Java and C# in Depth

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Exercise Session – Week 7
Project submission today

- Make sure assistants have access to SVN
  - Not necessary to send solution via email
- Make sure you are on Piazza
  - Several questions have been asked there already
- There will be no project presentations
  - Not even for final project phase
public class Quiz1 {
    private final int primitiveInt = 42;
    private final int lazyPrimitiveInt;
    private final Integer wrappedInt = 42;
    private final String stringValue = "42";
    public Quiz1() { lazyPrimitiveInt = 42; }

    public int getPrimitiveInt() { return primitiveInt; }
    public int getLazyPrimitiveInt() { return lazyPrimitiveInt; }
    public int getWrappedInt() { return wrappedInt; }
    public String getStringValue() { return stringValue; }

    public void changeField(String name, Object value) {
        Field field = Quiz1.class.getDeclaredField(name);
        field.setAccessible(true);
        field.set(this, value);
        println("reflection: " + name + " = " + field.get(this));
    }
}
Quiz 1: Java final (cont.)

```java
public static void main(String[] args) {
    Quiz1 test = new Quiz1();
    test.changeField("primitiveInt", 84);
    System.out.println("direct: primitiveInt = " + test.getPrimitiveInt());
    test.changeField("lazyPrimitiveInt", 84);
    System.out.println("direct: lazyPrimitiveInt = " +
                      test.getLazyPrimitiveInt());
    test.changeField("wrappedInt", 84);
    System.out.println("direct: wrappedInt = " + test.getWrappedInt());
    test.changeField("stringValue", "84");
    System.out.println("direct: stringValue = " + test.getStringValue());
}
```

```
reflection: primitiveInt = 84
direct: primitiveInt = 42
reflection: lazyPrimitiveInt = 84
direct: lazyPrimitiveInt = 84
reflection: wrappedInt = 84
direct: wrappedInt = 84
reflection: stringValue = 84
direct: stringValue = 42
```
17.5.3. Subsequent Modification of final Fields

In some cases, such as deserialization, the system will need to change the final fields of an object after construction. final fields can be changed via reflection and other implementation-dependent means …

Even then, there are a number of complications. If a final field is initialized to a compile-time constant expression (15.28) in the field declaration, changes to the final field may not be observed, since uses of that final field are replaced at compile time with the value of the constant expression.

Another problem is that the specification allows aggressive optimization of final fields. Within a thread, it is permissible to reorder reads of a final field with those modifications of a final field that do not take place in the constructor.
Object object = new Object();
Class<Object> c = Object.class;

for (int i = 0; i < 1000000; i++) {
    object.toString();
}

Method method = c.getMethod("toString");
for (int i = 0; i < 1000000; i++) {
    method.invoke(object);
}

for (int i = 0; i < 1000000; i++) {
    method = c.getMethod("toString");
    method.invoke(object);
}
Running each variant on its own

- JIT compiler likely to influence benchmark results.
- Running each loop in its own program:
  - direct call: 149 ms
  - reflection cached lookup: 156 ms
  - reflection with lookup: 370 ms
How to do micro-benchmarks

• Know your JVM and JIT compiler
• Include a warmup-phase
  • run code, so it can be compiled and optimized
  • no measurement yet
• Run benchmark program multiple times
  • background tasks can interfere
• Make sure compiler and GC are not interfering
  • print output of compiler and GC operations
    (e.g. -XX:+PrintCompilation flag for JVM)
Quiz 3: Java magic

```java
static void magic() {
    ...
}

public static void main(String args[]) {
    magic();
    System.out.format("The magic is %s", false);
}
```

Output: The magic is true
static void magic() {
    Field field;
    field = Boolean.class.getField("FALSE");
    field.setAccessible(true);
    Field modifiersField =
        Field.class.getDeclaredField("modifiers");
    modifiersField.setAccessible(true);
    modifiersField.setInt(
        field, field.getModifiers() & ~Modifier.FINAL);
    field.set(null, true);
}

• Boolean values are autoboxed to Boolean.TRUE/Boolean.FALSE
• Boolean.FALSE changed to true
• When false is autoboxed (e.g. when printed), it refers to true
Is there an easier way in C# to do a call using reflection?

Object o = "abc";

result = o.GetType().InvokeMember("Equals", BindingFlags.InvokeMethod, null, o, new object[]{"def"});

result = ((dynamic)o).Equals("def");
Delegates in Java using reflection

• Delegates could be emulated in Java with reflection:
  • Passing Method objects
  • Need to pass target explicitly (for non-static functions)
  • No multicast delegates
  • No type safety

• Not the Java way
C# code

```csharp
public delegate void Print (String s);
public void Display(Print pMethod)
{
    pMethod("Some text");
}
```

Corresponding Java code using reflection

```java
public void display(Object o, Method m)
{
    try {
        m.invoke(o, new Object[]{"Some text"});
    } catch(Exception e) {}
}
```
Delegates in Java using inner classes

• Create an interface for each delegate type
• Create an anonymous inner class for each instantiation of the delegate
• Declared inside a method
  • Access to locals declared as final
  • Access to member variables
• Drawbacks
  • More verbose than delegates
  • Captures reference to outer class
public interface Printable {
    public void print(String s);
}

public class Example {
    public Example() {
        display(new Printable() {
            public void print(String s) {
                System.out.println(s);
            }
        });
    }

    public void display(Printable p) {
        p.print("Some text");
    }
}
Capturing variables in inner classes

```java
public void Capture()
{
    final String prefix = "abc";
    display(new Printable()
    {
        public void print(String s)
        {
            System.out.println(prefix + s + postfix);
        }
    });
}

private String postfix;
```
Closures in Java 8

- Java 8 released in March 2014
- Support for lambda-expressions
  - [http://www.lambdafaq.org/](http://www.lambdafaq.org/)
  - [http://openjdk.java.net/projects/lambda/](http://openjdk.java.net/projects/lambda/)
- Basic syntax:
  ```java
  (int x, int y) -> x + y
  (x, y) -> x - y
  () -> 42
  (String s) -> System.out.println(s)
  x -> 2 * x
  c -> { int s = c.size(); c.clear(); return s; }
  ```
Closures as Functional Interfaces

- Function Interface: **one abstract method**
- Type of lambda expression based on target
- Can directly instantiate a Function interface

```java
FileFilter java = (File f) -> f.getName().endsWith(".java");

new Thread(() -> {
    connectToService();
    sendNotification();
}).start();

ActionListener l = (ActionEvent e) -> do(e.getModifiers());
```

Type **Function Interface**: one abstract method
Type **Runnable**: `connectToService()`, `sendNotification()`
Type **ActionListener**: `do(e.getModifiers())`
Variable capturing in Java closures

- Can capture local variables of surrounding context that are *effectively final*
- A variable is *effectively final*, if it could be declared as final without compiler error
- Captured variables cannot be modified in closure

```java
Callable<String> helloCallable(String name) {
    String hello = "Hello";
    return () -> (hello + ", " + name);
}
```
Library support for Java closures

- Existing Collection class extended with `stream()` function
- Stream interface offers several chainable operations like `filter`, `forEach`, `sorted`, ...

```java
List<Shape> blue = shapes.stream()
    .filter(s -> s.getColor() == BLUE)
    .collect(Collectors.toList());

bool hasHeavyBlue = shapes.stream()
    .filter(s -> s.getColor() == BLUE)
    .map(s -> s.getWeight())
    .anyMatch(i -> i > 13);
```
Questions?