MapReduce与Yarn

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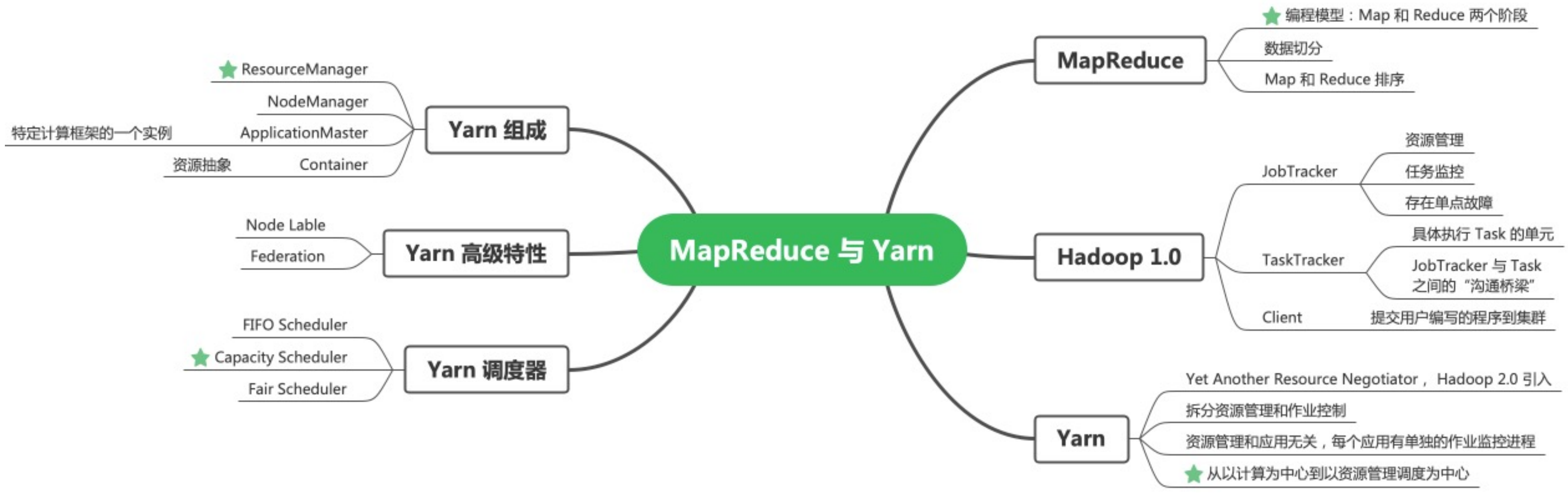
重点内容回顾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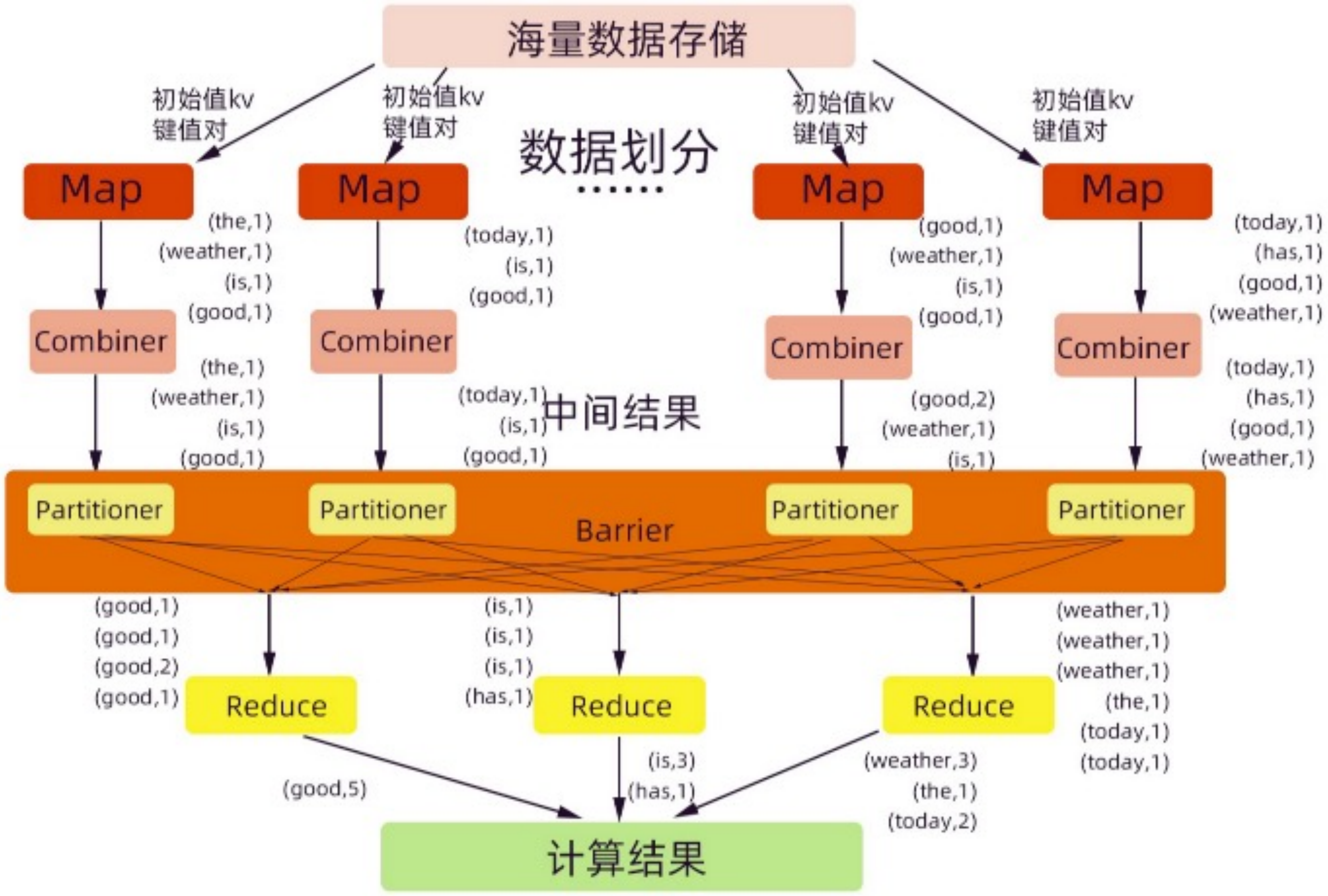
MapReduce编程模型



