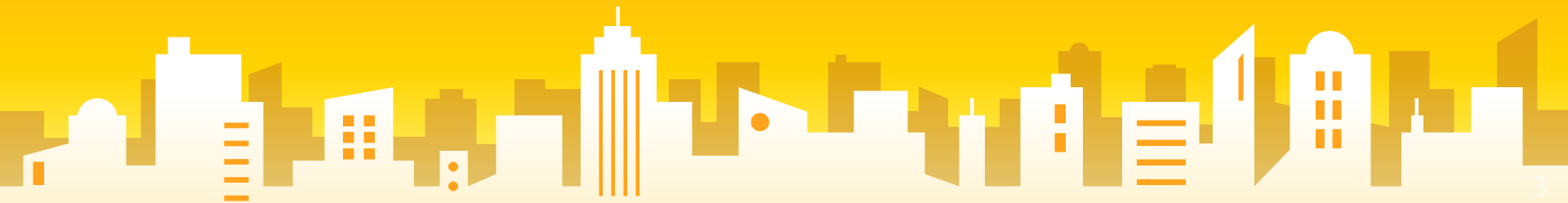
Object Oriented Programming

First Lesson. (Most Important)

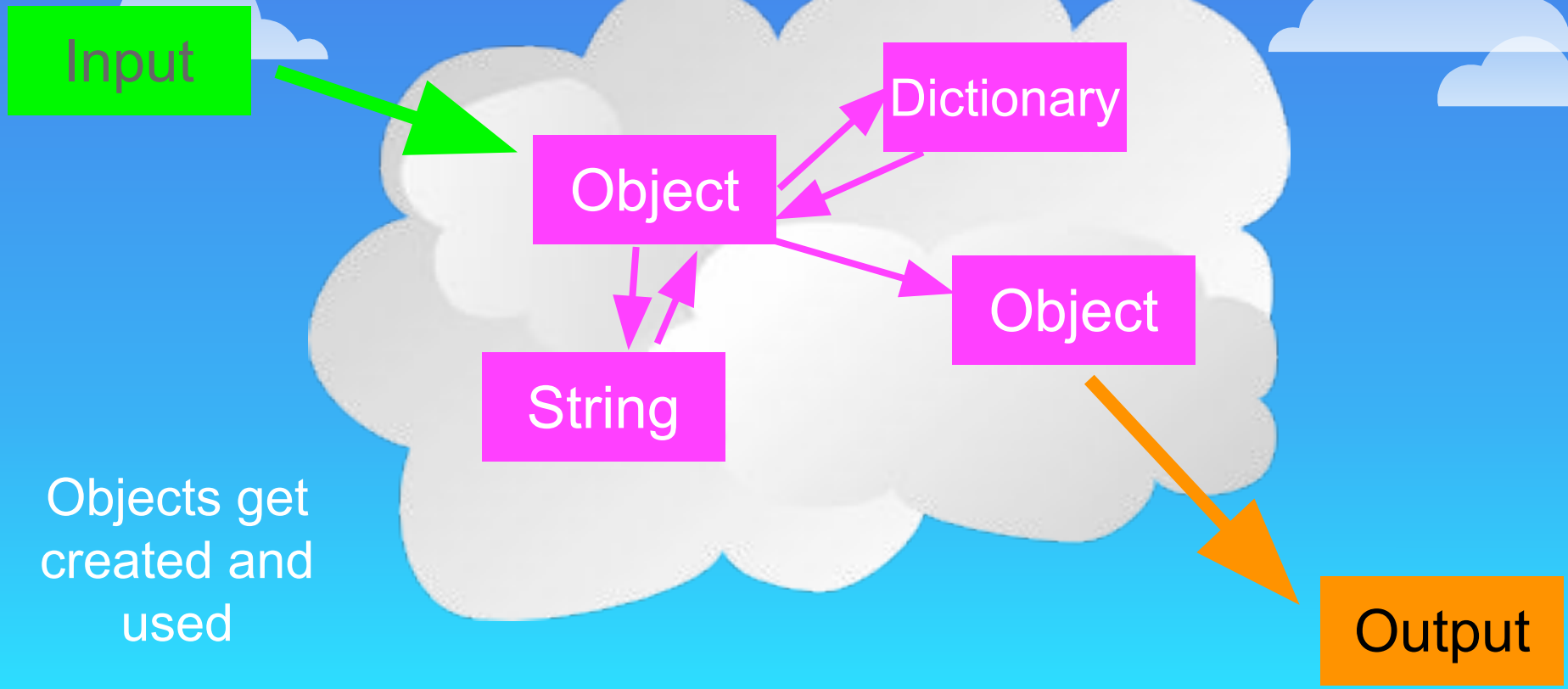


Object Oriented

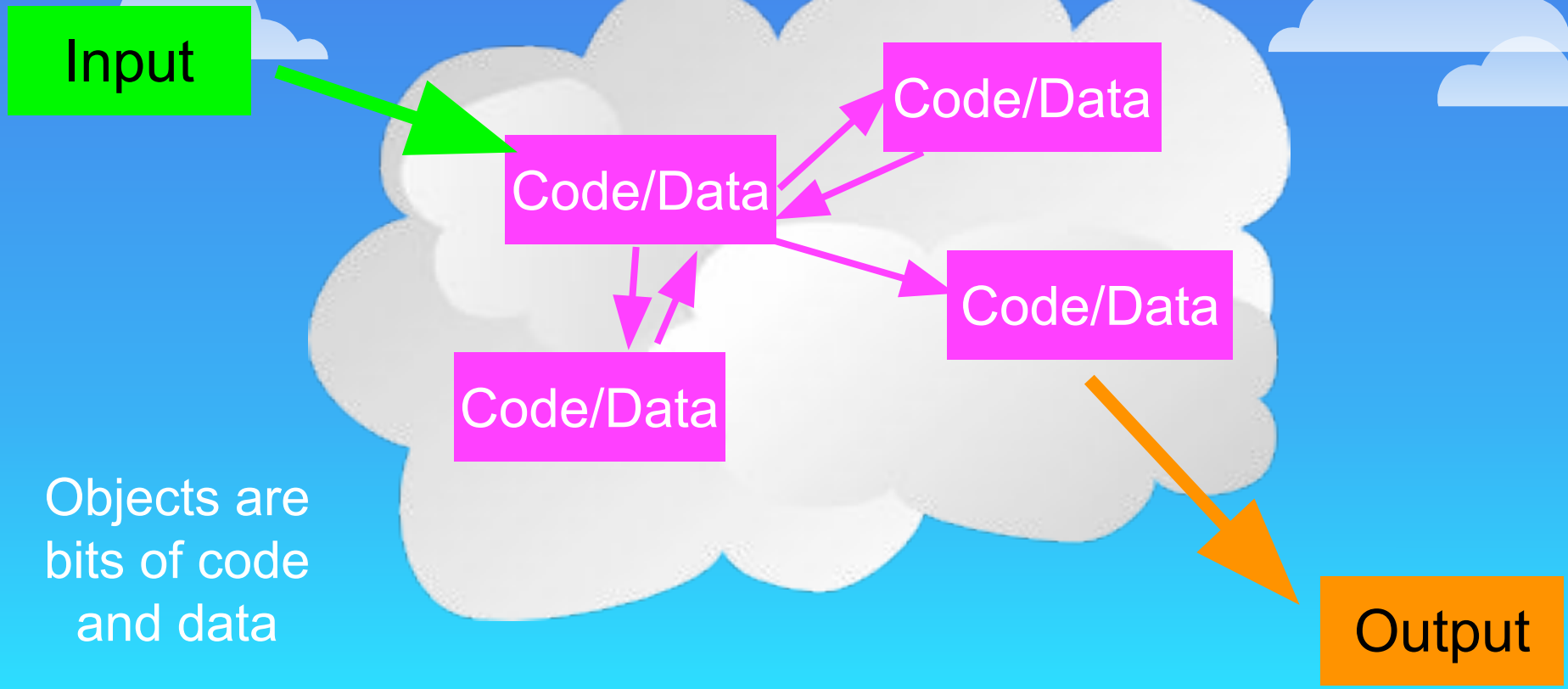
- A program is made up of many cooperating objects
- Instead of being the “whole program” - each object is a little “island” within the program and cooperatively working with other objects
- A program is made up of one or more objects working together - objects make use of each other’s capabilities

