WATERFLOW

Using Machine Learning for Water Potability Classification

Brice & Enam
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La grande école du numérique pour tous

Sommaire

Using Machine Learning for Water Potability Classification

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Introduction & Environnement

MLOps: A set of practices to deploy and maintain machine learning models in production reliably and efficiently.

Importance of MLOps

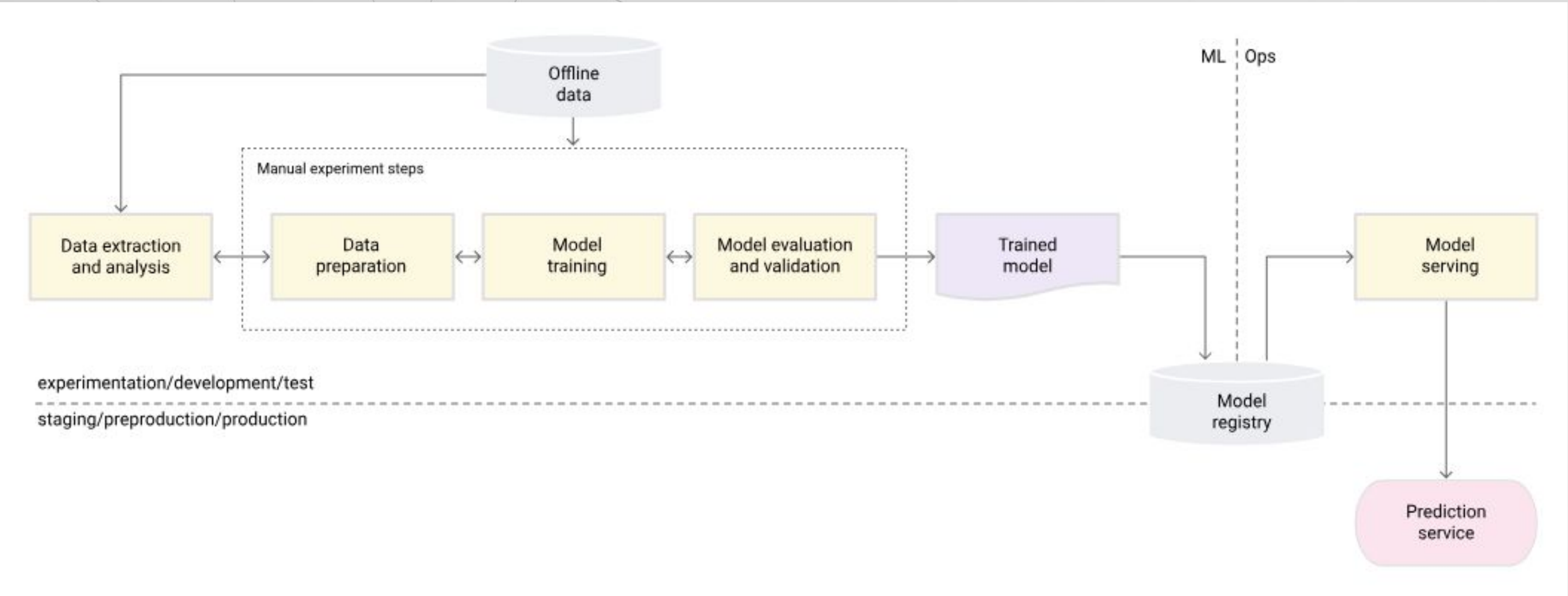
- *Streamlining Workflows*: Automates and manages the end-to-end machine learning lifecycle, improving productivity and model performance.

Key Components

- Version Control: Tracks changes to data, code and models.
- Automation: Automates repetitive tasks such as model training and deployment.
- Monitoring: Continuously monitors model performance and data quality.
- Testing: Ensures model reliability through rigorous testing.

