1 Administrative Topics

- Let’s look at Project 8 images.

2 Inheritance with Shapes

Today, in lab, you will be designing classes to make standard, geometric shapes.

Let’s look at the drawString method in Interpreter. It takes a distance, an angle, and a string. It does not mandate that the string is generated by an L-system. That means we can use this class to draw non-L-system shapes (modularity at work!). For example.

```python
terp = interpreter.Interpreter()
terp.drawString(dstring='F−F−F−F', distance=100, angle=90)
```

And we draw a square.

Let’s design a Shape class that can draw the shape specified by a string field.

```python
def __init__(self, distance = 100, angle = 90, color = (0, 0, 0), istring = ''):
    self.distance = distance
    self.angle = angle
    self.color = color
    self.string = istring
```
```python
def draw(self, xpos, ypos, scale=1.0, orientation=0):
    terp = interpreter.Interpreter()
    terp.place(xpos, ypos, orientation)
    terp.color(self.color)
    terp.drawString(self.string, distance=self.distance*scale,
                    angle=self.angle)
```

We have a draw method that uses methods in the Interpreter to place, orient, and draw the given string. We should have accessor and mutator methods for the data fields, but we won’t take the time to do that now.

Now we can make specific shapes by deriving a subclass the the Shape class (it is a super class). For example a Square:

```python
class Square(Shape):
    def __init__(self, distance=100, color=(0, 0, 0)):
        Shape.__init__(self, distance=distance, angle=90, color=color, istring='−F−F−F−F−')
```

We use the parentheses in the class definition to indicate that the Square is derived from a Shape. Another way of putting it is “A Square is a Shape”. The Square class inherits all of the methods from the Shape class. That means its symbol table has an entry for each method in Shape, and that its value is an arrow directing you to the corresponding entry in Shape’s symbol table. With one exception... Square has an __init__ method that overrides the __init__ method of the Shape class. That means the entry for __init__ in Square’s symbol table contains an arrow pointing to this new method.

When a new Square is instantiated using the code `s = Square()`, a new object of type Square is created, and then Square’s __init__ method is called on that new object. The body of Square.__init__ then, in turn, calls Shape.__init__ because we still want to run that code. Notice that the Class.method(obj) notation is used. This is the only way to force the overridden method to run.

When a the line `s.draw(xpos=0,ypos=0)` is executed, python goes to s’s symbol table and looks up draw. It finds a pointer to the draw entry in the Square class symbol table, which in turn contains a pointer to the draw entry in the Shape class. Finally, the draw entry in the Shape class contains a method, and that method is executed. In other words, a chain of arrows leads us from the instance object to the method. It may lead us all the way up the inheritance hierarchy, or it may stop sooner when it arrives at an overriding
method (as it does with the \_init\_ method).

3 Symbol tables and inheritance

When a child class is derived from a parent class, its symbol tables entries are “copied” from the parent class’s symbol table (i.e. the values are pointers to the corresponding entries in the parent’s table). Any method that overrides the parent’s method has a value that points to the new function (instead of an arrow to the parent table). Consider the Shape class from the project. It has methods \_init\_ and draw (in addition to a bunch of mutators that I will ignore for this example). The Square class is derived from the Shape class, and it overrides the \_init\_ method. So we have these two symbol tables as shown in Fig. 1.
Figure 1: Symbol tables for parent class Shape and child class Square
When we make an instance of the Square class (i.e. a Square object), the object’s symbol table contains entries pointing to the Square table’s entries. It also contains data field (e.g. distance). If we were to call the draw method on the object, Python would look in the object’s symbol table for the draw entry, and follow the arrow up to the Square table’s draw entry, and up to the Shape table’s draw entry until it finally finds the function definition. See Fig. 2 for the arrows.

![Symbol tables for parent class Shape, child class Square, and a Square object](image)

Figure 2: Symbol tables for parent class Shape, child class Square, and a Square object
4 Parameters to \_init\_

When we design the class, we decide who should have control over the initial values:

- The user/caller/main code must determine it. Then we include it as a parameter, and force the user to supply a value. We use that value to initialize the field.

  ```python
  def \_init\_(self, name):
      self.name = name
  ```

- The user has the option of supplying the value. We include it as a parameter, but provide a default value, so the user can include or exclude a name argument.

  ```python
  def \_init\_(self, name='George '):
      self.name = name
  ```

- We mandate the initial name is some specific value (e.g. 'Milo'). We exclude it as a parameter, so the user has no ability to set the value.

  ```python
  def \_init\_(self):
      self.name = 'Milo'
  ```

We use the first option for a Student’s name. We could use the second option for the year if we are creating a bunch of MatriculatedStudents at once, and most are going to graduate the same year. We use the third option for a Student’s grades (the list must start empty).

5 Dictionaries

I need to tell you about a very neat data structure that Python supports, that is similar to a list, but doesn’t require the indexing to use numbers. It is called a dictionary and it maps “keys” to values.

Suppose we want to build a dictionary mapping names to favorite color.
Here is the code to do it:

```python
d = {}
# make empty dictionary

d['George'] = 'black'
d['Stephanie'] = 'purple'
d['Scott'] = 'green'
d['Milo'] = 'blue'
```

We can explicitly test to see if certain values are in the dictionary. And we can access values.

```python
# Is there a color for Linda?
print 'Linda' in d

# Is there a color for George?
print 'George' in d

# What is George's favorite color?
print d['George']
```