# Java Programming

Language

Inheritance

Interfaces

## Java


- Class-based, object-oriented design
  - C++ syntax
  - Strongly typed
  - Manages memory, garbage collection
- Extensive class libraries – robust
- Primary language for Android – mobile + desktop
- Java Virtual Machine (JVM) – cross platform

- Open Source
  - Designed by James Gosling
  - released by Sun Microsystems in 1995
  - Made open source under GNU GPL in 2007
  - Sun and Java acquired by Oracle in 2010

## (Almost) Everything is a Class

- **`Classes`** and objects are core constructs
- OO features: polymorphism, encapsulation, inheritance, …
- Static member variables and methods
- Resembles C++ on the surface, but really not the same
  - No pointers, all objects are references
  - No type ambiguity; classes resolved at runtime
  - No destructor (due to garbage collector)
  - No multiple inheritance (single only, but with class **`Interfaces`**)

## Java Class Library

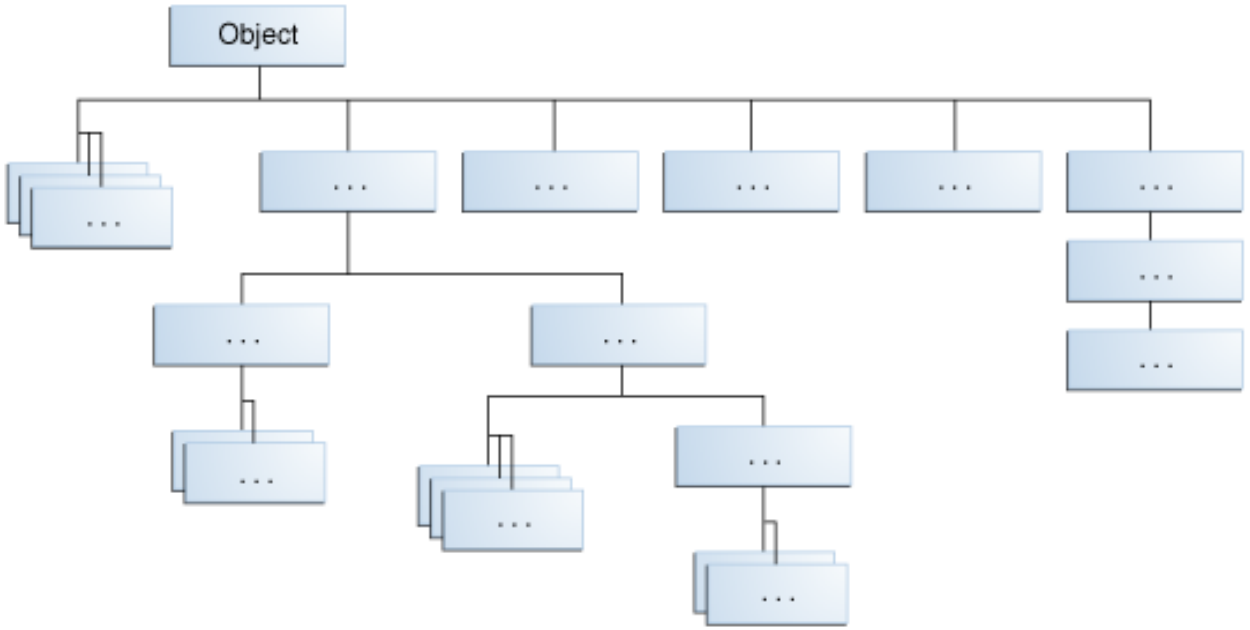
Classes are grouped into ”packages”

- **`package`** keyword to assign source to a package
  - Typically, a package is a subdirectory
  - e.g. “graphics” package is in subdirectory of the same name
- **`import`** keyword to include a class from a different package
  - This is how you include bundled Java libraries.

