Task 1: Creating and Managing Threads

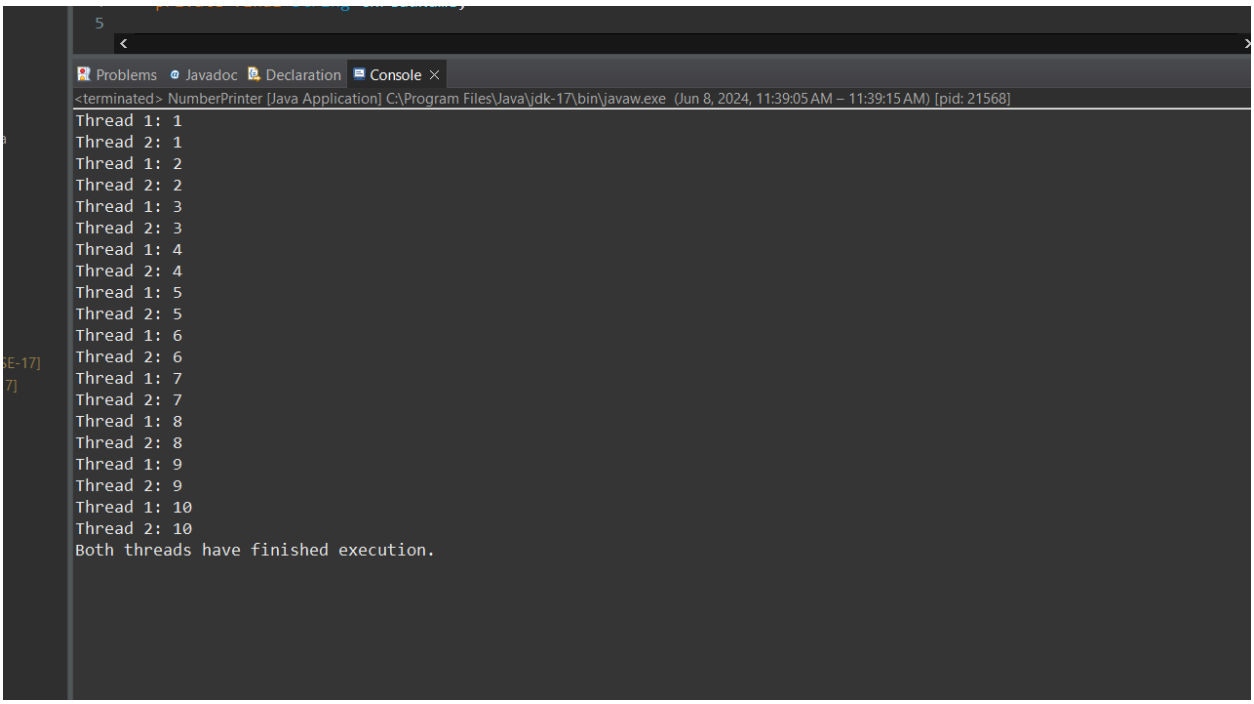
Write a program that starts two threads, where each thread prints numbers from 1 to 10 with a 1-second delay between each number

Ans:

```
package Assignments;


public class NumberPrinter implements Runnable {
   private final String threadName;


   public NumberPrinter(String threadName) {
      this.threadName = threadName;
   }


   @Override
   public void run() {
      for (int i = 1; i <= 10; i++) {
         System.out.println(threadName + ": " + i);
         try {
            Thread.sleep(1000);
         } catch (InterruptedException e) {
            System.err.println(threadName + " interrupted.");
         }
      }
   }


   public static void main(String[] args) {
      Thread thread1 = new Thread(new NumberPrinter("Thread 1"));
      Thread thread2 = new Thread(new NumberPrinter("Thread 2"));
```

```
        thread1.start();
        thread2.start();

        try {
            thread1.join();
            thread2.join();
        } catch (InterruptedException e) {
            System.err.println("Main thread interrupted.");
        }

        System.out.println("Both threads have finished execution.");
    }
}
```

Output:



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..

