Apache Flink Tutorial

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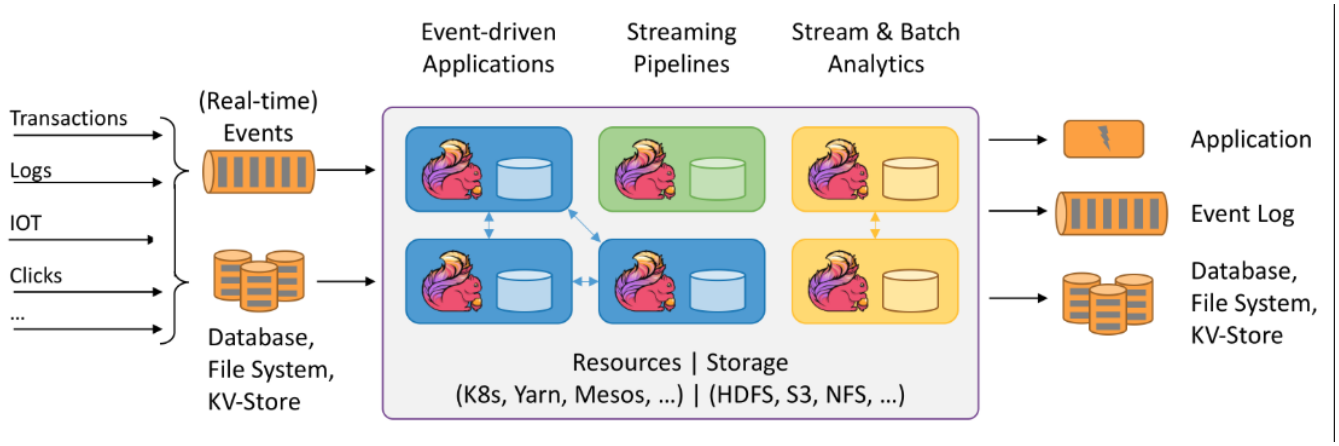
Section 1 – Introduction

1) Flink: A Quick Overview

- Apache Flink is a powerful open-source stream processing framework for distributed, high-performing, always-available, and accurate data streaming applications. It provides efficient, fast, and reliable processing of both batch and stream data, making it a valuable tool for real-time analytics such as stock market analysis.



(**Must watch**

: https://www.youtube.com/watch?v=3cg5dABA6mo&list=PLa7VYi0yPIH1UdmQcnUr8lvjbUV8JriK0&index=1

)

- *Use Case*: Flink is ideal for processing continuous data streams, offering advantages in real-time analytics, where timely insights are crucial, such as monitoring stock market trends.
- *Read the article at: https://infofarm.be/streaming-first-with-apache-flink/ (I like how the other four big data technologies' drawbacks are established to give us a comprehensive understanding)*

2) Advantages:

- High throughput and low-latency processing.
- Scalable and fault tolerant.
- Supports event time processing and state management.

3) Disadvantages:

- Complexity in setup and management.
- Steeper learning curve compared to some other streaming platforms.

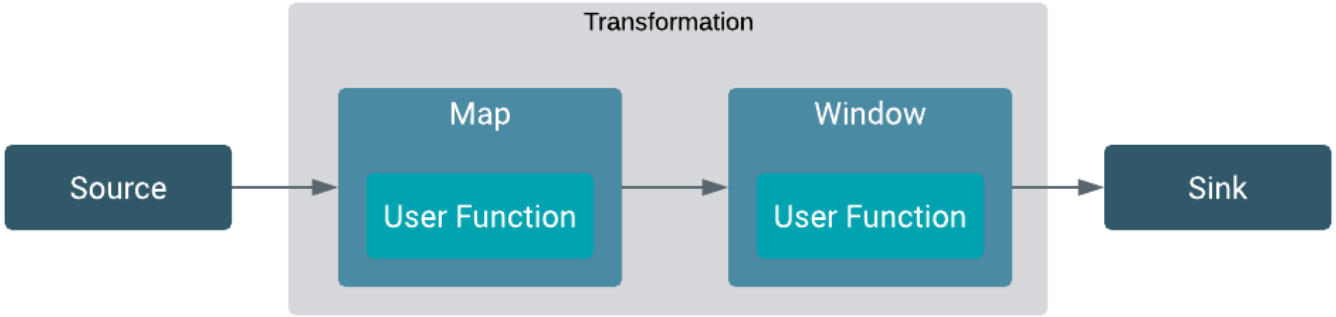
4) Alternatives Comparison:

Compared to Hadoop's MapReduce, Flink offers lower latency and can handle real-time streaming data. Unlike Spark, Flink's native support for streaming allows for more fine-grained control of state and time.

5) Flink Dataflow Model

Flink operates on the principle of dataflow, where data flows through a series of transformations. The core concepts include:

- DataStream: Represents a stream of data.
- Transformation: Operations applied to DataStreams.
- Sink: Defines where the processed data should be sent.



Further Reading : https://nightlies.apache.org/flink/flink-docs-release-1.2/concepts/programming-model.html

Section 2 – Requirements

Before you begin this tutorial, you will need an AWS (Amazon Web Services) account. If you do not already have an AWS account, you can create one by visiting the AWS Sign-Up Page . Please note that while AWS offers a free tier for new accounts, some services and resources used in this tutorial may incur costs. To avoid any errors or interruptions in service, make sure to provide your credit card details when setting up your account. This will enable you to access AWS services that are beyond the scope of the free tier or to continue using services after the free tier limits are exceeded.

