Python Programming Essentials

Unit 1: Basic Python

CHAPTER 2: WRITE SIMPLE PROGRAMS

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Objectives

- To know the steps in an orderly software development process.
- To understand programs following the input, process, output (IPO) pattern and be able to modify them in simple ways.
- To understand the rules for forming valid Python identifiers and expressions.

Objectives

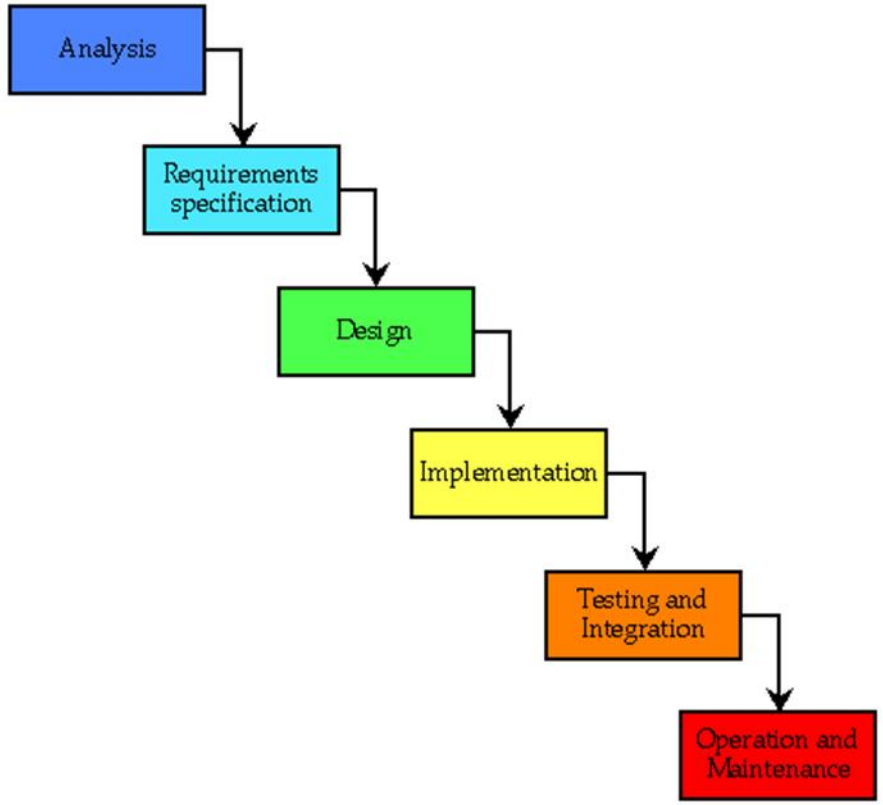
- To be able to understand and write Python statements to output information to the screen, assign values to variables, get numeric information entered from the keyboard, and perform a counted loop

Software Development

LECTURE 1

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.
  - Feasibility Study, Project Goal, and Budgeting

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.
  - Develop your own algorithm that meets the specifications.

