MLOps Virtual Event: Building Machine Learning Platforms

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databricks

A Common Story

ginablaber
@ginablaber

The story of enterprise Machine Learning: “It took me 3 weeks to develop the model. It’s been >11 months, and it’s still not deployed.” @DineshNirmalIBM #StrataData #strataconf

10:19 AM · Mar 7, 2018 · TweetDeck

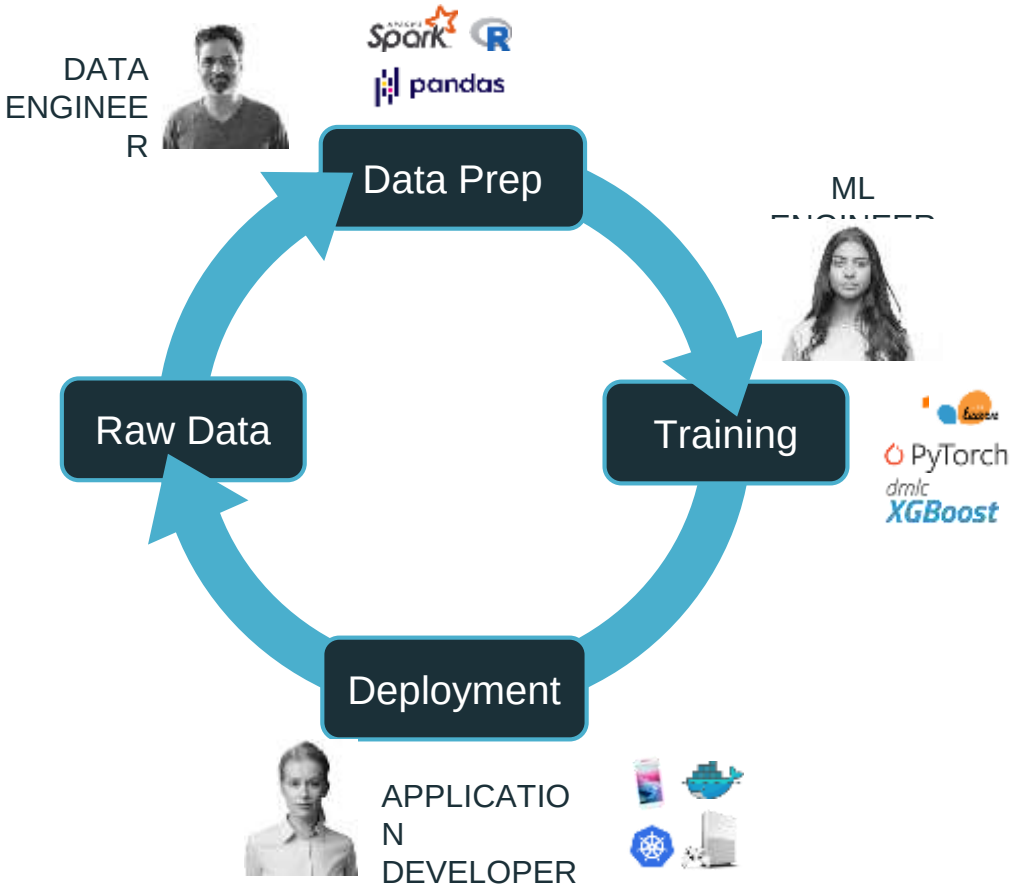
Even After Deploying, Operating ML is Complex!

- Monitoring performance of the model
- Data drift
- Governance and security

Many ML teams spend >50% of their time maintaining existing models

Why is ML Hard to Operationalize?

- Dependence on data
- Multiple, application-specific ways to evaluate performance
- Many teams and systems involved



Response: ML Platforms

- Software platforms to manage ML applications, from development to production
- Most companies that use ML at scale are building one
- Tech examples: Facebook FBLearner, Google TFX, Uber Michelangelo

Common Components in an ML Platform

- Data management, in development and at scoring time
  - Data transformation, quality monitoring, data versioning
  - Feature stores

- Model management
  - Packaging, review, quality assurance, versioning

- Code and deployment management
  - Reproducibility, deployment, monitoring, experimentation

Our Approach at Databricks

Azure

- Every team's requirements will be different, and will change over time

- Provide a **general** platform that is **easy to integrate** with diverse tools

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Data science & ML workspace

mlflow

Open source machine learning platform

python R Java

DELTA LAKE

Transactional, versioned data lake storage

Amazon S3 Azure STORAGE HDFS

In This Webinar

- How we and other organizations handle the different components of a machine learning platform
- Demos and experience from 4 different companies

End-to-End Data Science and Machine Learning on Databricks

Clemens Mewald

Director of Product Management, Databricks

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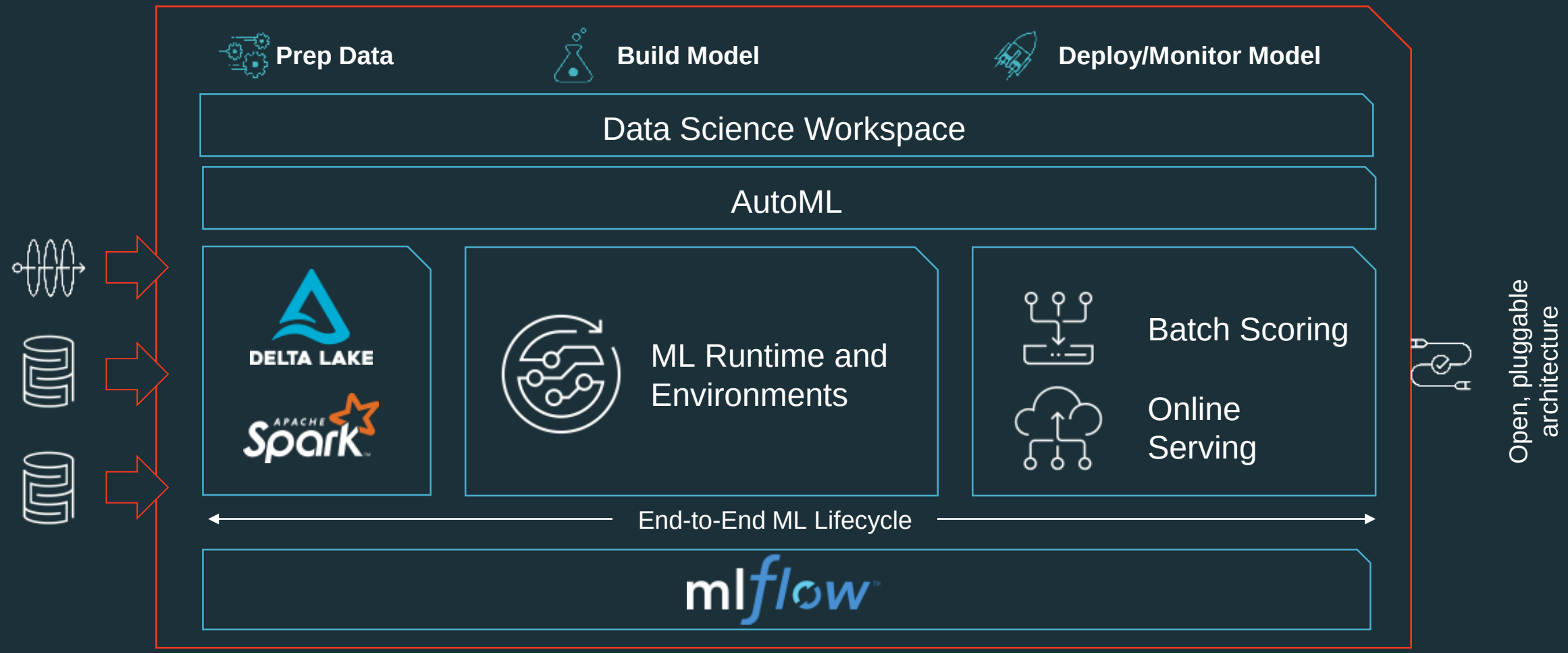
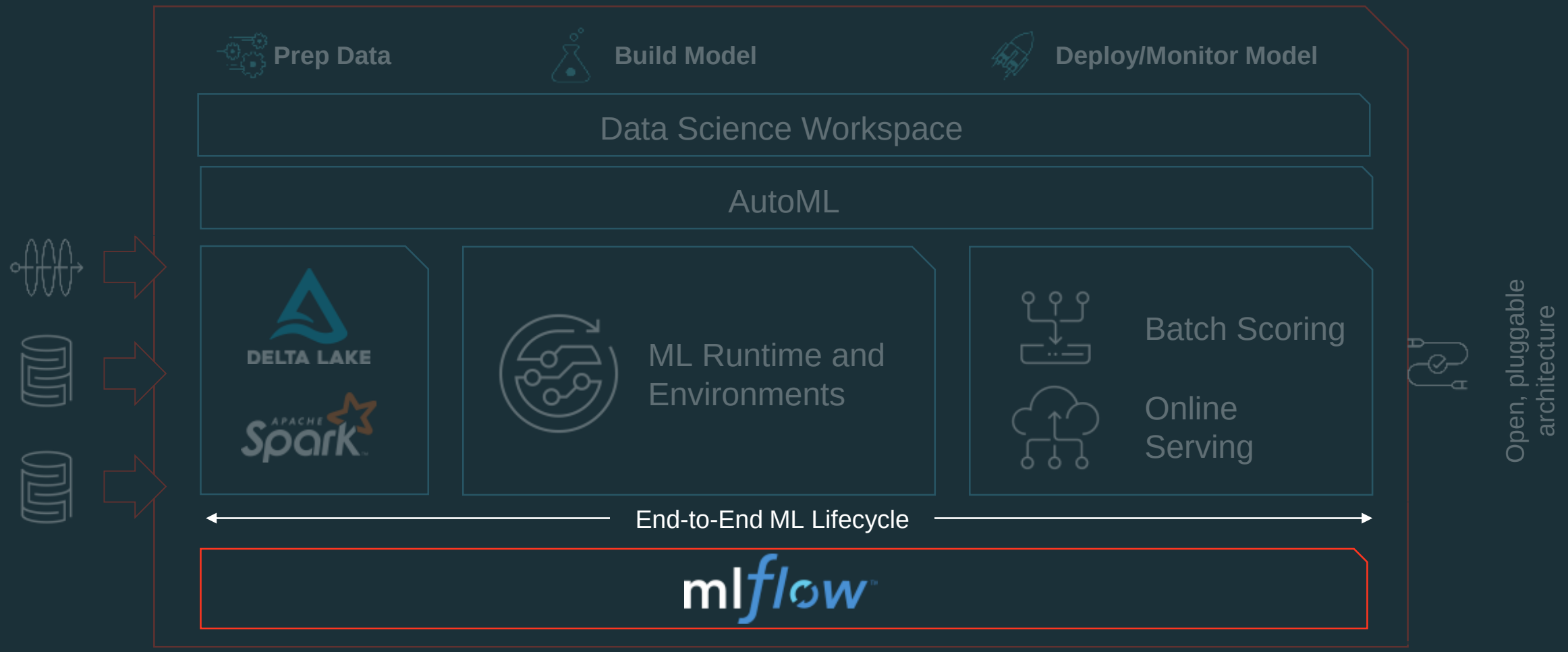
End-to-End Data Science and ML on



