ISE 101 – Introduction to Information Systems

- Lecture 2 Objectives:
  - Variable types
  - Boolean algebra
  - Branches

Python Variable Types

- Numeric data types
  - Integers
  - Floating point numbers (floats)
  - Complex numbers

Python Variable Types

- Integers

  Represents negative and positive integers without fractional parts

  -2 24 -5 -22

- Floating point numbers (floats)

  Represents negative and positive numbers with fractional parts

  2.45 -4.47 4.0 8e3 4e9 -3e-4

Python Variable Types

- Even if the fractional part is zero, the number is a floating point number

  3.0 ← float

  -12.0 ← float

- Floating point numbers can be represented by scientific notation

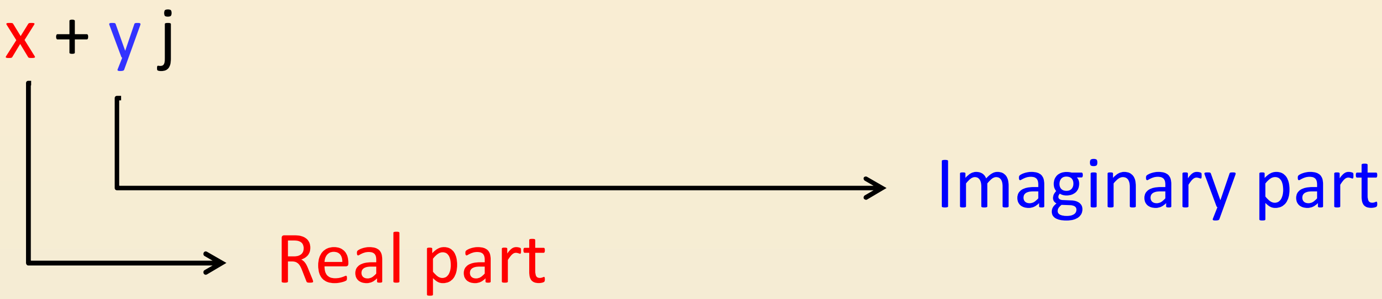
  a x 10^b ← aEb

  23,000 can be represented as 23E3 or 2.3E4 or 0.23E5 …

  -0.0001 can be represented as -1E-4 or -10E-5 …

Python Variable Types

- Complex numbers have real and imaginary components



x + y j

Imaginary part

Real part

-3+5.4j

- In math imaginary part is denoted with “i”
- In engineering, “j” is used (as i typically represent current)
- Complex number will be covered in your Calculus courses
- We will not deal with complex numbers in this course

Python Variable Types

- Strings

  Array of characters used with single quotes or double quotes

  “This is a string”

  ‘This is also a string’

- Triple quotes can be used for multiple line strings

  ‘’’ This is a multiple line
      string example and it can extend
      to many lines’’’

Python Variable Types

- Boolean (bool)

  Represents variables that can only take 2 values

  - True

  - False

- Other variable types that we will use later
  - Byte
  - List
  - Tuple
  - Dictionary

Python Variable Types

- In order to learn the type of a variable use

```
type(variable_name)
```

```
>>> type('test input')
<class 'str'>
>>> type(3.4)
<class 'float'>
>>> type(3)
<class 'int'>
>>> type(-3.2E3+4j)
<class 'complex'>
>>> var=True
>>> type(var)
<class 'bool'>
```

Python Variable Types

- In other programming languages, a variable has to be declared before using
- For example in C,
  - type of variables are required to be declared before using it
  - once declared, the type of a variable cannot be changed
- No need to declare variable type in Python
- Variable types are assigned when you assign a value to a variable
- Types of variables can change if you assign a value of another type

Python Variable Types

- Variable types are assigned when you assign a value to a variable

```
>>> x=3.2
>>> type(x)
<class 'float'>
```

- Types of variables can change if you assign a value of another type

```
>>> x=3.2
>>> type(x)
<class 'float'>
>>> x=True
>>> type(x)
<class 'bool'>
```

Boolean Algebra

- Boolean algebra is defined on set

  { True, False }
- Three logical operators are defined on this set
  - and
  - or
  - not
- Operator precedence from high to low is

