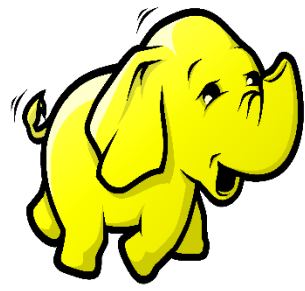


THE HADOOP ECOSYSTEM



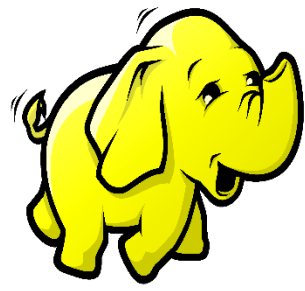
WHAT IS BIG DATA?

Big data is a supercomputing environment engineered to parallel process computer jobs across massive amounts of distributed data for the purpose of analysis and automated decision-making.

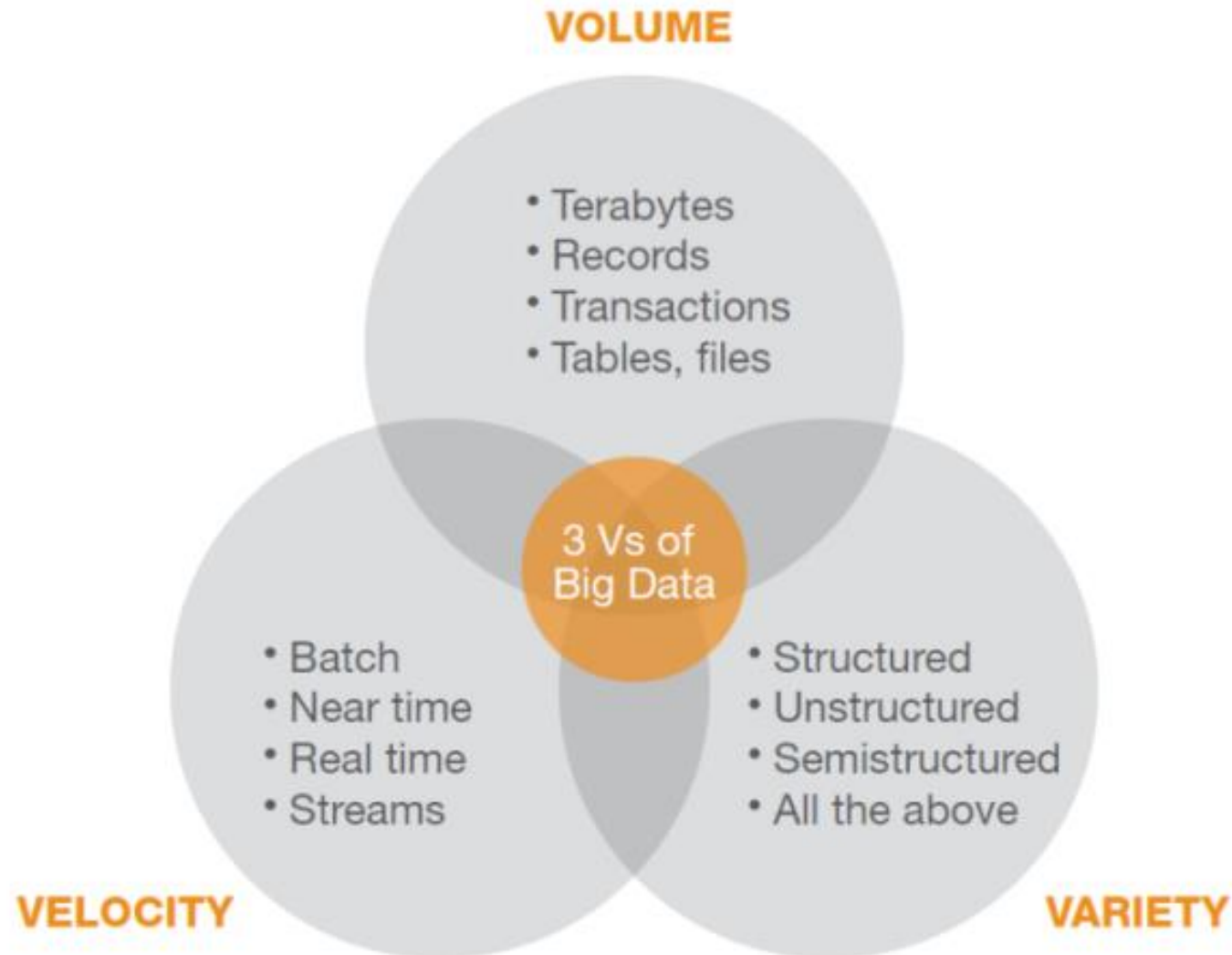
Hadoop ecosystem

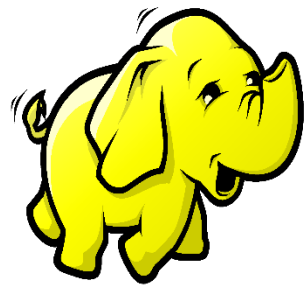
Distributed computing environment

Supercomputing platform



BIG DATA CHALLENGES





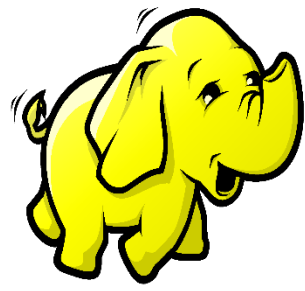
DISTRIBUTED SYSTEM CHALLENGES

Programming Complexity

Finite bandwidth

Partial failure

The data bottleneck



MAP THE BIG DATA STACK

Business value

Data fusion

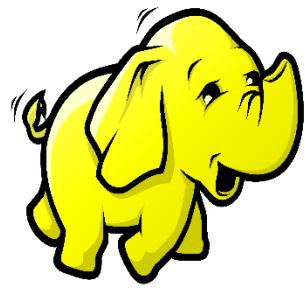
Data factory

Data refinery

Data repository

Infrastructure

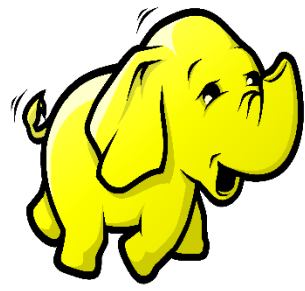
NEW APPROACH TO DISTRIBUTED COMPUTING



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



DESIGN PRINCIPLES FOR HADOOP

Recognized design problems

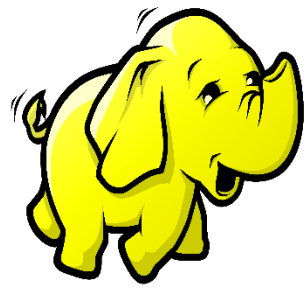
Dumb hardware and smart software

Shared nothing

Move processing, not data

Embrace failure

Build application, not infrastructure



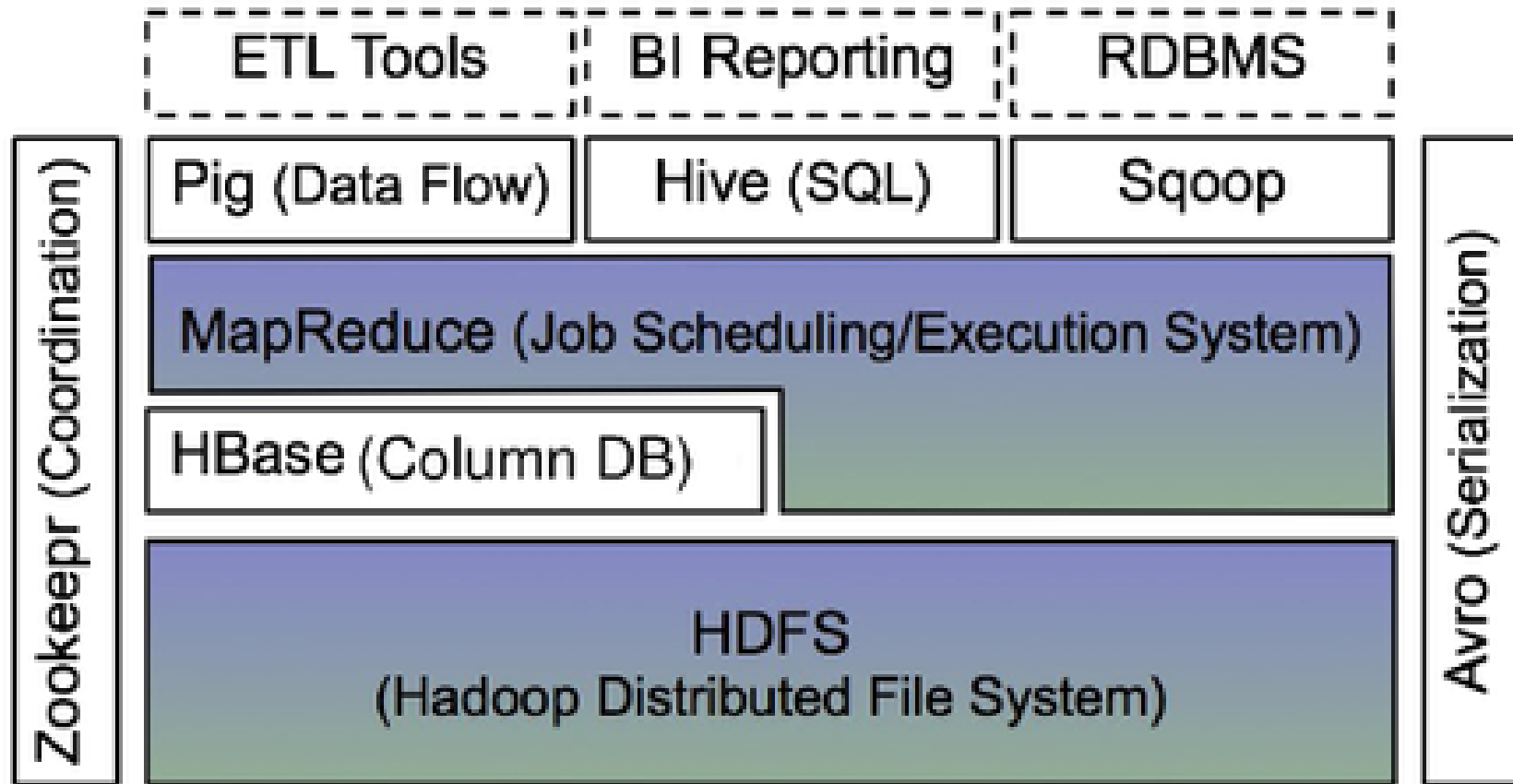
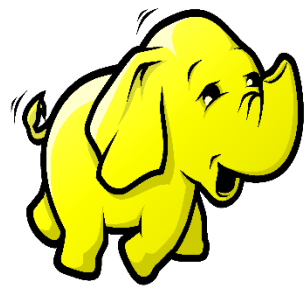
HADOOP INTRODUCTION

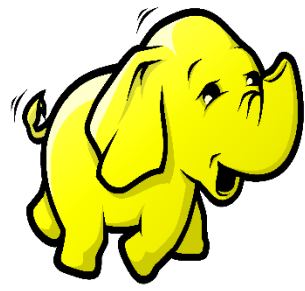
