# Python: Object Oriented Programming - 2

# Recap

- Object Orientation
  - merge data and functions (that operate on the data) together into classes
  - class is like a blue print of an object
  - objects are instances of a class
  - typically two kinds of members in a class
    - members that store data are attributes
    - members that are functions are methods

# Exmple 1: Class Coordinate

Keyword to indicate declaration of a class

```
class Coordinate(object):

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def distance(self, other):
        x_diff_sq = (self.x - other.x)*(self.x - other.x)
        y_diff_sq = (self.y - other.y)*(self.y - other.y)
        return sqrt(x_diff_sq + y_diff_sq)
```

# Exmple 1: Class Coordinate

Name of a class

```
class Coordinate(object):

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def distance(self, other):
        x_diff_sq = (self.x - other.x)*(self.x - other.x)
        y_diff_sq = (self.y - other.y)*(self.y - other.y)
        return sqrt(x_diff_sq + y_diff_sq)
```

# Exmple 1: Class Coordinate

Parent class

```
class Coordinate(object):

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def distance(self, other):
        x_diff_sq = (self.x - other.x)*(self.x - other.x)
        y_diff_sq = (self.y - other.y)*(self.y - other.y)
        return sqrt(x_diff_sq + y_diff_sq)
```

# Exmple 1: Class Coordinate

```
class Coordinate(object):

    def __init__(self, x, y):
        self.x = x
        self.y = y

    def distance(self, other):
        x_diff_sq = (self.x - other.x)*(self.x - other.x)
        y_diff_sq = (self.y - other.y)*(self.y - other.y)
        return sqrt(x_diff_sq + y_diff_sq)
```

special method
constructor

# Exmple 1: Class Coordinate

```
class Coordinate(object):
```

```
    def __init__(self, x, y):
        self.x = x
        self.y = y
```

method distance

```
    def distance(self, other):
        x_diff_sq = (self.x - other.x)*(self.x - other.x)
        y_diff_sq = (self.y - other.y)*(self.y - other.y)
        return sqrt(x_diff_sq + y_diff_sq)
```

# Exmple 1: Class Coordinate

```
c = Coordinate(3,4)
z = Coordinate(0,0)

d = c.distance(z)
print(d)

d = Coordinate.distance(c,z)
print(d)
```

new object of type Coordinate with initial attributes

Equivalent

# Operator Overloading

What the operator does, depends on the objects it operates on. For example:

```
>>> a = "Hello "; b = "World"
>>> a + b # concatenation
'Hello World'
>>> c = 10; d = 20
>>> c + d # addition
30
```

This is called *operator overloading* because the operation is overloaded with more than one meaning.

# Exmple 2: Class Fraction

```
class Fraction(object):

    def __init__(self, num, denom):
        self.num = num
        self.denom = denom
    def __str__(self):
        return str(self.num) + "/" + str(self.denom)
    def __add__(self, other):
        num = self.num*other.denom + self.denom*other.num
        denom = self.denom*other.denom
        return Fraction(num, denom)
    def __sub__(self, other):
        num = self.num*other.denom - self.denom*other.num
        denom = self.denom*other.denom
        return Fraction(num, denom)
    def __float__(self):
        return self.num/self.denom
```

# Methods: set and get

A well designed class provides methods to get and set attributes.

- These methods define the *interface* to that class.
- This allows to perform error checking when values are set, and to hide the implementation of the class from the user.

# Methods: set and get

```
class Time(object):
  def __init__(self,hour,min):
      self.setHour(hour)
      self.setMin(min)

  def setHour(self, hour):
    if 0 <= hour <= 23:
      self.hour = hour
    else:
      raise ValueError("Invalid hour value")

  def setMin(self, min):
    if 0 <= min <= 59:
      self.min = min
    else:
      raise ValueError("Invalid min value")
```

