04-800K: AIOps: Continuous and Automated IT and AI Monitoring

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Lab 6: Anomaly detection in GKE with Prophet and Istio

Lab Preparations:

Creating Clusters

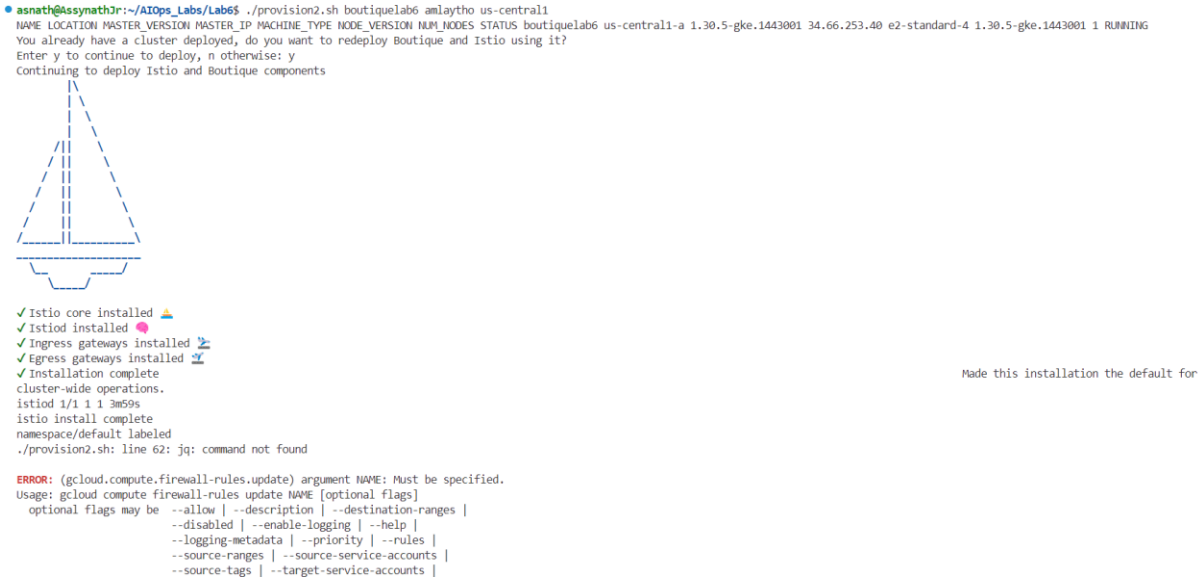

Figure 1: Creating a cluster.

```
NAME                    TYPE           CLUSTER-IP       EXTERNAL-IP   PORT(S)                      AGE
adservice               ClusterIP      34.118.238.30    <none>        9555/TCP                     20s
cartservice             ClusterIP      34.118.225.173   <none>        7070/TCP                     19s
checkoutservice         ClusterIP      34.118.231.181   <none>        5050/TCP                     19s
currencyservice         ClusterIP      34.118.234.3     <none>        7000/TCP                     18s
emailservice            ClusterIP      34.118.237.219   <none>        5000/TCP                     18s
frontend                ClusterIP      34.118.232.88    <none>        80/TCP                       17s
istio-gateway-istio     LoadBalancer   34.118.236.95    <pending>     15021:32081/TCP,80:32144/TCP 5s
kubernetes              ClusterIP      34.118.224.1     <none>        443/TCP                      49m
paymentservice          ClusterIP      34.118.228.210   <none>        50051/TCP                    16s
productcatalogservice   ClusterIP      34.118.238.16    <none>        3550/TCP                     16s
recommendationservice   ClusterIP      34.118.228.55    <none>        8080/TCP                     15s
redis-cart              ClusterIP      34.118.236.55    <none>        6379/TCP                     15s
shippingservice         ClusterIP      34.118.239.88    <none>        50051/TCP                    14s
serviceaccount/grafana created
configmap/grafana created
service/grafana created
deployment.apps/grafana created
configmap/istio-grafana-dashboards created
configmap/istio-services-grafana-dashboards created
deployment.apps/jaeger created
service/tracing created
service/zipkin created
service/jaeger-collector created
serviceaccount/kiali created
configmap/kiali created
clusterrole.rbac.authorization.k8s.io/kiali created
clusterrolebinding.rbac.authorization.k8s.io/kiali created
role.rbac.authorization.k8s.io/kiali-controlplane created
rolebinding.rbac.authorization.k8s.io/kiali-controlplane created
service/kiali created
deployment.apps/kiali created
serviceaccount/loki created
configmap/loki created
configmap/loki-runtime created
service/loki-memberlist created
service/loki-headless created
service/loki created
```

Figure 2: Cluster being deployed with services.

```
configmap/prometheus created
clusterrole.rbac.authorization.k8s.io/prometheus created
clusterrolebinding.rbac.authorization.k8s.io/prometheus created
service/prometheus created
deployment.apps/prometheus created
NAME                TYPE           CLUSTER-IP       EXTERNAL-IP     PORT(S)                                                                      AGE
grafana             ClusterIP      34.118.239.104   <none>          3000/TCP                                                                     29s
istio-egressgateway ClusterIP      34.118.228.254   <none>          80/TCP,443/TCP                                                               4m59s
istio-ingressgateway LoadBalancer  34.118.232.91    34.28.105.103   15021:31107/TCP,80:31456/TCP,443:31076/TCP,31400:31580/TCP,15443:31398/TCP   4m59s
istiod              ClusterIP      34.118.237.146   <none>          15010/TCP,15012/TCP,443/TCP,15014/TCP                                        5m9s
jaeger-collector    ClusterIP      34.118.239.231   <none>          14268/TCP,14250/TCP,9411/TCP,4317/TCP,4318/TCP                               19s
kiali               ClusterIP      34.118.229.249   <none>          20001/TCP,9090/TCP                                                           14s
loki                ClusterIP      34.118.227.133   <none>          3100/TCP,9095/TCP                                                            7s
loki-headless       ClusterIP      None             <none>          3100/TCP                                                                     8s
loki-memberlist     ClusterIP      None             <none>          7946/TCP                                                                     9s
prometheus          ClusterIP      34.118.230.125   <none>          9090/TCP                                                                     3s
tracing             ClusterIP      34.118.233.161   <none>          80/TCP,16685/TCP                                                             21s
zipkin              ClusterIP      34.118.239.185   <none>          9411/TCP                                                                     20s
```

Figure 3: Cluster created successfully.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ pip install locust
Defaulting to user installation because normal site-packages is not writeable
Collecting locust
  Downloading locust-2.32.2-py3-none-any.whl (1.2 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.2/1.2 MB 2.3 MB/s eta 0:00:00
Collecting pyzmq>=25.0.0
  Downloading pyzmq-26.2.0-cp310-cp310-manylinux_2_28_x86_64.whl (868 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 868.8/868.8 KB 3.1 MB/s eta 0:00:00
Collecting msgpack>=1.0.0
  Downloading msgpack-1.1.0-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (378 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 378.0/378.0 KB 3.3 MB/s eta 0:00:00
Collecting Flask-Login>=0.6.3
  Downloading Flask_Login-0.6.3-py3-none-any.whl (17 kB)
Collecting geventhttpclient>=2.3.1
  Downloading geventhttpclient-2.3.1-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_64.whl (112 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 112.7/112.7 KB 3.5 MB/s eta 0:00:00
Collecting psutil>=5.9.1
  Downloading psutil-6.1.0-cp36-abi3-manylinux_2_12_x86_64.manylinux2010_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_64.whl (287 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 287.3/287.3 KB 3.1 MB/s eta 0:00:00
Collecting tomli>=1.1.0
  Downloading tomli-2.1.0-py3-none-any.whl (13 kB)
Collecting Werkzeug>=2.0.0
  Downloading werkzeug-3.1.3-py3-none-any.whl (224 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 224.5/224.5 KB 3.9 MB/s eta 0:00:00
Requirement already satisfied: requests>=2.26.0 in /home/asnath/.local/lib/python3.10/site-packages (from locust) (2.32.3)
Collecting Flask-Cors>=3.0.10
  Downloading Flask_Cors-5.0.0-py2.py3-none-any.whl (14 kB)
Collecting gevent>=22.10.2
  Downloading gevent-24.11.1-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (6.6 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 6.6/6.6 MB 3.5 MB/s eta 0:00:00
Collecting flask>=2.0.0
  Downloading flask-3.0.3-py3-none-any.whl (101 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 101.7/101.7 KB 2.6 MB/s eta 0:00:00
Collecting typing_extensions>=4.6.0
  Downloading typing_extensions-4.12.2-py3-none-any.whl (37 kB)
Collecting ConfigArgParse>=1.5.5
  Downloading ConfigArgParse-1.7-py3-none-any.whl (25 kB)
Collecting blinker>=1.6.2
  Downloading blinker-1.9.0-py3-none-any.whl (8.5 kB)
```

Figure 4: Installing Locust

