Fertilizers Recommendation System For Disease Prediction

1 INTRODUCTION

1.1 Overview:

Agriculture is the most important sector in today's life. Most plants are affected by a wide variety of bacterial and fungal diseases. Diseases on plants placed a major constraint on the production and a major threat to food security. Hence, early and accurate identification of plant diseases is essential to ensure high quantity and best quality. In recent years, the number of diseases on plants and the degree of harm caused has increased due to the variation in pathogenvarieties, changes in cultivation methods, and inadequate plant protection techniques.

An automated system is introduced to identify different diseases on plants by checking the symptoms shown on the leaves of the plant. Deep learning techniques are used to identify the diseases and suggest the precautions that can be taken for those diseases.

1.2 Purpose:

To detect and recognize the plant diseases and to recommend fertilizer, it is necessary to provide symptoms in identifying the disease at its earliest. Hence a fertilizer recommendation system for disease prediction of fruits and vegetables is implemented in this project.

2 LITERATURE SURVEY

2.1 Existing problem:

Adequate mineral nutrition is central to crop production. However, it can also exert considerable Influence on disease development. Fertilizer application can increase or decrease development of diseases caused by different pathogens, and the mechanisms responsible are complex, including effects of nutrients on plant growth, plant resistance mechanisms and direct effects on the pathogen. The effects of mineral nutrition on plant disease and the mechanisms responsible for those effects have been dealt with comprehensively elsewhere.In India, around 40% of land is kept and grown using reliable irrigation technologies, while the rest relies on the monsoon environment for water. Irrigation decreases reliance on the monsoon, increases food security, and boosts agricultural production.

Most research articles use humidity, moisture, and temperature sensors near the plant's root, with an external device handling all of the data provided by the

sensors and transmitting it directly to an external display or an Android application. The application was created to measure the approximate values of temperature, humidity,and moisture sensors that were programmed into a microcontroller to manage the amount of water.

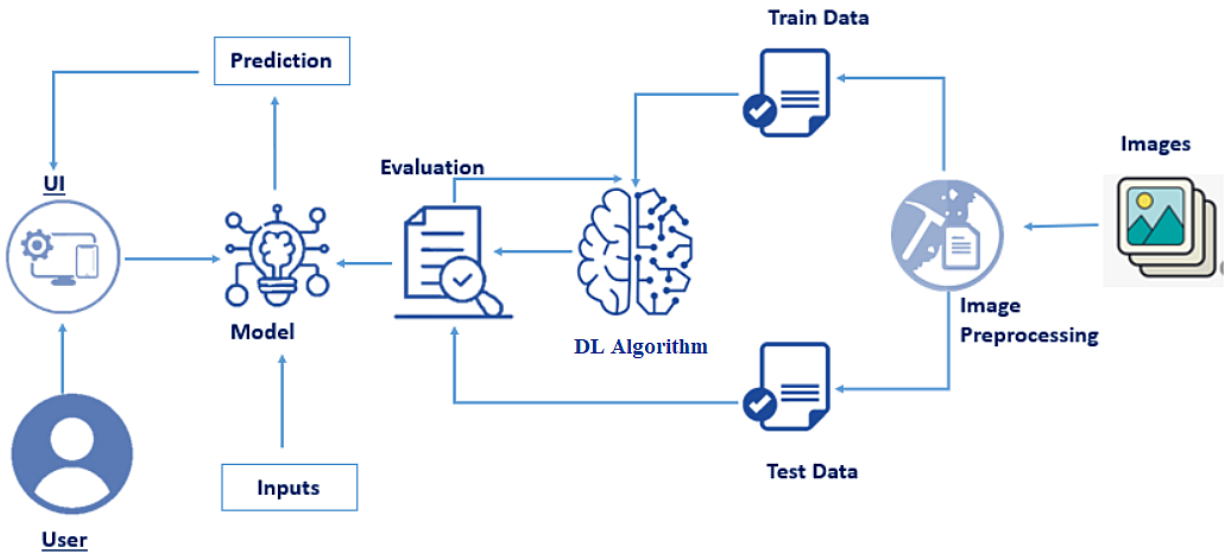
2.2 Proposed solution:

Web Application is built where :

1. Farmers interact with the portal build
2. Interacts with the user interface to upload images of diseased leaf
3. Our model built analyses the Disease and suggests the farmer with fertilizers are to be used.

3 THEORITICAL ANALYSIS

3.1 Block diagram :



3.2 Hardware / Software designing :

To complete this project you should have the following software and packages.
Softwares:

- Anaconda Navigator
- pycharm
- Visual studio code
- Jupiter notebook
- IBM watson studio

Packages:

- Tensor flow
- Keras
- Flask
- Numpy
- Pandas

By using the above listed softwares and packages ,we build this application to take the input (image) from the farmer and detects whether the plant is infected or not. Here we use Deep learning techniques and give the out put to the user (Farmer).

4 EXPERIMENTAL INVESTIGATIONS :

In this project an automated system is introduced to identify different diseases on plants by checking the symptoms shown on the leaves of the plant. Deep learning techniques are used to identify the diseases and suggest the precautions that can be taken for those diseases.

