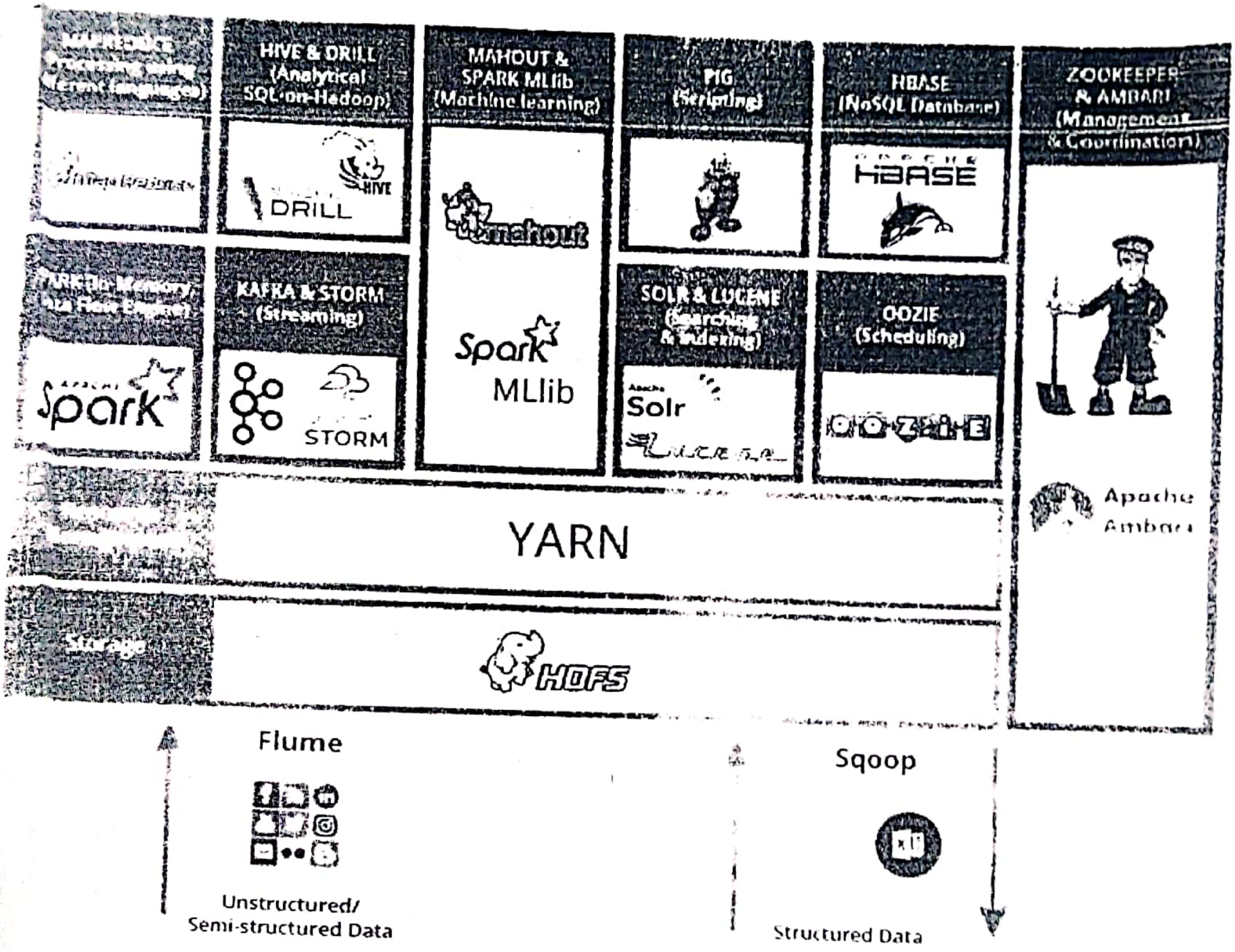
UNIT -III

ADOOP ECOSYSTEM:

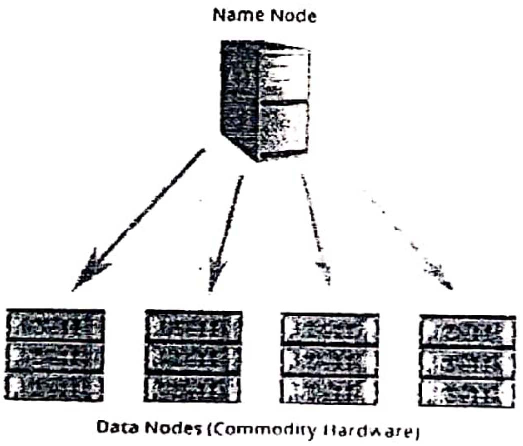
- Hadoop Ecosystem is neither a programming language nor a service, it is a platform or framework which solves big data problems.
- We can consider it as a suite which encompasses a number of services (ingesting, storing, analyzing and maintaining) inside it.
- The following are the Hadoop components, that together form a Hadoop Ecosystem.


MAPREDUCE (Data processing using different languages)
HIVE & DRILL (Analytical SQL-on-Hadoop)
DRILL
HIVE
MAHOUT & SPARK MLlib (Machine learning)
mahout
Spark MLlib
PIG (Scripting)
HBASE (NoSQL Database)
HBASE
ZOOKEEPER & AMBARI (Management & Coordination)
SPARK (In-Memory, Data Flow Engine)
Spark
KAFKA & STORM (Streaming)
STORM
SOLR & LUCENE (Searching & Indexing)
Solr
Lucene
OOZIE (Scheduling)
OOZIE
Apache Ambari
YARN
Storage
HDFS
Flume
Unstructured/ Semi-structured Data
Sqoop
Structured Data

❖ HDFS	:Hadoop Distributed File System
❖ YARN	:Yet Another Resource Negotiator
❖ MapReduce	:Data processing using programming
❖ Spark	:In-memory Data Processing
❖ PIG, HIVE	:Data Processing Services using Query (SQL-like)
❖ HBase	:NoSQL Database
❖ Mahout, Spark MLlib	:Machine Learning
❖ Apache Drill	:SQL on Hadoop
❖ Zookeeper	:Managing Cluster
❖ Oozie	:Job Scheduling
❖ Flume, Sqoop	:Data Ingesting Services
❖ Solr & Lucene	:Searching & Indexing
❖ Ambari	:Provision, Monitor and Maintain cluster

HDFS

- **Hadoop Distributed File System** is the core component or you can say, the backbone of Hadoop Ecosystem.
- HDFS is the one, which makes it possible to store different types of large data sets (i.e structured, unstructured and semi structured data).
- It helps us in storing our data across various nodes and maintaining the log file about the stored data (metadata).
- HDFS has two core components, i.e. **NameNode and DataNode.**
  1. The **NameNode** is the main node and it doesn't store the actual data. It contains metadata, just like a log file or you can say as a table of content. Therefore, it requires less storage and high computational resources.
  2. All your data is stored on the **DataNodes** and hence it requires more storage resources. These DataNodes are commodity hardware (like your laptops and desktops) in the distributed environment. That's the reason, why Hadoop solutions are very cost effective.
  3. You always communicate to the NameNode while writing the data. Then, it internally sends a request to the client to store and replicate data on various DataNodes.



YARN

Consider YARN as the brain of your Hadoop Ecosystem. It performs all your processing activities by allocating resources and scheduling tasks.

- It has two major components, i.e. **ResourceManager and NodeManager**.
  1. **ResourceManager** is again a main node in the processing department.
  2. It receives the processing requests, and then passes the parts of requests to corresponding NodeManagers accordingly, where the actual processing takes place.
  3. **NodeManagers** are installed on every DataNode. It is responsible for execution of task on every single DataNode.

ResourceManager has two components, i.e. **Schedulers andApplicationsManager**.

1. **Schedulers:** Based on your application resource requirements, Schedulers perform scheduling algorithms and allocates the resources.
2. **ApplicationsManager:** While ApplicationsManager accepts the job submission, negotiates to containers (i.e. the Data node environment where process executes) for executing theapplication specific ApplicationMaster and monitoring the progress.

MAPREDUCE

is the core component of processing in a Hadoop Ecosystem as it provides the logic of processing. In othe ords. MapReduce is a software framework which helps in writing applications that processes large dat ets using distributed and parallel algorithms inside Hadoop environment.