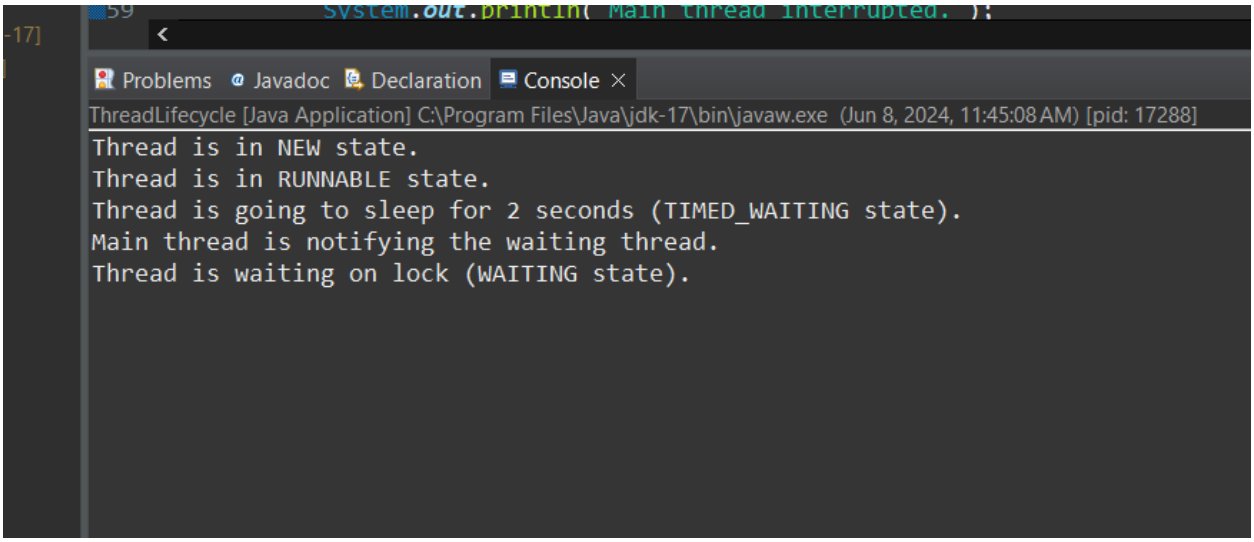
Ans:

```
package Assignments;


public class ThreadLifecycle implements Runnable {
   private final Object lock = new Object();


   @Override
   public void run() {
      try {


         System.out.println("Thread is in RUNNABLE state.");



         System.out.println("Thread is going to sleep for 2 seconds (TIMED_WAITING state).");
         Thread.sleep(2000);



         synchronized (lock) {
            System.out.println("Thread is waiting on lock (WAITING state).");
            lock.wait();
         }



         System.out.println("Thread is back to RUNNABLE state after being notified.");
```

```
            synchronized (lock) {
                System.out.println("Thread is going to wait on lock for 2 seconds (TIMED_WAITING state).");
                lock.wait(2000);
            }


            System.out.println("Thread is trying to acquire lock (BLOCKED state simulation).");
            synchronized (lock) {
                System.out.println("Thread acquired the lock (RUNNABLE state).");
            }

        } catch (InterruptedException e) {
            System.out.println("Thread interrupted.");
        }


        System.out.println("Thread is in TERMINATED state.");
    }

    public static void main(String[] args) {
        ThreadLifecycle runnableInstance = new ThreadLifecycle();
        Thread thread = new Thread(runnableInstance);
        System.out.println("Thread is in NEW state.");
        thread.start();

        try {
            Thread.sleep(1000);
            synchronized (runnableInstance.lock) {
```

```
            System.out.println("Main thread is notifying the waiting thread.");
            runnableInstance.lock.notify();
        }
        thread.join();
    } catch (InterruptedException e) {
        System.out.println("Main thread interrupted.");
    }
  }
}
```

Output:



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.