```
   Downloading flask-3.0.3-py3-none-any.whl (101 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 101.7/101.7 KB 2.6 MB/s eta 0:00:00
Collecting typing_extensions>=4.6.0
  Downloading typing_extensions-4.12.2-py3-none-any.whl (37 kB)
Collecting ConfigArgParse>=1.5.5
  Downloading ConfigArgParse-1.7-py3-none-any.whl (25 kB)
Collecting blinker>=1.6.2
  Downloading blinker-1.9.0-py3-none-any.whl (8.5 kB)
Collecting click>=8.1.3
  Downloading click-8.1.7-py3-none-any.whl (97 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 97.9/97.9 KB 2.8 MB/s eta 0:00:00
Collecting Jinja2>=3.1.2
  Downloading jinja2-3.1.4-py3-none-any.whl (133 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 133.3/133.3 KB 3.6 MB/s eta 0:00:00
Collecting itsdangerous>=2.1.2
  Downloading itsdangerous-2.2.0-py3-none-any.whl (16 kB)
Collecting zope.event
  Downloading zope.event-5.0-py3-none-any.whl (6.8 kB)
Collecting greenlet>=3.1.1
  Downloading greenlet-3.1.1-cp310-cp310-manylinux_2_24_x86_64.manylinux_2_28_x86_64.whl (599 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 599.5/599.5 KB 3.6 MB/s eta 0:00:00
Collecting zope.interface
  Downloading zope.interface-7.1.1-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_17_x86_64.manylinux2014_x86_64.whl (254 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 254.2/254.2 KB 4.1 MB/s eta 0:00:00
Requirement already satisfied: urllib3 in /home/asnath/.local/lib/python3.10/site-packages (from geventhttpclient>=2.3.1->locust) (2.2.3)
Collecting brotli
  Downloading Brotli-1.1.0-cp310-cp310-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux_2_12_x86_64.manylinux2010_x86_64.whl (3.0 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 3.0/3.0 MB 3.7 MB/s eta 0:00:00
Requirement already satisfied: certifi in /home/asnath/.local/lib/python3.10/site-packages (from geventhttpclient>=2.3.1->locust) (2024.8.30)
Requirement already satisfied: charset-normalizer<4,>=2 in /home/asnath/.local/lib/python3.10/site-packages (from requests>=2.26.0->locust) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /home/asnath/.local/lib/python3.10/site-packages (from requests>=2.26.0->locust) (3.10)
Collecting MarkupSafe>=2.1.1
  Downloading MarkupSafe-3.0.2-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (20 kB)
Requirement already satisfied: setuptools in /usr/lib/python3/dist-packages (from zope.event->gevent>=22.10.2->locust) (59.6.0)
Installing collected packages: brotli, zope.interface, zope.event, typing_extensions, tomli, pyzmq, psutil, msgpack, MarkupSafe, itsdangerous, greenlet, ConfigArgParse, click, blinker, Werkzeug, Jinja2, gevent, geventhttpclient, flask, Flask-Login, Flask-Cors, locust
Successfully installed ConfigArgParse-1.7 Flask-Cors-5.0.0 Flask-Login-0.6.3 Jinja2-3.1.4 MarkupSafe-3.0.2 Werkzeug-3.1.3 blinker-1.9.0 brotli-1.1.0 click-8.1.7 flask-3.0.3 gevent-24.11.1 geventhttpclient-2.3.1 greenlet-3.1.1 itsdangerous-2.2.0 locust-2.32.2 msgpack-1.1.0 psutil-6.1.0 pyzmq-26.2.0 tomli-2.1.0 typing_extensions-4.12.2 zope.event-5.0 zope.interface-7.1.1
```

Figure 5: Successfully installed Locust.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ istioctl dashboard prometheus
http://localhost:9090
```

Figure 6: Creating Prometheus Dashboard

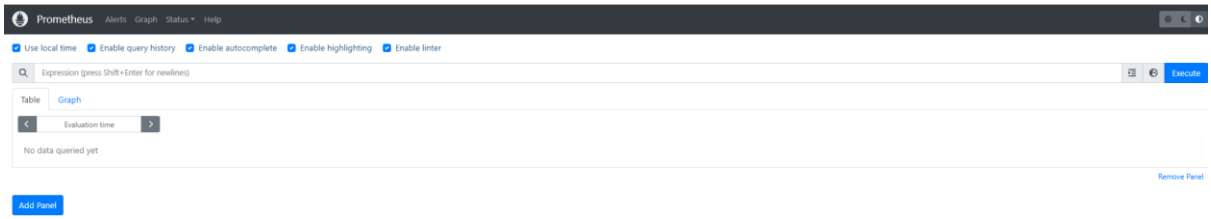

Figure 7: Prometheus Dashboard.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ istioctl dashboard grafana
http://localhost:3000
```

Figure 8: Creating Grafana Dashboard.

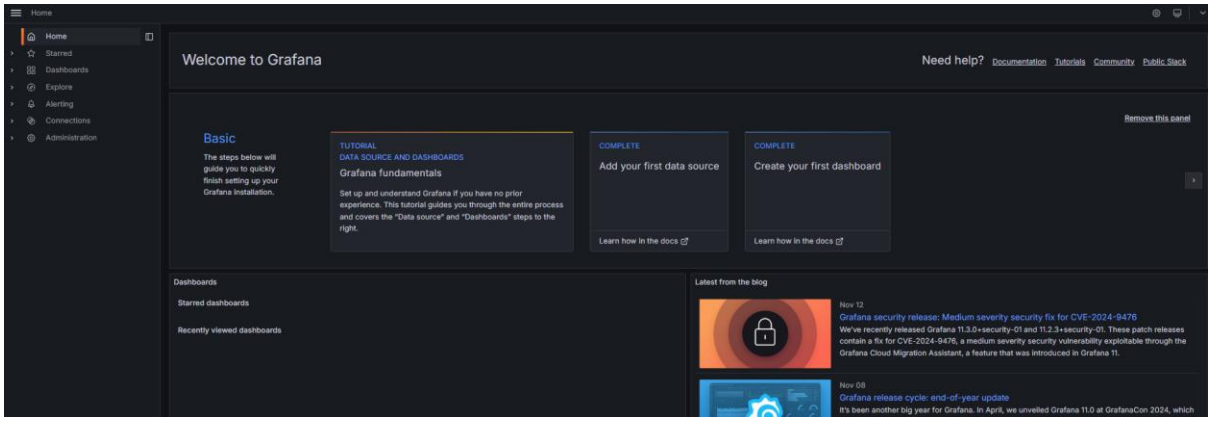

Figure 9: Grafana Dashboard.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ istioctl dashboard kiali
http://localhost:20001/kiali
```

Figure 10: Creating Kiali Dashboard.

