Big Data Fundamentals

What is Big Data?

Big Data refers to datasets that are too large or complex for traditional data-processing tools to handle.

These datasets typically require advanced technologies to store, process, and analyze. Big Data is characterized by the 5 V's: Volume, Velocity, Variety, Veracity, and Value.

Big Data: The 5 V's

V	Description
Volume	Refers to the large scale of data generated. Big Data systems can handle terabytes or even petabytes of data.
Velocity	The speed at which data is generated and processed in real-time from various sources, like social media, IoT devices, etc.
Variety	The different forms of data, including structured, semi-structured, and unstructured (e.g., text, images, videos).
Veracity	The uncertainty or quality of the data, ensuring data accuracy despite potential inconsistencies or incompleteness.
Value	The benefit or insights derived from Big Data, driving business decisions, enhancing efficiency, and creating opportunities.

Big Data processing systems

Hadoop/MapReduce: Scalable and fault tolerant framework written in Java

- Open source
- Batch processing

Apache Spark: General purpose and lightning fast cluster computing system

- Open source
- Both batch and real-time data processing

Note: Apache Spark is nowadays preferred over Hadoop/MapReduce

What is PySpark?

PySpark is the Python API for Apache Spark, an open-source, distributed computing framework.

PySpark enables parallel processing on large datasets by using Python to write Spark applications, making it accessible to developers familiar with Python while leveraging Spark's power.

Overview of PySpark

Apache Spark is written in Scala

To support Python with Spark, Apache Spark Community released PySpark

Similar computation speed and power as Scala

PySpark APIs are similar to Pandas and Scikit-learn

Difficulty level of questions

- Easy : Focus on basic concepts, definitions
- Medium: joins, aggregations, general scenarios
- Hard: performance optimization, Spark's architecture

