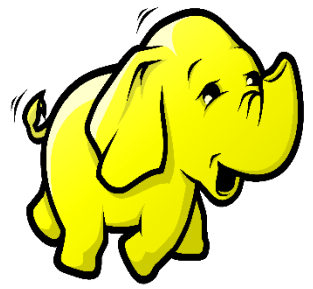


# The Hadoop Ecosystem

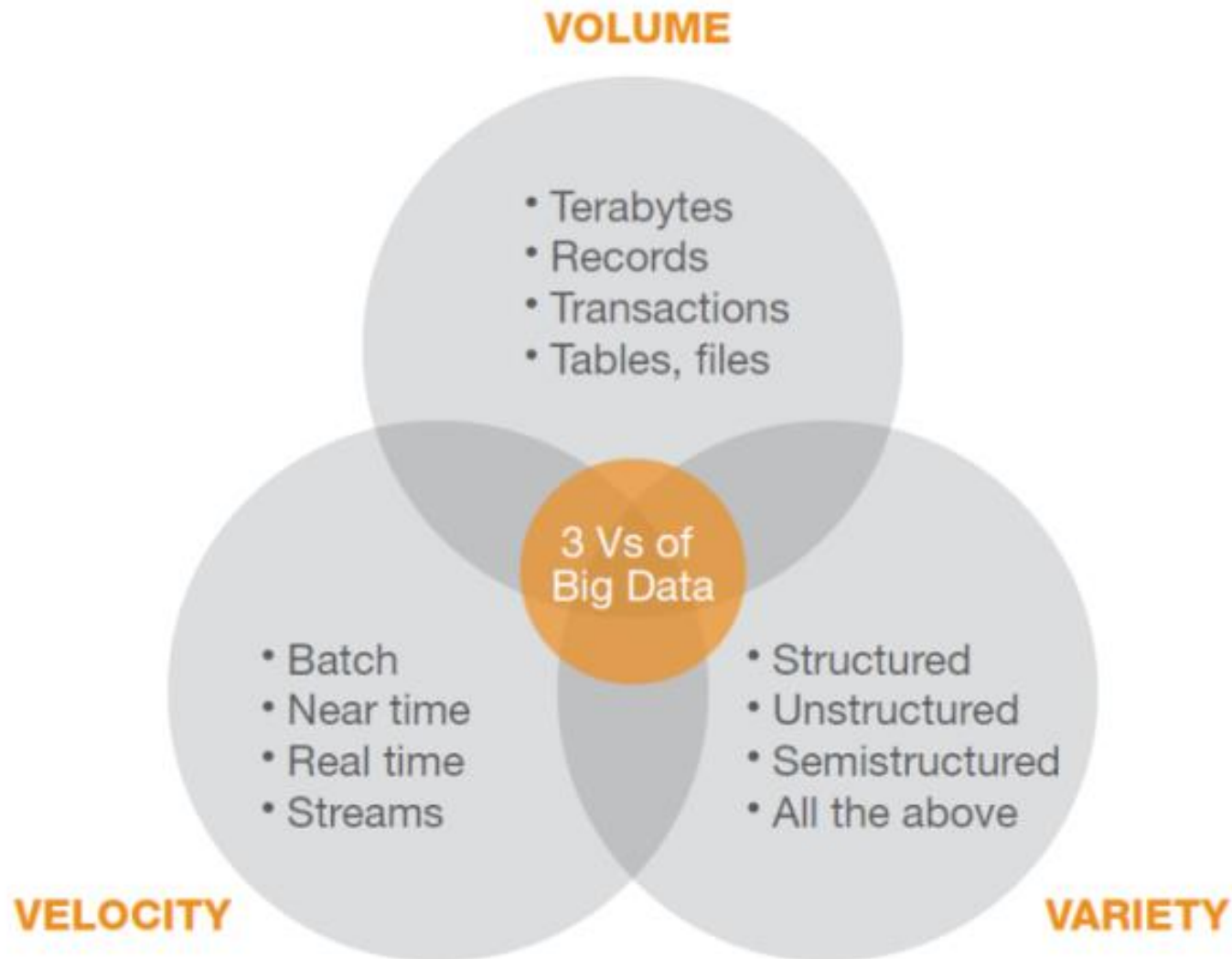
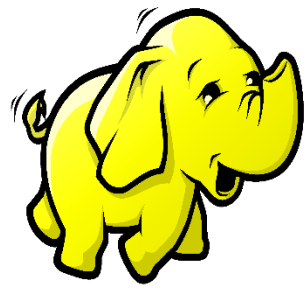
By  
Pragya Singhvi

