Lecture 9

Dictionaries & Objects

Type: Set of values and the operations on them

- Type **int**:
  - **Values**: integers
  - **Ops**: +, –, *, /, %, **
- Type **float**:
  - **Values**: real numbers
  - **Ops**: +, –, *, /, **
- Type **bool**:
  - **Values**: **True** and **False**
  - **Ops**: not, and, or
- Type **str**:
  - **Values**: string literals
    - Double quotes: "abc"
    - Single quotes: 'abc'
  - **Ops**: +, slicing
- Type **list**:
  - **Values**: list of values
    - Indicate with []
  - **Ops**: +, slicing

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Are these the only types that exist?

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Dictionaries (Type dict)

Description

- List of key-value pairs
  - Keys are unique
  - Values need not be
- Example: net-ids
  - net-ids are **unique** (a key)
  - names need not be (values)
  - js1 is John Smith (class '13)
  - js2 is John Smith (class '16)
- Many other applications

Python Syntax

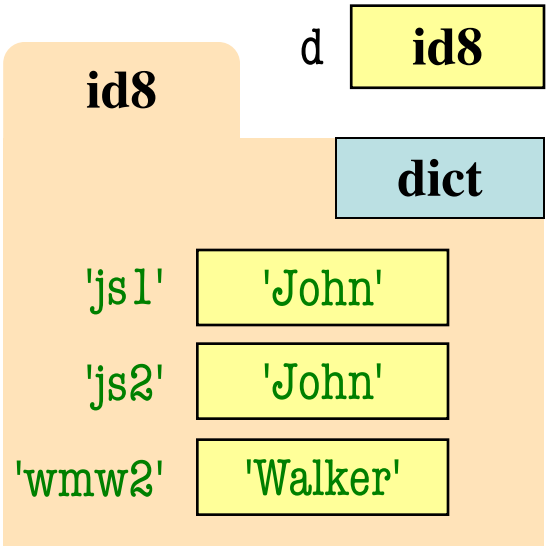
- Create with format:
  `{k1:v1, k2:v2, ...}`
- Keys must be non-mutable
  - ints, floats, bools, strings
  - **Not** lists or custom objects
- Values can be anything
- Example:

```
d = {'js1':'John Smith',
     'js2':'John Smith',
     'wmw2':'Walker White'}
```

Using Dictionaries (Type dict)

- Access elts. like a list
  - d['js1'] evaluates to 'John'
  - But cannot slice ranges!
- Dictionaries are **mutable**
  - Can reassign values
  - d['js1'] = 'Jane'
  - Can add new keys
  - d['aa1'] = 'Allen'
  - Can delete keys
  - del d['wmw2']

d = {'js1':'John','js2':'John', 'wmw2':'Walker'}



Key-Value order in folder is not important

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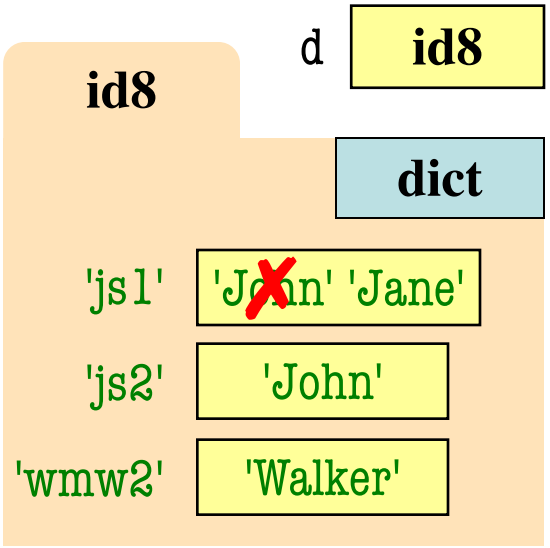

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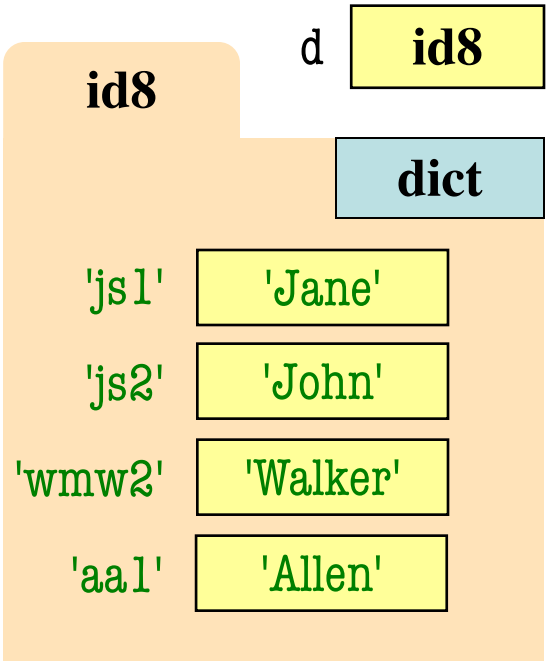

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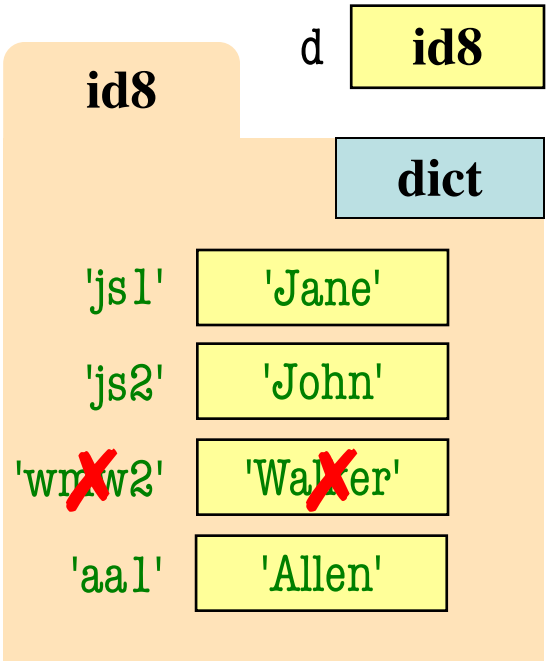


Deleting key deletes both

Dictionaries and For-Loops

- Dictionaries != sequences
  - Cannot slice them
- *Different* inside for loop
  - Loop variable gets the key
  - Then use key to get value
- Can **extract iterators** with dictionary *methods*
  - Key iterator: d.keys()
  - Value iterator: d.values()
  - key-value pairs: d.items()

