International Journal of Scientific Research in Multidisciplinary Studies
Vol.3, Issue.7, pp.23-27, July (2017)

Research Paper
E-ISSN: 2454-9312
P-ISSN: 2454-6143

Decision Support System for Rice Plant Disease Diagnosis using Naïve Bayes' Algorithm

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Available online at: www.isroset.org

Received 12th Jun 2017, Revised 26th Jun 2017, Accepted 19th Jul 2017, Online 30th Jul 2017

***Abstract*—**This paper presents the development of a Decision Support System (DSS) for diagnosing the diseases of rice plant so that the diagnosis process of human expert knowledge could be available to other farmers in solving their problem. The designed system is intended for the diagnosis of common diseases in rice plantoccurred during the life span. The proposed system facilitates different components including the decision support module with interactive user interface for diagnosis on the basis of response(s) of the user made against the queries related to the disease symptoms and predisposing factors. Naïve Bayes algorithm which is a Machine learning algorithm is used in the diagnosis process in this system. It is a classification technique based on Bayes' theorem with an assumption of independence between the symptoms and preconditions of diseases of the rice plant.

Keywords*—*DSS, Rice Plant, Disease, Naïve Bayes

I. INTRODUCTION

Agriculture is the single largest basis of livelihood formajority of the population in India and the state Manipur ispredominantly an agrarian state. Agricultural activities are the largest source of livelihood for the rural masses and the mainstay of the state's economy[1].When many states in India are gradually moving away from their traditional agriculture-based to industry or service-oriented economy, Manipur continues to depend on agricultural sector, especially the rice crop[2].Rice crop is one of the most important crops all over the world considering its impact in the global food market. With the growing population, the demand for food items like rice is increasing more than ever.In the production of better rice yields, gathering and assimilating of related knowledge and information from various sources play an important role. Rice specialists and raw experiences are the common sources to provide information that the different stakeholders require for decision making to improve yields production. It is mainly available from the knowledge and high experience of human experts. It also contains large amount of uncertain information. Effective decisions are made by handling this uncertain information from the specialists. On the other hand, these specialists' assistance is not always available when the need arises for their help. In recent years, tools, technologies and applications of information technologies have emerged as efficient and effective measures for up gradation of the agricultural, ranging from scientific studies to farmers help. Integration of decision support system as a powerful tool for the stakeholders of agricultural production has extensive potential.

The main concern of the present study is in the design and development of a decision support system (DSS) using Naïve Bayes' algorithm. The proposed system is intended to facilitate the farmers to recognize about the diseases occurred in the rice plant during their life span and necessary action to be taken up to control the diseases timely. Timely identification of diseases and controlling them with the developed system will improve the production of yields. The system background starts with collection of disease symptoms along with predisposing factors of occurrencesof the rice plant diseases appearing during their life span from agriculture experts, plant pathologists and literature and then the acquired knowledge is represented to develop the decision support system (DSS).

II. DSS IN AGRICULTURE

Decision Support System (DSS) generate information to the farmers by using the knowledge base of the system and reasoning mechanism from human experts and others. It unites the accumulated expertise of individual disciplines such as plant pathology, entomology, horticulture and agricultural meteorology into a framework in agricultural application that best address the specific, on-site needs of

modern farmers. The integration of knowledge and experiences of different specialists is facilitated in the decision support system which can be used for explanation purpose of basic terms and operations to confirm the reached conclusion in some situations. It unites the experimental knowledge with the instinctive reasoning skills of a multitude of specialists to help farmers in making the best decisions for their crop.

The application of DSS are significantly increasing in agriculture domain. Many domain specific systems are being used at different levels in agriculture. "Next generation Decision Support System for farmers: Sustainable Agriculture through Sustainable IT" is one of the application of DSS in agriculture which enables stakeholders to get access to the best knowledge available, and at the same time involve them in the process of developing the user interface design [3]. The paper "Decision support tools for agriculture: Towards effective design and delivery" [4] uses a mixed methods approach to investigate the factors affecting the uptake and use of decision support tools by farmers and advisers in the UK. "Agriculture Decision Support System As Android Application" [5] suggest most probable matching crops to people according to basic inputs like water availability in mm, average temperature, average soil Ph of farm, locality of farm, soil Type, Crop Duration etc. so by certain calculation at backend this app will show most probable crops List for that farm. "Design of intelligent decision support systems in agriculture" [6] describes the role of decision support systems (DSS) in agriculture, with a special emphasis to the aspects of DSS architecture and design. Based on existing research studies, an overview of factors that are crucially important for acceptance of agricultural DSS is provided. "A Decision Support System for Agriculture Using Natural Language Processing (ADSS)" [7] suggests development of a decision support system for agriculture based on the natural language processing. The analytical data about the rainfall pattern, soil structure of the area will be maintained at back end, the system will retrieve the information based on the interaction with the user, which will be a farmer in this case.

