SparkSQL

Structured big-data processing in Spark

Structured Data Processing

- Spark RDD is good for general-purpose processing
- For (semi-)structured data, you need to provide your own parser and logic
- Due to the popularity of (semi-) structured data processing, SparkSQL was added to facilitate this task

Shark (Spark on Hive)

- A small side project that aimed to running RDD jobs on Hive data using HiveQL
- Still limited to the data model of Hive
- Tied to the Hadoop world

SparkSQL

- Redesigned to consider Spark query model
- Supports all the popular relational operators
- Can be intermixed with RDD operations
- Uses the Dataframe API as an enhancement to the RDD API

Dataframe = RDD + schema

Dataframes

- SparkSQL's counterpart to relations or tables in RDMBS
- Consists of rows and columns
- A dataframe is **NOT** in 1NF
  - Why?
- Can be created from various data sources
  - CSV file
  - JSON file
  - MySQL database
  - Hive
  - Parquet column-format files

Dataframe Vs RDD

Dataframe

- Lazy execution
- Spark is aware of the data model
- Spark is aware of the query logic
- Can optimize the query

RDD

- Lazy execution
- The data model is hidden from Spark
- The transformations and actions are black boxes
- Cannot optimize the query

Built-in operations in SprkSQL

- Filter (Selection)
- Select (Projection)
- Join
- GroupBy (Aggregation)
- Load/Store in various formats
- Cache
- Conversion between RDD (back and forth)

SparkSQL Examples

Project Setup

```
# In dependencies pom.xml
<!--
https://mvnrepository.com/artifact/org.apache.spark
/spark-sql -->
<dependency>
    <groupId>org.apache.spark</groupId>
    <artifactId>spark-sql_2.12</artifactId>
    <version>3.0.1</version>
</dependency>
```

Code Setup

```
SparkSession sparkS = SparkSession
        .builder()
        .appName("Spark SQL examples")
        .master("local")
        .getOrCreate();

Dataset<Row> log_file = sparkS.read()
        .option("delimiter", "\t")
        .option("header", "true")
        .option("inferSchema", "true")
        .csv("nasa_log.tsv");
log_file.show();
```

Filter Example

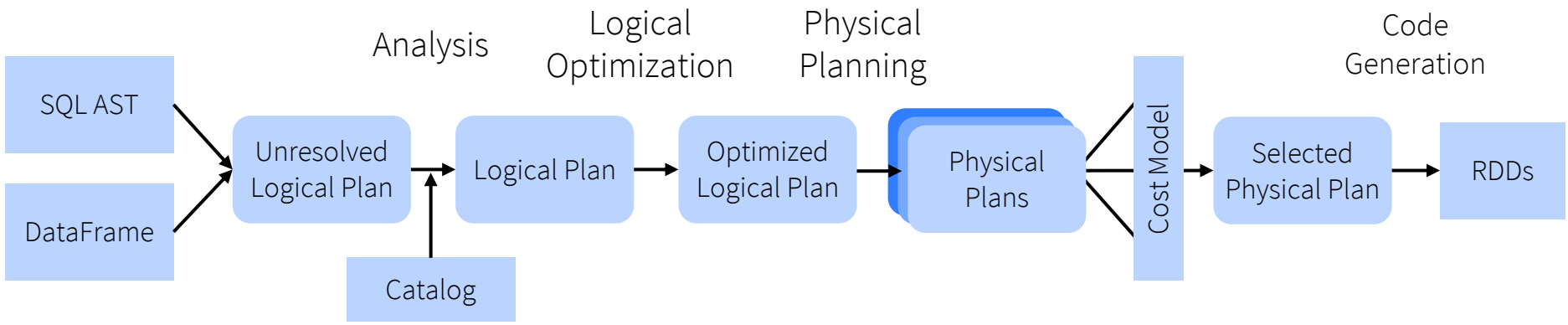
```
# Select OK lines
Dataset<Row> ok_lines =
log_file.filter("response=200");
long ok_count = ok_lines.count();
System.out.println("Number of OK lines is
"+ok_count);


# Grouped aggregation using SQL
Dataset<Row> bytesPerCode =
log_file.sqlContext().sql("SELECT response,
sum(bytes) from log_lines GROUP BY response");
```

