Crop Suggestion Based on Soil

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ABSTRACT

India is Agriculture based Country. Soil is one main characteristic when it comes to Crop Production. The Crop if grown on right Soil improves productivity. For improving uses cases of soil prediction we are working building on model which helps in identifying soil classes. For achieve this purpose we have a 3 phase model, Dataset, Transfer Learning Model and Ui and Backend . For training our model we have been using methods like Custom CNN, VGG, Densenet. This project is an end-end project for farmers for improving productivity. CNNs are primarily used to solve difficult image-driven pattern recognition tasks and with their precise yet simple architecture, offer a simplified method of getting started with ANN. Previous Researches have been done Text data but we have tried to create a end-end system which can be used to detect class of soil and tell crop to grow .

Keywords: Convolution Neural Network , Artificial Neural Network , Visual Geometric Graph , Densenet , User Interface , flask

I INTRODUCTION

 This Project is dealing with identification Soil and then based on soil type it tells the best crop that farmer can grow in respective seasons. In this project we have used Image of Soil for doing predictions. Here we are using Image Classification. We have tried to use CNN, Transfer learning like DenseNet , Vgg .

In this project we are trying create Solution compare between various Soil Classes . Here we are have used Various Deep Learning and Transfer Learning for training Our Model. We have done comparative study of 1)CNN-: CNN is deep Neural Network Model, used for large image datasets. CNN has been very much used in advance techniques like Computer Vision ,etc . CNN uses Mathematical operation called "Convolution". It is done on two functions that produces a third function that expresses how the shape of one is modified by the other.[1].Considering CNN in simple worlds we can state it as process were images are Converted to form were image can be easily processed without losing feature required for prediction.2)Densenet-: DenseNet is a type of convolution neural network that utilizes dense connections between layers, through Dense Blocks, where we connect all layers (with matching feature-map sizes) directly with each other. To preserve the feed-forward nature, each layer obtains additional inputs from all preceding layers and passes on its own feature-maps to all subsequent layers.[2].Dense Blocks is used in CNN directly connected layer . Here for preserving feed-forwarding nature, layers receive additional Input from previous block and pass it on it own feature-map to all Subsequent layer[3]. 3) VGG-:VGG was develop at Oxford University. Full form of VGG is Visual Geometric Graph .Main aim of developing VGG was to improve model performance. VGG is example of Standard deep CNN . Here term deep refer to VGG16 and Vgg19. VGG is created to improve model performance. Architecture

of VGG is created with very small Convolution Filter.VGG uses 3 RELU unit . Have large number of weight layer due to small-size Convolution [4]. In VGG NUMBER OF LAYER α   PERFORMANCE.

We have use flask framework for developing our webpage. As for storing data we have use Mysql database. My Sql is Relational Databases . In such databases there exist relation between rows and columns. As we also have multi language content of webpage we have Google api .

The basic structure of a ANN can be modeled. We would load the input, usually in the form of a multidimensional vector to the input layer of which will distribute it to the hidden layers. The hidden layers will then make decisions from the previous layer and weigh up how a stochastic change within itself detriments or improves the final output, and this is referred to as the process of learning. Having multiple hidden layers stacked upon each-other is commonly called deep learning is referred to as the process of learning. Having multiple hidden layers stacked upon each-other is commonly called deep learning [5].Crop's productivity is mainly based on the type of soil replacing the traditional method. Machine Learning techniques can be used to improve the productivity and quality of the crops in the agricultural sector Various classes of soil that we have for implementation of our project are

1. Laterite Soil , 2. Black Soil , 3. Red Soil , 4. Peat Soil , 5. Cinder Soil.

ǁ RESEARCH GAP

Author in Paper [6] states that Precision Agriculture (PA) was originally developed to address variability in soil and crop parameters for large-scale agriculture in developed countries. The general concepts of PA can also be adapted for farm-based agriculture for small and marginal farmers in Developing Countries. This approach is characterized by a farmer-soil-crop database acquired from the field, crop calendars provided by agricultural experts, real-time acquisition of parameters such as temperature and rainfall through sensors, and an analytical model that simulates the crop calendar using static, semi-static and dynamic inputs, leading to farmer- and crop-level support advisories delivered through devices such as mobile phones and tablets.[6]. Author in Paper[7] give study about classification algorithms and performance of various algorithms that we can use.