Initially the data set is divided into train and test folders with each folder having subfolders with leaf images of different plant diseases. Two datasets have been used to create two models one to detect vegetable leaf diseases like tomato, potato, and pepper plants and the second model be for fruits diseases like corn, peach, and apple. Then the images are preprocessed. ImageDataGenerator class is used to load the images with different modifications like considering the zoomed image, flipping the image and rescaling the images to range of 0 and 1.

After preprocessing the images, the libraries that are required to initialize the neural network layer, create and add different layers to the neural network model are imported. Then the model is initialized by creating a reference/object to the Sequential class. Then three layers are added for CNN namely Convolution layer, Pooling layer, and Flattening layer. Convolution layer returns a feature map. Max Pooling selects the maximum element from the region of the feature map covered by the filter. Finally the flatten layer is used to convert n-dimensional arrays to 1-dimensional arrays.

Next step is to add hidden and output layers. Two hidden layers are added in this project. The 1st hidden layer with 40 neurons and 2nd hidden layer with 20neurons. Now an output layer is added by specifying the number of classes your dependent variable has (6 in this case).

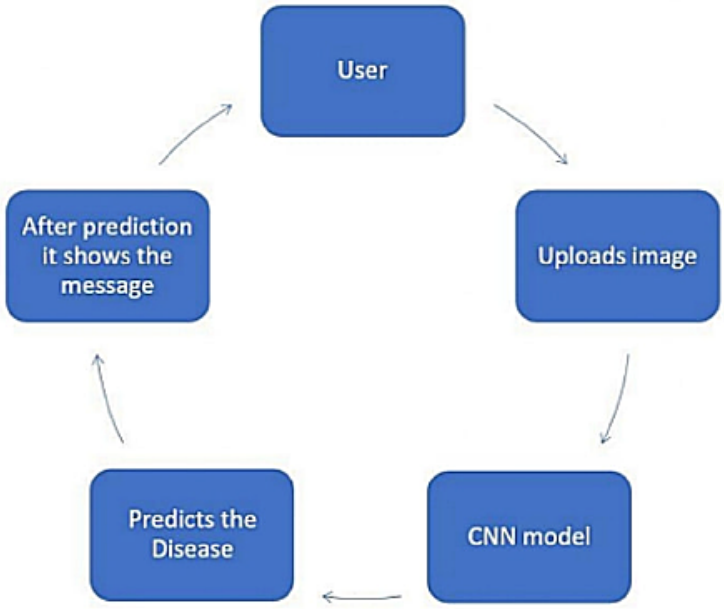
After adding all the required layers, the model is to be compiled. For this step, loss function, optimizer and metrics for evaluation are passed as arguments. Then the model is trained and saved. Loss value implies how poorly or well a model behaves after each iteration of optimization. An accuracy metric is used to measure the algorithm's performance in an interpretable way. The accuracy of a model is

usually determined after the model parameters and is calculated in the form of a percentage. The weights are to be saved for future use. The weights are saved in as .h5 file using save().

Finally the model is to tested with different images to know if it is working correctly or not. The saved model is loaded and tested.

After the model is built, it is integrating it into a web application so that normal users can also use it. The new users need to initially register in the portal. After registration users can log in to browse the images to detect the disease.

