Lab 1: Prometheus Fundamentals

Monarch NSSDC is powered by Prometheus for monitoring and data collection.

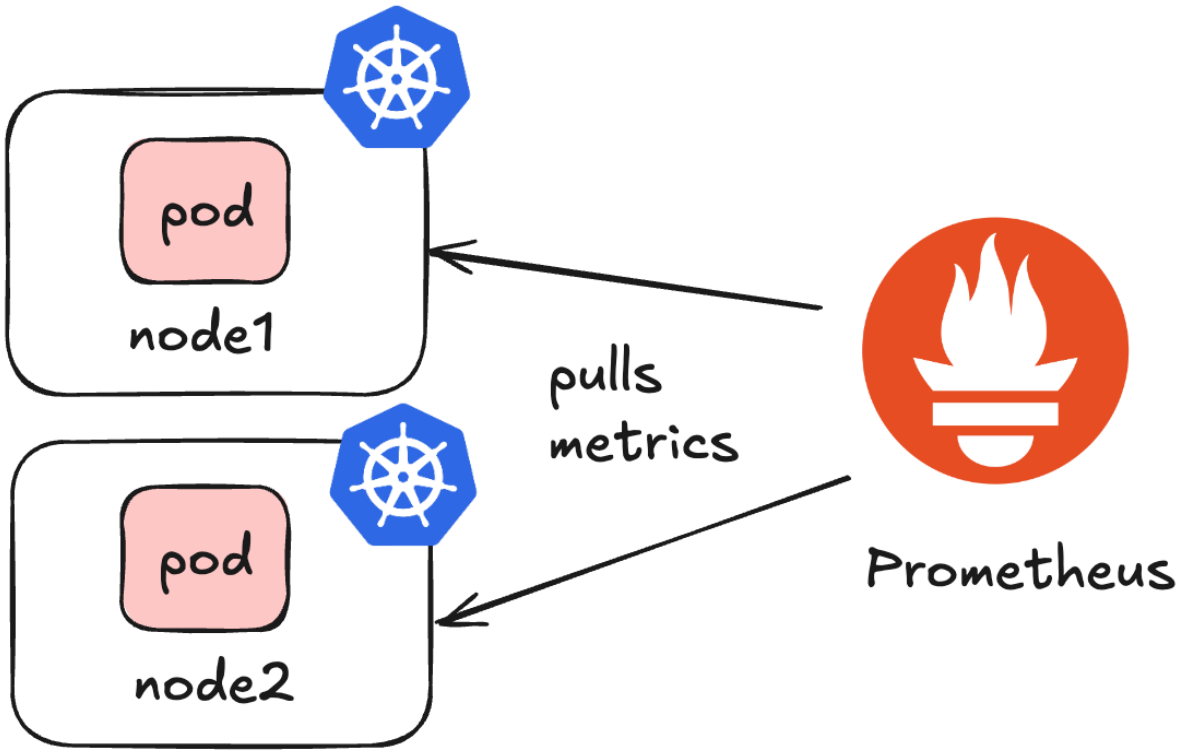
In this lab, you will learn essential Prometheus concepts, including:

- **Introduction to Prometheus** – What it is and how it works
- **Instrumentation** – How to expose application data to Prometheus
- **Service Discovery** – How to automatically track your exposed metrics

What is Prometheus?

Prometheus is a metrics-based monitoring toolkit that provides libraries and components for:

- Tracking and exposing metrics
- Collecting metrics
- Storing metrics
- Querying metrics

