A Project Report on

A Model For Smart agriculture

COMPUTER DEPARTMENT

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Approval Sheet

This Project Report entitled ***A Model For Smart Agriculture*** Submitted by ***Pratik Jain(16102060),Kshitija Shah(16102027),Tina Shah(16102019)*** is approved for the partial fulfillment of the requirenment for the award of the miniproject in ***Computer Department*** from ***University of Mumbai.***

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CERTIFICATE

This is to certify that the project entitled ***A Model For Smart Agriculture*** submitted by ***Pratik Jain(16102060),Kshitija Shah(16102027),Tina Shah(16102019)*** for the partial fulfillment of the requirement for award of a ***Miniproject*** in ***Computer Department***,to the University of Mumbai,is a bonafide work carried out during academic year 2018-2019

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Declaration

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, We have adequately cited and referenced the original sources. We also declare that We have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Climate changes and rainfall has been erratic over the past decade. Due to this in recent era, climate-smart methods called as smart agriculture is adopted by many Indian farmers. Smart agriculture is an automated and directed information technology implemented with the IOT.

Major objective is to collect real time data of soil for production environment that provides easy access for agricultural facilities and using this information we have generated the dataset using xlsx library in python. Further we have trained the dataset without using any library function in python language.

The library functions are readily available and can be used to train and test any kind of dataset. These functions are difficult to generate and their codes are not easy to understand. Our model creates a decision tree and predicts the outcome of the given dataset. This is a generalized decision tree which works on every kind of dataset.

It is a self reliant model which does not have any pre-requisite. It is a powerful way to make agriculture smart and reduce human efforts as a whole. The Machine Learning and real time data analysing takes care of every aspect. If joint with IOT and sensory objects. The whole model becomes independent of any object.

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CHAPTER 1: INTRODUCTION

Agriculture is the basic source of livelihood of people in India. In past decade, it is observed that there is not much crop development in agriculture sector. Food prices are continuously increasing because crop rate is declined. It has pushed over 40 million people into poverty since 2010[1]. There are number of factors which are responsible for this, it may be due to water waste, low soil fertility, fertilizer abuse, climate change or diseases, etc. It is very essential to make effective intervention in agriculture and the solution is IOT in integration with Wireless sensor networks and Machine Learning. It has potential to change the way of development in agriculture and gives great contribution to make it smart agriculture.

The sensor technology helps to collect information regarding the environment and soil. And with the help of IOT we can make communication of devices possible. Machine learning on the other hand helps in analysing and calculating the raw information of data and predicting the outcomes of it.

So it basically happens in four steps starting with installation of the bot, then surveying the farmland with help of censors for its conditions, followed by sending the captured data to the backend. And finally this real time data of soil and environment is evaluated and analysed to determine the conditions of farm or a land. Which in turn will help predicting the type of plant/crop that can be grown in the current conditions of the farmland that is being inspected.

CHAPTER 2: LITERATURE REVIEW

The research in agriculture area is enhanced in various aspects to improve the quality and quantity of productivity of agriculture. Researchers have been worked on many different projects on soil attributes, different weather conditions as well as scouting crops. Some projects worked on actual farm fields and some worked on polyhouses. Researches of Carrnige Mellon University worked on plant nursery using Wireless Sensor Technology [2].

Wireless Sensor Network based polyhouse monitoring system is explained in [3] which make use of environment temperature, humidity, CO2 level and sufficient light detection modules. This polyhouse control technology provides automatic adjustment of polyhouse. In [4] authors have proposed development of wsn based above mentioned parameters for agriculture using ZigBee protocol and GPS technology. In some projects such as [5] authors have designed and implemented an approach in development of crops monitoring system in real time to increase production of rice plants. This system has used motes with sensors to check leaf wetness. Later on use of IoT has been proposed in [6-8].

