Homework 1

CSE 461 – Yousef Jarrar

Dr. Tong Yu

1. (10 points) **Extra Credit for 461 Students*
We have discussed in the class the implementation of the readers-writers problem in Java. However, the read and write tasks of the reader thread and the writer thread are not given. Implement these tasks in Java as reading and writing of a file named counter.txt, which contains an integer counter.
A reader thread

reads the counter from the file, and

prints out its thread name and the value of the counter.

A writer thread

increments the value of the counter in the file,

prints out its thread name and the new value of the counter.

Each thread repeats its task indefinitely in a random amount of time between 0 and 3000 ms. Your main program should create 20 reader threads and 3 writer threads.

Besides the source code, turn in scripts showing that you compile and run the program successfully. Turn in also some sample outputs.

```
/*
* Class created to hold lock and condition
* */

import java.io.File;
import java.io.FileInputStream;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Scanner;
import java.util.concurrent.locks.Condition;
import java.util.concurrent.locks.Lock;
import java.util.concurrent.locks.ReentrantLock;

public class ReadWrites {
    private final String file = "counter.txt";
```

```
    private final Lock _mutex = new ReentrantLock();// create mutex instance
    private final Condition readerQueue = _mutex.newCondition();// Returns a new condition for
// reader that is bound to this Lock instance.
    private final Condition writerQueue = _mutex.newCondition();// Returns a new condition for writer that
// is bound to this Lock instance.

    private int readers_count = 0;// to store current readers count
    private int writers_count = 0;// to store current writers count
    public ReadWrites() {
        try {
            FileWriter filewriter = new FileWriter(new File(file));
            filewriter.write(new Integer(0).toString());
            filewriter.close();
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
    void readerrun() throws InterruptedException {
        _mutex.lock(); // acquire lock
        while (!(writers_count == 0)) {
            readerQueue.await();
        }
        readers_count++;
        _mutex.unlock();
        read(file);//read file
        _mutex.lock();
        if (--readers_count == 0) {
            writerQueue.signal();//signal writers
        }
        _mutex.unlock();//remove lock
    }
    void writerrun() throws InterruptedException {
```

```
        _mutex.lock();
        while (!((readers_count == 0) && (writers_count == 0))) {
            writerQueue.await();// when reader and writer is zero wait in
// writerQueue
        }
        writers_count++; // increment writer
        _mutex.unlock();// remove lock
        write(file);// write to file
        _mutex.lock(); // acquire lock
        writers_count--; // only one writer at a time
        writerQueue.signal(); // signal writers
        readerQueue.signalAll(); // signal all readers
        _mutex.unlock();// remove lock
    }
    void read(String path) {
        try {
            Scanner reader = new Scanner(new FileInputStream(path));
            int x = reader.nextInt();
            System.out.printf(Thread.currentThread().getName() + " is reading ...");
            System.out.printf(" Counter value : %d\n", x);
            reader.close();
        } catch (IOException ex) {
            ex.printStackTrace();
        }
    }
    void write(String path) {
        int countw;
        try {
            Scanner reader = new Scanner(new FileInputStream(path));
            countw = (int) reader.nextInt();
            countw++;
            FileWriter f = new FileWriter(new File(path));
```

```
            f.write(new Integer(countw).toString());
            f.close();
            System.out.printf(Thread.currentThread().getName() + " Writing... ");
            System.out.printf(" Counter value : %d\n", countw);
            reader.close();
        } catch (IOException ex) {
            ex.printStackTrace();
        }
    }
}
```

OUTPUT:

