

Steps to setup Preventive Maintenance ML Application

1. Before installing the application, user must enable the following list of APIs in Google Cloud project. Go to to APIs & Service in google cloud console and enable the following APIs
 1. Compute engine
 2. Cloud Storage
 3. Cloud AutoML API
 4. AI Platform Training & Prediction API
 5. Google Cloud Storage JSON API
 6. Deployment manager API

Goto to APIs and Services in google cloud console,

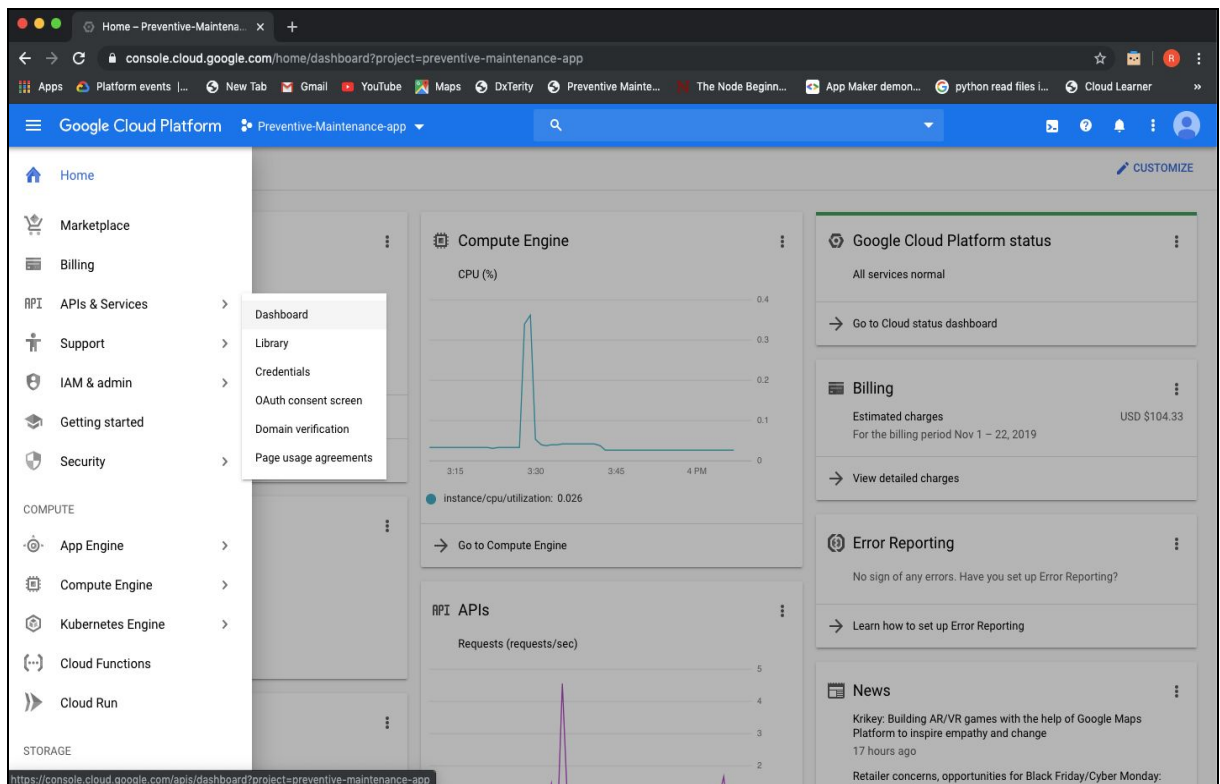


Fig: APIs & Services

Click on ENABLE APIS AND SERVICES,

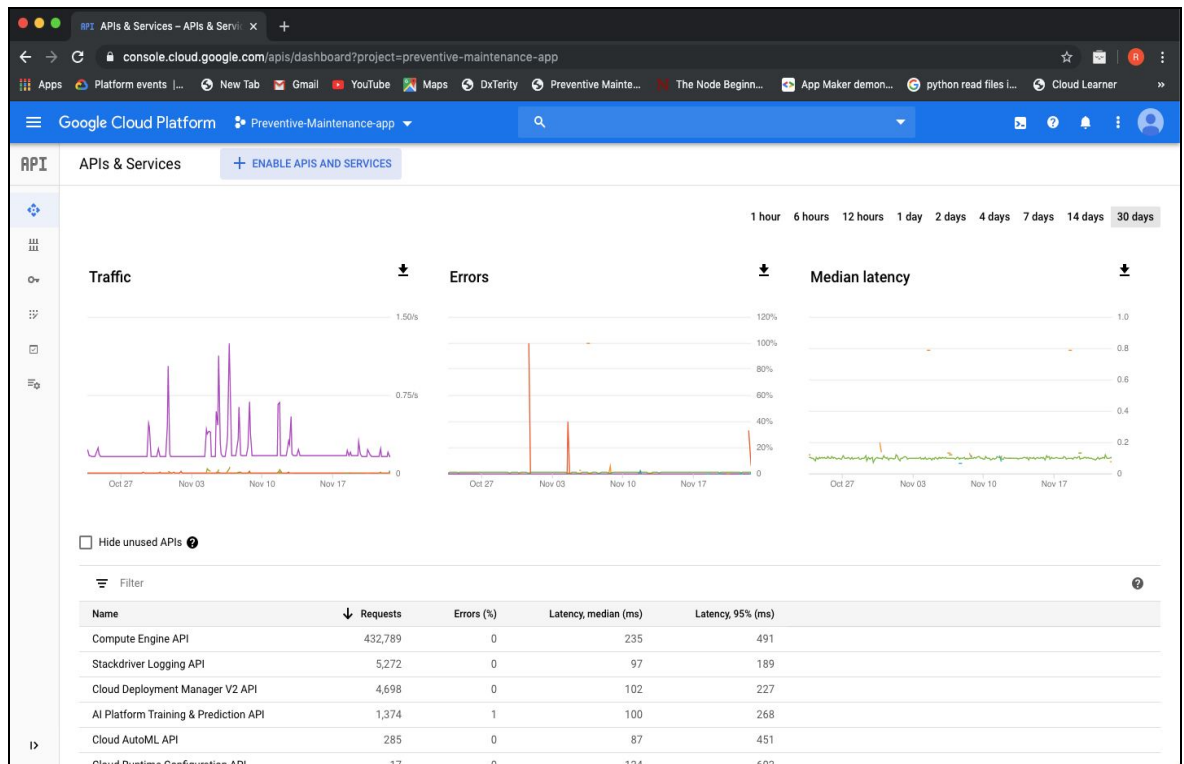


Fig: APIs & Services Dashboard

Search and Enable the following APIs in the API library

1. Compute engine
2. Cloud Storage
3. Cloud AutoML API
4. AI Platform Training & Prediction API
5. Google Cloud Storage JSON API

