

머신러닝 파이프라인

# Model Registry

## mlflow

송호연





# 목차



## Model Registry mlflow



1. mlflow 소개



2. mlflow Model 실습

3. mlflow Model Registry 실습



# 학습목표



## Model Registry mlflow



01. Model Registry mlflow에 대해 이해한다.

Model Registry mlflow의 개념에 이해한다.



02. mlflow Model 실습을 통해 작동 방식을 이해한다.

실습을 진행하면서 mlflow Model 기본 사용법에 대해 공부한다.



03. mlflow Model Registry 실습을 통해 작동 방식을 이해한다.

실습을 진행하면서 mlflow Model Registry 기본 사용법에 대해 공부한다.

# mlflow 소개



01



# mlflow 소개



## 개요

머신러닝 프로젝트를 진행하다보면  
실험 기록, 프로젝트 관리, 모델 관리가 필요하게 된다.

\*출처 : Google Cloud Tech Youtube([https://www.youtube.com/watch?v=\\_AY8mmbR1o4](https://www.youtube.com/watch?v=_AY8mmbR1o4))



# mlflow 소개



## 개요

# mlflow

### Tracking

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

### Projects

Packaging format for reproducible runs on any platform

### Models

General format for sending models to diverse deploy tools

\*출처 : <https://databricks.com/blog/2018/06/05/introducing-mlflow-an-open-source-machine-learning-platform.html>



# mlflow 소개



## 개요

mlflow

모델  
Model

모델 저장소  
Model Registry

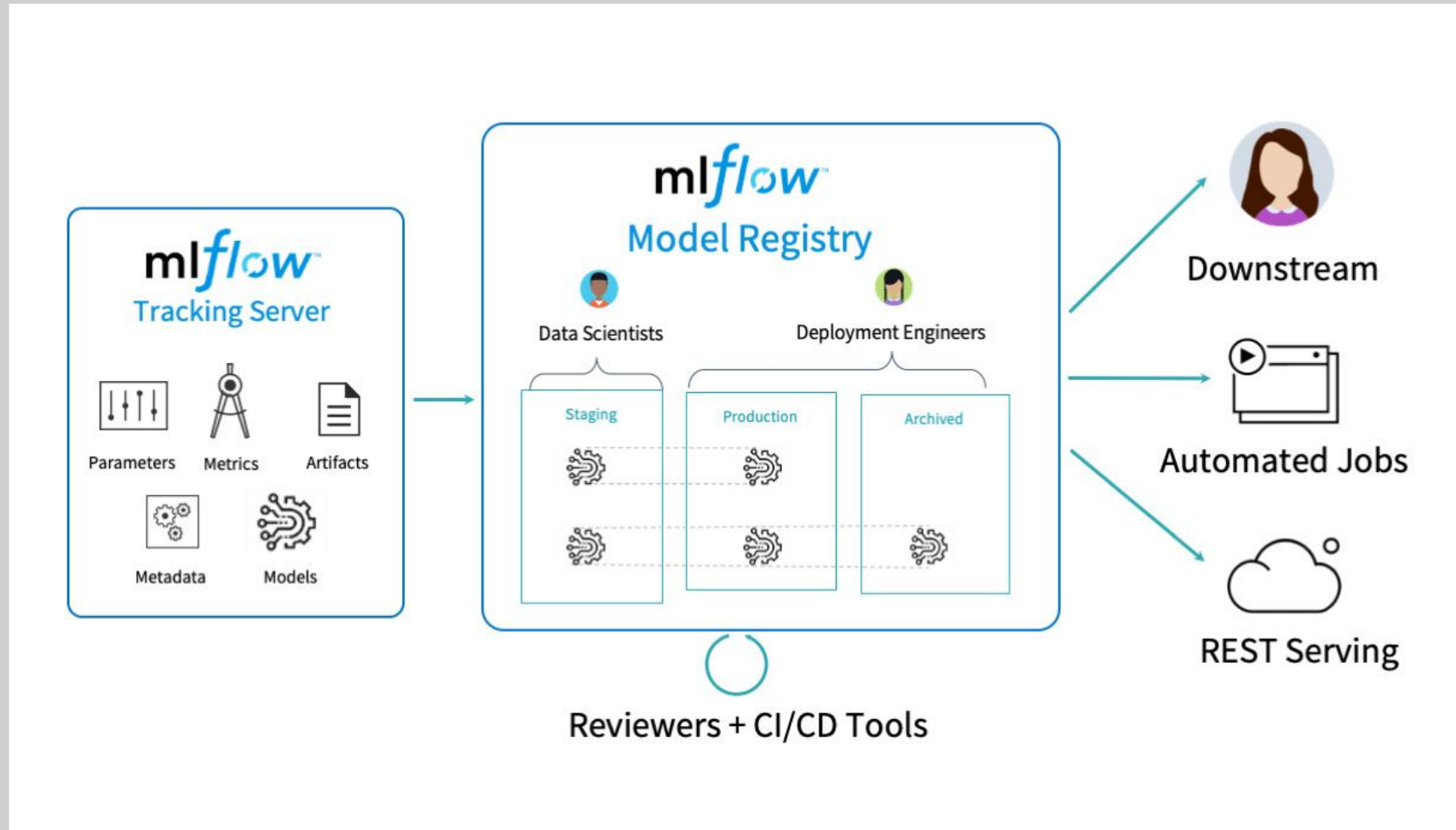
\*출처 : Google Cloud Tech Youtube([https://www.youtube.com/watch?v=\\_AY8mmbR1o4](https://www.youtube.com/watch?v=_AY8mmbR1o4))



