Procesamiento Distribuido Masivo

Apache Spark

APACHE SPARK

- Research project at UC Berkeley in 2009
- Fast and general-purpose cluster computing system
- APIs: Scala, Java, Python, R, and SQL
- Built by more than 1,000 developers from more than 200 companies

What is Apache Spark?

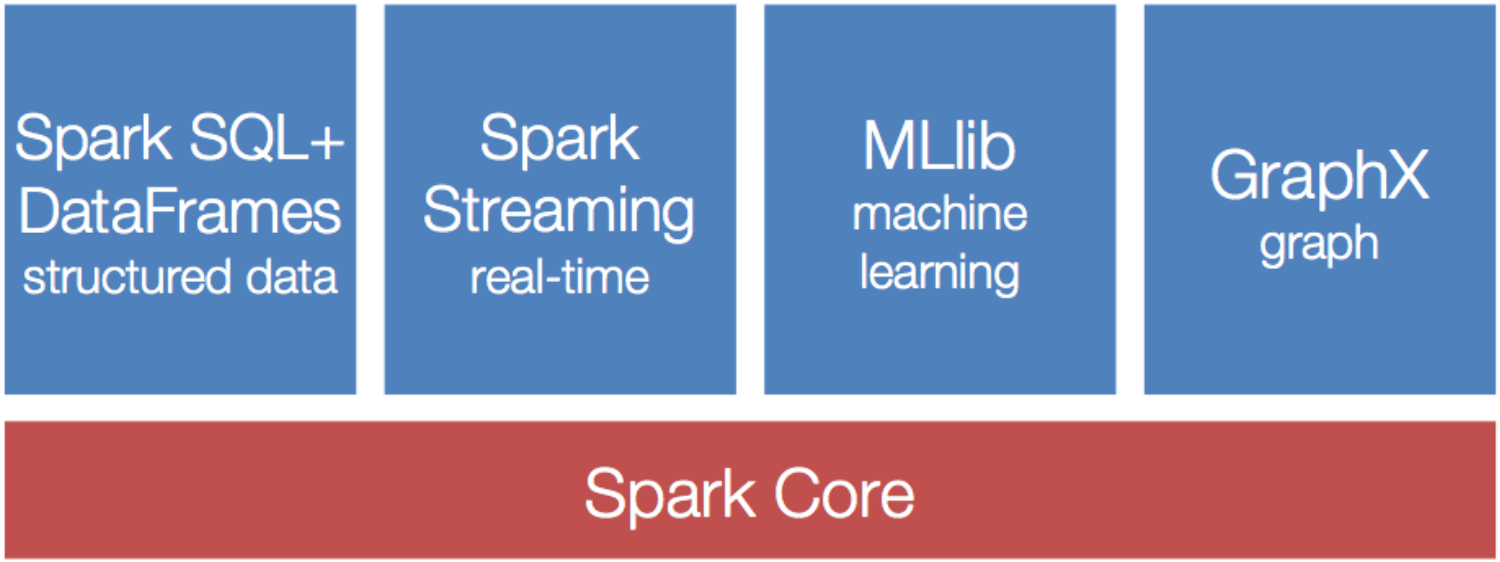
- Open source computing engine for clusters

- Many API and libraries
  - API: scala, java, python, R
  - SQL, ML, Graphs, Streaming

