Containment in Unions and Methods

Part 1: Containment in union

Managing Inventory

- A sales clerk in a toy store needs to know not only the name of the toy, but also its price, warehouse availability.
- The representation of an inventory as a list of toys.

Data definition

- Inventory is one of:
  - a empty
  - a construct of Toy Inventory

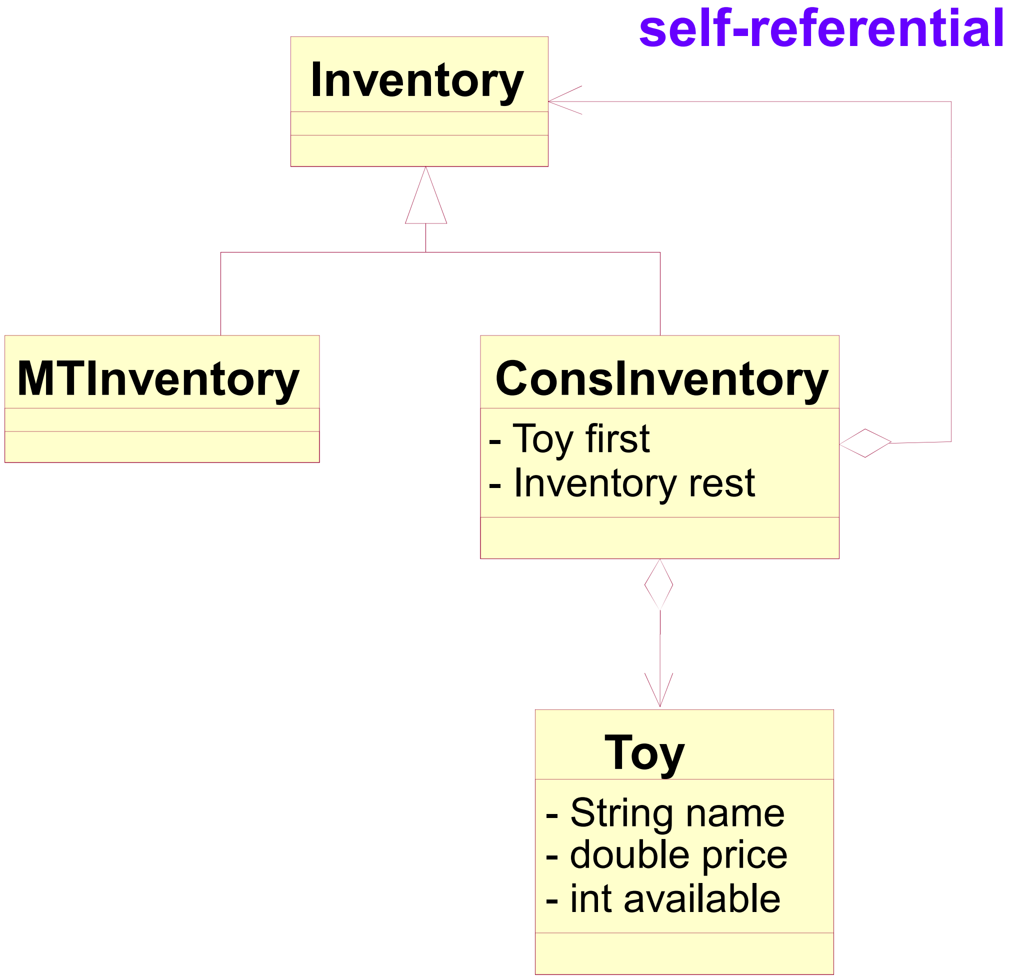
- The class of Inventory is a union:
  - Inventory, which is the type of all kind of inventories;
  - MTInventory, which represents an empty inventory;

  and

  - ConsInventory, which represents the construction of a new inventory from a Toy and an existing Inventory.

Class diagram

- An `MTInventory` class don't have any fields for it.
- A `ConsInventory` class requires two field definitions: one for the first Toy and one for the rest of the Inventory.



Define classes an constructors

```java
public interface Inventory {
}
```

```java
public class MTInventory implements Inventory {
}
```

```java
public class ConsInventory implements Inventory {
   private Toy first;
   private Inventory rest;
   public ConsInventory(Toy first, Inventory rest ) {
      this.first = first;
      this.rest= rest;
   }
}
```

Define classes and constructors

```
public class Toy {
   private String name;
   private double price;
   private int available;

   public Toy(String name, double price,
              int available) {
      this.name = name;
      this.price = price;
      this.available = available;
   }
}
```

Test Constructor

```
public class InventoryTest extends TestCase {
   public void testConstructor() {
      Toy doll = new Toy("doll", 17.95, 5);
      Toy robot = new Toy("robot", 22.05, 3);
      Toy gun = new Toy ("gun", 15.0, 4);

      Inventory empty = new MTInventory();
      Inventory i1 = new ConsInventory(doll, empty);
      Inventory i2 = new ConsInventory(robot, i1);
      Inventory all = new ConsInventory(gun, i2);
      System.out.println(all);

      Inventory all = new ConsInventory(doll,
             new ConsInventory(robot,
             new ConsInventory(gun, new MTInventory())));
      System.out.println(all);
   }
}
```

Print the content of an inventory

Q: How can we print the content of an object.

A: overwriting `toString()` method of class `Object`.

Q: Do we need to add `toString()` in `Inventory` class?

A: No !

toString() in classes

```
// inside of MTInventory class
public String toString() {
   return "";
}
```

```
// inside of ConsInventory class
public String toString() {
   return this.first.toString() + "\n"
        + this.rest.toString();
}
```

```
// inside of Toy class
public String toString() {
   return "name: " + this.name
        + ", price: " + this.price
        + ", available: " + this.available;
  }
}
```

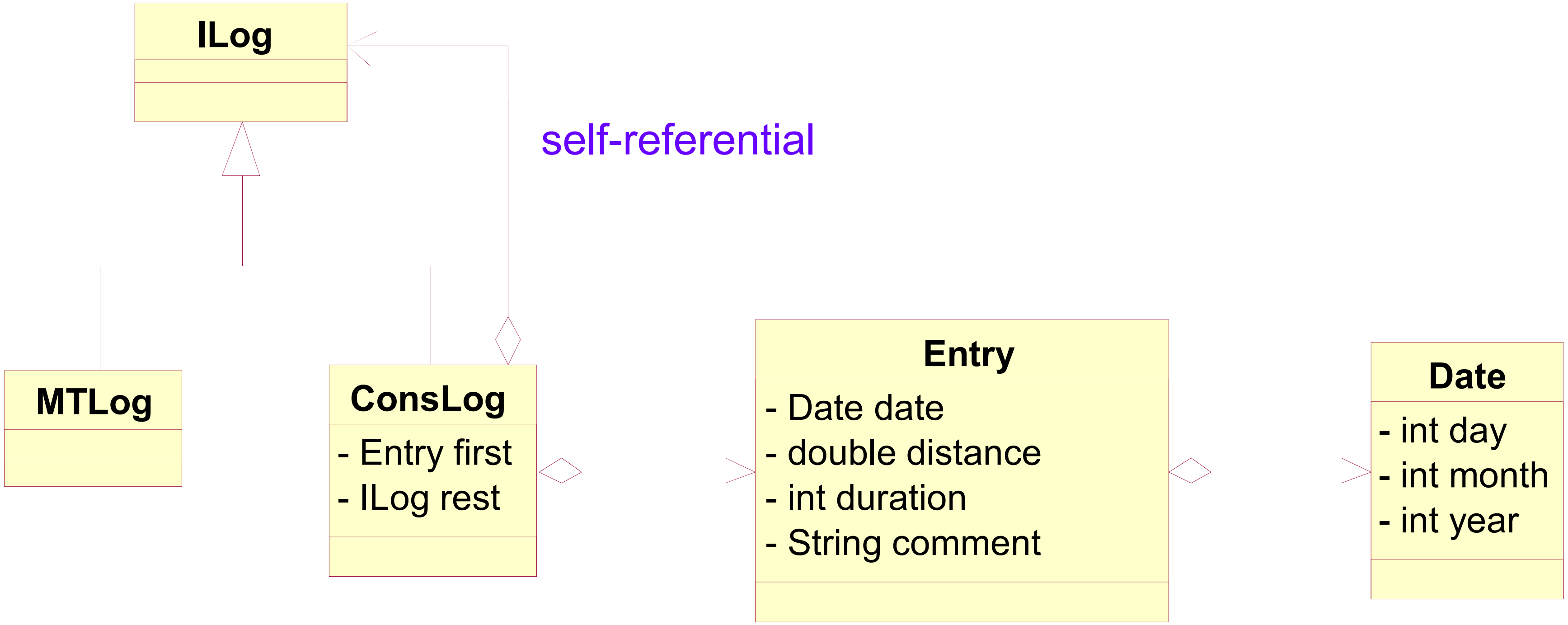
Managing a Runner’s Logs Example

- Develop a program that manages a runner's training log. Every day the runner enters one entry concerning the day's run. Each entry includes the day's date, the distance of the day's run, the duration of the run, and a comment describing the runner's post-run disposition.
- Naturally the program shouldn't just deal with a single log entry but sequences of log entries.

Data definition

- The class of Logs is a union:
  - **`ILog`**, which is the type of all logs;
  - **`MTLog`**, which represents an empty log; and
  - **`ConsLog`**, which represents the construction of a new log from an entry and an existing log.

Class diagram



Define classes an constructors

```
public interface ILog {
}
```

```
public class MTLog implements ILog {
}
```

```
public class ConsLog implements ILog {
   private Entry first;
   private ILog rest;
   public ConsLog(Entry first, ILog rest) {
      this.first = first;
      this.rest = rest;
   }
}
```

Define classes and constructors

```
public class Entry {
   private Date date;
   private double distance;
   private int duration;
   private String comment;
   public Entry(Date date, double distance,
                int duration,
                String comment) {
      this.date = date;
      this.distance = distance;
      this.duration = duration;
      this.comment = comment;
   }
}
```

Define classes and constructors

```java
public class Date {
   private int day;
   private int month;
   private int year;
   public Date(int day, int month, int year) {
      this.day = day;
      this.month = month;
      this.year = year;
   }
}
```

Test Constructor

```java
public class LogTest extends TestCase {
   public void testConstructor() {
      Entry e1 =
          new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
      Entry e2 =
          new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
      Entry e3 =
          new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

      ILog empty = new MTLog();
      ILog l1 = new ConsLog(e1, empty);
      ILog l2 = new ConsLog(e2, l1);
      ILog l3 = new ConsLog(e3, l2);
      System.out.println(l3);

      ILog all = new ConsLog(e1, new ConsLog(e2,
                     new ConsLog(e3, new MTLog())));
      System.out.println(all);
  }
}
```

toString() method

```
// inside of ConsLog class
public String toString() {
   return this.first.toString() + " \n" + this.rest.toString();
}
```

```
// inside of MTLog class
public String toString() {
   return "";
}
```

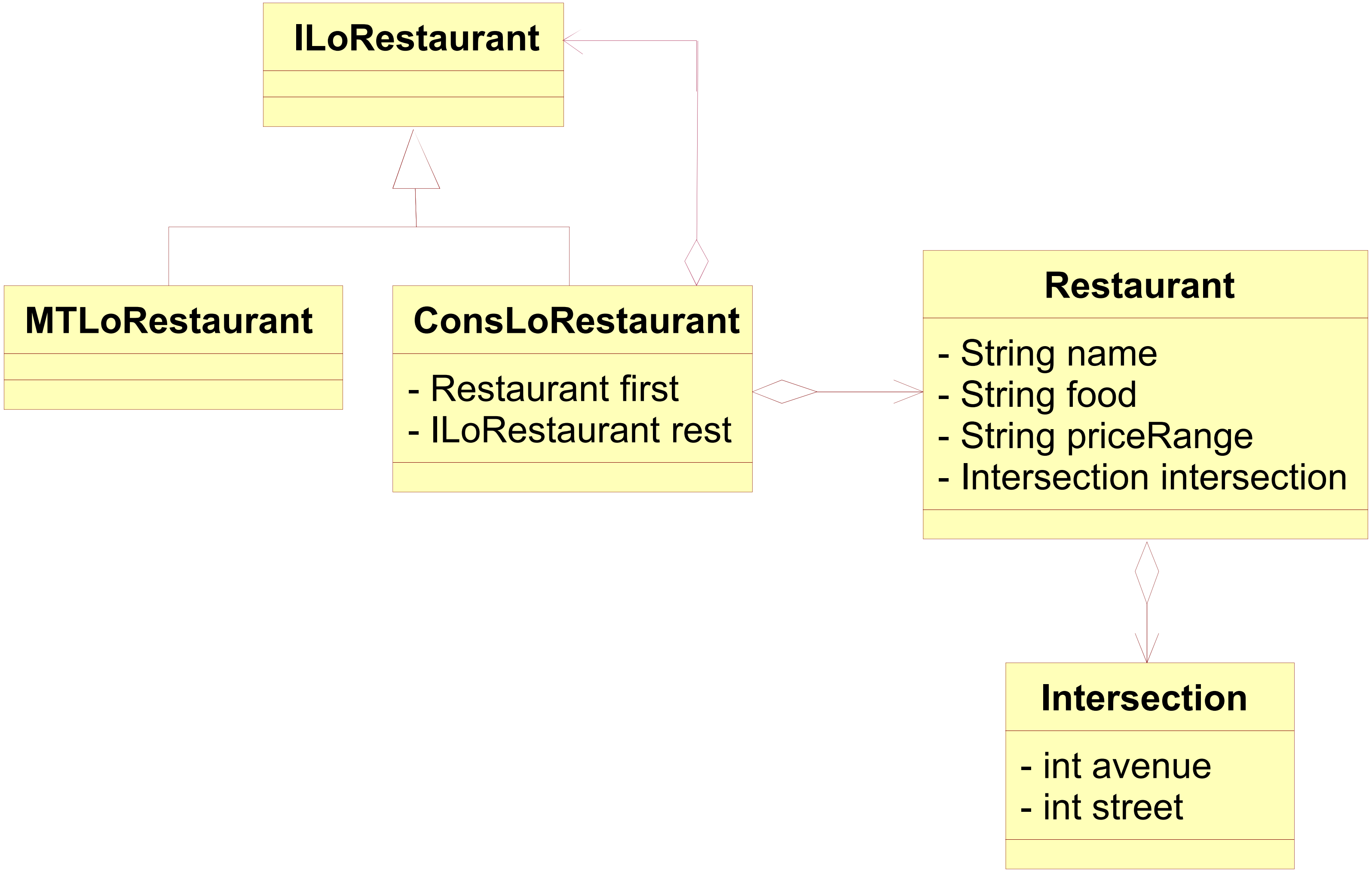
```
// inside of Entry class
public String toString() {
   return "date: " + this.date.toString()
        + ", distance: " + this.distance
        + ", duration: " + this.duration
        + ", comment: " + this.comment;
}
```

```
// inside of Date class
public String toString() {
   return this.day + "/" + this.month + "/" + this.year;
}
```

Recall restaurant example

- Develop a program that helps a visitor navigate Manhattan's restaurant scene. The program must be able to provide four pieces of information for each restaurant: its name, the kind of food it serves, its price range, and the closest intersection (street and avenue).
- Clearly, the visitor assistant should deal with lists of restaurants, not just individual restaurants. A visitor may, for example, wish to learn about all Chinese restaurants in a certain area or all German restaurants in a certain price range.

Class diagram



Define classes and constructors

```
public interface ILoRestaurant {
}
```

```
public class MTLoRestaurant implements ILoRestaurant {
}
```

```
public class ConsLoRestaurant implements ILoRestaurant {
  private Restaurant  first;
  private ILoRestaurant rest;
  public ConsLoRestaurant(Restaurant first,
                        ILoRestaurant rest) {
    this.first = first;
    this.rest = rest;
  }
}
```

Define Restaurant class

```java
public class Restaurant {
   private String name;
   private String food;
   private String priceRange;
   private Intersection intersection;
   public Restaurant(String name, String food,
               String priceRange,
               Intersection intersection) {
      this.name = name;
      this.food = food;
      this.priceRange = priceRange;
      this.intersection = intersection;
   }
}
```

Define Intersection class

```
public class Intersection {
   private int avenue;
   private int street;

   public Intersection(int avenue, int street) {
      this.avenue = avenue;
      this.street = street;
   }
}
```

toString() method

```java
// in class ConsLoRestaurant
public String toString() {
  return this.first.toString() + " \n" + this.rest.toString();
}
```

```java
// in class MTLoRestaurant
public String toString() {
  return "";
}
```

```java
// in class Restaurant
public String toString() {
  return "Name: " + this.name + ", food: " + this.food
     + ", range price: " + this.priceRange
     + ", intersection: " + this.intersection.toString() + "\n"
     + this.rest;
  }
}
```

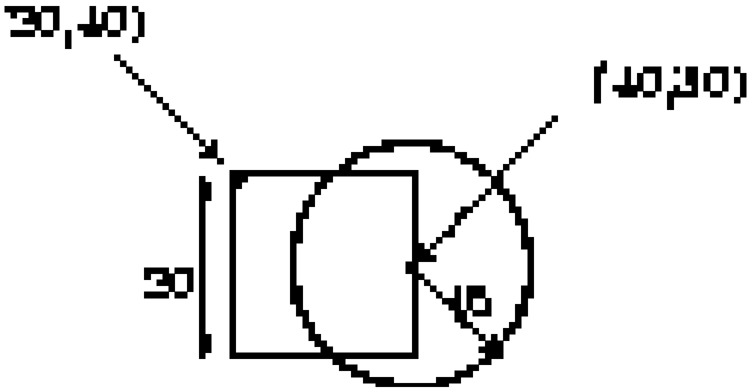
```java
// in class Intersection
public String toString() {
  return "avenue: " + this.avenue
       + ", street: " + this.street;
}
```

Test Constructor

```
public class ConsLoRestaurantTest extends TestCase {
  public void testConstructor() {
    Restaurant r1 = new Restaurant("Chez Nous",
         "French", "exp.", new Intersection(7, 65));
    Restaurant r2 = new Restaurant("Das Bier",
         "German", "cheap", new Intersection(2, 86));
    Restaurant r3 = new Restaurant("Sun",
       "Chinese", "cheap", new Intersection(10, 13));

    ILoRestaurant empty = new MTLoRestaurant();
    ILoRestaurant l1 = new ConsLoRestaurant(r1, empty);
    ILoRestaurant l2 = new ConsLoRestaurant(r2, l1);
    ILoRestaurant l3 = new ConsLoRestaurant(r3, l2);
    System.out.println(l3);

    ILoRestaurant all = new ConsLoRestaurant(r1,
        new ConsLoRestaurant (r2,
        new ConsLoRestaurant(r3, new MTLoRestaurant())));
    System.out.println(all);
  }
}
```

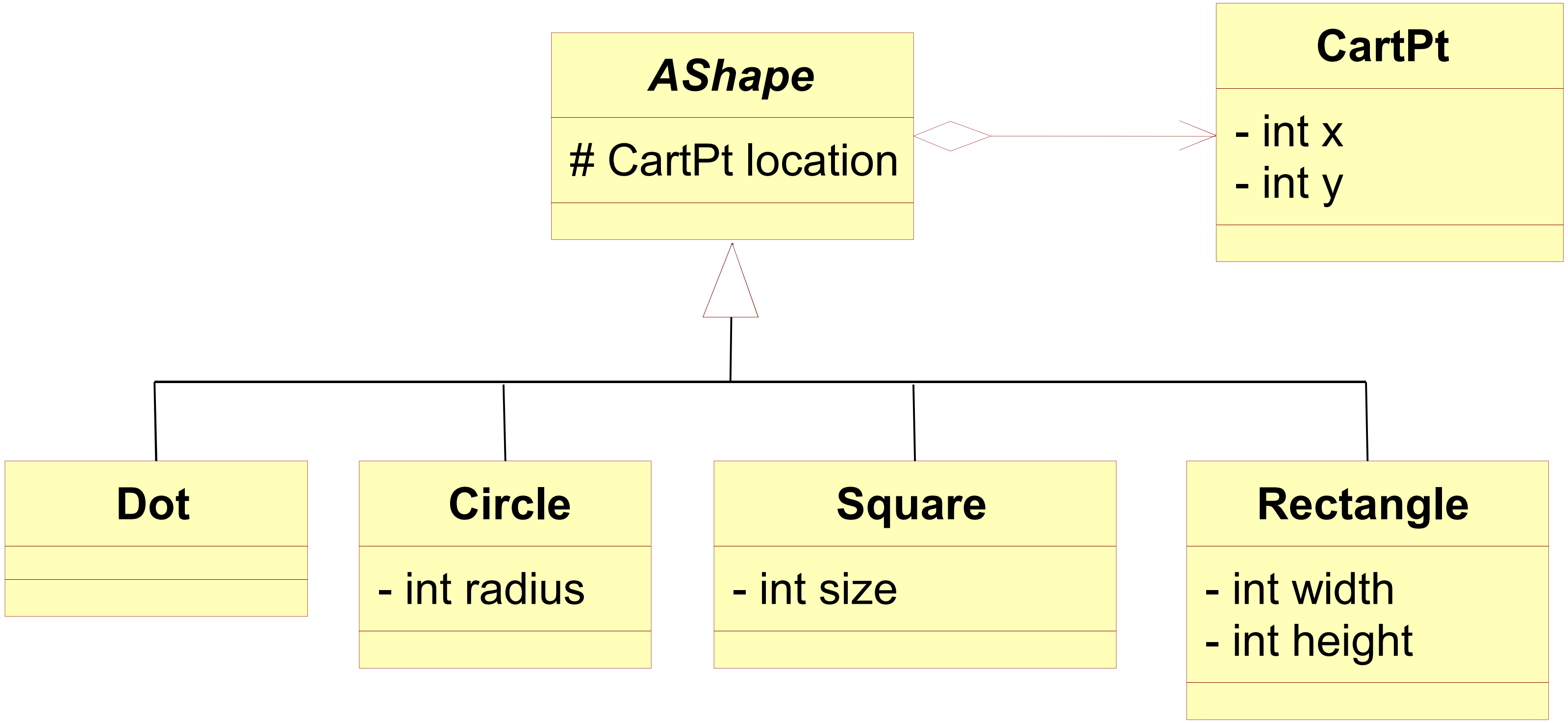
Overlaying shape example

- Lists are by no means the only form of information that requires a self-referential class diagram. Let's take another look at the problem of drawing shapes
- Develop a drawing program that deals with at least three kinds of shapes: dots, squares, and circles. ...In addition, the program should also deal with overlaying shapes on each other. In the following figure, for example, we have superimposed a circle on the right side of a square:

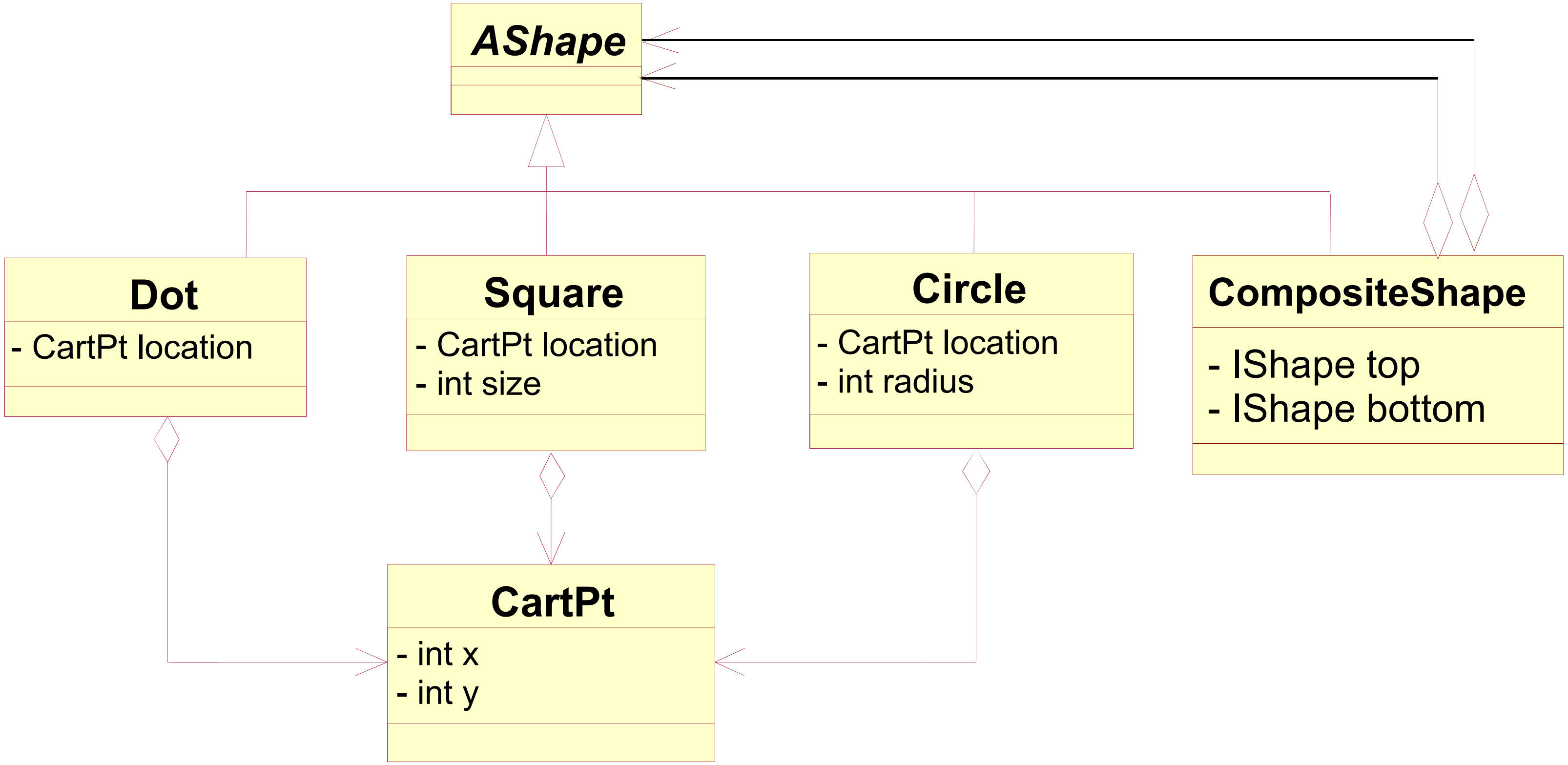


- We could now also superimpose (thêm vào) this compounded shape on another shape and so on.

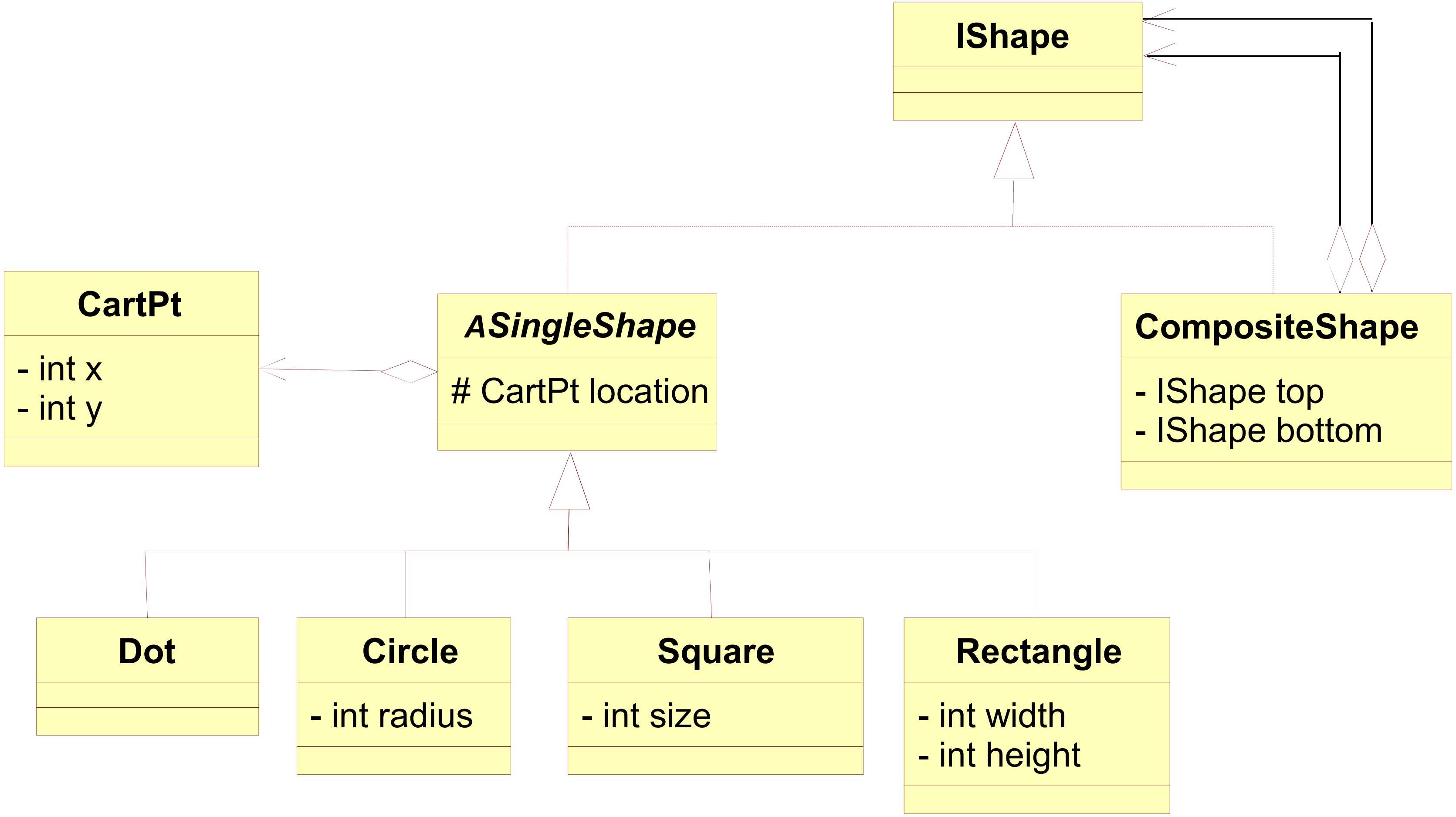
Old class design



New design after add Composite Shape



New design after add Composite Shape



Define classes and constructors

```
public interface IShape {
}
```

```
public class CompositeShape implements IShape {
   private IShape top;
   private IShape bottom;
   public CompositeShape(IShape top, IShape bottom) {
      this.top = top;
      this.bottom = bottom;
   }
}
```

```
public abstract class ASingleShape implements Ishape {
   protected CartPt location;
   public ASingleShape(CartPt location) {
      this.location = location;
   }
}
```

Define classes and constructors

```
public class Square extends ASingleShape {
  private int size;
  public Square(CartPt location, int size){
    super(location);
    this.size = size;
  }
}
```

```
public class Circle extends ASingleShape {
  private int radius;
  public Circle(CartPt location, int radius) {
    super(location);
    this.radius = radius;
  }
}
```

```
public class Dot extends ASingleShape {
  public Dot(CartPt location) {
    super(location);
  }
}
```

Define classes and constructors

```java
public class Rectangle extends ASingleShape {
  private int width;
  private int height;
  public Rectangle(CartPt location, int width, int height) {
    super(location);
    this.width = width;
    this.height = height;
  }
}
```

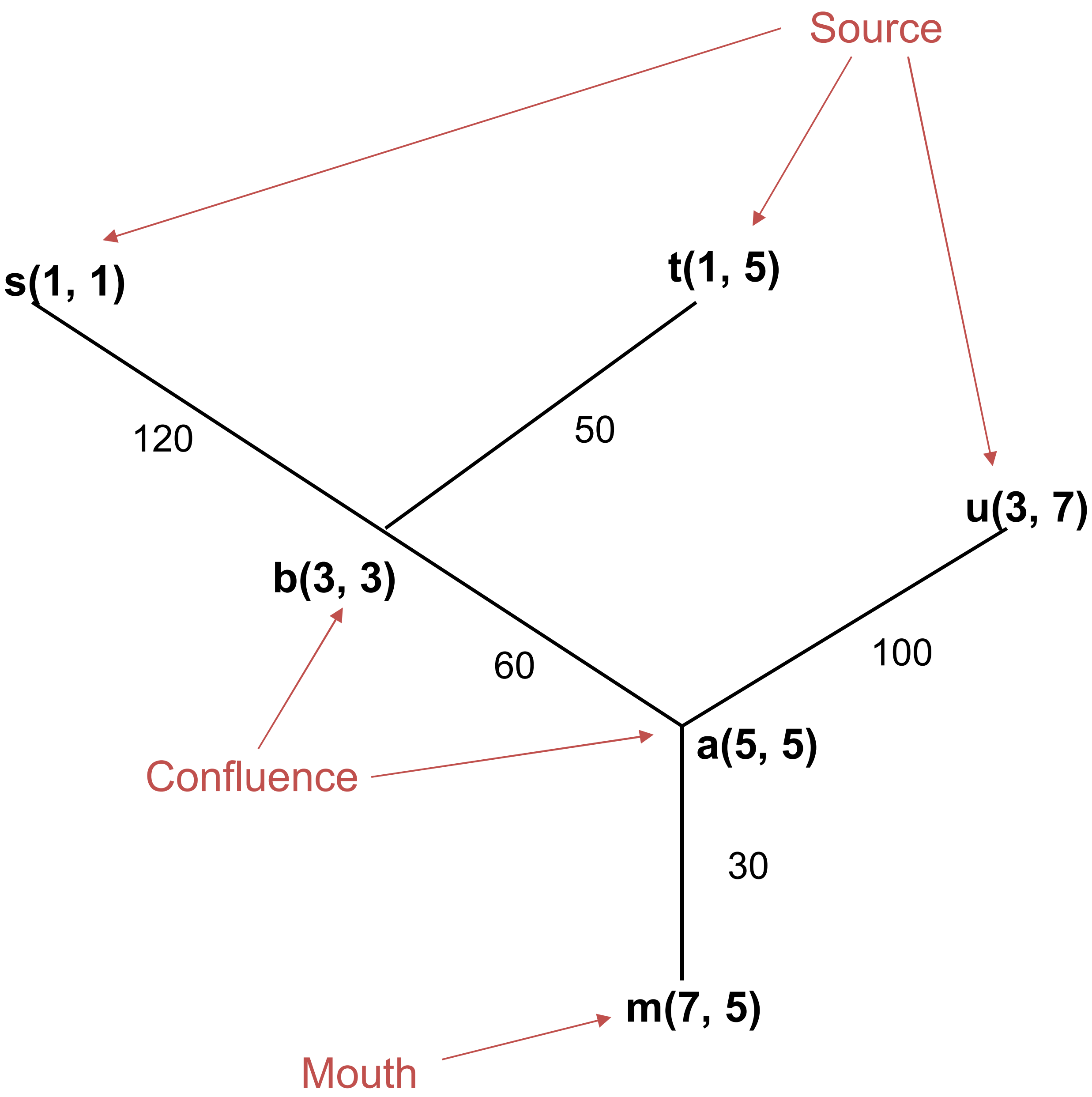
```java
public class CartPt {
  private int x;
  private int y;
  public CartPt(int x, int y){
    this.x = x;
    this.y = y;
  }
}
```

Test Constructor

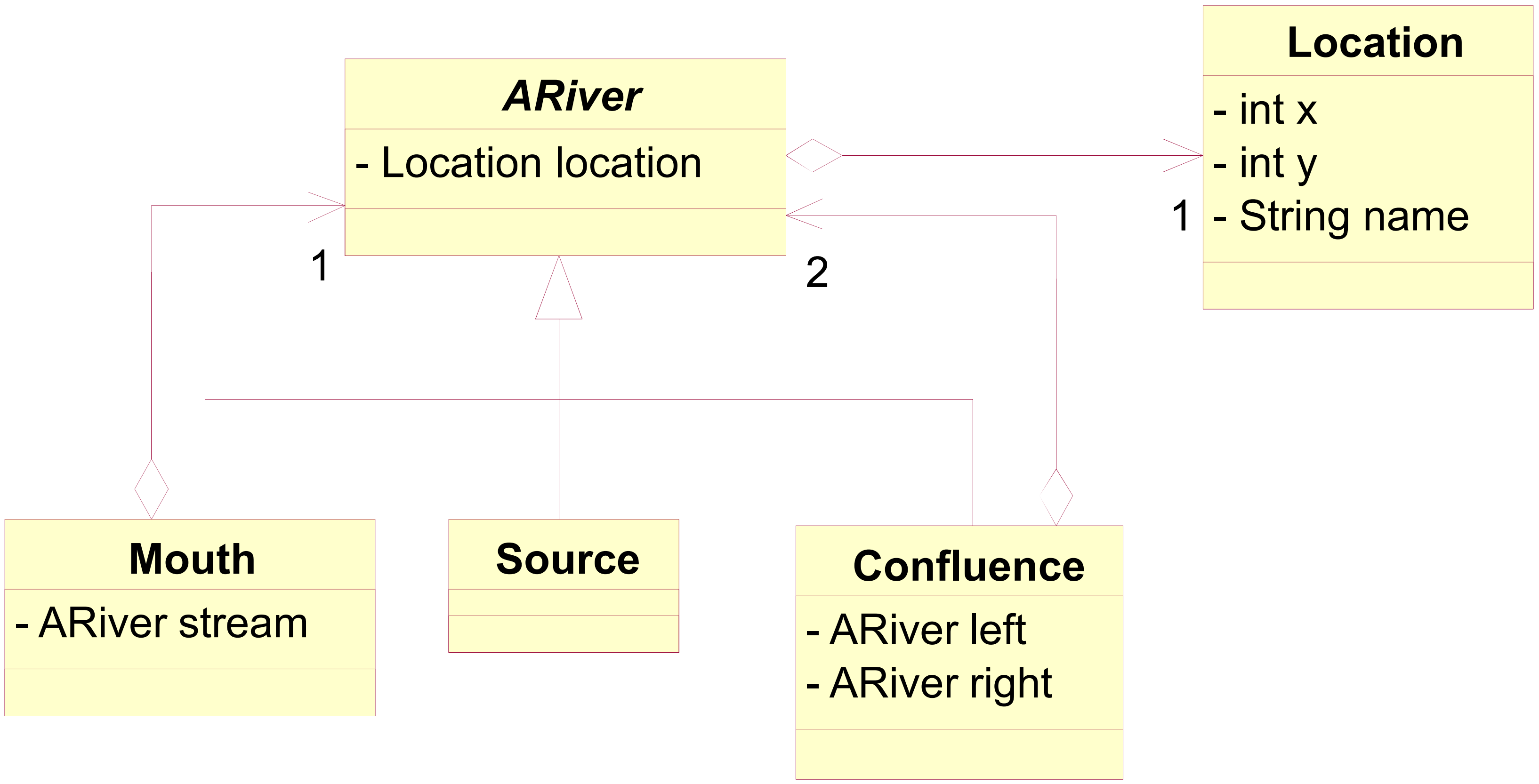
```
public class ShapeTest extends TestCase {
   public void testConstructor() {
      IShape s1 = new Square(new CartPt(4, 3), 40);
      IShape s2 = new Square(new CartPt(3, 4), 50);
      IShape c1 = new Circle(new CartPt(0, 0), 20);
      IShape c2 = new Circle(new CartPt(12, 5), 20);

      IShape u1 = new CompositeShape(s1, s2);
      IShape u2 = new CompositeShape(s1, c2);
      IShape u3 = new CompositeShape(c1, u1);
      IShape u4 = new CompositeShape(u3, u2);
      IShape u5 = new CompositeShape(s1,
                     new Compositeshape(c1, s2));
      System.out.println(u5);
   }
}
```

River Systems Example

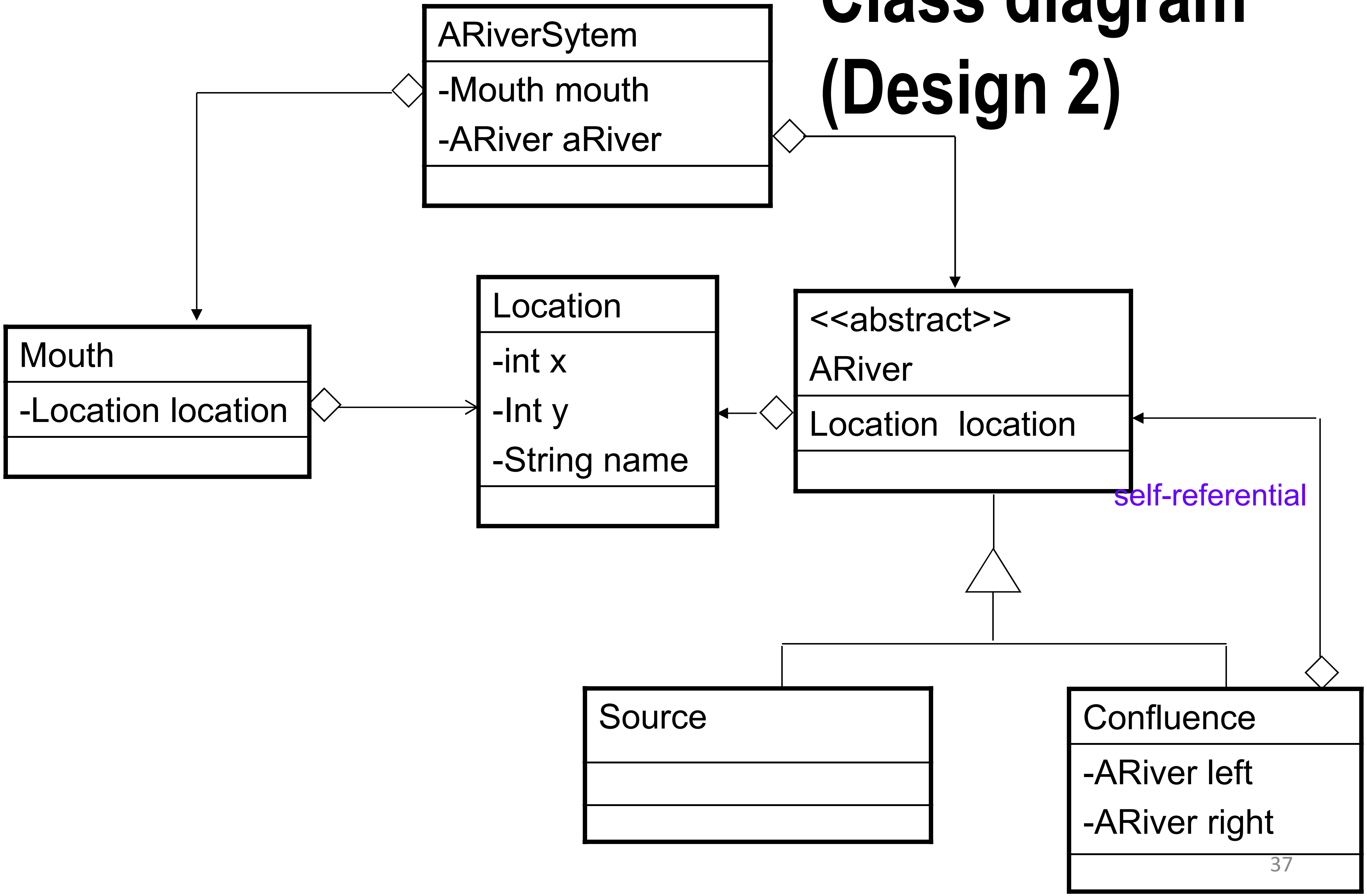
- The environmental protection agency monitors the water quality for river systems.
- A river system consists of a source of river, its tributaries (nhánh sông), the tributaries of the tributaries, and so on. Besides, each of part in the river system has location, and its length.
- The place where a tributary flows into a river is called confluence (hợp dòng).
- The initial river segment is its source (bắt nguồn)
- The river's end - the segment that ends in a sea or another river - is called its mouth (cửa sông)