Author says Paper[8]tell abouts Artificial Neural Network and it advance uses like pattern Recognition , Object Detection and Classification . Document also tell about CNNs, discussing recently published papers and newly formed techniques in developing these brilliantly fantastic image recognition models. Paper[9]tell about CNN and how it is use in Visual Recognition . it also describe efficient method to constrain the complexity of feedforward neural networks by weight sharing and restriction to local connections. This network topology has been applied in particular to image classification when sophisticated preprocessing is to be avoided and raw images are to be classified directly. In this paper two variations of convolutional networks-neocognitron and a modification of neocognitron-are compared with classifiers based on fully connected feedforward layers with respect to their visual recognition performance. For a quantitative experimental comparison with standard classifiers two very different recognition tasks have been-chosen: handwritten digit recognition and face recognition. In the first example, the generalization of convolutional networks is compared to fully connected networks; in the second example human face recognition is investigated under constrained and variable conditions, and the limitations of convolutional networks are discussed. Paper[10] give us knowledge about VGG 16 . this paper tell us about various layer present in vgg16 and also describe about overview and advantage

of using it for feature extraction of image. Paper[11] talks about torchvision library use for computer vision . Torchvision Library is collection of popular dataset. It also act as dataset loader for various vision dataset such as ImageNet, COCO, Cityscapes. Paper[12] talks about densenet and it comparative advantage over traditional network like: they alleviate the vanishing-gradient problem, strengthen feature propagation, encourage feature reuse, and substantially reduce the number of parameters.. Paper also describe about Dense Convolutional Network (DenseNet), which connects each layer to every other layer in a feed-forward fashion . Paper[13] describe about soil Properties . It tell how soil's physical properties affect soil condition . tell he supporting capability; movement, retention and availability of water and nutrients to plants; ease in penetration of roots, and flow of heat and air are directly associated with physical properties of the soil. Physical properties also influence the chemical and biological properties

III METHODOLOGY

Our Project focus on study of soil that the kind of soil land has and then suggesting the crop that framer can grow on his land for best result. For accomplishing our task we have Use deep learning models. For better understanding of model which performs best with given data we have done comparative study of models. As we are building full end to end solution so we have tried to build complete web Solution . For recognition of soil we have have Transfer Learning Model "VGG" as shown by our comparative study . Data of crop is stored in MySQL databases . Our Frontend is created by React and Backend is built over Flask frame of Python.

Cinder	Black Soil	Laterite Soil	Peat Soil	Yellow Soil

The main part of our project is soil recognition model built over deep learning concept. As any artificial model has 3 phase that are 1)Data Preparation 2) Model Training 3) Deployment . Each step here are dependent as machine learning model depends directly upon dataset. As data preparation is first step of building our Model. Moreover our project concentrate of suggesting right crop to framer based upon soil. Soil is one main characteristic that one consider when it come to crop. Our Model or any model depend upon dataset for training

and building knowledge base. In our Model we are trying to build a Deep learning Model that could classify between various type of soil. We have 5 Classes of Soil and each soil has different Properties and thus crop grown on soil is also different . In our Project we have taken our dataset from kaggle[14] . Dataset have 5 classes of soil are 1)Cinder Soil 2) Peat Soil 3) Yellow Soil , 4) Black Soil , 5) Laterite Soil.
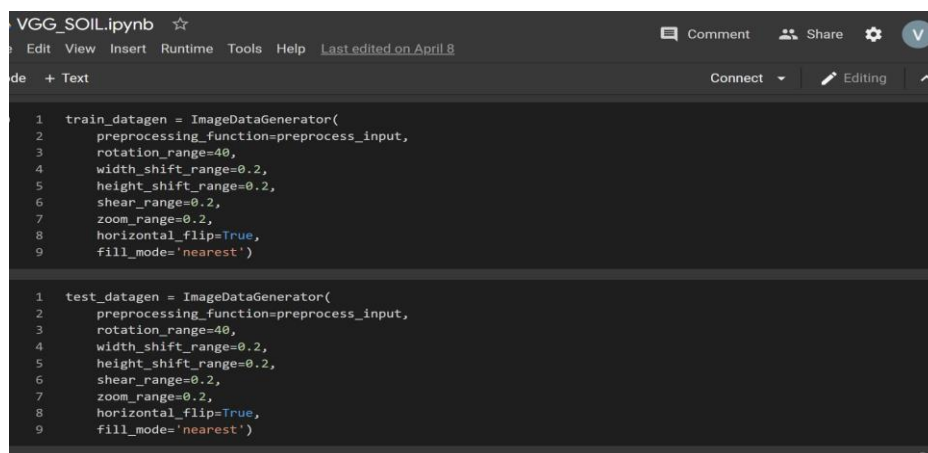
Each class of Soil have different properties and characteristics . So it is very important for us to find and maintain the right data . Data we used is mentioned in Table 2.

