ISYS90088
Introduction to Application Development

Week 2 – continue from week01; Software Development Life Cycle

Variable, data types - integers and floating point numbers, construct arithmetic expressions

Initialize and use variables

And others (if time permits)

Semester 2 , 2018

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Objectives

After completing this Lecture, you will be able to:

- Describe the basic phases of software development: analysis, design, coding, and testing

- Variables, data types - use integers and floating point numbers in arithmetic operations

- Construct arithmetic expressions
- Initialize and use variables with appropriate names
- Use strings for the terminal input and output of text

Objectives (continued)

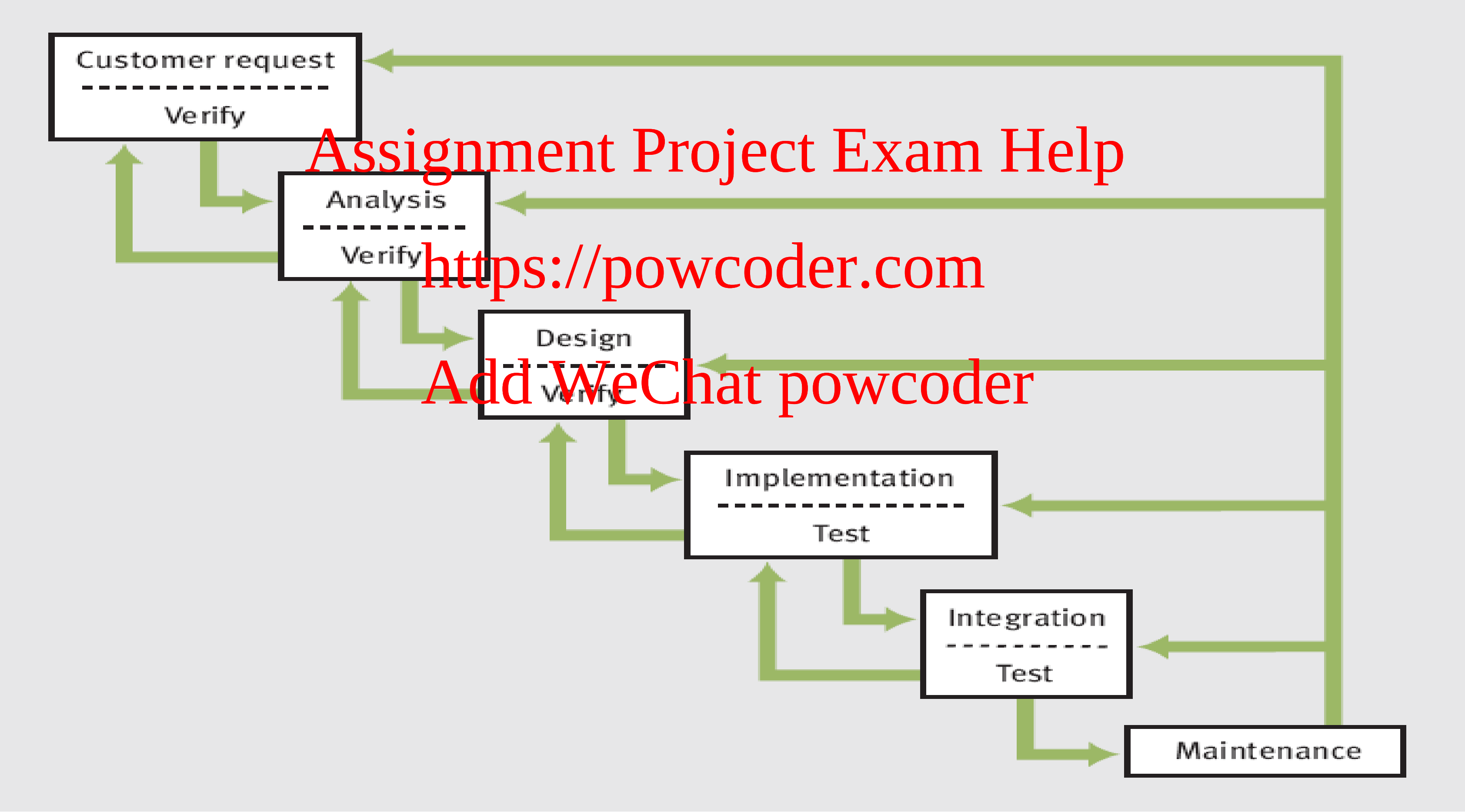
- Construct a simple Python program that performs inputs, calculations, and outputs
- Commenting - use docstrings to document Python programs
- Import functions from library modules – Math

The Software Development Process

- **Software development:** process of planning and organizing a program
  - Several approaches; one is the **waterfall model**

- Another is - **incremental** and **iterative/agile methodology**
  - Analysis and design may produce a **prototype** of a system for coding, and then back up to earlier phases to fill in more details after some testing

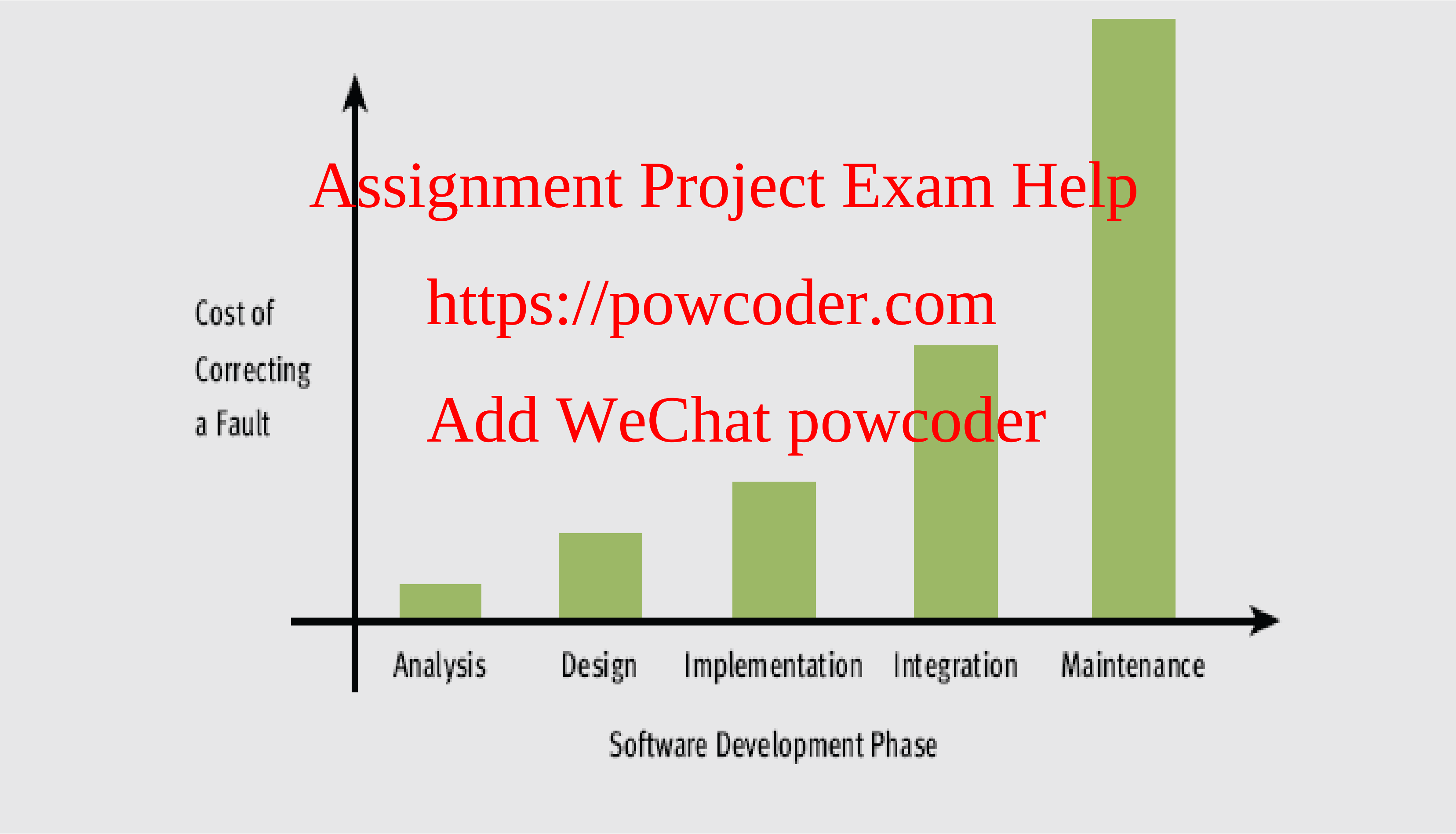
The Software Development Process (continued)



The Software Development Process (continued)

- Programs rarely work as hoped the first time they are run
  - Must perform extensive and careful testing
  - The cost of developing software is not spread equally over the phases

The Software Development Process (continued)



Variables and the Assignment Statement

- A **variable** associates a name with a value
  - Makes it easy to remember and use later in program

- Variable naming rules:
  - Reserved words cannot be used as variable names
    - Examples: **if**, **for**, **while** and **import**

  - Name must begin with a letter or underscore _
- The rest of the name can contain zero or more occurrences of the following things:
  - Digits (**0** to **9**) .
  - Alphabetic letters.
  - Underscores.

