Evaluation of Users' Behavior Using Adaptive Fuzzy Prediction Technique

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Abstract
User behavior is a considerable determinant of a products ecological blow as manufacturing advances authorize enlarged effectiveness of product purpose, the consumers alternatives and habits ultimately enclose a major outcome on possessions utilized by the product. A variety of design methods developed in diverse contexts propose chances for engineers and other stakeholders functioning in the ground of sustainable improvement to involve consumers actions at communication with the result or system, in result building the user more competent. Approaches to varying users actions from varied amount of fields are evaluated and discussed. But it fails to predict the user behaviors accurately. In this work, Adaptive Fuzzy Prediction technique is presented to interpret and predict the users behavior towards product demand, quantity of products, features of the product/services, annual sales with the multi-clustered web usage data. The fuzzy model works on the feedback pattern to arrive at predictive feature of the web usage data value moments, across different time periods, and adapt to the recent consumer behavior and liking of the products and service. Experimentation conduct with real data sets extracted from web log files collected from websites. Performance evaluation is made to show the effectiveness of the proposed technique.
Keywords Users behavior, product, behavior-patterns, feedback pattern, multi-clustered data, adaptive fuzzy prediction technique.

1 Introduction

Web data mining is a type of approaches that proficiently processes the tasks of providing the required information from the Internet, enhancing the Web site framework to offer better Internet service quality and identifying the informative expertise from the Internet for enhanced Web appliances. Usually, web data mining are of three types, Web content, Web structure and, Web usage mining.

In addition to identifying the requirements of the customers, organization also require to recognize what motivates them to buy, and how can processes the purchasing procedures to make sure that the products or services are on the purchasing list. Understanding the customers will assist, to enhance and provide the product, in addition to obtaining the right price crossing points and enhancing successful promotional behaviors. The psychology of the purchasing procedures has been greatly noted and no matter what size organization business, proce-

dures that assist company turn into be more successful. Both organizations and consumers provide patterns of purchasing actions. The business representation is less process to debate as the business consumers will almost dominantly encompass some generalized procedures of buying in place. The organization task is to recognize the procedure and match the marketing behaviors to the diverse stages of the procedure. This means that the consumer will obtain the right type of contact at the precise time. To process insights into areas for instance indicators of consumer defection, crossing points sensitivity, clustering, and consumer needs examination, to process a few.

Most marketers identify the value of sensing consumer data, but also act as the endeavors of leveraging this expertise to produce intelligent, proactive routes rear to the consumer. Data mining approaches and techniques for identifying and monitoring patterns among data - assists businesses sift during layers of seemingly unspecified data for purposeful relationships, where they could processes, rather than merely route to, consumer requirements.

Defined and precise predictive representations are very significant in viewing schemes. The requirement for novel techniques and attitudes in representing calculation and vulnerability are prejudiced by the current proceeds in soft computing also the problematic accurateness and inapplicability to person calculation of formerly required after geometric analysis methods. Thus founding accurate analytical representations become gradually harder for multivariable projecting representations. Conventionally, such troubles have been lectured by geometric logistic deterioration methods for binary reliant variables.

Therefore, it can be accomplished that the Web is an assorted, energetic and amorphous data depository, which gives huge quantity of valuable information and also demonstrates the difficulty of managing enormous amount of information from the diverse perspectives, users, Web repair providers, commerce analysts. The efficient search tools are very greatly essential to recognize significant and practical information accurately. The growth has enthused the web service suppliers to predict the users web usage behaviors so that, they can

- Personalize the information offered to them
- construct the websites more users sociable
- decrease the traffic load
- make or adapt their website to outfit diverse group of people

In this work, predict the users behaviors based on their selection over product demand, quantity of products, features of the product/services, annual sales, etc., by employing the proposed adaptive fuzzy prediction technique.

2 Related work

World Wide Web is an enormous depository of web pages and associations. It presents great quantity information for the Internet users.

