

Apache Spark 2.4 and Beyond

Xiao Li, Wenchen Fan

Mar 2019 @ Strata Data Conf



About US

- Software Engineers at  databricks
- Apache Spark Committers and PMC Members



Xiao Li (Github: [gatorsmile](#))



Wenchen Fan (Github: [cloud-fan](#))

Databricks Customers Across Industries

Financial Services



Healthcare & Pharma



Media & Entertainment



Data & Analytics Services



Technology



Public Sector



Retail & CPG



Consumer Services



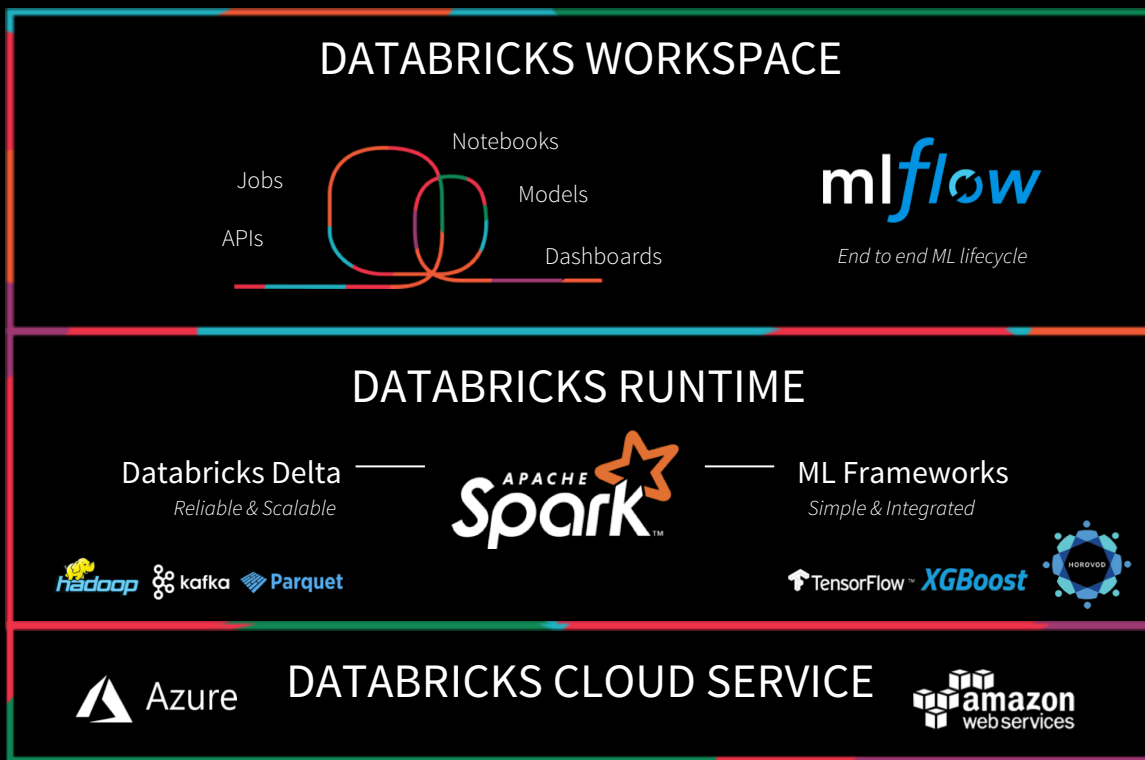
Marketing & AdTech



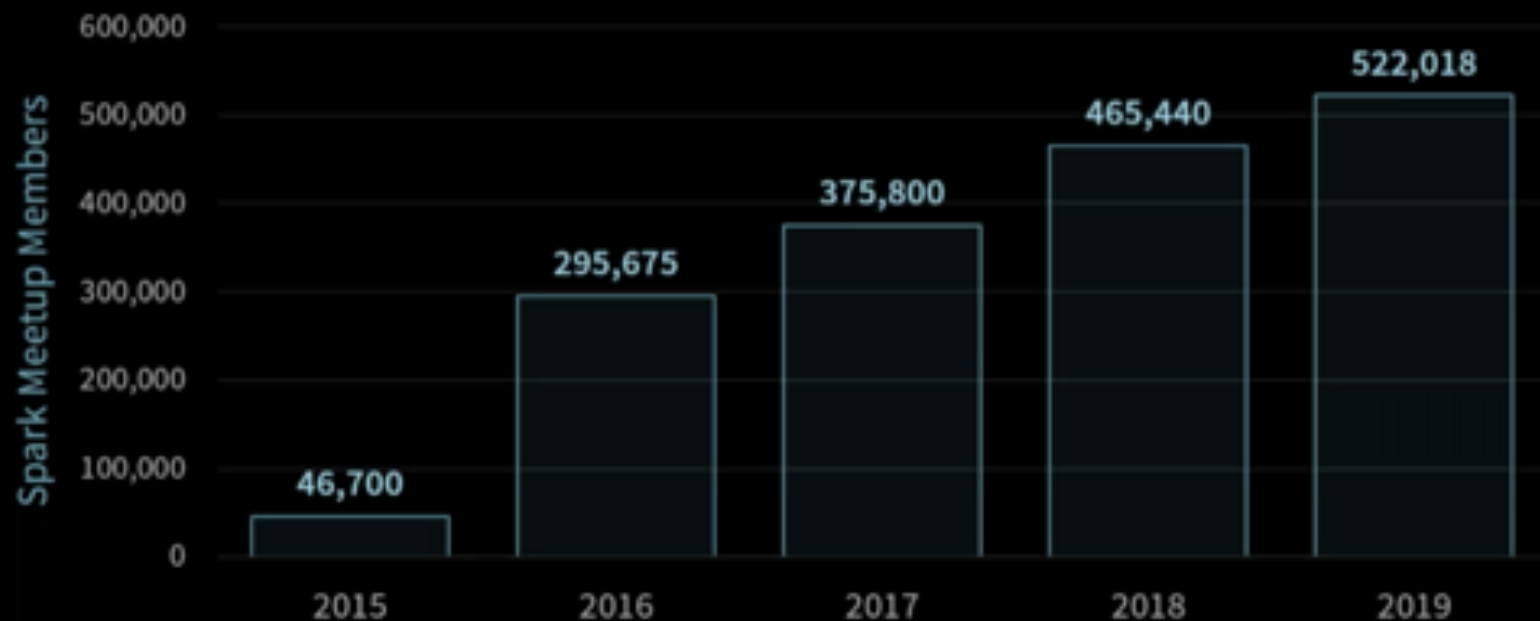
Energy & Industrial IoT



Databricks Unified Analytics Platform



The Growth of the Spark Community



Developer Survey Results 2018

