OO Design

CPSC 1181 – O.O.

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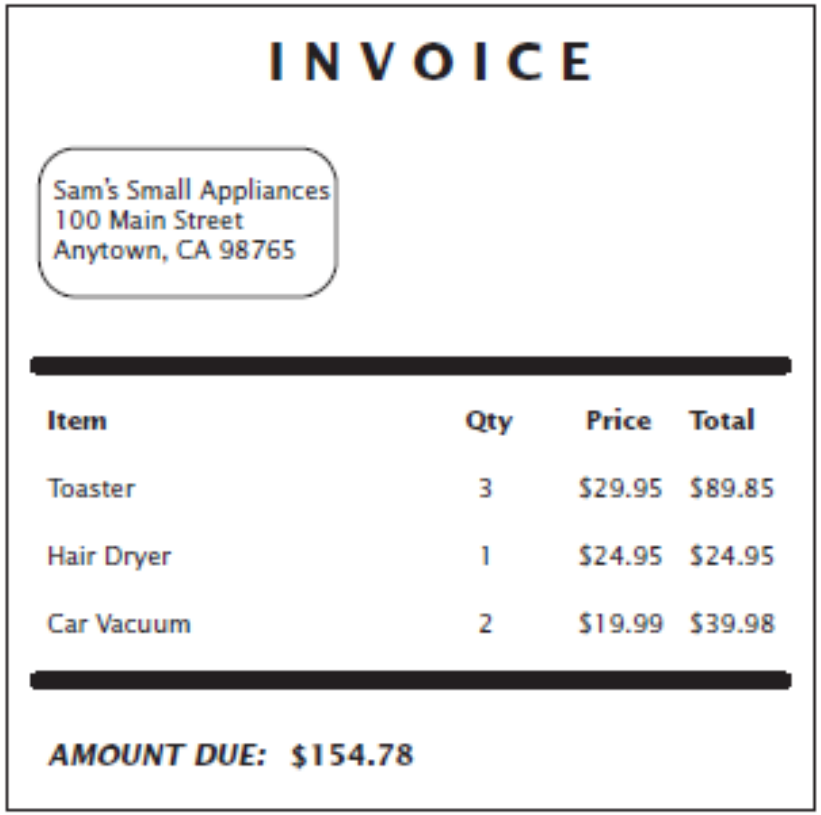
Overview

- Example

- User Story
- Use Case
- Discover classes
- CRC cards
- Dev process

Example



INVOICE

Sam's Small Appliances
100 Main Street
Anytown, CA 98765

Item	Qty	Price	Total
Toaster	3	$29.95	$89.85
Hair Dryer	1	$24.95	$24.95
Car Vacuum	2	$19.99	$39.98

AMOUNT DUE: **$154.78**

User Story: Invoice

- **As a** vendor
- **I want to** create an invoice
- **So that** both the customer and I have a record of the transaction (what was sold, how many, for what price, and the amount due)

Use Case

	Customer	Vendor	System
1	Orders some items		
2		Opens a new invoice	Creates new invoice
4		Enters an item and quantity ordered	
5			Creates line item containing item, quantity, price, quantity*price
6			Updates total amount due
7		Repeat step 4 - 6 as needed	
8		Finalize invoice	Finalize invoice […]
9		Print invoice	Record invoice
10	Receive goods & invoice		

Recall: Discovering Classes

- **Nouns**
  - Classes?
    - First Class Citizen?
  - Composite attribute?
  - Represents a single concept from the domain.
  - “Is a” relationship
- Verbs
  - Behaviours (mutators)
- Questions
  - Accessors, Predicates
- Adjectives
  - Attributes (“Has a” relationship)
  - Parameters

Advice

- Write some potential classes
- Determine which ones are first class citizens
- Err on the side of too few classes
  - YAGNI, KISS
  - Can always add a class if you decide it is a first class citizen
- Concepts from the problem domain are good concepts for classes
- Not all classes can be discovered this way
  - Will need some supporting classes

Example

- Potential classes
  - Order
  - Invoice
  - Customer
    - Address
  - Line Item
    - Product
    - Quantity
    - Price
    - Total
  - Total amount due

