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Research paper

User profiling for web personalization using multi agent and DBSCAN based approach

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Abstract

The user experience is enhanced by the Web Personalization System (WPS), which depends on the User's Interests (UI) and references are stored in the User Profile (UP). The profiles should be able to adapt and reproduce the change of user's behavior for such system. Existing web page Recommendation Systems (RS) are still limited by several problems, some of which are the problem of recommending web pages to a new user whose browsing history is not available (Cold Start), sparse data structures (Sparsity), and the problem of over-specialization. In this paper, the UI has been tracked and Dynamic User Profiles have been maintained by introducing a method called Density-Based Spa-tial Clustering of Applications with Noise-User Profiling (DBSCAN-UP). The mapping web pages, construct the ontological concepts, which represent the UI, and the interests of users are learned by the reference ontology, which are used to map the visited web pages. The process of storage, management and adaptation of UI is facilitated by multi-agent system. The different user browsing behaviors learning and adapting capability is built in the proposed system and the efficiency of the DBSCAN-UP model is evaluated by the series of experi-ments. The accuracy of the DBSCAN-UP was achieved up to 5% compared to the existing methods.

Keywords: *Web Personalization System; User's Interests; Dynamic User Profile; Recommendation Systems; Density-Based Spatial Clustering of Applica-Tinos with Noise-User Profiling*

1. Introduction

A specific information provided by the World Wide Web for finding the requirements of the users leads to information overloading and prolonged procedure [1]. The consumers who are seeking services to support their applications can be benefitted from Web Service Discovery (WSD). By overcoming the issues with the WSD help to provide a suitable web service for the consumers [2]. In recent years, the WPS has emerged to provide a modified experience to the customers based on their individual preferences, needs and interest and the different domains of application have been developed by WPS. In e-commerce, the web modified system recommend new items and products to the users based on their previous purchasing history [3]. The system which used to deliver the information of items based on the UI are called as RS. The RS is a specific form of information filtering allows the customer to compare a UP to certain reference characteristics, and the system can capable of recognizing the opinion of a user [4]. Profiling' is one major example in which personal data can be used in unexpected ways that potentially threaten an individual's privacy and control over their private information [5].

The method has to be designed using static and dynamic features in different property to provide the modified information services. The static features include age, education which cannot change over time and the dynamic features include location, interest which can vary according to time. The user profiling method is an effective way of providing such information services [6]. WPS includes demographic data, user's interest, preferences and their previous history, which require and maintain information about customers. The major limitations in such systems are that UI, preferences and needs are not fixed, but change over time. The system compelling the personalization process and providing the irrelevant services and items over time which contains static information in UP [7]. When user profiling applied to enormous social networks, the approaches lead to the following problems based on the data of user's interest [8]. The problem of user profiling is computational complexity by the essentials of millions of messages for the process, poor ability to review the number of extracted interest labels and variation in time because of the user's unstable behavior [9]. The methods required for providing learning basic user behavior and understanding different user behaviors and then able to adapt the profiles to overcome the current problems [10]. In this proposed method, the approach aimed to demonstrate Dynamic User Profiles (DUP) that are used to capture UI as well as user's behavior change including interest change and point. The UP can be used as a part of a WPS to provide accurate services to users by means of Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm depend on Multi-Agent (MA) system. The proposed method is called as DBSCAN-UP which is more effective compared to the existing methods.

This paper is composed as follows. Section II surveys several recent papers in the web-page recommendation system. In section III, DBSCAN based user profiling methodology for recommending the related web pages. In Section IV, comparative analysis of proposed web-page recommendation systems using MSNBC dataset has been presented. The conclusion is made in the Section V.

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2. Literature review

Several techniques have been suggested by researchers in the web-page recommendation system. In this scenario, a brief evaluation of some important contributions to the existing literatures is presented.

M. Amoretti et al. [11] developed UTravel in the Context-Aware Personalization System (CAPS) for universal profiling and recommendation method. The application informed and guided the users towards points of their interest which called as UTravel application. The system contained two modules such as user profiling and item filtering and the UPR-based UTravel scheme made by the strong RS system. A high degree of precision, recall and coverage were given by the system recommendation and the results were proven by the experimental evaluation. The method was very expensive when the service-oriented architecture was deployed in the cloud storage system. The method was scalable and needed to design a decentralized version with no central server for reducing the maintenance costs. This technique didn't have the ability to handle the large number of users, which leads to the overload of the system. Only the limited amount of information is stored in each node and this severely affects the efficiency.

