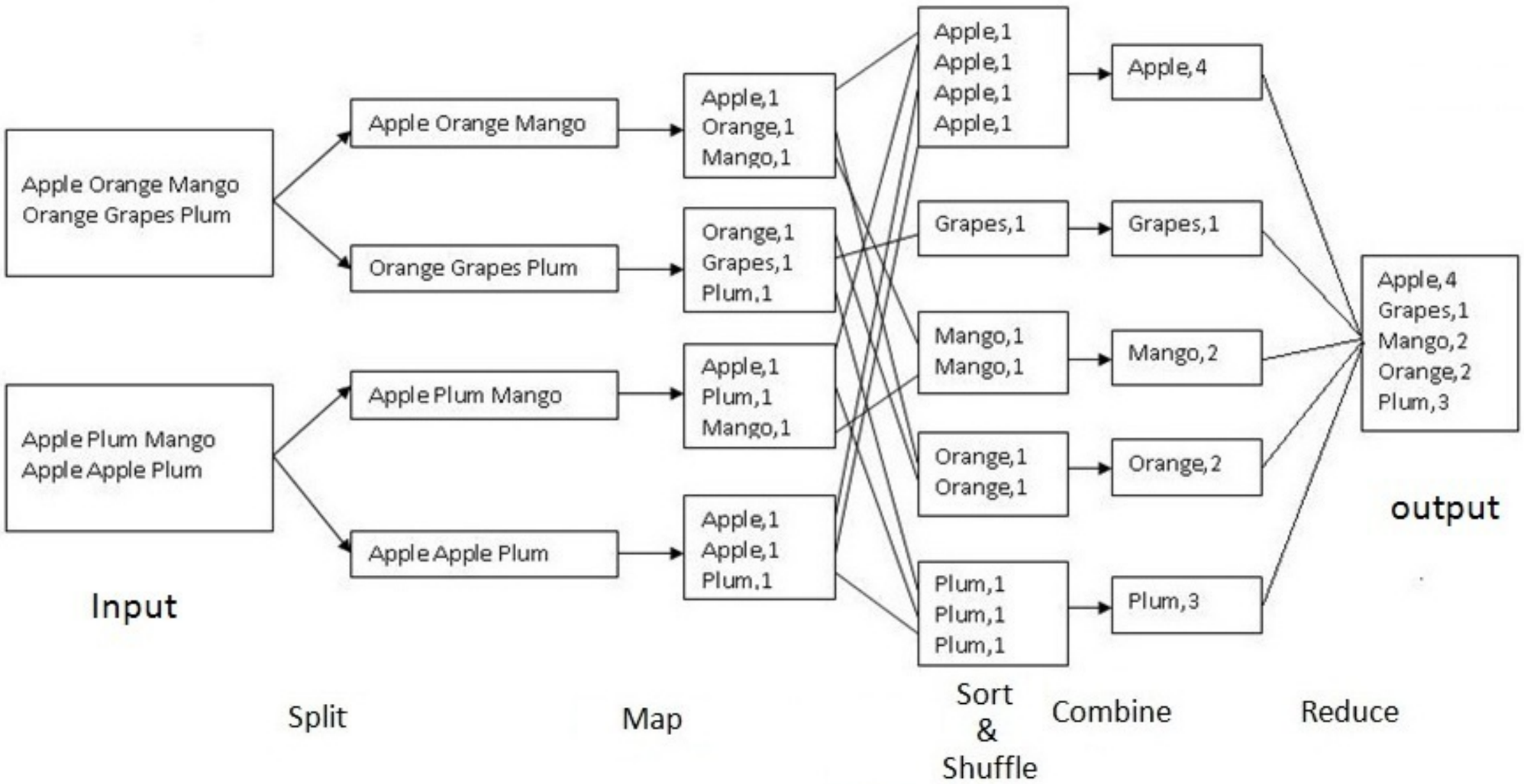
WordCount Program with Map-Reduce

The MapReduce algorithm contains two important tasks, namely Map and Reduce.

- The Map task takes a set of data and converts it into another set of data, where individual elements are broken down into tuples (key-value pairs).
- The Reduce task takes the output from the Map as an input and combines those data tuples (key-value pairs) into a smaller set of tuples.

The reduce task is always performed after the map job.

