DAY 2 | Apache Spark Fundamentals

Apache Spark Architecture (Simple Explanation)

Spark architecture mainly has 4 core parts:

1. *Driver*
2. *Cluster Manager*
3. *Executors*
4. *DAG (Directed Acyclic Graph)*

1. Driver (The Brain)

Driver is the main controller of your Spark application

What the Driver does:

- *Runs your notebook code*
- *Creates SparkSession*
- *Understands your SQL / PySpark commands*
- *Builds the execution plan (DAG)*
- *Sends work to executors*
- *Collects results*

📌 *In Databricks:*

- *Your notebook is running on the driver*
- *When you click ▶️ Run, driver starts working*

Example :

```
df = spark.read.csv("file.csv")
df.count()
```

2. Cluster Manager (The Allocator)

It decides:

- *How many executors?*
- *How much memory?*
- *How many cores?*

Examples:

- *Databricks (managed)*
- *YARN*
- *Kubernetes*
- *Standalone Spark*

👷 3. Executors (The Workers)

Executors do the actual data processing

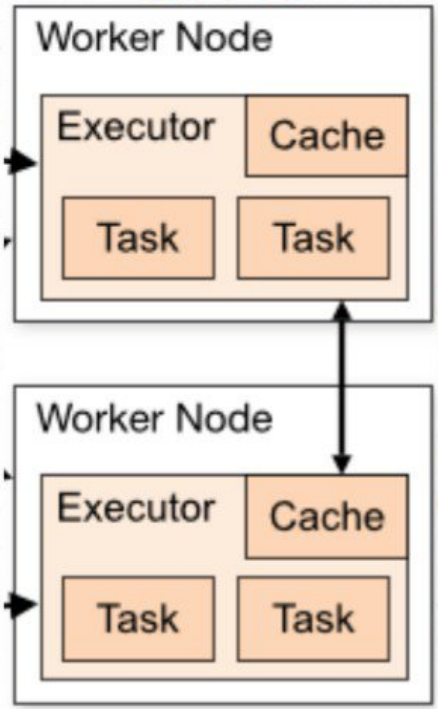
What Executors do:

- *Run tasks in parallel*
- *Process chunks of data*
- *Store data in memory/disk*
- *Send results back to driver*

📌 *Each executor:*

- *Runs on a different node*
- *Handles partitions of data*

Example: If your CSV has 10 million rows
->Spark splits it into partitions
->Each executor processes some rows



👉 This is why Spark is fast

🔗 4. DAG (Directed Acyclic Graph)

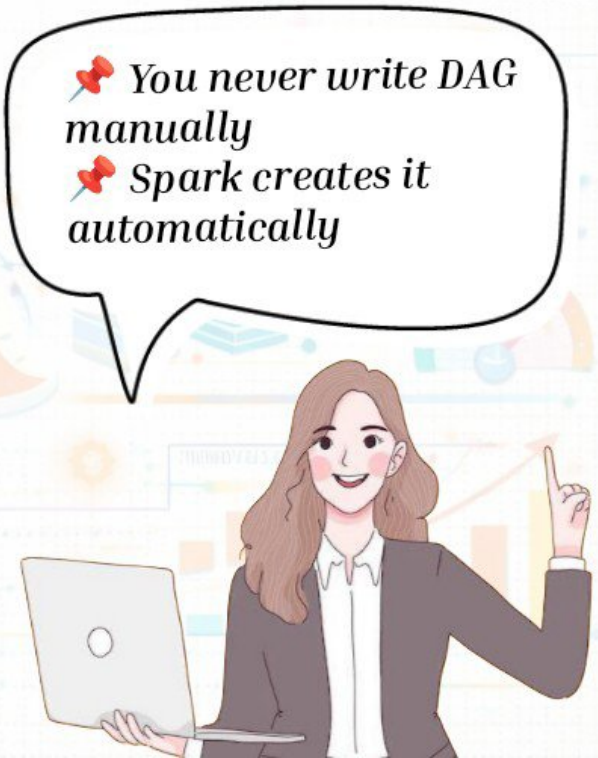
DAG is Spark's execution plan

What DAG means:

- *Directed → execution flows in one direction*
- *Acyclic → no loops*
- *Graph → steps connected logically*

Spark creates DAG based on:

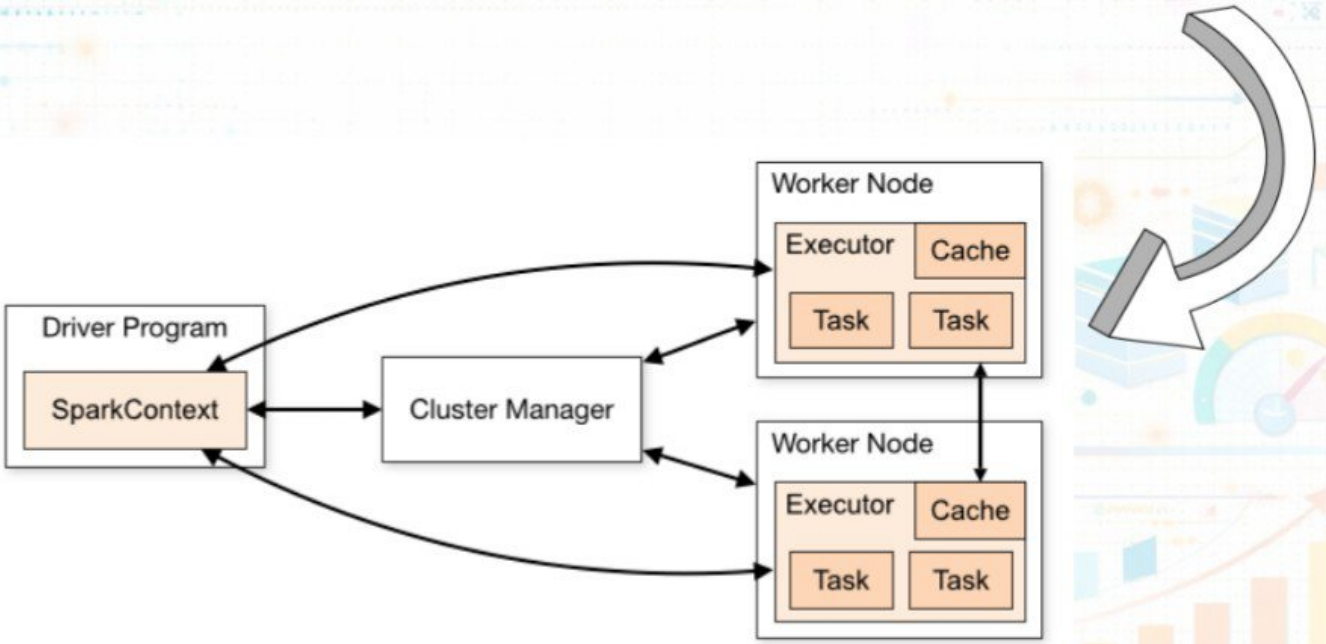
- *select*
- *filter*
- *groupBy*
- *orderBy*



🔁 How Everything Works Together (Flow)

Let's say you run this:

```
df = spark.read.csv("data.csv")
df.filter(df.price >
100).groupBy("category").count().show(
)
```



🔁 How Everything Works Together (Flow)

Step-by-step:

1.Driver

•Reads your code

•Builds logical plan (DAG)