Ans:

```
package com.wipro;


class Common{
```

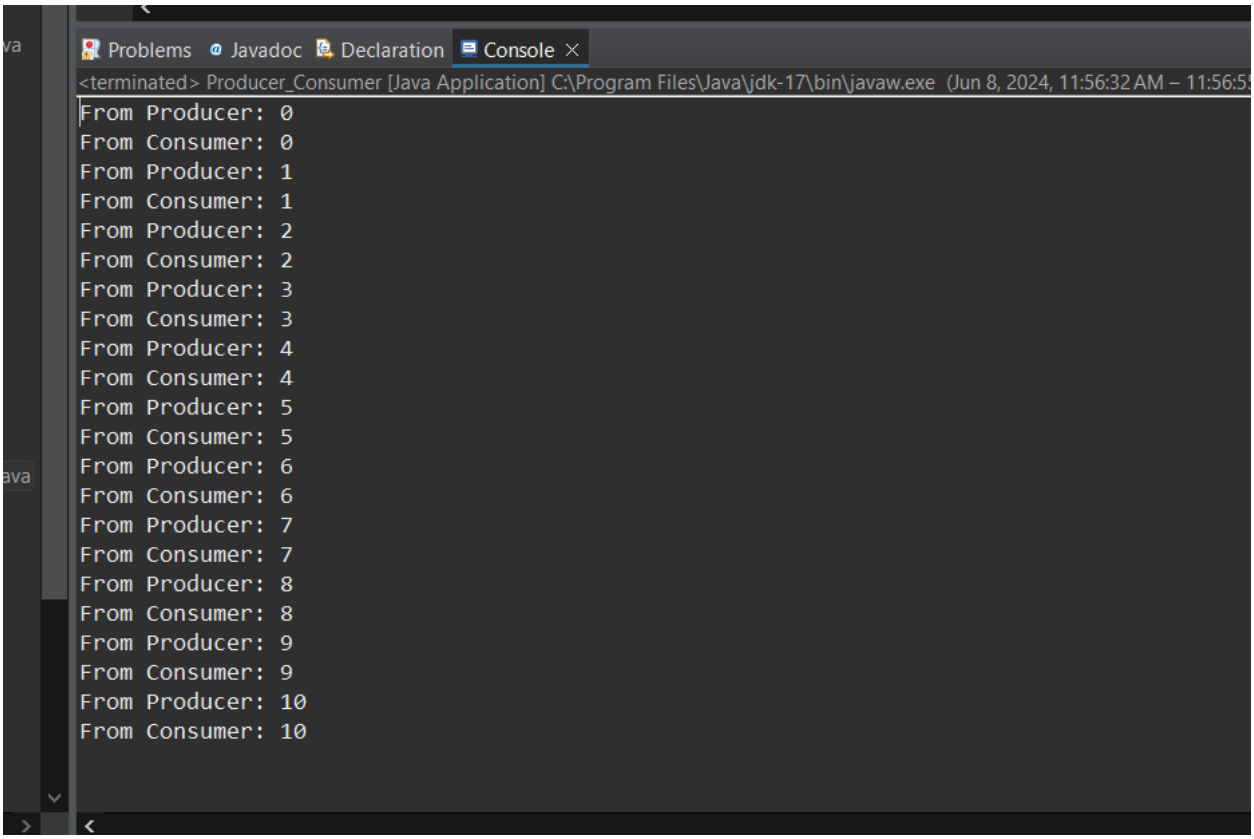
```
int num;
boolean available=false;

public synchronized int put(int num)
{
	if(available)
	try {
		wait();
	} catch (InterruptedException e) {

		e.printStackTrace();
	}
	this.num=num;
	System.out.println("From Producer: "+this.num);

	try {
		Thread.sleep(1000);
	} catch (InterruptedException e) {
		// TODO Auto-generated catch block
		e.printStackTrace();
	}
	available=true; //imp var
	notify();
	return num;
}
public synchronized int get()
{
	if(!available)
		try {
```

```
                wait();
            } catch (InterruptedException e) {

                e.printStackTrace();
            }
        System.out.println("From Consumer: "+this.num);

        try {
            Thread.sleep(1000);
        } catch (InterruptedException e) {
            // TODO Auto-generated catch block
            e.printStackTrace();
        }
          available=false;
          notify();
          return num;
    }
}

class Producer extends Thread{
    Common c;
    public Producer(Common c)
    {
        this.c=c;
        new Thread(this, "Producer: ").start();
    }
    public void run()
    {
        int x=0,i=0;
```

```
                while(x<=10)
                {
                        c.put(i++);
                        x++;
                }
        }
}
class Consumer extends Thread{
        Common c;
        public Consumer(Common c)
        {
                this.c=c;
                new Thread(this, " Consumer: ").start();
        }
        public void run()
        {
                int x=0;
                while(x<=10)
                {
                        c.get();
                        x++;
                }
        }
}
public class Producer_Consumer {

        public static void main(String[] args) {
                Common c=new Common();
                new Producer(c);
```

```
                new Consumer(c);
        }
}
```

OUTPUT:



Task 4: Synchronized Blocks and Methods

Write a program that simulates a bank account being accessed by multiple threads to perform deposits and withdrawals using synchronized methods to prevent race conditions.