Object

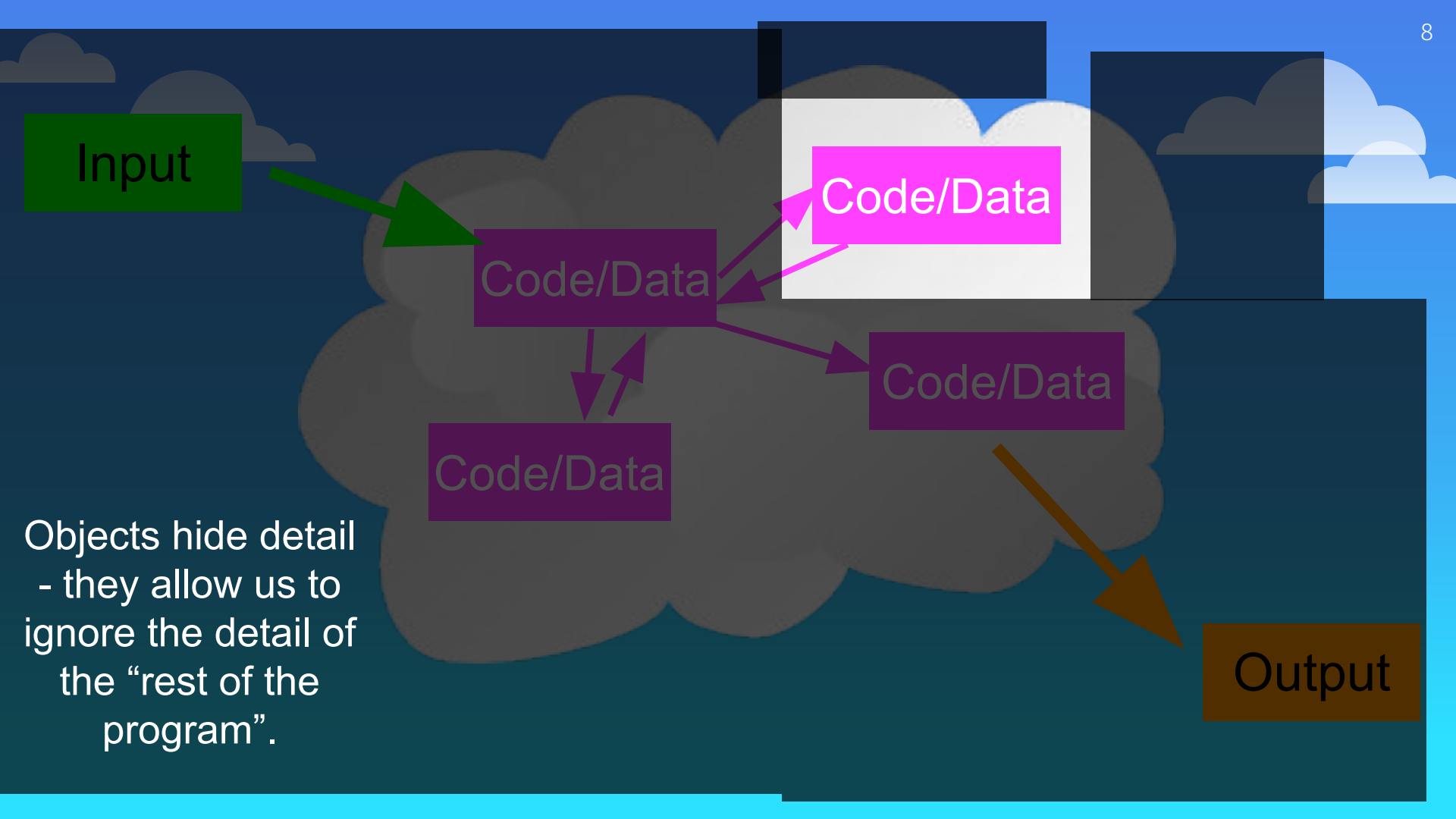
- An Object is a bit of self-contained Code and Data
- A key aspect of the Object approach is to break the problem into smaller understandable parts (divide and conquer)
- Objects have boundaries that allow us to ignore un-needed detail
- We have been using objects all along: String Objects, Integer Objects, Dictionary Objects, List Objects…



