Environmental Monitoring and Pollution Prediction MLOPS Final Project

Task 3: Monitoring and Live Testing

Part 1) Set Up Monitoring:

- Key aspects employ Grafana and Prometheus to monitor data ingestion, model predictions, and API performance.

PRE-STEPS:

- Created Prometheus.yml (Prometheus configuration for scraping metrics.)
- Created docker-compose.yaml (Manages Prometheus, Grafana, and the Flask App as Docker services.)
- Created Docker file

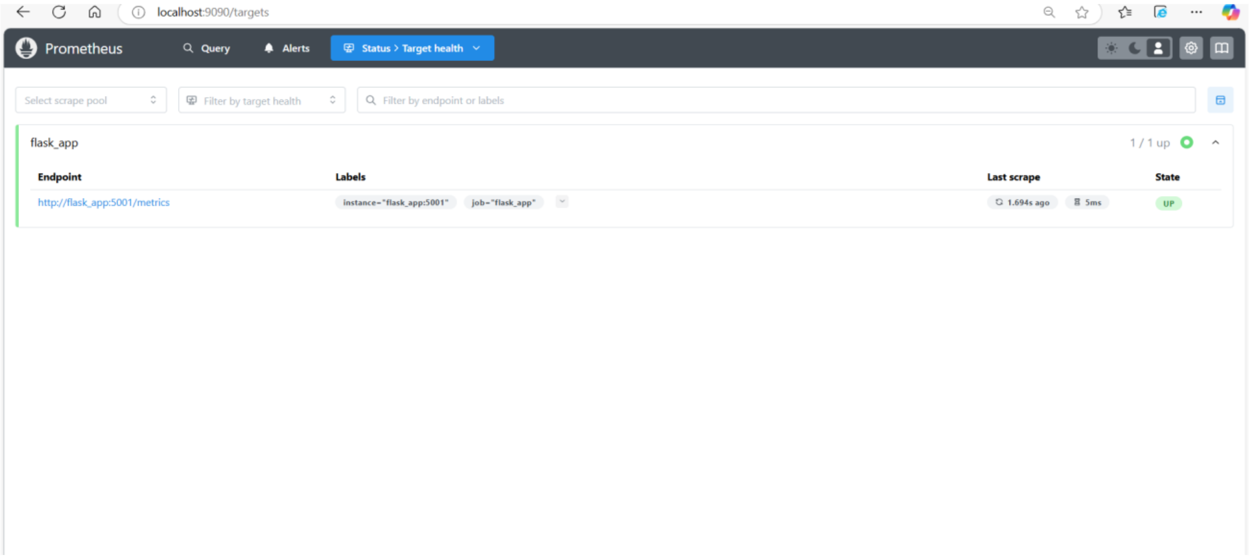
  Created app.py

IMPLEMENTATION:

- Configured Prometheus to scrape metrics from the Flask App.
- Link Grafana with Prometheus as a data source.
- Create real-time performance dashboards for API metrics such as request duration and scraped samples in Grafana.

SCREENSHOTS:

