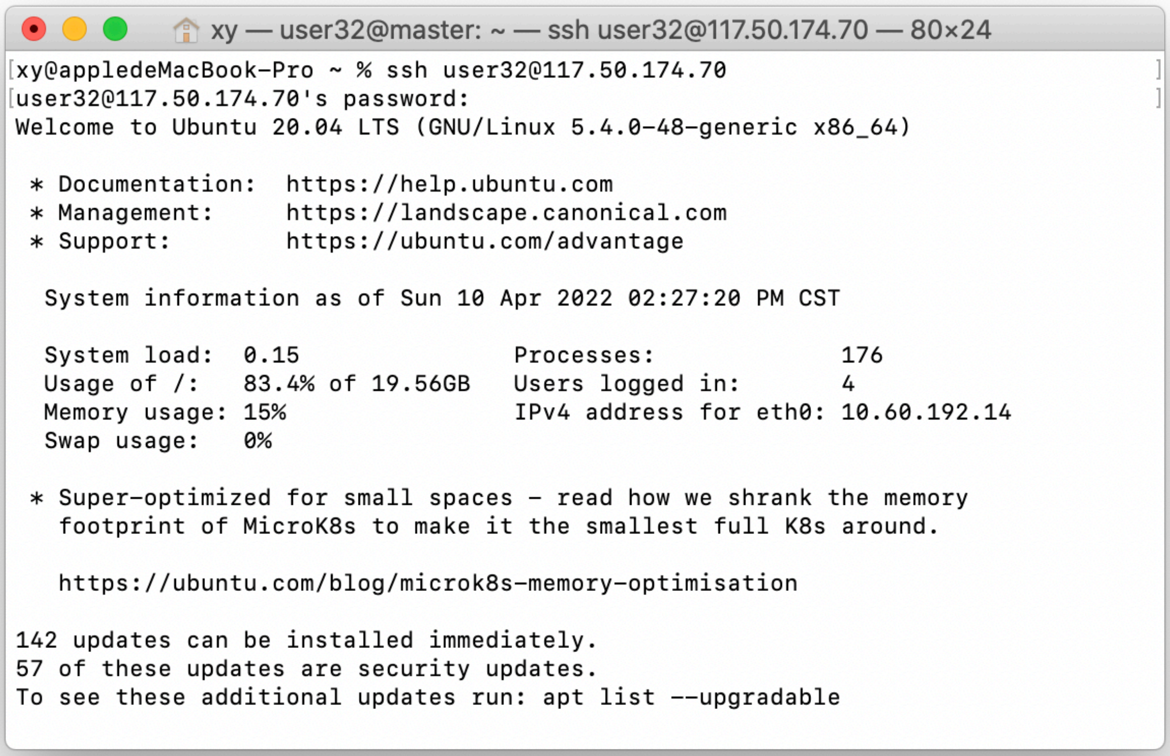
云计算-2051495-徐奕-作业4

零、登陆集群

> ssh user32@117.50.174.70



xy — user32@master: ~ — ssh user32@117.50.174.70 — 80×24

```
xy@appledeMacBook-Pro ~ % ssh user32@117.50.174.70
user32@117.50.174.70's password:
Welcome to Ubuntu 20.04 LTS (GNU/Linux 5.4.0-48-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  System information as of Sun 10 Apr 2022 02:27:20 PM CST

  System load:  0.15               Processes:             176
  Usage of /:   83.4% of 19.56GB   Users logged in:       4
  Memory usage: 15%                IPv4 address for eth0: 10.60.192.14
  Swap usage:   0%

 * Super-optimized for small spaces - read how we shrank the memory
   footprint of MicroK8s to make it the smallest full K8s around.

   https://ubuntu.com/blog/microk8s-memory-optimisation

142 updates can be installed immediately.
57 of these updates are security updates.
To see these additional updates run: apt list --upgradable
```

