Object-Oriented Programming

olsen software

Contents

Demo folder: 06-OOP

1. Essential Concepts

- What is a class?
- What is an object?
- Class diagrams

What is a Class?

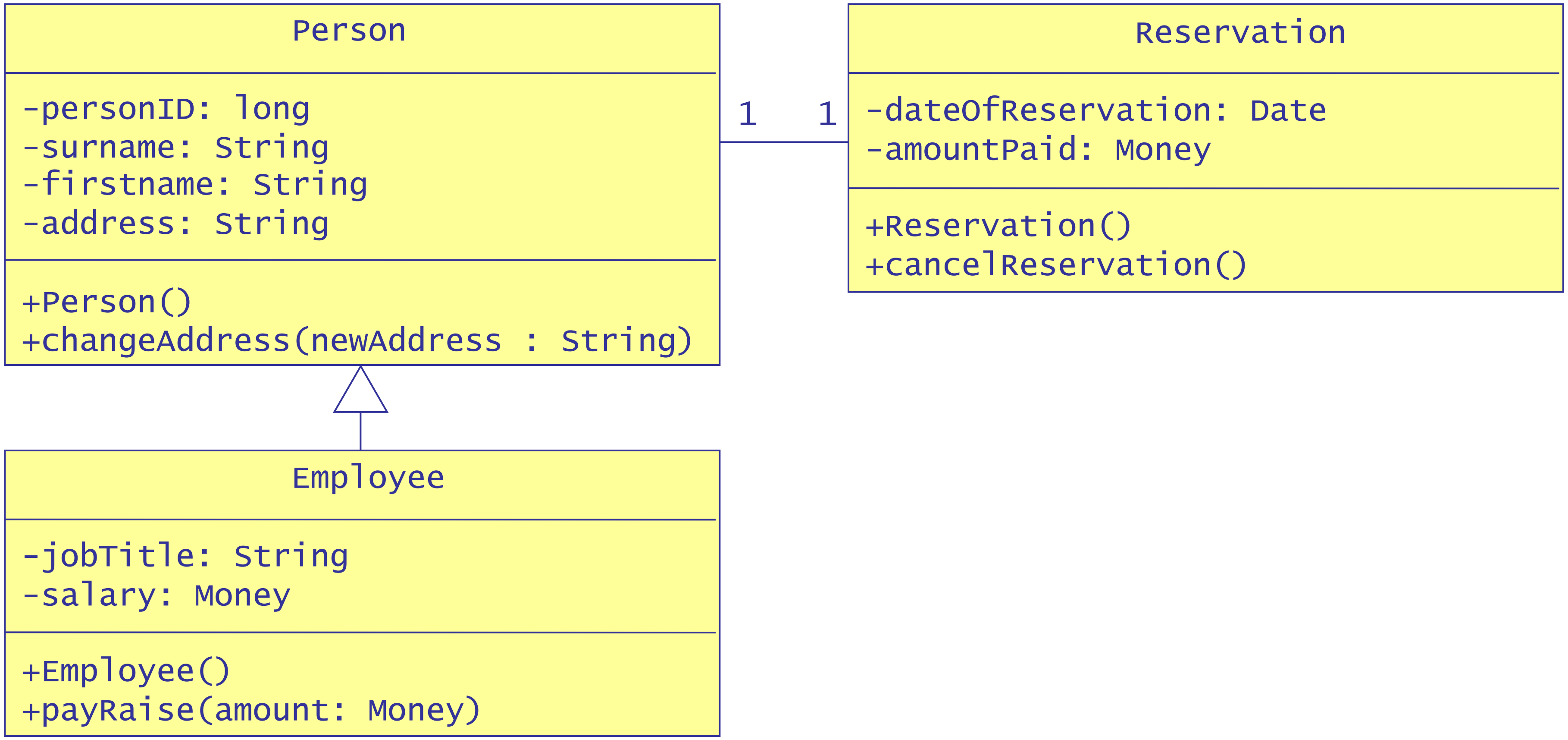
- A class is a representation of a real-world entity
  - Defines data, plus methods to work on that data
  - You can hide data from external code, to enforce encapsulation
- Domain classes
  - Specific to your business domain
  - E.g. `BankAccount`, `Customer`, `Patient`, `MedicalRecord`
- Infrastructure classes
  - Implement technical infrastructure layer
  - E.g. `NetworkConnection`, `AccountsDataAccess`, `IPAddress`
- Error classes
  - Represent known types of error
  - E.g. `Error`, `BankError`, `CustomerError`
- Etc.

What is an Object?

