ArrayList and Lists

What is a list?

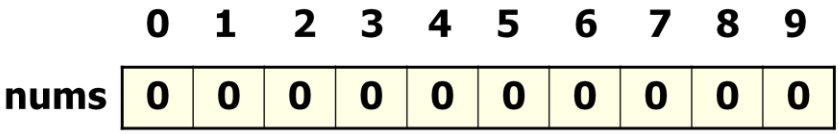
	Name	Time	Artist	Album
5	I Dare You to Move	4:08	Switchfoot	Learning to Breathe
6	I've Been Everywhere	3:20	Johnny Cash	Unchained
7	Brown Eyed Girl (Single Version)	3:05	Van Morrison	Super Hits
8	Born to Be Wild	3:31	Steppenwolf	Steppenwolf: All Time Greatest
9	Magic Carpet Ride	4:28	Steppenwolf	Steppenwolf: All Time Greatest
10	Crazy (Single Version)	2:42	Patsy Cline	Patsy Cline's Greatest Hits (Rer
11	Brick House	3:46	The Commodores	20th Century Masters - The Mill
12	Cleveland Rocks	2:33	The Presidents of the...	Pure Frosting
13	Chariots of Fire: Main Title Theme	3:32	Carl Davis & Royal Li...	Great Movie Themes
14	Dueling Banjos (From "Deliverance")	3:11	The Hit Crew	Smash Hit Dramas Movie Theme
15	Main Theme (From "Superman")	4:12	John Williams	The Music of John Williams - 40
16	Main Theme (From "Superman")	4:12	John Williams	The Music of John Williams - 40
17	I've Been Everywhere	3:20	Johnny Cash	Unchained
18	Born to Be Wild	3:31	Steppenwolf	Steppenwolf: All Time Greatest

What is an ArrayList?

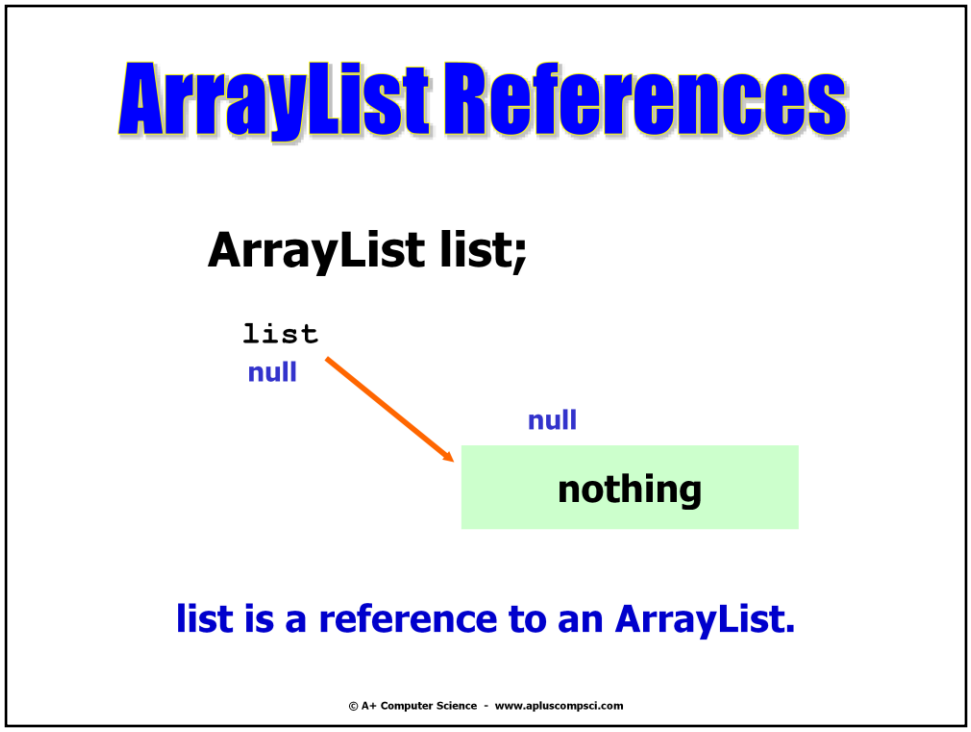
ArrayList can store a reference to any type of Object.
ArrayList was built using an array[] of object references.

What is an array?

```
int[] nums = new int[10];        //Java int array
```



An array is a group of items all of the same type which are accessed through a single identifier.



A reference variable is used to store the location of an Object. In most situations, a reference stores the actual memory address of an Object.

`list` stores the location / memory address of an ArrayList.

ArrayList Instantiation

new ArrayList();

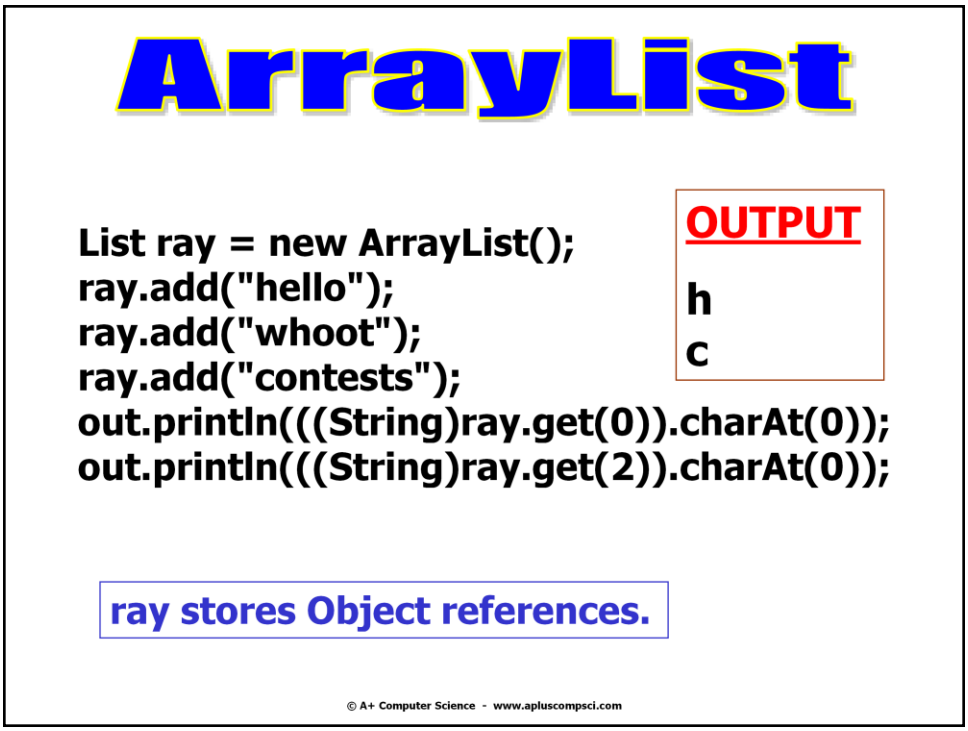
0x213

[]

ArrayLists are Objects.

A reference variable is used to store the location of an Object. In most situations, a reference stores the actual memory address of an Object.

`list` stores the location / memory address of an ArrayList.