一、倒排索引

- 第一题：倒排索引（50分）

　　倒排索引是构造搜索引擎的核心部件。它是一个纯文本的HDFS大数据文件。里面记录着每个索引词出现的位置：所在的文件，偏移量是多少。

　　示例程序 扫描input目录中的每个输入文件：

　　　　　　提取word，记录word在这个文件中出现的次数。

把<word，文件名，出现次数>写入HDFS文件。同一个word，出现在多少个文件中，倒排索引就有多少条记录。

要求：修改示例程序，生成的倒排索引文件中，每个索引词一行，格式：
索引词，tab键，文件1：文件1中出现的次数；文件2：文件2中出现的次数……

file1

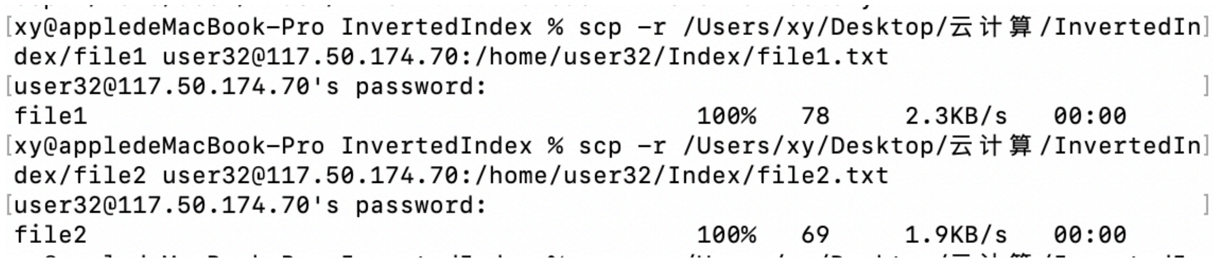
```
Hello World Bye World
Hello World Bye World
Hello World Bye World
Hello World
```

file2

```
Hello Hadoop Goodbye Hadoop
Hello Hadoop Goodbye Hadoop
Hello Hadoop
```

导入云主机

> location:/home/user32/Index



```
[xy@appledeMacBook-Pro InvertedIndex % scp -r /Users/xy/Desktop/云计算/InvertedIn]
dex/file1 user32@117.50.174.70:/home/user32/Index/file1.txt
[user32@117.50.174.70's password:                                              ]
file1                                         100%   78     2.3KB/s   00:00
[xy@appledeMacBook-Pro InvertedIndex % scp -r /Users/xy/Desktop/云计算/InvertedIn]
dex/file2 user32@117.50.174.70:/home/user32/Index/file2.txt
[user32@117.50.174.70's password:                                              ]
file2                                         100%   69     1.9KB/s   00:00
```

class InvertedIndex主要构成：

Mapper

```
/*1.实现Mapper端的逻辑
   * KEYIN：文件中读取的偏移量-->LongWritable(固定的)
   * VALUEIN：文件中实际读取的内容-->Text
   * KEYOUT:Mapper处理完成后传递给Reducer中的KEYIN的数据类型-->不固定，根据需求来
   * VALUEOUT：Mapper端处理完成后传递给Reducer中的VALUEIN的数据类型-->不固定，根据需求来
   */

  public static class TokenizerMapper
       extends Mapper<Object, Text, Text, Text>{
    //修改一：统一map和reduce的key-value类型
    private final static Text one = new Text();
    private Text word = new Text();
    private String fileName = null;

    /*
     * 需要实现Mapper端的处理逻辑
     * 将每个词拆开，key设为文件名加词，value设成空值。
     *  好处：可以在reduce之前先进行一次计数，减少后续数据处理压力
     * key:是文件中数据的偏移量，数据类型是由泛型中定义得来的KEYIN
     * value:是文件中实际的内容，数据类型是泛型中定义得来的VALUEIN
     * context：将处理过后产生的KV，写成文件输出
     */

    public void map(Object key, Text value, Context context
                    ) throws IOException, InterruptedException {

      if(fileName == null)
      {
         FileSplit fileSplit = (FileSplit)context.getInputSplit();
         fileName = fileSplit.getPath().getName();
      }
      StringTokenizer itr = new StringTokenizer(value.toString());
      while (itr.hasMoreTokens()) {
        word.set(itr.nextToken() + '\t' + fileName);
        context.write(word, one);
      }

    }
  }
```

Reducer

IntSumReducer

```
/*
   * Reducer相当于对Mapper端处理过后的数据进行一个实际的处理业务,在此处统计拥有同一个key的键值对个数，然后统一形式输出
     (此题：<词汇/t文件名,one> -> <词汇,文件名：个数>)
   * KEYIN-->Mapper处理过后输出key的数据类型，由Mapper的泛型中第三个参数决定
   * VALUE-->Mapper处理过后输出value的数据类型，由Mapper的泛型中第四个参数决定
   * KEYOUT-->Reducer端处理完数据之后要写出key的数据类
      (此题：词)
   * VALUEOUT-->Reducer处理完数据之后，要写出value的 数据类
      (此题：文件名和个数)
   */

  public static class IntSumReducer
       extends Reducer<Text,Text,Text,Text> {
    private IntWritable result = new IntWritable();

    public void reduce(Text key, Iterable<Text> values,
                       Context context
                       ) throws IOException, InterruptedException {
     String keyString =key.toString();
     String[] keySplited =keyString.split("\t");
```

```
      //把词汇和文件名用'/t'分开
      int sum = 0;
      for (Text val : values) {
        sum += 1;
      }
      result.set(sum);
      String resultString=keySplited[1]+':'+result;
      context.write(new Text(keySplited[0]) ,new Text(resultString));
    }
  }
```