A. Hawalah and M. Fasli [12] introduced a set of methods designed to capture and track UIs and maintained DUP within a WPS. The ontological concepts were constructed by mapping web pages which was used to represent the UIs. The web pages were used to acquire short-term and long-term interests which were visited by the customers in a Reference Ontology (RO). A MA system facilitated and coordinated the capture, storage, management and adaptation of UIs. A search system utilized the DUP to provide a modified search experience. The experimental results showed that the method performed a DUP effectively and was capable of earning and adapting to different user browsing behaviors. The method suffered from a cold start problem and also suffered from the problem of over-specialization. As the UP adapted, the profile information became more specialized and the system was unable to make unique suggestions to the users.

Hawalah Ahmad and Maria Fasli [13] developed a CAPS to build a contextual model. The CAPS method was able to detail the Ontological User Profiles (OUP) based on the interest of the user and the context information. The development and the conclusion were made on the UP and the profiles provided the contextual recommendations to users. The methods and system were evaluated through a user study which showed that considering context information in WPS provided more effective personalization services and offered enhanced recommendations to customers. The method was flexible, applicable to multiple domains and facilitated the creation of distinct and modified ontological profiles for each user. The limitations in the method were building an ontology is expensive in terms of time and effort and the method required a number of parameters that needed to be identified based on the RO.

R. Katarya and O. P. Verma [14] provided a structure considering the sequential information which was used by the customer to generate recommendations that exists in their web pages. The method proposed a sequential approach by employing fuzzy clustering for providing recommender system. The method calculated weights for each page category considered and predicted top page recommendation for the target user. The accuracy of the method was three times better than the existing systems which was shown by the experimental results. The database used by the method for the experimental research was MSNBC dataset. The outcomes had demonstrated the practicability of the method, i.e. the subsequent visit of a user provided useful evidence about their likes and perception. The method was unable to focus on inclusion of privacy, trust and social networks with the utilization of hybrid intelligent systems.

R. Thiyagarajan et al. [15] presented a system which was used to predict the user's navigational behavior by a new RS. The RS was a special type of information filtering system which was used to predict the browsing activity of the user. The web user behavior was examined by the Web Usage Mining (WUM) and the automatic discovery was used to investigate the navigation pattern based on the web user patterns. After the prediction process, the filtering method recommended to the user web pages' items. The method had paid an attention to group the similar usage behavior of users using K-Means algorithm and new validating measure were applied to consider the cluster's quality. The accuracy rate of the prediction of user sensitivity capturing was shown by the implementation of the algorithm. In this method, a user placed more than one cluster and this had not been taken care, hence overlapping may be obtained.

3. Proposed methodology

The DBSCAN-UP presented the RS built on the UIs and utilized the ontological profiles for capturing the interest of users. The mapping process between the web pages which is visited by the users are improved by the DBSCAN-UP by introducing two algorithms. The implicit information about the UI are contained in the web pages and the RO represents the interests of the user. The DBSCAN-UP prepares a RO, collect user navigation behavior and map the visited web pages to the RO in the information retrieval phase and also introduce a WPS. The aim of the retrieval phase is to collect user browsing behavior to discover their interests. The process of retrieving information from the user based on their interests is called personalization. The interest of the customer can change over time due to loss of interest in an objects very often. In general, the MA system handles the change of their interest and the browsing history of the user. The UI consists of three types of interests: temporary interest, long-lasting or stable interest and period based interest in dynamic learning and adaption phase. The paper aim to demonstrate that the approach on DUP can effectively capture UIs as well as the change in user behaviors including interest shift and drift. This can be used as part of a WPS to provide more effective and accurate services to users. The architecture of the generalized system is displayed in figure (1).

