# Python Programming: An Introduction to Computer Science


Chapter 2
Writing Simple Programs



## Objectives

- To be able to understand and write Python statements to output information to the screen, assign values to variables, get numeric information entered from the keyboard, and perform a counted loop



## The Software Development Process

- The process of creating a program is often broken down into stages according to the information that is produced in each phase.



## The Software Development Process

- **Analyze the Problem**
  Figure out exactly the problem to be solved. Try to understand it as much as possible.



## The Software Development Process

- **Determine Specifications**
  Describe exactly what your program will do.
  - Don't worry about *how* the program will work, but *what* it will do.
  - Includes describing the inputs, outputs, and how they relate to one another.



## The Software Development Process

- **Create a Design**
  - Formulate the overall structure of the program.
  - This is where the *how* of the program gets worked out.
  - You choose or develop your own algorithm that meets the specifications.

## The Software Development Process

- **Implement the Design**
  - Translate the design into a computer language.
  - In this course we will use Python.



## The Software Development Process

- **Test/Debug the Program**
  - Try out your program to see if it worked.
  - If there are any errors (*bugs*), they need to be located and fixed. This process is called *debugging*.
  - Your goal is to find errors, so try everything that might "break" your program!



## The Software Development Process

- **Maintain the Program**
  - Continue developing the program in response to the needs of your users.
  - In the real world, most programs are never completely finished – they evolve over time.



## Example Program: Temperature Converter

- Analysis – the temperature is given in Celsius, user wants it expressed in degrees Fahrenheit.
- Specification
  - Input – temperature in Celsius
  - Output – temperature in Fahrenheit
  - Output = 9/5(input) + 32



## Example Program: Temperature Converter

- Design
  - Input, Process, Output (IPO)
  - Prompt the user for input (Celsius temperature)
  - Process it to convert it to Fahrenheit using F = 9/5(C) + 32
  - Output the result by displaying it on the screen



## Example Program: Temperature Converter

- Before we start coding, let's write a rough draft of the program in *pseudocode*
- Pseudocode is precise English that describes what a program does, step by step.
- Using pseudocode, we can concentrate on the algorithm rather than the programming language.

## Example Program: Temperature Converter

- Pseudocode:
  - Input the temperature in degrees Celsius (call it celsius)
  - Calculate fahrenheit as (9/5)*celsius+32
  - Output fahrenheit
- Now we need to convert this to Python!



## Example Program: Temperature Converter

```
#convert.py
# A program to convert Celsius temps to Fahrenheit
# by: Susan Computewell

def main():
    celsius = input("What is the Celsius temperature? ")
    fahrenheit = (9.0/5.0) * celsius + 32
    print "The temperature is ",fahrenheit," degrees
   Fahrenheit."

main()
```



## Example Program: Temperature Converter

- Once we write a program, we should test it!

```
>>>
What is the Celsius temperature? 0
The temperature is  32.0  degrees Fahrenheit.
>>> main()
What is the Celsius temperature? 100
The temperature is  212.0  degrees Fahrenheit.
>>> main()
What is the Celsius temperature? -40
The temperature is  -40.0  degrees Fahrenheit.
>>>
```



## Elements of Programs

- Names
  - Names are given to variables (celsius, fahrenheit), modules (main, convert), etc.
  - These names are called *identifiers*
  - Every identifier must begin with a letter or underscore ("_"), followed by any sequence of letters, digits, or underscores.
  - Identifiers are case sensitive.



## Elements of Programs

- These are all different, valid names
  - X
  - Celsius
  - Spam
  - spam
  - spAm
  - Spam_and_Eggs
  - Spam_And_Eggs



## Elements of Programs

- Some identifiers are part of Python itself. These identifiers are known as *reserved words*. This means they are not available for you to use as a name for a variable, etc. in your program.
- and, del, for, is, raise, assert, elif, in, print, etc.
- For a complete list, see table 2.1

## Elements of Programs

- Expressions
  - The fragments of code that produce or calculate new data values are called *expressions*.
  - *Literals* are used to represent a specific value, e.g. 3.9, 1, 1.0
  - Simple identifiers can also be expressions.



## Elements of Programs

```
>>> x = 5
>>> x
5
>>> print x
5
>>> print spam

Traceback (most recent call last):
  File "<pyshell#15>", line 1, in -toplevel-
    print spam
NameError: name 'spam' is not defined
>>>
```

- NameError is the error when you try to use a variable without a value assigned to it.



## Elements of Programs

- Simpler expressions can be combined using *operators*.
- +, -, *, /, **
- Spaces are irrelevant within an expression.
- The normal mathematical precedence applies.
- ((x1 – x2) / 2*n) + (spam / k**3)



## Elements of Programs

- Output Statements
  - A print statement can print any number of expressions.
  - Successive print statements will display on separate lines.
  - A bare print will print a blank line.
  - If a print statement ends with a ",", the cursor is not advanced to the next line.



## Elements of Programs

```
print 3+4              7
print 3, 4, 3+4        3 4 7
print
print 3, 4,            3 4 7
print 3+      4        The answer is 7
print "The answer
  is", 3+4
```



## Assignment Statements

- Simple Assignment
- <variable> = <expr>
  variable is an identifier, expr is an expression
- The expression on the RHS is evaluated to produce a value which is then associated with the variable named on the LHS.

