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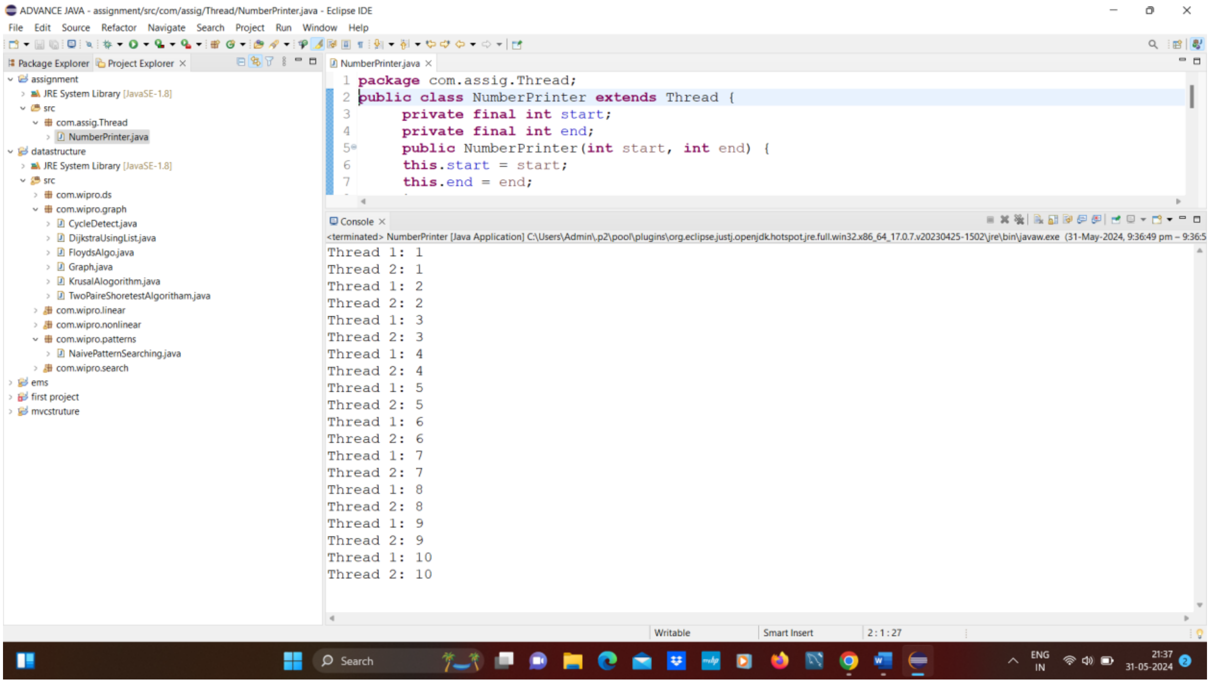
Day 18

Task 1: Creating and Managing Threads Write a program that starts two threads, where each thread prints numbers from 1 to 10 with a 1-second delay between each number .

```
package com.assig.thread;
public class NumberPrinter extends Thread {
 private final int start;
 private final int end;
 public NumberPrinter(int start, int end) {
 this.start = start;
 this.end = end;
 }
 public void run() {
 for (int i = start; i <= end; i++) {
 System.out.println(Thread.currentThread().getName() + ": " + i);
 try {
 Thread.sleep(1000);
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 }
 }
 public static void main(String[] args) {
 Thread thread1 = new NumberPrinter(1, 10);
 Thread thread2 = new NumberPrinter(1, 10);
 thread1.setName("Thread 1");
 thread2.setName("Thread 2");
 thread1.start();
 thread2.start();
 }
}
```

OUTPUT:



```
package com.assig.Thread;
public class NumberPrinter extends Thread {
      private final int start;
      private final int end;
      public NumberPrinter(int start, int end) {
      this.start = start;
      this.end = end;
```

```
<terminated> NumberPrinter [Java Application] C:\Users\Admin\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.7.v20230425-1502\jre\bin\javaw.exe  (31-May-2024, 9:36:49 pm – 9:36:5
Thread 1: 1
Thread 2: 1
Thread 1: 2
Thread 2: 2
Thread 1: 3
Thread 2: 3
Thread 1: 4
Thread 2: 4
Thread 1: 5
Thread 2: 5
Thread 1: 6
Thread 2: 6
Thread 1: 7
Thread 2: 7
Thread 1: 8
Thread 2: 8
Thread 1: 9
Thread 2: 9
Thread 1: 10
Thread 2: 10
```