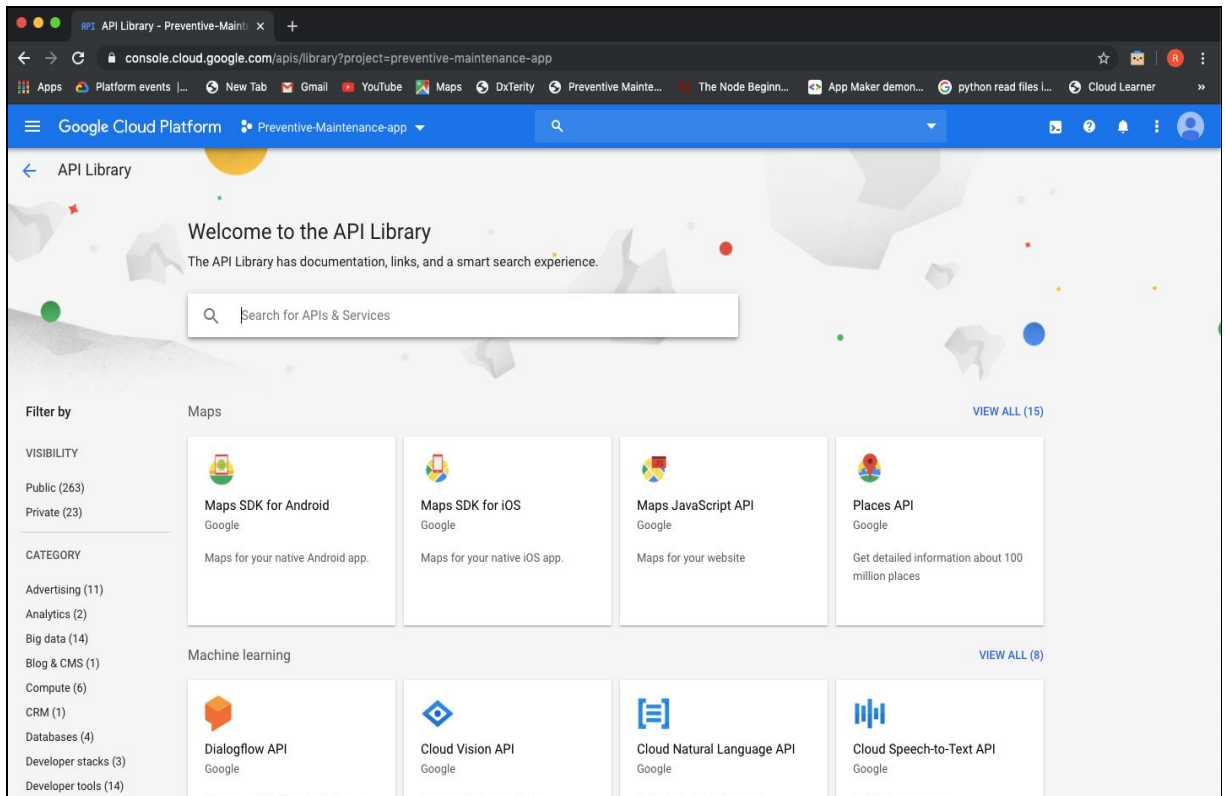
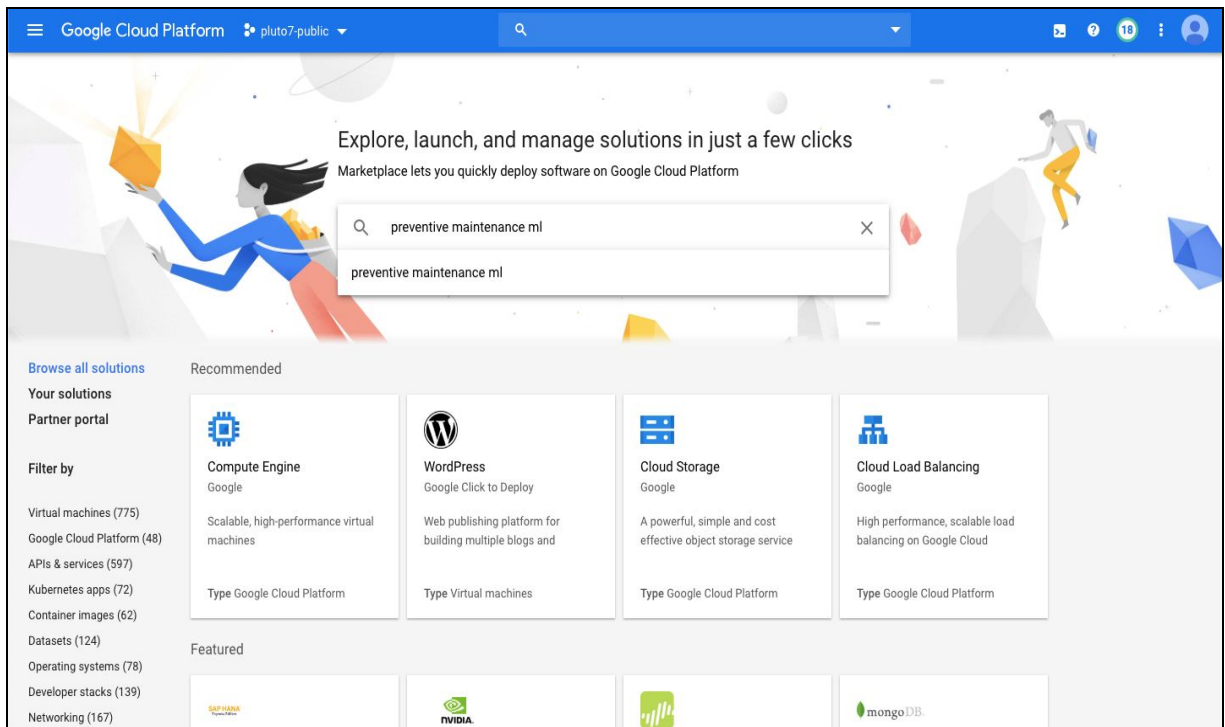


Fig: API library

- After enabling all the APIs mentioned above, go to [google cloud market place](#) and search for Preventive Maintenance ML



After selecting Preventive Maintenance ML , it redirects to Preventive Maintenance ML solution home screen and below is the reference of that page. Next, click on **LAUNCH ON COMPUTE ENGINE** button.

The screenshot shows the Google Cloud Platform interface for the 'Preventive Maintenance ML' solution. The header includes the Google Cloud Platform logo, the project name 'pluto7-public', and a search bar. The main content area features a circular logo with 'Pluto7' and a blue lightning bolt icon. To the right of the logo, the text reads 'Preventive Maintenance ML', 'Pluto7', 'Estimated costs: \$1,144.02/month', and 'Predicting the Remaining Useful Life.' Below this is a blue button labeled 'LAUNCH ON COMPUTE ENGINE'.

Below the main content area, there are several sections:

- Runs on:** Google Compute Engine
- Type:** Virtual machines, Single VM
- Last updated:** 12/3/19, 7:09 PM
- Category:** Analytics, Compute
- Version:** 1.0
- Operating system:** Ubuntu 18.04 LTS
- Overview:** Preventive Maintenance the reduction of unnecessary scheduled repairs or replacement in production plant in Consumer Products and Goods domain. [Learn more](#)
- About Pluto7:** "Pluto7 is a services and solutions company focused on building machine learning, artificial intelligence, and analytics solutions to accelerate business transformation. We are a Premier Google Cloud Partner, servicing Retail, Manufacturing, Healthcare, and Hi-Tech industries."
- Pricing:** Free for first 15 days or up to \$500 of usage whichever come earlier, 1 user, US clients can get up to \$500 free credit for using GCP platform. \$1.5 per hour or 2.5 cents per min You can customize the configuration later when deploying this solution.

At the bottom right, there is a table with the following data:

Item	Estimated costs
Preventive ML Usage Fee	\$1,095.00/month

Fig: Preventive Maintenance ML home screen.

After clicking on LAUNCH ON COMPUTE ENGINE it redirects to the deployment page.

The screenshot shows the 'New Preventive Maintenance ML deployment' page on Google Cloud Platform. The header includes the Google Cloud Platform logo, the project name 'pluto7-public', and a search bar. The main content area is divided into two columns.