Source
s(1, 1)
t(1, 5)
120
50
u(3, 7)
b(3, 3)
60
100
a(5, 5)
Confluence
30
m(7, 5)
Mouth

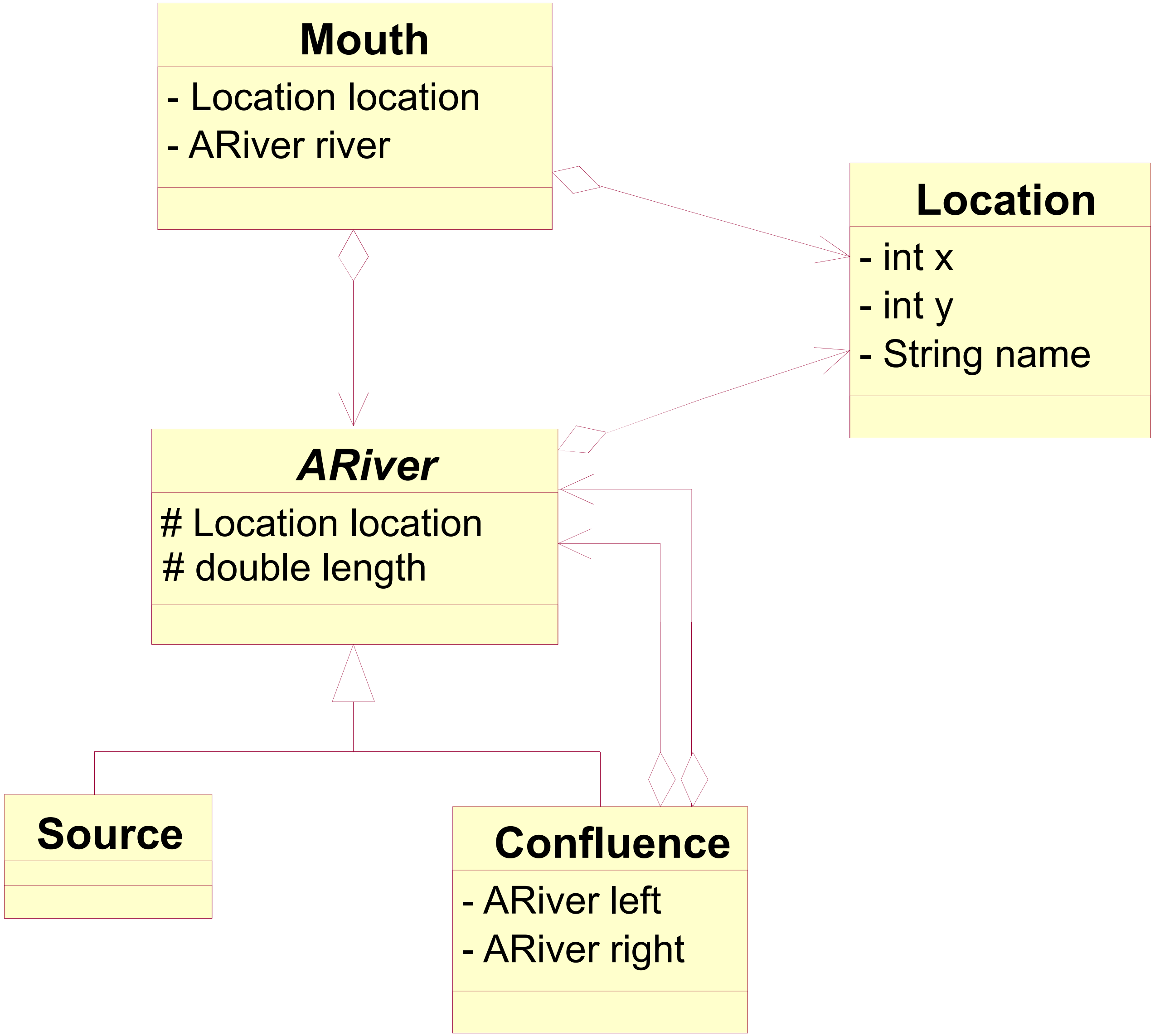
Class Diagram (design 1)



Class diagram (Design 2)



Class diagram (design 3)



Define classes and constructors

```
public class Location {
   private int x;
   private int y;
   private String name;
   public Location(int x, int y, String name) {
      this.x = x;
      this.y = y;
      this.name = name;
   }
}
```

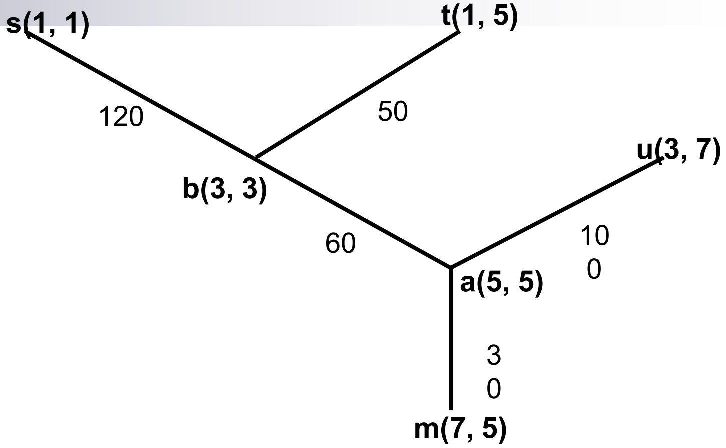
```
public class Mouth {
   private Location location;
   private ARiver river;
   public Mouth(Location location, ARiver river) {
      this.location = location;
      this.river = river;
   }
}
```

```
public abstract class ARiver {
   protected Location location;
   protected double length;
   public ARiver(Location location, double length) {
      this.location = location;
      this.length = length;
   }
}
```

```
public class Source extends ARiver {
   public Source(Location location, double length) {
      super(location,length);
   }
}
```

```
public class Confluence extends ARiver {
   private ARiver left;
   private ARiver right;
   public Confluence(Location location, double length,
                     ARiver left, ARiver right) {
      super(location,length);
      this.left = left;
      this.right = right;
   }
}
```

Test Constructor



```
public class ARiverTest extends TestCase {
   public void testConstructor() {
      ARiver s = new Source(new Location(1, 1, "s"), 120.0);
      ARiver t = new Source(new Location(1, 5, "t"), 50.0);
      ARiver u = new Source(new Location(3, 7, "u"), 100.0);

      ARiver b = new Confluence(
                   new Location(3, 3, "b"), 60.0, s, t);
      ARiver a = new Confluence(
                   new Location(5, 5, "a"), 30.0, b, u);

      Mouth m = new Mouth(new Location(7, 5, "m"), a);
   }
}
```

Exercises 5.1

- Develop a program that assists real estate agents. The program deals with listings of available houses
  - Make examples of listings.
    Develop a data definition for listings of houses.
  - Implement the definitionwith classes.
    Translate the examples into objects

Exercises 5.2

- Design a program that assists a bookstore manager with reading lists for local schools. . .
  - Develop a class diagramfor a list of books (by hand). Translate the diagram into classes.
  - Create two lists of books that contain at least one of the your favorite books

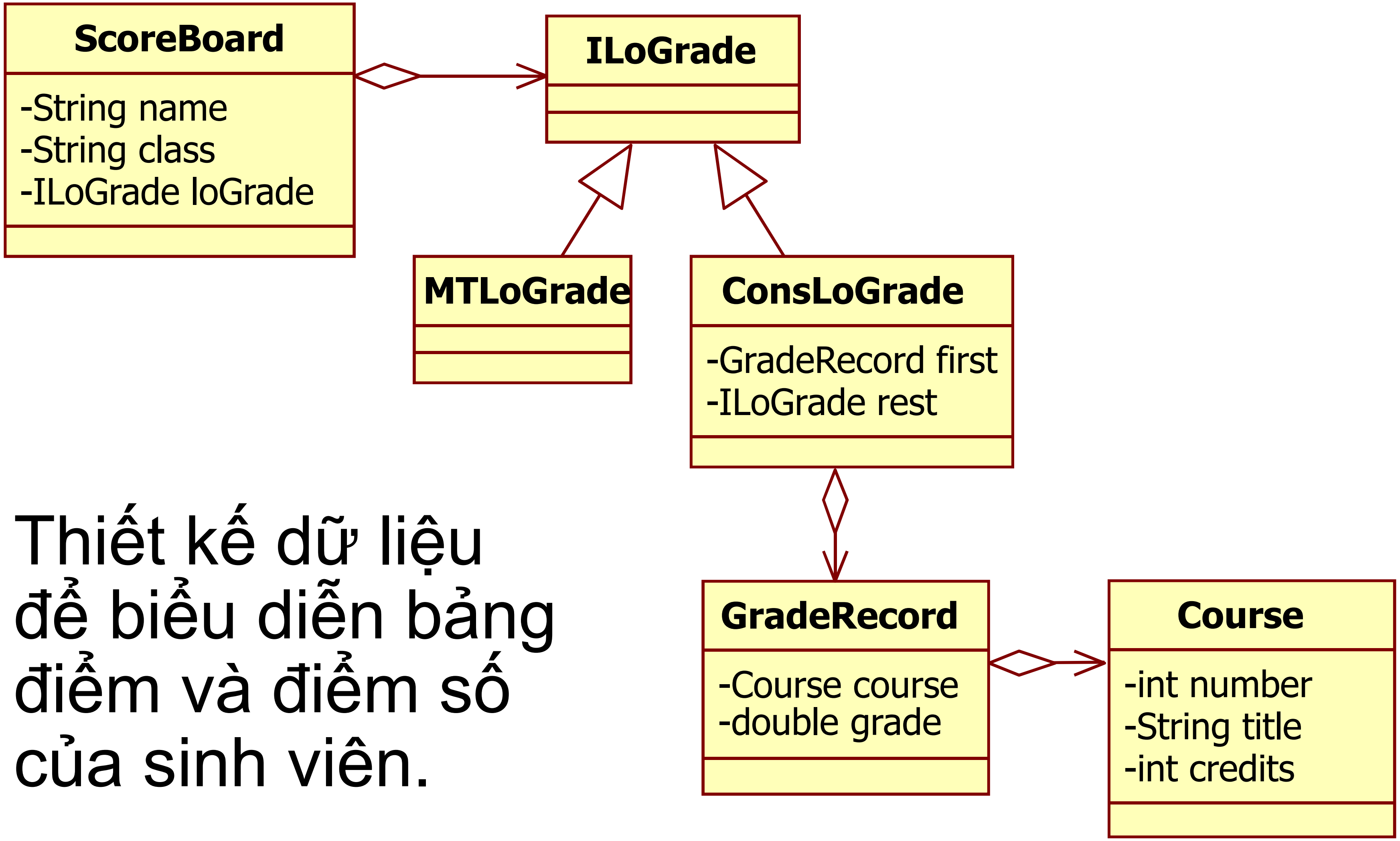
Exercise 5.3

- Research the tributaries of your favorite river. Create a data representation of the river and its tributaries. Draw the river system as a schematic diagram.
- Modify the classes that represent river segments, mouths, and sources so that you can add the names of these pieces to your data representation. Can you think of a river system that needs names for all three segments involved in a confluence? Represent such a confluence with the revised classes.

Exercises 5.4

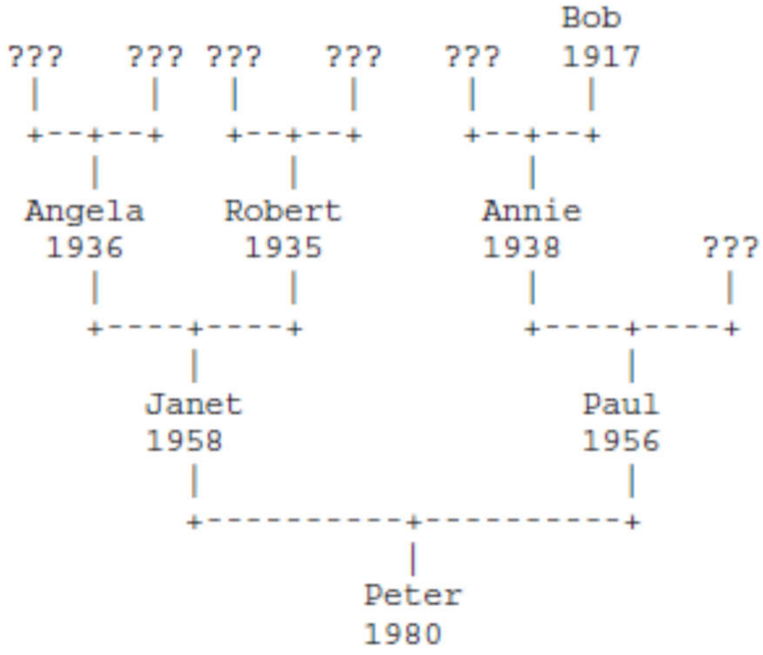
- Thông tin về điểm số của mỗi sinh viên được cho trong một bảng điểm. Mỗi bảng điểm (**ScoreBoard**) bao gồm tên sinh viên (**name**), khóa học (**class**), và một danh sách điểm số các môn học của sinh viên. Thông tin về điểm số (**GradeRecord**) của sinh viên bao gồm mã số môn học (**number**), tên môn học (**title**), số tín chỉ (**credits**) và điểm số (**grade**).
  - Ví dụ: một bảng điểm của sinh viên **Tran Van Hoa**, khóa **2009** gồm các mục điểm số:
    - 211, "Database Fundamentals", 3, 7.5
    - 220, "Basic Programming", 2, 5.0
    - 690, "Algorithms", 4, 7.0
    - 721, "Data Structure", 4, 8.0

ScoreBoard class diagram



Thiết kế dữ liệu để biểu diễn bảng điểm và điểm số của sinh viên.

Exercises 5.5



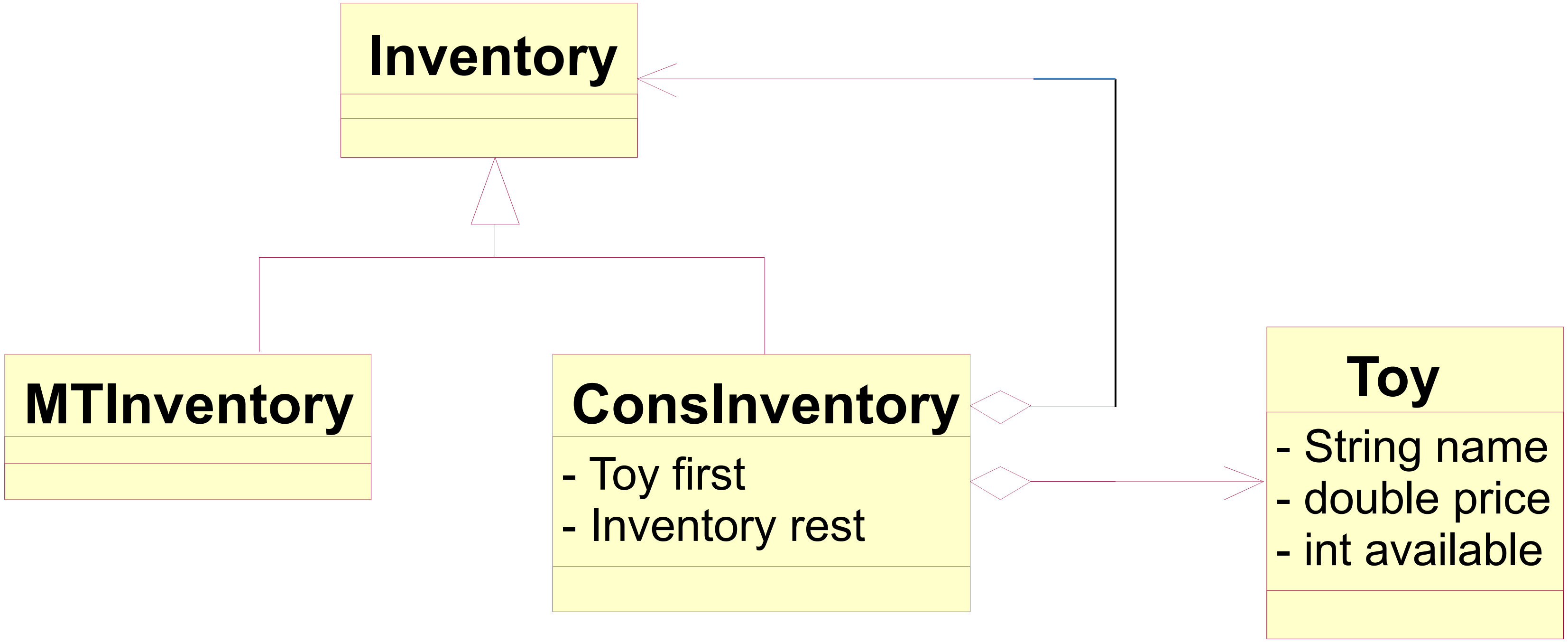
. . . Develop a programthat helps with recording a person’s ancestor tree. Specifically, for each person we wish to remember the person’s name and year of birth, in addition to the ancestry on the father’s and the mother’s side, if it is available.

The tree on the left is an example; the nodes with “???” indicate where the genealogist couldn’t find any information.

- . . .Develop the class diagram (by hand) and the class definitions to represent ancestor family trees. Then translate the sample tree into an object.
- Also draw your family’s ancestor tree as far as known and represent it as an object.

Part 2: Methods and Classes with Mutual References

Recall Inventory problem



Inventory

MTInventory

ConsInventory

- Toy first
- Inventory rest

Toy

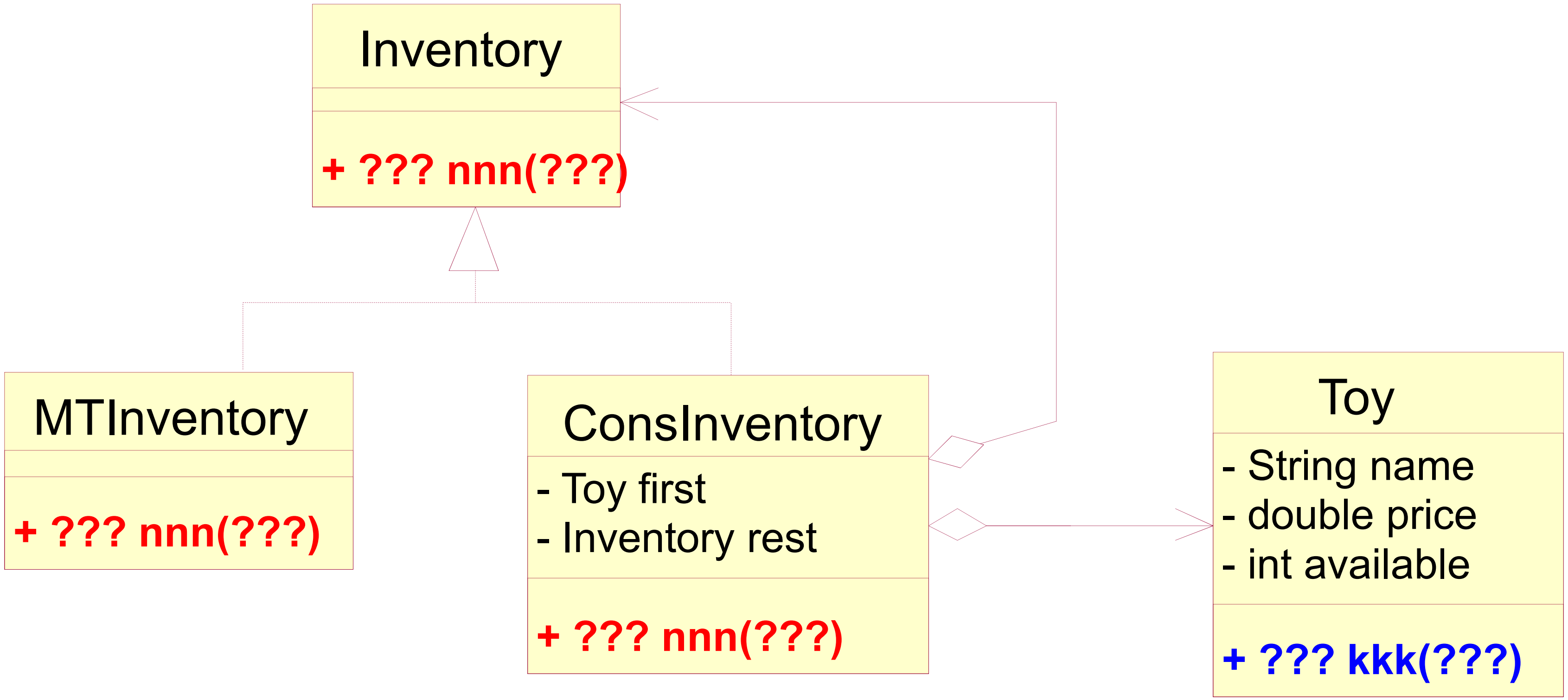
- String name
- double price
- int available

Class diagram

Recall Inventory problem

- Develop the method `contains`, which determines whether or not the name of toy occurs in the Inventory
- Develop the method `isBelow`, which checks whether all of the prices of toys in inventory are below the threshold.
- Develop the method `howMany`, which produces the number of items in the list.
- Develop the method `raisePrice`, which produces an inventory in which all prices are raised by a rate 5% (use ***mutable*** and ***immutable***).

