Grouping Objects (lecture 2 of 2)

ArrayList and Iteration

(based on Ch. 4, Objects First with Java - A Practical Introduction using BlueJ, © David J. Barnes, Michael Kölling)

Produced by: Dr. Siobhán Drohan
Mr. Colm Dunphy
Mr. Diarmuid O'Connor
Dr. Frank Walsh

Waterford Institute *of* Technology
INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE

Department of Computing and Mathematics
http://www.wit.ie/

Topic list

- Grouping Objects
  - Developing a basic personal notebook project using Collections e.g. ArrayList
- Indexing within Collections
  - Retrieval and removal of objects
- Generic classes e.g. ArrayList
- Iteration
  - Using the for loop
  - Using the while loop
  - Using the for each loop
- Shop**V3.0** – use an **ArrayList of Products** instead of an array.

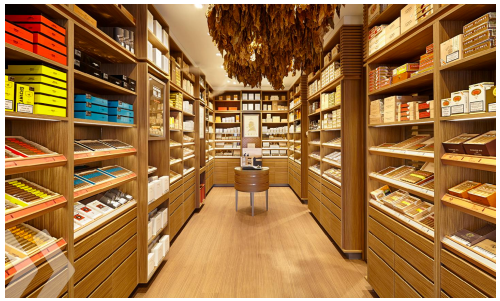
RECAP:Summary Shop V2.0

Driver

Some changes

Store

new class



Product

No changes

Product class stores details of a product's name, code, unit cost and whether it is in the current product line or not.

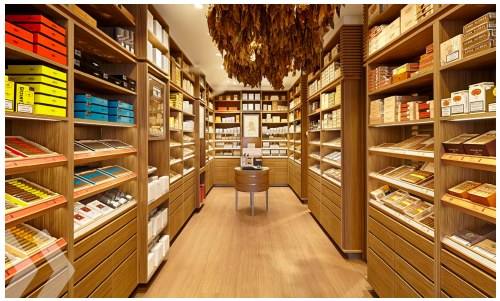
RECAP:Summary Shop V2.0

Driver

Some changes

Store

new class



Product

No changes

Store class maintains a collection of Products
i.e. an **array of Products**; store.Products[]

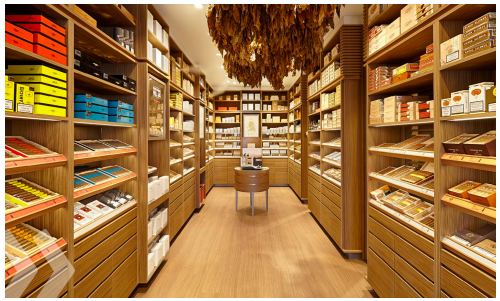
RECAP:Summary Shop V2.0

Driver

Some changes

Store

new class



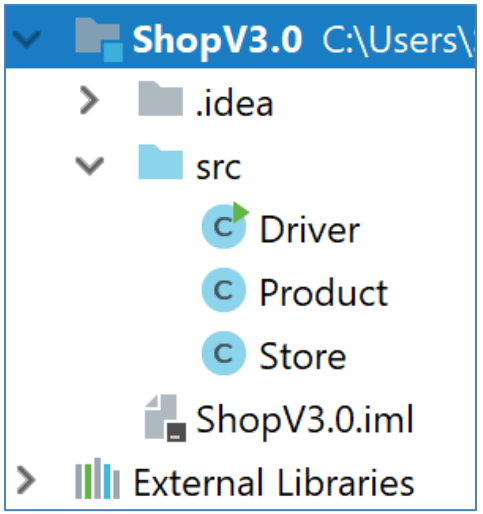
Product

No changes

Driver allows the user to decide **how many product** details they want to store.

Methods updated to work with this new **store.Products[] array**

Shop **V3.0**



GOAL: use an **ArrayList of Products** instead of an array.

