31.1 Derived classes

A class will commonly share attributes with another class, but with some additions or variations. For example, a store inventory system might use a class called Item, having name and quantity attributes. But for fruits and vegetables, a class Produce might have name, quantity, and expiration date attributes. Note that Produce is really an Item with an additional feature, so ideally a program could define the Produce class as being the same as the Item class but with the addition of an expiration date attribute.

Such similarity among classes is supported by indicating that a class is *derived* from another class, as shown below.

Figure 31.1.1: A derived class example: Class Produce is derived from class Items.

```
class Item:
    def __init__(self):
        self.name = ''
        self.quantity = 0

    def set_name(self, nm):
        self.name = nm

    def set_quantity(self, qnty):
        self.quantity = qnty

    def display(self):
        print(self.name, self.quantity)


class Produce(Item):  # Derived from Item
    def __init__(self):
        Item.__init__(self)  # Call base class
constructor
        self.expiration = ''

    def set_expiration(self, expir):
        self.expiration = expir

    def get_expiration(self):
        return self.expiration

item1 = Item()
item1.set_name('Smith Cereal')
item1.set_quantity(9)
item1.display()

item2 = Produce()
item2.set_name('Apples')
item2.set_quantity(40)
item2.set_expiration('May 5, 2012')
item2.display()
print(f'  (Expires:({item2.get_expiration()}))')
```

```
Smith Cereal 9
Apples 40
  (Expires:(May 5,
2012))
```


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The example defines a class named Item. In the script, an instance of Item called item1 is created, the instance's attributes are set to Smith Cereal and 9, and the display() method is called. A class named Produce is also defined, that class was *derived* from the Item class by including the base class Item within parentheses after Produce, i.e., `class Produce(Item):`. As such, instantiating a Produce instance item2 creates an instance object with data attributes name and quantity (from Item), plus expiration (from Produce), as well as with the methods set_name(), set_quantity(), and

display() from Item, and set_expiration() and get_expiration() from Produce. In the script, item2 has instance data attributes set to Apples, 40, and May 5, 2012. The display() method is called, and then the expiration date is printed using the get_expiration() method.[interfaces]

All of the class attributes of Item are available to instances of Produce, though instance attributes are not. The __init__ method of Item must be explicitly called in the constructor of Produce, e.g., `Item.__init__(self)`, so that the instance of Produce is assigned the name and quantity data attributes. When an instantiation of a Produce instance occurs, Produce.__init__() executes and immediately calls Item.__init__(). The newly created Produce instance is passed as the first argument (self) to the Item constructor, which creates the name and quantity attributes in the new Item instance's namespace. Item.__init__() returns, and Produce.__init__() continues, creating the expiration attribute. The following tool illustrates:

PARTICIPATION ACTIVITY 31.1.1: Derived class explicitly calls base class' constructor.

The term ***derived class*** refers to a class that inherits the class attributes of another class, known as a ***base class***. Any class may serve as a base class; no changes to the definition of that class are required. The derived class is said to *inherit* the attributes of its base class, a concept commonly

called ***inheritance***. An instance of a derived class type has access to all the attributes of the derived class as well as the *class* attributes of the base class by default, including the base class' methods. A derived class instance can simulate inheritance of *instance* attributes as well by calling the base class constructor manually. The following animation illustrates the relationship between a derived class and a base class.

PARTICIPATION ACTIVITY 31.1.2: Derived class example: Produce derived from Item.

Animation captions:

1. Item is the base class.
2. Produce is derived so Produce inherits Item's attributes.

The inheritance relationship is commonly drawn as follows, using Unified Modeling Language (UML) notation (Wikipedia: UML).

PARTICIPATION ACTIVITY 31.1.3: UML derived class example: Produce derived from Item.

Animation content:

undefined

Animation captions:

1. A class diagram depicts a class' name, data members, and methods.
2. A solid line with a closed, unfilled arrowhead indicates a class is derived from another class.
3. The derived class only shows additional members.