End-to-End Data Science and ML on databricks



mlflow Components

mlflow

Projects

Packaging format for reproducible runs on any compute platform

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mlflow Projects

Packaging format for reproducible runs on any compute platform

mlflow Models

General model format that standardizes deployment options

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mlflow Tracking

Record and query experiments: code, metrics, parameters, artifacts, models

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Packaging format for reproducible runs on any compute platform

mlflow Models

General model format that standardizes deployment options

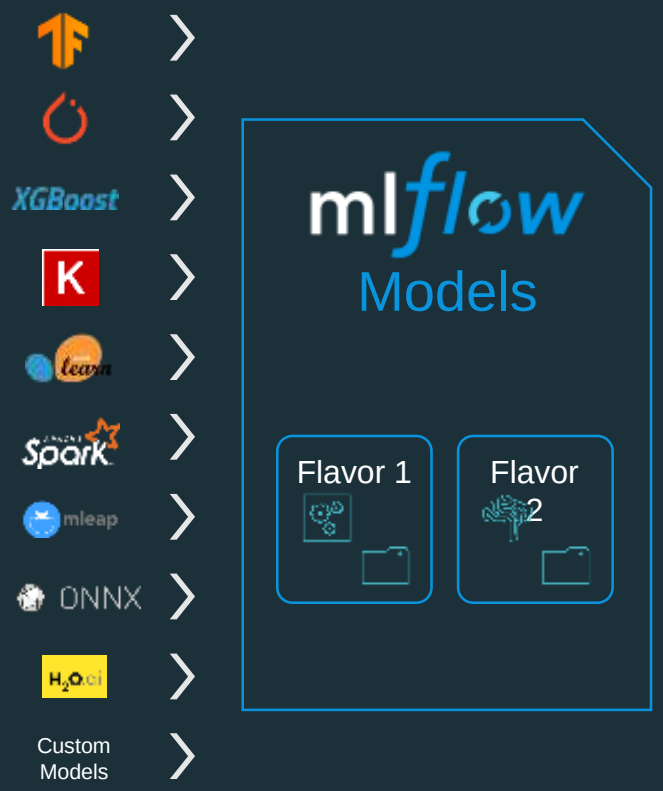
mlflow Tracking

Record and query experiments: code, metrics, parameters, artifacts, models

mlflow Model Registry

Centralized and collaborative model lifecycle management

mlflow Model Lifecycle



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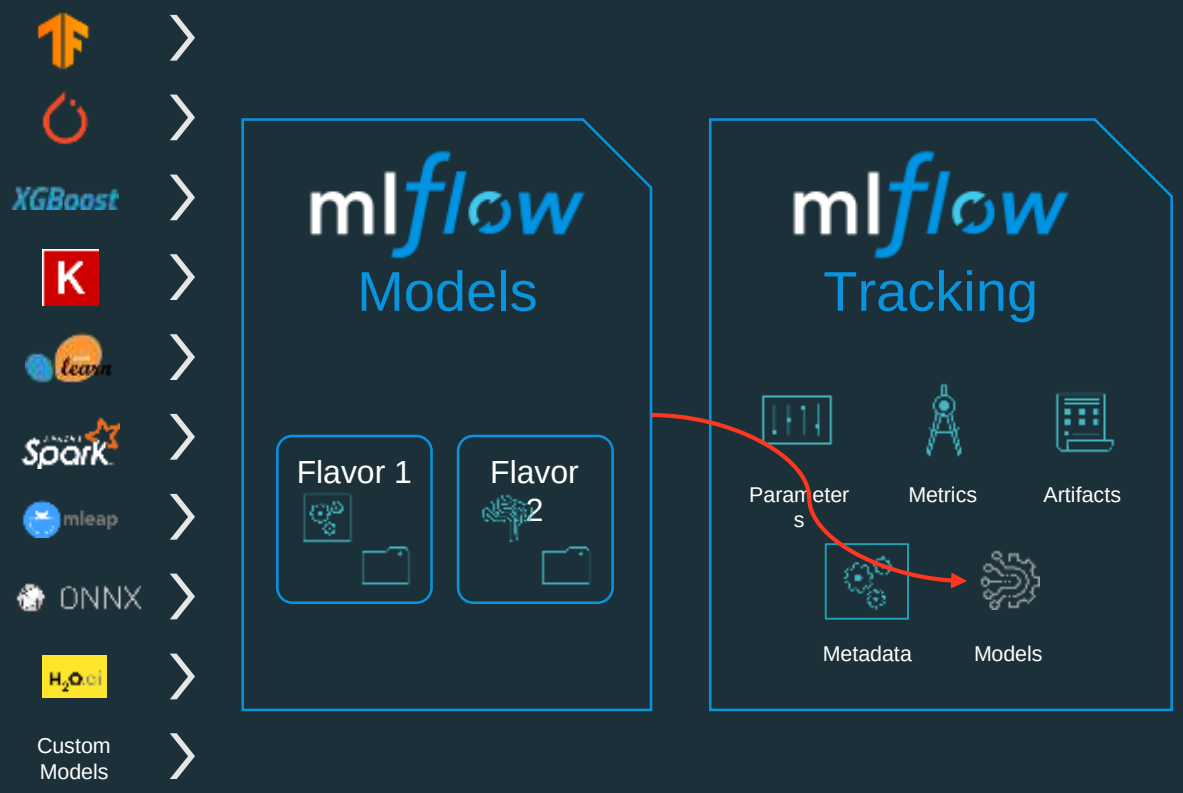
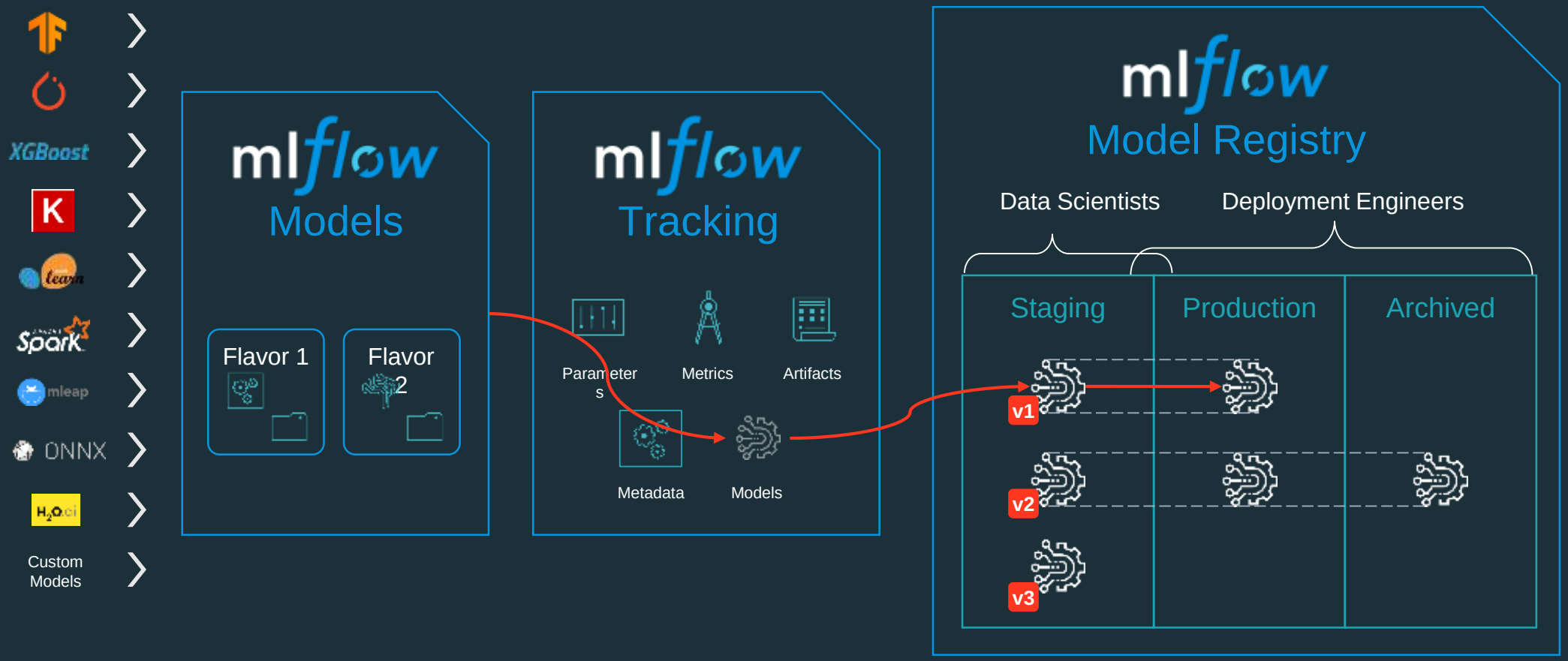
mlflow Model Lifecycle