In the example above, ray is an ArrayList that stores Object references. In order to call non-Object methods on a spot in ray, casting would be required.

```
ray.add(0,"hello");
out.println(((String)ray.get(0)).charAt(0));
```

Open objects.java

Generic ArrayLists

ArrayList

With Java 5, you can now specify which type of reference you want to store in the ArrayList.

```
ArrayList<String> words;
words = new ArrayList<String>();

List<Double> decNums;
decnums = new ArrayList<Double>();
```


In the example above, words can only store String references. decNums can only store Double references.

Java knows the exact type of reference in both ArrayLists; thus, there is no need for casting when accessing class specific methods.

```
words.add("Hello");
out.println(words.get(0).charAt(0));
```

ArrayList

With Java 5, you can now specify which type of reference you want to store in the ArrayList.

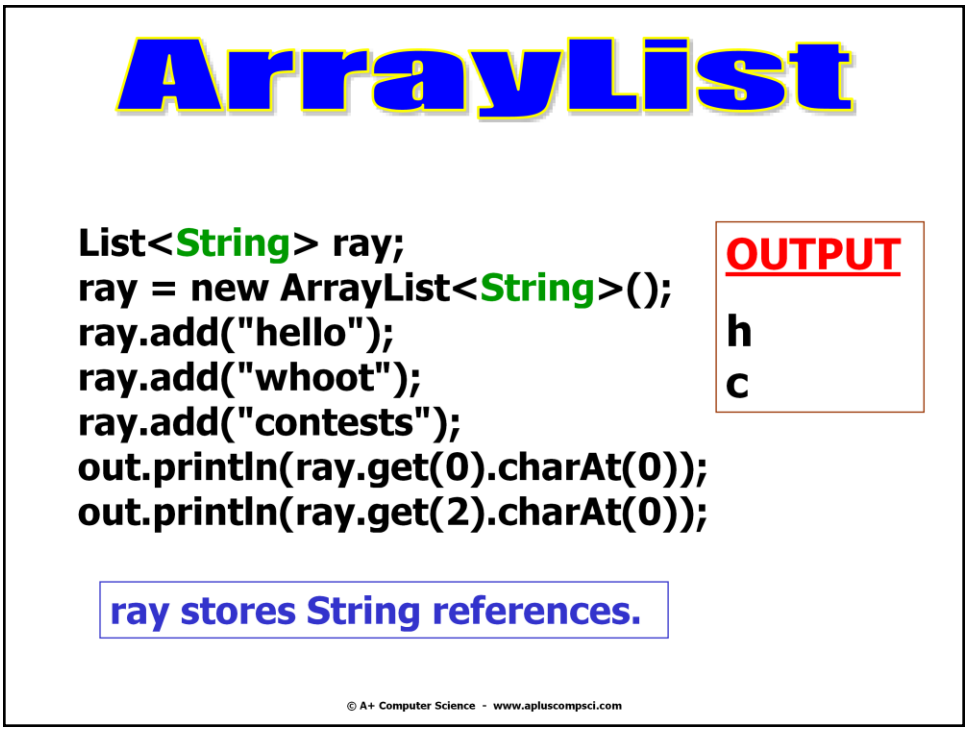
```
ArrayList<Long> bigStuff;
bigStuff = new ArrayList<Long>();

List<It> itList;
itList = new ArrayList<It>();
```


In the example above, words can only store String references. decNums can only store Double references.

Java knows the exact type of reference in both ArrayLists; thus, there is no need for casting when accessing class specific methods.

```
itList.add(new It(34.21));
out.println(itList.get(0).getIt());
```



In the example above, ray is an ArrayList that stores String references. Casting would not be required to call non-Object methods on ray.

```
ray.add(0,"hello");
ray.add(1,"chicken");

out.println(ray.get(0).charAt(0));
out.println(ray.get(1).charAt(5));
```

Open generics.java

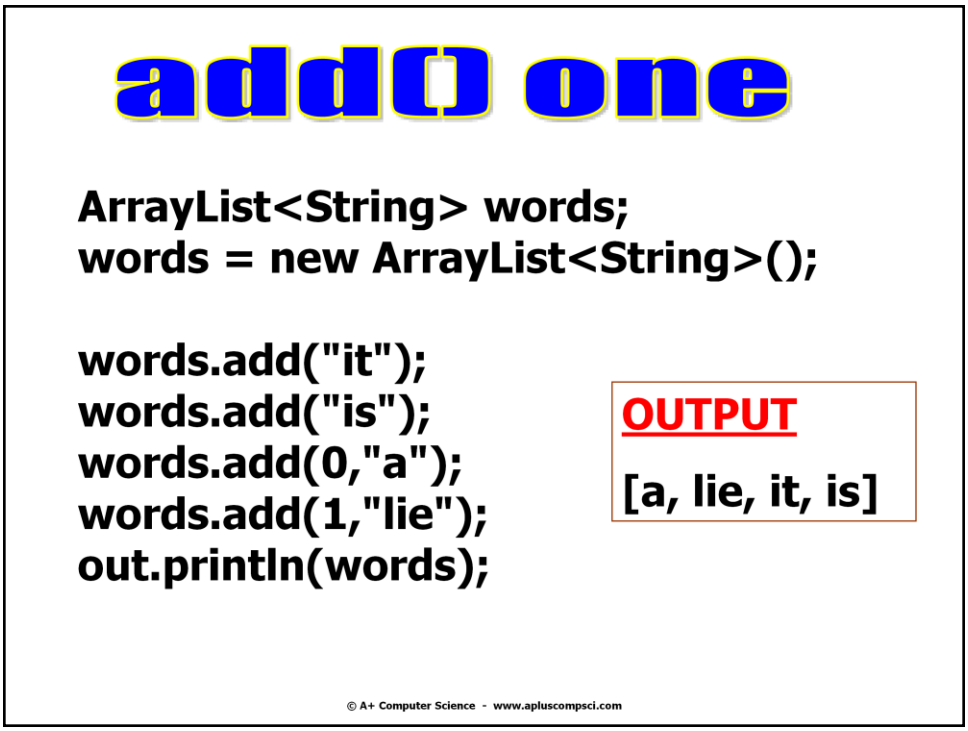
ArrayList Methods

ArrayList

frequently used methods

Name	Use
add(item)	adds item to the end of the list
add(spot,item)	adds item at spot – shifts items up->
set(spot,item)	put item at spot z[spot]=item
get(spot)	returns the item at spot return z[spot]
size()	returns the # of items in the list
remove()	removes an item from the list
clear()	removes all items from the list

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



The `add(item)` method adds the new item to the end of the ArrayList.

The `add(spot, item)` method adds the new item at the spot specified.
All other existing items are shifted toward the end of the ArrayList.
The add method does not override existing values.

add() two

```
List<Integer> nums;
nums = new ArrayList<Integer>();

nums.add(34);
nums.add(0,99);
nums.add(21);
nums.add(0,11);
out.println(nums);
```

OUTPUT

```
[11, 99, 34, 21]
```


The `add(item)` method adds the new item to the end of the ArrayList.

The `add(spot, item)` method adds the new item at the spot specified.
All other existing items are shifted toward the end of the ArrayList.
The add method does not override existing values.

