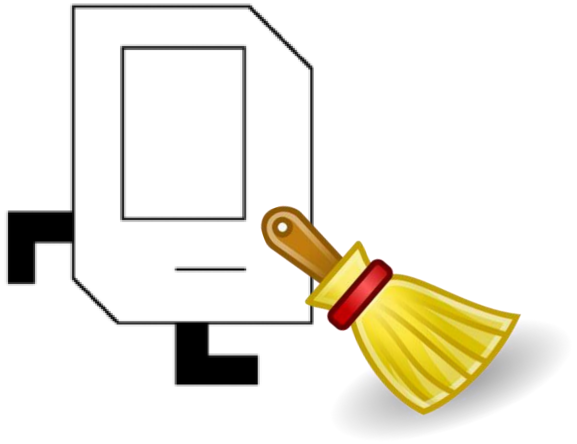
Classes + Objects

Chris Piech and Mehran Sahami

CS106A, Stanford University

Housekeeping



- Hope you're well
- Diagnostic will be graded this weekend
- The Stanford Honor Code
  - CS106A retraction policy
  - Deadline to retract any assignments: Nov. 16th

Learning Goals

1. Learning about Object-Oriented Programming
2. Writing code using Classes and Objects in Python

Object-Oriented Programming (OOP)

It's not a mistake!

Object-Oriented Programming

- There are different *paradigms* in programming
- So far, you've learned *imperative* programming
  - Provide series of direct commands for program execution
  - Commands are changing the program's *state*
- *Object-oriented* programming
  - Define *objects* that contain data and behavior (functions)
  - Program is (mostly) an interaction between objects
  - You are calling function of objects (called "methods")
- Python allows for programming in either paradigm!
  - Other programming paradigms exist, but we won't talk about those in this class

What are Classes and Objects?

- Classes are like blueprints
  - They provide a template for a kind of object
  - They define a new **type**
  - E.g., "Human" would be a class
    - Generally, have two arms, have two legs, breathe air, etc.

- Objects are *instances* of Classes
  - Can have multiple objects of the same Class type
  - E.g., <u>You</u> would be an instance of the Human class
    - So, you have the properties of your Class (Human)
  - There are lots of other people out there too
    - You are all of type "Human"
    - You are all objects of the same Class

Example of a Class in Python

- Let's create a Counter class
  - Can ask is for the "next" ticket number
  - Need to keep track of next ticket number
  - Class names start with Uppercase character
  - No **`main()`** function (Class is **not** a program)

Two (or double) underscores – called "dunder" for short

```
class Counter:

    # Constructor
    def __init__(self):
        self.ticket_num = 0    # "instance" variable

    # Method (function) that returns next ticket value
    def next_value(self):
        self.ticket_num += 1
        return self.ticket_num
```

Let's See It In Action: counter.py

Objects are Mutable

- When you pass an object as a parameter, changes to object in that function persist after function ends

```
from counter import Counter     # import the Class

def count_two_times(count):
    for i in range(2):
        print(count.next_value())

def main():
    count1 = Counter()
    count2 = Counter()

    print('Count1: ')
    count_two_times(count1)

    print('Count2: ')
    count_two_times(count2)

    print('Count1: ')
    count_two_times(count1)
```

Output:

```
Count1:
1
2
Count2:
1
2
Count1:
3
4
```

General Form for Writing a Class

- Filename for class is usually *classname*`.py`
  - Filename is usually lowercase version of class name in file

```
class Classname:

    # Constructor
    def __init__(self, additional parameters):
        body
        self.variable_name = value    # example instance variable

    # Method
    def method_name(self, additional parameters):
        body
```

Constructor of a Class

- Constructor
  - Syntax:

    `def __init__(self,` ***additional parameters*** `):`

        body

- Called when a new object is being created
  - Does not explicitly specify a return value
  - New object is created and returned
    - Can think of constructor as the "factory" that creates new objects
  - Responsible for initializing object (setting initial values)
  - Generally, where instance variables are created (with **`self`**)

