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Advanced Analytics With Splunk Using Apache Spark Machine Learning And Spark Graph

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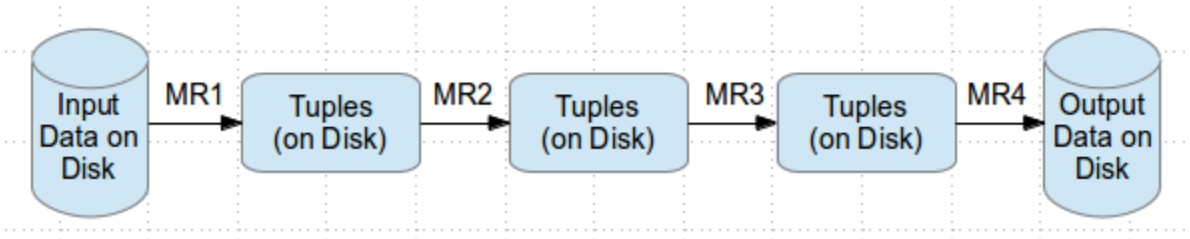
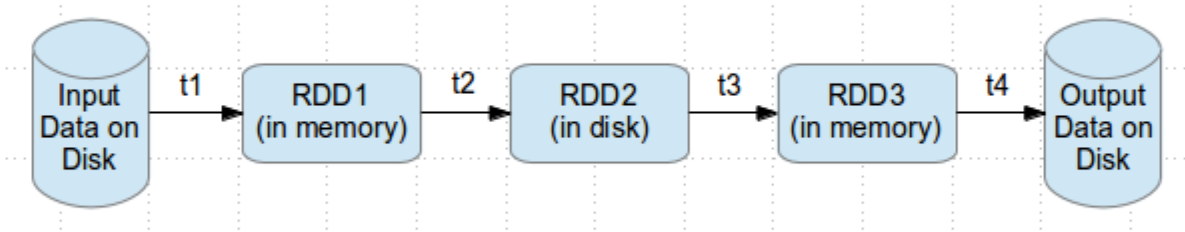
Why Spark?

- Most of machine learning algorithms are iterative because each iteration can improve the results
- With disk based approach each iteration's output is written to disk, making it slow

Hadoop execution flow



Spark execution flow



http://www.wiziq.com/blog/hype-around-apache-spark/

About Apache Spark

- Initially started at UC Berkeley in 2009
- Fast and general purpose cluster computing system
- 10x (on disk) - 100x (In-Memory) faster
- Most popular for running *Iterative Machine Learning Algorithms.*
- Provides high level APIs in
  - Java, Scala, Python
- Integration with Hadoop and its ecosystem and can **read existing data**

http://spark.apache.org/

Introducing Spark

Spark SQL DataFrames | Spark Streaming | MLlib | GraphX

Spark Core

HDFS | Hive | HBase | S3 | Cassandra | Others

Spark Core

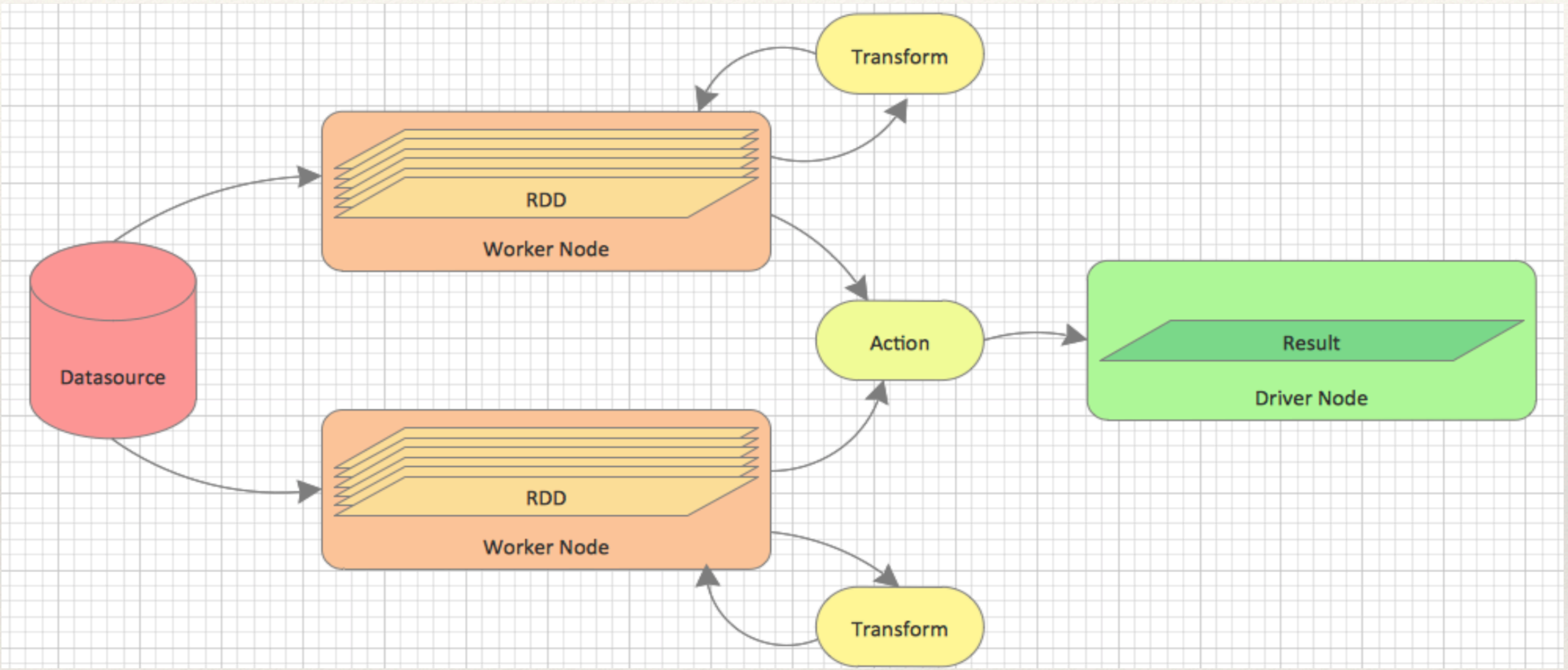
Spark Core

- Spark Core contains the basic functionality of Spark
  - Task scheduling
  - Memory management
  - Fault recovery
  - Interacting with storage systems
- Home to ***Resilient Distributed Datasets (RDDs)***
- Provides many APIs for building and manipulating RDD

Resilient Distributed Dataset (RDD)