III. RICE PLANT DISEASES

Rice is one of the most important crops all over the world considering its impact. Rice based agriculture plays a very crucial role in the economy of the state of Manipur. Understanding the various components of grain yields of rice and how to improve them will help in increasing the production by raising current yield level. Yields and production efficiency of such an important crop are usually increased by adopting modern techniques in cultivating and use high yielding nitrogen fertilizers. But it had been seen that the adoption improvised new fungicides and start developing resistances which help to enter diseases. The major influence on increasing production is the effective management of diseases and pests. Farmers lose a large amount of their crop to pests and diseases every year. It is important that the farmers get to identify the condition of their crop well ahead of time before it is too late, in order to avoid any kind disaster that can be caused by the diseases. Accurate diagnosis and timely solving of disease is thus a vital component of rice production management aiming for enhanced productivity. Microorganisms such as fungi, bacteria and viruses are the known causes of these diseases which limit health, quality and production potential. Diseases in rice plants are easily recognized by the presence of symptoms and visible changes occurred along with the predisposing factors favoring the diseases [8]. Symptoms may vary according to time, environment, host variety, and race of the pathogen present. The three main principle elements that present for the occurrence of a disease are: a susceptible host, a pathogen, and a favorable factor for disease development [9]. Rice plant diseases are the major cause of yield loss and decrease in production. With keeping all these concerns, this paper aims at the development of DSS for the diagnosis of rice plant diseases mainly caused by fungi, bacteria and viruses during their life span.

IV. MACHINE LEARNING

Machine learning is a useful technology for DSS and assumes greater importance in research and practice. Whilst much of the work focuses technical implementations and the adaption of machine learning algorithms to application domains, the factors of machine learning design affecting the usefulness of decision support are still understudied. To enhance the understanding of machine learning and its use in decision support systems, the results of content analysis of design-oriented research were reported[10]. It further suggested that the usefulness of machine learning for supporting decision-makers is dependent on the task, the phase of decision-making, and the applied technologies. It is also known about the advantages and limitations of prior research, the applied evaluation methods and implications for future decision support research. The findings also suggest the future decision support research should shed more light on organizational and people-related evaluation criteria.

Machine learning is a method of data analysis that automates analytical model building. Using algorithms that iteratively learn from data, machine learning allows computers to find hidden insights without being explicitly programmed where to look. To solve problems, computers require intelligence. Learning is central to intelligence. As intelligence requires knowledge, it is necessary for the computers to acquire knowledge. Machine learning serves this purpose. Machine learning refers to a system capable of acquiring and integrating the knowledge automatically. The capability of the systems to learn from experience, training, analytical observation, and other means, results in a system that can continuously self-improve and thereby exhibit efficiency and effectiveness. In machine learning, learning can be achieved by using training data that has domain experts i.e. supervised

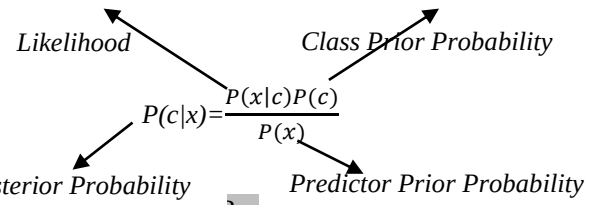
learning, unlabeled data i.e. unsupervised learning, and a combination of both supervised and unsupervised learning i.e. semi-supervised learning. Sometimes reinforcement learning which strengthens the solution strategies leading to good decisions and weakens those leading to inferior decisions is used in the learning process.