Program Start

Reader Thread-21: Started

Reader Thread-10: Started

Reader Thread-4: Started

Reader Thread-14: Started

Reader Thread-20: Started

Reader Thread-16: Started

Reader Thread-5: Started

Reader Thread-8: Started

Reader Thread-9: Started

Reader Thread-7: Started

Reader Thread-19: Started

Writer Thread-1: Started

Reader Thread-15: Started

Reader Thread-11: Started

Writer Thread-0: Started

Reader Thread-13: Started

Reader Thread-17: Started

Reader Thread-6: Started

Writer Thread-2: Started

Reader Thread-22: Started

Reader Thread-12: Started

Reader Thread-18: Started

Reader Thread-3: Started

Thread-7 is reading ...Thread-15 is reading ... Counter value : 0

Thread-5 is reading ... Counter value : 0

Thread-13 is reading ... Counter value : 0

Thread-10 is reading ... Counter value : 0

Thread-20 is reading ... Counter value : 0

Thread-8 is reading ... Counter value : 0

Thread-18 is reading ... Counter value : 0

Thread-17 is reading ... Counter value : 0

Thread-22 is reading ... Counter value : 0

Thread-6 is reading ... Counter value : 0

Thread-19 is reading ... Counter value : 0

Thread-3 is reading ... Counter value : 0

Thread-14 is reading ... Counter value : 0

Thread-9 is reading ... Counter value : 0

Thread-16 is reading ... Counter value : 0

Thread-21 is reading ... Counter value : 0

Thread-4 is reading ... Counter value : 0

Thread-12 is reading ... Counter value : 0

Thread-11 is reading ... Counter value : 0

Counter value : 0

Thread-1 Writing... Counter value : 1

Thread-0 Writing... Counter value : 2

Thread-2 Writing... Counter value : 3

Thread-4 is reading ... Counter value : 3

Thread-0 Writing... Counter value : 4

Thread-5 is reading ... Counter value : 4

Thread-19 is reading ... Counter value : 4

Thread-8 is reading ... Counter value : 4

Thread-9 is reading ... Counter value : 4

Thread-14 is reading ... Counter value : 4

Thread-9 is reading ... Counter value : 4

Thread-13 is reading ... Counter value : 4

Thread-2 Writing... Counter value : 5

Thread-19 is reading ... Counter value : 5

Thread-18 is reading ... Counter value : 5

Thread-17 is reading ... Counter value : 5

Thread-3 is reading ... Counter value : 5

Thread-20 is reading ... Counter value : 5

Thread-11 is reading ... Counter value : 5

Thread-15 is reading ... Counter value : 5

Thread-6 is reading ... Counter value : 5

Thread-1 Writing... Counter value : 6

Thread-13 is reading ... Counter value : 6

Thread-19 is reading ... Counter value : 6

Thread-17 is reading ... Counter value : 6

Thread-8 is reading ... Counter value : 6

Thread-16 is reading ... Counter value : 6

Thread-10 is reading ... Counter value : 6

Thread-14 is reading ... Counter value : 6

Thread-3 is reading ... Counter value : 6

Thread-16 is reading ... Counter value : 6

Thread-22 is reading ... Counter value : 6

Thread-3 is reading ... Counter value : 6

Thread-2 Writing... Counter value : 7

Thread-12 is reading ... Counter value : 7

Thread-21 is reading ... Counter value : 7

Thread-7 is reading ... Counter value : 7

Thread-17 is reading ... Counter value : 7

Thread-4 is reading ... Counter value : 7

Thread-9 is reading ... Counter value : 7

Thread-7 is reading ... Counter value : 7

Thread-5 is reading ... Counter value : 7

Thread-11 is reading ... Counter value : 7

Thread-2 Writing... Counter value : 8

Thread-1 Writing... Counter value : 9

Thread-7 is reading ... Counter value : 9

Thread-16 is reading ... Counter value : 9

Thread-0 Writing... Counter value : 10

Thread-11 is reading ... Counter value : 10

---

2. ***(10 points) **Extra Credit for 461 Students*****

We discussed in class the readers-writer's problem with writers priority, which can be solved in guarded commands:

```
void reader()
{
  when ( writers == 0 ) [
    readers++;
  ]

  //read

  [readers--;]
}
```

```
void writer()
{
  [writers++;]
  when ( (readers == 0) && (active_writers == 0) )[
    active_writers++;
  ]

  //write

  [writers--;  active_writers--;]
}
```

Here writers represent the number of threads that are either writing or waiting to write. The variable active_writers represents the number of threads (0 or 1) that are currently writing.

