

# Hadoop Streaming

## Table of contents

|                                                                                 |    |
|---------------------------------------------------------------------------------|----|
| 1 Hadoop Streaming.....                                                         | 3  |
| 2 How Streaming Works .....                                                     | 3  |
| 3 Streaming Command Options.....                                                | 4  |
| 3.1 Specifying a Java Class as the Mapper/Reducer.....                          | 5  |
| 3.2 Packaging Files With Job Submissions.....                                   | 5  |
| 3.3 Specifying Other Plugins for Jobs .....                                     | 6  |
| 3.4 Setting Environment Variables.....                                          | 6  |
| 3.5 Specifying the Communication Format.....                                    | 7  |
| 4 Generic Command Options.....                                                  | 7  |
| 4.1 Specifying Configuration Variables with the -D Option.....                  | 8  |
| 4.2 Working with Large Files and Archives.....                                  | 10 |
| 5 More Usage Examples.....                                                      | 12 |
| 5.1 Hadoop Partitioner Class.....                                               | 12 |
| 5.2 Hadoop Comparator Class.....                                                | 13 |
| 5.3 Hadoop Aggregate Package.....                                               | 14 |
| 5.4 Hadoop Field Selection Class.....                                           | 14 |
| 6 Configurable parameters.....                                                  | 15 |
| 7 Frequently Asked Questions .....                                              | 18 |
| 7.1 How do I run an arbitrary set of (semi) independent tasks? .....            | 18 |
| 7.2 How do I process files, one per map? .....                                  | 18 |
| 7.3 How many reducers should I use? .....                                       | 18 |
| 7.4 How does the use of streaming differ from the Java MapReduce API?.....      | 18 |
| 7.5 If I set up an alias in my shell script, will that work after -mapper?..... | 19 |

|                                                                                    |    |
|------------------------------------------------------------------------------------|----|
| 7.6 Can I use UNIX pipes?.....                                                     | 19 |
| 7.7 What do I do if I get the "No space left on device" error?.....                | 19 |
| 7.8 How do I specify multiple input directories? .....                             | 20 |
| 7.9 How do I generate output files with gzip format? .....                         | 20 |
| 7.10 How do I provide my own input/output format with streaming? .....             | 20 |
| 7.11 How do I parse XML documents using streaming? .....                           | 20 |
| 7.12 How do I update counters in streaming applications? .....                     | 20 |
| 7.13 How do I update status in streaming applications? .....                       | 20 |
| 7.14 How do I get the JobConf variables in a streaming job's mapper/reducer? ..... | 21 |

## 1 Hadoop Streaming

Hadoop streaming is a utility that comes with the Hadoop distribution. The utility allows you to create and run MapReduce jobs with any executable or script as the mapper and/or the reducer. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \  
-input myInputDirs \  
-output myOutputDir \  
-mapper cat \  
-reducer wc
```

## 2 How Streaming Works

In the above example, both the mapper and the reducer are executables that read the input from stdin (line by line) and emit the output to stdout. The utility will create a MapReduce job, submit the job to an appropriate cluster, and monitor the progress of the job until it completes.

When an executable is specified for mappers, each mapper task will launch the executable as a separate process when the mapper is initialized. As the mapper task runs, it converts its inputs into lines and feed the lines to the stdin of the process. In the meantime, the mapper collects the line-oriented outputs from the stdout of the process and converts each line into a key/value pair, which is collected as the output of the mapper. By default, the *prefix of a line up to the first tab character* is the **key** and the rest of the line (excluding the tab character) will be the **value**. If there is no tab character in the line, then entire line is considered as key and the value is null. However, this can be customized, as discussed later.

When an executable is specified for reducers, each reducer task will launch the executable as a separate process then the reducer is initialized. As the reducer task runs, it converts its input key/values pairs into lines and feeds the lines to the stdin of the process. In the meantime, the reducer collects the line-oriented outputs from the stdout of the process, converts each line into a key/value pair, which is collected as the output of the reducer. By default, the prefix of a line up to the first tab character is the key and the rest of the line (excluding the tab character) is the value. However, this can be customized, as discussed later.

This is the basis for the communication protocol between the MapReduce framework and the streaming mapper/reducer.

User can specify `stream.non.zero.exit.is.failure` as `true` or `false` to make a streaming task that exits with a non-zero status to be `Failure` or `Success` respectively. By default, streaming tasks exiting with non-zero status are considered to be failed tasks.

### 3 Streaming Command Options

Streaming supports streaming command options as well as [generic command options](#). The general command line syntax is shown below.

**Note:** Be sure to place the generic options before the streaming options, otherwise the command will fail. For an example, see [Making Archives Available to Tasks](#).

