UNIVERSITÉ DE NEUCHÂTEL

Institut d'informatique
Université de Neuchâtel

CONCURRENCY: MULTI-CORE PROGRAMMING & DATA PROCESSING

Lab01 - Introduction and Java basics

ORGANIZATION & WORK ENVIRONMENT

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- Lab session: ~2 hours
- 5 assignments
  - Every 2 weeks
  - Deadline: 2pm lecture day
- First assignment: next week
- ILIAS
  - Assignments
  - Exercises
  - Homework submission

- Environment:
  - Your own laptop
  - Larger server machines
- Programming language: Java
- IDE (e.g., Eclipse and IntelliJ)
- Java in command line:
  - Compile: `javac Program.java`
  - Execute: `java Program`

Questions/comments:

- Forum on ILIAS
- E-mail: isabelly.rocha@unine.ch
- Room E122

JAVA CONCURRENCY BASICS

DEFINING & STARTING A THREAD

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- Extending *Thread* class

```
public class HelloThread extends Thread {
    @Override
    public void run() {
        System.out.println("Hello from a thread!");
    }

    public static void main(String args[]) {
        Thread thread = new HelloThread();
        thread.start();
    }
}
```

DEFINING & STARTING A THREAD

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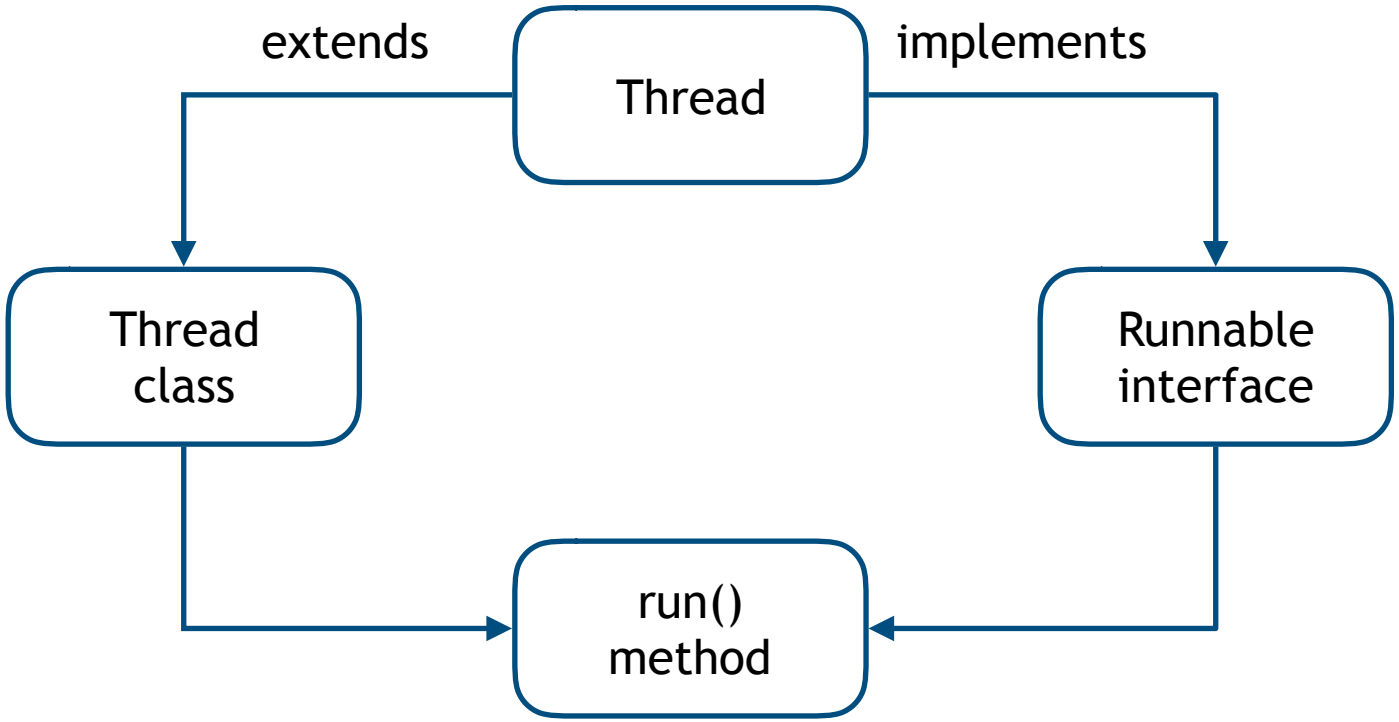
- Implementing *Runnable* interface

```
public class HelloRunnable implements Runnable {
    @Override
    public void run() {
        System.out.println("Hello from a thread!");
    }
    public static void main(String args[]) {
        Thread thread = new Thread(new HelloRunnable());
        thread.start();
    }
}
```

EXTEND THREAD VS IMPLEMENT RUNNABLE

Which method is the best?