In the above animation, the +, -, and # symbols refer to the access level of an attribute, i.e., whether or not that attribute can be accessed by anyone (public), only instances of that class (private), or instances derived from that class (protected), respectively. *In Python, all attributes are public.* [privacy]. Many languages, like Java, C, and C++, explicitly require setting access levels on every variable and function in a class, thus UML as a language-independent tool includes the symbols.

Various class derivation variations are possible:

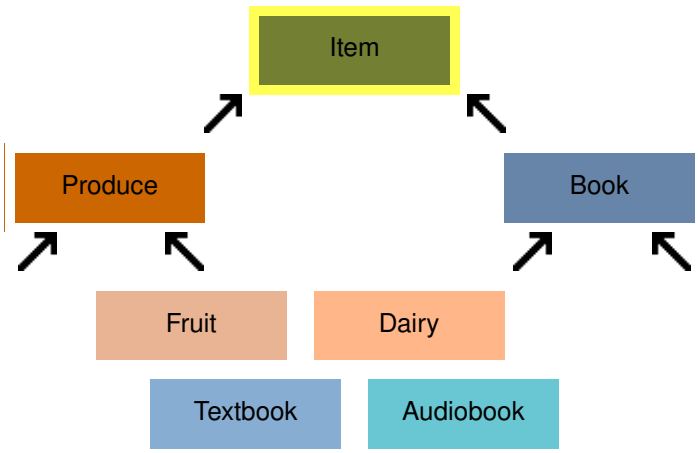
- A derived class can itself serve as a base class for another class. In the earlier example, "class Fruit(Produce):" could be added.
- A class can serve as a base class for multiple derived classes. In the earlier example, "class Book(Item):" could be added.
- A class may be derived from multiple classes. For example, "class House(Dwelling, Property):"

could be defined.

PARTICIPATION ACTIVITY 31.1.4: Interactive inheritance tree.

Click a class to see available methods and data for that class.

Inheritance tree



Selected class pseudocode


```
def set_name(self, nm):
def set_quantity(self, qnty):
def display(self):
```

```
Data attributes:
    self.name
    self.quantity
```

Selected class code

```
class Item:
    def __init__(self):
        self.name = ''
        self.quantity = 0

    def set_name(self, nm):
        self.name = nm

    def set_quantity(self, qnty):
        self.quantity = qnty

    def display(self):
        # print name, quantity
```


PARTICIPATION ACTIVITY 31.1.5: Derived classes basics.

1) A class that can serve as the basis for another class is called a _____ class.

Check Show answer

2) Class "Dwelling" has the method open_door(). Class "House" is derived from Dwelling and has the methods open_window() and open_basement(). After `h = House()` executes, how many different methods can h call, ignoring constructors?

Check Show answer

CHALLENGE ACTIVITY 31.1.1: Derived classes.

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Start

Type the program's output

```
class Vehicle:
    def __init__(self):
        self.speed = 0

    def set_speed(self, speed_to_set):
        self.speed = speed_to_set

    def print_speed(self):
```


CHALLENGE ACTIVITY 31.1.2: Basic inheritance.

Set course_student's last_name to Smith, age_years to 20, and id_num to 9999.

