Huawei Big Data Certification Training

HCIA-Big Data
Lab Guide for Big Data Engineers

ISSUE:3.0

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The HCIA-Big Data certificate system introduces you the technical principles and architectures of common and important big data components, and enables you to stand atop the Big Data frontiers.

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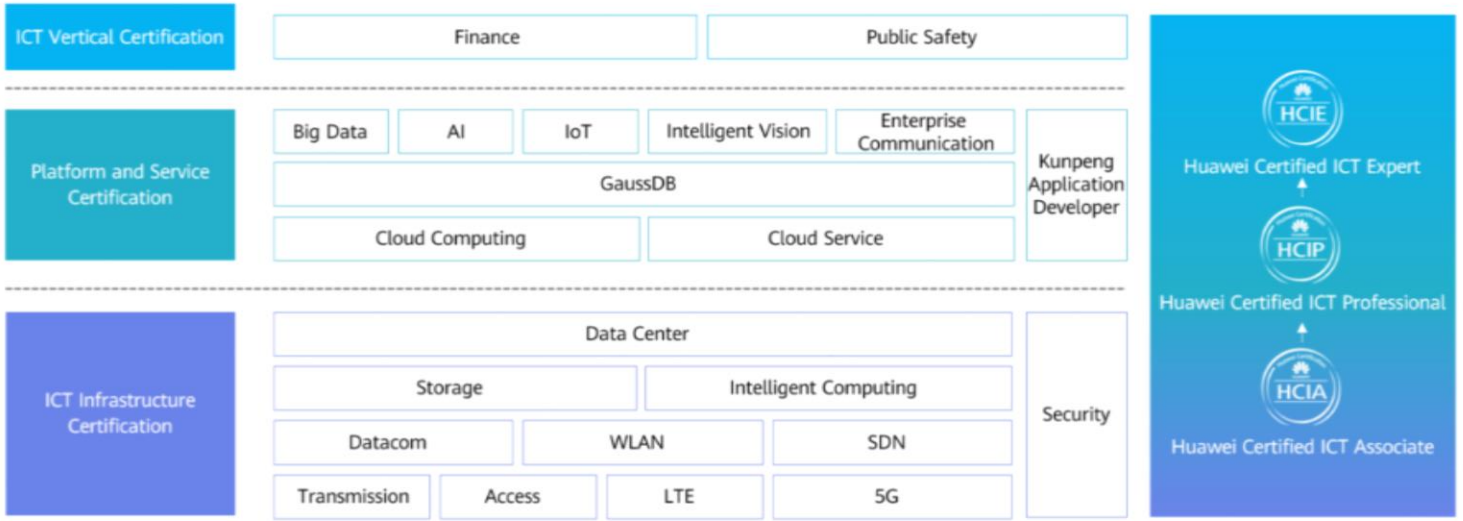


Contents

1 About This Document

1.1 Introduction

This document uses HUAWEI CLOUD MapReduce Service (MRS) as the exercise environment to guide trainees through related tasks and help them understand how to use big data components of MRS.

1.2 Content Description

This document consists of eight exercises and illustrates how to use important big data components.

The exercises include HUAWEI CLOUD MRS application practice, HDFS practice, Loader data import and export practice, Flume data collection practice, Kafka message subscription practice, Hive data warehouse practice, HBase database practice, and comprehensive cluster practice.

1.3 Precautions

A HUAWEI CLOUD account and real-name authentication are required.

It is recommended that each trainee uses one exercise environment so that they do not affect each other.

1.4 References

To obtain the MapReduce help documents, visit https://support.huaweicloud.com/intl/en-us/mrs/index.html.

1.5 MRS Architecture

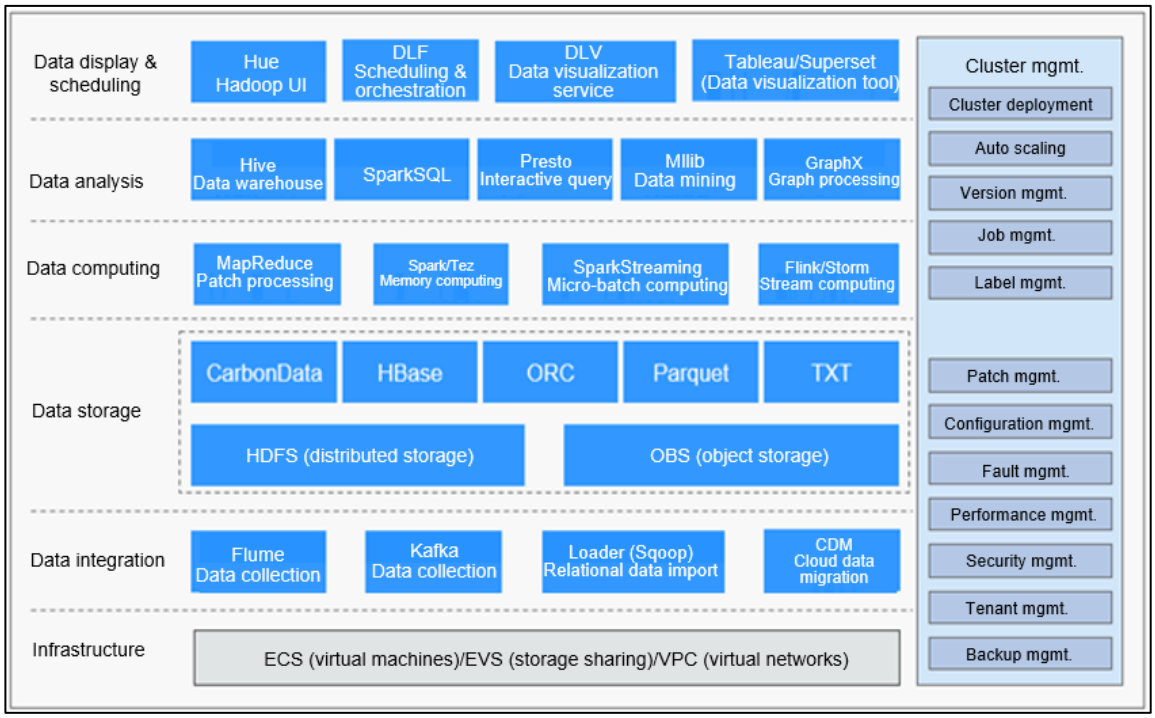


Figure 1-1

2 HDFS Practice

2.1 Background

HDFS is the basis of big data components. Hive data, MapReduce and Spark computing data, and regions of HBase are all stored in HDFS. On the HDFS shell client, you can perform various operations, such as uploading, downloading, and deleting data, and managing file systems. Learning HDFS will help you better understand and master big data knowledge.

2.2 Objectives

- Understand command HDFS operations.
- Understand HDFS management operations.

2.3 Tasks

2.3.1 Task 1: Understating Common HDFS Commands

Run the following command to set environment variables before running commands to operate the MRS components:

```
source   /opt/client/bigdata_env
```

Step 1 Run the **help** command.

This command is used to view the command help document.

```
hdfs   dfs   -help
```

```
[root@node-master1duzY ~]# hdfs dfs -help
Usage: hadoop fs [generic options]
        [-appendToFile <localsrc> ... <dst>]
        [-cat [-ignoreCrc] <src> ...]
        [-checksum <src> ...]
        [-chgrp [-R] GROUP PATH...]
        [-chmod [-R] <MODE[,MODE]... | OCTALMODE> PATH...]
        [-chown [-R] [OWNER][:[GROUP]] PATH...]
        [-copyFromLocal [-f] [-p] [-l] [-d] [-t <thread count>] <localsrc> ... <dst>]
        [-copyToLocal [-f] [-p] [-ignoreCrc] [-crc] <src> ... <localdst>]
        [-count [-q] [-h] [-v] [-t [<storage type>]] [-u] [-x] [-e] <path> ...]
        [-cp [-f] [-p | -p[topax]] [-d] <src> ... <dst>]
        [-createSnapshot <snapshotDir> [<snapshotName>]]
        [-deleteSnapshot <snapshotDir> <snapshotName>]
        [-df [-h] [<path> ...]]
        [-du [-s] [-h] [-v] [-x] <path> ...]
        [-expunge]
        [-find <path> ... <expression> ...]
        [-get [-f] [-p] [-ignoreCrc] [-crc] <src> ... <localdst>]
        [-getfacl [-R] <path>]
        [-getfattr [-R] {-n name | -d} [-e en] <path>]
        [-getmerge [-nl] [-skip-empty-file] <src> <localdst>]
        [-head <file>]
```

Figure 2-1

Check how to use the **ls** command.

```
hdfs dfs -help ls
```

```
[root@node-master1duzY ~]# hdfs dfs -help ls
-ls [-C] [-d] [-h] [-q] [-R] [-t] [-S] [-r] [-u] [-e] [<path> ...] :
  List the contents that match the specified file pattern. If path is not
  specified, the contents of /user/<currentUser> will be listed. For a directory a
  list of its direct children is returned (unless -d option is specified).

  Directory entries are of the form:
        permissions - userId groupId sizeOfDirectory(in bytes)
  modificationDate(yyyy-MM-dd HH:mm) directoryName

  and file entries are of the form:
        permissions numberOfReplicas userId groupId sizeOfFile(in bytes)
  modificationDate(yyyy-MM-dd HH:mm) fileName

    -C  Display the paths of files and directories only.
```

Figure 2-2

Step 2 Run the **ls** command.

This command is used to display the directory information.

```
hdfs dfs -ls /
```

```
[root@node-master1HaCu ~]# hdfs  dfs  -ls  /
2020-04-06 17:13:35,810 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 11 items
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 13:29 /app-logs
drwxrwxrwx   - hive   hive            0 2020-04-06 13:36 /apps
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 13:29 /ats
drwxr-xr-x   - hdfs   hadoop          0 2020-04-06 13:29 /datasets
drwxr-xr-x   - hdfs   hadoop          0 2020-04-06 13:29 /datastore
drwxrwxrwx   - flink  hadoop          0 2020-04-06 13:31 /flink
drwxr-xr-x   - hbase  hadoop          0 2020-04-06 13:33 /hbase
drwxrwxrwx   - mapred hadoop          0 2020-04-06 13:29 /mr-history
drwxrwxrwt   - spark  hadoop          0 2020-04-06 13:43 /sparkJobHistory
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 13:42 /tmp
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 13:39 /user
[root@node-master1HaCu ~]#
```

Figure 2-3

Step 3 Run the **mkdir** command.

This command is used to create directories in HDFS.

To create the **stu01** folder in the **user** folder of the **root** directory, view the content in the **user** folder, create the folder, and then run the **ls** command. The **stu01** folder is displayed.

```
hdfs  dfs  -mkdir  /user/stu01
```

```
[root@node-master1HaCu ~]# hdfs  dfs  -mkdir  /user/stu01
2020-04-06 17:24:58,832 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1HaCu ~]# hdfs  dfs  -ls  /user
2020-04-06 17:26:16,824 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 6 items
drwxrwxrwx   - hive   hive            0 2020-04-06 13:29 /user/hive
drwxr-x---   - loader hadoop          0 2020-04-06 13:35 /user/loader
drwxr-xr-x   - mapred hadoop          0 2020-04-06 13:29 /user/mapred
drwxrwxrwx   - omm    hadoop          0 2020-04-06 13:43 /user/omm
drwxrwxrwx   - omm    hadoop          0 2020-04-06 13:39 /user/spark
drwxr-xr-x   - root   hadoop          0 2020-04-06 17:24 /user/stu01
[root@node-master1HaCu ~]#
```

Figure 2-4

Step 4 Run the **put** command.

This command is used to upload a file in the Linux system to a specified HDFS directory. Before executing this command, run the following command to edit a file in a local Linux host:

```
vi  stu01.txt
```

```
[root@node-master1duzY ~]# vi stu01.txt
```

Figure 2-5

Press **i** to enter the editing mode, enter the content, and press **Esc**. Then, press **Shift** and a colon (:), and enter **wq** to save the settings and exit. The following is a file content example:

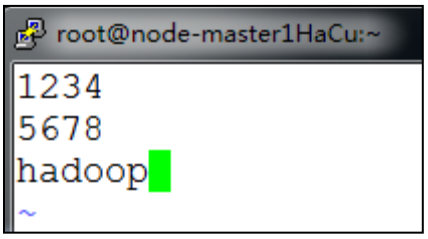


Figure 2-6

Run the **hdfs dfs -put stu01.txt /user/stu01/** command to upload the file.

```
[root@node-master1HaCu ~]# hdfs  dfs  -put  stu01.txt  /user/stu01/
2020-04-06 17:41:22,430 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1HaCu ~]# hdfs  dfs  -ls  /user/stu01
2020-04-06 17:43:16,663 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 1 items
-rw-r--r--   1 root hadoop         17 2020-04-06 17:41 /user/stu01/stu01.txt
[root@node-master1HaCu ~]#
```

Figure 2-7

Run the **ls** command to check whether the **stu01.txt** file has been uploaded to the **/user/stu01** directory.

Step 5 Run the **cat** command.

This command is used to display the file content.

```
hdfs  dfs  -cat /user/stu01/stu01.txt
```

```
[root@node-master1duzY ~]#  hdfs  dfs  -cat /user/stu01/stu01.txt
1234
5678
hadoop
[root@node-master1duzY ~]#
```

Figure 2-8

Step 6 Run the **text** command.

This command is used to show the content of a file in character format.

```
hdfs  dfs  -text /user/stu01/stu01.txt
```

```
[root@node-master1duzY ~]#  hdfs  dfs  -text /user/stu01/stu01.txt
1234
5678
hadoop
[root@node-master1duzY ~]#
```

Figure 2-9

Step 7 Run the **moveFromLocal** command.

This command is used to cut and paste data from the local PC to HDFS.

Run the **vi** command to create a data file, for example, **stu01_2.txt**, on a local Linux host. The following figure shows the content of the file.

```
[root@node-master1duzY ~]# vi stu01_2.txt
[root@node-master1duzY ~]# cat stu01_2.txt
hadoop
hive
[root@node-master1duzY ~]#
```

Figure 2-10

Run the following command:

```
hdfs dfs -moveFromLocal stu01_2.txt /user/stu01/
```

```
[root@node-master1HaCu ~]# vi stu01_2.txt
[root@node-master1HaCu ~]# hdfs dfs -moveFromLocal stu01_2.txt /user/stu01/
2020-04-06 17:57:53,914 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1HaCu ~]# hdfs dfs -ls /user/stu01
2020-04-06 17:57:59,608 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 2 items
-rw-r--r--   1 root hadoop         17 2020-04-06 17:41 /user/stu01/stu01.txt
-rw-r--r--   1 root hadoop         12 2020-04-06 17:57 /user/stu01/stu01_2.txt
[root@node-master1HaCu ~]#
```

Figure 2-11

The **stu01_2.txt** file has been uploaded to the **/user/stu01** directory on the HDFS. Run the **ls** command to check the Linux local host. The **stu01_2.txt** file does not exist, indicating that the file is cut and pasted to the destination HDFS directory. Comparatively, after the **put** command is executed, the local file is only copied to the HDFS and still exists on the Linux host.

Step 8 Run the **appendToFile** command.

This command is used to add a file to the end of an existing file.

Run the **vi** command to edit data file **stu01_3.txt** on a local Linux host. The file content is as follows:

```
[root@node-master1duzY ~]# vi stu01_3.txt
[root@node-master1duzY ~]# cat stu01_3.txt
www.huawei.com
```

Figure 2-12

Run the following command:

```
hdfs dfs -appendToFile stu01_3.txt /user/stu01/stu01_2.txt
```

Add the content of the **stu01_3.txt** file to the **stu01_2.txt** file in the HDFS.

Run the **cat** command to view the result. The following information is displayed:

```
[root@node-master1HaCu ~]# vi stu01_3.txt
[root@node-master1HaCu ~]# hdfs  dfs  -appendToFile  stu01_3.txt  /user/stu01/stu01_2.txt
2020-04-06 18:01:17,023 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1HaCu ~]# hdfs  dfs  -cat  /user/stu01/stu01_2.txt
2020-04-06 18:01:29,846 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
hadoop
hive
www.huawei.com
[root@node-master1HaCu ~]#
```

Figure 2-13

Step 9 Run the **cp** command.

This command is used to copy a file from one HDFS path to another HDFS path.

Run the **vi** command to edit the **stu01_4.txt** file on a local Linux host, and run the **put** command to upload the file to the HDFS **root** directory, as shown in the following figure:

```
[root@node-master1duzY ~]# vi stu01_4.txt
[root@node-master1duzY ~]# hdfs dfs -put  stu01_4.txt /
[root@node-master1duzY ~]#
```

Figure 2-14

Run the **hdfs dfs -cp /stu01_4.txt /user/stu01/** command.

```
[root@node-master1HaCu ~]# vi stu01_4.txt
[root@node-master1HaCu ~]# hdfs  dfs  -put  stu01_4.txt  /
2020-04-06 18:03:35,115 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1HaCu ~]# hdfs  dfs  -cp  /stu01_4.txt  /user/stu01/
2020-04-06 18:03:42,513 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1HaCu ~]# hdfs  dfs  -ls  /user/stu01
2020-04-06 18:03:57,522 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 3 items
-rw-r--r--   1 root hadoop         17 2020-04-06 17:41 /user/stu01/stu01.txt
-rw-r--r--   1 root hadoop         27 2020-04-06 18:01 /user/stu01/stu01_2.txt
-rw-r--r--   1 root hadoop         18 2020-04-06 18:03 /user/stu01/stu01_4.txt
[root@node-master1HaCu ~]# hdfs  dfs  -ls  /
2020-04-06 18:04:09,980 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 12 items
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 13:29 /app-logs
drwxrwxrwx   - hive   hive              0 2020-04-06 13:36 /apps
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 13:29 /ats
drwxr-xr-x   - hdfs   hadoop            0 2020-04-06 13:29 /datasets
drwxr-xr-x   - hdfs   hadoop            0 2020-04-06 13:29 /datastore
drwxrwxrwx   - flink  hadoop            0 2020-04-06 13:31 /flink
drwxr-xr-x   - hbase  hadoop            0 2020-04-06 13:33 /hbase
drwxrwxrwx   - mapred hadoop            0 2020-04-06 13:29 /mr-history
drwxrwxrwt   - spark  hadoop            0 2020-04-06 13:43 /sparkJobHistory
-rw-r--r--   1 root   ficommon         18 2020-04-06 18:03 /stu01_4.txt
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 13:42 /tmp
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 17:24 /user
[root@node-master1HaCu ~]#
```

Figure 2-15

The **stu01_4.txt** file exists in the **/user/stu01** directory and the **root** directory.

Step 10 Run the **mv** command.

This command is used to move files in the HDFS directory.

Run the **vi** command to edit the **stu01_5.txt** file on the local Linux host, and run the **put** command to upload the file to the HDFS **root** directory, as shown in the following figure:

```
[root@node-master1dCrC ~]# vi stu01_5.txt
[root@node-master1dCrC ~]# hdfs dfs -put stu01_5.txt /
2020-04-06 19:53:54,863 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1dCrC ~]# hdfs dfs -ls /
2020-04-06 19:54:05,132 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 12 items
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 18:24 /app-logs
drwxrwxrwx   - hive   hive              0 2020-04-06 18:27 /apps
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 18:24 /ats
drwxr-xr-x   - hdfs   hadoop            0 2020-04-06 18:24 /datasets
drwxr-xr-x   - hdfs   hadoop            0 2020-04-06 18:24 /datastore
drwxrwxrwx   - flink  hadoop            0 2020-04-06 18:25 /flink
drwxr-xr-x   - hbase  hadoop            0 2020-04-06 18:26 /hbase
drwxrwxrwx   - mapred hadoop            0 2020-04-06 18:24 /mr-history
drwxrwxrwt   - spark  hadoop            0 2020-04-06 18:29 /sparkJobHistory
-rw-r--r--   1 root   ficommon         21 2020-04-06 19:53 /stu01_5.txt
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 18:28 /tmp
drwxrwxrwx   - hdfs   hadoop            0 2020-04-06 18:28 /user
```

Figure 2-16

Run the **hdfs dfs -mv /stu01_5.txt /user/stu01/** command.

```
[root@node-master1dCrC ~]# hdfs  dfs  -mv  /stu01_5.txt  /user/stu01/
2020-04-06 19:58:05,822 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1dCrC ~]# hdfs dfs -ls /user/stu01
2020-04-06 19:58:19,434 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 1 items
-rw-r--r--   1 root ficommon         21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]# hdfs dfs -ls /
2020-04-06 19:58:28,693 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 11 items
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 18:24 /app-logs
drwxrwxrwx   - hive   hive            0 2020-04-06 18:27 /apps
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 18:24 /ats
drwxr-xr-x   - hdfs   hadoop          0 2020-04-06 18:24 /datasets
drwxr-xr-x   - hdfs   hadoop          0 2020-04-06 18:24 /datastore
drwxrwxrwx   - flink  hadoop          0 2020-04-06 18:25 /flink
drwxr-xr-x   - hbase  hadoop          0 2020-04-06 18:26 /hbase
drwxrwxrwx   - mapred hadoop          0 2020-04-06 18:24 /mr-history
drwxrwxrwt   - spark  hadoop          0 2020-04-06 18:29 /sparkJobHistory
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 18:28 /tmp
drwxrwxrwx   - hdfs   hadoop          0 2020-04-06 19:56 /user
[root@node-master1dCrC ~]#
```

Figure 2-17

The **stu01_5.txt** file exists in the **/user/stu01** folder, but it has been removed from the **root** directory.

Step 11 Run the **get** command.

Similar to copyToLocal, this command is used to download files from the HDFS to a local host.

Delete the **stu01_5.txt** file from the Linux host.

```
[root@node-master1duzY ~]# ls
env_file  stu01_2.txt  stu01_3.txt  stu01_4.txt  stu01_5.txt  stu01.txt
[root@node-master1duzY ~]# rm -rf stu01_5.txt
[root@node-master1duzY ~]# ls
env_file  stu01_2.txt  stu01_3.txt  stu01_4.txt  stu01.txt
[root@node-master1duzY ~]#
```

Figure 2-18

Run the **hdfs dfs -copyToLocal /user/stu01/stu01_5.txt** command.

```
[root@node-master1duzY ~]# hdfs  dfs  -copyToLocal  /user/stu01/stu01_5.txt  .
[root@node-master1duzY ~]# ls
env_file  stu01_2.txt  stu01_3.txt  stu01_4.txt  stu01_5.txt  stu01.txt
[root@node-master1duzY ~]#
```

Figure 2-19

The **stu01_5.txt** file exists on the Linux host.

Note the period at the end of the HDFS command, which indicates the current directory. If you specify another directory, you can specify the path for saving the file.

Step 12 Run the **getmerge** command.

This command is used to download a combination of multiple files.

Run the **ls** to view the files in the **/user/stu01/** directory.

```
[root@node-master1dCrC ~]# hdfs dfs -ls /user/stu01
2020-04-06 20:00:29,828 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 3 items
-rw-r--r--   1 root hadoop          16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop          12 2020-04-06 20:00 /user/stu01/stu01_4.txt
-rw-r--r--   1 root ficommon        21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]#
```

Figure 2-20

Run the **hdfs dfs -getmerge /user/stu01/* ./merge.txt** command.

```
[root@node-master1dCrC ~]# hdfs  dfs  -getmerge  /user/stu01/*  ./merge.txt
2020-04-06 20:01:08,357 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1dCrC ~]# ls
env_file  merge.txt  stu01_3.txt  stu01_4.txt  stu01_5.txt
[root@node-master1dCrC ~]# cat merge.txt
www.huawei.com

hive
hadoop
41324124
41341241234
[root@node-master1dCrC ~]#
```

Figure 2-21

The **merge.txt** file is generated in the current directory. The content in the file is a combination of the files in **/user/stu01/**.

Step 13 Run the **rm** command.

This command is used to delete an HDFS file or folder.

Run the **hdfs dfs -rm /user/stu01/stu01_5.txt** command.

```
[root@node-master1dCrC ~]# hdfs dfs -ls /user/stu01
2020-04-06 20:02:10,508 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 3 items
-rw-r--r--   1 root hadoop          16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop          12 2020-04-06 20:00 /user/stu01/stu01_4.txt
-rw-r--r--   1 root ficommon        21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]# hdfs  dfs  -rm  /user/stu01/stu01_5.txt
2020-04-06 20:02:24,735 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
2020-04-06 20:02:25,159 INFO fs.TrashPolicyDefault: Moved: 'hdfs://hacluster/user/stu01/stu01_5.txt' to
 trash at: hdfs://hacluster/user/root/.Trash/Current/user/stu01/stu01_5.txt
[root@node-master1dCrC ~]# hdfs dfs -ls /user/stu01
2020-04-06 20:02:33,592 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 2 items
-rw-r--r--   1 root hadoop         16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop         12 2020-04-06 20:00 /user/stu01/stu01_4.txt
[root@node-master1dCrC ~]#
```

Figure 2-22

The **stu01_5.txt** file does not exist in **/user/stu01/**.

Step 14 Run the **df** command.

This command is used to collect information on the available space of a file system.

Run the **hdfs dfs -df -h /** command.

```
[root@node-master1duzY ~]# hdfs dfs -df -h /
Filesystem              Size     Used  Available  Use%
hdfs://hacluster  98.3 G  627.9 M     91.8 G    1%
[root@node-master1duzY ~]#
```

Figure 2-23

Step 15 Run the **du** command.

This command is used to collect information on the folder size.

Run the **hdfs dfs -du -s -h /user/stu01** command.

```
[root@node-master1duzY ~]# hdfs  dfs -ls  /user/stu01
Found 3 items
-rw-r--r--   1 root hive         17 2019-03-25 13:47 /user/stu01/stu01.txt
-rw-r--r--   1 root hive         27 2019-03-25 14:07 /user/stu01/stu01_2.txt
-rw-r--r--   1 root hive         21 2019-03-25 15:59 /user/stu01/stu01_4.txt
[root@node-master1duzY ~]# hdfs  dfs  -du -s  -h  /user/stu01
65  65  /user/stu01
[root@node-master1duzY ~]#
```

Figure 2-24

Step 16 Run the **count** command.

This command is used to collect information on the number of file nodes in a specified directory.

Run the **hdfs dfs -count -v /user/stu01** command.

```
[root@node-master1duzY ~]# hdfs  dfs  -count  -v /user/stu01
   DIR_COUNT   FILE_COUNT       CONTENT_SIZE PATHNAME
           1            3                 65 /user/stu01
[root@node-master1duzY ~]#
```

Figure 2-25

2.3.2 Task 2: Using the Recycle Bin

Files may be deleted by mistake in daily work. In this case, you can find the deleted files in the recycle bin of HDFS. By default, the deleted files are retained in the recycle bin for seven days. For example, after the **/user/stu01/stu01_5.txt** file is deleted, the **stu01_5.txt** file is moved to the recycle bin

Run the **hdfs dfs -ls /user/root/.Trash/Current/user/stu01/** command.

The **stu01_5.txt** file in the recycle bin is displayed.

```
[root@node-master1dCrC ~]# hdfs dfs -ls /user/root/.Trash/Current/user/stu01/
2020-04-06 20:03:22,934 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 1 items
-rw-r--r--   1 root ficommon         21 2020-04-06 19:53 /user/root/.Trash/Current/user/stu01/stu01_5.t
xt
[root@node-master1dCrC ~]#
```

Figure 2-26

Note that deleted data is retained for seven days by default.

Run the **mv** command to move the file back to the **/user/stu01/** directory.

```
hdfs dfs -mv /user/root/.Trash/Current/user/stu01/stu01_5.txt   /user/stu01
```

```
[root@node-master1dCrC ~]# hdfs dfs -mv /user/root/.Trash/Current/user/stu01/stu01_5.txt  /user/stu01
2020-04-06 20:04:47,513 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1dCrC ~]# hdfs dfs -ls /user/stu01
2020-04-06 20:04:59,144 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 3 items
-rw-r--r--   1 root hadoop          16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop          12 2020-04-06 20:00 /user/stu01/stu01_4.txt
-rw-r--r--   1 root ficommon        21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]#
```

Figure 2-27

2.4 Summary

This exercise mainly describes common operations on HDFS. After completing this exercise, you will be able to perform common HDFS operations.

3 Hive Data Warehouse Practice

3.1 Background

Hive is a data warehouse tool and plays an important role in data mining, data aggregation, and statistics analysis. In telecom services, Hive can be used to collect statistics on users' data usage and phone bills, and mine user consumption models to help carriers better design packages.

3.2 Objectives

- Understand common Hive operations.
- Learn how to run HQL on Hue.

3.3 Tasks

3.3.1 Task 1: Creating Hive Tables

3.3.1.1 Viewing Statements for Creating Tables

```
CREATE [EXTERNAL] TABLE [IF NOT EXISTS] table_name
  [(col_name data_type [COMMENT col_comment], ...)]
  [COMMENT table_comment]
  [PARTITIONED BY (col_name data_type [COMMENT col_comment], ...)]
  [CLUSTERED BY (col_name, col_name, ...)
  [SORTED BY (col_name [ASC|DESC], ...)] INTO num_buckets BUCKETS]
  [ROW FORMAT row_format]
  [STORED AS file_format]
  [LOCATION hdfs_path]
```

3.3.1.2 Creating Database Tables

Set environment variable using **source /opt/client/bigdata_env**.

Enter **beeline** and press **Enter** to go to Hive.

Note that all statements in Hive must end with a semicolon (;). Otherwise, the statements cannot be executed.

Reference: Run the following command to filter the output of INFO logs:

```
beeline  --hiveconf hive.server2.logging.operation.level=NONE
```

```
[root@node-master1dCrC ~]# beeline
Connecting to jdbc:hive2://192.168.0.195:2181/;serviceDiscoveryMode=zooKeeper;zooKeeperN
amespace=hiveserver2
Connected to: Apache Hive (version 3.1.0-mrs-2.0)
Driver: Hive JDBC (version 3.1.0-mrs-2.0)
Transaction isolation: TRANSACTION_REPEATABLE_READ
Beeline version 3.1.0-mrs-2.0 by Apache Hive
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-1

Statement for creating database tables (If multiple users share the same environment, it is recommended that the name of each table contain the first letters of the user's last and first names to differentiate tables.)

```
create table cx_stu01(name string,gender string ,age int) row format delimited fields terminated by ','
stored as textfile;
```

```
No rows selected (0.057 seconds)
0: jdbc:hive2://192.168.0.195:2181/> create  table  cx_stu01(name string,gender string ,age int) row fo
No rows affected (0.087 seconds)
0: jdbc:hive2://192.168.0.195:2181/> show tables;
+------------+
| tab_name   |
+------------+
| cx_stu01   |
+------------+
1 row selected (0.034 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-2

The **show tables** command is used to display all tables.

3.3.1.3 Creating Foreign Tables

Run the following command:

```
create external table cx_stu02(name string,gender string ,age int)  row format delimited fields
terminated by ',' stored as textfile ;
```

```
1 row selected (0.034 seconds)
0: jdbc:hive2://192.168.0.195:2181/> create external table cx_stu02(name string,gender string ,age int)
  row format delimited fields terminated by ',' stored as textfile ;
No rows affected (0.079 seconds)
0: jdbc:hive2://192.168.0.195:2181/> show tables;
+------------+
| tab_name   |
+------------+
| cx_stu01   |
| cx_stu02   |
+------------+
2 rows selected (0.035 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-3

3.3.1.4 Loading HDFS Data

Press **Ctrl+C** to exit Hive (or open a new shell window), and edit the **cx_stu01.txt** file on the local Linux host. The file content is as follows:

```
[root@node-master1dCrC ~]# vi cx_stu01.txt
[root@node-master1dCrC ~]# cat cx_stu01.txt
tom,male,19
hanmeimei,female,20
jack,female,22
lilei,female,18
Lily,male,23
[root@node-master1dCrC ~]#
```

Figure 3-4

Run the following **put** command to upload data to the **/user/stu01/** directory of the HDFS:

```
hdfs dfs -put cx_stu01.txt /user/stu01/
```

```
[root@node-master1dCrC ~]# hdfs  dfs  -put  cx_stu01.txt  /user/stu01/
2020-04-06 20:18:38,196 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1dCrC ~]# hdfs  dfs  -ls  /user/stu01/
2020-04-06 20:18:56,431 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 4 items
-rw-r--r--   1 root hadoop          76 2020-04-06 20:18 /user/stu01/cx_stu01.txt
-rw-r--r--   1 root hadoop          16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop          12 2020-04-06 20:00 /user/stu01/stu01_4.txt
-rw-r--r--   1 root ficommon        21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]#
```

Figure 3-5

Run the **beeline** command to go to Hive and run the following command to load data and import data to the foreign table:

```
load  data  inpath  '/user/stu01/cx_stu01.txt'  into table  cx_stu02;
```

```
0: jdbc:hive2://192.168.0.195:2181/> load  data  inpath  '/user/stu01/cx_stu01.txt'  into table  cx_stu
02;
No rows affected (0.35 seconds)
0: jdbc:hive2://192.168.0.195:2181/> select * from cx_stu02;
+----------------+-----------------+---------------+
| cx_stu02.name  | cx_stu02.gender | cx_stu02.age  |
+----------------+-----------------+---------------+
| tom            | male            | 19            |
| hanmeimei      | female          | 20            |
| jack           | female          | 22            |
| lilei          | female          | 18            |
| Lily           | male            | 23            |
+----------------+-----------------+---------------+
5 rows selected (0.276 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-6

3.3.2 Task 3: Performing Basic Hive Queries

3.3.2.1 Fuzzy Queries

Run the **show tables like 'cx_stu*'**; statement.

```
0: jdbc:hive2://192.168.0.195:2181/> show  tables  like  'cx_stu*';
+-----------+
| tab_name  |
+-----------+
| cx_stu01  |
| cx_stu02  |
+-----------+
2 rows selected (0.05 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-7

3.3.2.2 Simple Queries

Step 1 Run the following Limit statement:

```
select  *  from  cx_stu02  limit  2;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select  *  from  cx_stu02  limit  2;
+----------------+------------------+---------------+
| cx_stu02.name  | cx_stu02.gender  | cx_stu02.age  |
+----------------+------------------+---------------+
| tom            | male             | 19            |
| hanmeimei      | female           | 20            |
+----------------+------------------+---------------+
2 rows selected (0.064 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-8

Step 2 Run the following Where statement:

```
select  *  from  cx_stu02  where  gender ='male'  limit  2;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select  *  from  cx_stu02  where  gender ='male'  limit  2;
+----------------+------------------+---------------+
| cx_stu02.name  | cx_stu02.gender  | cx_stu02.age  |
+----------------+------------------+---------------+
| tom            | male             | 19            |
| Lily           | male             | 23            |
+----------------+------------------+---------------+
2 rows selected (30.776 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-9

Step 3 Run the following Order statement:

```
select  *  from  cx_stu02  where  gender ='female'  order  by  age  limit  2;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select  *  from  cx_stu02  where  gender ='female'  order  by  age
  limit  2;
+----------------+------------------+---------------+
| cx_stu02.name  | cx_stu02.gender  | cx_stu02.age  |
+----------------+------------------+---------------+
| lilei          | female           | 18            |
| hanmeimei      | female           | 20            |
+----------------+------------------+---------------+
2 rows selected (6.976 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-10

3.3.2.3 Complex Queries

Step 1 Use the **vi** editor to edit the **cx_stu03.txt** file on the local Linux host. The file content is as follows:

```
[root@node-master1dCrC ~]# vi cx_stu03.txt
[root@node-master1dCrC ~]# cat cx_stu03.txt
1001,Jack,Chinese,78
1002,Jack,English,82
1003,Jack,Math,87
1004,Mark,Chinese,69
1005,Mark,English,89
1006,Mark,Math,73
1007,Hanke,Chinese,89
1008,Hanke,English,85
1009,Hanke,Math,75
[root@node-master1dCrC ~]#
```

Figure 3-11

Step 2 Upload data to the HDFS.

Run the **hdfs dfs -put cx_stu03.txt /user/stu01/** command.

```
[root@node-master1dCrC ~]# hdfs  dfs  -put  cx_stu03.txt   /user/stu01/
2020-04-06 20:50:55,148 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1dCrC ~]# hdfs  dfs  -ls   /user/stu01/
2020-04-06 20:51:04,395 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 4 items
-rw-r--r--   1 root hadoop          183 2020-04-06 20:50 /user/stu01/cx_stu03.txt
-rw-r--r--   1 root hadoop           16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop           12 2020-04-06 20:00 /user/stu01/stu01_4.txt
-rw-r--r--   1 root ficommon         21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]#
```

Figure 3-12

Step 3 Create a table and import data to the table.

Run the **beeline** command to go to Hive and enter the following table creation statement:

```
create external table cx_table_stu03(id int,name string ,subject string,score   float)   row format delimited fields terminated by ',' stored as textfile ;
```

Run the following statement to import data:

```
load data inpath '/user/stu01/cx_stu03.txt' into table cx_table_stu03;
```

```
0: jdbc:hive2://192.168.0.195:2181/> create external table cx_table_stu03(id int,name string ,subject s
tring,score  float)  row format delimited fields terminated by ',' stored as textfile ;
No rows affected (0.055 seconds)
0: jdbc:hive2://192.168.0.195:2181/> load  data  inpath  '/user/stu01/cx_stu03.txt'  into  table  cx_ta
ble_stu03;
No rows affected (0.271 seconds)
0: jdbc:hive2://192.168.0.195:2181/> select * from cx_table_stu03;
+---------------------+-----------------------+-------------------------+------------------------+
| cx_table_stu03.id   | cx_table_stu03.name   | cx_table_stu03.subject  | cx_table_stu03.score   |
+---------------------+-----------------------+-------------------------+------------------------+
| 1001                | Jack                  | Chinese                 | 78.0                   |
| 1002                | Jack                  | English                 | 82.0                   |
| 1003                | Jack                  | Math                    | 87.0                   |
| 1004                | Mark                  | Chinese                 | 69.0                   |
| 1005                | Mark                  | English                 | 89.0                   |
| 1006                | Mark                  | Math                    | 73.0                   |
| 1007                | Hanke                 | Chinese                 | 89.0                   |
| 1008                | Hanke                 | English                 | 85.0                   |
| 1009                | Hanke                 | Math                    | 75.0                   |
+---------------------+-----------------------+-------------------------+------------------------+
9 rows selected (0.116 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-13

Step 4 Perform the sum operation.

To calculate the total score of each student, run the following statement:

```
select  name  ,sum(score)  total_score  from  cx_table_stu03  group  by  name ;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select  name  ,sum(score)  total_score  from  cx_table_stu03  grou
p  by  name;
+--------+--------------+
|  name  | total_score  |
+--------+--------------+
| Hanke  | 249.0        |
| Jack   | 247.0        |
| Mark   | 231.0        |
+--------+--------------+
3 rows selected (5.453 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-14

To calculate the total score of each student and filter out students whose total score is greater than 230, run the following statement:

```
select  name  ,sum(score)  total_score  from  cx_table_stu03  group  by  name  having
total_score > 235;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select  name  ,sum(score)  total_score  from  cx_table_stu03  grou
p  by  name  having  total_score > 235;
+--------+--------------+
|  name  | total_score  |
+--------+--------------+
| Hanke  | 249.0        |
| Jack   | 247.0        |
+--------+--------------+
2 rows selected (5.429 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-15

Step 5 Perform the max operation.

To view the highest score of each course, run the following statement:

```
select  subject,max(score)  from  cx_table_stu03  group by subject;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select  subject,max(score)  from  cx_table_stu03  group by subject
;
+----------+-------+
| subject  |  _c1  |
+----------+-------+
| Chinese  | 89.0  |
| English  | 89.0  |
| Math     | 87.0  |
+----------+-------+
3 rows selected (4.548 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-16

Step 6 Perform the count operation.

To calculate the number of trainees taking the exam of each course, run the following statement:

```
select subject,count(1) from cx_table_stu03 group by subject;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select subject,count(1) from cx_table_stu03 group by subject;
+----------+------+
| subject  | _c1  |
+----------+------+
| Chinese  | 3    |
| English  | 3    |
| Math     | 3    |
+----------+------+
3 rows selected (4.649 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-17

3.3.3 Task 3: Performing Hive Join Operations

Hive supports common SQL join statements, such as INNER JOIN, LEFT OUTER JOIN, RIGHT OUTER JOIN, and map-side JOIN.

Step 1 Create a table and import data to the table.

Create three tables: **cx_table_employee** (employee table), **cx_table_department** (department table), and **cx_table_salary** (salary table). Import data to the three tables. For details about how to import data, see the previous content.

Statements for creating **cx_table_employee**:

```
create table if not exists cx_table_employee(
user_id int,
username string,
dept_id int)
row format delimited fields terminated by ','
stored as textfile ;
```

```
0: jdbc:hive2://192.168.0.195:2181/> create table if not exists cx_table_employee(user_id int,username
string,dept_id int) row format delimited fields terminated by ' '  lines terminated by '\n';
No rows affected (0.052 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-18

Statements for creating **cx_table_department**:

```
create table if not exists cx_table_department(
dept_id int,
```

```
dept_name string)
row format delimited fields terminated by ','
stored as textfile ;
```

```
0: jdbc:hive2://192.168.0.195:2181/> create table if not exists cx_table_department(dept_id int,dept_na
me string) row format delimited fields terminated by ' '  lines terminated by '\n';
No rows affected (0.053 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-19

Statements for creating **cx_table_salary**:

```
create table if not exists cx_table_salary(
userid int,
dept_id int,
salarys double)
row format delimited fields terminated by ','
stored as textfile ;
```

```
0: jdbc:hive2://192.168.0.195:2181/> create table if not exists cx_table_salary(userid int,dept_id int,
salarys double) row format delimited fields terminated by ' '  lines terminated by '\n';
No rows affected (0.051 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-20

The data in the three tables is as follows:

cx_table_ employee (employee table):

1,zhangsas,1

2,lisi,2

3,wangwu,3

4,tom,1

5,lily,2

6,amy,3

7,lilei,1

8,hanmeimei,2

9,poly,3

cx_table_department (department table):

1,Technical

2,sales

3,HR

4,marketing

cx_table_salary (salary table):

1,1,20000

2,2,16000

3,3,20000

4,1,50000

5,2,18900

6,3,12098

7,1,21900

Step 2 Perform INNER JOIN.

When INNER JOIN join is performed on multiple tables, only the data that matches the on condition in all tables is displayed. For example, the following SQL statement implements the join between the employee table and the department table. The on condition is dept_id. Only data with the same dept_id is matched and displayed.

Run the following statement:

```
select e.username,e.dept_id,d.dept_name,d.dept_id from cx_table_employee e join
cx_table_department d on e.dept_id = d.dept_id;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e.username,e.dept_id,d.dept_name,d.dept_id from cx_table_em
ployee e join cx_table_department d on e.dept_id = d.dept_id;
+-------------+------------+--------------+------------+
| e.username  | e.dept_id  | d.dept_name  | d.dept_id  |
+-------------+------------+--------------+------------+
| zhangsas    | 1          | Technical    | 1          |
| lisi        | 2          | sales        | 2          |
| wangwu      | 3          | HR           | 3          |
| tom         | 1          | Technical    | 1          |
| lily        | 2          | sales        | 2          |
| amy         | 3          | HR           | 3          |
| lilei       | 1          | Technical    | 1          |
| hanmeimei   | 2          | sales        | 2          |
| poly        | 3          | HR           | 3          |
+-------------+------------+--------------+------------+
9 rows selected (30.606 seconds)
```

Figure 3-21

You can join two or more tables. Run the following statement to query the employee names, departments, and salaries:

```
select e.username,d.dept_name,s.salarys from cx_table_employee e join cx_table_department d on
e.dept_id = d.dept_id join cx_table_salary s on e.user_id = s.userid;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e.username,d.dept_name,s.salarys from cx_table_employee e join cx_t
able_department d on e.dept_id = d.dept_id join cx_table_salary s on e.user_id = s.userid;
+-------------+--------------+------------+
| e.username  | d.dept_name  | s.salarys  |
+-------------+--------------+------------+
| tom         | Technical    | 50000.0    |
| lilei       | Technical    | 21900.0    |
| amy         | HR           | 12098.0    |
| zhangsas    | Technical    | 20000.0    |
| lily        | sales        | 18900.0    |
| lisi        | sales        | 16000.0    |
| wangwu      | HR           | 20000.0    |
+-------------+--------------+------------+
7 rows selected (30.69 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-22

Generally, a MapReduce job is generated for a join. If more than two tables are joined, Hive associates the tables from left to right. For the preceding SQL statement, a MapReduce job is started to connect the employee and department tables, and then the second MapReduce job is started to connect the output of the first MapReduce job to the salary table. This is contrary to the standard SQL, which performs the join operation from

right to left. Therefore, in Hive SQL, small tables are written on the left to improve the execution efficiency.

Hive supports the **/*+STREAMTALBE*/** syntax to specify which table is a large table. For example, in the following SQL statement, **dept** is specified as a large table. If the **/+STREAMTALBE/** syntax is not used, Hive considers the rightmost table as a large table.

Run the following statement:

```
select /*+STREAMTABlE(d)*/ e.username,e.dept_id,d.dept_name,d.dept_id from cx_table_employee e
join cx_table_department d on e.dept_id = d.dept_id;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select /*+STREAMTABlE(d)*/ e.username,e.dept_id,d.dept_name,d.dept_id from
 cx_table_employee e join cx_table_department d on e.dept_id = d.dept_id;
+-------------+------------+--------------+------------+
| e.username  | e.dept_id  | d.dept_name  | d.dept_id  |
+-------------+------------+--------------+------------+
| zhangsas    | 1          | Technical    | 1          |
| lisi        | 2          | sales        | 2          |
| wangwu      | 3          | HR           | 3          |
| tom         | 1          | Technical    | 1          |
| lily        | 2          | sales        | 2          |
| amy         | 3          | HR           | 3          |
| lilei       | 1          | Technical    | 1          |
| hanmeimei   | 2          | sales        | 2          |
| poly        | 3          | HR           | 3          |
+-------------+------------+--------------+------------+
9 rows selected (6.291 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-23

Generally, the number of MapReduce jobs to be started is the same as the number of tables to be joined. However, if the join keys of the on condition are the same, only one MapReduce job is started.

Step 3 Perform LEFT OUTER JOIN.

LEFT OUTER JOIN, same as the standard SQL statement, uses the left table as a baseline. If the right table matches the on condition, the data is displayed. Otherwise, NULL is displayed.

Run the following statement:

```
select e.user_id,e.username,s.salarys from cx_table_employee e left outer join cx_table_salary s on
e.user_id = s.userid;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e.user_id,e.username,s.salarys from cx_table_employee e left outer
join cx_table_salary s on e.user_id = s.userid;
+------------+-------------+------------+
| e.user_id  | e.username  | s.salarys  |
+------------+-------------+------------+
| 1          | zhangsas    | 20000.0    |
| 2          | lisi        | 16000.0    |
| 3          | wangwu      | 20000.0    |
| 4          | tom         | 50000.0    |
| 5          | lily        | 18900.0    |
| 6          | amy         | 12098.0    |
| 7          | lilei       | 21900.0    |
| 8          | hanmeimei   | NULL       |
| 9          | poly        | NULL       |
+------------+-------------+------------+
9 rows selected (6.743 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-24

As shown in the preceding figure, all records in the employee table on the left are displayed, and the data that meets the on condition in the salary table on the right is displayed. The data that does not meet the on condition is displayed as NULL.

Step 4 Perform RIGHT OUTER JOIN.

LEFT OUTER JOIN is opposite to LEFT OUTER JOIN. It uses the table on the right as a baseline. If the table on the left matches the on condition, the data is displayed. Otherwise, NULL is displayed.

Hive is a component for processing big data. It is often used to process hundreds of GB or even TB-level data. Therefore, you are advised to use the where condition to filter out data that does not meet the condition when compiling SQL statements. However, for LEFT and RIGHT OUTER JOINs, the where condition is executed after the on condition is executed. Therefore, to optimize the Hive SQL execution efficiency, use subqueries in scenarios where OUTER JOINs are required and use the where condition to filter out data that does not meet the conditions in the subqueries.

Run the following statement:

```
select e1.user_id,e1.username,s.salarys from (select e.* from cx_table_employee e where e.user_id < 8)
e1 left outer join cx_table_salary s on e1.user_id = s.userid;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e1.user_id,e1.username,s.salarys from (select e.* from cx_table_emp
loyee e where e.user_id < 8) e1 left outer join cx_table_salary s on e1.user_id = s.userid;
+-------------+--------------+------------+
| e1.user_id  | e1.username  | s.salarys  |
+-------------+--------------+------------+
| 1           | zhangsas     | 20000.0    |
| 2           | lisi         | 16000.0    |
| 3           | wangwu       | 20000.0    |
| 4           | tom          | 50000.0    |
| 5           | lily         | 18900.0    |
| 6           | amy          | 12098.0    |
| 7           | lilei        | 21900.0    |
+-------------+--------------+------------+
7 rows selected (6.117 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-25

In the preceding SQL statement, the data whose **user_id** is greater than or equal to **8** is filtered out in the subquery.

Step 5 Perform FULL OUTER JOIN.

FULL OUTER JOIN returns all the data that meets the where condition in the table. The data that does not meet the where condition is replaced with NULL.

Run the following statement:

```
select e.user_id,e.username,s.salarys from cx_table_employee e full outer join cx_table_salary s on
e.user_id = s.userid where e.user_id > 0;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e.user_id,e.username,s.salarys from cx_table_employee e full outer
join cx_table_salary s on e.user_id = s.userid where e.user_id > 0;
+------------+-------------+------------+
| e.user_id  | e.username  | s.salarys  |
+------------+-------------+------------+
| 1          | zhangsas    | 20000.0    |
| 2          | lisi        | 16000.0    |
| 3          | wangwu      | 20000.0    |
| 4          | tom         | 50000.0    |
| 5          | lily        | 18900.0    |
| 6          | amy         | 12098.0    |
| 7          | lilei       | 21900.0    |
| 8          | hanmeimei   | NULL       |
| 9          | poly        | NULL       |
+------------+-------------+------------+
9 rows selected (7.032 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-26

The results of FULL OUTER JOIN and LEFT OUTER JOIN are the same.

Step 6 Perform LEFT SEMI JOIN.

LEFT SEMI JOIN is used to query only the data that meets the requirements of the left table.

Run the following statement:

```
select e.* from cx_table_employee e LEFT SEMI JOIN cx_table_salary s on e.user_id=s.userid;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e.* from cx_table_employee e LEFT SEMI JOIN cx_table_salary s on e.
user_id=s.userid;
+------------+-------------+------------+
| e.user_id  | e.username  | e.dept_id  |
+------------+-------------+------------+
| 1          | zhangsas    | 1          |
| 2          | lisi        | 2          |
| 3          | wangwu      | 3          |
| 4          | tom         | 1          |
| 5          | lily        | 2          |
| 6          | amy         | 3          |
| 7          | lilei       | 1          |
+------------+-------------+------------+
7 rows selected (5.919 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-27

LEFT SEMI JOIN is evolved from INNER JOIN. When a data record in the left table exists in the right table, Hive stops scanning. Therefore, the efficiency is higher than that of INNER JOIN. However, only the fields in the left table can be displayed behind the select and where keywords in the LEFT SEMI JOIN. Hive does not support RIGHT SEMI JOIN.

Step 7 Perform CARTESIAN JOIN.

The result of Cartesian product join is to multiply the data in the left table by the data in the right table.

Run the following statement:

```
select e.user_id,e.username,s.salarys from cx_table_employee e join cx_table_salary s;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select e.user_id,e.username,s.salarys from cx_table_employee e join cx_tab
le_salary s;
+-------------+--------------+-------------+
| e.user_id   | e.username   | s.salarys   |
+-------------+--------------+-------------+
| 1           | zhangsas     | 20000.0     |
| 1           | zhangsas     | 21900.0     |
| 1           | zhangsas     | 12098.0     |
| 1           | zhangsas     | 18900.0     |
| 1           | zhangsas     | 50000.0     |
| 1           | zhangsas     | 20000.0     |
| 1           | zhangsas     | 16000.0     |
| 2           | lisi         | 20000.0     |
| 2           | lisi         | 21900.0     |
| 2           | lisi         | 12098.0     |
| 2           | lisi         | 18900.0     |
| 2           | lisi         | 50000.0     |
| 2           | lisi         | 20000.0     |
| 2           | lisi         | 16000.0     |
| 3           | wangwu       | 20000.0     |
| 3           | wangwu       | 21900.0     |
| 3           | wangwu       | 12098.0     |
| 3           | wangwu       | 18900.0     |
| 3           | wangwu       | 50000.0     |
| 3           | wangwu       | 20000.0     |
| 3           | wangwu       | 16000.0     |
| 4           | tom          | 20000.0     |
| 4           | tom          | 21900.0     |
| 4           | tom          | 12098.0     |
| 4           | tom          | 18900.0     |
| 4           | tom          | 50000.0     |
| 4           | tom          | 20000.0     |
| 4           | tom          | 16000.0     |
| 5           | lily         | 20000.0     |
| 5           | lily         | 21900.0     |
| 5           | lily         | 12098.0     |
| 5           | lily         | 18900.0     |
| 5           | lily         | 50000.0     |
| 5           | lily         | 20000.0     |
| 5           | lily         | 16000.0     |
| 6           | amy          | 20000.0     |
| 6           | amy          | 21900.0     |
| 6           | amy          | 12098.0     |
| 6           | amy          | 18900.0     |
| 6           | amy          | 50000.0     |
| 6           | amy          | 20000.0     |
| 6           | amy          | 16000.0     |
| 7           | lilei        | 20000.0     |
| 7           | lilei        | 21900.0     |
| 7           | lilei        | 12098.0     |
```

Figure 3-28

The execution result of the preceding SQL statement is the number of records in the employee table multiplied by the number of records in the salary table.

Step 8 Perform map-side JOIN.

Map-side JOIN is an optimization of Hive SQL. Hive converts SQL statements into MapReduce jobs. Therefore, the map-side JOIN corresponds to the map-side JOIN in the Hadoop Join. Small tables are loaded to the memory to improve the Hive SQL execution speed. You can use either of the following methods to use map-side JOIN of Hive SQL. The first method is to use **/*+ MAPJOIN*/**:

Run the following statement:

```
select /*+ MAPJOIN(d)*/ e.username,e.dept_id,d.dept_name,d.dept_id from cx_table_employee e join
cx_table_department d on e.dept_id = d.dept_id;
```

```
0: jdbc:hive2://192.168.0.195:2181/> select /*+ MAPJOIN(d)*/ e.username,e.dept_id,d.dept_name,d.dept_id from cx
_table_employee e join cx_table_department d on e.dept_id = d.dept_id;
+-------------+------------+--------------+------------+
| e.username  | e.dept_id  | d.dept_name  | d.dept_id  |
+-------------+------------+--------------+------------+
| zhangsas    | 1          | Technical    | 1          |
| lisi        | 2          | sales        | 2          |
| wangwu      | 3          | HR           | 3          |
| tom         | 1          | Technical    | 1          |
| lily        | 2          | sales        | 2          |
| amy         | 3          | HR           | 3          |
| lilei       | 1          | Technical    | 1          |
| hanmeimei   | 2          | sales        | 2          |
| poly        | 3          | HR           | 3          |
+-------------+------------+--------------+------------+
9 rows selected (13.647 seconds)
0: jdbc:hive2://192.168.0.195:2181/>
```

Figure 3-29

The second one is to set **hive.auto,convert.JOIN** to **true**.

3.3.4 Task 4: Using Hue to Execute HQL

Step 1 Log in to MRS Manager.

On the **Services** page, click **Hue**. On the displayed page, click **Hue (Active)**. The Hue page is displayed.

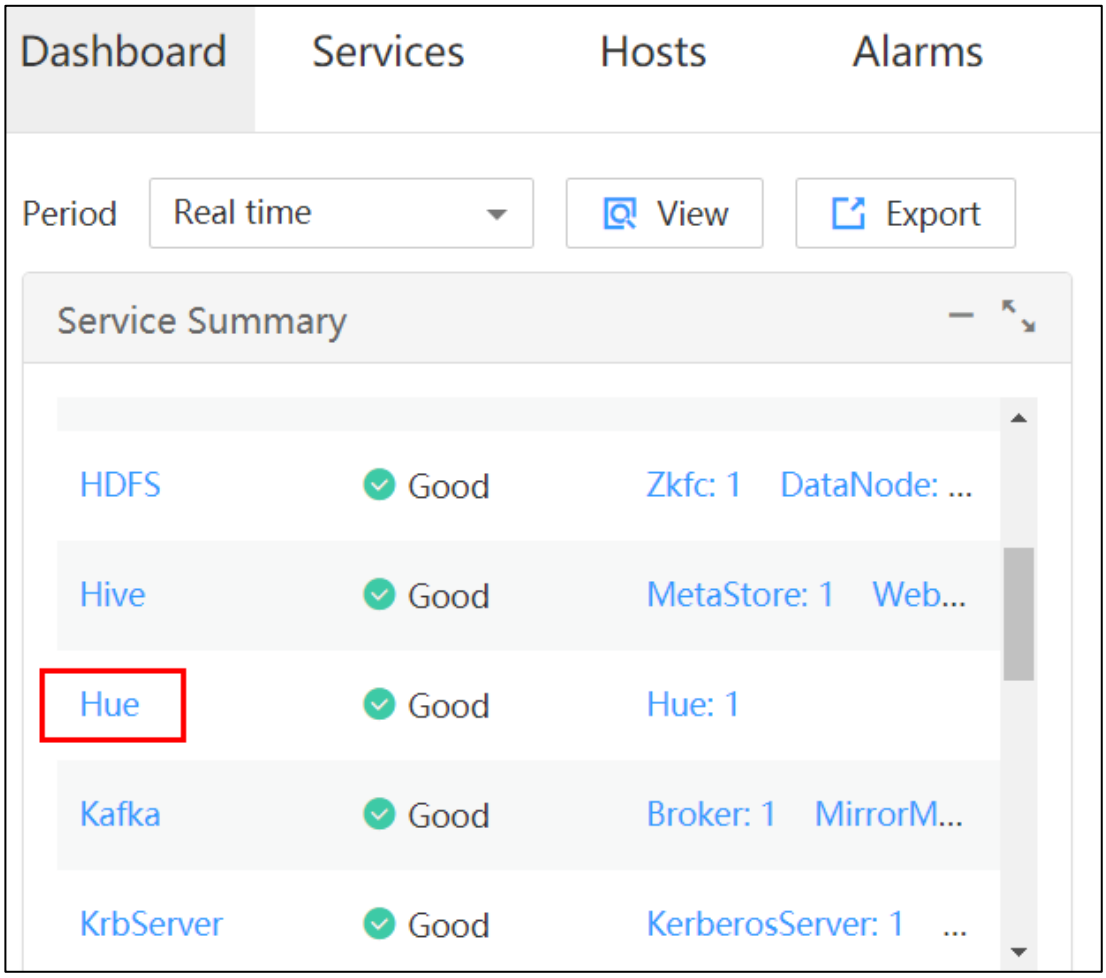


Figure 3-30

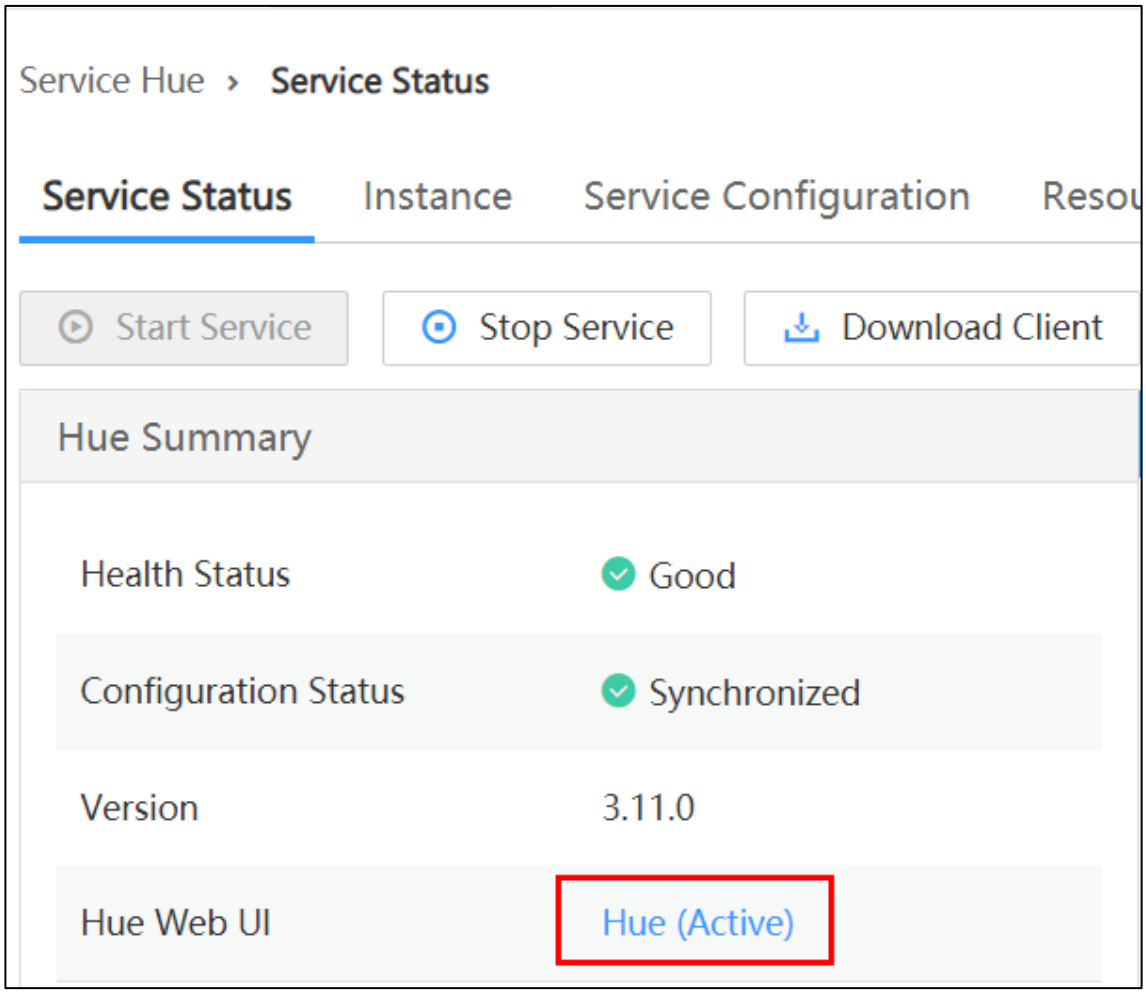


Figure 3-31

Click the **Query Editor** and select **Hive**.

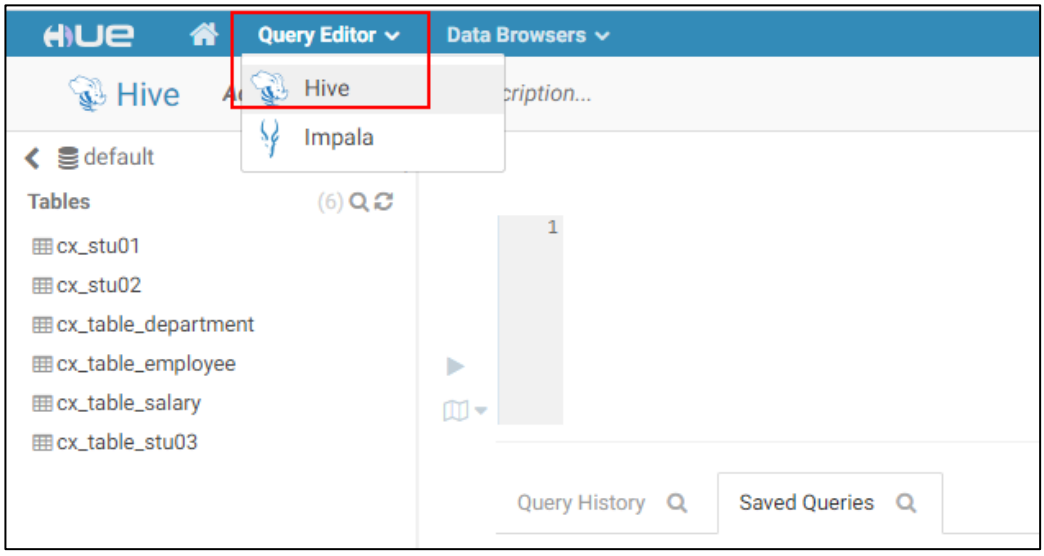


Figure 3-32

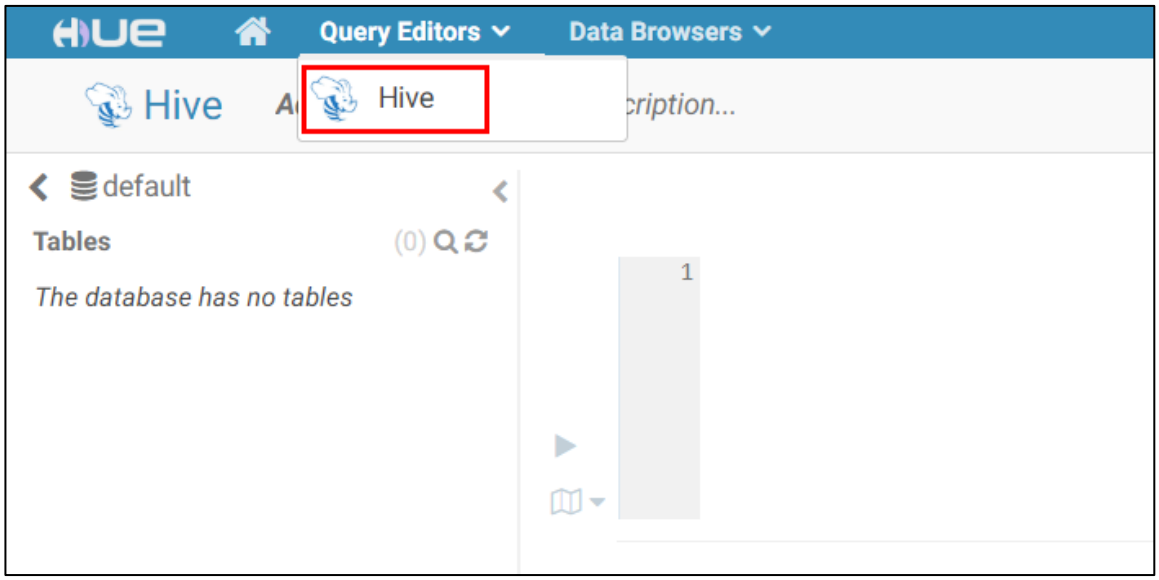


Figure 3-33

Step 2 Compile HQL.