# mlflow 소개



## 개요



\* 출처 : <https://databricks.com/blog/2018/06/05/introducing-mlflow-an-open-source-machine-learning-platform.html>



mlflow Model 실습



02



# mlflow 실습



## mlflow 설치

**pip install**로 **mlflow**를 설치한다.

```
pip install mlflow==1.15.0
```

\*출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris.py)



# mlflow 실습

## mlflow Tracking API - 실험 로그 남기기

<https://github.com/chris-chris/mlflow-tutorial/blob/master/track1/track.py>

```
import os
from random import random, randint
from mlflow import log_metric, log_param, log_artifacts

if __name__ == "__main__":
    # Log a parameter (key-value pair)
    log_param("param1", randint(0, 100))

    # Log a metric; metrics can be updated throughout the run
    log_metric("foo", random())
    log_metric("foo", random() + 1)
    log_metric("foo", random() + 2)

    # Log an artifact (output file)
    if not os.path.exists("outputs"):
        os.makedirs("outputs")
    with open("outputs/test.txt", "w") as f:
        f.write("hello world!")
    log_artifacts("outputs")
```

\* 출처 : <https://www.mlflow.org/docs/latest/quickstart.html>



# mlflow 실습



## mlflow UI

track.py를 실행해서 로깅을 수행해보고, mlflow ui로 mlflow 대시보드를 띄워보겠습니다.

```
$ python track.py  
$ mlflow ui
```

The screenshot shows the mlflow UI interface. At the top, there's a dark blue header with the mlflow logo, 'Experiments' and 'Models' tabs, and links to 'GitHub' and 'Docs'. Below the header, the 'Experiments' section is active, showing a search bar and a list of experiments with 'Default' selected. To the right, the 'Default' experiment details are shown, including the 'Experiment ID: 0' and 'Artifact Location: file:///Users/chris/Workspace/practice/mlflow-tutorial/track1\_log/mlruns/0'. Below this, there's a 'Notes' section with a '페이지 새로고침' (Refresh page) button. Further down, a 'Search Runs' section contains a search query 'metrics.rmse < 1 and params.model = "tree" and tags.mlflow', a 'State' dropdown set to 'Active', and 'Search' and 'Clear' buttons. Below the search section, there are buttons for 'Compare', 'Delete', and 'Download CSV'. At the bottom, a table displays the search results, showing one matching run.

	Start Time	Run Name	User	Source	Version	Parameters	Metrics
<input type="checkbox"/>	2021-04-19 11:54:37	-	chris	track.py	854ff1	param1: 50	foo: 2.684

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris.py)



# mlflow 실습



## Iris 머신러닝 모델 저장

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris.py)

```
import pandas as pd
from sklearn import datasets
from sklearn.ensemble import RandomForestClassifier
import mlflow
import mlflow.sklearn
from mlflow.models.signature import infer_signature

iris = datasets.load_iris()
iris_train = pd.DataFrame(iris.data, columns=iris.feature_names)
clf = RandomForestClassifier(max_depth=7, random_state=0)
clf.fit(iris_train, iris.target)
signature = infer_signature(iris_train, clf.predict(iris_train))
mlflow.sklearn.log_model(clf, "iris_rf", signature=signature)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris.py)



# mlflow 실습

## Iris 머신러닝 모델 저장 - 명시적 스키마

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris2.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris2.py)