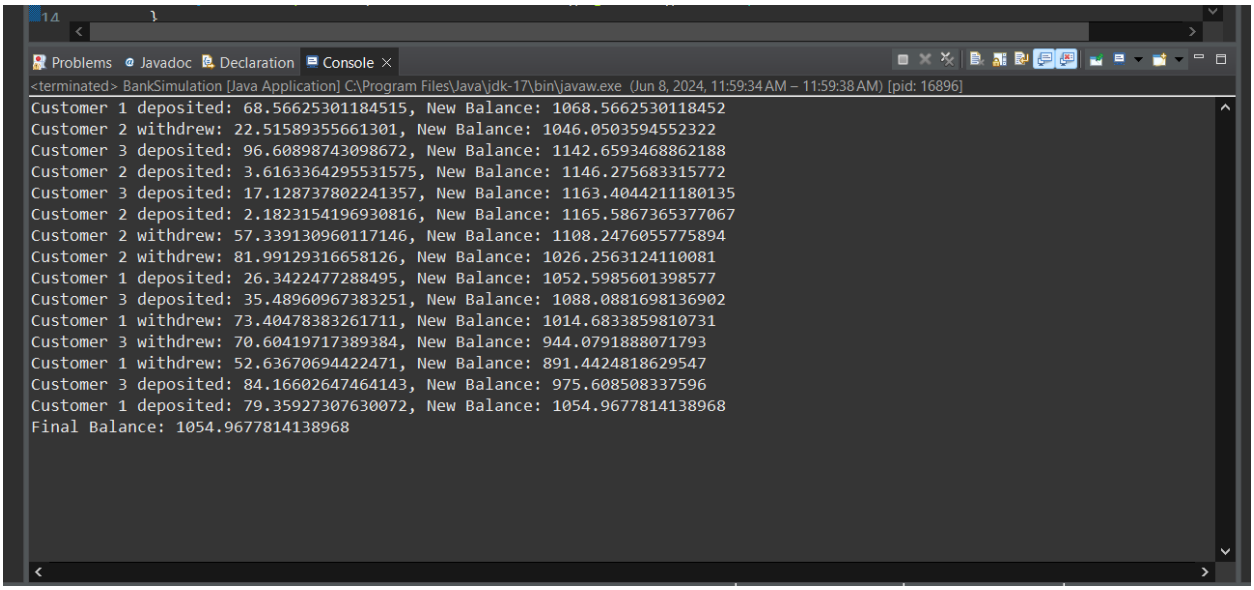
```
package Assignments;


class BankAccount {

    private double balance;
```

```
    public BankAccount(double initialBalance) {
        this.balance = initialBalance;
    }

    public synchronized void deposit(double amount) {
        if (amount > 0) {
            balance += amount;
            System.out.println(Thread.currentThread().getName() + " deposited: " + amount + ", New Balance: " + balance);
        }
    }

    public synchronized void withdraw(double amount) {
        if (amount > 0 && amount <= balance) {
            balance -= amount;
            System.out.println(Thread.currentThread().getName() + " withdrew: " + amount + ", New Balance: " + balance);
        } else {
            System.out.println(Thread.currentThread().getName() + " attempted to withdraw: " + amount + ", Insufficient Funds");
        }
    }

    public synchronized double getBalance() {
        return balance;
    }
}

class BankCustomer implements Runnable {
```

```
    private BankAccount account;

    public BankCustomer(BankAccount account) {
        this.account = account;
    }

    @Override
    public void run() {
        for (int i = 0; i < 5; i++) {
            double amount = Math.random() * 100;
            if (Math.random() > 0.5) {
                account.deposit(amount);
            } else {
                account.withdraw(amount);
            }
            try {
                Thread.sleep((int)(Math.random() * 1000)); // Simulate time taken for transactions
            } catch (InterruptedException e) {
                e.printStackTrace();
            }
        }
    }
}

public class BankSimulation {
    public static void main(String[] args) {
        BankAccount sharedAccount = new BankAccount(1000);

        Thread customer1 = new Thread(new BankCustomer(sharedAccount), "Customer 1");
```

```
        Thread customer2 = new Thread(new BankCustomer(sharedAccount), "Customer 2");
        Thread customer3 = new Thread(new BankCustomer(sharedAccount), "Customer 3");

        customer1.start();
        customer2.start();
        customer3.start();

        try {
            customer1.join();
            customer2.join();
            customer3.join();
        } catch (InterruptedException e) {
            e.printStackTrace();
        }

        System.out.println("Final Balance: " + sharedAccount.getBalance());
    }
}
```