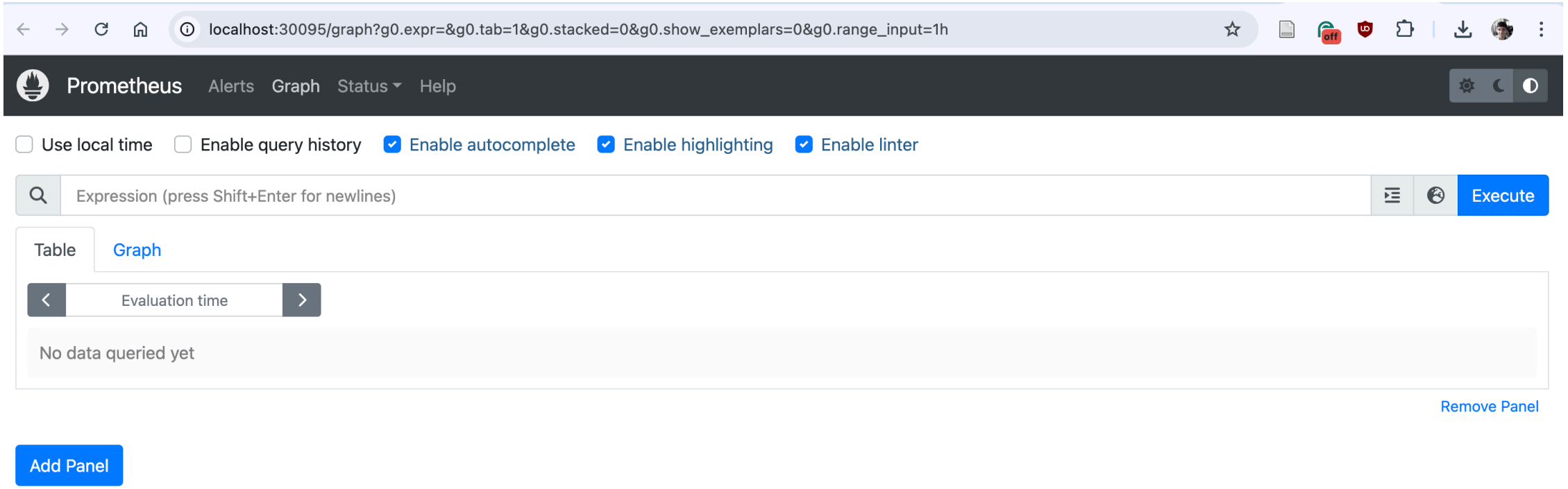


Accessing Prometheus

Use `kubectl get pods -n monarch` to verify our Prometheus deployment as `Running`.

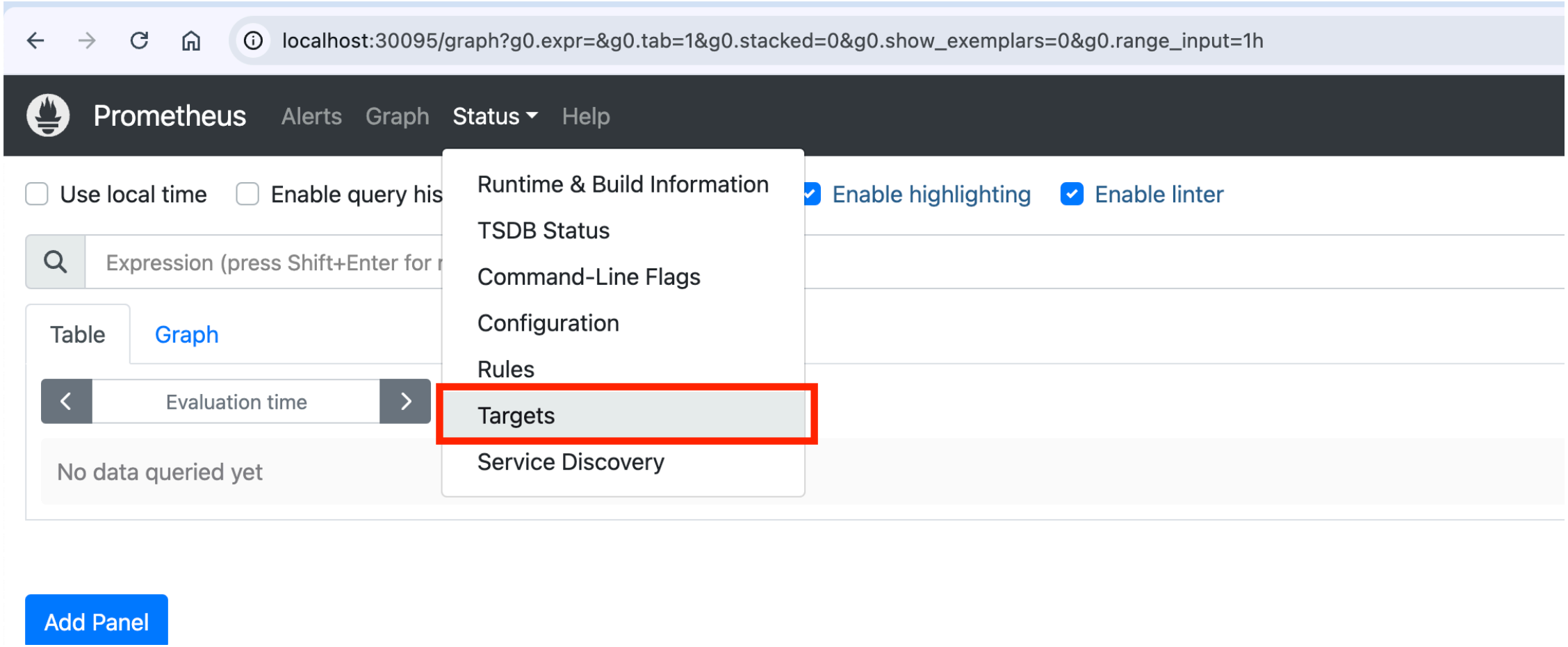
```
prometheus-nssdc-prometheus-0       3/3     Running   0          36m
```