- An object is an instance of a class
  - Created (or "instantiated") by client code
  - Each object is uniquely referenced by its memory address (no need for primary keys, as in a database)
- Object management
  - Objects are allocated on the garbage-collected heap
  - An object remains allocated until the last remaining object reference disappears
  - At this point, the object is available for garbage collection
  - The garbage collector will reclaim its memory sometime thereafter

Class Diagrams

- During OO analysis and design, you map the real world into candidate classes in your application



2. Defining and Using a Class

- General syntax for class declarations
- Creating objects
- Defining and calling methods
- Defining instance variables
- Initialization methods
- Making an object's attributes private
- Implementing method behaviour

General Syntax for Class Declarations

- General syntax for declaring a class:

```
class ClassName :
  #
  # Define attributes (data and methods) here.
  #
```

- Example:

```
class BankAccount :
  #
  # Define BankAccount attributes (data and methods) here.
  #
```

accounting.py

Creating Objects

- To create an instance (object) of the class:
  - Use the name of the class, followed by parentheses
  - Pass initialization parameters if necessary (see later)
  - You get back an object reference, which points to the object in memory

```
objectRef = ClassType(initializationParams)
```

- Example

```
from accounting import BankAccount

acc1 = BankAccount()
acc2 = BankAccount()                                    clientcode.py
```

Defining and Calling Methods

- You can define methods in a class
  - i.e. functions that operate on an instance of a class

- In Python, methods must receive an extra first parameter
  - Conventionally named `self`
  - Allows the method to access attributes in the target object

```
class BankAccount :
  def deposit(self, amount):
    print("TODO: implement deposit() code")

  def withdraw(self, amount):
    print("TODO: implement withdraw() code")
```

accounting.py

- Client code can call methods on an object

```
acc1 = BankAccount()
acc1.deposit(200)
acc1.withdraw(50)
```

clientcode.py

Initialization Methods (1 of 2)

- You can implement a special method named `__init__()`
  - Called automatically by Python, whenever a new object is created
  - The ideal place for you to initialize the new object!
  - Similar to constructors in other OO languages

- Typical approach:
  - Define an `__init__()` method, with parameters if needed
  - Inside the method, set attribute values on the target object
  - Perform any additional initialization tasks, if needed

- Client code:
  - Pass in initialization values when you create an object

Initialization Methods (2 of 2)

- Here's an example of how to implement `__init__()`

```
class BankAccount:

    def __init__(self, accountHolder="Anonymous"):
        self.accountHolder = accountHolder
        self.balance = 0.0

    …                                                        accounting.py
```

- This is how client code creates objects now

```
acc1 = BankAccount("Fred")
acc2 = BankAccount("Wilma")                                  clientcode.py
```

Making an Object's Attributes Private

- One of the goals of OO is encapsulation
  - Keep things as private as possible
- However, attributes in Python are public by default
  - Client code can access the attributes freely!

```
acc1 = BankAccount("Fred")
print("acc1 account holder is %s" % acc1.accountHolder)          clientcode.py
```

- To make an object's attributes private:
  - Prefix the attribute name with two underscores, __

```
class BankAccount:

    def __init__(self, accountHolder="Anonymous"):
        self.accountHolder = accountHolder
        self.__balance = 0.0

    …                                                            accounting.py
```

Implementing Method Behaviour

- Here's a more complete implementation of our class

```
class BankAccount:
    """Simple BankAccount class"""

    def __init__(self, accountHolder="Anonymous"):
        self.accountHolder = accountHolder
        self.__balance = 0.0

    def deposit(self, amount):
        self.__balance += amount
        return self.__balance

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

    def toString(self):
        return "{0}, {1}".format(self.accountHolder, self.__balance)
```

accounting.py

3. Class-Wide Members

- Class-wide variables
- Class-wide methods
- @classmethod and @staticmethod

Class-Wide Variables (1 of 2)

- Class-wide variables belong to the class as a whole
  - Allocated once, before usage of first object
  - Remain allocated regardless of number of objects

- To define a class-wide variable:
  - Define the variable at global level in the class

```
class BankAccount:
    __nextId = 1
    __OVERDRAFT_LIMIT = -1000
    …
```

- To access the class-wide variable in methods:
  - Prefix with the class name

```
def __init__(self, accountHolder="Anonymous"):
    self.accountHolder = accountHolder
    self.__balance = 0.0
    self.id = BankAccount.__nextId
    BankAccount.__nextId += 1
```

Class-Wide Variables (2 of 2)

- Here's an example that puts it all together

```
class BankAccount:

    __nextId = 1
    __OVERDRAFT_LIMIT = -1000


    def __init__(self, accountHolder="Anonymous"):
        self.accountHolder = accountHolder
        self.__balance = 0.0
        self.id = BankAccount.__nextId
        BankAccount.__nextId += 1


     def withdraw(self, amount):
        newBalance = self.__balance - amount
        if newBalance < BankAccount.__OVERDRAFT_LIMIT:
            print("Insufficient funds to withdraw %f" % amount)
        else:
            self.__balance = newBalance
        return self.__balance

    …
```

accounting.py

Class-Wide Methods

- Typical uses for class-wide methods:
  - Get/set class-wide variables
  - Factory methods, responsible for creating instances
  - Instance management, keeping track of all instances

- Example:

```
class BankAccount:

    __nextId = 1
    __OVERDRAFT_LIMIT = -1000
    …

    def getOverdraftLimit():
        return BankAccount.__OVERDRAFT_LIMIT
```

accounting.py

- Client code:

```
print("Overdraft limit for all accounts is %d" % BankAccount.getOverdraftLimit())
```

clientcode.py

@classmethod and @staticmethod

- The `@classmethod` and `@staticmethod` decorators can be applied to class-wide methods

- Example

classmethod_staticmethod.py

```
class BankAccount:

    __OVERDRAFT_LIMIT = -1000
    …

    @classmethod
    def getOverdraftLimit(cls):
        return cls.__OVERDRAFT_LIMIT

    @staticmethod
    def getBanner():
        return "\nThis is the BankAccount Banner"
```

Invoking via the class

```
print(BankAccount.getBanner())
print(BankAccount.getOverdraftLimit())
```

Invoking via an instance

```
acc1 = BankAccount("Luke")
print(acc1.getBanner())
print(acc1.getOverdraftLimit())
```

Any Questions?