Implement the solution using Java threads. Again simulate the tasks by reading from and writing to a file named counter.txt as in the previous problem.

Besides the source code, turn in scripts showing that you compile and run the program successfully. Turn in also some sample outputs.

```
/*
* Yousef Jarrar
* Home Work #1 -- Problem 6 or #2
* Dr. Tong Yu -- CSE 461
* Read_Write Threads
* RWThread.java
* */

import java.io.File;
import java.io.FileInputStream;
import java.io.FileWriter;
import java.io.IOException;
import java.util.Random;
import java.util.Scanner;
import java.util.concurrent.locks.Condition;
import java.util.concurrent.locks.Lock;
import java.util.concurrent.locks.ReentrantLock;

// Read and Writer Implementation for threads.

public class RWThread {

    final Lock mutex = new ReentrantLock();
    final Condition readerQueue = mutex.newCondition();
    final Condition writerQueue = mutex.newCondition();
    int reader_count = 0;
    int writer_count = 0;
```

```
int activeWriter_count = 0;
String INP_FILE = "counter.txt";
public static Random random = new Random();


//constructor

public RWThread() {
    FileWriter f;
    try {
        f = new FileWriter(new File(INP_FILE));
        f.write(new Integer(0).toString());
        f.close();
    } catch (IOException e) {
        e.printStackTrace();
    }
}

//Reader Implementation

void reader() throws InterruptedException {
    mutex.lock();
    while (writer_count != 0) {
        readerQueue.await();
    }
    reader_count++;
    mutex.unlock();
    readFile(INP_FILE);
    mutex.lock();
    if (--reader_count == 0) {
        writerQueue.signal();
    }
    mutex.unlock();
}

//Writer Implementation

void writer() throws InterruptedException {
    mutex.lock();
    writer_count++;
    while (!((reader_count == 0) && (activeWriter_count == 0))) {
        writerQueue.await();
    }
    activeWriter_count++;
    mutex.unlock();
    writeFile(INP_FILE);
    mutex.lock();
    activeWriter_count--;
    if (--writer_count == 0) {
        readerQueue.signalAll();
    } else {
        writerQueue.signal();
    }
    mutex.unlock();
}


//Read Count

public void readFile(String path) {
    try {
        int inp = new Scanner(new FileInputStream(path)).nextInt();
```

```
            System.out.printf(Thread.currentThread().getName() + " Reader reading");
            System.out.printf(" Counter value: %d\n", inp);
        } catch (IOException e) {
            e.printStackTrace();
        }
    }


    //Write Count
    public void writeFile(String path) {
        int writerCount;
        try {
            writerCount = (int) new Scanner(new FileInputStream(path)).nextInt();
            writerCount++;
            FileWriter writr = new FileWriter(new File(path));
            writr.write(new Integer(writerCount).toString());
            writr.close();
            System.out.printf(Thread.currentThread().getName() + " Writer writing");
            System.out.printf(" Counter value: %d\n", writerCount);
        } catch (IOException e) {
            e.printStackTrace();
        }

    }
}
```

```
/*
 * Yousef Jarrar
 * Home Work #1 -- Problem 6 or #2
 * Dr. Tong Yu -- CSE 461
 * Read_Write Threads
 * Main Program
 * output.java
 * */


import java.util.Random;

//Start of running program.

public class sample {

    public final static int READ_MAX = 20; //maximum number of readers
    public final static int WRITE_MAX = 3; //maximum number of writers
    public static RWThread readerWriterthread = new RWThread(); //instantiate RW_Thread
    public static Random random = new Random(); //create random variable
    static class readerThread extends Thread {
        public void run() {
            System.out.println("Reader :" + getName() + ": Start");
            while (true) {
                try {
                    readerWriterthread.reader();
                    int time = random.nextInt(3000);
                    Thread.sleep(time);
                } catch (InterruptedException e) {
                    e.printStackTrace();
                }
            }
        }
    }
```

```
    static class writerThread extends Thread {
        public void run() {
            System.out.print("Writer :" + getName() + ": Start");
            while (true) {
                try {
                    readerWriterthread.writer();
                    Thread.sleep(random.nextInt(3000));
                } catch (InterruptedException e) {
                    e.printStackTrace();
                }
            }
        }
    }
    public static void main(String[] args) {
        readerThread readerThreads[] = new readerThread[READ_MAX];
        writerThread writerThreads[] = new writerThread[WRITE_MAX];
        System.out.println("start");
        for (int i = 0; i < WRITE_MAX; ++i) {
            writerThreads[i] = new writerThread();
            writerThreads[i].start();
        }
        for (int i = 0; i < READ_MAX; ++i) {
            readerThreads[i] = new readerThread();
            readerThreads[i].start();
        }
    }
}
```