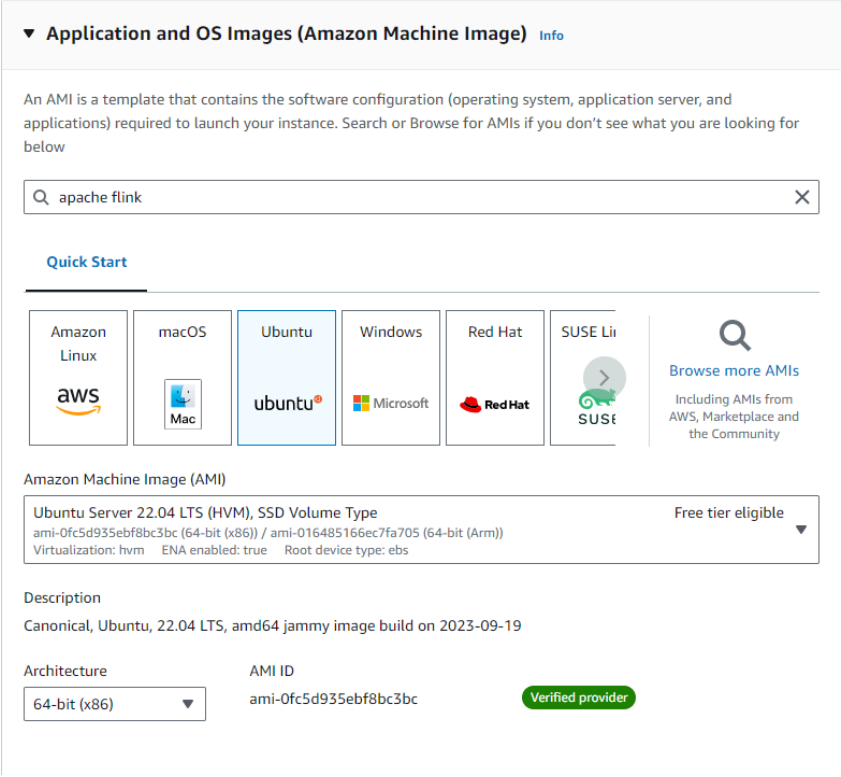
Let's Start !

1. In the **AWS Management Console** choose **Services**, choose **Compute** and then choose **EC2**.
2. Choose the Launch instance menu and select **Launch instance.**

Step 1: Name and tags + Application and OS Images (Amazon Machine Image)

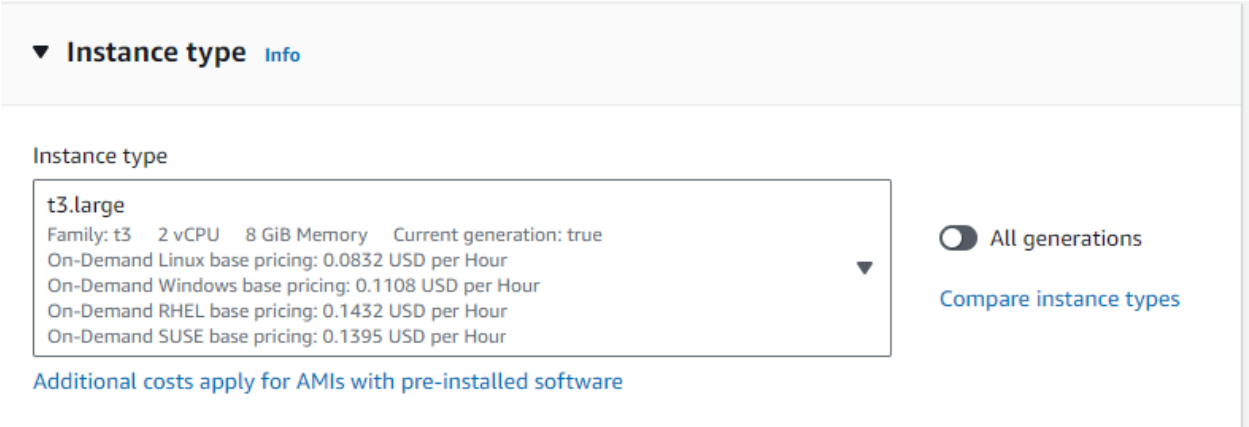
3. Configure the instance as follows:

- **Name :** MyFlink
- **Quick Start AMIs** : Ubuntu
- **AMI** : Ubuntu Server 22.04 LTS (HVM), SSD Volume Type (Free tier Eligible)



Step 2 : Instance Type

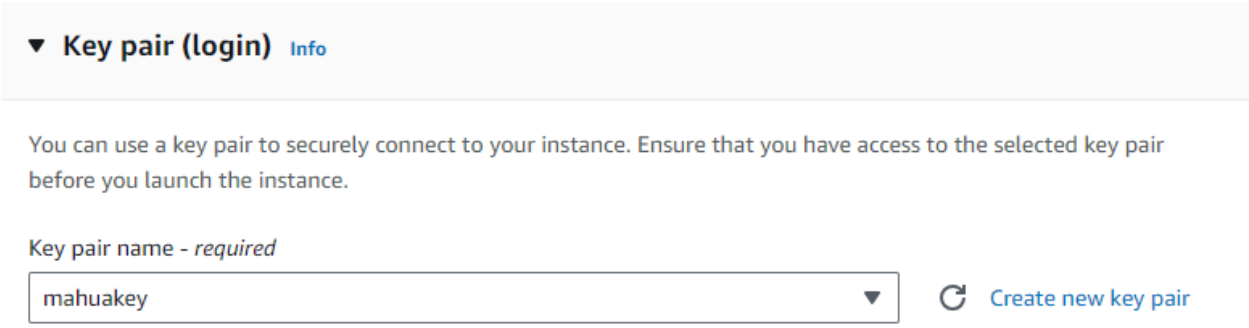
4. In the Instance type panel, select **t3.large**



Step 3 : Key pair (login)

5. For Key pair name - required, create new key pair

- **Key pair name :** mahuakey
- **Key pair type :** RSA
- **Private key file format :** .pem *(For use with OpenSSH)*
- **Click on Create key pair , it will be in your downloads, store it safely in your root folder.**



Step 4 : Network settings

6. Under Firewall (security groups) , choose all the three options :

- Allow SSH traffic from Helps you connect to your instance
- Allow HTTPS traffic from the internetTo set up an endpoint, for example when creating a web server

