Advanced Class Features

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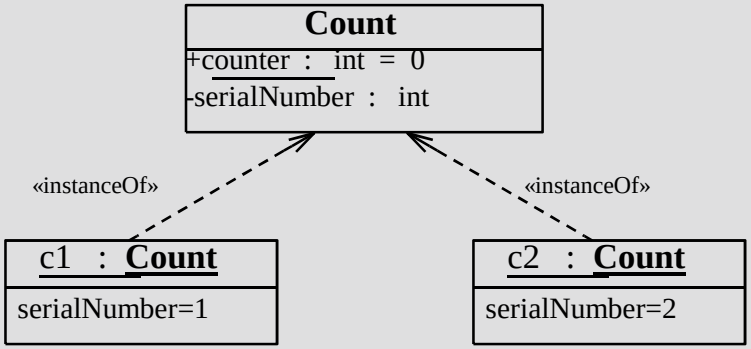
The static Keyword

- The static key word is used as a modifier on variables, methods, and nested classes.
- The static keyword declares the attribute or method is associated with the class as a whole rather than any particular instance of that class.
- Thus static members are often called *class members*, such as *class attributes* or *class methods*.

Class Attributes

Class attributes are shared among all instances of a class:




```
28  public class Count {
29      private int serialNumber;
30      public static int counter = 0;
31
32      public Count() {
33          counter++;
34          serialNumber = counter;
35      }
36  }
```

Class Attributes

If the static member is public:

```
1    public class Count1 {
2       private int serialNumber;
3       public static int counter = 0;
4       public Count1() {
5          counter++;
6          serialNumber = counter;
7       }
8    }
```

it can be accessed from outside the class without an instance:

```
1    public class OtherClass {
2       public void incrementNumber() {
3          Count1.counter++;
4       }
5    }
```

Class Methods

You can create static methods:

```
1   public class Count2 {
2       private int serialNumber;
3       private static int counter = 0;
4
5       public static int getTotalCount() {
6           return counter;
7       }
8
9       public Count2() {
10          counter++;
11          serialNumber = counter;
12      }
13  }
```

Class Methods

You can invoke static methods without any instance of the class to which it belongs:

```
1    public class TestCounter {
2      public static void main(String[] args) {
3        System.out.println("Number of counter is "
4                                    + Count2.getTotalCount());
5        Count2 counter = new Count2();
6        System.out.println("Number of counter is "
7                                    + Count2.getTotalCount());
8      }
9    }
```

The output of the TestCounter program is:

```
Number of counter is 0
Number of counter is 1
```

Class Methods

Static methods cannot access instance variables:

```
1    public class Count3 {
2       private int serialNumber;
3       private static int counter = 0;
4
5       public static int getSerialNumber() {
6          return serialNumber;          // COMPILER ERROR!
7       }
8    }
```

Static Initializers

- A class can contain code in a *static block* that does not exist within a method body.
- Static block code executes once only, when the class is loaded.
- Usually, a static block is used to initialize static (class) attributes.

Static Initializers

```
1    public class Count4 {
2       public static int counter;
3       static {
4          counter = Integer.getInteger("myApp.Count4.counter").intValue();
5       }
6    }
```

```
1    public class TestStaticInit {
2       public static void main(String[] args) {
3          System.out.println("counter = "+ Count4.counter);
4       }
5    }
```

The output of the TestStaticInit program is:

```
java -DmyApp.Count4.counter=47 TestStaticInit
counter = 47
```

The final Keyword

- You cannot subclass a final class.
- You cannot override a final method.
- A final variable is a constant.
- You can set a final variable once only, but that Assignment can occur independently of the declaration; this is called a *blank final variable*.
  - A blank final instance attribute must be set in every constructor.
  - A blank final method variable must be set in the method body before being used.