Left Column (Deployment Configuration):

- Deployment name:** preventivemi-1
- Zone:** us-west1-b
- Machine type:** 2 vCPUs, 7.5 GB memory, [Customize](#)
- Boot Disk:**
 - My Boot Disk type:** Standard Persistent Disk
 - My Boot Disk size in GB:** 10
- Networking:**
 - Network interfaces:** default default (10.138.0.0/20), [Add network interface](#)
 - Firewall:** Add tags and firewall rules to allow specific network traffic from the Internet. [Creating certain firewall rules may expose your instance to the Internet. Please check if the rules you are creating are aligned with your security requirements.](#)

Right Column (Preventive Maintenance ML overview):

- Preventive Maintenance ML overview**
Solution provided by Pluto7
- Costs:** \$1,144.02 per month estimated
Effective hourly rate \$1.567 (730 hours per month)
- Details:** [Details](#)
- Software:**
 - Operating System:** Ubuntu (18.04 LTS)
- Terms of Service:**

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Fig: Deployment page 1.

In the deployment page scroll to the bottom of the page and to deploy the solution, click on the deploy button.

Google Cloud Platform pluto7-public

New Preventive Maintenance ML deployment

Boot Disk

My Boot Disk type [?](#)
Standard Persistent Disk

My Boot Disk size in GB [?](#)
10

Networking

Network interfaces
default default (10.138.0.0/20) [✎](#)

[+ Add network interface](#)

Firewall [?](#)
Add tags and firewall rules to allow specific network traffic from the Internet.

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Google is providing this software or service "as-is" and any support for this software or service will be provided by Pluto7 under their terms of service.

☒ Allow HTTP traffic from the Internet

Source IP ranges for HTTP traffic [?](#)
0.0.0.0/0, 192.169.0.2/24

[More](#)

Deploy

Fig: Deployment page 2.

Page will be redirected to deployment manager page, where it lists all the Google Cloud resources that will be deployed for Preventive Maintenance ML solution,

Google Cloud Platform pluto7-public

preventiveml-1

[DELETED](#)

preventive-ml [preventive-ml](#) [EXIT PREVIEW](#)

Preventive Maintenance ML
Solution provided by Pluto7

Admin user	admin
Admin password (Temporary)	root123
Instance	preventiveml-1-vm
Instance zone	us-west2-a
Instance machine type	n1-standard-2

[More about the software](#)

Get started with Preventive Maintenance ML

SSH [?](#)

Suggested next steps

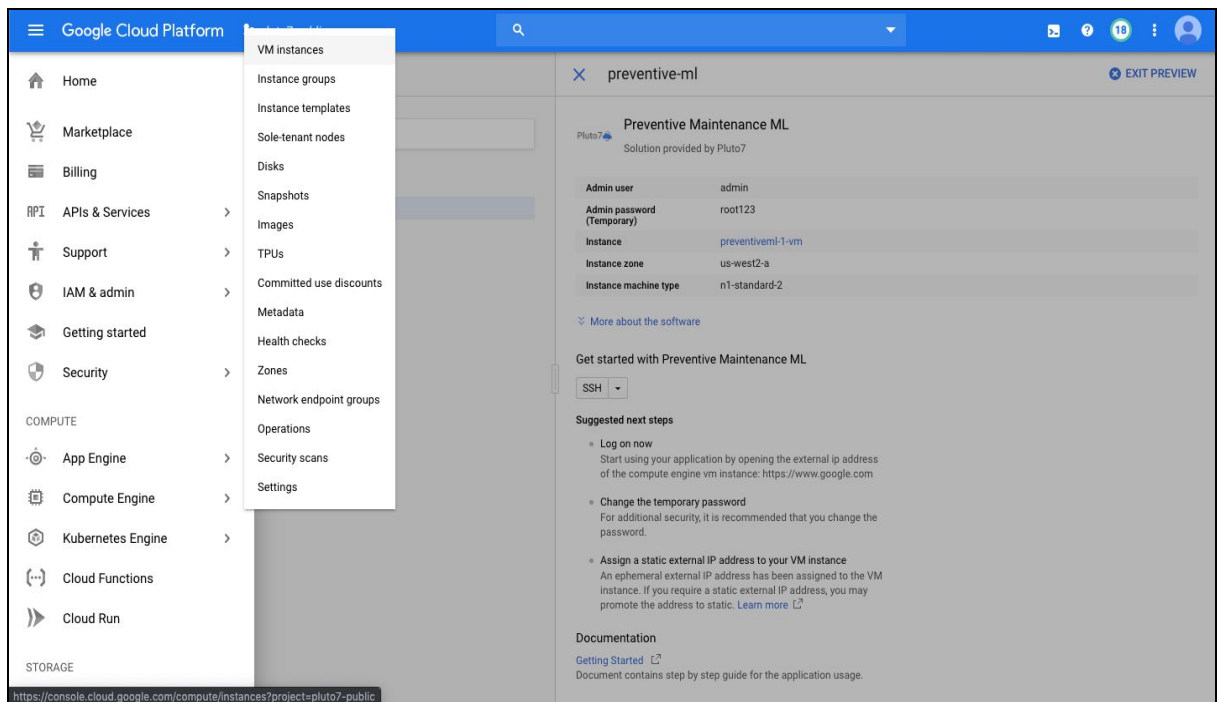
- Log on now**
Start using your application by opening the external IP address of the compute engine vm instance: <https://www.google.com>
- Change the temporary password**
For additional security, it is recommended that you change the password.
- Assign a static external IP address to your VM instance**
An ephemeral external IP address has been assigned to the VM instance. If you require a static external IP address, you may promote the address to static. [Learn more](#)

Documentation

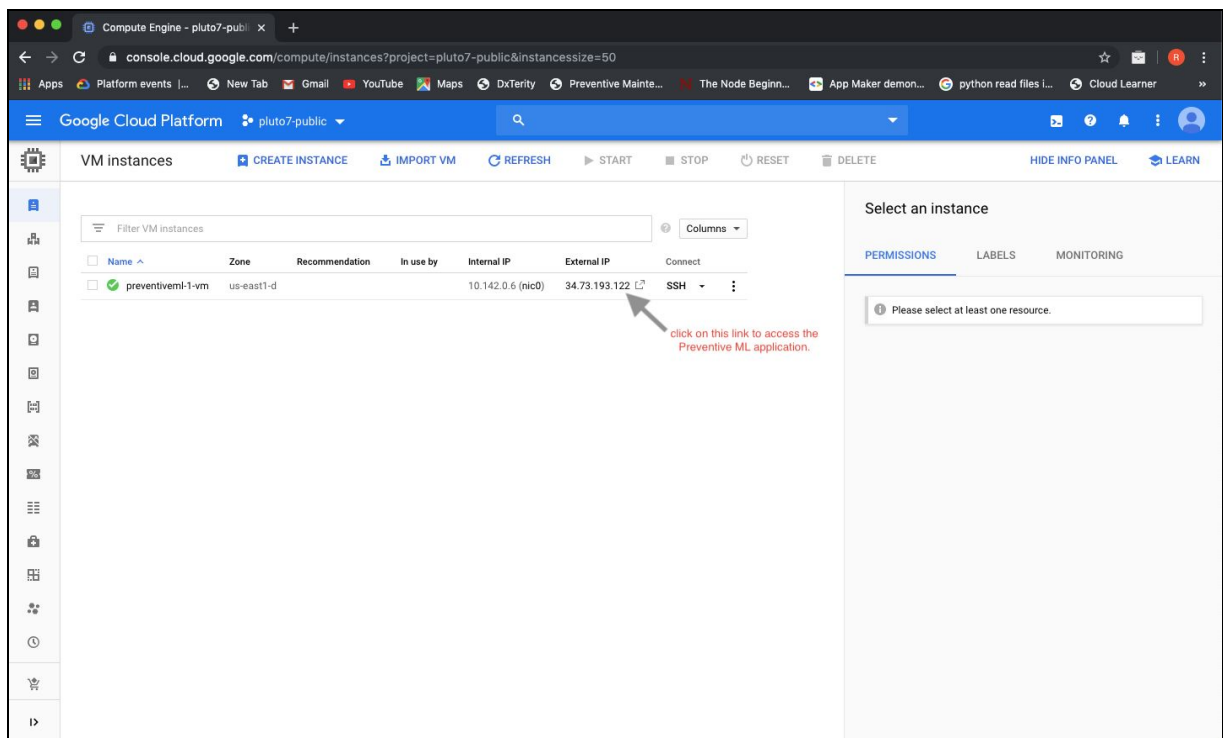
[Getting Started](#) [?](#)
Document contains step by step guide for the application usage.

