



Data + AI
Online Meetup Group

mlflow

Platform for Complete Machine
Learning Lifecycle

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Outline – Introduction to MLflow: Model Registry Workflows Explained – Part 3

- Review & Recap Part 2: MLflow Projects & Models
- Concepts and Motivations
- MLFlow Component
 - MLflow Model Registry
 - Model Registry UI & API Workflow
 - Managed MLflow Model Registry Demo
 - Tutorials on local host
- Q & A

<https://dbricks.co/mlflow-part-3>

MLflow Components

mlflow Tracking

Record and query experiments: code, data, config, and results

mlflow Projects

Package data science code in a format that enables reproducible runs on any platform

mlflow Models

Deploy machine learning models in diverse serving environments

new

mlflow Model Registry

Store, annotate and manage models in a central repository

[databricks.com
/mlflow](https://databricks.com/mlflow)



mlflow.org



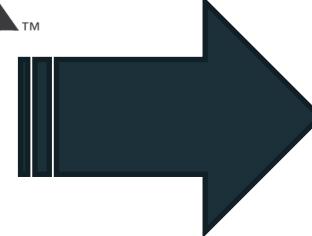
github.com/mlflow



twitter.com/MLflow

MLflow Projects Motivation

Diverse set of tools



Diverse set of environments

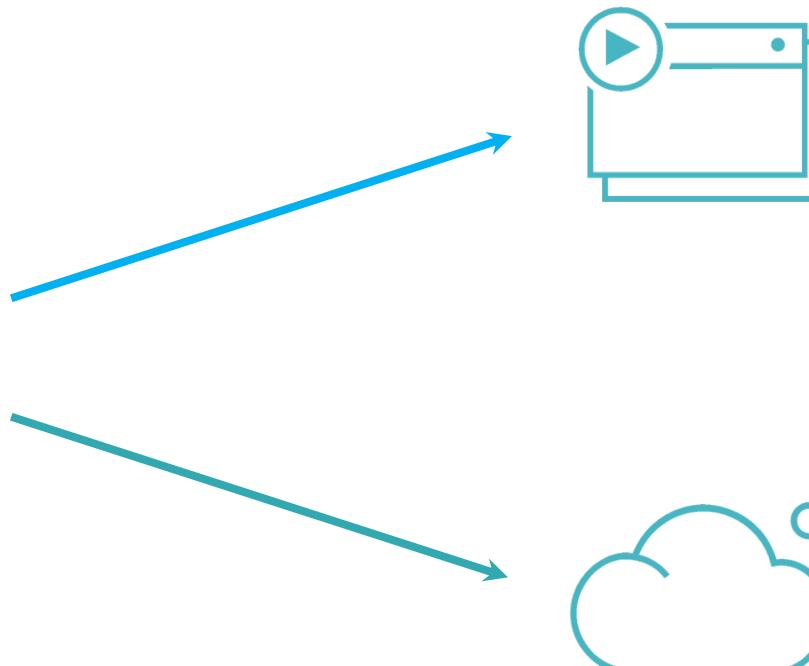
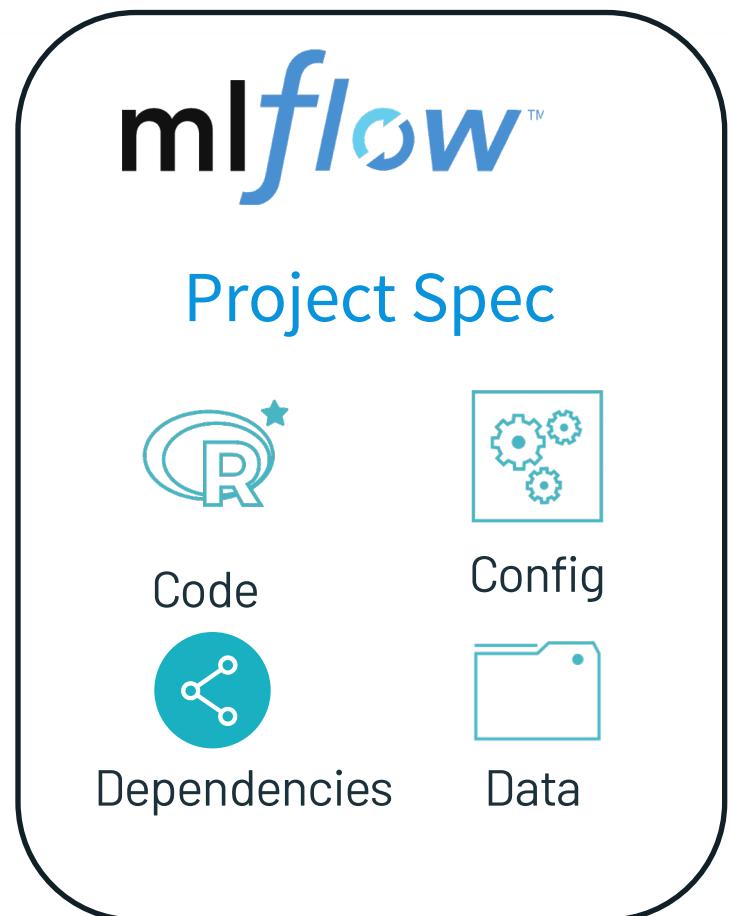


mlflow™
Projects

Package data science
code in a format that
enables reproducible runs
on any platform

Challenge: ML results difficult to reproduce

MLflow Projects



Local Execution



Remote Execution



Example MLflow Project

```
my_project/
└── MLProject
    ├── conda.yaml
    ├── main.py
    └── model.py
...

