COSC 2626
Cloud Computing

Final Report

FARM MONITOR
BY

Swati Arora	s3796848
Maaz Shaikh	s3795603

RMIT University

Table of Contents

Summary

We have a strategy that allows the farmers and the government to monitor and control their fields in a much-simplified way. Several factors influence the production of crops such as the Moisture Index and the pH value of the soil. The health and well-being of the crops are regulated by these variables. It is recommended for farmers to consider these principles prior to actually making a decision amelioration of the crops. Having information about the weather forecast and prior awareness of the above-mentioned factors will assist the farmers in production planning and harvesting, and preparing marketing strategies beforehand. Knowledge about the accurate harvesting time and the health of the crops will aid in planning the precise amount of storage required, schedule shipping and distribution to customers in advance.

The solution we provide will include details about the Vegetation Index (NDVI) of the crops acknowledging farmers about the crop's health. Through our approach, the Moisture Index and the pH value of the soil appropriate for the growth of the sugarcane can also be studied.
A small area in the land of Queensland was selected for our study and required information and data were obtained from a newly launched satellite called Landsat 8. The purpose of the Landsat 8 satellite is to gather data and images for the agriculture, research, businesses and government. Various data is supplied through different channels and bands.

Introduction

Farming is a calling, not just a job. The agriculture industry is the backbone of most countries' economies, especially here in Australia.It creates opportunities to bring people out of poverty in developing nations. Monitoring the growth of the crop and performance during the stages of development is an important feature for the management of agriculture. Proper management enables farmers to implement timely interventions to ensure high rates of crop yields. Since,agricultural lands are so vast like in Australia where they cover 61% of Australia's landmass[5], monitoring the crops growth and health of the soil is extremely difficult and stressful for farmers. This has a big impact on the crop production which means it has an impact on people's life and the economy. We intend to aid our farmers and the government, and have come up with a solution to help them monitor and maintain their fields.

Our Solution

We use the Landsat-8 satellite data to track the various factors for crop growth like the soil pH, the moisture index and the vegetation index. With this we provide the following functions:

Monitoring the health of the crops

The Normalised Difference Vegetation Index is a basic calculation that represents the general vegetation health. To get the Vegetation Index from the Landsat satellite, we use the NDVI indicator. This process is done remotely without any hassle of visiting the fields and gathering the soil sample to monitor.

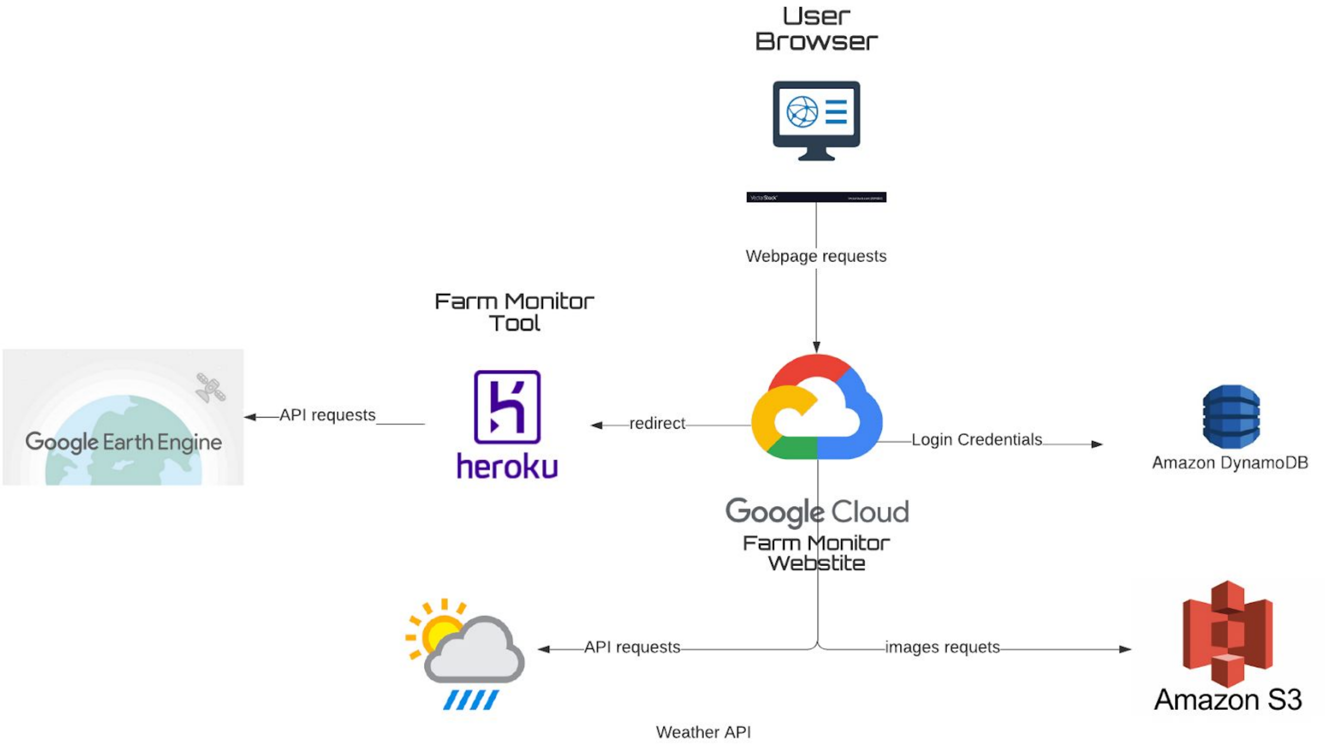
Monitoring soil composition

The Normalised Difference Moisture Index is used to calculate the moisture content in the fields. Low moisture index can hinder the growth of the crop, hence it is important to monitor the moisture content.

Allowing comparison

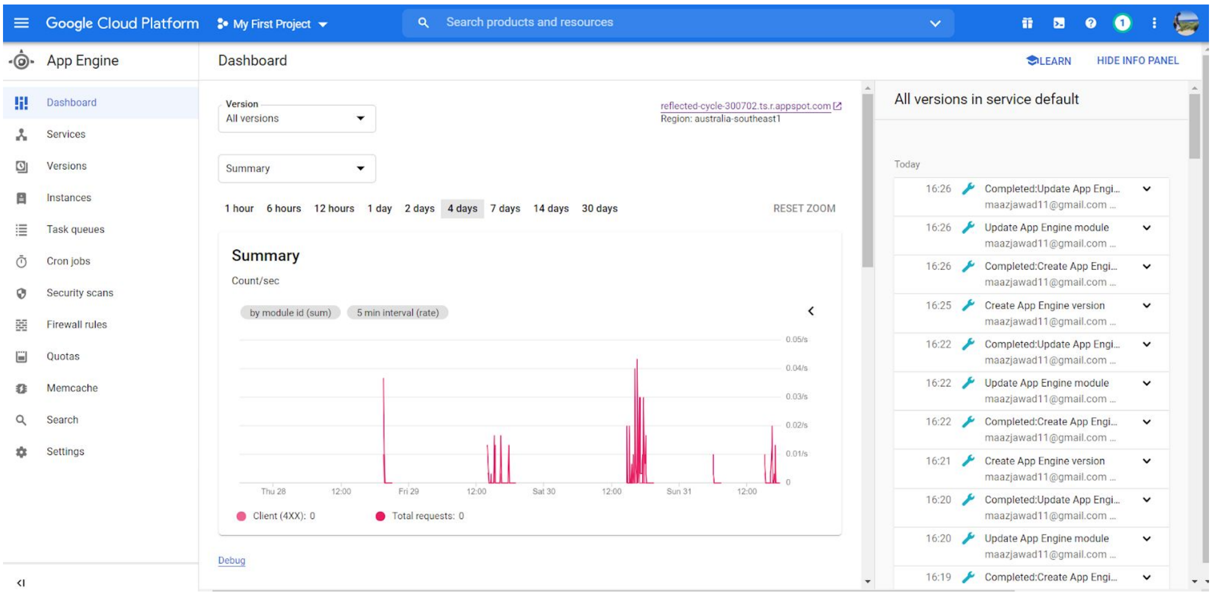
With the help of Vegetation Index, farmers and the government can compare their fields and educate themselves about the methods and procedures used by other farmers to improve their crop's health. The standard way of measuring the vegetation index includes taking the soil sample from the field which will undergo the process of finding the vegetation index. It is time-consuming and needs more man-hours to complete the whole task. Furthermore, the Vegetation Index can be beneficial to the government as it enables them to accurately compare different regions to identify which fields require additional assistance to increase the overall production.

