mlflow

A platform for the Complete Machine Learning Lifecycle

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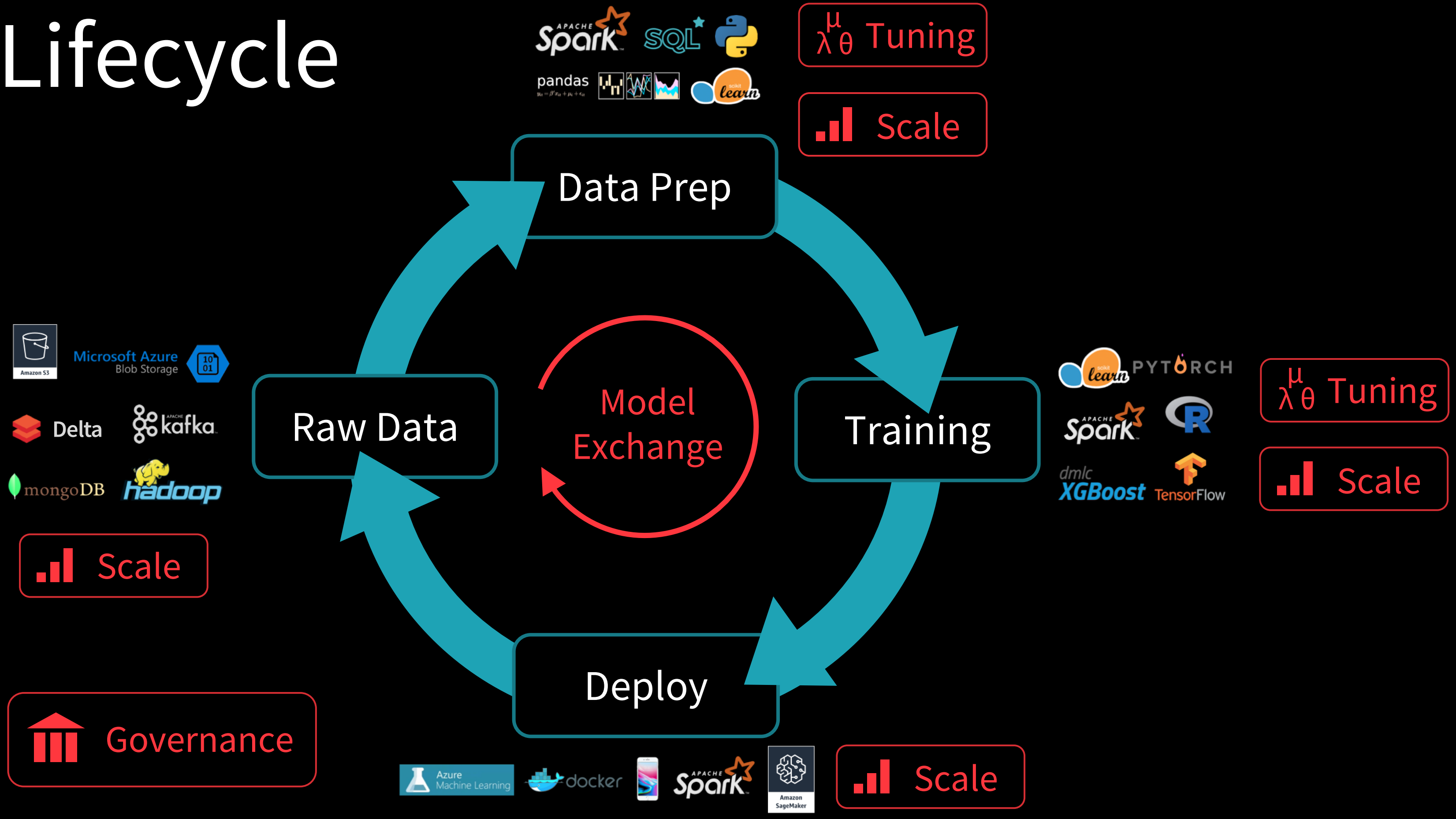
databricks

Outline

- Overview of ML development challenges
- How MLflow tackles these challenges
- MLflow components
- Demo
- How to get started

Machine Learning Development is Complex

ML Lifecycle



Custom ML Platforms

Facebook FBLearner, Uber Michelangelo, Google TFX

- + Standardize the data prep / training / deploy loop: if you work with 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 machine learning platform