start

Reader :Thread-8: Start

Reader :Thread-9: Start

Reader :Thread-10: Start

Reader :Thread-16: Start

Reader :Thread-11: Start

Reader :Thread-19: Start

Reader :Thread-14: Start

Writer :Thread-0: StartReader :Thread-7: Start

Reader :Thread-17: Start

Reader :Thread-4: Start

Reader :Thread-15: Start

Reader :Thread-22: Start

Reader :Thread-6: Start

Reader :Thread-3: Start

Reader :Thread-5: Start

Reader :Thread-21: Start

Writer :Thread-2: StartReader :Thread-12: Start

Reader :Thread-13: Start

Writer :Thread-1: StartReader :Thread-18: Start

Reader :Thread-20: Start

Thread-10 Reader readingThread-14 Reader reading Counter value: 0

Thread-16 Reader reading Counter value: 0

Thread-9 Reader reading Counter value: 0

Counter value: 0

Thread-0 Writer writing Counter value: 1

Thread-2 Writer writing Counter value: 2

Thread-1 Writer writing Counter value: 3

Thread-20 Reader reading Counter value: 3

Thread-4 Reader reading Counter value: 3

Thread-11 Reader reading Counter value: 3

Thread-8 Reader reading Counter value: 3

Thread-19 Reader reading Counter value: 3

Thread-6 Reader reading Counter value: 3

Thread-21 Reader reading Counter value: 3

Thread-7 Reader reading Counter value: 3

Thread-3 Reader reading Counter value: 3

Thread-17 Reader reading Counter value: 3

Thread-22 Reader reading Counter value: 3

Thread-15 Reader reading Counter value: 3

Thread-5 Reader reading Counter value: 3

Thread-13 Reader reading Counter value: 3

Thread-12 Reader reading Counter value: 3

Thread-18 Reader reading Counter value: 3

Thread-8 Reader reading Counter value: 3

Thread-21 Reader reading Counter value: 3

Thread-10 Reader reading Counter value: 3

Thread-4 Reader reading Counter value: 3

Thread-19 Reader reading Counter value: 3

Thread-19 Reader reading Counter value: 3

Thread-2 Writer writing Counter value: 4

Thread-0 Writer writing Counter value: 5

Thread-3 Reader reading Counter value: 5

Thread-2 Writer writing Counter value: 6

Thread-15 Reader reading Counter value: 6

Thread-22 Reader reading Counter value: 6

Thread-4 Reader reading Counter value: 6

Thread-16 Reader reading Counter value: 6

Thread-10 Reader reading Counter value: 6

Thread-1 Writer writing Counter value: 7

Thread-4 Reader reading Counter value: 7

Thread-13 Reader reading Counter value: 7

