**GTU Department of Computer Engineering**

**CSE443 Object Oriented Analysis and Design**

**Fall 2021 - Homework 3 Report**

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**Question 1**

Use Adapter Design pattern. Why?

Timeline

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As you can see adapter design pattern is appropriate for this problem and it is simple compared to decorator and proxy patterns which they can be used for this problem.

**Solution**

**1.1 Implement simple BestDSEver Class**



**1.2 Test BestDSEver Class**

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**Output:**

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**1.3 Implement Adapter Design Pattern**

**1.3.1 Understanding synchronization problem**

Since each thread is trying to use same data structure, we have critical sections. We will solve this problem by applying following solution.

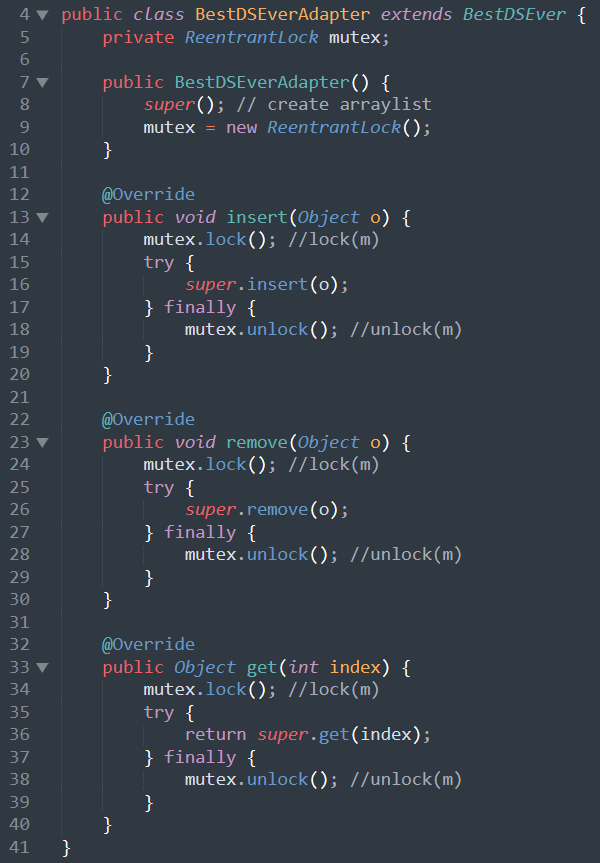
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\*You can think push and pop methods as insert and remove methods.

**1.3.2 Creating Adapter Class**

I will apply the **Class Adapter** solution for this problem.



**\***Here, we have a mutex for threads and we are using it in critical regions. Also we don’t need a composition here because we are already using super class methods. Here we are making **unlock in finaly block** because if we **get an exception in try block,** still we should be able to unlock otherwise we will leave without unlocking.

**1.4 Testing with multiple Threads**

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**1.5 Output**

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**1.6 Class Diagram**

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\*Here, we are using inheritance(class adapter) because we don’t have an interface for BestDSEver class. Also we don’t have Adaptee class which means BestDSEverAdapter class is already an Adaptee therefore, we don’t use composition in this solution.

**Question 2 – Composite and Iterator**

**Solution**

**2.1** **Understanding the problem**

The problem is like the following picture;

Diagram

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Here, emails contains both address and name of its owner, groups contains an arbitrary number of personal or group addresses also **groups are composite, emails are leaf**.

**2.2 Class Diagram**

**2.2.1 Classes in my solution**

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**2.2.2 Composite Pattern Class Diagram**

Graphical user interface, text

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Here, EmailComponent class is abstract class, Email is leaf class and CompositeEmail is a composite class with add, remove and get methods.

**2.2.3 Full Class Diagram**

Here, we will see full diagram note that I used iterator design pattern to traverse all tree easily as expected in homework pdf file.

Graphical user interface

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Here, Composite iterator implements **java.util iterator** interface to use in composite email class. NullIterator class is used in Email leaf class. Main class is for test purpose.