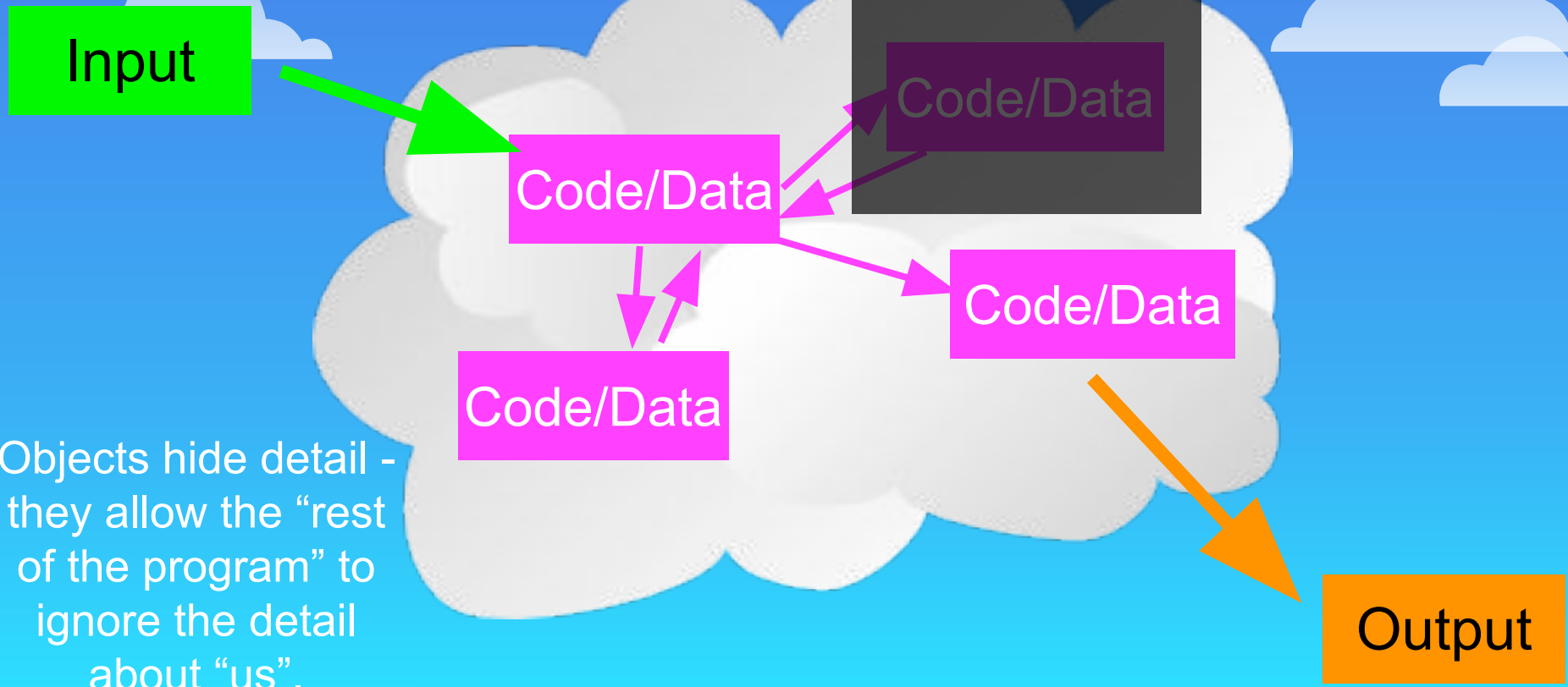
Objects get created and used



Objects are bits of code and data



Objects hide detail - they allow us to ignore the detail of the “rest of the program”.



Objects hide detail - they allow the “rest of the program” to ignore the detail about “us”.

Definitions

- Class - a template
- Method or Message - A defined capability of a class
- Field or attribute- A bit of data in a class
- Object or Instance - A particular instance of a class

Terminology: Class

Defines the abstract characteristics of a thing (object), including the thing's characteristics (its attributes, fields or properties) and the thing's behaviors (the things it can do, or methods, operations or features). One might say that a class is a blueprint or factory that describes the nature of something. For example, the class Dog would consist of traits shared by all dogs, such as breed and fur color (characteristics), and the ability to bark and sit (behaviors).

http://en.wikipedia.org/wiki/Object-oriented_programming

Terminology: Instance

One can have an instance of a class or a particular object. The instance is the actual object created at runtime. In programmer jargon, the Lassie object is an instance of the Dog class. The set of values of the attributes of a particular object is called its state. The object consists of state and the behavior that's defined in the object's class.

Object and Instance are often used interchangeably.

http://en.wikipedia.org/wiki/Object-oriented_programming

Terminology: Method

An object's abilities. In language, methods are verbs. Lassie, being a Dog, has the ability to bark. So bark() is one of Lassie's methods. She may have other methods as well, for example sit() or eat() or walk() or save_timmy(). Within the program, using a method usually affects only one particular object; all Dogs can bark, but you need only one particular dog to do the barking

Method and Message are often used interchangeably.

http://en.wikipedia.org/wiki/Object-oriented_programming

Some Python Objects

```
>>> x = 'abc'
>>> type(x)
<class 'str'>
>>> type(2.5)
<class 'float'>
>>> type(2)
<class 'int'>
>>> y = list()
>>> type(y)
<class 'list'>
>>> z = dict()
>>> type(z)
<class 'dict'>
```

```
>>> dir(x)
[ … 'capitalize', 'casefold', 'center', 'count',
'encode', 'endswith', 'expandtabs', 'find',
'format', … 'lower', 'lstrip', 'maketrans',
'partition', 'replace', 'rfind', 'rindex', 'rjust',
'rpartition', 'rsplit', 'rstrip', 'split',
'splitlines', 'startswith', 'strip', 'swapcase',
'title', 'translate', 'upper', 'zfill']
>>> dir(y)
[… 'append', 'clear', 'copy', 'count', 'extend',
'index', 'insert', 'pop', 'remove', 'reverse',
'sort']
>>> dir(z)
[…, 'clear', 'copy', 'fromkeys', 'get', 'items',
'keys', 'pop', 'popitem', 'setdefault', 'update',
'values']
```

A Sample Class

class is a reserved word

Each PartyAnimal object has a bit of code

Tell the an object to run the party() code within it

```
class PartyAnimal:
   x = 0

   def party(self) :
     self.x = self.x + 1
     print("So far",self.x)

an = PartyAnimal()

an.party()
an.party()
an.party()
```

