

Interfaces in Java

Interface Overview

- Think of interfaces as higher level templates than classes
 - In the blueprint analogy.
 - Class = blueprint (template of how a building will look like when created)
 - Object = creation of the blueprint (the actual building)
 - Interface = commonalities between blueprints (house, skyscraper, library, etc)
 - Interfaces are groupings of methods
 - You're creating a type where you do not care about the implementation (Class) but want to express desired functionality (Interface as a grouping of methods).

Interface Example

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  public interface StringSplitter {
7
8      String[] split(String input, String by);
9
10 }
```

Interface Usage Example

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  public class Book {
7
8      private final String[] words;
9
10     public Book(String text, StringSplitter stringSplitter) {
11         this.words = stringSplitter.split(text, " ");
12     }
13
14     public int getWordCount() {
15         return this.words.length;
16     }
17
18     public String[] getWords() {
19         return words;
20     }
21 }
```

Interface Implementation

```
1  package edu.nyu.cs9053.interfaces;
2
3  import java.util.regex.Pattern;
4
5  /**
6   * User: blangel
7   */
8  public class RegexStringSplitter implements StringSplitter {
9
10     @Override public String[] split(String input, String by) {
11         if ((input == null) || (by == null)) {
12             return (input == null ? null : new String[] { input });
13         }
14         return input.split(Pattern.quote(by));
15     }
16 }
```

Interface Implementation (cont)

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  public class DistributedStringSplitter extends NetworkAccessor implements StringSplitter {
7
8      @Override public String[] split(String input, String by) {
9          String hashKey = computeHash(by, input);
10         return process(hashKey);
11     }
12 }
```

Interface Particulars

- All methods are public (so no need to put `public` in front of each method)
- Interfaces cannot have instance variables
 - But can have `static final` variables (if you don't specify this it'll be defaulted)
- Interfaces can extend one another
- Interfaces without methods are called marker or tagging interfaces (in general don't do this)
- Classes can implement multiple interfaces

Multiple (interface) Inheritance

- A class can implement 0 to many interfaces. This is a very powerful way to get most of the benefits of multiple inheritance without the “double diamond” problem.
 - To share code, prefer composition (more about this later)

Multiple (interface) Inheritance Example

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  public class DistributedStringSplitter extends NetworkAccessor implements Distributed, StringSplitter {
7
8      private final String serverUrl;
9
10     public DistributedStringSplitter(String serverUrl) {
11         this.serverUrl = serverUrl;
12     }
13
14     @Override public String[] split(String input, String by) {
15         String hashKey = computeHash(by, input);
16         return process(hashKey);
17     }
18
19     @Override public String getServer() {
20         return serverUrl;
21     }
22 }
```

Super Interfaces

- Interfaces can extend other interfaces

```
1 package edu.nyu.cs9053.interfaces;
2
3 /**
4  * User: blangel
5  */
6 public interface Reader {
7
8     void read(String text);
9
10 }
```

```
1 package edu.nyu.cs9053.interfaces;
2
3 /**
4  * User: blangel
5  */
6 public interface BookReader extends Reader {
7
8     void read(Book book);
9
10 }
```

Marker Interfaces

- Interfaces without methods
 - Form of meta-programming; prefer @Annotations (next Lecture)

```
1    ...  
2    * @see java.io.Externalizable  
3    * @since   JDK1.1  
4    */  
5    public interface Serializable {  
6    }
```

```
1    ...  
2    public class Book implements Serializable {  
3    ...
```

Interface v. Abstract Class

- More often than not prefer Interfaces.
- A good distinction is that interfaces are cross-cutting concerns irrespective of concrete type (Splitter, Searcher, Cloner, etc) and abstract-classes are something nearly concrete but which is shared by other concrete classes (e.g., AbstractEmployee is abstract class of Manager and Programmer)
- Typing to an interface allows for more flexibility in the future and makes tasks like testing much easier.
 - A good pattern is to first make an Interface then make an AbstractClass which implements that Interface and provide the common implementations then provide the ConcreteClasses.