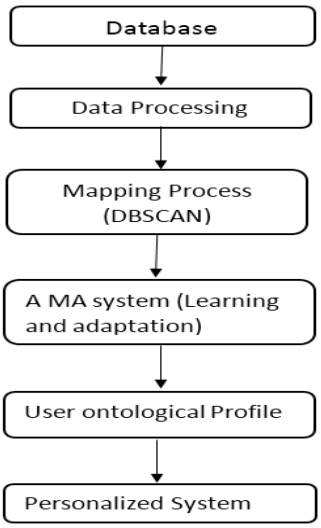


Fig. 1: Architecture of the Generalize System.

3.1. Data pre-processing

All the textual contents are cleaned and tokenized, it is important to reduce the dimensionality of terms by removing all unnecessary ones which have low discriminating values as well as reducing their ambiguity. Hence, first remove all the common terms such as 'and', 'or' and 'the' (stop words) using a stop list. The DBSCAN-UP done the preprocessing by applying the algorithm called Porter stemming algorithm which is applied to all the textual contents. In this algorithm, each term is returned to its stem and the final outcome is a P-log file that is processed for the mapping process.

3.2. Mapping process

The web logs are mapped the appropriate concepts in the RO of the DBSCAN-UP. In this concept, DBSCAN algorithm is applied for grouping the web pages to the right concepts. In any database D, the DBSCAN algorithm is designed for finding the random shaped clusters and the noise points are discriminated by the algorithm. The basic designs of DBSCAN involve a number of definitions, which are presented as follows:

- Neighborhood : The neighborhood is determined by a distance function like Euclidean Distance for two points x *and* y denoted by $dis(x,y)$
- $\varepsilon - Neighborhood$: The $\varepsilon - neighborhood$ of a point p is defined by $\{y \in D \mid dis(x,y) \le \varepsilon\}$.
- Core entity: The neighborhood radius (ε) has to contain however a Minimum Number (MN) of other points which are referred as core entity.
- Directly Density-reachable (DDR): If an entity x is within the $\varepsilon - Neighborhood\ of\ y$, then an entity x is DDR and y is a core entity.
- Density-reachable (DR) : An entity x is DR from the entity y with respect to ε and MN if there is a chain of entity's $x_1,...,x_n, x_1 = y$ *and* $x_n = y$ such that x_{i+1} is DDR from x_i relating to ε and MN, for $1 \le i \le n, x_i \in D$.
- Density-connected: An entity x *and* y are density-connected in a set which depends upon ε and MN. Both the entity x *and* y are DR to all the units that belongs to the database D regarding ε and MN.
- Density-based cluster : A cluster $C \ne \varnothing D$ sustaining the following "maximality" and "connectivity" requests:
- $\forall x, y$: If $y \in C$ and x is DR from y with regard to ε and MN, then $x \in C$.
- $\forall x, y \in C : x$ Is density-connected to y relating to ε and MN.
- Border Entity: An entity x is a border entity if it is not a core entity but from core entity.

The algorithm begins with the first point and within the distance in the database D; all the neighbor points in the scheme are retrieved. When the MN is lesser than the total number of these neighbors in a core-entity, a new cluster is created. The new clusters are assigned from the points and its neighbors which are collected within the distance from the core points. The process will end if all of the points are processed. In addition, the output of the mapping phase will give the data to learning and adaptation phase, which is called as MA system for further processing.

3.3. Multi agent system based on web personalized system

The DBSCAN-UP use the MA system effectively because the MA system has two main reasons. First, the agents are enable to describe the functionalities and interactions between them with specific responsibilities in the learning and adaptation process and the processing of information and their flow are also defined by the MA system. This also facilitates the use and processing of the same piece of information from multiple perspectives as different agents in the system may have access to the same information, but the agents are dealing with the information in a different way. The second main reason is that of flexibility and extensibility. The various agents within the system can be upgraded and modified on their own without affecting the rest of the agents. The MA system provides the information to the OUP for understanding the needs of the user. The DBSCAN-UP introduce the complex processes of agents such as insert, forget, and delete which deals with the system called MA system. The Insert Agent (IA) uses the MA system for inserting the web pages which are more frequently used by the users. The IA stored the web pages and this agent contains the sequence of web pages of the UP which is called learning phase. The concept is classified when a web page is browsed and the interest weight is calculated for that concept. The weight value is accumulated based on the event and the duration which are associated with the web pages.

