

Computational Structures in Data Science

Object-Oriented Programming: Part 2, Inheritance

Berkeley
UNIVERSITY OF CALIFORNIA

Announcements

- **Midterm Thursday!**
 - Seating announcements sent out.
 - <https://go.c88c.org/seating> to login in and see your seat.
- Reminders: 5 hand-written pages.
- **Please write names and hand them in with your exam.**

Computational Structures in Data Science

Reviewing Our Account



Example: Suggested “private” attributes

```
class BaseAccount:

    def __init__(self, name, initial_deposit):
        self._name = name
        self._balance = initial_deposit

    def name(self):
        return self._name

    def balance(self):
        return self._balance

    def withdraw(self, amount):
        self._balance -= amount
        return self._balance
```

Python's Instance Attributes

- `self.attribute_name = x`
 - Sets up an attribute which can be modified by anyone
- `self._attribute_name = x`
 - Sets up an attribute which is suggested that is "internal only"
 - e.g. `my_instance._attribute_name = y` will work, but should *look* wrong.
 - Internally, `self._attribute_name = y` is OK.
- `self.__attribute_name = x`
 - Sets up an attribute which is *private*
 - e.g. `my_instance.__attribute_name = y` will *error!*
 - Internally, `self.__attribute_name = y` is OK.

Computational Structures in Data Science

Object-Oriented Programming: Part 2, Inheritance

Berkeley
UNIVERSITY OF CALIFORNIA

Class Attributes: Keeping Track of Our Instances?

- **Problem:**

- We can make many accounts... they all live in memory.
- But how do we know what all of our accounts are?
- How could we create an account number which is always increasing?

- **Solution:**

- A *class* in Python can manage data shared across all instances
- We call these *class attributes* which are distinguished from *instance attributes*

Classes Can Have Attributes Too!

- Class attributes (as opposed to *instance* attributes) belong to the class itself, instead of each object
 - This means there is one value which is shared for all of the class's objects
- Be Careful!
 - It's easy to overdo class attributes
- Methods that rely only on class attributes are called *class methods*
 - Python has some special features we won't use, but are useful
 - [Declaring a method as belonging to a class, not an instance.](#)

Example: class attribute

```
class BaseAccount:
    account_number_seed = 1000

    def __init__(self, name, initial_deposit):
        self._name = name
        self._balance = initial_deposit
        self._acct_no = BaseAccount.account_number_seed
        BaseAccount.account_number_seed += 1

    def name(self):
        return self._name

    def balance(self):
        return self._balance

    def withdraw(self, amount):
        self._balance -= amount
        return self._balance
```

More class attributes

```
class BaseAccount:
    account_number_seed = 1000
    accounts = []
    def __init__(self, name, initial_deposit):
        self._name = name
        self._balance = initial_deposit
        self._acct_no = BaseAccount.account_number_seed
        BaseAccount.account_number_seed += 1
        BaseAccount.accounts.append(self)

    def name(self):
        ...

    def show_accounts():
        for account in BaseAccount.accounts:
            print(account.name(),
                  account.account_no(), account.balance())
```

Are There Better Approaches?

- **BEWARE!** Class attributes are useful but can get confusing.
- Perhaps what we want is a **Bank()** class
 - The bank would have a `create_account()` method
 - Each `Bank()` would have its own accounts list, as a set of instance variables.

```
class Bank():
    def __init__(self):
        self.account_no_seed = 1000
        self.accounts = []
    def create_account(self, name, balance):
        acct = BaseAccount(name, balance, self.account_no_seed)
        self.accounts.append(acct)
        self.account_no_seed += 1
```

Computational Structures in Data Science

Object-Oriented Programming: "Magic" Methods

Berkeley
UNIVERSITY OF CALIFORNIA

Learning Objectives

- Python's Special Methods define built-in properties
 - `__init__` # Called when making a new instance
 - `__sub__` # Maps to the `-` operator
 - `__str__` # Called when we call `print()`
 - `__repr__` # Called in the interpreter