Overview

This year, over 100,000 developers told us how they learn, build their careers, which tools they're using, and what they want in a job.

Survey Respondents

Monthly Stack Overflow Visits

Professional Developers



Most Loved, Dreaded, and Wanted Frameworks, Libraries, and Tools

Loved

Dreaded

Wanted

TensorFlow 73.5%

React 69.4%

Torch/PyTorch 68.0%

Node.js 66.4%

.NET Core 66.0%

Spark 66.0%

Spring 60.0%

Django 58.3%

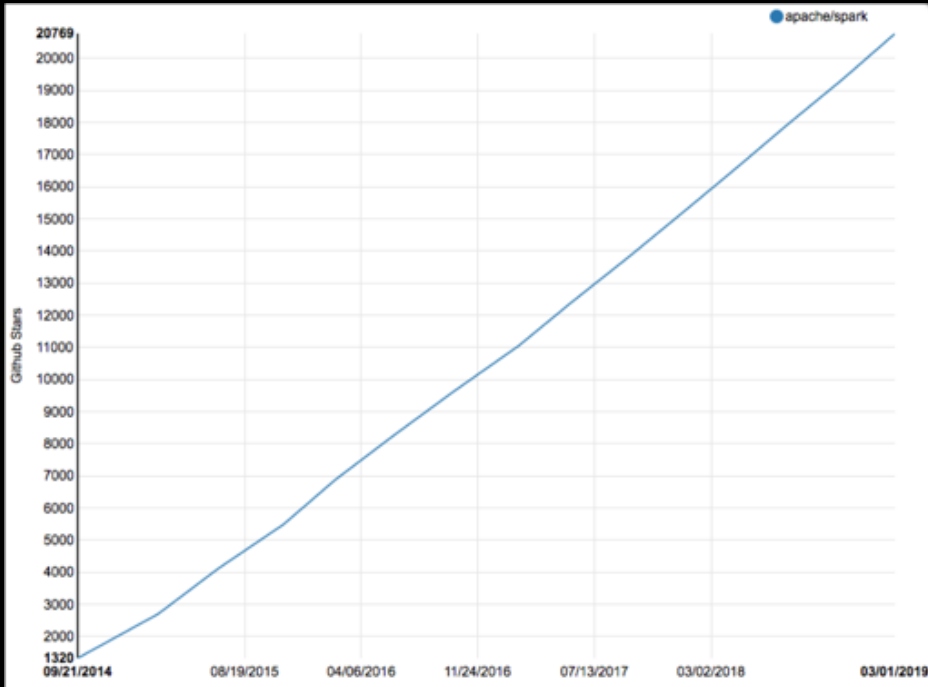
Angular 54.6%

Hadoop 53.9%

Xamarin 49.0%

Cordova 40.4%

% of developers who are developing with the language or technology and have expressed interest in continuing to develop with it