- In a MapReduce program, **Map() and Reduce()** are two functions.
  1. The **Map function** performs actions like filtering, grouping and sorting.
  2. While **Reduce function** aggregates and summarizes the result produced by map function
  3. The result generated by the Map function is a key value pair (K, V) which acts as the input for Reduce function.

APACHE PIG

- PIG has two parts: **Pig Latin**, the language and **the pig runtime**, for the execution environment. You can better understand it as Java and JVM.
- It supports *pig latin* language, which has SQL like command structure.

10 line of pig latin = approx. 200 lines of Map-Reduce Java code

- The compiler internally converts pig latin to MapReduce. It produces a sequential set of MapReduce jobs
- PIG was initially developed by Yahoo.
- It gives you a platform for building data flow for ETL (Extract, Transform and Load), processing and analyzing huge data sets.

5

How Pig works?

- In PIG, first the load command loads the data. Then we perform various functions on it like grouping, filtering, joining, sorting, etc. At last, either you can dump the data on the screen or you can store the result back in HDFS.

APACHE HIVE

- Facebook created HIVE for people who are fluent with SQL. Thus, HIVE makes them feel at home while working in a Hadoop Ecosystem.
- Basically, HIVE is a data warehousing component which performs reading, writing and managing large data sets in a distributed environment using SQL-like interface.

HIVE + SQL = HQL

- The query language of Hive is called Hive Query Language(HQL), which is very similar like SQL.
- It has 2 basic components: **Hive Command Line and JDBC/ODBC driver**.
- The **Hive Command line** interface is used to execute HQL commands.
- While, Java Database Connectivity (**JDBC**) and Object Database Connectivity (**ODBC**) is used to establish connection from data storage.
- Hive is highly scalable. As, it can serve both the purposes, i.e. large data set processing (i.e. Batch query processing) and real time processing (i.e. Interactive query processing).
- It supports all primitive data types of SQL.
- You can use predefined functions or write user defined functions (UDF) also to accomplish your specific needs.

✓ APACHE MAHOUT

Mahout provides an environment for creating machine learning applications which are scalable.

What is machine learning?

Machine learning algorithms allow us to build self-learning machines that evolve by itself without being explicitly programmed. Based on user behavior, data patterns and past experiences it makes important future decisions. You can call it a descendant of Artificial Intelligence (AI).

5

What Mahout does?

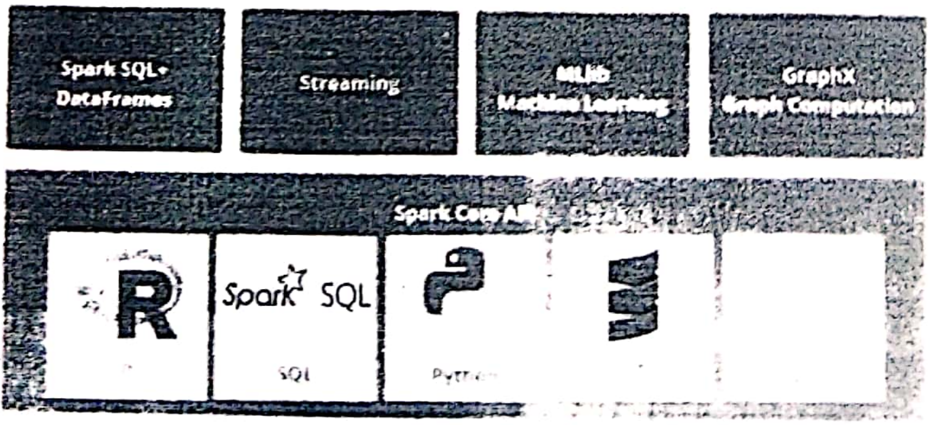
It performs **collaborative filtering, clustering and classification.** Some people also consider frequent item set missing as Mahout's function. Let us understand them individually:

1. **Collaborative filtering:** Mahout mines user behaviors, their patterns and their characteristics and based on that it predicts and make recommendations to the users. The typical use case is E-commerce website.
2. **Clustering:** It organizes a similar group of data together like articles can contain blogs, news, research papers etc.
3. **Classification:** It means classifying and categorizing data into various sub-departments like articles can be categorized into blogs, news, essay, research papers and other categories.
4. **Frequent item set missing:** Here Mahout checks, which objects are likely to be appearing together and make suggestions, if they are missing. For example, cell phone and cover are brought together in general. So, if you search for a cell phone, it will also recommend you the cover and cases.