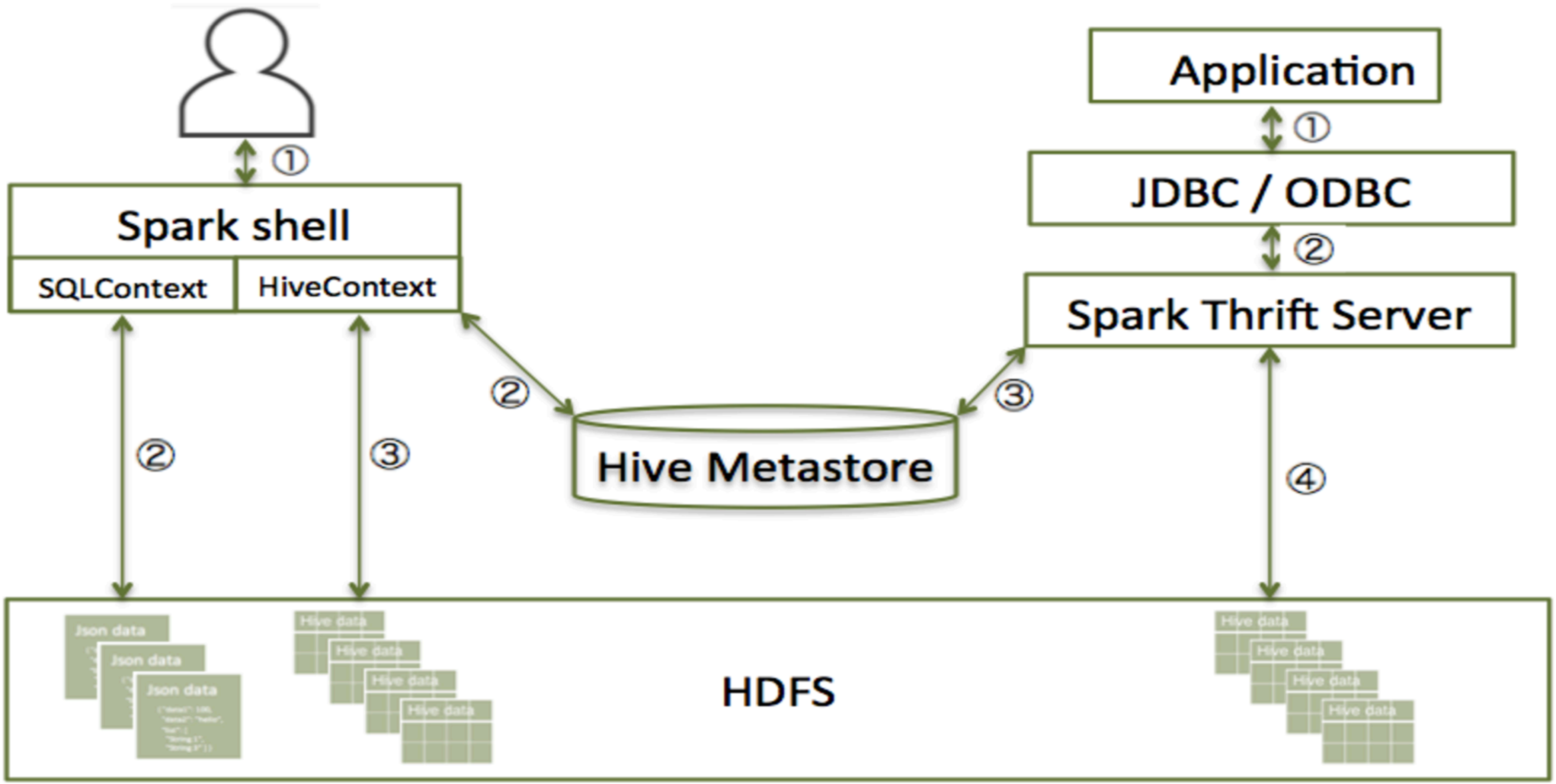
- Resilient Distributed Dataset (RDD) is a basic abstraction in Spark
- Immutable, partitioned collection of elements that can be operated in parallel
- Basic Operations
  - map
  - filter
  - persist
- Multiple Implementation
  - PairRDDFunctions : RDD of Key-Value Pairs, groupByKey, Join
- RDD main characteristics:
  - A list of partitions
  - A function for computing each split

Spark Core Architecture



Spark SQL DataFrames

Interfaces to Spark SQL



SQLContext

- Most powerful way to use Spark SQL is inside a Spark application
- Load data and query it with SQL while simultaneously combining it with "regular" program code utilizing `SQLContext` or `HiveContext`

```
// SQL Imports
// Import Spark SQL. If you can't have
the
// hive dependencies

import org.apache.spark.sql.SQLContext

// Construct SQL Context
val sqlContext = new SQLContext(…)
```

```
// SQL Imports
// Import Spark SQL

import
org.apache.spark.sql.hive.HiveContext

// Construct Hive Context
val hiveContext = new HiveContext(…)
```

HiveContext (Recommended)

- Provides a superset of the functionality in addition to the basic SQLContext
- Write queries using the more complete HiveQL parser
- Access to Hive UDFs and ability to read data from Hive tables
- Build DataFrames (represent structure data), and operate on them with SQL or with normal RDD operations like map

DataFrames

- Offers rich relational/procedural integration within Spark programs
- DataFrames:
  - Collections of structured records that can be manipulated using Spark's procedural API or new relational API
  - Perform relational operations on DataFrames using a domain-specific language (DSL) similar to R data frames and Python Pandas
  - Pass Scala, Java or Python functions through DataFrames to build a logical plan
  - Create directly from Spark's distributed objects
  - Enable relational relational processing in existing Spark programs
- Automatically store data in a columnar format
- Go through a relational optimizer, *Catalyst*
- Standard data representation in a new "ML pipeline" API for machine learning

