Roadmap

Last week we learned

- Conditionals and *while* Loops
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This week we will learn
- Objects
- Types
- Variables
- Methods
- Tuples
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The Python Zoo:
Imagine there is a zoo inside your Python interpreter. Every time you create an object, an animal is born. What an animal can do depends on the type (kind) of animal: birds can fly, fish can swim, elephants can lift weights, etc. When an animal is no longer used, it dies (disappears).
Making objects

You can create objects as follows:

- **Numbers**: Simply write them.
- **Strings**: A piece of text. Write it between quotation marks (" and ' are both okay).
- **Booleans**: Truth values. Write `True` or `False`. 
Making objects

You can create objects as follows:

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3.14159265
-5
3 + 6j
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Making more objects

Complicated objects are made by calling functions that create them:

```python
from cslrobots import *
Robot()

from cslmedia import *
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from cs1robots import *
Robot()
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load_picture("photos/geowi.jpg")
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A **tuple** object is an object that contains other objects. To create a tuple, write objects separated by commas (usually in parenthesis):
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load_picture("photos/geowi.jpg")
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A **tuple** object is an object that contains other objects.
To create a tuple, write objects separated by commas (usually in parenthesis):

```python
(3, 2.5, 7)
("red", "yellow", "green")
(20100001, "Hong Gildong")
```
Different animals: Types

Every object has a **type**. The type determines what the object can do, and what you can do with the object. For instance, you can add two numbers, but you cannot add two robots.
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The Python interpreter can tell you the type of an object:

```python
>>> type(3)
<class 'int'>
Integer number: **int**

>>> type(3.1415)
<class 'float'>
Floating point number: **float**

>>> type("CS101 is fantastic")
<class 'str'>
String: **str**

>>> type(3 + 7j)
<class 'complex'>
Complex number: **complex**

>>> type(True)
<class 'bool'>
Boolean: **bool**
```
More types

Types of more complicated objects:

```python
>>> type(Robot())
<class 'cs1robots.Robot'>
>>> type((3, -1.5, 7))
<class 'tuple'>
>>> type(load_picture("geowi.jpg"))
<class 'cs1media.Picture'>
```
Names

Objects can be given a name:

```python
message = "CS101 is fantastic"
n = 17
hubo = Robot()
pi = 3.1415926535897931
finished = True
img = load_picture("geowi.jpg")
```
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Objects can be given a name:

message = "CS101 is fantastic"
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In the Python zoo, the name is a sign board on the animal’s cage.
Variable names

The rules for variable and function names:

- A name consists of letters, digits, and the underscore `_`.
- The first character of a name should not be a digit.
- The name should not be a keyword such as `def`, `if`, `else`, or `while`.
- Upper case and lower case are different: `Pi` is not the same as `pi`. 
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Good:

```python
my_message = "CS101 is fantastic"
a13 = 13.0
```

Bad:

```python
more@ = "illegal character"
13a = 13.0
def = "Definition 1"
```
Variables

Names are often called variables, because the meaning of a name is variable: the same name can be assigned to different objects during a program:

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n = "Seventeen"
n = 17.0
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The object assigned to a name is called the **value** of the variable. The value can change over time.

To indicate that a variable is **empty**, we use the special object `None` (of class `'NoneType'`):

```python
n = None
```
Methods

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>>> img = load_picture("geowi.jpg")
>>> print(img.size())  # width and height in pixels
(58, 50)
>>> img.show()  # display the image
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>>> b = "banana"
>>> print(b.upper())
BANANA
```
Operators

For numbers, we use the operators +, -, *, /, //, %, and **.
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\[ a \, ** \, b = a^b \]

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>>> 2**16
65536
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>>> 7 % 3
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1
```

// is integer division (division without fractional part):

```python
>>> 13.0 // 4.0
3.0
>>> 9 / 7
1.2857142857142858
```
Expressions

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\[ 3.0 \times (2 \times 15 - 12 \div 4) + 4 \times 3 \]
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The operators have precedence as in mathematics:

1. exponentiation \( \times \times \)
2. multiplication and division \( \times, \div, \div\div, \% \)
3. addition and subtraction \( +, - \)

When in doubt, use parentheses!
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e.g., \( \frac{a}{2\pi} \) is not `a/2*pi`.

Use `a/(2*pi)` or `a/2/pi`. 
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e.g., \( \frac{a}{2\pi} \) is **not** \( a/2*\pi \).

Use \( a/(2*\pi) \) or \( a/2/pi \).

All operators also work for complex numbers.
String expressions

The operators + and * can be used for strings:

```python
>>> "Hello" + " CS101"
'HelloCS101'

>>> "CS101" * 8
'CS101 CS101 CS101 CS101 CS101 CS101 CS101 CS101 CS101 CS101 ''
Boolean expressions

A **boolean expression** is an expression whose value has type **bool**. They are used in **if** and **while** statements.
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The operators `==, !=, >, <, <=` and `>=` return boolean values.

```python
>>> 3 < 5
True
>>> 27 == 14  # Equality - don't confuse with =
False
>>> 3.14 != 3.14
False
>>> 3.14 >= 3.14
True
>>> "Cheong" < "Choe"
True
>>> "3" == 3
False
```
Logical operators

The keywords **not**, **and** and **or** are logical operators:

```python
not True == False
not False == True

False and False == False
False and True == False
True and False == False
True and True == True

False or False == False
False or True == True
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**Careful**: If the second operand is not needed, Python does not even compute its value.
Tuples

A tuple is an object that contains other objects:

```python
>>> position = (3.14, -5, 7.5)
>>> profs = ("In-Young Ko", "Sunghee Choi", "Lee YoungHee", "Duksan Ryu", "Key-Sun Choi")
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>>> print(position, type(position))
(3.14, -5, 7.5) <class 'tuple'>
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Packing and unpacking in one line:

```python
>>> a, b = ("aa", "bb")
>>> a, b = b, a
>>> print(b)
aa
```
Colors

Colors are often represented as a tuple with three elements that specify the intensity of red, green, and blue light:

```python
red = (255, 0, 0)
blue = (0, 0, 255)
white = (255, 255, 255)
black = (0, 0, 0)
yellow = (255, 255, 0)
purple = (128, 0, 128)
```

```python
from cs1media import *
img = create_picture(100, 100, purple)
img.show()
img.set_pixels(yellow)
img.show()
```
A digital image of width $w$ and height $h$ is a rectangular matrix with $h$ rows and $w$ columns:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
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\[
\begin{array}{cccccc}
0, 0 & 1, 0 & 2, 0 & 3, 0 & 4, 0 \\
0, 1 & 1, 1 & 2, 1 & 3, 1 & 4, 1 \\
0, 2 & 1, 2 & 2, 2 & 3, 2 & 4, 2 \\
\end{array}
\]

We access pixels using their \( x \) and \( y \) coordinates. \( x \) is between 0 and \( w-1 \), \( y \) is between 0 and \( h-1 \).

```python
>>> img.get(250, 188)
(101, 104, 51)
>>> img.set(250, 188, (255, 0, 0))
```
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red, green, blue triple
For loops

A for-loop assigns integer values to a variable:

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>>> for i in range(4):
...    print(i)
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1
2
3
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...     print(i)
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1
2
3
```

```python
>>> for i in range(7):
...     print("*" * i)

*  
** 
*** 
**** 
***** 
****** 
*******
```
Negative of a photo

```python
from cslmedia import *

img = load_picture("../photos/geowi.jpg")
w, h = img.size()
for y in range(h):
    for x in range(w):
        r, g, b = img.get(x, y)
        r, g, b = 255 - r, 255 - g, 255 - b
        img.set(x, y, (r, g, b))

img.show()
```
Black & white photo

```python
from cslmedia import *

threshold = 100
white = (255, 255, 255)
black = (0, 0, 0)

img = load_picture("../photos/yuna1.jpg")
w, h = img.size()
for y in range(h):
    for x in range(w):
        r, g, b = img.get(x, y)
        v = (r + g + b) // 3  # average of r,g,b
        if v > threshold:
            img.set(x, y, white)
        else:
            img.set(x, y, black)

img.show()
```
Objects with two names

The same object can have more than one name:

hubo = Robot("yellow")
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The same object can have more than one name:

```python
hubo = Robot("yellow")
hubo.move()
ami = hubo
```

hubo
ami
yellow robot
Objects with two names

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hubo = Robot("yellow")
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hubo.move()

hubo = Robot("blue")
hubo.move()
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ami.move()
```