IoT gives platform to researches to maintain real time data and send alerts immediately to farmers. IoT implementation gives easy access to information that comes from sensor nodes. IoT is also used for product supply chain business process. Cloud architecture gives additional support to IoT in maintaining Big data of agriculture information viz. History information, soil properties, fertilizers distribution, image cultivation through camera and information collected through sensors, recording information etc. Authors have analyzed collected data for finding correlation between environment, work and yield for standard work model construction. Monitoring for adverse signs and fault detection. In [9] authors have discussed the application of data mining with the help of WEKA tool and analysis model using of machine learning algorithms. In [10] authors have concentrated on crop monitoring. Information of temperature and rainfall is collected as initial spatial data and analyzed to reduce the crop losses and to improve the crop production. They have used optimization method to show progressive refinement for spatial association analysis.

Although authors mentioned above have proposed many models in agriculture domain, the effective model is needed that uses new technologies and provides an integrated approach to monitor environmental conditions periodically and various soil properties of farm field through IoT devices and store these details at the central place in the cloud storage which results in Big –data over the time. It is also usable by multiple vendors or farmers who enquire about crop yield maximization. Farmer can analyze these data for fertilizer requirements for current crop. It will help for smart climate solutions and disaster prevention.

CHAPTER 3: MACHINE LEARNING

Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. Many researchers also think it is the best way to make progress towards human-level AI. In this class, you will learn about the most effective machine learning techniques, and gain practice implementing them and getting them to work for yourself. More importantly, you'll learn about not only the theoretical underpinnings of learning, but also gain the practical know-how needed to quickly and powerfully apply these techniques to new problems. Finally, you'll learn about some of Silicon Valley's best practices in innovation as it pertains to machine learning and AI.

ML is one of the most exciting technologies that one would have ever come across. As it is evident from the name, it gives the computer that which makes it more similar to humans: *The ability to learn*. Machine learning is actively being used today, perhaps in many more places than one would expect.The basic premise of machine learning is to build algorithms that can receive input data and use stastical analysis to predict an output while updating outputs as new data becomes available.The processes involved in machine learning are similar to that of data mining and predictive modeling. Both require searching through data to look for patterns and adjusting program actions accordingly.

Machine learning is being used in a wide range of applications today. One of the most well-known examples is Facebook's News Feed. The News Feed uses machine learning to personalize each member's feed. If a member frequently stops scrolling to read or like a particular friend's posts, the News Feed will start to show more of that friend's activity earlier in the feed. Behind the scenes, the software is simply using statistical analysis and predictive analytics to identify patterns in the user's data and use those patterns to populate the News Feed. Should the member no longer stop to read, like or comment on the friend's posts, that new data will be included in the data set and the News Feed will adjust accordingly.

3.1: Supervised Learning

There are various ways to classify machine learning problems. Here, we discuss the most obvious ones. On basis of the nature of the learning “signal” or “feedback” available to a learning system,we have various kinds of learning varied by their dependencies:

- **Supervised learning**: The computer is presented with example inputs and their desired outputs, given by a “teacher”, and the goal is to learn a general rule that maps inputs to outputs. The training process continues until the model achieves the desired level of accuracy on the training data. Some real-life examples are:
  - **Image Classification:** You train with images/labels. Then in the future you give a new image expecting that the computer will recognize the new object.
  - **Market Prediction/Regression:** You train the computer with historical market data and ask the computer to predict the new price in the future.
- **Semi-supervised learning**: Problems where you have a large amount of input data and only some of the data is labeled, are called semi-supervised learning problems. These problems sit in between both supervised and unsupervised learning. For example, a photo archive where only some of the images are labeled, (e.g. dog, cat, person) and the majority are unlabeled.

Our main focuss on the Supervise Learning mentioned above. If we exclude those there still remains a few more techniques which helps us to train a mchine. These techniques are the ones which helps us when we less amount of data available. These are as follows:

- **Unsupervised learning**: No labels are given to the learning algorithm, leaving it on its own to find structure in its input. It is used for clustering population in different groups. Unsupervised learning can be a goal in itself (discovering hidden patterns in data).

As you can see clearly, the data in supervised learning is labelled, where as data in unsupervised learning is unlabelled.

- **Reinforcement learning**: A computer program interacts with a dynamic environment in which it must perform a certain goal (such as driving a vehicle or playing a game against an opponent). The program is provided feedback in terms of rewards and punishments as it navigates its problem space.