Example

- Potential classes
  - ~~Order~~ (not yet)
  - **Invoice**
  - ~~Customer~~
    - **Address**
  - **Line Item**
    - Product
      - ~~Price~~ (attribute)
    - ~~Quantity~~ (attribute)
    - ~~Total~~ (calculated)
  - ~~Total amount due~~ (calculated)

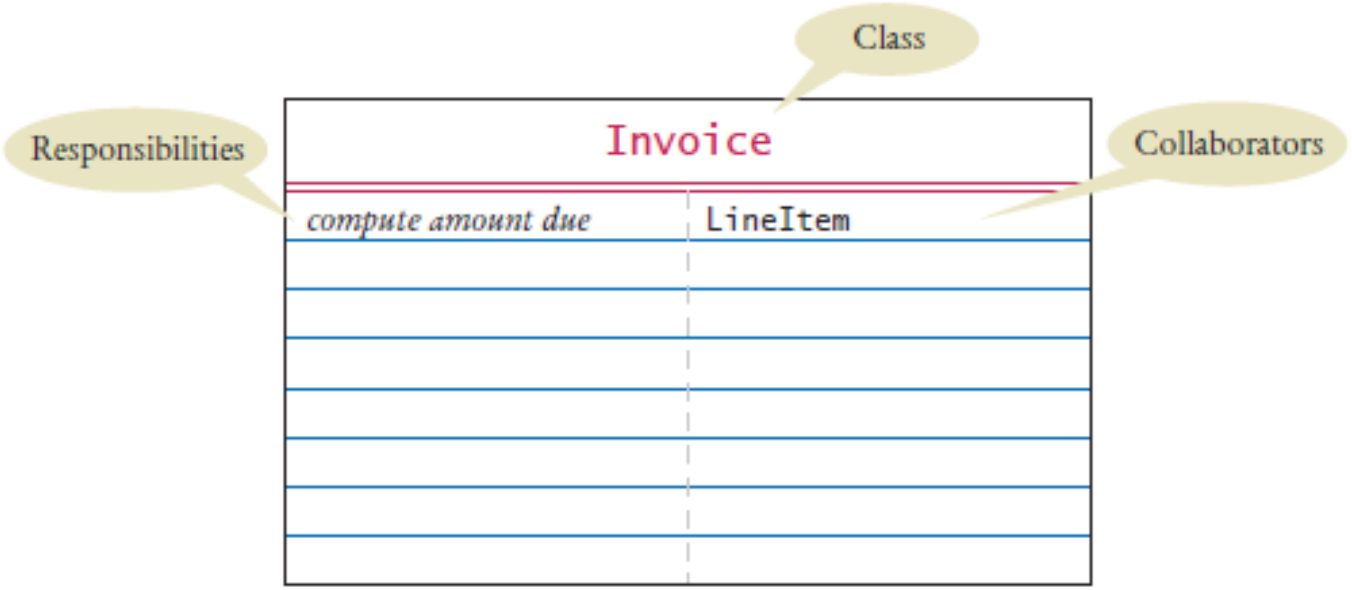
CRC Card Method

- Class-responsibility-collaboration (CRC) cards
  - K. Beck and W. Cunningham. 1989. A laboratory for teaching object oriented thinking. In *Conference proceedings on Object-oriented programming systems, languages and applications* (OOPSLA '89). ACM, New York, NY, USA, 1-6. DOI=http://dx.doi.org/10.1145/74877.74879
  - http://www.extremeprogramming.org/rules/crccards.html