Soil	Feature
Laterite	BOTH Soil and rock type rich in iron and alluminum
Peat	Composed of partially decomposed organic matter
Cinder	Form by wastage by-product intense heat from industries
Black	Have black enrich surface horizon, enrich organic carbon
Yellow	Formed under board -leaved forest in humid area

Table 2. Characteristics of soil[20]

Soil' s color tells a lot about it feature like yellow soil yellow color depicts iron content in it , black color due decomposed organic matter.

Since our dataset has less number of image ie approx 30 to 40 image and it is not enough to get good model . Thus we are using the Image Generator module. Code is depicted in Fig.1


```
train_datagen = ImageDataGenerator(
    preprocessing_function=preprocess_input,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest')

test_datagen = ImageDataGenerator(
    preprocessing_function=preprocess_input,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest')
```

Fig.1 Image Data Generator Used in Model

Here we used image Data Generator for doing Data Argumentation. Data Augmentation help in making copies image virtually and help to train our model regardless of less number of data images. For Image Data generators help to do limited data or whether you want to add variety in terms of noise augmentation both statically as well as on the fly by using the multi-processing capabilities of the modern CPUs. [18]. In Data Image Generator we have various filter like **rotation_range, height_shift_range,width_shift_range,rescale** .

In our model we have used filter mention in table 3.[19]

Filter Name	Value_type	Description	Value_Used
rotation_range	int	Degree range for random rotations.	40
Width_shift_range	1-D array-like or int	Help to shift width range by[-1,0,1] or by[-1.0 ,1.0]	0.2
Height_shift_range	1-D array-like or int	Help to shift height range by[-1,0,1] or by[-1.0 ,1.0]	0.2
Shear_Range	Float	Shear Intensity ,Shear angle in counter-clockwise direction in degrees	0.2
Horizontal_flip	Bollean	Randomly flip inputs horizontally.	TRUE
Fill_Mode	One of {"constant", "nearest", "reflect" or "wrap"}.	points outside the boundaries of the input are filled according to the given mode:	nearest

Table 3. Filter Used

We have tried to approach our project in such a way that we can make thing simple and effective. Our Use procedure for implementing our project is shown in fig.2

Our procedure mainly consists of 4 module in which we have broken our whole project.

1)Machine Learning model 2) User Interface 3) Databases 4) Backend Framework
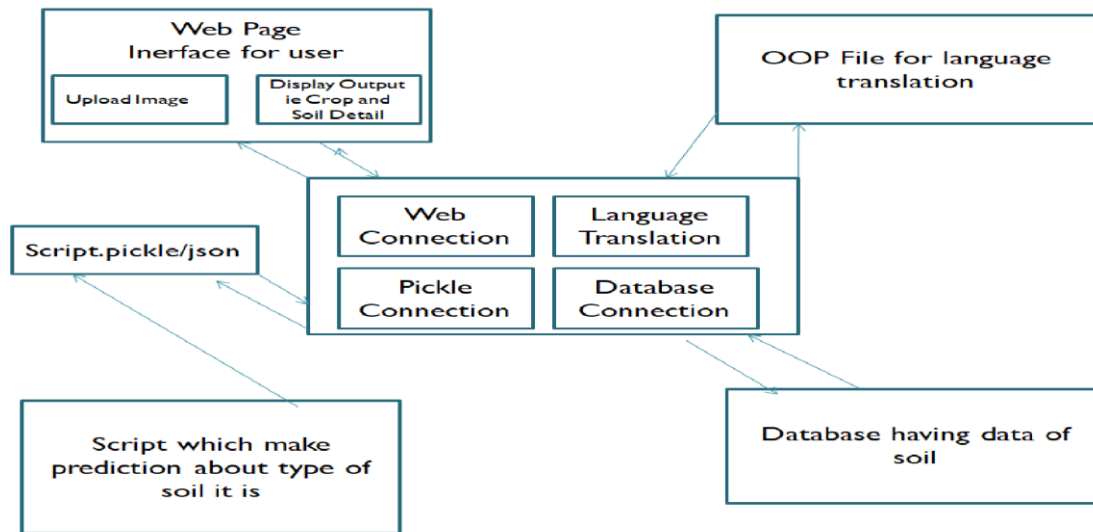
Fig.2 Used Procedure