Open addone.java addtwo.java

set()

```
ArrayList<Integer> ray;
ray = new ArrayList<Integer>();
ray.add(23);
ray.add(11);
ray.set(0,66);
ray.add(53);
ray.set(1,93);
ray.add(22);
out.println(ray);
```

OUTPUT

[66, 93, 53, 22]

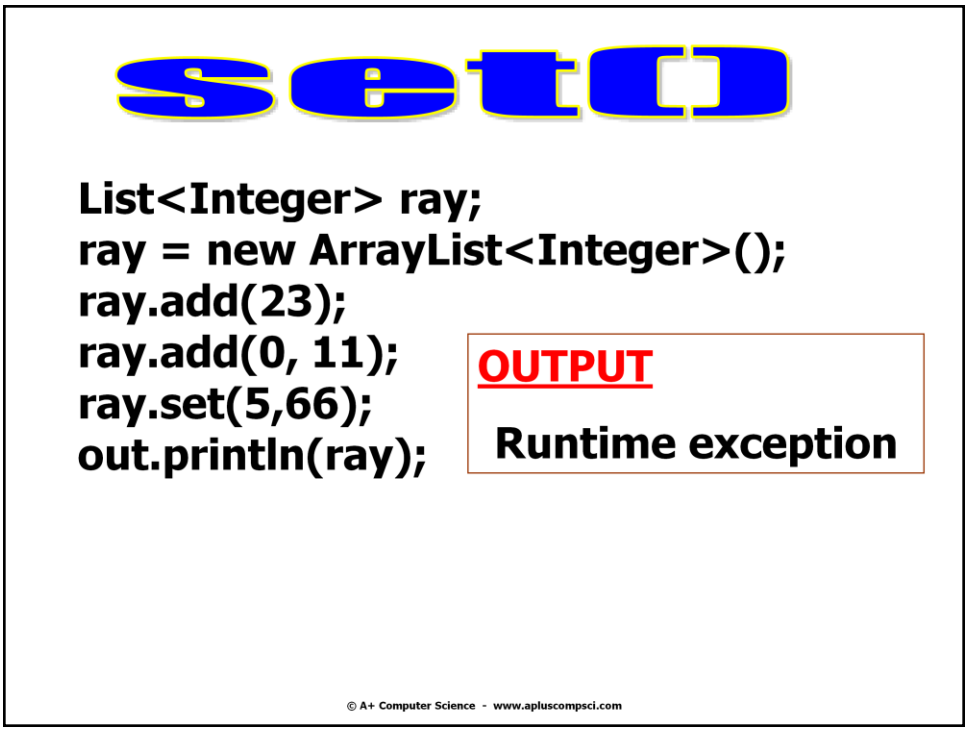
The `add(item)` method adds the new item to the end of the ArrayList.

The `set(spot, item)` method replaces the reference at spot with the new item.

The location / address of item is placed in spot.

You cannot set a location to a value if the location does not already exist.

This will result in an index out of bounds exception.



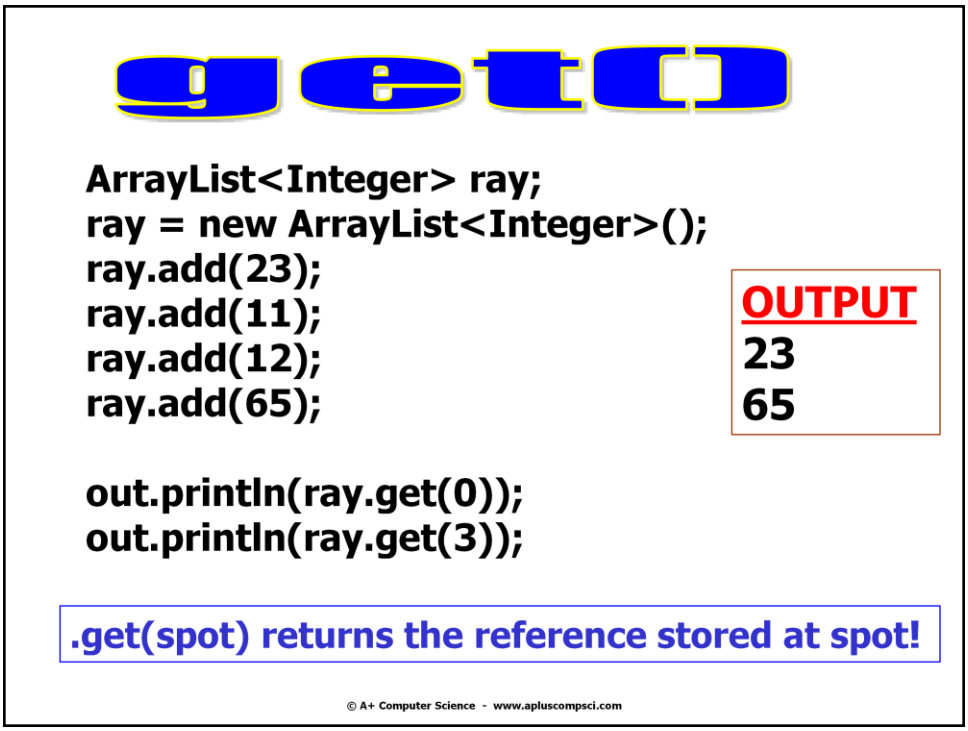
The `add(item)` method adds the new item to the end of the ArrayList.

The `set(spot, item)` method replaces the reference at spot with the new item.

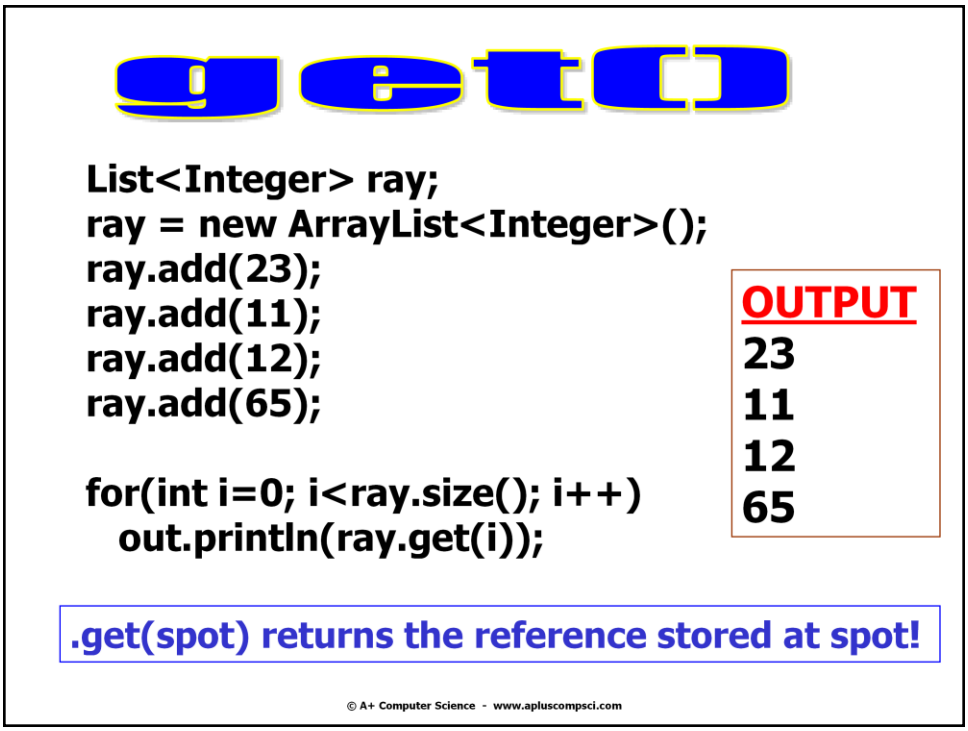
The location / address of item is placed in spot.