# Methods: set and get

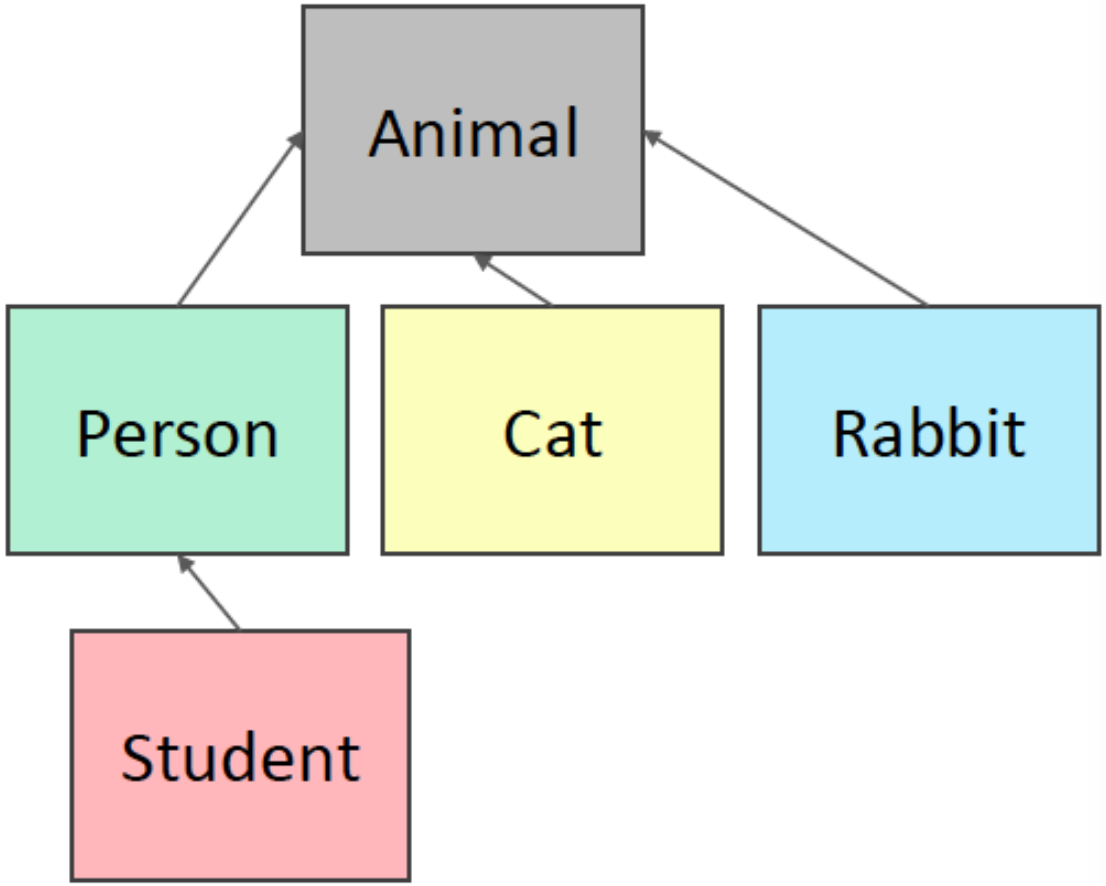
```
  def getHour(self):
      return self.hour

  def getMin(self):
      return self.min

t = Time(15,45)
print(t.getHour())
t.setHour(34)
print(t.getHour())
```

# Class Hierarchy

- **parent class** (superclass)
- **child class** (subclass)
  - **inherits** all data and behaviors of parent class
  - **add** more **info**
  - **add** more **behavior**
  - **override** behavior




Source:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/lecture-slides-code/

# Class Inheritance

Sometimes, we need classes that share certain (or very many, or all) attributes but are slightly different.

- Example 1: Geometry
  - a point (in 2 dimensions) has an *x* and *y* attribute
  - a circle is a point with a radius
  - a cylinder is a circle with a height
- Example 2: People at universities
  - A person has an address.
  - A student is a person and selects modules.
  - A lecturer is a person with teaching duties.

- In these cases, we define a *base class* and *derive* other classes from it.
- This is called *inheritance*.

# Class Inheritance

```
class Animal(object):
    def __init__(self, age):
        self.age = age
        self.name = None
    def get_age(self):
        return self.age
    def get_name(self):
        return self.name
    def set_age(self, newage):
        self.age = newage
    def set_name(self, newname=""):
        self.name = newname
    def __str__(self):
        return "animal:"+str(self.name)+":"+str(self.age)
```

- everything is an object
- class `object`
implements basic operations in Python, like binding variables, etc

Source:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/lecture-slides-code/

# INHERITANCE: SUBCLASS

inherits all attributes of `Animal`:
`__init__()`
`age, name`
`get_age(), get_name()`
`set_age(), set_name()`
`__str__()`

```
class Cat(Animal):
    def speak(self):
        print("meow")
    def __str__(self):
        return "cat:"+str(self.name)+":"+str(self.age)
```

add new functionality via speak method

overrides `__str__`

- add new functionality with `speak()`
  - instance of type `Cat` can be called with new methods
  - instance of type `Animal` throws error if called with `Cat`'s new method
- `__init__` is not missing, uses the `Animal` version

Source:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/lecture-slides-code/

# Class Inheritance

- subclass can have **methods with same name** as superclass
- for an instance of a class, look for a method name in **current class definition**
- if not found, look for method name **up the hierarchy** (in parent, then grandparent, and so on)
- use first method up the hierarchy that you found with that method name

Source:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0001-introduction-to-computer-science-and-programming-in-python-fall-2016/lecture-slides-code/

# Class Inheritance: Another Example

```
import math

class Point:                          # this is the base class
    """Class that represents a point """
    def __init__(self, x=0, y=0):
        self.x = x
        self.y = y

class Circle(Point):                  # is derived from Point
    """Class that represents a circle """
    def __init__(self, x=0, y=0, radius=0):
        Point.__init__(self, x, y)
        self.radius = radius
```

Source:Computational Science and Engineering in Python by Hans Fangohr, Engineering and Environment, University of Southampton, United Kingdom

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class Circle(Point):                  # is derived from Point
    """Class that represents a circle """
    def __init__(self, x=0, y=0, radius=0):
        Point.__init__(self, x, y)
        self.radius = radius
```

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# Class Inheritance: Another Example

```
    def area(self):
        return math.pi * self.radius ** 2

class Cylinder(Circle):              # is derived from Circle
    """Class that represents a cylinder"""

    def __init__(self, x=0, y=0, radius=0, height=0):
        Circle.__init__(self, x, y, radius)
        self.height = height

    def volume(self):
        return self.area() * self.height
```

Source:Computational Science and Engineering in Python by Hans Fangohr, Engineering and Environment, University of Southampton, United Kingdom