2.DAG

•filter → groupBy → count

3.Cluster Manager

•Assigns executors

4.Executors

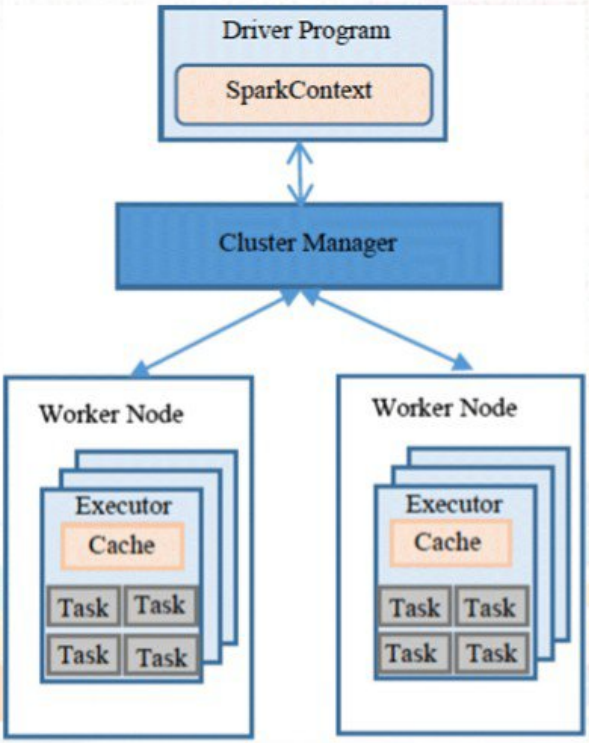
•Execute tasks in parallel

•Process data partitions

5.Driver

•Collects final result

•Displays output



💤 Important Concept: Lazy Evaluation

Spark does nothing until an action is called.

Transformations (Lazy):

- *select*
- *filter*
- *groupBy*

Actions (Trigger execution):

- *count()*
- *show()*
- *collect()*
- *write()*

🔑 Remember This

Driver = Brain
Executors = Workers
DAG = Plan
Cluster = Infrastructure
Parallel processing = Spark's power

DataFrame vs RDD (Apache Spark)

What is an RDD?

RDD (Resilient Distributed Dataset) is:

- *The lowest-level data structure in Spark*
- *A distributed collection of objects*
- *Immutable and fault-tolerant*

📌 *You manually control:*

Data processing

Transformations

Logic

Example :

```
rdd =
spark.sparkContext.textFile("file.txt"
)
```

What is a DataFrame?

DataFrame is:

- *A higher-level abstraction built on RDD*
- *Structured data (rows + columns)*
- *Similar to a SQL table*

📌 *Spark handles:*

- *Optimization*
- *Execution planning*
- *Memory management*

Example:

```
df = spark.read.csv("file.csv",
header=True)
```

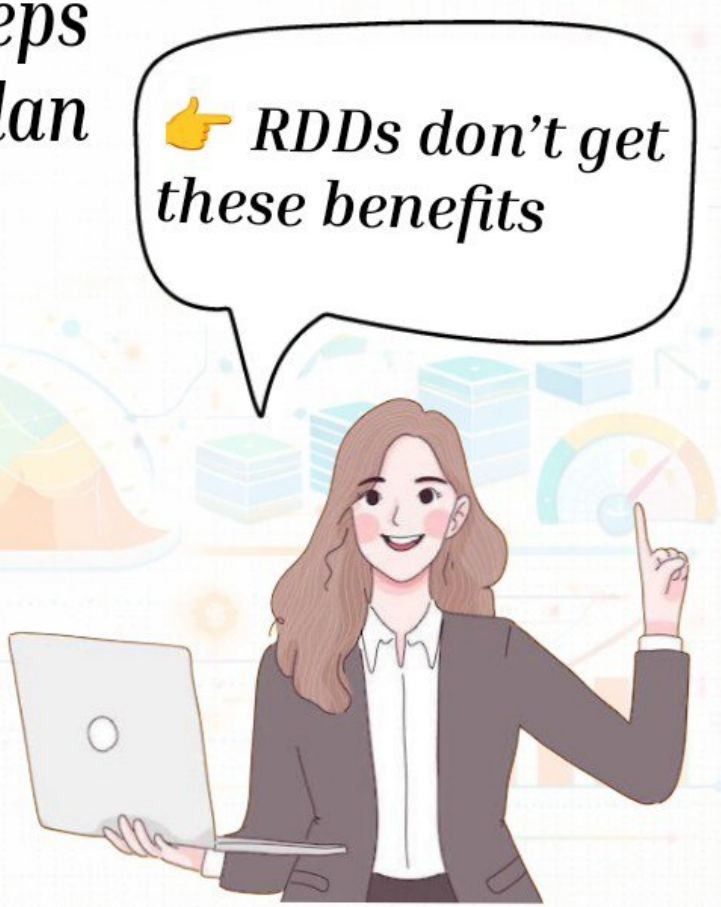
⚡ Why DataFrames are Faster?