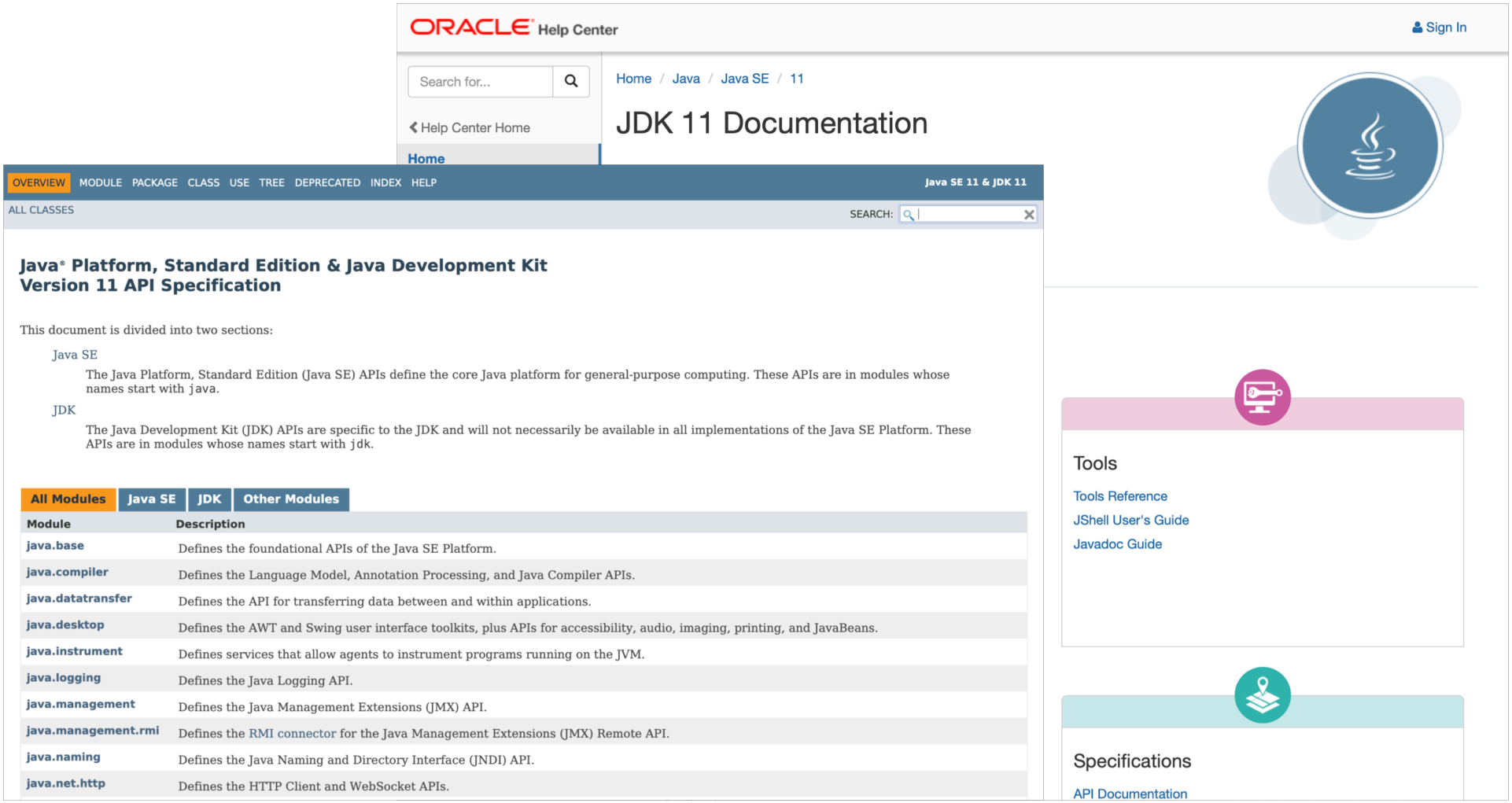
For your assignments, don’t worry about putting your code in a package! You can put everything in a single directory (e.g. assignments/a2).

