Arrays and ArrayLists

CSE 413, Autumn 2002

Programming Languages

http://www.cs.washington.edu/education/courses/413/02au/

Readings and References

- Reading
  - » Chapter 3, Section Arrays, *Core Java Volume 1*
  - » Chapter 5, Section Object, Subsection Array Lists , *Core Java Volume 1*
- Other References
  - » "Arrays", Java tutorial
  - » http://java.sun.com/docs/books/tutorial/java/data/arrays.html

Arrays

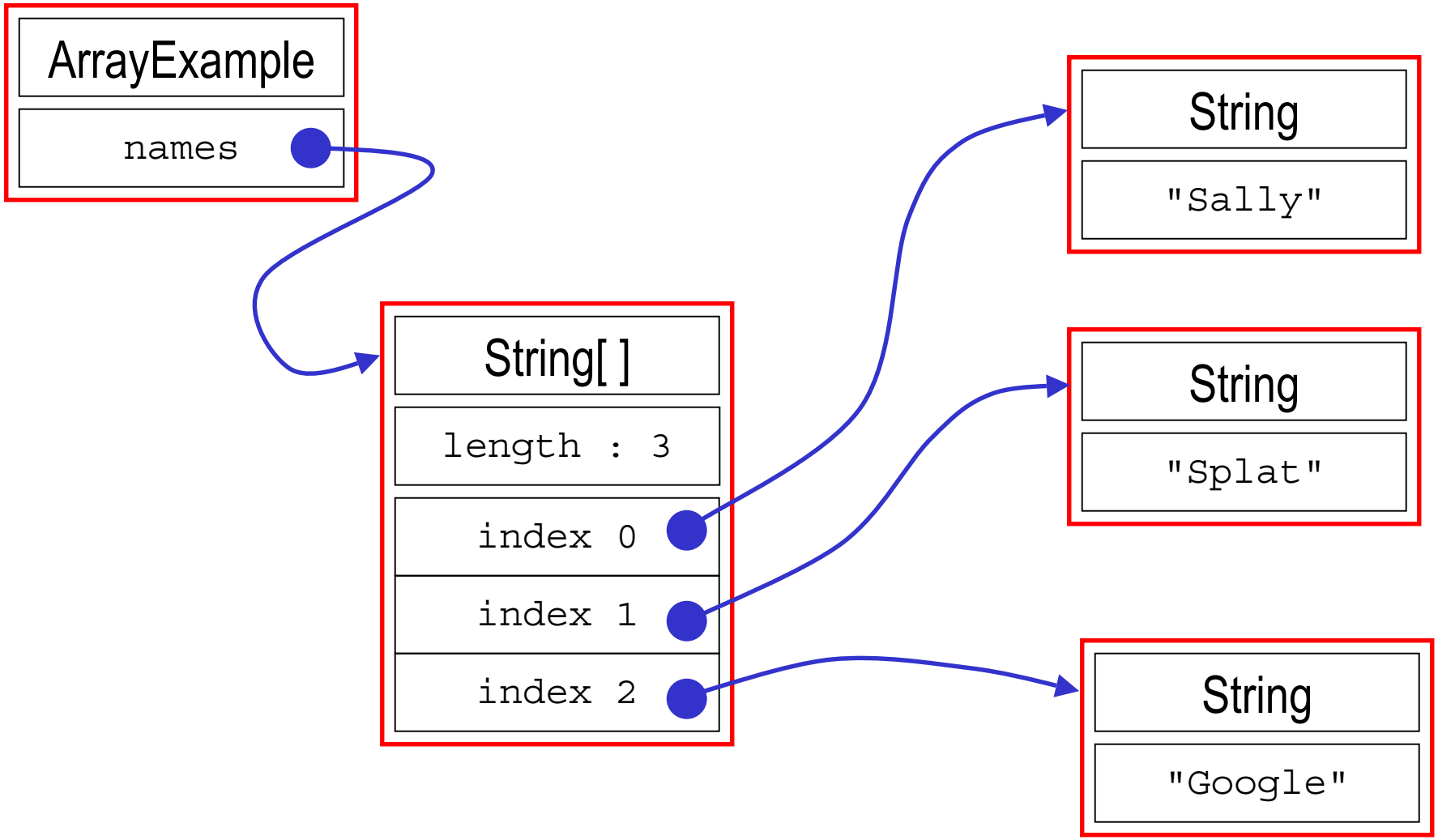
- Java (and many other languages) include *arrays* as the most basic kind of collection.
  - » Simple, ordered collections
  - » Special syntax for declaring values of array type
  - » Special syntax for accessing elements by position
- Unlike ArrayLists:
  - » The size is fixed when the array is created
  - » Can specify the type of the elements of arrays