Query Federation To External Databases

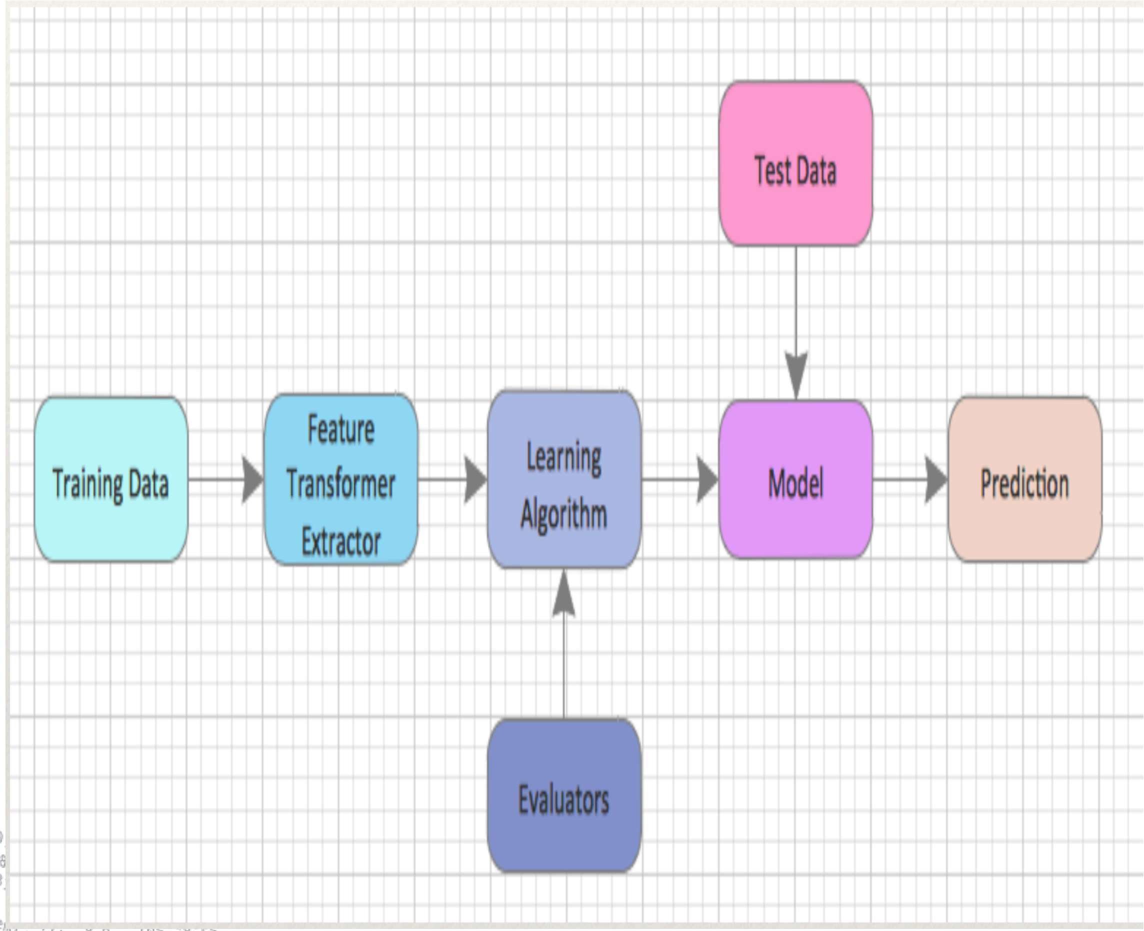
- Data pipelines often combine data from heterogeneous sources
- Spark SQL data sources leverage Catalyst to push predicates down into the data sources whenever possible

Example: **Use JDBC data source and JSON data source to join two tables together**

```
▶CREATE TEMPORARY TABLE users USING jdbc
OPTIONS(driver "mysql" url "jdbc:mysql://userDB/users ")
▶CREATE TEMPORARY TABLE logs
USING json OPTIONS (path "logs.json")
▶SELECT users.id,users.name,logs.message
FROM users JOIN logs WHERE users.id=logs.userId
AND users.registrationDate > "2015-01-01"
```

Spark MLlib

Spark Machine Learning Basics



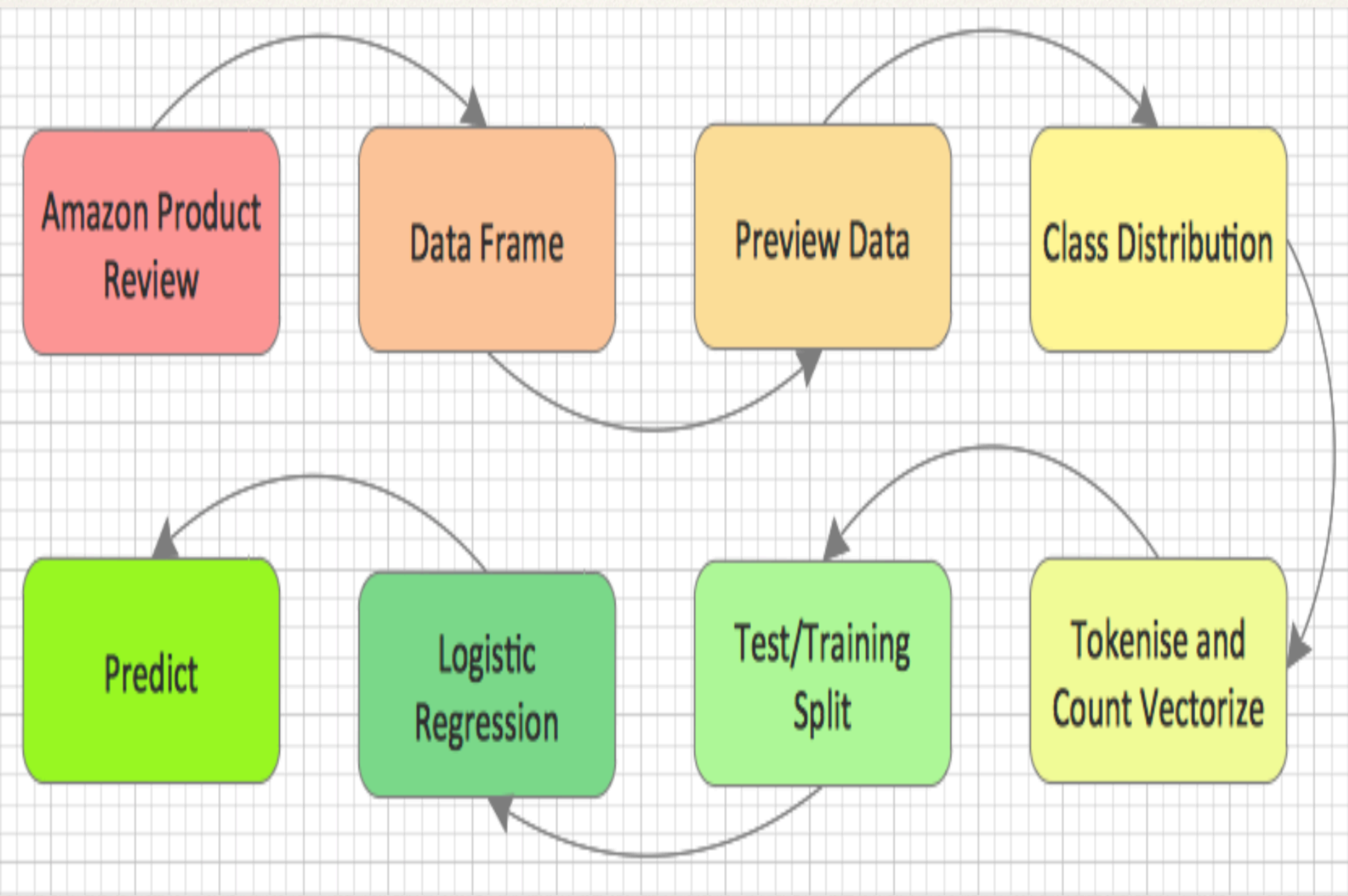
ML algorithms include:

- Classification: logistic regression, naive Bayes,...
- Regression: generalized linear regression, survival regression...
- Decision trees, random forests, and gradient-boosted trees
- Recommendation: alternating least squares (ALS)
- Clustering: K-means, Gaussian mixtures (GMMs),...
- Topic modeling: latent Dirichlet allocation (LDA)
- Frequent itemsets, association rules, and sequential pattern mining

ML workflow utilities include:

- Feature transformations: standardization, normalization, hashing,...
- ML Pipeline construction
- Model evaluation and hyper-parameter tuning
- ML persistence: saving and loading models and Pipelines
- Distributed linear algebra: SVD, PCA,...
- Statistics: summary statistics, hypothesis testing,...

