

# MLOps

# What is MLOps?

MLOps in simple term is DevOps for Machine Learning

End-to-End machine learning development process to design, build and manage reproducible, testable, and evolvable ML-powered software.

# Why MLOps?

- MLOps aims to unify the release cycle for machine learning and software application release.
- MLOps enables automated testing of machine learning artifacts (e.g. data validation, ML model testing, and integration testing)
- MLOps enables the application of agile principles to machine learning projects.
- MLOps enables supporting machine learning models and datasets to build these models as first-class citizens within CI/CD systems.
- MLOps reduces technical debt across machine learning models.

"Practicing MLOps means that you advocate for automation and monitoring at all steps of ML system construction, including integration, testing, releasing, deployment and infrastructure management"

- **Google**

# How MLOps is different from DevOps?

1. Data/Schema versioning apart from code versioning
2. Experiment tracking (Model hyperparameters, Data Distribution, Model performance, feature importance etc)
3. Model artifacts versioning
4. Monitor continuously for data and model drift
5. Continuous re-training of model
6. Capture sensitivity of key features to target

# How MLOps is different from devOps?

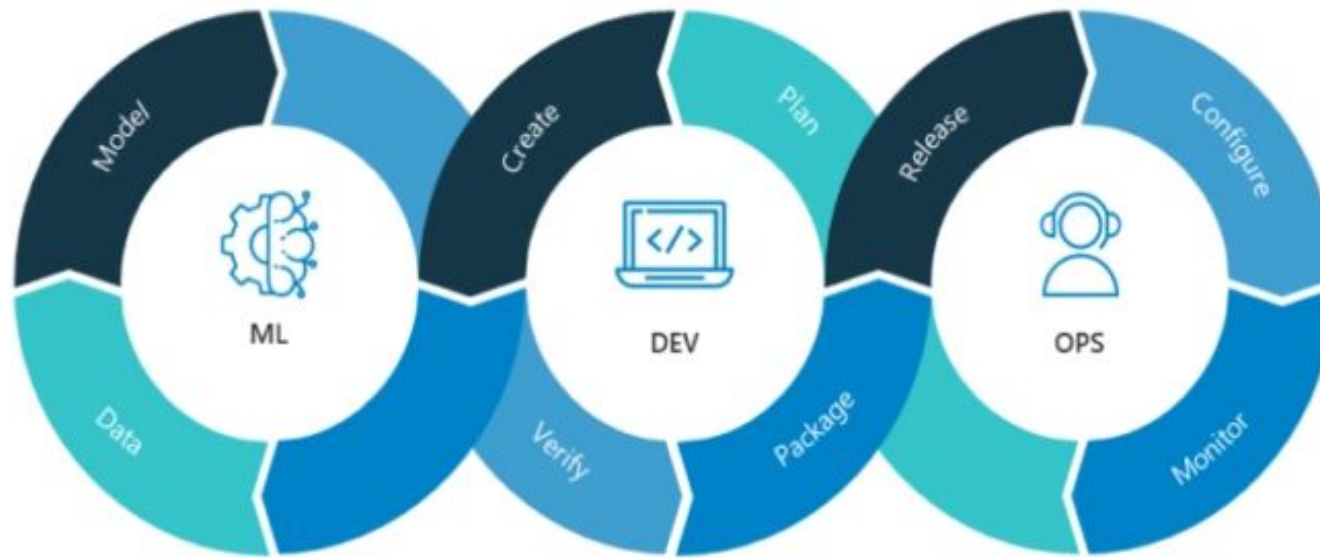


Image Source:  
Nvidia

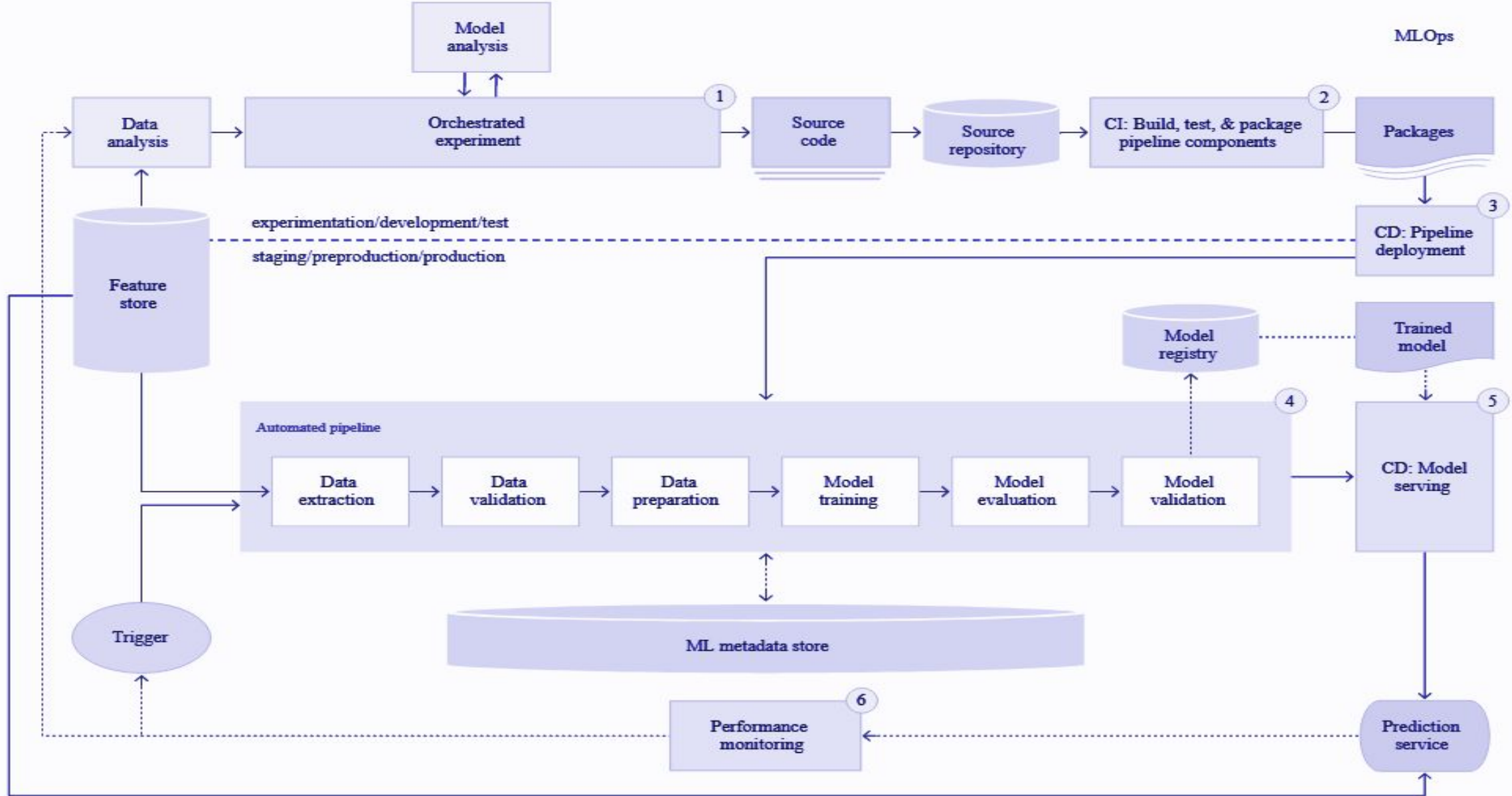
# ML + DevOps = MLOps

CI - Build, Test and validate code + data + schema + models

CD - ML Training Pipeline + (or) Serving Component

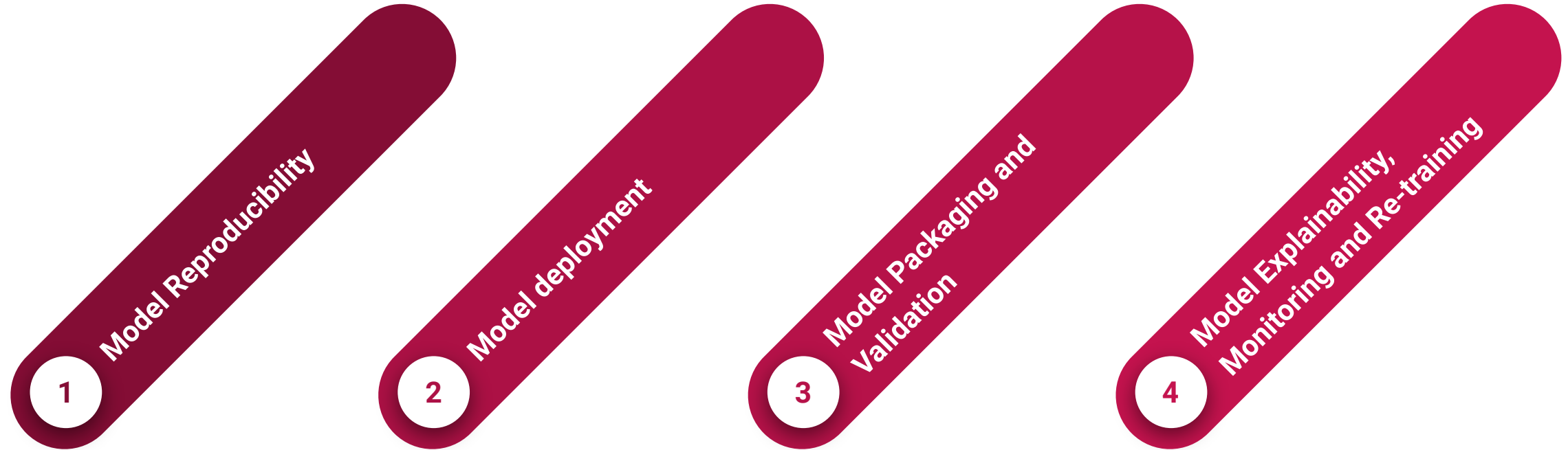
CT - Automatically re-train and serve the model

