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Article · January 2014

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ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 1, January 2014

Development of Software for Research Farm Management System

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Abstract: In this research work we have developed an integrated application for farm management which works, on first building decision tree for recommendation of agricultural solutions that a research student (user) is looking for, and the recommended solution may include application of some fertilizer, pesticide etc. For further allotment of inventory, which is required in order to complete any task on the research farm, the user can browse and open the requesting module for requisition of resources required on research farm. Inventory related to farming such as various machines, fertilizers, chemicals is maintained and all task involved can be e-mailed as report by the student to their respective advisor. Advisors can post the daily tasks list for each supervised student and the current status of that job will be visible to the advisor, helping to maintain better communication channel and easy record maintenance. Finally the system was evaluated against the ground truth, and we found the recall and precision values for our system.

Keywords: DECISION TREE, RECOMMENDATION SYSTEM, RECALL and PRECISION

I. INTRODUCTION

RFMS is a computer-based management tool that interacts with the user in a real environment and assists research students to take agriculture-oriented decisions. According to Kay and Edward (1994) farm management can be thought of as a decision-making process. It is a continual process, the decisions are concerned with allocating the limited resources of land, labour, equipment and capital among alternative and competing users. The Punjab Agricultural University covers an area of 580 hectare of land of which several hectares are used for research. Management of such large area where various farming equipments, manpower and multiple crops are grown is a tedious work. Therefore a web-based research farm management system is proposed. Research farm management system aims to provide better control over research farms by providing organized database of available farming equipments, it provides a tool for better resource allocation and scheduling and provides a platform to supervise and manage the day to day activities of the research farm. Major issues concerning inventory scheduling is: when to order and how much to order. To answer these questions we have synchronized the allocation of inventory with the cultivation steps of any crop. This system has been developed for the cultivation of cereal crop- wheat. Agronomic practices carried out for the cultivation of wheat were studied and were categorized as main process and sub-process, main processes such as Tillage preparation, Irrigation, Seed treatment, Soil test, Fertilizers and chemicals, Plant protection etc. Rules or procedures to accomplish these set of modules and the material and inventory required in order to complete the task, have been stored in the form of knowledge in our database. This knowledge repository is structured as well as unstructured. Therefore we have formulated Algorithms to identify student's requirements from our table oriented as well as from our text-based database to recommend the best possible solution. The system was later evaluated to check the overall effectiveness of the system.

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II. RELATED WORK

Churi *et al* (2013) designed a system with an aim to investigate decision support systems for assisting strategic and tactical decision making of smallholder farmers to reduce climate risks and increase crop productivity of semi-arid areas. The study assessed farm-level decisions used by the farmers for reducing climate risks; examined information communication and knowledge sharing strategies for enhancing decision making. They developed this DSS to enhance communication, among different agricultural actors, using mobile phones and internet application for accessing not only climate information directly from meteorological services but also agricultural knowledge from other farmers, agricultural extension workers and research institutions through a centralized database. The developed database provides a depository of agricultural information and knowledge of climate, market and agricultural inputs required for various decisions making at farm-level. The system aimed at automatic generation and coordination of advisories for farmers in linking climate forecasts, inputs availability and strategic and tactical decisions

Whelpton and Cooke (2006) developed computer system for equipment management to meet the requirements of equipment management. The system was originally developed to run on personal computers, but has been upgraded to provide true multiuser facilities and more advanced program capabilities. This was achieved using improved hardware and a relational database. The system provided a wide range of information, including inventory data, repair costs and time as well as service records and worksheets. Emphasis was placed on the integrity of the data and ease of entry of additional data.

The DSSAT4 Shell program provided a user-friendly working environment in which various standalone tools and applications are seamlessly integrated with the DSSAT4 crop models. It enabled the user to launch applications for creating and modifying data files, running the crop models, and analyzing the results. The project has been developed as a XBuild program in order to provide more effective tool to access all of the functionality of the crop models. It allowed users to specify any combination of management options for simulation of several crops for purpose of validation (comparison with observed data), seasonal analysis, crop rotations, and spatial analysis that are available in DSSAT. This menu driven software asks the users to enter various factors present on the current day and accordingly suggest management strategies for the planting date, plant density, row spacing and planting depth, Irrigation and water management which defined the dates and amounts of irrigation applications, Fertilizer which defines the dates, amount, and types of fertilizer applications, residues and other