Add methods to the Inventory's Class Diagram



Q: Write Java method templates for all the classes in the class diagram ?

Java template for Toy

```java
public class Toy {
   private String name;
   private double price;
   private int available;
   public Toy(String name, double price, int available) {
      this.name = name;
      this.price = price;
      this.available = available;
   }

   public ??? kkk(???) {
      ...this.name...
      ...this.price...
      ...this.available...
   }
}
```

Java template for Inventory

```
public interface Inventory {
   public ??? nnn(???);
}
```

Java template for MTInventory

```
public class MTInventory implements Inventory {

   public MTInventory () { }

   public ??? nnn(???) {
      ...
   }
}
```

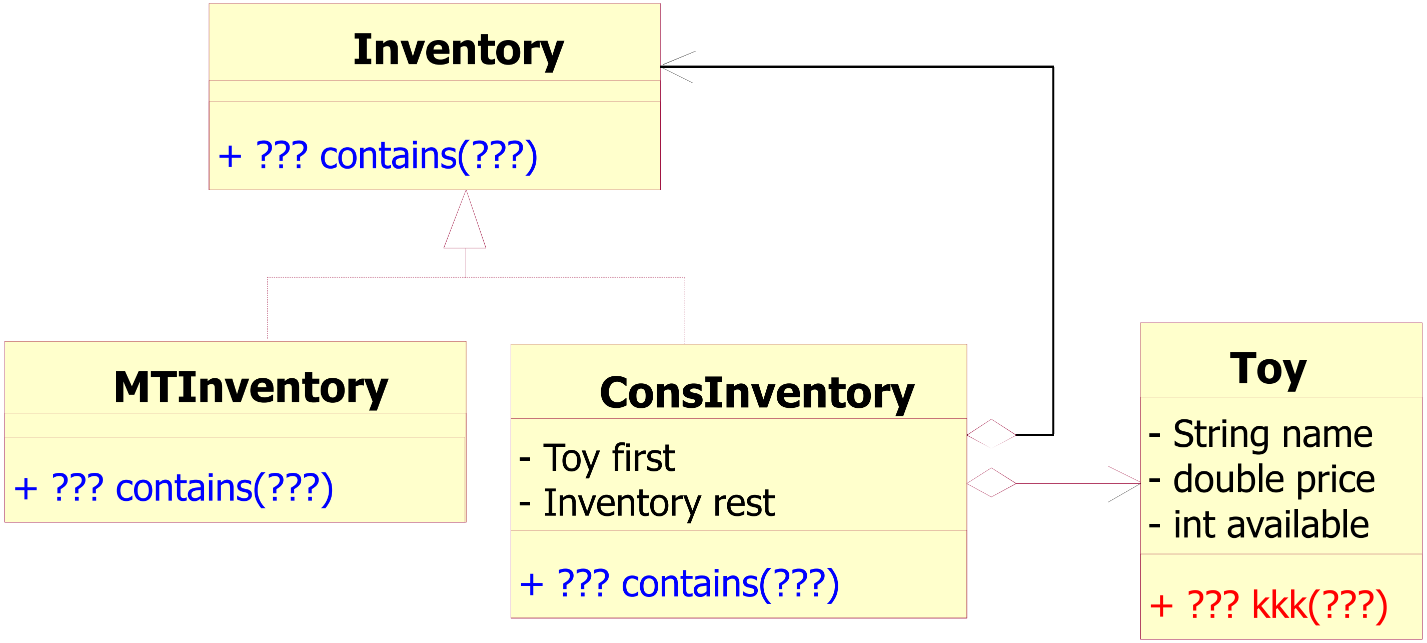
Java template for **ConsInventory**

```
public class ConsInventoy implements Inventory {
   private Toy first;
   private Inventory rest;
   public Cons(Toy first, Inventory rest) {
      this.first = first;
      this.rest = rest;
   }

   public ??? nnn(???) {
      ...this.first.kkk(???)...
      ...this.rest.nnn(???)...
   }
}
```

Since all instances in the **`rest`** field are always created from either **`MTInventory`** or **`ConsInventory`**, this means that the method call **`this.rest.nnn()`** really invokes one of the concrete **`nnn()`** methods in **`MTInventory`** or **`ConsInventory`**

Add contains method

- Develop the method contains, which determines whether or not the name of toy occurs in the Inventory



Purpose and contract of contains() for Inventory

```java
public interface Inventory {
   // determines whether or not the name of
   // toy occurs in the Inventory
   public boolean contains(String toyName);
}
```

Examples to test contains()

```
Toy doll = new Toy("doll", 17.95, 5);
Toy robot = new Toy("robot", 22.05, 3);
Toy gun = new Toy ("gun", 15.0, 4);

Inventory empty = new MTInventory();
Inventory i1 = new ConsInventory(doll, empty);
nventory i2 = new ConsInventory(robot, i1);
Inventory all = new ConsInventory(doll,
                new ConsInventory(robot,
                new ConsInventory(gun, new MTInventory())));

empty.contains("robot") → should be false
i1.contains("robot") → should be false
i2.contains("robot") → should be true
all.contains("robot") → should be true
all.contains("car") → should be false
```

contains() for MTInventory and ConsInventory

```
//in class MTInventory
public boolean contains(String toyName) {
   return false;
}
```

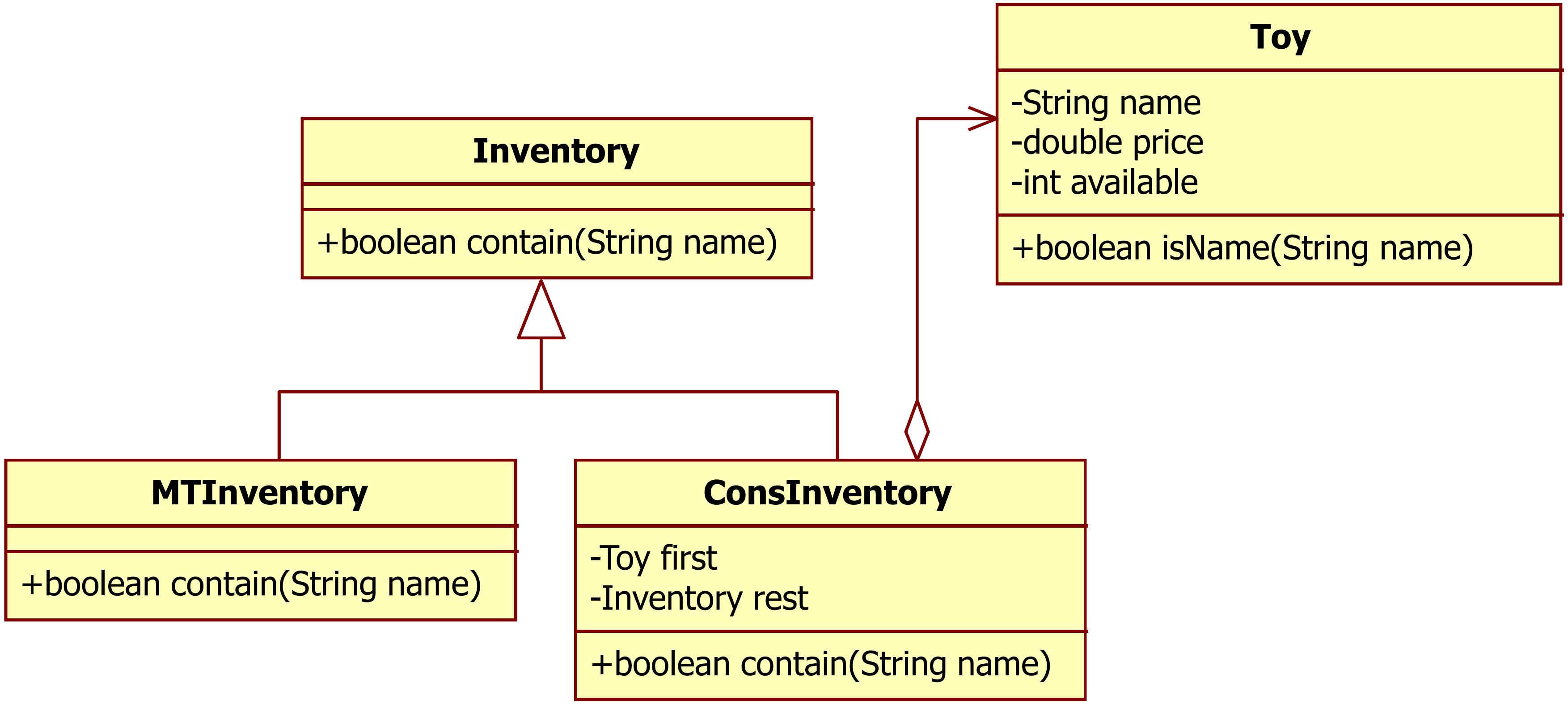
```
// in class ConsInventory
public boolean contains(String toyName) {
   return this.first.isName(toyName)
         || this.rest.contains(toyName);
}
```

```
//in class Toy
 public boolean isName(String toyName) {
      return this.name.equals(toyName);
   }
```

Test contains()

```
public void testContains(){
   Toy doll = new Toy("doll", 17.95, 5);
   Toy robot = new Toy("robot", 22.05, 3);
   Toy gun = new Toy ("gun", 15.0, 4);

   Inventory empty = new MTInventory();
   Inventory i1 = new ConsInventory(doll, empty);
   Inventory i2 = new ConsInventory(robot, i1);
   Inventory all = new ConsInventory(doll,
        new ConsInventory(robot,
        new ConsInventory(gun, new MTInventory())));

   assertFalse(empty.contains("robot"));
   assertfalse(i1.contains("robot"));
   assertTrue(i2.contains("robot"));
   assertTrue(all.contains("robot"));
   assertFalse(all.contains("car"));
}
```

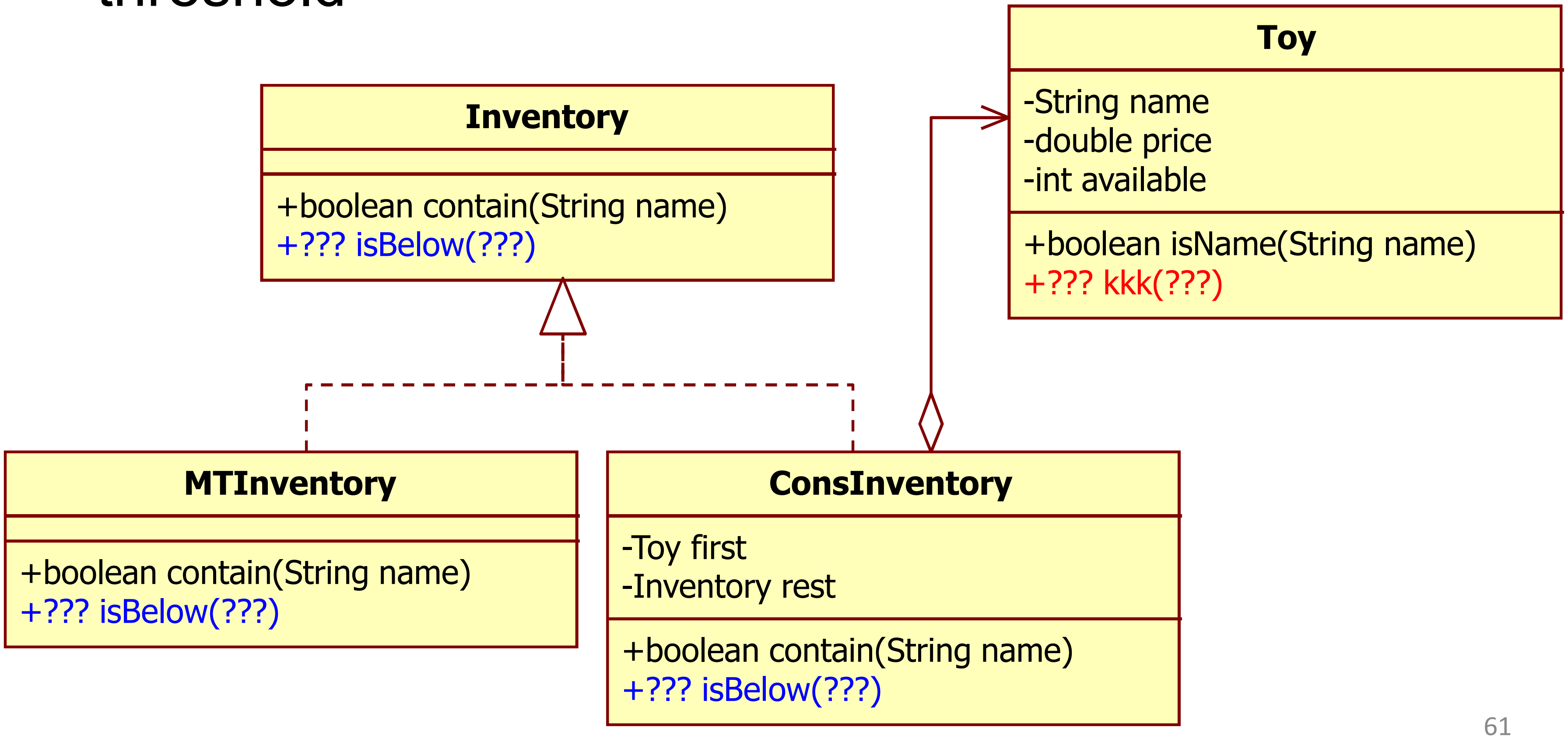
Class diagram after add `contains()`



Toy
-String name
-double price
-int available
+boolean isName(String name)
Inventory
+boolean contain(String name)
MTInventory
+boolean contain(String name)
ConsInventory
-Toy first
-Inventory rest
+boolean contain(String name)

Add isBelow method

- Develop the method isBelow, which checks whether all of the prices of toys in inventory are below the threshold



Inventory

+boolean contain(String name)
+??? isBelow(???)

Toy

-String name
-double price
-int available

+boolean isName(String name)
+??? kkk(???)

MTInventory

+boolean contain(String name)
+??? isBelow(???)

ConsInventory

-Toy first
-Inventory rest

+boolean contain(String name)
+??? isBelow(???)

Purpose and contract of isBellow() for Inventory

```
public interface Inventory {
   // determines whether or not the name of
   // toy occurs in the Inventory
   public boolean contains(String toyName);

   // determines whether or not all prices of toys
   // in the Inventory bellow a threshold
   public boolean isBelow(double threshold);
}
```

Examples to test isBelow()

```
Toy doll = new Toy("doll", 17.95, 5);
Toy robot = new Toy("robot", 22.05, 3);
Toy gun = new Toy ("gun", 15.0, 4);

Inventory empty = new MTInventory();
Inventory i1 = new ConsInventory(doll, empty);
Inventory i2 = new ConsInventory(robot, i1);
Inventory all = new ConsInventory(doll,
                new ConsInventory(robot,
                new ConsInventory(gun, new MTInventory())));

empty.isbelows(20) → should be true
i1.isBelow(20) → should be true
i2.isBelow(20) → should be false
all.isBelow(20) → should be false
all.contains(25) → should be true
```

isBelow() for MTInventory and ConsInventory

```
//inside of MTInventory class
public boolean isBelow(double threshold) {
   return true;
}
```

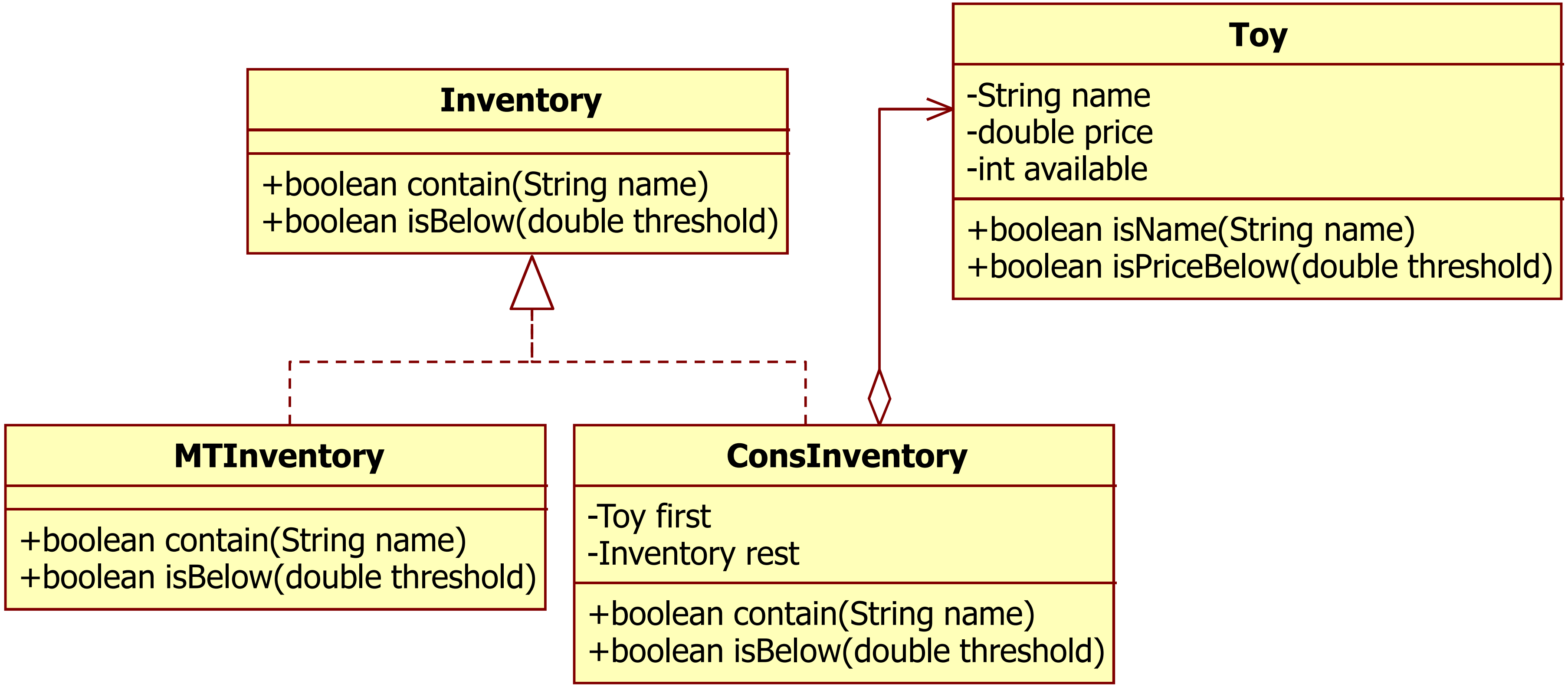
```
// inside of ConsInventory class
public boolean isBelow(double threshold) {
   return this.first.isPriceBelow(threshold)
          && this.rest.isBelow(threshold);
}
```

```
// inside of Toy class
public boolean isPriceBelow(double threshold) {
   return this.price < threshold;
}
```

Test isBelow()