Shop **V3.0** – **changes** to classes (refactoring)

Driver

Refactor:

any changes to the **Store** "interface" are reflected in this class

Store

Refactor:

to an **ArrayList of Product**

from storing Products in an array

Product

No changes

Let’s Look At

PRODUCT

Product

No changes

The **Product** Class

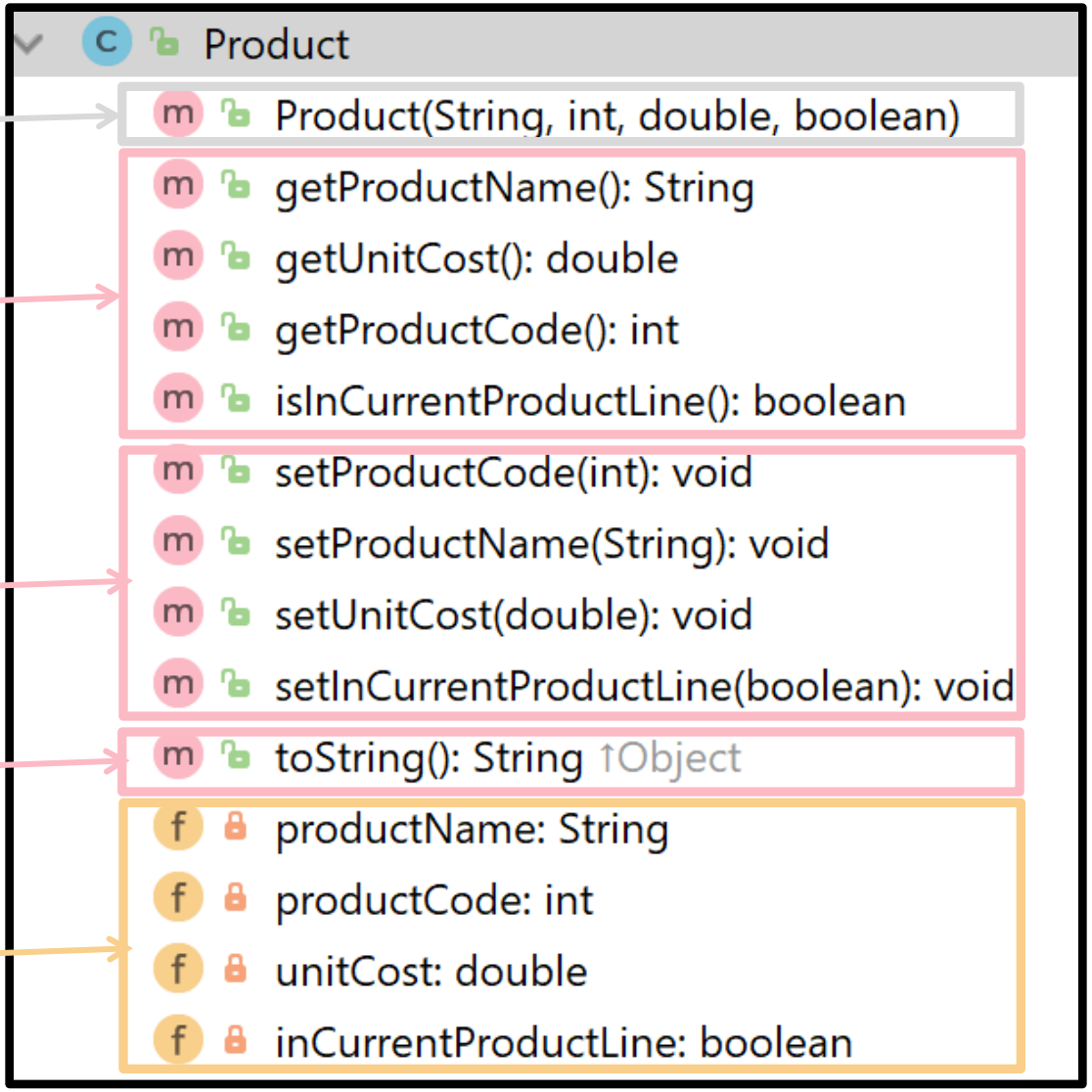
Constructor

getters

setters

toString

fields



Product

Our Product class contains four fields - instance variables

```
public class Product {

    private String productName;
    private int productCode;
    private double unitCost;
    private boolean inCurrentProductLine;
```

