Chapter 2 – Introduction to Python Programming

Outline

2.1 Introduction

- Introduction to Python programming
- Introduction to programming techniques
  - Structured programming
  - Object-oriented programming

2.2 First Program in Python: Printing a Line of Text

- Python
  - The **#** symbol
    - Used to denote a single line comment
  - The **`print`** function
    - Used to send a stream of text to be output to the user
- Executing
  - Saving as a file
    - Type code into a .py file and save it
    - To run it type **`python`** ***`fileName`*****`.py`**
  - Executing code
    - Type **`python`** in the command line
    - Runs the python interpreter

```
# Fig. 2.1: fig02_01.py
# Printing a line of text in Python.

print "Welcome to Python!"
```

This is a comment

Prints out the line of text

Fig02_01.py

```
Welcome to Python!
```

Program Output

2.2 First Program in Python: Printing a Line of Text

```
Python 2.2b2 (#26, Nov 16 2001, 11:44:11) [MSC 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information-.
>>> print "Welcome to Python!"
Welcome to Python!
>>> ^Z
```

Fig. 2.2 Interactive mode.

2.3 Modifying our First Python Program

- Text outputs
  - How to display the text on one line through multiple statements, 2.3.1
  - How to display the text on several lines with only one code statement, 2.3.2

2.3.1 Displaying a Single Line of Text with Multiple Statements

- Printing Lines of Text
  - Python displays each print function on a new line
  - The comma can be used to tell the compiler to make a space rather than a white line

2.3.1 Displaying a Single Line of Text with Multiple Statements

Computer system	Keyboard combination
UNIX/Linux systems	*Ctrl-D* (on a line by itself)
DOS/Windows	*Ctrl-Z* (sometimes followed by pressing *Enter*)
Macintosh	*Ctrl-D*

Fig. 2.3 End-of-file key combinations for various popular computer systems.

Fig02_04.py

```
# Fig. 2.4: fig02_04.py
# Printing a line with multiple statements.

print "Welcome",
print "to Python!"
```

The comma tells the compiler to insert a space rather than go to the next line

Program Output

```
Welcome to Python!
```

2.3.2 Displaying Multiple Lines of Text with a Single Statement

- Escape characters
  - Used to perform a different task that normally intended
  - `\n` – insert a new line
  - `\"` – insert double quotes
  - `\'` – insert a single quote
  - `\\` – inserts a backslash
  - More are listed in Fig. 2.6

```
# Fig. 2.5: fig02_05.py
# Printing multiple lines with a single statement.

print "Welcome\nto\n\nPython!"
```

The **\n** is used to make the text appear on the next line

```
Welcome
To

Python!
```

Fig02_05.py

Program Output

2.3.2 Displaying Multiple Lines of Text with a Single Statement

Escape Sequence	Description
`\n`	Newline. Move the screen cursor to the beginning of the next line.
`\t`	Horizontal tab. Move the screen cursor to the next tab stop.
`\r`	Carriage return. Move the screen cursor to the beginning of the current line; do not advance to the next line.
`\b`	Backspace. Move the screen cursor back one space.
`\a`	Alert. Sound the system bell.
`\\`	Backslash. Print a backslash character.
`\"`	Double quote. Print a double quote character.
`\'`	Single quote. Print a single quote character.

Fig. 2.6 Escape sequences.

2.4 Another Program: Adding Integers

- Functions
  - The **`raw_input`** function
    - Used to retrieve data from the user
  - The **`int`** function
    - Used to convert strings to integers

```
# Fig. 2.7: fig02_07.py
# Simple addition program.

# prompt user for input
integer1 = raw_input( "Enter first integer:\n" )  # read string
integer1 = int( integer1 )   # convert string to integer

integer2 = raw_input( "Enter second integer:\n" ) # read string
integer2 = int( integer2 )   # convert string to integer

sum = integer1 + integer2    # compute and assign sum

print "Sum is", sum          # print sum
```

Prompts the user to enter and integer value

Converts the string value into an integer value

Adds up and then prints out the sum of the two numbers

Program Output

```
Enter first integer:
45
Enter second integer:
72

Sum is 117
```

2.4 Another Program: Adding Integers

```
Python 2.2b2 (#26, Nov 16 2001, 11:44:11) [MSC 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> value1 = raw_input( "Enter an integer: " )
Enter an integer: 2
>>> value2 = raw_input( "Enter an integer: " )
Enter an integer: 4
>>> print value1 + value2
24
```

Fig. 2.8 Adding values from `raw_input` (incorrectly) without converting to integers (the result should be 6).

