Bidirectional Associative Memory Classifier for Personalized Recommendations for Farmers

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Abstract

This paper suggests Bidirectional Associative Memory based classifier for agricultural recommendation system. Use of ICT in agriculture sector enables farmers getting the right information at right time. Online web application for farmers can help them in getting information about crops, seeds, fertilizers, price information, their competitors and potential markets. Yet, not all farmers are equally educated to use online information since they have diverse economic and educational background. Hence the web application intended for agriculture sector must be personalized to suit the requirements of individual farmer. This research paper presents an approach for reducing the knowledge gap between farmers and agriculture experts. In this paper a framework for an agricultural website is proposed. The framework consists of different segments. Each segment is designed to fulfill the requirement of a group of users classified on the basis of their personal profile and information needs. Here we propose a novel dynamic classification algorithm based on Bidirectional Associative Memory that stores the profiles of farmers and their associated ratings for information requirement. When a user logs in, his/her profile is matched against the stored results in the model. The user is then redirected to an appropriate segment of the website. Finally, the recommendations are made by the website and made available to the user. A survey is conducted to generate the dataset and results show that proposed model has performed satisfactorily and classifies the users with reasonable level of accuracy.

Keywords: Bidirectional Associative Memory, Content Filtering, Web Personalization.

Introduction

Personalization is a technique by which user can search their related contents. Personalization can be expressed in terms of ontology. Web Personalization is very common now a days, it can be popularly seen in many web applications as well as has been used in content filtering method.

Earlier the problem with website was that when it was created the information on the website was either too good for the people or too less for the people who want to use that. Here we have proposed the architecture of the website in which farmers can interact manually with the personalized helper who are ready to help them 24x7 online. We have rated users to provide them a personalized environment in which if the farmer is illiterate than also there is someone to help them on a website.

In this study we have created a framework, consisting of classifier which will distinguish between different types of user for example, whether the user is literate or not. A personalization system that integrates usage of data with content filteration, expressed in ontology terms, in order to compute semantically enhanced navigational patterns and effectively generates useful recommendations which create and store user profile of farmers and provide online information to farmers personalized on the basis of their profile. This application is for the farmers who need personalized help for their agriculture related queries. Agriculture is a major contributor to India's GDP in the agriculture sector. Currently this sector contributes 17.2%. Nearly half of the India's population depends on the earnings made from agricultural products. Yet the decline in its percentage has been seen. This fact makes us think about bringing innovation to

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agriculture sector with the use of Information & Communication Technology (ICT). Use of ICT in agriculture sector enables farmers getting the right information at right time. A number of ICT projects for agriculture sector have been initiated by Government of India. Yet there is a communication gap among people who receive the information and the people who actually need this information, that is, the farmers. ICT's Agriculture Business Division has started the project eChoupal to disseminate value added information to its customers. eChoupal project is now launched in several states. This project requires a facilitator to be appointed for a land-size of 25 acres. This facilitator is called the *Sanchalak*. *Sanchalak* provides the technical support to villagers in accessing web portal. ICT is in control of price setting of the commodities and decides daily procurement volumes. ICT monitors the payments made to villagers and appointment of Sanchalaks. However, farmers are bound to use the services of Sanchalak in order to utilize the facilities provided by eChoupal. All the decisions are made by ITC with overall profitability of ICT taken into consideration. This makes monopoly on the part of ITC. In addition, eChoupal projects are targeted for long-run, thereby, this monopoly is also going to sustain in future. The viability of the benefits of ICT eChoupal reaching to weaker section of farmers is also questionable.What is required is the establishment of a public system which can be made available to farmers easily and with low cost. As the computer literacy among farmers is still low and the cost involved in acquiring the equipments for accessing web portals such as personal computers and laptops is not affordable by weaker section of farmers, majority of farmers are still unable to use websites. ICT's eChoupal was successful in eliminating middle man from the system yet farmers require more. The monopoly established by ICT should be short-lived. Farmers need not be dependent on Sanchalak to get day-to-day information such as climate conditions etc. the purpose of ICT should not be to introduce another form of middleman in the form of ICT itself. Such a system will also make farmers aware of the functioning of system. They will feel part of the system and it will remove fear of using technology.

