

# Running a Machine Learning Algorithm with Google Compute Engine

## Problem Statement:

The Problem Statement is to run Machine Learning Algorithms using Google Compute Engine (GCE).

## Tools Used:

Google Compute Engine(GCE)

## Steps:

**Step1:** Open your web browser and go to the Google Cloud Console at <https://console.cloud.google.com/>. Sign in with your Google account.

**Step2:** For creating new Project, Click on the project drop-down menu at the top of the page and select "New Project." Follow the prompts to set up the project.

**Step3:** In the Cloud Console, click on the navigation menu in the upper-left corner and navigate to "Compute Engine" under the "Compute" section. After that enable the API and wait a few minutes for the service to be activated.

**Step4:** In the Compute Engine section, click on the "Create" button to start the VM instance creation process.

**Step5:** Configure the VM instance settings:

- **Name:** Enter a name for creating VM instance.
- **Region and Zone:** Select the region and zone where the VM instance to be located nearby to the user. The region is a geographic area, and the zone is a specific data center within that region.
- **Machine configuration:** Choose the desired machine type, such as the number of CPU's and the amount of memory.
- **Boot disk:** Select the boot disk image for your VM instance. Choose it from various operating system images.

- **Firewall:** Configure the network firewall settings. By default, Compute Engine allows SSH access.
- **Networking:** Choose the network and subnet for creation of VM instance.
- **Management, security, disks, and other options:** Configure additional settings based on user requirements.

**Step6:** Review the configuration details and click on the "Create" button to create the VM instance. The process might take a few moments to provision the resources and set up the instance.

**Step7:** Once the VM instance is created, there will be Compute Engine instances list available. Then the VM starts running.

**Note:** Create 2 VM instances for running Linear Regression and SVM program.

**Step8:** Installing Libraries to run the machine learning program

- sudo apt update
- sudo apt install python3-pip
- pip install numpy
- pip install pandas
- pip install matplotlib
- !pip install -U scikit-learn
- pip install seaborn

**Step9:** Load the dataset and python program (Linear Regression in one VM instance1 and SVM in VM instance2)

**Step10:** For Viewing and editing the python code using

- sudo nano Linear\_regression.py
- sudo nano svm.py

**Step11:** Run the code using

- python3 Linear\_Regression.py
- python3 svm.py

## Screenshots:

Creating VM Instance 1 in GCE.

The image contains three screenshots of the Google Cloud Platform (GCP) interface, specifically the Compute Engine section, illustrating the process of creating a VM instance.

**Screenshot 1: Dashboard Overview**

- The top navigation bar shows tabs for "Inbox", "Linear Regressions", "Exercise\_2.html", "google cloud", "Cloud Compute", and "Dashboard".
- The main dashboard includes sections for "Project info", "APIs", "Google Cloud Platform status", and "Resources".
- The left sidebar lists "Cloud overview", "Products & services", "Billing", "IAM & Admin", "Marketplace", "Compute Engine", "Kubernetes Engine", and "Cloud Storage".
- The URL in the address bar is <https://console.cloud.google.com/home/dashboard?authuser=2&project=civic-source-387905>.

**Screenshot 2: Virtual Machines Overview**

- The top navigation bar shows tabs for "Inbox", "Linear Regressions", "Exercise\_2.html", "google cloud", "Cloud Compute", and "Dashboard".
- The main dashboard includes sections for "VM instances", "Instance templates", "Sole-tenant nodes", "Machine images", "TPUs", "Committed use discounts", "Reservations", "Migrate to Virtual Machines", "Storage", "Disks", "Snapshots", "Images", and "Async Replication".
- The left sidebar lists "Cloud overview", "Products & services", "Billing", "IAM & Admin", "Marketplace", "Compute Engine", "Kubernetes Engine", and "Cloud Storage".
- The URL in the address bar is <https://console.cloud.google.com/compute/instances?authuser=2&project=civic-source-387905>.

