

MLOps Assignment Report: Heart Disease Prediction

Contributors

GROUP 33

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Demo Video

[YouTube URL](#)

Repository Link (with setup)

[GitHub Repository](#)

1. Introduction

This report details the implementation of an end-to-end MLOps pipeline for heart disease risk prediction using the UCI Heart Disease dataset. The project demonstrates modern MLOps practices including data processing, model development, experiment tracking, CI/CD, containerization, and deployment.

2. Dataset and Data Acquisition

Dataset: UCI Heart Disease Dataset

- **Source:** UCI Machine Learning Repository
- **Features:** 13 clinical features + target

- **Samples:** ~300 instances
- **Target:** Binary (0: no disease, 1: disease)

Data Acquisition:

- **Script:** `src/data_prep.py` downloads from UCI URL
- **Cleaning:** Handle missing values (marked as '?'), convert to binary target
- **Storage:** `data/raw/heart.csv`

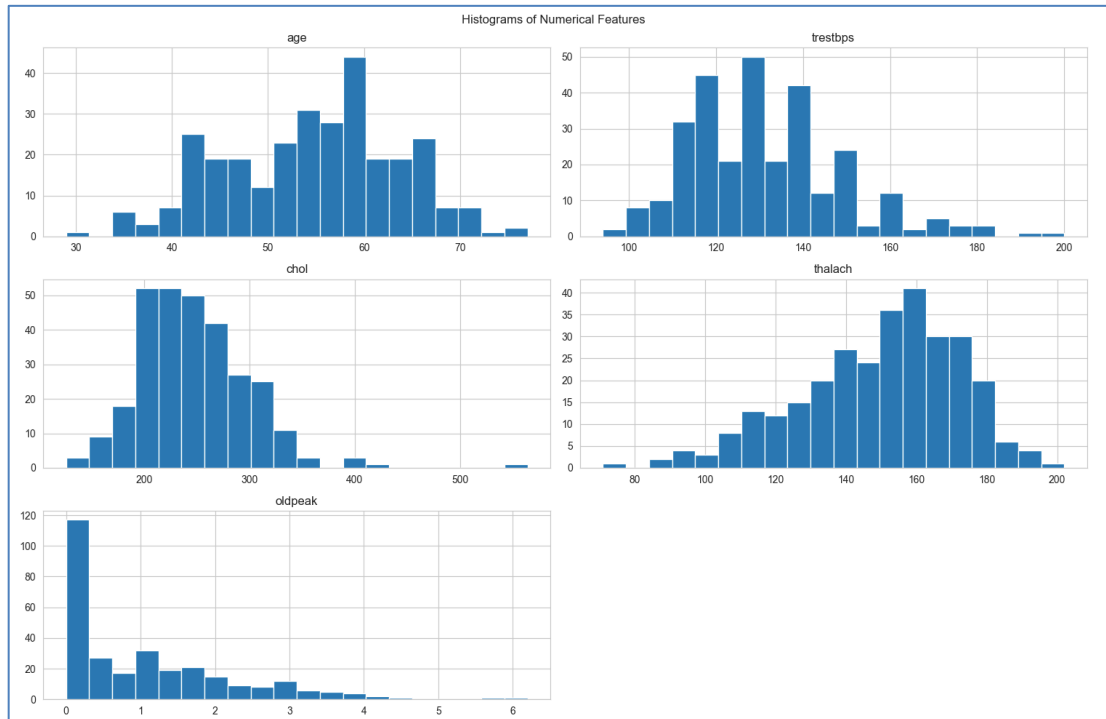
3. Exploratory Data Analysis (EDA)

Key Findings (see `notebooks/eda.ipynb`):

