- Previous Lecture:
  - Overriding methods
  - Using super to access members from the superclass
- Today's Lecture:
  - Polymorphism
  - `Object` class
  - `Abstract`
- Reading:
  - Sec 8.1, 8.2

Another polymorphic example

```
Vehicle[] mover = new Vehicle[5];

mover[0]= new Vehicle(...);
mover[1]= new Plane(...);
mover[2]= new Plane(...);
mover[3]= mover[1];
```

The reference type may not be the same as the object type!

Accessing methods/variables through a polymorphic reference

Dice d= new TrickDice(…);

Consider the reference type and object type:

1. Which type determines whether a method/variable can be accessed?
2. For an overridden method, which type determines which version gets invoked?

Accessing methods/variables through polymorphic references

The ***type of the reference*** determines the methods and fields that can be accessed

```
class V {
  public int num1;
  public void vmethod() { num1++; }
}
class W extends V {
  public int num2;
  public void wmethod() { num2++; }
}
```


Client code:

```
V x= new W();
System.out.println(x.num1);  //valid?
System.out.println(x.num2);  //valid?
x.vmethod();  //valid?
x.wmethod();  //valid?

System.out.println( ((W) x).num2 );
((W) x).wmethod();
```


Client code:

```
V x;  // x references type V or its subtype
String s= "Which type, V or W? ";
System.out.print(s);
char input= Keyboard.readChar();
if (input=='V')
   x= new V();
else
   x= new W();

System.out.println(x.num1);  //?
System.out.println(x.num2);  //?
x.vmethod();  //?
x.wmethod();  //?
```

Accessing *overridden* methods through polymorphic references

- The ***type of the object*** determines which version of the method gets invoked
- Class `Vehicle` has method `toString` that class `Plane` overrides:

```
Vehicle v1= new Vehicle(...);
Vehicle v2= new Plane(...);
System.out.println(v1); //Vehicle's version
System.out.println(v2); //Plane's version
```


instanceof

- instanceof is an operator for determining when an instance is of (from) a particular class
- See example in class House

The `Object` class

If a class is not explicitly defined to be the child of an existing class, it is assumed to be the child of the `Object` class

⇒ All classes are derived from the **`Object`** class

`class Room`

is the same as

`class Room extends Object`

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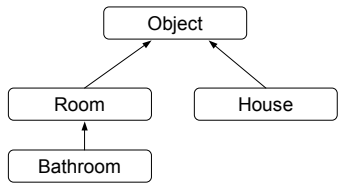

The `Object` class

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  ⇒ All classes are derived from the **`Object`** class

- `toString`: "default" instance method defined in the `Object` class
- Arrays are `Object`s, literally!

`abstract` class

- A placeholder in a class hierarchy that represents a generic concept
- Cannot be instantiated
- Modifier: `abstract`

```
public abstract class Geometry
```

- Can contain abstract methods

```
public abstract double Area();
```

- Subclasses of abstract classes will "fill out" these abstract methods