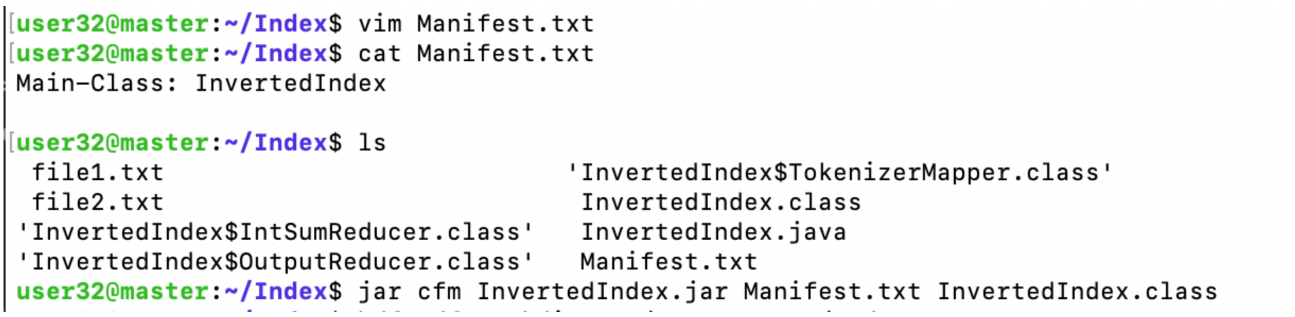
OutputReducer

```
 //对相同key的键值对 合并value
  public static class OutputReducer
       extends Reducer<Text,Text,Text,Text> {
    public void reduce(Text key, Iterable<Text> values,
                       Context context
                       ) throws IOException, InterruptedException {
      String result = new String();
      boolean isFirst = true;
      for (Text val : values)
      {
          if(isFirst==false)
            result = result+';';
          isFirst = false;
          result = result + val.toString();
      }
        context.write(key, new Text(result));
    }
  }
```

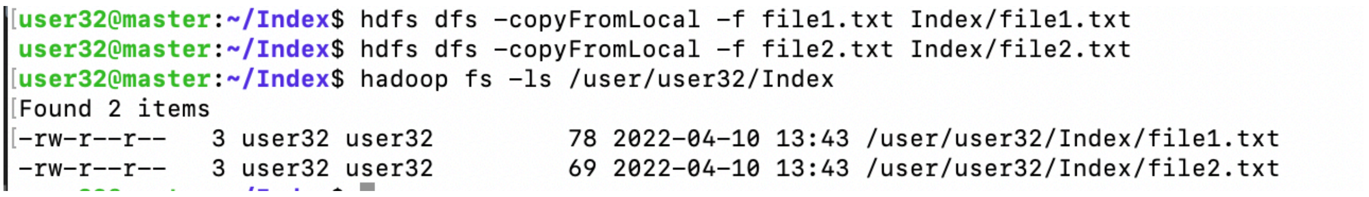
Main

```
public static void main(String[] args) throws Exception {
    Configuration conf = new Configuration();
    String[] otherArgs = new GenericOptionsParser(conf, args).getRemainingArgs();
    if (otherArgs.length < 2) {
      System.err.println("Usage: wordcount <in> [<in>...] <out>");
      System.exit(2);
    }
    Job job = Job.getInstance(conf, "word count");

    job.setJarByClass(InvertedIndex.class);
    job.setMapperClass(TokenizerMapper.class);
    job.setCombinerClass(IntSumReducer.class);
    job.setReducerClass(OutputReducer.class);
    job.setMapOutputKeyClass(Text.class);
    job.setMapOutputValueClass(Text.class);

    job.setOutputKeyClass(Text.class);
    job.setOutputValueClass(Text.class);
    for (int i = 0; i < otherArgs.length - 1; ++i) {
      FileInputFormat.addInputPath(job, new Path(otherArgs[i]));
    }
    FileOutputFormat.setOutputPath(job,
      new Path(otherArgs[otherArgs.length - 1]));
    System.exit(job.waitForCompletion(true) ? 0 : 1);
}////最终实现倒序索引
```