mlflow Model Lifecycle



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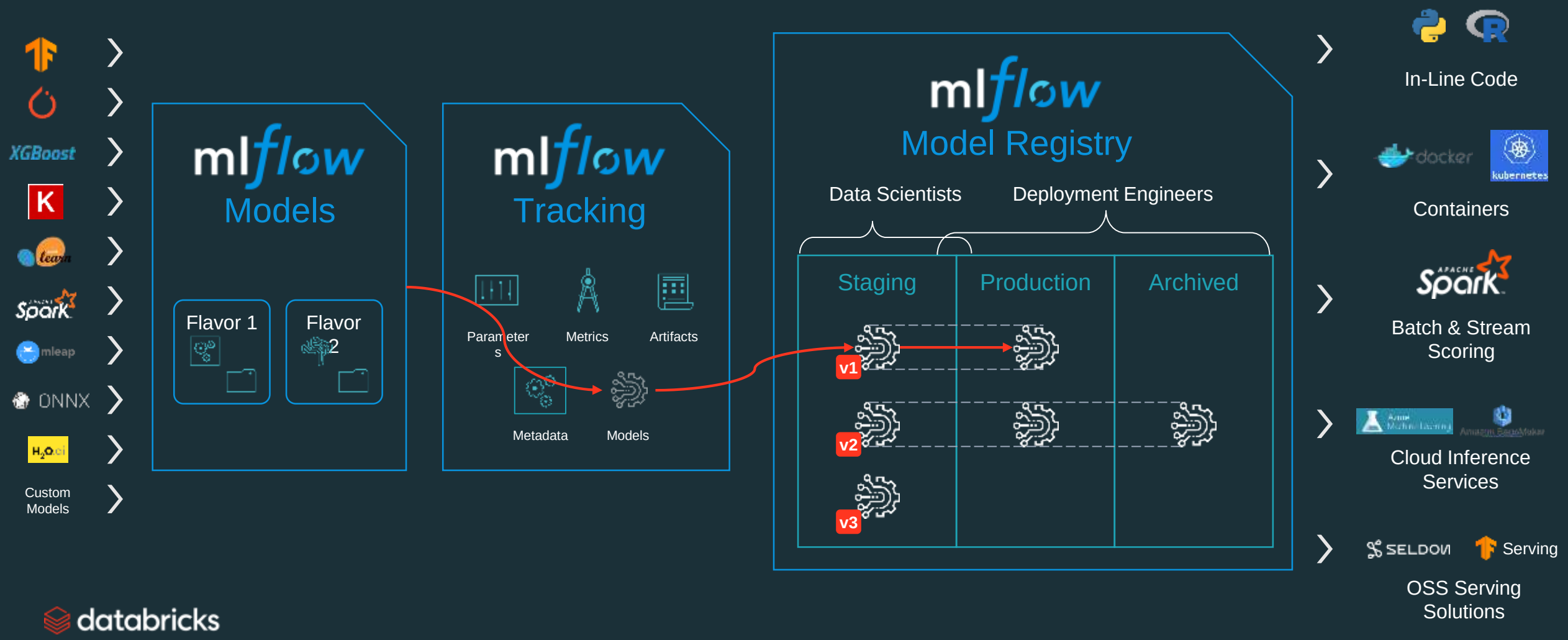
mlflow Model Lifecycle



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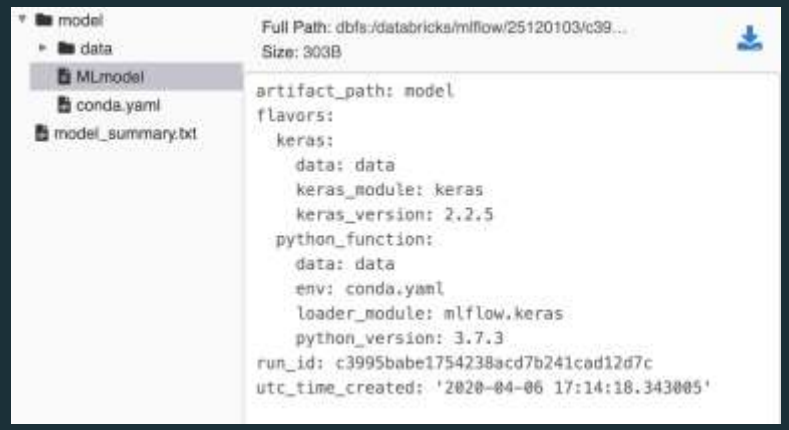
mlflow Auto-Logging

Auto-logging for ML Frameworks: A single line of code logs parameters, metrics, and artifacts.

