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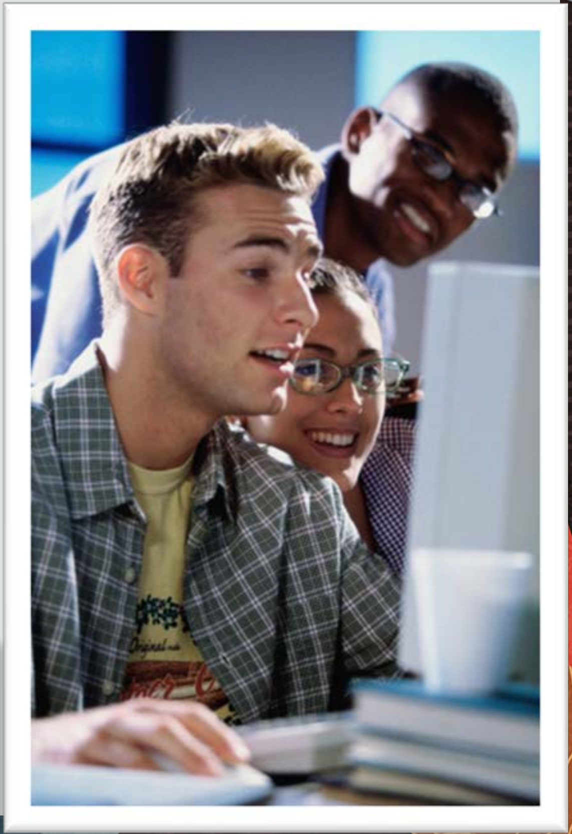
Java Foundations

8-2
ArrayLists



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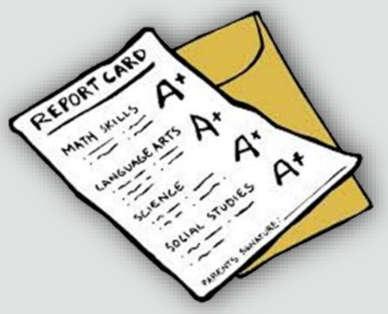
Objectives

- This lesson covers the following objectives:
  - Create an ArrayList
  - Manipulate an ArrayList by using its methods
  - Traverse an ArrayList using iterators and for-each loops
  - Use wrapper classes and Autoboxing to add primitive data types to an ArrayList

Collection of Objects (Real Life)

- In real life, objects often appear in groups
- For example:
  - Parking lots contain multiple cars
  - Banks contain multiple accounts
  - Stores have multiple customers
  - A student has multiple assignment grades



Collection of Objects (Programming)

- When programming, you often gather data (objects)
- This is commonly referred to as a collection

- In Java, the simplest way of collecting information is by using the ArrayList
- The Java ArrayList class can store a group of many objects

Managing Students Enrolled in a Class

- Say a group of students is enrolled in Java Programming 101
- You want to write a Java program to track the enrolled students
- The simplest way would be to create an array, as discussed in the previous lesson

Using Arrays to Manage Enrolled Students

- You can write a student array like this:

```
String[] students={"Mary", "Sue", "Harry", "Rick", "Cindy", "Bob"};
```

- Consider a scenario where, after a week, two students (Mike and Larry) enroll in the course and Sue drops out
- How easy do you think it is to modify the students array to accommodate these changes?

Limitations of Arrays

- Their size is fixed on creation and cannot grow or shrink after initialization
- You have to create manual methods to manipulate their contents
- For example: insert or delete an item from an array

ArrayList Class

- Arrays aren’t the only way to store lists of related data
- Java provides a special utility class called `ArrayList`
- The `ArrayList` class:
  - Is a part of the Java library, like the String and Math classes.
  - It can be used to store a list of objects
  - Has a set of useful methods for managing its elements:
    - add(), get(), remove(), indexOf(), and many others

What Can an ArrayList Contain?

