

# **mlflow**: Accelerating Production Machine Learning

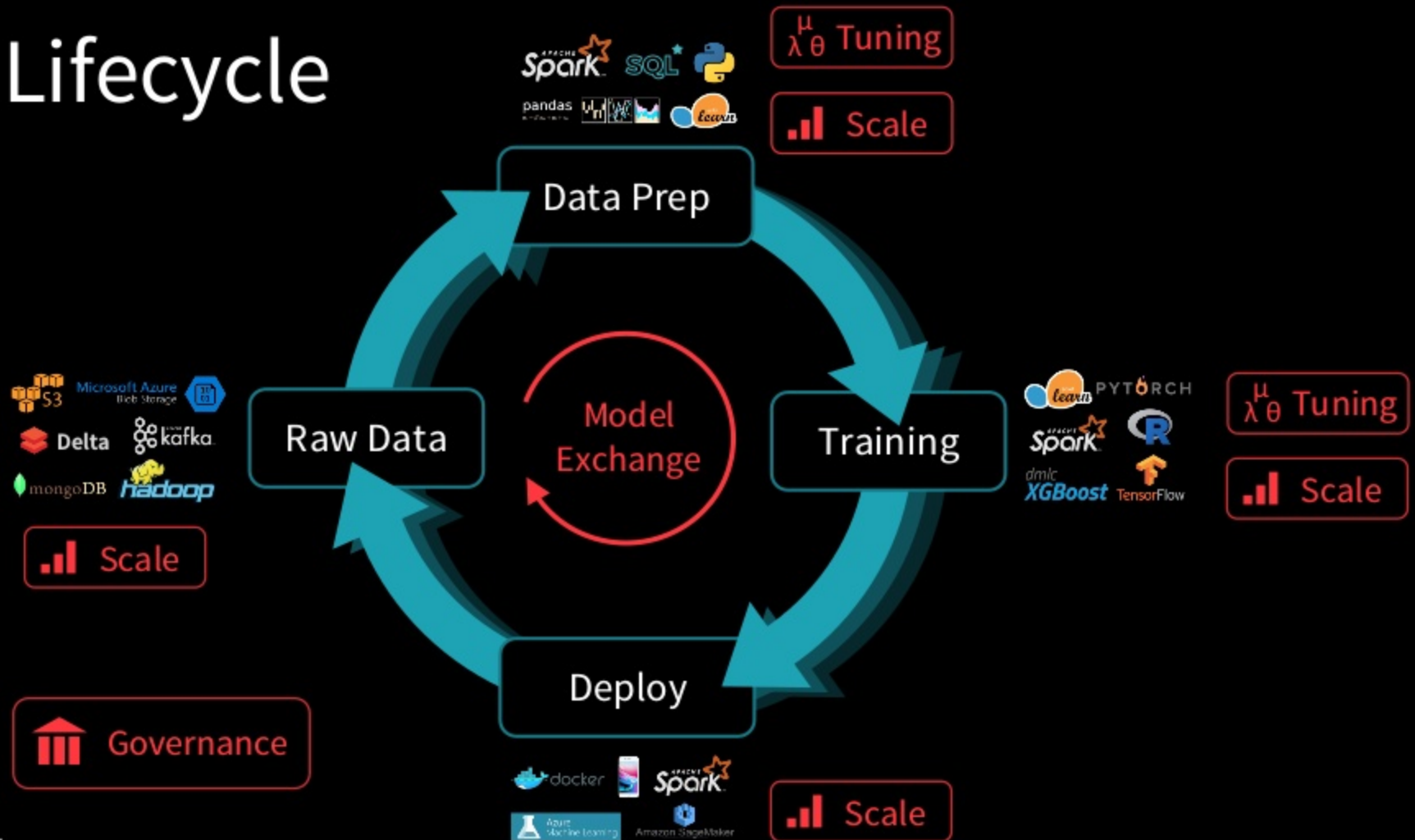
Matei Zaharia

@matei\_zaharia



# Machine Learning Development is Complex

# ML Lifecycle



# Custom ML Platforms

**Facebook FBLearner, Uber Michelangelo, Google TFX**

**+ Standardize the data prep / training / deploy cycle:  
if you work within the platform, you get these!**

- Limited to a few algorithms or frameworks**
- Tied to one company's infrastructure**

**Can we provide similar benefits in an **open** manner?**

# Introducing **mlflow**

## **Open source machine learning platform**

- Works with any ML library & language
- Runs the same way everywhere & cross-cloud
- Scales to big data with Apache Spark

## **Launched this June**

- Already 48 contributors and many new features!

