**CHAPTER 1**

**INTRODUCTION**

**SIGNIFICANCE OF AGRICULTURE**

India is a country which is mainly depends on agriculture and it is considered as the back-bone of Indian economy. India is second largest in the whole world and lot of improvements happened in agriculture after Independence, but crop yield per hectare is among the poorest in the world. Lot of problems is faced by Indian farmers and agriculture is inefficient. The Indian farmers have suffered over the years partly due to lack of timely, comprehensive information. It is required to provide them timely reliable information at a reasonable cost to the farmers in particular and rural people in general.

Then media started to share information to farmers, Radio and television to some extent helped in disseminating the technologies but it has the in-born limitation that it is one way audio/visual media, with no immediate feedback. The farmers in particular and rural India in general need to be provided with the latest technologies at a shortest span of time effectively to run the farming on a profitable venture in present competitive world. Then the idea of using Information Communication Technology (ICT) came up, as it is capable of sorting out the above problem.

Indian Space and Research Organization (ISRO) started village Resource Centers (VRCs) all over India which is a place to render variety of services from a single window to remote rural people in a given geographical location through modern information and satellite technologies. Increasing penetration of the mobile phone usage over rural India led to the development of support system through mobile. Many government organizations, NGOs and private organizations including Tata Consultancy Services (TCS) started SMS services for the farmers. These services were started for providing information to the farmers. They sent daily SMS providing information about soil, crop, weather, prices of crops, etc., according to particular geographical location and in their local language. Even though such supporting systems using ICT came up using lot of latest technologies, its success rate is very low and not up to the mark.

This critical issue in Agriculture is because of knowledge deficit and infrastructure deficit. This brings up the need for a good Agricultural Knowledge Base or an Information System. It is capable of reducing a knowledge deficit and infrastructure deficit too. We here propose a solution for this problem using semantic technologies. Ontology will be a model base for achieving this task. It is the way for structuring the domain, and knowledge can be accommodated in that structure. And it is capable of accommodating as much knowledge we want and the way in which we structure.

* 1. **INDIAN AGRICULTURE**

India is an agricultural nation. Almost majority of the Indians traditional occupation is agriculture. Many of them worship their land as god. Agriculture has always been India’s most important economic sector.Agriculture is the cultivation and breeding of animals, plants and fungi for food, fiber, biofuel, medicinal plants and other products used to sustain and enhance human life As per the 2010 FAO world agriculture statistics, India is the world's largest producer of many fresh fruits and vegetables, milk, major spice, select fibrous crops such as jute, staples such as millets and castor oil seed. India is the second largest producer of wheat and rice, the world's major food staples.

India is the world's second or third largest producer of several dry fruits, agriculture-based textile raw materials, roots and tuber crops, pulses, farmed fish, eggs, coconut, sugarcane and numerous vegetables. India ranked in the world's five largest producers of over 80% of agricultural produce items, including many cash crops such as coffee and cotton, in 2010.India is one of the world's five largest producers of livestock and poultry meat, with one of the fastest growth rates, as of 2011.

* 1. **Types of agriculture:**

In shifting cultivation, a small area of a forest is cleared by cutting downfall the trees and the area is burned. The land is then used for growing crops for several years. When the soil becomes less fertile, the area is then abandoned. Another patch of land is selected and the process is repeated. This type of farming is practiced mainly in areas with abundant rainfall where the forest regenerates quickly. This practice is used in Northeast India, Southeast Asia, and the Amazon Basin. Subsistence farming is practiced to satisfy family or local needs alone, with little left over for transport elsewhere. It is intensively practiced in Monsoon Asia and South-East Asia.

In intensive farming, the crops are cultivated for commercial purpose i.e., for selling. The main motive of the farmer is to make profit, with a low fallow ratio and a high use of inputs. This type of farming is mainly practiced in highly developed countries.

* 1. **History:**

Indian Agriculture has a very long history which is 10000 years old. It started as a result of early civilization of plants and domestication of crops and animals. The Indian monsoon influenced the flora and fauna of the Asia-Africa region. The Indian Ocean summer monsoon reached the peak of its intensification in those years. The abundant summer rain helped early people to enhance their agricultural practices. They grew variety of cereals and grains. These agricultural practices brought a change in living style of the people from hunting to a subsistence economy one centered on settled agriculture and domestication of animals. Then the summer monsoon steadily reduced. Weakening of summer monsoon led to the beginning of arid phase in India in the middle ages. This triggered a chain of changes in agricultural practices and food habits among Indian population. People started to monsoon failures by constructing ponds, dams and other rain harvesting structures and the irrigation channel reached a new level of sophistication in India. The south-west monsoon gained strength from past four centuries. The monsoonal changes over last millennium brought up some important changes in socio-economic changes in India. Thus 2 monsoons in India and it led to two harvests in a year. They managed water for the whole year effectively what they get from these two monsoons. These land and water management provided uniform growth.

Until British Rule in India, the economy was popularly known for its self-contained village communities which included people who were agriculturists, cottage industrialists, village craftsmen, artisan professions, unskilled workers and village officials. These people communities played a major role in meeting their needs and also exporting various products to foreign countries. During British rule in India, Industrial revolution was going on in England. In that period, farmers are forced to switch to commercial crops like cotton and indigo. They provided financial assistance to the farmers through zamindars and British agents. They exported surplus amount of cash crops to England. They exploited our economic wealth and natural resources continuously till our Independence. This became permanent loss for Indian national income and wealth. As a result, traditional handicrafts were completely wiped out and artisans lost their hereditary occupation. This led more people to migrate to agriculture for their livelihood and this sector became over-crowded. This led to de-industrialization which stagnated our Indian economy.

* 1. **Green Revolution after Independence:**

After Independence is the time for beginning of economic development in our country. Because of migration of more people towards agriculture before independence, this sector became very large which comprised about 70% of the population. They are poor and they depend their livelihood on agriculture and related activities. So if the government tries to promote industrialization neglecting agriculture, it tends to fail. Next issue is how to raise the income and alleviate property in rural areas. Another important issue is growing population. This brought up the importance of development of agricultural sector, mainly the staple food sector. And it showed the importance of increasing the productivity growth, rather than growth in horizontal expansion of farmland. This led to the green revolution in India. It provided increase in production to make India self-sufficient in food grains. Following are the green revolution on Agriculture in India:

* Increase in Agricultural production.
* Increase in per Hectare yield.
* Change in attitude which made agriculture as an industry.
* Enlargement of production function.
* Impact on employment both in agricultural sector and associated non-agricultural sectors.
* Shift from traditional agriculture to use latest and modern technology.
* Significant change in cropping pattern.
* Prosperity of farmers.
* Reduction in import of food practices.

But this green revolution has some negative effects too. Due to the increase in use of chemical pesticides and fertilizers, there were many negative effects on the soil and land such as land degradation.

* 1. **Present Scenario of Agriculture in India:**

Today, India ranks second in the world as an agricultural country and in agricultural production. The Indian agricultural sector employs 60% of the workforce. It is still the largest economic sector and is the backbone of India’s economy. Agriculture plays a significant role in overall socio-economic development in India. But one of the main concerns is, crop yield per hectare is very low and it is among the poorest in the world. This is because of the multiple problems faced by Indian Agriculture.

* 1. **Problems Faced by Indian Agriculture:**

The major problems faced by Indian Agriculture are as follows:

* **Population pressure:** Population in India is second largest in the world and it is growing still. This has created demand for lands. They are trying to bring every bit of land to cultivation. Even hill slopes are cut in to terraces and brought under cultivation. More population also led to urbanization. Cultivable lands are made in to buildings and houses. In this way, lot of cultivable land is getting reduced.
* **Small and fragmented land holdings:** The pressure of increase in population brings another problem. It is the problem of dividing lands equally among their heirs. This practice brings division of lands, sub-division and so on. Then the holdings will become so small and agriculture is not economical. This makes them to sell their land to someone and in this way; cultivable lands are becoming idle land or buildings.
* **Inadequate Irrigation facilities:** So far in India only half of the total area under food crops has been brought under irrigation. Remaining half are left to the mercy of monsoon which is erratic in time and space.
* **Depleted soil:** Indian soils have been used for growing crops for thousands of years which have resulted in the depletion of soil fertility. With deforestation the sources of maintaining natural fertility of soil has been drying out. Lack of material resources and ignorance of scientific knowledge have further depleted the soils of the natural fertility. Earlier only animal waste was enough to maintain soil fertility.
* **Storage of food grains:** This is a big problem. Nearly 10% of the harvest is getting wasted every year because of no proper storage place.
* **Farm Implements:** Even though latest technologies are available. Either farmers are un-aware of the technologies or they could not afford for it.
* **Lack of Agricultural Research, Education and Training:** Agricultural research in India is still in infantile stage. No proper co-ordination between agricultural farm and the research laboratories. No proper attention in educating and training farmers on new technologies and adopting the environmental and climatic changes.
* **Problem of climate:** Variable climate all over India. Some places are cold, some places are hot, some places receive more rainfall, and some places less, and so on. In a same place, one year we will have more rainfall than expected and next year it may be drought. In every case, farmers lose out and it will affect the production. It is one of the main reasons for having poorest yield per hectare. Farmers should be provided effective training and education to adopt for the climate and cultivate based on it. Should be trained to change the agricultural pattern based on climate.

**Knowledge Deficit:** Knowledge deficit and lack of proper information flow at different levels are one of the critical issues in Indian agriculture. Government failure and inadequate government support is the main reason for this. Even though some private concerns are trying to wipe out this problem, it still exists.

**1.7 ROLE OF ICT IN INDIAN AGRICULTURE**

India has 127 different agro climatic zones and immense bio-diversity and natural resources. The only main problem is lack of information flow and knowledge deficit. Reducing knowledge deficit and improving information flow can bring up lot of changes and improvements in agricultural domain. Information and Communication Technology (ICT) is an umbrella term that includes all the technologies for manipulation and communication of information. ICT encompasses any medium for recording information and technology for broadcasting information. Radio/Television is the earliest medium or disseminating the technologies, but they had the inborn limitation that it is one way audio/visual communication. Some of the other technologies that play a role in Agriculture are:

**1.8 Village Resource Centers (VRCs)**

Village Resource Centers (VRCs) are set up by Indian Space and Research Organization (ISRO) which uses latest Satellite Communication (SATCOM) and renders variety of services from a single window to remote rural mass in a given geographical area. It connects village level communities to the Expert Centers which are located in strategic places. The main objective of this is to deliver information on agriculture, health and variety of livelihood needs directly to the communities at grass root level. The expert centers are established in different states to provide information support to VRCs. The expert can provide large number of rural people simultaneously through VRCs. Some of the benefits of VRCs are;

* System is scale neutral and can reach all type of people irrespective of their social and economic background.
* Information to large number of people who are geographically dispersed.
* Access to best available learning resources irrespective of geographical location.
* Learning becomes effective as there is face to face interaction between the experts and the receivers

The Indian farmers suffered over years due to lack of timely comprehensive information support for taking rational decisions. VRCs are capable of providing such information. But these VRCs failed to attract people as it is not providing such information. [1]

**1.9** **SOIL :**

Soil can be simply defined as a mixture of small rock particles/debris and organic materials/ humus which develop on the earth surface and support growth of plants.

**MAJOR CLASSIFICATION OF INDIAN SOIL**: Alluvial soil [43%],Red soil [18.5%,]Black / regur soil [15%],Arid / desert soil, Laterite soil, Saline soil, Peaty / marshy soil, Forest soil, Sub-mountain soil, Snowfields

**ALLUVIAL SOIL:** Mostly available soil in India (about 43%) which covers an area of 143 sq.km.Widespread in northern plains and river valleys. In peninsular-India, they are mostly found in deltas and estuaries. Humus, lime and organic matters are present. Highly fertile. New alluvium is termed as **Khadar** and old alluvium is termed as **Bhangar**.**Colour:** Light Grey to Ash Grey.**Texture:** Sandy to salty loam or clay. Rich in: potash Poor in: phosphorous. Wheat, rice, maize, sugarcane, pulses, oilseed etc. are cultivated mainly.