Apache Hadoop is an open-source software framework for storage and large-scale processing of data-sets on clusters of commodity hardware.

Some of the characteristics:

- Open source
- Distributed processing
- Distributed storage
- Scalable
- Reliable
- Fault-tolerant
- Economical
- Flexible

The Hadoop Ecosystem



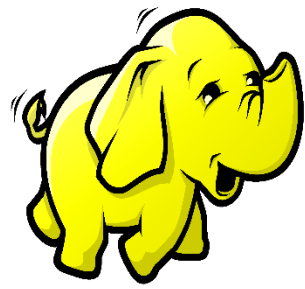


HADOOP CORE COMPONENTS

Data repository: HDFS – Hadoop Distributed File System (Storage)

Data refinery: YARN is the parallel processing framework

Data refinery: MapReduce is a parallel processing engine



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 Google File System.

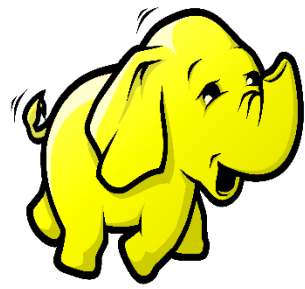
Distribute large data file into blocks

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

NODES



NameNode:

- Master of the system
- Maintains and manages the blocks which are present on the DataNodes

DataNodes:

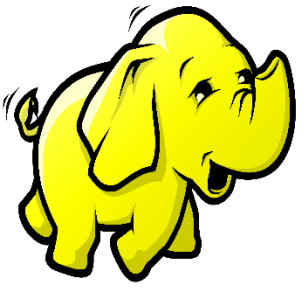
- Slaves which are deployed on each machine and provide the actual storage
- Responsible for serving read and write requests for the clients

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

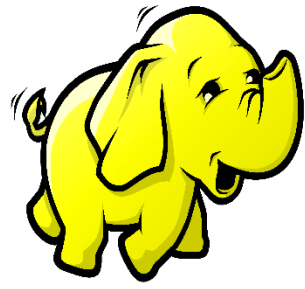


YARN KEY CONCEPT

Resource management

Schedule management

Application management



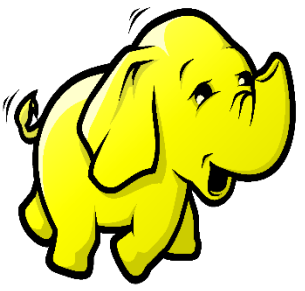
MAP REDUCE

The Mapper:

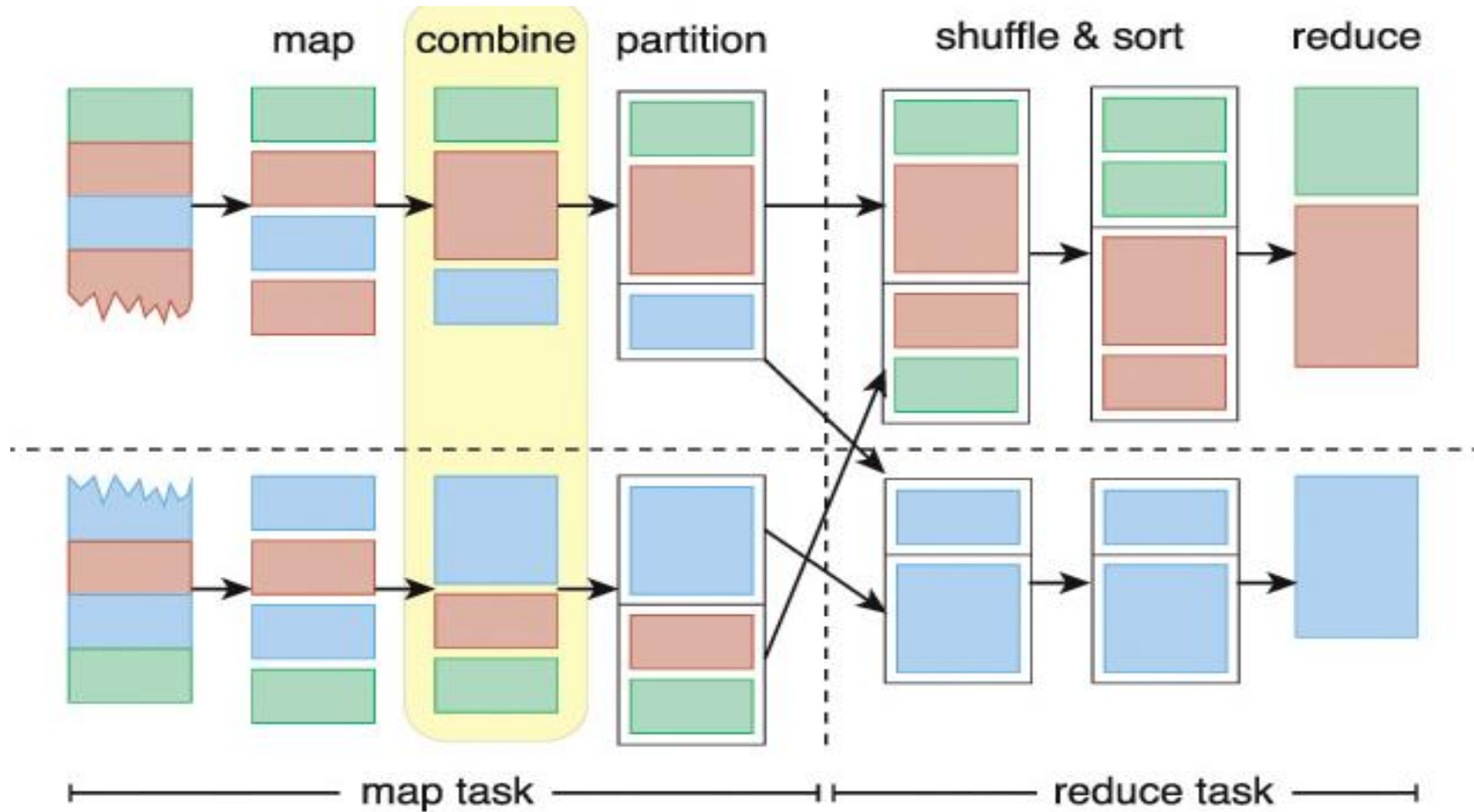
- ❑ Each block is processed in isolation by a map task called mapper
- ❑ Map task runs on the node where the block is stored

The Reducer:

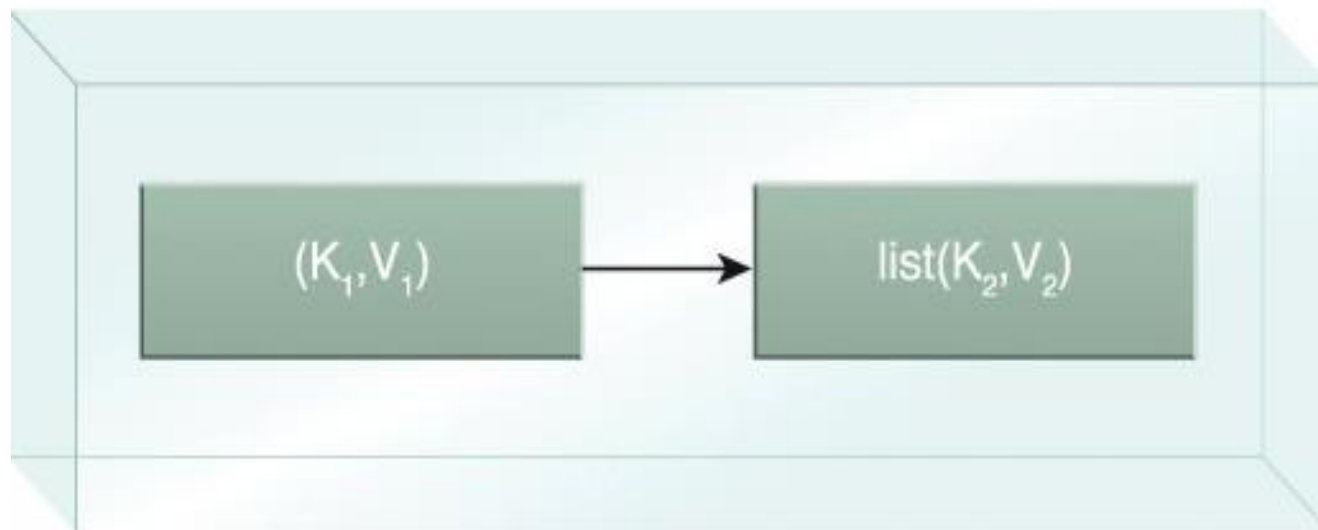
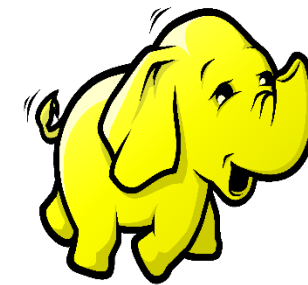
- ❑ Consolidate result from different mappers
- ❑ Produce final output



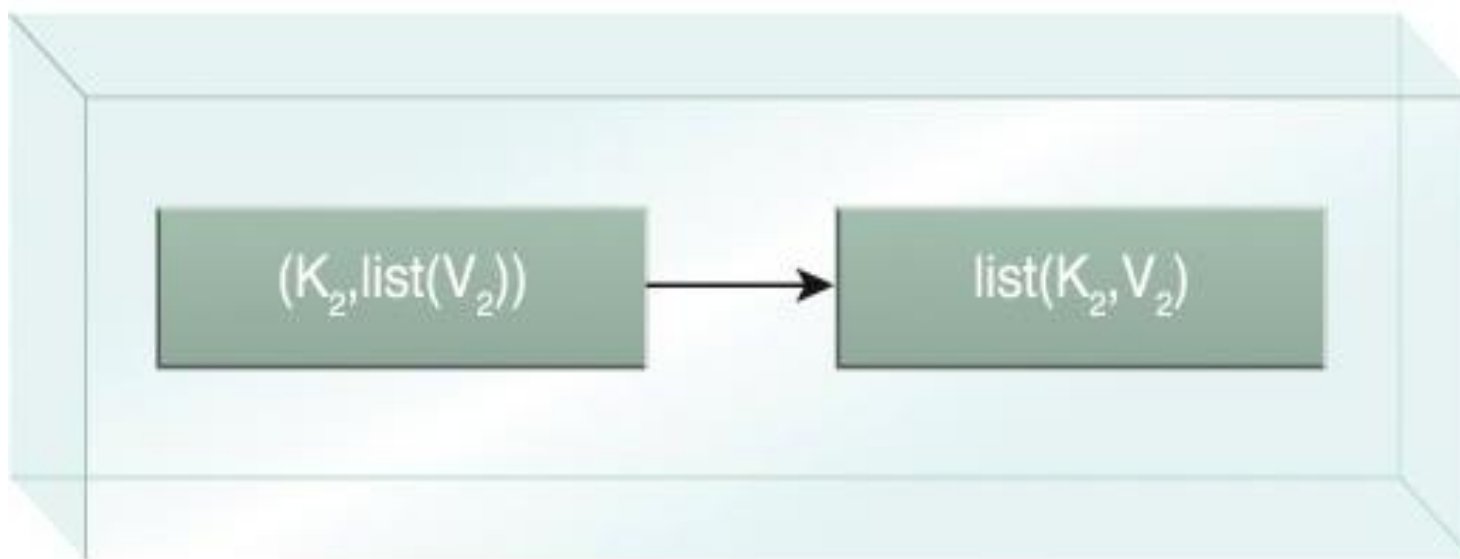
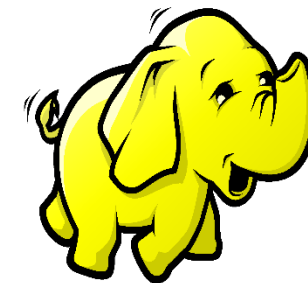
MAPREDUCE