Product

The **constructor** uses the data passed in the four parameters to update the instance fields.

```
public Product(String productName, int productCode, double unitCost, boolean inCurrentProductLine)
{
    this.productName = productName;
    this.productCode = productCode;
    this.unitCost = unitCost;
    this.inCurrentProductLine = inCurrentProductLine;
}
```

Name Overloading using ***this.***

Product

The class has **get**ters for each instance field.

```
public String getProductName(){
     return productName;
}


public double getUnitCost(){
     return unitCost;
}


public int getProductCode() {
     return productCode;
}


public boolean isInCurrentProductLine() {
     return inCurrentProductLine;
}
```

Product

The class has **set**ters for each instance field.

```
public void setProductCode(int productCode) {
    this.productCode = productCode;
}

public void setProductName(String productName) {
    this.productName = productName;
}

public void setUnitCost(double unitCost) {
    this.unitCost = unitCost;
}

public void setInCurrentProductLine(boolean inCurrentProductLine) {
    this.inCurrentProductLine = inCurrentProductLine;
}
```

Product

The class has a **toString** method
to return a String
containing a user-friendly representation
of the object state.

```
public String toString()
{
    return "Product description: " + productName
            + ", product code: " + productCode
            + ", unit cost: " + unitCost
            + ", currently in product line: " + inCurrentProductLine;
}
```

We will call this method from the **Store** class
that we will construct over the next few slides.

Let's Look At

STORE

Store

Refactor:

to an **ArrayList of Product**

from storing Products in an array

Store

Constructor

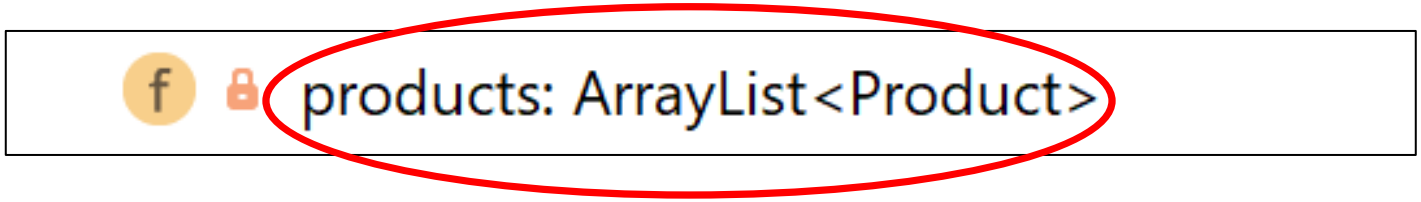
methods

1 field

- Store
  - Store()
  - add(Product): void
  - listProducts(): String
  - cheapestProduct(): String
  - listCurrentProducts(): String
  - averageProductPrice(): double
  - listProductsAboveAPrice(double): String
  - toTwoDecimalPlaces(double): double
  - products: ArrayList<Product>

Store class - **Fields**

- The Store class now has just one field called **products**
  - an **ArrayList of Product**.



1. Declaring an **ArrayList** of Product

importing the ArrayList class so we can use it.

declaring an ArrayList of Product as a private instance variable.

calling the constructor of the ArrayList class to build the ArrayList object.

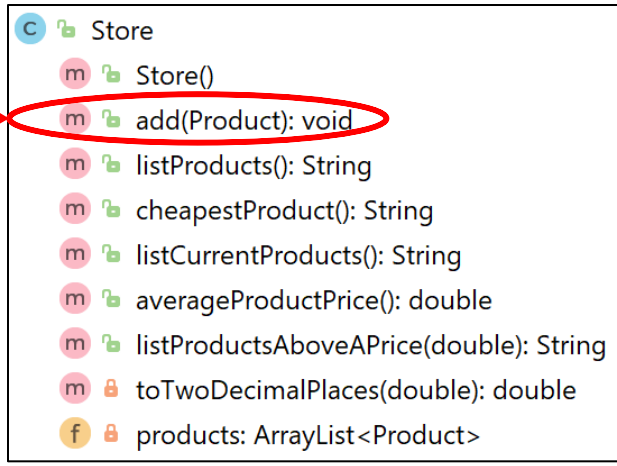
```
import java.util.ArrayList;

public class Store
{
        private ArrayList<Product> products;

        // constructor
        public Store()
        {
        products = new ArrayList<Product> ();
        }

}
```