Environnement

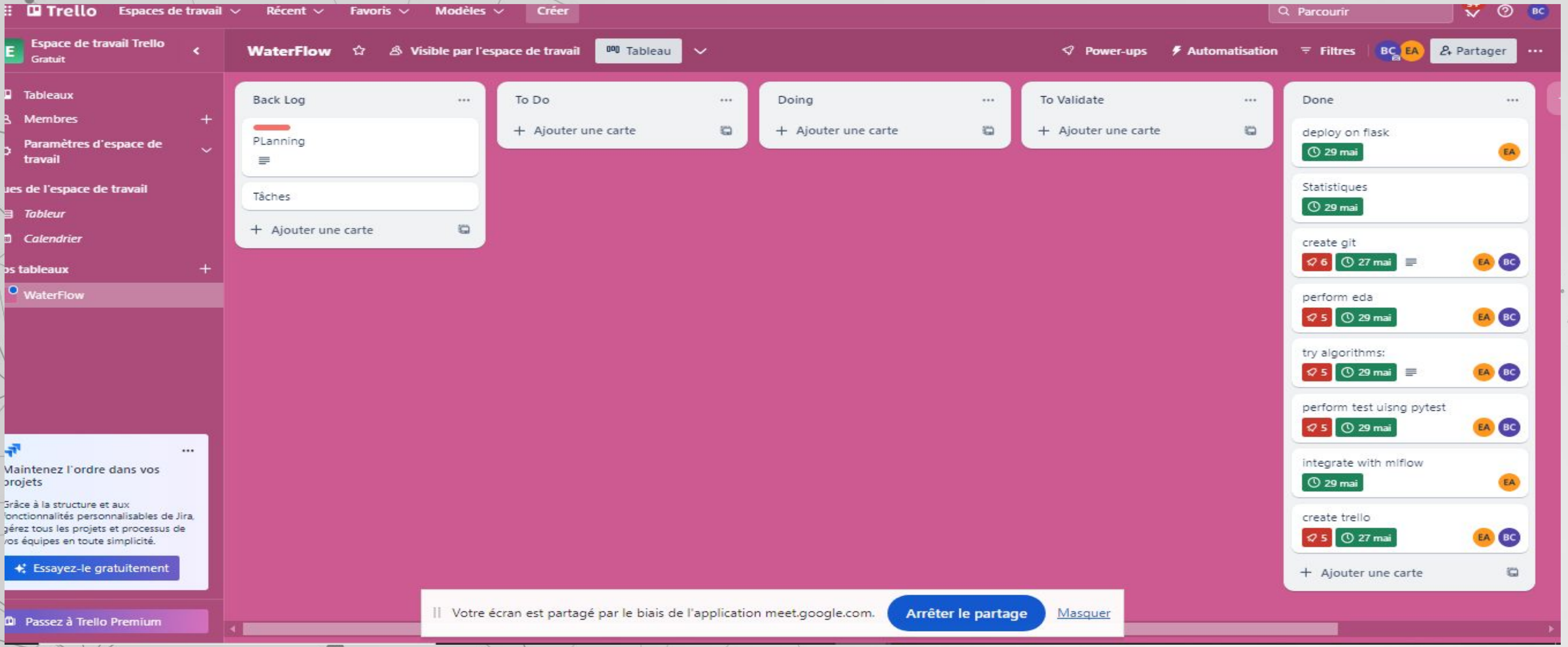
ML OPS Niveau 0 : rappel



Managed the machine learning lifecycle using MLflow
Components: Tracking, Projects, Models, Registry
Benefits: Experiment tracking, reproducibility, model management

Planning & Trello

Trello



- Used Trello for project management
- Organized tasks and milestones
- Monitored progress and collaborated effectively

