OOPs- Python

Object-oriented programming

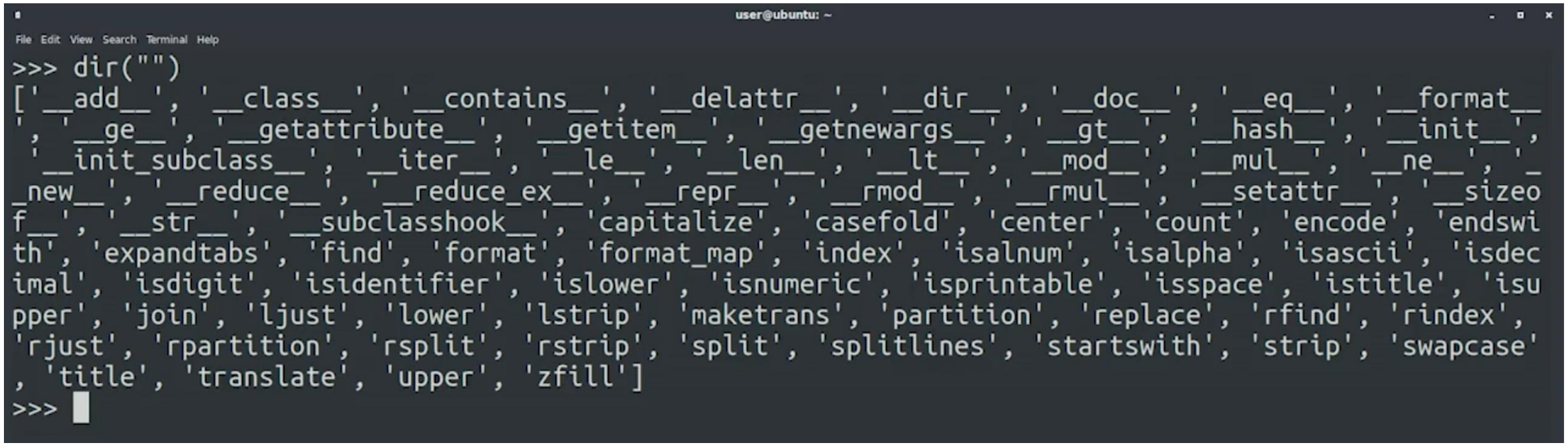
A flexible, powerful paradigm where classes represent and define concepts, while objects are instances of classes

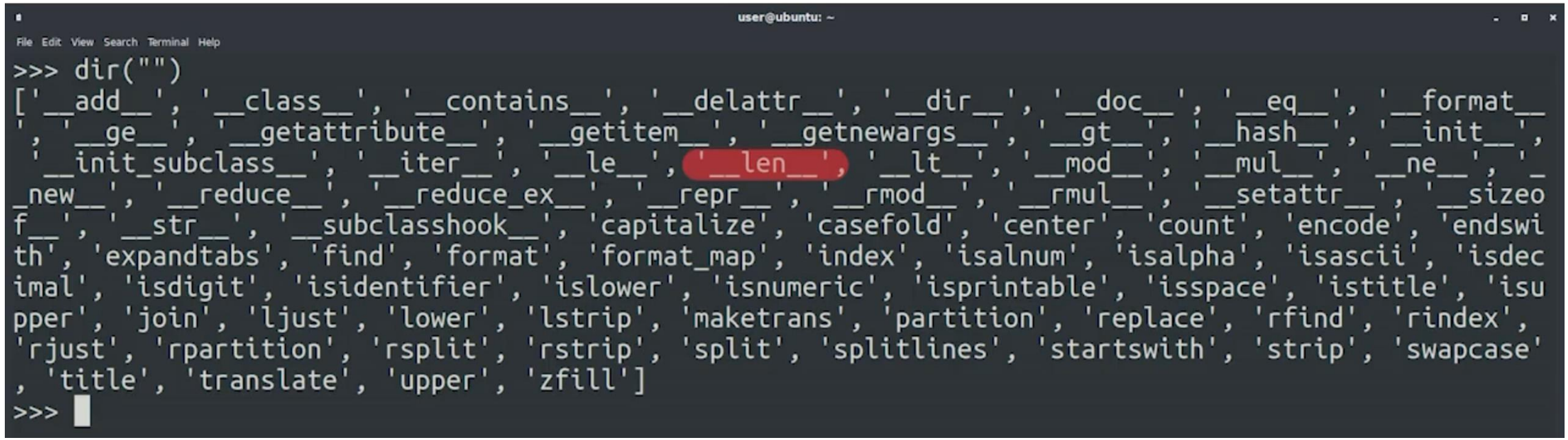
Object-Oriented Programming Defined

In object-oriented programming, concepts are modeled as classes and objects. An idea is defined using a class, and an instance of this class is called an object. Almost everything in Python is an object, including strings, lists, dictionaries, and numbers. When we create a list in Python, we're creating an object which is an instance of the list class, which represents the concept of a list. Classes also have attributes and methods associated with them. Attributes are the characteristics of the class, while methods are functions that are part of the class.

Classes and Objects in Detail

We can use the **type()** function to figure out what class a variable or value belongs to. For example, **type(" ")** tells us that this is a string class. The only attribute in this case is the string value, but there are a bunch of methods associated with the class. We've seen the **upper()** method, which returns the string in all uppercase, as well as **isnumeric()** which returns a boolean telling us whether or not the string is a number. You can use the **dir()** function to print all the attributes and methods of an object. Each string is an instance of the string class, having the same methods of the parent class. Since the content of the string is different, the methods will return different values. You can also use the **help()** function on an object, which will return the documentation for the corresponding class. This will show all the methods for the class, along with parameters the methods receive, types of return values, and a description of the methods.


user@ubuntu: ~
File Edit View Search Terminal Help
>>> dir("")
['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq__', '__format__', '__ge__', '__getattribute__', '__getitem__', '__getnewargs__', '__gt__', '__hash__', '__init__', '__init_subclass__', '__iter__', '__le__', '__len__', '__lt__', '__mod__', '__mul__', '__ne__', '__new__', '__reduce__', '__reduce_ex__', '__repr__', '__rmod__', '__rmul__', '__setattr__', '__sizeof__', '__str__', '__subclasshook__', 'capitalize', 'casefold', 'center', 'count', 'encode', 'endswith', 'expandtabs', 'find', 'format', 'format_map', 'index', 'isalnum', 'isalpha', 'isascii', 'isdecimal', 'isdigit', 'isidentifier', 'islower', 'isnumeric', 'isprintable', 'isspace', 'istitle', 'isupper', 'join', 'ljust', 'lower', 'lstrip', 'maketrans', 'partition', 'replace', 'rfind', 'rindex', 'rjust', 'rpartition', 'rsplit', 'rstrip', 'split', 'splitlines', 'startswith', 'strip', 'swapcase', 'title', 'translate', 'upper', 'zfill']
>>>