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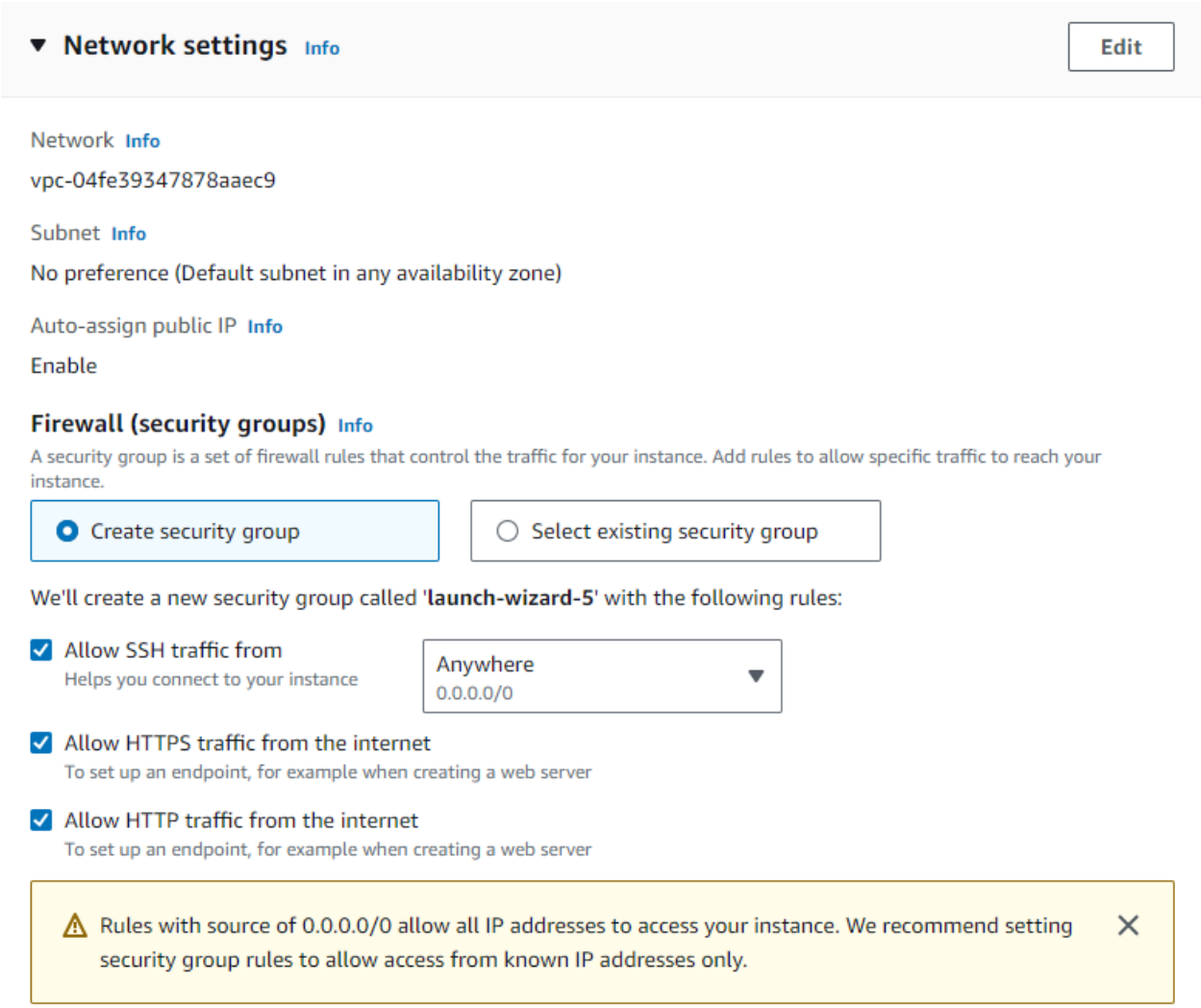


Step 5 : Launch the instance

7. At the bottom of the Summary panel on the right side of the screen choose Launch instance You will see a Success message

8. Choose View all instances

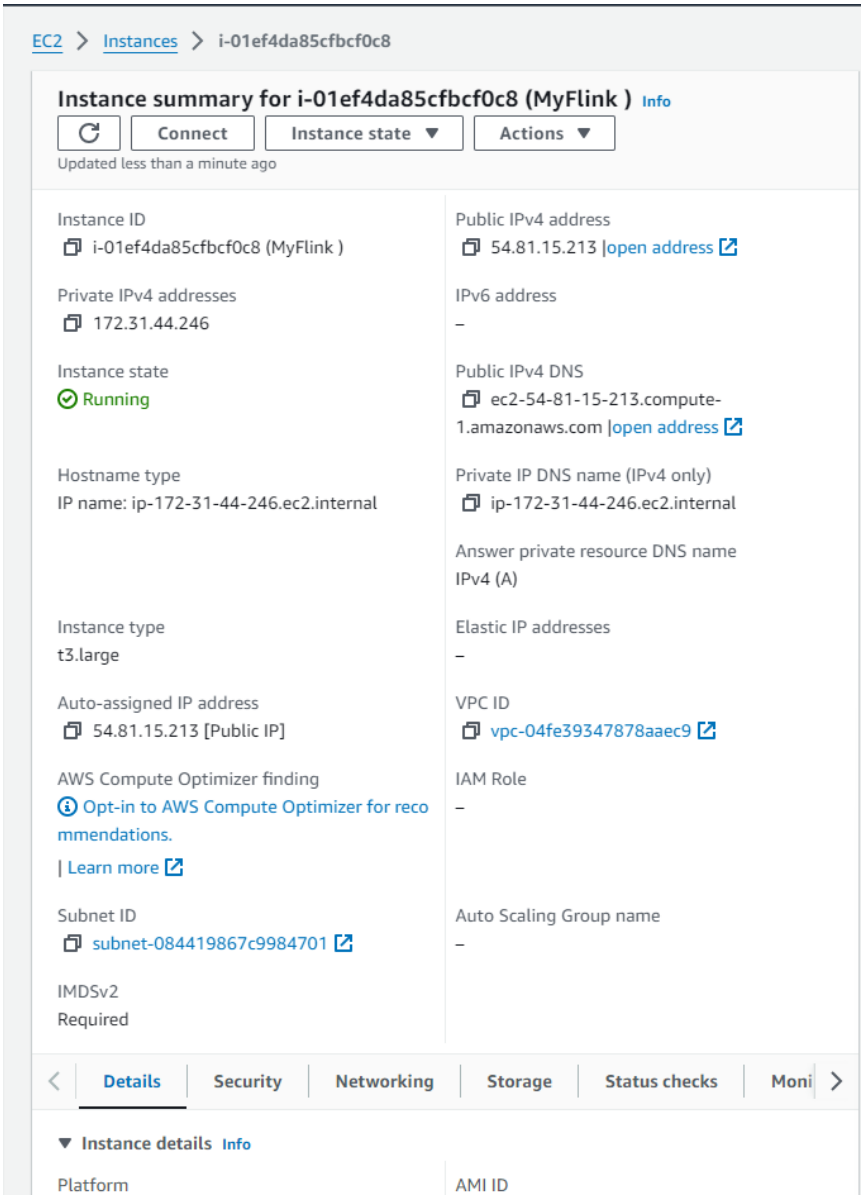
- In the Instances list, select Web Server.
- Review the information displayed in the Details tab.

- It includes information about the instance type, security settings and network settings.

- The instance is assigned a *Public IPv4 DNS* that you can use to contact the instance from the Internet.