Special Initialization Method

`__init__` is called automatically when we write:

```
my_account = BaseAccount('me', 0)
```

```
class BaseAccount:
```

```
    def __init__(self, name, initial_deposit):  
        self.name = name  
        self.balance = initial_deposit
```

```
    def account_name(self):  
        return self.name
```

```
    def account_balance(self):  
        return self.balance
```

```
    def withdraw(self, amount):  
        self.balance -= amount  
        return self.balance
```

return None



More special methods

```
class BaseAccount:
    ... (init, etc removed)
    def deposit(self, amount):
        self._balance += amount
        return self._balance

    def __repr__(self):
        return '< ' + str(self._acct_no) +
            '[' + str(self._name) + ']' >'
        Goal: unambiguous

    def __str__(self):
        return 'Account: ' + str(self._acct_no) +
            '[' + str(self._name) + ']'
        Goal: readable

    def show_accounts():
        for account in BaseAccount.accounts:
            print(account)
```

More Magic Methods

- We will **not** go through an exhaustive list!
- Magic Methods start and end with "double underscores" `__`
- They map to built-in functionality in Python. Many are logical names:
 - `__init__` → Class Constructor
 - `__add__` → + operator
 - `__sub__` → - operator
 - `__getitem__` → [] operator
 - `__repr__` and `__str__` → control output
- A longer list for the curious:
 - <https://docs.python.org/3/reference/datamodel.html>

Live Demo

Computational Structures in Data Science

Object-Oriented Programming: Inheritance

Berkeley
UNIVERSITY OF CALIFORNIA

Learning Objectives

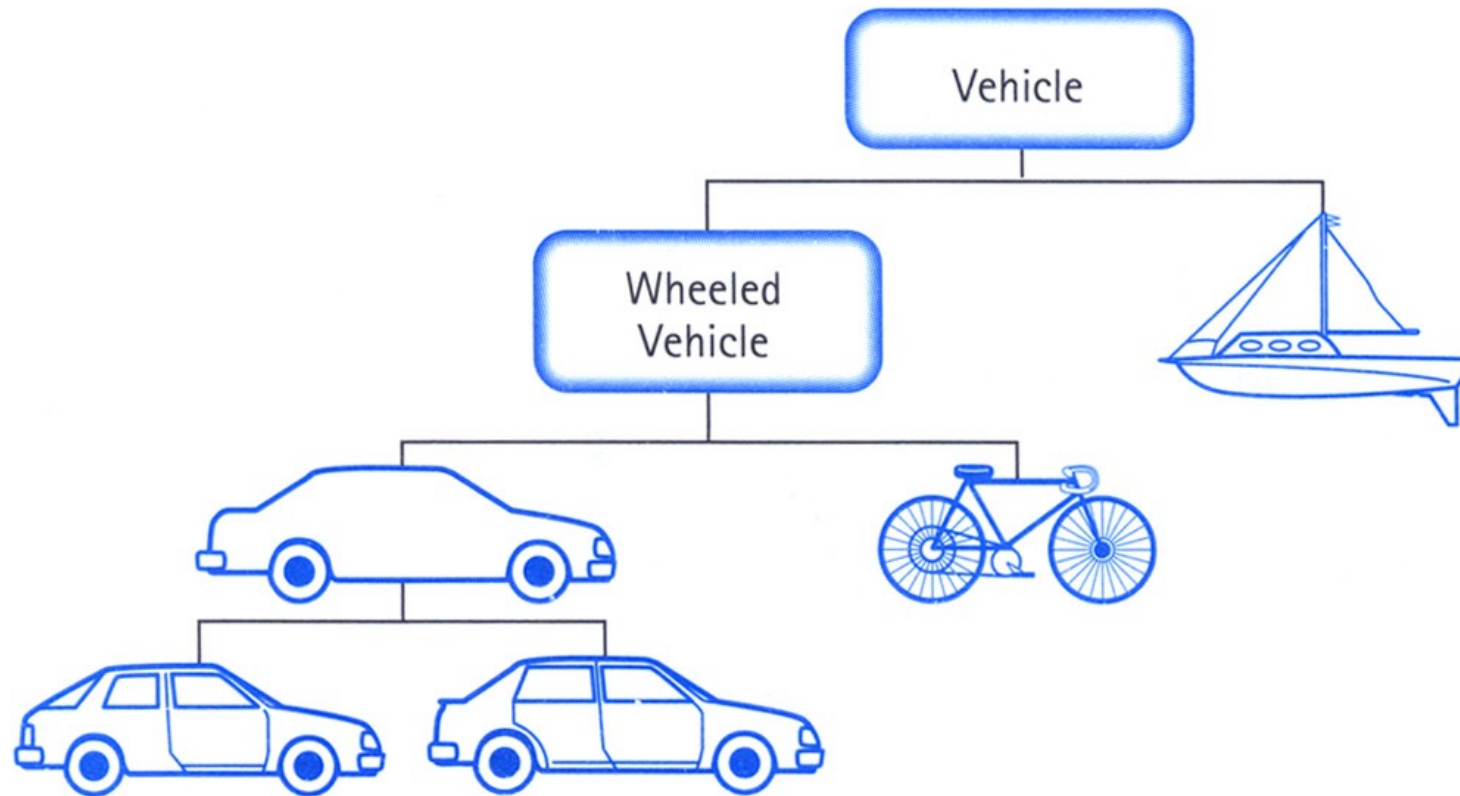
- Inheritance allows classes to reuse methods and attributes from a parent class.
- `super()` is a new method in Python
- Subclasses or child classes are distinct from one another, but share properties of the parent.