Spark Classification ML Example



Supervised learning for predicting discrete labels

Multiple algorithms

- **logistic regression**
- Decision tree classifier
- Random forest classifier
- Gradient boosted tree classifier
- Multi-layer neural network classifier

Spark Classification ML Code Example

1 Extract Fields

```
val trainingDataTable = sql("""

  SELECT e.action

         u.age,

         u.latitude,

         u.logitude

  FROM Users u

  JOIN Events e

  ON u.userId = e.userId""")
```

2 Build Model

```
val trainingData = trainingDataTable.map { row =>
```

```
val model =

  new LogisticRegressionWithSGD().run(trainingData)
```

3 Predict

```
case class Score(userId: Int, score: Double)

val scores = allCandidates.map { row =>

  val features = Array[Double](row(1), row(2), row(3))

  Score(row(0), model.predict(features))

}
```

Spark GraphX

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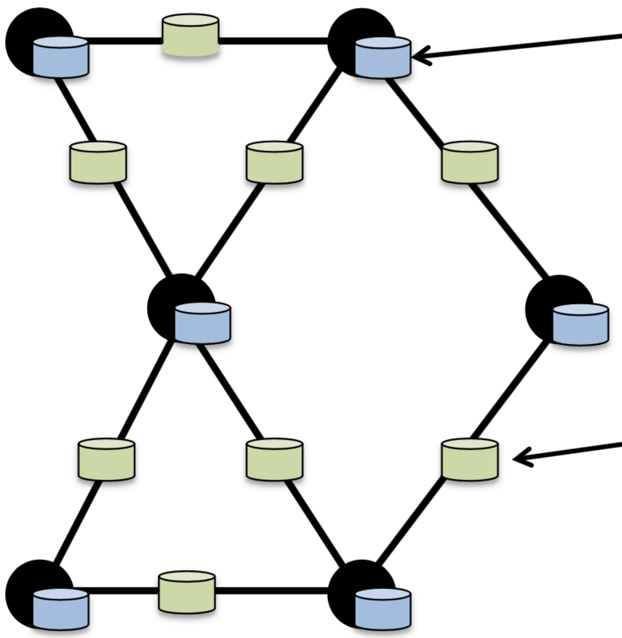
Spark GraphX



Vertex Property:

- User Profile
- Current PageRank Value

Edge Property:

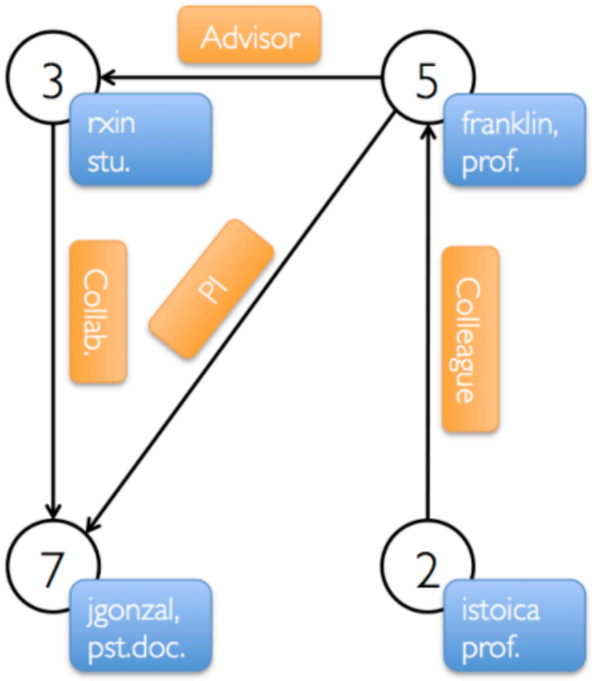
- Weights
- Relationships
- Timestamps

Multiple Algorithms

- PageRank
- Connected components
- Label propagation
- SVD++
- Strongly connected components
- Triangle count

Spark GraphX Example

Property Graph



Vertex Table

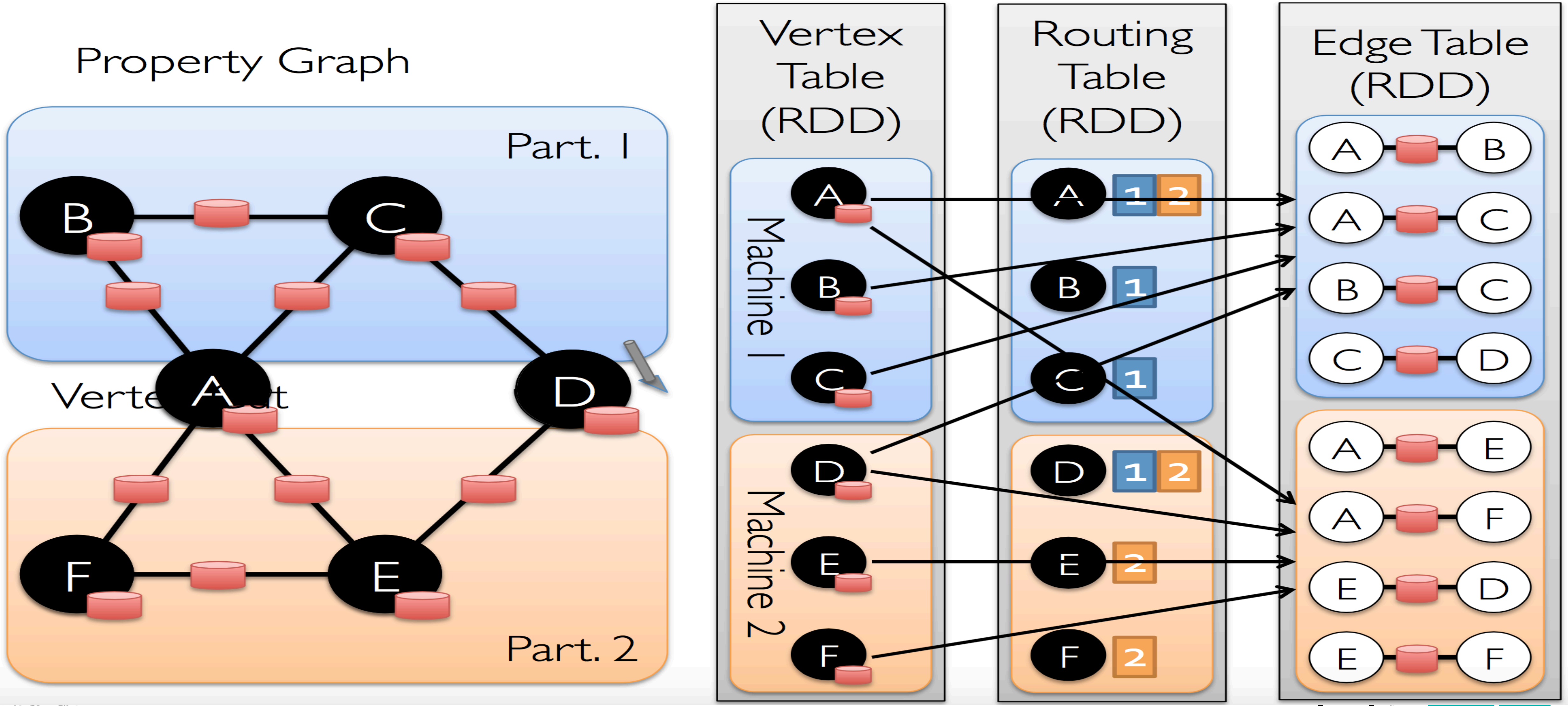
Id	Property (V)
3	(rxin, student)
7	(jgonzal, postdoc)
5	(franklin, professor)
2	(istoica, professor)