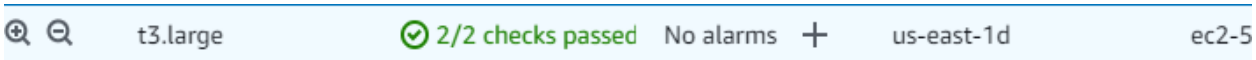
- To view more information, drag the window divider upwards.

- At first, the instance will appear in a *Pending* state, which means it is being launched. It will then change to *Initializing*, and finally to *Running*.

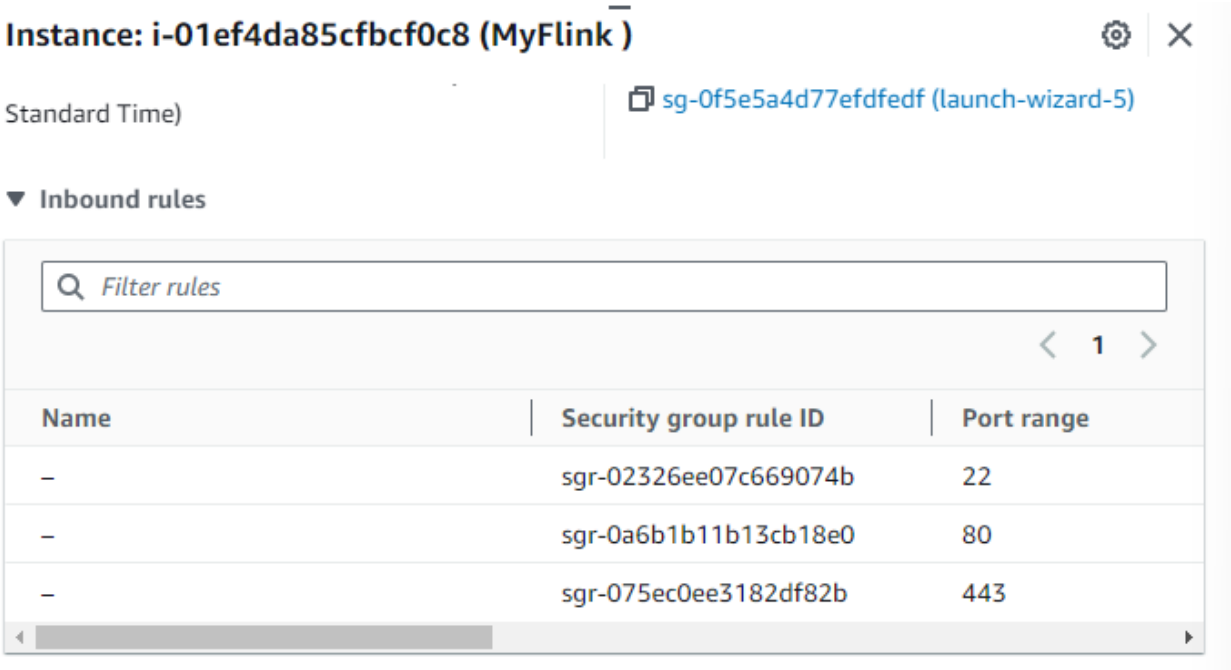


9. Wait for your instance to display the following:

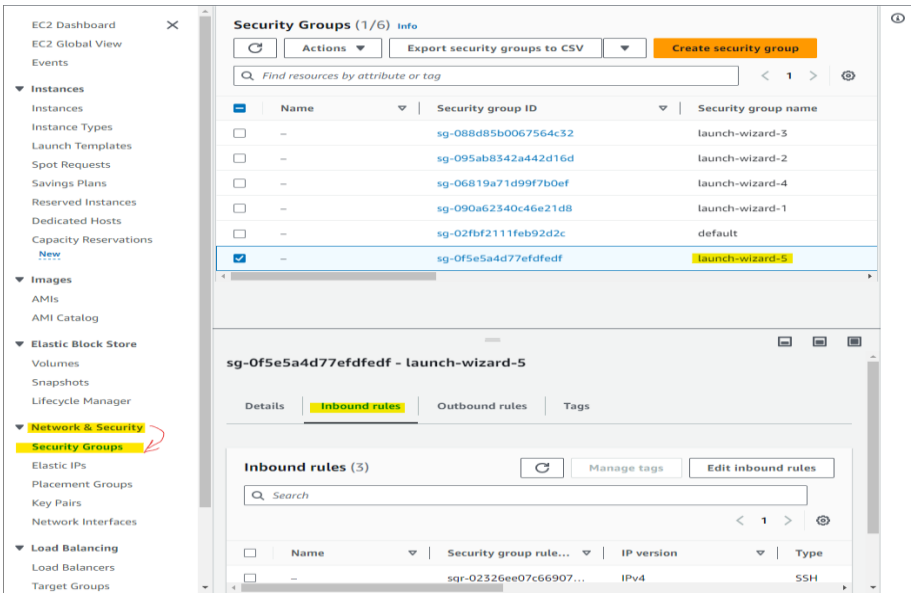
- **Instance State:** *Running*
- **Status Checks:** *2/2 checks passed*



10. Select *MyFlink* and click on the security dashboard and under inbound rules , scroll and check the three port range.