  Paranthesis → not → and → or
- Result of any logical expression is again either True or False

NOT

not	False	=	True
Not	True	=	False

- Complement is denoted by (..)’ sign
- For example

not (3 < 5) = False

not (3.4 <2) = True

AND

False	and	False	=	False
False	and	True	=	False
True	and	False	=	False
True	and	True	=	True

- For example

  (3 < 5) and (4 > 6) = False

  (3 < 5) and (4 < 6) = True

OR

False	or	False	=	False
False	or	True	=	True
True	or	False	=	True
True	or	True	=	True

- For example

  (3 < 5) or (4 > 6) = True

  (3 < 5) or (4 < 6) = True

De Morgan Theorem

- De Morgan theorem is used to complement expressions
- To complement an expression using De Morgan theorem
  - Complement all variables in the function
  - Replace all and operators with or
  - Replace all or operators with and
  - Replace all True statements with False
  - Replace all False statements with True
- Examples:

f(x,y)=(x’ and y) or (y’ and x) then

f’(x,y)=(x or y’) and (y or x’)

De Morgan Theorem

- Examples:

  f(x,y)=(x’ and y) or True

  then

  f’(x,y)=(x or y’) and False

- Example

  f(a,b,c)=(a and b and c) or (a’ and b)

  then

  f’(a,b,c)=(a’ or b’ or c’) and (a or b’)

Expression Readability

- not 3 < 8 and 1 > 7 or 44<12.4 = ? False
- This expression is not readable
- Use more paranthesis and spaces to make it readable

((not (3<8)) and (1>7))   or   (44<12.4) False

not(((3<8) and (1>7))   or   (44<12.4)) True

Value Comparisons in Python

- In Python there are 6 ways of comparing numbers

Symbol	Description
>	greater than
<	smaller than
>=	greater than or equal to
<=	less than or equal to
==	equal to
!=	not equal to

Why Use “==“ ?

- Remember that = means **assign** in Python (and in many other programming languages)

  i = i + 1

- For checking equality of two numbers or expressions, “==“ is used. This generates a Boolean output (True or False)
- Examples

3 == 5	False
3 == 3.0	True
3+0j == 3	True

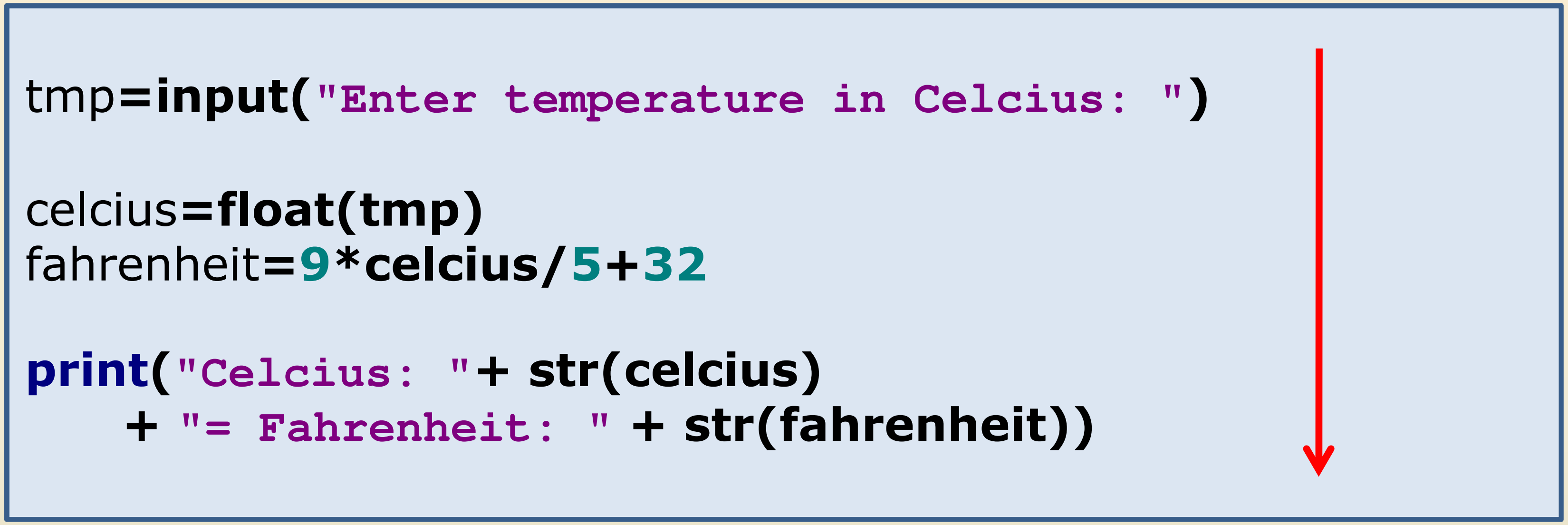
Why Use “==“ ?

