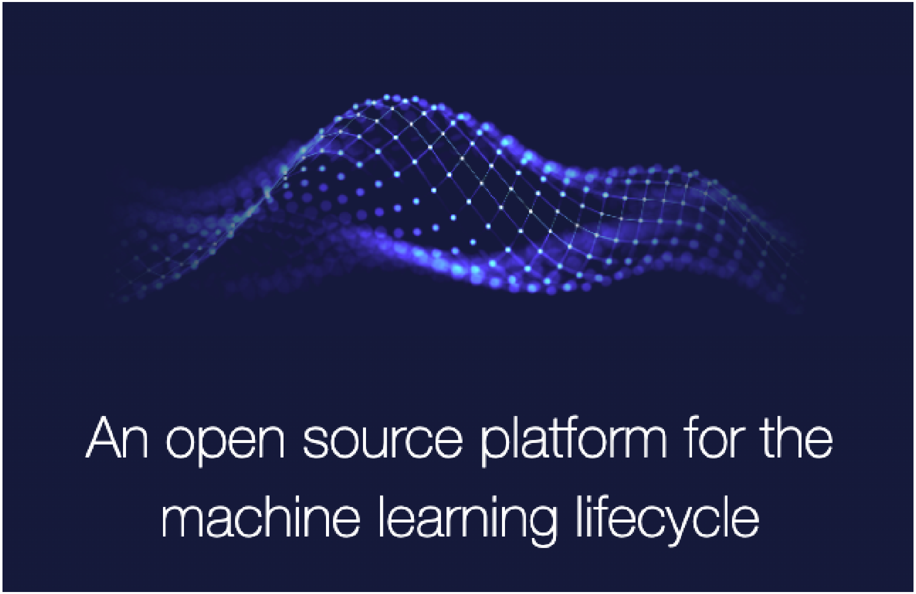
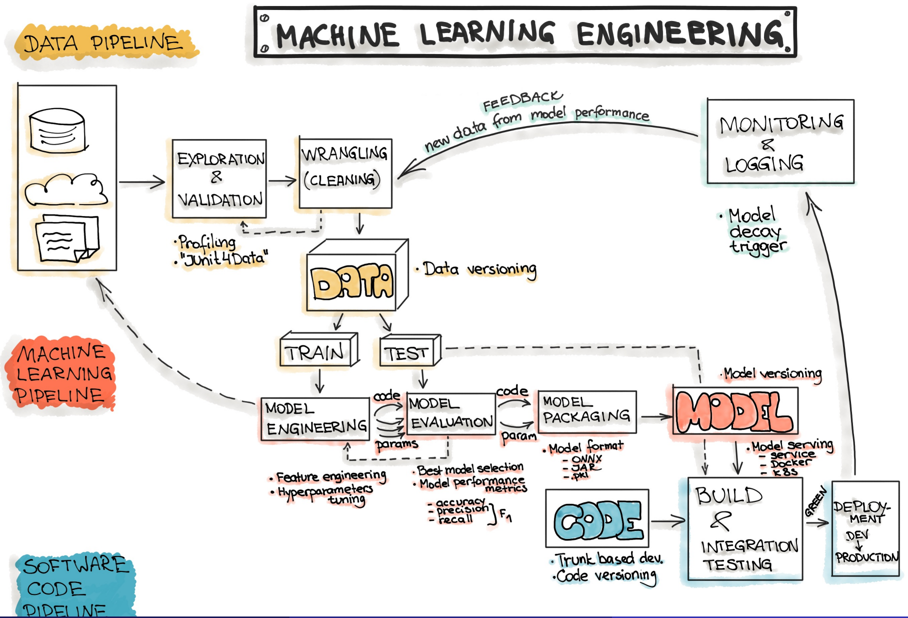
Introduction to MLflow: Experiment Tracking and Model Registry