Task 2: States and Transitions

Create a Java class that simulates a thread going through different lifecycle states: NEW, RUNNABLE, WAITING, TIMED_WAITING, BLOCKED, and TERMINATED. Use methods like sleep(), wait(), notify(), and join() to demonstrate these states

```
package com.assig.thread;
public class ThreadLifecycleSimulation {
 public static void main(String[] args) {
 Thread thread = new Thread(() -> {
 System.out.println("Thread state: " +
Thread.currentThread().getState()); // new state
 try {
```

```
 Thread.sleep(1000); // thread sleeps for 1 second
 System.out.println("Thread state: " +
Thread.currentThread().getState()); // state runneable
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
synchronized (ThreadLifecycleSimulation.class) {
 try {
 ThreadLifecycleSimulation.class.wait(); // Thread enters waiting state
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 }System.out.println("Thread state: " +
Thread.currentThread().getState()); // timewaiting state
 try {
 Thread.sleep(2000); // Thread sleeps for 2 seconds
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 System.out.println("Thread state: " +
Thread.currentThread().getState()); // blocked state
 });
 System.out.println("Thread state: " + thread.getState()); //new state
 thread.start();
 try {
 Thread.sleep(500); // main thread sleeps for 0.5 seconds
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
```

System.out.println("Thread state: " + thread.getState()); // runnable

state

synchronized (ThreadLifecycleSimulation.class) {

ThreadLifecycleSimulation.class.notify(); // Thread transitions from

waiting to time waiting state

}

try {

thread.join(); // Main thread waits for the child thread to terminate

} catch (InterruptedException e) {

e.printStackTrace();

}

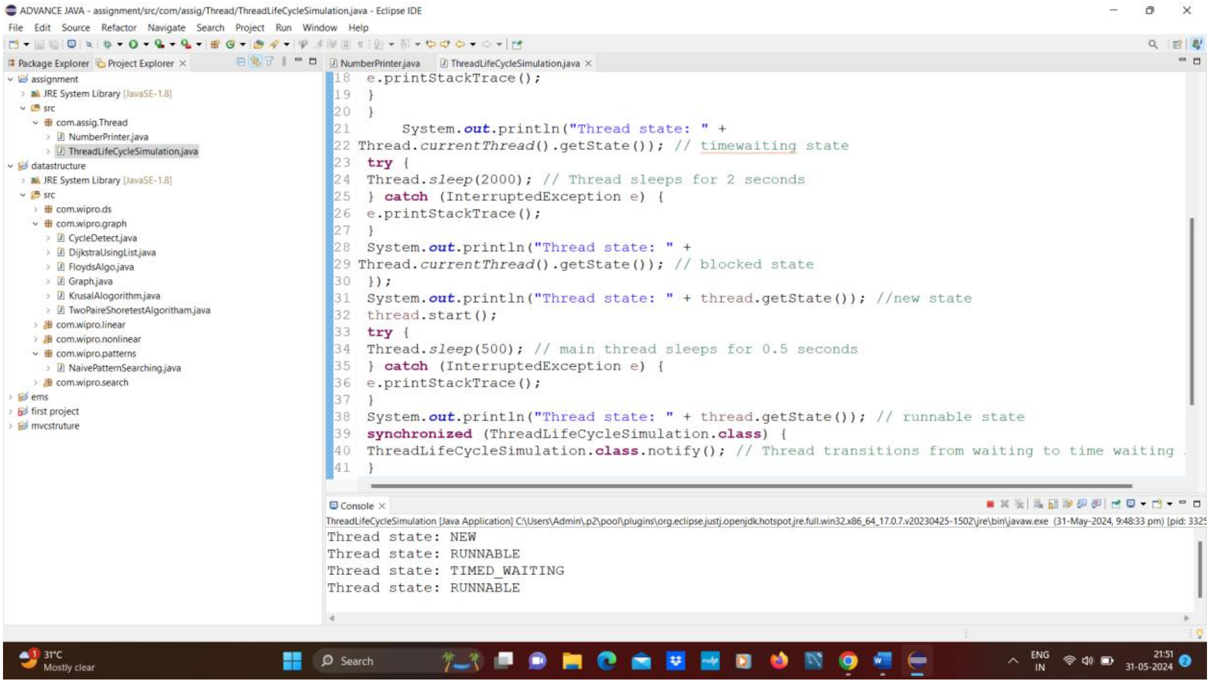
System.out.println("Thread state: " + thread.getState()); // termonated

