Methods and Inheritance: Overriding

- We might want to require that every Person can dance. But the way a Lecturer dances is not likely to be the same as the way a Student dances...

Person defines a 'default' implementation of dance()

```
class Person {
   public void dance() {
      jiggle_a_bit();
   }
}

class Student extends Person {
   public void dance() {
      body_pop();
   }
}

class Lecturer extends Person {
}
```

Student overrides the default

Lecturer just inherits the default implementation and jiggles

(Subtype) Polymorphism

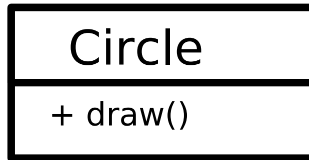
```
Student s = new Student();
Person p = (Person)s;
p.dance();
```

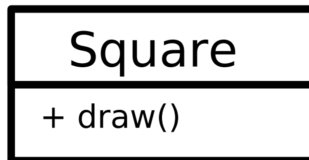
- Assuming Person has a default dance() method, what should happen here??

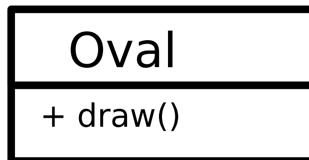
- **Option 1**
  - Compiler says “p is of type Person”
  - So p.dance() should do the default dance() action in Person

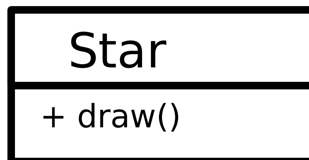
- **Option 2**
  - Compiler says “The object in memory is really a Student”
  - So p.dance() should run the Student dance() method

The Canonical Example I



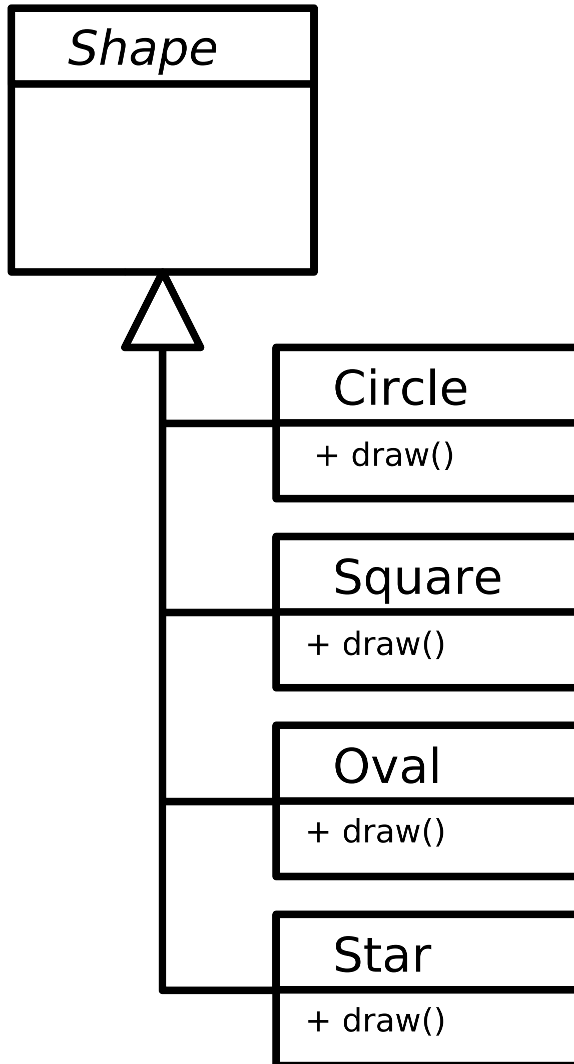






- A drawing program that can draw circles, squares, ovals and stars
- It would presumably keep a list of all the drawing objects
- **Option 1**
  - Keep a list of Circle objects, a list of Square objects,...
  - Iterate over each list drawing each object in turn
  - What has to change if we want to add a new shape?