user@ubuntu: ~
File Edit View Search Terminal Help
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['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq__', '__format__
', '__ge__', '__getattribute__', '__getitem__', '__getnewargs__', '__gt__', '__hash__', '__init__',
'__init_subclass__', '__iter__', '__le__', '__len__', '__lt__', '__mod__', '__mul__', '__ne__', '_
_new__', '__reduce__', '__reduce_ex__', '__repr__', '__rmod__', '__rmul__', '__setattr__', '__sizeo
f__', '__str__', '__subclasshook__', 'capitalize', 'casefold', 'center', 'count', 'encode', 'endswi
th', 'expandtabs', 'find', 'format', 'format_map', 'index', 'isalnum', 'isalpha', 'isascii', 'isdec
imal', 'isdigit', 'isidentifier', 'islower', 'isnumeric', 'isprintable', 'isspace', 'istitle', 'isu
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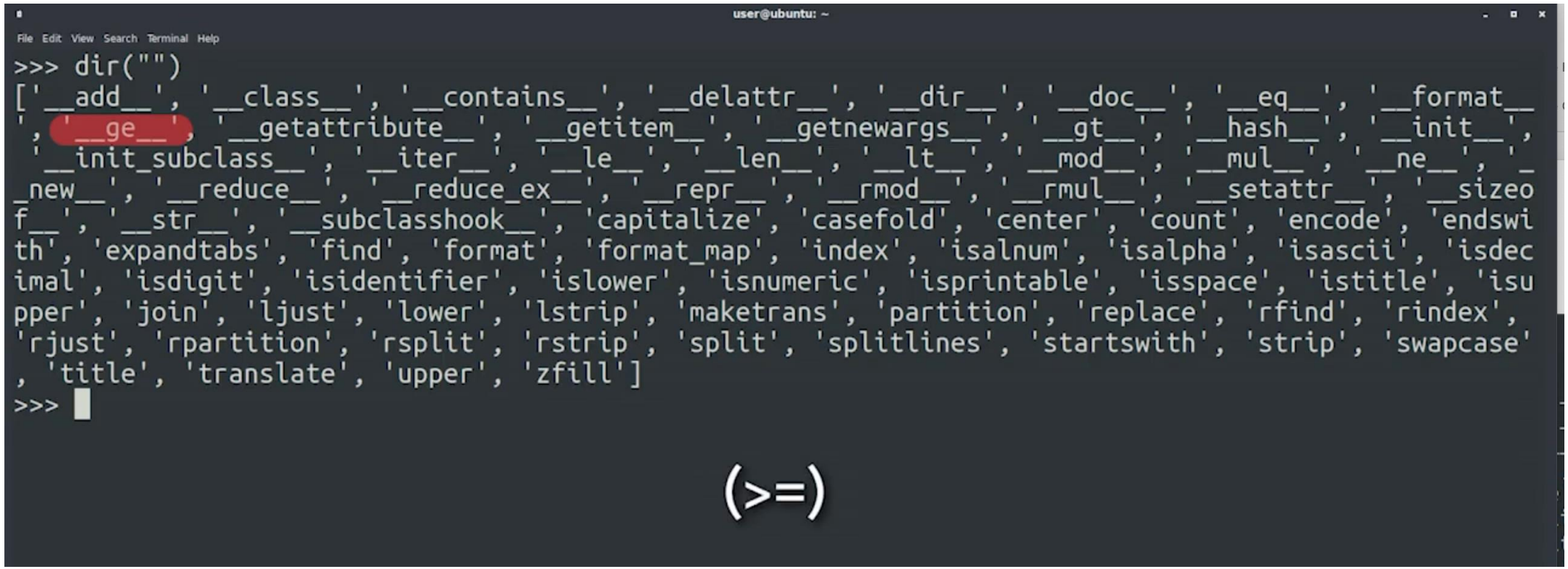
, 'title', 'translate', 'upper', 'zfill']
>>>


user@ubuntu: ~
File Edit View Search Terminal Help
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['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq__', '__format__
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imal', 'isdigit', 'isidentifier', 'islower', 'isnumeric', 'isprintable', 'isspace', 'istitle', 'isu
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'rjust', 'rpartition', 'rsplit', 'rstrip', 'split', 'splitlines', 'startswith', 'strip', 'swapcase'
, 'title', 'translate', 'upper', 'zfill']
>>>
(>=)

```
>>> help("")
```

user@ubuntu: ~

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```
Help on class str in module builtins:

class str(object)
 |  str(object='') -> str
 |  str(bytes_or_buffer[, encoding[, errors]]) -> str
 |
 |  Create a new string object from the given object. If encoding or
 |  errors is specified, then the object must expose a data buffer
 |  that will be decoded using the given encoding and error handler.
 |  Otherwise, returns the result of object.__str__() (if defined)
 |  or repr(object).
 |  encoding defaults to sys.getdefaultencoding().
 |  errors defaults to 'strict'.
 |
 |  Methods defined here:
 |
 |  __add__(self, value, /)
 |      Return self+value.
 |
 |  __contains__(self, key, /)
 |      Return key in self.
 |
 |  __eq__(self, value, /)
 |      Return self==value.
 |
:
```

```
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  capitalize(self, /)
      Return a capitalized version of the string.

      More specifically, make the first character have upper case and the rest lower
      case.

  casefold(self, /)
      Return a version of the string suitable for caseless comparisons.

  center(self, width, fillchar=' ', /)
      Return a centered string of length width.

      Padding is done using the specified fill character (default is a space).

  count(...)
      S.count(sub[, start[, end]]) -> int

      Return the number of non-overlapping occurrences of substring sub in
      string S[start:end].  Optional arguments start and end are
      interpreted as in slice notation.

  encode(self, /, encoding='utf-8', errors='strict')
      Encode the string using the codec registered for encoding.