3.3.1. User ontological profile

In the proposed system, an ontology plays a significant role in modelling DUP and the OUP deliver better services by understanding the needs of the user in an effective way, therefore the ontological user comprises a rich representation of UIs. For this reason, the DBSCAN is used to rate the comparison between a query and all the documents for all concepts in the UP from learning phase. A different application in a particular domain is described by the RO in a hierarchical way and the sub-classes of the ontology are linked with the class which is superior. The RO is used in DBSCAN-UP for two purposes, which is used to identify the interest of customer depend on their visited web pages, and second to represent the ontological concepts. The ontological profile gives the information to the WPS phase to provide more effective and accurate services to users. The similarity of the web pages is adapted in the learning and adaption phase and this adaption phase uses the Forgot Agent (FA) and Delete Agent (DA) for providing the better web page recommendation to the users. When a user loses interest in the concept, then the FA handles the behavior and this changes is adapted by the effective WPS for forgetting such interest from the UP. The agent forgot the concepts gradually until the concept is no longer interest to the user and the process of forgetting might be paused when a user shows interest again. But the FA continue if the user interest reaches the size of zero in the concept and then the concept will be send to the DA. The DA manages the concept deletion process from a UP and this concept is no longer interested in his/her profile and the interests should not be appearing in the profile. The DA removed the user's interests' concepts much faster based on the time of the last appearance and until the weight reaches the threshold point and then the concepts removed altogether. The output of the learning and adaption phase is the sequence of the WPS and the personalization consists of a service for accommodating individuals in a specific concept, sometimes tied to segments of individuals. The DBSCAN-UP developed the personalization for addressing specific domain problems based on the customization. The characteristics, action, intent and other parameters are identified and associated with an individual for the web pages. The DBSCAN-UP aimed to improve models and can be integrated and deployed to deliver a range of personalization services.

3.4. Validation of DBSCAN-UP

The performance of the proposed DUP and the effectiveness of the learning and adaption phases are validated in this section. Suppose if the user is new to the system, how the test user is generated the query, mapping the query and calculating the similarity and the ranking process are accumulated. The structure of the WPS is validated and presented in figure 2.

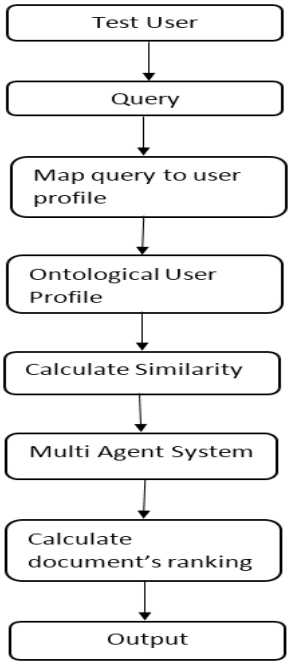


Fig. 2: Structure of WPS.

3.4.1. Test user

The method aims to demonstrate that the DUP can effectively capture UIs in addition to the change in user behaviors. In user-centered evaluations, real users are recruited to facilitate the order of realistic behaviors to test the act of the scheme. Such evaluations involve three steps: recruiting users, creating a set of tasks to be completed by the users and assembling and examining user interactions and behaviors. The test user presents a query in a modified system for the mapping process.

3.4.2. Query

A database query may be classified as either a selected query or an action query and a data retrieval query is used in the select query. The operations like insertion, updating, modification or deletion is processed in the action query and the scheme used the selection query for finding the UI. In this DBSCAN-UP, the user generates a query as a testing data, to test the RS trained with OUP and compare the results with ground truth value to evaluate its accuracy.

3.4.3. Mapping the query

The query is mapped to the OUP once the user gives a query for the method of identification of the most similar concept that resembles the query. In this DBSCAN-UP method, web pages are applied by the Cosine Similarity Algorithm (CSA) for the arrangement of pages to right concepts. The two vectors may contain the similarity and these are identified by the CSA and the cosine angle between the vectors are measured by the CSA. In the DBSCAN-UP method, the CSA is used for their property of calculating the relationship between a query and all the documents for all concepts in the UP.

3.4.4. Ontological user profile

The ontologies encapsulate knowledge approximately a domain of applications and provide an expressive medium for describing UIs and precedence and rich interconnections among UI. The idea of UP in powerful, deeper and wider hierarchy represented by the ontology. In this part, the data which are stored in the UP are retrieved and used for computation process and given as an input for similarity calculation.