MapReduce编程模型

极客时间 训练营

- 分治法
  1. 分解原问题。将原问题分解为若干个规模较小，相互独立，且与原问题形式相同的子问题
  2. 求解子问题。若子问题规模较小且容易被解决则直接求解，否则递归地求解各个子问题
  3. 合并解，就是将各个子问题的解合并为原问题的解
- MapReduce
  - Map：分解，把复杂的任务分解为若干个简单的任务执行
  - Reduce：合并，对 Map 阶段的结果进行汇总

MapReduce编程模型

极客时间 训练营

- 使用场景：任务可被分解成相互独立的子问题
  1. 迭代。遍历输入数据，并解析成 key/value 对
  2. 将输入 key/value 对映射（map）成另外一些 key/value 对
  3. 根据 key 对中间数据进行分组（group）
  4. 以组为单位对数据进行归约（reduce）
  5. 迭代。将 reduce 阶段产生的key/value对保存到输出文件中

MapReduce 缺点

- **高昂的维护成本**
  - MapReduce 模型过于抽象，当遇到复杂度较高的需求时需要手动编排多个Map和多个Reduce任务
  - Spark、Flink等使用有向无环图（DAG）表达数据处理流程
    - 每个节点都表达一种通用的数据集
    - 每一条边表达一种通用的数据变换
- **时间性能较差**
  - Map 和 Reduce 的输出都需要落盘（本地磁盘、HDFS）

作业讲解

- 统计每一个手机号耗费的总上行流量、下行流量、总流量
- 作业详见：https://u.geekbang.org/lesson/180?article=491889
- 基本思路：
  - Map 阶段：
    - 读取一行数据，切分字段。
    - 抽取手机号、上行流量、下行流量。
    - 以手机号为 key，bean 对象为 value 输出，即 context.write(手机号，bean)。
  - Reduce 阶段：
    - 累加上行流量和下行流量得到总流量。
    - 实现自定义的 bean 来封装流量信息，并将 bean 作为 map 输出的 key 来传输