Variables and the Assignment Statement (continued)

- Nothing else is allowed in a variable name. Here is (incomplete) list of the **things you can't use anywhere in a variable name**:
  - Whitespace characters (the space, tab, new line).
  - Hyphens (**-**)
  - Quotation marks (single or double)
  - Symbol characters such as: the question mark, exclamation mark, brackets, and so forth.

- The following words having special meaning in Python (reserve words), and so they cannot be used for variable

Examples:

def, if, for, while, else, except, return, True, range, list, continue

Variables and the Assignment Statement (continued)

- Variables receive initial values and can be reset to new values with an **assignment statement**

Syntax:

<variable name> = <expression>

  – Subsequent uses of the variable name in expressions are known as **variable references**

Variables : Example 1

#Which of the following are valid variable names?

a. length
b. _width
c. firstWord
d. 2MoreToGo
e. halt!

Solution: ????

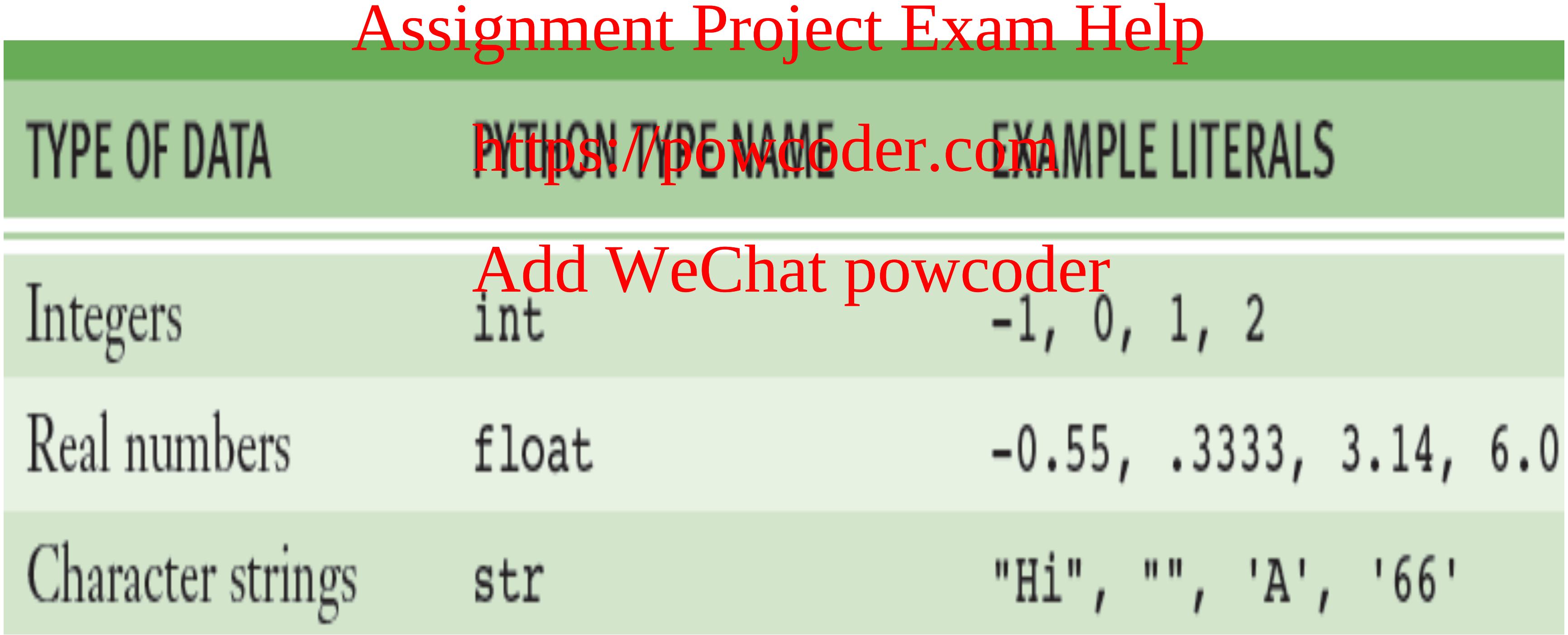
Data Types

- A **data type** consists of a set of values and a set of operations that can be performed on those values

- A **literal** is the way a value of a data type looks to a programmer eg; 4 5 0.5 “hi” etc….

Data Types (continued)

Numeric Data types integers, floating point numbers and their cousins Character sets



TYPE OF DATA	PYTHON TYPE NAME	EXAMPLE LITERALS
Integers	int	-1, 0, 1, 2
Real numbers	float	-0.55, .3333, 3.14, 6.0
Character strings	str	"Hi", "", 'A', '66'

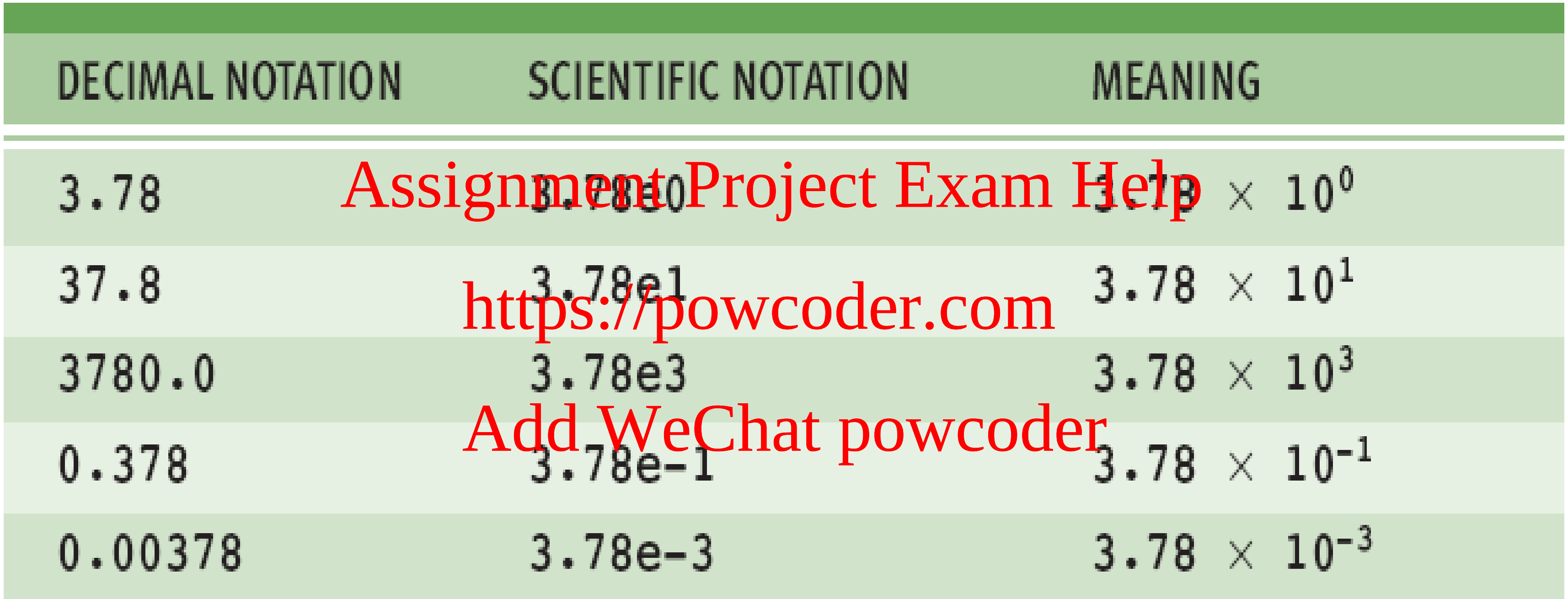
Data Types - Integers

- Integers include 0, all of the positive whole numbers, all of the negative whole numbers
- Integer literals in Python are written without commas
- A leading negative sign indicates a negative value in python
- A computer's memory places a limit on magnitude of the largest positive and negative integers - Python's **int** typical range: -2^{31} to $2^{31} - 1$ ie., (-2147483648 to 2147483647)
- A long integer is quite large. But still limited to your computers memory capacity.
  – Try evaluating: 2147483647 ** 100

