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Data Engineering SPARK

ALL CONCEPTS TO GET STARTED

APACHE Spark™

Driver Program

The main program that runs the user's application and creates the SparkContext.

Example

Initializing SparkContext: from pyspark import SparkContext; sc = SparkContext("local", "App").

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Executors

Worker nodes that execute tasks and store data for the application.

Example
Executors process tasks and cache data in memory.

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Cluster Manager

Manages resources and schedules jobs across the cluster.

Example
Using YARN, Mesos, or Standalone mode for resource management.

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SparkContext

The entry point to Spark functionality.

Example

```
sc = SparkContext("local", "App")
```

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SparkSession

The entry point for DataFrame and SQL functionality.

Example

```
from pyspark.sql import SparkSession;
spark = SparkSession.builder.appName("App")
.getOrCreate()
```

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Resilient Distributed Datasets (RDDs)

Immutable distributed collections of objects that can be processed in parallel.

Example

```
rdd = sc.parallelize([1, 2, 3, 4, 5]).
```

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Transformations

Operations that create a new RDD from an existing one.

Example

```
rdd2 = rdd.map(lambda x: x * 2).
```

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Actions

Operations that trigger computation and return a result to the driver.

Example

count = rdd.count().

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Lazy Evaluation

Transformations are not executed until an action is called.

Example

Defining transformations but no computation until action:

```
rdd2 = rdd.map(x => x * 2);
rdd2.count().
```

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Directed Acyclic Graph (DAG)

A sequence of computations represented as a graph.

Example

Viewing the DAG in Spark UI.

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Spark SQL

A module for working with structured data using SQL.

Example

```
df = spark.sql("SELECT * FROM table").
```

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DataFrame

A distributed collection of data organized into named columns.

Example

```
df = spark.read.json("file.json").
```

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Dataset

A strongly-typed collection of objects.

Example

```
ds = spark.createDataset([(1, "Alice"), (2, "Bob")]).
```

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Catalyst Optimizer

Spark's query optimizer that generates efficient execution plans.

Example

Analyzing query plans with df.explain().

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PySpark

The Python API for Spark, allowing Python developers to use Spark's features.

Example

```
from pyspark.sql import SparkSession;
spark =
SparkSession.builder.appName("App").getOrCreate().
```

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SQL

Allows execution of SQL queries in PySpark.

Example

```
spark.sql("SELECT COUNT(*) FROM table").
```

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DataFrame

Similar to pandas DataFrame, but distributed across a cluster.

Example

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

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RDD

Low-level API for distributed data manipulation.

Example

```
rdd = sc.textFile("file.txt").
```

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UDF

User-defined functions for extending PySpark's built-in functions.

Example

```
spark.udf.register("add_one", lambda x: x + 1,
IntegerType()).
```

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Window Functions

Functions that allow calculations across a set of rows related to the current row.

Example

```
df.withColumn("rank", row_number()
.over(Window.partitionBy("dept")
.orderBy("salary"))).
```

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Machine Learning

Using MLlib for scalable machine learning in PySpark.

Example

```
from pyspark.ml.classification import
LogisticRegression; lr = LogisticRegression().
```

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Streaming

Processing real-time data streams with Spark Streaming.

Example

```
from pyspark.streaming import StreamingContext;
ssc = StreamingContext(sc, 1).
```

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GraphFrames

A library for graph processing using PySpark.

Example

```
from graphframes import GraphFrame; g =
GraphFrame(vertices, edges).
```

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Accumulators

Variables that can only be "added" to, used for aggregating information across executors.

Example

accum = sc.accumulator(0).

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Broadcast Variables

Variables that are cached on each machine to efficiently distribute large values.

Example

broadcastVar = sc.broadcast([1, 2, 3]).

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Partitioning

Dividing data into partitions for parallel processing.

Example

```
rdd = rdd.repartition(4).
```

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Shuffling

Redistributing data across different nodes, required by certain transformations like reduceByKey.

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Caching

Storing RDDs in memory for faster access during iterative algorithms.

Example

rdd.cache().

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Persisting

Storing RDDs with different storage levels (memory, disk, etc.).

Example

rdd.persist(StorageLevel.MEMORY_AND_DISK).

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Checkpointing

Saving RDDs to reliable storage to truncate lineage graphs and provide fault tolerance.

Example

rdd.checkpoint().

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Fault Tolerance

Recovering lost data using lineage information.

Example

Handling node failures by recomputing lost partitions.

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Lineage

Tracking the sequence of transformations that produced an RDD.

Example
Viewing lineage with rdd.toDebugString.