**Screenshot 3: Create VM Instance Wizard**

- The top navigation bar shows tabs for "Inbox", "Linear Regressions", "Exercise\_2.html", "google cloud", "Cloud Compute", and "Compute Engine".
- The main page is titled "Create an instance" under "Compute Engine".
- Options for creating a VM instance include "New VM instance" (selected), "New VM instance from template", and "New VM instance from machine image".
- Machine configuration details:
  - Name: instance-1
  - Labels: + ADD LABELS
  - Region: asia-south2 (Delhi)
  - Zone: asia-south2-a
  - Machine type: General purpose (selected)
  - Series: E2
- Pricing summary table:
 

Item	Monthly estimate
2 vCPU + 4 GB memory	\$29.38
10 GB balanced persistent disk	\$1.20
Total	\$30.58

To create a VM instance, select one of the options:

- New VM instance Create a single VM instance from scratch
- New VM instance from template Create a single VM instance from an existing template
- New VM instance from machine image Create a single VM instance from an existing machine image
- Marketplace Deploy a ready-to-go solution onto a VM instance

**Machine type**

Choose a machine type with present amounts of vCPUs and memory that suit most workloads. Or, you can create a custom machine for your workload's particular needs. [Learn more](#)

PRESET	CUSTOM
e2	e2 medium (2 vCPU, 4 GB memory)
vCPU	2 vCPU (1 shared core)
Memory	4 GB

**ADVANCED CONFIGURATIONS**

Display device

Enable to use screen capturing and recording tools.

Enable display device

**Pricing summary**

Monthly estimate **\$30.58**

That's about \$0.04 hourly

Pay for what you use: no upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 4 GB memory	\$29.38
10 GB balanced persistent disk	\$1.20
Total	\$30.58

[Compute Engine pricing](#) [LESS](#)

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**Confidential VM service**

Confidential Computing is disabled on this VM instance

ENABLE

**Container**

Deploy a container image to this VM instance

**DEPLOY CONTAINER**

**Boot disk**

Name	Instance-1
Type	New balanced persistent disk
Size	10 GB
License type	Free
Image	Debian GNU/Linux 11 (bullseye)

**Pricing summary**

Monthly estimate **\$30.58**

That's about \$0.04 hourly

Pay for what you use: no upfront costs and per second billing

Item	Monthly estimate
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**Identity and API access**

Service account

Compute Engine default service account

Requires the Service Account User role (rolesiam.serviceAccountUser) to be set for users who want to access VMs with this service account. [Learn more](#)

**Access scope**

- Allow default access
- Allow full access to all Cloud APIs
- Set access for each API

**Firewall**

Add tags and firewall rules to allow specific network traffic from the Internet

- Allow HTTP traffic
- Allow HTTPS traffic

**Advanced options**

**Pricing summary**

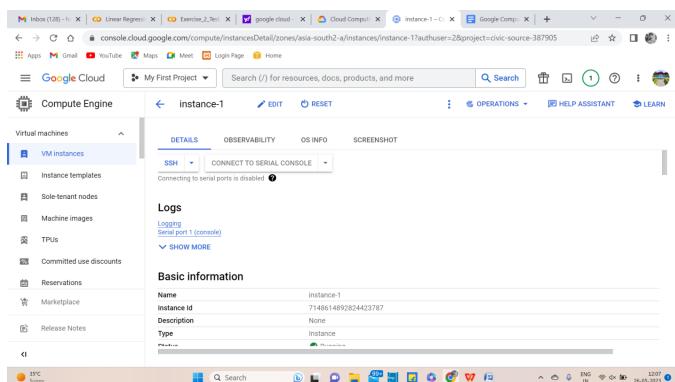
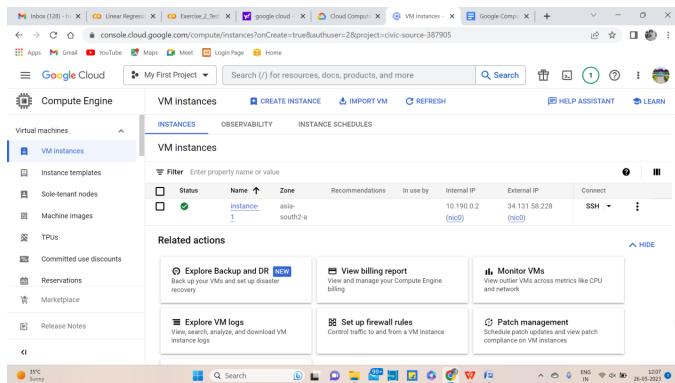
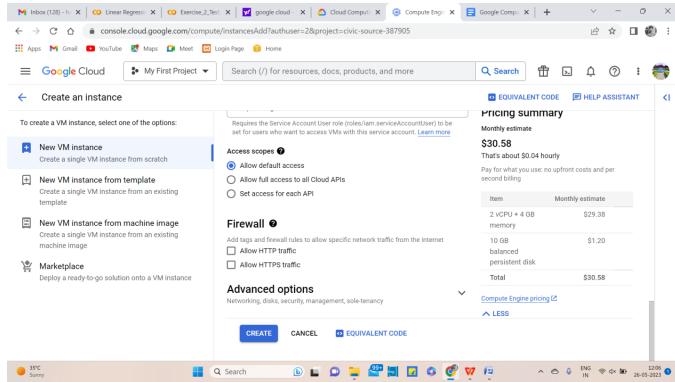
Monthly estimate **\$30.58**