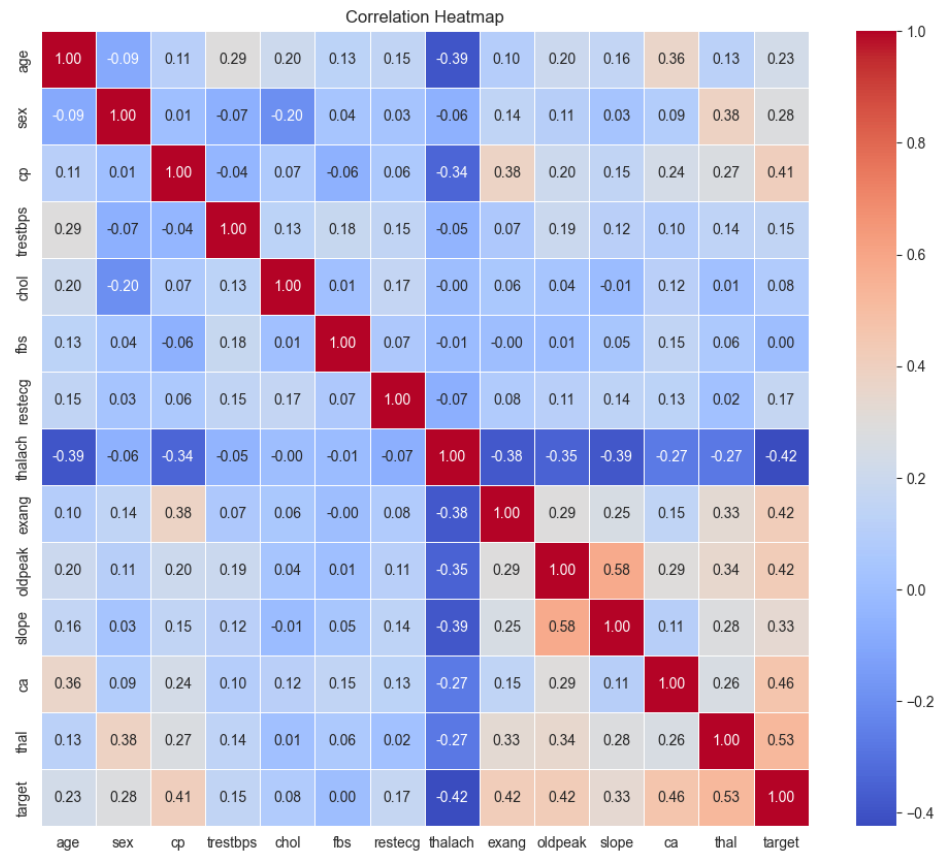
- **Class Balance:** Slight imbalance (~46% positive cases; 137/297).
- **Correlations:** Strongest correlations with target include **thal** and **ca** (positive) and **thalach** (negative); **cp** and **oldpeak** are also meaningfully associated.
- **Distributions:** Age is roughly bell-shaped; cholesterol shows clear outliers.
- **Categorical Analysis:** Higher chest pain types associated with disease.

Visualizations:

