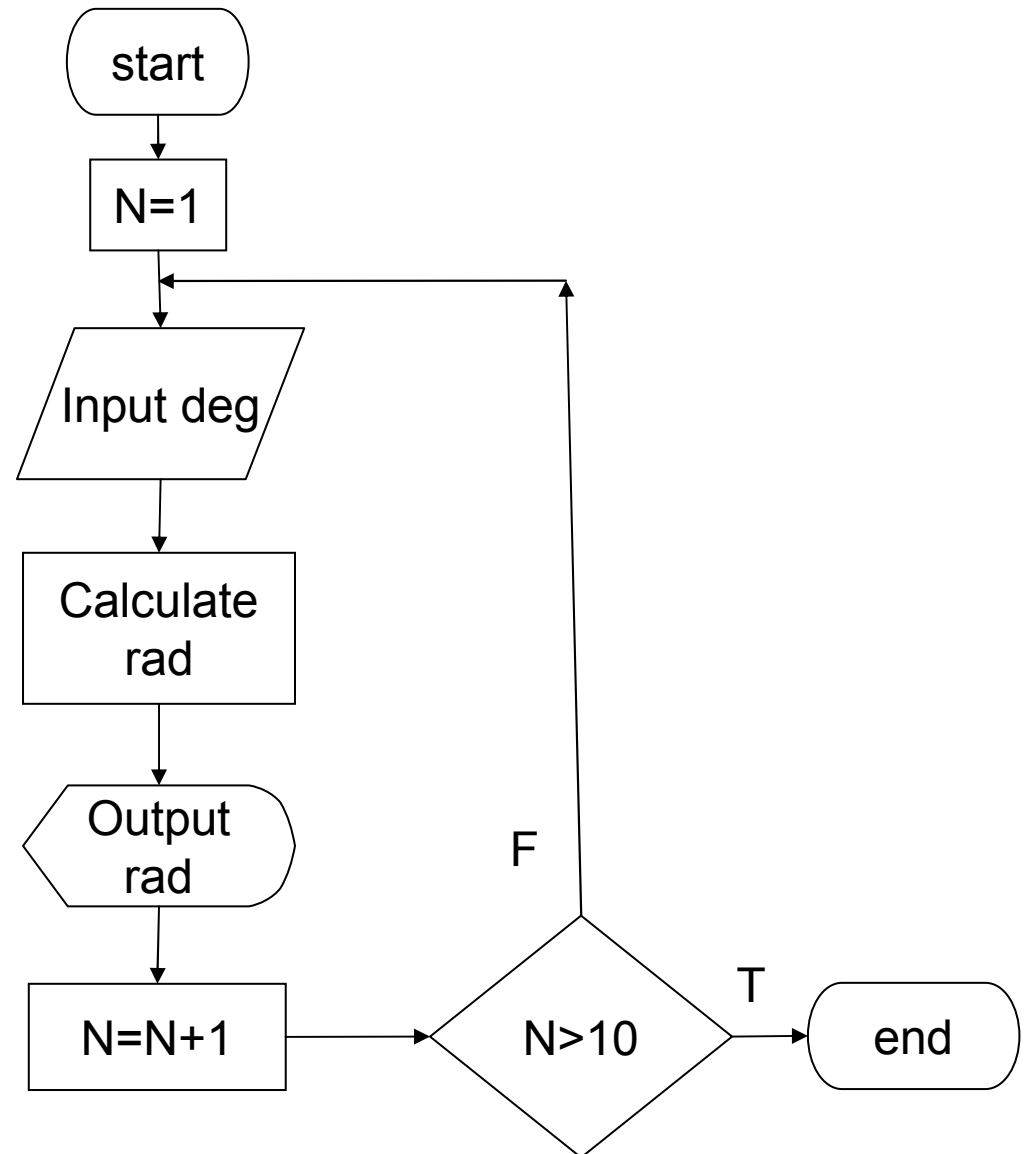
Write a flowchart for a program, which converts positive angles in degrees to radians; the program works in a **loop** and it stops when an angle entered is negative.

```
                          ┌──────────┐
                          │  start   │
                          └────┬─────┘
                               │
                               ▼
                          ╱──────────╲
                         │ Input deg  │
                          ╲──────────╱
                               │
                               ▼
                          ╱──────────╲
                         ╱            ╲    True    ┌──────┐
                        │   deg<0 ?    │─────────▶│ end  │