- An ArrayList can contain only objects, not primitives
  - It may contain any object type, including a type that you created by writing a class
- For example, an ArrayList can hold objects of type:
  - String
  - Person
  - Car

Importing and Declaring an ArrayList

- You must import `java.util.ArrayList` to use an `ArrayList`

```
import java.util.ArrayList;

public class ArrayListExample {
   public static void main (String[] args) {
      ArrayList<String> states = new  ArrayList<>();

    }//end method main
}//end class ArrayListExample
```

You can specify an initial capacity, but it isn't mandatory

You may specify any object type, called as Type Parameters, specifies that it contains only String objects

Working with an ArrayList

- You don’t access elements in an ArrayList by using index notation
- Instead, you use a series of methods that are available in the ArrayList class

Some ArrayList Methods

add(value)	Appends the value to the end of the list
add(index, value)	Inserts the given value just before the given index, shifting subsequent values to the right
clear()	Removes all elements of the list
indexOf(value)	Returns the first index where the given value is found in the list (-1 if not found)
get(index)	Returns the value at the given index
remove(index)	Removes the value at the given index, shifting subsequent values to the left
set(index, value)	Replaces the value at the given index with a given value
size()	Returns the number of elements in the list
toString()	Returns a string representation of the list, such as "[3, 42, -7, 15]"

Working with an ArrayList

- Here's an example that uses these methods:

```
ArrayList<String> names;                    Declare an ArrayList of Strings
names = new ArrayList();                    Instantiate the ArrayList

names.add("Jamie");
names.add("Gustav");                        Add items
names.add("Alisa");
names.add("Jose");
names.add(2,"Prashant");

String str=names.get(0);                    Retrieve a value
System.out.println(str);
names.remove(0);
names.remove(names.size() - 1);             Remove items
names.remove("Gustav");

System.out.println(names);                  View an item
```

Benefits of the ArrayList Class

- Dynamic resizing:
  - An ArrayList grows as you add elements
  - An ArrayList shrinks as you remove elements
- Several built-in methods:
  - An ArrayList has several methods to perform operations
  - For example, to add, retrieve, or remove an element

Exercise 1, Part 1

- Create a new project and add the `ArrayListEx1.java` file to the project
- Examine `ArrayListEx1.java`
- Modify the program to implement:
  - Create an ArrayList of Strings called students
  - Add four students to the ArrayList: Amy, Bob,Cindy and David
  - Print the elements in the ArrayList and display its size

Exercise 1, Part 2

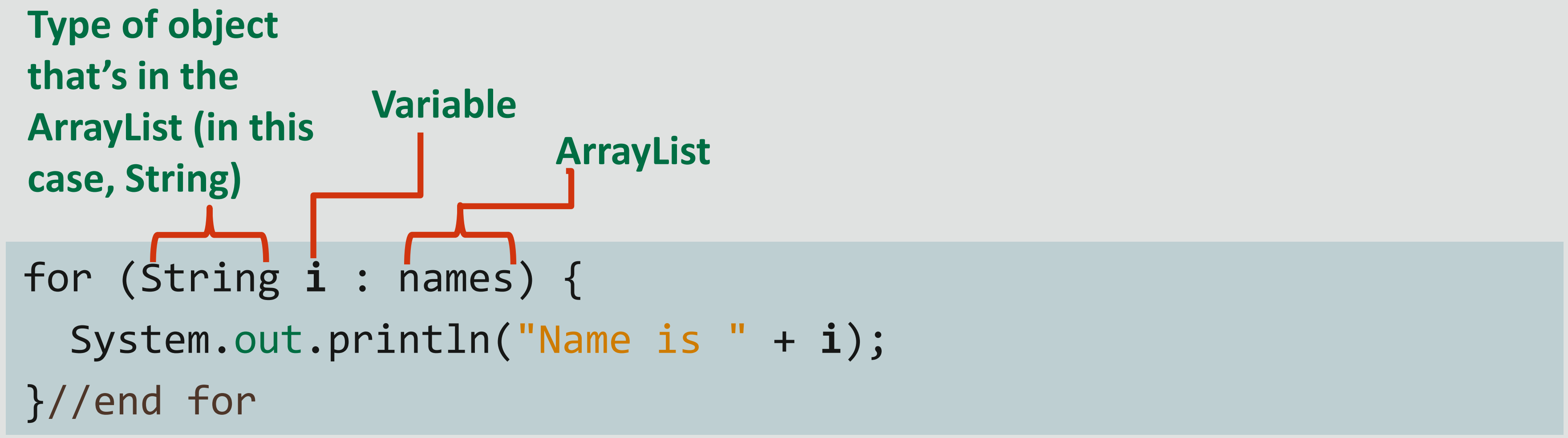
- Modify the program to implement:
  - Add two more students, Nick and Mike, at index 0 and 1
  - Remove the student at index 3
  - Print the elements in the ArrayList and display its size