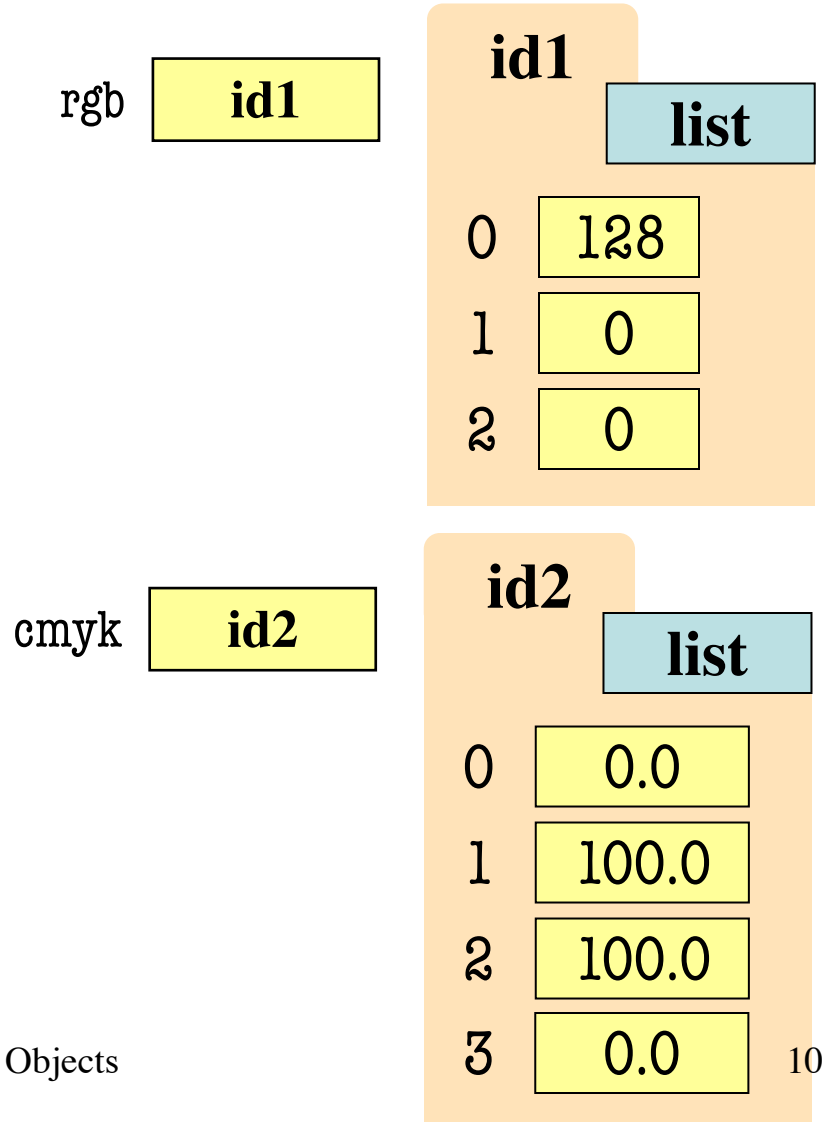
```
for k in d:
    # Loops over keys
    print(k)      # key
    print(d[k])   # value

# To loop over values only
for v in d.values():
    print(v)      # value
```

See grades.py

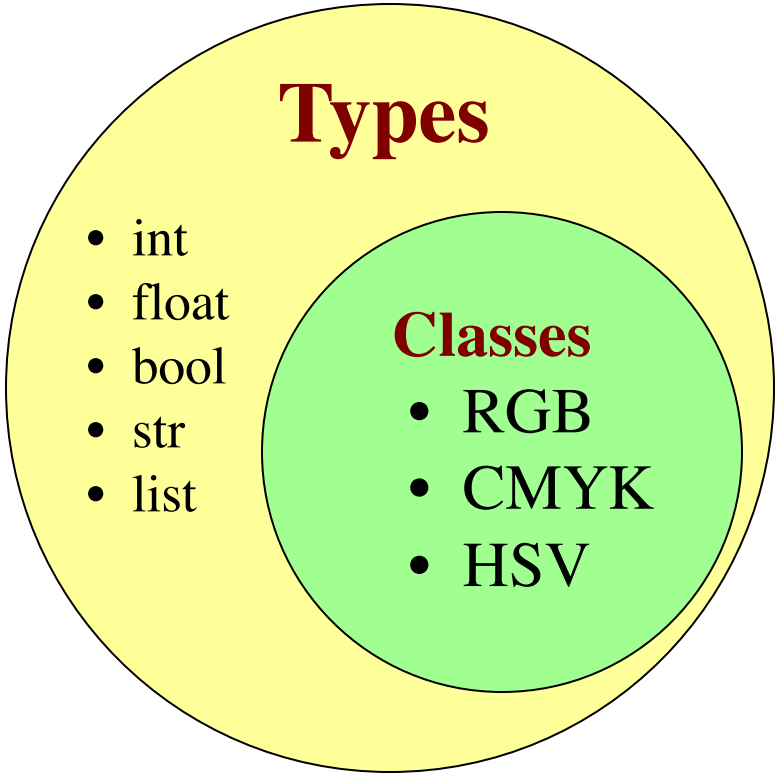
Thinking About Assignment 2

- **A2**: three color models
  - `RGB`: 3 ints 0 to 255
  - `CMYK`: 4 floats 0.0 to 100.0
  - `HSV`: 3 floats, mult. bounds
  - We could represent as lists
- Can get really confusing
  - Easy to mix-up models
  - Easy to go out of bounds
- **We want custom types**
  - One for each color model
  - Motivation for ***classes***

