UC Berkeley
EECS
Lecturer
Michael Ball

15: Mutable Functions & Object-Oriented Programming

Announcements

- Midterm Tues Oct 26, 7-9pm
- Reference Sheet linked on the website, will be making some updates to this soon.
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Mutable Functions

Learning Objectives

- A function has its own environment
- Inner functions can access data in the parent environment
- Use an inner function along with a mutable data type to capture changes

Functions with Changing State

- Goal: Use a function to repeatedly withdraw from a bank account that starts with $100.

- First call to the function:

```
withdraw(25)        # 75
```

- Second call to the function:

```
withdraw(25)        # 50
```

- Third call to the function:

```
withdraw(60)        # 'Insufficient funds'
```

Implementing Bank Accounts

- A mutable value in the parent frame can maintain the local state for a function.

```
def make_withdraw_account(initial):
    balance = [initial]

    def withdraw(amount):
        if balance[0] - amount < 0:
            return 'Insufficient funds'
        balance[0] -= amount
        return balance[0]
    return withdraw
```

View in PythonTutor

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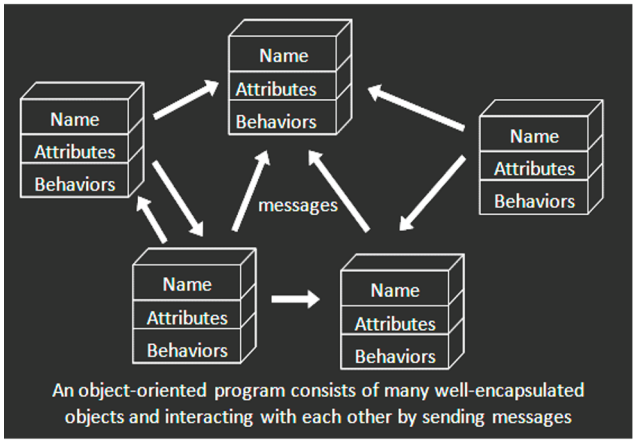
Object-Oriented Programming

Learning Objectives

- Learn how to make a class in Python
  - Class keyword
  - __init__ method
  - self

Object-Oriented Programming (OOP)

- **Objects as data structures**
  - **With methods you ask of them**
    - **»These are the behaviors**
  - **With local state, to remember**
    - **»These are the attributes**
- **Classes & Instances**
  - **Instance an example of class**
  - **E.g., Fluffy is instance of Dog**
- **Inheritance saves code**
  - **Hierarchical classes**
  - **E.g., pianist special case of musician, a special case of performer**
- **Examples (though not pure)**
  - **Java, C++**