## Java Class Hierarchy

- All classes (implicitly) derive from Object class (in java.lang)
  - has methods like `clone()`, `toString()`, `finalize()`
- All classes inherit these basic behaviours



# Class Hierarchy & Documentation




https://docs.oracle.com/en/java/javase

## Common Classes/Packages

| Package | Classes (Examples) | Description |
|---|---|---|
| java.awt | Color, Graphics, Font, Graphics2D, event. | Contains all of the classes for creating user interfaces and for painting graphics and images. |
| javax.swing | JFrame, JButton, JList, JToolbar | Provides a set of "lightweight" (all-Java language) components that works the same on all platforms. |
| java.io | File, FileReader, FileWriter, InputStream | Provides for system input and output through data streams, serialization and the file system. |
| java.lang | Boolean, Integer, String, System, Thread, Math | Provides classes that are fundamental to the design of the Java programming language. |
| java.util | ArrayList, HashMap, Observable | Contains the collections framework, legacy collection classes, event model,… |

## Hello Java

```
public class Hello {

    public static void main(String args[]) {
        new Hello();
    }

    Hello() {
        System.out.println("Hello world!");
    }
}
```

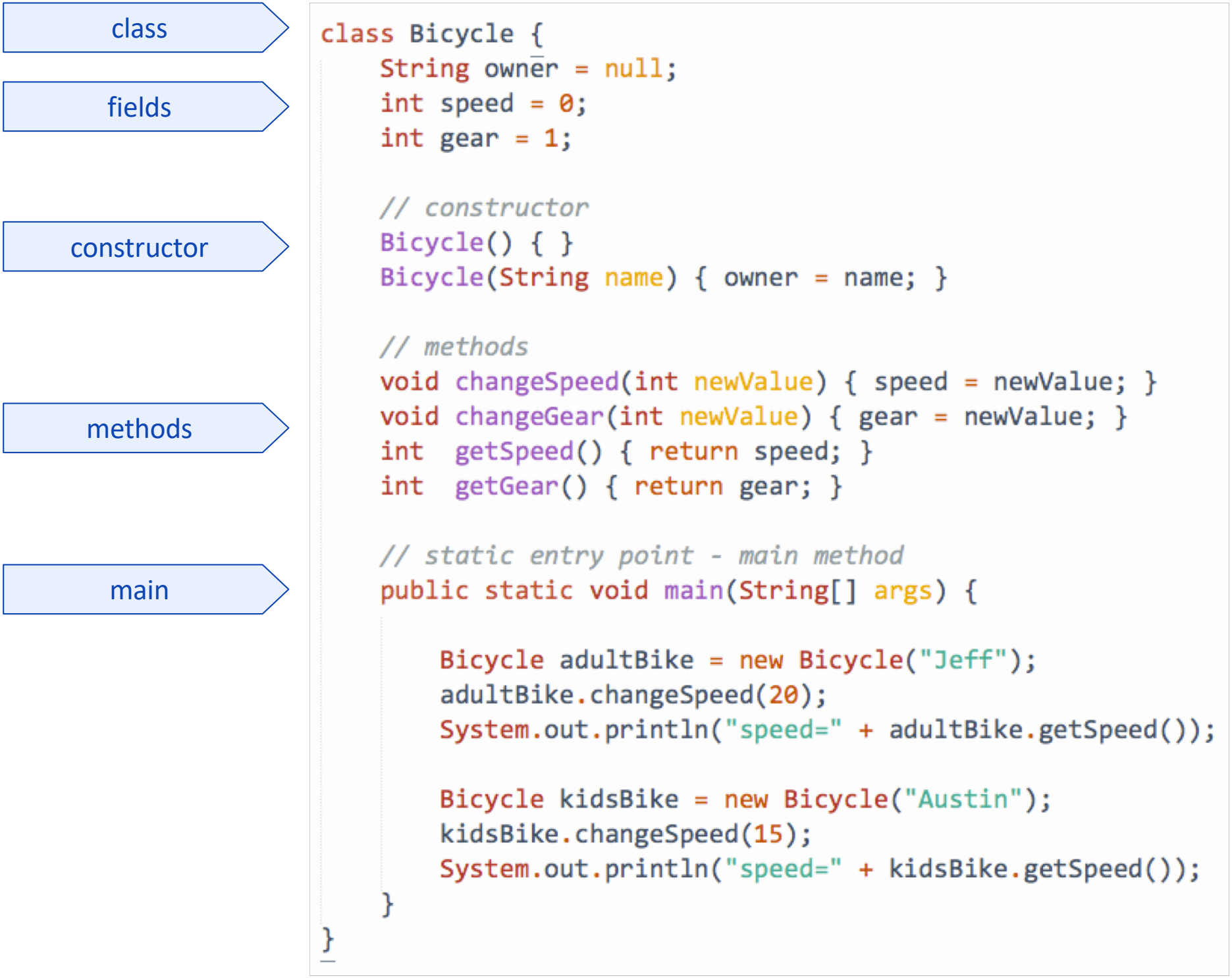
class definition

static main

constructor

Things that stand out

- Top-level class definition
- Static main method is scoped within the class
- System package is used for basic IO


class
fields
constructor
methods
main
class Bicycle {
String owner = null;
int speed = 0;
int gear = 1;
// constructor
Bicycle() { }
Bicycle(String name) { owner = name; }
// methods
void changeSpeed(int newValue) { speed = newValue; }
void changeGear(int newValue) { gear = newValue; }
int getSpeed() { return speed; }
int getGear() { return gear; }
// static entry point - main method
public static void main(String[] args) {