- Works with any ML library & language
- Runs the same way anywhere (e.g. any cloud)
- Designed to be useful for 1 or 1000+ person orgs

MLflow Components

mlflow
Tracking

Record and query experiments: code, configs, results, …etc

mlflow
Projects

Packaging format for reproducible runs on any platform

mlflow
Models

General model format that supports diverse deployment tools

Key Concepts in Tracking

Parameters: key-value inputs to your code

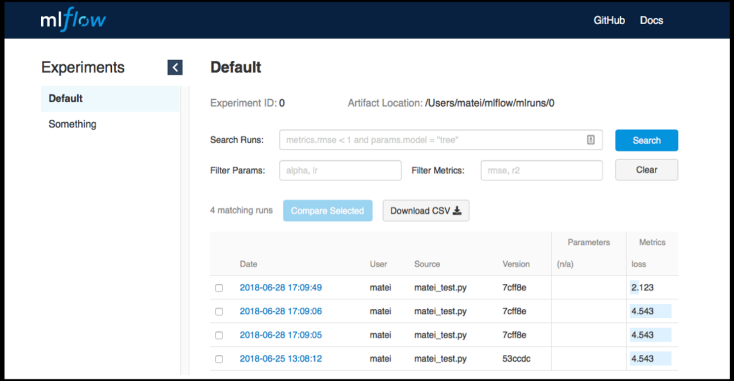
Metrics: numeric values (can update over time)

Source: training code that ran

Version: version of the training code

Artifacts: files, including data and models

Tags and Notes: any additional information



Default

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

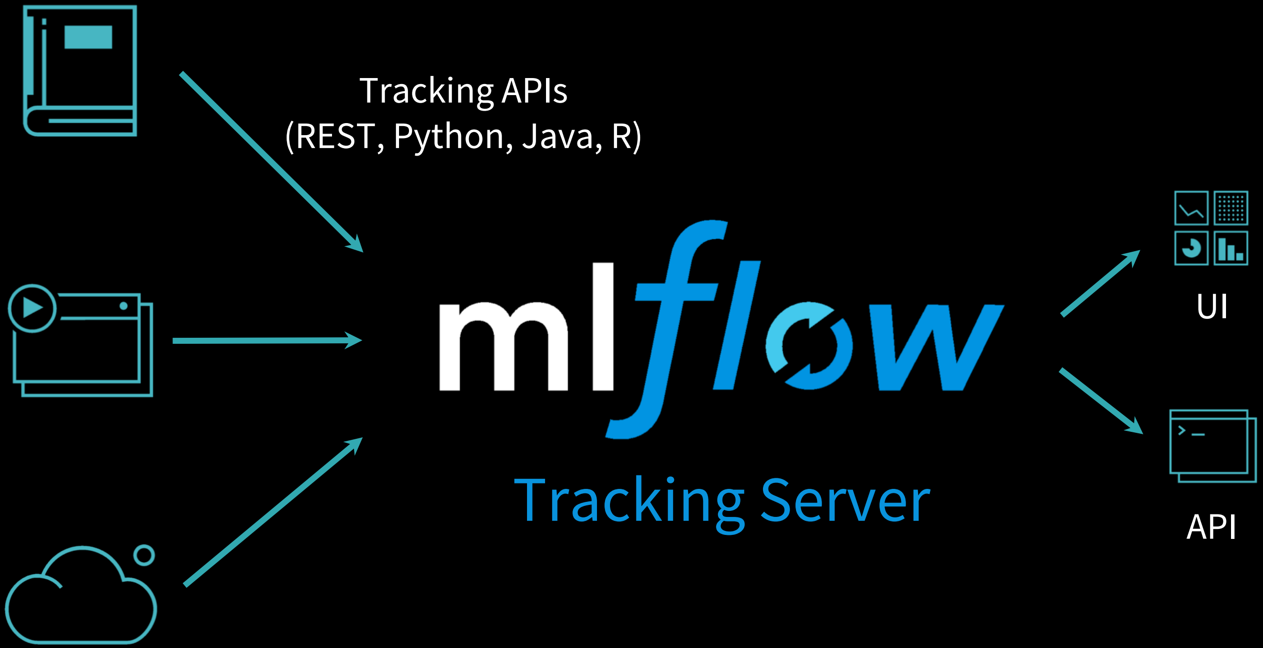
Search Runs: metrics.rmse < 1 and params.model = "tree"