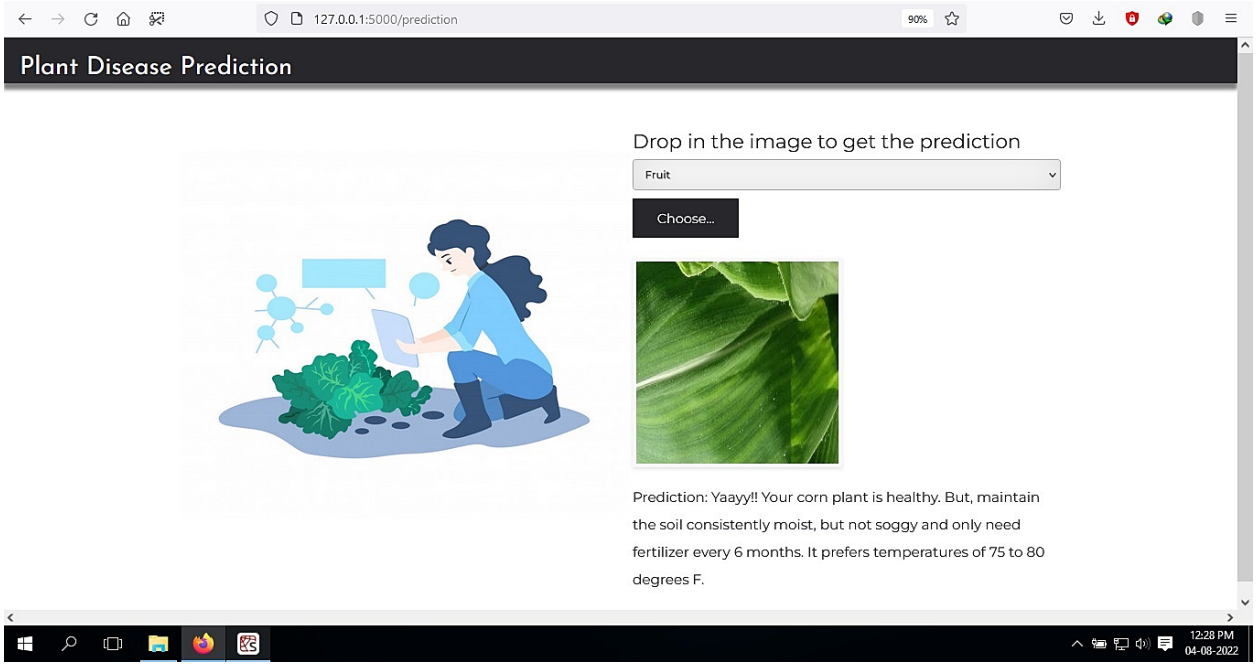
5 FLOWCHART

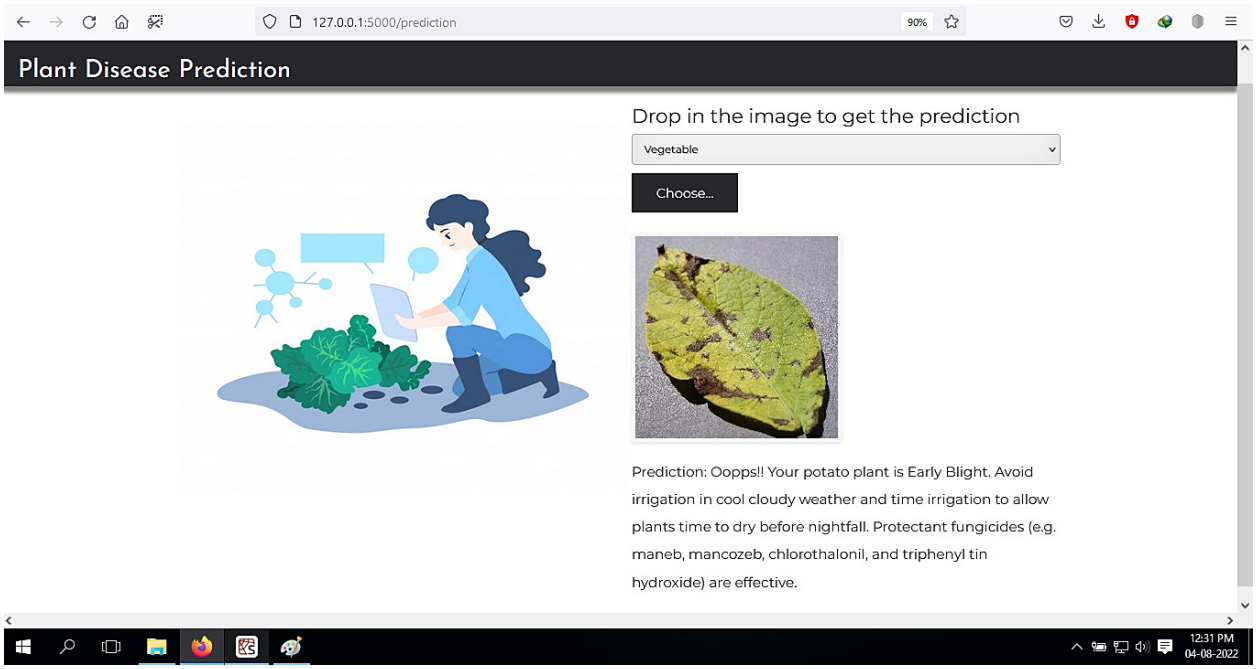


To accomplish the above task you must complete the below activities and tasks :

- Download the dataset.
- Classify the dataset into train and test sets.
- Add the neural network layers.
- Load the trained images and fit the model.
- Test the model.
- Save the model and its dependencies.
- Build a Web application using a flask that integrates with the model built.

6 RESULT





7 ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

- The proposed model could predict the disease just from the image of a particular plant
- 2. Easy to use UI
- 3. Model has some good accuracy in detecting the plant just by taking the input as leaf

DISADVANTAGES:

- Prediction is limited to few plants as we haven't trained all the plants

8 APPLICATIONS

This web application can be used by farmers or users to check whether their plant is infected or
not and can also show the remedy so that the user can take necessary precautions. These kind of web applications can be used in the agricultural sector as well as for small house hold plants.

9 CONCLUSION

Agriculture is the most important sector in today's life. Most plants are affected by a wide variety of bacterial and fungal diseases. Diseases on plants placed a major constraint on the production and a major threat to food security. Hence, early and accurate identification of plant diseases is essential to ensure high quantity and best quality.

In recent years, the number of diseases on plants and the degree of harm caused has increased due to the variation in pathogen varieties, changes in cultivation methods, and inadequate plant protection techniques. Usage of such applications could help the farmers to necessary precautions so that they dont face any loss as such.

10 FUTURE SCOPE

As of now we have just build the web application which apparently takes the input as an image and then predict the output. In the near future we can develop an application with computer vision and AI techniques to predict the infection once you keep the camera near the plant or leaf. This could make the project even more usable.