3.4.5. Similarity calculation

The method subsequently calculates the comparison between individual retrieved search document from the OUP and the contents of the interesting concept that represents the initial user query. The calculated data are given as an input for document re-ranking process to deliver the outcomes to the consumer.

3.4.6. Multi agent system

3.4.6.1. Insert agent

The user inserts the web pages to the ontological profile and the interested weight also assigned by the user to the profile for calculating the weight of the concepts. For example, the Conformed Concepts (CC) is assigned by 150 weights, the previous concepts are allocated by 100 weights and the new concepts are given by 50 weights.

3.4.6.2. Forgot agent

In order to apply the forgetting process, the new method called time-based forgetting factor is introduced. Consider the New Pages as NP and Previous Pages as PP and the corresponding values for NP and PP as NPv and PPv and the forgetting process will be done. If the NP is not equal to CC, then the PP is reduced by 25 weights (i.e. PPv-25), and the NP is not equal to previous history, then the PP is reduced by 50 weights (i.e. PPv-50) and the NP is equal to CC, then the PP remains stable (i.e. PPv-0).

3.4.6.3. Delete agent

The DA compares the interest weight of all web pages from the browser history of the user based on UP. Whenever the value of a corresponding web page (PP) attains zero, (i.e. PPv-0), the DA removes the PP from the storage. The resulting web pages alone will be forwarded to the documentation ranking for WPS.

3.4.7. Documentation ranking

In this DBSCAN-UP, the goal is to calculate the presentation of the developed search WPS that utilizes DUP to re-rank search results. An effective re-ranking approach should place the most applicable results at the top of the retrieved results. Finally, the documents are arranged and re-rank all the retrieved search results in descending order and present them to the user.

4. Experimental outcome

For experimental simulation, Net-Beans (version 8.2) was employed on PC with 3.2 GHz with i5 processor. The MSNBC dataset was used in the experiments to evaluate the efficiency of the proposed DBSCAN-UP algorithm. The algorithms like Gradual Extra Weight (GEW) and Contextual Concept Clustering (3C) were compared with the DBSCAN based user profile for estimating the scheme performance. The performance of the proposed methodology was compared in terms of accuracy and precision.

4.1. Database description

4.1.1. MSNBC dataset

The real dataset was used for the experiments that are taken from the repository of UCI dataset. The news-related portions of msn.com and Internet Information Server (IIS) logs for msnbc.com present in the UCI dataset. The visits of the web logs of the users are recorded by the Uniform Resource Locator in time order. In the dataset, each sequence resembles the pages viewed by the users and the event in the sequence represent the requests of a customer for a page.

4.1.2. CTI dataset

The proposed method was also carried on CTI dataset. The De-Paul CTI Web server contains the CTI dataset and the unfiltered data contained 20,950 sessions from 5,446 users. The filtered data contain 13,745 sessions and 683 page views and these data files are produced by filtering low support page views.

4.2. Performance measure

4.2.1. Accuracy

The accuracy is measured as the proportion of the number of positively mapped web pages to correct concepts from a RO to the all web pages visited by the user. The calculation of the accuracy is evaluated by the following equation,

$$Accuracy = \frac{|Positive\ mapped\ web\ pages|}{|All\ web\ pages|} \quad (1)$$

4.2.2. Precision

The precision of learning and adapting the user profiles for each day of the experiment duration. The precision can be calculated as,

$$Precision = \frac{|Number\ of\ correct\ learned\ and\ adapted\ interests|}{|Total\ number\ of\ actual\ interests|} \quad (2)$$

The precision in this equation is computed as the ratio of correctly modelled interests in user profiles to the actual number of interests in the scenarios.

4.3. Result for MSNBC dataset

MSNBC dataset was assessed to compare the performance of existing methods and the proposed scheme in the experimental analysis. In table 1, the accuracy of the proposed and existing methodology is compared to the five samples and three predictions. The average accuracy of existing methods (PFCM-RFPG) for each prediction delivers 45.7%, 53.21%, 43.6% and 58.7%. Likewise, the average accuracy of the proposed method (DBSCAN-UP) for each prediction delivers 47.44%, 57.64%, 48.64% and 64.44%. The performance evaluation of MSNBC dataset is presented in the following figure 3.

