Programming - Python

Comment – Text within the code that is ignored by the computer. A Python comment is preceeded by a #.

```
# This is an example of a comment
```

Output – Processed information that is sent out from a computer

Python	Pseudocode

`print("Hello World!")`
Hello World!
`print("Hello", "World!")`
Hello World!
`print("Hello"+"World!")`
HelloWorld!
`print("Hello\nWorld!")`
Hello
World!
	`OUTPUT "Hello World"`

Input – Data sent to a computer to be processed

`print("Enter name")`	`OUTPUT "Enter name"`
`name=input()`	`name ← USERINPUT`
`print("Hello", name)`	`OUTPUT "Hello", name`
`print("Enter age")`	`OUTPUT "Enter age"`
`age=int(input())`	`age ← USERINPUT`

Assignment - The allocation of data values to variables, constants, arrays and other data structures so that the values can be stored.

- *Variable* – Value that can change during the running of a program. By convention we use lower case to identify variables (eg `a=12`)
- *Constant* – Value that remains unchanged for the duration of the program. By convention we use upper case letters to identify constants. (e.g. `PI=3.141`)

Data Types

Integer – Whole number	`age = 12`	`age ← 12`
Float (real) number – A number with a decimal point	`height = 1.52`	`height ← 12`
Character – A single letter, symbol or number	`a = 'a'`	`a ← 'a'`
String – multiple characters	`name = "Bart"`	`name ← "Bart"`

Boolean – Has two values: true of false.	`a = True`
	`b = False`
		`a ← True`
		`b ← False`

Arithmetic Operators

Add	`7 + 2    = 9`	`7 + 2`
Subtract	`7 - 2    = 5`	`7 - 2`
Multiply	`7 * 2    = 14`	`7 * 2`
Divide	`4 / 2    = 2`	`4 / 2`
power	`2 ** 3   = 8`	`2 ** 3`
Integer division	`7 // 2   = 3`	`7 DIV 2`
Modulus (remainder)	`7 % 2    = 1`	`7 MOD 2`

Relational Operators – Allows the Comparison of values

Less than	`<`	`<`	`7<2`	`-> False`
Greater than	`>`	`<`	`7 > 2`	`-> True`
Equal to	`==`	`==`	`7==2`	`-> False`
Not equal to	`!=`	`≠ or <>`	`7!=2`	`-> True`
Less than or equal to	`<=`	`≤`	`7<=2`	`-> False`
Greater than or equal to	`>=`	`≥`	`7>=2`	`-> True`

Boolean Operators

`AND`	`and`	`7 < 2 and 1 < 2`	`-> False`
`OR`	`or`	`7 < 2 or 1 < 2`	`-> False`
`NOT`	`not`	`not 7 < 2`	`-> True`

Sequencing represents a set of steps. Each line of code will have some operation and these operations will be carried out in order line-by-line

Using + operator for adding
 	
`a = 1`
`b = 2`
`c = a + b`
`print(c)   -> 3`
	`a ← 1`
	`b ← 2`
	`c ← a + b`
	`OUTPUT c`

Using + operator for concatenation
 	
`a = 'Hello '`
`b = 'World'`
`c = a + b`
`print(c) -> Hello World`
	`a ← 'Hello '`
	`b ← 'World'`
	`c ← a + b`
	`OUTPUT c`

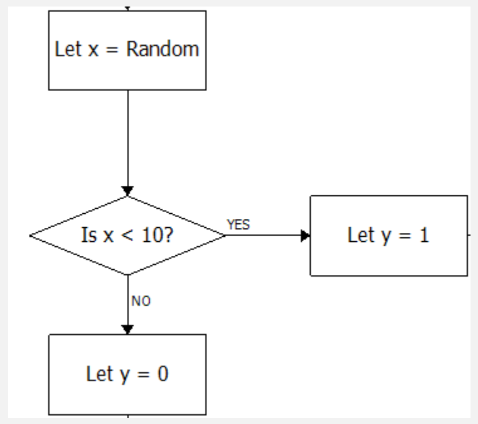
Random number

Random integer	`import random`
	`random.randint(0,9)`
		`RANDOM_INT(0,9)`

Choice	`random.choice('a','b','c')`	
Random value from 0 to 1	`random.random()`	

Selection represents a decision in the code according to some condition. The condition is met then the block of code is executed otherwise it is not. Often alternative blocks of code are executed according to some condition.

```
x=RANDOM_INT()
IF  x < 10 THEN
 y=1
ELSE
 y=0
ENDIF
```



