

ISIT312 Big Data Management

Introduction to Spark

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Introduction to Spark

Outline

MapReduce Challenges

Meet Spark !

Features of Spark

Spark Architecture

Overview of Spark Components

Spark Glossary

MapReduce Challenges

Google introduced **MapReduce**, which was a breakthrough in the history of big data technologies

- It makes the processing of big data feasible and practical

However, **Hadoop MapReduce framework** releases the developer from the distributing computing trickiness, its **Java** API is still too low-level

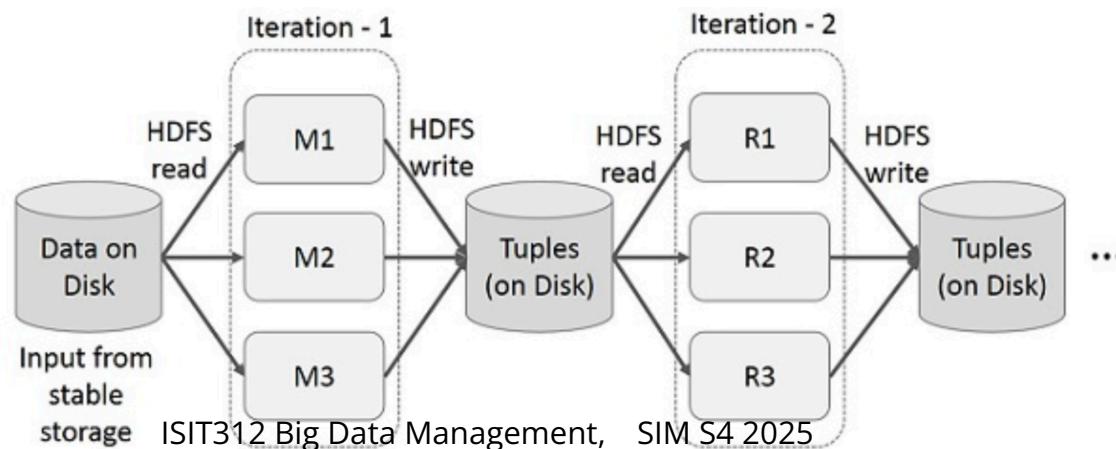
- Think how would you implement an inner join in **MapReduce** ?
- **Hive**, **Pig** and other frameworks based on **MapReduce** can help

More importantly, the persistent storage I/O makes the interactive and iterative computation (two important forms of data processing) very inefficient and leads to potential I/O latency

MapReduce Challenges

Data Sharing in Hadoop

- In the [Hadoop MapReduce](#) framework, the reuse data between computations (e.g., between two [MapReduce](#) jobs) is to write it to an external stable storage system, for example [HDFS](#))
- Although [Hadoop](#) provides numerous abstractions for data access, data sharing is slow due to replication, serialisation and persistent storage IO
- **More than 90% of the time for running a MapReduce job is doing HDFS read-write operations**
- Substantial overhead is caused by data replication, persistent storage I/O, and serialization



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Meet Spark !

Apache Spark, as a cluster computing platform, is designed to be **fast** and **general-purpose**

On the speed, **Spark** extends the **MapReduce** model to efficient support more types of computations, for example, interactive and iterative computations

- This is mainly due to **Spark's in-memory computing**, although **Spark** is also more efficient than **MapReduce** for persistent storage complex applications

On the generality, **Spark** covers a wide ranges of workloads, including batch applications, iterative queries, streaming and advanced analytics

- It provides a **unified environment** makes the combination of those different engines easy and inexpensive
- It provides **multiple language APIs**, including **Scala**, **Python**, **Java**, **SQL**, and **R**, as well as a very rich (yet fast-growing) built-in libraries

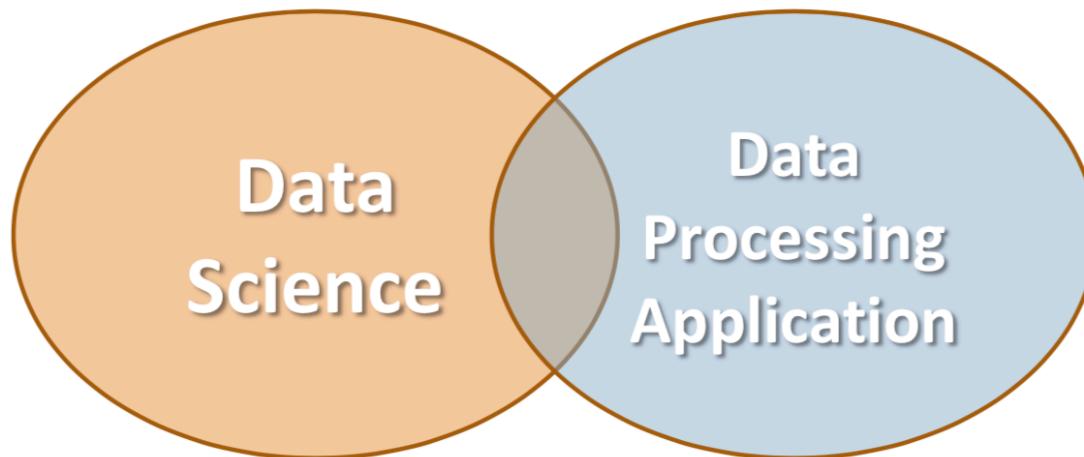
Meet Spark !

Data Scientists use Spark to:

- Analyse and model data
- Make prediction based on data
- Build data pipelines to fulfil certain tasks

Data Engineers use Spark to:

- Develop data processing applications
- Deploy the output of data scientists in production



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Features of Spark

As mentioned, **Spark** supports not only batch computing (as **MapReduce** does) but also **interactive**, **iterative**, and **real-time** computing

The main feature of **Spark** is its in-memory cluster computing that increases the processing speed of an application

The programming model of **Spark** is based on **Directed Acyclic Graphs (DAG)** and it is more flexible than the **MapReduce** model

Unlike **MapReduce**, **Spark** has built-in high-level APIs to process structured data, e.g., tables in **Hive**

Spark reduces the management burden of maintaining separate tools

Features of Spark

Speed

Spark helps to run an application in Hadoop cluster, up to 100 times faster in memory, and 10 times faster when running on disk

- This is achieved by reducing number of read/write operations to persistent storage
- It stores the intermediate processing data in memory

Support for multiple languages

Spark provides built-in APIs in Java, Scala, or Python

Advanced Analytics

Spark not only supports MapReduce It also supports SQL queries, Streaming data, Machine Learning (ML), and Graph algorithms

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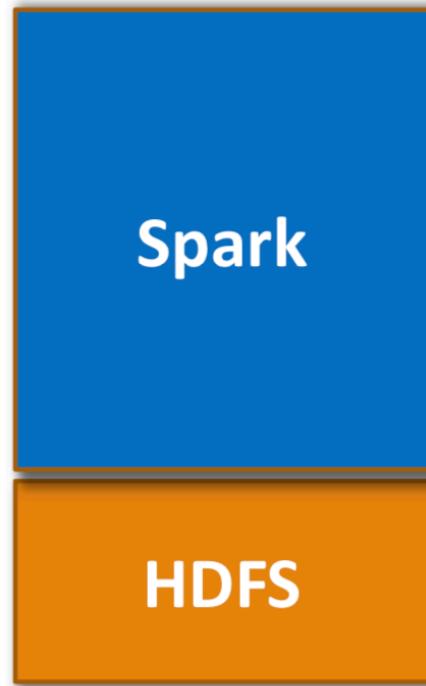
Driver program is the main **Spark** application that consists of the data processing logic

Executor is a **JVM** process that runs on each worker node and processes the jobs that the driver program submits

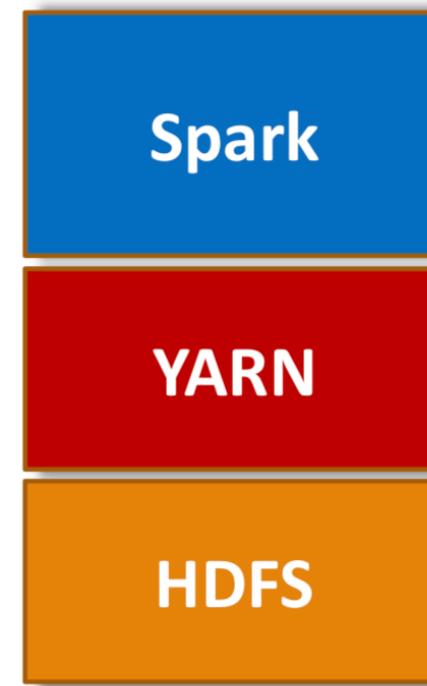
Task is a subcomponent of a data processing job

Spark Architecture

Two modes of Building Spark on Hadoop



standalone



Hadoop YARN

These modes are different from full-distributed mode and pseudo-distributed mode

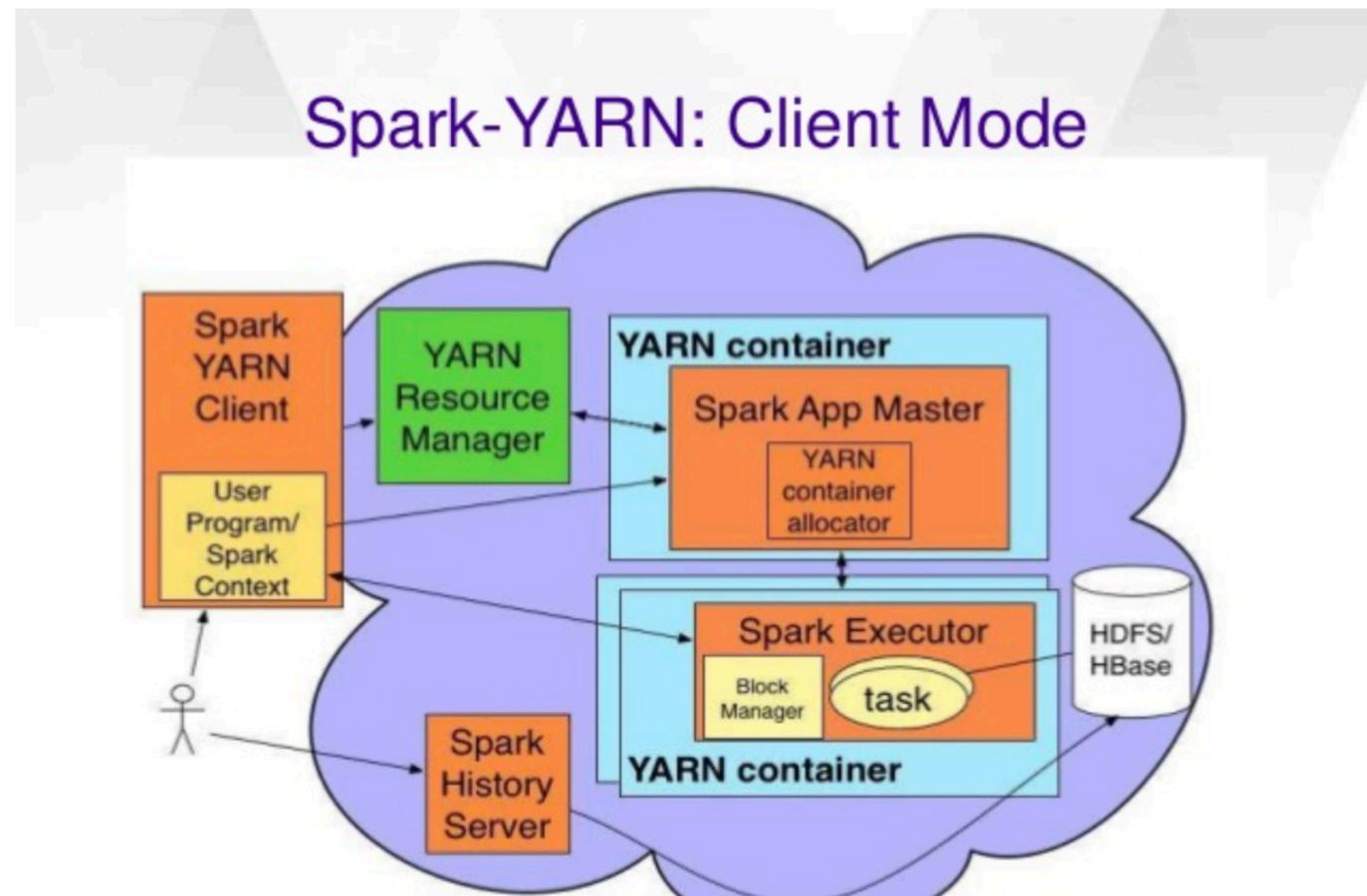
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Spark Architecture

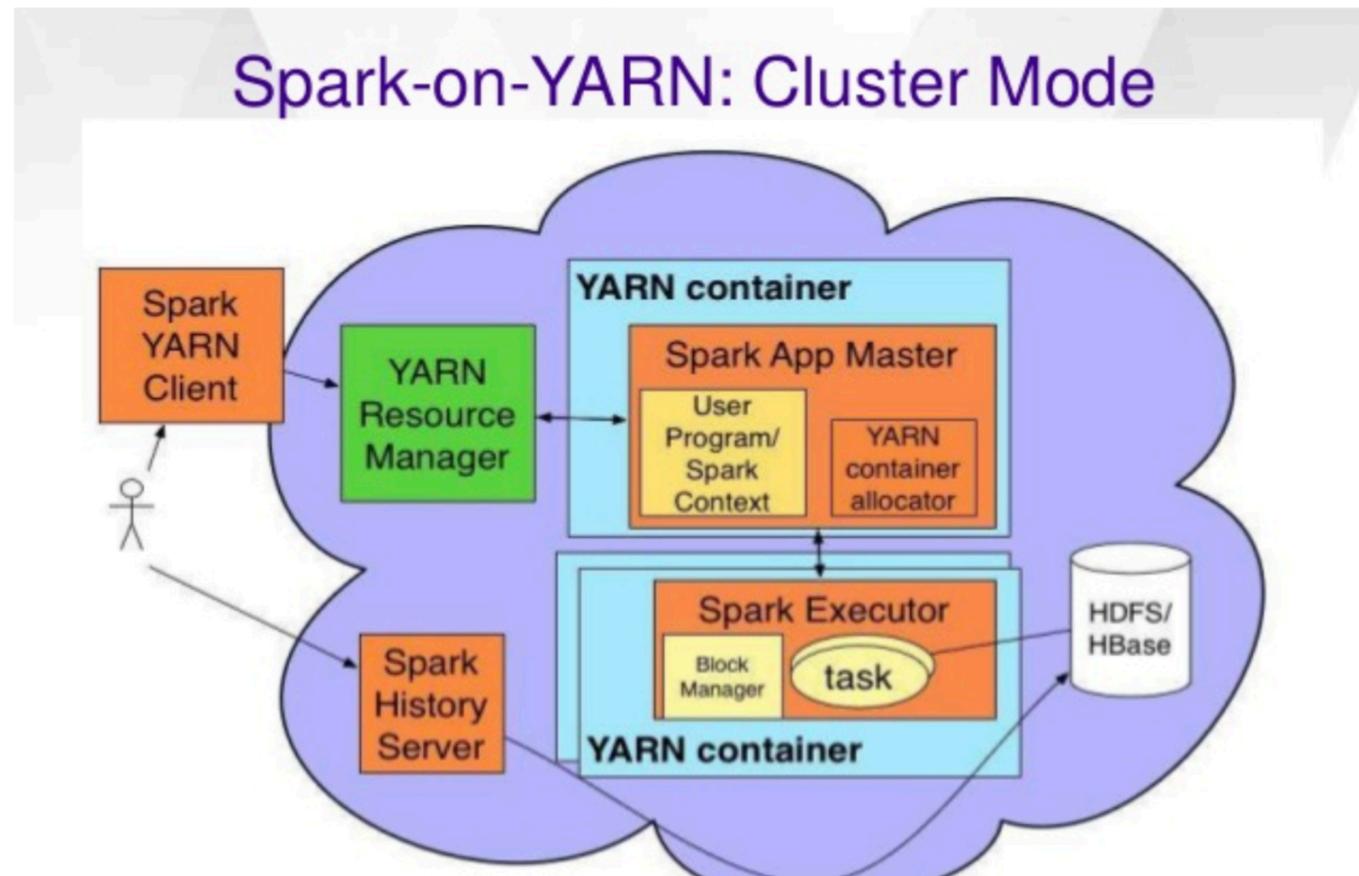
Spark on YARN: Client-Mode



`spark-submit MYJAR --master yarn-client –class MYCLASS`
YAHOO!

Spark Architecture

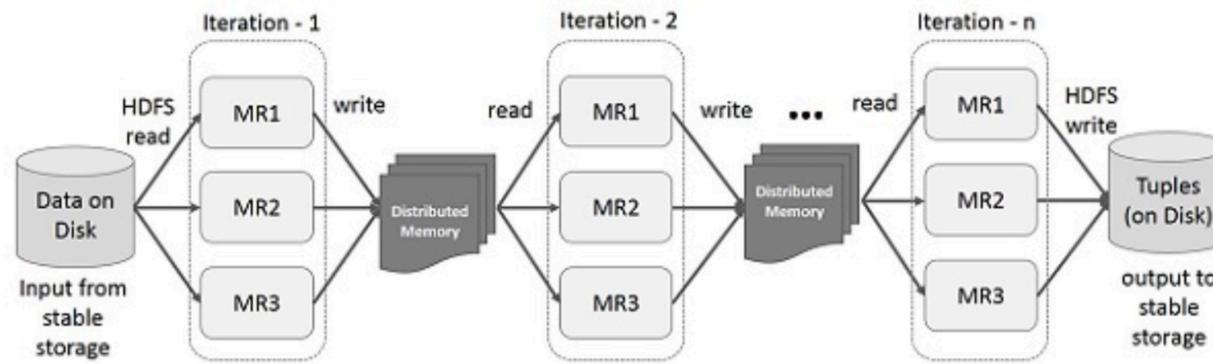
Spark on YARN: Cluster-Mode



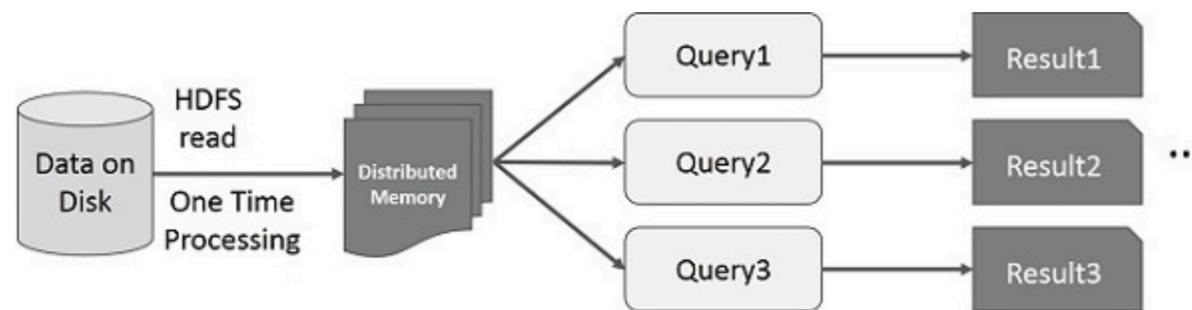
`spark-submit MYJAR --master yarn-cluster –class MYCLASS`
YAHOO!

Spark Architecture

Writing to and reading from memory in Spark reduces I/O overhead



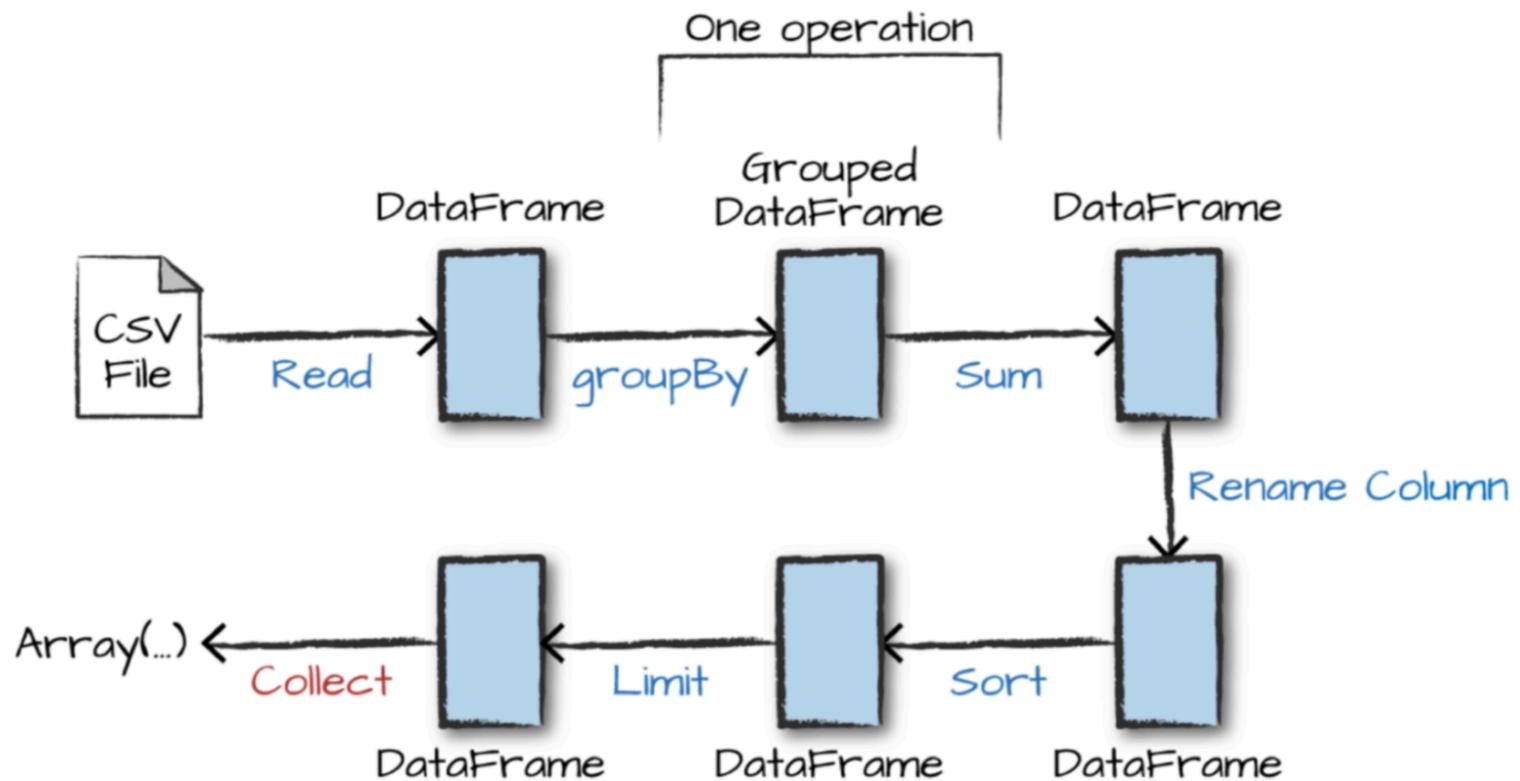
Data persists in memory and enables fast access



Spark Architecture

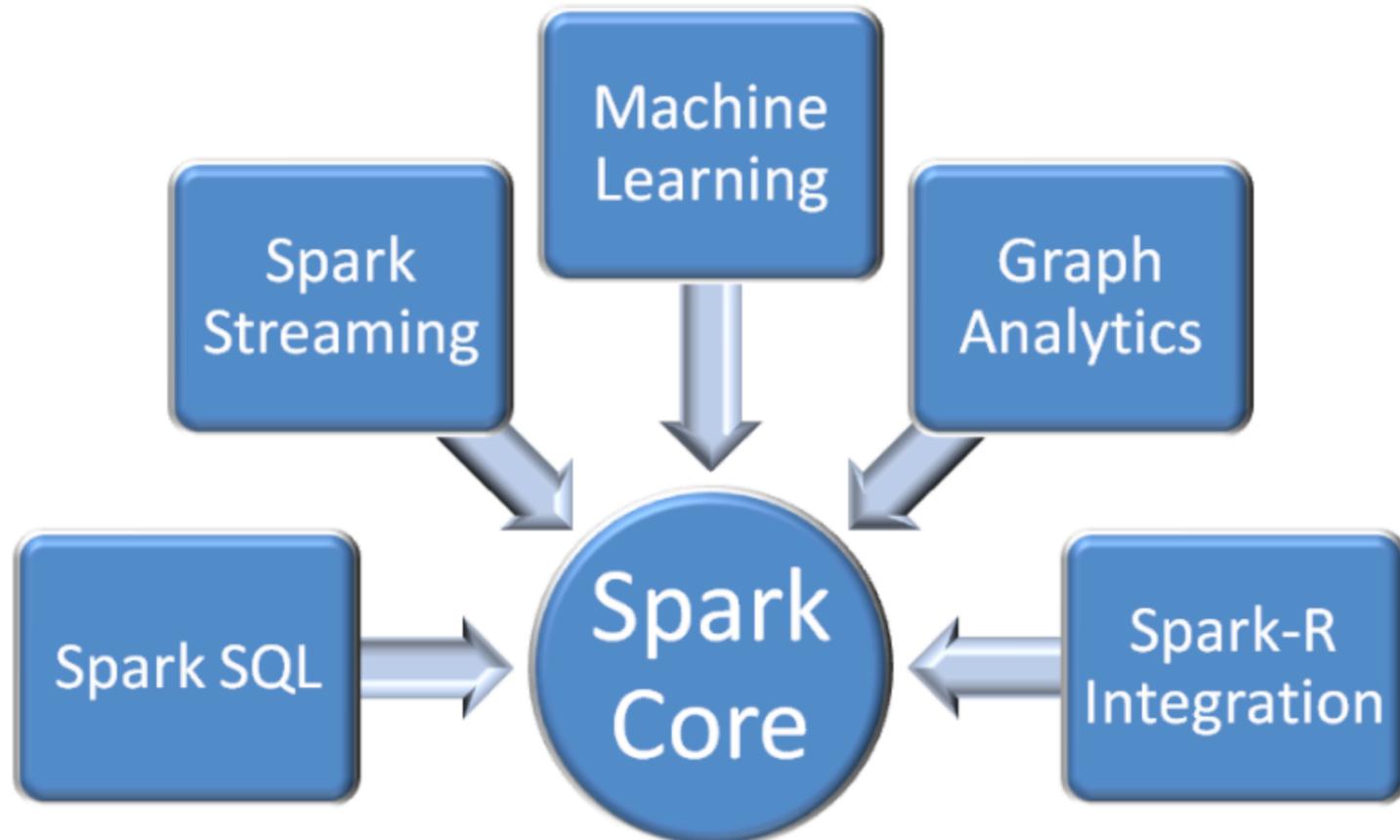
High-level API of **Spark** eases the development of a data processing pipeline

- No need to confirm to a specific pattern, for example MapReduce



Spark Architecture

Components of Spark



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Overview of Spark Components

Spark Core

- **Spark Core** is the underlying general execution engine for **Spark** platform that all other functionality is built upon
- It provides **In-Memory** computing and referencing datasets in external storage systems

Spark SQL

- **Spark SQL** is a component on top of **Spark Core** that introduces a new data abstraction called **SchemaRDD**, which provides support for structured and semi-structured data

Spark Streaming

- **Spark Streaming** leverages **Spark Core** fast scheduling capability to perform streaming analytics

Overview of Spark Components

SparkML

- **SparkML** is a distributed machine learning framework above **Spark** because of the distributed memory-based **Spark** architecture

GraphX

- **GraphX** is a distributed graph-processing framework on top of Spark
- It provides an API for expressing graph computation and provides an optimized runtime for this abstraction

SparkR

- **SparkR** is an **R** package that provides a light-weight frontend to use **Spark** from **R**

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| Term | Meaning |
|-----------------|--|
| Application | User program built on Spark. Consists of a <i>driver program</i> and <i>executors</i> on the cluster. |
| Application jar | A jar containing the user's Spark application. Usually jar not include Hadoop/Spark libraries, which are added at runtime. |
| Driver program | The process running the main() function of the application and creating the SparkContext |
| Cluster manager | An external service for acquiring resources on the cluster (e.g. standalone manager, YARN, Mesos) |
| Worker node | Any node that can run application code in the cluster |

Spark Glossary

| Term | Meaning |
|-------------|--|
| Deploy mode | Distinguishes where the driver process runs. In "cluster" mode, the framework launches the driver inside of the cluster. In "client" mode, the submitter launches the driver outside of the cluster. |
| Executor | A process launched for an application on a worker node, that runs tasks and keeps data in memory or disk storage across them. Each application has its own executors. |
| Task | A unit of work that will be sent to one executor |
| Job | A parallel computation consisting of multiple tasks that gets spawned in response to a Spark <i>action</i> (e.g. save, collect) |
| Stage | A subset of tasks in a job that depend on each other (similar to the map and reduce stages in MapReduce) |

References

A Gentle Introduction to Spark, Databricks, (Available in **READINGS** folder)

Spark Overview

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Srinivasa, K.G., Guide to High Performance Distributed Computing: Case Studies with Hadoop, Scalding and SparkSpringer, 2015 (Available from UOW Library)

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