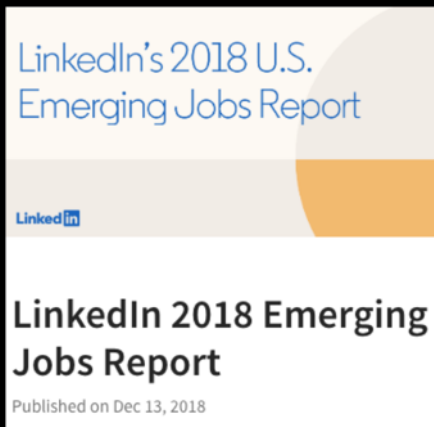


20000+ Stars in Github



Top Skill in 2018: Apache Spark

<https://economicgraph.linkedin.com/research/linkedin-2018-emerging-jobs-report>



2. Machine Learning Engineer (12X growth)

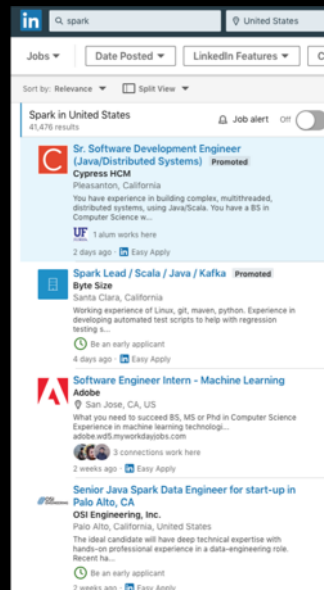
- **Top Skills:** Deep Learning, Machine Learning, Tensorflow, Apache Spark, Natural Language Processing
- **Where They Work:** Apple, Intel, NVIDIA
- **Top Industries:** Computer Software, Internet, Information Technology & Services
- **Cities Where Demand is High:** San Francisco, Denver, Austin

7. Data Science Specialist (5X growth)

- **Top Skills:** Machine Learning, Data Science, Python, R, Apache Spark
- **Where They Work:** IBM, Facebook, McKinsey & Company
- **Top Industries:** Higher Education, Information Technology & Services, Computer Software
- **Cities Where Demand is High:** New York City, San Francisco, Chicago

15. Data Science Manager (4X growth)

- **Top Skills:** Data Science, Machine Learning, Apache Spark, Python, R
- **Companies Employing This Talent:** Facebook, Capital One, Microsoft
- **Top Industries:** Internet, Computer Software, Financial Services
- **Cities Where Demand is High:** Atlanta, New York City, Los Angeles



[Stack Overflow Insights](#) > Trends

Stack Overflow Trends

See how technologies have trended over time based on use of their tags since 2008, when Stack Overflow was founded. Enter up to 15 tags to compare growth and decline.

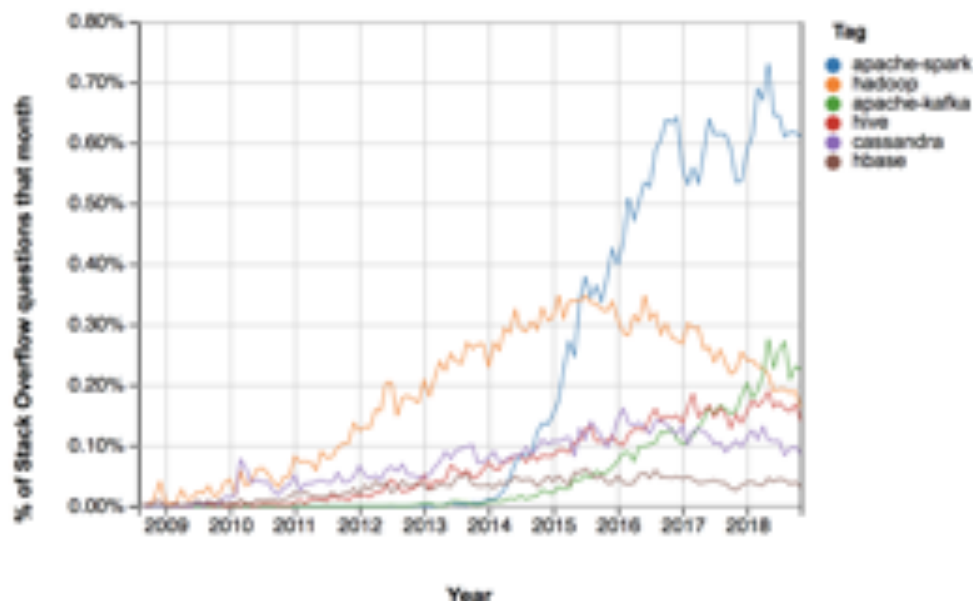
Tags:

[apache-spark](#) ×
 [hadoop](#) ×
 [apache-kafka](#) ×
[hive](#) ×
 [cassandra](#) ×
 [hbase](#) ×

Don't know what tags to look at? Try one of our presets:

- [Most Popular Languages \(TIOBE Index for May 2017\)](#)
- [Operating Systems](#)
- [Mobile Operating Systems](#)
- [Javascript Frameworks](#)
- [Smaller Javascript Frameworks](#)
- [Closed-source Browser Plugins](#)
- [Data Science and Big Data](#)
- [Apache Open-source Projects](#)

For more on this tool and what you can learn from it, see our [blog post](#).



Introducing Apache Spark 2.4

Now available on Databricks Runtime 5.0



by Wenchen Fan, Xiao Li and Reynold Xin
Posted in ENGINEERING BLOG | November 8, 2018

UPDATED: 11/19/2018

We are excited to announce the availability of [Apache Spark 2.4](#) on Databricks as part of the [Databricks Runtime 5.0](#). We want to thank the Apache Spark community for all their valuable contributions to the Spark 2.4 release.