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MapReduce

A programming model for processing large datasets with a distributed algorithm on a cluster.

Example

Implementing a simple MapReduce job:
rdd.map(...).reduceByKey(...).

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HDFS

Integration with Hadoop Distributed File System for data storage.

Example

```
rdd = sc.textFile("hdfs://path/to/file").
```

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Data Sources

Reading and writing data from various sources like HDFS, S3, JDBC, and more.

Example

```
df = spark.read.jdbc(url, table, properties).
```

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SQL Functions

Built-in functions for data manipulation and analysis in Spark SQL.

Example

```
df.select(concat(col("name"), lit(" "),
col("surname"))).
```

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Column Pruning

An optimization technique that only reads necessary columns from the data source.

Example

Using column pruning with DataFrame API.

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Predicate Pushdown

An optimization technique that pushes filter conditions to the data source.

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Catalyst Optimization

Spark's internal optimization framework for generating efficient execution plans.

Example

Viewing optimized logical plan with df.queryExecution.optimizedPlan.

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Tungsten

An execution engine in Spark SQL for memory management and binary processing.

Example

Enabling Tungsten optimization:
spark.sql.tungsten.enabled = true.

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Job

A complete computation expressed as a high-level action like count or saveAsTextFile.

Example

rdd.count().

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Stage

A set of parallel tasks that will be executed as a unit.

Example
Viewing stages in Spark UI for a job.

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Task

The smallest unit of work in Spark, executed by an executor.

Example

Monitoring task execution in Spark UI.

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Cache

Storing RDDs in memory to speed up repeated access.

Example

rdd.cache().

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Persist

Storing RDDs with different storage levels (memory, disk, etc.).

Example

rdd.persist(StorageLevel.MEMORY_AND_DISK).

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Checkpoint

Saving an RDD to a reliable storage to truncate the lineage graph and provide fault tolerance.

Example

rdd.checkpoint().

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Fault Tolerance

Spark's ability to recompute lost data using lineage information.

Example

Handling node failures by recomputing lost partitions.

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Lineage

The logical execution plan that Spark builds to keep track of the transformations applied to an RDD.

Example
Viewing lineage with rdd.toDebugString.

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MapReduce

A programming model for processing large datasets with a parallel, distributed algorithm.

Example

Implementing a simple MapReduce job in Spark: rdd.map(...).reduceByKey(...).

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HDFS

Integration with Hadoop Distributed File System for data storage.

Example

Reading data from HDFS:

```
val rdd = sc.textFile("hdfs://path/to/file").
```

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Data Sources

Interfaces for reading and writing data from various sources like HDFS, S3, JDBC, and more.

Example

Reading data from a JDBC source:

```
val df = spark.read.jdbc(url, table, properties).
```

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SQL Functions

Built-in functions for data manipulation and analysis in Spark SQL.

Example

Using concat function:

```
df.select(concat(col("name"), lit(" "),
col("surname")).
```

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User-Defined Functions (UDFs)

Custom functions defined by users to extend Spark SQL capabilities.

Example

```
spark.udf.register("add_one", lambda x: x + 1,
IntegerType()).
```

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Window Functions

Functions that perform calculations across a set of rows related to the current row.

Example

```
df.withColumn("rank", row_number()
.over(Window.partitionBy("dept")
.orderBy("salary"))).
```

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GroupBy

Grouping data by one or more columns for aggregation.

Example

```
df.groupBy("department").agg(avg("salary")).
```

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Join

Combining rows from two or more DataFrames based on a related column.

Example

```
df1.join(df2, df1("id") === df2("id")).
```

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Sorting

Ordering rows in a DataFrame based on column values.

Example

```
df.sort("age", ascending=True).
```

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Aggregations

Computing summary statistics of data groups.

Example

```
df.groupBy("department").agg(sum("salary"))
```

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Pivot

Transforming unique values from one column into multiple columns.

Example

```
df.groupBy("year").pivot("quarter").sum("revenue").
```

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DataFrame Operations

Common operations on DataFrames, such as selecting, filtering, and grouping.

Example

```
df.select("name").filter(df("age") > 21).
```

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Schema

Defining the structure of a DataFrame with column names and types.

Example

```
schema = StructType([StructField("name",
StringType(), True), StructField("age",
IntegerType(), True)]).
```

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DataFrame Creation

Creating DataFrames from various data sources like CSV, JSON, and RDDs.

Example

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

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DataFrame Transformation

Modifying DataFrames using operations like withColumn, filter, groupBy, and agg.