```
$HADOOP_HOME/bin/hadoop command [genericOptions] [streamingOptions]
```

The Hadoop streaming command options are listed here:

| Parameter                                   | Optional/Required | Description                                                                                                            |
|---------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------|
| -input directoryname or filename            | Required          | Input location for mapper                                                                                              |
| -output directoryname                       | Required          | Output location for reducer                                                                                            |
| -mapper executable or JavaClassName         | Optional          | Mapper executable                                                                                                      |
| -reducer executable or JavaClassName        | Optional          | Reducer executable                                                                                                     |
| -file filename                              | Optional          | File/dir to be shipped in the Job jar file. Deprecated, use generic option -files instead.                             |
| -inputformat JavaClassName                  | Optional          | Class you supply should return key/value pairs of Text class. If not specified, TextInputFormat is used as the default |
| -outputformat JavaClassName                 | Optional          | Class you supply should take key/value pairs of Text class. If not specified, TextOutputFormat is used as the default  |
| -partitioner JavaClassName                  | Optional          | Class that determines which reduce a key is sent to                                                                    |
| -combiner streamingCommand or JavaClassName | Optional          | Combiner executable for map output                                                                                     |
| -cmdenv name=value                          | Optional          | Pass environment variable to streaming commands                                                                        |
| -inputreader spec                           | Optional          | Specifies a record reader class (instead of an input format class)                                                     |

| Parameter           | Optional/Required | Description                                                                                                                                                                  |
|---------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -background         | Optional          | Submit the job and don't wait till it completes.                                                                                                                             |
| -verbose            | Optional          | Verbose output                                                                                                                                                               |
| -lazyOutput         | Optional          | Create output lazily. For example, if the output format is based on FileOutputFormat, the output file is created only on the first call to output.collect (or Context.write) |
| -numReduceTasks num | Optional          | Specify the number of reducers                                                                                                                                               |
| -mapdebug cmd       | Optional          | Script to be called when map task fails                                                                                                                                      |
| -reducedebg cmd     | Optional          | Script to be called when reduce task fails                                                                                                                                   |
| -io identifier      | Optional          | Format to use for input to and output from client processes.                                                                                                                 |

### 3.1 Specifying a Java Class as the Mapper/Reducer

You can supply a Java class as the mapper and/or the reducer.

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
  -input myInputDirs \
  -output myOutputDir \
  -mapper org.apache.hadoop.mapred.lib.IdentityMapper \
  -reducer org.apache.hadoop.mapred.lib.IdentityReducer
```

### 3.2 Packaging Files With Job Submissions

You can specify any executable as the mapper and/or the reducer. The executables do not need to pre-exist on the machines in the cluster; however, if they don't, you will need to use "-file" option to tell the framework to pack your executable files as a part of job submission. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
  -input myInputDirs \
  -output myOutputDir \
  -mapper myPythonScript.py \
  -reducer wc \
  -file myPythonScript.py
```

The above example specifies a user defined Python executable as the mapper. The option "-file myPythonScript.py" causes the python executable shipped to the cluster machines as a part of job submission.

In addition to executable files, you can also package other auxiliary files (such as dictionaries, configuration files, etc) that may be used by the mapper and/or the reducer. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
  -input myInputDirs \
  -output myOutputDir \
  -mapper myPythonScript.py \
  -reducer wc \
  -file myPythonScript.py \
  -file myDictionary.txt
```

If files with extension .class are added using -file option, they are packaged into "classes" directory in the job jar. Similarly, if files with extension .jar or .zip are added using -file option they are packaged into "lib" directory in the job jar. When unjarred on tasktracker, symlinks to the directories "classes" and "lib" are created from the cwd of the task. All the files in classes and lib directories are automatically added to classpath of the task. If you'd like to explicitly access these .class or .jar/.zip files inside your mapper/reducer code, access them as ./lib/jarfile.jar or ./lib/zipfile.zip or ./classes/classFile.class".