Software Design/Architecture



Google Cloud

Google Cloud Platform is a provider of computing resources for deploying and operating **applications** on the web. We deployed our farm monitor website on it (see below).



Version: All versions

reflected-cycle-300702.ts.r.appspot.com
Region: australia-southeast1

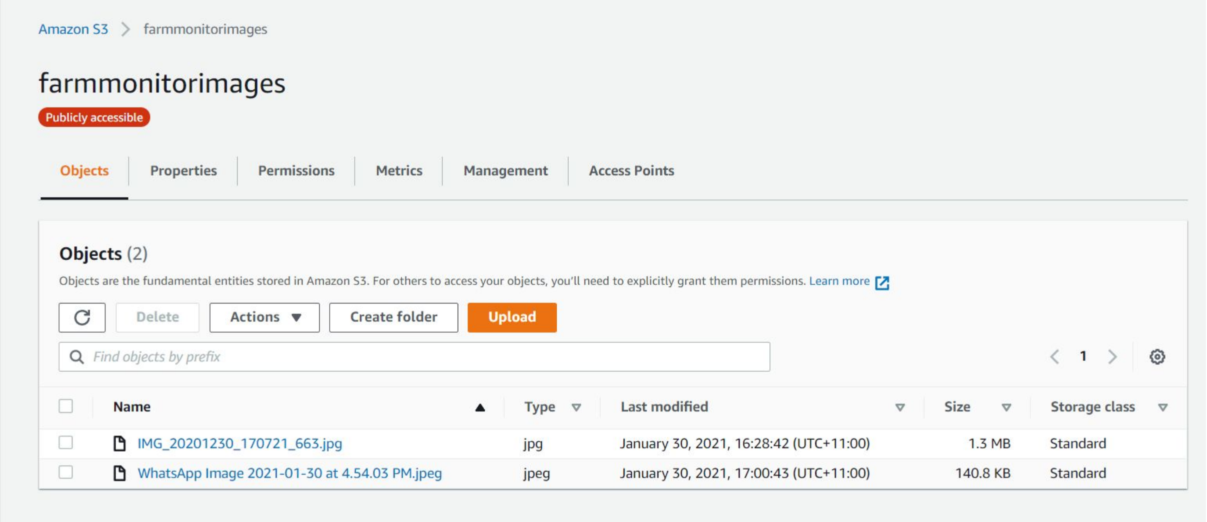
All versions in service default

Today

16:26	Completed:Update App Engi... maazjawad11@gmail.com ...
16:26	Update App Engine module maazjawad11@gmail.com ...
16:26	Completed:Create App Engi... maazjawad11@gmail.com ...
16:25	Create App Engine version maazjawad11@gmail.com ...
16:22	Completed:Update App Engi... maazjawad11@gmail.com ...
16:22	Update App Engine module maazjawad11@gmail.com ...
16:22	Completed:Create App Engi... maazjawad11@gmail.com ...
16:21	Create App Engine version maazjawad11@gmail.com ...
16:20	Completed:Update App Engi... maazjawad11@gmail.com ...
16:20	Update App Engine module maazjawad11@gmail.com ...
16:19	Completed:Create App Engi...

Amazon S3

Amazon S3 or the Amazon Simple Storage Service is internet storage designed for designers to simplify web-scale computing. Amazon S3 has a convenient design for web services which can be used to store and recover data to any quantity from any location and at any time on the web. We use S3 to store images that are required for the farm monitor website (see below).



farmmonitorimages

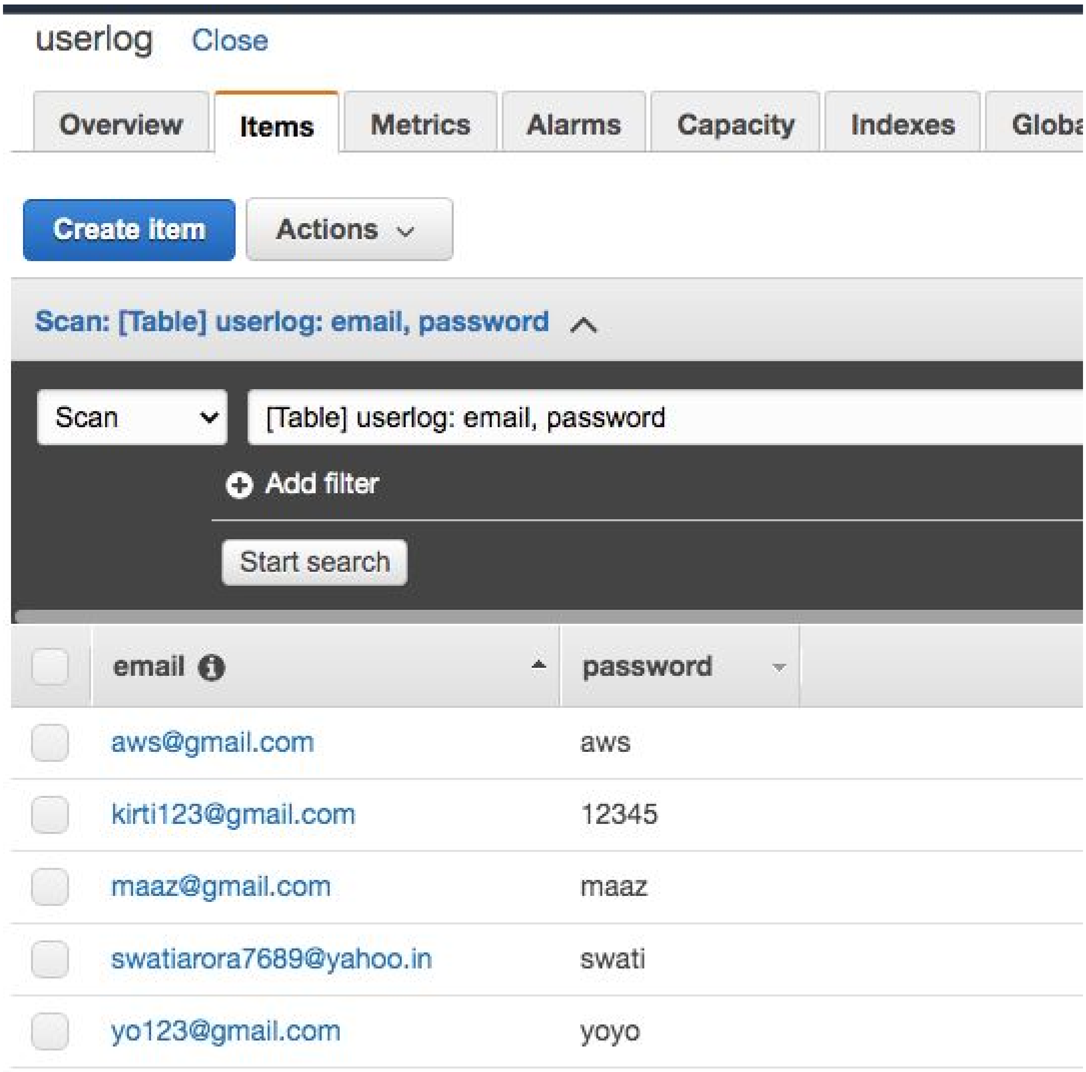
Objects (2)

Objects are the fundamental entities stored in Amazon S3. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

□	Name ▲	Type ▽	Last modified ▽	Size ▽	Storage class ▽
□	IMG_20201230_170721_663.jpg	jpg	January 30, 2021, 16:28:42 (UTC+11:00)	1.3 MB	Standard
□	WhatsApp Image 2021-01-30 at 4.54.03 PM.jpeg	jpeg	January 30, 2021, 17:00:43 (UTC+11:00)	140.8 KB	Standard

