

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)

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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
- **ShopV3.0** – use an **ArrayList of Products** instead of an array.

RECAP: Summary Shop V2.0



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



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

RECAP: Summary Shop V2.0

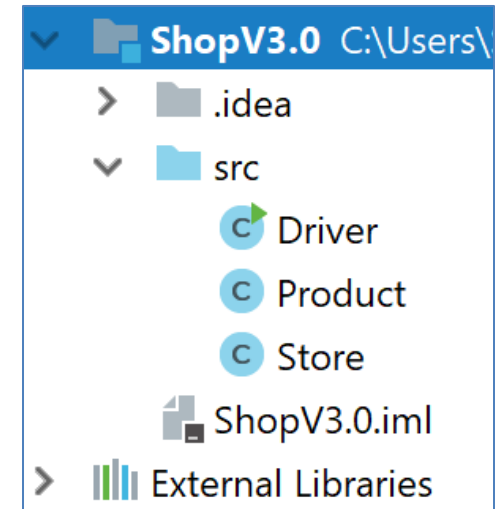


Driver allows the user to decide **how many product** details they want to store.

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

JVM



Store

Refactor:
to an **ArrayList of Product**
from storing Products in an array



Product

No changes



Let's Look At

PRODUCT

Product

No changes



Product



The Product Class

Constructor

getters

setters

toString

fields

```
Product
├── m Product(String, int, double, boolean)
├── m getProductName(): String
├── m getUnitCost(): double
├── m getProductCode(): int
├── m isInCurrentProductLine(): boolean
├── m setProductCode(int): void
├── m setProductName(String): void
├── m setUnitCost(double): void
├── m setIsInCurrentProductLine(boolean): void
├── m toString(): String ↑Object
├── f productName: String
├── f productCode: int
├── f unitCost: double
└── f inCurrentProductLine: boolean
```

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 **getters** 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 **setters** 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





C  Store

Constructor


m  Store()


methods


m  add(Product): void

m  listProducts(): String

m  cheapestProduct(): String


m  listCurrentProducts(): String

m  averageProductPrice(): double

m  listProductsAboveAPrice(double): String

m  toTwoDecimalPlaces(double): double

1 field

f  products: ArrayList<Product>

Store class - **Fields**



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

```
f 🔒 products: ArrayList<Product>
```



1. Declaring an **ArrayList** of Product

importing the ArrayList class so we can use it.

```
import java.util.ArrayList;
```

declaring an ArrayList of Product as a private instance variable.

```
public class Store  
{
```

```
    private ArrayList<Product> products;
```

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

```
    // constructor  
    public Store()  
    {
```

```
        products = new ArrayList<Product> ();  
    }
```

```
}
```



Store



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

```
C Store
  m Store()
  m add(Product): void
  m listProducts(): String
  m cheapestProduct(): String
  m listCurrentProducts(): String
  m averageProductPrice(): double
  m listProductsAboveAPrice(double): String
  m toTwoDecimalPlaces(double): double
  f products: ArrayList<Product>
```

Store



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



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

```
C Store
  m Store()
  m add(Product): void
  m listProducts(): String
  m cheapestProduct(): String
  m listCurrentProducts(): String
  m averageProductPrice(): double
  m listProductsAboveAPrice(double): String
  m toTwoDecimalPlaces(double): double
  f products: ArrayList<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



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**

```
C Store
  m Store()
  m add(Product): void
  m listProducts(): String
  m cheapestProduct(): String
  m listCurrentProducts(): String
  m averageProductPrice(): double
  m listProductsAboveAPrice(double): String
  m toTwoDecimalPlaces(double): double
  f products: ArrayList<Product>
```


Finding the Cheapest Product

getter

Product



private field – unit cost

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

Store



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

Store



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";  
}
```

Store



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?

Store



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?

Store



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



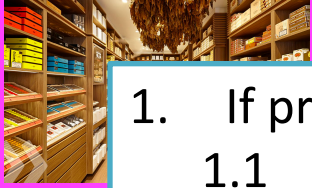
```
if (products.size() > 0) {
    Product cheapestProduct = products.get(0);
    for (Product product : products)
    {
    }
}
else{
    return "No products are in the ArrayList";
}
```

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.

Store



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?

Store

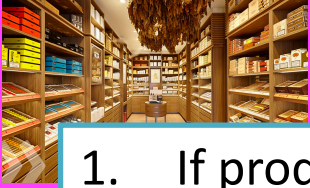


step 1.2.1



```
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?

Store



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?

Store



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



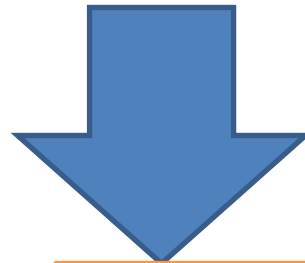
Constructor

```
c Store
m Store()
m add(Product): void
m listProducts(): String
m cheapestProduct(): String
m listCurrentProducts(): String
m averageProductPrice(): double
m listProductsAboveAPrice(double): String
m toTwoDecimalPlaces(double): double
f 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?