You cannot set a location to a value if the location does not already exist.

This will result in an index out of bounds exception.



The get(spot) method returns the reference stored at spot.



The get(spot) method returns the reference stored at spot.


Open
set.java
get.java
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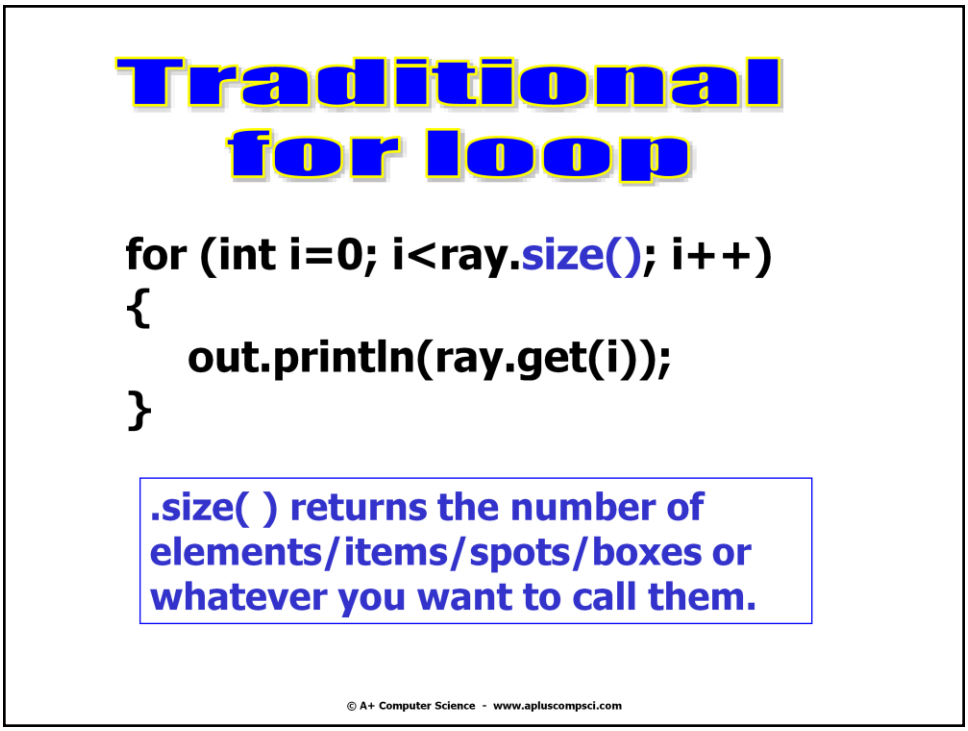
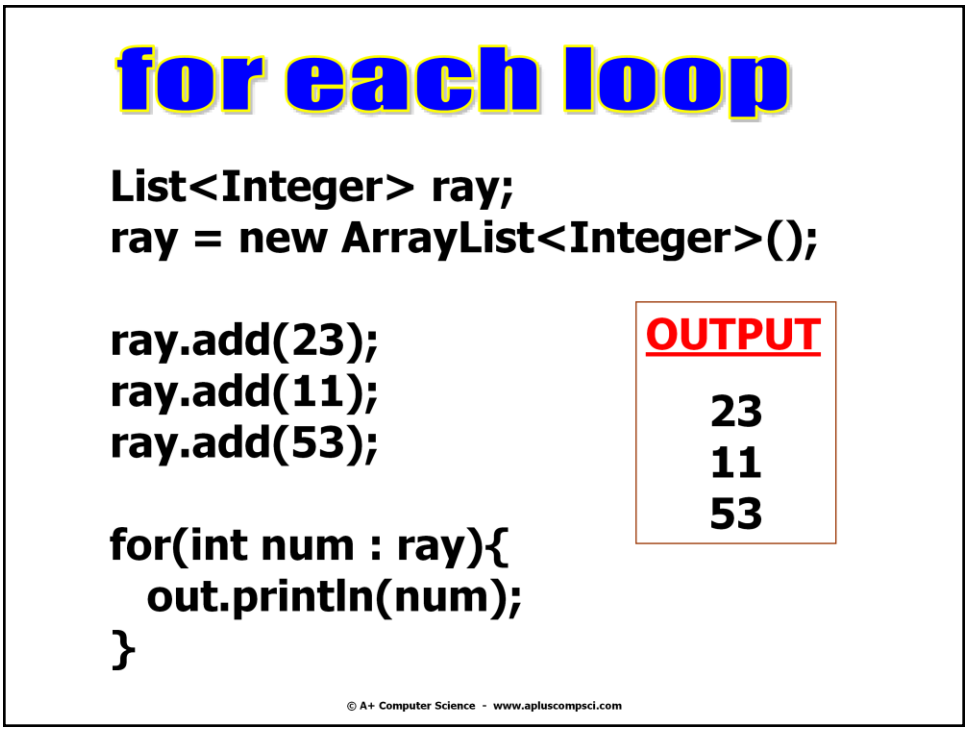
Processing a list using loops



The `size()` method returns the number of items in the ArrayList. If the ArrayList is storing seven references, `size()` would return a 7.



The new for loop is great to print out Arrays and Collections. The new for loop extracts an item from ray each time it iterates. The new for loop is an iterator based loop. Once the loop reaches the end of ray, it stops iterating.

Open foreachloopone.java

remove methods

remove() one

```
ArrayList<String> ray;
ray = new ArrayList<String>();

ray.add("a");
ray.add("b");
ray.remove(0);
ray.add("c");
ray.add("d");
ray.remove(0);
out.println(ray);
```

OUTPUT

[c, d]

The remove method will remove the item at the specified spot / location or the specified value. When an item is removed, all items above the removed item are shifted down toward the front of the ArrayList. All items are shifted to the left.

`[a, b]` becomes `[b]`

`[b, c, d]` becomes `[c, d]`

remove() two

```
List<String> ray;
ray = new ArrayList<String>();

ray.add("a");
ray.add("b");
ray.remove("a");
ray.add("c");
ray.add("d");
ray.remove("d");
out.println(ray);
```

OUTPUT

[b, c]