Data mining has developed as a ground of essential and functional study in computer science. In [1], an adaptive technique for predicting cancer susceptibility was designed by combining fuzzy concept with statistical logistic regression which was tested on cancer dataset. As to the authors suggestion regarding the generalization of the algorithm into prediction problem involving other types of intrinsic linear functions, and adaptive fuzzy prediction technique is used to evaluate users behavior. The development of web is unbelievable as it can be observed in current days. Users admittance is traced in web logs. From the users viewpoint, it is very complicated to haul out practical knowledge from the enormous quantity of information and secondly, it is also hard to take out for the users to admit pertinent information professionally.

Web logs extracted and purpose of this exposition is to assess, suggest and progress the exercise of a quantity of the current approaches, architectures and Web mining methods (gathering individual information from consumers) are the earnings of operating data mining techniques to persuade and take out helpful information from Web information and service where data mining has been practiced in the pastures of e-commerce and e-business (that funds Users actions) [2].

One method to solve such problem is the application of Web Usage Mining as in [3]. The evaluation of users behavior using adaptive fuzzy prediction technique deploys the multi-clustered web usage data in order to derive the behavior pattern. A developing clustering algorithm is planned for cluster production. Clusters are recognized and customized supported on restraint measure of mapping consistence and companionable dimension.

Auspiciously, online social networks and social standard have completed it simple for users to point to whom they reliant and whom they achieve not. Nevertheless, this does not resolve the crisis since every user is only possible to recognize an insignificant portion of other users; the author must encompass techniques for deducing reliant - and disbelieve - among users who do not recognize one another. In [4], the authors present a novel technique for calculating both reliant and non-reliant (i.e., optimistic and pessimistic trust). The authors supply to this region a novel algorithm for efficiently forecasting reliance and mistrust in web-based communal systems. The authors in [5] unite a path possibility reliance inference algorithm with a new method employing spring-embedding to deduce system distance. The product of the classifiers is evaluated with offered techniques which exercise considerably diverse techniques. When a user needs admin contact, a communal conversation page is associate for users to converse and cast

your vote on whether to disclose the mediator. Optimistic and pessimistic votes are calculated as optimistic and pessimistic trust ratings [6]. The methods in [7] have exposed an enormous potential for humanizing classification accuracy. This revision is concerned with the assessment of training data allotment and its strength on the arrangement of frequent classifier schemes.

Temporal data clustering presents establishment techniques for shaping the intrinsic association and concentrating information in excess of chronological data. The author in [8] calculated techniques for communication seek out in associated, high-dimensional data sets, which are resultant surrounded by a clustering organization. The author takes you back that indexing by vector processes (VA-File), which was anticipated as a way to match the disfigurement of Dimensionality, uses scalar qualification, and so fundamentally ignores dependences obliquely magnitude, which represents an origin of sub-optimality [9].

Researches on Position-Based Service (LBS) have been promising in modern years remaining to a large cycle of probable applications [10]. One of the vital subjects is the removal and computation of mobile actions and associated communication. Feature clustering is a scheming method to reduce the dimensionality of distinctive vectors for content tagging. In this paper, the author in [11] suggests fuzzy similarity-based self-constructing practices for characteristic grouping [12]. The paper [13] urbanized a novel resolution structure for adaptive production response fuzzy direct schemes aimed at efficiently selling with nonlinear schemes with numerous input-multiple production (MIMO) setback and in the attendance of dynamics and normal function suspicions. A multiple delay fuzzy scheme calculation representation is consequent and its scheme possessions are elucidated. Such a calculation representation allows the exercise of a model-based technique for fuzzy control.

The paper [14] investigated the possibility of concerning a comparatively new neural system method, i.e., great learning mechanism (ELM), to understand a neuro-fuzzy Takagi-Sugeno-Kang (TSK) fuzzy supposition scheme. The TSK technique is an enhanced report of the standard neuro-fuzzy TSK fuzzy deduction scheme. At the equivalent time, the consequential fraction of the fuzzy rules is attained by numerous ELMs. Finally, the estimated calculation value is dogged by a load calculation system.