That's about \$0.04 hourly

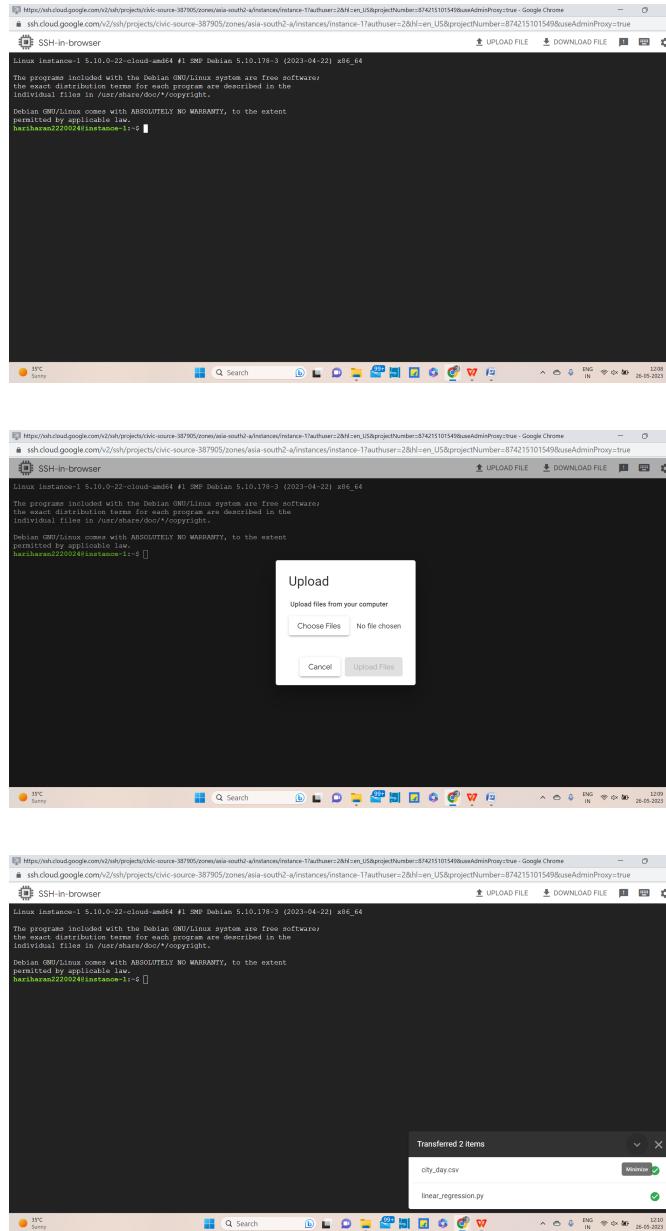
Pay for what you use: no upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 4 GB memory	\$29.38
10 GB balanced persistent disk	\$1.20
Total	\$30.58

[Compute Engine pricing](#) [LESS](#)