作业讲解

hadoop-mapreduce-project/hadoop-mapreduce-client/hadoop-mapreduce-client-core/src/main/java/org/apache/hadoop/mapreduce/Mapper.java

```java
public class Mapper<KEYIN, VALUEIN, KEYOUT, VALUEOUT> {

  /** The <code>Context</code> passed on to the {@link Mapper} implementations. */
  public abstract class Context
    implements MapContext<KEYIN,VALUEIN,KEYOUT,VALUEOUT> {
  }

  /** Called once at the beginning of the task. */
  protected void setup(Context context
                       ) throws IOException, InterruptedException {}

  /**
   * Called once for each key/value pair in the input split. Most applications
   * should override this, but the default is the identity function.
   */
  /unchecked/
  protected void map(KEYIN key, VALUEIN value,
                     Context context) throws IOException, InterruptedException {
    context.write((KEYOUT) key, (VALUEOUT) value);
  }
```

作业讲解

hadoop-mapreduce-project/hadoop-mapreduce-client/hadoop-mapreduce-client-core/src/main/java/org/apache/hadoop/mapreduce/Reducer.java

```java
public class Reducer<KEYIN,VALUEIN,KEYOUT,VALUEOUT> {

  /** The <code>Context</code> passed on to the {@link Reducer} implementations. */
  public abstract class Context
    implements ReduceContext<KEYIN,VALUEIN,KEYOUT,VALUEOUT> {
  }

  /** Called once at the start of the task. */
  protected void setup(Context context
                       ) throws IOException, InterruptedException {}

  /**
   * This method is called once for each key. Most applications will define
   * their reduce class by overriding this method. The default implementation
   * is an identity function.
   */
  /unchecked/
  protected void reduce(KEYIN key, Iterable<VALUEIN> values, Context context
                        ) throws IOException, InterruptedException {
    for(VALUEIN value: values) {
      context.write((KEYOUT) key, (VALUEOUT) value);
    }
  }
```

作业讲解

```java
public class PhoneTraffic implements Writable {
    // 上行流量
    private long up;
    // 下行流量
    private long down;
    // 总流量
    private long sum;

    public PhoneTraffic() {}

    public PhoneTraffic(long up, long down, long sum) {...}

    @Override
    public void write(DataOutput dataOutput) throws IOException {
        dataOutput.writeLong(up);
        dataOutput.writeLong(down);
        dataOutput.writeLong(sum);
    }

    @Override
    public void readFields(DataInput dataInput) throws IOException {
        this.up = dataInput.readLong();
        this.down = dataInput.readLong();
        this.sum = dataInput.readLong();
    }
```

作业讲解

```java
public static class TrafficMapper extends Mapper<Object, Text, Text, PhoneTraffic> {

    public void map(Object key, Text value, Context context) throws IOException, InterruptedException {
        String[] lines = value.toString().split( regex: "\t");
        if (lines.length < 10) {
            return;
        }

        String phone = lines[1];
        try {
            long up = Long.parseLong(lines[8]);
            long down = Long.parseLong(lines[9]);
            context.write(new Text(phone), new PhoneTraffic(up, down,  sum: up + down));
        } catch (NumberFormatException e) {
            System.err.println("parseLong failed" + e.getMessage());
        }
    }
}
```

作业讲解

极客时间 训练营

```java
public static class TrafficReducer extends Reducer<Text,PhoneTraffic,Text,PhoneTraffic> {

    public void reduce(Text key, Iterable<PhoneTraffic> values, Context context
    ) throws IOException, InterruptedException {
        int totalUp = 0;
        int totalDown = 0;
        int sumTraffic = 0;
        for (PhoneTraffic val : values) {
            totalUp += val.getUp();
            totalDown += val.getDown();
            sumTraffic += val.getSum();
        }

        context.write(key, new PhoneTraffic(totalUp, totalDown, sumTraffic));
    }
}
```

作业讲解


```java
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: TrafficStat <in> <out>");
        System.exit( status: 2);
    }
    System.out.println("otherArgs: " + Arrays.toString(otherArgs));

    Job job = Job.getInstance(conf,  jobName: "TrafficStat");
    job.setJarByClass(TrafficStat.class);
    job.setMapperClass(TrafficMapper.class);
    job.setCombinerClass(TrafficReducer.class);
    job.setReducerClass(TrafficReducer.class);

    job.setOutputKeyClass(Text.class);
    job.setOutputValueClass(PhoneTraffic.class);

    job.setNumReduceTasks(1);

    FileInputFormat.addInputPath(job, new Path(otherArgs[otherArgs.length - 2]));
    FileOutputFormat.setOutputPath(job, new Path(otherArgs[otherArgs.length - 1]));
    System.exit(job.waitForCompletion( verbose: true) ? 0 : 1);
}
```

