Bags

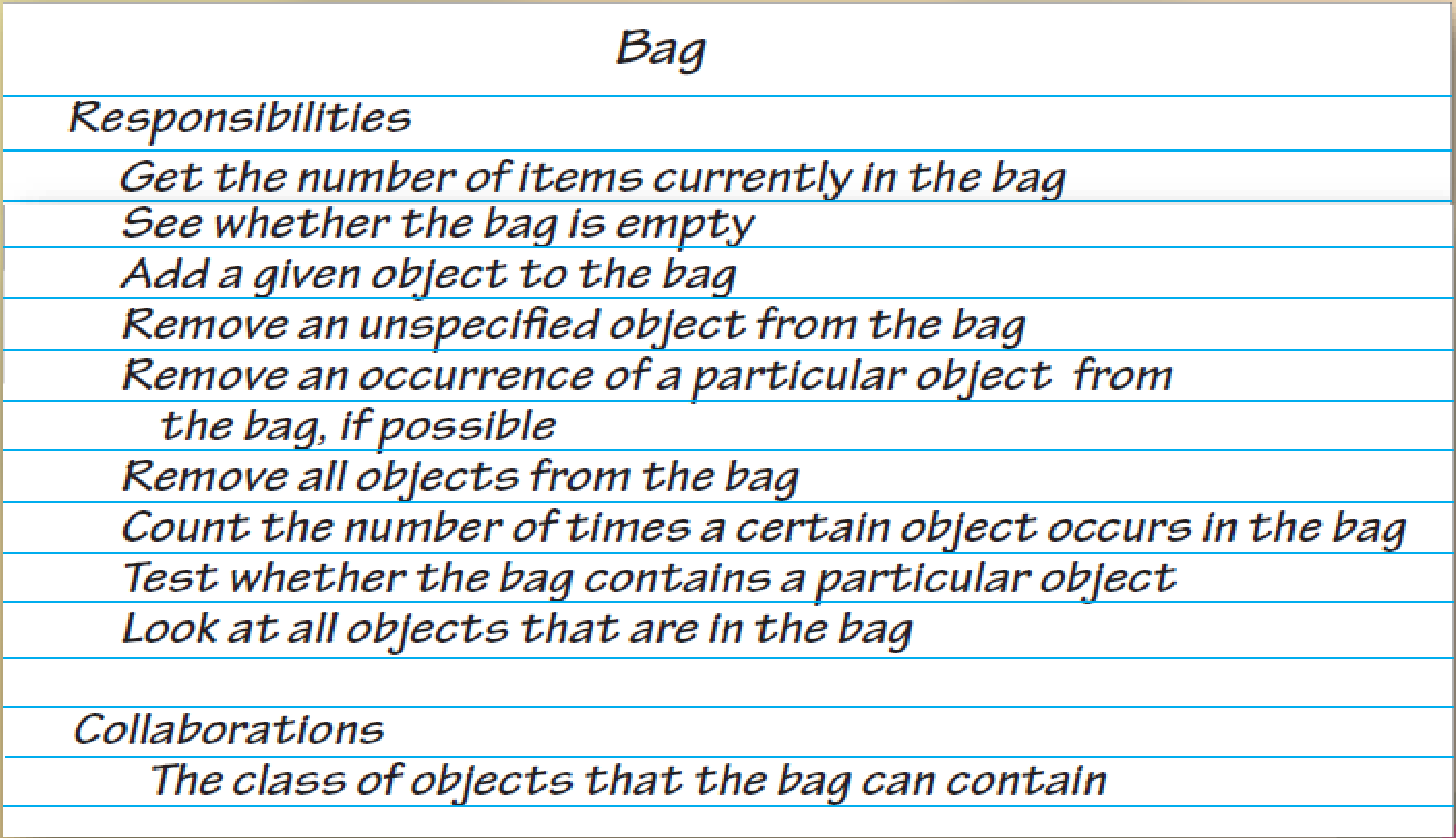
Chapter 1

Data Structures and Abstractions with Java, 4e, Global Edition
Frank Carrano

The ADT Bag

- Definition
  - A finite collection of objects **in no particular order**
  - **Can contain duplicate items**
- Possible behaviors
  - Get number of items
  - Check for empty
  - Add, remove objects

Class-Responsibility-Collaboration (CRC) Card



Bag

Responsibilities

Get the number of items currently in the bag
See whether the bag is empty
Add a given object to the bag
Remove an unspecified object from the bag
Remove an occurrence of a particular object from the bag, if possible
Remove all objects from the bag
Count the number of times a certain object occurs in the bag
Test whether the bag contains a particular object
Look at all objects that are in the bag

Collaborations

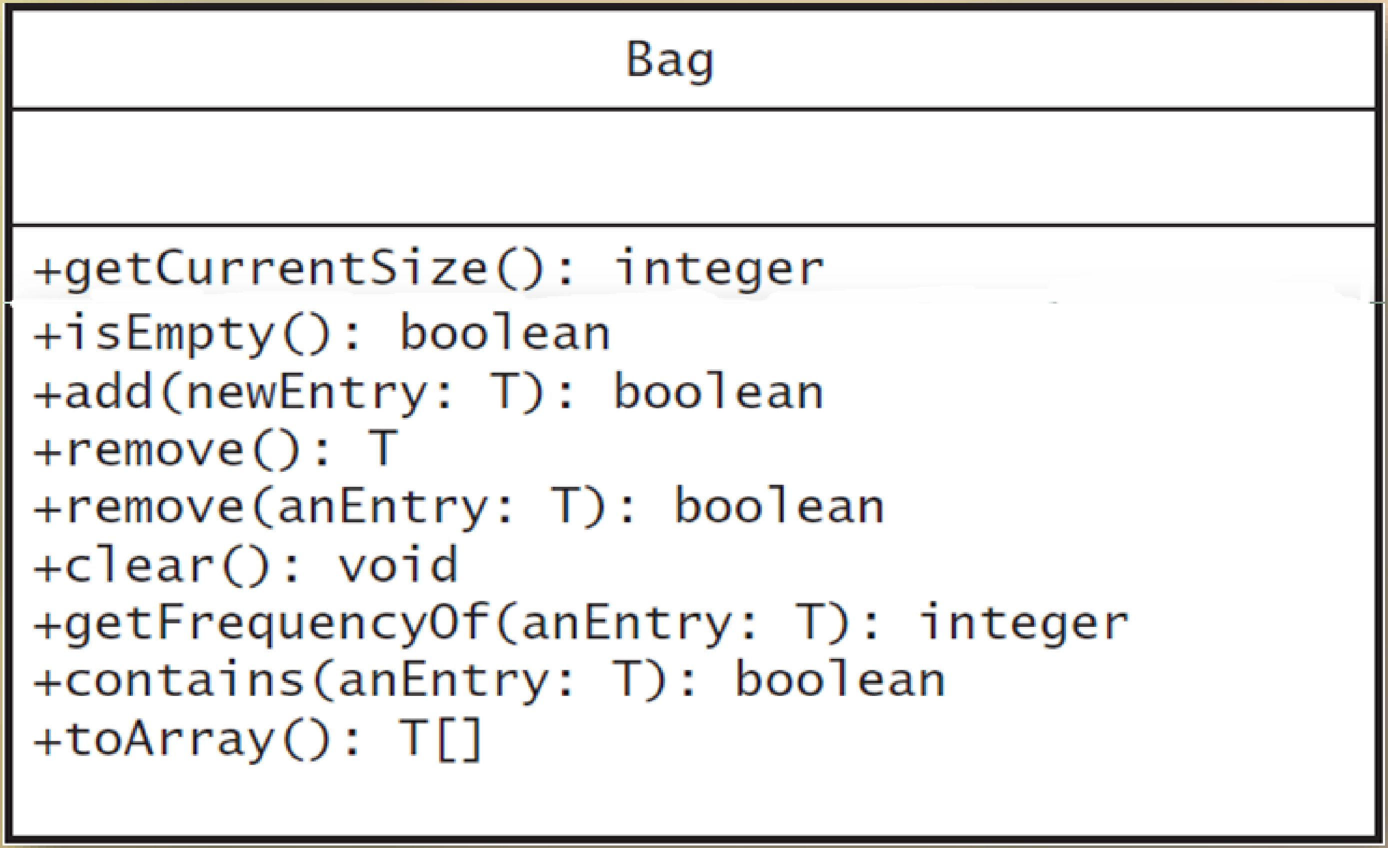
The class of objects that the bag can contain