Edit the HQL statement in the blank area.

```
select *,row_number() over(order by totalscore desc) rank from (select name,sum(score) totalscore from cx_table_stu03 group by name) a;
```

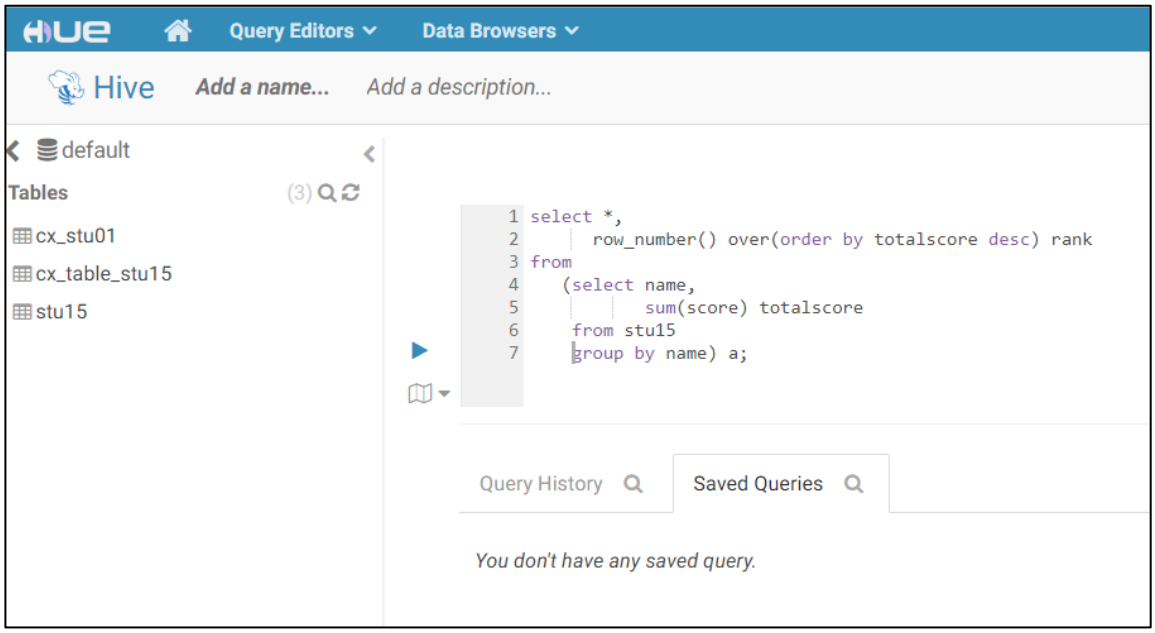


Figure 3-34

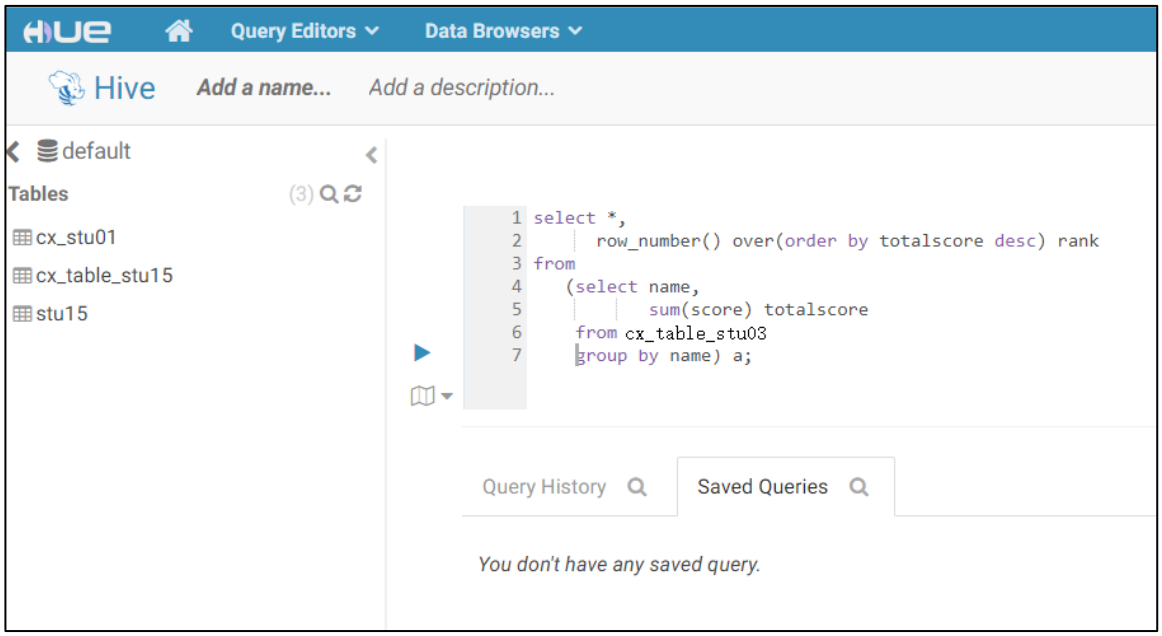


Figure 3-35

Step 3 Query data.

Click the triangle button to execute HQL.

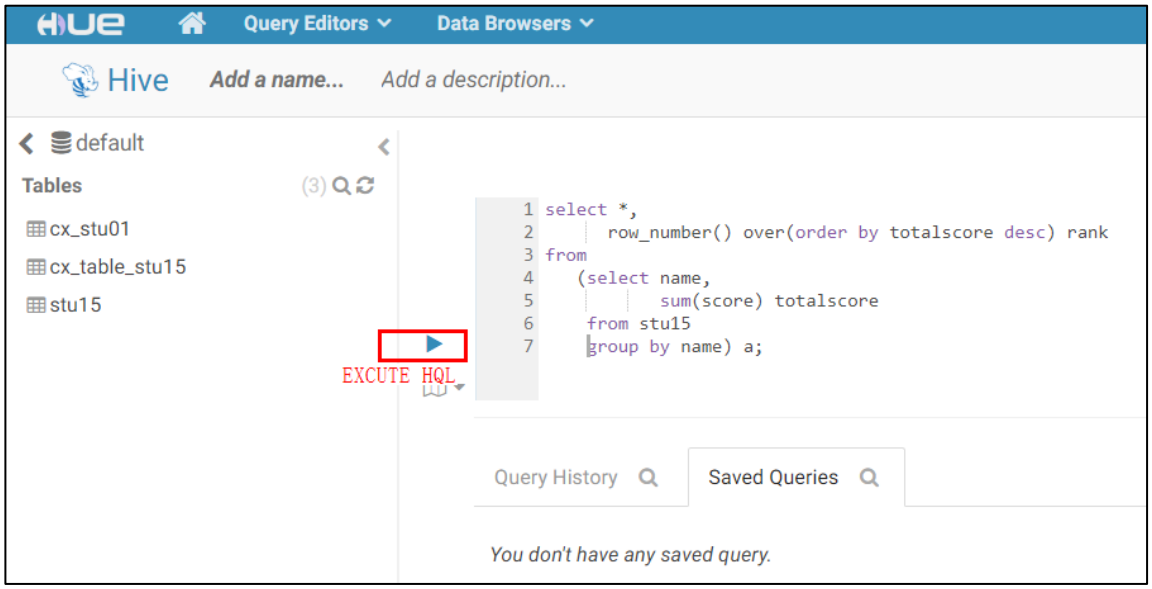


Figure 3-36

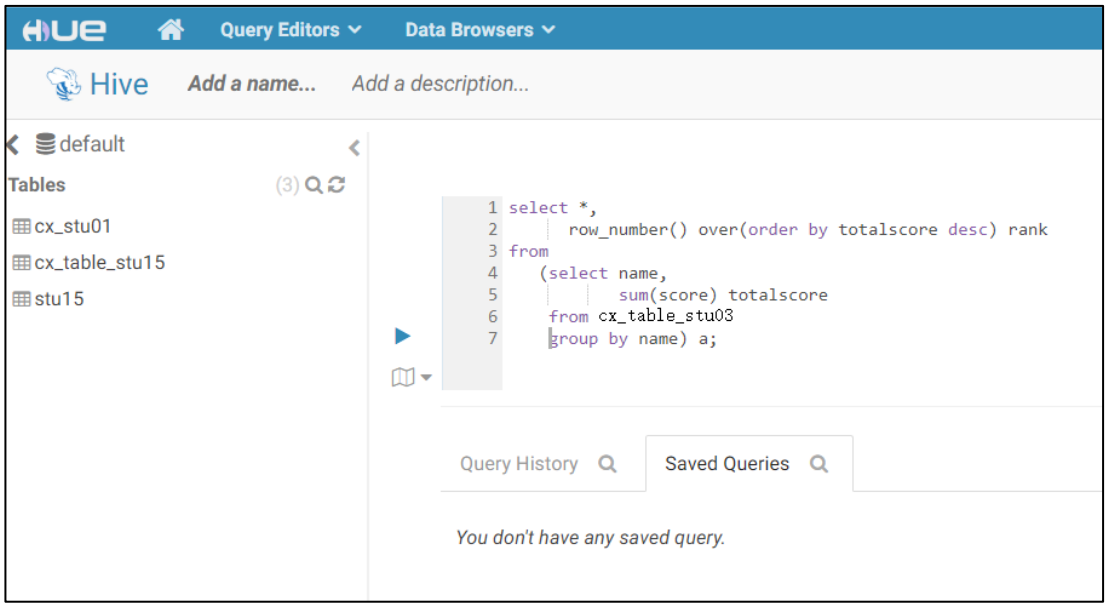


Figure 3-37

Step 4 View the result.

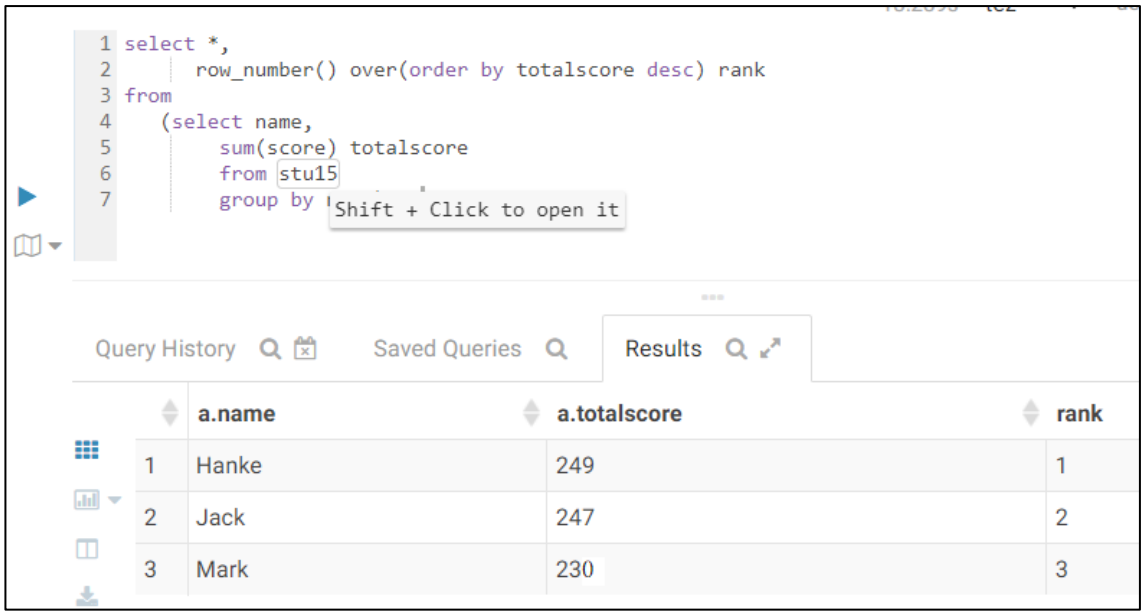


Figure 3-38

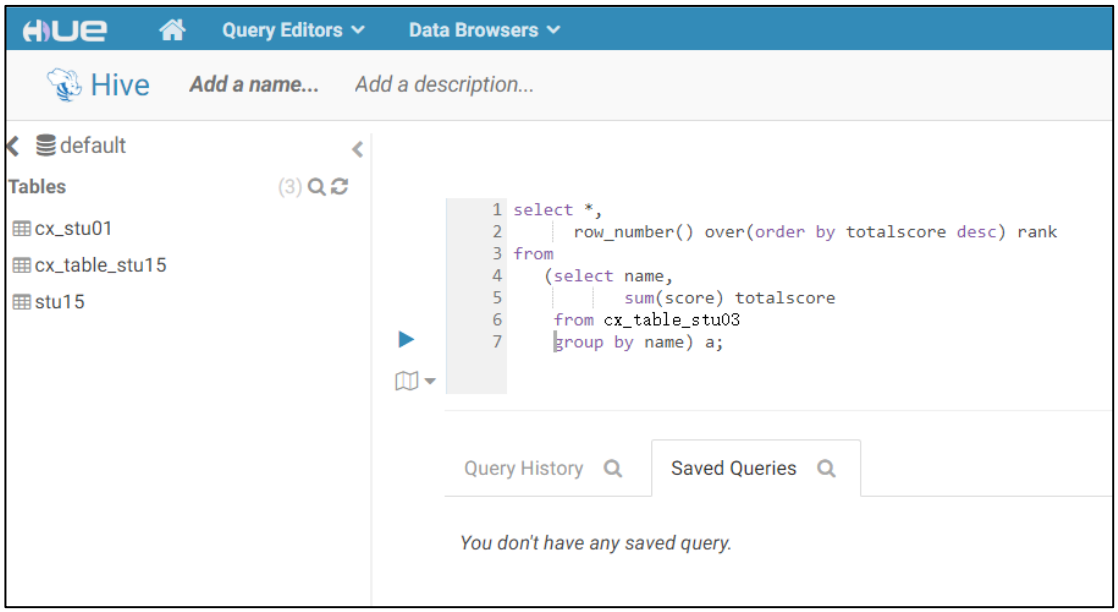


Figure 3-39

3.4 Summary

This exercise describes the add, delete, modify, and query operations of the Hive data warehouse and introduces multiple join methods to help trainees understand the join types and differences. This exercise aims to help trainees better understand and use Hive.

4 HBase Columnar Database Practice

4.1 Background

The HBase database is an important big data component and is the most commonly used NoSQL database in the industry. Banks can store new customer information in HBase and update or delete out-of-date data in HBase.

4.2 Objectives

- Understand common HBase operations, region operations, and filter usage.

4.3 Tasks

4.3.1 Task 1: Performing Common HBase Operations

Run the **source /opt/client/bigdata_env** command to set environment variables.

Run the **hbase shell** command to access the HBase shell client.

```
[root@node-master1duzY ~]# source  /opt/client/bigdata_env
[root@node-master1duzY ~]# hbase shell
```

Figure 4-1

4.3.1.1 Creating Common Tables

Run the **create 'cx_table_stu01' , 'cf1'** command.

```
hbase(main):011:0> create  'cx_table_stu01' , 'cf1'
2020-04-07 09:51:31,723 INFO  [main] client.HBaseAdmin: Operation: CREATE, Table Name: default:cx_t
able_stu01, procId: 15 completed
Created table cx_table_stu01
Took 2.2636 seconds
=> Hbase::Table - cx_table_stu01
hbase(main):012:0> list
TABLE
cx_table_stu01
1 row(s)
Took 0.0112 seconds
=> ["cx_table_stu01"]
hbase(main):013:0>
```

Figure 4-2

list: displays all tables.

4.3.1.2 Adding Data

Run the following commands:

```
put 'cx_table_stu01','20200001','cf1:name','tom'
put 'cx_table_stu01','20200001','cf1:gender','male'
put 'cx_table_stu01','20200001', 'cf1:age','20'
put 'cx_table_stu01','20200002', 'cf1:name','hanmeimei'
put 'cx_table_stu01','20200002', 'cf1:gender','female'
put 'cx_table_stu01','20200002', 'cf1:age','19'
```

```
hbase(main):021:0> put  'cx_table_stu01','20200001','cf1:name','tom'
Took 0.0120 seconds
hbase(main):022:0> put  'cx_table_stu01','20200001','cf1:gender','male'
Took 0.0105 seconds
hbase(main):023:0> put  'cx_table_stu01','20200001', 'cf1:age','20'
Took 0.0110 seconds
hbase(main):024:0> put  'cx_table_stu01','20200002', 'cf1:name','hanmeimei'
Took 0.0053 seconds
hbase(main):025:0> put  'cx_table_stu01','20200002', 'cf1:gender','female'
Took 0.0044 seconds
hbase(main):026:0> put  'cx_table_stu01','20200002', 'cf1:age','19'
Took 0.0074 seconds
hbase(main):027:0> scan 'cx_table_stu01'
ROW                     COLUMN+CELL
 20200001               column=cf1:age, timestamp=1586224622452, value=20
 20200001               column=cf1:gender, timestamp=1586224622397, value=male
 20200001               column=cf1:name, timestamp=1586224622340, value=tom
 20200002               column=cf1:age, timestamp=1586224622561, value=19
 20200002               column=cf1:gender, timestamp=1586224622531, value=female
 20200002               column=cf1:name, timestamp=1586224622492, value=hanmeimei
2 row(s)
Took 0.0142 seconds
hbase(main):028:0>
```

Figure 4-3

4.3.1.3 Querying Data in Scan Mode

Run the following commands:

```
scan 'cx_table_stu01',{COLUMNS=>'cf1'}      #Queries only the data in the cf1 column family.
scan 'cx_table_stu01',{COLUMNS=>'cf1:name'}    #Queries only the name information in the cf1 column family.
```

```
hbase(main):034:0> scan 'cx_table_stu01',{COLUMNS=>'cf1'}
ROW                     COLUMN+CELL
 20200001               column=cf1:age, timestamp=1586224622452, value=20
 20200001               column=cf1:gender, timestamp=1586224622397, value=male
 20200001               column=cf1:name, timestamp=1586224622340, value=tom
 20200002               column=cf1:age, timestamp=1586224622561, value=19
 20200002               column=cf1:gender, timestamp=1586224622531, value=female
 20200002               column=cf1:name, timestamp=1586224622492, value=hanmeimei
2 row(s)
Took 0.0190 seconds
hbase(main):035:0> scan 'cx_table_stu01',{COLUMNS=>'cf1:name'}
ROW                     COLUMN+CELL
 20200001               column=cf1:name, timestamp=1586224622340, value=tom
 20200002               column=cf1:name, timestamp=1586224622492, value=hanmeimei
2 row(s)
Took 0.0116 seconds
hbase(main):036:0>
```

Figure 4-4

4.3.1.4 Querying Data in Get Mode

In Get mode, data is queried based on the row key.

Run the following commands:

```
get   'cx_table_stu01','20200001'
get   'cx_table_stu01','20200001','cf1:name'
```

```
hbase(main):038:0> get  'cx_table_stu01','20200001'
COLUMN                  CELL
 cf1:age                timestamp=1586224622452, value=20
 cf1:gender             timestamp=1586224622397, value=male
 cf1:name               timestamp=1586224622340, value=tom
1 row(s)
Took 0.0095 seconds
hbase(main):039:0> get  'cx_table_stu01','20200001','cf1:name'
COLUMN                  CELL
 cf1:name               timestamp=1586224622340, value=tom
1 row(s)
Took 0.0082 seconds
hbase(main):040:0>
```

Figure 4-5

4.3.1.5 Querying Data by Specified Criteria

Run the following commands:

```
scan 'cx_table_stu01',{STARTROW=>'20200001','LIMIT'=>2,STOPROW=>'20200002'}
scan 'cx_table_stu01',{STARTROW=>'20200001','LIMIT'=>2,COLUMNS=>'cf1:name'}
```

```
hbase(main):007:0> scan 'cx_table_stu01',{STARTROW=>'20200001','LIMIT'=>2,STOPROW=>'20200002'}
ROW                     COLUMN+CELL
 20200001               column=cf1:age, timestamp=1586224622452, value=20
 20200001               column=cf1:gender, timestamp=1586224622397, value=male
 20200001               column=cf1:name, timestamp=1586224622340, value=tom
1 row(s)
Took 0.0250 seconds
hbase(main):008:0> scan 'cx_table_stu01',{STARTROW=>'20200001','LIMIT'=>2,COLUMNS=>'cf1:name'}
ROW                     COLUMN+CELL
 20200001               column=cf1:name, timestamp=1586224622340, value=tom
 20200002               column=cf1:name, timestamp=1586224622492, value=hanmeimei
2 row(s)
Took 0.0086 seconds
hbase(main):009:0>
```

Figure 4-6

Note: In addition to column (COLUMNS) modifiers, HBase supports Limit (limiting the number of rows in the query results) and STARTROW (ROWKEY start row. The system locates the region based on the key and then scans the region backwards.), STOPROW (end row), TIMERANGE (timestamp range), VERSIONS (the number of versions), and FILTER (filtering rows based on conditions).

4.3.1.6 Querying Multiversion Data

HBase can store data of historical versions. You can set **VERSIONS** to specify the number of versions to be stored.

Add data.

```
put   'cx_table_stu01','20200001','cf1:name','ZhangSan'
put   'cx_table_stu01','20200001','cf1:name','LiSi'
```

```
put   'cx_table_stu01','20200001','cf1:name','WangWu'
```

Scan the table to view the result.

```
hbase(main):001:0> put  'cx_table_stu01','20200001','cf1:name','ZhangSan'
Took 0.3839 seconds
hbase(main):002:0> put  'cx_table_stu01','20200001','cf1:name','LiSi'
Took 0.0028 seconds
hbase(main):003:0> put  'cx_table_stu01','20200001','cf1:name','WangWu'
Took 0.0030 seconds
hbase(main):004:0> scan 'cx_table_stu01'
ROW                   COLUMN+CELL
 20200001             column=cf1:age, timestamp=1586224622452, value=20
 20200001             column=cf1:gender, timestamp=1586224622397, value=male
 20200001             column=cf1:name, timestamp=1586239656833, value=WangWu
 20200002             column=cf1:age, timestamp=1586224622561, value=19
 20200002             column=cf1:gender, timestamp=1586224622531, value=female
 20200002             column=cf1:name, timestamp=1586224622492, value=hanmeimei
2 row(s)
Took 0.0189 seconds
hbase(main):005:0>
```

Figure 4-7

Specify multiple versions to be queried.

```
get   'cx_table_stu01','20200001',{COLUMNS=>'cf1',VERSIONS=>5}
```

```
hbase(main):009:0> get  'cx_table_stu01','20200001',{COLUMNS=>'cf1',VERSIONS=>5}

COLUMN                CELL
 cf1:age              timestamp=1586224622452, value=20
 cf1:gender           timestamp=1586224622397, value=male
 cf1:name             timestamp=1586239656833, value=WangWu
1 row(s)
Took 0.0309 seconds
hbase(main):010:0>
```

Figure 4-8

The version is specified during the search, but the last record is still displayed. Although **VERSIONS** is added, only one record is returned after the get operation. This is because the default value of **VERSIONS** is **1** during table creation.

Run the **desc'cx_table_stu01'** statement to view the table attributes.

```
hbase(main):011:0> desc  'cx_table_stu01'
Table cx_table_stu01 is ENABLED
cx_table_stu01
COLUMN FAMILIES DESCRIPTION
{NAME => 'cf1', VERSIONS => '1', EVICT_BLOCKS_ON_CLOSE => 'false', NEW_VERSION_B
EHAVIOR => 'false', KEEP_DELETED_CELLS => 'FALSE', CACHE_DATA_ON_WRITE => 'false
', DATA_BLOCK_ENCODING => 'NONE', TTL => 'FOREVER', MIN_VERSIONS => '0', REPLICA
TION_SCOPE => '0', BLOOMFILTER => 'ROW', CACHE_INDEX_ON_WRITE => 'false', IN_MEM
ORY => 'false', CACHE_BLOOMS_ON_WRITE => 'false', PREFETCH_BLOCKS_ON_OPEN => 'fa
lse', COMPRESSION => 'NONE', BLOCKCACHE => 'true', BLOCKSIZE => '65536'}
1 row(s)
Took 0.0136 seconds
hbase(main):012:0>
```

Figure 4-9

To view data of multiple versions, run the following statement to change the value of **VERSIONS** of the table or specify the value when creating the table:

alter 'cx_table_stu01',{NAME=>'cf1','VERSIONS'=>5}

```
alter ‘cx_table_stu01’,{NAME=>'cf1','VERSIONS'=>5}
```

Then, insert multiple data records.

```
put   'cx_table_stu01','20200001','cf1:name','ZhangSan'
put   'cx_table_stu01','20200001','cf1:name','LiSi'
put   'cx_table_stu01','20200001','cf1:name','WangWu'
```

The value of name has multiple versions.

```
hbase(main):022:0> alter 'cx_table_stu01',{NAME=>'cf1','VERSIONS'=>5}
Updating all regions with the new schema...
1/1 regions updated.
Done.
Took 3.3525 seconds
hbase(main):023:0> get  'cx_table_stu01','20200001',{COLUMNS=>'cf1',VERSIONS=>5}

COLUMN                CELL
 cf1:age              timestamp=1586224622452, value=20
 cf1:gender           timestamp=1586224622397, value=male
 cf1:name             timestamp=1586239656833, value=WangWu
 cf1:name             timestamp=1586224622340, value=tom
1 row(s)
Took 0.0148 seconds
hbase(main):024:0> put  'cx_table_stu01','20200001','cf1:name','ZhangSan'
Took 0.0082 seconds
hbase(main):025:0> put  'cx_table_stu01','20200001','cf1:name','LiSi'
Took 0.0034 seconds
hbase(main):026:0> put  'cx_table_stu01','20200001','cf1:name','WangWu'
Took 0.0032 seconds
hbase(main):027:0> get  'cx_table_stu01','20200001',{COLUMNS=>'cf1',VERSIONS=>5}

COLUMN                CELL
 cf1:age              timestamp=1586224622452, value=20
 cf1:gender           timestamp=1586224622397, value=male
 cf1:name             timestamp=1586240738902, value=WangWu
 cf1:name             timestamp=1586240738884, value=LiSi
 cf1:name             timestamp=1586240738860, value=ZhangSan
 cf1:name             timestamp=1586239656833, value=WangWu
 cf1:name             timestamp=1586224622340, value=tom
1 row(s)
Took 0.0336 seconds
hbase(main):028:0>
```

Figure 4-10

4.3.1.7 Deleting Data

Run the **delete 'cx_table_stu01','20200002','cf1:age'** command to delete data from a column family.

```
hbase(main):028:0> get 'cx_table_stu01','20200002'
COLUMN                CELL
 cf1:age              timestamp=1586224622561, value=19
 cf1:gender           timestamp=1586224622531, value=female
 cf1:name             timestamp=1586224622492, value=hanmeimei
1 row(s)
Took 0.0117 seconds
hbase(main):029:0> delete 'cx_table_stu01','20200002','cf1:age'
Took 0.0065 seconds
hbase(main):030:0> get 'cx_table_stu01','20200002'
COLUMN                CELL
 cf1:gender           timestamp=1586224622531, value=female
 cf1:name             timestamp=1586224622492, value=hanmeimei
1 row(s)
Took 0.0088 seconds
hbase(main):031:0>
```

Figure 4-11

Run the **deleteall 'cx_table_stu01','20200002'** command to delete a row of data.

```
hbase(main):031:0> deleteall  'cx_table_stu01','20200002'
Took 0.0030 seconds
hbase(main):032:0> get 'cx_table_stu01','20200002'
COLUMN                CELL
0 row(s)
Took 0.0080 seconds
hbase(main):033:0>
```

Figure 4-12

4.3.1.8 Deleting Tables

You can run the **drop** command to delete a table. However, you must disable a table before deleting it.

Step 1 Run the **disable** '*table name*' command.

Step 2 Run the **drop** '*table name*' command.

```
hbase(main):033:0> disable 'cx_table_stu01'
2020-04-07 14:32:54,815 INFO  [main] client.HBaseAdmin: Started disable of cx_ta
ble_stu01
2020-04-07 14:32:57,068 INFO  [main] client.HBaseAdmin: Operation: DISABLE, Tabl
e Name: default:cx_table_stu01, procId: 22 completed
Took 2.2688 seconds
hbase(main):034:0> drop 'cx_table_stu01'
2020-04-07 14:33:06,518 INFO  [main] client.HBaseAdmin: Operation: DELETE, Table
 Name: default:cx_table_stu01, procId: 24 completed
Took 0.2700 seconds
hbase(main):035:0> list
TABLE
0 row(s)
Took 0.0145 seconds
=> []
hbase(main):036:0>
```

Figure 4-13

4.3.2 Task 2: Pre-splitting Regions During Table Creation

By default, HBase creates a table with only one region. The row key of the region has no boundary, that is, there is no start key or end key. All data is written to the default region. As the data volume increases, the region cannot handle the increasing data. Therefore, the region is split into two regions. During this process, the following problems may occur:

1. When data is written to a region, data hotspots may occur.
2. Region splitting consumes valuable cluster I/O resources.

To resolve the preceding problems, create multiple empty regions during table creation, and determine the start and end row keys of each region. In this way, as long as the row key can evenly hit each region, the write hotspot problem does not exist, and the probability of splitting is greatly reduced. HBase provides two pre-splitting algorithms: HexStringSplit and UniformSplit. HexStringSplit applies to the row key of hexadecimal characters, and UniformSplit applies to the row key of random byte arrays.

4.3.2.1 Splitting into Four Regions Randomly by Row Key

Run the **create 'cx_table_stu02','cf2', {NUMREGIONS => 4 , SPLITALGO => 'UniformSplit'}** to create a table.

```
hbase(main):037:0> create 'cx_table_stu02','cf2', {NUMREGIONS => 4 , SPLITALGO =
> 'UniformSplit'}
2020-04-07 15:10:11,345 INFO  [main] client.HBaseAdmin: Operation: CREATE, Table
 Name: default:cx_table_stu02, procId: 25 completed
Created table cx_table_stu02
Took 2.2548 seconds
=> Hbase::Table - cx_table_stu02
hbase(main):038:0>
```

Figure 4-14

Region name format: [table],[region start key],[region id]

Log in to the HBase WebUI and check the table partitions.

Log in to MRS Manager, choose **Services** > **HBase**.

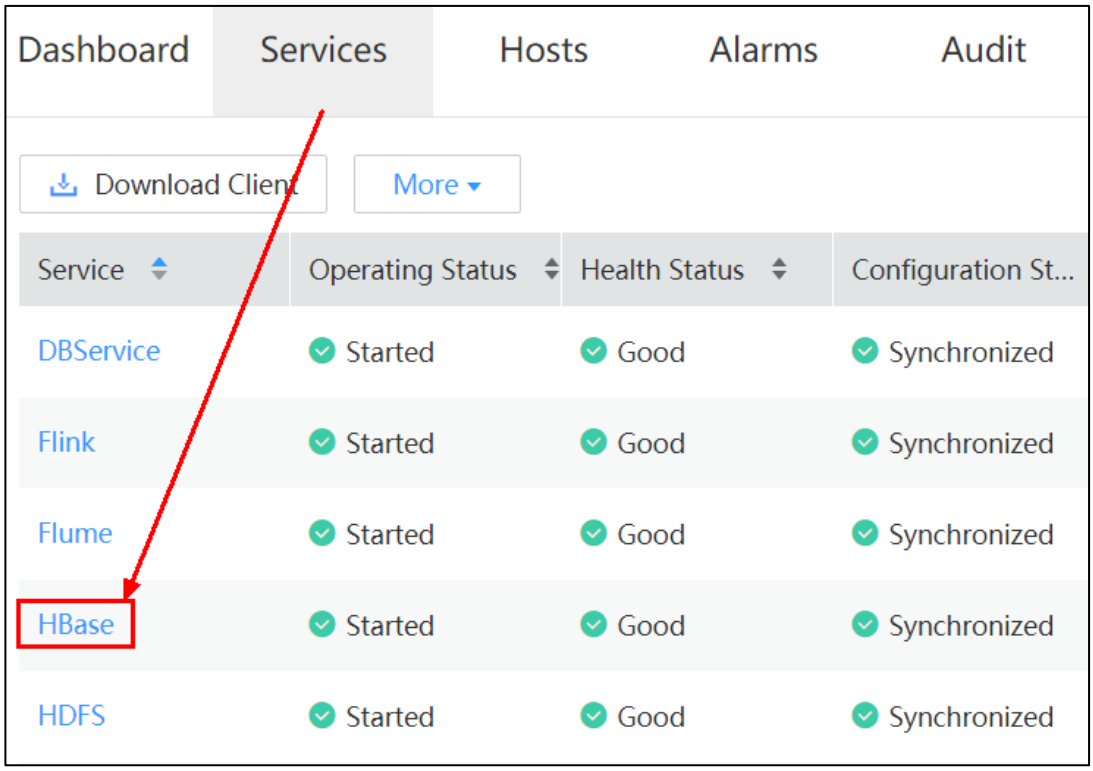


Figure 4-15

Click **HMaster (Active)**. The HMaster WebUI is displayed.

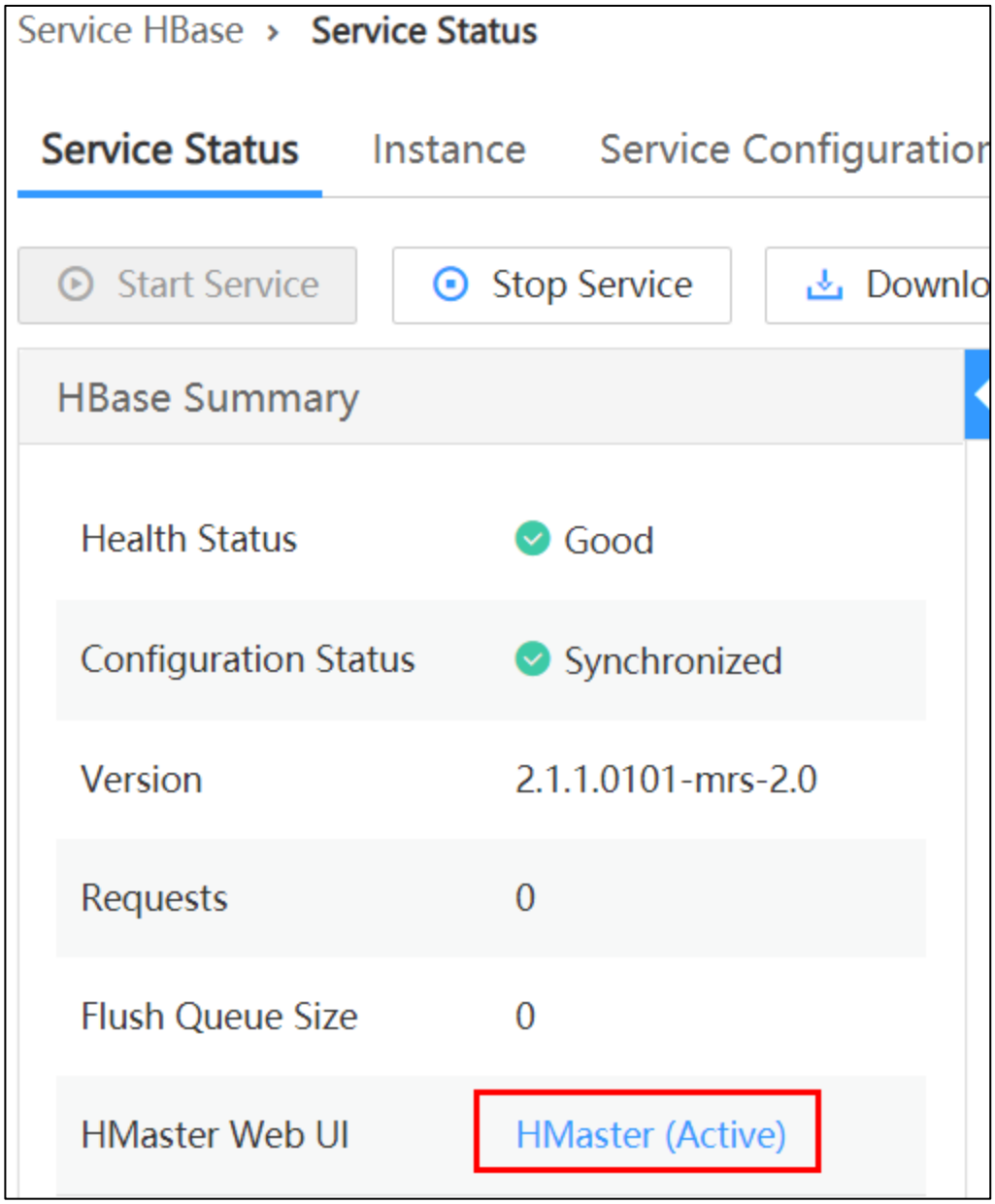


Figure 4-16

Click **cx_table_stu02** on the **User Tables** tab page. The **Tables Regions** page is displayed.

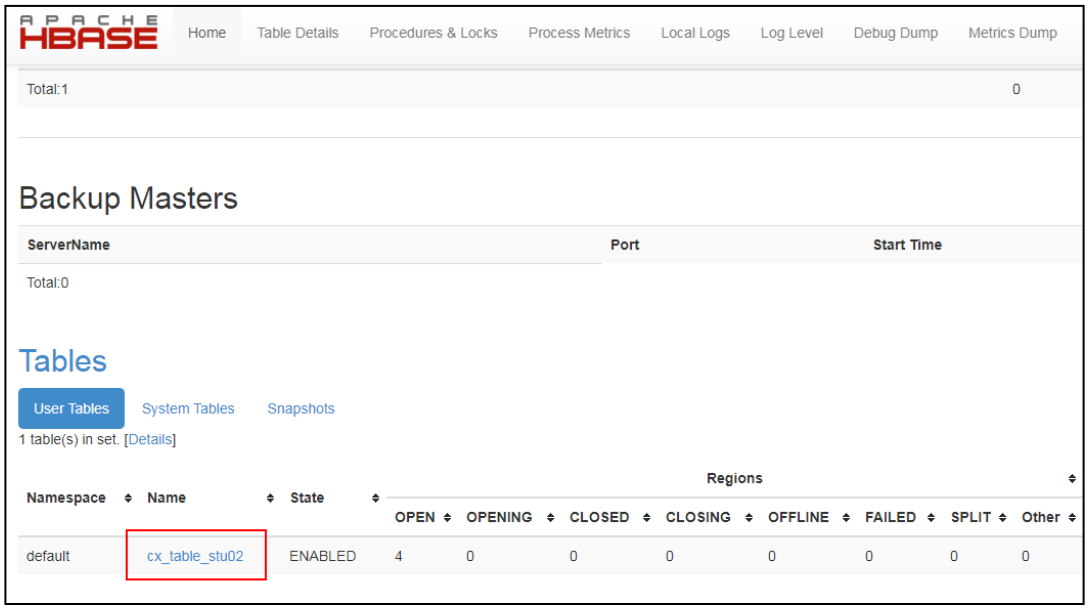


Figure 4-17

The **cx_table_stu02** table has four partitions.

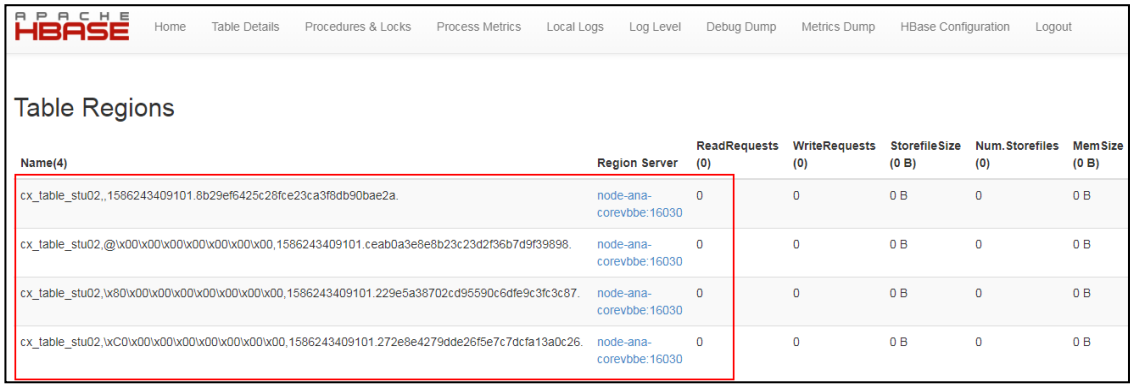


Figure 4-18

4.3.2.2 Viewing the Start Key and End Key of Specified Regions

Run the **create 'cx_table_stu03', 'cf3', SPLITS => ['10000', '20000', '30000']** command to create a table.

Check the table partitions.

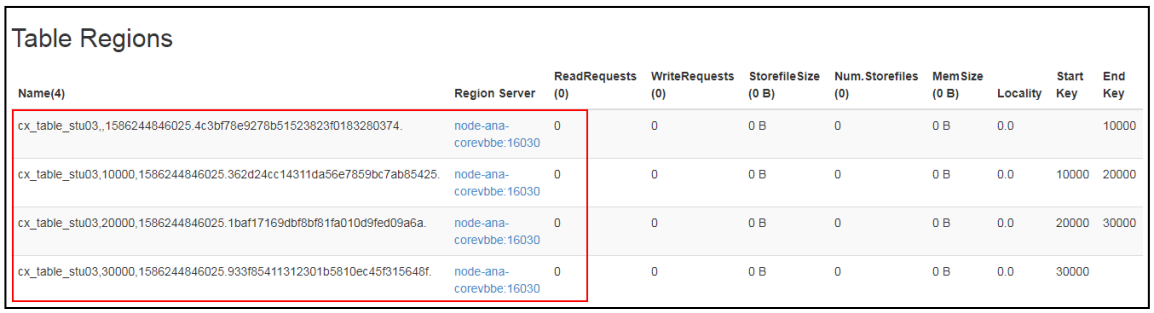


Figure 4-19

4.3.3 Task 3: Using Filters

If the **cx_table_stu01** table is deleted in the previous practice, recreate the table and insert data.

Run the following commands:

```
scan 'cx_table_stu01',{FILTER=>"ValueFilter(=,'binary:20')"}
scan 'cx_table_stu01',{FILTER=>"ValueFilter(=,'binary:tom')"}
scan 'cx_table_stu01',FILTER=>"ColumnPrefixFilter('gender')"
scan 'cx_table_stu01',{FILTER=>"ColumnPrefixFilter('name') AND ValueFilter(=,'binary:hanmeimei')"}
```

```
Took 0.0025 seconds
hbase(main):043:0> put  'cx_table_stu01','20200001', 'cf1:age','20'
Took 0.0032 seconds
hbase(main):044:0> put  'cx_table_stu01','20200002', 'cf1:name','hanmeimei'
Took 0.0027 seconds
hbase(main):045:0> put  'cx_table_stu01','20200002', 'cf1:gender','female'
Took 0.0026 seconds
hbase(main):046:0> put  'cx_table_stu01','20200002', 'cf1:age','19'
Took 0.0029 seconds
hbase(main):047:0> scan 'cx_table_stu01',{FILTER=>"ValueFilter(=,'binary:20')"}
ROW                   COLUMN+CELL
 20200001             column=cf1:age, timestamp=1586245100377, value=20
1 row(s)
Took 0.0410 seconds
hbase(main):048:0> scan 'cx_table_stu01',{FILTER=>"ValueFilter(=,'binary:tom')"}

ROW                   COLUMN+CELL
 20200001             column=cf1:name, timestamp=1586245100345, value=tom
1 row(s)
Took 0.0040 seconds
hbase(main):049:0> scan 'cx_table_stu01',FILTER=>"ColumnPrefixFilter('gender')"
ROW                   COLUMN+CELL
 20200001             column=cf1:gender, timestamp=1586245100362, value=male
 20200002             column=cf1:gender, timestamp=1586245100406, value=female
2 row(s)
Took 0.0085 seconds
hbase(main):050:0> scan 'cx_table_stu01',{FILTER=>"ColumnPrefixFilter('name') AN
D ValueFilter(=,'binary:hanmeimei')"}
ROW                   COLUMN+CELL
 20200002             column=cf1:name, timestamp=1586245100391, value=hanmeimei
1 row(s)
Took 0.0140 seconds
hbase(main):051:0>
```

Figure 4-20

4.4 Summary

This exercise describes how to create and delete HBase tables and add, delete, modify, and query data, how to pre-split regions, and how to use filters to query data. After completing this exercise, you will be able to know how to use HBase.

5 MapReduce Data Processing Practice

5.1 Background

This section mainly introduces how to use MR to count words.

5.2 Objectives

Understand the principles of MapReduce programming.

5.3 Tasks

5.3.1 Task 1: MapReduce Shell Practice

Step 1 Log in to an ECS.

Use PuTTY to log in to the ECS and set environment variables.

Run the **source /opt/client/bigdata_env** command.

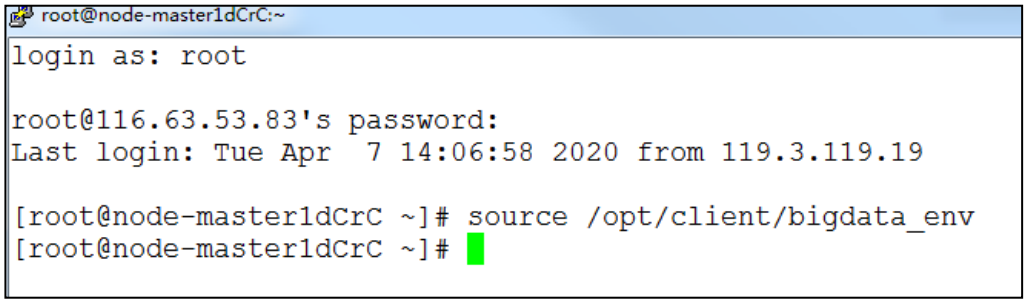


Figure 5-1

Step 2 Edit a data file on the local Linux host.

The file content is as follows:

```
[root@node-master1dCrC ~]# vi cx_wd.txt
[root@node-master1dCrC ~]# more cx_wd.txt
hadoop  hive    hadoop
hbase   spark   hive    hadoop
spark
[root@node-master1dCrC ~]#
```

Figure 5-2

Step 3 Upload the file to the HDFS.

```
[root@node-master1dCrC ~]# hdfs  dfs  -put  cx_wd.txt  /user/stu01
2020-04-11 16:51:59,993 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
[root@node-master1dCrC ~]# hdfs  dfs  -ls  /user/stu01
2020-04-11 16:52:08,852 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
Found 4 items
-rw-r--r--   1 root hadoop          49 2020-04-11 16:52 /user/stu01/cx_wd.txt
-rw-r--r--   1 root hadoop          16 2020-04-06 20:00 /user/stu01/stu01_3.txt
-rw-r--r--   1 root hadoop          12 2020-04-06 20:00 /user/stu01/stu01_4.txt
-rw-r--r--   1 root ficommon        21 2020-04-06 19:53 /user/stu01/stu01_5.txt
[root@node-master1dCrC ~]#
```

Figure 5-3

Step 4 Run the following command to execute the JAR file program:

```
yarn  jar  /opt/client/Yarn/hadoop/share/hadoop/mapreduce
/hadoop-mapreduce-examples-3.1.1-mrs-2.0.jar  wordcount  /user/stu01/cx_wd.txt  /user/st
u01/output01
```

```
[root@node-master1dCrC mapreduce]# yarn jar /opt/client/Yarn/hadoop/share/hadoop/mapredu
ce/hadoop-mapreduce-examples-3.1.1-mrs-2.0.jar wordcount /user/stu01/cx_wd.txt  /user/st
u01/output01
2020-04-11 17:04:00,452 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
2020-04-11 17:04:01,256 INFO client.AHSProxy: Connecting to Application History server a
t /0.0.0.0:10200
2020-04-11 17:04:01,479 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for
 path: hdfs://hacluster/tmp/hadoop-yarn/staging/root/.staging/job_1586168696337_0101
2020-04-11 17:04:01,725 INFO input.FileInputFormat: Total input files to process : 1
2020-04-11 17:04:04,249 INFO mapreduce.JobSubmitter: number of splits:1
2020-04-11 17:04:04,298 INFO Configuration.deprecation: yarn.resourcemanager.system-metr
ics-publisher.enabled is deprecated. Instead, use yarn.system-metrics-publisher.enabled
2020-04-11 17:04:05,603 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1586168696337_0101
2020-04-11 17:04:05,605 INFO mapreduce.JobSubmitter: Executing with tokens: []
2020-04-11 17:04:05,858 INFO conf.Configuration: resource-types.xml not found
2020-04-11 17:04:05,858 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
2020-04-11 17:04:06,114 INFO impl.YarnClientImpl: Submitted application application_1586168696337_0101
2020-04-11 17:04:06,145 INFO mapreduce.Job: The url to track the job: http://node-master1dCrC:8088/proxy/applic
ation_1586168696337_0101/
2020-04-11 17:04:06,146 INFO mapreduce.Job: Running job: job_1586168696337_0101
2020-04-11 17:04:13,223 INFO mapreduce.Job: Job job_1586168696337_0101 running in uber mode : false
2020-04-11 17:04:13,224 INFO mapreduce.Job:  map 0% reduce 0%
2020-04-11 17:04:18,264 INFO mapreduce.Job:  map 100% reduce 0%
2020-04-11 17:04:23,285 INFO mapreduce.Job:  map 100% reduce 100%
2020-04-11 17:04:26,302 INFO mapreduce.Job: Job job_1586168696337_0101 completed successfully
2020-04-11 17:04:26,380 INFO mapreduce.Job: Counters: 53
        File System Counters
                FILE: Number of bytes read=67
                FILE: Number of bytes written=525279
                FILE: Number of read operations=0
                FILE: Number of large read operations=0
                FILE: Number of write operations=0
                HDFS: Number of bytes read=151
                HDFS: Number of bytes written=32
                HDFS: Number of read operations=6
                HDFS: Number of large read operations=0
                HDFS: Number of write operations=2
        Job Counters
                Launched map tasks=1
                Launched reduce tasks=1
                Data-local map tasks=1
                Total time spent by all maps in occupied slots (ms)=13488
                Total time spent by all reduces in occupied slots (ms)=17370
                Total time spent by all map tasks (ms)=3372
                Total time spent by all reduce tasks (ms)=2895
                Total vcore-milliseconds taken by all map tasks=3372
                Total vcore-milliseconds taken by all reduce tasks=2895
```

Figure 5-4

Note: This JAR package is a sample JAR package built-in the Hadoop framework. The default file separator is the Tab key. The **output01** folder does not exist. The program automatically creates the folder.

Step 5 View statistics results.

The result file is saved in the **output01** folder. The system automatically generates a **part-r-00000** file.

```
[root@node-master1dCrC mapreduce]# hdfs dfs -ls /user/stu01/output01
2020-04-11 17:04:44,916 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 2 items
-rw-r--r--   1 root hadoop          0 2020-04-11 17:04 /user/stu01/output01/_SUCCESS
-rw-r--r--   1 root hadoop         32 2020-04-11 17:04 /user/stu01/output01/part-r-00000
[root@node-master1dCrC mapreduce]# hdfs dfs -cat /user/stu01/output01/part-r-00000
2020-04-11 17:04:58,887 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
hadoop  3
hbase   1
hive    2
spark   2
[root@node-master1dCrC mapreduce]#
```

Figure 5-5

The file statistics are complete.

Step 6 Parse the source code of the WordCount JAR package.

```
package com.huawei.bigdata.mapreduce.examples;
```

```
import java.io.IOException;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;

public class WordCountDemo {
public static class MyMapper extends Mapper<LongWritable, Text, Text, LongWritable>{
	@Override
	protected void map(LongWritable key, Text value, Mapper<LongWritable, Text, Text,
LongWritable>.Context context)
			throws IOException, InterruptedException {
				String line = value.toString();
				String[] splited = line.split("\t");
				for (String word : splited) {
						Text k2 = new Text(word);
						LongWritable v2 = new LongWritable(1);
						context.write(k2, v2);
				}
			}
}

public static class MyReducer extends Reducer<Text, LongWritable, Text, LongWritable> {
	@Override
	protected void reduce(Text k2, Iterable<LongWritable> v2s,
			Reducer<Text, LongWritable, Text, LongWritable>.Context context)
			throws IOException, InterruptedException {
			long count = 0L;
			for (LongWritable times : v2s) {
					count += times.get();
			}
			LongWritable v3 = new LongWritable(count);
			context.write(k2, v3);
	}
}

public static void main(String[] args) throws Exception {
	Configuration conf = new Configuration();
	Job job = Job.getInstance(conf, WordCountDemo.class.getSimpleName());
	// Mandatory
	job.setJarByClass(WordCountDemo.class);

	// Specify where data comes from.
	FileInputFormat.setInputPaths(job, args[0]);
	// Specify where the custom mapper is.
	job.setMapperClass(MyMapper.class);
	// Specify the type of <k2,v2> output by the mapper.
	job.setMapOutputKeyClass(Text.class);
```

```
        job.setMapOutputValueClass(LongWritable.class);
        // Specify where the custom reducer comes from.
        job.setReducerClass(MyReducer.class);
        // Specify the type of <k3,v3> output by reducer.
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(LongWritable.class);
        // Specify where data is written.
        FileOutputFormat.setOutputPath(job, new Path(args[1]));
        // true indicates that information such as running progress is sent to users in time.
        job.waitForCompletion(true);
}
}
package com.huawei.bigdata.mapreduce.examples;

import java.io.IOException;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.mapreduce.Job;
import org.apache.hadoop.mapreduce.Mapper;
import org.apache.hadoop.mapreduce.Reducer;
import org.apache.hadoop.mapreduce.lib.input.FileInputFormat;
import org.apache.hadoop.mapreduce.lib.output.FileOutputFormat;

public class WordCountDemo {
public static class MyMapper extends Mapper<LongWritable, Text, Text, LongWritable>{
        @Override
        protected void map(LongWritable key, Text value, Mapper<LongWritable, Text, Text,
LongWritable>.Context context)
                        throws IOException, InterruptedException {
                        String line = value.toString();
                        String[] splited = line.split("\t");
                        for (String word : splited) {
                                        Text k2 = new Text(word);
                                        LongWritable v2 = new LongWritable(1);
                                        context.write(k2, v2);
                        }
                }
}

public static class MyReducer extends Reducer<Text, LongWritable, Text, LongWritable> {
        @Override
        protected void reduce(Text k2, Iterable<LongWritable> v2s,
                        Reducer<Text, LongWritable, Text, LongWritable>.Context context)
                        throws IOException, InterruptedException {
                        long count = 0L;
                        for (LongWritable times : v2s) {
                                        count += times.get();
                        }
                        LongWritable v3 = new LongWritable(count);
                        context.write(k2, v3);
        }
}
```

```
public static void main(String[] args) throws Exception {
        Configuration conf = new Configuration();
        Job = Job.getInstance(conf, WordCountDemo.class.getSimpleName());
        // Mandatory
        job.setJarByClass(WordCountDemo.class);

        // Specify where data comes from.
        FileInputFormat.setInputPaths(job, args[0]);
        // Specify where the custom mapper is.
        job.setMapperClass(MyMapper.class);
        // Specify the type of <k2,v2> output by the mapper.
        job.setMapOutputKeyClass(Text.class);
        job.setMapOutputValueClass(LongWritable.class);
        // Specify where the custom reducer comes from.
        job.setReducerClass(MyReducer.class);
        // Specify the type of <k3,v3> output by reducer.
        job.setOutputKeyClass(Text.class);
        job.setOutputValueClass(LongWritable.class);
        // Specify where data is written.
        FileOutputFormat.setOutputPath(job, new Path(args[1]));
        // true indicates that information such as running progress is sent to users in time.
        job.waitForCompletion(true);
}
}
```

5.3.1 (Optional) Task 2: MapReduce Java Practice: Collecting Statistics on Online Duration

Prerequisites: The Java development environment has been installed and the MRS2.0 sample project has been imported. For details, see *Appendix 1*.

Step 1 Check the imported sample project.

The directory structure of the imported sample project is as follows:

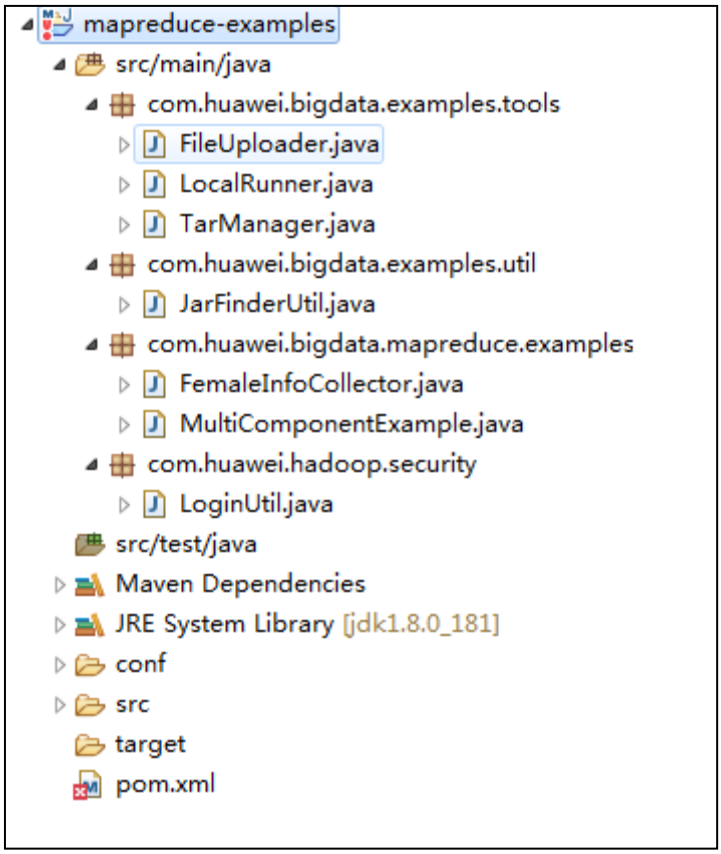


Figure 5-6

Step 2 Understand the scenario.

Develop a MapReduce application to perform the following operations on logs about Time On Page (TP) of netizens for shopping online.

1. Collect statistics on female netizens whose TP for online shopping is more than 2 hours on the weekend.
2. The first column in the log file records names, the second column records gender, and the third column records the TP in the unit of minute. Three columns are separated by comma (,).

log1.txt: logs collected on Saturday.

```
LiuYang,female,20
YuanJing,male,10
GuoYijun,male,5
CaiXuyu,female,50
Liyuan,male,20
FangBo,female,50
LiuYang,female,20
YuanJing,male,10
GuoYijun,male,50
CaiXuyu,female,50
FangBo,female,60
```

log2.txt: logs collected on Sunday.

```
LiuYang,female,20
YuanJing,male,10
CaiXuyu,female,50
FangBo,female,50
GuoYijun,male,5
CaiXuyu,female,50
Liyuan,male,20
CaiXuyu,female,50
FangBo,female,50
LiuYang,female,20
YuanJing,male,10
FangBo,female,50
GuoYijun,male,50
CaiXuyu,female,50
FangBo,female,60
```

Step 3 Plan data.

Save the original log files in the HDFS.

1. Create two text files on the local host, copy the content in **log1.txt** to **cx_input_data1.txt**, and copy the content in **log2.txt** to **cx_input_data2.txt**.
2. Create folder **/user/stu01/input** in the HDFS and upload **cx_input_data1.txt** and **cx_input_data2.txt** to the directory.
   a Run the **hdfs dfs -mkdir /user/stu01/input** command on the HDFS client in the Linux system.
   b Run the hdfs dfs –put local_filepath /user/stu01/input command twice.

After the operation is complete, the files in the corresponding HDFS directory are as follows:

```
[root@node-master1dCrC ~]# hdfs dfs -mkdir /user/stu01/input
2020-04-11 21:42:35,184 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
[root@node-master1dCrC ~]# hdfs dfs -put cx_input_data1.txt /user/stu01/input
2020-04-11 21:43:04,177 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
[root@node-master1dCrC ~]# hdfs dfs -put cx_input_data2.txt /user/stu01/input
2020-04-11 21:43:10,927 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
[root@node-master1dCrC ~]# hdfs dfs -ls /user/stu01/input
2020-04-11 21:43:30,372 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 2 items
-rw-r--r--   1 root hadoop        188 2020-04-11 21:43 /user/stu01/input/cx_input_data1.txt
-rw-r--r--   1 root hadoop        258 2020-04-11 21:43 /user/stu01/input/cx_input_data2.txt
[root@node-master1dCrC ~]#
```

Figure 5-7

Step 4 Understand the development approaches.

Collect statistics on female netizens whose TP is more than 2 hours on the weekend.

To achieve the objective, the process is as follows:

1. Read the original file data.
2. Filter data about the TP of the female netizens.
3. Summarize the total TP of each female.

4. Filter information about female netizens whose TP for online shopping is more than two hours.

Parse sample code. The class in the sample project is FemaleInfoCollector.java.

Collect statistics on female netizens whose TP for online shopping is more than 2 hours on the weekend.

To achieve the objective, the process is as follows:

1. Filter the TP of female netizens in original files using the CollectionMapper class inherited from the Mapper abstract class.
2. Summarize the TP of each female netizen, and output information about female netizens whose TP is more than 2 hours using the CollectionReducer class inherited from the Reducer abstract class.
3. Use the main method to create a MapReduce job and submit the MapReduce job to the Hadoop cluster.

Step 5 Run the MR packaging program.

Open the cmd window, go to the directory where the project is located, and run the **mvn package** command to package the project.

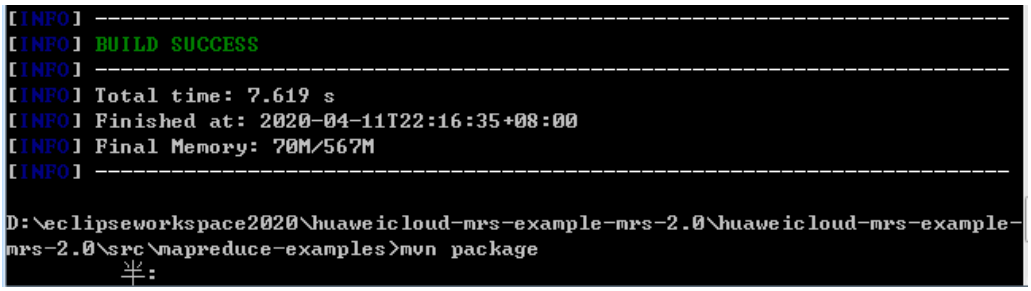


Figure 5-8

Run the **mvn package** command to generate a JAR package and obtain it from the target directory in the project directory, for example, **mapreduce-examples-mrs-2.0.jar**.

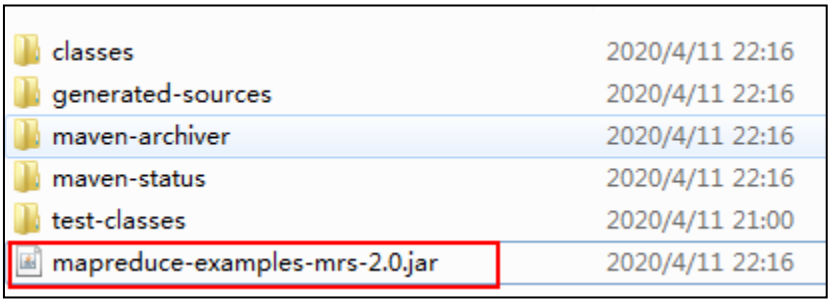


Figure 5-9

Step 6 Use WinSCP to log in to an ECS.

Upload the JAR package to the **/root** directory.

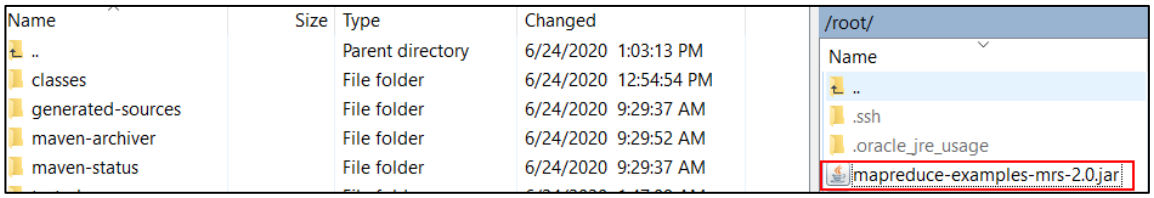


Figure 5-10

Step 7 Use PuTTY to log in to the ECS and run the MR program.

Run the source /opt/client/bigdata_env command.