**This Talk: MLflow Overview + New Announcements**

# How Does MLflow Work?

## mlflow Tracking

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

## mlflow Projects

Package workflows into reproducible and reusable steps

## mlflow Models

Model packaging format for diverse deployment tools

# Model Development without MLflow

```
data    = load_text(file)
ngrams  = extract_ngrams(data, N=n)
model   = train_model(ngrams,
                      learning_rate=lr)
score   = compute_accuracy(model)

print("For n=%d, lr=%f: accuracy=%f"
      % (n, lr, score))

pickle.dump(model, open("model.pkl"))
```

```
For n=2, lr=0.1: accuracy=0.71
For n=2, lr=0.2: accuracy=0.79
For n=2, lr=0.5: accuracy=0.83
For n=2, lr=0.9: accuracy=0.79
For n=3, lr=0.1: accuracy=0.83
For n=3, lr=0.2: accuracy=0.82
For n=4, lr=0.5: accuracy=0.75
...
```

What version of  
my code was this  
result from?

# Model Deployment without MLflow

DATA  
SCIENTIST



Code & Models



PRODUCTION  
ENGINEER



Please deploy this  
*ArXiv paper!*

...



# Model Development *with* MLflow

```
data    = load_text(file)
ngrams  = extract_ngrams(data, N=n)
model   = train_model(ngrams,
                      learning_rate=lr)
score   = compute_accuracy(model)

print("For n=%d, lr=%f: accuracy=%f"
      % (n, lr, score))

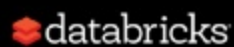
pickle.dump(model, open("model.pkl"))
```

# Model Development *with* MLflow

```
data = load_text(file)
ngrams = extract_ngrams(data, N=n)
model = train_model(ngrams,
                    learning_rate=lr)
score = compute_accuracy(model)
```

```
mlflow.log_param("data_file", file)
mlflow.log_param("n", n)
mlflow.log_param("learning_rate", lr)
mlflow.log_metric("score", score)
```

```
mlflow.sklearn.log_model(model)
```


A screenshot of the MLflow web interface for a "Language Model" experiment. It shows search filters, a table of runs with columns for Date, User, Status, Version, Parameters, and Metrics, and a table with 5 rows of run data. The interface includes a search bar, filters for parameters and metrics, and buttons for "Compare", "Delete", and "Download CSV".

		Parameters		Metrics	
Date	User	Status	Version	Input Size	Score
2018-12-02 21:58:57	mlflow	Running	0.0.0.0	data.txt	0.77
2018-12-02 21:58:58	mlflow	Running	0.0.0.0	data.txt	0.80
2018-12-02 21:58:59	mlflow	Running	0.0.0.0	data.txt	0.80
2018-12-02 21:59:00	mlflow	Running	0.0.0.0	data.txt	0.80
2018-12-02 21:59:01	mlflow	Running	0.0.0.0	data.txt	0.80

Track parameters, metrics,  
output files & code version

Search using UI or API


# MLflow UI: Inspecting Runs




GitHub Docs







## Language Model

Experiment ID: 0      Artifact Location: /Users/matei/mlflow/mlruns/0

Search Runs:   State: Active ▾ Search


Filter Params:  Filter Metrics:  Clear

10 matching runs Compare Delete Download CSV 

<input type="checkbox"/>	Date ▾	User	Source	Version	Parameters			Metrics	
					input_file	lr	n	accuracy	f1
<input type="checkbox"/>	2018-10-02 21:53:57	matei	 lang_model.py	e55d56	data.txt	2.0	1	0.77	0.704
<input type="checkbox"/>	2018-10-02 21:53:56	matei	 lang_model.py	e55d56	data.txt	1.0	2	0.254	0.222
<input type="checkbox"/>	2018-10-02 21:53:55	matei	 lang_model.py	e55d56	data.txt	2.0	4	0.835	0.609
<input type="checkbox"/>	2018-10-02 21:53:53	matei	 lang_model.py	e55d56	data.txt	1.0	1	0.663	0.468
<input type="checkbox"/>	2018-10-02 21:53:52	matei	 lang_model.py	e55d56	data.txt	0.2	4	0.034	0.032
<input type="checkbox"/>	2018-10-02 21:53:51	matei	 lang_model.py	e55d56	data.txt	0.1	4	0.177	0.16