Fig: PML Deployment.

Next, go to compute engine VM instance section of Google Cloud Console,



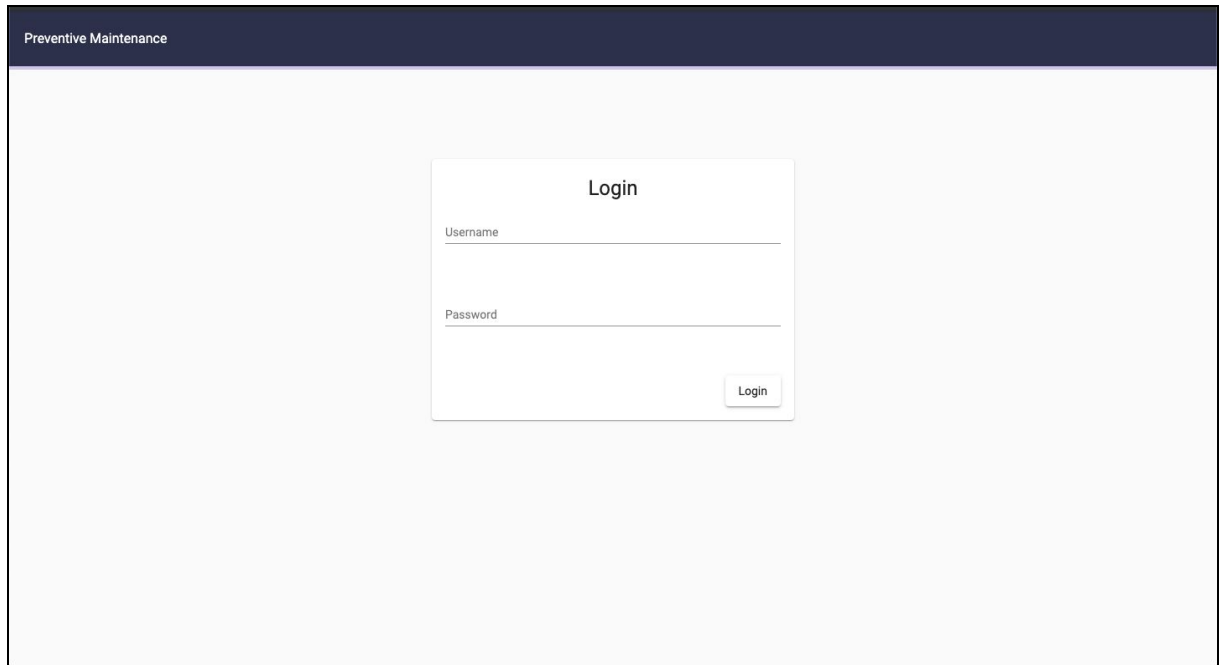
Next, in the Compute Engine the VM instances list shows an instance with name **preventiveml-1-vm**. Click on external IP of the VM to access the Preventive Maintenance ML application.



- After enabling all the APIs listed above, open the external link of the VM instance in a web browser which opens a login page. The default login details are-

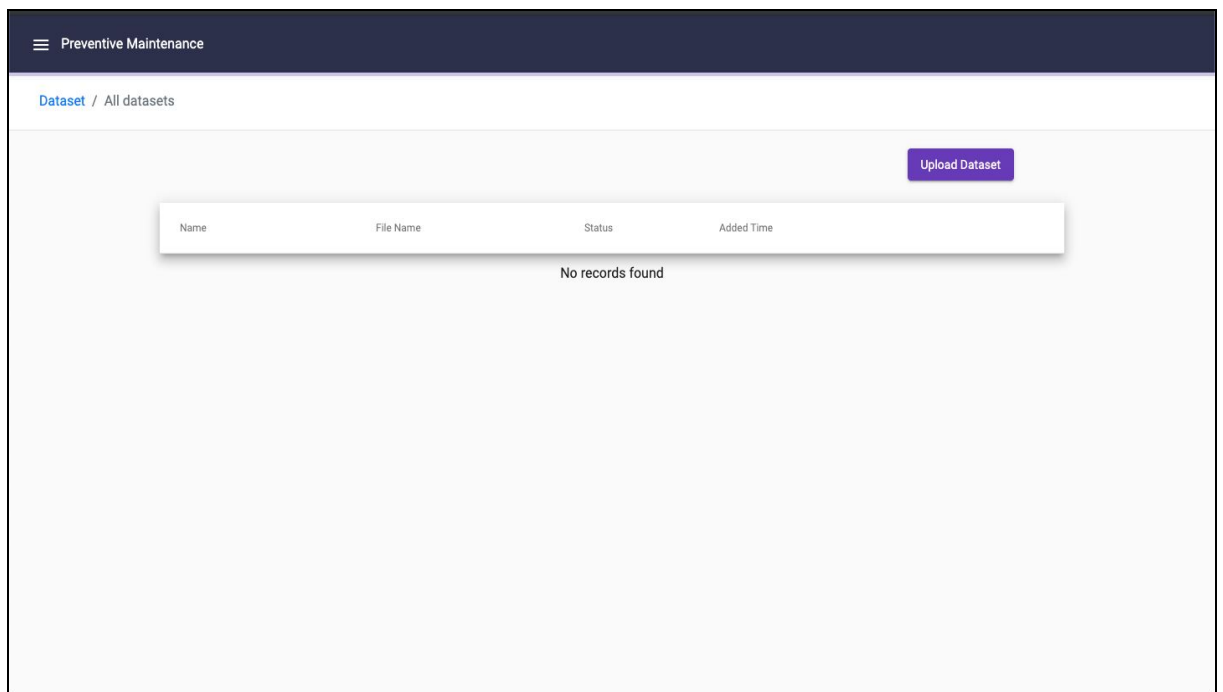
User: **Admin**

Password: **root123**



The screenshot shows a web application interface with a dark blue header bar containing the text "Preventive Maintenance". The main content area is light gray and features a white login form in the center. The form is titled "Login" and contains two input fields: "Username" and "Password". A "Login" button is located at the bottom right of the form.

- After successful login, app loads datasets page



The screenshot shows the "Dataset" page of the application. The dark blue header bar contains a hamburger menu icon and the text "Preventive Maintenance". Below the header, the breadcrumb "Dataset / All datasets" is visible. On the right side, there is a purple button labeled "Upload Dataset". In the center, there is a white table with the following columns: "Name", "File Name", "Status", and "Added Time". Below the table, the text "No records found" is displayed.