Databricks Runtime Version ⓘ

- 5.0 (includes Apache Spark 2.4.0, Scala 2.11) ⬆
- ✓ 5.0 (includes Apache Spark 2.4.0, Scala 2.11)
- 5.0 ML Beta (Scala 2.11)
- 5.0 (includes Apache Spark 2.4.0, GPU, Scala 2.11)
- 4.3 (includes Apache Spark 2.3.1, Scala 2.11)
- 4.3 (includes Apache Spark 2.3.1, GPU, Scala 2.11)
- 4.2 (includes Apache Spark 2.3.1, Scala 2.11)
- 4.2 (includes Apache Spark 2.3.1, GPU, Scala 2.11)
- 4.1 (includes Apache Spark 2.3.0, Scala 2.11)
- 4.1 ML Beta (includes Apache Spark 2.3.0, Scala 2.11)
- 4.1 ML Beta (includes Apache Spark 2.3.0, GPU, Scala 2.11)
- 4.1 (includes Apache Spark 2.3.0, GPU, Scala 2.11)
- 3.5 LTS (includes Apache Spark 2.2.1, Scala 2.11)
- 3.5 LTS (includes Apache Spark 2.2.1, Scala 2.10)

Release: Nov 8, 2018

Blog: <https://t.co/k7kEHrNZXp>

Above **1100** tickets.

Major Features on Spark 2.4



Barrier
Execution



Spark on
Kubernetes



Beta support
Scala 2.12



PySpark
Improvement



Structured
Streaming



Image
Source



Native Avro
Support



Built-in source
Improvement



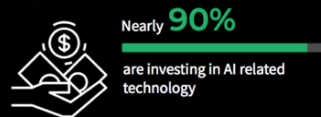
Higher-order
Functions



Various SQL
Features

CIO Survey Key Findings: The AI Dilemma

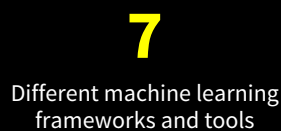
Investment in AI is Growing Quickly



However, very few are succeeding



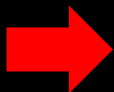
Major contributing factors to this AI dilemma



CIO Survey Key Findings: Unified Analytics Enables AI Success

79%

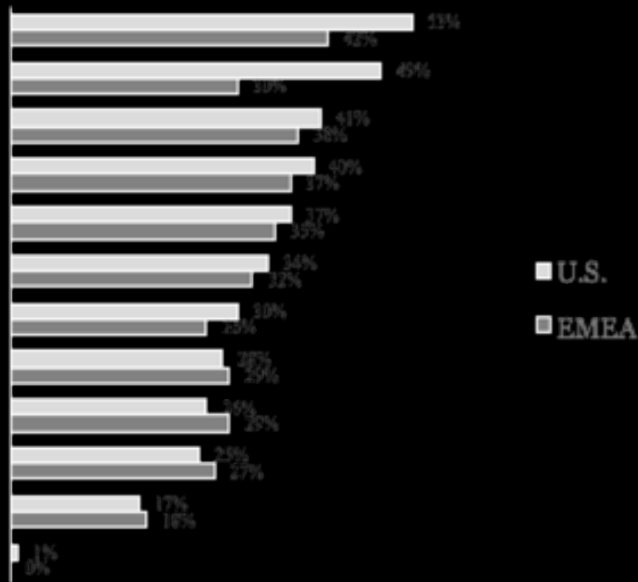
highly value the notion of a
unified analytics platform



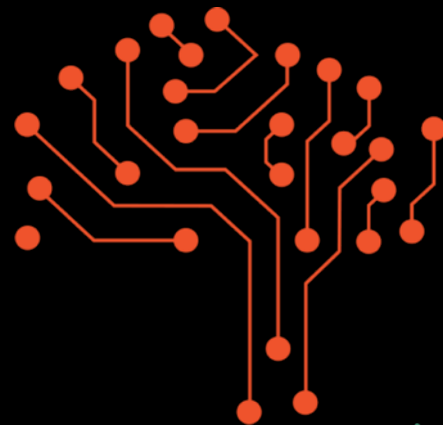
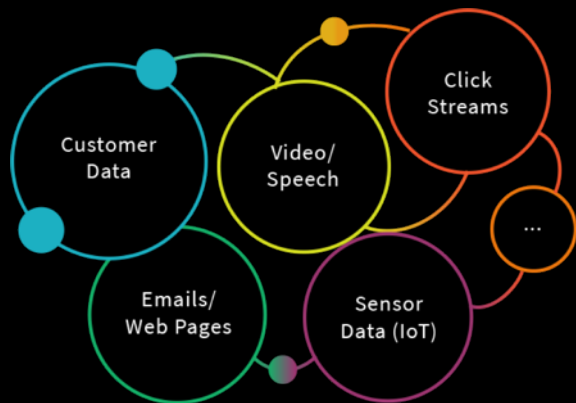
Unifying data science & engineering

Benefits Expected from a Unified Approach to Data & AI

Increased operational efficiency
More effective decision making
Accelerated time to market
Improved security
Increased innovation
Improved customer experience
Increased competitive advantage
Increased employee satisfaction
Increased customer engagement
Product/service transformation
Topline growth
Other (specify)



Big data v.s. AI Technologies



Project Hydrogen: Spark + AI

A **gang scheduling** to Apache Spark that embeds a distributed DL job as a Spark stage to simplify the distributed training workflow. [[SPARK-24374](#)]