Sample output for the given program:

```
Name: Smith, Age: 20, ID: 9999
```

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```
1  class PersonData:
2      def __init__(self):
3          self.last_name = ''
4          self.age_years = 0
5
6      def set_name(self, user_name):
7          self.last_name  = user_name
8
9      def set_age(self, num_years):
10         self.age_years = num_years
11
12     # Other parts omitted
13
14     def print_all(self):
15         output_str = 'Name: ' + self.last_name + ', Age: ' + str(self.age_years)
16         return output_str
17
```

Run

(*interfaces) For maximal simplicity and brevity in the example, we have used a set of methods that either set or return the value of an attribute. Such an interface to a class is commonly known as a getter/setter design pattern. In Python, the getter/setter interface is better replaced with simple attribute reference operations; e.g., instead of item1.set_name('Hot Pockets'), use item1.name = 'Hot Pockets'.

(*privacy) Python does have a way to support private variables through name mangling using double underscores in front of an identifier, e.g., *self.__data*. A private variable is mostly used as a

way to prevent name collisions in inheritance trees, instead of as a form of information hiding.

31.2 Accessing base class attributes

A derived class can access the attributes of all of its base classes via normal attribute reference operations. For example, item1.set_name() might refer to the set_name method attribute of a class from which item1 is derived. An attribute reference is resolved using a search procedure that first checks the instance's namespace, then the classes' namespace, then the namespaces of any base classes.

The search for an attribute continues all the way up the ***inheritance tree***, which is the hierarchy of classes from a derived class to the final base class. Ex: Consider the following class structure in which Motorcycle is derived from MotorVehicle, which itself is derived from TransportMode.

Figure 31.2.1: Searching the inheritance tree for an attribute.

```
class TransportMode:
    def __init__(self, name, speed):
        self.name = name
        self.speed = speed

    def info(self):
        print(f'{self.name} can go
{self.speed} mph.')

class MotorVehicle(TransportMode):
    def __init__(self, name, speed, mpg):
        TransportMode.__init__(self, name,
speed)
        self.mpg = mpg
        self.fuel_gal = 0

    def add_fuel(self, amount):
        self.fuel_gal += amount

    def drive(self, distance):
        required_fuel = distance /
self.mpg
        if self.fuel_gal < required_fuel:
            print('Not enough gas.')
        else:
            self.fuel_gal -= required_fuel
            print(f'{self.fuel_gal:f}
gallons remaining.')

class MotorCycle(MotorVehicle):
    def __init__(self, name, speed, mpg):
        MotorVehicle.__init__(self, name,
speed, mpg)

    def wheelie(self):
        print('That is too dangerous.')


scooter = MotorCycle('Vespa', 55, 40)
dirtbike = MotorCycle('KX450F', 80, 25)

scooter.info()
dirtbike.info()
choice = input('Select scooter (s) or
dirtbike (d): ')
bike = scooter if (choice == 's') else
dirtbike

menu = '\nSelect add fuel(f), go(g),
wheelie(w), quit(q): '
command = input(menu)
while command != 'q':
    if command == 'f':
```



```
Vespa can go 55 mph.
KX450F can go 80 mph.
Select scooter (s) or
dirtbike (d): d

Select add fuel(f), go(g),
wheelie(w), quit(q): f
Enter amount: 3

Select add fuel(f), go(g),
wheelie(w), quit(q): g
Enter distance: 60
0.600000 gallons remaining.

Select add fuel(f), go(g),
wheelie(w), quit(q): g
Enter distance: 10
0.200000 gallons remaining.

Select add fuel(f), go(g),
wheelie(w), quit(q): g
Enter distance: 25
Not enough gas.
Select add fuel(f), go(g),
wheelie(w), quit(q): w
That is too dangerous.

Select add fuel(f), go(g),
wheelie(w), quit(q): q
```

```
    if command == 'f':
        fuel = int(input('Enter amount:
'))
        bike.add_fuel(fuel)
    elif command == 'g':
        distance = int(input('Enter
distance: '))
        bike.drive(distance)
    elif command == 'w':
        bike.wheelie()
    elif command == 'q':
        break
    else:
        print('Invalid command.')

    command = input(menu)
```


The above illustrates a program with three levels of inheritance. The scooter and dirt bike variables are instances of the Motorcycle class at the bottom of the inheritance tree. Calling the add_fuel() or drive() methods initiates a search, first in MotorCycle, and then in MotorVehicle. Calling the info() method defined at the top of the inheritance tree, as in `scooter.info()`, results in searching MotorCycle first, then MotorVehicle, and finally TransportMode.

zyDE 31.2.1: Extending the transportation modes class hierarchy.

Extend the above example with the following additional modes of transportation:

- Implement an Airplane class that is derived from TransportMode. Airplane shou the methods add_fuel(), and fly(), and a data attribute num_passengers.
- Implement a JetPlane class that is derived from Airplane. Add some methods t JetPlane of your own choosing, such as barrel_roll() or immelman().

Load default template...