Fig 1.1: Dataset home page

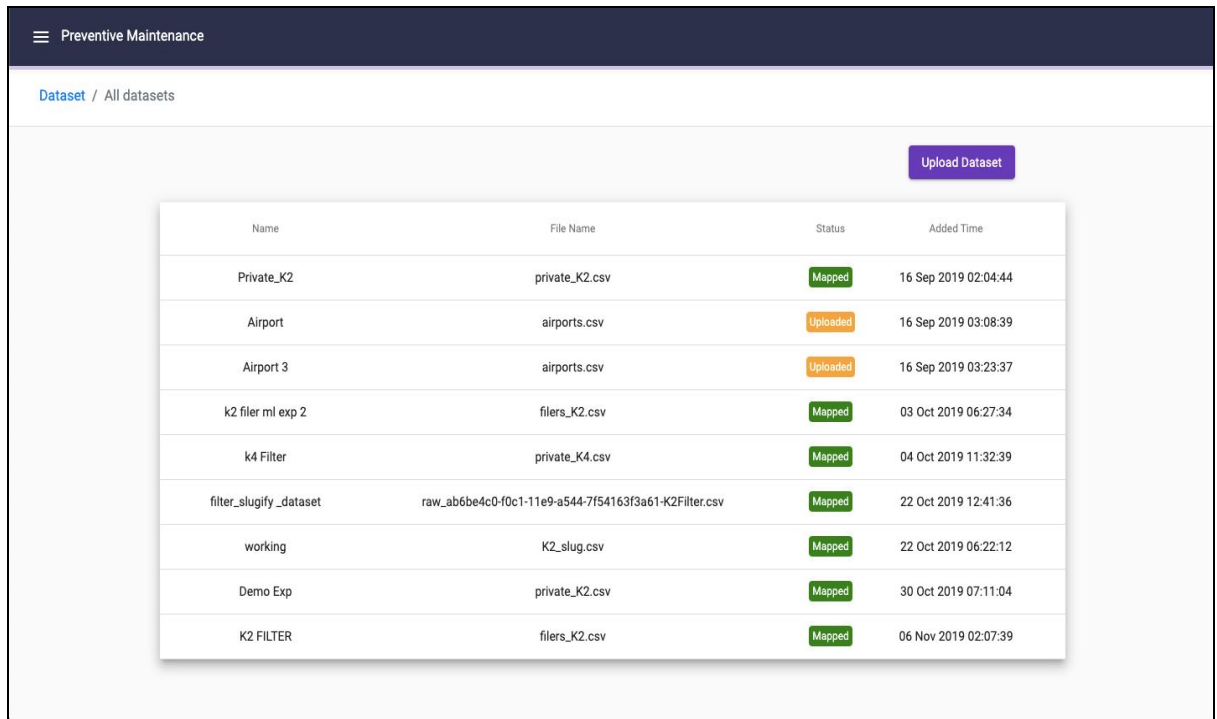
5. Upload New Dataset. Sample dataset is available in the [cloud storage bucket](#) and bucket name can be identified as [GOOGLE_CLOUD_PROJECT_NAME]-pma-objects. Name of the file is `sample_dataset/sample-dataset.csv`. Name field in Upload Dataset is mandatory along with the csv file.

Note: Dataset file size is limited to < 50MB currently.

The screenshot shows a web application interface for uploading a dataset. At the top, there is a dark blue header with a hamburger menu icon and the text 'Preventive Maintenance'. Below the header, a breadcrumb trail reads 'Datasets / Create'. The main content area is divided into two panels. The left panel, titled 'Upload Dataset', contains a 'Name' input field, a dashed box for file upload with a 'CHOOSE FILE' button and the text 'or drag and drop file here', and a 'Submit' button. The right panel, titled 'What's in the box?', displays a horizontal flow of four steps: 1. UPLOAD DATASET (highlighted with a green circle), 2. ANALYTICS, 3. DATA CLEANING, and 4. MODEL & PREDICTION.

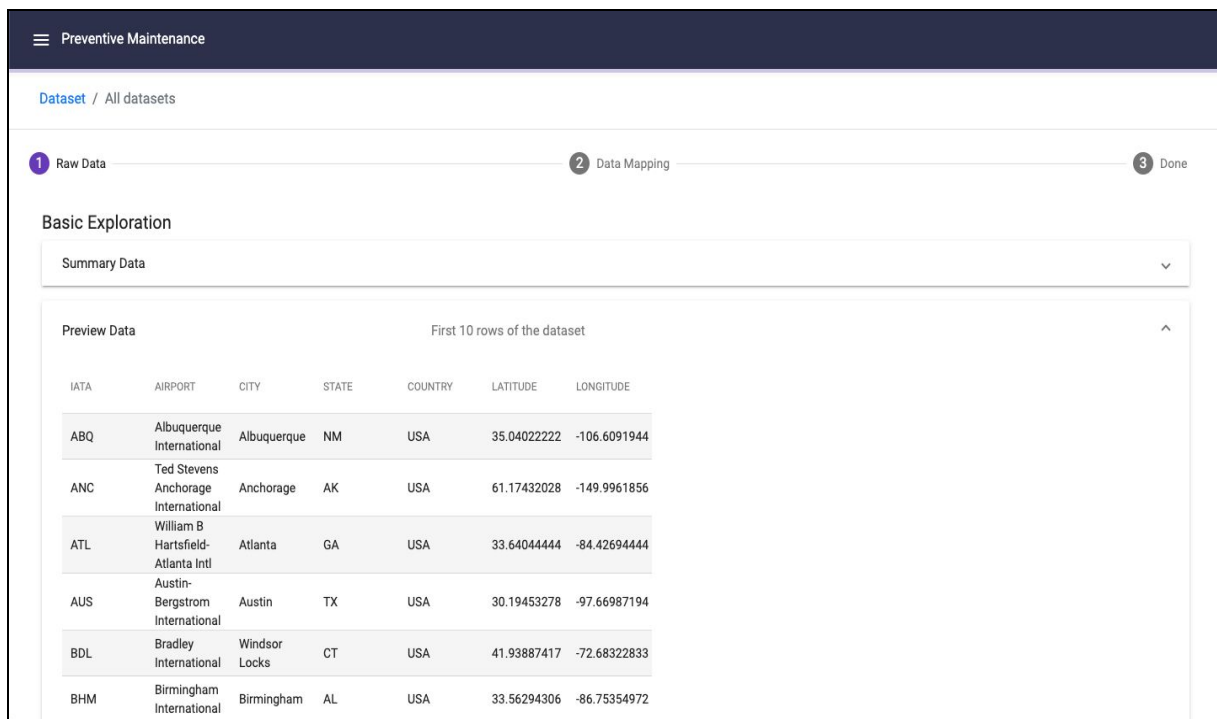
Fig 1.2: Upload Dataset

6. After uploading dataset, the app will redirect to datasets list page and select any one from the list to see sample set of the data. In the same page there is an option for attribute mapping. In fig 1.4 data step 2 is attribute mapping.



Name	File Name	Status	Added Time
Private_K2	private_K2.csv	Mapped	16 Sep 2019 02:04:44
Airport	airports.csv	Uploaded	16 Sep 2019 03:08:39
Airport 3	airports.csv	Uploaded	16 Sep 2019 03:32:37
k2 filer ml exp 2	filers_K2.csv	Mapped	03 Oct 2019 06:27:34
k4 Filter	private_K4.csv	Mapped	04 Oct 2019 11:32:39
filter_slugify_dataset	raw_ab6be4c0-f0c1-11e9-a544-7f54163f3a61-K2Filter.csv	Mapped	22 Oct 2019 12:41:36
working	K2_slug.csv	Mapped	22 Oct 2019 06:22:12
Demo Exp	private_K2.csv	Mapped	30 Oct 2019 07:11:04
K2 FILTER	filers_K2.csv	Mapped	06 Nov 2019 02:07:39

Fig 1.3: List of Datasets



IATA	AIRPORT	CITY	STATE	COUNTRY	LATITUDE	LONGITUDE
ABQ	Albuquerque International	Albuquerque	NM	USA	35.04022222	-106.6091944
ANC	Ted Stevens Anchorage International	Anchorage	AK	USA	61.17432028	-149.9961856
ATL	William B Hartsfield-Atlanta Intl	Atlanta	GA	USA	33.64044444	-84.42694444
AUS	Austin-Bergstrom International	Austin	TX	USA	30.19453278	-97.66987194
BDL	Bradley International	Windsor Locks	CT	USA	41.93887417	-72.68322833
BHM	Birmingham International	Birmingham	AL	USA	33.56294306	-86.75354972

Fig 1.4: Sample data of uploaded dataset.

