CS 112

Iterator

Iterator Design Pattern

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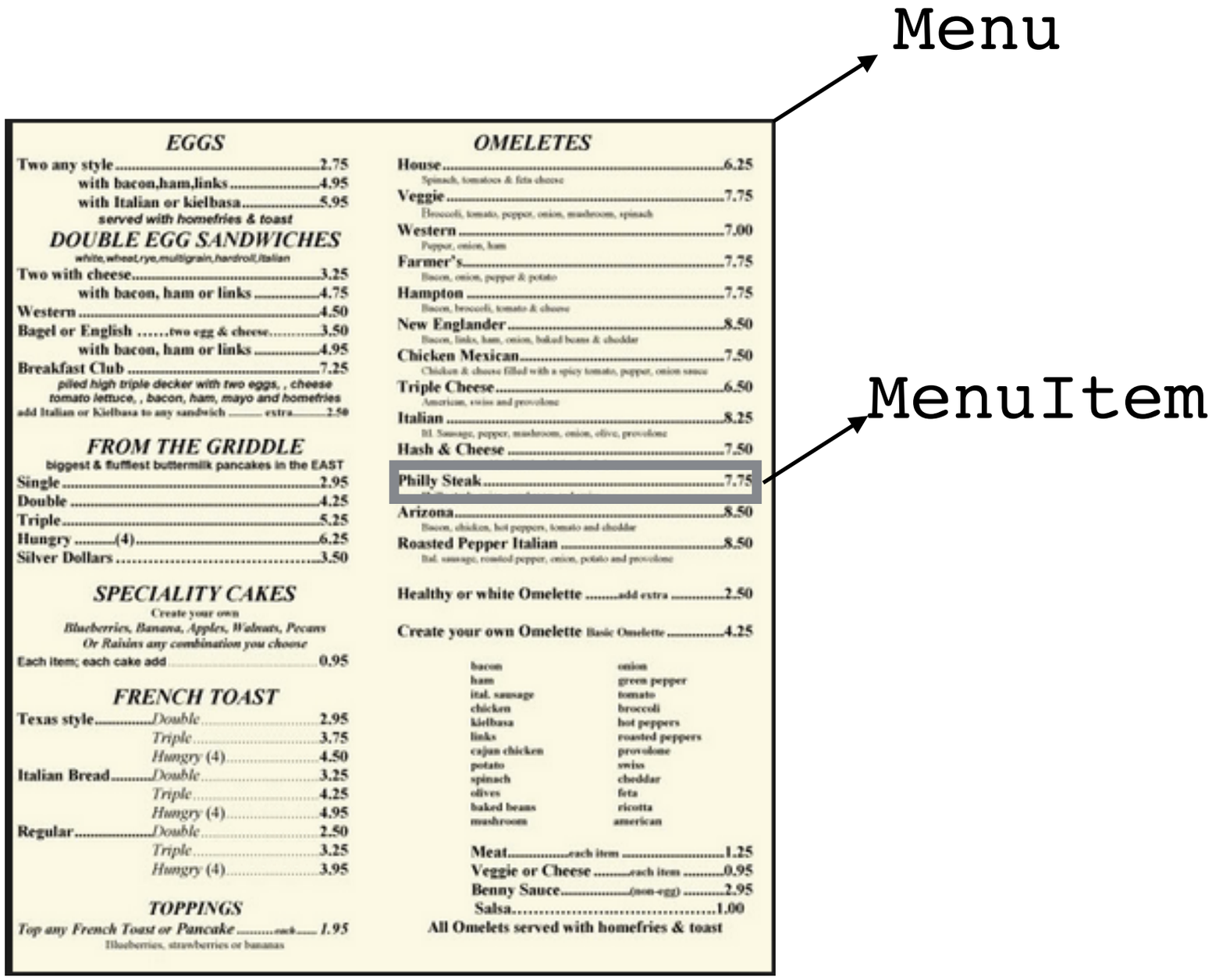
- The Iterator Pattern allows traversal *of the elements of an collection* without exposing the underlying implementation.

- Lets understand the Iterator design pattern by working through a design question.

