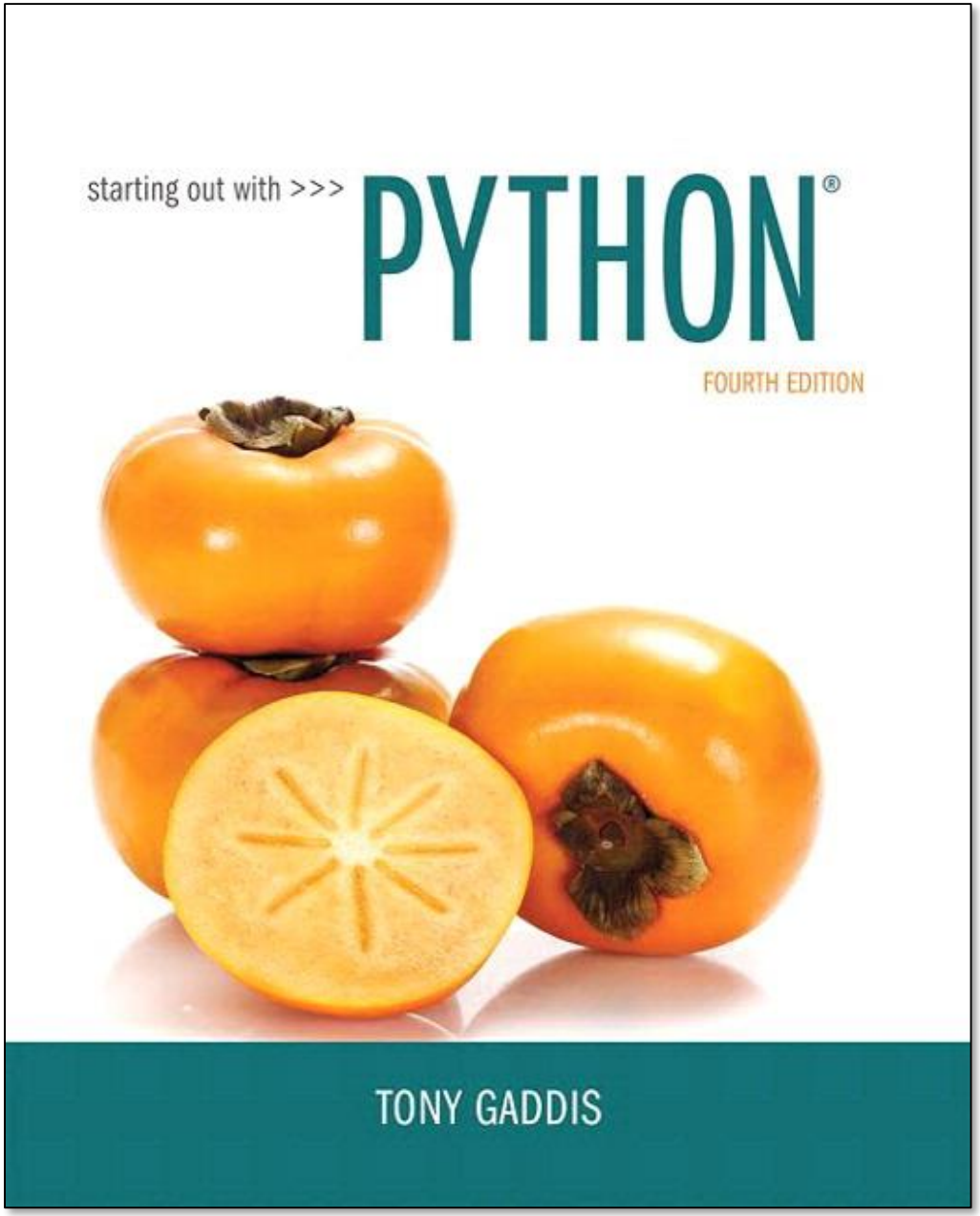
CHAPTER 10

Classes and Object-Oriented Programming



Topics

- **Procedural and Object-Oriented Programming**
- **Classes**
- **Working with Instances**
- **Techniques for Designing Classes**