Final Variables

Constants are static final variables.

```
public class Bank {
   private static final double DEFAULT_INTEREST_RATE = 3.2;
   ... // more declarations
}
```

Blank Final Variables

```
1   public class Customer {
2
3       private final long customerID;
4
5       public Customer() {
6           customerID = createID();
7       }
8
9       public long getID() {
10          return customerID;
11      }
12
13      private long createID() {
14          return ... // generate new ID
15      }
16
17      // more declarations
18
19  }
```

Old-Style Enumerated Type Idiom

Enumerated types are a common idiom in programming.

```
0
1   package cards.domain;
2
3   public class PlayingCard {
4
5       // pseudo enumerated type
6       public static final int SUIT_SPADES    = 0;
7       public static final int SUIT_HEARTS    = 1;
8       public static final int SUIT_CLUBS     = 2;
9       public static final int SUIT_DIAMONDS  = 3;
10
11      private int suit;
12      private int rank;
13
14      public PlayingCard(int suit, int rank) {
15          this.suit = suit;
16          this.rank = rank;
17      }
```

Old-Style Enumerated Type Idiom

```
22   public String getSuitName() {
23         String name = “”;
24         switch ( suit ) {
25            case SUIT_SPADES:
26               name = “Spades”;
27               break;
28            case SUIT_HEARTS:
29               name = “Hearts”;
30               break;
31            case SUIT_CLUBS:
32               name = “Clubs”;
33               break;
34            case SUIT_DIAMONDS:
35               name = “Diamonds”;
36               break;
37            default:
38               System.err.println(“Invalid suit.”);
39         }
40         return name;
41      }
```

Old-Style Enumerated Type Idiom

Old-style idiom is not type-safe:

```
1   package cards.tests;
2
3   import cards.domain.PlayingCard;
4
5   public class TestPlayingCard {
6      public static void main(String[] args) {
7
8         PlayingCard card1
9            = new PlayingCard(PlayingCard.SUIT_SPADES, 2);
10        System.out.println("card1 is the " + card1.getRank()
11                                 + " of " + card1.getSuitName());
12
13        // You can create a playing card with a bogus suit.
14        PlayingCard card2 = new PlayingCard(47, 2);
15        System.out.println("card2 is the " + card2.getRank()
16                                 + " of " + card2.getSuitName());
17     }
18  }
```

Old-Style Enumerated Type Idiom

This enumerated type idiom has several problems:

- Not type-safe
- No namespace
- Brittle character
- Uninformative printed values

The New Enumerated Type

Now you can create type-safe enumerated types:

```
1    package  cards.domain;
2
3    public  enum  Suit  {
4        SPADES,
5        HEARTS,
6        CLUBS,
7        DIAMONDS
8    }
9
```

The New Enumerated Type

Using enumerated types is easy:

```
1   package cards.domain;
2
3   public class PlayingCard {
4
5       private Suit suit;
6       private int rank;
7
8       public PlayingCard(Suit suit, int rank) {
9           this.suit = suit;
10          this.rank = rank;
11      }
12
13      public Suit getSuit() {
14          return suit;
15      }
```

The New Enumerated Type

```
16   public String getSuitName() {
17         String name = ““;
18         switch ( suit ) {
19            case SPADES:
20               name = “Spades”;
21               break;
22            case HEARTS:
23               name = “Hearts”;
24               break;
25            case CLUBS:
26               name = “Clubs”;
27               break;
28            case DIAMONDS:
29               name = “Diamonds”;
30               break;
31            default:
32            // No need for error checking as the Suit
33            // enum is finite.
34         }
35         return name;
36      }
```

The New Enumerated Type

Enumerated types are type-safe:

```
1   package cards.tests;
2
3   import cards.domain.PlayingCard;
4   import cards.domain.Suit;
5
6   public class TestPlayingCard {
7      public static void main(String[] args) {
8
9         PlayingCard card1
10           = new PlayingCard(Suit.SPADES, 2);
11        System.out.println("card1 is the " + card1.getRank()
12                                  + " of " + card1.getSuitName());
13
14        // PlayingCard card2 = new PlayingCard(47, 2);
15        // This will not compile.
16     }
17  }
```

Advanced Enumerated Types

Enumerated types can have attributes and methods:

```
1   package cards.domain;
2
3   public enum Suit {
4       SPADES      (“Spades”),
5       HEARTS      (“Hearts”),
6       CLUBS       (“Clubs”),
7       DIAMONDS    (“Diamonds”);
8
9       private final String name;
10
11      private Suit(String name) {
12          this.name = name;
13      }
14
15      public String getName() {
16          return name;
17      }
18  }
```

Advanced Enumerated Types

Public methods on enumerated types are accessible:

```
1   package cards.tests;
2
3   import cards.domain.PlayingCard;
4   import cards.domain.Suit;
5
6   public class TestPlayingCard {
7      public static void main(String[] args) {
8
9         PlayingCard card1
10           = new PlayingCard(Suit.SPADES, 2);
11        System.out.println("card1 is the " + card1.getRank()
12                                 + " of " + card1.getSuit().getName());
13
14        // NewPlayingCard card2 = new NewPlayingCard(47, 2);
15        // This will not compile.
16     }
17  }
```