## Running Linear Regression in VM Instance 1



```
https://cloud.google.com/vizier/projects/civic-source-387905/zones/usia-south2/instances/instance-17authuser-2Bhl=en_US&projectNumber=37425105511&useAdminProxy=true - Google Chrome
  sh cloud.google.com/vizier/projects/civic-source-387905/zones/usia-south2/instances/instance-17authuser-2Bhl=en_US&projectNumber=074215101549&useAdminProxy=true
SSH in-browser
  UPLOAD FILE DOWNLOAD FILE
  [x] Linear regression.py
  [x] Linear regression.ipynb
  automatically generated by Colaboratory.
Original file is located at
  https://colab.research.google.com/drive/1HUN0EStqyCq1Lzv478qfXw5Uhp-qqk
...
Step#1: Data Pre-processing Step
#Importing libraries
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
#Importing dataset
data_set= pd.read_csv("city_day.csv")
data_set
# Removing the rows where AQI values are null
data_set = data_set.dropna(subset=['AQI'])
# Fill the Null values with median .
data_set = data_set.fillna(data_set.median())
data_set
  Help Exit Write Out Head File Where Is Replace Cut Paste Execute Justify Location Go To Line Undo Set Mark Copy To Bracket Where Was
  3VC Sorry
  Search
  EWD IN OK 26-06-2022 12:14
```