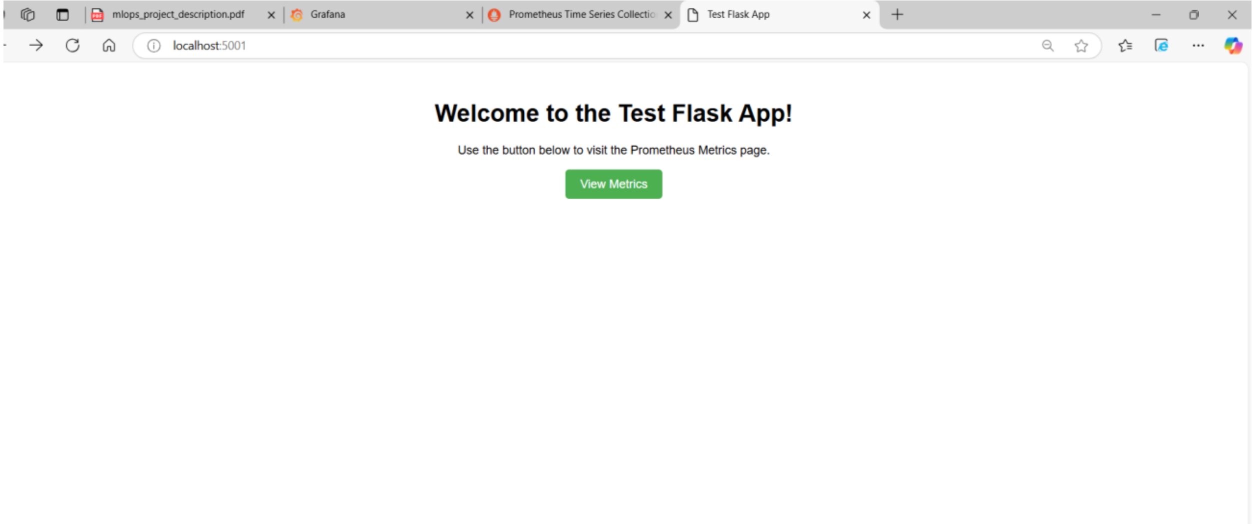
Prometheus



flask_app — 1 / 1 up

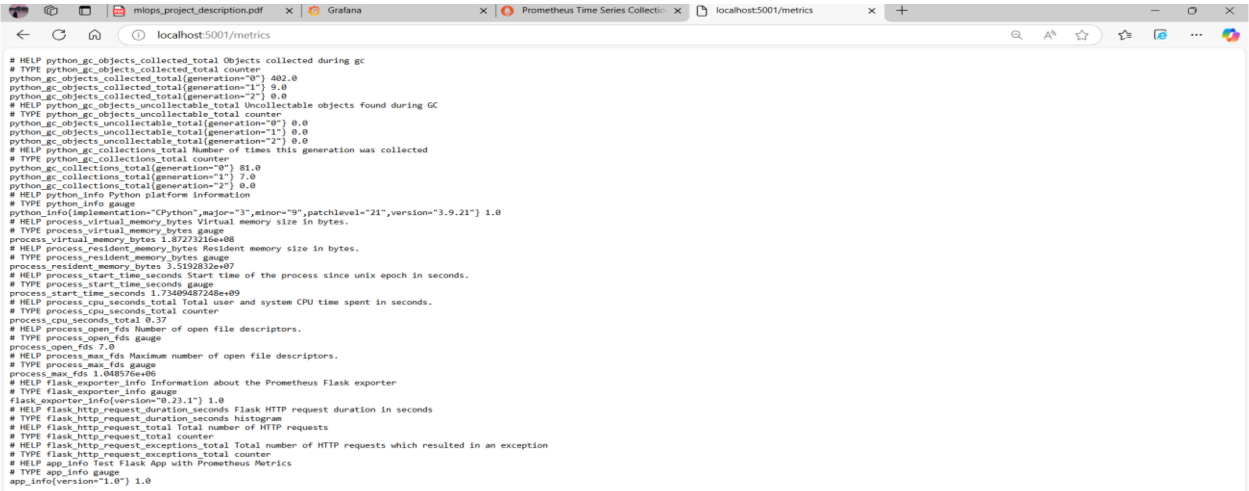
Endpoint	Labels	Last scrape	State
http://flask_app:5001/metrics	instance="flask_app:5001" job="flask_app"	1.694s ago 5ms	UP

Flask App


mlops_project_description.pdf
Grafana
Prometheus Time Series Collectio
Test Flask App
localhost:5001

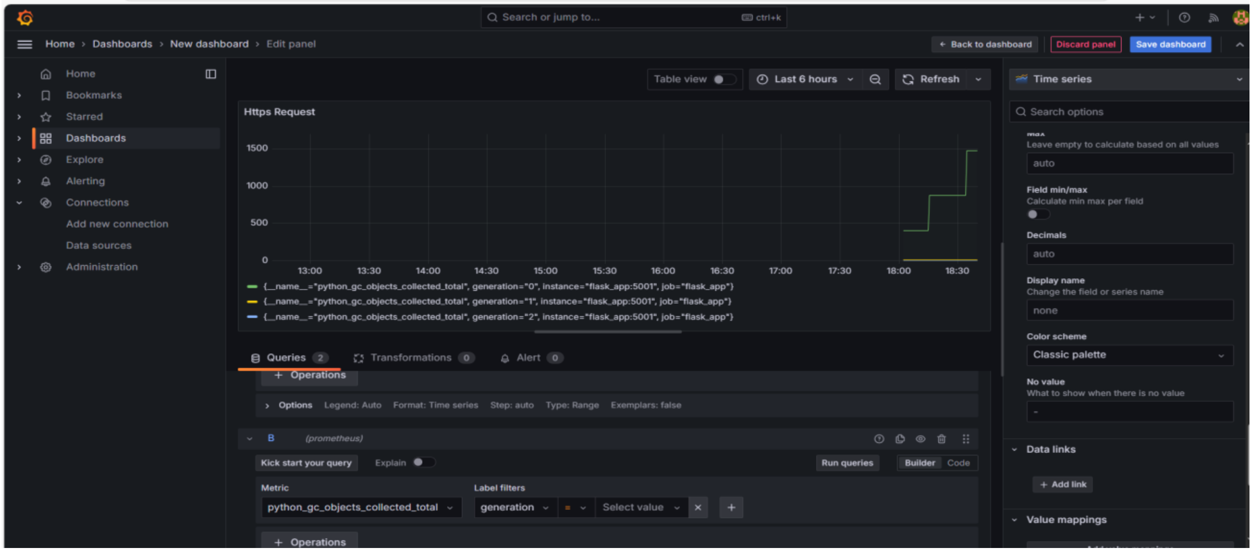
Welcome to the Test Flask App!