NOTE THE SYNTAX

Store class – **Methods (1)**

These methods work on the **ArrayList** to:

1. **add** Products
2. print out the contents
3. print out the cheapest product



Add a product object to an ArrayList of Product

```
public void add (Product product)
{
        products.add (product);
}
```

This is the ArrayList of Product.

This is an object variable of type Product that we want to add to the ArrayList.

The ArrayList holds objects of this type

This is the **.add()** method from the ArrayList class that we just imported.

Store

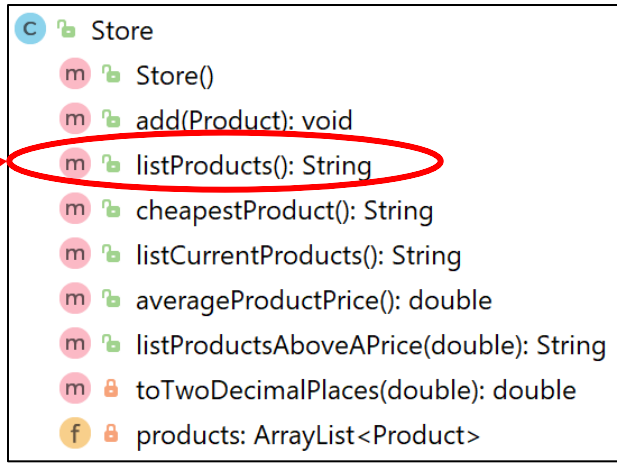
Add a product object to an ArrayList of Product

```
import java.util.ArrayList;

public class Store{

        private ArrayList<Product> products;

        public Store(){
            products = new ArrayList<Product> ();
        }

        public void add (Product product){
            products.add (product);
        }
}
```

Store class – **Methods (2)**

These methods work on the **ArrayList** to:

1. **add** Products
2. print out the contents
3. print out the cheapest product



Store

Print out the contents

If the size of the products ArrayList is **zero**,
return the String “No products” to the Driver class to be printed.

```
public String listProducts() {
    if (products.size() == 0) {
        return "No products";
    } else {
        String listOfProducts = "";
        for (int i = 0; i < products.size(); i++) {
            listOfProducts += i + ": " + products.get(i) + "\n";
        }
        return listOfProducts;
    }
}
```

If there are products in the ArrayList…
return a String containing the index number of each product & the product details.

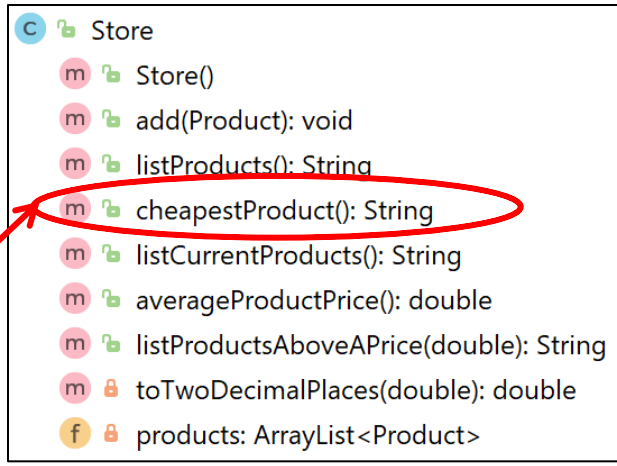
Sample Output

```
0: Product description: Product1, product code: 1, unit cost: 45.99, currently in product line: true
1: Product description: Product2, product code: 2, unit cost: 12.99, currently in product line: false
2: Product description: Product3, product code: 3, unit cost: 23.5, currently in product line: true
```