Bicycle adultBike = new Bicycle("Jeff");
adultBike.changeSpeed(20);
System.out.println("speed=" + adultBike.getSpeed());
Bicycle kidsBike = new Bicycle("Austin");
kidsBike.changeSpeed(15);
System.out.println("speed=" + kidsBike.getSpeed());
}
}

## Object passing

Parameters are passed by value. However, this isn't always obvious.

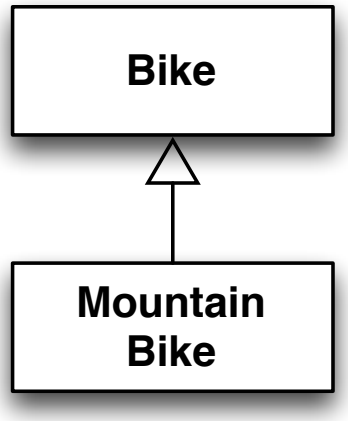
- Primitive types (**`int`**, **`float`**, etc.) are allocated on the stack and always passed by value.
- Objects are allocated on the heap, and the *address* is passed-by-value
  - Java uses pass-by-reference semantics, so it *appears* as-if you're passing by reference.
  - Practically, you can treat Java as passing objects by reference.
- There are no pointer semantics in Java
  - i.e. no **`*`**, no **`&`**, no **`out`**, no **`ref`**

both refer to same memory on the heap

```
Bicycle my_bike = new Bicycle();
Bicycle kids_bike = my_bike;
```

## Inheritance

- Inherit some methods or fields from a base class (“is a”)
- Very common in Java to extend and override other classes
- Example:
  - “Mountain Bike” is-a “Bike”
  - Mountain bike inherits speed and gear fields
  - Mountain bike  defines addition field for suspension type



container class

abstract inner base class

inner derived class

” Meow! “
“ Woof! “

Animals1.java

```java
public class Animals1 {

    // base class
    abstract class Pet {
        abstract String talk();
    }

    // derived classes
    class Cat extends Pet {
        String talk() { return "Meow!"; }
    }

    class Dog extends Pet {
        String talk() { return "Woof!"; }
    }

    // container class methods
    Animals1() {
        speak(new Cat());
        speak(new Dog());
    }

    void speak(Pet a) {
        System.out.println( a.talk() );
    }

    // static main methods -- entry point
    Run | Debug
    public static void main(String[] args) {
        new Animals1();
    }
}
```