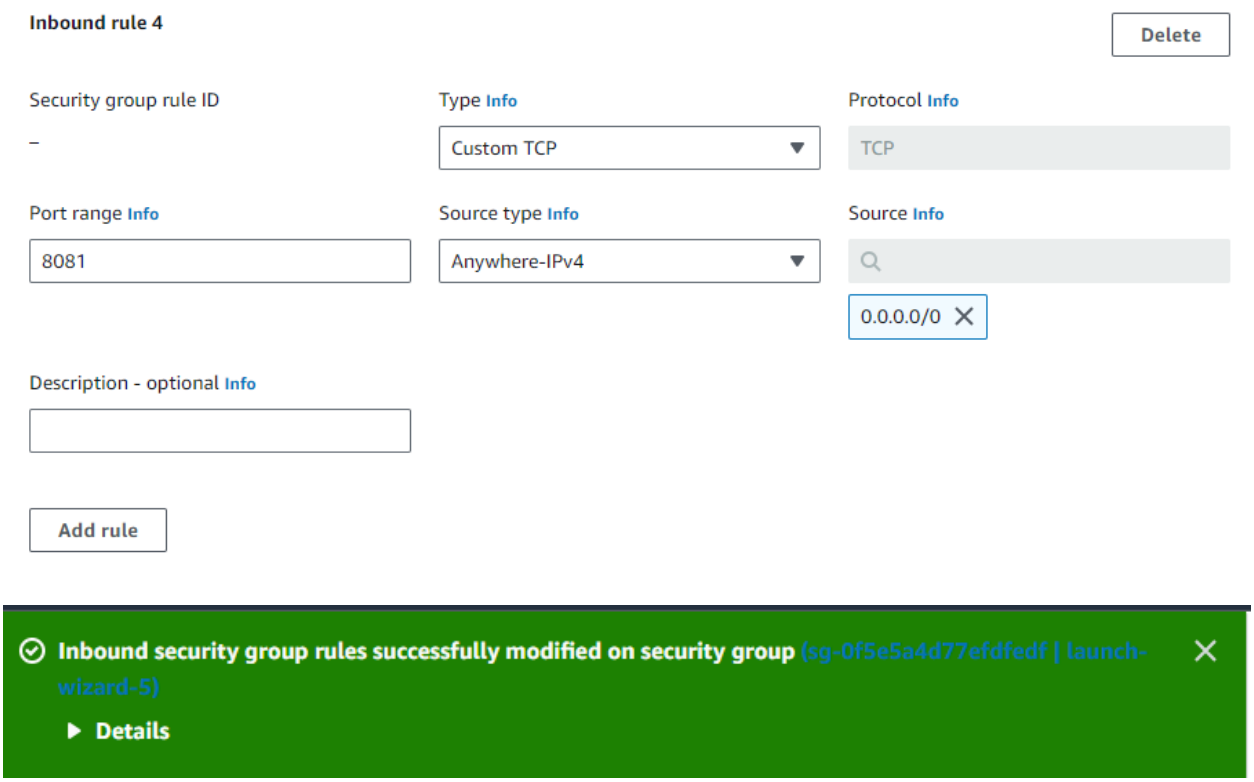


11. On the left hand side , under network and security click on security Groups
12. Select the recent security group we made while launching the instance

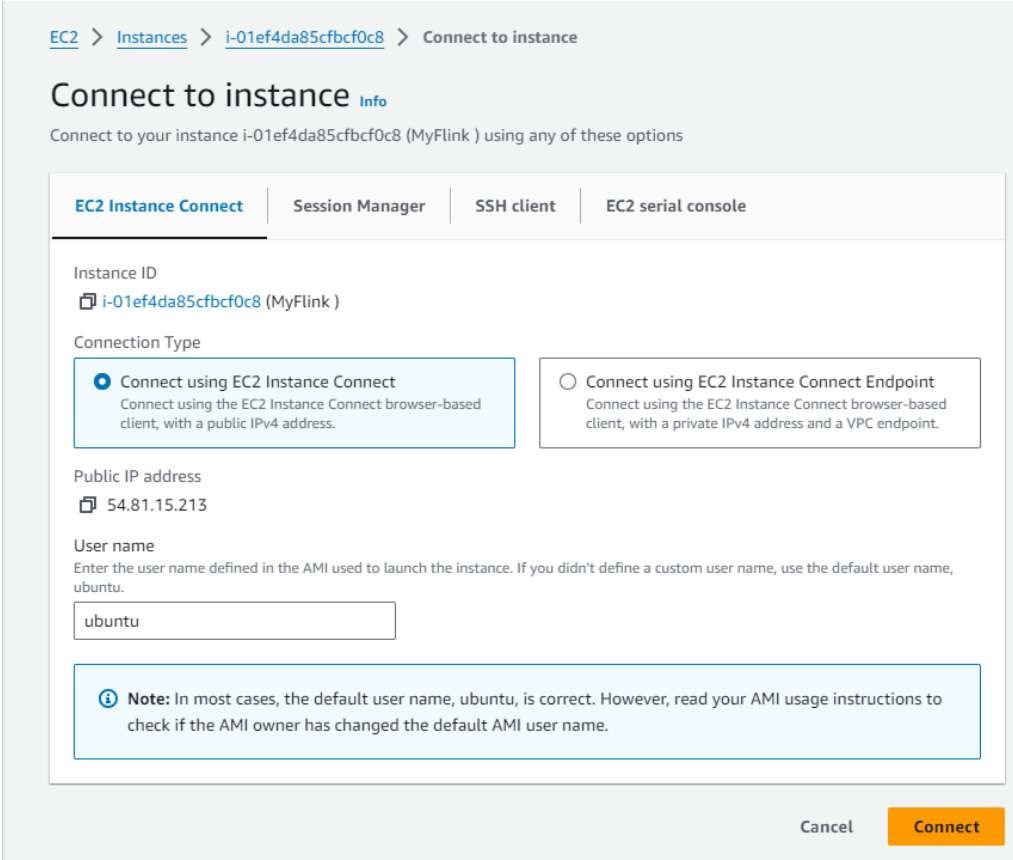


13. Under Inbound Rules , select Edit Inbound Rules
14. Scroll down , and then select add rule.
15. Configure a rule as follows :

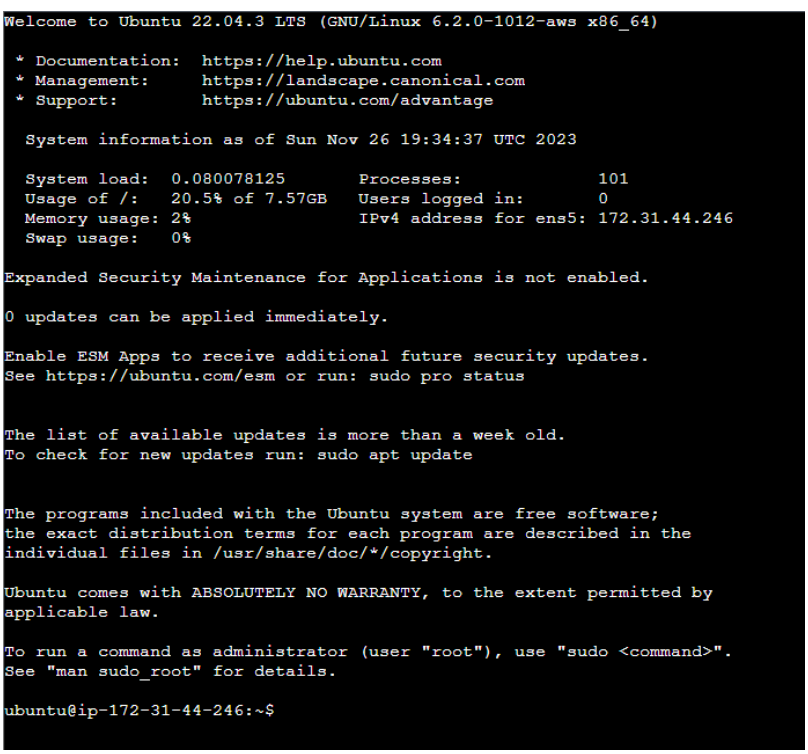
- **Type :** Custom TCP
- **Port Range :** 8081
- **Source Type :** Anywhere – Ipv4