Table 1: Accuracy Comparison of Existing and Proposed Method Using MSNBC Dataset

Methods	No. of predictions	Random (%)	Sample 1(%)	Sample 2(%)	Sample 3(%)	Sample 4(%)	Sample 5(%)
SVD [16]	1	5.88	11.76	12.50	9.38	17.24	13.64
	2	11.76	23.53	18.75	18.75	24.14	13.64
	3	17.65	29.41	37.50	28.13	31.03	22.73
PFCM-RFPG	1	18.23	22.54	18.13	27.3	29.6	27.5
	2	45.7	53.21	43.6	58.7	61.6	58.7
	3	77	76.21	72.6	83	89	87
DBSCAN-UP	1	30.769	44.32	44.443	30.76923	58.832	66.66
	2	47.44	57.64	48.64	64.44	67.23	66.66
	3	86.66	85	78.32	85.83	87	89.25

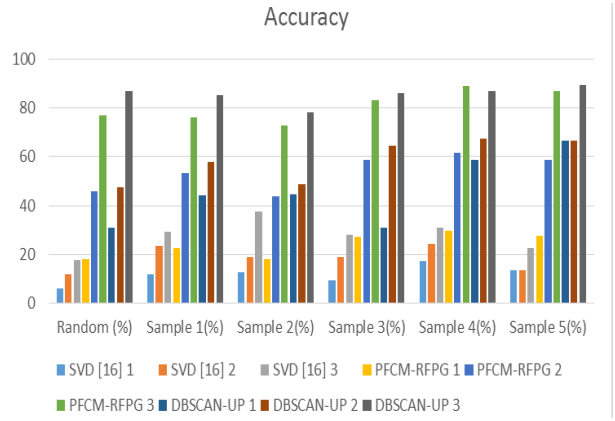


Fig. 3: Performance Comparison Using MSNBC Dataset.

4.4. Results for castings technology international dataset

The experimental analysis of castings technology international dataset was evaluated for comparing the performance of existing and the proposed method. In table 2, the accuracy of the proposed and existing methodology has been compared to five samples and three predictions. The average accuracy of existing methods (PFCM- RFPG) for each prediction delivers 19.8%, 22%, 20.4% and 19.3%. Similarly, the average accuracy of the proposed method (DBSCAN-UP) for each prediction delivers 54.6%, 54.6%, 59.6% and 49.6%. The table 1 and 2 confirmed that the proposed approach performed effectively compared to the existing methods on the both MSNBC dataset and castings technology international dataset. The performance evaluation of castings technology international dataset is presented in the following figure 4.

Table 2: Accuracy Comparison of Existing and Proposed Method Using Castings Technology International Dataset

Methods	No. of predictions	Random (%)	Sample 1 (%)	Sample 2 (%)	Sample 3 (%)	Sample 4 (%)	Sample 5 (%)
SVD[16]	1	6.25	9.38	6.90	7.41	6.90	6.25
	2	12.50	21.88	31.03	18.52	48.28	31.25
	3	18.75	28.13	34.48	25.93	48.28	37.50
PFCM-RFPG	1	19.8	22	20.4	19.3	24	21
	2	50.6	53.5	57.8	49.6	57.4	52.3
	3	90.6	94.5	96	90.6	97	90.3
DBSCAN-UP	1	29.8	27	27.8	24.3	31	26.5
	2	54.6	54.6	59.6	49.6	59.6	53.7
	3	92.6	96.8	96.3	90.6	98.3	96.3

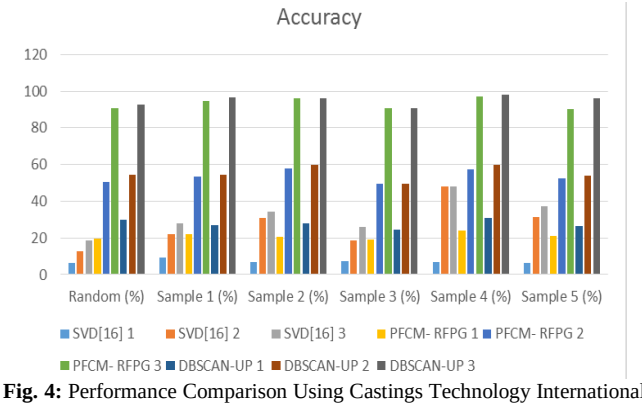


Fig. 4: Performance Comparison Using Castings Technology International Dataset.