Filter Params: alpha, lr   Filter Metrics: rmse, r2

4 matching runs

					Parameters	Metrics
	Date	User	Source	Version	(n/a)	loss
☐	2018-06-28 17:09:49	matei	matei_test.py	7cff8e		2.123
☐	2018-06-28 17:09:06	matei	matei_test.py	7cff8e		4.543
☐	2018-06-28 17:09:05	matei	matei_test.py	7cff8e		4.543
☐	2018-06-25 13:08:12	matei	matei_test.py	53ccdc		4.543

MLflow Tracking



MLflow Tracking

mlflow
Tracking

Record and query experiments: code, configs, results, …etc

```
import mlflow

with mlflow.start_run():
  mlflow.log_param("layers", layers)
  mlflow.log_param("alpha", alpha)

  # train model

  mlflow.log_metric("mse", model.mse())
  mlflow.log_artifact("plot", model.plot(test_df))
  mlflow.tensorflow.log_model(model)
```

Demo

Goal: Classify hand-drawn digits

1. Instrument Keras training code with MLflow tracking APIs
2. Run training code as an MLflow Project
3. Deploy an MLflow Model for real-time serving

MLflow backend stores

1. **Entity (Metadata) Store**
   - FileStore (local filesystem)
   - SQLStore (via SQLAlchemy)
   - REST Store

2. **Artifact Store**
   - S3 backed store
   - Azure Blob storage
   - Google Cloud storage
   - DBFS artifact repo

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MLflow Projects Motivation

Diverse set of training tools

PYTORCH TensorFlow scikit learn APACHE Spark dmlc XGBoost R

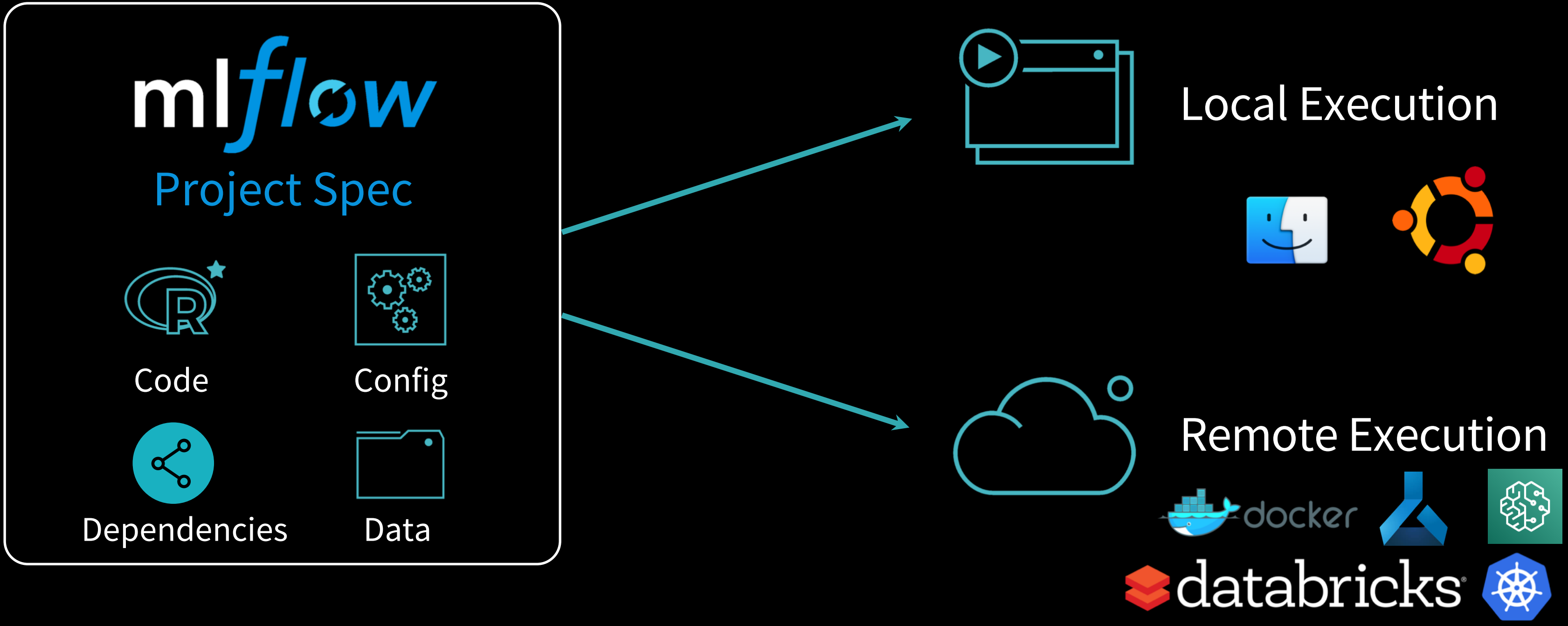
Diverse set of environments

docker databricks

Challenge:

ML results are difficult to reproduce.