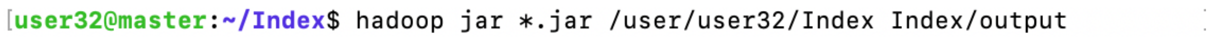
编译运行



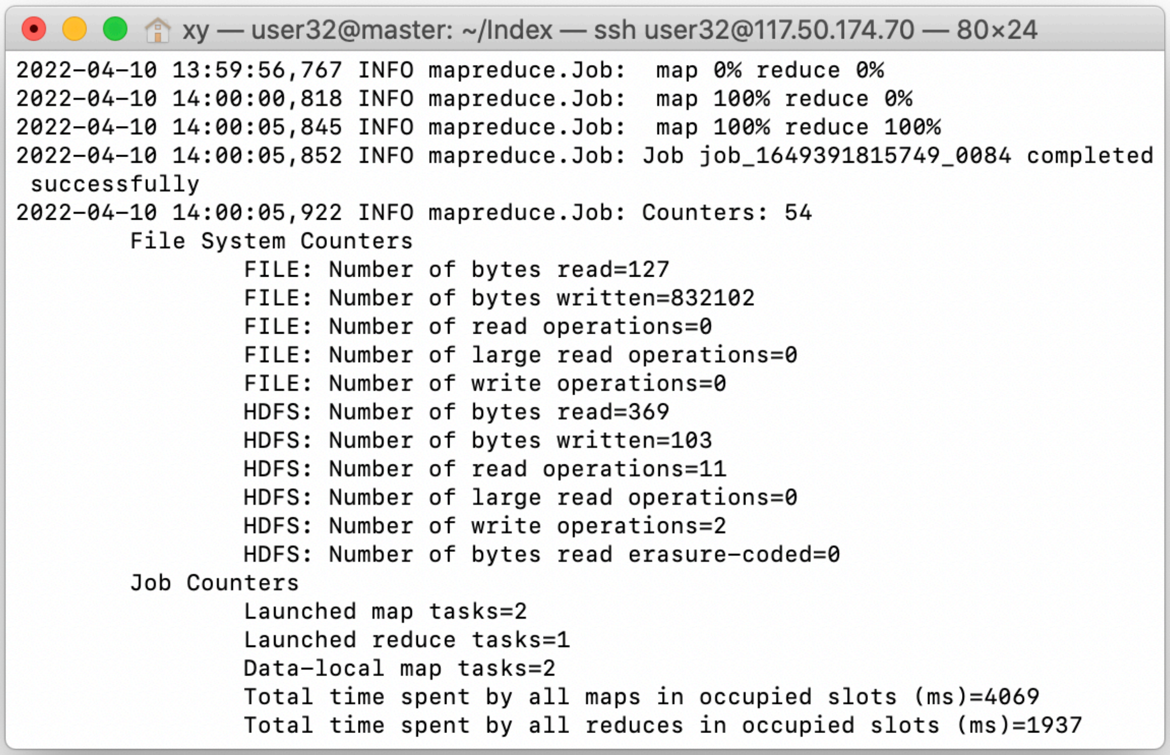
```
user32@master:~/Index$ vim Manifest.txt
user32@master:~/Index$ cat Manifest.txt
Main-Class: InvertedIndex

user32@master:~/Index$ ls
 file1.txt                            'InvertedIndex$TokenizerMapper.class'
 file2.txt                             InvertedIndex.class
'InvertedIndex$IntSumReducer.class'    InvertedIndex.java
'InvertedIndex$OutputReducer.class'    Manifest.txt
user32@master:~/Index$ jar cfm InvertedIndex.jar Manifest.txt InvertedIndex.class
```



```
user32@master:~/Index$ hdfs dfs -copyFromLocal -f file1.txt Index/file1.txt
user32@master:~/Index$ hdfs dfs -copyFromLocal -f file2.txt Index/file2.txt
user32@master:~/Index$ hadoop fs -ls /user/user32/Index
Found 2 items
-rw-r--r--   3 user32 user32         78 2022-04-10 13:43 /user/user32/Index/file1.txt
-rw-r--r--   3 user32 user32         69 2022-04-10 13:43 /user/user32/Index/file2.txt
```



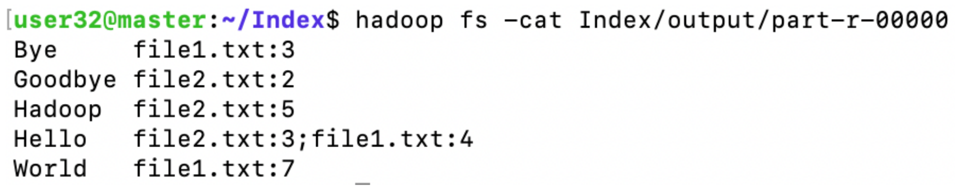
```
user32@master:~/Index$ hadoop jar *.jar /user/user32/Index Index/output
```