FIGURE 1-1 A CRC card for a class **Bag**

Specifying a Bag

- Describe its data and specify in detail the methods
- Options that we can take when `add` cannot complete its task:
  - Do nothing
  - Leave bag unchanged, but signal client
- Note which methods change the object or do not

UML Notation



```
Bag

+getCurrentSize(): integer
+isEmpty(): boolean
+add(newEntry: T): boolean
+remove(): T
+remove(anEntry: T): boolean
+clear(): void
+getFrequencyOf(anEntry: T): integer
+contains(anEntry: T): boolean
+toArray(): T[]
```

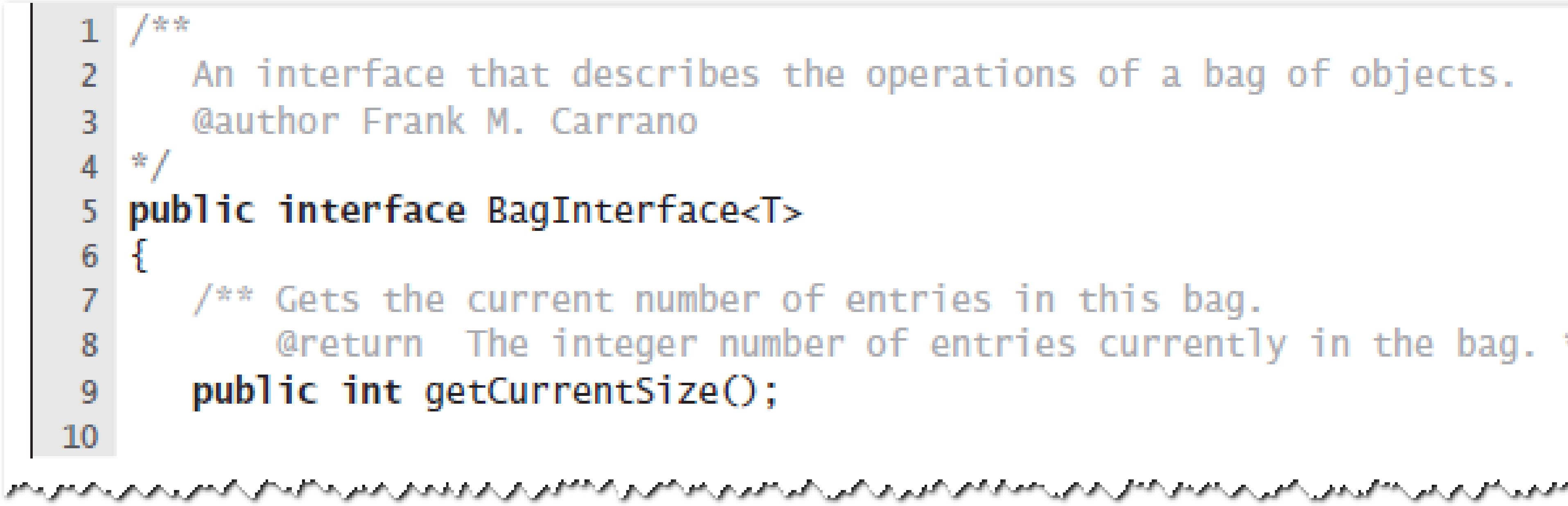
FIGURE 1-2 UML notation for the class `Bag`

Design Decision

What to do for unusual conditions?

- Assume it won’t happen
- Ignore invalid situations
- Guess at the client’s intention
- Return value that signals a problem
- Return a boolean
- Throw an exception