AWS DynamoDB

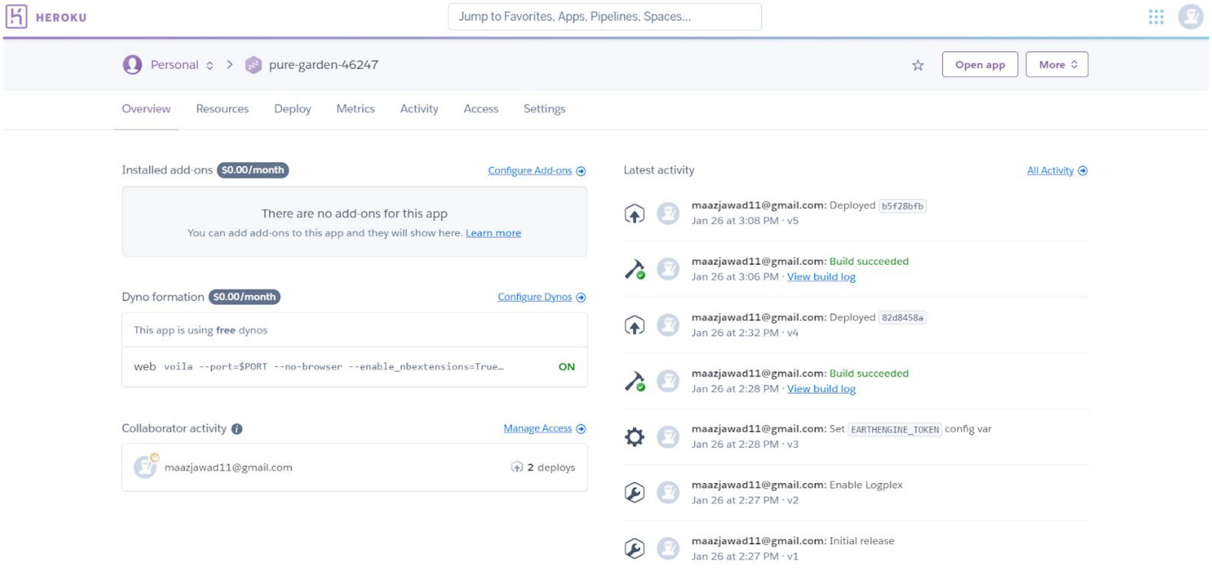
Amazon DynamoDB is a NoSQL database offered by Amazon Web Services. We created a table called ‘userlog’ to store the data entered by the users. So anything that the user enters in the signup form will be stored into the table (see below).



	email	password
□	aws@gmail.com	aws
□	kirti123@gmail.com	12345
□	maaz@gmail.com	maaz
□	swatiarora7689@yahoo.in	swati
□	yo123@gmail.com	yoyo

Heroku

Heroku is a platform as a service (PaaS) that enables developers to build, run, and operate applications entirely in the cloud. We use heroku to deploy our farm monitor tool which is a jupyter notebook app wrapped around the voilà library (see below).



Installed add-ons $0.00/month

There are no add-ons for this app

You can add add-ons to this app and they will show here. Learn more

Dyno formation $0.00/month

This app is using **free** dynos

```
web voila --port=$PORT --no-browser --enable_nbextensions=True…    ON
```

Collaborator activity

maazjawad11@gmail.com — 2 deploys

Latest activity

maazjawad11@gmail.com: Deployed `b5f28bfb`
Jan 26 at 3:08 PM · v5

maazjawad11@gmail.com: Build succeeded
Jan 26 at 3:06 PM · View build log

maazjawad11@gmail.com: Deployed `82d8458a`
Jan 26 at 2:32 PM · v4

maazjawad11@gmail.com: Build succeeded
Jan 26 at 2:28 PM · View build log

maazjawad11@gmail.com: Set `EARTHENGINE_TOKEN` config var
Jan 26 at 2:28 PM · v3

maazjawad11@gmail.com: Enable Logplex
Jan 26 at 2:27 PM · v2

maazjawad11@gmail.com: Initial release
Jan 26 at 2:27 PM · v1

API’s & Datasets

Google earth engine API [2]

Google earth engine is a service that performs geospatial processing. Geospatial analysis on a scale can be done with Earth Engine, provided by Google Cloud Platform. Farm monitor encrypts the recent pictures with Google Earth Engine API, and the Earth Engine sorts the dataset by date, automating the whole process, rendering it scalable. By this way, analysing any field in this world can be possible.

Property Boundaries [1]

For users to help in choosing their sites for study, we obtained from the Queensland spatial catalogue for a few areas in the Whitsunday area of Queensland. The collected Spatial data is then layered on top of the map interface. For any area needed, this overlap process can be used by extracting the data from the catalogue.

Datasets

USGS Landsat 8 Collection 1 Tier 1 TOA Reflectance [3]

Pictures from Landsat 8 satellite are used obtained from the data catalogue of the Google Earth Engine. We use a measured Top-Of-Atmosphere (TOA) reflectance dataset from various Landsat 8 datasets generated. The pictures from Google Earth Engine API are collected and saved in the ImageCollection format, which seems to be a pile or sequence of pictures. These ImageCollection items are then used to filter Landsat 8 catalogue to generate the NDMI, NDVI and pH layer for the selected area.

Weather API [4]

We use the new york times weather API to provide our users the forecast of the next 5 days in their current region.

Implementation - Developer Manual

Front-end:

1. Develop a front end using HTML and CSS.

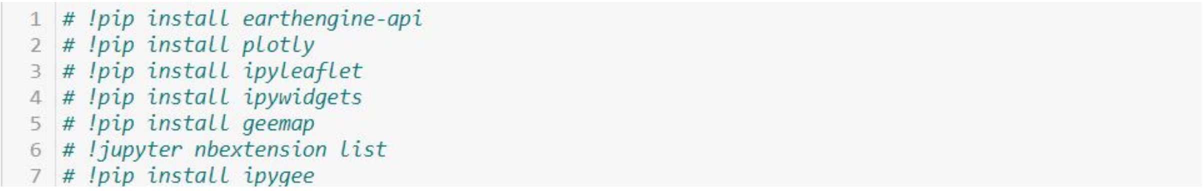
2 . Install flask and boto3 to create an application and to connect it to DynamoDB.

3. Create a login and signup page so that users can enter their details and access the website through it.

4. Create a homepage to provide a summary of the application and a link to the Farm monitor tool.

5. Insert a weather API (we used new york times weather API[4]. Link provided in references) to provide weather forecasts.

6. Develop the Farm monitor tool using python on the jupyter notebook software. You will require the following packages:



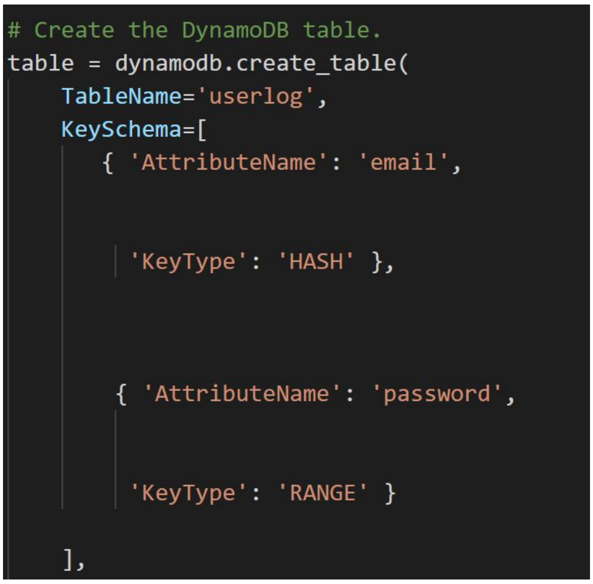
```
# !pip install earthengine-api
# !pip install plotly
# !pip install ipyleaflet
# !pip install ipywidgets
# !pip install geemap
# !jupyter nbextension list
# !pip install ipygee
```

7. Download the property boundary files[1] (link in references) and add them to the project. Convert the shapefiles to earth engines objects using geemap.shp_to_ee() and then add as a layer using geemap.Map.addLayer().

Back-end:

1. Login & Sign up link to Dynamodb:

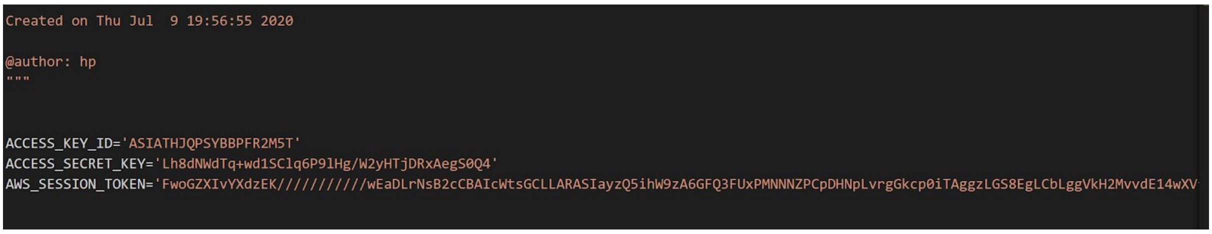
1.1.Create a dynamo db table ‘userlog’ using the following table having columns email and password.



```
# Create the DynamoDB table.
table = dynamodb.create_table(
    TableName='userlog',
    KeySchema=[
       { 'AttributeName': 'email',


         'KeyType': 'HASH' },



        { 'AttributeName': 'password',


         'KeyType': 'RANGE' }

    ],
```

1.2.Once the user inputs all the fields, the data is collected by us and is stored in various variables. After that, we inform flask where this collected information is to be stored and to connect our DynamoDB table ‘userinfo’’.