- “==“ can be used to check equality of Boolean and string type
- Example

‘aaa’ == ‘aaa’	True
False == False	True
False == (5<3)	True
True == (5!=3)	True

Branches

- Until now, all Python scripts flows from top to bottom without any branching



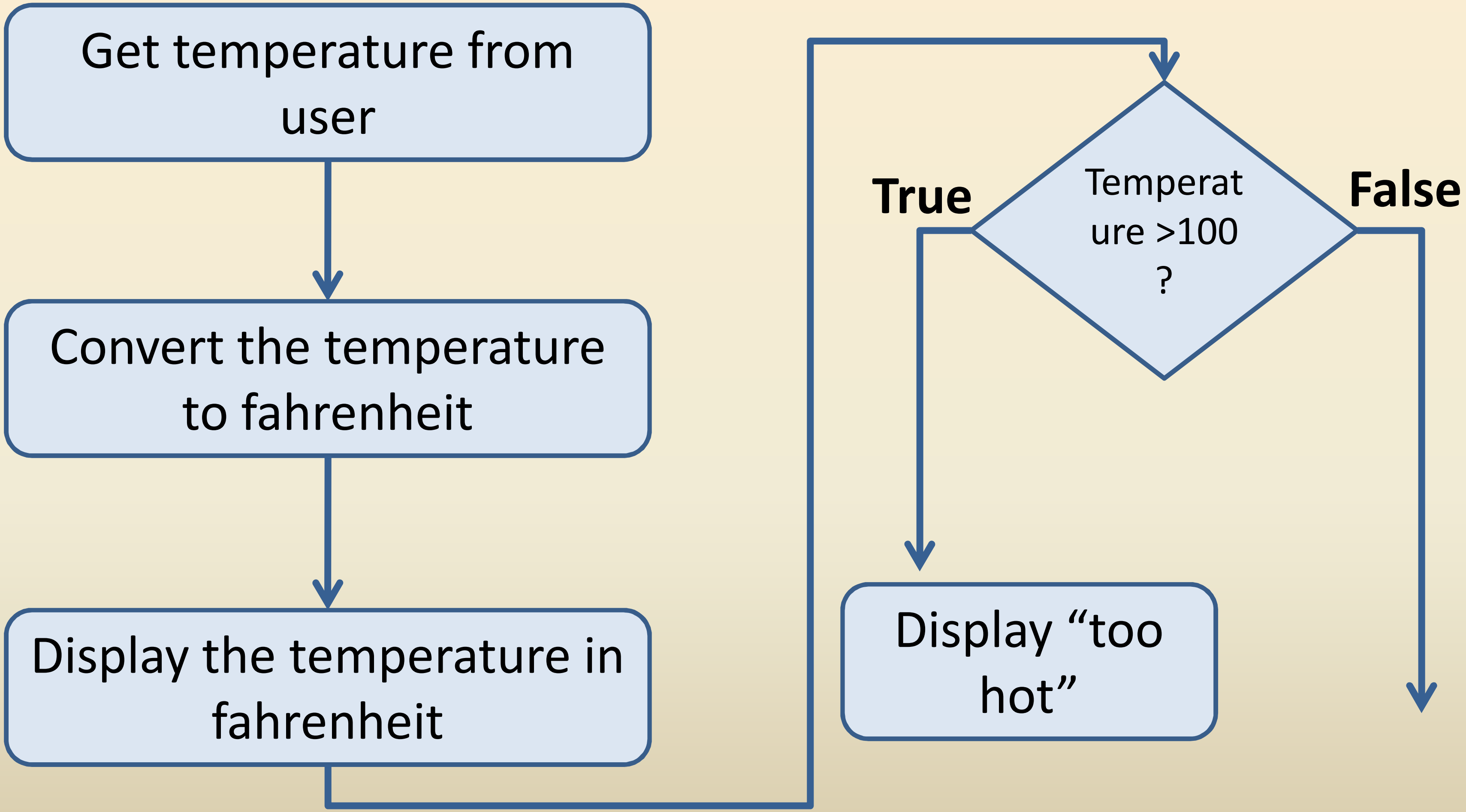
```
tmp=input("Enter temperature in Celcius: ")

celcius=float(tmp)
fahrenheit=9*celcius/5+32

print("Celcius: "+ str(celcius)
    + "= Fahrenheit: " + str(fahrenheit))
```