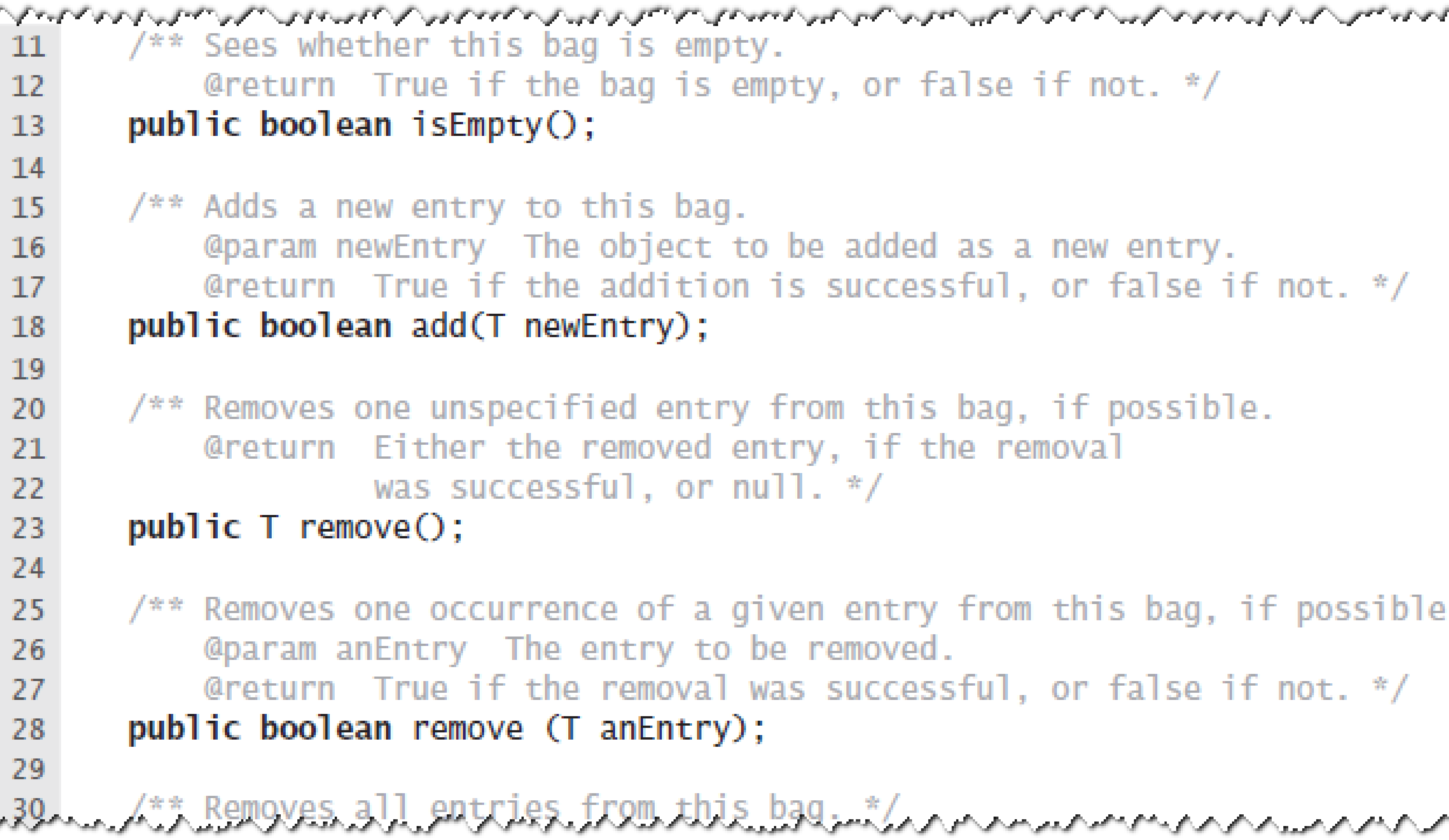
An Interface



```java
/**
   An interface that describes the operations of a bag of objects.
   @author Frank M. Carrano
*/
public interface BagInterface<T>
{
   /** Gets the current number of entries in this bag.
       @return  The integer number of entries currently in the bag.
   public int getCurrentSize();

```

LISTING 1-1 A Java interface for a class of bags

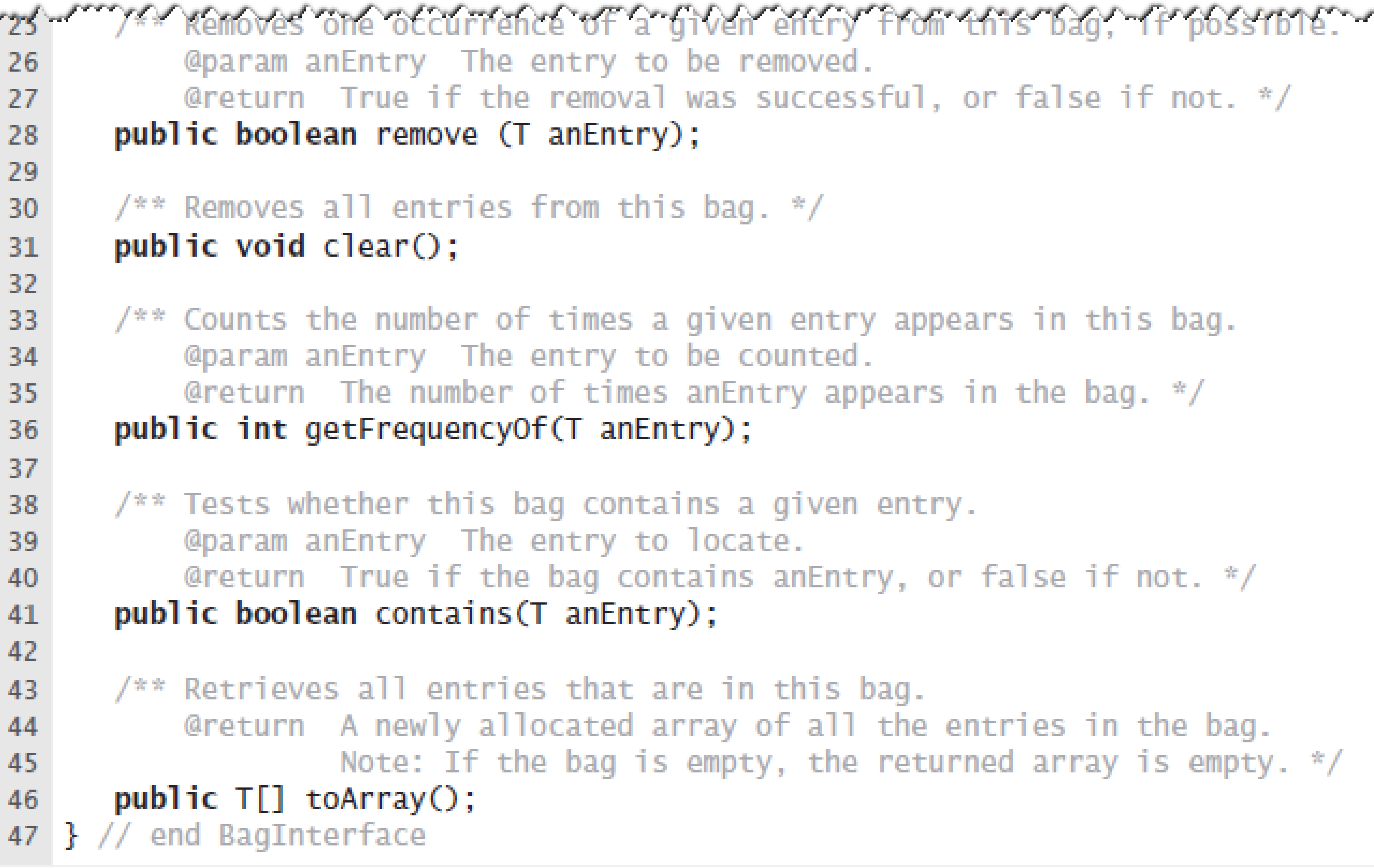
An Interface



```java
    /** Sees whether this bag is empty.
        @return  True if the bag is empty, or false if not. */
    public boolean isEmpty();

    /** Adds a new entry to this bag.
        @param newEntry  The object to be added as a new entry.
        @return  True if the addition is successful, or false if not. */
    public boolean add(T newEntry);

    /** Removes one unspecified entry from this bag, if possible.
        @return  Either the removed entry, if the removal
                 was successful, or null. */
    public T remove();

    /** Removes one occurrence of a given entry from this bag, if possible
        @param anEntry  The entry to be removed.
        @return  True if the removal was successful, or false if not. */
    public boolean remove (T anEntry);

    /** Removes all entries from this bag. */
```