```
1
2  class TransportMode:
3      def __init__(self, name, speed):
4          self.name = name
5          self.speed = speed
6
7      def info(self):
8          print(f'{self.name} can go {self.sp
9
10 class MotorVehicle(TransportMode):
11     def __init__(self, name, speed, mpg):
12         TransportMode.__init__(self, name,
13         self.mpg = mpg
14         self.fuel_gal = 0
15
16     def add_fuel(self, amount):
17         self.fuel_gal += amount
```

Pre-enter any input for program, th run.

Run

PARTICIPATION ACTIVITY 31.2.1: Searching for attributes in the inheritance tree.

1) "Inheritance tree" describes the hierarchy between base and derived classes.
   - ○ True
   - ○ False

2) Evaluating bike.wheelie() searches TransportMode, then MotorVehicle, then finally MotorCycle for the wheelie() method.
   - ○ True
   - ○ False

3) When adding a new derived class, a programmer has to change the base class as well.

- True
- False

31.3 Overriding class methods

A derived class may define a method having the same name as a method in the base class. Such a member function ***overrides*** the method of the base class. The following example shows the earlier Item/Produce example where the Produce class has its own display() method that overrides the display() method of the Item class.

Figure 31.3.1: Produce's display() function overrides Item's display() function.

```
class Item:
   def __init__(self):
       self.name = ''
       self.quantity = 0

   def set_name(self, nm):
       self.name = nm

   def set_quantity(self, qnty):
       self.quantity = qnty

   def display(self):
       print(self.name, self.quantity)


class Produce(Item):  # Derived from Item
   def __init__(self):
       Item.__init__(self)  # Call base class
constructor
       self.expiration = ''

   def set_expiration(self, expir):
       self.expiration = expir

   def get_expiration(self):
       return self.expiration

   def display(self):
       print(self.name, self.quantity, end='
')
       print(f'  (Expires:
{self.expiration})')


item1 = Item()
item1.set_name('Smith Cereal')
item1.set_quantity(9)
item1.display()  # Will call Item's display()

item2 = Produce()
item2.set_name('Apples')
item2.set_quantity(40)
item2.set_expiration('May 5, 2012')
item2.display()  # Will call Produce's
display()
```

```
Smith Cereal 9
Apples 40   (Expires: May
5, 2012)
```


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When the derived class defines the method being overwritten, that method is placed in the class's

namespace. Because attribute references search the inheritance tree by starting with the derived class and then recursively searching base classes, the method called will always be the method defined in the instance's class.

A programmer will often want to *extend*, rather than replace, the base class method. The base class method can be explicitly called at the start of the method, with the derived class then performing additional operations:

Figure 31.3.2: Method calling overridden method of base class.

```
class Produce(Item):
    # ...
    def display(self):
        Item.display(self)
        print(f'  (Expires:
{self.expiration})')
    # ...
```

Above, the display() method of Produce calls the display() method of Item, passing self as the first argument. Thus, when Item's display() executes, the name and quantity instance attributes from the Produce instance are retrieved and printed.

PARTICIPATION ACTIVITY 31.3.1: Overriding base class methods.

Assume my_item is an instance of Item, and my_produce is an instance of Produce, with classes Item and Produce defined as above.

1) Will my_item.display() call the display() function for Item or for Produce?

Check Show answer

2) Will my_produce.display() call the display() function for Item or for Produce?

Check Show answer

3) Provide a statement within the display() method of the Produce class to call the display() method of Produce's base class.

Check Show answer

4) If Produce did NOT have its own display() method defined, the display method of which class would be called in the following code? Type "ERROR" if appropriate.