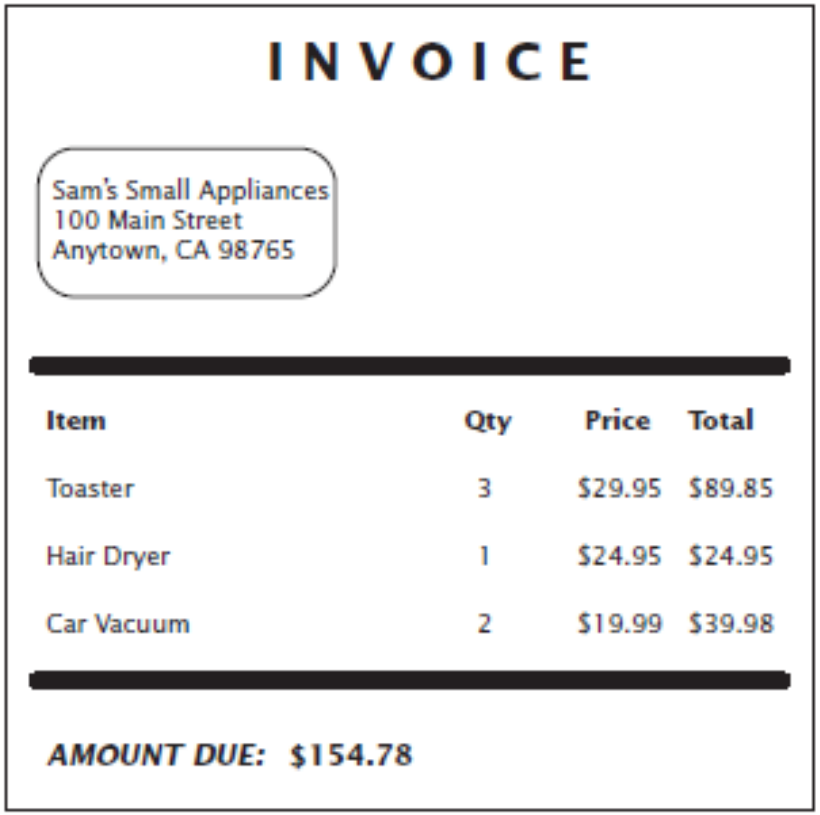
CRC Method

- After you have some (minimal) classes
- Define (minimal) behaviours
  - Verbs (mutators)
  - Questions (accessors)
  - Match them to the most appropriate object
    - Eg: need to compute total amount due
    - Who's responsible?
      - Invoice
- Indicate what other classes are needed to fulfill responsibility (collaborators)

CRC Card


Class
Responsibilities
Invoice
Collaborators
compute amount due
LineItem

Example



INVOICE

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AMOUNT DUE: **$154.78**

Check

- Suppose an invoice is to be saved to a file
- Name a likely collaborator
    - InvoiceFileSaver ?
    - PrintStream ?

Check

- What is a likely responsibility of the Customer class?
    - Produce the shipping address of the customer

Check

- What to do if a CRC card has a dozen responsibilities?
  - High cohesion: reword them so that they are at a higher level
  - Low cohesion: separation of concerns; break into more classes

Recall: Dependencies

			Line	Tip
Strongest	Inheritance	Is-a	Solid	Triangle
	Composition	Has-a (non-separable)	Solid	Filled diamond
	Aggregation	Has-a (separable)	Solid	Open diamond
	Association	Has-a (no ownership)	Solid	Open arrow
Weakest	Dependency	Knows-about	Dotted	Open arrow

5 Part Program Dev Process (Horstmann)

1. Gather requirements
2. Make CRC cards
3. Make UML
4. Write Javadoc
5. Implementation

We do:
- Iterate
  - Iterate
    - Write test
    - Implement
  - javadoc

Printing Invoice – Req's

- Start the development process by gathering and documenting program requirements.
- Task: Print out an invoice
- Invoice: Describes the charges for a set of products in certain quantities.
- Omit complexities
  - Dates, taxes, and invoice and customer numbers
- Print invoice
  - Billing address, all line items, amount due
- Line item
  - Description, unit price, quantity ordered, total price
- For simplicity, do not provide a user interface.

- Test program: Adds line items to the invoice and then prints it.

Printing Invoice – Req's

```
                  I N V O I C E

Sam's Small Appliances
100 Main Street
Anytown, CA 98765

Description                     Price Qty Total
Toaster                         29.95  3  89.85
Hair dryer                      24.95  1  24.95
Car vacuum                      19.99  2  39.98

AMOUNT DUE: $154.78
```