LISTING 1-1 A Java interface for a class of bags

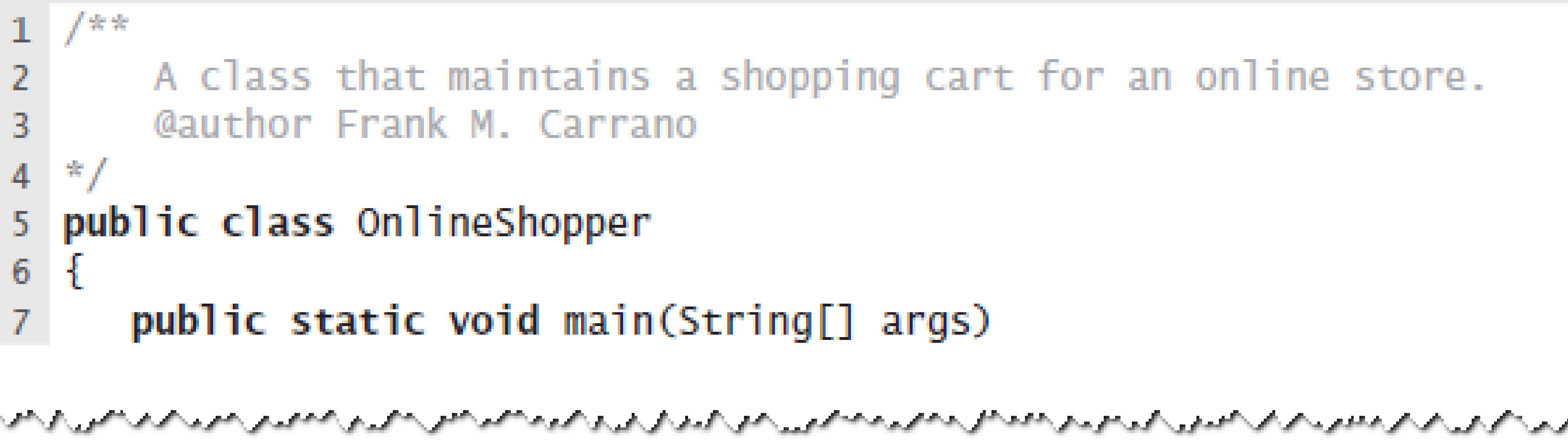
An Interface



```
   /** Removes one occurrence of a given entry from this bag, if possible.
       @param anEntry  The entry to be removed.
       @return  True if the removal was successful, or false if not. */
   public boolean remove (T anEntry);

   /** Removes all entries from this bag. */
   public void clear();

   /** Counts the number of times a given entry appears in this bag.
       @param anEntry  The entry to be counted.
       @return  The number of times anEntry appears in the bag. */
   public int getFrequencyOf(T anEntry);

   /** Tests whether this bag contains a given entry.
       @param anEntry  The entry to locate.
       @return  True if the bag contains anEntry, or false if not. */
   public boolean contains(T anEntry);

   /** Retrieves all entries that are in this bag.
       @return  A newly allocated array of all the entries in the bag.
                Note: If the bag is empty, the returned array is empty. */
   public T[] toArray();
} // end BagInterface
```

LISTING 1-1 A Java interface for a class of bags

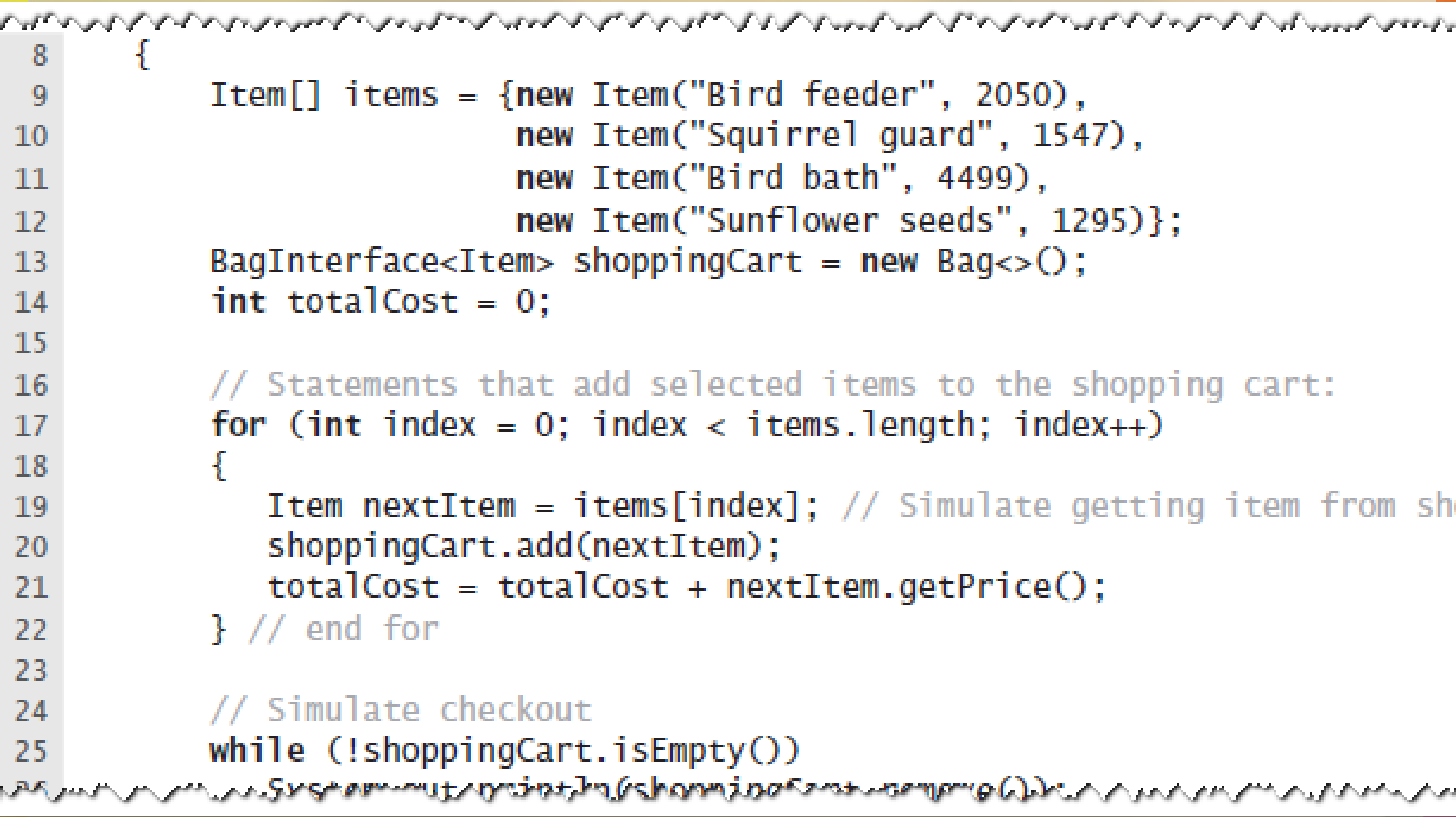
Using the ADT Bag



```java
/**
    A class that maintains a shopping cart for an online store.
    @author Frank M. Carrano
*/
public class OnlineShopper
{
   public static void main(String[] args)
```