                         ╲            ╱            └──────┘
                          ╲──────────╱
                               │ False
                               ▼
                          ┌──────────┐
                          │ Calculate│
                          │   rad    │
                          └────┬─────┘
                               │
                               ▼
                          ╱──────────╲
                         │  Output    │
                         │   rad      │
                          ╲──────────╱
```
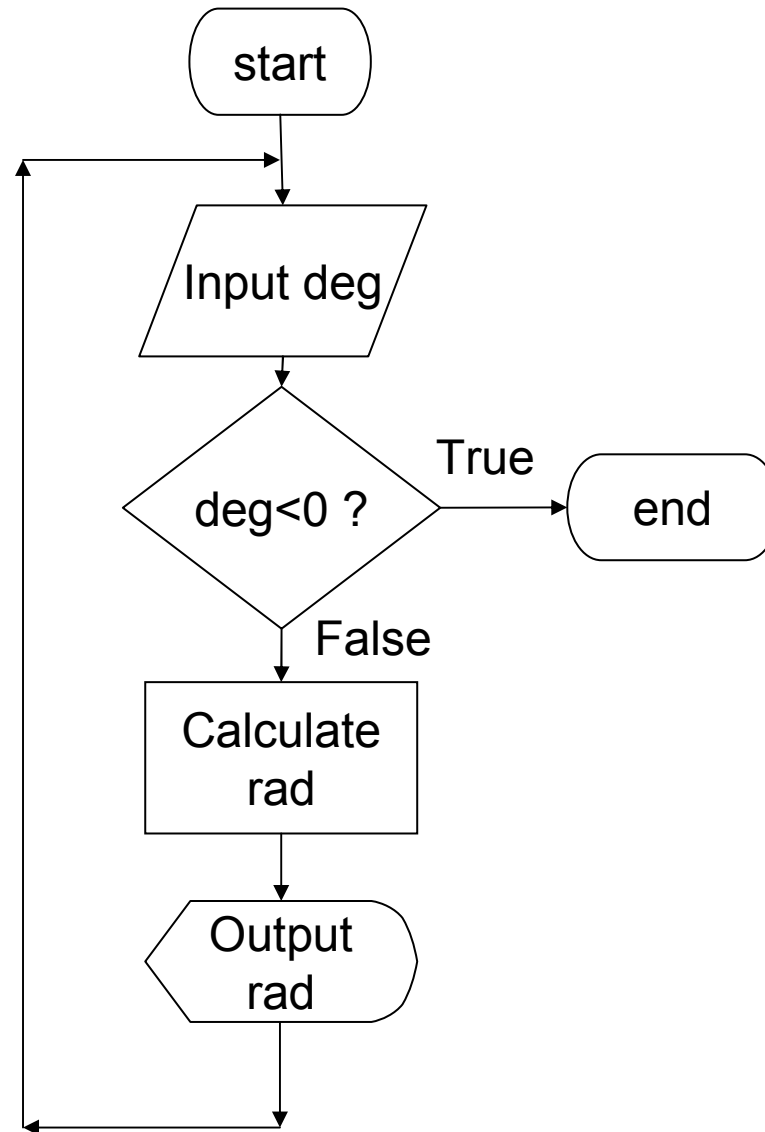
Write a flowchart for a program, which converts angles in degrees to radians; the program works in a loop until 10 angles have been converted.