state

}

}

OUTPUT:



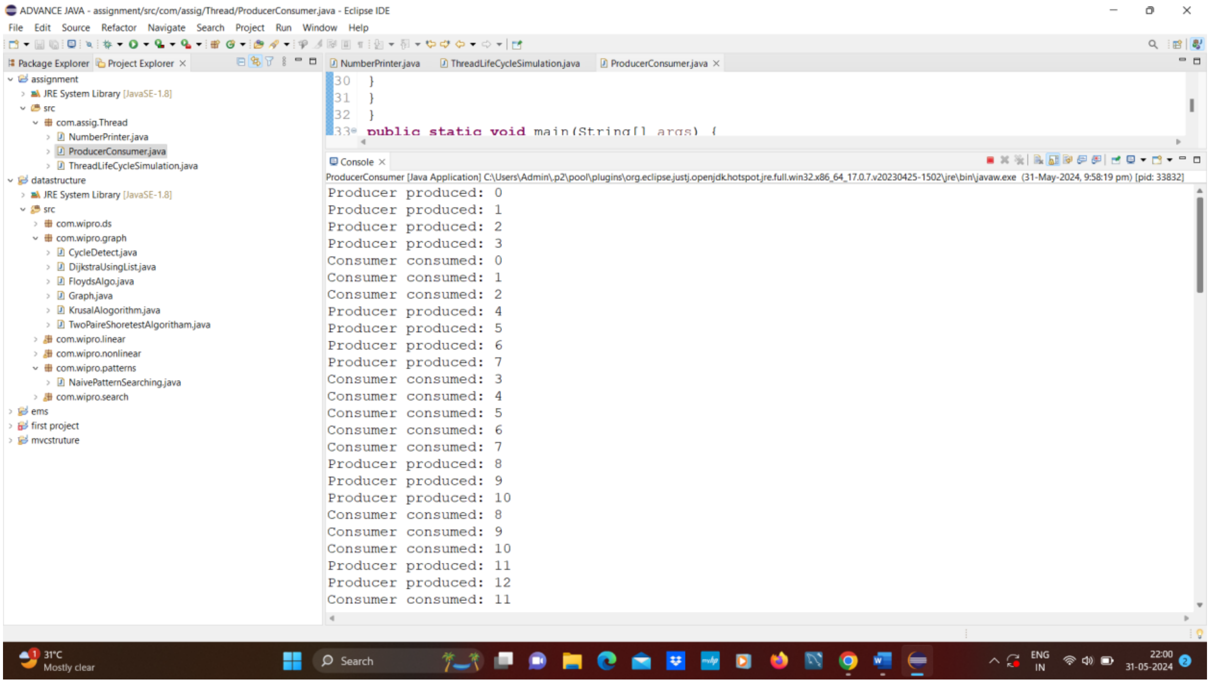
```
 e.printStackTrace();
 }
 }
     System.out.println("Thread state: " +
Thread.currentThread().getState()); // timewaiting state
 try {
 Thread.sleep(2000); // Thread sleeps for 2 seconds
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 System.out.println("Thread state: " +
Thread.currentThread().getState()); // blocked state
 });
 System.out.println("Thread state: " + thread.getState()); //new state
 thread.start();
 try {
 Thread.sleep(500); // main thread sleeps for 0.5 seconds
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 System.out.println("Thread state: " + thread.getState()); // runnable state
 synchronized (ThreadLifeCycleSimulation.class) {
 ThreadLifeCycleSimulation.class.notify(); // Thread transitions from waiting to time waiting
 }
```

```
ThreadLifeCycleSimulation [Java Application] C:\Users\Admin\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.7.v20230425-1502\jre\bin\javaw.exe (31-May-2024, 9:48:33 pm) [pid: 3325
Thread state: NEW
Thread state: RUNNABLE
Thread state: TIMED_WAITING
Thread state: RUNNABLE
```