## Assignment Statements

- `x = 3.9 * x * (1-x)`
- `fahrenheit = 9.0/5.0 * celsius + 32`
- `x = 5`



## Assignment Statements

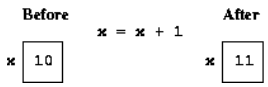
- Variables can be reassigned as many times as you want!

```
>>> myVar = 0
>>> myVar
0
>>> myVar = 7
>>> myVar
7
>>> myVar = myVar + 1
>>> myVar
8
>>>
```



## Assignment Statements

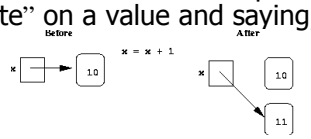
- Variables are like a box we can put values in.
- When a variable changes, the old value is erased and a new one is written in.






## Assignment Statements

- Technically, this model of assignment is simplistic for Python.
- Python does not recycle these memory locations (boxes).
- Assigning a variable is more like putting a "sticky note" on a value and saying, "this is x".






## Assigning Input

- The purpose of an input statement is to get input from the user and store it into a variable.
- <variable> = input(<prompt>)
- E.g., x = input("Enter a temperature in Celsius: ")



## Assigning Input

- First the prompt is evaluated
- The program waits for the user to enter a value and press <enter>
- The expression that was entered is evaluated and assigned to the input variable.

```
>>> def inp():
    x = input("Enter something ")
    print x


>>> inp()
Enter something 3+4
7
```

## Simultaneous Assignment

- Several values can be calculated at the same time
- <var>, <var>, … = <expr>, <expr>, …
- Evaluate the expressions in the RHS and assign them to the variables on the LHS



## Simultaneous Assignment

- sum, diff = x+y, x-y
- How could you use this to swap the values for x and y?
  - Why doesn't this work?
    x = y
    y = x
- We could use a temporary variable…



## Simultaneous Assignment

- We can swap the values of two variables quite easily in Python!
  - x, y = y, x

```
>>> x = 3
>>> y = 4
>>> print x, y
3 4
>>> x, y = y, x
>>> print x, y
4 3
```



## Simultaneous Assignment

- We can use this same idea to input multiple variables from a single input statement!
- Use commas to separate the inputs

```
>>> def spamneggs():
    spam, eggs = input("Enter the number of slices of spam
followed by the number of eggs: ")
    print "You ordered", eggs, "eggs and", spam, "slices
of spam. Yum!"

>>> spamneggs()
Enter the number of slices of spam followed by the number
of eggs: 3, 2
You ordered 2 eggs and 3 slices of spam. Yum!
>>>
```



## Definite Loops

- A *definite* loop executes a definite number of times, i.e., at the time Python starts the loop it knows exactly how many *iterations* to do.
- for <var> in <sequence>:
    <body>
- The beginning and end of the body are indicated by indentation.



## Definite Loops

for <var> in <sequence>:
  <body>

- The variable after the *for* is called the *loop index*. It takes on each successive value in *sequence*.

## Definite Loops

```
>>> for i in [0,1,2,3]:
    print i


0
1
2
3
>>> for odd in [1, 3, 5, 7]:
    print odd*odd


1
9
25
49
>>>
```



## Definite Loops

- In chaos.py, what did *range(10)* do?

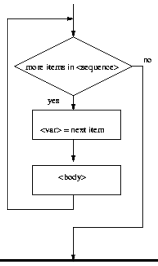
```
>>> range(10)
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

- Range is a built-in Python function that returns a list of numbers, starting with 0.
- Range(10) will make the body of the loop execute 10 times.



## Definite Loops

- **for** loops alter the flow of program execution, so they are referred to as *control structures*.






## Example Program: Future Value

- Analysis
  - Money deposited in a bank account earns interest.
  - How much will the account be worth 10 years from now?
  - Inputs: principal, interest rate
  - Output: value of the investment in 10 years



## Example Program: Future Value

- Specification
  - User enters the initial amount to invest, the principal
  - User enters an annual percentage rate, the interest
  - The specifications can be represent like this …



## Example Program: Future Value

- **Program** Future Value
- **Inputs**
  **principal** The amount of money being invested, in dollars
  **apr** The annual percentage rate expressed as a decimal number.
- **Output** The value of the investment 10 years in the future
- **Relatonship** Value after one year is given by *principal* * (1 + *apr*). This needs to be done 10 times.

## Example Program: Future Value

- Design

Print an introduction
Input the amount of the principal (principal)
Input the annual percentage rate (apr)
Repeat 10 times:
  principal = principal * (1 + apr)
Output the value of principal



## Example Program: Future Value

- Implementation
  - Each line translates to one line of Python (in this case)
  - Print an introduction
    **print "This program calculates the future**
    **print "value of a 10-year investment."**
  - Input the amount of the principal
    **principal = input("Enter the initial principal: ")**



## Example Program: Future Value

- Input the annual percentage rate
  **apr = input("Enter the annual interest rate: ")**
- Repeat 10 times:
  **for i in range(10):**
- Calculate principal = principal * (1 + apr)
  **principal = principal * (1 + apr)**
- Output the value of the principal at the end of 10 years
  **print "The value in 10 years is:", principal**



## Example Program: Future Value

```
# futval.py
#    A program to compute the value of an investment
#    carried 10 years into the future

def main():
    print "This program calculates the future value of a 10-year investment."

    principal = input("Enter the initial principal: ")
    apr = input("Enter the annual interest rate: ")

    for i in range(10):
        principal = principal * (1 + apr)

    print "The value in 10 years is:", principal

main()
```



## Example Program: Future Value

```
>>> main()
This program calculates the future value of a 10-year investment.
Enter the initial principal: 100
Enter the annual interest rate: .03
The value in 10 years is: 134.391637934
>>> main()
This program calculates the future value of a 10-year investment.
Enter the initial principal: 100
Enter the annual interest rate: .10
The value in 10 years is: 259.37424601
```