Traversing an ArrayList

- You can traverse an ArrayList in the following ways:
  - Using the for-each loop
  - Using an Iterator
  - Using a ListIterator

Traversing an ArrayList: for-each Loop

- In the previous lesson, you used a for-each loop to traverse an array
- You can use a for-each loop to traverse an ArrayList
- The variable i represents a particular name as you loop through the names ArrayList



Type of object that's in the ArrayList (in this case, String)
Variable
ArrayList

```
for (String i : names) {
  System.out.println("Name is " + i);
}//end for
```

Traversing an ArrayList: for-each Loop

```
public class ArrayListTraversal {
   public static void main(String[] args) {
      ArrayList<String> names = new ArrayList<>();
      names.add("Tom");
      names.add("Mike");
      names.add("Matt");
      names.add("Nick");
      System.out.println("");
      for (String i : names) {
         System.out.println("Name is " + i);
      }//end for
   }//end method main
}//end class ArrayListTraversal
```

```
Output:
 Name is Tom
 Name is Mike
 Name is Matt
 Name is Nick
```

Introducing Iterator

- Is a member of the collections framework
- Enables traversing through all elements in the ArrayList, obtaining or removing elements
- Has the following methods:
  - `hasNext(),next(),remove()`
- Is only used to traverse forward
- You must import `java.util.Iterator` to use an Iterator

Traversing an ArrayList: Iterator

- Here’s an example of traversing the names collection by using an iterator

Returns an iterator object

ArrayList

```
Iterator<String> iterator = names.iterator();
while (iterator.hasNext())
{
          System.out.println("Name is " + iterator.next());

}//end while
```

Attaching a collection to an iterator

Introducing ListIterator

- ListIterator
  - Is a member of the collections framework
  - Allows you to traverse the ArrayList in both directions
  - Doesn’t contain the remove method
- You must import `java.util.ListIterator` to use an ListIterator

Traversing an ArrayList: ListIterator

- Here’s an example of using ListIterator to traverse the names ArrayList in forward and backward directions:

```
ListIterator<String> litr = names.listIterator();

System.out.println("Traversing list forwards: ");
while (litr.hasNext()) {
    System.out.println("Name is " + litr.next());
}//end while

System.out.println("Traversing list backwards: ");
while (litr.hasPrevious()) {
    System.out.println("Name is " + litr.previous());
}//end while
```

ArrayList and Primitives

- An ArrayList can store only objects, not primitives

```
✘ ArrayList<int> list = new ArrayList<int>();
```

int can't be a type parameter

- But you can still use ArrayList with primitive types by using special classes called wrapper classes

```
ArrayList<Integer> list = new ArrayList<Integer>();
```

Wrapper class for int

Wrapper Classes

- Java provides classes, known as wrapper classes, that correspond to the primitive types
- These classes encapsulate, or wrap, the primitive types within an object
- The eight wrapper class types correspond to each primitive data type