V. DECISION SUPPORT SYSTEM USING NAÏVE BAYES

A decision support system (DSS) is a computer-based information system that supports the decision making activities in ranking, sorting or choosing from among the alternatives. It helps the people in making decisions about problems that may rapidly changing and not easily specified in advance i.e. the unstructured and semi-structured decision problems. The emergence of research in DSS is came upon the idea of using computers in decision making process [11]. The framework for decision making support by combining Simon's model of decision making and Anthony's categories of management activity is introduced by Gorry and Scott Morton [12, 13, 14]. The term DSS is defined in their work as system supporting decision makers in semi structured or unstructured decisions which is widely used today. After these foundations of DSS academic era, DSS research diverged into a multidisciplinary field comprising of Information Systems, Operation Research and Decision Theory etc. in addition to this, the related concepts like Expert Systems, Business Intelligence are subsumed under the DSS field of research [15].

Machine Learning techniques can be applied to any data problem and it can be classified in several ways. Naïve Bayes is one of those machine learning techniques used in this system. It is a classification technique based on Bayes' theorem with an assumption of independence between predictors. In simple terms, a Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about 3 inches in diameter. Even if these features depend on each other or upon the existence of the other features, a naive Bayes classifier would consider all of these properties to independently contribute to the probability that this fruit is an apple.

Naive Bayesian model is easy to build and particularly useful for very large data sets. Along with simplicity, Naive Bayes is known to outperform even highly sophisticated classification methods. Bayes theorem provides a way of calculating posterior probability P(c|x) from P(c), P(x) and P(x|c). Look at the equation below:



Here, $P(c|x) = P(x_1|c) \times P(x_2|c) \times \text{------} \times P(x_n|c) \times P(c)$

where

- P(c|x) is the posterior probability of *class* (*target*) given *predictor* (*attribute*).
- P(c) is the prior probability of *class*.
- P(x|c) is the likelihood which is the probability of *predictor* given *class*.
- P(x) is the prior probability of *predictor*.

A list of probabilities is stored to file for a learned Naïve Bayes model which includes: a) **Class Probabilities**: The probabilities of each class in the training dataset. b) **Conditional Probabilities**: The conditional probabilities of each input value given each class value.

Naive Bayes or Bayes' Rule is the basis for many machine-learning and data mining methods. There are many DSS developed using Naïve Bayes' algorithm. Some of such systems using this algorithm is discussed here. "Applying Naive Bayesian Networks to Disease Prediction: A Systematic Review" [16] shows the application of NBNs in predicting disease and it tries to show NBNs as the fundamental algorithm for the best performance in comparison with other algorithms. "Decision Support in Heart Disease Prediction System using Naive Bayes" [17]predict the likelihood of patients getting a heart disease using medical profiles such as age, sex, blood pressure and blood sugar. S.I ndhumathi and G. Vijaybaskar presents "Web Based Health Care Detection Using Naive Bayes Algorithm"[18]. In their system, it can discover and extract hidden knowledge (patterns and relationships) associated with heart disease from a historical heart disease database based on user answers. It can answer complex queries for diagnosing heart disease and thus assist healthcare practitioners to make intelligent clinical decisions which traditional decision support systems cannot. "A Decision Support System for Predicting Student Performance" [19] uses Naive Bayes algorithm (NB) approach to predict graduating cumulative Grade Point Average based on applicant data collected from the surveys. "Decision Support System for Industries using Naïve Bayesian Classification with Laplace Smoothing" [20] is presented for establishing a jute industry is presented. Where the system guides the user to make a decision about establishment of jute industry in villages of East Godavari.

VI. DSS FOR RICE PLANT DISEASE DIAGNOSIS USING NAÏVE BAYES' ALGORITHM

The idea behind the development ofDSS for Rice Plant disease diagnosis is that it can enable many people to benefit from the experts' knowledge. It simulates the judgment and

behavior of a human that has expert knowledge and experience in a particular field. In the development of a DSS, knowledge base development is the most important part. The quality of the system depends on its knowledge base. Knowledge Base development with the help of domain specific expert in this system is with Naïve Bayes technique of Machine Learning algorithm.The steps for developing this system is shown in the following architecture and presented a comprehensive description of the system.