Lazzari and Mazzetto (1996) introduced a model called Computed Farm Machinery System (ComFARMS). It was developed to analyze mechanization problems of Italian arable farms (<250 ha) from strategic and management standpoints. It mainly focused on the strategic approach to select farm machinery for multicropping. Once a given crop rotation pattern and a list of operations per crop are put in, the selection offers the user a machinery set (tractors and implements) where each machine is defined in terms of type, number and size. It is being incorporated in a more general decision support system to improve its use by farmers and advisors at farm level as well

Tahir and Chaudhary (2011) presented an intelligent decision support system (DSS) for Inventory Analysis and Control utilizing technology management. The DSS includes three different types of analyses methods; Price based Analysis, Quantity based Analysis and ABC Analysis.DSS has been developed to manage a gas plant inventory A comparative analysis matrix is formulated for the prior two analyses to isolate the most critical parts in terms of their prices and quantities respectively. The

ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering
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system is developed in MATLAB. Three main inputs of the system are: inventory items, their prices and quantities consumed over a stipulated time-period. From these inputs, DSS outputs critical items based on price, quantity, annual cost and subsequently critical items based on all three elements together. They concluded that Decision Support

System for Inventory Analysis and Control has become inevitably

III. METHODOLOGY

RFMS is not a static web application, it searches the database in order to show the user updated information and interaction with the back end i:e server-side database is only possible with the help of any server-sided programming language. The software has been developed using server-sided scripting language PHP which will query MySql databases (Agri-knowledge repository). We have used two algorithms, algorithm- I (AGRI_DDS) works on structured data and algorithm-II (AGRI_DDS_2) works on unstructured data.

Pseudlogic (Algorithm AGRI_DDS):

Step 1: Let ‘u’ be the set of users (students)

Step 2: Let ‘s’ be the set of solutions they are looking for.

Step 3: Let ‘f(r)’ is the function which produces user a solution (recommended).

Step 4: Then the most appropriate solution from the set of solutions available.

$$f(r) \Rightarrow r \in \{ s(i)\}$$

where function ‘f(r)’ is built dynamically based on ‘n’ inputs or hints from user.

Algorithm: AGRI_DDS

The decision- making and control problem may be formulated with the help of this algorithm. The structured facts, procedures, instructions and best practices related to agriculture have been stored in the form of relational tables as databases. The stored data is processed and analyzed from different aspects with issues and problems to be solved for summarization of the outcomes into useful information (agricultural solutions) - information that can be used to recommend the desired result to the user, (data mining using knowledge discovery). The key values are entered by the students, nitrogen contents, soil type etc. is matched with the relevant predefined best practices recommended by Punjab Agriculture University (PAU) from the database and the best solution is recommended to the student for example: in one of the modules of the RFMS where the student has to find recommendation on the basis of soil test results, he is asked to enter results of soil test i:e percentage contents of organic carbon (Nitrogen), phosphorus and micronutrients which forms the basis for taking any cultivation and planting decision . Our algorithm AGRI_DDS recognizes the entries and recommends the best solution to the user of all the available solutions based on multi parameters having complex decision tree.

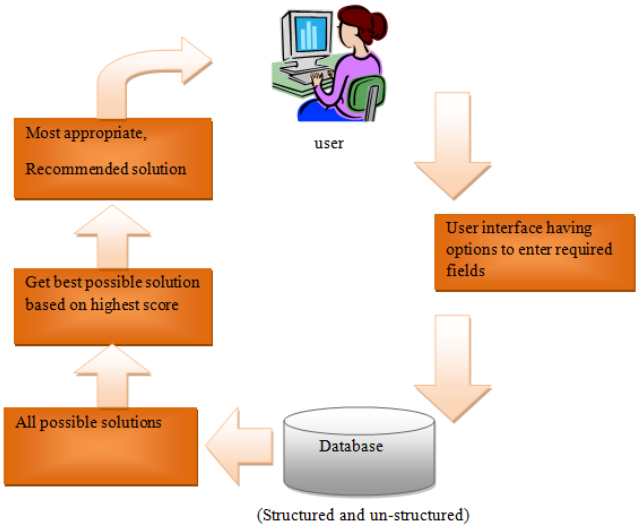

Fig. 1. Flow model of Algorithm-I for structured data

Pseudlogic (Algorithm AGRI_DDS_2):

For each query in queries, repeat steps: 1 to 6

Step 1: Convert each query in the form of Tokens.

Step 2: Remove stop words, if any.

Step 3: Remove duplicacy, if any.

Step 4: Calculate main process score (similarity score – dis-similarity score)

If (user query data (tokens) matches with the keywords from the text-based data)

⇨ **Calculate** Similarity score

Else

⇨ **Calculate** Dis-similarity score

Step 5: Calculate all sub-process scores.