11 BIBILOGRAPHY

1. Usman Ahmed, Jerry Chun-Wei Lin, Gautam Srivastava, Youcef Djenouri, "A nutrient recommendation system for soil fertilization based on evolutionary computation", *Computers and Electronics in Agriculture*, vol. 189, 2021.
2. Guiling Sun, Xinglong Jia and Tianyu Geng, "Plant Disease Recognition Based on Image Processing Technology", *Journal of Electrical and Computer Engineering Volume*, 2018.
3. R Sujatha, Y Sravan Kumar and Garine Uma Akhil, "Leaf Disease Detection using Image Processing", *Journal of Chemical and Pharmaceutical Sciences*, vol. 10, no. 1, March 2017.
4. Rajneet Kaur and Manjeet Kaur, "A Brief Review on Plant Disease Detection using in Image Processing", *International Journal of Computer Science and Mobile Computing*, February 2017.
5. H. Al-Hiary, S. Bani-Ahmad, M. Reyalat, M. Braik and Z. ALRahamneh, "Fast and Accurate Detection and Classification of Plant Diseases", *International Journal of Computer Applications (0975 –8887)*, vol. 17, no. 1, March 2011.

APPENDIX

A. Source Code

Fruit Training

Image Preprocessing

In [1]:
```
from keras.preprocessing.image import ImageDataGenerator
train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
test_datagen=ImageDataGenerator(rescale=1./255)
```

In [2]:
```
x_train = train_datagen.flow_from_directory('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/fruit-dataset/fruit-dataset/train',target_size = (128,1
x_test = test_datagen.flow_from_directory('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/fruit-dataset/fruit-dataset/test',target_size = (128,128)
```

```
Found 5384 images belonging to 6 classes.
Found 1686 images belonging to 6 classes.
```

In [3]:
```
x_train.class_indices
```

Out[3]:
```
{'Apple___Black_rot': 0,
 'Apple___healthy': 1,
 'Corn_(maize)___Northern_Leaf_Blight': 2,
 'Corn_(maize)___healthy': 3,
 'Peach___Bacterial_spot': 4,
 'Peach___healthy': 5}
```

In [4]:
```
x_test.class_indices
```

Out[4]:
```
{'Apple___Black_rot': 0,
 'Apple___healthy': 1,
 'Corn_(maize)___Northern_Leaf_Blight': 2,
 'Corn_(maize)___healthy': 3,
 'Peach___Bacterial_spot': 4,
 'Peach___healthy': 5}
```

Importing Libraries

In [5]:
```
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Convolution2D
from keras.layers import MaxPooling2D
from keras.layers import Flatten
```

Initializing the model

In [6]:
```
model=Sequential()
```

Adding CNN Layers

In [7]:
```
model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 126, 126, 32)      896

 max_pooling2d (MaxPooling2D  (None, 63, 63, 32)       0
 )

 flatten (Flatten)           (None, 127008)            0

=================================================================
Total params: 896
Trainable params: 896
Non-trainable params: 0
_________________________________________________________________
```

Adding Dense Layers

In [8]:
```
model.add(Dense(40,activation='relu'))
model.add(Dense(20,activation='relu'))
model.add(Dense(6,activation='softmax'))
```

Compile the model

In [9]:
```
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```

Fit & Save the model

In [10]:
```
model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
```

```
Epoch 1/10
C:\Users\SRT\AppData\Local\Temp\ipykernel_5992\1582812018.py:1: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future versio
n. Please use `Model.fit`, which supports generators.
  model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
673/673 [==============================] - 102s 150ms/step - loss: 0.6724 - accuracy: 0.7981 - val_loss: 0.3418 - val_accuracy: 0.8826
Epoch 2/10
673/673 [==============================] - 119s 177ms/step - loss: 0.2896 - accuracy: 0.9047 - val_loss: 0.3573 - val_accuracy: 0.8968
Epoch 3/10
673/673 [==============================] - 93s 139ms/step - loss: 0.2227 - accuracy: 0.9246 - val_loss: 0.1992 - val_accuracy: 0.9383
Epoch 4/10
673/673 [==============================] - 91s 135ms/step - loss: 0.1937 - accuracy: 0.9315 - val_loss: 0.2791 - val_accuracy: 0.9152
Epoch 5/10
673/673 [==============================] - 103s 154ms/step - loss: 0.1696 - accuracy: 0.9456 - val_loss: 0.2423 - val_accuracy: 0.9217
Epoch 6/10
673/673 [==============================] - 93s 138ms/step - loss: 0.1666 - accuracy: 0.9452 - val_loss: 0.1918 - val_accuracy: 0.9425
Epoch 7/10
673/673 [==============================] - 101s 149ms/step - loss: 0.1907 - accuracy: 0.9335 - val_loss: 0.2243 - val_accuracy: 0.9353
Epoch 8/10
673/673 [==============================] - 113s 168ms/step - loss: 0.1537 - accuracy: 0.9521 - val_loss: 0.1775 - val_accuracy: 0.9460
Epoch 9/10
673/673 [==============================] - 102s 152ms/step - loss: 0.0958 - accuracy: 0.9662 - val_loss: 0.1119 - val_accuracy: 0.9650
Epoch 10/10
673/673 [==============================] - 114s 169ms/step - loss: 0.1267 - accuracy: 0.9591 - val_loss: 0.1949 - val_accuracy: 0.9526
```

Out[10]:
```
<keras.callbacks.History at 0x5ec20db8b0>
```

In [11]:
```
model.save("fruit.h5")
```

Fruit Testing

In [9]:
```
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.models import load_model
import numpy as np
```

In [10]:
```
model=load_model("fruit.h5")
```

In [12]:
```
img=image.load_img('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/fruit-dataset/fruit-dataset/test/Peach___Bacterial_spot/0bb77fcc-27ca-474f-beae-6b3519727cf9___Rutg._Ba
```

In [14]:
```
x=image.img_to_array(img)
x=np.expand_dims(x,axis=0)
```

In [22]:
```
pred=np.argmax(model.predict(x),axis=1)
```