Output:



Task 5: Thread Pools and Concurrency Utilities

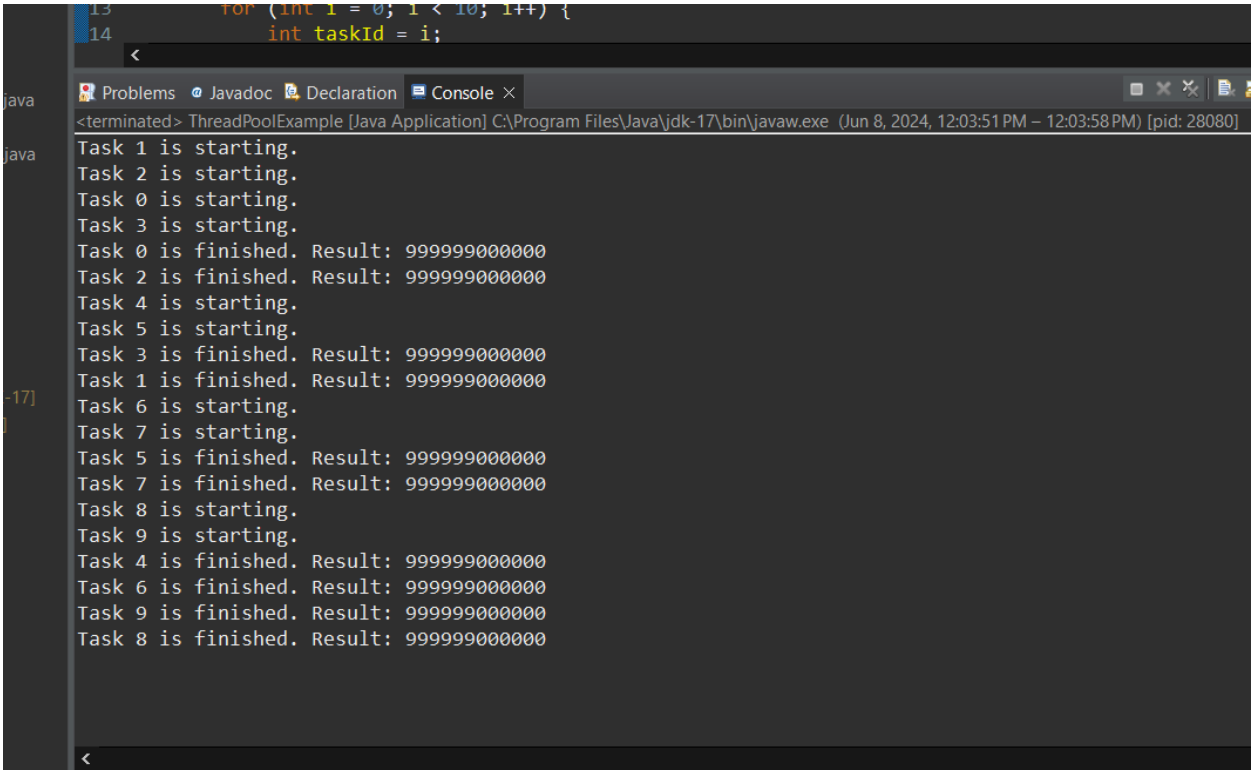
Create a fixed-size thread pool and submit multiple tasks that perform complex calculations or I/O operations and observe the execution.