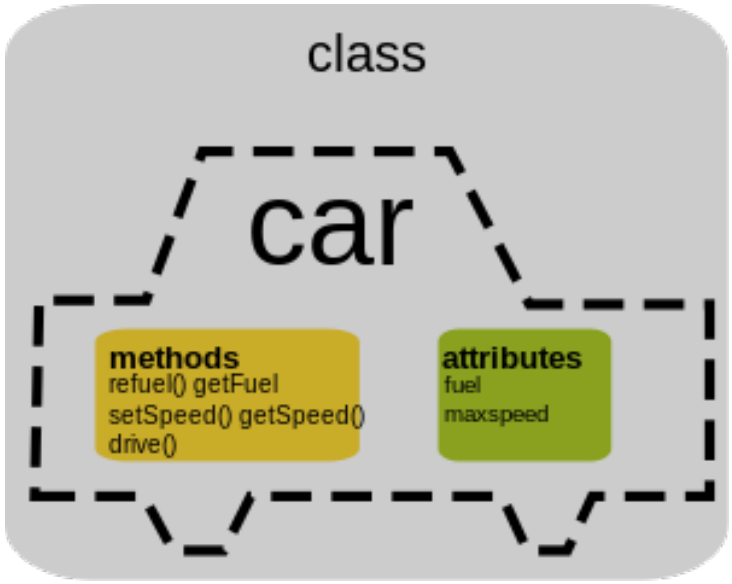


www3.ntu.edu.sg/home/ehchua/programming/java/images/OOP-Objects.gif

Classes

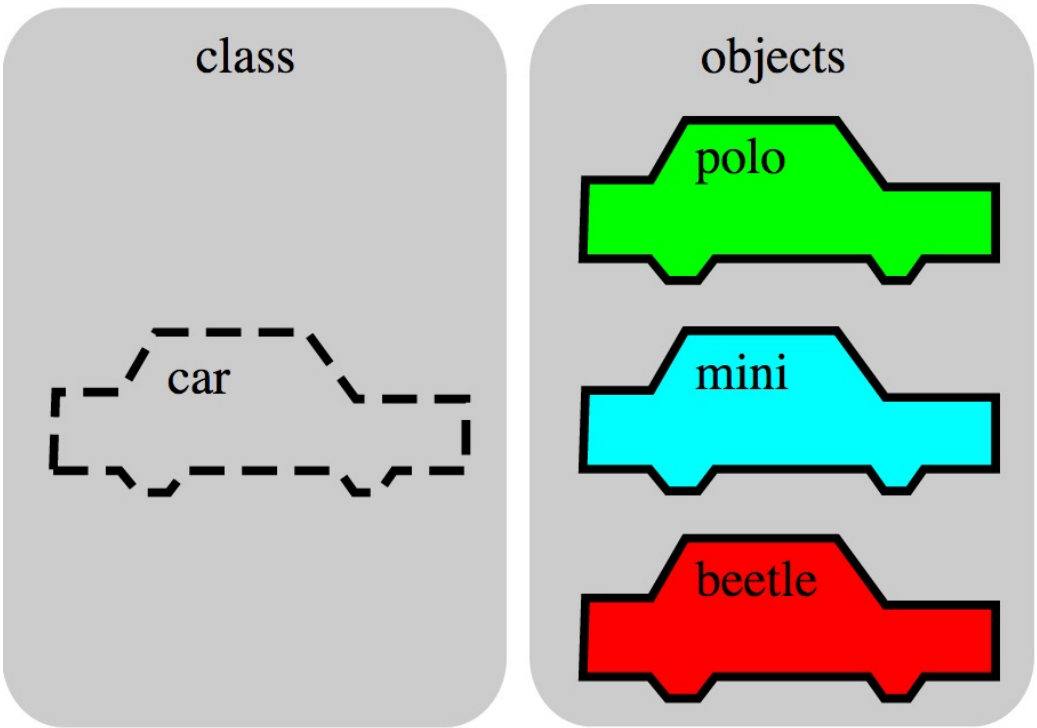
- Consist of data and behavior, bundled together to create abstractions
  - –Abstract Data Types
- A class has
  - –attributes (variables)
  - –methods (functions)

  that define its behavior.



Objects

- An object is the instance of a class.



Objects

- Objects are concrete instances of classes in memory.

- They can have state
  - mutable vs immutable (lists vs tuples)