Edge Table

SrcId	DstId	Property (E)
3	7	Collaborator
5	3	Advisor
2	5	Colleague
5	7	PI

```scala
// Assume the SparkContext has already been constructed
val sc: SparkContext
// Create an RDD for the vertices
val users: RDD[(VertexId, (String, String))] =
  sc.parallelize(Array((3L, ("rxin", "student")), (7L, ("jgonzal", "postdoc")),
                       (5L, ("franklin", "prof")), (2L, ("istoica", "prof"))))
// Create an RDD for edges
val relationships: RDD[Edge[String]] =
  sc.parallelize(Array(Edge(3L, 7L, "collab"),    Edge(5L, 3L, "advisor"),
                       Edge(2L, 5L, "colleague"), Edge(5L, 7L, "pi")))
// Define a default user in case there are relationship with missing user
val defaultUser = ("John Doe", "Missing")
// Build the initial Graph
val graph = Graph(users, relationships, defaultUser)
```

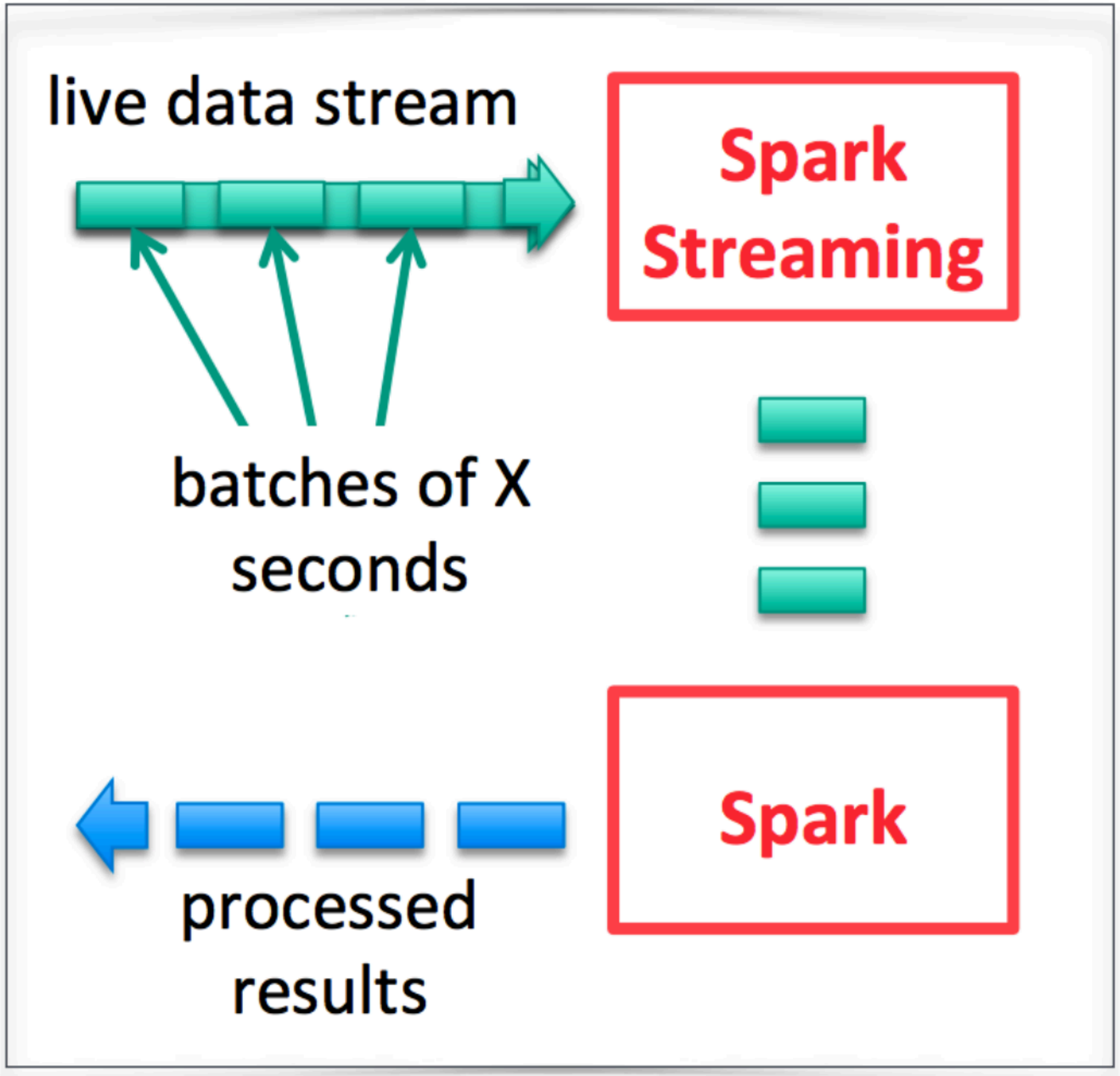
Spark GraphX Architecture



Spark Stream

Spark Stream

- *Chop up the live stream into batches of X seconds*
- *Spark treats each batch of data as RDDs and processes them using RDD operations*
- *Finally, the processed results of the RDD operations are returned in batches*