Data types - Floating-Point Numbers

- A **real number** consists of a whole number, a decimal point and fractional part.
- Python uses **floating-point** numbers to represent real numbers.
- Python's **float** typical range: -10^{308} to 10^{308}
- A floating point number can be written using either ordinary decimal notation or **scientific notation**
- Scientific notation is usually useful when representing very large numbers

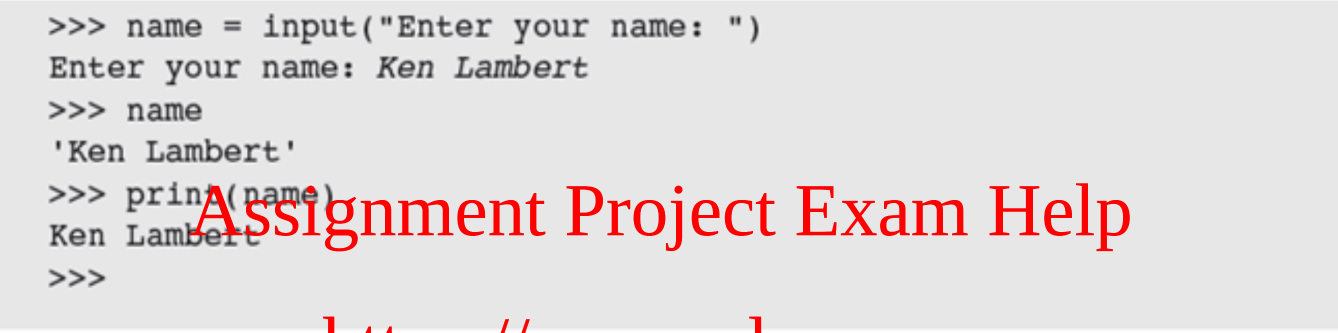
Floating-Point Numbers (continued)



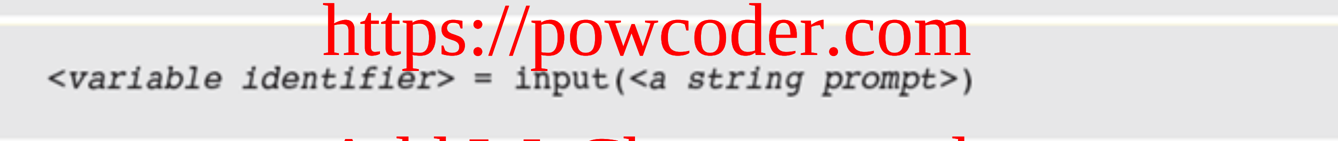
DECIMAL NOTATION	SCIENTIFIC NOTATION	MEANING
3.78	3.78e0	3.78 × 10^{0}
37.8	3.78e1	3.78 × 10^{1}
3780.0	3.78e3	3.78 × 10^{3}
0.378	3.78e-1	3.78 × 10^{-1}
0.00378	3.78e-3	3.78 × 10^{-3}

Lets check this out !!!!

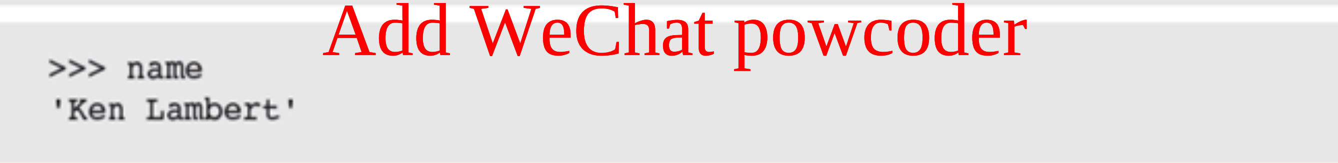
Revisit the input statement - example



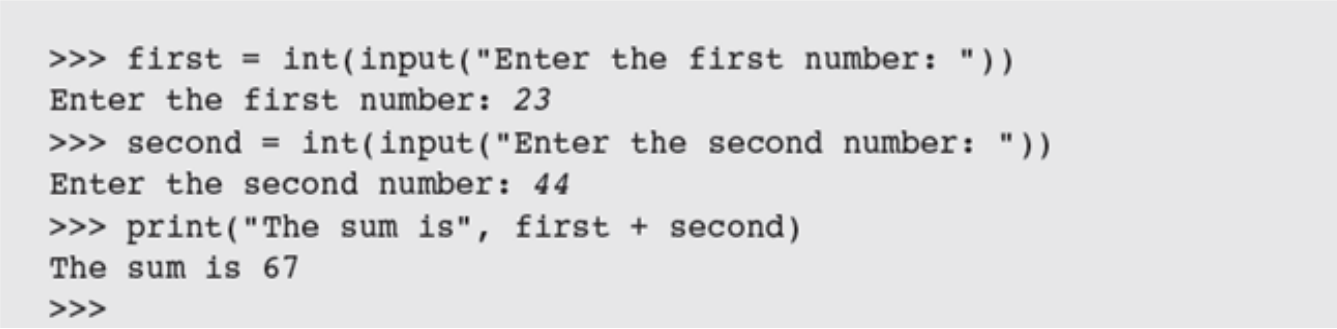
```
>>> name = input("Enter your name: ")
Enter your name: Ken Lambert
>>> name
'Ken Lambert'
>>> print(name)
Ken Lambert
>>>
```



```
<variable identifier> = input(<a string prompt>)
```



```
>>> name
'Ken Lambert'
```



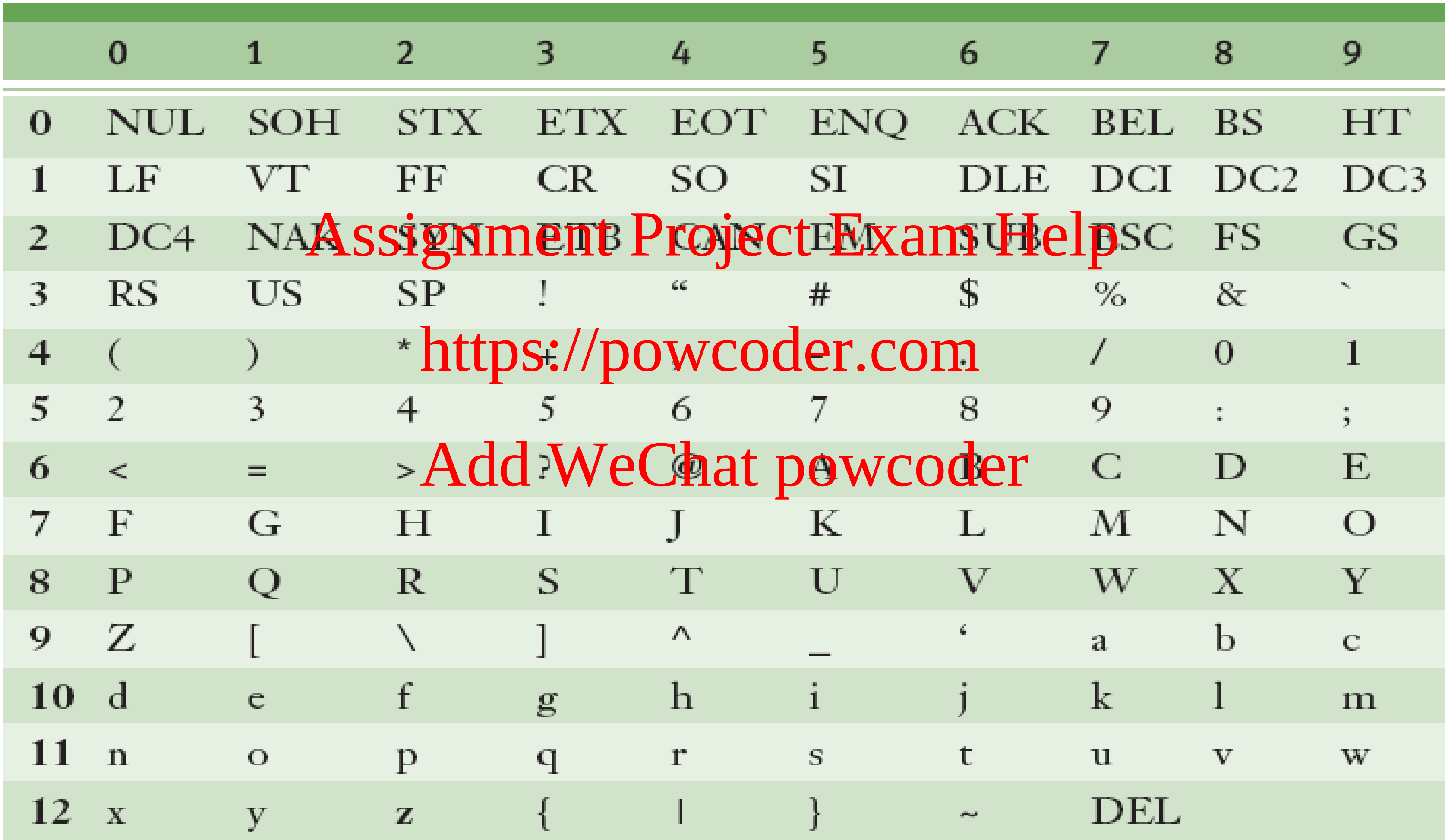
```
>>> first = int(input("Enter the first number: "))
Enter the first number: 23
>>> second = int(input("Enter the second number: "))
Enter the second number: 44
>>> print("The sum is", first + second)
The sum is 67
>>>
```