LISTING 1-2 A program that maintains a bag for online shopping

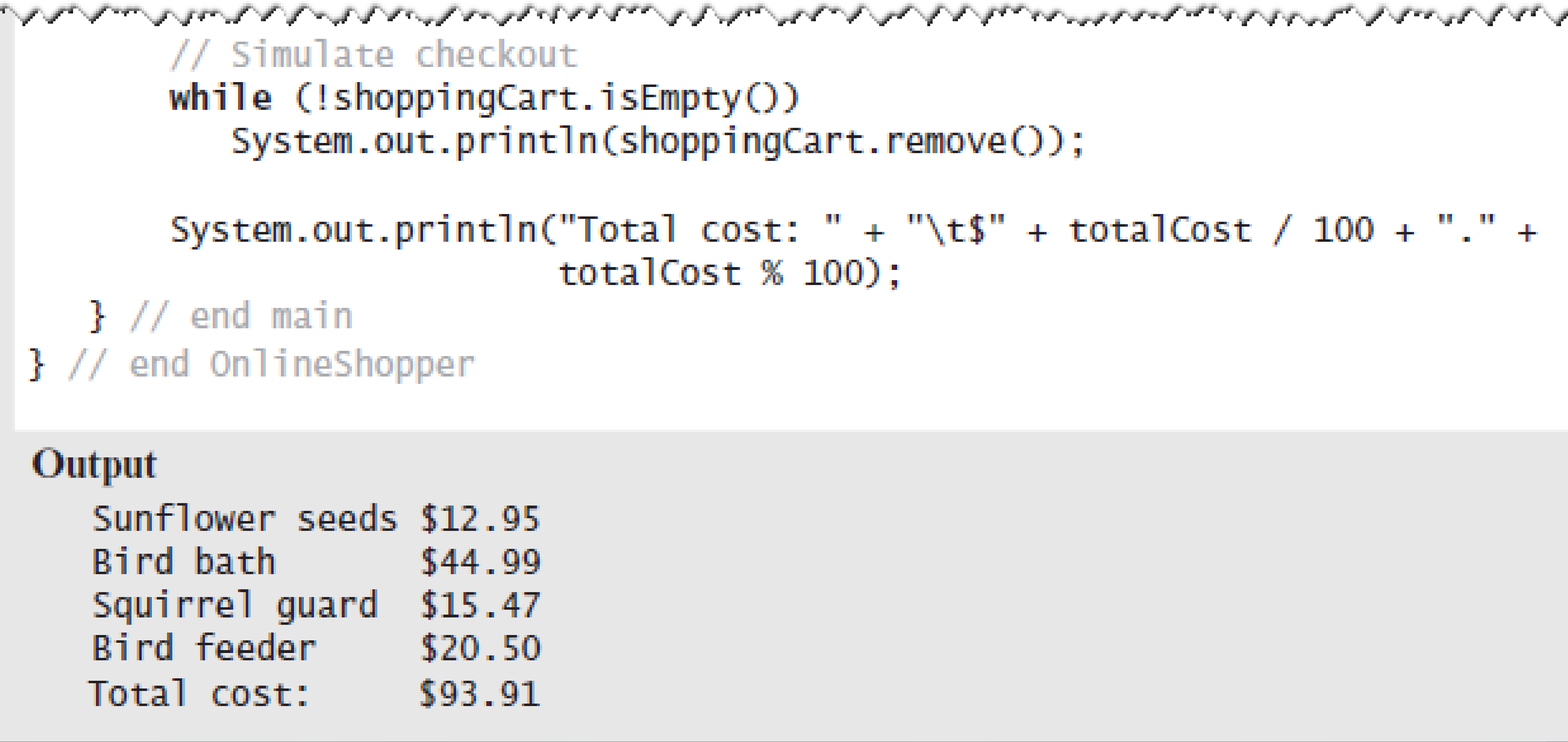
Using the ADT Bag



```
{
    Item[] items = {new Item("Bird feeder", 2050),
                    new Item("Squirrel guard", 1547),
                    new Item("Bird bath", 4499),
                    new Item("Sunflower seeds", 1295)};
    BagInterface<Item> shoppingCart = new Bag<>();
    int totalCost = 0;

    // Statements that add selected items to the shopping cart:
    for (int index = 0; index < items.length; index++)
    {
       Item nextItem = items[index]; // Simulate getting item from sh
       shoppingCart.add(nextItem);
       totalCost = totalCost + nextItem.getPrice();
    } // end for

    // Simulate checkout
    while (!shoppingCart.isEmpty())
       System.out.println(shoppingCart.remove());
```

LISTING 1-2 A program that maintains a bag for online shopping

Using the ADT Bag



```
        // Simulate checkout
        while (!shoppingCart.isEmpty())
           System.out.println(shoppingCart.remove());

        System.out.println("Total cost: " + "\t$" + totalCost / 100 + "." +
                                   totalCost % 100);
    } // end main
} // end OnlineShopper
```

Output

```
   Sunflower seeds $12.95
   Bird bath       $44.99
   Squirrel guard  $15.47
   Bird feeder     $20.50
   Total cost:     $93.91
```