**RED SOIL:** Seen mainly in low rainfall area. Also known as **Omnibus group.** Porous, friable structure. Absence of lime, kankar (impure calcium carbonate).**Deficient in**: lime, phosphate, manganese, nitrogen, humus and potash.**Colour:** Red because of Ferric oxide. The lower layer is reddish yellow or yellow. **Texture:** Sandy to clay and loamy. Wheat, cotton, pulses, tobacco, oilseeds, potato etc. are cultivated.

## BLACK SOIL:Regur means cotton – best soil for cotton cultivation. Most of the Deccan is occupied by Black soil. Mature soil. High water retaining capacity. Swells and will become sticky when wet and shrink when dried. Self-ploughing is a characteristic of the black soil as it develops wide cracks when dried.

**SOIL NUTRIENTS:**Soil is a major component of the Earth’s ecosystem. Soil is a major source of nutrients needed by plants for growth. The three main nutrients are **nitrogen (N)**, **phosphorus** (P) and **potassium (K)**. Together they make up the trio known as NPK. Other important nutrients are **calcium**, **magnesium** and **sulfur**.

**NITROGEN**: Nitrogen is an integral part of all proteins, and is one of the main chemical elements required for plant growth and photosynthesis.  In most agricultural conditions, availability of usable Nitrogen is the most limiting factor of high growth.  Your crop absorbs nitrogen by absorbing either ammonium or nitrate through its root system.  The plant will then utilize Nitrogen as a building block to produce protein in the form of enzymes.

**POTASSIUM:** Potassium, the third of three elements in healthy soil nutrition, can greatly increase crop yield. It aids in water absorption and retention, also encourages strong roots, sturdy stems, and healthy, full grown crops that have longer shelf life. Potassium is in the soil naturally in two forms, one of the forms is able to be absorbed into the plant, while the other is unavailable to the plant. Many agricultural crops depend on abundant supply of potassium so they must rely on fertilizers and soil amendments to add to the potassium that’s in soil.

**FERTILIZERS**

Fertilizers enhance the growth of plants. This goal is met in two ways, the traditional one being additives that provide nutrients. The second mode by which some fertilizers act is to enhance the effectiveness of the soil by modifying its water retention and aeration. This article, like many on fertilizers, emphasizes the nutritional aspect. Fertilizers typically provide, in varying proportions.

* three main macronutrients:
  + Nitrogen(N): leaf growth;
  + Phosphorus(P): Development of roots, flowers, seeds, fruit;
  + Potassium (K): Strong stem growth, movement of water in plants, promotion of flowering and fruiting;
* three secondary macronutrients: calcium (Ca), magnesium (Mg), and sulphur(S);
* micronutrients: copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), boron (B), and of occasional significance there are silicon(Si), cobalt(Co), and vanadium (V) plus rare mineral catalysts.

The nutrients required for healthy plant life are classified according to the elements, but the elements are not used as fertilizers. Instead compounds containing these elements are the basis of fertilizers. The macronutrients are consumed in larger quantities and are present in plant tissue in quantities from 0.15% to 6.0% on a dry matter (DM) (0% moisture) basis. Plants are made up of four main elements: hydrogen, oxygen, carbon, and nitrogen. Carbon, hydrogen and oxygen are widely available as water and carbon dioxide. Although nitrogen makes up most of the atmosphere, it is in a form that is unavailable to plants. Nitrogen is the most important fertilizer since nitrogen is present in proteins, DNA and other components (e.g., chlorophyll). To be nutritious to plants, nitrogen must be made available in a "fixed" form. Only some bacteria and their host plants (notably legumes) can fix atmospheric nitrogen (N2) by converting it to ammonia. Phosphate is required for the production of DNA and ATP, the main energy carrier in cells, as well as certain lipids.

Micronutrients are consumed in smaller quantities and are present in plant tissue on the order of parts-per-million (ppm), ranging from 0.15 to 400 ppm DM, or less than 0.04% DM. These elements are often present at the active sites of enzymes that carry out the plant's metabolism. Because these elements enable catalysts (enzymes) their impact far exceeds their weight percentage.

## CLASSIFICATION: Fertilizers are classified in several ways. They are classified according to whether they provide a single nutrient (say, N, P, or K), in which case they are classified as "straight fertilizers." "Multinutrient fertilizers" (or "complex fertilizers") provide two or more nutrients, for example N and P. Fertilizers are also sometimes classified as inorganic (the topic of most of this article) versus organic. Inorganic fertilizers exclude carbon-containing materials except urea’s. Organic fertilizers are usually (recycled) plant- or animal-derived matter. Inorganic are sometimes called synthetic fertilizers since various chemical treatments are required for their manufacture.

## SINGLE NUTRIENT STRAIGHT FERTILIZER: The main nitrogen-based straight fertilizer is ammonia or its solutions. Ammonium nitrate (NH4NO3) is also widely used. Urea is another popular source of nitrogen, having the advantage that it is solid and non-explosive, unlike ammonia and ammonium nitrate, respectively. A few percent of the nitrogen fertilizer market (4% in 2007) has been met by calcium ammonium nitrate(Ca(NO3)2•NH4NO3•10H2O).

The main straight phosphate fertilizers are the superphosphates. "Single superphosphate" (SSP) consists of 14–18% P2O5, again in the form of Ca(H2PO4)2, but also phosphogypsum (CaSO4 · 2 H2O). Triple superphosphate (TSP) typically consists of 44-48% of P2O5 and no gypsum. A mixture of single superphosphate and triple superphosphate is called double superphosphate. More than 90% of a typical superphosphate fertilizer is water-soluble.

**MULTINUTRIENT FERTILIZER:** These fertilizers are the most common. They consist of two or more nutrient components.

**BINARY(NP NK PK) FERTILIZERS:** Major two-component fertilizers provide both nitrogen and phosphorus to the plants. These are called NP fertilizers. The main NP fertilizers are mono ammonium phosphate (MAP) and di ammonium phosphate (DAP). The active ingredient in MAP is NH4H2PO4. The active ingredient in DAP is (NH4)2HPO4. About 85% of MAP and DAP fertilizers are soluble in water.

**NPK FERTILIZERS**:NPK fertilizers are three-component fertilizers providing nitrogen, phosphorus, and potassium.

NPK rating is a rating system describing the amount of nitrogen, phosphorus, and potassium in a fertilizer. NPK ratings consist of three numbers separated by dashes (e.g., 10-10-10 or 16-4-8) describing the chemical content of fertilizer. The first number represents the percentage of nitrogen in the product; the second number, P2O5; the third, K2O. Fertilizers do not actually contain P2O5 or K2O, but the system is a conventional shorthand for the amount of the phosphorus (P) or potassium (K) in a fertilizer. A 50-pound (23 kg) bag of fertilizer labeled 16-4-8 contains 8 lb. (3.6 kg) of nitrogen (16% of the 50 pounds), an amount of phosphorus equivalent to that in 2 pounds of P2O5 (4% of 50 pounds), and 4 pounds of K2O (8% of 50 pounds). Most fertilizers are labeled according to this N-P-K convention, although Australian convention, following an N-P-K-S system, adds a fourth number for sulfur.

**OVER FERTILIZATION:** Careful fertilization technologies are important because excess nutrients can be as detrimental. Fertilizer burn can occur when too much fertilizer is applied, resulting in drying out of the leaves and damage or even death of the plant. Fertilizers vary in their tendency to burn roughly in accordance with their salt index**.**

**1.10 PRECISION FARMING**

Precision farming or precision agriculture is a farming management concept based on modern information technologies such as GPS (Global Positioning System), Remote Sensing Technology and GIS (Geographic Information Systems). In Indian context, precision farming may be defined as an accurate application of agricultural inputs for crop growth considering relevant factors such as soil, weather and crop management practices. It is actually information and technology based farming system where inputs are managed and distributed on a site-specific basis for long term benefit.

some of the benefits of precision farming include:

* Reduce fertilizer costs
* Reduce chemical application costs
* Reduce pollution through poor use of chemicals
* Improve crop yields
* Provide better information for management decisions

**1.11 DATA MINING TECHNIQUES:**

**ASSOCIATION:**

Association is one of the best-known data mining technique. In association, a pattern is discovered based on a relationship between items in the same transaction. That’s is the reason why association technique is also known as RELATION TECHNIQUE. The association technique is used in MARKET BASKET ANALYSIS to identify a set of products that customers frequently purchase together.

Retailers are using association technique to research customer’s buying habits. Based on historical sale data, retailers might find out that customers always buy crisps when they buy beers, and, therefore, they can put beers and crisps next to each other to save time for customer and increase sales.

## CLASSIFICATION

Classification is a classic data mining technique based on machine learning. Basically, classification is used to classify each item in a set of data into one of a predefined set of classes or groups. Classification method makes use of mathematical techniques such as decision trees, linear programming, neural network and statistics. In classification, we develop the software that can learn how to classify the data items into groups. For example, we can apply classification in the application that “given all records of employees who left the company, predict who will probably leave the company in a future period.” In this case, we divide the records of employees into two groups that named “leave” and “stay”.

## CLUSTERING

Clustering is a data mining technique that makes a meaningful or useful cluster of objects which have similar characteristics using the automatic technique. The clustering technique defines the classes and puts objects in each class, while in the classification techniques, objects are assigned into predefined classes. To make the concept clearer, we can take book management in the library as an example. In a library, there is a wide range of books on various topics available. The challenge is how to keep those books in a way that readers can take several books on a particular topic without hassle. By using the clustering technique, we can keep books that have some kinds of similarities in one cluster or one shelf and label it with a meaningful name. If readers want to grab books in that topic, they would only have to go to that shelf instead of looking for the entire library.

## PREDICTION

The prediction, as its name implied, is one of a data mining techniques that discovers the relationship between independent variables and relationship between dependent and independent variables. For instance, the prediction analysis technique can be used in the sale to predict profit for the future if we consider the sale is an independent variable, profit could be a dependent variable. Then based on the historical sale and profit data, we can draw a fitted regression curve SSSthat is used for profit prediction.

**CHAPTER 2**

**LITERATURE SURVEY**

In this section the literature survey has been carried out. The main focus is on data mining techniques on agriculture. The rest of papers focused on android application projects. The literature survey gives a clear idea for proposed system.

Dr.P.Isakki et’al [1] presented “a study on crop yield forecasting using classification techniques”. They discussed that farmers are struggling to produce yield because of unpredictable climate and reduction of water resources.to overcome this situation they used various data mining techniques which could provide best results and suggestion to farmers by comparing the historical data.

Dr.Ramesh et’al [2] presented “analysis of crop yield prediction using data mining techniques”. They discussed to solve the problem of yield prediction based on available data. The main aim is to create a user friendly interface for farmers which give the analysis of crop production based on available data. They considered six variables as input parameters: year, rainfall, area of sowing, yield, fertilizers, and production. Hence the dataset collection is carried out for all districts of Andhra Pradesh in India. They use “multiple linear regression” and “density based clustering” techniques to solve the prediction of crop yield. Multiple Linear Regression (MLR) technique is based on least squares and probably the most widely used method in climatology for developing models to reconstruct climate variables from tree ring services. This crop yield prediction model is presented with the use of Multiple Linear Regression (MLR) technique where the predictant is the Production and there are seven predictors namely Year, Rainfall, Area of Sowing, Yield and Fertilizers (Nitrogen, phosphorus and potassium). The primary idea of Density-based clustering techniques is that, for each point of a cluster, the neighborhood of a given unit distance contains at least a minimum number of points. These methods group the objects according to specific density objective functions. This is considered to be different from the idea in partitioning algorithms that use iterative relocation of points that give a certain number of clusters. Initially the statistical model Multiple Linear Regression technique is applied on existing data. The results so obtained were verified and analyzed using the Data Mining technique namely Density-based clustering technique.