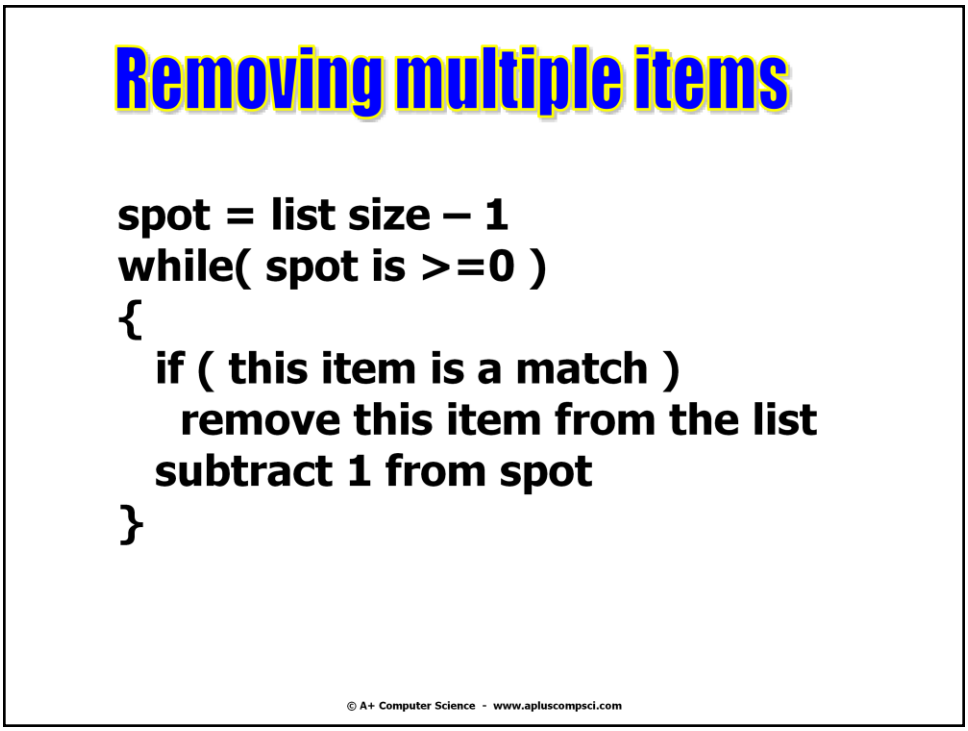
The remove method will remove the item at the specified spot / location or the specified value. When an item is removed, all items above the removed item are shifted down toward the front of the ArrayList. All items are shifted to the left.

`[a, b]` becomes `[b]`

`[b, c, d]` becomes `[b, c]`

Open removeone.java removetwo.java

Removing Multiple Items



In order to remove multiple values from an ArrayList, a loop must be used.
The loop will need an if statement to identify the items to remove.
Keep in mind that the ArrayList shrinks when items are removed.
The items in the ArrayList shift down towards spot 0.
The loop must start at size()-1 and go down in order to account for the shift.

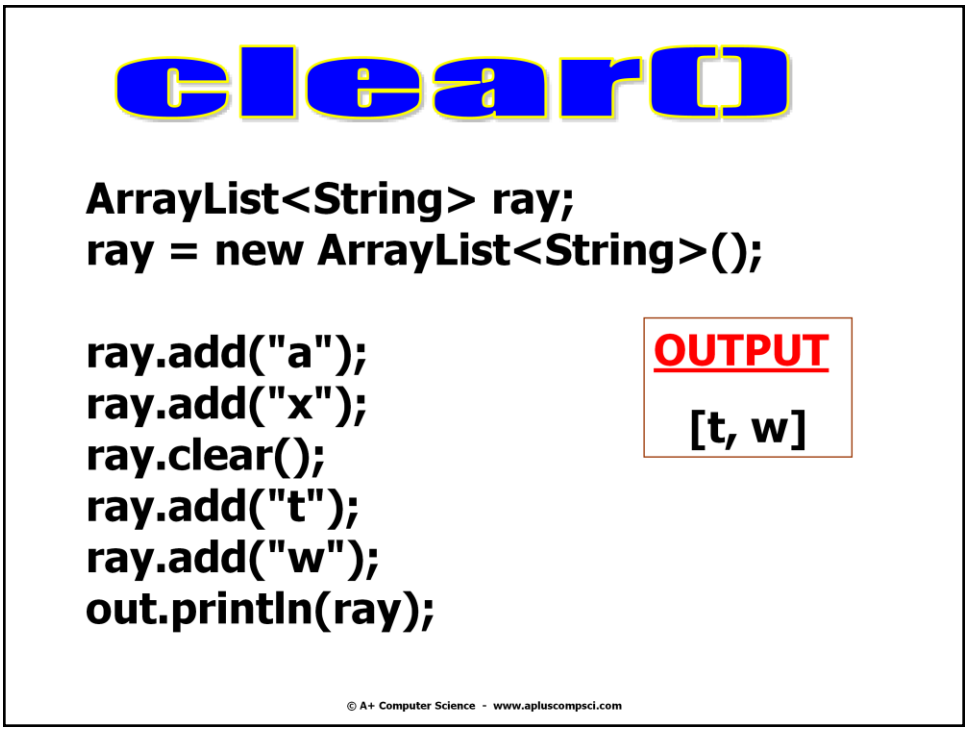
Removing multiple items

```
spot = list.size() – 1
while( spot >= 0 )
{
  if ( list.get(spot).equals( value ) )
    list.remove( spot );
  spot = spot - 1
}
```


In order to remove multiple values from an ArrayList, a loop must be used.
The loop will need an if statement to identify the items to remove.
Keep in mind that the ArrayList shrinks when items are removed.
The items in the ArrayList shift down towards spot 0.
The loop must start at size()-1 and go down in order to account for the shift.

Open removeall.java

Complete the code



The `clear()` method removes all items from the ArrayList.

The ArrayList becomes an `[]` empty ArrayList with a size() of 0.

The clear() method essentially performs the same operation as instantiating a new ArrayList.


Open
clear.java
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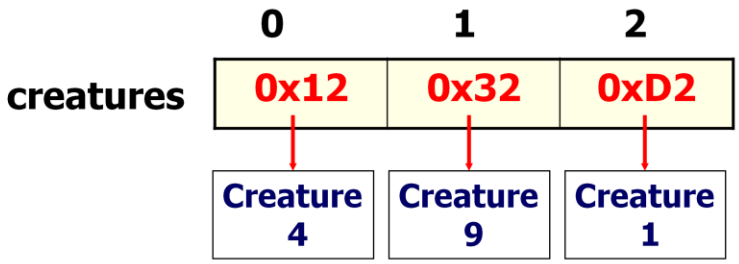
ArrayList with User-defined classes

ArrayList w/User Classes

```
public class Creature implements Comparable {
  private int size;

   //checks to see if this Creature is big – size > x
  public boolean isBig()
        //implementation details not show

  public boolean equals(Object obj)
        //implementation details not show

   public int compareTo(Object obj)
        //implementation details not show

   //other methods and constructors not shown
}
```

ArrayList w/User Classes

```
ArrayList<Creature> creatures;
creatures  = new ArrayList<Creature>();
creatures.add(new Creature(4));
creatures.add(new Creature(9));
creatures.add(new Creature(1));
```



ArrayList w/User Classes

```
ArrayList<Creature> creatures;
creatures  = new ArrayList<Creature>();
creatures.add( new Creature(41) );
creatures.add( new Creature(91) );
creatures.add( new Creature(11) );

out.println( creatures.get(0) );

creatures.get(0).setSize(79);
out.println( creatures.get(0) );

out.println( creatures.get(2) );
out.println( creatures.get(1).isBig() );
```