Step 6: Calculate total score for each query using product.

End loop

Step 7: Display result having largest score.

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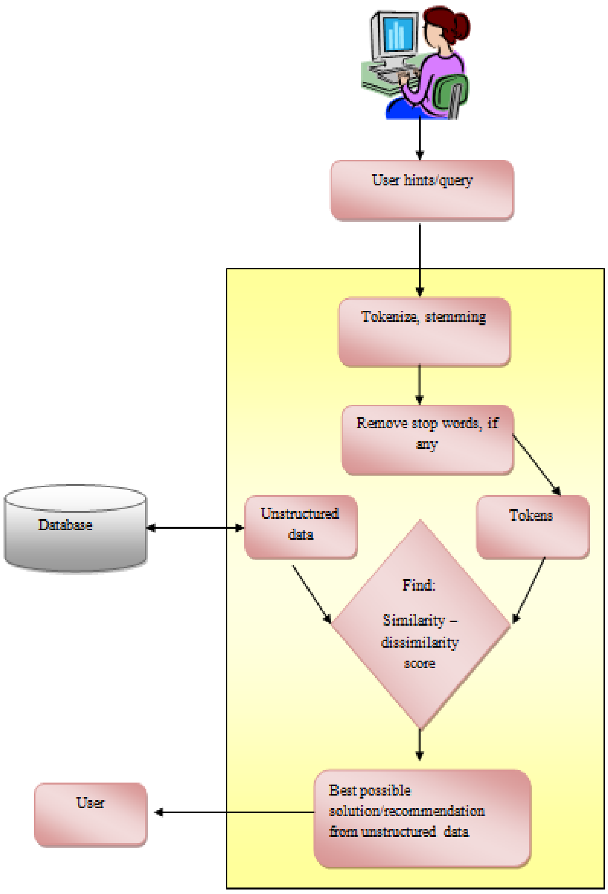

Fig. 2. Flow model of Algorithm-II for unstructured data

Algorithm: AGRI_DDS_2

This algorithm first finds the categorical difference between the query token and the possible recommended solutions. It first builds a similarity and dissimilarity matrices by which we are able to find the term frequency on the basis of both common and disjoint sets. This way it is able to recommend a solution which is calculated on the basis of relevance score defined by both common and disjoint set product. All the irrelevant and stock words are removed before, from calculation of relevance score which is nothing but the difference between categorical Euclidean distance and between common and disjoint sets of the query and the possible multiple recommended solutions.

IV RESULTS AND DISCUSSION

Performance or efficiency of any recommendation system can be evaluated on the factor that how closely the estimated result matches the actual preference of the user. Further the proposed recommendations by the RFMS have been evaluated using precision and recall matrices score. Precision and recall are the basic measures used in evaluating search strategies where precision are the set of solutions that matches our requirement, or it is relevant information to the user divided by the total number of documents retrieved by that search. And Recall is defined as the number of relevant documents retrieved by a search divided by the total number of existing relevant documents (precision). The system was initially tested by taking 15 sample queries and the output for the same has been shown as diverse results in table data. Table I here lists few of the queries that were fired, to evaluate the system.

Query No.	Query	No. of Results	No. of relevant results	No. of irrelevant results	Total results in database	No. of results left in database
1	Nitrogen to wheat	16	10	4	30	2
2	Brown leaves around the edge	13	8	2	25	3
3	DAP in medium soil type	19	12	2	38	5
4	Pest in wheat	26	16	6	53	4
5	manganese deficiency	22	14	5	44	3

Table I Results for different unstructured queries

Against the ground truth, we have found the recall and precision values for the following system: Example for query no. 1 from table I.

$$\text{Recall } \% = \frac{\text{No. of relevant results}}{\text{Total results in database}} \Rightarrow \frac{10}{30} = 33$$

$$\text{Precision } \% = \frac{\text{No. of relevant results}}{\text{No. of results}} \Rightarrow \frac{10}{16} = 62$$

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COLUMN NAMES	DESCRIPTION	EXAMPLE
Query No.	Number of sample queries	Total 15 has been taken
Query	Text queries fired by the user to interact with our database (DB)	For query 1: Nitrogen application
No. of Results	Total results fetched (having score count more than 0 for the matched keywords in DB)	For query 1: 16
No. of relevant results	All results matched in DB for queried keywords	For query 1: 10
No. of irrelevant results	Those rows which are extraneous to the problem	For query 1: 4
Total results in database	Count of the queried phrase available in the DB in totality	For query 1: 30
No. of results left in database	Those relevant solutions which could not be fetched from DB	For query 1: 2