Interface v. Abstract Class (cont)

- Consider this (old Employee structure)

```
1 public abstract class Employee {
2
3     private final String name;
4
5     private final double salary;
6
7     Employee(String name, double salary) {
8         this.name = name;
9         this.salary = salary;
10    }
11
12    public String getName() {
13        return name;
14    }
15
16    public double getSalary() {
17        return salary;
18    }
19 }
```

Interface v. Abstract Class (cont)

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   * Date: 9/21/14
6   * Time: 1:02 PM
7   */
8  public interface Employee {
9
10     String getName();
11
12     Double getSalary();
13
14 }
```

Interface v. Abstract Class (cont)

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  abstract class AbstractEmployee implements Employee {
7
8      private final String name;
9
10     private final Double salary;
11
12     AbstractEmployee(String name, Double salary) {
13         this.name = name;
14         this.salary = salary;
15     }
16
17     @Override public String getName() {
18         return name;
19     }
20
21     @Override public Double getSalary() {
22         return salary;
23     }
24
25 }
```

Interface v. Abstract Class (cont)

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  public class SalesPerson extends AbstractSalesPerson implements Employee {
7
8      private final String name;
9
10     private final Double base;
11
12     private final Double commission;
13
14     public SalesPerson(String name, Double base, Double commission) {
15         this.name = name;
16         this.base = base;
17         this.commission = commission;
18     }
19
20     @Override public String getName() {
21         return name;
22     }
23
24     @Override public Double getSalary() {
25         return (base + commission);
26     }
27 }
```


Callback Pattern

- Common for UI programming, asynchronous programming and as a way to pass function “pointers” around.

```
1 package edu.nyu.cs9053.interfaces;
2
3 /**
4  * User: blangel
5  */
6 public interface Callback {
7
8     void loaded(String[] results);
9
10 }
```

```
1 package edu.nyu.cs9053.interfaces;
2
3 /**
4  * User: blangel
5  */
6 public class CallbackImplementation implements Callback {
7
8     @Override public void loaded(String[] results) {
9         for (String result : results) {
10             System.out.printf("%s\n", result);
11         }
12     }
13 }
```

Callback Pattern (cont)

```
1  package edu.nyu.cs9053.interfaces;
2
3  /**
4   * User: blangel
5   */
6  public class CallbackInvoker {
7
8      public void callAsynchronousTask(AsynchronousMethod async) {
9          CallbackImplementation callback = new CallbackImplementation();
10         async.invoke(callback);
11         // will return here immediately, once the async task has
12         // completed the callback.loaded value will be called
13     }
14
15 }
```

Attack of the Clones!

- Do not use `Object.clone()`
 - Older construct of Java which has fallen out of practice.
 - Better ways to do this - immutable objects with constructors
 - Hard to maintain - if you add a field you have to ensure you update your clone method as well.

Inner Classes

```
1  package edu.nyu.cs9053.inner;
2
3  /**
4   * User: blangel
5   */
6  public class Outer {
7
8      public class Inner {
9
10     }
11
12 }
```

Inner Classes (cont)

- Useful organizational construct.
 - Can mark the inner class private to hide from outside classes

```
1 public class Sorter {
2
3     private class Alphabetic implements Iterator<String> {
4
5         private int current;
6
7         private Alphabetic() {
8             Arrays.sort(values);
9             this.current = 0;
10        }
11
12        @Override public boolean hasNext() {
13            return (current != values.length);
14        }
15        @Override public String next() {
16            return values[current++];
17        }
18        @Override public void remove() {
19            throw new UnsupportedOperationException();
20        }
21    }
22
23    private final String[] values;
24
25    public Sorter(String[] values) {
26        this.values = values;
27    }
28
29    public Iterator<String> alphabeticIterator() {
30        return new Alphabetic();
31    }
32
33 }
```

Inner Classes (cont)

- The inner class has an implicit reference to the outer class.
 - Careful as this can leak memory!