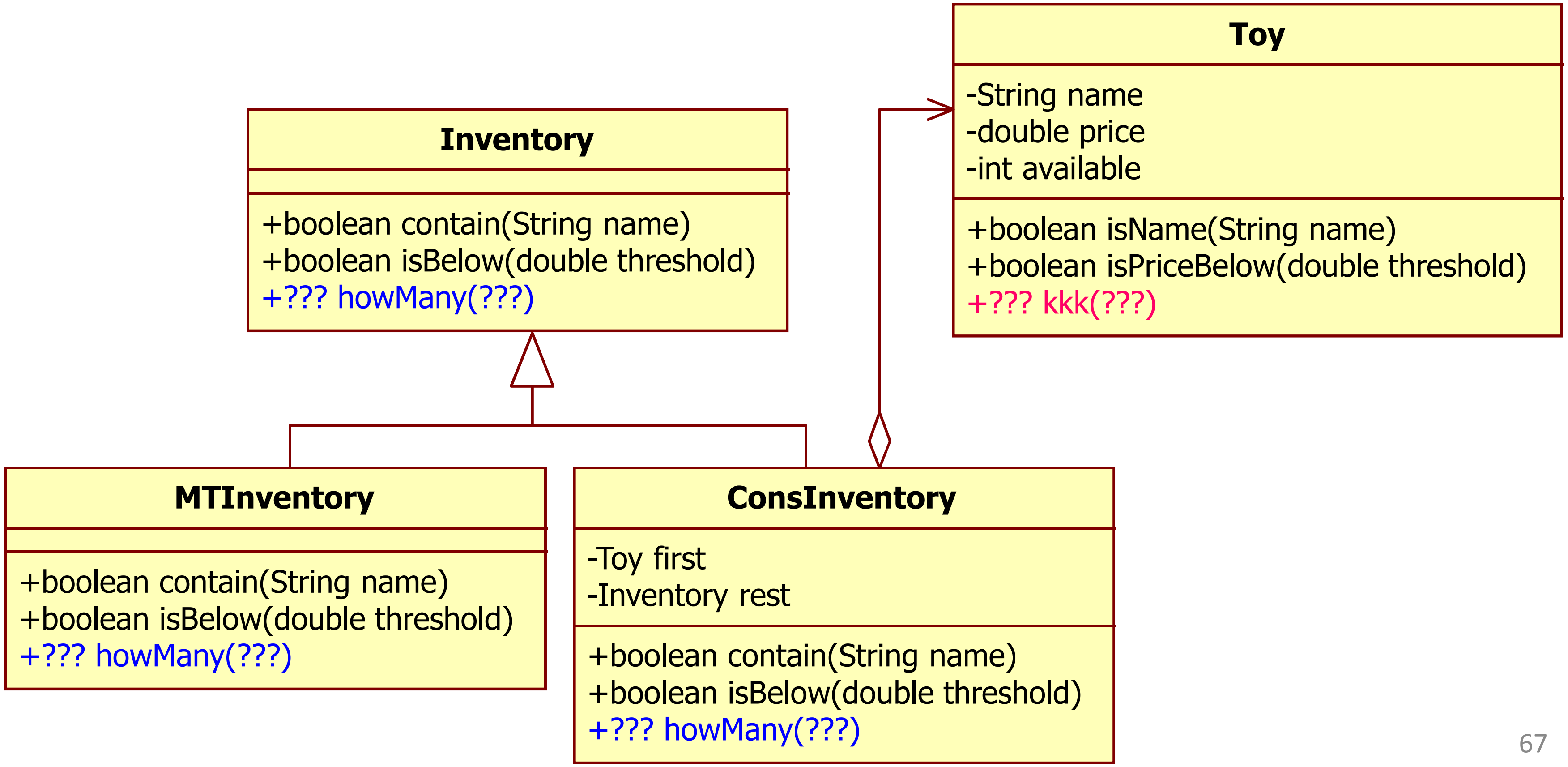
```
public void testIsBellow(){
   Toy doll = new Toy("doll", 17.95, 5);
   Toy robot = new Toy("robot", 22.05, 3);
   Toy gun = new Toy ("gun", 15.0,4);

   Inventory empty = new MTInventory();
   Inventory i1 = new ConsInventory(doll, empty);
   Inventory i2 = new ConsInventory(robot, i1);
   Inventory all = new ConsInventory(doll,
               new ConsInventory(robot,
               new ConsInventory(gun, new MTInventory())));

   assertTrue(empty.isbelows(20));
   assertTrue(i1.isBelow(20));
   assertFalse(i2.isBelow(20));
   assertFalse(all.isBelow(20));
   assertTrue(all.contains(25));
}
```

Class diagram after add `isBelow()`


Inventory
+boolean contain(String name)
+boolean isBelow(double threshold)
Toy
-String name
-double price
-int available
+boolean isName(String name)
+boolean isPriceBelow(double threshold)
MTInventory
+boolean contain(String name)
+boolean isBelow(double threshold)
ConsInventory
-Toy first
-Inventory rest
+boolean contain(String name)
+boolean isBelow(double threshold)

Add howMany method

- Develop the method howMany, which produces the number of toy items in the inventory.


Toy
-String name
-double price
-int available
+boolean isName(String name)
+boolean isPriceBelow(double threshold)
+??? kkk(???)
Inventory
+boolean contain(String name)
+boolean isBelow(double threshold)
+??? howMany(???)
MTInventory
+boolean contain(String name)
+boolean isBelow(double threshold)
+??? howMany(???)
ConsInventory
-Toy first
-Inventory rest
+boolean contain(String name)
+boolean isBelow(double threshold)
+??? howMany(???)

Purpose and contract of howMany() for Inventory

```
public interface Inventory {
  ...

  // count the number of items in the Inventory
  public int howMany();
}
```

Examples to test howMany()

```
Toy doll = new Toy("doll", 17.95, 5);
Toy robot = new Toy("robot", 22.05, 3);
Toy gun = new Toy ("gun", 15.0, 4);

Inventory empty = new MTInventory();
Inventory i1 = new ConsInventory(doll, empty);
Inventory i2 = new ConsInventory(robot, i1);
Inventory all = new ConsInventory(doll,
                new ConsInventory(robot,
                new ConsInventory(gun, new MTInventory())));

empty.howMany() → should be 0
i1.howMany() → should be 1
i2.howMany() → should be 2
all.howMany() → should be 3
```

howMany() for MTInventory and ConsInventory

```
// inside of MTInventory class
public int howMany() {
   return 0;
}
```

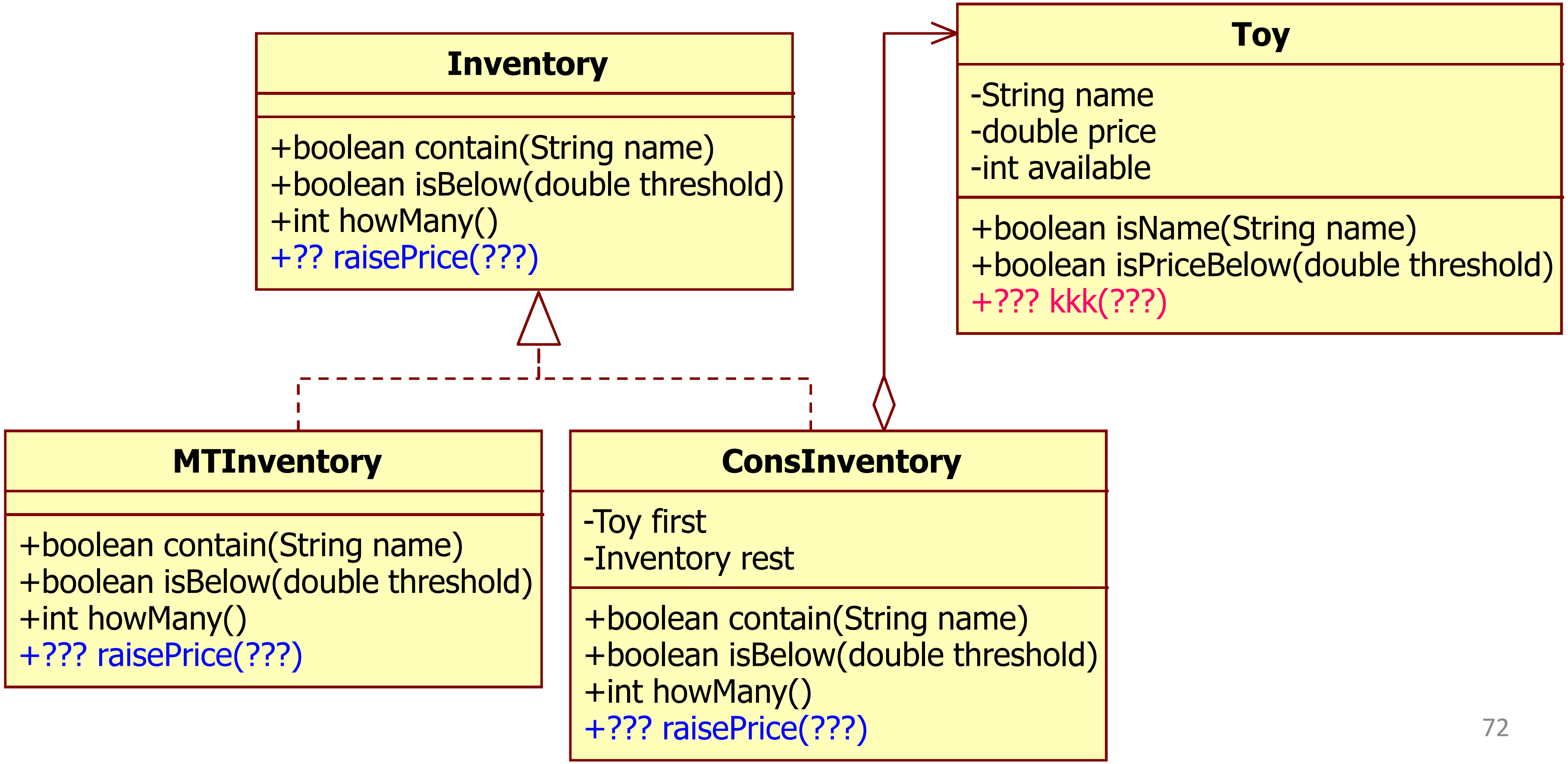
```
// inside of ConsInventory class
public int howMany() {
   return 1 + this.rest.howMany();
}
```

Test howMany()

```
public void testHowMany() {
  Toy doll = new Toy("doll", 17.95, 5);
  Toy robot = new Toy("robot", 22.05, 3);
  Toy gun = new Toy ("gun", 15.0,4);

  Inventory empty = new MTInventory();
  Inventory i1 = new ConsInventory(doll, empty);
  Inventory i2 = new ConsInventory(robot, i1);
  Inventory all = new ConsInventory(doll,
                  new ConsInventory(robot,
                  new ConsInventory(gun, new MTInventory())));

  assertEquals(0, empty.howMany());
  assertEquals(1, i1.howMany());
  assertEquals(2, i2.howMany());
  assertEquals(3, all.howMany());
}
```

Add raisePrice() method

- Develop the method raisePrice, which produces an inventory in which all prices are raised by a given rate


Inventory
+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+?? raisePrice(???)
Toy
-String name
-double price
-int available
+boolean isName(String name)
+boolean isPriceBelow(double threshold)
+??? kkk(???)
MTInventory
+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+??? raisePrice(???)
ConsInventory
-Toy first
-Inventory rest
+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+??? raisePrice(???)

Purpose and contract of raisePrice() for Inventory - Immutable version

- **Q**: what does the raisePrice method return?
- **A:** It returns a new Inventory whose each element has new price

```
public interface Inventory {
   ...
   // raise all prices of toys
   // in the Inventory with rate
   public Inventory raisePrice(double rate);
}
```

Examples to test raisePrice()

```
Toy doll = new Toy("doll", 17.95, 5);
Toy robot = new Toy("robot", 22.05, 3);
Toy gun = new Toy ("gun", 15.0, 4);

Inventory empty = new MTInventory();
Inventory all = new ConsInventory(doll,
                new ConsInventory(robot,
                new ConsInventory(gun, new MTInventory())));

empty.raisePrice(0.05) → should be new MTLog()
all.raisePrice(0.05) → new ConsLog(new Toy("doll", 18.8475, 5),
                 new ConsLog(new Toy("robot", 23.1525, 5),
                 new ConsLog(new Toy("gun", 15.75, 5),
                 new MTLog())))
```

raisePrice() for MTInventory and ConsInventory

```
// inside of MTInventory class
public Inventory raisePrice(double rate) {
   return new MTInventory();
}
```

```
// inside of ConsInventory class
public Inventory raisePrice(double rate) {
   Toy aToy = this.first.copyWithRaisePrice(rate);
   return new ConsInventory(aToy, this.rest.raisePrice(rate));
}
```

```
// inside of Toy class
public Toy copyWithRaisePrice(double rate) {
   return new Toy(this.name,
                  this.price * (1 + rate), this.available);
}
```

Test raisePrice()

```
public void testRaisePrice(){
   Toy doll = new Toy("doll", 17.95, 5);
   Toy robot = new Toy("robot", 22.05, 3);
   Toy gun = new Toy ("gun", 15.0,4);

   Inventory all = new ConsInventory(doll,
       new ConsInventory(robot,
       new ConsInventory(gun, new MTInventory())));

   assertEquals(all.raisePrice(0.05),
          new ConsLog(new Toy("doll", 18.8475, 5),
              new ConsLog(new Toy("robot", 23.1525, 5),
                  new ConsLog(new Toy("gun", 15.75, 5),
                      new MTLog())))
               );
   System.out.println(all.raisePrice(0.05));
}
```

equals() method

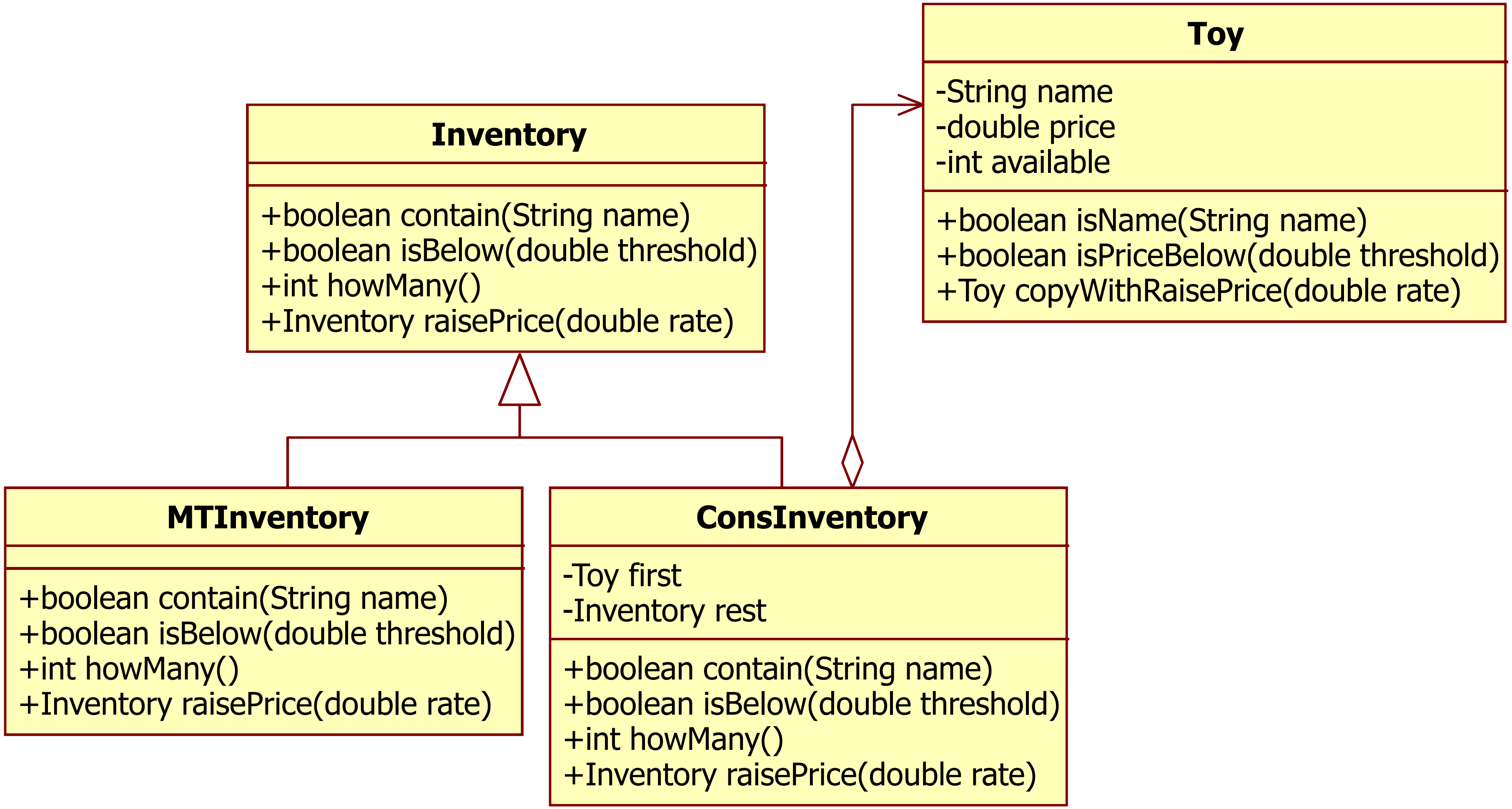
```
// in MTInventory class
public boolean equals(Object obj) {
   if (obj == null || !(obj instanceof MTInventory)
      return false;
   return true;
}
```

```
// inside ConsInventory class
public boolean equals(Object obj) {
      if (obj == null || !(obj instanceof ConsInventory))
         return false;
      else {
         ConsInventory that = (ConsInventory) obj;
         return this.first.equals(that.first)
               && this.rest.equals(that.rest);
      }
   }
```

equals() method in Toy

```
// in Toy class
public boolean equals(Object obj) {
   if (obj == null || !(obj instanceof Toy))
      return false;
   else {
      Toy that = (Toy) obj;
      return this.name.equals(that.name) &&
          this.price == that.price &&
          this.available == that.available;
      }
   }
}
```

Class diagram after add raisePrice()


Inventory
+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+Inventory raisePrice(double rate)
Toy
-String name
-double price
-int available
+boolean isName(String name)
+boolean isPriceBelow(double threshold)
+Toy copyWithRaisePrice(double rate)
MTInventory
+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+Inventory raisePrice(double rate)
ConsInventory
-Toy first
-Inventory rest
+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+Inventory raisePrice(double rate)

raisePrice() - mutable version

- Develop the method raisePrice, which produces an inventory in which all prices are raised by a given rate (use mutable).

Purpose and contract of raisePrice() for Inventory - mutable version

- **Q**: what does the `raisePrice` method return?
- **A:** It just updates Inventory whose each element has new price and return void.

```java
public interface Inventory {
  // raise all prices of toys
  // in the Inventory with rate
  public void raisePriceMutable(double rate);
}
```

raisePrice() for MTInventory and ConsInventory

```
// inside of MTInventory class
public void raisePriceMutable(double rate) { }
```

```
// inside of ConsInventory class
public void raisePriceMutable(double rate) {
   this.first.setNewPrice(rate);
   this.rest.raisePriceMutable(rate);
}
```

Delegation to **Toy** object

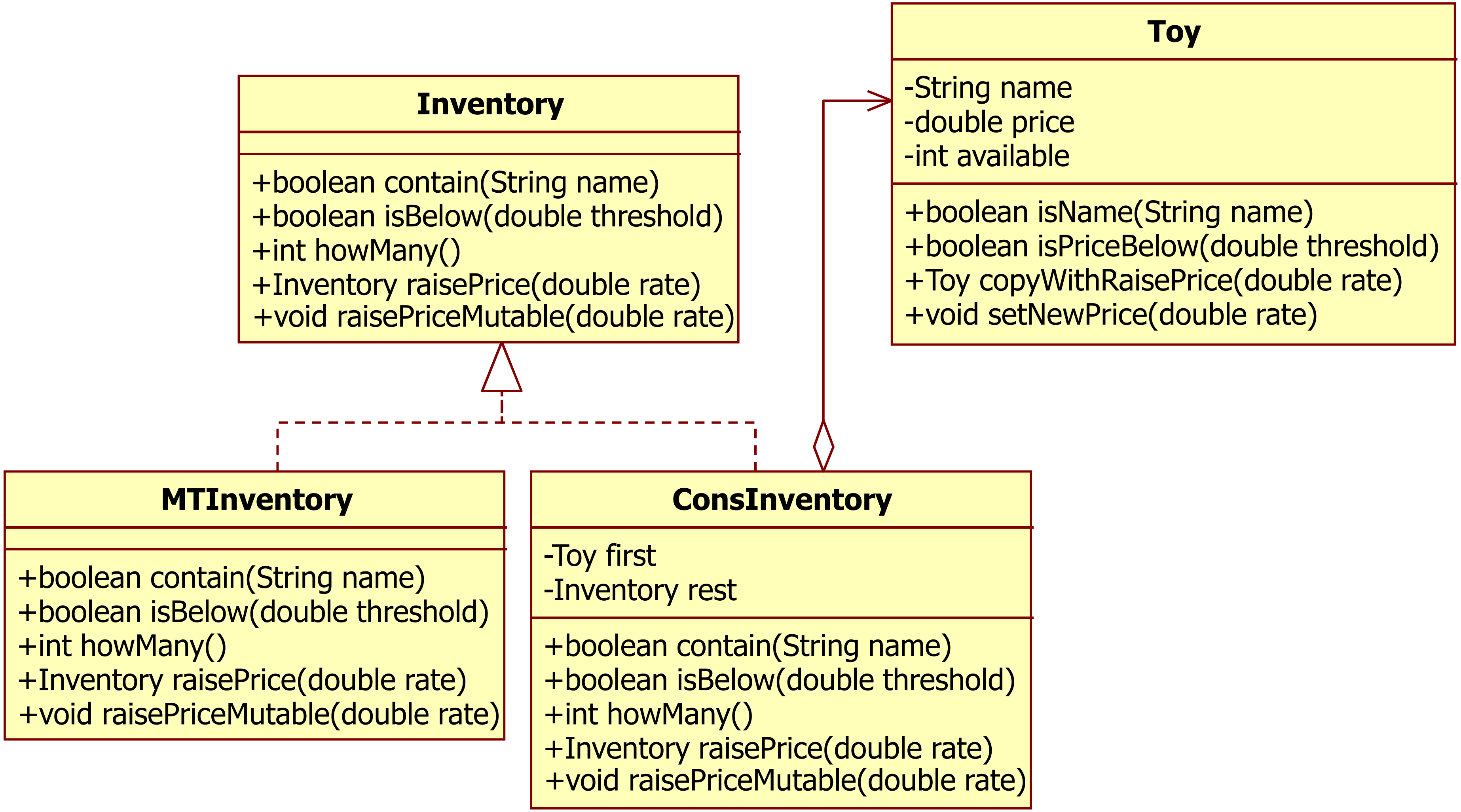
setNewPrice() in **Toy** class

```
public void setNewPrice(double rate) {
   this.price = this.price * (1 + rate);
}
```