```

```
conda_env: conda.yaml

entry_points:
  main:
    parameters:
      training_data: path
      lambda: {type: float, default: 0.1}
  command: python main.py {training_data} {lambda}
```

```
$ mlflow run git://<my_project> -P lambda=0.2
mlflow.run("git://<my_project>", ...)
mlflow run . -e main -P lambda=0.2
```

Example

```
my_project/
    └── MLproject
        |
        └── conda.yaml
        └── main.py
        └── model.py
    ...

```

```
channels:
  - defaults
dependencies:
  - python=3.7.3
  - scikit-learn=0.20.3
  - pip:
    - mlflow
    - cloudpickle==0.8.0
name: mlflow-env
```

MLflow Model Motivations



ML Frameworks

N x M
Combination of
Model support for
all Serving tools



Inference Code

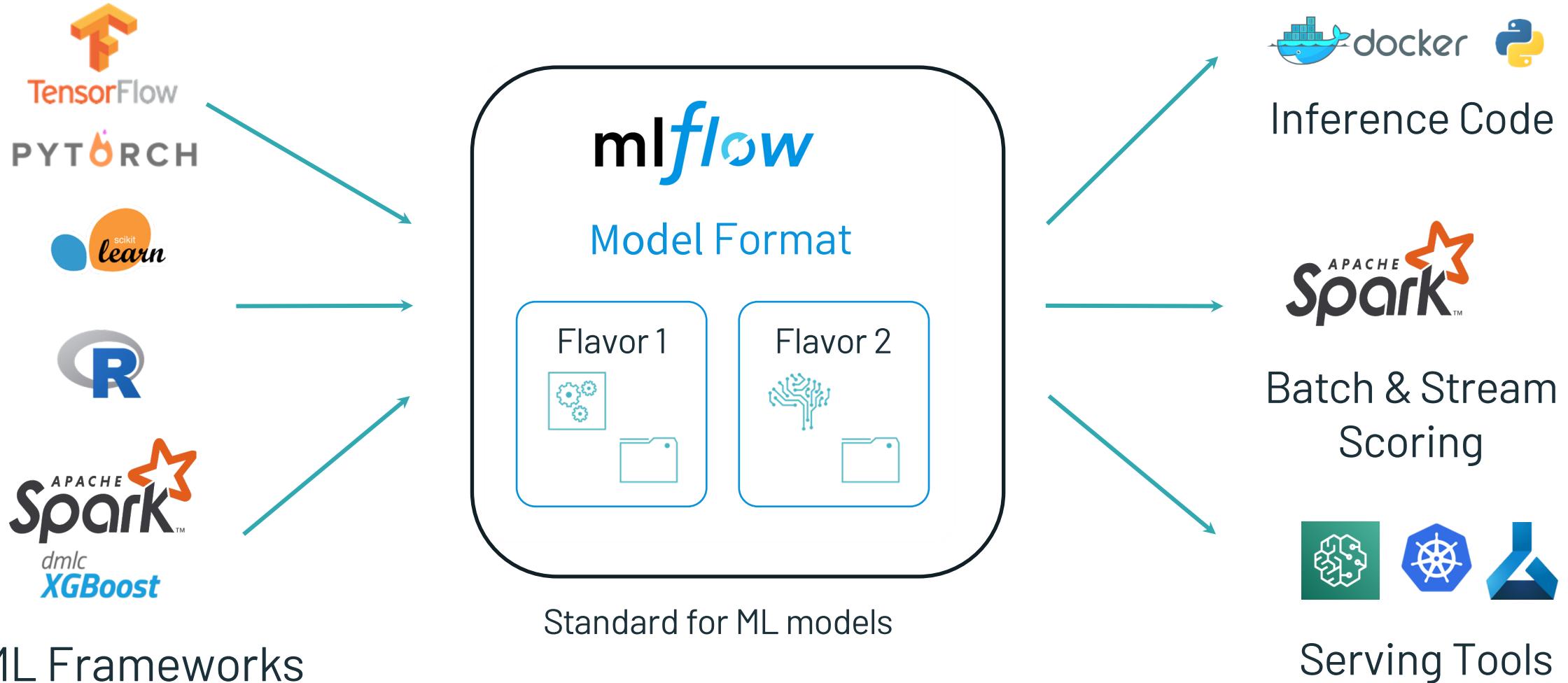


Batch & Stream Scoring



Serving Tools

MLflow Models



Example MLflow Model

```
mlflow.tensorflow.log_model(...)
```

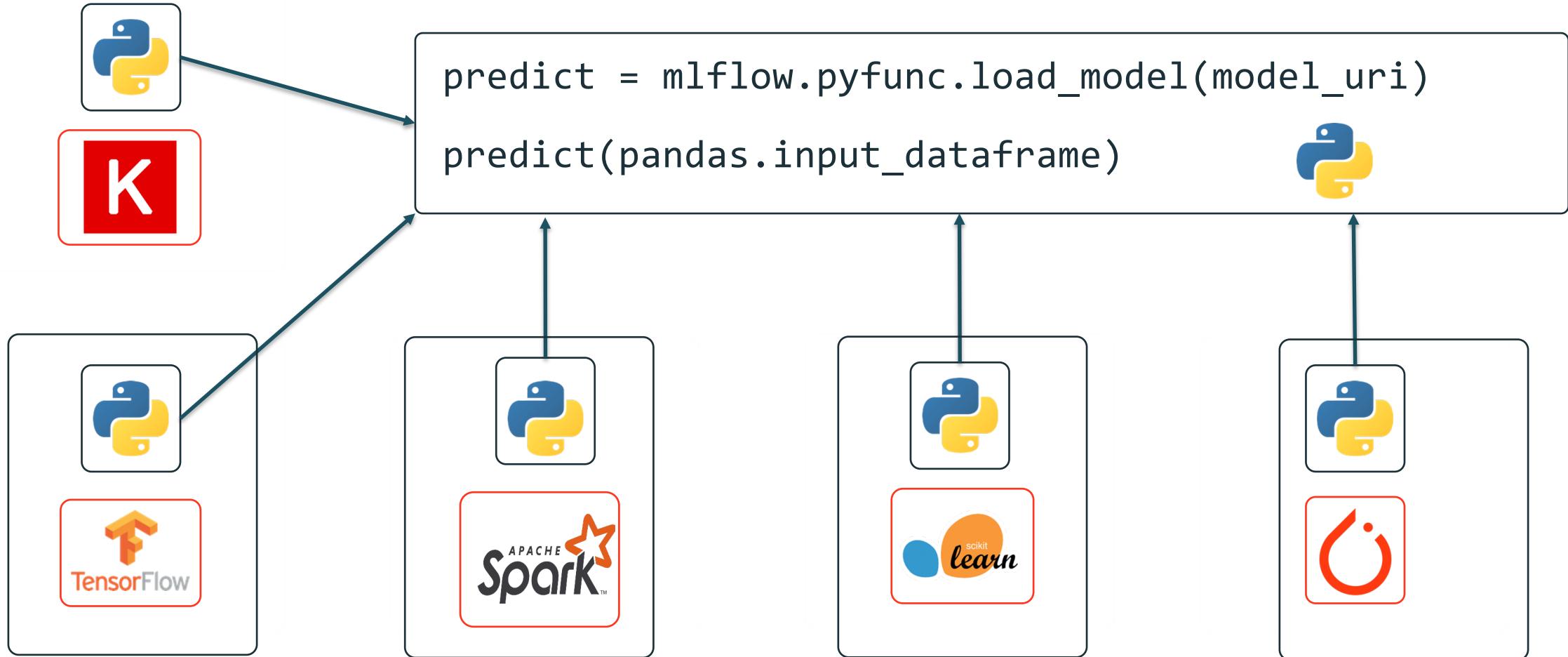
```
my_model/  
└── MLmodel
```

```
run_id: 769915006efd4c4bbd662461  
time_created: 2018-06-28T12:34  
flavors:  
    tensorflow:  
        saved_model_dir: estimator  
        signature_def_key: predict  
    python_function:  
        loader_module: mlflow.tensorflow
```

```
estimator/  
└── saved_model.pb  
variables/  
...
```

} Usable by tools that understand TensorFlow model format
} Usable by any tool that can run Python (Docker, Spark, etc!)

