CS 378 – Big Data Programming

Lecture 5

Summarization Patterns

Review

- Assignment 2 – Questions?

- mrunit – How do you test `map()` or `reduce()` calls that produce multiple outputs?

Summarization

- Other summarizations of interest
  - Min, max, median

- Suppose we are interested in these metrics for paragraph length (Assignment 2 data)
  - If paragraph lengths are normally distributed, then the median will be very near the mean
  - If the distribution of paragraph lengths is skewed, then the mean and median will be very different

Summarization

- Min and max are straightforward
- For each paragraph, output two values
  - Min length (the length of the current paragraph)
  - Max length (the length of the current paragraph)
  - Key?

- Combiner will get a key and list of values pair
  - Select the min, max from the list, output the values
  - Key?
- Reducer does the same

Summarization

- Median
  - Get all the values, sort them, then find the middle

- Since our computation is distributed, no mapper sees all the values

- Should we send them all to one reducer?
  - Not utilizing map-reduce (computation not distributed)
  - Data sizes likely too large to keep in memory

Summarization

- Median
  - Keep the unique paragraph lengths, and
  - The frequency of each length

- Map output:
  - <paragraph length, 1>

- Combiner gets a list of these pairs and updates the count for recurring lengths
- Reducer does the same, then computes the median

Summarization

- Median
  - Hadoop provides the **`SortedMapWritable`** class
  - Can associate a frequency count with a paragraph length
  - Keeps the lengths in sorted order