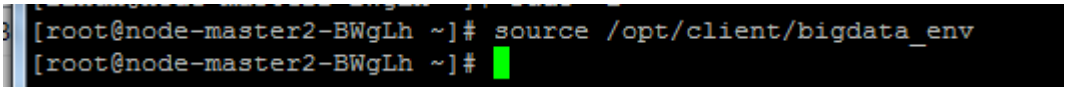


Figure 5-11

Run the mapreduce program.

```
yarn jar /root/mapreduce-examples-mrs-2.0.jar
com.huawei.bigdata.mapreduce.examples.FemaleInfoCollector /user
/stu01/input /user/stu01/output2
```

Note: **/output2** must not exist.

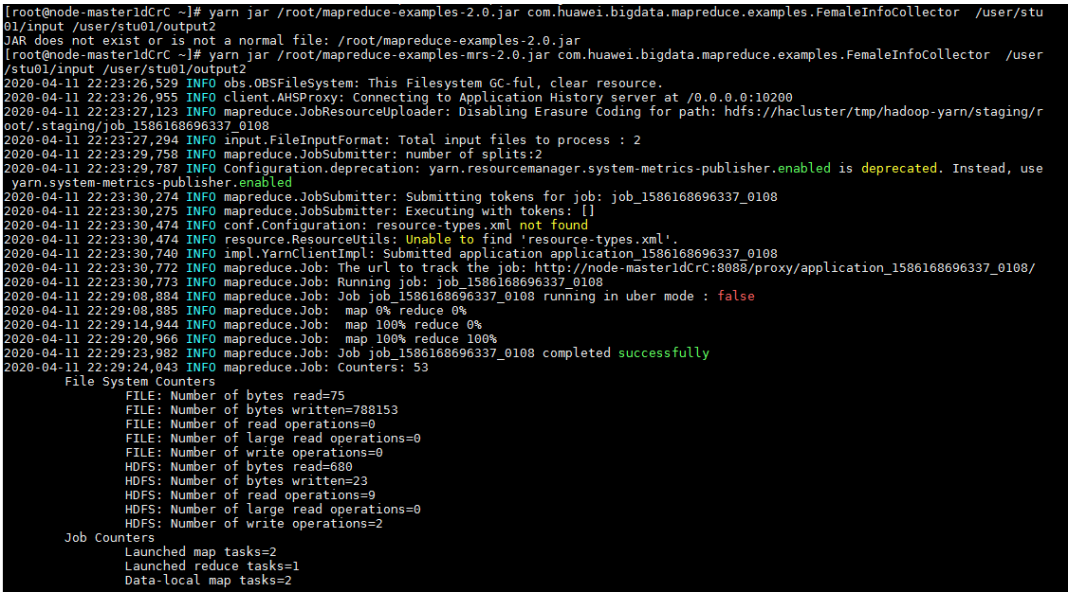


Figure 5-12

Step 8 View the result. The MR output result is stored in the **/output2** directory. A result file **part-r-00000** is generated. Run the **cat** command to view the result.

```
2020-04-11 22:54:10,139 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 2 items
-rw-r--r--   1 root hadoop          0 2020-04-11 22:29 /user/stu01/output2/_SUCCESS
-rw-r--r--   1 root hadoop         23 2020-04-11 22:29 /user/stu01/output2/part-r-00000
[root@node-master1dCrC ~]# hdfs dfs -cat /user/stu01/output2/part-r-00000
2020-04-11 22:54:13,781 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
CaiXuyu 300
FangBo  320
[root@node-master1dCrC ~]#
```

Figure 5-13

There are two persons whose TP exceeds 2 hours.

5.4 Summary

This exercise describes the MapReduce programming process in shell and Java modes and explains the source code to help trainees quickly get started with MapReduce.

6 Spark Memory Computing Practice

6.1 Background

Spark is implemented in the Scala language, and uses Scala as its application framework. Different from Hadoop, Spark can be tightly integrated with Scala. Scala can operate Resilient Distributed Datasets (RDDs) so easily as operating local combined objects. This exercise describes how to use Scala to operate Spark RDD and Spark SQL.

6.2 Objectives

Understand Spark programming by exercising Spark RDD and Spark SQL.

6.3 Tasks

6.3.1 Task 1: Spark RDD Programming

This exercise introduces Spark RDD programming to help you understand the working principles and core mechanism of Spark Core.

The process is as follows:

- Understand how to create an RDD.
- Understand the common operator of RDD.
- Understand how to use Scala project code to complete RDD operations.

Step 1 Load data from a file system to create an RDD.

Spark uses the textFile() method to load data from a file system to create an RDD.

This method takes the URI of the file as a parameter, which can be the address of the local file system, the address of the HDFS, the address of Amazon S3, or more.

Connect to the cluster, start PuTTY or another connection software, load environment variables, and enter spark-shell.

```
source /opt/client/bigdata_env
spark-shell
```

```
2020-04-11 22:58:10,874 | WARN  | main | The configuration key 'spark.yarn.access.
 the new key 'spark.yarn.access.hadoopFileSystems' instead. | org.apache.spark.int
2020-04-11 22:58:10,880 | WARN  | main | The configuration key 'spark.yarn.access.
 the new key 'spark.yarn.access.hadoopFileSystems' instead. | org.apache.spark.int
2020-04-11 22:58:10,881 | WARN  | main | The configuration key 'spark.yarn.access.
 the new key 'spark.yarn.access.hadoopFileSystems' instead. | org.apache.spark.int
2020-04-11 22:58:13,712 | WARN  | main | load mapred-default.xml, HIVE_CONF_DIR en
tate.java:1101)
Spark context Web UI available at http://node-master1dCrC:22688
Spark context available as 'sc' (master = local[*], app id = local-1586617091054).
Spark session available as 'spark'.
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /___/ .__/\_,_/_/ /_/\_\   version 2.3.2-mrs-2.0
      /_/

Using Scala version 2.11.8 (OpenJDK 64-Bit Server VM, Java 1.8.0_212)
Type in expressions to have them evaluated.
Type :help for more information.

scala>
```

Figure 6-1

1. Load data from a Linux local file system.

```
scala> val lines = sc.textFile("file:///home/data/log1.txt")
```

```
scala> val line = sc.textFile("file:///root/cx_input_data1.txt")
line: org.apache.spark.rdd.RDD[String] = file:///root/cx_input_data1.txt MapPartitionsRDD[3] at textFil
e at <console>:24

scala> line.count()
res3: Long = 11

scala> line.collect()
res4: Array[String] = Array(LiuYang,female,20, YuanJing,male,10, GuoYijun,male,5, CaiXuyu,female,50, Li
yuan,male,20, FangBo,female,50, LiuYang,female,20, YuanJing,male,10, GuoYijun,male,50, CaiXuyu,female,5
0, FangBo,female,60)

scala>
```

Figure 6-2

2. Load data from the HDFS. If the file does not exist, put it again.

```
scala> val lines1 = sc.textFile("hdfs://hacluster/user/stu01/cx_input_data1.txt")
scala> val lines2 = sc.textFile("/user/stu01/cx_input_data1.txt ")
```

You can use either of the statements but the second one is recommended.

```
scala> val lines1 = sc.textFile("hdfs://hacluster/user/stu01/cx_input_data1.txt")
lines1: org.apache.spark.rdd.RDD[String] = hdfs://hacluster/user/stu01/cx_input_data1.txt MapPartitions
RDD[11] at textFile at <console>:24

scala> lines1.collect()
res7: Array[String] = Array(LiuYang,female,20, YuanJing,male,10, GuoYijun,male,5, CaiXuyu,female,50, Li
yuan,male,20, FangBo,female,50, LiuYang,female,20, YuanJing,male,10, GuoYijun,male,50, CaiXuyu,female,5
0, FangBo,female,60)

scala> val lines2 = sc.textFile("/user/stu01/cx_input_data1.txt")
lines2: org.apache.spark.rdd.RDD[String] = /user/stu01/cx_input_data1.txt MapPartitionsRDD[13] at textF
ile at <console>:24

scala> lines2.collect()
res8: Array[String] = Array(LiuYang,female,20, YuanJing,male,10, GuoYijun,male,5, CaiXuyu,female,50, Li
yuan,male,20, FangBo,female,50, LiuYang,female,20, YuanJing,male,10, GuoYijun,male,50, CaiXuyu,female,5
0, FangBo,female,60)

scala>
```

Figure 6-3

Step 2 Create an RDD using a parallel set (array).

You can call the parallelize method of SparkContext to create an RDD on an existing set (array) in Driver.

```
scala> val array = Array(1,2,3,4,5)
array: Array[Int] = Array(1, 2, 3, 4, 5)
scala> val rdd = sc.parallelize(array)
rdd: org.apache.spark.rdd.RDD[Int] = ParallelCollectionRDD[14] at parallelize at <console>:26
scala> rdd.collect()
res9: Array[Int] = Array(1, 2, 3, 4, 5)
```

Alternatively, you can create an RDD as follows:

```
scala> val list = List(1,2,3,4,5)
list: List[Int] = List(1, 2, 3, 4, 5)
scala> val rdd = sc.parallelize(list)
rdd: org.apache.spark.rdd.RDD[Int] = ParallelCollectionRDD[15] at parallelize at <console>:26
scala> rdd.collect()
res10: Array[Int] = Array(1, 2, 3, 4, 5)
scala>
```

6.3.2 Task 2: RDD Shell Operations

Common transformations

Table 6-1

Transformation	Meaning
map(func)	Returns a new RDD formed by passing each element of the source through a function *func*.
filter(func)	Returns a new RDD formed by selecting those elements of the source on which *func* returns **true**.
flatMap(func)	Similar to map, but each input item can be mapped to 0 or more output items (so *func* should return a

Transformation	Meaning
	Seq instead of a single item).
mapPartitions(func)	Similar to map, but runs separately on each partition (block) of the RDD, so *func* must be of type Iterator<T> => Iterator<U> when running on an RDD of type T.
mapPartitionsWithIndex(func)	Similar to mapPartitions, but also provides *func* with an integer value representing the index of the partition, so *func* must be of type (Int, Iterator<T>) => Iterator<U> when running on an RDD of type T.
union(otherDataset)	Returns a new RDD that contains the union of the elements in the source RDD and the argument.
intersection(otherDataset)	Returns a new RDD that contains the intersection of the elements in the source RDD and the argument.
distinct([numTasks]))	Returns a new RDD that contains the distinct elements of the source RDD.
groupByKey([numTasks])	When called on an RDD of (K, V) pairs, returns an RDD of (K, Iterable<V>) pairs.
reduceByKey(func, [numTasks])	When called on an RDD of (K, V) pairs, returns an RDD of (K, V) pairs where the values for each key are aggregated using the given reduce function *func*, which must be of type (V,V) => V. Like in groupByKey, the number of reduce tasks is configurable through an optional second argument.
sortByKey([ascending], [numTasks])	When called on an RDD of (K, V) pairs where K implements Ordered, returns an RDD of (K, V) pairs sorted by keys in descending order.
sortBy(func,[ascending], [numTasks])	Similar to sortByKey, but more flexible.
join(otherDataset, [numTasks])	When called on RDDs of type (K, V) and (K, W), returns an RDD of (K, (V, W)) pairs with all pairs of elements for each key.
cogroup(otherDataset, [numTasks])	When called on RDDs of type (K, V) and (K, W), returns an RDD of (K, (Iterable<V>, Iterable<W>)) tuples.
coalesce(numPartitions)	Decreases the number of partitions in the RDD to numPartitions.
repartition(numPartitions)	Reshuffles the data in the RDD randomly to create

Transformation	Meaning
	either more or fewer partitions and balance it across them.
repartitionAndSortWithinPartitions(partitioner)	Repartitions the RDD according to the given partitioner and, within each resulting partition, sorts records by their keys.

Common actions

Action	Meaning
reduce(func)	Aggregates the elements of the RDD using a function which takes two arguments and returns one.
collect()	Returns all the elements of the RDD as an array at the driver program.
count()	Returns the number of elements in the RDD.
first()	Returns the first element of the RDD, which is similar to take(1).
take(n)	Returns an array with the first *n* elements of the RDD.
takeOrdered(n, [ordering])	Returns the first *n* elements of the RDD using either their natural order or a custom comparator.
saveAsTextFile(path)	Writes the elements of the RDD as a text file (or set of text files) in a given directory in the local filesystem, HDFS or any other Hadoop-supported file system. Spark will call toString on each element to convert it to a line of text in the file.
saveAsSequenceFile(path)	Writes the elements of the RDD as a Hadoop SequenceFile in a given path in the local filesystem, HDFS or any other Hadoop-supported file system.
saveAsObjectFile(path)	Writes the elements of the RDD in a simple format using Java serialization.
countByKey()	Only available on RDDs of type (K, V). Returns a hashmap of (K, Int) pairs with the count of each key.
foreach(func)	Runs a function *func* on each element of the RDD.
foreachPartition(func)	Runs a function *func* on each partition of the RDD.

Step 1 Use map and filter.

Generate RDDs in parallel.

```
val rdd1 = sc.parallelize(List(5, 6, 4, 7, 3, 8, 2, 9, 1, 10))
//Multiply each element in rdd1 by 2 and sort the results.
val rdd2 = rdd1.map(_ * 2).sortBy(x => x, true)
//Filter elements greater than or equal to 5.
val rdd3 = rdd2.filter(_ >= 5)
//Display elements on the client in array mode.
```

The result is as follows:

```
scala> val rdd1 = sc.parallelize(List(5, 6, 4, 7, 3, 8, 2, 9, 1, 10))
rdd1: org.apache.spark.rdd.RDD[Int] = ParallelCollectionRDD[16] at parallelize at <console>:24

scala> val rdd2 = rdd1.map(_ * 2).sortBy(x => x, true)
rdd2: org.apache.spark.rdd.RDD[Int] = MapPartitionsRDD[22] at sortBy at <console>:25

scala> val rdd3 = rdd2.filter(_ >= 5)
rdd3: org.apache.spark.rdd.RDD[Int] = MapPartitionsRDD[23] at filter at <console>:25

scala> rdd3.collect
res11: Array[Int] = Array(6, 8, 10, 12, 14, 16, 18, 20)

scala>
```

Figure 6-4

Step 2 Use flatMap.

```
val rdd1 = sc.parallelize(Array("a b c", "d e f", "h i j"))
//Divide each element in rdd1 and flatten the elements.
val rdd2 = rdd1.flatMap(_.split(" "))
rdd2.collect
```

The result is as follows:

```
scala> val rdd1 = sc.parallelize(Array("a b c", "d e f", "h i j"))
rdd1: org.apache.spark.rdd.RDD[String] = ParallelCollectionRDD[24] at parallelize at <console>:24

scala> val rdd2 = rdd1.flatMap(_.split(" "))
rdd2: org.apache.spark.rdd.RDD[String] = MapPartitionsRDD[25] at flatMap at <console>:25

scala> rdd2.collect
res12: Array[String] = Array(a, b, c, d, e, f, h, i, j)

scala>
```

Figure 6-5

Step 3 Use intersection and union.

```
val rdd1 = sc.parallelize(List(5, 6, 4, 3))
val rdd2 = sc.parallelize(List(1, 2, 3, 4))
//Obtain the union set.
val rdd3 = rdd1.union(rdd2)
//Obtain the intersection.
val rdd4 = rdd1.intersection(rdd2)
//Deduplicate data.
```

```
rdd3.distinct.collect
rdd4.collect
```

The result is as follows:

```
scala> val rdd1 = sc.parallelize(List(5, 6, 4, 3))
rdd1: org.apache.spark.rdd.RDD[Int] = ParallelCollectionRDD[0] at parallelize at <console>:24

scala> val rdd2 = sc.parallelize(List(1, 2, 3, 4))
rdd2: org.apache.spark.rdd.RDD[Int] = ParallelCollectionRDD[1] at parallelize at <console>:24

scala> // Get Union Set

scala> val rdd3 = rdd1.union(rdd2)
rdd3: org.apache.spark.rdd.RDD[Int] = UnionRDD[2] at union at <console>:27

scala> // Get Intersection Set

scala> val rdd4 = rdd1.intersection(rdd2)
rdd4: org.apache.spark.rdd.RDD[Int] = MapPartitionsRDD[8] at intersection at <console>:27

scala> // Deduplication

scala> rdd3.distinct.collect
res0: Array[Int] = Array(1, 2, 3, 4, 5, 6)

scala> rdd4.collect
```

Figure 6-6

```
res1: Array[Int] = Array(3, 4)

scala>
```

Figure 6-7

Step 4 Use join and groupByKey.

```
val rdd1 = sc.parallelize(List(("tom", 1), ("jerry", 3), ("kitty", 2)))
val rdd2 = sc.parallelize(List(("jerry", 2), ("tom", 1), ("shuke", 2)))
//Obtain the join.
val rdd3 = rdd1.join(rdd2)
rdd3.collect
//Obtain the union set.
val rdd4 = rdd1 union rdd2
rdd4.collect
//Group by key.
val rdd5=rdd4.groupByKey
rdd5.collect
```

Step 5 Use cogroup.

```
val rdd1 = sc.parallelize(List(("tom", 1), ("tom", 2), ("jerry", 3), ("kitty", 2)))
val rdd2 = sc.parallelize(List(("jerry", 2), ("tom", 1), ("jim", 2)))
//cogroup
val rdd3 = rdd1.cogroup(rdd2)
//Pay attention to the difference between cogroup and groupByKey.
rdd3.collect
```

Step 6 Use reduce.

```
val rdd1 = sc.parallelize(List(1, 2, 3, 4, 5))
```

```
//Reduce aggregation.
val rdd2 = rdd1.reduce(_ + _)
rdd2
```

```
scala> val rdd1 = sc.parallelize(List(1, 2, 3, 4, 5))
rdd1: org.apache.spark.rdd.RDD[Int] = ParallelCollectionRDD[31] at parallelize at <console>:24

scala> //reduce aggregation

scala> val rdd2 = rdd1.reduce(_ + _)
rdd2: Int = 15

scala> rdd2
res12: Int = 15

scala>
```

Figure 6-8

Step 7 Use reduceByKey and sortByKey.

```
val rdd1 = sc.parallelize(List(("tom", 1), ("jerry", 3), ("kitty", 2),  ("shuke", 1)))
val rdd2 = sc.parallelize(List(("jerry", 2), ("tom", 3), ("shuke", 2), ("kitty", 5)))
val rdd3 = rdd1.union(rdd2)
//Aggregate by key.
val rdd4 = rdd3.reduceByKey(_ + _)
rdd4.collect
//Sort by value in descending order.
val rdd5 = rdd4.map(t => (t._2, t._1)).sortByKey(false).map(t => (t._2, t._1))
rdd5.collect
```

Figure 6-9

```
scala> val rdd1 = sc.parallelize(List(("tom", 1), ("jerry", 3), ("kitty", 2),  ("shuke", 1)))
rdd1: org.apache.spark.rdd.RDD[(String, Int)] = ParallelCollectionRDD[32] at parallelize at <console>:24

scala> val rdd2 = sc.parallelize(List(("jerry", 2), ("tom", 3), ("shuke", 2), ("kitty", 5)))
rdd2: org.apache.spark.rdd.RDD[(String, Int)] = ParallelCollectionRDD[33] at parallelize at <console>:24

scala> val rdd3 = rdd1.union(rdd2)
rdd3: org.apache.spark.rdd.RDD[(String, Int)] = UnionRDD[34] at union at <console>:27

scala> //Aggregation by key

scala> val rdd4 = rdd3.reduceByKey(_ + _)
rdd4: org.apache.spark.rdd.RDD[(String, Int)] = ShuffledRDD[35] at reduceByKey at <console>:25

scala> rdd4.collect
res13: Array[(String, Int)] = Array((tom,4), (shuke,3), (kitty,7), (jerry,5))

scala> // Sort by value in descending order

scala> val rdd5 = rdd4.map(t => (t._2, t._1)).sortByKey(false).map(t => (t._2, t._1))
rdd5: org.apache.spark.rdd.RDD[(String, Int)] = MapPartitionsRDD[40] at map at <console>:25

scala> rdd5.collect
res14: Array[(String, Int)] = Array((kitty,7), (jerry,5), (tom,4), (shuke,3))

scala>
```

Figure 6-10

Step 8 Understand the lazy mechanism.

The lazy mechanism means that the entire transformation process only records the track of the transformation and does not trigger real calculation. Only when an operation is performed, real calculation is triggered from the beginning to the end.

A simple statement is provided to explain the lazy mechanism of Spark. The **data.txt** file does not exist, but the first two statements are executed successfully. An error occurs only when the third action statement is executed.

```
scala> val   lines = sc.textFile("data.txt")
scala> val   lineLengths = lines.map(s => s.length)
scala> val   totalLength = lineLengths.reduce((a, b) => a + b)
```

```
scala> val  lines = sc.textFile("data.txt")
lines: org.apache.spark.rdd.RDD[String] = data.txt MapPartitionsRDD[42] at textFile at <console>:24

scala> val  lineLengths = lines.map(s => s.length)
lineLengths: org.apache.spark.rdd.RDD[Int] = MapPartitionsRDD[43] at map at <console>:25

scala> val  totalLength = lineLengths.reduce((a, b) => a + b)
org.apache.hadoop.mapred.InvalidInputException: Input path does not exist: hdfs://hacluster/user/root/data.txt
  at org.apache.hadoop.mapred.FileInputFormat.singleThreadedListStatus(FileInputFormat.java:297)
  at org.apache.hadoop.mapred.FileInputFormat.listStatus(FileInputFormat.java:239)
  at org.apache.hadoop.mapred.FileInputFormat.getSplits(FileInputFormat.java:325)
  at org.apache.spark.rdd.HadoopRDD.getPartitions(HadoopRDD.scala:200)
  at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:253)
  at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:251)
  at scala.Option.getOrElse(Option.scala:121)
  at org.apache.spark.rdd.RDD.partitions(RDD.scala:251)
  at org.apache.spark.rdd.MapPartitionsRDD.getPartitions(MapPartitionsRDD.scala:46)
  at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:253)
  at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:251)
  at scala.Option.getOrElse(Option.scala:121)
  at org.apache.spark.rdd.RDD.partitions(RDD.scala:251)
  at org.apache.spark.rdd.MapPartitionsRDD.getPartitions(MapPartitionsRDD.scala:46)
  at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:253)
  at org.apache.spark.rdd.RDD$$anonfun$partitions$2.apply(RDD.scala:251)
  at scala.Option.getOrElse(Option.scala:121)
  at org.apache.spark.rdd.RDD.partitions(RDD.scala:251)
  at org.apache.spark.SparkContext.runJob(SparkContext.scala:2137)
  at org.apache.spark.rdd.RDD$$anonfun$reduce$1.apply(RDD.scala:1035)
  at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:151)
  at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOperationScope.scala:112)
  at org.apache.spark.rdd.RDD.withScope(RDD.scala:363)
  at org.apache.spark.rdd.RDD.reduce(RDD.scala:1017)
  ... 49 elided

scala>
```

Figure 6-11

Step 9 Perform persistence operations.

The following is an example of calculating the same RDD for multiple times:

```
scala> val   list = List("Hadoop","Spark","Hive")
list: List[String] = List(Hadoop, Spark, Hive)
scala> val   rdd = sc.parallelize(list)
rdd: org.apache.spark.rdd.RDD[String] = ParallelCollectionRDD[22] at parallelize at <console>:29
scala> println(rdd.count())
//Action operation, which triggers a real start-to-end calculation.
3
scala> println(rdd.collect().mkString(","))
//Action operation, which triggers a real start-to-end calculation.
Hadoop,Spark,Hive
```

After the preceding instance is added, the execution process after a persistence statement is added is as follows:

```
scala> val   list = List("Hadoop","Spark","Hive")
list: List[String] = List(Hadoop, Spark, Hive)
scala> val   rdd = sc.parallelize(list)
rdd: org.apache.spark.rdd.RDD[String] = ParallelCollectionRDD[22] at parallelize at <console>:29
scala> rdd.cache()
```

```
//Persist(MEMORY_ONLY) is called. However, when the statement is executed, the RDD is not cached because the RDD has not been calculated and generated.
scala> println(rdd.count())
//The first action triggers a real start-to-end calculation. In this case, the preceding rdd.cache() is executed and the RDD is stored in the cache.
3
scala> println(rdd.collect().mkString(","))
//The second action does not need to trigger a start-to-end calculation. Only the RDD in the cache needs to be reused.
Hadoop,Spark,Hive
```

6.3.3 (Optional) Task 3: RDD Code Programming — Java Programming

Step 1 Understand the scenario.

Same as the MapReduce exercise background, this exercise requires you to calculate the TP.

Develop a Spark application to perform the following operations on logs about the TP of netizens for online shopping on a weekend:

1. Collect statistics on female netizens whose TP for online shopping is more than 2 hours on the weekend.
2. The first column in the log file records names, the second column records gender, and the third column records the TP in the unit of minute. Three columns are separated by comma (,).

log1.txt: logs collected on Saturday.

```
LiuYang,female,20
YuanJing,male,10
GuoYijun,male,5
CaiXuyu,female,50
Liyuan,male,20
FangBo,female,50
LiuYang,female,20
YuanJing,male,10
GuoYijun,male,50
CaiXuyu,female,50
FangBo,female,60
```

log2.txt: logs collected on Sunday.

```
LiuYang,female,20
YuanJing,male,10
CaiXuyu,female,50
FangBo,female,50
GuoYijun,male,5
CaiXuyu,female,50
Liyuan,male,20
CaiXuyu,female,50
FangBo,female,50
```

```
LiuYang,female,20
YuanJing,male,10
FangBo,female,50
GuoYijun,male,50
CaiXuyu,female,50
FangBo,female,60
```

Step 2 Plan data.

Upload two Internet access log files to the **/user/stu01/input** directory of the HDFS. If the log files already exist, you do not need to upload it.

Step 3 Start a Spark sample project.

Based on the MRS 2.0 sample project imported during environment installation, start the **FemaleInfoCollection** project, which is the Spark Core project. The folder in the MRS 2.0 sample project package is **SparkJavaExample**.

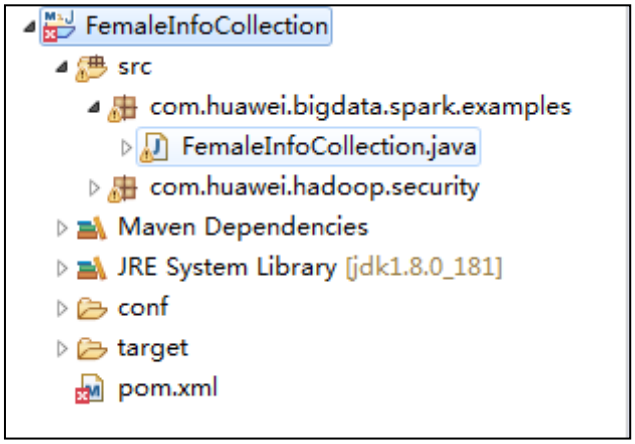


Figure 6-12

Step 4 Package the project.

Open the cmd window, go to the directory where the project is located, and run the **mvn package** command to package the project.

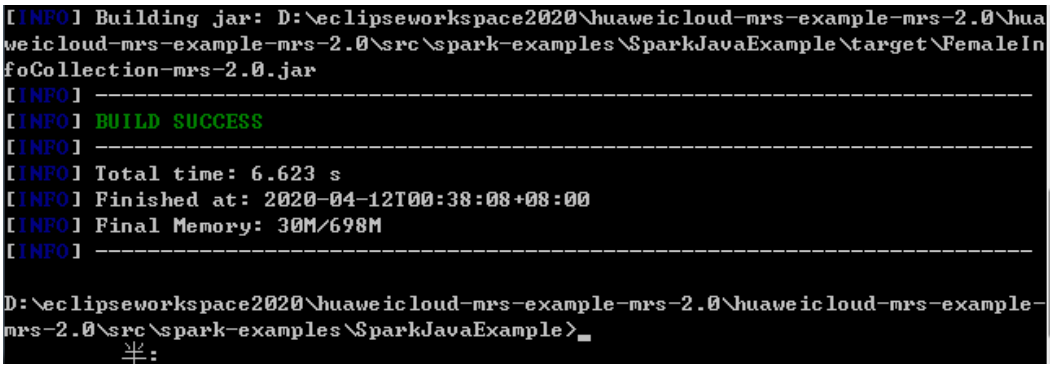


Figure 6-13

Step 5 Use WinSCP to log in to an ECS.

Upload the JAR package to the **/root** directory.

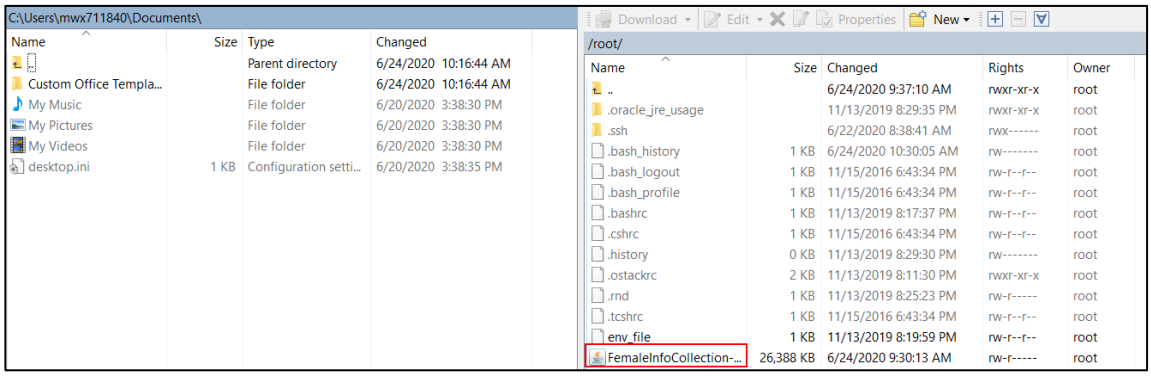


Figure 6-14

Step 6 Use PuTTY to log in to the ECS and run the Spark program.

Run the **source /opt/client/bigdata_env** command.

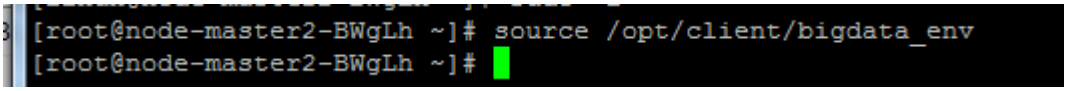


Figure 6-15

Execute the Spark program.

```
/opt/client/Spark/spark/bin/spark-submit --class
com.huawei.bigdata.spark.examples.FemaleInfoCollection --master yarn --deploy-mode client
/root/FemaleInfoCollection-mrs-2.0.jar /user/stu01/input
```

```
gInfo(Logging.scala:54)
2020-04-12 00:50:52,546 | INFO  | dispatcher-event-loop-7 | Starting task 2.0 in stage 1
.apache.spark.internal.Logging$class.logInfo(Logging.scala:54)
2020-04-12 00:50:52,551 | INFO  | task-result-getter-3 | Finished task 1.0 in stage 1.0
l.Logging$class.logInfo(Logging.scala:54)
2020-04-12 00:50:52,567 | INFO  | task-result-getter-0 | Finished task 0.0 in stage 1.0
l.Logging$class.logInfo(Logging.scala:54)
2020-04-12 00:50:52,570 | INFO  | task-result-getter-1 | Finished task 2.0 in stage 1.0
.Logging$class.logInfo(Logging.scala:54)
2020-04-12 00:50:52,570 | INFO  | task-result-getter-1 | Removed TaskSet 1.0, whose task
ogging.scala:54)
2020-04-12 00:50:52,571 | INFO  | dag-scheduler-event-loop | ResultStage 1 (collect at F
g$class.logInfo(Logging.scala:54)
2020-04-12 00:50:52,578 | INFO  | main | Job 0 finished: collect at FemaleInfoCollection
.scala:54)
CaiXuyu,300
FangBo,320
2020-04-12 00:50:52,592 | INFO  | main | Stopped Spark web UI at http://node-master1dCrC
2020-04-12 00:50:52,625 | INFO  | Yarn application state monitor | Interrupting monitor
2020-04-12 00:50:52,647 | INFO  | main | Shutting down all executors | org.apache.spark.
2020-04-12 00:50:52,648 | INFO  | dispatcher-event-loop-0 | Asking each executor to shut
2020-04-12 00:50:52,659 | INFO  | main | Stopping SchedulerExtensionServices
(serviceOption=None,
 services=List(),
 started=false) | org.apache.spark.internal.Logging$class.logInfo(Logging.scala:54)
2020-04-12 00:50:52,660 | INFO  | main | Stopped | org.apache.spark.internal.Logging$cla
2020-04-12 00:50:52,664 | INFO  | dispatcher-event-loop-1 | MapOutputTrackerMasterEndpoi
2020-04-12 00:50:52,693 | INFO  | main | MemoryStore cleared | org.apache.spark.internal
2020-04-12 00:50:52,694 | INFO  | main | BlockManager stopped | org.apache.spark.interna
2020-04-12 00:50:52,702 | INFO  | main | BlockManagerMaster stopped | org.apache.spark.i
2020-04-12 00:50:52,705 | INFO  | dispatcher-event-loop-1 | OutputCommitCoordinator stop
2020-04-12 00:50:52,734 | INFO  | main | Successfully stopped SparkContext | org.apache.
2020-04-12 00:50:53,738 | INFO  | pool-1-thread-1 | Shutdown hook called | org.apache.sp
2020-04-12 00:50:53,740 | INFO  | pool-1-thread-1 | Deleting directory /tmp/spark-71e36c
ging.scala:54)
2020-04-12 00:50:53,740 | INFO  | pool-1-thread-1 | Deleting directory /tmp/spark-583704
ging.scala:54)
[root@node-master1dCrC spark]#
```

Figure 6-16

The total TP of the two persons exceeds 2 hours.

6.3.4 Task 4: Spark SQL DataFrame Programming

In versions earlier than Spark 2.0, SQLContext in Spark SQL is the entry for creating DataFrames and executing SQL statements. You can use HiveContext to operate Hive table data through Hive SQL statements. HiveContext is compatible with Hive operations and is inherited from SQLContext. In versions later than Spark 2.0, all these functions are integrated into SparkSession. SparkSession encapsulates SparkContext and SQLContext. You can obtain SparkConetxt and SQLContext objects through SparkSession.

```
Spark context Web UI available at http://node-master1jhOP:22615
Spark context available as 'sc' (master = local[*], app id = local-1586920279462).
Spark session available as 'spark'.
Welcome to
      ____              __
     / __/__  ___ _____/ /__
    _\ \/ _ \/ _ `/ __/  '_/
   /___/ .__/\_,_/_/ /_/\_\   version 2.3.2-mrs-2.0
      /_/

Using Scala version 2.11.8 (OpenJDK 64-Bit Server VM, Java 1.8.0_212)
Type in expressions to have them evaluated.
Type :help for more information.
```

Figure 6-17

Step 1 Edit a data file.

Create the **cx_person.txt** file on the local Linux host. The file contains three columns: id, name, and age. The three columns are separated by space. The content of the **cx_person.txt** file is as follows:

```
1 zhangsan 20
2 lisi 29
3 wangwu 25
4 zhaoliu 30
5 tianqi 35
6 kobe 40
```

Step 2 Upload the data file to a directory in the HDFS.

```
hdfs dfs -put cx_person.txt  /
```

```
[root@node-master1jhOP ~]# vi cx_person.txt
[root@node-master1jhOP ~]# hdfs dfs -put cx_person.txt  /
2020-04-15 11:08:57,886 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
[root@node-master1jhOP ~]# hdfs dfs -ls  /
2020-04-15 11:09:09,512 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear re
source.
Found 12 items
drwxrwxrwx   - hdfs   hadoop            0 2020-04-15 10:09 /app-logs
drwxrwxrwx   - hive   hive              0 2020-04-15 10:12 /apps
drwxrwxrwx   - hdfs   hadoop            0 2020-04-15 10:09 /ats
-rw-r--r--   1 root   ficommon         72 2020-04-15 11:08 /cx_person.txt
drwxr-xr-x   - hdfs   hadoop            0 2020-04-15 10:09 /datasets
drwxr-xr-x   - hdfs   hadoop            0 2020-04-15 10:09 /datastore
drwxrwxrwx   - flink  hadoop            0 2020-04-15 10:10 /flink
drwxr-xr-x   - hbase  hadoop            0 2020-04-15 10:11 /hbase
drwxrwxrwx   - mapred hadoop            0 2020-04-15 10:09 /mr-history
drwxrwxrwt   - spark  hadoop            0 2020-04-15 10:14 /sparkJobHistory
drwxrwxrwx   - hdfs   hadoop            0 2020-04-15 10:14 /tmp
drwxrwxrwx   - hdfs   hadoop            0 2020-04-15 10:13 /user
[root@node-master1jhOP ~]#
```

Figure 6-18

Run the **spark-shell** command to go to Spark. Then run the following command to read data and separate data in each row using column separators:

```
val lineRDD= sc.textFile("/cx_person.txt").map(_.split(" "))
```

```
scala> val lineRDD= sc.textFile("/cx_person.txt").map(_.split(" "))
lineRDD: org.apache.spark.rdd.RDD[Array[String]] = MapPartitionsRDD[2] at map at <console>:2
4

scala>
```

Figure 6-19

Step 3 Define a case class.

A class is equivalent to a schema of a table.

```
case class Person(id:Int, name:String, age:Int)
```

```
scala> case class Person(id:Int, name:String, age:Int)
defined class Person

scala>
```

Figure 6-20

Step 4 Associate an RDD with the case class.

```
val personRDD = lineRDD.map(x => Person(x(0).toInt, x(1), x(2).toInt))
```

```
scala> val personRDD = lineRDD.map(x => Person(x(0).toInt, x(1), x(2).toInt))
personRDD: org.apache.spark.rdd.RDD[Person] = MapPartitionsRDD[3] at map at <console>:27

scala>
```

Figure 6-21

Step 5 Transform the RDD into DataFrame.

```
val personDF = personRDD.toDF
```

```
scala> val personDF = personRDD.toDF
personDF: org.apache.spark.sql.DataFrame = [id: int, name: string ... 1 more field]

scala>
```

Figure 6-22

Step 6 View information about DataFrame.

```
personDF.show
```

```
scala> personDF.show
+---+--------+---+
| id|    name|age|
+---+--------+---+
|  1|zhangsan| 20|
|  2|    lisi| 29|
|  3|  wungwu| 25|
|  4| zhaoliu| 20|
|  5|  tianqi| 35|
|  6|   sunba| 40|
+---+--------+---+
```

Figure 6-23

```
personDF.printSchema
```

```
scala> personDF.printSchema
root
 |-- id: integer (nullable = true)
 |-- name: string (nullable = true)
 |-- age: integer (nullable = true)
```

Figure 6-24

Step 7 Use the domain-specific language (DSL).

DataFrame provides the DSL to operate structured data.

View the data of the **name** field.

```
personDF.select(personDF.col("name")).show
```

```
scala> personDF.select(personDF.col("name")).show
+--------+
|    name|
+--------+
|zhangsan|
|    lisi|
|  wangwu|
| zhaoliu|
|  tianqi|
|    kobe|
+--------+
```

Figure 6-25

Check another format of the **name** field.

```
personDF.select("name").show
```

```
scala> personDF.select("name").show
+--------+
|    name|
+--------+
|zhangsan|
|    lisi|
|  wungwu|
| zhaoliu|
|  tianqi|
|   sunba|
+--------+


scala>
```

Figure 6-26

Step 8 Check the data of the **name** and **age** fields.

```
personDF.select(col("name"), col("age")).show
```

```
scala> personDF.select(col("name"), col("age")).show
+--------+---+
|    name|age|
+--------+---+
|zhangsan| 20|
|    lisi| 29|
|  wungwu| 25|
| zhaoliu| 20|
|  tianqi| 35|
|   sunba| 40|
+--------+---+


scala>
```

Figure 6-27

Step 9 Query all names and ages and increase the value of **age** by 1.

```
personDF.select(col("id"), col("name"), col("age") + 1).show
```

```
scala> personDF.select(col("id"), col("name"), col("age") + 1).show
+---+--------+---------+
| id|    name|(age + 1)|
+---+--------+---------+
|  1|zhangsan|       21|
|  2|    lisi|       30|
|  3|  wungwu|       26|
|  4| zhaoliu|       21|
|  5|  tianqi|       36|
|  6|   sunba|       41|
+---+--------+---------+
```

Figure 6-28

You can also perform the following operation:

```
personDF.select(personDF("id"), personDF("name"), personDF("age") + 1).show
```

Step 10 Use the **filter** method to filter the records where **age** is greater than or equal to 25.

```
personDF.filter(col("age") >= 25).show
```

```
scala> personDF.filter(col("age") >= 25).show
+---+------+---+
| id|  name|age|
+---+------+---+
|  2|  lisi| 29|
|  3|wungwu| 25|
|  5|tianqi| 35|
|  6| sunba| 40|
+---+------+---+
```

Figure 6-29

Step 11 Count the number of people who are older than 30.

```
personDF.filter(col("age")>30).count()
```

```
scala> personDF.filter(col("age")>30).count()
res10: Long = 2
```

Figure 6-30

Step 12 Group people by age and collect statistics on the number of people of the same age.

```
personDF.groupBy("age").count().show
```

```
scala> personDF.groupBy("age").count().show
+---+-----+
|age|count|
+---+-----+
| 20|    2|
| 40|    1|
| 35|    1|
| 25|    1|
| 29|    1|
+---+-----+
```

Figure 6-31

Step 13 Use SQL.

A powerful feature of DataFrame is that it can be regarded as a relational data table. You can use **spark.sql()** in the program to execute SQL statements for query. The result is returned as a DataFrame.

If the SQL is used, you need to register DataFrame as a table in the following way:

```
personDF.registerTempTable("cx_t_person")
```

Run the following command to display the schema information of the table:

```
spark.sql("desc cx_t_person ").show
```

```
scala> spark.sql("desc cx_t_person ").show
+--------+---------+-------+
|col_name|data_type|comment|
+--------+---------+-------+
|      id|      int|   null|
|    name|   string|   null|
|     age|      int|   null|
+--------+---------+-------+
```

Figure 6-32

Step 14 Query the two oldest people.

```
spark.sql("select * from    cx_t_person    order by age desc limit 2").show
```

```
scala> spark.sql("select * from  cx_t_person  order by age desc limit 2").show
+---+------+---+
| id|  name|age|
+---+------+---+
|  6| sunba| 40|
|  5|tianqi| 35|
+---+------+---+
```

Figure 6-33

Step 15 Query information about people older than 30.

```
spark.sql("select * from cx_t_person where age > 30 ").show
```

```
scala> spark.sql("select * from cx_t_person where age > 30 ").show
+---+------+---+
| id|  name|age|
+---+------+---+
|  5|tianqi| 35|
|  6| sunba| 40|
+---+------+---+
```

Figure 6-34

6.3.5 Task 5: Spark SQL DataSet Programming

Step 1 Create a dataset using **spark.createDataset**.

```
val ds1 = spark.createDataset(1 to 5)
ds1.show
```

```
scala> val ds1 = spark.createDataset(1 to 5)
ds1: org.apache.spark.sql.Dataset[Int] = [value: int]

scala> ds1.show
+-----+
|value|
+-----+
|    1|
|    2|
|    3|
|    4|
|    5|
+-----+
```

Figure 6-35

Step 2 Create a dataset using a file.

```
val ds2 = spark.createDataset(sc.textFile("/cx_person.txt"))
ds2.show
```

```
scala> val ds2 = spark.createDataset(sc.textFile("/person.txt"))
ds2: org.apache.spark.sql.Dataset[String] = [value: string]

scala> ds2.show
+-------------+
|        value|
+-------------+
|1 zhangsan 20|
|    2 lisi 29|
|  3 wangwu 25|
| 4 zhaoliu 30|
|  5 tianqi 35|
|    6 kobe 40|
+-------------+
```

Figure 6-36

Step 3 Create a dataset using the **toDS** method.

```
case class Person2(id:Int, name:String, age:Int)
val data = List(Person2(1001,"liubei",20),Person2(1002,"guanyu",30))
val ds3 = data.toDS
ds3.show
```

```
scala> case class Person2(id:Int, name:String, age:Int)
defined class Person2

scala> val data = List(Person2(1001,"liubei",20),Person2(1002,"guanyu",30))
data: List[Person2] = List(Person2(1001,liubei,20), Person2(1002,guanyu,30))

scala> val ds3 = data.toDS
ds3: org.apache.spark.sql.Dataset[Person2] = [id: int, name: string ... 1 more field]

scala> ds3.show
+----+------+---+
|  id|  name|age|
+----+------+---+
|1001|liubei| 20|
|1002|guanyu| 30|
+----+------+---+
```

Figure 6-37

Step 4 Create a database using DataFrame and as[Type].

Perform transformation based on the DataFrame of personDF in task 1. Note that the **person** object fields in Person2 and personDF must be the same.

```
val ds4= personDF.as[Person2]
ds4.show
```

```
scala> val ds4= personDF.as[Person2]
ds4: org.apache.spark.sql.Dataset[Person2] = [id: int, name: string ... 1 more field]

scala> ds4.show
+---+--------+---+
| id|    name|age|
+---+--------+---+
|  1|zhangsan| 20|
|  2|    lisi| 29|
|  3|  wungwu| 25|
|  4| zhaoliu| 20|
|  5|  tianqi| 35|
|  6|   sunba| 40|
+---+--------+---+
```

Figure 6-38

Step 5 Collect statistics on the number of people older than 30 in the dataset.

```
ds4.filter(col("age") >= 25).show
```

```
scala> ds4.filter(col("age") >= 25).show
+---+------+---+
| id|  name|age|
+---+------+---+
|  2|  lisi| 29|
|  3|wungwu| 25|
|  5|tianqi| 35|
|  6| sunba| 40|
+---+------+---+
```

Figure 6-39

6.4 Summary

This exercise introduces RDD-based Spark Core programming and DataFrame- and DataSet-based Spark SQL programming, and enables trainees to understand the basic operations of Spark programming.

7 Flink Real-Time Processing System Practice

7.1 Background

Flink is a unified computing framework that supports both batch processing and stream processing. It provides a stream data processing engine that supports data distribution and parallel computing.

Flink provides high-concurrency pipeline data processing, millisecond-level latency, and high reliability, making it extremely suitable for low-latency data processing.

7.2 Objectives

The asynchronous CheckPoint mechanism and real-time hot-selling product statistics of Flink help you understand the core ideas of Flink and how to use Flink to solve problems.

7.3 Tasks

7.3.1 Task 1: Importing a Flink Sample Project

Step 1 Download Flink sample code.

Visit https://support.huaweicloud.com/en-us/devg-mrs/mrs_06_0002.html#mrs_06_0002__section336726849219.

Click the sample project of HUAWEI CLOUD MRS 1.8 for download.

Figure 7-1

Step 2 Import the sample project.

For details about how to import the MRS sample project, navigate to the Appendix to refer to the instructions on how to import an MRS sample project in Eclipse. After the import, the project automatically downloads related dependency packages.

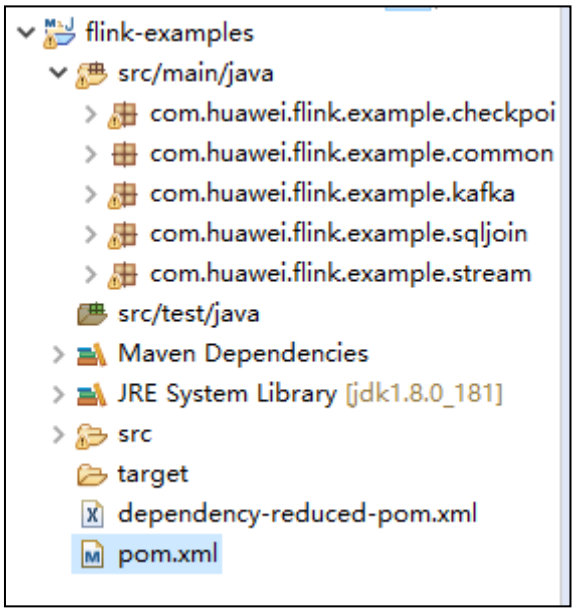


Figure 7-2

The preceding figure shows the project code structure.

7.3.2 Task 2: Exercising the Asynchronous CheckPoint Mechanism

Assume that you want to collect data volume in a 4-second time window every other second and the status of operators must be strictly consistent. That is, if an application recovers from a failure, the status of all operators must the same.

7.3.2.1 Data Planning

1. A custom operator generates about 10,000 pieces of data per second.
2. The generated data is a quadruple (Long, String, String, Integer).
3. After the statistics are collected, the statistical result is displayed on the terminal.
4. The output data is of the Long type.

7.3.2.2 Exercise Process

1. The source operator sends 10,000 pieces of data every second and injects the data into the window operator.
2. The window operator calculates the data generated in the last 4 seconds every second.
3. The statistical result is displayed on the terminal every second.
4. A checkpoint is triggered every 6 seconds and saved to the HDFS.

7.3.2.3 Procedure

Step 1 Write the snapshot data code.

The snapshot data is used to store the number of data pieces recorded by operators during snapshot creation.

Create a class named **UDFState** in the **com.huawei.flink.example.common** package of the sample project. The code is as follows:

```
import java.io.Seriablizale;
// This class is part of the snapshot and is used to save UDFState.
public class UDFState implements Serializable {
    private long count;
    // Initialize UDFState.
    public UDFState() {
        count = 0L;
    }
    // Set UDFState.
    public void setState(long count) {
        this.count = count;
    }
    // Obtain UDFState.
    public long geState() {
        return this.count;
    }
}
```

Step 2 Compile a data source with a checkpoint.

The code snippet of a source operator pauses 1 second every time after sending 10,000 pieces of data. When a snapshot is created, the code saves the total number of sent data pieces in UDFState. When the snapshot is used for restoration, the number of sent data pieces saved in UDFState is read and assigned to the count variable.

Create the SimpleSourceWithCheckPoint class in the common package. The code is as follows:

```
import org.apache.flink.api.java.tuple.Tuple4;
import org.apache.flink.streaming.api.checkpoint.ListCheckpointed;
import org.apache.flink.streaming.api.functions.source.SourceFunction;

import java.util.ArrayList;
import java.util.List;
import java.util.Random;

public class SimpleSourceWithCheckPoint implements SourceFunction<Tuple4<Long, String, String,
Integer>>, ListCheckpointed<UDFState> {

    private long count = 0;
    private boolean isRunning = true;
    private String alphabet = "justtest";

    @Override
    public List<UDFState> snapshotState(long l, long l1) throws Exception
    {
        UDFState udfState = new UDFState();
        List<UDFState> udfStateList = new ArrayList<UDFState>();
        udfState.setState(count);
```

```
            udfStateList.add(udfState);
            return udfStateList;
        }

        @Override
        public void restoreState(List<UDFState> list) throws Exception
        {
            UDFState udfState = list.get(0);
            count = udfState.geState();
        }

        @Override
        public void run(SourceContext<Tuple4<Long, String, String, Integer>> sourceContext) throws
Exception
        {
            Random random = new Random();
            while (isRunning) {
                for (int i = 0; i < 10000; i++) {
                    sourceContext.collect(Tuple4.of(random.nextLong(), "hello" + count, alphabet, 1));
                    count ++;
                }
                Thread.sleep(1000);
            }
        }

        @Override
        public void cancel()
        {
            isRunning = false;
        }
}
```

Step 3 Define a window with a checkpoint.

This code snippet is about a window operator and is used to calculate the number or tuples in the window.

Create the WindowStatisticWithChk class in the common package. The code is as follows:

```
import org.apache.flink.api.java.tuple.Tuple;
import org.apache.flink.api.java.tuple.Tuple4;
import org.apache.flink.streaming.api.checkpoint.ListCheckpointed;
import org.apache.flink.streaming.api.functions.windowing.WindowFunction;
import org.apache.flink.streaming.api.windowing.windows.TimeWindow;
import org.apache.flink.util.Collector;

import java.util.ArrayList;
import java.util.List;

public class WindowStatisticWithChk implements WindowFunction<Tuple4<Long, String, String,
Integer>, Long, Tuple, TimeWindow>, ListCheckpointed<UDFState> {

    private long total = 0;

    @Override
```

```
    public List<UDFState> snapshotState(long l, long l1) throws Exception
    {
        UDFState udfState = new UDFState();
        List<UDFState> list = new ArrayList<UDFState>();
        udfState.setState(total);
        list.add(udfState);
        return list;
    }

    @Override
    public void restoreState(List<UDFState> list) throws Exception
    {
        UDFState udfState = list.get(0);
        total = udfState.geState();
    }
    @Override
    public void apply(Tuple tuple, TimeWindow timeWindow, Iterable<Tuple4<Long, String, String,
Integer>> iterable, Collector<Long> collector) throws Exception
    {
        long count = 0L;
        for (Tuple4<Long, String, String, Integer> tuple4 : iterable) {
            count ++;
        }
        total += count;
        collector.collect(total);
    }
}
```

Step 4 Develop application code.

The code is about the definition of StreamGraph and is used to implement services. The processing time is used as the time for triggering the window.

Create the FlinkProcessingTimeAPIChkMain class in the common package. The code is as follows:

```
import org.apache.flink.api.java.utils.ParameterTool;
import org.apache.flink.runtime.state.StateBackend;
import org.apache.flink.runtime.state.filesystem.FsStateBackend;
import org.apache.flink.streaming.api.CheckpointingMode;
import org.apache.flink.streaming.api.environment.StreamExecutionEnvironment;
import org.apache.flink.streaming.api.windowing.assigners.SlidingProcessingTimeWindows;
import org.apache.flink.streaming.api.windowing.time.Time;
public class FlinkProcessingTimeAPIChkMain {
    public static void main(String[] args) throws Exception
    {
        String chkPath = ParameterTool.fromArgs(args).get("chkPath",
"hdfs://hacluster/flink/checkpoints/");
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();

        env.setStateBackend((StateBackend) new FsStateBackend((chkPath)));
        env.enableCheckpointing(6000, CheckpointingMode.EXACTLY_ONCE);
        env.addSource(new SimpleSourceWithCheckPoint())
                .keyBy(0)
```

```
                .window(SlidingProcessingTimeWindows.of(Time.seconds(4), Time.seconds(1)))
                .apply(new WindowStatisticWithChk())
                .print();

        env.execute();
    }
}
```

The code is compiled.

Step 5 Package the program.

Open the cmd window, go to the directory where the project is located, and run the **mvn package** command to package the project.

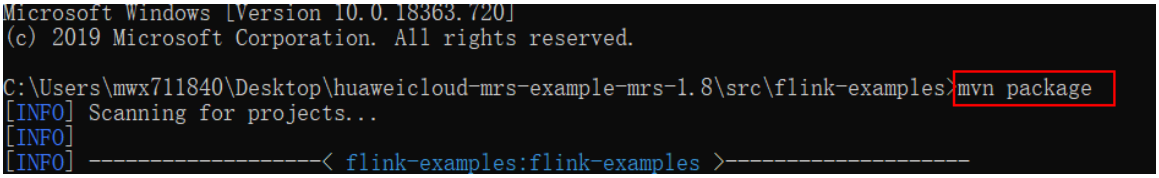


Figure 7-3

Run the **mvn package** command to generate a JAR package and obtain it from the target directory in the project directory, for example, **mapreduce-examples-mrs-2.0.jar**.

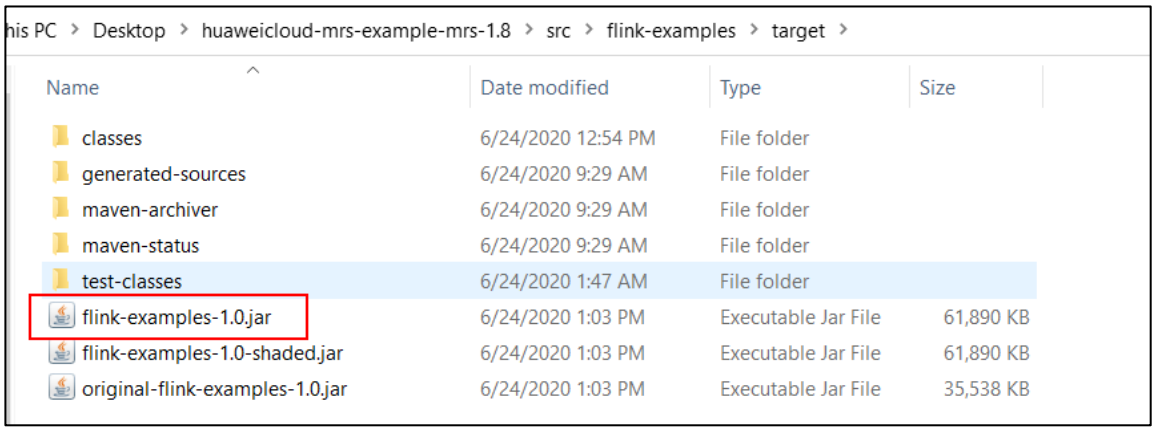


Figure 7-4

Step 6 Use WinSCP to log in to an ECS.

Upload the JAR package to the **/root** directory.

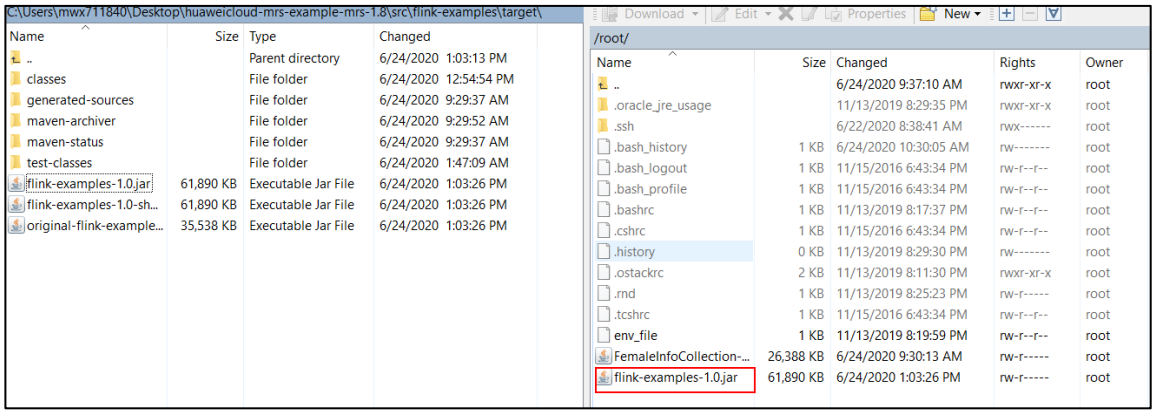


Figure 7-5

Step 7 Start the Flink cluster.

Use PuTTY to log in to the ECS and run the **source /opt/client/bigdata_env** command.

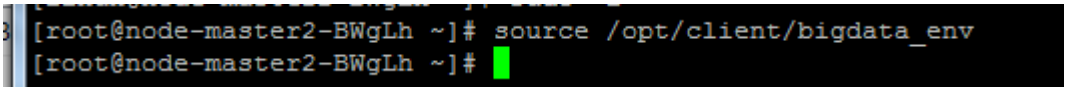


Figure 7-6

Start the Flink cluster before running the Flink applications on Linux. Run the **yarn session** command on the Flink client to start the Flink cluster. The following is a command example:

```
/opt/client/Flink/flink/bin/yarn-session.sh  -n 3  -jm  1024  -tm  1024
```

Note: **yarn-session** starts a running Flink cluster on Yarn. Once the session is successfully created, you can use the bin/flink tool to submit tasks to the cluster. The system uses the **conf/flink-conf.yaml** configuration file by default.

Parameters in the **yarn-session** command:

Mandatory:

```
-n,--container <arg>: number of Yarn containers(= number of taskmanagers)
```

Optional:

```
-D <arg>: dynamic attribute
-d,--detached: independent running
-jm,--jobManagerMemory <arg>: JobManager memory [in MB]
-nm,--name: sets a name for a user-defined application on Yarn.
-q,--query: displays the available resources (memory and the number of CPU cores) on Yarn.
-qu,--queue <arg>: specifies the Yarn queue.
-s,--slots <arg>: number of slots used by each TaskManager
-tm,--taskManagerMemory <arg>: memory of each TaskManager [in MB]
-z,--zookeeperNamespace <arg>: creates a namespace in the ZooKeeper in HA mode.
```

After the command is executed, the following result is displayed:

```
[root@node-master1JRhg ~]# /opt/client/Flink/flink/bin/yarn-session.sh  -n 3  -j
m  1024  -tm  1024
2020-04-16 16:43:56,978 | WARN  | [main] | Unable to load native-hadoop library
for your platform... using builtin-java classes where applicable | org.apache.ha
doop.util.NativeCodeLoader (NativeCodeLoader.java:60)
2020-04-16 16:43:57,000 | WARN  | [main] | The short-circuit local reads feature
 cannot be used because libhadoop cannot be loaded. | org.apache.hadoop.hdfs.sho
rtcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
Flink JobManager is now running on node-ana-corekxim:32586 with leader id 4b602d18-9a
1f-46bd-82e8-a298960861c0.
JobManager Web Interface: http://192.168.0.69:42552
```

Figure 7-7

The IP address of the JobManager web page is an intranet IP address. Log in to MRS Manager, find the server, and bind an EIP to it. For details about how to bind an EIP, see the related operations in the MRS documents. Use the EIP to replace the intranet IP address and access the server. For example, if the bound IP address is 119.3.4.47, the access address is http://119.3.4.47:42552.

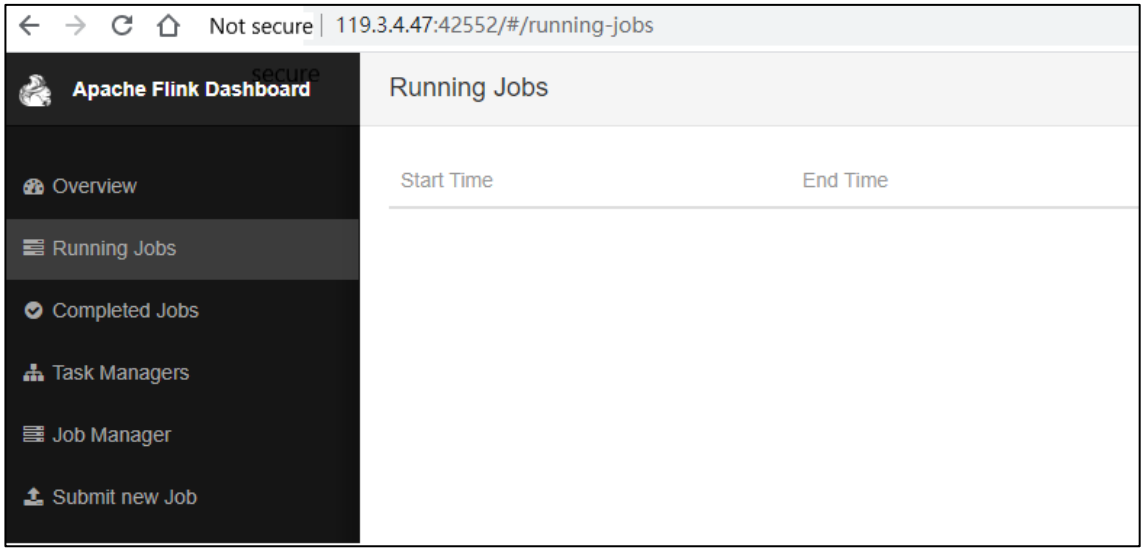


Figure 7-8

Step 8 Run the JAR package of Flink.

Save the checkpoint snapshot information to HDFS

Press **Ctrl+C** to close the cluster command window (the cluster is still running in the background), or start PuTTY and run the following command:

```
/opt/client/Flink/flink/bin/flink  run  --class
com.huawei.flink.example.checkpoint.FlinkProcessingTimeAPIChkMain  /root/flink-examples-1.0.jar
--chkPath  hdfs://hacluster/flink/checkpoints/
```

Parameter description: **class** is followed by the full path of the main program entry class and then the JAR package of the program. **chkPath** is the path for storing the checkpoint file. In cluster mode, Flink stores the checkpoint file in HDFS.

The **run** parameter can be used to compile and run a program.

Usage: run [OPTIONS] <jar-file> <arguments>

Run parameters:

-c,--class <classname>: If the entry class is not specified in the JAR package, this parameter is used to specify the entry class.
-m,--jobmanager <host:port>: specifies the address of the JobManager (active node) to be connected. This parameter can be used to specify a JobManager that is different from that in the configuration file.
-p,--parallelism <parallelism>: specifies the degree of parallelism of a program. The default value in the configuration file can be overwritten.

Execution result:

```
[root@node-master1JRhg ~]# source /opt/client/bigdata_env
[root@node-master1JRhg ~]# /opt/client/Flink/flink/bin/flink run --class com.hua
wei.flink.example.checkpoint.FlinkProcessingTimeAPIChkMain /opt/Flink_test/flink
-examples-1.0.jar --chkPath hdfs://hacluster/flink-checkpoint/
^C[root@node-master1JRhg ~]# /opt/client/Flink/flink/bin/flink run --class com.h
wei.flink.example.checkpoint.FlinkProcessingTimeAPIChkMain /root/flink-examples-
1.0.jar --chkPath hdfs://hacluster/flink-checkpoint/
YARN properties set default parallelism to 9
2020-04-16 12:47:22,625 | WARN  | [main] | The short-circuit local reads feature
 cannot be used because libhadoop cannot be loaded. | org.apache.hadoop.hdfs.sho
rtcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
2020-04-16 12:47:22,625 | WARN  | [main] | The short-circuit local reads feature
 cannot be used because libhadoop cannot be loaded. | org.apache.hadoop.hdfs.sho
rtcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
Starting execution of program
```

Figure 7-9

On the Flink management panel, one more running Flink job is displayed.