You can access Prometheus GUI at http://localhost:30095/

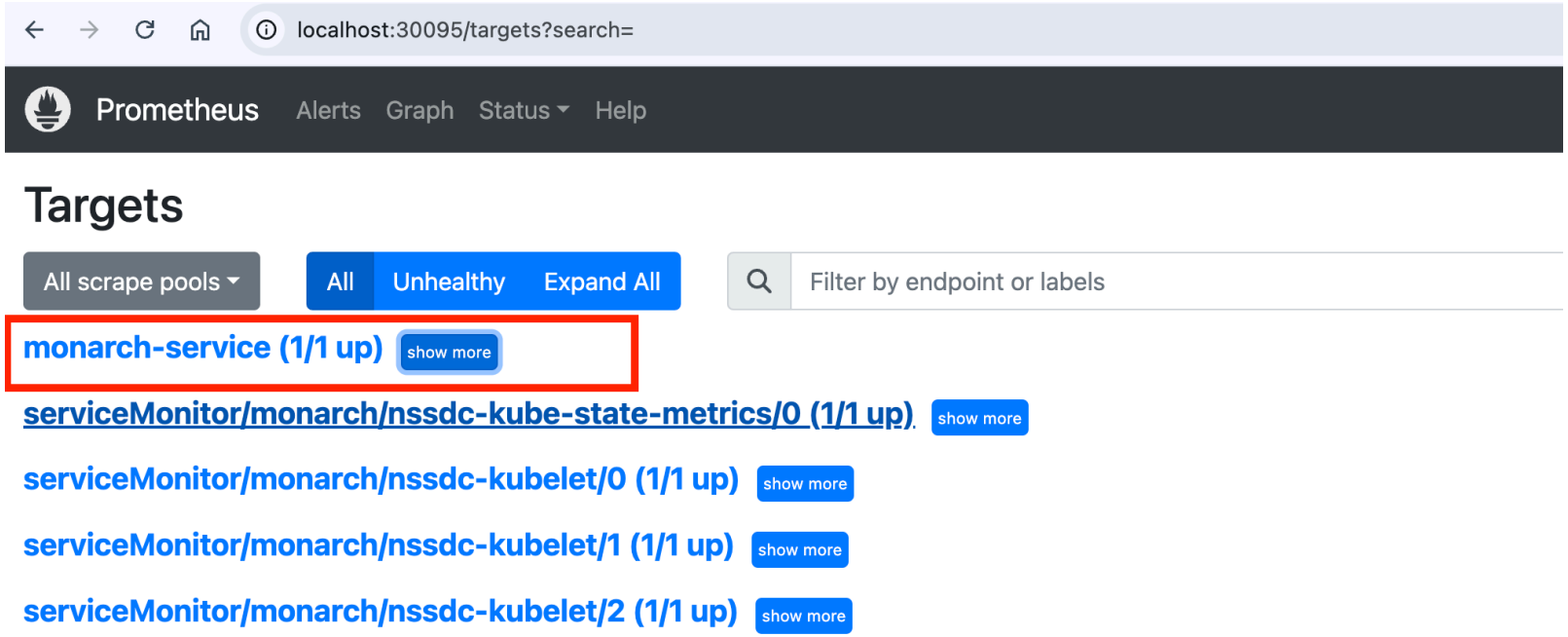


Prometheus Targets

In Prometheus, a **target** is a resource or endpoint that provides metrics for collection.