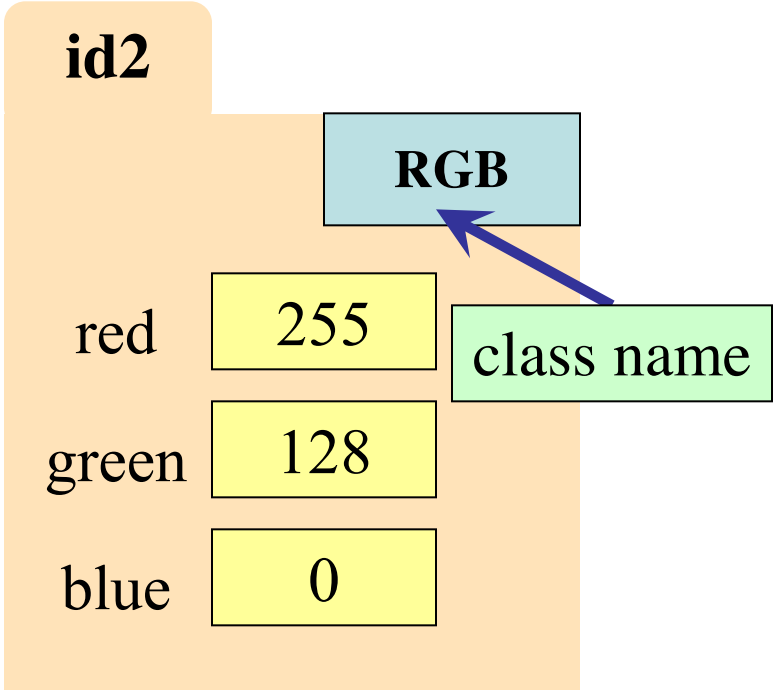


Classes are Customized Types

- Classes are how we add new types to Python



- Values look like **dicts**
  - Represent as a folder
  - Variables are named



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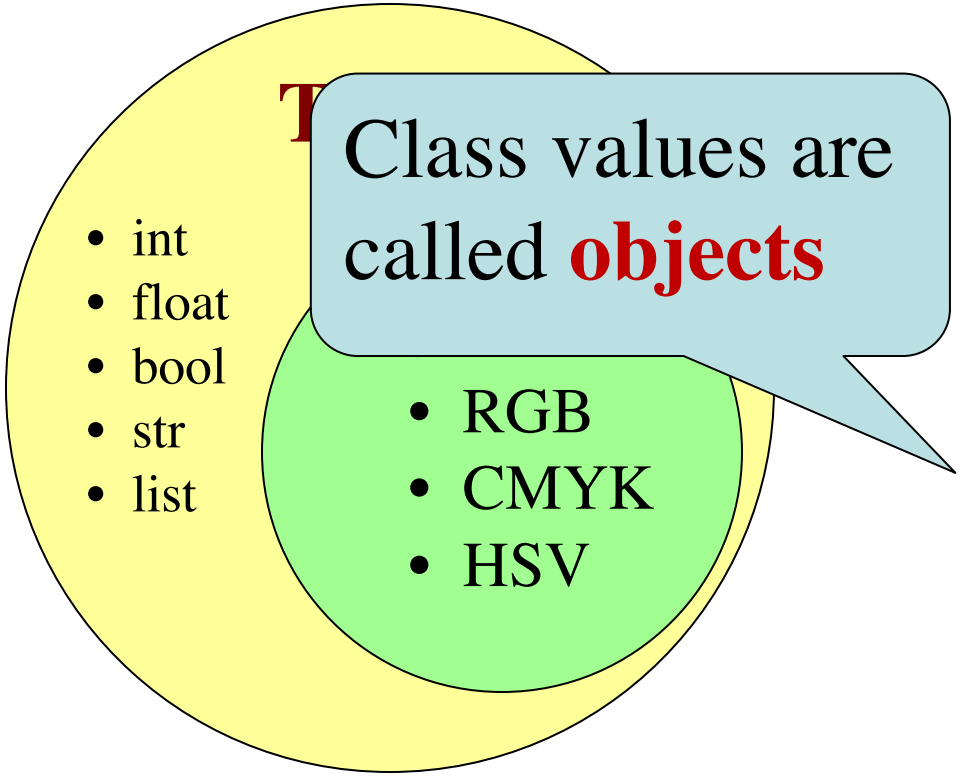

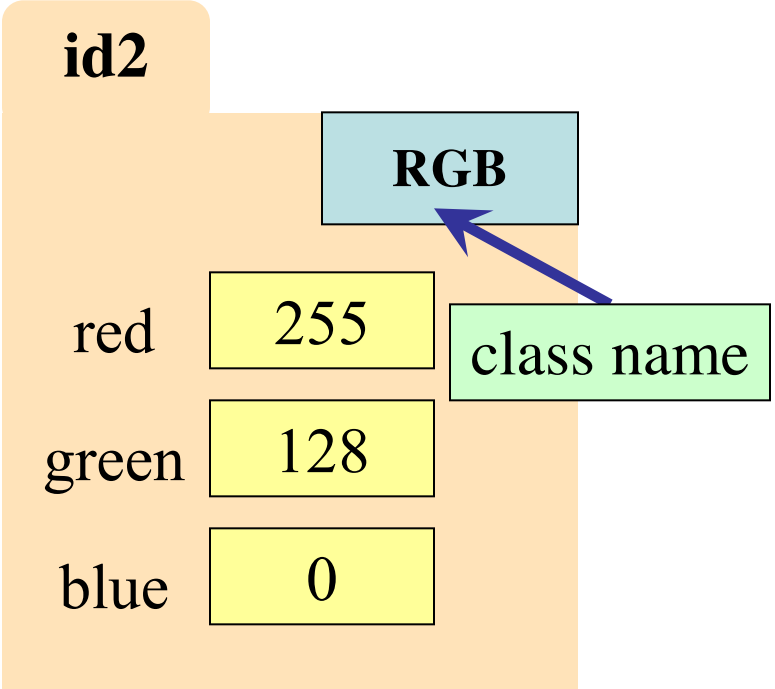

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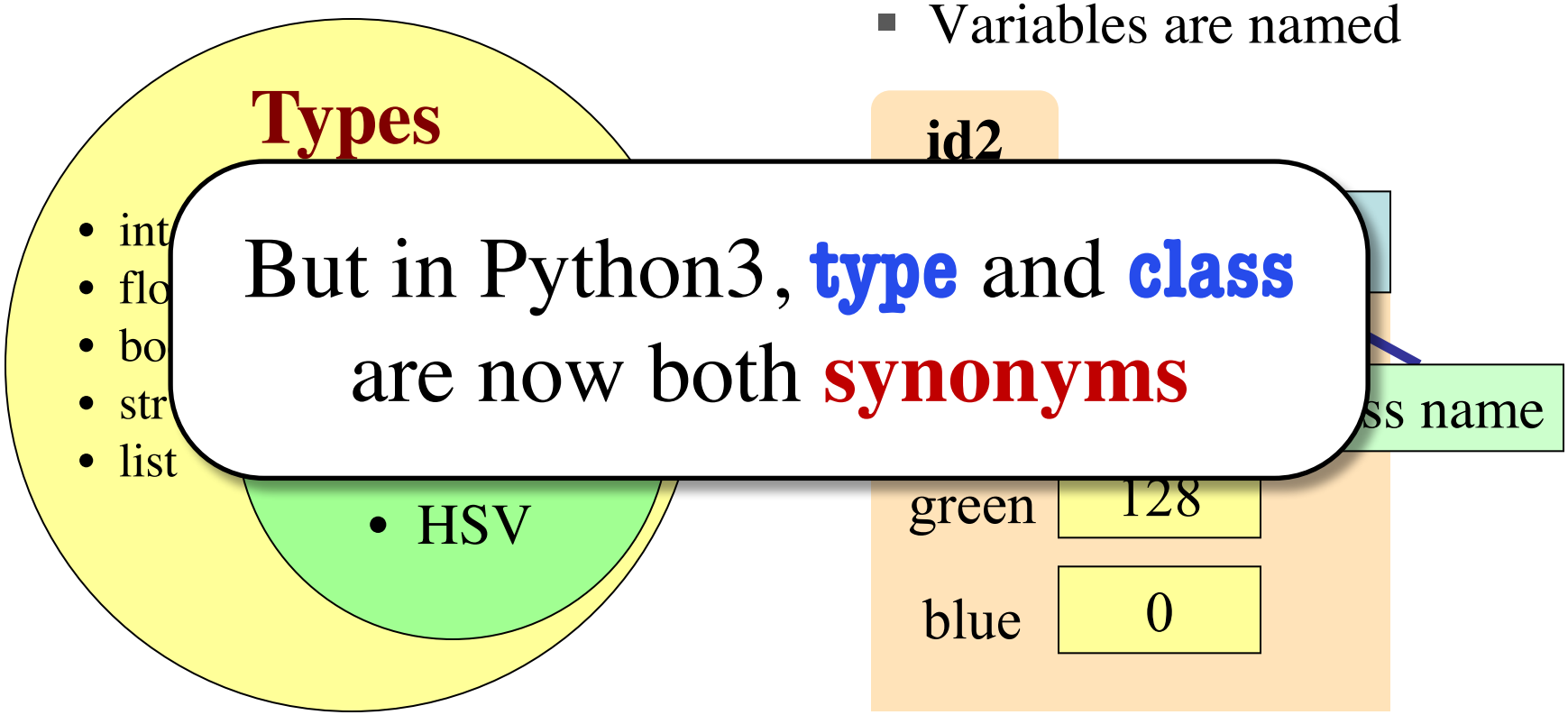
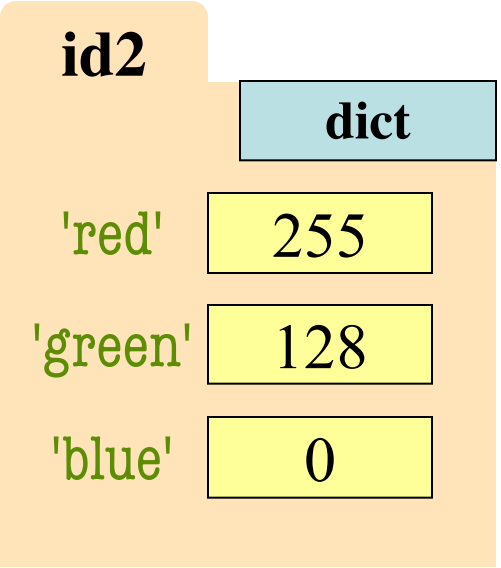
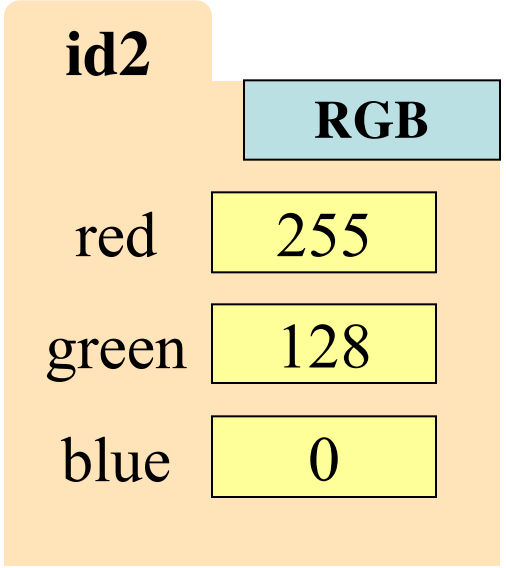