Store class – **Methods (3)**

These methods work on the **ArrayList** to:

1. **add** Products
2. print out the contents
3. print out the cheapest product



Finding the Cheapest **Product**

getter

private field – unit cost

- Product
  - Product(String, int, double, boolean)
  - getProductName(): String
  - getUnitCost(): double
  - getProductCode(): int
  - isInCurrentProductLine(): boolean
  - setProductCode(int): void
  - setProductName(String): void
  - setUnitCost(double): void
  - setInCurrentProductLine(boolean): void
  - toString(): String ↑Object
  - productName: String
  - productCode: int
  - unitCost: double
  - inCurrentProductLine: boolean

Finding the Cheapest Product – **Algorithm** (numbered steps)

1. If products have been added to the ArrayList
   1.1 Assume that the first Product in the ArrayList is the cheapest (set a local variable to store this object).
   1.2 For all product objects in the ArrayList
      1.2.1 if the current product cost is lower than the cost of the product object stored in the local variable,
         1.2.1.1 update the local variable to hold the current product object.
      end if
   end for
   1.3 Return the name of the cheapest product.
   else
   1.4 Return a message indicating that no products exist.
   end if

Finding the Cheapest Product (**step 1.**)

Working on the outer if statement (step 1.)

```
if products have been added to the ArrayList
        // return the cheapest product
else
        return a message indicating that no products exist.
end if
```

Q: How do we write the code for this algorithm?

Store

```
if (products.size() != 0){
      //return the cheapest product
}
else{
      return "No products are in the ArrayList";
}
```

Working on **step 1.1**

```
if products have been added to the ArrayList
        // 1.1   Assume that the first Product in the ArrayList is the  cheapest
        // (set a local variable to store this object).
else
        return a message indicating that no products exist.
end if
```

Q: How do we write the code for this step?

step 1.1

```
if (products.size() != 0){
        Product cheapestProduct = products.get(0);
  }
else{
      return "No products are in the ArrayList";
}
```

Store

Working on the for loop **step 1.2**

```
if products have been added to the ArrayList
        // 1.1   Assume that the first Product in the ArrayList is the cheapest
        // (set a local variable to store this object).
        // 1.2   For all product objects in the ArrayList
        //         determine the cheapest product
        //  end for
else
        return a message indicating that no products exist.
end if
```

Q: How do we write the code for this step?

step 1.2

```
if (products.size() > 0){
        Product cheapestProduct = products.get(0);
        for (Product product : products)
        {
        }
  }
else{
        return "No products are in the ArrayList";
}
```

Store

for each loop

```
if (products.size() > 0){
      Product cheapestProduct = products.get(0);
      for (Product product : products)
      {
      }
  }
else{
      return "No products are in the ArrayList";
}
```

Product: This is the type of object that is stored in the ArrayList.

product: This is the reference to the current object we are looking at in the ArrayList. As we iterate over each object in the ArrayList, this reference will change to point to the next object, and so on.

products: This is the ArrayList of Product.

step 1.2.1

1. If products have been added to the ArrayList
   1.1 Assume that the first Product in the ArrayList is the cheapest (set a local variable to store this object).
   1.2 For all product objects in the ArrayList
   1.2.1 if the current product cost is lower than the cost of the product object stored in the local variable,
   1.2.1.1 update the local variable to hold the current product object.
   end if
   end for
   1.3 Return the name of the cheapest product.
   else
   1.4 Return a message indicating that no products exist.
   end if

Q: How do we write the code for this step?

step 1.2.1

```
if (products.size() > 0){
        Product cheapestProduct = products.get(0);
        for (Product product : products){
             if (product.getUnitCost() < cheapestProduct.getUnitCost())
             {
              }
        }
}
else
{
        return "No products are in the ArrayList";
}
```

Store

Step 1.2.1.1

1. If products have been added to the ArrayList
   1.1 Assume that the first Product in the ArrayList is the cheapest (set a local variable to store this object).
   1.2 For all product objects in the ArrayList
      1.2.1 if the current product cost is lower than the cost of the product object stored in the local variable,
         1.2.1.1 update the local variable to hold the current product object.
      end if
   end for
   1.3 Return the name of the cheapest product.
   else
   1.4 Return a message indicating that no products exist.
   end if

Q: How do we write the code for this step?