2.5 Memory Concepts

- Objects
  - Every object has a type, size, value, and location
    - Stored in computers memory
    - Type and location cannot be changed
  - When a variable is made the name is binded to the value
  - Values are not modified as a computer performs the calculation

2.5 Memory Concepts

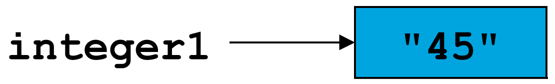


Fig. 2.9 Memory location showing value of a variable and the name bound to the value.

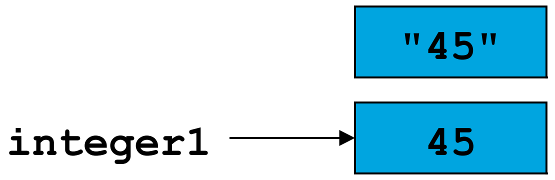


Fig. 2.10 Memory location showing the name and value of a variable.

2.5 Memory Concepts

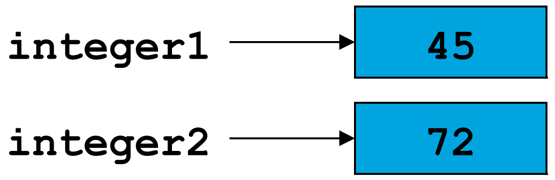


Fig. 2.11 Memory locations after values for two variables have been input.

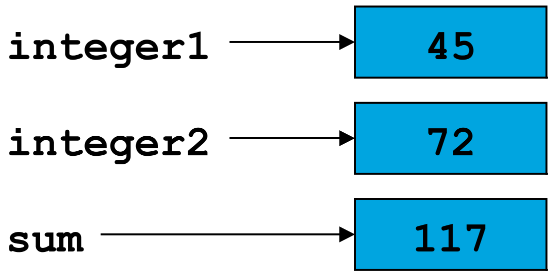


Fig. 2.12 Memory locations after a calculation.

Outline

Fig02_13.py

```
# Fig. 2.13: fig02_13.py
# Displaying an object's location, type and value.

# prompt the user for input
integer1 = raw_input( "Enter first integer:\n" )  # read a string
print "integer1: ", id( integer1 ), type( integer1 ), integer1
integer1 = int( integer1 )   # convert the string to an integer
print "integer1: ", id( integer1 ), type( integer1 ), integer1

integer2 = raw_input( "Enter second integer:\n" ) # read a string
print "integer2: ", id( integer2 ), type( integer2 ), integer2
integer2 = int( integer2 )   # convert the string to an integer
print "integer2: ", id( integer2 ), type( integer2 ), integer2

sum = integer1 + integer2    # assignment of sum
print "sum: ", id( sum ), type( sum ), sum
```

Prints the id, type and value before and after the variable is converted into an integer

Notice in the output that after the conversion the value is the same but the type and id have changed

```
Enter first integer:
5
integer1:  7956744 <type 'str'> 5
integer1:  7637688 <type 'int'> 5
Enter second integer:
27
integer2:  7776368 <type 'str'> 27
integer2:  7637352 <type 'int'> 27
sum:  7637436 <type 'int'> 32
```

2.6 Arithmetic

- Symbols
  - * = multiply
  - / = divide
  - % = modulus
  - ** = exponential
  - // = floor division
    - Only available in Python 2.2
    - Must use `from __future__ import division`
- Order
  - Operators are done in order of parenthesis, exponents, multiple and divide (left to right), and lastly add and subtract (left to right)

2.6 Arithmetic

Python operation	Arithmetic operator	Algebraic expression	Python expression
Addition	`+`	$f + 7$	`f + 7`
Subtraction	`-`	$p - c$	`p - c`
Multiplication	`*`	bm	`b * m`
Exponentiation	`**`	x^y	`x ** y`

Division	`/`
	`//` **(new in Python 2.2)**
		x / y or <Anchor4> or $x \quad y$	`x / y`
			`x // y`

Modulus	`%`	$r \bmod s$	`r % s`

Fig. 2.14 Arithmetic operators.