    `self.`***variable_name*** `=` ***value***   `# create instance variable`

Instance Variables

- Instance variables are variable associated with objects
  - Each object get its <u>**own set**</u> of instance variables
  - Generally, they are initialized in constructor for class
  - Instance variables accessed using **`self`**:

    `self.`<u>*variable_name*</u> **`=`** <u>*value*</u>

  - Self really refers to the object that a method is called on

```
def main():
    count1 = Counter()
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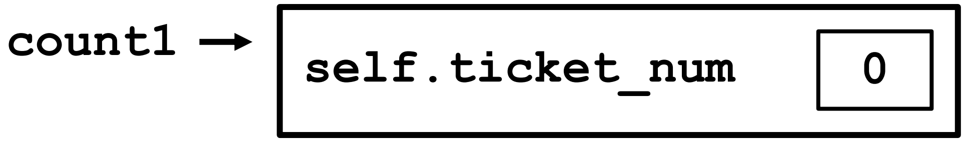

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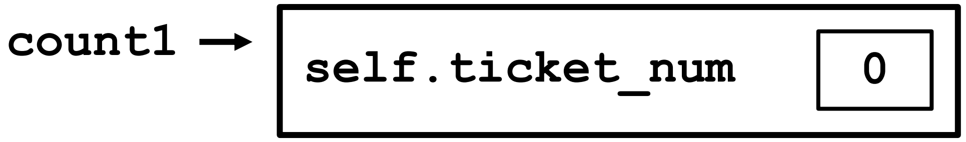