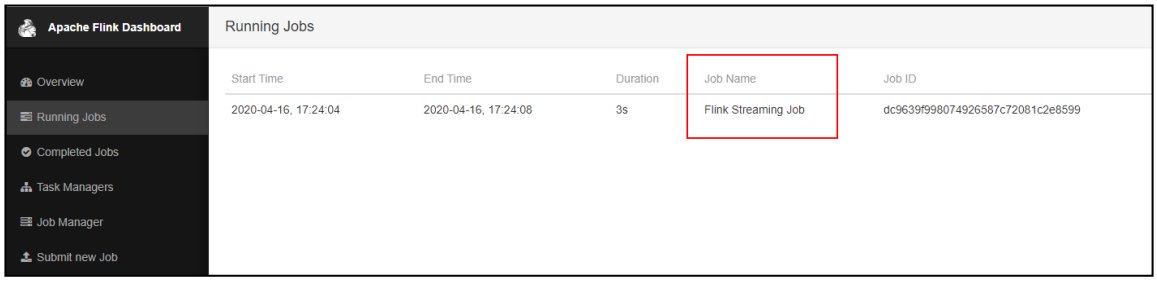


Figure 7-10

Step 9 View the output.

On the **Task Manager** page of the Flink management panel, click **Stdout** to view the output.

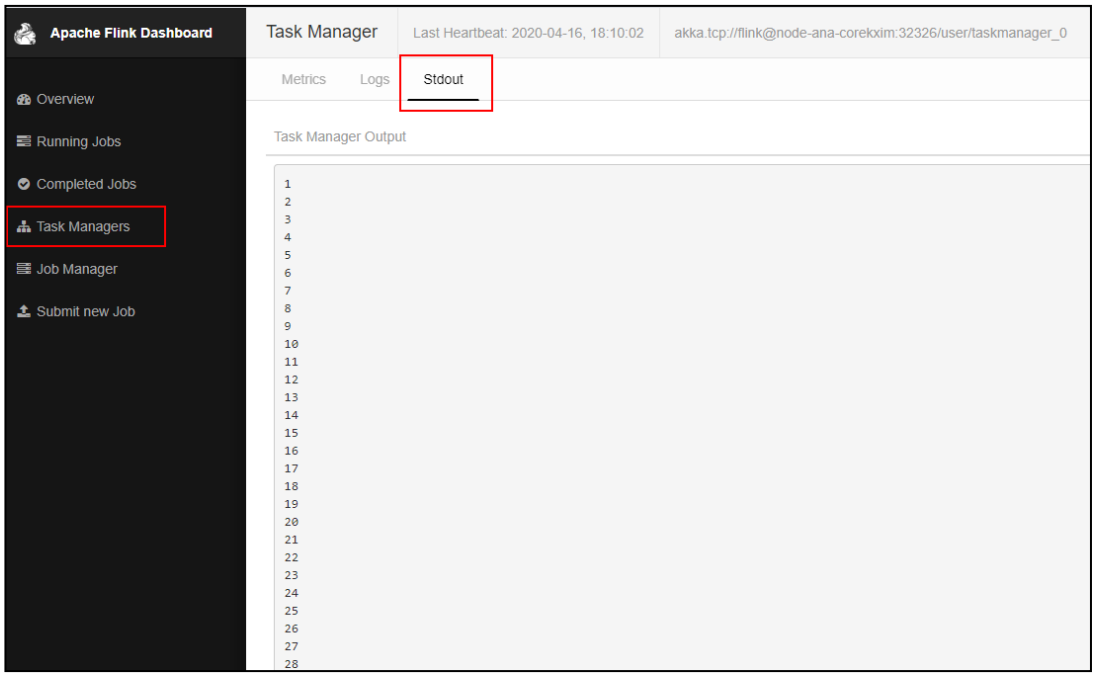


Figure 7-11

Step 10 View checkpoints.

Start PuTTY and run the HDFS command to view the **/flink/checkpoints** directory.

```
[root@node-master1JRhg ~]# hdfs dfs -ls /flink/checkpoints
2020-04-16 18:16:49,765 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 4 items
drwxr-xr-x   - root hadoop          0 2020-04-16 17:21 /flink/checkpoints/86d77ce7fc06776dae2d6c41419216ef
drwxr-xr-x   - root hadoop          0 2020-04-16 18:16 /flink/checkpoints/a83182851598f6632d2a4b55be324f28
drwxr-xr-x   - root hadoop          0 2020-04-16 14:00 /flink/checkpoints/cb16da625337a397af5fe263ba9f1da2
drwxr-xr-x   - root hadoop          0 2020-04-16 17:59 /flink/checkpoints/dc9639f998074926587c72081c2e8599
[root@node-master1JRhg ~]#
```

Figure 7-12

Step 11 Kill a Flink job.

Run the **/opt/client/Flink/flink/bin/flink list** command to view the Flink task list.

```
[root@node-master1JRhg ~]# /opt/client/Flink/flink/bin/flink  list
YARN properties set default parallelism to 9
2020-04-16 17:57:30,119 | WARN  | [main] | The short-circuit local reads feature cannot be used
ortcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
2020-04-16 17:57:30,119 | WARN  | [main] | The short-circuit local reads feature cannot be used
ortcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
Waiting for response...
------------------ Running/Restarting Jobs -------------------
16.04.2020 17:24:04 : dc9639f998074926587c72081c2e8599 : Flink Streaming Job (RUNNING)
--------------------------------------------------------------
No scheduled jobs.
[root@node-master1JRhg ~]#
```

Figure 7-13

Specify the obtained job ID and run the following command to kill the job:

```
/opt/client/Flink/flink/bin/flink  cancel  dc9639f998074926587c72081c2e8599
```

```
[root@node-master1JRhg ~]# /opt/client/Flink/flink/bin/flink  cancel  dc9639f998074926587c72081c2e8599
Cancelling job dc9639f998074926587c72081c2e8599.
YARN properties set default parallelism to 9
2020-04-16 17:59:39,234 | WARN  | [main] | The short-circuit local reads feature cannot be used because libhadoop
ortcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
2020-04-16 17:59:39,234 | WARN  | [main] | The short-circuit local reads feature cannot be used because libhadoop
ortcircuit.DomainSocketFactory (DomainSocketFactory.java:116)
Cancelled job dc9639f998074926587c72081c2e8599.
[root@node-master1JRhg ~]#
```

Figure 7-14

7.3.3 Task 3: Obtaining Top N Hot-Selling Offerings in Flink in Real Time

This exercise illustrates how to develop a complex Flink application for obtaining best-selling offerings in real time.

7.3.3.1 Tasks

1. How is data processed based on EventTime and how is Watermark specified?
2. How are Window APIs with flexible Flink used?
3. When and how is State used?
4. How is ProcessFunction used to Implement the TopN function?

7.3.3.2 Exercise Process

1. Extract the service timestamp and enable the Flink framework to create a window based on the service time.
2. Filter click behavior data.
3. Collect statistics on the size of the sliding window every five minutes and aggregate the sliding windows.
4. Aggregate by window and output the top *N* offerings with the most clicks in each window.

7.3.3.3 Procedure

Step 1 Prepare a Flink project.

Import the Flink sample project.

Create the **com.huawei.flink.example.goods** package in **src/main/java**.

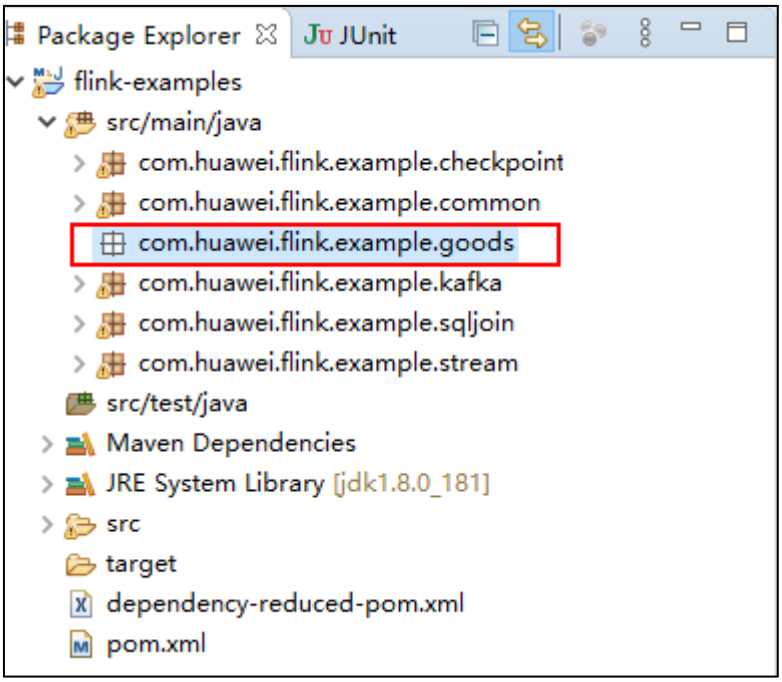


Figure 7-15

Step 2 Prepare data.

Data file attached to the exercise manual: UserBehavior.csv

This dataset contains all operation data (including click, purchase, add-on, and favorites) of one million users at random on e-commerce websites every day. Each row in the dataset indicates a user behavior, consists of the user ID, offering ID, offering category ID, behavior type, and timestamp, and is separated by comma (,). Each column in the dataset is described as follows:

Table 7-1

Column	Description
User ID (integer type)	Encrypted user ID
Offering ID (integer type)	Encrypted offering ID
Offering category ID (integer type)	ID of the category to which an encrypted offering belongs
Behavior type (enumeration type)	Character string, including **pv**, **buy**, **cart**, and **fav**
Timestamp	Timestamp when a behavior occurs, in seconds

Create the **resources** folder in the **src/main** directory of the project and save the data file to the folder.

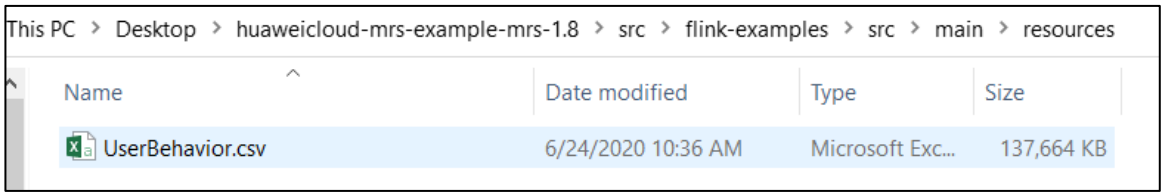


Figure 7-16

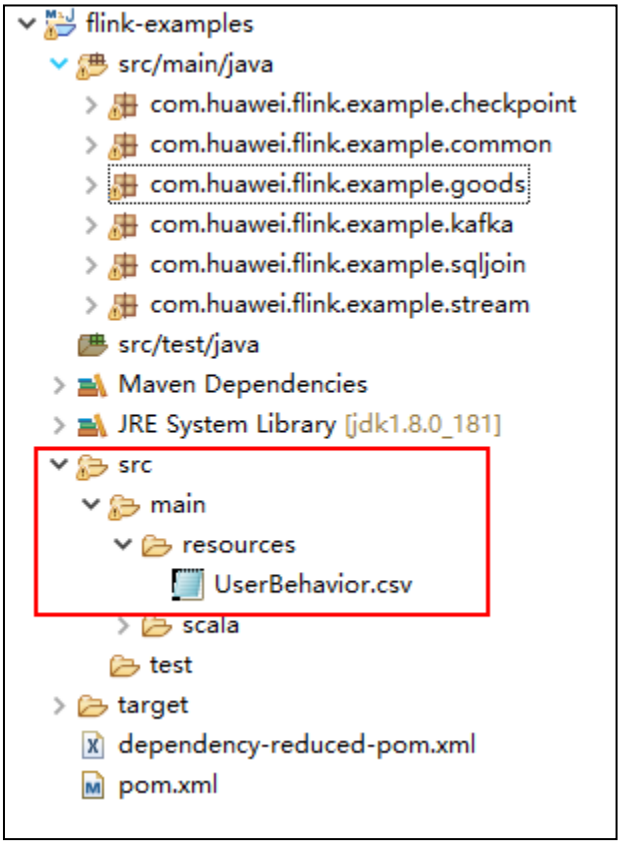


Figure 7-17

The preceding figure shows the project directory.

Step 3 Compile the HotGoods.Java class.

Create the HotGoods class in the **goods** package. The code is as follows:

```
package com.huawei.flink.example.goods;

import java.io.File;
import java.net.URL;
import java.sql.Timestamp;
import java.util.ArrayList;
import java.util.Comparator;
import java.util.List;

import org.apache.flink.api.common.functions.AggregateFunction;
import org.apache.flink.api.common.functions.FilterFunction;
import org.apache.flink.api.common.state.ListState;
```

```
import org.apache.flink.api.common.state.ListStateDescriptor;
import org.apache.flink.api.java.io.PojoCsvInputFormat;
import org.apache.flink.api.java.tuple.Tuple;
import org.apache.flink.api.java.tuple.Tuple1;
import org.apache.flink.api.java.typeutils.PojoTypeInfo;
import org.apache.flink.api.java.typeutils.TypeExtractor;
import org.apache.flink.configuration.Configuration;
import org.apache.flink.core.fs.Path;
import org.apache.flink.streaming.api.TimeCharacteristic;
import org.apache.flink.streaming.api.environment.StreamExecutionEnvironment;
import org.apache.flink.streaming.api.functions.KeyedProcessFunction;
import org.apache.flink.streaming.api.functions.timestamps.AscendingTimestampExtractor;
import org.apache.flink.streaming.api.functions.windowing.WindowFunction;
import org.apache.flink.streaming.api.windowing.time.Time;
import org.apache.flink.streaming.api.windowing.windows.TimeWindow;
import org.apache.flink.util.Collector;

public class HotGoods {

public static void main(String[] args) throws Exception {

        // Step 1 Create the execution environment.
        StreamExecutionEnvironment env = StreamExecutionEnvironment.getExecutionEnvironment();
        // Start processing based on EventTime.
        env.setStreamTimeCharacteristic(TimeCharacteristic.EventTime);
        // To keep the results shown on the console in order, configure concurrency as 1. Changing the
concurrency value does not affect the result accuracy.
        env.setParallelism(1);

        // The /root directory in the Linux file system of UserBehavior.csv
        URL fileUrl = HotGoods.class.getClassLoader().getResource("/root/UserBehavior.csv");
        Path filePath = Path.fromLocalFile(new File(fileUrl.toURI()));
        // To extract TypeInformation of UserBehavior, which is PojoTypeInfo
        PojoTypeInfo<UserBehavior> pojoType = (PojoTypeInfo<UserBehavior>)
TypeExtractor.createTypeInfo(UserBehavior.class);
        // To show the sequence of the fields in a specified file because the sequence of fields extracted
by Java is uncertain
        String[] fieldOrder = new String[]{"userId", "itemId", "categoryId", "behavior", "timestamp"};
        // To create PojoCsvInputFormat
        PojoCsvInputFormat<UserBehavior> csvInput = new PojoCsvInputFormat<>(filePath, pojoType,
fieldOrder);


        env
                // To create data source and obtain DataStream of the UserBehavior type
                .createInput(csvInput, pojoType)
                // To extract time and generate watermark
                .assignTimestampsAndWatermarks(new AscendingTimestampExtractor<UserBehavior>() {
                        @Override
                        public long extractAscendingTimestamp(UserBehavior userBehavior) {
                                // Convert the unit of the source data from seconds to millisecond
                                return userBehavior.timestamp * 1000;
                        }
                })
                // To filter the click data
```

```
            .filter(new FilterFunction<UserBehavior>() {
                @Override
                public boolean filter(UserBehavior userBehavior) throws Exception {
                    // To filter the click data
                    return userBehavior.behavior.equals("pv");
                }
            })
            .keyBy("itemId")
            .timeWindow(Time.minutes(60), Time.minutes(5))
            .aggregate(new CountAgg(), new WindowResultFunction())
            .keyBy("windowEnd")
            .process(new TopNHotItems(3))
            .print();

        env.execute("Hot Items Job");
}

/** To obtain the top N hot items in a window. key indicates the timestamp of the window. The output is a character string of TopN. */
public static class TopNHotItems extends KeyedProcessFunction<Tuple, ItemViewCount, String> {

        private final int topSize;

        public TopNHotItems(int topSize) {
            this.topSize = topSize;
        }

        // To save the states of the stored items and click count, and calculate TopN when all data in a window is collected
        private ListState<ItemViewCount> itemState;

        @Override
        public void open(Configuration parameters) throws Exception {
            super.open(parameters);
            ListStateDescriptor<ItemViewCount> itemsStateDesc = new ListStateDescriptor<>(
                    "itemState-state",
                    ItemViewCount.class);
            itemState = getRuntimeContext().getListState(itemsStateDesc);
        }

        @Override
        public void processElement(
                ItemViewCount input,
                Context context,
                Collector<String> collector) throws Exception {

            // Each data record is saved in the item state.
            itemState.add(input);
            // To register EventTime Timer in windowEnd+1. When triggered, it indicates that all item data in the windowEnd window has been collected.
            context.timerService().registerEventTimeTimer(input.windowEnd + 1);
        }

        @Override
        public void onTimer(
```

```
            long timestamp, OnTimerContext ctx, Collector<String> out) throws Exception {
            // To obtain the click count of all received items
            List<ItemViewCount> allItems = new ArrayList<>();
            for (ItemViewCount item : itemState.get()) {
                allItems.add(item);
            }
            // To clear data in state in advance to release space
            itemState.clear();
            // To sort by click count in descending order
            allItems.sort(new Comparator<ItemViewCount>() {
                @Override
                public int compare(ItemViewCount o1, ItemViewCount o2) {
                    return (int) (o2.viewCount - o1.viewCount);
                }
            });
            // To format the ranking information to String for easy display
            StringBuilder result = new StringBuilder();
            result.append("====================================\n");
            result.append("time: ").append(new Timestamp(timestamp-1)).append("\n");
                        for (int i=0; i<allItems.size() && i < topSize; i++) {
                ItemViewCount currentItem = allItems.get(i);
                // No1:   item ID=12224   view count=2413
                result.append("No").append(i).append(":")
                        .append("   Item ID=").append(currentItem.itemId)
                        .append("   View count=").append(currentItem.viewCount)
                        .append("\n");
            }
            result.append("====================================\n\n");

            // To control the output frequency and simulate the real-time scrolling result
            Thread.sleep(1000);

            out.collect(result.toString());
        }
}

/** To output the result of the window */
public static class WindowResultFunction implements WindowFunction<Long, ItemViewCount, Tuple,
TimeWindow> {

    @Override
    public void apply(
            Tuple key,   // Primary key of the window, that is, itemId
            TimeWindow window,   // Window
            Iterable<Long> aggregateResult, // Result of the aggregate function, that is, count value
            Collector<ItemViewCount> collector   // Output type: ItemViewCount
    ) throws Exception {
            Long itemId = ((Tuple1<Long>) key).f0;
            Long count = aggregateResult.iterator().next();
            collector.collect(ItemViewCount.of(itemId, window.getEnd(), count));
    }
}

/** COUNT of aggregate function implementation. The value increases by 1 each time a record is
generated. */
```

```
public static class CountAgg implements AggregateFunction<UserBehavior, Long, Long> {

    @Override
    public Long createAccumulator() {
        return 0L;
    }

    @Override
    public Long add(UserBehavior userBehavior, Long acc) {
        return acc + 1;
    }

    @Override
    public Long getResult(Long acc) {
        return acc;
    }

    @Override
    public Long merge(Long acc1, Long acc2) {
        return acc1 + acc2;
    }
}

/** Item click count (output type of the window operation) */
public static class ItemViewCount {
    public long itemId;       // Item ID
    public long windowEnd;   // Window end timestamp
    public long viewCount;   // Item click count

    public static ItemViewCount of(long itemId, long windowEnd, long viewCount) {
        ItemViewCount result = new ItemViewCount();
        result.itemId = itemId;
        result.windowEnd = windowEnd;
        result.viewCount = viewCount;
        return result;
    }
}


/** User behavior data structure **/
public static class UserBehavior {
    public long userId;           // User ID
    public long itemId;           // Item ID
    public int categoryId;        // Item category ID
    public String behavior;       // User behavior, including ("pv", "buy", "cart", "fav")
    public long timestamp;        // Timestamp when the behavior occurs, in seconds
}
}
```

Step 4 Run the program.

Flink can run on a single server or even a single Java virtual machine (VM). This mechanism enables users to test or debug Flink programs locally. Now, run the Flink program locally. You can also refer to task 2 to run the Flink program in the cluster.

Right-click **Run as** and choose **Java Application** from the shortcut menu. Run the main function. The hot-selling offering IDs at each time point are displayed.

```
<terminated> HotGoods [Java Application] C:\Program Files\Java\jdk1.8.0_201\bin\javaw.exe  (Jun 24, 2020 1:34:04 PM – 1:34:59 PM)
====================================
TIME: 2017-09-11 16:25:00.0
No0:  ItemID=1328010  ViewCount=1
====================================


====================================
TIME: 2017-09-11 16:30:00.0
No0:  ItemID=1328010  ViewCount=1
====================================


====================================
TIME: 2017-09-11 16:35:00.0
No0:  ItemID=1328010  ViewCount=1
====================================


====================================
TIME: 2017-09-11 16:40:00.0
No0:  ItemID=1328010  ViewCount=1
```

Figure 7-18

7.4 Summary

This exercise describes two cases of implementing the asynchronous CheckPoint mechanism and real-time hot-selling offerings, and helps trainees learn multiple core concepts and API usage of Flink, including how to use EventTime, Watermark, State, Window API, and TopN. It is expected that this exercise can deepen your understanding of Flink and help you resolve real-world problems.

8 Kafka Message Subscription Practice

8.1 Background

The Kafka message subscription system plays an important role in big data services, especially in real-time services. The typical Taobao You May Like service uses Kafka to store page clickstream data. After the streaming analysis, the analysis result is pushed to users.

8.2 Objectives

- Understand how to use Kafka shell producers and consumers to generate and consume data in real time.

8.3 Tasks

8.3.1 Task 1: Producing and Consuming Kafka Messages on the Shell Side

Step 1 Log in to Kafka.

Use PuTTY to log in to a server and run the source command to set environment variables.

source /opt/client/bigdata_env

```
[root@node-master1jicC ~]# source /opt/client/bigdata_env
[root@node-master1jicC ~]#
```

Figure 8-1

Run the **cd /opt/client/Kafka/kafka/** command to go to the Kafka directory.

```
[root@node-master1jicC ~]# cd /opt/client/Kafka/kafka/
[root@node-master1jicC kafka]# ls
bin  config  libs  LICENSE  logs  NOTICE  site-docs
[root@node-master1jicC kafka]#
```

Figure 8-2

Step 2 Create a Kafka topic.

Run the following command:

```
bin/kafka-topics.sh --create --zookeeper 192.168.0.151:2181/kafka --partitions 1 --replication-factor 1 --topic cx_topic2
```

```
[root@node-master1bBdj kafka]# bin/kafka-topics.sh --create --zookeeper 192.168.0.151:2181/kafka --partitions 1 --replication-factor 1 --topic cx_topic2
WARNING: Due to limitations in metric names, topics with a period ('.') or underscore ('_') could collide. To avoid issues it is best to use either, but not both.
Created topic "cx_topic2".
[root@node-master1bBdj kafka]#
```

Figure 8-3

Note: For details about how to obtain the ZooKeeper IP address, see the related content in the Appendix.

Step 3 View the topic.

Run the following command:

```
bin/kafka-topics.sh --list --zookeeper 192.168.0.151:2181/kafka
```

```
[root@node-master1bBdj kafka]# bin/kafka-topics.sh --list --zookeeper 192.168.0.151:2181/kafka
__consumer_offsets
cx_topic1
cx_topic2
[root@node-master1bBdj kafka]#
```

Figure 8-4

Step 4 Create a console consumer.

Run the following command:

```
bin/kafka-console-consumer.sh --topic cx_topic2 --bootstrap-server 192.168.0.152:9092 --new-consumer --consumer.config config/consumer.properties
```

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic2 --bootstrap-server 192.168.0.152:9092 --new-consumer --consumer.config config/consumer.properties
The --new-consumer option is deprecated and will be removed in a future major release.The new consumer is used by default if the --bootstrap-server option is provided.
```

Figure 8-5

Note: The IP address of **bootstrap-server** is the IP address of the Kafka broker. You can obtain the IP address by referring to the related content in the Appendix.

After this command is executed, the **cx_topic2** data is consumed. Do not perform other operations in this window or close the window.

Step 5 Create a console producer.

Log in to PuTTY again, run the source command to obtain the environment variables, and go to the Kafka directory.

```
[root@node-master1bBdj ~]# source /opt/client/bigdata_env
[root@node-master1bBdj ~]# cd /opt/client/Kafka/kafka/
[root@node-master1bBdj kafka]# ls
bin  config  libs  LICENSE  logs  NOTICE  site-docs
[root@node-master1bBdj kafka]#
```

Figure 8-6

Run the following command to create a producer:

```
bin/kafka-console-producer.sh  --broker-list  192.168.0.152:9092  --topic cx_topic2  --
producer.config  config/producer.properties
```

After the command is executed, enter any data.

```
[root@node-master1bBdj kafka]# bin/kafka-console-producer.sh  --broker-list  192.168.0.152:9092  --topic
 cx_topic2  --producer.config  config/producer.properties
[2020-04-18 13:49:02,887] WARN The configuration 'producer.type' was supplied but isn't a known config.
(org.apache.kafka.clients.producer.ProducerConfig)
[2020-04-18 13:49:02,887] WARN The configuration 'request.required.acks' was supplied but isn't a known
config. (org.apache.kafka.clients.producer.ProducerConfig)
[2020-04-18 13:49:02,888] WARN The configuration 'serializer.class' was supplied but isn't a known confi
g. (org.apache.kafka.clients.producer.ProducerConfig)
>11111
>test
>
```

Figure 8-7

Note: The IP address of **broker-list** is the broker address of Kafka. For details about how to obtain the IP address, see the related content in the Appendix.

Step 6 Test the producer and consumer.

Switch to the shell of the consumer. The console data output is displayed.

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic2 --bootstrap-server 192.16
8.0.152:9092 --new-consumer --consumer.config config/consumer.properties
The --new-consumer option is deprecated and will be removed in a future major release.The new consumer i
s used by default if the --bootstrap-server option is provided.
11111
test
```

Figure 8-8

You can continue to enter data on the producer for testing.

8.3.2 Task 2: Using Kafka Consumer Groups

The consumer group is a very interesting design of Kafka. In terms of high concurrency, multiple servers can be placed in the same consumer group to ensure that all consumers do not pull the same message and the message is complete, thereby improving execution efficiency of the consumers.

Step 1 Create a topic.

Create a topic named **cx_topic3**. For details, see Task 1.

```
[root@node-master1bBdj kafka]# bin/kafka-topics.sh  --create  --zookeeper 192.168.0.151:2181/kafka  --pa
rtitions  3  --replication-factor  1  --topic  cx_topic3
WARNING: Due to limitations in metric names, topics with a period ('.') or underscore ('_') could collid
e. To avoid issues it is best to use either, but not both.
Created topic "cx_topic3".
[root@node-master1bBdj kafka]# bin/kafka-topics.sh --list --zookeeper 192.168.0.151:2181/kafka
__consumer_offsets
cx_topic1
cx_topic2
cx_topic3
[root@node-master1bBdj kafka]#
```

Figure 8-9

Note that the topic partition is set to 3. Different value settings will lead to different effects.

For example, to delete the topic, run the bin/kafka-topics.sh --delete --topic cx_*** --zookeeper 192.168.0.151:2181/kafka command.

Step 2 Create a producer and consumer.

Start the producer.

```
bin/kafka-console-producer.sh  --broker-list  192.168.0.152:9092  --topic cx_topic3  --
producer.config  config/producer.properties
```

Open three PuTTY windows, set environment variables, go to the Kafka directory, and run the following command to start three consumers:

```
bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.168.0.152:9092  --consumer-
property  group1  --consumer.config config/consumer.properties
```

Note that you can add **--consumer-property group1** to specify consumer group **group1**.

Step 3 Configure three consumers.

Send the following six messages in sequence in the producer window:

```
[root@node-master1bBdj kafka]# bin/kafka-console-producer.sh  --broker-list  192.168.0.152:9092  --topic
 cx_topic3  --producer.config  config/producer.properties
[2020-04-18 14:35:01,078] WARN The configuration 'producer.type' was supplied but isn't a known config.
(org.apache.kafka.clients.producer.ProducerConfig)
[2020-04-18 14:35:01,078] WARN The configuration 'request.required.acks' was supplied but isn't a known
config. (org.apache.kafka.clients.producer.ProducerConfig)
[2020-04-18 14:35:01,078] WARN The configuration 'serializer.class' was supplied but isn't a known confi
g. (org.apache.kafka.clients.producer.ProducerConfig)
>1
2
>3
4>
5
6>
>>>
```

Figure 8-10

Switch to the three consumer windows. It is found that each window consumes two messages evenly.

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:05,662] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
2
5
```

First consumer

Figure 8-11

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:09,096] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
3
6
```

Second consumer

Figure 8-12

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:12,509] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
1
4
```

Third consumer

Figure 8-13

The three consumers evenly consume six messages. Each consumer processes two messages. This ensures data integrity.

Step 4 Start the fourth consumer.

Open another PuTTY window, set environment variables, go to the Kafka directory, and run the following command to start the fourth consumer:

```
bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.168.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
```

Specify the same consumer group **group1**.

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:44:27,115] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
```

Fourth consumer

Figure 8-14

Step 5 Configure four consumers.

Continue to send six messages in sequence in the producer window.

```
[root@node-master1bBdj kafka]# bin/kafka-console-producer.sh  --broker-list  192.168.0.152:9092  --topic
 cx_topic3  --producer.config  config/producer.properties
[2020-04-18 14:35:01,078] WARN The configuration 'producer.type' was supplied but isn't a known config.
(org.apache.kafka.clients.producer.ProducerConfig)
[2020-04-18 14:35:01,078] WARN The configuration 'request.required.acks' was supplied but isn't a known
config. (org.apache.kafka.clients.producer.ProducerConfig)
[2020-04-18 14:35:01,078] WARN The configuration 'serializer.class' was supplied but isn't a known confi
g. (org.apache.kafka.clients.producer.ProducerConfig)
>1
2
>3
4>
5
6>
>>>a
b>
>c
>d
>e
f>
>
```

Producer

Figure 8-15

Switch to the four consumer windows:

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:05,662] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
2
5
a
d
```

First consumer

Figure 8-16

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:09,096] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
3
6
b
e
```

Second consumer

Figure 8-17

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:12,509] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
1
4
```

Third consumer

Figure 8-18

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:44:27,115] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
c
f
```

Fourth consumer

Figure 8-19

As shown in the preceding figure, a consumer does not have a corresponding partition. Therefore, the consumer cannot obtain messages. Therefore, when creating topics, you can create more partitions to ensure that multiple consumers can correspond to the

partitions, preventing consumers from being wasted. To add partitions, you can run the **kafka-reassign-partitions.sh** command.

Step 6 Configure two consumers.

Disable two consumers by pressing **Ctrl+C** and retain the remaining two consumers.

Enter the following six messages in sequence in the producer window:

```
[2020-04-18 14:35:01,078] WARN The configuration 'serializer.class' was supplied but isn't a known confi
g. (org.apache.kafka.clients.producer.ProducerConfig)
>1
2
>3
4>
5
6>
>>>a
b>
>c
>d
>e
f>
>111
22>2
>333
>444
>555
6>66
>
```

Producer

Figure 8-20

Check the status of the two consumer windows.

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:05,662] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
2
5
a
d
111
444
```

First consumer

Figure 8-21

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic3 --bootstrap-server 192.16
8.0.152:9092  --consumer-property  group1  --consumer.config config/consumer.properties
[2020-04-18 14:35:09,096] WARN The configuration 'group1' was supplied but isn't a known config. (org.ap
ache.kafka.clients.consumer.ConsumerConfig)
3
6
b
e
222
333
555
666
```

Second consumer

Figure 8-22

When two consumers are used, the unexpected phenomenon also occurs. That is, messages are not evenly distributed. Instead, they are divided into four messages and two messages. The reason is that one consumer corresponds to two partitions, and the other corresponds to one partition. Messages are consumed based on partitions.

Check the partitions of the **cx_topic3** topic.

View the consumer group list.

```
bin/kafka-consumer-groups.sh  --bootstrap-server 192.168.0.152:9092  --list
```

```
[root@node-master1bBdj kafka]# bin/kafka-consumer-groups.sh  --bootstrap-server 192.168.0.152:9092  --list
Note: This will not show information about old Zookeeper-based consumers.
example-group1
[root@node-master1bBdj kafka]#
```

Figure 8-23

View the details about the consumer group.

```
bin/kafka-consumer-groups.sh  --bootstrap-server 192.168.0.152:9092  --describe  --group example-group1
```

```
[root@node-master1bBdj kafka]# bin/kafka-consumer-groups.sh  --bootstrap-server 192.168.0.152:9092  --describe  --group example-group1
Note: This will not show information about old Zookeeper-based consumers.

TOPIC           PARTITION  CURRENT-OFFSET  LOG-END-OFFSET  LAG             CONSUMER-ID                                     HOST            CLIENT-ID
cx_topic3       0          10              10              0               consumer-1-404604b8-be64-4a1d-9a15-42b7bf5f475f /192.168.0.151  consumer-1
cx_topic3       1          11              11              0               consumer-1-404604b8-be64-4a1d-9a15-42b7bf5f475f /192.168.0.151  consumer-1
cx_topic3       2          10              10              0               consumer-1-9667f89c-4b0f-4b89-bbe8-c4745c80f004 /192.168.0.151  consumer-1
cx_topic1       0          10              10              0               -                                               -               -
cx_topic2       0          4               4               0               -                                               -               -
[root@node-master1bBdj kafka]#
```

Figure 8-24

As the figure shows, the **consumer_id** values of **partition0** and **partition1** are both **consumer-1-404604b8-be64-4a1d-9a15-42b7bf5f475f**.

Sometimes, the data consumption sequences of different partitions are different. This is because Kafka messages are stored by partition, and only messages in the same partition are pulled in sequence.

8.4 Summary

This exercise describes how to generate and consume data in real time the shell end and enables trainees to have a deeper understanding of Kafka. Multiple consumers in the same consumer group are equivalent to one consumer, which improves consumption efficiency.

9 Flume Data Collection Practice

9.1 Background

Flume is an important data collection tool in the big data components, and is often used to collect data from various data sources for other components to analyze. In the log analysis service, server logs are collected to analyze whether servers are running properly. In real-time services, data is usually collected to the Kafka for analysis and processing by real-time components such as streaming and Spark. Flume is an important application in big data services.

9.2 Objectives

- Configure and use Flume to collect data.

9.3 Tasks

9.3.1 Task 1: Installing the Flume Client

Step 1 Open the Flume service page.

Access the MRS Manager cluster management page and choose **Services** > **Flume**.

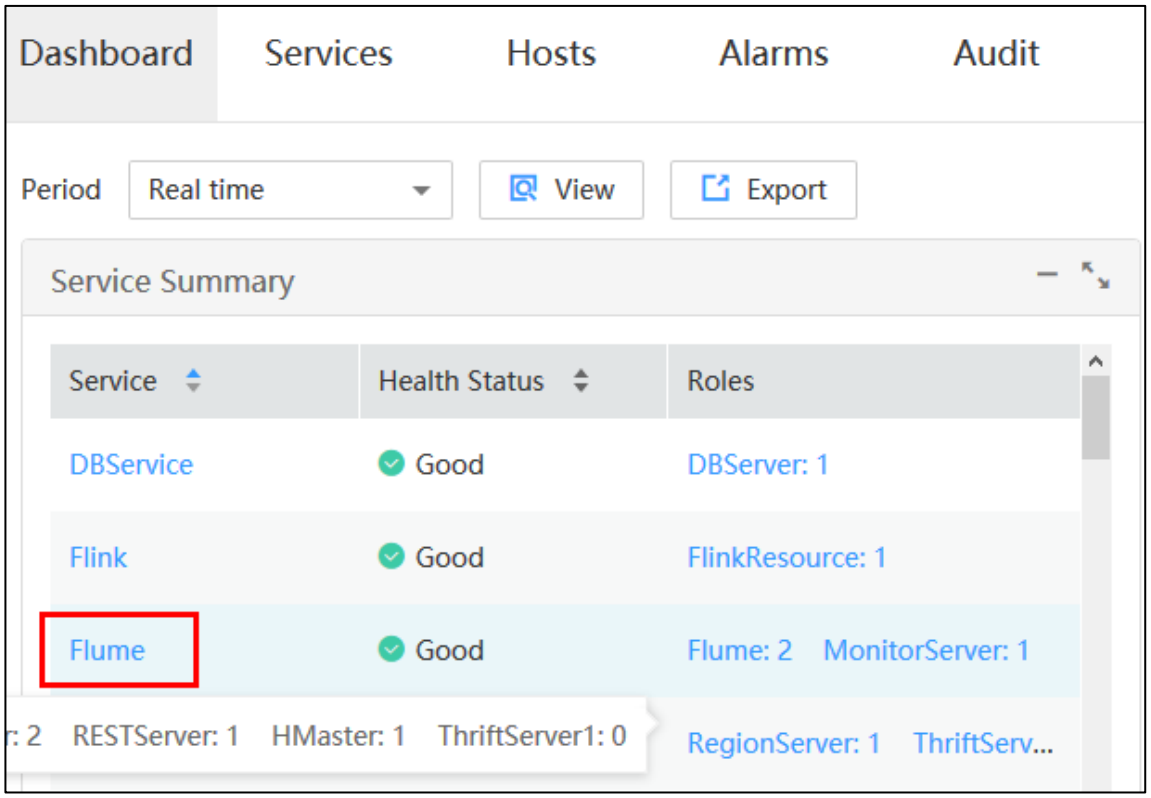


Figure 9-1

Step 2 Click Download Client.

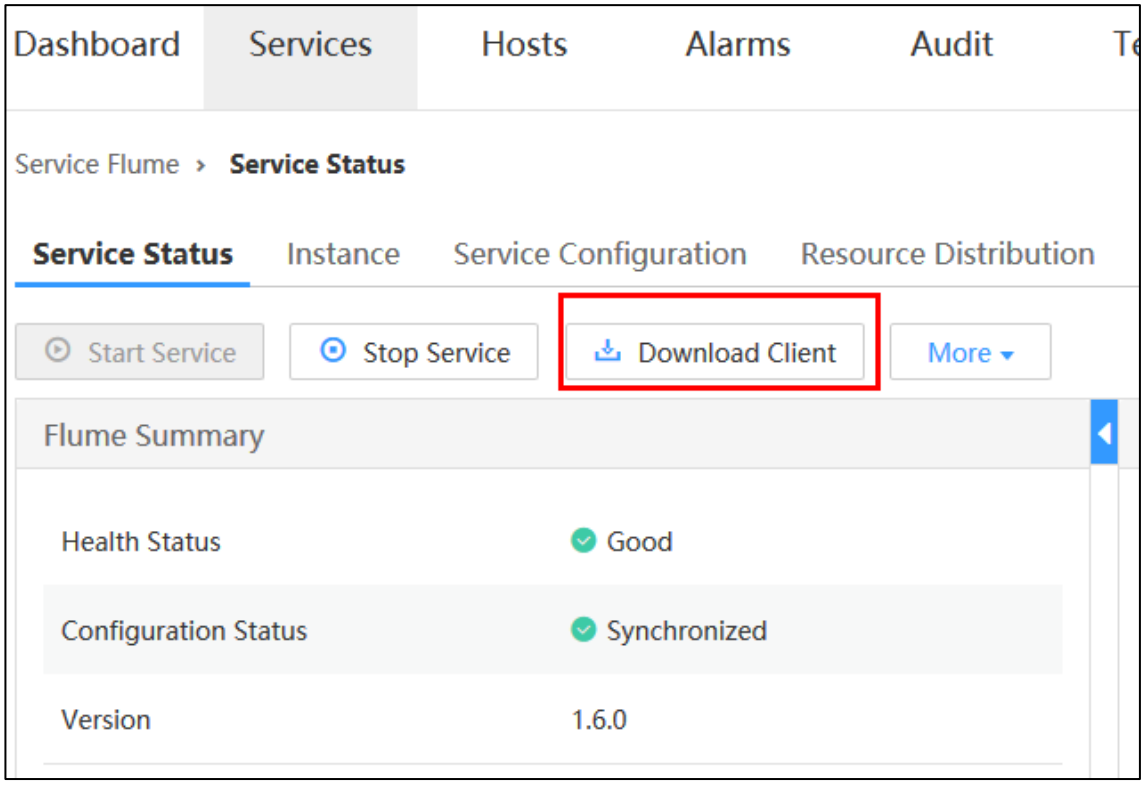


Figure 9-2

Click **OK** and wait for the download.

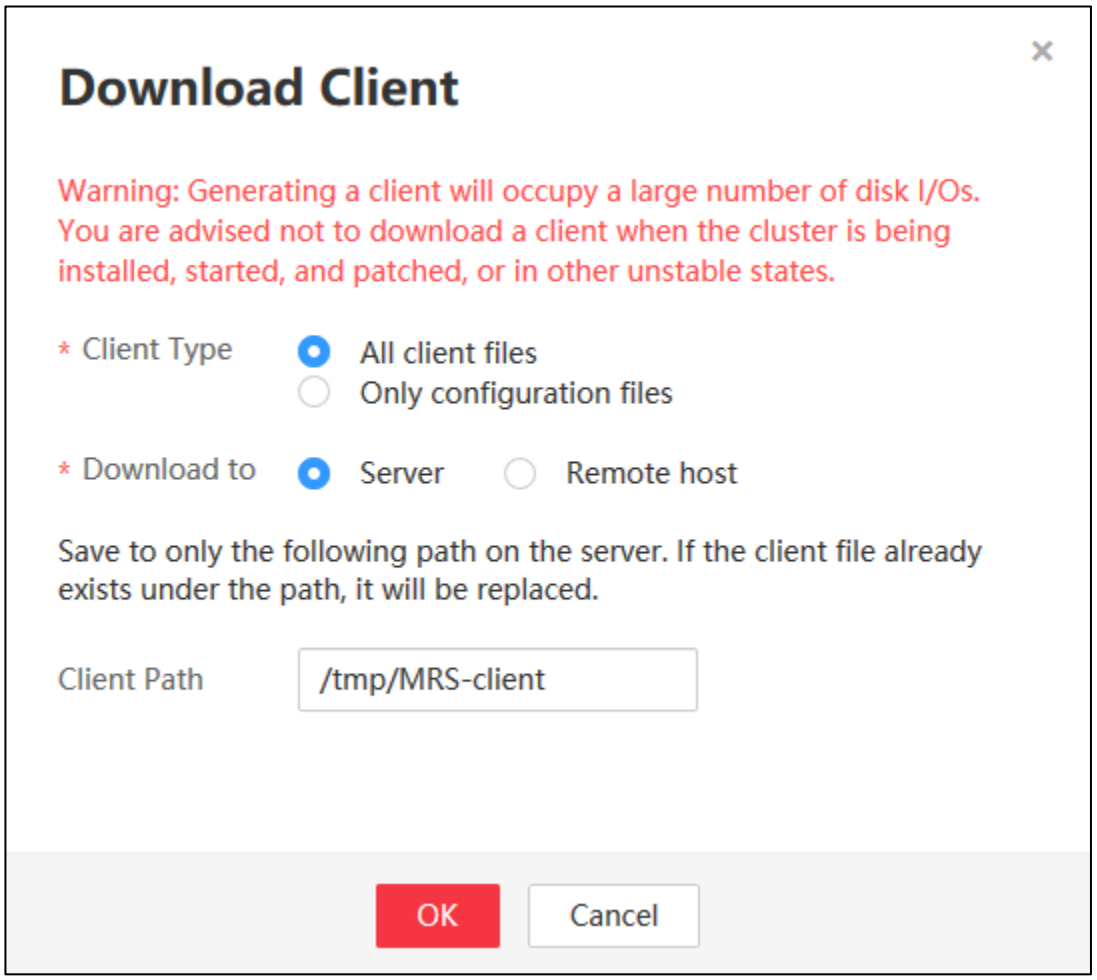


Figure 9-3

After the download is complete, a dialog box is displayed, indicating the server (Master node) to which the file is downloaded. The path is **/tmp/MRS-client**.

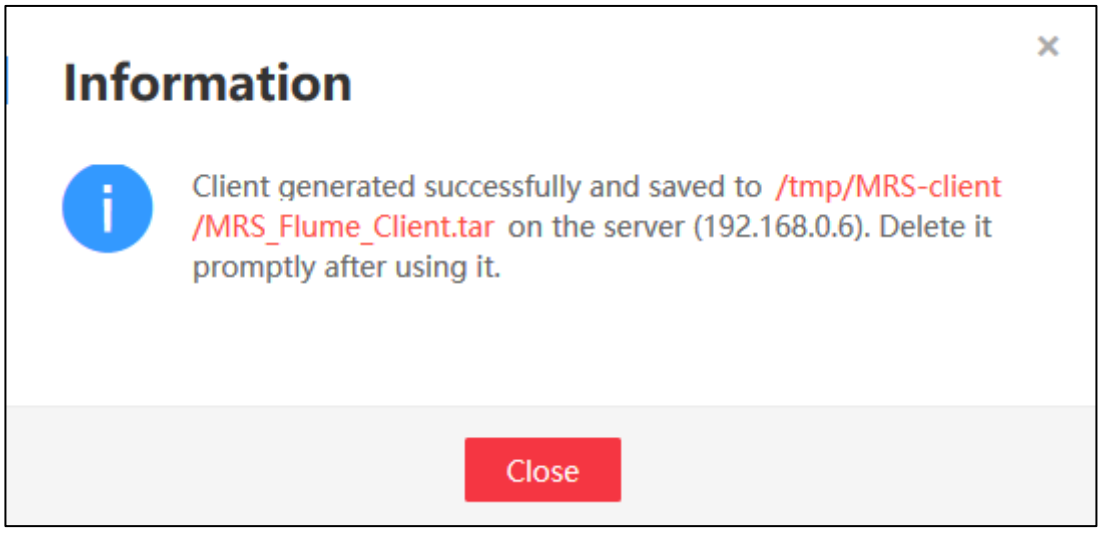


Figure 9-4

Step 3 Decompress the Flume client installation package.

Use MobaXterm to log in to the ECS of the preceding step and go to the **/tmp/MRS-client** directory.

```
[root@node-master1jicC ~]# cd /tmp/MRS-client/
[root@node-master1jicC MRS-client]# ls
MRS_Flume_Client.tar
[root@node-master1jicC MRS-client]#
```

Figure 9-5

Run the following command and decompress the package to obtain the verification file and client configuration packages:

```
tar -xvf MRS_Flume_Client.tar
```

```
[root@node-master1jicC MRS-client]# tar -xvf MRS_Flume_Client.tar
MRS_Flume_ClientConfig.tar
MRS_Flume_ClientConfig.tar.sha256
[root@node-master1jicC MRS-client]#
```

Figure 9-6

Step 4 Verify the file package.

Run the sha256sum -c MRS_Flume_ClientConfig.tar.sha256 command.

If the following information is displayed, the file package is successfully verified:

MRS_Flume_ClientConfig.tar: OK

Step 5 Decompress MRS_Flume_ClientConfig.tar.

Run the tar -xvf MRS_Flume_ClientConfig.tar command.

```
[root@node-master1jicC MRS-client]# tar -xvf MRS_Flume_ClientConfig.tar
MRS_Flume_ClientConfig/
MRS_Flume_ClientConfig/switchuser.py
MRS_Flume_ClientConfig/jython-standalone-2.7.0.jar
MRS_Flume_ClientConfig/Flume/
MRS_Flume_ClientConfig/install.sh
MRS_Flume_ClientConfig/hosts
MRS_Flume_ClientConfig/ca.crt
MRS_Flume_ClientConfig/bigdata_env.sample
MRS_Flume_ClientConfig/conf.py
MRS_Flume_ClientConfig/log4j.properties
MRS_Flume_ClientConfig/install.bat
MRS_Flume_ClientConfig/JDK/
MRS_Flume_ClientConfig/application.properties
MRS_Flume_ClientConfig/refreshConfig.sh
MRS_Flume_ClientConfig/JDK/install.sh
MRS_Flume_ClientConfig/JDK/component_env.sample
MRS_Flume_ClientConfig/JDK/jdk.tar.gz
MRS_Flume_ClientConfig/Flume/FusionInsight-Flume-1.6.0.tar.gz
[root@node-master1jicC MRS-client]#
```

Figure 9-7

Step 6 Install the Flume environment variables.

Run the following command to install the client running environment to the new directory **/opt/Flumeenv**.

The directory is generated automatically during installation.

```
sh   /tmp/MRS-client/MRS_Flume_ClientConfig/install.sh   /opt/Flumeenv
```

Check the command output. If the following information is displayed, the client running environment has been successfully installed:

```
Components client installation is complete.
```

```
[19-03-27 20:55:12]: Install JDK begin ...
[19-03-27 20:55:12]: Decompress jdk.tar.gz to /opt/Flumeenv/JDK.
/tmp/MRS-client/MRS_Flume_ClientConfig/JDK
[19-03-27 20:55:17]: Create JRE env file "/opt/Flumeenv/JDK/component_env".
[19-03-27 20:55:17]: JDK installation is complete.
[19-03-27 20:55:17]: Components client installation is complete.
[root@node-master1jicC MRS-client]#
```

Figure 9-8

Step 7 Configure the environment variables.

Run the source /opt/Flumeenv/bigdata_env command.

Step 8 Decompress the Flume client.

Run the following commands:

```
cd /tmp/MRS-client/MRS_Flume_ClientConfig/Flume
tar -xvf FusionInsight-Flume-1.6.0.tar.gz
```

```
[root@node-master1jicC MRS-client]# cd /tmp/MRS-client/MRS_Flume_ClientConfig/Flume
[root@node-master1jicC Flume]# ls
FusionInsight-Flume-1.6.0.tar.gz
[root@node-master1jicC Flume]# tar -xvf FusionInsight-Flume-1.6.0.tar.gz
flume/
flume/CHANGELOG
flume/DEVNOTES
flume/LICENSE
flume/NOTICE
```

Figure 9-9

Step 9 Install the Flume client.

Install Flume to the new directory **/opt/FlumeClient**. The directory is automatically generated during installation.

Run the following command:

```
sh   /tmp/MRS-client/MRS_Flume_ClientConfig/Flume/install.sh   -d /opt/FlumeClient
```

```
[root@node-master1jicC Flume]# sh  /tmp/MRS-client/MRS_Flume_ClientConfig/Flume/in
-d /opt/FlumeClient
CST 2019-03-27 21:00:24 [flume-client install]: install flume client successfully.
[root@node-master1jicC Flume]#
```

Figure 9-10

-d: The Flume client installation path.

If the following information is displayed, the client running environment is successfully installed:

install flume client successfully.

Step 10 Copy the HDFS configuration file.

Run the following commands to copy the HDFS configuration file to the **conf** directory of Flume:

```
cp /opt/client/HDFS/hadoop/etc/hadoop/hdfs-site.xml /opt/FlumeClient/fusioninsight-flume-1.6.0/conf/
cp /opt/client/HDFS/hadoop/etc/hadoop/core-site.xml /opt/FlumeClient/fusioninsight-flume-1.6.0/conf/
```

Step 11 Restart the Flume service.

Go to the **/opt/FlumeClient/fusioninsight-flume-1.6.0** directory and restart the Flume.

Run the following commands:

```
cd /opt/FlumeClient/fusioninsight-flume-1.6.0
sh bin/flume-manage.sh restart
```

```
[root@node-master1jicC fusioninsight-flume-1.6.0]# sh bin/flume-manage.sh restart
Stop Flume PID=15340 successful.
Start flume successfully,pid=6815.
[root@node-master1jicC fusioninsight-flume-1.6.0]#
```

Figure 9-11

9.3.2 Task 2: Using SpoolDir to Collect and Upload Data to HDFS

Flume uses SpoolDir to monitor folders in a specified path and then collects and uploads the data in the folders to HDFS. Check that the HDFS and HBase clients are installed. Flume is mainly used for data collection. Therefore, you need to configure the Flume based on service requirements.

Step 1 Download the Flume configuration planning tool.

Visit https://support.huawei.com/enterprise/en/doc/EDOC1000113257.

Step 2 Enable macros.

After the decompression, start the Flume configuration planning tool. If macros are disabled, enable them. Otherwise, the tool does not work.

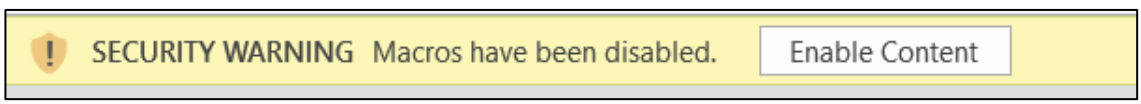
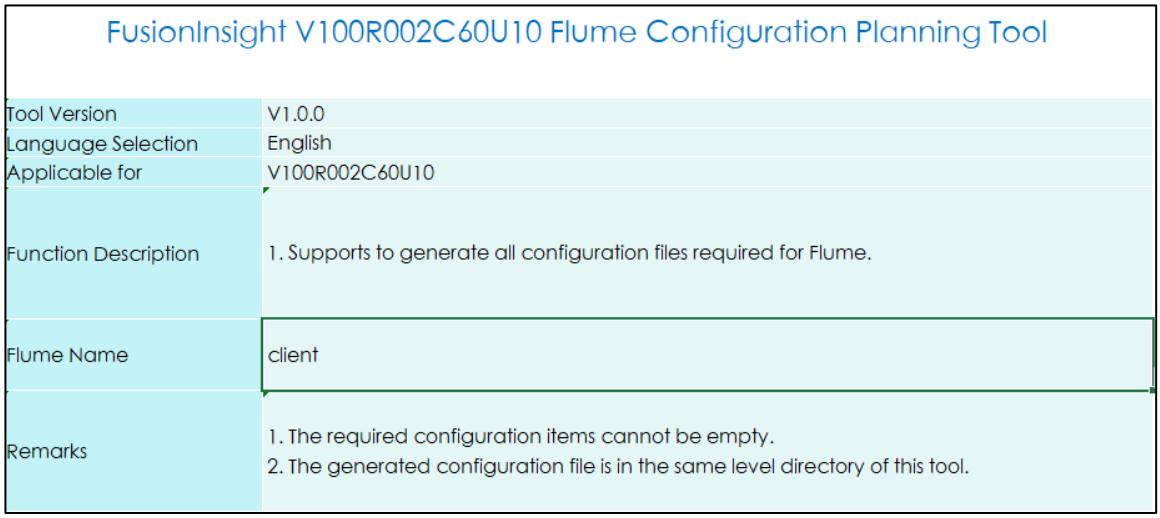


Figure 9-12

Step 3 Configure parameters.

In the **Flume Name** row of the first sheet, select **client**. Then, switch to the **Flume Configuration** row of the second sheet.



FusionInsight V100R002C60U10 Flume Configuration Planning Tool

Tool Version	V1.0.0
Language Selection	English
Applicable for	V100R002C60U10
Function Description	1. Supports to generate all configuration files required for Flume.
Flume Name	client
Remarks	1. The required configuration items cannot be empty. 2. The generated configuration file is in the same level directory of this tool.

Figure 9-13

Step 4 Configure the source.

Click **Add Source** and configure the parameters as follows:

SourceName: s1. The value cannot be empty.

type: spooldir. In this exercise, data in the static folder is collected and uploaded to the HDFS.

spoolDir: /tmp/flume_spooldir, which is the folder monitored by Flume.

channel: s-c1. The value cannot be empty.

Retain the default values for other parameters, as shown in the following figure:

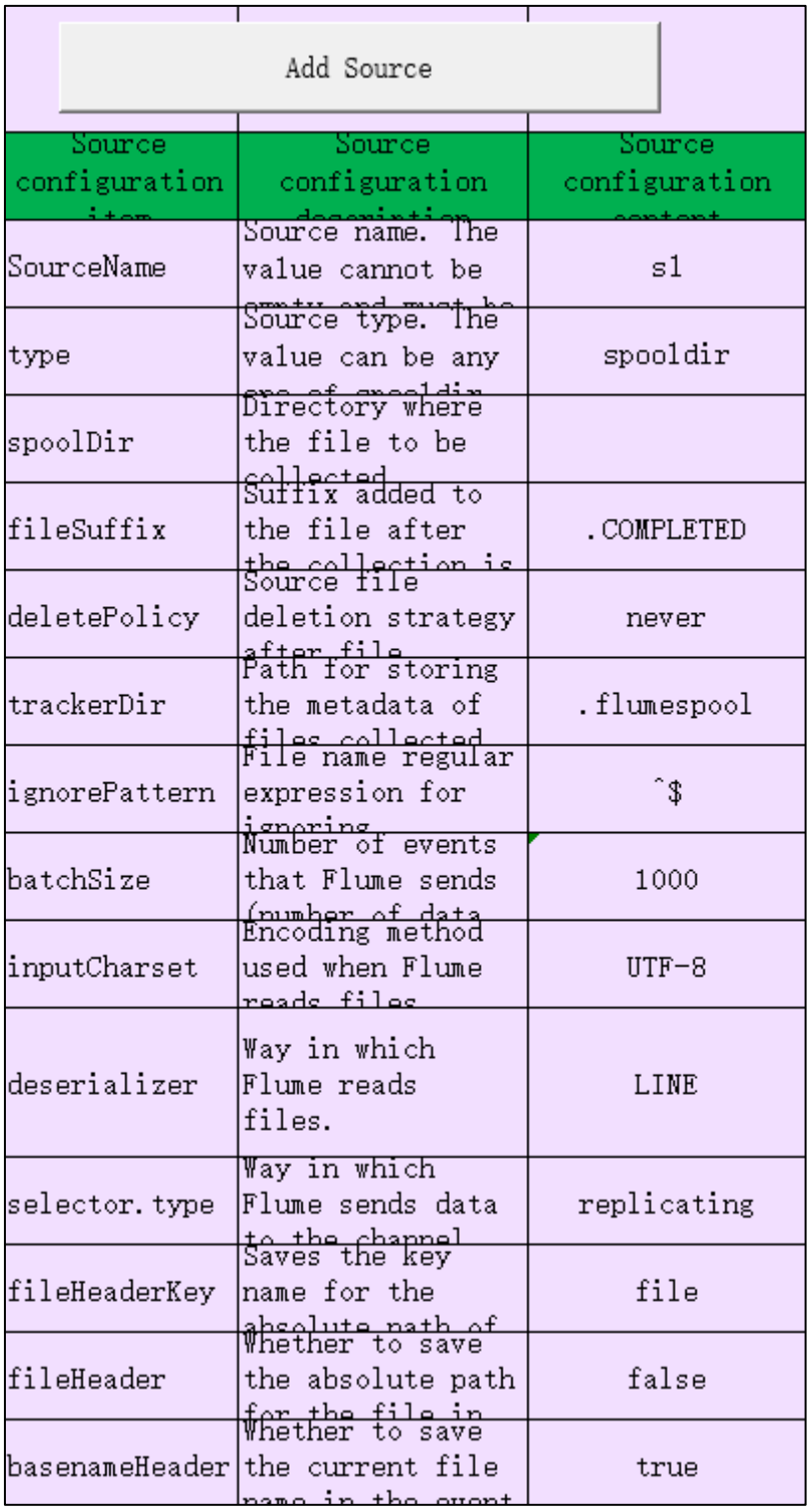

Add Source
Source configuration item
Source configuration description
Source configuration content
SourceName
Source name. The value cannot be empty and must be
s1
type
Source type. The value can be any one of spooldir
spooldir
spoolDir
Directory where the file to be collected
fileSuffix
Suffix added to the file after the collection is
.COMPLETED
deletePolicy
Source file deletion strategy after file
never
trackerDir
Path for storing the metadata of files collected
.flumespool
ignorePattern
File name regular expression for ignoring
^$
batchSize
Number of events that Flume sends (number of data
1000
inputCharset
Encoding method used when Flume reads files
UTF-8
deserializer
Way in which Flume reads files.
LINE
selector.type
Way in which Flume sends data to the channel
replicating
fileHeaderKey
Saves the key name for the absolute path of
file
fileHeader
Whether to save the absolute path for the file in
false
basenameHeader
Whether to save the current file name in the event
true

Figure 9-14

basenameHeaderKey	Saves the key name of the current file name	basename
deserializer.maxBatchLine	Specifies the number of rows merged into an event when Flume	1
deserializer.maxLineLength	Specifies the number of characters to be	2048
channels	Sends the data that the current source reads to a specified	c1

Figure 9-15

Add Source

Source configuration item	Source configuration description	Source configuration content
SourceName	Source name. The value cannot be empty.	s1
type	Source type. The value can be one of	spooldir
spoolDir	Directory where the file to be collected	/tmp/flume_spooldir
fileSuffix	Suffix added to the file after the collection is	.COMPLETED
deletePolicy	Source file deletion strategy after file	never
trackerDir	Path for storing the metadata of files collected	.flumespool
ignorePattern	File name regular expression for ignoring	^$
batchSize	Number of events that Flume sends (number of data	1000
inputCharset	Encoding method used when Flume reads files	UTF-8
deserializer	Way in which Flume reads files.	LINE

Figure 9-16

selector.type	Way in which Flume sends data to the channel	replicating
fileHeaderKey	Saves the key name for the absolute path of	file
fileHeader	Whether to save the absolute path for the file in	false
basenameHeader	Whether to save the current file name in the event	true
basenameHeaderKey	Saves the key name of the current file name	basename
deserializer.maxBatchLine	Specifies the number of rows merged into an event when Flume	1
deserializer.maxLineLength	Specifies the number of characters to be	2048
channels	Sends the data that the current source reads to a	c1

Figure 9-17

Step 5 Configure a channel.

Click **Add Channel**. Set **ChannelName** to **c1**, which corresponds to that in **Source**, set **type** to **memory**, and retain the default values for other parameters.

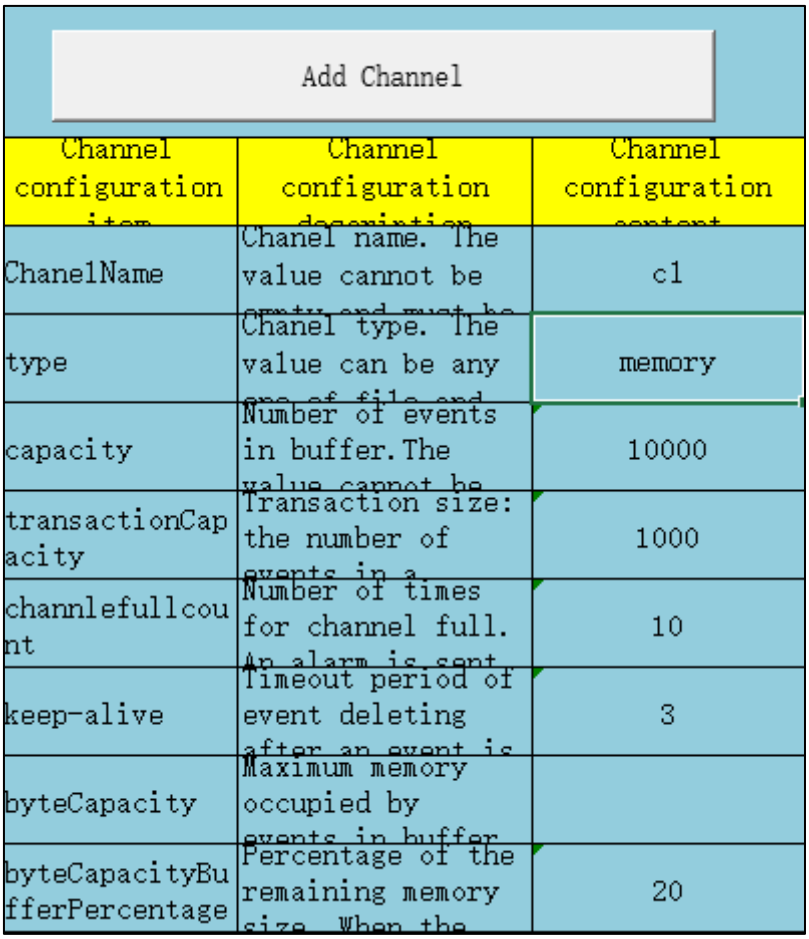


Figure 9-18

Step 6 Configure a sink.

Click **Add Sink** and configure the parameters as follows:

SinkName: sh1

type: hdfs

hdfs.path: hdfs://hacluster/user/stu02/. The **stu02** directory is automatically created by the system.

channel:-c1. The name is the same as the channel name.