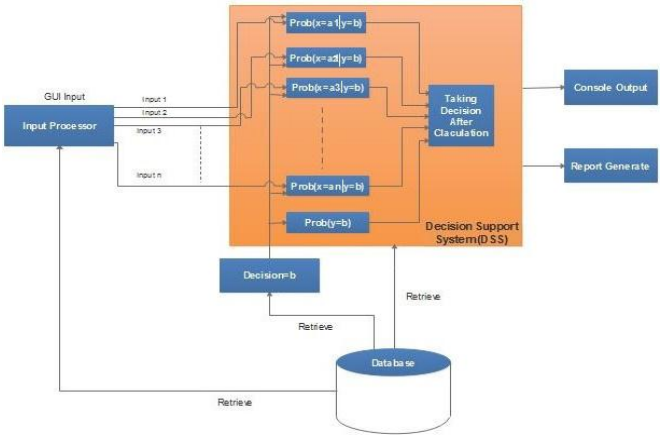


Fig: DSS Architecture

In the above architecture of the DSS for diagnosing the diseases of rice plant:

i. The users/clients supply the inputs to the user interface through the input processor which is retrieve from the database.
ii. For each input from input processor, say 'a1' conditional probability i.e. P(x=a1|y=b) is calculated.
e.g. P(x="greyish lesions" given y="Bacterial Blight")
i.e. Probability = no. of times the symptom is "greyish colour" and the disease is "Bacterial Blight"/no. of times Disease is "Bacterial Blight"
iii. Similarly, all the probabilities for different diseases of rice plant with the given inputs are calculated.
iv. Calculation of all the probabilities is done by accessing the database and counting the no. of times each parameter set occurs in the database i.e. count(symptom = "greyish colour" and disease = " Bacterial Blight")
v. With the given input parameter set (i.e. symptoms and predisposing factors) and given decision (i.e. diseases), the highest probability is chosen as the final predicted decision i.e. the disease.
vi. Once the decision (i.e. disease) is predicted, the control measures of the predicted disease is provided along with the disease in the output.

This DSS for rice plant disease diagnosis is based on windows platform. It is developed in Python Programming Language by using Python 2.7.13 and used Tkinter as User Interface. The Python installers for the Windows platform usually include the entire standard library and often also include many additional components. For Unix-like operating systems, Python is normally provided as a collection of packages, so it may be necessary to use the packaging tools provided with the operating system to obtain some or all of the optional components. Machine learning algorithm is used in this project and the algorithm used in this system is Naïve Bayes. Machine learning is a field of computer science, probability theory, and optimization theory which allows complex tasks to be solved for which a logical/procedural approach would not be possible or feasible. This propose system will help the users to predict the diseases about the rice plants occurred during their life span which is categorized under fungal, bacterial and viral diseases.

Here it is shown in the following how to arrive a decision of a disease using Naïve Bayes' algorithm in the proposed system.

```
def naive(dic):
    iflen(dic["Disease_condition"]) != 0:
        final_dc = 1
        final_dc_str= dic["Disease_condition"][0]
    else:
        decision1=getDataByColumn("Disease_co
        ndition",dic["Table"])
        final_dc = 0.0
        final_dc_str = ""
    for d1 in decision1:
        a=probc("Symptoms",
        dic,"Disease_condition",d1, dic["Table"])
        b=probc("Pre_Disposing",dic,
        "Disease_condition", d1, dic["Table"])
        f=proba("Disease_condition",d1,
        dic["Table"])

        res1 = a*b*f

        iffinal_dc< res1:
            final_dc = res1
            final_dc_str = d1
        print " "
        print "Probability of Disease_condition=
        "+d1+" is "+str(res1)
        print " "
    print " "
    print "### FINAL DECISION IS
    Disease_condition = "+final_dc_str+" with
    probability "+str(final_dc)+" ###"
    print " "
print " "
```

VII. CONCLUSION

The DSS for rice plant disease diagnosis contain important rules on predicting decisions on diseases by giving the

symptoms and predisposing factors which favour the spread of diseases. It offers solution on how the predicted diseases can be handled by a reasoning approach based on its knowledge base. It is also easy to be accessed by the users. Such system is especially useful for those farmers who are not getting the agricultural specialists at any time for their help to control the problems in their rice plant. The system is having the prospect of not only the rice plant disease diagnosis using the Naïve Bayes technique of machine learning algorithm, but also shows the prospects of the application of machine learning technique in different sub-fields of Artificial Intelligence to various decision prediction research.

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