# Overview

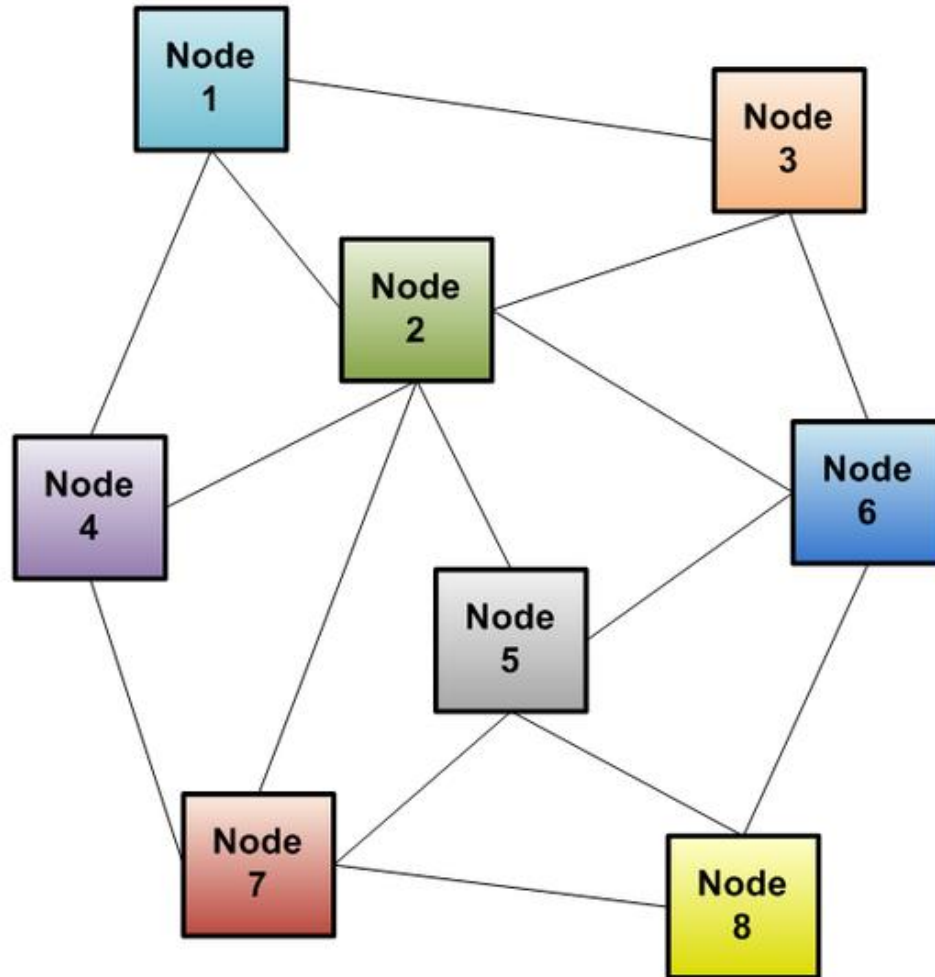
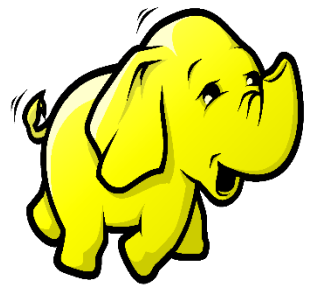


- ▶ Big Data Challenges
- ▶ Distributed system and challenges
- ▶ Hadoop Introduction
- ▶ History
- ▶ Who uses Hadoop
- ▶ The Hadoop Ecosystem
  - ❑ Hadoop core components
    - ❖ HDFS
    - ❖ Map Reduce
  - ❑ Other Hadoop ecosystem components
    - ❖ Hbase
    - ❖ Hive
    - ❖ Pig
    - ❖ Impala
    - ❖ Sqoop
    - ❖ Flume
    - ❖ Hue
    - ❖ Zookeeper
- ▶ Demo

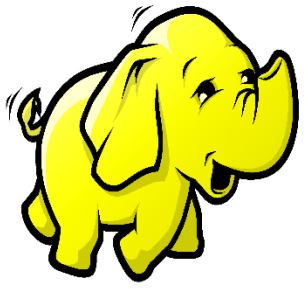
# Big Data Challenges



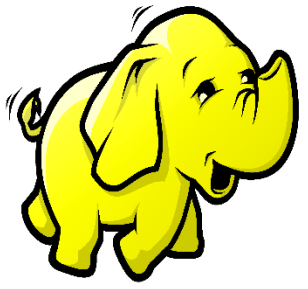
# Solution: Distributed system



# Distributed System Challenges



- ▶ Programming Complexity
- ▶ Finite bandwidth
- ▶ Partial failure
- ▶ The data bottleneck



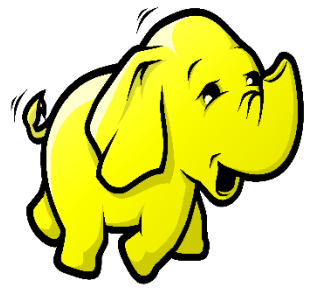
# New Approach to distributed computing

Hadoop:

A scalable fault-tolerant distributed system for data storage and processing

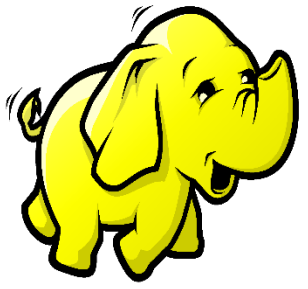
- ▶ Distribute data when the data is stored
- ▶ Process data where the data is
- ▶ Data is replicated

# Hadoop Introduction



- ▶ Apache Hadoop is an open-source software framework for storage and large-scale processing of data-sets on clusters of commodity hardware.
- ▶ Some of the characteristics:
  - Open source
  - Distributed processing
  - Distributed storage
  - Scalable
  - Reliable
  - Fault-tolerant
  - Economical
  - Flexible

# History

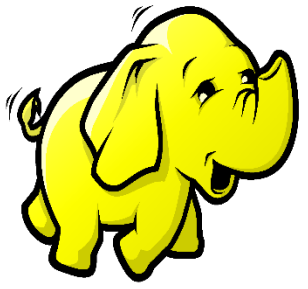


- ▶ Originally built as a Infrastructure for the “Nutch” project.
- ▶ Based on Google’s map reduce and google File System.
- ▶ Created by Doug Cutting in 2005 at Yahoo
- ▶ Named after his son’s toy yellow elephant.