EXTEND THREAD VS IMPLEMENT RUNNABLE

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Which method is the best?

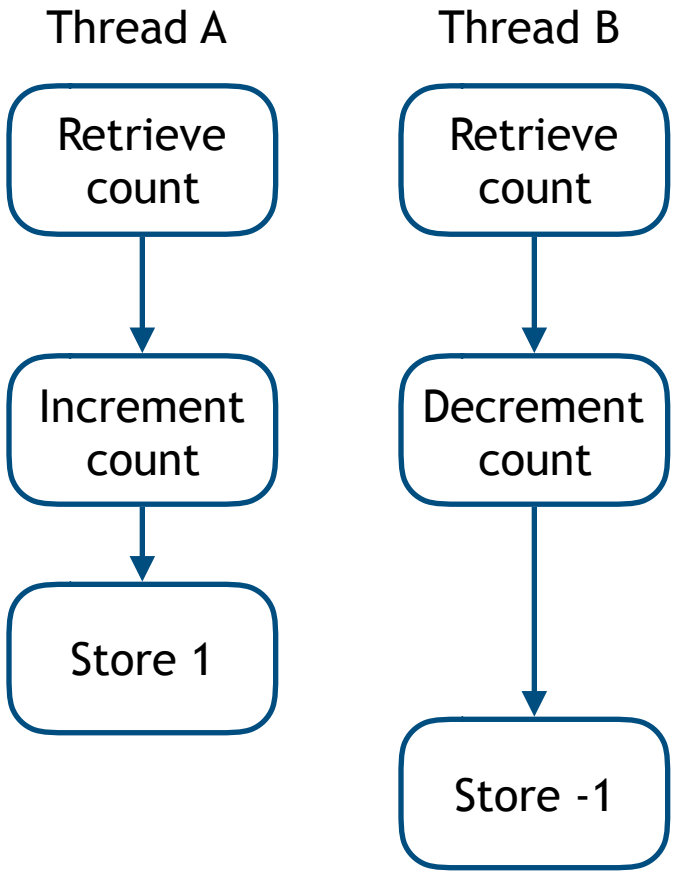
	Extend Thread	Implement Runnable
Inheritance option	no	yes
Loosely coupled	no	yes
Code reusability	no	yes
Method overhead	yes	no
Core reusability	no	yes

SYNCHRONIZATION

```
class Counter {
    private int count;

    public void increment() {
        count++;
    }

    public void decrement() {
        count--;
    }
}
```



A's result is lost!

SYNCHRONIZED METHODS

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```
class SynchronizedCounter {
   private int count;

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

   public synchronized void decrement() {
        count--;
    }
}
```

SYNCHRONIZED STATEMENTS

```
class SyncBlockCounter {
   private int count;

   public void increment() {
        synchronized (this) {
            count++;
        }
    }

   public void decrement() {
        synchronized (this) {
            count--;
        }
    }
}
```

SYNCHRONIZED STATEMENTS

```
public class DoubleCounter {
    private int count;
    private Object lock = new Object();

    public void increment() {
        synchronized(lock) {
            count++;
        }
    }

    public void decrement() {
        synchronized(lock) {
            count--;
        }
    }
}
```

SYNCHRONIZED STATEMENTS

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```
public class DoubleCounter {
    private int count1;
    private int count2;
    private Object lock1 = new Object();
    private Object lock2 = new Object();

    public void increment1() {
        synchronized(lock1) {
            count1++;
        }
    }

    public void increment2() {
        synchronized(lock2) {
            count2++;
        }
    }
}
```

SYNCHRONIZED METHODS VS STATEMENTS

Which method is the best?
It **depends** on your problem!

- Advantages of synchronized methods:
  - More compact syntax
  - Forces modularity
- Advantages of synchronized statements:
  - Flexibility
  - Reduced scope of lock
  - Better performance

INTERACTING WITH A THREAD

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- Pause execution

```
sleep(milliseconds);
```

- Suspend a thread

```
wait();
```

- Wake a thread up

```
notify();
```

- Check if thread is still running

```
isAlive();
```

- Temporary interrupt thread

```
yield();
```

- Wait for another thread

```
join();
```

- Stop thread

```
stop();
```

EXERCISES

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1. Write a thread class that calls the `increment()` method of the class `Counter` for a given number of times. Create several threads, start them all, and wait for all the threads to terminate. Print the final value of the counter, and see whether it is correct.
2. Write a `synchronizedIncrement()` method on the class Counter, repeat the previous tests using the new method and compare the results.
3. Modify the `synchronizedIncrement()` method to use synchronized statements, repeat the previous tests using the new method and compare the results.
4. Write a program that uses multiple threads to find the integer with the largest number of divisors in a given range between `x` and `y`. Output the elapsed time, the integer that has the largest number of divisors, and the number of divisors that it has.