xy — user32@master: ~/Index — ssh user32@117.50.174.70 — 80×24

```
2022-04-10 13:59:56,767 INFO mapreduce.Job:  map 0% reduce 0%
2022-04-10 14:00:00,818 INFO mapreduce.Job:  map 100% reduce 0%
2022-04-10 14:00:05,845 INFO mapreduce.Job:  map 100% reduce 100%
2022-04-10 14:00:05,852 INFO mapreduce.Job: Job job_1649391815749_0084 completed
 successfully
2022-04-10 14:00:05,922 INFO mapreduce.Job: Counters: 54
        File System Counters
                FILE: Number of bytes read=127
                FILE: Number of bytes written=832102
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=369
                HDFS: Number of bytes written=103
                HDFS: Number of read operations=11
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
                HDFS: Number of bytes read erasure-coded=0
        Job Counters
                Launched map tasks=2
                Launched reduce tasks=1
                Data-local map tasks=2
                Total time spent by all maps in occupied slots (ms)=4069
                Total time spent by all reduces in occupied slots (ms)=1937
```

查看结果



```
user32@master:~/Index$ hadoop fs -cat Index/output/part-r-00000
Bye     file1.txt:3
Goodbye file2.txt:2
Hadoop  file2.txt:5
Hello   file2.txt:3;file1.txt:4
World   file1.txt:7
```

二、 大数组排序

• 第2题：编程排序256M个整数组成的大数组（50分）。

要求，外部编程，随机生成256M个整数。传入HDFS文件系统。编写MapReduce程序，对数组进行排序。

提示：

每个reduce任务生成一个输出文件。这个输出文件，按key排序。

如果，系统中有多个reduce任务。简单合并输出文件，里面的记录是没有按照key排序的。需要再编一个MapReduce程序。

总之，想要排序的结果，最后一级reduce，只能有一个reduce任务。

注意点：在map阶段需要将输入的文本转换成整数

256mIntArray.txt

大数组数据txt location

> /common/Big_Array/256mIntArray.txt

SortMapper.java

```java
package Sort;

import java.io.IOException;
import org.apache.hadoop.io.NullWritable;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapred.*;

public class SortMapper extends MapReduceBase implements Mapper<LongWritable,
Text,IntWritable, NullWritable> {
        private static IntWritable data= new IntWritable();
        public void map(LongWritable key, Text value, OutputCollector<IntWritable,
NullWritable> output, Reporter reporter) throws IOException {
//String[] SingleCountryData = valueString.split(",");
//output.collect(new Text(SingleCountryData[7]), one);
//if(SingleCountryData[7].equals("United States"))
                String valueString = value.toString();
                data.set(Integer.parseInt(valueString));
                output.collect(data, NullWritable.get());
        }
}
```

SortReducer.java

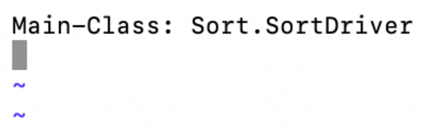
```java
package Sort;
import java.io.IOException;
import org.apache.hadoop.io.NullWritable;
import org.apache.hadoop.io.IntWritable;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import java.util.*;
import org.apache.hadoop.mapred.*;
public class SortReducer extends MapReduceBase implements Reducer<IntWritable,
NullWritable,IntWritable, NullWritable> {
        public void reduce(IntWritable t_key, Iterator<NullWritable> values,
OutputCollector<IntWritable,NullWritable> output, Reporter reporter) throws IOException
{
                //Text key = t_key;
                //int frequencyForCountry = 0;
                while(values.hasNext())
                {
                        NullWritable val = values.next();
                        output.collect(t_key,NullWritable.get());
                }
        }
}
```

> mapreduce中的reduce阶段会对key自动排序，但是当数组中有多个相同的数时，他们会共享同一个key。需要在reduce阶段对这个key重复输出。输出次数等于value表的长度。

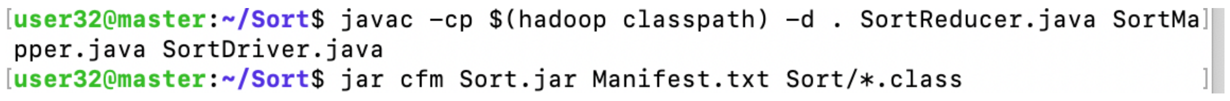
SortDriver.java

```
package Sort;

                import org.apache.hadoop.fs.Path;
                import org.apache.hadoop.io.*;
                import org.apache.hadoop.mapred.*;

public class SortDriver {
        public static void main(String[] args) {
                JobClient my_client = new JobClient();
                // Create a configuration object for the job
                JobConf job_conf = new JobConf(SortDriver.class);

                // Set a name of the Job
                job_conf.setJobName("XySortDemo");

                // Specify data type of output key and value
                job_conf.setOutputKeyClass(IntWritable.class);
                job_conf.setOutputValueClass(NullWritable.class);

                // Specify names of Mapper and Reducer Class
                job_conf.setMapperClass(Sort.SortMapper.class);
                job_conf.setReducerClass(Sort.SortReducer.class);
               // Specify formats of the data type of Input and output
                job_conf.setInputFormat(TextInputFormat.class);
                job_conf.setOutputFormat(TextOutputFormat.class);
                FileInputFormat.setInputPaths(job_conf, new Path(args[0]));
                FileOutputFormat.setOutputPath(job_conf, new Path(args[1]));

                my_client.setConf(job_conf);
                try {
                        // Run the job
                        JobClient.runJob(job_conf);
                }
                catch (Exception e) {
                        e.printStackTrace();
                }
        }
}
```