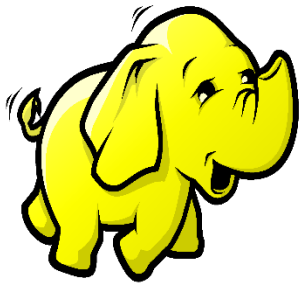


# Who uses Hadoop



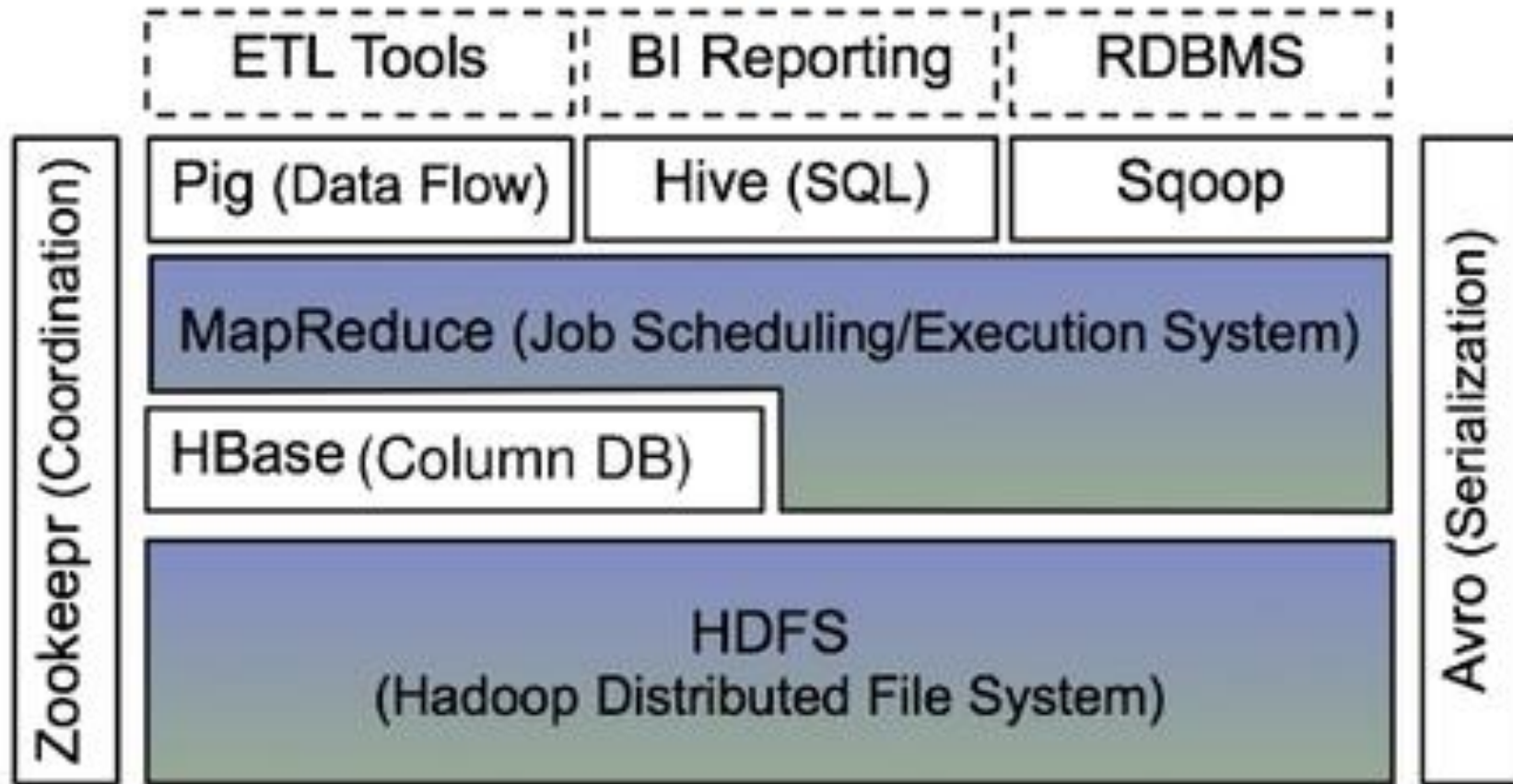
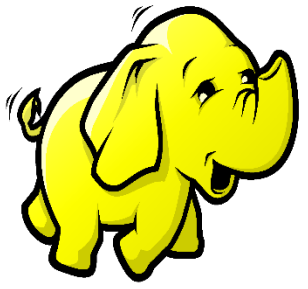
- ▶ <http://wiki.apache.org/hadoop/PoweredBy>
- ▶ <http://wiki.apache.org/hadoop/Distributions%20and%20Commercial%20Support>