Manav singhal et’al [3] presented “Krishi ville-Android based Solution for Indian Agriculture”. They discussed about importance of ICT in Indian agriculture. It is Android based mobile application which would provide all the facilities to the farmers related to their agricultural activities. It would be helping them in getting the weather updates and they can also access the news related to agriculture and farms.Krishiville would be based on client-server architecture. The server will provide all required agricultural market information, weather updates and forecasting. It is designed to meet the needs of the Indian farmers. The main objective of this project is to develop a mobile phone based solution that helps in farm’s management, leads to agricultural yield improvement and helps in care/maintenance of the farms. This application for agriculture enables the farmer to calculate profitability based on where the grain markets are currently trading and to see how higher or lower grain markets are presently. They would be able to get the current market prices depending upon the commodities. Krishi Ville presents the new updates of different agricultural commodities, weather forecast updates, agricultural news updates. The application could help in guiding the people to manage and organize their tasks and particularly help them in remembering those tasks during usual hectic routines.

Monali Paul et’al [4] presented “Analysis of Soil Behavior and Prediction of Crop Yield using Data Mining approach”.This work presents a system, which uses data mining techniques in order to predict the category of the analyzed soil datasets. In this work, classification of soil into low, medium and high categories are done by adopting data mining techniques in order to predict the crop yield using available dataset. The category, thus predicted will indicate the yielding of crops**.** This work talks about K-Nearest Neighbor and Naive Bayes algorithm. Nearest Neighbor does not have any learning phase, because every time a classification is performed it uses a training set. The assumption behind the k-nearest neighbor algorithm is that a similar classification is produced by similar samples. The similar known samples used for assigning a classification to an unknown sample are described by the parameter K.Naive Bayes classifier assumes that the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature. Depending on the precise nature of the probability model, Naive Bayes classifiers can be trained very efficiently in a supervised learning setting. Despite of its naive design and most likely conspicuous assumptions, Naive Bayes work much better in many complex and real world situations. The Experiments are performed on the real world data obtained from the Soil Testing Laboratory in Jabalpur, Madhya Pradesh. Datasets considered in this work have sufficient amount of readings of nutrients and micronutrients taken from different lands of Jabalpur area. The dataset used in this experiment consists of 100 instances with 12 attributes. The tuples of dataset thus define the availability of nutrients and micronutrients in soil. Availability of these nutrients and micronutrients can be divided into different categories which can be used to decide effects on the yielding capability of crops. With the help of Rapid Miner 5.3, training models from KNN and Naive Bayes algorithms are created. This study can help the soil analysts and farmers to decide sowing in which land may result in better crop production.

V. Jirapure et’al[5] presented “Qualitative data analysis using Regression method for Agricultural data”. The focus of this paper is to provide and build agricultural based information system for Customer and Farmer interaction where scalability, reliability and integrity of information can be access through cloud based technology. This paper aims to analyze and use data mining techniques specially Regression analysis to forecast the crop production**.** Data is gathered from or generated in different ways like documents, reports, books, observations, feedbacks and other Media. Regression is a method of finding correlation between different metric variables, datasets or fields also a way of learning a function in which data items are analyzed and provided a real valued prediction figure. Strong relationship or weak relationship between the variables is also calculated based on certain assumptions. The proposed system works in building agricultural information system by bridging gap between farmer and customer. Using qualitative analysis of agriculture product, customer can easily differentiate among different farmers and their respective products. Regression analysis has been implemented to forecast the crop production and analyze the patterns between different set of data. Different researchers can access the data to find and analysis different patterns.

Vikas kumar et’al [6] presented “Crop Cultivation Information System on Mobile Devices”. They discussed an information system for farmers which can be operated on their mobile phones. The system is developed using Service Oriented Architecture (SOA) to process spatial data and knowledge base. The knowledge base is maintained in the form of ontologies. The system is an effort to fill the gap between farmers and agricultural experts. A farmer can provide inputs related to crops being cultivated and location specific information to get specific suggestions, alerts and recommendations to improve productivity. It will be generated using the knowledge base. Whenever a farmer observes some anomalous behavior for crops or climate, the system is able to generate recommendations based on inputs provided. We have resolved some of the queries as a part of on-going work and results are displayed on an Android based mobile devices for demonstration of the system. In this paper, we have developed a GIS data base and ontology for cotton crop in north Gujarat region. After successful implementation of this system, we will generalize the system for other crops and regions in India. In this paper, we have shown the results of complex queries processing, using GIS information and cotton ontology. Results for queries are tested on Android based mobile phone.

Sanjay chaudry et’al [7] proposed “Agro Advisory System for Cotton Crop”. Here Huge amount of agriculture related data like weather data, soil health records, cropping pattern, location specific crop disease and pest are collected from different sources like services, remote satellites, And network of sensors. An agro advisory system presented in this paper helps to bridge the gap between farmers and the agriculture domain experts and developed for the cotton farmers in Gujarat region of India. The system consists of three basic components; Cotton Ontology, Web Services, and Mobile Application Development. The cotton ontology maintains domain knowledge required for answering farmer queries. The ontology contains information regarding crop, soil, cultivation process, disease, pest, and other relevant information. The web services are invoked from the mobile device and in turn they connect to various data sources like Open Weather API, SQL database and the Ontologies. The farmers can use this application based on very simple android mobile interfaces. The prototype is developed using Java, Android SDK - v14 and Eclipse IDE. The system is capable of answering queries like Disease preventions and pest cure based on symptoms, obtaining types of crops and soils etc. We have used the Open Weather Map web services to get the weather data. The farmers/users can get current weather information for their current locations through the system. Apart from that we have gathered past weather data to deduce patterns and detect spikes in weather conditions. We have added the provision for reporting diseases easily which are updated instantly in our database. The pest attacks report can be presented on a map with live data.

S.S Baskar et’al [8] demonstrated “Applying Data Mining Techniques on Soil Fertility Prediction”. Here they deal with various data mining techniques for analysis of soil dataset. This data mining algorithms are used for analyzing the soil datasets for classification purposes. The various techniques of data mining is used and compared. In this research they carried out a comparative study of various classification techniques with the help of data mining tool known as WEKA. The dataset used, was collected from one of the soil testing laboratories in Trichirapalli District (Tamil Nadu, India).Rest of this paper focuses on the prediction of untested attributes. In this approach, they have proposed an analysis of the soil data using different algorithms and prediction technique. In spite the fact that the least median squares regression is known to produce better results than the classical linear regression technique. From the given set of attributes, the most accurately predicted attribute was Nitrogen content of the soil, which was determined using the Linear Regression technique in lesser time as compared to Least Median Squares Regression. They also demonstrated a comparative study of various classification algorithms i.e. Naïve Bayes, J48 (C4.5), JRip with the help of data mining tool WEKA. J48 is very simple classifier to make a decision tree, but it gave the best result in the experiment.

Li Dongming et’al [9] presented “The Application of Decision Tree C4.5 Algorithm to Soil Quality Grade Forecasting Model”. They propose that the decision tree C4.5 algorithm is used to construct the data mining model for predicting the soil quality grade. First of all, the decision tree carries out data learning, according to each data of soil quality levels in the training sample, and then gets the decision tree that accords with learning rules. The experiment proves that the decision tree generated by calculation can intuitively show the relationship between the composition of soil and soil quality grade. The decision tree algorithm is simple and efficient which handles the data to generate rules, and easy to program. Due to dispersion, large amount, and fast updating of the agricultural soil data, it takes difficulty to statistical evaluation for people. The decision tree C4.5 algorithm provides a train of thought and method to solve this difficulty, and it provides the reliable theory basis for precision fertilization.

M.Atchatha et’al [10] presented “crop rotation based on space and time”. Here they tries to suggest an alternate for this dependency by introducing the crop rotation based on the space and time. The proposed system works into four modules 1) sensing and gathering data 2) decision making 3) methodology and 4) algorithm**.** The methodology will help to improve the net profit of the farmers having a better organic farming practice. The method will help to get rid of poverty of farmers and agricultural runoff. Nowadays the information technology plays key role in agriculture industry.

**CHAPTER 3**

**SYSTEM ANALYSIS**

**3.1 EXISTING SYSTEM**

* Krishi Ville- Provides Android based Application Solution For Indian Agriculture.
* The above system gives us “Accurate and Timely relevant "information by using ICT.
* Village Resource Centers (VRCs) are set up by Indian Space and Research Organization (ISRO)
* Estimation of Crop yield forecasting has been done using CLASSIFICATION system.
* Mobile based application-mkrishi,ekisan,fisherfriend,etc.
* Expert system-Rule based, web based.

**3.2 LIMITATIONS**

* Classification of dataset is not efficient.
* Prediction of crops is not accurate.
* Mobile application does not provide much relevant information to increase productivity.
* The existing does not give any awareness about fertilizers and pesticides.

**3.3 PROPOSED SYSTEM**

The proposed system focuses mainly to increase the **productivity**. The three main objective of our system is to reduce “**crop loss**”, to suggest “**fertilizers**”. The proposed system has more enhancements on classification module and it produces more accuracy. The system is mainly for beginners and future farmers. The process of developing the proposed system involves the following modules:

1. Dataset collection and classification

2. Fertilizer suggestion

**CHAPTER 4**

**SYSTEM SPECIFICATION**

**4.1 SOFTWARE REQUIREMENTS**

Operating system : Windows 8.1

Front end : Anaconda

Back end : My SQL

Language : python

**4.2 HARDWARE REQUIREMENTS**

Processor : intel(R) core(TM)i5-5200u

Hard disk : 583 GB

RAM : 4GB

**ANDROID STUDIO**

Android Studio is an IDE based on Intel IDEA used for android application development. It is released on 15th may 2013. This tool has more options for Android Development, making the process faster and more productive. A “live layout” was shown that renders your app as you’re editing in real-time.

Prior to Android Studio, developers were relying only on the open source eclipse as IDE with ADT plugin for android development. Due to this android was always falling back compared Apples xCode IDE for iOS based development. After android studio release Google can equally bet with iOS platform in terms of development assets. Now let’s see more of the IDE capabilities.

FEATURES:

1. Gradle-based build support.
2. Android-specific refactoring and quick fixes
3. Lint tools to catch performance, usability, version compatibility and other problems
4. Pro Guard and app-signing capabilities
5. Template-based wizards to create common Android designs and components.

**5. SYSTEM DESIGN**

**5.1 SYSTEM ARCHITECTURE**

crop prediction

Prediction phase

Training phase

Soil nutrient dataset

Input data

Classification

Suggesting fertilizer

Trained data

fertilizer

Suggesting fertilizer

deficiency

**Figure5.1 system architecture**

**5.2 MODULE DESCRIPTION**

. The process of developing the proposed system involves the following modules:

1. Dataset collection and classification

2. Fertilizer suggestion

**5.3 Dataset** **collection and classification:**

Thecollection of dataset is the major part in the proposed system. Here we collect data’s in the nearby agricultural soil research Centre (krishi vigyan Kendra).The data consist of four attributes (N,P,K) and 342 instances. The data’s are preprocessed and refined into CSV format. The preprocessing consists of four steps: data cleaning, data integration, data reduction, and data transformation. Further the preprocessed data is loaded into anaconda.

**Attribute description:**

There are three attributes considered. They are nitrogen,phosphate and potassium.

For loading into anaconda we should remove duplicate values, and normalize it into csv format. Further the normalized data’s are loaded into anaconda for classification. The data’s are classified using various classifiers. In such a way logistic regression provides better accuracy when compared to other classifiers.

data from soil testing lab

preprocessing

Soil dataset

Loading into anaconda

Logistic regression classifier

classification

**Figure 5.2 data collection and classification**

**5.4 Fertilizer suggestion:**

The main objective of the proposed system is to suggest crops to the farmer for his land. But there is an alternate case in which a farmer wants to use his own desired crop into his field. In such controversial situation the proposed system has an added advantage of suggesting the fertilizer for his land for his desired crop. Also it says, whether the desired crop of the farmer, can yield productivity or not. Here Nitrogen, Phosphor and Potassium are the three basic important minerals for a crop growth and hence the fertilizer suggestion is based on these three values.

