ETH Zürich
Chair of Software Engineering

Java and C# in Depth

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Exercise Session – Week 8

Java 8 release date

- Was early September 2013
- Currently moved to March 2014

- http://openjdk.java.net/projects/jdk8/milestones
- http://mreinhold.org/blog/secure-the-train

Quiz 1: What is printed? (Java)

```
class MyTask implements Runnable {
    public void run() {
        throw new RuntimeException("Help!");
    }
}

public static void main(String[] args) {
    try {
        (new Thread(new MyTask())).start();
        System.out.println("Everything is ok!");
    } catch (RuntimeException e) {
        System.out.println("Something went wrong...");
    }
}
```

«Everything is ok!

Exception in thread...: Help!»

Exceptions from other threads are not propagated to *main*

Quiz 1: A C# solution

In C# you can use asynchronous delegates to propagate exceptions to the main thread:

```
static void MyTask() { throw new Exception("Help!"); }
delegate void MyTaskInvoker();
public static void Main() {
        try {
            MyTaskInvoker method = MyTask;
            IAsyncResult res = method.BeginInvoke(null, null);
            method.EndInvoke(res);
            // This doesn't work:
            // new Thread(MyTask).Start();
        } catch (Exception) {
            Console.WriteLine("Something went wrong");
        }
```

Quiz 2: What happens (C#)?

```
static void MyTask() {
    try {
        ... // Some heavy work
    } catch { ...
    } finally {
        Console.WriteLine("Very important cleanup");
    }
}

public static void Main() {
    Thread t = new Thread(MyTask);
    t.IsBackground = true;
    t.Start();
    ...
    t.Interrupt();
}
```

finally block may not be executed: the main thread may exit before that and the application does not wait for background threads to finish

Quiz 3: What can go wrong? (Java)

```
public walkUnderTheRain() {
    if(!isRaining) {
        try { wait(); }
        catch (InterruptedException e) {…}
    }
    System.out.println("Walking under the rain!");
}
```

Shared variable

Don’t expect that the first interrupt we get is the one we need: use *while* instead of *if*

To call *wait* the enclosing method must be synchronized

(otherwise *IllegalMonitorStateException* is thrown at runtime)

Quiz 3: A C# solution: wait handles

```
static EventWaitHandle rain = new AutoResetEvent(false);

static void WalkUnderTheRain() {
    rain.WaitOne();
    Console.WriteLine("Walking under the rain!”);
}

public static void Main() {
    new Thread(WalkUnderTheRain).Start();
    Thread.Sleep(500);
    rain.Set();
}
```

Quiz 4.a: What happens? (Java)

```
class MyTask implements Runnable {
    public void run() {
        while (true) { }
    }
}
public static void main(String[] args) {
    try {
        Thread t = new Thread(new MyTask());
        t.start();
        t.interrupt();
        t.join();
        System.out.println("t interrupted");
    } catch (InterruptedException e) {…}
}
```

run does not handle interrupts

this code will be never executed

Quiz 4.a: How to handle interrupts?

1. Calling methods that throw *InterruptedException*

```
public synchronized void run() {
    while (true) try {
        sleep (200);
    } catch (InterruptedException e) {
        return;
    }
}
```

2. Checking Thread.interrupted flag

```
public void run() {
    while (true) {
        if (Thread.interrupted()) { return; }
    }
}
```

Quiz 4.b: What happens? (C#)

```
static void Run() { while (true) { } }

public static void Main() {
    Thread t = new Thread(Run);
    t.Start();
    Thread.Sleep(500);
    t.Abort();
    t.Join();
    Console.WriteLine("t aborted");
}
```

This code is executed.

Unlike *Interrupt*, *Abort* stops the thread even if it's currently running

Quiz 4.c: What happens (C#)?

```
static void Run() {
    while (true) {
        try {
            Thread.Sleep(1000);
        } catch (ThreadAbortException e) {
            Console.WriteLine("Ha-ha! I will be executing FOREVER!");
        }
    }
}

public static void Main() {
    Thread t = new Thread(Run);
    t.Start();
    Thread.Sleep(500);
    t.Abort();
    t.Join();
    Console.WriteLine("t aborted");
}
```

Thread *t* is still aborted!