作业讲解

运行演示

hadoop jar bigdata-tutorial-1.0-SNAPSHOT.jar TrafficStat /user/public/week2/ /user/public/week2_out/

Hadoop Streaming

- 允许用户使用**可执行文件或者脚本**作为 Mapper/Reducer 创建和运行 MapReduce 任务，降低开发门槛
- 要求编写的 Mapper/Reducer 从标准输入中读取数据，将结果写到标准输出中
- 官方文档：https://hadoop.apache.org/docs/stable/hadoop-streaming/HadoopStreaming.html

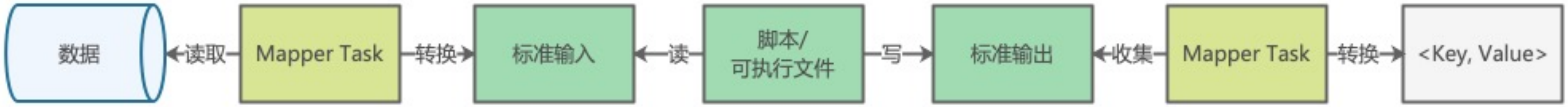
```
mapred streaming \
        -input myInputDirs \
        -output myOutputDir \
        -mapper /bin/cat \
        -reducer /usr/bin/wc
```

Hadoop Streaming – 配置

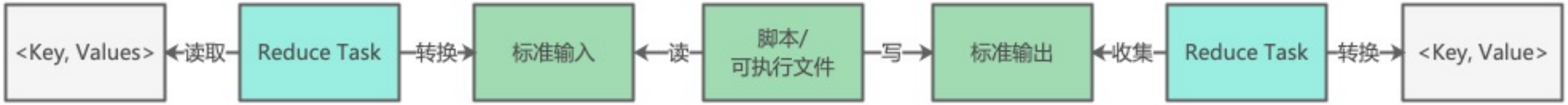
Parameter	Optional/Required	Description
-input directoryname or filename	Required	Input location for mapper
-output directoryname	Required	Output location for reducer
-mapper executable or JavaClassName	Optional	Mapper executable. If not specified, IdentityMapper is used as the default
-reducer executable or JavaClassName	Optional	Reducer executable. If not specified, IdentityReducer is used as the default
-file filename	Optional	Make the mapper, reducer, or combiner executable available locally on the compute nodes
-combiner streamingCommand or JavaClassName	Optional	Combiner executable for map output
-cmdenv name=value	Optional	Pass environment variable to streaming commands
-numReduceTasks	Optional	Specify the number of reducers

Hadoop Streaming – 原理

- 使用可执行文件或者脚本文件充当Mapper或者Reducer时，Java端的Mapper或者Reducer充当了wrapper角色，将输入文件中的key和value直接传递给可执行文件或者脚本文件进行处理，并将处理结果写入HDFS



Map 阶段



Reduce 阶段

Hadoop Streaming – 原理

难点：如何使用标准输入输出实现Java与可执行文件、脚本之间的通信？

```java
// Start the process
ProcessBuilder builder = new ProcessBuilder(argvSplit);
builder.environment().putAll(childEnv.toMap());
sim = builder.start();

clientOut_ = new DataOutputStream(new BufferedOutputStream(
                                        sim.getOutputStream(),
                                        BUFFER_SIZE));
clientIn_ = new DataInputStream(new BufferedInputStream(
                                        sim.getInputStream(),
                                        BUFFER_SIZE));
clientErr_ = new DataInputStream(new BufferedInputStream(sim.getErrorStream()));
```

hadoop-tools/hadoop-streaming/src/main/java/org/apache/hadoop/streaming/PipeMapRed.java

Hadoop Streaming – 使用

```python
def traffic_mapper():
    for line in sys.stdin:
        arr = line.strip().split("\t")
        if len(arr) < 10:
            continue
        # 电话号码, 上行流量, 下行流量
        print("%s\t%s\t%s" % (arr[1], arr[8], arr[9]))
```