All other files added using -file option (e.g. .txt or .pl) are packaged directly in the job jar. When unjarred on tasktracker, symlinks to these files are created from the cwd of the task.

### 3.3 Specifying Other Plugins for Jobs

Just as with a normal MapReduce job, you can specify other plugins for a streaming job:

```
-inputformat JavaClassName
-outputformat JavaClassName
-partitioner JavaClassName
-combiner streamingCommand or JavaClassName
```

The class you supply for the input format should return key/value pairs of Text class. If you do not specify an input format class, the TextInputFormat is used as the default. Since the TextInputFormat returns keys of LongWritable class, which are actually not part of the input data, the keys will be discarded; only the values will be piped to the streaming mapper.

The class you supply for the output format is expected to take key/value pairs of Text class. If you do not specify an output format class, the TextOutputFormat is used as the default.

### 3.4 Setting Environment Variables

To set an environment variable in a streaming command use:

```
-cmdenv EXAMPLE_DIR=/home/example/dictionaries/
```

### 3.5 Specifying the Communication Format

By default Hadoop Streaming uses tab-separated lines of text as input/output format for passing data to and from client processes, but it is also possible to use other formats. Specifying the communication format can be done as follows:

```
-io [identifier]
```

where `[identifier]` can be `text`, `rawbytes` or `typedbytes`. These identifiers correspond to the following formats:

- `text`: The default tab-separated lines of text.
- `rawbytes`: Keys and values are passed as a 4 byte length followed by the raw bytes.
- `typedbytes`: The "typed bytes" format as described in the [API documentation](#) for the package `org.apache.hadoop.typedbytes`.

## 4 Generic Command Options

Streaming supports generic command options as well as [streaming command options](#). The general command line syntax is shown below.

**Note:** Be sure to place the generic options before the streaming options, otherwise the command will fail. For an example, see [Making Archives Available to Tasks](#).

```
$HADOOP_HOME/bin/hadoop command [genericOptions] [streamingOptions]
```

The Hadoop generic command options you can use with streaming are listed here:

| Parameter                | Optional/Required | Description                                                         |
|--------------------------|-------------------|---------------------------------------------------------------------|
| -conf configuration_file | Optional          | Specify an application configuration file                           |
| -D property=value        | Optional          | Use value for given property                                        |
| -fs host:port or local   | Optional          | Specify a namenode                                                  |
| -jt host:port or local   | Optional          | Specify a job tracker                                               |
| -files                   | Optional          | Specify comma-separated files to be copied to the MapReduce cluster |

| Parameter | Optional/Required | Description                                                               |
|-----------|-------------------|---------------------------------------------------------------------------|
| -libjars  | Optional          | Specify comma-separated jar files to include in the classpath             |
| -archives | Optional          | Specify comma-separated archives to be unarchived on the compute machines |

## 4.1 Specifying Configuration Variables with the -D Option

You can specify additional configuration variables by using "-D <property>=<value>".

### 4.1.1 Specifying Directories

To change the local temp directory use:

```
-D dfs.data.dir=/tmp
```

To specify additional local temp directories use:

```
-D mapreduce.cluster.local.dir=/tmp/local
-D mapreduce.jobtracker.system.dir=/tmp/system
-D mapreduce.cluster.temp.dir=/tmp/temp
```

**Note:** For more details on jobconf parameters see: [mapred-default.html](http://mapred-default.html)

### 4.1.2 Specifying Map-Only Jobs

Often, you may want to process input data using a map function only. To do this, you can pass the option -numReduceTasks as zero or simply set mapreduce.job.reduces to zero. The MapReduce framework will not create any reduce task. Rather, the outputs of the mapper tasks will be the final output of the job.

```
-numReduceTasks 0

-D mapreduce.job.reduces=0
```

To be backward compatible, Hadoop Streaming also supports the "-reduce NONE" option, which is equivalent to "-D mapreduce.job.reduces=0".

### 4.1.3 Specifying the Number of Reducers

To specify the number of reducers, for example two, you can pass the option -numReduceTasks as two or simply set mapreduce.job.reduces to two.



```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
  -numReduceTasks 2 \
  -input myInputDirs \
  -output myOutputDir \
  -mapper cat \
  -reducer wc
```

Note : If both `-numReduceTasks` and generic option `-Dmapreduce.job.reduces` are specified, `-numReduceTasks` value will override the value specified by `-Dmapreduce.job.reduces`.