This is the template for making PartyAnimal objects

Each PartyAnimal object has a bit of data

Construct a PartyAnimal object and store in an

PartyAnimal.party(an)

```
class PartyAnimal:
  x = 0

  def party(self) :
    self.x = self.x + 1
    print("So far",self.x)

an = PartyAnimal()

an.party()
an.party()
an.party()
```

```
$ python party1.py
```

```
class PartyAnimal:
  x = 0

  def party(self) :
    self.x = self.x + 1
    print("So far",self.x)

an = PartyAnimal()

an.party()
an.party()
an.party()
```

```
$ python party1.py
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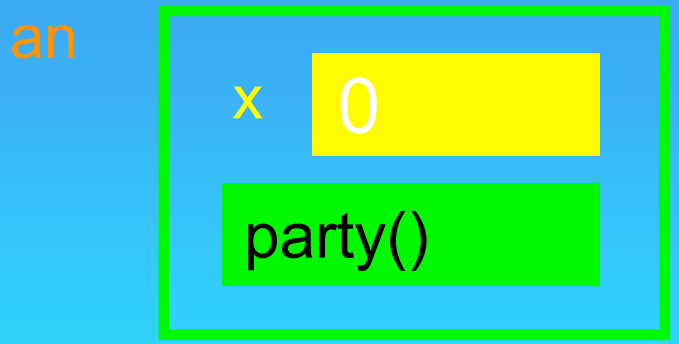


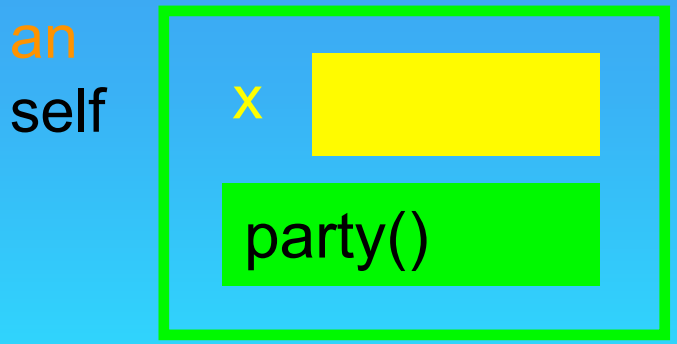
```
class PartyAnimal:
  x = 0

  def party(self) :
    self.x = self.x + 1
    print("So far",self.x)

an = PartyAnimal()

an.party()
an.party()
an.party()
```

```
$ python party1.py
So far 1
So far 2
So far 3
```



PartyAnimal.party(an)

Playing with dir() and type()

A Nerdy Way to Find Capabilities

- The dir() command lists capabilities
- Ignore the ones with underscores - these are used by Python itself
- The rest are real operations that the object can perform
- It is like type() - it tells us something *about* a variable

```
>>> y = list()
>>> type(y)
<class 'list'>
>>> dir(x)
['__add__', '__class__',
'__contains__', '__delattr__',
'__delitem__', '__delslice__',
'__doc__', … '__setitem__',
'__setslice__', '__str__',
'append', 'clear', 'copy',
'count', 'extend', 'index',
'insert', 'pop', 'remove',
'reverse', 'sort']
>>>
```

```
class PartyAnimal:
    x = 0

    def party(self) :
      self.x = self.x + 1
      print("So far",self.x)

an = PartyAnimal()

print("Type", type(an))
print("Dir ", dir(an))
```

We can use dir() to find the “capabilities” of our newly created class.

```
$ python party3.py
Type <class '__main__.PartyAnimal'>
Dir  ['__class__', ... 'party', 'x']
```

Try dir() with a String

```
>>> x = 'Hello there'
>>> dir(x)
['__add__', '__class__', '__contains__', '__delattr__',
'__doc__', '__eq__', '__ge__', '__getattribute__',
'__getitem__', '__getnewargs__', '__getslice__', '__gt__',
'__hash__', '__init__', '__le__', '__len__', '__lt__',
'__repr__', '__rmod__', '__rmul__', '__setattr__', '__str__',
'capitalize', 'center', 'count', 'decode', 'encode', 'endswith',
'expandtabs', 'find', 'index', 'isalnum', 'isalpha', 'isdigit',
'islower', 'isspace', 'istitle', 'isupper', 'join', 'ljust',
'lower', 'lstrip', 'partition', 'replace', 'rfind', 'rindex',
'rjust', 'rpartition', 'rsplit', 'rstrip', 'split',
'splitlines', 'startswith', 'strip', 'swapcase', 'title',
'translate', 'upper', 'zfill']
```

Object Lifecycle

http://en.wikipedia.org/wiki/Constructor_(computer_science)

Object Lifecycle

- Objects are created, used, and discarded
- We have special blocks of code (methods) that get called
  - At the moment of creation (constructor)
  - At the moment of destruction (destructor)
- Constructors are used a lot
- Destructors are seldom used

Constructor

The primary purpose of the constructor is to set up some instance variables to have the proper initial values when the object is created