As the procedure that we follow was having a web page for upload image . then we have machine learning script file were our model is trained. Next we our databases were all information regarding soil , crop , ect . Most important part that we are having was our flask backend were we put all module together and it act as connector. For making thing simple and reusable we have used Object Oriented Program due which our each module is developed into a function which can be called when required

Implementation

Our project proposed working to define layout of our approach . We have tried to build a solution which can be used by framer for getting suggestion about crop that they can grow in farms ,
Our mainly focuses on ease of use and accuracy of model . As we broke our project in 4 part as mention earlier. We followed the Iterative **Software development** Model. This SDLC help us in working on each model independently . Problems in one module do not affect other modules' working and progress. Second reason was that it is easy to understand and plan . Thirdly, it allow us to have scope of future improvement and modification. Talking about implementing each module separately . Firstly start about deep learning model . So we have done comparative study of CNN , VGG , Densenet over our dataset. Since Any Machine Learning model undergoes 3 phase journey as shown.in figure 3.
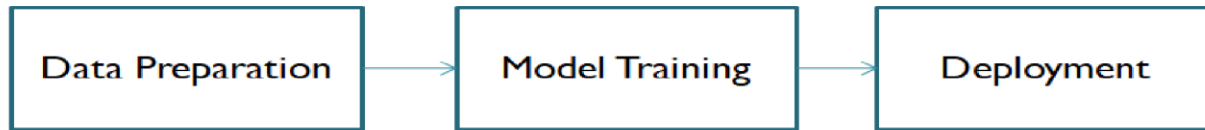
Fig 3. Life Cycle of Machine learning model

Implementing our model we are doing 2nd phase of LifeCycle that is model training . For training our model we have use Custom CNN but as we Custom CNN work well on large So thus fail since our data was not enough to train CNN . Then we move on to transferLearning for training model . We used VGG and DenseNet . These models have predefined weights that we used. These models are really helpful when we have a small size dataset.

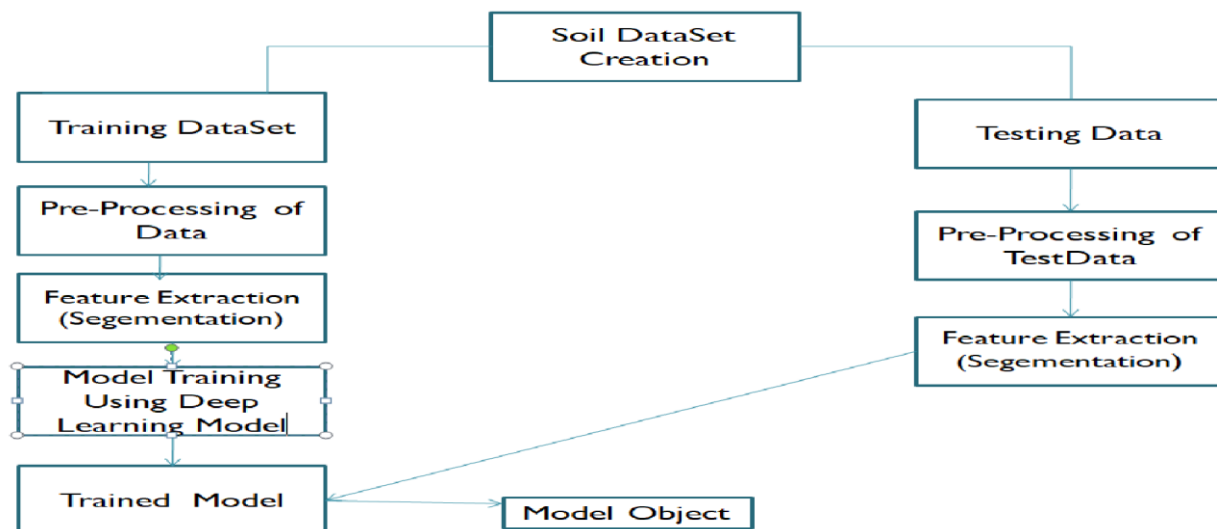For Our training purpose we have use step mention in fig.4

Fig.4 Model Training Method

When we implemented deep learning we find VGG to best performing model as compared to CNN and Densenet. As a result of study of our deep learning model we conclude that VGG performs best with given dataset. As val_accuracy and val_loss are parameter that one look for and result of our comparative study is shown in table 4 and table5 respectively

Val_Accuracy.