2.6 Arithmetic

```
Python 2.2b2 (#26, Nov 16 2001, 11:44:11) [MSC 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> 3 / 4       # floor division (default behavior)
0
>>> 3.0 / 4.0   # true division (floating-point operands)
0.75
>>> 3 // 4      # floor division (only behavior)
0
>>> 3.0 // 4.0  # floating-point floor division
0.0
>>> from __future__ import division
>>> 3 / 4       # true division (new behavior)
0.75
>>> 3.0 / 4.0   # true division (same as before)
0.75
```

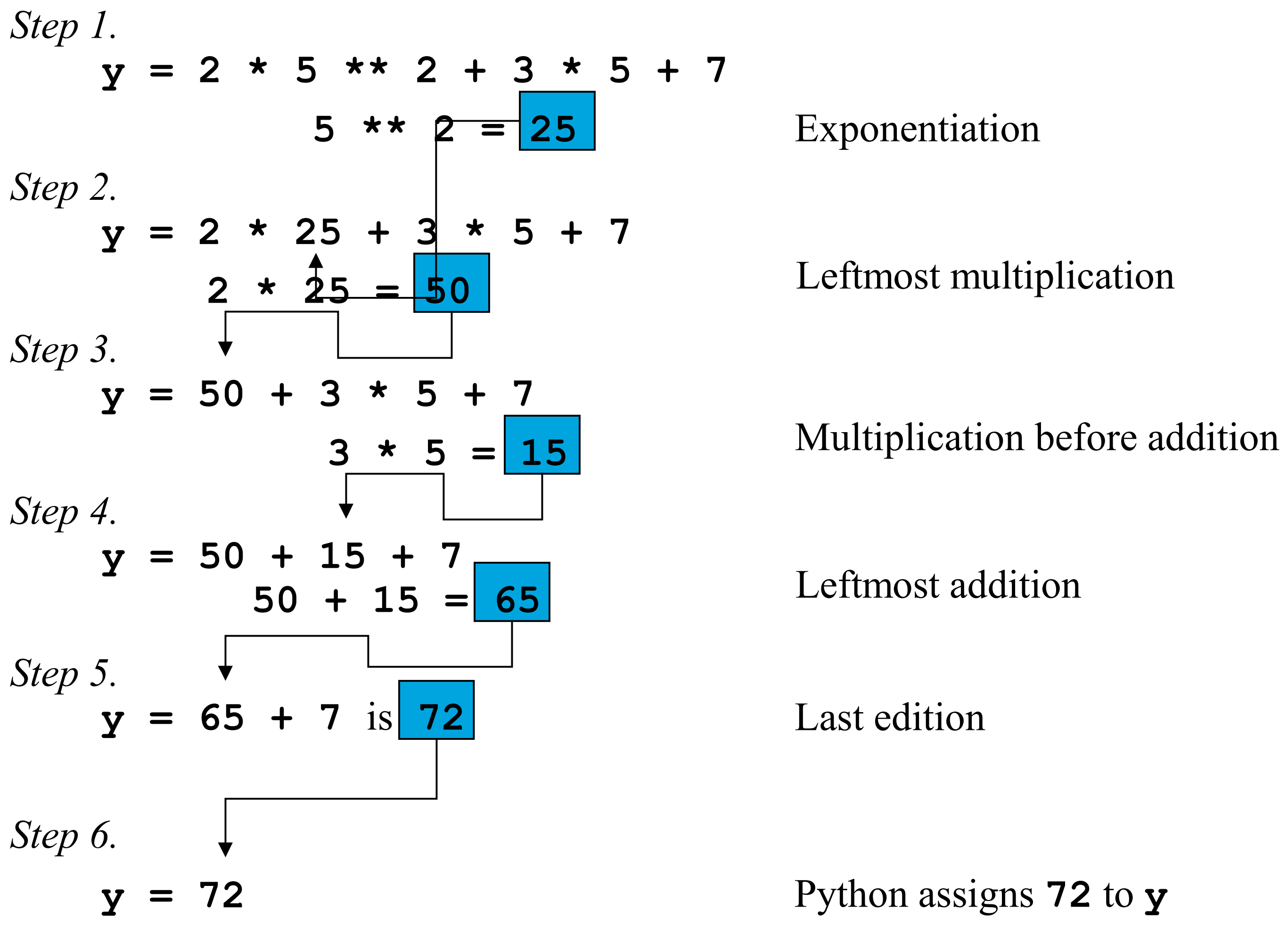
Fig. 2.15 Difference in behavior of the **/** operator.

2.6 Arithmetic

Operator(s)	Operation(s)	Order of Evaluation (Precedence)
`( )`	Parentheses	Evaluated first. If the parentheses are nested, the expression in the innermost pair is evaluated first. If there are several pairs of parentheses "on the same level" (i.e., not nested), they are evaluated left to right.
`**`	Exponentiation	Evaluated second. If there are several, they are evaluated right to left.
`* / // %`	Multiplication Division Modulus	Evaluated third. If there are several, they are evaluated left to right. [*Note:* The `//` operator is new in version 2.2]
`+ -`	Addition Subtraction	Evaluated last. If there are several, they are evaluated left to right.

Fig. 2.16 Precedence of arithmetic operators.