Task 3: Synchronization and Inter-thread Communication Implement a producer-consumer problem using wait() and notify() methods to handle the correct processing sequence between threads.

```
package com.assig.thread;
import java.util.LinkedList;
public class ProducerConsumer {
 private LinkedList<Integer> buffer = new LinkedList<>();
 private int capacity = 5;
 public void produce() throws InterruptedException {
 int value = 0;
 while (true) {
 synchronized (this) {
 while (buffer.size() == capacity) {
 wait();
 }
System.out.println("Producer produced: " + value);
 buffer.add(value++);
 notify();
 Thread.sleep(1000);
 }
 }
}
 public void consume() throws InterruptedException {
 while (true) {
 synchronized (this) {
 while (buffer.size() == 0) {
 wait(); // Wait if buffer is empty
 }
 int val = buffer.removeFirst();
 System.out.println("Consumer consumed: " + val);
 notify();
 Thread.sleep(1000);
 }
 }
 }
 public static void main(String[] args) {
 ProducerConsumer pc = new ProducerConsumer();
 Thread producerThread = new Thread(() -> {
 try {
 pc.produce();
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 });
 Thread consumerThread = new Thread(() -> {
 try {
 pc.consume();
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 });
 producerThread.start();
 consumerThread.start();
 }
}
```

OUTPUT:



```
   }
  }
 }
public static void main(String[] args) {
```

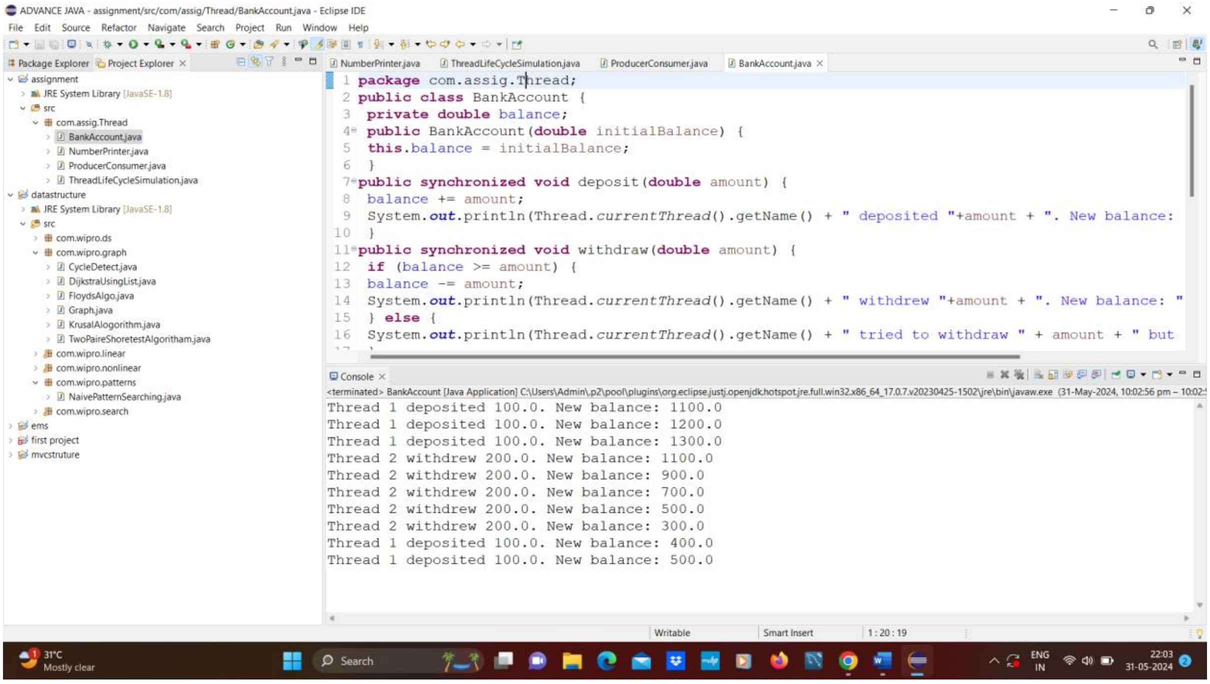
ProducerConsumer [Java Application] C:\Users\Admin\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.7.v20230425-1502\jre\bin\javaw.exe (31-May-2024, 9:58:19 pm) [pid: 33832]

```
Producer produced: 0
Producer produced: 1
Producer produced: 2
Producer produced: 3
Consumer consumed: 0
Consumer consumed: 1
Consumer consumed: 2
Producer produced: 4
Producer produced: 5
Producer produced: 6
Producer produced: 7
Consumer consumed: 3
Consumer consumed: 4
Consumer consumed: 5
Consumer consumed: 6
Consumer consumed: 7
Producer produced: 8
Producer produced: 9
Producer produced: 10
Consumer consumed: 8
Consumer consumed: 9
Consumer consumed: 10
Producer produced: 11
Producer produced: 12
Consumer consumed: 11
```