Data Processing & Analysis

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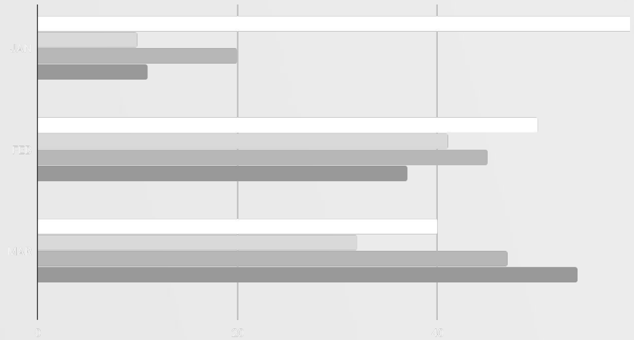
VALEURS MANQUANTES

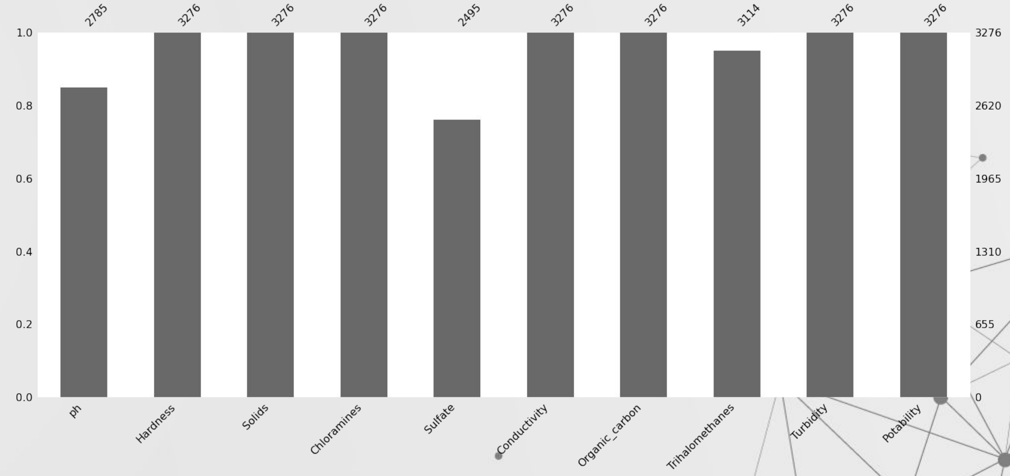


PH 14.99 SULFATE 23.84 TRIHALOMETHANES 4.95

DÉTECTION DES VALEURS MANQUANTES
AIDE A LA PRISE DE DÉCISION SUR LES COLONNE.

	Total	Manquants	%
ph	3276	**491**	**14.99**
Hardness	3276	0	0.00
Solids	3276	0	0.00
Chloramines	3276	0	0.00
Sulfate	3276	**781**	**23.84**
Conductivity	3276	0	0.00
Organic_carbon	3276	0	0.00
Trihalomethanes	3276	**162**	**4.95**
Turbidity	3276	0	0.00
Potability	3276	0	0.00