# The Hadoop Ecosystem

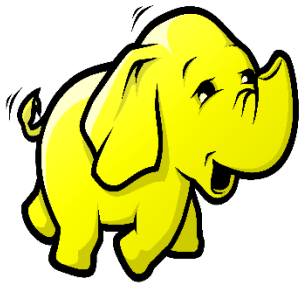


- ▶ <http://hadoopecosystemtable.github.io/>

# The Hadoop Ecosystem

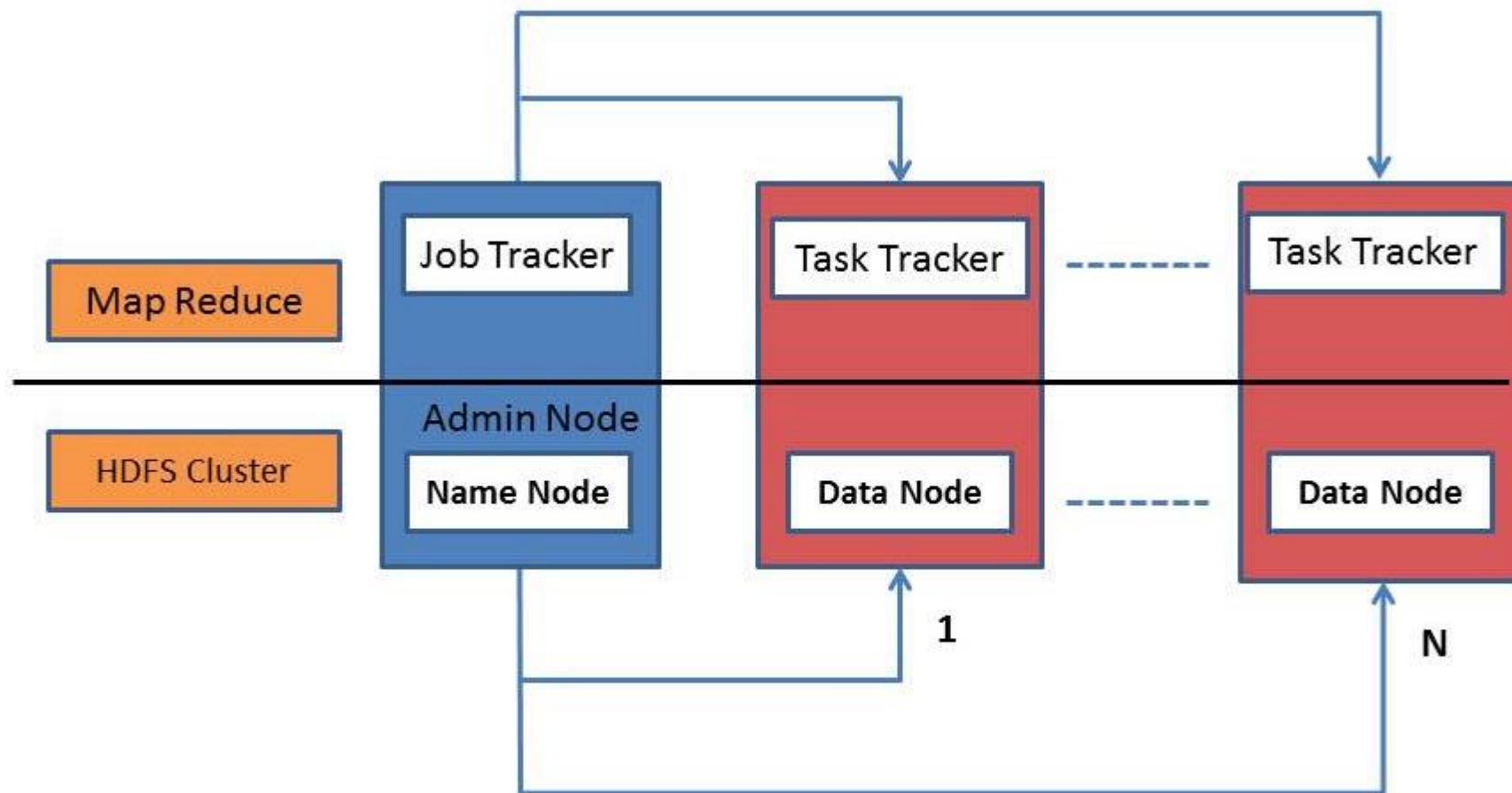
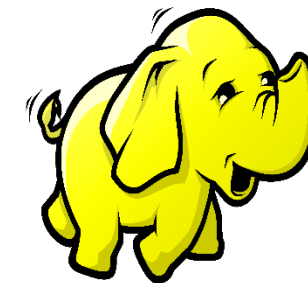


