MSML 605

Show Jupyter Notebook Demo for pickle and joblib

Objects and Classes

Outline

- Objects, classes, and object-oriented programming
  - relationship between classes and objects
  - abstraction
- Anatomy of a class
  - instance variables
  - instance methods
  - constructors

Objects and classes

- **object**: An entity that combines state and behavior.
  - **object-oriented programming (OOP)**: Writing programs that perform most of their behavior as interactions between objects.
- **class**: 1. A program. or,
  2. A blueprint of an object.
  - classes you may have used so far:

    `str, list, dict, etc`
- We will write classes to define new types of objects.

Abstraction

- **abstraction**: A distancing between ideas and details.
  - Objects in Python provide abstraction:
    We can use them without knowing how they work.

- You use abstraction every day.
  Example: Your smart phone.
  - You understand its external behavior (home button, screen, etc.)
  - You don't understand its inner details (and you don't need to).

Encapsulation

- **encapsulation**:
  Hiding implementation details of an object from clients.
- Encapsulation provides *abstraction*;
  we can use objects without knowing how they work.

  The object has:
  - an external view (its behavior)
  - an internal view (the state and methods that accomplish the behavior)

Class = blueprint, Object = instance

Music player blueprint

state:
current song
volume
battery life

behavior:
power on/off
change station/song
change volume
choose random song

Music player #1

state:
song = "Let it snow"
volume = 17
battery life = 2.5 hrs

behavior:
power on/off
change station/song
change volume
choose random song

Music player #2

state:
song = "Galaxy song"
volume = 9
battery life = 3.41 hrs

behavior:
power on/off
change station/song
change volume
choose random song

Music player #3

state:
song = "Code Monkey"
volume = 24
battery life = 1.8 hrs

behavior:
power on/off
change station/song
change volume
choose random song

Scope

```python
def scopes():
    def localscope():
        s = 'local scope'

    def notlocalscope():
        nonlocal s
        s = 'nonlocal scope'

    def globalscope():
        global s
        s = 'global scope'

    s = 'scope'
    localscope()
    print('After local scope: ',s)
    notlocalscope()
    print('After notlocalscope: ',s)
    globalscope()
    print('After global scope: ',s)

print('Before calling scope')
scopes()
print('After calling scope ', s)
```

```
Before calling scope
After local scope:  scope
After notlocalscope:  nonlocal scope
After global scope:  nonlocal scope
After calling scope  global scope
```

Class example

```python
class test():
    """ Example class"""
    x = 14
    def t(self):
        return('test class')

r = test()
print(r.x)
a = r.t()
print(a)
```

```
14
test class
```

Class constructor

```
class Complex:
    def __init__(self, realpart, imagpart):
        self.r = realpart
        self.i = imagpart
```

```
x = Complex(3,4)
x.r,x.i
```

```
(3, 4)
```

Instance variables and behavior (definitions)

```
class Cars():
    def __init__(self,model,color,year):
        self.model = model
        self.color = color
        self.year = year
        self.kind = 'Automobile'
        self.behavior = []
    def add_behavior(self,move):
        self.behavior.append(move)
```

Instance variables and behavior (definitions)

```
class Cars():
    def __init__(self,model,color,year):
        self.model = model
        self.color = color
        self.year = year
        self.kind = 'Automobile'
        self.behavior = []
    def add_behavior(self,move):
        self.behavior.append(move)
```

```
c1 = Cars('Toyota','Silver','2009')
```

```
print(c1.model,c1.color,c1.year)
```

```
Toyota Silver 2009
```

```
c1.add_behavior('start')
```

```
print(c1.behavior)
```

```
['start']
```

```
c2 = Cars('Honda','white','2010')
```

```
print(c2.model,c2.color,c2.year)
```

```
Honda white 2010
```

```
c2.add_behavior('accelerate')
```

```
print(c2.behavior)
```

```
['accelerate']
```

How often would you expect to get snake eyes?