```
import pandas as pd
from sklearn import datasets
from sklearn.ensemble import RandomForestClassifier
import mlflow
import mlflow.sklearn
from mlflow.models.signature import ModelSignature
from mlflow.types.schema import Schema, ColSpec
iris = datasets.load_iris()
iris_train = pd.DataFrame(iris.data, columns=iris.feature_names)
clf = RandomForestClassifier(max_depth=7, random_state=0)
clf.fit(iris_train, iris.target)
input_schema = Schema([
    ColSpec("double", "sepal length (cm)"),
    ColSpec("double", "sepal width (cm)"),
    ColSpec("double", "petal length (cm)"),
    ColSpec("double", "petal width (cm)"),
])
output_schema = Schema([ColSpec("long")])
signature = ModelSignature(inputs=input_schema, outputs=output_schema)
mlflow.sklearn.log_model(clf, "iris_rf", signature=signature)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris2.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris2.py)



# mlflow 실습

## Iris 머신러닝 모델 저장 - 명시적 스키마

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris2.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris2.py)

```
import pandas as pd
from sklearn import datasets
from sklearn.ensemble import RandomForestClassifier
import mlflow
import mlflow.sklearn
from mlflow.models.signature import ModelSignature
from mlflow.types.schema import Schema, ColSpec
iris = datasets.load_iris()
iris_train = pd.DataFrame(iris.data,
                           columns=iris.feature_names)
clf = RandomForestClassifier(max_depth=7, random_state=0)
clf.fit(iris_train, iris.target)
```

```
input_schema = Schema([
    ColSpec("double", "sepal length (cm)"),
    ColSpec("double", "sepal width (cm)"),
    ColSpec("double", "petal length (cm)"),
    ColSpec("double", "petal width (cm)"),
])
output_schema = Schema([ColSpec("long")])
signature = ModelSignature(inputs=input_schema,
                           outputs=output_schema)
mlflow.sklearn.log_model(clf, "iris_rf", signature=signature)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris2.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris2.py)



# mlflow 실습

## Iris 머신러닝 모델 저장 - Input Example

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)

```
import pandas as pd
from sklearn import datasets
from sklearn.ensemble import RandomForestClassifier
import mlflow
import mlflow.sklearn
from mlflow.models.signature import ModelSignature
from mlflow.types.schema import Schema, ColSpec

iris = datasets.load_iris()
iris_train = pd.DataFrame(iris.data,
                           columns=iris.feature_names)
clf = RandomForestClassifier(max_depth=7, random_state=0)
clf.fit(iris_train, iris.target)

input_schema = Schema([
    ColSpec("double", "sepal length (cm)"),
    ColSpec("double", "sepal width (cm)"),
    ColSpec("double", "petal length (cm)"),
    ColSpec("double", "petal width (cm)"),
])
```

```
output_schema = Schema([ColSpec("long")])
signature = ModelSignature(inputs=input_schema,
                           outputs=output_schema)
input_example = {
    "sepal length (cm)": 5.1,
    "sepal width (cm)": 3.5,
    "petal length (cm)": 1.4,
    "petal width (cm)": 0.2
}
mlflow.sklearn.log_model(clf, "iris_rf", signature=signature,
                        input_example=input_example)
mlflow.sklearn.save_model(path="iris_rf", sk_model=clf)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)





# mlflow 실습



## Iris 머신러닝 모델 서빙

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/serve.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/serve.sh)

```
$ mlflow models serve -m iris_rf -p 1234
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)



# mlflow 실습



## Iris 머신러닝 모델 서빙 curl 추론

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/curl\\_inference.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/curl_inference.sh)

```
curl --location --request POST 'localhost:1234/invocations' \  
--header 'Content-Type: application/json' \  
--data-raw '{  
  "columns":["sepal length (cm)", "sepal width (cm)", "petal length (cm)", "petal width (cm)"],  
  "data": [[5.1, 3.5, 1.4, 0.2]]  
}'
```

\*출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)



[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist.py)