```
1/1 [==============================] - 0s 32ms/step
```

In [23]:
```
pred
```

Out[23]:
```
array([4], dtype=int64)
```

In [25]:
```
index=['Apple_Black_rot','Apple_healthy','Corn_(maize)_Northern_Leaf_Blight','Corn_(maize)_healthy','Peach_Bacterial_spot','Peach_healthy']
```

In [27]:
```
index[pred[0]]
```

Out[27]:
```
'Peach_Bacterial_spot'
```

In [28]:
```
img=image.load_img('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/fruit-dataset/fruit-dataset/test/Apple___healthy/0c056dd8-2040-48cf-a9a8-53d8ae5662d0___RS_HL 7987.JPG'
x=image.img_to_array(img)
x=np.expand_dims(x,axis=0)
pred=np.argmax(model.predict(x),axis=1)
index[pred[0]]
```

```
1/1 [==============================] - 0s 31ms/step
```

Out[28]:
```
'Apple_healthy'
```

Vegetable Training

Image Preprocessing

In [1]:
```
from keras.preprocessing.image import ImageDataGenerator
train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
test_datagen=ImageDataGenerator(rescale=1./255)
```

In [2]:
```
x_train = train_datagen.flow_from_directory('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/Veg-dataset/Veg-dataset/train_set',target_size = (128,128),batch_size=8,class_
x_test = test_datagen.flow_from_directory('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/Veg-dataset/Veg-dataset/test_set',target_size = (128,128),batch_size=8,class_mod
```

```
Found 11386 images belonging to 9 classes.
Found 3416 images belonging to 9 classes.
```

In [3]:
```
x_train.class_indices
```

Out[3]:
```
{'Pepper,_bell___Bacterial_spot': 0,
 'Pepper,_bell___healthy': 1,
 'Potato___Early_blight': 2,
 'Potato___Late_blight': 3,
 'Potato___healthy': 4,
 'Tomato___Bacterial_spot': 5,
 'Tomato___Late_blight': 6,
 'Tomato___Leaf_Mold': 7,
 'Tomato___Septoria_leaf_spot': 8}
```

In [4]:
```
x_test.class_indices
```

Out[4]:
```
{'Pepper,_bell___Bacterial_spot': 0,
 'Pepper,_bell___healthy': 1,
 'Potato___Early_blight': 2,
 'Potato___Late_blight': 3,
 'Potato___healthy': 4,
 'Tomato___Bacterial_spot': 5,
 'Tomato___Late_blight': 6,
 'Tomato___Leaf_Mold': 7,
 'Tomato___Septoria_leaf_spot': 8}
```

Importing Libraries

In [5]:
```
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Convolution2D
from keras.layers import MaxPooling2D
from keras.layers import Flatten
```

Initializing the model

In [6]:
```
model=Sequential()
```

Adding CNN Layers

In [7]:
```
model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
```

Adding Dense Layers

In [8]:
```
model.add(Dense(200,activation='relu'))
model.add(Dense(100,activation='relu'))
model.add(Dense(50,activation='relu'))
model.add(Dense(9,activation='softmax'))
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 126, 126, 32)      896

 max_pooling2d (MaxPooling2D  (None, 63, 63, 32)       0
 )

 flatten (Flatten)           (None, 127008)            0

 dense (Dense)               (None, 200)               25401800

 dense_1 (Dense)             (None, 100)               20100

 dense_2 (Dense)             (None, 50)                5050

 dense_3 (Dense)             (None, 9)                 459

=================================================================
Total params: 25,428,305
Trainable params: 25,428,305
Non-trainable params: 0
_________________________________________________________________
```

Compile the model

In [9]:
```
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```