- Functions do one thing (well)
  - Objects do a collection of related things

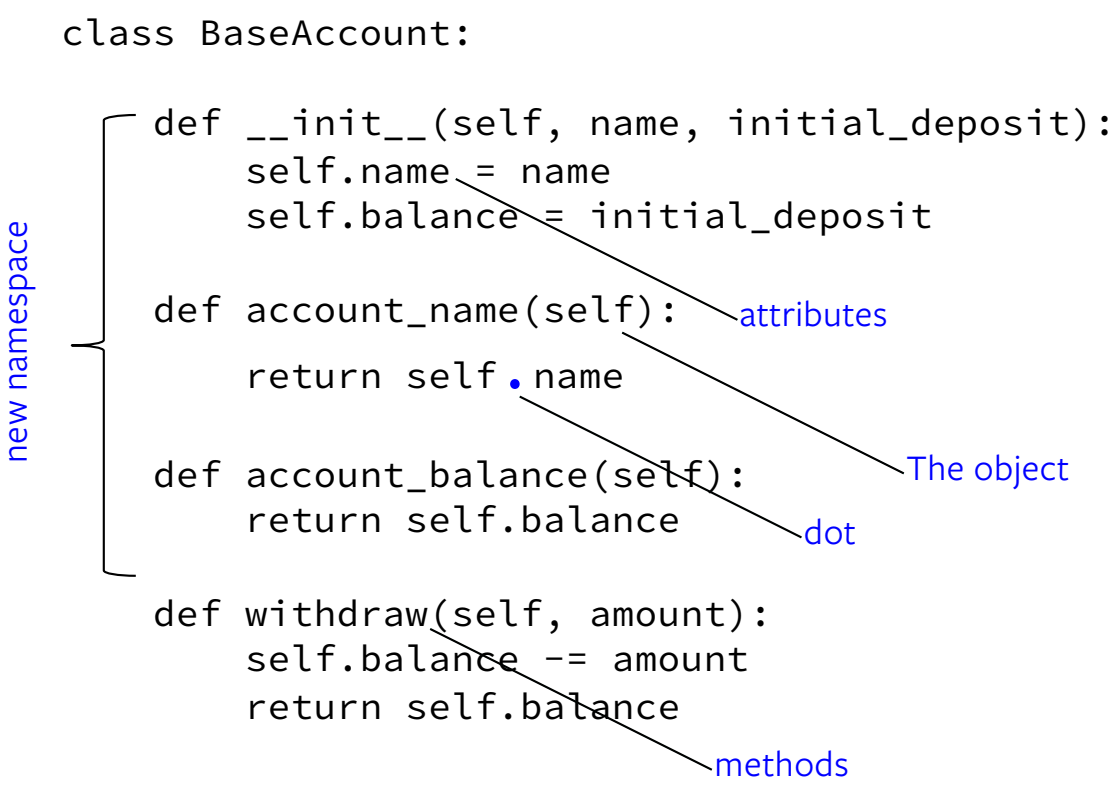
- In Python, everything is an object
  - All objects have attributes
  - Manipulation happens through methods

Python class statement

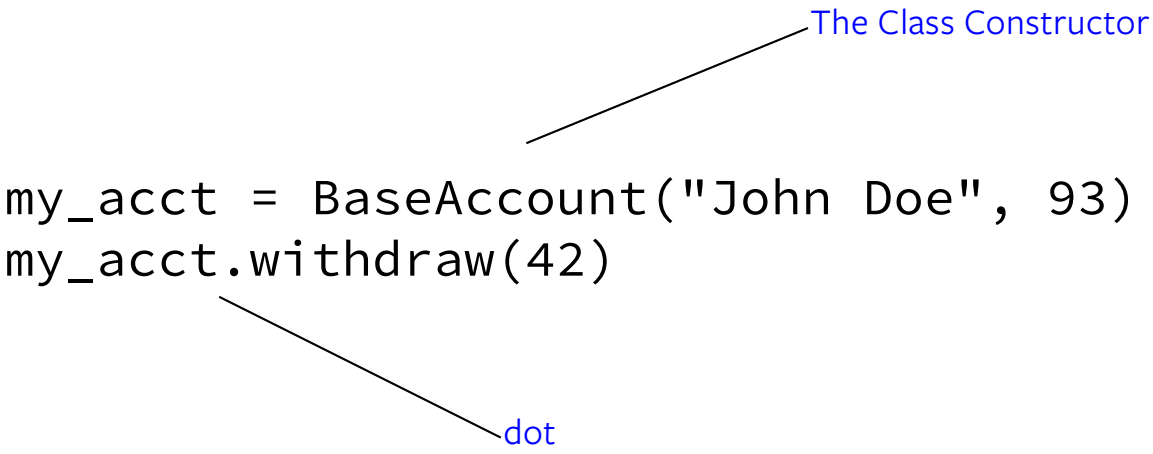
```
class ClassName:
    <statement-1>
    .
    .
    .
    <statement-N>


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

Example: Account



Creating an object, invoking a method



Special Initialization Method

```
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 on Attributes

- Attributes of an object accessible with 'dot' notation

```
obj.attr
```

- You can distinguish between "public" and "private" data.
  - Used to clarify to programmers how you class should be used.
  - In Python an _ prefix means "this thing is private"
  - `_foo` and `__foo` do different things inside a class.
  - More for the curious.
- Class variables vs Instance variables:
  - Class variable set for all instances at once
  - Instance variables per instance value

Example

```
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
```

Example: “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
```

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())
```