- Sometimes we have perform different actions depending on the situation

Branches

- Write a Python script that
  - gets the temperature from the user,
  - converts it to fahrenheit
  - Displays the result
  - Displays a warning “too hot” if the temperature is greater than 100 fahrenheit

Flow Diagram



Get temperature from user

Convert the temperature to fahrenheit

Display the temperature in fahrenheit

Temperature >100 ?

True

False

Display “too hot”

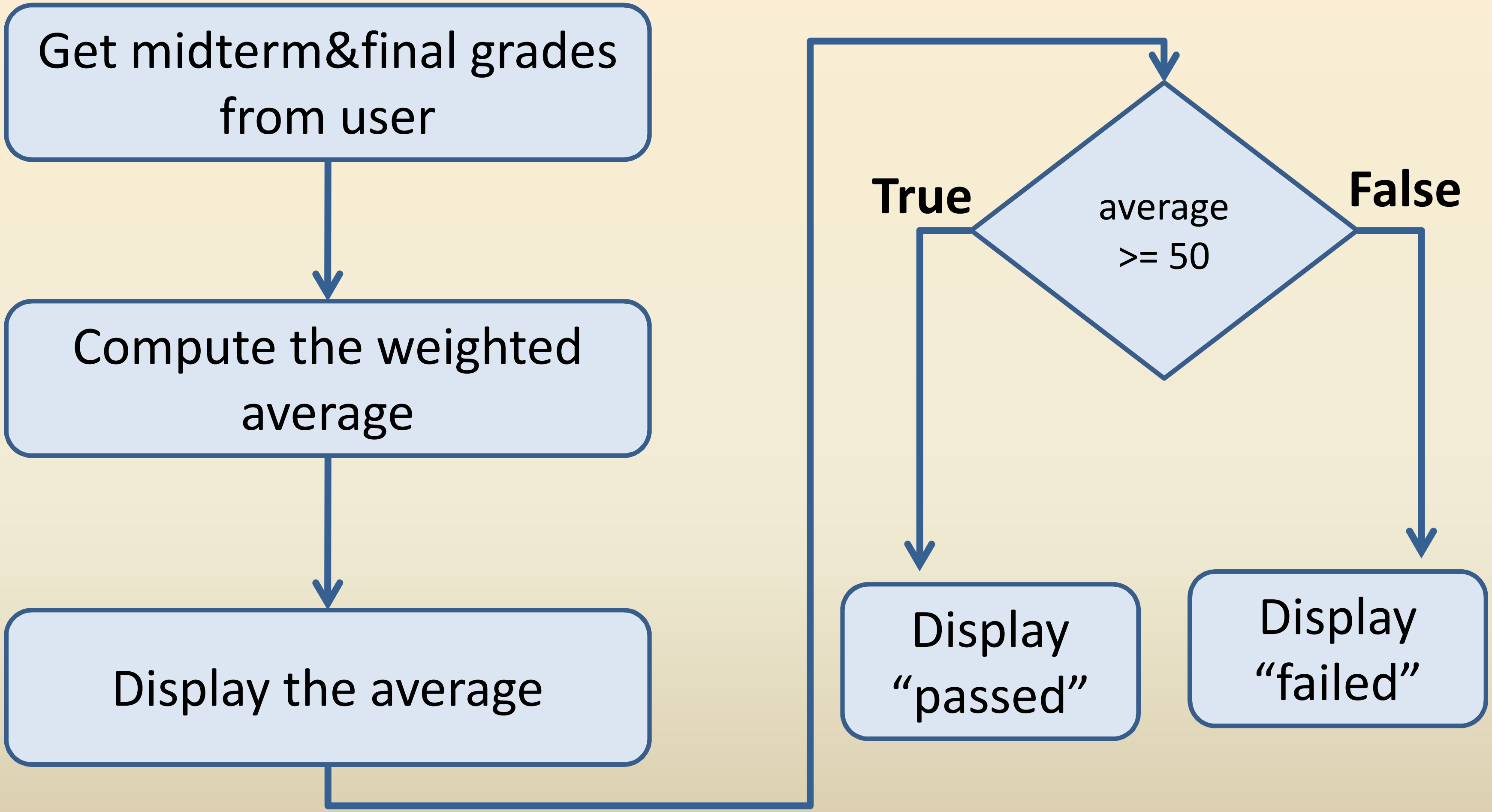
Branches

```
tmp=input("Enter temperature in Celcius: ")

celcius=float(tmp)
fahrenheit=9*celcius/5+32

print("Celcius: "+ str(celcius)
      + "= Fahrenheit: " + str(fahrenheit))

if (fahrenheit>100):
    print('too hot')
```