16. Now go back to EC2 and connect Instance.

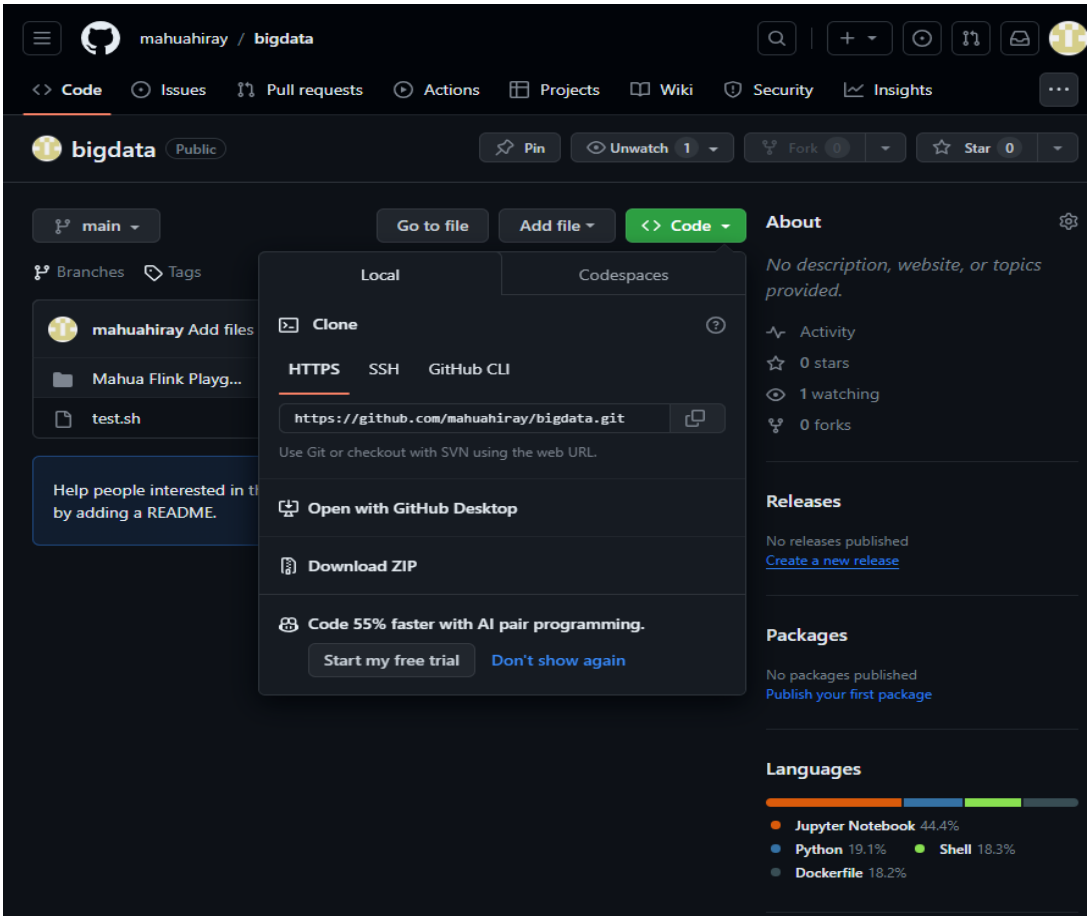


17. Ubuntu cluster will be loaded.



```
Welcome to Ubuntu 22.04.3 LTS (GNU/Linux 6.2.0-1012-aws x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

  System information as of Sun Nov 26 19:34:37 UTC 2023

  System load:  0.080078125       Processes:             101
  Usage of /:   20.5% of 7.57GB   Users logged in:       0
  Memory usage: 2%                IPv4 address for ens5: 172.31.44.246
  Swap usage:   0%

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status


The list of available updates is more than a week old.
To check for new updates run: sudo apt update


The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-44-246:~$
```

18. Now open this GitHub link : https://github.com/mahuahiray/bigdata.git



19. Copy the code and come back to the Ubuntu cluster as displayed above.

Before copying the code take note :

This is the wrong way of copying the code :

```
ubuntu@ip-172-31-44-246:~$ git clone ^[[200~https://github.com/mahuahiray/bigdata.git~
```

This is the correct way :

```
ubuntu@ip-172-31-44-246:~$ git clone https://github.com/mahuahiray/bigdata.git
```

20. Type git clone and paste the link from GitHub. Press Enter.

```
ubuntu@ip-172-31-40-87:~$ git clone https://github.com/mahuahiray/bigdata.git
Cloning into 'bigdata'...
remote: Enumerating objects: 14, done.
remote: Counting objects: 100% (14/14), done.
remote: Compressing objects: 100% (12/12), done.
remote: Total 14 (delta 0), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (14/14), 4.76 KiB | 1.19 MiB/s, done.
```

21. Type `ls` (List the files inside the Folder)

```
ubuntu@ip-172-31-40-87:~$ ls
bigdata
```

22. Type `cd bigdata` (Changing Directory)

```
ubuntu@ip-172-31-18-182:~$ cd bigdata/
ubuntu@ip-172-31-18-182:~/bigdata$ ls
'Mahua Flink Playground'   dependencies.sh
ubuntu@ip-172-31-18-182:~/bigdata$
ubuntu@ip-172-31-18-182:~/bigdata$
```

23. Become a root user using `Sudo su`

```
ubuntu@ip-172-31-18-182:~/bigdata$ sudo su
root@ip-172-31-18-182:/home/ubuntu/bigdata#
root@ip-172-31-18-182:/home/ubuntu/bigdata#
```

24. To install dependency run `bash dependencies.sh`
25. If prompted click "*enter*" to complete the installation
26. Once the installation completes it should show us the "docker" and " docker-compose version"

```
Installation complete.
Docker version:
Docker version 24.0.7, build afdd53b
Docker Compose version:
docker-compose version 1.29.2, build 5becea4c
root@ip-172-31-18-182:/home/ubuntu/bigdata#
root@ip-172-31-18-182:/home/ubuntu/bigdata#
root@ip-172-31-18-182:/home/ubuntu/bigdata#
```

27. When you type `ls` you can now see two directories: 'Mahua Flink Playground' and 'dependencies.sh'
28. Now change directory into 'Mahua Flink Playground' using `cd Mahua Flink Playground`

```
root@ip-172-31-18-182:/home/ubuntu/bigdata# cd Mahua\ Flink\ Playground/
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground#
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground#
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground# ls
docker-compose.yml  examples  image
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground#
```

29. After using `cd Mahua Flink Playground` you will go to 'Mahua Flink Playground'
30. Type `ls` to see three directories inside.
31. Type `docker compose up -d` after this Apache Flink and its components will be installed and running on your server.