HISTOGRAMME

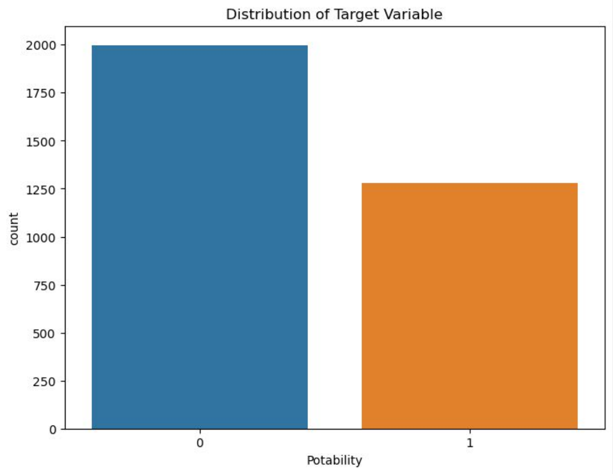


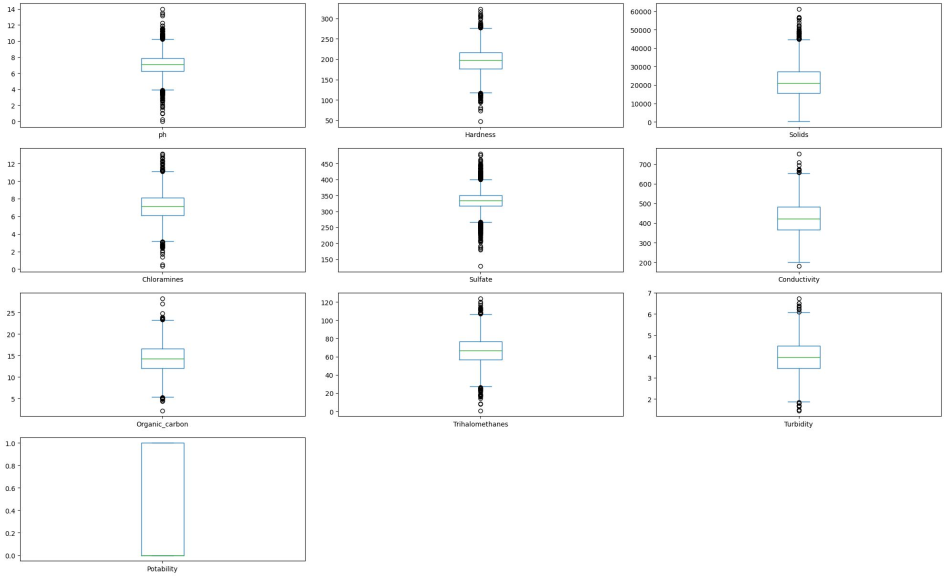
Stratégie choisie pour les valeurs manquantes : les moyennes.

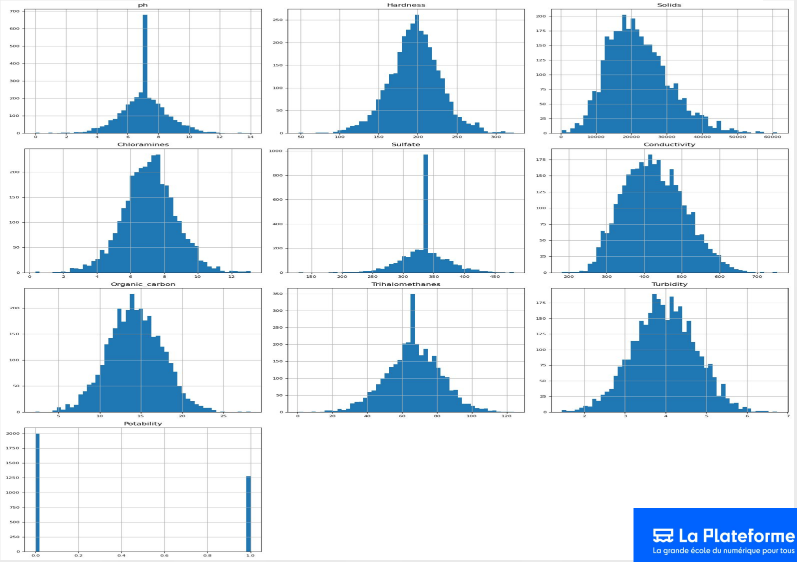
Data Preparation: Cleaned and preprocessed data

Data Exploration: Analyzed data for insights and patterns

Tools used: Pandas, NumPy, Scikit-learn







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Data Version Control (DVC)

What is DVC?