SparkSQL Features

- Catalyst query optimizer
- Code generation
- Integration with libraries

SparkSQL Query Plan

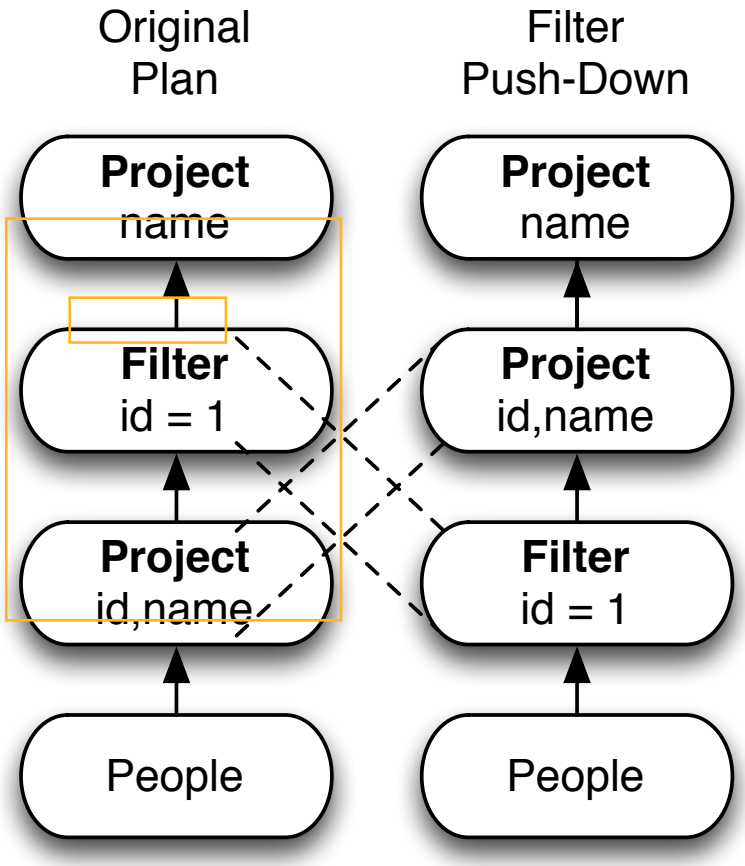


DataFrames and SQL share the same