Inheritance

- Define a class as a specialization of an existing class
- Inherent its attributes, methods (behaviors)
- Add additional ones
- Redefine (specialize) existing ones
 - Ones in superclass still accessible in its namespace

Class Inheritance

- Classes can inherit methods and attributes from parent classes but extend into their own class.



Python class statement

```
class ClassName:  
    <statement-1>  
    .  
    .  
    .  
    <statement-N>
```

```
class ClassName ( inherits / parent-class ):  
    <statement-1>  
    .  
    .  
    .  
    <statement-N>
```

Example

```
class BaseAccount:
    def __init__(self, name, initial_deposit):
        # Initialize the instance attributes
        self._name = name
        self._acct_no = Account._account_number_seed
        Account._account_number_seed += 1
        self._balance = initial_deposit

class CheckingAccount(BaseAccount):
    def __init__(self, name, initial_deposit):
        # Use superclass initializer
        BaseAccount.__init__(self, name, initial_deposit)
        # Alternatively:
        # super().__init__(name, initial_deposit)
        # Additional initialization
        self._type = "Checking"
```

Accessing the Parent Class

- `super()` *binds* methods in the parent or "superclass" to the current instance
 - Can be called anywhere in our class
 - Handles passing `self` to the method
 - Handles looking up an attribute on a parent class, too.
- We can directly call `ParentClass.method(self, ...)`
 - This is not quite as flexible if our class structure changes.
- In general, prefer using `super()`!
- Outside of C88C, things can get complex...
 - <https://docs.python.org/3/library/functions.html#super>

Computational Structures in Data Science

Object-Oriented Programming: Evolving The Bank Model

Berkeley
UNIVERSITY OF CALIFORNIA

Composing Classes Together

- Currently, our **BaseAccount** stores a lot of data in class attributes...
- This suggests we are trying to accomplish an entirely new kind of class, or object
 - A Bank!
- We should extract that these functions into their own class
- A bank can now manage:
 - making accounts
 - keeping track of account numbers
 - showing and listing accounts

Live Demo