MLflow Projects



MLflow Projects

Packaging format for reproducible ML runs

- Any code folder or GitHub repository
- Optional MLproject file with project configuration

Defines dependencies for reproducibility

- Conda (+ R, Docker, …) dependencies can be specified in MLproject
- Reproducible in (almost) any environment

Execution API for running projects

- CLI / Python / R / Java
- Supports local and 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>
```

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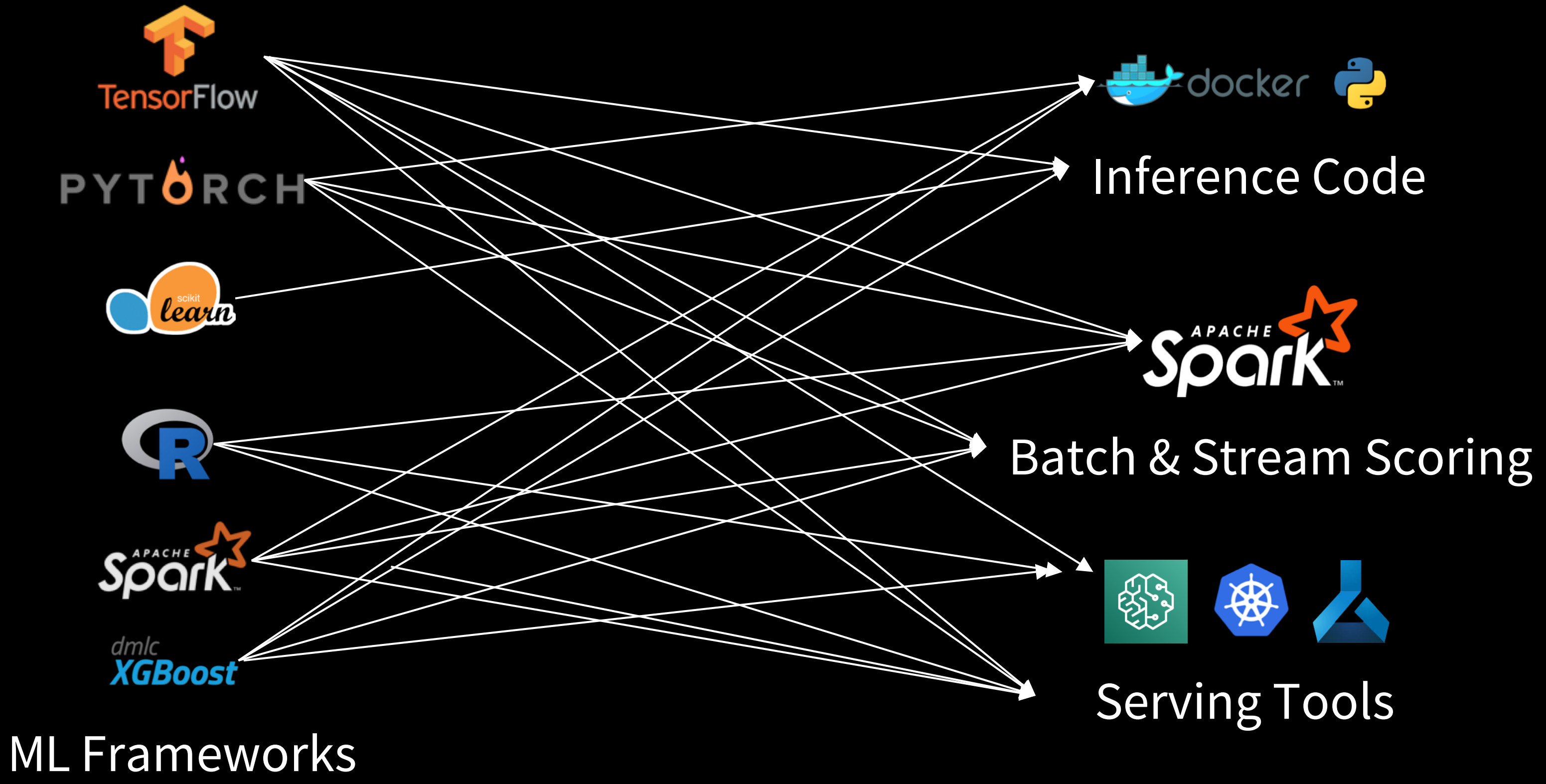
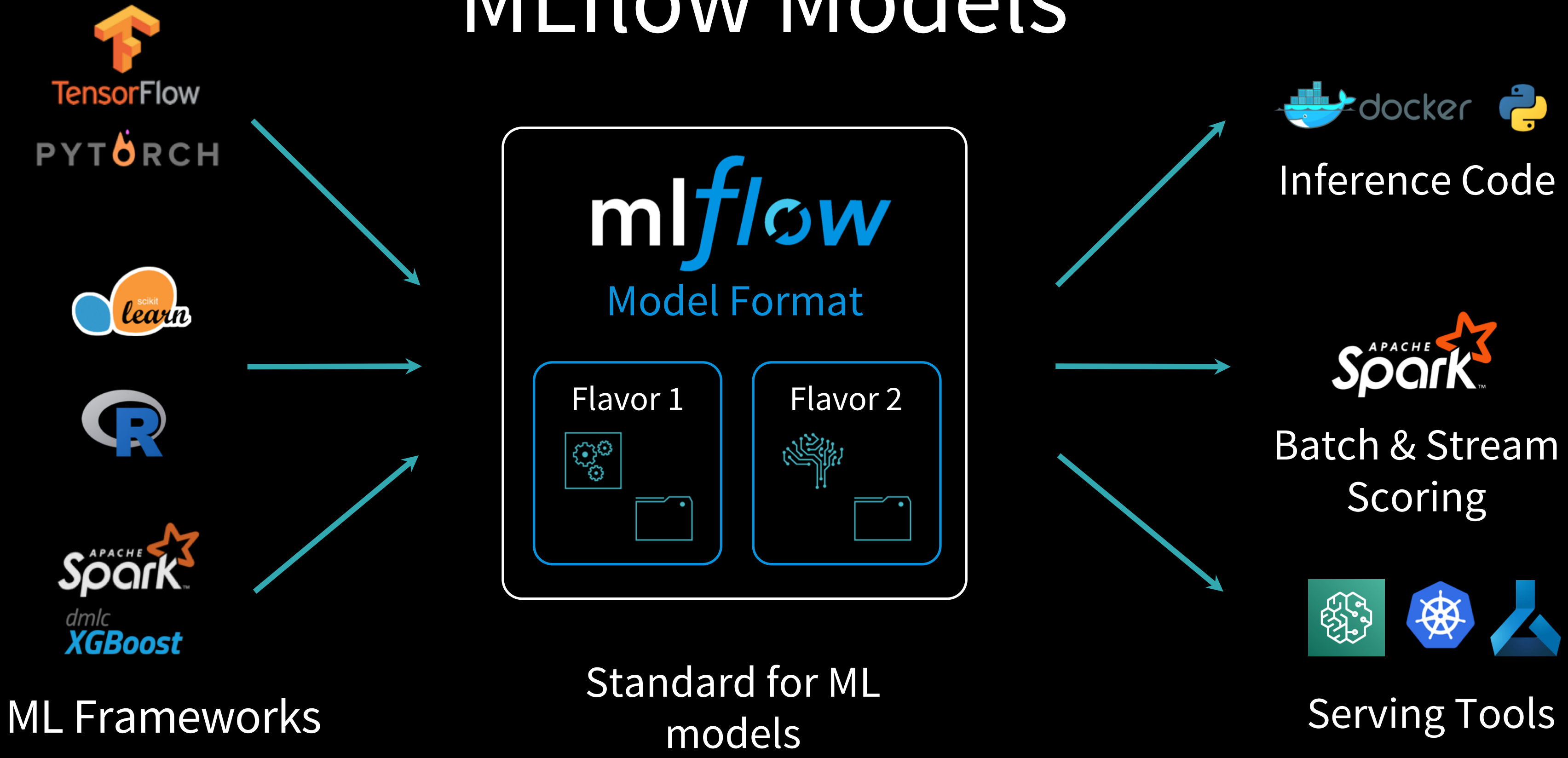
Mlflow Models Motivation



MLflow Models



MLflow Models

Packaging format for ML Models

- Any directory with MLmodel file

Defines dependencies for reproducibility

- Conda environment can be specified in MLmodel configuration

Model creation utilities

- Save models from any framework in MLflow format

Deployment APIs

- CLI / Python / R / Java

Example MLflow Model

