EE 602
Java Assignment #1
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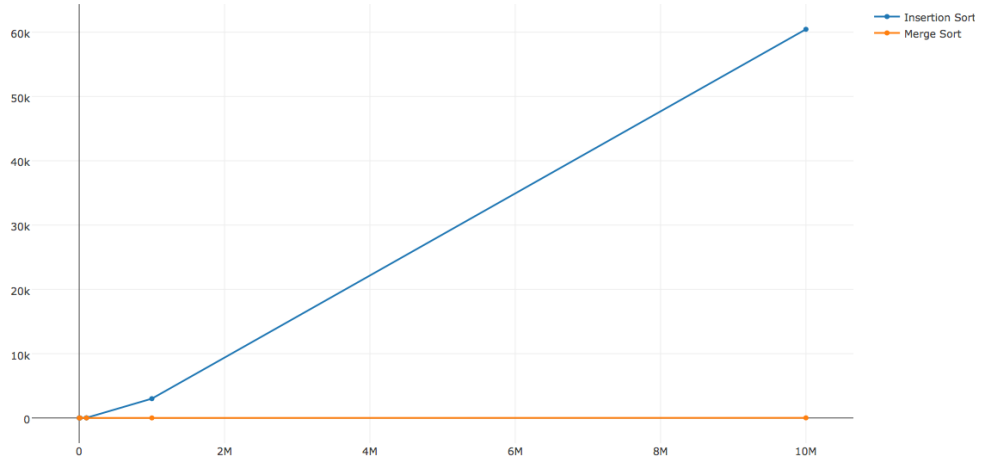
Task 1:

To run mysortGUI code, move mysortGUI.java to the test driver folder you provide to us, it is same directory with sortGUI.java. Then just run it. Then it will pop up a GUI. Then, you can generate different data sizes and different sorting algorithms. The elapsed time will be printed in the console within eclipse.

See attached source code in the email for detailed implementation. Basically speaking, I just reused the sortGUI class and added the time measurement. I also change the data type from float to integer. Below is my plot of different data size vs. elapsed time for merge sort and insertion sort:



Here is the table:

Data Size choose as x choose as y	Insertion Sort choose as x choose as y	Merge Sort choose as x choose as y
1000	0.008	0.003
10000	0.212	0.03
100000	22.088	0.046
1000000	3002.083	0.997
10000000	60450.344	14.978

From the result, I can see that for small data size, the insertion sort is as fast as

merge sort. However, as data size increasing, the merge sort is much efficient then the insertion sort. This is because the insertion sort is $O(n^2)$, while the merge sort is O(nlogn).

Task 2:

To run ExternalSort.java, move my ExternalSort.java to the test driver folder you provided, it is the same folder with sortGUI.java. Then just run it. The console will print out:

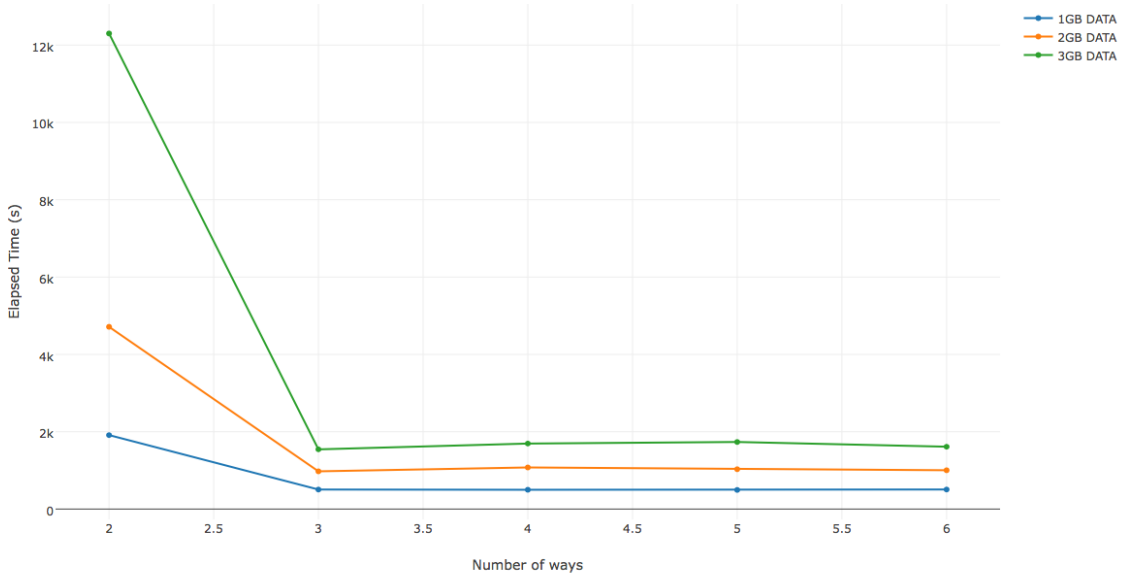
Size of the input file to be sorted;
Memory capacity we can use to sort for a run;
Number of blocks we are sorting for each pass;
The total elapsed time;

To change the number of ways, say you want to implement 2-way external sort, go to main function and change variable "numWays" to 2. For 3-way, change it to 3, and so on so forth.