Use the button below to visit the Prometheus Metrics page.


mlops_project_description.pdf
Grafana
Prometheus Time Series Collectio
localhost:5001/metrics
localhost:5001/metrics

```
# HELP python_gc_objects_collected_total Objects collected during gc
# TYPE python_gc_objects_collected_total counter
python_gc_objects_collected_total{generation="0"} 402.0
python_gc_objects_collected_total{generation="1"} 9.0
python_gc_objects_collected_total{generation="2"} 0.0
# HELP python_gc_objects_uncollectable_total Uncollectable objects found during GC
# TYPE python_gc_objects_uncollectable_total counter
python_gc_objects_uncollectable_total{generation="0"} 0.0
python_gc_objects_uncollectable_total{generation="1"} 0.0
python_gc_objects_uncollectable_total{generation="2"} 0.0
# HELP python_gc_collections_total Number of times this generation was collected
# TYPE python_gc_collections_total counter
python_gc_collections_total{generation="0"} 81.0
python_gc_collections_total{generation="1"} 7.0
python_gc_collections_total{generation="2"} 0.0
# HELP python_info Python platform information
# TYPE python_info gauge
python_info{implementation="CPython",major="3",minor="9",patchlevel="21",version="3.9.21"} 1.0
# HELP process_virtual_memory_bytes Virtual memory size in bytes.
# TYPE process_virtual_memory_bytes gauge
process_virtual_memory_bytes 1.87273216e+08
# HELP process_resident_memory_bytes Resident memory size in bytes.
# TYPE process_resident_memory_bytes gauge
process_resident_memory_bytes 3.5192832e+07
# HELP process_start_time_seconds Start time of the process since unix epoch in seconds.
# TYPE process_start_time_seconds gauge
process_start_time_seconds 1.73409487248e+09
# HELP process_cpu_seconds_total Total user and system CPU time spent in seconds.
# TYPE process_cpu_seconds_total counter
process_cpu_seconds_total 0.37
# HELP process_open_fds Number of open file descriptors.
# TYPE process_open_fds gauge
process_open_fds 7.0
# HELP process_max_fds Maximum number of open file descriptors.
# TYPE process_max_fds gauge
process_max_fds 1.048576e+06
# HELP flask_exporter_info Information about the Prometheus Flask exporter
# TYPE flask_exporter_info gauge
flask_exporter_info{version="0.23.1"} 1.0
# HELP flask_http_request_duration_seconds Flask HTTP request duration in seconds
# TYPE flask_http_request_duration_seconds histogram
# HELP flask_http_request_total Total number of HTTP requests
# TYPE flask_http_request_total counter
# HELP flask_http_request_exceptions_total Total number of HTTP requests which resulted in an exception
# TYPE flask_http_request_exceptions_total counter
# HELP app_info Test Flask App with Prometheus Metrics
# TYPE app_info gauge
app_info{version="1.0"} 1.0
```

Grafana



Https Request

- {__name__="python_gc_objects_collected_total", generation="0", instance="flask_app:5001", job="flask_app"}
- {__name__="python_gc_objects_collected_total", generation="1", instance="flask_app:5001", job="flask_app"}
- {__name__="python_gc_objects_collected_total", generation="2", instance="flask_app:5001", job="flask_app"}

Options Legend: Auto Format: Time series Step: auto Type: Range Exemplars: false

B (prometheus)