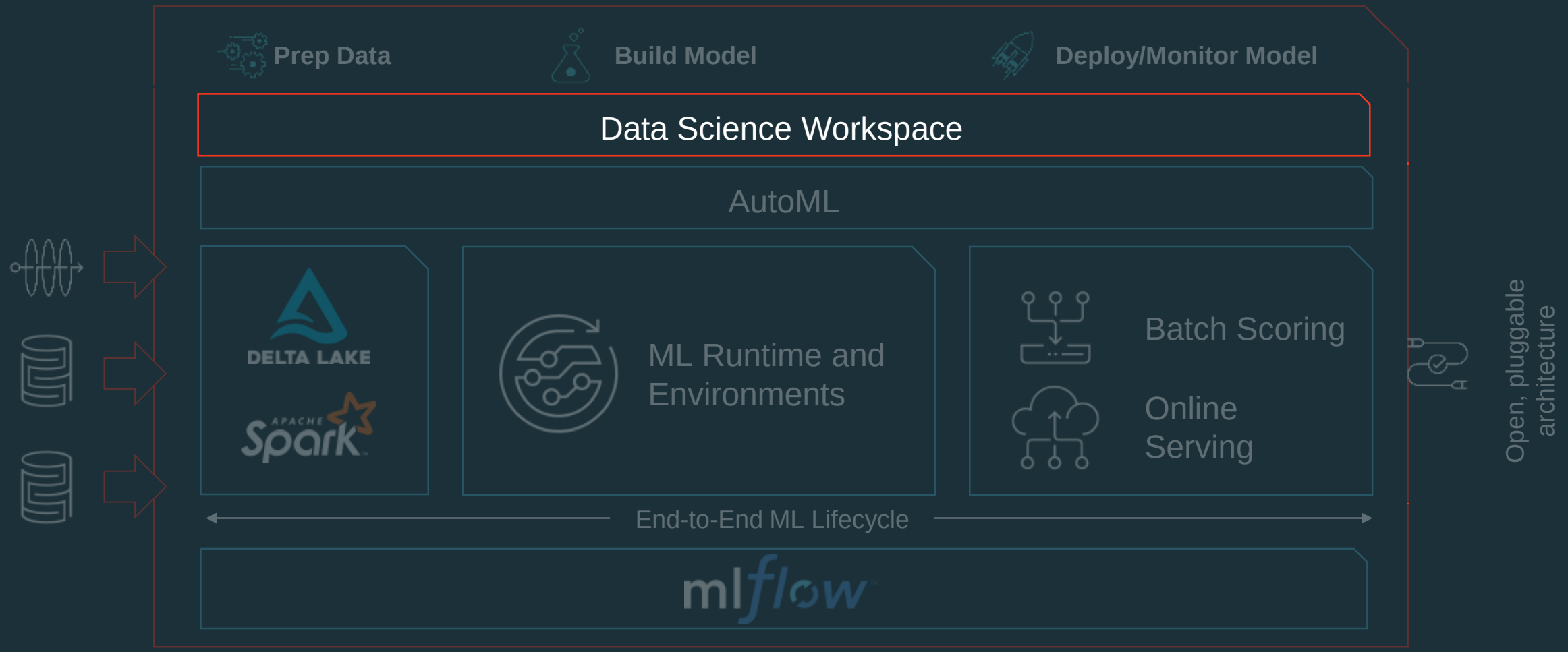
```
mlflow.keras.autolog() # or: mlflow.tensorflow.autolog()
```

Parameters and (a time series of) metrics

Artifacts (including model)



End-to-End Data Science and ML on databricks



Databricks Notebooks

Provide a collaborative environment for Unified Data Analytics

Multi-Language

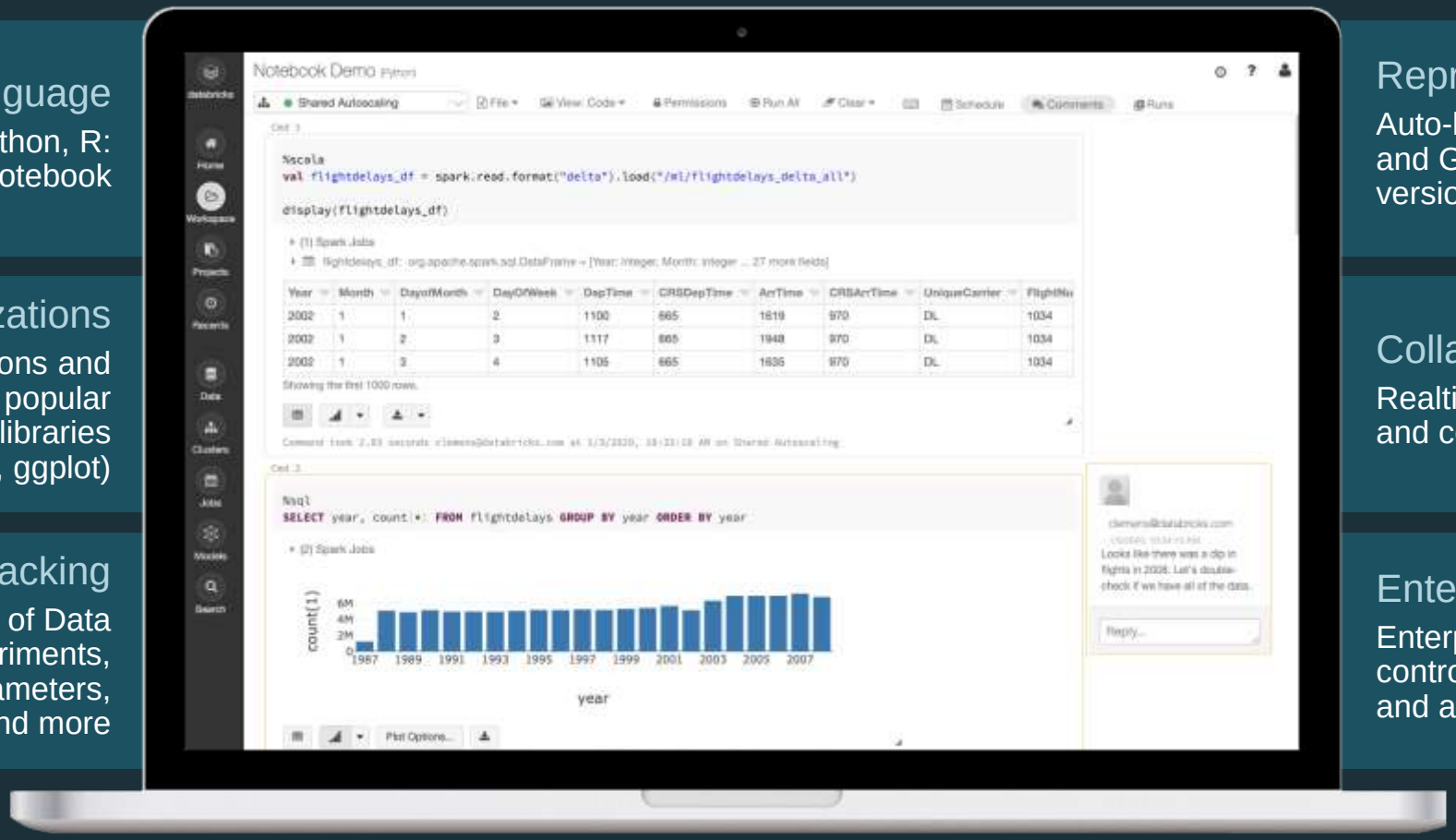
Scala, SQL, Python, R: All in one notebook

Visualizations

Built-in visualizations and support for the most popular visualization libraries (e.g. matplotlib, ggplot)

Experiment Tracking

Built-in tracking of Data Science and ML experiments, with metrics, parameters, artifacts, and more



Reproducible

Auto-logged revision history and Git integration for version control

Collaborative

Realtime co-editing and commenting

Enterprise Ready

Enterprise grade access controls, identity pass-through, and auditability

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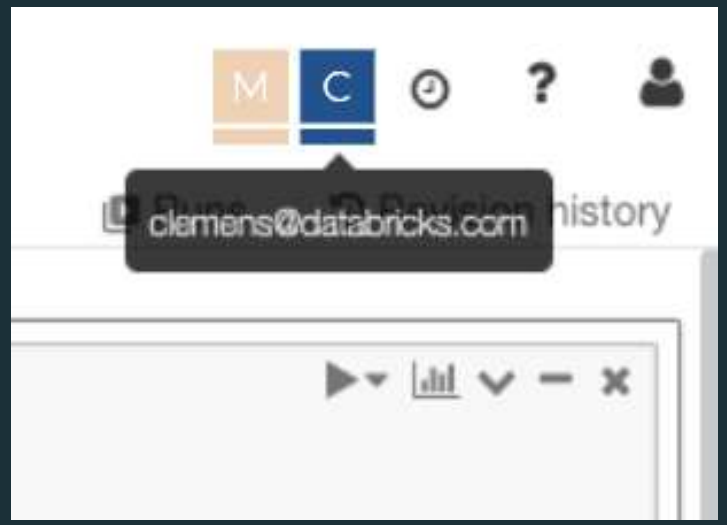
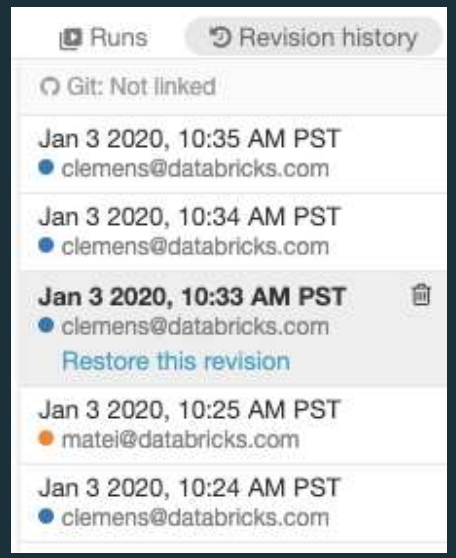
Databricks Notebooks for Collaborative Data Science

Data Engineers, Data Scientists, ML Engineers, and Data Analysts can all collaborate in one shared environment using modern collaboration patterns.