Hadoop Streaming – 使用

极客时间 训练营

```python
def traffic_reducer():
    last_phone = ""
    up, down = 0, 0
    for line in sys.stdin:
        arr = line.strip().split("\t")

        if last_phone == "":
            last_phone = arr[0]
        elif last_phone != arr[0]:
            # 输出上一个电话的流量统计
            print("%s\t%s\t%s\t%s" % (last_phone, up, down, up + down))
            last_phone = arr[0]
            up, down = 0, 0

        up += int(arr[1])
        down += int(arr[2])

    if last_phone != "":
        print("%s\t%s\t%s\t%s" % (last_phone, up, down, up + down))
```

Hadoop Streaming – 使用

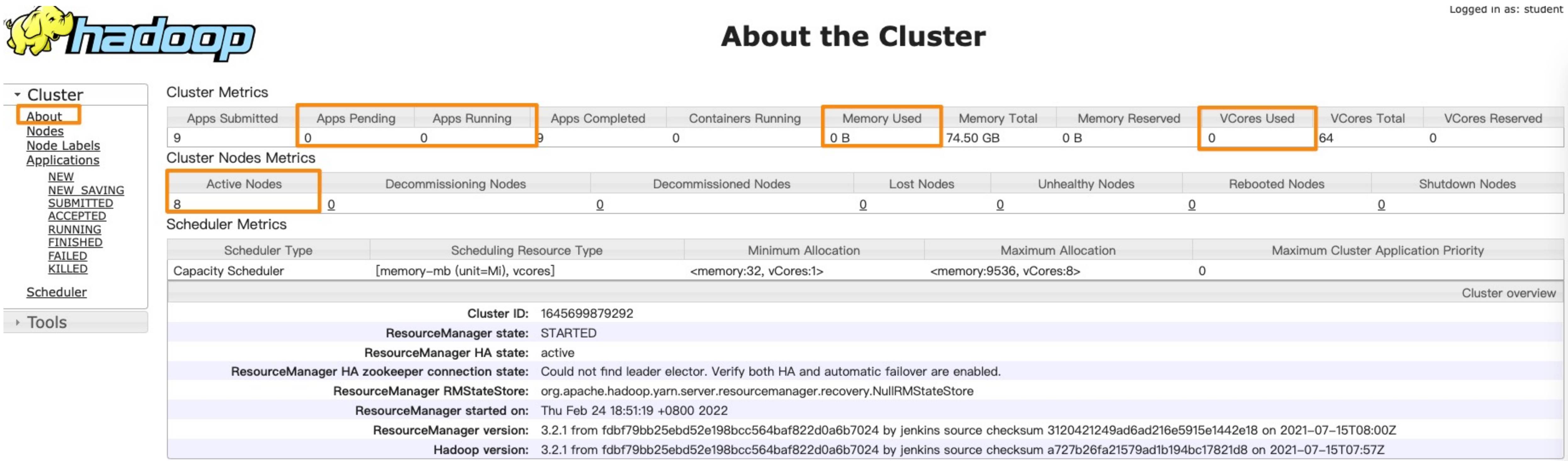
```python
def main():
    if sys.argv[1] == "map":
        traffic_mapper()
    elif sys.argv[1] == "reduce":
        traffic_reducer()

if __name__ == "__main__":
    main()
```