Task 4: Synchronized Blocks and MethodsWrite a program that simulates a bank account being accessed by multiple threads to perform deposits and withdrawals usingsynchronized methods to prevent race conditions.

```
package com.assig.thread;

public class BankAccount {

 private double balance;

 public BankAccount(double initialBalance) {

 this.balance = initialBalance;

 }

public synchronized void deposit(double amount) {

 balance += amount;

 System.out.println(Thread.currentThread().getName() + " deposited "+amount + ". New balance: " + balance);

 }

public synchronized void withdraw(double amount) {

 if (balance >= amount) {

 balance -= amount;

 System.out.println(Thread.currentThread().getName() + " withdrew "+amount + ". New balance: " + balance);
 } else {
 System.out.println(Thread.currentThread().getName() + " tried to withdraw " + amount + " but insufficient funds.");
 }
 }
public static void main(String[] args) {
 BankAccount account = new BankAccount(1000);
 Thread thread1 = new Thread(() -> {
 for (int i = 0; i < 5; i++) {
 account.deposit(100);
 }
 });
Thread thread2 = new Thread(() -> {
 for (int i = 0; i < 5; i++) {
 account.withdraw(200);
 }
 });
thread1.setName("Thread 1");
 thread2.setName("Thread 2");
 thread1.start();
 thread2.start();
 }
}
```

OUTPUT:



```
package com.assig.Thread;
public class BankAccount {
 private double balance;
 public BankAccount(double initialBalance) {
 this.balance = initialBalance;
 }
public synchronized void deposit(double amount) {
 balance += amount;
 System.out.println(Thread.currentThread().getName() + " deposited "+amount + ". New balance:
 }
public synchronized void withdraw(double amount) {
 if (balance >= amount) {
 balance -= amount;
 System.out.println(Thread.currentThread().getName() + " withdrew "+amount + ". New balance: "
 } else {
 System.out.println(Thread.currentThread().getName() + " tried to withdraw " + amount + " but
```