```
my_model/
├── MLmodel
│
│
│
│
│
└ estimator/
    ├─ saved_model.pb
    └─ variables/
       ...
```

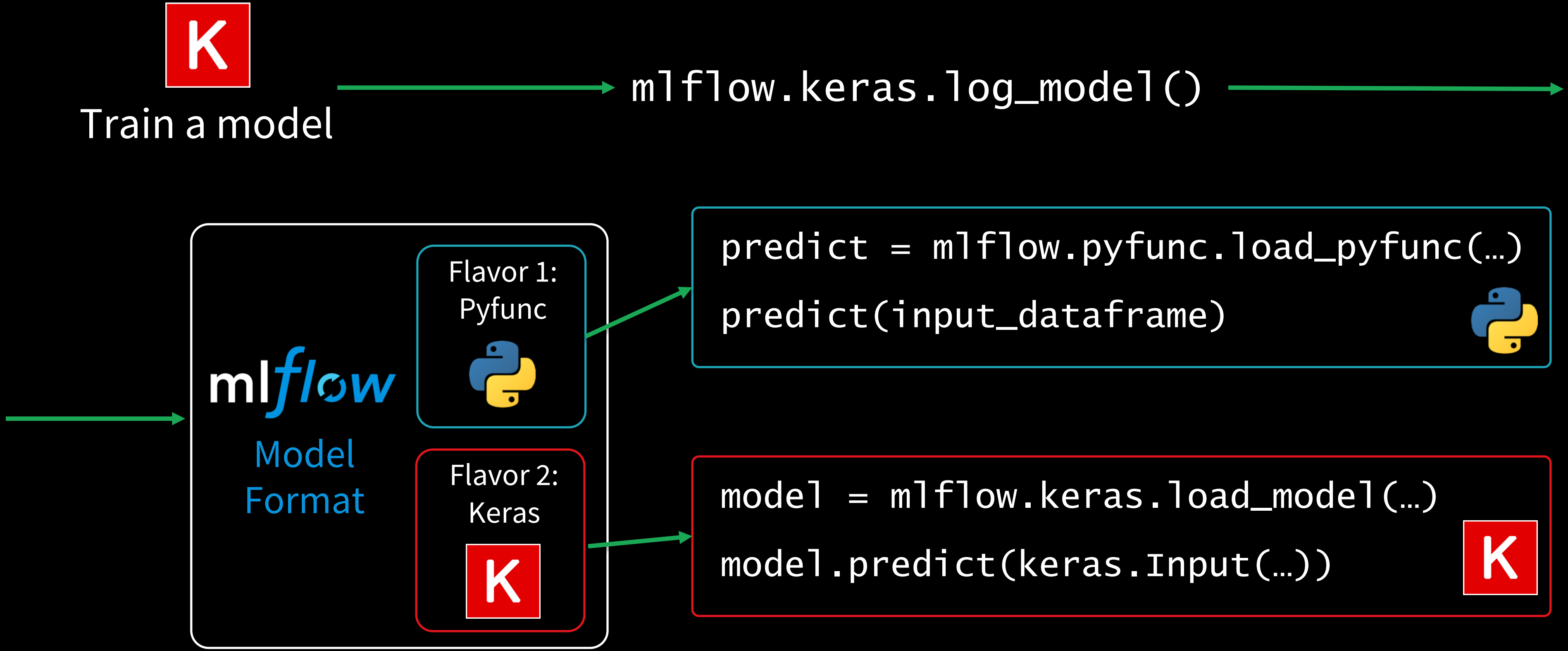
```
run_id: 769915006efd4c4bbd662461
time_created: 2018-06-28T12:34
flavors:
  tensorflow:
    saved_model_dir: estimator
    signature_def_key: predict
  python_function:
    loader_module:
       mlflow.tensorflow
```

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

Usable with Tensorflow tools / APIs

Usable with any Python tool

Model Flavors Example

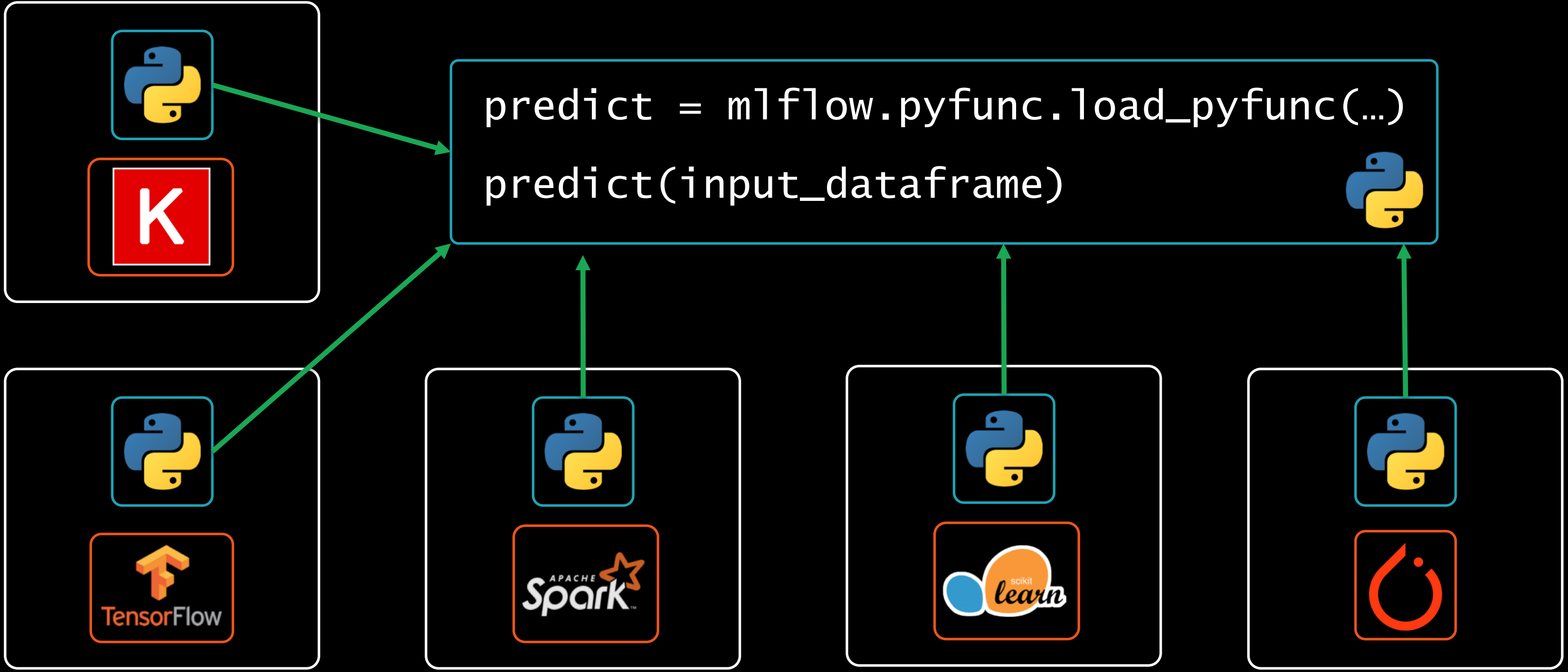


```
mlflow.keras.log_model()
```

```
predict = mlflow.pyfunc.load_pyfunc(…)
predict(input_dataframe)
```

```
model = mlflow.keras.load_model(…)
model.predict(keras.Input(…))
```

Model Flavors Example



```
predict = mlflow.pyfunc.load_pyfunc(…)

predict(input_dataframe)
```

Demo

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1.0 Release

MLflow 1.0 was released recently! Major features:

- New metrics UI
- “Step” axis for metrics
- Improved search capabilities
- Package MLflow Models as Docker containers
- Support for ONNX models

Ongoing MLflow Roadmap

- New component: Model Registry for model management
- Multi-step project workflows
- Fluent Tracking API for Java and Scala
- Packaging projects with build steps
- Better environment isolation when loading models
- Improved model input/output schemas

Get started with MLflow

`pip install mlflow` to get started

Find docs & examples at **mlflow.org**

tinyurl.com/mlflow-slack

Thank you!