- After attribute mapping is completed for the dataset, go to data experiments page and create a data experiment for the mapped dataset.

Preventive Maintenance

Data Experiment / All Experiments

Create Experiment

Id	Name	Dataset	Status
1	K2 1	Private_K2	Started
2	K2 Exp 2	Private_K2	Started
3	K2 Exp 3	Private_K2	Completed
4	Data Exp 4	Private_K2	Completed
5	k2 data exp	k2 filer ml exp 2	Completed
6	K4 Filter Testing	k4 Filter	Completed
7	Data Exp 10	Private_K2	Completed
8	Slugify Dataset Exp	filter_slugify_dataset	Completed
9	working_exp	working	Completed
10	Demo Exp	Demo Exp	Completed

Fig 1.5: List of all data experiments.

In Create Data Experiment give a name for the experiment and choose a mapped dataset. Then click create.

The screenshot shows the 'Create Data Experiment' interface. On the left is a sidebar with a menu containing 'Datasets', 'Experiments', 'Data Experiments', and 'ML Experiments'. The main header is 'Preventive Maintenance'. The breadcrumb trail is 'Data Experiment / Create'. The main content area is titled 'Create Data Experiment' and contains a form with a 'Name' input field, a 'Choose Dataset' dropdown menu, and a 'Create' button. To the right of the form is a vertical sequence of four steps: 1. UPLOAD DATASET, 2. ANALYTICS, 3. DATA CLEANING, and 4. MODEL & PREDICTION. Steps 1 and 2 are highlighted with green circles.

Fig 1.6: Create a new data experiment.

8. In data experiments list page click on any of the list item to see the transformations applied on the dataset.

The screenshot shows the 'Data Experiment Details' page. The sidebar is the same as in Fig 1.6. The breadcrumb trail is 'Data Experiment / DATA EXP'. There are two tabs: 'Details' (selected) and 'Visualizations'. The 'Details' tab is divided into two sections. The left section, 'Experiment Summary', contains a table with the following data: 'Started At' (06 Nov 2019 02:12:10), 'Completed At' (06 Nov 2019 02:12:22), 'Total Transformations' (4), and 'Status' (Completed). The right section, 'Applied Transforms', contains a list of four transforms: 'Type Casting', 'Columns to drop', 'Columns to drop', and 'Impute Missing Values'. Each transform is represented by a button with a downward arrow.

Fig 1.7: Data experiment details and transformations.

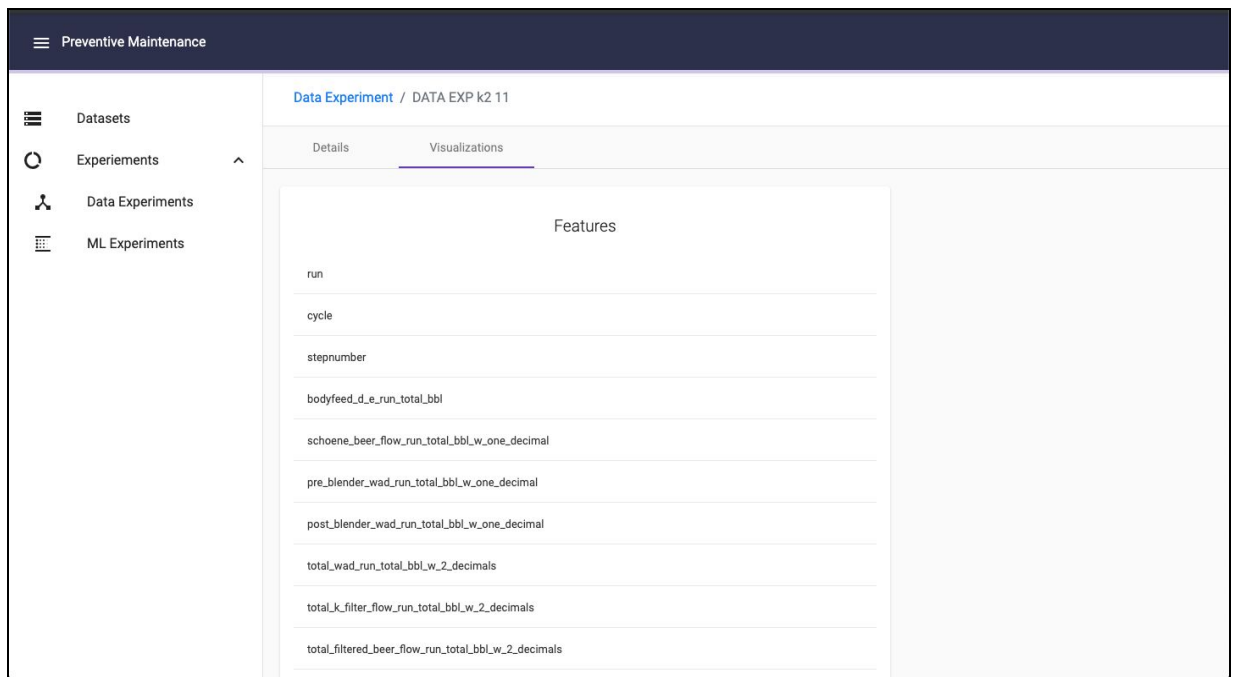


Fig 1.8: Lists of all features of dataset.

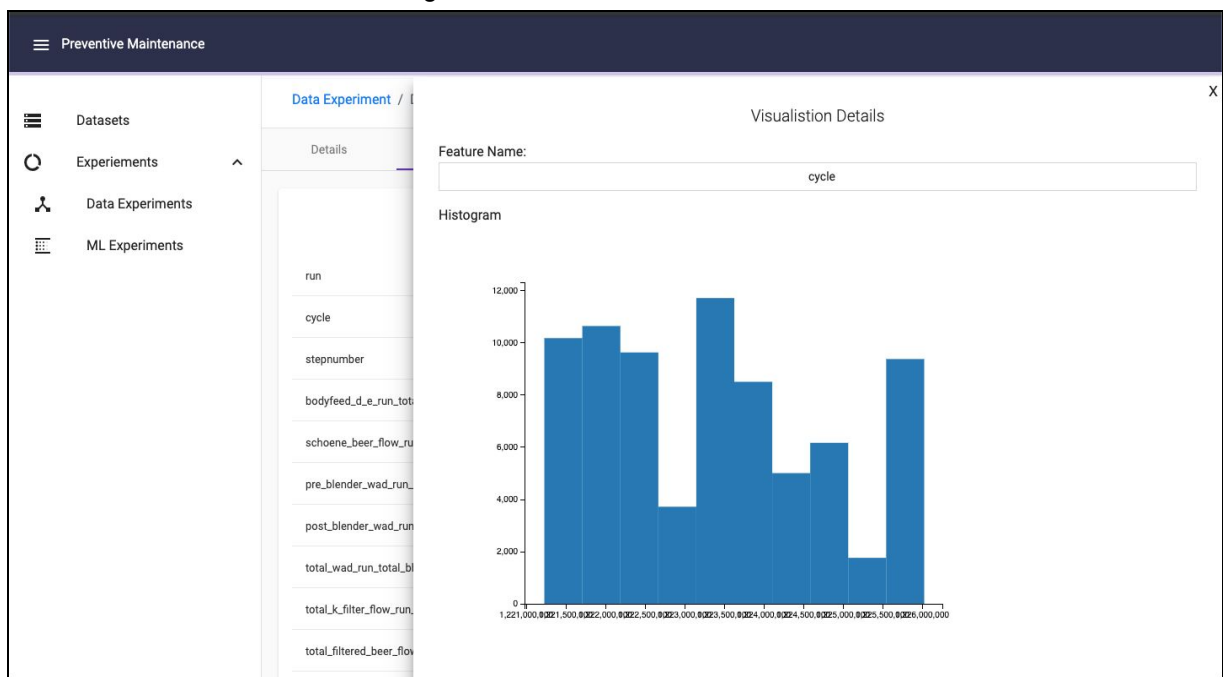


Fig 1.9: Data distribution.