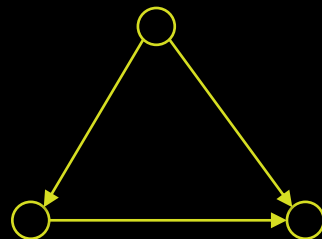
Task 1



Task 2



Task 3



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Scala
2.12



Structured
Streaming



Various SQL
Features

Flexible Streaming Sink

[[SPARK-24565](#)] Exposing output rows of each microbatch as a DataFrame

```
foreachBatch(f: Dataset[T] => Unit)
```

- Scala/Java/Python APIs in DataStreamWriter.
- Reuse existing batch data sources
- Write to multiple locations
- Apply additional DataFrame operations

Reuse existing batch data sources

```
spark.readStream.format("rate").load()
  .selectExpr("value % 10 as key")
  .groupBy("key")
  .count()
  .toDF("key", "value")
  .writeStream
  .foreachBatch { (batchDF: DataFrame, batchId: Long) =>

    batchDF.write          // Use Cassandra batch data source to write streaming out
      .cassandraFormat(tableName, keyspace)
      .option("cluster", clusterName)
      .mode("append")
      .save()
  }
  .outputMode("update")
  .start()
```

Write to multiple location

```
streamingDF.writeStream.foreachBatch { (batchDF: DataFrame, batchId: Long) =>
  batchDF.persist()
  batchDF.write.format(...).save(...) // location 1
  batchDF.write.format(...).save(...) // location 2
  batchDF.unpersist()
}
```

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Parquet



Update from 1.8.2 to 1.10.0 [[SPARK-23972](#)].

- [PARQUET-1025](#) - Support new min-max statistics in parquet-mr
- [PARQUET-225](#) - INT64 support for delta encoding
- [PARQUET-1142](#) Enable `parquet.filter.dictionary.enabled` by default.

Predicate pushdown

- STRING [[SPARK-23972](#)] [**20x faster**]
- Decimal [[SPARK-24549](#)]
- Timestamp [[SPARK-24718](#)]
- Date [[SPARK-23727](#)]
- Byte/Short [[SPARK-24706](#)]
- StringStartsWith [[SPARK-24638](#)]
- IN [[SPARK-17091](#)]

ORC



Native vectorized ORC reader is GAed!

- Native ORC reader is on by default [[SPARK-23456](#)]
- Update ORC from 1.4.1 to 1.5.2 [[SPARK-24576](#)]
- Turn on ORC filter push-down by default [[SPARK-21783](#)]
- Use native ORC reader to read Hive serde tables by default [[SPARK-22279](#)]
- Avoid creating reader for all ORC files [[SPARK-25126](#)]

Major Features on Upcoming Spark 2.4



Barrier
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Various SQL
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Higher-order Functions

Transformation on complex objects like **arrays**, **maps** and **structures** inside of columns.

```
tbl_nested
|-- key: long (nullable = false)
|-- values: array (nullable = false)
|   |-- element: long (containsNull = false)
```

UDF ? **Expensive data serialization**

Higher-order Functions

1) Check for element existence

```
SELECT EXISTS(values, e -> e > 30) AS v  
FROM tbl_nested;
```

tbl_nested

-- key: long (nullable = false)

-- values: array (nullable = false)

| -- element: long (containsNull = false)

2) Transform an array

```
SELECT TRANSFORM(values, e -> e * e) AS v  
FROM tbl_nested;
```

Higher-order Functions

3) Filter an array

```
SELECT FILTER(values, e -> e > 30) AS v  
FROM tbl_nested;
```

tbl_nested

|-- key: long (nullable = false)

|-- values: array (nullable = false)

| |-- element: long (containsNull = false)

4) Aggregate an array

```
SELECT REDUCE(values, 0, (value, acc) -> value + acc) AS sum  
FROM tbl_nested;
```

Ref Databricks Blog: <http://dbricks.co/2rUKQ1A>

Built-in Functions

[[SPARK-23899](#)] New or extended built-in functions for ArrayTypes and MapTypes

- 26 functions for ArrayTypes

transform, filter, reduce, array_distinct, array_intersect, array_union, array_except, array_join, array_max, array_min, ...

- 3 functions for MapTypes

map_from_arrays, map_from_entries, map_concat

Blog: Introducing New Built-in and Higher-Order Functions for Complex Data Types in Apache Spark 2.4. <https://t.co/p1TRRtabJJ>

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Various SQL
Features

Native Spark App in K8S

New Spark scheduler backend

- PySpark support [[SPARK-23984](#)]
- SparkR support [[SPARK-24433](#)]
- Client-mode support [[SPARK-23146](#)]
- Support for mounting K8S volumes [[SPARK-23529](#)]

Blog: What's New for Apache Spark on Kubernetes in the Upcoming Apache Spark 2.4 Release

<https://t.co/uUpdUj2Z4B>



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What's Next?

Safe Harbor Statement

This presentation may contain projections or other forward-looking statements regarding the upcoming release (Apache Spark 3.0). The statements are intended to outline our general direction. They are intended for information purposes only. They are not a commitment to deliver code or functionality. The development, release and timing of any feature or functionality described for Apache Spark remains at the sole discretion of ASF and the Apache Spark PMC.

What's Next?



