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Chapter 5: Functions

PART 5.8: VARIABLE SCOPE

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Chapter Goals and Contents

Goal:

- To be able to differentiate between local variables and global variables

Content:

- Variable Scope

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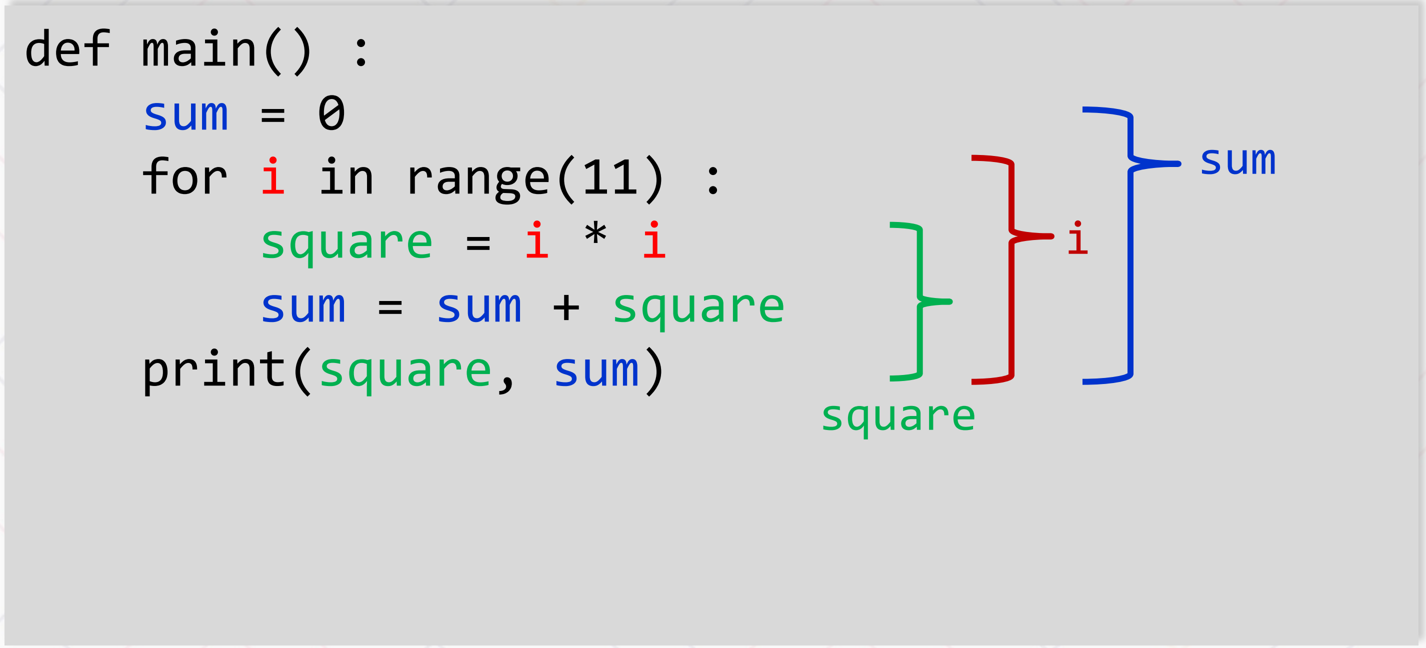
Variable Scope

- Variables can be declared:
  - **Inside a function**
    - Known as 'local variables'
    - Only available inside this function
    - Parameter variables **are like** local variables
  - **Outside of a function**
    - Sometimes called 'global scope'
    - Can be used (and changed) by code in any function
- How do you choose?