If you're unsure on how to compute the probability then you write a program that simulates the process

Snake Eyes

```
class SnakeEyes():
    def __init__(self,num_rolls):
        self.rolls = num_rolls
        self.count = 0
    def rollingDie(self):
        die1 = Die(6)
        die2 = Die(6)

        for i in range(self.rolls):
            face1Val = die1.roll()
            face2Val = die2.roll()
            # print(face1Val,' ',face2Val)
            # print("===========================")
            if face1Val == 1 and face2Val == 1:
                self.count += 1
        print("Num Snake Eyes: ",self.count)
        print("Num Rolls: ",self.rolls)
        print("Snake eyes probability: ", self.count/self.rolls)


def main():
    s = SnakeEyes(5000)
    s.rollingDie()

if __name__ == "__main__":
    main()
```

Need to write the Die class!

Die object

- State (data) of a `Die` object:

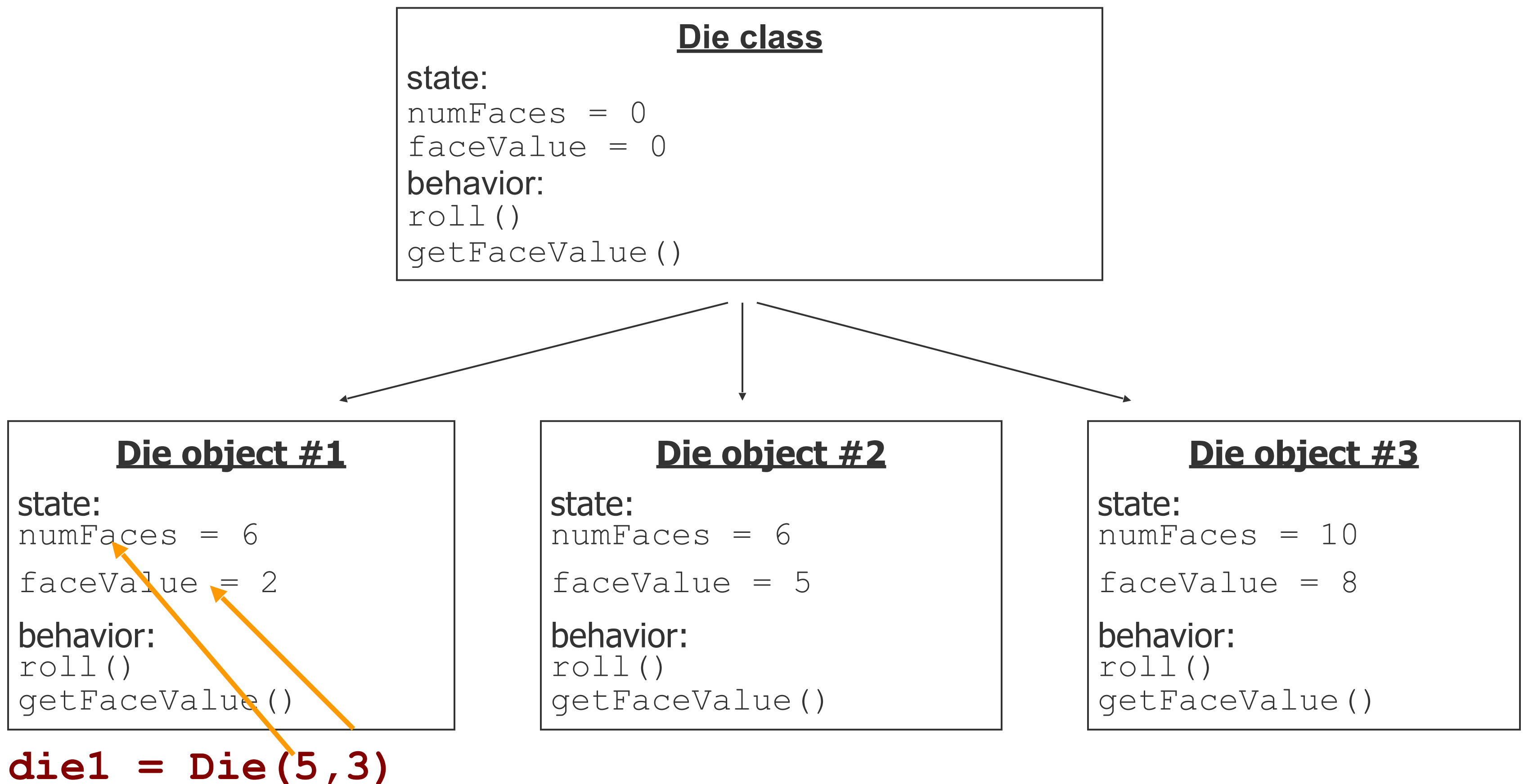
Instance variable	Description
`numFaces`	the number of faces for a die