The Software Development Process

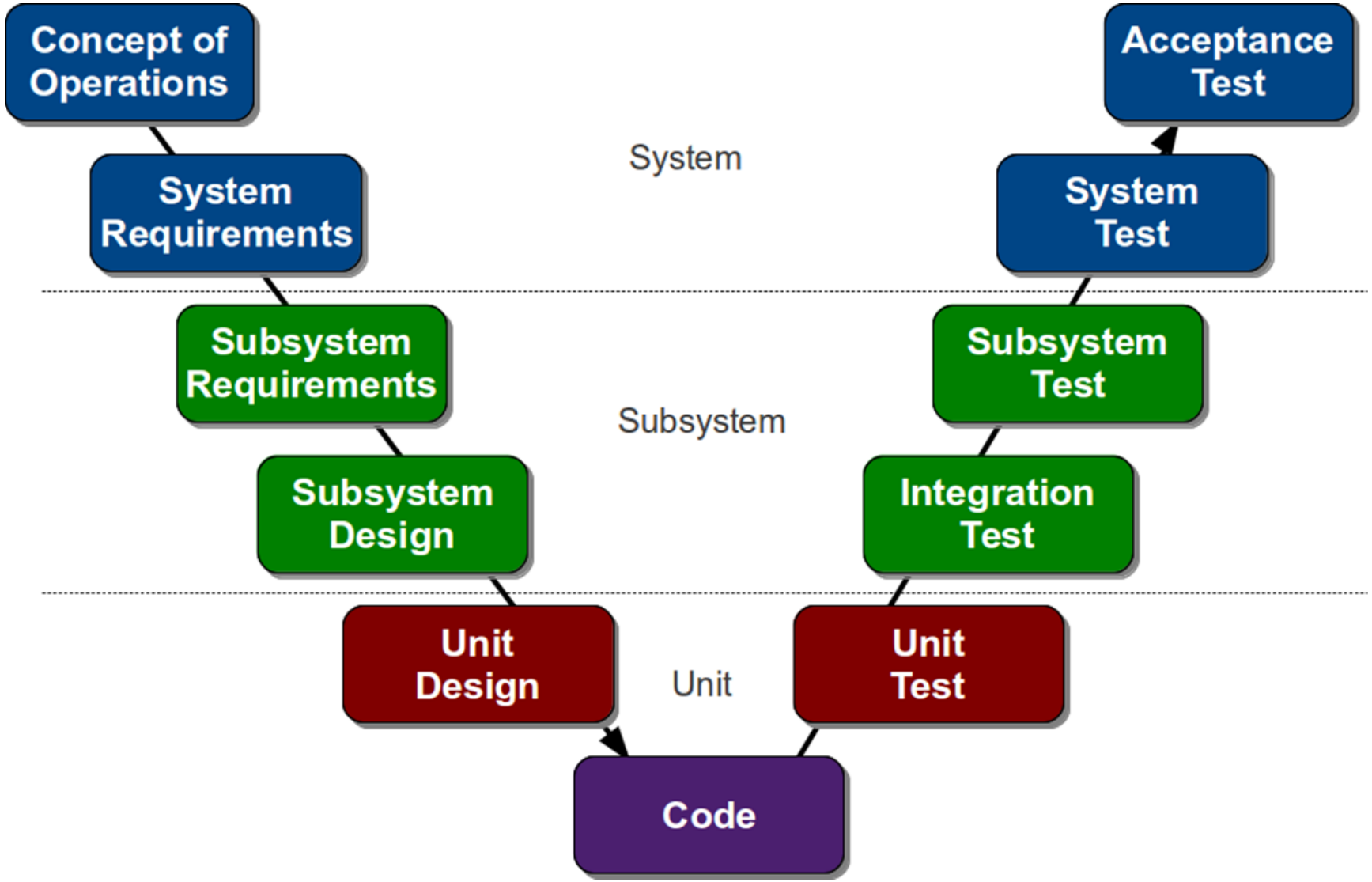
- **Implement the Design**
  - Translate the design into a computer language.
  - In this course we will use Python.

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.


Concept of Operations
System Requirements
Subsystem Requirements
Subsystem Design
Unit Design
Code
Unit Test
Integration Test
Subsystem Test
System Test
Acceptance Test
System
Subsystem
Unit

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.