3.2: Terminologies of Machine Learning:

There are a few terminologies which are unavoidable. When you work on a project or model related to machine learning these terminologies are bound to come across:

- **Model**
  A model is a specific representation learned from data by applying some machine learning algorithm. A model is also called hypothesis.
- **Feature**
  A feature is an individual measurable property of our data. A set of numeric features can be conveniently described by a feature vector. Feature vectors are fed as input to the model. For example, in order to predict a fruit, there may be features like color, smell, taste, **etc.**
  Note: Choosing informative, discriminating and independent features is a crucial step for effective algorithms. We generally employ a feature extractor to extract the relevant features from the raw data.
- **Target**
  A target variable or label is the value to be predicted by our model. For the fruit example discussed in the features section, the label with each set of input would be the name of the fruit like apple, orange, banana, etc.
- **Training**
  The idea is to give a set of inputs(features) and it’s expected outputs(labels), so after training, we will have a model (hypothesis) that will then map new data to one of the categories trained on.
- **Prediction**
  Once our model is ready, it can be fed a set of inputs to which it will provide a predicted output(label).

3.3: DECISION TREE

Just as there are nearly limitless uses of machine learning, there is no shortage of machine learning algorithms. They range from the fairly simple to the highly complex. Here we are dealing with Decision trees. Decision trees are nothing but a hierarchical model. Having different levels of nodes ,each derived from the parent node. Decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label.

Decision trees: These models use observations abcut certain actions and identify an optimal path for arriving at a desired outcome. But if we keep Decision Tree as an exception we can also find other powerful models which work perfectly and give good amount of accuracy on various datasets.

So now the question arises why use Decision Tree when there are different models equally powerful as this. The answer is its accuracy. In decision analysis, a decision tree can be used to visually and explicitly represent decisions and decision making. As the name goes, it uses a tree-like model of decisions. The construction of decision tree classifier does not require any domain knowledge or parameter setting, and therefore is appropriate for exploratory knowledge discovery. Decision trees can handle high dimensional data. In general decision tree classifier has good accuracy. Decision tree induction is a typical inductive approach to learn knowledge on classification.Decision trees are able to generate understandable rules. Decision trees perform classification without requiring much computation. Decision trees are able to handle both continuous and categorical variables. Decision trees provide a clear indication of which fields are most important for prediction or classification.

Below are some assumptions that we made while using decision tree:

- At the beginning, we consider the whole training set as the root.
- Feature values are preferred to be categorical. If the values are continuous then they are discretized prior to building the model.
- On the basis of attribute values records are distributed recursively.
- We use statistical methods for ordering attributes as root or the internal node.

As you can see from the above image that Decision Tree works on the Sum of Product form which is also knnown as *Disjunctive Normal Form*. In the above image we are predicting the use of computer in daily life of the people.

In Decision Tree the major challenge is to identification of the attribute for the root node in each level. This process is known as attribute selection. We have two popular attribute selection measures:

1. Information Gain
2. Gini Index

1.Information Gain:

When we use a node in a decision tree to partition the training instances into smaller subsets the entropy changes. Information gain is a measure of this change in entropy.

Definition*: Suppose S is a set of instances, A is an attribute, S_v is the subset of S with A = v, and Values (A) is the set of all possible values of A, then*

Entropy

Entropy is the measure of uncertainty of a random variable, it characterizes the impurity of an arbitrary collection of examples. The higher the entropy more the information content.

Definition*: Suppose S is a set of instances, A is an attribute, S_v is the subset of S with A = v, and Values (A) is the set of all possible values of A, then*

Example:

For the set X = {a,a,a,b,b,b,b,b}
Total intances: 8
Instances of b: 5
Instances of a: 3

$$= -[0.375 * (-1.415) + 0.625 * (-0.678)]$$
$$=-(-0.53-0.424)$$
$$= 0.954$$

Building Decision Tree using Information Gain

The essentials:

- *Start with all training instances associated with the root node*
- *Use info gain to choose which attribute to label each node with*
- *Note: No root-to-leaf path should contain the same discrete attribute twice*
- *Recursively construct each subtree on the subset of training instances that would be classified down that path in the tree.*