If Statement

- Sometimes the script should perform different actions when a logical expression is correct and incorrect
- Write a Python script that
  - Gets midterm and final grades from the user
  - Computes the weighted average (40% midterm, 60% final)
  - Display the weighted average and
  - Display
    - 'Passed' if the average is greater or equal to 50
    - 'Failed' if the average is less than 50

Flow Diagram



Get midterm&final grades from user

Compute the weighted average

Display the average

average >= 50

True

False

Display “passed”

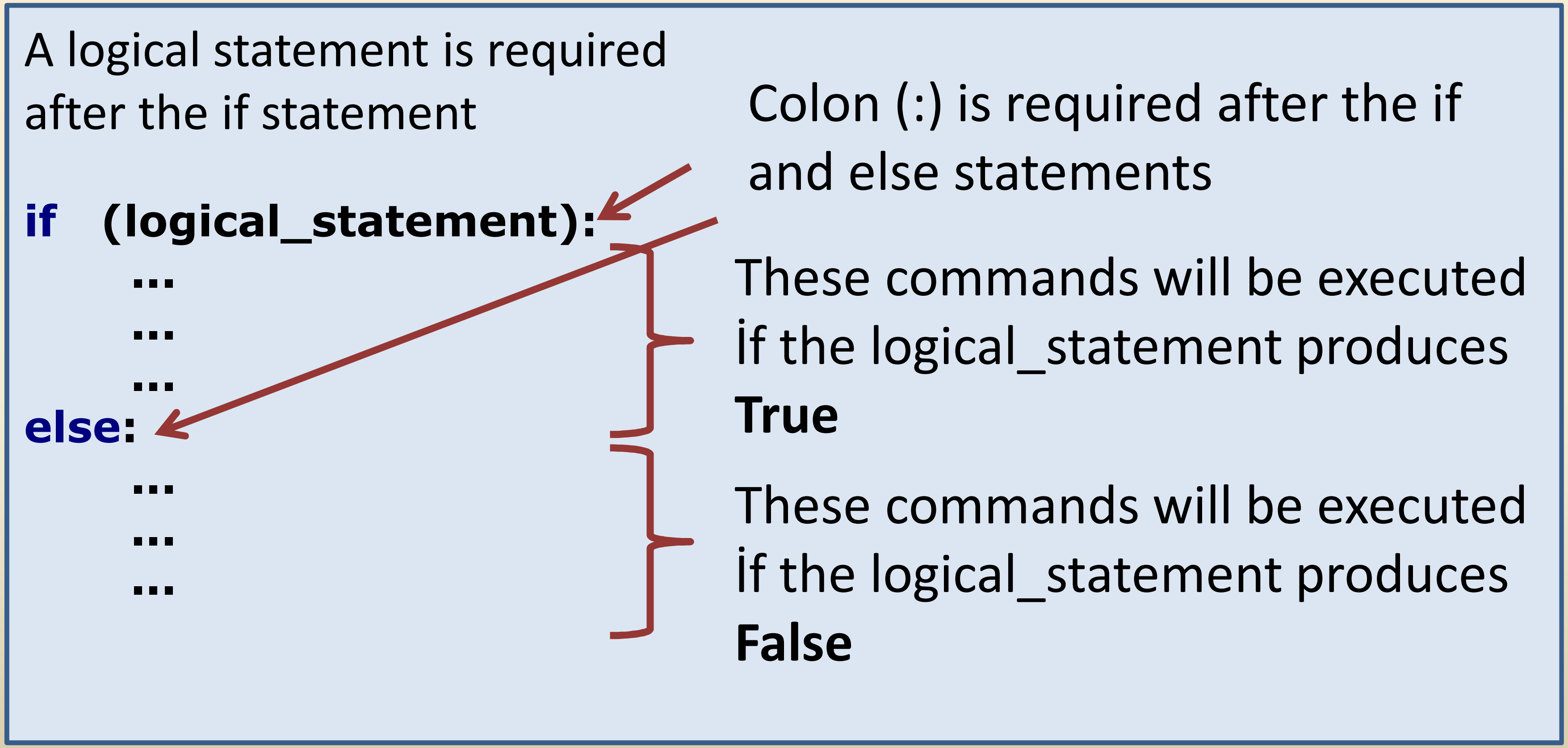
Display “failed”