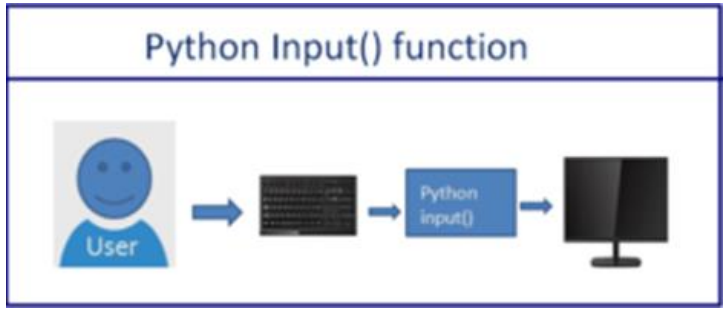
Example Program: Temperature Converter

- 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 = eval(input("What is the Celsius temperature? "))
    fahrenheit = (9/5) * 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.
>>>
```

Python Data Type Conversion

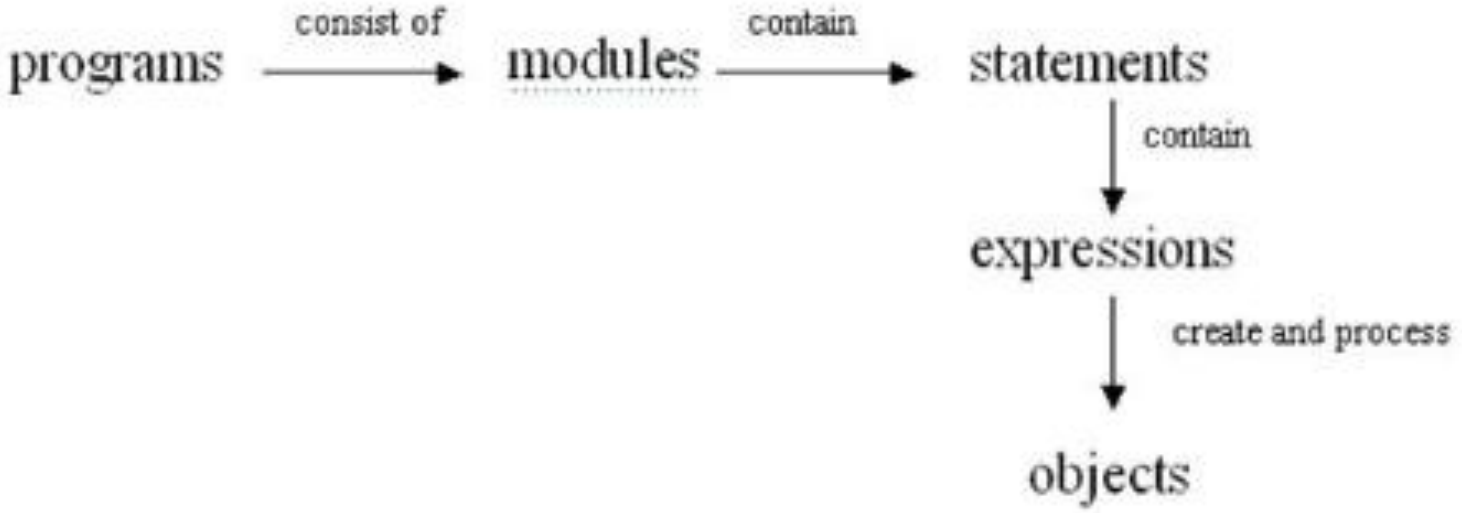
Function	Meaning
float(<expr>)	Convert expr to a floating point value
int(<expr>)	Convert expr to an integer value
str(<expr>)	Return a string representation of expr
eval(<string>)	Evaluate string as an expression

Elements of Programs

LECTURE 2

Python programs consist of:

- Modules
- Statements
- Expressions
- Objects



Python Basics:

Statements

Expressions

Loops

Strings

Functions