If there is the optimum availability of these basic nutrition in the soil, then no fertilizers are required. When there occurs the deficiency of nutrients then the fertilizers are suggested based on the deficiency.Fertilizer is the main component for healthy growth of crops. There are many kinds of fertilizers. People are unaware of some banned fertilizers. The proposed system suggests fertilizers for suitable crop and gives more information about banned fertilizers. ,It calculates the deficiency of nutrients and suggests fertilizer by comparing with the fertilizer database stored.

Fertilizer suggestion

Fertilizer

Nutrient deficiency

**Figure 5.3 Fertilizer Suggestion**

**CHAPTER 6**

**EXPERIMENTAL RESULTS**

**Dataset Collection**

The dataset is a part of surveys which are carried out regularly in Trichirappalli District. Primary data for the soil survey are acquired by field sampling. These samples are then sent for chemical and physical analysis at the soil testing laboratories; hence this dataset was collected from a private soil testing lab in Trichirappalli. It contains information about number of soil samples taken from 4 regions of Trichirappalli district (Musiri, thotiyam, thuraiyur and sirugamani). Dataset has 4 attributes and a total 342 instances of soil samples. Table7.1 describes data collected for each soil

|  |  |
| --- | --- |
| Field | Description |
| N | Nitrogen |
| P | Phosphorous |
| K | Potassium |

**Table 6.1** **Attributes description**

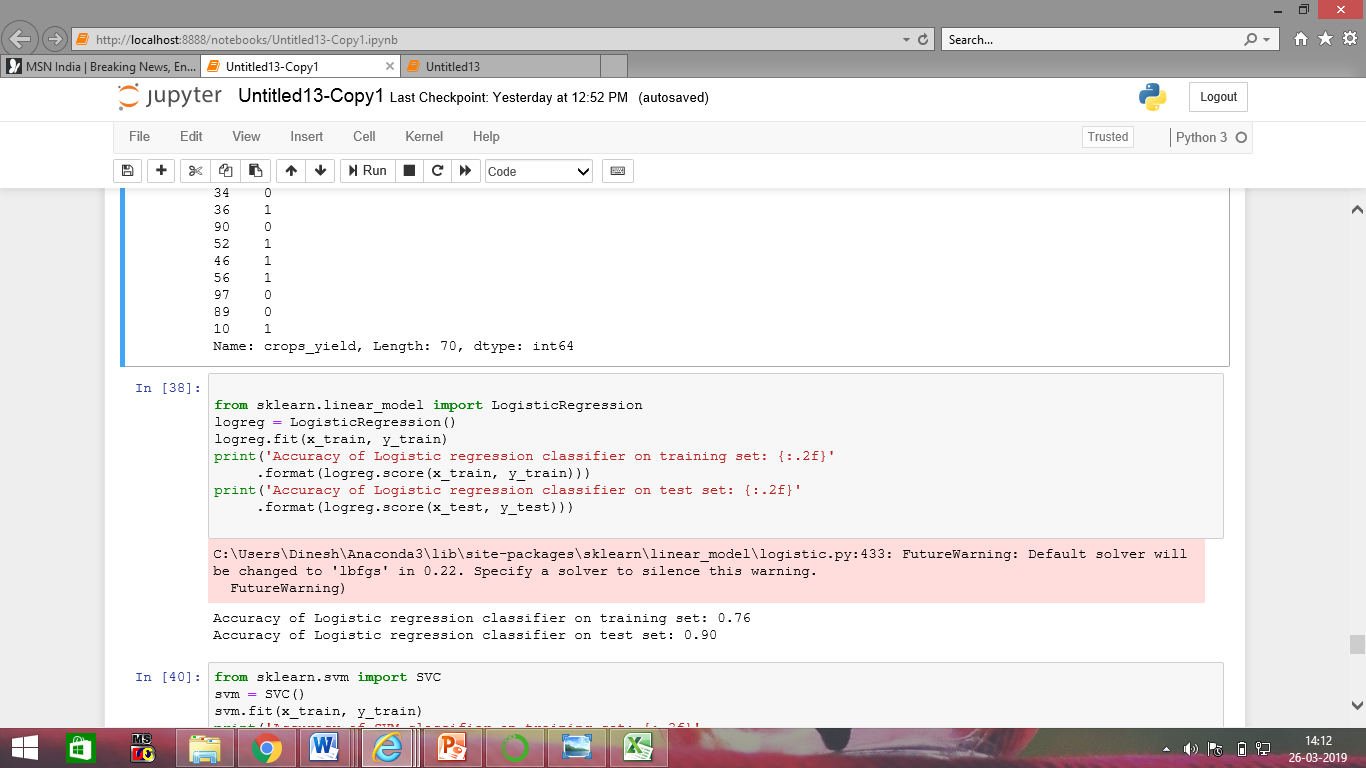
**A Comparative Study of Soil Classification**

The classification of soil was considered critical to study because depending upon the fertility class of the soil the domain knowledge experts determines which crops should be taken on that particular soil and which fertilizers should be used for the same. The following section describes Logistic Regression and K-nearest Neighbouring Algorithm

**ALGORITHMS TO CLASSIFY THE DATASET:**

**LOGISTIC REGRESSION ALGORITHM:**

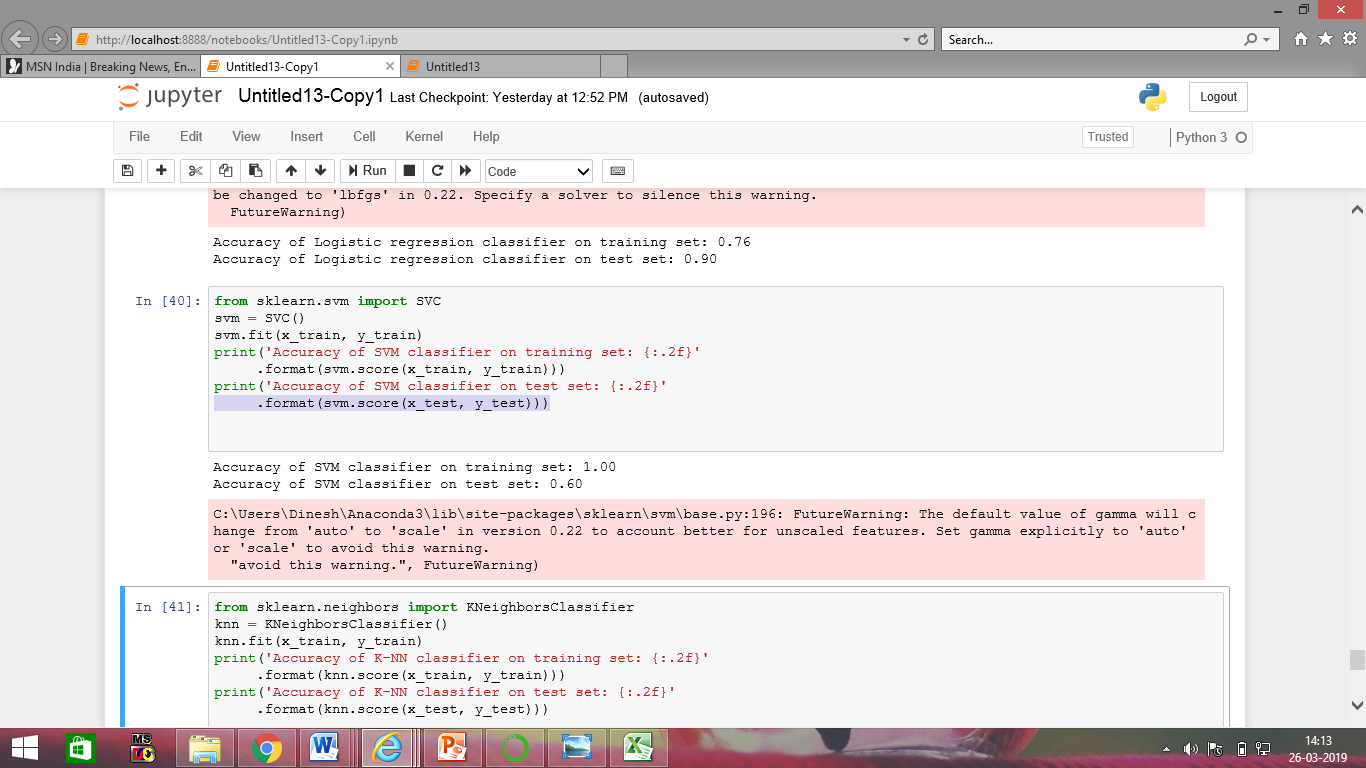
Logistic regression was developed by statistician [David Cox](https://en.wikipedia.org/wiki/David_Cox_(statistician)) in 1958.The binary logistic regression model has [extensions](https://en.wikipedia.org/wiki/Logistic_regression#Extensions) to more than two levels of the dependent variable. In [statistics](https://en.wikipedia.org/wiki/Statistics), the **logistic model** is a widely used [statistical model](https://en.wikipedia.org/wiki/Statistical_model) that, in its basic form, uses a [logistic function](https://en.wikipedia.org/wiki/Logistic_function) to model a [binary](https://en.wikipedia.org/wiki/Binary_variable) [dependent variable](https://en.wikipedia.org/wiki/Dependent_variable); many more complex [extensions](https://en.wikipedia.org/wiki/Logistic_regression#Extensions) exist. In [regression analysis](https://en.wikipedia.org/wiki/Regression_analysis), **logistic regression** is [estimating](https://en.wikipedia.org/wiki/Estimation_theory) the parameters of a logistic model; it is a form of [binomial regression](https://en.wikipedia.org/wiki/Binomial_regression). Mathematically, a binary logistic model has a dependent variable with two possible values, such as pass/fail, win/lose, alive/dead or healthy/sick; these are represented by an [indicator variable](https://en.wikipedia.org/wiki/Indicator_variable), where the two values are labelled "0" and "1"



**Figure6.1: Accuracy of LR classifier**

**SVM ALGORITHM:**

Support Vector Machine” (SVM) is a supervised [machine learning algorithm](https://courses.analyticsvidhya.com/courses/introduction-to-data-science-2?utm_source=blog&utm_medium=understandingsupportvectormachinearticle) which can be used for both classification and regression challenges. However, it is mostly used in classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiate the two classes very well. Support Vectors are simply the co-ordinates of individual observation. Support Vector Machine is a frontier which best segregates the two classes (hyper-plane/ line)