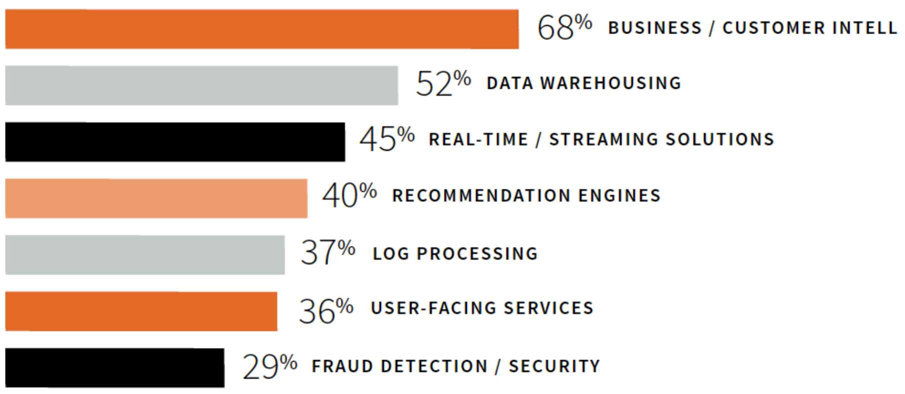
	Kafka Streams	Storm	Spark Streaming	Flink
Integration	Easy	Difficult	Difficult	Difficult
Development	Easy, flexible	Difficult	Difficult	Difficult
Operations	Easy	Difficult (Clustering)	Difficult (Clustering)	Difficult (Clustering)
Infrastructure	Small	Large (Clustering)	Large (Clustering)	Large (Clustering)
Delivery	At least once	At least once	Exactly Once	Exactly Once
Latency	Milliseconds	Seconds	Milliseconds	Milliseconds
Fault Tolerance	Yes	Yes	Yes	Yes
Scalability	Yes	No	Yes	No

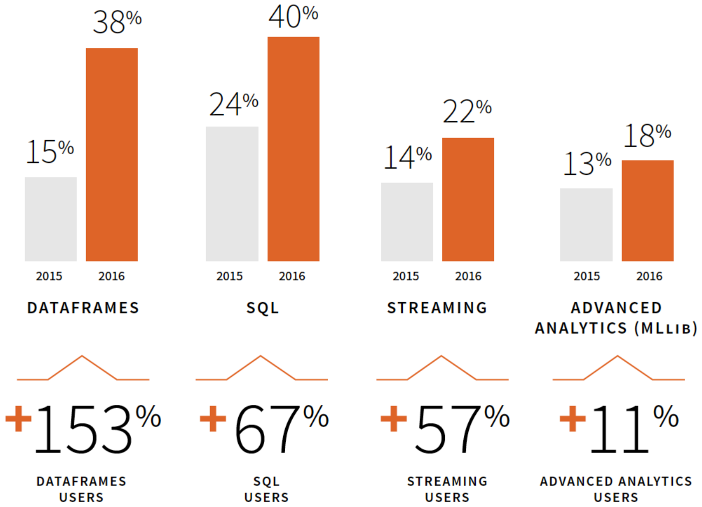
Document Classification With Splunk And Spark

2016 Spark Survey

TYPES OF PRODUCTS BUILT

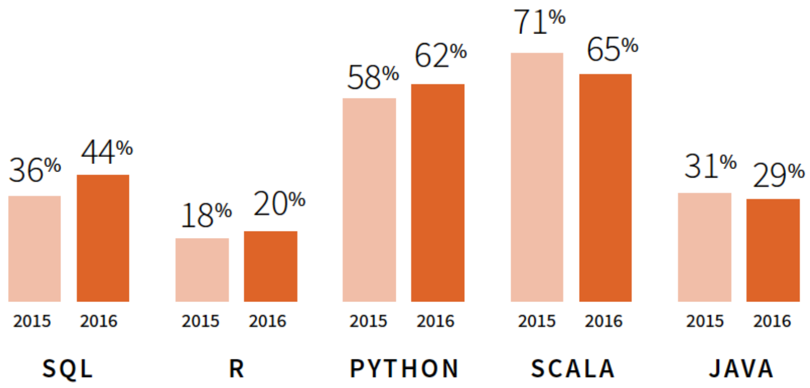
% of respondents who use Spark to create each product (more than one product could be selected)





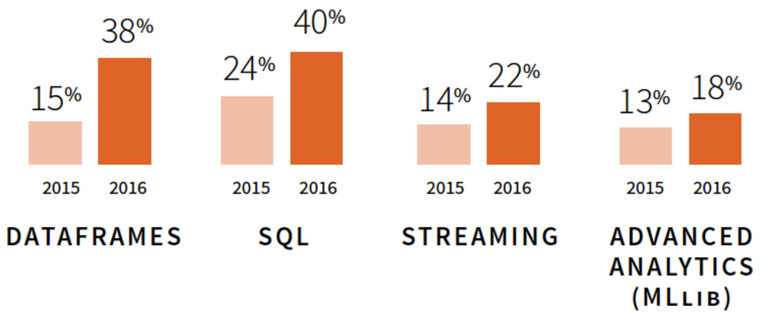
LANGUAGES USED IN SPARK YEAR-OVER-YEAR

% of respondents who use each language (more than one language could be selected)



SPARK COMPONENTS USED IN PRODUCTION YEAR-OVER-YEAR

% of respondents who use each component in production (more than one component could be selected)