Procedural Programming

- **Procedural programming: writing programs made of functions that perform specific tasks**
  - Procedures typically operate on data items that are separate from the procedures
  - Data items commonly passed from one procedure to another
  - Focus: to create procedures that operate on the program's data

Object-Oriented Programming

- **Object-oriented programming: focused on creating objects**
- **Object: entity that contains data and procedures**
  - Data is known as data attributes and procedures are known as methods
    - Methods perform operations on the data attributes

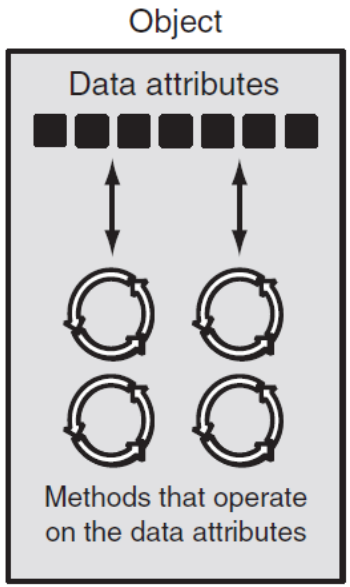
Object-Oriented Concepts

1. Encapsulation: combining data and code into a single object
2. Data hiding: object's data attributes are hidden from code outside the object
3. Inheritance: used to create an "is a" relationship between classes
4. Polymorphism: Ability to define a method in a superclass and override it in a subclass

Object-Oriented Programming (cont'd.)

Encapsulation: Combining data and code into a single object

Figure 10-1 An object contains data attributes and methods

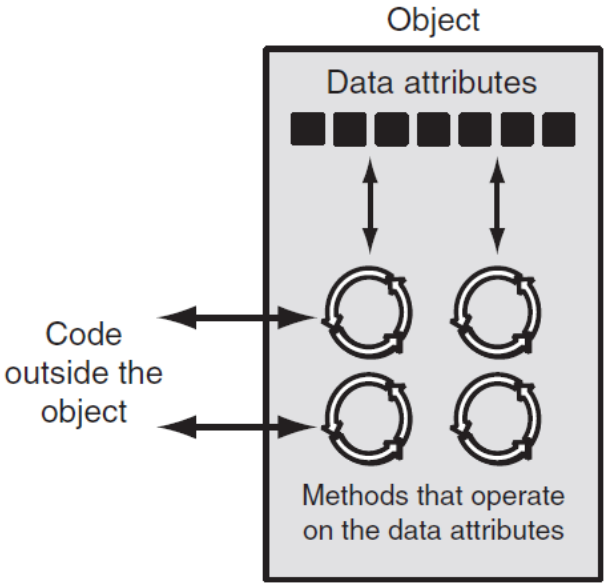


Object-Oriented Programming (cont'd.)

- **Data hiding: object's data attributes are hidden from code outside the object**
  - Access restricted to the object's methods
    - Protects from accidental corruption
    - Outside code does not need to know internal structure of the object
- **Object reusability: the same object can be used in different programs**
  - Example: 3D image object can be used for architecture and game programming

Object-Oriented Programming (cont'd.)

Figure 10-2 Code outside the object interacts with the object's methods



An Everyday Example of an Object

- **Data attributes: define the state of an object**
  - Example: clock object would have `second`, `minute`, and `hour` data attributes
- **Public methods: allow external code to manipulate the object**
  - Example: `set_time, set_alarm_time`
- **Private methods: used for object's inner workings**
  - Example: `increment_current_second`, `increment_current_minute`

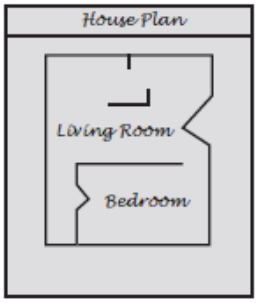
Classes

- **Class: code that specifies the data attributes and methods of a particular type of object**
  - Similar to a blueprint of a house or a cookie cutter
- **Instance: an object created from a class**
  - Similar to a specific house built according to the blueprint or a specific cookie
  - There can be many instances of one class

Classes (cont'd.)