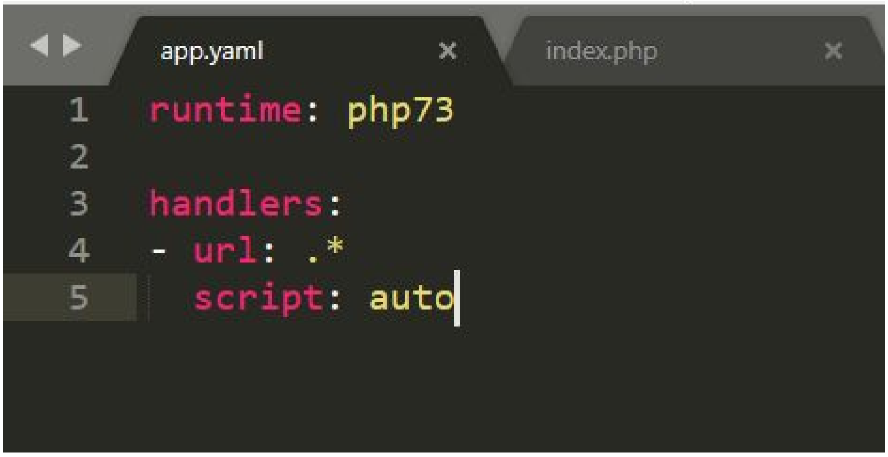
1.3 Create a key configuration file and enter the aws credentials to connect the dynamodb with your application.



```
Created on Thu Jul  9 19:56:55 2020

@author: hp
"""


ACCESS_KEY_ID='ASIATHJQPSYBBPFR2M5T'
ACCESS_SECRET_KEY='Lh8dNWdTq+wd1SClq6P9lHg/W2yHTjDRxAegS0Q4'
AWS_SESSION_TOKEN='FwoGZXIvYXdzEK///////////wEaDLrNsB2cCBAIcWtsGCLLARASIayzQ5ihW9zA6GFQ3FUxPMNNNZPCpDHNpLvrgGkcp0iTAggzLGS8EgLCbLggVkH2MvvdE14wXV
```

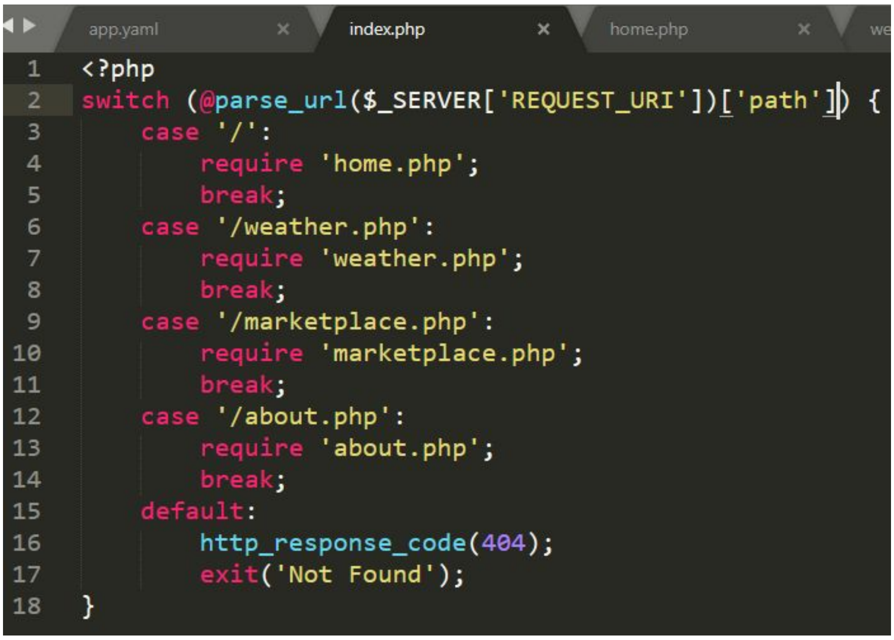
2. Deploying website on Google cloud

2.1 Create app.yaml file with following code:



```yaml
runtime: php73

handlers:
- url: .*
  script: auto
```

2.2 Create index.php with following code:



```php
<?php
switch (@parse_url($_SERVER['REQUEST_URI'])['path']) {
    case '/':
        require 'home.php';
        break;
    case '/weather.php':
        require 'weather.php';
        break;
    case '/marketplace.php':
        require 'marketplace.php';
        break;
    case '/about.php':
        require 'about.php';
        break;
    default:
        http_response_code(404);
        exit('Not Found');
}
```

2.3 Install Google Cloud SDK. Create a google account if you do not have one.

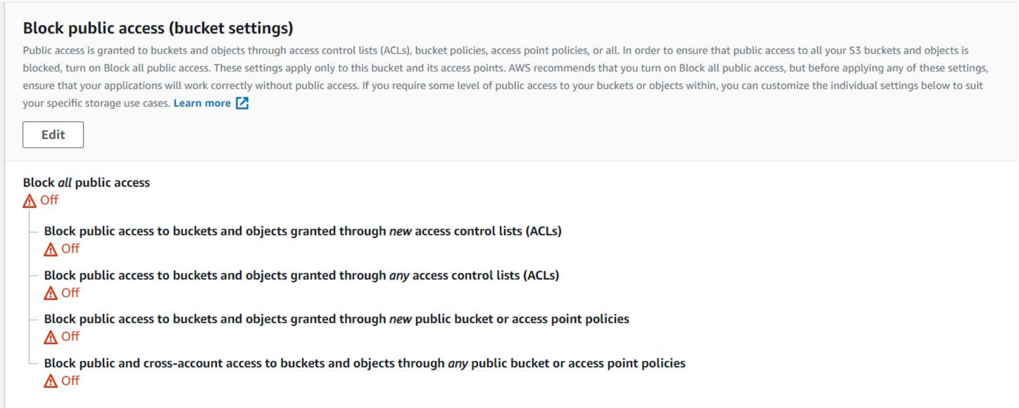
2.4 Write command ‘gcloud init’. Select your account. Then write the following command `gcloud app create` [`--region`=`REGION`] write your specific region.

2.5 Write command `gcloud app deploy` to deploy your app on google cloud.

2.6 Write command `gcloud app browse` to open your app on your browser

3. Accessing s3 objects

3.1 Create a bucket on S3 with following permissions



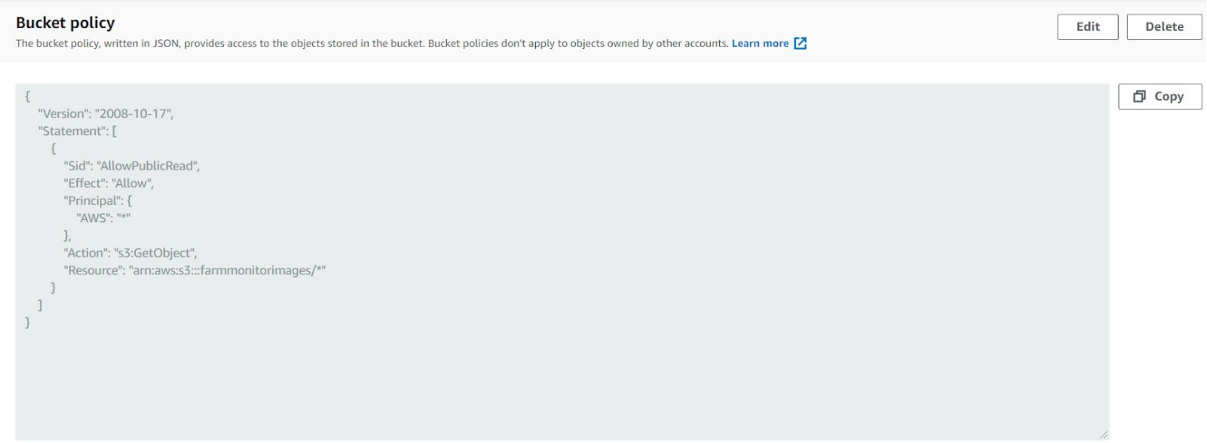
Block public access (bucket settings)