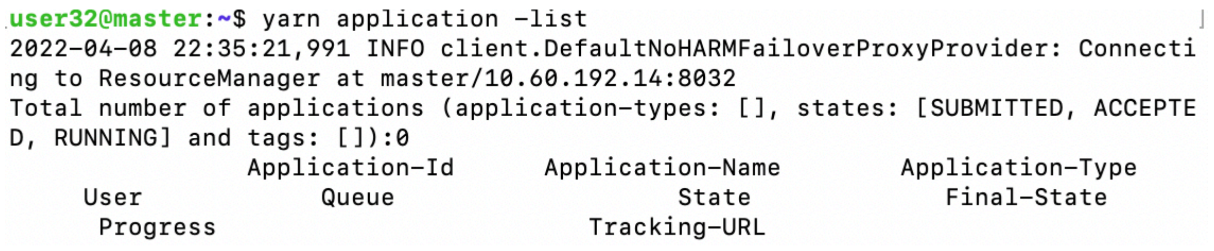
Manifest.txt



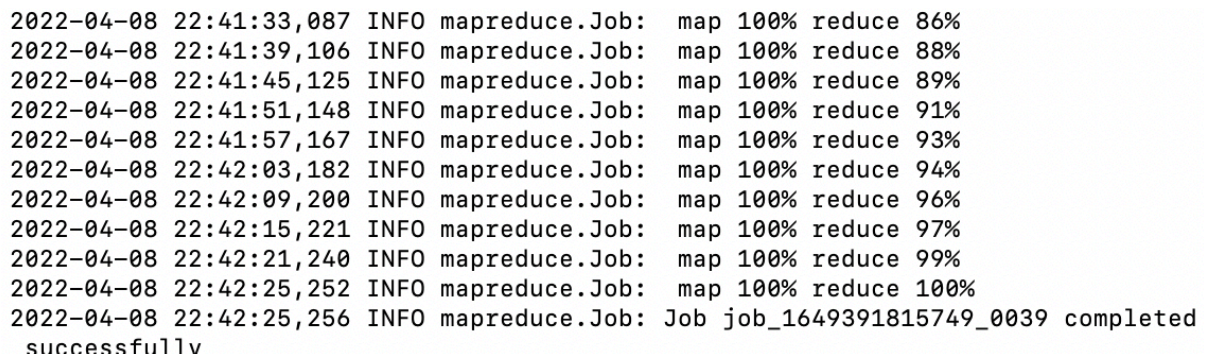
```
Main-Class: Sort.SortDriver

~
~
```



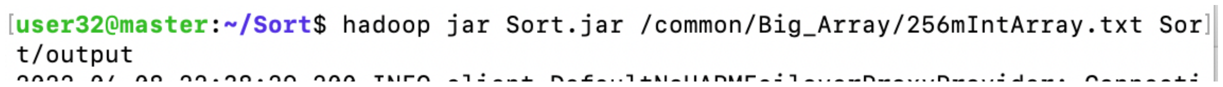
```
user32@master:~/Sort$ javac -cp $(hadoop classpath) -d . SortReducer.java SortMa
pper.java SortDriver.java
user32@master:~/Sort$ jar cfm Sort.jar Manifest.txt Sort/*.class
```



```
user32@master:~$ yarn application -list
2022-04-08 22:35:21,991 INFO client.DefaultNoHARMFailoverProxyProvider: Connecti
ng to ResourceManager at master/10.60.192.14:8032
Total number of applications (application-types: [], states: [SUBMITTED, ACCEPTE
D, RUNNING] and tags: []):0
                Application-Id      Application-Name        Application-Type
     User           Queue                   State             Final-State
      Progress                        Tracking-URL
```



