

CS 378 – Big Data Programming

Lecture 4

Summarization Patterns

Review

- Assignment 1 – Questions?
 - Using maven
 - Using AWS
 - Hadoop Java API

Simple Debugging

- Counters
 - controller
 - syslog

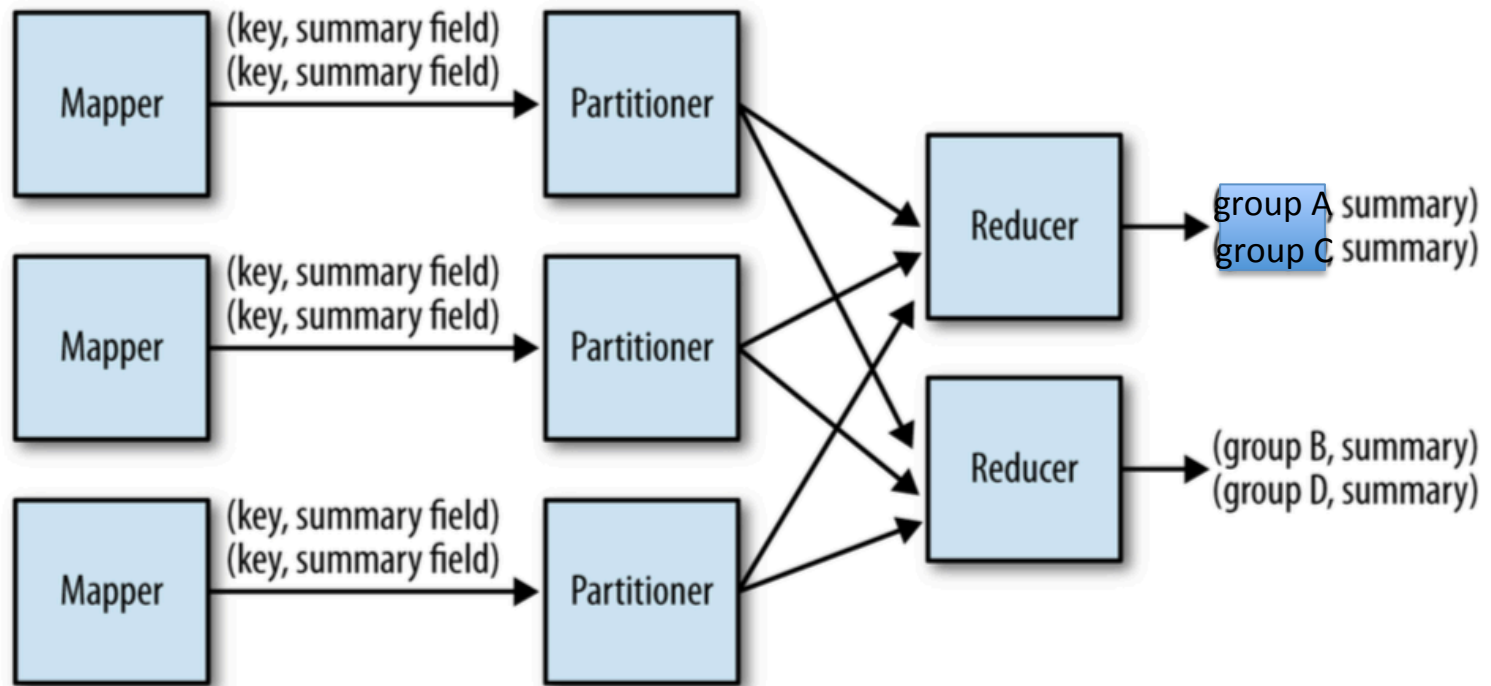
- Custom counters
 - `context.getCounter(group, counter).increment(1L);`
 - *group* and *counter* are strings

Summarization

- Counting things is a common map-reduce task
 - Word count was a simple example
 - Min, max, mean, median, variance, ...
- By making the “things” being counted keys, MapReduce is doing much of the work for us
 - Hadoop sorts and groups data by key
- In WordCount, the words counted are the keys

Summarization

Figure 2.4, Map Reduce Design Patterns (edited)



Summarization

- Simple and useful pattern
- Mappers do local counts, reducers sum up
- Combiners are very useful here
- Usually collecting multiple statistics

Assignment 2 – Word Statistics

- Input:
 - Each input record/value is a paragraph of a document
- Output (similar to word count, but more numbers):
 - For each word in the document, output:
 - Number of paragraphs containing the word
 - Mean
 - In paragraphs where the word appears, what is the average number of times it appears
 - Variance
 - In paragraphs where the word appears, what is the variance

Word Statistics

- What do we need to calculate mean, variance?
- Mean is straightforward
 - Total number of occurrences of the word
 - Number of paragraphs containing the word
- Variance is less obvious
 - We can get there with a little algebra
 - “Mean of square minus square of mean”

Designing a Map-Reduce App

- We need to answer these questions:
 - What are the map input key and value types?
 - What does the mapper do?
 - What are the map output key and value types?
 - Can we use a combiner?
 - What does the reducer do?
 - What are the reduce output key and value types?
- And: What are the file formats?
 - For now we are using text files, we'll expand our options later

Multiple Output Values

- If we are to output multiple values for each key
 - How do we do that?
 - WordCount output a single number as the value
- Remember, our object containing the values needs to implement the **Writable** interface
- We could use **Text**
 - Value is a string of comma separated values
 - Have to convert our counts to strings, build the full string
 - Have to parse the string on input (not hard)

Multiple Output Values

- Suppose we wanted to implement a custom class
- Call it: **LongArrayWritable**
 - How would we implement this class?
 - Needs to implement the **Writable** interface
 - **write()** method:
 - Output the length of the array
 - Output that many long values
 - **readFields()** method:
 - Read the length of the array
 - Read that many long values

Multiple Output Values

- Our **LongArrayWritable** class could use some other methods and instance data
 - An instance variable to hold the values.
 - What would its type be?
 - A method to set the values (an array)
 - A method to get the values (an array)

 - A method to sum (combine) the instances?
 - What would the signature be?

Multiple Output Values

- Hadoop provides a class to facilitate this:
- **ArrayWritable**
- In addition to **write()** and **readFields()**:
 - **Writable[] get()**
 - **Class getValueClass()**
 - **void setWritable(Writable[] values)**
 - **Object toArray()**
 - **String[] toStrings()**

Multiple Output Values

- If our **ArrayWritable** object is input to a reducer, we need to tell Hadoop how to set the value to the proper type
- To do this, we'll extend this class to **LongArrayWritable**

```
public class LongArrayWritable extends ArrayWritable
    public LongArrayWritable() {
        super(LongWritable.class);
    }
}
```

Multiple Output Values

- We can add methods to **LongArrayWritable** class to make it easier to use.

```
public long[] getValueArray() {
    Writable[] wValues = get();
    long[] values = new long[wValues.length];
    for (int i = 0; i < values.length; i++) {
        values[i] = ((LongWritable)wValues[i]).get();
    }
    return values;
}
```

Word Statistics

- Mapper will output what values?
- Reducer will calculate non-integer values
 - Mean, variance
- So we'll need to handle float/double values
 - Do we need to create **DoubleArrayWritable** for reduce output?

Word Statistics

- Combiner will be useful for computing word statistics
- Can we reuse the reducer class for the combiner?
 - What are the combiner inputs and outputs?

MapReduce in Hadoop

Figure 2.4, Hadoop - The Definitive Guide