Througputh

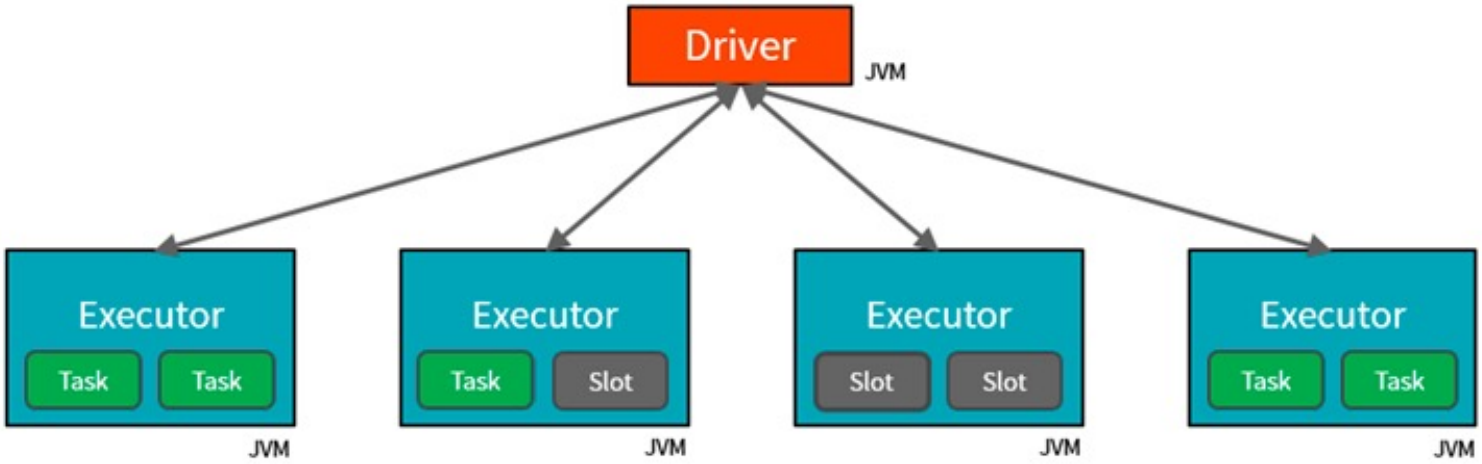

K-means Clustering
4.1
121
Spark
Hadoop MR
0
50
100
150 sec
Logistic Regression
0.96
80
Spark
Hadoop MR
0
20
40
60
80
100 sec

Libraries Built on Spark



SPARK CLUSTER

- One Driver and many Executor JVMs



RDD

- *Resilient:* Fault-tolerant
- *Distributed:* Computed across multiple nodes
- *Dataset:* Collection of partitioned data

- Immutable once constructed
- Track lineage information
- Operations on collection of elements in parallel

Basic Idea

- Write apps in terms of transformations on distributed datasets
- Resilient distributed datasets (RDDs)
  - Objects across the cluster
  - Transformations: Operations over RDD (map, filter, groupBy, etc)
  - Actions (count, collect, save, etc)
- In-memory computing

Transformations	Actions
Map	Reduce
Filter	Count
Sample	TakeSample
Union	Take
ReduceByKey	Collect

DATAFRAME

- Data with columns (built on RDDs)
- Improved performance via optimizations

Construct DataFrames via:

- Transforming existing DataFrame
- Files in storage system (e.g. HDFS, SQL DW)
- Parallelizing existing collections (e.g. Pandas DF)

Spark SQL & DataFrames

APIs for *structured data* (table-like data)

- SQL
- DataFrames: dynamically typed
- Datasets: statically typed

Similar optimizations to relational databases

DataFrame API

Domain-specific API similar to Pandas and R

» DataFrames are tables with named columns

```
users = spark.sql("select * from users")

ca_users = users[users["state"] == "CA"]

ca_users.count()

ca_users.groupBy("name").avg("age")

caUsers.map(lambda row: row.name.upper())
```

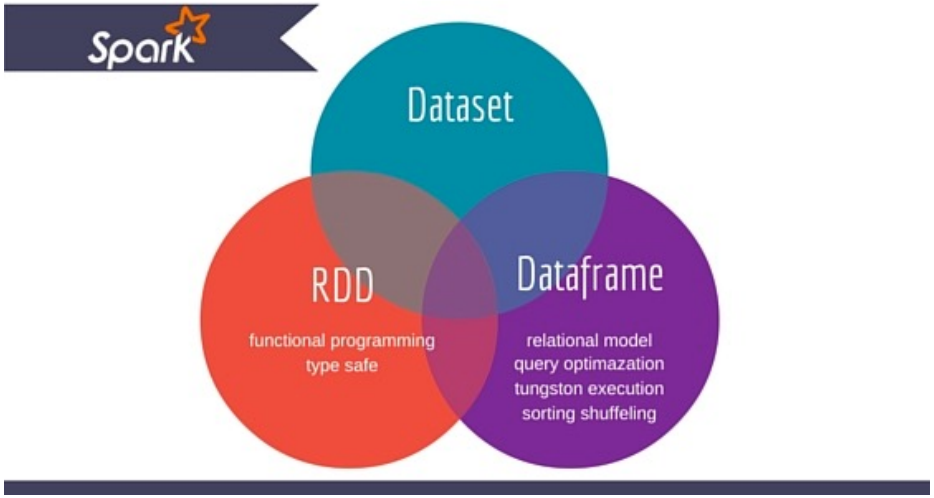
Expression AST

WHY SWITCH TO DATAFRAMES?