```
import tensorflow as tf
from tensorflow.keras.layers import Conv2D, MaxPooling2D,
Dense, Flatten
from tensorflow.keras.optimizers import SGD
import mlflow
import mlflow.keras
from mlflow.models.signature import infer_signature

(train_X, train_Y), (test_X, test_Y) =
tf.keras.datasets.mnist.load_data()
trainX = train_X.reshape((train_X.shape[0], 28, 28, 1))
testX = test_X.reshape((test_X.shape[0], 28, 28, 1))
trainY = tf.keras.utils.to_categorical(train_Y)
testY = tf.keras.utils.to_categorical(test_Y)
```

```
model = tf.keras.models.Sequential()
model.add(Conv2D(32, (3, 3), activation='relu',
kernel_initializer='he_uniform', input_shape=(28, 28, 1)))
model.add(MaxPooling2D((2, 2)))
model.add(Flatten())
model.add(Dense(100, activation='relu',
kernel_initializer='he_uniform'))
model.add(Dense(10, activation='softmax'))
opt = SGD(lr=0.01, momentum=0.9)
model.compile(optimizer=opt, loss='categorical_crossentropy',
metrics=['accuracy'])
model.fit(trainX, trainY, epochs=1, batch_size=32,
validation_data=(testX, testY))

signature = infer_signature(testX, model.predict(testX))
mlflow.keras.log_model(model, "mnist_cnn",
signature=signature)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist.py)



## MNIST Tensorflow 딥러닝 모델 저장 - 명시적 스키마

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist2.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist2.py)

```
import tensorflow as tf
from tensorflow.keras.layers import Conv2D, MaxPooling2D,
Dense, Flatten
from tensorflow.keras.optimizers import SGD
import numpy as np
import mlflow
import mlflow.keras
from mlflow.models.signature import ModelSignature
from mlflow.types.schema import Schema, TensorSpec

(train_X, train_Y), (test_X, test_Y) =
tf.keras.datasets.mnist.load_data()
trainX = train_X.reshape((train_X.shape[0], 28, 28, 1))
testX = test_X.reshape((test_X.shape[0], 28, 28, 1))
trainY = tf.keras.utils.to_categorical(train_Y)
testY = tf.keras.utils.to_categorical(test_Y)
model = tf.keras.models.Sequential()
model.add(Conv2D(32, (3, 3), activation='relu',
kernel_initializer='he_uniform', input_shape=(28, 28, 1)))
model.add(MaxPooling2D((2, 2)))
```

```
model.add(Flatten())
model.add(Dense(100, activation='relu',
kernel_initializer='he_uniform'))
model.add(Dense(10, activation='softmax'))

opt = SGD(lr=0.01, momentum=0.9)
model.compile(optimizer=opt, loss='categorical_crossentropy',
metrics=['accuracy'])
model.fit(trainX, trainY, epochs=1, batch_size=32,
validation_data=(testX, testY))
input_schema = Schema([TensorSpec(np.dtype(np.uint8), (-1,
28, 28, 1)),])
output_schema = Schema([TensorSpec(np.dtype(np.float32),
(-1, 10))])
signature = ModelSignature(inputs=input_schema,
outputs=output_schema)

mlflow.keras.log_model(model, "mnist_cnn",
signature=signature)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist.py)



[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist3_example.py)

```
import tensorflow as tf
from tensorflow.keras.layers import Conv2D, MaxPooling2D,
Dense, Flatten
from tensorflow.keras.optimizers import SGD
import numpy as np
import mlflow
import mlflow.keras
from mlflow.models.signature import ModelSignature
from mlflow.types.schema import Schema, TensorSpec

(train_X, train_Y), (test_X, test_Y) =
tf.keras.datasets.mnist.load_data()
trainX = train_X.reshape((train_X.shape[0], 28, 28, 1))
testX = test_X.reshape((test_X.shape[0], 28, 28, 1))
trainY = tf.keras.utils.to_categorical(train_Y)
testY = tf.keras.utils.to_categorical(test_Y)

model = tf.keras.models.Sequential()
model.add(Conv2D(32, (3, 3), activation='relu',
kernel_initializer='he_uniform', input_shape=(28, 28, 1)))
```