      encoding
:
```

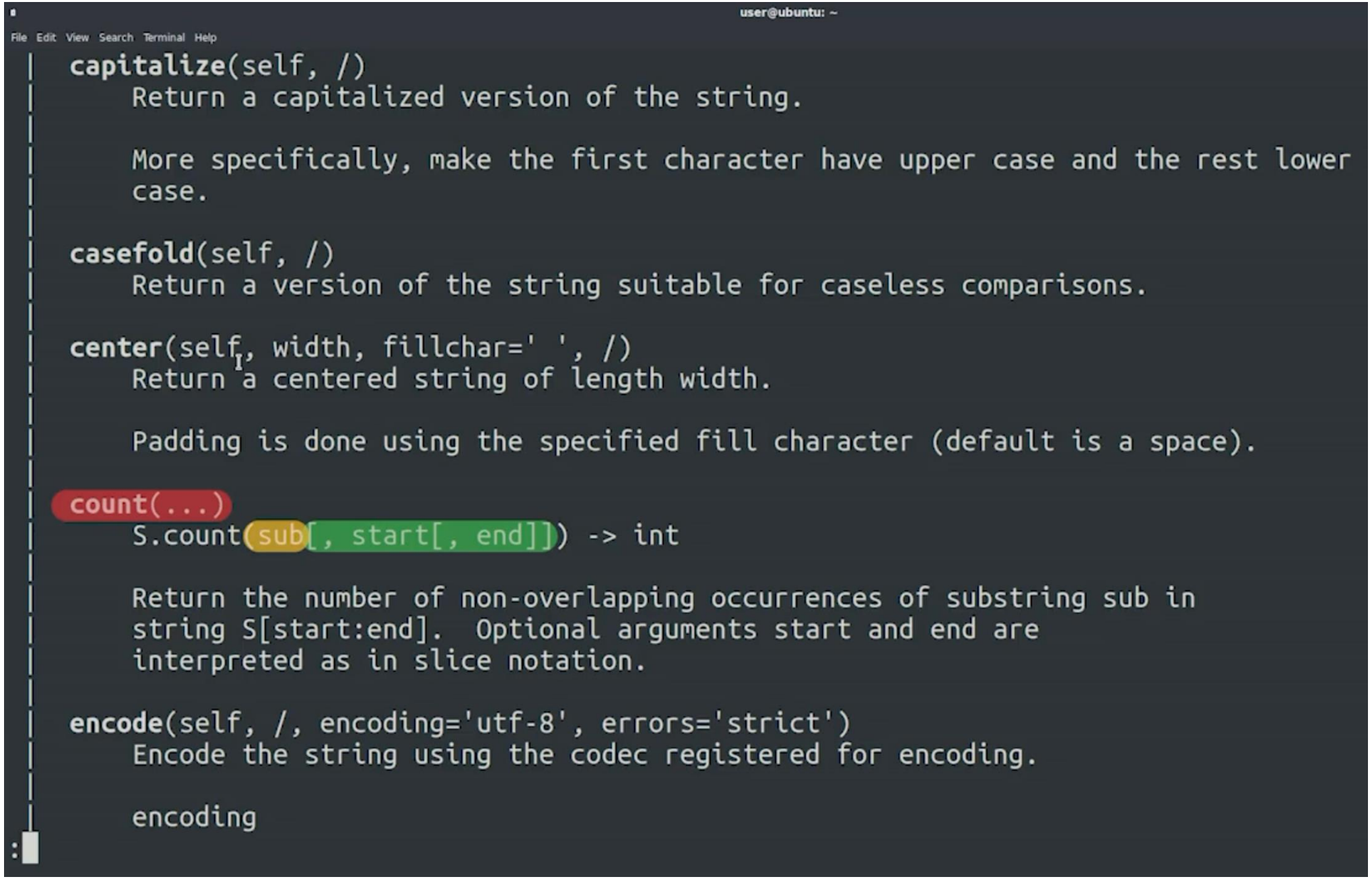
user@ubuntu: ~
File Edit View Search Terminal Help
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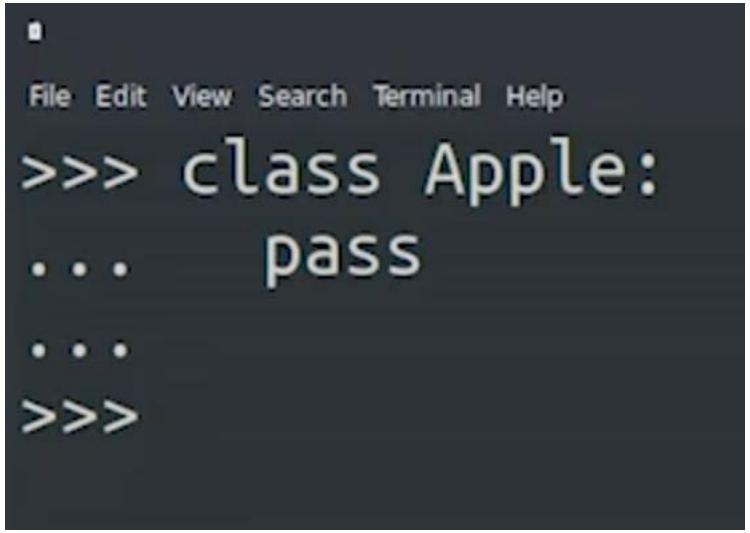
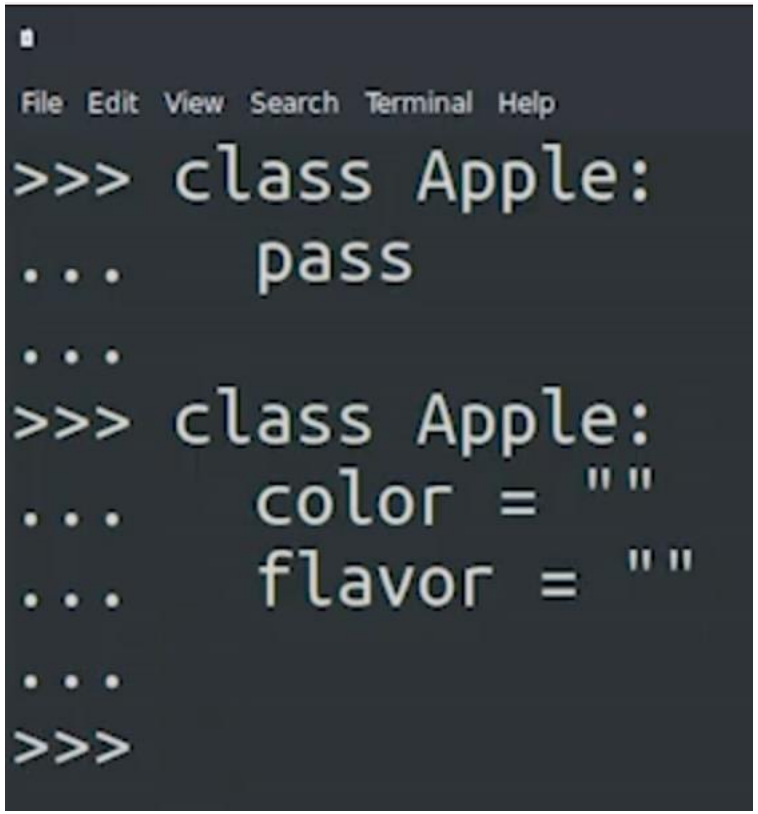
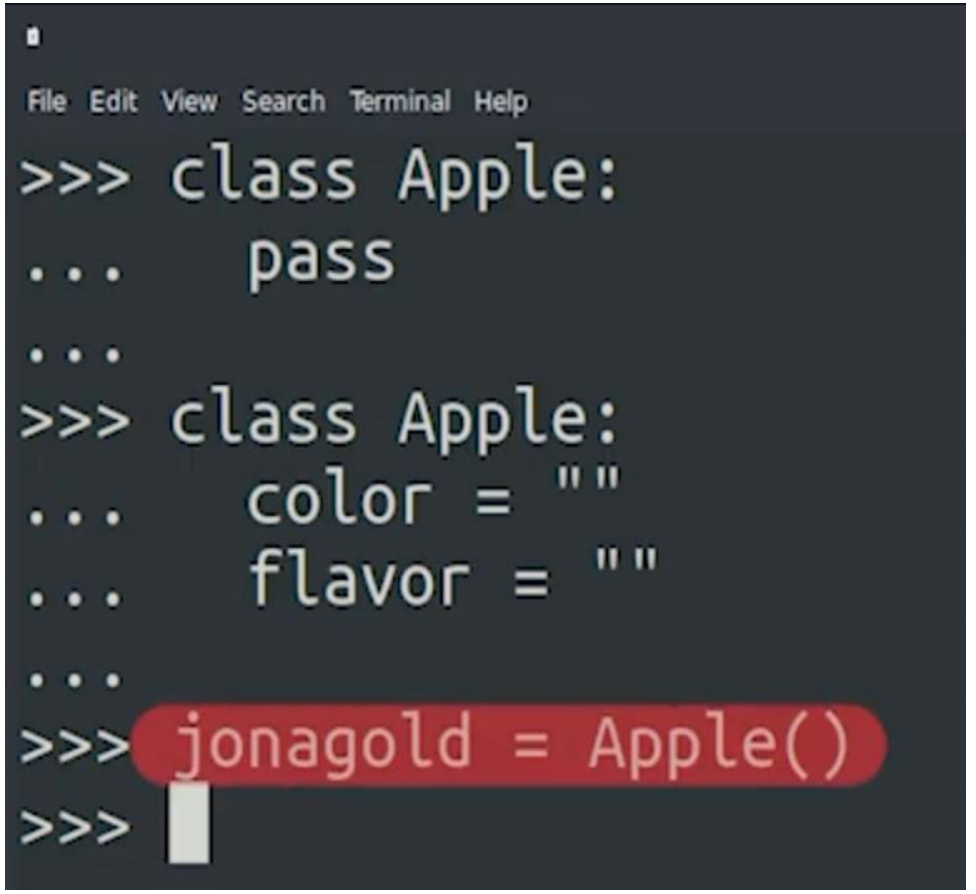
Encode the string using the codec registered for encoding.
encoding
:

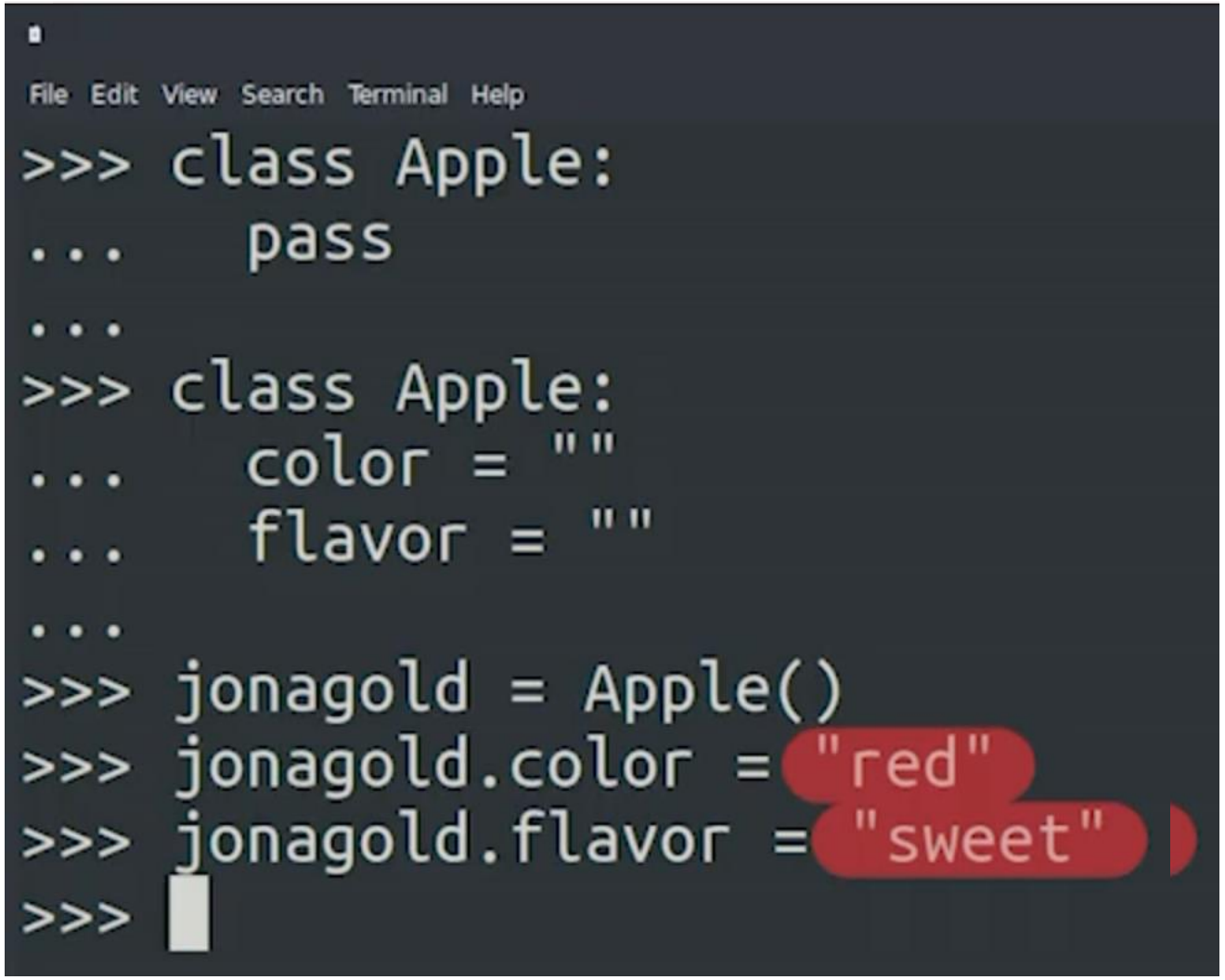
Defining New Classes

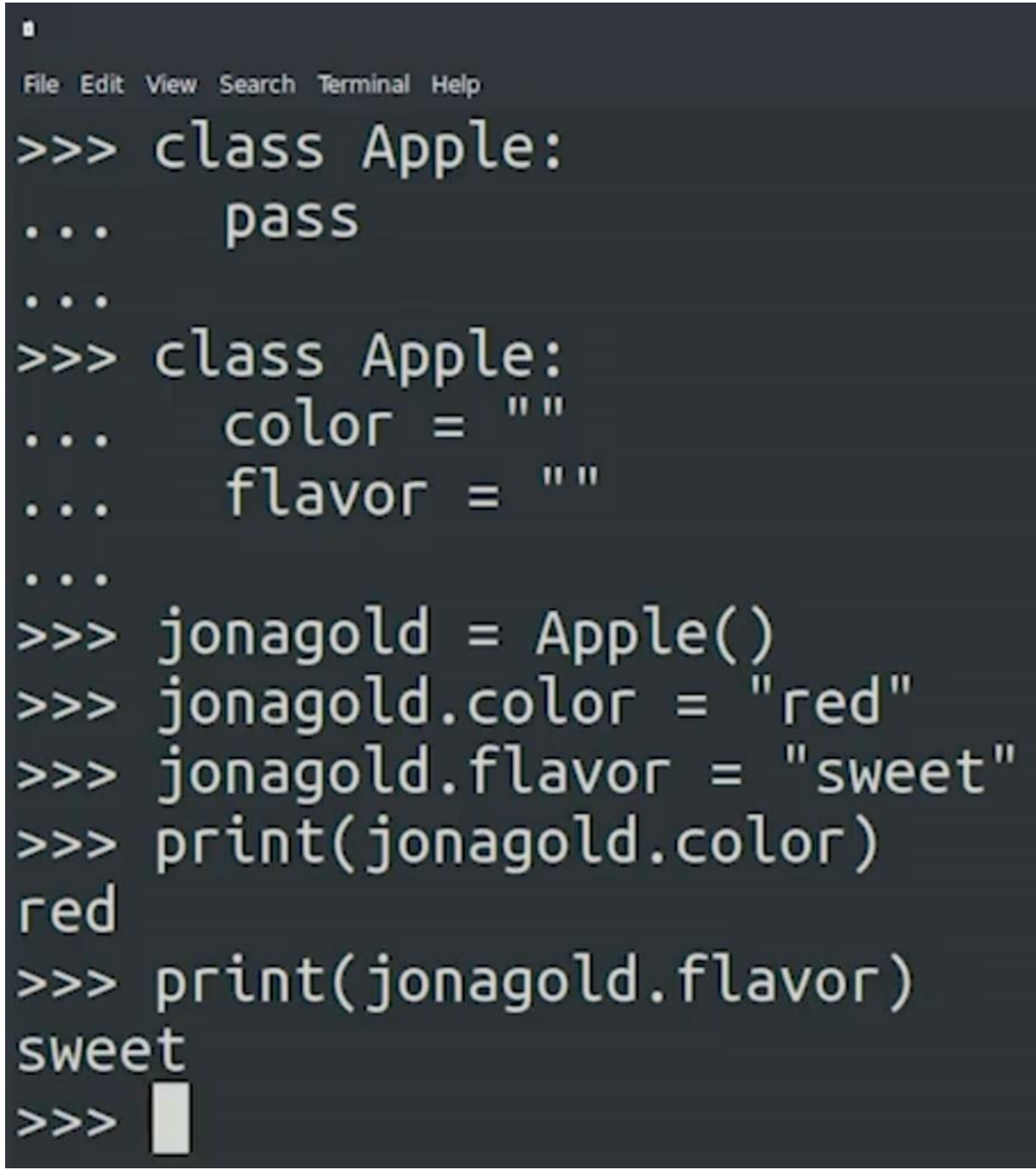


pass keyword to show body is empty
Any empty python block






File Edit View Search Terminal Help
>>> class Apple:
... pass
...
>>> class Apple:
... color = ""
... flavor = ""
...
>>> jonagold = Apple()
>>> jonagold.color = "red"
>>> jonagold.flavor = "sweet"
>>>


File Edit View Search Terminal Help
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... pass
...
>>> class Apple:
... color = ""
... flavor = ""
...
>>> jonagold = Apple()
>>> jonagold.color = "red"
>>> jonagold.flavor = "sweet"
>>> print(jonagold.color)
red
>>> print(jonagold.flavor)
sweet
>>>

We can create and define our classes in Python similar to how we define functions. We start with the **class** keyword, followed by the name of our class and a colon. Python style guidelines recommend class names to start with a capital letter. After the class definition line is the class body, indented to the right. Inside the class body, we can define attributes for the class.

Let's take our Apple class example:

```
>>> class Apple:
...     color = ""
...     flavor = ""
...
```

We can create a new instance of our new class by assigning it to a variable. This is done by calling the class name as if it were a function. We can set the attributes of our class instance by accessing them using dot notation. Dot notation can be used to set or retrieve object attributes, as well as call methods associated with the class.

```
>>> jonagold = Apple()
>>> jonagold.color = "red"
>>> jonagold.flavor = "sweet"
```

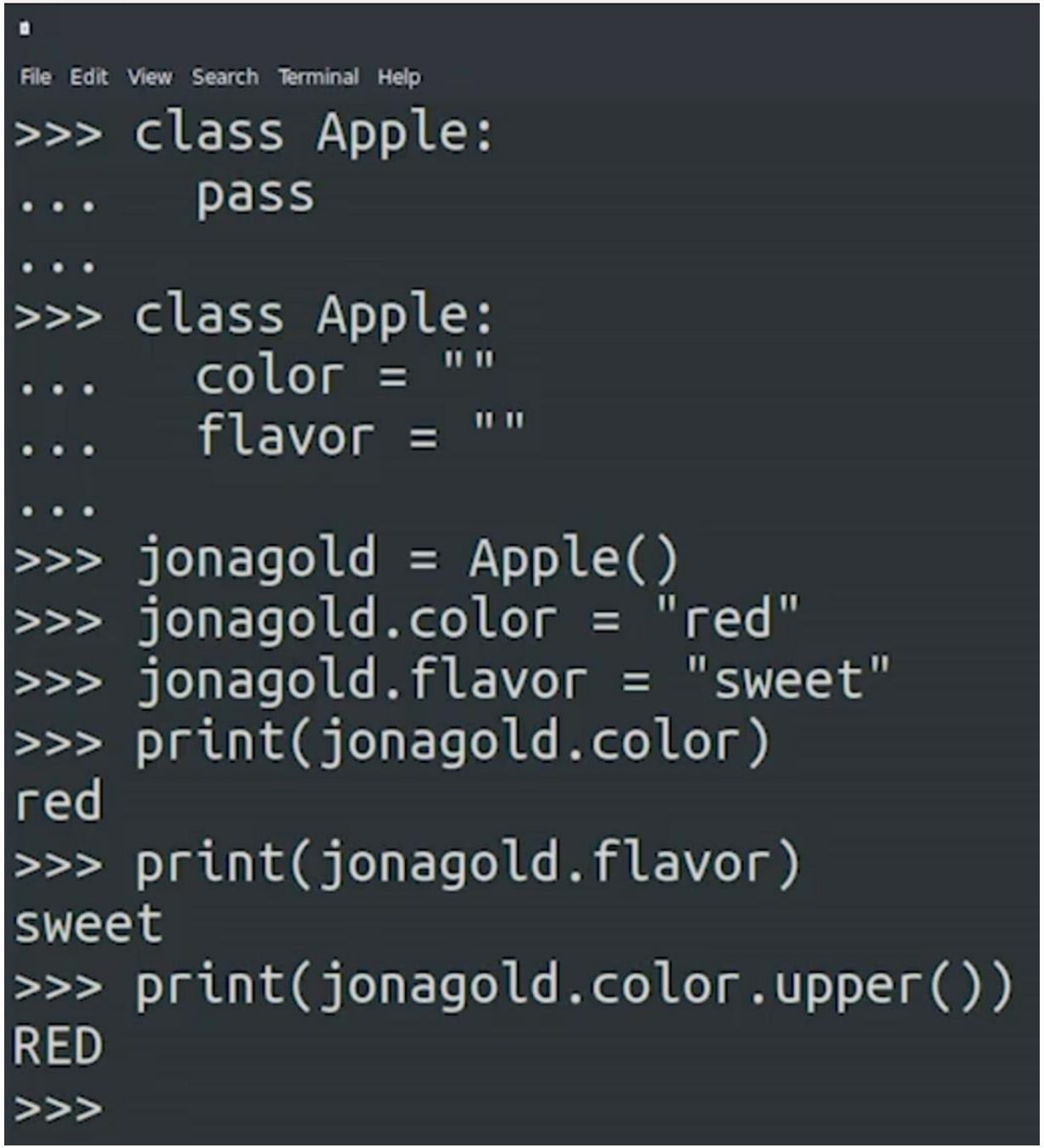
We created an Apple instance called jonagold, and set the color and flavor attributes for this Apple object. We can create another instance of an Apple and set different attributes to differentiate between two different varieties of apples.