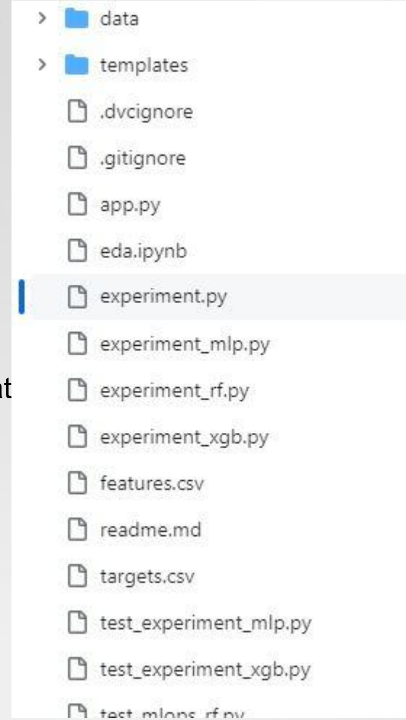
- **DVC**: A tool for versioning data and machine learning models, enabling reproducibility and collaborat data science projects.

Importance of DVC

- **Data Versioning**: Keeps track of changes to datasets and models.
- **Reproducibility**: Ensures experiments can be reliably reproduced.
- **Collaboration**: Facilitates collaboration among data scientists by managing data dependencies.

Key Features

- **Data Management**: Efficiently manages large datasets.
- **Pipeline Management**: Automates and tracks machine learning pipelines.
- **Integration**: Integrates seamlessly with Git for version control



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Model Training

Split data into training and validation and test sets
Trained a binary classification model using MLP, Random Forest XBoost
Hyperparameter tuning with RandomizedSearchCV with more focus on MLP

experiment_water_quality_mlp >

entertaining-cod-47

Model registere

Overview | Model metrics | System metrics | Artifacts

No description

Details

Created at	2024-05-21 13:40:18
Created by	eakli
Status	Finished
Run ID	1cad89fafb6242a596f3ae49f5ef96c5
Duration	12.2s
Datasets used	—
Tags	Add
Source	.\experiment_mlp.py f42a1a940c69d0f51e321869588f7886fbc1007c
Logged models	tensorflow
Registered models	WaterQualityMLP v2

Parameters (7)

Search parameters

Parameter	Value
best_dropout_rate	0.3
best_learning_rate	0.001
data_url	data/water_potability.csv
data_version	v1
epochs	50
input_cols	9
input_rows	3276

Best parameter after model tuning using RandomizedSearchCV

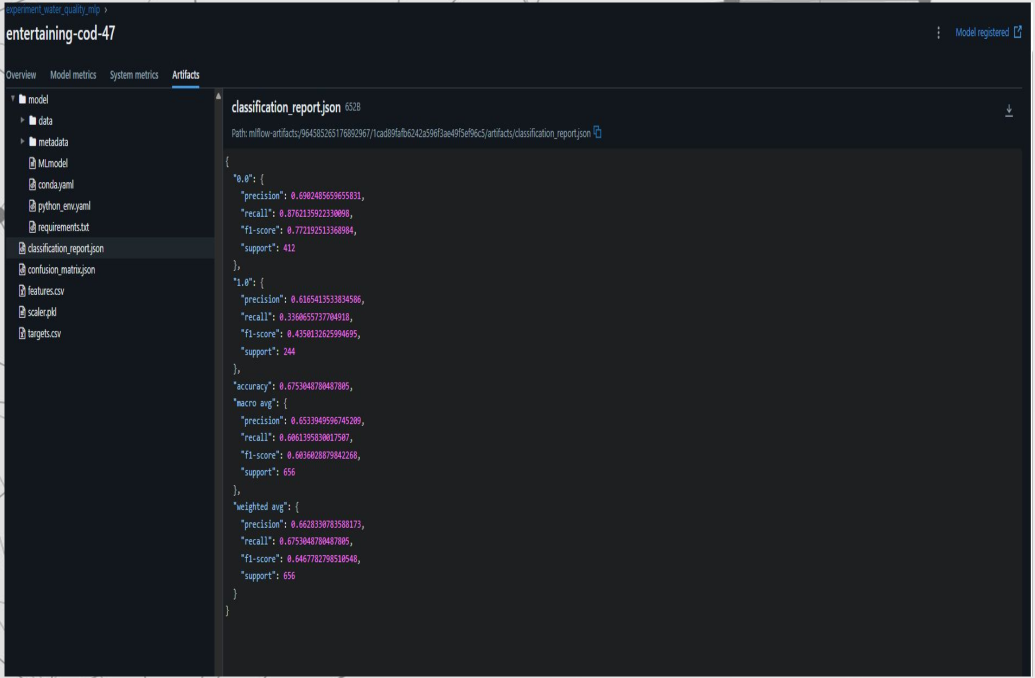
Metrics (3)