Model Flavors Example



MLflow Components

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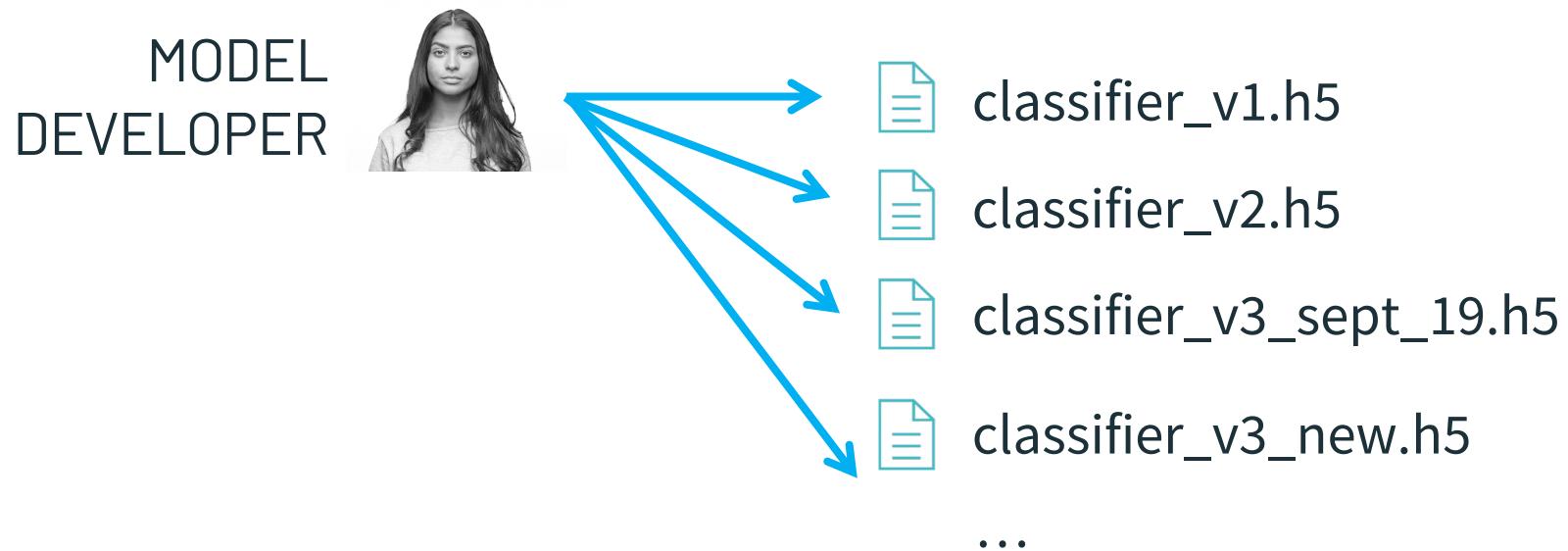
github.com/mlflow



twitter.com/MLflow

The Model Management Problem

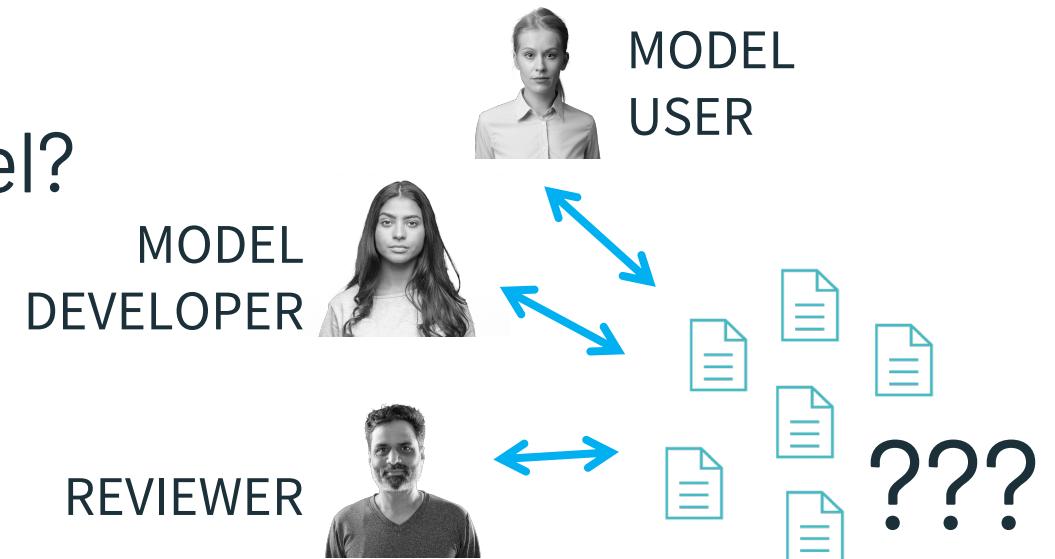
When you're working on one ML app alone, storing your models in files is manageable



The Model Management Problem

When you work in a large organization with many models, many data teams, management becomes a major challenge:

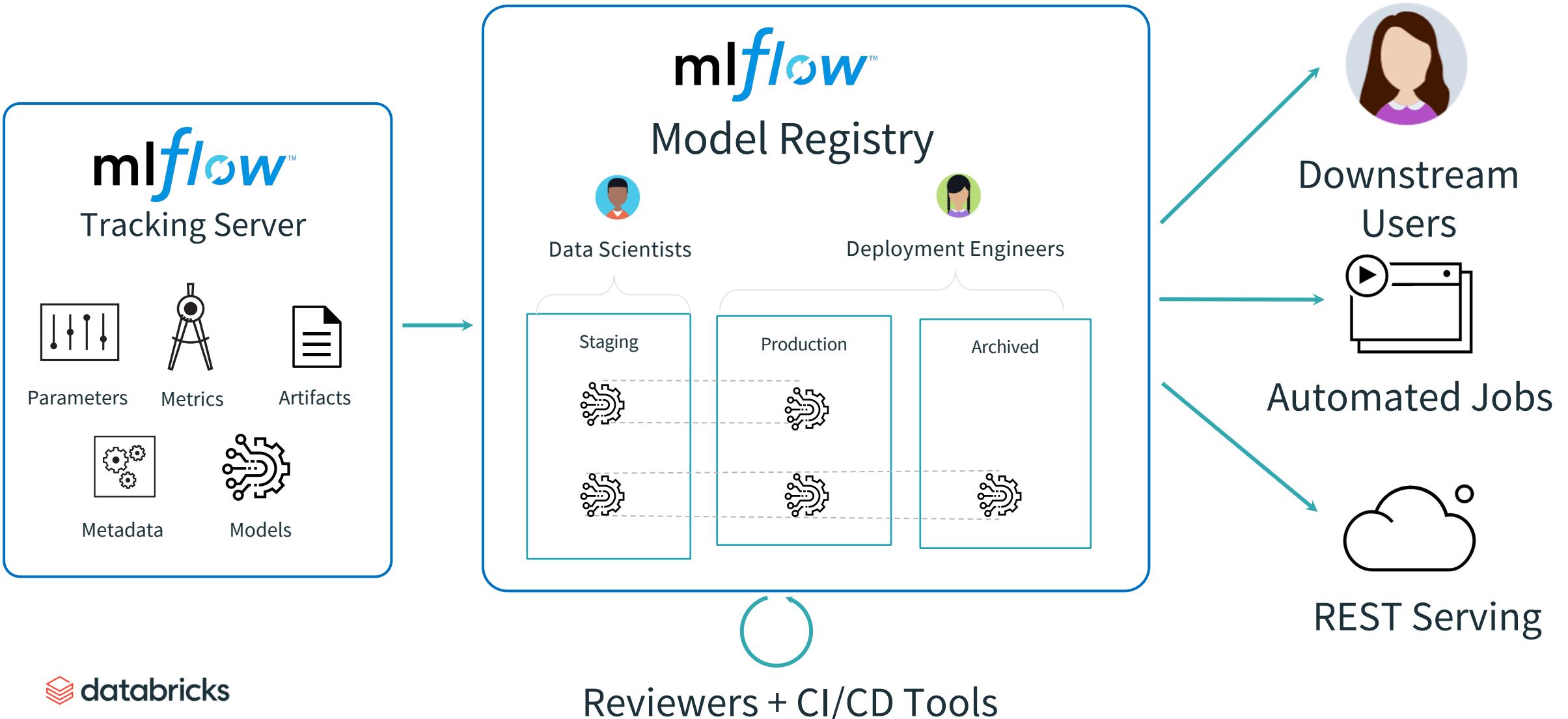
- Where can I find the best version of this model?
- How was this model trained?
- How can I track docs for each model?
- How can I review models?
- How can I integrate with CI/CD?





Model Registry

VISION: Centralized and collaborative model lifecycle management



MLflow Model Registry

- Repository of named, versioned models with comments & tags
- Track each model's stage: none, staging, production, or archived
- Easily inspect a specific version and its run info
- Easily load a specific version
- Provides model description, lineage and activities

Registered Models > Airline_Delay_SparkML ▾

Created Time: 2019-10-10 15:20:29 Last Modified: 2019-10-14 12:17:04

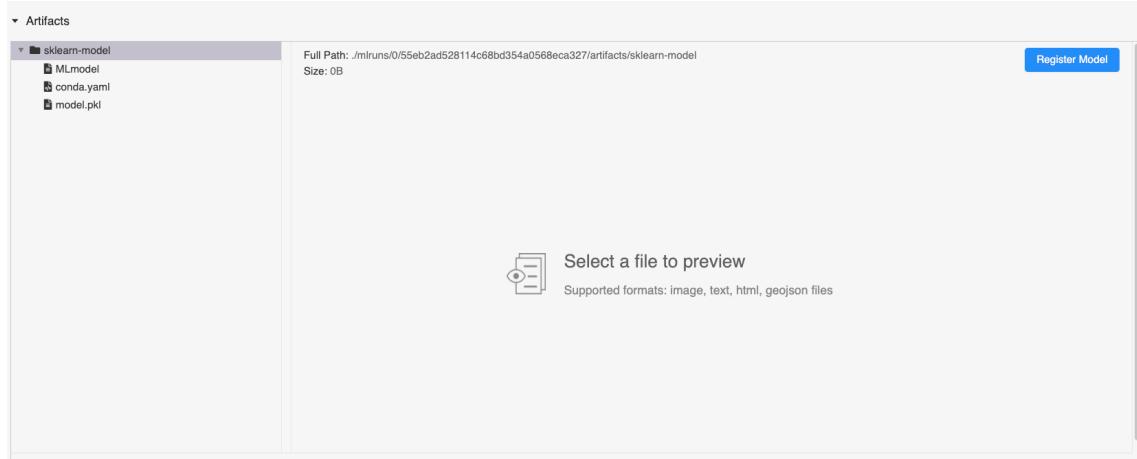
▼ Description 

Predicts airline delays (in minutes) using the best Spark RF model from the AutoML Toolkit.