Co-Presence / Co-Editing

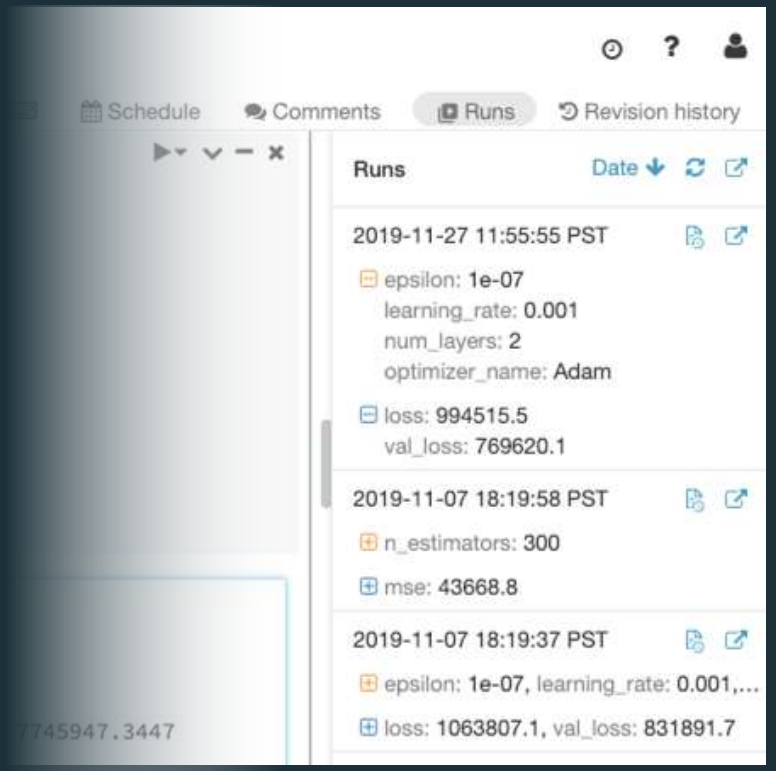


Versioning



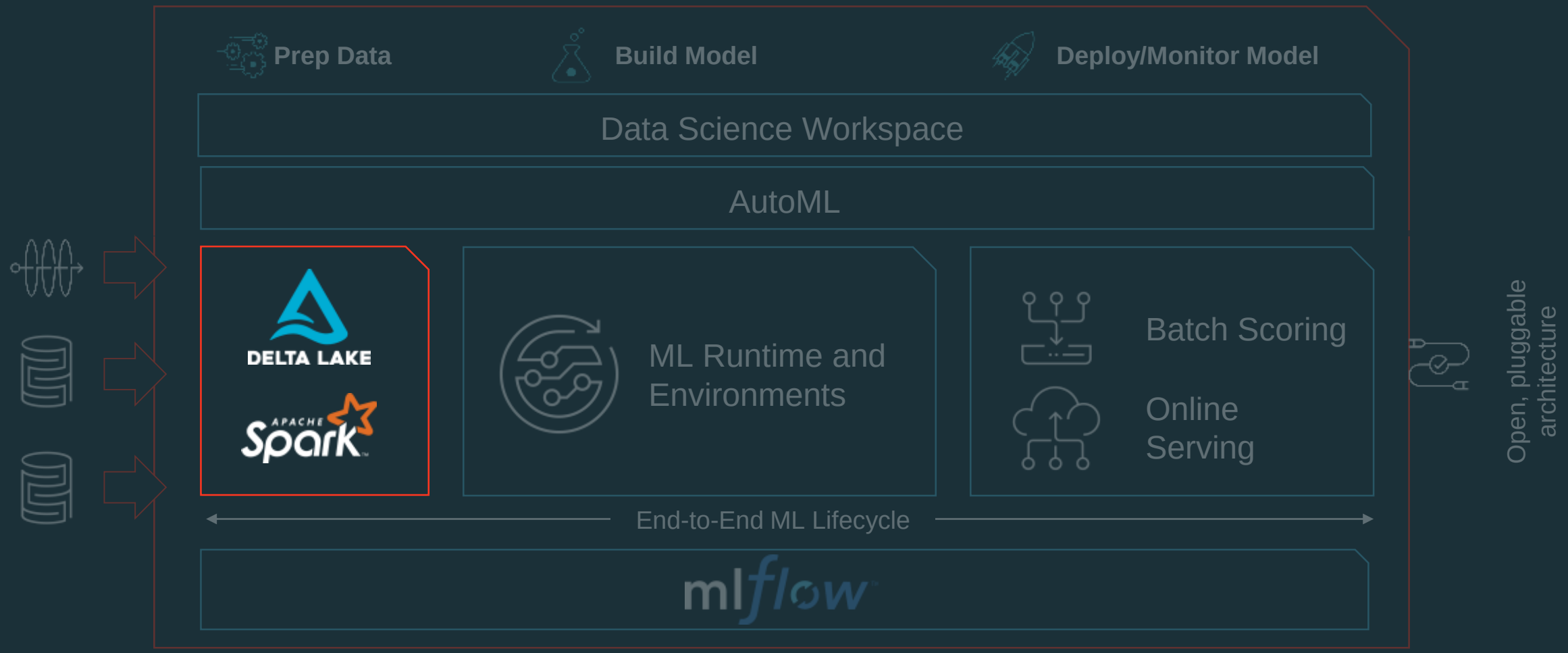
Commenting

mlflow Integration with Databricks Notebooks



- Runs Sidebar integrated with MLflow Tracking
- Track runs, sort by metrics and parameters
- Linked to revision history of the notebook