Metric: python_gc_objects_collected_total

Label filters: generation = Select value

Max
Leave empty to calculate based on all values
auto

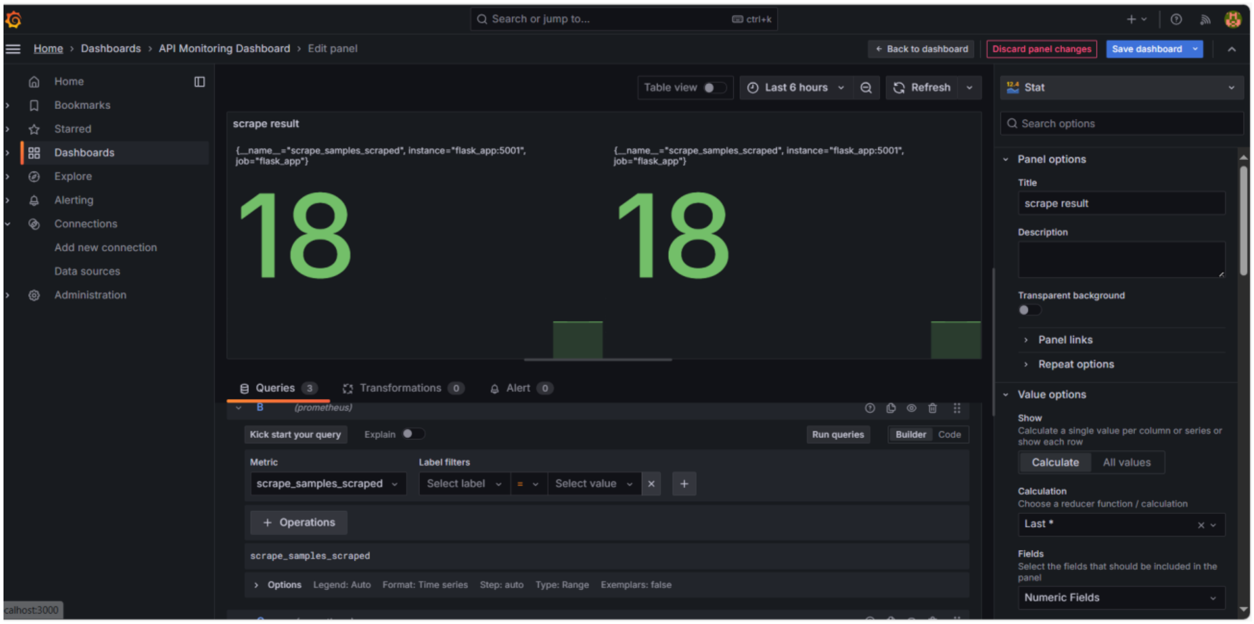
Field min/max
Calculate min max per field

Decimals
auto

Display name
Change the field or series name
none

Color scheme
Classic palette

No value
What to show when there is no value
-



scrape result

{__name__="scrape_samples_scraped", instance="flask_app:5001", job="flask_app"}
18

{__name__="scrape_samples_scraped", instance="flask_app:5001", job="flask_app"}
18

B (prometheus)

Metric: scrape_samples_scraped

Label filters: Select label = Select value

```
scrape_samples_scraped
```

Options Legend: Auto Format: Time series Step: auto Type: Range Exemplars: false

Title
scrape result

Description

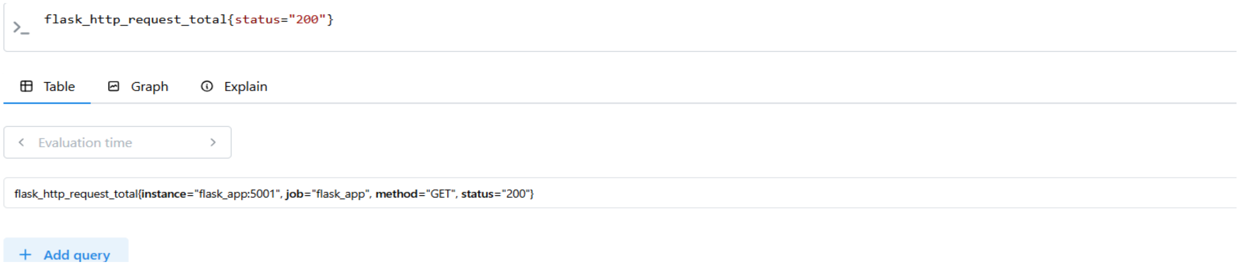
Transparent background

Show
Calculate a single value per column or series or show each row
Calculate | All values