Branches

```
midterm_grade=float(input("Enter midterm grade: "))
final_grade=float(input("Enter final grade: "))

average_grade=0.40*midterm_grade+0.60*final_grade


print("Average: "+ str(average_grade))

if (average_grade>=50):
    print('Passed')
else:
    print('Failed')
```

IF … ELSE Statement

- “if” is used to generate branches in the flow of the script
- Structure



A logical statement is required after the if statement

```
if   (logical_statement):
        …
        …
        …
else:
        …
        …
        …
```

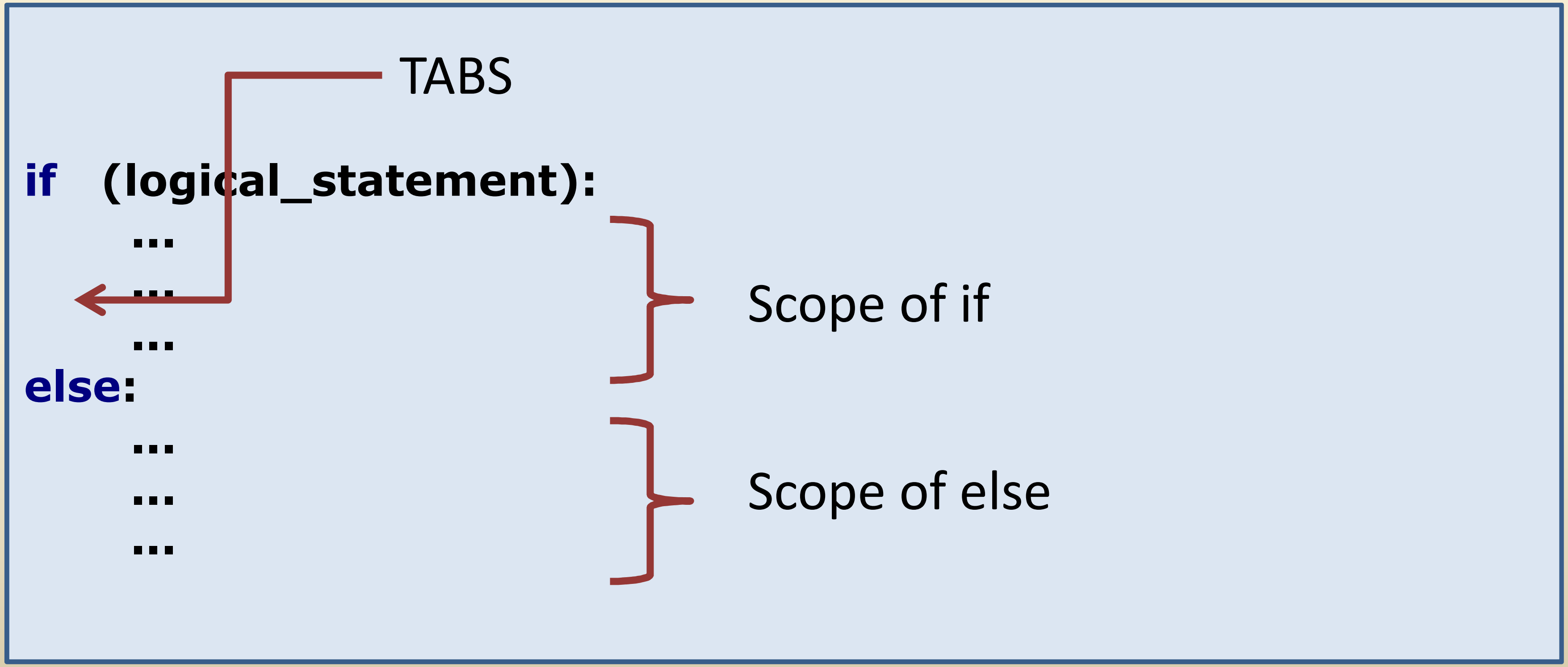
Colon (:) is required after the if and else statements