```
p = Produce()
p.display()
```

Check Show answer

CHALLENGE ACTIVITY 31.3.1: Basic derived class member override.

Define a member method print_all() for class PetData. Make use of the base class' print_all() method.

Sample output for the given program with inputs: 'Fluffy' 5 4444

```
Name: Fluffy
Age: 5
ID: 4444
```


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```
1 class AnimalData:
2     def __init__(self):
3         self.full_name = ''
4         self.age_years = 0
5
```

Run

31.4 Is-a versus has-a relationships

The concept of *inheritance* is often confused with *composition*. Composition is the idea that one object may be made up of other objects. For instance, a "mother" class can be made up of objects like "name" (possibly a string object), "children" (which may be a list of Child objects), etc. Defining that "mother" class does *not* involve inheritance, but rather just composing the sub-objects in the class.

Figure 31.4.1: Composition.

The 'has-a' relationship. A Mother object 'has-a' string object and 'has' child objects, but no inheritance is involved.

```
class Child:
    def __init__(self):
        self.name = ''
        self.birthdate = ''
        self.schoolname = ''
    # ...

class Mother:
    def __init__(self):
        self.name = ''
        self.birthdate = ''
        self.spouse_name = ''
        self.children = []
    # ...
```


In contrast, a programmer may note that a mother and a child are both a kind of person, and all

persons have a name and birthdate. So the programmer may decide to better organize the program by defining a Person class, and then by creating the Mother and Child classes as derived from Person.

Figure 31.4.2: Inheritance.

The 'is-a' relationship. A Mother object 'is a' kind of Person. The Mother class thus inherits from the Person class. Likewise for the Child class.

```
class Person:
    def __init__(self):
        self.name = ''
        self.birthdate = ''
    # ...

class Child(Person):
    def __init__(self):
        Person.__init__(self)
        self.schoolname = ''
    # ...

class Mother(Person):
    def __init__(self):
        Person.__init__(self)
        self.spousename = ''
        self.children = []
    # ...
```

PARTICIPATION ACTIVITY 31.4.1: Is-a vs. has-a relationships.

Indicate whether the relationship of the everyday items is an is-a or has-a relationship. Derived classes and inheritance are related to is-a relationships, not has-a relationships.

1) Pear / Fruit

- Is-a
- Has-a

2) House / Door

- Is-a
- Has-a

3) Dog / Owner

- Is-an
- Has-an

4) Mug / Cup

- Is-a
- Has-a

31.5 Mixin classes and multiple inheritance

A class can inherit from more than one base class, a concept known as ***multiple inheritance***. The derived class inherits all of the class attributes and methods of every base class.

PARTICIPATION ACTIVITY 31.5.1: Multiple inheritance.

Animation content:

undefined

Animation captions:

1. Vampire bats are both winged animals and mammals.
2. VampireBat can access methods of WingedAnimal and Mammal.

A class can inherit from multiple base classes by specifying multiple items in the inheritance list:

Figure 31.5.1: Inheriting from multiple base classes.

```
class VampireBat(WingedAnimal, Mammal):  # Inherit from WingedAnimal,
Mammal classes
    # ...
```


A common usage of multiple inheritance is extending the functionality of a class using mixins. ***Mixins*** are classes that provide some additional behavior, by "mixin in" new methods, but are not themselves meant to be instantiated.

Figure 31.5.2: Using mixins to extend a class's functionality with new methods.

```
class DrivingMixin:
    def drive(self, distance):
        # ...

    def change_tire(self):
        # ...

    def check_oil(self):
        # ...

class FlyingMixin:
    def fly(self, distance, altitude):
        # ...

    def roll(self):
        # ...

    def eject(self):
        # ...

class TransportMode:
    def __init__(self, name, speed):
        self.name = name
        self.speed = speed

    def display(self):
        print(f'{self.name} can go {self.speed} mpg')

class SemiTruck(TransportMode, DrivingMixin):
    def __init__(self, name, speed, cargo):
        TransportMode.__init__(self, name, speed)
        self.cargo = cargo

    def go(self, distance):
        self.drive(distance)
        # ...

class FlyingCar(TransportMode, FlyingMixin,
DrivingMixin):
    def __init__(self, name, speed, max_altitude):
        TransportMode.__init__(self, name, speed)
        self.max_altitude = max_altitude

    def go(self, distance):
        self.fly(distance / 2, self.max_altitude)
        # ...
        self.drive(distance / 2)

s = SemiTruck('MacTruck', 85, 'Frozen beans')
f = FlyingCar('Jetson35K', 325, 15000)

s.go(100)
```

```
s.go(100)
f.go(100)
```