Calculation
Choose a reducer function / calculation
Last *

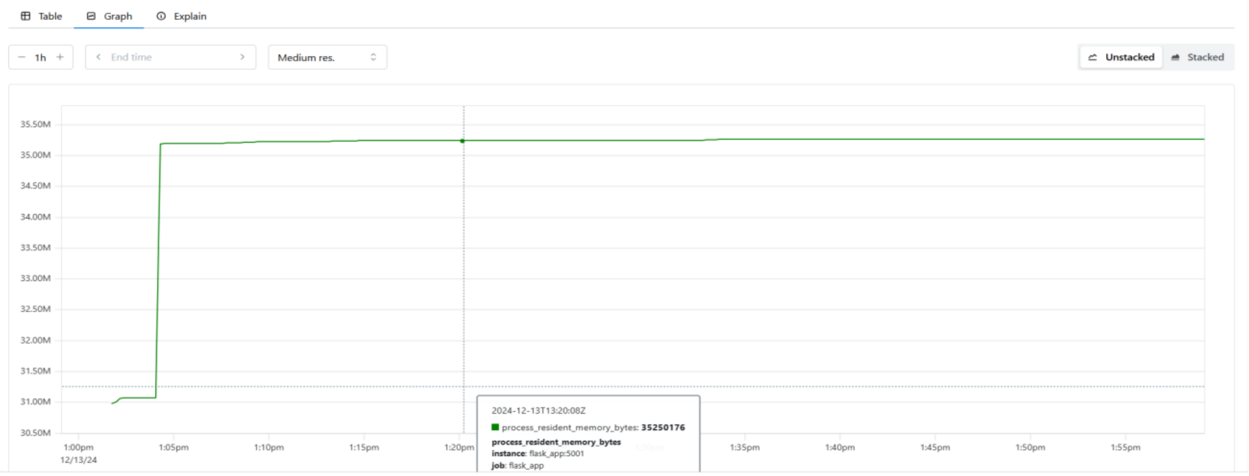
Fields
Select the fields that should be included in the panel
Numeric Fields

Prometheus Queries

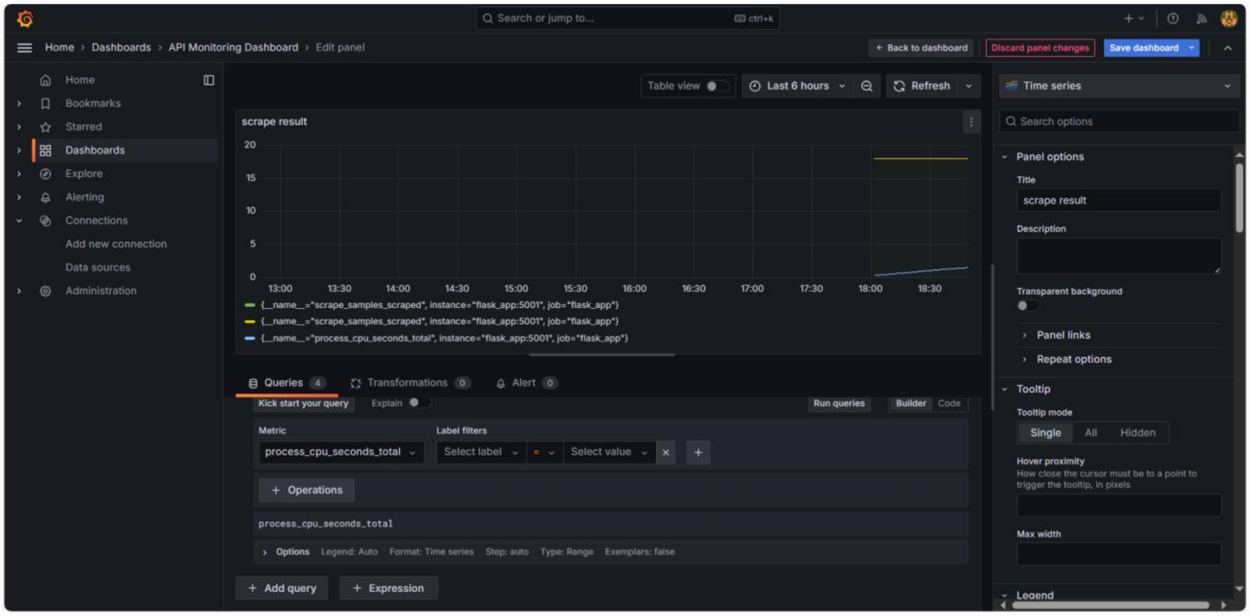


```
flask_http_request_total{status="200"}
```

flask_http_request_total{**instance**="flask_app:5001", **job**="flask_app", **method**="GET", **status**="200"}