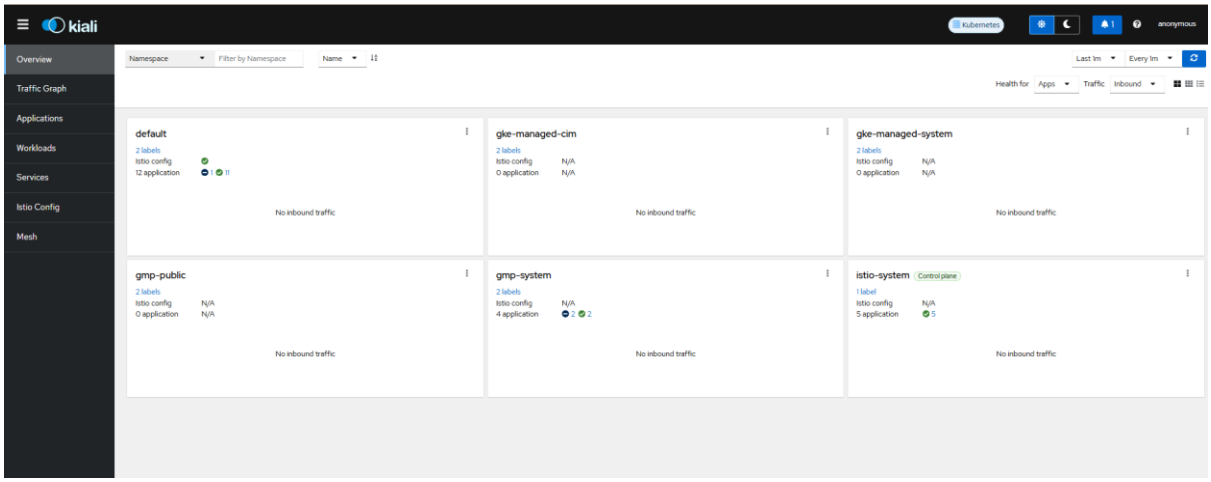

Figure 11: Kiali Dashboard

Lab Task1: Train a Prophet model with seasonality for normal operation.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get svc
NAME                    TYPE           CLUSTER-IP       EXTERNAL-IP     PORT(S)                        AGE
adservice               ClusterIP      34.118.238.30    <none>          9555/TCP                       55m
cartservice             ClusterIP      34.118.225.173   <none>          7070/TCP                       55m
checkoutservice         ClusterIP      34.118.231.181   <none>          5050/TCP                       55m
currencyservice         ClusterIP      34.118.234.3     <none>          7000/TCP                       55m
emailservice            ClusterIP      34.118.237.219   <none>          5000/TCP                       55m
frontend                ClusterIP      34.118.232.88    <none>          80/TCP                         55m
istio-gateway-istio     LoadBalancer   34.118.236.95    34.123.73.217   15021:32081/TCP,80:32144/TCP   55m
kubernetes              ClusterIP      34.118.224.1     <none>          443/TCP                        104m
paymentservice          ClusterIP      34.118.228.210   <none>          50051/TCP                      55m
productcatalogservice   ClusterIP      34.118.238.16    <none>          3550/TCP                       55m
recommendationservice   ClusterIP      34.118.228.55    <none>          8080/TCP                       55m
redis-cart              ClusterIP      34.118.236.55    <none>          6379/TCP                       55m
shippingservice         ClusterIP      34.118.239.88    <none>          50051/TCP                      55m
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get deployments
NAME                    READY   UP-TO-DATE   AVAILABLE   AGE
adservice               1/1     1            1           55m
cartservice             1/1     1            1           55m
checkoutservice         1/1     1            1           55m
currencyservice         1/1     1            1           55m
emailservice            1/1     1            1           55m
frontend                1/1     1            1           55m
istio-gateway-istio     1/1     1            1           55m
loadgenerator           1/1     1            1           55m
paymentservice          1/1     1            1           55m
productcatalogservice   1/1     1            1           55m
recommendationservice   1/1     1            1           55m
redis-cart              1/1     1            1           55m
shippingservice         1/1     1            1           55m
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl scale deployment loadgenerator --replicas=0
deployment.apps/loadgenerator scaled
```

Figure 12: Scaling down the loadgenerator deployment.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get deployments
NAME                    READY   UP-TO-DATE   AVAILABLE   AGE
adservice               1/1     1            1           62m
cartservice             1/1     1            1           62m
checkoutservice         1/1     1            1           62m
currencyservice         1/1     1            1           62m
emailservice            1/1     1            1           62m
frontend                1/1     1            1           62m
istio-gateway-istio     1/1     1            1           62m
loadgenerator           0/0     0            0           62m
paymentservice          1/1     1            1           62m
productcatalogservice   1/1     1            1           62m
recommendationservice   1/1     1            1           62m
redis-cart              1/1     1            1           62m
shippingservice         1/1     1            1           62m
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 13: loadgenerator scaled down to 0.

File Edit View

```
  ports:
    - name: http
      port: 9090
      protocol: TCP
      targetPort: 9090
  selector:
    app.kubernetes.io/component: server
    app.kubernetes.io/name: prometheus
    app.kubernetes.io/instance: prometheus
  sessionAffinity: None
  type: "LoadBalancer"
---
# Source: prometheus/templates/deploy.yaml
apiVersion: apps/v1
```

Figure 14: Edited the prometheus.yaml and changed ClusterIP to LoadBalancer.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6/istio-master/samples/addons$ kubectl apply -f prometheus.yaml
serviceaccount/prometheus unchanged
configmap/prometheus unchanged
clusterrole.rbac.authorization.k8s.io/prometheus unchanged
clusterrolebinding.rbac.authorization.k8s.io/prometheus unchanged
service/prometheus configured
deployment.apps/prometheus configured
asnath@AssynathJr:~/AIOps_Labs/Lab6/istio-master/samples/addons$ cd ..
asnath@AssynathJr:~/AIOps_Labs/Lab6/istio-master/samples$ cd ..
asnath@AssynathJr:~/AIOps_Labs/Lab6/istio-master$ cd ..
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get svc prometheus -n istio-system
NAME         TYPE           CLUSTER-IP       EXTERNAL-IP    PORT(S)          AGE
prometheus   LoadBalancer   34.118.230.125   34.136.17.74   9090:30864/TCP   74m
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 15: Applying the edited prometheus.yaml and the external IP address was obtained.

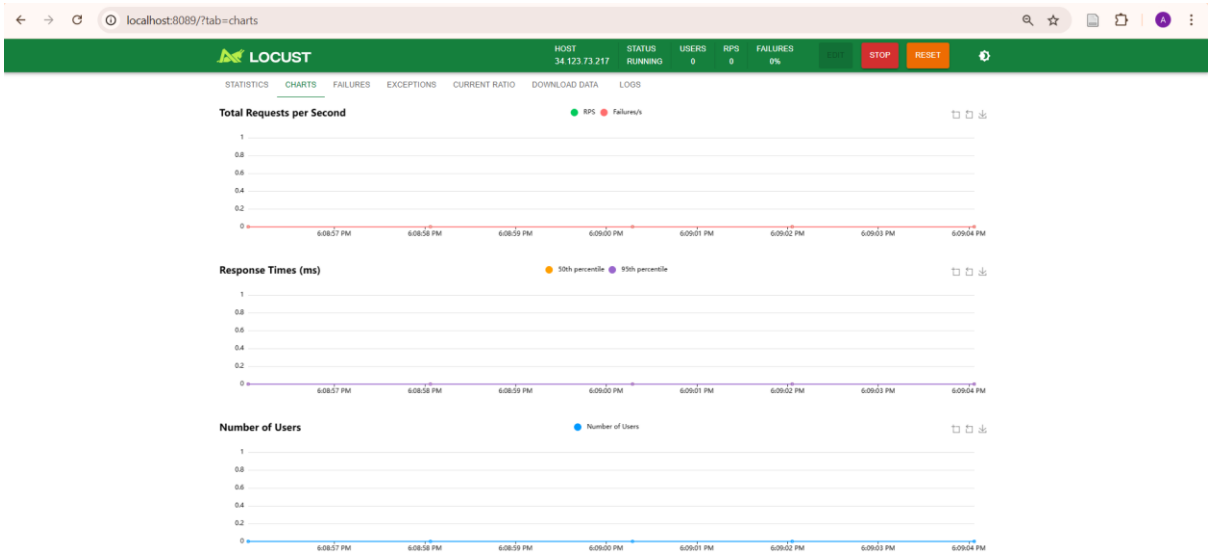

Figure 16: Starting the visualization on Locust after installation

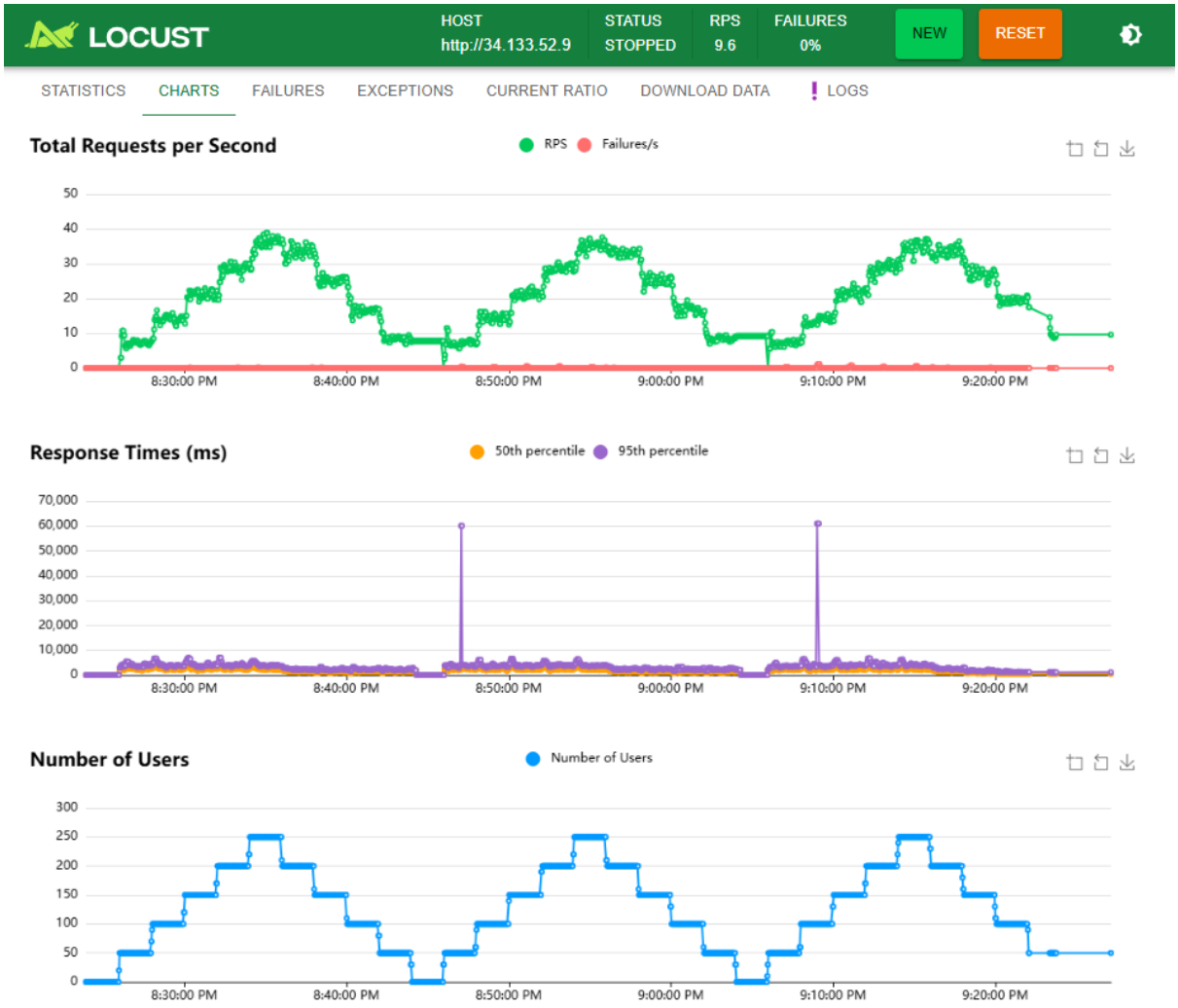

Figure 17: Visualizing on Locust

Figure 18: Saving the training data in Json file.