What are the Targets for Monarch?



- **Target**: `monarch-service (1/1 up)` – tracks metrics from Monitoring Data Exporters (MDEs).
- **Status Indicator**: The number (1/1 up) shows how many services are discovered and actively monitored. For instance, if all MDEs are running, you'll see (4/4 up).

Service Discovery (1/2)

Prometheus uses dynamic service discovery, eliminating the need for manual configuration of each service, device, pod, or container.

- **Flexible Discovery Options**: Prometheus supports various discovery mechanisms, including file-based and HTTP methods.
- **Kubernetes Integration**: In Monarch, we leverage Kubernetes service discovery to automatically detect and monitor dynamic endpoints, such as pods, containers, and services.

Service Discovery (1/2)

The following snippet from `nssdc/values.yaml` shows how we configure Prometheus to automatically discover services in the `open5gs` and `monarch` namespaces:

```
additionalScrapeConfigs:
    - job_name: "monarch-service"
    scrape_interval: 1s
    kubernetes_sd_configs:
        - role: service
        namespaces:
            names:
            - 'open5gs'
            - 'monarch'
```

Instrumenting Applications with Prometheus SDK

Prometheus offers SDKs in various languages (e.g., Python, C, Java) to enable applications to expose metrics for monitoring.

In this lab, we'll use the **Python SDK** to instrument a sample application.

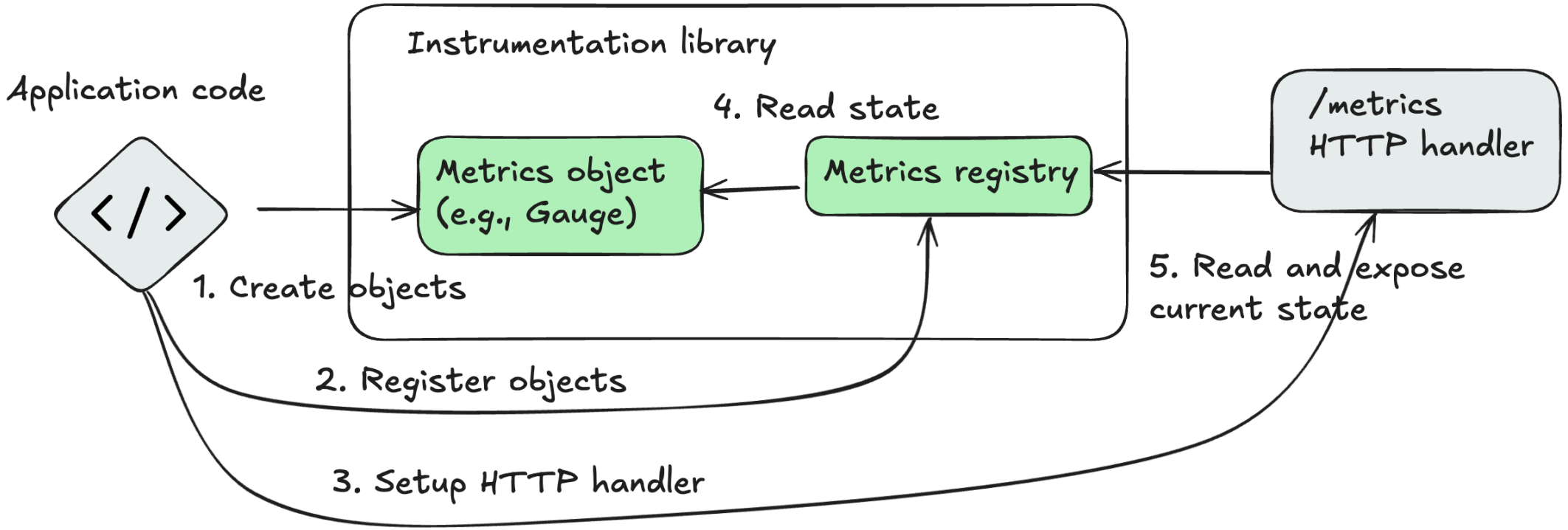
1. Navigate to the `lab1` directory:

```
cd labs/lab1
```