Public access is granted to buckets and objects through access control lists (ACLs), bucket policies, access point policies, or all. In order to ensure that public access to all your S3 buckets and objects is blocked, turn on Block all public access. These settings apply only to this bucket and its access points. AWS recommends that you turn on Block all public access, but before applying any of these settings, ensure that your applications will work correctly without public access. If you require some level of public access to your buckets or objects within, you can customize the individual settings below to suit your specific storage use cases. Learn more

Block *all* public access
⚠ Off

- Block public access to buckets and objects granted through *new* access control lists (ACLs)
⚠ Off
- Block public access to buckets and objects granted through *any* access control lists (ACLs)
⚠ Off
- Block public access to buckets and objects granted through *new* public bucket or access point policies
⚠ Off
- Block public and cross-account access to buckets and objects through *any* public bucket or access point policies
⚠ Off

3.2 After creation go to bucket policy and write the following code:



Bucket policy

The bucket policy, written in JSON, provides access to the objects stored in the bucket. Bucket policies don't apply to objects owned by other accounts. Learn more

```
{
  "Version": "2008-10-17",
  "Statement": [
    {
      "Sid": "AllowPublicRead",
      "Effect": "Allow",
      "Principal": {
        "AWS": "*"
      },
      "Action": "s3:GetObject",
      "Resource": "arn:aws:s3:::farmmonitorimages/*"
    }
  ]
}
```

3.3 Upload images, and copy their URL to access them.

4. Deploying Farm monitor tool & login/sign-up on Heroku

4.1 Create an account on Heroku & Download Heroku CLI.

4.2 In CLI type command “heroku login”, it will redirect you to a webpage. Click on login.

For login/sign-up:

4.3 Create requirements.txt file. You can use the command pip freeze > requirements. txt

4.4 Create Procfile with the following code => web: gunicorn app:app

4.5 Create template folder with login.html & index.html

4.6 In CLI type command “heroku create” to create a new app on heroku. It also creates a git repo for your app.

4.7 type command “git init” to initialize a git repo. Then type “ heroku git:remote -a <Your app name>” to link the heroku repo with your project.

4.8 type commands “git add .” “git commit -m <your message>” “git push heroku master”. To push the login & sign-up on heroku.

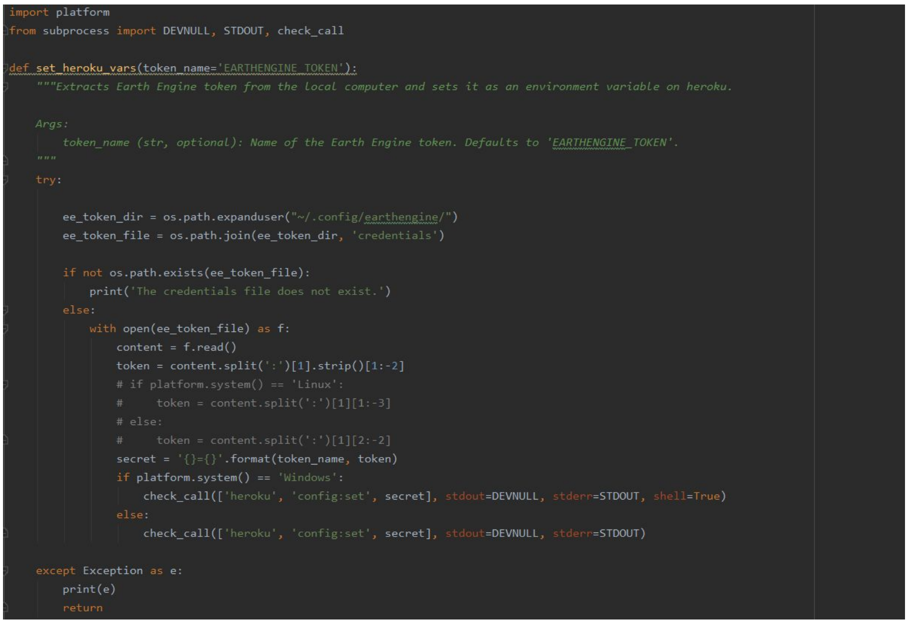
For Farm Monitor:

4.9 Create requirements.txt file. You can use the command pip freeze > requirements. txt

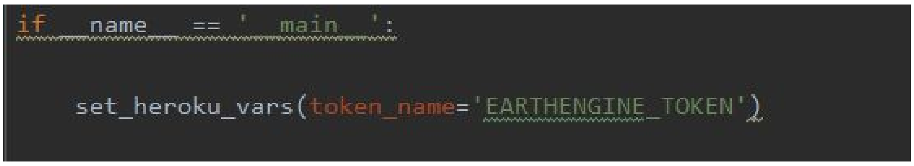
4.10 Create Procfile with the following code => web: voila --port=$PORT --no-browser --enable_nbextensions=True FarmMonitor.ipynb

4.11 Create runtime.txt file with following text => python-3.6.12

4.12 Create config_vars.py containing following code to authorize the google earth engine.



```python
import platform
from subprocess import DEVNULL, STDOUT, check_call

def set_heroku_vars(token_name='EARTHENGINE_TOKEN'):
    """Extracts Earth Engine token from the local computer and sets it as an environment variable on heroku.

    Args:
        token_name (str, optional): Name of the Earth Engine token. Defaults to 'EARTHENGINE_TOKEN'.
    """
    try:

        ee_token_dir = os.path.expanduser("~/.config/earthengine/")
        ee_token_file = os.path.join(ee_token_dir, 'credentials')

        if not os.path.exists(ee_token_file):
            print('The credentials file does not exist.')
        else:
            with open(ee_token_file) as f:
                content = f.read()
                token = content.split(':')[1].strip()[1:-2]
                # if platform.system() == 'Linux':
                #     token = content.split(':')[1][1:-3]
                # else:
                #     token = content.split(':')[1][2:-2]
                secret = '{}={}'.format(token_name, token)
                if platform.system() == 'Windows':
                    check_call(['heroku', 'config:set', secret], stdout=DEVNULL, stderr=STDOUT, shell=True)
                else:
                    check_call(['heroku', 'config:set', secret], stdout=DEVNULL, stderr=STDOUT)

    except Exception as e:
        print(e)
        return
```



```
if __name__ == '__main__':

    set_heroku_vars(token_name='EARTHENGINE_TOKEN')
```

4.13 In CLI type command “heroku create” to create a new app on heroku. It also creates a git repo for your app.

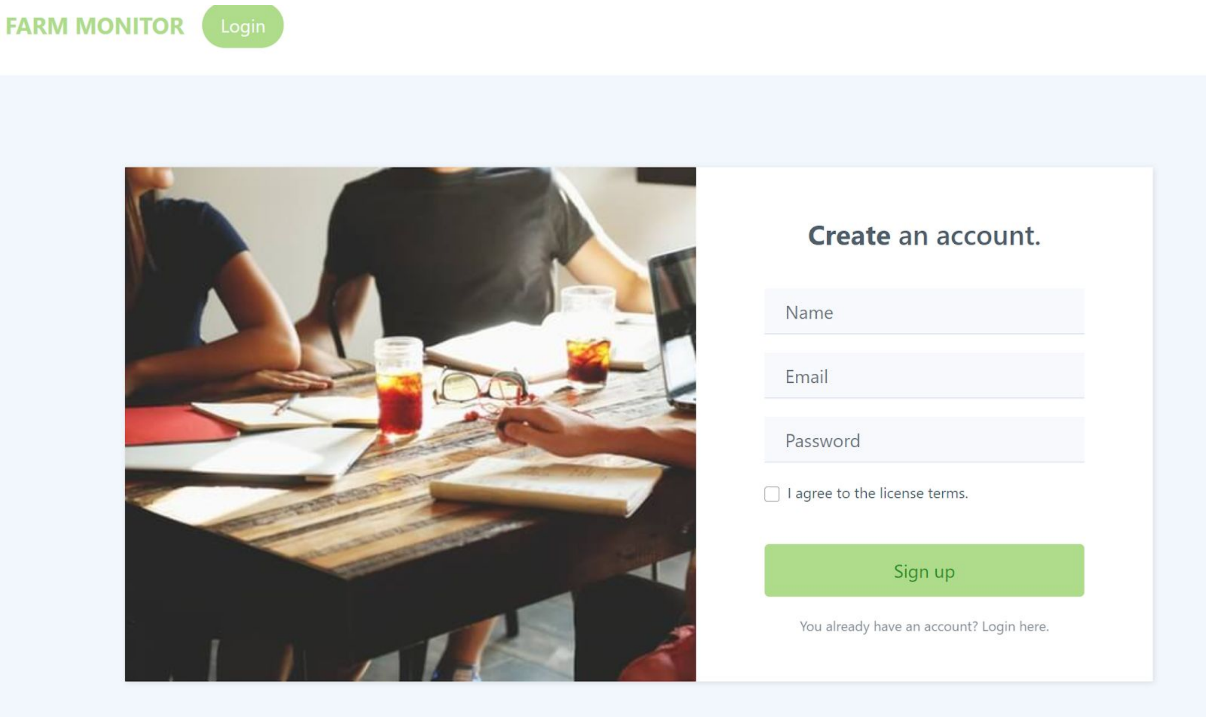
4.14 type command “git init” to initialize a git repo. Then type “ heroku git:remote -a <Your app name>” to link the heroku repo with your project.