```
{
  "status": "success",
  "data": {
    "resultType": "matrix",
    "result": [
      {
        "metric": {},
        "values": [
          [
            1732468770,
            "4.246376811594203"
          ],
          [
            1732468800,
            "4.424242424242424"
          ],
          [
            1732468830,
            "4.9016393442622945"
          ],
          [
            1732468860,
            "6.853932584269662"
          ],
          [
            1732468890,
            "6.15566037735849"
          ],
          [
            1732468920,
            "5.88235294117647"
          ],
          [
            1732468950,
            "6.4393939393939394"
          ],
          [
            1732468980,
            "7.516891891891892"
          ],
          [
            1732469010,
            "7.880794701986755"
```


Figure 19: Contents in the json file

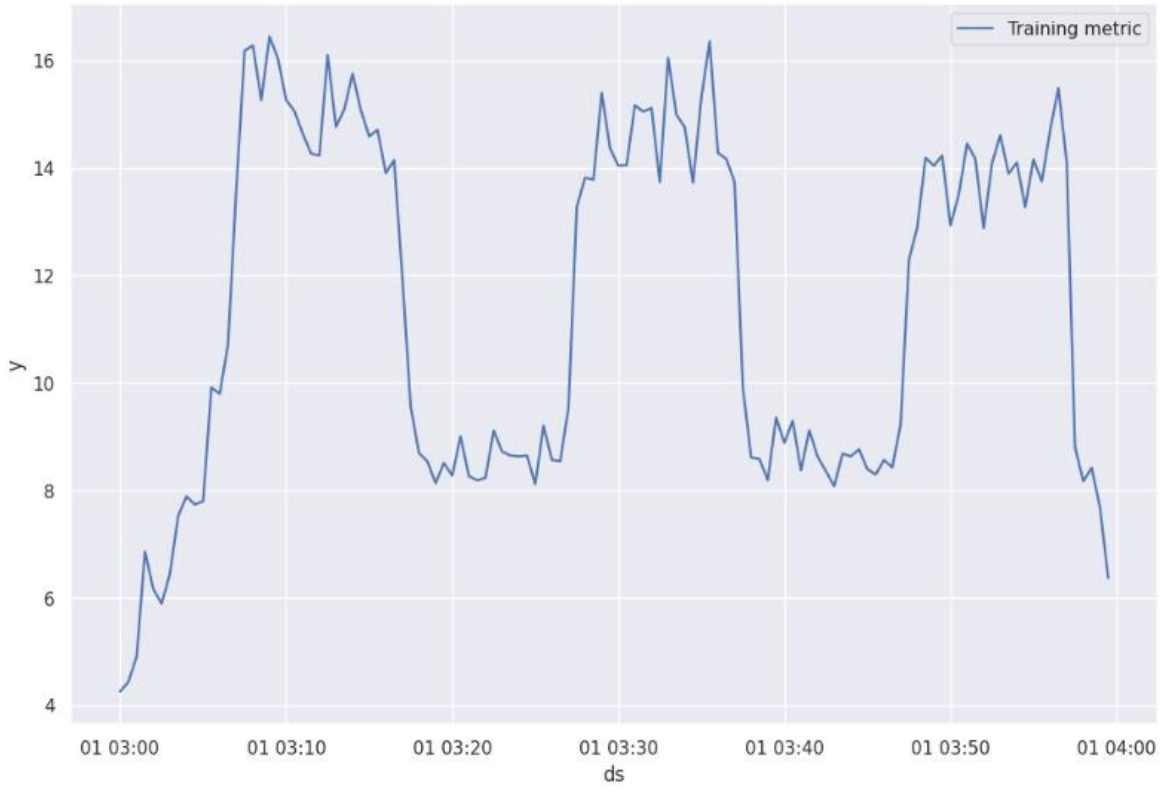

Figure 20: Fitting the training data.

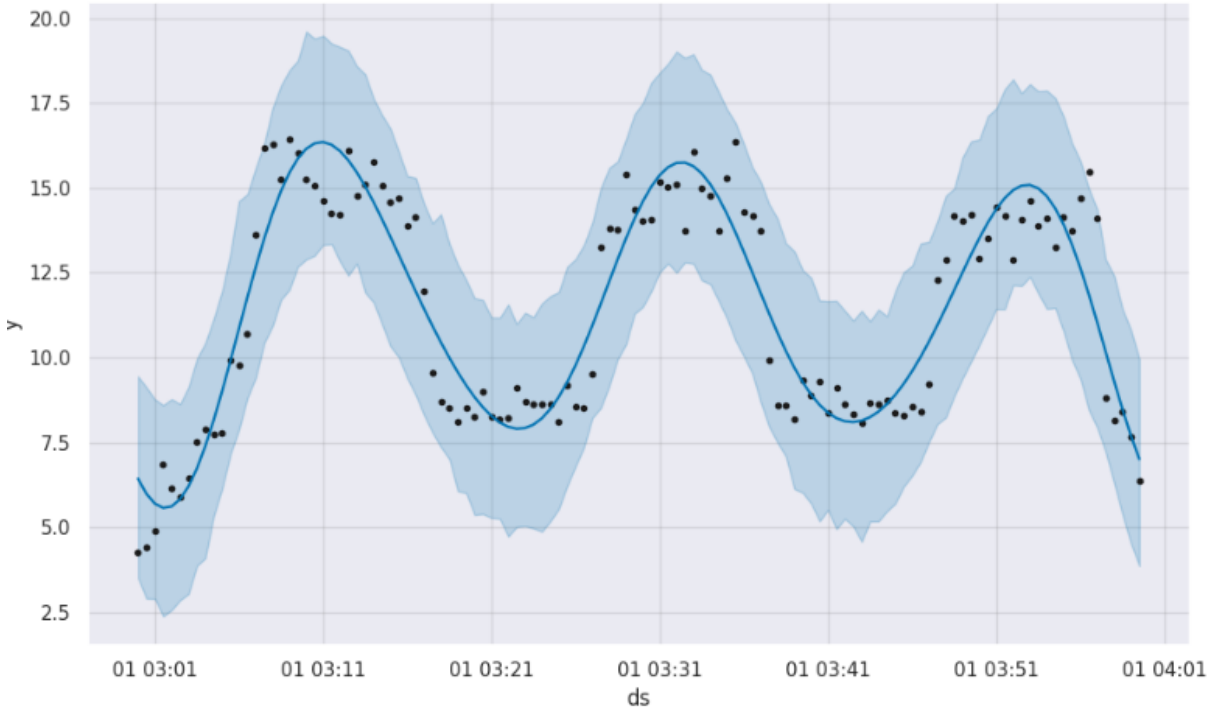

Figure 21: The prophet model

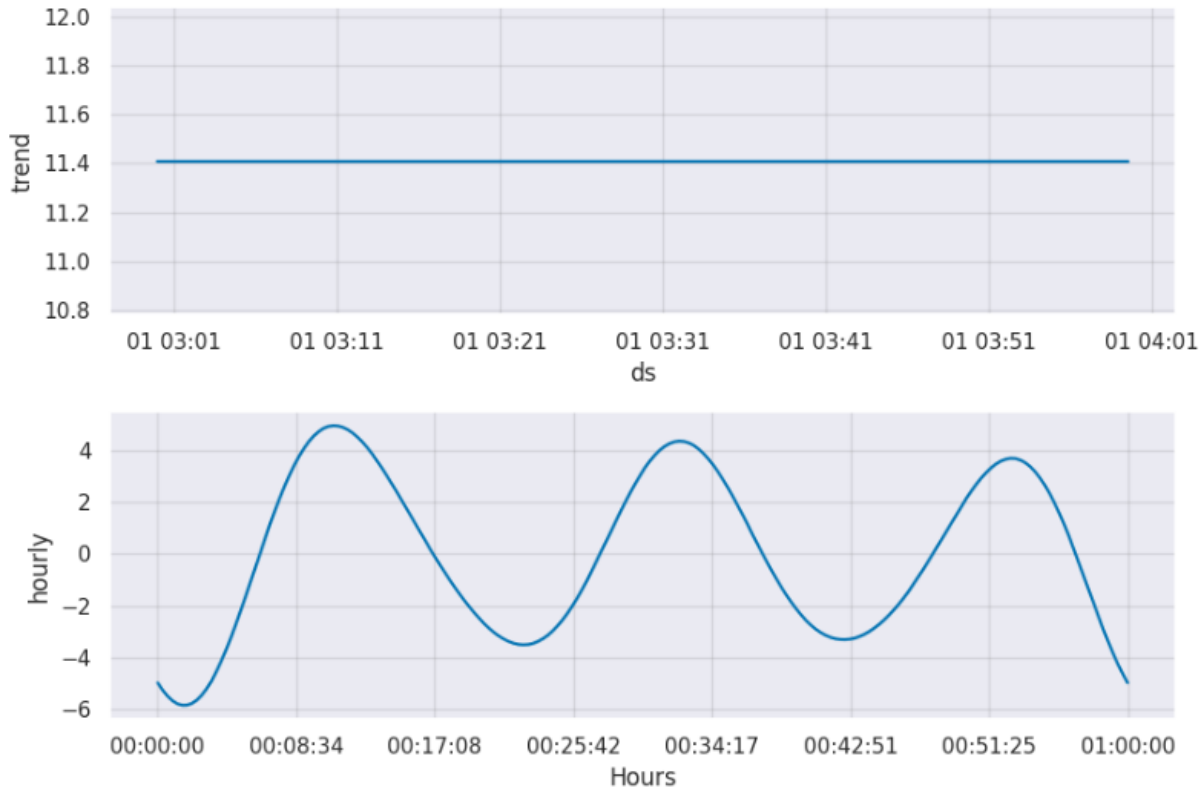

Figure 22: Forecast Seasonality.

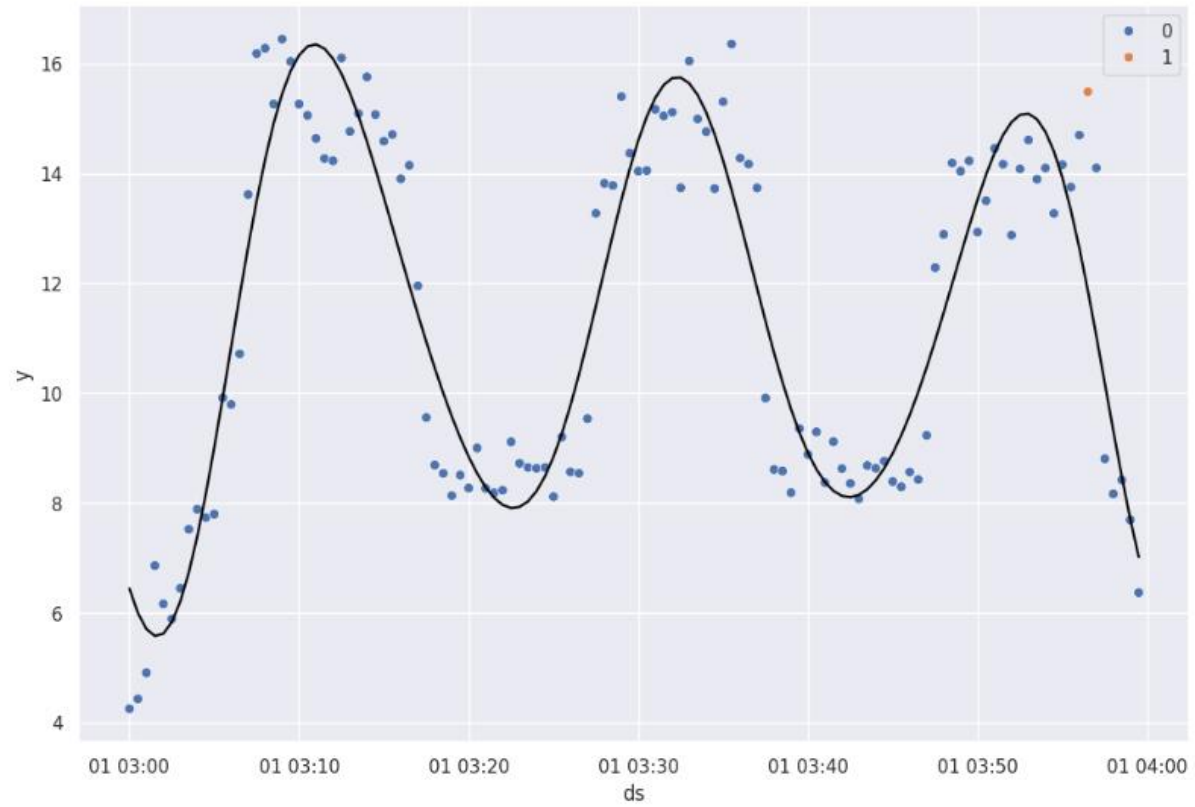

Figure 23: Anomalies in the data. Blue scatter plots represent the actual values while the orange scatter plots represent the outliers.

Lab Task2: Verify no/minimal anomaly detection under normal operation.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ python3 prophet_model.py
17:40:00 - cmdstanpy - INFO - Chain [1] start processing
17:40:00 - cmdstanpy - INFO - Chain [1] done processing
Actual value: nan
Predicted value: 3.081214236784401
+---------------------------+-------------+-------+--------+
| Timestamp                 |   Anomalies | MAE   | MAPE   |
+===========================+=============+=======+========+
| 2024-11-26 17:40:01.489724 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
Actual value: 3.015625
Predicted value: 3.085387652551399
+---------------------------+-------------+---------------------+----------------------+
| Timestamp                 |   Anomalies | MAE                 | MAPE                 |
+===========================+=============+=====================+======================+
| 2024-11-26 17:40:01.489724 |           0 | N/A                 | N/A                  |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:41:02.098602 |           0 | 0.06976265255139902 | 0.023133729343469106 |