These commands will be executed İf the logical_statement produces **True**

These commands will be executed İf the logical_statement produces **False**

IF … ELSE Statement

- The scope in Python is determined using Tab (NOT white space)
- In C/C++, paranthesis are used for this purpose



TABS

```
if   (logical_statement):
        …
        …
        …
else:
        …
        …
        …
```

Scope of if

Scope of else

Scope

- If the logical expression after the “if” statement produces True, all instructions within the scope of “if” will be sequentially executed

- If the logical expression after the “if” statement produces False, all instructions within the scope of “else” will be sequentially executed

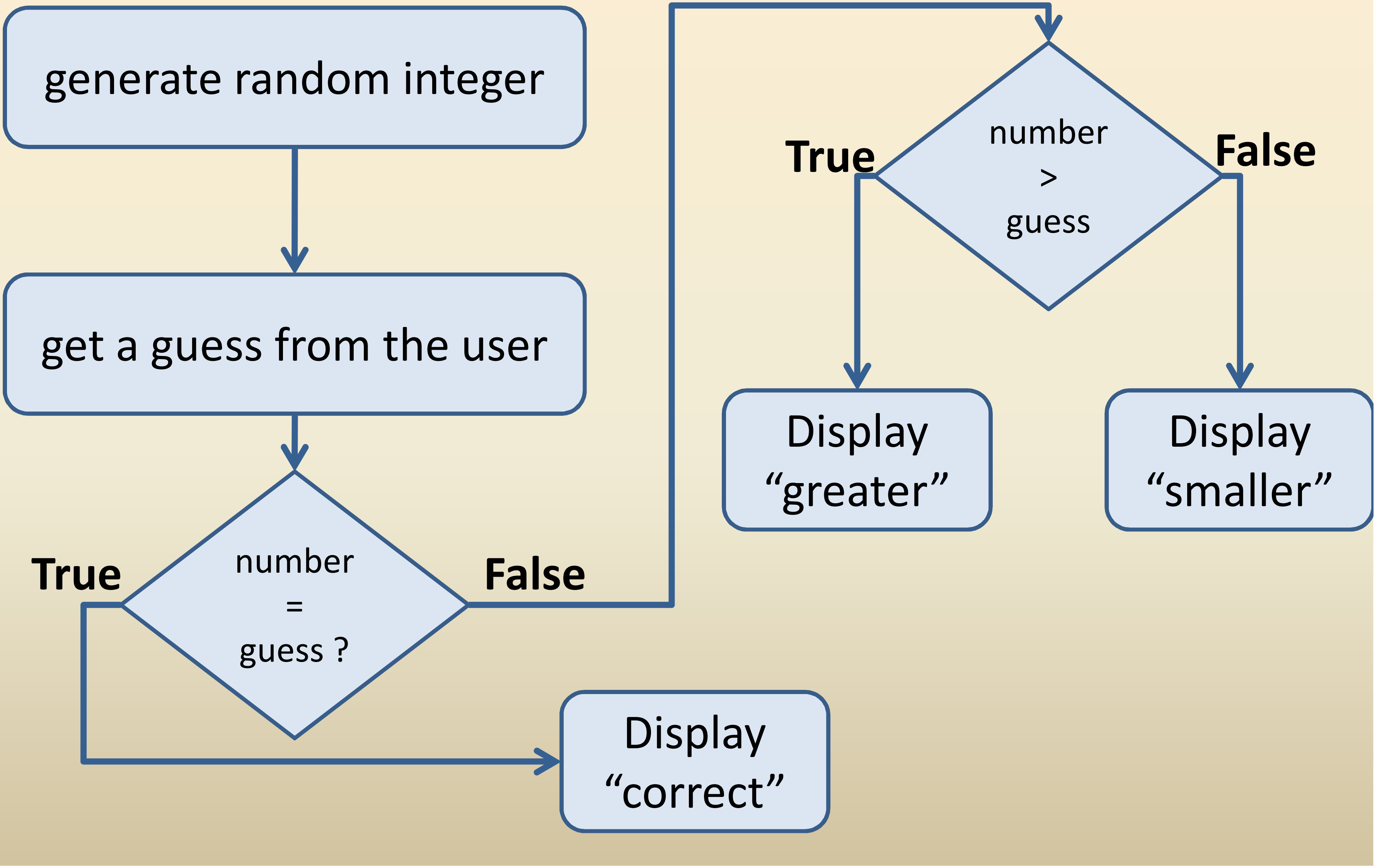
Example

- Write a Python script that
  - generates a random integer number between 1 and 10
  - gets a guess from the user
  - if the guess is equal to the random number display ‘correct’
  - if the guess is greater than the random number display ‘My number is smaller than your guess’
  - if the guess is smaller than the random number display ‘My number is greater than your guess’

Example

```
import random

my_number=random.randint(1,10)

user_guess=int(input('Guess my number: '))

if (user_guess == my_number):
    print('Correct')

if (user_guess > my_number):
    print('My number is greater than your guess')
else:
    print('My number is smaller than your guess')
```

Flow Diagram



generate random integer

get a guess from the user

number = guess ?

True

False

Display "correct"

number > guess

True

False

Display "greater"

Display "smaller"

Example

```
import random

my_number=random.randint(1,10)

user_guess=int(input('Guess my number: '))

if (user_guess == my_number):
    print('Correct')
elif (user_guess > my_number):