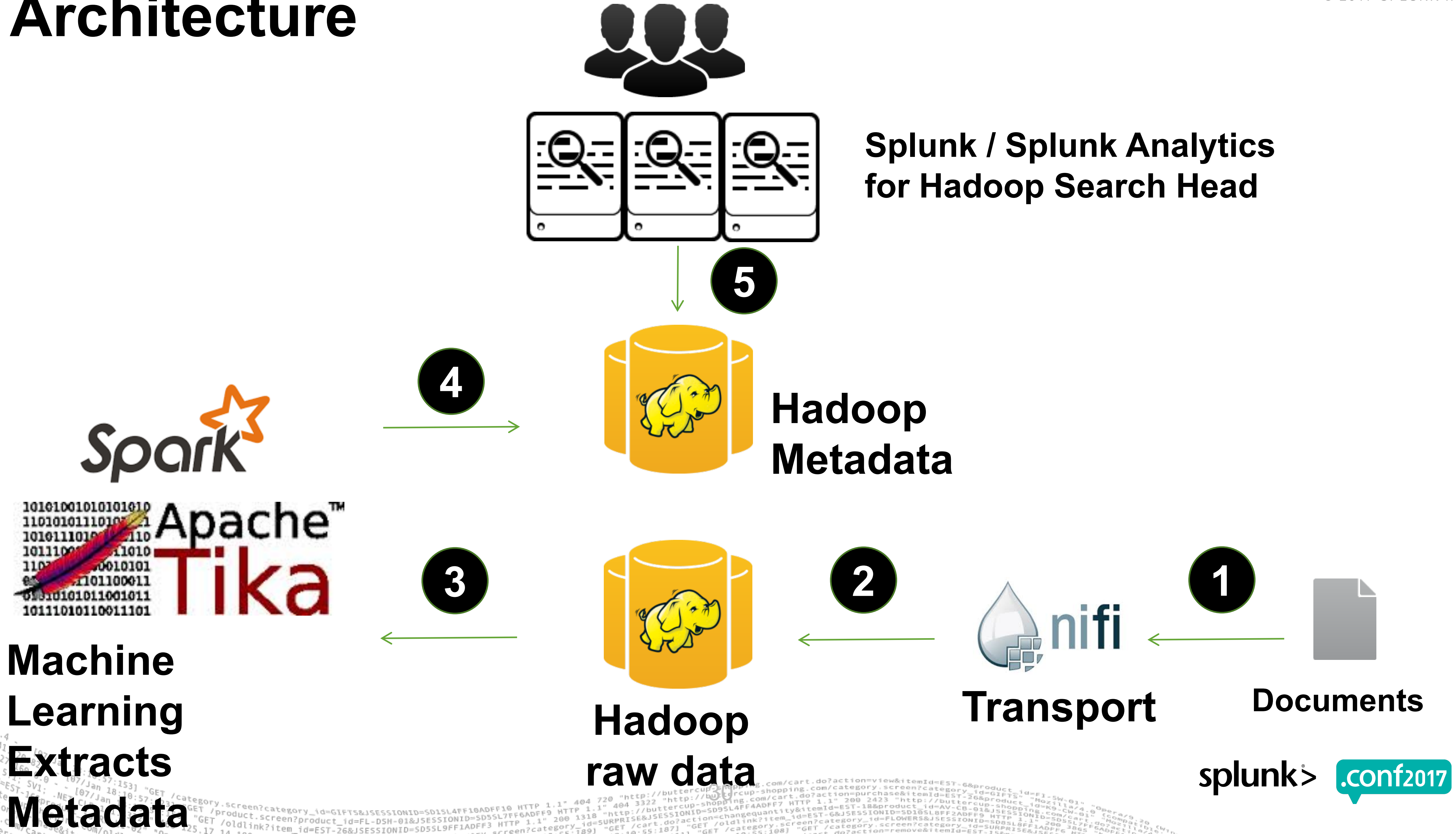
Document Classification: Why Spark?

Problem: Spark processing does not provide easy analytics or any visualizations

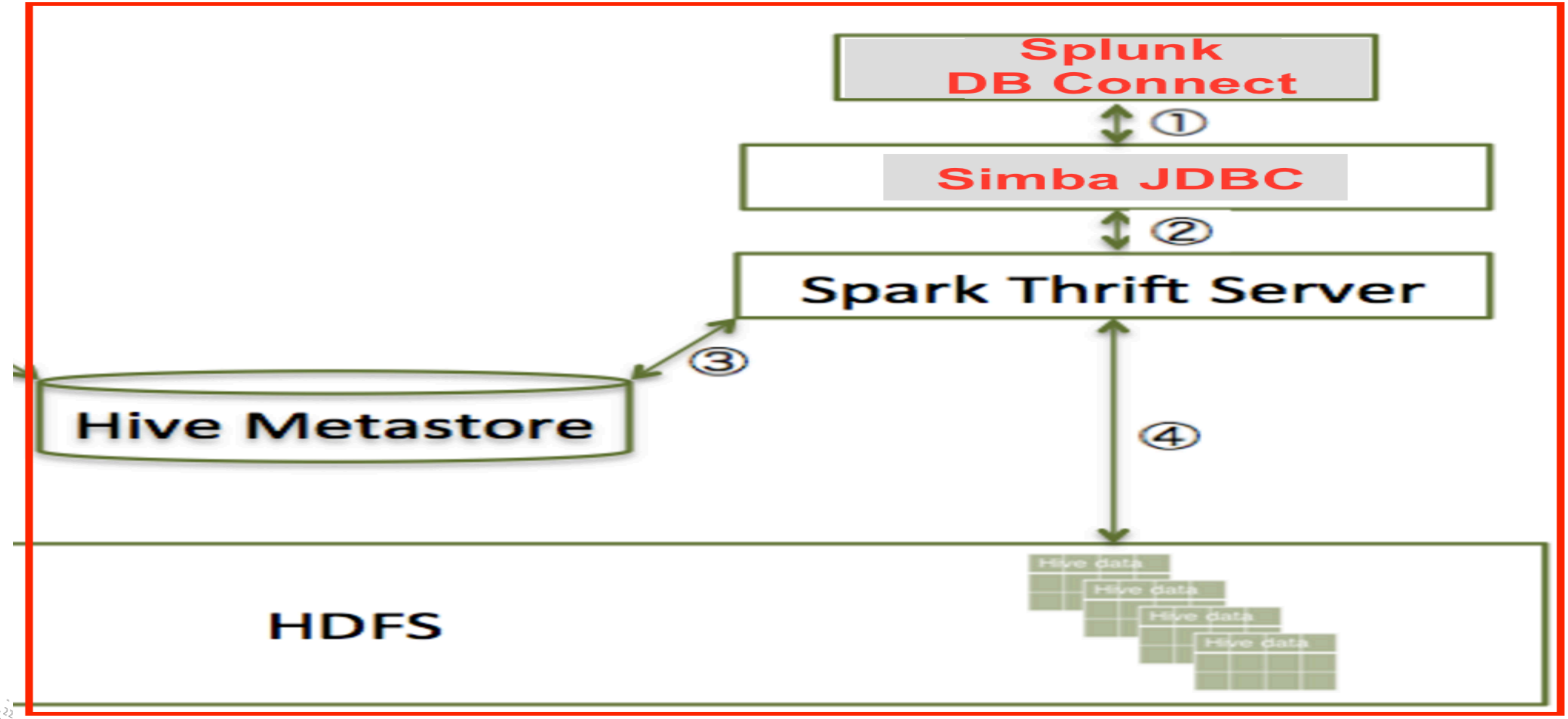
Goal: Allow analysts and regulators the ability to know exactly where each file exists in the system

Solution: Apache Nifi collect all new files from NFS and stores it on Hadoop. Spark Core, Spark Machine Learning, and Apache Tika create Metadata classification. Splunk Analytics for Hadoop exposes metadata classification files to end users.