Retain the default values for other parameters, as shown in the following figure:

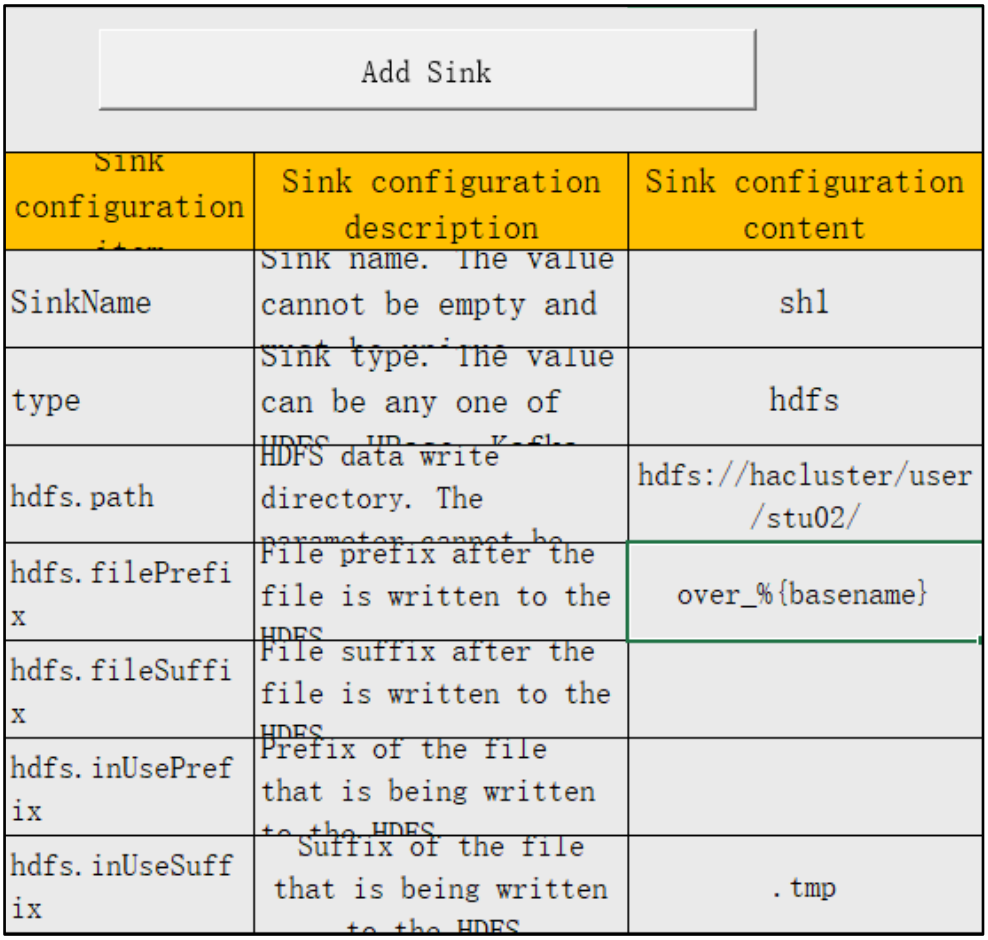

Add Sink
Sink configuration item
Sink configuration description
Sink configuration content
SinkName
Sink name. The value cannot be empty and
sh1
type
Sink type. The value can be any one of
hdfs
hdfs.path
HDFS data write directory. The
hdfs://hacluster/user/stu02/
hdfs.filePrefix
File prefix after the file is written to the
over_%{basename}
hdfs.fileSuffix
File suffix after the file is written to the
hdfs.inUsePrefix
Prefix of the file that is being written
hdfs.inUseSuffix
Suffix of the file that is being written
.tmp

Figure 9-19

hdfs.threadsPoolSize	Thread pool size during HDFS writing.	10
hdfs.rollTimerPoolSize	Thread pool size for rolling file generation	1
hdfs.kerberosPrincipal	Kerberos authentication user. Must fill in the	
hdfs.kerberosKeytab	KeyTab file path for Kerberos authentication. Must	
hdfs.round	Whether to generate documents in accordance with the	false
hdfs.roundUnit	Time range unit.	second
hdfs.useLocalTimeStamp	Whether to use the local time. The value can be true or false	false
hdfs.failcount	Number of failures for consecutively data writings to the HDFS	10
hdfs.fileCloseByEndEvent	Whether to be closed the HDFS file that is being written based on	true
channel	Channel to which data read by Sink is sent. The parameter cannot	c1

Figure 9-20

Note: The MRS cluster is in non-security mode. Therefore, you do not need to configure Kerberos in the sink.

Step 7 Generate a configuration file.

Click **Generate a configuration file** in the upper right corner. A **properties.properties** configuration file is automatically generated in the Excel file and saved in the same directory as the configuration tool.

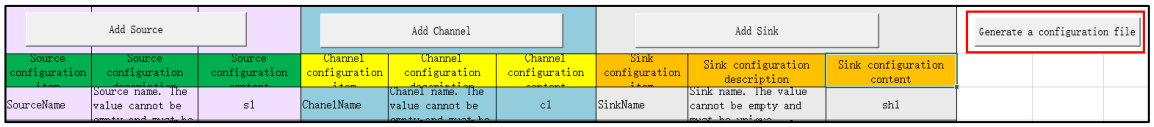


Figure 9-21

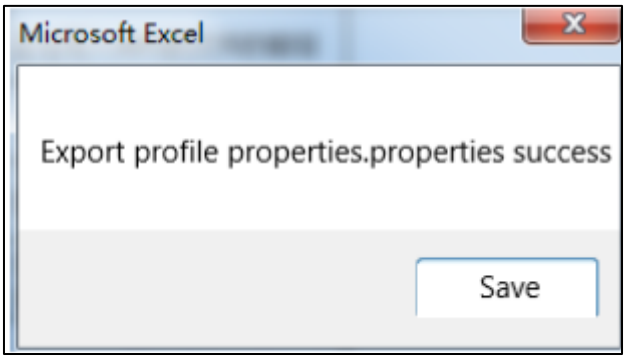


Figure 9-22

Step 8 Create /tmp/flume_spooldir in Linux

The commands are as follows:

```
[root@node-master1jicC ~]# cd /tmp
[root@node-master1jicC tmp]# mkdir flume_spooldir/
[root@node-master1jicC tmp]#
```

Figure 9-23

Step 9 Upload the Flume configuration file.

Use WinSCP to upload **properties.properties** to the following directory:

```
/opt/FlumeClient/fusioninsight-flume-1.6.0/conf/
```

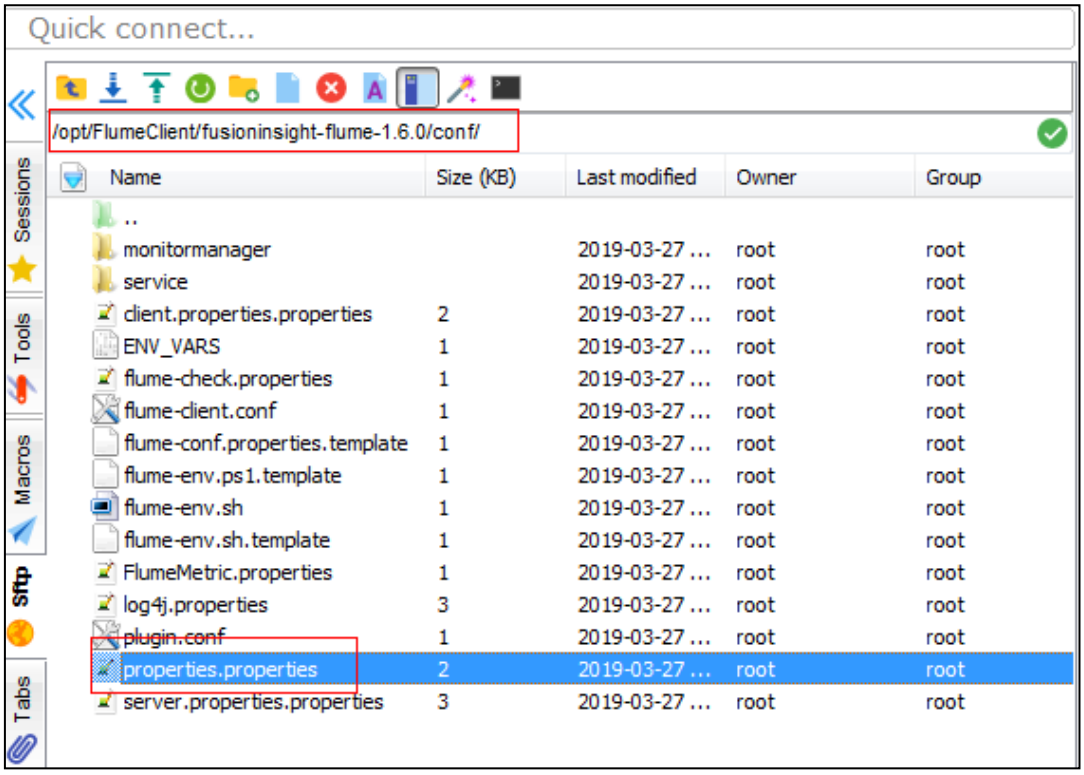


Figure 9-24

Note: The Flume client automatically loads the **properties.properties** file.

Step 10 Write a file for testing.

Go to the **/tmp/flume_spooldir** directory, run the **vi** command to create the **test1.txt** file, and enter any content.

```
[root@node-master1jicC flume_spooldir]# vi test1.txt
[root@node-master1jicC flume_spooldir]#
```

Figure 9-25

Step 11 View the result.

```
[root@node-master1jicC flume_spooldir]# hdfs dfs -ls /user/stu02
Found 1 items
-rw-r--r--   1 root hive         26 2019-03-28 15:41 /user/stu02/over_test1.txt
[root@node-master1jicC flume_spooldir]#
```

Figure 9-26

The data is successfully collected and uploaded to the HDFS. You can continue to create a data file for testing.

9.3.3 Task 3: Using SpoolDir to Collect and Upload Data to Kafka

Flume uses SpoolDir to monitor folders in a specified path and then collects and uploads the data in the folders to Kafka. The consumers can read the data on the console.

Step 1 Modify the Flume configuration file.

On the tool description page of the configuration tool, change **server** to **client**.

Figure 9-27

If the FlumeServer is deployed in a cluster, set this parameter to **server**. If the FlumeServer is not deployed in a cluster, set this parameter to **client**.

Step 2 Modify Sink configurations.

In the Flume configuration planning tool, change **type** of sink to **kafka** and set the value of **kafka.bootstrap.servers**.

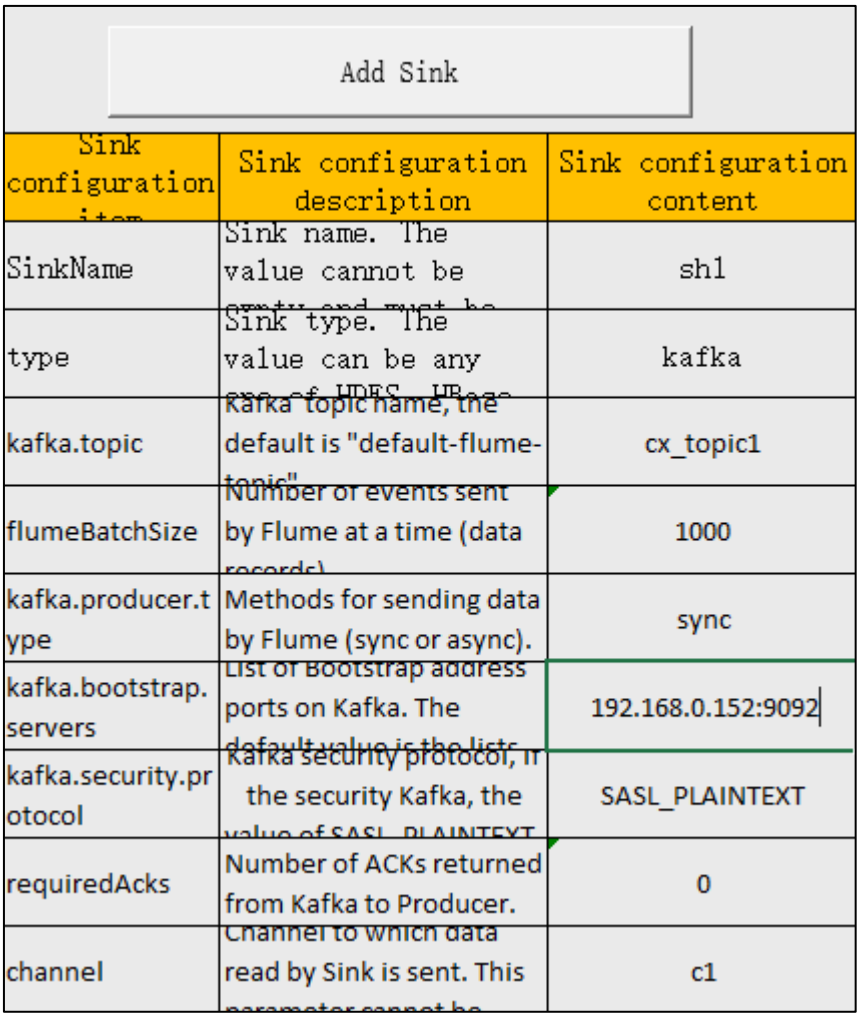


Figure 9-28

kafka.topic: cx_topic1

kafka.bootstrap.servers: 192.168.0.152:9092. If there are multiple Kafka instances in the cluster, you need to configure all of them. If the Kafka is installed in the cluster and configuration has been synchronized, you do not need to configure this parameter.

kafka.security.protocol: PLAINTEXT. The cluster used in this exercise is a non-security cluster.

After the configuration is complete, click **Generate a configuration file**.

Step 3 Create a Kafka topic.

Go to the Kafka directory **cd /opt/client/Kafka/kafka** and run the following command:

```
bin/kafka-topics.sh --create --zookeeper 192.168.0.151:2181/kafka --partitions 1 --replication-factor 1 --topic cx_topic1
```

```
^C[root@node-master1bBdj kafka]# bin/kafka-topics.sh  --create  --zookeeper 192.168.0.151:2181/kafka  --
rtitions  1  --replication-factor  1  --topic  cx_topic1
WARNING: Due to limitations in metric names, topics with a period ('.') or underscore ('_') could collid
e. To avoid issues it is best to use either, but not both.
Created topic "cx_topic1".
[root@node-master1bBdj kafka]#
```

Figure 9-29

Note: You can obtain the IP address of the ZooKeeper by referring to the related content in the Appendix.

Step 4 Upload the Flume configuration file.

Use WinSCP to upload **properties.properties** to the following directory:

```
/opt/FlumeClient/fusioninsight-flume-1.6.0/conf/
```

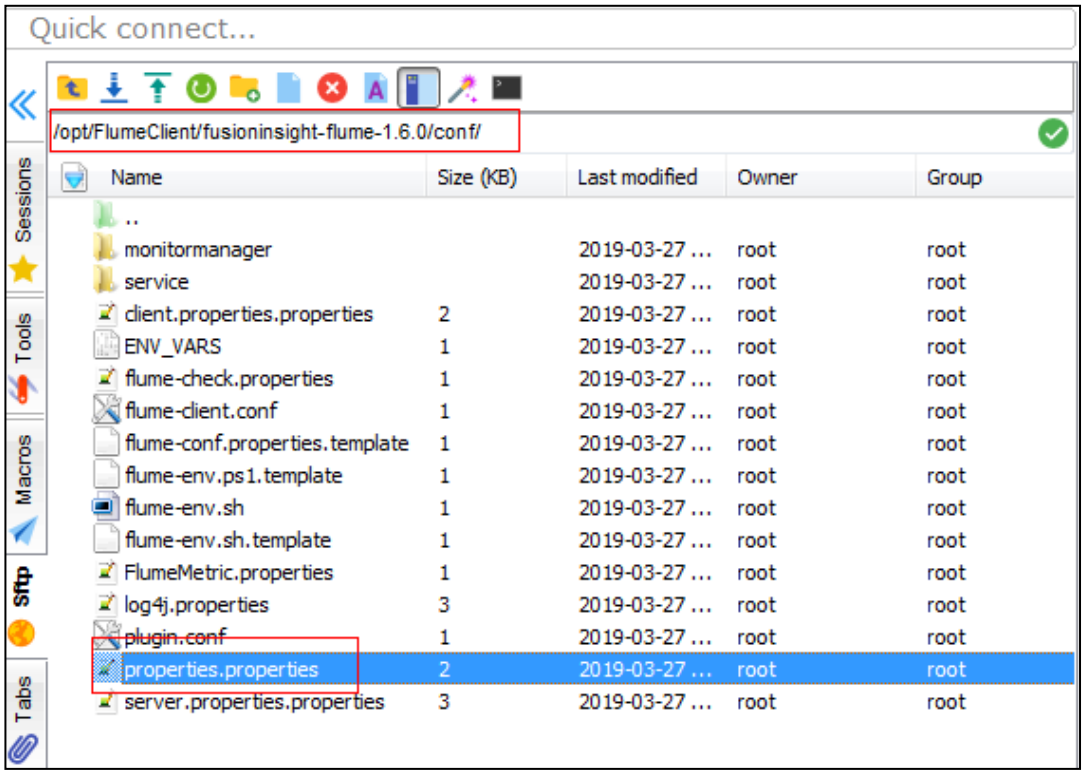


Figure 9-30

Note: The Flume client automatically loads the **properties.properties** file.

Step 5 Create a console consumer.

Run the following command in the Kafka directory:

```
bin/kafka-console-consumer.sh --topic cx_topic1 --bootstrap-server 192.168.0.152:9092 --new-
consumer --consumer.config config/consumer.properties
```

```
[root@node-master1jicC kafka]# bin/kafka-console-consumer.sh --topic topic-1001 --b
ootstrap-server 192.168.0.250:9092 --new-consumer --consumer.config config/consumer
.properties
The --new-consumer option is deprecated and will be removed in a future major relea
se.The new consumer is used by default if the --bootstrap-server option is provided
.
```

Figure 9-31

Note: The IP address of **bootstrap-server** corresponds to the IP address of the Kafka instance. You can obtain the IP address by referring to the related content in the Appendix.

After this command is executed, the **cx_topic1** data is consumed. Do not perform other operations in this window or close it.

Step 6 Test data.

On PuTTY, open a shell connection (do not close the consumer window that is just started) and go to the **/tmp/flume_spooldir** directory.

Run the **vi** command to edit the **testkafka.txt** file, enter any content, save the file, and exit.

```
[root@node-master1jicC flume_spooldir]# vi testkafka.txt
[root@node-master1jicC flume_spooldir]# cat testkafka.txt.COMPLETED
hello world
hello ketty
[root@node-master1jicC flume_spooldir]#
```

Figure 9-32

Step 7 View the result.

Switch back to the shell window of the consumer. The data output is displayed.

```
[root@node-master1bBdj kafka]# bin/kafka-console-consumer.sh --topic cx_topic1 --bootstrap-server 192.16
8.0.152:9092 --new-consumer --consumer.config config/consumer.properties
The --new-consumer option is deprecated and will be removed in a future major release.The new consumer i
s used by default if the --bootstrap-server option is provided.
hello world
hello ketty
```

Figure 9-33

9.4 Summary

This exercise mainly describes how to collect data using Flume SpoolDir and Avro sources. This exercise aims to help trainees better understand Flume by learning common offline and real-time data collection methods.

10 Loader Data Import and Export Practice

10.1 Background

Big data services often involve data migration, especially data migration between relational databases and big data components. Loader is often used to migrate data between MySQL and HDFS/HBase. The graphical operations of Loader make data migration easier.

10.2 Objectives

- Use Loader to migrate data in service scenarios.

10.3 Tasks

10.3.1 Task 1: Preparing MySQL Data

Step 1 Apply for the MySQL service.

Log in to the HUAWEI CLOUD website at https://www.huaweicloud.com/en-us/ and choose **Products** > **Database** > **RDS for MySQL**.

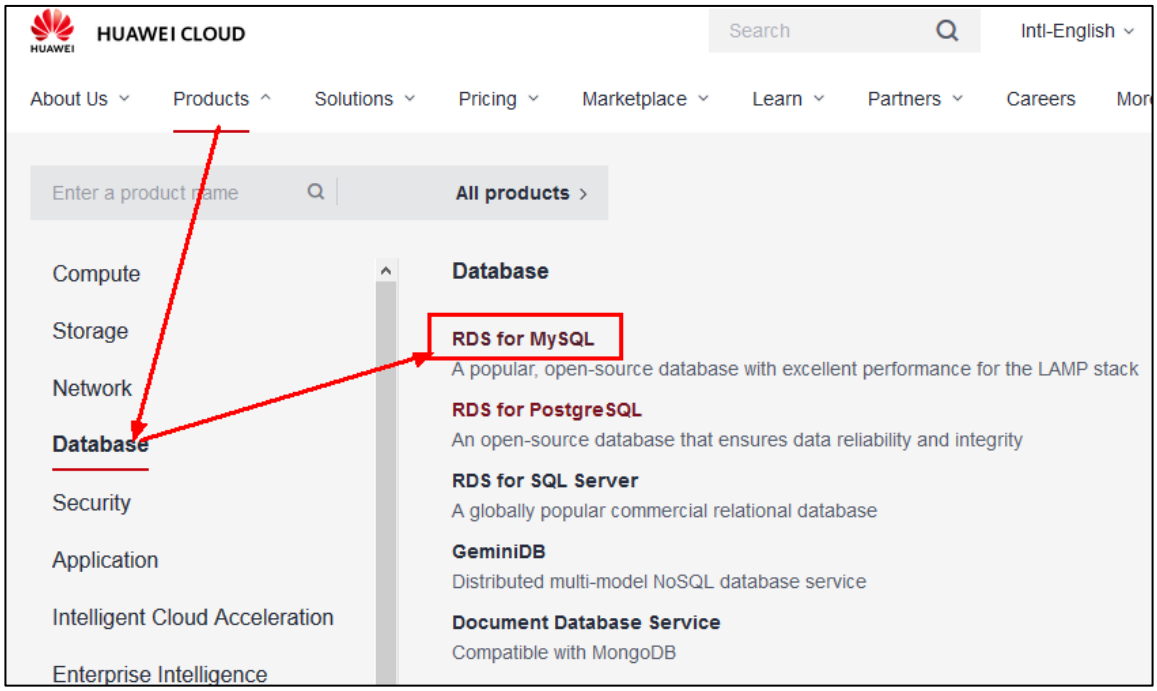


Figure 10-1

Click **Buy Now** and configure the database instance information as follows:

Billing Mode: Pay-per-use

Region: CN East-Shanghai2 (the same region as MRS)

DB Instance Name: Enter a custom name. In this exercise, **rds_loader** is used as an example. The instance name must start with a letter and contain 4 to 64 characters. Only letters, digits, hyphens (-), and underscores (_) are allowed.

DB Engine: MySQL

DB Engine Version: 5.6

DB Instance Type: Single

AZ: default value

Time Zone: default value

Instance Class: 1 vCPU | 2 GB

Storage Type: Ultra-high I/O

Storage Space: 40 GB

Disk Encryption: Disable

VPC: default value (the same network as MRS)

Security Group: default value (the same security group as MRS)

Administrator: root

Administrator Password: set the password as required.

Parameter Template: default value

Tag: not specified

Quantity: 1

Confirm the information and click **Next**.

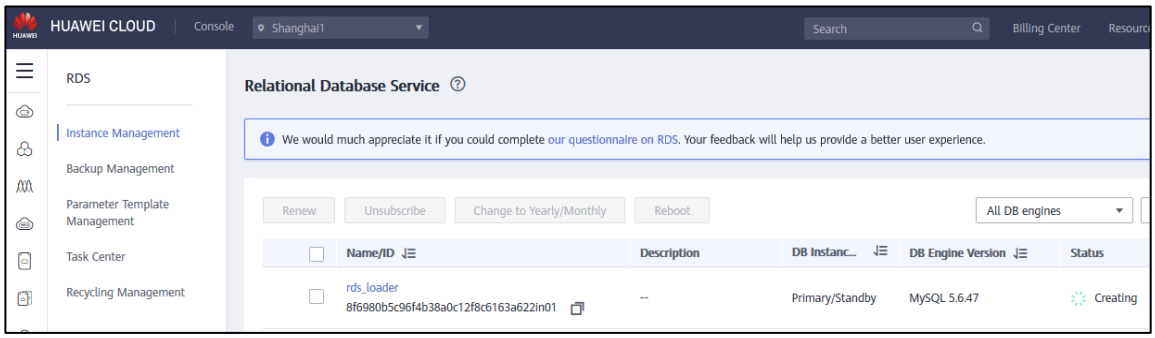


Figure 10-2

Step 2 Log in to MySQL.

After the RDS for MySQL DB instance is created, click **Log In** and enter username **root** and password to log in to the MySQL DB instance.

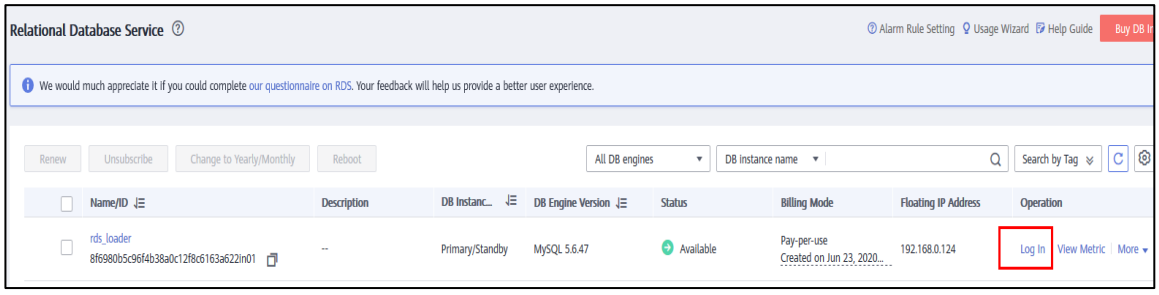


Figure 10-3

The MySQL data service management page is displayed.

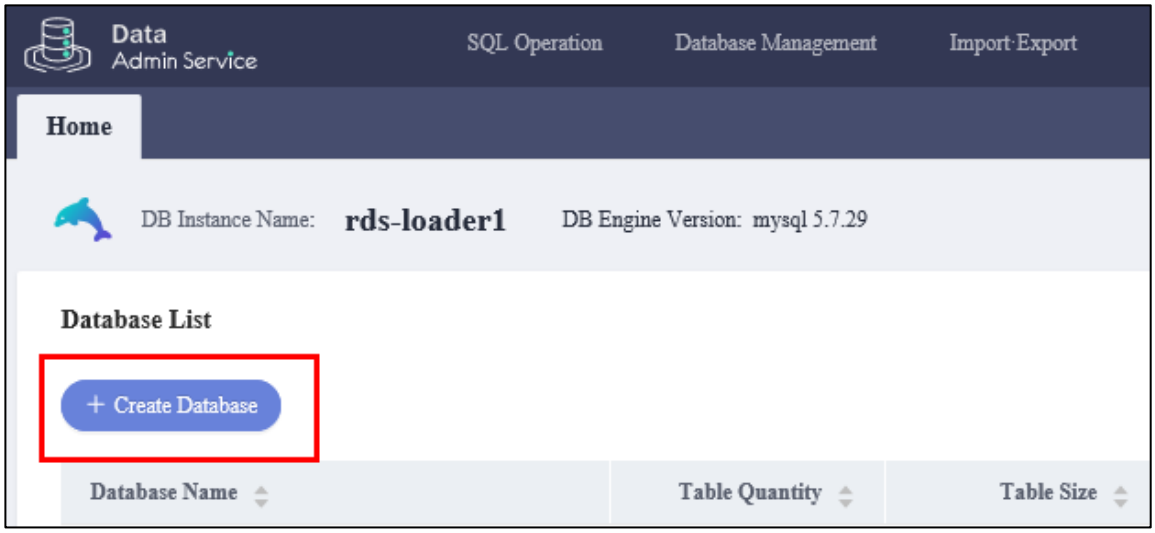


Figure 10-4

Step 3 Create a database.

Click **Create Database**, enter a database name, for example, **rdsdb**, set **Character Set** to **utf8**, and click **OK**.

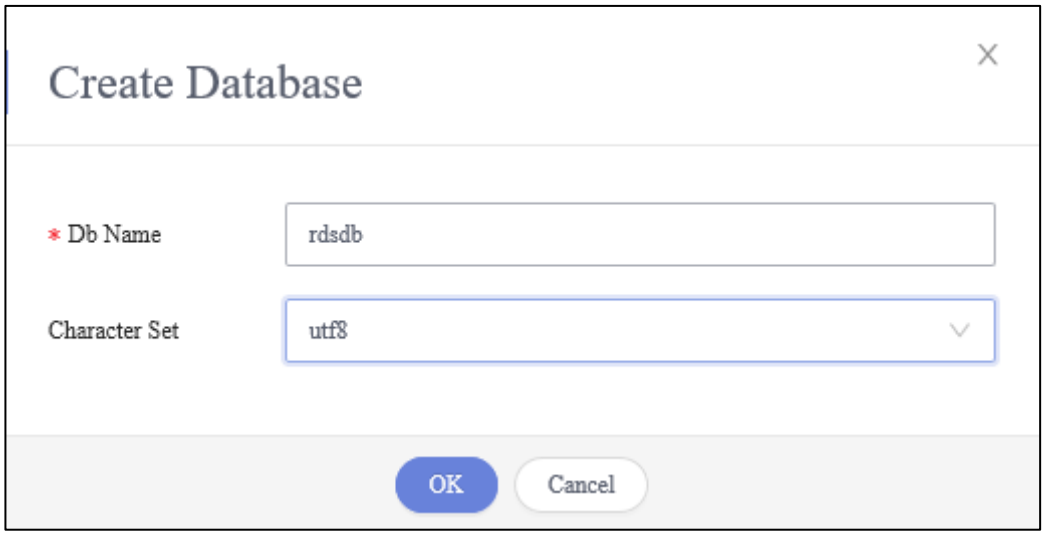


Figure 10-5

Step 4 Create a table.

In the list on the left, choose **rdsdb**. On the displayed page, click **Create Table**, name the table, and change the character set, as shown in the following figure:

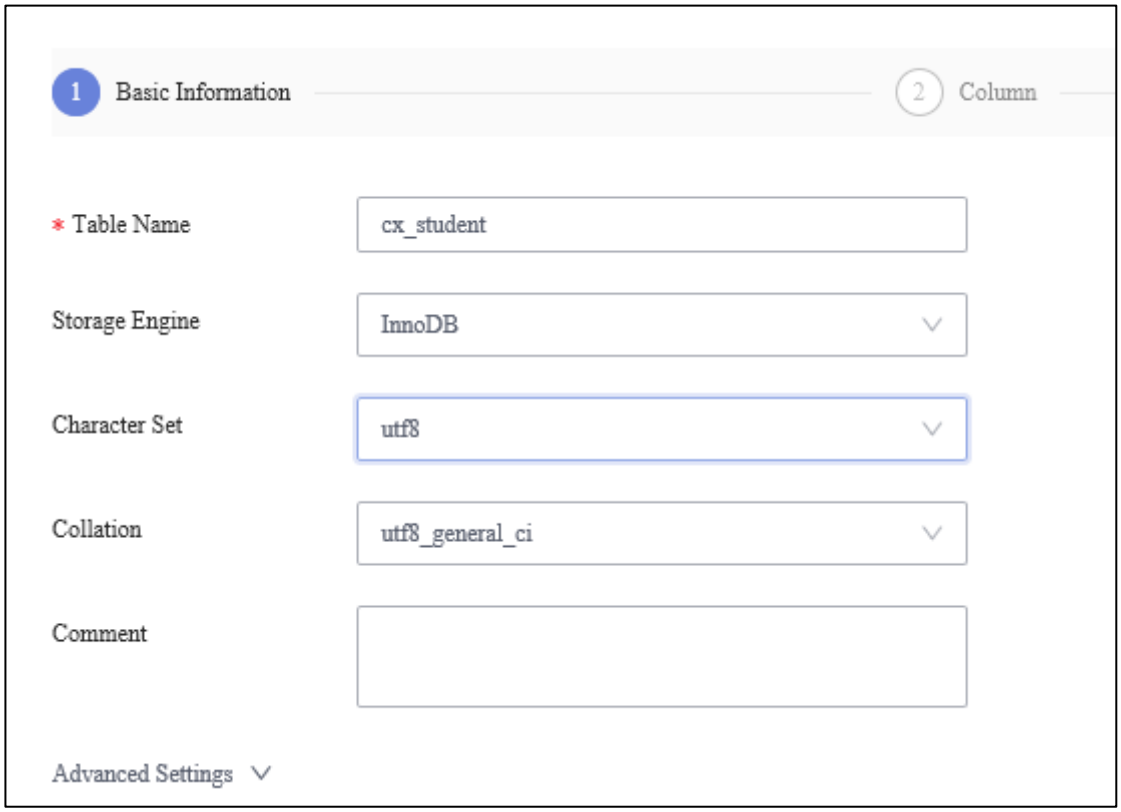


Figure 10-6

Click **Next**, and then **Add**, and set the fields as follows:

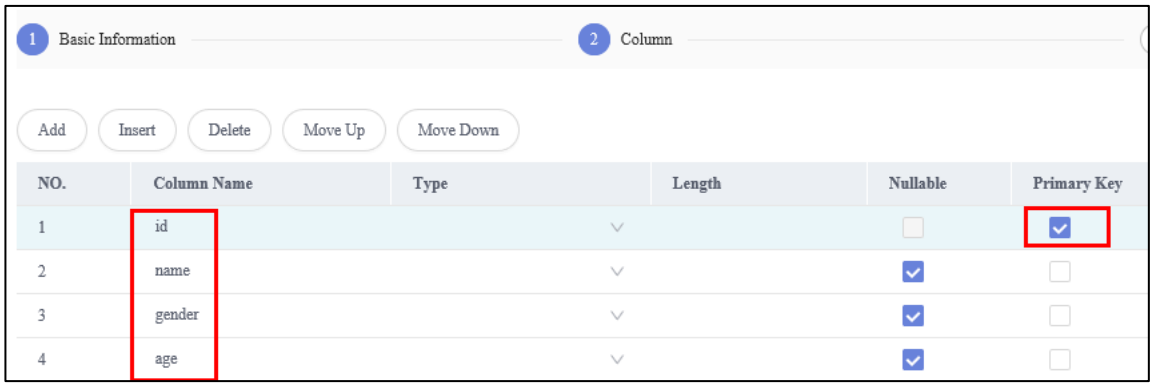


Figure 10-7

Set **id** to the primary key and click **Next**. Do not set the index and foreign key. Then click **Create Now**.

Figure 10-8

Click **Execute**.

Step 5 Insert data.

Click the SQL operation button in the upper part, select **SQL Window**, select the **rdsdb** database on the left, and enter the following statement in the SQL window:

```
insert into cx_student(id,name,gender,age) VALUES('1001','MacDonald','male','30');
insert into cx_student(id,name,gender,age) VALUES('1002','Calvin','male','25');
insert into cx_student(id,name,gender,age) VALUES('1003','Haley','female','18');
insert into cx_student(id,name,gender,age) VALUES('1004','Madonna','female','22');
insert into cx_student(id,name,gender,age) VALUES('1005','Randell','male','36');
```

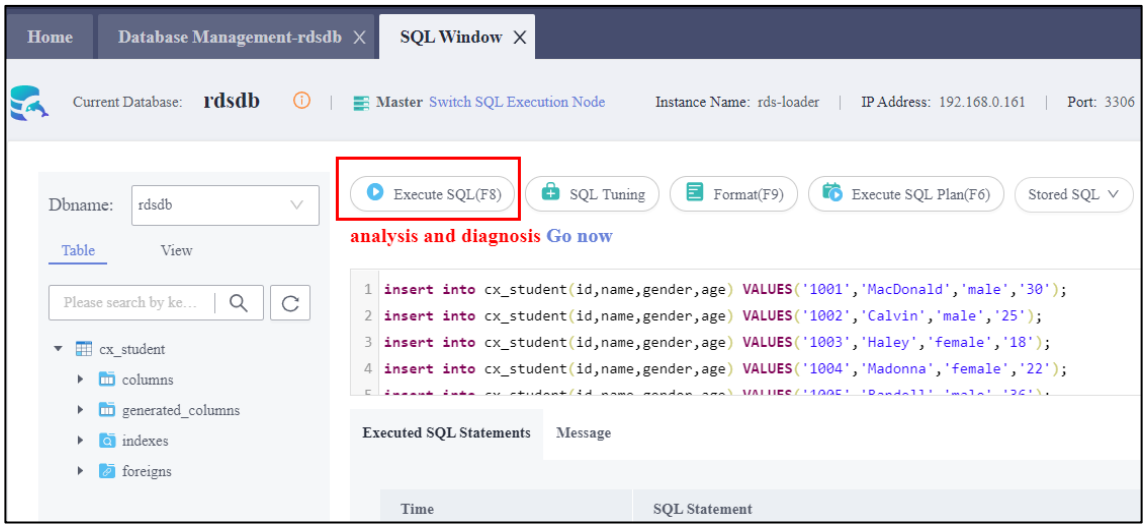


Figure 10-9

Click **Execute SQL** to insert data.

10.3.2 Task 2: Configuring the MySQL Driver of Loader

In the Loader service of MRS, the default MySQL connection JAR package is 5.1.12. Therefore, you need to update the MySQL connection JAR package.

Step 1 Download the MySQL driver package.

Visit http://mvnrepository.com/artifact/mysql/mysql-connector-java/5.1.21 to go to the maven repository and download the MySQL JDBC driver **mysql-connector-java-5.1.21.jar**. Make sure that the version number is the same. Click **jar** to download the driver.

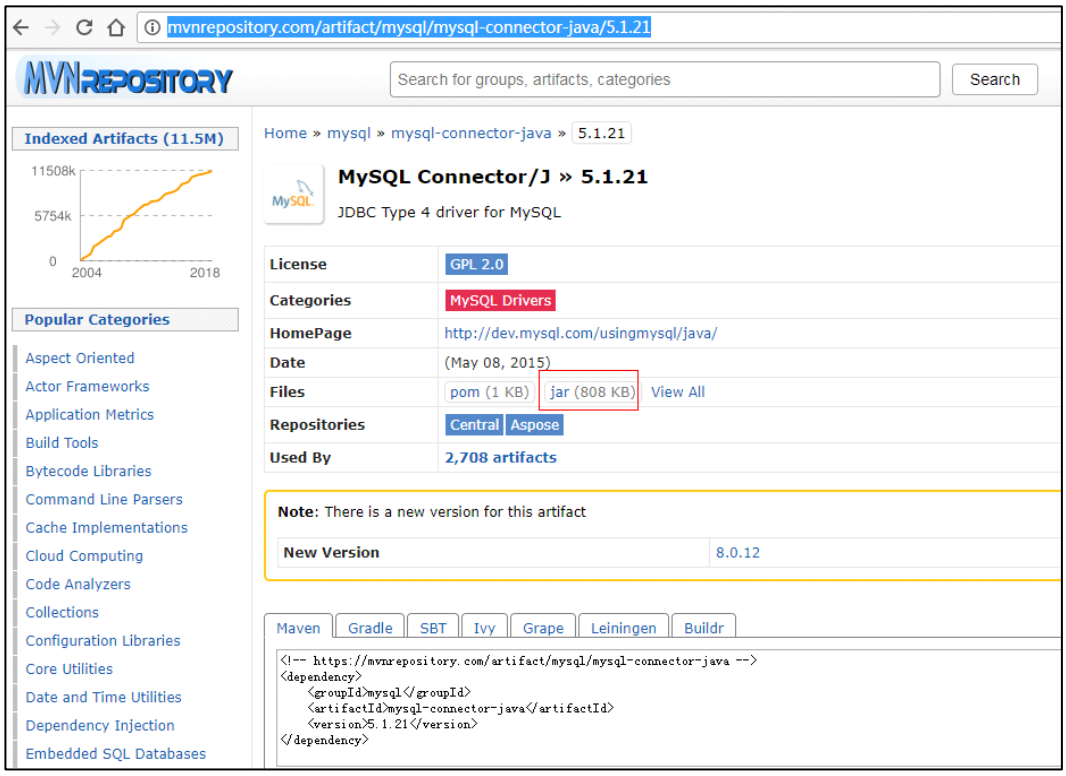


Figure 10-10

Step 2 Upload the JAR file.

Start WinSCP, connect to the master node, and upload the MySQL JAR package to the **/opt/Bigdata/MRS_2.1.0/1_18_Sqoop/install/FusionInsight-Sqoop-1.99.7/server/jdbc** directory.

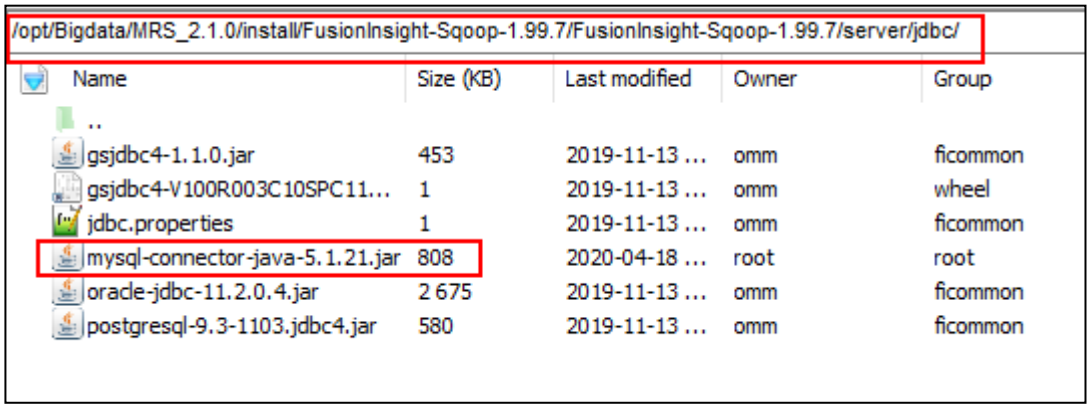


Figure 10-11

Note: If the MRS cluster is highly available, upload the package to each master node. In this exercise, the HA function is not enabled for the MRS cluster. You only need to upload the package to one master node.

Step 3 Modify the properties of mysql-connector-java-5.1.21.jar.

Start PuTTY, go to the /opt/Bigdata/MRS_2.1.0/1_18_Sqoop/install/FusionInsight-Sqoop-1.99.7/server/jdbc directory, and change the owner of the mysql-connector-java-5.1.21.jar package to omm:wheel.

Run the following command:

```
chown omm:wheel mysql-connector-java-5.1.21.jar
```

After the modification, run the **ll** command to view the result.

```
[root@node-master1bBdj jdbc]# chown omm:wheel mysql-connector-java-5.1.21.jar
[root@node-master1bBdj jdbc]# ll
total 4536
-rw-------. 1 omm ficommon  463904 Nov 13 19:46 gsjdbc4-1.1.0.jar
lrwxrwxrwx. 1 omm wheel         66 Nov 13 20:29 gsjdbc4-V100R003C10SPC115.jar -> /opt/share/gsjdbc4-V100R0
03C10SPC115/gsjdbc4-V100R003C10SPC115.jar
-rw-------. 1 omm ficommon     171 Nov 13 19:46 jdbc.properties
-rw-r-----. 1 omm wheel     827942 Apr 18 21:27 mysql-connector-java-5.1.21.jar
-rw-------. 1 omm ficommon 2739670 Nov 13 19:46 oracle-jdbc-11.2.0.4.jar
-rw-------. 1 omm ficommon  594361 Nov 13 19:46 postgresql-9.3-1103.jdbc4.jar
[root@node-master1bBdj jdbc]#
```

Figure 10-12

Note: If the MRS cluster is highly available, you need to modify this attribute on each master node. In this exercise, the HA function is not enabled for the MRS cluster. You only need to modify the attribute for server master nodes.

Step 4 Modify the **jdbc.properties** configuration file on the master node.

Modify the **jdbc.properties** file in the folder in the previous step. Change the key value of MySQL to the name of the uploaded JDBC driver package **mysql-connector-java-5.1.21.jar**. If the name is already **mysql-connector-java-5.1.21.jar**, you do not need to change it.

```
[root@node-master1jicC jdbc]# more jdbc.properties
GAUSSDB=gsjdbc4-V100R003C10SPC115.jar
POSTGRESQL=postgresql-9.1-901.jdbc4.jar
MYSQL=mysql-connector-java-5.1.21.jar
ORACLE=oracle-jdbc-11.2.0.4.jar
MPPDB=gsjdbc4-1.1.0.jar
[root@node-master1jicC jdbc]#
```

Figure 10-13

Note: If the MRS cluster is in HA mode, you need to change the value of this parameter on each master node. In this exercise, the HA function is not enabled for the MRS cluster. You only need to change the value of this parameter on one master node.

Step 5 Restart the Loader service.

Log in to the MRS management page. On the **Services** tab page, click **Loader**.

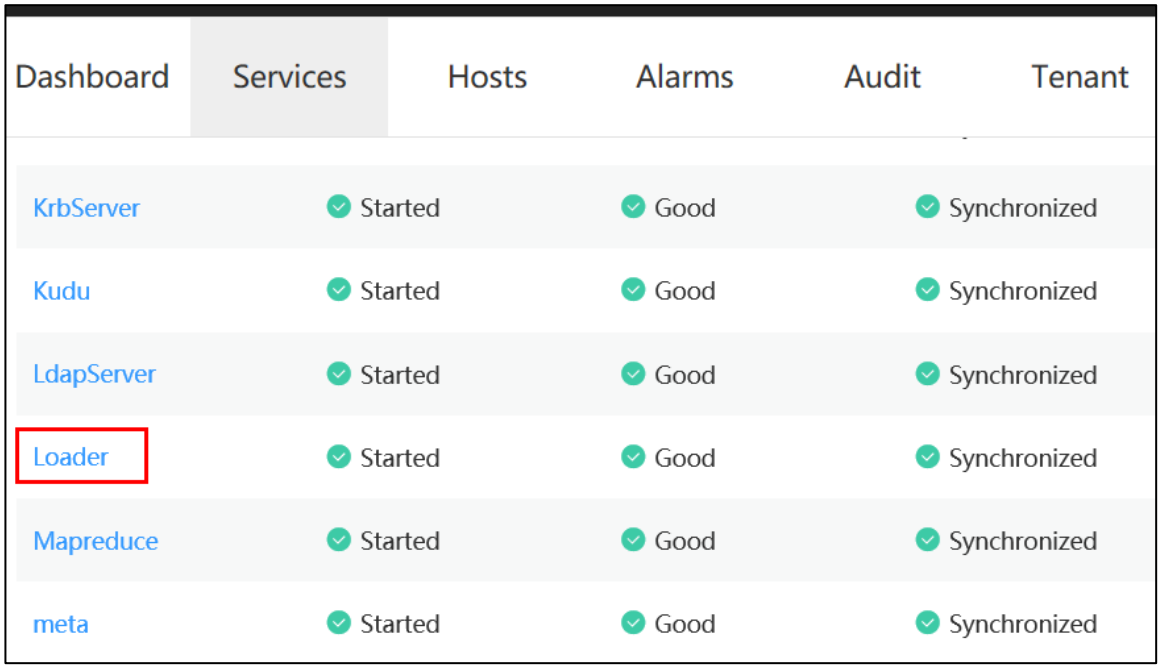


Figure 10-14

Choose **More > Restart Service**.

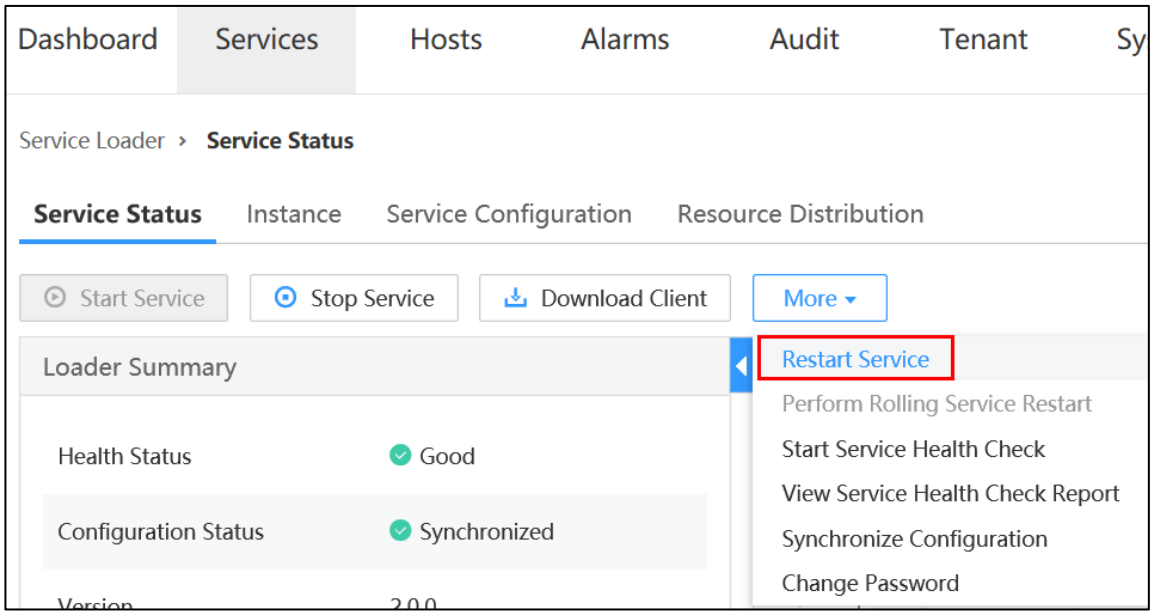


Figure 10-15

Enter the verification password and click **OK**. In the **Restart Service** dialog box, select **Restart all upper-layer services**, and wait for the service to restart.

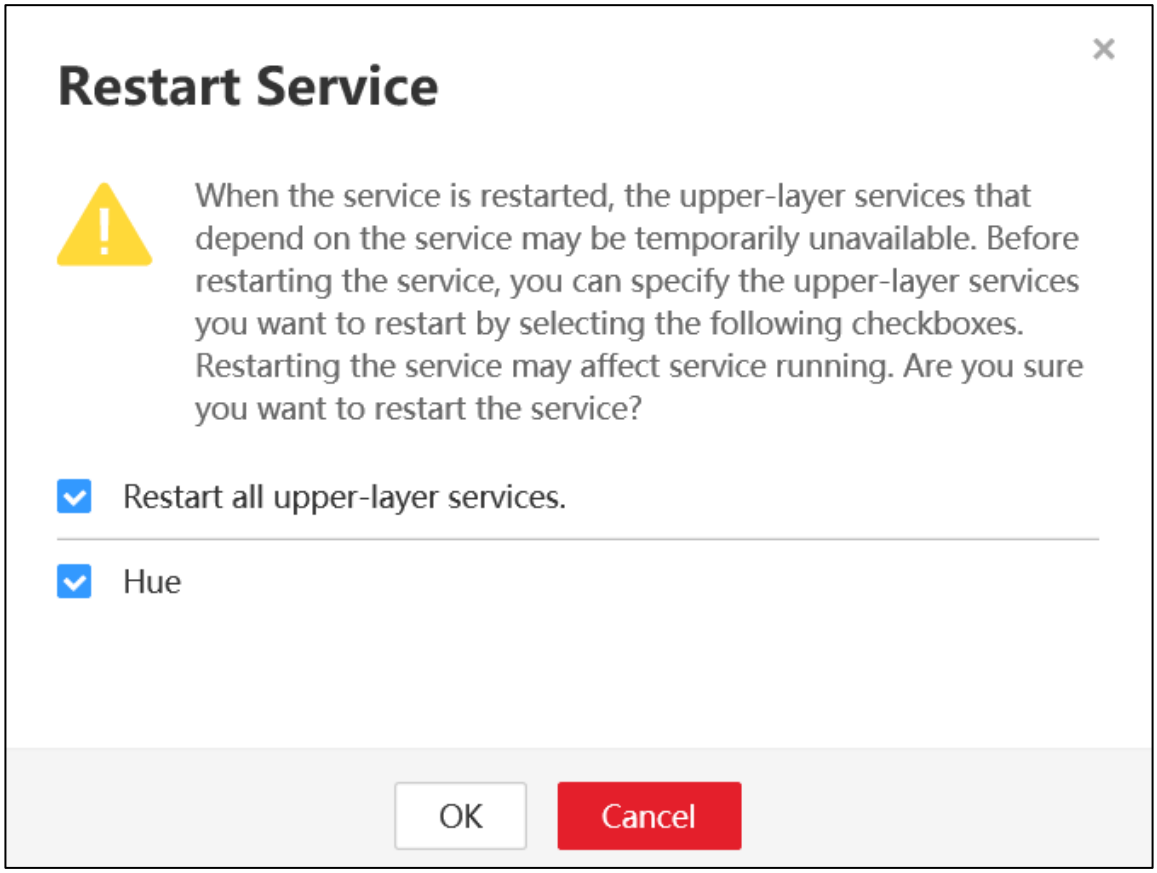


Figure 10-16

Wait for the service to restart.

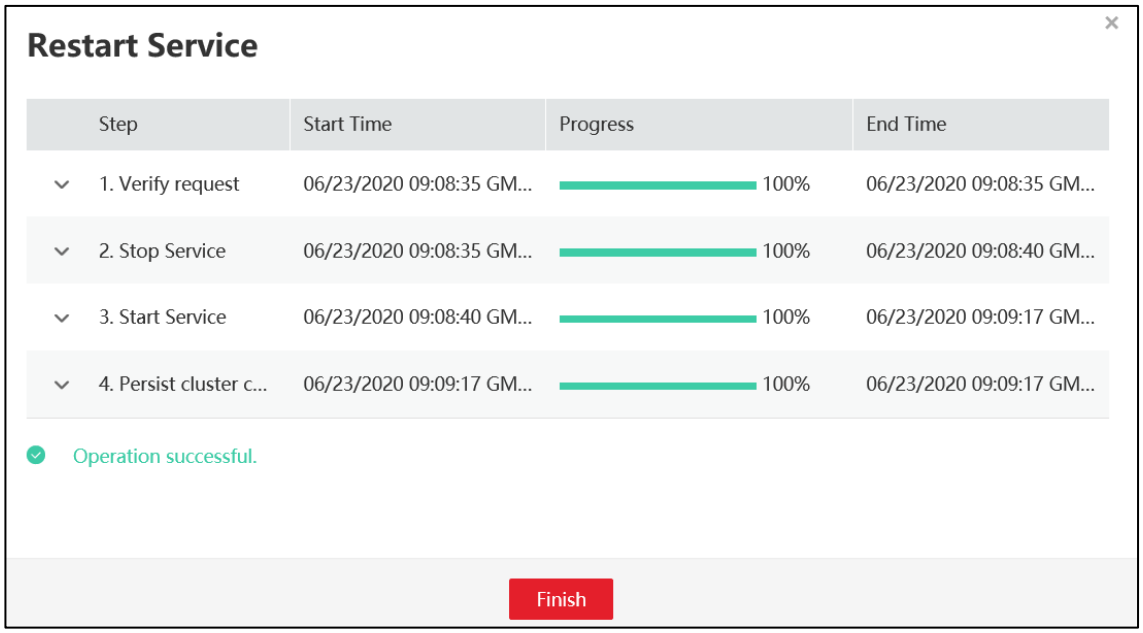


Figure 10-17

10.3.3 Task 3: Creating a Loader Link

Step 1 Log in to Hue.

Log in to MRS Manager and choose **Service Hue**> **Service Status**. Click **Hue (Active)** to access the Hue page.

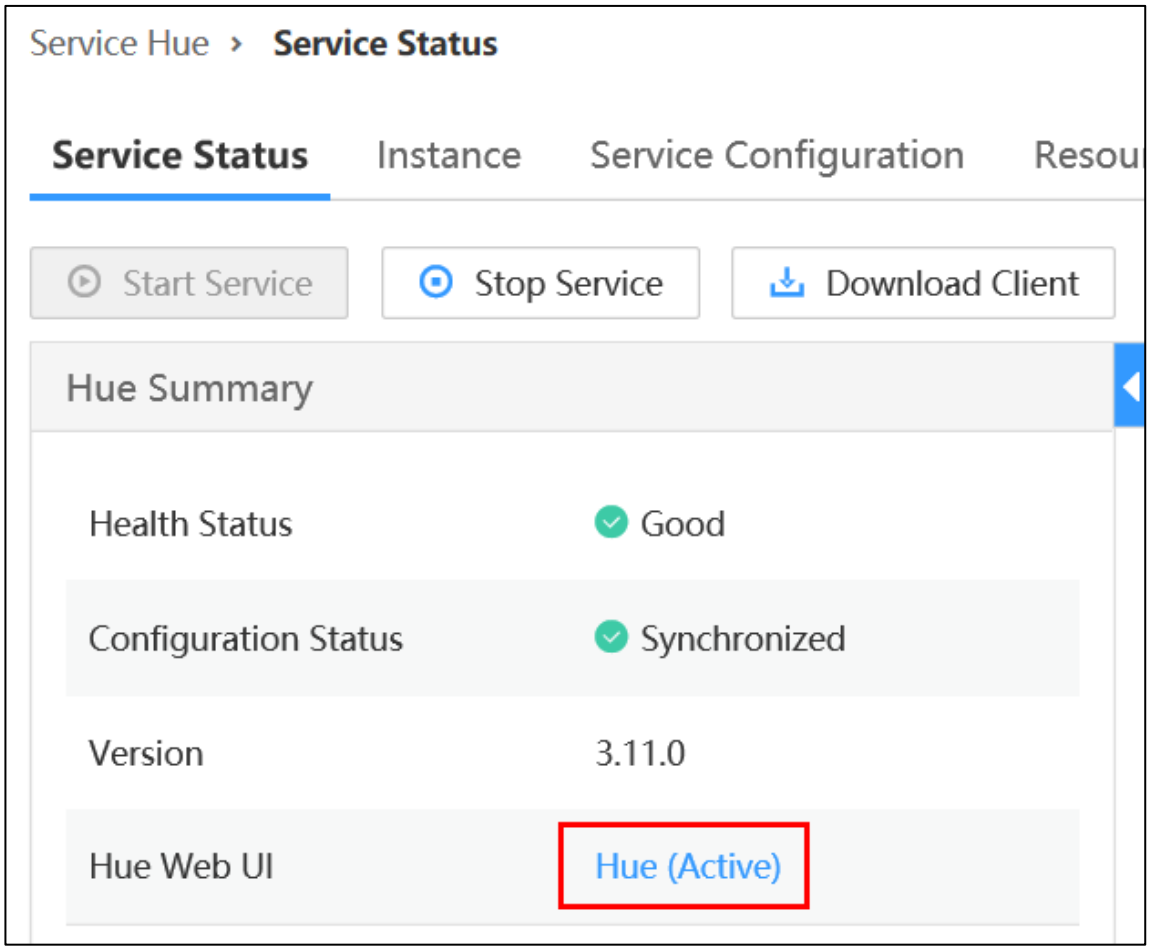


Figure 10-18

Step 2 Access Sqoop.

The open-source framework Sqoop is Loader in Huawei products. Click **Sqoop** in the **Data Browsers** drop-down list. The Sqoop page is displayed.

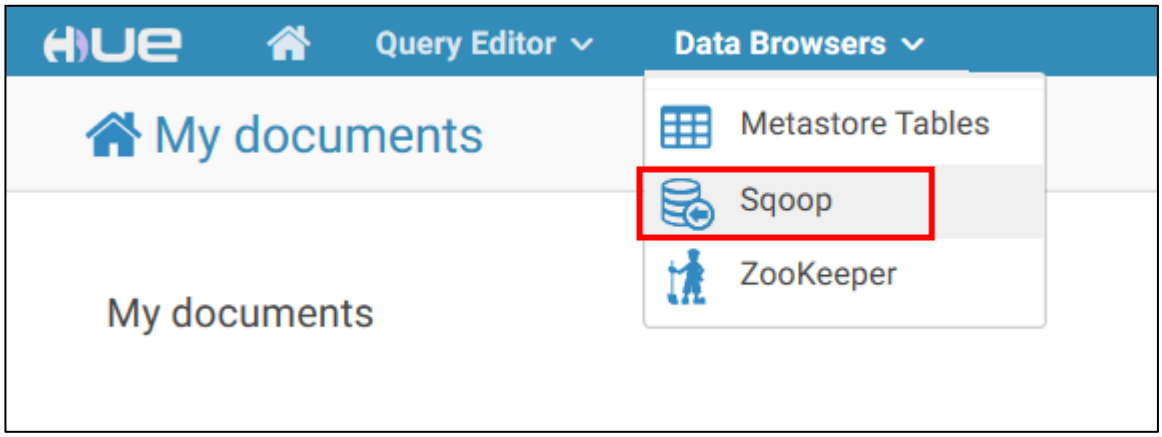


Figure 10-19

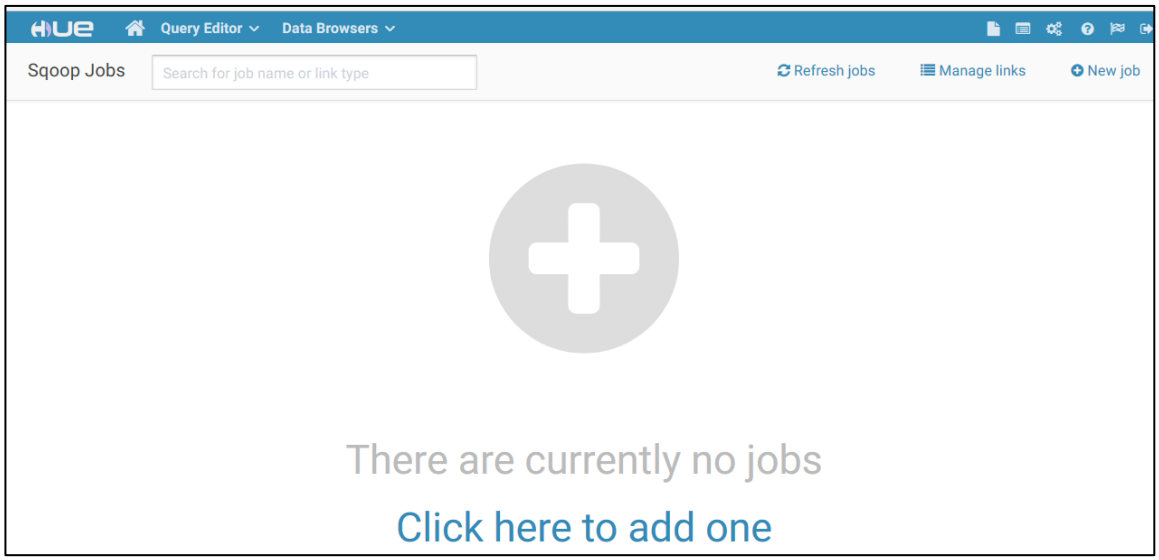


Figure 10-20

Step 3 Create a MySQL link.

In the upper right corner, choose **Manage links** > **New link**.