2.6 Arithmetic



Step 1.

```
y = 2 * 5 ** 2 + 3 * 5 + 7
          5 ** 2 = 25
```

Exponentiation

Step 2.

```
y = 2 * 25 + 3 * 5 + 7
     2 * 25 = 50
```

Leftmost multiplication

Step 3.

```
y = 50 + 3 * 5 + 7
          3 * 5 = 15
```

Multiplication before addition

Step 4.

```
y = 50 + 15 + 7
     50 + 15 = 65
```

Leftmost addition

Step 5.

y = 65 + 7 is 72

Last edition

Step 6.

```
y = 72
```

Python assigns `72` to `y`

Fig. 2.17 Order in which a second-degree polynomial is evaluated.

2.7 String Formatting

- Strings
  - Unlike other languages strings are a built in data type
    - Allows for easy string manipulation
  - Double quote strings
    - Single quotes need not be escaped
  - Single quote strings
    - Double quotes need not be escaped
  - Triple quoted strings
    - Do not need any escape sequence
    - Used for large blocks of text

Outline

```
# Fig. 2.18: fig02_18.py
# Creating strings and using quote charact

print "This is a string with \"double quotes.\""
print 'This is another string with "double quotes."'
print 'This is a string with \'single quotes.\''
print "This is another string with 'single quotes.'"
print """This string has "double quotes" and 'single quotes'.
   You can even do multiple lines."""
print '''This string also has "double" and 'single' quotes.'''
```

Strings in single quotes need not have double quotes escaped

Strings with double quotes need not escape single quotes

n Output

```
This is a string with "double quotes."
This is another string with "double quotes."
This is a string with 'single quotes.'
This is another string with 'single quotes.'
This string has "double quotes" and 'single quotes'.
   You can even do multiple lines.
This string also has "double" and 'single' quotes.
```

Strings in triple quotes do not have to escape anything and can span many lines

Fig02_19.py

```
# Fig. 2.19: fig02_19.py
# String formatting.

integerValue = 4237
print "Integer ", integerValue
print "Decimal integer %d" % integerValue
print "Hexadecimal integer %x\n" % integerValue

floatValue = 123456.789
print "Float", floatValue
print "Default float %f" % floatValue
print "Default exponential %e\n" % floatValue

print "Right justify integer (%8d)" % integerValue
print "Left justify integer  (%-8d)\n" % integerValue

stringValue = "String formatting"
print "Force eight digits in integer %.8d" % integerValue
print "Five digits after decimal in float %.5f" % floatValue
print "Fifteen and five characters allowed in string:"
print "(%.15s) (%.5s)" % ( stringValue, stringValue )
```

The %e is used to format the string

Formats the string to contain exactly a specified amount of letters

Formats the string to only allow so many characters

Fig02_19.py
Program Output

```
Integer  4237
Decimal integer 4237
Hexadecimal integer 108d

Float 123456.789
Default float 123456.789000
Default exponential 1.234568e+005

Right justify integer (    4237)
Left justify \integer  (4237    )

Force eight digits in integer 00004237
Five digits after decimal in float 123456.78900
Fifteen and five characters allowed in string:
(String formatti) (Strin)
```

2.7 String Formatting

Conversion Specifier Symbol	Meaning
`c`	Single character (i.e., a string of length one) or the integer representation of an ASCII character.
`s`	String or a value to be converted to a string.
`d`	Signed decimal integer.
`u`	Unsigned decimal integer.
`o`	Unsigned octal integer.
`x`	Unsigned hexadecimal integer (with hexadecimal digits **`a`** through **`f`** in lowercase letters).
`X`	Unsigned hexadecimal integer (with hexadecimal digits **`A`** through **`F`** in uppercase letters).
`f`	Floating-point number.
`e`, **`E`**	Floating-point number (using scientific notation).
`g`, **`G`**	Floating-point number (using least-significant digits).

Fig. 2.20 String-formatting characters.

2.8 Decision Making: Equality and Relational Operators

- The if structure
  - Can be formed with equality and relational operators
    - <, >, ==, …

2.8 Decision Making: Equality and Relational Operators

Standard algebraic equality operator or relational operator	Python equality or relational operator	Example of Python condition	Meaning of Python condition
Relational operators	2.1		
>	`>`	`x > y`	`x` is greater than `y`
<	`<`	`x < y`	`x` is less than `y`
	`>=`	`x >= y`	`x` is greater than or equal to `y`
£	`<=`	`x <= y`	`x` is less than or equal to `y`
Equality operators			
=	`==`	`x == y`	`x` is equal to `y`
	`!=`, `<>`	`x != y`, `x <> y`	`x` is not equal to `y`

Fig. 2.21 Equality and relational operators.