▼ Versions  

Version	Registered at	Created by	Stage
 Version 1	2019-10-10 15:20:30	clemens@demo.com	Archived
 Version 2	2019-10-10 21:47:29	clemens@demo.com	Archived
 Version 3	2019-10-10 23:39:43	clemens@demo.com	Production
 Version 4	2019-10-11 09:55:29	clemens@demo.com	None
 Version 5	2019-10-11 12:44:44	matei@demo.com	Staging

Model Registry Workflow UI



Artifacts

sklearn-model

- MLmodel
- conda.yaml
- model.pkl

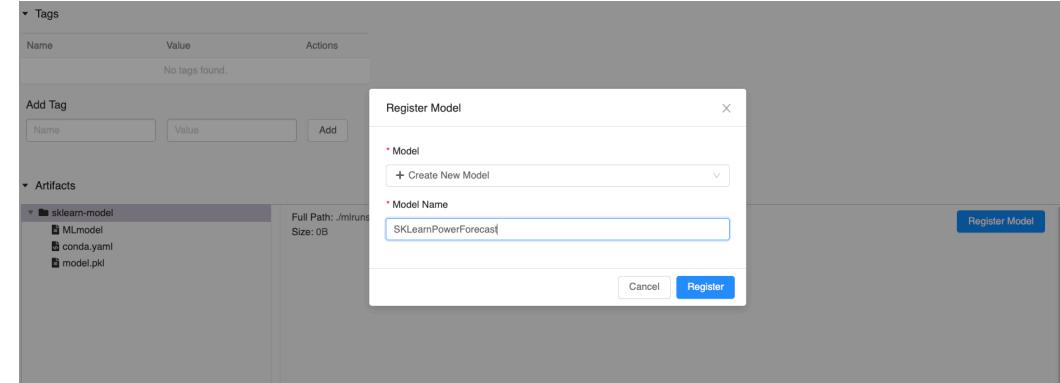
Full Path: ./mirluns/0/55eb2ad528114c68bd354a0568eca327/artifacts/sklearn-model
Size: 0B

Select a file to preview
Supported formats: image, text, html, geojson files

Register Model



MODEL
DEVELOPER



Tags

Name	Value	Actions
No tags found.		

Add Tag

Artifacts

sklearn-model

- MLmodel
- conda.yaml
- model.pkl

Full Path: ./mirluns/0/55eb2ad528114c68bd354a0568eca327/artifacts/sklearn-model
Size: 0B

Register Model

Model

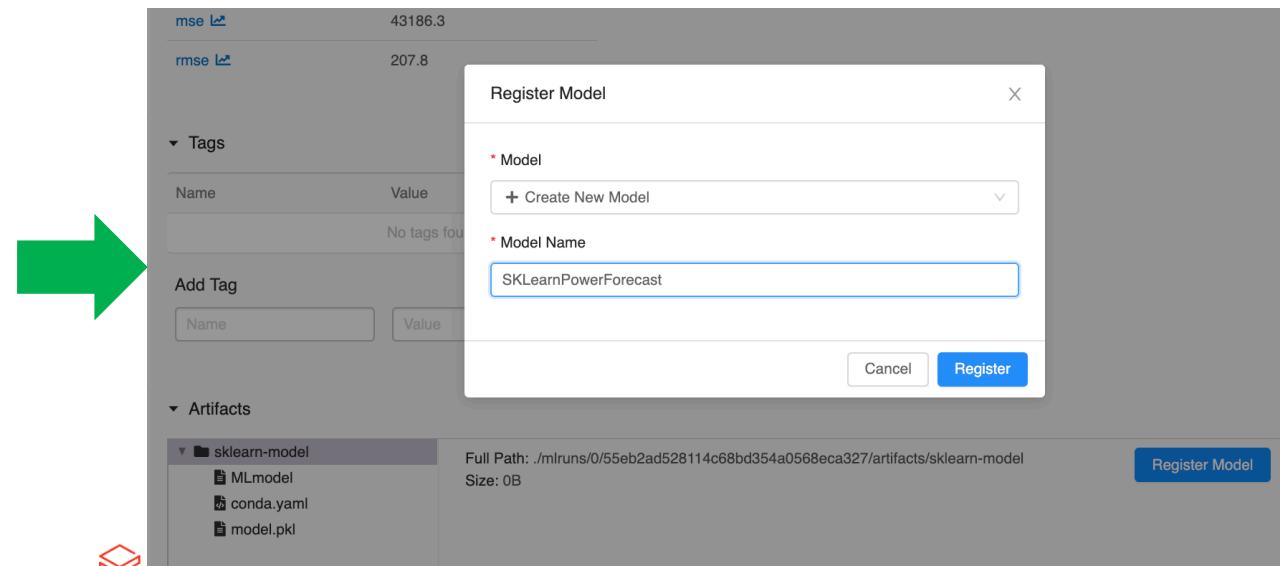
+ Create New Model

Model Name

SKLearnPowerForecast

Cancel Register

Register Model



mse ↗ 43186.3

rmse ↗ 207.8

Tags

Name	Value
No tags found.	