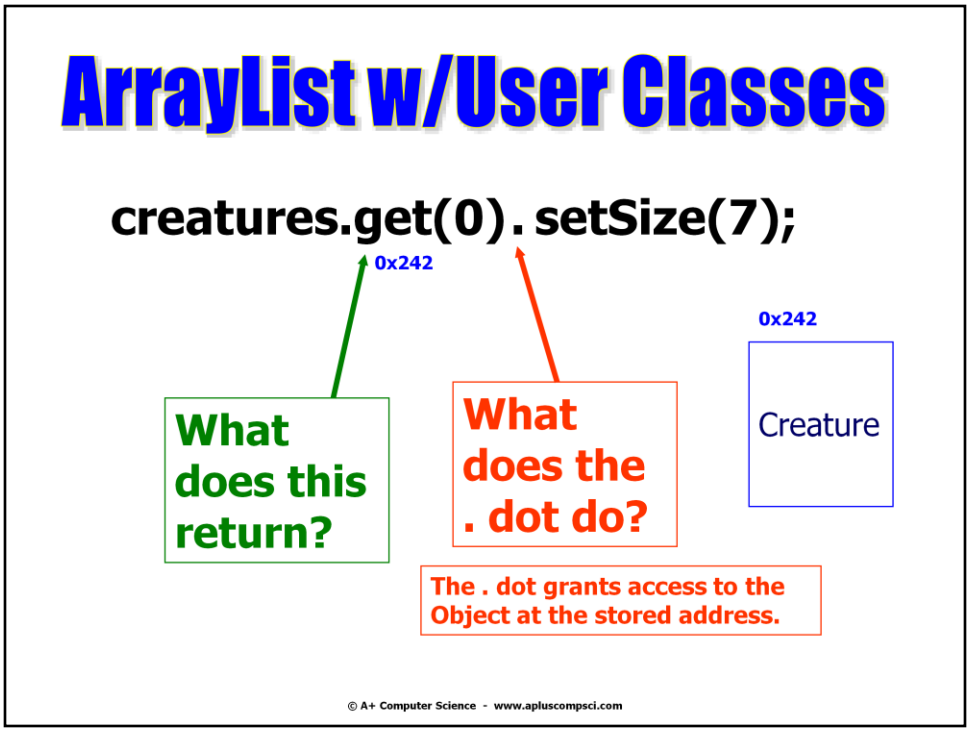
OUTPUT

```
41
79
11
true
```


Creatures is an ArrayList that stores reference to Creature objects.

In this example, creatures stores the addresses / locations of 3 Creature objects.

`creatures.get(1).isBig()` accesses the reference at spot 1 and calls the isBig() method on the creature to which the ArrayList is referring.



Creatures.get(0) returns the address / location of a Creature object. Applying a . dot to a reference grants you access to the object referred to by the reference. .setSize() is a Creature method that changes the size property of the Creature.

ArrayList w/User Classes

```
/* method countBigOnes should return the count of
   big creatures - use the isBig() Creature method
*/
public int countBigOnes()
{
  int cnt = 0;

  //for each loop
     //if statement
          //increase cnt by 1

  return cnt;
}
```


The countBigOnes method will go through all of the Creature objects to find out how many of them are big.
The for each loop is not required, but it sure makes writing this type of method much easier.

This is a classic example of a linear search.
The AP Free Response questions always ask students to write this style of code every single year.

Open userclassesone.java

Open
creature.java
herd.java
herdrunner.java

Complete the code

Start work on Lab 16

AutoBoxing
AutoUnboxing

Box/Unbox

primitive	object
byte	Byte
short	Short
int	Integer
long	Long
float	Float
double	Double
char	Character
boolean	Boolean
==	.equals()

For each of the primitive types, there is a corresponding wrapper class.

`int` has a corresponding wrapper class named `Integer`.

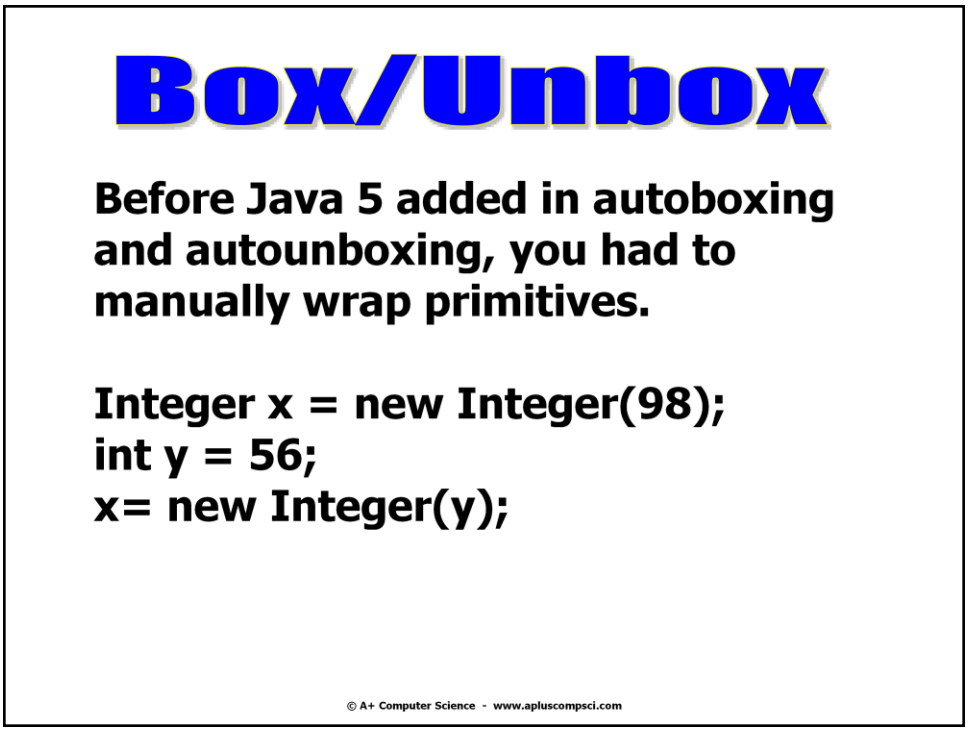
`int` stores a non-decimal value.

`Integer` stores the location / memory address of an `Integer` Object which stores an `int` value.

`double` has a corresponding wrapper class named `Double`.

`double` stores decimal and non-decimal values.

`Double` stores the location / memory address of a `Double` Object which stores a `double` value.



Before autoboxing and autounboxing, a reference could only refer to a primitive if a Wrapper class was instantiated and the primitive passed to the constructor.

Box/Unbox

Java now wraps automatically.

```
Integer numOne = 99;
Integer numTwo = new Integer(99);
```

```
=99;
=new Integer(99);
```

These two lines are equivalent.

`Integer numOne = 99;` is equivalent to

`Integer numOne = new Integer(99);`

With the introduction of Java 5, the `new Integer()` Object instantiation code happens in the background. Java takes care of these details, but does not show the work.

Box/Unbox

Java now wraps automatically.