optimization/execution pipeline

Credits: M. Armbrust

Catalyst Query Optimizer

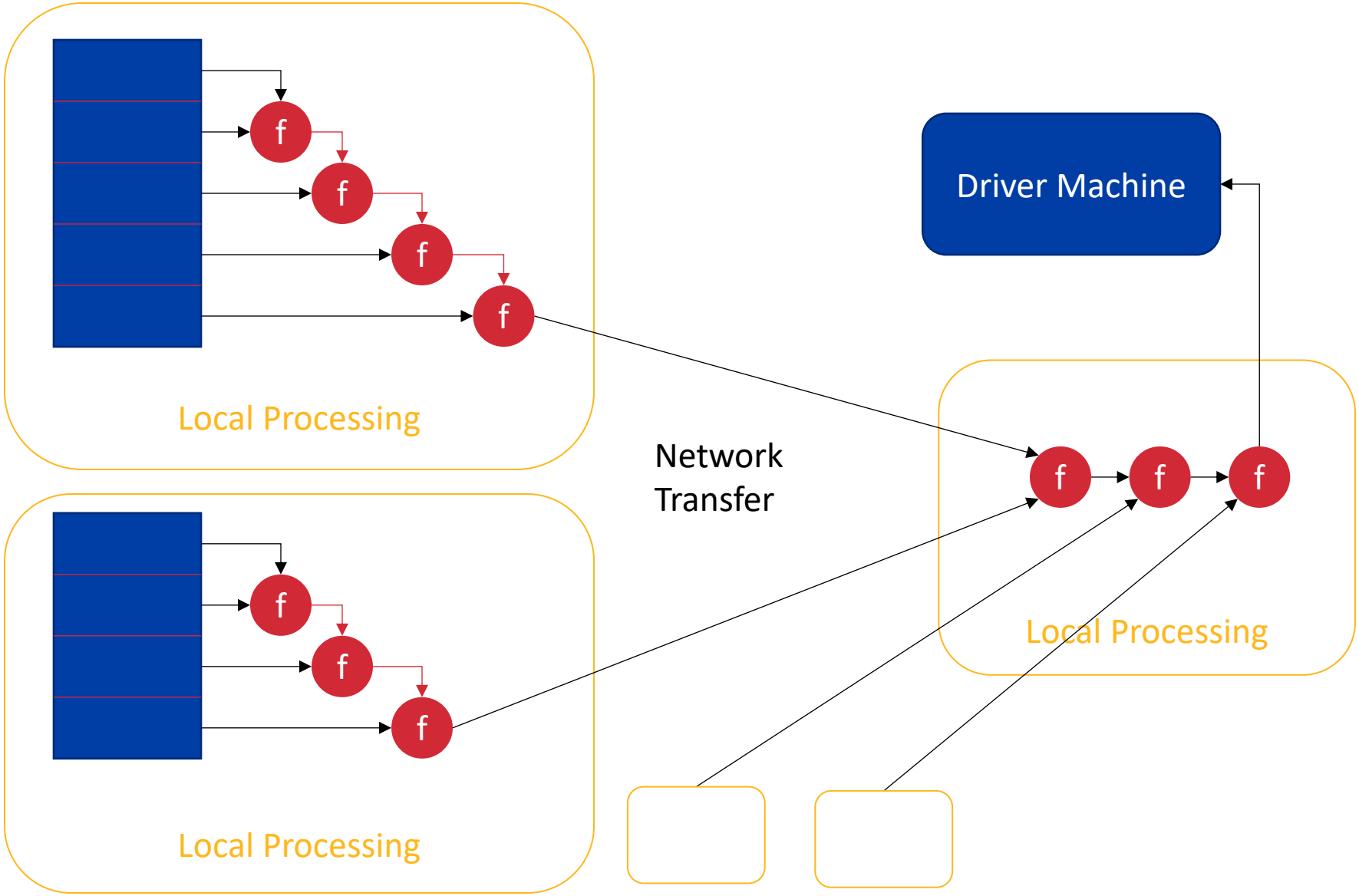
- Extensible rule-based optimizer
- Users can define their own rules