Data types - Character Sets

- Character literals in python look like strings and are of **string types**
- They belong to character sets – ASCII set (128 codes) (**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange)

- ASCII set encodes each keyboard characters
  - The digits in the left column represent the leftmost digits of the ASCII Code.
  - The digit in the top row are the rightmost digits.
  - ASCII code for ‘R’ = 82

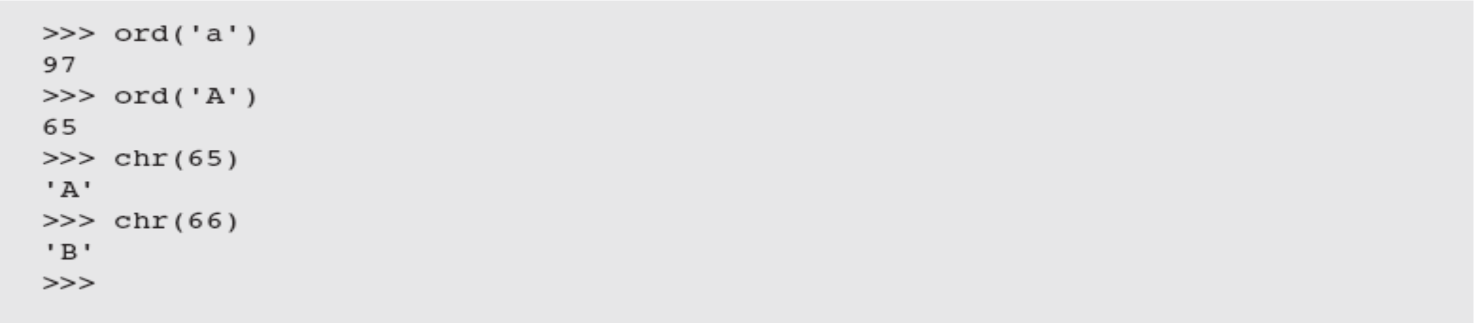
Character Sets



	0	1	2	3	4	5	6	7	8	9
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT
1	LF	VT	FF	CR	SO	SI	DLE	DCI	DC2	DC3
2	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS
3	RS	US	SP	!	“	#	$	%	&	`
4	(	)	*	+	,	-	.	/	0	1
5	2	3	4	5	6	7	8	9	:	;
6	<	=	>	?	@	A	B	C	D	E
7	F	G	H	I	J	K	L	M	N	O
8	P	Q	R	S	T	U	V	W	X	Y
9	Z	[	\	]	^	_	‘	a	b	c
10	d	e	f	g	h	i	j	k	l	m
11	n	o	p	q	r	s	t	u	v	w
12	x	y	z	{	|	}	~	DEL		

Character Sets (continued)

- In Python, character literals look just like string literals and are of the string type
  - They belong to several different **character sets**, among them the **ASCII set**
  - ASCII character set maps to set of integers
- **ord** and **chr** convert characters to and from ASCII



```
>>> ord('a')
97
>>> ord('A')
65
>>> chr(65)
'A'
>>> chr(66)
'B'
>>>
```

Example: if you want to shift three places to the right of the letter ‘A’, simply write: chr(ord(‘A’) + 3)

Data types: Quiz

#Write the values of the following floating point numbers in Python's scientific notation:

a. 355.76

b. 0.007832

c. 4.3212

Data types: Quiz

#Which data type would most appropriately be used to represent the following data values?

a. The number of months in a year

b. The area of a circle

c. The current minimum wage

d. The approximate age of the universe (12,000,000,000 yrs)

e. Your name

Program Comments and Docstrings

- **What is a program comment?**

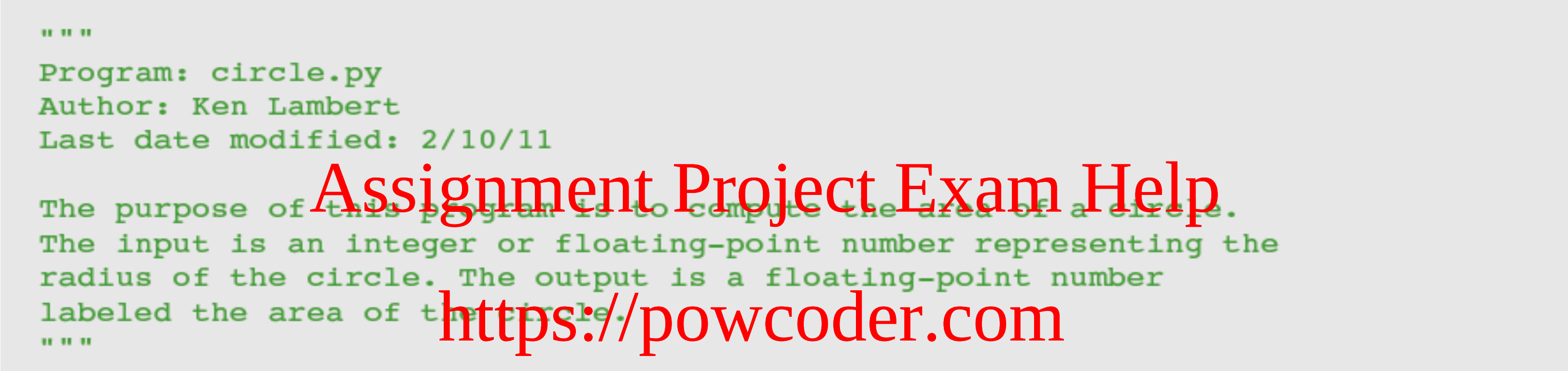
A comment is a piece of program text that the interpreter ignores but that provides useful documentation to programmers.

- **Why is it necessary?** A good programming style
  - Readability
  - Re-use

Docstring: It is a multi-line string that briefly describes parts of the program.

Program Comments and Docstrings

- **Docstring** example:



```
"""
Program: circle.py
Author: Ken Lambert
Last date modified: 2/10/11

The purpose of this program is to compute the area of a circle.
The input is an integer or floating-point number representing the
radius of the circle. The output is a floating-point number
labeled the area of the circle.
"""
```

- **End-of-line comment**: these comments begin with a # symbol and extend to the end of a line.
  – May explain the purpose of a variable or a strategy used in a piece of code.
- **End-of-line comment example**:

>>> rate = 4.5 # this variable provides a constant value

Program Comments and Docstrings

Good programming style:

1. Begin a program with a statement of its purpose and other information that helps the programmer or reader. This includes: what the program does, the authors name, version, date etc…

2. Accompany a variable definition with a comment that explains the variables purpose

3. Precede major segments of code with comments
4. Use comments to explain certain complex segments in your code

- Break (if time permits continue)!