Table II Describing table I

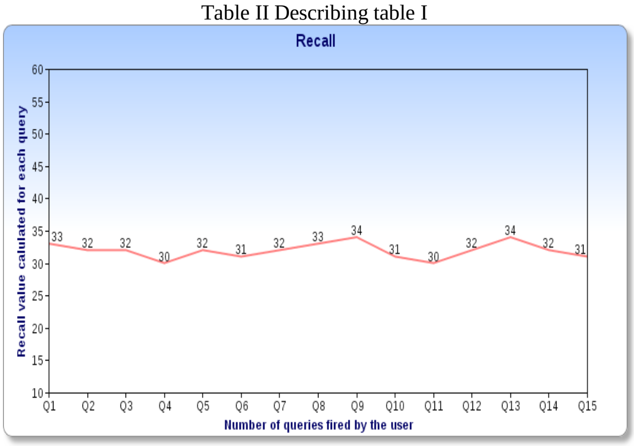

Fig. 3. Graph for recall value

Figure 3 shows the Recall values for all the sample diverse queries which were tested to evaluate the effectiveness of the system. X-axis having values Q1, Q2, Q3….. Q15 are the query numbers fired for testing and Y-axis denotes the minimum and maximum percentage range for recall values. The graphs shows that the recall value for all fifteen sample diverse queries lie between 30% to 34%.

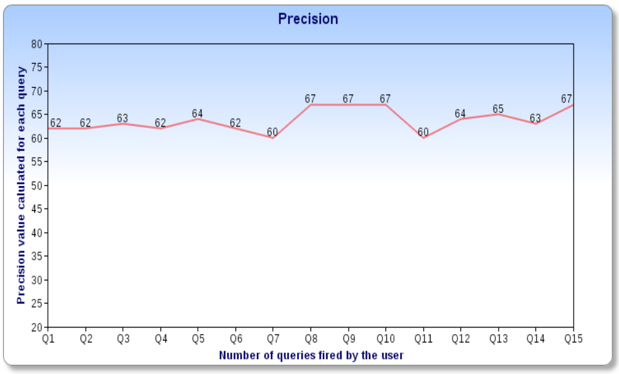

Fig. 4. Graph for precision value

Figure 4 shows the Precision values for all the sample diverse queries which were tested to evaluate the effectiveness of the system. X-axis having values Q1, Q2, Q3….. Q15 are the query numbers fired for testing and Y-axis denotes the minimum and maximum percentage range for precision values. The graphs shows that the recall value for all fifteen sample diverse queries lie between 60% to 67%.

V CONCLUSION

It is evident from the graph that the values of precision and recall are fluctuating for each query. It is not coming constant which is natural on the part of our system because each query will carry some different weight in terms of precision, and accuracy values. Therefore, in our conclusion we can say that the values of recall and precision are lying between 31% and 67% which is a comfortable ratio for a system like this and based on these values, we can safely say that our system needs little bit more data for improving its quality of results. Since it was an academic research , the data set which we have used consist of some 300 rows and the efficiency of our system will be improved if more data is inserted into it, hence overall the ratio shows that the existing algorithm and the quality of data which is there in our system is good enough.

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ISSN (Print) : 2319-5940
ISSN (Online) : 2278-1021

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 1, January 2014

BIOGRAPHIES

Dr. OP Gupta, alumni of PAU, Ludhiana, Thapar University, Patiala and GNDU, Amritsar has demonstrated his intellectual, interpersonal and managerial skills in various domains. He is the winner of PAU Meritorious Teacher Award for 2009-10. Currently he is Associate Professor of Computer Science. His areas of interests include Parallel and Distributed Computing, Grid Computing for Bioinformatics, Network Testing and Network Management.

Dr. B.K. Sawhney is working as an Associate Professor in the School of Elect. Engg. & Information Tech. (SEEIT), Punjab Agricultural University. Her qualification are B.Sc (Non Medical), B.tech (Electrical Engg.), M.tech (Instrumentation) and Ph.D in the field of Electronics Technology. She has twenty five years of experience of teaching Under-Graduate and Post-Graduate students. She has published many research papers in National and International Journals and Conferences.

Sonam is pursuing his M.Tech (CSE) degree from Punjab Agricultural University, Ludhiana, Punjab (India) respectively. Holds a B.Tech degree in Computer Science & Engg. from Punjab Technical University, Jalandhar, Punjab.