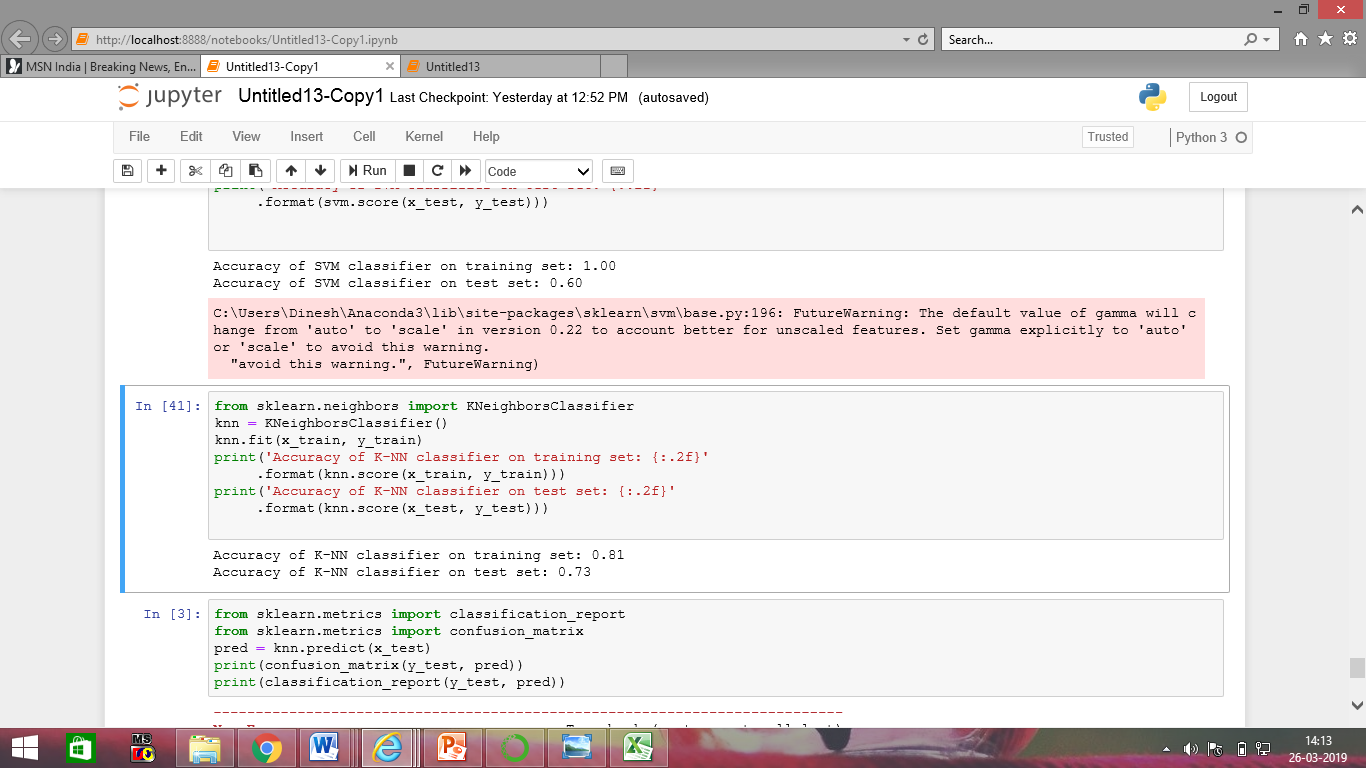
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**Figure 6.2: Accuracy of SVM classifier**

**K-NN ALGORITHM:**

In [pattern recognition](https://en.wikipedia.org/wiki/Pattern_recognition), the ***k*-nearest neighbors algorithm** is a [non-parametric](https://en.wikipedia.org/wiki/Non-parametric_statistics) method used for [classification](https://en.wikipedia.org/wiki/Statistical_classification) and [regression](https://en.wikipedia.org/wiki/Regression_analysis).In both cases, the input consists of the *k* closest training examples in the [feature space](https://en.wikipedia.org/wiki/Feature_space). The output depends on whether *k*-NN is used for classification or regression:

* In *k-NN classification*, the output is a class membership. An object is classified by a plurality vote of its neighbors, with the object being assigned to the class most common among its *k* nearest neighbors (*k* is a positive [integer](https://en.wikipedia.org/wiki/Integer), typically small). If *k* = 1, then the object is simply assigned to the class of that single nearest neighbor.
* In *k-NN regression*, the output is the property value for the object. This value is the average of the values of*k' nearest neighbors.*

****

**Figure6.3: Accuracy of k-NN classifier**

**COMPARATIVE STUDY:**

Comparison of these three algorithms we decide that the logistic regression is the best classification algorithm for accuracy of test and train datasets.

|  |  |  |  |
| --- | --- | --- | --- |
| **S.NO** | **LOGISTIC REGRESSION** | **SUPPORT VECTOR**  **MACHINE** | ****K-NEAREST NEIGHBORS**** |
| TRAIN | 0.76 | 1.00 | 0.81 |
| TEST | 0.90 | 0.60 | 0.73 |

**Table6.2 Comparative study for three algorithms**

**Figure 6.4 comparative graph for three algorithms**

The following table represents the database considered for prediction system,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.NO** | **Crops** | **P\_ppm** | **K\_ppm** | **N\_ppm** |
| 1 | Rice | 5 | 5 | 15 |
| 2 | Wheat | 4 | 4 | 8 |
| 3 | Ragi | 3 | 3 | 6 |
| 4 | Cumbu | 3.5 | 3.5 | 7 |
| 5 | Soyabeen | 8 | 4 | 2 |
| 6 | Sunflower | 5 | 4 | 4 |
| 7 | Sugarbeet | 7.5 | 7.5 | 15 |
| 8 | Sugarcane | 10 | 20 | 30 |
| 9 | Cotton | 6 | 3 | 3 |

**Table6.3 Sample database for prediction system**

**APPENDIX 1**

**SAMPLE SOURCE CODE:**

**CLASSIFICATION:**

**LOGISTIC REGRESSION:**

from sklearn.linear\_model import LogisticRegression

logreg = LogisticRegression()

logreg.fit(x\_train, y\_train)

print('Accuracy of Logistic regression classifier on training set: {:.2f}'

.format(logreg.score(x\_train, y\_train)))

print('Accuracy of Logistic regression classifier on test set: {:.2f}'

.format(logreg.score(x\_test, y\_test)))

**SUPPORT VECTOR MACHINE:**

from sklearn.svm import SVC

svm = SVC()

svm.fit(x\_train, y\_train)

print('Accuracy of SVM classifier on training set: {:.2f}'

.format(svm.score(x\_train, y\_train)))

print('Accuracy of SVM classifier on test set: {:.2f}'

.format(svm.score(x\_test, y\_test)))

**K\_NEAREST NEIGHBORS:**

from sklearn.neighbors import KNeighborsClassifier

knn = KNeighborsClassifier()

knn.fit(x\_train, y\_train)

print('Accuracy of K-NN classifier on training set: {:.2f}'

.format(knn.score(x\_train, y\_train)))

print('Accuracy of K-NN classifier on test set: {:.2f}'

.format(knn.score(x\_test, y\_test)))

**CHAPTER 7**

**CONCLUSION AND FUTURE WORKS**

**7.1 CONCLUSION**:

The proposed system uses Logistic Regression classifier and prediction algorithm for crop yield prediction to increase the productivity. The prediction errors calculated by various datasets can be reduced while including climatic factors along with the existing data sets. The existing system consists of artificial neural networks which works efficiently only on the related data items. But logistic regression work efficiently on soil data’s including missing data values.

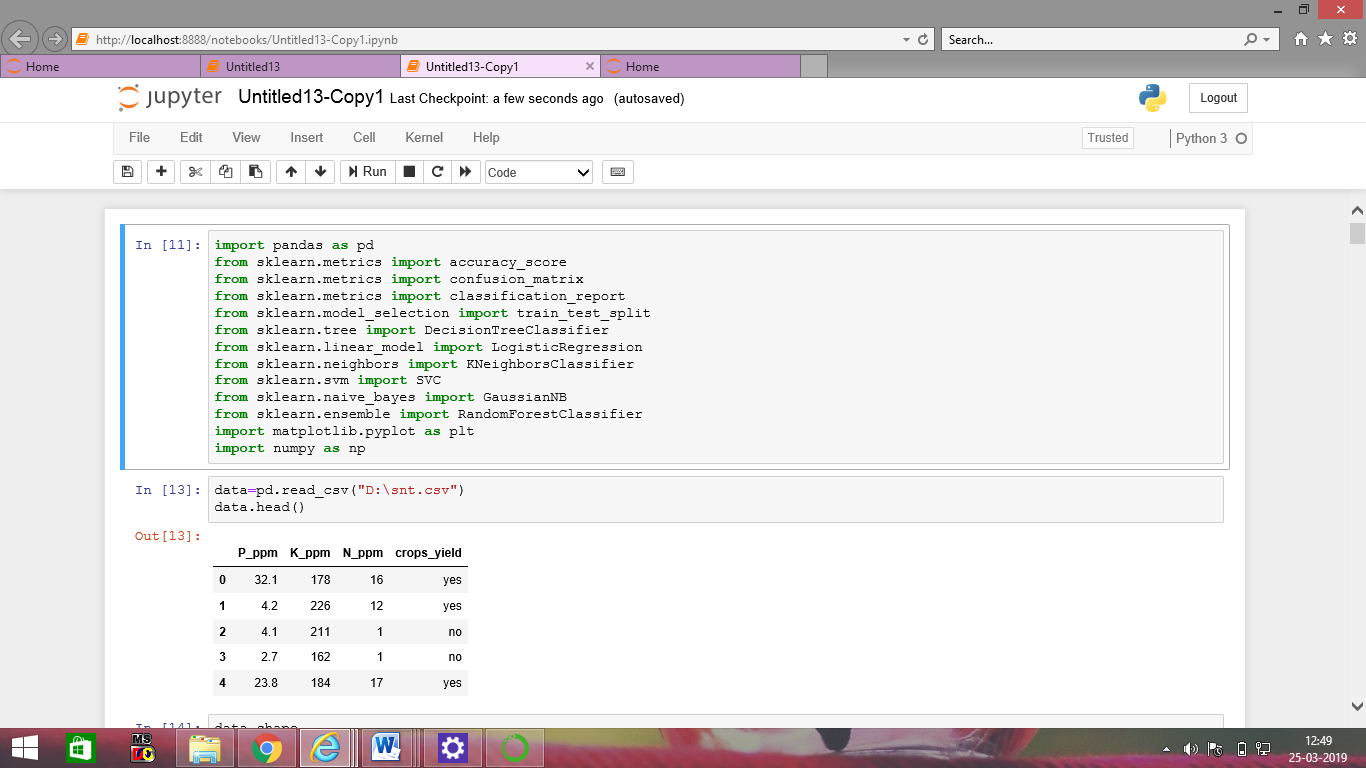
**7.2 FUTURE WORKS:**

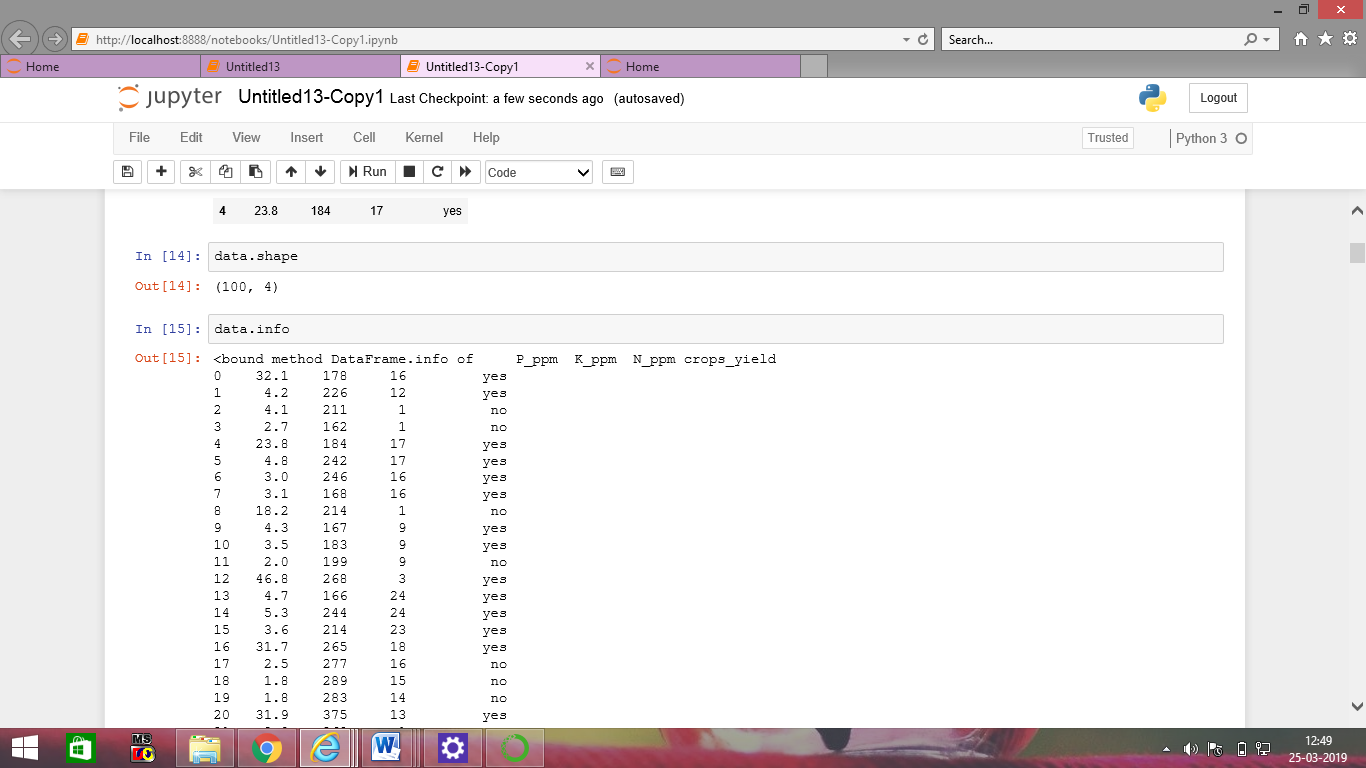
Classification algorithm relies more on crop yield as major parameter in decision making. Future works should consider environmental and meteorological parameters along with existing crop knowledge base and relational issues. We use logistic regression that gives perfect accuracy, future works may consider some other data mining algorithms for better result.it may also add further attributes like electrical conductivity, water content, hydrogen ion concentration etc.