Mahout provides a command line to invoke various algorithms. It has a predefined set of library which already contains different inbuilt algorithms for different use cases.

✓ APACHE SPARK

- Apache Spark is a framework for real time data analytics in a distributed computing environment.
- The Spark is written in Scala and was originally developed at the University of California, Berkeley.
- It executes in-memory computations to increase speed of data processing over Map-Reduce.
- It is 100x faster than Hadoop for large scale data processing by exploiting in-memory computations and other optimizations. Therefore, it requires high processing power than Map-Reduce.



- Spark comes packed with high-level libraries, including support for R, SQL, Python, Scala, Java etc.
- These standard libraries increase the seamless integrations in complex workflow.
- It also allows various sets of services to integrate with it like MLlib, GraphX, SQL + Data Frames, Streaming services etc. to increase its capabilities.

APACHE HBASE

- HBase is an open source, non-relational distributed database. In other words, it is a NoSQL database
- It supports all types of data and that is why, it's capable of handling anything and everything inside Hadoop ecosystem.
- It is modeled after Google's BigTable, which is a distributed storage system designed to cope up with large data sets.
- The HBase was designed to run on top of HDFS and provides BigTable like capabilities
- It gives us a fault tolerant way of storing sparse data, which is common in most Big Data use cases
- The HBase is written in Java, whereas HBase applications can be written in REST, Avro and Thrift APIs.

APACHE DRILL

As the name suggests, Apache Drill is used to drill into any kind of data. It's an open source application which works with distributed environment to analyze large data sets.

- It is a replica of Google Dremel.
- It supports different kinds NoSQL databases and file systems, which is a powerful feature of Drill

For example:Google Cloud Storage, HBase, MongoDB, MapR-DB HDFS, MapR-FS, Amazon S3, Swift, NAS and local files.

- The main aim behind Apache Drill is to provide scalability so that we can process petabytes and exabytes of data efficiently (or you can say in minutes).
- The main power of Apache Drill lies in ***combining a variety of data stores just by using a single query.***
- Apache Drill basically follows the ANSI SQL.
- It has a powerful scalability factor in supporting millions of users and serves their query requests over large scale data.

APACHE ZOOKEEPER

- Apache Zookeeper is the coordinator of any Hadoop job which includes a combination of various services in a Hadoop Ecosystem.
- Apache Zookeeper coordinates with various services in a distributed environment.
- Before Zookeeper, it was very difficult and time consuming to coordinate between different services in Hadoop Ecosystem.
- The services earlier had many problems with interactions like common configuration while synchronizing data.
- Even if the services are configured, changes in the configurations of the services make it complex and difficult to handle. The grouping and naming was also a time-consuming factor.

Due to the above problems, Zookeeper was introduced. It saves a lot of time by performing **synchronization, configuration maintenance, grouping and naming.**

APACHE OOZIE

Consider Apache Oozie as a clock and alarm service inside Hadoop Ecosystem. For Apache jobs, Oozie has been just like a scheduler. It schedules Hadoop jobs and binds them together as one logical work.

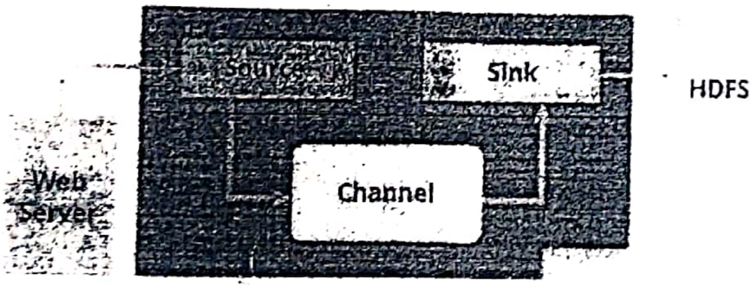
There are two kinds of Oozie jobs:

1. **Oozie workflow**: These are sequential set of actions to be executed. You can assume it as a relay race. Where each athlete waits for the last one to complete his part.
2. **Oozie Coordinator**: These are the Oozie jobs which are triggered when the data is made available to it. Think of this as the response-stimuli system in our body. In the same manner as we respond to an external stimulus, an Oozie coordinator responds to the availability of data and it rests otherwise.