Test raisePriceMutable()

```
public void testRaisePrice(){
   Toy doll = new Toy("doll", 17.95, 5);
   Toy robot = new Toy("robot", 22.05, 3);
   Toy gun = new Toy ("gun", 15.0,4);

   Inventory all = new ConsInventory(doll,
       new ConsInventory(robot,
       new ConsInventory(gun, new MTInventory())));

   all.raisePriceMutable(0.05);
   // after invoking raisePriceMutable(rate)
   assertEquals(all, new ConsLog(new Toy("doll", 18.8475, 5),
              new ConsLog(new Toy("robot", 23.1525, 5),
                  new ConsLog(new Toy("gun", 15.75, 5),
                      new MTLog())))
               );
   System.out.println(all);
}
```

Final class diagram



Inventory

+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+Inventory raisePrice(double rate)
+void raisePriceMutable(double rate)

Toy

-String name
-double price
-int available

+boolean isName(String name)
+boolean isPriceBelow(double threshold)
+Toy copyWithRaisePrice(double rate)
+void setNewPrice(double rate)

MTInventory

+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+Inventory raisePrice(double rate)
+void raisePriceMutable(double rate)

ConsInventory

-Toy first
-Inventory rest

+boolean contain(String name)
+boolean isBelow(double threshold)
+int howMany()
+Inventory raisePrice(double rate)
+void raisePriceMutable(double rate)

Review "Overiding" and "Overloading"

- All classes in Java extends `Object` class
- **Q**: distinguish "overloading" and "overriding" ?
- **A**:
  - Method `toString()` in class `Cons` is called overriding method `toString ()` in class `Object`.
    Method toString () in class `Cons` disables method `toString()` in class `Object`.
  - Method `raisePrice()` and `raisePrice(double )` in class `Cons` have the same name but different parameter is called overloading.
    When we invoke overloading methods, the method with appropriate argument will do

Exercise 6.1

6.1.1 Define the method `averagePrice`. It computes the average price of toys in `Inventory`. The average is the total of all prices divided by the number of toys

6.1.2 Develop the method `replaceName`, which consumes a list of toy and replaces all occurrences of “robot” with “r2d2” and otherwise retains the toy descriptions in the same order.

6.1.3 Develop the method `eliminate`. The method consumes a string, called `toyOfName` and produces a list of toys that contains all components of list with the exception of the toy whose name matches `toyOfName`.

Exercise 6.2

- A phone directory combines names with phone numbers. Develop a data definition for phone records and directories.
  Develop the methods:
  - `whoseNumber`, which determines the name that goes with some given phone number and phone directory.
  - `phoneNumber`, which determines the phone number that goes with some given name and phone directory

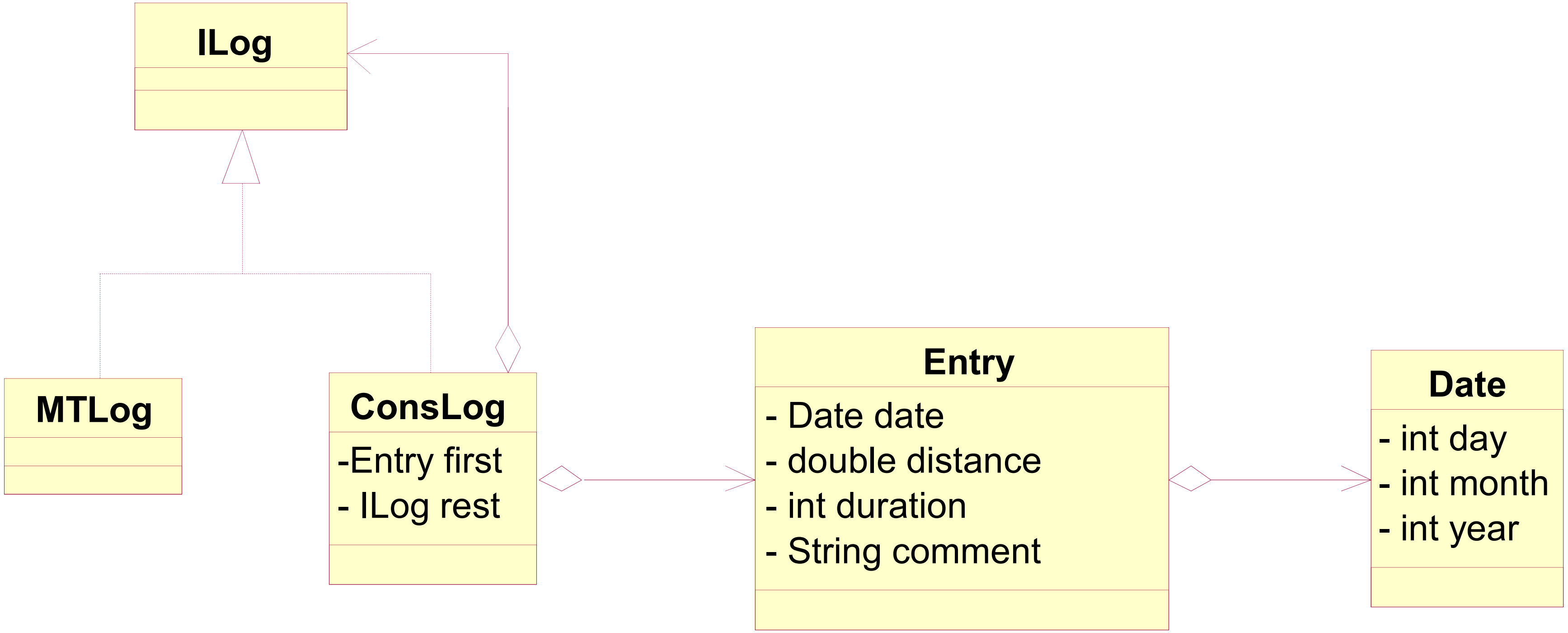
Relax &

…Do Exercises …

Recall the problem of tracking a runner's workouts

- Develop a program that manages a runner's training log. Every day the runner enters one entry concerning the day's run. ...For each entry, the program should compute how fast the runner ran (Exercise 3.1.4 & 3.1.5 in week 1). ...***The runner may also wish to determine the total number of miles run***
- **Q:** Draw a class diagram for a runner's log

Class diagram for a runner’s log



ILog

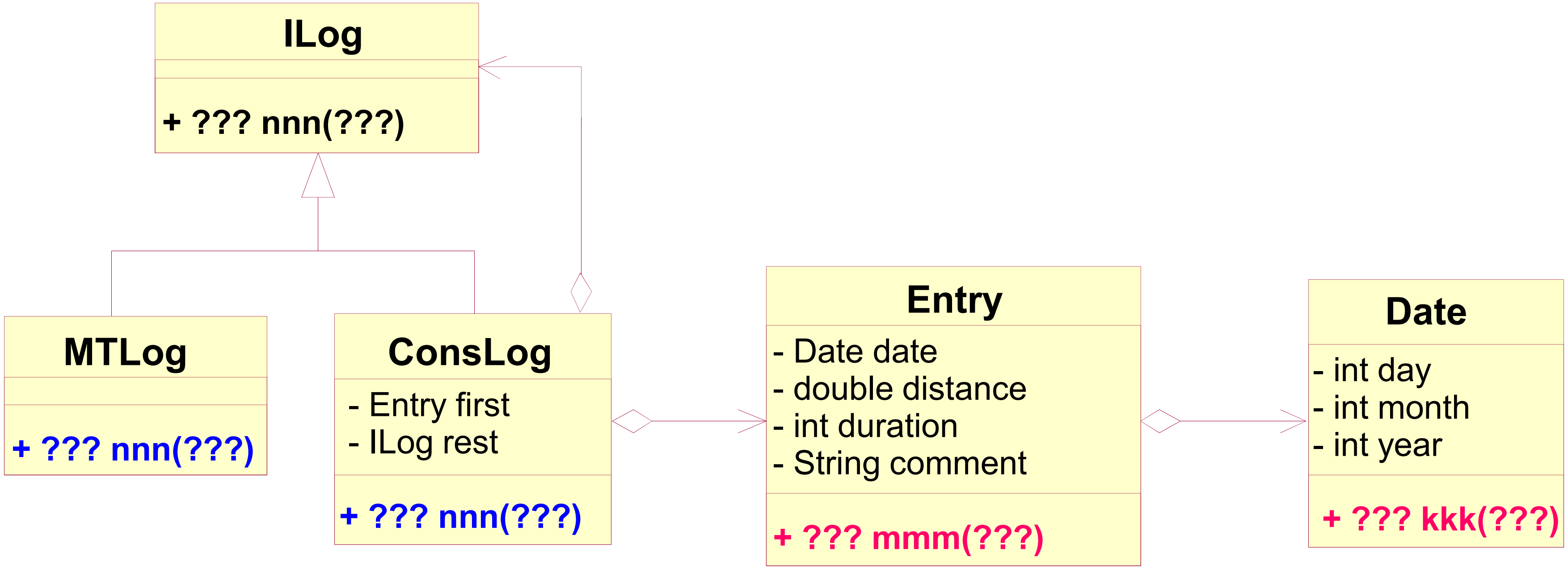
MTLog

ConsLog
-Entry first
- ILog rest

Entry
- Date date
- double distance
- int duration
- String comment

Date
- int day
- int month
- int year

Add methods to the runner’s log Class Diagram



Q: Write Java method templates for all the classes in the class diagram ?

Java template for `ILog`

```
public interface ILog {
   public ??? nnn(???);
}
```

Java template for `MTLog`

```
public class MTLog implements ILog {

  public ??? nnn(???) {
    ...
  }
}
```

Java template for ConsLog

```java
public class ConsLog implements ILog {
   private Entry first;
   private ILog rest;

   public ConsLog(Entry first, ILog rest) {
      this.first = first;
      this.rest = rest;
   }

   public ??? nnn(???) {
      ... this.first.mmm(??) ...
      ... this.rest.nnn(??) ...
   }
}
```

Java template for Entry

```
public class Entry {
   private Date date;
   private double distance;
   private int duration;
   private String comment;
   public Entry(Date date, double distance,
        int duration, String comment) {
      this.date = date;
      this.distance = distance;
      this.duration = duration;
      this.comment = comment;
   }
   public ??? mmm(???) {
      ... this.date.kkk(??) ...
      ... this.distance ...
      ... this.duration ...
      ... this.comment ...
   }
```

Java template for Date

```
public class Date {
   private int day;
   private int month;
   private int year;

   public Date(int day, int month, int year) {
      this.day = day;
      this.month = month;
      this.year = year;
   }

   public ??? kkk(???) {
      ... this.day ...
      ... this.month ...
      ... this.year ...
   }
}
```

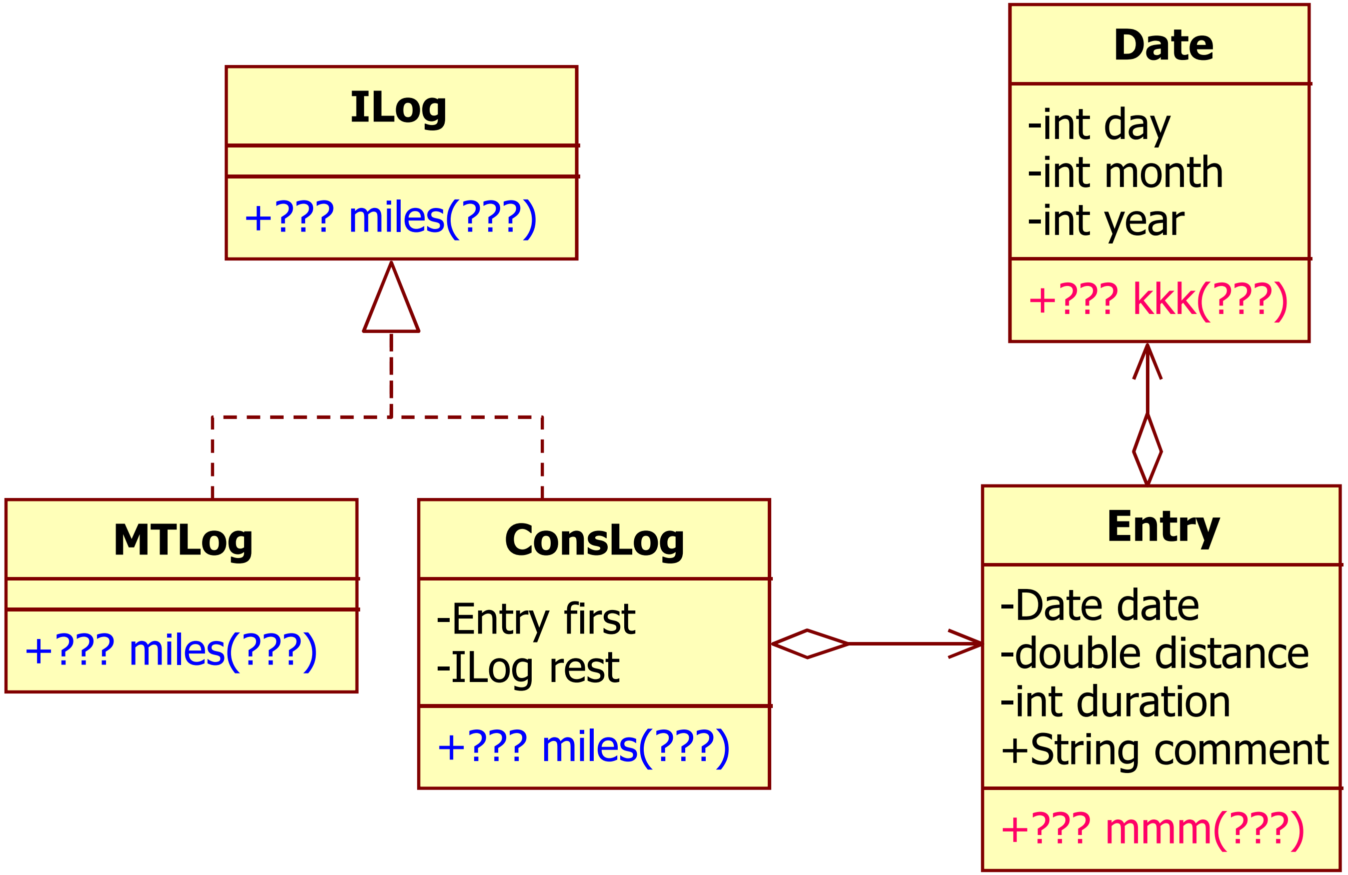
Examples for a runner’s log

- **Q**: Give some examples for a runner’s log.
  How many examples are at least needed?

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

ILog log = new ConsLog(e1, new ConsLog(e2,
             new ConsLog(e3, new MTLog())));
```

Compute the total number of miles run

- Using the method template for ILog, design a method to compute the total number of miles run



miles() for ILog

```
public interface ILog {
   // to compute the total number of miles
   // recorded in this log
   public double miles();
}
```

- **Q**: Develop some examples to test the `miles()` method

Examples to test miles()

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

ILog l0 = new MTLog();
ILog l1 = new ConsLog(e1, l0);
ILog l2 = new ConsLog(e2, l1);
ILog l3 = new ConsLog(e3, l2);

l0.miles() → should be 0.0
l1.miles() → should be 5.0
l2.miles() → should be 8.0
l3.miles() → should be 34.0
```

Q: Implement `miles()` in `MTLog` and `ConsLog`

miles() in MTLog

```
public class MTLog implements ILog {

   public double miles() {
      return 0.0;
   }
}
```

miles() in ConsLog

```java
public class ConsLog implements ILog {
  private Entry first;
  private ILog rest;

  public ConsLog(Entry first, ILog rest) {
    this.first = first;
    this.rest = rest;
  }

  public double miles() {
    return this.first.getDistance() +
           this.rest.miles();
  }
}
```

getDistance() in Entry

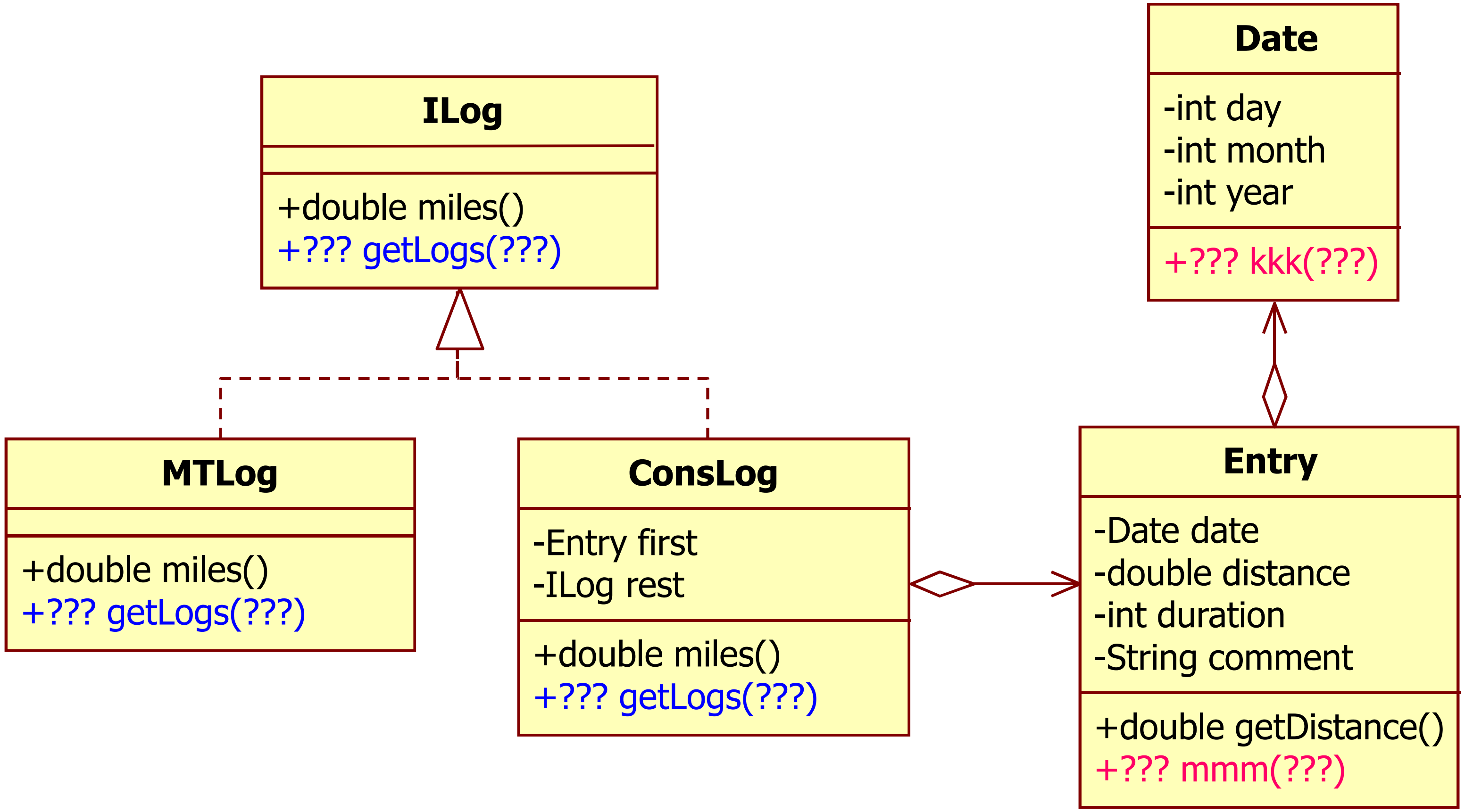
```java
public class Entry {
  private Date date;
  private double distance;
  private int duration;
  private String comment;

  ...

  public double getDistance() {
    return this.distance;
  }
}
```

Test miles() method

```java
public void testMiles() {
   Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
   Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
   Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

   ILog l0 = new MTLog();
   ILog l1 = new ConsLog(e1, l0);
   ILog l2 = new ConsLog(e2, l1);
   ILog l3 = new ConsLog(e3, l2);

   asserEquals(l0.miles(), 0.0);
   asserEquals(l1.miles(), 5.0);
   asserEquals(l2.miles(), 8.0);
   asserEquals(l3.miles(), 34.0);
}
```

Extension of the runner's log problem

... The runner wants to see his log for a specific month of his training season. ...



