

Open source Google-style large scale data analysis with Hadoop

Ioannis Konstantinou

Email: ikons@cslab.ece.ntua.gr

Web: <http://www.cslab.ntua.gr/~ikons>

Computing Systems Laboratory
School of Electrical and Computer Engineering
National Technical University of Athens

Big Data

- Facebook: 20TB/day compressed
- CERN/LHC: 40TB/day (15PB/year)
- NYSE: 1TB/day
- 2009 Digital Universe: 800.000 Petabytes or 0.8 Zettabytes
- Moore's Law: Data doubles every 18 months
- 2020 prediction: 35 Zettabytes (44 times bigger than 2009)

What is Hadoop?

- It's a distributed framework for **large-scale data processing**:
- Inspired by Google's architecture: Map Reduce and Google File System
- Can scale to thousands of nodes and petabytes of data
- A top-level Apache project (since 2008) – Hadoop is open source
- Written in Java, plus a few shell scripts

Why Hadoop?

- Hadoop is designed to run on cheap commodity hardware
- Fault-tolerant hardware is **expensive**
- It automatically handles data replication and node failure
- It does the hard work – you can focus on processing data

When to use Hadoop?

- There is access to lots of commodity hardware
- The processing can be easily parallelized
- Need to process lots of unstructured data
 - Data intensive applications
- It is ok to run batch jobs (no need for interactive results)

Architecture

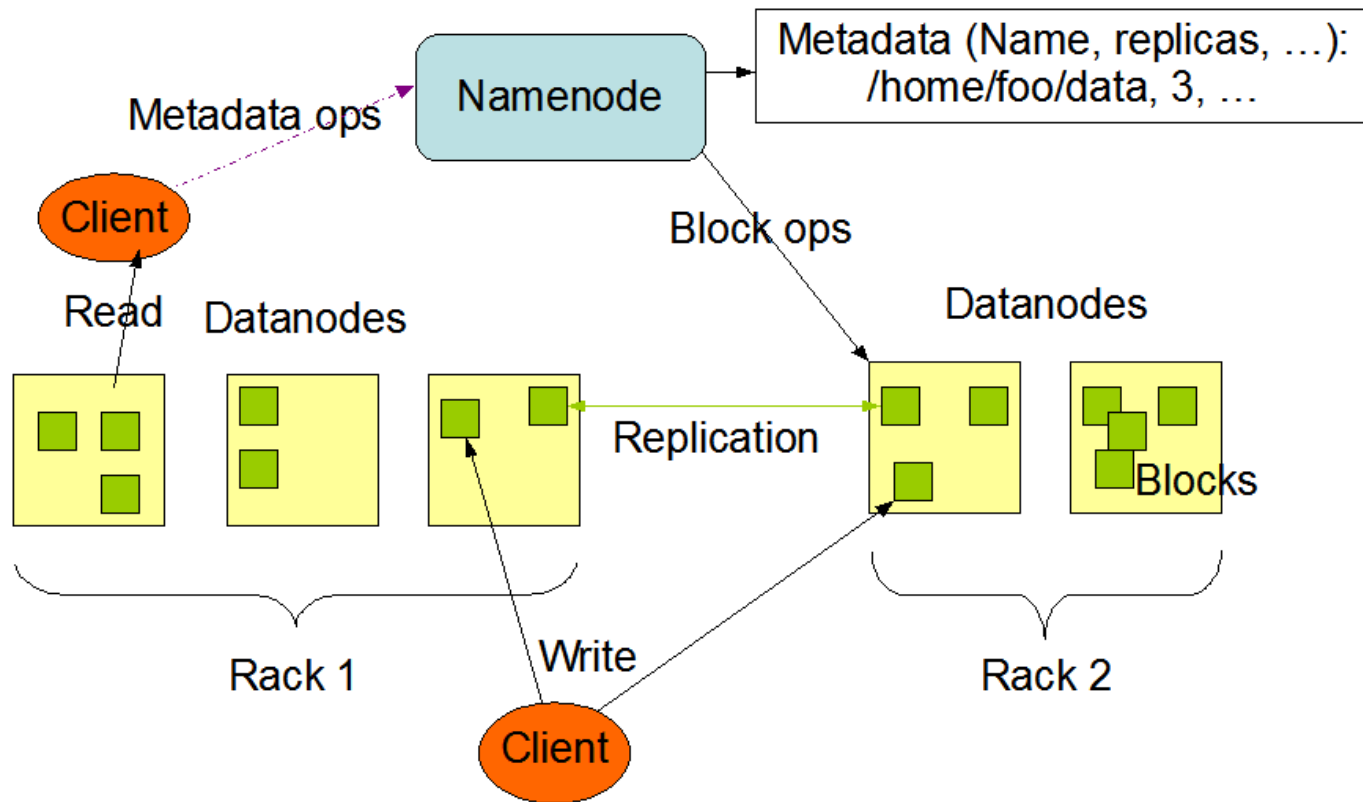
- HDFS: Distributed file system
 - Hard to store a PB
 - Based on Google FS
 - Fault-tolerant: handles replication, node failure, etc
- MapReduce : Data aware parallel computation framework
 - Even harder to process a PB
 - Based on a research paper by Google

Hadoop Distributed File System 1/2

- Master/Slave Architecture
- Files are split into one or more blocks and these blocks are stored in a set of DataNodes
- A Master NameNode
 - a master server that manages the file system namespace and regulates access to files by clients
 - determines the mapping of blocks to DataNodes
- Many DataNodes
 - Serve client read/write requests
 - Create/delete/replicate blocks