Lets create a breakfast menu



```
class MenuItem
{




}
```

```
class MenuItem
{
   private String name;
   private String description;
   private boolean isVegetarian;
   private double price;
```

```
}
```

```
class MenuItem
{
   private String name;
   private String description;
   private boolean isVegetarian;
   private double price;

   public MenuItem(String name,String
description,boolean veg,double price)
   {
      this.name=name;
      this.description=description;
      this.isVegetarian=veg;
      this.price=price;
   }

}
```

MenuItem cont…

```
class MenuItem
{
```

MenuItem cont…

```
class MenuItem
{
    .
    .
```

MenuItem cont…

```
class MenuItem
{
   .
   .
   public String getName()
   {
      return name;
   }
   public String getDescription()
   {
      return description;
   }
   public double getPrice()
   {
      return price;
   }
   public boolean isVegetarian()
   {
      return isVegetarian;
   }
```

`Menu` Interface

```
interface Menu

{

}
```

Menu Interface

```
interface Menu

{

   public void addItem(String name,
                       String description,
                       boolean veg,
                       double price);

}
```

```
public class BreakfastMenu
{

}
```

```
public class BreakfastMenu implements Menu
{

}
```

```
public class BreakfastMenu implements Menu
{









    public void addItem(String name, String description, boolean veg, double price)
    {


    }




}
```

```
public class BreakfastMenu implements Menu
{
    private List menuItems;




    public void addItem(String name, String description, boolean veg, double price)
    {

    }



}
```

```
public class BreakfastMenu implements Menu
{
    private List menuItems;
    public BreakfastMenu()
    {
        menuItems=new ArrayList();
        this.addItem(“Pancakes!”, “Pancakes with cream!!!”,true,2.99);
        this.addItem(“Bagels”, “Bagels with butter!!!”,true,2.99);
        this.addItem(“Fresh Juice”, “Orange Juice!!!”,true,2.99);
        this.addItem(“Fresh Tea”, “Sweet Tea!!!”,true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
        {

        }



}
```

```
public class BreakfastMenu implements Menu
{
    private List menuItems;
    public BreakfastMenu()
    {
        menuItems=new ArrayList();
        this.addItem(“Pancakes!”, “Pancakes with cream!!!”,true,2.99);
        this.addItem(“Bagels”, “Bagels with butter!!!”,true,2.99);
        this.addItem(“Fresh Juice”, “Orange Juice!!!”,true,2.99);
        this.addItem(“Fresh Tea”, “Sweet Tea!!!”,true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        menuItems.add(item);
    }



}
```

```
public class BreakfastMenu implements Menu
{
    private List menuItems;
    public BreakfastMenu()
    {
        menuItems=new ArrayList();
        this.addItem(“Pancakes!”, “Pancakes with cream!!!”,true,2.99);
        this.addItem(“Bagels”, “Bagels with butter!!!”,true,2.99);
        this.addItem(“Fresh Juice”, “Orange Juice!!!”,true,2.99);
        this.addItem(“Fresh Tea”, “Sweet Tea!!!”,true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        menuItems.add(item);
    }

    public List getMenuItems()
    {
        return menuItems;
    }

}
```

Lets create a dinner menu

```
public class DinnerMenu
{

}
```

```
public class DinnerMenu implements Menu
{

}
```

```
public class DinnerMenu implements Menu
{









    public void addItem(String name, String description, boolean veg, double price)
    {

    }




}
```

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;









    public void addItem(String name, String description, boolean veg, double price)
    {

    }




}
```

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;
    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem(“Shawarma”, “Chicken!!”,true,2.99);
        this.addItem(“Biryani”, “Chicken!!”,true,2.99);
        this.addItem(“Curry”, “ButterChicken”,true,2.99);
        this.addItem(“Naan”, “Butter Naan”,true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
```

```
    }
}
```

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;
    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem("Shawarma", "Chicken!!",true,2.99);
        this.addItem("Biryani", "Chicken!!",true,2.99);
        this.addItem("Curry", "ButterChicken",true,2.99);
        this.addItem("Naan", "Butter Naan",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        if (counter>=NUMBER_OF_ITEMS)
        {
            System.err.println("Error, array is full");
        }
        else
        {
            dinnerItems[counter]=item;
            counter++;
        }
    }



}
```

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;
    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem("Shawarma", "Chicken!!",true,2.99);
        this.addItem("Biryani", "Chicken!!",true,2.99);
        this.addItem("Curry", "ButterChicken",true,2.99);
        this.addItem("Naan", "Butter Naan",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        if (counter>=NUMBER_OF_ITEMS)
        {
            System.err.println("Error, array is full");
        }
        else
        {
            dinnerItems[counter]=item;
            counter++;
        }
    }

    public MenuItem[] getMenuItems()
    {
        return dinnerItems;
    }

}
```

Problem:

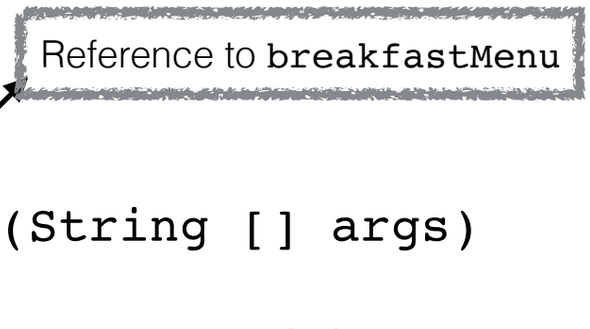
- Ok, so now you are asked to print out the two menus on the console.

```
class PrintMenus
{
    public static void main(String [] args)
    {

    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();


        }
}
```




```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();


    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();
```


```
        }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();
            Menu dinnerM= new DinnerMenu();
            MenuItem[] dinnerItems=((DinnerMenu)dinnerM).getMenuItems();
            .
            .
            .

    }
}
```

Reference to **breakfastMenu**

downcasting from Menu to BreakfastMenu. Why?

Questions…

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- Are the two menus implemented differently?

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- Are the two menus implemented differently?
- What kind of data structure did we use to implement the **`breakfastMenu`**?

Questions…

- Are the two menus implemented differently?
- What kind of data structure did we use to implement the `breakfastMenu`?
- What kind of data structure did we use to implement the `dinnerMenu`?

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();
```



```
        }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();

            for (int i=0;i<breakfastItems.size();i++)
            {
                    MenuItem menuItem=breakfastItems.get(i);
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
                }

                .
                .
                .

        }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            ArrayList breakfastItems=((BreakfastMenu)breakfastM).getMenuItems();

            for (int i=0;i<breakfastItems.size();i++)
            {
                    MenuItem menuItem=breakfastItems.get(i);
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
                }

                    .
                    .
                    .

        }
}
```

look @ JavaDoc of list for size and get

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            MenuItem[] dinnerItems=((DinnerMenu)dinnerM).getMenuItems();
```

```
    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            MenuItem[] dinnerItems=((DinnerMenu)dinnerM).getMenuItems();

            for (int i=0;i<dinnerItems.length;i++)
            {
                    MenuItem menuItem=dinnerItems[i];
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
            }

            .
            .
            .

    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            MenuItem[] dinnerItems=((DinnerMenu)dinnerM).getMenuItems();

            for (int i=0;i<dinnerItems.length;i++)
            {
                    MenuItem menuItem=dinnerItems[i];
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
            }

            .
            .
            .

    }
}
```

look @ JavaDoc of array for length and []

What are some issues here?

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- Is the code that is printing the menus required to know the inner details of the **`BreakfastMenu`** and **`DinnerMenu`**?

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- Is the code that is printing the menus required to know the inner details of the `BreakfastMenu` and `DinnerMenu`?
- Encapsulation?

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- Encapsulation?
- What was the whole point of Encapsulation?

What are some issues here?

- Is the code that is printing the menus required to know the inner details of the `BreakfastMenu` and `DinnerMenu`?
  - Encapsulation?
  - What was the whole point of Encapsulation?
- Do we really care or are concerned about the inner collection used in the `Menu` when printing `MenuItem`?

What are some issues here?

- We were earlier printing the menu to the console. But assume now, that we are also:
    - printing the menu to a file.
    - printing the menu to a web page.
    - printing the menu and sending an email.

- Now, if **`breakfastMenu`** and **`dinnerMenu`** decide to use a different collection (**`tree`**, **`set`**, **`linked list`**, etc etc) does that mean the following code must be modified?
    - the code for printing to a file.
    - the code for printing to a web page
    - the code for printing the menu and sending an email
    - the code for printing to the console

Lets use Iterator Design Pattern

```
interface Menu

{
    public void addItem(String name, String description, boolean
    veg, double price);



}
```

Lets use Iterator Design Pattern

```
interface Menu

{
    public void addItem(String name, String description, boolean
    veg, double price);

    public Iterator createIterator();

}
```

What is an `Iterator` in Java JDK?

- An `Iterator` is an interface in the Java JDK. The interface contains the following three abstract methods:

Method Summary	
boolean	**hasNext**() Returns `true` if the iteration has more elements.
E	**next**() Returns the next element in the iteration.
void	**remove**() Removes from the underlying collection the last element returned by the iterator (optional operation).

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
```

```
    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
          Menu dinnerM= new DinnerMenu();
          Iterator iterator=dinnerM.createIterator();


    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            Iterator iterator=dinnerM.createIterator();

            while (iterator.hasNext())
            {

                    MenuItem item = (MenuItem)iterator.next();
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
            }

            .
            .
            .

    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            Iterator iterator=dinnerM.createIterator();

            while (iterator.hasNext())
            {
                    MenuItem item = (MenuItem)iterator.next();
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
                }

                .
                .
                .