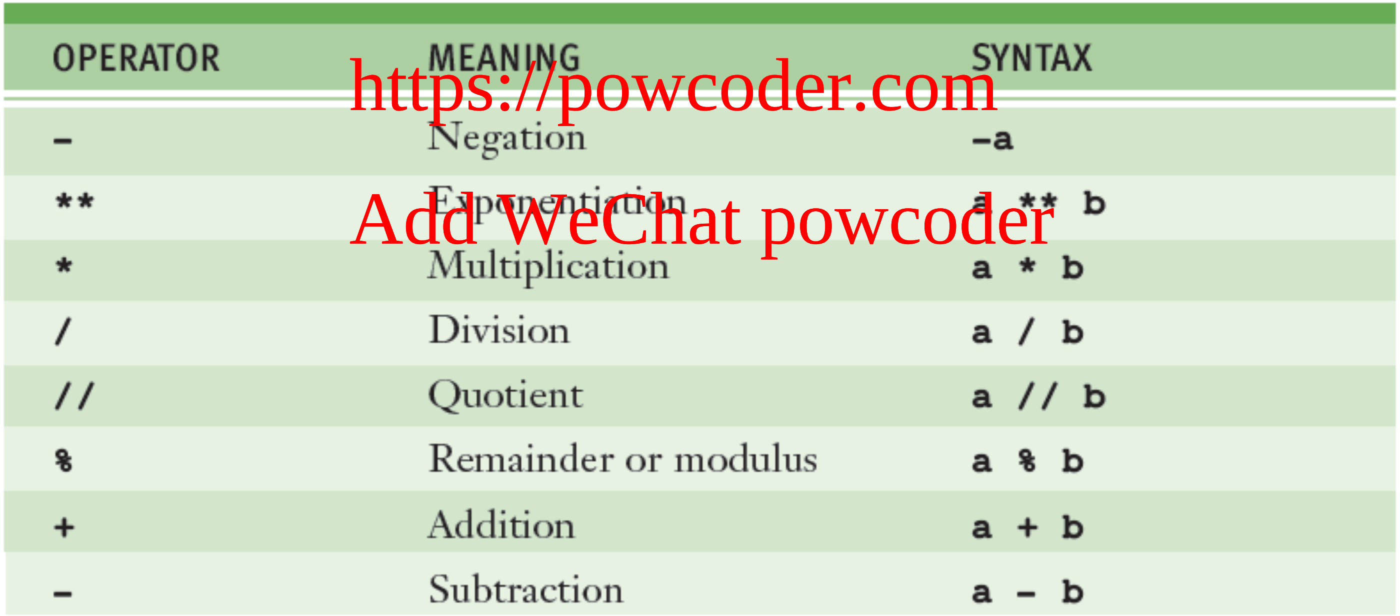
Expressions

- **Expressions** provide easy way to perform operations on data values to produce other values

- When entered at Python shell prompt:
  - an expression's operands are evaluated
  - its operator is then applied to these values to compute the value of the expression

Arithmetic Expressions

- An **arithmetic expression** consists of operands and operators combined in a manner that is already familiar to you from learning algebra



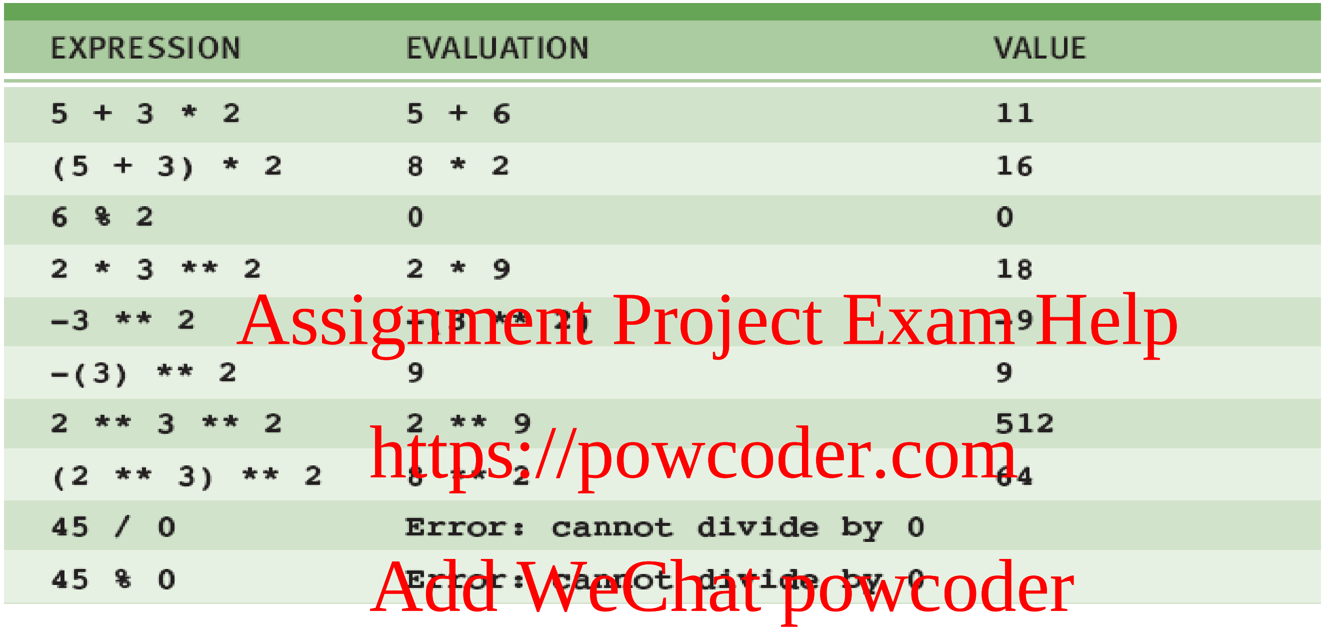
OPERATOR	MEANING	SYNTAX
-	Negation	-a
**	Exponentiation	a ** b
*	Multiplication	a * b
/	Division	a / b
//	Quotient	a // b
%	Remainder or modulus	a % b
+	Addition	a + b
-	Subtraction	a - b

Arithmetic Expressions (continued)

- **Precedence rules**:
  - ** has the highest precedence and is evaluated first
  - Unary negation is evaluated next
  - *, /, and % are evaluated before + and -
  - + and - are evaluated before =
  - With two exceptions, operations of equal precedence are **left associative**, so they are evaluated from left to right
    - Exponentiation (**) and assignment (=) are **right associative**

    (show examples on IDLE)
  - You can use () to change the order of evaluation as parenthesis takes precedence

Arithmetic Expressions (continued)



EXPRESSION	EVALUATION	VALUE
`5 + 3 * 2`	`5 + 6`	`11`
`(5 + 3) * 2`	`8 * 2`	`16`
`6 % 2`	`0`	`0`
`2 * 3 ** 2`	`2 * 9`	`18`
`-3 ** 2`	`-(3 ** 2)`	`-9`
`-(3) ** 2`	`9`	`9`
`2 ** 3 ** 2`	`2 ** 9`	`512`
`(2 ** 3) ** 2`	`8 ** 2`	`64`
`45 / 0`	`Error: cannot divide by 0`	
`45 % 0`	`Error: cannot divide by 0`	

Syntax error: set of rules for constructing well formed expressions in a language (error when an expression or sentence is not well formed).

Semantic error: detected when the action that an expression describes cannot be carried out, even if the expression is syntactically correct.

Example: 45%0 is a **semantic error**

Arithmetic calculations - Questions:

#Let x = 8 and y = 2. Write the values of the following expressions:

a. x + y * 3

b. (x + y) * 3

c. x ** y

d. x % y

e. x / 12.0

f. x // 6

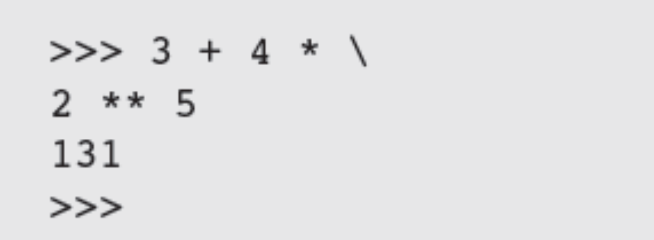
Variables and the Assignment Statement – Question !