Static Imports

- A *static import* imports the static members from a class:

  import static *<pkg_list>.<class_name>.<member_name>*;
  OR
  import static *<pkg_list>.<class_name>*.*;

- A static import imports members individually or collectively:

  import **static** cards.domain.**Suit.SPADES**;
  OR
  import **static** cards.domain.**Suit.***;

- There is no need to qualify the static constants:

  PlayingCard card1 = new PlayingCard(**SPADES**, 2);

- *Use this feature sparingly.*

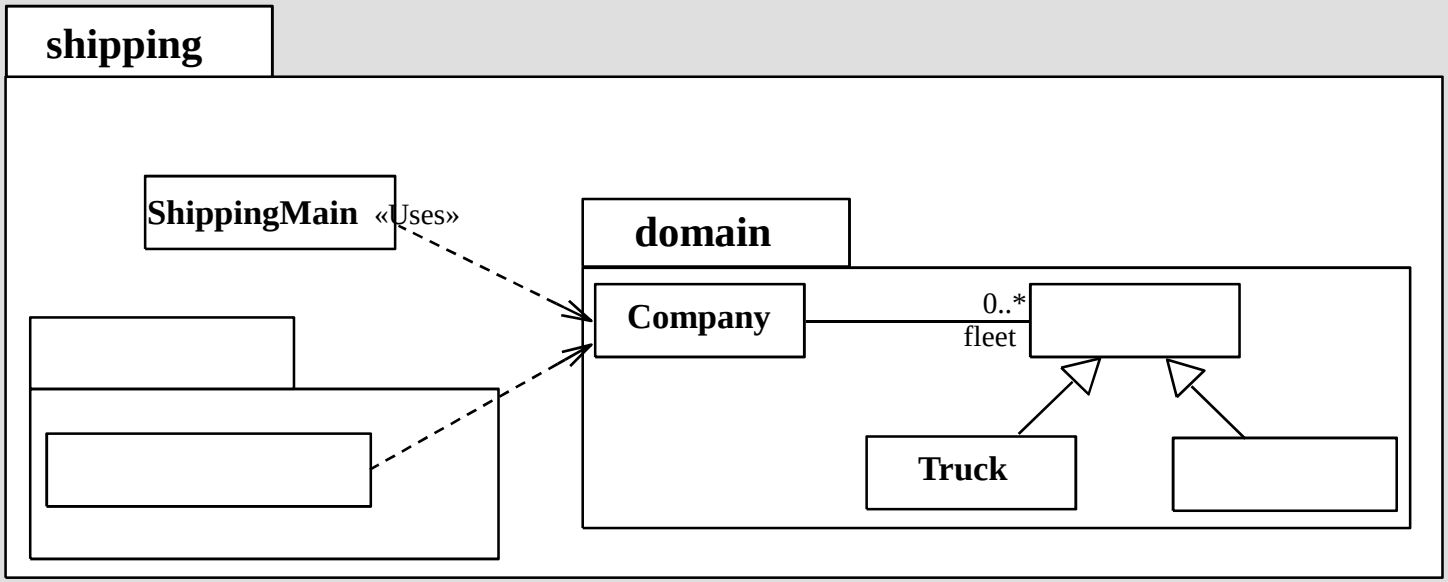
Static Imports

An example of a static import is:

```
1   package cards.tests;
2
3   import cards.domain.PlayingCard;
4   import static cards.domain.Suit.*;
5
6   public class TestPlayingCard {
7      public static void main(String[] args) {
8
9         PlayingCard card1 = new PlayingCard(SPADES, 2);
10        System.out.println("card1 is the " + card1.getRank()
11                                  + " of " + card1.getSuit().getName());
12
13        // NewPlayingCard card2 = new NewPlayingCard(47, 2);
14        // This will not compile.
15     }
16  }
```

Abstract Classes

The design of the Shipping system looks like this:



Abstract Classes

Fleet initialization code is shown here:

```
1     public class ShippingMain {
2        public static void main(String[] args) {
3           Company c = new Company();
4
5           // populate the company with a fleet of vehicles
6           c.addVehicle( new Truck(10000.0) );
7           c.addVehicle( new Truck(15000.0) );
8           c.addVehicle( new RiverBarge(500000.0) );
9           c.addVehicle( new Truck(9500.0) );
10          c.addVehicle( new RiverBarge(750000.0) );
11
12          FuelNeedsReport report = new FuelNeedsReport(c);
13          report.generateText(System.out);
14       }
15    }
```