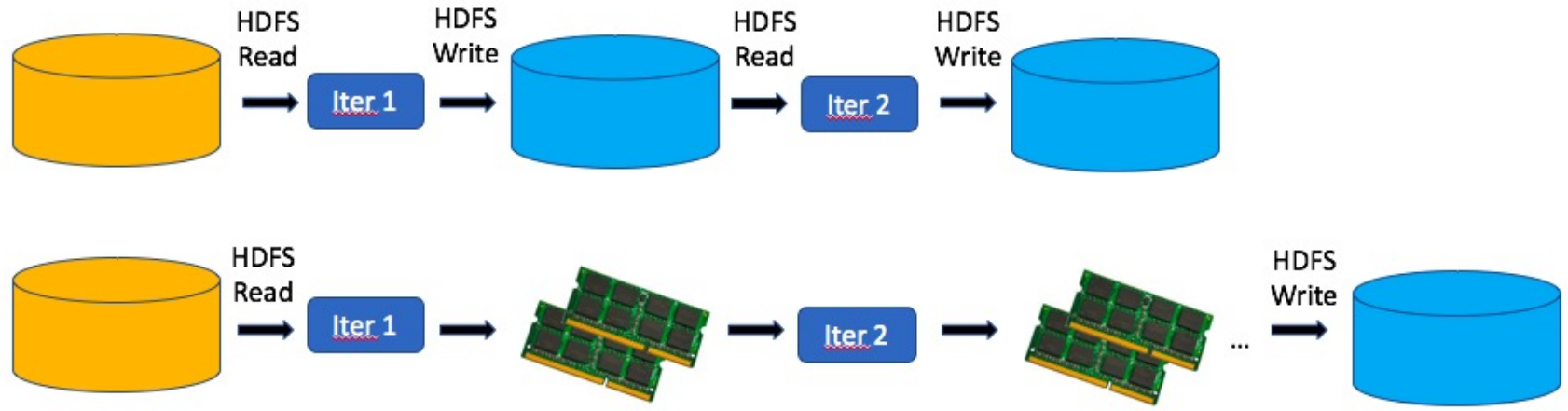
- User-friendly API
- Benefits:
  - SQL/DataFrame queries
  - Tungsten and Catalyst optimizations
  - Uniform APIs across languages
- Facilitate ML Pipelines

DATASETS

- Generalization of DataFrames
- Supports more data types and stronger type enforcement



SPARK VS MAPREDUCE



WHEN TO USE SPARK?

- Scale out: Model or data too large to process on a single machine
- Speed up: Benefit from faster results

Wordcount in pyspark

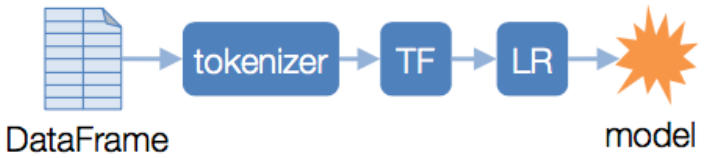
```
$ pyspark

>>> filesRDD = sc.textFile(”hdfs:///datasets/gutenberg-small/")

>>> wc = filesRDD.flatMap(lambda line: line.split(" ")).map(lambda word:
(word,1)).reduceByKey(lambda x,y: x + y)

>>> output = wc.collect()

>>> for (word,count) in output:

…                print("%s: %i" % (word,count))
```

MLlib

High-level *pipeline* API similar to SciKit-Learn

Acts on DataFrames

Grid search and cross validation for tuning

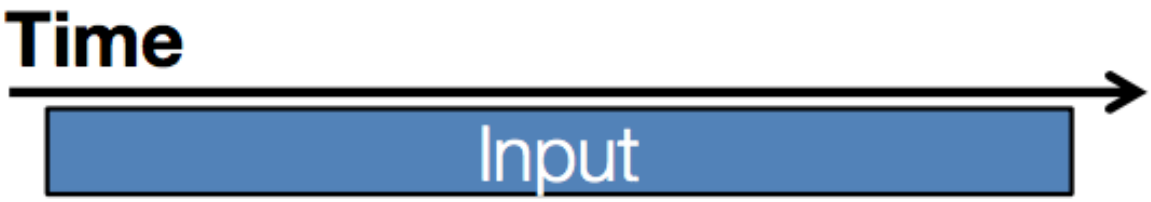



```
tokenizer = Tokenizer()
tf = HashingTF(numFeatures=1000)
lr = LogisticRegression()

pipe = Pipeline(
    [tokenizer, tf, lr])
model = pipe.fit(df)
```

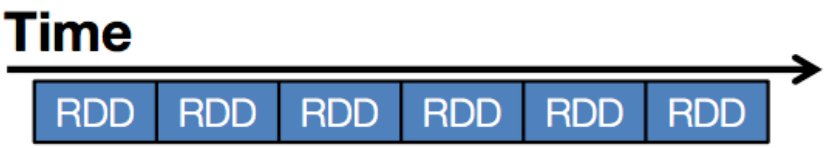
MLlib Algorithms

- Generalized linear models
- Alternating least squares
- Decision trees
- Random forests, GBTs
- Naïve Bayes
- PCA, SVD
- AUC, ROC, f-measure
- K-means
- Latent Dirichlet allocation
- Power iteration clustering
- Gaussian mixtures
- FP-growth
- Word2Vec
- Streaming k-means

Spark Streaming



Spark Streaming



Represents streams as a series of RDDs over time

```
val spammers = sc.sequenceFile("hdfs://spammers.seq")

sc.twitterStream(...)
  .filter(t => t.text.contains("Stanford"))
  .transform(tweets => tweets.map(t => (t.user, t)).join(spammers))
  .print()
```