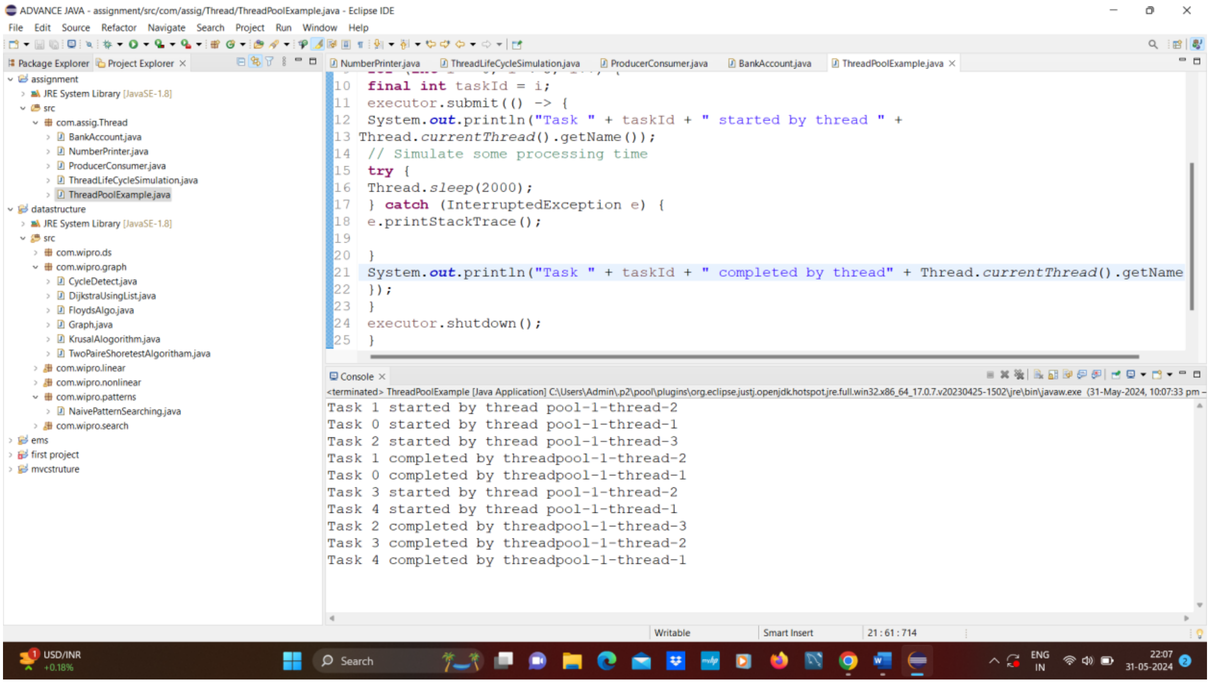
```
<terminated> BankAccount [Java Application] C:\Users\Admin\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.7.v20230425-1502\jre\bin\javaw.exe (31-May-2024, 10:02:56 pm – 10:02:
Thread 1 deposited 100.0. New balance: 1100.0
Thread 1 deposited 100.0. New balance: 1200.0
Thread 1 deposited 100.0. New balance: 1300.0
Thread 2 withdrew 200.0. New balance: 1100.0
Thread 2 withdrew 200.0. New balance: 900.0
Thread 2 withdrew 200.0. New balance: 700.0
Thread 2 withdrew 200.0. New balance: 500.0
Thread 2 withdrew 200.0. New balance: 300.0
Thread 1 deposited 100.0. New balance: 400.0
Thread 1 deposited 100.0. New balance: 500.0
```

Task 5: Thread Pools and Concurrency Utilities Create a fixed-size thread pool and submit multiple tasks that perform complex calculations or I/O operations and observe the execution

```
package com.assig.thread;

import java.util.concurrent.ExecutorService;

import java.util.concurrent.Executors;

public class ThreadPoolExample {

 public static void main(String[] args) {

 // Create a fixed-size thread pool with 3 threads

 ExecutorService executor = Executors.newFixedThreadPool(3);

 // Submit tasks to the thread pool

 for (int i = 0; i < 5; i++) {

 final int taskId = i;

 executor.submit(() -> {

 System.out.println("Task " + taskId + " started by thread " +

Thread.currentThread().getName());

 // Simulate some processing time

 try {
```

```
Thread.sleep(2000);
} catch (InterruptedException e) {
e.printStackTrace();
}
System.out.println("Task " + taskId + " completed by thread
" + Thread.currentThread().getName());
});
}
executor.shutdown();
}
}
```

OUTPUT:


ADVANCE JAVA - assignment/src/com/assig/Thread/ThreadPoolExample.java - Eclipse IDE
File Edit Source Refactor Navigate Search Project Run Window Help
Package Explorer
Project Explorer
NumberPrinter.java
ThreadLifeCycleSimulation.java
ProducerConsumer.java
BankAccount.java
ThreadPoolExample.java
Console
Writable
Smart Insert
21 : 61 : 714

```
final int taskId = i;
executor.submit(() -> {
System.out.println("Task " + taskId + " started by thread " +
Thread.currentThread().getName());
// Simulate some processing time
try {
Thread.sleep(2000);
} catch (InterruptedException e) {
e.printStackTrace();

}
System.out.println("Task " + taskId + " completed by thread" + Thread.currentThread().getName
});
}
executor.shutdown();
}
```

```
<terminated> ThreadPoolExample [Java Application] C:\Users\Admin\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.7.v20230425-1502\jre\bin\javaw.exe (31-May-2024, 10:07:33 pm –
Task 1 started by thread pool-1-thread-2
Task 0 started by thread pool-1-thread-1
Task 2 started by thread pool-1-thread-3
Task 1 completed by threadpool-1-thread-2
Task 0 completed by threadpool-1-thread-1
Task 3 started by thread pool-1-thread-2
Task 4 started by thread pool-1-thread-1
Task 2 completed by threadpool-1-thread-3
Task 3 completed by threadpool-1-thread-2
Task 4 completed by threadpool-1-thread-1
```

Task 6: Executors, Concurrent Collections, CompletableFuture Use an ExecutorService to parallelize a task that calculates prime numbers up to a given number and then use CompletableFuture to write the results to a file asynchronously.

```
package com.assig.thread;

import java.io.BufferedWriter;

import java.io.FileWriter;
```

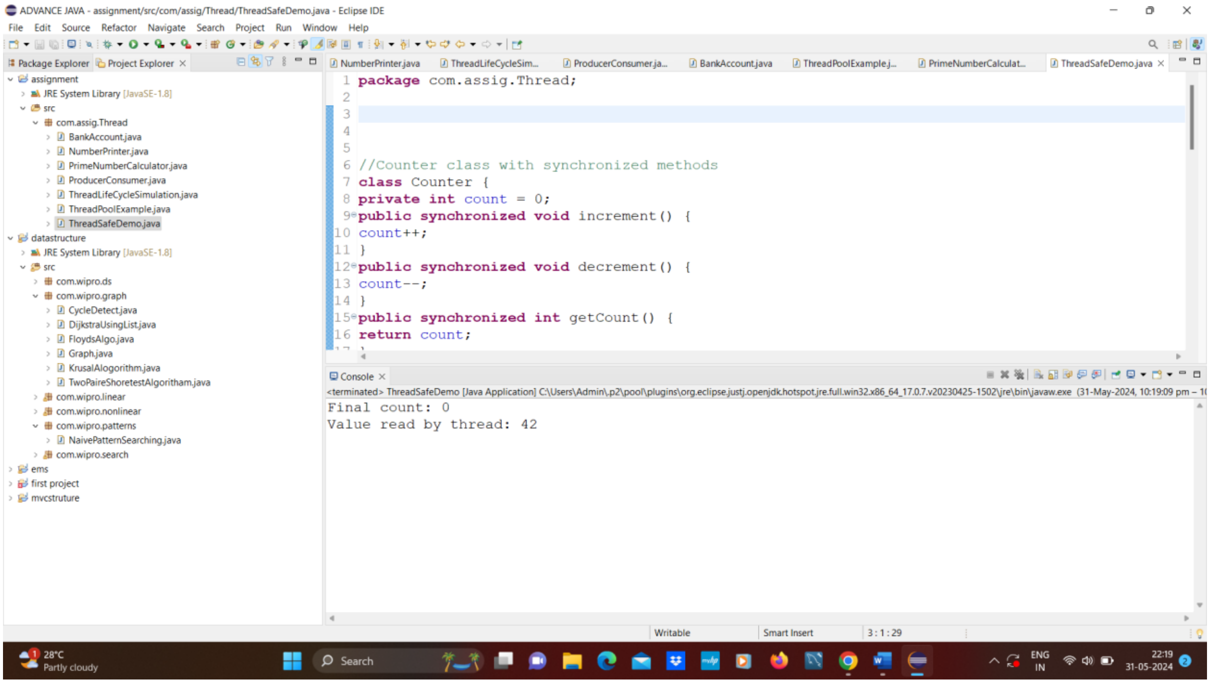
```java
import java.io.IOException;
import java.util.ArrayList;
import java.util.List;
import java.util.concurrent.CompletableFuture;
import java.util.concurrent.ExecutorService;
import java.util.concurrent.Executors;
import java.util.stream.Collectors;
public class PrimeNumberCalculator {
 private static final int THREAD_COUNT = 4;
 public static void main(String[] args) {
 int maxNumber = 100;
 ExecutorService executor = Executors.newFixedThreadPool(THREAD_COUNT);
 // Calculate prime numbers in parallel
 List<CompletableFuture<List<Integer>>> futures = new ArrayList<>();
 for (int i = 0; i < THREAD_COUNT; i++) {
 int start = i * (maxNumber / THREAD_COUNT) + 1;
 int end = (i + 1) * (maxNumber / THREAD_COUNT);
 CompletableFuture<List<Integer>> future =
CompletableFuture.supplyAsync(() -> calculatePrimes(start, end), executor);
 futures.add(future);
 }
 // Combine results from all threads
 CompletableFuture<List<Integer>> combinedFuture = CompletableFuture.allOf(
 futures.toArray(new CompletableFuture[0]))
 .thenApply(v -> futures.stream()
 .map(CompletableFuture::join)
 .flatMap(List::stream)
 .collect(Collectors.toList()));
 // Write results to file asynchronously
 combinedFuture.thenAcceptAsync(primes -> {
 try (BufferedWriter writer = new BufferedWriter(new
FileWriter("primes.txt"))) {
 for (Integer prime : primes) {
 writer.write(prime.toString());
 writer.newLine();
 }
 } catch (IOException e) {
 e.printStackTrace();
 }
 }, executor);

executor.shutdown();
 }
 private static List<Integer> calculatePrimes(int start, int end) {
 List<Integer> primes = new ArrayList<>();
 for (int i = start; i <= end; i++) {
 if (isPrime(i)) {
 primes.add(i);
 }
 }
 return primes;
 }
 private static boolean isPrime(int number) {
 if (number <= 1) {
 return false;
 }
 for (int i = 2; i <= Math.sqrt(number); i++) {
 if (number % i == 0) {
 return false;
 }
 }
 return true;
 }
}
```