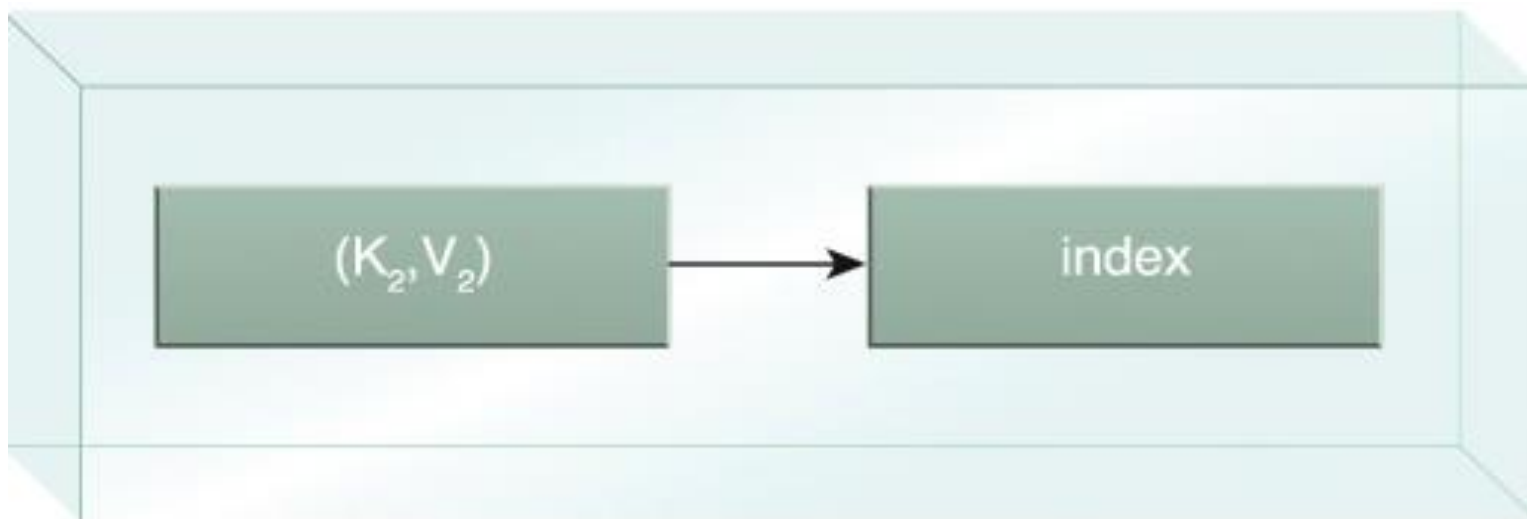
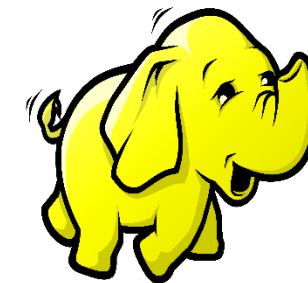
MAP

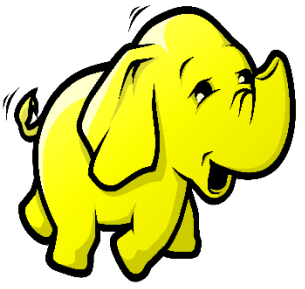


COMBINE

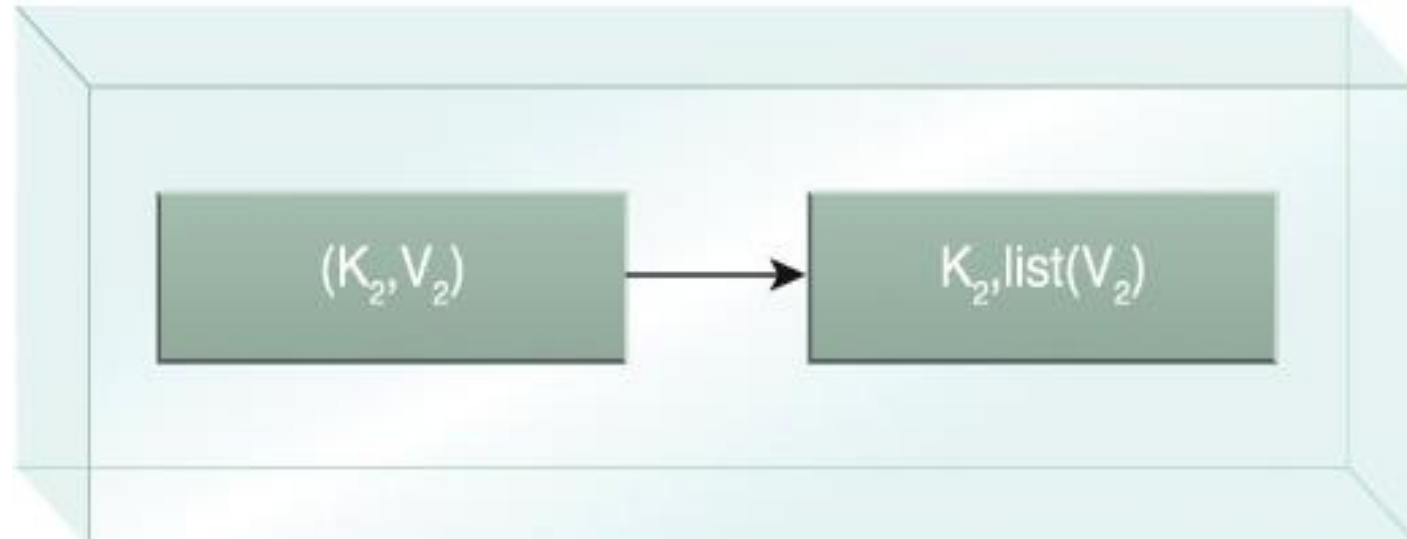


PARTITION

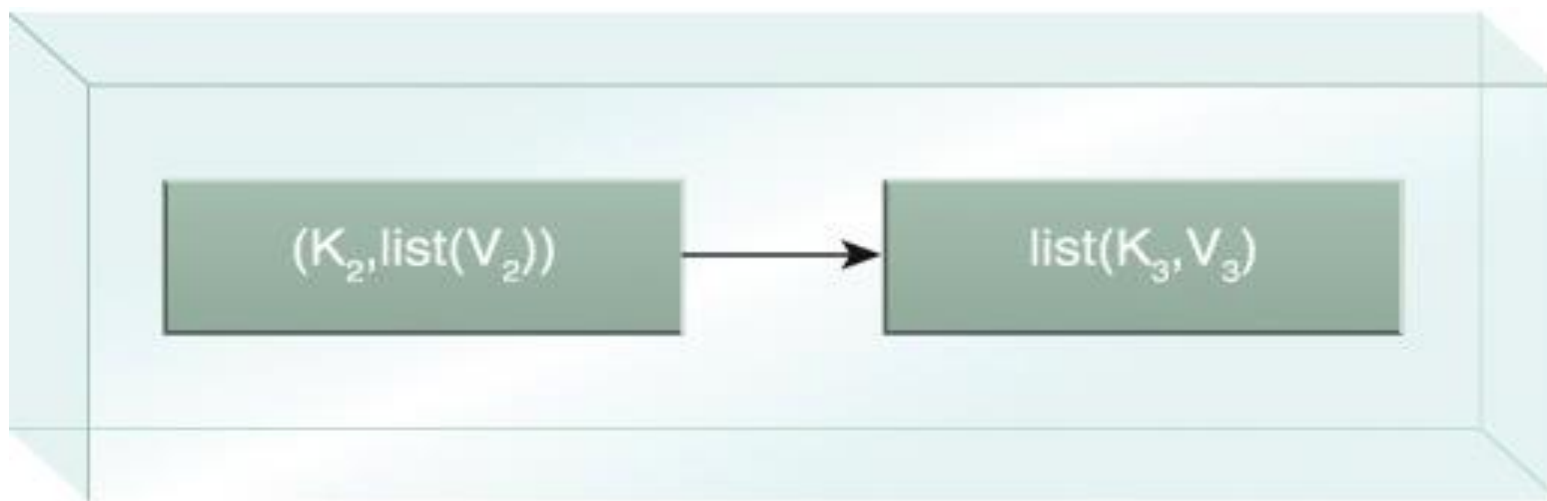
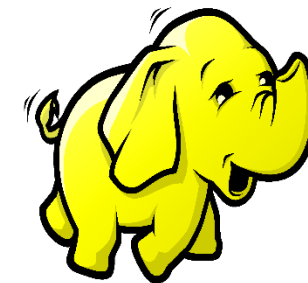