Abstract Classes

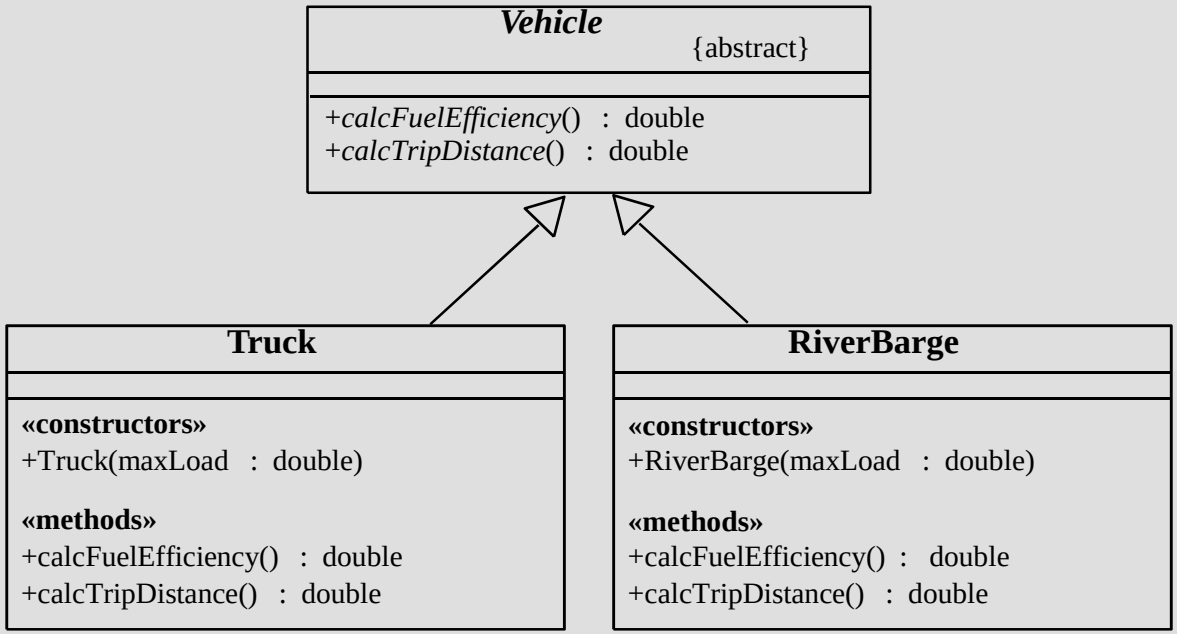
```
1   public class FuelNeedsReport {
2      private Company company;
3
4      public FuelNeedsReport(Company company) {
5         this.company = company;
6      }
7
8      public void generateText(PrintStream output) {
9         Vehicle1 v;
10        double fuel;
11        double total_fuel = 0.0;
12
13        for ( int i = 0; i < company.getFleetSize(); i++ ) {
14           v = company.getVehicle(i);
15
```

Abstract Classes

```
16              // Calculate the fuel needed for this trip
17              fuel = v.calcTripDistance() / v.calcFuelEfficency();
18
19              output.println("Vehicle " + v.getName() + " needs "
20                                  + fuel + " liters of fuel.");
21              total_fuel += fuel;
22          }
23          output.println("Total fuel needs is " + total_fuel + " liters.");
24      }
25  }
```

The Solution

An abstract class models a class of objects in which the full implementation is not known but is supplied by the concrete subclasses.



The Solution

The declaration of the Vehicleclass is:

```
1    public abstract class Vehicle {
2       public abstract double calcFuelEfficiency();
3       public abstract double calcTripDistance();
4    }
```

The Truckclass must create an implementation:

```
1    public class Truck extends Vehicle {
2       public Truck(double maxLoad) {...}
3       public double calcFuelEfficiency() {
4          /* calculate the fuel consumption of a truck at a given load */
5       }
6       public double calcTripDistance() {
7          /* calculate the distance of this trip on highway */
8       }
9    }
```

The Solution

Likewise, the RiverBargeclass must create an implementation:

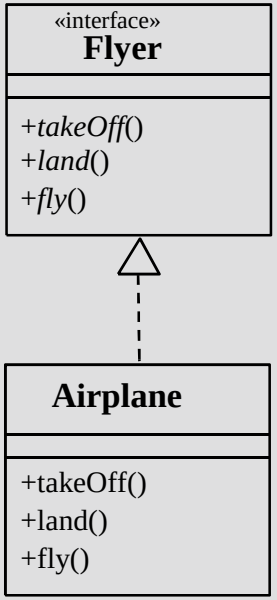
```
1    public class RiverBarge extends Vehicle {
2       public RiverBarge(double maxLoad) {...}
3       public double calcFuelEfficiency() {
4          /* calculate the fuel efficiency of a river barge */
5       }
6       public double calcTripDistance() {
7          /* calculate the distance of this trip along the river-ways */
8       }
9    }
```

Interfaces

- A *public interface* is a contract between *client code* and the class that implements that interface.
- A Java *interface* is a formal declaration of such a contract in which all methods contain no implementation.
- Many unrelated classes can implement the same interface.
- A class can implement many unrelated interfaces.
- Syntax of a Java class is as follows:

```
<modifier>  class  <name>  [extends  <superclass>]
                   [implements  <interface>  [,<interface>]*  ]  {
   <member_declaration>*
}
```

The Flyer Example

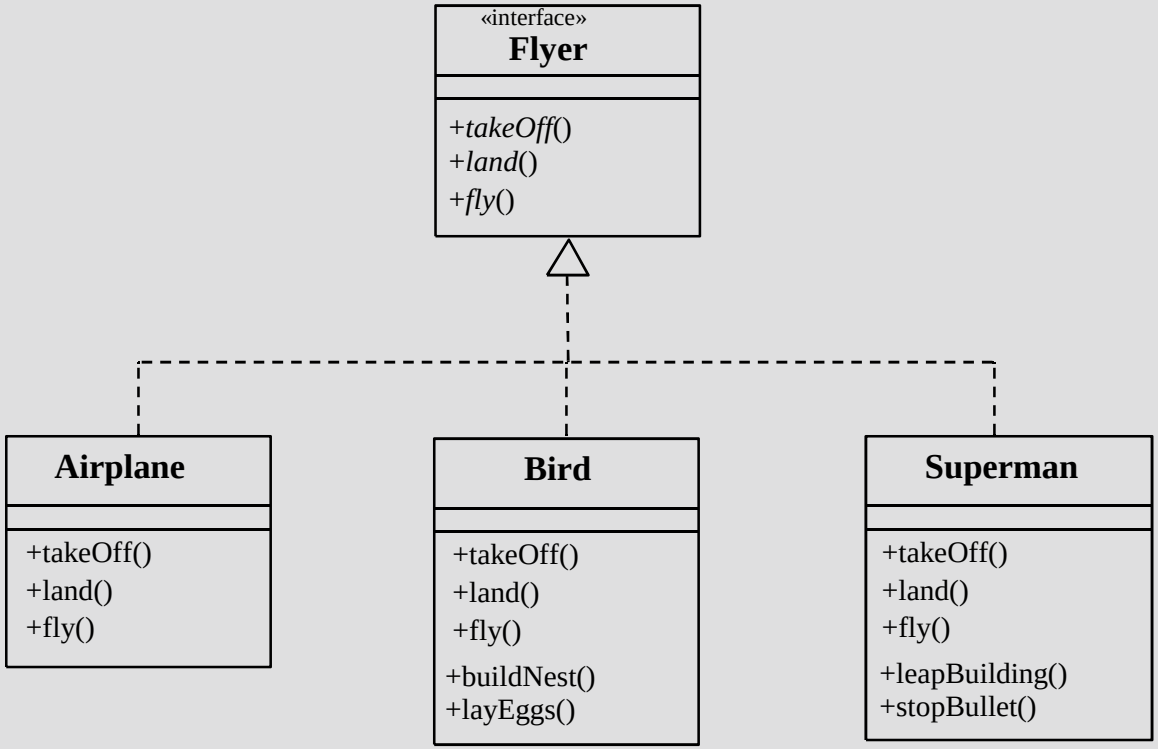



```
public interface Flyer {
   public void takeOff();
   public void land();
   public void fly();
}
```