- After data experiment is completed, go to ML Experiments. Click on create experiment present on top right side of the page.

In create ml experiment zoo type indicates custom model developed by pluto7 and AutoML which represents google cloud AutoML Table.

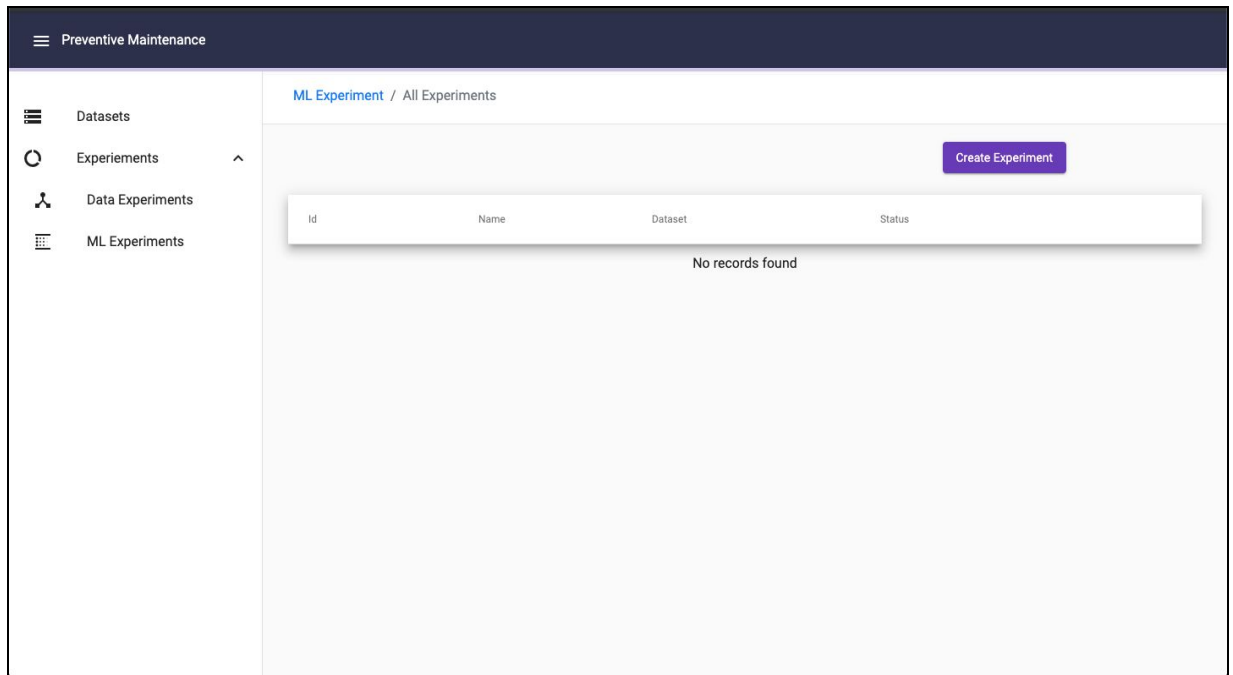


Fig 1.9: List of all ML Experiments.

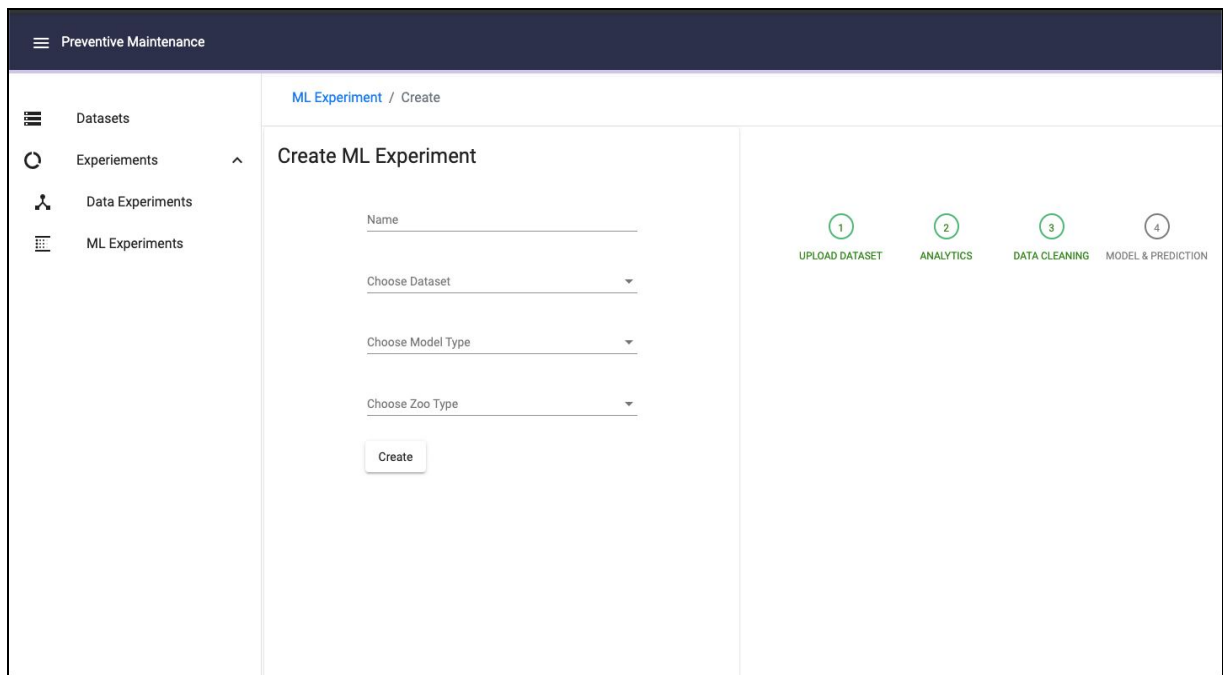


Fig 2.1: Create ML Experiment.

10. In ML Experiments list page click on any of the list item to see the model output.

Preventive Maintenance

Datasets

Data Experiments

ML Experiments

ML Experiment / All Experiments

Create Experiment

id	Name	Dataset	Status
1	ML Exp 2	K2 Exp 3	Created
2	ML Exp 2	K2 Exp 3	Created
3	ML Exp 3	K2 Exp 3	Created
4	ML Exp 4	Data Exp 4	Created
5	ML Exp 5	Data Exp 4	Created
6	ML Exp 6	Data Exp 4	Created
7	Exp 3	Data Exp 4	Created
8	Exp 8	Data Exp 4	Trained
9	k2 ml exp	k2 data exp	Created
10	testing_exp	k2 data exp	Trained

Fig 2.2: ML Experiment details.