运行演示

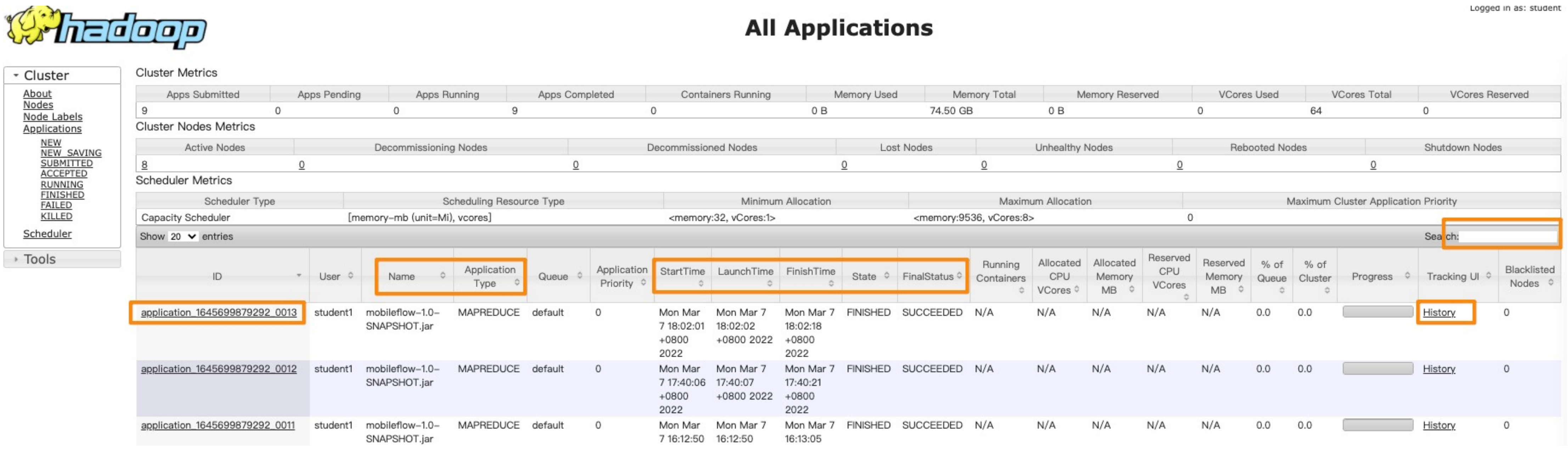
```
mapred streaming \
  -input /user/public/week2/ \
  -output /user/public/week2_streaming/ \
  -mapper '/usr/bin/python3 traffic_stat.py map' \
  -reducer '/usr/bin/python3 traffic_stat.py reduce' \
  -file traffic_stat.py \
  -numReduceTasks 1
```

Yarn UI

https://knox.c-01b94588f59c7655.cn-hangzhou.emr.aliyuncs.com:8443/gateway/cluster-topo/yarn/cluster/apps