With the passage of time farmers will become more educated and they will be able to use information systems independently without the help of a facilitator. The personalized agricultural recommender system can also be used to promote awareness among farmers by providing information on educational programs and seeking their participation. Government initiative is required in order to establish mobile based web portal which can provide personalized agricultural services to farmers. Vikas Kumar et al. presented a recommender system, KrishiMantra, for farmers which provide agricultural recommendations to the farmers on weather conditions using spatial data. The system is implemented in Web 2.0 technologies. The system has query engine, recommender system, knowledge base and analysis and reporting module. The system can be further extended to incorporate real time pricing and mundi information. However, mobile based solution can work for poor farmers. Here a personalized mobile based solution is proposed. The personalized recommendations can be sent to farmers via SMS with which they are more familiar. The personalized recommender can support the needs of farmers in a variety of ways. A knowledge base is required for the recommender system to work with. This knowledge base is required to be created by experts and stores the data about prices and demands, weather information through GIS, information about specific crops, availability of seeds and fertilizers and expert tips. Farmers may send their query through a query interface. Farmers can use SMS for sending queries. The queries can be formulated by specific set of commands.

Some features that may be present in personalized agricultural system include:

1. Sending time to time climate information
2. Information on specific crops, seeds and fertilizers
3. Price of commodities
4. Alert on price change
5. Gathering requirement for procurement
6. Farmer's queries
7. Conducting short surveys
8. Getting farmer's feedback
9. Alerts on educational programs
10. Making awareness about system

Objective

Objective of this study is to create and store user profile and to provide relevant online information to farmers through a single web interface. Since farmers have diverse educational background, the information should be filtered and classified correctly before it is consumed by the user.

For recommending appropriate information to users, a classification mechanism based on Bidirectional Associative Memory is used.

Literature Survey

Personalization technology enables the dynamic insertion, customization or suggestion of content in any format that is relevant to the individual user, based on the user's implicit behavior and preferences, and explicitly given details [A. Jebaraj Ratnakumar, 2010]. This implicitly and explicitly collected user information can greatly influence the effectiveness of a content delivery framework. Personalization can result in increased customer satisfaction and therefore can lead to more visitors of the site as well as customer retention [A. Jebaraj Ratnakumar, 2010]. Personalization has several components such as *memorization, customization, recommendation and support.*

Accuracy and user satisfaction are two important qualities of a recommender system. Accuracy, robustness and scalability can affect user experience. A good recommendation system relies on correct user modeling. There are several strategies for user-modeling. User-modeling requires behavior of users is stored as patterns which can later be retrieved for providing recommendations. Yash Pal Singh et.al [2009] discusses the use of Artificial Neural Networks as a mechanism for pattern recognition. These mechanisms differ in learning strategy. Learning can be supervised or unsupervised. Supervised techniques require training set which consists of input data and response. Unsupervised learning works by clustering input patterns. Artificial Neural Networks can be used for pattern storage and recall. Bidirectional Associative Memory (BAM) can also be implemented as two-layer non-linear feedback neural networks [Bart Kosko 1988]. When BAM is presented with a given input pattern, it has potential of correctly classifying it to one of the stored output patterns. M. Y. Kiang has given a comparative study of various classification techniques [Melody Y. Kiang , 2003] including Neural Networks, Logistic Models, Decision Trees, Multivariate Discriminant Analysis and Kth-Nearest Neighbor (KNN). Each method has potential of classifying with reasonable accuracy with specific data sets. However, Neural Networks and Logistic Regression work efficiently for most cases. For designing recommender system choice of correct classification method matters a lot. Whenever required different methods can also be combined [Melody Y. Kiang, 2003].