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 (or keywords). 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 (p. 32)

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.
  - Also included are strings (textual data) and string literals (like "Hello").

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

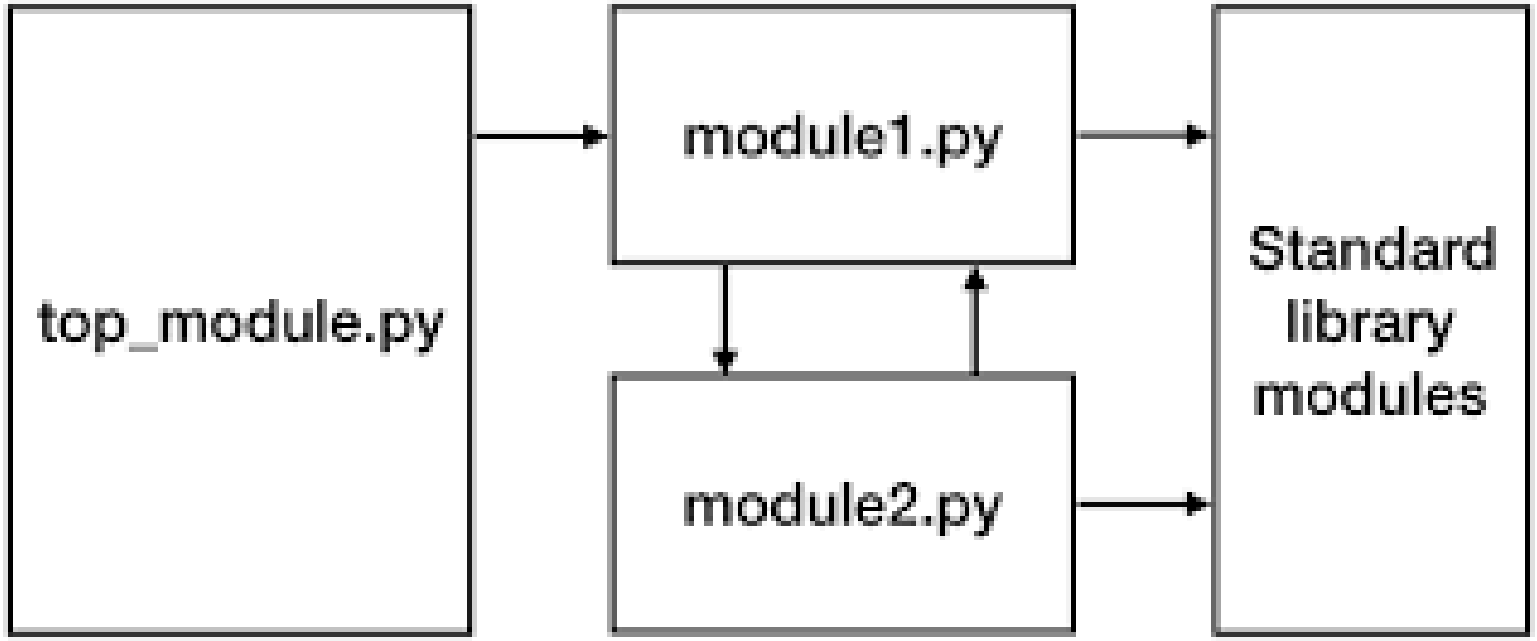
- Simpler expressions can be combined using operators.
- +, -, *, /, **
- Spaces are irrelevant within an expression.
- The normal mathematical precedence applies.
- ((x1 – x2) / 2*n) + (spam / k**3)

Elements of Programs

- **Output Statements**
  - `print()`
  - `print(<expr>, <expr>, …, <expr>)`
  - 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.

Elements of Programs

