1 Expressions

1.1 Arithmetic operators

Operator	Operation	Expression	Description	Result
+	addition	3 + 4	3 plus 4	7
-	subtraction	3 - 4	3 minus 4	-1
-	negation	-3 + 5	negative 3 plus 5	2
*	multiplication	3 * 5	3 times 5	15
/	division (of ints)	10 / 4	10 divided by 2, truncating remainder	2
/	division (of floats)	10.0 / 4.0	10 divided by 2	2.5
**	exponentiation	2 ** 4	2 to the power of 4	16
%	modulo (remainder)	10 % 3	10 mod 3	1

The inputs to an operator are called **operands**. For example, in this expression, `3 * 5`, the operator is `*` and the operands are `3` and `5`.

1.2 Types & Expressions

A **type** is a set of values and operations that can be performed on those values.

- `int`: the type representing integers. Operators include the arithmetic operators above.
- `float`: the type representing floating points numbers, which are *approximations* of real numbers. Operators include the arithmetic operators above.

An **expression** is a combination of operators and values (and/or variables) that python can evaluate, resulting in a single value. This definition will evolve as the course progresses.

1.3 Operator precedence

Higher precedence operators are evaluated first. To break ties, python evaluates from left to right.

Operator	Precedence
**	highest
- (negation)	
*, /, %	
+ (addition), - (subtraction)	lowest

To control what gets evaluated first, use parentheses. Example:

```
>>> 3 + 2 * 10
23
>>> (3 + 2) * 10
50
```

2 Variables & Assignments

Data values are stored in memory. A **variable** is a named memory location. To make or update a variable, use an **assignment statement**.

An assignment statement has this form:

variable = expression

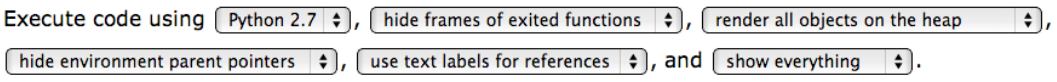
How python executes assignment statement:

1. Evaluate the expression on the right-hand side. This produces a value. The value is stored in memory, at a particular address.
2. Store the memory address in the variable on left-hand side.

Example:

```
>>> hourly_wage = 8.00
>>> hours_worked = 42
>>> total_pay = hourly_wage * hours_worked
>>> total_pay
336.0
```

You can use the python visualizer (`http://www.pythontutor.com/visualize.html`) to visualize of what happens when python executes. Be sure to adjust the settings so they look like this:



Variable names should be meaningful, like in the example above. Variable names must start with a letter or _ and contain only letters, digits, and _. Some names, like `print`, are special keywords in python and cannot be used.

3 Errors

There are three kinds of errors in programming:

1. **syntax error**: the statement does not match rules of python language. Ex: `3 + 5 * * 2`
2. **runtime error**: the expression causes a crash. Ex: `4 / (8 - 2 ** 3)`
3. **semantic error**: the program runs but produces the wrong answer. Ex:

```
>>> base = 3
>>> height = 3
>>> triangle_area = base * height / 2
>>> triangle_area   # calculation is wrong: it should be 4.5, where is the bug??
4
```