APACHE FLUME

Ingesting data is an important part of our Hadoop Ecosystem.

- The Flume is a service which helps in ingesting unstructured and semi-structured data into HDFS.
- It gives us a solution which is reliable and distributed and helps us in collecting, **aggregating** and **moving large amount of data sets.**
- It helps us to ingest online streaming data from various sources like network traffic, social media, email messages, log files etc. in HDFS.



There is a **Flume agent** which ingests the streaming data from various data sources to HDFS. From the diagram, you can easily understand that the web server indicates the data source. Twitter is among one of the famous sources for streaming data.

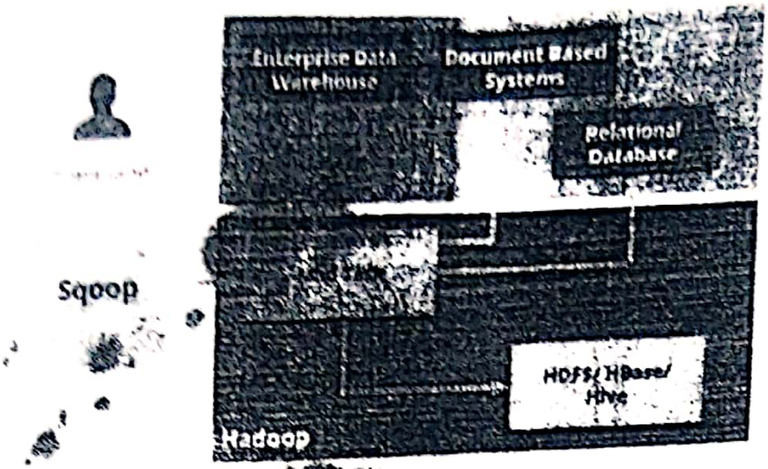
The flume agent has 3 components: **source, sink and channel.**

1. **Source:** it accepts the data from the incoming streamline and stores the data in the channel.
2. **Channel:** it acts as the local storage or the primary storage. A Channel is a temporary storage between the source of data and persistent data in the HDFS.
3. **Sink:** Then, our last component i.e. Sink, collects the data from the channel and commits or writes the data in the HDFS permanently.

APACHE SQOOP

Another data ingesting service in Hadoop ecosystem is Sqoop. The major difference between Flume and Sqoop is that:

- Flume only ingests unstructured data or semi-structured data into HDFS.
- While Sqoop can import as well as export structured data from RDBMS or Enterprise data warehouses to HDFS or vice versa.



✓ APACHE SOLAR & LUCENE

Apache Solr and Apache Lucene are the two services which are used for searching and indexing in Hadoop Ecosystem.

- Apache Lucene is based on Java, which also helps in spell checking.
- If Apache Lucene is the engine, Apache Solr is the car built around it. Solr is a complete application built around Lucene.
- It uses the Lucene Java search library as a core for search and full indexing.

✓ APACHE AMBARI

Ambari is an Apache Software Foundation Project which aims at making Hadoop ecosystem more manageable.

It includes software for **provisioning, managing and monitoring**Apache Hadoop clusters.

The Ambari provides:

1. **Hadoop cluster provisioning:**
   - It gives us step by step process for installing Hadoop services across a number of hosts.
   - It also handles configuration of Hadoop services over a cluster.
2. **Hadoop cluster management:**
   - It provides a central management service for starting, stopping and re-configuring Hadoop services across the cluster.
3. **Hadoop cluster monitoring:**
   - For monitoring health and status. Ambari provides us a dashboard.
   - The **Amber Alert framework** is an alerting service which notifies the user, whenever the attention is needed. For example, if a node goes down or low disk space on a node, etc.