    }
}
```

Iterator

Method Summary

boolean	**hasNext()** Returns `true` if the iteration has more elements.
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```
class PrintMenus
{
    public static void main(String [] args)
    {
          Menu breakfastM= new BreakfastMenu();
```

```
    }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            Iterator iterator=breakfastM.createIterator();


        }
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            Iterator iterator=breakfastM.createIterator();

            while (iterator.hasNext())
            {

                    MenuItem item = (MenuItem)iterator.next();
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
            }

            .
            .
            .

    }
}
```

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class PrintMenus
{
    public static void main(String [] args)
    {
            Menu breakfastM= new BreakfastMenu();
            Iterator iterator=breakfastM.createIterator();

            while (iterator.hasNext())
            {
                    MenuItem item = (MenuItem)iterator.next();
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
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                }

                .
                .
                .

    }
}
```

Iterator

Method Summary

boolean	**hasNext()** Returns `true` if the iteration has more elements.
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```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;
    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem("Shawarma", "Chicken!!",true,2.99);
        this.addItem("Biryani", "Chicken!!",true,2.99);
        this.addItem("Curry", "ButterChicken",true,2.99);
        this.addItem("Naan", "Butter Naan",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        if (counter>=NUMBER_OF_ITEMS)
        {
            System.err.println("Error, array is full");
        }
        else
        {
            dinnerItems[counter]=item;
            counter++;
        }
    }

    public Iterator createIterator()
    {

    }

}
```

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;
    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem("Shawarma", "Chicken!!",true,2.99);
        this.addItem("Biryani", "Chicken!!",true,2.99);
        this.addItem("Curry", "ButterChicken",true,2.99);
        this.addItem("Naan", "Butter Naan",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        if (counter>=NUMBER_OF_ITEMS)
        {
            System.err.println("Error, array is full");
        }
        else
        {
            dinnerItems[counter]=item;
            counter++;
        }
    }

    public Iterator createIterator()
    {
        ???
    }

}
```

```
class DinnerMenuIterator
{

}
```

```
class DinnerMenuIterator implements Iterator
{

}
```

```
class DinnerMenuIterator implements Iterator
{

        public Object next()
        {

}
```

```
class DinnerMenuIterator implements Iterator
{

        public Object next()
        {

        }

}
```

```
class DinnerMenuIterator implements Iterator
{




        public Object next()
        {

        }

        public boolean hasNext()
        {



}
```

```
class DinnerMenuIterator implements Iterator
{
        private MenuItems[] items;
        int counter;









        public Object next()
        {

        }

        public boolean hasNext()
        {


}
```

```
class DinnerMenuIterator implements Iterator
{
        private MenuItems[] items;
        int counter;

        public DinnerMenuIterator(MenuItems[] items)
        {
            this.items=items;
            counter=0;
        }

        public Object next()
        {

        }

        public boolean hasNext()
        {



}
```

```
class DinnerMenuIterator implements Iterator
{
        private MenuItems[] items;
        int counter;

        public DinnerMenuIterator(MenuItems[] items)
        {
            this.items=items;
            counter=0;
        }

        public Object next()
        {
            MenuItem item=items[counter];
            counter++;
            return item;
        }

        public boolean hasNext()
        {









}
```

```
class DinnerMenuIterator implements Iterator
{
        private MenuItems[] items;
        int counter;

        public DinnerMenuIterator(MenuItems[] items)
        {
            this.items=items;
            counter=0;
        }

        public Object next()
        {
            MenuItem item=items[counter];
            counter++;
            return item;
        }

        public boolean hasNext()
        {
            if (counter>=items.length || items[counter]==null)
            {
                    return false;
            }
            else
            {
                return true;
            }

}
```

Revist `DinnerMenu` Class

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
    int counter=0;
    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem("Shawarma", "Chicken!!",true,2.99);
        this.addItem("Biryani", "Chicken!!",true,2.99);
        this.addItem("Curry", "ButterChicken",true,2.99);
        this.addItem("Naan", "Butter Naan",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        if (counter>=NUMBER_OF_ITEMS)
        {
            System.err.println("Error, array is full");
        }
        else
        {
            dinnerItems[counter]=item;
            counter++;
        }
    }

    public Iterator createIterator()
    {

    }

}
```

Revist `DinnerMenu` Class

```
public class DinnerMenu implements Menu
{
    private static final int NUMBER_OF_ITEMS=6;
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    private MenuItem[] dinnerItems;
    public DinnerMenu()
    {
        dinnerItems=new MenuItem[NUMBER_OF_ITEMS];
        this.addItem("Shawarma", "Chicken!!",true,2.99);
        this.addItem("Biryani", "Chicken!!",true,2.99);
        this.addItem("Curry", "ButterChicken",true,2.99);
        this.addItem("Naan", "Butter Naan",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        if (counter>=NUMBER_OF_ITEMS)
        {
            System.err.println("Error, array is full");
        }
        else
        {
            dinnerItems[counter]=item;
            counter++;
        }
    }

    public Iterator createIterator()
    {
        return new DinnerMenuIterator(menuItems);
    }

}
```

Ok.. how do we fix our `breakfastMenu`?