Content Filtering

We have applied the BAM Model (bidirectional associative memory) which consists of content filtering. Content filtering (also known as *information filtering*) is the use of a program to screen and exclude from access or availability, the Web pages or e-mail that is deemed objectionable. Content filtering is used by corporations as part of Internet firewall computers and also by home computer owners, especially by parents to screen the content their children have access to from a computer. Content filtering usually works by specifying character strings that if matched; indicate undesirable content that is to be screened out. Content is typically screened for violence- or hate-oriented content. Critics of content filtering programs point out that it is not difficult to unintentionally exclude desirable content.

Bidirectional Associative Memory Model (BAM)

Bidirectional Associative Model has some basics functions or we can say basic operations that retrieve the nearest pair, addition and deletion of pattern pair, energy for BAM model. But the basic question (what is associative memory?). Associative memory is content addressable structure that maps a set of input pattern with a set of output pattern. When an input is presented it is matched with the store Input pattern. If the match is found the corresponding Output pattern is presented to the user otherwise the most similar match is determined and accordingly the output is presented. In BAM which is of single layer,

by incorporating another layer with the help of auto associations and hetro-associations on the stored memories. The network structure of this is similar to the linear associator but the connections are bidirectional.

Bidirectional Associative Memory (BAM) represents association between two patterns $<A_i, B_i>$. BAM are used for two-way associative search. Association between patterns $<A_i, B_i>$ is represented as a matrix M. Matrix M denotes the associative memory. Information is passed through M as well as its transpose M^T. Therefore BAM behave likes a content addressable memory, which can store as well as recall information patterns [Bart Kosko (1988].

Encoding in BAM is carried out by computing the product of transpose of input pattern vector and output pattern vector:

$$\mathbf{W_k = X_k^T Y_k}$$

To simultaneously store a number of patterns a matrix, H is used:

$$\mathbf{H = \Sigma} W_K$$

For decoding the information when a new input Pattern is arrived, the product of input pattern and matrix H is computed to get the output pattern.

Experiments

Survey

We have used the BAM model for our application. In order to gather user input for designing the model, a survey is conducted. A sample of questions used in the survey is given in Table 1.

Table 1. Ratings

Questions	User 1	User 2	User 3	User 4	User 5
Computer literate	5	2	3	4	1
Can access internet	5	4	2	1	3
Need online help	5	3	2	1	1
Personalised help (selling products)	5	4	1	2	2
Need operator assistant	–	2	4	5	5
Compare prices	5	1	3	3	4

[1] For each question user is required to give a rating value in the range 1-5. For instance, if the farmer is computer literate, rating value is 5.

[2] The computation of result given below is based upon the data obtained from 5 users. The rating values are normalized to [-1, 1] and is given below.

[3] **A[1]** = [1 1 1 1 – 1 1],

[4] **A[2]** = [–1 –1 1 1 1 1],

[5] **A[3]** = [1 1 –1 –1 –1 –1],

[6] **A[4]** = [1 1 1 –1 1 –1],

[7] **A[5]** = [–1 1 –1 –1 1 1].

[8] Our Hetro-Correlator (BAM) stores the resulting pattern which is computed as: **A[i] × A[i]^T,** where **A[i]^T** is the transpose of above expression. We compute this as follows:

[9] **R1** = A[1]×A[1]^T = [1 1 1 1 –1 1] × $\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ -1 \\ 1 \end{bmatrix}$ = $\begin{bmatrix} 1 & 1 & 1 & 1-1 & 1 \\ 1 & 1 & 1 & 1-1 & 1 \\ 1 & 1 & 1 & 1-1 & 1 \\ 1 & 1 & 1 & 1-1 & 1 \\ -1 & -1 & -1 & -1 & 1-1 \\ 1 & 1 & 1 & 1-1 & 1 \end{bmatrix}$