The Canonical Example II

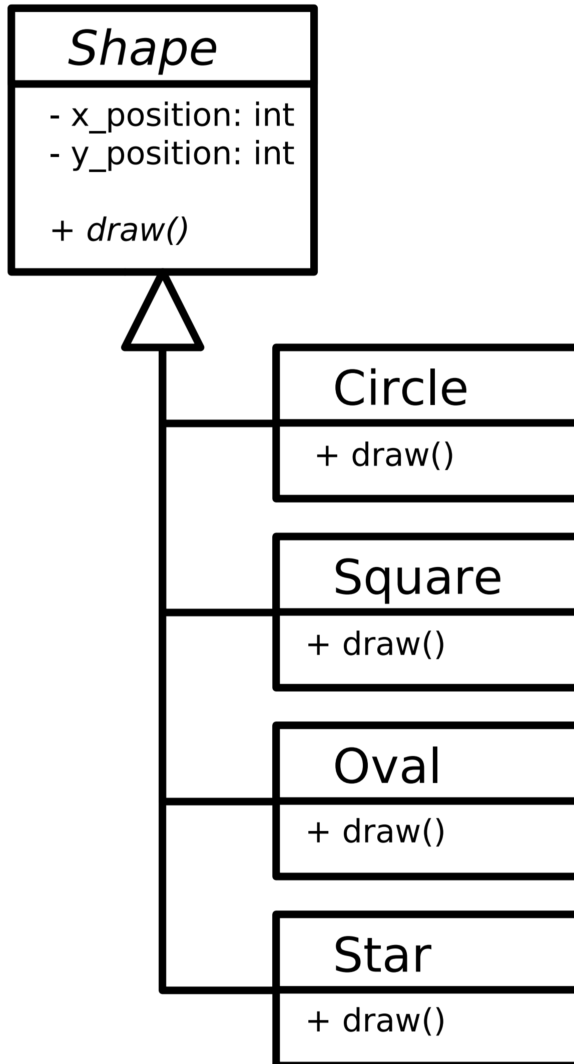


- **Option 2**
  - Keep a single list of Shape references
  - Figure out what each object really is, narrow the reference and then draw()

```
for every Shape s in myShapeList
   if (s is really a Circle)
      Circle c = (Circle)s;
      c.draw();
   else if (s is really a Square)
      Square sq = (Square)s;
      sq.draw();
   else if...
```

  - What if we want to add a new shape?

The Canonical Example III



- **Option 3 (Polymorphic)**
  - Keep a single list of Shape references
  - Let the compiler figure out what to do with each Shape reference

```
For every Shape s in myShapeList
   s.draw();
```

- What if we want to add a new shape?

Implementations

- Java
  - All methods are polymorphic. Full stop.
- Python
  - All methods are polymorphic.
- C++
  - Only functions marked *virtual* are polymorphic

- Polymorphism is an extremely important concept that you need to make sure you understand...

Abstract Methods

```
class Person {
   public void dance();
}

class Student extends Person {
   public void dance() {
      body_pop();
   }
}

class Lecturer extends Person {
   public void dance() {
      jiggle_a_bit();
   }
}
```

- There are times when we have a definite concept but we expect every specialism of it to have a different implementation (like the draw() method in the Shape example). We want to enforce that idea without providing a default method
- E.g. We want to enforce that all objects that are Persons support a dance() method
  - But we don't now think that there's a default dance()
- We specify an **abstract** dance method in the Person class
  - i.e. we don't fill in any implementation (code) at all in Person.

Abstract Classes

- Before we could write Person p = new Person()
- But now p.dance() is undefined
- Therefore we have implicitly made the class abstract ie. It cannot be directly instantiated to an object
- Languages require some way to tell them that the class is meant to be abstract and it wasn't a mistake:

```java
public abstract class Person {
   public abstract void dance();
}
```