But in Python3, **type** and **class** are now both **synonyms**

Why Are They Better Than dicts?





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- Does not check bounds of the content variables

- Variables fixed (sort-of)
- Possibly checks bounds of the content variables

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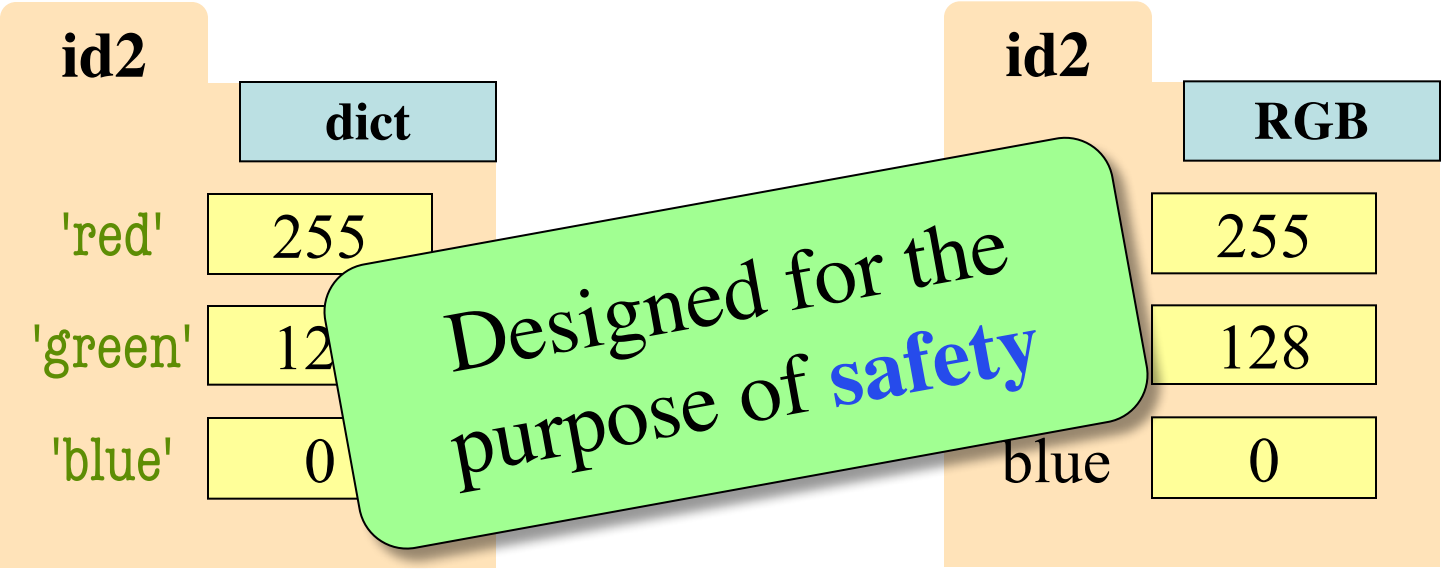