[10] **R2** $=A[2]\times A[2]^T=[-1\ -1\ 1\ 1\ 1\ 1]\times \begin{bmatrix}-1\\-1\\1\\1\\1\\1\end{bmatrix} = \begin{bmatrix}1&1&-1&-1&-1&-1\\1&1&-1&-1&-1&-1\\-1&-1&1&1&1&1\\-1&-1&1&1&1&1\\-1&-1&1&1&1&1\\-1&-1&1&1&1&1\end{bmatrix}$

[11] **R3** $= A[3]\times A[3]^T = [1\ 1\ -1\ -1\ -1\ -1]\times \begin{bmatrix}1\\1\\-1\\-1\\-1\\-1\end{bmatrix} = \begin{bmatrix}1&1&-1&-1&-1&-1\\1&1&-1&-1&-1&-1\\-1&-1&1&1&1&1\\-1&-1&1&1&1&1\\-1&-1&1&1&1&1\\-1&-1&1&1&1&1\end{bmatrix}$

[12] **R4**$=A[4]\ A[4]^T=[1\ 1\ 1\ -1\ 1\ -1]\times \begin{bmatrix}-1\\-1\\1\\1\\1\\1\end{bmatrix} = \begin{bmatrix}1&1&1&-1&1&-1\\1&1&1&-1&1&-1\\1&1&1&-1&1&-1\\-1&-1&-1&1&-1&1\\1&1&1&-1&1&-1\\-1&-1&-1&1&-1&1\end{bmatrix}$

[13] **R5**$=A[5]A[5]^T=[-1\ 1\ -1\ -1\ 1\ 1]\times \begin{bmatrix}-1\\1\\-1\\-1\\1\\1\end{bmatrix} = \begin{bmatrix}1&-1&-1&1&-1&-1\\-1&1&1&-1&1&1\\1&-1&-1&1&-1&-1\\1&-1&-1&1&-1&-1\\-1&1&1&-1&1&1\\-1&1&1&-1&1&1\end{bmatrix}$

H = R1+R2+R3+R4+R5 $= \begin{bmatrix}5&3&-1&-1&-3&-3\\3&5&1&-1&-1&-1\\1&-3&3&-3&-1&-1\\-1&-3&1&5&-3&3\\-3&-1&-3&-3&5&1\\-3&-1&3&1&1&5\end{bmatrix}$

Result

We have collected a number of test patterns and applied these patterns on H.

Evaluation of Model

We have conducted the evaluation of our model on the data obtained by conducting a survey on 75 anonymous users. We have given each user a set of questions. Evaluation data is again normalized and applied on our model matrix. It has been observed that the model accurately classified the users on appropriate segment of the website.

For further evaluation of our approach we have conducted another survey on the users who have used our application for obtaining correctness of results. The classifier has divided the users into three segments. The users rated the information on a 5 point scale.

Result of the survey is shown in Table 2. This table consists of data which tells whether this personalization is helpful for users or not.

It indicates segment 1 users who are more computer literate indicated that classification is helpful for them.

Table 2: Result

	Segment 1	Segment 2	Segment 3
Strongly agree	**60%**	**74%**	**45%**
Agree	**35%**	**20%**	**43%**
Neither agree nor disagree	**4%**	**4%**	**7%**
Disagree	**1%**	**2%**	**3%**
Strongly disagree	**Nil**	**Nil**	**2%**

Conclusion

The personalized recommendation system for agriculture sector is highly beneficial for farmers. The framework can be implemented in web applications easily. Websites having this kind of recommendation systems can filter the information to fulfill the needs of individual users.

The classifier based on Bidirectional Associative Memory (BAM) divides the information in different segments. The BAM model is dynamic. It takes into consideration online update of user profiles and accordingly computes the recommendation information. The result shows that performance of our model is satisfactory.

BAM model has advantage of correctly classifying the input data containing noise also. But this model has comparatively low memory capacity. Hence further research is required to explore classification mechanisms which eliminate this limitation.

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