

Hadoop MapReduce

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High Performance for Big Data Applications

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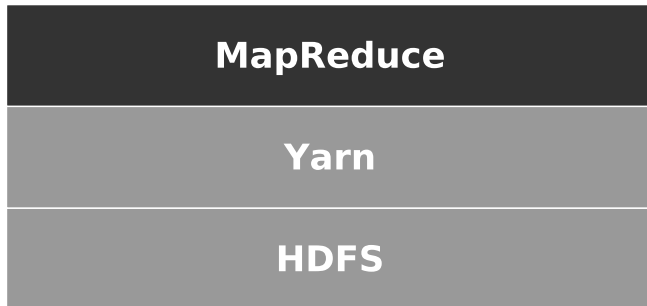
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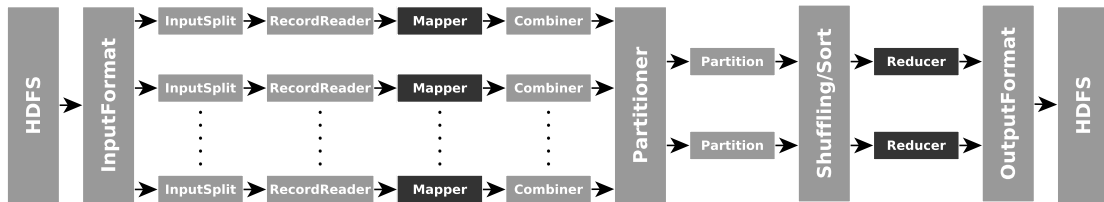
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What we mean by Hadoop



<https://data-flair.training/blogs/hadoop-ecosystem-components>

MapReduce execution flow



<https://data-flair.training/blogs/hadoop-ecosystem-components>

Custom data types

- LongWritable = long;
- IntWritable = int;
- Text = String;
- Other data types ([link](#));

```
public class IntWritable implements WritableComparable<IntWritable> {
    private int value;

    public IntWritable(int value) { set(value); }

    public void set(int value) { this.value = value; }

    public int get() { return value; }

    @Override
    public void readFields(DataInput in) throws IOException {
        value = in.readInt();
    }

    @Override
    public void write(DataOutput out) throws IOException {
        out.writeInt(value);
    }

    @Override
    public int compareTo(IntWritable o) {
        int thisValue = this.value;
        int thatValue = o.value;
        return (thisValue < thatValue ? -1 : (thisValue == thatValue ? 0 : 1));
    }
}
```

► Source

- TextInputFormat: `<LongWritable, Text>`
- KeyValueTextInputFormat: `<Text, Text>`
 - Key splitted by `\t`;
- NLineInputFormat: `<LongWritable, Text>`
 - `config.setInt(NLineInputFormat.LINES_PER_MAP, 256);`
- Custom InputFormat must implement `getSplits` and `getRecordReader`;

<https://hadoop.apache.org/docs/stable/api/org/apache/hadoop/mapred/InputFormat.html>

- Defines the level of parallelism;
- Splitted by the size of the block;
 - $10\text{TB}/128\text{MB} = 82000$
- It is a logical division of the input data;

<https://hadoop.apache.org/docs/stable/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html>

- Split InputSplit into <key, value> pairs;
 - Custom implementations can read values from outside the InputSplit;
- Lines greater than the max record length are ignored:
 - `config.setInt(LineRecordReader.MAX_LINE_LENGTH, Integer.MAX_VALUE);`
- Vanilla example:

```
public void run(Context context) {  
    setup(context);  
    while (context.nextKeyValue()) {  
        map(context.setCurrentKey(), context.getCurrentValue(), context);  
    }  
    cleanup(context);  
}
```

- Maps $\langle \text{key1}, \text{value1} \rangle$ to $\langle \text{key2}, \text{value2} \rangle$;
- Vanilla example:

```
public class SimpleMapper extends Mapper<LongWritable, Text, Text, IntWritable> {  
    private IntWritable one = new IntWritable(1);  
    private Text word = new Text();  
  
    @Override  
    public void map(LongWritable key, Text value, Context context) {  
        StringTokenizer itr = new StringTokenizer(value.toString());  
        while (itr.hasMoreElements()) {  
            word.set(itr.nextToken());  
            context.write(word, one);  
        }  
    }  
}
```