```
print(3+4)                          7
print(3, 4, 3+4)                    3 4 7
print()
print(3, 4, end=" "),
print(3 + 4)                        3 4 7
print("The answer is", 3+4)         The answer is 7
```


top_module.py
module1.py
module2.py
Standard
library
modules

Assignment Statements

LECTURE 3

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 = 9/5 * celsius + 32`
- `x = 5`

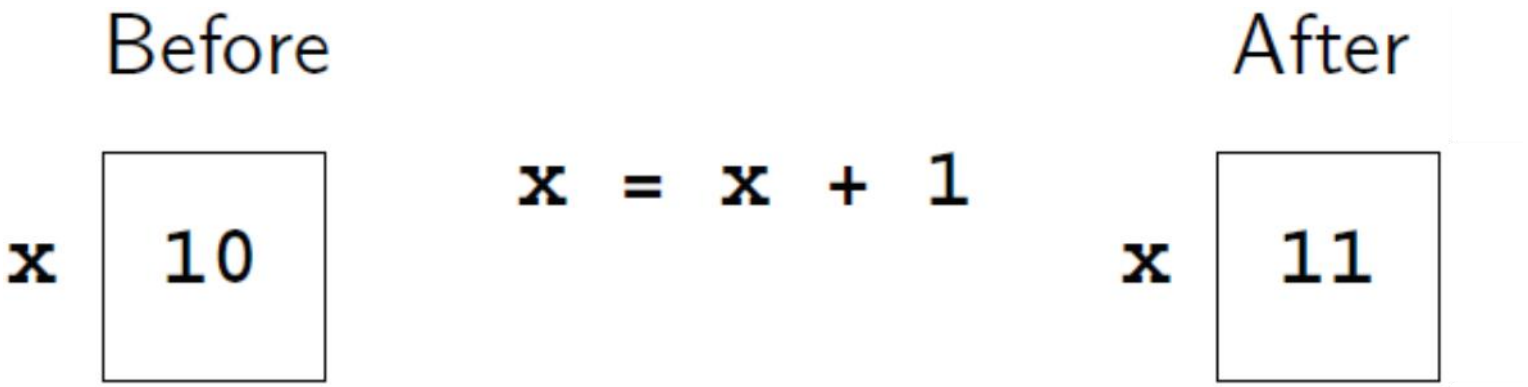
Assignment Statements

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

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

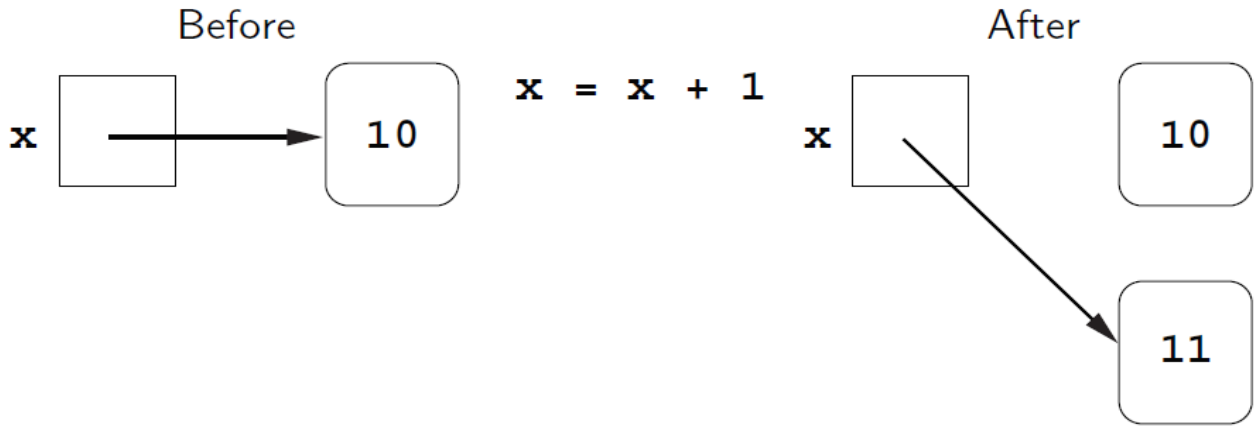
Assignment Statements

- 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 doesn't overwrite these memory locations (boxes).
- Assigning a variable is more like putting a “sticky note” on a value and saying, “this is x”.



Assigning Input

LECTURE 4

Assigning Input

- The purpose of an input statement is to get input from the user and store it into a variable.
- `<variable> = eval(input(<prompt>))`
- Here, `eval` is wrapped around the `input` function.

Assigning Input

- First the prompt is printed
- The input part waits for the user to enter a value and press <enter>
- The expression that was entered is evaluated to turn it from a string of characters into a Python value (a number).
- The value is assigned to the variable.
- For string input:
- `<var> = input(<prompt>)`

Assigning Input

- **Beware:** the function is very powerful and potentially dangerous!
- When we evaluate user input, we allow the user to enter a portion of our program, which Python will then evaluate.

Assigning Input

- Someone who knows Python could exploit this ability and enter malicious instructions, e.g. capture private information or delete files on the computer.
- This is called a **code injection** attack, because an attacker is injecting malicious code into the running program.

