Azure MLOps in Machine Learning

## What is MLOps

MLOps is based on [DevOps](https://azure.microsoft.com/overview/what-is-devops/) principles and practices that increase the efficiency of workflows. Examples include continuous integration, delivery, and deployment. MLOps applies these principles to the machine learning process, with the goal of:

* Faster experimentation and development of models.
* Faster deployment of models into production.
* Quality assurance and end-to-end lineage tracking.

## MLOps in Machine Learning

Machine learning operation (MLOPs) automates the process of building machine learning models and taking the model to production. This is a complex process. It usually requires collaboration from different teams with different skills. A well-defined machine learning pipeline can abstract this complex process into a multiple steps workflow, mapping each step to a specific task such that each team can work independently.

For example, a typical machine learning project includes the steps of data collection, data preparation, model training, model evaluation, and model deployment. Usually, the data engineers concentrate on data steps, data scientists spend most time on model training and evaluation, the machine learning engineers focus on model deployment and automation of the entire workflow. By leveraging machine learning pipeline, each team only needs to work on building their own steps.

Machine Learning provides the following MLOps capabilities:

* **Create reproducible machine learning pipelines.** Use machine learning pipelines to define repeatable and reusable steps for your data preparation, training, and scoring processes.

**For more details:** [What are machine learning pipelines? - Azure Machine Learning | Microsoft Learn](https://learn.microsoft.com/en-us/azure/machine-learning/concept-ml-pipelines)

* **Create reusable software environments.** Use these environments for training and deploying models.

**For more details:** [About Azure Machine Learning environments - Azure Machine Learning | Microsoft Learn](https://learn.microsoft.com/en-us/azure/machine-learning/concept-environments)

* **Register, package, and deploy models from anywhere.** You can also track associated metadata required to use the model.
* **Capture the governance data for the end-to-end machine learning lifecycle.** The logged lineage information can include who is publishing models and why changes were made. It can also include when models were deployed or used in production.
* **Notify and alert on events in the machine learning lifecycle.** Event examples include experiment completion, model registration, model deployment, and data drift detection.
* **Monitor machine learning applications for operational and machine learning-related issues.** Compare model inputs between training and inference. Explore model-specific metrics. Provide monitoring and alerts on your machine learning infrastructure.
* **Automate the end-to-end machine learning lifecycle with Machine Learning and Azure Pipelines.** By using pipelines, you can frequently update models. You can also test new models. You can continually roll out new machine learning models alongside your other applications and services.

**For more information,** [Data pipelines, automated training, and deployment of machine learning models - Azure Pipelines | Microsoft Learn](https://learn.microsoft.com/en-us/azure/devops/pipelines/targets/azure-machine-learning?view=azure-devops)

## MLOps implementation in Churn Modelling

**Workspace Name: Clustering\_Analysis**

1. **Created reproducible machine learning pipelines:**

**Goto MLStudio** 🡪 Notebooks 🡪Users/musthaq.mohammed/prod/churn-prediction/aggModel\_PROD/ prod-pipeline-aggModel.ipynb

1. **Created reusable software environments: Goto MLStudio 🡪 Environments/Custom environments/test\_bgnbd\_pipeline\_env**
2. **Register, package, and deploy models from anywhere: Registered the model and deployed as Batch Scoring Endpoint.**

* **Check registered model in: MLStudio 🡪Models 🡪 CHURN\_PREDICTION\_BGNBD**
* **Check Endpoint in: MLStudio 🡪 pipelines 🡪 Pipeline endpoints 🡪CHURN\_PREDICTION\_EP\_PROD**

1. **Capture the governance data for the end-to-end machine learning lifecycle: These are auto logged by Azure as we work on different stages of lifecycle**
2. **Notify and alert on events in the machine learning lifecycle: created an Email alert. whenever a production pipeline completes an email is triggered with success or failure notification**
3. **Monitor machine learning applications for operational and machine learning-related issues: Yet to Implement**
4. **Automate the end-to-end machine learning lifecycle with Machine Learning and Azure Pipelines: This can be implemented using DevOps. Yet to Implement**

## MLOps implementation in Clustering Model

Clustering Model is trained using Designer (**Workspace Name: Clustering\_Analysis)**

1. **Created reproducible machine learning pipelines:**

**Goto MLStudio** 🡪 Jobs 🡪 All Experiments 🡪 Search for Experiment: HCP-ClusteringModel-C360 🡪 search: Training\_Clustering\_Model

1. **Created reusable software environments: Not Created**

**To know the dependencies: Goto Models --> ClusteringModelv1 --> in details tab, click on the link under Created by Job --> in overview tab, click the link under Environment**

1. **Register, package, and deploy models from anywhere: Registered the model and deployed as Batch Scoring Endpoint.**

* **Check registered model in: MLStudio 🡪Models 🡪 ClusteringModelv1**
* **Check Endpoint in: MLStudio 🡪 Pipelines 🡪 Pipeline endpoints 🡪** **HCP\_CLUSTERING\_PIPELINE\_ENDPOINT\_PROD**

1. **Capture the governance data for the end-to-end machine learning lifecycle: These are auto logged by Azure as we work on different stages of lifecycle**
2. **Notify and alert on events in the machine learning lifecycle: created an Email alert. whenever a production pipeline completes an email is triggered with success or failure notification**
3. **Monitor machine learning applications for operational and machine learning-related issues: Yet to Implement**
4. **Automate the end-to-end machine learning lifecycle with Machine Learning and Azure Pipelines: Yet to Implement, This can be implemented using DevOps.**

## References

[MLOps: Machine learning model management - Azure Machine Learning | Microsoft Learn](https://learn.microsoft.com/en-us/azure/machine-learning/concept-model-management-and-deployment)

[What are machine learning pipelines? - Azure Machine Learning | Microsoft Learn](https://learn.microsoft.com/en-us/azure/machine-learning/concept-ml-pipelines)