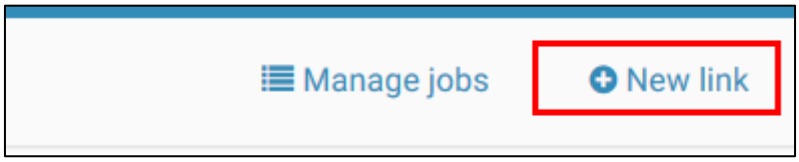


Figure 10-21

Name: cx_mysql_conn

Connector: generic-jdbc-connector

Database type: MySQL

Host: Enter the private IP address of the MySQL instance, as shown in the following figure:

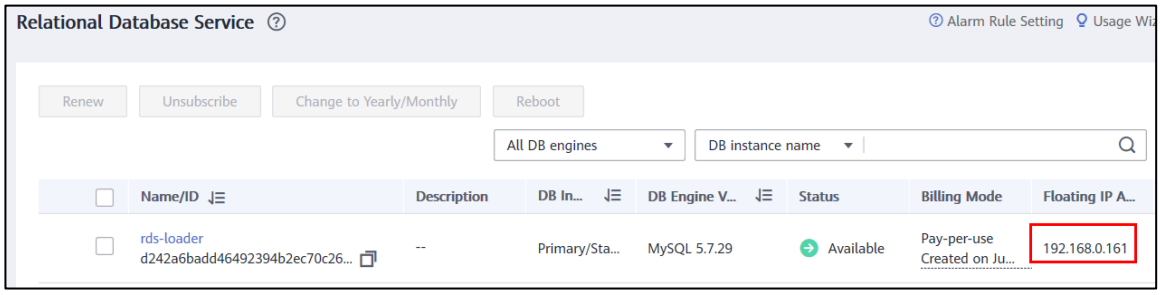


Figure 10-22

Port: 3306

Database: rdsdb

Username: root

Password: the password of user **root** set when you apply for the MySQL service

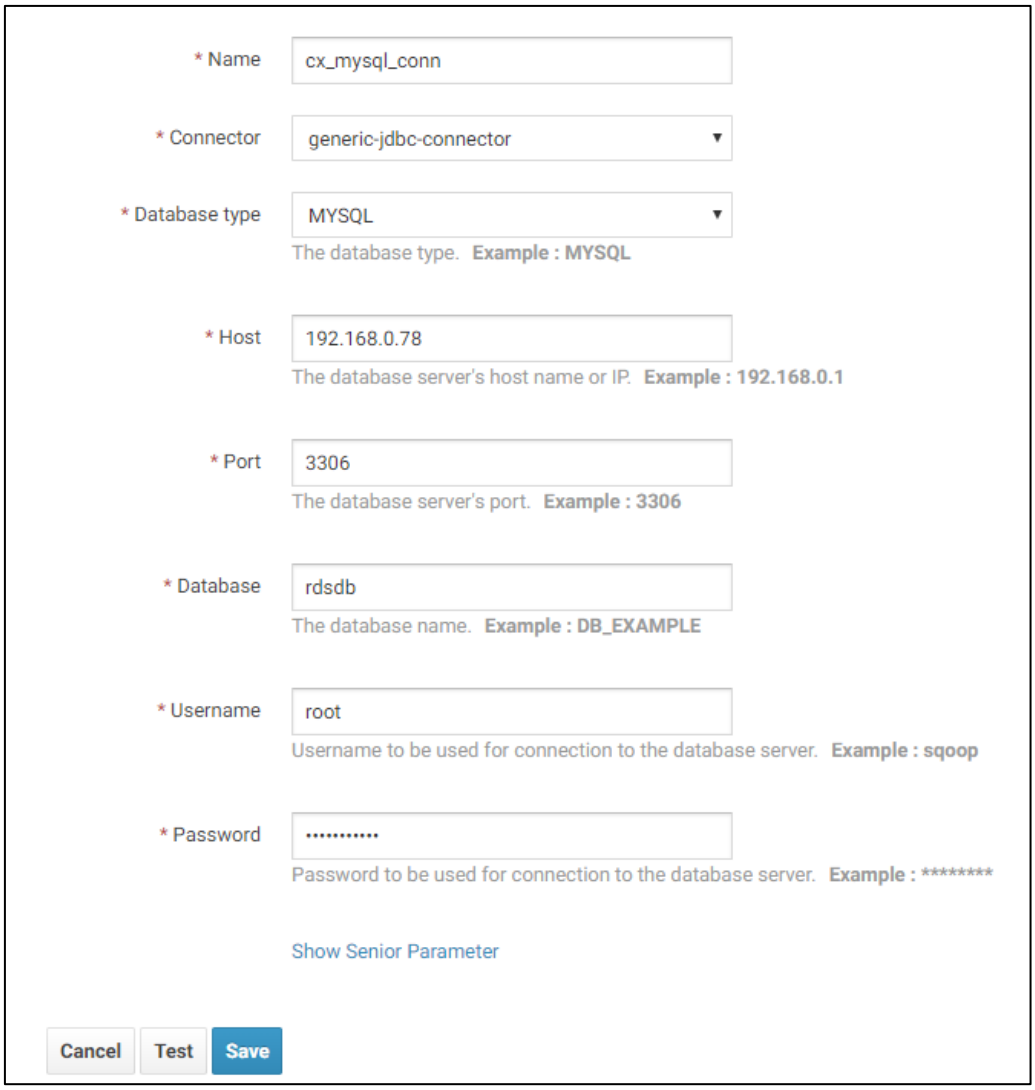

* Name
cx_mysql_conn
* Connector
generic-jdbc-connector
* Database type
MYSQL
The database type. Example : MYSQL
* Host
192.168.0.78
The database server's host name or IP. Example : 192.168.0.1
* Port
3306
The database server's port. Example : 3306
* Database
rdsdb
The database name. Example : DB_EXAMPLE
* Username
root
Username to be used for connection to the database server. Example : sqoop
* Password
Password to be used for connection to the database server. Example : ********
Show Senior Parameter
Cancel
Test
Save

Figure 10-23

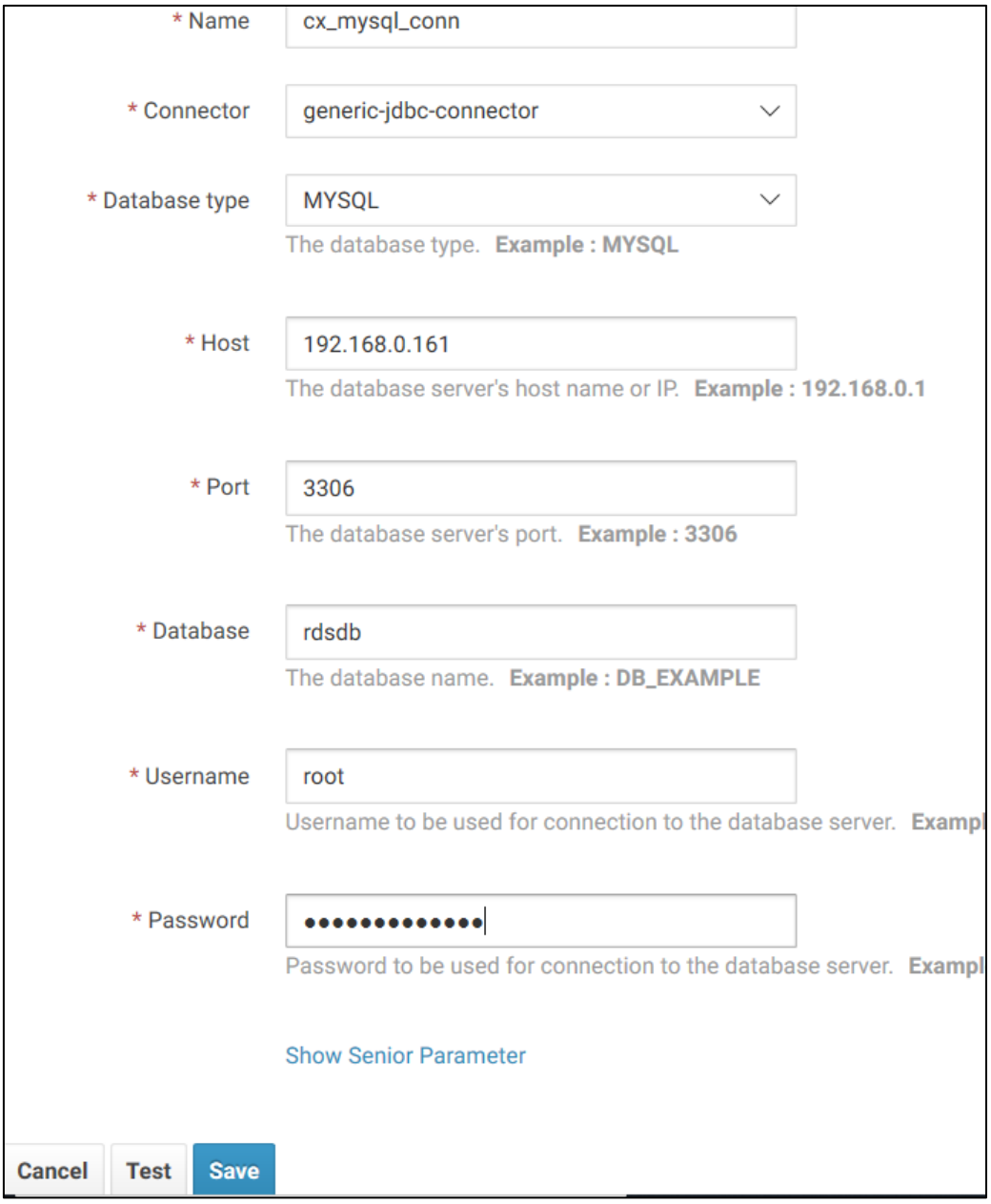


Figure 10-24

After the configuration is complete, click **Test**. If the testing succeeds, click **Save**. The MySQL link is created.

Step 4 Create a HBase link.

Click **New link** and set the parameters as follows:

Name: cx_hbase_conn

Connector: hbase-connector

After the configuration is complete, click **Test**. If the testing succeeds, click **Save**.

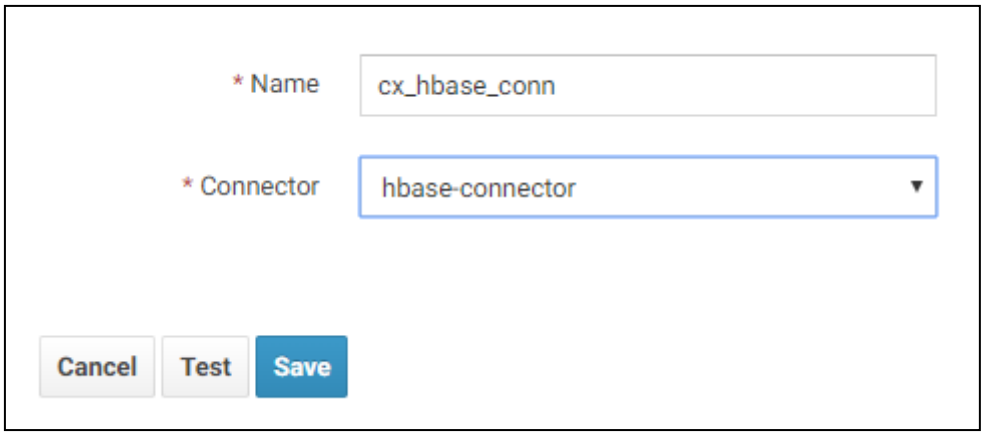


Figure 10-25

Step 5 Create a Hive link.

Click **New link** and set the parameters as follows:

Name: cx_hive_conn

Connector: hive-connector

After the configuration is complete, click **Test**. If the testing succeeds, click **Save**.

Figure 10-26

Step 6 Create an HDFS link.

Click **New link** and set the parameters as follows:

Name: cx_hdfs_conn

Connector: hdfs-connector

After the configuration is complete, click **Test**. If the testing succeeds, click **Save**.

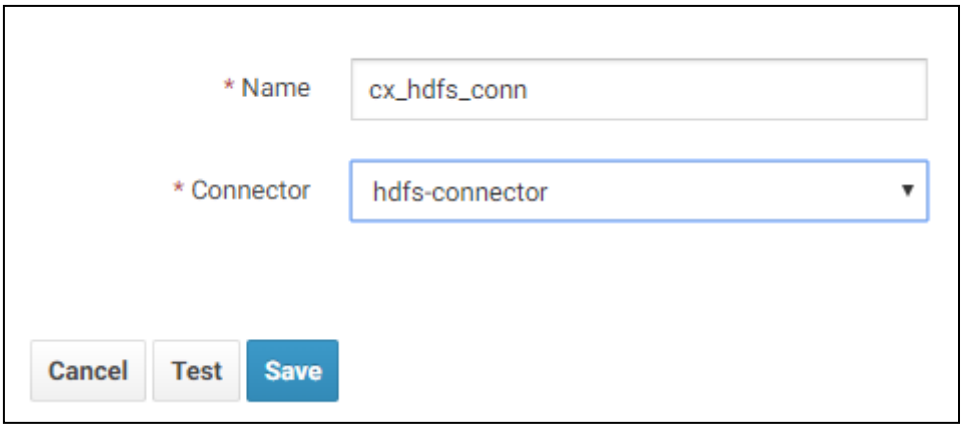


Figure 10-27

10.3.4 Task 4: Importing MySQL Data to HDFS

Step 1 Prepare MySQL data.

MySQL tables and data have been prepared in task 1. The data is as follows:

Executed SQL Statements | Message | Result Set1

The following is the execution result set of SELECT * FROM cx_student.

Click on the cell to edit the data. After adding or editing, you need to submit and save the changes.

Copy Row | Copy | Column Settings

	id	name	gender	age
1	1001	MacDonald	male	30
2	1002	Calvin	male	25
3	1003	Haley	female	18
4	1004	Madonna	female	22
5	1005	Randell	male	36

Figure 10-28

Step 2 Log in to Hue and create a job.

On the Sqoop page of Hue, click **Create Job** and set the parameters as follows:

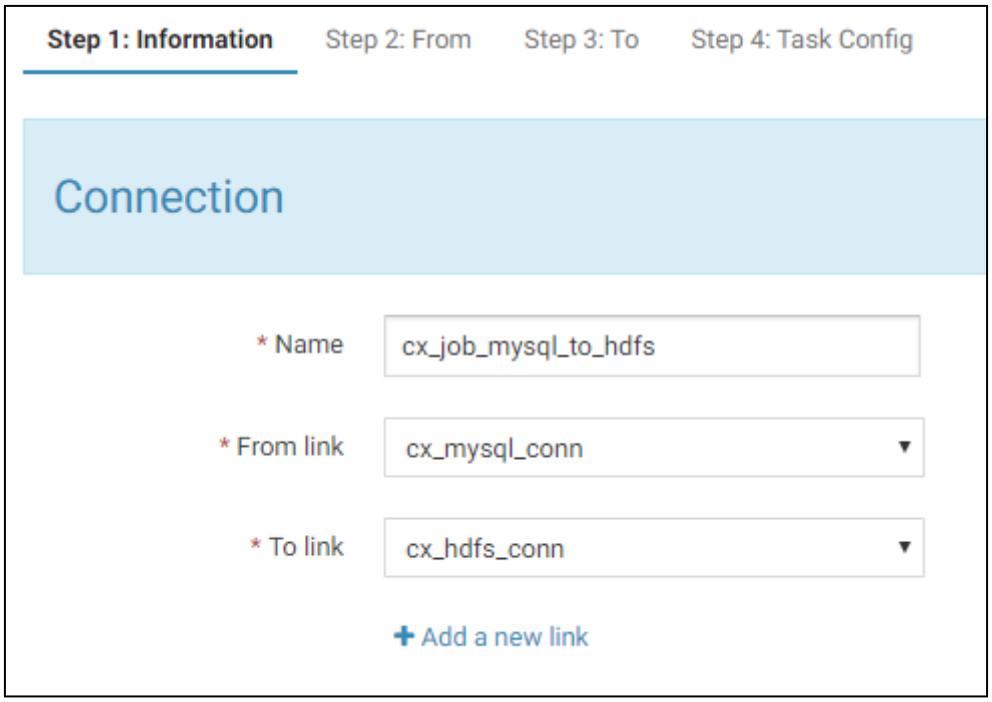


Figure 10-29

Click **Next**.

Step 3 Configure MySQL.

Set **Schema name** to **rdsdb**, **Table name** to **cx_student**, and **Partition column** to **id**, as shown in the following figure:

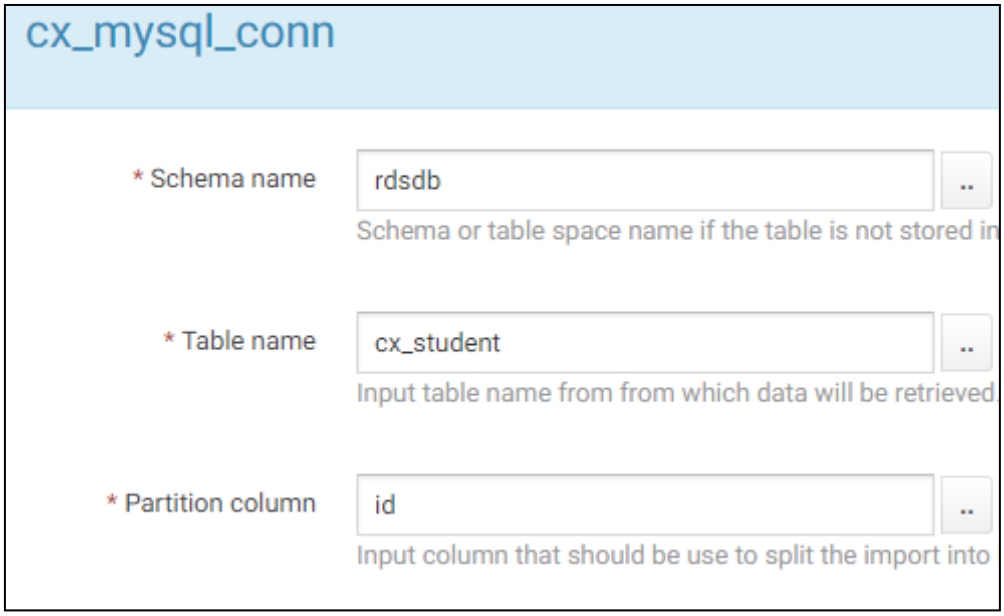


Figure 10-30

Click **Next**.

Step 4 Configure HDFS.

Set **Output directory** to the **/user/stu01/output2** directory. Retain the default values for other parameters, as shown in the following figure:

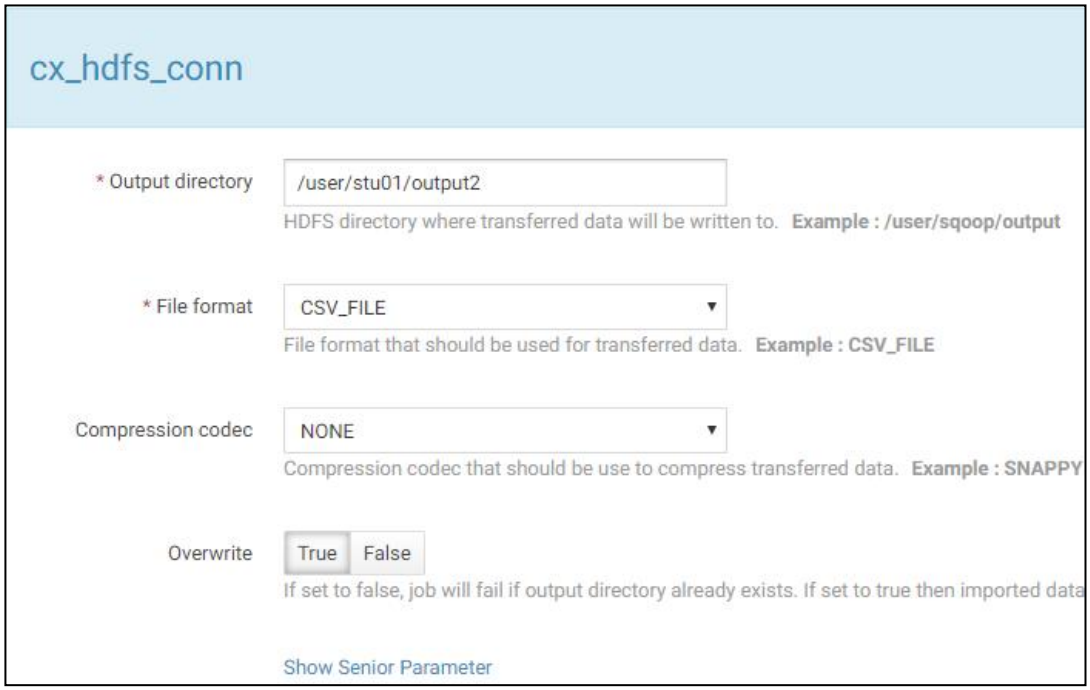


Figure 10-31

Note: If **output2** does not exist, the system automatically creates one.

Step 5 Configure a task.

Set Extractors to 1 and click Save and execute.

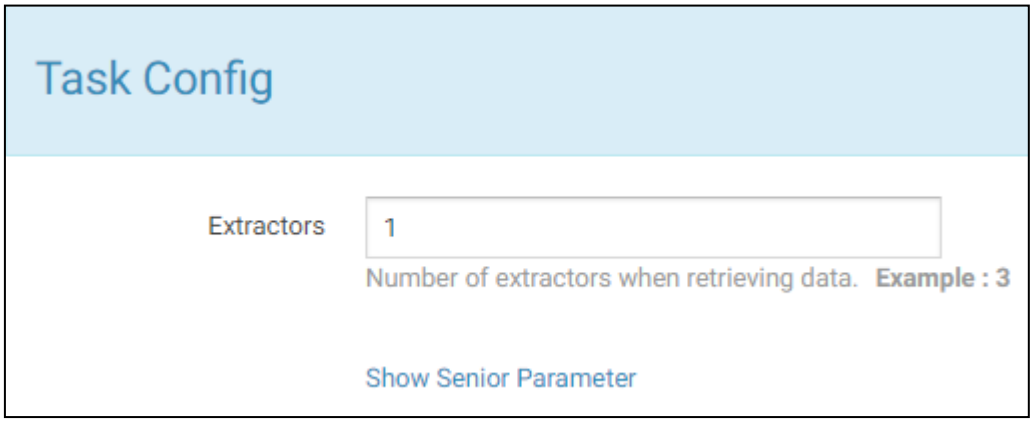


Figure 10-32

The task is successfully run.

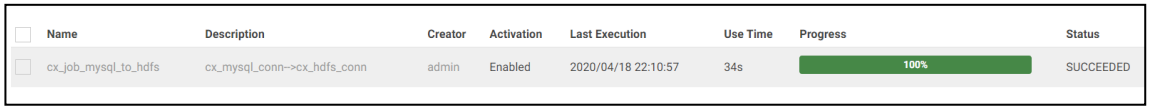


Figure 10-33

Step 6 View the result.

Use PuTTY to log in to the master node and go to the HDFS directory to view data files.

```
[root@node-master1bBdj ~]# source /opt/client/bigdata_env
[root@node-master1bBdj ~]# hdfs dfs -ls /user/stu01/output2
2020-04-18 22:12:37,811 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 1 items
-rw-r-----   3 loader hadoop        108 2020-04-18 22:10 /user/stu01/output2/cx_job_mysql_to_hdfs-2020-04-
18_22.10.50.314.csv
[root@node-master1bBdj ~]# hdfs dfs -cat /user/stu01/output2/cx_job_mysql_to_hdfs-2020-04-18_22.10.50.314.
csv
2020-04-18 22:12:59,531 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
1001,MacDonald,male,30
1002,Calvin,male,25
1003,Haley,female,18
1004,Madonna,female,22
1005,Randell,male,36
[root@node-master1bBdj ~]#
```

Figure 10-34

10.3.5 Task 5: Importing MySQL Data to Hive

Step 1 Prepare a MySQL table.

Use the **cx_student** table data as the MySQL data.

Step 2 Create a table in Hive.

Use PuTTY to log in to a master node, go to Hive, and run the following statement to create a table:

```
create table cx_loader_stu01(id int,name string,gender string ,age int) row format delimited fields terminated by ',' stored as textfile ;
```

```
0: jdbc:hive2://192.168.0.151:2181/> create  table  cx_loader_stu01(id int,name string,gender string ,age int) row
format delimited fields terminated by ',' stored as textfile ;
INFO  : Compiling command(queryId=omm_20200418221616_920bce3e-b989-4c1a-beee-aafa9496be79): create  table  cx_loade
r_stu01(id int,name string,gender string ,age int) row format delimited fields terminated by ',' stored as textfile
INFO  : Concurrency mode is disabled, not creating a lock manager
INFO  : Semantic Analysis Completed (retrial = false)
INFO  : Returning Hive schema: Schema(fieldSchemas:null, properties:null)
INFO  : EXPLAIN output for queryid omm_20200418221616_920bce3e-b989-4c1a-beee-aafa9496be79 : STAGE DEPENDENCIES:
  Stage-0 is a root stage [DDL]
```

Figure 10-35

Step 3 Log in to Hue and create a job.

Click **Create** Job and set the parameters as follows:

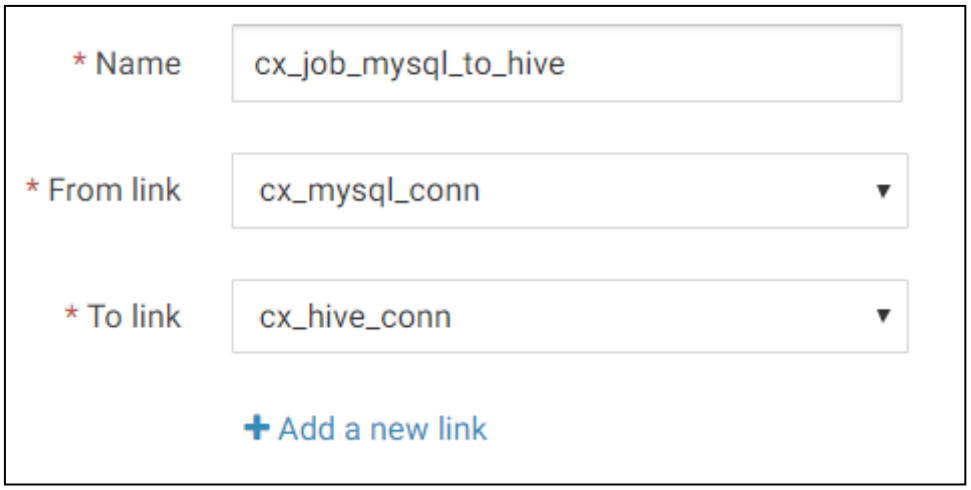


Figure 10-36

Click **Next**.

Step 4 Configure MySQL.

Set **Schema name** to **rdsdb**, **Table name** to **cx_student**, and **Partition column** to **id**, as shown in the following figure:

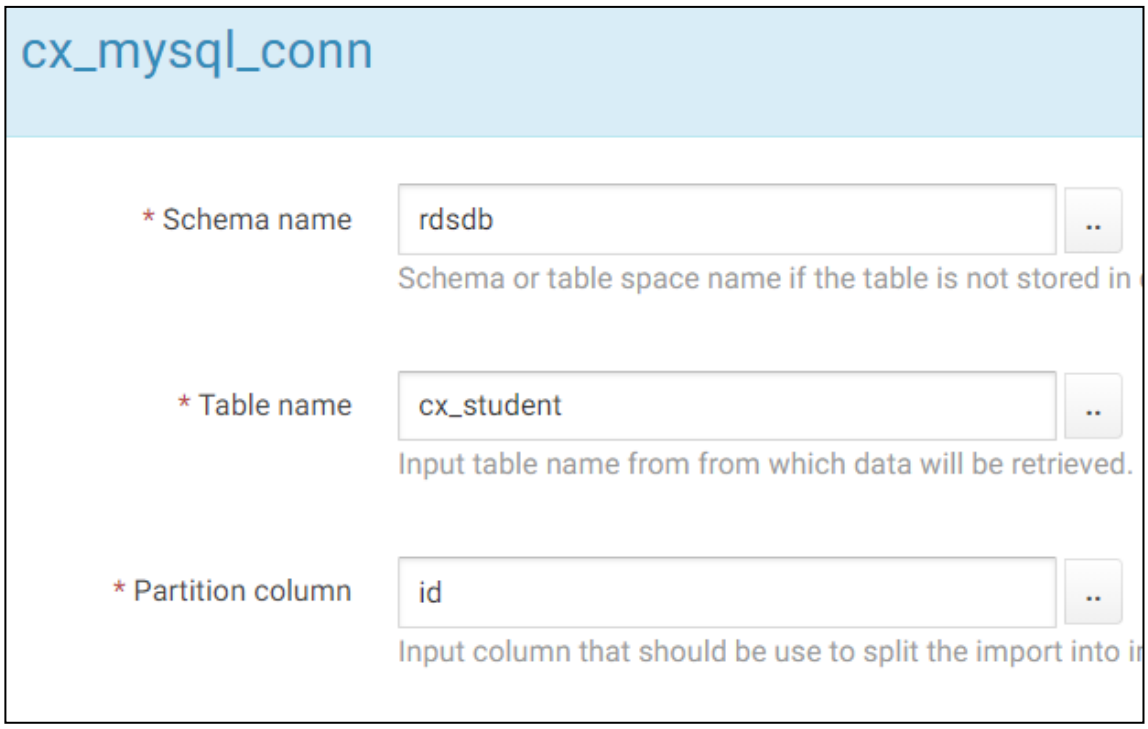


Figure 10-37

Click **Next**.

Step 5 Configure Hive.

Retain the default database name **default** and set **Table** to **cx_loader_stu01**, as shown in the following figure:

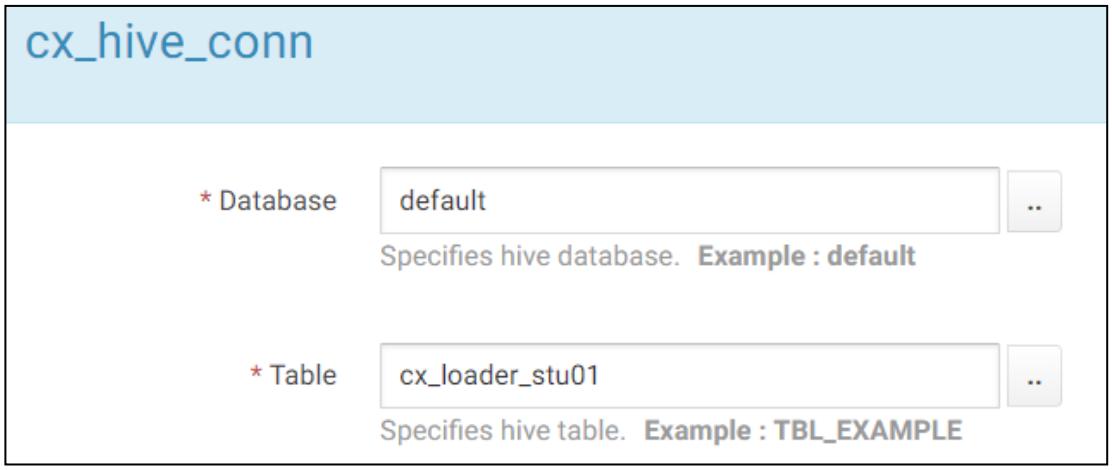


Figure 10-38

Step 6 Configure the field mapping.

Retain the default settings.

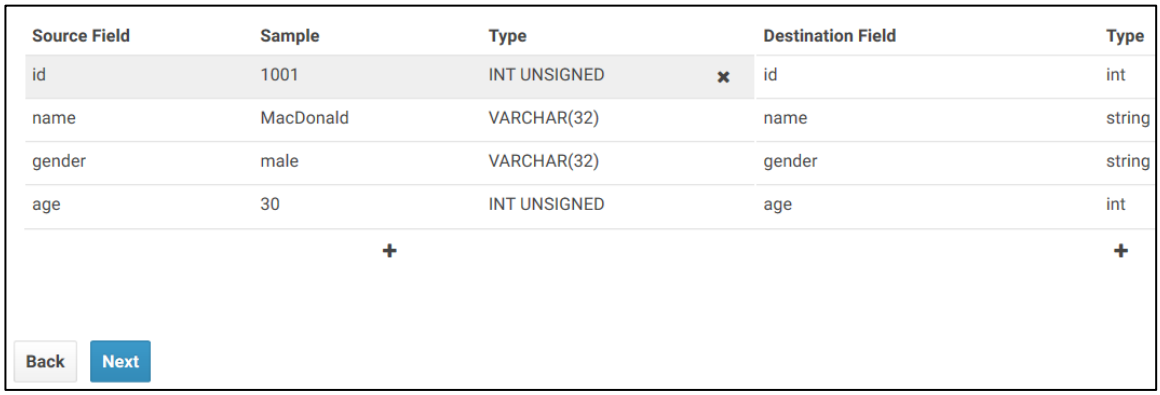


Figure 10-39

Click **Next**.

Step 7 Configure a task.

Set Extractors to 1 and click Save and execute.

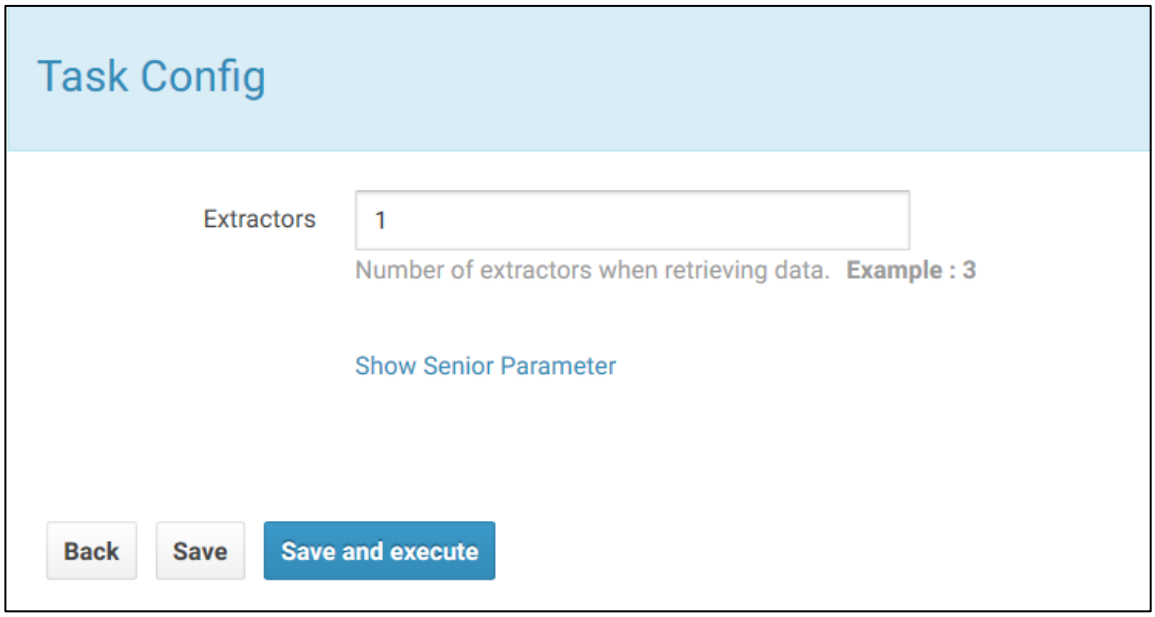


Figure 10-40

The task is successfully run.

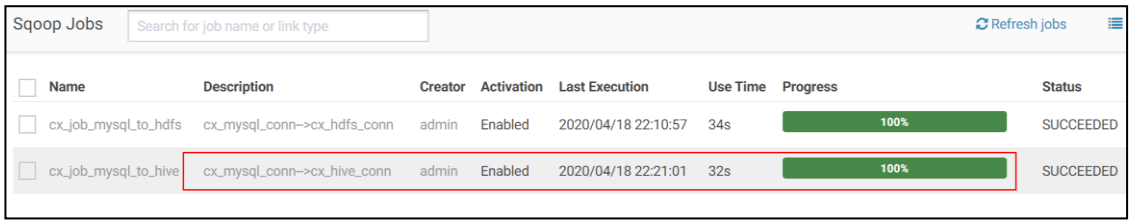


Figure 10-41

Step 8 View the result.

Use PuTTY to log in to the master node, run the **beeline** command to go to Hive, and run the **select** statement to view the result.

```
select * from cx_loader_stu01;
```

```
INFO  : OK
INFO  : Concurrency mode is disabled, not creating a lock manager
+----------------------+------------------------+--------------------------+-----------------------+
| cx_loader_stu01.id   | cx_loader_stu01.name   | cx_loader_stu01.gender   | cx_loader_stu01.age   |
+----------------------+------------------------+--------------------------+-----------------------+
| 1001                 | MacDonald              | male                     | 30                    |
| 1002                 | Calvin                 | male                     | 25                    |
| 1003                 | Haley                  | female                   | 18                    |
| 1004                 | Madonna                | female                   | 22                    |
| 1005                 | Randell                | male                     | 36                    |
+----------------------+------------------------+--------------------------+-----------------------+
5 rows selected (0.261 seconds)
0: jdbc:hive2://192.168.0.151:2181/>
```

Figure 10-42

10.3.6 Task 6: Importing HDFS Data to HBase

Step 1 Create a HBase table.

Use PuTTY to log in to the master node, run **hbase shell** to go to the HBase window, and run the following statement to create a table:

```
create 'cx_table_stu02','cf1'
```

```
hbase(main):001:0> create 'cx_table_stu02','cf1'
2020-04-18 22:25:54,656 INFO  [main] client.HBaseAdmin: Operation:
Id: 9 completed
Created table cx_table_stu02
Took 4.7276 seconds
=> Hbase::Table - cx_table_stu02
hbase(main):002:0>
```

Figure 10-43

Step 2 Create a data file and upload it to the HDFS.

Edit data file **cx_stu_info2.txt** on the Linux PC. The file content is as follows:

```
[root@node-master1bBdj ~]# vi cx_stu_info2.txt
[root@node-master1bBdj ~]# cat cx_stu_info2.txt
2001,Jack,male,20
2002,Lucy,female,18
[root@node-master1bBdj ~]#
```

Figure 10-44

Run the following command to upload the file to the HDFS:

```
hdfs  dfs  -put  cx_stu_info2.txt  /user/stu01
```

```
[root@node-master1bBdj ~]# hdfs dfs -put cx_stu_info2.txt /user/stu01
2020-04-18 22:30:45,430 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
[root@node-master1bBdj ~]# hdfs dfs -ls /user/stu01
2020-04-18 22:30:54,672 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 2 items
-rw-r--r--   1 root   hadoop         38 2020-04-18 22:30 /user/stu01/cx_stu_info2.txt
drwxrwxrwx   - loader hadoop          0 2020-04-18 22:10 /user/stu01/output2
[root@node-master1bBdj ~]#
```

Figure 10-45

Step 3 Log in to the Hue page and create a job.

Click **Create Job** and set the parameters as follows:

Figure 10-46

Click **Next**.

Step 4 Configure the source path.

The input path is the path of the HDFS file to be imported. The configuration is as follows:

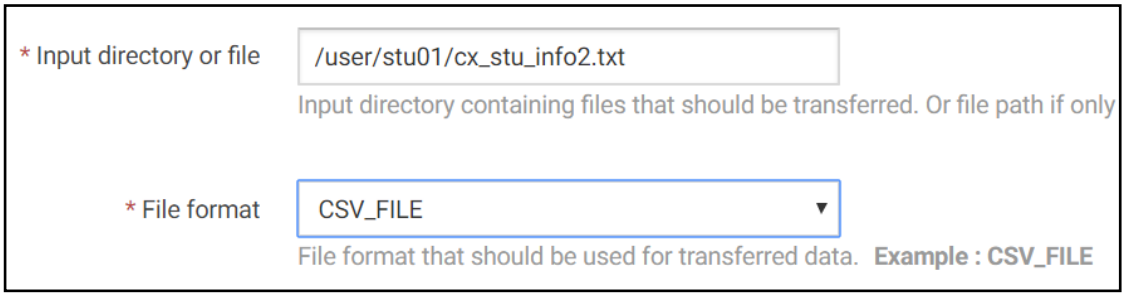


Figure 10-47

Click **Next**.

Step 5 Configure HBase information.

Set **Table name** to **cx_stu_info2** and **Method** to **PUTLIST**, as shown in the following figure:

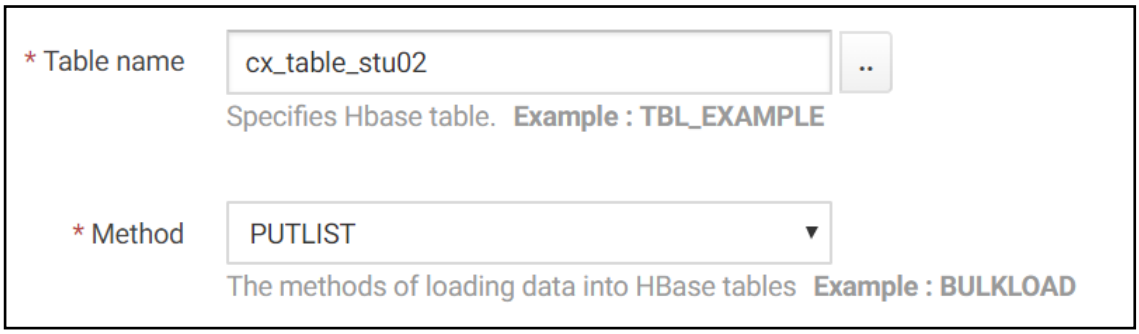


Figure 10-48

Click **Next**.

Step 6 Configure the field mapping.

The following figure shows the configuration information:

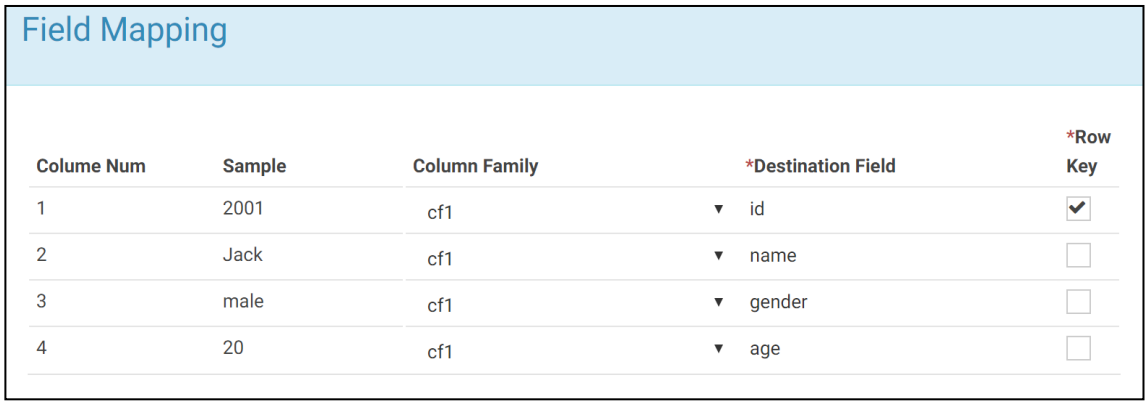


Figure 10-49

Select **Row Key** in the first row, name the destination field, which the qualifier of the column in HBase, and click **Next**.

Step 7 Configure a task.

Set **Extractors** to **1** and click **Save and execute**.

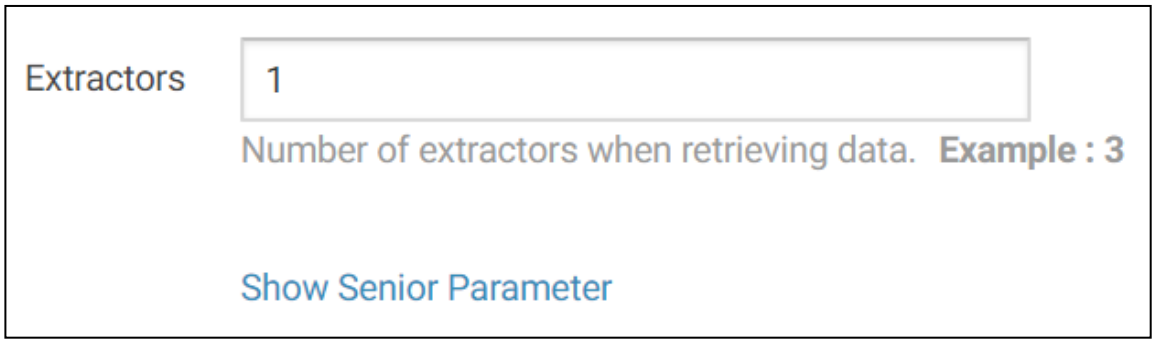


Figure 10-50

The task is successfully run.

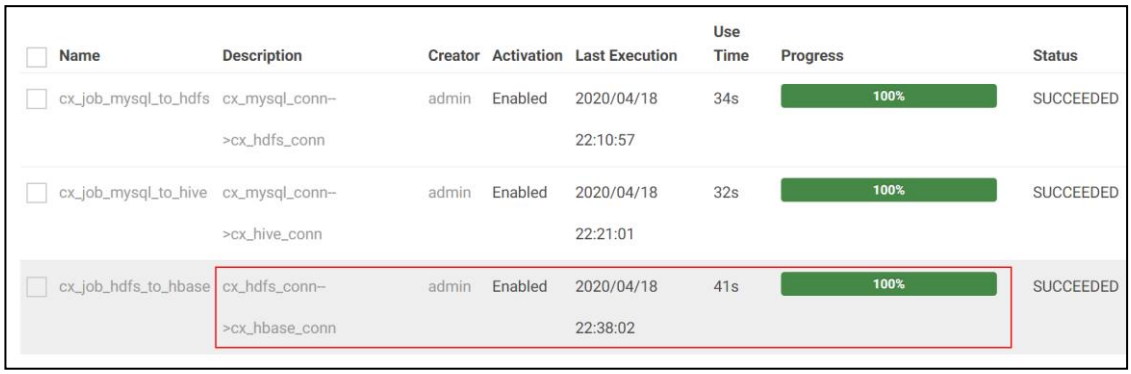


Figure 10-51

Step 8 View the result.

Log in to HBase and run the **scan** command to view the table data.

```
hbase(main):002:0> scan 'cx_table_stu02'
ROW                           COLUMN+CELL
 2001                         column=cf1:age, timestamp=1587220677033, value=20
 2001                         column=cf1:gender, timestamp=1587220677033, value=male
 2001                         column=cf1:name, timestamp=1587220677033, value=Jack
 2002                         column=cf1:age, timestamp=1587220677033, value=18
 2002                         column=cf1:gender, timestamp=1587220677033, value=female
 2002                         column=cf1:name, timestamp=1587220677033, value=Lucy
2 row(s)
Took 0.1269 seconds
hbase(main):003:0>
```

Figure 10-52

10.4 Summary

This exercise describes how to use Loader in multiple service scenarios. Trainees can perform data migration operations in actual services after completing this exercise. Note that tables must be created before table data is migrated among MySQL, HBase, and Hive. Otherwise, an error may occur and the exercise may fail.

11 Comprehensive Exercise: Hive Data Warehouse

11.1 Background

In the big data services, multiple components form a service system. The following two exercises involve these components.

The first one is a typical data analysis exercise. Loader periodically migrates MySQL database data to Hive. Because data in Hive is stored in HDFS, Loader is used to import data in the HDFS to HBase. Use HBase to query data in real time and use the big data processing capability of Hive to analyze related results.

The second one is to use Flume to collect incremental data, upload the data to HDFS, and use Hive to query and analyze the data.

11.2 Objectives

- Use big data components to convert and query data in real time.

11.3 Tasks

Data is imported from the MySQL database to Hive, and then imported from Hive to HBase for data analysis.

11.3.1 Preparing MySQL Data

Step 1 Log in to the MySQL database.

Go to the MySQL instance page and click **Log In**. You can use MySQL resources purchased in section 11.3. If no MySQL resource is available, purchase one.

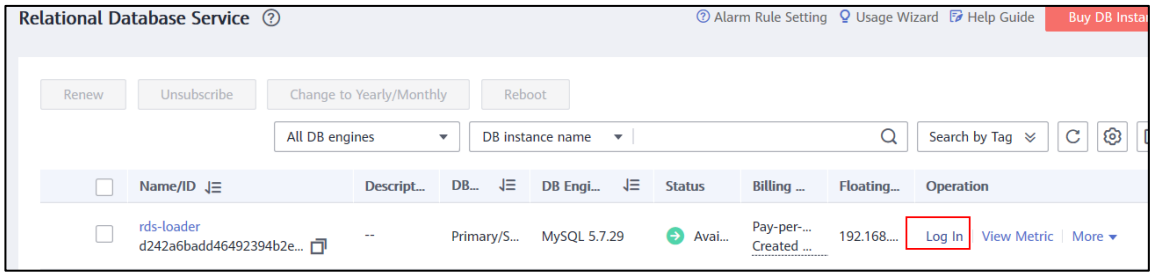


Figure 11-1

Step 2 Create the **cx_socker** table and set **timestr** as the primary key.

Create the **rdsdb** database (if there is no such a database) and create a table.

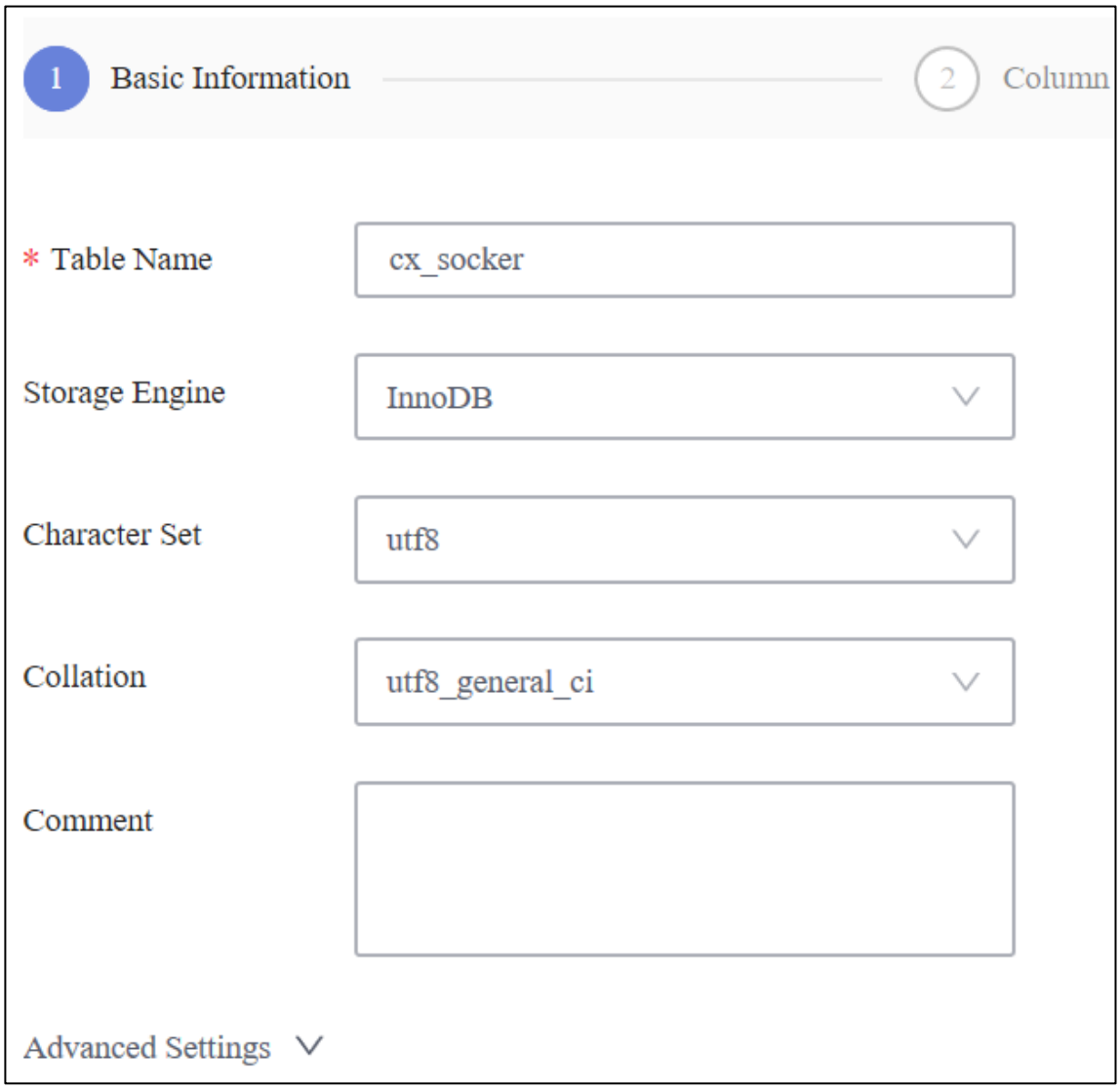


Figure 11-2

Create a field.

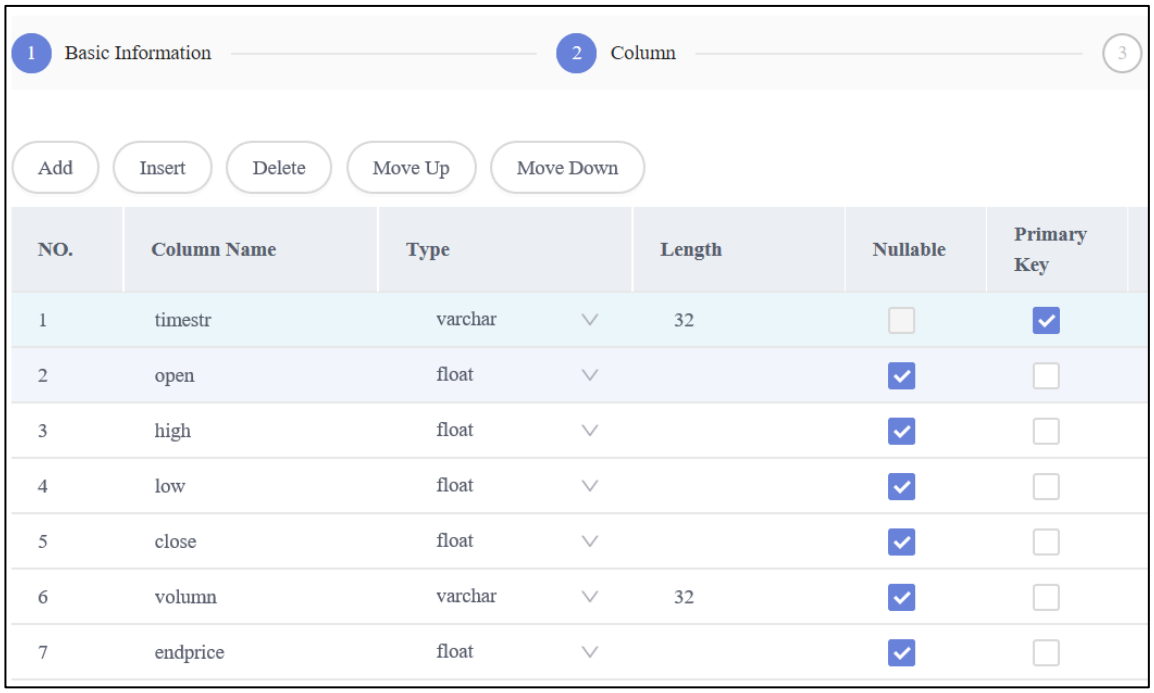


Figure 11-3

Click **Create Now** and execute the script.

Step 3 Import data to **cx_socker**.

On the MySQL management page, choose **Import·Export** > **Import**.

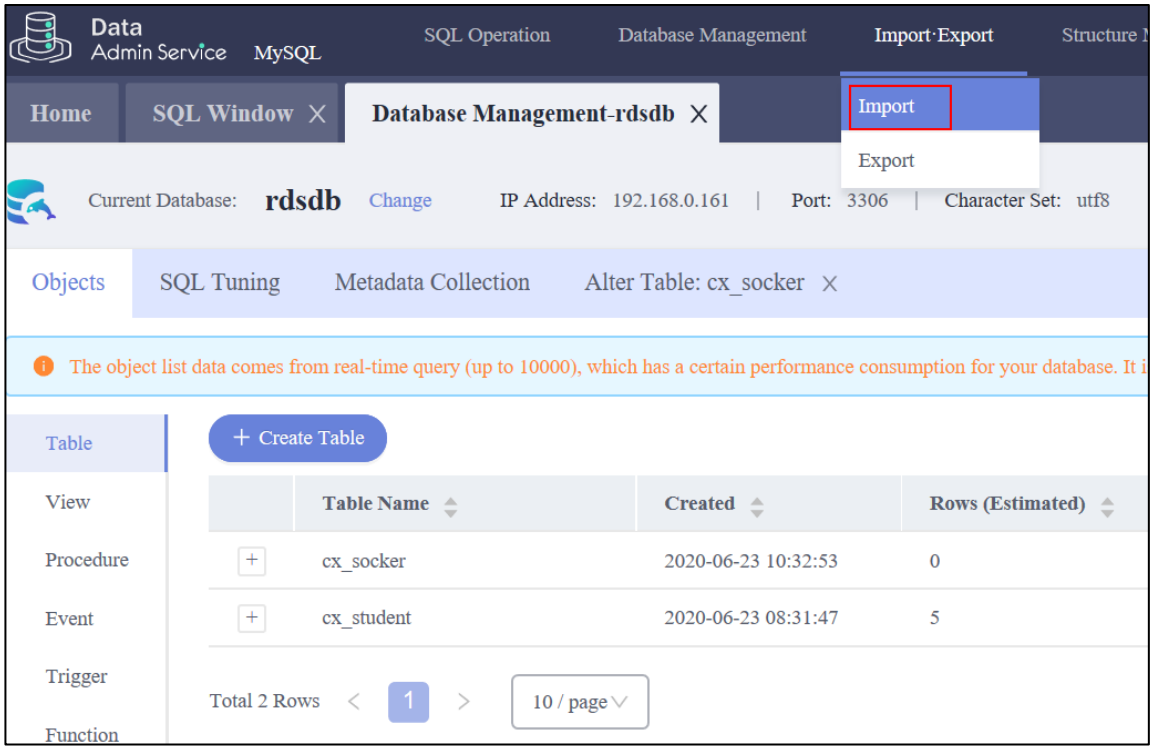


Figure 11-4

Click **Create Task**. By default, no bucket is available. Click **Create OBS bucket**.

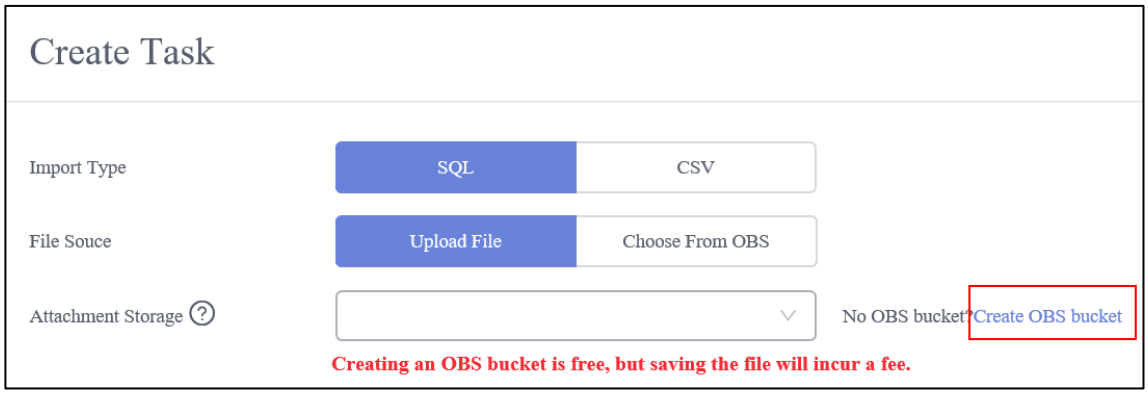


Figure 11-5

Click **OK** to return to the import page. Select data file **sp500.csv** and upload it. The configuration is as follows:

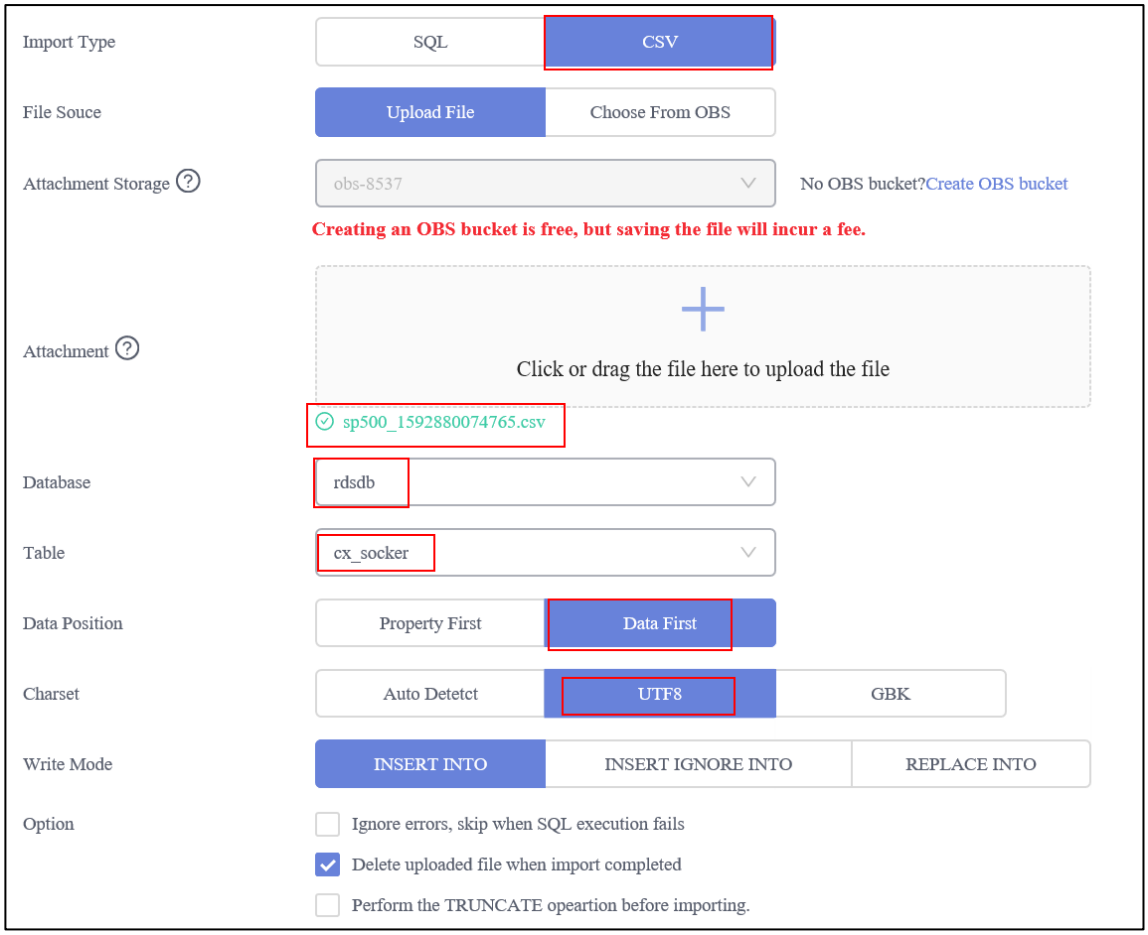


Figure 11-6

Click **Create Import Task** and wait for the task to be executed.

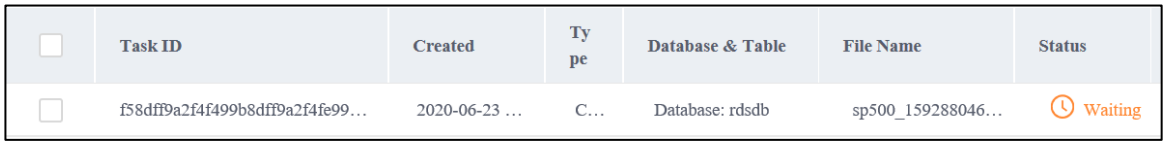


Figure 11-7

The execution succeeded.

Figure 11-8

Step 4 View data in **cx_socker**.

On the database management page, click **Query**.

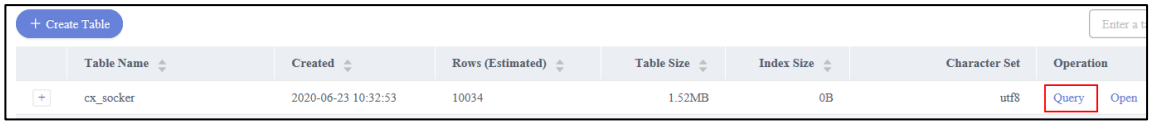


Figure 11-9

Detailed data is shown as follows:

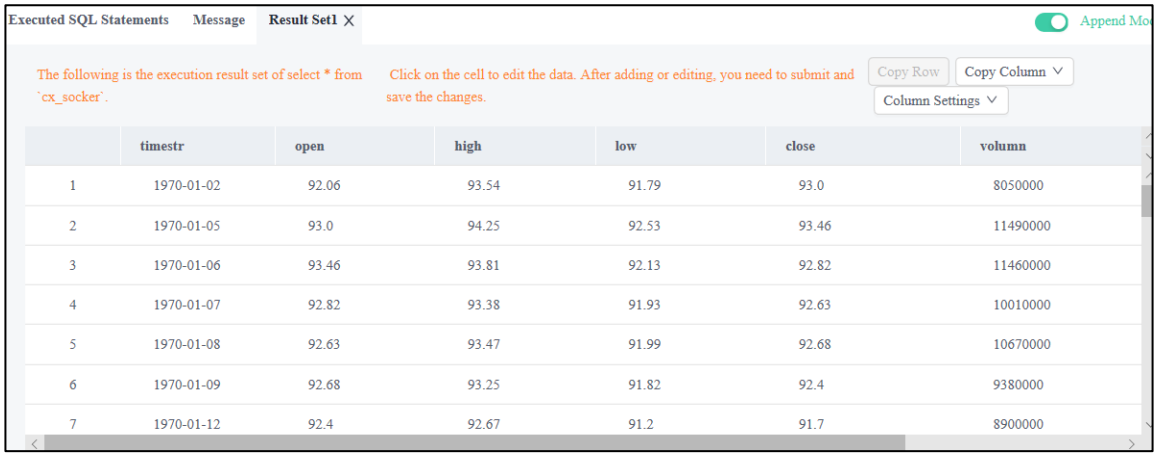


Figure 11-10

11.3.2 Importing MySQL Data to Hive

Step 1 Create a table in Hive.

Log in to Hive and run the following command to create the **cx_hive_socker** table:

```
create table cx_hive_socker (timestr string,open float,high float,low float,close float,volume string,endprice float) row format delimited fields terminated by ',' stored as textfile;
```

```
0: jdbc:hive2://192.168.0.10:2181/> create table socker(timestr string,open floa
t,high float,low float,close float,volume string,endprice float) row format deli
mited fields terminated by ',' stored as textfile;
No rows affected (0.052 seconds)
0: jdbc:hive2://192.168.0.10:2181/>
```

Figure 11-11

Step 2 Log in to Hue and create a job in Sqoop.

Configure parameters as follows:

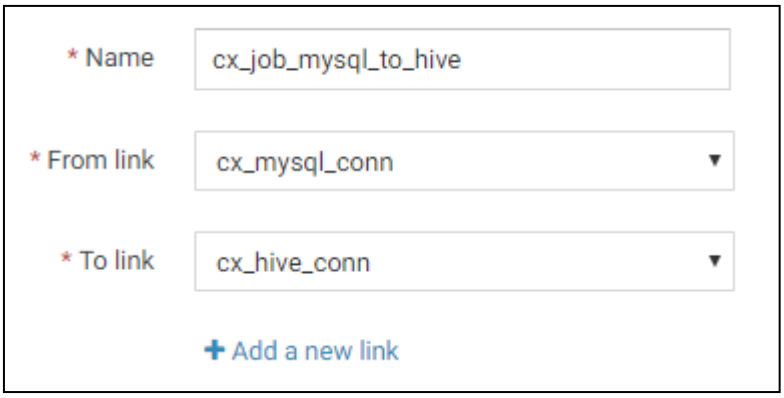


Figure 11-12

Step 3 Set the MySQL information for the job.