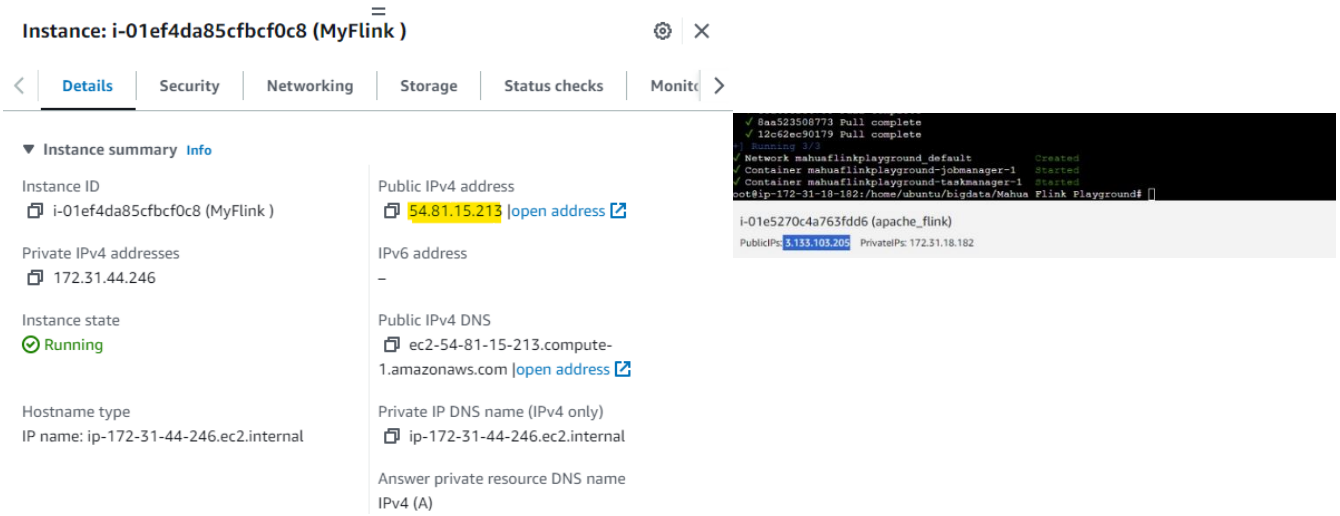
```
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground# docker compose up -d
[+] Running 20/22
 ⠿ taskmanager Pulling
 ⠿ jobmanager 20 layers [⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿]      0B/0B      Pulling
   ✓ bd8f6a7501cc Pull complete
   ✓ 44718e6d535d Pull complete
   ✓ efe9738af0cb Pull complete
   ✓ c647a8e650d3 Pull complete
   ✓ 4c209a1e5186 Pull complete
   ✓ 2ea976dfda62 Pull complete
   ✓ 5d9f9110ab0f Pull complete
   ✓ aac3410d44e8 Download complete
   ✓ 00ff9be65265 Download complete
   ✓ 263b17b8a316 Download complete
   ✓ 1607bd8b25ad Download complete
   ✓ 84d043623632 Download complete
   ✓ eb7388d52077 Download complete
   ✓ da3704983bfc Download complete
   ✓ 00a25e5f57db Download complete
   ✓ 721c9f97bc85 Download complete
   ✓ 662acff7199a Download complete
   ✓ c8a63e2c6705 Download complete
   ✓ 8aa523508773 Download complete
   ✓ 12c62ec90179 Download complete
```

32. Wait for the completion. This takes about 5- 7 minutes.

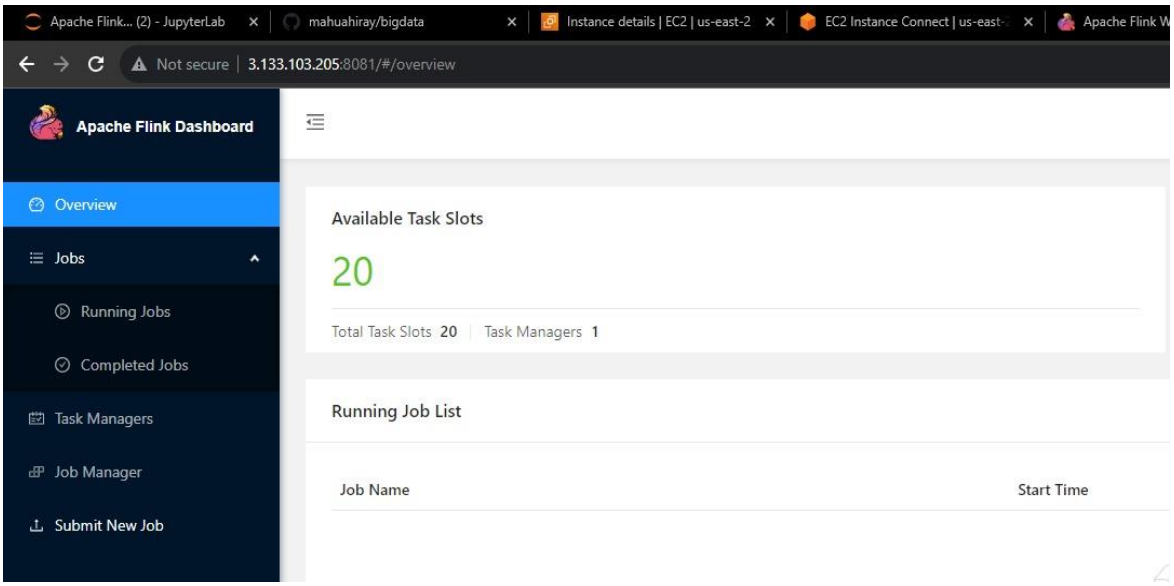
```
[+] Running 22/22
 ✓ taskmanager Pulled
 ✓ jobmanager 20 layers [⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿⠿]      0B/0B      Pulled
   ✓ bd8f6a7501cc Pull complete
   ✓ 44718e6d535d Pull complete
   ✓ efe9738af0cb Pull complete
   ✓ c647a8e650d3 Pull complete
   ✓ 4c209a1e5186 Pull complete
   ✓ 2ea976dfda62 Pull complete
   ✓ 5d9f9110ab0f Pull complete
   ✓ aac3410d44e8 Pull complete
   ✓ 00ff9be65265 Pull complete
   ✓ 263b17b8a316 Pull complete
   ✓ 1607bd8b25ad Pull complete
   ✓ 84d043623632 Pull complete
   ✓ eb7388d52077 Pull complete
   ✓ da3704983bfc Pull complete
   ✓ 00a25e5f57db Pull complete
   ✓ 721c9f97bc85 Pull complete
   ✓ 662acff7199a Pull complete
   ✓ c8a63e2c6705 Pull complete
   ✓ 8aa523508773 Pull complete
   ✓ 12c62ec90179 Pull complete
[+] Running 3/3
 ✓ Network mahuaflinkplayground_default          Created
 ✓ Container mahuaflinkplayground-jobmanager-1   Started
 ✓ Container mahuaflinkplayground-taskmanager-1  Started
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground#
```

