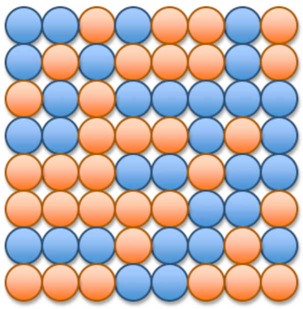


UNIT 2A
An Introduction to Programming

Python

- Python is one of *many* programming languages.
- 2 widely used versions. We will use Python 3. (Specifically, Python version 3.3.2)
- Running Python on the command line:

```
> python3 –i  filename.py
```

(`–i` means interactive mode)

Arithmetic Expressions

- Mathematical Operators

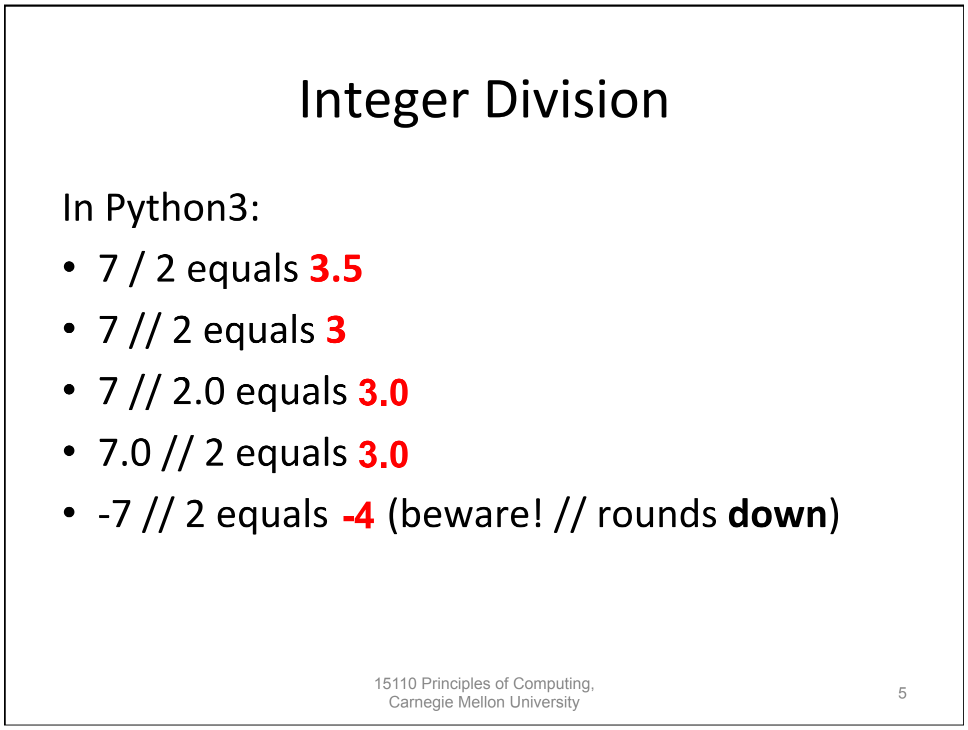
+	Addition	/	Division
-	Subtraction	%	Modulo
*	Multiplication	**	Exponentiation

- Order of Precedence
  {**}   then {* / %}   then {+ -}
- Use parentheses to force alternate precedence
  5 * 6 + 7 ≠ 5 * (6 + 7)
- Left associativity except for **
  2 + 3 + 4 = (2 + 3) + 4   2 ** 3 ** 4 = 2 **(3 ** 4)

Data Types

- Integers
```
4       15110    -53      0
```
- Floating Point Numbers
```
4.0     -0.8     0.3333333333333333
7.34e+014
```
- Strings
```
"hello"     "A"    " "     ""     "7up!"
'there'     '"'    '15110'
```
- Booleans
```
True    False
```

George Boole,
1815-1864



Integer Division

In Python3:

