Control Structures

Lecture 3

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Contents

Introduction

- Control structures are used for non-sequential and repetitive execution of instructions.
- Control statements (also called control structures) are used to control the flow of program execution by allowing non-sequential or repetitive execution of instructions.
- Python supports ***if, for, and while*** control structures.
- In a control statement, Python code following the colon (:) is indented.

Conditional Statement: if

- *if* statement allows non-sequential execution depending upon whether the condition is satisfied.
- The general form of *if* conditional statement is as follows:
  if ⟨*condition*⟩ :
  Sequence S of statements to be executed
- Here, condition is a Boolean expression which is evaluated at the beginning of the if statement.
- If condition evaluates to **True**, then the sequence S of statements is executed, and the control is transferred to the statement following if statement.
- However, if condition evaluates to **False**, then the sequence S of statements is ignored, and the control is immediately transferred to the statement.

Conditional Statement: if

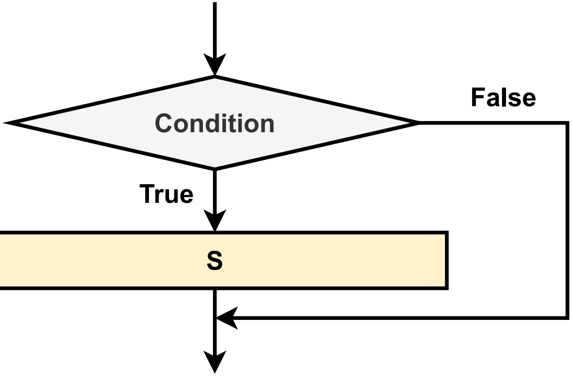


Figure 1: Flow diagram for *if* statement.

Conditional Statement: if

- Marks to be updated to passMarks based on a condition:

```
def moderate(marks, passMarks):
    '''Objective: To moderate result by maximum 1 or 2 marks to achieve passMarks
    Input parameters:  marks - int,  passMarks - int
    Return Value: marks - int
    '''
    if marks == passMarks-1 or marks == passMarks-2:
        marks=passMarks
    return marks

def main():
    '''Objective: To moderate marks if a student just misses pass marks
    Input Parameter: None
    Return Value: None
    '''
    passMarks=40
    marks = input('Enter marks:')
    intmarks = int(marks)
    moderatedMarks = moderate(intmarks,passMarks)
    print('Moderated marks:',moderatedMarks)

if__name__='__main__':
    main()
```

Conditional Statement: if

- For Example:
  $>>>$ Enter marks: 38
  Moderated marks: 40

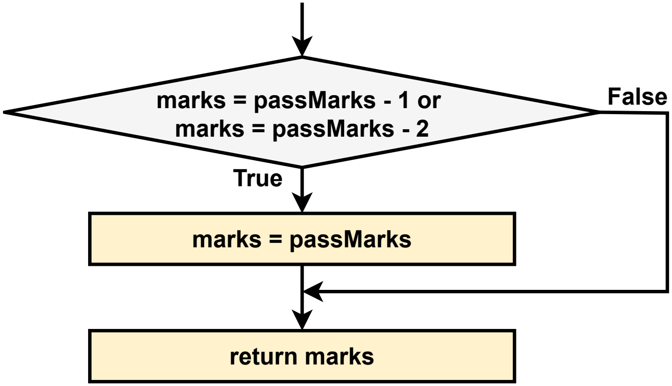


Figure 2: Flowchart of function **moderate**.

Conditional Statement: if-else

- The general form of *if-else* statement is as follows:

  if ⟨*condition*⟩ :

  Sequence S1 of statements to be executed

  else:

  Sequence S2 of statements to be executed
- Here, condition is a Boolean expression.
- If condition evaluates to **True**, then the sequence S1 of statements gets executed, otherwise, the sequence S2 of statements gets executed.

Conditional Statement: if-else

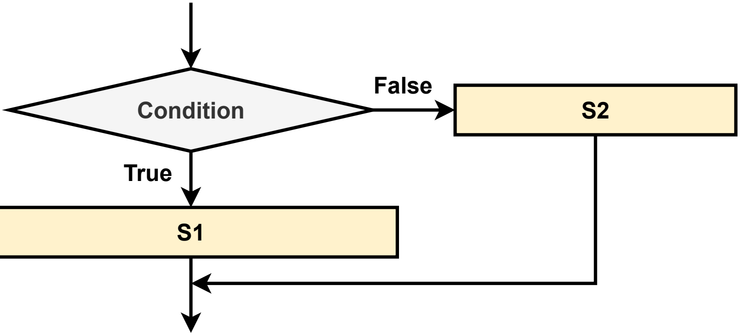


Figure 3: Flow diagram of *if-else* structure.

