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Hadoop Infrastructure

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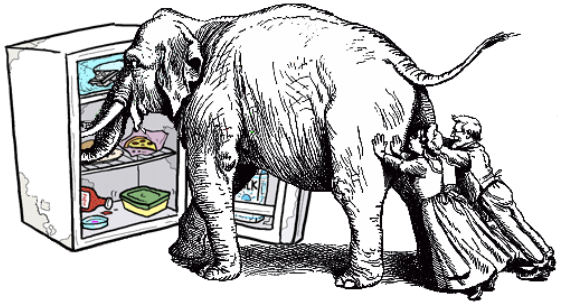
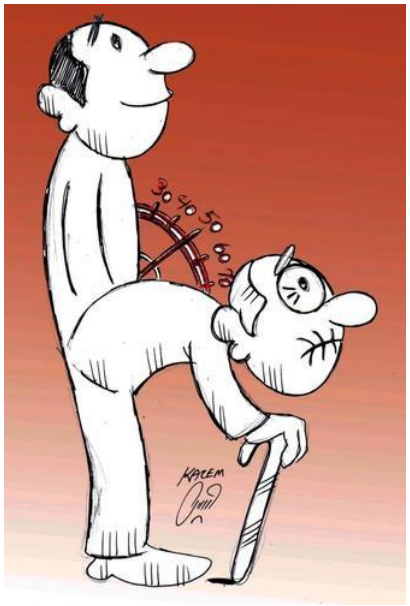
Outline

- Motivation - Hadoop
- Hadoop ecosystem
  - HDFS, MapReduce, Spark, Hive, Ambari, Zookeeper etc
- HDFS Concept
  - HDFS Arxchitecture
  - HDFS Read-Write Mechanism
  - HDFS Replication
  - Rack Awareness Algorithm
- Hands-on HDFS

Data!



Storing big data was a problem



Processing it take "years"

Problem

- Data storage
  - Although the storage capacities of hard drives have increased massively over the years, access speeds—the rate at which data can be read from drives— have not kept up
- Data processing/analysis
  - Most analysis tasks need to be able to combine the data in some way, and data read from one disk may need to be combined with data from any of the other disks

Hadoop

Hadoop provides: a reliable, scalable platform for storage and analysis. What's more, because it runs on commodity hardware and is open source, Hadoop is affordable.

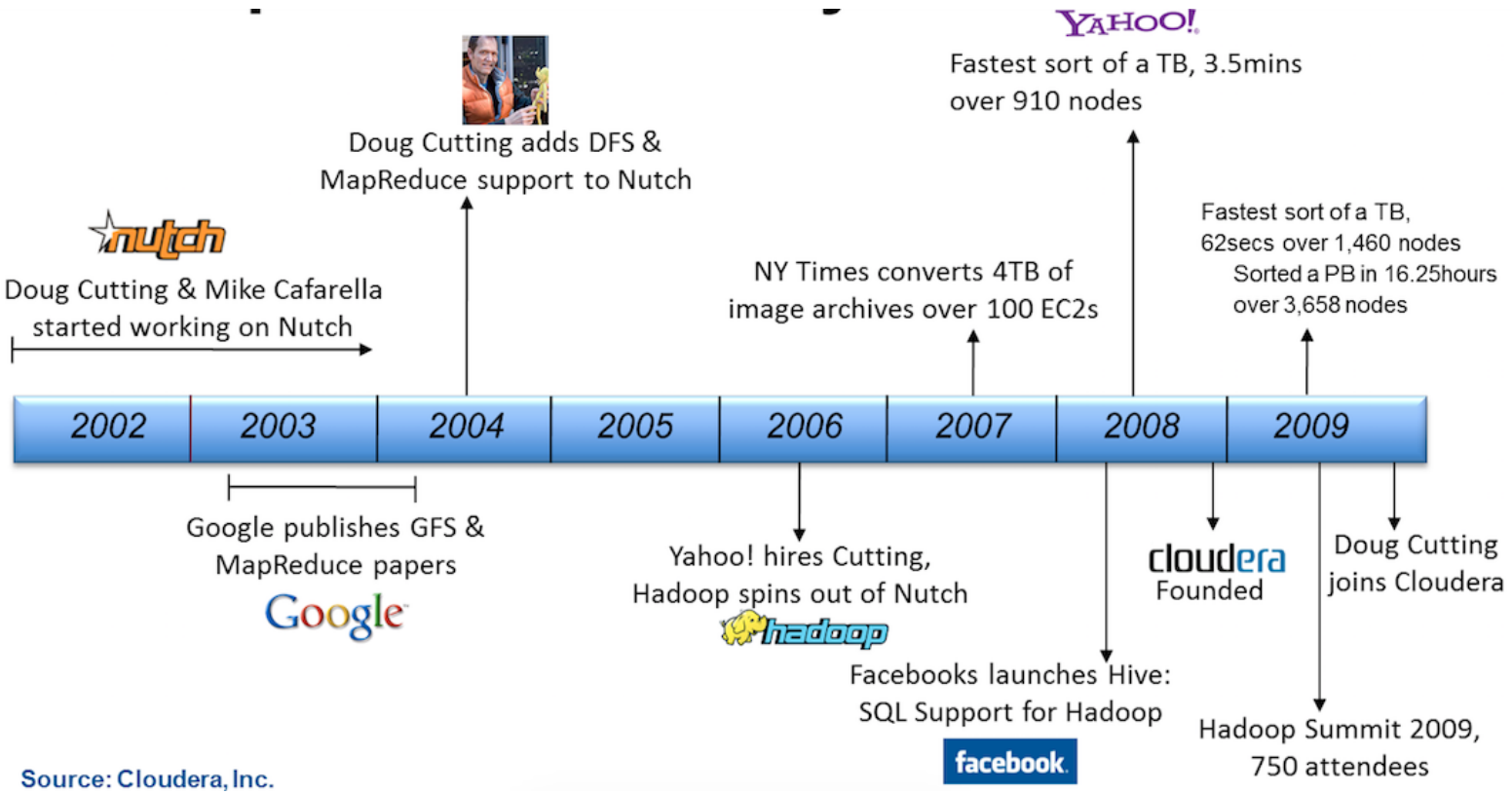
Hadoop characteristics

- Open-source
- Reliable
- Scalable
- Distributed data replication
- Commodity hardware

Hadoop vs RDBMS

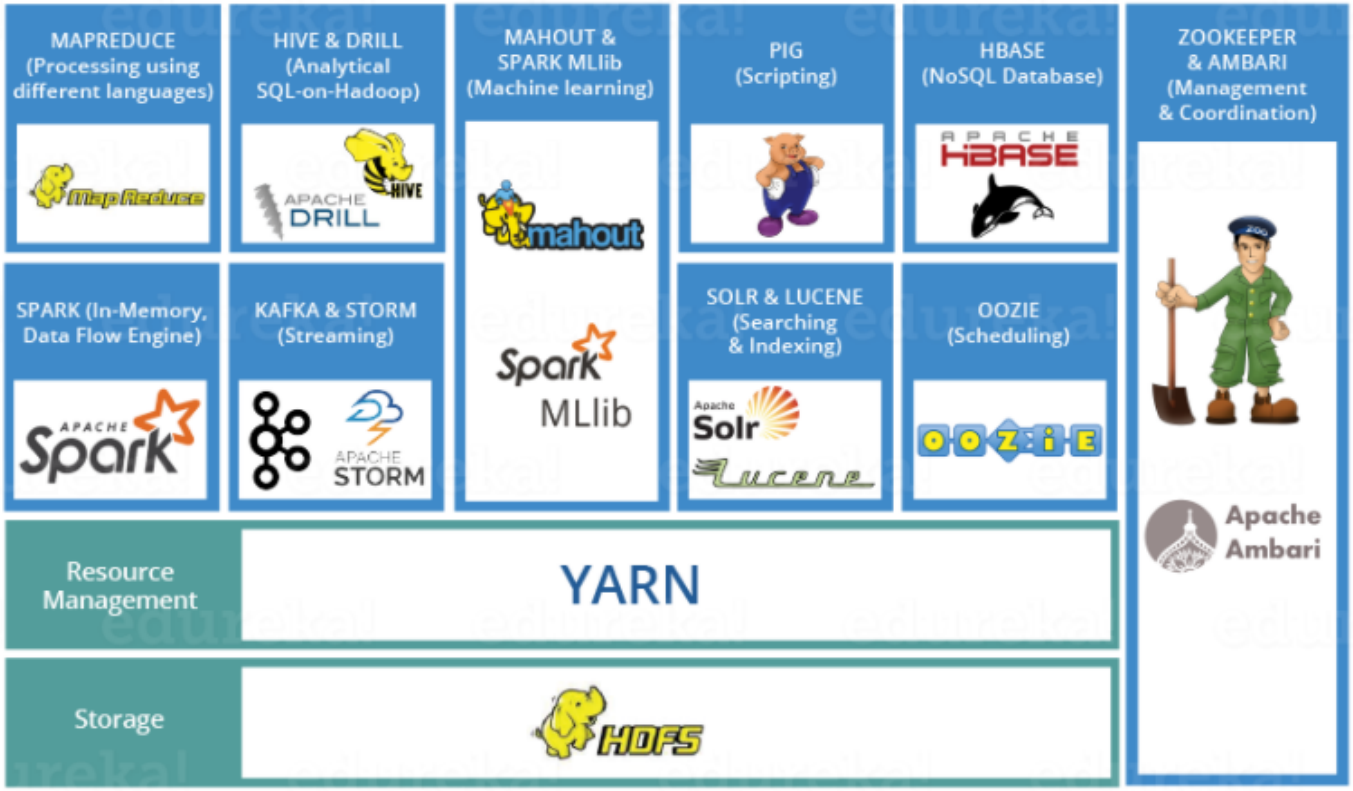
	Traditional RDBMS	MapReduce
Data size	Gigabytes	Petabytes
Access	Interactive and batch	Batch
Updates	Read and write many times	Write once, read many times
Transactions	ACID	None
Structure	Schema-on-write	Schema-on-read
Integrity	High	Low
Scaling	Nonlinear	Linear

Brief History of Hadoop



Source: Cloudera, Inc.

Hadoop Ecosystem



Core Hadoop

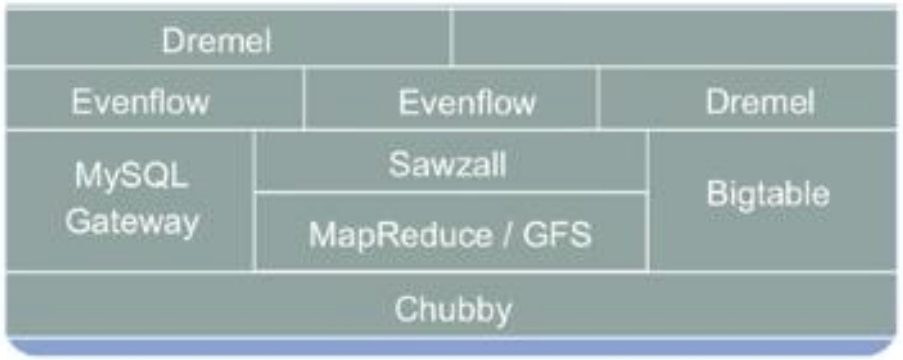
- Core Hadoop components: HDFS, MapReduce, YARN
- HDFS (Hadoop Distributed File System)
  - Provides abstraction on distributed resources
- MapReduce
  - Two functions: map() & reduce()
  - map() performs actions such as filtering, grouping, and sorting
  - reduce() aggregates and summarizes the result produced by map
  - Can be implemented in various programming languages

YARN

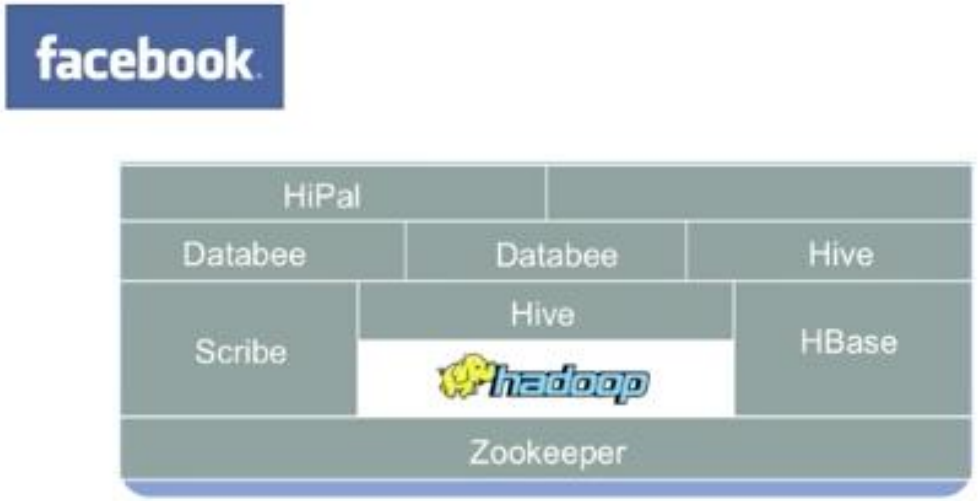
- Introduced in Hadoop 2.0
- Performs all processing activities by allocating resources and scheduling tasks
- Two services: Resource Manager and Node Manager

Original Google Data Stack

Google

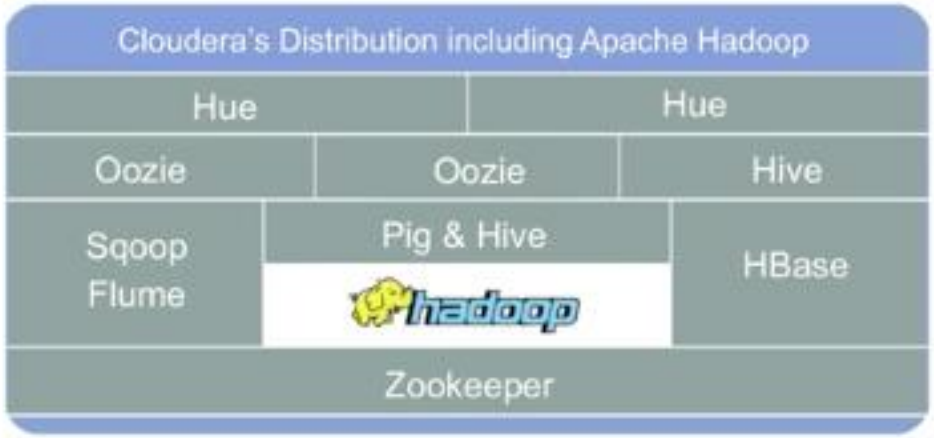


Facebook Stack



Cloudera Stack

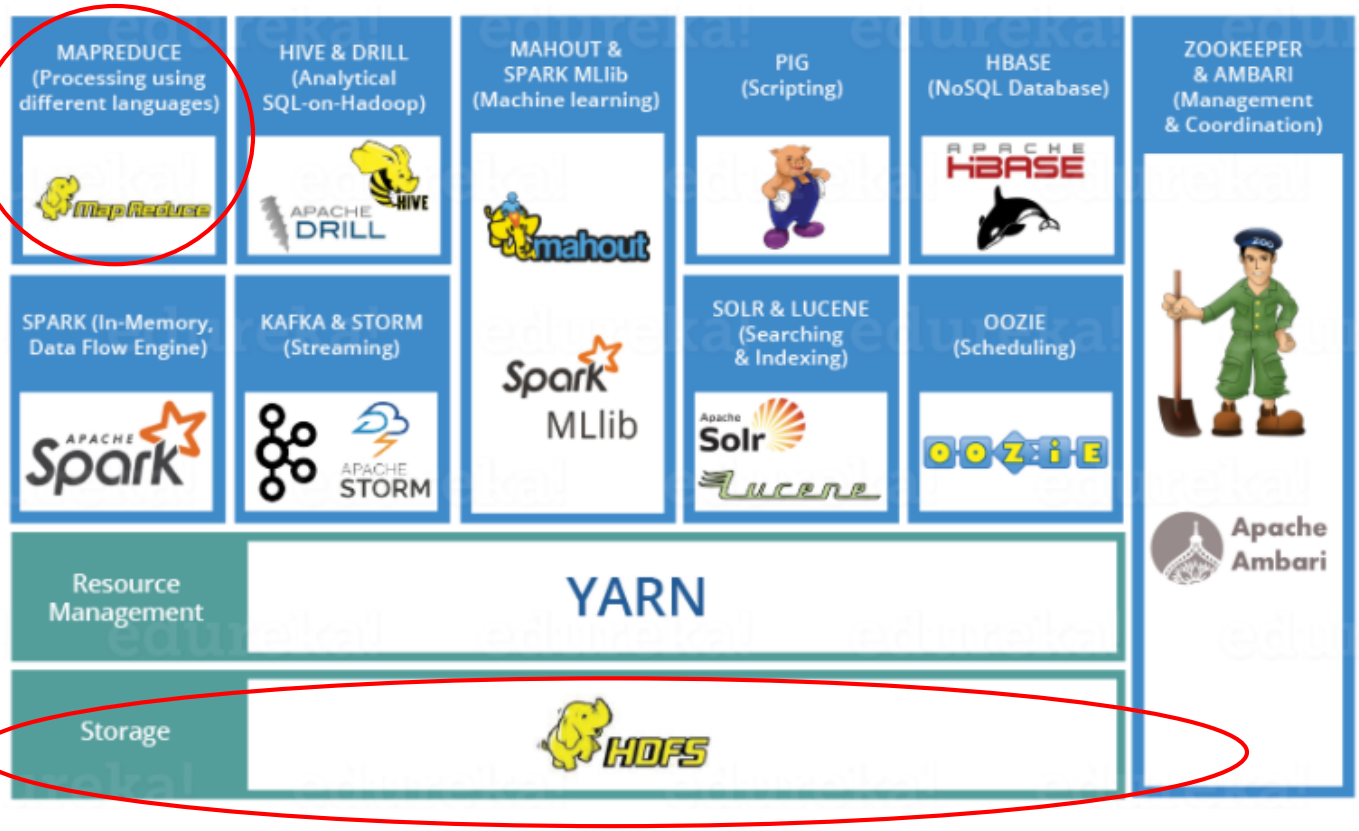
cloudera



Hadoop Core Components

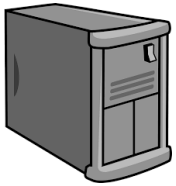
Processing

Storage



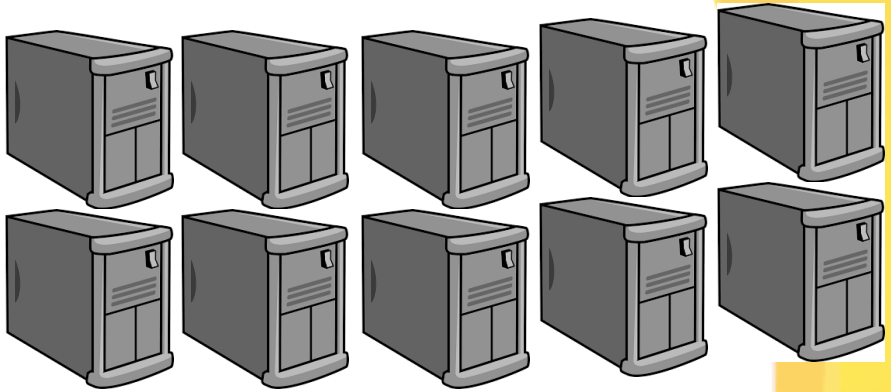
Distributed File System

HDFS (Distributed File System)



1 Machine
4 I/O Channel
Each channel
100 MB/s

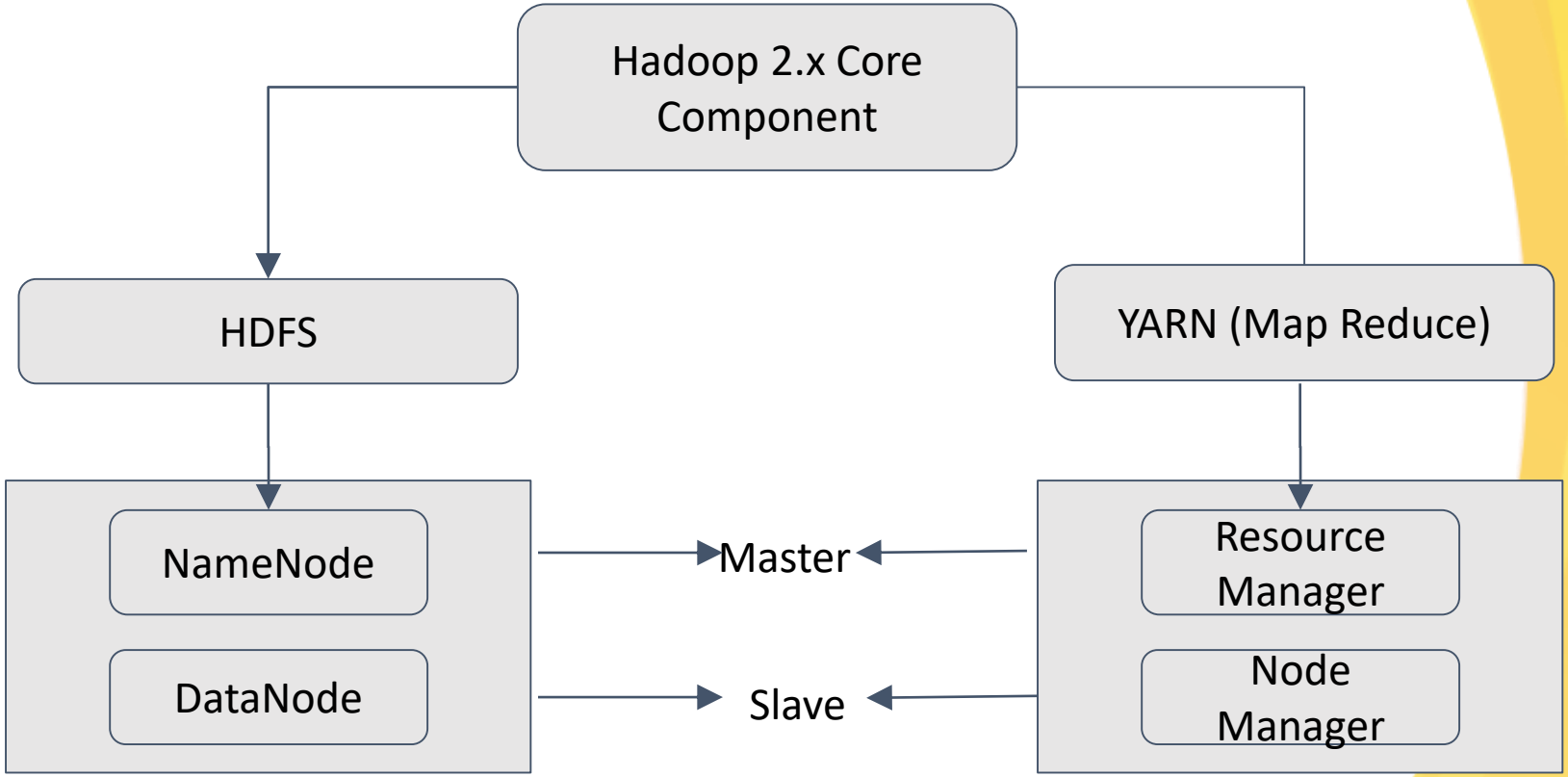
43 minutes



10 Machine
4 I/O Channel
Each channel
100 MB/s

4.3 minutes

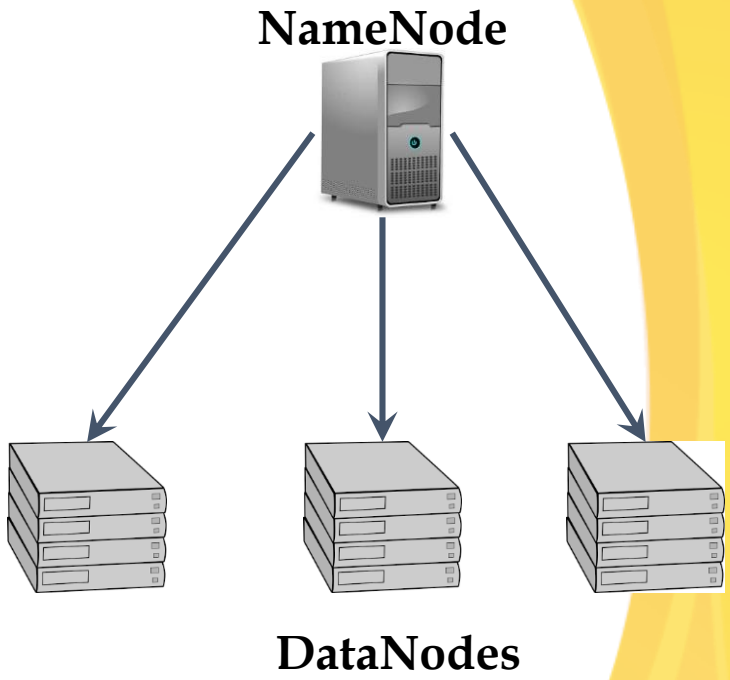
Hadoop 2.x Daemons



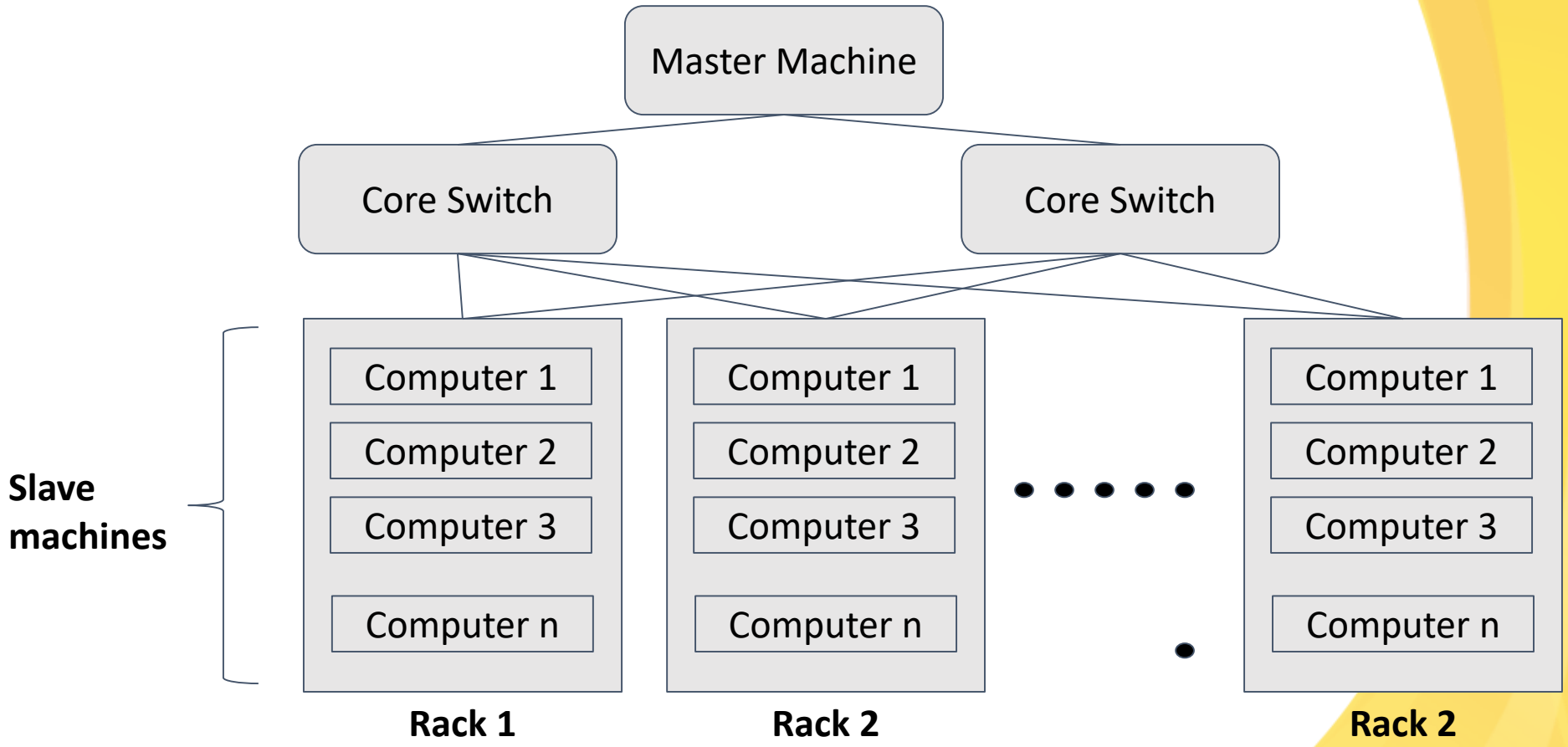
NameNode and DataNode

NameNode:
- Master daemon
- Maintain and manage DataNode
- Records metadata
- Receives heartbeat from DataNode

DataNode:
- Slave daemon
- Stores the actual data
- Serves read and write requests from clients

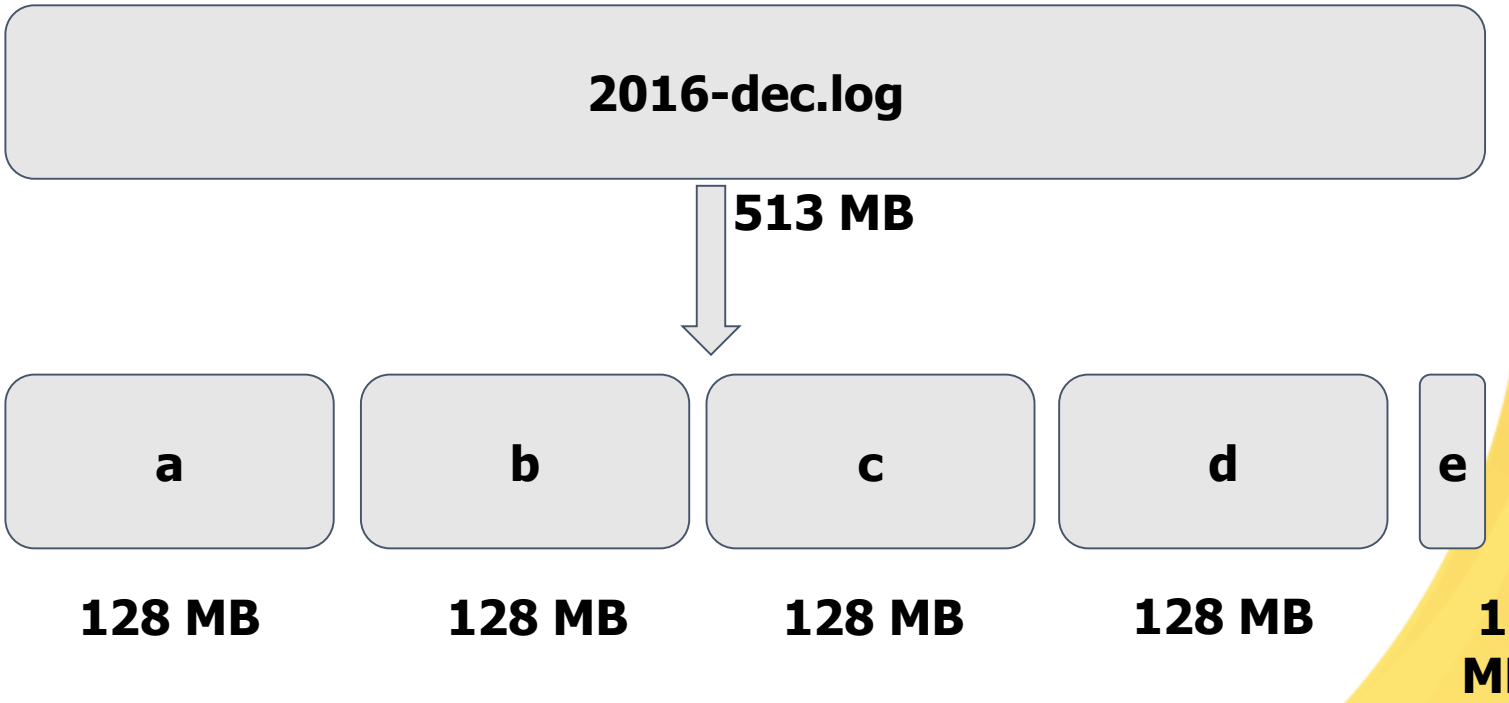


Hadoop Cluster Architecture



HDFS blocks

- File is divided into HDFS blocks (128 MB by default) and duplicated into multiple places



HDFS block

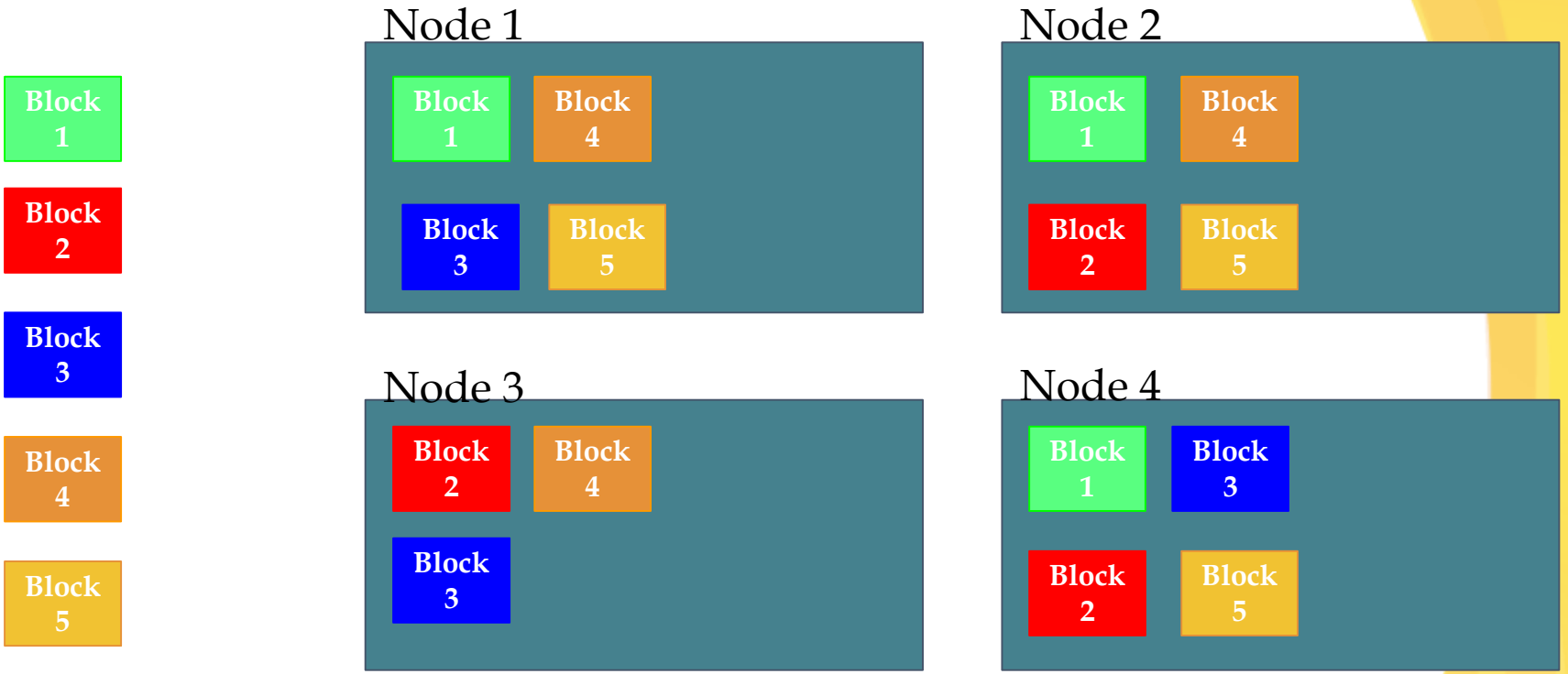
- Why is a block in HDFS so large?

"The reason is to **minimize the cost of seeks**. If the block is large enough, the time it takes to transfer the data from the disk can be significantly longer than the time to seek to the start of the block. Thus, transferring a large file made of multiple blocks operates at the disk transfer rate."

HDFS Blocks

- Let say we have a file with the size of 100 MB :
- Store it in 1 block vs 100 blocks

HDFS Block Replication



Using HDFS

- Command Line/Shell
- UI (e.g. Hue)

References

- Tom White. Hadoop The Definitive Guide 4th ed. O'Reilly. 2015
- https://www.edureka.co/blog/hadoop-tutorial/
- https://www.edureka.co/blog/apache-hadoop-hdfs-architecture/
- Hadoop Big Data Tutorial
- Coursera Big Data
- Hadoop Official Website

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Intro to MapReduce

(credit : Samuel Louvan, Alfan Farizki W., Bayu Distiawan)

Outline

- Motivation - MapReduce
- MapReduce Framework
- MapReduce Flow
- Implementing simple MapReduce programs

The problem

- Big data means :

Lots of data, lots of hard drives

The problem

- Iterate over a large number of records
- Extract something of interest from each
- Shuffle and sort intermediate results
- Aggregate intermediate results
- Generate final output
- Example : Given a very large text data we want to index the words, counting the frequency etc
- Parallelization is difficult

Parallelization Challenges

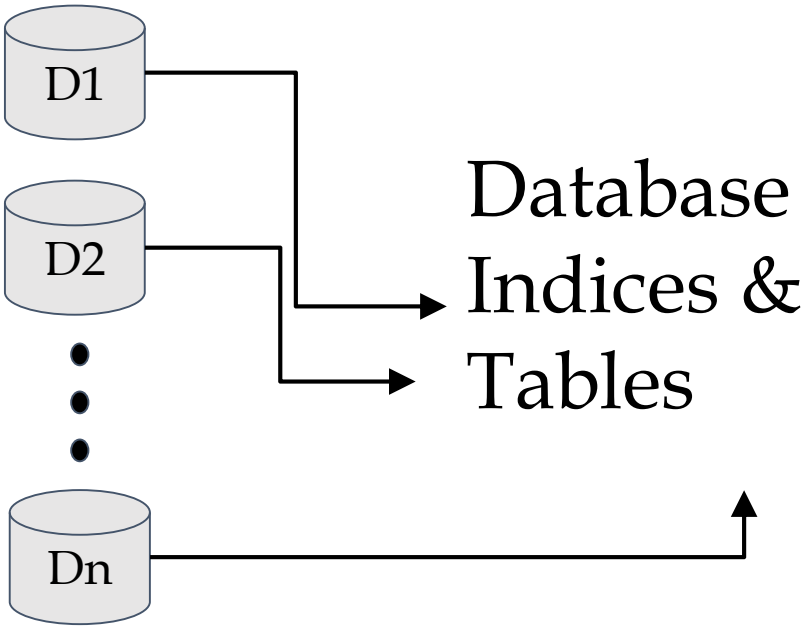
- How do we assign work units to workers?
- What if we have more work units than workers?
- What if workers need to share partial results?
- How do we aggregate partial results?
- How do we know all the workers have finished?
- What if workers die?

The solution

- We should bring computation to data
- Process data sequentially, avoid random access

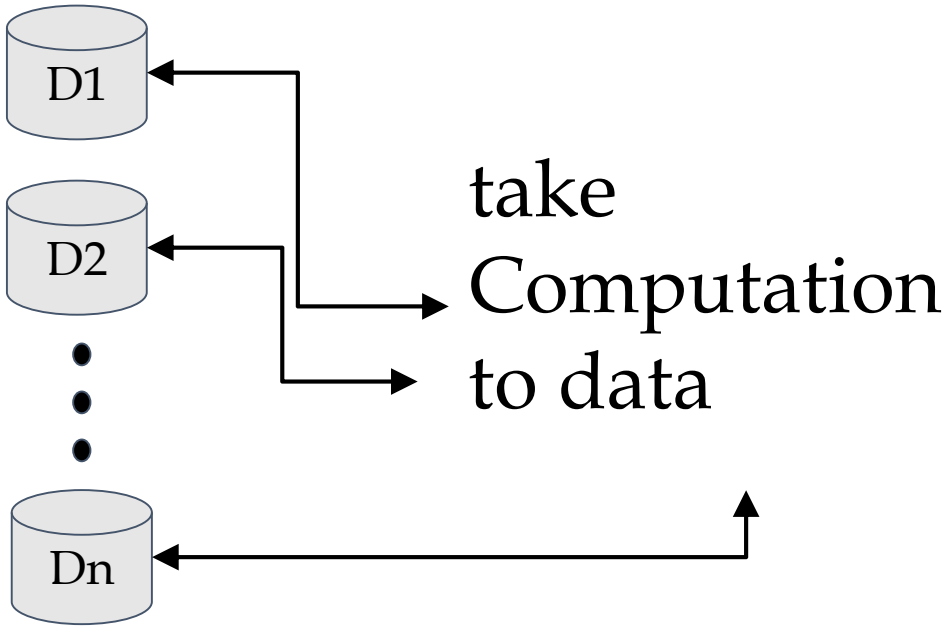
Possibilities when we have “Big Data”

Case 1 : Data needs updating



Possibilities when we have “Big Data”

- Case 2 : need to sweep through data so:



Map Reduce Framework

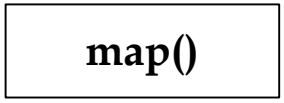
- User defines:
  - <key, value> pair
  - Mapper & Reducer functions
- Hadoop handle the logistics

The logistics

- Hadoop handles the distribution and execution

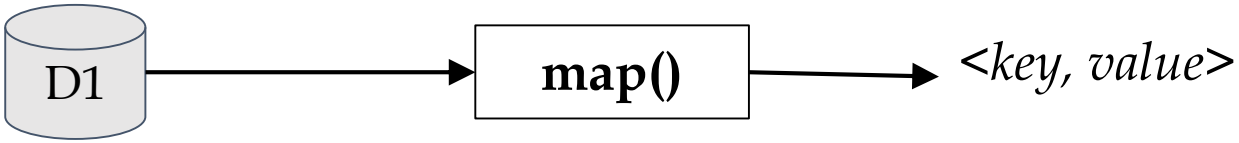
Map Reduce Flow

- User defines a map function



Map Reduce Flow

- map() reads data and outputs <key, value>



Map/Reduce Flow

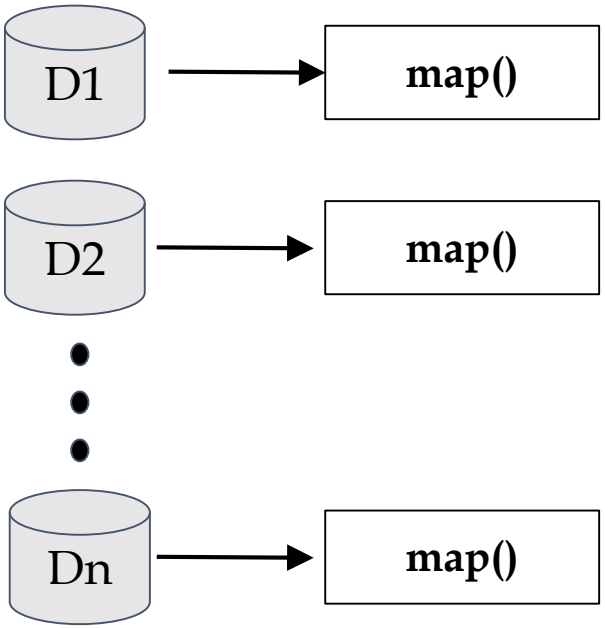
- User defines a reduce function

Map/Reduce Flow

- reduce reads <key, value> and outputs your result

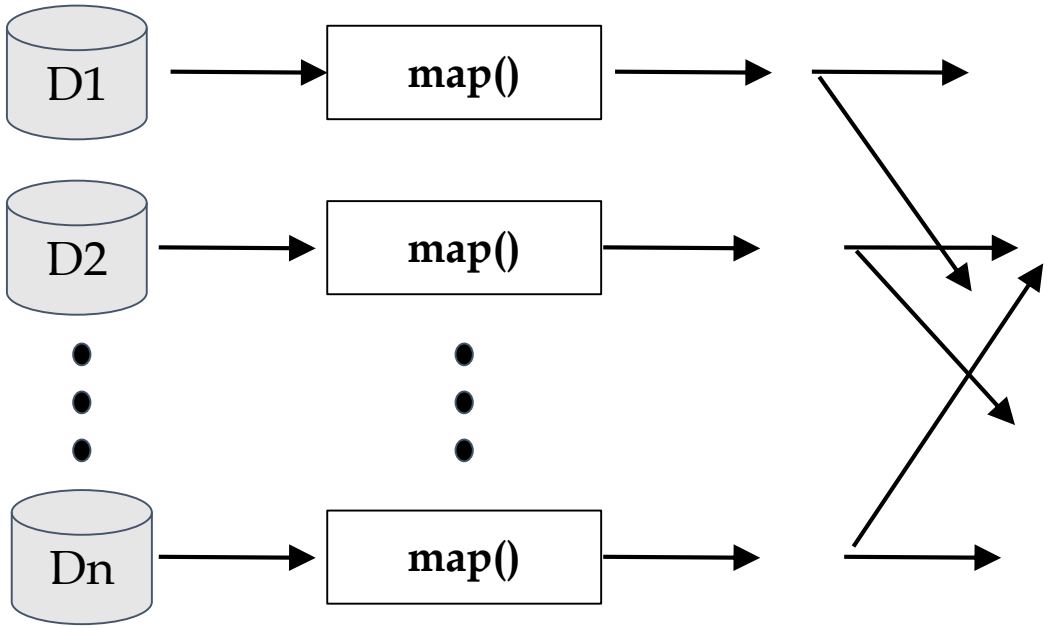
Map/Reduce Flow

- Hadoop distributes map() to data



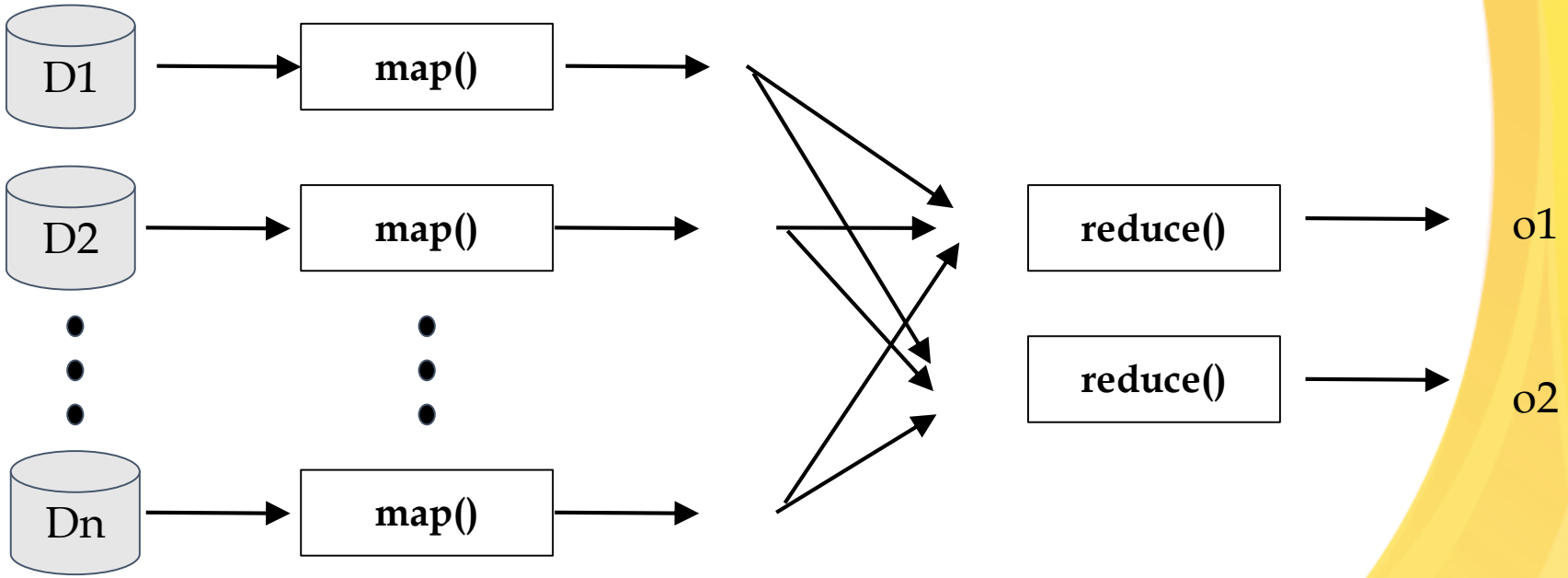
Map/Reduce Flow

- Hadoop groups <key, value> data



Map/Reduce Flow

- Hadoop distributes groups to reducers()



Map/Reduce Example

- "Hello world" : Count word frequencies

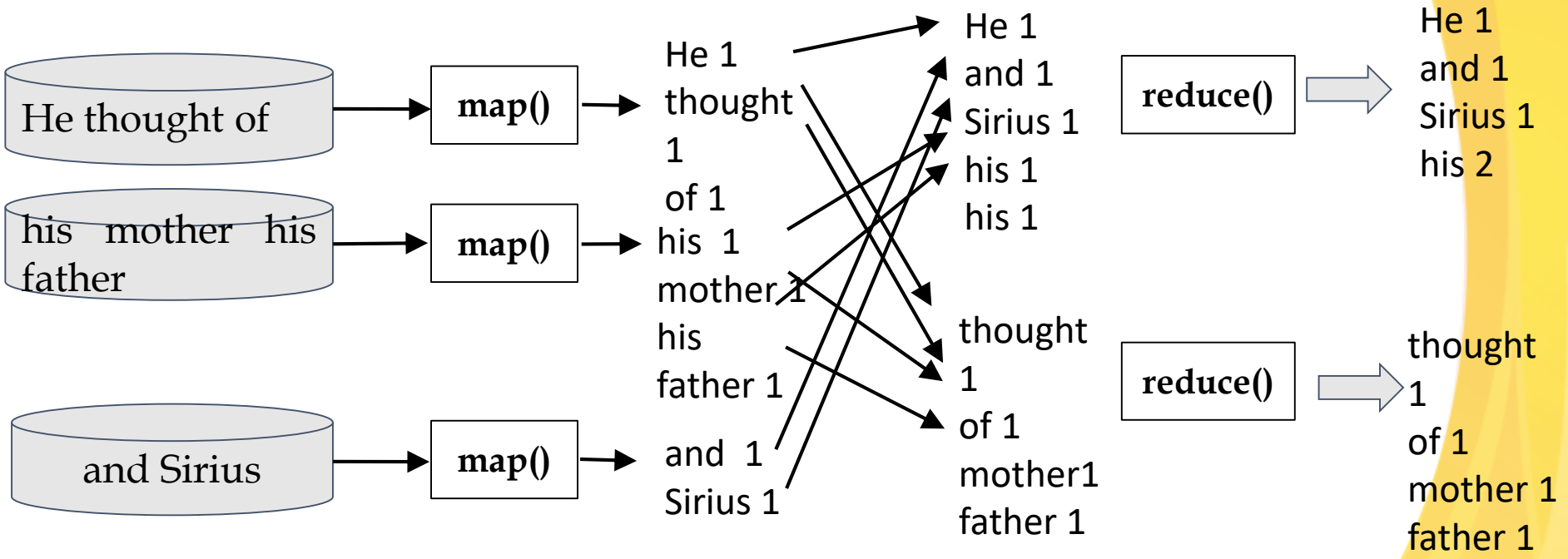
Input

Harry watched Dumbledore striding up and down in front of him, and thought. He thought of his mother, his father and Sirius. He thought of Cedric Diggory. .....

Output

Harry 1
He 2
Watched 1
Dumbledore 1
…
…

Putting it all together



References

- Tom White. Hadoop The Definitive Guide 4th ed. O'Reilly. 2015
- MapReduce Tutorial @ Edureka
- Hadoop Big Data Tutorial
- Coursera Big Data
- Hadoop Official Website

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