Configure parameters as follows:

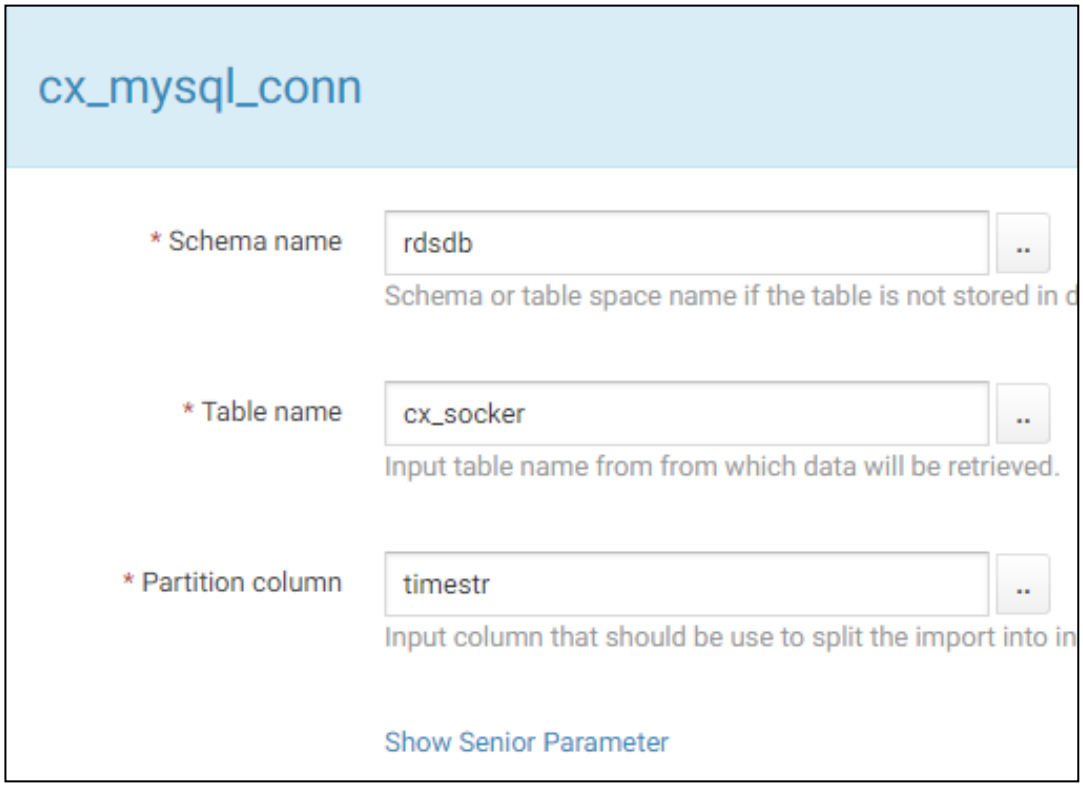


Figure 11-13

Step 4 Configure the Hive information for the job.

Configure parameters as follows:

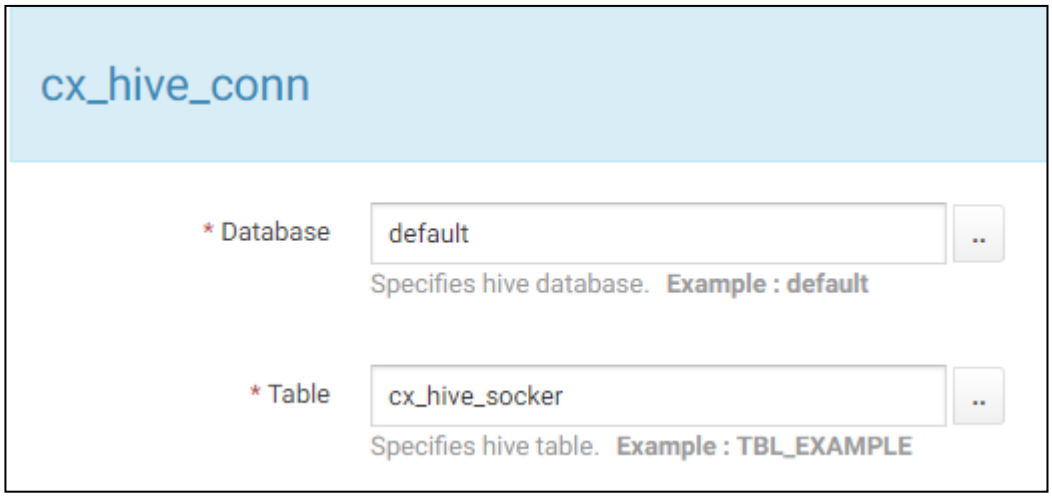


Figure 11-14

Step 5 Configure the field mapping.

Retain the default values.

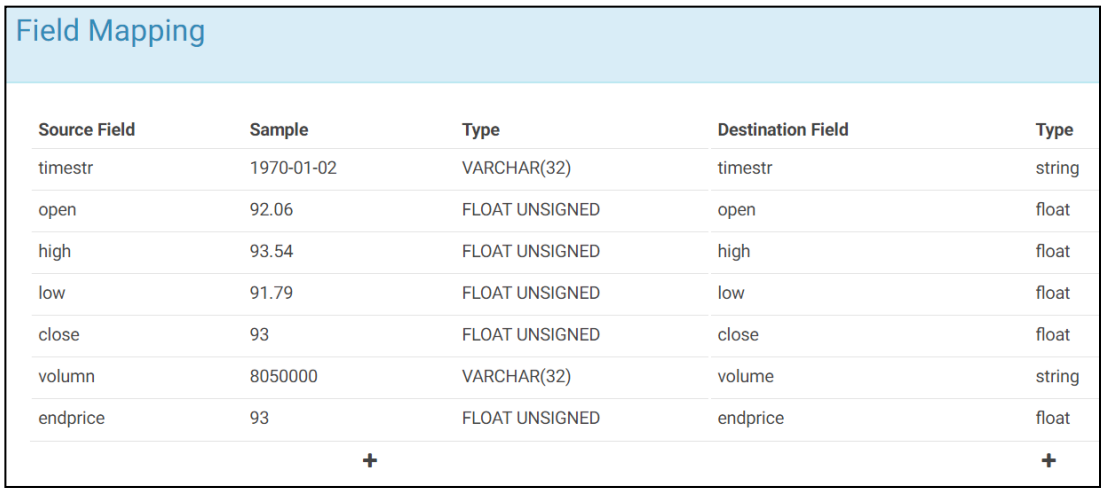


Figure 11-15

Click **Next**.

Step 6 Configure a task.

Set **Extractors** to **1** and click **Save and execute**.

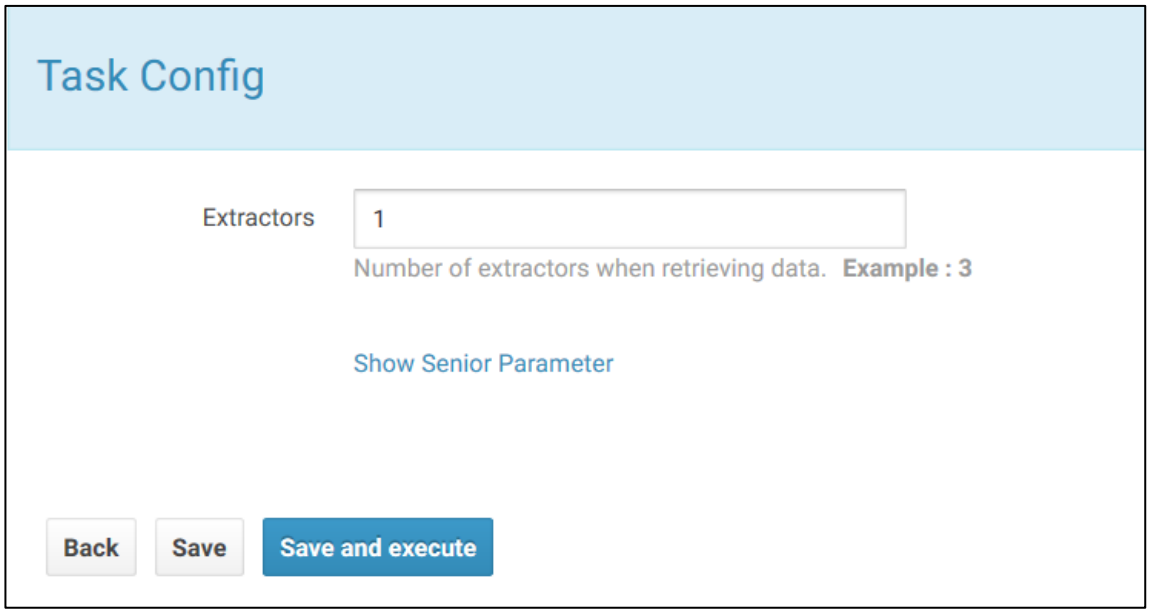


Figure 11-16

The task is successfully run.

Figure 11-17

Step 7 View data in Hive.

Run the **select * from cx_hive_socker limit 10** command in Hive.

cx_hive_socker.timestr	cx_hive_socker.open	cx_hive_socker.high	cx_hive_socker.low	cx_hive_socker.close	cx_hive_socker.volume	cx_hive_socker.endprice
1970-01-02	92.06	93.54	91.79	93.0	8050000	93.0
1970-01-05	93.0	94.25	92.53	93.46	11490000	93.46
1970-01-06	93.46	93.81	92.13	92.82	11460000	92.82
1970-01-07	92.82	93.38	91.93	92.63	10010000	92.63
1970-01-08	92.63	93.47	91.99	92.68	10670000	92.68
1970-01-09	92.68	93.25	91.82	92.4	9380000	92.4
1970-01-12	92.4	92.67	91.2	91.7	8900000	91.7
1970-01-13	91.7	92.61	90.99	91.92	9870000	91.92
1970-01-14	91.92	92.4	90.88	91.65	10380000	91.65
1970-01-15	91.65	92.35	90.73	91.68	11120000	91.68

Figure 11-18

11.3.3 Processing Hive Data

Obtain the latest stock growth data and save the result to a new Hive table.

Step 1 Create a table in Hive.

Run the following command in the Hive shell to create a table:

```
create table cx_up_hive_socker like cx_hive_socker;
```

```
0: jdbc:hive2://192.168.0.187:2181/> create table cx_up_hive_socker like cx_hive_socker;
No rows affected (0.087 seconds)
0: jdbc:hive2://192.168.0.187:2181/> show tables;
+--------------------+
|      tab_name      |
+--------------------+
| cx_hive_socker     |
| cx_up_hive_socker  |
+--------------------+
2 rows selected (0.029 seconds)
0: jdbc:hive2://192.168.0.187:2181/>
```

Figure 11-19

Step 2 Run the following command to insert data:

```
insert into cx_up_hive_socker select * from cx_hive_socker where cx_hive_socker.endprice>
cx_hive_socker.open sort by cx_hive_socker.endprice desc;
```

```
0: jdbc:hive2://192.168.0.187:2181/> insert into cx_up_hive_socker select * from cx_hive_socker where cx_hive_socker.endprice> cx_hive_socker.open sort by cx_hiv
e_socker.endprice desc;
No rows affected (34.168 seconds)
0: jdbc:hive2://192.168.0.187:2181/> show tables;
+--------------------+
|      tab_name      |
+--------------------+
| cx_hive_socker     |
| cx_up_hive_socker  |
+--------------------+
2 rows selected (0.064 seconds)
0: jdbc:hive2://192.168.0.187:2181/> select * from cx_up_hive_socker limit 10;
+-----------------------------+-----------------------------+-----------------------------+----------------------------+-----------------------------+-----------------------------+-----------------------------+
| cx_up_hive_socker.timestr  | cx_up_hive_socker.open  | cx_up_hive_socker.high  | cx_up_hive_socker.low  | cx_up_hive_socker.close  | cx_up_hive_socker.volume  | cx_up_hive_socker.endprice  |
+-----------------------------+-----------------------------+-----------------------------+----------------------------+-----------------------------+-----------------------------+-----------------------------+
| 2007-10-09                  | 1553.18                     | 1565.26                     | 1551.82                    | 1565.15                     | 2932040000                  | 1565.15                     |
| 2007-10-12                  | 1555.41                     | 1563.03                     | 1554.09                    | 1561.8                      | 2788690000                  | 1561.8                      |
| 2007-10-05                  | 1543.84                     | 1561.91                     | 1543.84                    | 1557.59                     | 2919030000                  | 1557.59                     |
| 2007-07-19                  | 1546.13                     | 1555.2                      | 1546.13                    | 1553.08                     | 3251450000                  | 1553.08                     |
| 2007-07-13                  | 1547.68                     | 1555.1                      | 1544.85                    | 1552.5                      | 2801120000                  | 1552.5                      |
| 2007-10-31                  | 1532.15                     | 1552.76                     | 1529.4                     | 1549.38                     | 3953070000                  | 1549.38                     |
| 2007-07-12                  | 1518.74                     | 1547.92                     | 1518.74                    | 1547.7                      | 3489600000                  | 1547.7                      |
| 2007-10-01                  | 1527.29                     | 1549.02                     | 1527.25                    | 1547.04                     | 3281990000                  | 1547.04                     |
| 2007-10-04                  | 1539.91                     | 1544.02                     | 1537.63                    | 1542.84                     | 2690430000                  | 1542.84                     |
```

Figure 11-20

Step 3 Run the following command to obtain the total number of the stocks that grow:

```
select count(*) from cx_hive_socker where cx_hive_socker.endprice> cx_hive_socker.open;
```

```
0: jdbc:hive2://192.168.0.187:2181/> select count(*) from cx_hive_socker where cx_hive_socker.endprice> cx_hive_socker.open;
+-------+
|  _c0  |
+-------+
| 5228  |
+-------+
1 row selected (16.963 seconds)
0: jdbc:hive2://192.168.0.187:2181/>
```

Figure 11-21

11.3.4 Importing HDFS Data to HBase

Step 1 Create a table in HBase.

Access the hbase shell and run the following statement to create a table:

```
create 'cx_hbase_socker','cf1'
```

```
hbase(main):001:0> create 'cx_hbase_socker','cf1'
2020-04-22 13:44:37,594 INFO  [main] client.HBaseAdmin: Operation: CREATE, Table Name: default:cx_hbase_socker, procId:
 9 completed
Created table cx_hbase_socker
Took 2.8852 seconds
=> Hbase::Table - cx_hbase_socker
hbase(main):002:0>
```

Figure 11-22

Step 2 Create a Loader job.

Configure parameters as follows:

Figure 11-23

Step 3 Configure the source path.

The input path is the path of the HDFS file to be imported. The address is the data in the Hive table **cx_hive_socker**, and is in the Hive data warehouse directory of the HDFS, as shown in the following figure:

```
[root@node-master1floZ ~]# hdfs dfs -ls /user/hive/warehouse/cx_hive_socker/
2020-04-22 13:49:36,461 INFO obs.OBSFileSystem: This Filesystem GC-ful, clear resource.
Found 1 items
-rw-r-----   3 loader hive     567946 2020-04-22 12:00 /user/hive/warehouse/cx_hive_socker/60f9ba12-3a37-472f-baaf-1b09
2c82740f
[root@node-master1floZ ~]#
```

Figure 11-24

To configure the HDFS address of the Loader job, you need to query the specific path. In this example, the HDFS path is as follows:

```
/user/hive/warehouse/cx_hive_socker/60f9ba12-3a37-472f-baaf-1b092c82740f
```

The HDFS configuration of the job is as follows:

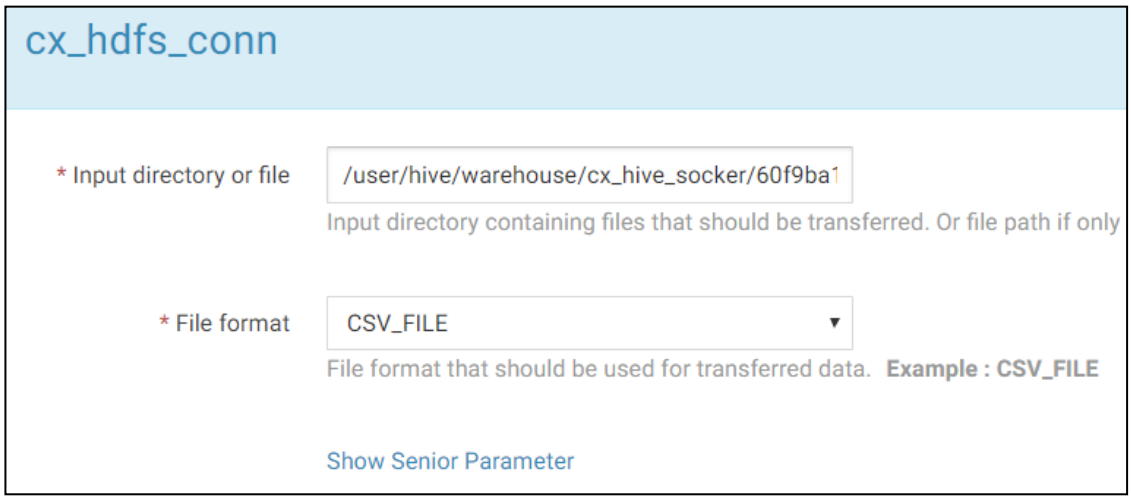


Figure 11-25

Click **Next**.

Step 4 Configure the HBase information.

Configure parameters as follows:

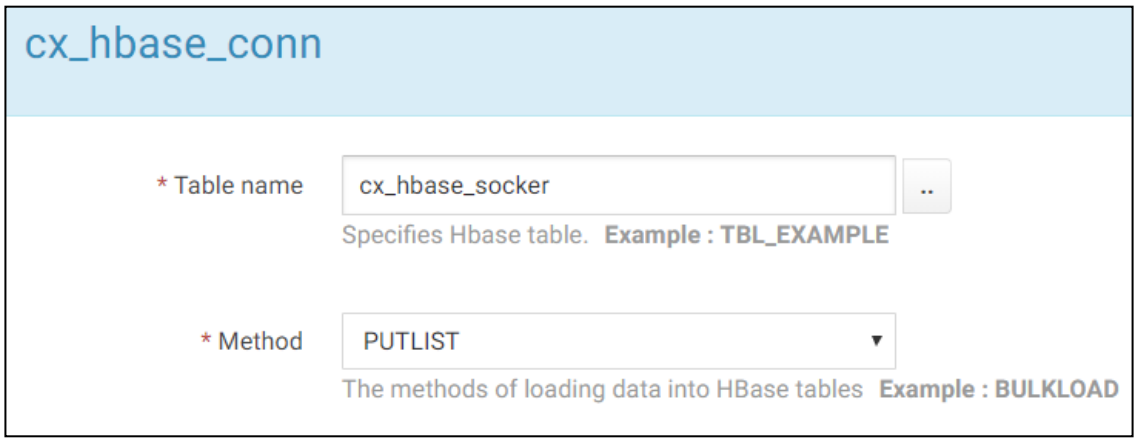


Figure 11-26

Click **Next**.

Step 5 Configure the field mapping.

Configure parameters as follows:

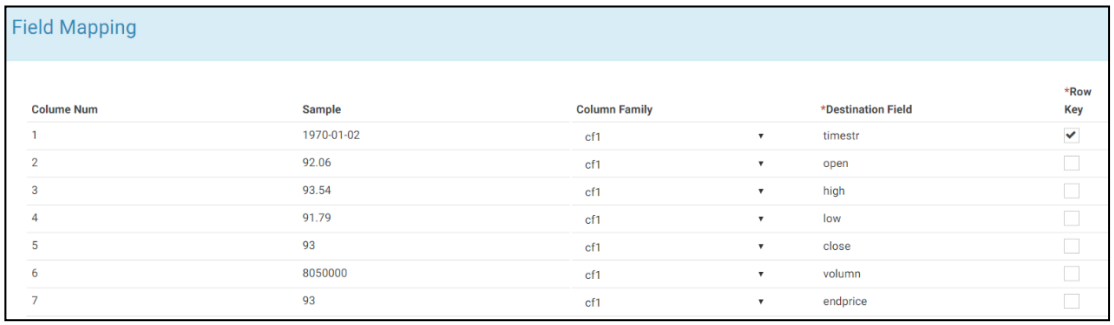


Figure 11-27

Click **Next**.

Step 6 Configure a task.

Set **Extractors** to **1** and click **Save and execute**.

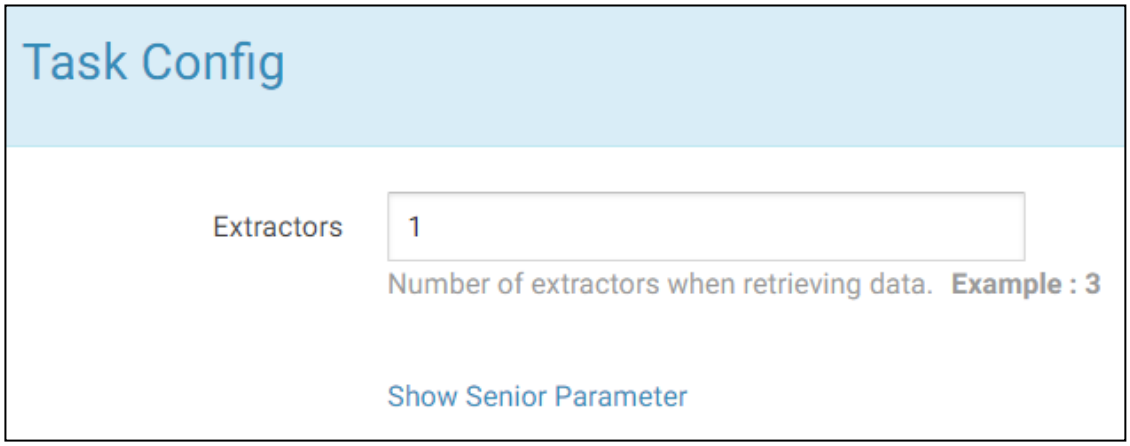


Figure 11-28

The task is successfully run.

Figure 11-29

Step 7 View the result.

Log in to HBase and run the **scan** command to view the table data.

```
hbase(main):001:0> scan 'cx_hbase_socker'
ROW                           COLUMN+CELL
 1970-01-02                   column=cf1:close, timestamp=1587534878585, value=93
 1970-01-02                   column=cf1:endprice, timestamp=1587534878585, value=93
 1970-01-02                   column=cf1:high, timestamp=1587534878585, value=93.54
 1970-01-02                   column=cf1:low, timestamp=1587534878585, value=91.79
 1970-01-02                   column=cf1:open, timestamp=1587534878585, value=92.06
 1970-01-02                   column=cf1:volumn, timestamp=1587534878585, value=8050000
 1970-01-05                   column=cf1:close, timestamp=1587534878585, value=93.46
 1970-01-05                   column=cf1:endprice, timestamp=1587534878585, value=93.46
 1970-01-05                   column=cf1:high, timestamp=1587534878585, value=94.25
 1970-01-05                   column=cf1:low, timestamp=1587534878585, value=92.53
 1970-01-05                   column=cf1:open, timestamp=1587534878585, value=93
 1970-01-05                   column=cf1:volumn, timestamp=1587534878585, value=11490000
 1970-01-06                   column=cf1:close, timestamp=1587534878585, value=92.82
 1970-01-06                   column=cf1:endprice, timestamp=1587534878585, value=92.82
 1970-01-06                   column=cf1:high, timestamp=1587534878585, value=93.81
 1970-01-06                   column=cf1:low, timestamp=1587534878585, value=92.13
 1970-01-06                   column=cf1:open, timestamp=1587534878585, value=93.46
 1970-01-06                   column=cf1:volumn, timestamp=1587534878585, value=11460000
 1970-01-07                   column=cf1:close, timestamp=1587534878585, value=92.63
 1970-01-07                   column=cf1:endprice, timestamp=1587534878585, value=92.63
 1970-01-07                   column=cf1:high, timestamp=1587534878585, value=93.38
 1970-01-07                   column=cf1:low, timestamp=1587534878585, value=91.93
```

Figure 11-30

11.3.5 Querying Data in HBase in Real Time

Step 1 Query specified records.

Run the following command in HBase:

```
get 'cx_hbase_socker','2009-09-15'
```

```
hbase(main):004:0> get 'cx_hbase_socker','2009-09-15'
COLUMN                        CELL
 cf1:close                    timestamp=1587534879064, value=1052.63
 cf1:endprice                 timestamp=1587534879064, value=1052.63
 cf1:high                     timestamp=1587534879064, value=1056.04
 cf1:low                      timestamp=1587534879064, value=1043.42
 cf1:open                     timestamp=1587534879064, value=1049.03
 cf1:volumn                   timestamp=1587534879064, value=6185620000
1 row(s)
Took 0.0595 seconds
hbase(main):005:0>
```

Figure 11-31

Step 2 Query the number of records in a specified period.

Run the following command in HBase:

```
scan 'cx_hbase_socker',{COLUMNS=>'cf1:endprice',STARTROW=>'2009-08-15',STOPROW=>'2009-09-15'}
```

```
hbase(main):006:0> scan 'cx_hbase_socker',{COLUMNS=>'cf1:endprice',STARTROW=>'2009-08-15',STOPROW=>'2009-09-15'}
ROW                           COLUMN+CELL
 2009-08-17                   column=cf1:endprice, timestamp=1587534879064, value=979.73
 2009-08-18                   column=cf1:endprice, timestamp=1587534879064, value=989.67
 2009-08-19                   column=cf1:endprice, timestamp=1587534879064, value=996.46
 2009-08-20                   column=cf1:endprice, timestamp=1587534879064, value=1007.37
 2009-08-21                   column=cf1:endprice, timestamp=1587534879064, value=1026.13
 2009-08-24                   column=cf1:endprice, timestamp=1587534879064, value=1025.57
 2009-08-25                   column=cf1:endprice, timestamp=1587534879064, value=1028
 2009-08-26                   column=cf1:endprice, timestamp=1587534879064, value=1028.12
 2009-08-27                   column=cf1:endprice, timestamp=1587534879064, value=1030.98
 2009-08-28                   column=cf1:endprice, timestamp=1587534879064, value=1028.93
 2009-08-31                   column=cf1:endprice, timestamp=1587534879064, value=1020.62
 2009-09-01                   column=cf1:endprice, timestamp=1587534879064, value=998.04
 2009-09-02                   column=cf1:endprice, timestamp=1587534879064, value=994.75
 2009-09-03                   column=cf1:endprice, timestamp=1587534879064, value=1003.24
 2009-09-04                   column=cf1:endprice, timestamp=1587534879064, value=1016.4
 2009-09-08                   column=cf1:endprice, timestamp=1587534879064, value=1025.39
 2009-09-09                   column=cf1:endprice, timestamp=1587534879064, value=1033.37
 2009-09-10                   column=cf1:endprice, timestamp=1587534879064, value=1044.14
 2009-09-11                   column=cf1:endprice, timestamp=1587534879064, value=1042.73
 2009-09-14                   column=cf1:endprice, timestamp=1587534879064, value=1049.34
20 row(s)
Took 0.0125 seconds
hbase(main):007:0>
```

Figure 11-32

Step 3 Queries all columns whose values are greater than a specified value. Values are compared as character strings.

Run the following command in HBase:

```
scan 'cx_hbase_socker',{FILTER => "ValueFilter(>,'binary:999')"}
```

```
hbase(main):013:0> scan 'cx_hbase_socker',{FILTER => "ValueFilter(>,'binary:999')"}
ROW                           COLUMN+CELL
 1970-10-22                   column=cf1:volumn, timestamp=1587534878585, value=9e+06
 1998-02-04                   column=cf1:low, timestamp=1587534878961, value=999.43
 2000-04-26                   column=cf1:volumn, timestamp=1587534878961, value=999600000
 2003-08-18                   column=cf1:close, timestamp=1587534878996, value=999.74
 2003-08-18                   column=cf1:endprice, timestamp=1587534878996, value=999.74
 2003-08-19                   column=cf1:open, timestamp=1587534878996, value=999.74
 2003-08-21                   column=cf1:low, timestamp=1587534878996, value=999.33
 2003-08-29                   column=cf1:low, timestamp=1587534878996, value=999.52
 2009-08-07                   column=cf1:low, timestamp=1587534879044, value=999.83
 2009-08-07                   column=cf1:open, timestamp=1587534879044, value=999.83
 2009-08-19                   column=cf1:high, timestamp=1587534879064, value=999.61
9 row(s)
```

Figure 11-33

Step 4 Query all information ending with endprice. The value of the character string must be greater than 999.

Run the following command in HBase:

```
scan 'cx_hbase_socker',{FILTER=>"ValueFilter(>,'binary:999') AND ColumnPrefixFilter('endprice')"}
```

```
hbase(main):014:0> scan 'cx_hbase_socker',{FILTER=>"ValueFilter(>,'binary:999') AND ColumnPrefixFilter('endprice')"}
ROW                           COLUMN+CELL
 2003-08-18                   column=cf1:endprice, timestamp=1587534878996, value=999.74
1 row(s)
Took 0.1199 seconds
hbase(main):015:0>
```

Figure 11-34

11.4 Summary

These exercises integrate the applications of each component, helping trainees better understand and use big data components.

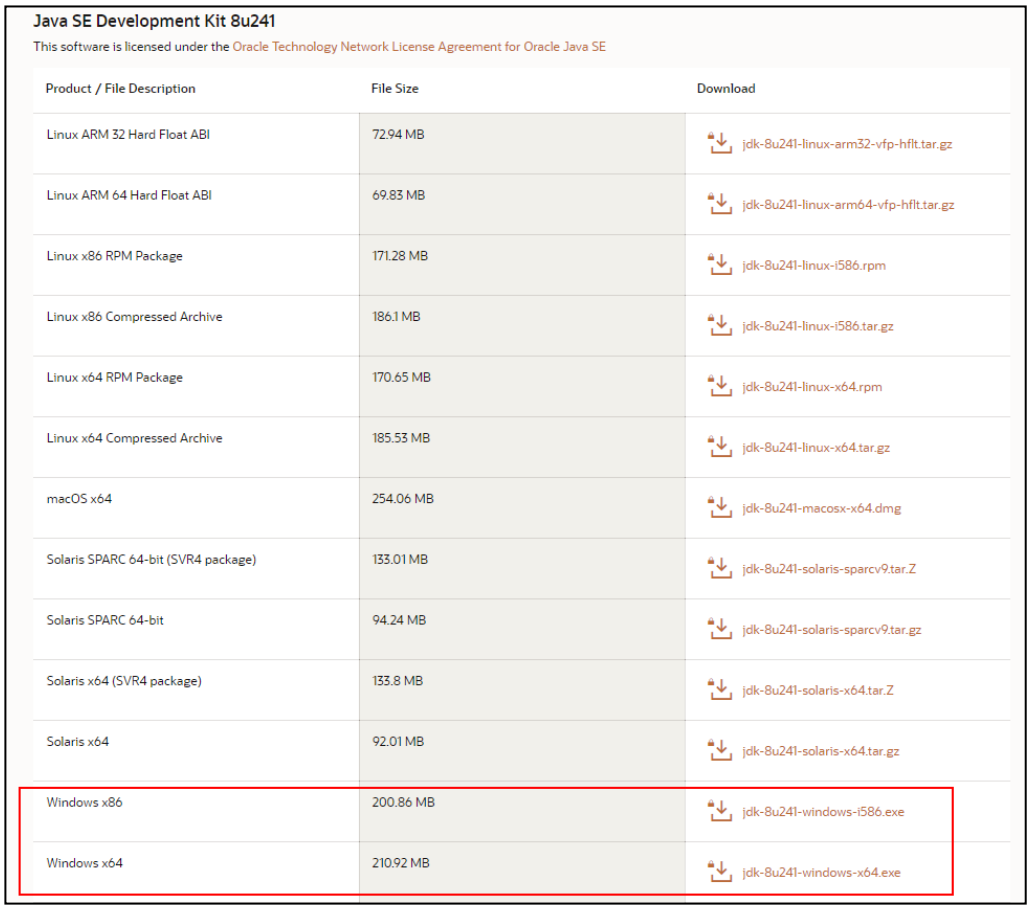
12 Appendix: Environment Preparations and Commands

12.1 (Optional) Preparing the Java Environment

12.1.1 Installing JDK

Step 1 Download JDK.

Visit https://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html, select **Accept License Agreement**, and download the JDK of the Windows x64 version. If the operating system is 32-bit, select the x86 version.



Java SE Development Kit 8u241

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Product / File Description	File Size	Download
Linux ARM 32 Hard Float ABI	72.94 MB	jdk-8u241-linux-arm32-vfp-hflt.tar.gz
Linux ARM 64 Hard Float ABI	69.83 MB	jdk-8u241-linux-arm64-vfp-hflt.tar.gz
Linux x86 RPM Package	171.28 MB	jdk-8u241-linux-i586.rpm
Linux x86 Compressed Archive	186.1 MB	jdk-8u241-linux-i586.tar.gz
Linux x64 RPM Package	170.65 MB	jdk-8u241-linux-x64.rpm
Linux x64 Compressed Archive	185.53 MB	jdk-8u241-linux-x64.tar.gz
macOS x64	254.06 MB	jdk-8u241-macosx-x64.dmg
Solaris SPARC 64-bit (SVR4 package)	133.01 MB	jdk-8u241-solaris-sparcv9.tar.Z
Solaris SPARC 64-bit	94.24 MB	jdk-8u241-solaris-sparcv9.tar.gz
Solaris x64 (SVR4 package)	133.8 MB	jdk-8u241-solaris-x64.tar.Z
Solaris x64	92.01 MB	jdk-8u241-solaris-x64.tar.gz
Windows x86	200.86 MB	jdk-8u241-windows-i586.exe
Windows x64	210.92 MB	jdk-8u241-windows-x64.exe

Figure 12-1

Step 2 Double-click the downloaded **.exe** file and click **Next**.

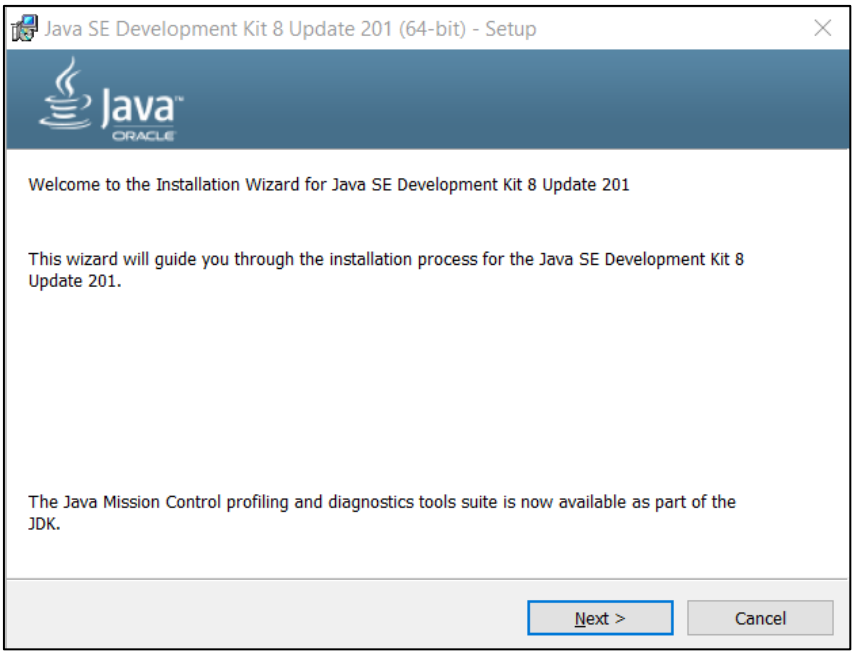

Figure 12-2

Step 3 Select the installation path. You can use the default address.

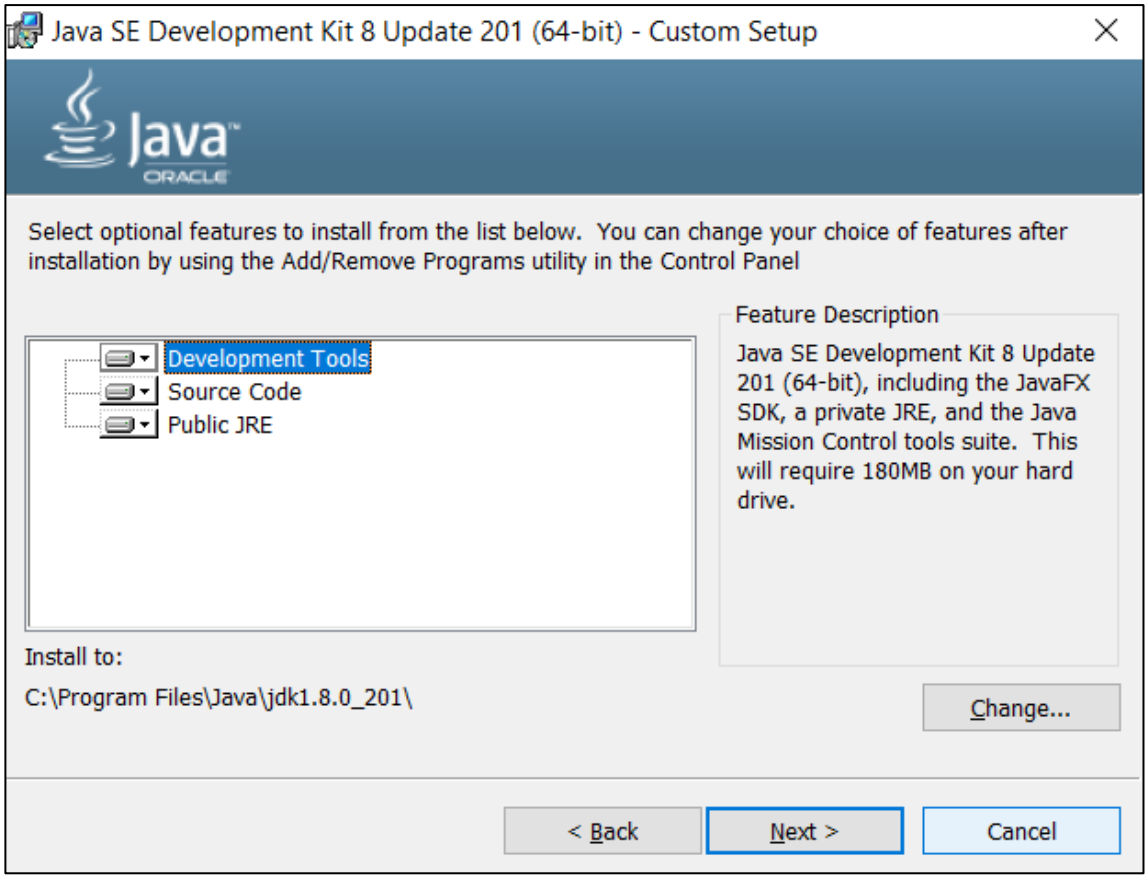

Figure 12-3

Step 4 On the **Change in License Terms** page, click **OK**.

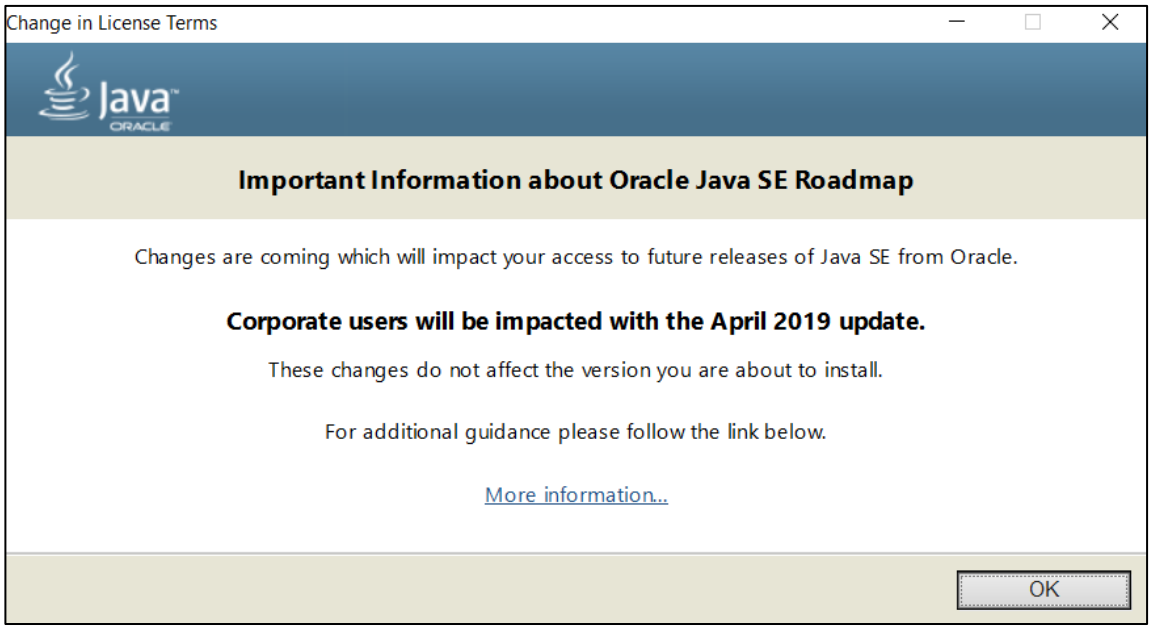

Figure 12-4

Step 5 Retain the default address and click **Next**.

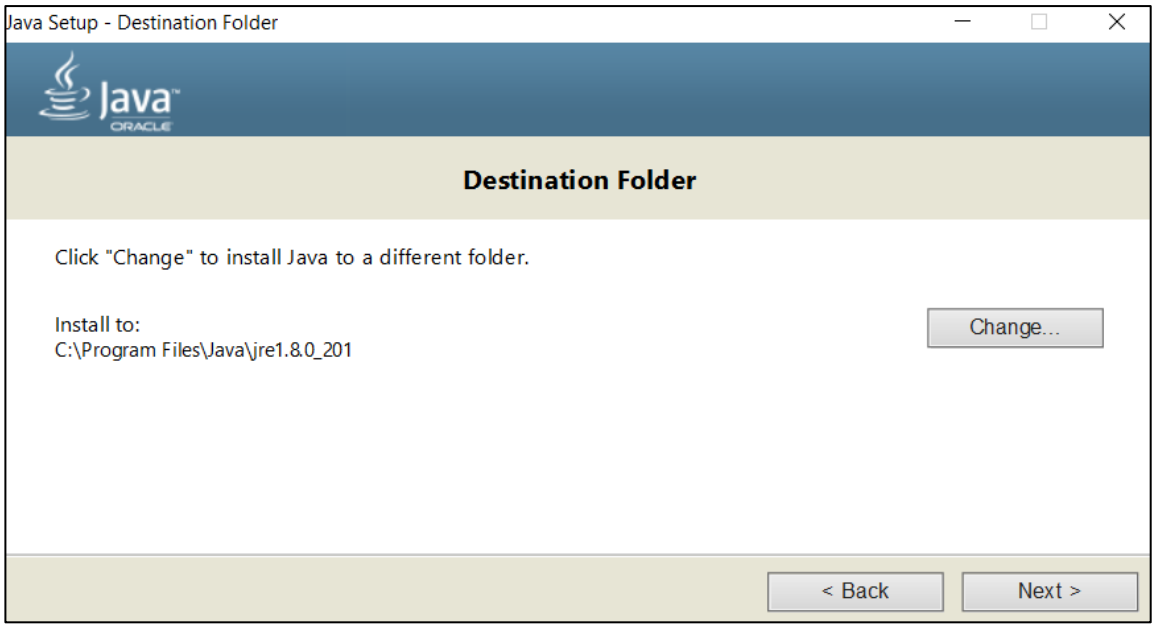

Figure 12-5

Wait for the installation to complete.

Figure 12-6

After the installation is complete, click **Close**.

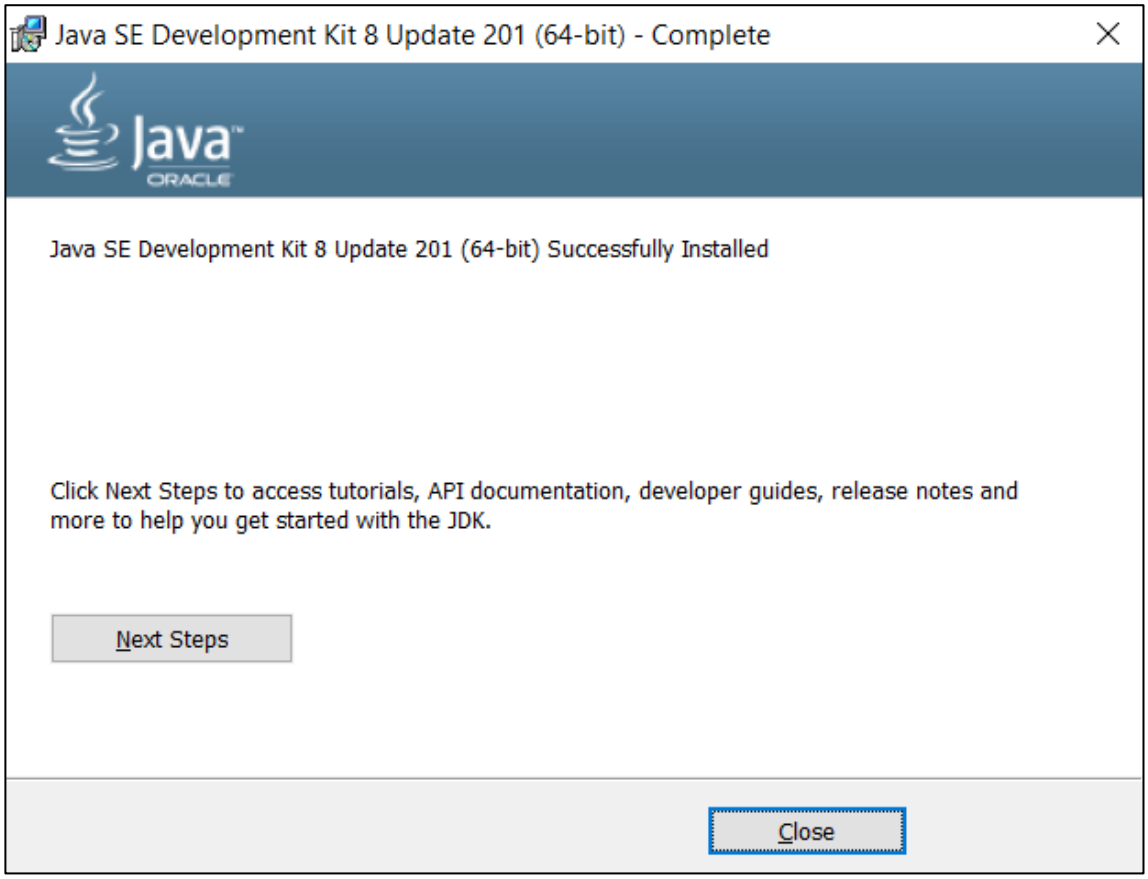

Figure 12-7

Step 6 Configure JDK environment variables.

Choose **My Computer** > **Properties** > **Advanced system settings** > **Environment Variables**.

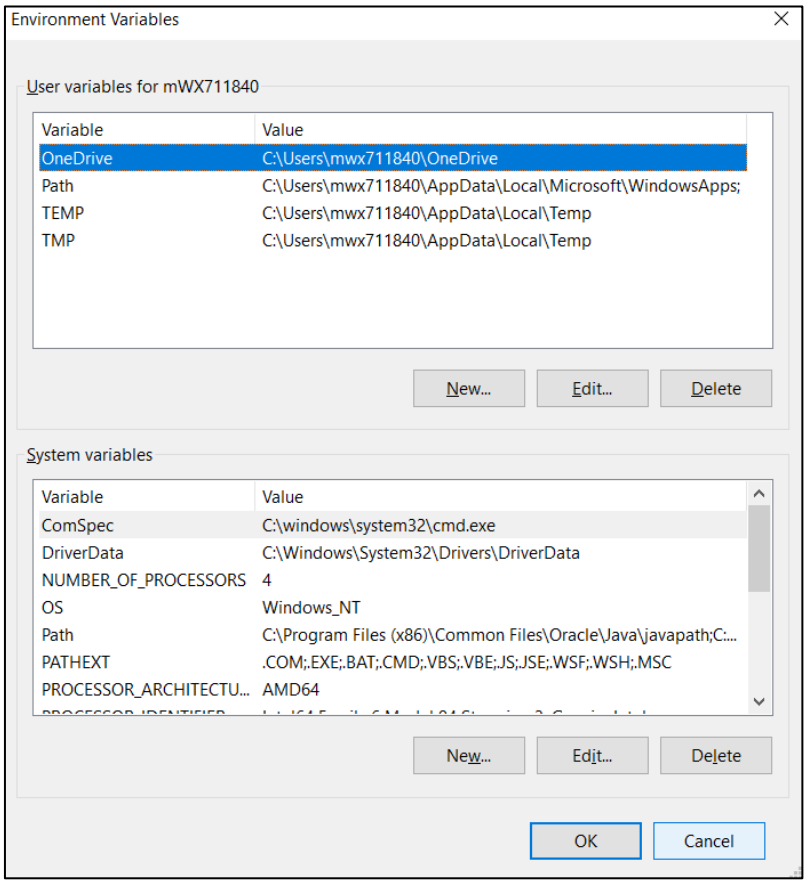

Figure 12-8

Click **New** in the **System variables** area. Set **Variable name** to **JAVA_HOME** (all uppercase letters) and **Variable value** to the JDK installation path.

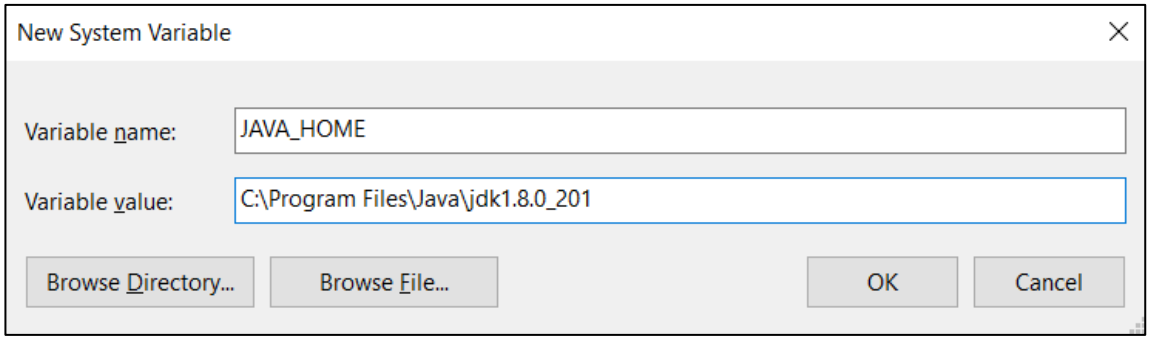

Figure 12-9

Find **Path** in the system variables and edit the variable.

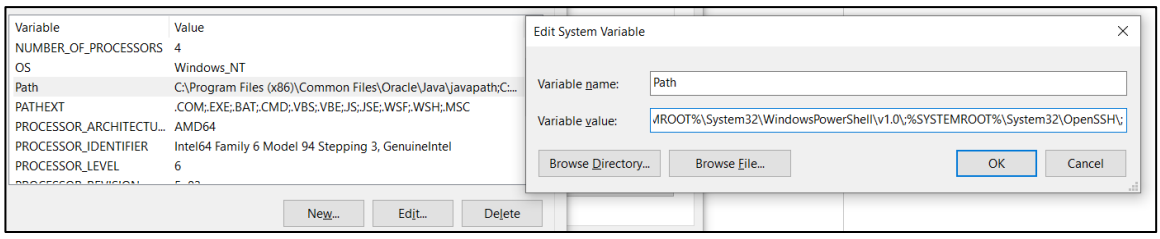

Figure 12-10

Add a semicolon (;) at the end of the variable value, and then add **%JAVA_HOME%\bin**.

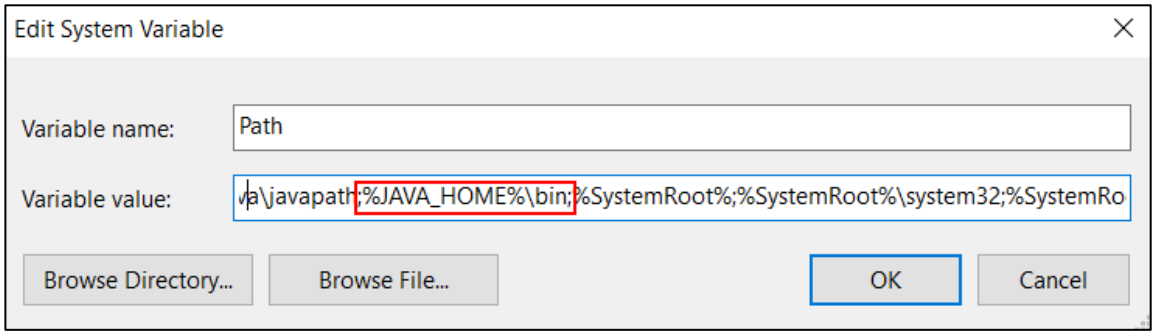

Figure 12-11

Step 7 Check whether the JDK is installed successfully.

Choose **Start** > **Run**, enter **cmd**, and press **Enter**. In the displayed dialog box, enter **java -version**.

Figure 12-12

If the Java version information is displayed, the installation is successful.

12.1.2 Installing Apache Maven

Step 1 Install Apache Maven.

Maven is a software project management tool that manages project construction, reports, and documents through a small segment of description information. In short, Maven is one of the tools for managing Java projects.

After Maven is used, third-party JAR packages such as **spring.jar** and **hibernate.jar** do not need to be copied to the **lib** directory of the project each time. The Maven configuration file can be used to automatically import JAR packages to the project. Programmers do not need to manually copy the JAR packages.

Download the latest version at http://maven.apache.org/download.cgi and decompress it to the **D:\apache-maven-3.5.0** directory.

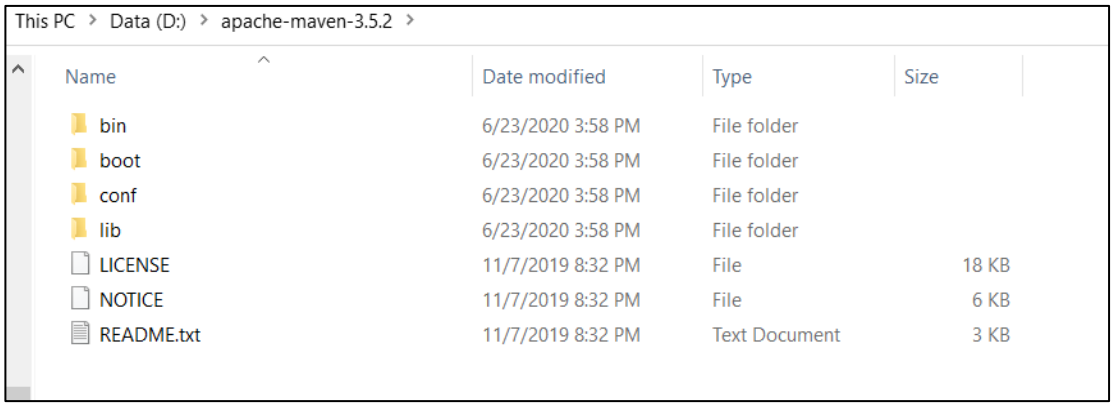

Figure 12-13

Add **MAVEN_HOME** or **M2_HOME** to the system environment variables. Its value is the Maven installation directory **D:\apache-maven-3.5.0**.

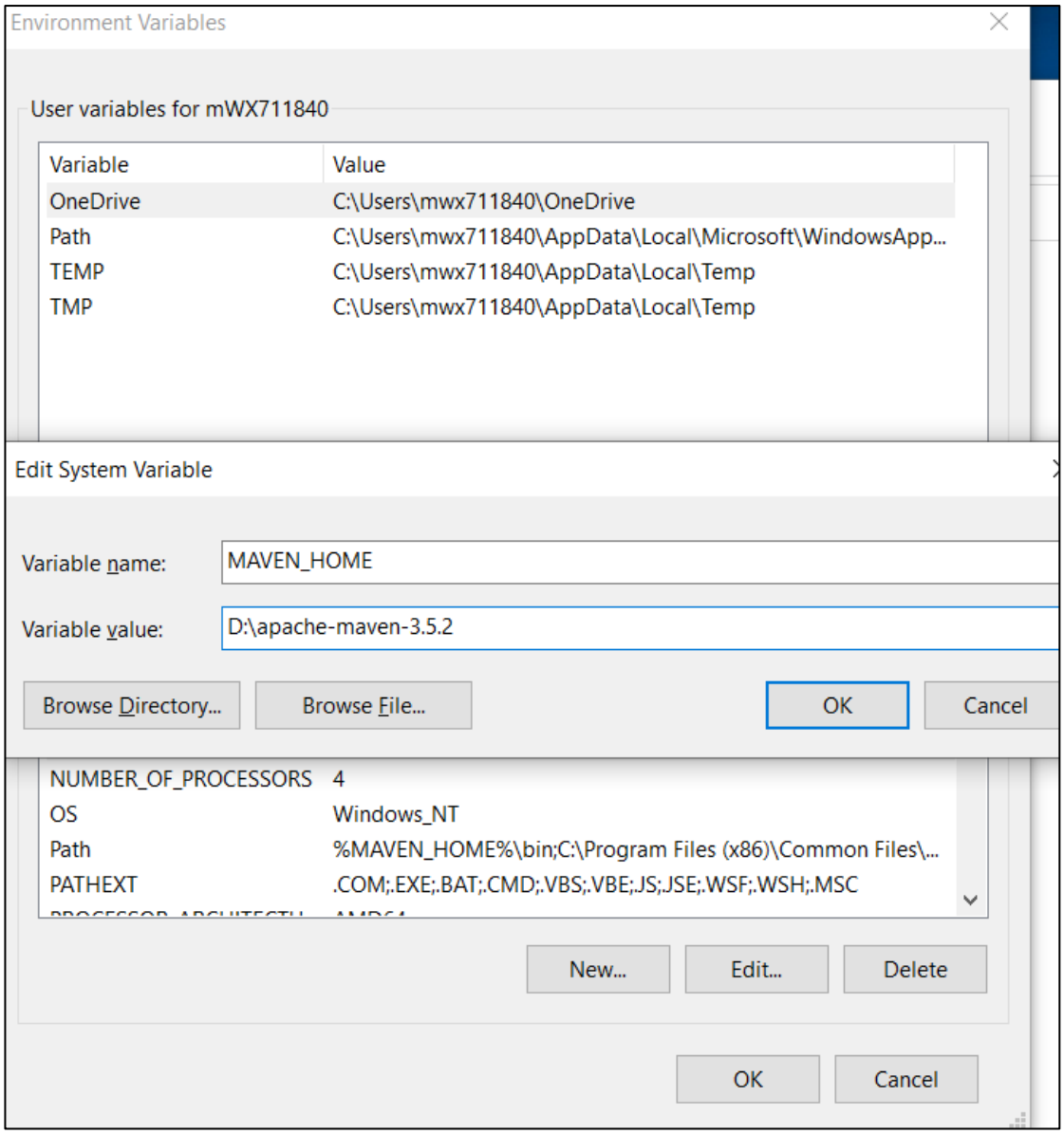

Figure 12-14

Step 2 Verify the Maven installation.

Press **Win+R** to open the **Run** window, enter **cmd**, and run the **mvn -version** command to check the version.

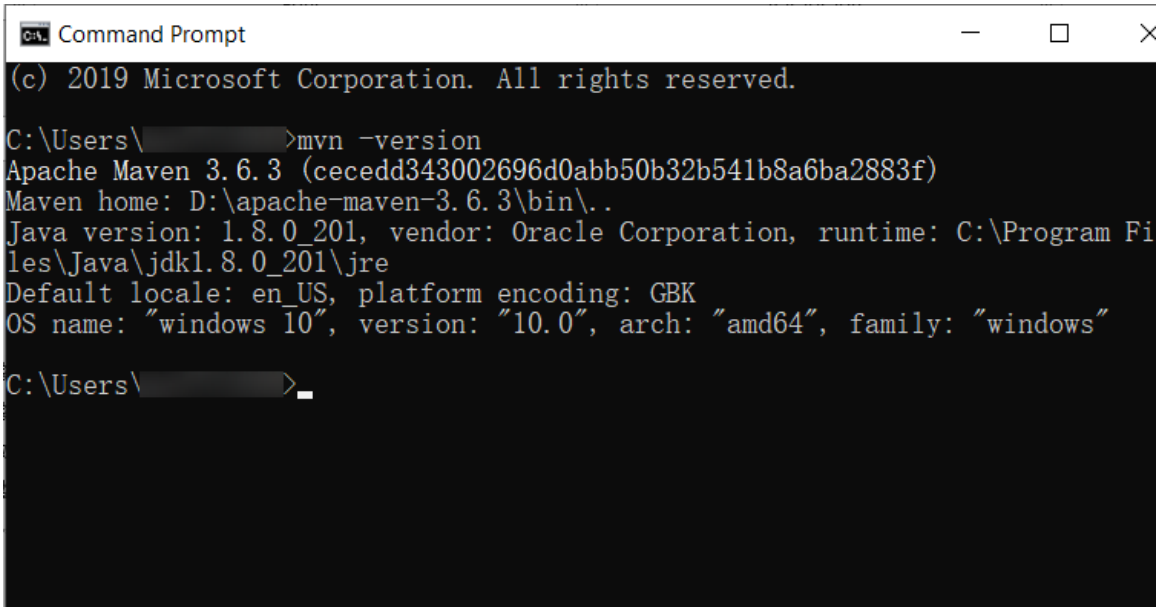

Figure 12-15

12.1.3 Installing Eclipse

Step 1 Download Eclipse.

Visit https://www.eclipse.org/downloads/packages/ and click **Downloads** on the menu bar.

Figure 12-16

Step 2 Select a version to download.

Select 64-bit to download. If the computer is 32-bit, click **Download Packages** and select 32-bit to download.

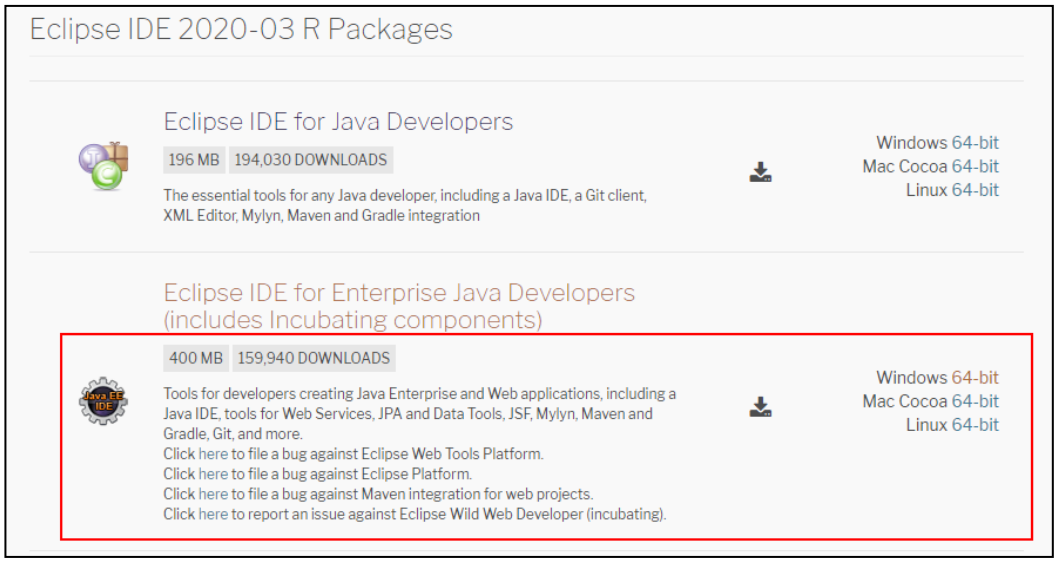

Figure 12-17

Step 3 Decompress the downloaded package and go to the folder. The following figure shows the Eclipse startup program.

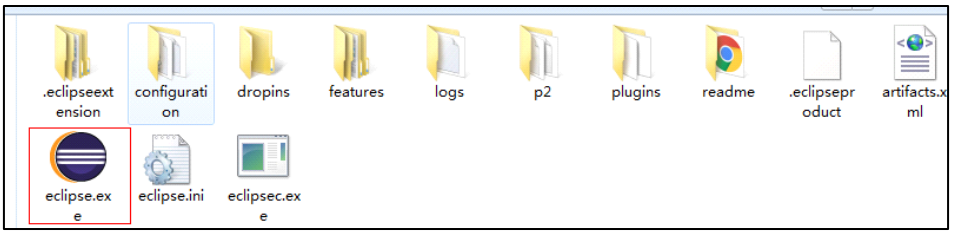

Figure 12-18

Double-click the program to start it. If you open the tool for the first time, you need to configure a workspace. You can select another location or use the default drive C. Then click **OK**.

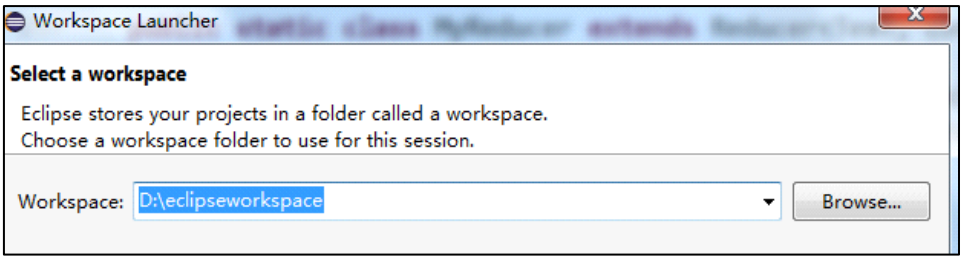

Figure 12-19

Step 4 Choose **Help** > **Eclipse Marketplace**, search for Maven, and click **Install** to Install the Maven plug-in in Eclipse.

