Big Data, Hadoop, MapReduce

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NoSQL Data Modeling and Management

1.1 NoSQL Concepts and Characteristics

1.2 Major Categories of NoSQL Data Models

1.3 NoSQL Features and Operations

1.4 ElasticSearch

NOSQL CONCEPTS AND CHARACTERISTICS

What is NoSQL?

NoSQL is a term that refers to a specific type of database model or database management system (DBMS).

The term NoSQL is very broad, not referring to a specific database model. It refers to a whole different models that have as main feature not fitting the relational model.

Many argue that the only thing all NoSQL databases have in common is that they do not follow the relational model. "NoREL" would be a more appropriate name.

One of the main reasons why the NoSQL approach started to be adopted was because of the big data arrival.

NOSQL CONCEPTS AND CHARACTERISTICS

Characteristics of a NoSQL Database

Non Relational
The most common situation occurs where data is unstructured or semi-structured.

Open Source
Open source is not necessarily a "NoSQL requirement", but it's a "NoSQL observation."

No Schema
In DBMS relational modeling we always have to consider the modeling effort before entering any data.

Scalable horizontally
Most NoSQL databases have excellent behavior in cluster environments.

Do not follow the principles of ACID

Without a standard query language.

Not all NoSQL databases have these features.
However, most of these features are inherently non-existent in relational databases.

MAJOR CATEGORIES OF NOSQL DATA MODELS

Key-value stores

Store data together as columns instead of rows and are optimized for queries over large datasets

Graph databases

Are used to store information about networks, such as social connections

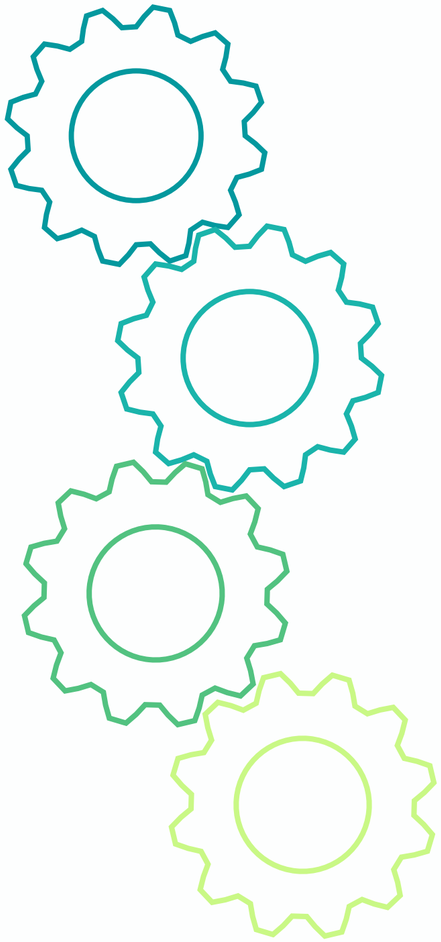
Wide-column stores

Are the simplest. Every item in the database is stored as an attribute name (or "key") together with its value.

Document databases

Pair each key with a complex data structure known as a document.

NOSQL FEATURES AND OPERATIONS



01 DYNAMIC SCHEMAS

insert the data without the predefined schema

02 AUTO-SHARDING

automatically spread data across a various number of servers

03 REPLICATION

sophisticated NoSQL databases provide automated recovery and are fully self- healing

04 INTEGRATED CACHING

keep frequently used data in system memory and remove the need for the separate caching layer

05 SIMPLE API

offers interfaces that are easy to use for storing and querying data

ELASTIC SEARCH: DEFINITION

Search engine and data analysis

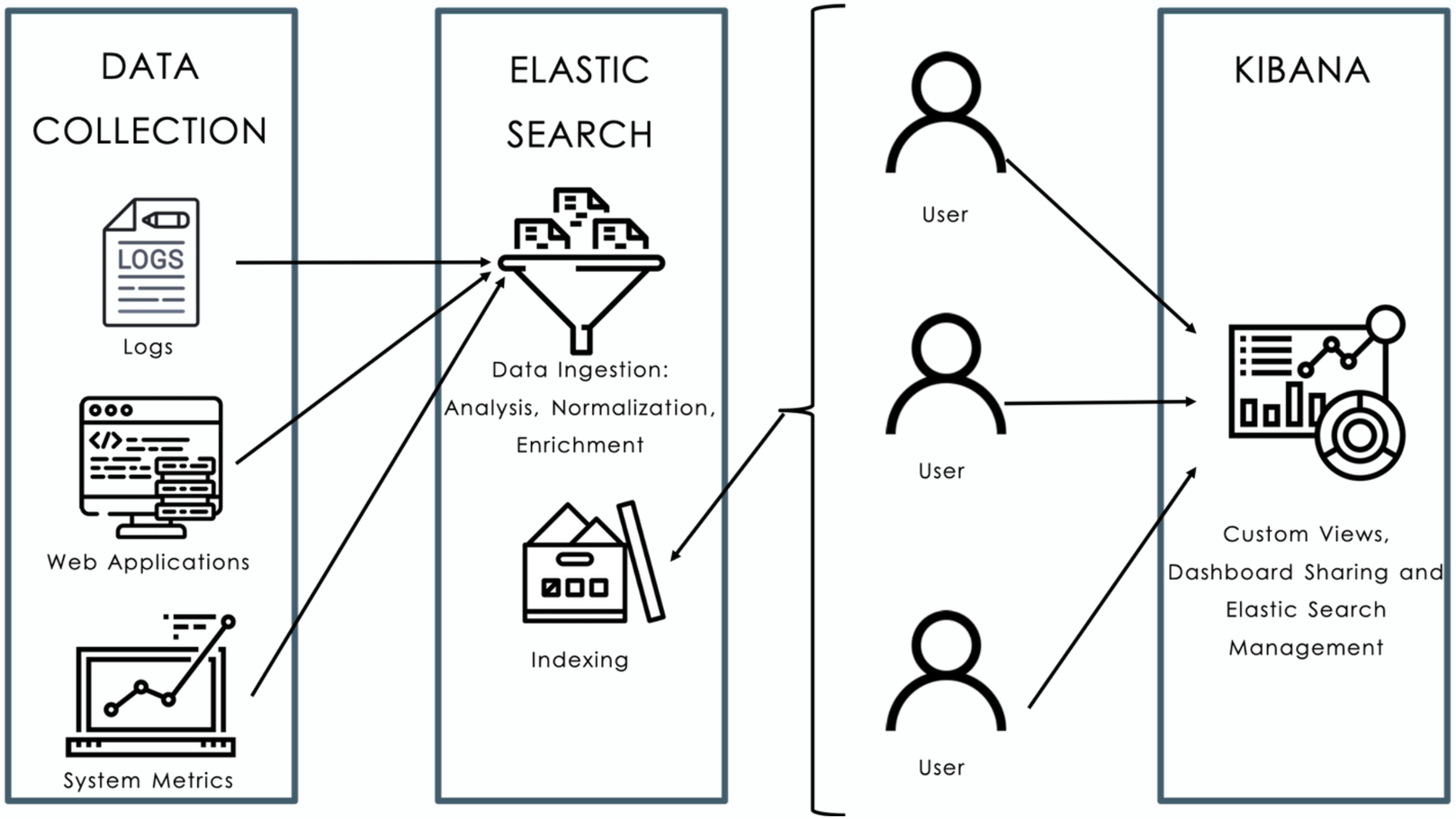
Known for its distributed speed and scalability

Includes several programming languages and 34 idioms

Is open source and accepts all types of data

Collects raw data from various sources for later processing and analysis

HOW DOES ELASTIC SEARCH OPERATES



ELASTIC SEARCH: PRACTICAL APPLICATIONS

Search in application	Business Search	Logging and analysis of log data
Search in website	Business Data Analysis	Application Performance Monitoring
Safety Analysis	Analysis and Visualization of geospacial data	Infrastructure metrics and container monitoring

REASONS TO USE ELASTIC SEARCH

1 SPEED

Is a nearly real-time search platform, meaning that the latency from the moment a document is indexed until it becomes searchable is very small - usually one second.

2 FACTORY DISTRIBUTION

Documents stored on Elasticsearch are distributed in various containers known as shards, which are replicated to provide backup copies of data in case of hardware failure

3 EXTENSIVE SET OF RESOURCES

In addition to speed, scalability, and resiliency, Elasticsearch has several integrated advanced features that make data storage and search even more efficient, such as data rollups and index lifecycle management.

4 SIMPLIFIES DATA INGESTION, VISUALIZATION AND REPORTING

Integration with Beats and Logstash makes it easier to process data before indexing on Elasticsearch. And Kibana provides real-time visualization of the data.

2

Large Scale Data Handling

2.1 Big Data Characteristics

2.2 Big Data Modeling and Management

2.3 MapReduce

2.4 Hadoop

BIG DATA CONCEPT

The concept of Big Data remains so far a relative term with regard to the boundary between what is and is not considered Big Data. For a company such as Google, the concept and size of Big Data is much different from that assumed for a medium-sized company.

The most accepted definition was given by Douglas Laney. Laney observed that Big Data grew in three different dimensions:

Volume

Velocity

Variety

However, other authors have crossed these characteristics by adding several other V's to this definition, such as: Value, Veracity, Visualization, Viscosity, Virality, among others. The 4th most consensual V's is undoubtedly the **veracity**.

BIG DATA CHARACTERISTICS

VOLUME

The volume of data gives the large amount of data, mostly described in several petabytes or even more. However, not even this definition is consensual among the authors, since the definition depends on the type of data being analyzed.

VELOCITY

The velocity concerns both the rate of data generation and the speed of analysis they require. Big Data Velocity deals with the speed at which data flows in from sources.

VARIETY

The variety of data has increased exponentially due to the diversity of collection sources. Data can have several organizations and reach the collection point in a structured, semi-structured or even unstructured way. In addition, data formats must be taken into account.

VERACITY

Veracity encompasses the reliability inherent in some sources of data collection. For example, information taken from a social network cannot be given the same relevance as information taken from hospital software.

BIG DATA MODELING

Why Is Data Modeling Necessary?

Large amounts of data imply a system or method to keep everything in order. The process of sorting and storing data is called "data modeling". A data model is a method by which we can organize and store data.

Proper models and storage environments offer the following benefits to large data:

- **Performance**: Ensures fast query and reduces I/O output.
- **Cost**: Significantly reduces data redundancy, reducing storage and computing costs for the large data system.
- **Efficiency**: They greatly improve the user experience as well as the efficiency of data use.
- **Quality**: They make data statistics more consistent and reduce the possibility of computing errors.

6 TIPS FOR MODELING BIG DATA

01 DON'T IMPOSE TRADITIONAL MODELING

02 DESIGN A SYSTEM, NOT A SCHEMA

03 LOOK FOR BIG DATA MODELING TOOLS

04 FOCUS ON DATA THAT IS CORE TO YOUR BUSINESS

05 DELIVER QUALITY DATA

06 LOOK FOR KEY INROADS INTO THE DATA

BIG DATA MANAGEMENT

Big Data Management is a set of practices that promotes the collection, organization, administration and interpretation of large volumes of data.

The main objective is to treat the contents so that they become accessible and reliable.There are 4 terms that are essential to the definition of this method:

Adequacy

Integration

Migration

Management

BIG DATA MANAGEMENT

Adequacy

Ability to analyze a large amount of information, structured or not, allows the detection and correction of errors in stored information

Integration

Ability to filter and classify data so that it can later be handled assuming a standardized structure.

Migration

Ability to move data from one environment to another quickly and conveniently.

Management

Ensure the availability and security of data, ensuring that it follows all the organization's policies and standards.

BIG DATA MANAGEMENT: ADVANTAGES

Increase in company revenue

More accurate decision making

Strategy improvement

Team productivity and efficiency

DATA WAREHOUSE VS DATA LAKE

Processed, Structured	**DATA**	Structured, Semi-Structures, unstructured, raw
Schema on write	**PROCESSING**	Schema on read
Expensive for large data volumes	**STORAGE**	Design for low cost storage
Fixed Configuration	**AGILITY**	Configure/Reconfigure as necessary
Business Professional	**SECURITY**	Data Scientists/Analysts

3

Practice

3.1 Hadoop Ecosystem

3.2 MapReduce & Hadoop

3.3 Word Count Practice

3.4 Challenge

HADOOP: ECOSYSTEM

hadoop

APACHE Spark

Apache Pig

mahout

HIVE

kafka

APACHE Spark Streaming

- Drill
- Zookeeper
- Ambari
- Hbase
- Solr
- Lucene
- Storm

Yarn
(Resource Manager)

hadoop YARN

HDFS
(Storage System)

hadoop HDFS

Unstructured Data

FLUME

sqoop

Relational Data

MAP REDUCE

MapReduce is a **programming paradigm** that allows massive scalability across hundreds of thousands of servers in a Hadoop CLuster.

Map Reduce is **THE HEART OF HADOOP**

MAP

Takes a dataset in its raw form and converts in into another dataset, where individual elements are broken into tupples (key/value pairs)

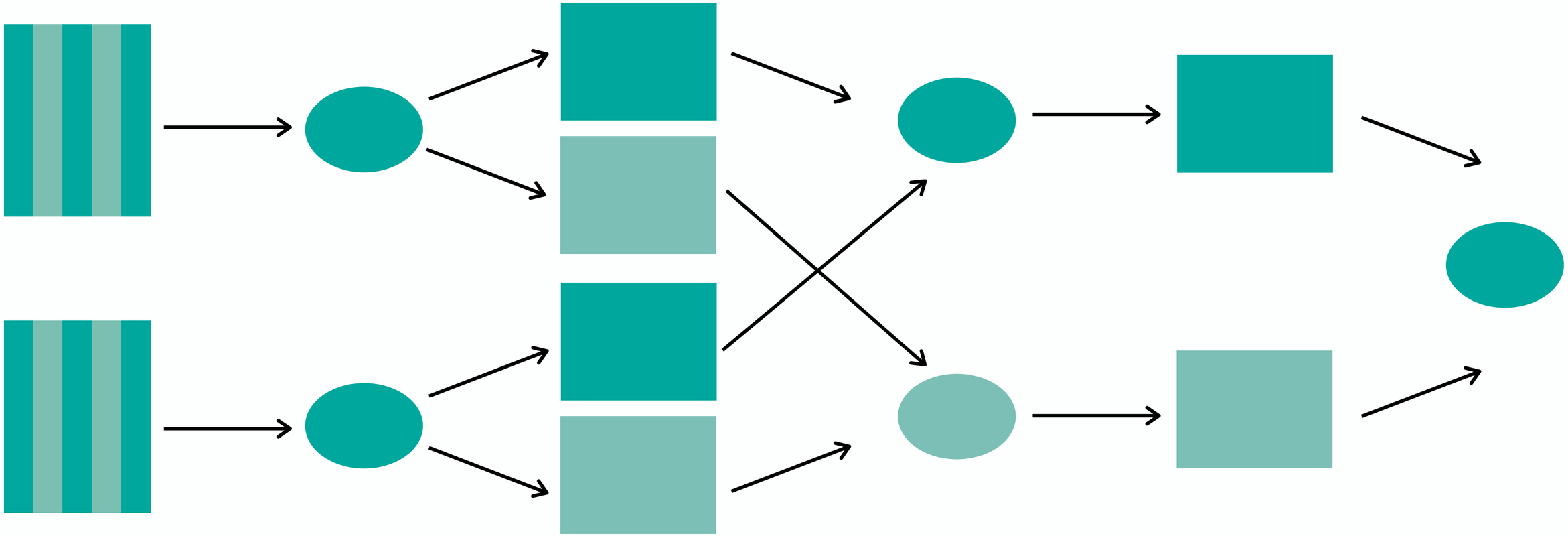
REDUCE

Takes the Map process output and combine the dara tuples into a small set of tuples

MAP REDUCE: CHARACTERISTICS

- Scalable
- Fault-tolerant
- High availability
- Reliable
- Works on the key value concept
- No traffic congestion in the network

MAP REDUCE: HOW IT WORKS



MAP ()

SHUFFLE ()

REDUCE ()

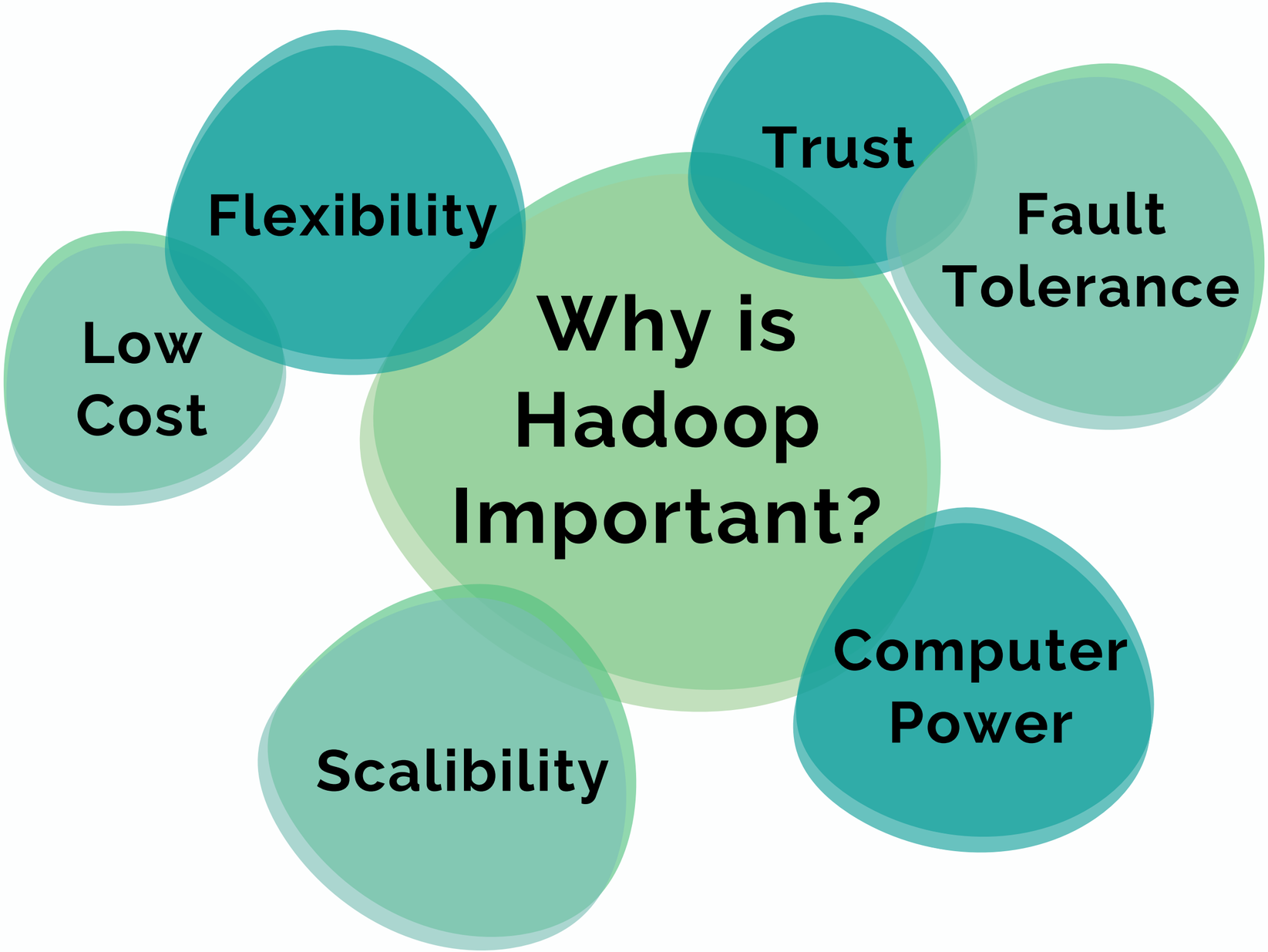
HADOOP

Hadoop is open source software that can handle both the storage and processing of large amounts of data, in a distributed way, using clusters of computers with commodity hardware.

WITH HADOOP, NO DATA IS TOO BIG.

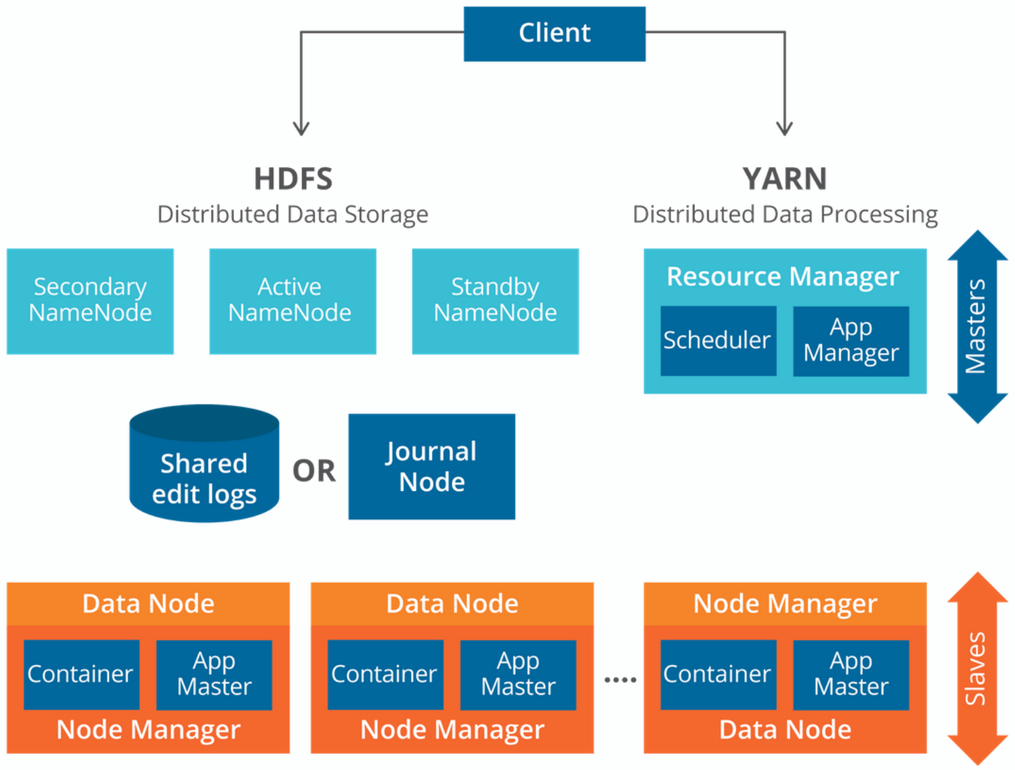
Curiosity: "Hadoop" was the name one of the creator's sons, Doug Cutting, gave his stuffed elephant.

HADOOP IMPORTANCE



HADOOP

Apache Hadoop 2.0 and YARN



HADOOP DISTRIBUTED FILE SYSTEM

HDFS is the basis of Hadoop and is therefore the most important component of the ecosystem. It is a Java software that offers features such as scalability, high availability, fault tolerance, cost-benefit, etc. It provides a distributed and robust data storage.
This component is composed by 3 other essential subcomponents:
- DataNode
- NameNode
- Secondary NameNode

HDFS: MAIN COMMANDS

It is a different file system from the patterns we see, for example in linux

Differentiated access (no direct compatibility)

There is some similarity between commands and it is possible to share files between the two

HDFS: MAIN COMMANDS

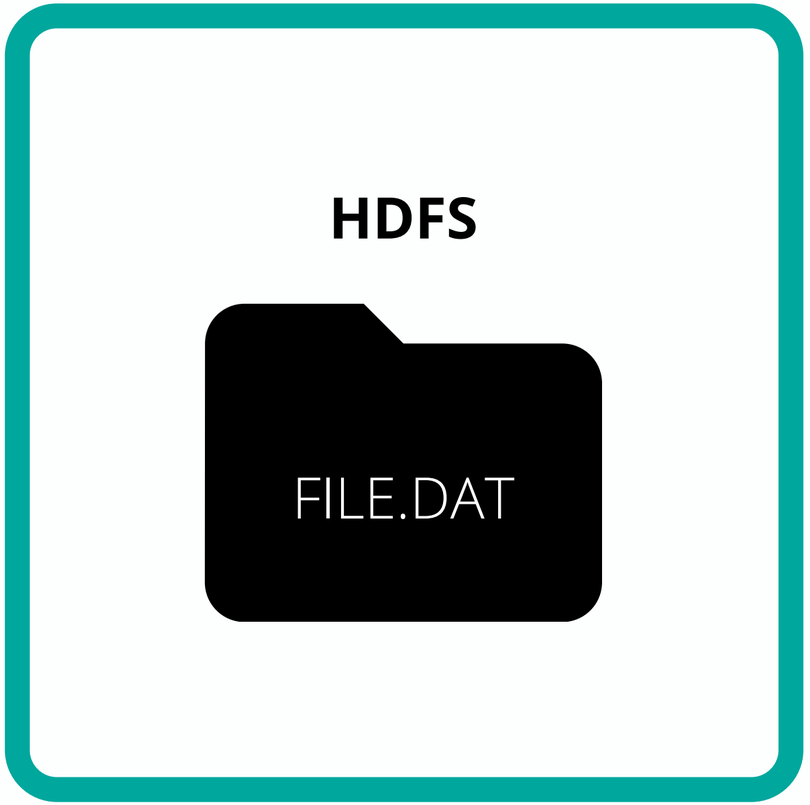
Command	Description	Parameters	Example
-ls	List the content of the board	-d simple list -r recursivE	hdfs dsf -ls -R /
-put	Copy the file from the local system to the HDFS		hdfs dfs -put name.txt /diretoria/name2.txt
-mv	Moves the file or directory from the local system to the HDFS		hdfs dfs -mv name.txt /user
-rm	Remove the file or folder	-r excludes in a recursive way	hdfs dfs -rm /user/name.txt

HDFS: MAIN COMMANDS

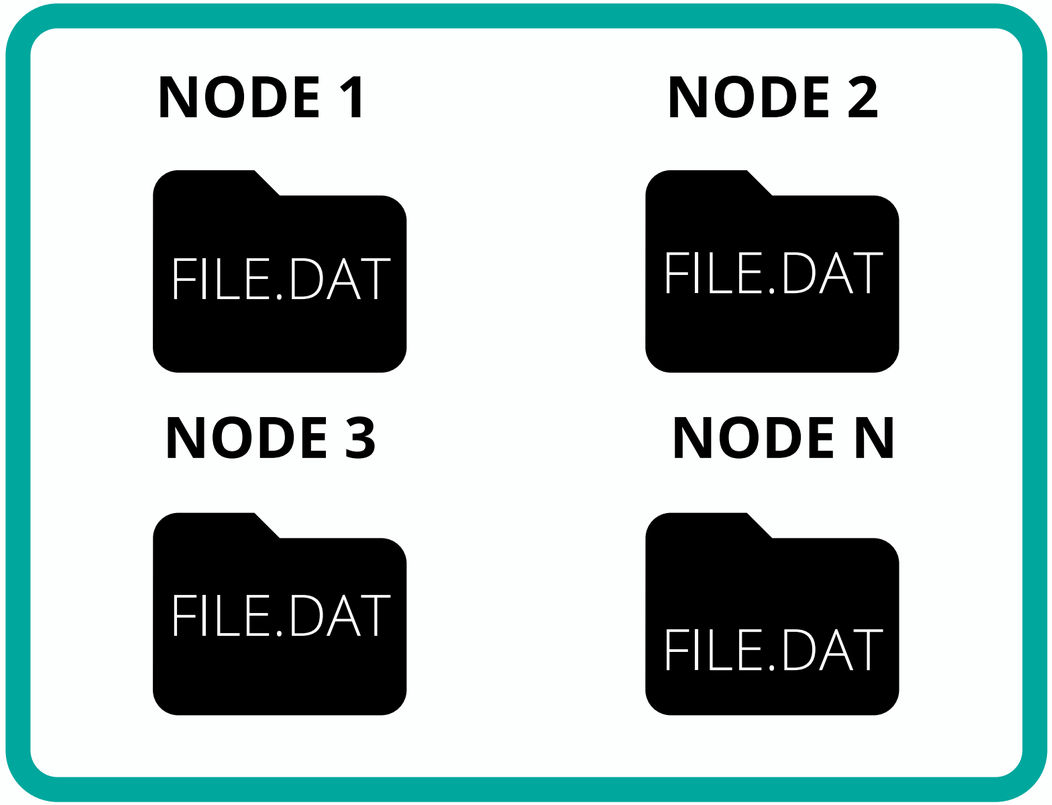
Command	Description	Parameters	Example
-du	Check file size		hdfs dsf -du /user/name.txt
-cat	Displays the contents of the file		hdfs dfs -cat name.txt
-mkdir	Create a folder	-p Creates a path	hdfs dfs -mkdir /user/diretoria
-tail	Shows the end of the file		hdfs dfs -tail /user/name.txt

HDFS: ARRANGEMENT

WHAT WE SEE



WHAT IT REALLY IS



HDFS: FILE TYPES

Text:

Standard in tools such as HIVE

ORC:

Optimized for columns and rows (the favorite of the whole ecosystem).

Parquet:

Column oriented (Binary)

Sequence File:

Key-value
Can be easily divided or unified

AVRO:

Binary format for serialization. Very useful for data exchange

RC:

Column oriented, key-value.

HADOOP DISTRIBUTION

IN WHAT WAYS CAN WE IMPLEMENT THIS TECHNOLOGY?

- Open source distribution, provided by Apache
- Distributed by third parties:
  - Includes the open souce tool + add-ons
  - Possible support offer
  - Free version with limited number of us.

Cloudera
53%

HortonWorks
16%

MapR
11%

IMPLEMENTATION: NEEDS

- **Virtual Box (Oracle, VMWare, Docker,...):** https://www.virtualbox.org/wiki/Downloads
- **Cloudera Image :** https://www.cloudera.com/downloads/cdp-private-cloud-trial.html
- Hadoop.zip :
  - search.txt
  - WordCount.java (Class)

VirtualBox cloudera

PROBLEM 1: STATEMENT

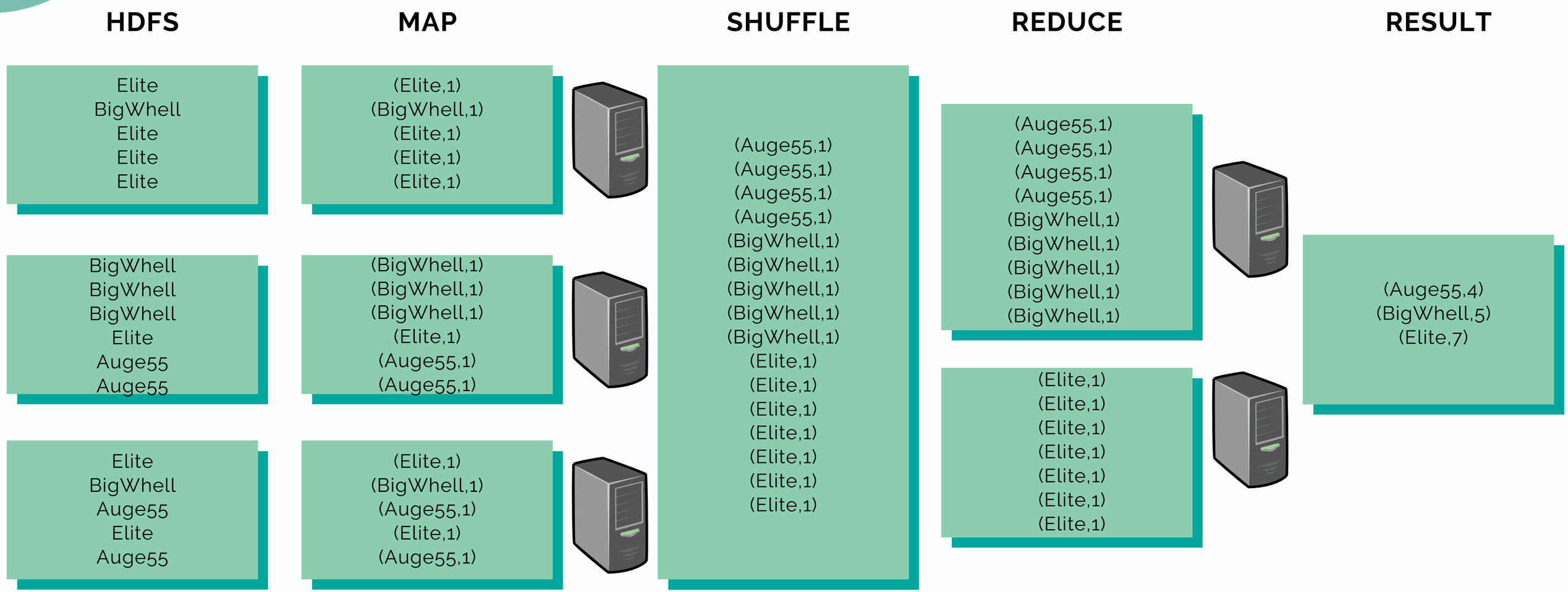
Batch

A bicycle producer wants to know which model is most sought after

The producer has a website where in the search field he always keeps the model that the user searches for

Let's take the word file in its raw point and, using Hadoop count how many times each template was searched

UNDERSTANDING THE EXERCISE



PROBLEM 1: NEEDS

```
Auge555
Auge555
StradaRacing
StradaRacing
Auge555
Elite
Auge555
Auge555
Auge555
StradaRacing
StradaRacing
StradaRacing
AudaxVentus
AudaxVentus
SL429F
SL429F
AudaxVentus
AudaxVentus
Elite
Elite
```

Raw File

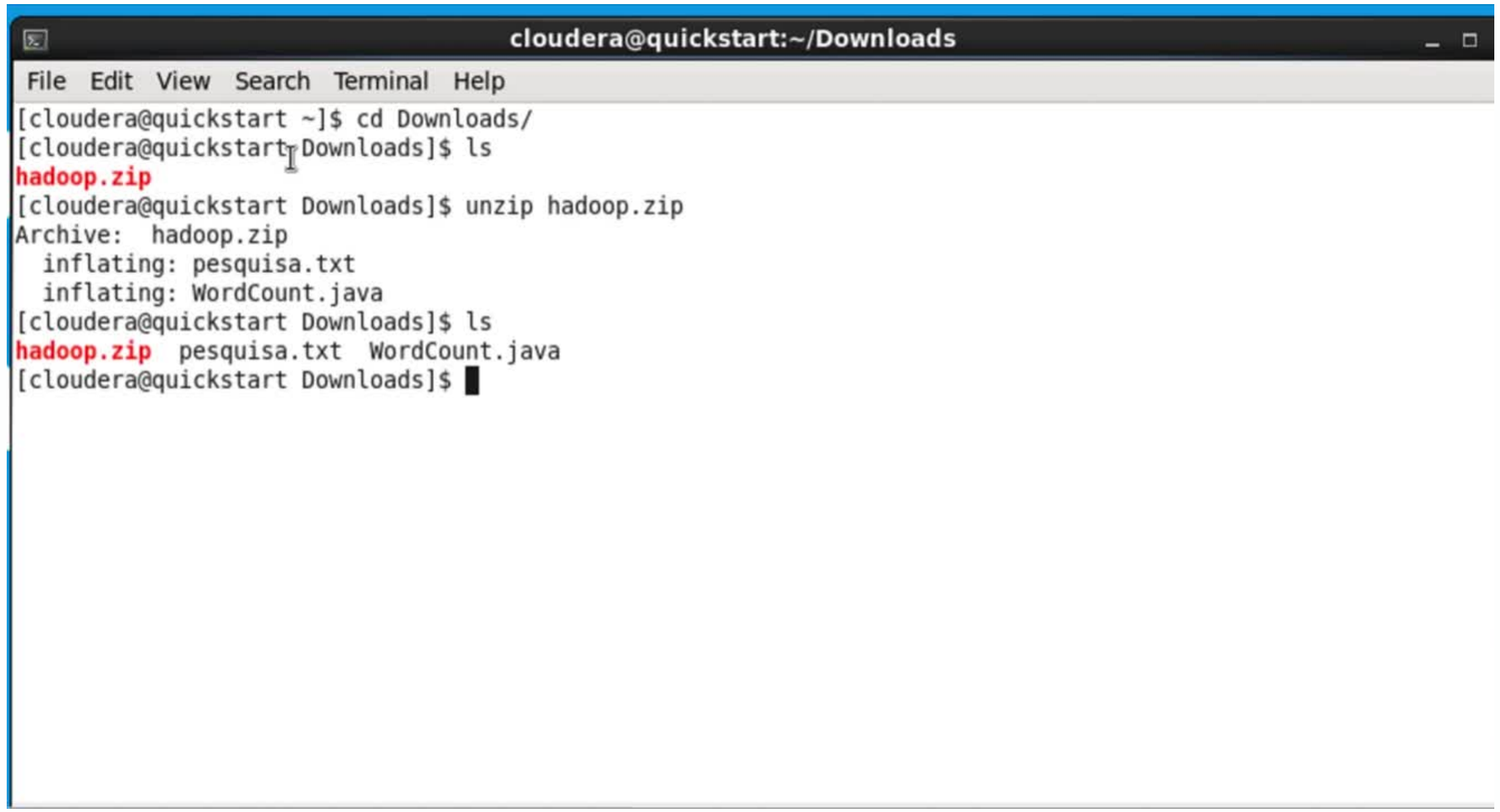
WordCount.java

```java
package PackageDemo;

import ...


public class WordCount {

    public static void main(String [] args) throws Exception
    {
    Configuration c=new Configuration();
    String[] files=new GenericOptionsParser(c,args).getRemainingArgs();
    Path input=new Path(files[0]);
    Path output=new Path(files[1]);
    Job j=new Job(c,"wordcount");
    j.setJarByClass(WordCount.class);
    j.setMapperClass(MapForWordCount.class);
    j.setReducerClass(ReduceForWordCount.class);
    j.setOutputKeyClass(Text.class);
    j.setOutputValueClass(IntWritable.class);
    FileInputFormat.addInputPath(j, input);
    FileOutputFormat.setOutputPath(j, output);
    System.exit(j.waitForCompletion(true)?0:1);
```

JAVA Compiler

PHASE 1

- hdfs dfs -mkdir /count/
- hdfs dfs -ls /
- hdfs dfs -put /home/cloudera/Downloads/pesquisa.txt /count/search.txt



PHASE 2


VirtualBox Arquivo Máquina Janela Ajuda
sáb 12:32 Regina Sousa
Oracle VM VirtualBox Gerenciador
Ferramentas
Novo
Configurações
Descartar
Exibir (h)
cloudera-quickstart-...
Executando
Geral
Nome: cloudera-quickstart-vm-5.4.2-0-virtualbox
Sistema Operacional: Red Hat (64-bit)
Sistema
Memória Principal: 7403 MB
Processadores: 3
Ordem de Boot: Disco Rígido, Óptico
Aceleração: VT-x/AMD-V, Paginação Aninhada, PAE/NX
Pré-Visualização
cloudera
Tela
Memória de Vídeo: 8 MB
Fator de Escala: 3.00
Controladora Gráfica: VBoxVGA
Servidor de Desktop Remoto: Desabilitado
Gravação: Desabilitado
Armazenamento
Controladora: IDE Controller
IDE Primário Master: cloudera-quickstart-vm-5.4.2-0-virtualbox-disk1.vdi (Normal, 64,00 GB)
IDE Secundário Master: [Disco Óptico] VBoxGuestAdditions.iso (58,16 MB)
MAQUINAS
Sem título.pdf
original-2
OutrosProjetos
BOSCH
SENSORS
Aula.docx
Fotos para imprimir
VirtualBox
Cloudera
VirtualBox
AIDA 2
AP
Doutoramento2

PHASE 3

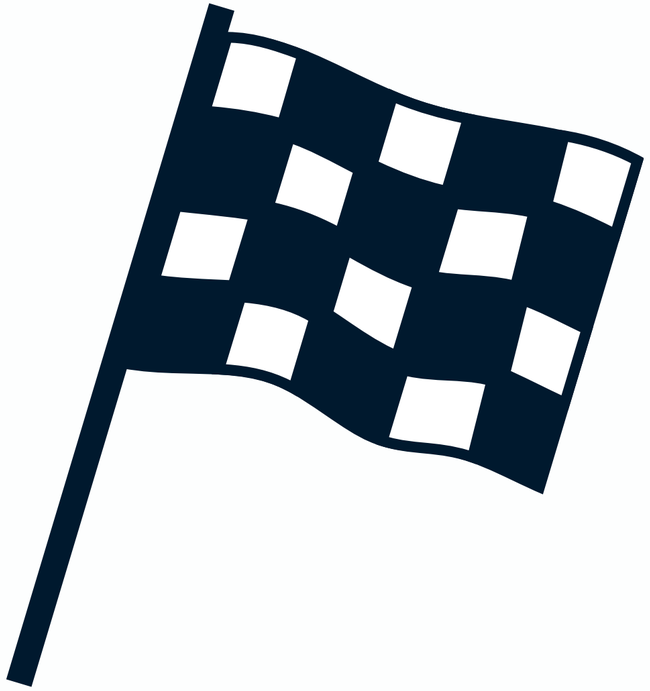
```
hadoop jar /home/cloudera/MRProgram.jar PackageDemo.WordCount  /count/search.txt /count2
hdfs dfs -ls /count2
hdfs dfs -cat /count2/part-r-00000
```

MATERIAL

https://drive.google.com/drive/folders/1Crg5Zg0N3t86oXuUxAOPmiWlrl8bJ6YU?usp=sharing

TITLE	LAST MODIFIED
cloudera-quickstart-vm-5.4.2-0-virtualbox.ovf	6/9/15
Gravação do ecrã 2020-11-06, às 21.11.01.mov	5:24 am
Gravação do ecrã 2020-11-07, às 12.32.37.mov	5:24 am
Gravação do ecrã 2020-11-07, às 13.11.24.mov	5:15 am
hadoop.zip	Nov 5
VirtualBox-6.1.16-140961-OSX-1.dmg	Nov 6
words	5:47 am

CHALLENGE



Do the same exercise but with dataset words.txt

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- https://www.sas.com/en_ae/insights/articles/data-management/Big-data-management-5-things-you-need-to-know.html
- https://docs.microsoft.com/en-us/azure/machine-learning/team-data-science-process/lifecycle

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