Example

```
df.withColumn("new_col", df("col1") + df("col2"))
```

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DataFrame Actions

Triggering computations and returning results to the driver.

Example

df.show().

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SQL Queries

Executing SQL queries on DataFrames.

Example

```
df.createOrReplaceTempView("table");
spark.sql("SELECT * FROM table").
```

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Joins

Combining DataFrames based on common columns.

Example

```
df1.join(df2, df1("id") === df2("id")).
```

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Aggregations

Aggregating data in DataFrames using functions like sum, avg, and count.

Example

```
df.groupBy("department").agg(sum("salary"))
```

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Filtering

Filtering rows based on column values.

Example

```
df.filter(df("age") > 21).
```

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Selection

Selecting specific columns from a DataFrame.

Example

```
df.select("name", "age").
```

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Renaming

Renaming columns in a DataFrame.

Example

```
df.withColumnRenamed("old_name",
"new_name")
```

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Dropping Columns

Removing columns from a DataFrame.

Example

```
df.drop("column_name").
```

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Merging

Combining multiple DataFrames into one.

Example

df1.union(df2).

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Pivoting

Transforming data to show unique values from one column as multiple columns.

Example

```
df.groupBy("year")
.pivot("quarter")
.sum("revenue").
```

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Unpivoting

Transforming data from columns into rows.

Example

```
melted_df = df.selectExpr("stack(3, 'Q1', Q1,
'Q2', Q2, 'Q3', Q3) as (quarter, revenue)").
```

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Writing

Writing DataFrames to external storage systems like HDFS, S3, or databases.

Example

df.write.csv("output.csv").

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Reading

Reading data from various external storage systems into DataFrames.

Example

```
df = spark.read.json("input.json").
```

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Repartitioning

Changing the number of partitions of a DataFrame.

Example

df.repartition(10).

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Coalescing

Reducing the number of partitions of a DataFrame.

Example

df.coalesce(1).

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Serialization

Converting DataFrame rows into a format that can be stored and transmitted.

Example

Using PySpark's built-in serializers like pickle and Kryo.

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Deserialization

Converting serialized data back into DataFrame rows.

Example

Reading serialized data and converting it back to DataFrame.

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Functions

Built-in functions for performing operations on DataFrames.

Example

```
from pyspark.sql.functions
import col, lit; df.select(col("name"), lit(1)).
```

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Column Operations

Performing operations on DataFrame columns.

Example

```
df.withColumn("new_col", df("col1") + df("col2"))
```

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Exploding

Transforming a DataFrame with nested structures into a flat DataFrame.

Example

```
df.select("name", explode("hobbies"))
```

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Aggregation Functions

Built-in functions for aggregating data in DataFrames.

Example

```
from pyspark.sql.functions import sum, avg;
df.groupBy("dept")
.agg(sum("salary"), avg("salary"))
```

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Statistics

Computing summary statistics of DataFrames.

Example

df.describe().show().

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Union

Combining rows from two DataFrames into one.

Example

df1.union(df2).

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Intersect

Finding common rows between two DataFrames.

Example

df1.intersect(df2).

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Except

Finding rows in one DataFrame that are not in another.

Example

df1.except(df2).

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Distinct

Removing duplicate rows from a DataFrame.

Example

df.distinct().

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Drop Duplicates

Removing duplicate rows based on specific columns.

Example

```
df.dropDuplicates(["col1", "col2"]).
```

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Missing Data Handling

Handling missing values in DataFrames.

Example

df.fillna(0).

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Date Functions

Working with date and time data in DataFrames.

Example

```
df.withColumn("year", year("date_col"))
```

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String Functions

Performing operations on string columns in DataFrames.

Example

```
df.withColumn("uppercase_name",
upper("name"))
```

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Conversion

Converting between different data types in DataFrames.

Example

```
df.withColumn("int_col", col("string_col")
.cast("int")).
```

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Explode

Converting an array column into multiple rows, one for each element in the array.

Example

```
df.select("name", explode("hobbies")).
```

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JSON Functions

Working with JSON data in DataFrames.

Example

```
df.selectExpr("json_tuple(json_col, 'key1',
'key2')").
```

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Advanced Analytics

Using advanced analytical functions available in PySpark.

Example

```
df.stat.freqItems(["col1", "col2"]).
```

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Vectorized UDFs

UDFs that operate on entire columns at once, improving performance.

Example

```
from pyspark.sql.functions import pandas_udf;
@pandas_udf("int") def add_one(s: pd.Series) -
> pd.Series: return s + 1.
```

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THANK YOU

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