Fit & Save the model

In [10]:
```
model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
```

```
Epoch 1/10
C:\Users\SRT\AppData\Local\Temp\ipykernel_2512\1582812018.py:1: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
1424/1424 [==============================] - 441s 309ms/step - loss: 1.1204 - accuracy: 0.6246 - val_loss: 0.7601 - val_accuracy: 0.7550
Epoch 2/10
1424/1424 [==============================] - 419s 294ms/step - loss: 0.6134 - accuracy: 0.7857 - val_loss: 0.4293 - val_accuracy: 0.8522
Epoch 3/10
1424/1424 [==============================] - 395s 278ms/step - loss: 0.5117 - accuracy: 0.8220 - val_loss: 0.6385 - val_accuracy: 0.7971
Epoch 4/10
1424/1424 [==============================] - 471s 331ms/step - loss: 0.4350 - accuracy: 0.8502 - val_loss: 0.4554 - val_accuracy: 0.8489
Epoch 5/10
1424/1424 [==============================] - 409s 287ms/step - loss: 0.3891 - accuracy: 0.8682 - val_loss: 0.2624 - val_accuracy: 0.9095
Epoch 6/10
1424/1424 [==============================] - 413s 290ms/step - loss: 0.3401 - accuracy: 0.8858 - val_loss: 0.3192 - val_accuracy: 0.8888
Epoch 7/10
1424/1424 [==============================] - 387s 272ms/step - loss: 0.3229 - accuracy: 0.8905 - val_loss: 0.2865 - val_accuracy: 0.8975
Epoch 8/10
1424/1424 [==============================] - 380s 267ms/step - loss: 0.2948 - accuracy: 0.9024 - val_loss: 0.5083 - val_accuracy: 0.8302
Epoch 9/10
1424/1424 [==============================] - 387s 272ms/step - loss: 0.2707 - accuracy: 0.9076 - val_loss: 0.1508 - val_accuracy: 0.9491
Epoch 10/10
1424/1424 [==============================] - 381s 267ms/step - loss: 0.2543 - accuracy: 0.9131 - val_loss: 0.1271 - val_accuracy: 0.9561
```

Out[10]:
```
<keras.callbacks.History at 0x901f9b7fd0>
```

In [11]:
```
model.save("vegetable.h5")
```

Vegetable Testing

In [1]:
```
from tensorflow.keras.preprocessing import image
from tensorflow.keras.preprocessing.image import img_to_array
from tensorflow.keras.models import load_model
import numpy as np
```

In [2]:
```
model=load_model("vegetable.h5")
```

In [3]:
```
img=image.load_img('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/Veg-dataset/Veg-dataset/test_set/Tomato___Late_blight/ce3f895d-e031-4ed9-ac40-7f6550894bff___GHLB_PS Leaf
x=image.img_to_array(img)
x=np.expand_dims(x,axis=0)
pred=np.argmax(model.predict(x),axis=1)
index=['Pepper,_bell___Bacterial_spot','Pepper,_bell___healthy','Potato___Early_blight','Potato___Late_blight','Potato___healthy','Tomato___Bacterial_spot','Tomato___Late_blight
index[pred[0]]
```

```
1/1 [==============================] - 0s 185ms/step
```

Out[3]:
```
'Tomato___Late_blight'
```

In [4]:
```
img=image.load_img('C:/Users/SRT/Desktop/Project/Dataset Plant Disease/Veg-dataset/Veg-dataset/test_set/Potato___healthy/ff700844-68ad-4e99-8427-58a39c07f817___RS_HL 1860.JPG',t
x=image.img_to_array(img)
x=np.expand_dims(x,axis=0)
pred=np.argmax(model.predict(x),axis=1)
index[pred[0]]
```

```
1/1 [==============================] - 0s 34ms/step
```

Out[4]:
```
'Potato___healthy'
```

Flask Integration

```
import requests
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import load_model
import numpy as np
import pandas as pd
import tensorflow as tf
from flask import Flask, request, render_template, redirect, url_for
import os
from werkzeug.utils import secure_filename
from tensorflow.python.keras.backend import set_session
app=Flask(__name__)
model=load_model("C:/Users/SRT/Desktop/Project/vegetable.h5")
model1=load_model("C:/Users/SRT/Desktop/Project/fruit.h5")
@app.route('/')
def home():
    return render_template('home.html')

@app.route('/prediction')
def prediction():
    return render_template('predict.html')

@app.route('/predict',methods=['POST'])

def predict():
    if request.method == 'POST':

        f = request.files['image']


        basepath = os.path.dirname(__file__)
        file_path = os.path.join(
            basepath, 'Dataset Plant Disease', secure_filename(f.filename))
        f.save(file_path)
        img = image.load_img(file_path, target_size=(128, 128))

        x = image.img_to_array(img)
        x = np.expand_dims(x, axis=0)

```

```
         plant=request.form['plant']
         print(plant)

         if(plant=="vegetable"):
             preds = model.predict(x)
             preds = np.argmax(preds)
             print(preds)
             df=pd.read_excel('precautions - veg.xlsx')
             print(df.iloc[preds]['caution'])
         else:
             preds = model1.predict(x)
             preds = np.argmax(preds)

             df=pd.read_excel('precautions - fruits.xlsx')
             print(df.iloc[preds]['caution'])


         return df.iloc[preds]['caution']




if __name__ == "__main__":
    app.run(debug=False)
```

IBM Training

In [1]:
```
pwd
```

Out[1]:
```
'/home/wsuser/work'
```

Image Preprocessing

In [21]:
```
from keras.preprocessing.image import ImageDataGenerator
train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,zoom_range=0.2,horizontal_flip=True)
test_datagen=ImageDataGenerator(rescale=1./255)
```