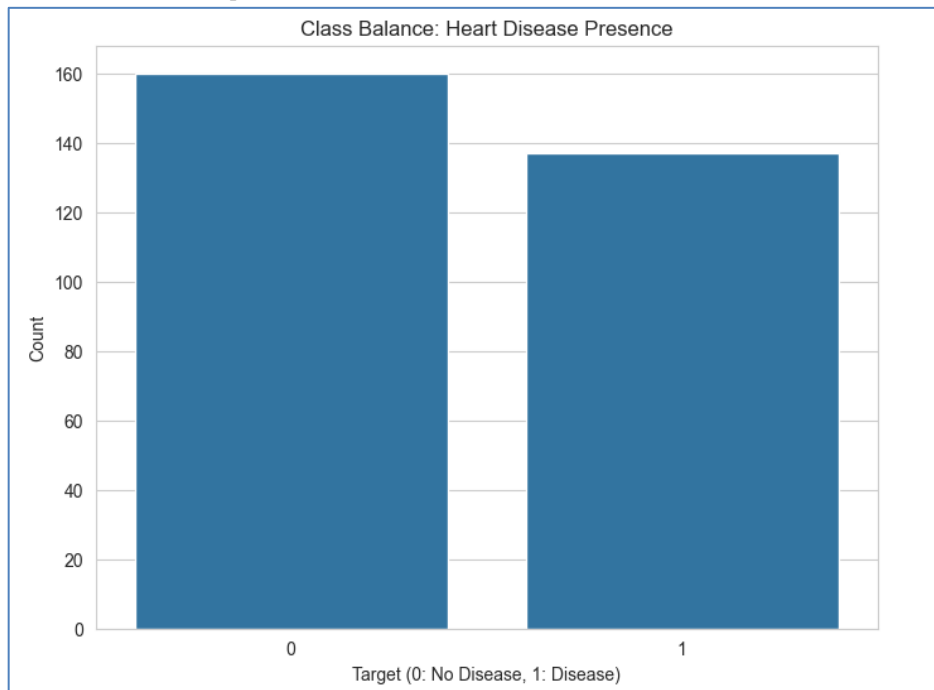
- Histograms for numerical features



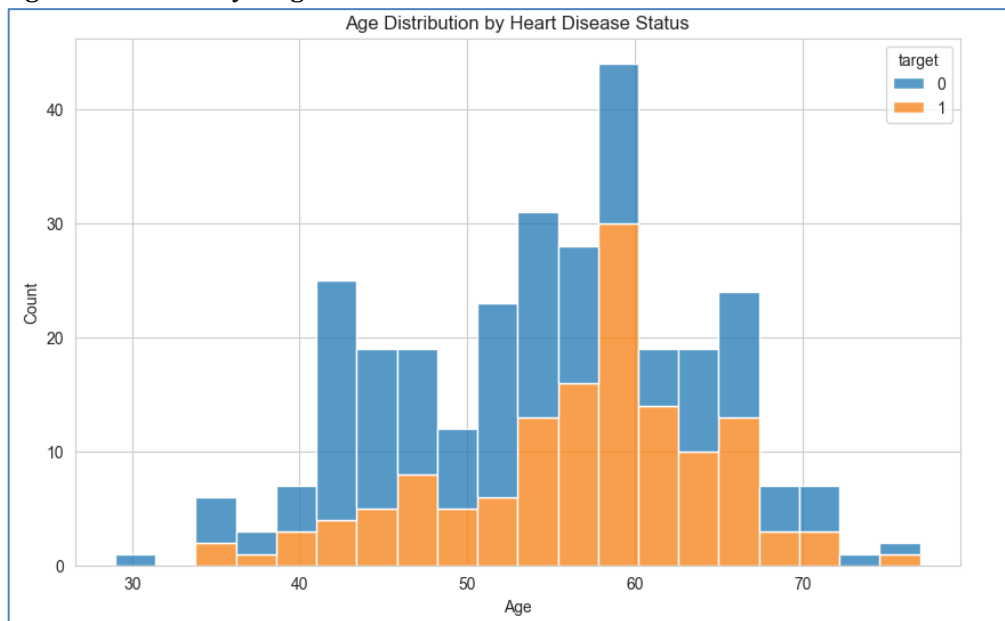
- Correlation heatmap



- Class balance bar plot



- Age distribution by target



4. Feature Engineering and Model Development

Preprocessing Pipeline:

- Numerical: StandardScaler

- Categorical: OneHotEncoder (handle_unknown='ignore')
- Pipeline: ColumnTransformer + Model

Models Evaluated:

1. Logistic Regression (tuned C, penalty)
2. Random Forest (tuned n_estimators, max_depth)

Hyperparameter Tuning: GridSearchCV with 5-fold CV, ROC-AUC scoring

Evaluation Metrics:

- ROC-AUC (primary)
- Accuracy, Precision, Recall

Best Model: Logistic Regression (ROC-AUC: 0.9113)

5. Experiment Tracking

Tool: MLflow

- **Experiments:** Logged parameters, metrics, model artifacts
- **Runs:** Separate runs for each model with best params
- **UI:** `mlflow ui` for visualization