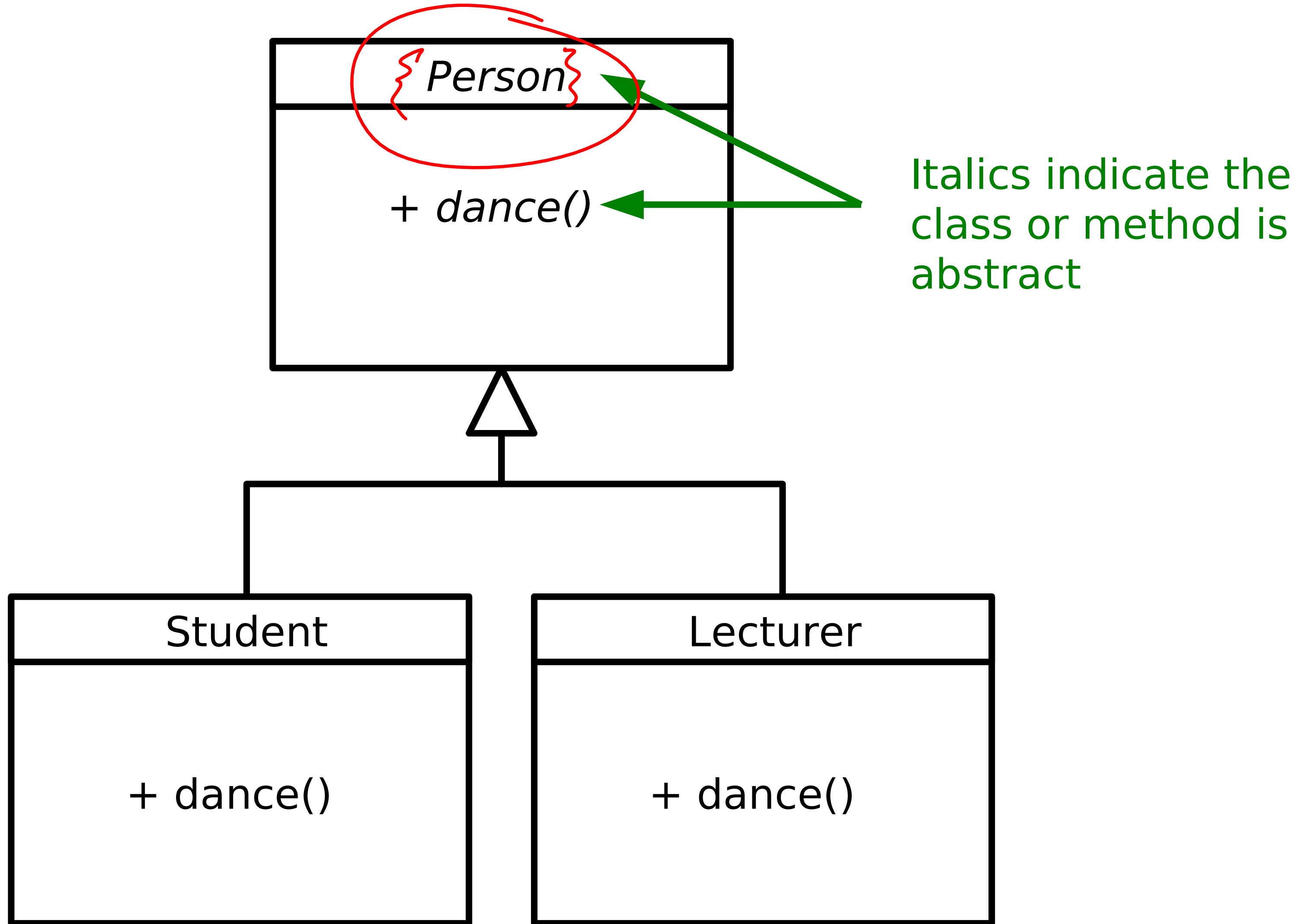
Java

```cpp
class Person {
   public:
      virtual void dance()=0;
}
```

C++

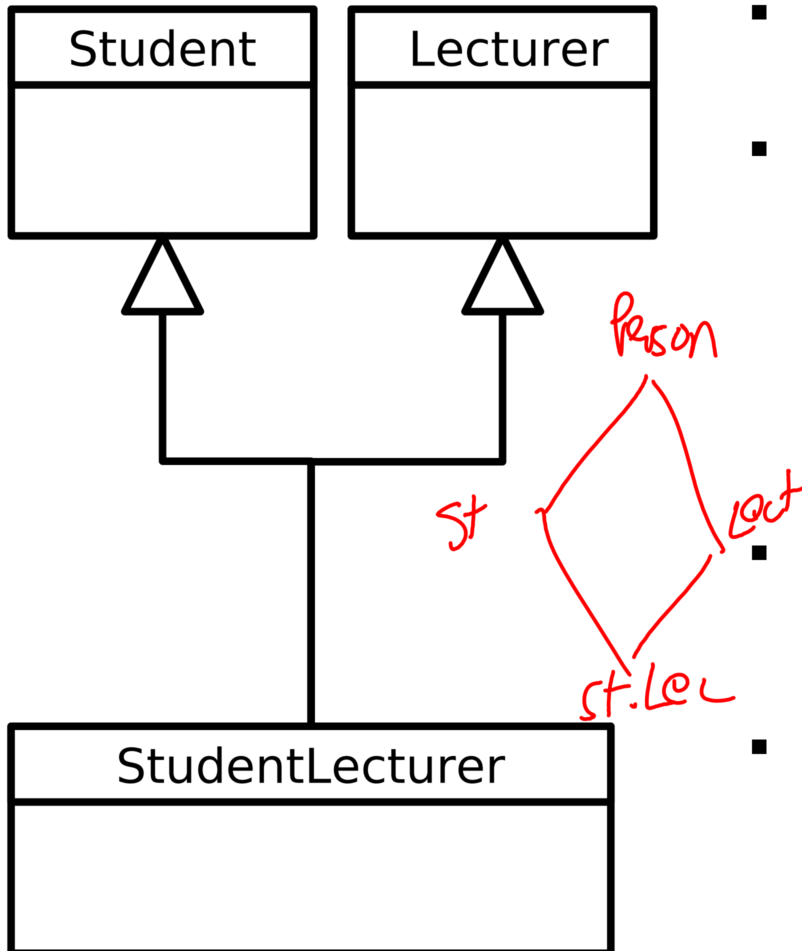
- Note that an abstract class can contain state variables that get inherited as normal
- Note also that, in Java, we can declare a class as abstract despite not specifying an abstract method in it!!