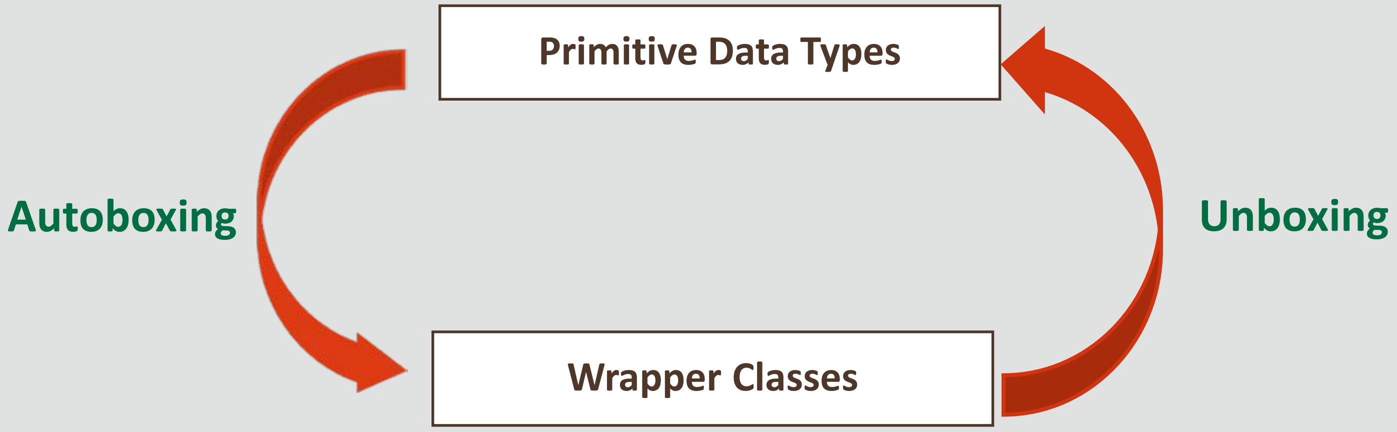
List of Wrapper Classes

- Here's the list of primitive data types and their corresponding wrapper classes:

Primitive Type	Wrapper Type
byte	Byte
Short	Short
int	Integer
long	Long
float	Float
double	Double
char	Character
boolean	Boolean

Introducing AutoBoxing and Unboxing

- Java has a feature called Autoboxing and Unboxing
- This feature performs automatic conversion of primitive data types to their wrapper classes and vice versa
- It enables you to write leaner and cleaner code, making it easier to read



What Is Autoboxing?

- The automatic conversion that the Java compiler makes between the primitive types and their corresponding object wrapper classes

```
Double score = 18.58;
```

Autoboxing of primitive double value

What Is Unboxing?

- Converting an object of a wrapper type to its corresponding primitive value

```
Double score = 18.58;
double goal = score;
```

Unboxing of Double object, Score, to primitive double value score

ArrayList and Wrapper Classes

- Wrapper classes allow an ArrayList to store primitive values

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

   ArrayList<Integer> nums = new ArrayList<>();
   for (int i = 1; i < 50; i++) {
      nums.add(i);
   }//end for

   for(Integer i:nums ){
      int nos = i;
      System.out.println(nos);
   }//end for
}//end method main
```

AutoBoxing

UnBoxing

Exercise 2

- Add the file `ArrayListEx2.java` to the project you created for exercise 1
- Examine `ArrayListEx2.java`
- Perform the following:
  - Create an ArrayList with a list of numbers
  - Display the contents of the ArrayList by using Iterator
  - Remove all even numbers
  - Display the contents of the ArrayList

Summary

- In this lesson, you should have learned how to:
  - Create an ArrayList
  - Manipulate an ArrayList by using its methods
  - Traverse an ArrayList by using iterators and for-each loops
  - Use wrapper classes and Autoboxing to add primitive data types to an ArrayList

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