Array Example

```
public class ArraySample {
    public ArraySample() {
        names = new String[3];
        names[0] = "Sally";
        names[1] = "Splat";
        names[2] = "Google";
        for (int i=0; i<names.length; i++) {
            System.out.println("Name "+i+" is "+names[i]);
        }
    }

    String[] names;
}
```

Array Example



Java Array Object

- Arrays are objects! They...
  - » Must be instantiated with **`new`** unless immediately initialized
  - » Can contain **`Object`** references or primitive types
  - » Have class members (length, clone(),…)
  - » Have zero-based indexes
  - » Throw an exception if bounds are exceeded

Array Declaration and Creation

- Array have special type and syntax:

  ***<element type>*[ ]** *<array name>* = **new *<element type>* [*<length>*]**;

- Arrays can only hold elements of the specified type.
  - » Unlike ArrayList, element type can be int, double, etc.
  - » type can be Object, in which case very similar to ArrayList
- *<length>* is any positive integer expression
- Elements of newly created arrays are initialized
  - » but generally you should provide explicit initialization
- Arrays have an instance variable that stores the length

  <array name>`.length`

Declaring and Allocating Arrays

- Declare an Array of ten **`String`** references

```
String[] myArray = new String[10];
```

- Declare an array and initialize elements
  - » the compiler counts the number of elements in this case

```
String[] myArray = { "Java","is","cool"};
```

- Declare, initialize, and use an array
  - » this is an "anonymous" array

```
boolean okay = doLimitCheck(x,new int[] {1,100});
```

Array Element Access

- Access an array element using the array name and position: <*array name*> [<*position*>]
- Details:
  - » <*position*> is an integer expression.
  - » Positions count from zero
  - » Type of result is the element type of the array
- Can update an array element by assigning to it:

  <*array name*> [<*position*>] = <*new element value*> ;

Looping Over Array Contents

- The length attribute makes looping over Array objects easy:

```
for (index=0; index<myArray.length; index++) {
   System.out.println(myArray[index]);
}
```

- The length attribute is a read-only value
  - » You can't change the size of the array after it has been created

Passing Array Objects to Methods

- You must declare that a method parameter is an Array:

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

- Arrays are objects and so you are passing a reference when you call a method with an array
  - » This means array contents can be changed by methods
  - » This may be what you want, but if not, you need to make sure that other methods only get a copy of your array and the elements in it

Array Summary

- Arrays are the fundamental low-level collection type built in to the Java language.
  - » Also found in essentially all programming languages
- Size fixed when created
- Indexed access to elements
- Used to implement higher-level, richer container types
  - » ArrayList for example
  - » More convenient, less error-prone for users

The Arrays Class

- There is also a class called java.util.Arrays
  - » Note the capital A, this is a class name
  - » part of package java.util
  - » utility functions for using arrays

    search

    sort

    initialize
  - » These are **static** methods so they exist and can be used without creating an object first

An Ordered Collection: ArrayList

- ArrayList is a Java class that specializes in representing an ordered collection of things
- The ArrayList class is defined in the Java libraries
  - » part of the java.util package
- We can store *any* kind of object in an ArrayList
  - » myList.add(theDog);
- We can retrieve an object from the ArrayList by specifying its index number
  - » myList.get(0)

ArrayList

- **`ArrayList()`**
  - » This constructor builds an empty list with an initial capacity of 10
- **`int size()`**
  - » This method returns the number of elements in this list
- **`boolean add(Object o)`**
  - » This method appends the specified element to the end of this list and increases the size of the array if needed
- **`Object get(int index)`**
  - » This method returns the element at the specified position