- 7 / 2 equals **3.5**
- 7 // 2 equals **3**
- 7 // 2.0 equals **3.0**
- 7.0 // 2 equals **3.0**
- -7 // 2 equals **-4** (beware! // rounds **down**)

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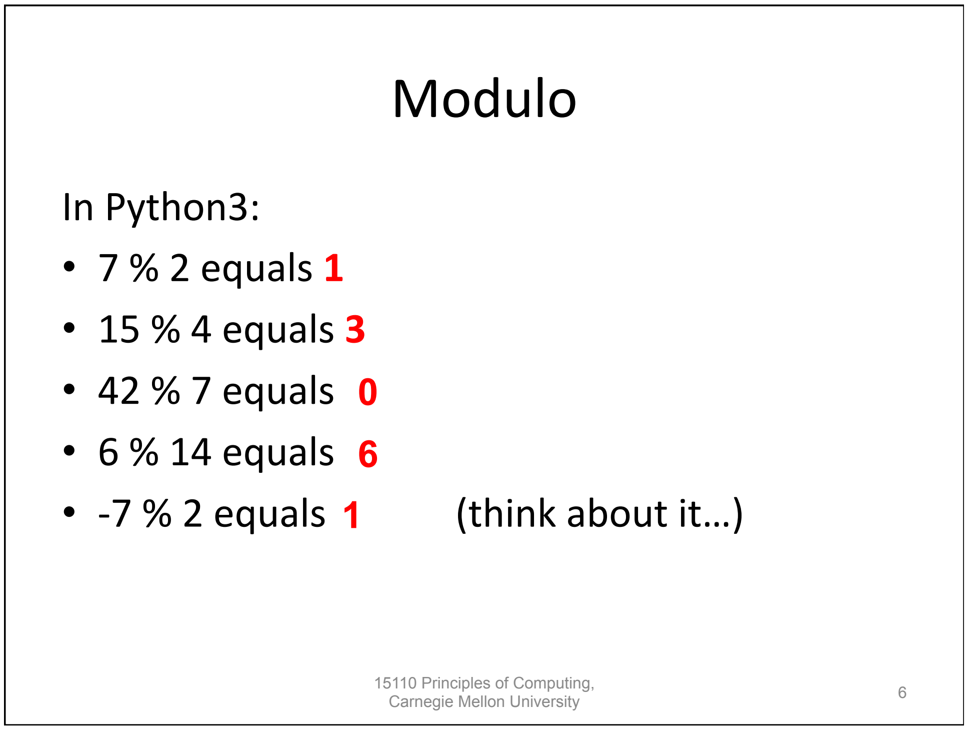

Modulo

In Python3:

- 7 % 2 equals **1**
- 15 % 4 equals **3**
- 42 % 7 equals **0**
- 6 % 14 equals **6**
- -7 % 2 equals **1** (think about it…)

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Variables

- All variable names must start with a letter (lowercase recommended).
- The remainder of the variable name (if any) can consist of any combination of uppercase letters, lowercase letters, digits and underscores (_).
- Variables are case sensitive.
  Example: `Value` is not the same as `value`.

Using predefined modules

- `math` is a predefined module of methods (functions) that we can use without writing the implementations.

```
import math
math.sqrt(16)
math.pi
math.sin(math.pi / 2)
```

- We must **`import math`** before we can use the math functions.

Assignment Statements

- The lefthand side must contain a single variable.
- The righthand side can be any valid Python expression:
  - A numerical, string or boolean value.
    ```
    x = 45.2
    ```
  - A numerical expression.
    ```
    y = x * 15
    ```
  - A method (function) call.
    ```
    z = math.sqrt(15110)
    ```
  - Any combination of these:
    ```
    root1 = -b + math.sqrt(b*b-4*a*c)/(2*a)
    ```

Methods

- Methods are used to capture small algorithms that might be repeated with different initial conditions.