# Hadoop Core Components

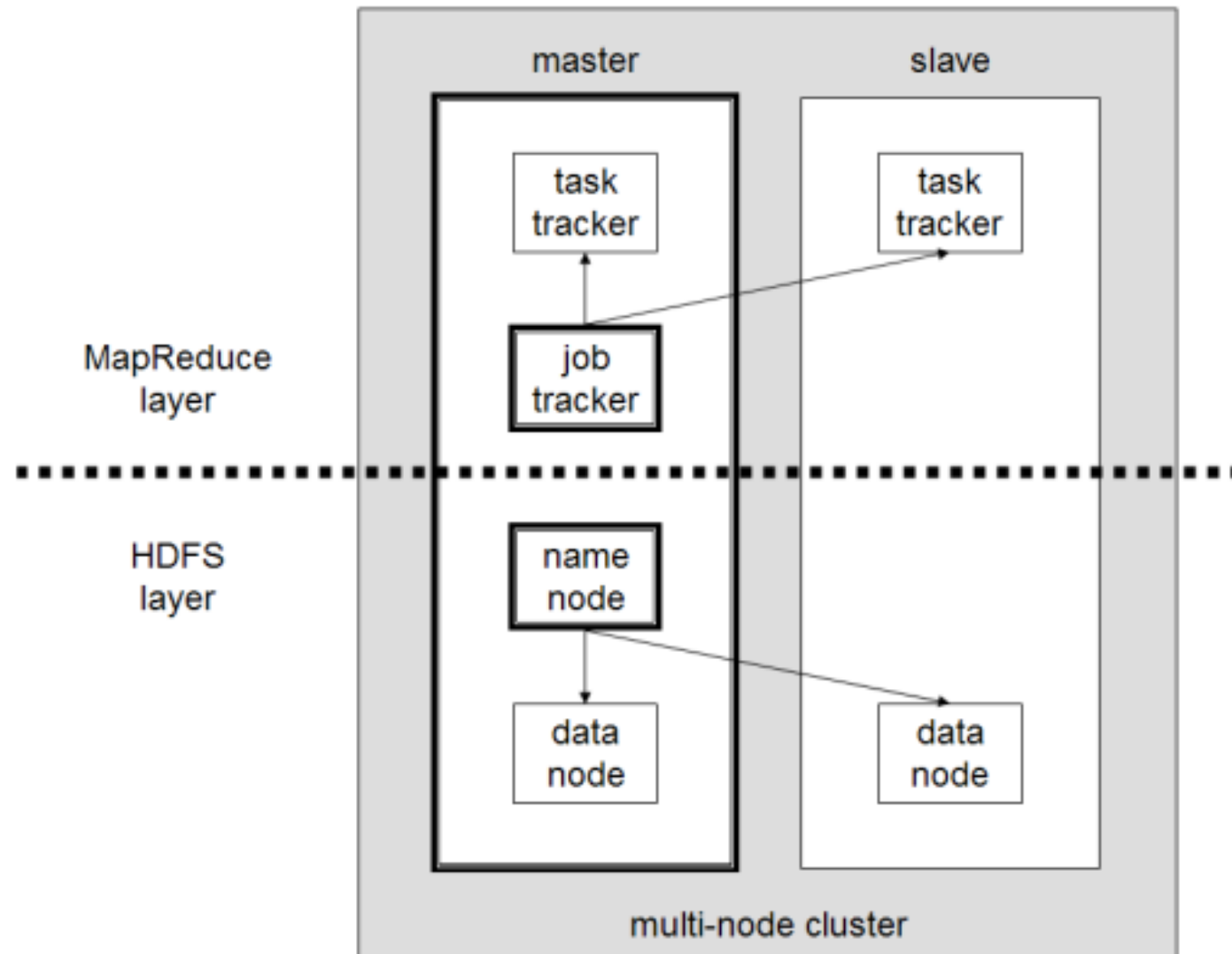
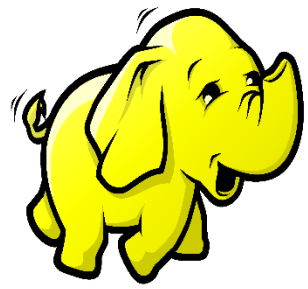


- ▶ HDFS - Hadoop Distributed File System (Storage)
- ▶ Map Reduce (Processing)

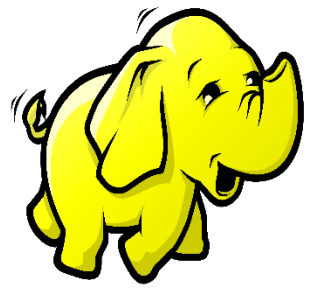
# Hadoop Core Components



# A multi-node Hadoop cluster

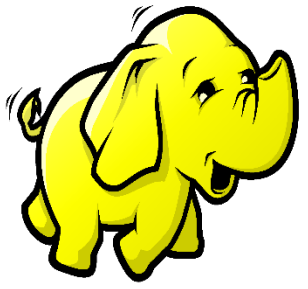


# Nodes



- ▶ **NameNode:**
  - ▶ Master of the system
  - ▶ Maintains and manages the blocks which are present on the DataNodes
- ▶ **DataNodes:**
  - ▶ Slaves which are deployed on each machine and provide the actual storage
  - ▶ Responsible for serving read and write requests for the clients
- ▶ **Jobtracker:**
  - ▶ takes care of all the job scheduling and assign tasks to Task Trackers.
- ▶ **TaskTracker:**
  - ▶ a node in the cluster that accepts tasks - Map, Reduce and Shuffle operations - from a jobtracker