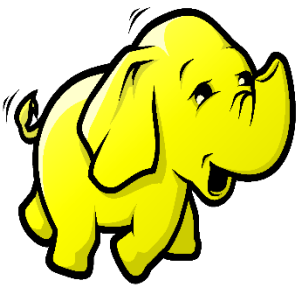


SHUFFLE AND SORT

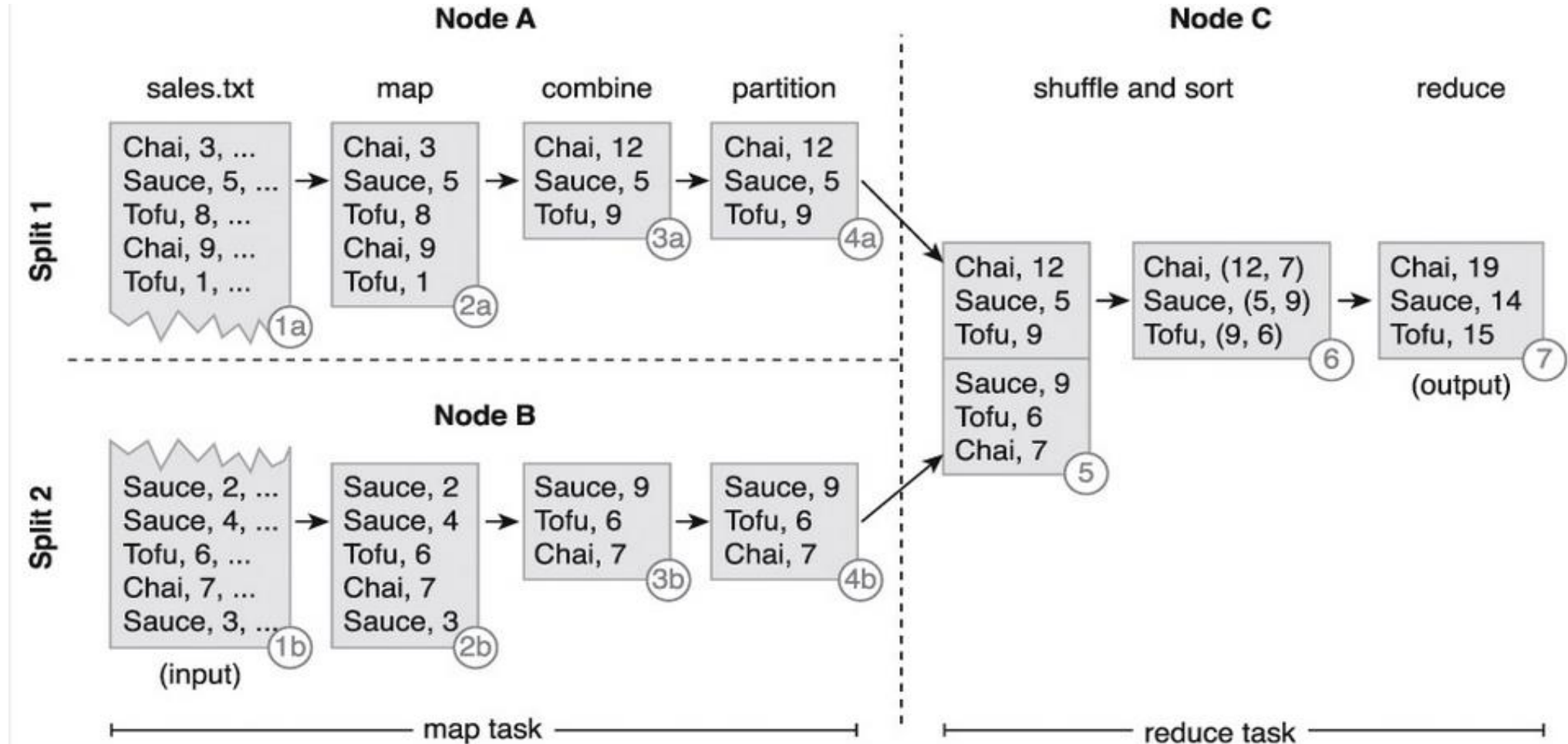


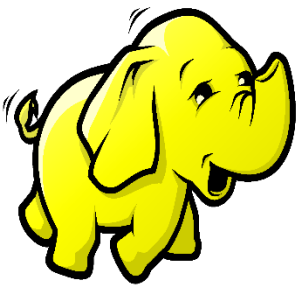
REDUCE



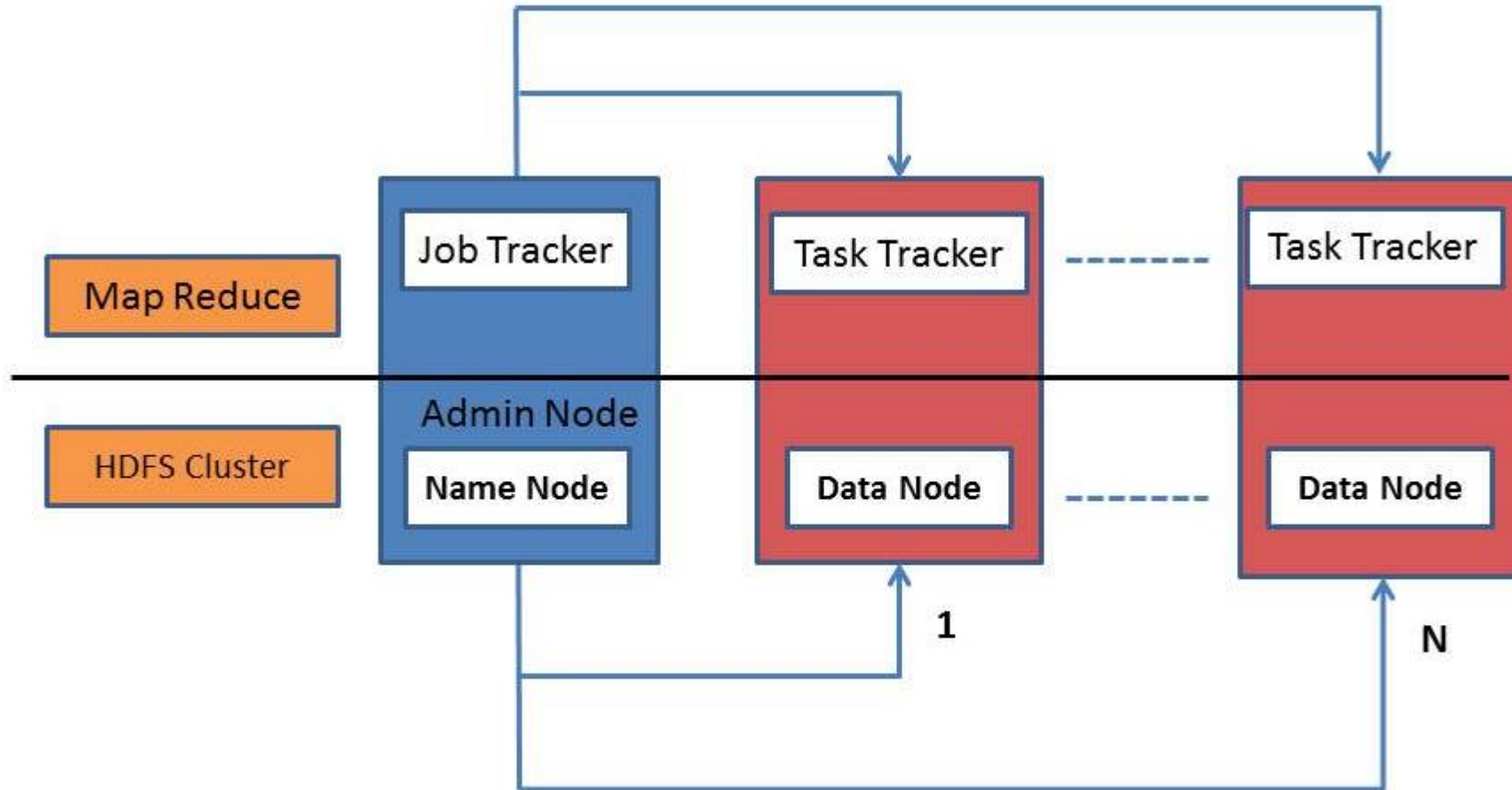


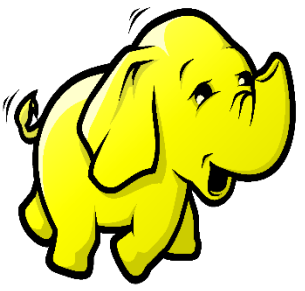
EXAMPLE



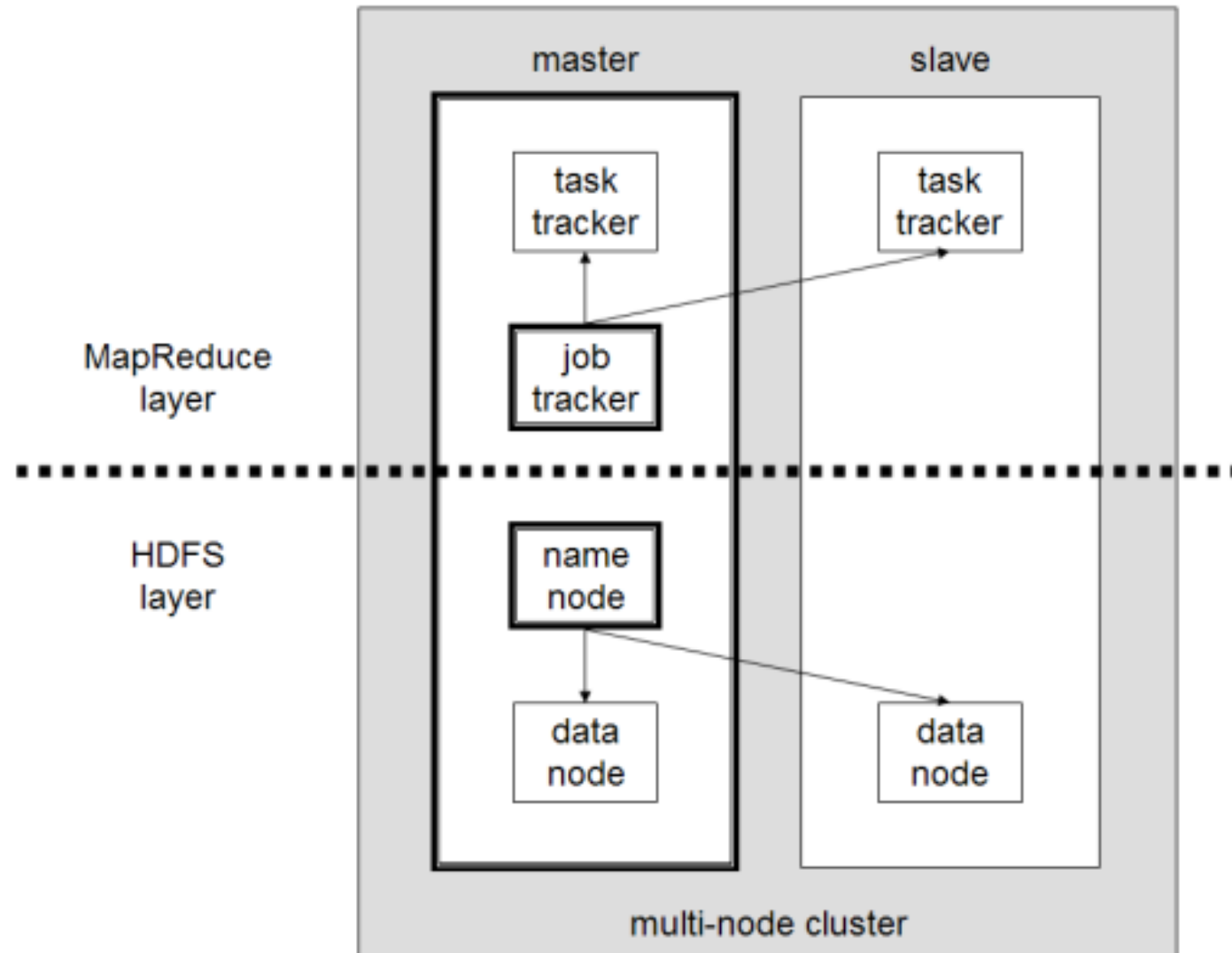


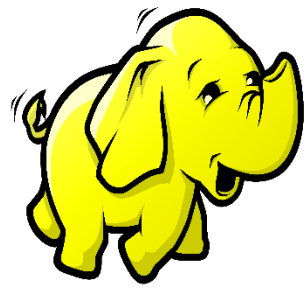
HADOOP CORE COMPONENTS





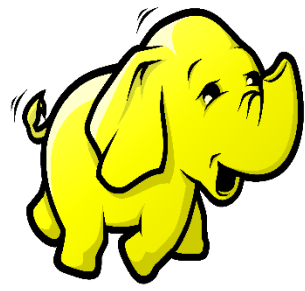
A MULTI-NODE HADOOP CLUSTER





OTHER HADOOP COMPONENTS IN ECOSYSTEM

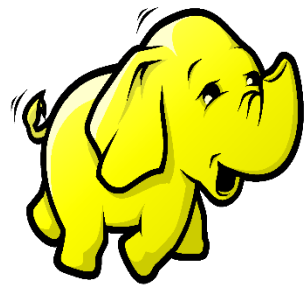
HBase	Hadoop database for random read/write access
Hive	SQL-like queries and tables on large datasets
Pig	Data flow language and compiler
Oozie	Workflow for interdependent Hadoop jobs
Sqoop	Integration of databases and data warehouses with Hadoop
Flume	Configurable streaming data collection
ZooKeeper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

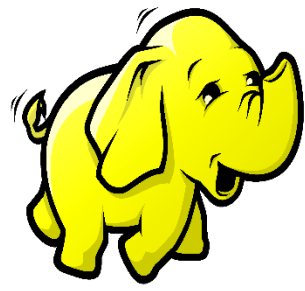
Automatic RegionServer failover

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.



WHEN TO USE HBASE

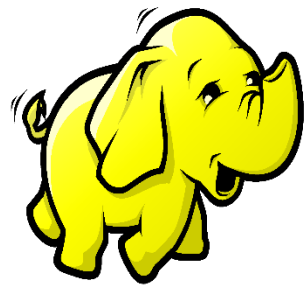
When there is real big data: millions or billions of rows, in other way data can not store in a single node.