In [15], the author are disturbed with a technique for building quantum-based adaptive neuro-fuzzy systems (QANFNs) by means of a Takagi-Sugeno-Kang (TSK) fuzzy category supported on the fuzzy granulation from a specified effort production data set. For this reason, the author urbanized a methodical technique in creating habitual fuzzy rules supported on fuzzy subtractive quantum grouping. The clustering method is not only an addition of thoughts intrinsic to scale-space and support-vector grouping but also symbolizes an efficient sample that shows

definite uniqueness of the objective scheme to be represented from the fuzzy subtractive technique.

Through the precedent few years, the primary deduction for corporeal repossession is being anticipated employing regression methods from sounder comments. The current system employs fuzzy reason and data clustering to institute an association among replicated sounder comments and impressive outlines. This association is more reinforced employing the Adaptive Neuro-Fuzzy supposition scheme (ANFIS) by fine-tuning the offered fuzzy-rule stand [16]. The paper [17] presents an appliance of fuzzy-logic methods to the reversible firmness of grayscale images. With suggestion to a spatial degree of difference pulse code intonation (DPCM) system, calculation might be skilled in a space-varying manner moreover as adaptive, i.e., with predictors recalculated at every pixel, or as confidential, in which image chunks or pixels are tagged in a number of lessons.

A novel method to the devise and employ of inferential sensors in the procedure trade is proposed in [18], which is supported on the lately introduced idea of developing fuzzy models (EFMs). They speak to the confront that the current procedure industry faces nowadays, that is, to expand such adaptive and self-calibrating online inferential sensors that decrease the preservation costs while charging the elevated accuracy and interpretability/transparency. Kalman filter (KF) is the mainly regularly employed assessment method for incorporating signals from short-term elevated presentation schemes, similar to inertial direction-finding schemes (INSs), with position systems showing long-term constancy, similar to the comprehensive positioning scheme (GPS) [19]. The paper [20] presents completion consequences using lately pioneered discrete-time adaptive calculation and direct methods employing online task approximators.

A fuzzy time series [21] has been functional to the calculation of employment, hotness, stock directories, and other areas. Associated studies mostly center on three issues, specifically, the separation of conversation, the pleased of forecasting system, and the techniques of defuzzification, all of which really control the calculation accurateness of forecasting representations. The presentation of an adaptive neurofuzzy assumption scheme (ANFIS) considerably falls when improbability lives in the data or scheme process. Prediction period (PIs) can enumerate the indecision connected with ANFIS point forecasts. The paper [22] first nears a method to acclimatize the delta method for the creation of PIs for conclusions of the ANFIS representations. In [23], a developing fuzzy system (EFS) is urbanized for scheme condition forecasting.

3 Proposed Adaptive Fuzzy Prediction Technique To Evaluate Users Behavior

The process of identifying the users behavior based on their demands over the products and its quality is done by accomplishing the adaptive fuzzy prediction technique. The adaptive fuzzy prediction model is used to predict the users behaviors efficiently across different time periods and adapt to the recent user behavior and liking of the products and service. Here the adaptive fuzzy prediction model is combined with the representation of fuzzy assumption with user behavior predictor. The fuzzy prediction technique is applied to the multi-clustered web usage data. The architecture diagram of the proposed evaluation of users behavior using adaptive fuzzy prediction technique [EUBAFP] is shown in Fig. 1.

From the Fig.1, it is being observed that the web log file data is given as input to the system to estimate the performance. Before fuzzification, the web log file data is being pre-processed with the corresponding method and normalized to the self-organizing maps. With these, web usage data was multi-clustered in an appropriate manner based on the similarity based clustering. With the web usage multi-clustered data, fuzzy prediction model is applied to classify the users data based on their products demands over the market. The fuzzy inference model will form a set of rules at first as a base for classifying the rules.

The adaptive fuzzy prediction model of the website could be processed in the constructing phase under which it collects web browsing log. The browsing behaviors of the users are modeled and compared with the representation of the prediction model to improve the browsing performance of the users.