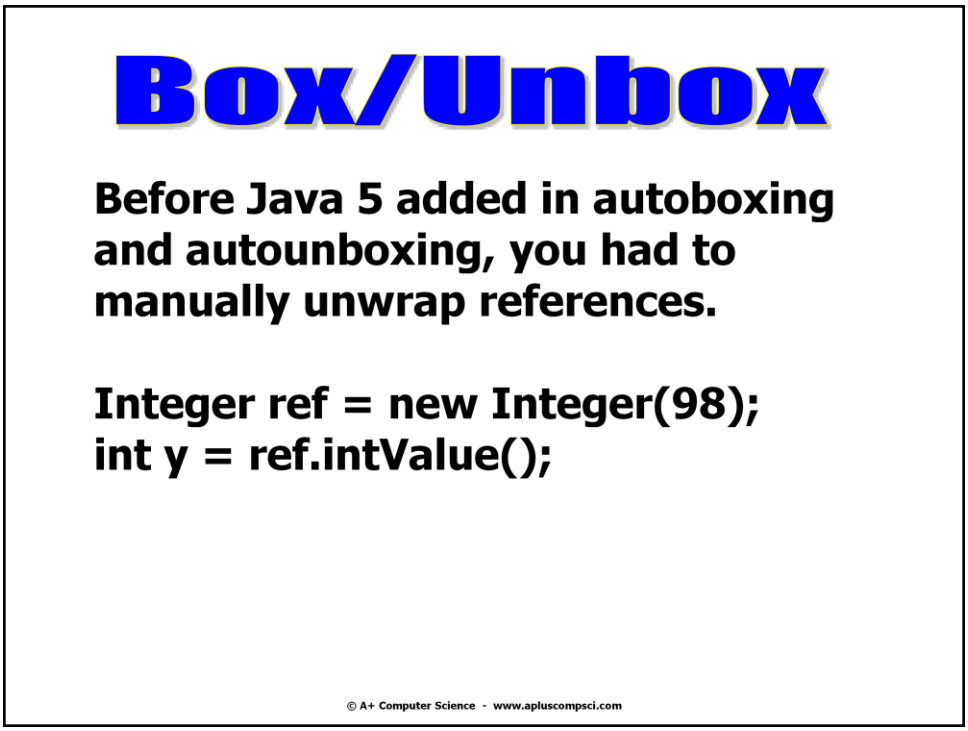
```
Double numOne = 99.1;
Double numTwo = new Double(99.1);
```

=99.1;
=new Double(99.1);
These two lines are equivalent.

`Double numOne = 99;` is equivalent to

`Double numOne = new Double(99);`

With the introduction of Java 5, the `new Double()` Object instantiation code happens in the background. Java takes care of these details, but does not show the work.



Before autoboxing and autounboxing, a reference value could only be stored in a primitive if the corresponding reference get method was called to retrieve the primitive value from the reference.

Box/Unbox

Java now unwraps automatically.

```
Integer num = new Integer(3);
int prim = num.intValue();
out.println(prim);
prim = num;
out.println(prim);
```

OUTPUT

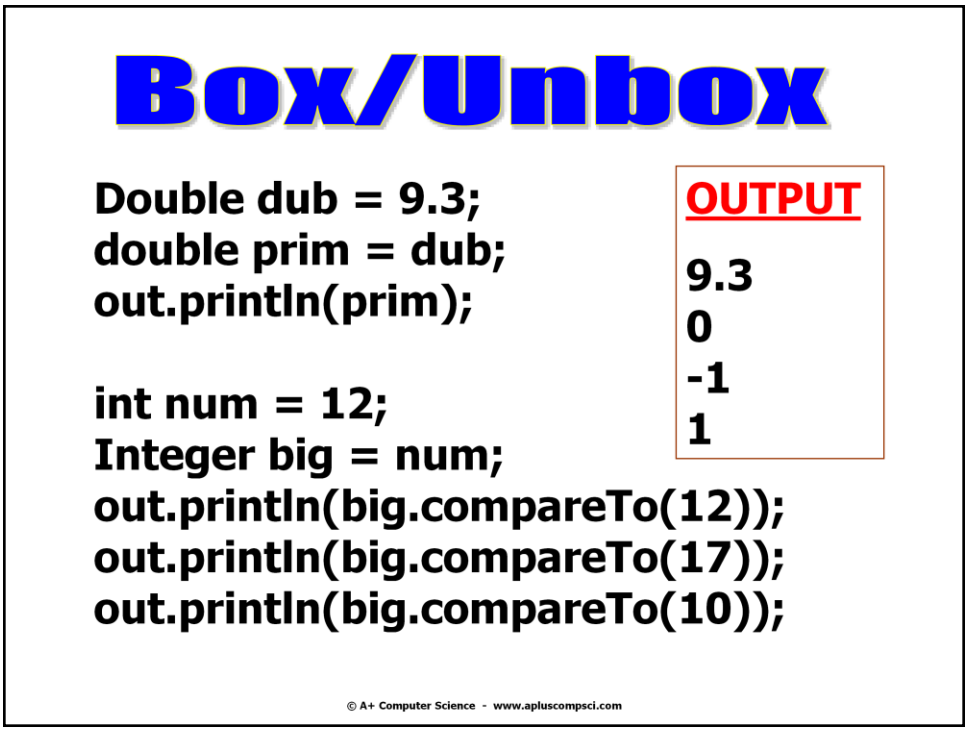
```
3
3
```

```
prim=num.intValue();
prim=num;
```

These two lines are equivalent.


```
Integer numOne = new Integer(99);
int primInt = numOne;
```
is equivalent to
```
int primInt = numOne.intValue();
```

With the introduction of Java 5, the `intValue()` method call happens in the background. Java takes care of these details, but does not show the work.



Before autoboxing and autounboxing, a reference could only refer to a primitive if a Wrapper class was instantiated and the primitive passed to the constructor.

Before autoboxing and autounboxing, a reference value could only be stored in a primitive if the corresponding reference get method was called to retrieve the primitive value from the reference.

With the introduction of Java 5, the wrapping and unwrapping / boxing and unboxing happens in the background. Java takes care of these details, but does not show the work.

Open autoboxunbox.java

new for loop

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

//add some values to ray

int total = 0;
for(Integer num : ray)
{
  //this line shows the AP preferred way
  //it shows the manual retrieval of the primitive
  total = total + num.intValue();

  //the line below accomplishes the same as the line above
  //but, it uses autounboxing to get the primtive value
  //total = total + num;
}
out.println(total);
```

OUTPUT
153

The new for loop is great to print out Arrays and Collections. The new for loop extracts an item from ray each time it iterates. The new for loop is an iterator based loop. Once the loop reaches the end of ray, it stops iterating.

Open foreachloopone.java foreachlooptwo.java

Collections class

Collections

frequently used methods

Name	Use
sort(x)	puts all items in x in ascending order
binarySearch(x,y)	checks x for the location of y
fill(x,y)	fills all spots in x with value y
rotate(x,y)	shifts items in x left or right y locations
reverse(x)	reverses the order of the items in x

```
import  java.util.Collections;
```

Collections

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

ray.add(23);
ray.add(11);
ray.add(66);
ray.add(53);
Collections.sort(ray);
out.println(ray);
out.println(Collections.binarySearch(ray,677));
out.println(Collections.binarySearch(ray,66));
```

OUTPUT

```
[11, 23, 53, 66]
-5
3
```


Collections.sort() will put all items in natural ascending order.

Collectoins.binarySearch() will locate an item. If the item does not exist, binarySearch() will return -1+ -(where the value would be if it was there).