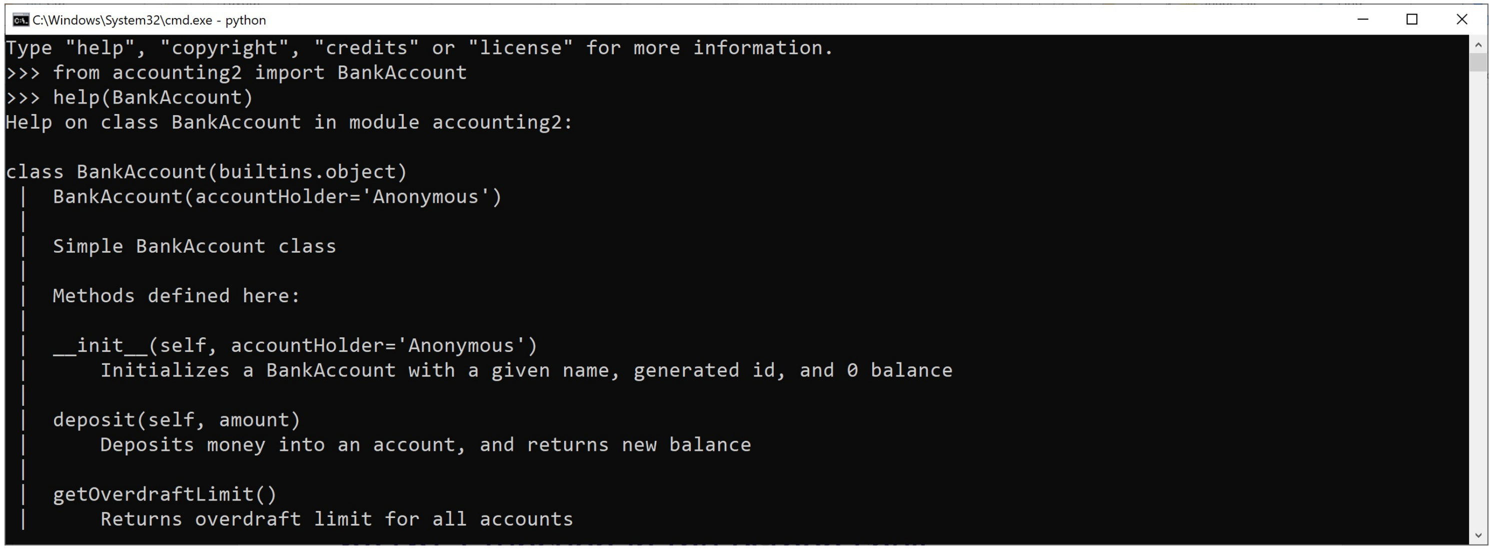
Annex: Additional Techniques

- Help documentation
- Copying object state
- Reading/writing objects to a file

Help Documentation

- You can provide "help" documentation at the start of the class and the start of each method
  - Define a help string `"""like this"""`
  - For an example, see `accounting2.py`

- You can then get help for the class or methods via the `help()` function in the Python shell



C:\Windows\System32\cmd.exe - python

```
Type "help", "copyright", "credits" or "license" for more information.
>>> from accounting2 import BankAccount
>>> help(BankAccount)
Help on class BankAccount in module accounting2:

class BankAccount(builtins.object)
 |  BankAccount(accountHolder='Anonymous')
 |
 |  Simple BankAccount class
 |
 |  Methods defined here:
 |
 |  __init__(self, accountHolder='Anonymous')
 |      Initializes a BankAccount with a given name, generated id, and 0 balance
 |
 |  deposit(self, amount)
 |      Deposits money into an account, and returns new balance
 |
 |  getOverdraftLimit()
 |      Returns overdraft limit for all accounts
```

Copying Object State

- When you assign one object reference to another:
  - It just copies the object reference
  - So both references refer to the same actual object
- If you want to create a copy of an object:
  - Call the `copy()` function, defined in the `copy` module
- Example:
  - See `demoCopying.py`

Reading/Writing Objects to a File

- A common requirement is to read/write objects to a file
- There are various ways to do this in Python:
  - As JSON (see Chapter 5)
  - As XML (see the Chapter 8)
  - As CSV (e.g. using Pandas, see Chapter 10)
- You can also write your own custom code
  - See `accounting3.py`, `clientcodeReadWriteObjects.py`