Conditional Statement: if-else

- Program to authenticate user and allow access to system using if else statement:

```
def authenticateUser(password):
    ''' Objective to authenticate user and allow access to system
     Input parameter : password - string                    Return Value: message - string
    '''
    if password == 'magic':
        message='Login Successful!!\n Welcome to system.'
    else:
        message=' Password mismatch!!\n'
    return message

def main():
    '''Objective: To authenticate user
     Input Parameter: None                    Return Value: None
    '''
   print(' \t LOGIN SYSTEM ')
   print('======================')
   password = input('Enter Password:')
   message = authenticateUser(password)
   print(message)

if__name__='__main__':
   main()
```

Conditional Statement: if-else

- For Example:

```
if password = 'magic':
        message = 'Login Successful !! \n'
else:
        message = 'Password mismatch !! \n'
```

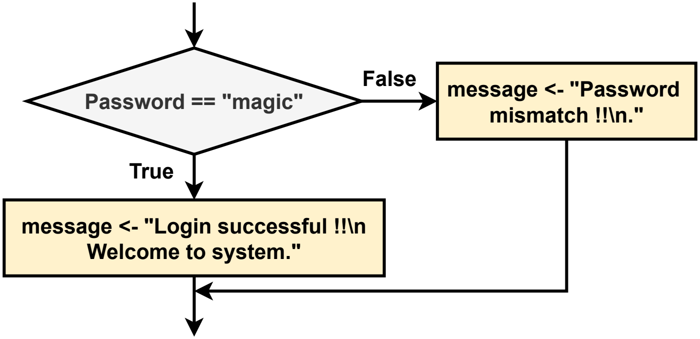

Password == "magic"
False
message <- "Password mismatch !!\n."
True
message <- "Login successful !!\n Welcome to system."

Figure 4: Flowchart of *if-else* statement in the function authenticateUser

Conditional Statement: if-elif-else

- The general form of *if-elif-else* statement is as follows:

```
if ⟨condition⟩ :
        Sequence $S_1$ of statements to be executed
elif ⟨condition2⟩ :
        Sequence $S_2$ of statements to be executed
elif ⟨condition3⟩ :
        Sequence $S_3$ of statements to be executed
...
else:
        Sequence $S_n$ of statements to be executed
```

- The clauses *elif* and *else* of *if* control structure are optional.
- When a control structure is specified within another control structure, it is called nesting of control structures.

Iteration (for and while statements)

- The process of repetitive execution of statement or a sequence of statements is called a **loop**.
- Loops eliminates repetitive writing of the same sequence of statements.
- Execution of a sequence of statements in a loop is known as an iteration of the loop.
- Commonly employed commands for executing in a loop are:
  1. **for**: This is used when we want to execute a sequence of statements a fixed number of times.
  2. **while**: This is used when the number of times to execute a sequence of statements is not known in advance.

Iteration: for loop

- The general form of *for* statement is as follows:

  ```
  for variable in sequence :
          Sequence S of Statements
  ```

  Here,
  – variable refers to the control variable.
  – The sequence S of statements is executed for each value in sequence.
- The function call range(1, n+1) generates a sequence of numbers from 1 to n.
- In general, **range(start, end, increment)** produces a sequence of numbers from start up to end (but not including end) in steps of increment.
- If third argument is not specified, increment is assumed to be 1.

Iteration: for loop

- For Example (Program to find sum of first n positive integers):

```
def summation(n):
       ''' Objective: To find sum of first n positive integers
       Input Parameter : n - numeric value
       Return Value: total - numeric value
       '''
       total = 0
       for count in range(1,n+1):
            total += count
       return total

def main():
      '''Objective: To find sum of first n positive integers based on user input
      Input Parameter: None
      Return Value: None
      '''
      n = int(input('Enter number of terms:'))
      total = summation(n)
      print('Sum of first', n, 'positive integers:', total )

if __name__=='__main__':
      main()
```

Iteration: while statement

- A while loop is used for iteratively executing a sequence of statements again and again on the basis of a test-condition.
- The general form of while loop is as follows:

  while $\langle test - condition \rangle$:

  Sequence S of statements
- Here, test-condition is a Boolean expression which is evaluated at the beginning of the loop.
- If the test-condition evaluates to True, the control flows through the Sequence S of statements (i.e, the body of the loop), otherwise the control moves to the statement immediately following the while loop.
- On execution of the body of the loop, the test-condition is evaluated again, and the process of evaluating the test-condition and executing the body of the loop is continued until the test-condition evaluates to False.