Example

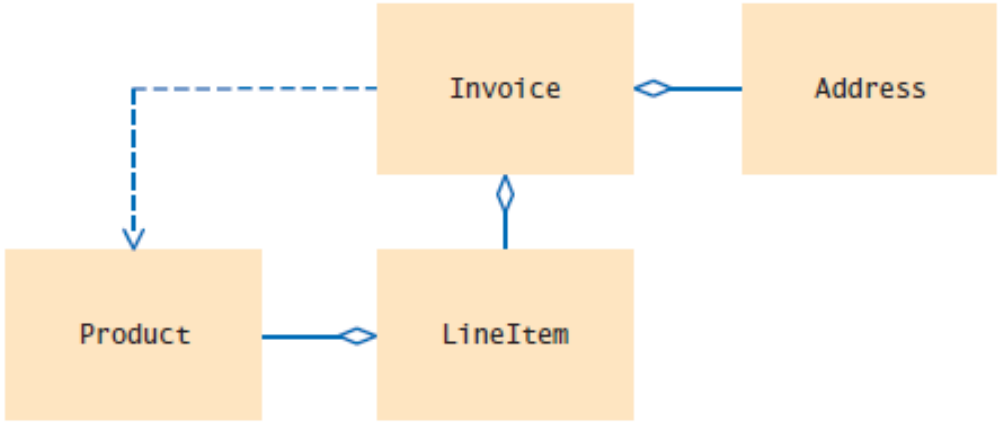
- Potential classes
  - ~~Order~~ (not yet)
  - **Invoice**
  - ~~Customer~~
    - **Address**
  - **Line Item**
    - Product
      - ~~Price~~ (attribute)
    - ~~Quantity~~ (attribute)
    - ~~Total~~ (calculated)
  - ~~Total amount due~~ (calculated)

Invoice	
format the invoice	Address
add a product and quantity	LineItem
	Product

Address
format the address

Product
get description
get unit price

LineItem	
format the item	Product
get total price	



Now Follow TDD

- Iterate
  - Iterate
    - Write test
    - Implement
  - javadoc

Check

- Which class is responsible for computing the amount due?
  - Invoice
- What are its collaborators for this task?
  - LineItem

Check

- Why did we use the toString() method instead of directly printing to console?
  - Reduces coupling.
  - No dependency on System.out
  - Can attach to other UIs

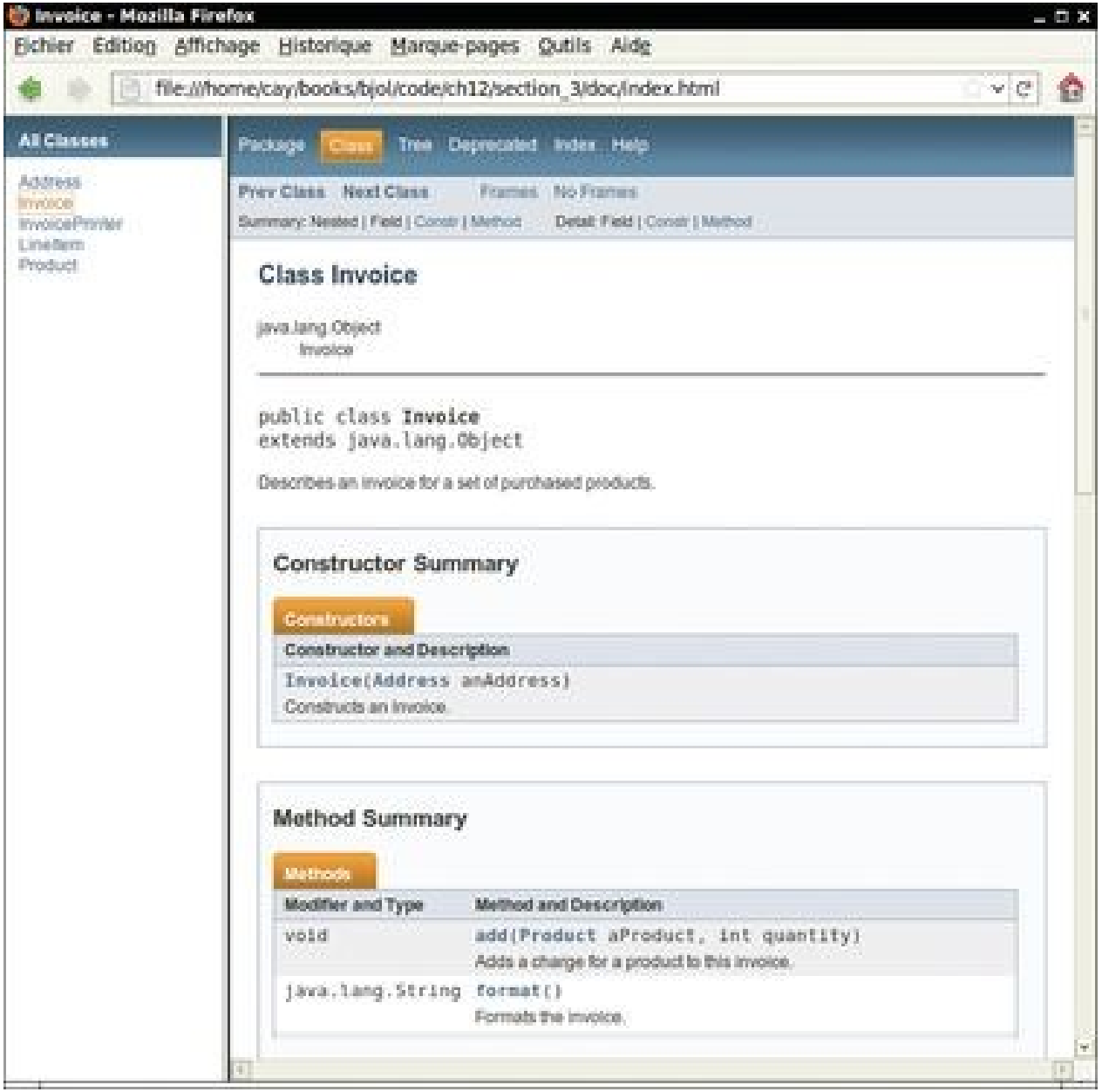
Non-TDD Follows

```java
/**
   Describes an invoice for a set of purchased products.
*/
public class Invoice {
   /**
      Adds a charge for a product to this invoice.
      @param aProduct the product that the customer ordered
      @param quantity the quantity of the product
   */
   public void add(Product aProduct, int quantity) {
   }

   /**
      Formats the invoice.
      @return the formatted invoice
   */
   public String toString() {
   }
}