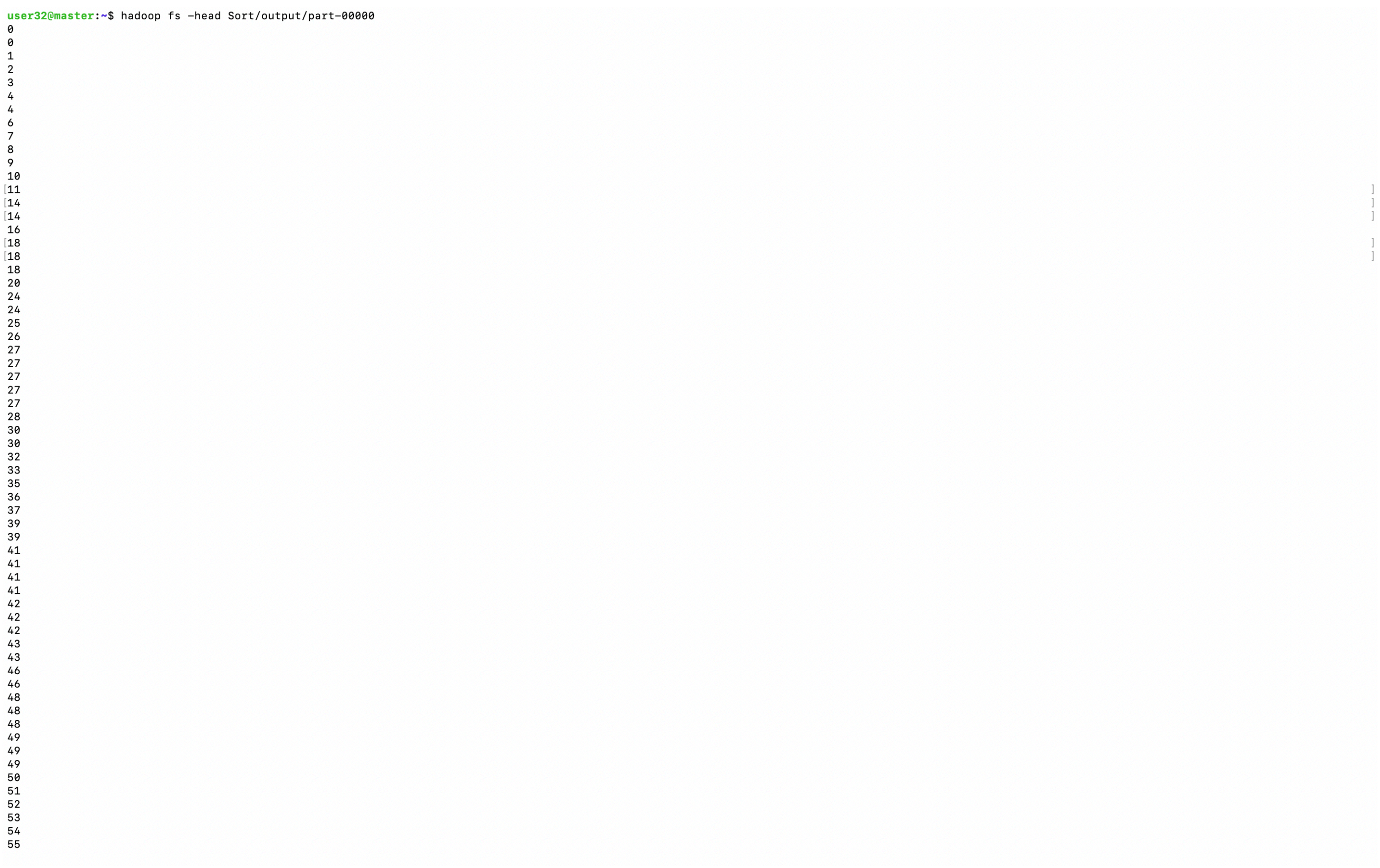
```
2022-04-08 22:41:33,087 INFO mapreduce.Job:  map 100% reduce 86%
2022-04-08 22:41:39,106 INFO mapreduce.Job:  map 100% reduce 88%
2022-04-08 22:41:45,125 INFO mapreduce.Job:  map 100% reduce 89%
2022-04-08 22:41:51,148 INFO mapreduce.Job:  map 100% reduce 91%
2022-04-08 22:41:57,167 INFO mapreduce.Job:  map 100% reduce 93%
2022-04-08 22:42:03,182 INFO mapreduce.Job:  map 100% reduce 94%
2022-04-08 22:42:09,200 INFO mapreduce.Job:  map 100% reduce 96%
2022-04-08 22:42:15,221 INFO mapreduce.Job:  map 100% reduce 97%
2022-04-08 22:42:21,240 INFO mapreduce.Job:  map 100% reduce 99%
2022-04-08 22:42:25,252 INFO mapreduce.Job:  map 100% reduce 100%
2022-04-08 22:42:25,256 INFO mapreduce.Job: Job job_1649391815749_0039 completed
 successfully
```



```
user32@master:~/Sort$ hadoop jar Sort.jar /common/Big_Array/256mIntArray.txt Sor
t/output
2022-04-08 22:38:29,200 INFO client.DefaultNoHARMFailoverProxyProvider: Connecti
```