+---------------------------+-------------+---------------------+----------------------+
Actual value: 3.032
Predicted value: 3.08955923422944
+---------------------------+-------------+---------------------+----------------------+
| Timestamp                 |   Anomalies | MAE                 | MAPE                 |
+===========================+=============+=====================+======================+
| 2024-11-26 17:40:01.489724 |           0 | N/A                 | N/A                  |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:41:02.098602 |           0 | 0.06976265255139902 | 0.023133729343469106 |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:42:02.710808 |           0 | 0.05755923422943976 | 0.018983916302585672 |
+---------------------------+-------------+---------------------+----------------------+
Actual value: 3.0
Predicted value: 3.0937310758944943
+---------------------------+-------------+---------------------+----------------------+
| Timestamp                 |   Anomalies | MAE                 | MAPE                 |
+===========================+=============+=====================+======================+
| 2024-11-26 17:40:01.489724 |           0 | N/A                 | N/A                  |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:41:02.098602 |           0 | 0.06976265255139902 | 0.023133729343469106 |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:42:02.710808 |           0 | 0.05755923422943976 | 0.018983916302585672 |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:43:03.326253 |           0 | 0.09373107589449425 | 0.031243691964831417 |
+---------------------------+-------------+---------------------+----------------------+
Actual value: 3.018691588785047
Predicted value: 3.0979005272209057
+---------------------------+-------------+---------------------+----------------------+
| Timestamp                 |   Anomalies | MAE                 | MAPE                 |
+===========================+=============+=====================+======================+
| 2024-11-26 17:40:01.489724 |           0 | N/A                 | N/A                  |
+---------------------------+-------------+---------------------+----------------------+
| 2024-11-26 17:41:02.098602 |           0 | 0.06976265255139902 | 0.023133729343469106 |
+---------------------------+-------------+---------------------+----------------------+
```