Thread-10 Reader reading Counter value: 7

Thread-9 Reader reading Counter value: 7

Thread-19 Reader reading Counter value: 7

Thread-6 Reader reading Counter value: 7

Thread-4 Reader reading Counter value: 7

Thread-19 Reader reading Counter value: 7

Thread-14 Reader reading Counter value: 7

Thread-18 Reader reading Counter value: 7

Thread-10 Reader reading Counter value: 7

Thread-7 Reader reading Counter value: 7

Thread-0 Writer writing Counter value: 8

Thread-17 Reader reading Counter value: 8

Thread-0 Writer writing Counter value: 9

Thread-12 Reader reading Counter value: 9

Thread-20 Reader reading Counter value: 9

Thread-8 Reader reading Counter value: 9

Thread-11 Reader reading Counter value: 9

3. ***Consider a chain of processes P_1, P_2, ..., P_n implementing a multitiered client-server architecture. Process P_i is client of process P_{i+1}, and P_i will return a reply to P_{i-1} only after receiving a reply from P_{i+1}. What are the main problems with this organization when taking a look at the request-reply performance at process P_1?***

- P1 needs to wait on pi to finish all its processes (waiting until the last one). It then waits for all processes to give a reply in the reverse order. If it so happens that a process gets stuck. Then the entire process then fails.
- Also note that when one machine in the chain performs badly, the whole entire organization is affected with bad performance. If N is "Large" then the performance will not be reliable.

4. ***Show the B-trees of order four resulted from loading the following sets of keys (each letter is a key) in order:***

a. C G J X

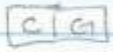
b. C G J X N S U O A E B H I

c. C G J X N S U O A E B H I F

d. C G J X N S U O A E B H I F K L Q R T V U W Z

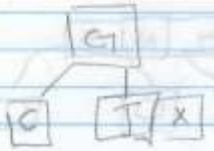
Question 8

Part A: inserting C

inserting G 

inserting J 

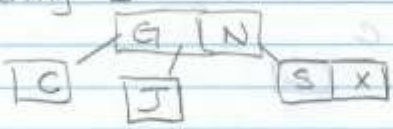
- By inserting X, we would split the node; as a maximum of 3 key is allowed.

so → 

Part B:

inserting N

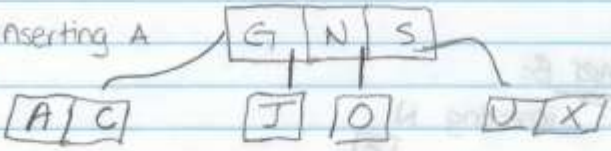
inserting S



inserting U

inserting O

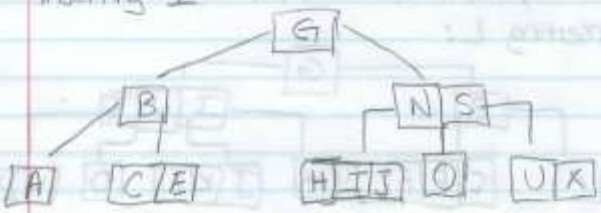
inserting A



inserting E

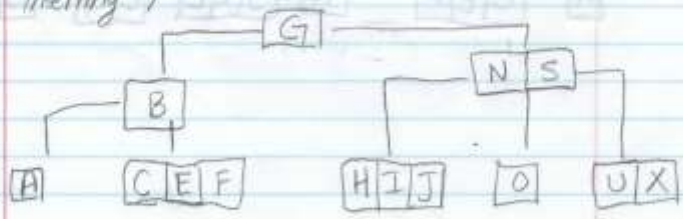
inserting H

inserting I



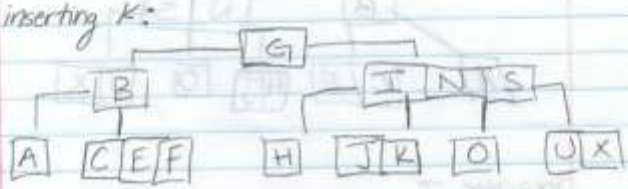
PART C • All of the information (keys) hold the same and continue by:

inserting F

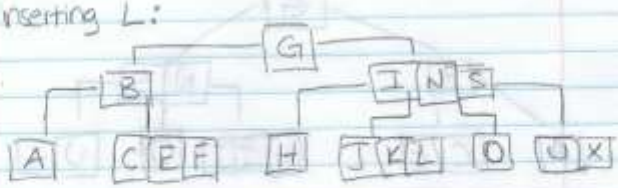


PART D • Some idea applies for the 5 B-Tree:

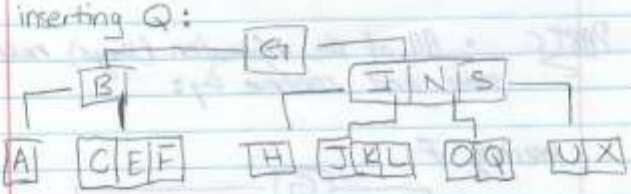
inserting K:



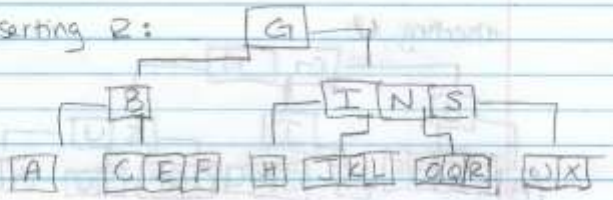
inserting L:



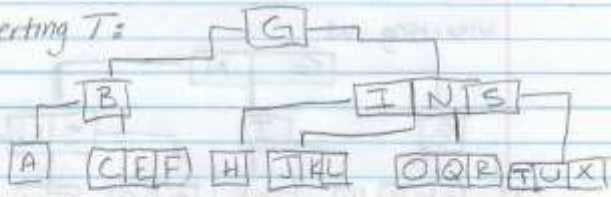
inserting Q:



inserting R:

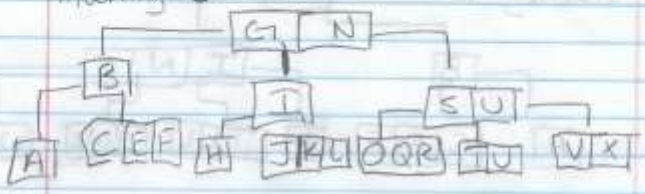


inserting T:



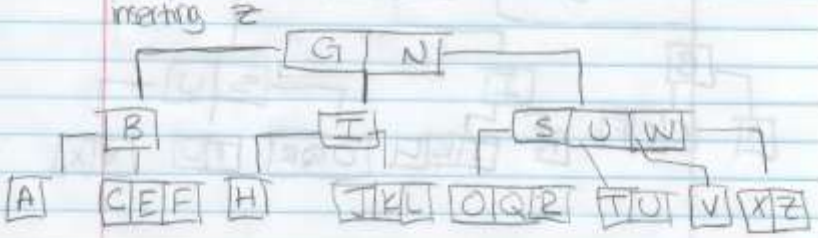
inserting V

inserting U



inserting W

inserting Z



5. ***Given a B-tree of order 256,***

a. what is the maximum number of children from a node?

- The maximum number of children a node can have is 256.

b. excluding the root and the leaves, what is the minimum number of children from a node?

- When calculating the minimum number of children, we have to remember we are excluding leaf and root. This can only conclude (m/2) child nodes. Therefore, 256/2 = 128

c. what is the minimum number of children from the root?