End-to-End Data Science and ML on databricks



for Data Science and ML

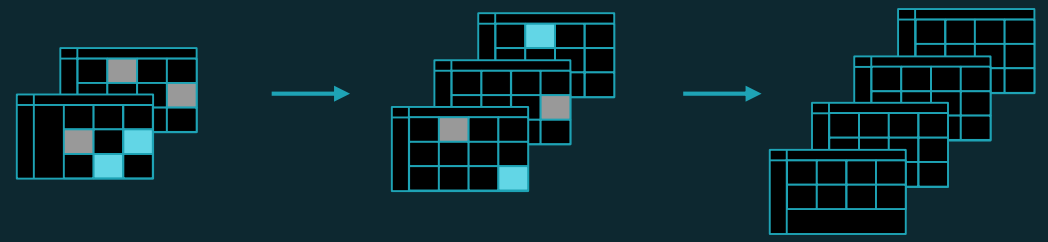
Files

Streaming

Batch

3rd Party Data Marketplace

DELTA LAKE™



Ingestion Tables → Data Catalog → Feature Store

Your Existing Data Lake

Azure Data Lake Storage

hadoop

Amazon S3

ML Runtime

- Schema enforced high quality data
- Optimized performance

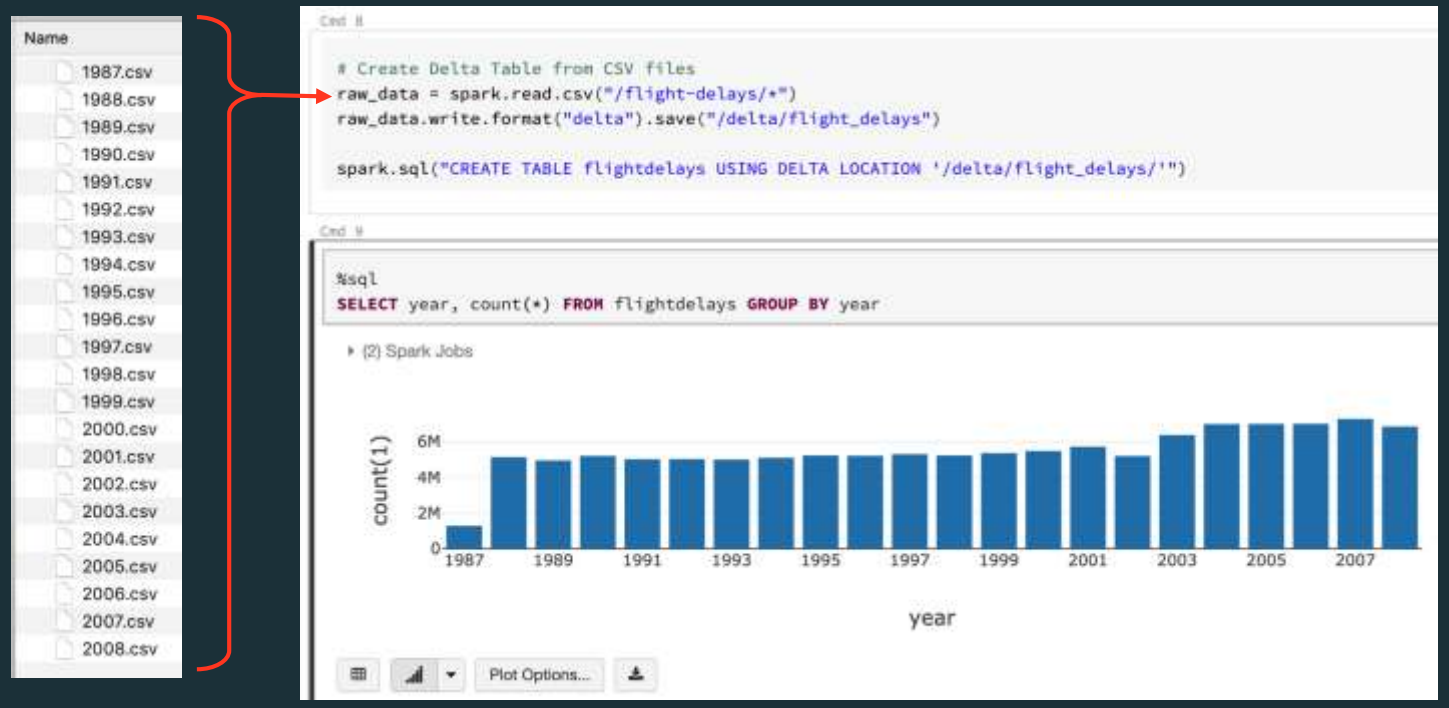
mlflow™

- Full data lineage / governance
- Reproducibility through time travel

databricks

for Data Science and ML

Ingest data and visualize data distribution



for Data Science and ML

Data versioning and time travel

Cmd 10

```
%sql
DESCRIBE HISTORY flightdelays
```

(3) Spark Jobs

version	timestamp	userId	userName	operation	operationParameters	job	notebook	clusterId	readVersion	isolati
7	2019-10-08T16:47:22.000+0000	101543	clemens.mewald@databricks.com	MERGE	{"predicate":"((k.`Origin` = f.`Dest`) AND (k.`Dest` = f.`Origin`))"}	null	{"notebookId":"21190735"}	0304-201045-hoary804	6	WriteS
6	2019-10-08T16:44:16.000+0000	101543	clemens.mewald@databricks.com	MERGE	{"predicate":"((k.`Origin` = f.`Origin`) AND (k.`Dest` = f.`Dest`))"}	null	{"notebookId":"21190735"}	0304-201045-hoary804	5	WriteS

Command took 6.04 seconds -- by clemens.mewald@databricks.com at 11/10/2019, 2:19:12 PM on Shared Autoscaling

for Data Science and ML

Data versioning and time travel

Cmd 10

```
%sql
DESCRIBE HISTORY flightdelays
```

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7	2019-10-08T16:47:22.000+0000	101543	clemens.mewald@databricks.com	MERGE	{"predicate":"((k.`Origin` = f.`Dest`) AND (k.`Dest` = f.`Origin`))"}	null	{"notebookId":"21190735"}	0304-201045-hoary804	6	WriteS
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Command took 6.84 seconds -- by clemens.mewald@databricks.com at 11/10/2019, 2:19:12 PM on Shared Autoscaling

Cmd 11

```
%sql
SELECT * FROM flightdelays VERSION AS OF 6
```

(4) Spark Jobs

Year	Month	DayofMonth	DayOfWeek	DepTime	CRSDepTime	ArrTime	CRSArrTime	UniqueCarrier	FlightNum	TailNum	ActualElapsedTime	CRSElapsedTime
2006	11	1	3	1900	1130	2140	1262	EV	4608	N902EV	160	132
2006	11	2	4	1903	1130	2056	1262	EV	4608	N920EV	113	132

mlflow Integration with Delta

Auto-Logging for any Spark Datasource

Cmd 1

```
with mlflow.start_run():
  mlflow.spark.autolog()

  df = spark.read.table('flightdelays')
  display(df)
```

(2) Spark Jobs

df: pyspark.sql.dataframe.DataFrame = [Year: integer, Month: integer ... 27 more fields]

Year	Month	DayofMonth	DayOfWeek	DepTime	CRSDepTime	ArrTime	CRSArrTi
2004	5	1	6	1746	675	855	300
2004	5	2	7	1745	675	835	300
2004	5	3	1	1748	675	837	300
2004	5	4	2	1752	675	837	300
2004	5	5	3	1747	675		
2004	5	6	4	1749	675		
2004	5	7	5	1747	675		
2004	5	8	6	1749	675		

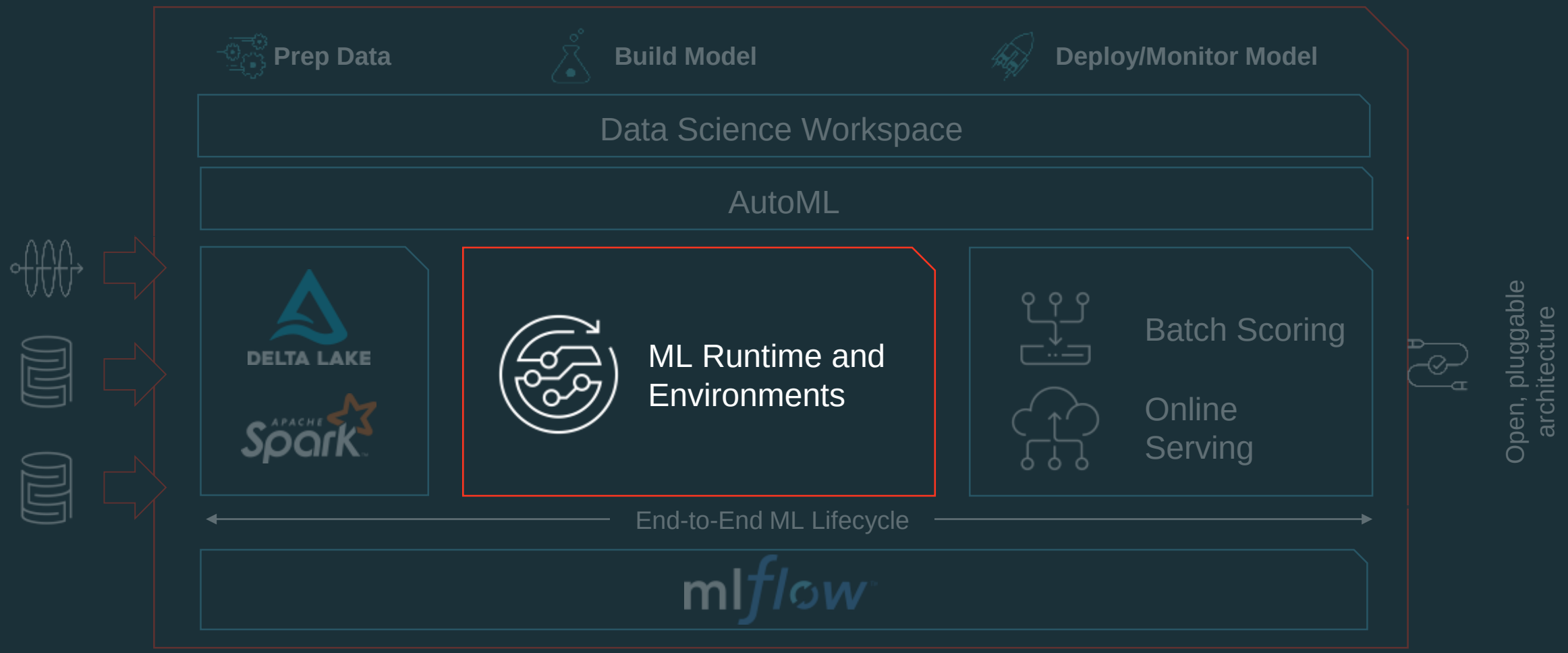
Showing the first 8809 rows.

Command took 2.80 seconds -- by clemens.mewald@databricks.com at 4/2

Tags

Name	Value	Actions
sparkDatasourceInfo	path=dbfs:/ml/flightdelays_delta_all/_delta_log/00000000000000000000.json,format=json	

End-to-End Data Science and ML on databricks



Machine Learning Runtime

Packages and optimizes most common ML Frameworks

XGBoost

...