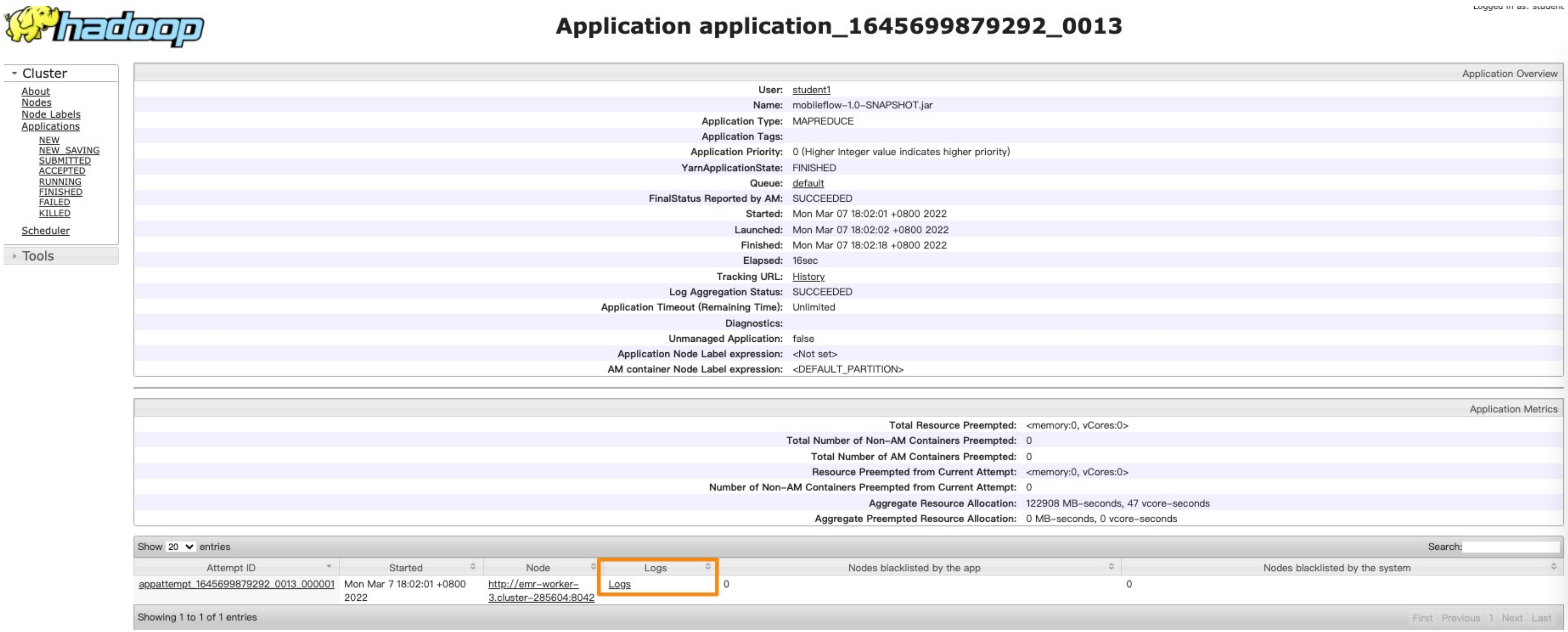


Yarn UI-Applications



Yarn UI-Applications

极客时间 训练营



Yarn UI-Applications

Application History

- About
- Applications
  - FINISHED
  - FAILED
  - KILLED

Tools

Log Type: directory.info

Log Upload Time: Mon Mar 07 18:02:26 +0800 2022

Log Length: 2244

```
ls -l:
total 36
-rw-r----- 1 hadoop hadoop  100 Mar  7 18:02 container_tokens
-rwx------ 1 hadoop hadoop  616 Mar  7 18:02 default_container_executor_session.sh
-rwx------ 1 hadoop hadoop  671 Mar  7 18:02 default_container_executor.sh
lrwxrwxrwx 1 hadoop hadoop   95 Mar  7 18:02 job.jar -> /mnt/disk1/yarn/usercache/student1/appcache/application_1645699879292_0013/filecache/11/job.jar
drwxrwxr-x 2 hadoop hadoop 4096 Mar  7 18:02 jobSubmitDir
lrwxrwxrwx 1 hadoop hadoop   95 Mar  7 18:02 job.xml -> /mnt/disk3/yarn/usercache/student1/appcache/application_1645699879292_0013/filecache/13/job.xml
-rwx------ 1 hadoop hadoop 6403 Mar  7 18:02 launch_container.sh
drwx--x--- 2 hadoop hadoop 4096 Mar  7 18:02 tmp
find -L . -maxdepth 5 -ls:
2097165    4 drwx--x---   4 hadoop   hadoop      4096 Mar  7 18:02 .
2097171    4 -rwx------   1 hadoop   hadoop       616 Mar  7 18:02 ./default_container_executor_session.sh
2097168    4 -rw-r-----   1 hadoop   hadoop        12 Mar  7 18:02 ./.container_tokens.crc
2097175    4 drwxrwxr-x   2 hadoop   hadoop      4096 Mar  7 18:02 ./jobSubmitDir
2228243    4 -r-x------   1 hadoop   hadoop       161 Mar  7 18:02 ./jobSubmitDir/job.split
2228240    4 -r-x------   1 hadoop   hadoop        71 Mar  7 18:02 ./jobSubmitDir/job.splitmetainfo
2097172    4 -rw-r-----   1 hadoop   hadoop        16 Mar  7 18:02 ./.default_container_executor_session.sh.crc
1835022    4 drwx------   2 hadoop   hadoop      4096 Mar  7 18:02 ./job.jar
1835023    8 -r-x------   1 hadoop   hadoop      6573 Mar  7 18:02 ./job.jar/job.jar
2097166    4 drwx--x---   2 hadoop   hadoop      4096 Mar  7 18:02 ./tmp
2097169    8 -rwx------   1 hadoop   hadoop      6403 Mar  7 18:02 ./launch_container.sh
2097174    4 -rw-r-----   1 hadoop   hadoop        16 Mar  7 18:02 ./.default_container_executor.sh.crc
2097173    4 -rwx------   1 hadoop   hadoop       671 Mar  7 18:02 ./default_container_executor.sh
2097170    4 -rw-r-----   1 hadoop   hadoop        60 Mar  7 18:02 ./.launch_container.sh.crc
2097167    4 -rw-r-----   1 hadoop   hadoop       100 Mar  7 18:02 ./container_tokens
1835021  204 -r-x------   1 hadoop   hadoop    206913 Mar  7 18:02 ./job.xml
broken symlinks(find -L . -maxdepth 5 -type l -ls):
```

Log Type: launch_container.sh

Log Upload Time: Mon Mar 07 18:02:26 +0800 2022

Log Length: 6403

Showing 4096 bytes of 6403 total. Click here for the full log. 点击跳转到日志详情

```
disk2/log/hadoop-yarn/containers/application_1645699879292_0013/container_1645699879292_0013_01_000001,/mnt/disk3/log/hadoop-yarn/containers/application_16456998792
export USER="student1"
export LOGNAME="student1"
export HOME="/home/"
export PWD="/mnt/disk2/yarn/usercache/student1/appcache/application_1645699879292_0013/container_1645699879292_0013_01_000001"
```