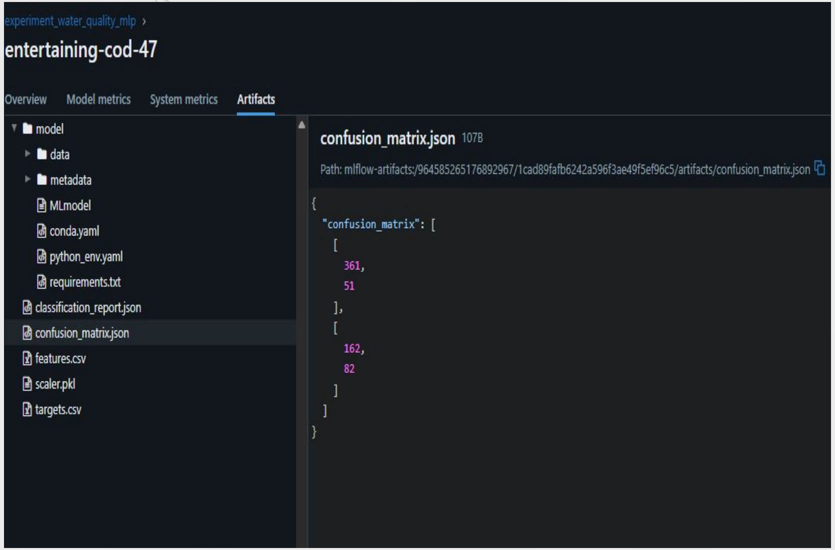
Search metrics

Metric	Value
accuracy_test	0.6753048780487805
precision_test	0.6165413533834586
recall_test	0.3360655737704918

Prediction & Evaluation

Made predictions on the validation set
Evaluation metrics: Accuracy, Precision, Recall
Confusion Matrix and Classification Report





MLflow Configuration

Configured MLflow server on port 5000
Initialized MLflow experiment: "experiment_water_quality_mlp"
Logged model and metadata during training

```python
def main():
    mlflow.set_tracking_uri("http://localhost:5000")
    experiment_name = "experiment_water_quality_mlp"
    experiment_id = mlflow.create_experiment(experiment_name)
    client = mlflow.tracking.MlflowClient()
    experiment = client.get_experiment(experiment_id)

    data_path = 'data/water_potability.csv'
    repo = r'C:\Users\eakli\Downloads\task\ecole\mlops-mlflow'
    version = 'v1'

    data = load_data(data_path, repo, version)
    X_train, X_val, X_test, y_train, y_val, y_test, feature_names, scaler = preprocess_data(data)
    best_params = tune_hyperparameters(X_train, y_train)
    final_model = train_final_model(X_train, y_train, X_val, y_val, best_params)
    evaluate_and_log_model(final_model, X_test, y_test, feature_names, experiment_id, data_path, version, y_train, y_val, best_params, scaler)

if __name__ == "__main__":
    main()
```