Figure 10-3 A blueprint and houses built from the blueprint

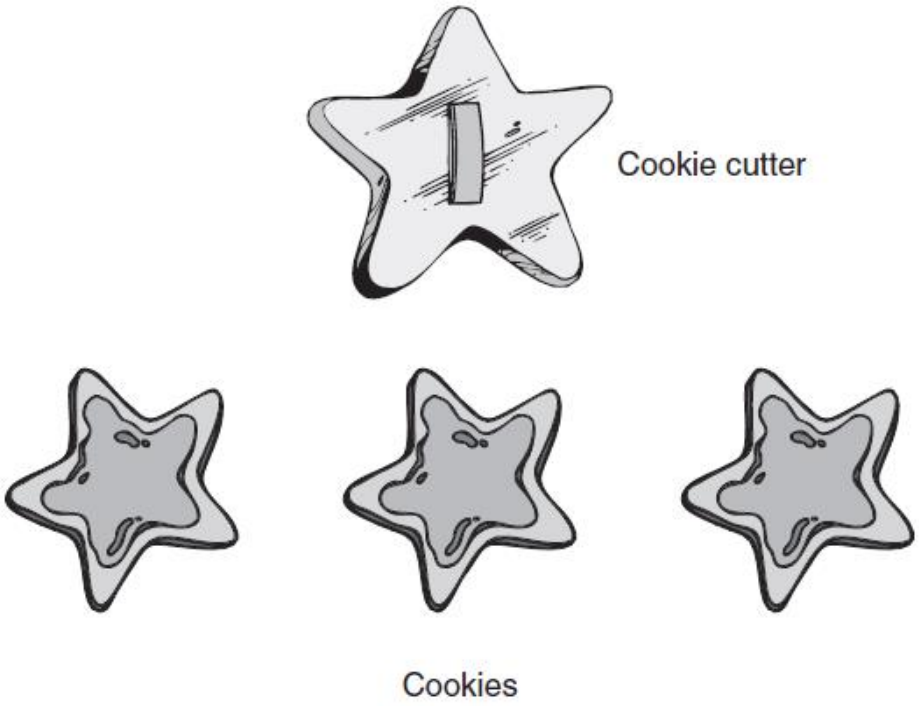
Blueprint that describes a house



Instances of the house described by the blueprint

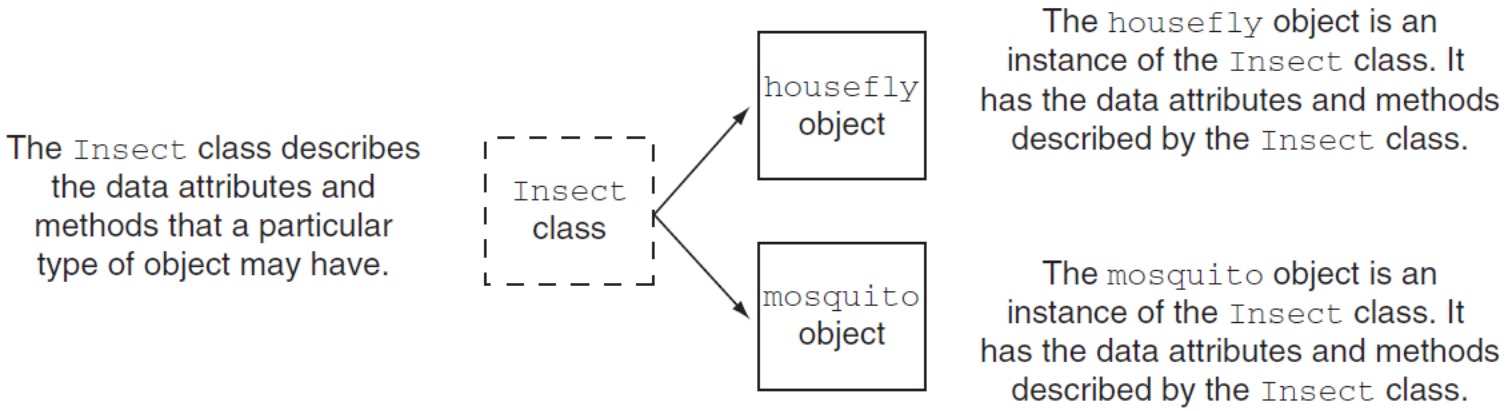
Classes (cont'd.)

