(Mis)Use of Hadoop

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NYU Large Scale Learning Class, February 19, 2013

(Post presentation version)

The data problem

Traditional high performance computing is FLoating Operations Per Second. http://top500.org/lists/2012/11/
Titan http://www.olcf.ornl.gov/titan/: 17.6PFlops, 8.2MW
Flops first, network second, data is irrelevant.
Primary use = simulations.

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Data is different.
$\Rightarrow$ the need to store information. With large amounts of data, errors should be assumed. Use replication to zero out the chance of error.
$\Rightarrow$ the need for quick access. No single machine can handle all data requests. Use locality to minimize bandwidth.

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3. Java's first serious use as an OS
4. Open Source clone of GFS + Map Reduce system.
5. Yahoo!'s bulk data processing system.
6. The craze at Strata (= data business conference). Nearly every company is interoperating with, extending, and/or using Hadoop.

The NYU Hadoop cluster

~92 machines
8 cores @ 2Ghz to 2.5Ghz / machine
16GB RAM / machine
1Gb/s network card
~100TB storage (in Hadoop).
A low end Hadoop cluster, of most use as a shared datarich environment.

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For nonNYU students, you can experiment with Hadoop easily using AWS.

Hadoop Distributed File System (HDFS)

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2. 1/3 storage.
3. You don't "backup" a Hadoop cluster.
4. Multiple sources for any one piece of data.

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No support for file modification.
$\Rightarrow$ HDFS is in it's own namespace.
$\Rightarrow$ Need new comands.

HDFS ops

Execute:

```
echo alias hfs= 'hadoop fs ' >> .bashrc
source .bashrc
```

Common commands:

1. `hfs` See available commands.
2. `hfs -help` more command details.
3. `hfs -ls [<path>]` List files
4. `hfs -cp <src> <dst>` Copy stuff
5. `hfs -mkdir <path>` Create path
6. `hfs -rm <path>` remove a file
7. `hfs -chmod <path>` Modify permissions.
8. `hfs -chown <path>` Modify owner.

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Remote access commands:

1. `hfs -cat <src>` Cat contents to stdout.
2. `hfs -copyFromLocal <localsrc> <dst>` Copy stuff
3. `hfs -copyToLocal <src> <localdst>` Copy stuff

File system is browsable. For NYU: `http://babar:50070/`

Hadoop Map-Reduce

An example of "Bulk Synchronous Parallel" data processing.
Map (Programming language ideal): A function $f : A \rightarrow B$.

Reduce (Programming language ideal): A function $g : BxB \rightarrow B$.

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Map (Programming language ideal): A function $f : A \rightarrow B$.
Map (Hadoop ideal): A function $f : A^* \rightarrow B^*$

In between Map and Reduce is sort(B^*) which partitions elements across multiple reducers.
Reduce (Programming language ideal): A function $g : BxB \rightarrow B$.
Reduce (Hadoop ideal): A function $g : B^* \rightarrow C$.

A, B, C are often (but not always) line oriented.

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Map (Programming language ideal): A function $f : A \to B$.
Map (Hadoop ideal): A function $f : A^* \to B^*$
Map (Real implementation): Any program consuming A^* and outputting B^*.
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Reduce (Real Implementation): Any program consuming B^* and outputing C.
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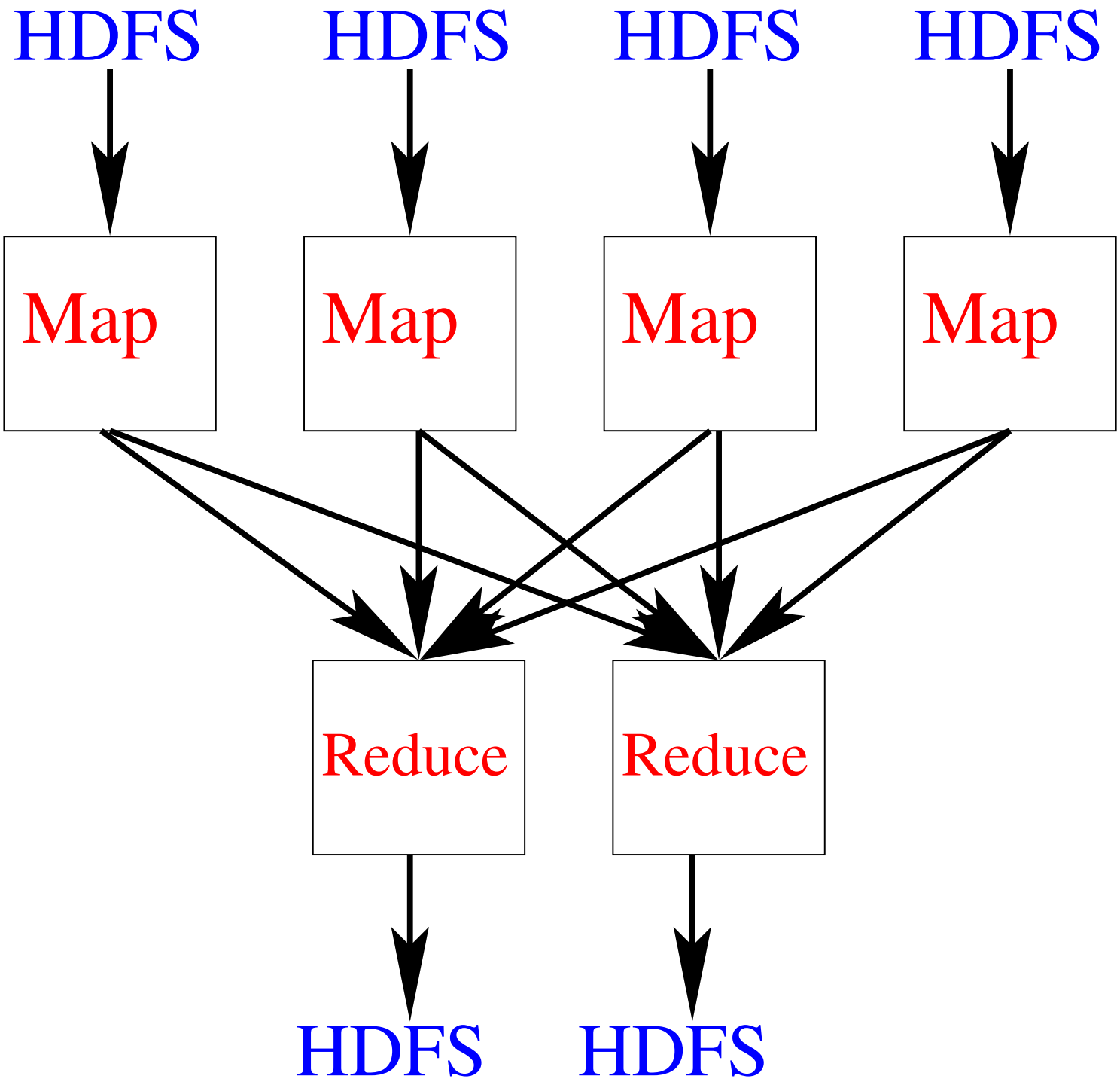
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Hadoop Streaming