#### 4.1.4 Customizing How Lines are Split into Key/Value Pairs

As noted earlier, when the MapReduce framework reads a line from the stdout of the mapper, it splits the line into a key/value pair. By default, the prefix of the line up to the first tab character is the key and the rest of the line (excluding the tab character) is the value.

However, you can customize this default. You can specify a field separator other than the tab character (the default), and you can specify the nth ( $n \geq 1$ ) character rather than the first character in a line (the default) as the separator between the key and value. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
  -D stream.map.output.field.separator=. \
  -D stream.num.map.output.key.fields=4 \
  -input myInputDirs \
  -output myOutputDir \
  -mapper cat \
  -reducer cat
```

In the above example, `"-D stream.map.output.field.separator=."` specifies `"."` as the field separator for the map outputs, and the prefix up to the fourth `"."` in a line will be the key and the rest of the line (excluding the fourth `"."`) will be the value. If a line has less than four `"."`s, then the whole line will be the key and the value will be an empty Text object (like the one created by `new Text("")`).

Similarly, you can use `"-D stream.reduce.output.field.separator=SEP"` and `"-D stream.num.reduce.output.fields=NUM"` to specify the nth field separator in a line of the reduce outputs as the separator between the key and the value.

Similarly, you can specify `"stream.map.input.field.separator"` and `"stream.reduce.input.field.separator"` as the input separator for MapReduce inputs. By default the separator is the tab character.

You can specify `"stream.map.input.ignoreKey"` so the key is not emitted to the mapper when using text input. This is the default behavior when using `TextInputFormat`.

#### 4.1.5 Specifying Communication Formats in Detail

The above-mentioned `-io [identifier]` option is pretty coarse-grained since it triggers usage of the format corresponding to the given identifier for everything. A more fine-grained way of specifying the communication formats is by using the following generic options:

```
-D stream.map.input=[identifier]
-D stream.map.output=[identifier]
-D stream.reduce.input=[identifier]
-D stream.reduce.output=[identifier]
```

## 4.2 Working with Large Files and Archives

The `-files` and `-archives` options allow you to make files and archives available to the tasks. The argument is a URI to the file or archive that you have already uploaded to HDFS. These files and archives are cached across jobs. You can retrieve the host and `fs_port` values from the `fs.default.name` config variable.

**Note:** The `-files` and `-archives` options are generic options. Be sure to place the generic options before the command options, otherwise the command will fail. For an example, see [Making Archives Available to Tasks](#).

### 4.2.1 Making Files Available to Tasks

The `-files` option creates a symlink in the current working directory of the tasks that points to the local copy of the file.

In this example, Hadoop automatically creates a symlink named `testfile.txt` in the current working directory of the tasks. This symlink points to the local copy of `testfile.txt`.

```
-files hdfs://host:fs_port/user/testfile.txt
```

User can specify a different symlink name for `-files` using `#`.

```
-files hdfs://host:fs_port/user/testfile.txt#testfile
```

Multiple entries can be specified like this:

```
-files hdfs://host:fs_port/user/testfile1.txt,hdfs://host:fs_port/user/testfile2.txt
```

### 4.2.2 Making Archives Available to Tasks

The `-archives` option allows you to copy jars locally to the current working directory of tasks and automatically unjar the files.

In this example, Hadoop automatically creates a symlink named `testfile.jar` in the current working directory of tasks. This symlink points to the directory that stores the unjarred contents of the uploaded jar file.

```
-archives hdfs://host:fs_port/user/testfile.jar
```

User can specify a different symlink name for `-archives` using `#`.