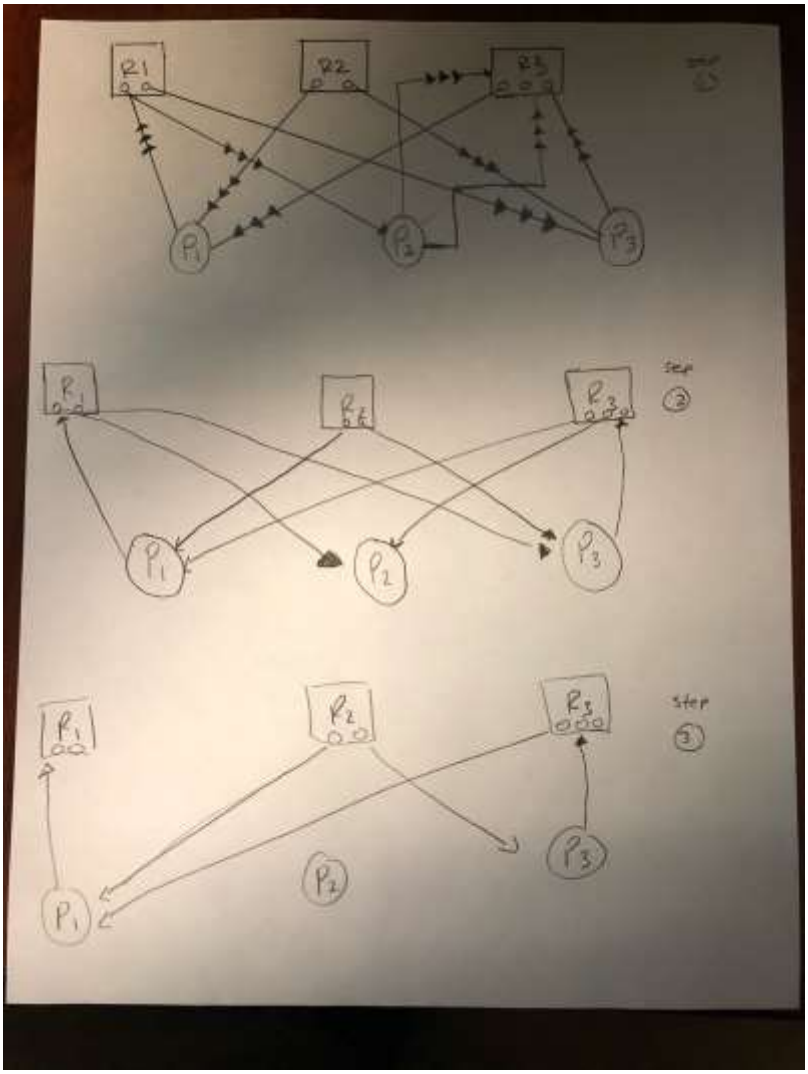
- If the root node is not the leaf node, then it should have a minimum amount of 2 children.