programming rules:

➢ '=' means 'becomes'
➢ variable at right side of '=' has the data before the instruction
➢ variable at left side of '=' has the data after the instruction
➢ arithmetic calculation
    variable = formula
➢ variables in formula must have values

```
        ( start )
            │
            ▼
         ┌──────┐
         │ N=1  │
         └──────┘
            │
            ▼◄─────────────────┐
         ╱ Input deg ╱         │
            │                  │
            ▼                  │
        ┌──────────┐           │
        │ Calculate│           │
        │   rad    │           │
        └──────────┘           │
            │                  │
            ▼                  │
        ⟨ Output  ⟩        F   │
        ⟨  rad    ⟩            │
            │                  │
            ▼                  │
      ┌─────────┐      ◇───────┘
      │ N=N+1   │────►◇ N>10 ◇──T──( end )
      └─────────┘      ◇
```
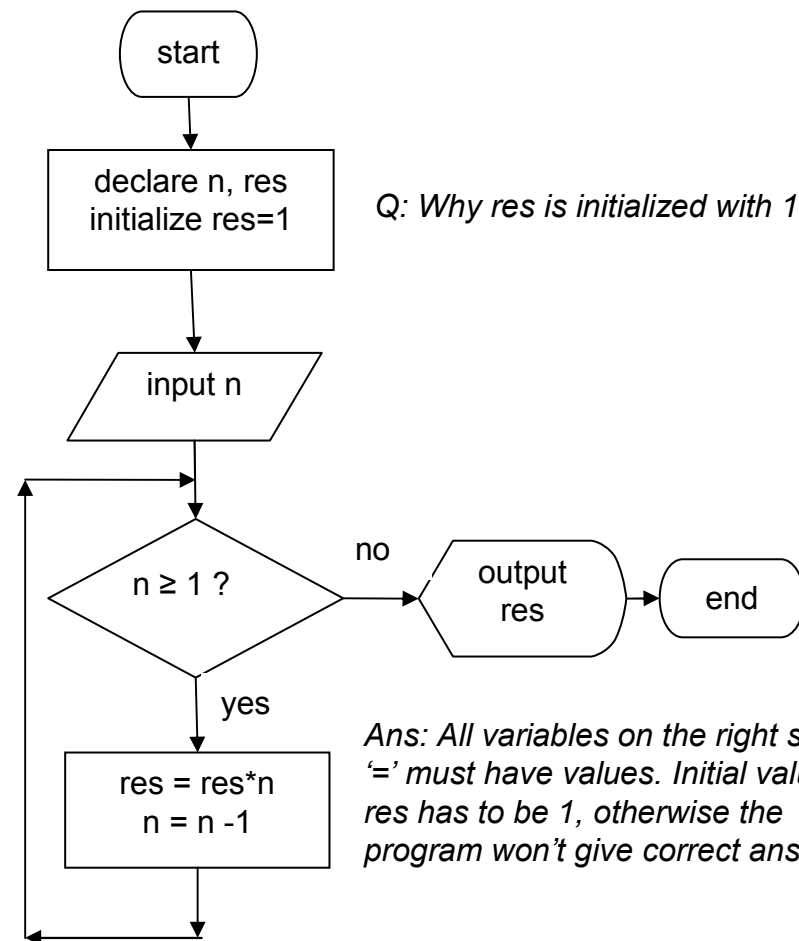
Factorial

Write a flowchart for a program which calculates the factorial (n!) of n. n is an integer number entered from the keyboard. The result, factorial of n is displaced on the PC monitor.   n! = n*(n-1)*(n-2)*…….*1

• Two variables are needed in the program:

       n: n
       res: n!

• variables are declared (optional)

• Learning points:
   1. counting down
   2. multiplication of a sequence of numbers

start

declare n, res
initialize res=1

Q: Why res is initialized with 1?

input n

n ≥ 1 ?   no   output res   end

yes

res = res*n
n = n -1

Ans: All variables on the right side of '=' must have values. Initial value of res has to be 1, otherwise the program won't give correct answer.

Supermarket Checkout

Write a flowchart to design a program for supermarket checkout. The program should have following functions:

  The price of each item is typed in on the keyboard.

  After a price is entered, the number of items and the subtotal price so far are displayed.

  Enter zero or a negative number on the keyboard to indicate that all items have been checked out.