Add Tag

Name Value

Register Model

Model

+ Create New Model

Model Name

SKLearnPowerForecast

Cancel Register

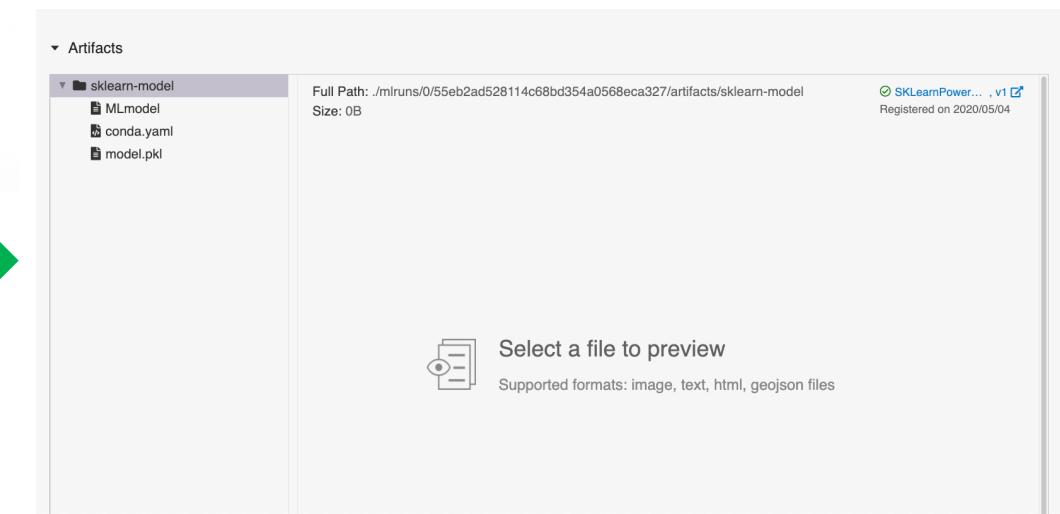
Artifacts

sklearn-model

- MLmodel
- conda.yaml
- model.pkl

Full Path: ./mirluns/0/55eb2ad528114c68bd354a0568eca327/artifacts/sklearn-model
Size: 0B

Register Model



Artifacts

sklearn-model

- MLmodel
- conda.yaml
- model.pkl

Full Path: ./mirluns/0/55eb2ad528114c68bd354a0568eca327/artifacts/sklearn-model
Size: 0B

SKLearnPowerForecast, v1

Registered on 2020/05/04

Select a file to preview
Supported formats: image, text, html, geojson files

Model Registry Workflow UI

This screenshot shows the mlflow Model Registry UI. It displays a model version named 'SKLearnPowerForecast > Version 1'. The page includes details such as 'Registered At: 2020-05-04 11:38:47', 'Creator:', 'Stage: None', and 'Source Run: Random Forest Regressor: Power Forecasting Model'. A large green arrow points from this screen to the 'MODEL REVIEWER' section.



MODEL
REVIEWER

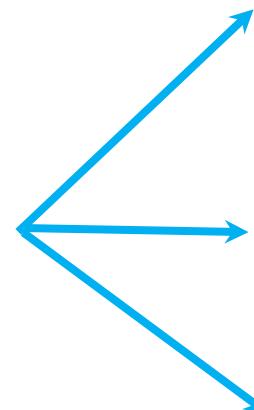
This screenshot shows the mlflow Model Registry UI. It displays a model version named 'SKLearnPowerForecast > Version 1'. The 'Stage' dropdown is set to 'None'. Below it, there are three buttons for transitioning the model: 'Transition to → Staging' (orange), 'Transition to → Production' (green), and 'Transition to → Archived' (grey). A large green arrow points from the 'MODEL REVIEWER' section to this screen.



DOWNSTREAM
USERS

This screenshot shows the mlflow Model Registry UI. It displays a list of model versions for 'SKLearnPowerForecast'. The table includes columns for 'Version', 'Registered at', 'Created by', and 'Stage'. Three versions are listed: Version 1 (Staging), Version 2 (Staging), and Version 3 (Production). A large green arrow points from the 'DOWNSTREAM USERS' section to this screen.

Version	Registered at	Created by	Stage
Version 1	2020-05-04 11:38:47		Staging
Version 2	2020-05-04 11:41:37		Staging
Version 3	2020-05-04 11:42:07		Production



AUTOMATED JOBS



REST SERVING

Model Registry Workflow API

```
mlflow.register_model(model_uri, "WeatherForecastModel")
```

MODEL
DEVELOPER



mlflow™

Model Registry

REVIEWERS,
CI/CD TOOLS



```
client = mlflow.tracking.MlflowClient()  
client.transition_model_version_stage(name="WeatherForecastModel",  
                                      version=5,  
                                      stage="Production")
```

```
model_uri= "models:/{}model_name}/production".format(  
          model_name="WeatherForecastModel")  
model_prod = mlflow.sklearn.load_model(model_uri)  
model_prod.predict(data)
```

