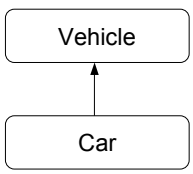
- Previous Lecture:
  - Array of objects
  - Method overloading
- Today's Lecture:
  - Review
  - Introduction to inheritance
  - Class diagrams and hierarchy
  - Visibility modifier **`protected`**
- Reading (JV):
  - Sec 7.1
- Announcement:
  - Project 6 Part A will be posted Friday, due 5/2

Inheritance

- Allows programmer to *derive* a class from an existing one
- Existing class is called the *parent class,* or *superclass*
- Derived class is called the *child class* or *subclass*
- The child class *inherits* the methods and data defined for the parent class
- Inherited trait can be *accessed as though it were locally declared (defined)*

Inheritance, cont'd

Inheritance relationships often shown graphically in a *class diagram*, with the arrow pointing to the parent class



Create an ***is-a*** relationship, meaning the child ***is a*** more specific version of the parent

Single inheritance: one parent only

Deriving a subclass

Reserved word `extends` establishes an inheritance relationship:

```
class Vehicle {
   // class contents
}

class Car extends Vehicle {
   // class contents
}
```

`protected` visibility

- Visibility modifiers control which members get inherited
- **`private`**
  - Not inherited, can be *accessed* by local class only
- **`public`**
  - Inherited, can be *accessed* by all classes
- **`protected`**
  - Inherited, can be *accessed* by subclasses
- *Access*: access as though declared locally
- All variables from a superclass *exist* in the subclass, but some (`private`) cannot be *accessed* directly


```
public class Vehicle {
  protected int plateNum;  //plate #
  private int numWheels;   //# of wheels

  public void writeOut() {
    System.out.println("Plate number:"
                       + plateNum);
  }
} //class Vehicle

public class Plane extends Vehicle {
  protected double wingSpan;
  private boolean hasPropeller;

  public void writeProperties() {
    System.out.println(plateNum);  //?
    System.out.println(numWheels); //?
    if (hasPropeller)              //?
      System.out.println("Prop plane");
  }
} //class Plane
```


Reserved word `super`

- Invoke constructor of superclass

```
super(parameter-list);
```

  - `parameter-list` must match that in superclass' constructor
- Access methods and variables from superclass


```
// New definition of class Vehicle
public class Vehicle {
  protected int plateNum;  //plate #
  private int numWheels;   //# of wheels

  public Vehicle(int plate, int wheels)
  {
    plateNum = plate;
    numWheels = wheels;
  }

  public void writeOut() {
    System.out.println("Plate number:"
                       + plateNum);
  }

} //class Vehicle
```

```
// New definition of class Plane
public class Plane extends Vehicle {
  protected double wingSpan;
  private boolean hasPropeller;

  public Plane(int plate, int wheels,
            double span, boolean prop) {
    super(plate,wheels);
    wingSpan = span;
    hasPropeller = prop;
  }

  public void writeProperties() {
    System.out.println(plateNum);
    //System.out.println(numWheels);
    if (hasPropeller)
      System.out.println("Prop plane");
  }

} //class Plane
```


Overriding methods

- Subclass can *override* definition of inherited method in favor of its own
- New method in subclass must have same signature as superclass (but has different method body)
- Which method gets used??
  The object that is used to invoke a method determines which version is used
- Method declared to be `final` cannot be overridden
- Do not confuse *overriding* with *overloading*!


```
// Better definition of class Plane
public class Plane extends Vehicle {
  protected double wingSpan;
  private boolean hasPropeller;

  public Plane(int plate, int wheels,
              double span, boolean prop) {
    super(plate,wheels);
    wingSpan = span;
    hasPropeller = prop;
  }

  // Override method writeOut
  // Also access method from superclass
  public void writeOut() {
    super.writeOut();
    System.out.println("Wing Span: " +
                       wingSpan);
    if (hasPropeller)
      System.out.println("Prop plane");
  }

} //class Plane
```


Important ideas in inheritance

- Use different hierarchies for different problems
- Single inheritance
- Keep common features as high in the hierarchy as reasonably possible
- Inherited features are continually passed down the line
- Use the superclass' features as much as possible
- "Inherited" ⇒ "can be accessed as though declared locally"
  (**`private`** variables in superclass *exists* in subclasses; they just cannot be accessed directly)