Variables needed in the program:
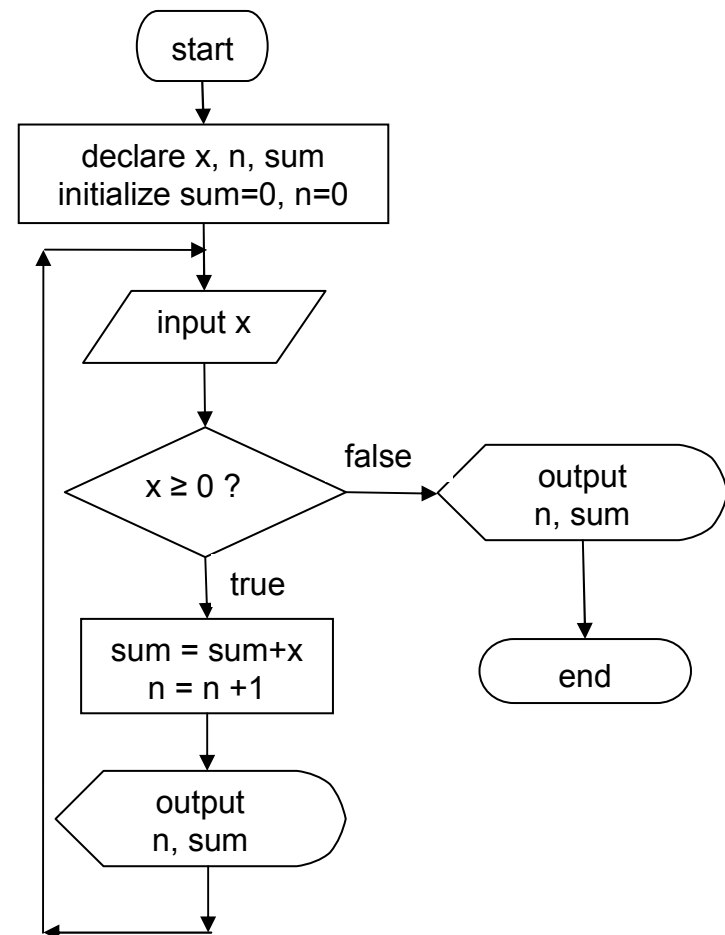 x: price of a single item
  n: number of items
  sum: total price

• Two variables must be initialized

• Learning points:
  1. counting
  2. adding
  3. breaking the program loop

start

declare x, n, sum
initialize sum=0, n=0

input x

x ≥ 0 ?

false → output n, sum → end

true

sum = sum+x
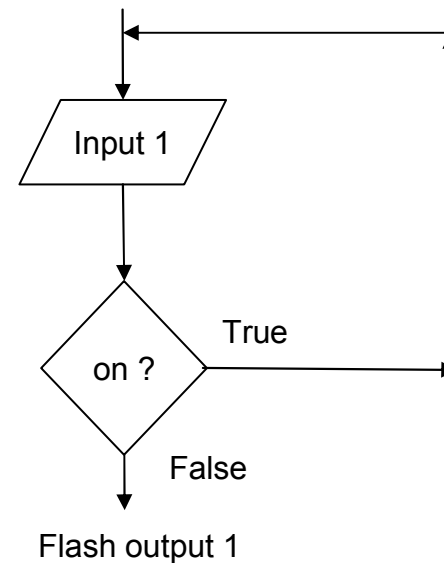n = n +1

output n, sum

Lighthouse

You need to set up the lighthouse system to respond to the light levels. When the Sun (Input 1) is shining, you do not want the lighthouse (Output 1) to flash. When it is dark, you do. The lighthouse flashes on and off for 1 second when it is dark.
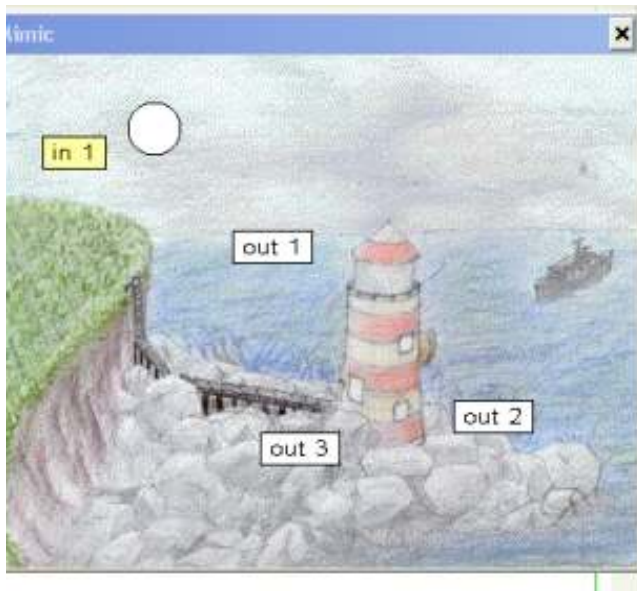
(Picture from Flowol2)

How can a PC 'see', 'wait' and 'judge'?

Input 1

on ?

True

False

Flash output 1

Exercise 1: Write a flowchart for controlling "output 1" in the lighthouse

Exercise 2:

Write a flowchart for a program which reads 7 positive numbers from keyboard and finds the maximum value in those 7 numbers.