# MLOps Automated pipeline and components





# Key outcomes of MLOps



# MLOps – Best Practices

**5 Best Practices** to optimize your MLOps lifecycle on Azure:

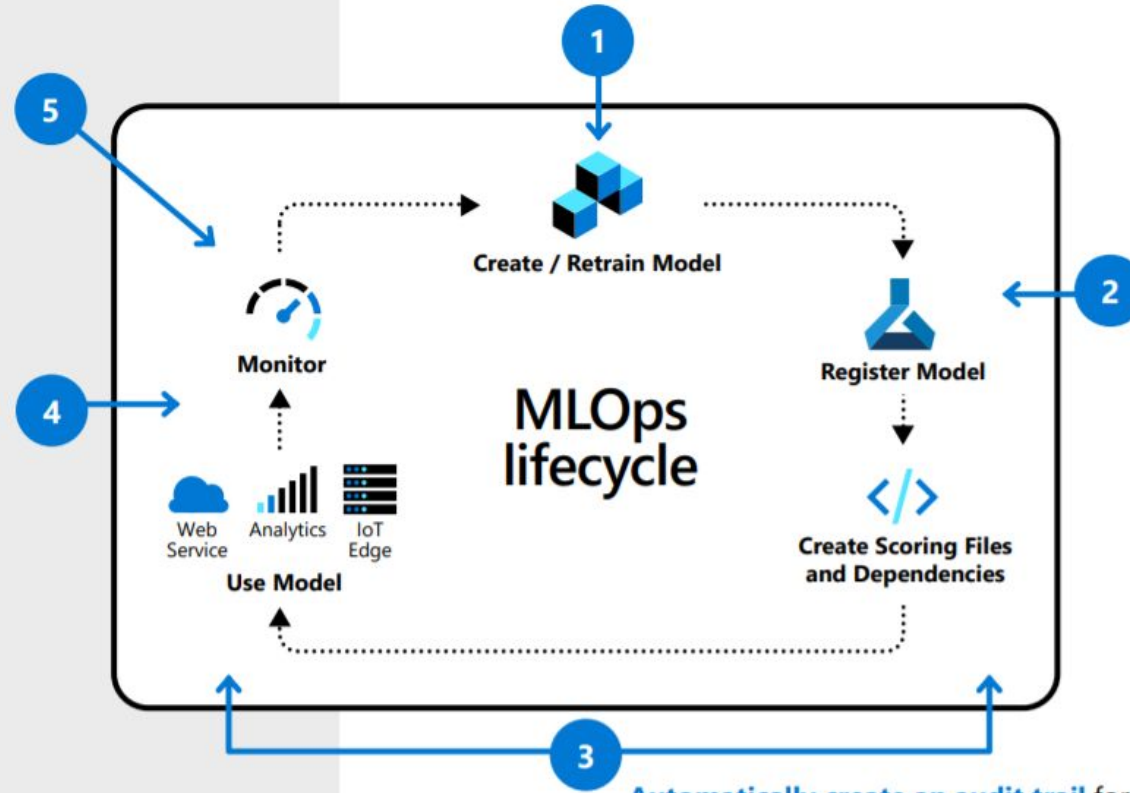
**Observe data drift and** feed back model information to improve future training.