getLogs() for ILog

```
public interface ILog {
   // to compute the total number of miles
   // recorded in this log
   public double miles();

   // to extract those entries in this log
   // for the given month and year
   public ILog getLogs(int month, int year);
}
```

- Q: Develop some examples to test the getLogs() method

Examples to test getLogs()

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

ILog l0 = new MTLog();
ILog l1 = new ConsLog(e1, l0);
ILog l2 = new ConsLog(e2, l1);
ILog l3 = new ConsLog(e3, l2);

l0.getLogs(6, 2005) → should be new MTLog()
l1.getLogs(6, 2005) → should be new MTLog()
l2.getLogs(6, 2005) → should be new ConsLog(e2, new MTLog())
l3.getLogs(6, 2005) → should be
   new ConsLog(e3, new ConsLog(e2, new MTLog()))
```

Q: Implement getLogs() in MTLog and ConsLog

getLog() for MTLog

```
public class MTLog implements ILog {
   // ...

   public ILog getLogs(int month, int year) {
      return new MTLog();
   }
}
```

getLogs() for ConsLog

```
public class ConsLog implements ILog {
   private Entry first;
   private ILog  rest;
   // ...

   public ILog getLogs(int month, int year) {
      if (this.first.sameMonthInAYear(month, year))
         return new ConsLog(this.first,
                            this.rest.getLogs(month, year));
      else
         return this.rest.getLogs(month, year);
   }
}
```

sameMonthInAYear() in Entry

```java
public class Entry {
   private Date date;
   private double distance;
   private int duration;
   private String comment;
   //...
   public double getDistance() {
      return this.distance;
   }

  // was this entry made in the given month and year
   public boolean sameMonthInAYear(int month, int year) {
      return this.date.sameMonthInAYear(month, year);
   }
}
```

sameMonthInAYear() in Date

```java
public class Date {
   private int day;
   private int month;
   private int year;

   public Date(int day, int month, int year) {
      this.day = day;
      this.month = month;
      this.year = year;
   }

   public boolean sameMonthInAYear(int month, int year) {
      return (this.month == month) &&
             (this.year == year);
   }
}
```

Q: Review delegation ?

Test getLogs()

```
public void testGetLogs() {
   Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
   Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
   Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

   ILog l0 = new MTLog();
   ILog l1 = new ConsLog(e1, l0);
   ILog l2 = new ConsLog(e2, l1);
   ILog l3 = new ConsLog(e3, l2);

   assertTrue(l0.getLogs(6, 2005).equals(new MTLog()));
   assertTrue(l1.getLogs(6, 2005).equals(new MTLog()));
   assertTrue(l2.getLogs(6, 2005).equals(
                 new ConsLog(e2, new MTLog())));
   assertTrue(l3.getLogs(6, 2005).equals(
                 new ConsLog(e3, new ConsLog(e2, new MTLog()))));
}
```

equals() method

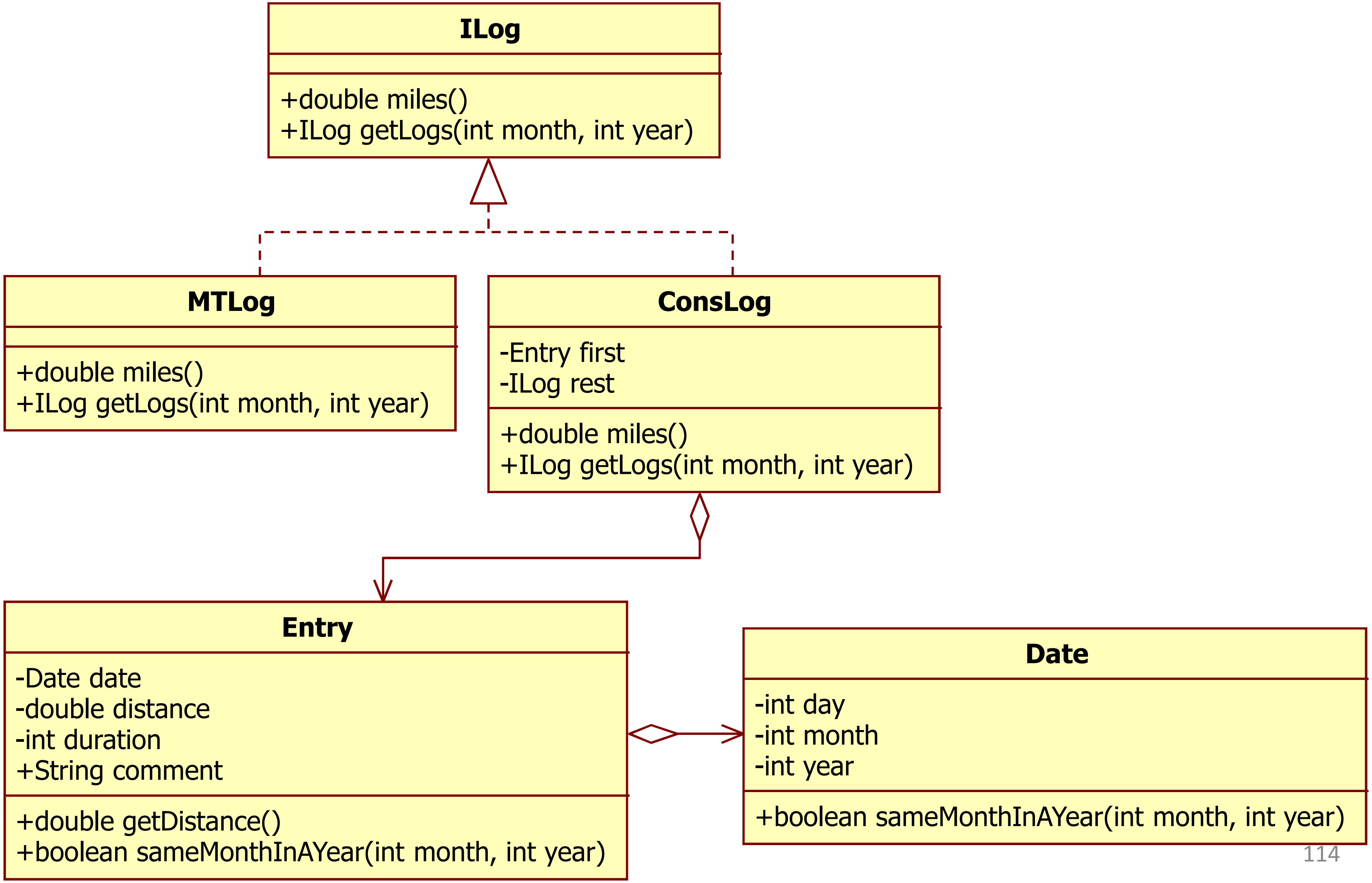
```
// in MTLog class
public boolean equals(Object obj) {
   if (obj == null || !(obj instanceof MTLog)
      return false;
   return true;
}
```

```
// inside ConsLog class
public boolean equals(Object obj) {
      if (obj == null || !(obj instanceof ConsLog))
         return false;
      else {
         ConsLog that = (ConsLog) obj;
         return this.first.equals(that.first)
               && this.rest.equals(that.rest);
      }
   }
```

```
// in Entry class
public boolean equals(Object obj) {
   if (obj == null || !(obj instanceof Entry))
      return false;
   else {
      Entry that = (Entry) obj;
      return this.date.equals(that.date) &&
          this.distance == that.distance &&
          this.durationInMinutes == that.durationInMinutes &&
          this.postRunFeeling.equals(that.postRunFeeling);
      }
   }
}
```

```
// inside Date class
public boolean equals(Object obj) {
   if (obj == null || !(obj instanceof Date))
      return false;
   else {
      Date that = (Date) obj;
      return this.day == that.day &&
             this.month == that.month &&
             this.year == that.year;
   }
}
```

class diagram



ILog
+double miles()
+ILog getLogs(int month, int year)
MTLog
+double miles()
+ILog getLogs(int month, int year)
ConsLog
-Entry first
-ILog rest
+double miles()
+ILog getLogs(int month, int year)
Entry
-Date date
-double distance
-int duration
+String comment
+double getDistance()
+boolean sameMonthInAYear(int month, int year)
Date
-int day
-int month
-int year
+boolean sameMonthInAYear(int month, int year)

Exercise 6.3

6.3.1 Collect all the pieces of getLogs() and insert the method definitions in the class hierarchy for logs.
Develop examples for sameMonthInAYear() and include them with the test suite.
Draw the class diagram for this hierarchy

6.3.2 Suppose the requirements for the program that tracks a runner's log includes this request:

... The runner wants to know the total distance run in a given month...

Design the method that computes this number and add it to the class hierarchy of exercise 6.3.1.

Exercise 6.3 (cont)

6.3.3 Suppose the requirements for the program that tracks a runner's log includes this request:

... A runner wishes to know the maximum distance ever run ...

Design the method that computes this number and add it to the class hierarchy of exercise 6.3.1

Assume that the method produces 0 if the log is empty.

miles() for ILog

```
public interface ILog {
   ...

   // to compute the total number of miles
   // recorded in this log for the given month and year
   public double miles(int month, int year);
}
```

- Q: Develop some examples to test the `miles()` method

Examples to test miles()

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

ILog l0 = new MTLog();
ILog l1 = new ConsLog(e1, l0);
ILog l2 = new ConsLog(e2, l1);
ILog l3 = new ConsLog(e3, l2);

l0.miles(6, 2005) → should be 0.0
l1.miles(6, 2005) → should be 0.0
l2.miles(6, 2005) → should be 3.0
l3.miles(6, 2005) → should be 29.0
```

Q: Implement `miles()` in `MTLog` and `ConsLog`

miles() for MTLog

```
public class MTLog implements ILog {
   // ...

   public double miles(int month, int year) {
      return 0.0;
   }
}
```

miles() for ConsLog

```
public class ConsLog implements ILog {
   private Entry first;
   private ILog  rest;
   // ...

   public double miles(int month, int year) {
      if (this.first.sameMonthInAYear(month, year))
         return this.first.getDistance() +
                this.rest.miles(month, year));
      else
         return this.rest.miles(month, year);
   }
}
```

maxDistance() for ILog

```
public interface ILog {
   ...

   // to compute the total number of miles
   // recorded in this log for the given month and year
   public double miles(int month, int year);

   // to compute the maximize distance
   // recorded in this log
   public double maxDistance();
}
```

- Q: Develop some examples to test the `maxDistance()` method

Examples to test maxDistance()

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

ILog l0 = new MTLog();
ILog l1 = new ConsLog(e1, l0);
ILog l2 = new ConsLog(e2, l1);
ILog l3 = new ConsLog(e3, l2);

l0.max() → should be 0.0
l1.maxDistance() → should be 0.0
l2.maxDistance() → should be 3.0
l3.maxDistance() → should be 26.0
```

Q: Implement maxDistance() in MTLog and ConsLog

maxDistance() for MTLog

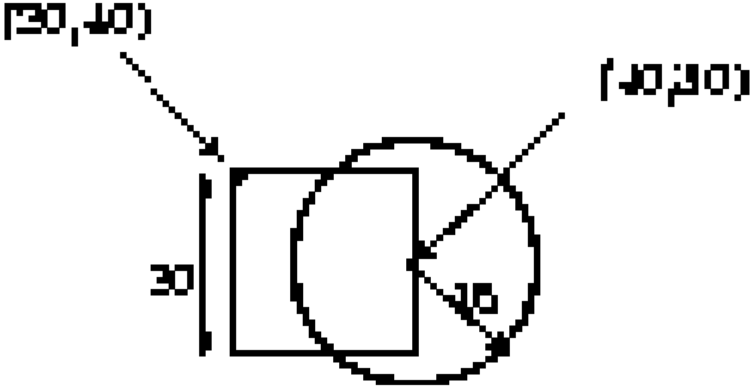
```
public class MTLog implements ILog {
   // ...

   public double maxDistance() {
      return 0.0;
   }
}
```

maxDistance() for ConsLog

```
public class ConsLog implements ILog {
   private Entry first;
   private ILog  rest;
   // ...

   public double maxDistance() {
      return Math.max(this.first.getDistance(),
                      this.rest.maxDistance());
   }
}
```

6.4 Overlapping Shapes

- Develop a drawing program that deals with at least three kinds of shapes: dots, squares, and circles. ...In addition, the program should also deal with overlaying shapes on each other. In the following figure, for example, we have superimposed a circle on the right side of a square:



- We could now also superimpose(thêm vào) this compounded shape on another shape and so on.

Problem1

- ... The user wishes to know how close a combination of shapes is to the origin ...
- ... Add a method that determines whether some point in the Cartesian space falls within the boundaries of some shape. ...
- ... A graphics program must compute the bounding box for a shape. ...

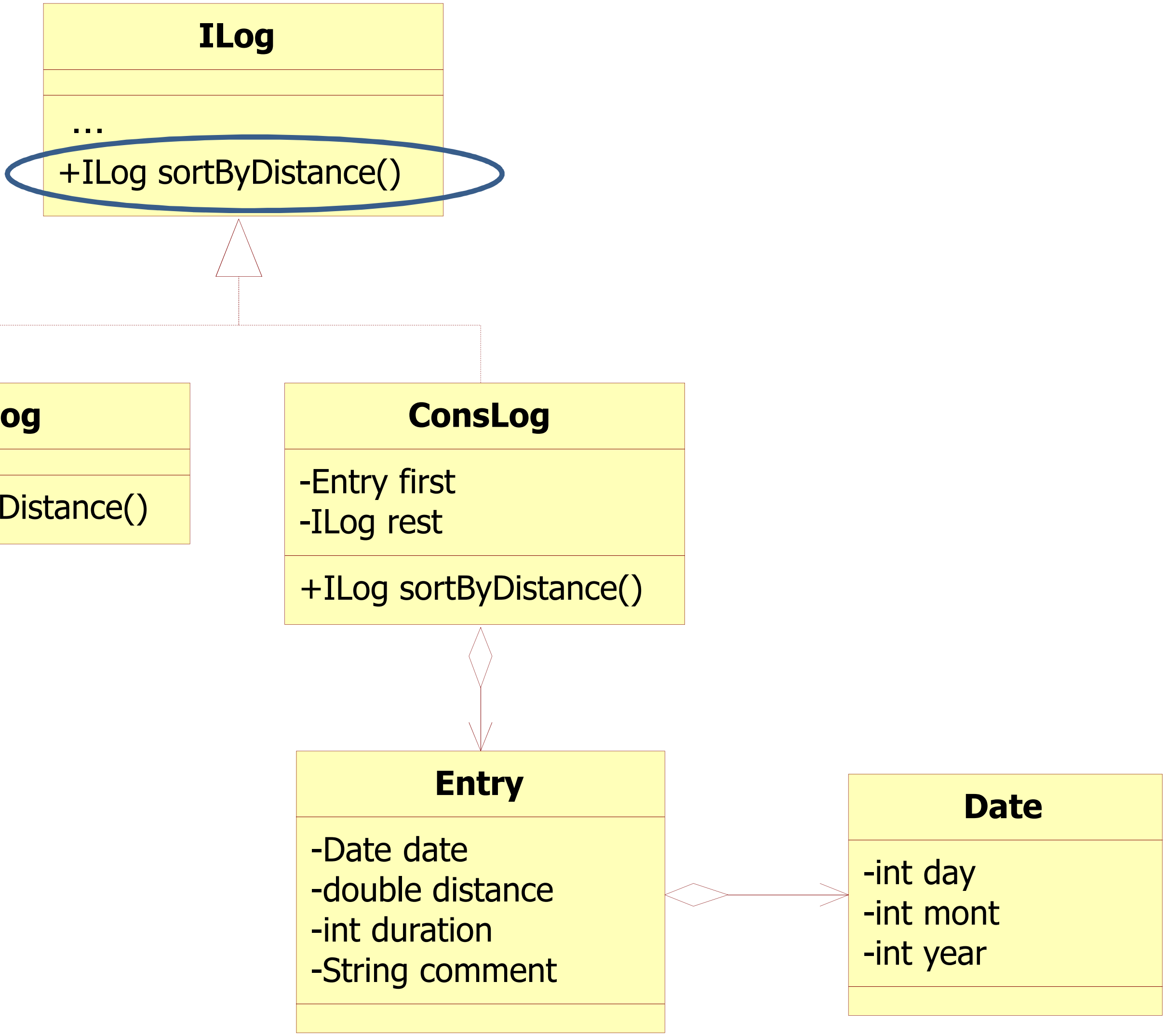
List Sorting

Problem Statement

The runner would like to see the log with entries ordered according to the distance covered in each run, from the shortest to the longest distance.

- **Q:** Which class should this operation belong to?

Modification of ILog



Examples

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

ILog l0 = new MTLog();
ILog l1 = new ConsLog(e1, l0);
ILog l2 = new ConsLog(e2, l1);
ILog l3 = new ConsLog(e3, l2);

l0.sortByDistance() → should be new MTLog()
l1.sortByDistance() → should be new ConsLog(e1, new MTLog())

l2.sortByDistance()
→ should be new ConsLog(e2, new ConsLog(e1, new MTLog()))

l3.sortByDistance()
→ should be new ConsLog(e2, new ConsLog(e1,
                        new ConsLog(e3, new MTLog()))
```

`sortByDistance()` in `ILog`

```
public interface ILog {
   // ...

   // to create from this log a new log with
   // entries sorted by distance
   public ILog sortByDistance();
}
```

sortByDistance() in MTLog

```
public class MTLog implements ILog {
  public MTLog() { }
  // ...

  public ILog sortByDistance() {
    return new MTLog();
  }
}
```

Template of sortByDistance() in ConsLog

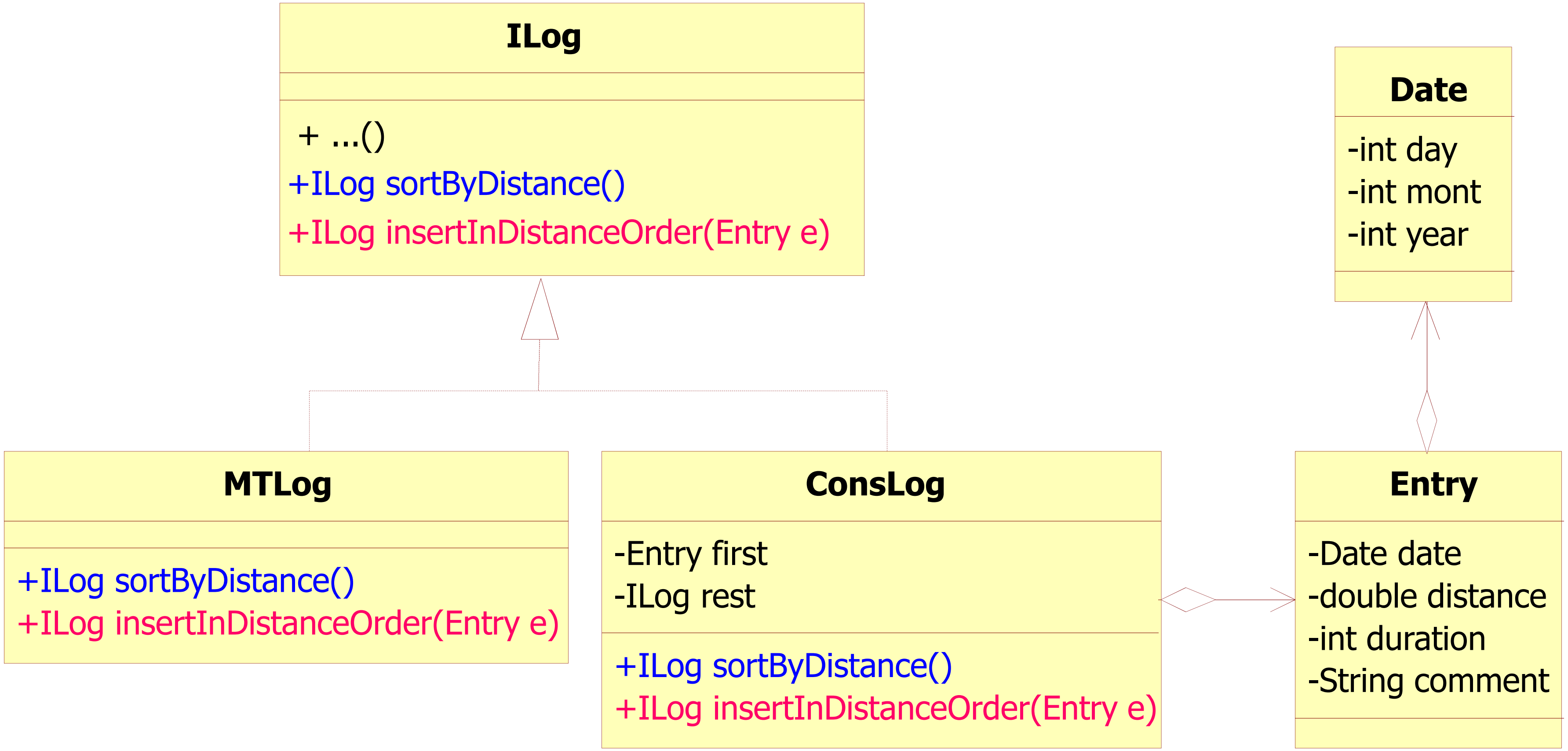
```
public class ConsLog implements ILog {
   private Entry first;
   private ILog rest;
   // ...

   public ILog sortByDistance() {
      ... this.first.mmm(??) ...
      ... this.rest.sortByDistance() ...
   }
}
```