Click Ctrl + O for Save

Click Ctrl + X for Exit

```
https://deb.debian.org/debian/bullseye/main InRelease  
https://deb.debian.org/debian-security/bullseye-security InRelease [46.4 kB]  
https://deb.debian.org/debian/bullseye-backports InRelease [49.0 kB]  
https://packages.cloud.google.com/apt/google-compute-engine-bullseye-stable InRelease [516.8 kB]  
https://deb.debian.org/debian-security/bullseye-security/main amd64 Packages [19.6 kB]  
https://deb.debian.org/debian-security/bullseye-security/main i386 Packages [16.0 kB]  
https://deb.debian.org/debian/bullseye-updates/main Sources [160.8 kB]  
https://deb.debian.org/debian/bullseye-updates/main Sources.diff/Index [16.5 kB]  
https://deb.debian.org/debian/bullseye-updates/main amd64 Packages.diff/Index [19.8 kB]  
https://deb.debian.org/debian/bullseye-updates/main i386 Packages.diff/Index [16.5 kB]  
https://deb.debian.org/debian/bullseye-updates/main Sources.T-2023-05-24-2006.01.pdf [547 B]  
https://deb.debian.org/debian/bullseye-updates/main Sources.T-2023-05-24-2006.01.pdf.sha256 [162 B]  
https://deb.debian.org/debian/bullseye-updates/main amd64 Packages.T-2023-05-24-2006.01.pdf [362 B]  
https://deb.debian.org/debian/bullseye-updates/main i386 Packages.T-2023-05-24-2006.01.pdf [362 B]  
https://deb.debian.org/debian/bullseye-updates/main Translation-en [160.8 kB]  
https://deb.debian.org/debian/bullseye-updates/main Translation-en.T-2023-05-24-2006.01.pdf [160.8 kB]  
https://deb.debian.org/debian/bullseye-backports/main Sources.diff/Index [63.3 kB]  
https://deb.debian.org/debian/bullseye-backports/main Sources.T-2023-05-24-2006.01.pdf [63.3 kB]  
https://deb.debian.org/debian/bullseye-backports/main Sources.T-2023-05-24-2006.01.pdf.sha256 [15.0 kB]  
https://deb.debian.org/debian/bullseye-backports/main amd64 Packages [1916 B]  
https://deb.debian.org/debian/bullseye-backports/main Sources.T-2023-05-24-02-03-08..08-02-2023-05-09-2004.12.pdf [13.4 kB]  
https://deb.debian.org/debian/bullseye-backports/main Sources.T-2023-05-24-02-03-08..08-02-2023-05-09-2004.12.pdf.sha256 [13.4 kB]  
https://deb.debian.org/debian/bullseye-backports/main Translation-en [13.4 kB]  
https://deb.debian.org/debian/bullseye-backports/main Translation-en.T-2023-05-22-0802.59.pdf [871 B]  
https://deb.debian.org/debian/bullseye-backports/main Translation-en.T-2023-05-22-0802.59.pdf.sha256 [871 B]  
https://deb.debian.org/debian/bullseye-updates/main Sources.T-2023-05-22-0802.59.pdf [295 kB]  
Fetched 1315 kB in 1s (1113 kB/s)  
Reading package lists... done  
Building dependency tree... done
```

```
harishiran220024@harishiran-OptiPlex-5090:~$ pip install numpy
Collecting numpy
  Downloading numpy-1.24.3-cp39-cp39-manylinux_2014_x86_64.whl (17.3 MB)
    17.3 MB 23.4 MB

Installing collected packages: numpy
  Found existing installation: numpy 1.24.3
    Consider adding this directory to PATH or, if you prefer to suppress this warning, use --no-warn-script-location.
  Successfully installed numpy-1.24.3
```

```
[root@workstation-02 ~]# python3.6 -m pip install matplotlib
Collecting matplotlib>=2.0.0
  Downloading matplotlib-2.0.3-py3-none-any.whl (11.1 MB)
    100% |████████████████████████████████| 11.1 MB 22.9 MB/s
Collecting packaging<20.0
  Downloading packaging-23.1-py3-none-any.whl (48 kB)
    100% |████████████████████████████████| 48 kB 8.0 MB/s
Collecting python-dateutil<2.7
  Downloading python_dateutil-2.8.1-py3-none-any.whl (247 kB)
    100% |████████████████████████████████| 247 kB 65.0 MB/s
Collecting importlib-resources<3.2
  Downloading importlib_resources-3.1.0-py3-none-any.whl (36 kB)
Collecting fonttools<4.22.0
  Downloading fonttools-4.22.0-py3-none-any.whl (1.0 MB)
    100% |████████████████████████████████| 1.0 MB 13.1 MB/s
Collecting condenser<1.0.1
  Downloading condenser-1.0.1-py3-none-any.whl (299 kB)
    100% |████████████████████████████████| 299 kB 9.6 MB/s
[werkzeug: already satisfied] numpy<1.20.0 in /local/lib/python3.6/site-packages (from matplotlib) (1.24.3)
Collecting cycler<0.10
  Downloading cycler-0.10.0-py3-none-any.whl (6.4 kB)
Collecting six<2.1.0
  Downloading six-1.14.0-py3-none-any.whl (16 kB)
Collecting pillow<6.2.0
  Downloading pillow-9.3.0-py3-cp39-cp39-manylinux_2_12_x86_64.manylinux2010_x86_64.whl (3.4 MB)
    100% |████████████████████████████████| 3.4 MB 14.4 MB/s
Collecting pyrsistent<2.3.1
  Downloading pyrsistent-2.3.1-py3-none-any.whl (98 kB)
    100% |████████████████████████████████| 98 kB 10.7 MB/s
Collecting six<1.10.0
  Downloading six-1.15.0-py3-none-any.whl (6.8 kB)
Collecting pygments<2.15.0
  Downloading pygments-2.15.0-py3-none-any.whl (1.5 MB)
    100% |████████████████████████████████| 1.5 MB 13.0 MB/s
Requirement already satisfied: size-1.5.0 in /usr/lib/python3/dist-packages (from python-dotenv)>=2.7>matplotlib) (1.16.0)
```

```
[harchi@arch220024:~]# pip install pandas
Collecting pandas
  Downloading pandas-2.0.1-rpmbuild-0.9-py3-none-any.whl (12.4 MB)
    12.4 MB 21.9 MB/s
Requirement already satisfied: numpy>=1.20.3 in ./.local/lib/python3.9/site-packages (from pandas) (1.24.3)
Requirement already satisfied: python-dateutil>2.8.2 in ./.local/lib/python3.9/site-packages (from pandas) (2.8.2)
Collecting pytz
  Downloading pytz-2023.3-py3-none-any.whl (502 kB)
    502 kB 49.6 MB/s
Collecting tzdata
  Downloading tzdata-2022.1-py3-none-any.whl (341 kB)
    341 kB 53.1 MB/s
Requirement already satisfied: six>=1.14.0 in /usr/lib/python3/dist-packages (from python-dateutil>2.8.2>pandas) (1.16.0)
Installing collected packages: tzdata, pytz, pandas
Successfully installed pandas-2.0.1 pytz-2023.3 tzdata-2022.3
[harchi@arch220024:~]#
```

```
[root@localhost ~]# ./wheelhouse2wheel.sh sklearn-0.20.post1.tar.gz -S pip install sklearn
Extracting archive: ./wheelhouse2wheel.sh sklearn-0.20.post1.tar.gz (3.7 MB)
Building wheels for collected packages: sklearn
  Running setup.py bdist_wheel for sklearn
    Created wheel for sklearn: filename=sklearn-0.20.post1-py3-none-any.whl size=2360 sha256=0e4d1cfafca9a29d91c5d7feba8030ccb51b3d3e7ca4c288e49e7c3edc
  Stored in directory: /root/.cache/pip/wheels/04/49/c5/2374fe1bb1599fb6ab6094863e60bf62a02cc62b7fe
Successfully built sklearn
Uploading distributions to https://files.pythonhosted.org/packages/200a/44/cache/pip/wheels/04/49/c5/2374fe1bb1599fb6ab6094863e60bf62a02cc62b7fe
  Successfully installed sklearn-0.20.post1
```

```
[hariharan220024@instance-1:~]$ pip install -U scikit-learn
pip: install already installed --upgrade scikit-learn
Requirement already satisfied: sklearn in ./local/lib/python3.9/site-packages (0.0.post5)
Collecting sklearn
  Using cached sklearn-0.0.post5-py3-none-any.whl
    Preparing metadata (pyproject.toml) ... done
    Downloading sklearn-0.0.post4.tar.gz (3.6 kB)
Collecting install
  Downloading install-1.3.5-py3-none-any.whl (3.2 kB)
Collecting scikit-learn
  Downloading scikit_learn-1.2.2-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (9.6 MB)
Collecting threadpoolctl>=2.0.0
  Downloading threadpoolctl-3.1.0-py3-none-any.whl (14 kB)
Requirement already satisfied: numpy>=1.17.3 in ./local/lib/python3.9/site-packages (from scikit-learn) (1.24.3)
Collecting joblib<1.1
  Downloading joblib-1.2.0-py3-none-any.whl (297 kB)
Collecting scipy>=1.3.2
  Downloading scipy-1.10.1-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (34.5 MB)
Installing collected packages: threadpoolctl, numpy, joblib, scikit-learn, install
Successfully installed install-1.3.5-py3lib1.2.0 scikit-learn-1.2.2 scipy-1.10.1 threadpoolctl-3.1.0
[hariharan220024@instance-1:~]$
```