#It is typical that you have a first name and a surname. Write a python program that prints the first name followed by the surname, making sure that there is a blank space between the first name and the surname. Your program should store the first name in a variable called firstName and the surname in a variable secondName. You may use additional variables for the task.

Arithmetic Expressions (continued)

- When **both operands of an expression are of the same numeric type**, the resulting value is also of that type

- When each operand is of a different type, the resulting value is of the more general type
  - Example: **3 // 4** is **0**, whereas **3 / 4.0** is **.75**

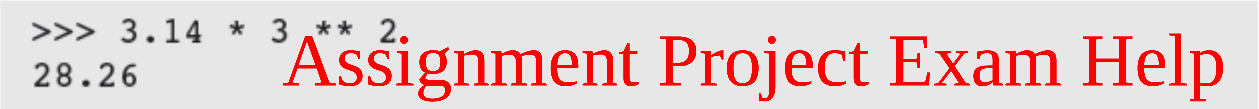


```
>>> 3 + 4 * \
2 ** 5
131
>>>
```

Note: For multi-line expressions, use a \

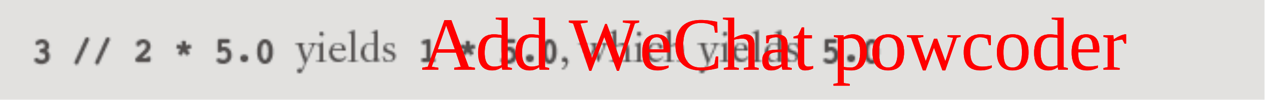
Mixed-Mode Arithmetic and Type Conversions

- **Mixed-mode arithmetic** involves integers and floating-point numbers:

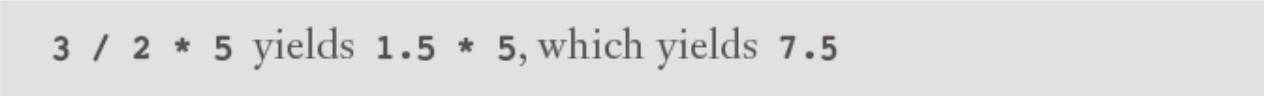


```
>>> 3.14 * 3 ** 2
28.26
```

- **Remember**—Python has different operators for quotient and exact division:



3 // 2 * 5.0 yields 1 * 5.0, which yields 5.0



3 / 2 * 5 yields 1.5 * 5, which yields 7.5

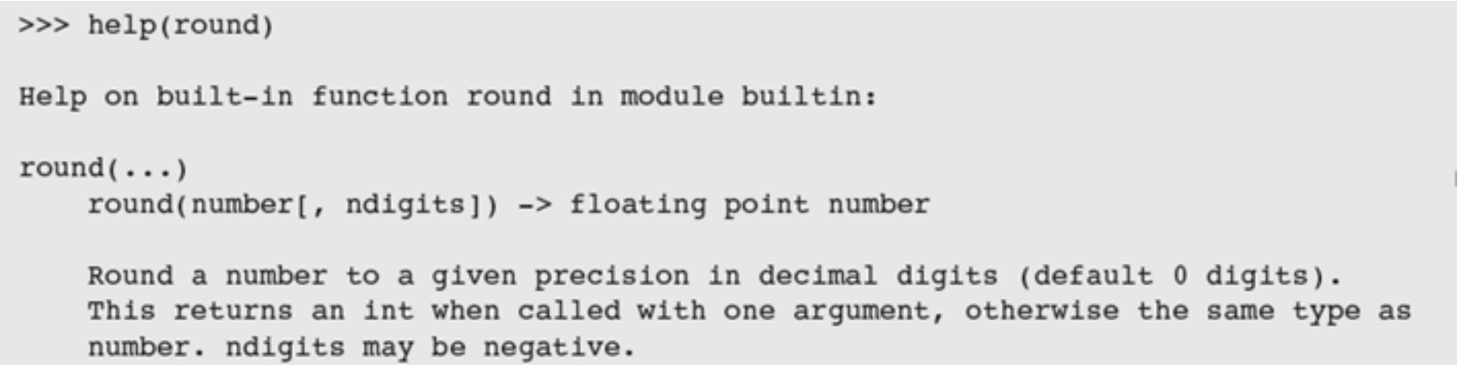
Using Functions and Modules

- Python includes many useful functions, which are organized in libraries of code called **modules**

Calling Functions: Arguments and Return Values

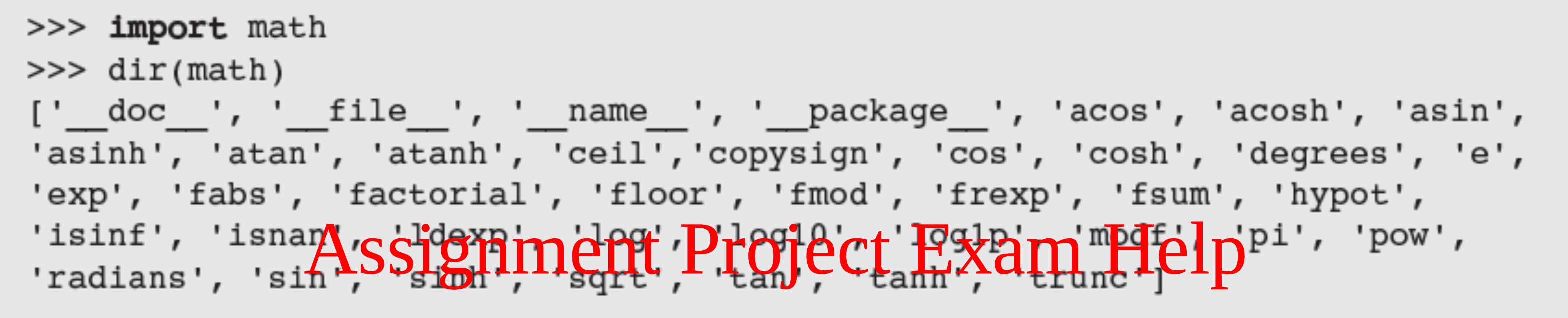
(to be taught in detail later in the course)

- A **function** is chunk of code that can be called by name to perform a task
- Functions often require **arguments** or **parameters**
  - Arguments may be **optional** or **required**
- When function completes its task, it may **return a value** back to the part of the program that called it



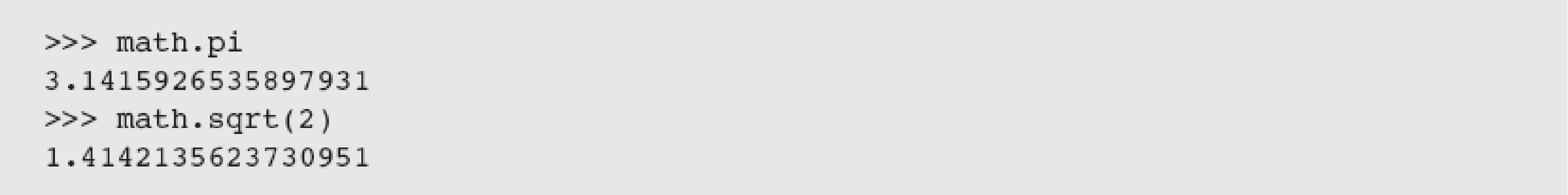
```
>>> help(round)

Help on built-in function round in module builtin:

round(...)
    round(number[, ndigits]) -> floating point number

    Round a number to a given precision in decimal digits (default 0 digits).
    This returns an int when called with one argument, otherwise the same type as
    number. ndigits may be negative.
```

The `math` Module



```
>>> import math
>>> dir(math)
['__doc__', '__file__', '__name__', '__package__', 'acos', 'acosh', 'asin',
'asinh', 'atan', 'atanh', 'ceil','copysign', 'cos', 'cosh', 'degrees', 'e',
'exp', 'fabs', 'factorial', 'floor', 'fmod', 'frexp', 'fsum', 'hypot',
'isinf', 'isnan', 'ldexp', 'log','log10','log1p', 'modf', 'pi', 'pow',
'radians', 'sin', 'sinh', 'sqrt', 'tan', 'tanh', 'trunc']
```