4.15 type commands “git add .” “git commit -m <your message>” “git push heroku master”. To push the Farm monitor tool on heroku.

User guide

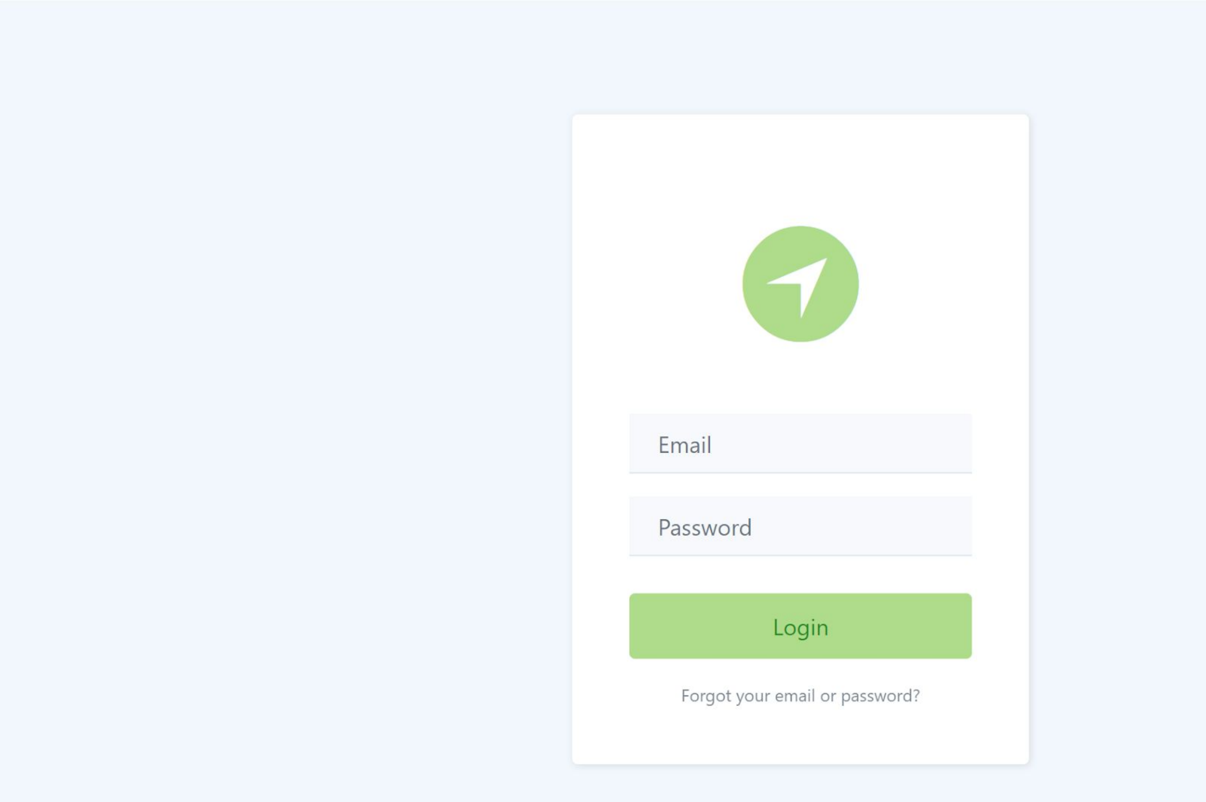
Our application is publicly accessible via the following URL:
https://radiant-mesa-27926.herokuapp.com/

Our application home page is publicly accessible via the following URL:
https://reflected-cycle-300702.ts.r.appspot.com/

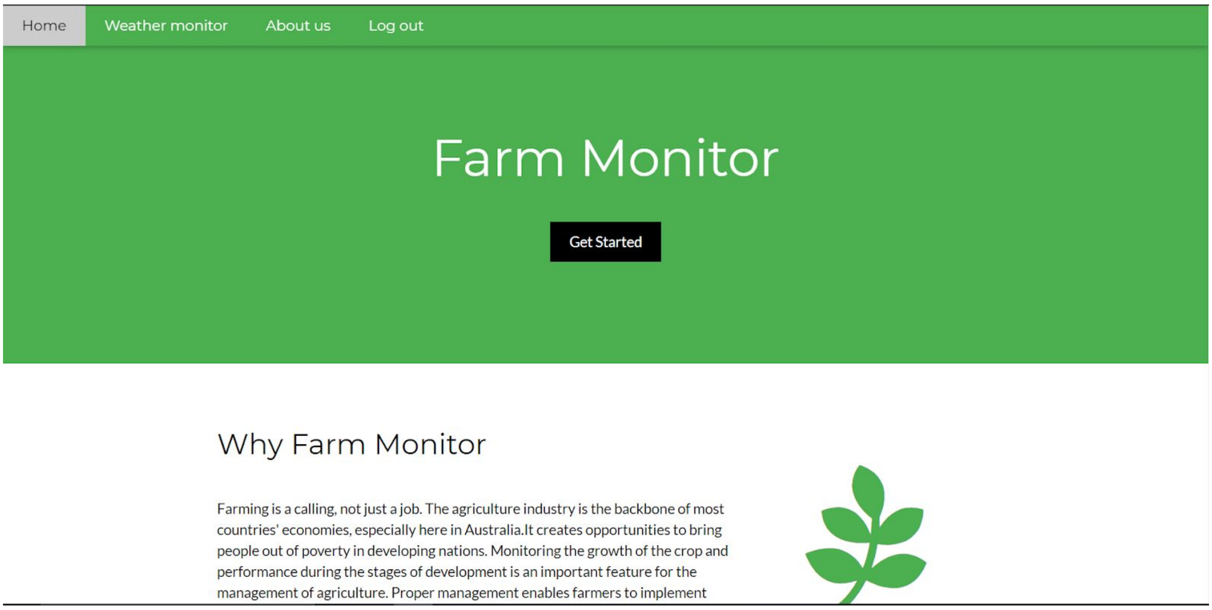

FARM MONITOR
Login
Create an account.
Name
Email
Password
□ I agree to the license terms.
Sign up
You already have an account? Login here.

If the user doesn't have an account, they must sign up to enter the website. After entering the name, email and password, the website will redirect the user to the login page. These details are stored in AWS Dynamodb.

FARM MONITOR



Now the user must enter the correct credentials as entered in the signup form, otherwise, the user won’t be redirected to the website.