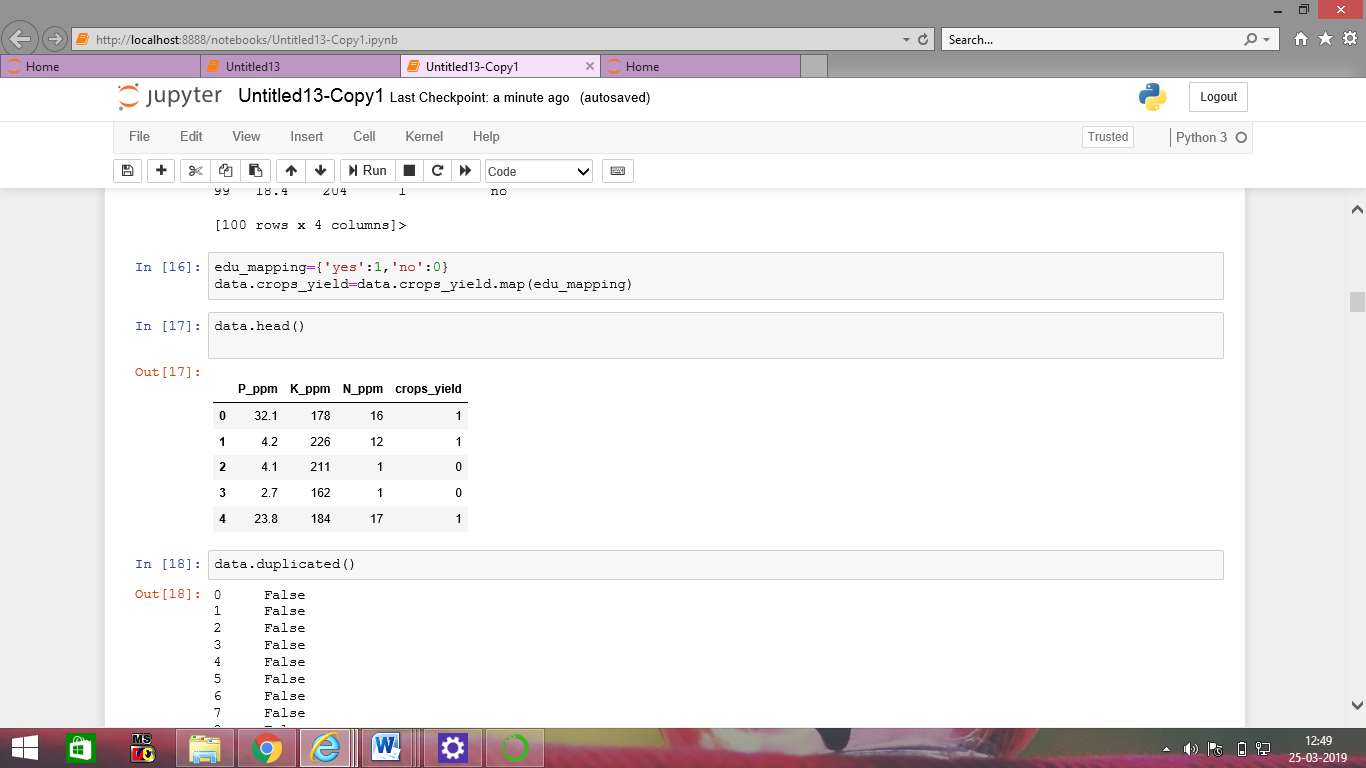
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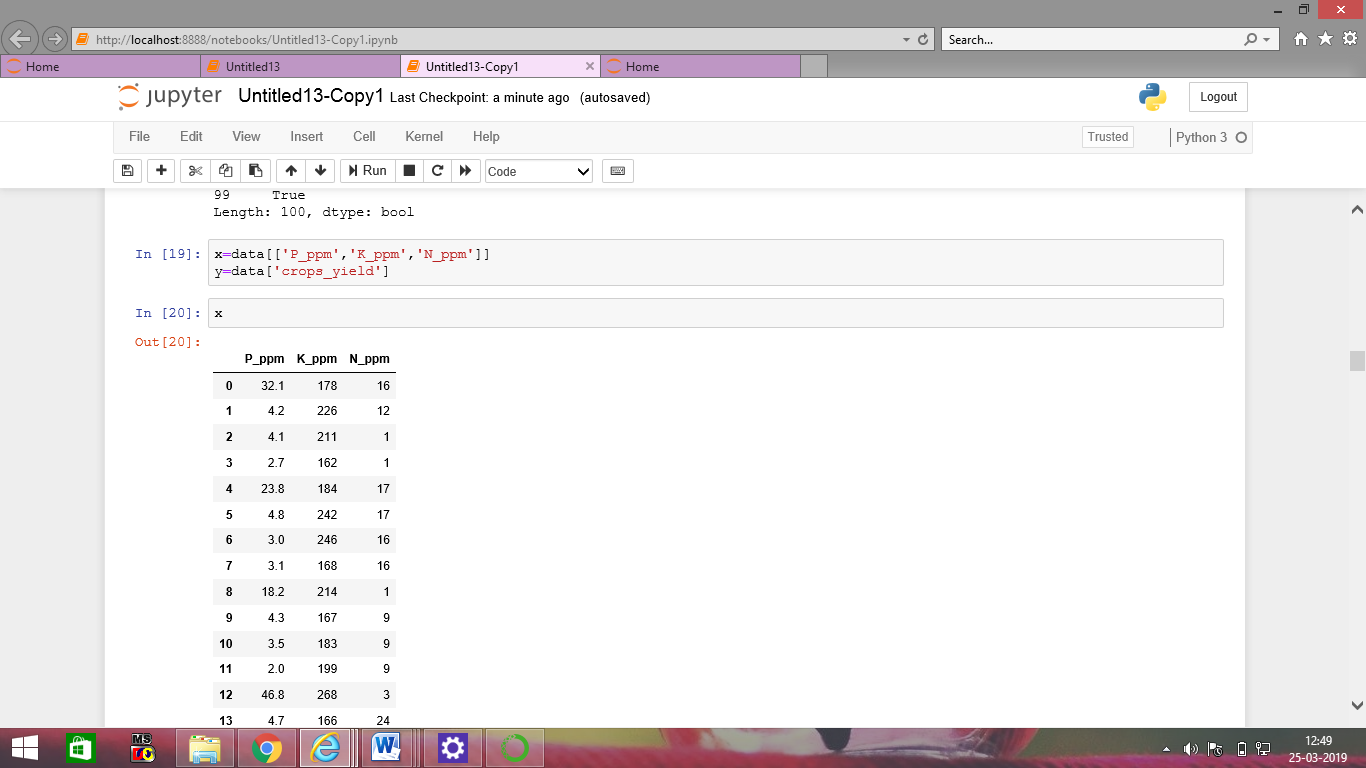
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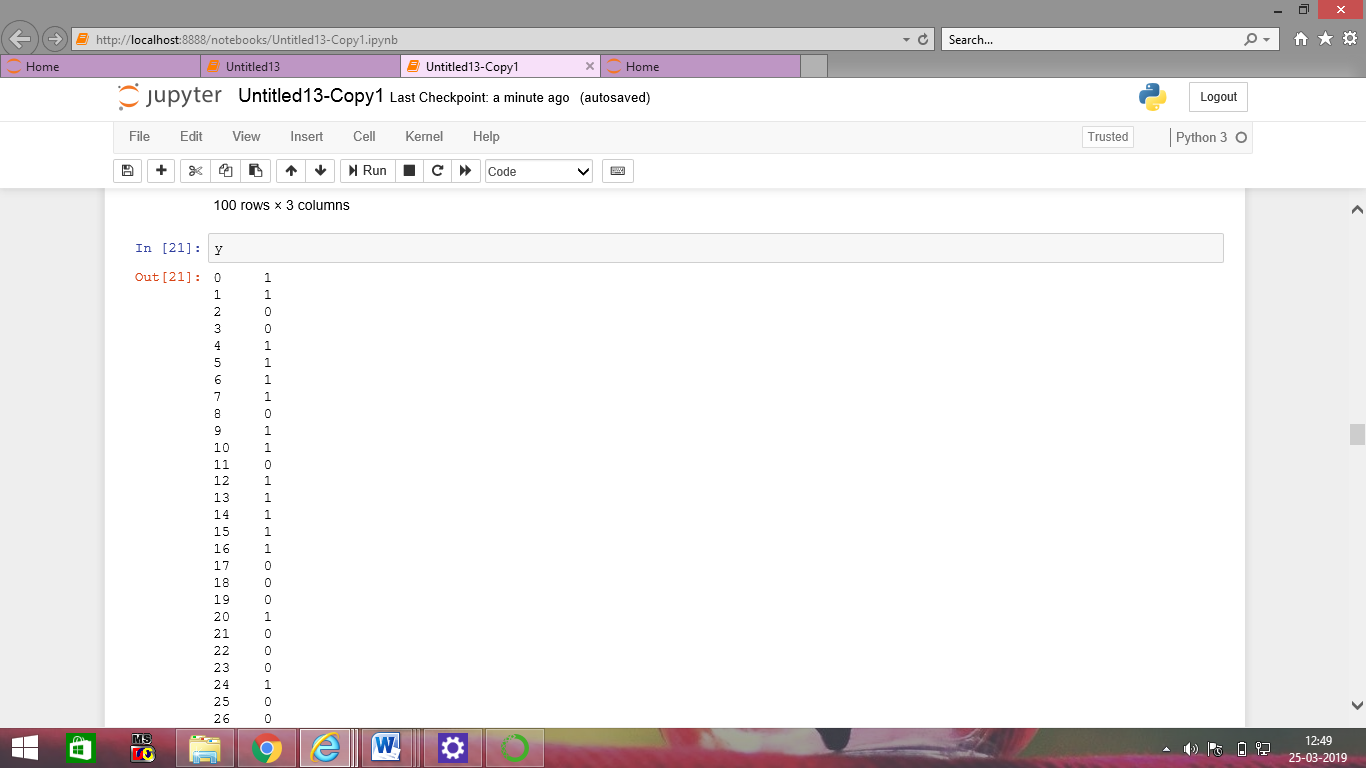
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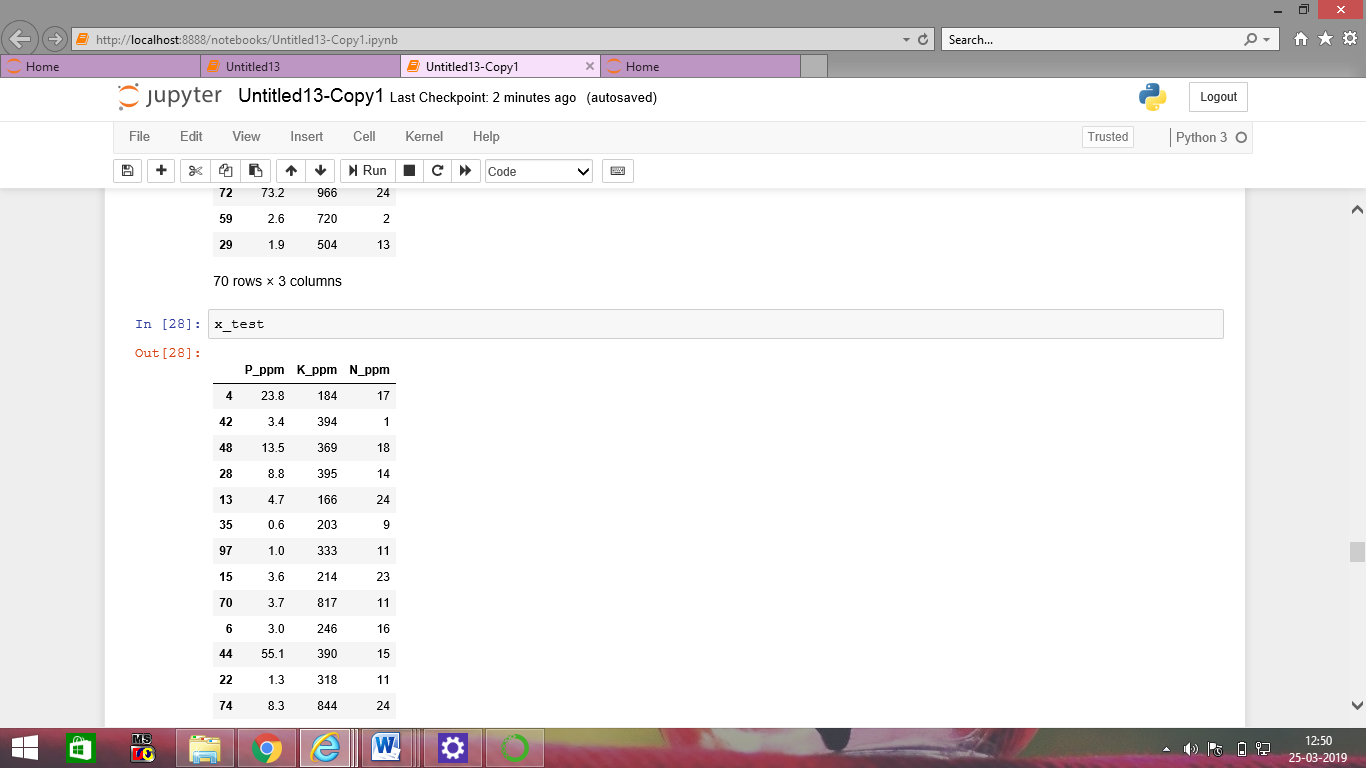