2024-12-13T13:20:08Z
🟩 process_resident_memory_bytes: **35250176**
process_resident_memory_bytes
instance: flask_app:5001
job: flask_app



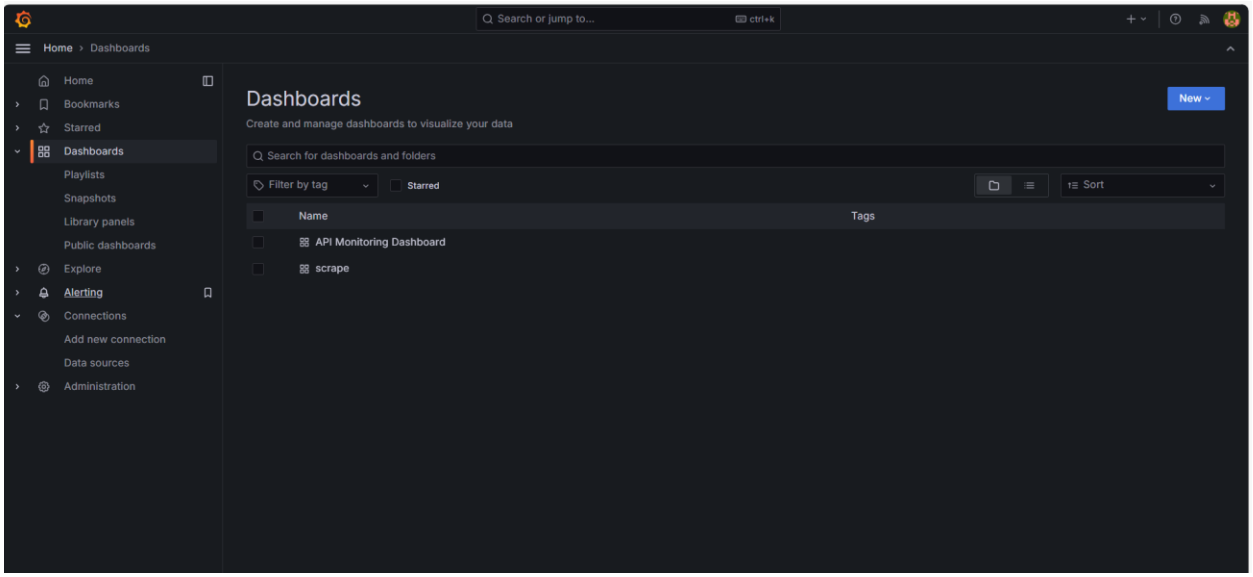
🟩 {__name__="scrape_samples_scraped", instance="flask_app:5001", job="flask_app"}
🟨 {__name__="scrape_samples_scraped", instance="flask_app:5001", job="flask_app"}
🟦 {__name__="process_cpu_seconds_total", instance="flask_app:5001", job="flask_app"}

Metric: process_cpu_seconds_total
Label filters: Select label = Select value

```
process_cpu_seconds_total
```

Options Legend: Auto Format: Time series Step: auto Type: Range Exemplars: false

Title: scrape result
Description:
Transparent background
Tooltip mode: Single
Hover proximity
How close the cursor must be to a point to trigger the tooltip, in pixels
Max width



Dashboards

Create and manage dashboards to visualize your data

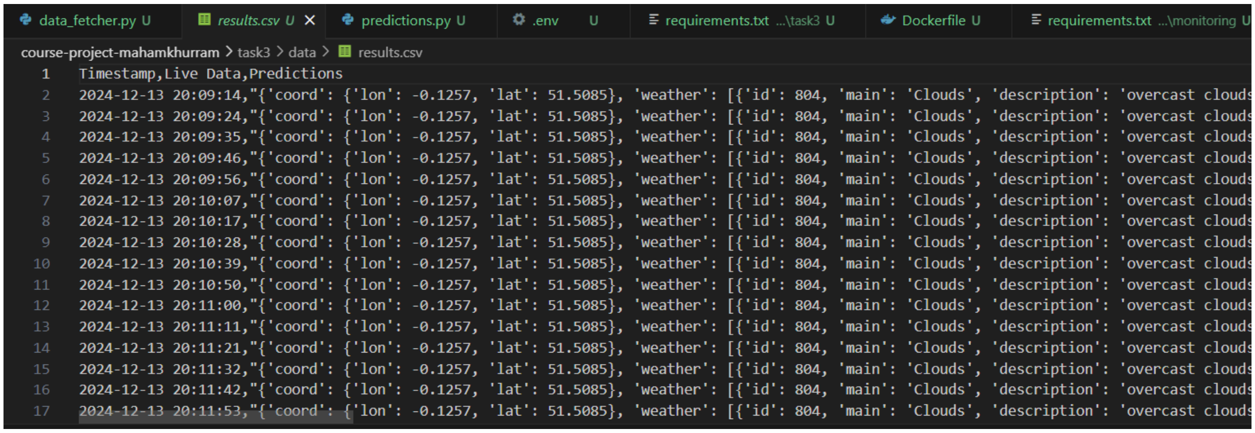
Name	Tags
API Monitoring Dashboard	
scrape	