```
class PartyAnimal:
    x = 0

    def __init__(self):
      print('I am
constructed')

    def party(self) :
      self.x = self.x + 1
      print('So far',self.x)

    def __del__(self):
      print('I am destructed',
self.x)

an = PartyAnimal()
an.party()
an.party()
an = 42
```

```
$ python party4.py
I am constructed
So far 1
So far 2
I am destructed 2
an contains 42
```

The constructor and destructor are optional. The constructor is typically used to set up variables. The destructor is seldom used.

Constructor

In object oriented programming, a constructor in a class is a special block of statements called when an object is created

http://en.wikipedia.org/wiki/Constructor_(computer_science)

Many Instances

- We can create lots of objects - the class is the template for the object
- We can store each distinct object in its own variable
- We call this having multiple instances of the same class
- Each instance has its own copy of the instance variables

```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, z):
      self.name = z
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

s = PartyAnimal("Sally")
j = PartyAnimal("Jim")

s.party()
j.party()
s.party()
```

Constructors can have additional parameters. These can be used to set up instance variables for the particular instance of the class (i.e., for the particular object).

party5.py

```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, z):
      self.name = z
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

s = PartyAnimal("Sally")
j = PartyAnimal("Jim")

s.party()
j.party()
s.party()
```

```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, z):
      self.name = z
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

s = PartyAnimal("Sally")
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s.party()
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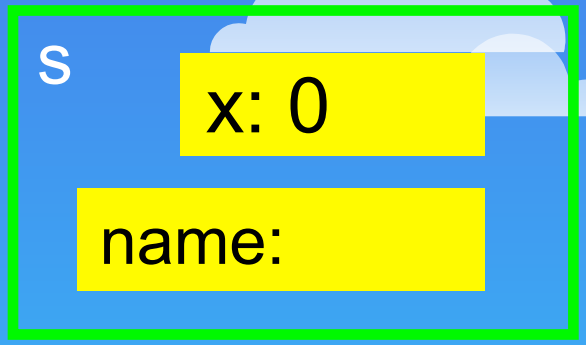
```



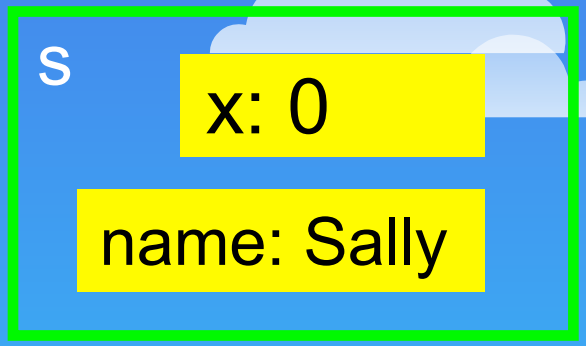
```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, z):
      self.name = z
      print(self.name,"constructed")

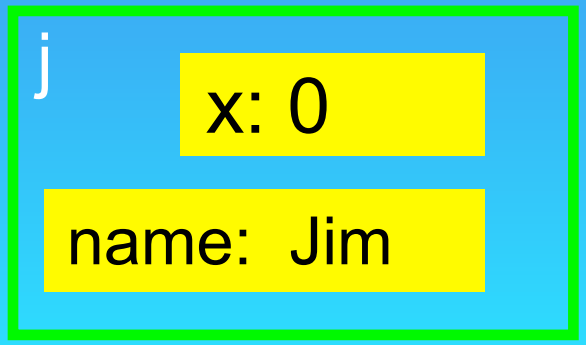
    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

s = PartyAnimal("Sally")
j = PartyAnimal("Jim")

s.party()
j.party()
s.party()
```

We have two independent instances





```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, z):
      self.name = z
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

s = PartyAnimal("Sally")
j = PartyAnimal("Jim")

s.party()
j.party()
s.party()
```

```
Sally constructed
Jim constructed
Sally party count 1
Jim party count 1
Sally party count 2
```

Inheritance

http://www.ibiblio.org/g2swap/byteofpython/read/inheritance.html

Inheritance

- When we make a new class - we can reuse an existing class and inherit all the capabilities of an existing class and then add our own little bit to make our new class
- Another form of store and reuse
- Write once - reuse many times
- The new class (child) has all the capabilities of the old class (parent) - and then some more

Terminology: Inheritance

‘Subclasses’ are more specialized versions of a class, which inherit attributes and behaviors from their parent classes, and can introduce their own.

http://en.wikipedia.org/wiki/Object-oriented_programming

```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
      self.name = nam
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

class FootballFan(PartyAnimal):
    points = 0
    def touchdown(self):
       self.points = self.points + 7
       self.party()
       print(self.name,"points",self.points)
```