Architecture



Spark SQL And Splunk

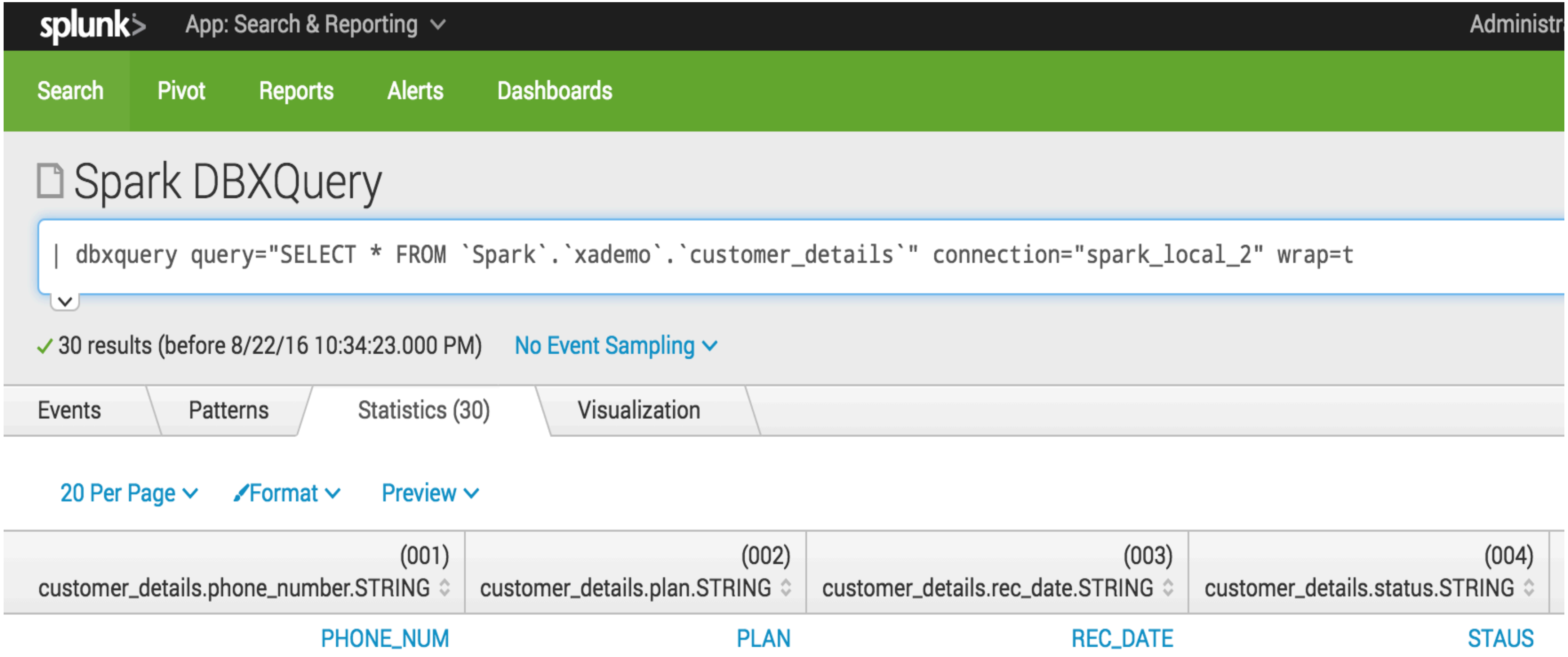


Spark SQL And Splunk

db_connection_types.conf

[spark_sql]
displayName = Spark SQL
serviceClass = com.splunk.dbx2.sparksql.SparkSqlJDBC
jdbcUrlFormat = jdbc:spark://<**Thrift Server Host**>:<**Thrift Server Port**>/<database>
jdbcDriverClass = com.simba.spark.jdbc41.Driver

Spark SQL And Splunk



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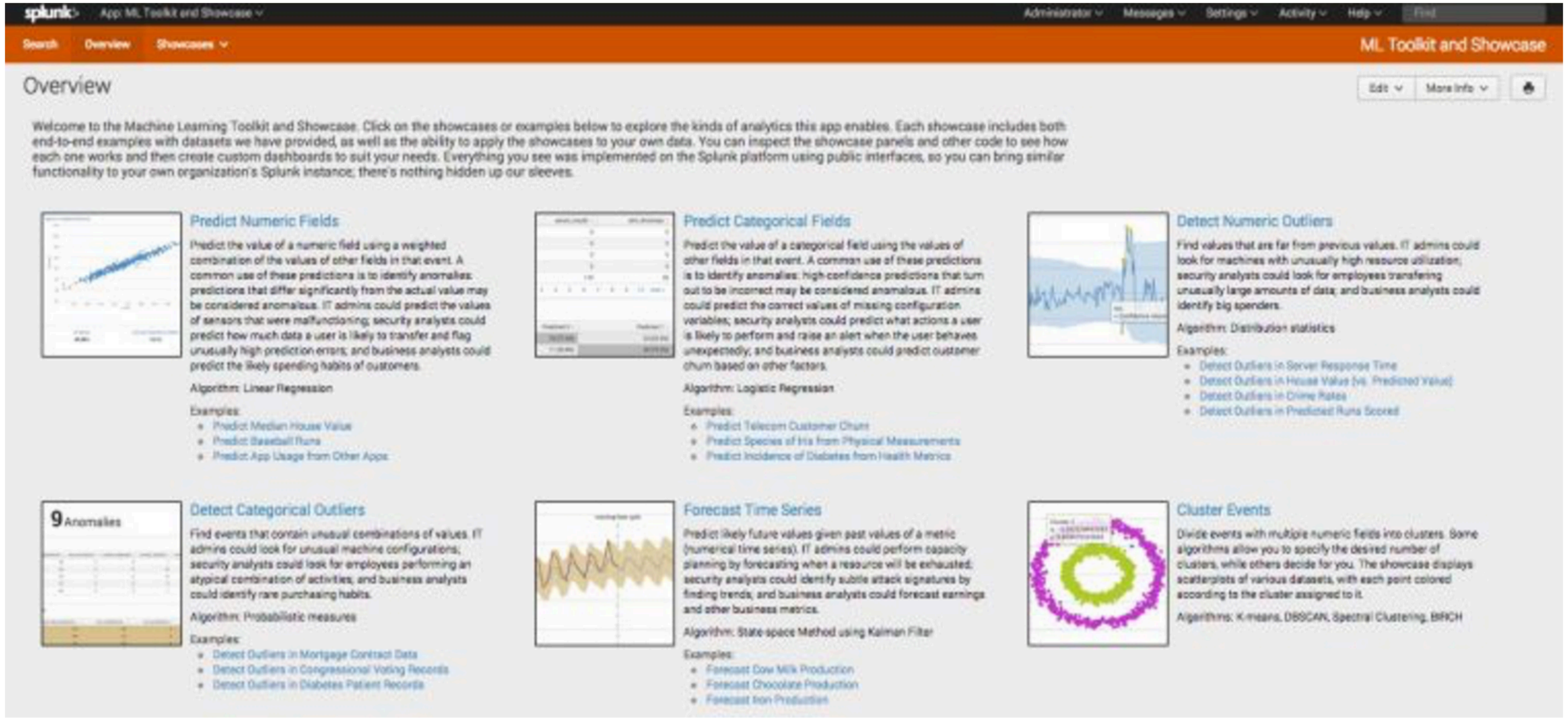
Spark ML → Splunk

Spark SQL with Spark Mllib: https://databricks.com/blog/2014/03/26/spark-sql-manipulating-structured-data-using-spark-2.html



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