MLflow experiment runs and metrics

- MLflow UI - experiment list

mlflow

3.8.1

heart-disease-experiments

Machine learning

Runs

Models

Traces

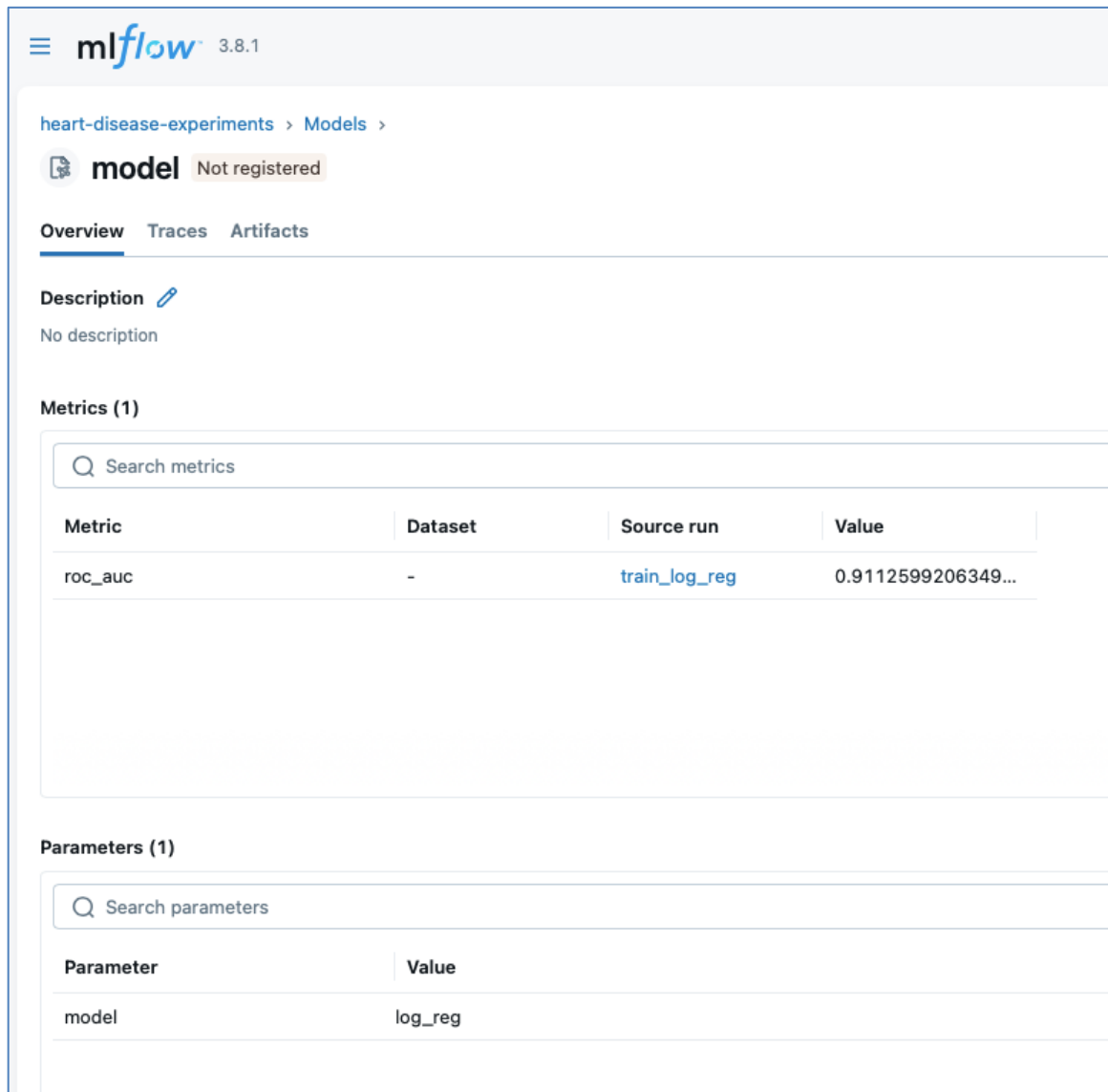
Sort: Created

Columns

Group by

Model attributes			Model attributes		No dataset	Parameters
Model name	Status	Created ↓	Logged from	Source run	roc_auc	model
<div></div> model	<div>✓ Ready</div>	26 seconds ago	<div></div> train.py	<div>train_log_reg</div>	0.9112599206349208	log_reg
<div></div> model	<div>✓ Ready</div>	41 seconds ago	<div></div> train.py	<div>train_rf</div>	0.8980902777777777	rf
<div></div> model	<div>✓ Ready</div>	50 seconds ago	<div></div> train.py	<div>train_rf</div>	0.8980902777777777	rf
<div></div> model	<div>✓ Ready</div>	1 minute ago	<div></div> train.py	<div>train_log_reg</div>	0.9112599206349208	log_reg
<div></div> model	<div>✓ Ready</div>	18 hours ago	<div></div> train.py	<div>train_log_reg</div>	0.9112599206349208	log_reg
<div></div> model	<div>✓ Ready</div>	19 hours ago	<div></div> train.py	<div>train_log_reg</div>	0.9112599206349208	log_reg
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- MLflow UI - best run details



The screenshot displays the MLflow UI interface for a specific model. At the top, the MLflow logo and version 3.8.1 are visible. The breadcrumb navigation shows the path: heart-disease-experiments > Models > model. The model name 'model' is followed by a 'Not registered' status