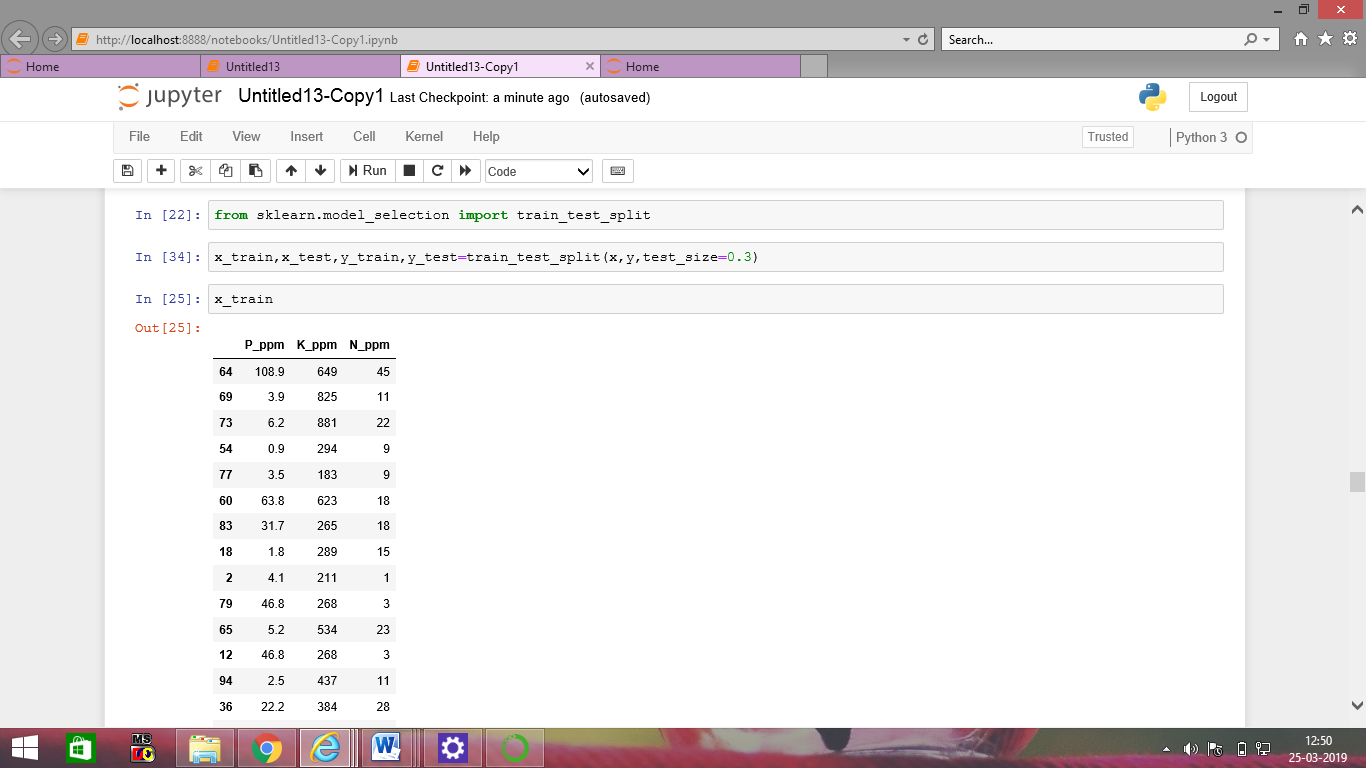
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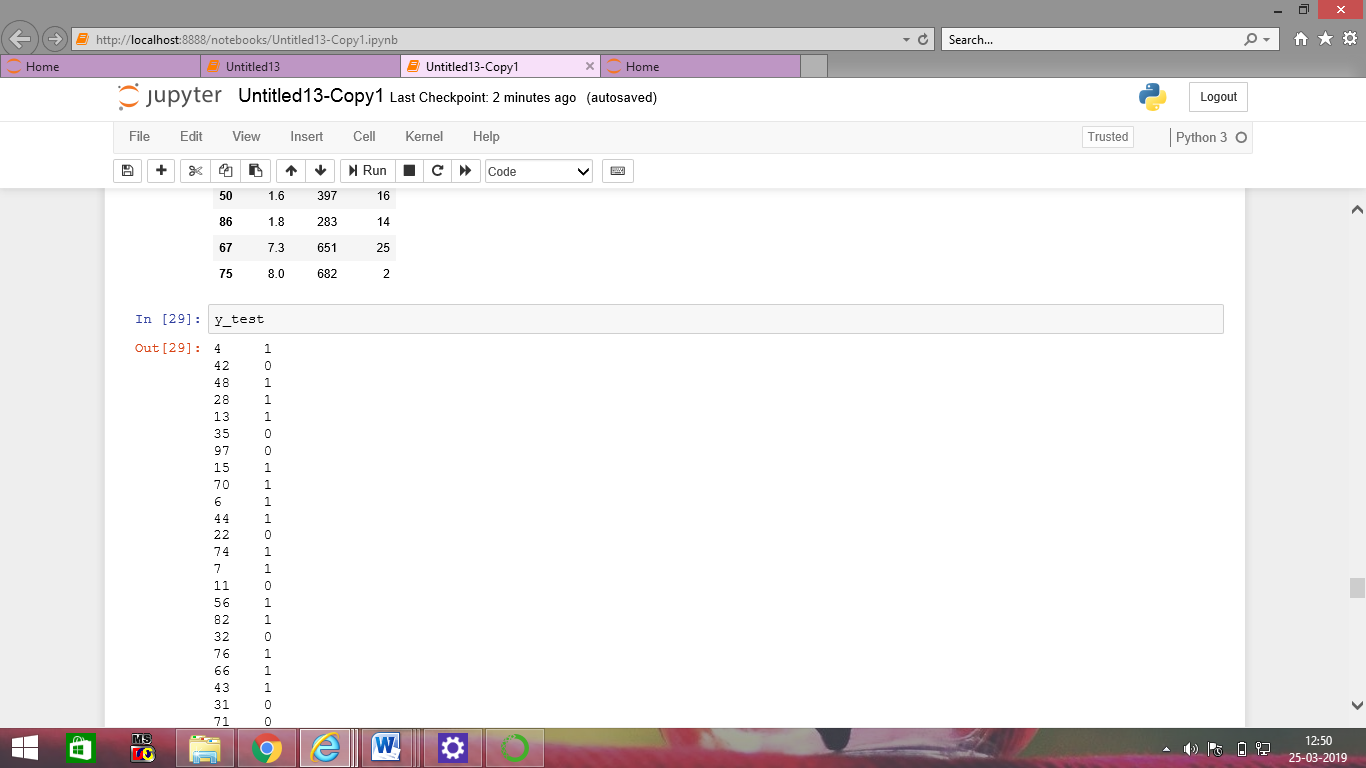
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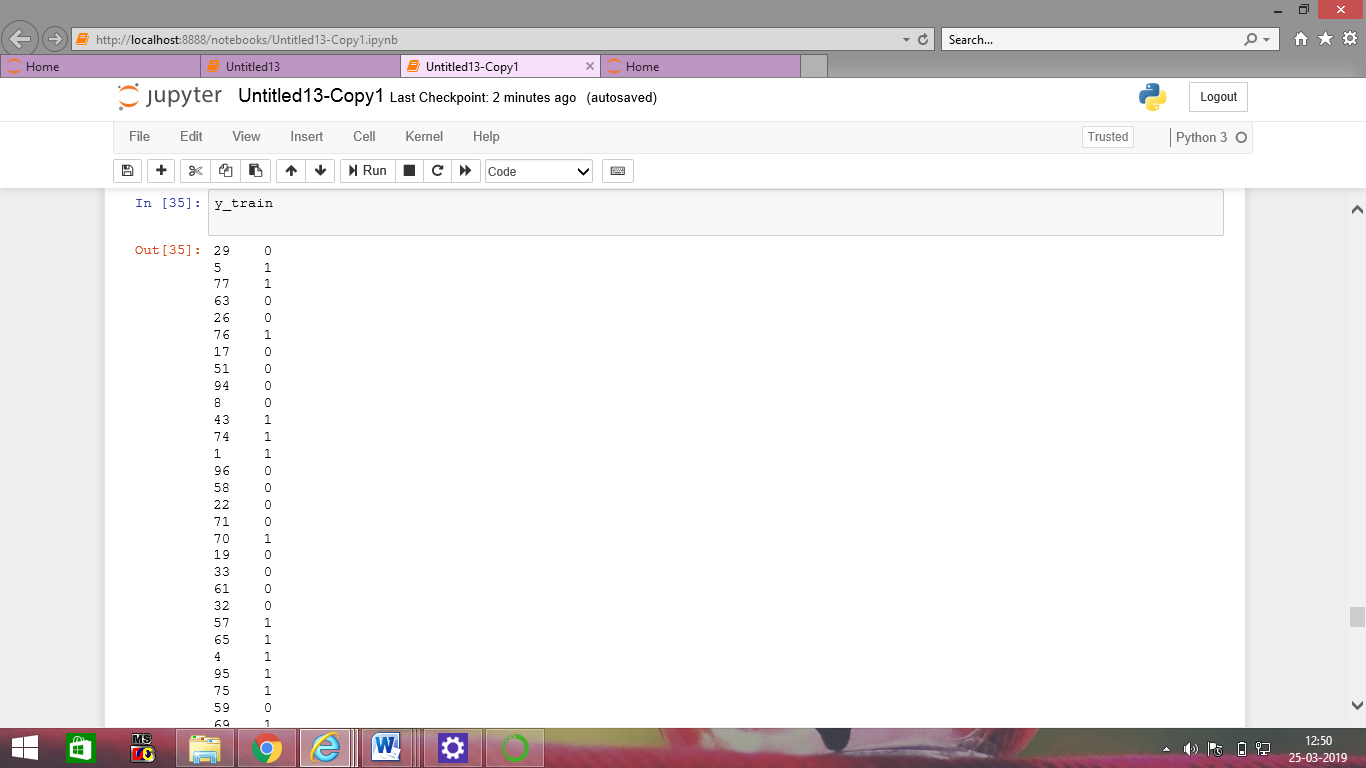