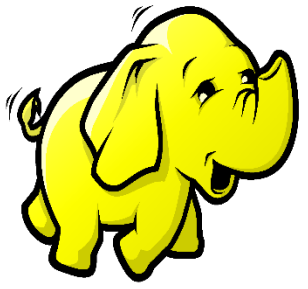
# HDFS



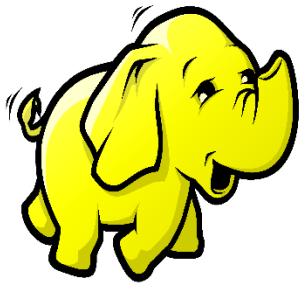
- ▶ Hadoop Distributed File System (HDFS) is designed to reliably store very large files across machines in a large cluster. It is inspired by the GoogleFileSystem.
- ▶ Distribute large data file into blocks
- ▶ Blocks are managed by different nodes in the cluster
- ▶ Each block is replicated on multiple nodes
- ▶ Name node stored metadata information about files and blocks



# Map Reduce

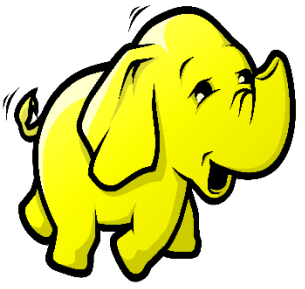


- ▶ The Mapper:
  - ❑ Each block is processed in isolation by a map task called mapper
  - ❑ Map task runs on the node where the block is stored
- ▶ The Reducer:
  - ❑ Consolidate result from different mappers
  - ❑ Produce final output



# What makes Hadoop unique

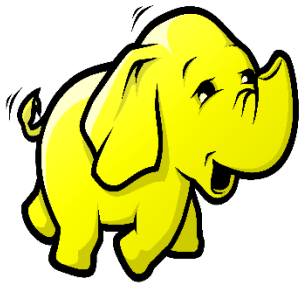
- ▶ Moving computation to data, instead of moving data to computation.
- ▶ Simplified programming model: allows user to quickly write and test
- ▶ Automatic distribution of data and work across machines



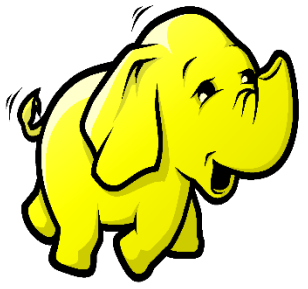
# Other Hadoop components in Ecosystem

HBase	Hadoop database for random read/write access
Hive	SQL-like queries and tables on large datasets
Pig	Data flow language and compiler
Oozie	Workflow for interdependent Hadoop jobs
Sqoop	Integration of databases and data warehouses with Hadoop
Flume	Configurable streaming data collection
ZooKeeper	Coordination service for distributed applications

# Hbase



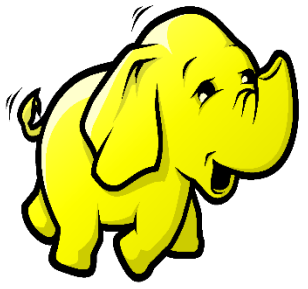
- ▶ HBase is an open source, non-relational, distributed database modeled after Google's BigTable.
- ▶ It runs on top of Hadoop and HDFS, providing BigTable-like capabilities for Hadoop.



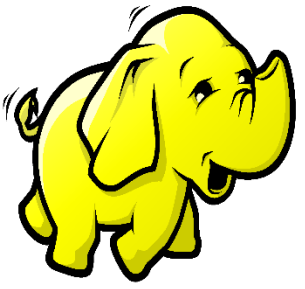
# Features of Hbase

- ▶ Type of NoSql database
- ▶ Strongly consistent read and write
- ▶ Automatic sharding
- ▶ Automatic RegionServer failover
- ▶ Hadoop/HDFS Integration
- ▶ HBase supports massively parallelized processing via MapReduce for using HBase as both source and sink.
- ▶ HBase supports an easy to use Java API for programmatic access.
- ▶ HBase also supports Thrift and REST for non-Java front-ends.

# Hbase in CAP theorem

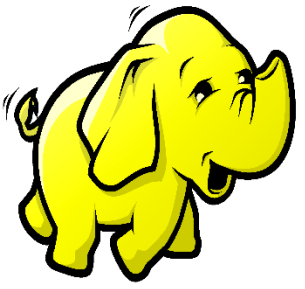


- ▶ Eric Brewer's CAP theorem, HBase is a CP type system.



# When to use Hbase

- ▶ When there is real big data: millions or billions of rows, in other way data can not store in a single node.
- ▶ When random read/write access to big data
- ▶ When require to do thousands of operations on big data
- ▶ When there is no need of extra features of RDMS like typed columns, secondary indexes, transactions, advanced query languages, etc.
- ▶ When there is enough hardware.

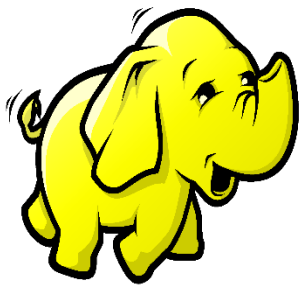


# Difference between Hbase and HDFS

HDFS	Hbase
Good for storing large file	Built on top of HDFS. Good for hosting very large tables like billions of rows X millions of column
Write once. Append to files in some of recent versions but not commonly used	Read/write many
No random read/write	Random read/write
No individual record lookup rather read all data	Fast records lookup(update)

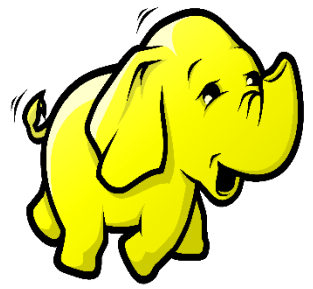


# Hive



- ▶ An sql like interface to Hadoop.
- ▶ Data warehouse infrastructure built on top of Hadoop
- ▶ Provide data summarization, query and analysis
- ▶ Query execution via MapReduce
- ▶ Hive interpreter convert the query to Map reduce format.
- ▶ Open source project.
- ▶ Developed by Facebook
- ▶ Also used by Netflix, Cnet, Digg, eHarmony etc.