In [22]:
```
import os, types
import pandas as pd
from botocore.client import Config
import ibm_boto3

def __iter__(self): return 0

# @hidden_cell
# The following code accesses a file in your IBM Cloud Object Storage. It includes your credentials.
# You might want to remove those credentials before you share the notebook.
client_0ef70f313fde4b659f04ac75d99b4f3c = ibm_boto3.client(service_name='s3',
    ibm_api_key_id='LeEierGXhXUJFNO77KPXvpNUB8Et35CuQbse0gsct-D_',
    ibm_auth_endpoint="https://iam.cloud.ibm.com/oidc/token",
    config=Config(signature_version='oauth'),
    endpoint_url='https://s3.private.us.cloud-object-storage.appdomain.cloud')

streaming_body_1 = client_0ef70f313fde4b659f04ac75d99b4f3c.get_object(Bucket='fertilizersrecommendationsystemfo-donotdelete-pr-dfzzgm9hsg1qkl', Key='Dataset Plant Disease.zip')['B

# Your data file was loaded into a botocore.response.StreamingBody object.
# Please read the documentation of ibm_boto3 and pandas to learn more about the possibilities to load the data.
# ibm_boto3 documentation: https://ibm.github.io/ibm-cos-sdk-python/
# pandas documentation: http://pandas.pydata.org/
```

In [23]:
```
from io import BytesIO
import zipfile
unzip=zipfile.ZipFile(BytesIO(streaming_body_1.read()),'r')
file_paths=unzip.namelist()
for path in file_paths:
    unzip.extract(path)
```

In [24]:
```
ls
```

```
'Dataset Plant Disease'/   fertilizer-recommendation.tgz
```

In [25]:
```
x_train = train_datagen.flow_from_directory('/home/wsuser/work/Dataset Plant Disease/fruit-dataset/fruit-dataset/train',target_size = (128,128),batch_size=8,class_mode = 'categori
x_test = test_datagen.flow_from_directory('/home/wsuser/work/Dataset Plant Disease/fruit-dataset/fruit-dataset/test',target_size = (128,128),batch_size=8,class_mode = 'categorical
```

```
Found 5384 images belonging to 6 classes.
Found 1686 images belonging to 6 classes.
```

In [26]:
```
x_train.class_indices
```

Out[26]:
```
{'Apple___Black_rot': 0,
 'Apple___healthy': 1,
 'Corn_(maize)___Northern_Leaf_Blight': 2,
 'Corn_(maize)___healthy': 3,
 'Peach___Bacterial_spot': 4,
 'Peach___healthy': 5}
```

In [27]:
```
x_test.class_indices
```

Out[27]:
```
{'Apple___Black_rot': 0,
 'Apple___healthy': 1,
 'Corn_(maize)___Northern_Leaf_Blight': 2,
 'Corn_(maize)___healthy': 3,
 'Peach___Bacterial_spot': 4,
 'Peach___healthy': 5}
```

Importing Libraries

In [28]:
```
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Convolution2D
from keras.layers import MaxPooling2D
from keras.layers import Flatten
```

Initializing the model

In [29]:
```
model=Sequential()
```

Adding CNN Layers

In [30]:
```
model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 126, 126, 32)      896

 max_pooling2d (MaxPooling2D  (None, 63, 63, 32)       0
 )

 flatten (Flatten)           (None, 127008)            0

=================================================================
Total params: 896
Trainable params: 896
Non-trainable params: 0
_________________________________________________________________
```

Adding Dense Layers

In [31]:
```
model.add(Dense(40,activation='relu'))
model.add(Dense(20,activation='relu'))
model.add(Dense(6,activation='softmax'))
```

Compile the model

In [32]:
```
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```

Fit & Save the model

In [33]:
```
model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
```

```
/tmp/wsuser/ipykernel_164/1582812018.py:1: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)
Epoch 1/10
673/673 [==============================] - 63s 93ms/step - loss: 0.6957 - accuracy: 0.7602 - val_loss: 0.2967 - val_accuracy: 0.8980
Epoch 2/10
673/673 [==============================] - 63s 93ms/step - loss: 0.3288 - accuracy: 0.8884 - val_loss: 0.2402 - val_accuracy: 0.9098
Epoch 3/10
673/673 [==============================] - 62s 93ms/step - loss: 0.2788 - accuracy: 0.9032 - val_loss: 0.2982 - val_accuracy: 0.8873
Epoch 4/10
673/673 [==============================] - 61s 91ms/step - loss: 0.2336 - accuracy: 0.9242 - val_loss: 0.1606 - val_accuracy: 0.9448
Epoch 5/10
673/673 [==============================] - 62s 92ms/step - loss: 0.2184 - accuracy: 0.9246 - val_loss: 0.1968 - val_accuracy: 0.9342
Epoch 6/10
673/673 [==============================] - 61s 91ms/step - loss: 0.1876 - accuracy: 0.9342 - val_loss: 0.1621 - val_accuracy: 0.9395
Epoch 7/10
673/673 [==============================] - 62s 91ms/step - loss: 0.1726 - accuracy: 0.9424 - val_loss: 0.2014 - val_accuracy: 0.9407
Epoch 8/10
673/673 [==============================] - 62s 92ms/step - loss: 0.1507 - accuracy: 0.9510 - val_loss: 0.2241 - val_accuracy: 0.9324
Epoch 9/10
673/673 [==============================] - 60s 89ms/step - loss: 0.1504 - accuracy: 0.9504 - val_loss: 0.1567 - val_accuracy: 0.9567
Epoch 10/10
673/673 [==============================] - 60s 89ms/step - loss: 0.1182 - accuracy: 0.9593 - val_loss: 0.3144 - val_accuracy: 0.9247
```

Out[33]:
```
<keras.callbacks.History at 0x7f3815c2b310>
```

In [34]:
```
model.save("fruit.h5")
```

In [35]:
```
ls
```