The performance of the various clustering techniques over several methodologies has been illustrated with the help of Table 3. The value of M represents the number of clusters used for the experiments to evaluate the performance of the approach. This table portrays the comparison of proposed DBSCAN-UP performance over the other existing methodologies in terms of precision for both MSNBC and CTI datasets. DBSCAN-UP gives better preci-

sion for various clustering samples compared to other methods that is also graphically represented in figure 5 and 6 as follows.

Table 3: Precision Comparison of Existing and Proposed Method

Methods	MSNBC dataset				Castings technology international dataset		
		First (%)	Second (%)	Third (%)	First (%)	Second (%)	Third (%)
SVD [16]	M=20	12.61	19.8	28.12	7.37	30.19	34.86
	M=22	10.6	16.7	24.38	7.98	21	27.51
	M=32	11.02	17.9	28.8	8.2	23.94	24.89
	Random	5.88	11.8	17.65	4	8	12
PFCM-RFPG	M=20	23.88	53.6	80.8	21.8	53.53	93.17
	M=22	20.21	51.6	81.23	21.6	52	90.25
	M=32	20.75	51.7	81.9	22.3	51.7	91.3
	Random	22.7	52.4	81.6	21.15	51.32	90.36
DBSCAN-UP	M=20	45.96	58.7	85.34	27.73	55.28	95.15
	M=22	41.36	56.3	81.56	25.21	54.56	91.25
	M=32	44.63	57.3	82.34	26.03	55.81	92.36
	Random	42.89	58.2	80.25	27.73	56.28	94.85

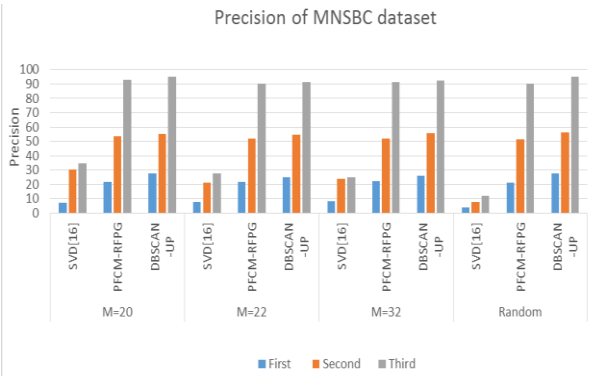


Fig. 5: Precision Comparison for MSNBC Dataset.

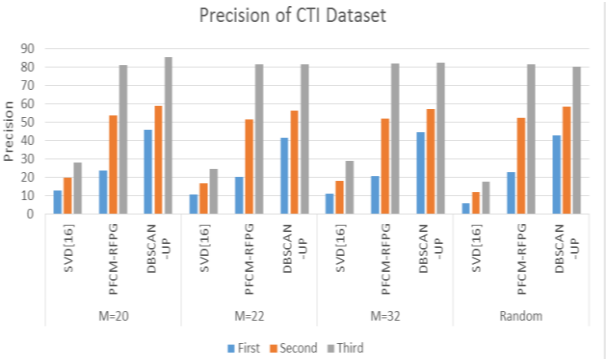


Fig. 6: Precision Comparison for Castings Technology International Dataset.

5. Conclusion

In this paper, a DBSCAN based user profile modelling approach has been presented for web personalization. A number of domains and applications used the DBSCAN based user profile modelling approach and the extraction of user interests and information about user preferences, the user behavior has been captured and modelled by the DBSCAN-UP. The re-ranking algorithm developed the contribution for modelling user profiles and the system provided the results of personalized search to the users. Compared to the other existing search approaches, DBSCAN-UP technique achieved higher performance. The evaluation results showed that the user interests are effectively captured by the proposed scheme. While any changes in user behaviors, the system can able to adapt to that changes and the performance of the modified system enhanced by the experimental results. In future the user profiling mechanism will be enhanced to handle different interest of user to their application oriented recommendation system.

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