```

```java
/**
   Describes a quantity of an article to purchase and its price.
*/
public class LineItem {
   /**
      Computes the total cost of this line item.
      @return the total price
   */
   public double getTotalPrice() {
   }

   /**
      Formats this item.
      @return a formatted string of this line item
   */
   public String toString() {
   }
}
```

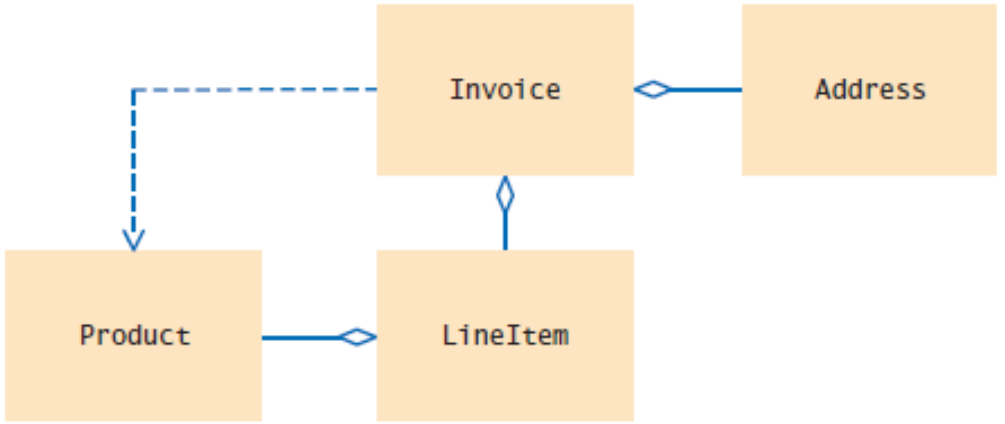
```java
/**
   Describes a product with a description and a price.
*/
public class Product {
   /**
      Gets the product description.
      @return the description
   */
   public String getDescription() {
   }

   /**
      Gets the product price.
      @return the unit price
   */
   public double getPrice() {
   }
}
```

```
1  /**
2     Describes a mailing address.
3  */
4  public class Address {
5     /**
6        Formats the address.
7        @return the address as a string with three lines
8     */
9     public String format() {
10    }
11 }
12
```


