Plant health monitoring with photos based on Deep Learning

Course Tittle: Deep Learning

SUBMITTED BY	SUBMITTED TO
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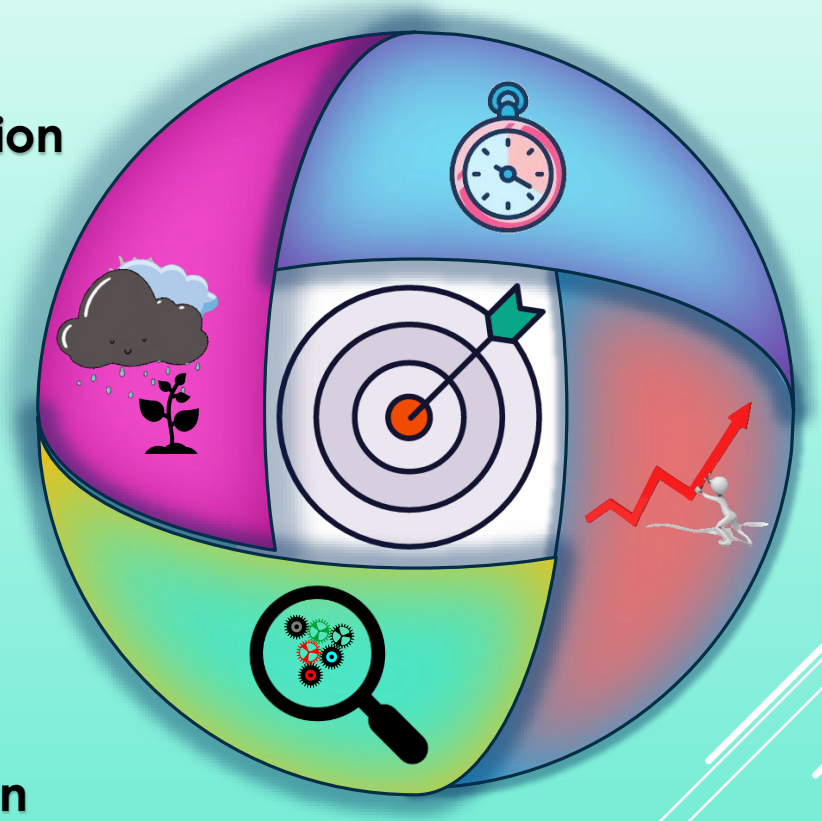
Motivation

01

Plant, Weed & Parasite Identification

Monitoring plant leaves to identify plant categories, Weed and parasite.



03

Design a Model

For precision farming, I want to design a TAPAAL Model

02

Accurate Results Prediction

I want to find out a state forward results like name of the Plant, weed or parasite

04

Verification & Simulation

I want to check some verification process like deadlock free or not and Some simulation.

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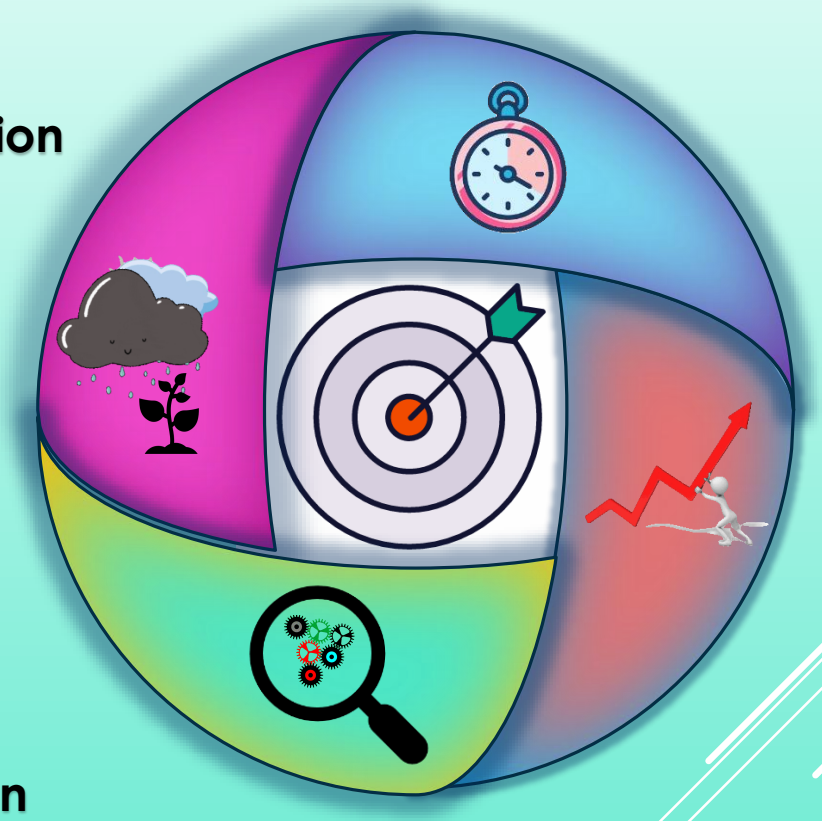

