CS101 - Variables and Basic Data Types

Lecture 3

School of Computing
KAIST

Roadmap

Last week we learned

- Conditionals and `while` Loops

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This week we will learn

- Objects
- Types
- Variables
- Methods
- Tuples

Objects

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Every object has a **type**. The type determines what you can do with an object.

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

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-5
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Write text between quotation marks (" and ' are both okay):

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"CS101 is wonderful"
'The instructor said: "Well done!" and smiled'
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Write text between quotation marks (`"` and `'` are both okay):

```
"CS101 is wonderful"
'The instructor said: "Well done!" and smiled'
```

Booleans: (truth values) Write `True` or `False`.

Making more objects

Complicated objects are made by calling functions that create them:

```
from cs1robots import *
Robot()

from cs1media import *
load_picture("photos/geowi.jpg")
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```
(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:

```
>>> type(3)
<class 'int'>
>>> type(3.1415)
<class 'float'>
>>> type("CS101 is fantastic")
<class 'str'>
>>> type(3 + 7j)
<class 'complex'>
>>> type(True)
<class 'bool'>
```

Integer number: **int**

Floating point number: **float**

String: **str**

Complex number: **complex**

Boolean: **bool**

More types

Types of more complicated objects:

```
>>> 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**:

```
message = "CS101 is fantastic"
n = 17
hubo = Robot()
pi = 3.1415926535897931
finished = True
img = load_picture("geowi.jpg")
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We call a statement like `n = 17` an **assignment**, because the **name** `n` is **assigned** to the object `17`.

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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:

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

Bad:

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

```
n = None
```

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>>> b = "banana"
>>> print(b.upper())
BANANA
```

Operators

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>>> 7 % 3
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1
```

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

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

Expressions

An **expression** is a combination of objects, variables, operators, and function calls:

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

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All operators also work for complex numbers.

String expressions

The operators `+` and `*` can be used for strings:

```
>>> "Hello" + "CS101"
'HelloCS101'
>>> "CS101 " * 8
'CS101 CS101 CS101 CS101 CS101 CS101 CS101 CS101 '
```

Boolean expressions

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The operators `==`, `!=`, `>`, `<`, `<=` and `>=` return boolean values.

```
>>> 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:

```
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:

```
>>> 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))
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3.14
```

Packing and unpacking in one line:

```
>>> 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:

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

from cs1media import *
img = create_picture(100, 100, purple)
img.show()
img.set_pixels(yellow)
img.show()
```

Colors

A digital image of width `w` and height `h` is a rectangular matrix with `h` rows and `w` columns:

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

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```
>>> img.get(250, 188)
(101, 104, 51)
>>> img.set(250, 188, (255, 0, 0))
```

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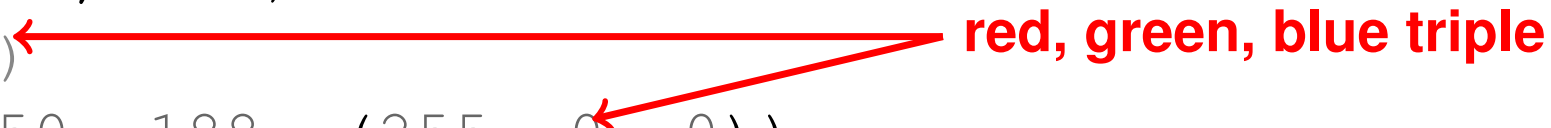

For loops

A for-loop assigns integer values to a variable:

```
>>> for i in range(4):
...     print(i)
0
1
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```
>>> for i in range(4):
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>>> for i in range(7):
...     print ("*" * i)


*
**
***
****
*****
******
```
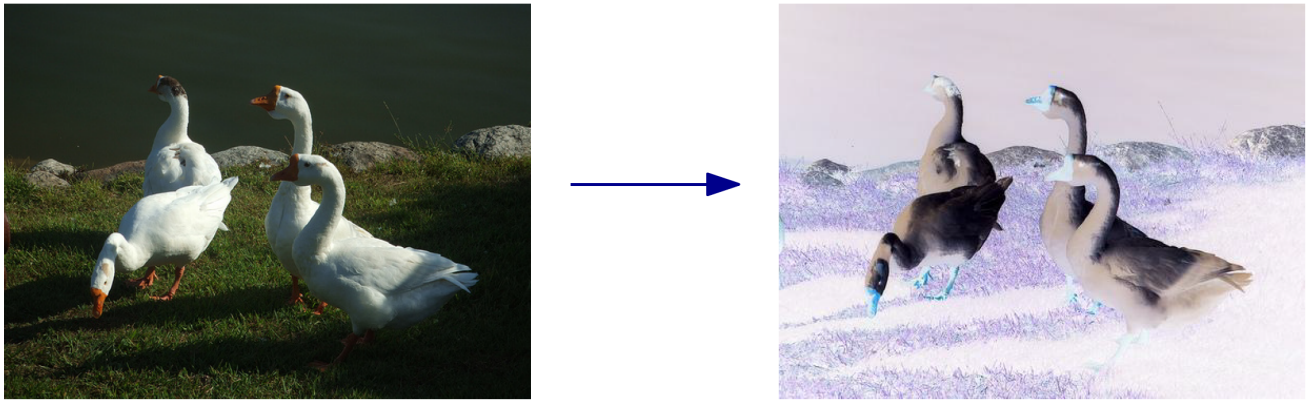

Negative of a photo

```
from cs1media 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

```
from cs1media 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:

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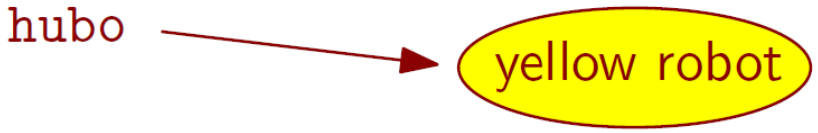

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hubo = Robot("yellow")
hubo.move()
ami = hubo
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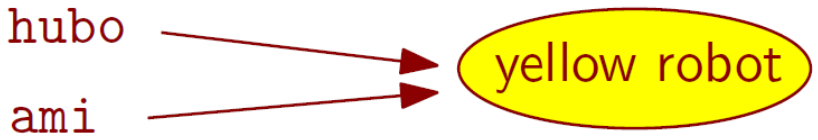

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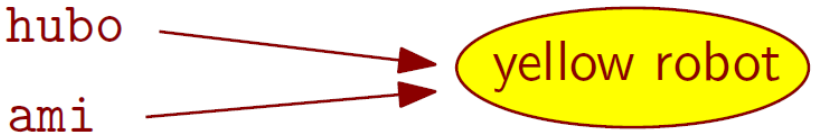

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```
hubo = Robot("yellow")
hubo.move()
ami = hubo
ami.turn_left()
hubo.move()

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