```
>>> golden = Apple()
>>> golden.color = "Yellow"
>>> golden.flavor = "Soft"
```

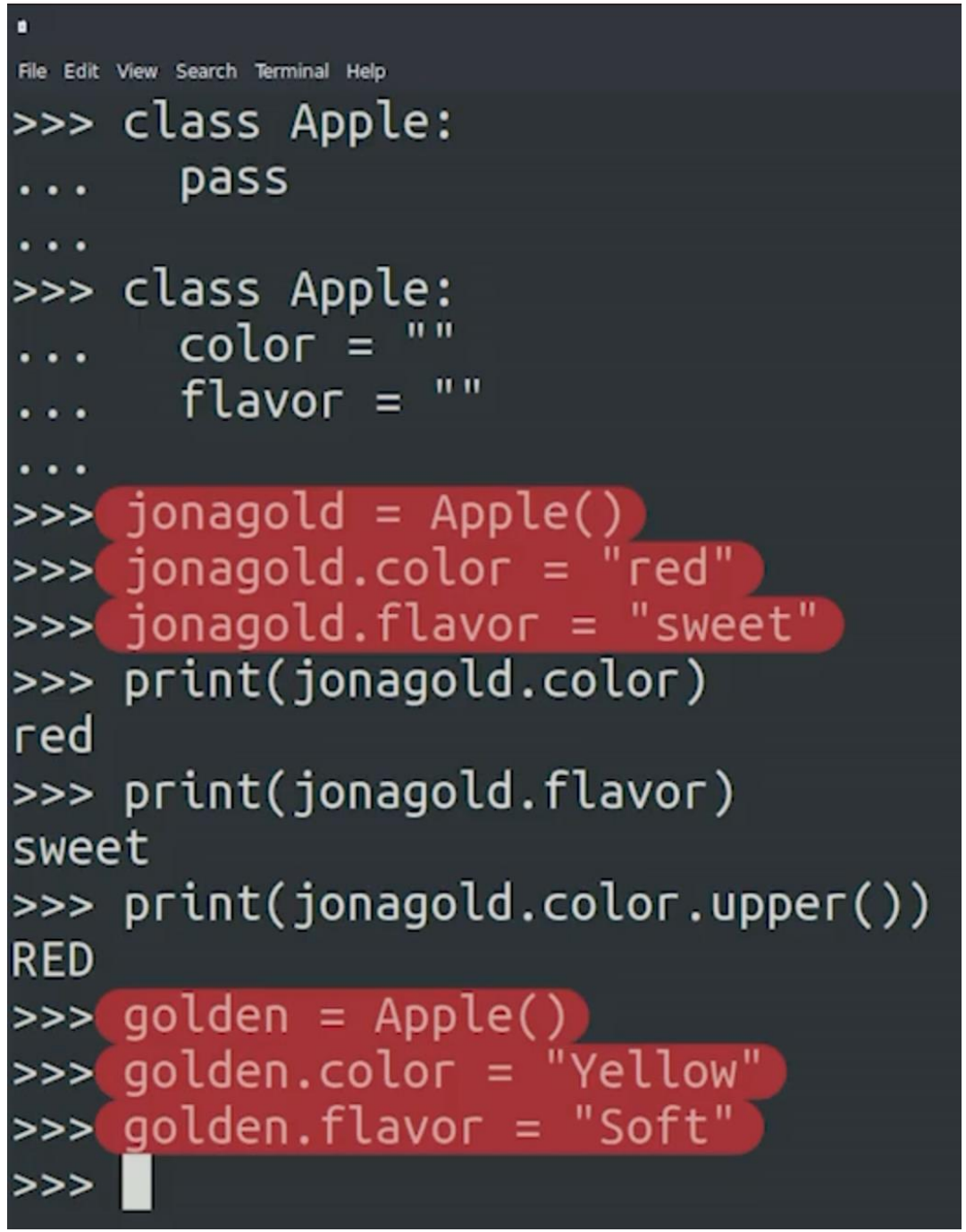
We now have another Apple object called golden that also has color and flavor attributes. But these attributes have different values.

Dot notation

Lets you access any of the abilities the object might have (called methods) or information it might store (called attributes)



The attributes and methods of some objects can be other objects and can have attributes and methods of their own. For example, we could use the upper method to turn the string of the color attribute to uppercase. So print (jonagold.color.upper()).


File Edit View Search Terminal Help
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... pass
...
>>> class Apple:
... color = ""
... flavor = ""
...
>>> jonagold = Apple()
>>> jonagold.color = "red"
>>> jonagold.flavor = "sweet"
>>> print(jonagold.color)
red
>>> print(jonagold.flavor)
sweet
>>> print(jonagold.color.upper())
RED
>>> golden = Apple()
>>> golden.color = "Yellow"
>>> golden.flavor = "Soft"
>>>

We can create and define our classes in Python similar to how we define functions. We start with the **class** keyword, followed by the name of our class and a colon. Python style guidelines recommend class names to start with a capital letter. After the class definition line is the class body, indented to the right. Inside the class body, we can define attributes for the class.

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```
>>> golden = Apple()
>>> golden.color = "Yellow"
>>> golden.flavor = "Soft"
```

We now have another Apple object called golden that also has color and flavor attributes. But these attributes have different values.

Question

Want to give this a go? Fill in the blanks in the code to make it print a poem.

```
class:
  color = 'unknown'

rose = Flower()
rose.color = ___

violet = ___
___

this_pun_is_for_you = ___

print("Roses are {},".format(rose.color))
print("violets are {},".format(violet.color))
print(this_pun_is_for_you)
```

Question

Want to give this a go? Fill in the blanks in the code to make it print a poem.

```
1
2   class Flower:
3     color = 'unknown'
4
5   rose = Flower()
6   rose.color = "red"
7
8   violet = Flower()
9   violet.color = "blue"
10
11  this_pun_is_for_you = "Sugar is sweet, and so are you."
12
13  print("Roses are {},".format(rose.color))
14  print("violets are {},".format(violet.color))
15  print(this_pun_is_for_you)
```

Instance Methods

Methods

Functions that operate on the attributes of a specific instance of a class

What Is a Method?

Calling methods on objects executes functions that operate on attributes of a specific instance of the class. This means that calling a method on a list, for example, only modifies that instance of a list, and not all lists globally. We can define methods within a class by creating functions inside the class definition. These instance methods can take a parameter called **self** which represents the instance the method is being executed on. This will allow you to access attributes of the instance using dot notation, like **self.name**, which will access the name attribute of that specific instance of the class object. When you have variables that contain different values for different instances, these are called instance variables.

```
class Cat:
    pass
myCat = Cat()
```

```
class Cat:
    def speak(self):
        print("Meow Meow Meow .....")
myCat = Cat()
myCat.speak()
```

```
Meow Meow Meow .....
```

```
class Cat:
    name = ""
    def speak(self):
        print("Meow! I'm {}! Meow".format(self.name))
myLuna = Cat()
myLuna.name = "Luna"
myLuna.speak()
```

```
Meow! I'm Luna! Meow
```

```
class Cat:
    name = ""
    def speak(self):
        print("Meow! I'm {}! Meow".format(self.name))
myLuna = Cat()
myLuna.name = "Luna"
myLuna.speak()

myBella = Cat()
myBella.name = "Bella"
myBella.speak()
```

```
Meow! I'm Luna! Meow
Meow! I'm Bella! Meow
```

Variables that have different values for different instances of the same class are called **instance variables**.

```
class Cat:
    years = 0
    def age (self):
        return self.years * 12
myLuna = Cat()
myLuna.age()
```

```
0
```

In [15]:
```
class Cat:
    years = 0
    def age (self):
        return self.years * 12
myLuna = Cat()
myLuna.years = 2
myLuna.age()
```