Yarn UI-Applications

MapReduce Job job_1645699879292_0013

- Application
- Job
  - Overview
  - Counters
  - Configuration
  - Map tasks
  - Reduce tasks
- Tools

Job Name:	mobileflow-1.0-SNAPSHOT.jar
User Name:	student1
Queue:	default
State:	SUCCEEDED
Uberized:	false
Submitted:	Mon Mar 07 18:02:01 CST 2022
Started:	Mon Mar 07 18:02:07 CST 2022
Finished:	Mon Mar 07 18:02:18 CST 2022
Elapsed:	10sec
Diagnostics:	
Average Map Time	2sec
Average Shuffle Time	2sec
Average Merge Time	0sec
Average Reduce Time	0sec

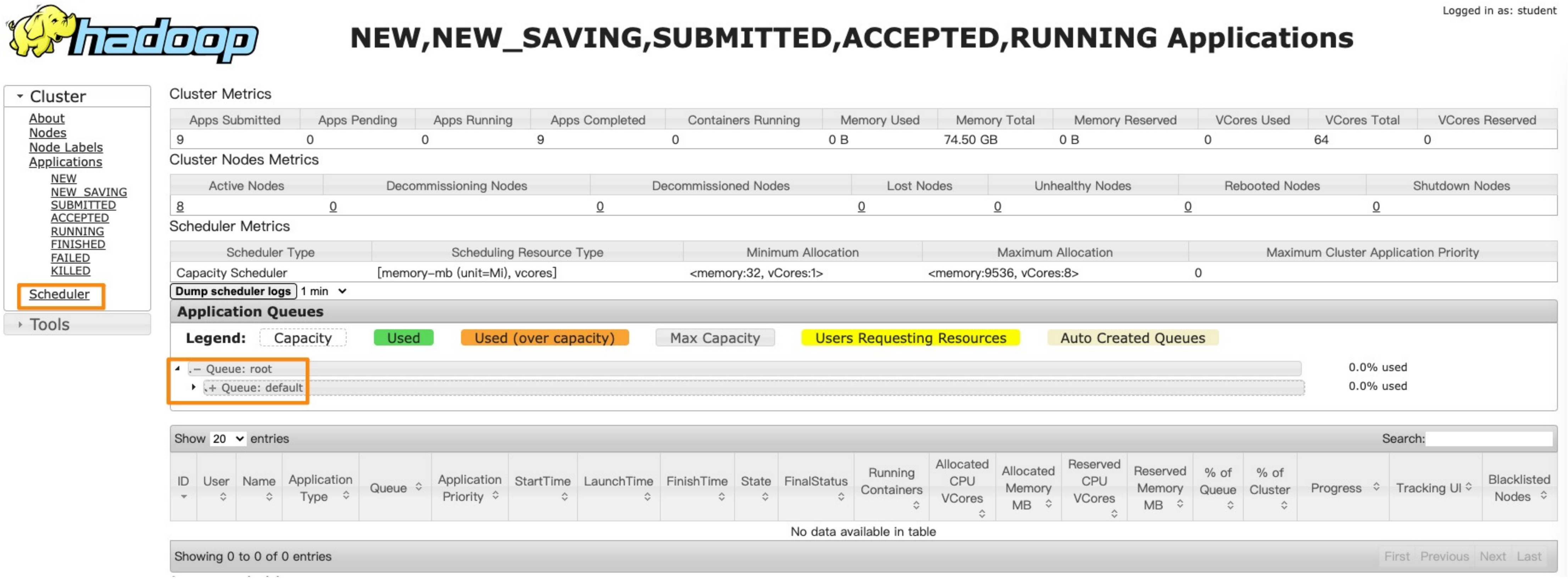
ApplicationMaster

Attempt Number	Start Time	Node	Logs
1	Mon Mar 07 18:02:03 CST 2022	emr-worker-3.cluster-285604:8042	https://knox.c-01b94588f59c7655.cn-hangzhou.emr.aliyuncs.com:8443/gateway/jobhistoryui/jobhistory/logs

Task Type	Total	Complete
Map	1	1
Reduce	7	7

Attempt Type	Failed	Killed	Successful
Maps	0	0	1
Reduces	0	0	7

Yarn UI-Scheduler



QA