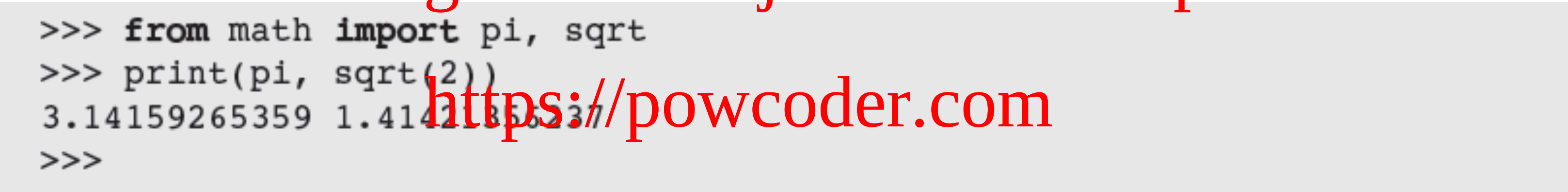
- To use a resource from a module, you write the name of a module as a qualifier, followed by a dot (.) and the name of the resource
  - Example: **math.pi**



```
>>> math.pi
3.141592653589793l
>>> math.sqrt(2)
1.4142135623730951
```

The `math` Module (continued)

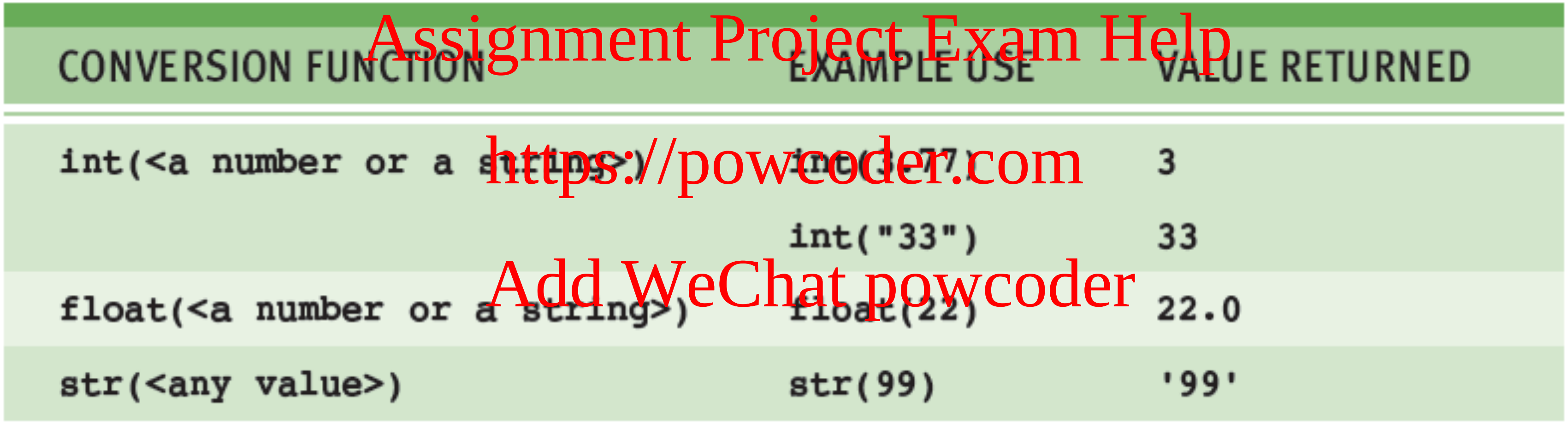
- You can avoid the use of the qualifier with each reference by importing the individual resources



```
>>> from math import pi, sqrt
>>> print(pi, sqrt(2))
3.14159265359 1.41421356237
>>>
```

- You may import all of a module’s resources to use without the qualifier
  - Example: **`from math import *`**

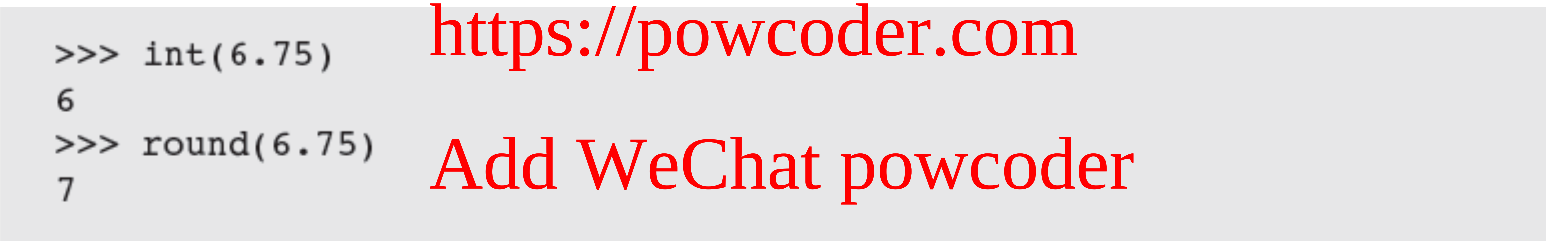
Mixed-Mode Arithmetic and Type Conversions (continued)



CONVERSION FUNCTION	EXAMPLE USE	VALUE RETURNED
int(<a number or a string>)	int(3.77)	3
	int("33")	33
float(<a number or a string>)	float(22)	22.0
str(<any value>)	str(99)	'99'

Mixed-Mode Arithmetic and Type Conversions (continued)

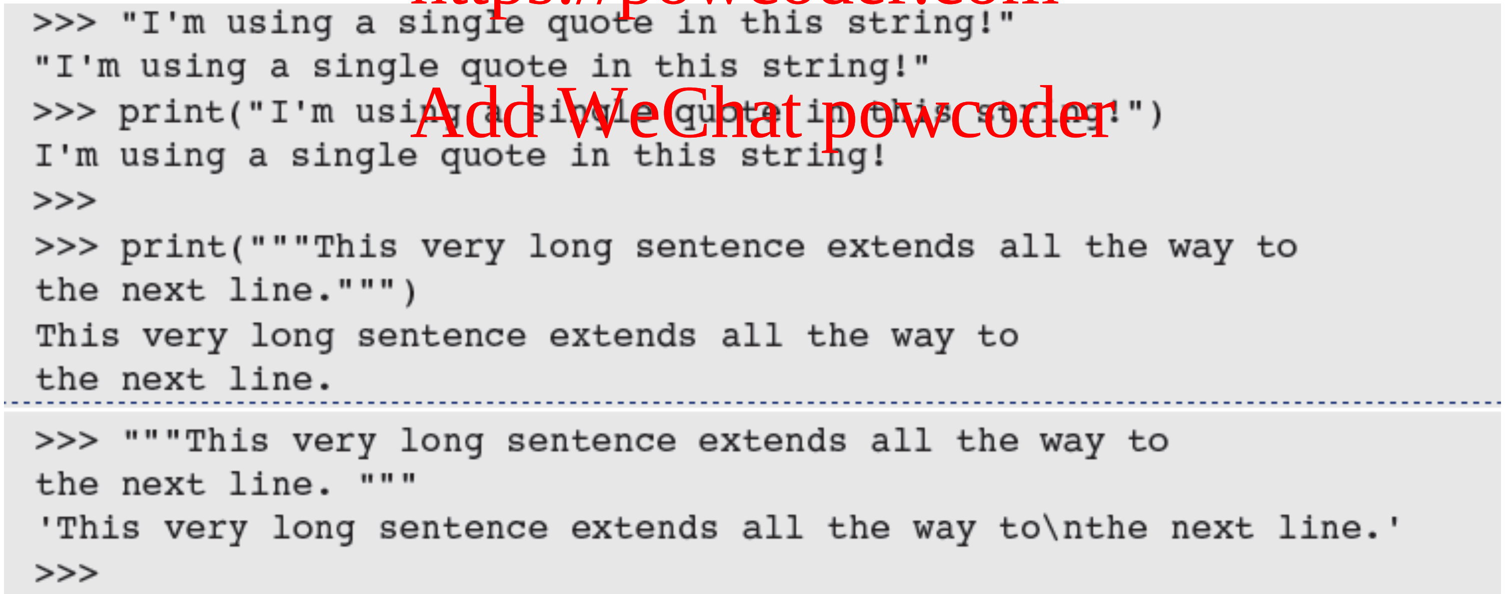
- Note that the **int** function converts a **float** to an **int** by truncation, not by rounding



```
>>> int(6.75)
6
>>> round(6.75)
7
```