Above, the DrivingMixin and FlyingMixin classes each define a set of methods. Any class can be derived from one or both of the mixins. Note that the resolution order by which the base classes are searched for an attribute is related to the order in which classes appear in the inheritance list parenthesis. The resolution order is from left to right, so in the FlyingCar class, TransportMode is searched first, then FlyingMixin, and finally DrivingMixin. When using a mixin class, a programmer should be careful to either avoid clashing names, or carefully choose the order of classes in the inheritance list.

PARTICIPATION ACTIVITY 31.5.2: Mixin classes and multiple inheritance.

Consider the above program and class inheritance tree. Match the new class definitions with methods that would be inherited by instances of that class.

If unable to drag and drop, refresh the page.

class Camel(TransportMode):

class Motorcycle(DrivingMixin, TransportMode):

class Jet(TransportMode, FlyingMixin):

class HoverCraft(DrivingMixin, FlyingMixin, TransportMode):

---

display()

display(), fly(), roll(), eject()

display(), drive(), change_tire(), check_oil()

display(), drive(), fly(), change_tire(), roll(), eject(), check_oil()

Reset

31.6 Testing your code: The unittest module

A critical part of software development is testing that a program behaves correctly. For large projects, changing code in one file or class may create new bugs in other parts of the program that import or inherit from the changed code. Maintaining a ***test suite***, or a set of repeatable tests, that can be run after changing the source code of a program is critical.

A programmer commonly performs ***unit testing***, testing the individual components of a program, such as specific methods, class interfaces, data structures, and so on. The Python standard library ***unittest*** module implements unit testing functionality:

Figure 31.6.1: Unit testing with the unittest module.

```
import unittest

# User-defined class
class Circle:
    def __init__(self, radius):
        self.radius = radius

    def compute_area(self):
        return 3.14 *
self.radius**2


# Class to test Circle
class
TestCircle(unittest.TestCase):
    def test_compute_area(self):
        c = Circle(0)

self.assertEqual(c.compute_area(),
0.0)

        c = Circle(5)

self.assertEqual(c.compute_area(),
78.5)

    def test_will_fail(self):
        c = Circle(5)

self.assertLess(c.compute_area(),
0)

if __name__ == "__main__":
    unittest.main()
```

```
.F
======================================================
FAIL: test_will_fail (__main__.TestCircle)
------------------------------------------------------
Traceback (most recent call last):
  File "area.py", line 23, in test_will_fail
    self.assertLess(c.compute_area(), 0)
AssertionError: 78.5 not less than 0

------------------------------------------------------
Ran 2 tests in 0.000s

FAILED (failures=1)
```


The program above implements a unit test for the Circle.compute_area() method. A new class TestCircle is defined that inherits from unittest.TestCase. Methods within the TestCircle class that begin with "test_" are the unit tests to be run. A unit test performs ***assertions*** to check if a computed value meets certain requirements. Above, `self.assertEqual( c.compute_area(), 78.5 )` asserts that the result of c.compute_area() is equal to 78.5. If the assertion is not true, then an AssertionError will be raised and the current test will report as a failure. Executing the unittest.main() function begins the test process. After all tests have completed, a report is automatically printed.

Assertions for many types of relationships exist, for example assertEqual() tests equality, assertIn tests if a value is in a container, etc. The below table (from docs.python.org) lists common

assertions.

Table 31.6.1: Assertion methods.