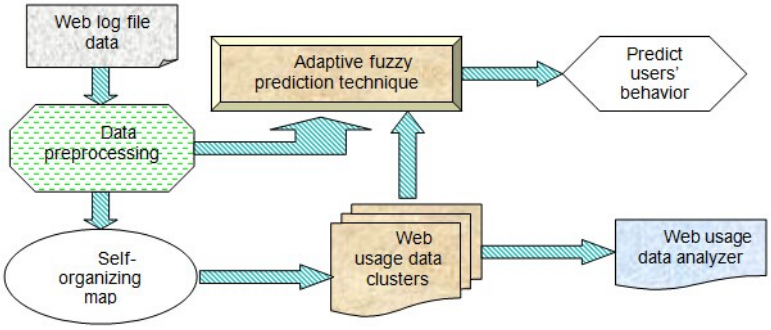


Fig.1 Architecture diagram of the proposed EUBAFP

3.1 Design of Adpative Fuzzy Prediction Technique

Fig.2 shows the block diagram of an adaptive fuzzy prediction technique. It comprises of two subsystems: A fuzzy prediction system, and Behavior Predictor.

At first, in the fuzzy prediction model, the users in the web log data file are clustered based on their behaviors. The fuzzy prediction system assumes the possibility of the active time of the user in the cluster based on the behaviors of the user. Next, in order to identify the active time of the user in the group, behavior predictor is used. The behavior predictor identifies the possibility of number of users visited the web page. The expected possibility information is employed in web usage data management to handle users' behavior.

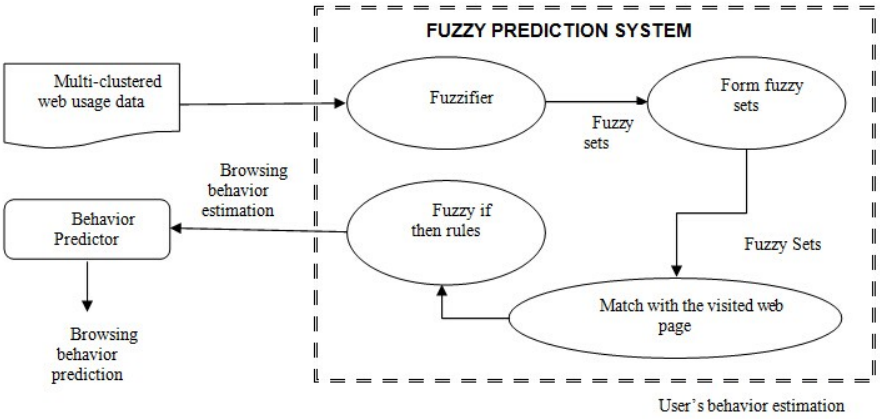


Fig.2 Adaptive Fuzzy Prediction Technique

The browsing behaviors of users are predicted based on the prediction model. Since the browsing behaviors are identified, the predictable patterns should be combined or the prediction pattern should be built, correspondingly. The browsing behavior of a user is compared with all matching visited web pages in prediction model for expecting the future traveling path. The design of the subsystems is given below.

Normally, there is a greater chance of the people to process the inaccurate information obtained from the web usage data. At first, before deriving the set of fuzzy rules, the clustering process is done based on users, session and the web pages they viewed. After forming the user groups, fuzzy inference system is presented. The fuzzy prediction follows the fuzzy ifthen rules for identifying the user behaviors. The fuzzy prediction model to identify the user behavior is processed based on subsequent steps.

- Choose appropriate input and output variables.
- Form a group based on the web pages, users and sessions they entered
- Select a appropriate kind of fuzzy prediction method
- Design a set of fuzzy if-then rules (information base)
- Predict the behavior of the user

Fuzzy Prediction-based User Behavior. The fuzzy prediction subsystem is a unique authority scheme. It utilizes an information support, articulated in terms of fuzzy implication rules, and a suitable implication engine to identify the active time of the user in the respective group. The facts based on the identification of the users behavior is considered as,

- Identify the relation between the user visited web pages and their behaviors
- Predict the rules based on their behaviors

The primary step is to obtain the inputs and decide the amount to which they fit in to each of the suitable fuzzy sets by means of association functions. After the efforts are fuzzified, we recognize the extent to which every part of the visited web pages are used for every rule. The fuzzy rules are then formed once the groups are generated, based on user, web pages visited and sessions. In each set of fuzzy rule, the subsequent steps have to be followed.