Hadoop Distributed File System 2/2

HDFS Architecture



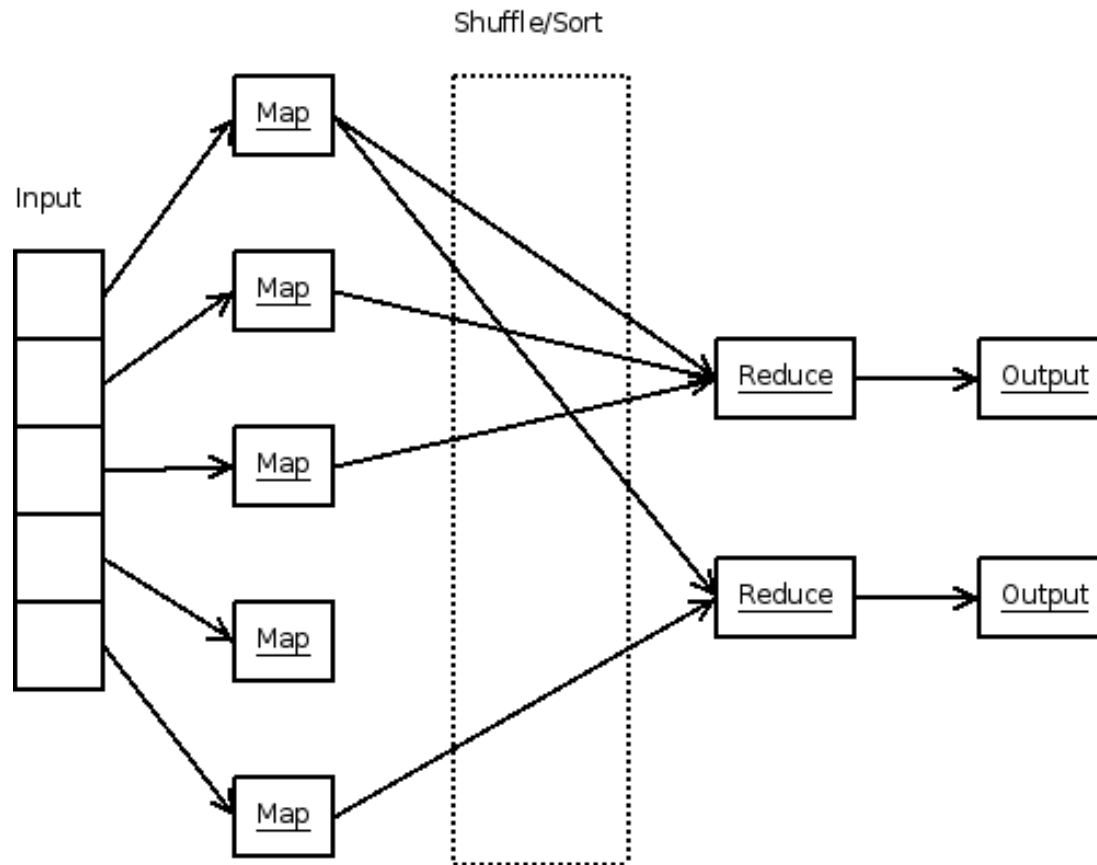
MapReduce 1/3

- A programming model
- A software framework
- for writing applications that
 - rapidly process vast amounts of data in parallel
 - on large clusters of compute nodes

MapReduce 2/3

- Problem is separated in two different phases, the Map and Reduce phase.
- **Map:** Non overlapping chunks of input data is assigned to separate processes (mappers) that emit a set of intermediate results
- **Reduce:** Map results are fed to a usually smaller number of processes called reducers that “summarize” their input in a smaller number of results

MapReduce 3/3



When should I use it?

- Good choice for
 - Indexing log files
 - Sorting vast amounts of data
 - Image analysis
- Bad choice for
 - Figuring π to 1,000,000 digits
 - Calculating Fibonacci sequences
 - MySQL replacement

Hadoop MapReduce

- Master/Slave architecture
- A JobTracker Master
 - Runs together with NameNode
 - Receives client job requests
 - Schedules and monitors MR jobs
 - Move computation near the data
 - Speculative execution
- Many TaskTrackers
 - Run together with DataNodes
 - Perform I/O operations with DataNodes

Typical problems

- Log and/or clickstream analysis of various kinds
- Marketing analytics
- Machine learning and/or sophisticated data mining
- Image processing
- Processing of XML messages
- Web crawling and/or text processing
- General archiving, including of relational/tabular data, e.g. for compliance

Use cases 1/3

The New York Times

- Large Scale Image Conversions
- 100 Amazon EC2 Instances, 4TB raw TIFF data
- 11 Million PDF in 24 hours and 240\$



facebook

- Internal log processing
- Reporting, analytics and machine learning
- Cluster of 1110 machines, 8800 cores and 12PB raw storage
- Open source contributors (Hive)



twitter™

- Store and process tweets, logs, etc
- Open source contributors (hadoop-izo)

Use cases 2/3



- 100.000 CPUs in 25.000 computers
- Content/Ads Optimization, Search index
- Machine learning (e.g. spam filtering)
- Open source contributors (Pig)
- Natural language search (through Powerset)
- 400 nodes in EC2, storage in S3
- Open source contributors (!) to HBase
- ElasticMapReduce service
- On demand elastic Hadoop clusters for the Cloud



Use cases 3/3



- ETL processing, statistics generation
- Advanced algorithms for behavioral analysis and targeting



- Used for discovering People you May Know, and for other apps
- 3X30 node cluster, 16GB RAM and 8TB storage



- Leading Chinese language search engine
- Search log analysis, data mining
- 300TB per week
- 10 to 500 node clusters

Questions