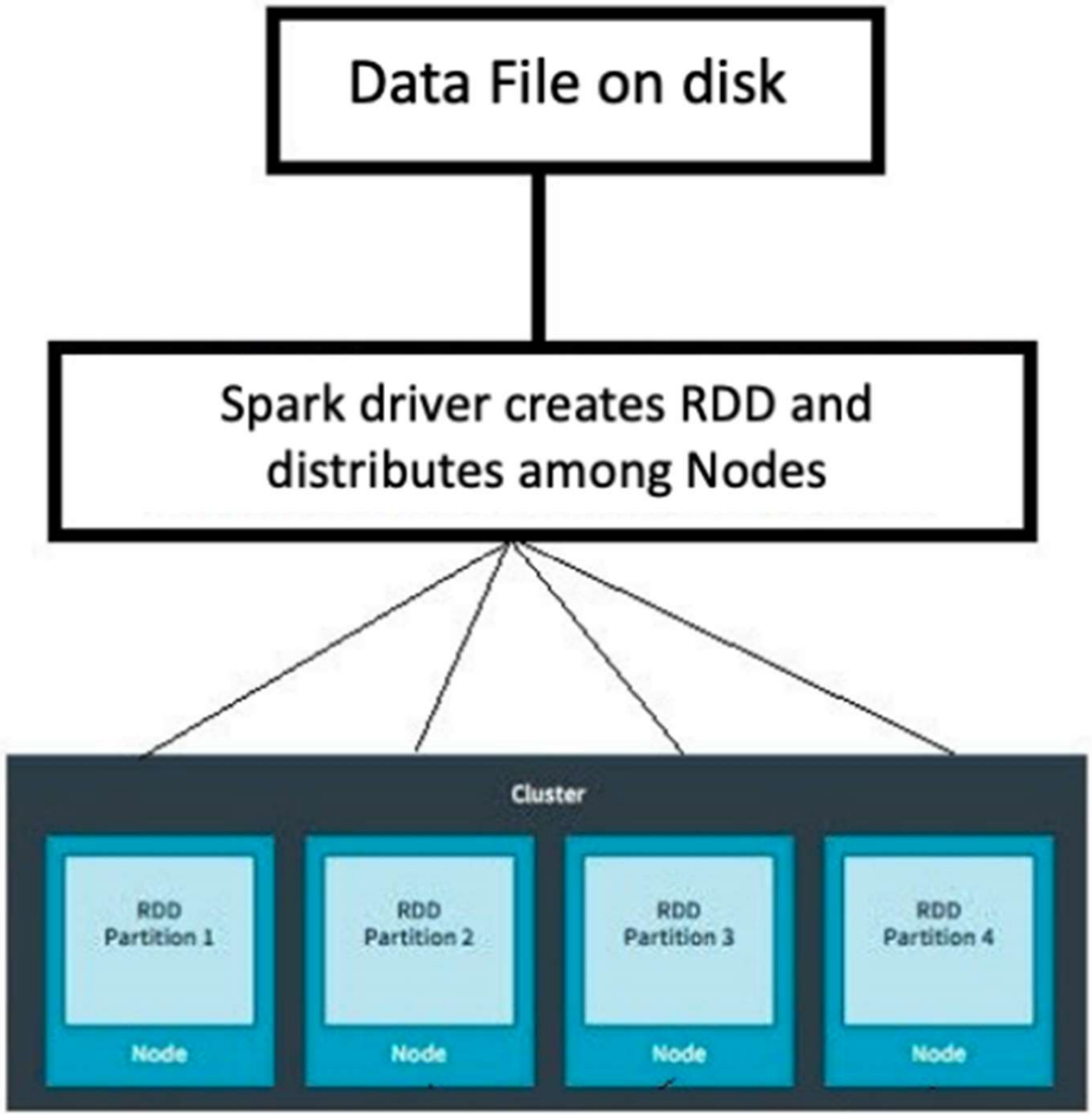
Analyzing Titanic Dataset with Spark

- This tutorial demonstrates how to analyze the Titanic dataset using Spark, covering basic operations like groupBy(), aggregateByKey(), sortByKey(), joins, and more.

- Notebook link to be provided

What is RDD

RDD = Resilient Distributed Datasets



What is RDD and what is its importance?

- **RDD** stands for **Resilient Distributed Dataset**.

- It is the fundamental data structure in Apache Spark.

- **Resilient**: If part of the data is lost (due to node failure), the RDD can recover that lost data using the original transformations (thanks to lineage).

- **Distributed**: RDDs are divided into partitions that are distributed across the nodes in a cluster. This allows Spark to process the data in parallel, making it much faster than traditional systems.

- **Dataset**: RDDs represent datasets that can be created from data in external storage systems like HDFS, local files, or existing data in memory.

Why is RDD Important for Spark?

- **Fault Tolerance**: RDDs can automatically recover lost data. If a node fails, Spark uses the **lineage** (a record of transformations applied) to recreate the lost data without rerunning the entire job.

- **Parallel Processing**: Since RDDs are distributed across multiple nodes, Spark can process them in parallel, which speeds up data processing.

- **In-memory Computation:** RDDs allow Spark to cache data in memory, reducing disk I/O operations. This leads to faster execution, especially in iterative algorithms (like machine learning).

- **Immutable:** Once created, RDDs cannot be modified, but you can apply transformations (like map and filter) to create new RDDs.

- **Lazy Evaluation:** RDD transformations (like map() or filter()) are not executed immediately. Instead, Spark builds an execution plan (called a DAG) and only runs it when an action (like collect(), count()) is triggered. This allows Spark to optimize and combine operations.

What are transformations and actions in PySpark? Give examples.

- **Transformations**: Operations that define how data is transformed but do not execute immediately. They are **lazy**.
  - Example: `map()`, `filter()`, `groupBy()`
  - **Example code**: `titanic_df.filter(titanic_df.Age > 30)`
- **Actions**: Operations that trigger the actual execution of transformations and return results.
  - Example: `collect()`, `count()`, `show()`
  - **Example code**: `titanic_df.count()`

What are the different file formats supported by PySpark

- PySpark supports various file formats for reading and writing data, including:
  - **CSV**: Comma-separated values.
  - **Parquet**: Columnar storage format that is efficient for large datasets.
  - **JSON**: JavaScript Object Notation, useful for semi-structured data.
  - **ORC**: Optimized Row Columnar format, commonly used in the Hadoop ecosystem.
  - **Avro**: A compact, fast, and efficient data serialization format.

What is the difference between caching and persistence?

- **Caching** and **persistence** allow you to store a DataFrame or RDD in memory (or memory/disk) so that future operations don't need to recompute the data.
- **Caching**: Stores the data in memory only. It's shorthand for `persist()` with the **memory-only** option.
- **Persistence** (`persist()`): Allows you to specify different storage levels, like memory, disk, or a combination of both.
  - **Why useful**:
    - If you're reusing the same DataFrame or RDD multiple times, caching/persistence saves time by avoiding the need to re-compute the same transformations.
    - **Improves performance** for iterative algorithms (like machine learning), where the same data is processed repeatedly.

Thank you!