# MLflow UI: Comparing Runs



GitHub Docs







## Language Model

Experiment ID: 0      Artifact Location: /Users/matei/mlflow/mlruns/0

Search Runs:   State: Active ▾

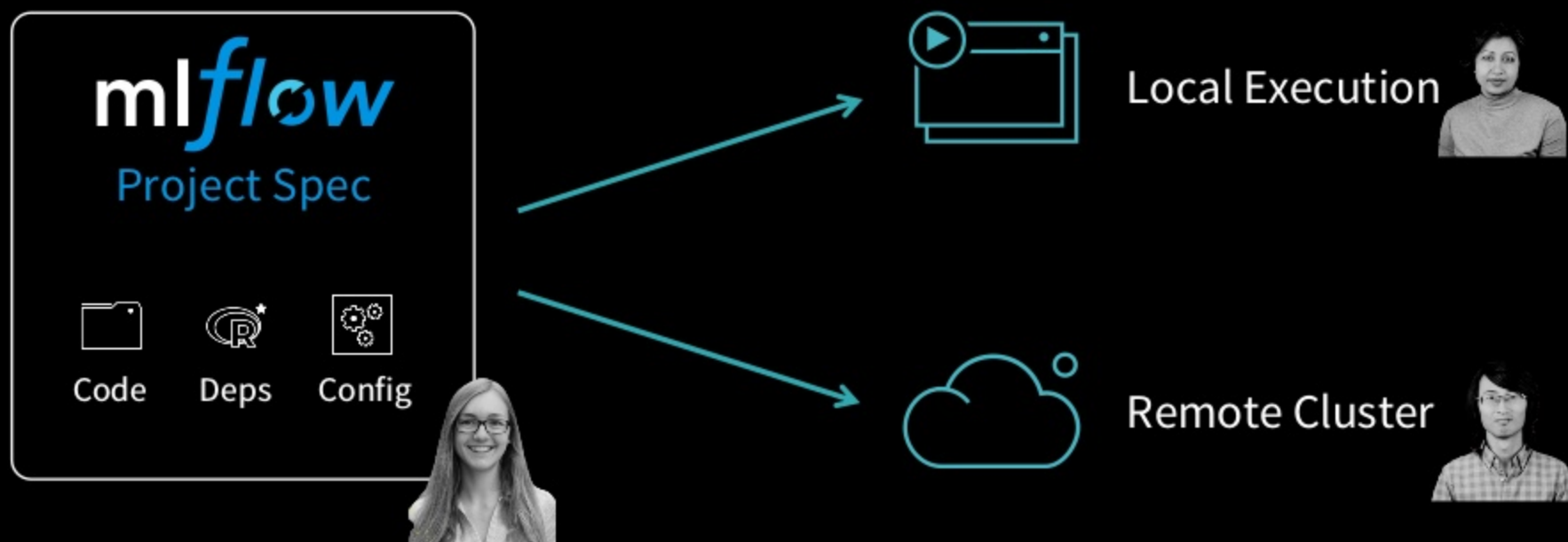
Filter Params:  Filter Metrics:

10 matching runs

<input type="checkbox"/>	Date ▾	User	Source	Version	Parameters			Metrics	
					input_file	lr	n	accuracy	f1
<input type="checkbox"/>	2018-10-02 21:53:57	matei	 lang_model.py	e55d56	data.txt	2.0	1	0.77	0.704
<input type="checkbox"/>	2018-10-02 21:53:56	matei	 lang_model.py	e55d56	data.txt	1.0	2	0.254	0.222
<input type="checkbox"/>	2018-10-02 21:53:55	matei	 lang_model.py	e55d56	data.txt	2.0	4	0.835	0.609
<input type="checkbox"/>	2018-10-02 21:53:53	matei	 lang_model.py	e55d56	data.txt	1.0	1	0.663	0.468
<input type="checkbox"/>	2018-10-02 21:53:52	matei	 lang_model.py	e55d56	data.txt	0.2	4	0.034	0.032
<input type="checkbox"/>	2018-10-02 21:53:51	matei	 lang_model.py	e55d56	data.txt	0.1	4	0.177	0.16

