Reusing Code: Modules & Object-Oriented Programming

L435/L555

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Functions were our first step in reusing code. We’ll look at:

- Modules: packaging functions into libraries
- Classes: packaging new data types
We’ve already seen modules, such as `math`, `fileinput`, `sys`, `random`, & `nltk`.

Different ways to import:

1. `import math ... and then use, e.g., math.log(...)`
2. `from math import log ... and then use log(...)`
3. `from math import *` to import all functions
Making a module

Put a variety of function definitions into a program, e.g., contents of `nov10.py`:

```python
def hello(name, greeting='howdy '):
    return str(greeting) + ',', ' ' + str(name) + '!
```

In a separate program (`example.py`):

```python
import nov10
s = nov10.hello('benny', 'hejsan')
print(s)
```
It often helps to have everything within your code in functions, e.g.,

```python
def hello(name, greeting='howdy '):
    return str(greeting) + ', ' + str(name) + '!

def main():
    print(hello('bjorn ', 'hej '))

main()
```
Running as main vs. module

But what if I want to sometimes run the main code and sometimes just use the available functions?

```python
def hello(name, greeting='howdy '):
    return str(greeting) + ', ' + str(name) + '!

def main():
    print(hello('bjorn ', 'hej '))

if __name__ == '__main__':
    main()
```
Many more modules ...

Some modules I’ve used:

▸ argparse: flexible command-line options
▸ os: interaction with the operating system
▸ codecs: working with different character encodings
▸ csv: working with .csv files
▸ bsddb: one of the many database libraries
▸ libxml2/libxslt: working with XML files (external package)

For more modules, see:

▸ https://docs.python.org/3/library/
▸ https://docs.python.org/3/py-modindex.html
Programming paradigms

Three main types of programming paradigms (styles, genres, etc.)

- **imperative** Programs simply proceed one line at a time
- **functional** Programs consist mostly of functions
- **object-oriented** Programs are designed to mimic real-world objects
Objects and Classes

Definition

Classes are types and objects are tokens.

Example

- All cars have wheels and are self propelled. (class - describes car in general)
- Today I drove my car to work. (object - particular instance)
Methods and Attributes

Definition

**method**  (1) Something you can do with or to an object.  
(2) Function which is bound to a particular class.

**attribute** Property of a class.

Example

- An attribute of a car is its color, or its engine type
  mycar = Car() # create a new car object
  mycar.color = 'silver'
  mycar.engine = '4-cylinder'

- A method of a car is to drive, or to open a door
  mycar.drive(to='Florida')
  mycar.open(door='front-driver-side')
A Lexicon Class

attributes

- lexicon (stores the data)
- headers (stores the headers)

methods

- readFile()
- lookup()
- sorted()
- printWord()
- printDict()
class MyContact:
    def getPhone(self):
        self.phone = input('What is the phone number of ' + self.first + ' ' + self.last + '?')
    def enterNew(self, first_name, last_name):
        self.first = first_name
        self.last = last_name
        self.getPhone()
    def printInfo(self):
        print(self.first, self.last, ':', self.phone)

phonebook = MyContact()
phonebook.enterNew('Markus', 'Dickinson')
phonebook.printInfo()
Do’s and Don’t’s

No

Do not refer to class attributes from outside.

phonebook.name = 'Markus'

Yes

Write methods to initialize/access/change them!

phonebook.enterNew( 'Sandra', 'Kuebler' )
Define a Superclass

class Person:
    def enterNew(self, first_name, last_name):
        self.first = first_name
        self.last = last_name
    def getAge(self):
        self.age = input('What is the age?')
Use a Superclass

class Phone(Person):
    def getPhone(self):
        self.phone = input('What is the phone number of ' + self.first + self.last + '? ')
    def enterNew(self, first_name, last_name):
        self.first = first_name
        self.last = last_name
        self.getPhone()
    def printInfo(self):
        print(self.first, self.last, ':', self.phone, self.age)

phonebook = Phone()
phonebook.enterNew('Markus', 'Dickinson')
phonebook.getAge()
phonebook.printInfo()
Theory
Encapsulation

Definition

- Attributes and methods of a particular object should not affect other objects. This is akin to the no-no of using global variables.
- All the inner workings of a class are said to be encapsulated.
- The rest of the world need only know how to use the various methods of the class, but not how they are implemented.
- This is similar to an API (Application Programming Interface).
In the real world, there are classes and sub-classes (and sub-sub-classes etc.).

For example, humans belong to the class of primates, which belongs to the class of mammals, which belongs to the class of vertebrates, which belong to the class of animals.

Humans inherit attributes from these superclasses, such as the fact that humans have spines (inherited from vertebrates).
Theory
Polymorphism

Definition

▶ Flexibly defined classes can work with many different types of variables.
▶ This is referred to as polymorphism.
▶ For example, the + operator can add 2 integers, but can also concatenate strings.
▶ Polymorphism can be very powerful and handy, but it can also be tricky to implement.
▶ We won’t worry about it too much.