```
1 public class Sorter {
2
3     private class Alphabetic implements Iterator<String> {
4
5         private final String[] values;
6
7         private int current;
8
9         private Alphabetic() {
10             this.values = Arrays.copyOf(Sorter.this.values, Sorter.this.values.length);
11             Arrays.sort(values);
12             this.current = 0;
13         }
14
15         @Override public boolean hasNext() {
16             return (current != values.length);
17         }
18         @Override public String next() {
19             return values[current++];
20         }
21         @Override public void remove() {
22             throw new UnsupportedOperationException();
23         }
24     }
25
26     private final String[] values;
27
28     public Sorter(String[] values) {
29         this.values = values;
30     }
31
32     public Iterator<String> alphabeticIterator() {
33         return new Alphabetic();
34     }
35
36 }
```

Inner Classes - Implicit Reference

```
1  public class Outer {  
2  
3      public class Inner {  
4  
5          private final Outer implicitReference;  
6  
7          public Inner(Outer implicitReference) {  
8              this.implicitReference = implicitReference;  
9          }  
10     }  
11  
12     public Inner createInner() {  
13         return new Inner(this);  
14     }  
15  
16 }
```

Inner Class - Gotcha!

```
1 public class Processor {
2
3     public class Result {
4
5         private final String result;
6
7         public Result(String result) {
8             this.result = result;
9         }
10
11         public String getResult() {
12             return result;
13         }
14     }
15
16     private final String[] hasher;
17
18     public Processor() {
19         this.hasher = new String[1024];
20         for (int i = 0; i < hasher.length; i++) {
21             this.hasher[i] = UUID.randomUUID().toString();
22         }
23     }
24
25     public Result process(String find) {
26         for (String hash : hasher) {
27             if (hash.equals(find)) {
28                 return new Result(hash);
29             }
30         }
31         return new Result("");
32     }
33
34 }
```


Inner Class - Gotcha! (cont)

```
1 public class MemoryProcessor {
2
3     public static void main(String[] args) {
4         List<Processor.Result> results = new ArrayList<>(1000);
5         int i = 0;
6         do {
7             printFreeMemory();
8             Processor.Result result = getResult();
9             results.add(result);
10            printFreeMemory();
11            System.out.printf("Result %s%n", result.getResult());
12        } while (i++ < 35);
13    }
14
15    private static Processor.Result getResult() {
16        Processor processor = new Processor();
17        printFreeMemory();
18        return processor.process("something");
19    }
20
21    private static void printFreeMemory() {
22        long memory = Runtime.getRuntime().freeMemory();
23        System.out.printf("%d MB memory%n", Math.round(memory / 1024d / 1024d));
24        System.gc();
25    }
26
27 }
```

Inner (static) Class!

```
1  public class Processor {  
2  
3      public static class Result {  
4  
5          private final String result;  
6  
7          public Result(String result) {  
8              this.result = result;  
9          }  
10  
11         public String getResult() {  
12             return result;  
13         }  
14     }  
15     ...
```

Local Classes - Avoid!

- Classes contained within a method
 - Extremely rare to use (bad practice)
 - One advantage, they are completely hidden from outside world

```
1  public class ContainingLocalClass {  
2  
3      public void someMethod() {  
4          class Local {  
5              void print(String foo) {  
6                  System.out.printf("%s%n", foo);  
7              }  
8          }  
9          Local local = new Local();  
10         local.print("foo");  
11     }  
12  
13 }
```

Anonymous Classes

- Classes inlined without a name.
 - Often see this with the Callback pattern

```
1  public class AnonymousCallbackExample {  
2  
3      public void callAsynchronousTask(AsynchronousMethod async) {  
4          async.invoke(new Callback() {  
5              @Override public void loaded(String[] results) {  
6                  for (String result : results) {  
7                      System.out.printf("%s%n", result);  
8                  }  
9              }  
10         });  
11     }  
12  
13 }
```

Variable Scope - Anonymous Class

- Can anonymous classes access variables outside of themselves?
 - If so, do they have an implicit reference to the outer class?

```
1  public class Scope {  
2  
3      public void invoke(AsynchronousMethod method) {  
4          String id = UUID.randomUUID().toString();  
5          method.invoke(new Callback() {  
6              @Override public void loaded(String[] results) {  
7                  System.out.printf("Invocation id = %s%n", id);  
8                  for (String result : results) {  
9                      System.out.printf("%s%n", result);  
10                 }  
11             }  
12         });  
13     }  
14  
15 }
```

Read Chapter 7

All sections

- I'll provide supplemental information in lecture

Homework 5

<https://github.com/NYU-CS9053/Fall-2019-II/homework/week5>