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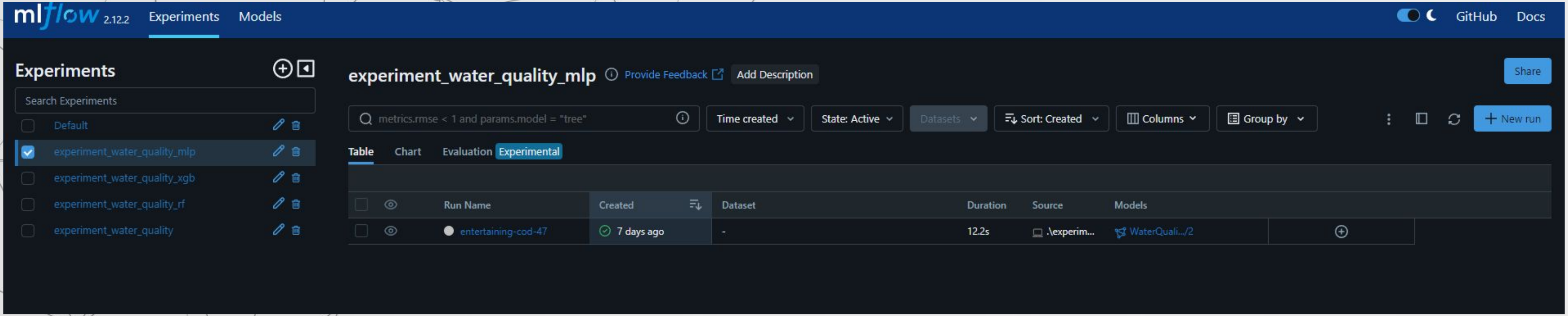
Model Transition

Explored different model versions in MLflow
Transitioned the best model which is MLP to the Model Registry
Ensured model meets quality criteria before transition



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Model Deployment

Deployed the registered model using Flask
Created an API for real-time predictions
Integrated with a web interface for user input

Flask

```python
app = Flask(__name__)

# Set the MLflow tracking URI
mlflow.set_tracking_uri("http://localhost:5000")

# Load model from the MLflow Model Registry
model_name = "WaterQualityMLP"
model_version = 2
model = mlflow.keras.load_model(f"models:/{model_name}/{model_version}")

# Load scaler used during training
scaler = joblib.load("artifacts/scaler.pkl")

@app.route('/')
def home():
    return render_template('index.html')

@app.route('/predict', methods=['POST'])
def predict():
    # Get form data
    data = request.form.to_dict()

    # Convert form data to DataFrame
    input_df = pd.DataFrame([data])

    # Ensure the input data contains all necessary features
    required_features = [
        "ph", "Hardness", "Solids", "Chloramines", "Sulfate",
        "Conductivity", "Organic_carbon", "Trihalomethanes", "Turbidity"
    ]
```