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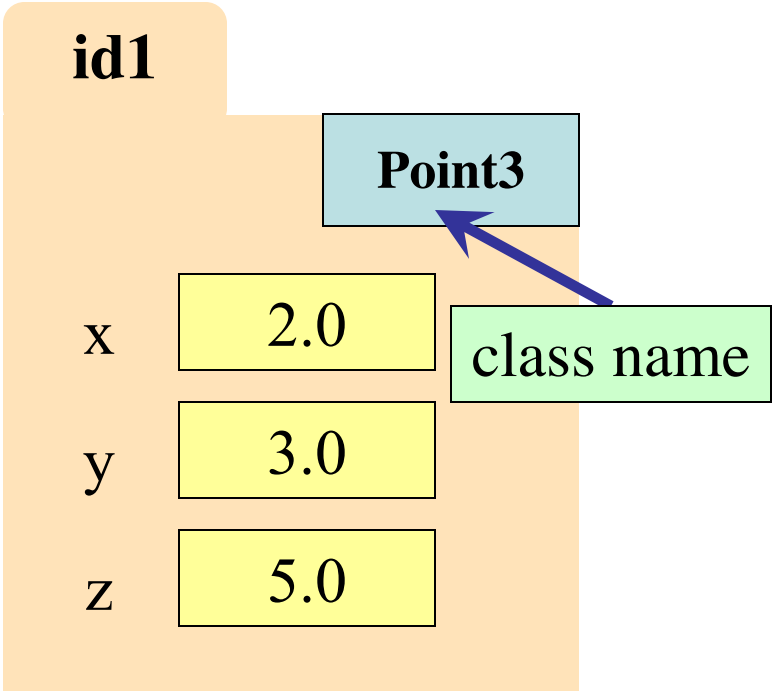
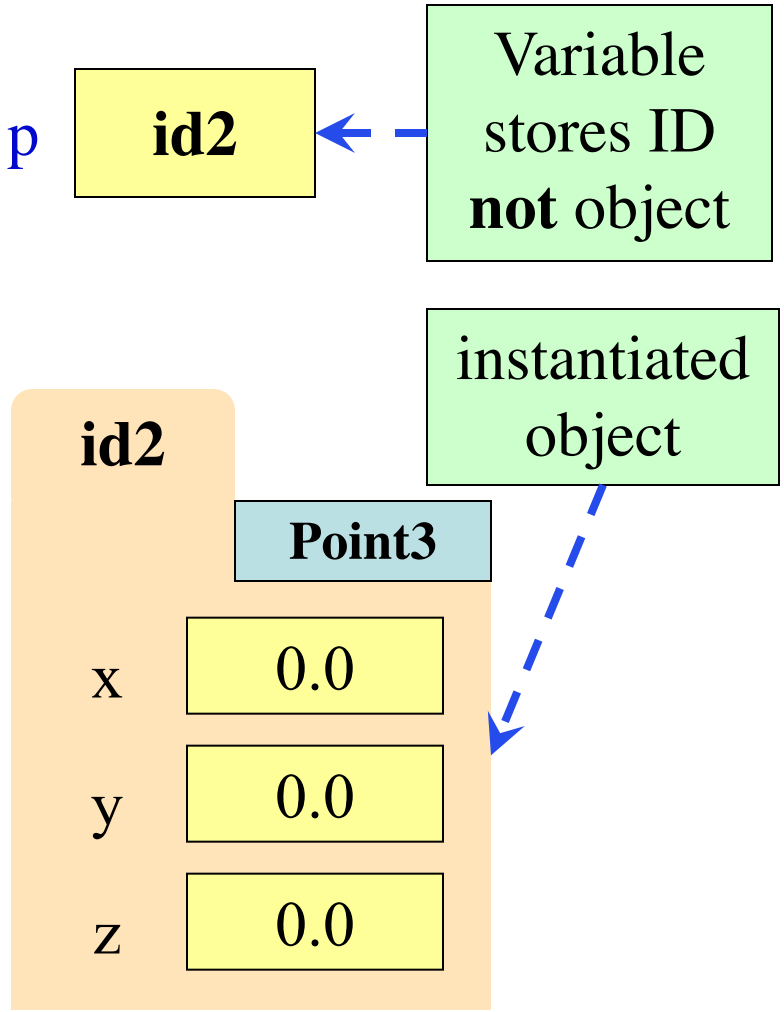
Using Classes in Python

- **Modules** provide classes
  - Import to use the class
  - Will show contents later
- **Example**: `cornell`
  - Color classes for A2: `RGB`, `CMYK`, `HSV`
  - Geometry classes: `Point2`, `Point3`
- Will make our own later



Constructor: Function to make Objects

- How do we create objects?
  - Other types have **literals**
  - **Example**: 1, 'abc', **true**
  - No such thing for objects
- **Constructor Function**:
  - Same name as the class
  - **Example**: Point3(0,0,0)
  - Makes an object (manila folder)
  - Returns folder ID as value
- **Example**: p = Point3(0, 0, 0)
  - Creates a Point object
  - Stores object's ID in p



Constructors and Modules

```
>>> import cornell
```

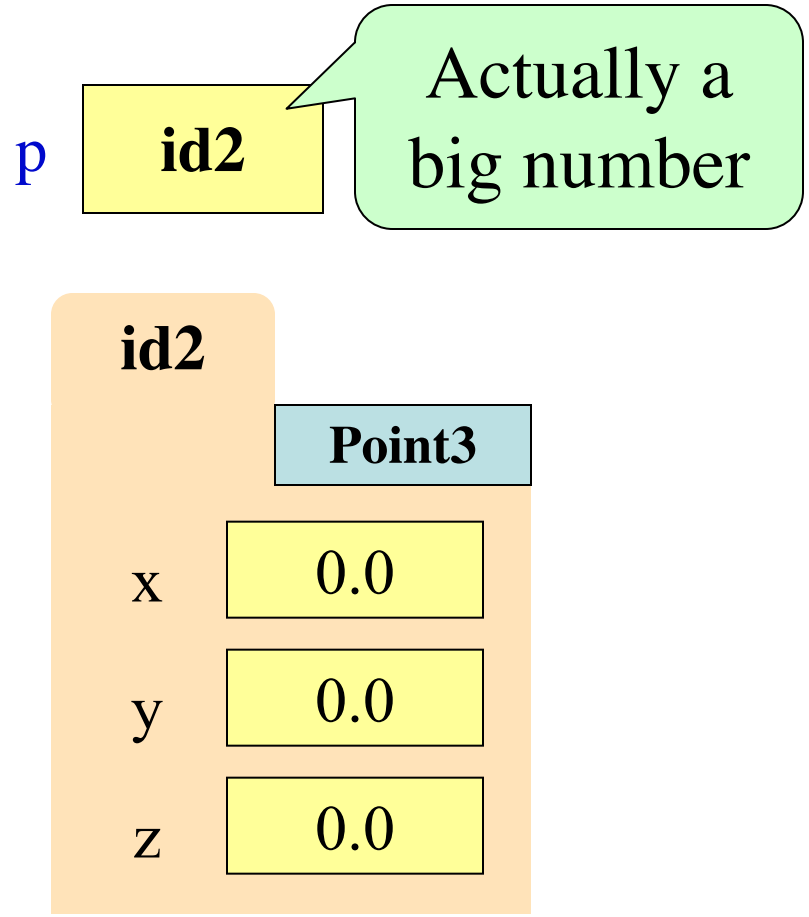
Need to import module that has Point class.

```
>>> p = cornell.Point3(0,0,0)
```

Constructor is function. Prefix w/ module name.

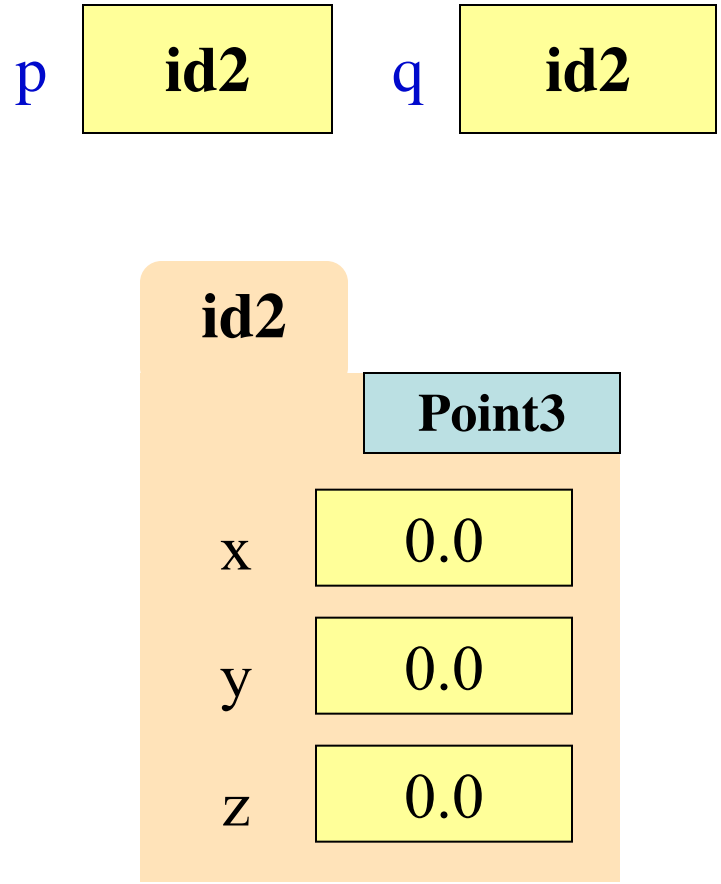
```
>>> id(p)
```

Shows the ID of p.