Figure 10-4 The cookie cutter metaphor



Classes (cont'd.)

Figure 10-5 The `housefly` and `mosquito` objects are instances of the `Insect` class



Class Definitions

- **Class definition: set of statements that define a class's methods and data attributes**
  - Format: begin with `class` *`Class_name`*`:`
    - Class names often start with uppercase letter
  - Method definition like any other python function definition
    - `self` parameter: required in every method in the class – references the specific object that the method is working on

Class Definitions (cont'd.)

- **Initializer method: automatically executed when an instance of the class is created**
  - Initializes object's data attributes and assigns `self` parameter to the object that was just created
  - Format: `def __init__ (self):`
  - Usually the first method in a class definition

coin.py

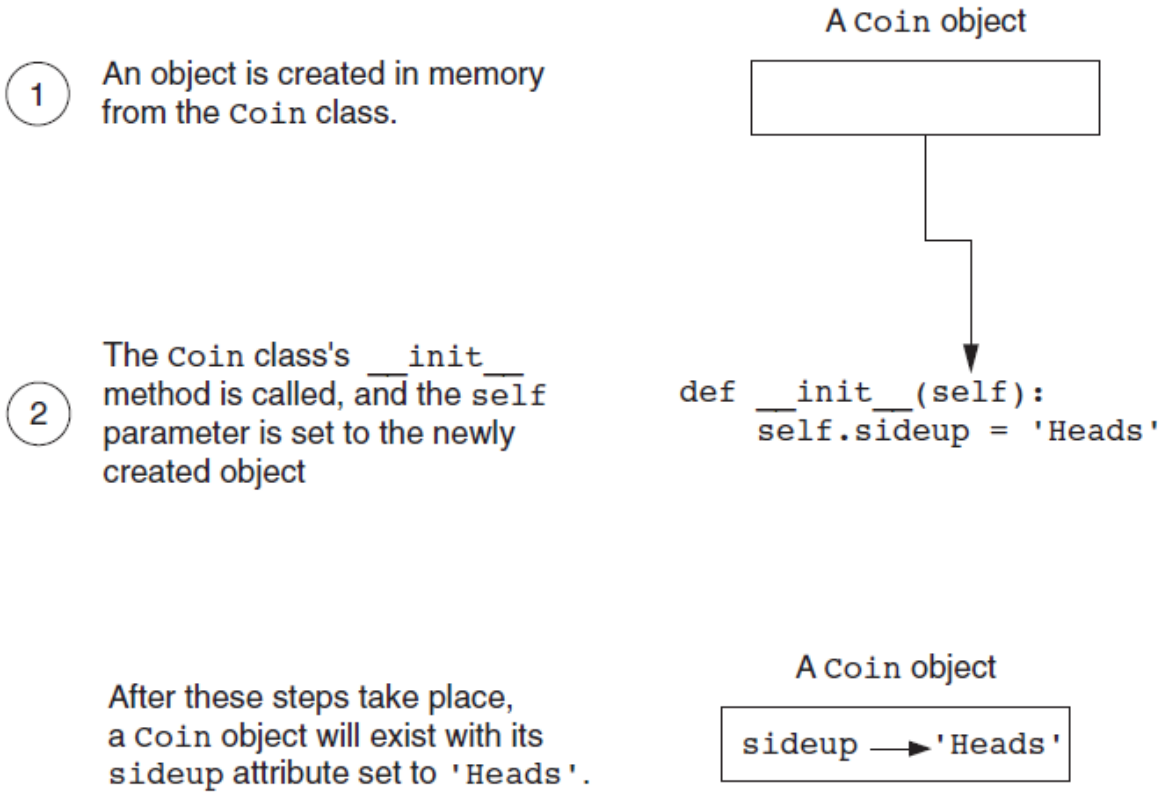
Creating instances

- **To create a new instance of a class call the initializer method**
  - Format: *My_instance = Class_Name*()
- **To call any of the class methods using the created instance, use dot notation**
  - Format: *My_instance.method*()
  - Because the `self` parameter references the specific instance of the object, the method will affect this instance

coin_demo1.py

Creating instances (cont'd.)

Figure 10-6 Actions caused by the `Coin()` expression



Hiding Attributes and Storing Classes in Modules

- **An object's data attributes should be private**
  - To make sure of this, place two underscores (__) in front of attribute name