Assigning Input

- When writing programs for your own personal use, this is probably not much of an issue.
- When the input is coming from untrusted sources, like users on the Internet, the use of `eval` could be disastrous.
- We will see some safer alternatives in the next chapter.

Simultaneous Assignment

LECTURE 5

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 = eval(input("Enter # of slices of spam followed by # 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

LECTURE 6

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**.
- Often, the sequence portion consists of a *list* of values.
  - A **list** is a sequence of expressions in square brackets.

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

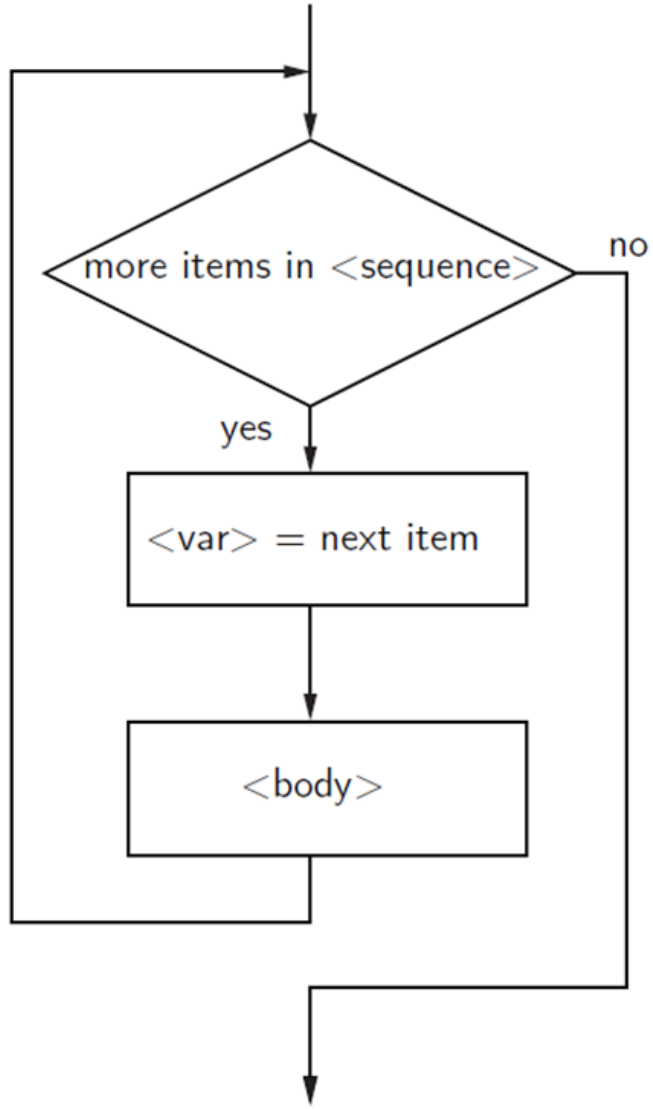
- In chaos.py, what did range(10) do?

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

- range is a built-in Python function that generates a sequence of numbers, starting with 0.
- list is a built-in Python function that turns the sequence into an explicit list
- The body of the loop executes 10 times.

Definite Loops

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



Future Value Project

LECTURE 7

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 represented 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
- **Relationship** 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 = eval(input("Enter the initial principal: "))

Example Program: Future Value

- Input the annual percentage rate
- apr = eval(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 = eval(input("Enter the initial principal: "))
    apr = eval(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
```

Homework

LECTURE 8

Homework Chapter 2

1. Exercise True/False, Multiple Choice
2. Exercise Discussion
3. Exercise Programming Exercises: 5