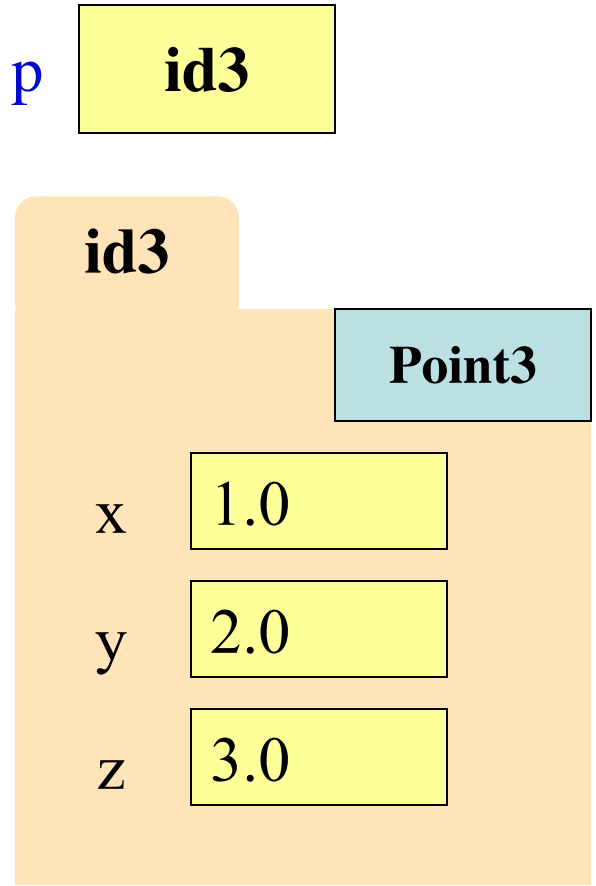
Object Variables

- Variable stores object name
  - **Reference** to the object
  - Reason for folder analogy
- Assignment uses object name
  - **Example**: q = p
  - Takes name from p
  - Puts the name in q
  - Does not make new folder!
- **Like we saw with lists**
  - Reason for using folders



Objects and Attributes

- Attributes are variables that live inside of objects
  - Can **use** in expressions
  - Can **assign** values to them
- **Access**: `<variable>.<attr>`
  - **Example**: `p.x`
  - Look like module variables
- Putting it all together
  - `p = cornell.Point3(1,2,3)`
  - `p.x = p.y + p.z`



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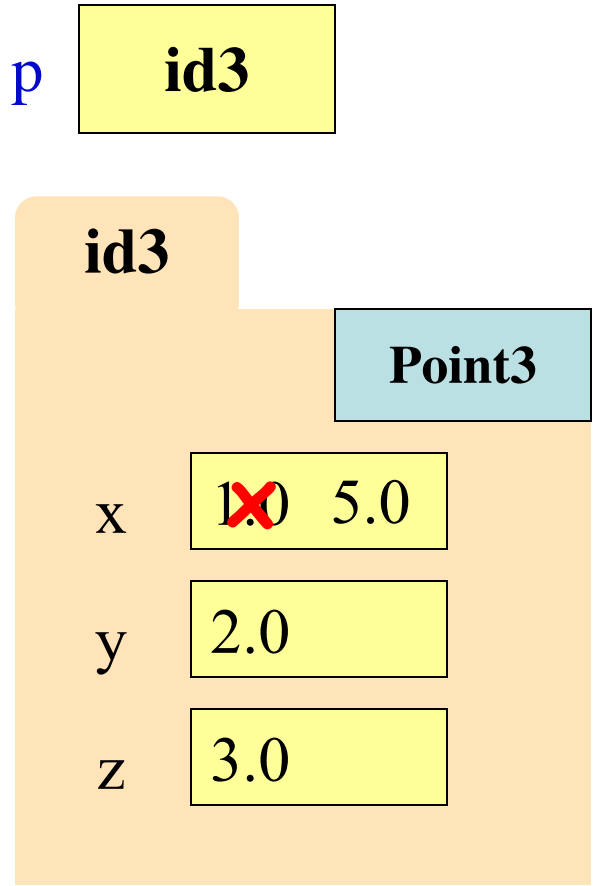


Exercise: Attribute Assignment

- Recall, `q` gets name in `p`

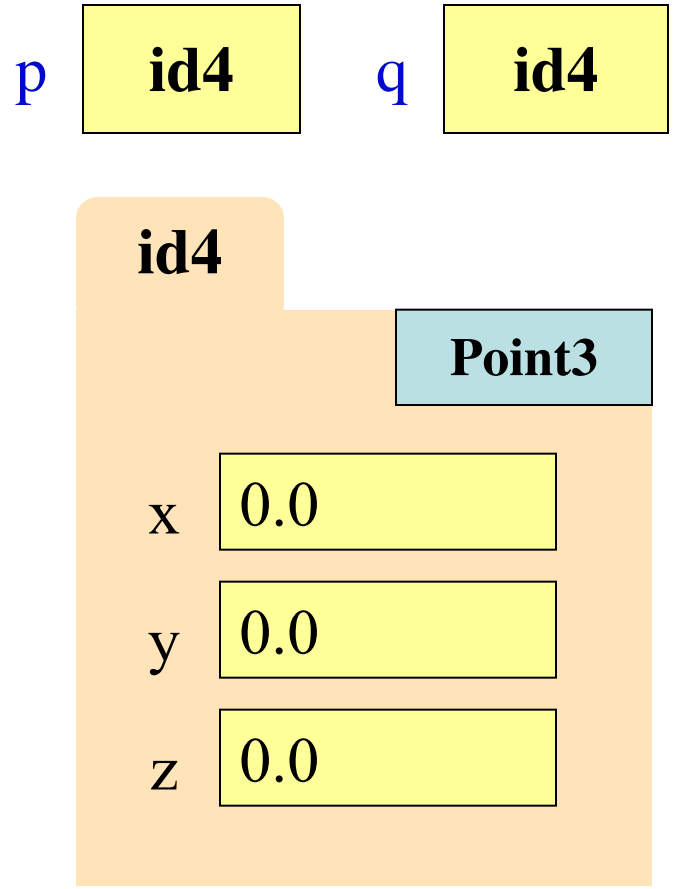
```
>>> p = cornell.Point3(0,0,0)
>>> q = p
```

- Execute the assignments:

```
>>> p.x = 5.6
>>> q.x = 7.4
```

- What is value of `p.x`?