- See the example in Chapter 2 of *Map-Reduce Design Patterns*

- How could we compute all in one pass over the data?
  - min, max, median

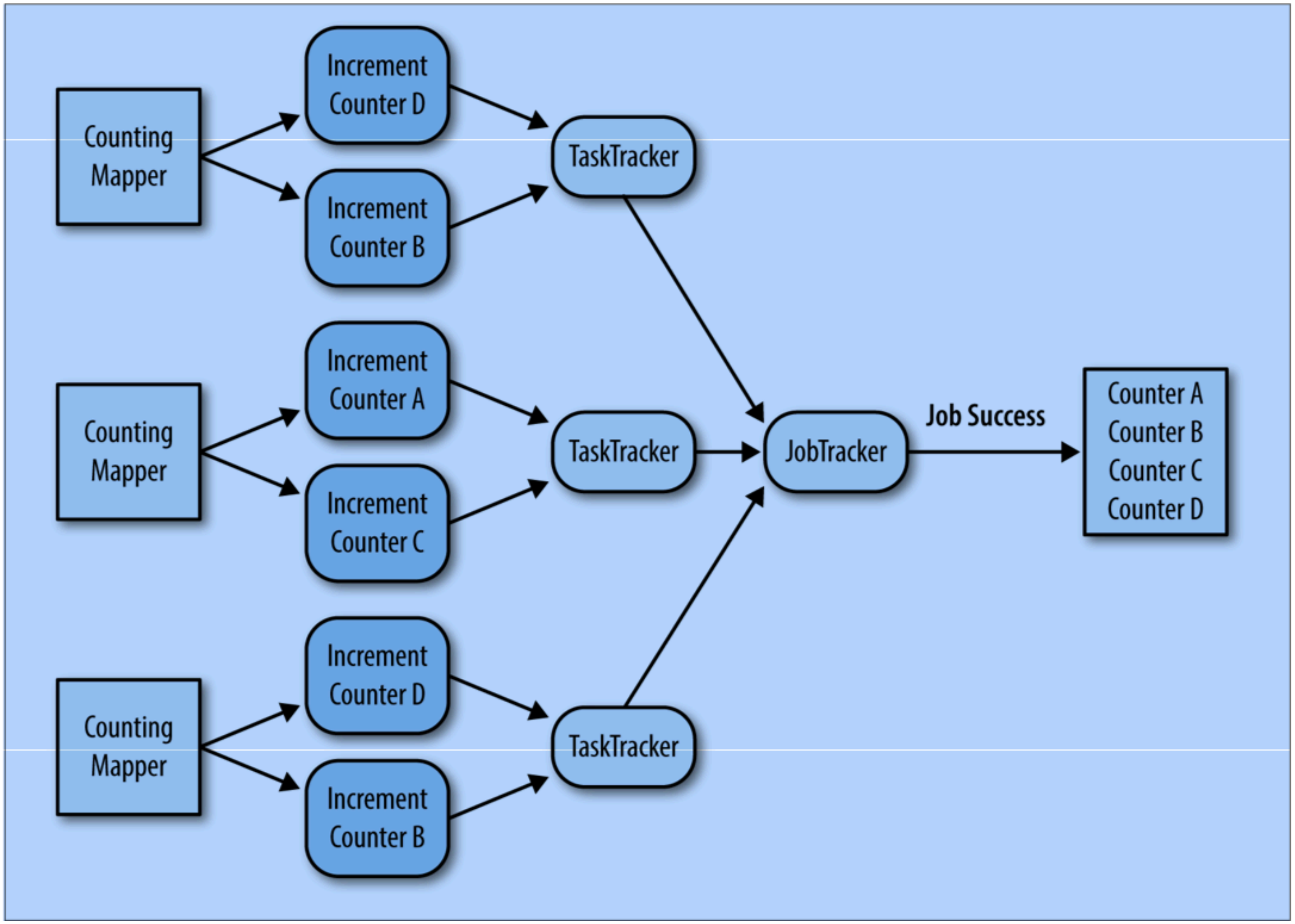
Counters

- Hadoop map-reduce infrastructure provides counters
  - Accessed by group name
  - Cannot have a large number of counters
    - For example, can’t use counters to solve WordCount
  - A few tens of counters can be used

- Counters are stored in memory on **`JobTracker`**

Counters

Figure 2-6, MapReduce Design Patterns

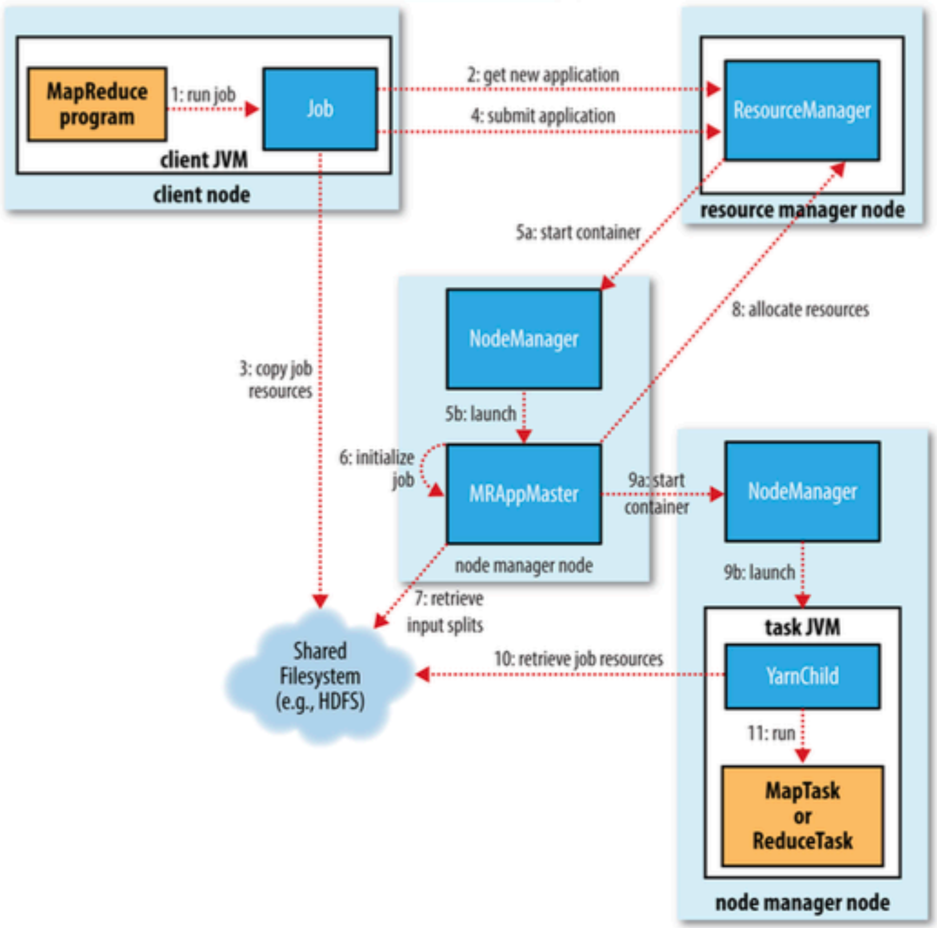


How Hadoop MapReduce Works

- We've seen some terms like:
  - Job, JobTracker, TaskTracker (MapReduce 1)
  - Job, ResourceManager, NodeManager (YARN, MapReduce 2)
- Let's look at what they do
- Details from Chapter 7, *Hadoop: The Definitive Guide 4th Edition*

How Hadoop MapReduce Works

Figure 7-1, Hadoop: The Definitive Guide 4th Edition



Job Submission

- Job submission
  - Input files exist? Can splits be computed?
  - Output directory exist?
    - If yes, it fails. Hadoop expects to create this directory
  - Copy resources to HDFS
    - JAR files
    - Configuration file
    - Computed file splits