Hadoop streaming = use any program written in any language for mapreduce operations.
Execute:

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echo "export HAS=/usr/lib/hadoop/contrib/streaming
export HSJ=hadoop-streaming-1.0.3.16.jar
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```

Get the first example from every mapped chunk in rcv1.

```
echo ``cat > temp; head -n 1 temp'' > header
hjs -input /user/jl5386/rcv1.train.txt -output
headresults -mapper header -reducer cat -file header
hfs -cat headresults/part-00000 | wc -l
```

= number of mappers

Guess what it does

```
echo ‘‘cut -d ’ ’ -f 1 | grep 1’’ > cutter
echo wc -l > counter
hjs -input /user/jl5386/rcv1.train.txt -output
countres -mapper cutter -reducer counter -file cutter
-file counter
hfs -cat countres/part-00000
```

Guess what it does

```
echo grep 326:  > grepper
echo wc -l > counter
hjs -input /user/jl5386/rcv1.train.txt -output fcount
-mapper grepper -reducer counter -file grepper -file
counter
hfs -cat fcount/part-00000
```

Guess what it does

```
echo ‘‘cut -d ’ ’ -f 1 | sort -u’’ > cutsort
echo sort -u > sorter
hjs -input /user/jl5386/rcv1.train.txt -output labels
-mapper cutsort -reducer sorter -file cutsort -file
sorter
hfs -cat labels/part-00000
```

Hadoop job control

Watch what is happening with job tracker URL (given on job launch).

```
hadoop job -list
```

```
hadoop job -kill <id>
```

Abusing Hadoop Streaming

Hadoop streaming makes Hadoop into a general purpose job submission system.

```
hjs -Dmapred.task.timeout=600000000
-Dmapred.job.map.memory.mb=3000 -input <yourdata>
-output <finaloutput> -mapper cat -reducer
<yourprogram> -file <yourprogram>
```

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```

Why Hadoop for job control?

1. map can be handy for selecting a subset or different data for features or examples.
2. much better bandwidth limits.

Parallel Learning for Parameter Search

Hadoop streaming makes Hadoop into a general purpose job submission system.

```
for a in 0.1 0.3 1 3 10; do

echo ./vw -l $a > job_$a

hjs -Dmapred.task.timeout=600000000
-Dmapred.job.map.memory.mb=3000 -input <yourdata>
-output output_$a -mapper cat -reducer job_$a -file
job_$a  -file vw
done
```

Parallel Learning for Speed

The next lecture.

More Hadoop things

PIG(Y!) is an SQL→MapReduce compiler

Zookeeper(Y!) is a system for sharing small amounts of info.

Hive(Facebook): Much faster data query and exploration. ...

References

[Hadoop Tutorial]
http://developer.yahoo.com/hadoop/tutorial/
[GFS] Sanjay Ghemawat, Howard Gobioff, Shun-Tak Leung, "The Google file system", SOSP '03.
[MapReduce] Jeffrey Dean, Sanjay Ghemawat MapReduce: simplified data processing on large clusters, Communications of the ACM, Volume 51 Issue 1, January 2008, Pages 107-113.

In general, MapReduce is an example of bulk synchronous parallel computation—there are many other papers.