MLflow

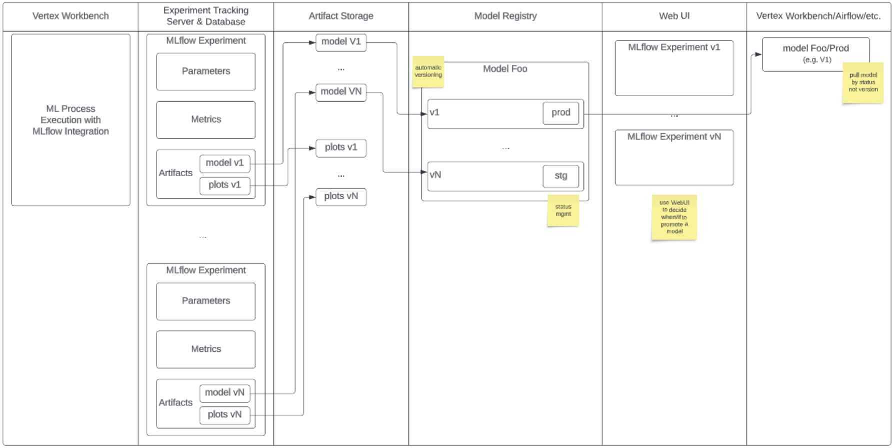

An open source platform for the machine learning lifecycle

ML-Ops



MACHINE LEARNING ENGINEERING
DATA PIPELINE
EXPLORATION & VALIDATION
WRANGLING (CLEANING)
·Profiling
·"Junit4Data"
DATA
·Data versioning
FEEDBACK
new data from model performance
MONITORING & LOGGING
·Model decay trigger
MACHINE LEARNING PIPELINE
TRAIN
TEST
MODEL ENGINEERING
code
params
MODEL EVALUATION
code
param
MODEL PACKAGING
MODEL
·Model versioning
·Feature engineering
·Hyperparameters tuning
·Best model selection
·Model performance metrics
- accuracy
- precision
- recall
F1
·Model format
- ONNX
- JAR
- .pkl
·Model serving
- service
- Docker
- K8s
SOFTWARE CODE PIPELINE
CODE
·Trunk based dev.
·Code versioning
BUILD & INTEGRATION TESTING
GREEN
DEPLOYMENT
DEV
PRODUCTION

MLflow


Vertex Workbench
Experiment Tracking Server & Database
Artifact Storage
Model Registry
Web UI
Vertex Workbench/Airflow/etc.
ML Process Execution with MLflow Integration
MLflow Experiment
Parameters
Metrics
Artifacts
model v1
plots v1
...
MLflow Experiment
Parameters
Metrics
Artifacts
model vN
plots vN
model V1
...
model VN
plots v1
...
plots vN
automatic versioning
Model Foo
v1
prod
...
vN
stg
status mgmt
MLflow Experiment v1
...
MLflow Experiment vN
use WebUI to decide when/if to promote a model
model Foo/Prod
(e.g. V1)
pull model by status not version

MLflow Overview

- **Tracking**: Logs and queries machine learning experiments, including parameters, metrics, and artifacts.
- **Projects**: Packages code in a reusable, reproducible format, defining the environment and the steps to run.
- **Models**: Standardizes the format for exchanging models between various tools, keeping track of which model was used in each experiment.
- **Registry**: Acts as a central model store to share, version, and manage machine learning models.

MLflow Overview

We'll focus on Experiment Tracking and Model Registry as the most useful to our workflow.

Experiment Tracking with MLflow

Why?