```
-archives hdfs://host:fs_port/user/testfile.tgz#tgzdir
```

In this example, the `input.txt` file has two lines specifying the names of the two files: `cachedir.jar/cache.txt` and `cachedir.jar/cache2.txt`. "`cachedir.jar`" is a symlink to the archived directory, which has the files "`cache.txt`" and "`cache2.txt`".

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
    -archives 'hdfs://hadoop-nn1.example.com/user/me/samples/cachefile/
cachedir.jar' \
    -D mapreduce.job.maps=1 \
    -D mapreduce.job.name="Experiment" \
    -numReduceTasks 1 \
    -input "/user/me/samples/cachefile/input.txt" \
    -output "/user/me/samples/cachefile/out" \
    -mapper "xargs cat" \
    -reducer "cat"

$ ls test_jar/
cache.txt  cache2.txt

$ jar cvf cachedir.jar -C test_jar/ .
added manifest
adding: cache.txt(in = 30) (out= 29)(deflated 3%)
adding: cache2.txt(in = 37) (out= 35)(deflated 5%)

$ hadoop dfs -put cachedir.jar samples/cachefile

$ hadoop dfs -cat /user/me/samples/cachefile/input.txt
cachedir.jar/cache.txt
cachedir.jar/cache2.txt

$ cat test_jar/cache.txt
This is just the cache string

$ cat test_jar/cache2.txt
This is just the second cache string

$ hadoop dfs -ls /user/me/samples/cachefile/out
Found 1 items
/user/me/samples/cachefile/out/part-00000  <r 3>    69

$ hadoop dfs -cat /user/me/samples/cachefile/out/part-00000
This is just the cache string
This is just the second cache string
```

## 5 More Usage Examples

### 5.1 Hadoop Partitioner Class

Hadoop has a library class, [KeyFieldBasedPartitioner](#), that is useful for many applications. This class allows the MapReduce framework to partition the map outputs based on certain key fields, not the whole keys. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
-D stream.map.output.field.separator=. \
-D stream.num.map.output.key.fields=4 \
-D mapreduce.map.output.key.field.separator=. \
-D mapreduce.partition.keypartitioner.options=-k1,2 \
-numReduceTasks 12 \
-input myInputDirs \
-output myOutputDir \
-mapper cat \
-reducer cat \
-partitioner org.apache.hadoop.mapred.lib.KeyFieldBasedPartitioner
```

Here, `-D stream.map.output.field.separator=.` and `-D stream.num.map.output.key.fields=4` are as explained in previous example. The two variables are used by streaming to identify the key/value pair of mapper.

The map output keys of the above MapReduce job normally have four fields separated by ".". However, the MapReduce framework will partition the map outputs by the first two fields of the keys using the `-D mapreduce.partition.keypartitioner.options=-k1,2` option. Here, `-D mapreduce.map.output.key.field.separator=.` specifies the separator for the partition. This guarantees that all the key/value pairs with the same first two fields in the keys will be partitioned into the same reducer.

*This is effectively equivalent to specifying the first two fields as the primary key and the next two fields as the secondary. The primary key is used for partitioning, and the combination of the primary and secondary keys is used for sorting. A simple illustration is shown here:*

Output of map (the keys)

```
11.12.1.2
11.14.2.3
11.11.4.1
11.12.1.1
11.14.2.2
```

Partition into 3 reducers (the first 2 fields are used as keys for partition)

```
11.11.4.1
-----
11.12.1.2
11.12.1.1
```

```
-----
11.14.2.3
11.14.2.2
```

Sorting within each partition for the reducer(all 4 fields used for sorting)

```
11.11.4.1
-----
11.12.1.1
11.12.1.2
-----
11.14.2.2
11.14.2.3
```

## 5.2 Hadoop Comparator Class

Hadoop has a library class, [KeyFieldBasedComparator](#), that is useful for many applications. This class provides a subset of features provided by the Unix/GNU Sort. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
-D
mapreduce.job.output.key.comparator.class=org.apache.hadoop.mapred.lib.KeyFieldBasedComparator \
-D stream.map.output.field.separator=. \
-D stream.num.map.output.key.fields=4 \
-D mapreduce.map.output.key.field.separator=. \
-D mapreduce.partition.keycomparator.options=-k2,2nr \
-numReduceTasks 12 \
-input myInputDirs \
-output myOutputDir \
-mapper cat \
-reducer cat
```

The map output keys of the above MapReduce job normally have four fields separated by ".". However, the MapReduce framework will sort the outputs by the second field of the keys using the `-D mapreduce.partition.keycomparator.options=-k2,2nr` option. Here, `-n` specifies that the sorting is numerical sorting and `-r` specifies that the result should be reversed. A simple illustration is shown below:

Output of map (the keys)

```
11.12.1.2
11.14.2.3
11.11.4.1
11.12.1.1
11.14.2.2
```

Sorting output for the reducer(where second field used for sorting)

```
11.14.2.3
```

```
11.14.2.2
11.12.1.2
11.12.1.1
11.11.4.1
```

### 5.3 Hadoop Aggregate Package

Hadoop has a library package called [Aggregate](#). Aggregate provides a special reducer class and a special combiner class, and a list of simple aggregators that perform aggregations such as "sum", "max", "min" and so on over a sequence of values. Aggregate allows you to define a mapper plugin class that is expected to generate "aggregatable items" for each input key/value pair of the mappers. The combiner/reducer will aggregate those aggregatable items by invoking the appropriate aggregators.