<https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html>

Combiner

- Reduces data transfer between mapper and reducer;
- Reduces the amount of data to be processed in the reducer;



Partitioner

- Redirects the Combiner output to a specific reducer;
- Has the same number as the number of reducers;
- Used only when there is more than one reducer;
- Vanilla example:

```
public class StupidPartitioner extends Partitioner<Text, IntWritable> {  
    public int getPartition(Text key, IntWritable value, int numPartitions) {  
        if (value.get() < 35) {  
            return 0;  
        } else {  
            return 1;  
        }  
    }  
}
```

<https://hadoop.apache.org/docs/stable/api/org/apache/hadoop/mapreduce/Partitioner.html>

- Collects output from the mappers to the reducers using HTTP requests;
- Sorts the collected <key, value> pairs based on the key;
 - `job.setSortComparatorClass(StupidSortComparator.class);`

<https://hadoop.apache.org/docs/stable/hadoop-mapreduce-client/hadoop-mapreduce-client-core/PluggableShuffleAndPluggableSort.html>

<https://hadoop.apache.org/docs/stable/hadoop-mapreduce-client/hadoop-mapreduce-client-core/EncryptedShuffle.html>

- Reduces $\langle \text{key2}, \text{list}(\text{value2}) \rangle$ to $\langle \text{key3}, \text{value3} \rangle$;
- Change the number of reducers:
 - `job.setNumReduceTasks(2);`
- Vanilla example:

```
public static class SimpleReducer extends Reducer<Text, IntWritable, Text, IntWritable> {  
    private IntWritable result = new IntWritable();  
  
    @Override  
    public void reduce(Text key, Iterable<IntWritable> values, Context context) {  
        int sum = 0;  
        for (IntWritable val : values) {  
            sum += val.get();  
        }  
        result.set(sum);  
        context.write(key, result);  
    }  
}
```

<https://hadoop.apache.org/docs/current/hadoop-mapreduce-client/hadoop-mapreduce-client-core/MapReduceTutorial.html>

https://docs.cloudera.com/HDPDocuments/HDP2/HDP-2.6.5/bk_command-line-installation/content/determine-hdp-memory-config.html

- Specifies how reducer output will be written;
 - `config.set(TextOutputFormat.SEPARATOR, “,”);`
- Allows to write multiple outputs;
 - <https://hadoop.apache.org/docs/stable/api/org/apache/hadoop/mapred/lib/MultipleOutputs.html>

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How many maps?

- Usually defined by the size of the input;
- Around 10-100 maps per-node;

Change the number of maps

- Change the block size;
 - Describe how to change;

How many reducers?

- 0.95 or 1.75 multiplied by ($\text{<number of nodes> * <number of maximum containers per node>}$);
 - 1.75 has a much better load balancing;
 - Scale factor are not using whole numbers to reserve a few slots for speculative-tasks and failed tasks;

https://docs.cloudera.com/HDPDocuments/HDP2/HDP-2.6.5/bk_command-line-installation/content/determine-hdp-memory-config.html

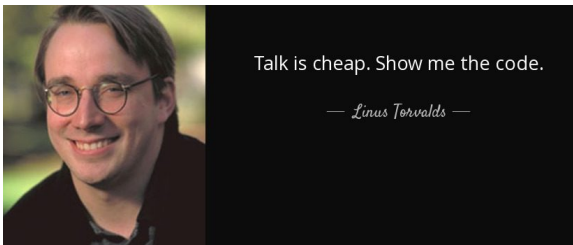
- Monitors specific action in the mapreduce job;
- User can define custom counters;

- Used when the cost of negotiating a container on a remote node is more than running the task on the JVM Application Master itself;
- Changing default values in `mapred-site.xml`:
 - `mapreduce.job.ubertask.enable`
 - `mapreduce.job.ubertask.maxmaps`
 - `mapreduce.job.ubertask.maxreduces`
 - `mapreduce.job.ubertask.maxbytes`

- Useful settings that can be changed in `mapred-site.xml`:
 - `mapreduce.job.running.map.limit`: The maximum number of simultaneous map tasks per job;
 - `mapreduce.job.max.map`: Limit on the number of map tasks allowed per job;
 - `mapreduce.input.fileinputformat.split.maxsize`: Default split size;

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Objectives

- How to setup Hadoop on a multi-node cluster;
- Show coding examples;
- Show how to monitor running jobs;