When random read/write access to big data

When require to do thousands of operations on big data

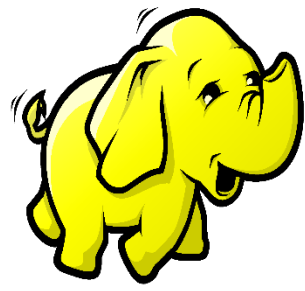
When there is no need of extra features of RDMS like typed columns, secondary indexes, transactions, advanced query languages, etc.

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

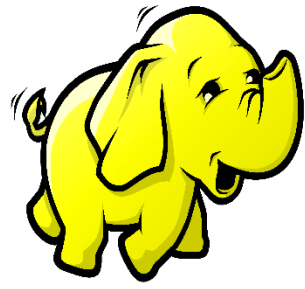
Query execution via MapReduce

Hive interpreter convert the query to Map reduce format.

Open source project.

Developed by Facebook

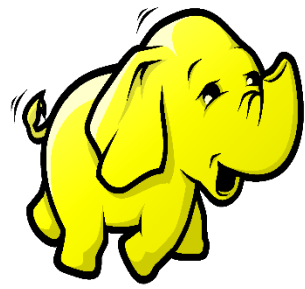
Also used by Netflix, Cnet, Digg, eHarmony etc.



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

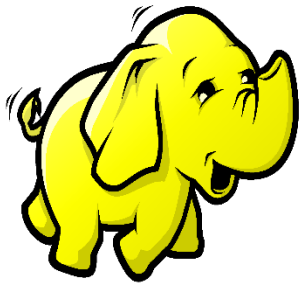
Pig Latin is data flow language.

Pig translate Pig Latin script into MapReduce to execute within Hadoop.

Open source project

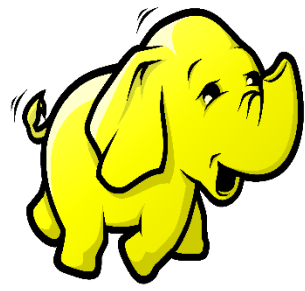
Developed by Yahoo

PIG



Pig Latin example:

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

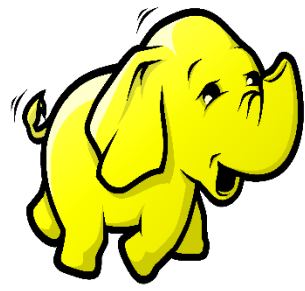
PIG AND HIVE

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



SQOOP

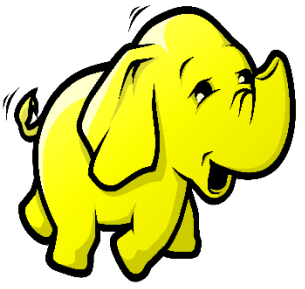
Command-line interface for transforming data between relational database and Hadoop

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

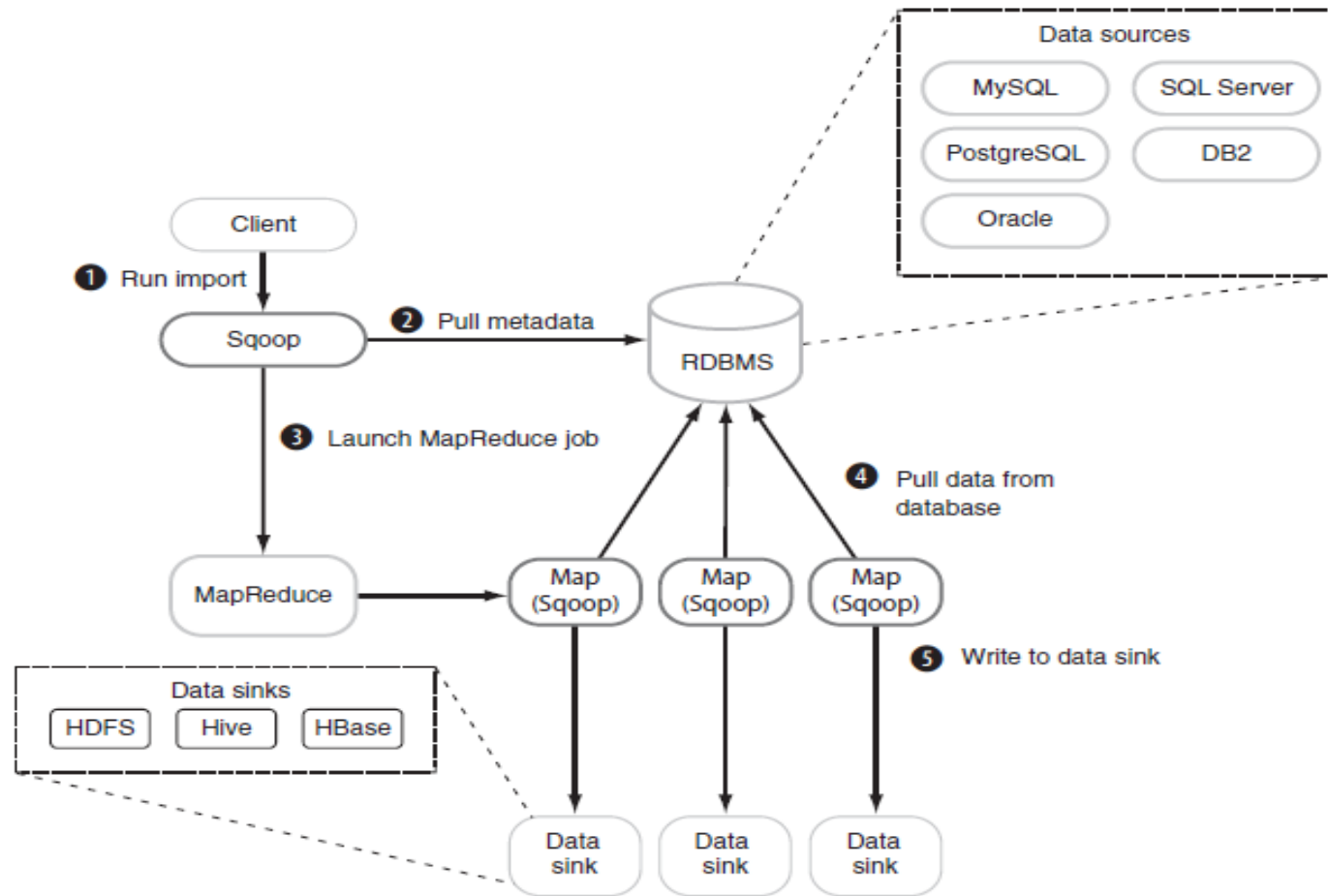
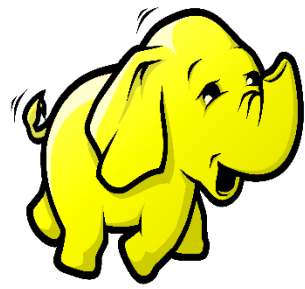
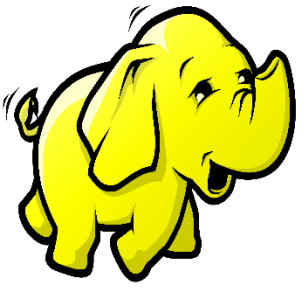


Figure 2.20 Five-stage Sqoop import overview: connecting to the data source and using MapReduce to write to a data sink



FLUME

Apache Flume is a distributed, reliable, and available service for efficiently collecting, aggregating, and moving large amounts of streaming data into the Hadoop Distributed File System (HDFS).