Out[15]: 24

Special Methods

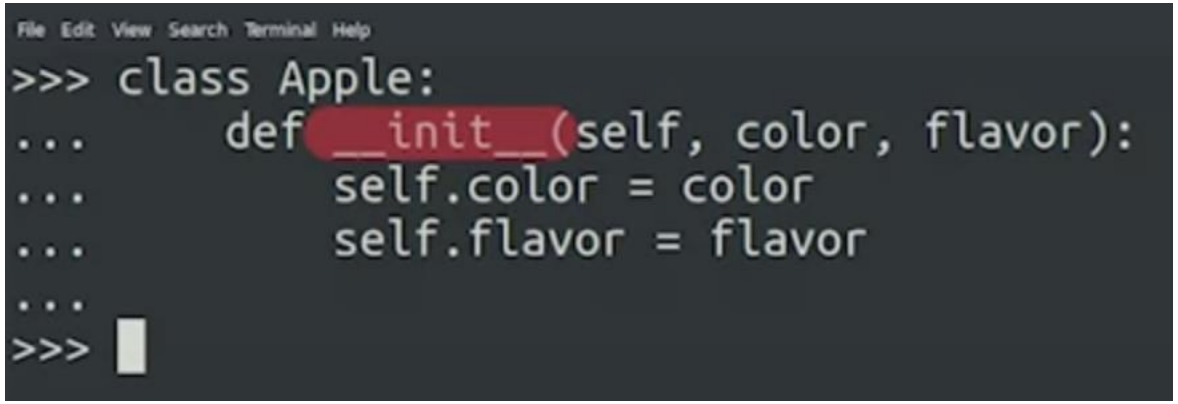
Instead of creating classes with empty or default values, we can set these values when we create the instance. This ensures that we don't miss an important value and avoids a lot of unnecessary lines of code. To do this, we use a special method called a **constructor**. Below is an example of an Apple class with a constructor method defined.

```
>>> class Apple:
...     def __init__(self, color, flavor):
...         self.color = color
...         self.flavor = flavor
```

When you call the name of a class, the constructor of that class is called. This constructor method is always named **__init__**. You might remember that special methods start and end with two underscore characters. In our example above, the constructor method takes the self variable, which represents the instance, as well as color and flavor parameters. These parameters are then used by the constructor method to set the values for the current instance. So we can now create a new instance of the Apple class and set the color and flavor values all in go:

```
>>> jonagold = Apple("red", "sweet")
>>> print(jonagold.color)
Red
```

Special Method - Constructor




```
class Apple:
    def __init__(self, color, flavor):
        self.color = color
        self.flavor = flavor

jonagold = Apple("red", "sweet")
print(jonagold.color)
```

```
red
```

In addition to the **__init__** constructor special method, there is also the **__str__** special method. This method allows us to define how an instance of an object will be printed when it's passed to the print() function. If an object doesn't have this special method defined, it will wind up using the default representation, which will print the position of the object in memory. Not super useful. Here is our Apple class, with the **__str__** method added:

```
>>> class Apple:
...     def __init__(self, color, flavor):
...         self.color = color
...         self.flavor = flavor
...     def __str__(self):
...         return "This apple is {} and its flavor is {}".format(self.color, self.flavor)
...
```

Now, when we pass an Apple object to the print function, we get a nice formatted string:

```
>>> jonagold = Apple("red", "sweet")
>>> print(jonagold)
This apple is red and its flavor is sweet
```

Documenting Functions, Classes, and Methods

Docstring

A brief text that explains what something does

Documenting with Docstrings

The Python **help** function can be super helpful for easily pulling up documentation for classes and methods. We can call the **help** function on one of our classes, which will return some basic info about the methods defined in our class:

```
>>> class Apple:
...     def __init__(self, color, flavor):
...         self.color = color
...         self.flavor = flavor
...     def __str__(self):
...         return "This apple is {} and its flavor is {}".format(self.color, self.flavor)
...
>>> help(Apple)
Help on class Apple in module __main__:

class Apple(builtins.object)
 |  Methods defined here:
 |
 |  __init__(self, color, flavor)
 |      Initialize self.  See help(type(self)) for accurate signature.
 |
 |  __str__(self)
 |      Return str(self).
 |
 |  ----------------------------------------------------------------------
 |  Data descriptors defined here:
 |
 |  __dict__
 |      dictionary for instance variables (if defined)
 |
```

We can add documentation to our own classes, methods, and functions using **docstrings**. A docstring is a short text explanation of what something does. You can add a docstring to a method, function, or class by first defining it, then adding a description inside triple quotes. Let's take the example of this function:

```
>>> def to_seconds(hours, minutes, seconds):
...     """Returns the amount of seconds in the given hours, minutes and seconds."""
...     return hours*3600+minutes*60+seconds
...
```

We have our function called *to_seconds* on the first line, followed by the docstring which is indented to the right and wrapped in triple quotes. Last up is the function body. Now, when we call the help function on our to_seconds function, we get a handy description of what the function does:

```
>>> help(to_seconds)
Help on function to_seconds in module __main__:

to_seconds(hours, minutes, seconds)
    Returns the amount of seconds in the given hours, minutes and seconds.
```

Docstrings are super useful for documenting our custom classes, methods, and functions, but also when working with new libraries or functions. You'll be extremely grateful for docstrings when you have to work with code that someone else wrote!

Question

Remember our Person class from the last video? Let's add a docstring to the greeting method. How about, "Outputs a message with the name of the person".

```
class Person:
  def __init__(self, name):
    self.name = name
  def greeting(self):
    ___
    print("Hello! My name is {name}.".format(name=s

help(___)

```

Run

Reset

Question

Remember our Person class from the last video? Let's add a docstring to the greeting method. How about, "Outputs a message with the name of the person".

```
class Person:
    def __init__(self, name):
        self.name = name
    def greeting(self):
        """Outputs a message with the name of the person"""
        ___
        print("Hello! My name is {name}.".format(name=self.name))

help(Person)
```

Classes and Methods Cheat Sheet (Optional)

Classes and Methods Cheat Sheet

In the past few videos, we've seen how to define classes and methods in Python. Here, you'll find a run-down of everything we've covered, so you can refer to it whenever you need a refresher.

Defining classes and methods

```
class ClassName:
    def method_name(self, other_parameters):
        body_of_method
```

Classes and Instances

- Classes define the behavior of all instances of a specific class.
- Each variable of a specific class is an instance or object.
- Objects can have attributes, which store information about the object.
- You can make objects do work by calling their methods.
- The first parameter of the methods (self) represents the current instance.
- Methods are just like functions, but they can only be used through a class.

Special methods

- Special methods start and end with __.
- Special methods have specific names, like __init__ for the constructor or __str__ for the conversion to string.

Documenting classes, methods and functions

- You can add documentation to classes, methods, and functions by using docstrings right after the definition. Like this:

```
class ClassName:
    """Documentation for the class."""
    def method_name(self, other_parameters):
        """Documentation for the method."""
        body_of_method

def function_name(parameters):
    """Documentation for the function."""
    body_of_function

```

Inheritance

Inheritance lets you reuse code written for one class in other classes.