Iteration: while statement

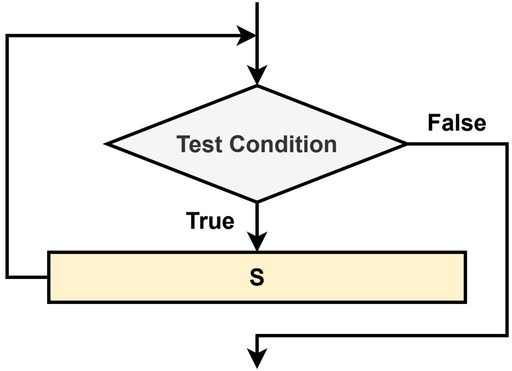
- For Example (Program to compute sum of numbers):

```
def main():
        '''
        Objective: To compute sum of numbers entered by user until
        user provides with null string as the input
        Input Parameter: None
        Return Value: None
        '''
        total=0
        number = input('Enter a number')
        while number != ' ':
            total += int(number)
            number = input('Enter a number: ')
        print('Sum of all input numbers is', total)

if__name__='__main__':
        main()
```

Iteration: while statement

- The flow diagram of While structure:



Iteration: for vs while statements

while statement vs for statement

- Let us consider the code of for statement:

```
for count in range(1, n+1):
        total += count
```

- We can re-write the above statement in while statement:

```
count = 1
while count < n+1:
        total += count
        count += 1
```

- N.T. - For computing the sum of first few natural numbers, the use of for loop is more elegant and easy as compared to the while loop.

Iteration (for and while statements)

Example: To print some pictures

- Program to print right triangle and inverted triangle:

```
def rightTriangle(nRows):
        '''
        Objective: To print right triangle
        Input Parameter: nRows - integer value
        Return Value: None
        '''
        for i in range(1, nRows + 1)
            print(' * ' * i)

def invertedTriangle(nRows):
        '''
        Objective: To print inverted triangle
        Input Parameter: nRows - integer value
        Return Value: None
        '''
        nSpaces = 0
        nStars = 2 * nRows - 1
        for i in range(1, nRows+1):
            print(' ' * nSpaces + ' * ' * nStars)
            nStars -=2
            nSpaces +=1
```

Iteration (for and while statements)

Example: To print some pictures [Cont.]

```
def main():
    '''
   Objective: To print right triangle or inverted triangle
   depending on user 's choice
   Input Parameter: None
   Return Value: None
    '''
    choice = int(input('Enter 1 for right triangle.\n'+ 'Enter 2 for inverted triangle.\n'))
    assert choice == 1 or choice == 2
    nRows = int(input('Enter no. of rows))
    if choice == 1:
        rightTriangle(nRows)
    else:
        invertedTriangle(nRows)
if __name__='__main__':

   main()
```

Output: (a) Right Triangle (b) Inverted Triangle

```
*
* *
* * *
* * * *

* * * * *
```

```
* * * * * * * * *
  * * * * * * *
    * * * * *
      * * *

        *
```

Iteration (for and while statements)

Examples of nested control structures

```
for(...):
    #Sequence of statements S1
    for(...):
      #Sequence of statements S2
    #Sequence of statements S3
```

```
while (...):
    #Sequence of statements S1
    while(...):
      #Sequence of statements S2
    #Sequence of statements S3
```

```
for(...):
    #Sequence of statements S1
    while(...):
      #Sequence of statements S2
    #Sequence of statements S3
```

```
while (...):
    #Sequence of statements S1
    for(...):
      #Sequence of statements S2
    #Sequence of statements S3
```

```
for(...):
    #Sequence of statements S1
    for(...):
      #Sequence of statements S2
      while(...):
        #Sequence of statements S3
      #Sequence of statements S4
    #Sequence of statements S5
```

```
while (...):
    #Sequence of statements S1
    for(...):
      #Sequence of statements S2
      while(...):
        #Sequence of statements S3
      #Sequence of statements S4
    #Sequence of statements S5
```

Iteration (for and while statements)

break, continue and pass statements

- The break statement is used for exiting from the loop to the statement following the body of the loop.
- The continue statement is used to transfer the control to next iteration of the loop without executing rest of the body of loop.
- The pass statement lets the program go through this piece of code without performing any action.
- The else clause can be used with for and while loop. Statements specified in else clause will be executed on smooth termination of the loop. However, if the loop is terminated using break statement, then the else clause is skipped.

References

[1] Python Programming: A modular approach by Taneja Sheetal, and Kumar Naveen, *Pearson Education India, Inc.*, 2017.