Method	Checks that
assertEqual(a, b)	`a == b`
assertNotEqual(a,b)	`a != b`
assertTrue(x)	`bool(x) is True`
assertFalse(x)	`bool(x) is False`
assertIs(a, b)	`a is b`
assertIsNot(a,b)	`a is not b`
assertIsNone(x)	`x is None`
assertIsNotNone(x)	`x is not None`
assertIn(a, b)	`a in b`
assertNotIn(a, b)	`a not in b`
assertAlmostEqual(a, b)	round(a - b, 7) == 0
assertGreater(a, b)	a > b
assertGreaterEqual(a, b)	a >= b
assertLess(a, b)	a < b
assertLessEqual(a, b)	a <= b

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zyDE 31.6.1: Writing unit tests.

Complete the unit tests for testing the evens() and odds() methods. Each unit test sh either odds() or evens(), passing in a known array of values, and then testing the resu ensure only the correct values are in the array.

Load default template... Run


```
1
2  import unittest
3
4  def evens(numbers):
5      """Return the even values in numbers"""
6      return [i for i in numbers if (i % 2 ==
7
8  def odds(numbers):
9      """Return the odd values in numbers"""
10     return [i for i in numbers if (i % 2 ==
11
12
13 class TestNumbers(unittest.TestCase):
14     test_nums = [1, 3, 5, 6, 8, 2, 1]
15
16     def test_evens(self):
17         # Fill in the unit test.
```

PARTICIPATION ACTIVITY 31.6.1: Unit testing.

1) What is the Python standard library module that allows the definition of unit tests?

Check Show answer

2) Write an assertion that checks if c.valid is True.

```
def test_a(self):
    c = Widget()
    self.
```

Check Show answer

3) Write an assertion that checks if c.sprockets is less than 5.

```
def test_b(self):
    c = Widget()
    self.
```


Check Show answer

31.7 LAB: Pet information (derived classes)

The base class `Pet` has attributes name and age. The derived class `Dog` inherits attributes from the base class `Pet` class and includes a breed attribute. Complete the program to:

- Create a generic pet, and print the pet's information using print_info().
- Create a `Dog` pet, use print_info() to print the dog's information, and add a statement to print the dog's breed attribute.

Ex: If the input is:

```
Dobby
2
Kreacher
3
German Schnauzer
```

the output is:

```
Pet Information:
   Name: Dobby
   Age: 2
Pet Information:
   Name: Kreacher
   Age: 3
   Breed: German Schnauzer
```


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LAB ACTIVITY | 31.7.1: LAB: Pet information (derived classes) 0 / 10

main.py Load default template...

```
class Pet:
    def __init__(self):
        self.name = ''
        self.age = 0

    def print_info(self):
        print('Pet Information:')
        print('   Name:', self.name)
        print('   Age:', self.age)

class Dog(Pet):
    def __init__(self):
        Pet.__init__(self)
        self.breed = ''

my_pet = Pet()
my_dog = Dog()
```


Develop mode | **Submit mode**

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program

Input (from above) → **main.py** (Your program) → O

Program output displayed here

Coding trail of your work What is this?

History of your effort will appear here once you begin working on this zyLab.

31.8 LAB: Instrument information (derived

classes)

Given the base class `Instrument`, define a derived class `StringInstrument` for string instruments.

Ex: If the input is:


```
Drums
Zildjian
2015
2500
Guitar
Gibson
2002
1200
6
19
```

the output is:

```
Instrument Information:
   Name: Drums
   Manufacturer: Zildjian
   Year built: 2015
   Cost: 2500
Instrument Information:
   Name: Guitar
   Manufacturer: Gibson
   Year built: 2002
   Cost: 1200
   Number of strings: 6
   Number of frets: 19
```

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LAB ACTIVITY 31.8.1: LAB: Instrument information (derived classes) 0 / 10

main.py Load default template...

```
1 class Instrument:
2     def __init__(self, name, manufacturer, year_built, cost):
3         self.name = name
4         self.manufacturer = manufacturer
```

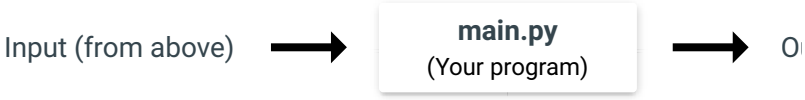
Develop mode | Submit mode

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program



Program output displayed here

Coding trail of your work What is this?

```
History of your effort will appear here once you begin
working on this zyLab.
```


31.9 LAB: Course information (derived classes)

Define a `Course` base class with attributes number and title. Define a print_info() method that displays the course number and title.