  `def` *methodname* `(`*parameterlist*`)` **:**

  □□□□*instruction1*

  □□□□*instruction2*

  etc.
- `def` is a reserved wors and cannot be used as a variable name.
- *Indentation is critical.* Use spaces *only.*

Methods (cont’ d)

- The name of a method follows the same rules as names for variables.
- The parameter list can contain 1 or more variables that represent data to be used in the method’s computation.
  - A method can have 0 parameters.

```
def hello_world():
    print("Hello World!\n”)
end
```

(`\n` is a newline character)

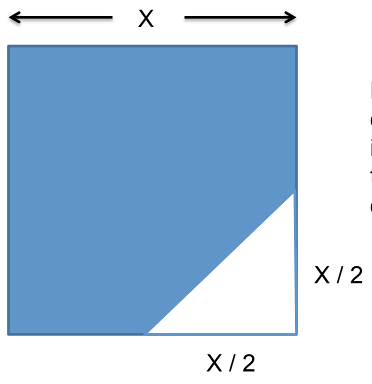
tip.py

```
def tip(total):
    return total * 0.18
```

To run the function `tip` in `python3`:

```
python3 –i tip.py
>>> tip(100)
⇒18.0
>>> tip(135.72)
⇒24.4296
```

Example: Countertop



Determine the area of a countertop that is a square with a triangle cut out of one of its corners.

countertop.py

parameter

```
def compute_area(side):
    square = side * side
    triangle = 0.5 * side / 2 * side / 2
    area = square - triangle
    return area
```

To run the function.method in `python3`:

```
python3 -i countertop.py
>>> compute_area(109)
```

argument
(run function with side = 109)
(note: there are no units)

Methods (cont’d)

- To run a method, we say we “call” the method.
- A method can return either one answer or no answer to its “caller”.
- The `hello_world` function does not return anything to its caller. It simply prints something on the screen.
- The `compute_area` function does return its result to its caller so it can use the value in another computation:
  `compute_area(109) + compute_area(78)`

Methods (cont’d)

- Suppose we write `compute_area2` this way:

```
def compute_area2(side):
    square = side * side
    triangle = 0.5 * side/2 * side/2
    area = square - triangle
    print area
```

- Now this computation does not work since each function call prints but returns nothing:
  `compute_area2(109) + compute_area2(78)`

Caution: return vs. print

- When you return a result from a function, the caller of that function can use that result in another computation.

OK

```
>>> x = 15 + compute_area(110)
```

- When you print a result in a function, the user will see the result on the screen, but the caller of that function won't get anything back so it cannot use the result in another computation.

```
>>> x = 15 + compute_area2(110)
```

NOT OK

escape.py

(a function with two parameters)

```
import math
def compute_ev(mass, radius):
    # computes escape velocity
    univ_grav = 6.67e-011
    return math.sqrt(2*univ_grav*mass/radius)
```

Comments begin with #

To run the function for Earth in `python3`:

```
python3 -i escape.py
>>> compute_ev(5.9742e+024, 6378.1)
35348592957.826279
```

Cautions

- Python has no idea what units you're using for computations, so data must be given in the proper units or the results are meaningless.
- When you call a function, the number of arguments you supply must match the number of parameters the function requires.
- When you call a function, if you reverse the arguments, Python won't catch this error:
  `compute_ev(6378.1, 5.9742e+024)`

Printing multiple things on one line

```
python3 -i tip.py
>>> print("My tip is $", tip(19.95))
```

In tip.py:

```
def tip(total):
    print("$", tip(19.95), "is my tip.")
    return None
```

Stand-alone programs
(non-interactive)

```
import math

def compute_ev(mass, radius):
    # computes escape velocity
    univ_grav = 6.67e-011
    return math.sqrt(2*univ_grav*mass/radius)

def main():
    print compute_ev(6378.1, 5.9742e+024)

main()
```

Store this program in the file escape2.py

```
> python escape2.py
35348592957.8
>
```

On the command line, run this command (no –i flag)