    - Example: `__current_minute`

coin_demo2.py

coin_demo3.py

- **Classes can be stored in modules**
  - Filename for module must end in .py
  - Module can be imported to programs that use the class

coin.py

coin_demo4.py

The `BankAccount` Class – More About Classes

- **Class methods can have multiple parameters in addition to `self`**
  - For `__init__`, parameters needed to create an instance of the class
    - Example: a `BankAccount` object is created with a balance
      - When called, the initializer method receives a value to be assigned to a `__balance` attribute
  - For other methods, parameters needed to perform required task
    - Example: `deposit` method amount to be deposited

bankaccount.py
account_test.py

The `__str__` method

- **Object's state: the values of the object's attribute at a given moment**
- **`__str__` `method`: displays the object's state**
  - Automatically called when the object is passed as an argument to the `print` function
  - Automatically called when the object is passed as an argument to the `str` function

account_test2.py

bankaccount2.py

Working With Instances

- **Instance attribute: belongs to a specific instance of a class**
  - Created when a method uses the `self` parameter to create an attribute
- **If many instances of a class are created, each would have its own set of attributes**

Figure 10-8 The `coin1`, `coin2`, and `coin3` variables reference three `Coin` objects

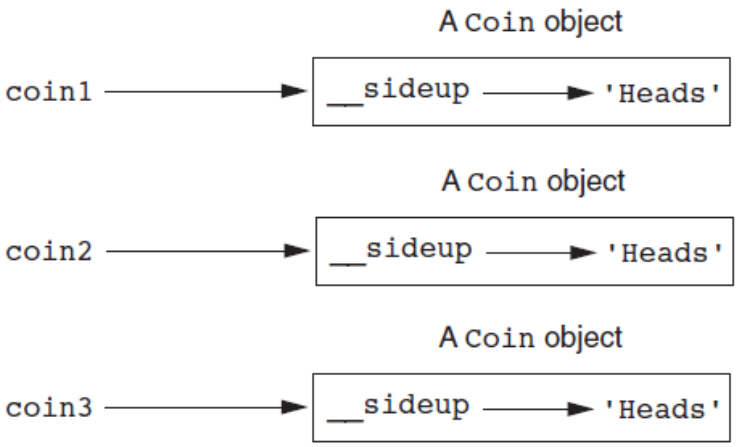
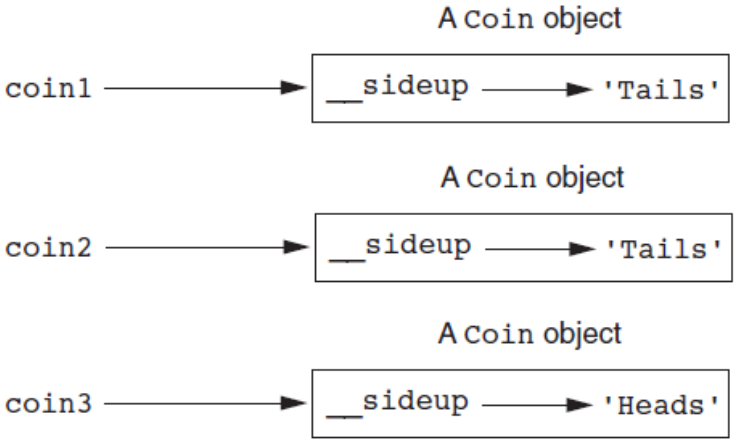