GPU-aware
Scheduling



Spark Graph



Data Source
APIs



Adaptive
Execution



Spark on
Kubernetes



mlflow



Hadoop 3.x



Scala 2.12



Various SQL
Features



PySpark
Usability

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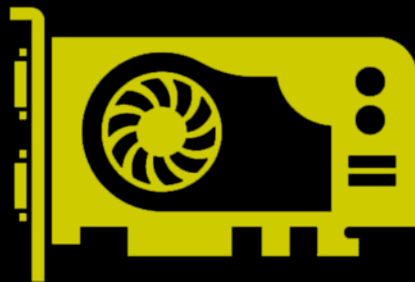


PySpark
Usability

Project Hydrogen: Spark + AI

GPU Aware Scheduling

- widely used for accelerating special workloads, e.g., deep learning and signal processing



It's Hard to Productionize ML

ML Lifecycle is Manual, Inconsistent and Disconnected

Data Prep

- Low level integrations for Data and ML
- Difficult to track data used for a model



Build Model

- Ad hoc approach to track experiments
- Very hard to reproduce experiments

GitHub

CONDA



TensorFlow™



Deploy Model

- Multiple tightly coupled deployment options
- Different monitoring approach for each framework



kubernetes



docker



Amazon SageMaker



Azure Machine Learning



databricks

What is *mlflow*?

Open source platform to manage ML development

- Lightweight APIs & abstractions that work with any ML library
- Designed to be useful for 1 user or 1000+ person orgs
- Runs the same way anywhere (e.g. any cloud)

Key principle: “open interface” APIs that work with any existing ML library, app, deployment tool, etc

MLflow Components

mlflow Tracking

Record and query experiments: code, params, results, etc

mlflow Projects

Code packaging for reproducible runs on any platform

mlflow Models

Model packaging and deployment to diverse environments

What's Next?

MLflow Tracking

- SQL database backend for scaling the tracking server (0.9)
- UI scalability improvements (0.8, 0.9, etc.)
- X-coordinate logging for metrics & batched logging (1.0)
- Fluent API for Java and Scala (1.0)

MLflow Projects

- Docker-based project environment specification (0.9)
- X-coordinate logging for metrics & batched logging (1.0)
- Packaging projects with build steps (1.0+)

MLflow Models

- Custom model logging in Python, R and Java (0.8, 0.9, 1.0)
- Better environment isolation when loading models (1.0)
- Logging schema of models (1.0+)

MLflow: An open platform to simplify the machine learning lifecycle

4:20pm-5:00pm, Mar 27 / 2008

Session

Topics: Data Engineering & Architecture

Developing applications that leverage machine learning is difficult. Practitioners need to be able to reproduce their model development pipelines, as well as deploy models and monitor their health in production. Corey Zumar offers an overview of MLflow, which simplifies this process by managing, reproducing, and operationalizing machine learning through a suite of model tracking and deployment APIs.



Corey Zumar
Databricks

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Various SQL
Features



PySpark
Usability

Challenges in Existing Graph Library

GraphX

- Not DataFrame based
- Not actively maintained

GraphFrame

- Limited graph pattern matching
- Semantically weak graph data model

(:Cypher)-[: FOR] -> (Apache:Spark™)

Spark Graph

Given a single **Property Graph** data model and a **Cypher** query, Spark returns a tabular result **[DataFrame]**

What's Next?



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mlflow



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Various SQL
Features



PySpark
Usability

Data Source API V2

- Unified API for batch and streaming
- Flexible API for high performance implementation
- Flexible API for metadata management

JDBC source with data source v1

1. Specify the info of **remote catalog** for each op

```
df.write.format("jdbc")  
  .option("url", ...)   
  .option("dbtable", ...)   
  .option("driver", ...)   
  .save()
```

JDBC source with data source v1

2. Register each **table** before usage

```
CREATE TABLE tab1(...) USING jdbc OPTIONS("url" ..., "dbtable" ..., ...)
```

```
CREATE TABLE tab2(...) USING jdbc OPTIONS("url" ..., "dbtable" ..., ...)
```

```
SELECT * FROM tab1 join tab2
```

```
INSERT INTO tab1 SELECT ...
```

JDBC source with data source v2

New: Register the **catalog** before usage

spark-defaults.conf

spark.sql.catalog.jdbcCatalogName my.jdbc.v2.impl

spark.sql.catalog.jdbcCatalogName.url ...

Spark.sql.catalog.jdbcCatalogName.driver ...

JDBC source with data source v2

- No need to register the tables.
- Access the tables using **n-part name**.
- **DDL/DML** support.

CREATE TABLE **jdbcCatalogName.db1.t1**(...)

ALTER TABLE **jdbcCatalogName.db1.t2** CHANGE COLUMN ...

SELECT * FROM **jdbcCatalogName.db2.t3**

INSERT INTO **jdbcCatalogName.db3.t4** SELECT ...

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Various SQL
Features



PySpark
Usability

Spark adaptive execution: Unleash the power of Spark SQL

1:50pm-2:30pm, Mar 28 / 2004

Session

Topics: Data Engineering & Architecture

Spark SQL is widely used, but it still suffers from stability and performance challenges in highly dynamic environments with large-scale data. Haifeng Chen shares a Spark adaptive execution engine built to address these challenges. It can handle task parallelism, join conversion, and data skew dynamically during runtime, guaranteeing the best plan is chosen using runtime statistics.