Invoice - Mozilla Firefox
Fichier Edition Affichage Historique Marque-pages Outils Aide
file:///home/cay/books/bjol/code/ch12/section_3/doc/index.html
All Classes
Address
Invoice
InvoicePrinter
LineItem
Product
Package Class Tree Deprecated Index Help
Prev Class Next Class Frames No Frames
Summary: Nested | Field | Constr | Method Detail: Field | Constr | Method
Class Invoice
java.lang.Object
Invoice
public class Invoice
extends java.lang.Object
Describes an invoice for a set of purchased products.
Constructor Summary
Constructors
Constructor and Description
Invoice(Address anAddress)
Constructs an invoice.
Method Summary
Methods
Modifier and Type
Method and Description
void
add(Product aProduct, int quantity)
Adds a charge for a product to this invoice.
java.lang.String
format()
Formats the invoice.

Implementation: Variables

- The UML will indicate instance variables
  - Aggregation
  - Composition
  - Possibly relationships



Implementation: Variables

```
1   public class Invoice {
2       private Address billingAddress;
3       private ArrayList<LineItem> items;
4       // ...
5   }
6
7   public class LineItem {
8       private int quantity;
9       private Product theProduct;
10      // ...
11  }
12
```

Implementation: Methods

- Should be straight-forward

```
1  public class LineItem {
2      // ...
3      /**
4         Computes the total cost of this line item.
5         @return the total price
6      */
7      public double getTotalPrice() {
8         return theProduct.getPrice() * quantity;
9      }
10     // ...
11 }
12
```

```
1  import java.util.ArrayList;
2
3  /**
4     Describes an invoice for a set of purchased products.
5  */
6  public class Invoice
7  {
8     private Address billingAddress;
9     private ArrayList<LineItem> items;
10
11    /**
12       Constructs an invoice.
13       @param anAddress the billing address
14    */
15    public Invoice(Address anAddress)
16    {
17       items = new ArrayList<LineItem>();
18       billingAddress = anAddress;
19    }
20
21    /**
22       Adds a charge for a product to this invoice.
23       @param aProduct the product that the customer ordered
24       @param quantity the quantity of the product
25    */
26    public void add(Product aProduct, int quantity)
27    {
28       LineItem anItem = new LineItem(aProduct, quantity);
29       items.add(anItem);
```

```
1  /**
2     Describes a quantity of an article to purchase.
3  */
4  public class LineItem
5  {
6     private int quantity;
7     private Product theProduct;
8
9     /**
10       Constructs an item from the product and quantity.
11       @param aProduct the product
12       @param aQuantity the item quantity
13    */
14    public LineItem(Product aProduct, int aQuantity)
15    {
16       theProduct = aProduct;
17       quantity = aQuantity;
18    }
19
20    /**
21       Computes the total cost of this line item.
22       @return the total price
23    */
24    public double getTotalPrice()
25    {
26       return theProduct.getPrice() * quantity;
27    }
28
29    /**
```

```
1  /**
2     Describes a product with a description and a price.
3  */
4  public class Product
5  {
6     private String description;
7     private double price;
8
9     /**
10       Constructs a product from a description and a price.
11       @param aDescription the product description
12       @param aPrice the product price
13    */
14    public Product(String aDescription, double aPrice)
15    {
16       description = aDescription;
17       price = aPrice;
18    }
19
20    /**
21       Gets the product description.
22       @return the description
23    */
24    public String getDescription()
25    {
26       return description;
27    }
28
29    /**
```

```
1  /**
2     Describes a mailing address.
3  */
4  public class Address
5  {
6     private String name;
7     private String street;
8     private String city;
9     private String state;
10    private String zip;
11
12    /**
13       Constructs a mailing address.
14       @param aName the recipient name
15       @param aStreet the street
16       @param aCity the city
17       @param aState the two-letter state code
18       @param aZip the ZIP postal code
19    */
20    public Address(String aName, String aStreet,
21          String aCity, String aState, String aZip)
22    {
23       name = aName;
24       street = aStreet;
25       city = aCity;
26       state = aState;
27       zip = aZip;
28    }
```

Recap

- Example

- User Story
- Use Case
- Discover classes
- CRC cards
- Dev process