Figure 24: Data is being fetched from locust and anomalies are being predicted by the prophet model.

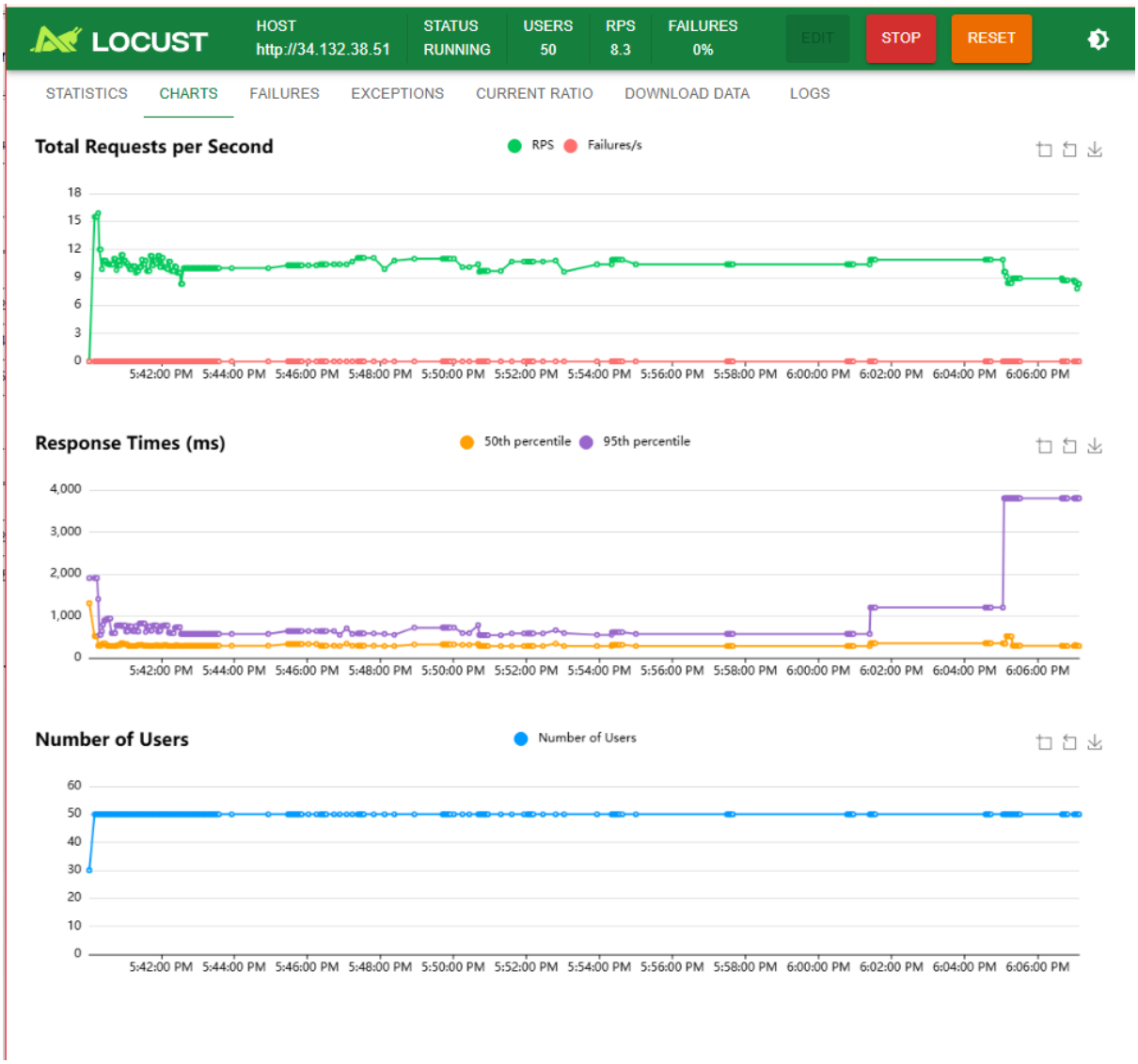

Figure 25: Scrapping data from locust as test data after training the model.

Lab Task3: Inject faults with Istio to detect anomalies.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl apply -f lab5_faultinjection.yaml
virtualservice.networking.istio.io/shippingservice created
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 26: Applying fault injections.

2024-11-26 17:55:11.228307	0	0.08978409785357355	0.029398332925506383
2024-11-26 17:56:11.786532	0	0.14800799019569055	0.04933599673189685
2024-11-26 17:57:12.288245	0	0.15217268381209914	0.05072422793736638
2024-11-26 17:58:12.800281	0	0.15633800313181734	0.05211266771060578
2024-11-26 17:59:13.366949	0	0.14355798243162532	0.04758382563744884
2024-11-26 18:00:13.928567	0	0.16467559671478016	0.05489186557159339
2024-11-26 18:01:14.483142	0	0.11667011354182844	0.03822525087552784
2024-11-26 18:02:14.998889	0	0.1730093703411817	0.05766979011372723
2024-11-26 18:03:15.524641	0	0.1387143264064683	0.045652816285673116
2024-11-26 18:04:16.071039	0	0.18134342419180438	0.060447808063934794
2024-11-26 18:05:16.573605	1	3746.8144918821918	0.9991505311685844
2024-11-26 18:06:17.123659	1	3746.810324766505	0.9991494199377347
2024-11-26 18:07:17.656700	1	3746.8061576314753	0.9991483087017268
2024-11-26 18:08:18.214729	1	3746.8019887991995	0.9991471970131198
2024-11-26 18:09:18.733859	1	3746.7978230838075	0.999146086155682
2024-11-26 18:10:19.271643	1	3746.7936561925694	0.9991449749846851

Figure 27: Anomalies observed after fault injection.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl delete -f lab5_faultinjection.yaml
virtualservice.networking.istio.io "shippingservice" deleted
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 28: Removing the fault injection.