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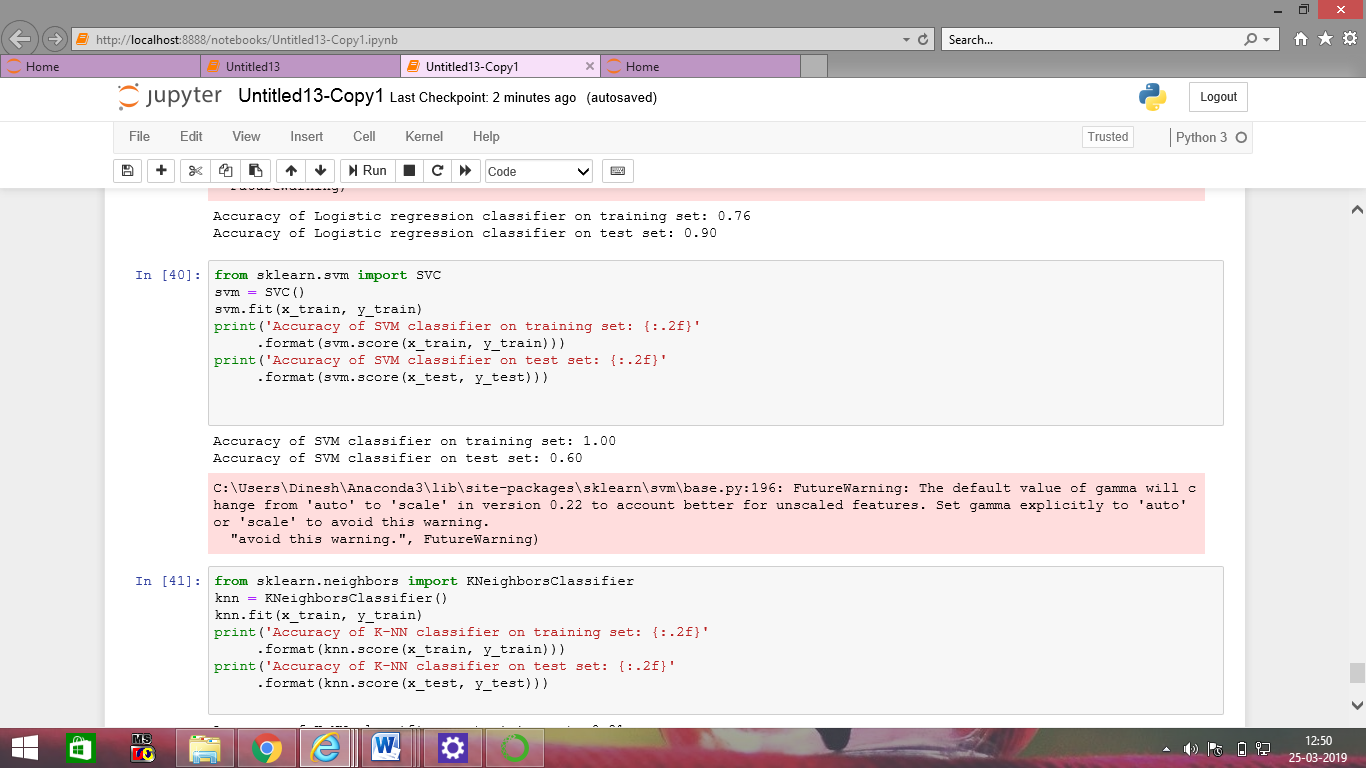
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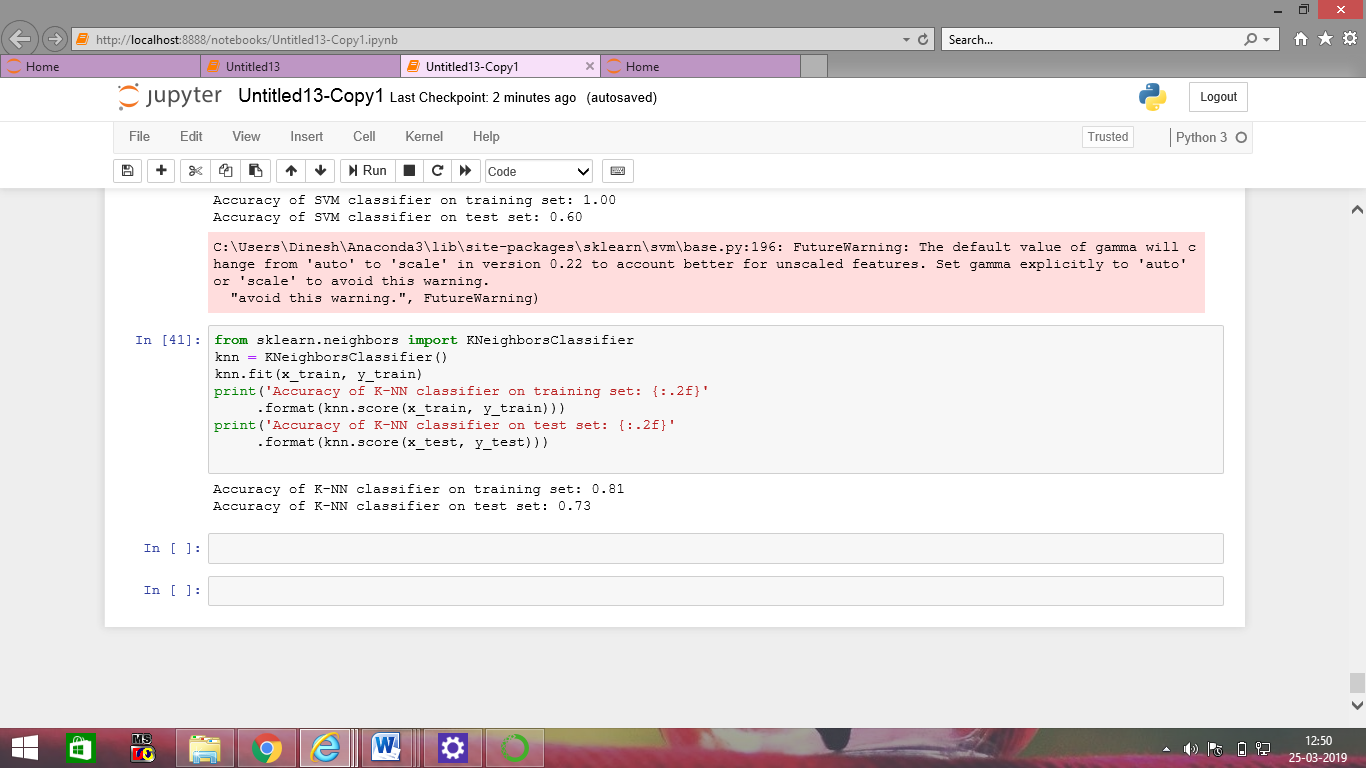
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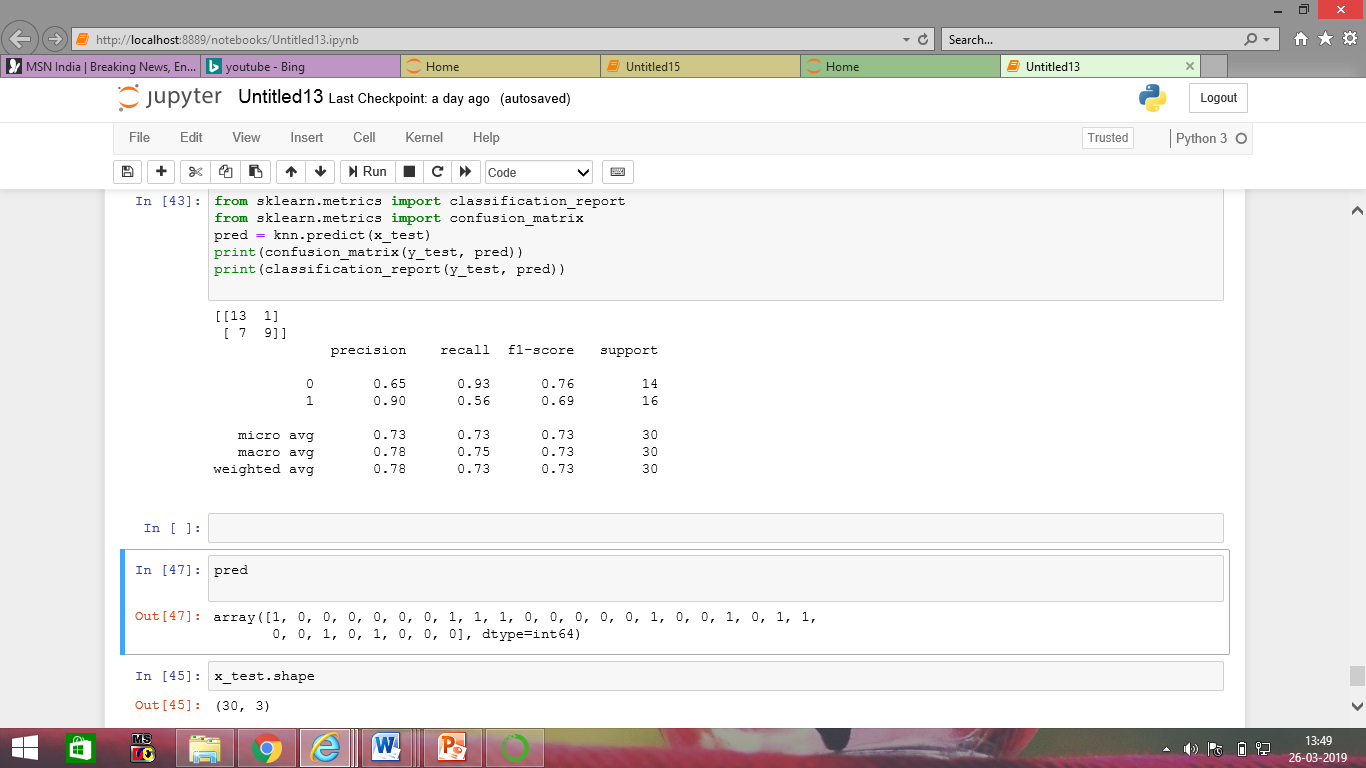
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