To use Aggregate, simply specify "-reducer aggregate":

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
  -numReduceTasks 12 \
  -input myInputDirs \
  -output myOutputDir \
  -mapper myAggregatorForKeyCount.py \
  -reducer aggregate \
  -file myAggregatorForKeyCount.py \
```

The python program myAggregatorForKeyCount.py looks like:

```
#!/usr/bin/python

import sys;

def generateLongCountToken(id):
    return "LongValueSum:" + id + "\t" + "1"

def main(argv):
    line = sys.stdin.readline();
    try:
        while line:
            line = line[:-1];
            fields = line.split("\t");
            print generateLongCountToken(fields[0]);
            line = sys.stdin.readline();
    except "end of file":
        return None
    if __name__ == "__main__":
        main(sys.argv)
```

### 5.4 Hadoop Field Selection Class

Hadoop has a library class, org.apache.hadoop.mapred.lib.FieldSelectionMapReduce, that effectively allows you to process text data like the unix "cut" utility. The map function

defined in the class treats each input key/value pair as a list of fields. You can specify the field separator (the default is the tab character). You can select an arbitrary list of fields as the map output key, and an arbitrary list of fields as the map output value. Similarly, the reduce function defined in the class treats each input key/value pair as a list of fields. You can select an arbitrary list of fields as the reduce output key, and an arbitrary list of fields as the reduce output value. For example:

```
$HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
-D mapreduce.map.output.key.field.separator=. \
-D mapreduce.partition.keypartitioner.options=-kl,2 \
-D mapreduce.fieldsel.data.field.separator=. \
-D mapreduce.fieldsel.map.output.key.value.fields.spec=6,5,1-3:0- \
-D mapreduce.fieldsel.reduce.output.key.value.fields.spec=0-2:5- \
-numReduceTasks 12 \
-input myInputDirs \
-output myOutputDir \
-mapper org.apache.hadoop.mapred.lib.FieldSelectionMapReduce \
-reducer org.apache.hadoop.mapred.lib.FieldSelectionMapReduce \
-partitioner org.apache.hadoop.mapred.lib.KeyFieldBasedPartitioner
```

The option "-D mapreduce.fieldsel.map.output.key.value.fields.spec=6,5,1-3:0-" specifies key/value selection for the map outputs. Key selection spec and value selection spec are separated by ":". In this case, the map output key will consist of fields 6, 5, 1, 2, and 3. The map output value will consist of all fields (0- means field 0 and all the subsequent fields).

The option "-D mapreduce.fieldsel.reduce.output.key.value.fields.spec=0-2:5-" specifies key/value selection for the reduce outputs. In this case, the reduce output key will consist of fields 0, 1, 2 (corresponding to the original fields 6, 5, 1). The reduce output value will consist of all fields starting from field 5 (corresponding to all the original fields).

## 6 Configurable parameters

This section lists all the streaming specific configuration parameters which are configurable for a streaming job.

The Hadoop streaming configurable parameters are

| Parameter                  | Default value | Description                                                                                                                                                                                                   |
|----------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| stream.map.streamprocessor | -             | The command for mapper.                                                                                                                                                                                       |
| stream.map.input.ignoreKey | true          | Specifies whether to ignore key or not while writing input for the mapper. The configuration parameter is valid only if stream.map.input.writer.class is org.apache.hadoop.streaming.io.TextInputWriter.class |

| Parameter                            | Default value | Description                                                                                                                                                                                     |
|--------------------------------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      |               | By default, for TextInputFormat, it is true.                                                                                                                                                    |
| stream.map.input.field.separator     | \t            | Seperator for key and value, while writing input for mapper. This is honoured only if "stream.map.input.ignoreKey" is false.                                                                    |
| stream.map.output.field.separator    | \t            | Seperator for key and value, while reading output from mapper.                                                                                                                                  |
| stream.num.map.output.key.fields     | 1             | Specifies the nth field separator in the line of the map output as the separator between the key and the value.                                                                                 |
| stream.combine.streamprocessor       | -             | The command for combiner.                                                                                                                                                                       |
| stream.reduce.streamprocessor        | -             | The command for reducer.                                                                                                                                                                        |
| stream.reduce.input.field.separator  | \t            | Seperator for key and value, while writing input for reducer.                                                                                                                                   |
| stream.reduce.output.field.separator | \t            | Seperator for key and value, while reading output from reducer.                                                                                                                                 |
| stream.num.reduce.output.key.fields  | 1             | Specifies the nth field separator in the line of the reduce output as the separator between the key and the value.                                                                              |
| stream.map.input                     | text          | Identifier to specify the communication format used for map input. Possible values are text, typedbytes and rawbytes. This value is honored only if no identifier is specified via -io option   |
| stream.map.output                    | text          | Identifier to specify the communication format used for map output. Possible values are text, typedbytes and rawbytes. This value is honored only if no identifier is specified via -io option. |



| Parameter                           | Default value                             | Description                                                                                                                                                                                        |
|-------------------------------------|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| stream.reduce.input                 | text                                      | Identifier to specify the communication format used for reduce input. Possible values are text, typedbytes and rawbytes. This value is honored only if no identifier is specified via -io option.  |
| stream.reduce.output                | text                                      | Identifier to specify the communication format used for reduce output. Possible values are text, typedbytes and rawbytes. This value is honored only if no identifier is specified via -io option. |
| stream.io.identifier.resolver.class | org.apache.hadoop.streaming.io.Identifier | The class to resolve iospec passed via option -io.                                                                                                                                                 |
| stream.recordreader.class           | -                                         | RecordReader class passed via -inputreader option.                                                                                                                                                 |
| stream.recordreader.*               | -                                         | Configuration properties for record reader passed via stream.recordreader.class.                                                                                                                   |
| stream.shipped.hadoopstreaming      | -                                         | Custom streaming build along with standard hadoop install                                                                                                                                          |
| stream.non.zero.exit.is.failure     | true                                      | Specifies whether to treat non-zero exit code of the map/reduce process as a failure or not.                                                                                                       |
| stream.tmpdir                       | -                                         | Temporary directory used for jar packaging                                                                                                                                                         |
| stream.joindelay.milli              | 0                                         | Expert: Timeout in milliseconds for joining the error and output threads at the end of mapper/reducer, after the streaming process exits. A timeout of "0" means to wait forever.                  |
| stream.minRecWrittenToEnableSkip    | -                                         | Minimum number of input records written to skip map failure                                                                                                                                        |
| stream.stderr.reporter.prefix       | reporter:                                 | Reporter prefix to indicate reporter statements emitted from stderr.                                                                                                                               |

## 7 Frequently Asked Questions

### 7.1 How do I run an arbitrary set of (semi) independent tasks?

Often you do not need the full power of Map Reduce, but only need to run multiple instances of the same program - either on different parts of the data, or on the same data, but with different parameters. You can use Hadoop Streaming to do this.

### 7.2 How do I process files, one per map?

As an example, consider the problem of zipping (compressing) a set of files across the hadoop cluster. You can achieve this using either of these methods:

1. Hadoop Streaming and custom mapper script:
  - Generate a file containing the full HDFS path of the input files. Each map task would get one file name as input.
  - Create a mapper script which, given a filename, will get the file to local disk, gzip the file and put it back in the desired output directory
2. The existing Hadoop Framework:
  - Add these commands to your main function:

```
FileOutputFormat.setCompressOutput(conf, true);
FileOutputFormat.setOutputCompressorClass(conf,
org.apache.hadoop.io.compress.GzipCodec.class);
conf.setOutputFormat(NonSplittableTextInputFormat.class);
conf.setNumReduceTasks(0);
```

- Write your map function:

```
public void map(WritableComparable key,
               Writable value,
               OutputCollector output,
               Reporter reporter)
    throws IOException {
    output.collect((Text)value, null);
}
```

- Note that the output filename will not be the same as the original filename

### 7.3 How many reducers should I use?

For details see [Reducer](#).

### 7.4 How does the use of streaming differ from the Java MapReduce API?

The Java MapReduce API provides a higher level API that lets the developer focus on writing map and reduce functions that act upon a pair of key and associated value(s). The Java API takes care of the iteration over the data source behind the scenes. In streaming, the

framework pours in the input data over the stdin to the mapper/reduce program, and thus these programs ought to be written from the reading (via stdin) iteration level. A practical consequence of this is that reducers for streaming need to be able to deal with different input keys. Some alternative interfaces for particular programming languages can be found [here](#).

### 7.5 If I set up an alias in my shell script, will that work after -mapper?

For example, say I do: `alias c1='cut -f1'`. Will `-mapper "c1"` work?

Using an alias will not work, but variable substitution is allowed as shown in this example:

```
$ hadoop dfs -cat samples/student_marks
alice 50
bruce 70
charlie 80
dan 75

$ c2='cut -f2'; $HADOOP_HOME/bin/hadoop jar hadoop-streaming.jar \
-D mapreduce.job.name='Experiment'
-input /user/me/samples/student_marks
-output /user/me/samples/student_out
-mapper "$c2" -reducer 'cat'

$ hadoop dfs -ls samples/student_out
Found 1 items/user/me/samples/student_out/part-00000    <r 3>    16

$ hadoop dfs -cat samples/student_out/part-00000
50
70
75
80
```

### 7.6 Can I use UNIX pipes?

For example, will `-mapper "cut -f1 | sed s/foo/bar/g"` work?

Currently this does not work and gives an "java.io.IOException: Broken pipe" error. This is probably a bug that needs to be investigated.

### 7.7 What do I do if I get the "No space left on device" error?

For example, when I run a streaming job by distributing large executables (for example, 3.6G) through the `-file` option, I get a "No space left on device" error.

The jar packaging happens in a directory pointed to by the configuration variable `stream.tmpdir`. The default value of `stream.tmpdir` is `/tmp`. Set the value to a directory with more space:

```
-D stream.tmpdir=/export/bigspace/...
```

## 7.8 How do I specify multiple input directories?

You can specify multiple input directories with multiple '-input' options:

```
hadoop jar hadoop-streaming.jar -input '/user/foo/dir1' -input '/user/foo/dir2'
```

## 7.9 How do I generate output files with gzip format?

Instead of plain text files, you can generate gzip files as your generated output. Pass '-D mapreduce.output.fileoutputformat.compress=true -D mapreduce.output.fileoutputformat.compression.codec=org.apache.hadoop.io.compress.GzipCodec' as option to your streaming job.

## 7.10 How do I provide my own input/output format with streaming?

You can pass them using -inputformat and -outputformat options. You can pass your custom jar using -libjars option.

## 7.11 How do I parse XML documents using streaming?

You can use the record reader StreamXmlRecordReader to process XML documents.

```
hadoop jar hadoop-streaming.jar \
-inputreader "StreamXmlRecordReader,begin=BEGIN_STRING,end=END_STRING" \
..... (rest of the command)
```

Anything found between BEGIN\_STRING and END\_STRING would be treated as one record for map tasks.

## 7.12 How do I update counters in streaming applications?

A streaming process can use the stderr to emit counter information. `reporter:counter:<group>,<counter>,<amount>` should be sent to stderr to update the counter. You can specify a different reporter prefix by specifying the value for the configuration property `stream.stderr.reporter.prefix`, by default it is `reporter:`.

## 7.13 How do I update status in streaming applications?

A streaming process can use the stderr to emit status information. To set a status, `reporter:status:<message>` should be sent to stderr. You can specify a different reporter prefix by specifying the value for the configuration property `stream.stderr.reporter.prefix`, by default it is `reporter:`.

### 7.14 How do I get the JobConf variables in a streaming job's mapper/reducer?

See the [Configured Parameters](#). The configuration parameters can be accessed as environment variables in your mapper/reducer. But during the execution of a streaming job, the names of the configuration parameters are transformed. The dots ( . ) become underscores ( \_ ). For example, `mapreduce.job.id` becomes `mapreduce_job_id` and `mapreduce.job.jar` becomes `mapreduce_job_jar`. In your code, access them as environment variables and use the parameter names with the underscores.