CSE443 - Object-Oriented Analysis & Design - HW 3

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Part 1

The proxy pattern is used to provide safe access to data structure from multiple threads. The synchronization problem is handled as in the readers-writers problem. Synchronization is ensured using Java's `ReentrantReadWriteLock` by wrapping the methods of data structure with lock and unlock methods of the appropriate lock type.
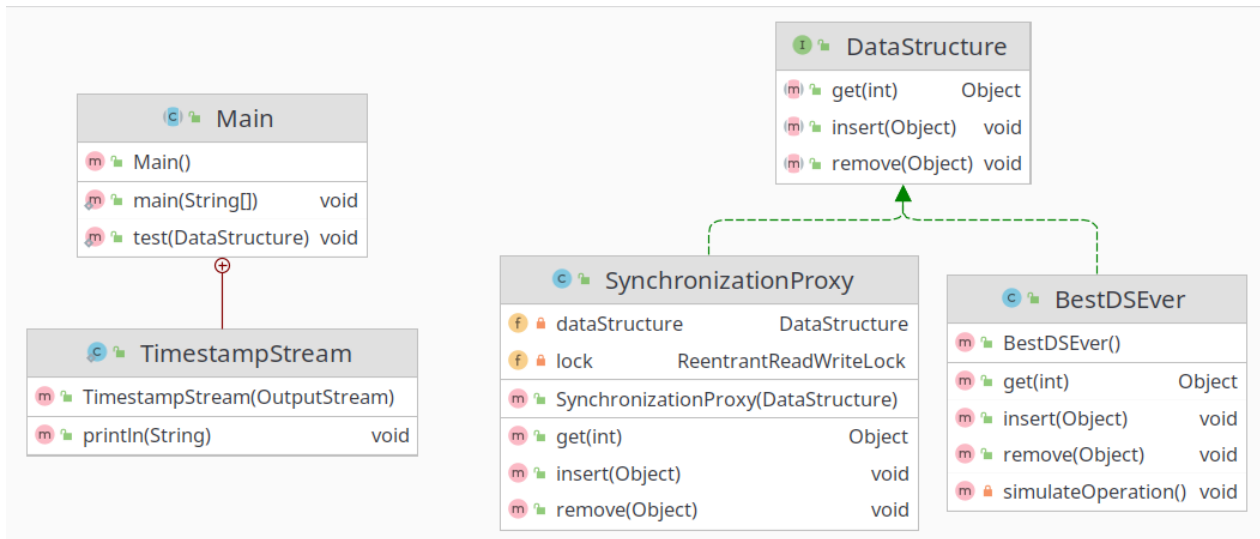

Figure 1: Class Diagram

To test, two threads are created in `Main` method, which calls `insert()`, `get()` and `remove()` respectively. The output stream is modified to the print timestamp to demonstrate synchronization. All operations are simulated using `Thread.sleep(1000)`. So, the thread-unsafe version is expected to take about 3 seconds, and the thread-safe version is expected to take about 5 seconds (not 6 because both threads can read the data if no writers have the lock).

Output:

```
[19:43:35.154400] ==== TEST: THREAD UNSAFE ====
[19:43:35.190006] Thread 1 started
[19:43:35.190242] Thread 2 started
[19:43:35.190334] inserting
[19:43:35.190360] inserting
[19:43:36.190616] getting
[19:43:36.190627] getting
[19:43:37.191169] removing
[19:43:37.191284] removing
[19:43:38.191698] Thread 1 finished
[19:43:38.191903] Thread 2 finished
[19:43:38.192742] ==== TEST: THREAD SAFE ====
[19:43:38.193765] Thread 1 started
[19:43:38.194064] Thread 2 started
[19:43:38.195885] inserting
[19:43:39.196609] inserting
[19:43:40.197320] getting
[19:43:40.197895] getting
[19:43:41.198459] removing
[19:43:42.199258] Thread 2 finished
[19:43:42.199355] removing
[19:43:43.200355] Thread 1 finished
```

Part 2

Corresponding classes of composite design pattern;

- Component: `EmailComponent`

- Composite: `EmailGroup`

- Leaf: `Email`

`EmailComponent` is an abstract class instead of an interface because the email address field is common in both `Email` and `EmailGroup`.
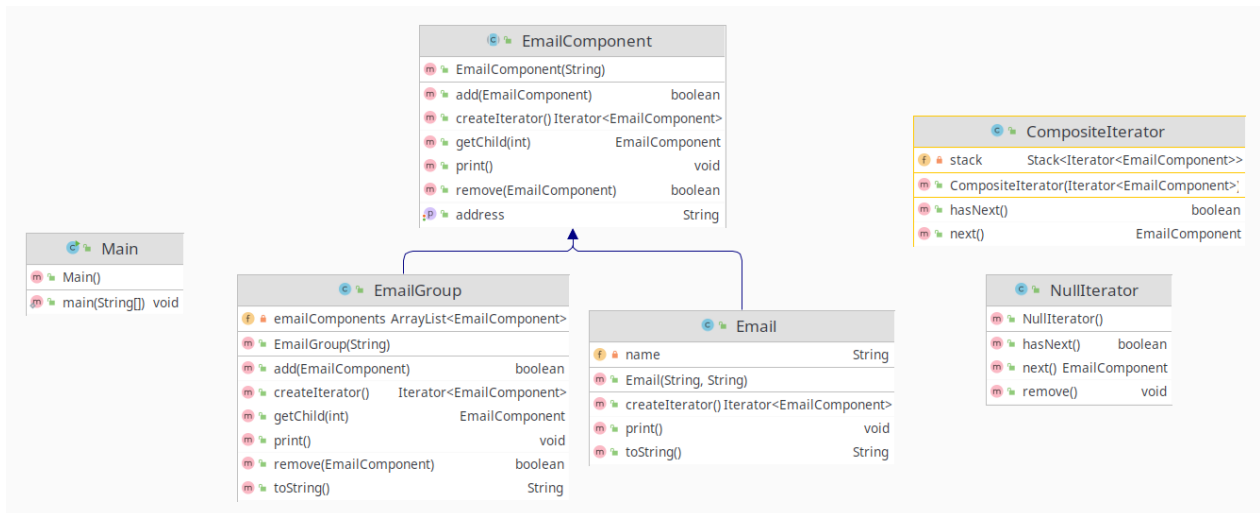

Figure 2: Class Diagram

Output:

```
==== TEST: print method called on an email =====
kendallroy@waystar.com Kendall Roy
==== TEST: print method called on an email group where elements are an email and an email group =====
loganroy@waystar.com Logan Roy
roysiblings@waystarroyco.com:{siobhanroy@waystar.com Siobhan Roy, kendallroy@waystar.com Kendall Roy,
↪    romanroy@waystar.com Roman Roy}
==== TEST: print method called on an email group where elements are emails and nested email groups =====
gerrikelman@waystar.com Gerri Kelman
tomwambsgans@waystar.com Tom
royfamily@waystarroyco.com:{loganroy@waystar.com Logan Roy,
↪    roysiblings@waystarroyco.com:{siobhanroy@waystar.com Siobhan Roy, kendallroy@waystar.com Kendall Roy,
↪    romanroy@waystar.com Roman Roy}}
```