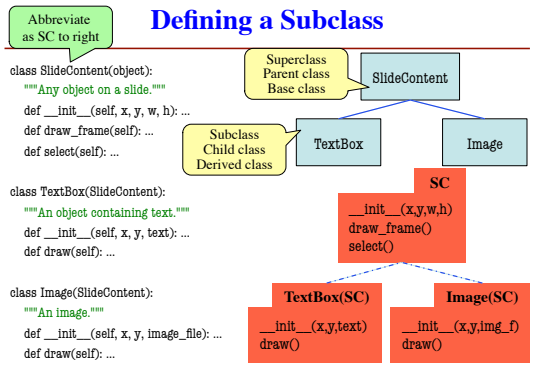
An Application

- **Goal**: Presentation program (e.g. PowerPoint)
- **Problem**: There are many types of content
  - **Examples**: text box, rectangle, image, etc.
  - Have to write code to display each one
- **Solution**: Use object oriented features
  - Define class for every type of content
  - Make sure each has a draw method:

```
for x in slide[i].contents:
    x.draw(window)
```

Defining a Subclass



Class Definition: Revisited

```
class <name>(<superclass>):
    """Class specification"""
    getters and setters
    initializer (__init__)
    definition of operators
    definition of methods
    anything else
```

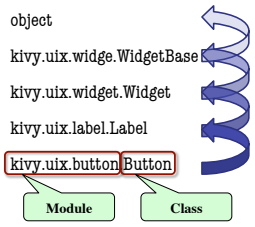
Class type to extend (may need module name)

- Every class must extend *something*
- Previous classes all extended object

object and the Subclass Hierarcy

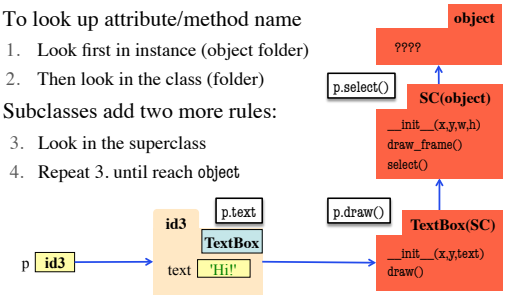
- Subclassing creates a **hierarchy** of classes
  - Each class has its own super class or parent
  - Until object at the "top"
- object has many features
  - Special built-in fields: __class__, __dict__
  - Default operators: __str__, __repr__

Kivy Example



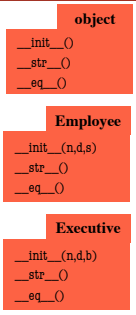
Name Resolution Revisited

- To look up attribute/method name
  1. Look first in instance (object folder)
  2. Then look in the class (folder)
- Subclasses add two more rules:
  3. Look in the superclass
  4. Repeat 3. until reach object



A Simpler Example

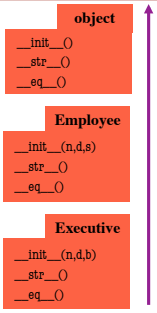
```
class Employee(object):
    """Instance is salaried worker
    INSTANCE ATTRIBUTES:
        name:  full name [string]
        start:  first year hired
                [int ≥ -1, -1 if unknown]
        salary: yearly wage [float]"""

class Executive(Employee):
    """An Employee with a bonus
    INSTANCE ATTRIBUTES:
        bonus: annual bonus [float]"""
```



Method Overriding

- Which __str__ do we use?
  - Start at bottom class folder
  - Find first method with name
  - Use that definition
- New method definitions **override** those of parent
- Also applies to
  - Initializers
  - Operators
  - Properties

  } all "methods"



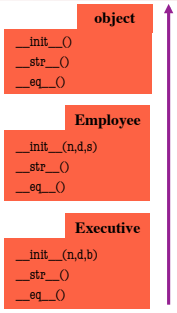
Accessing the "Previous" Method

- What if you want to use the original version method?
  - New method = original+more
  - Do not want to repeat code from the original version
- Call old method **explicitly**
  - Use method as a function
  - Pass object as first argument
- **Example**: Employee.__str__(self)
- **Cannot do with properties**

```
class Employee(object):
    """An Employee with a salary"""
    ...
    def __str__(self):
        return (self.name +
                ', year ' + str(self.start) +
                ', salary ' + str(self.salary))

class Executive(Employee):
    """An Employee with a bonus."""
    ...
    def __str__(self):
        return (Employee.__str__(self)
                + ', bonus ' + str(self.bonus) )
```

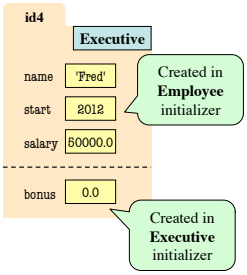
Primary Application: Initializers

```
class Employee(object):
    ...
    def __init__(self,n,d,s=50000.0):
        self._name = n
        self._start = d
        self._salary = s

class Executive(Employee):
    ...
    def __init__(self,n,d,b=0.0):
        Employee.__init__(self,n,d)
        self._bonus = b
```



Instance Attributes are (Often) Inherited

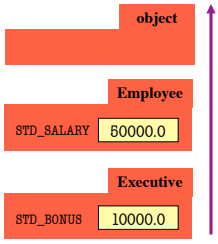
```
class Employee(object):
    ...
    def __init__(self,n,d,s=50000.0):
        self._name = n
        self._start = d
        self._salary = s

class Executive(Employee):
    ...
    def __init__(self,n,d,b=0.0):
        Employee.__init__(self,n,d)
        self._bonus = b
```



Also Works With Class Attributes

Class Attribute: Assigned outside of any method definition

```
class Employee(object):
    """Instance is salaried worker"""
    # Class Attribute
    STD_SALARY = 50000.0

class Executive(Employee):
    """An Employee with a bonus."""
    # Class Attribute
    STD_BONUS = 10000.0
```



Properties and Inheritance

- Properties: all or nothing
  - Typically inherited
  - Or fully overridden (both getter and setter)
- When override property, **completely** replace it
  - Cannot use super()
- Very rarely overridden
  - **Exception**: making a property read-only
  - See employee2.py

```
class Employee(object):
    ...
    @property
    def salary(self):
        return self._salary
    @salary.setter
    def salary(self,value):
        self._salary = value

class Executive(Employee):
    ...
    @property  # no setter; now read-only
    def salary(self):
        return self._salary
```