IF ...	`IF i > 2 THEN`
	` j ← 10`
	`ENDIF`
		`if i  > 2:`
		` j=10`

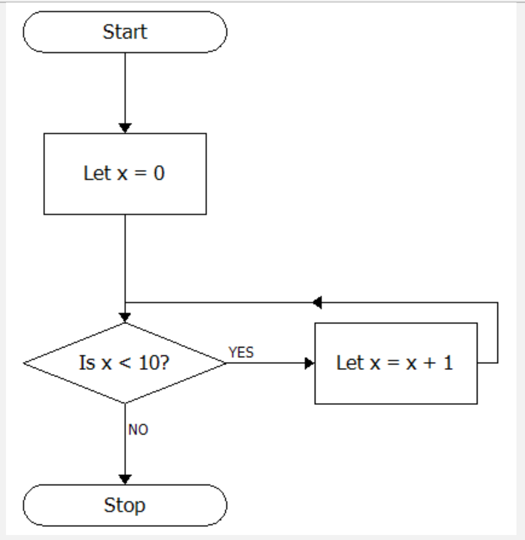
IF ... ELSE ...	`IF i > 2  THEN`
	` j ← 10`
	`ELSE`
	` j ← 3`
	`ENDIF`
		`if i > 2:`
		`   j=10`
		`else:`
		`   j=3`

IF ... ELSE IF ... ELSE	`IF i ==2 THEN`
	` j ← 10`
	`ELSE IF i==3`
	` j ← 3`
	`ELSE`
	` j ← 1`
	`ENDIF`
		`if i ==2:`
		` j=10`
		`elif i==3:`
		` j=3`
		`else:`
		` j=1`

Iteration Sometimes we wish the code to repeat a set of instructions

`WHILE` loops are used when the we do not know beforehand the number of iterations needed and this varies according to some condition.

```
x = 0
while (x < 10):
      x = x + 1
```



`while True:`
` print("Hello World")`
	`WHILE TRUE`
	` OUTPUT "Hello World"`
	`ENDWHILE`

`a=0`
`while a<4:`
` print(a)`
` a=a+3`
	`a ← 0`
	`WHILE a < 4`
	` OUTPUT a`
	` a ← a + 3`
	`ENDWHILE`

`FOR` loops are used when we know before hand the number of iterations we wish to make.

`for a in range(3):`
` print(a)`
	`FOR a ← 0 TO 3`
	`    OUTPUT a`
	`ENDFOR`

Nested structures - Use constructs (e.g. `WHILE, FOR, IF`) inside another.

use a nested FOR loop to print out a grid	`for i in range (10):`
	` for i in range (10):`
	`  print ("x ",end="")`
	` print()`

Use a nested while and if to print out only even numbers	`i=0`
	`while i<51:`
	` if (i%2==0):`
	`  print(i)`
	` i=i+1`

Lists

Create a list	`shapes=["square","circle"]`
Access element by index pos	`shapes[1] -> circle`
Append item to list	`shapes.append("triangle”)`
Remove item from list	`shapes.remove("circle”)`
Remove item from list by index	`shapes.pop(1)`
Insert item into list	`shapes.insert(2,”rectangle”)`
Number of elements in a list	`len(shapes)`
Get index pos of item in list	`shapes.index("triangle”)`

Concatenating lists	`shapesGroup1["square”,”circle”]`
	`shapesGroup2=["triangle”]`
	`shapes=shapesGroup1+shapesGroup2`

Loop through list	`for i in range(len(shapes)):`
	` print(shapes[i])`

Reverse elements in a list	`shapes.reverse()`
Order elements in a list	`shapes.sort()`

2D lists - A list if lists

Create a 2D list	`d = [ [23, 14, 17], [12, 18, 37], [16, 67, 83]]`

Another way to create a 2D list	`a = [23, 14, 17]`
	`b = [12, 18, 37]`
	`c = [16, 67, 83]`
	`d = [a,b,c]`

Access element by index position	`d[1][2] -> 37`

Strings

Get length of a string	`len("Hello”)`	`LEN("Hello”)`
Character to character code	`ord("a") -> 97`	`ORD("a")`
Character code to character	`chr(101) -> ‘e’`	`CHR(101)`
String to integer	`a=int("12”)`	`a=INT("12”)`
String to float	`a=float("12.3”)`	`a=FLOAT("12.3”)`
integer to string	`a=str(12)`	`a=STR(12)`
real to string	`a=str(12.3)`	`a=STR(12.3)`

Concatenation -merge multiple strings together	`a="hello ”`
	`b="world”`
	`c=a+b`
	`print(c) ->`
	`hello world`

Return the position of a character
If there is more than 1 of the same character the position of the first character is returned.
	`student = "Hermione"`
	`student.index(‘i')`

Find the character at a specified position	`student = "Hermione"`
	`print(student[2]) -> r`

sub strings - select parts of a string

Example	`student="Harry Potter”`	
Output the first two characters	`print(student[0:2])`	Ha
Output the first three characters	`print(student[:3])`	Har
Output characters 2-4	`print(student[2:5])`	Rry
Output the last 3 characters	`print(student[-3:])`	Ter
Output a middle set of characters	`print(student[4:-3])`	y Pot

*A negative value is taken from the end of the string.

Subroutines are a way of managing and organising programs in a structured way. This allows us to break up programs into smaller chunks.

- Can make the code more modular and more easy to read as each function performs a specific task.
- Functions can be reused within the code without having to write the code multiple times.