The border cases:

- *If all positive or all negative training instances remain, label that node “yes” or “no” accordingly*
- *If no attributes remain, label with a majority vote of training instances left at that node*
- *If no instances remain, label with a majority vote of the parent’s training instances*

3.4 :DECISION TREE SUM:

NAME	HAIR	HEIGHT	WEIGHT	LOCATION	CLASS
Sunita	Blonde	Average	Light	No	Yes
Anita	Blonde	Tall	Average	Yes	No
Kavita	Brown	Short	Average	Yes	No
Sushma	Blonde	Short	Average	No	Yes
Xavier	Red	Average	Heavy	No	Yes
Balaji	Brown	Tall	Heavy	No	No
Ramesh	Brown	Average	Heavy	No	No
Shweta	Blonde	Short	Light	Yes	No

Table 3.4.1

For Hair:

	Yes	No
Blonde	2	2
Brown	0	3
Red	1	0

Table 3.4.2

Entropy
=4/8[-2/4.log(2/4)-(2/4)] + 3/8[0-3/3.log(3/3)] + 1/8[-1/1.log(1/1)-0]
=0.5

For Height:

	Yes	No
Tall	0	2
Average	2	1
Short	1	2

Table 3.4.3

Entropy
=2/8[0-2/2.log(2/2)] + 3/8[-2/3.log(2/3)-1/3.log(1/3)] + 3/8[-1/3.log(1/3)-2/3.log(2/3)]
=0.6857

For Weight:

	Yes	No
Light	1	1
Average	1	2
Heavy	1	2

Table 3.4.4

Entropy
=2/8[-1/2.log(1/2)-1/2.log(1/2)] + 3/8[-1/3.log(1/3)-2/3.log(2/3)] + 3/8[-1/3.log(1/3)-2/3.log(2/3)]
=0.9387

For Location:

	Yes	No
Yes	0	3
No	3	2

Table 3.4.5

Entropy
=3/8[-0-3/3.log(3/3)] + 5/8[-3/5.log(3/5)-2/5.log(2/5)]
=0.6068

Here the lowest value of Entropy is of Hair that is 0.5, which will become the ROOT node.

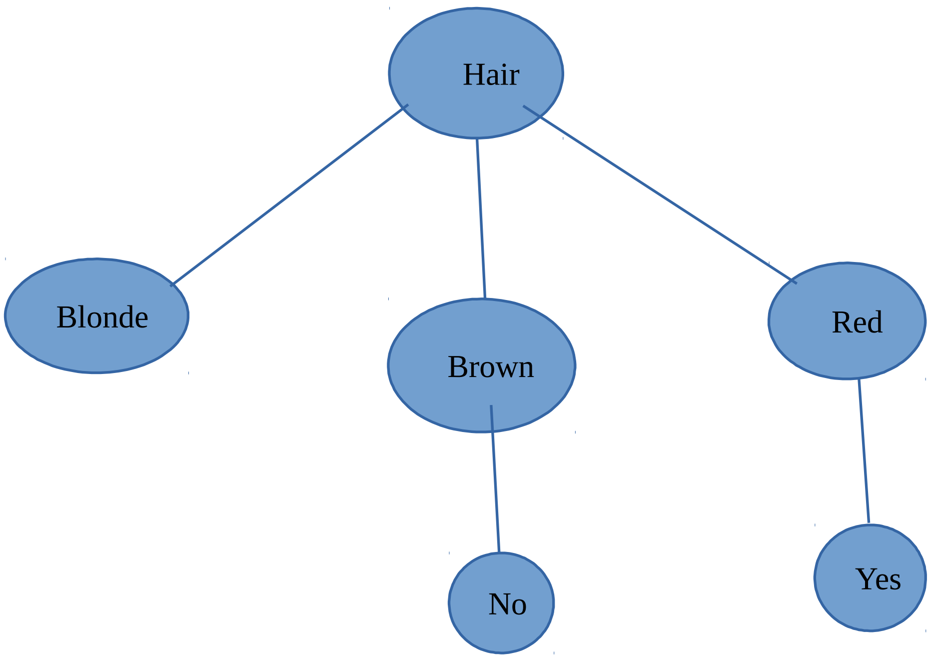

Figure 3.4.1

For Blonde Calculate:

For Height:

	Yes	No
Tall	1	0
Average	0	1
Short	1	1

Table 3.4.6

Entropy
=1/4[-1/1.log(1/1)] + 1/4[0-1/1.log(1/1)] + 2/4[-1/2.log(1/2)-1/2]
=0.5

For Weight:

	Yes	No
Light	1	1
Average	1	1
Heavy	0	0

Table 3.4.7

Entropy
=2/4[-1/2.log(1/2)-1/2.log(1/2)] + 2/4[-1/2.log(1/2)-1/2.log(1/2)]
=1

For Location:

	Yes	No
Yes	0	2
No	2	0

Table 3.4.8

Entropy
=2/4[-2/2.log(2/2)] + 2/4[-2/2.log(2/2)-0]
= 0

Here, lowest valuest of Entropy is of location. So, it becomes the next node under Blonde.

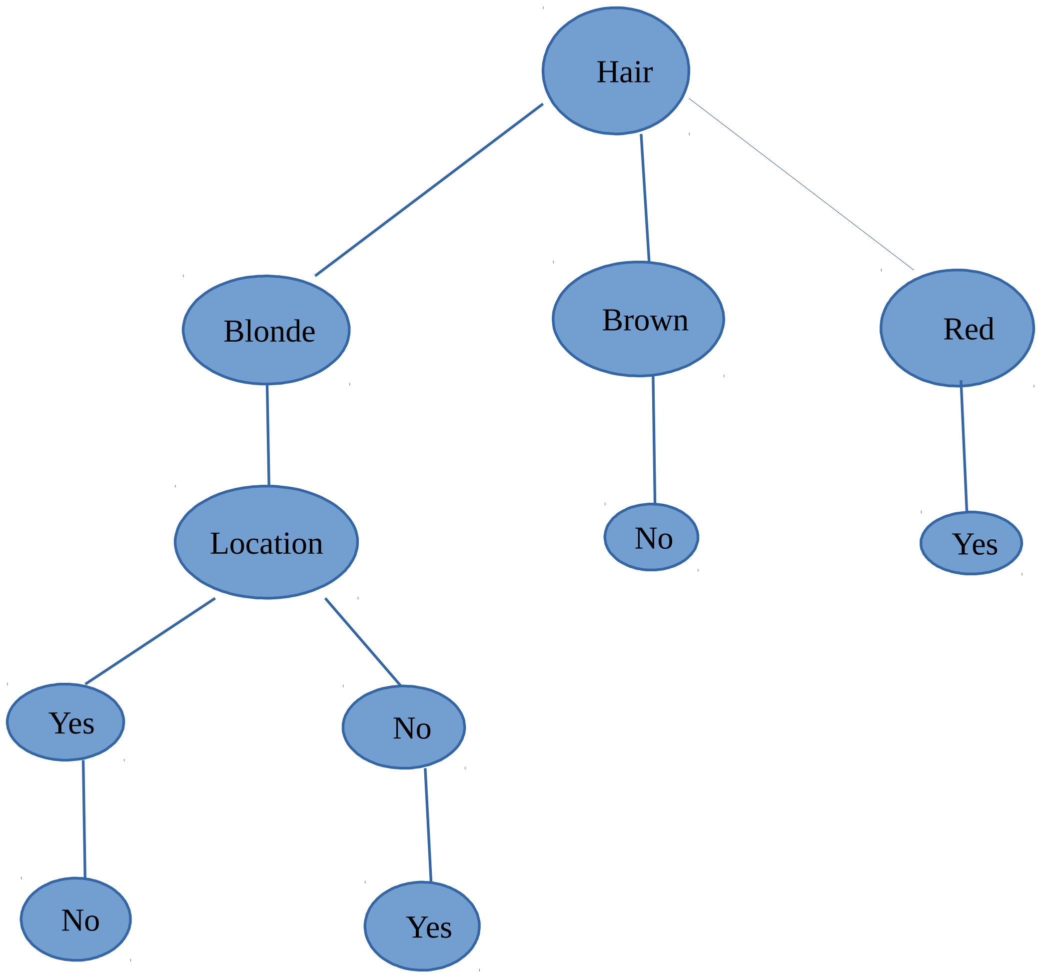

Figure 3.4.2

Rules:

1. If Hair color is Blonde and Location is Yes, then class is No.
2. If Hair color is Blonde and Location is No, then class is Yes.
3. If Hair color is Brown, class is No.
4. If Hair color is Red, class is Yes.