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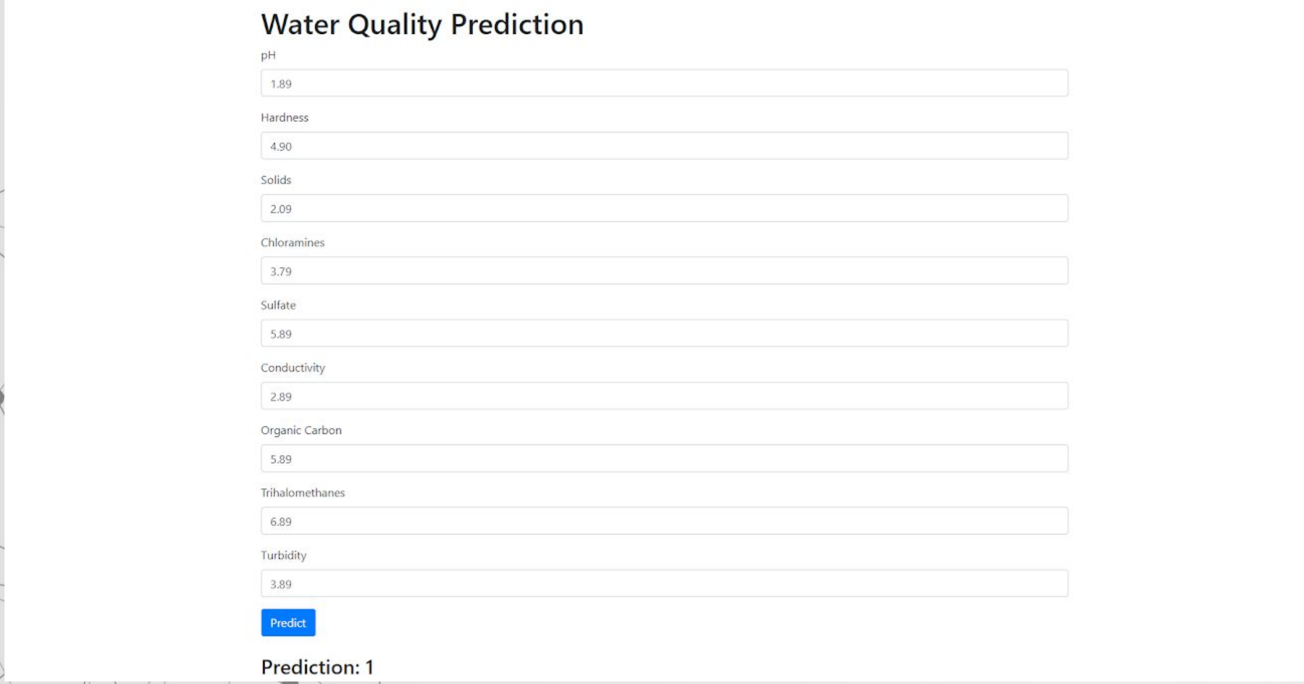
Flask Application Demo



- Live demonstration of the web application
- How to use the web interface to input data
- Real-time prediction results displayed on the UI

Using Pytest for Unit Testing

- Ensured code reliability and correctness with `pytest`
- Created unit tests for data processing and model functions
- Integrated tests into the CI/CD pipeline
- Benefits: Early bug detection, improved code quality

```
rootdir: C:\Users\eakli\Downloads\task\ecole\mlops-mlflow
plugins: hydra-core-1.3.2, mock-3.14.0
collected 2 items

test_experiment_mlp.py::test_load_data PASSED              [ 50%]
test_experiment_mlp.py::test_main PASSED                   [100%]

===================== warnings summary ======================
..\..\..\..\anaconda3\envs\env_mlops\Lib\site-packages\mlflow\ut
ils\requirements_utils.py:20
  C:\Users\eakli\anaconda3\envs\env_mlops\Lib\site-packages\mlfl
```

```python
import pytest
from experiment_mlp import load_data, preprocess_data, create_model, train_final_model

def test_load_data():
    data = load_data('data/water_potability.csv', 'repo', 'v1')
    assert not data.empty

def test_preprocess_data():
    data = load_data('data/water_potability.csv', 'repo', 'v1')
    X_train, X_val, X_test, y_train, y_val, y_test, feature_names, scaler = preprocess_dat
    assert X_train.shape[0] > 0
    assert y_train.shape[0] > 0

def test_create_model():
    model = create_model(input_shape=9, learning_rate=0.001, dropout_rate=0.5)
    assert model is not None

def test_train_final_model():
    data = load_data('data/water_potability.csv', 'repo', 'v1')
    X_train, X_val, X_test, y_train, y_val, y_test, feature_names, scaler = preprocess_dat
    best_params = {'learning_rate': 0.001, 'dropout_rate': 0.5, 'epochs': 50}
    model = train_final_model(X_train, y_train, X_val, y_val, best_params)
    assert model is not None
```

Challenges and Solutions

- Handling missing data - mean or median
- Hyperparameter tuning -
- Model deployment using MLflow
- Integrating model with a web application
- Some tests failed

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Conclusion

- Random Forest est le efficace.

References

MLflow: A Tool for Managing the Machine Learning Lifecycle — MLflow 2.13.0 documentation

Home | Data Version Control · DVC

Home - MLOps Community

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THANK YOU

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