Classes and Objects

You will learn how to define new types of variables.

Composite Types: Review

- Ones that you should be familiar with now:
  - Strings
  - Lists
  - Tuples
  - Dictionaries
- Lists can be used to track relatively simple information e.g., grades, text-based virtual worlds.
- It is less effective at storing more complex information (e.g., client list) – as you will see.
- Previous example: tracking client information

```
firstClient = ["James Tam"
               "(403)210-9455",
               "tamj@cpsc.ucalgary.ca",
               0]

secondClient = ["Peter Griffin"
                "(708)123-4567",
                "griffinp@familyguy.com",
                100]
```

Composite Types: Review (2)

- If a large number of composite types need to be tracked (e.g., many clients) then you can employ lists of lists.
- (This means that each list element consists of another list).

Example: List Of Lists

- The full online example can be found in under the name: list_of_lists.py

```
MAX = 4

def initialize (myClients):
   for i in range (0, MAX, 1):
      temp = [(i+1),
            “default name”,
            "(111)111-1111",
            "foo@bar.com",
            0]
      myClients.append(temp)
```

Example: Lists Of Lists (2)

```
def display (myClients):
    for i in range (0, MAX, 1):
        print myClients[i]

# MAIN
myClients = []
initialize (myClients)
display(myClients)
```


Some Drawbacks Of Using A List

- Which field contains what type of information? This isn't immediately clear from looking at the program statements.

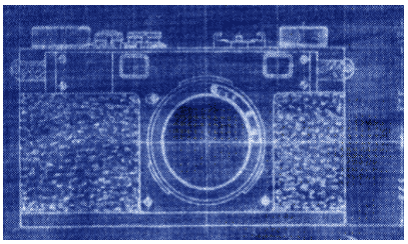
```
temp = [(i+1),
        "default name",
        "(111)111-1111",
        "foo@bar.com",
        0]
```

What is this?

- Is there any way to specify rules about the type of information to be stored in a field e.g., a data entry error could allow alphabetic information to be entered in the phone number field.

Classes

- Can be used to define a generic template for a new non-homogeneous composite type.
- It can label and define more complex entities than a list.
- This template defines what an instance or example of this new composite type would consist of but it doesn't create an instance.



Defining A Class

Note the convention: The first letter is capitalized.

- **Format:**

  class <*Name of the class*>:
  name of first field = <*default value*>
  name of second field = <*default value*>

- **Example:**

```
class Client:
    name = "default"
    phone = "(123)456-7890"
    email = "foo@bar.com"
    purchases = 0
```

Describes what information that would be tracked by a "Client" but doesn't actually create a client in memory

Creating An Instance Of A Class

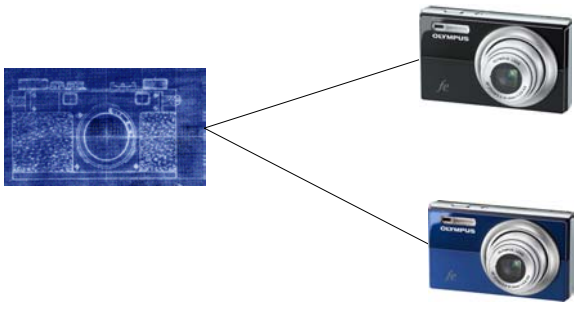
- **Format:**
  <*reference name*> = <*name of class*> ()

- **Example:**
  firstClient = Client ()

Defining A Class Vs. Creating An Instance Of That Class

- Defining a class
  - A template that describes that class: how many fields, what type of information will be stored by each field, what default information will be stored in a field.

- Creating a class
  - Instances of that class (instantiations) which can take on different forms.



Accessing And Changing The Fields

- **Format:**

  <reference name>.<field name> # Accessing value
  <reference name>.<field name> = *<value>* # Changing value

- **Example:**

  aClient.name = "James"

The Client List Example Implemented Using Classes

- The full version can be found under the name: client.py

```
class Client:
    name = "default"
    phone = "(123)456-7890"
    email = "foo@bar.com"
    purchases = 0
```

The Client List Example Implemented Using Classes (2)

```
def main ():
  firstClient = Client ()
  firstClient.name = "James Tam"
  firstClient.email = "tamj@cpsc.ucalgary.ca"
  print firstClient.name
  print firstClient.phone
  print firstClient.email
  print firstClient.purchases

main ()
```


What Is The Benefit Of Defining A Class

- It allows new types of variables to be declared.
- The new type can model information about most any arbitrary entity:
  - Car
  - Movie
  - Your pet
  - A biological entity in a simulation
  - A 'critter' (e.g., monster, computer-controlled player) a video game
  - An 'object' (e.g., sword, ray gun, food) in a video game
  - Etc.

What Is The Benefit Of Defining A Class (2)

•Unlike creating a composite type by using a list a predetermined number of fields can be specified and those fields can be named.

```
class Client:
    name = "default"
    phone = "(123)456-7890"
    email = "foo@bar.com"
    purchases = 0

firstClient = Client ()
print firstClient.middleName
```


What Is The Benefit Of Defining A Class (2)

•Unlike creating a composite type by using a list a predetermined number of fields can be specified and those fields can be named.

```
class Client:
    name = "default"
    phone = "(123)456-7890"
    email = "foo@bar.com"
    purchases = 0

firstClient = Client ()
print firstClient.middleName
```

There is no field by this name

Class Methods

- Somewhat similar to the other composite types, classes can have functions associated with them.
  - E.g.,

```
filename = "foo.txt"
name, suffix = filename.split('.')
```

- Unlike these pre-created functions, the ones that you associate with classes can be customized to do anything that a regular function can.
- Functions that are associated with classes are referred to as *methods*.