Haifeng Chen
Intel

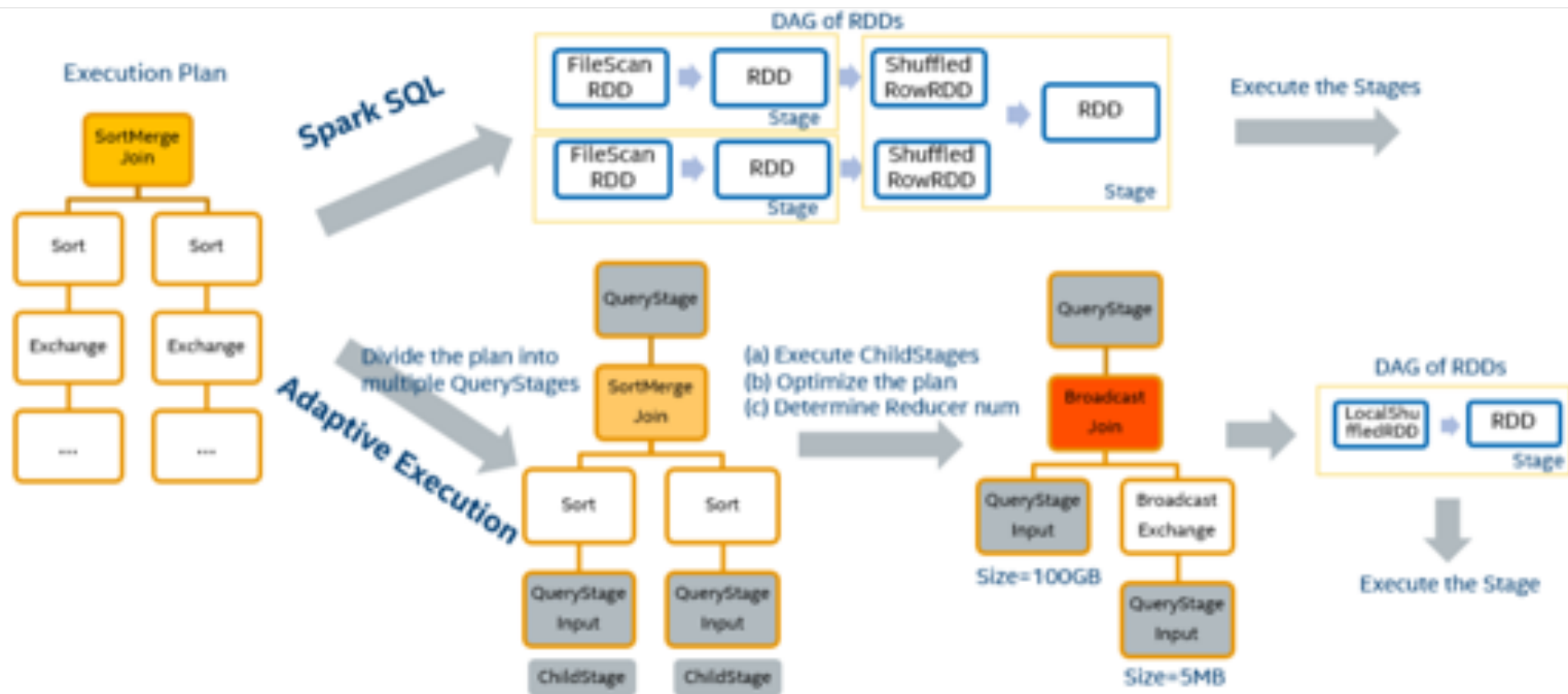
Adaptive Query Processing

Based on statistics of the materialized plan nodes, re-optimize the execution plan of the remaining queries

- Self tuning the number of reducers
- Adaptive join strategy
- Automatic skew join handling

Intel Blog: <https://tinyurl.com/y3rjwcoss>

Adaptive Query Processing



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Various SQL
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PySpark
Usability

Native Spark App in K8S

- Support for using a pod template to customize the driver and executor pods.
- Dynamic resource allocation and external shuffle service.
- Better support for local application dependencies on client machines
- Driver resilience for Spark Streaming
- Better scheduling support.



Scaling Apache Spark on Kubernetes at Lyft

3:50pm-4:30pm, Mar 28 / 2001

Session

Topics: Data Engineering & Architecture

Li Gao and Bill Graham discuss the challenges the Lyft team faced and solutions they developed to support Apache Spark on Kubernetes in production and at scale.



Li Gao
Lyft



Bill Graham
Lyft

The other targets in Apache Spark 3.0

- Hadoop 3.x support
- Hive execution from 1.2.1 to 2.3.4
- Scala 2.12 GA
- Better ANSI SQL compliance
- PySpark usability