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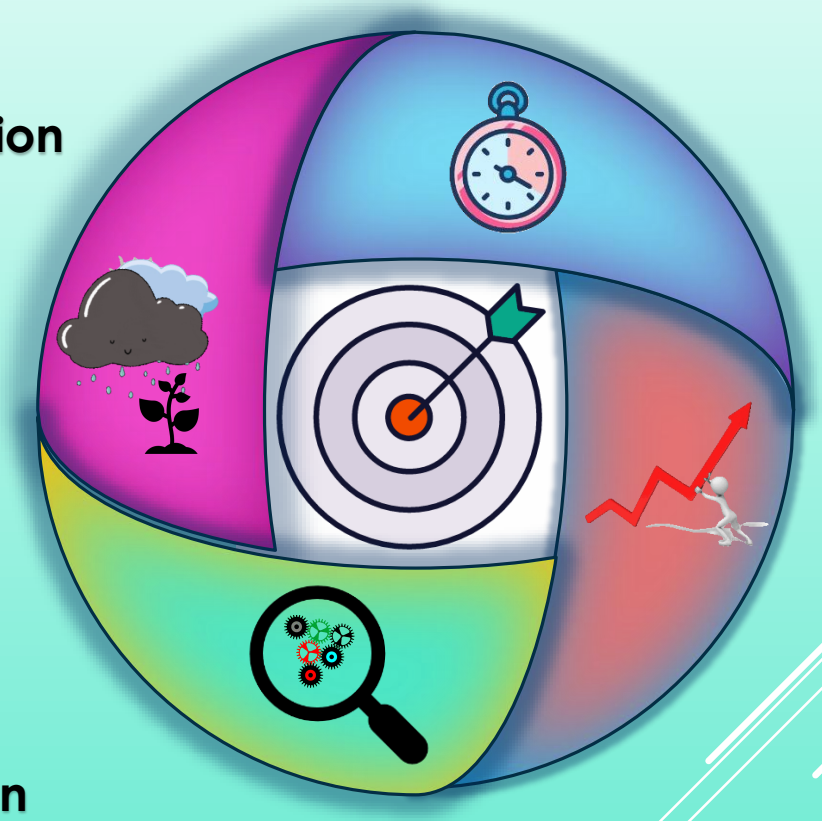

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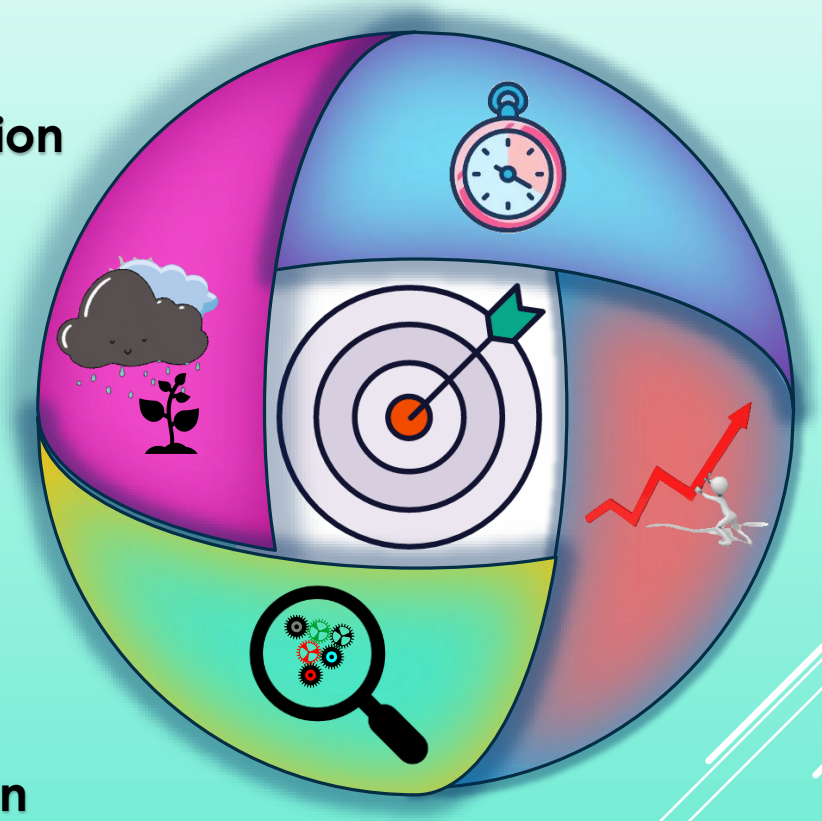

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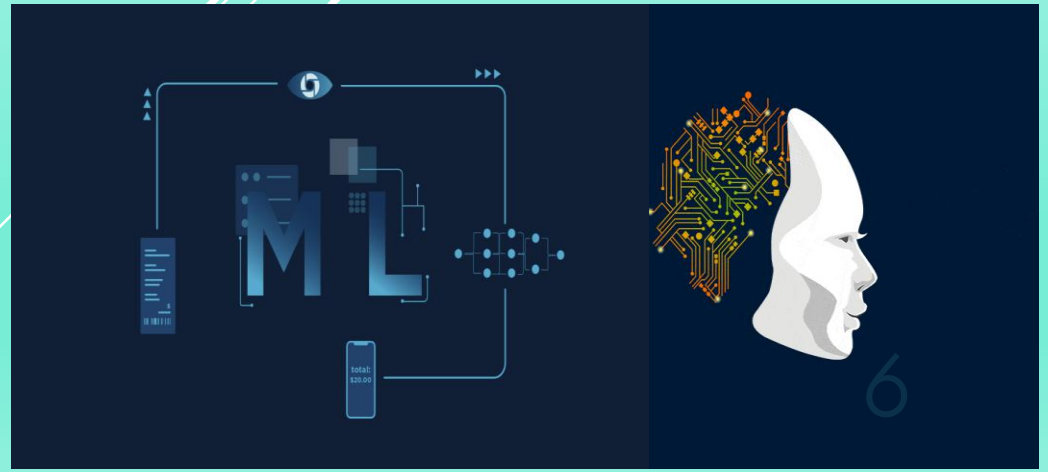
Plant Health & Deep Learning

Plant Health:

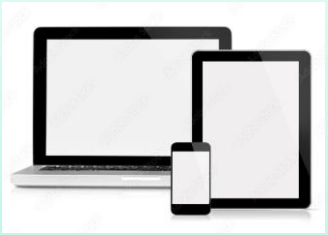
Refers to the condition of a plant including healthy or diseases affected.

