Python as a Calculator

Introduction to Computer Programming

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Using Python as a calculator.

Operations

$+$ $-$ $*$ $/$

New operations

$//$ $**$ $\%$

```
pvrbik@abacus /~]$python3
 Python 3.6.1 (default, Apr  4 2017, 09:40:21)
>>> 2 + 2
4
>>> 2 - 3
-1
>>> 2 * 3
6
>>> 2 + 3 * 2 - 1
7
>>> (2 + 3) * 2 - 1
9
```

```
>>> 4 / 2
2.0
```

Notice the decimal.

```
>>> type(2)
<class 'int'>

>>> type(2.0)
<class 'float'>

>>> 6 / 2 * (1 + 2)
9.0
```

```
>>> 1 / 3
0.3333333333333333
```

Notice the finite number of digits.

```
>>> 1 / 0
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ZeroDivisionError: division by zero

>>> 1 / float('inf')
0.0
```

```
>>> 2 ** 3
8

>>> 2 ** 3.0
8.0

>>> 2 ** -1
0.5

>>> 2 ** 0
1
```

Theorem (Integer division)

Let x and $y \neq 0$ be integers. There are integers q and r called the quotient and remainder such that $0 \leq r < |y|$, and

$$x = q \cdot y + r.$$

In grade-school terms: "x divided by y is q remainder r."

Proof.

The division algorithm. □

Example

When $x = 17$ and $y = 3$ then $q = 5$ and $r = 2$:

$$17 \div 3 \text{ is } 5 \text{ remainder } 2$$

and notice

$$17 = 5 \cdot 3 + 2.$$

```
>>> 17 // 3
5

>>> 17 % 3
2

>>> 3 * (17 // 3) + (17 % 2)
17
```

```
>>> 2 // 3
0

>>> -2 // 3
-1

>>> -2 % 3
1
```

Remember that we agreed $0 \leq r < y = 3$.

```
>>>  (-2 // 3) * 3 + (-2 % 3)
-2
```

Variables

Sometimes it is expedient to give values a name. These names are called variables.

For instance,

```
>>> x = -2
>>> y = 3
>>> q = x // y
>>> r = x % y
>>> x - (q * y + r)
0
```

Equal in Python is for assignment and does not denote equality as it does in mathematics.

```
>>> x = 1
>>> x = x + 1
>>> x
2
```

Notice in mathematics that

$$x = x + 1 \implies 0 = 1$$

and so is an "illegal" statement.

```
>>> 1 = 1
    1 = 1
        ^
SyntaxError: can't assign to literal

>>> 1 == 1
True

>>> x = y
NameError: name 'y' is not defined
```

Question

What is y after entering the following

```
>>> x = 2
>>> y = 4
>>> x = 1
```

Answer

$y = 4$.

Question

What are x and y after entering the following?

```
>>> x = 1 + 4
>>> y = x - 1
>>> x = y + 1 * x
>>> x = y // x
```

Answer

$(x, y) = (0, 4)$.

Question

What is x, y, z after entering the following

```
>>> x = 1
>>> y = x + x
>>> z = y + y + 1.0
>>> y = y // x
>>> x = z // x
>>> z = x + x / 4
>>> y = y ** ((y * y) % 3)
```

Answer

$(x, y, z) = (5.0, 2, 6.25)$.

Functions

Unlike variables, Python functions are directly analogous to that of mathematics and can also be named.

For instance a parabola in mathematics is given by the function

$$f(x) = x^2$$

and in python we write

```
f = lambda x :  x**2
```

and furthermore

```
>>> f(3)
9
```

Combining Functions

```
>>> quo = lambda x, y : x // y
>>> rem = lambda x, y : x % y
>>> ChkDivThm = lambda x, y : quo(x, y) * y + rem(x, y)
>>> ChkDivThm(15, 3)
15
```

Question

What is the value of x after entering the following?

```
>>> f = lambda x, y : x % y
>>> x = f( -f(5, 2) - 2, f(20, 7) )
```

Answer

$x = 3$.

Next week

1. More on functions.