The scope of a variable is the part of the program in which it is visible

Examples of Scope

- sum, square & i are **local variables** in main



```
def main() :
    sum = 0
    for i in range(11) :
        square = i * i
        sum = sum + square
    print(square, sum)
```

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Local Variables of functions

- Variables declared inside one function are not visible to other functions
  - sideLength is local to main
  - Using it outside main will cause a compiler error

```
def main():
   sideLength = 10
   result = cubeVolume()
   print(result)


def cubeVolume():
  return sideLength * sideLength * sideLength # ERROR
```

Re-using Names for Local Variables

- Variables declared inside one function are not visible to other functions
  - result is local to square and result is local to main
  - They are two different variables and do not overlap
  - This can be very confusing

```
def square(n):
    result = n * n      } result
    return result

def main():
    result = square(3) + square(4)   } result
    print(result)
```

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Global Variables

- They are variables that are defined outside functions
- A global variable is visible to all functions that are defined after it
- However, any function that wishes to use a global variable must include a global declaration

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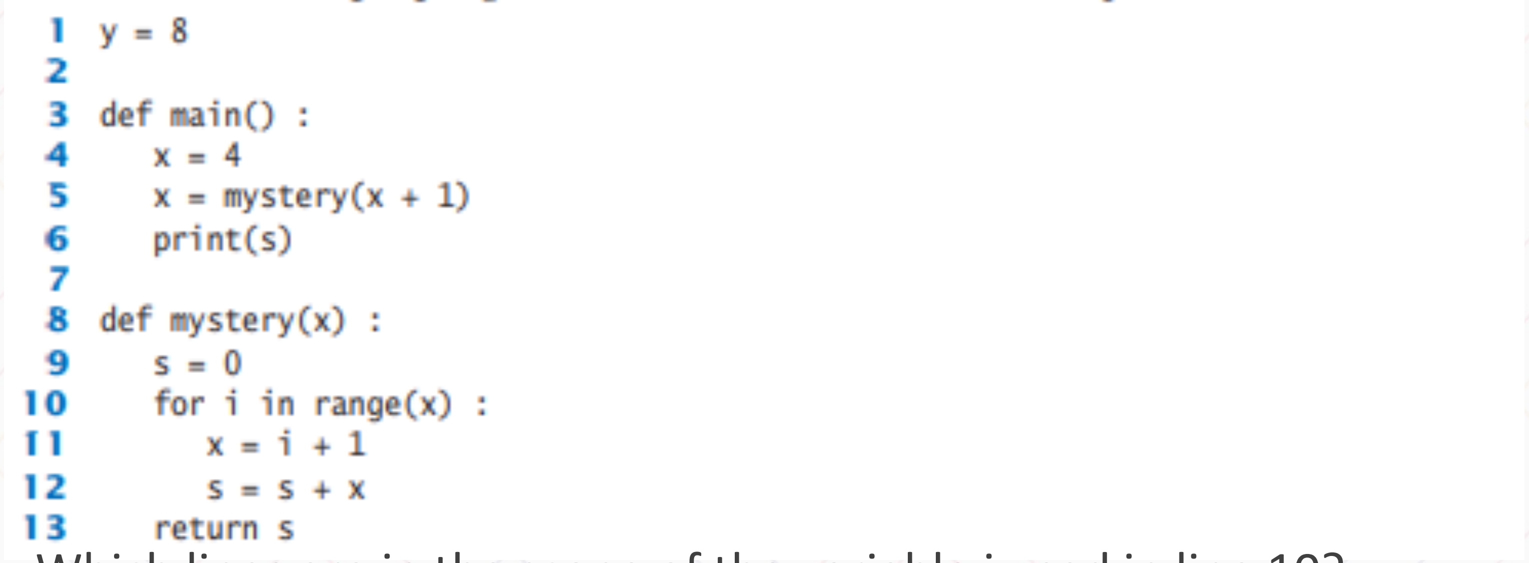
Example Use of a Global Variable

- If you omit the global declaration, then the balance variable inside the withdraw function is considered a local variable

```
balance = 10000    # A global variable
def withdraw(amount) :
    # This function intends to access the
    # global ‘balance’ variable
    global balance
    if balance >= amount :
        balance = balance – amount
withdraw(350)
Print(“balance = “, balance)
```

Sample program 1: Answer the Self Check questions.



```
1  y = 8
2
3  def main() :
4      x = 4
5      x = mystery(x + 1)
6      print(s)
7
8  def mystery(x) :
9      s = 0
10     for i in range(x) :
11         x = i + 1
12         s = s + x
13     return s
```

- Which lines are in the scope of the variable i used in line 10?
- Which lines are in the scope of the parameter variable x defined in line 8?
- The program defines two local variables with the same name whose scopes don't overlap. What are they?
- Which line defines a global variable?
- There is a scope error in the main function. What is it, and how do you fix it?