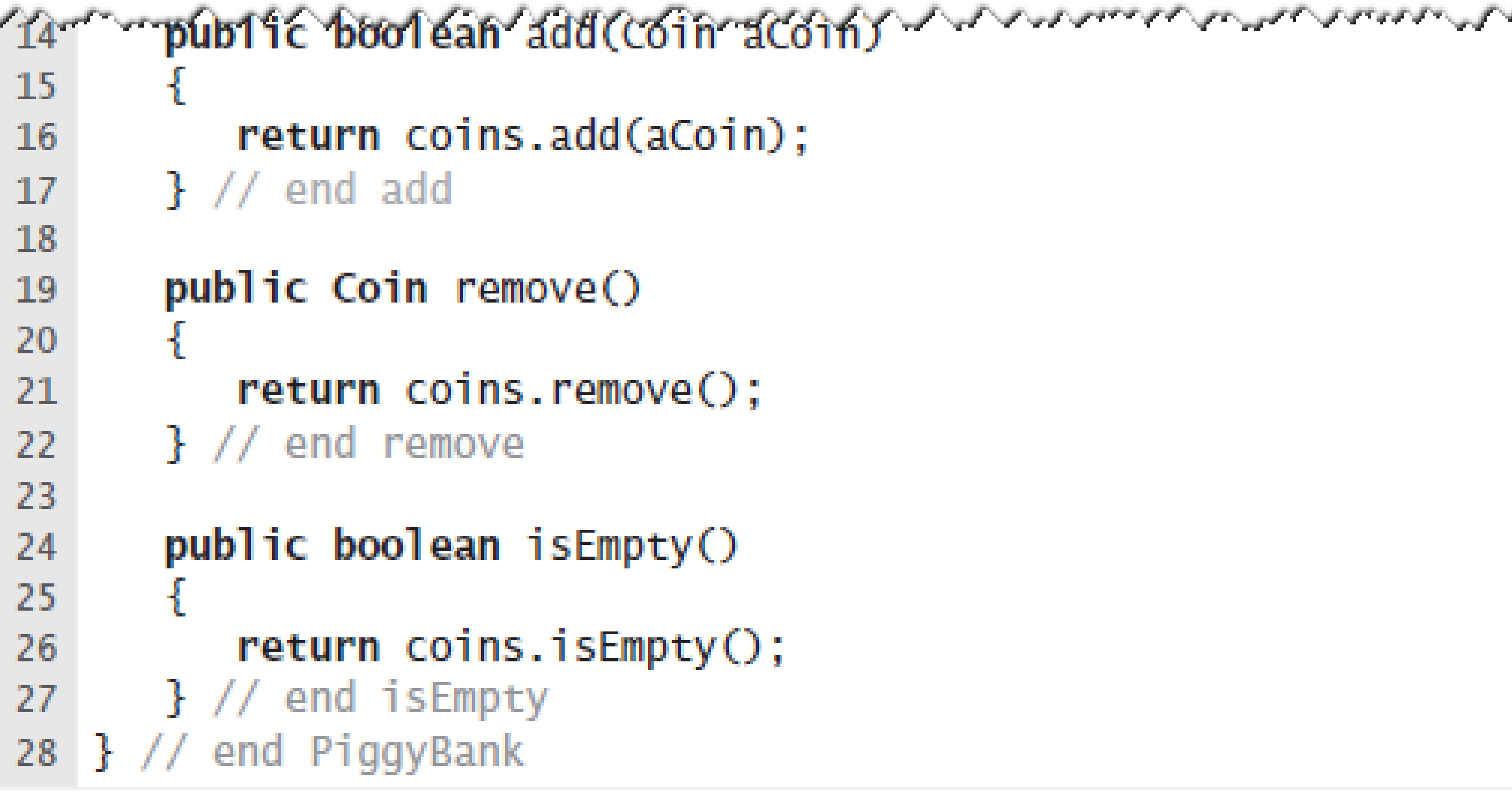
LISTING 1-2 A program that maintains a bag for online shopping

Example: A Piggy Bank

```
/**
    A class that implements a piggy bank by using a bag.
    @author Frank M. Carrano
*/
public class PiggyBank
{
    private BagInterface<Coin> coins;

    public PiggyBank()
    {
        coins = new Bag<>();
    } // end default constructor

    public boolean add(Coin aCoin)
    {
        return coins.add(aCoin);
    } // end add
```

LISTING 1-3 A class of piggy banks

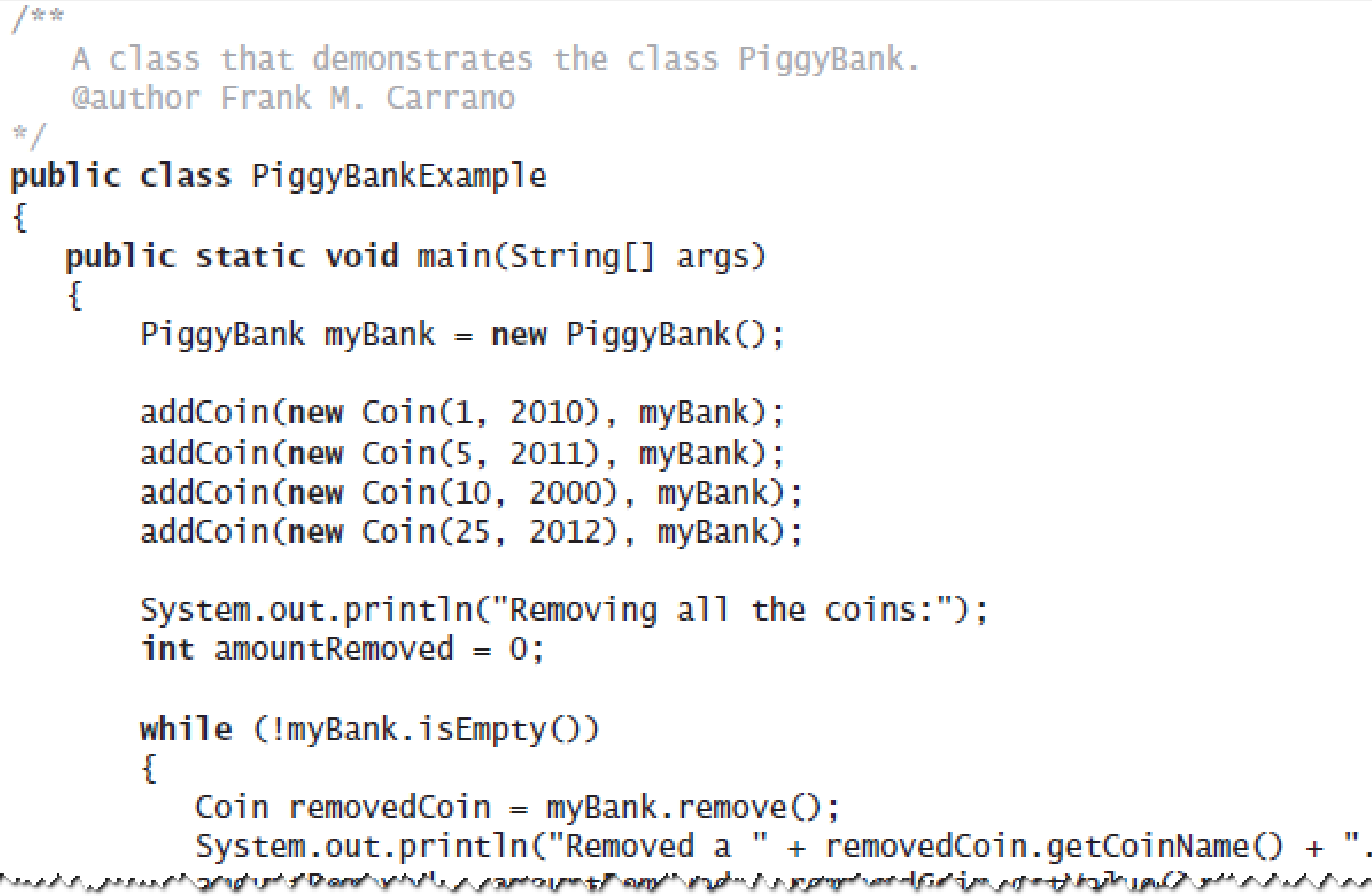
Example: A Piggy Bank



```
    public boolean add(Coin aCoin)
    {
        return coins.add(aCoin);
    } // end add

    public Coin remove()
    {
        return coins.remove();
    } // end remove

    public boolean isEmpty()
    {
        return coins.isEmpty();
    } // end isEmpty
} // end PiggyBank
```