## Interfaces

- Java only supports single (class) inheritance
- However, to specify complex class behavior, you can use interfaces

- An `interface` represents an API (i.e. it defines functionality)
  - It represents a set of methods a class must have
  - You can't instantiate an interface
  - Essentially, it's a pure abstract class

- Classes can choose to *implement* an interface
  - A class that implements an interface must implement *all* of the methods in the interface
  - A class can implement multiple interfaces, representing different behaviours that the class wants to support (e.g. you might have interfaces indicating that something printable and loggable).

interface

implementations

The interface Pet is like a type

Animals2.java

```java
public class Animals2 {

    // interface
    interface Pet {
        String talk();
    }

    // inner classes
    class Cat implements Pet {
        public String talk() { return "Meow!"; }
    }

    class Dog implements Pet {
        public String talk() { return "Woof!"; }
    }

    // container class methods
    Animals2() {
        speak(new Cat());
        speak(new Dog());
    }

    void speak(Pet a) {
        System.out.println( a.talk() );
    }

    // static main methods -- entry point
    Run | Debug
    public static void main(String[] args) {
        new Animals2();
    }
}
```

base class

interface

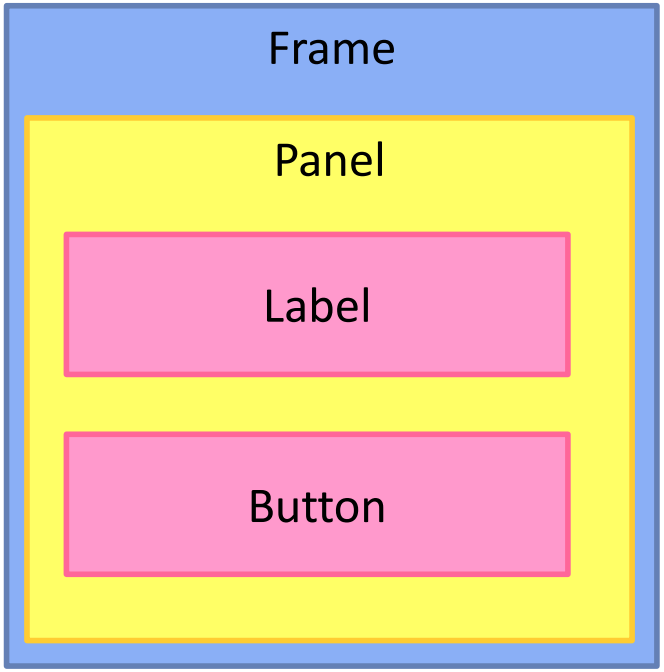
derived class

Bikes2.java

```
// base class
abstract class Bike {
    int wheels = 0;
    int speed = 0;

    void setWheels(int val) { wheels = val; }
    void setSpeed(int val) { speed = val; }
    void show() {
        System.out.println("wheels  = " + wheels);
        System.out.println("speed   = " + speed);
    }
}

// interface for ANYTHING driveable
// could be applied to car, scooter etc.
interface Driveable {
    void accelerate();
    void brake();
}

// derived two-wheel bike
class Bicycle extends Bike implements Driveable {
```

## How to Build a Simple User Interface

- Create a top-level application window (`JFrame` or `JDialog`).
- Add components to this window.
  - Typically, you create a smaller container (like a `JPanel`) and add components to the panel.



# Creating a Window

*BasicForm1.java*

```
import javax.swing.*;

// Create a simple form
public class BasicForm1 {
    public static void main(String[] args) {
        // create a window
        JFrame frame = new JFrame("Layout Demo");
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

        // create a panel and add components
        // all Swing components are types of JComponent
        JPanel panel = new JPanel();
        JButton button = new JButton("Ok");
        panel.add(button);

        // add panel to the window
        frame.add(panel);

        // set window behaviour and display it
        frame.setResizable(false);
        frame.setSize(200, 200);
        // frame.pack();
        frame.setVisible(true);
    }
}
```