A: 5.6
B: 7.4
C: **id4**
D: I don't know



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>>> p = geom.Point3(0,0,0)
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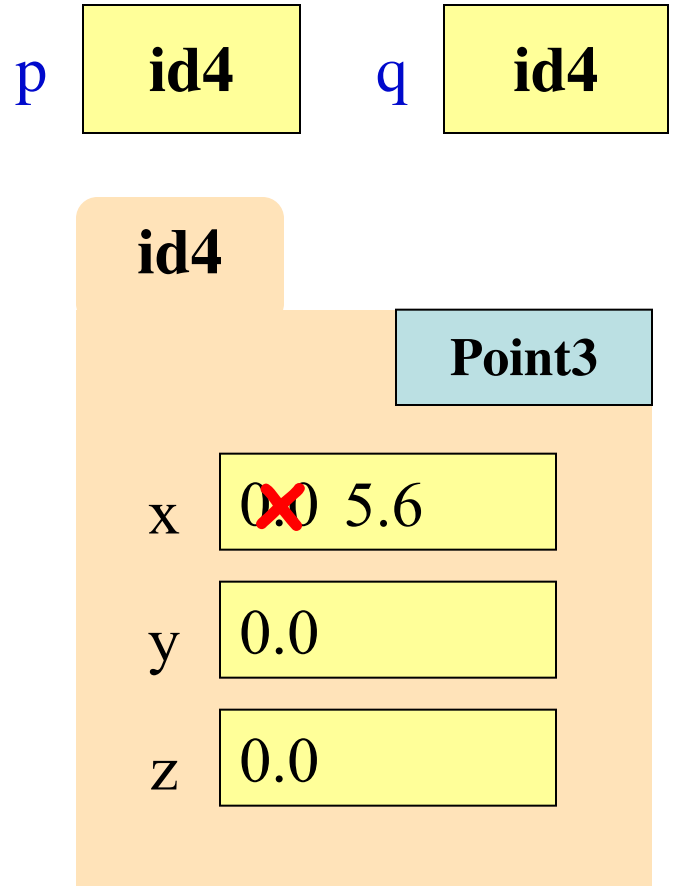

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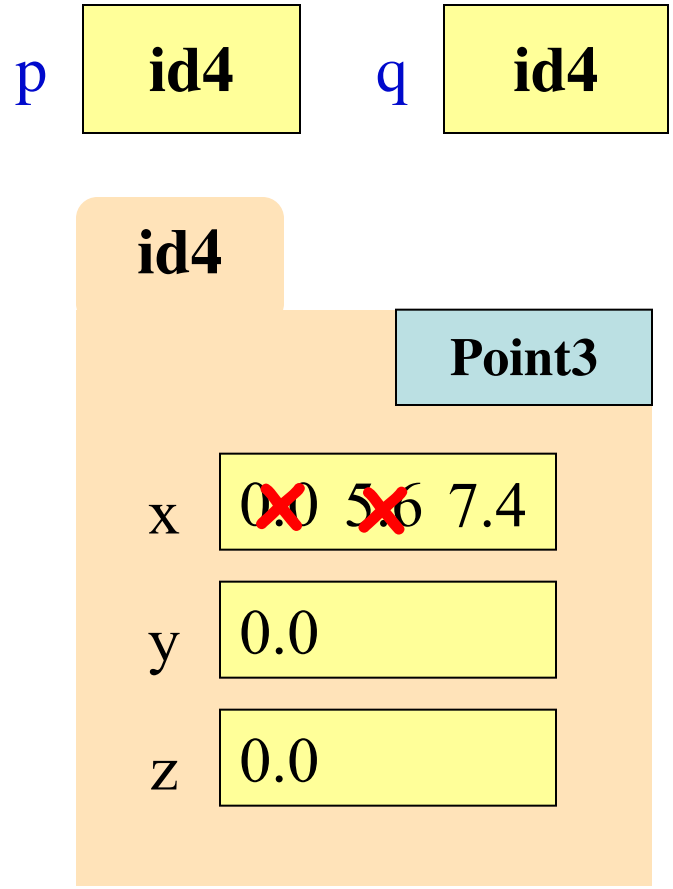
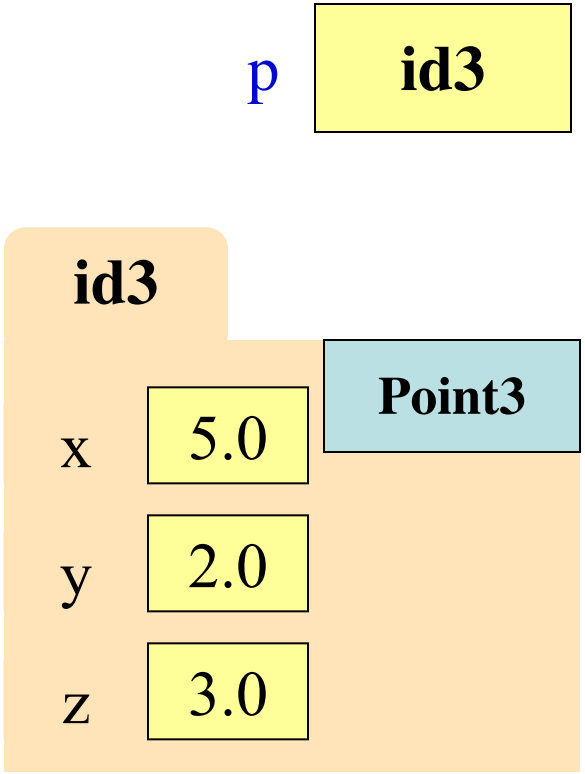


Methods: Functions Tied to Objects

- **Method**: function tied to object
  - Method call looks like a function call preceded by a variable name:

    ⟨*variable*⟩.⟨*method*⟩(⟨*arguments*⟩)

  - **Example**: `p.distance(q)`
  - **Example**: `p.abs()` # makes x,y,z ≥ 0
- Just like we saw for strings
  - `s = 'abracadabra'`
  - `s.index('a')`
- Are strings objects?