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Consider the following function that is intended to swap the values of two integers:

```
def main() :
        x = 3
        y = 4
        falseSwap(x, y)
        print(x, y)
def falseSwap(a, b) :
        temp = a
        a = b
        b = temp
```

Why doesn't the falseSwap function swap the contents of x and y?

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Programming Tip

- There are a few cases where global variables are required (such as `pi` defined in the math module), but they are quite rare
- Programs with global variables are difficult to maintain and extend because you can no longer view each function as a “black box” that simply receives arguments and returns a result
- Instead of using global variables, use function parameter variables and return values to transfer information from one part of a program to another

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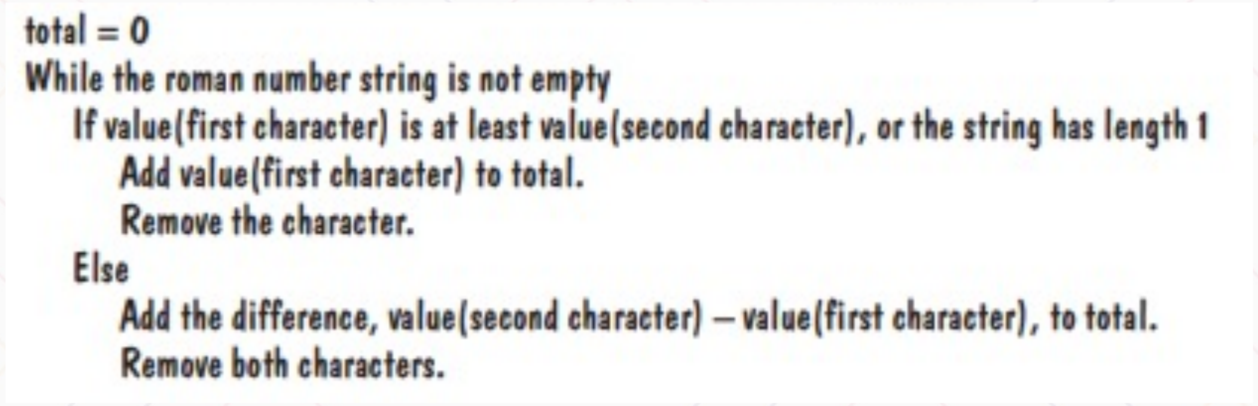
Practice programs:

- **Sample program 1 :** Write a function def countVowels(*string*) that returns a count of all vowels in the string *string*. Vowels are the letters a, e, i, o, and u, and their uppercase variants.
- **Sample program 2:** It is a well-known phenomenon that most people are easily able to read a text whose words have two characters flipped, provided the first and last letter of each word are not changed. For example, I dn'ot gvie a dman for a man taht can olny sepll a wrod one way. (Mrak Taiwn) Write a function scramble(word) that constructs a scrambled version of a given word, randomly flipping two characters other than the first and last one. Then write a program that reads words and prints the scrambled words.
- Write a program that converts a Roman number such as MCMLXXVIII to its decimal number representation. Hint: First write a function that yields the numeric value of each of the letters. Then use the following algorithm:



```
total = 0
While the roman number string is not empty
    If value(first character) is at least value(second character), or the string has length 1
        Add value(first character) to total.
        Remove the character.
    Else
        Add the difference, value(second character) – value(first character), to total.
        Remove both characters.
```

Summary: Function Returns

- Complete computations that can be reused into functions
- Use the process of stepwise refinement to decompose complex tasks into simpler ones
- A function may require simpler functions to carry out its work
- The scope of a variable is the part of the program in which the variable is visible
  - Two local or parameter variables can have the same name, provided that their scopes do not overlap
  - You can use the same variable name within different functions since their scope does not overlap
  - Local variables declared inside one function are not visible to code inside other functions