```
model.add(MaxPooling2D((2, 2)))
model.add(Flatten())
model.add(Dense(100, activation='relu',
kernel_initializer='he_uniform'))
model.add(Dense(10, activation='softmax'))
opt = SGD(lr=0.01, momentum=0.9)
model.compile(optimizer=opt, loss='categorical_crossentropy',
metrics=['accuracy'])
model.fit(trainX, trainY, epochs=1, batch_size=32,
validation_data=(testX, testY))

input_schema = Schema([
    TensorSpec(np.dtype(np.uint8), (-1, 28, 28, 1)),
])
output_schema = Schema([TensorSpec(np.dtype(np.float32),
(-1, 10))])
signature = ModelSignature(inputs=input_schema,
outputs=output_schema)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist3_example.py)



# mlflow 실습



## MNIST Tensorflow 딥러닝 모델 저장 - 입력 예시

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist3_example.py)

```
input_example = np.array([
    [[ 0,  0,  0,  0],
     [ 0, 134, 25, 56],
     [253, 242, 195,  6],
     [ 0, 93, 82, 82]],
    [[ 0, 23, 46,  0],
     [33, 13, 36, 166],
     [76, 75,  0, 255],
     [33, 44, 11, 82]]
], dtype=np.uint8)

mlflow.keras.log_model(model, "mnist_cnn",
signature=signature, input_example=input_example)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/tf\\_mnist3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/tf_mnist3_example.py)



[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson3\\_pyfunc/add\\_n.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson3_pyfunc/add_n.py)

```
import mlflow.pyfunc

# Define the model class
class AddN(mlflow.pyfunc.PythonModel):

    def __init__(self, n):
        self.n = n

    def predict(self, context, model_input):
        return model_input.apply(lambda column: column +
self.n)

# Construct and save the model
model_path = "add_n_model"
add5_model = AddN(n=5)
mlflow.pyfunc.save_model(path=model_path,
python_model=add5_model)
```

```
# Load the model in `python_function` format
loaded_model = mlflow.pyfunc.load_model(model_path)

# Evaluate the model
import pandas as pd
model_input = pd.DataFrame([range(10)])
model_output = loaded_model.predict(model_input)
assert model_output.equals(pd.DataFrame([range(5, 15)]))
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson3\\_pyfunc/add\\_n.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson3_pyfunc/add_n.py)



## mlflow 실습



### Add N 모델 서빙

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson3\\_pyfunc/serve.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson3_pyfunc/serve.sh)

```
$ mlflow models serve -m add_n_model -p 1234
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)





# mlflow 실습



## Add N 모델 curl 추론

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/curl\\_inference.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/curl_inference.sh)

```
curl --location --request POST 'localhost:1234/invocations' \  
--header 'Content-Type: application/json' \  
--data-raw '[4]'
```

\*출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)



[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)

```
# Load training and test datasets
from sys import version_info
import xgboost as xgb
from sklearn import datasets
from sklearn.model_selection import train_test_split

PYTHON_VERSION =
"{major}.{minor}.{micro}".format(major=version_info.major,
                                minor=version_info.minor,
                                micro=version_info.micro)

iris = datasets.load_iris()
x = iris.data[:, 2:]
y = iris.target
x_train, x_test, y_train, _ = train_test_split(x, y, test_size=0.2,
random_state=42)
dtrain = xgb.DMatrix(x_train, label=y_train)

# Train and save an XGBoost model
xgb_model = xgb.train(params={'max_depth': 10},
dtrain=dtrain, num_boost_round=10)
```

```
xgb_model_path = "xgb_model.pth"
xgb_model.save_model(xgb_model_path)

# Create an `artifacts` dictionary that assigns a unique name
to the saved XGBoost model file.
# This dictionary will be passed to
`mlflow.pyfunc.save_model`, which will copy the model file
# into the new MLflow Model's directory.
artifacts = {
    "xgb_model": xgb_model_path
}
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)



# mlflow 실습



## XGBoost Iris 모델 등록 예시 - Iris

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)

```
# Define the model class
import mlflow.pyfunc
class XGBWrapper(mlflow.pyfunc.PythonModel):

    def load_context(self, context):
        import xgboost as xgb
        self.xgb_model = xgb.Booster()

    self.xgb_model.load_model(context.artifacts["xgb_model"])

    def predict(self, context, model_input):
        input_matrix = xgb.DMatrix(model_input.values)
        return self.xgb_model.predict(input_matrix)
```

```
# Create a Conda environment for the new MLflow Model that
contains all necessary dependencies.
import cloudpickle
conda_env = {
    'channels': ['defaults'],
    'dependencies': [
        'python={}'.format(PYTHON_VERSION),
        'pip',
        {
            'pip': [
                'mlflow',
                'xgboost=={}'.format(xgb.__version__),
                'cloudpickle=={}'.format(cloudpickle.__version__),
            ],
        },
    ],
    'name': 'xgb_env'
}
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)



# mlflow 실습



## XGBoost Iris 모델 등록 예시 - Iris

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)