Part 2) Test Predictions with Live Data

- Objective- Live continuous fetching of data from APIs to ascertain the accuracy of deployed models.

IMPLEMENTATION:

- Fetched real-time data using OpenWeather API via Python (data_fetcher.py script).
- Flask API (/predict endpoint) is used for validation of predictions based on live data.
- Results (live data and predictions) stored in a CSV file (results.csv) for analysis.


data_fetcher.py U
results.csv U
predictions.py U
.env U
requirements.txt ...\task3 U
Dockerfile U
requirements.txt ...\monitoring U
course-project-mahamkhurram > task3 > data > results.csv

```
Timestamp,Live Data,Predictions
2024-12-13 20:09:14,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:09:24,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:09:35,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:09:46,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:09:56,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:10:07,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:10:17,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:10:28,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:10:39,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:10:50,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:11:00,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:11:11,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:11:21,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:11:32,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:11:42,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
2024-12-13 20:11:53,"{'coord': {'lon': -0.1257, 'lat': 51.5085}, 'weather': [{'id': 804, 'main': 'Clouds', 'description': 'overcast clouds
```

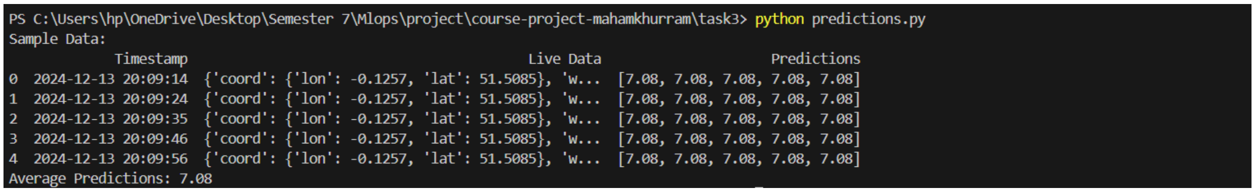
Part 3) Analyze and Optimize:

- Analyze system performance and improve models or data pipelines as appropriate.

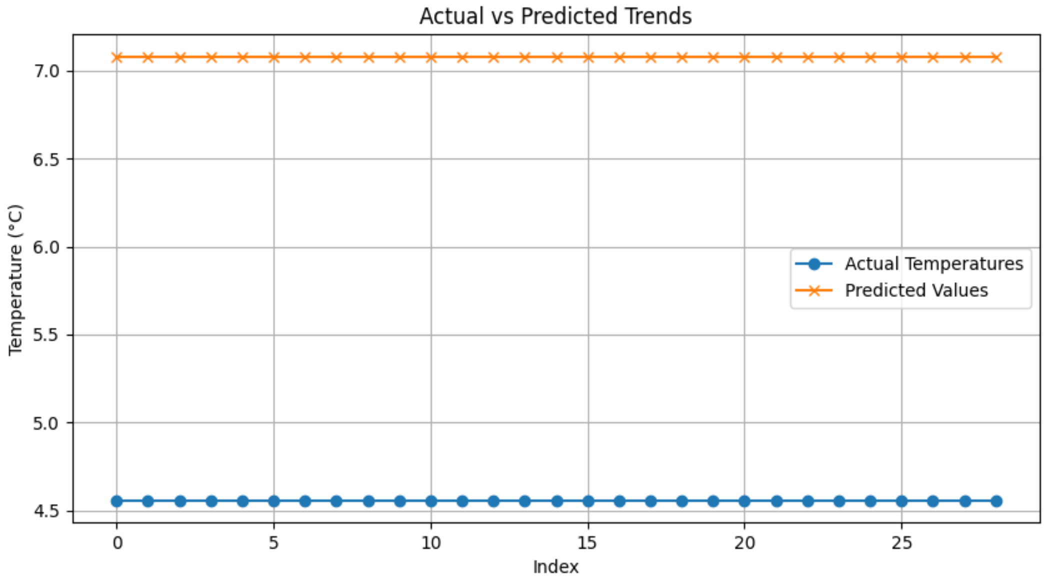
IMPLEMENTATION:

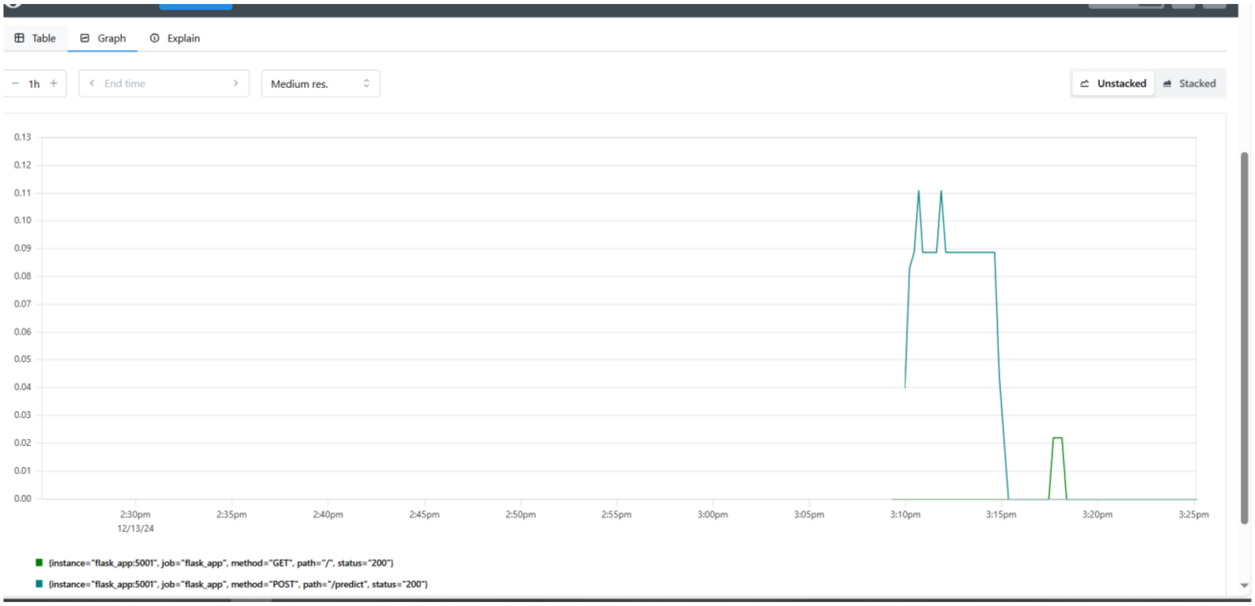
- Prometheus metrics (Flask request duration, garbage collection) were reviewed.
- Visualize prediction trends using Matplotlib (predictions.py script).
- Inferences drawn through the average calculated predictions and comparing them with live data trends.

SCREENSHOTS:



```
PS C:\Users\hp\OneDrive\Desktop\Semester 7\Mlops\project\course-project-mahamkhurram\task3> python predictions.py
Sample Data:
             Timestamp                                         Live Data                    Predictions
0  2024-12-13 20:09:14  {'coord': {'lon': -0.1257, 'lat': 51.5085}, 'w...  [7.08, 7.08, 7.08, 7.08, 7.08]
1  2024-12-13 20:09:24  {'coord': {'lon': -0.1257, 'lat': 51.5085}, 'w...  [7.08, 7.08, 7.08, 7.08, 7.08]
2  2024-12-13 20:09:35  {'coord': {'lon': -0.1257, 'lat': 51.5085}, 'w...  [7.08, 7.08, 7.08, 7.08, 7.08]
3  2024-12-13 20:09:46  {'coord': {'lon': -0.1257, 'lat': 51.5085}, 'w...  [7.08, 7.08, 7.08, 7.08, 7.08]
4  2024-12-13 20:09:56  {'coord': {'lon': -0.1257, 'lat': 51.5085}, 'w...  [7.08, 7.08, 7.08, 7.08, 7.08]
Average Predictions: 7.08
```





🟩 {instance="flask_app:5001", job="flask_app", method="GET", path="/", status="200"}

🟩 {instance="flask_app:5001", job="flask_app", method="POST", path="/predict", status="200"}