查看开头

> $hadoop fs -head path



```
user32@master:~$ hadoop fs -head Sort/output/part-00000
0
0
1
2
3
4
4
6
7
8
9
10
11
14
14
16
18
18
18
20
24
24
25
26
27
27
27
27
27
28
30
30
32
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41
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49
50
51
52
53
54
55
```
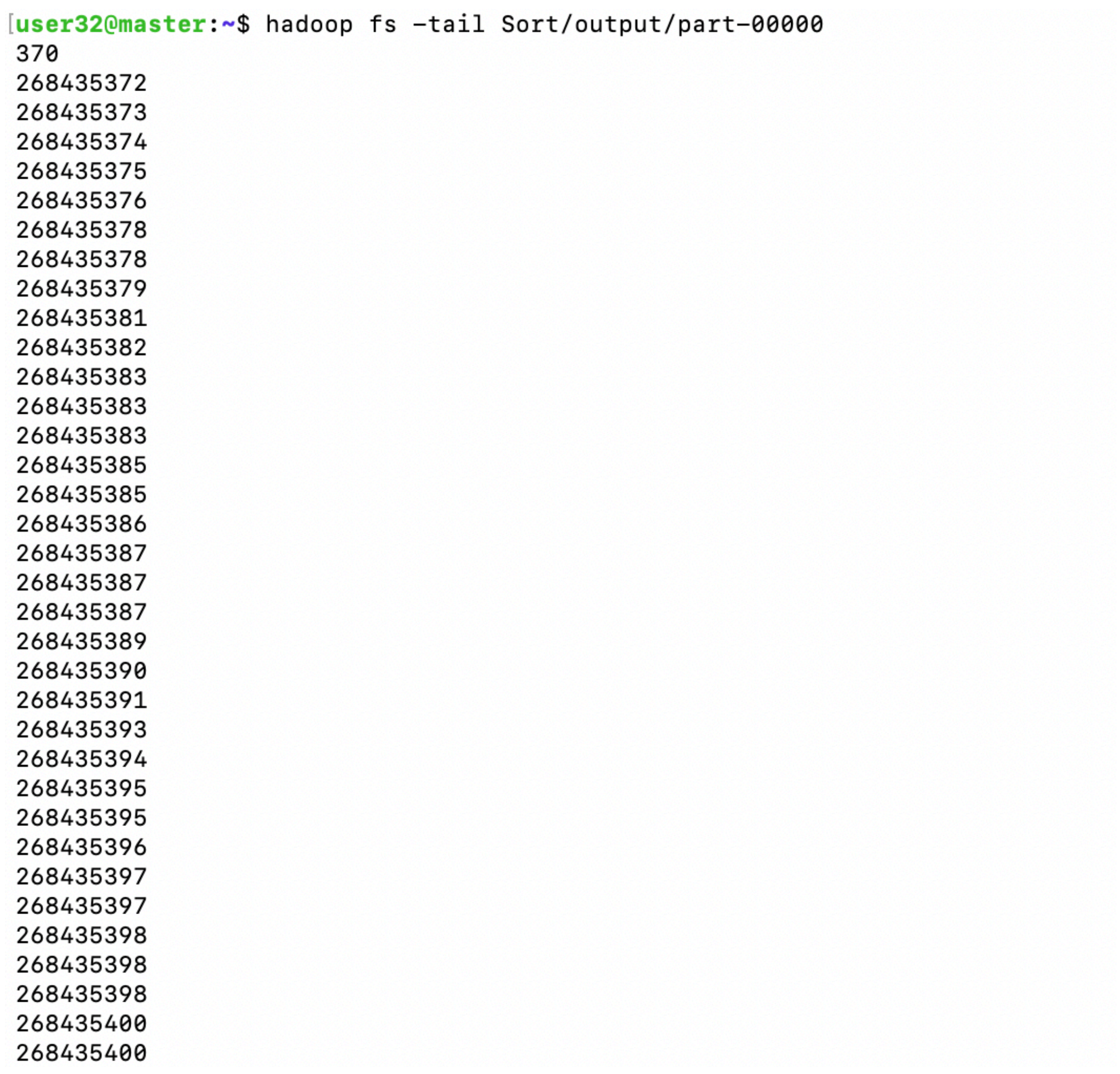

查看结尾



```
[user32@master:~$ hadoop fs -tail Sort/output/part-00000
370
268435372
268435373
268435374
268435375
268435376
268435378
268435378
268435379
268435381
268435382
268435383
268435383
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268435398
268435398
268435398
268435400
268435400
```

> 出现370可能因为tail是按字节算不是按行算的

由此看出结果有序