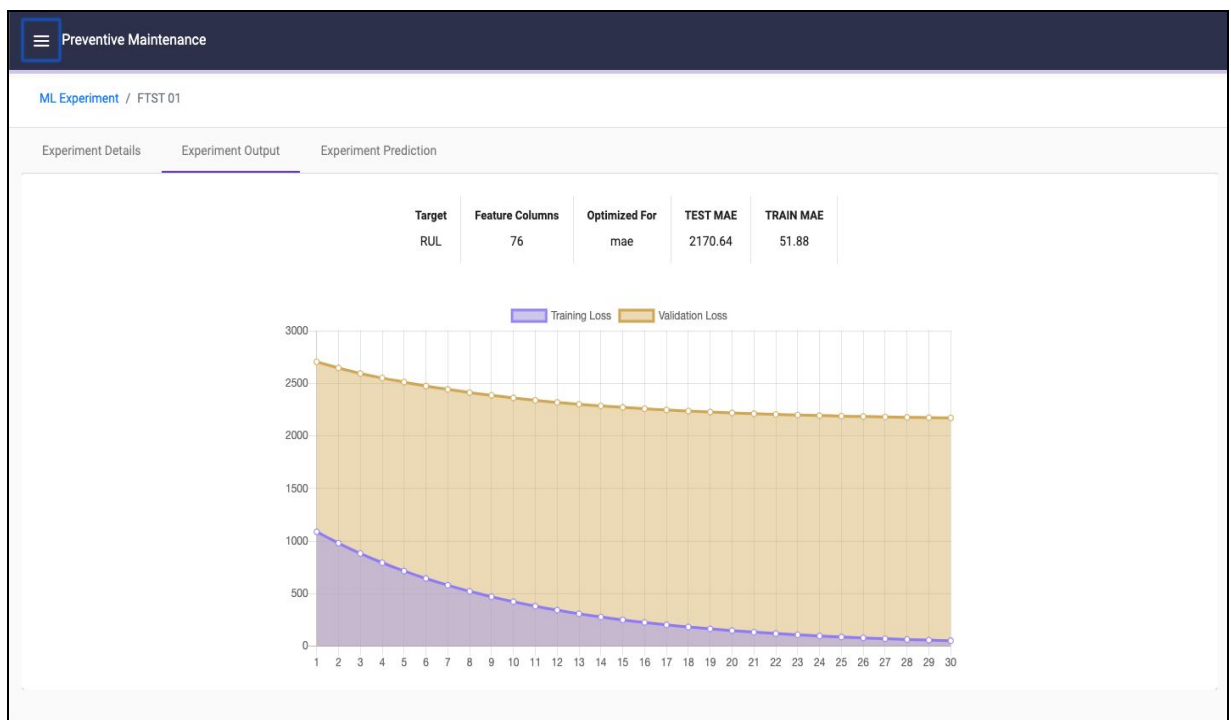
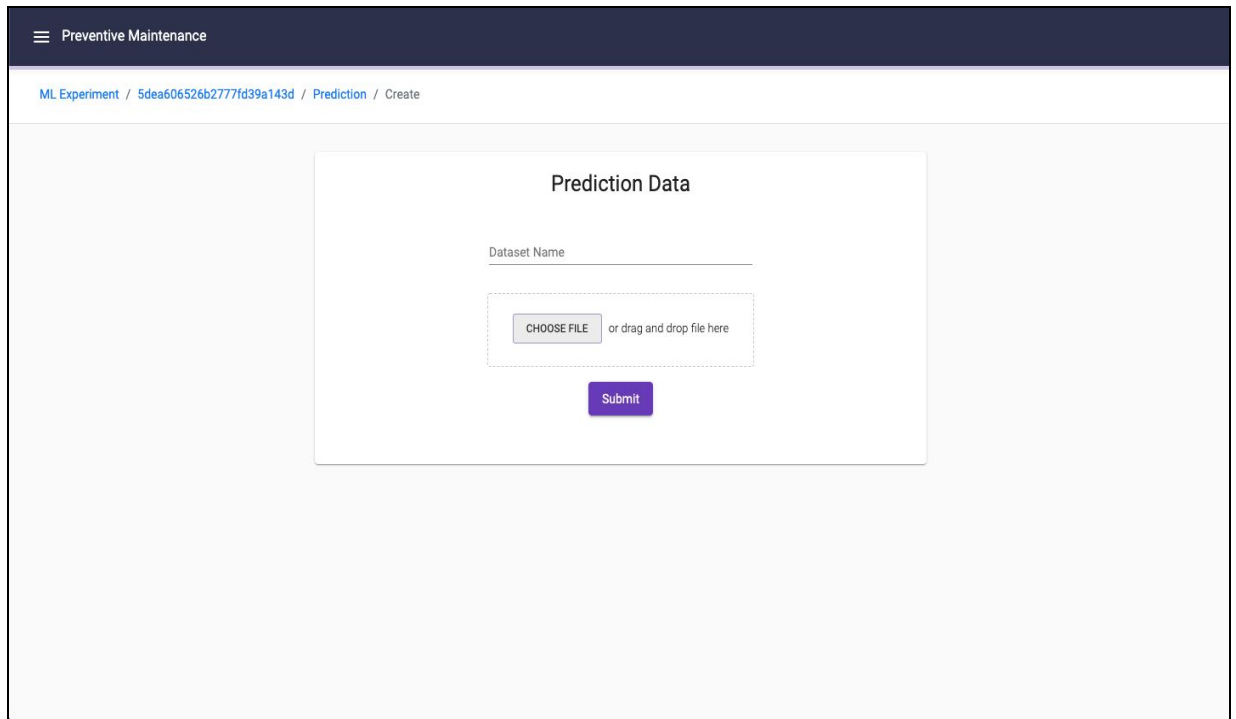


Fig 2.3: Model performance over the time period.

Once model is **trained** successfully then predictions can be generated for the model. To create a new prediction click on create prediction button and give a name for the prediction and upload the dataset. Sample dataset is available in the [cloud storage bucket](#) and bucket name can be identified as [GOOGLE_CLOUD_PROJECT_NAME]-pma-objects. Name of the file is sample_dataset/prediction-test-dataset.csv. Name field in Upload Dataset is mandatory along with the csv file.

Note: Dataset file size is limited to < 50MB currently.



The screenshot shows a web application interface for creating a new prediction. At the top, there is a dark blue header with a hamburger menu icon and the text 'Preventive Maintenance'. Below the header is a breadcrumb trail: 'ML Experiment / 5dea606526b2777fd39a143d / Prediction / Create'. The main content area is light gray and contains a white box titled 'Prediction Data'. Inside this box, there is a 'Dataset Name' label followed by a text input field. Below the input field is a dashed border box containing a 'CHOOSE FILE' button and the text 'or drag and drop file here'. At the bottom of the white box is a purple 'Submit' button.

Fig 2.5: Create new prediction.

Preventive Maintenance

[ML Experiment](#) / [5dea606526b2777fd39a143d](#) / Prediction

Experiment Details

Experiment Output

Experiment Prediction

Create Prediction

Id	Name	Status	Added Time
1	FTST 01 PRED	Completed	06 Dec 2019 07:46:37

Fig 2.5: Model Predictions.

Preventive Maintenance

[ML Experiment](#) / [5dea606526b2777fd39a143d](#) / [Prediction](#) / [5dea62c526b2777fd39a143e](#)

Prediction Details

Prediction Preview

Id

5dea62c526b2777fd39a143e

Status

Completed

ML Experiment

[5dea606526b2777fd39a143d](#)

Added At

2019-12-06T14:16:37.836Z

Dataset

[Prediction Dataset](#)

Download prediction

No.	Prediction (sequence steps in interval of 10 seconds)
1	2225
2	2225
3	2225
4	2225
5	2225
6	2225
7	2225
8	2225
9	2225
10	2225

Fig 2.5: Prediction output.

Contact Information:

For any queries please mail us at contact@pluto7.com.

Know more:

1. [Preventive maintenance](#).
2. Ab Inbev customer [success story](#) and google cloud [Case Study](#).