2024-11-26 18:15:22.339626	1	3746.7727946781943	0.9991394119141851
2024-11-26 18:16:22.841005	1	3746.768629899762	0.9991383013066032
2024-11-26 18:17:23.363487	1	3746.7644639917003	0.9991371903977867
2024-11-26 18:18:23.925784	1	3746.7602952823604	0.9991360787419628
2024-11-26 18:19:24.560567	1	3746.7561228149902	0.9991349660839974
2024-11-26 18:20:25.129112	1	2822.094418064607	0.9988503879695336
2024-11-26 18:21:25.699940	0	0.252217026849229	0.08407234228307632
2024-11-26 18:22:26.215594	0	0.2563825575899026	0.08546085252996753
2024-11-26 18:23:26.755495	0	0.2425297930482344	0.08036061799508663
2024-11-26 18:24:27.310811	0	0.26471831514968125	0.08823943838322708
2024-11-26 18:25:27.847160	0	0.24908293062687914	0.08248319997808129
2024-11-26 18:26:28.411508	0	0.2730536356120292	0.09101787853734307
2024-11-26 18:27:28.961319	0	0.27722192358296116	0.09240730786098705
2024-11-26 18:28:29.515566	0	0.2813901730069688	0.09379672433565626
2024-11-26 18:29:30.037268	0	0.28555615109840815	0.09518538369946938

Figure 29: Anomalies are no longer detected after the fault injection has been removed.

Lab Task4: Deploy your monitor into the Boutique cluster and publish to Grafana.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6/prophet$ docker build -t assynath/monitoringapp:latest .
[+] Building 111.4s (10/10) FINISHED
 => [internal] load build definition from Dockerfile
 => => transferring dockerfile: 619B
 => [internal] load metadata for docker.io/library/python:3.11-slim
 => [internal] load .dockerignore
 => => transferring context: 2B
 => [1/5] FROM docker.io/library/python:3.11-slim@sha256:e8381c802593deb0c4d25bd3f4e05e94382f6bf33090de22679fc7488cd68bbb
 => => resolve docker.io/library/python:3.11-slim@sha256:e8381c802593deb0c4d25bd3f4e05e94382f6bf33090de22679fc7488cd68bbb
 => => sha256:ed324500515ff7793e606ee73623fd77d1650ff398717a44409ac8dad25e991c 5.43kB / 5.43kB
 => => sha256:2d429b9e73a6cf90a5bb85105c8118b30a1b2deedeae3ea9587055ffcb80eb45 29.13MB / 29.13MB
 => => sha256:14dbff54af923889a0e26a829553caa713f43c3b921620fd2d5db341386ecfb2 3.51MB / 3.51MB
 => => sha256:71ba669986f7c60a5e178baa52bc67b3821d038c49d6bf03741d3fd43edd4e84 16.20MB / 16.20MB
 => => sha256:e8381c802593deb0c4d25bd3f4e05e94382f6bf33090de22679fc7488cd68bbb 9.13kB / 9.13kB
 => => sha256:84197f777db48a6d6eb5354a638a1cbdb77e2f03f6b85da7695a5e128d224cd7 1.75kB / 1.75kB
 => => sha256:173289c0cbe5b5760030dda93a84319ef683a489a0b33b176284679a3ab27be1 250B / 250B
 => => extracting sha256:2d429b9e73a6cf90a5bb85105c8118b30a1b2deedeae3ea9587055ffcb80eb45
 => => extracting sha256:14dbff54af923889a0e26a829553caa713f43c3b921620fd2d5db341386ecfb2
 => => extracting sha256:71ba669986f7c60a5e178baa52bc67b3821d038c49d6bf03741d3fd43edd4e84
 => => extracting sha256:173289c0cbe5b5760030dda93a84319ef683a489a0b33b176284679a3ab27be1
 => [internal] load build context
 => => transferring context: 26.08kB
 => [2/5] WORKDIR /app
 => [3/5] COPY . /app
 => [4/5] RUN pip install --no-cache-dir -r requirements.txt
 => [5/5] RUN sed -i 's/np.float_/np.float64/g' $(pip show prophet | grep Location | cut -d' ' -f2)/prophet/forecaster.py
 => exporting to image
 => => exporting layers
 => => writing image sha256:24a1d2eb45a859d006f92f60a1fb2f2ccda1401c89ca839f5b2df81d542dc030
 => => naming to docker.io/assynath/monitoringapp:latest
```

Figure 30: Building the docker image for the monitoring app.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6/prophet$ docker push assynath/monitoringapp:latest
The push refers to repository [docker.io/assynath/monitoringapp]
70004266b79e: Pushed
26295c31b24b: Pushed
5a9a3cb62ae8: Pushed
90bd2978e051: Pushed
bb4412c1f640: Mounted from library/python
25b72b8029f8: Mounted from library/python
2440dc0bfce0: Mounted from library/python
c3548211b826: Mounted from library/python
latest: digest: sha256:19d8d8c91457b23a828d1095f61d593224839cc221ced9174a7f7046a2a80d99 size: 1995
asnath@AssynathJr:~/AIOps_Labs/Lab6/prophet$
```

Figure 31: Pushing the image to the docker hub.

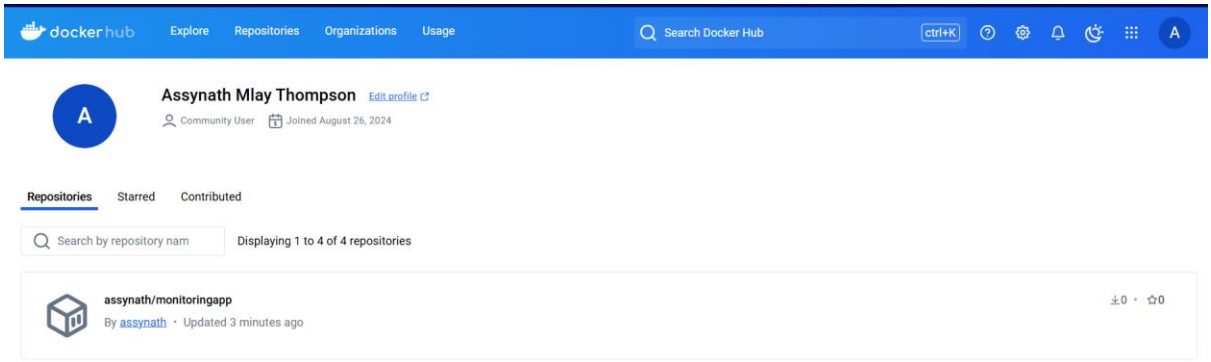

Figure 32: Image pushed in the docker hub.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl apply -f monskeleton_deploy_template.yaml
deployment.apps/monskeletondeploy created
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 33: Deploying the image to the cluster.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get deployments
NAME                    READY   UP-TO-DATE   AVAILABLE   AGE
adservice               1/1     1            1           3h52m
cartservice             1/1     1            1           3h52m
checkoutservice         1/1     1            1           3h52m
currencyservice         1/1     1            1           3h52m
emailservice            1/1     1            1           3h52m
frontend                1/1     1            1           3h52m
istio-gateway-istio     1/1     1            1           3h52m
loadgenerator           0/0     0            0           3h52m
monskeletondeploy       0/0     0            0           2m15s
paymentservice          1/1     1            1           3h52m
productcatalogservice   1/1     1            1           3h52m
recommendationservice   1/1     1            1           3h52m
redis-cart              1/1     1            1           3h52m
shippingservice         1/1     1            1           3h52m
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 34: Monskeleton deployed.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl scale deployments monskeletondeploy --replicas=1
deployment.apps/monskeletondeploy scaled
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get deployments
NAME                    READY   UP-TO-DATE   AVAILABLE   AGE
adservice               1/1     1            1           3h56m
cartservice             1/1     1            1           3h56m
checkoutservice         1/1     1            1           3h56m
currencyservice         1/1     1            1           3h56m
emailservice            1/1     1            1           3h56m
frontend                1/1     1            1           3h56m
istio-gateway-istio     1/1     1            1           3h56m
loadgenerator           0/0     0            0           3h56m
monskeletondeploy       1/1     1            1           6m29s
paymentservice          1/1     1            1           3h56m
productcatalogservice   1/1     1            1           3h56m
recommendationservice   1/1     1            1           3h56m
redis-cart              1/1     1            1           3h56m
shippingservice         1/1     1            1           3h56m
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 35: Scaling up the Monskeleton.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl get pods
NAME                                    READY   STATUS    RESTARTS   AGE
adservice-64586ccfb9-8jrpw              2/2     Running   0          3h58m
cartservice-6bd5c944b4-pbqlz            2/2     Running   0          3h58m
checkoutservice-6d4bcd6f95-sdghl        2/2     Running   0          3h58m
currencyservice-f987888c-sc5mq          2/2     Running   0          3h58m
emailservice-56fbcfbbf7-lvh5x           2/2     Running   0          3h58m
frontend-cb9967686-mcftn                2/2     Running   0          3h58m
istio-gateway-istio-5b8576f55b-gggn7    1/1     Running   0          3h58m
monskeletondeploy-6b87d5bf96-c968n      2/2     Running   0          3m37s
paymentservice-794b5dfdf7-rvfvf         2/2     Running   0          3h58m
productcatalogservice-74b4c878d5-gxw68  2/2     Running   0          3h58m
recommendationservice-65dd5bd87c-rglsk  2/2     Running   0          3h58m
redis-cart-7ff8f4d6ff-48h2k             2/2     Running   0          3h58m
shippingservice-699bcb7fd5-kszf6        2/2     Running   0          3h58m
asnath@AssynathJr:~/AIOps_Labs/Lab6$
```

Figure 36: Monskeleton pod running.