Deep Learning:

A subset of machine learning that uses neural networks to automatically learn patterns from data

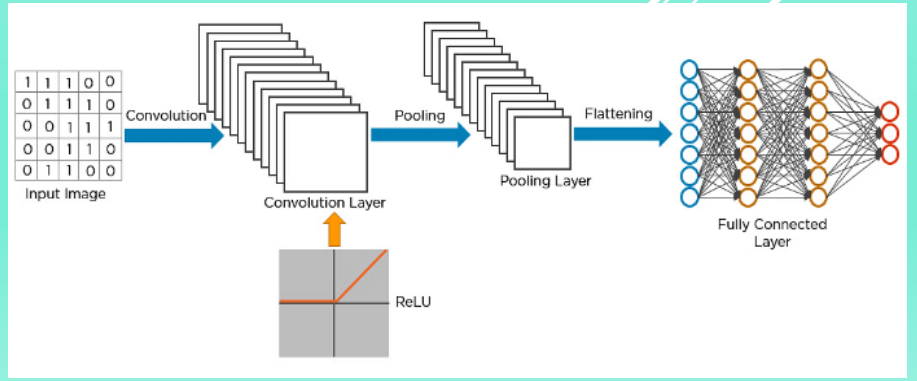


System Design



User interface layer

Dataset and Cloud layer



CNN Modelling and Training Layer

CNN Structure

01

Convolution & ReLU

In the convolution layer according, several feature and filter we get several feature maps for each channel of RGB. Finally, after combining all kernel channel and bias we get final feature map. Then for making our feature map non-linear and make training process first we can use Relu (Rectefied Linear Unit).

02

Pooling layer

This layer use for reduce image size and dimension as well as reduce over feeding since less parameter. There are total two polling method possible including max polling and average polling.

03

Fully connected Layer

This layer is responsible for classifying the images. In the Flatten layer we get one dimensional array and in this layer that is connected with neurons and finally give a output layer with prediction for each class.

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CNN Structure of My Model

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 128, 128, 32)	896
conv2d_1 (Conv2D)	(None, 126, 126, 32)	9,248
max_pooling2d (MaxPooling2D)	(None, 63, 63, 32)	0
conv2d_2 (Conv2D)	(None, 63, 63, 64)	18,496
conv2d_3 (Conv2D)	(None, 61, 61, 64)	36,928
max_pooling2d_1 (MaxPooling2D)	(None, 30, 30, 64)	0
conv2d_4 (Conv2D)	(None, 30, 30, 128)	73,856
conv2d_5 (Conv2D)	(None, 28, 28, 128)	147,584
max_pooling2d_2 (MaxPooling2D)	(None, 14, 14, 128)	0
conv2d_6 (Conv2D)	(None, 14, 14, 256)	295,168
conv2d_7 (Conv2D)	(None, 12, 12, 256)	590,080
max_pooling2d_3 (MaxPooling2D)	(None, 6, 6, 256)	0
conv2d_8 (Conv2D)	(None, 6, 6, 512)	1,180,160
conv2d_9 (Conv2D)	(None, 4, 4, 512)	2,359,808
max_pooling2d_4 (MaxPooling2D)	(None, 2, 2, 512)	0
dropout (Dropout)	(None, 2, 2, 512)	0
flatten (Flatten)	(None, 2048)	0
dense (Dense)	(None, 2500)	5,122,500
dropout_1 (Dropout)	(None, 2500)	0
dense_1 (Dense)	(None, 38)	95,038

Total params: 9,929,762 (37.88 MB)
Trainable params: 9,929,762 (37.88 MB)
Non-trainable params: 0 (0.00 B)

Dataset

Dataset Source

- Kaggle

Dataset asset

- 14 Plants
- 38 Categories of disease
- 87.9K Training, Validation & Testing image

Available: https://www.kaggle.com/datasets/vipoooool/new-plant-diseases-dataset/data

CNN Implementation

Used tools

- Python
- TensorFlow
- Keras

Training Process

- Separate directory for training and validation
- Total 10 Epochs
- After getting desire accuracy and losses stopped training

```
training_history = cnn.fit(x=training_set,validation_data=validation_set,epochs=10)

Epoch 1/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2809s 1s/step - accuracy: 0.4094 - loss: 2.1314 - val_accuracy: 0.8234 - val_loss: 0.5801
Epoch 2/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2678s 1s/step - accuracy: 0.8400 - loss: 0.5077 - val_accuracy: 0.9095 - val_loss: 0.2814
Epoch 3/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2629s 1s/step - accuracy: 0.9072 - loss: 0.2897 - val_accuracy: 0.9334 - val_loss: 0.2075
Epoch 4/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2615s 1s/step - accuracy: 0.9364 - loss: 0.1961 - val_accuracy: 0.9537 - val_loss: 0.1506
Epoch 5/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2619s 1s/step - accuracy: 0.9513 - loss: 0.1479 - val_accuracy: 0.9533 - val_loss: 0.1431
Epoch 6/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2624s 1s/step - accuracy: 0.9656 - loss: 0.1053 - val_accuracy: 0.9535 - val_loss: 0.1536
Epoch 7/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2623s 1s/step - accuracy: 0.9687 - loss: 0.0953 - val_accuracy: 0.9520 - val_loss: 0.1586
Epoch 8/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2617s 1s/step - accuracy: 0.9750 - loss: 0.0741 - val_accuracy: 0.9612 - val_loss: 0.1289
Epoch 9/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2627s 1s/step - accuracy: 0.9768 - loss: 0.0665 - val_accuracy: 0.9641 - val_loss: 0.1204
Epoch 10/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2610s 1s/step - accuracy: 0.9813 - loss: 0.0585 - val_accuracy: 0.9717 - val_loss: 0.1038
```