- **Procedures** are subroutines that do not return values
- **Functions** are subroutines that have both input and output

Procedure:
No input parameters or return
	`SUB greeting()`
	` OUTPUT "hello”`
	`ENDSUB`
		`def greeting():`
		` print("hello”)`
		
		`call: greeting()`

Procedure: One input parameter, no return	`SUB`
	`greeting(name)`
	` OUTPUT`
	`"Hello”,name`
	`ENDSUB`
		`def greeting(name):`
		` print("Hello",name)`
		
		`greeting("grey”)`

Function:
1 input parameter, and 1 return value
	`SUB add(n)`
	` a ← 0`
	` FOR a ← 0 TO n`
	`  a ← a + n`
	` ENDFOR`
	` RETURN a`
	`ENDSUB`
		`def add(n):`
		` a=0`
		` for a in range(n+1):`
		` a=a+n`
		` return a`

Function:
Two input parameters, and 1 return value
	`SUB (num1,num2)`
	` sum=num1+num2`
	` return sum`
		`def add(num1,num2):`
		` sum=num1+num2`
		` return sum`
		
		`greeting(1,2)`

The **scope** of a variable determines which parts of a program can access and use that variable.

A **global variable** is a variable that can be used anywhere in a program. The issue with global variables is that one part of the code may inadvertently modify the value because global variables are hard to track.

A **local variable** is a variable that can only be accessed within a certain block of code typically within a function. Local variables are not recognized outside a function unless they are returned. There is no way of modifying or changing the behavior of a local variable outside its scope.

Global variables need to defined throughout the running of the whole program. This is an inefficient use of memory resources. Local variables are defined only when they are needed an so have less demand on memory. Local variables only exist within the subroutine.

Reading and writing files

Open file Whatever we are doing to a file whether we are reading, writing or adding to or modifying a file we first need to open it using:

```
open(filename,access_mode)
```

There are a range of access mode depending on what we want to do to the file, the principal ones are given below:

Access Mode	**Description**
r	Opens a file for reading only
w	Opens a file for writing only. Create a new file if one does not exist. Overwrites file if it already exists.
a	Append to the end of a file. Create a new file if one does not exist.

Reading text files

read – Reads in the whole file into a single string	`f=open("filetxt","r")`
	`print(f.read())`
	`f.close()`

readline – Reads in each line one at a time	`f=open("file.txt","r")`
	`print(f.readline())`
	`print(f.readline())`
	`print(f.readline())`
	`f.close()`

readlines – Reads in the whole file into a list	`f=open("file.txt","r")`
	`print(f.readlines())`
	`f.close()`

Writing text files

Write in single lines at a time	`file=open("days.txt",'w')`
	`file.write("Monday\n")`
	`file.write("Tuesday\n")`
	`file.write("Wednesday\n")`
	`file.close()`

Write in a list	`say=["How\n”,”are\n”,”you\n”]`
	`file=open("say.txt",'w')`
	`file.writelines(say)`
	`file.close()`

Data Validation Routines

Check if an entered string has a minimum length	`OUTPUT “Enter String”`
	`s ← USERINPUT`
	`IF LEN(S) > 5 THEN`
	`  OUTPUT “STRING OK”`
	`ELSE`
	`  OUTPUT “TOO SHORT”`
	`ENDIF`

Check is a string is empty	`OUTPUT “Enter String”`
	`s ← USERINPUT`
	`IF LEN(S) == 0 THEN`
	`  OUTPUT “EMPTY STRING”`
	`ENDIF`

Check if data entered lies within a given range	`OUTPUT “Enter number” s num ←`
	`USERINPUT`
	`IF num > 1 AND num < 10`
	`  OUTPUT “Within range”`
	`ENDIF`

Authentication Routine

```
OUTPUT “Enter Username”
username ← USERINPUT
OUTPUT “Enter Password”
password ← USERINPUT

WHILE username != "bart" OR password !="abc"

 OUTPUT “Login failed”
 OUTPUT “Enter Username”
 username ← USERINPUT
 OUTPUT “Enter Password”
 password ← USERINPUT

ENDWHILE

OUTPUT “Login Successful”
```

Debugging

Syntax errors – Errors in the code that mean the program will not even run at all. Normally this is things like missing brackets, spelling mistakes and other typos.

Runtime errors – Errors during the running of the program. This might be because the program is writing to a memory location that does not exist for instance. eg. An array index value that does not exist.

Logical errors - The program runs to termination, but the output is not what is expected. Often these are arithmetic errors.

Test data

Code needs to be tested with a range of different input data to ensure that it works as expected under all situations. Data entered need to be checked to ensure that the input values are:

- within a certain range
- in correct format
- the correct length
- The correct data type (eg float, integer, string)

The program is tested using normal, erroneous or boundary data.

Normal data - Data that we would normally expect to be entered. For example for the age of secondary school pupils we would expect integer values ranging from 11 to 19.

Erroneous data - Data that are input that are clearly wrong. For instance, if some entered 40 for the age of a school pupil. The program should identify this as invalid data but at the same time should be able to handle this sensibly which returns a sensible message and the program does not crash.

Boundary data - Data that are on the edge of what we might expect. For instance if someone entered their age as 10, 11, 19 or 20.