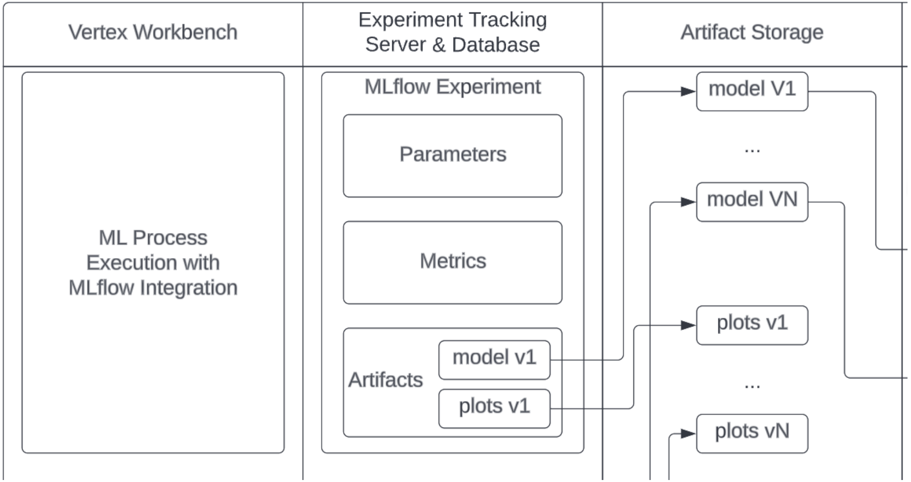
- **Reproducibility**: Facilitates the replication and understanding of experiments.
- **Collaboration**: Allows team members to build upon each other's work.
- **Insight and Analysis**: Provides data-driven insights into model performance.

Experiment Tracking with MLflow

How?

- MLflow tracks experiments through “runs”, which log parameters (algorithm inputs), metrics (performance measures), and artifacts (output files in any format).
- Each run, an execution of ml/data science code, has its own parameters, metrics, and artifacts and is part of a larger experiment.

Experiment Tracking with MLflow



A Subtlety

The model is serialized at this phase, not in interacting with the model registry.

Experiment Tracking with MLflow

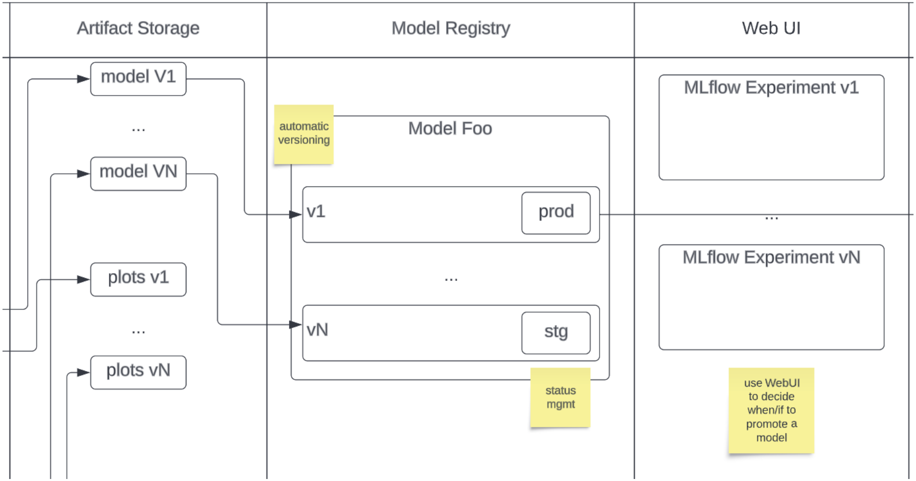
Demo

Experiment Tracking with MLflow

Demo

- `mlflow-demo-training.ipynb`
- `mlflow-demo-analysis.ipynb`

Model Registry with MLflow



Model Registry with MLflow

Model Registry: A centralized repository to manage ML models providing a systematic process to collaborate, manage, and deploy models.

Need for Model Registry: With numerous models and their versions being continuously developed, a model registry is essential to manage versions, track performance and serve as a single source of truth.

- *Model versions*: MLflow Model Registry stores versions of each registered model, keeping track of various metrics, parameters, and artifacts for each version.
- *Model stages*: In MLflow Model Registry, each model version can be assigned to stages like “Staging”, “Production”, or “Archived”, denoting their lifecycle stage.