## Output for Linear Regression

```
bhariharan2220024@instance-1:~$ python3 linear_regression.py
Independent Variable
[[8.3130e+01 9.6180e+01 6.9300e+00 ... 5.9760e+01 2.0000e-02 0.0000e+00]
 [7.9840e+01 9.6180e+01 1.3850e+01 ... 9.7070e+01 4.0000e-02 0.0000e+00]
 [9.4520e+01 9.6180e+01 2.4390e+01 ... 1.1130e+02 2.4000e-01 1.0000e-02]
 ...
 [2.2910e+01 6.5730e+01 3.4500e+00 ... 3.0960e+01 1.0000e-02 1.0000e-02]
 [1.6640e+01 4.9970e+01 4.0500e+00 ... 2.8300e+01 0.0000e+00 0.0000e+00]
 [1.5000e+01 6.6000e+01 4.0000e-01 ... 1.7050e+01 1.2900e+00 3.5750e+00]]
Dependent Variable
[209. 328. 514. ... 68. 54. 50.]
(24850, 15)
(19880, 11)
(4970, 11)
(19880, 11)
(4970, 11)
Normal Value [ 59. 107. 56. ... 462. 411. 116.]
Predicted Value [ 91.4690537 116.48872461 70.8257491 ... 486.06859824 233.5909127
 89.40970971]
Mean Absolute Error: 30.236654278074674
Mean Squared Error: 3387.196335602564
Root Mean Squared Error: 58.19962487510177
Train Score: 0.8541539230533385
Test Score: 0.8275839995101334
```

Creating Instance 2 and Running Support vector machine in GCE.

The screenshot shows the Google Cloud Compute Engine VM instances page. It lists two VM instances: 'instance1' and 'instance2'. Both instances are in the 'Running' state, located in the 'asia-south2-a' zone. Their internal IP addresses are 10.190.0.2 and 10.190.0.4 respectively, and their external IP addresses are 34.131.58.228 and 34.131.157.57. The 'Connect' dropdown menu for both instances is set to 'SSH'. Below the table, there are several related actions: 'Explore Backup and DR', 'View billing report', 'Monitor VMs', 'Explore VM logs', 'Set up firewall rules', 'Patch management', and 'Load balance between VMs'.