Defining Class Methods

Format:

```
class <classname>:
    def <method name> (self, <other parameters>):
        <method body>
```

Example:

```
class Person:
  name = "I have no name :("
  def sayName (self):
    print "My name is...", self.name
```

Defining Class Methods: Full Example

- The full example can be found online under the name: person.py

```
class Person:
   name = "I have no name :("
   def sayName (self):
      print "My name is...", self.name

def main ():
   aPerson = Person ()
   aPerson.sayName ()
   aPerson.name = "Big Smiley :D"
   aPerson.sayName ()

main ()
```


What Is The 'Self' Parameter

- When defining/call methods of a class there is always at least one parameter.
- This parameter is called the 'self' reference which allows an object to access it's attributes inside it's methods.
- It's needed to distinguish the attributes of different objects of the same class.
- Example:

```
bart = Person ()
lisa = Person ()
lisa.sayName ()
```

```
def sayName ():
    print "My name is...", name
```

Whose name is this?
(This won't work)

The Self Parameter: A Complete Example

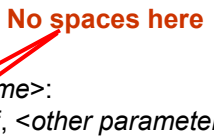
•The name of the full online example is: person2.py

```
class Person:
   name = "I have no name :("
   def sayName (self):
      print "My name is...", self.name

def main ():
   lisa = Person ()
   lisa.name = "Lisa Simpson"
   bart = Person ()
   bart.name = "I'm Bart Simpson, who the h*ck are you???!!!"

   lisa.sayName ()
   bart.sayName ()

main ()
```


Initializing The Attributes Of A Class

•Classes have a special method that can be used to initialize the starting values of a class to some specific values.

•This method is automatically called whenever an object is created.



•**Format**:

```
class <Class name>:
def __init__ (self, <other parameters>):
    <body of the method>
```

•**Example**:

```
class Person:
   name = ""
   def __init__ (self):
      self.name = "No name"
```

Full Example: Using The "Init" Method

•The name of the full online example is: init_method.py

```
class Person:
  name = ""
  def __init__ (self):
     self.name = "I am the nameless bard"

def main ():
  finder = Person ()
  print finder.name

main ()
```


Constructor: A Special Method

•Constructor method: a special method that is used when defining a class and it is automatically called when an object of that class has been created.
- E.g., aPerson = Person () # This calls the constructor

•In Python this method is named 'init'.

•Other languages may require a different name for the syntax but it serves the same purpose (initializing the fields of an objects as it's being created).

•This method never returns any values.

Default Parameters

- Methods such as 'init' can be defined so that if parameters aren't passed into them then default values can be assigned.
- Example:

```
def __init__ (self, name = "I have no name"):
```

This method can be called either when a personalized name is given or if the name is left out.

- Method calls (to 'init'), both will work

```
smiley = Person ()
jt = Person ("James")
```


Default Parameters: Full Example

- The name of the full online example is: init_method2.py

```
class Person:
   name = ""
   def __init__ (self, name = "I have no name"):
      self.name = name

def main ():
   smiley = Person ()
   print "My name is...", smiley.name
   jt = Person ("James")
   print "My name is...", jt.name

main ()
```

Modules: What You Should Know (Tutorial)

- In Python a module contains a part of a program in a separate file.
- In order to access a part of a program that resides in another file you must 'import' it.
- Example:

File: fun.py

```
def fun ():
    print "I'm fun!"
```

File: main.py

```
from fun import *1

def main ():
  fun ()

main ()
```

1 Import syntax:

From <filename> import <function names>

Quick Review Modules: Complete Example

- The complete example is compressed into the file "modules.zip".
- Extract both files into the same folder/directory and run the 'main' method (type: "python main.py")

<< **In file main.py** >>

```
from fun import fun1, fun2

def main ():
  fun1 ()
  fun2 ()

main ()
```

Quick Review Modules: Complete Example (2)

<< **In file fun.py** >>

```
def fun1 ():
  print "I'm fun1!"

def fun2 ():
  print "I'm fun2!"
```


Modules And Classes

- Class definitions are frequently contained in their own module.
- A common convention is to have the module (file) name match the name of the class.

Filename: Person.py

```
def Person:
    pass
```

Modules And Classes: Complete Example

- The complete example is compressed into the file "modules2.zip".
- Extract both files into the same folder/directory and run the 'main' method which is in the file called "driver.py" (type: "python driver.py")

<< **File driver.py** >>

```
from Foo import *

def main ():
   aFoo = Foo ()
   aFoo.hello ()

main ()
```

When importing modules containing class definitions the syntax is:

From <*filename*> import <*classes to be used in this module*>

Modules And Classes: Complete Example (2)

<< **File Foo.py** >>

```
class Foo:
   def hello (self):
      print "Hello! Sup?! Guten tag/morgen/aben! Buenos! Wei! Ohio! \
            Shalom! Bonjour! Salaam alikum!"
```

You Should Now Know

- How to define an arbitrary composite type using a class
- What are the benefits of defining a composite type by using a class definition over using a list
- How to create instances of a class (instantiate)
- How to access and change the attributes (fields) of a class
- How to define methods/call methods of a class
- What is a ‘self’ parameter and why is it needed
- What is a constructor, when it is used and why is it used
- How to write a method with default parameters
- How to divide your program into different modules