Model Registry with MLflow

Demo: Model Registry in MLflow

- `mlflow-demo-training-best-practice.ipynb`
- `mlflow-demo-load-model.ipynb`

A Best Practice

```
# register the model at the moment of logging
mlflow.sklearn.log_model(
  model,
  "model",
  registered_model_name=experiment_name
)
```

Promote the Best Model

Model Registry with MLflow

Model Flavors

In MLflow, a “flavor” is a particular way that a model can be saved and loaded. Each flavor defines a convention for certain filesystem formats and Python functions to save and load models. For instance, a model can be saved as a TensorFlow model or as a PyTorch model, and these would correspond to different flavors.
The benefit of this system is that different types of models can be managed through the same API and even be converted from one flavor to another.

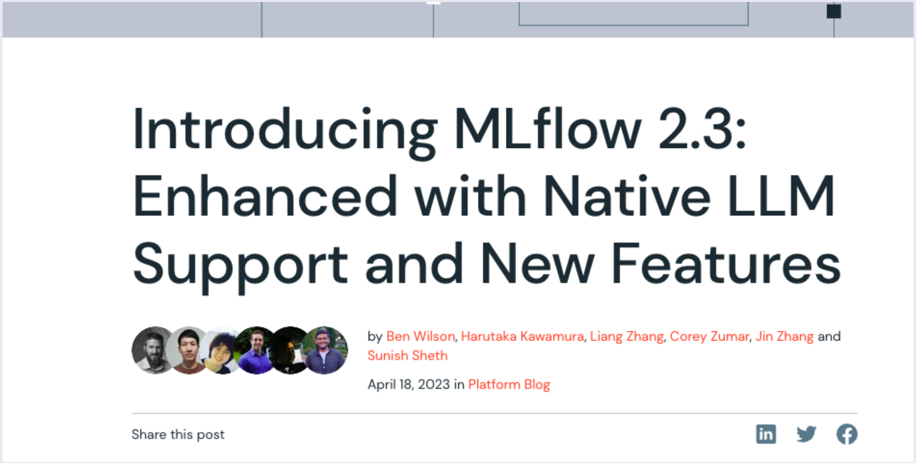
```
import mlflow.sklearn
import mlflow.pytorch

model_uri = "models:/my_model/Sklearn"
sklearn_model = mlflow.sklearn.load_model(model_uri)

model_uri = "models:/my_model/PyTorch"
pytorch_model = mlflow.pytorch.load_model(model_uri)
```

Model Registry with MLflow

Now with OpenAI and LangChain Support!!



Introducing MLflow 2.3: Enhanced with Native LLM Support and New Features

by Ben Wilson, Harutaka Kawamura, Liang Zhang, Corey Zumar, Jin Zhang and Sunish Sheth

April 18, 2023 in Platform Blog

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https://www.databricks.com/blog/2023/04/18/introducing-mlflow-23-enhanced-native-llm-support-and-new-features.html

Integration of MLflow with Existing Systems

- Using MLflow can be as simple as the following:

```
import mlflow

mlflow.set_tracking_uri('http://localhost:5000/')
mlflow.set_experiment("PENGUINS")

with mlflow.start_run():

    # ml code
    mlflow.log_params(params_dict)
    mlflow.log_param("param_1", value)
    mlflow.log_metric("accuracy", accuracy)
    mlflow.sklearn.log_model(
      model,
      "model",
      registered_model_name=experiment_name
```

Integration of MLflow with Existing Systems

A Subtlety

The ml code and its execution is independent of the mlflow execution context. While the time spent "in content" is automatically logged, it is perfectly fine to run code outside of the context and use it only for logging.

A Recommendation

Mlflow is a well-written package and should be used "by convention" rather than "by configuration". Thin wrappers are not necessary and may actually complicate things.
Rather, just make effective use of `mlflow.set_tracking_uri` and `mlflow.set_experiment`.

Q&A

- Open for questions