```
s = PartyAnimal("Sally")
s.party()

j = FootballFan("Jim")
j.party()
j.touchdown()
```

FootballFan is a class which extends PartyAnimal. It has all the capabilities of PartyAnimal and more.

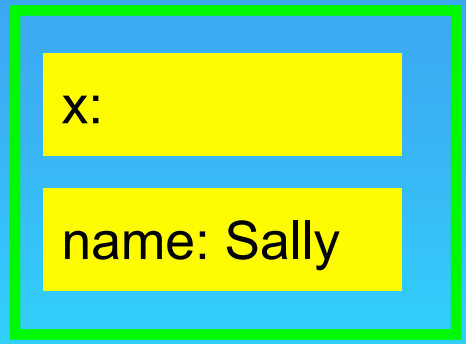
```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
      self.name = nam
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

class FootballFan(PartyAnimal):
    points = 0
    def touchdown(self):
       self.points = self.points + 7
       self.party()
       print(self.name,"points",self.points)
```

```
s = PartyAnimal("Sally")
s.party()

j = FootballFan("Jim")
j.party()
j.touchdown()
```



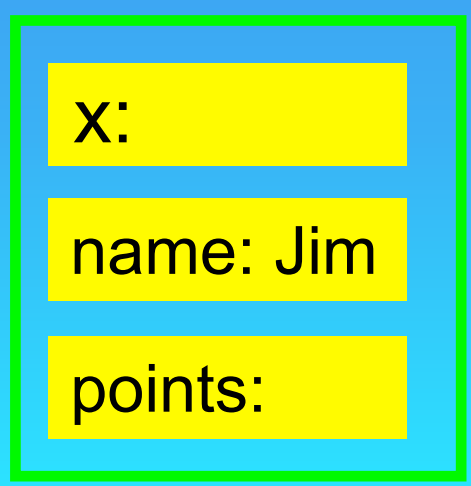
```
class PartyAnimal:
    x = 0
    name = ""
    def __init__(self, nam):
      self.name = nam
      print(self.name,"constructed")

    def party(self) :
      self.x = self.x + 1
      print(self.name,"party count",self.x)

class FootballFan(PartyAnimal):
    points = 0
    def touchdown(self):
       self.points = self.points + 7
       self.party()
       print(self.name,"points",self.points)
```

```
s = PartyAnimal("Sally")
s.party()

j = FootballFan("Jim")
j.party()
j.touchdown()
```



Encapsulation

Encapsulation

- Encapsulation gives you more control over the degree of coupling in your code, it allows a class to change its implementation without affecting other parts of the code.
- Why would you create them? Because some of the private values you may want to change after creation of the object while others may not need to be changed at all.

Encapsulation

Encapsulation

Encapsulation

The method can actually be called using redcar._Car__updateSoftware()

Encapsulation

Encapsulation

```
#!/usr/bin/env python

class Car:

    __maxspeed = 0
    __name = ""

    def __init__(self):
        self.__maxspeed = 200
        self.__name = "Supercar"

    def drive(self):
        print 'driving. maxspeed ' + str(self.__maxspeed)