**2.3 Test Results**

Check Main.java class and run to see results. Some part of result is following;

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**Question 3 – Concurrency patterns**

**Solution**

**3.1 Understanding the** **synchronization barrier problem**

In order to solve this problem, we will apply following solution in 2 different ways with java;

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**Some notes on my solution**

* In order **to create thread** in java I will use **Runnable interface** for both solutions.
* Note that, since all threads works with **different portion of the matrix** which means different buffer, we don’t have any synchronization problem other than synchronization barrier.
* In my solution, all threads will use **same thread function** with different coordinates.
* I will explain my solutions with simple example. You can check the source code after reading.

**3.2 Using Java’s synchronized**

**3.2.1 Classes in my solution**

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**3.2.2 Shared Data and Lock Object Class**

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\*Atomic integer is much better between threads in java.

**3.2.3 Common Thread Function between Threads**

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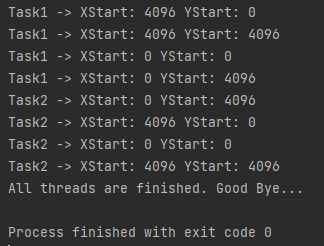
**\***Here, synchorized keyword acts like a mutex and it locks and unlock code in its scope. We are using **lockData object is** like a mutex(with the help of object class) since **it is common and shared between** all threads.

**3.2.4 Creating Threads and Testing**

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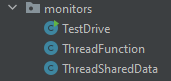
**3.3.5 Output**



**\***As you can see all task2s **didn’t start** all task1s are finished.

**3.3 Using mutex(es) and monitor(s)**

**3.3.1 Classes in my solution**



**3.3.2 Shared Data between Threads**

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\*Atomic integer is much better between threads in java.

**3.3.3 Common Thread Function between Threads**

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**3.3.4 Creating Threads and Testing**

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**3.3.5 Output**

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**\***As you can see all task2s **didn’t start** all task1s are finished.

**3.4 Calculating A+B and Discrete Fourier Transform**

**3.4.1 A+B Implementation**

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**3.4.2 Discrete Fourier Transform Formula and Implementation**

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**Implementation**

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\*Here, as you can see thread calculates dft for only its responsible portion of the matrix.

**3.5 Testing full implementation as console application**

In order to test we need to create 8192x8192 size of matrix and calculate dft on this matrix. But if I choose this size, I am getting **java.lang.OutOfMemoryError**. Therefore, **I tested my application with 4096x4096 size of matrix.**

**Java synchronized result**

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**Java monitor result**

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**Using a single thread result**

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\*As you can see in multi thread version we have gained about 1700 ms.

**Note:** As you have seen, main thread is used only for test purpose such as creating threads etc.

**3.5 Responsive GUI**

In java Swing GUI, **if we use these implementations directly** our gui **will not be respond** until calculation is done.

Therefore in order to solve this problem, I have used **java SwingWorker<T,V> class** and it worked.

**Definition:**

SwingWorker is designed for situations where you need to have a long running task run in a background thread and provide updates to the UI either when done, or while processing. \*docs.oracle.com\*

**3.5.1 My Simple GUI**

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\*with monitors = multi thread

\* not with monitor = single thread

**3.5.2 Making it responsive while calculating**

First See start button action listener code

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**Canceling operation**

To cancel current operation, SwingWorker cancel method is used

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**Output:**

Graphical user interface, application

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**3.5.3 See the total time gained by using multiple threads**

**Output:**

Graphical user interface, text, application

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\*As you can see, we gained **nearly same amount of time as in console test**. Note that in this test I have used 4096x4096 size of matrix.

**3.5 Full Class Diagram**

Graphical user interface

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**References**

* CSE344 System Programming Course slides
* Head First Design Patterns, 2nd Edition.
* <https://en.wikipedia.org/wiki/Discrete_Fourier_transform>
* <https://docs.oracle.com/javase/7/docs/api/java/util/concurrent/locks/ReentrantLock.html>
* <https://docs.oracle.com/javase/7/docs/api/javax/swing/SwingWorker.html>

**Java Version**

Project default java version is **17**. Therefore, executables(jar files) may not be working, if java 17 is not installed.