WordCount Example (Work Flow)



WordCount Program

```
import java.io.IOException;
import java.util.StringTokenizer;

import org.apache.hadoop.conf.Configuration;
import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.*;
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 WordCount
{
  public static class TokenizerMapper extends Mapper< LongWritable, Text, Text, IntWritable>
  {
    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();

    public void map(LongWritable key, Text value, Context context) throws IOException,
                                                              InterruptedException
    {
    StringTokenizer tokenizer = new StringTokenizer(value.toString());
    while (tokenizer.hasMoreTokens())
     {
      word.set(tokenizer.nextToken());
      context.write(word, one);
     }
   }
}

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

  public void reduce(Text key, Iterable<IntWritable> values,Context context) throws
                                                 IOException, InterruptedException
  {
    int sum = 0;
    for (IntWritable val : values)
    {
      sum += val.get();
    }
    result.set(sum);
    context.write(key, result);
  }
}

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

```
  {
    Configuration conf = new Configuration();
    Job job = Job.getInstance(conf, "word count");
    job.setJarByClass(WordCount.class);
    job.setMapperClass(TokenizerMapper.class);
    job.setCombinerClass(IntSumReducer.class);
    job.setReducerClass(IntSumReducer.class);
    job.setOutputKeyClass(Text.class);
    job.setOutputValueClass(IntWritable.class);
    FileInputFormat.addInputPath(job, new Path(args[0]));
    FileOutputFormat.setOutputPath(job, new Path(args[1]));
    System.exit(job.waitForCompletion(true) ? 0 : 1);
  }
}
```

Explanation

The program consist of 3 classes:

1. Map (i.e. TokenizerMapper) class which extends public class Mapper<KEYIN,VALUEIN,KEYOUT,VALUEOUT> and implements the Map function.
2. Reduce (i.e. IntSumReducer) class which extends public class Reducer<KEYIN,VALUEIN,KEYOUT,VALUEOUT> and implements the Reduce function.
3. Driver (i.e. WordCount) class (public static void main() - the entry point)

Mapper Class

Mapper <LongWritable, Text, Text, IntWritable>

- The data types provided here are Hadoop specific data types designed for operational efficiency suited for massive parallel and lightning fast read-write operations.
- All these data types are based out of java data types itself, for example LongWritable is the equivalent for long in java, IntWritable for int and Text for String.
- When we use it as Mapper<LongWritable, Text, Text, IntWritable> , it refers to the data type of input and output key value pairs specific to the mapper or rather the map method, ie Mapper<Input Key Type, Input Value Type, Output Key Type, Output Value Type>.
- In our example the input to a mapper is a single line, so this Text (one input line) forms the input value.
- The input key would be a long value assigned by default based on the position of Text in input file.
- Our output from the mapper is of the format "Word, 1" hence the data type of our output key value pair is <Text(String), IntWritable(int)>

The functionality of the map method is as follows

1. Create a IntWritable variable 'one' with value as 1
2. Convert the input line in Text type to a String
3. Use a StringTokenizer to split the line into words
4. Iterate through each word and a form key value pairs as
    a. Assign each word from the tokenizer(of String type) to a Text 'word'
    b. Form key value pairs for each word as <word,one> and write it to the context

Reducer Class

Reducer<Text, IntWritable, Text, IntWritable>

- The first two refers to data type of Input Key and Value to the reducer and the last two refers to data type of output key and value.
- Our mapper emits output as <apple,1> , <grapes,1> , <apple,1> etc. This is the input for reducer so here the data types of key and value in java would be String and int, the equivalent in Hadoop would be Text and IntWritable.
- Also we get the output as<word, no of occurrences> so the data type of output Key Value would be <Text, IntWritable>

The functionality of the reduce method is as follows

1. Initaize a variable 'sum' as 0
2. Iterate through all the values with respect to a key and sum up all of them
3. Write the final result (number of occurrence) for each word (key) to the context.

Execute the Program

Assuming environment variables are set as follows:

```
export JAVA_HOME=/usr/java/default
export PATH=${JAVA_HOME}/bin:${PATH}
export HADOOP_CLASSPATH=${JAVA_HOME}/lib/tools.jar
```

Compile WordCount.java and create a jar:

```
$ hadoop com.sun.tools.javac.Main WordCount.java
$ jar cf wc.jar WordCount*.class
```

Run the application:

Assuming that:

- **/projects/wordcount/input** - input directory in HDFS contains input text-files
- **/projects/wordcount/output** - output directory in HDFS

If not create using below commands (output directory will be created by program itself):

```
hdfs dfs -mkdir -p /projects/wordcount/input
```

Put some text files within input folder to validate the result later in output folder:

```
hdfs dfs -put *.txt /projects/wordcount/input
hdfs dfs -chmod -R 775 /projects
```

or

```
echo "Hello World Bye World" > file01
echo "Hello Hadoop Goodbye Hadoop" > file02
hdfs dfs -put file* /projects/wordcount/input
```

Run following command to execute program

```
$ hadoop jar wc.jar WordCount /projects/wordcount/input /projects/wordcount/output
```

Run the following command to see the output:

```
$ hadoop fs –cat /projects/wordcount/output/part-r-00000
```

Read this https://hadoop.apache.org/docs/stable/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html#Example:_WordCount_v1.0 [https://hadoop.apache.org/docs/stable/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html#Example:_WordCount_v1.0] for more details.

To rerun, you may need to delete output folder

```
hdfs dfs -rm -r /projects/wordcount/output
hdfs dfs -rmdir /projects/wordcount/output
```