33. Once it is completed you should see two containers inside it. *This ensures that the job manager and task manager has been downloaded.*

34. Copy the Public IPv4 address of your instance that is in the bottom left corner.



35. Go to your browser and paste this : http://<<public-ip>>:8081 **(Make sure it is http and not https)**



36. You should be able to see the Apache Flink Dashboard like above.

37. Now, its time to run some examples.

38. I have prepared 3 examples to demonstrate the data analysis.

1. Word-Count (Filter and count persons age > 25)

To do word-count:

Run: `docker-compose exec jobmanager ./bin/flink run -py /opt/examples/word-count.py`

```
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground# docker-compose exec jobmanager ./bin/flink run -py /opt/examples/word-count.py
Job has been submitted with JobID cb79e3552f93977961a9ce7fe2aef131
+----+--------------------------------+----------------------+
| op |                           name |            count_age |
+----+--------------------------------+----------------------+
| +I |                          Mahua |                    1 |
| +I |                          Yagna |                    1 |
| +I |                          Zubbi |                    1 |
| -U |                          Yagna |                    1 |
| +U |                          Yagna |                    2 |
+----+--------------------------------+----------------------+
5 rows in set
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground#
```

2. Product-Sales (Calculate total units sold per product)

To run product-sales example:

Run: `docker-compose exec jobmanager ./bin/flink run -py /opt/examples/product-`

```
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground# docker-compose exec jobmanager ./bin/flink run -py /opt/examples/product-sales.py
Job has been submitted with JobID ca3376857f5c6a79f12e14fe31b3b6cb
+----+--------------------------------+-------------+
| op |                     product_id | total_units |
+----+--------------------------------+-------------+
| +I |                           P001 |          10 |
| +I |                           P002 |           5 |
| -U |                           P001 |          10 |
| +U |                           P001 |          25 |
| +I |                           P003 |          20 |
| -U |                           P002 |           5 |
| +U |                           P002 |          15 |
+----+--------------------------------+-------------+
7 rows in set
```

`sales.py`

3. Employee data analysis (Employee age > 30 and sort them in descending order)

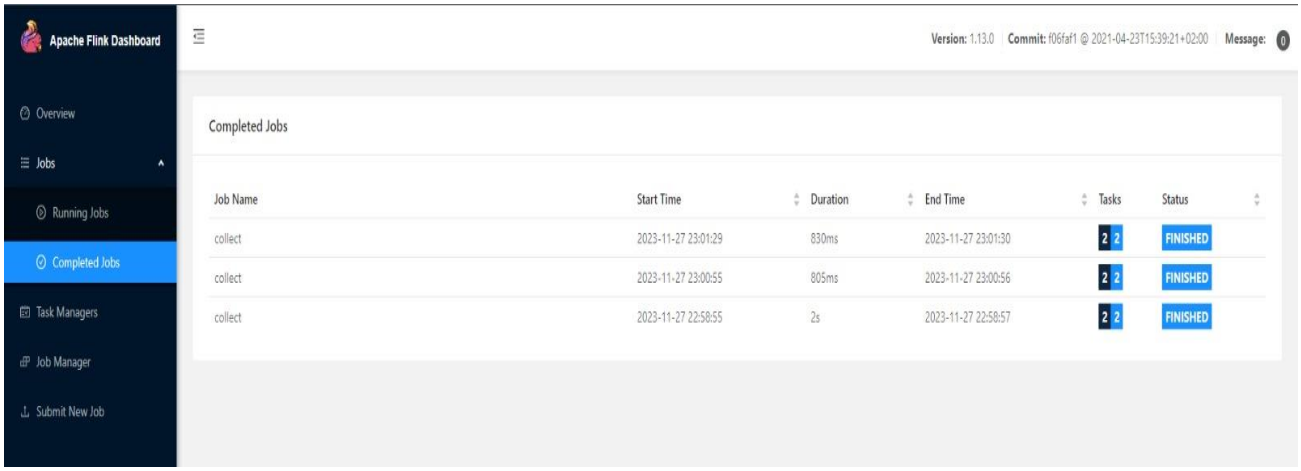
To run employee data analysis:

Run: `docker-compose exec jobmanager ./bin/flink run -py /opt/examples/employee-data-analysis.py`

```
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground# docker-compose exec jobmanager ./bin/flink run -py /opt/examples/employee-data-analysis.py
Job has been submitted with JobID 6149acd8f91e8a80f1c1e61a8a8974dc
+--------------------------------+--------------------------------+-------------+
|                    employee_id |                           name |         age |
+--------------------------------+--------------------------------+-------------+
|                           E001 |                           John |          45 |
|                           E004 |                           Emma |          42 |
|                           E003 |                           Mike |          32 |
+--------------------------------+--------------------------------+-------------+
3 rows in set
root@ip-172-31-18-182:/home/ubuntu/bigdata/Mahua Flink Playground#
```

The results show the analysis for all 3 examples. Also, you can check the status of the job that you ran on Apache Flink.

Navigate to http://<<public-ip>>:8081 and click on Completed Jobs.



39. Great job ! You've finished this tutorial.