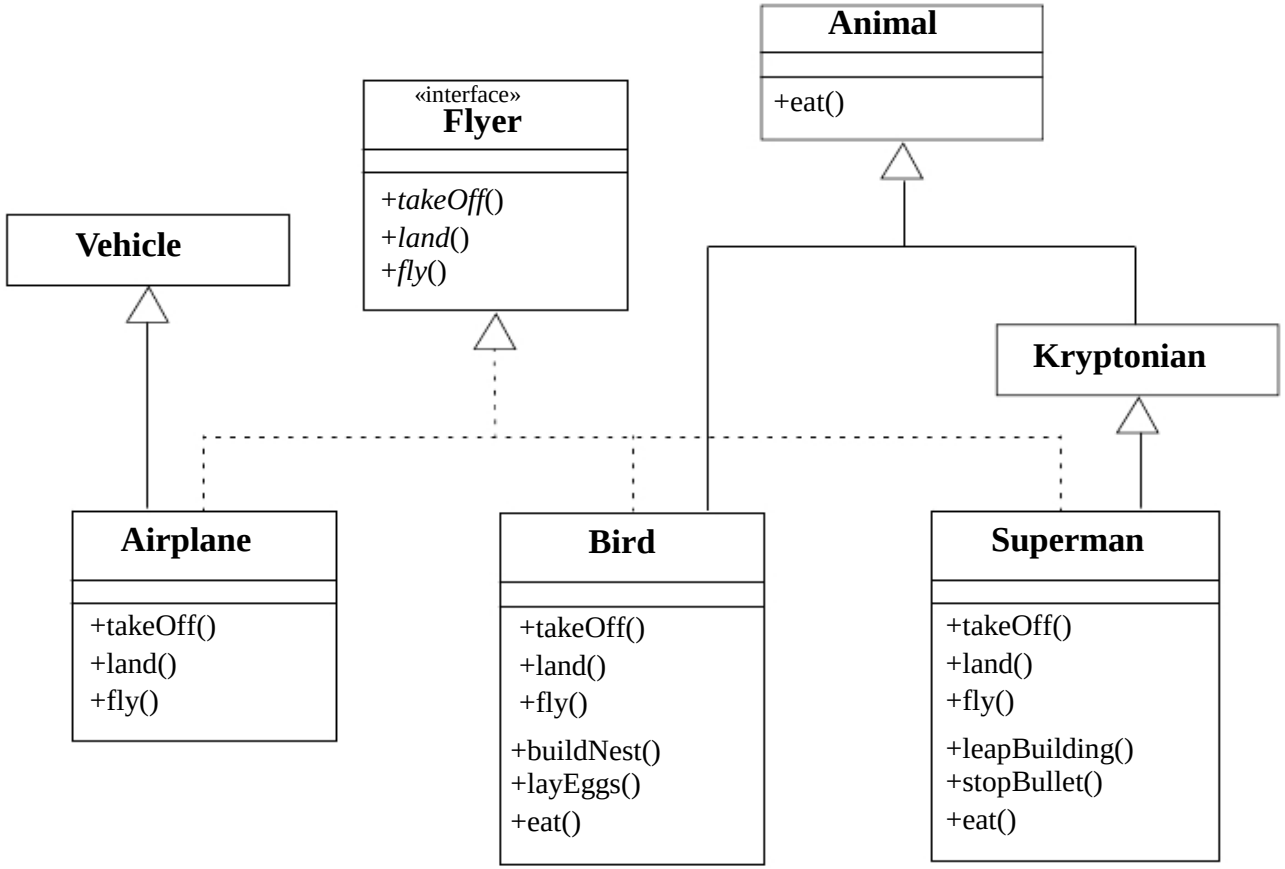
The Flyer Example

```
public class Airplane implements Flyer {
   public void takeOff() {
      // accelerate until lift-off
      // raise landing gear
   }
   public void land() {
      // lower landing gear
      // decelerate and lower flaps until touch-down
      // apply brakes
   }
   public void fly() {
      // keep those engines running
   }
}
```