Outline

Fig02_22.py

```
# Fig. 2.22: fig02_22.py
# Compare integers using if structures, relational operators
# and equality operators.

print "Enter two integers, and I will tell you"
print "the relationships they satisfy."

# read first string and convert to integer
number1 = raw_input( "Please enter first integer: " )
number1 = int( number1 )

# read second string and convert to integer
number2 = raw_input( "Please enter second integer: " )
number2 = int( number2 )

if number1 == number2:
   print "%d is equal to %d" % ( number1, number2 )

if number1 != number2:
   print "%d is not equal to %d" % ( number1, number2 )

if number1 < number2:
   print "%d is less than %d" % ( number1, number2 )

if number1 > number2:
   print "%d is greater than %d" % ( number1, number2 )

if number1 <= number2:
   print "%d is less than or equal to %d" % ( number1, number2 )

if number1 >= number2:
   print "%d is greater than or equal to %d" % ( number1, number2 )
```

Gets two values from the user and converts them to strings

Checks each of the rational operators or the numbers using if statements

`Fig02_22.py`
Program Output

```
Enter two integers, and I will tell you
the relationships they satisfy.
Please enter first integer: 37
Please enter second integer: 42
37 is not equal to 42
37 is less than 42
37 is less than or equal to 42
```

```
Enter two integers, and I will tell you
the relationships they satisfy.
Please enter first integer: 7
Please enter second integer: 7
7 is equal to 7
7 is less than or equal to 7
7 is greater than or equal to 7
```

```
Enter two integers, and I will tell you
the relationships they satisfy.
Please enter first integer: 54
Please enter second integer: 17
54 is not equal to 17
54 is greater than 17
54 is greater than or equal to 17
```

2.8 Decision Making: Equality and Relational Operators

```
Python 2.2b2 (#26, Nov 16 2001, 11:44:11) [MSC 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> print 1 +
  File "<string>", line 1
    print 1 +
            ^
SyntaxError: invalid syntax
>>> print 1 + \
... 2
3
>>>
```

2.8 Decision Making: Equality and Relational Operators

Operators				Associativity	Type
`()`				left to right	parentheses
`**`				right to left	exponential
`*`	`/`	`//`	`%`	left to right	multiplicative
`+`	`-`			left to right	additive
`<`	`<=`	`>`	`>=`	left to right	relational
`==`	`!=`	`<>`		left to right	equality

Fig. 2.24 Precedence and associativity of operators discussed so far.

2.9 Indentation

- Indenting
  - Used to delimit code
  - Python uses no end of statement character
  - Therefore a new line of code is determined by return space
  - Indenting is the same way
    - Python does not use {} to enclose a multi-line statement
    - The indentation must be exactly the same same
  - There is no exact rule for the number of spaces but they are generally in groups of three

Fig02_25.py

```
# Fig. 2.25: fig02_25.py
# Using if statements, relational operators and equality
# operators to show improper indentation.

print "Enter two integers, and I will tell you"
print "the relationships they satisfy."

# read first string and convert to integer
number1 = raw_input( "Please enter first integer: " )
number1 = int( number1 )

# read second string and convert to integer
number2 = raw_input( "Plea
number2 = int( number2 )

if number1 == number2:
   print "%d is equal to %d" % ( number1, number2 )

   # improper indentation causes this if statement to execute only
   # when the above if statement executes
   if number1 != number2:
      print "%d is not equal to %d" % ( number1, number2 )

if number1 < number2:
   print "%d is less than %d" % ( number1, number2 )

if number1 > number2:
   print "%d is greater than %d" % ( number1, number2 )

if number1 <= number2:
   print "%d is less than or equal to %d" % ( number1, number2 )

if number1 >= number2:
   print "%d is greater than or equal to %d" % ( number1, number2 )
```

Since this if statement is indented it is considered part of the other if statement

```
Enter two integers, and I will tell you
the relationships they satisfy.
Please enter first integer: 1
Please enter second integer: 2
1 is less than 2
1 is less than or equal to 2
```

`Fig02_25.py`
Program Output

2.10 Thinking about Objects: Introduction to Object Technology

- Objects
  - Everything in the real world is made of objects
  - Each object has attributes
    - Shape, size, color, weight
  - Each object has behaviors
    - Roll, bounce, inflate, deflate
- **O**bject **O**riented **P**rogramming (OOP)
  - Modes real world objects with programming counterparts
  - Information hiding
    - Know how to communicate with one another
    - Don’t know the specifics of other objects
  - Encapsulate, to prevent code repetition