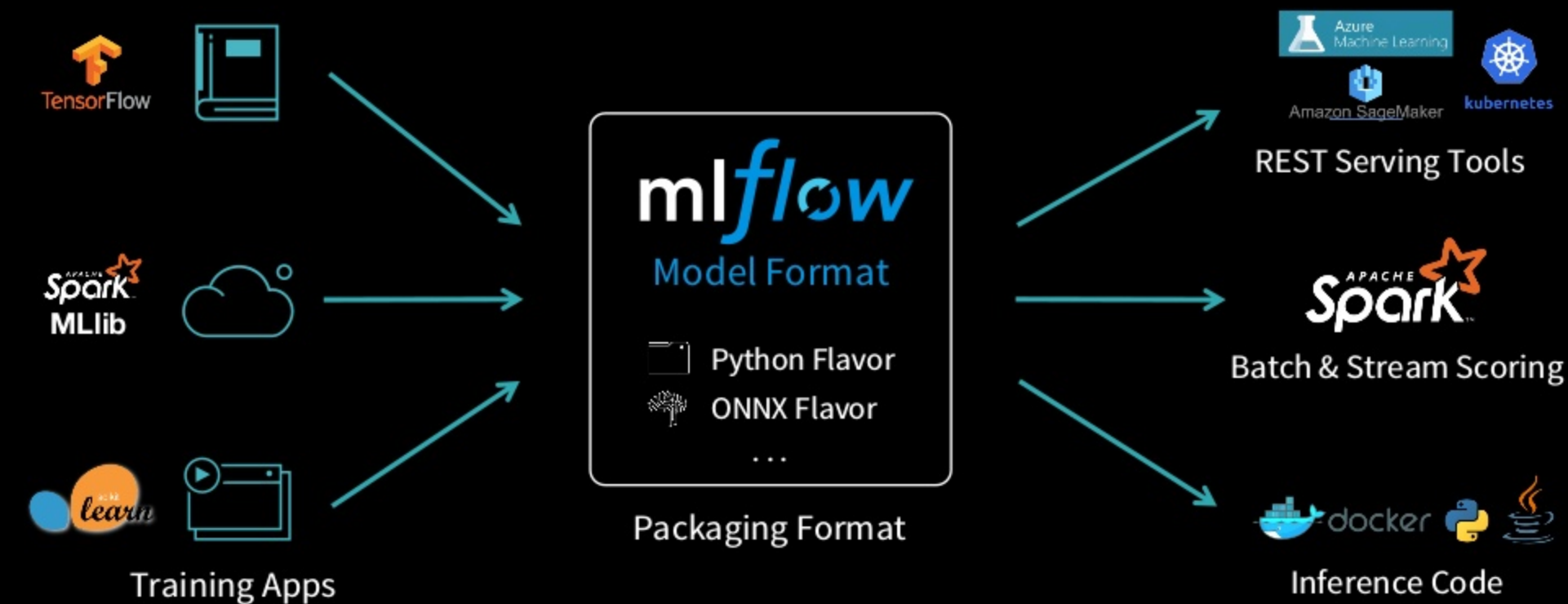


# Packaging Code: MLflow Projects



```
$ mlflow run git://...
```

# Packaging Models: MLflow Models



# Model Deployment *with* MLflow

DATA  
SCIENTIST



PRODUCTION  
ENGINEER

Please run this  
[MLflow Project](#)  
nightly for updates!

Don't even tell me  
what ArXiv paper  
that's from...

# MLflow Development Status

## Many new features since our release in June

- Model packaging for MLlib, H2O, TensorFlow, PyTorch, Keras
- Storage on Azure, AWS, Google, SFTP
- Java and Scala API
- New examples and UI features

**Just released MLflow 0.7.0 today!**

mlflow



# Major Announcement in MLflow 0.7.0



RStudio partnered with Databricks to add an MLflow R API

See Kevin Kuo's talk on this at 14:40 today!

# Conclusion

## Workflow platforms can greatly simplify ML development

- Improve usability for **both** data scientists and engineers

## Get started at [mlflow.org](https://mlflow.org), and come see our other talks:

- MLflow R API: 14:40 today
- ML Factories: 11:40 Thursday
- 1h Deep Dive: 14:00 Thursday

mlflow