Training Epochs

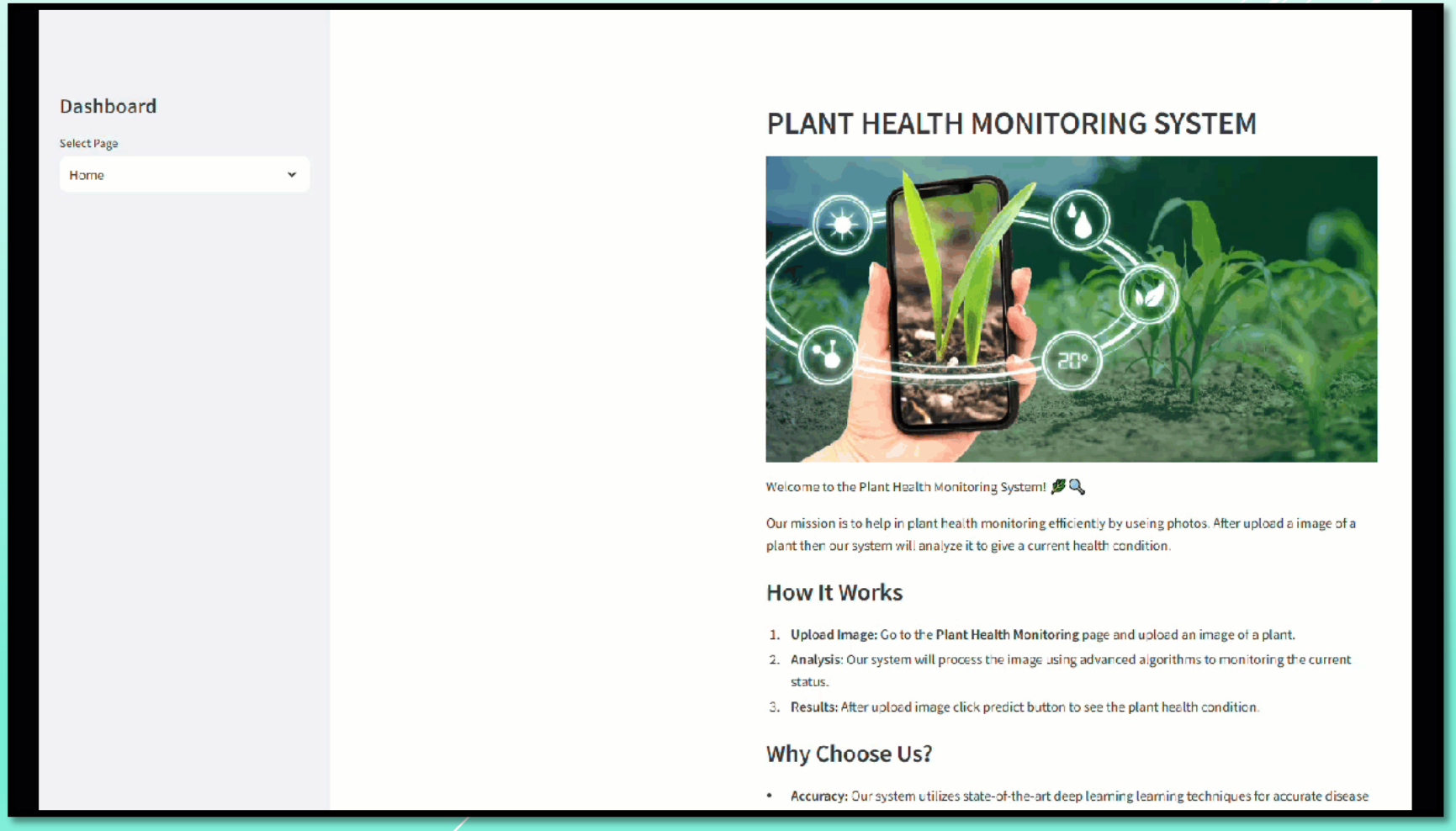
Web App Implementation

Used tools

- Streamlit
- Python
- Trained Model

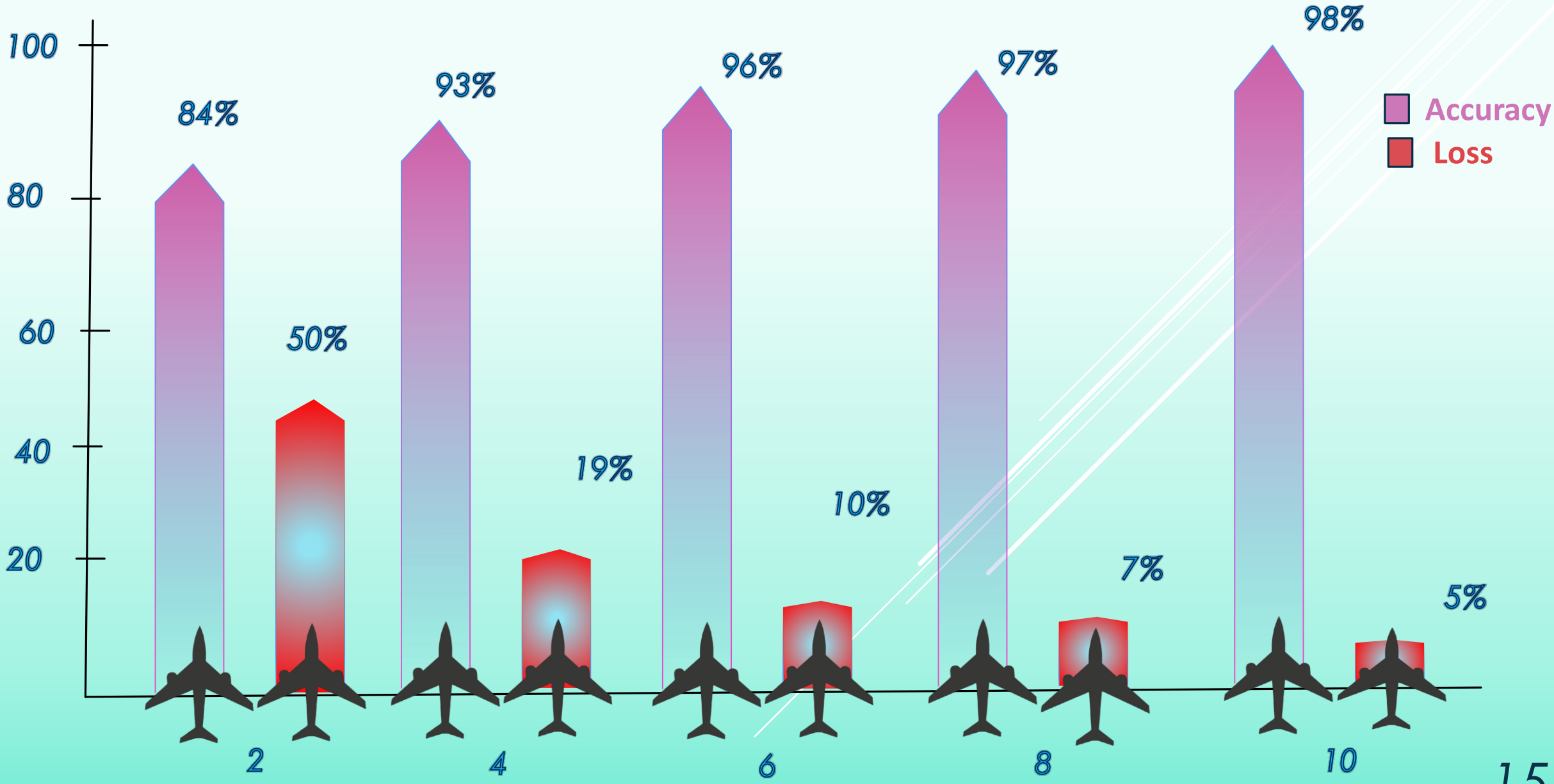
Benefits

- Easy to Use
- Real-Time Results
- Free of Cost



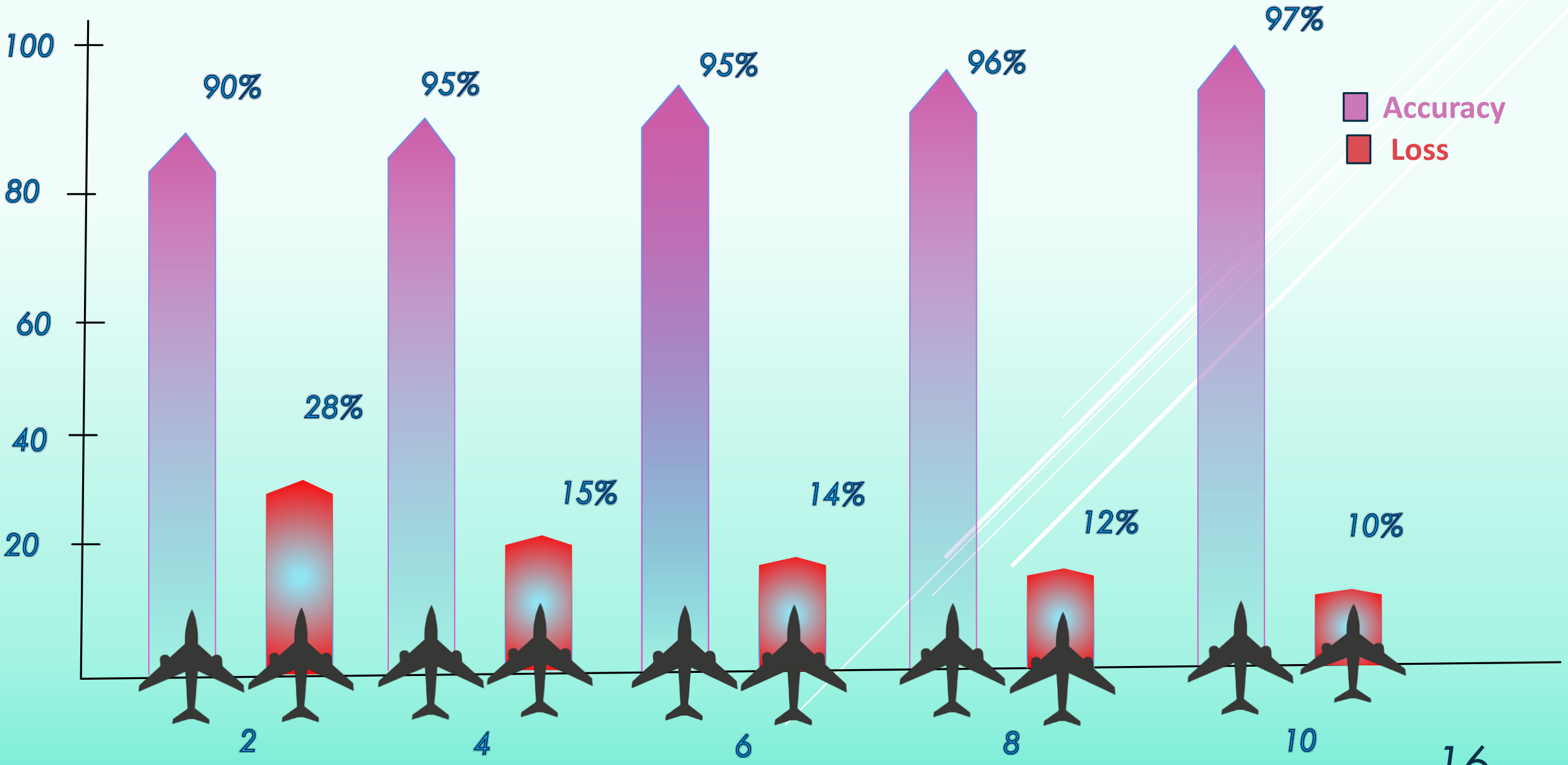
Web App Interface

Experimental Evaluation



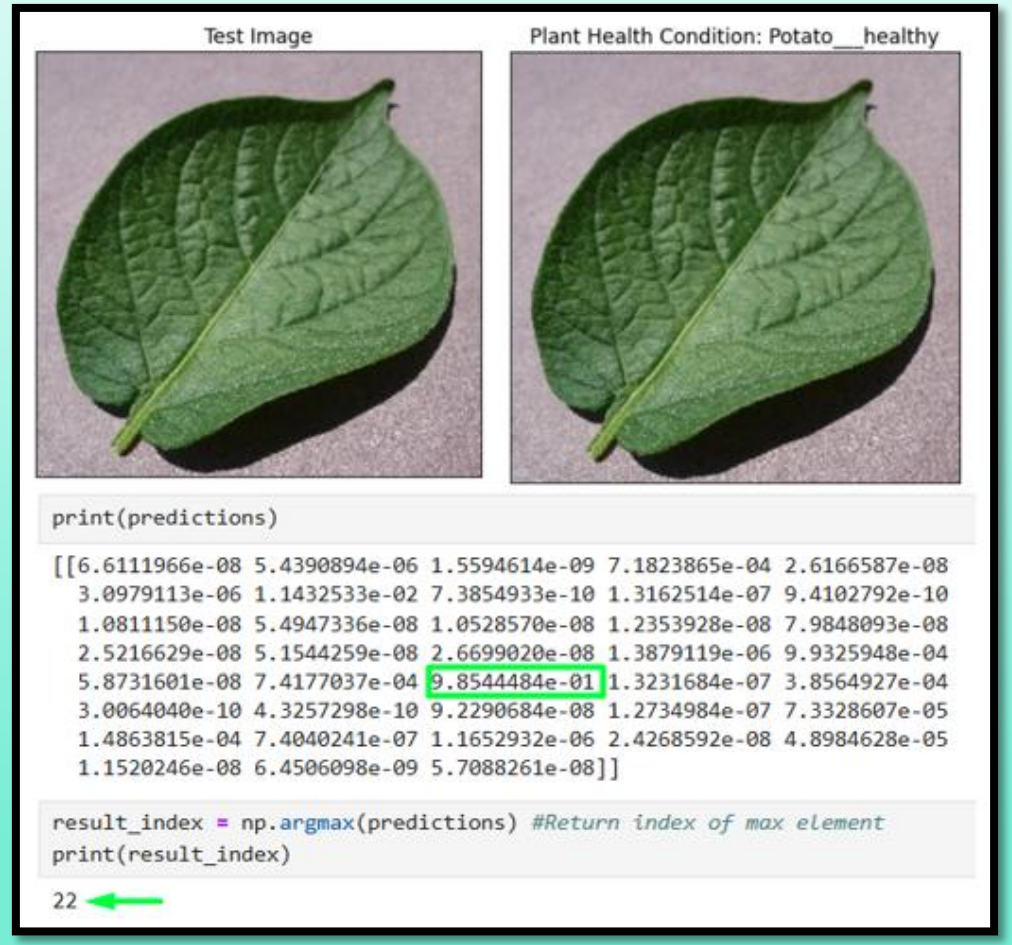
Training Accuracy and Loss

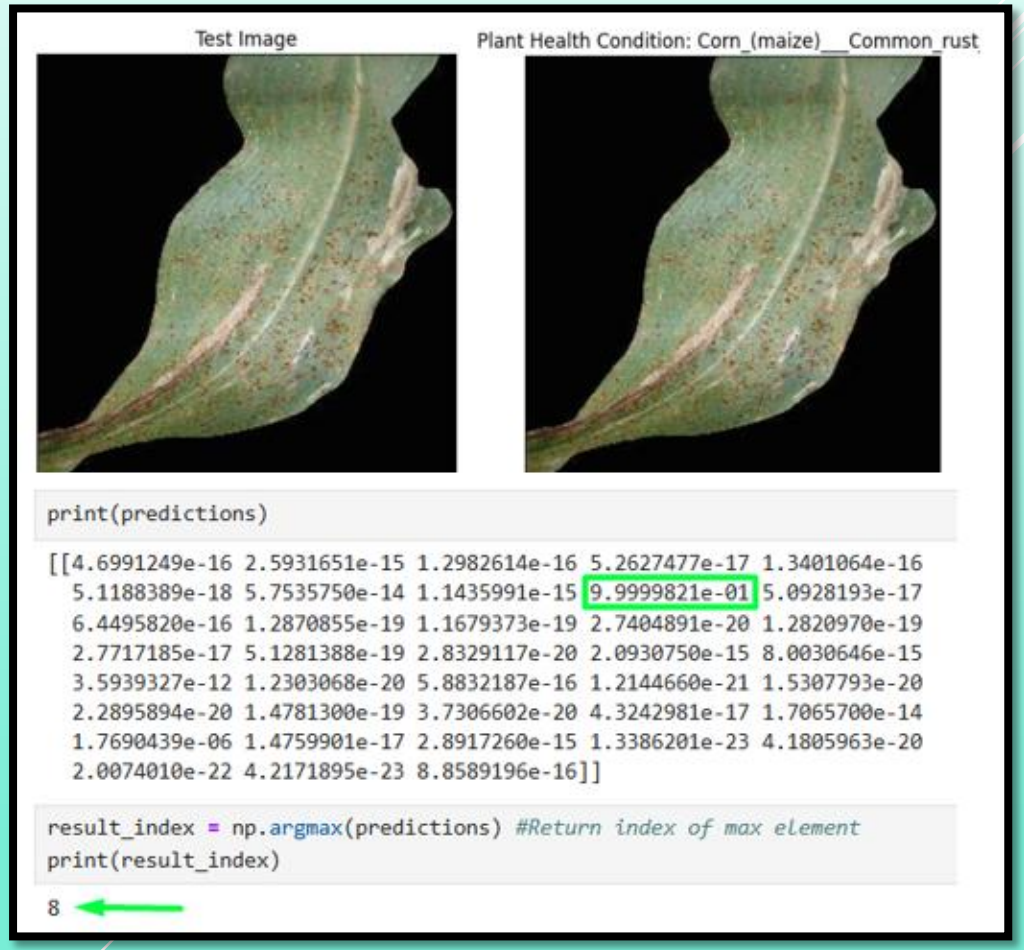
Experimental Evaluation



Validation Accuracy and Loss

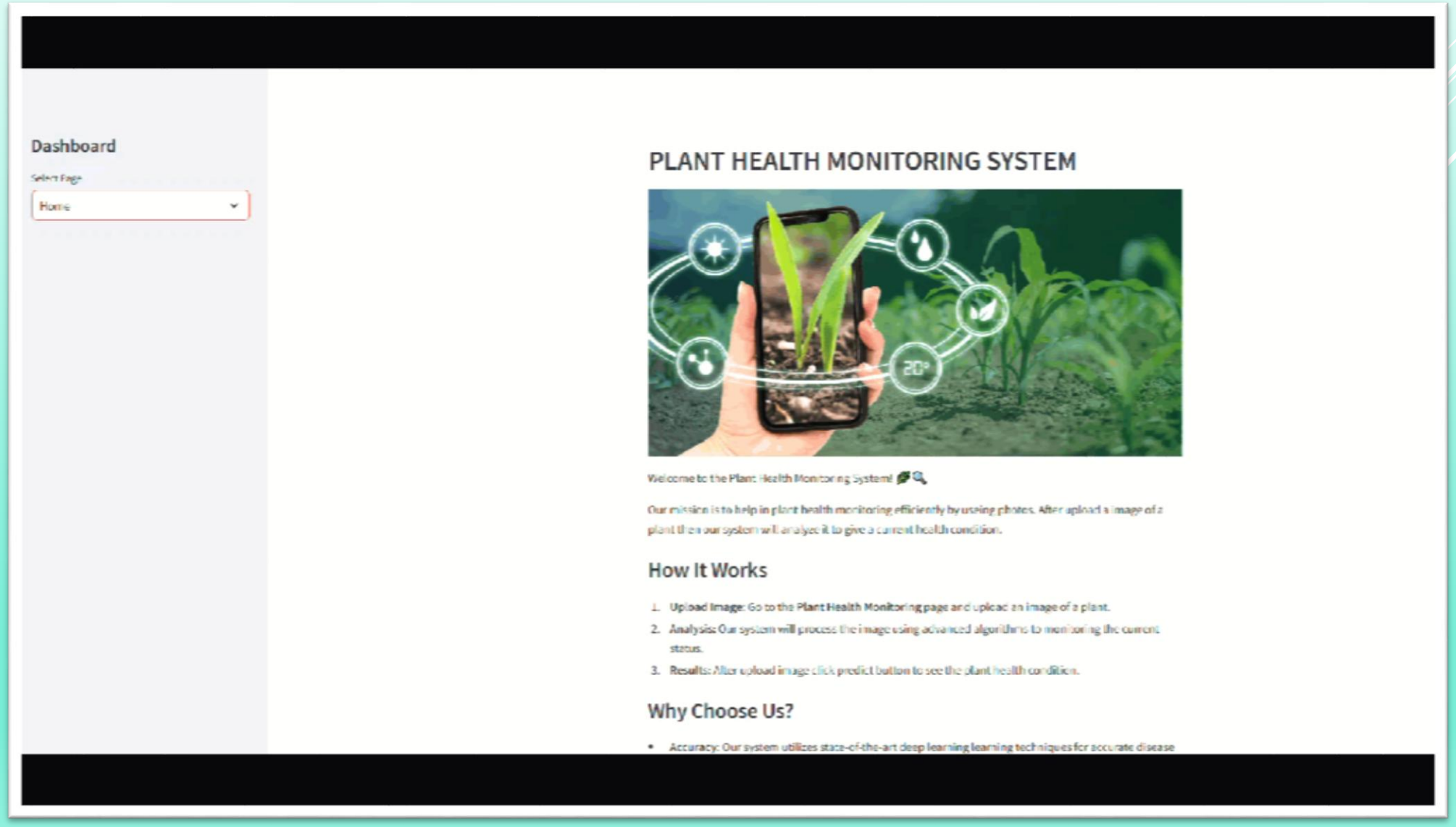
Experimental Evaluation





Model Prediction Results

Experimental Evaluation

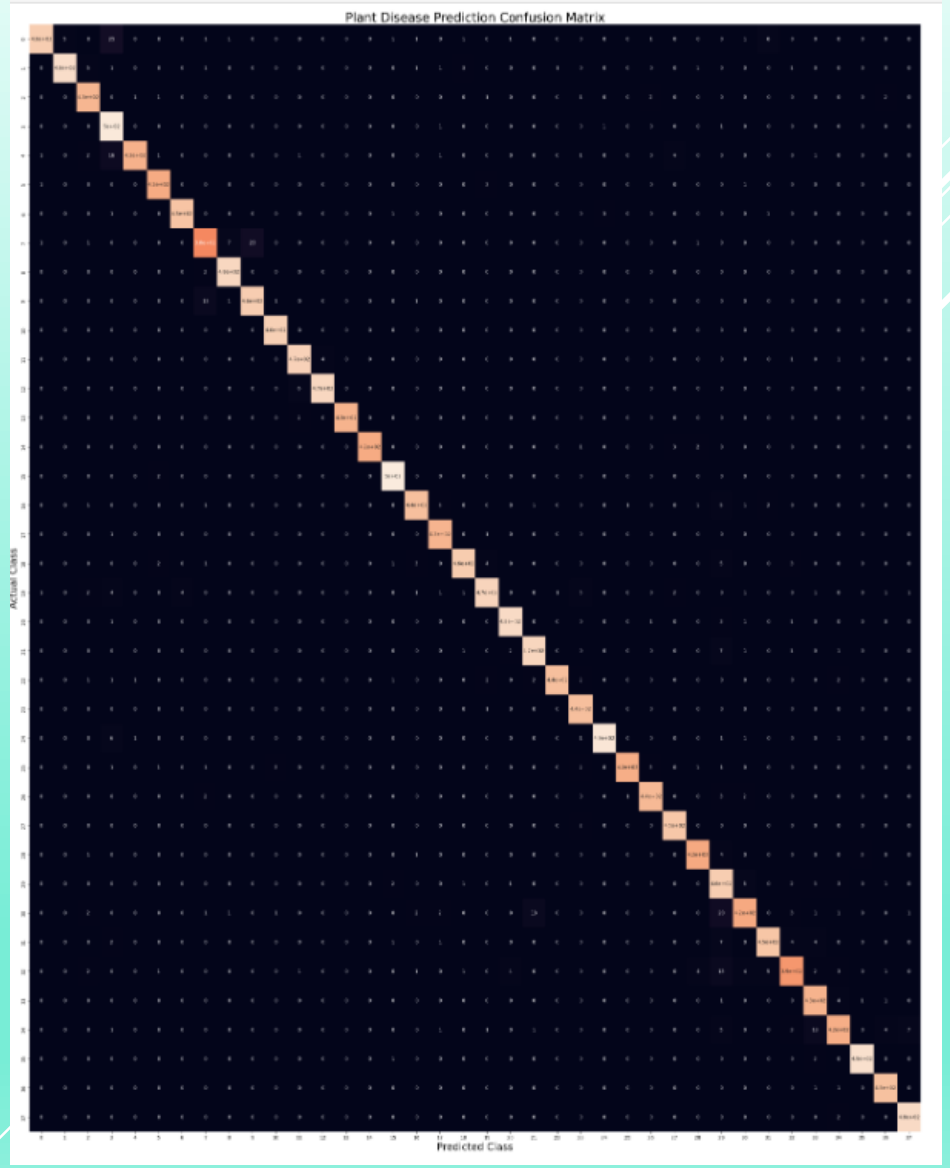


Web App Results