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Built-in Optimization for Distributed Deep Learning

Distribute and Scale any Single-Machine ML Code to 1,000's of machines

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Built-In AutoML and Experiment Tracking

mlflow

AutoML and Tracking / Visualizations with MLflow

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mlflow

AutoML and Tracking / Visualizations with MLflow

Customized Environments using Conda

requirements.txt
conda.yaml

Customization

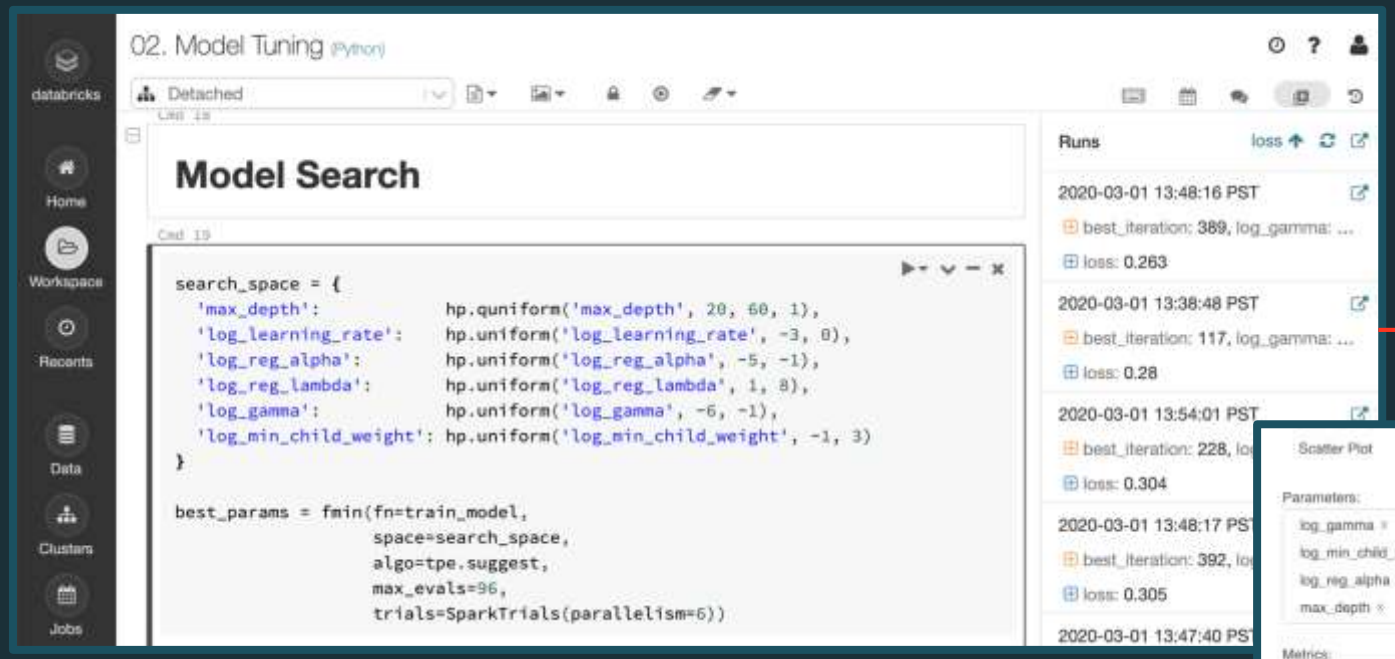
Pre-configured Environment

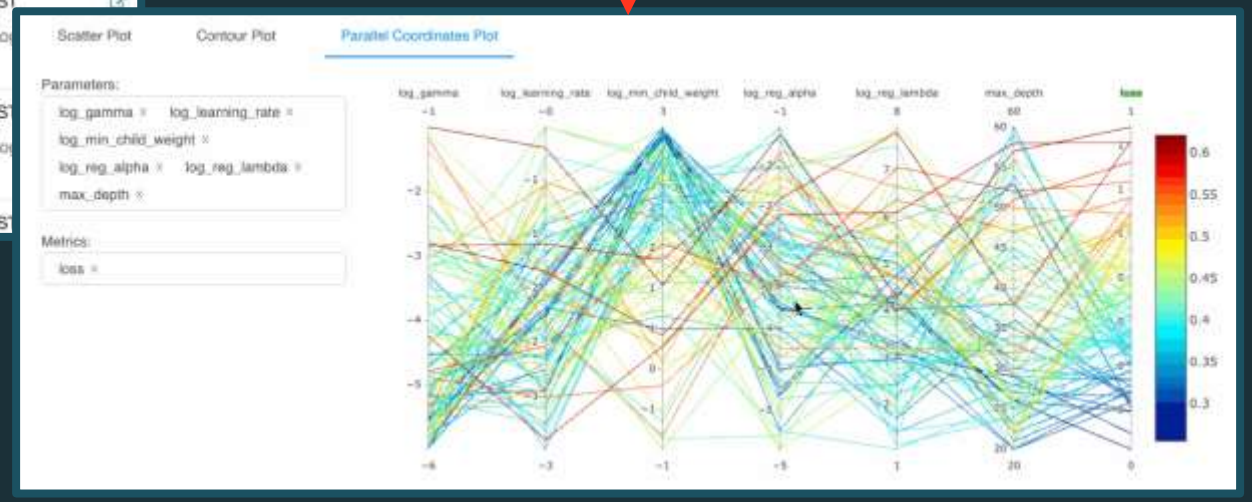
Machine Learning

Conda-Based

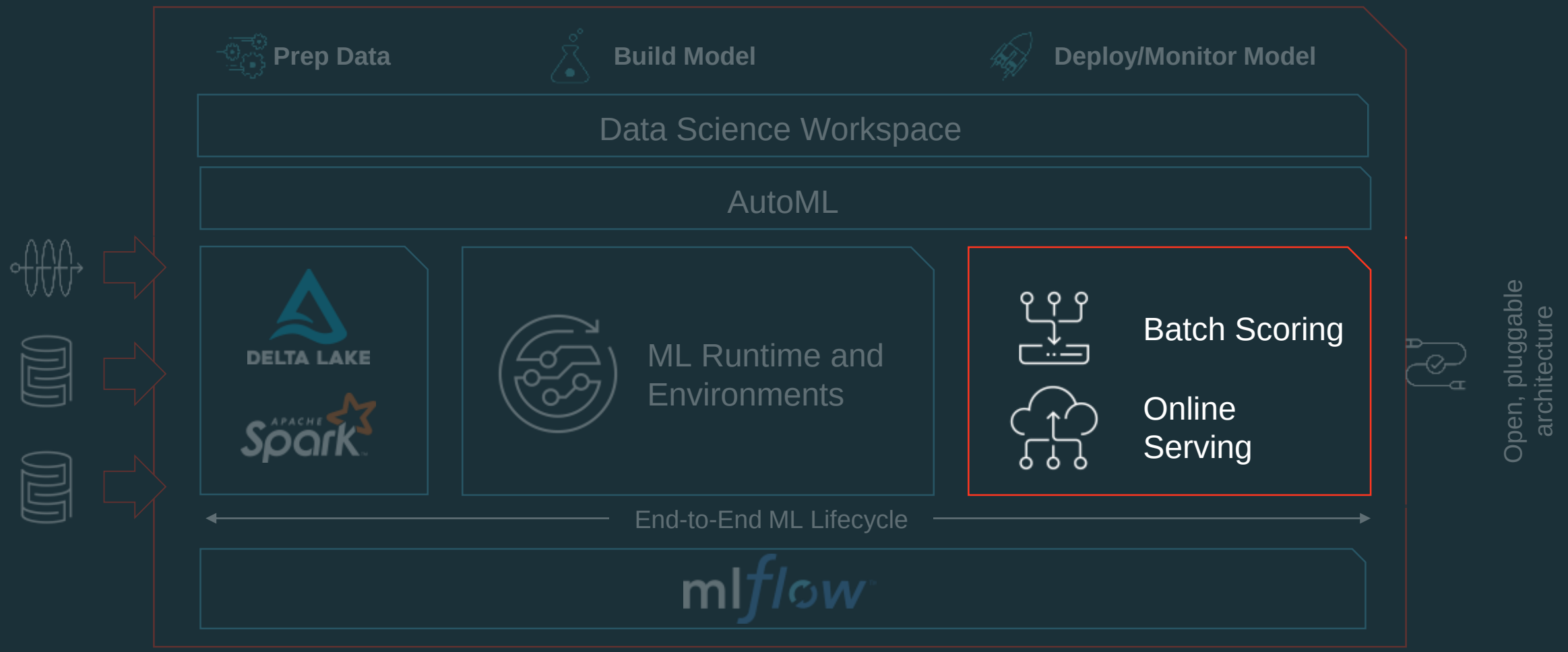