2. Inspect the Instrumented Code:

- Open `app/exporter.py` in VSCode to see a Python application for generating simulated metrics for this workshop.
- The app is instrumented with the Prometheus Python SDK to expose metrics.

Prometheus SDK



Sample application with Prometheus SDK (1/2)

1. Importing Prometheus Libraries

```
from prometheus_client import start_http_server, Gauge
```

- `start_http_server`: Starts a local HTTP server to expose metrics so Prometheus can scrape them.
- `Gauge`: A metric type in Prometheus for tracking values that can go up and down, like response times or temperatures.

2. Defining a Custom Metric

```
RESPONSE_TIME = Gauge('workshop_response_time_seconds',
'Response time in seconds', ['service', 'region'])
```

- We create a gauge metric named `workshop_response_time_seconds`.
- We add service and region **labels** to specify the origin of each metric instance.

Sample application with Prometheus SDK (2/2)

3. Setting Metric Values

```
RESPONSE_TIME.labels(service=service, region=region)
.set(metric_values[(service, region)])
```

- **Labels**: The labels method assigns values to the metric's service and region labels.
- **Set Value**: `set()` updates the gauge with the latest response time value for that specific service and region.

4. Starting the Metric Server

```
start_http_server(8000)
```

Launches an HTTP server on port 8000, allowing Prometheus to scrape exposed metrics from this application.

Deploying our Sample Application

The `deployment.yaml` file shown below deploys `prom-exporter` which contains our sample application instrumented with Prometheus SDK.

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: prom-exporter
...
```

```
kubectl apply -f deployment.yaml
```

Once running, open a shell using:

```
kubectl exec -it deployments/prom-exporter -n monarch -- /bin/bash
```

Checking Metrics

Since our pod is exposing metrics on port 8000, we can check that using

```
curl http://localhost:8000
```

Expected Output

If you scroll to the bottom, you should see our instrumented metrics:

```
# HELP workshop_response_time_seconds Response time in seconds
# TYPE workshop_response_time_seconds gauge
workshop_response_time_seconds{region="us-west",service="auth_service"} 0.3252940783542173
workshop_response_time_seconds{region="us-east",service="auth_service"} 0.8983759103853045
workshop_response_time_seconds{region="us-west",service="payment_service"} 0.9844379249303663
workshop_response_time_seconds{region="us-east",service="payment_service"} 0.9593282198671773
```

Next, let's look at how to deploy a service so that these metrics will be automatically discovered by Prometheus using Kubernetes service discovery.

Deploy Service for Metric Discovery

The `service.yaml` file shown below shows how we can deploy a service with some annotations that help Prometheus in discovering this service.

```yaml
metadata:
  name: prom-exporter-service
  annotations:
    prometheus.io/scrape: "true"
    prometheus.io.scheme: "http"
    prometheus.io/path: "/metrics"
    prometheus.io/port: "8000"  # which port should Prometheus scrape
```

Once deployed using `kubectl apply -f service.yaml`, you should see the target show up in the Prometheus targets.

monarch-service (2/2 up) show less

Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
http://prom-exporter-service.monarch.svc:8000/metrics	UP	instance="prom-exporter-service.monarch.svc:8000" job="monarch-service"	155.000ms ago	3.560ms	

Next Steps

Congratulations!

You've successfully completed the following:

- Learned about Prometheus and its basic capabilities.
- Deployed a sample application instrumented with the Prometheus SDK to expose metrics.
- Configured a Kubernetes service that enables Prometheus to automatically discover and scrape the target.

What's Next?

Continue to Lab 2 to learn the basics of querying and extracting insights from the collected metrics.