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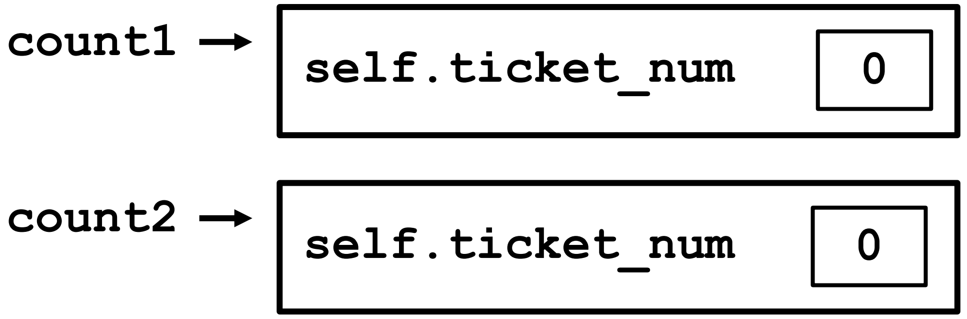

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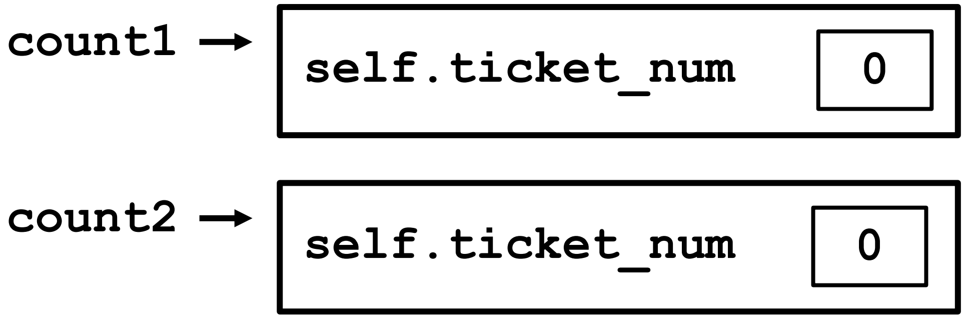

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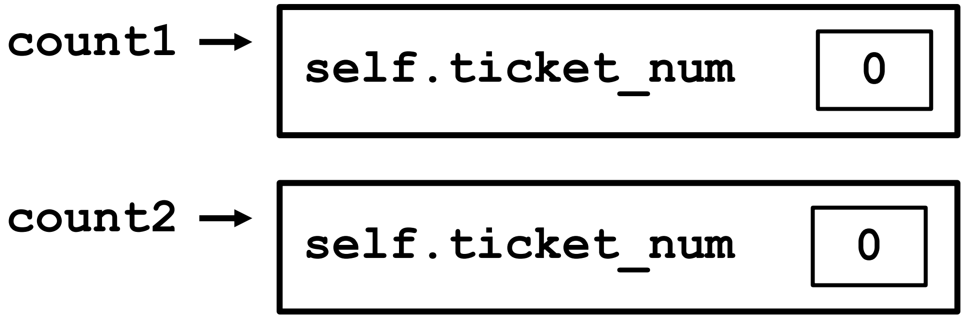

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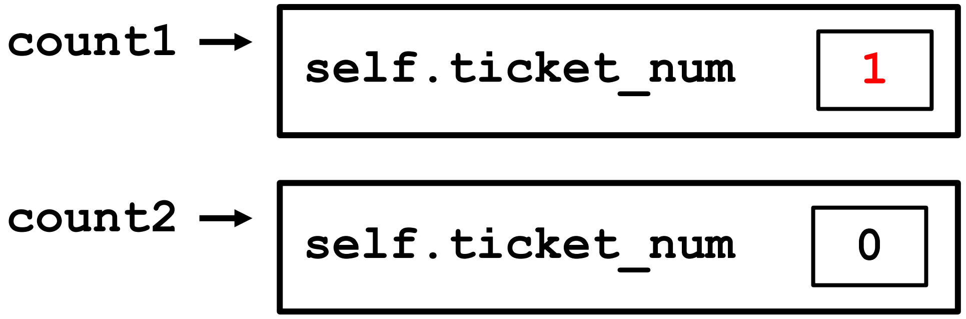

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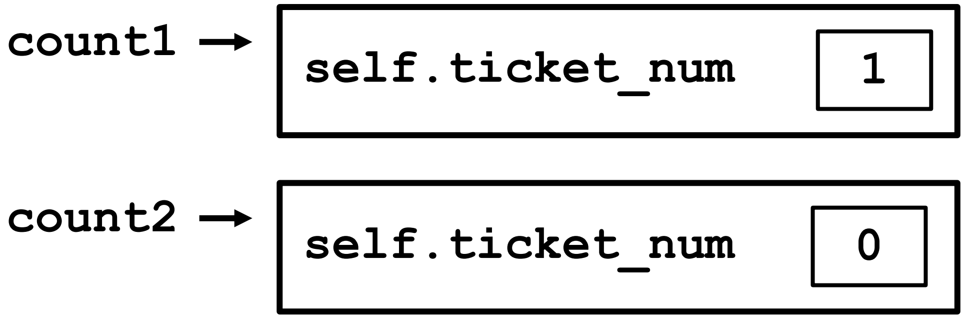

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    count2 = Counter()
    x = count1.next_value()
    y = count2.next_value()
```