    def setMaxSpeed(self,speed):
        self.__maxspeed = speed

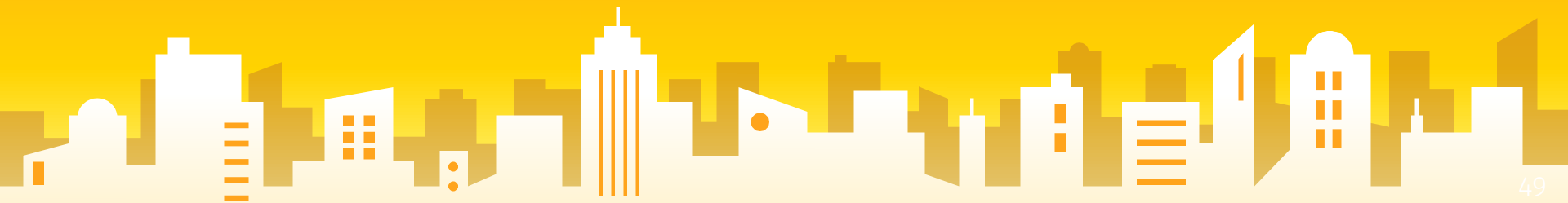
redcar = Car()
redcar.drive()
redcar.setMaxSpeed(320)
redcar.drive()
```

Definitions

- Class - a template
- Attribute – A variable within a class
- Method - A function within a class
- Object - A particular instance of a class
- Constructor – Code that runs when an object is created
- Inheritance - The ability to extend a class to make a new class.

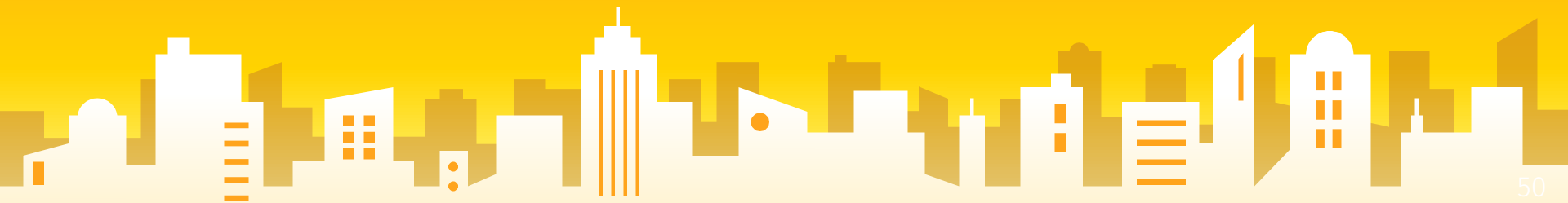
Write a Python class to convert an integer to a roman numeral.

Assignment



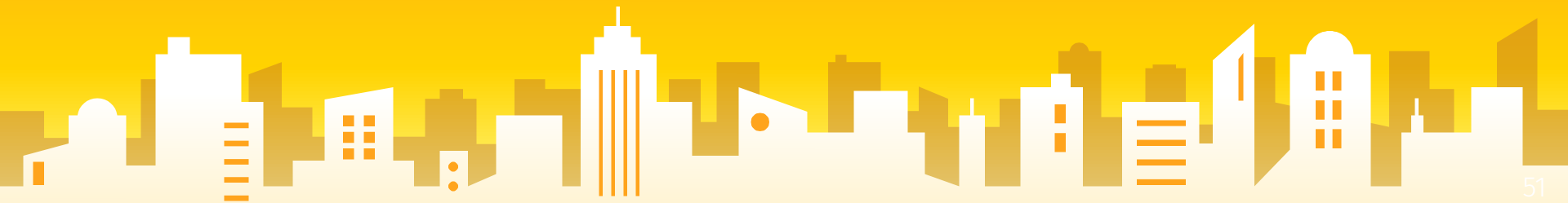
Write a Python class to convert a roman numeral to an integer.

Assignment



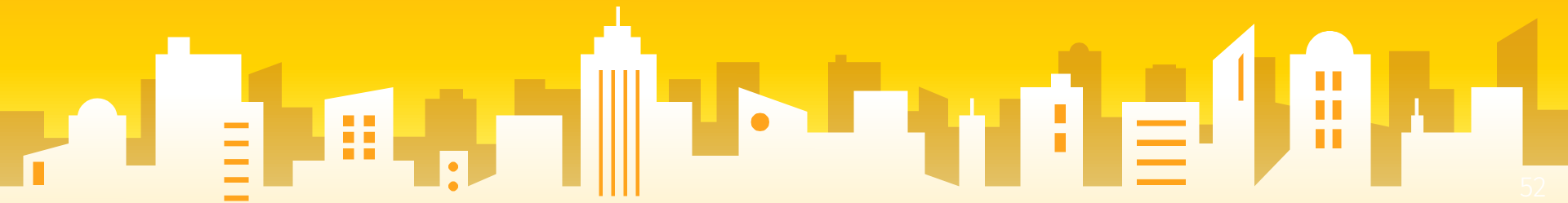
Write a Python class to find validity of a string of parentheses, '(', ')', '{', '}', '[' and ']. These brackets must be close in the correct order, for example "()" and "()[]{}" are valid but "[)", "({[)]" and "{{{" are invalid.

Assignment



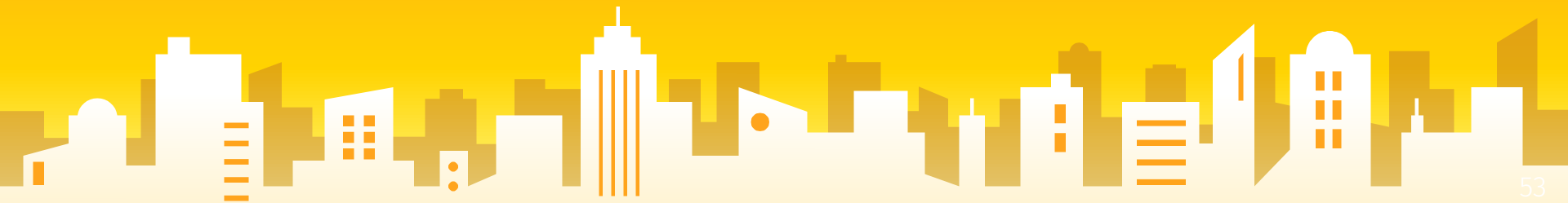
Write a Python class to get all possible unique subsets from a set of distinct integers.

Assignment



Write a Python class to find the three elements that sum to zero from a set of n real numbers.

Assignment



Thank you

Miss You...