-3 is -1 + -2(2 is the spot where the item would be)

Collections

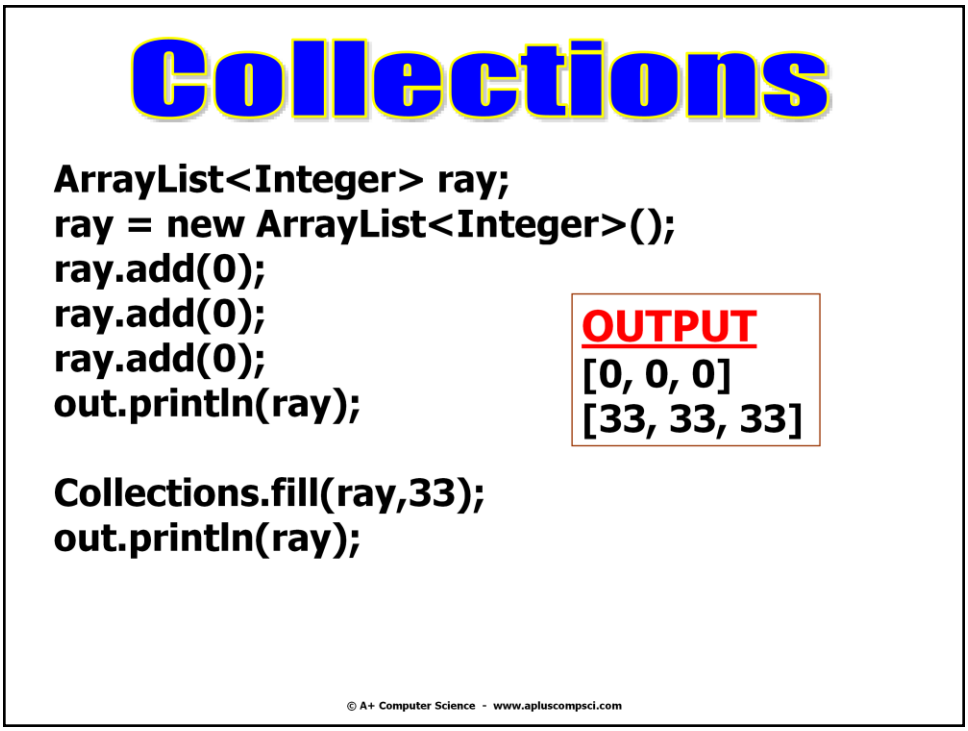
```
ArrayList<Integer> ray;
ray = ArrayList<Integer>();

ray.add(23);
ray.add(11);
ray.add(53);
out.println(ray);
rotate(ray,2);
out.println(ray);
rotate(ray,2);
reverse(ray);
out.println(ray);
```

OUTPUT

```
[23, 11, 53]
[11, 53, 23]
[11, 23, 53]
```


Collections.rotate() rotates items to the right or to the left a specified number of spots / positions. A negative number rotates to the left and a positive number rotates to the right.

Collections. reverse() reverses the order of all items.



Collections.fill() will fill in all spots with a specified value.

Open binarysearch.java rotate.java fill.java

search methods

ArrayList
frequently used methods

Name	Use
contains(x)	checks if the list contains x
indexOf(x)	checks the list for the location of x

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

ray.add(23);
ray.add(11);
ray.add(66);
ray.add(53);

out.println(ray);
out.println(ray.indexOf(21));
out.println(ray.indexOf(66));

out.println(ray);
out.println(ray.contains(21));
out.println(ray.contains(66));
```


OUTPUT

```
[23, 11, 66, 53]
-1
2
[23, 11, 66, 53]
false
true
```


Open
search.java
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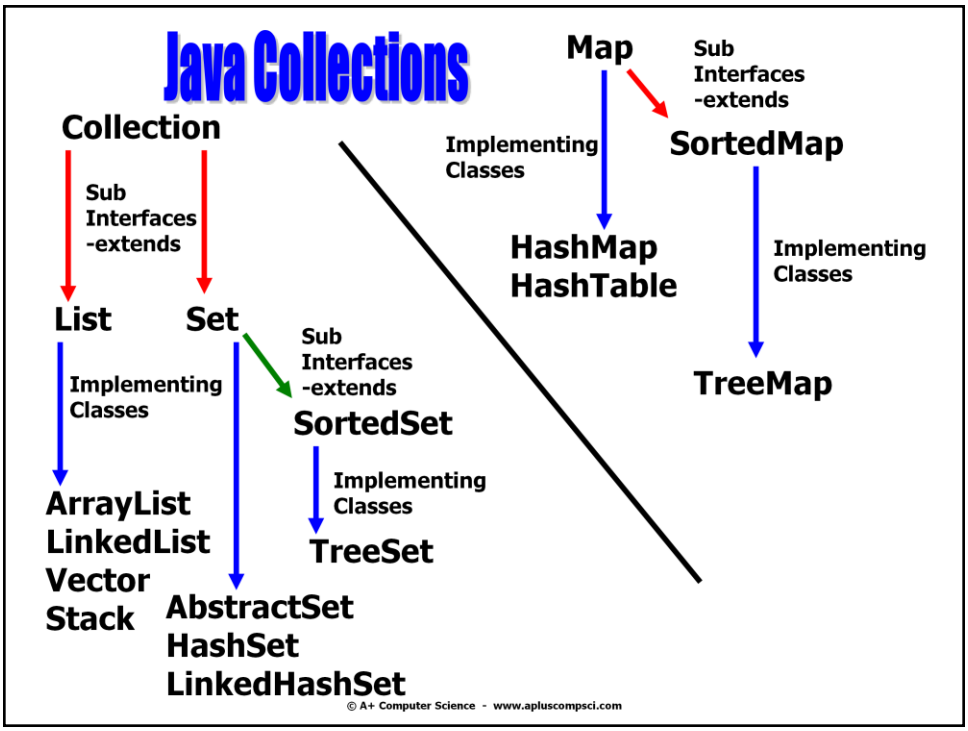
Open arraylistuserclassestwo.java

Java Collections

Java Interfaces

The following are important interfaces included in the Java language ::

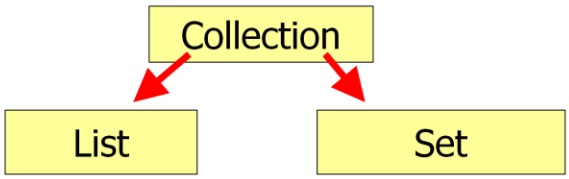
Collection
List



This Collections hierarchy chart is very important. It is a must to know which classes implement which interfaces and which interfaces extend which interfaces.

The Collection Interface

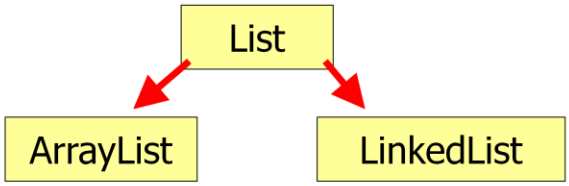
The Collection interface is the parent of List and Set. The Collection interface has many methods listed including add(), clear(), remove(), and size().



others not shown

The List Interface

The List interface extends the Collection interface. The List interface adds in the get() method as well as several others.



others not shown

In the example above, ray is an ArrayList that stores Object references. In order to call non-Object methods on a spot in ray, casting would be required.

```
ray.add(0,"hello");
out.println(((String)ray.get(0)).charAt(0));
```

Continue work on Lab 16