Experimental Evaluation

		precision	recall	f1-score
2	Apple___Apple_scab	0,991379	0,912698	0,950413
3	Apple___Black_rot	0,989733	0,969819	0,979675
4	Apple___Cedar_apple_rust	0,962138	0,981818	0,971879
5	Apple___healthy	0,892665	0,994024	0,940622
6	Blueberry___healthy	0,993007	0,938326	0,964892
7	Cherry_(including_sour)___Powdery_mildew	0,981176	0,990499	0,985816
8	Cherry_(including_sour)___healthy	0,991189	0,986842	0,989011
9	Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot	0,9425	0,919512	0,930864
10	Corn_(maize)___Common_rust_	0,979381	0,995807	0,987526
11	Corn_(maize)___Northern_Leaf_Blight	0,952479	0,966457	0,959417
12	Corn_(maize)___healthy	0,989362	1	0,994652
13	Grape___Black_rot	0,978992	0,987288	0,983122
14	Grape___Esca_(Black_Measles)	0,991632	0,9875	0,989562
15	Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	1	0,995349	0,997669
16	Grape___healthy	1	0,985816	0,992857
17	Orange___Haunglongbing_(Citrus_greening)	0,984283	0,996024	0,990119
18	Peach___Bacterial_spot	0,975771	0,965142	0,970427
19	Peach___healthy	0,975057	0,99537	0,985109
20	Pepper,_bell___Bacterial_spot	0,982869	0,960251	0,971429
21	Pepper,_bell___healthy	0,975155	0,947686	0,961224
22	Potato___Early_blight	0,983539	0,985567	0,984552
23	Potato___Late_blight	0,965235	0,973196	0,969199
24	Potato___healthy	0,995516	0,973684	0,984479