Figure 10-9 The objects after the `toss` method



coin_demo5.py

Accessor and Mutator Methods

- **Typically, all of a class's data attributes are private and provide methods to access and change them**
- **Accessor methods: return a value from a class's attribute without changing it**
  - Safe way for code outside the class to retrieve the value of attributes

cellphone.py

- **Mutator methods: store or change the value of a data attribute**
- **Storing objects in a list**

cell_phone_list.py

Passing Objects as Arguments

- **Methods and functions often need to accept objects as arguments**
- **When you pass an object as an argument, you are actually passing a reference to the object**
  - The receiving method or function has access to the actual object
    - Methods of the object can be called within the receiving function or method, and data attributes may be changed using mutator methods

coin_argument.py

Techniques for Designing Classes

- **UML diagram: standard diagrams for graphically depicting object-oriented systems**
  - Stands for Unified Modeling Language
- **General layout: box divided into three sections:**
  - Top section: name of the class
  - Middle section: list of data attributes
  - Bottom section: list of class methods

Figure 10-10 General layout of a UML diagram for a class

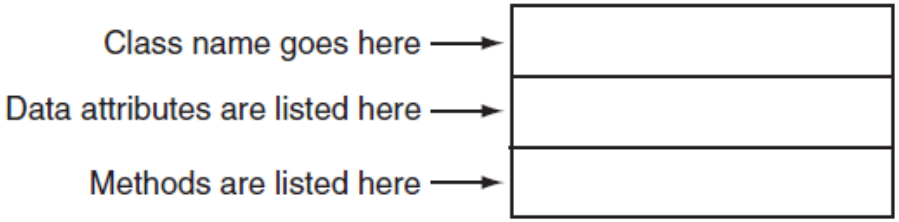
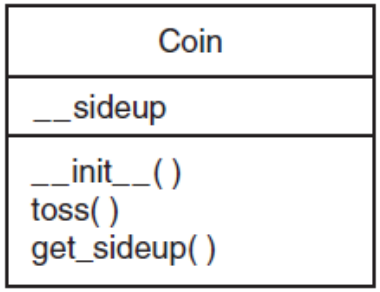


Figure 10-11 UML diagram for the `coin` class



Finding the Classes in a Problem

- **When developing object oriented program, first goal is to identify classes**
  - Typically involves identifying the real-world objects that are in the problem
  - Technique for identifying classes:
    1. Get written description of the problem domain
    2. Identify all nouns in the description, each of which is a potential class
    3. Refine the list to include only classes that are relevant to the problem

Finding the Classes in a Problem (cont'd.)

2. **Identify all nouns in the description, each of which is a potential class**
   - Should include noun phrases and pronouns
   - Some nouns may appear twice
3. **Refine the list to include only classes that are relevant to the problem**
   - Remove nouns that mean the same thing
   - Remove nouns that represent items that the program does not need to be concerned with
   - Remove nouns that represent simple values that can be assigned to a variable

Case Study: A written description of the problem

Joe's Automotive shop services foreign cars and specializes in serving cars made by Mercedes, Porsche and BMW. When a customer brings a car to the shop, the manager gets the customer's name, address and telephone number. The manager determines the make, model and year of the car and gives the customer a service quote. The service quote shows the estimated parts charges, estimated labor charges, sales tax and total estimated charges

Design it

Summary

- **This chapter covered:**
  - Procedural vs. object-oriented programming
  - Classes and instances
  - Class definitions, including:
    - The `self` parameter
    - Data attributes and methods
    - `__init__` and `__str__` functions
    - Hiding attributes from code outside a class
  - Storing classes in modules
  - Designing classes