- Assign each rule contain a binary weight (0 and 1).
- Consider weight of each rule is 0 which has no outcome of the behavior of the user.
- Assign appropriate weight to each of the rule formed to identify the behavior of the user.
- Apply inference technique to the corresponding rules

Design Process of Fuzzy Prediction-based User Behavior. The design process of fuzzy prediction-based user behavior comprises of two steps.

- Fuzzification
- Fuzzy assumption engine: a. Fuzzy implication rules; b. Fuzzy implication engine.

In the first step of fuzzy prediction-based user behavior, fuzzification is applied where numerical value is converted to qualitative value based on the user input called as linguistic variables. These linguistic variables are explained using membership function which has a value between zero and one. Let linguistic variable $L_{m,j}$ be the received input from the user at time T_m with probability $P_{m,i}$. For our study, three linguistic variables called triangular membership function are selected and stored in $UL_{m,j}$ which consists of elements, Short (S), Normal (N), and Large (L) given as follows.

$$Triangle(y, S, N, L) = \begin{cases} 0, y < S \\ y - S/N - S, S \leq y \leq N \\ L - y/L - N, N \leq y \leq L \\ 0, L \leq y \end{cases} \tag{1}$$

After the fuzzification process is completed the results are fed to fuzzy assumption engine which comprises of fuzzy implication rules and fuzzy implication engine. The fuzzy implication rules consist of a set of if-then statements known as linguistic rules which describes the behavior of the user for particular set of inputs

at a given time. The rule set for deriving user behavior using fuzzy assumption engine for ith rule is given below:

$$R_i = \begin{cases} f\,(L_{m,0} isA_{0,i})\,and\,(L_{m,1} isA_{1,i})\,and\,(L_{m,2} isA_{2,i})\,then \\ (P_{m,0} isP_{o,i})\,and\,(P_{m,2} isP_{1,i})\,and\,(P_{m,2} isP_{2,i}) \end{cases} \tag{2}$$

Where i = 1,2,...,i, is the total number of fuzzy rules for predicting user behavior using fuzzy adaptive preference techqnique. $(L_{m,0}, L_{m,1}, L_{m,2}) \in UL_{m,0}, ...,$ and $(P_{m,0}, P_{m,1}, P_{m,2} \in UP_{m,0}, ...$ denote linguistic variables, $(A_{0,i}A_{1,i}A_{2,i}, P_{o,i}P_{1,i}P_{2,i})$ denotes the fuzzy set present in $UL_{m,0}$ and $UP_{m,0}$ respectively.

The fuzzy implication engine then evaluates the set of rules to compute a qualitative output result and matches with the visited web page which generates nine rules for analyzing the user behavior.

The procedure below describes the process of the proposed adaptive fuzzy prediction technique shown below:

Input: Set of parameters like product demand, quantity of products, features of products

Step 1: Recognize the parameters that finest suits the fuzzy system for inputs, positions, and the outputs