Representing Abstract Classes



Italics indicate the class or method is abstract

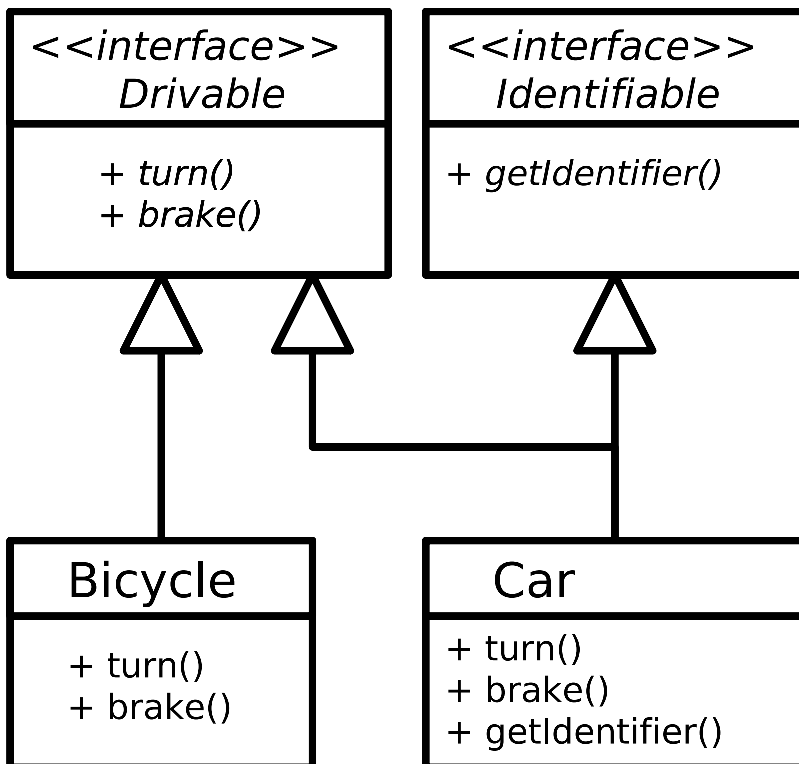
Multiple Inheritance



- What if we have a Lecturer who studies for another degree?
- If we do as shown, we have a bit of a problem
  - StudentLecturer inherits two different dance() methods
  - So which one should it use if we instruct a StudentLecturer to dance()?
- The Java designers felt that this kind of problem mostly occurs when you have designed your class hierarchy badly
- Their solution? **You can only extend (inherit) from one class in Java**
  - (which may itself inherit from another...)
  - This is a Java oddity (C++ allows multiple class inheritance)

Interfaces (Java only)

- Java has the notion of an **interface** which is like a class except:
  - There is no state whatsoever
  - All methods are abstract
- For an interface, there can then be no clashes of methods or variables to worry about, so we can allow multiple inheritance




```
Interface Drivable {
   public void turn();
   public void brake();
}

Interface Identifiable {
   public void getIdentifier();
}

class Bicycle implements Drivable {
   public void turn() {...}
   public void brake() {... }
}

class Car implements Drivable, Identifiable {
   public void turn() {...}
   public void brake() {... }
   Public void getIdentifier() {...}
}
```

abstract assumed for interfaces

Recap

- Important OOP concepts you need to understand:

  - Modularity (classes, objects)
  - Data Encapsulation
  - Inheritance
  - Abstraction
  - Polymorphism

Lifecycle of an Object

Constructors

```
MyObject m = new MyObject();
```

- You will have noticed that the RHS looks rather like a function call, and that's exactly what it is.
- It's a method that gets called when the object is constructed, and it goes by the name of a constructor (it's not rocket science).
- We use constructors to initialise the state of the class in a convenient way.
  - A constructor has the same name as the class
  - A constructor has no return type specified

Constructor Examples

```java
public class Person {
   private String mName;

   // Constructor
   public Person(String name) {
       mName=name;
   }

   public static void main(String[] args) {
     Person p = new Person("Bob");
   }

}
```

Java

```cpp
class Person {
   private:
      std::string mName;

   public:
      Person(std::string &name) {
         mName=name;
      }
};


int main(int argc, char ** argv) {
   Person p ("Bob");
}
```

C++

Default Constructor

```
public class Person {
   private String mName;

   public static void main(String[] args) {
     Person p = new Person();
   }

}
```

- If you specify no constructor at all, the Java fills in an empty one for you
- The default constructor takes no arguments