CHAPTER 4 : DATA

It can be any unprocessed fact, value, text, sound or picture that is not being interpreted and analyzed. Data is the most important part of all Data Analytics, Machine Learning, Artificial Intelligence. Without data, we can’t train any model and all modern research and automation will go vain. Big Enterprises are spending loads of money just to gather as much certain data as possible. **Example:** Why did Facebook acquire WhatsApp by paying a huge price of $19 billion? The answer is very simple and logical – it is to have access to the users’ information that Facebook may not have but WhatsApp will have. This information of their users is of paramount importance to Facebook as it will facilitate the task of improvement in their services. **INFORMATION :** Data that has been interpreted and manipulated and has now some meaningful interference for the users
KNOWLEDGE : Combination of inferred information, experiences, learning and insights. Results in awareness or concept building for an individual or organization.

How we split data in Machine Learning?

- **Training Data:** The part of data we use to train our model. This is the data which your model actually sees(both input and output) and learn from.
- **Validation Data:** The part of data which is used to do a frequent evaluation of model, fit on training dataset along with improving involved hyperparameters (initially set parameters before the model begins learning). This data plays it’s part when the model is actually training.
- **Testing Data:** Once our model is completely trained, testing data provides the unbiased evaluation. When we feed in the inputs of Testing data, our model will predict some values(without seeing actual output). After prediction, we evaluate our model by comparing it with actual output present in the testing data. This is how we evaluate and see how much our model has learned from the experiences feed in as training data, set at the time of training.

Our model works in a similar manner. We have two main types of dataset; one is training and validation dataset and the other is testing dataset. We have created our own dataset of 2000 entries from training the model. This dataset contains values based on research done regarding various plants of horticulture. This dataset is 100% reliable. We have taken the different parameters required for the plant to survive from trusted sources which includes research papers and websites. Our main focus in this model is based on 4 plants of horticulture, those are Roses,Lilies,Cactus and Hibiscus. Our testing dataset is based on the same attributes as considered in the training dataset. Testing dataset contains a few hundred entrie with missing target variable that is the plant which can be grown in that environment.

We have considered 4 attributes which require undeniable notice. These attributes include:

1. Soil Type: The type of soil found in that area or feild. This may Include soil types like Loamy,Sandy Loamy, Dry and Clay are the main types.

2. Soil Moisture: Once we know the soil type the second important aspect is soil moisture. How wet the soil is or dry the soil can be calculated on the basis of soil moisture. And in that amount of soil moisture will the crop survive or not.

3.pH: The most important aspect once the soil type is known is pH level. All differengt kind of plants survive at different pH levels. I t may be either acidic(<7), alkaline(>7) or neutral(=7).

4. Temperature: Other than soil related aspects there are environment aspects which play an equally important role in planting. Temperature is one such aspect which can either kill the crop or making it bloom.

We have written an algorithm which randomly generates these attributes. For each plant type it produces 500 entries at random. We have used basic write,loop and if,else conditions in our code of generation. Except this we have used a xslx library, which helps us print those values generated directly into an excell sheet. This xslx created file is thesn converted into a .csv format file before using it as a training dataset.

4.1: WORKING

First we will load the dataset onto colab in the .csv format. This format is not compulsory but our model works on .csv format. Now we are scanning the dataset column by column to check if there is integer or float value present inside the column. If any is present then we calculate the mean of the values in that column. This will help us divide the dataset into two parts. One be the greater than part, other the lesser than part. For string values no such calculation will be performed. It will be kept as it is. Now from this dataset we are setting 100 values aside for testing it.