**Deploy and monitor performance** so you can release models with confidence and know when to retrain.

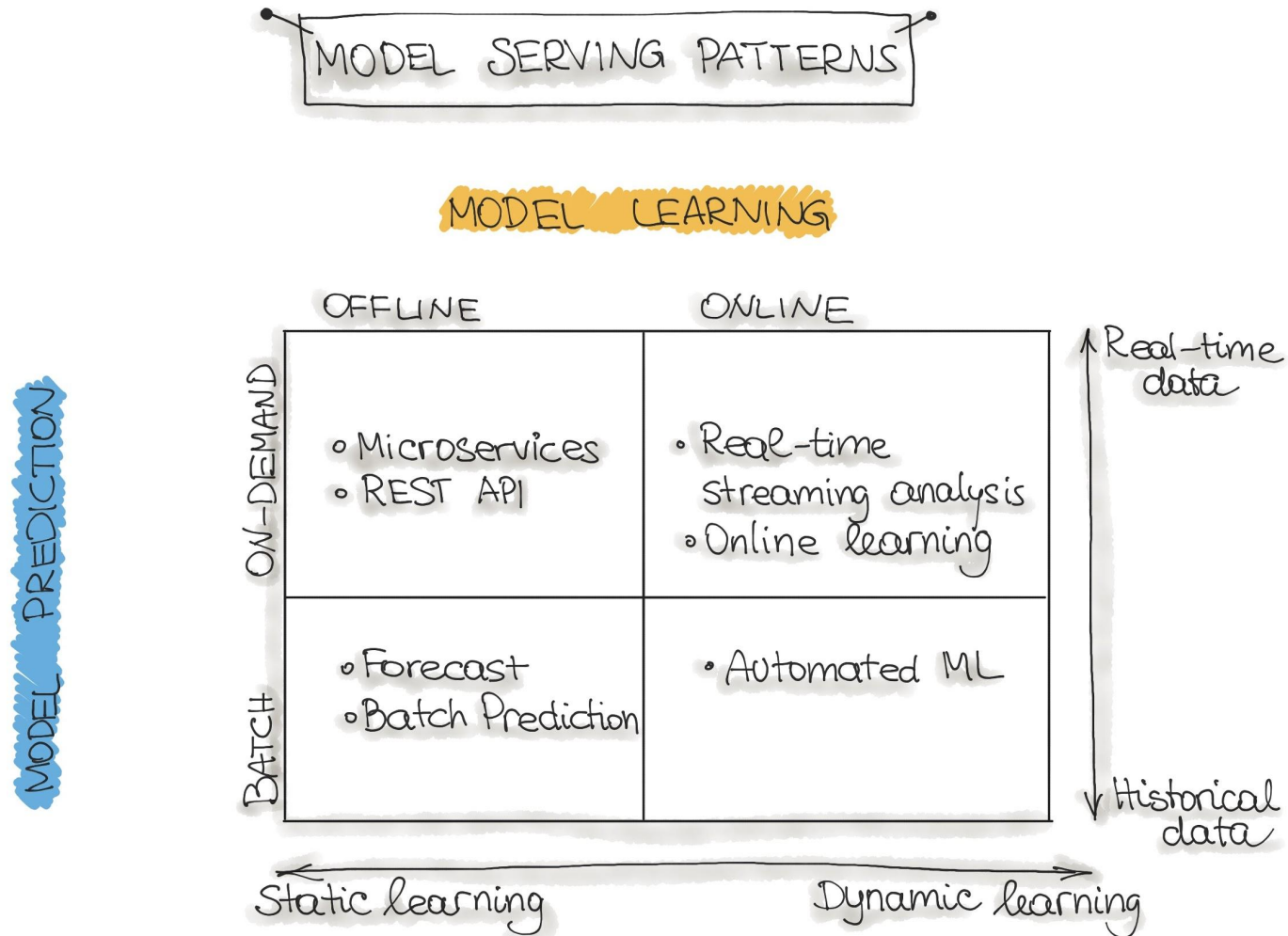
**Create models with reusable ML pipelines** using the Azure Machine Learning extension for Azure DevOps. Store your code in GitHub so it automatically integrates into your MLOps pipeline.

**Automate your MLOps rollout** using Azure DevOps + Azure Machine Learning for version models with rich metadata and event management.

**Automatically create an audit trail** for all artifacts in your MLOps pipeline ensure asset integrity and meet regulatory requirements.



# Model Serving Patterns



# References

- <https://cloud.google.com/solutions/machine-learning/mlops-continuous-delivery-and-automation-pipelines-in-machine-learning>
- <https://blogs.nvidia.com/blog/2020/09/03/what-is-mlops/>
- <https://ml-ops.org/>
  - <https://ml-ops.org/content/mlops-principles>
- <https://landscape.lfai.foundation/?fullscreen=yes>

# ML FLOW

MLflow is an open source platform to manage the ML lifecycle, including experimentation, reproducibility, deployment, and a central model registry. MLflow currently offers four components:

## MLflow Tracking

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

[Read more](#)

## MLflow Projects

Package data science code in a format to reproduce runs on any platform

[Read more](#)

## MLflow Models

Deploy machine learning models in diverse serving environments

[Read more](#)

## Model Registry

Store, annotate, discover, and manage models in a central repository

[Read more](#)

Integrations with:



# MLFlow Hands on Steps

- MLFlow Quick Start
- MLFlow UI
- MLFlow Local Server
- MLFlow Serve Models as API
- MLFlow Integration