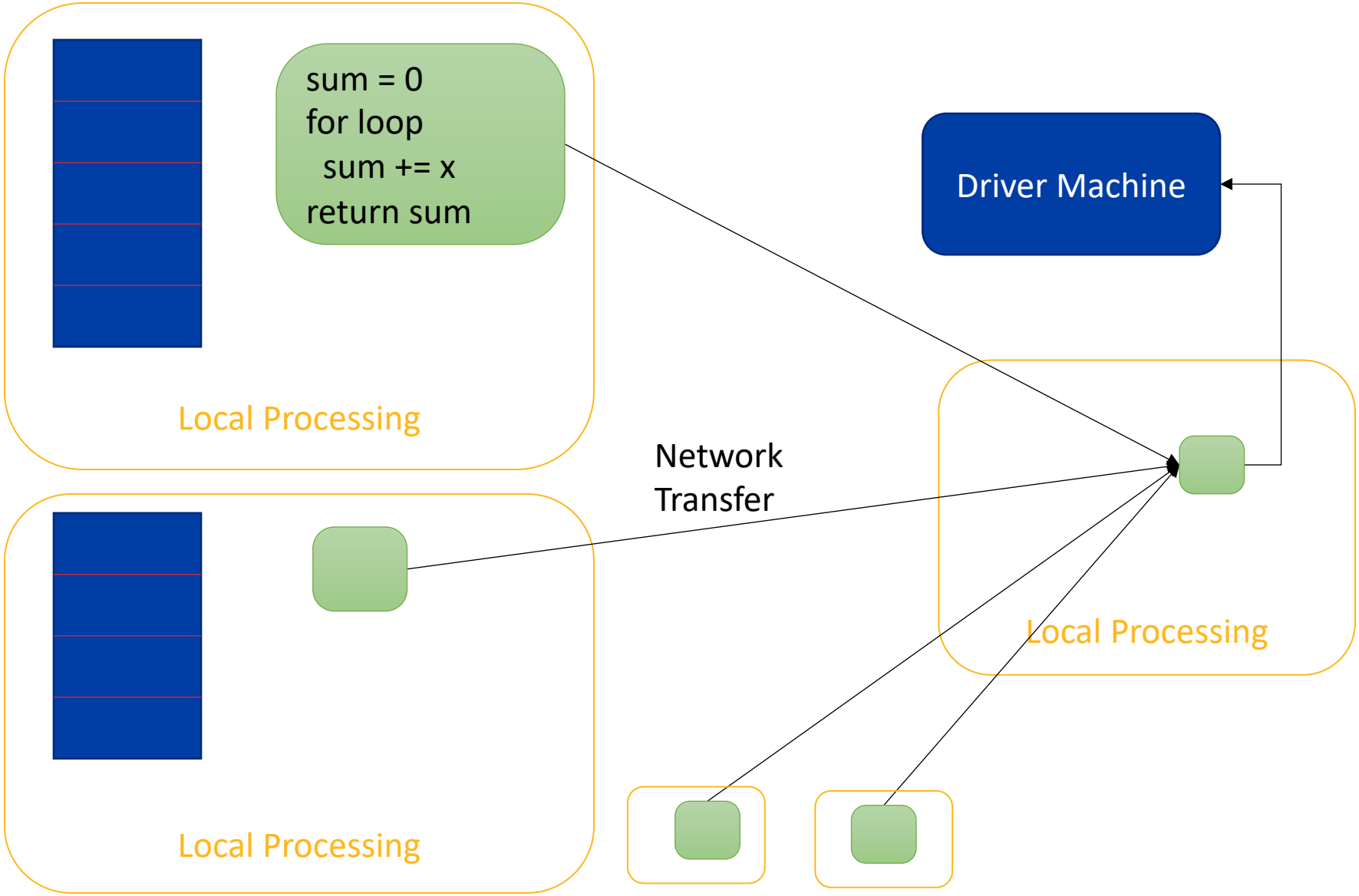
Code Generation

- Shift from black-box UDF to **Expressions**
- Example
  - `# Filter`
  - `Dataset<Row> ok_lines = log_file.filter("response=200");`
  - `# Grouped aggregation`
  - `Dataset<Row> bytesPerCode = log_file.sqlContext().sql("SELECT response, sum(bytes) from log_lines GROUP BY response");`
- SparkSQL understands the logic of user queries and rewrites them in a more concise way

Example: Aggregation (SparkRDD)



Example: Aggregation (SparkSQL)



Integration

- SparkSQL is integrated with other high-level interfaces such as MLlib, PySpark, and SparkR
- SparkSQL is also integrated with the RDD interface and they can be mixed in one program

Further Reading

- Documentation
  - http://spark.apache.org/docs/latest/sql-programming-guide.html
- SparkSQL paper
  - M. Armbrust *et al*. "Spark sql: Relational data processing in spark." SIGMOD 2015