CSC 543 Multiprocessing & Concurrent Programming, Spring 2024

Dr. Dale E. Parson, Assignment 4, Using Executors, ExecutorService & Future for thread pools
This assignment is due by 11:59 PM on Friday April 11 via make turnitin.

The goal of this assignment is to get experience using a variety of library classes that implement ExecutorService from java.util.concurrent. ExecutorService is a substantial building block for building a multithreaded server using a worker thread pool.

Perform the following steps to set up this project and to get my handout. Start out in your login directory on csit (a.k.a. acad).

```
cd  $HOME
cp  ~parson/multip/cliserver2024.problem.zip  multip/cliserver2024.problem.zip
```

Perform all your building and testing on mcgonagall. I will not grade on the basis of performance, but speedup is one way to verify that the ExecutorService is multi-threading.

After logging into mcgonagall, do the following.

```
cd  ./multip
unzip  cliserver2024.problem.zip
cd  ./cliserver2024
make  testnothreads
```

This test runs tests on client threads that do not construct an ExecutorService thread pool. There is some intentional error testing that results in error messages, but that does not stop the automated tests. As long as the **diff** step at the end of each test works correctly, all is well. Here is the output from **make testnothreads** in the handout code.

```
CLASSPATH=..:../jcip-annotations.jar time java cliserver2023.ClientSide 4 nothreads 100000000 1 | sort > testnothreads.out
There are 32 contexts on this machine.
EXCEPTION BY CLIENT THREAD 1 ON SUBMISSION -1 : java.lang.RuntimeException, java.lang.IllegalArgumentException: EXPLODING CLIENT!
EXCEPTION BY CLIENT THREAD 0 ON SUBMISSION -1 : java.lang.RuntimeException, java.lang.IllegalArgumentException: EXPLODING CLIENT!
EXCEPTION BY CLIENT THREAD 2 ON SUBMISSION -1 : java.lang.RuntimeException, java.lang.IllegalArgumentException: EXPLODING CLIENT!
EXCEPTION BY CLIENT THREAD 3 ON SUBMISSION -1 : java.lang.RuntimeException, java.lang.IllegalArgumentException: EXPLODING CLIENT!
ELAPSED CLIENT TIME = 21.025 seconds.
316.22user 17.39system 0:21.12elapsed 1579%CPU (0avgtext+0avgdata 8999920maxresident)k
0inputs+64outputs (0major+33151minor)pagefaults 0swaps
diff testnothreads.out testnothreads.ref > testnothreads.dif
```

The above “EXCEPTION BY CLIENT THREAD 3 ON SUBMISSION -1” messages are expected. Any such message with a SUBMISSION index that is **NOT** -1 is probably an error. Any hung process is an error. Here are the source files that we will go over in class.

ClientSide.java	# Do not change this. It is the test driver. # The client implements a previous year's project's pipeline stages # PipeSourceRandom.java and PipeStageMath.java, # as executed in your thread pool. The application is encapsulated # in a Callable<String> task, and is opaque to your code.
ServerInterface.java	# This is the interface for your server classes. Do not change.
NoThreadPool.java	# This is my single-threaded, non-thread pool implementation of # ServerInterface. Do not change.
SingleThreadPool.java	# STUDENT change per comments in the file.
FixedThreadPool.java	# STUDENT change per comments in the file.
CachedThreadPool.java	# STUDENT change per comments in the file.

Here are the individual tests you can run.

make testnothreads runs my handout stub class NoThreadPool, takes ~24 seconds on mcgonagall.
make testsingle runs tests on SingleThreadPool.java, takes ~24 seconds on mcgonagall.
make testfixed runs tests on FixedThreadPool.java, takes ~9 seconds on mcgonagall.
make testcached runs tests on CachedThreadPool.java, takes ~9 seconds on mcgonagall.
make clean test tests them all.

If anything hangs, run that java line manually with arguments like these.

```
CLASSPATH=..:./jcip-annotations.jar time java cliserver2024.ClientSide 4 single 1 1

CLASSPATH=..:./jcip-annotations.jar time java cliserver2024.ClientSide 4 single 100000000 1

CLASSPATH=..:./jcip-annotations.jar time java cliserver2024.ClientSide 4 fixed 1 1
CLASSPATH=..:./jcip-annotations.jar time java cliserver2024.ClientSide 4 fixed 100000000  1
CLASSPATH=..:./jcip-annotations.jar time java cliserver2024.ClientSide 4 cached 1 1
CLASSPATH=..:./jcip-annotations.jar time java cliserver2024.ClientSide 4 cached 100000000  1
```

These are the command lines printed by the makefile. If a process hangs, hit control-\ to see a stack trace of the threads.

Run **make turnitin** on one of our Linux machines by the due date. The late penalty is 10% per day.