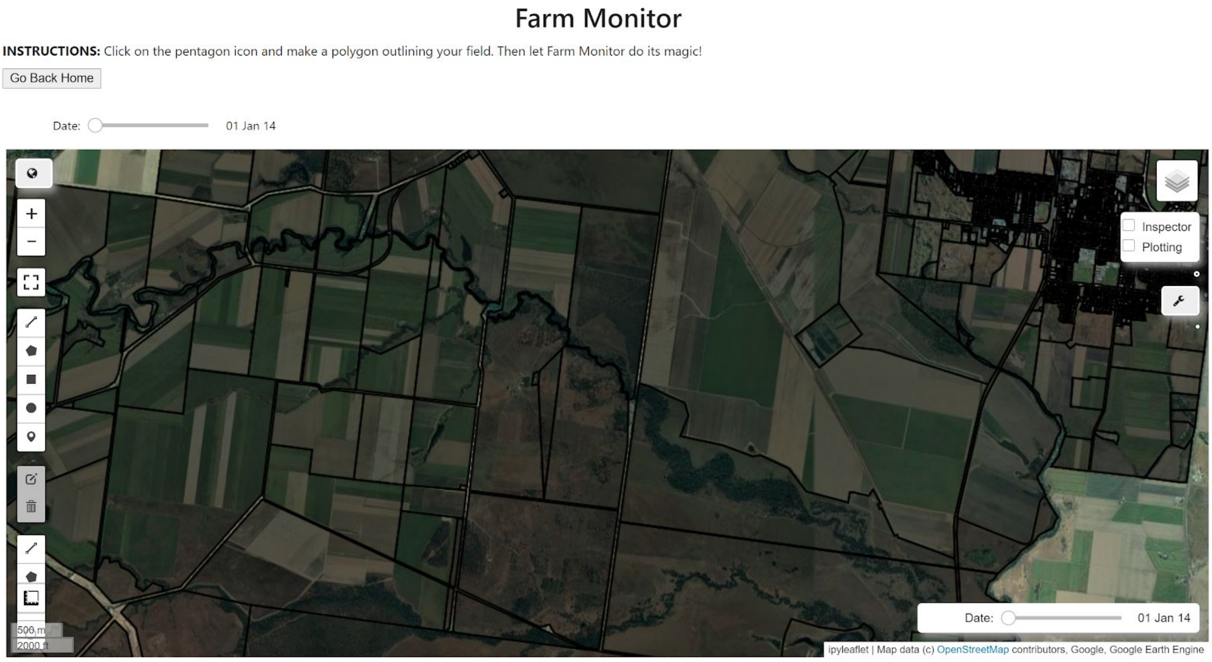


Why Farm Monitor

Farming is a calling, not just a job. The agriculture industry is the backbone of most countries' economies, especially here in Australia.It creates opportunities to bring people out of poverty in developing nations. Monitoring the growth of the crop and performance during the stages of development is an important feature for the management of agriculture. Proper management enables farmers to implement

After successfully logging in, the user enters the main page which looks like this.

To use our Farm Monitor tool, click on the ‘Get Started’ button. The user will be greeted with the google maps software with interactive tools on the side. Few regions are covered with border linings to show the property boundaries which are overlaid above the google maps.

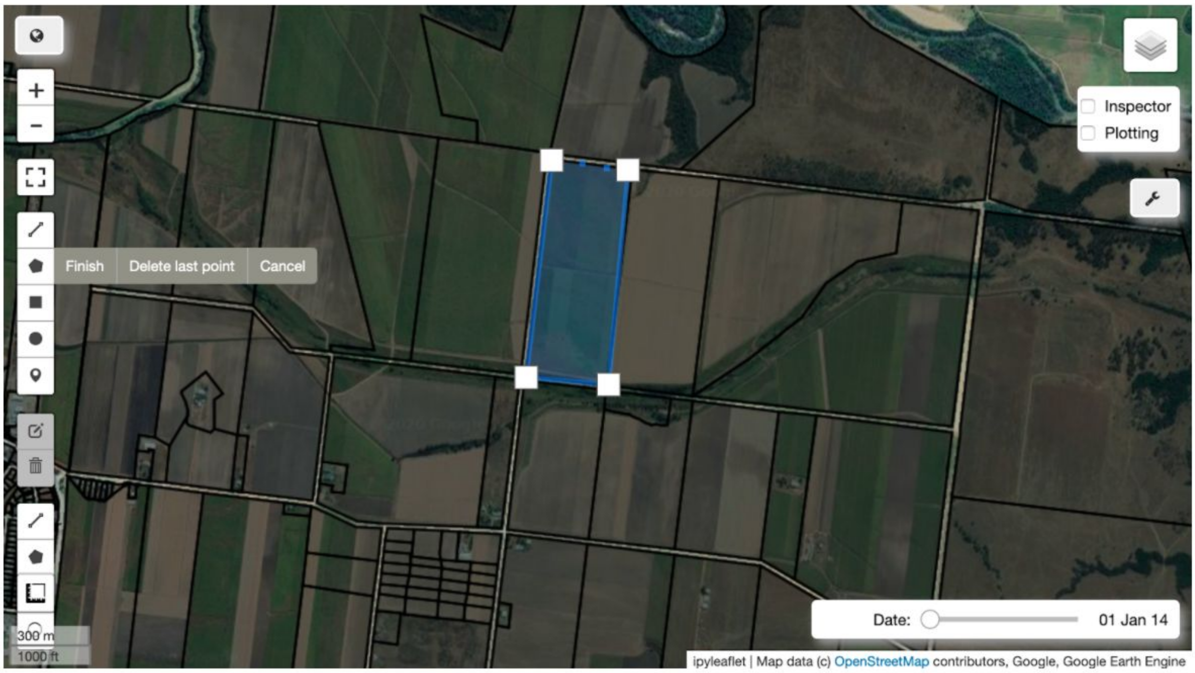


Farm Monitor

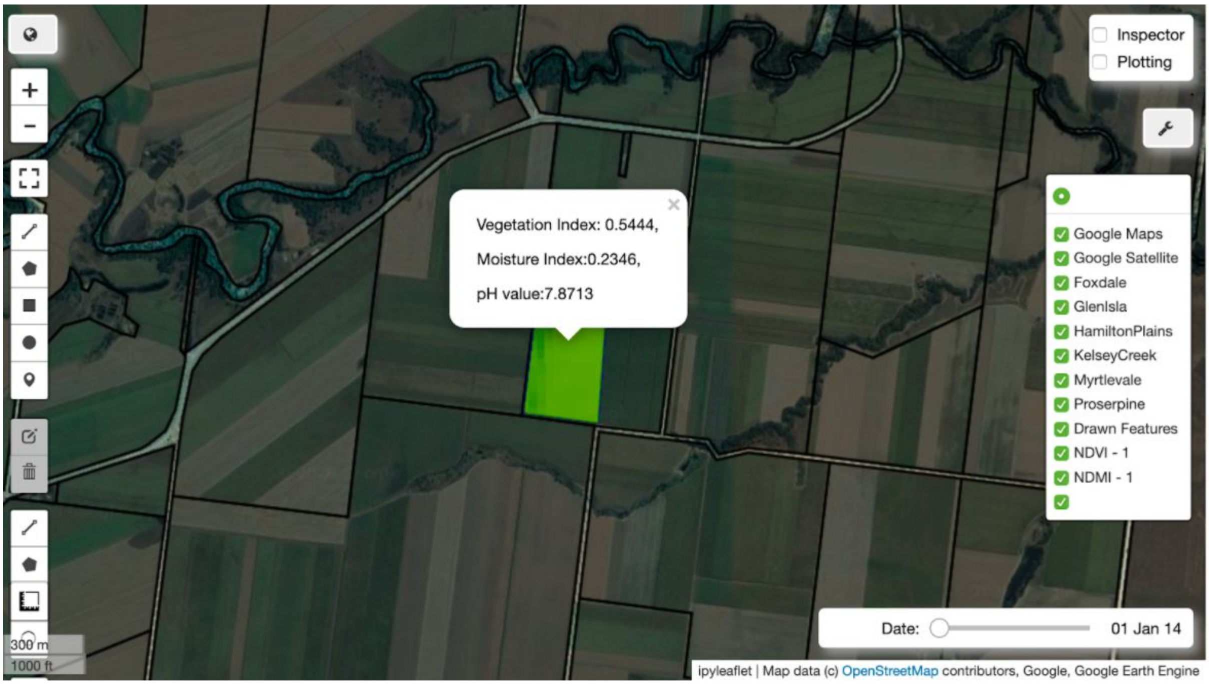
INSTRUCTIONS: Click on the pentagon icon and make a polygon outlining your field. Then let Farm Monitor do its magic!

Go Back Home
Date: 01 Jan 14
+
−
Inspector
Plotting
500 m
2000 ft
Date: 01 Jan 14
ipyleaflet | Map data (c) OpenStreetMap contributors, Google, Google Earth Engine

Farm Monitor tool


Inspector
Plotting
Finish
Delete last point
Cancel
Date:
01 Jan 14
300 m
1000 ft
ipyleaflet | Map data (c) OpenStreetMap contributors, Google, Google Earth Engine

With the polygon tool, users can select a field of their choice and create a polygon along the property boundary.