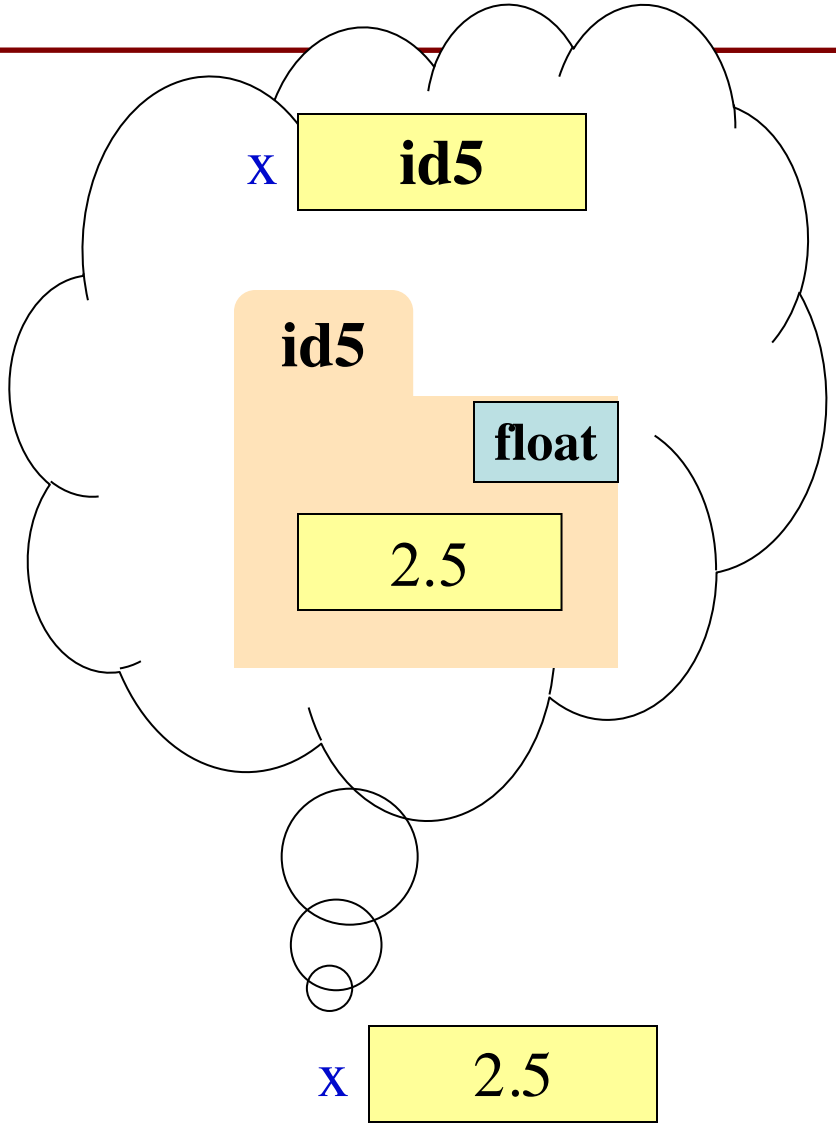


Surprise: All Values are in Objects!

- Including basic values
  - int, float, bool, str
- **Example**:

```
>>> x = 2.5
>>> id(x)
```

- But they are *immutable*
  - Contents cannot change
  - Distinction between *value* and *identity* is immaterial
  - So we can ignore the folder



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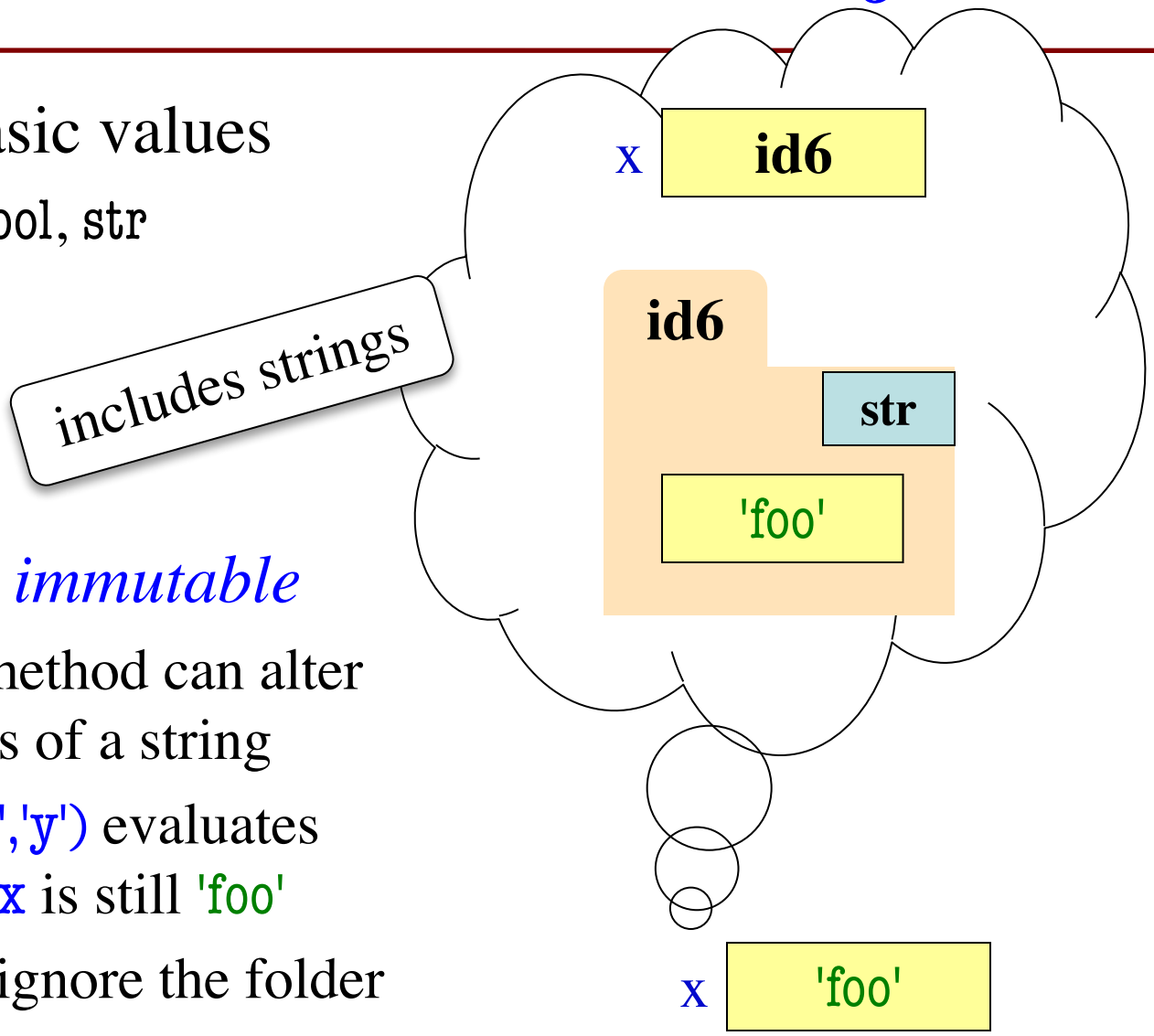
- **Example**:

```
>>> x = 'foo'
>>> id(x)
```

- But they are *immutable*
  - No string method can alter the contents of a string
  - x.replace('o','y') evaluates to 'fyy' but x is still 'foo'
  - So we can ignore the folder



Base Types vs. Classes

Base Types	Classes
• Built-into Python	• Provided by modules
• Refer to instances as *values*	• Refer to instances as *objects*
• Instantiate with *literals*	• Instantiate w/ *constructors*
• Are all immutable	• Can alter attributes
• Can ignore the folders	• Must represent with folders