25	Raspberry___healthy	0,96732	0,997753	0,982301
26	Soybean___healthy	0,991968	0,978218	0,985045
27	Squash___Powdery_mildew	0,995272	0,970046	0,982497
28	Strawberry___Leaf_scorch	0,984199	0,981982	0,983089
29	Strawberry___healthy	0,980562	0,995614	0,98803
30	Tomato___Bacterial_spot	0,976526	0,978824	0,977673
31	Tomato___Early_blight	0,858473	0,960417	0,906588
32	Tomato___Late_blight	0,956221	0,896328	0,925307
33	Tomato___Leaf_Mold	0,969892	0,959574	0,964706
34	Tomato___Septoria_leaf_spot	0,953995	0,90367	0,928151
35	Tomato___Spider_mites Two-spotted_spider_mite	0,938596	0,983908	0,960718
36	Tomato___Target_Spot	0,956818	0,921225	0,938685
37	Tomato___Tomato_Yellow_Leaf_Curl_Virus	0,991853	0,993878	0,992864
38	Tomato___Tomato_mosaic_virus	0,97807	0,995536	0,986726
39	Tomato___healthy	0,981557	0,995842	0,988648
40	accuracy	0,971659	0,971659	0,971659
41	macro avg	0,972484	0,971618	0,971725
42	weighted avg	0,97238	0,971659	0,971683

Precision, recall & f1-score



Confusion Matrix

Conclusion & Future Work

The System can successfully Identifies plant health issues with high accuracy

It prove a user friendly interactive web app for farmer

The System saving time and Money as well as increase production.

In future I want to integrate real-time monitoring and IOT.

Do you have any question?