```
'Dataset Plant Disease'/   fertilizer-recommendation.tgz   fruit.h5
```

IBM Deployment

In [36]:
```
!pip install watson-machine-learning-client
```

```
Requirement already satisfied: watson-machine-learning-client in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (1.0.391)
Requirement already satisfied: boto3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.18.21)
Requirement already satisfied: ibm-cos-sdk in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.11.0)
Requirement already satisfied: urllib3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.26.7)
Requirement already satisfied: lomond in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (0.3.3)
Requirement already satisfied: pandas in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.3.4)
Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.26.0)
Requirement already satisfied: tqdm in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (4.62.3)
Requirement already satisfied: certifi in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2022.6.15)
Requirement already satisfied: tabulate in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (0.8.9)
Requirement already satisfied: botocore<1.22.0,>=1.21.21 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (1.21.41)
Requirement already satisfied: s3transfer<0.6.0,>=0.5.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (0.5.0)
Requirement already satisfied: jmespath<1.0.0,>=0.7.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (0.10.0)
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from botocore<1.22.0,>=1.21.21->boto3->watson-machine-learning-client) (2.8.2)
Requirement already satisfied: six>=1.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from python-dateutil<3.0.0,>=2.1->botocore<1.22.0,>=1.21.21->boto3->watson-machine-learning-client) (1.15.0)
Requirement already satisfied: ibm-cos-sdk-s3transfer==2.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ibm-cos-sdk->watson-machine-learning-client) (2.11.0)
Requirement already satisfied: ibm-cos-sdk-core==2.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ibm-cos-sdk->watson-machine-learning-client) (2.11.0)
Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->watson-machine-learning-client) (3.3)
Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->watson-machine-learning-client) (2.0.4)
Requirement already satisfied: pytz>=2017.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->watson-machine-learning-client) (2021.3)
Requirement already satisfied: numpy>=1.17.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->watson-machine-learning-client) (1.20.3)
```

In [37]:
```
from ibm_watson_machine_learning import APIClient
wml_credentials={
    "url":"https://us-south.ml.cloud.ibm.com",
    "apikey":"iREwpeSu_L4djBA1HwpwWBXYRXpYpgKakkFqTqSiHEXR"
}
```

In [38]:
```
client=APIClient(wml_credentials)
```

In [39]:
```
def guid_space_name(client,Fertilizer_deploy):
    space=client.spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']['name']==Fertilizer_deploy)['metadata']['id'])
```

In [40]:
```
space_uid=guid_space_name(client,'Fertilizer_deploy')
print(space_uid)
```

```
72692168-1a03-4787-8b5b-8dc723713486
```

In [41]:
```
client.set.default_space(space_uid)
```

Out[41]:
```
'SUCCESS'
```

In [51]:
```
client.software_specifications.list(100)
```

In [52]:
```
software_space_uid=client.software_specifications.get_uid_by_name('tensorflow_rt22.1-py3.9')
software_space_uid
```

Out[52]:
```
'acd9c798-6974-5d2f-a657-ce06e986df4d'
```

In [44]:
```
ls
```

```
'Dataset Plant Disease'/   fertilizer-recommendation.tgz   fruit.h5
```

In [47]:
```
!tar -zcvf fertilizer-recommendation.tgz fruit.h5
```

```
fruit.h5
```

In [48]:
```
ls
```

```
'Dataset Plant Disease'/   fertilizer-recommendation.tgz   fruit.h5
```

In [53]:
```
model_details=client.repository.store_model(model='fertilizer-recommendation.tgz',
   meta_props={
               client.repository.ModelMetaNames.NAME:"CNN",
               client.repository.ModelMetaNames.TYPE:'tensorflow_2.7',
               client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_space_uid

   })
```

In [54]:
```
model_id=client.repository.get_model_id(model_details)
```

In [55]:
```
model_id
```

Out[55]:
```
'b8a5ddd2-c83f-4b7c-8f3b-4c159276ba1f'
```

In [56]:
```
client.repository.download(model_id,'fertilizer.tar.gb')
```

```
Successfully saved model content to file: 'fertilizer.tar.gb'
```

Out[56]:
```
'/home/wsuser/work/fertilizer.tar.gb'
```

In [57]:
```
ls
```

```
'Dataset Plant Disease'/         fertilizer.tar.gb
 fertilizer-recommendation.tgz   fruit.h5
```