```
# Save the MLflow Model
mlflow_pyfunc_model_path = "xgb_mlflow_pyfunc"
mlflow.pyfunc.save_model(
    path=mlflow_pyfunc_model_path,
    python_model=XGBWrapper(), artifacts=artifacts,
    conda_env=conda_env)

# Load the model in `python_function` format
loaded_model =
mlflow.pyfunc.load_model(mlflow_pyfunc_model_path)

# Evaluate the model
import pandas as pd
test_predictions =
loaded_model.predict(pd.DataFrame(x_test))
print(test_predictions)
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)



## mlflow 실습



### XGBoost Iris 모델 서빙

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/serve.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/serve.sh)

```
$ mlflow models serve -m xgb_mlflow_pyfunc -p 1234
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)



# mlflow 실습



## XGBoost Iris 모델 curl 추론

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2\\_mnist/curl\\_inference.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson2_mnist/curl_inference.sh)

```
curl --location --request POST 'localhost:1234/invocations' \  
--header 'Content-Type: application/json' \  
--data-raw '{  
  "columns":["sepal length (cm)", "sepal width (cm)", "petal length (cm)", "petal width (cm)"],  
  "data": [[5.1, 3.5, 1.4, 0.2]]  
}'
```

\*출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1\\_iris/sk\\_iris3\\_example.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson1_iris/sk_iris3_example.py)

mlflow Model Registry 실습



03



# mlflow Registry 실습



## XGBoost Iris 모델 등록 예시 - Iris

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6\\_registry/mlflow\\_server.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6_registry/mlflow_server.sh)

```
$ mlflow server --backend-store-uri sqlite:///sqlite.db --default-artifact-root ~/mlflow
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)





# mlflow Registry 실습



## XGBoost Iris 모델 등록 예시 - Iris

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6\\_registry/mlflow\\_host.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6_registry/mlflow_host.sh)

```
$ source mlflow_host.sh
```

```
$ export MLFLOW_TRACKING_URI=http://localhost:5000
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)



# mlflow Registry 실습



## XGBoost Iris 모델 등록 예시 - Iris

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6\\_registry/random\\_forest.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6_registry/random_forest.py)

```
from random import random, randint
from sklearn.ensemble import RandomForestRegressor

import mlflow
import mlflow.sklearn

with mlflow.start_run(run_name="YOUR_RUN_NAME") as run:
    params = {"n_estimators": 5, "random_state": 42}
    sk_learn_rfr = RandomForestRegressor(**params)

    # Log the sklearn model and register as version 1
    mlflow.sklearn.log_model(
        sk_model=sk_learn_rfr,
        artifact_path="sklearn-model",
        registered_model_name="sk-learn-random-forest-reg-model"
    )
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)



# mlflow Registry 실습



## XGBoost Iris 모델 등록 예시 - Iris

[https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6\\_registry/mlflow\\_host.sh](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson6_registry/mlflow_host.sh)

```
$ source mlflow_host.sh
```

```
$ export MLFLOW_TRACKING_URI=http://localhost:5000
```

\* 출처 : [https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4\\_xgboost/xgboost1.py](https://github.com/chris-chris/mlflow-tutorial/blob/master/lesson4_xgboost/xgboost1.py)



## 짚어보기



### Model Registry mlflow



01. Model Registry mlflow에 대해 이해한다.

Model Registry mlflow의 개념에 이해한다.



02. mlflow Model 실습을 통해 작동 방식을 이해한다.

실습을 진행하면서 mlflow Model 기본 사용법에 대해 공부한다.



03. mlflow Model Registry 실습을 통해 작동 방식을 이해한다.

실습을 진행하면서 mlflow Model Registry 기본 사용법에 대해 공부한다.

머신러닝 파이프라인

# Model Registry

## mlflow

송호연



# 감사합니다.

THANKS FOR WATCHING