```
asnath@AssynathJr:~/AIOps_Labs/Lab6$ kubectl logs -f monskeletondeploy-6b87d5bf96-fj46n
16:49:42 - cmdstanpy - INFO - Chain [1] start processing
16:49:42 - cmdstanpy - INFO - Chain [1] done processing
Actual value: nan
Predicted value: 3.0811768411250973
+---------------------------+-------------+-------+--------+
| Timestamp                 |   Anomalies | MAE   | MAPE   |
+===========================+=============+=======+========+
| 2024-11-26 16:49:42.459914 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
Actual value: nan
Predicted value: 3.085310085904111
+---------------------------+-------------+-------+--------+
| Timestamp                 |   Anomalies | MAE   | MAPE   |
+===========================+=============+=======+========+
| 2024-11-26 16:49:42.459914 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
| 2024-11-26 16:50:42.537583 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
Actual value: nan
Predicted value: 3.0894456665050307
+---------------------------+-------------+-------+--------+
| Timestamp                 |   Anomalies | MAE   | MAPE   |
+===========================+=============+=======+========+
| 2024-11-26 16:49:42.459914 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
| 2024-11-26 16:50:42.537583 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
| 2024-11-26 16:51:42.605423 |           0 | N/A   | N/A    |
+---------------------------+-------------+-------+--------+
Actual value: 3.0277777777777777
Predicted value: 3.0935803049713835
+---------------------------+-------------+--------------------+---------------------+
| Timestamp                 |   Anomalies | MAE                | MAPE                |
+===========================+=============+====================+=====================+
| 2024-11-26 16:49:42.459914 |           0 | N/A                | N/A                 |
+---------------------------+-------------+--------------------+---------------------+
| 2024-11-26 16:50:42.537583 |           0 | N/A                | N/A                 |
+---------------------------+-------------+--------------------+---------------------+
| 2024-11-26 16:51:42.605423 |           0 | N/A                | N/A                 |
+---------------------------+-------------+--------------------+---------------------+
| 2024-11-26 16:52:42.660586 |           0 | 0.0658025271936058 | 0.021732944761190906 |
+---------------------------+-------------+--------------------+---------------------+
Actual value: 3.0
Predicted value: 3.097714272303664
+---------------------------+-------------+--------------------+---------------------+
| Timestamp                 |   Anomalies | MAE                | MAPE                |
+===========================+=============+====================+=====================+
| 2024-11-26 16:49:42.459914 |           0 | N/A                | N/A                 |
+---------------------------+-------------+--------------------+---------------------+
| 2024-11-26 16:50:42.537583 |           0 | N/A                | N/A                 |
+---------------------------+-------------+--------------------+---------------------+
```

Figure 37: Monitoring app running on the cluster.

```
| 2024-11-26 16:56:42.874735 |           0 | 0.07934635534249068 | 0.026180269529248193 |
^[+----------------------------+-------------+---------------------+----------------------+
Actual value: 3.0
Predicted value: 3.114248923128649
+----------------------------+-------------+---------------------+----------------------+
| Timestamp                  |   Anomalies | MAE                 | MAPE                 |
+============================+=============+=====================+======================+
| 2024-11-26 16:49:42.459914 |           0 | N/A                 | N/A                  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:50:42.537583 |           0 | N/A                 | N/A                  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:51:42.605423 |           0 | N/A                 | N/A                  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:52:42.660586 |           0 | 0.0658025271936058  | 0.021732944761190906 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:53:42.707793 |           0 | 0.09771427230366392 | 0.032571424101221304 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:54:42.780674 |           0 | 0.10184746690249913 | 0.033949155634166374 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:55:42.826264 |           0 | 0.08888833064027768 | 0.02946157134536116  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:56:42.874735 |           0 | 0.07934635534249068 | 0.026180269529248193 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:57:42.919775 |           0 | 0.11424892312864898 | 0.03808297437621633  |
+----------------------------+-------------+---------------------+----------------------+
Actual value: 3.0
Predicted value: 3.118382069199329
+----------------------------+-------------+---------------------+----------------------+
| Timestamp                  |   Anomalies | MAE                 | MAPE                 |
+============================+=============+=====================+======================+
| 2024-11-26 16:49:42.459914 |           0 | N/A                 | N/A                  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:50:42.537583 |           0 | N/A                 | N/A                  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:51:42.605423 |           0 | N/A                 | N/A                  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:52:42.660586 |           0 | 0.0658025271936058  | 0.021732944761190906 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:53:42.707793 |           0 | 0.09771427230366392 | 0.032571424101221304 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:54:42.780674 |           0 | 0.10184746690249913 | 0.033949155634166374 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:55:42.826264 |           0 | 0.08888833064027768 | 0.02946157134536116  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:56:42.874735 |           0 | 0.07934635534249068 | 0.026180269529248193 |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:57:42.919775 |           0 | 0.11424892312864898 | 0.03808297437621633  |
+----------------------------+-------------+---------------------+----------------------+
| 2024-11-26 16:58:42.962971 |           0 | 0.11838206919932892 | 0.03946068973310964  |
+----------------------------+-------------+---------------------+----------------------+
```

Figure 38: Monitoring app running continued.

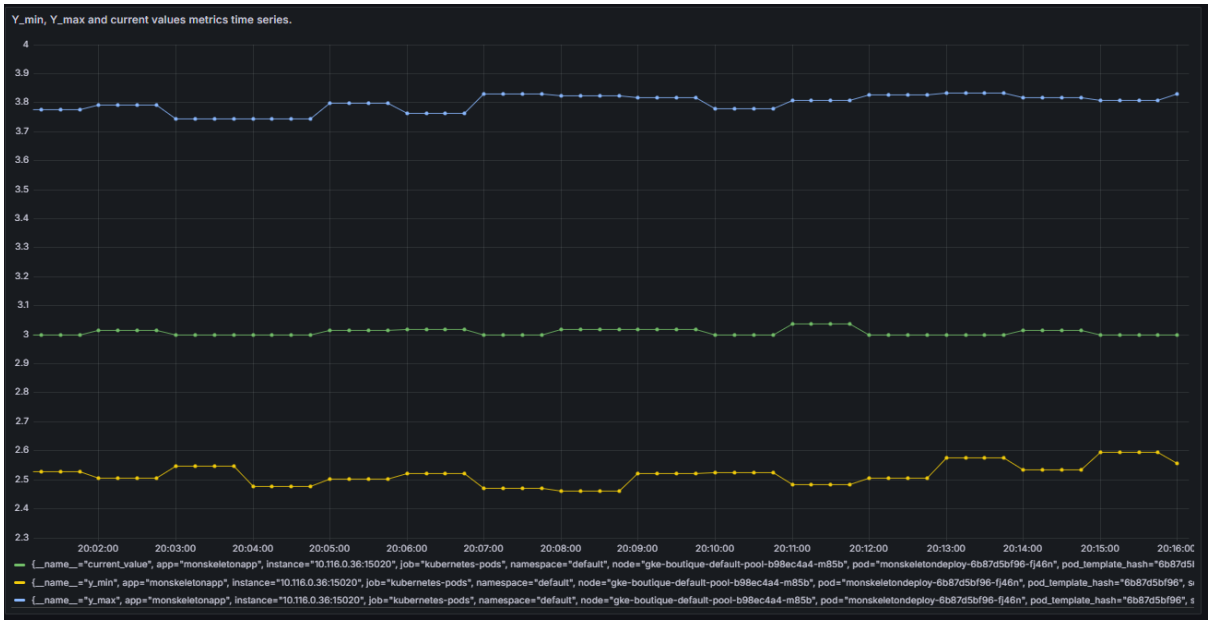

Figure 39: y_min, y_max and current values time series visualized on grafana.

Figure 40: Anomaly count, MAPE, MAE gauges.