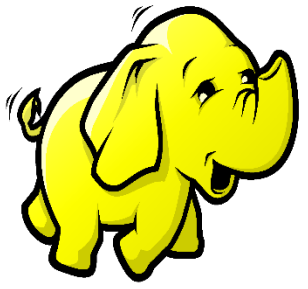
# Hive



► HiveQL example:

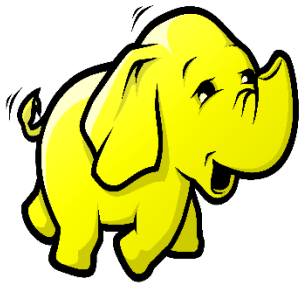
```
SELECT customerId, max(total_cost) from hive_purchases GROUP BY  
customerId HAVING count(*) > 3;
```

# Pig



- ▶ A scripting platform for processing and analyzing large data sets
- ▶ Apache Pig allows to write complex MapReduce programs using a simple scripting language.
- ▶ High level language: Pig Latin
- ▶ Pig Latin is data flow language.
- ▶ Pig translate Pig Latin script into MapReduce to execute within Hadoop.
- ▶ Open source project
- ▶ Developed by Yahoo

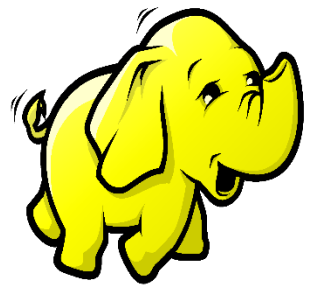
# Pig



## ► Pig Latin example:

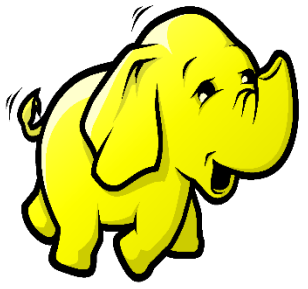
```
A = LOAD 'student' USING PigStorage() AS (name:chararray, age:int,  
gpa:float);  
X = FOREACH A GENERATE name,$2;  
DUMP X;
```

# Pig and Hive



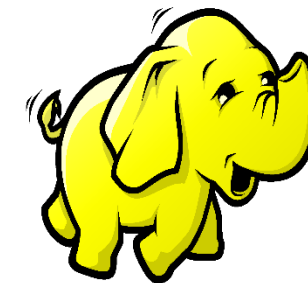
- ▶ Both requires compiler to generate Map reduce jobs
- ▶ Hence high latency queries when used for real time responses to ad-hoc queries
- ▶ Both are good for batch processing and ETL jobs
- ▶ Fault tolerant

# Impala



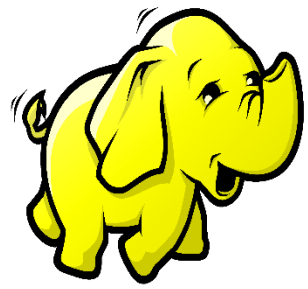
- ▶ Cloudera Impala is a query engine that runs on Apache Hadoop.
- ▶ Similar to HiveQL.
- ▶ Does not use Map reduce
- ▶ Optimized for low latency queries
- ▶ Open source apache project
- ▶ Developed by Cloudera
- ▶ Much faster than Hive or pig

# Comparing Pig, Hive and Impala



Description of Feature	Pig	Hive	Impala
SQL based query language	No	yes	yes
Schema	optional	required	required
Process data with external scripts	yes	yes	no
Extensible file format support	yes	yes	no
Query speed	slow	slow	fast
Accessible via ODBC/JDBC	no	yes	yes

# Sqoop

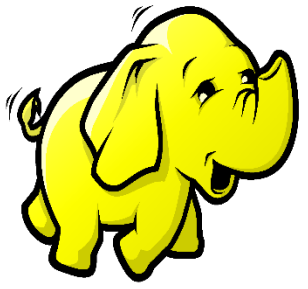


- ▶ Command-line interface for transforming data between relational database and Hadoop
- ▶ Support incremental imports
- ▶ Imports use to populate tables in Hadoop
- ▶ Exports use to put data from Hadoop into relational database such as SQL server