Ok.. how do we fix our `breakfastMenu`?

- Our **`BreakfastMenu`** uses an **`ArrayList`** as a collection to hold the **`MenuItems`**.

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- Our `BreakfastMenu` uses an `ArrayList` as a collection to hold the `MenuItems`.

- Here is a snapshot of the JavaDoc for an `ArrayList`:

Ok.. how do we fix our `breakfastMenu`?

- Our `BreakfastMenu` uses an `ArrayList` as a collection to hold the `MenuItems`.

- Here is a snapshot of the JavaDoc for an `ArrayList`:

Overview Package **Class** Use Tree Deprecated Index Help

Prev Class **Next Class** Frames No Frames All Classes

Summary: Nested | Field | Constr | Method Detail: Field | Constr | Method

java.util

Class ArrayList<E>

java.lang.Object
  java.util.AbstractCollection<E>
    java.util.AbstractList<E>
      java.util.ArrayList<E>

All Implemented Interfaces:

Serializable, Cloneable, Iterable<E>, Collection<E>, List<E>, RandomAccess

Direct Known Subclasses:

AttributeList, RoleList, RoleUnresolvedList

- `ArrayList` IS A `List`.

- The `List` has the following abstract instance method:

iterator

```
public Iterator<E> iterator()
```

Returns an iterator over the elements in this list in proper sequence.

- This implies that the `ArrayList` has implemented this method from the `List` interface.

```
public class BreakfastMenu implements Menu
{
    private List menuItems;
    public BreakfastMenu()
    {
        menuItems=new ArrayList();
        this.addItem(“Pancakes!”, “Pancakes with cream!!!”,true,2.99);
        this.addItem(“Bagels”, “Bagels with butter!!!”,true,2.99);
        this.addItem(“Fresh Juice”, “Orange Juice!!!”,true,2.99);
        this.addItem(“Fresh Tea”, “Sweet Tea!!!”,true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        menuItems.add(item);
    }

    public List getMenuItems()
    {
        return menuItems;
    }

    public Iterator createIterator()
    {

    }

}
```

```
public class BreakfastMenu implements Menu
{
    private List menuItems;
    public BreakfastMenu()
    {
        menuItems=new ArrayList();
        this.addItem("Pancakes!", "Pancakes with cream!!!",true,2.99);
        this.addItem("Bagels", "Bagels with butter!!!",true,2.99);
        this.addItem("Fresh Juice", "Orange Juice!!!",true,2.99);
        this.addItem("Fresh Tea", "Sweet Tea!!!",true,2.99);
    }

    public void addItem(String name, String description, boolean veg, double price)
    {
        MenuItem item=new MenuItem(name,description,veg,price);
        menuItems.add(item);
    }

    public List getMenuItems()
    {
        return menuItems;
    }

    public Iterator createIterator()
    {
        return menuItems.iterator();
    }

}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {









    }
```

;

}

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            Menu breakfastM = new BreakfastMenu();
            Iterator iterator=dinnerM.createIterator();
            Iterator iterator1=breakfastM.createIterator();
            print(iterator);
            print(iterator1);
    }
```

;

```
}
```

```
class PrintMenus
{
    public static void main(String [] args)
    {
            Menu dinnerM= new DinnerMenu();
            Menu breakfastM = new BreakfastMenu();
            Iterator iterator=dinnerM.createIterator();
            Iterator iterator1=breakfastM.createIterator();
            print(iterator);
            print(iterator1);
    }
    public static void print(Iterator itr)
    {
            while (itr.hasNext())
            {

                    MenuItem item = (MenuItem)iterator.next();
                    System.out.println(menuItem.getName());
                    System.out.println(menuItem.getPrice());
                    System.out.println(menuItem.getDescription());
            }
    }
}
```

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- Now, if **`breakfastMenu`** and **`dinnerMenu`** decide to use a different collection (**`tree`**, **`set`**, **`linked list`**, etc etc) does that mean the following code must be modified?

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    - the code for printing to a file.

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    - the code for printing to a web page
    - the code for printing the menu and sending an email
    - the code for printing to the console