Object Inheritance

In object-oriented programming, the concept of inheritance allows you to build relationships between objects, grouping together similar concepts and reducing code duplication. Let's create a custom Fruit class with color and flavor attributes:

```
>>> class Fruit:
...     def __init__(self, color, flavor):
...         self.color = color
...         self.flavor = flavor
...
```

We defined a Fruit class with a constructor for color and flavor attributes. Next, we'll define an Apple class along with a new Grape class, both of which we want to inherit properties and behaviors from the Fruit class:

```
>>> class Apple(Fruit):
...     pass
...
>>> class Grape(Fruit):
...     pass
...
```

In Python, we use parentheses in the class declaration to have the class inherit from the Fruit class. So in this example, we're instructing our computer that both the Apple class and Grape class inherit from the Fruit class. This means that they both have the same constructor method which sets the color and flavor attributes. We can now create instances of our Apple and Grape classes:

```
>>> granny_smith = Apple("green", "tart")
>>> carnelian = Grape("purple", "sweet")
>>> print(granny_smith.flavor)
tart
>>> print(carnelian.color)
purple
```

Inheritance allows us to define attributes or methods that are shared by all types of fruit without having to define them in each fruit class individually. We can then also define specific attributes or methods that are only relevant for a specific type of fruit. Let's look at another example, this time with animals:

We defined a parent class, Animal, with two animal types inheriting from that class: Cat and Cow. The parent Animal class has an attribute to store the sound the animal makes, and the constructor class takes the name that will be assigned to the instance when it's created. There is also the speak method, which will print the name of the animal along with the sound it makes. We defined the Cat and Cow classes, which inherit from the Animal class, and we set the sound attributes for each animal type. Now, we can create instances of our Cat and Cow classes and have them speak:

```
class Animal:
    sound = ""
    def __init__(self, name):
        self.name = name
    def speak(self):
        print("{sound} I'm {name}! {sound}".format(name=self.name, sound=self.sound))

class Cat(Animal):
    sound = "Meow!"

myLuna = Cat("Luna")
myLuna.speak()
```

```
Meow! I'm Luna! Meow!
```

```
class Animal:
    sound = ""
    def __init__(self, name):
        self.name = name
    def speak(self):
        print("{sound} I'm {name}! {sound}".format(name=self.name, sound=self.sound))

class Cat(Animal):
    sound = "Meow!"

myLuna = Cat("Luna")
myLuna.speak()

class Cow(Animal):
    sound = "Moooo"

myCow = Cow("Milky")
myCow.speak()
```

```
Meow! I'm Luna! Meow!
Moooo I'm Milky! Moooo
```

We create instances of both the Cat and Cow class, and set the names for our instances. Then we call the speak method of each instance, which results in the formatted string being printed; it includes the sound the animal type makes, along with the instance name we assigned.

Question

```
1   class Clothing:
2     material = ""
3     def __init__(self,name):
4       self.name = name
5     def checkmaterial(self):
6       print("This {} is made of {}".format(self.___,self.___))
7
8   class Shirt(___):
9     material="Cotton"
10
11  polo = Shirt("Polo")
12  polo.checkmaterial()
```

```
class Clothing:
  material = ""
  def __init__(self,name):
    self.name = name
  def checkmaterial(self):
    print("This {} is made of {}".format(self.name,self.material))

class Shirt(Clothing):
  material="Cotton"

polo = Shirt("Polo")
polo.checkmaterial()
```

```
Here is your output:
This Polo is made of Cotton
```

Object Composition

You can have a situation where two different classes are related, but there is no inheritance going on. This is referred to as **composition** -- where one class makes use of code contained in another class. For example, imagine we have a **Package** class which represents a software package. It contains attributes about the software package, like name, version, and size. We also have a **Repository** class which represents all the packages available for installation. While there's no inheritance relationship between the two classes, they are related. The Repository class will contain a dictionary or list of Packages that are contained in the repository. Let's take a look at an example Repository class definition:

```
class Repository:
    def __init__(self):
        self.packages = {}
    def add_package(self, package):
        self.packages[package.name] = package
    def total_size(self):
        result = 0
        for package in self.packages.values():
            result += package.size
        return result
```

```python
class Repository:
    def __init__(self):
        self.packages = {}
    def add_package(self, package):
        self.packages[package.name] = package
    def total_size(self):
        result = 0
        for package in self.packages.values():
            result += package.size
        return result
```

In the constructor method, we initialize the packages dictionary, which will contain the package objects available in this repository instance.

We initialize the dictionary in the constructor to ensure that every instance of the Repository class has its own dictionary.

```
class Repository:
    def __init__(self):
        self.packages = {}
    def add_package(self, package):
        self.packages[package.name] = package
    def total_size(self):
        result = 0
        for package in self.packages.values():
            result += package.size
        return result
```

We then define the add_package method, which takes a Package object as a parameter, and then adds it to our dictionary, using the package name attribute as the key.

```
class Repository:
    def __init__(self):
        self.packages = {}
    def add_package(self, package):
        self.packages[package.name] = package
    def total_size(self):
        result = 0
        for package in self.packages.values():
            result += package.size
        return result
```

Finally, we define a total_size method which computes the total size of all packages contained in our repository.

This method iterates through the values in our repository dictionary and adds together the size attributes from each package object contained in the dictionary, returning the total at the end. In this example, we're making use of Package attributes within our Repository class.

We're also calling the values() method on our packages dictionary instance. Composition allows us to use objects as attributes, as well as access all their attributes and methods.

Modules

Used to organize functions, classes, and other data together in a structured way

Augmenting Python with Modules

Python modules are separate files that contain classes, functions, and other data that allow us to import and make use of these methods and classes in our own code. Python comes with a lot of modules out of the box. These modules are referred to as the Python Standard Library. You can make use of these modules by using the **import** keyword, followed by the module name. For example, we'll import the **random** module, and then call the **randint** function within this module:

```
>>> import random
>>> random.randint(1,10)
8
>>> random.randint(1,10)
7
>>> random.randint(1,10)
1
```

This function takes two integer parameters and returns a random integer between the values we pass it; in this case, 1 and 10. You might notice that calling functions in a module is very similar to calling methods in a class. We use dot notation here too, with a period between the module and function names.

Let's take a look at another module: **datetime**. This module is super helpful when working with dates and times.

```
>>> import datetime
>>> now = datetime.datetime.now()
>>> type(now)
<class 'datetime.datetime'>
>>> print(now)
2019-04-24 16:54:55.155199
```

First, we import the module. Next, we call the **now()** method which belongs to the **datetime** class contained within the **datetime** module. This method generates an instance of the datetime class for the current date and time. This instance has some methods which we can call:

```
>>> print(now)
2019-04-24 16:54:55.155199
>>> now.year
2019
>>> print(now + datetime.timedelta(days=28))
2019-05-22 16:54:55.155199
```

```
>>> print(now)
2019-04-24 16:54:55.155199
>>> now.year
2019
>>> print(now + datetime.timedelta(days=28))
2019-05-22 16:54:55.155199
```

When we call the print function with an instance of the datetime class, we get the date and time printed in a specific format. This is because the datetime class has a **__str__** method defined which generates the formatted string we see here. We can also directly call attributes and methods of the class, as with **now.year** which returns the year attribute of the instance.

Lastly, we can access other classes contained in the datetime module, like the **timedelta** class. In this example, we're creating an instance of the timedelta class with the parameter of 28 days. We're then adding this object to our instance of the datetime class from earlier and printing the result. This has the effect of adding 28 days to our original datetime object.

- Real-world concepts are represented by **classes**
- Instances of classes are usually called **objects**
- Objects have **attributes** which are used to store information about them
- We can make objects do work by calling their **methods**

- Access attributes and methods using **dot notation**
- Objects can be organized by **inheritance**
- Objects can be contained inside each other using **composition**