ThreadAbortException is automatically rethrown at the end of the *catch* block if *Thread.ResetAbort* is not called

Quiz 5: Is this class thread-safe? (Java)

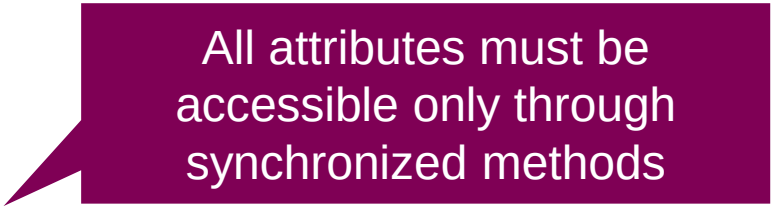
```
class Counter {
    private int c = 0;

    public void increment() {
        c++;
    }

    public void decrement() {
        c--;
    }

    public int value() {
        return c;
    }
}
```

```
Counter count = new Counter;
...
// In thread 1:
count.increment();
...
// In thread 2:
count.increment();
...
// In the main thread after joining
// threads 1 and 2:
System.out.println(count.value());
```

c++ is not atomic =>

the result might be 1

Quiz 5: Is this class thread-safe? (Java)




```
class Counter {
  private int c = 0;

    public synchronized void increment() {
        c++;
    }

    public synchronized void decrement() {
        c--;
    }

    public synchronized int value() {
        return c;
    }
}
```

Quiz 5: Is this class thread-safe? (Java)

```
class Counter {
    ... // Everything as before

    public static synchronized void increment_some(Counter count) {
        count.c++;
    }

    Counter(int c) {
        this.c = c;
    }
}
```

No: static methods use different object as a lock!

OK: constructors need not (and cannot) be synchronized, they are executed once per object

Quiz 6: What is printed? (Java)

```
public class Test extends Thread {
  boolean keepRunning = true;

  public static void main(String[] args) {
    Test t = new Test(); t.start();
    Thread.sleep(1000);
    t.keepRunning = false;
    System.out.println("keepRunning is false");
  }

  public void run() {
    while (keepRunning) {}
    System.out.println("finished");
  }
}
```

Fix by declaring attributes **volatile**

Thread might cache values locally. Here, it will run forever!

Quiz 7: Does it work? (C#)

```
volatile static bool go;
volatile static DateTime dt;

static void Wait() {
        while (!go) { }
        Console.WriteLine(dt);
    }

public static void Main() {
    new Thread(Wait).Start();
    Thread.Sleep(1000);
     dt = DateTime.Now;
     go = true;
}
```

Here we want to see the change to *dt* made by the main thread

Compilation error:

Objects of non-primitive value types cannot be cached by the processor => need not (and cannot) be *volatile*

C# volatile

- Only (up to) 32bit types can be declared volatile.
  - Reference types (just the reference is volatile)
  - sbyte, byte, short, ushort, int, uint, char, float, bool
- Threads will always get the most up-to-date value for volatile fields.
- Fields declared as volatile are not cached.

Quiz 8: Thread safe? (Java)

Shared data:

```
public static long data;
```

Should be declared volatile

Two threads:

```
new Thread(new Runnable() {
  public void run() {
    while (true) {
      data = someFunction();
    }
  }
}).start();
```

```
new Thread(new Runnable() {
  public void run() {
    while (true) {
      if (data == target) {
        doSomething();
      }
    }
  }
}).start();
```

Java Language Specification

17.7. Non-atomic Treatment of double and long

For the purposes of the Java programming language memory model, a single write to a non-volatile long or double value is treated as two separate writes: one to each 32-bit half. This can result in a situation where a thread sees the first 32 bits of a 64-bit value from one write, and the second 32 bits from another write.

Writes and reads of volatile long and double values are always atomic.

Writes to and reads of references are always atomic, regardless of whether they are implemented as 32-bit or 64-bit values.

Quiz 9: Communication via Mutex (C#)

- Given:
  - 1 Mutex
  - 2 Threads that can access only that Mutex

- How can you transfer data from one thread to the other, using ONLY the Mutex as a communication.

Quiz 9: Communication via Mutex (C#)

ReleaseMutex	Releases the Mutex once.
WaitOne()	Blocks the current thread until the current WaitHandle receives a signal. (Inherited from WaitHandle.) Return Value: true if the current instance receives a signal. If the current instance is never signaled, WaitOne never returns.
WaitOne(Int32)	Blocks the current thread until the current WaitHandle receives a signal, using a 32-bit signed integer to specify the time interval. (Inherited from WaitHandle.) Return Value: true if the current instance receives a signal; otherwise, false.

Quiz 9: Communication via Mutex (C#)

```
void SendData(int data)
{
  for (int i = 0; i < 32; i++) {
    if (((data >> i) & 0x1) == 1) {
      mutex.WaitOne();
      Thread.Sleep(timeout);
      mutex.ReleaseMutex();
    } else {
      Thread.Sleep(timeout);
    }
  }
}
```

```
void ReceiveData()
{
  for (int i = 0; i < 32; i++)
{
    if (mutex.WaitOne(0)) {
      mutex.ReleaseMutex();
      // bit is 0
    } else {
      // bit is 1
    }
    Thread.Sleep(timeout);
  }
}
```

Questions?