    print('My number is greater than your guess')
else:
    print('My number is smaller than your guess')
```

Example

- Write a Python script that
  - gets 3 floating point numbers from the user
  - finds the maximum of the 3 numbers
  - display it

- This script can be written in many different ways
- Prefer the simplest method

Example

```
number1=float(input('Enter first number: '))
number2=float(input('Enter second number: '))
number3=float(input('Enter third number: '))

# compare the first two numbers and assign the
# larger one to a variable max_number
if number1>=number2:
    max_number=number1
else:
    max_number=number2

# compare the max_number with number3
# is number3 is greater than max_number
# assign number3 to max_number
if number3>max_number:
    max_number=number3

# at this point, max_number is
# the largest of the three numbers
print('Largest number: ' + str(max_number))
```

Example

- Write a Python script that
  - gets 2 numbers from the user
  - Prints the following menu choice

    (1) Addition'
    (2) Subtraction'
    (3) Multiplication'
    (4) Divison`
  - Gets the user's choice
  - Perform the corresponding operation and display its result
  - If the user enters a wrong choice then warn the user

Example

```
number1=float(input('Enter first number: '))
number2=float(input('Enter second number: '))

print('(1) Addition')
print('(2) Subtraction')
print('(3) Multiplication')
print('(4) Divison')
choice=int(input('Choose the operation: '))

if choice==1:
    print('Addition ' + str(number1+number2))
elif choice==2:
    print('Subtraction ' + str(number1-number2))
elif choice==3:
    print('Multiplication ' + str(number1*number2))
elif choice==4:
    print('Division ' + str(number1/number2))
else:
    print('Wrong choice')
```