Now our main function that is construct_tree(), where the whole dataset will be passed. This dataset is splitted into X-train and Y-train, where X-train consisits of attributes except the target variable and Y-train has target variable. From this function an calculate_Information_gain() function is called, where this X-train and Y-train values are passed.

In this function at first we call the Entropy() function inside Information_gain() function. This function calculates the entropy of the entire dataset, similar to what we have do on the paper. After this is done, a similar function named calculate_attribute_entropy() is called, which calculates individual entropy of each column, one at a time. Once this is done, we move back to the function that called it that is calculate_Information_gain(). Now all the entropy values calculated in the previous function are passed here and a list of these entropy values is created.

Now to find the root node, at first we scan the list of entropy values to find the maximum entropy value. For this the list is passed through an in-built function that is argmax(). Then the index of the maximum value found in the argmax() is checked and that same index is referred from the attribute list to find the root node. Then it will check whether the value of the node is none or not. If not then it enters the loop, to clalculate the unique values of the node attibute. These unique values calculated will be stored in a list.

From these uniques values we first select the values lesser than the mean value and then the values greater then the mean value. This can even happen in a reverse manner, depending upon the unique value first encountered. This new dataset generated of unique values which are either less than or greater than mean value is returned back to the construct_tree() function which contains a variable directed to the string_partition() function.

Now this string_partition() function creates the dataset for each unique value attribute in the list passed onto string_partition(). Now it will check how many unique values the current dataset holds. If the current dataset holds only one uinque value then that value will be stored in the tree dictionary created in the construct_tree(). If not the construct_tree() will be executed again with the new current dataset which consists of multiple unique values. This above process will keep on iterating untill a final decision tree is generated.

4.1.1: SOFTWARE/HARDWARE USED:

We have used Ubuntu operating system while working on the code which works on an HP laptop of 4GB Ram. We have written the code in Colab, which is a google framework for developing and uploading codes, so that it cane be shared with anyone anywhere worldwide. We have used PYTHON as our programming language. Majority of machine learning algorithms are written using python as their programming language, as it is reliable, easy to use and provides alot of inbuilt functions and libraries.

CHAPTER 5: RESULTS

We found that with the help of attributes like soil moisture, soil type and pH of soil as well as temperature of the environment we can predict accurately what kind of plant can be grown in these conditions. The accuracy of the Decision Tree is highest among all the algorithms that we tested with the help of inbuilt functions and that is why we developed a code for the decision tree with accuracy of 96%.

It can also be stated that Soil Type is the most prominent aspect of all the aspects taken into consideration and thatis why it becomes the root node of the decision tree. It is also seen that for the soil type dry there can be make a direct prediction that plant Cactus can only be grown in that area and no other plantation is possible.

Other than that we see a conflict for the soil type loamy and sandy loamy between rose and hibiscus and hibiscus and lilies respectively. And even though at the end it is possible that for specific type of conditions more than one plant can be grown our module predicts randomly which plant should be grown in that land. This happens due to the nature of decision tree that there can be only one emerging final leaf node from the previous node.

CHAPTER 6: CONCLUSIONS AND FUTURE SCOPE

The project proposes a wise agricultural model in integration with machine learning. Village farmers may have planted the “same” crop for centuries, but over period, weather patterns and soil conditions and epidemics of pests and diseases changed. By using the proposed approach, received updated information allows the farmers to cope with and even benefit from these changes. It is really challenging task that needs to provide such knowledge because of highly localized nature of agriculture information specifically distinct conditions. The complete real-time and historical environment information is expected to help to achieve efficient management and utilization of resources. Therefore trying to produce a maximum yield out of the land.

Along with this model we can create a bot and an applicaion or website which would run ona phone or computer. The bot will examine the land with the help of different kind of sensors and connect to these cellphones and computer through IOT to share information between them about the same. This will avoid the extra human force that is required and reduce the error margin. Not only this the sensor bot along with the land conditions before farming can also help after farming is done to send alerts regarding irrigation. This all information can be viewed on the application and website and the farmer can control the irrigation even if he/she stays far away from the actual farmland. Thus overall scope of this project is huge and visionary. It is not only visionary but feasible and can make agriculture much more smart and efficient in all ways.

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