Ans:

```
package Assignments;


import java.util.concurrent.ExecutorService;

import java.util.concurrent.Executors;

import java.util.concurrent.TimeUnit;


public class ThreadPoolExample {


   public static void main(String[] args) {


      ExecutorService executorService = Executors.newFixedThreadPool(4);


      for (int i = 0; i < 10; i++) {
         int taskId = i;
         executorService.submit(() -> {
            performTask(taskId);
         });
      }


      executorService.shutdown();


      try {


         if (!executorService.awaitTermination(60, TimeUnit.SECONDS)) {
            executorService.shutdownNow();
```

```
            }
        } catch (InterruptedException e) {
            executorService.shutdownNow();
        }
    }

    private static void performTask(int taskId) {
        System.out.println("Task " + taskId + " is starting.");

        long result = 0;
        for (int i = 0; i < 1000000; i++) {
            result += i * 2;
        }


        try {
            TimeUnit.SECONDS.sleep(2);
        } catch (InterruptedException e) {
            Thread.currentThread().interrupt();
        }

        System.out.println("Task " + taskId + " is finished. Result: " + result);
    }
}
```

Output:



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.

Ans:

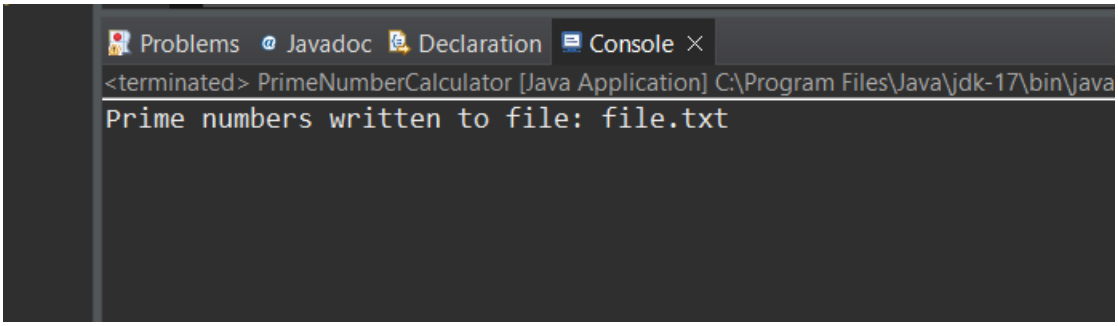
```
package Assignments;


import java.io.IOException;

import java.nio.file.Files;

import java.nio.file.Paths;

import java.util.List;

import java.util.concurrent.CompletableFuture;

import java.util.concurrent.ExecutorService;

import java.util.concurrent.Executors;
```