Task 7: Writing Thread-Safe Code, Immutable Objects Design a thread-safe Counter class with increment and decrement methods. Then demonstrate its usage from multiple threads. Also, implement and use an immutable class to share data between threads.

```
//Counter class with synchronized methods
class Counter {
private int count = 0;
public synchronized void increment() {
 count++;
}
public synchronized void decrement() {
 count--;
}
public synchronized int getCount() {
 return count;
}
}

//Immutable class to share data between threads
final class ImmutableData {
private final int value;
public ImmutableData(int value) {
 this.value = value;
}
```

```
public int getValue() {
 return value;
}
}
public class ThreadSafeDemo {
public static void main(String[] args) {
 Counter counter = new Counter();
 // Create multiple threads to increment and decrement the counter
 Thread incrementThread = new Thread(() -> {
 for (int i = 0; i < 1000; i++) {
 counter.increment();
 }
 });
 Thread decrementThread = new Thread(() -> {
 for (int i = 0; i < 1000; i++) {
 counter.decrement();
 }
 });
 incrementThread.start();
 decrementThread.start();
 // Wait for both threads to complete
 try {
 incrementThread.join();
 decrementThread.join();
 } catch (InterruptedException e) {
 e.printStackTrace();
 }
 // Print the final count
 System.out.println("Final count: " + counter.getCount());
 // Usage of ImmutableData class
 ImmutableData immutableData = new ImmutableData(42);
 Thread readThread = new Thread(() -> {
 System.out.println("Value read by thread: " + immutableData.getValue());
 });
 readThread.start();
}
}
```

output:



```
package com.assig.Thread;



//Counter class with synchronized methods
class Counter {
private int count = 0;
public synchronized void increment() {
count++;
}
public synchronized void decrement() {
count--;
}
public synchronized int getCount() {
return count;
```

```
<terminated> ThreadSafeDemo [Java Application] C:\Users\Admin\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.7.v20230425-1502\jre\bin\javaw.exe (31-May-2024, 10:19:09 pm – 1
Final count: 0
Value read by thread: 42
```