tag. Below this, there are tabs for Overview, Traces, and Artifacts, with 'Overview' being the active tab. The 'Description' section shows 'No description' with an edit icon. The 'Metrics (1)' section contains a search bar and a table with one metric: 'roc_auc' with a value of '0.9112599206349...'. The 'Parameters (1)' section also has a search bar and a table with one parameter: 'model' with a value of 'log_reg'.

Model Details:

- Model Name:** model (Not registered)
- Overview Tab:**
 - Description:** No description
 - Metrics (1):**

Metric	Dataset	Source run	Value
roc_auc	-	train_log_reg	0.9112599206349...
 - Parameters (1):**

Parameter	Value
model	log_reg

6. Model Packaging and Reproducibility

Format: Joblib pickle with sklearn Pipeline

Dependencies: requirements.txt with pinned versions

Reproducibility: Pipeline ensures consistent preprocessing

7. CI/CD Pipeline and Testing

Tool: GitHub Actions

Jobs:

- Ubuntu: Lint (flake8), test (pytest), data prep, train, upload artifact
- Windows: Test only

Tests:

- Data loading: tests/test_data.py
- Data prep: tests/test_prep.py

Artifacts: Trained model uploaded per run

8. Model Containerization

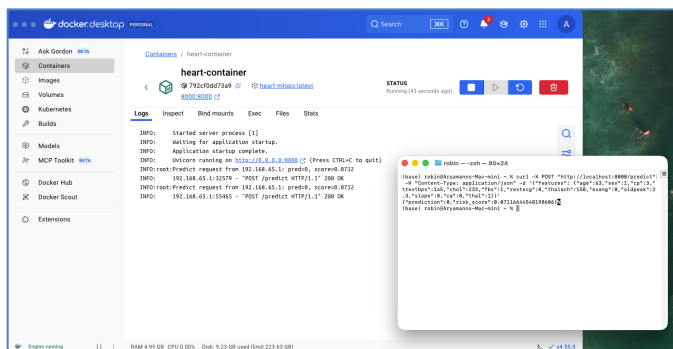
Tool: Docker

Image: Python 3.10 slim + dependencies

API: FastAPI with /predict endpoint

Testing: Local build/run with sample input

Docker build and local container test



9. Production Deployment

Platform: Railway (public cloud)