HOW FLUME WORKS

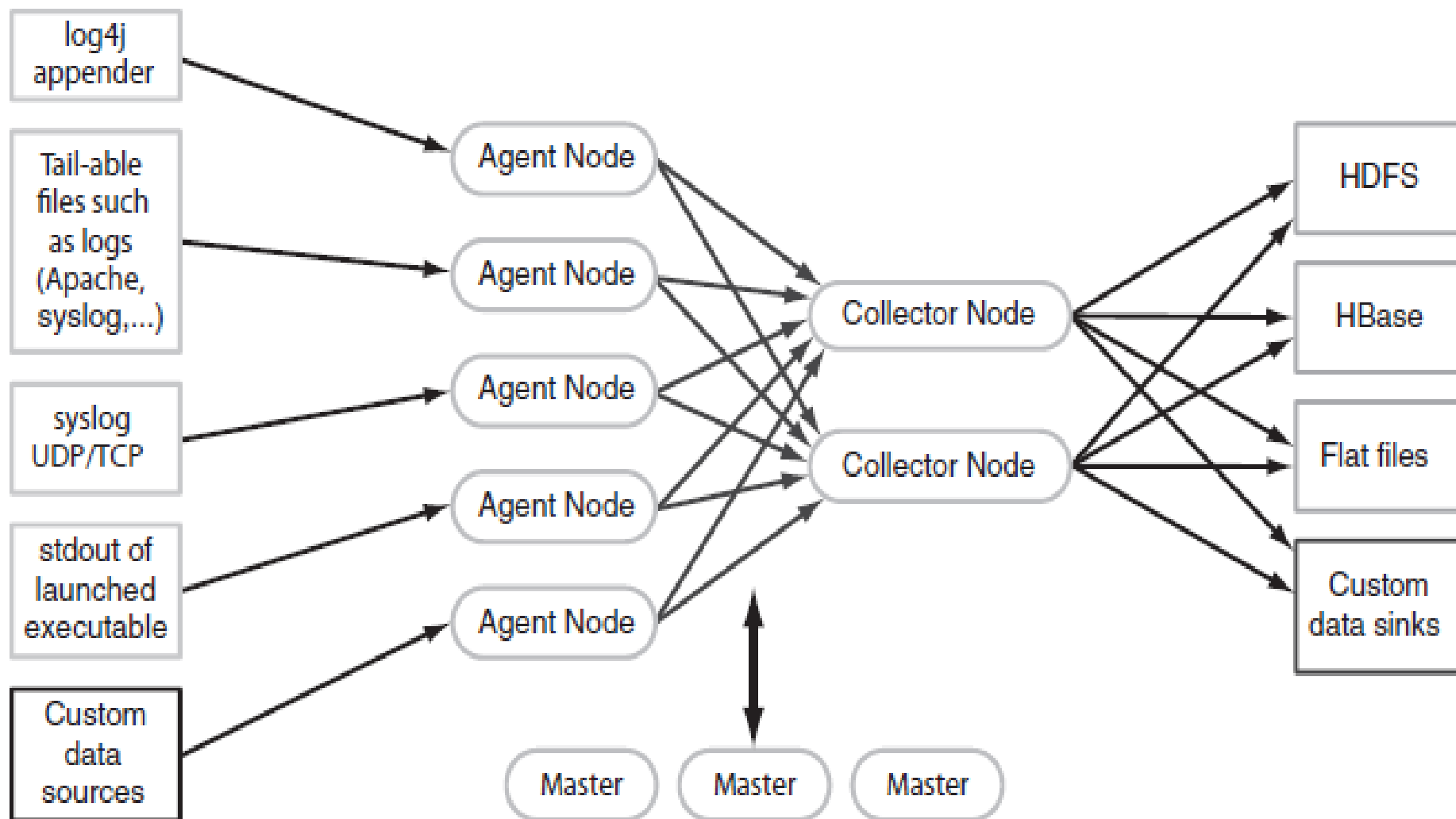
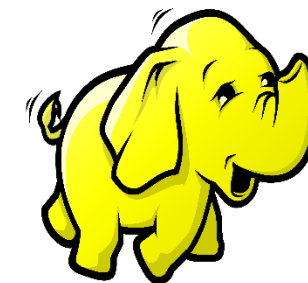
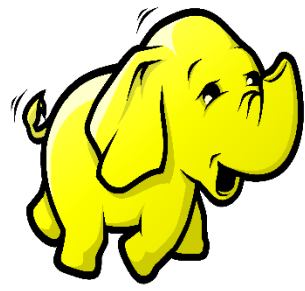


Figure 2.2 Flume architecture for collecting streaming data

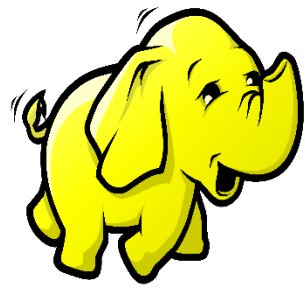


HOW FLUME WORKS

Data flows like:

Agent tier -> Collector tier -> Storage tier

Agent nodes are typically installed on the machines that generate the logs and are data's initial point of contact with Flume. They forward data to the next tier of ***collector nodes***, which aggregate the separate data flows and forward them to the final ***storage tier***.



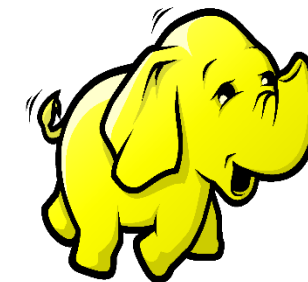
HUE

Graphical front end to the cluster.

Open source web interface.

Makes Hadoop platform (HDFS, Map reduce, oozie, Hive, etc.) easy to use

HUE



HUE

Query Editors ▾

Data Browsers ▾

Workflows ▾

Search ▾

File Browser

Job Browser

romain ▾

Hive Editor

Query Editor

My Queries

Saved Queries

History

Navigator

Settings

DATABASE

default ▾

Table name...

page_view

tweets

business

city (string)

review_count (int)

name (string)

neighborhoods (string)

type (string)

business_id (string)

full_address (string)

state (string)

longitude (float)

stars (float)

latitude (float)

open (boolean)

categories (string)

top_cool4_hbase

top_reviews

review

top_cool

top_cool_hbase

timestamp_invalid_data

test_partitions

counties

hanks

Sample: Salary growth

Salary growth (sorted) from 2007-08

```
1 SELECT s07.description, s07.salary, s08.salary,
2       s08.salary - s07.salary
3 FROM
4       sample_07 s07 JOIN sample_08 s08
5 ON ( s07.code = s08.code)
6 WHERE
7       s07.salary < s08.salary
8 ORDER BY s08.salary-s07.salary DESC
9 LIMIT 20
```

Execute

Save

Save as...

Explain

or create a

New query

...

Recent queries

Query

Log

Columns

Results

Chart

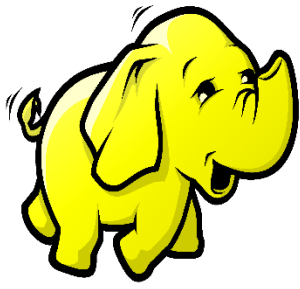
Chart type

X-Axis description ▾

Y-Axis salary ▾

Profession	Salary
Dentists, all specialists	120000
Surgeons	190000
Oral and maxillofacial surgeons	180000
Natural and managers	110000
Physicians and surgeons	150000
Orthodontists	180000
Internists, general	160000
Political scientists	90000
Obstetricians and gynecologists	180000
Chief executives	150000
Rotary drill operators, oil and gas	40000
Pediatricians, general	140000
Sociologists	60000
Family and general practitioners except epidemiologists	150000
Medical scientists, and sports competitors	70000
Athletes	70000
Animal scientists	50000
Dentists, general	140000
Education administrators all other postsecondary	80000
Psychologists	80000

ZOOKEEPER



ZooKeeper is a centralized service for maintaining configuration information, naming, providing distributed synchronization, and providing group services.