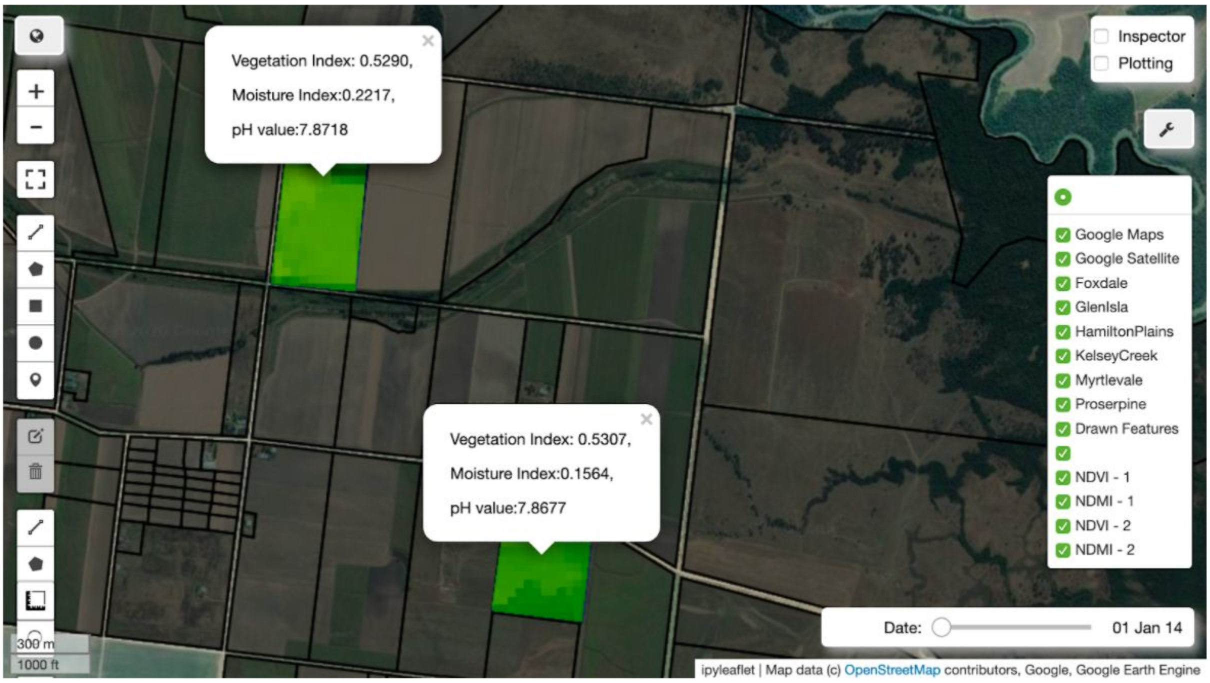


Vegetation Index: 0.5444,

Moisture Index:0.2346,

pH value:7.8713

Farm Monitor will generate the Vegetation,Moisture Index and pH values of that field of the specified date. You can also change the dates with the help of the slider.

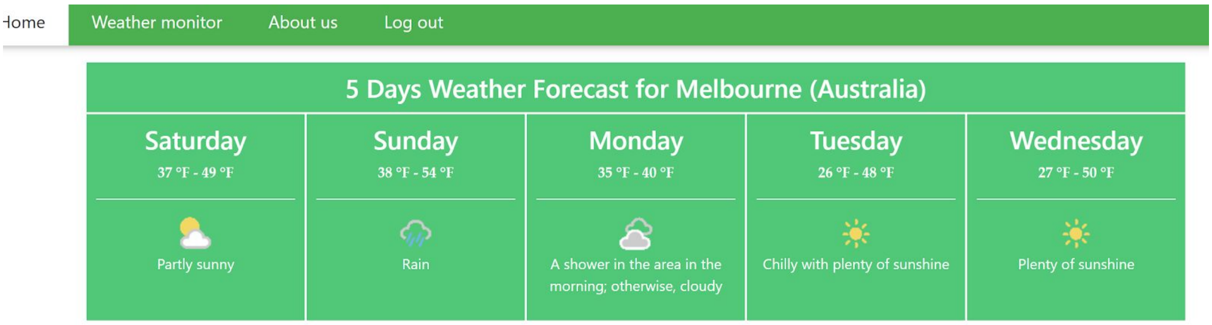


Vegetation Index: 0.5290,
Moisture Index:0.2217,
pH value:7.8718

Vegetation Index: 0.5307,
Moisture Index:0.1564,
pH value:7.8677

Date: 01 Jan 14

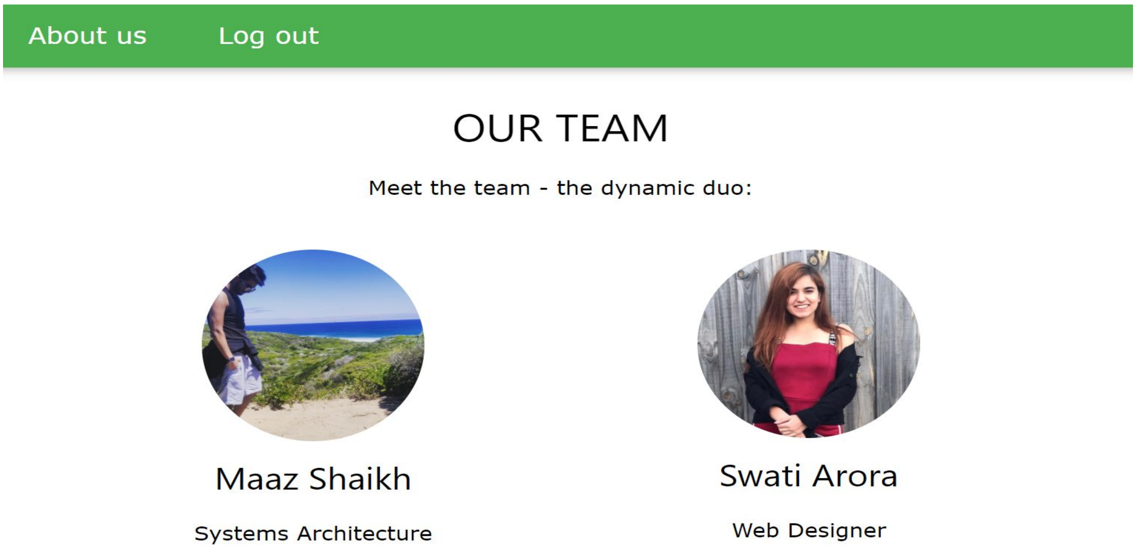
Users can also deploy multiple plots to then compare the various fields.



5 Days Weather Forecast for Melbourne (Australia)

Saturday	Sunday	Monday	Tuesday	Wednesday
37 °F - 49 °F	38 °F - 54 °F	35 °F - 40 °F	26 °F - 48 °F	27 °F - 50 °F
Partly sunny	Rain	A shower in the area in the morning; otherwise, cloudy	Chilly with plenty of sunshine	Plenty of sunshine

If the user clicks on ‘weather monitor’ they are redirected to the weather monitor page where they get the weather forecast for the next 5 days in their current location:



OUR TEAM

Meet the team - the dynamic duo:

Maaz Shaikh

Systems Architecture

Swati Arora

Web Designer

The user can check out our About us page to learn more about the developers.

References

[1]"Queensland SpatialCatalogue- QSpatial: QueenslandGovernment", Qldspatial.information.qld.gov.au ,
2020. [Online]. Available: http://qldspatial.information.qld.gov.au/catalogue/custom/index.page. [Accessed: 11- Jan-2021].

[2]"Python installation | Google Earth Engine | Google Developers", Google Developers , 2020. [Online].
Available: https://developers.google.com/earth-engine/guides/python_install. [Accessed: 09- Jan-2021].

[3]"ImageCollection Overview | Google Earth Engine | Google Developers", Google Developers , 2020.[Online].Available: https://developers.google.com/earth-engine/guides/ic_creating. [Accessed: 09- Jan-2021].

[4]*Content.api.nytimes.com*, 2021. [Online]. Available: https://content.api.nytimes.com/svc/weather/v2/current-and-seven-day-forecast.json. [Accessed: 21- Jan- 2021].

[5]https://web.archive.org/web/20110311165602/http://www.nynganobserver.com.au/news/local/news/rural/new-reference-reveals-facts-about-australian-farming/2051990.aspx. [Accessed: 31- Jan- 2021].