Step 2: Divide the discourse or the period extent by every variable

Step 3: Significance into a number of fuzzy subsets

Step 4: Conveying all a linguistic label

Step 5: Assign or decide an association utility for every fuzzy subset

Step 6: Determine the fuzzy relationships among the inputs, states fuzzy subsets

Step 7: Determine the fuzzy subsets for outputs

Step 8: Form the rule base

Step 9: Standardize the constraint variables

Step 10: Select suitable scaling features for the input and output variables

Step 11: Fuzzify the inputs to the checker

Step 12: Use fuzzy logic to deduce the output contributed from every rule

Step 13: Amassed the fuzzy outputs suggested by every rule

Step 14: Concern defuzzification to shape a crisp output

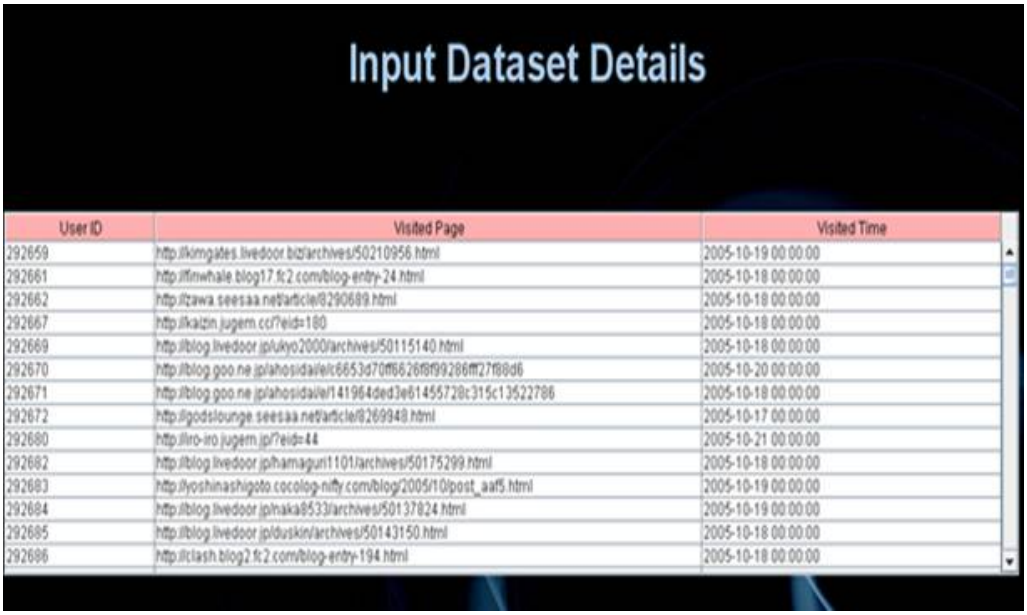
The above procedure determined the process of the fuzzy sets to identify the set of users behavior based on their activities over the demand and qualities of products. The next section will describe about the experimental evaluation of the proposed scheme.

4 Experimental Evaluation

Experimentations are conduct at all the web usage data obtained from web server logs with real data sets extracted from websites. Performance evaluation is

made to show the effectiveness of the proposed evaluation of users behavior using adaptive fuzzy prediction technique [EUBAFP] compared to the existing one referred from different contributors of web usage mining. A sample set of data has been taken for experimental evaluation by taking five sets of attributes. The attributes used here are product demand, quantity of products, features of the product/services, annual sales, etc., to identify the behavior of the user based on their actions.

Table 1 Web server logs Dataset details



The attributes are analyzed with the multi-clustered web usage data generated in the first phase. The predictive feature of the web usage data value is generated based on the fuzzy model across different time periods. The performance of the proposed evaluation of users behavior using adaptive fuzzy prediction technique [EUBAFP] is measured in terms of

- Implementation cost
- Prediction accuracy
- Execution time

Implementation cost. Implementation cost for adaptive fuzzy prediction technique refers to the cost incurred building the procedure based on the number of users in clustered parts, pattern, and running, testing, and building essential changes. The implementation cost is evaluated using the formula with simulated time (ST) and the simulation time (SnT), to predict the user behavior for T interval of time is derived below:

$$IC\,(N)\; = S_n T\,(N)\,/ST \tag{3}$$

Prediction accuracy. Prediction accuracy defines the accuracy rate for predicting the users behavior based on adaptive fuzzy prediction technique towards product demand, quantity of products, features of the product/services, annual sales. The prediction accuracy is evaluated using the formula given below:

$$P_{m,j}{}^{*} = \frac{N * P_{m,j}}{1 + (N-1) * P_{m,j}} \tag{4}$$

Where N denotes the total number of test conducted for a specific user at varied interval of time and $P_{m,j}$ denotes the reliability of adaptive fuzzy prediction technique.

Execution time. The parameter execution time using adaptive fuzzy prediction technique refers to the time taken to execute, towards predicting the behavior of users product demand in network environment.

$$ExecTime = (InsnCount)_i * (ClockCycleTime)_I \tag{5}$$

Where execution is evaluated by the products of number of instructions to be executed for n users (i=1,2,3..,N) and clock cycle time for the specific ith user (i = 1,2,3...,N).