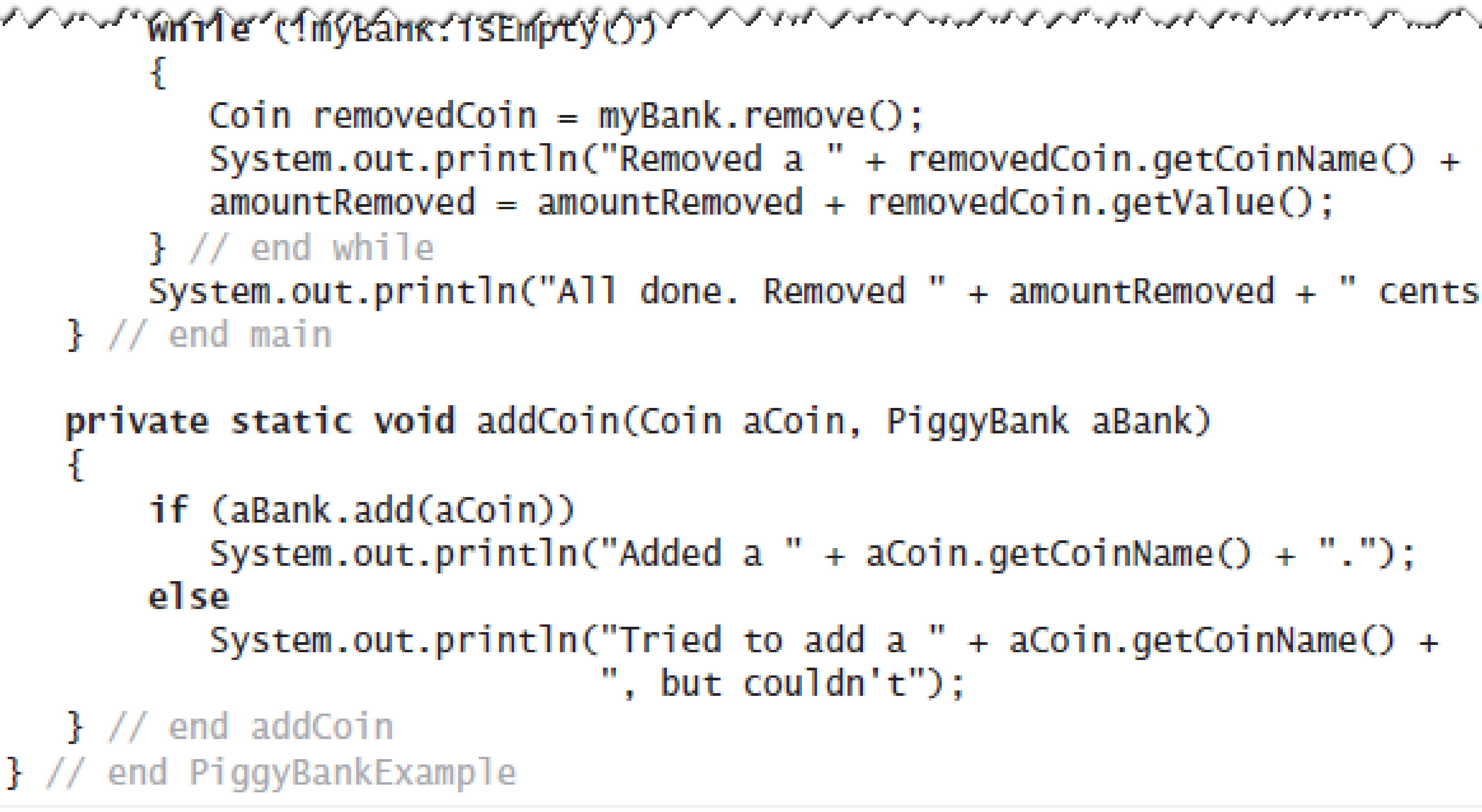
LISTING 1-3 A class of piggy banks

Example: A Piggy Bank



```
/**
   A class that demonstrates the class PiggyBank.
   @author Frank M. Carrano
*/
public class PiggyBankExample
{
   public static void main(String[] args)
   {
      PiggyBank myBank = new PiggyBank();

      addCoin(new Coin(1, 2010), myBank);
      addCoin(new Coin(5, 2011), myBank);
      addCoin(new Coin(10, 2000), myBank);
      addCoin(new Coin(25, 2012), myBank);

      System.out.println("Removing all the coins:");
      int amountRemoved = 0;

      while (!myBank.isEmpty())
      {
         Coin removedCoin = myBank.remove();
         System.out.println("Removed a " + removedCoin.getCoinName() + ".
         [illegible]
```