URL: <https://heart-mlops-production.up.railway.app>

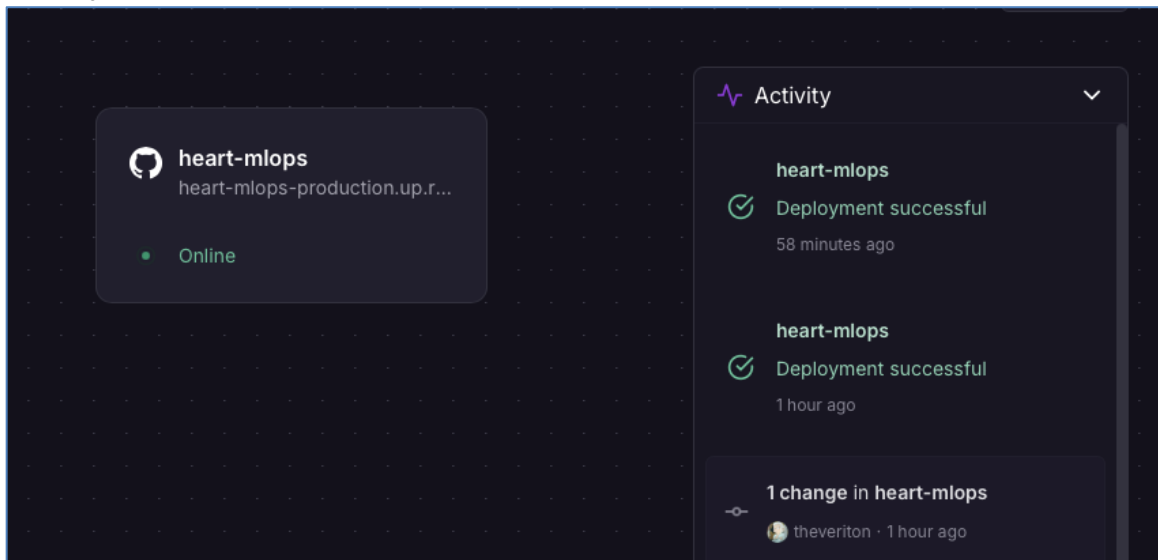
Manifests: Docker-based deployment

Service: Web service with automatic scaling

Verification: Endpoint testing with curl, deployed API functional

Railway deployment

- Railway service dashboard



- Deployed /predict response

```
robin — -zsh — 80x24

(base) robin@Aryamanns-Mac-mini ~ % curl -X POST "https://heart-mlops-production.up.railway.app/predict" -H "Content-Type: application/json" -d '{"features": {"age": 63, "sex": 1, "cp": 3, "trestbps": 145, "chol": 233, "fbs": 1, "restecg": 0, "thalach": 150, "exang": 0, "oldpeak": 2.3, "slope": 0, "ca": 0, "thal": 1}}'

{"prediction":0,"risk_score":0.07116644548198606}
(base) robin@Aryamanns-Mac-mini ~ %
```

10. Monitoring and Logging

Logging: Request logging with client IP, prediction, score

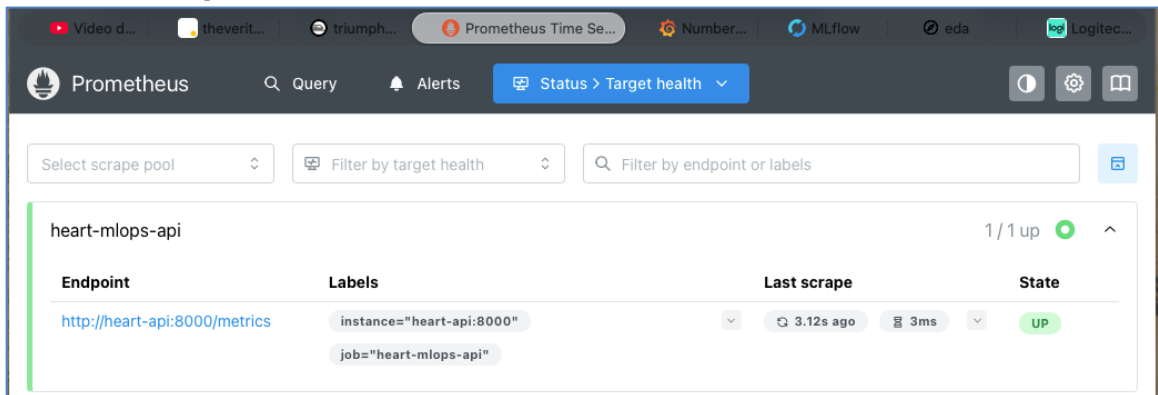
Metrics: `/metrics` endpoint exposes Prometheus-formatted metrics (including `predict_requests_total`)