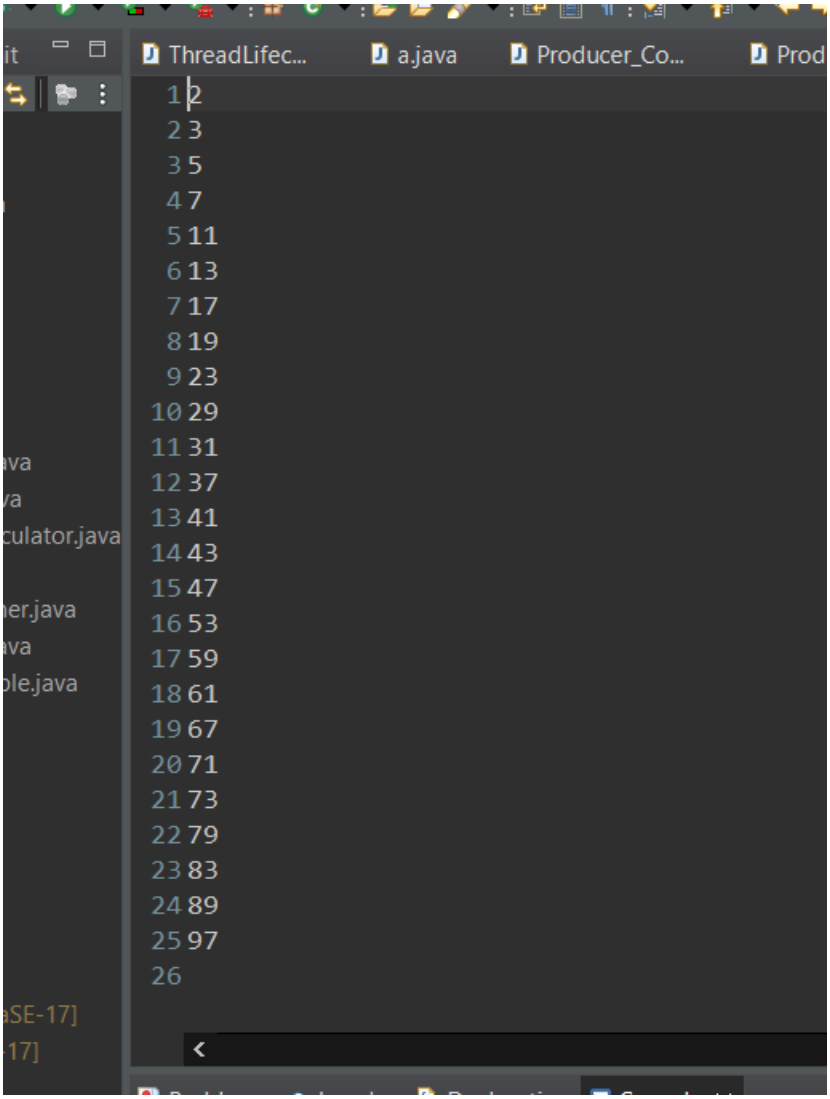
```
import java.util.stream.Collectors;
import java.util.stream.IntStream;

public class PrimeNumberCalculator {

    public static void main(String[] args) {
        int maxNumber = 100;
        String filePath = "file.txt";



        ExecutorService executor =
Executors.newFixedThreadPool(Runtime.getRuntime().availableProcessors());

        try {

            CompletableFuture<List<Integer>> future = CompletableFuture.supplyAsync(() ->
calculatePrimes(maxNumber), executor);



            future.thenAccept(primes -> writeToFile(primes, filePath))
                .exceptionally(ex -> {
                    System.err.println("Error: " + ex.getMessage());
                    return null;
                }).join();
        } finally {

            executor.shutdown();
        }
    }
```

```
private static List<Integer> calculatePrimes(int maxNumber) {
    return IntStream.rangeClosed(2, maxNumber)
                    .parallel()
                    .filter(PrimeNumberCalculator::isPrime)
                    .boxed()
                    .collect(Collectors.toList());
}


private static boolean isPrime(int number) {
    if (number <= 1) return false;
    if (number == 2) return true;
    if (number % 2 == 0) return false;
    for (int i = 3; i <= Math.sqrt(number); i += 2) {
        if (number % i == 0) return false;
    }
    return true;
}


private static void writeToFile(List<Integer> primes, String filePath) {
    try {
        Files.write(Paths.get(filePath), primes.stream()
                                        .map(String::valueOf)
                                        .collect(Collectors.toList()));
        System.out.println("Prime numbers written to file: " + filePath);
    } catch (IOException e) {
        System.err.println("Error writing to file: " + e.getMessage());
```

```
    }
  }
}
```

Output:


Problems
Javadoc
Declaration
Console
<terminated> PrimeNumberCalculator [Java Application] C:\Program Files\Java\jdk-17\bin\java
Prime numbers written to file: file.txt



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.

Ans:

```
package Assignments;


public class Counter {

    private int count;
```

```
    public Counter(int initialCount) {
        this.count = initialCount;
    }

    public synchronized void increment() {
        count++;
    }

    public synchronized void decrement() {
        count--;
    }

    public synchronized int getCount() {
        return count;
    }
}
```

```
package Assignments;

public final class ImmutableData {
    private final int value;

    public ImmutableData(int value) {
        this.value = value;
    }
```

```
    public int getValue() {
        return value;
    }
}
```

```
package Assignments;

import java.util.concurrent.ExecutorService;
import java.util.concurrent.Executors;
import java.util.concurrent.TimeUnit;

public class Main {
    public static void main(String[] args) {
        Counter counter = new Counter(0);
        ImmutableData immutableData = new ImmutableData(100);


        ExecutorService executor = Executors.newFixedThreadPool(10);

        for (int i = 0; i < 5; i++) {
            executor.submit(() -> {
                for (int j = 0; j < 1000; j++) {
                    counter.increment();
                }
            });
```

```
            executor.submit(() -> {
                for (int j = 0; j < 1000; j++) {
                    counter.decrement();
                }
            });
        }

        executor.shutdown();
        try {
            if (!executor.awaitTermination(60, TimeUnit.SECONDS)) {
                executor.shutdownNow();
            }
        } catch (InterruptedException e) {
            executor.shutdownNow();
        }

        System.out.println("Final Counter Value: " + counter.getCount());
        System.out.println("Immutable Data Value: " + immutableData.getValue());
    }
}
```

Output: