## Java and Spark

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#### Youtube playlist

<https://www.youtube.com/playlist?list=PLQDzPczdXrTgqEc0uomGYDS0SFu7qY3g3>

#### Github main

<https://github.com/backstreetbrogrammer/11_JavaSpark>

#### References

<https://spark.apache.org/>

<https://spark.apache.org/docs/latest/api/java/index.html>

<https://github.com/apache/spark/tree/master/examples/src/main/java/org/apache/spark/examples>

#### Chapter 01 - The Big Picture

###### Big Data

Big data is a term that describes large, hard-to-manage volumes of data – both structured and unstructured – that inundate businesses on a day-to-day basis.

These data sets are so voluminous that traditional data processing software just can’t manage them. But these massive volumes of data can be used to address business problems we wouldn’t have been able to tackle before.

The three **Vs** of big data:

**Volume**

The amount of data matters. With big data, we’ll have to process high volumes of low-density, unstructured data. This can be data of unknown value, such as Twitter data feeds, click-streams on a web page or a mobile app, or sensor-enabled equipment. For some organizations, this might be **tens of terabytes** of data. For others, it may be **hundreds of petabytes**.

**Velocity**

Velocity is the fast rate at which data is received and (perhaps) acted on. Normally, the highest velocity of data streams directly into memory versus being written to disk. Some internet-enabled smart products operate in real time or near real time and will require real-time evaluation and action.

**Variety**

Variety refers to the many types of data that are available. Traditional data types were structured and fit neatly in a relational database. With the rise of big data, data comes in new **unstructured** data types. Unstructured and semi-structured data types, such as text, audio, and video, require additional preprocessing to derive meaning and support metadata.

|  |  |  |
| --- | --- | --- |
| ****Name**** | ****Value**** | ****Value**** |
| kilobyte (kB) | 10^3 | 2^10 |
| megabyte (MB) | 10^6 | 2^20 |
| gigabyte (GB) | 10^9 | 2^30 |
| terabyte (TB) | 10^12 | 2^40 |
| petabyte (PB) | 10^15 | 2^50 |
| exabyte (EB) | 10^18 | 2^60 |
| zettabyte (ZB) | 10^21 | 2^70 |
| yottabyte (YB) | 10^24 | 2^80 |

###### Local versus Distributed Systems

Big data can not be processed or stored in a local system or a single node. It requires multiple machines or nodes to store / process it.

Master Node => Slave node**s**

A local single node will use the computation sources (CPU, cores) and storage (memory, hard disk) of a single machine only. Only **vertical scaling** is possible which means we can add powerful CPU or memory to a single machine but there will be a limit to it. Single point of failure if the local node goes down which makes it essential to store the important data in cloud or separate disk.

A distributed system has access to the computation sources (CPU, cores) and storage (memory, hard disk) across a number of machines connected through a network. **Horizontal scaling** is easier by just adding new nodes or systems to the distributed system. It also supports **fault tolerance**, if one machine fails, the whole network can still go on.

###### Apache Hadoop and MapReduce

Apache Hadoop is a collection of open-source software utilities that facilitates using a network of many computers to solve problems involving massive amounts of data and computation. It provides a software framework for distributed storage and processing of big data using the **MapReduce** programming model.

Hadoop uses **Hadoop Distributed File System** (**HDFS**) which is a distributed, scalable, and portable file system written in Java for the Hadoop framework and allows user to work with large data sets. It also duplicates blocks of data for **fault tolerance**.

HDFS uses **MapReduce** which allows computations on that data.

HDFS uses blocks of data of default size 128 MB and replicates it multiple times to the slave nodes for fault tolerance.

**MapReduce** is a way of splitting a computational task to a distributed set of files such as HDFS. It consists of a **Job Tracker** at Master Node and multiple **Task Trackers** in the slave nodes. Job Tracker sends code to run on the Task Trackers. The Task Trackers allocate CPU and memory for the tasks and monitor the tasks on the worker nodes.

To summarize,

* **HDFS** is used to distribute large data sets
* **MapReduce** is used to distribute a computational task to a distributed data set

###### Apache Spark

Apache Spark is a multi-language engine for executing data engineering, data science, and machine learning on single-node machines or clusters.

Key Features:

* SQL analytics using **RDDs** and **SparkSQL**

Execute fast, distributed ANSI SQL queries for dashboarding and ad-hoc reporting. Runs faster than most data warehouses.

* Machine learning using **SparkML**

Train machine learning algorithms on a laptop and use the same code to scale to fault-tolerant clusters of thousands of machines.

* Batch/streaming data using **Spark Streaming**

Unify the processing of data in batches and real-time streaming.

**Spark** is a flexible alternative to **MapReduce**.

**MapReduce** requires files to be stored only in HDFS, while **Spark** can work on data stored in a variety of formats like HDFS, AWS S3, Cassandra, HBase etc.

**Spark** can perform operations up to 100X faster than **MapReduce** because MapReduce writes most of data to **disk** after each map and reduce operation; however Spark keeps most of the data in **memory** after each transformation. Spark will write to disk only when the memory is full.

###### Spark RDDs

RDD (Resilient Distributed Dataset) is the fundamental data structure of Apache Spark which are an immutable collection of objects which computes on the different node of the cluster. Each and every dataset in Spark RDD is logically partitioned across many servers so that they can be computed on different nodes of the cluster.

RDD has these main features:

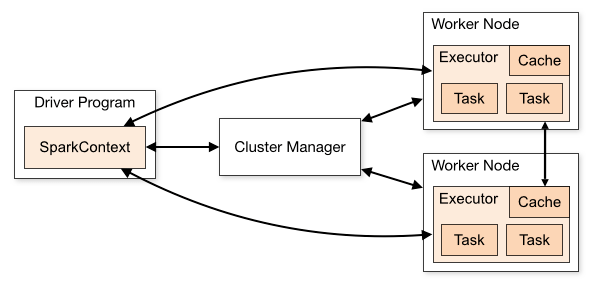
* Distributed collection of data
* Immutable, lazily evaluated and cacheable
* Fault-tolerant “in-memory” computations
* Parallel operation - partitioned
* Ability to use many data sources

RDDs support 2 kinds of operations:

1. **Transformation** – Spark RDD transformation is a function that produces new RDD from the existing RDDs. The transformer takes RDD as input and produces one or more RDD as output. Transformations are lazy in nature i.e., they get execute when we call an action.
2. **Action** – transformations create RDDs from each other, but when we want to work with the actual data set, at that point action is performed. Thus, Actions are Spark RDD operations that give **non-RDD** values. The values of action are stored to drivers or to the external storage system.

An action is one of the ways of sending data from **Executor** to the driver.

**Executors** are agents that are responsible for executing a task. While the driver is a JVM process that coordinates workers and execution of the task. Some of the actions of Spark are count and collect.



###### Youtube

<https://www.youtube.com/playlist?list=PLQDzPczdXrTgqEc0uomGYDS0SFu7qY3g3>

###### Github

<https://github.com/backstreetbrogrammer/11_JavaSpark>

#### Chapter 02 - Project Setup - Maven

We can create a Maven project and add spark dependencies.

<dependency>  
 <groupId>org.apache.spark</groupId>  
 <artifactId>spark-core\_2.13</artifactId>  
 <version>${apache-spark.version}</version>  
</dependency>  
  
<dependency>  
 <groupId>org.apache.spark</groupId>  
 <artifactId>spark-sql\_2.13</artifactId>  
 <version>${apache-spark.version}</version>  
</dependency>  
  
<dependency>  
 <groupId>org.apache.hadoop</groupId>  
 <artifactId>hadoop-hdfs</artifactId>  
 <version>3.3.2</version>  
</dependency>

Latest apache spark version as of this writing is **3.2.2**

Complete pom.xml can be found at Github: <https://github.com/backstreetbrogrammer/11_JavaSpark/pom.xml>

###### Youtube

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