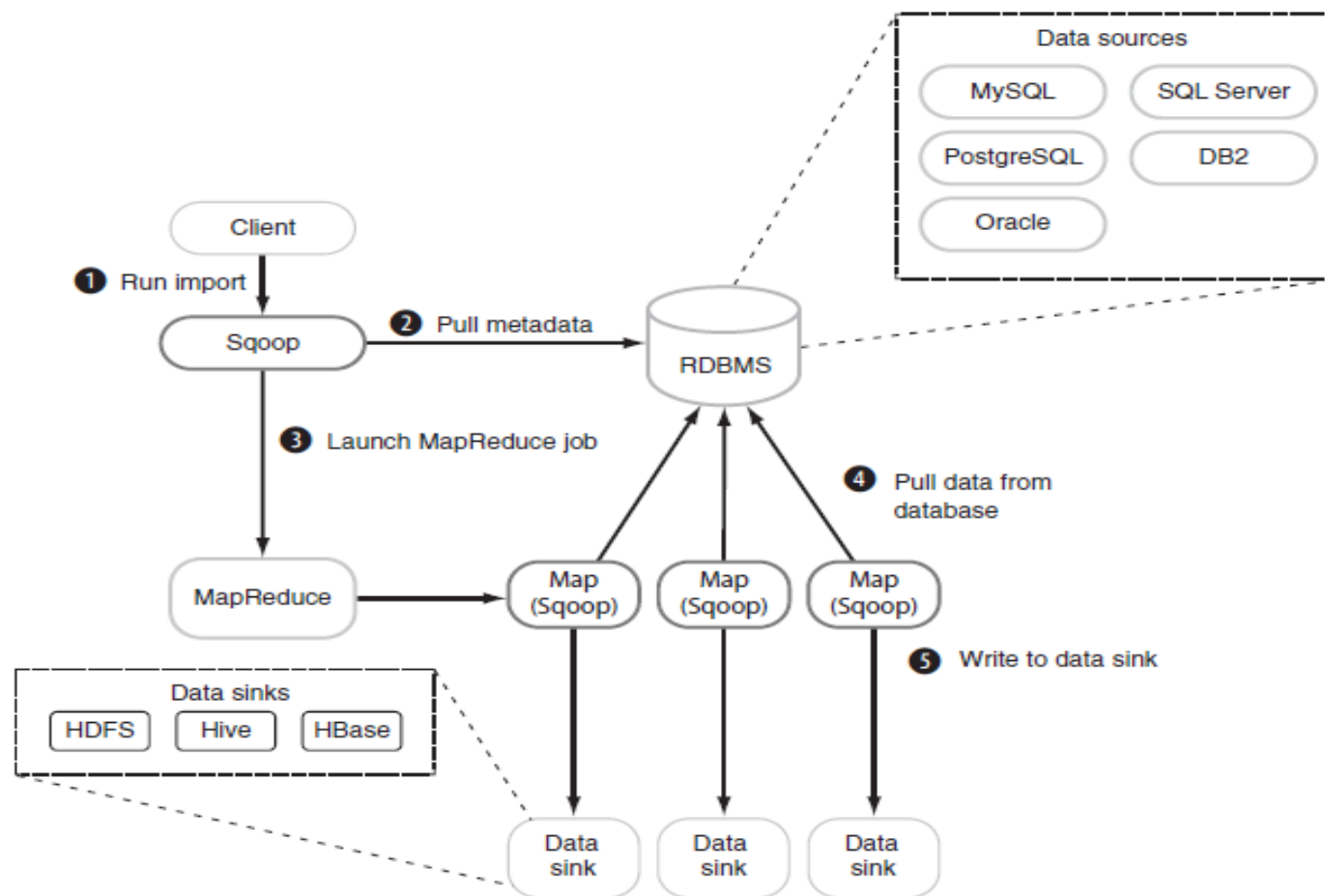
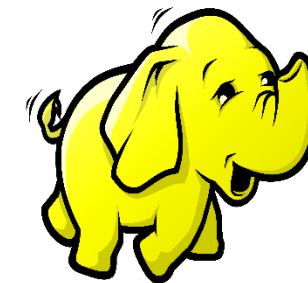


# How Sqoop works



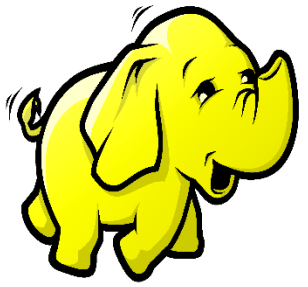
- ▶ The dataset being transferred is broken into small blocks.
- ▶ Map only job is launched.
- ▶ Individual mapper is responsible for transferring a block of the dataset.

# How Sqoop works

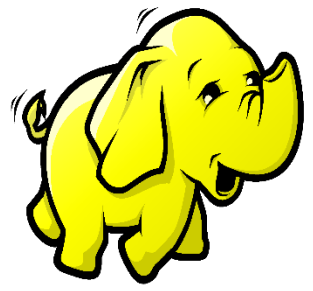


**Figure 2.20** Five-stage Sqoop import overview: connecting to the data source and using MapReduce to write to a data sink

# Zookeeper



- ▶ Because coordinating distributed systems is a Zoo.
- ▶ ZooKeeper is a centralized service for maintaining configuration information, naming, providing distributed synchronization, and providing group services.



# References

- ▶ <http://training.cloudera.com/essentials.pdf>
- ▶ [http://en.wikipedia.org/wiki/Apache\\_Hadoop](http://en.wikipedia.org/wiki/Apache_Hadoop)
- ▶ <http://practicalanalytics.wordpress.com/2011/11/06/explaining-hadoop-to-management-whats-the-big-data-deal/>
- ▶ <https://developer.yahoo.com/hadoop/tutorial/module1.html>
- ▶ <http://hadoop.apache.org/>
- ▶ <http://wiki.apache.org/hadoop/FrontPage>