mlflow Integration with ML Runtime

Hyperopt autlogging to MLflow

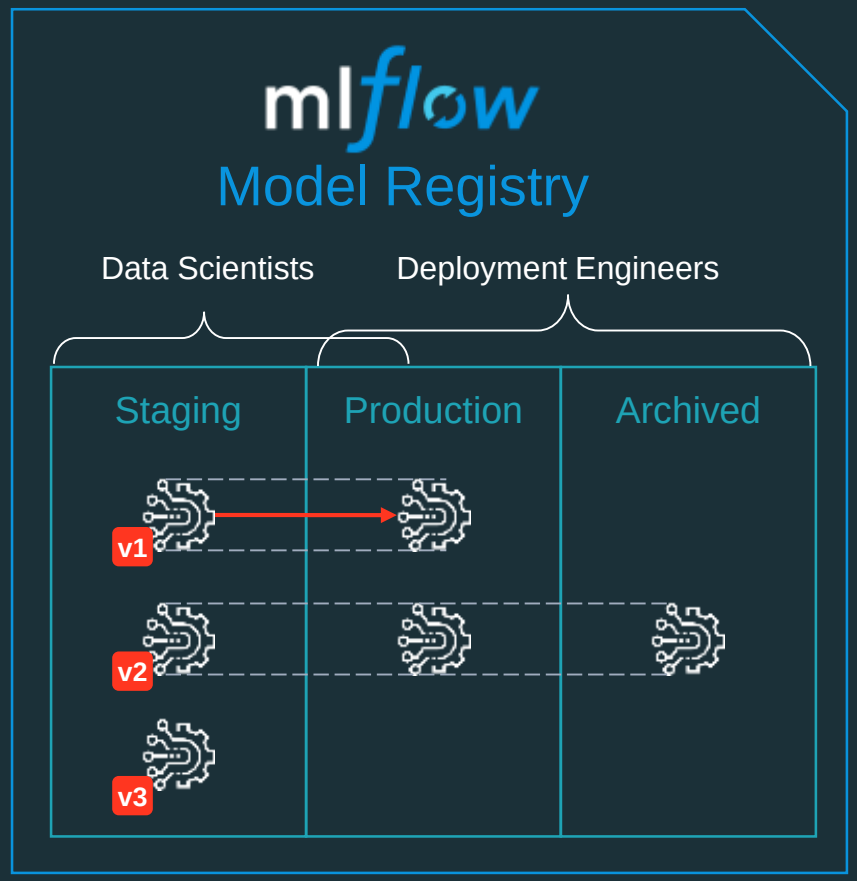




End-to-End Data Science and ML on databricks



mlflow Model Deployment



In-Line Code

Containers

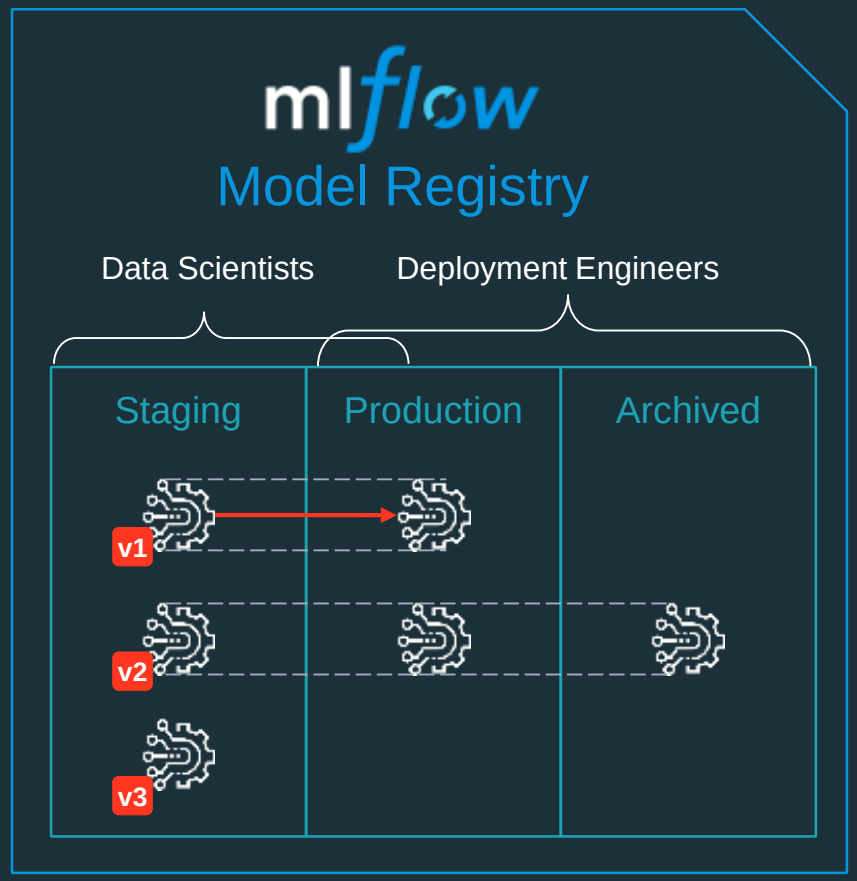
Batch & Stream Scoring

Cloud Inference Services

OSS Serving Solutions

databricks

mlflow Model Deployment



In-Line Code

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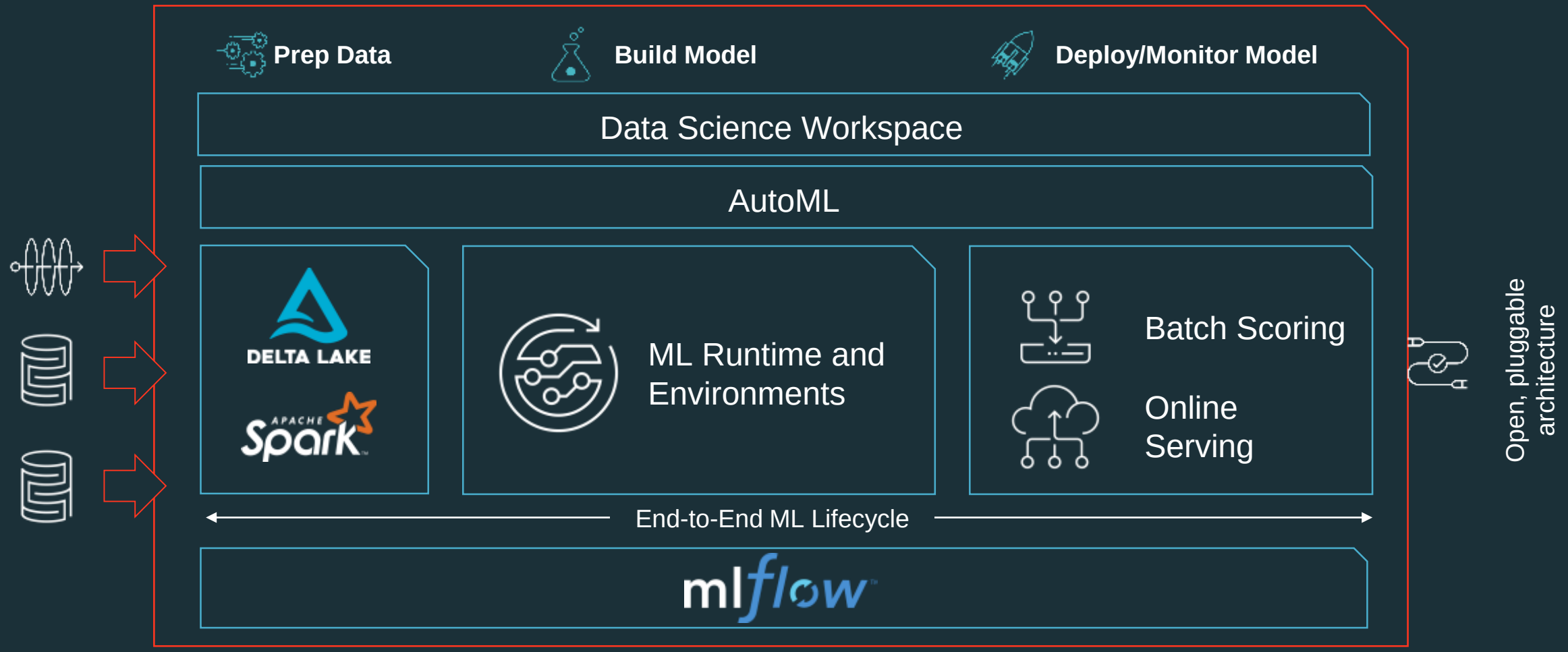
OSS Serving Solutions

```
model_udf =
    mlflow.pyfunc.spark_udf(
        spark,
        model_uri='models:/forecast/production')
```

databricks

In summary, databricks accelerates the full ML Lifecycle



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