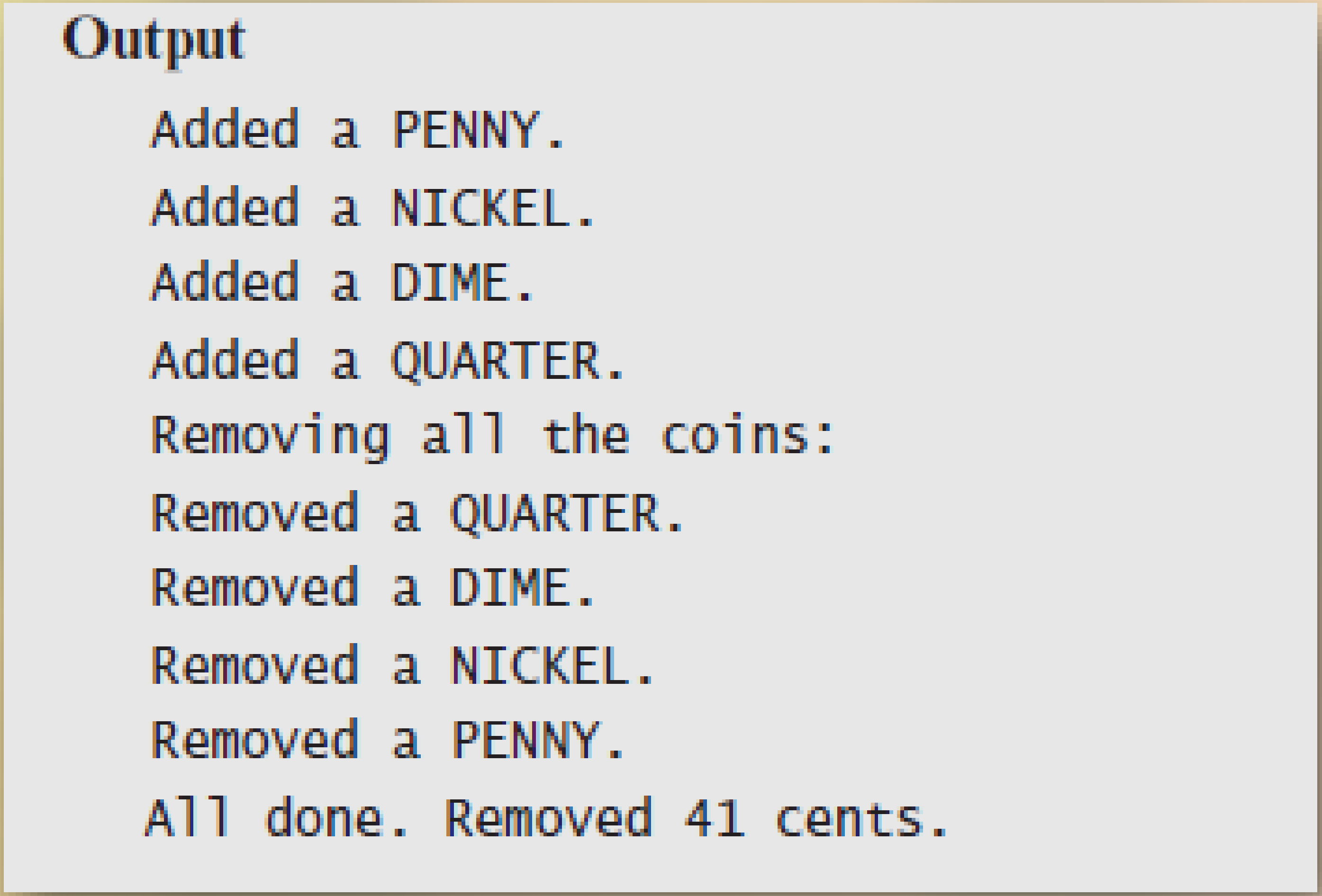
Example: A Piggy Bank



```
      while (!myBank.isEmpty())
      {
         Coin removedCoin = myBank.remove();
         System.out.println("Removed a " + removedCoin.getCoinName() +
         amountRemoved = amountRemoved + removedCoin.getValue();
      } // end while
      System.out.println("All done. Removed " + amountRemoved + " cents
   } // end main

   private static void addCoin(Coin aCoin, PiggyBank aBank)
   {
      if (aBank.add(aCoin))
         System.out.println("Added a " + aCoin.getCoinName() + ".");
      else
         System.out.println("Tried to add a " + aCoin.getCoinName() +
                            ", but couldn't");
   } // end addCoin
} // end PiggyBankExample
```

LISTING 1-4 A demonstration of the class **`PiggyBank`**

Example: A Piggy Bank



Output

```
Added a PENNY.
Added a NICKEL.
Added a DIME.
Added a QUARTER.
Removing all the coins:
Removed a QUARTER.
Removed a DIME.
Removed a NICKEL.
Removed a PENNY.
All done. Removed 41 cents.
```

LISTING 1-4 A demonstration of the class `PiggyBank`

Using ADT
Like Using Vending Machine

FIGURE 1-3 A vending machine

Observations about Vending Machines

- Can perform only tasks machine’s interface presents.
- You must understand these tasks.
- Cannot access the inside of the machine.
- You can use the machine even though you do not know what happens inside.
- Usable even with new insides.

Observations about ADT Bag

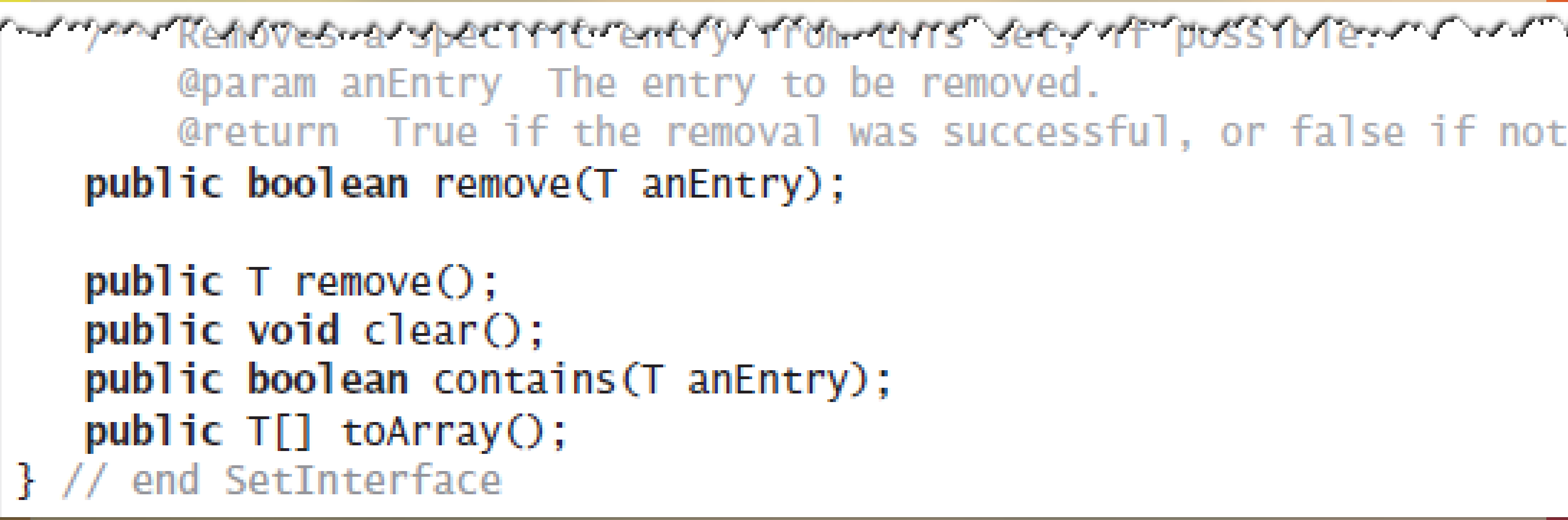
- Can perform only tasks specific to ADT.
- Must adhere to the specifications of the operations of ADT.
- Cannot access data inside ADT without ADT operations.
- Use the ADT, even if don’t know how data is stored.
- Usable even with new implementation.

Java Class Library: The Interface `Set`

```java
/** An interface that describes the operations of a set of objects.
public interface SetInterface<T>
{
   public int getCurrentSize();
   public boolean isEmpty();

   /** Adds a new entry to this set, avoiding duplicates.
       @param newEntry  The object to be added as a new entry.
       @return  True if the addition is successful, or
                false if the item already is in the set. */
   public boolean add(T newEntry);

   /** Removes a specific entry from this set, if possible.
       @param anEntry  The entry to be removed.
       @return  True if the removal was successful, or false if not.
   public boolean remove(T anEntry);
```

Listing 1-5 A Java interface for a class of sets

Java Class Library: The Interface Set



```
   /** Removes a specific entry from this set, if possible.
       @param anEntry  The entry to be removed.
       @return  True if the removal was successful, or false if not
   public boolean remove(T anEntry);

   public T remove();
   public void clear();
   public boolean contains(T anEntry);
   public T[] toArray();
} // end SetInterface
```

Listing 1-5 A Java interface for a class of sets

End

Chapter 1