Resource Manager

- Creates tasks (work to be done)
  - Map task for each input split
  - Requested number of reducer tasks
  - Job setup, job cleanup tasks

- Map tasks are assigned to task trackers that are “close” to the input split location
  - Data local preferred
  - Rack local next

- Reduce task can go anywhere. Why?
- Scheduling algorithm orders the tasks

Task Execution

- Configured for several map and reduce tasks
- Each task has status info (state, progress, counters)
- Periodically sends info to **`MRAppMaster`**
  - Running, successful completion, failed
  - Progress (% complete)

- For a new task
  - Copy files to local file system (JAR, configuration)
  - Launch a new JVM (**`YarnChild`** drives execution)
  - Load the mapper/reducer class and run the task

Task Progress

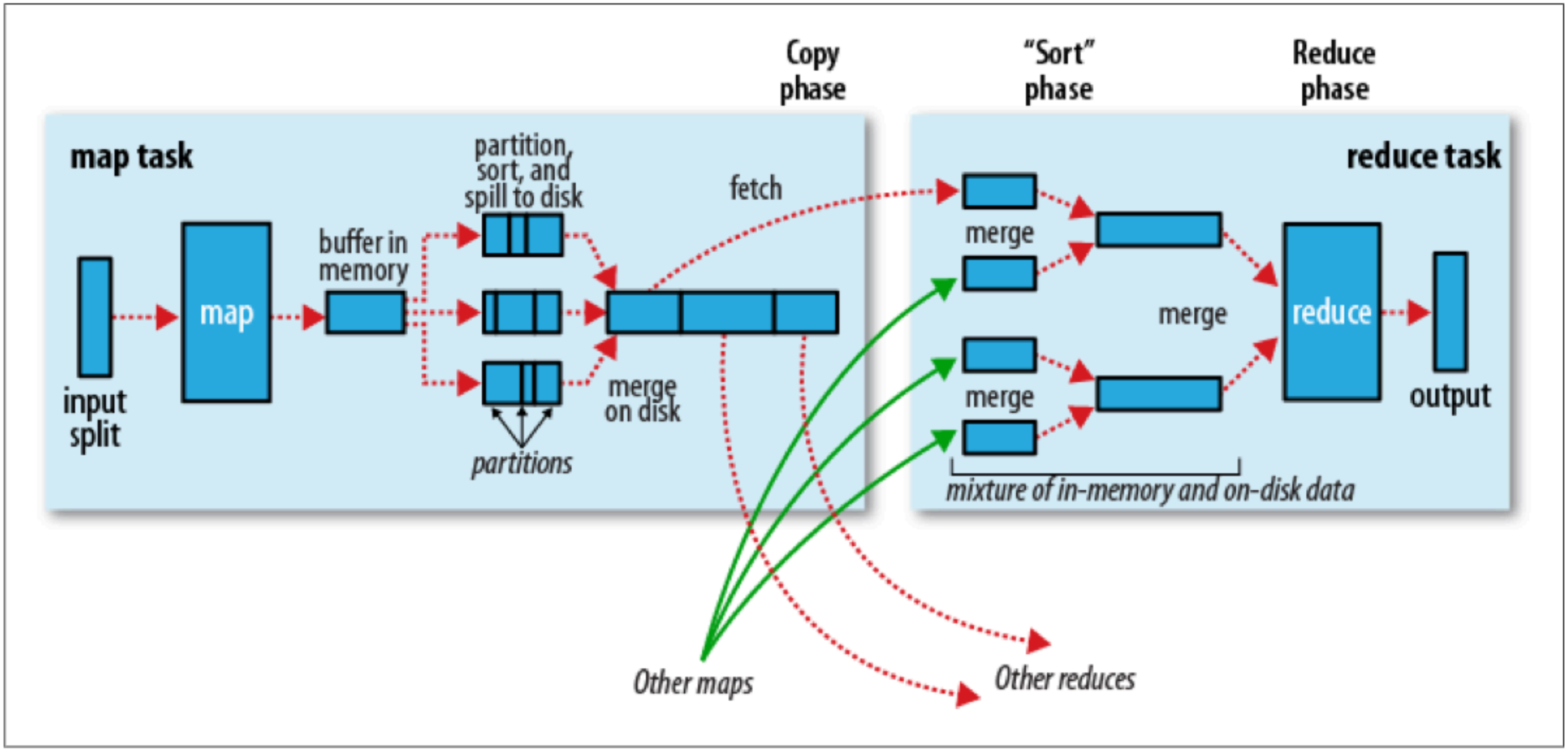
- Read in input pair (mapper or reducer)
- Write an output pair (mapper or reducer)
- Set the status description
- Increment a counter
- Reporting progress