5 Results and Discussion

In this work, we have seen that the proposed technique identified the behavior of the user based on their activities present in the network environment. The predictive feature of the web usage data are identified based on the fuzzy prediction model across different time periods. The below table and graph describes the performance of the proposed technique and compared the results with the existing adaptive fuzzy regression model (AFR) [1] and User Navigation Pattern Discovery using Fast Adaptive Neuro-Fuzzy Inference System (UNPD) for mining user profiles referred from different contributor s of web usage mining.

Fig. 4 describes the implementation cost required to handle the fuzzy inference systems based on the number of users in the clustered parts. The implementation cost for the fuzzy inference system in the proposed EUBAFP is low in the sense that adaptive fuzzy prediction technique is denoted by binary weighted model that results in less implementation cost than compared to the other two models AFR and UNPD. When the number of rules generated is small, its implementation cost is also less. As a result, the EUBAFP proposed system is realistic even when the number of users is large with a variance of 50-60% when compared to AFR.

Table 2 Number of users Vs. implementation cost. The implementation cost required to build the fuzzy inference system based on the number of users present

No. of users	Implementation cost		
	Proposed EUBAFP	Existing AFR	Existing UNPD
5	7	25	28
10	11	30	34
15	15	38	40
20	19	40	43
25	22	46	49
30	26	50	53
35	30	54	58

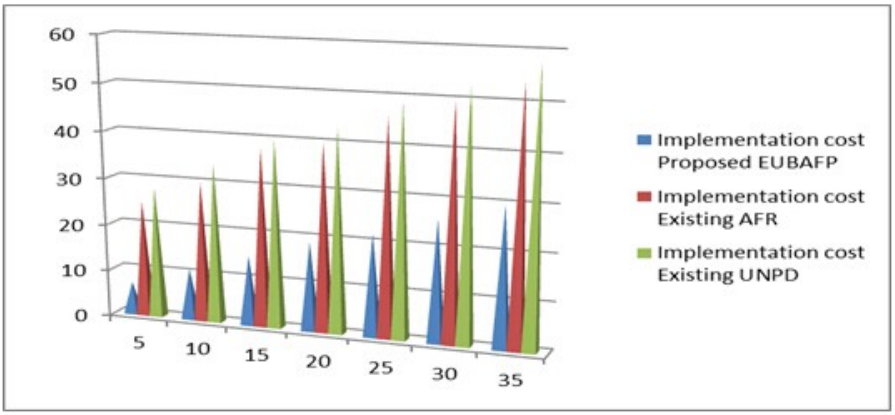


Fig.4 No. of users vs. Implementation cost

Table 3 Number of users Vs. prediction accuracy. The behaviors of users are identified by implementing the fuzzy inference systems by diverse set of approaches

No. of users	Prediction accuracy (%)		
	Proposed EUBAFP	Existing AFR	Existing UNPD
5	65	55	40
10	70	62	45
15	72	64	51
20	78	68	54
25	80	70	59
30	82	71	62
35	84	74	64

Fig.5 describes the prediction accuracy of users behavior based on the number of users present in it. From the figure it is evident that an increase in number of users also results in increased rate of prediction accuracy. When compared to the other two techniques AFR and UNPD, the proposed adaptive fuzzy prediction technique as shown in figure 5, achieves higher prediction accuracy. The higher prediction accuracy in adaptive fuzzy prediction technique is due to combining of both fuzzy prediction system and behavior predictor model which results in variance of 10-15% when compared to AFR.