Epocs	CNN	VGG	Densenet
1	0.3333	0.3876	0.3810
2	0.3333	0.5116	0.3333
3	0.3333	0.7984	0.3973
4	0.3333	0.7984	0.4110
5	0.3333	0.8682	0.4589
6	0.3333	0.8837	0.5959
7	0.3333	0.9147	0.5959
8	0.3333	0.9147	0.6438
9	0.3333	0.8450	0.6781

Table 4 . Val_Accuracy

Val_Loss

Epochs	CNN	VGG	Densenet
1	1.3053	2.1020	1.6812
2	1.3000	1.2334	1.4760
3	1.2978	0.6465	1.0739
4	1.2959	0.4859	1.1678
5	1.2798	0.3717	1.0255
6	1.2942	0.3335	0.9892
7	1.2864	0.4127	0.9844
8	1.2837	0.8139	0.8854
9	1.2811	0.3004	0.7003
10	1.2748	0.2385	0.8728

Table5 . Val_Loss

As result of our study We have used VGG for our model training and used it for prediction. Second part of our project was the database where we have stored the data of our crop that can be grown on particular Soil . for doing this task we used relational databases management system (RDBMS) MySql . We have Stored Soil_type and crop grown in databases.

The columns in databases are as . 1)Soil_type(Primary Key) 2) Rabi Crop 3) Kharif Crop 4)Zaid

Crop. All these data is stored in Table Crop data . Schema is shown in table.6

Soil_Type	Kharif Crop	Zaid Crop	Rabi Crop
Peat Soil	Cotton, groundnut, maize and rice	Watermelon,Musk melon,Cucumber	Barley, gram, peas and wheat
Yellow Soil	sugarcane,maize/corn, groundnut	mango, orange, citrus	wheat
Laterite Soil	Groundnut	pepper, tomato	Tea, coffee and cashew
Cinder Soil	paddy,maize,jowar, bajra,cotton	moong, urad, sunflower	Wheat.,Barley. Oats,Pulses,Mustar .
Black Soil	cotton, sugarcane, tobacco, wheat, millets,oilseeds	vine plants	sorghum and sunflower

Table 6. Schema of Crop database

As our third model that is our user interface which is built over reactjs. It is javascript framework for frontend development.React js is use to build easy , quick and light weigh website .t Outlook of Web Page is given in fig.5
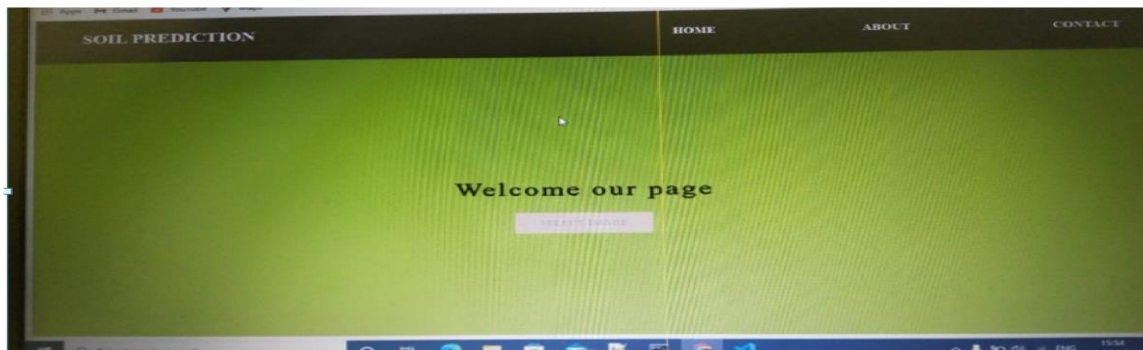

Fig 5. Webpage

As our important part of project was Flask framework which is handle whole backend. Here we was using Object Oriented Program . We created function for each task as will be want to updated our so it can be easily done.

As describe our whole implementation of our model we have shown in table7.

Use Library And Module

Part_NAme	Implementation method
Deep Learning Model	Language-:python
Model Used	Visual Geometric Graph
Frontend	Lanage-: Javascript , framework-: React
Backend	Language-:Python Framework-Flask:
Database	MYSQL

Table7. Summary Implementation Model

Conclusion.

We worked on the area of implementing machine learning to create a model which is capable of identifying soil and giving the best set of crops for particular soil. For achieving our goal we have used various methods like CNN , VGG , Densenet. We have worked on 5 categories of soil ie Black Soil , Alluvial Soil , Peat Soil , Red Soil , Laterite Soil. We have been testing our model over various test cases and found that densenet perform best We focus on improving our model accuracy, adding extension hardware . We can conclude that VGG performs best by giving 96.79% accuracy Talking of future scope we would like to improve accuracy , Attached hardware for more precise work , improve dataset , Creating more labels and parameter for improving soil quality.

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