DOWNSTREAM
USERS



DOWNSTREAM
USERS

AUTOMATED JOBS



REST SERVING



MLflow Backend Registry Stores

Entity (Metadata) Store and Models

- SQLStore (via SQLAlchemy)
 - PostgreSQL, MySQL, SQLite
 - Default is `mlruns.db` file locally
- Set programmatically for locally
- `mlflow.set_tracking_uri("sqlite:///mlruns.db")`
- `sqlite3 ./mlruns.db` (on local host)
- Managed MLflow on Databricks
 - MySQL on AWS and Azure

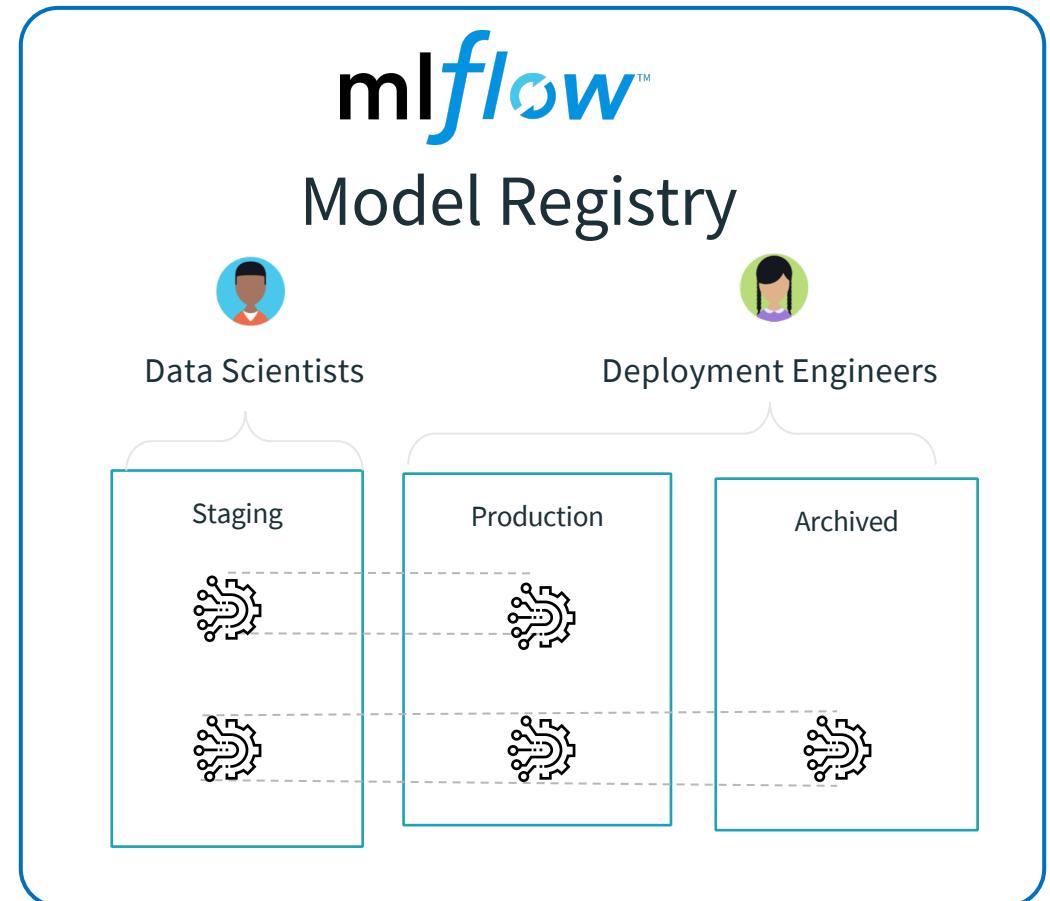
Artifact Store

- Local Filesystem
 - `mlruns` directory
- S3 backed store
- Azure Blob storage
- Google Cloud Storage
- DBFS artifact repo

```
(tutorials) ➔ src git:(master) ✘ sqlite3 ./mlruns.db
SQLite version 3.30.1 2019-10-10 20:19:45
Enter ".help" for usage hints.
sqlite> .databases
main: /Users/julesdamji/gits/mlflow-workshop-part-3/src./mlruns.db
sqlite> .tables
alembic_version      latest_metrics      params          tags
experiment_tags       metrics            registered_models
experiments           model_versions     runs
sqlite> █
```

MLflow Model Registry Recap

- **Central Repository:** Unique named registered models for discovery across data teams
- **Model Registry Workflow:** Provides UI and API for registry operations
- **Model Versioning:** Allow multiple versions of model in different stages
- **Model Stages:** Allow stage transition: none, staging, production, or archived
- **CI/CD Integration:** Easily load a specific version for testing and inspection
- **Model Lineage:** Provides model description, lineage and activities



Recap of all parts: What Did We Talk About?



- Modular Components greatly simplify the ML lifecycle
- Easy to install & Great Developer experience
- Develop & Deploy locally; track locally or remotely
- Available APIs: Python, Java & R (Soon Scala)
- REST APIs and CLI tools
- Visualize experiments and compare runs
- Centrally register and manage model lifecycle

Model Registry Demo

Tutorials: <https://github.com/dmatrix/mlflow-workshop-part-3>

Thank you! 😊

Q & A

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