String Literals

- A string literal is a sequence of characters enclosed in single or double quotation marks
- '' and "" represent the **empty string**
- Use ''' and """ for multi-line paragraphs

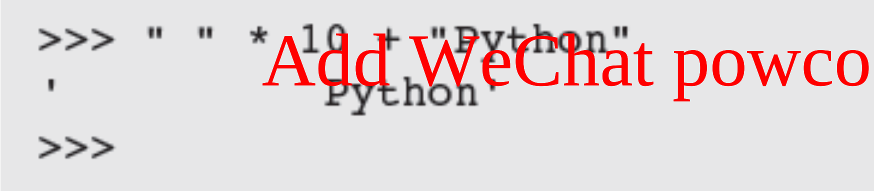


```
>>> "I'm using a single quote in this string!"
"I'm using a single quote in this string!"
>>> print("I'm using a single quote in this string!")
I'm using a single quote in this string!
>>>
>>> print("""This very long sentence extends all the way to
the next line.""")
This very long sentence extends all the way to
the next line.
```

```
>>> """This very long sentence extends all the way to
the next line. """
'This very long sentence extends all the way to\nthe next line.'
>>>
```

String Concatenation

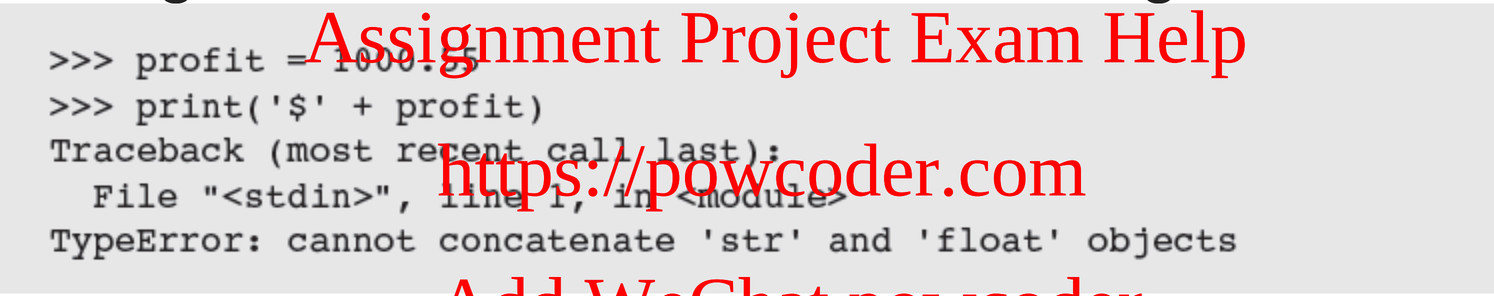
- You can join two or more strings to form a new string using the concatenation operator +
- The * operator allows you to build a string by repeating another string a given number of times



```
>>> " " * 10 + "Python"
'          Python'
>>>
```

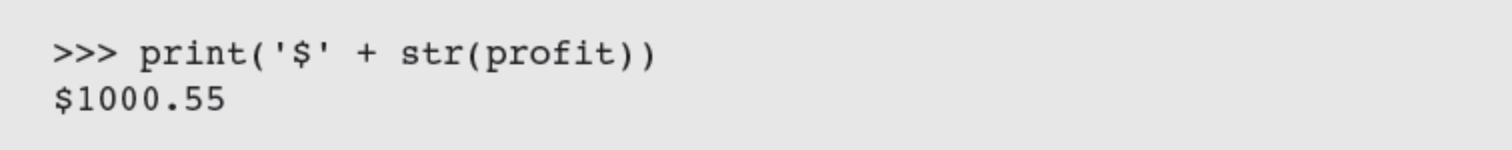
Mixed-Mode Arithmetic and Type Conversions (continued)

- Type conversion also occurs in the construction of strings from numbers and other strings



```
>>> profit = 1000.55
>>> print('$' + profit)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: cannot concatenate 'str' and 'float' objects
```

- Solution: use **`str`** function

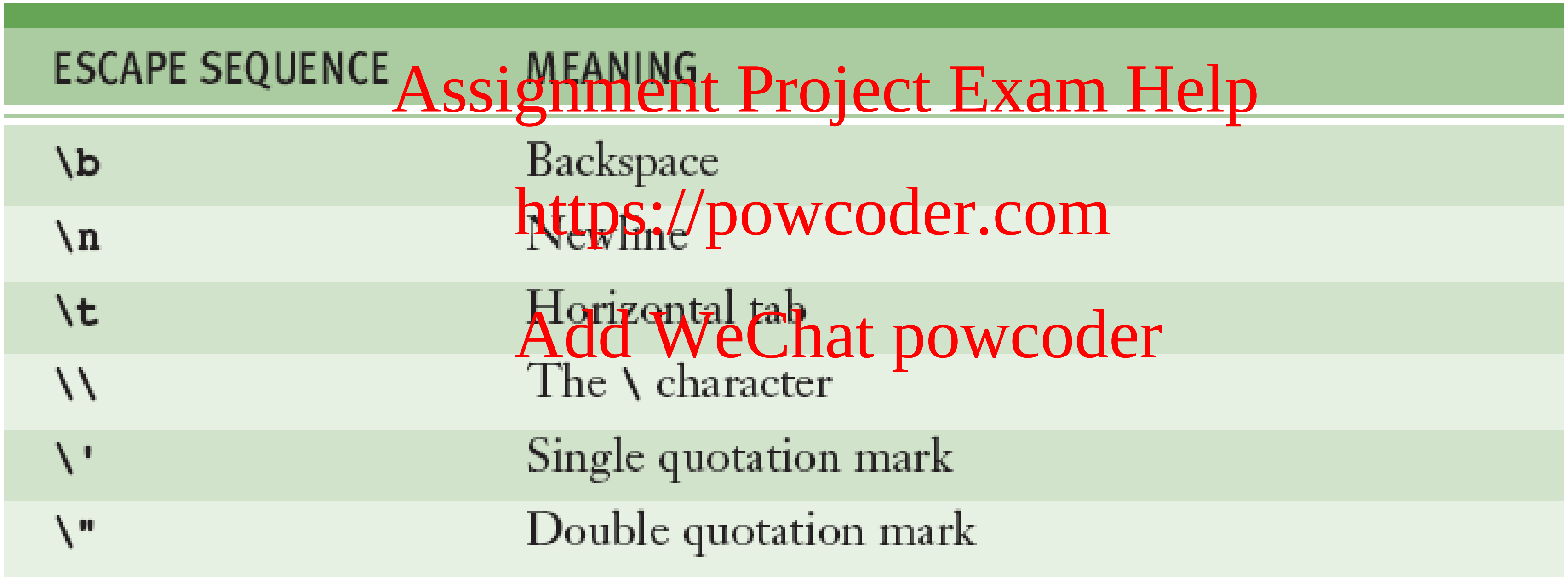


```
>>> print('$' + str(profit))
$1000.55
```

- Python is a strongly **typed** programming language

Escape Sequences

- The newline character **\n** is called an **escape sequence**



ESCAPE SEQUENCE	MEANING
\b	Backspace
\n	Newline
\t	Horizontal tab
\\	The \ character
\'	Single quotation mark
\"	Double quotation mark

Finally, program format and structure

- Start with comment with author's name, purpose of program, and other relevant information
  - In a docstring
- Then, include statements that:
  - Import any modules needed by program
  - Initialize important variables, suitably commented
  - Prompt the user for input data and save the input data in variables
  - Process the inputs to produce the results
  - Display the results

Summary

- Waterfall and agile models describes software development processes in terms of several phases
- Literals are data values that can appear in program
- The string data type is used to represent text for input and output
- Escape characters begin with backslash and represent special characters such as delete key
- A docstring is string enclosed by triple quotation marks and provides program documentation

Summary (continued)

- Comments are pieces of code not evaluated by the interpreter but can be read by programmers to obtain information about a program
- Variables are names that refer to values
- Some data types: **int** and **float**
- Arithmetic operators are used to form arithmetic expressions
  - Operators are ranked in precedence
- Mixed-mode operations involve operands of different numeric data types

Summary (continued)

- A function call consists of a function’s name and its arguments or parameters
  - May return a result value to the caller
- Python is a strongly typed language
- A module is a set of resources
  - Can be imported
- A semantic error occurs when the computer cannot perform the requested operation
- A logic error produces incorrect results