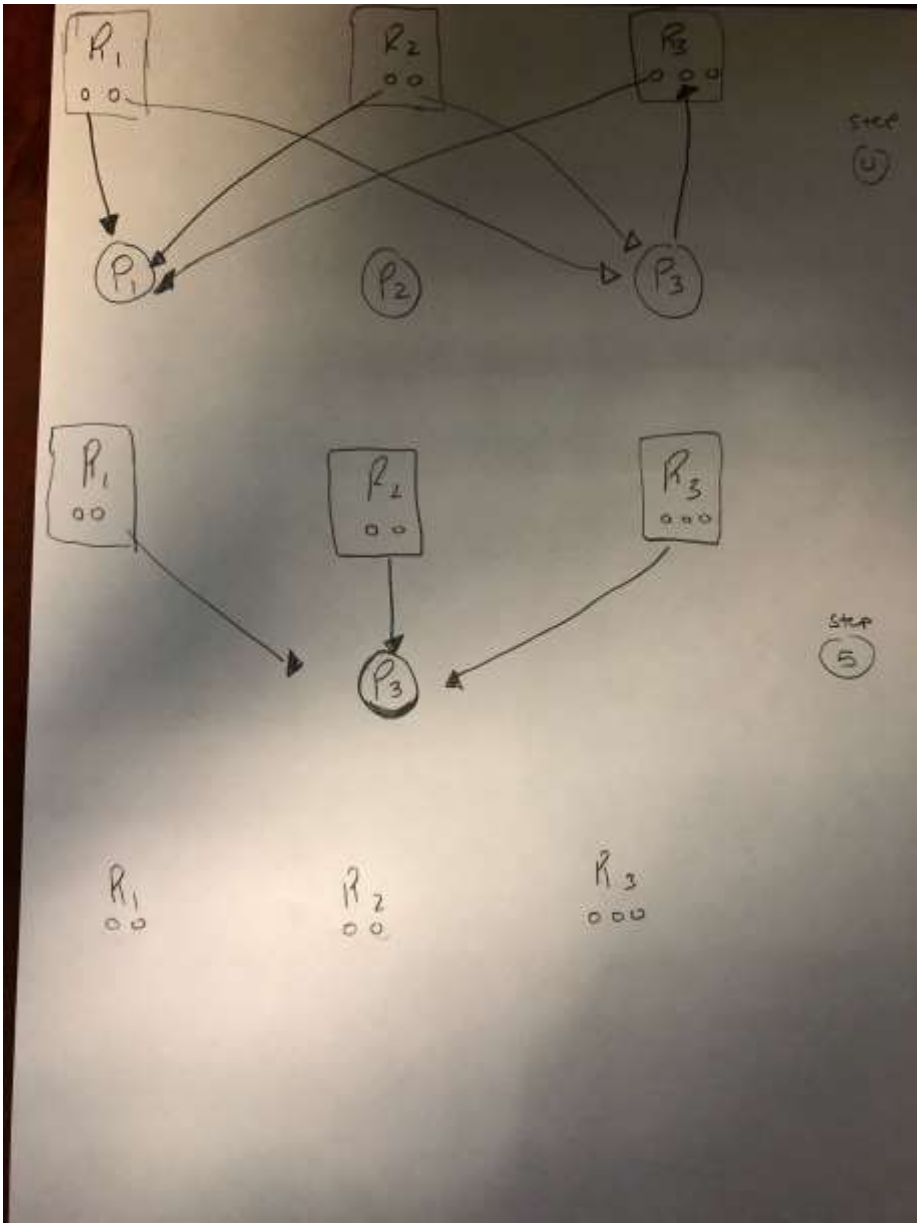
d. What is the maximum depth of the tree if it contains 100 000 keys?

- *Given to us from a formula: $H\_Max = Log_d((n+1)/2)$. Where d is the minimum number of children from the node (except the root and the leaf) and n is equal to the number of entries.*
- *N = 100,000*
- *D = (m/2) = 256/2 = 128*
- *$H\_Max = log_{128}((100,000+1)/2)$ =*
- *$Log_{128}((100,001)/2)$ =*
- *$Log_{128}(50,000.5)$*
- *We then use the base conversion formula. $log_b(y) = log_{10}(y)/log_{10}(b)$*
- *$H\_max = log_{10}(50000.5)/log_{10}(128)$*
- *= 4.69897 / 2.1072099*
- *= 2.2299487*

The maximum height should be 2 .

6. ***Construct a general resource graph for the following scenario and determine if the graph is completely reducible: R1, R2, and R3 are reusable resources with a total of two, two, and three units. Process P1 is allocated one unit each of R2 and R3 and is requesting one unit of R1. Process P2 is allocated one unit of R1 and is requesting two units of R3. Process P3 is allocated one unit each of R1 and R2 and is requesting one unit of R3.***




R1
R2
R3
P1
P2
P3
step
4
R1
R2
R3
P3
step
5
R1
R2
R3