1️⃣ Catalyst

- Optimizer
- Reorders operations
- Removes unnecessary steps
- Chooses best execution plan

2️⃣ Tungsten Engine

- Efficient memory usage
- CPU optimization
- Less JVM overhead



Lazy Evaluation (Connection)

Both:

- *Use lazy evaluation*
- *Execute only on actions*

But:

- *DataFrame builds optimized DAG*
- *RDD builds basic DAG*

✨ Notebook Magic Commands

Magic commands tell Databricks which language or tool to use for a notebook cell.

They always start with % and are written at the top of a cell.

Why Magic Commands are Needed

Without magic commands:

•Notebook runs in one default language (usually Python)

With magic commands:

•You can run SQL, Python, shell, file system commands in the same notebook

Most Important Magic Commands

1️⃣ %python (Default)

->*Used to write PySpark / Python code*

- ✔ *Used for transformations*
- ✔ *DataFrame operations*
- ✔ *Most common in Databricks*

```
%python
df = spark.read.csv(
    "/Volumes/workspace/ecommerce/
ecommerce_data/2019-Oct.csv",
    header=True,
    inferSchema=True
)
df.show(5)
```

Most Important Magic Commands

2️⃣ %sql

->*Used to run SQL queries directly*

✔ *Best for analysts*
✔ *Clean & readable*
✔ *Works on tables & temp views*

```
%sql
SELECT event_type, COUNT(*)
FROM oct_events
GROUP BY event_type
ORDER BY COUNT(*) DESC
```

Most Important Magic Commands

3️⃣ %fs

->*Used for file system operations*

Common uses:

- *List files*
- *Check paths*
- *Debug missing files*

```
%fs
ls /Volumes/workspace/ecommerce/
ecommerce_data/
```

Most Important Magic Commands

4️⃣ %sh

->*Runs Linux shell commands*

✔ *Used for:*

- *kaggle download*
- *unzip*
- *rm, mv, cp*

```
%sh
cd /Volumes/workspace/ecommerce/
ecommerce_data
ls -lh
```

🔑 Remember This

- %python → Data processing
- %sql → Analysis & queries
- %fs → Check files
- %sh → System-level tasks

Day 2 - Tasks Completed ✅

✔ *Uploaded dataset using Volumes*
✔ *Read CSV into Spark DataFrames*
✔ *Verified schema & row counts*
✔ *Created temporary views*
✔ *Performed:*
- *select*
- *filter*
- *groupBy*
- *orderBy*

Key Learning Takeaways 🧠

- *Spark uses lazy evaluation*
- *Execution happens only on actions*
- *SQL cannot read DataFrames directly*
- *Temp views bridge PySpark & SQL*
- *Volumes are the modern way to store data*

📈 *Big clarity on how Spark actually works*

Biggest “Aha” Moment 💡

Spark doesn’t execute code line by line —
it builds a plan first, then executes efficiently.

Day 2 built a strong Spark foundation
Ready to go deeper into real transformations & analytics 🔥
➡️ *On to Day 3!*