Solution of `sortByDistance()` in `ConsLog`

- To sort a `ConsLog`, we need to insert the `first` entry into the **sorted version** of `rest` to obtained the whole sorted log.

```java
public class ConsLog implements ILog {
   private Entry first;
   private ILog rest;
   //...

   public ILog sortByDistance() {
      return this.rest.sortByDistance()
                 .insertInDistanceOrder(this.first);
   }
}
```

Modification of ILog



insertInDistanceOrder() in ILog

```
public interface ILog {
  // ...
  // to create from this log a new log with
  // entries sorted by distance
  public ILog sortByDistance();

  // insert the given entry into
  // this sorted log
  public ILog insertInDistanceOrder(Entry e);
}
```

Examples for insertInDistanceOrder()

```
Entry e1 = new Entry(new Date(5, 5, 2005), 5.0,  25, "Good");
Entry e2 = new Entry(new Date(6, 6, 2005), 3.0,  24, "Tired");
Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");
Entry e4 = new Entry(new Date(15, 7, 2005), 10.0, 61, "Tierd");

ILog ls0 = new MTLog();
ILog ls1 = ls0.insertInDistanceOrder(e1);
// should be new new ConsLog(e1, new MTLog()))

ILog ls2 = ls1.insertInDistanceOrder(e2);
// should be new ConsLog(e2, new ConsLog(e1, new MTLog()))

ILog ls3 = ls2.insertInDistanceOrder(e3);
// should be new ConsLog(e2, new ConsLog(e1,
               new ConsLog(e3, new MTLog())))

ILog ls4 = ls3.insertInDistanceOrder(e4);
// should be new ConsLog(e2, new ConsLog(e1, new ConsLog(e4,
               new ConsLog(e3, new MTLog())))
```

insertInDistanceOrder() in MTLog

```
public class MTLog implements ILog {
    public MTLog() { }
    // ...

    public ILog sortByDistance() {
        return new MTLog();
    }

    public ILog insertInDistanceOrder(Entry e) {
        return new ConsLog(e, this);
    }
}
```

insertInDistanceOrder() in ConsLog

```
public class ConsLog implements ILog {
   private Entry first;
   private ILog rest;

   public ILog sortByDistance() {
     return this.rest.sortByDistance()
             .insertInDistanceOrder(this.first);
   }

   public ILog insertInDistanceOrder(Entry e) {
      if (e.hasDistanceShorterThan(this.first))
         return new ConsLog(e, this);
      else
         return new ConsLog(this.first,
               this.rest.insertInDistanceOrder(e));
  }
}
```

hasDistanceShorterThan() in Entry

```
public class Entry {
   private Date date;
   private double distance;
   private int duration;
   private String comment;
   // ...

   public boolean hasDistanceShorterThan(Entry that) {
      return this.distance < that.distance;
   }
}
```

Test sortByDistance()

```
public void testSortByDistance() {
   Entry e1 = new Entry(new Date(5, 5, 2005), 5.0, 25, "Good");
   Entry e2 = new Entry(new Date(6, 6, 2005), 3.0, 24, "Tired");
   Entry e3 = new Entry(new Date(23, 6, 2005), 26.0, 156, "Great");

   ILog l0 = new MTLog();
   ILog l1 = new ConsLog(e1, l0);
   ILog l2 = new ConsLog(e2, l1);
   ILog l3 = new ConsLog(e3, l2);

   assertEquals(l0.sortByDistance(), new MTLog());
   assertEquals(l1.sortByDistance(), new ConsLog(e1, MTLog()));
   assertEquals(l2.sortByDistance(),
            new ConsLog(e2, new ConsLog(e1, new MTLog())));
   assertEquals(l3.sortByDistance(), new ConsLog(e2,
            new ConsLog(e1, new ConsLog(e3, new MTLog()))));
}
```

Exercises

Exercise 6.5

Suppose the requirements for the program that tracks a runner’s log includes this request:

- ... The runner would like to see the log with entries ordered according to the pace computed in minutes per mile in each run, from the fastest to the slowest ...
- Design this sorting method.
  Hint: Don’t forget to design methods for auxiliary tasks.

Exercise 6.6

Develop a program that sorts lists of mail messages by date.
Mail structures are defined as follows: from, date, message

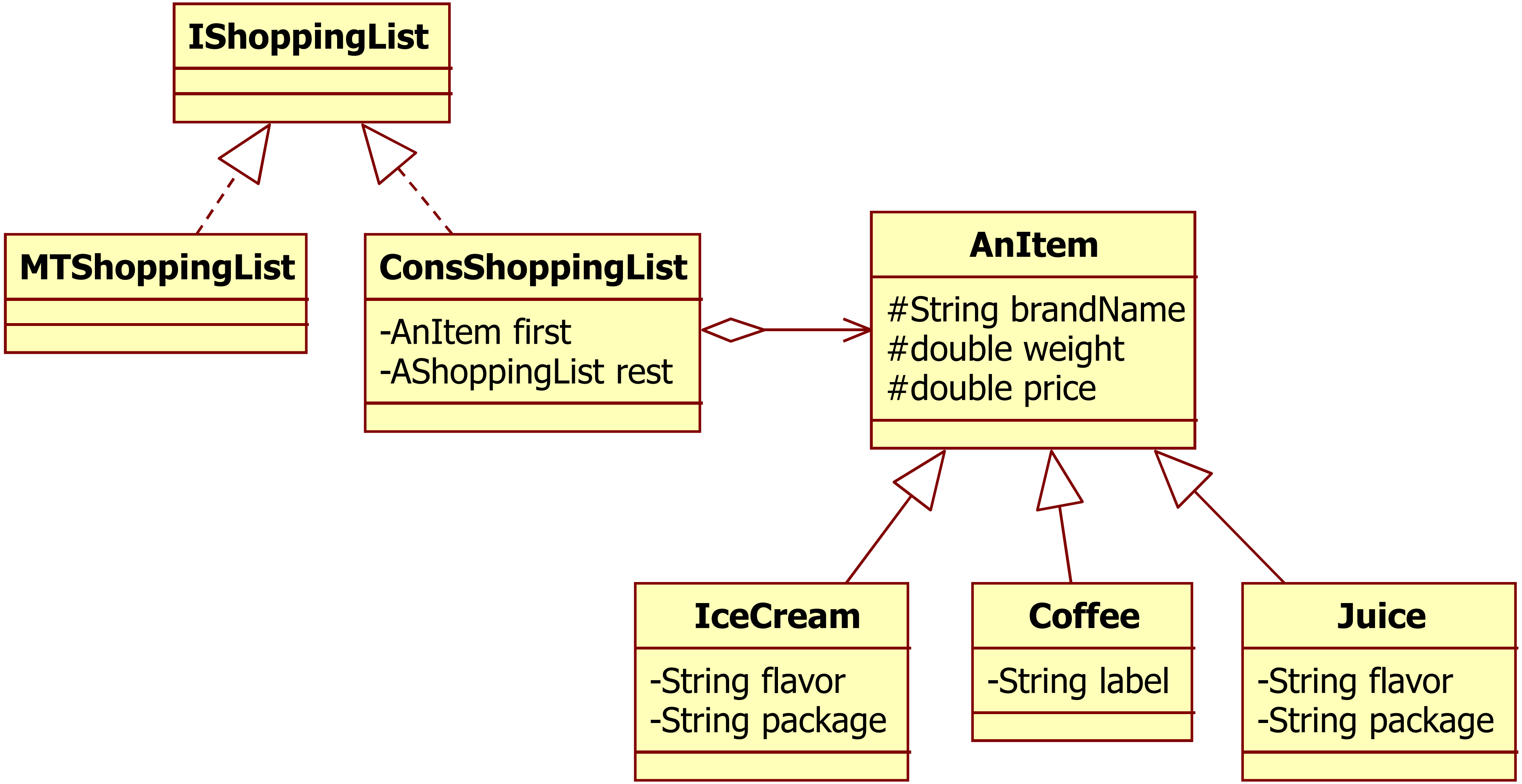
Exercise 6.7

Design a data representation for shopping lists.

Start from the class of grocery items developed in exercise 4.6. Add the following methods:

- howMany, which computes the number of items on the shopping list;
- brandList, which produces the list of all brand names;
- highestPrice, which determines the highest unit price among all items in the shopping list.

ShopingList class diagram

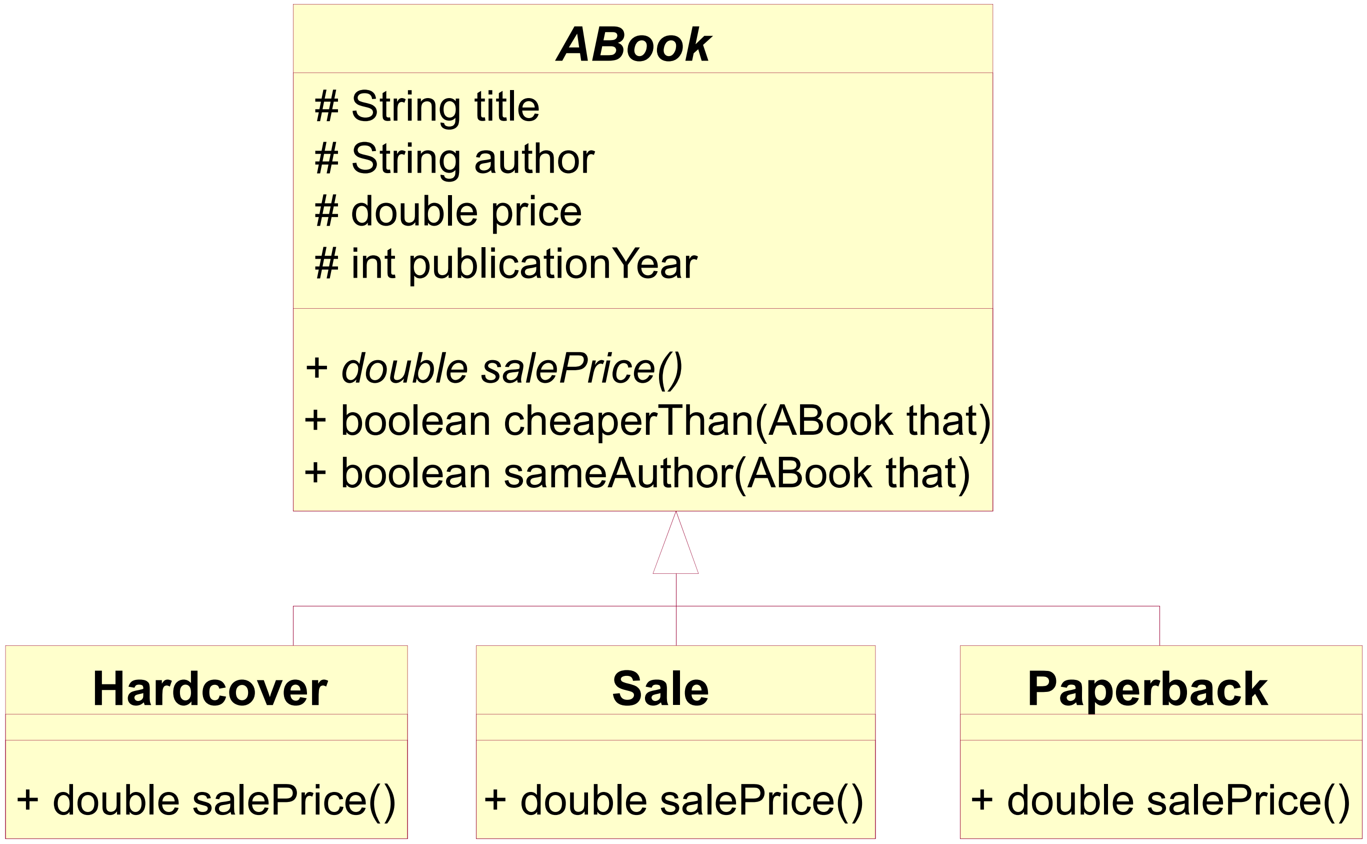


Exercise 6.8

Develop a program for managing discount bookstores (see exercise 4.8):

- Design a representation for lists of books;
- Write down (in English) three examples of book lists and their corresponding data representations;
- Develop the method thisAuthor, which produces the list of books that this author has authored.
- Develop the method sortByTitle, which sorts lists of books by title

Exercise 6.6 Class Diagram



ABook

# String title
# String author
# double price
# int publicationYear

+ *double salePrice()*
+ boolean cheaperThan(ABook that)
+ boolean sameAuthor(ABook that)

Hardcover

+ double salePrice()

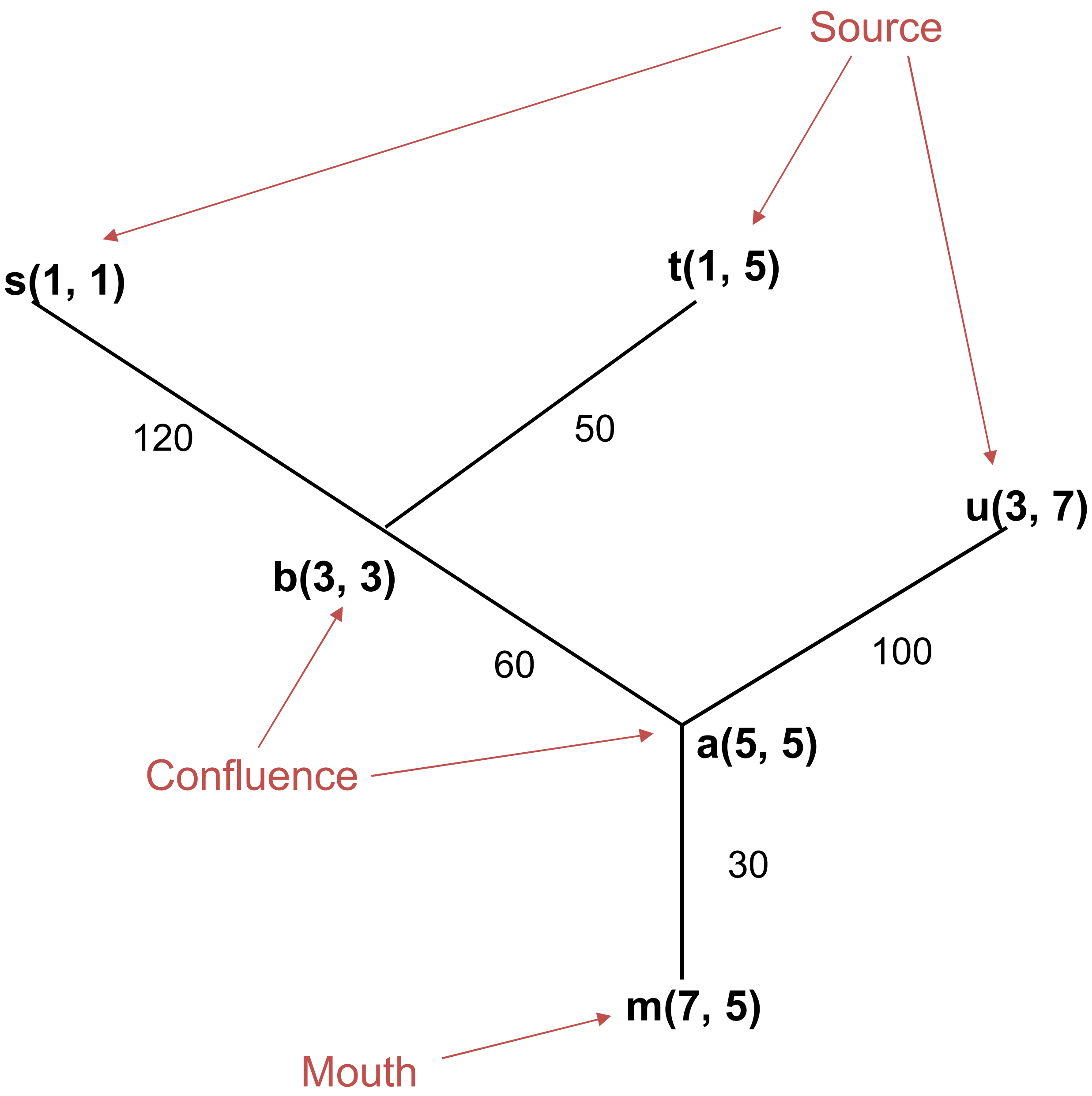
Sale

+ double salePrice()

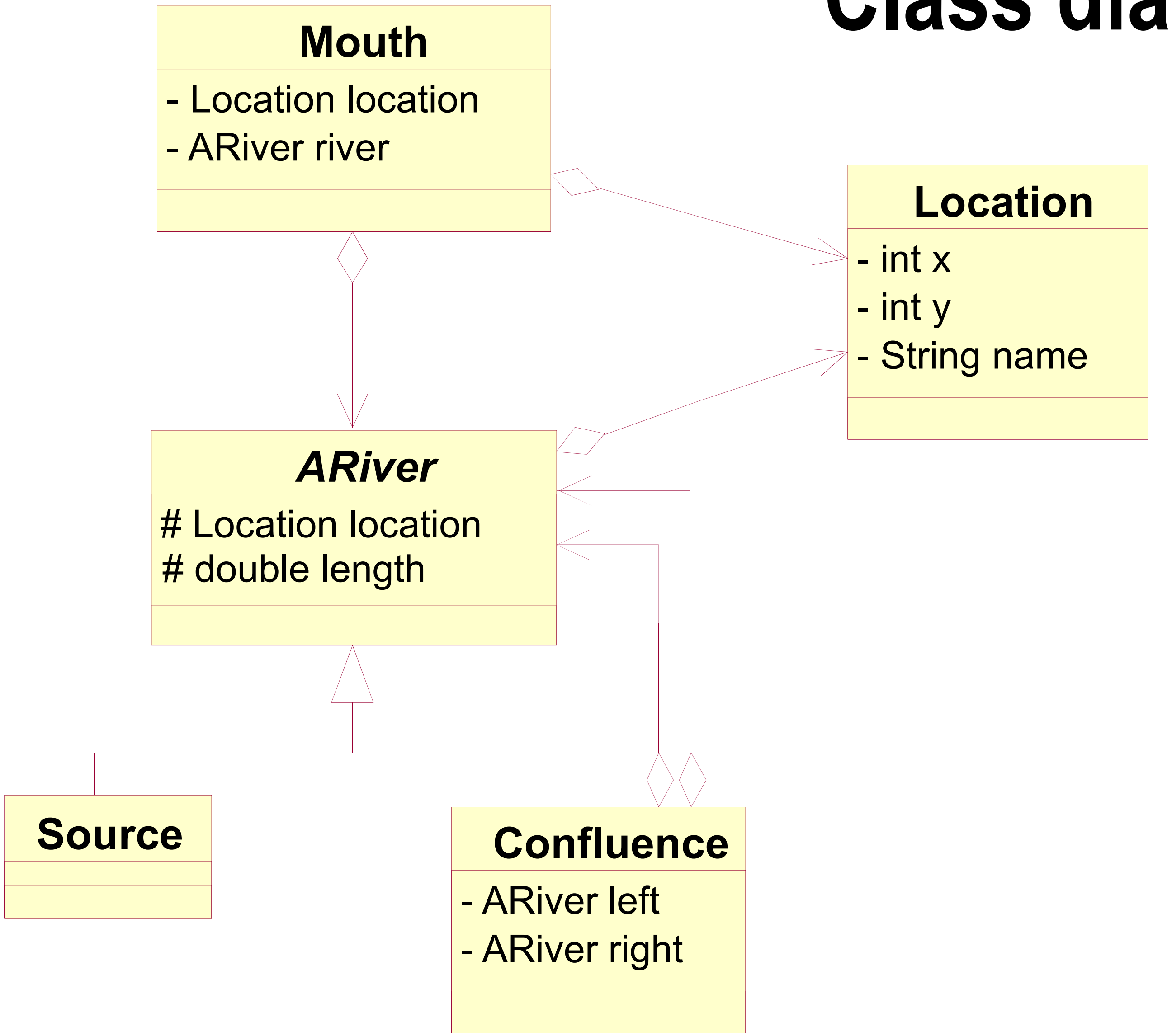
Paperback

+ double salePrice()

Exercise 6.9: River Systems Example


Source
s(1, 1)
t(1, 5)
u(3, 7)
120
50
b(3, 3)
60
100
a(5, 5)
Confluence
30
m(7, 5)
Mouth

Class diagram



Problems

- Problem 1: The EPA must represent river systems and monitor them… An EPA officer may wish to query a computer about the number of sources that feed a river system…
- Problem 2: An EPA officer may wish to find out whether some location is a part of a river system, regardless of whether it is a source, a confluence, or the river mouth. ...
- Problem 3: An EPA officer may request the number of miles of a river system, either starting from the river's mouth or any of its confluence points. ...

Problems

Extend the following methods to classes that represent river systems with the following methods:

- `maxlength`, which computes the length of the longest river segment;
- `confluences`, which counts the number of confluences in the river system; and
- `locations`, which produces a list of all locations on this river -- the sources, the mouths, and the confluences.

Relax &

...Do Exercises ...

Too much hard exercises now

Try again, never stop practicing!