Also define a derived class `OfferedCourse` with the additional attributes instructor_name, term, and class_time.

Ex: If the input is:

```
ECE287
Digital Systems Design
ECE387
Embedded Systems Design
Mark Patterson
Fall 2018
WF: 2-3:30 pm
```


the output is:

```
Course Information:
   Course Number: ECE287
   Course Title: Digital Systems Design
Course Information:
   Course Number: ECE387
   Course Title: Embedded Systems Design
   Instructor Name: Mark Patterson
   Term: Fall 2018
   Class Time: WF: 2-3:30 pm
```

Note: Indentations use 3 spaces.

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LAB ACTIVITY | 31.9.1: LAB: Course information (derived classes) | 0 / 10

main.py — Load default template...

```
1  class Course:
2      # TODO: Define constructor with attributes: number, title
3
4      # TODO: Define print_info()
5
6
7  class OfferedCourse(Course):
8      # TODO: Define constructor with attributes:
9      #       number, title, instructor_name, term, class_time
10
11
12 if __name__ == "__main__":
13     course_number = input()
14     course_title = input()
15
16     o_course_number =  input()
17     o_course_title =  input()
```

Develop mode | Submit mode

Run your program as often as you'd like, before submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program

Input (from above) → main.py (Your program) → O

Program output displayed here

Coding trail of your work What is this?

```
History of your effort will appear here once you begin
working on this zyLab.
```

31.10 LAB: Book information (overriding member methods)

Given the base class `Book`, define a derived class called `Encyclopedia`. Within the derived `Encyclopedia` class, define a print_info() method that overrides the `Book` class' print_info() method by printing not only the title, author, publisher, and publication date, but also the edition and number of volumes.

Ex: If the input is:


```
The Hobbit
J. R. R. Tolkien
George Allen & Unwin
21 September 1937
The Illustrated Encyclopedia of the Universe
James W. Guthrie
Watson-Guptill
```

```
2001
2nd
1
```

the output is:

```
Book Information:
   Book Title: The Hobbit
   Author: J. R. R. Tolkien
   Publisher: George Allen & Unwin
   Publication Date: 21 September 1937
Book Information:
   Book Title: The Illustrated Encyclopedia of the Universe
   Author: James W. Guthrie
   Publisher: Watson-Guptill
   Publication Date: 2001
   Edition: 2nd
   Number of Volumes: 1
```


Note: Indentations use 3 spaces.

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LAB ACTIVITY 31.10.1: LAB: Book information (overriding member methods) 0 / 10

main.py Load default template...

```
1  class Book:
2      def __init__(self, title, author, publisher, publication_date):
3          self.title = title
4          self.author = author
5          self.publisher = publisher
6          self.publication_date = publication_date
7
8      def print_info(self):
9          print('Book Information:')
10         print('   Book Title:', self.title)
11         print('   Author:', self.author)
12         print('   Publisher:', self.publisher)
13         print('   Publication Date:', self.publication_date)
14
15
16 class Encyclopedia(Book):
17     # TODO: Define constructor with attributes:
```


Develop mode **Submit mode** Run your program as often as you'd like, before

submitting for grading. Below, type any needed input values in the first box, then click **Run program** and observe the program's output in the second box.

Enter program input (optional)

If your code requires input values, provide them here.

Run program Input (from above) → **main.py** (Your program) → O

Program output displayed here

Coding trail of your work What is this?

```
History of your effort will appear here once you begin
working on this zyLab.
```

31.11 LAB: Plant information

This section's content is not available for print.