To change the input file size, go to main function in ExternalSort class, assign variable "inputSize" to the size you like. The size unit is in GB.

One thing worth to mention is I use priority queue to merge files. This is useful when we running B-way external sort.

Below are my plot and the table of different data size and different ways external sorting. I was using 30MB memory to sort.



From the plot, I can see that for file size 2GB, B=3 is my best system setup. This can be seen from the plot. This is because with more way merge, we reduce the height of the merge tree. The reading and writing is 2P(log(P)+1), reduce P will

reduce I/O. However, this does not keep decrease the elapsed time because after a certain B size, the sort will dominate the elapsed time, instead of file I/O.

Appendix A
Task 2: two way external sort and B way external sort:

```
package testjava;
import java.util.*;
import java.io.*;

// External Sort
// Adjust parameter in the main function
// Parameter includes target file size, which is the file to be sorted.
// Number of ways to sort, typically range in 2-6.
//
public class ExternalSort {

   public void generateFile(String fileName, double size) throws
FileNotFoundException, UnsupportedEncodingException
   {
      //Size in Gbs of my file that I want
      double wantedSize =
Double.parseDouble(System.getProperty("size",
Double.toString(size)));

      Random random = new Random();
      File file = new File(fileName);
      PrintWriter writer = new PrintWriter(new BufferedWriter(new
OutputStreamWriter(new FileOutputStream(file), "UTF-8")), false);
      int counter = 0;
      while (true) {
         String sep = "";
         for (int i = 0; i < 100; i++) {
            int number = random.nextInt(1000000000) + 1;
            writer.print(sep);
            writer.print(number);
            sep = "\n";
         }
         writer.println();
         //Check to see if the current size is what we want it to
be
         if (++counter == 50000) {
            System.out.printf("Now Size: %.3f GB%n", file.length()
/ 1e9);
```

```
            if (file.length() >= wantedSize * 1e9) {
               writer.close();
               break;
            } else {
               counter = 0;
            }
         }
      }
      System.out.printf("Created a file of %.3f GB\n", file.length()
/ 1e9);
   }
   // Divide the file into small blocks. If the blocks
   // are too small, we shall create too many temporary files.
   // If they are too big, we shall be using too much memory.
   public static long estimateBestSizeOfBlocks(File
filetobesorted) {
      long sizeoffile = filetobesorted.length();
      // we don't want to open up much more than 1024 temporary files,
better run
      // out of memory first. (Even 1024 is stretching it.)
      final int MAXTEMPFILES = 1024;
      long blocksize = sizeoffile / MAXTEMPFILES ;
      // on the other hand, we don't want to create many temporary
files
      // for naught. If blocksize is smaller than half the free memory,
grow it.
      //     long freemem = Runtime.getRuntime().freeMemory();
      long freemem = 1024*1024*30; //1kb * 1024 * 30 = 30MB

      System.out.println("File size= " + sizeoffile/1000000+"MB");
      System.out.println("Using memory = " + freemem/1000000 +"
MB");

      if( blocksize < freemem/2)
         blocksize = freemem/2;
      else {
         if(blocksize >= freemem)
            System.err.println("We expect to run out of memory. ");
      }
      return blocksize;
   }
```

```
   // This will simply load the file by blocks of x rows, then
   // sort them in-memory, and write the result to a bunch of
   // temporary files that have to be merged later.
   //
   // @param file some flat  file
   // @return a list of temporary flat files

   public static List<File> sortInBatch(File file,
Comparator<String> cmp) throws IOException {
      List<File> files = new ArrayList<File>();
      BufferedReader fbr = new BufferedReader(new
FileReader(file));
      long blocksize = estimateBestSizeOfBlocks(file);// in bytes
      try{
         List<String> tmplist =  new ArrayList<String>();
         String line = "";
         try {
            while(line != null) {
               long currentblocksize = 0;// in bytes
               while((currentblocksize < blocksize)
                     &&(   (line = fbr.readLine()) != null) ){ //
as long as you have 2MB
                  tmplist.add(line);
                  currentblocksize += line.length(); // 2 + 40; //
java uses 16 bits per character + 40 bytes of overhead (estimated)
               }
               files.add(sortAndSave(tmplist,cmp));
               tmplist.clear();
            }
         } catch(EOFException oef) {
            if(tmplist.size()>0) {
               files.add(sortAndSave(tmplist,cmp));
               tmplist.clear();
            }
         }
      } finally {
         fbr.close();
      }
      return files;
   }
```

```
   public static File sortAndSave(List<String> tmplist,
Comparator<String> cmp) throws IOException  {
      Collections.sort(tmplist,cmp);  //
      File newtmpfile = File.createTempFile("sortInBatch",
"flatfile");
      newtmpfile.deleteOnExit();
      BufferedWriter fbw = new BufferedWriter(new
FileWriter(newtmpfile));
      try {
         for(String r : tmplist) {
            fbw.write(r);