Using ArrayLists

- ArrayList is part of the java.util package
  - `import java.util.*;` to use ArrayList
- Creating a list

```
ArrayList names = new ArrayList ( );
```

- Getting the size

```
int numberOfNames = names.size( );
```

- Adding things

```
names.add("Billy");
names.add("Susan");
names.add("Frodo");
```

NameList.java

Using ArrayLists : import

- ArrayList is part of the java.util package
  - » `import java.util.ArrayList;` to use ArrayList
- The import statement tells the Java compiler where to look when it can't find a class definition in the local directory
  - » We tell the compiler to look in package java.util for the definition of ArrayList by putting an import statement at the top of the source code file
  - » Java always looks in package java.lang on its own

Using ArrayLists : constructor

- Creating a new ArrayList object

```
ArrayList names = new ArrayList ( );
```

- There are several constructors available
  - » **`ArrayList()`**

    Construct an empty list with an initial capacity of 10
  - » **`ArrayList(int initialCapacity)`**

    Construct an empty list with the specified initial capacity
  - » **`ArrayList(Collection c)`**

    Construct a list containing elements from another collection

Using ArrayLists : size

- Getting the size

```
int numberOfNames = names.size( );
```

- `size()` method returns integer value that caller can use to control looping, check for limits, etc
  - » Design pattern: The object keeps track of relevant information, and can tell the caller when there is a need to know

Using ArrayLists : add

- Adding things

```
names.add("Billy");
```

- `add(Object o)` method adds an object to the list at the end of the list
- The object can be of any class type
  - » String, File, InputStream, …
  - » can't add "primitive" types like int or double directly

    Can use the wrapper classes like Integer to store primitives

Using ArrayLists: get

- ArrayLists provide *indexed* access
  - » We can ask for the i^{th} item of the list, where the first item is at index 0, the second at index 1, and the last item is at index n-1 (where n is the size of the collection).

```
ArrayList names = new ArrayList ( );
names.add("Billy");
names.add("Susan");
Object x = names.get(0);
Object y = names.get(1);
```

A Problem

- We want to get things out of an ArrayList
- We might write the following:

```
public void printFirstNameString(ArrayList names) {
        String name = names.get(0);
        System.out.println("The first name is " + name);
}
```

- But the compiler complains at the green line:
  - » incompatible types:
  - » found : java.lang.Object
  - » required: java.lang.String

Recall: Casting

- The pattern is
  - » (<class-name>)<expression>
- For example

```
String name = (String)names.get(0);
```

- Casting an object does ***not*** change the type of the object
- A cast is a promise by the programmer that the object can be used to represent something of the stated type and nothing will go wrong

Miscasting

- We can lie about casting, but it will be caught at runtime

```
public void printFileList() {
    for (int i=0; i<names.size(); i++) {
          File f = (File)names.get(i);
          System.out.println(f);
    }
}
```

this will fail when you run the program

Reference vs. Primitive Types

- A few Java types are *primitive*:

  int, double, boolean, and a few other numeric types we haven't seen

  » Are atomic chunks with no parts (no instance variables)

  » Exist without having to be allocated with new

  » Cannot be message receivers, but can be arguments of messages and unary and binary operators

- All others are *reference types*:

  Rectangle, BankAccount, Color, String, etc.

  » Instances of the class are created using “new”

  » Can have instance variables and methods

  » All are special cases of the generic type “Object”

The Collections Class

- There is a class called java.util.Collections
  - » utility functions for using classes that implement the Collection interface
  - » This class consists exclusively of static methods that operate on or return collections. It contains polymorphic algorithms that operate on collections, "wrappers", which return a new collection backed by a specified collection, and a few other odds and ends.
  - » These are **static** methods so they exist and can be used without creating an object first

Useful methods in Collections class

- static void sort(List list)
  - » Sorts the specified list into ascending order, according to the natural ordering of its elements.
  - » "natural order" is defined when you implement the interface Comparable
- static void sort(List list, Comparator c)
  - » Sorts the specified list according to the order induced by the specified comparator
  - » Comparator lets you define several different orders