- Behavior (methods) of a `Die` object:

Method name	Description
`roll()`	roll the die

The Die class

- The class (blueprint) knows how to create objects.



Object state: instance variables

Die class

- The following code creates a new class named `Die`.

```
class Die():
    faceValue = 0
    def __init__(self,faces):
        self.numFaces = faces
```

declared outside of any method

  - Save this code into a file named `Die.py`.
- Each `Die` object contains two pieces of data:
  - `numFaces`
  - `faceValue`
- No behavior (yet).

dice = Die(5)

Instance variables

- **instance variable**: A variable inside an object that holds part of its state.
  - Each object has *its own copy*.
- Declaring an instance variable:

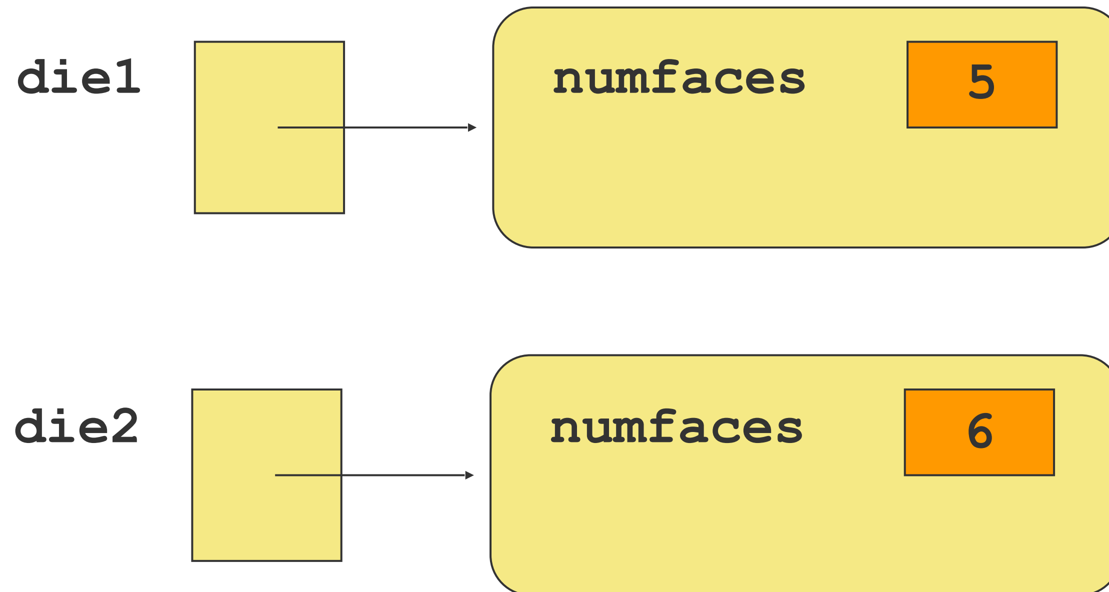
  <name>* = *<value>

```
class Die():
    faceValue = 0
    def __init__(self,faces):
        self.numFaces = faces
```

Instance variables

Each `Die` object maintains its own `numFaces` and `faceValue` variable, and thus its own state

```
die1 = Die(5)
die2 = Die(6)
```



Accessing instance variables

- Code in other classes can access your object's instance variables.
  - Accessing an instance variable: dot operator

    <variable name> . <instance variable>

  - Modifying an instance variable:

    <variable name> . <instance variable> = ***<value>***

- Examples:

```
print(”you rolled “, die.faceValue)
die.faceValue = 20
```

Client code

- `Die and snakeEyes` can have a main …
  - We will almost always do this…. WHY?
  - To test the class before it is used by other classes
- or can be used by other programs stored in separate `.py` files.
  - **client code***:* Code that uses a class

`Roll.py` (client code)

```
def main():
    s = SnakeEyes(5000)
    s.rollingDie()

if __name__ == "__main__":
    main()
```

`snakeEyes.py`

```
class SnakeEyes():
    def __init__(self,num_rolls):
        self.rolls = num_rolls
        self.count = 0
    .. ..
```

Object behavior: methods

OO Instance methods

- Classes combine state and behavior.
- **instance variables:** define state
- **instance methods**:
  define behavior for each object of a class. methods are the way objects communicate with each other and with users
- instance method declaration, general syntax:

<name> (***<parameter(s)>***) **:**

<statement(s)>

Rolling the dice: instance methods

```
class SnakeEyes():
    def __init__(self,num_rolls):
        self.rolls = num_rolls
        self.count = 0
    def rollingDie(self):
        die1 = Die(6)
        die2 = Die(6)

        for i in range(self.rolls):
            face1Val = die1.roll()
            face2Val = die2.roll()
            # print(face1Val,' ',face2Val)
            # print("============================")
            if face1Val == 1 and face2Val == 1:
                self.count += 1
        print("Num Snake Eyes: ",self.count)
        print("Num Rolls: ",self.rolls)
        print("Snake eyes probability: ", self.count/self.rolls)

class Die():
    faceValue = 0
    def __init__(self,faces):
        self.numFaces = faces
        # self.faceValue = faceVal
    def roll(self):
        faceValue = random.randrange(1,self.numFaces + 1)
        return faceValue
```

Object initialization: constructors

Initializing objects

- When we create a new object, we can assign values to all, or some of, its instance variables:

```
die1 = Die(6)
```

Die constructor

```
class Die():
    faceValue = 0
    def __init__(self,faces):
        self.numFaces = faces
        # self.faceValue = faceVal
    def roll(self):
        faceValue = random.randrange(1,self.numFaces + 1)
        return faceValue
```

```
die1 = Die(6)
```

Constructors

- **constructor**: creates and initializes a new object

```
def __init__ ( <parameter(s)> ) :
    <statement(s)>
```

  - For a constructor function name is __init__
  - A constructor runs when the client calls the `class`.
  - A constructor implicitly returns the newly created and initialized object.
  - You can create an object without calling on a constructor.

Multiple Constructors

- It is not supported by default.
- To define a class other than using __init__(), we can use a class method
- A class method receives the class as the first argument.
- This class is used within the method to create and return the final instance.

No Constructor

- When we want to create an object for a class without calling the constructor, we should use __new__

```
class noConstructorCall:
    def h(self):
        print("Hello")

t = noConstructorCall.__new__(noConstructorCall)
t.h()
```

Magic methods

- When we want to create an object for a class without calling the constructor, we should use __new__

```
class noConstructorCall:
    def h(self):
        print("Hello")

t = noConstructorCall.__new__(noConstructorCall)
t.h()
```

Magic methods

```
class magicMethods():
    def __new__(cls,*args,**kwargs):
        print("Magic Method runs first")
        print(cls)
        print(args)
        print(kwargs)
    def __init__(self,val1):
        self.val = val
        print("Inside magic methods")
```

```
instance = magicMethods(5)
```

```
instance
```

```
Magic Method runs first
<class '__main__.magicMethods'>
(5,)
{}
```

Magic methods

```
class magicMethods():
    def __new__(cls,*args,**kwargs):
        print("Magic Method runs first")
        print(cls)
        print(args)
        print(kwargs)
    def __init__(self,val1):
        self.val = val
        print("Inside magic methods")
```

```
instance = magicMethods(5,1,x =3,y=4)
```

```
Magic Method runs first
<class '__main__.magicMethods'>
(5, 1)
{'x': 3, 'y': 4}
```