Please follow the announcements
in Spark + AI Summit @ SF



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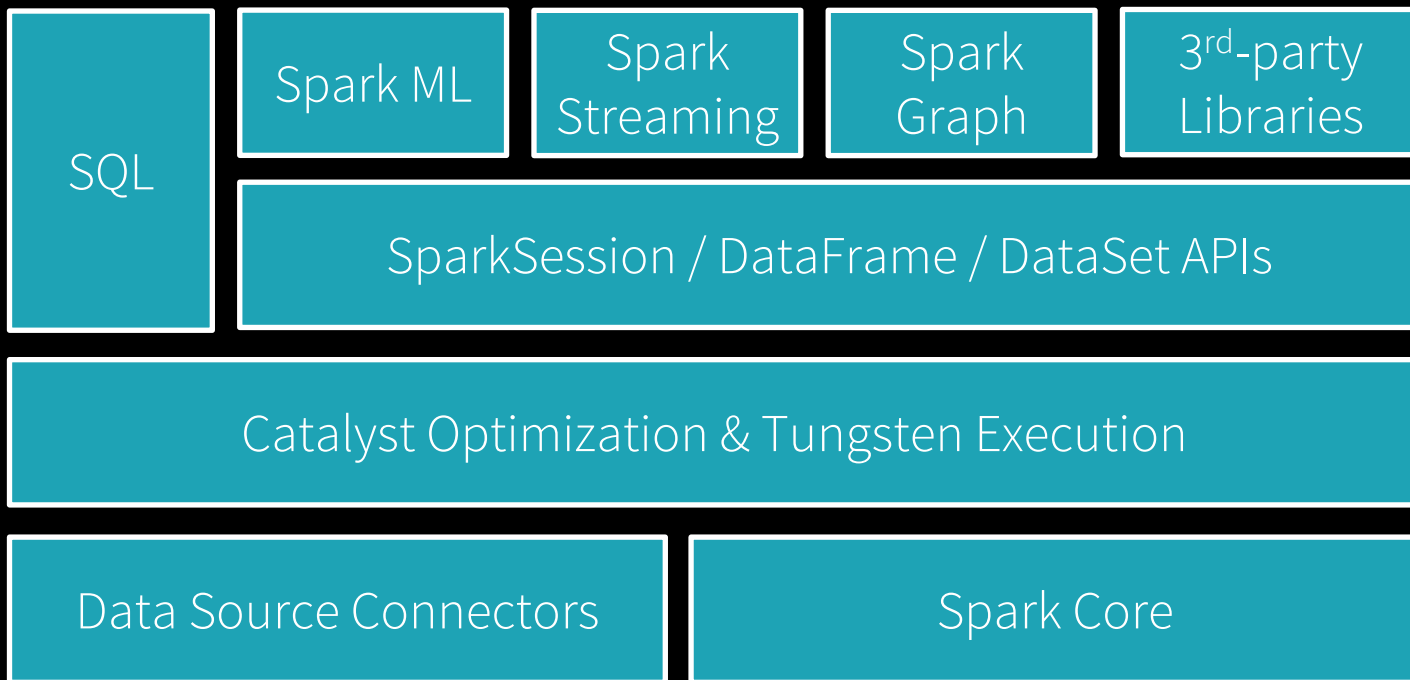


Various SQL
Features



PySpark
Usability

Apache Spark 3.x





SPARK+AI SUMMIT 2019

APRIL 23 - 25 | SAN FRANCISCO

ORGANIZED BY  databricks

TRACKS

Apache Spark™

- Use Cases
- Research
- Technical Deep Dives

AI

- Productionizing ML
- Deep Learning
- Cloud Hardware

Fields

- Data Science
- Data Engineering
- Enterprise

5000+ ATTENDEES

Practitioners:

Data Scientists, Data Engineers,
Analysts, Architects

Leaders:

Engineering Management, VPs,
Heads of Analytics & Data, CxOs

databricks.com/sparkaisummit

Nike: Enabling Data Scientists to bring their Models to Market
Facebook: Vectorized Query Execution in Apache Spark at Facebook
Tencent: Large-scale Malicious Domain Detection with Spark AI
IBM: In-memory storage Evolution in Apache Spark
Capital One: Apache Spark and Sights at Speed: Streaming, Feature management and Execution
Apple: Making Nested Columns as First Citizen in Apache Spark SQL
EBay: Managing Apache Spark workload and automatic optimizing.
Google: Validating Spark ML Jobs
HP: Apache Spark for Cyber Security in big company
Microsoft: Apache Spark Serving: Unifying Batch, Streaming and RESTful Serving
ABSA Group: A Mainframe Data Source for Spark SQL and Streaming
Facebook: an efficient Facebook-scale shuffle service
IBM: Make your PySpark Data Fly with Arrow!
Facebook: Distributed Scheduling Framework for Apache Spark
Zynga: Automating Predictive Modeling at Zynga with PySpark
World Bank: Using Crowdsourced Images to Create Image Recognition Models and NLP to Augment Global Trade indicator
JD.com: Optimizing Performance and Computing Resource.
Microsoft: Azure Databricks with R: Deep Dive



Airbnb: Apache Spark at Airbnb
Netflix: Migrating to Apache Spark at Netflix
Microsoft: Infrastructure for Deep Learning in Apache Spark
Intel: Game playing using AI on Apache Spark
Facebook: Scaling Apache Spark @ Facebook
Lyft: Scaling Apache Spark on K8S at Lyft
Uber: Using Spark Mllib Models in a Production Training and Serving Platform
Apple: Bridging the gap between Datasets and DataFrames
Salesforce: The Rule of 10,000 Spark Jobs
Target: Lessons in Linear Algebra at Scale with Apache Spark
Nationwide: Deploying Enterprise Scale Deep Learning in Actuarial Modeling at Nationwide
Workday: Lesson Learned Using Apache Spark

Thank you

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Wenchen Fan (wenchen@databricks.com)