Follow the same step as while creating VM Instance 1

This screenshot is identical to the one above, showing the Google Cloud Compute Engine VM instances page with two running instances: 'instance1' and 'instance2'. Both instances are in the 'Running' state, located in the 'asia-south2-a' zone. Their internal IP addresses are 10.190.0.2 and 10.190.0.4 respectively, and their external IP addresses are 34.131.58.228 and 34.131.157.57. The 'Connect' dropdown menu for both instances is set to 'SSH'. Below the table, there are several related actions: 'Explore Backup and DR', 'View billing report', 'Monitor VMs', 'Explore VM logs', 'Set up firewall rules', 'Patch management', and 'Load balance between VMs'.

Install the packages that are installed in instance 1

```

Collecting seaborn
  Downloading https://files.pythonhosted.org/packages/3e/0d/23c32f3a3a3a53333333333333333333/seaborn-0.11.1-py3-none-any.whl (253 kB)
    293 in 0.02s (2.5 MB/s)

Requirement already satisfied: numpy<1.23,>=1.19.2; python_version=='3.5' from https://files.pythonhosted.org/packages/9c/c5/site-packages/seaborn/_0_11_1.py (5.1 kB)
Requirement already satisfied: matplotlib<3.6,>=3.1.1; python_version=='3.5' from https://files.pythonhosted.org/packages/3f/5a/site-packages/seaborn/_0_11_1.py (3.7 kB)
Requirement already satisfied: numpy>=1.23, <1.24; python_version=='3.6' or python_version=='3.7' from https://files.pythonhosted.org/packages/01/24/site-packages/seaborn/_0_11_1.py (1.2 kB)
Requirement already satisfied: python-dateutil<2.1,>=2.0.1; python_version=='3.5' from https://files.pythonhosted.org/packages/6e/61/site-packages/seaborn/_0_11_1.py (2.8 kB)
Requirement already satisfied: pycparser<2.3.1,>=2.0.1; python_version=='3.5' from https://files.pythonhosted.org/packages/5e/3a/site-packages/seaborn/_0_11_1.py (3.0 kB)
Requirement already satisfied: pytz==2020.1; python_version=='3.5' from https://files.pythonhosted.org/packages/3e/5a/site-packages/seaborn/_0_11_1.py (1.1 kB)
Requirement already satisfied: kiwisolver<0.1.0,>=0.1.0; python_version=='3.5' from https://files.pythonhosted.org/packages/5f/37/site-packages/seaborn/_0_11_1.py (1.4 kB)
Requirement already satisfied: pillow<8.0.0,>=3.0.0; python_version=='3.5' from https://files.pythonhosted.org/packages/3e/5a/site-packages/seaborn/_0_11_1.py (1.5 kB)
Requirement already satisfied: tzdata<2020.1,>=2020.1; python_version=='3.5' from https://files.pythonhosted.org/packages/25/5a/site-packages/seaborn/_0_11_1.py (20.3 kB)
Requirement already satisfied: pandas<1.2,>=0.25; python_version=='3.5' from https://files.pythonhosted.org/packages/27/5a/site-packages/seaborn/_0_11_1.py (1.6 kB)

Installing collected packages: seaborn
  Found existing installation: seaborn 0.11.1
    Uninstalling seaborn-0.11.1:
      Successfully uninstalled seaborn-0.11.1

```

## Output for SVM

```
balaji$instance-2:~$ sudo nano svm.py
balaji$instance-2:~$ python3 svm.py
Null Values in Data Frame : False

Unique values in AQI Bucket column : ['Poor' 'Very Poor' 'Severe' 'Moderate' 'Satisfactory' 'Good']

Number of values in each class of AQI Bucket
AQI Bucket
Moderate      8829
Satisfactory   8224
Poor          2781
Very Poor     2337
Good           1341
Severe         1338
Name: count, dtype: int64

Confusion Matrix
[[ 8 13  0  0  0]
 [ 6 41  1  2]
 [ 3  0  0  0  0]
 [ 0  3  0 125  5]
 [ 0 12  0 10 21]]]

Accuracy score of train SVM
75.866666666666667

Accuracy score of test SVM
78.0

Predicted Value ['Severe']
balaji$instance-2:~$ []
```

## **Learning Outcome**

The Learning outcomes for the exercise are as follows:

- Practical application of machine learning algorithms.
- Understanding scalability and performance.
- Exploring advanced machine learning techniques.
- Infrastructure management and optimization.
- Collaboration and deployment.