count2

```
def next_value(self):
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    return self.ticket_num
```

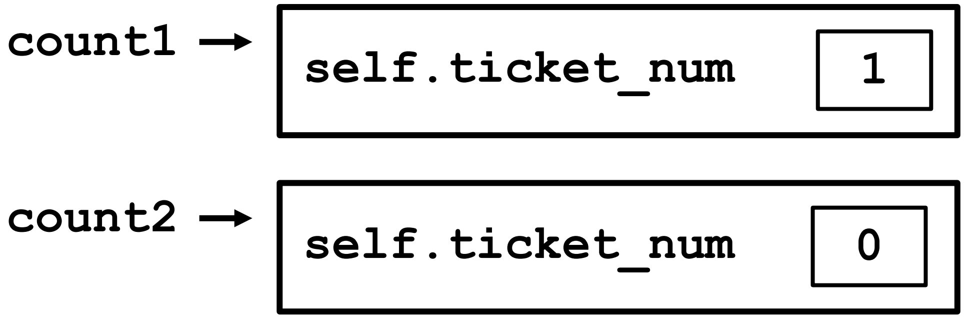

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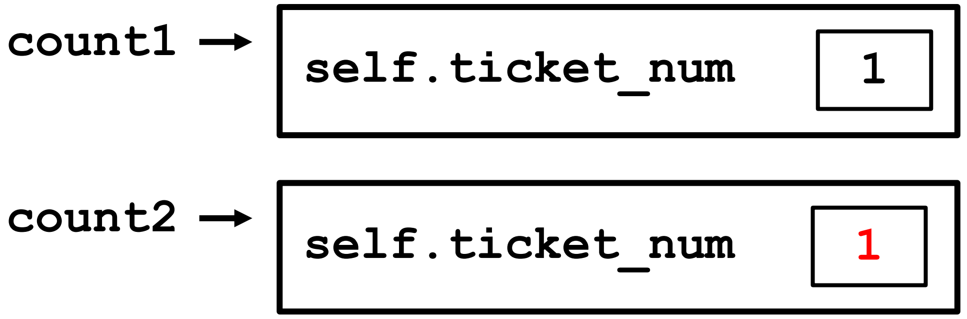

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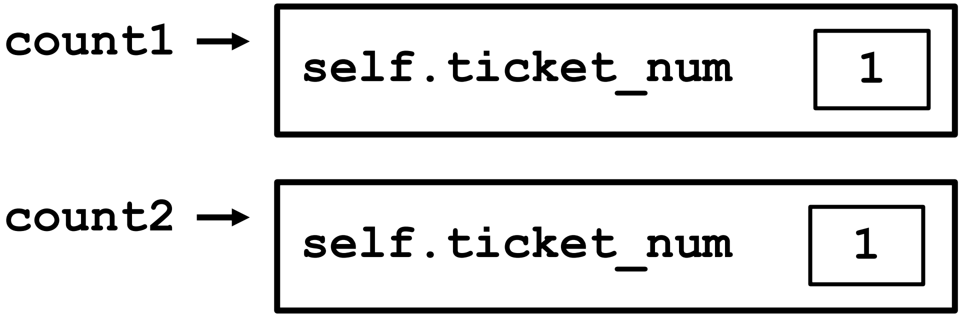

Methods (Functions) in Class

- Methods (name used for functions in objects)
  - Syntax:

    `def` ***method_name***`(self,` ***additional parameters***`):`

        body

- Works like a regular function in Python
  - Can return values (like a regular function)
  - Has access to *instance* variables (through **`self`**):

    `self.`***variable_name*** `=` ***value***
  - Called using an object:

    object_name `.` ***method_name*** **(*additional parameters*)**
  - Recall, parameter **`self`** is automatically set by Python as the object that this method is being called on
    - You write: **`number = count1.next_value()`**
    - Python treats it as: **`number = next_value(count1)`**

Another Example: Students

- Want a Class to keep track information for Students
  - Each student has information:
    - Name
    - ID number
    - Units completed
  - Want to specify a name and ID number when creating a student object
    - Initially, units completed set to 0
  - Student's number of units completed can be updated over time
  - Also want to be able to check if a student can graduate
    - Student needs to have at least **`UNITS_TO_GRADUATE`** units

Bring Me the Students!
student.py

Learning Goals

1. Learning about Object-Oriented Programming
2. Writing code using Classes and Objects in Python

```
class :

    def __init__(self):
        self.tasty = True

    def eat(self):
        print("Nom, nom, nom...")
        return self.tasty
```

```
from import

def main():
    meal = ()
    while True:
        happy = meal.eat()
```