

# **ISTANBUL TECHNICAL UNIVERSITY**

## **COMPUTER ENGINEERING DEPARTMENT**

### **BLG 546E OBJECT ORIENTED CONCURRENT PROGRAMMING**

**CRN: 23438**

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**Report of Homework #3**

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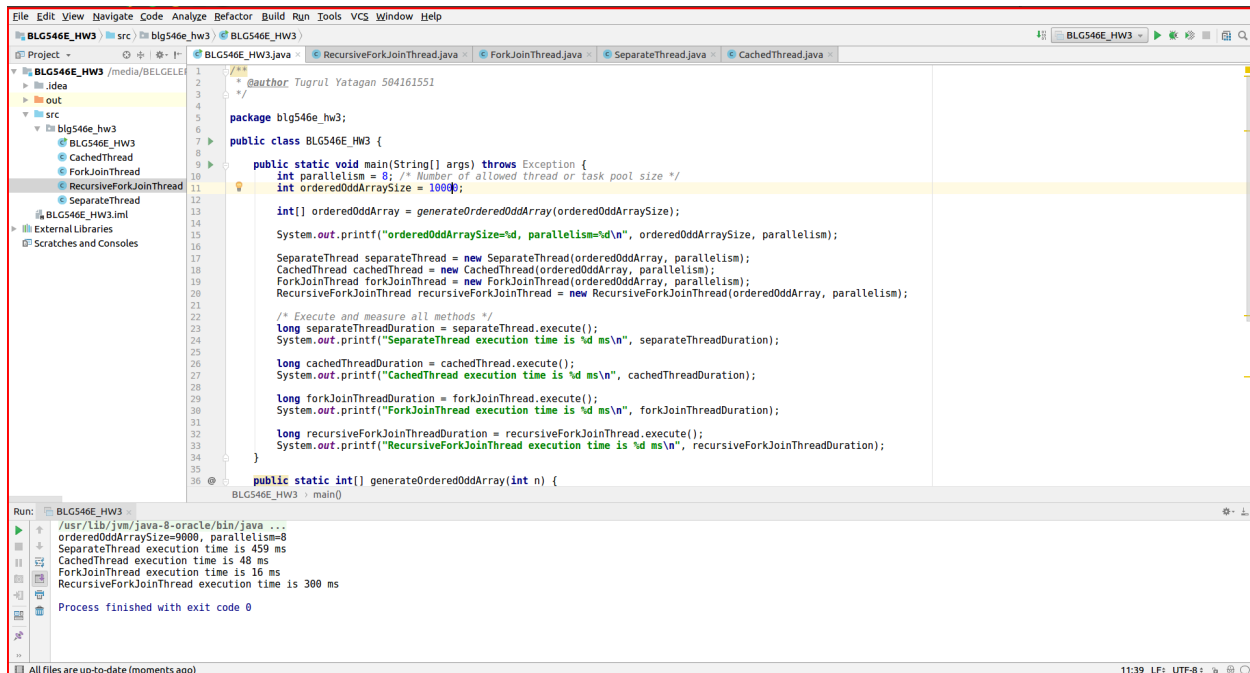
## Development, Build and Test Environment

Ubuntu 16.04.4 LTS Linux kernel 4.4.0-116-generic is used for build and test environment. Test system has 6 GB of RAM and 8 core i7-3632QM 2.20 GHz CPU. Oracle Java 8 is used for Java virtual machine. Following commands is used for installing Java virtual machine and IntelliJ IDEA:

```
sudo add-apt-repository ppa:webupd8team/java
sudo apt install oracle-java8-installer
sudo snap install intellij-idea-community -classic
```

Java VM Options: -Xmx4g -Xss256m

Example screen shot of development environment:



Example output:

Application is run with;

- Different concurrency methods;
  - SeparateThread
  - CachedThread
  - ForkJoinThread
  - RecursiveForkJoinThread

- RecursiveForkJoinThread
- Different array size parameters;
  - 10K
  - 100K
  - 1M
- Different thread or task pool size;
  - 8
  - 16
  - 32

### **N=10K**

orderedOddArraySize=10000, parallelism=8

SeparateThread execution time is 509 ms

CachedThread execution time is 51 ms

ForkJoinThread execution time is 26 ms

RecursiveForkJoinThread execution time is 393 ms

orderedOddArraySize=10000, parallelism=16

SeparateThread execution time is 510 ms

CachedThread execution time is 49 ms

ForkJoinThread execution time is 22 ms

RecursiveForkJoinThread execution time is 386 ms

orderedOddArraySize=10000, parallelism=32

SeparateThread execution time is 502 ms

CachedThread execution time is 38 ms

ForkJoinThread execution time is 26 ms

RecursiveForkJoinThread execution time is 364 ms

**N=100K**

orderedOddArraySize=100000, parallelism=8

SeparateThread execution time is 3879 ms

CachedThread execution time is 144 ms

ForkJoinThread execution time is 91 ms

orderedOddArraySize=100000, parallelism=16

SeparateThread execution time is 3786 ms

CachedThread execution time is 145 ms

ForkJoinThread execution time is 67 ms

orderedOddArraySize=100000, parallelism=32

SeparateThread execution time is 3826 ms

CachedThread execution time is 158 ms

ForkJoinThread execution time is 70 ms

**N=1M**

orderedOddArraySize=1000000, parallelism=8

SeparateThread execution time is 35075 ms

CachedThread execution time is 1158 ms

ForkJoinThread execution time is 379 ms

orderedOddArraySize=1000000, parallelism=16

SeparateThread execution time is 35927 ms

CachedThread execution time is 1095 ms

ForkJoinThread execution time is 449 ms

orderedOddArraySize=1000000, parallelism=32

SeparateThread execution time is 34989 ms

CachedThread execution time is 1124 ms

ForkJoinThread execution time is 687 ms

## Test Results

Execution time for SeparateThread, CachedThread, ForkJoinThread and RecursiveForkJoinThread methods are put in a chart.

Execution results shows that, ForkJoinThread performs best and SeparateThread method performs worst. Execution time for SeparateThread method increases drastically while array size increases. CachedThread and ForkJoinThread performs relatively well while array size increases thus CachedThread and ForkJoinThread are more scalable solution.

Thread or task pool size (parallelism factor) has no or very little effect on overall performance.