Monitoring Stack (Local):

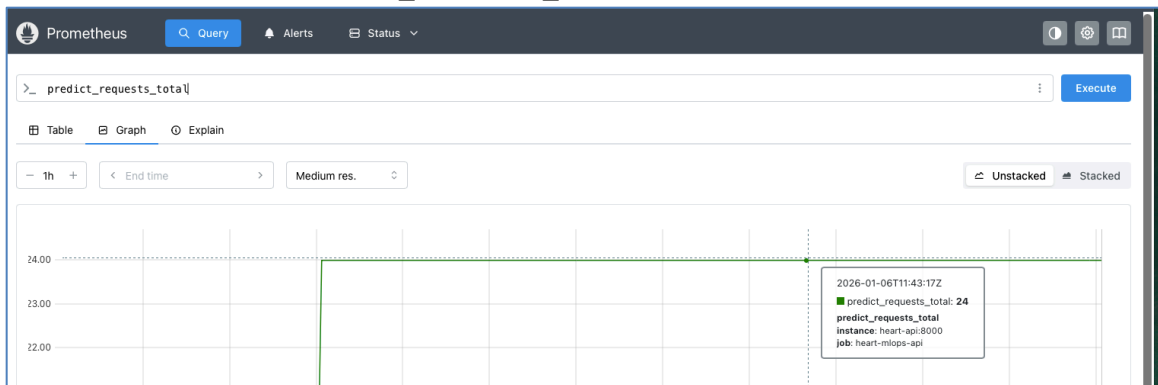
- Prometheus scrapes the API metrics endpoint
- Grafana visualizes metrics from Prometheus

Monitoring Screenshots

- Prometheus targets UP



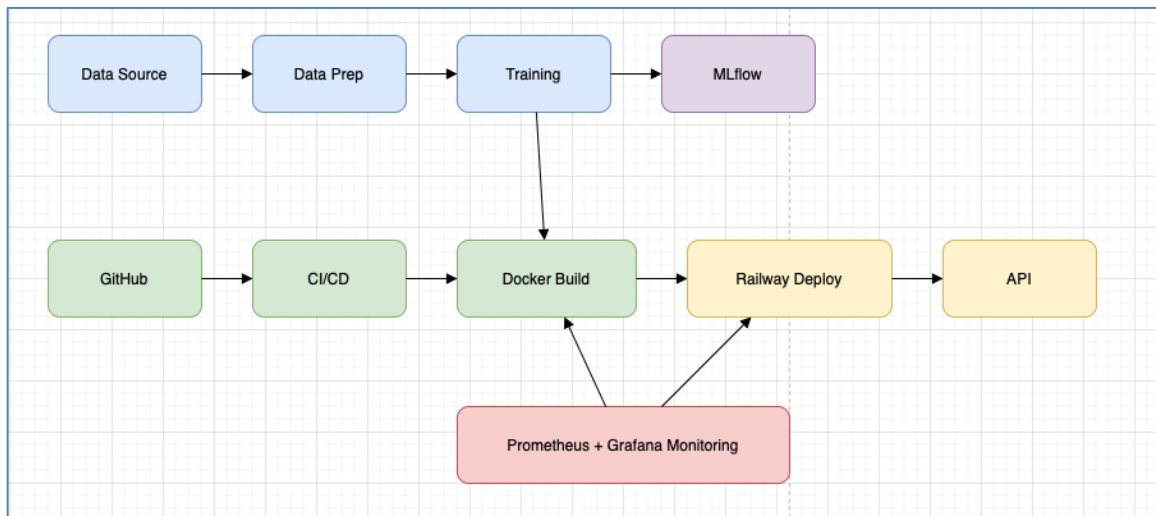
- Prometheus query for `predict_requests_total`



- Grafana dashboard panel showing `predict_requests_total`



11. Architecture Diagram



12. CI/CD Workflow Screenshots

- Build success:

Triggered via push 1 hour ago

theveriton pushed `-o- a63753c` `main`

Status

Success

Total duration

1m 47s

Artifacts

1

ci.yml

on: push

✓ test-and-train 59s

✓ build-windows 1m 41s

- Test results:

✓ Run tests

1 ▶ Run pytest -q

12 ..