            fbw.newLine();
         }
      } finally {
         fbw.close();
      }
      return newtmpfile;
   }

   // This merges a bunch of temporary flat files
   // @param files
   // @param output file
   // @return The number of lines sorted.

   public static File mergeSortedFiles(List<File> files, final
Comparator<String> cmp) throws IOException {
      PriorityQueue<BinaryFileBuffer> pq = new
PriorityQueue<BinaryFileBuffer>
      (11, new Comparator<BinaryFileBuffer>() {
         public int compare(BinaryFileBuffer i, BinaryFileBuffer
j) {
            return cmp.compare(i.peek(), j.peek());
         }
      });
      int total = 0;
      for (File f : files) {
         total += f.length();
         //System.out.println("file size = " + f.length()/1000000);
         BinaryFileBuffer bfb = new BinaryFileBuffer(f);
```

```
            pq.add(bfb);
        }
        final File folder = new File("./");
        File newtmpfile = File.createTempFile("merge", "flatfile",
folder);
        newtmpfile.deleteOnExit();

        BufferedWriter fbw = new BufferedWriter(new
FileWriter(newtmpfile));
        try {
            while(pq.size()>0) {
                BinaryFileBuffer bfb = pq.poll();  //poll block that
contains smallest in the priority queue
                String r = bfb.pop();           //pop out the block
head
                fbw.write(r);
                fbw.newLine();
                if(bfb.empty()) {
                    bfb.fbr.close();
                    bfb.originalfile.delete();// we don't need you
anymore
                } else {
                    pq.add(bfb); // add it back
                }
            }
        } finally {
            fbw.close();
            for(BinaryFileBuffer bfb : pq ) bfb.close();
        }
        //System.out.println("It should be: " + total + ". The real size
is: " + newtmpfile.length());
        return newtmpfile;
    }

    public static void copy(File inputfile, String output) throws
IOException{
        BufferedReader fbr = new BufferedReader(new
FileReader(inputfile));

        String line = "";
```

```
      PrintWriter writer = new PrintWriter(output, "UTF-8");
      try{writer.println(line);

      while((line = fbr.readLine()) != null){
         writer.println(line);
      }
      }finally{
         fbr.close();
         writer.close();
      }

   }
   public static void main(String[] args) throws IOException {
      //     if(args.length<2) {
      //        System.out.println("please provide input and output
file names");
      //        return;
      //     }
      //     String inputfile = args[0];
      //     String outputfile = args[1];

      String inputfile = "myinput";
      String outputfile = "myoutput";
      double inputSize = 2; //Unit: GB
      int numWays = 6;
      //new ExternalSort().generateFile(inputfile, inputSize);

      Comparator<String> comparator = new Comparator<String>() {
         public int compare(String r1, String r2){
            int val1, val2;
            val1 = Integer.parseInt(r1);
            val2 = Integer.parseInt(r2);
            return val1 - val2;
         }
      };
      long tStart = System.currentTimeMillis(); // starting a timer
couting in milliseconds //DO SORTING

      List<File> inputl = sortInBatch(new File(inputfile),
comparator);
      List<File> outputl = new ArrayList<File>();
```

```
        Boolean end = false;
        int pass = 0;
        while(!end){
            System.out.println("pass " + pass + ": number of blocks =
" + inputl.size());

            if(inputl.size() <= 1) break;
            outputl = new ArrayList<File>();
            for(int i=0; i<inputl.size(); i+=numWays){
                List<File> group = new ArrayList<File>();
                for(int j=i; j<i+numWays && j<inputl.size(); j++){
                    group.add(inputl.get(j));

                }
                outputl.add(mergeSortedFiles(group, comparator));
            }
            pass ++;
            inputl = outputl;

        }
        copy(outputl.get(0), outputfile);
        long tEnd = System.currentTimeMillis();
        long tDelta = tEnd - tStart;
        double elapsedSeconds = tDelta / 1000.0;
        System.out.println(elapsedSeconds);

    }
}


class BinaryFileBuffer  {
    public static int BUFFERSIZE = 2048;
    public BufferedReader fbr;
    public File originalfile;
    private String cache;
    private boolean empty;

    public BinaryFileBuffer(File f) throws IOException {
        originalfile = f;
        fbr = new BufferedReader(new FileReader(f), BUFFERSIZE);
```

```
        reload();
    }

    public boolean empty() {
        return empty;
    }

    private void reload() throws IOException {
        try {
            if((this.cache = fbr.readLine()) == null){
                empty = true;
                cache = null;
            }
            else{
                //System.out.println(cache);
                empty = false;
            }
        } catch(EOFException eof) {
            empty = true;
            cache = null;
        }
    }

    public void close() throws IOException {
        fbr.close();
    }


    public String peek() {
        if(empty()) return null;
        return cache.toString();
    }
    public String pop() throws IOException {
        String answer = peek();
        reload();
        return answer;
    }
}
```