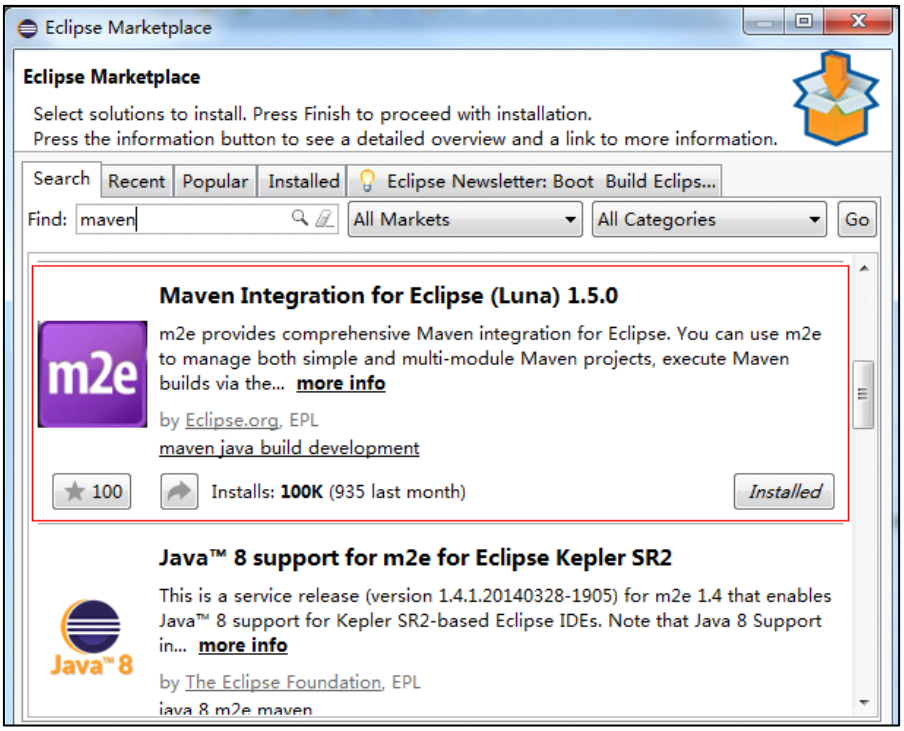

Figure 12-20

Step 5 Choose **Window** > **Preferences** > **Maven** > **User Settings** and configure the Maven in the installation directory.

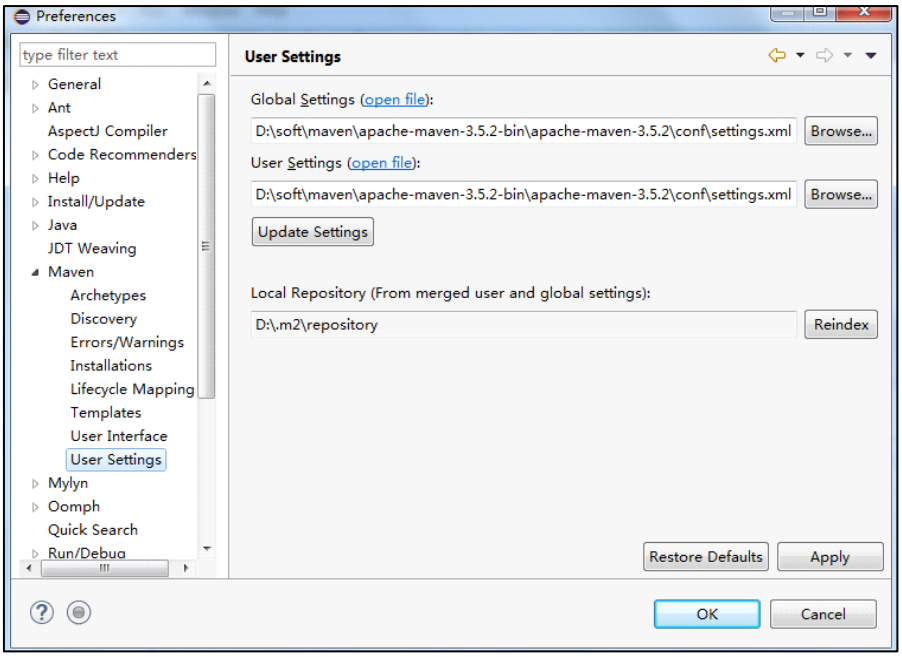

Figure 12-21

Step 6 Download the MRS2.0 sample code.

The address for downloading the sample project of MRS on HUAWEI CLOUD is https://github.com/huaweicloud/huaweicloud-mrs-example/tree/mrs-2.0.

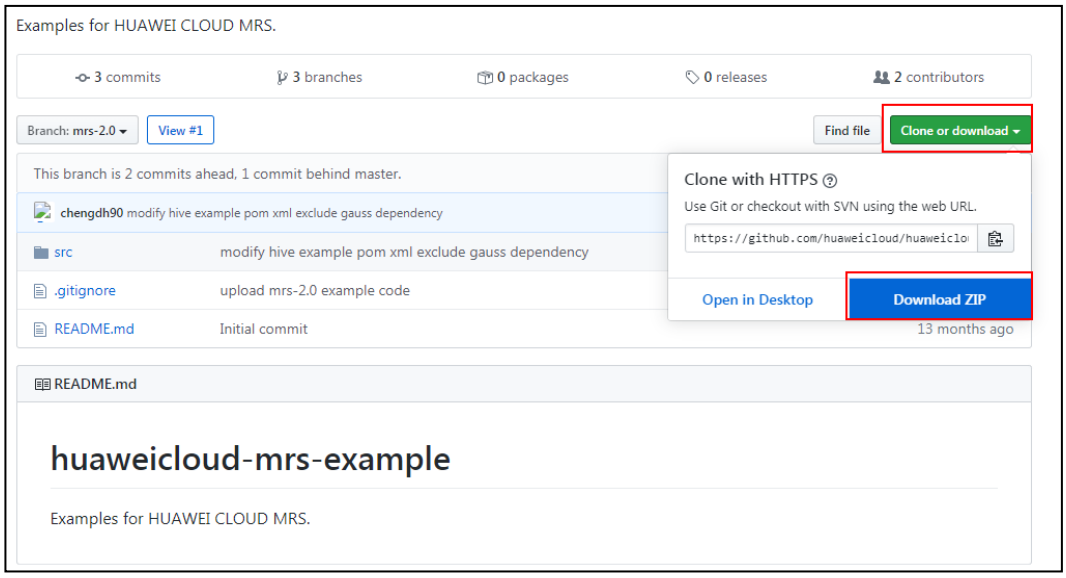

Figure 12-22

Download the ZIP package and decompress it.

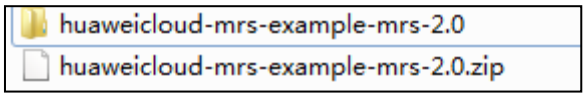

Figure 12-23

12.1.4 Importing an MRS 2.0 Sample Project to Eclipse

Step 1 Create a working set in Eclipse.

Start Eclipse, choose **File** > **New** > **Java Working Set**, enter the name, for example, **MRS2.0Demo**, and click **Finish**.

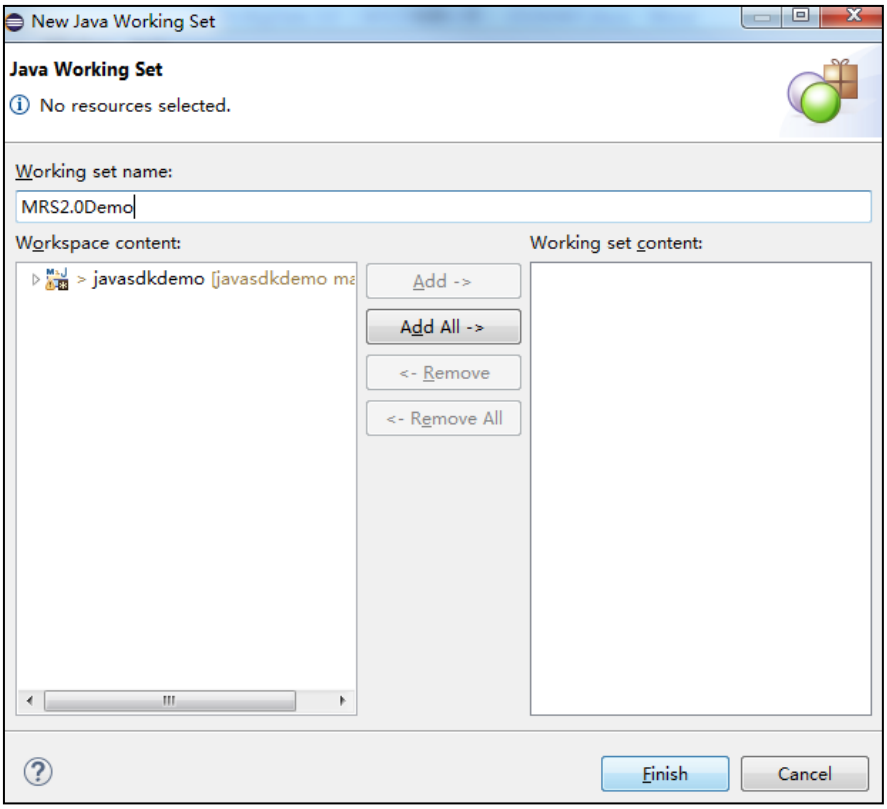

Figure 12-24

Step 2 Import a sample project to Eclipse.

Decompress the package and start **Eclipse**. Then choose **File** > **Import**.

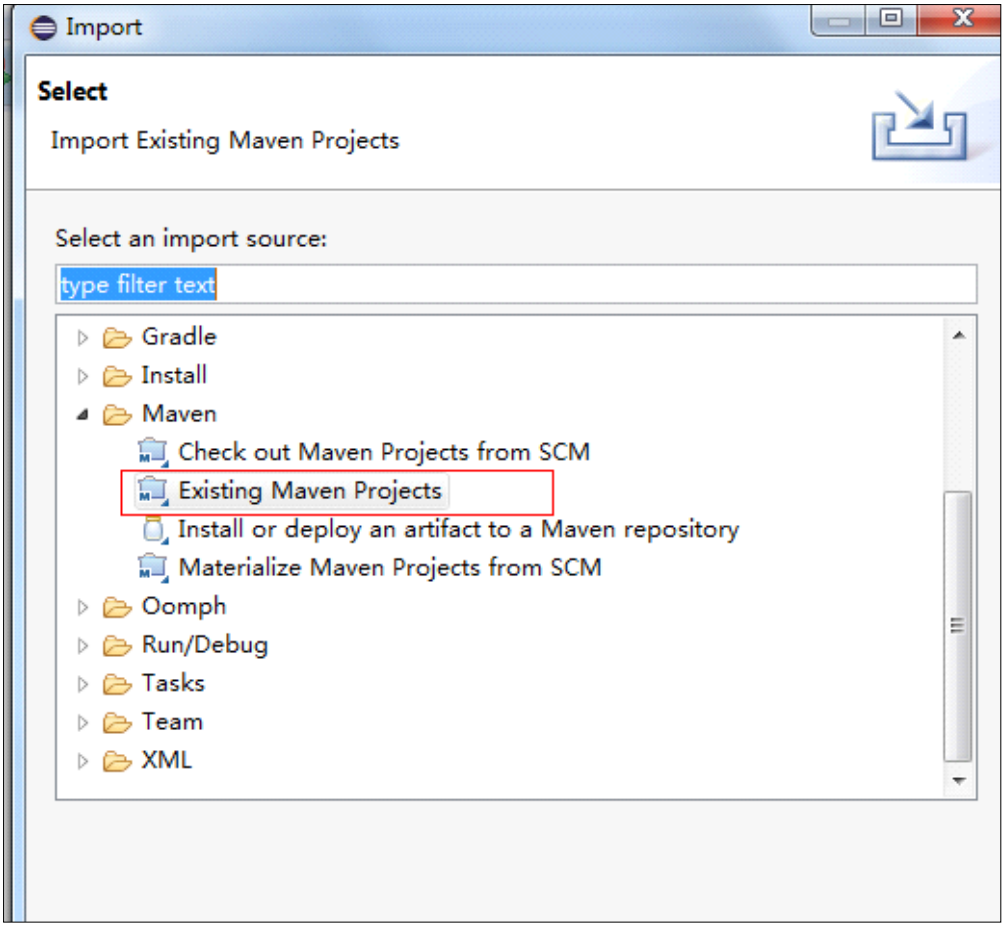

Figure 12-25

Click **Browse**, select the **huaweicloud-mrs-example-mrs-2.0** sample project folder in the decompressed package, select **Add project to working set**, select the **MRS2.0Demo** created in the previous step, and click **Finish**.

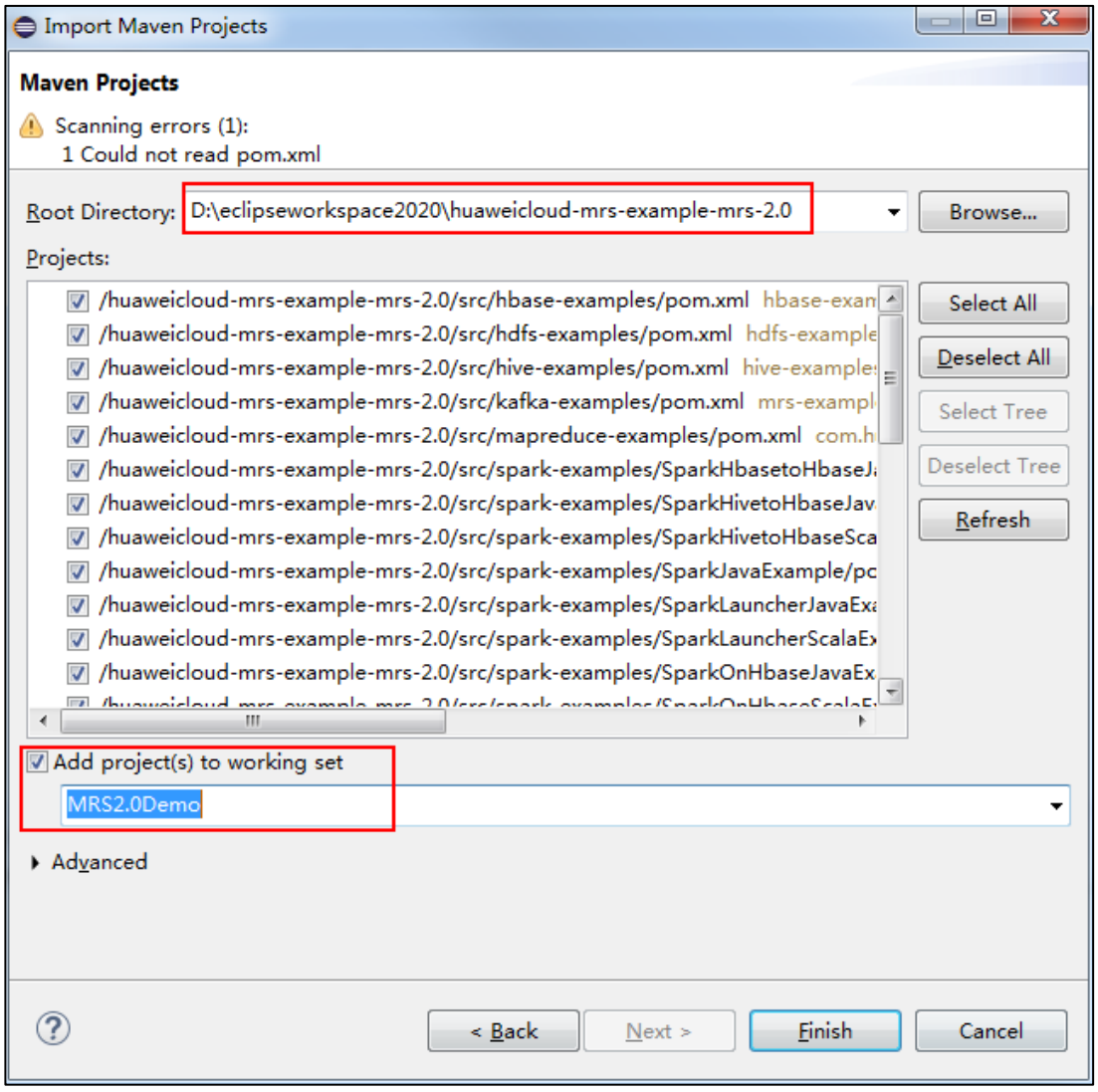

Figure 12-26

Wait until the Maven dependency package is loaded.

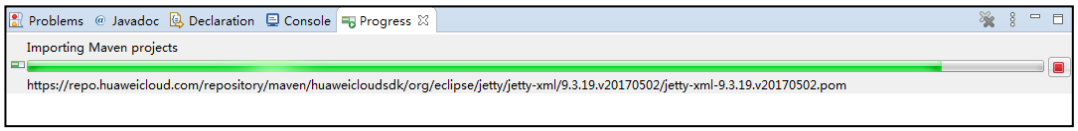

Figure 12-27

If an error is reported, ignore it and click **OK**.

Step 3 Modify the **pom** file.

Double-click the **pom** file in the **mapreduce-examples** project.

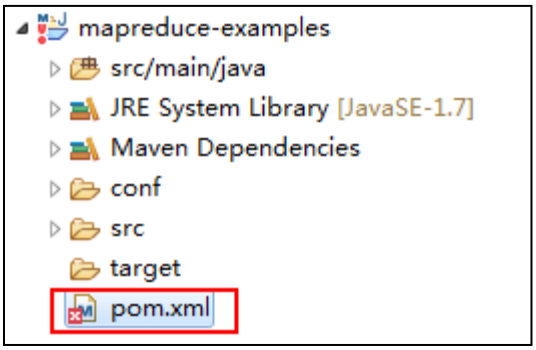

Figure 12-28

Switch to the **pom.xml** page and add the following code, where the repositories code after the dependencies tag.

```
<repositories>

        <repository>
            <id>huaweicloudsdk</id>
            <url>https://mirrors.huaweicloud.com/repository/maven/huaweicloudsdk/</url>
            <releases><enabled>true</enabled></releases>
            <snapshots><enabled>true</enabled></snapshots>
        </repository>

        <repository>
            <id>central</id>
            <name>Mavn Centreal</name>
            <url>https://repo1.maven.org/maven2/</url>
        </repository>
</repositories>
```

For details about the code, go to https://support.huaweicloud.com/en-us/devg-mrs/mrs_06_0002.html.

- **Configuration method 2**

  Add the following mirror warehouse address to the **pom.xml** file in the secondary development sample project.

```
<repositories>

    <repository>
        <id>huaweicloudsdk</id>
        <url>https://mirrors.huaweicloud.com/repository/maven/huaweicloudsdk/</url>
        <releases><enabled>true</enabled></releases>
        <snapshots><enabled>true</enabled></snapshots>
    </repository>

    <repository>
        <id>central</id>
        <name>Mavn Centreal</name>
        <url>https://repo1.maven.org/maven2/</url>
    </repository>

</repositories>
```

Figure 12-29

The modifications are as follows:

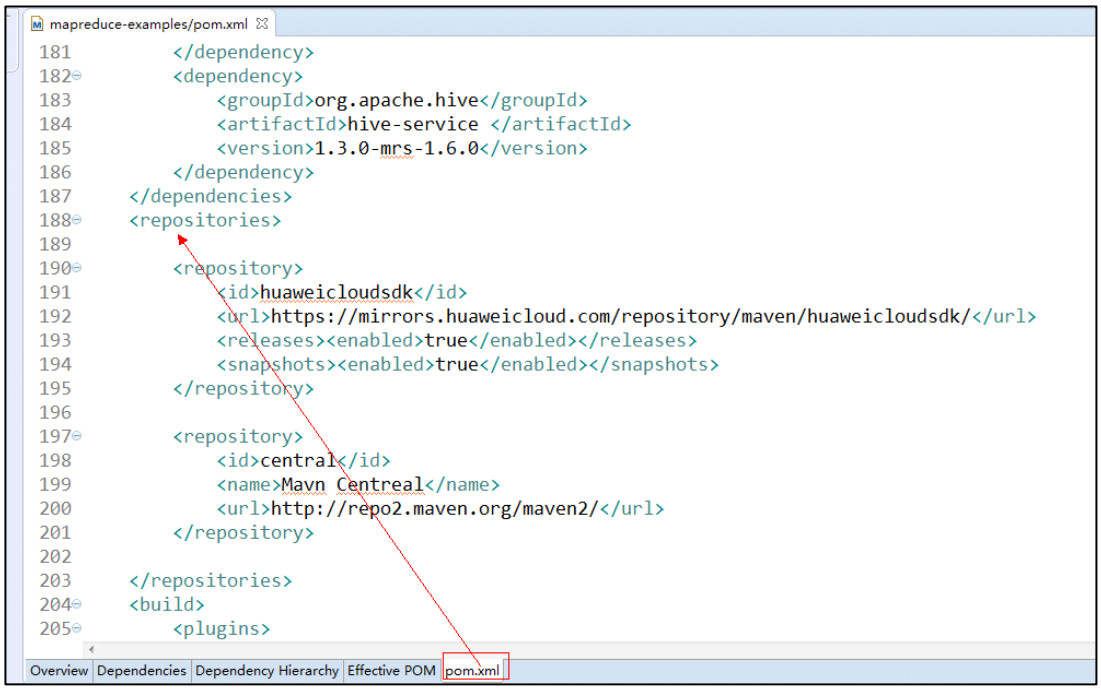

Figure 12-30

After saving the file, wait for Eclipse to download the JAR package and keep the network connection. Maven downloads the required JAR package from the Huawei image repository.

If the pom reports an error stating "Missing artifact jdk.tools:jdk.tools:jar:1.8", add the following information to the **pom.xml** file:

```
<dependency>
            <groupId>jdk.tools</groupId>
            <artifactId>jdk.tools</artifactId>
            <version>1.8</version>
            <scope>system</scope>
            <systemPath>${JAVA_HOME}/lib/tools.jar</systemPath>
</dependency>
```

The following figure shows the content added to the **pom.xml** file:

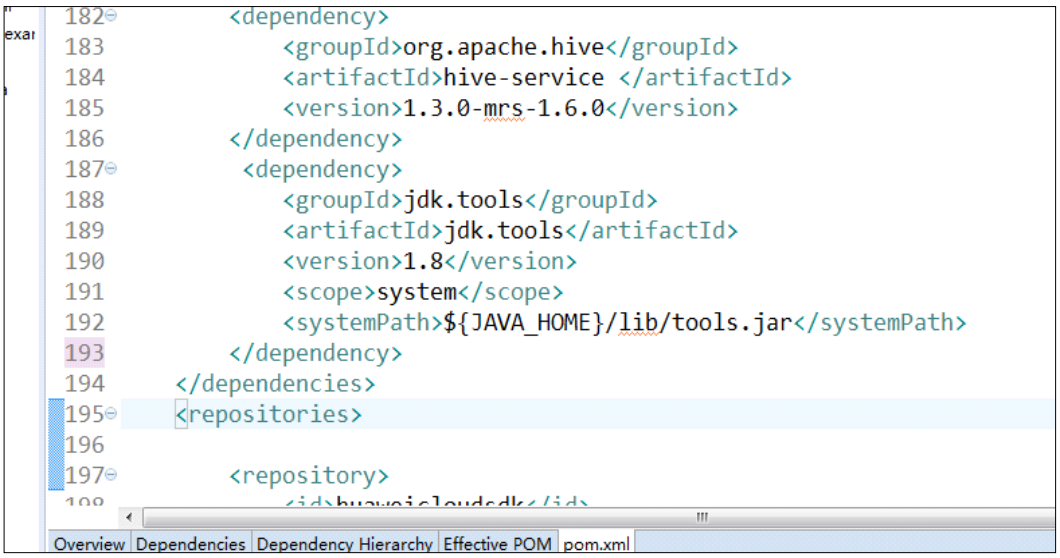

Figure 12-31

Step 4 Modify the **pom** file.

Add the marked code to the **pom** file, indicating that the JAR package of the Gauss database is not introduced to the project.

```
<dependency>
    <groupId>org.apache.hive</groupId>
    <artifactId>hive-jdbc</artifactId>
    <version>${hive.version}</version>
    <exclusions>
        <exclusion>
            <groupId>com.huawei.gsjdbc</groupId>
            <artifactId>gsjdbc4</artifactId>
        </exclusion>
        <exclusion>
            <groupId>com.huawei.gaussc10</groupId>
            <artifactId>gauss</artifactId>
        </exclusion>
    </exclusions>
</dependency>
```

Figure 12-32

```
<exclusion>                    <groupId>com.huawei.gaussc10</groupId>
    <artifactId>gauss</artifactId>
</exclusion>
```

Step 5 Modify the Java dependency.

Right-click the project name and choose **Build Path** > **Configure Build Path** from the shortcut menu.

Select **JRE System Library[J@SE-1.5]**, click **Remove**, click **Add Library**, select JRE System Library, and click **Next**.

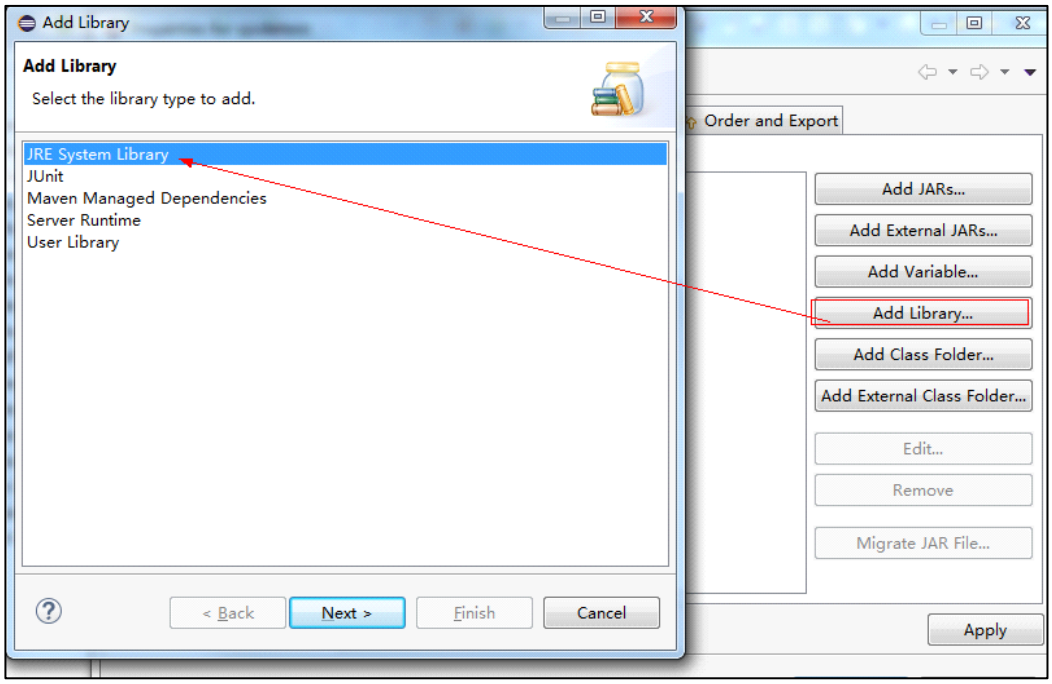

Figure 12-33

Select **JDK1.8** from the **Alternate JRE** drop-down list and click **Finish**.

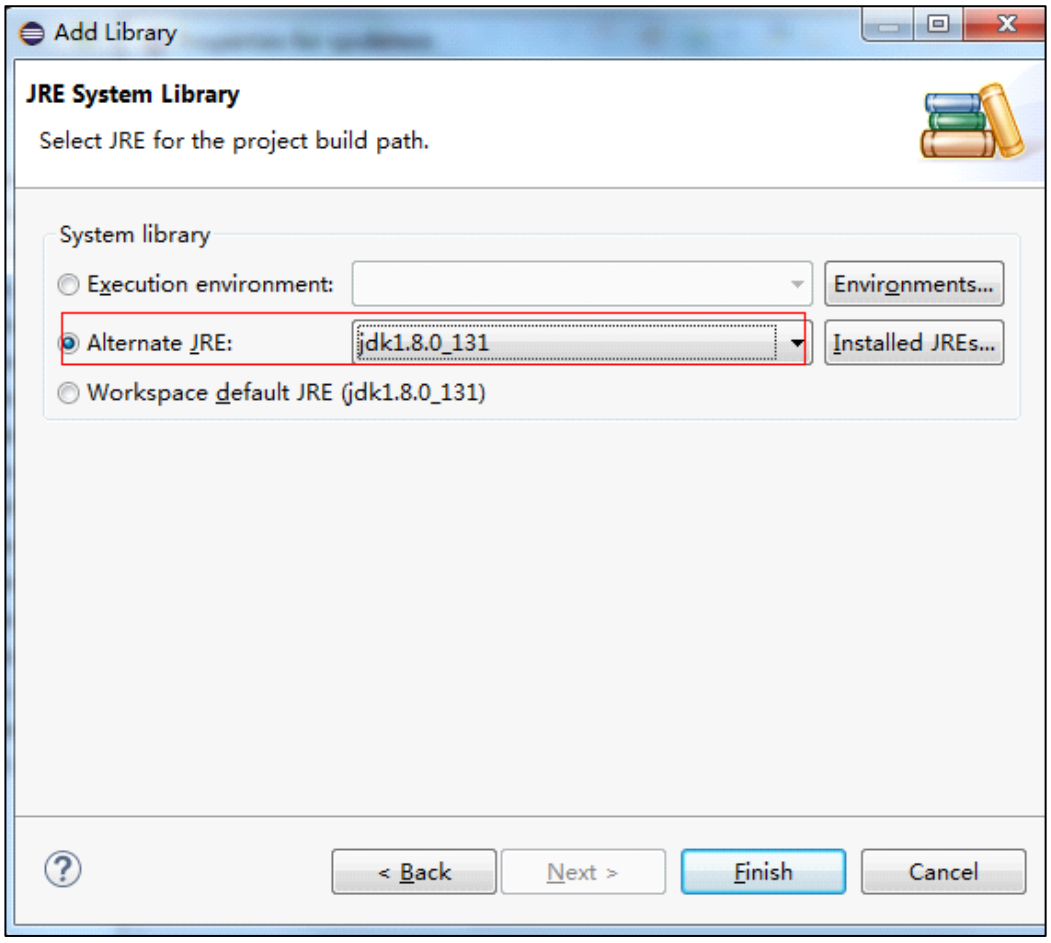

Figure 12-34

Select Java Compiler, set Compiler compliance level to 1.8, and click OK.

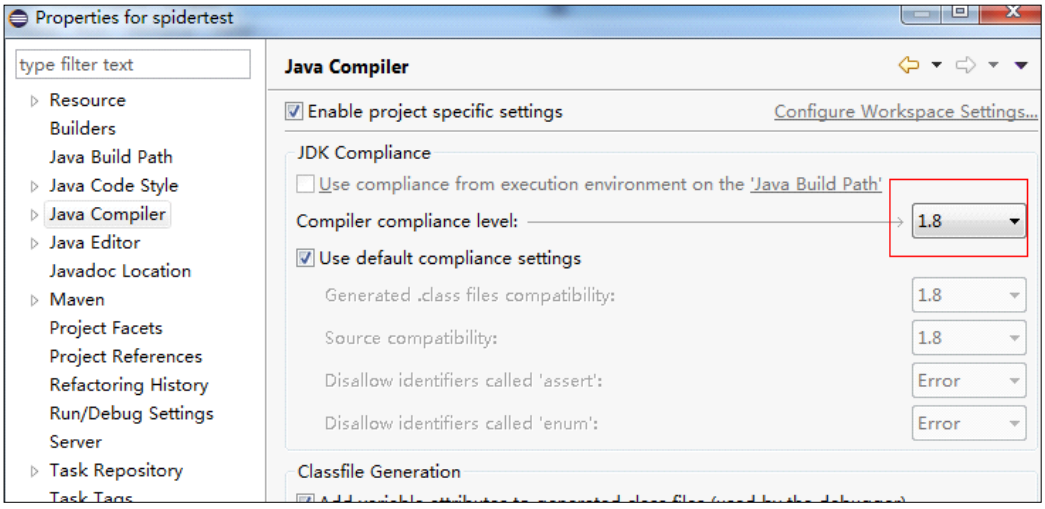

Figure 12-35

Select **Yes**.

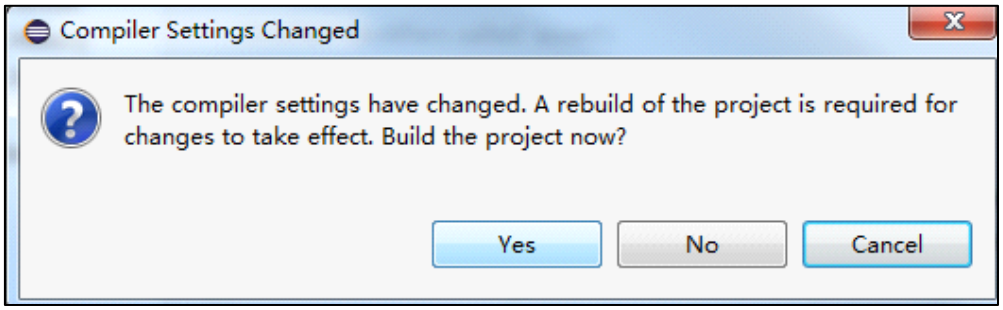

Figure 12-36

The project architecture is as follows:

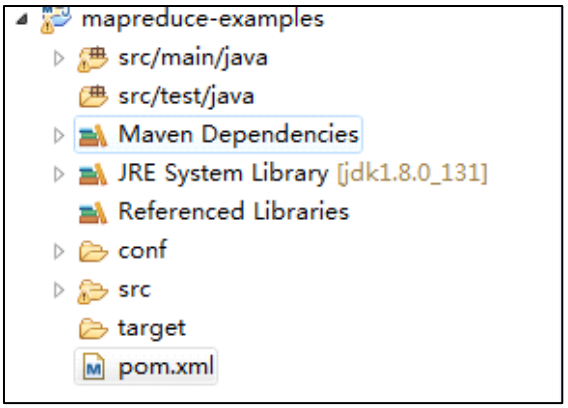

Figure 12-37

12.2 Binding an EIP to an ECS

Step 1 Access the cluster node management page.

Click the cluster name in the cluster list and click **Nodes**.

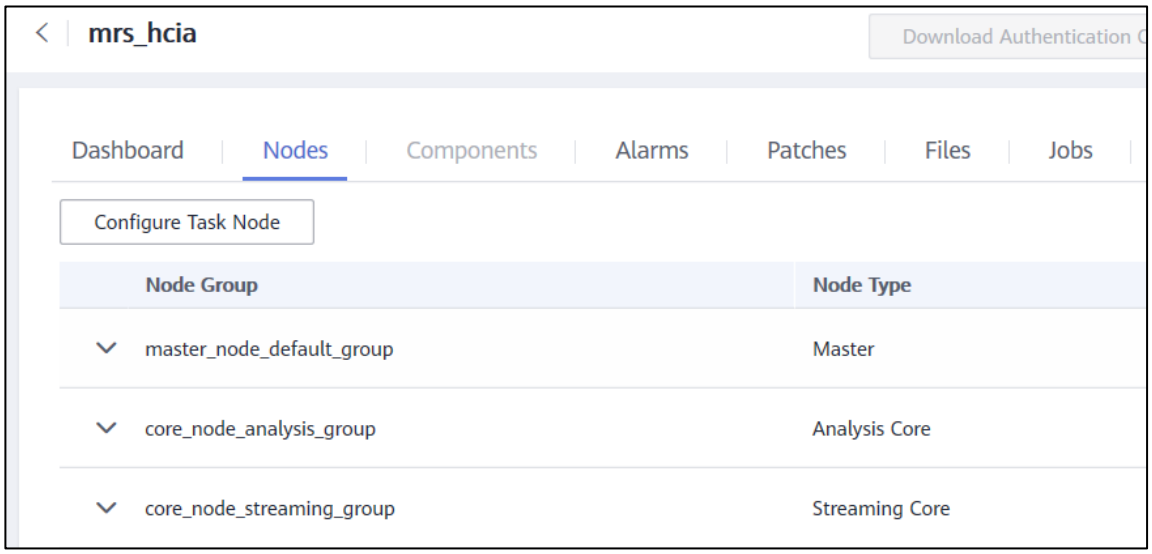

Figure 12-38

Step 2 Log in to the server where the streaming core is located.

Click a node name under **core_node_streaming_group**, as shown in the following figure:

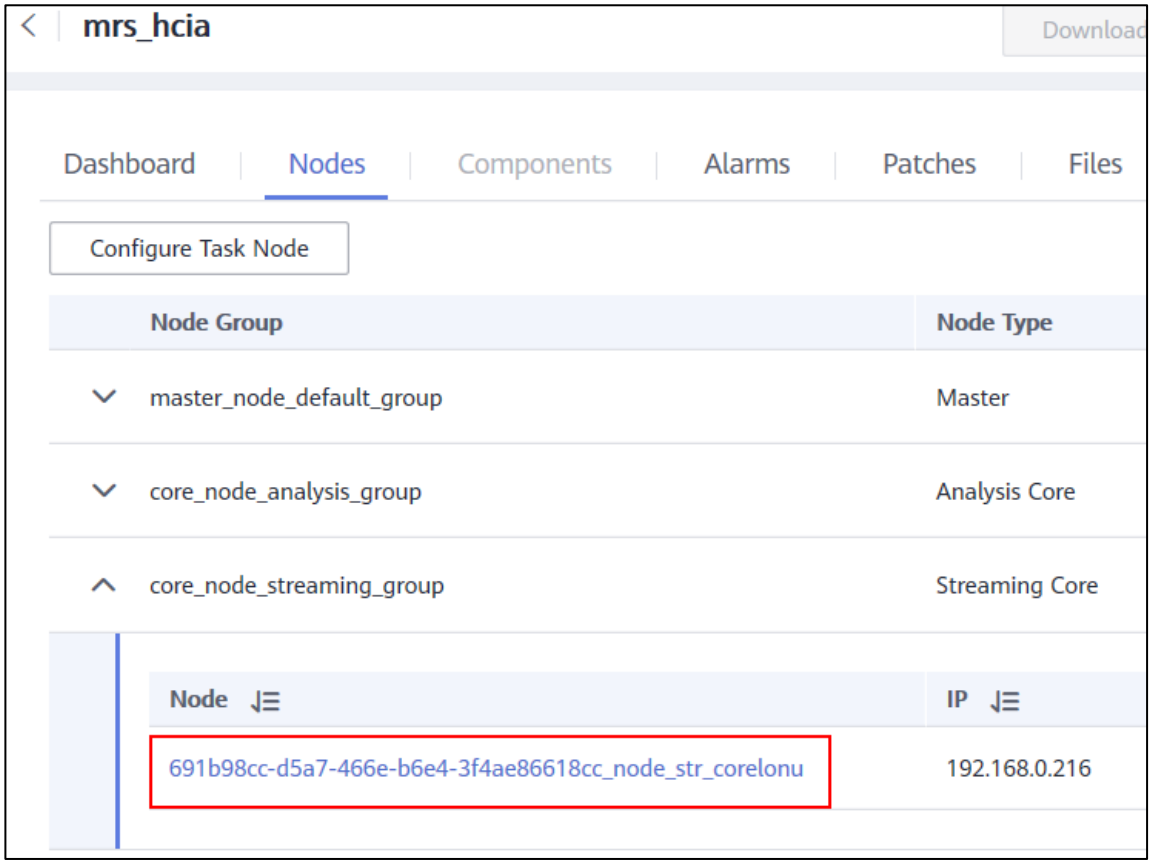

Figure 12-39

Select EIP and click **View EIP** to purchase an IP address. If you have purchased sufficient IP addresses when creating a cluster, click **Bind EIP**. Select **Pay-per-use**. After the purchase is complete, the Elastic Cloud Server page is displayed.

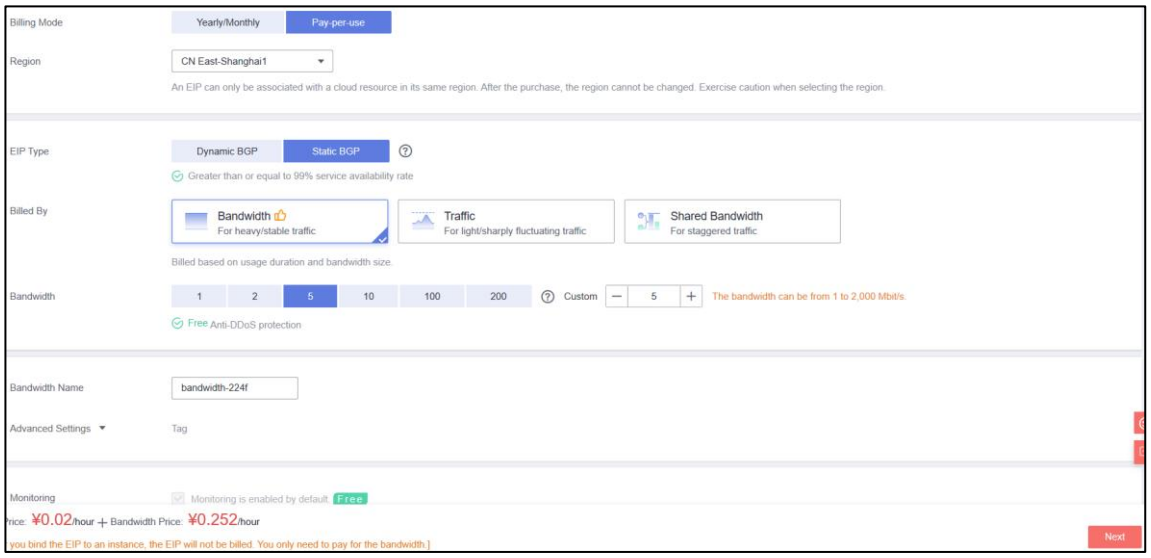

Figure 12-40

Step 3 Bind an IP address.

Click Bind EIP.

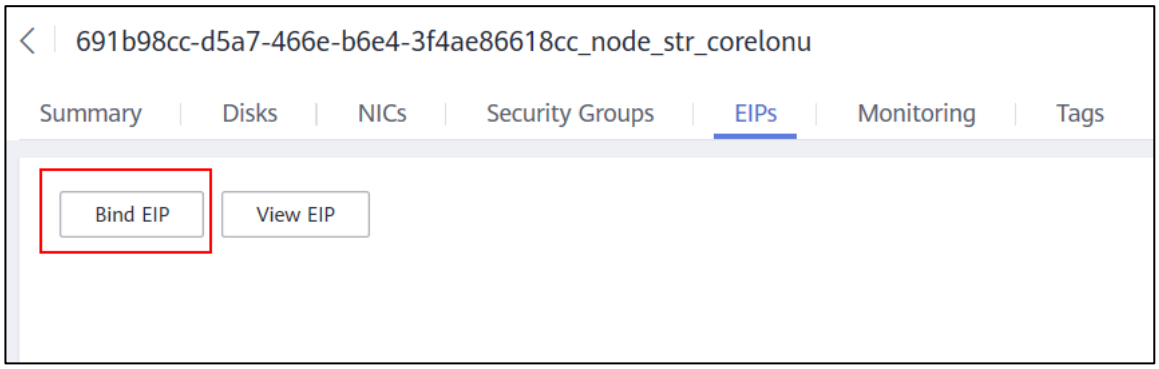

Figure 12-41

Select an IP address and click **OK**.

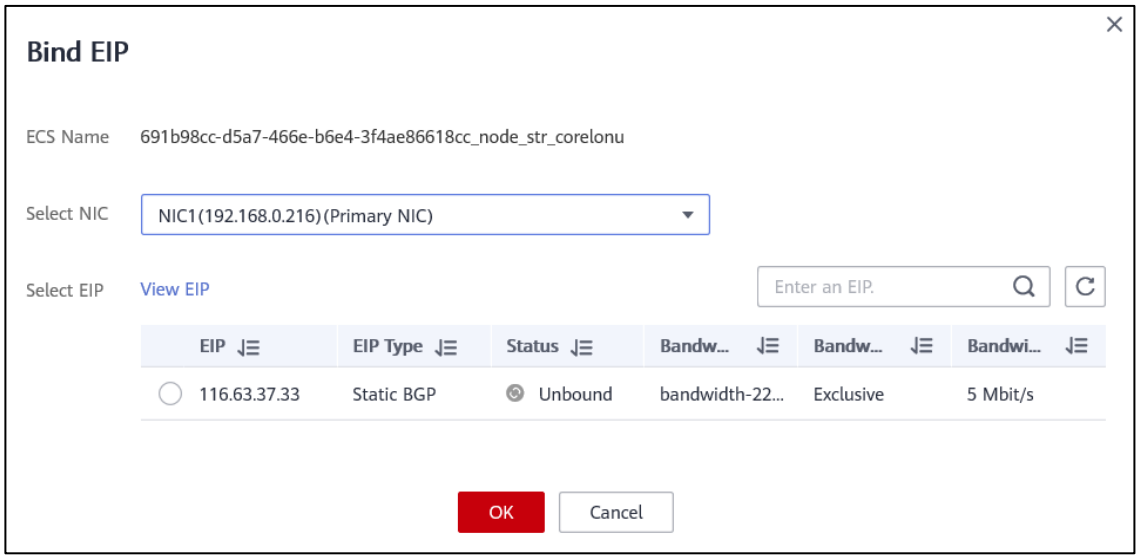

Figure 12-42

Refresh the page. You can see that the EIP is bound successfully.

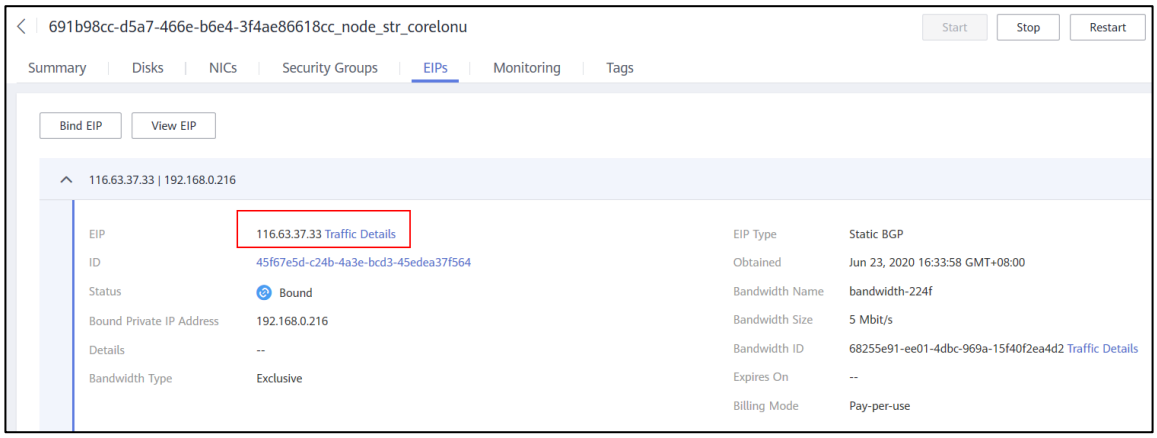

Figure 12-43

12.3 Viewing the IP address of ZooKeeper

Step 1 Log in to the MRS cluster management page.

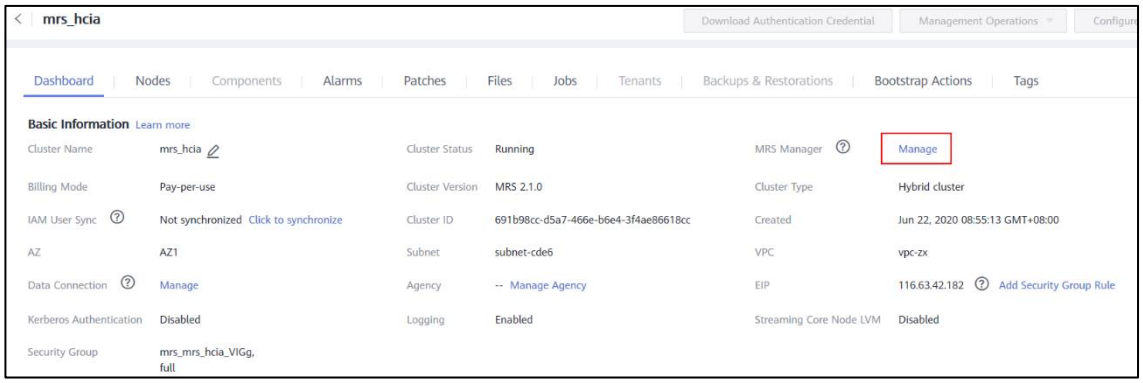

Figure 12-44

Step 2 Log in as user **admin**.

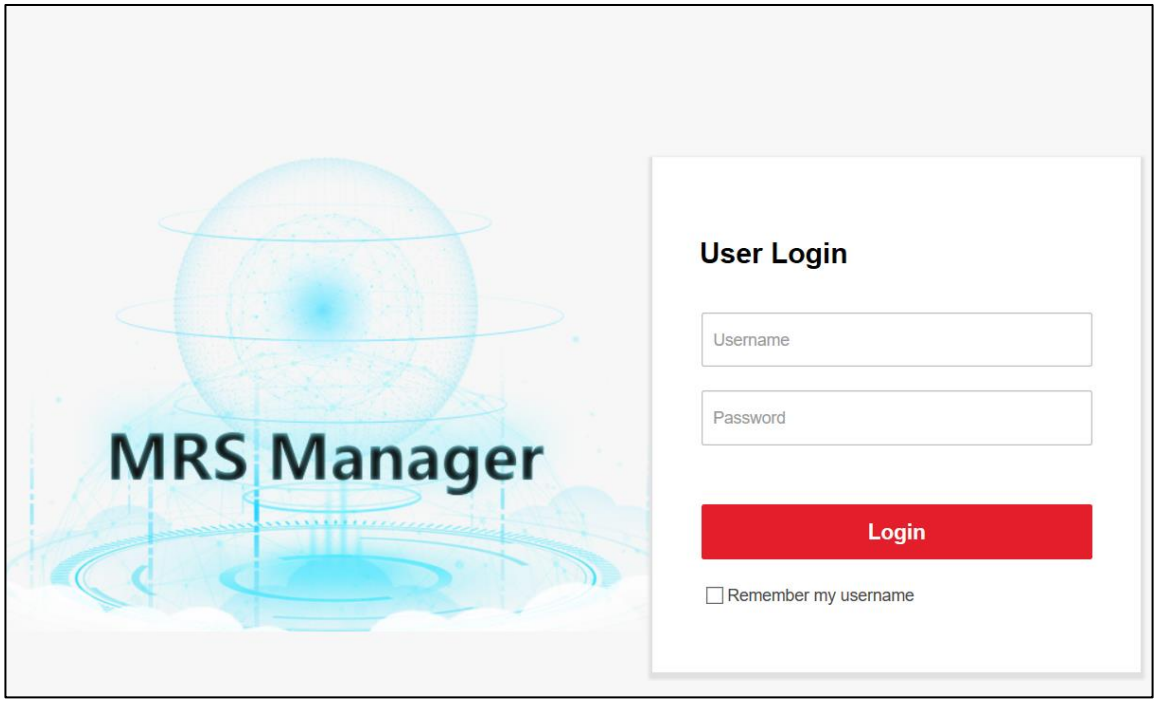

Figure 12-45

Step 3 Check the status of the Zookeeper service.

Choose **Services** > **Service ZooKeeper** > **Instance**. The business IP address of ZooKeeper is displayed.

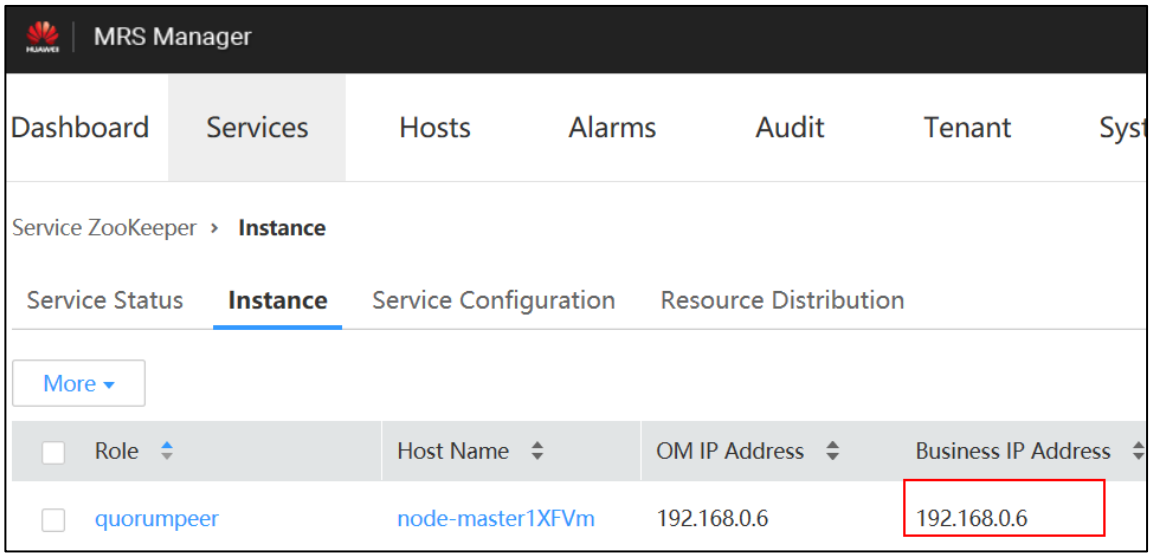

Figure 12-46

12.4 Viewing the IP Address of a Kafka Broker Instance

Step 1 Log in to the MRS cluster management page.

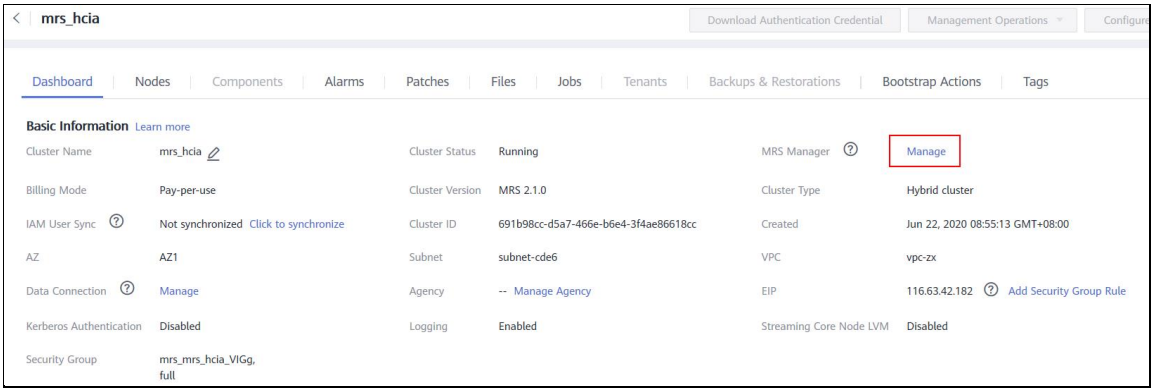

Figure 12-47

Step 2 Log in as user **admin**.

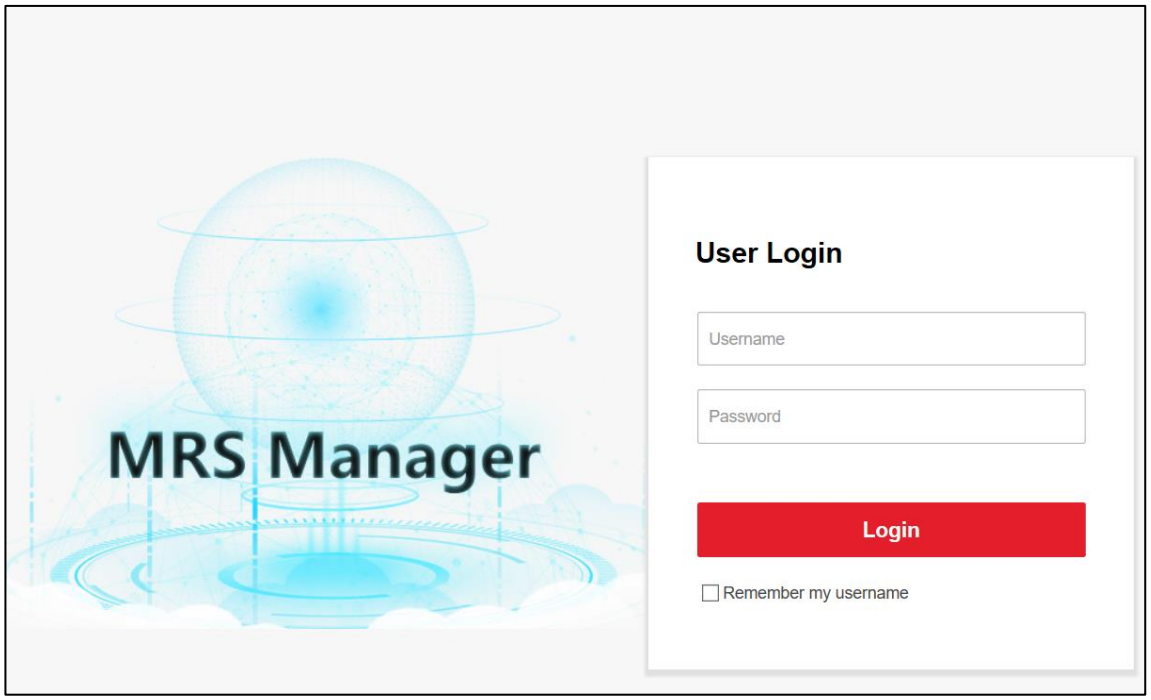

Figure 12-48

Step 3 Check the status of the Zookeeper service.

Choose **Services** > **Service Kafka** > **Instance**. The business IP address of the Kafka Broker is displayed.

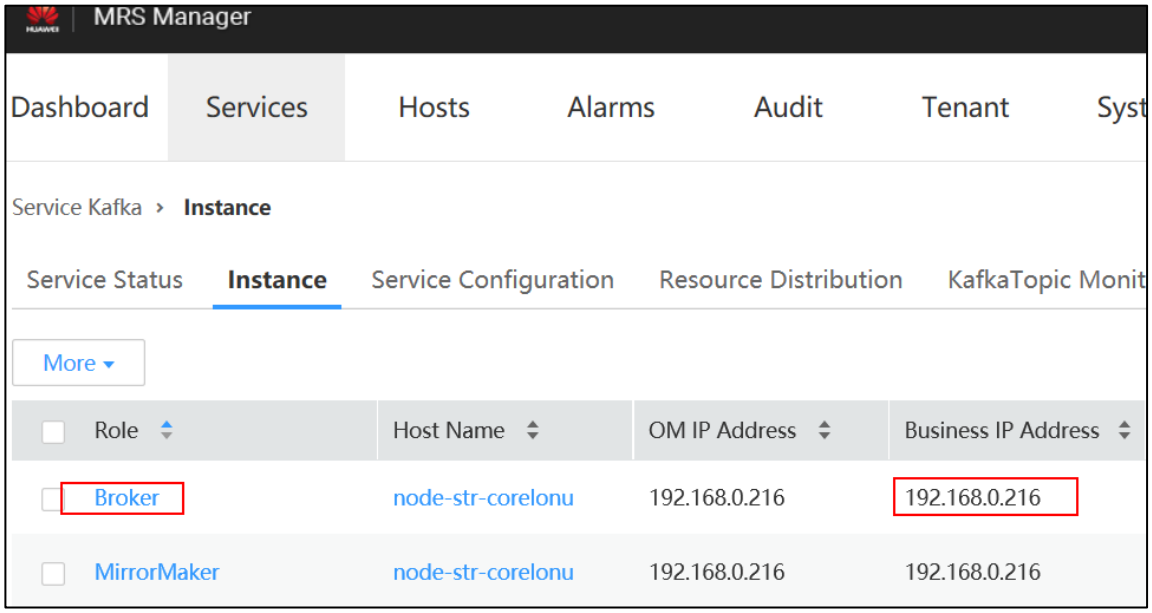

Figure 12-49

12.5 Common Linux Commands

cd /home: to go to the /home directory.

```
cd..: to move one directory up.
cd ../..: to move two directories up.
cd: to go to the personal home directory.
cd ~user1: to go to the personal home directory.
cd -: to move to your previous directory.
pwd: to show the current working directory you are in.
ls: to view files in the directory.
ls -F: to view files in a directory.
ls -l: to show details about files and directories.
ls -a: to show the hidden files.
ls *[0-9]*: to show hidden file names and directory names that contain digits.
tree: to show the contents of a directory in a tree-like format (1).
lstree: to show the contents of a directory in a tree-like format (2).
mkdir dir1: to create a directory named dir1.
mkdir dir1 dir2: to create two directories at the same time.
mkdir -p /tmp/. dir1/dir2: to create a directory tree.
rm -f file1: to delete a file named file1.
rmdir dir1: to delete a directory named dir1.
rm -rf dir1: to delete a directory named dir1 and its content.
rm -rf dir1 dir2: to delete two directories and their contents.
mv dir1 new_dir: to rename/move a directory.
cp file1 file2: to copy a file.
cp dir/*: to copy all files in a directory to the current working directory.
cp -a /tmp/dir1: to copy a directory to the current working directory.
cp -a dir1 dir2: to copy a directory.
ln -s file1 lnk1: to create a soft link to a file or directory.
```

12.6 HDFS Commands

The fsck command is executed in HDFS to check data inconsistency. The fsck command can report file problems, such as block loss or lack of blocks.

The usage of the fsck command is as follows:

```
hdfs fsck <path> [-move | -delete | -openforwrite] [-files [-blocks [-locations | -racks]]]
<path>: start directory to be checked
-move: to move the damaged file to /lost+found
-delete: to delete the damaged file
-openforwrite: to show the file that is being written
-files: to show all checked files
-blocks: to show the block report
-locations: to show the location of each block
-racks: to show the network topology of the DataNode
```

By default, fsck ignores files that are being written, and you can use the **-openforwrite** option to report such files.

Run the **hdfs fsck /1001/hive.log –racks** command to view the topology information of **/1001/hive.log**.

```
fi01host02:/tmp # hdfs fsck /1001/hive.log -racks
18/01/18 17:30:49 INFO hdfs.PeerCache: SocketCache disabled.
Connecting to namenode via https://fi01host02:25003/fsck?ugi=admin&racks=1&path=%2F1001%2Fhive.log
FSCK started by admin (auth:KERBEROS_SSL) from /192.168.225.12 for path /1001/hive.log at Thu Jan 18 17:30:49 GMT+08:00 2018
.Status: HEALTHY
 Total size:    446 B
 Total dirs:    0
 Total files:   1
 Total symlinks:                0
 Total blocks (validated):      1 (avg. block size 446 B)
 Minimally replicated blocks:   1 (100.0 %)
 Over-replicated blocks:        0 (0.0 %)
 Under-replicated blocks:       0 (0.0 %)
 Mis-replicated blocks:         0 (0.0 %)
 Default replication factor:    3
 Average block replication:     3.0
 Corrupt blocks:                0
 Missing replicas:              0 (0.0 %)
 Number of data-nodes:          3
 Number of racks:               3
FSCK ended at Thu Jan 18 17:30:49 GMT+08:00 2018 in 2 milliseconds
The filesystem under path '/1001/hive.log' is HEALTHY
```

Figure 12-50

```
hdfs fsck /1001/hive.log -files -blocks -locations –racks
```

The detailed information about each block in the file is displayed, including the rack information of the DataNode.

12.7 Yarn Application Operation Commands

1. Run the following command to check all applications on Yarn:

```
yarn application -list
```

In the Flink exercise, the **yarn-session.sh** script is used to start a Flink cluster. This is a Yarn application. Run the following command to view the Yarn application:

```
[root@node-master1JRhg ~]# source /opt/client/bigdata_env
[root@node-master1JRhg ~]# yarn application -list
2020-04-16 17:02:39,643 INFO client.AHSProxy: Connecting to Application History server at /0.0.0.0:10200
Total number of applications (application-types: [], states: [SUBMITTED, ACCEPTED, RUNNING] and tags: []):2
                Application-Id      Application-Name        Application-Type          User      Queue-User
inal-State             Progress                         Tracking-URL
application_1586998890444_0002  Spark-JDBCServer-192.168.0.99                SPARK           omm
        UNDEFINED                10%        http://node-master1JRhg:4040
application_1586998890444_0007  Flink session cluster          Apache Flink          root            root
 UNDEFINED                 100%           http://192.168.0.69:42552
[root@node-master1JRhg ~]#
```

Figure 12-51

2. Run the following command to kill the Yarn application:

```
yarn application -kill application id
```

For example, to kill a Flink cluster application, run the **-list** command to view the ID, and then run the **kill** command.

```
[root@node-master1JRhg ~]# yarn application -list
2020-04-16 17:02:39,643 INFO client.AHSProxy: Connecting to Application History server at /0.0.0.0:10200
Total number of applications (application-types: [], states: [SUBMITTED, ACCEPTED, RUNNING] and tags: []):2
                Application-Id      Application-Name        Application-Type          User      Queue-User
inal-State             Progress                         Tracking-URL
application_1586998890444_0002  Spark-JDBCServer-192.168.0.99                  SPARK           omm
        UNDEFINED                  10%        http://node-master1JRhg:4040
application_1586998890444_0007  Flink session cluster           Apache Flink          root            root
 UNDEFINED                100%           http://192.168.0.69:42552
[root@node-master1JRhg ~]# yarn application -kill  application_1586998890444_0007
2020-04-16 17:06:40,126 INFO client.AHSProxy: Connecting to Application History server at /0.0.0.0:10200
Killing application application_1586998890444_0007
2020-04-16 17:06:40,444 INFO impl.YarnClientImpl: Killed application application_1586998890444_0007
[root@node-master1JRhg ~]#
```

Figure 12-52