Step 1.2.1.1

```
if (products.size() > 0){
        Product cheapestProduct = products.get(0);
        for (Product product : products){
             if (product.getUnitCost() < cheapestProduct.getUnitCost()){
                cheapestProduct = product;
              }
        }
 }
else{
        return "No products are in the ArrayList";
}
```

Store

Working on the last **step, 1.3**

1. If products have been added to the ArrayList
   1.1 Assume that the first Product in the ArrayList is the cheapest (set a local variable to store this object).
   1.2 For all product objects in the ArrayList
      1.2.1 if the current product cost is lower than the cost of the product object stored in the local variable,
         1.2.1.1 update the local variable to hold the current product object.
      end if
   end for
   1.3 Return the name of the cheapest product.
   else
   1.4 Return a message indicating that no products exist.
   end if

Q: How do we write the code for this step?

step, 1.3

```
if (products.size() > 0){
        Product cheapestProduct = products.get(0);
        for (Product product : products){
              if (product.getUnitCost() < cheapestProduct.getUnitCost()){
                 cheapestProduct = product;
               }
        }
        return cheapestProduct.getProductName();
}
else{
        return "No products are in the ArrayList";
}
```

Let's Look At

DRIVER

Driver

Refactor:

any changes to the **Store** "interface" are reflected in this class

Store

Constructor

- Store
  - Store()
  - add(Product): void
  - listProducts(): String
  - cheapestProduct(): String
  - listCurrentProducts(): String
  - averageProductPrice(): double
  - listProductsAboveAPrice(double): String
  - toTwoDecimalPlaces(double): double
  - products: ArrayList<Product>

Previously our Shop used an array and we needed to know how many Products to store:


```
store = new Store(numberProducts);
```

Now that we are using an ArrayList, we don't need to set a capacity, so our constructor call becomes:

```
store = new Store();
```

Next Time, we'll add a **menu system** in the Driver class.

Right now, the user has **no control** over whether they want to add, list, etc products i.e.:


```
How many Products would you like to have in your Store?  3
Enter the Product Name:  Product1
Enter the Product Code:  1
Enter the Unit Cost:  45.99
Is this product in your current line (y/n): Y

Enter the Product Name:  Product2
Enter the Product Code:  2
Enter the Unit Cost:  12.99
Is this product in your current line (y/n): N

Enter the Product Name:  Product3
Enter the Product Code:  3
Enter the Unit Cost:  23.50
Is this product in your current line (y/n): Y

List of Products are:
0: Product description: Product1, product code: 1, unit cost: 45.99, currently in product line: true
1: Product description: Product2, product code: 2, unit cost: 12.99, currently in product line: false
2: Product description: Product3, product code: 3, unit cost: 23.5, currently in product line: true

List of CURRENT Products are:
0: Product description: Product1, product code: 1, unit cost: 45.99, currently in product line: true
2: Product description: Product3, product code: 3, unit cost: 23.5, currently in product line: true

The average product price is: 27.493333333333336
The cheapest product is:  Product2
View the product costing more than this price:  12.99
0: Product description: Product1, product code: 1, unit cost: 45.99, currently in product line: true
2: Product description: Product3, product code: 3, unit cost: 23.5, currently in product line: true
```

Collections

- Allow an **arbitrary number** of objects to be stored.
- Are implemented in **Java's Class libraries** which contain tried-and-tested collection classes.
- In Java's class libraries are called ***packages***.
- We have used the `ArrayList` class from the `java.util` **package**.

ArrayList

- Items may be **added** and **removed**.
- Each item has an **index**.
- **Index values may change** if items are removed (or further items added).
- The main `ArrayList` methods are:
  - **`add()`**
  - **`get()`**
  - **`remove()`**
  - **`size()`**
- `ArrayList` is a parameterized or generic type.

Questions?