The Flyer Example



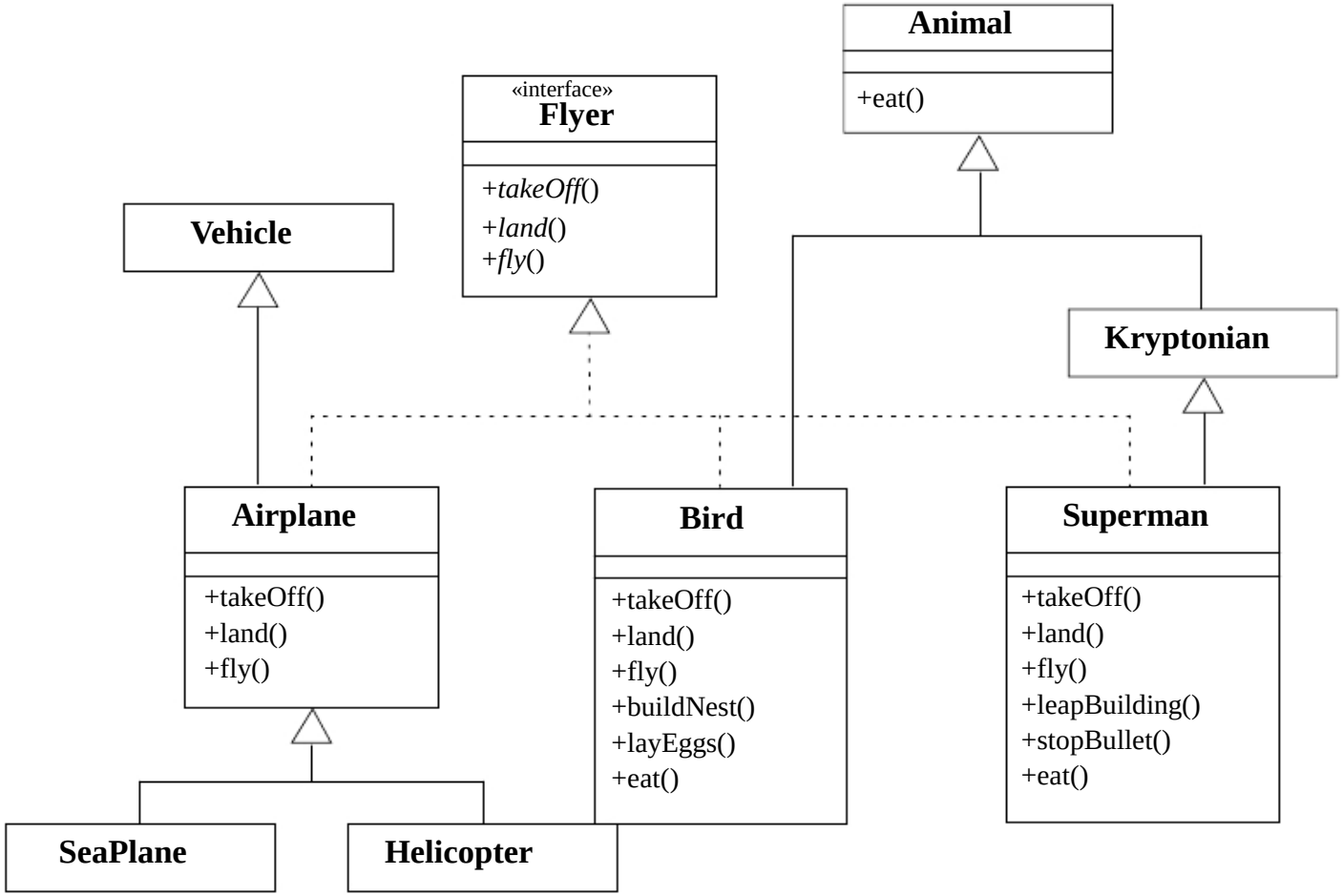
The Flyer Example



The Flyer Example

```
public class Bird extends Animal implements Flyer {
   public void takeOff()      { /* take-off implementation          */ }
   public void land()         { /* landing implementation           */ }
   public void fly()          { /* fly implementation               */ }
   public void buildNest()    { /* nest building behavior           */ }
   public void layEggs()      { /* egg laying behavior              */ }
   public void eat()          { /* override eating behavior         */ }
}
```