13 2 passed in 0.84s

[100%]

- Deployment:

Deployments

All deployments

Environments

triumphant-balance / production

Manage environments

triumphant-balance / production deployments

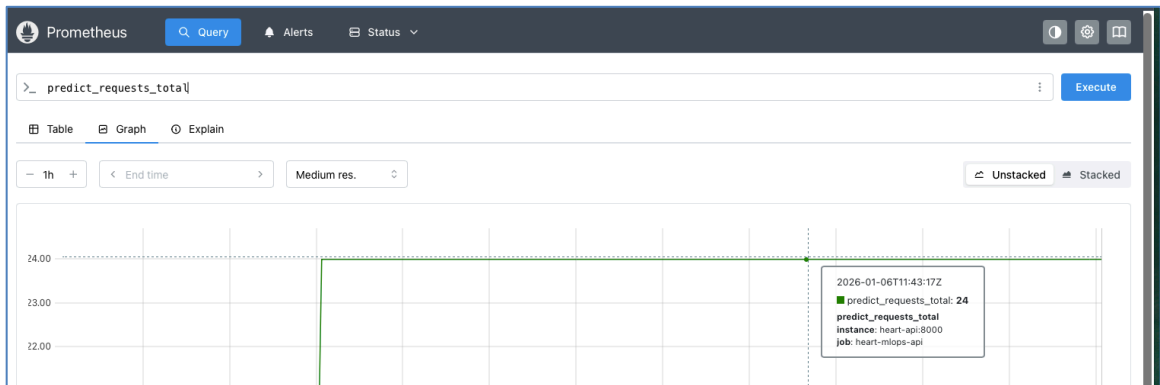
Latest deployments

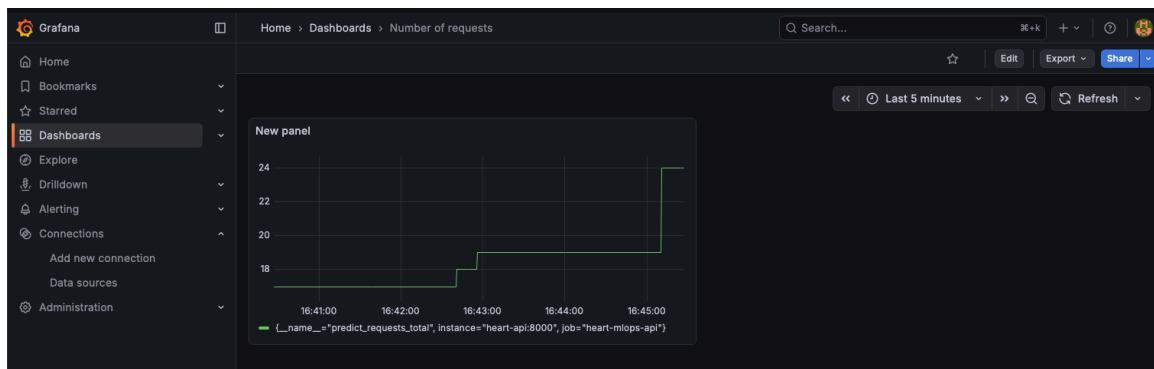
✓ triumphant-balance / production

Last deployed 2 hours ago

<https://railway.com/project/5b308d1e-803e-46b7-bce4-88696b263c2a?environmentId=4e5a7fef-bba8-47b8-99a1-3ceac946bb3a>

- Monitoring:





- MLflow:

mlflow 3.8.1

heart-disease-experiments Machine learning

Runs Models Traces

Sort: Created Columns Group by

Model attributes			Model attributes		No dataset	Parameters
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15. Conclusion

The project successfully implements all MLOps requirements with automated pipelines, reproducible models, and production-ready deployment on Railway. Key achievements include hyperparameter tuning, experiment tracking, containerization, and public cloud deployment.