Task Progress

- Mapper – straightforward
  - How much of the input has been processed
- Reducer – more complicated
  - Shuffle, sort and reduce are considered here
  - Progress is an estimate of how much of the total work has been done
  - One-third allocated to each

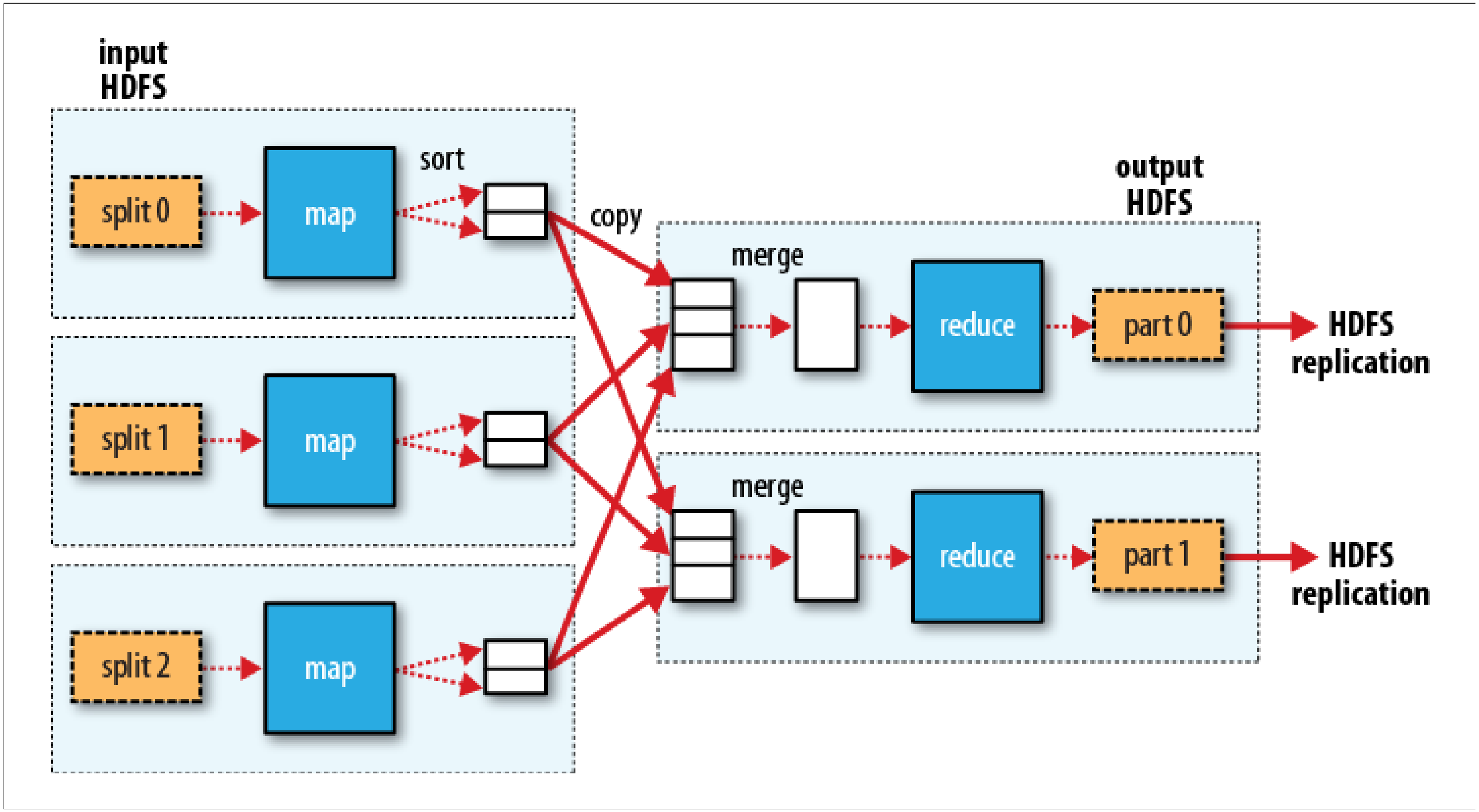
Shuffle

Figure 7-4, Hadoop: The Definitive Guide 4th Edition



MapReduce in Hadoop

Figure 2.4, Hadoop - The Definitive Guide


input
HDFS
split 0
map
sort
split 1
map
split 2
map
copy
output
HDFS
merge
reduce
part 0
HDFS
replication
merge
reduce
part 1
HDFS
replication