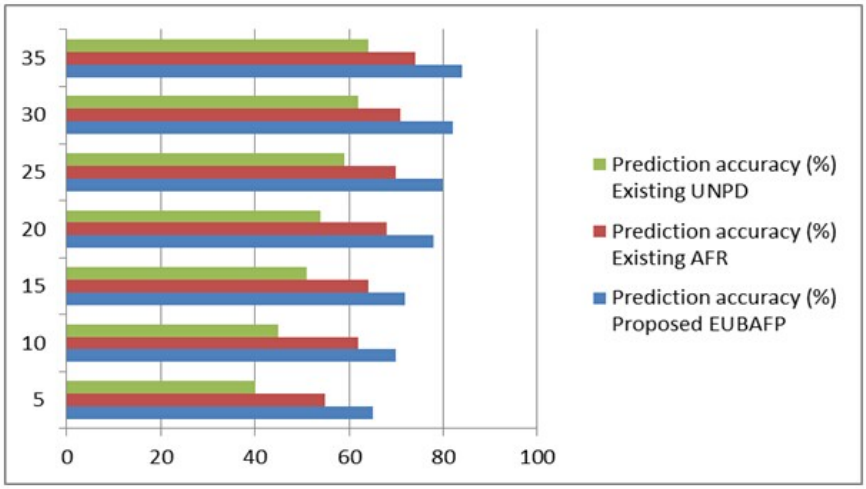


Fig.5 Number of users Vs. Prediction accuracy

The proposed EUBAFP construction presents the benefit of execution time. Compared to the existing works like adaptive fuzzy regression model (AFR) [1] and User Navigation Pattern Discovery using Fast Adaptive Neuro-Fuzzy Inference System (UNPD), the proposed EUBAFP provides an improvement in execution time in predicting users behavior.

Fig. 6 describes the efficiency of fuzzy prediction systems in terms of execution to identify the behavior of users in the network environment. Rather than using other existing works for user behaviors, the proposed EUBAFP achieves better efficiency in predicting the users behavior in terms of time with a variance of 10-15% when compared to two other methods, using defuzzificaiton, center of area. As EUBAFP consumes less execution time and proceed with a set of rules, the efficiency in predicting the user product demands is also being high. Finally it is being observed that the proposed EUBAFP performs well in terms of prediction accuracy and efficiency with less implementation cost.

Table 4 Number of users Vs. efficiency. The efficiency of the fuzzy prediction in terms of execution time for diverse set of approaches is illustrated

No. of users	Execution Time (sec)		
	Proposed EUBAFP	Existing AFR	Existing UNPD
5	32	40	50
10	40	43	55
15	46	52	65
20	50	58	70
25	55	65	75
30	60	70	80
35	62	75	85

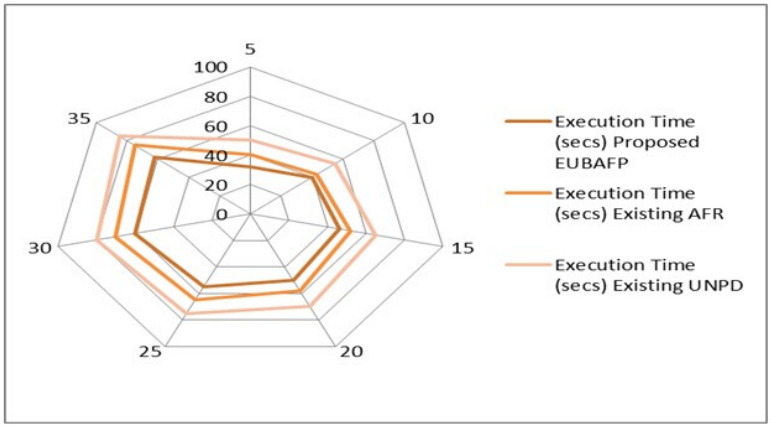


Fig.6 Number of users Vs. Execution Time

6 Conclusion

An adaptive fuzzy prediction system is developed to foresee the possibilities that the behavior user will be dynamic in the close by clusters at prospect instants employing the real-time dimension data established at the user. The merits of the adaptive fuzzy prediction system recline in

• Simplicity - it is a one-way build-up method that does not need time-consuming on-line accessing,

• Usefulness - the possibilities are serious for balancing proficient operation of the web usage data of users, and

• Low cost - the expected possibilities are attained supported on the appropriate demands of the user profiles.

Experimental results reveal that the performance of the adaptive fuzzy predic-

tion system depends on the extent of behaviors of the user based on their product demands, and on the accessibility of information which confines the number of probable behaviors of the user. Taking into report that the overall inference accuracy can be appreciably increased with value multiplexing, the fuzzy prediction scheme presents a fine resolution to getting users information.

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