The Flyer Example



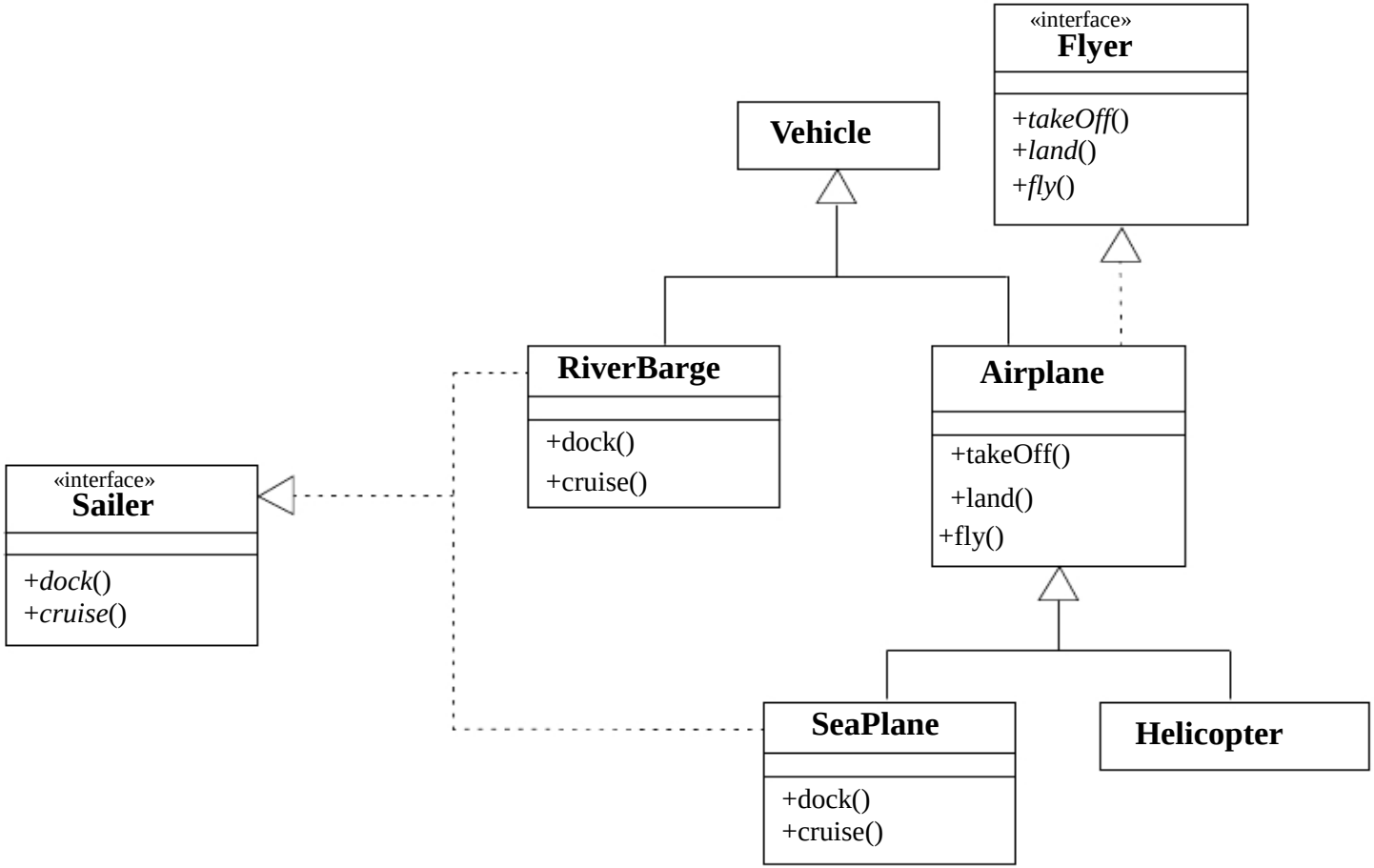
The Flyer Example

```
public class Airport {
   public static void main(String[] args) {
      Airport metropolisAirport = new Airport();
      Helicopter copter = new Helicopter();
      SeaPlane sPlane = new SeaPlane();

      metropolisAirport.givePermissionToLand(copter);
      metropolisAirport.givePermissionToLand(sPlane);
   }

   private void givePermissionToLand(Flyer f) {
      f.land();
   }
}
```

Multiple Interface Example



Multiple Interface Example

```
public class Harbor {
   public static void main(String[] args) {
      Harbor bostonHarbor = new Harbor();
      RiverBarge barge = new RiverBarge();
      SeaPlane sPlane = new SeaPlane();

      bostonHarbor.givePermissionToDock(barge);
      bostonHarbor.givePermissionToDock(sPlane);
   }

   private void givePermissionToDock(Sailer s) {
      s.dock();
   }
}
```

Uses of Interfaces

Interface uses include the following:

- Declaring methods that one or more classes are expected to implement
- Determining an object's programming interface without revealing the actual body of the class
- Capturing similarities between unrelated classes without forcing a class relationship
- Simulating multiple inheritance by declaring a class that implements several interfaces