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Prediction Techniques in Internet of Things (IoT) Environment: A Comparative Study

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Abstract-Socialization and Personalization in Internet of Things (IOT) environment are the current trends in computing research. Most of the research work stresses the importance of predicting the service & providing socialized and personalized services. This paper presents a survey report on different techniques used for predicting user intention in wide variety of IOT based applications like smart mobile, smart television, web mining, weather forecasting, health-care/medical, robotics, road-traffic, educational data mining, natural calamities, retail banking, e-commerce, wireless networks & social networking. As per the survey made the prediction techniques are used for: predicting the application that can be accessed by the mobile user, predicting the next page to be accessed by web user, predicting the users favorite TV program, predicting user navigational patterns and usage needs on websites & also to extract the users browsing behavior, predicting future climate conditions, predicting whether a patient is suffering from a disease, predicting user intention to make implicit and human-like interactions possible by accepting implicit commands, predicting the amount of traffic occurring at a particular location, predicting student performance in schools & colleges, predicting & estimating the frequency of natural calamities occurrences like floods, earthquakes over a long period of time & also to take precautionary measures, predicting & detecting false user trying to make transaction in the name of genuine user, predicting the actions performed by the user to improve the business, predicting & detecting the intruder acting in the network, predicting the mood transition information of the user by using context history, etc. This paper also discusses different techniques like Decision Tree algorithm, Artificial Intelligence and Data Mining based Machine learning techniques, Content and Collaborative based Recommender algorithms used for prediction.

Keywords: *Socialization, Personalization, Internet of Things, navigational patterns, browsing behavior, intruder.*

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I. INTRODUCTION

User intention prediction based on the contextual data generated by Internet of Things in Ubiquitous computing applications has become an emerging research trend. Prediction becomes more meaningful when we use the contextual data generated by Internet of things (IoT) for achieving user intention prediction. IoT reduces Human intervention by facilitating communication between different objects or devices at real-time. In all the manners, even though the ubiquitous computing devices provide certain entertainment programs they may not comfort the people to their expectation level. This results in some sort of unsatisfaction among users. So there is a need to predict & recommend personalized services based on their intentions. The main objective of the intention prediction system should be what the user wants to accomplish at a particular instance of time. With effective assistance of the prediction system new skills and knowledge can be acquired by the users which help them to easily get the recommended service which in turn increases their satisfaction level. There are several applications where prediction techniques are applied on the contextual data generated by IoT to make the user more comfortable & also to accomplish his needs. They are as follows: 1) Smart Mobile 2) Smart TV 3) Web mining 4) Weather forecasting 5) Health-care 6) Robotics 7) Road traffic 8) Educational Data Mining 9) Natural calamities 10) Retail Banking 11) E-commerce 12)Wireless Networks 13) Social networking.

In Smart Mobile application user intention prediction is necessary to provide desirable services to the user. This can be achieved by using the contextual data generated from IoT devices like sensors & by applying prediction techniques to the acquired data. Why user intention prediction is necessary in smart mobiles? User may open several applications continuously. But automatically determining and predicting each user's frequently-used applications in a fixed time slot (e.g. half an hour), i.e., finding user navigational patterns is a tedious task. So instead of transiting the raw context data back to the end server it is desirable to directly perform usage patterns mining on user's smart phones. This results in providing the user privacy & controlling the flow of data. Finally the smart phone will efficiently know which application the user may use and respond even before user requests. For example, when a user intend to make a call to his friend, smart phone guessed the motivation and displays the calling application on screen, then without finding and opening the application manually user can directly do a call. After the call has been made, the smart phone predicts that he will not

use the application again for a longer duration, and it can shut down the application automatically. This saves both energy & cost. Free memory will be available for upcoming applications. Prediction techniques used rapidly in smart mobiles are Attribute Driven Model Tree algorithm, Classification & Clustering algorithms etc.

In Smart TV application user intention is predicted by taking into account contextual attributes like mood, activity, time, location, role etc. Why user intention prediction is necessary in smart TV? Nowadays there is an extensive improvement in the features embedded in TV's compared to traditional TV's which was provided with limited number of channels & also there is a drastic increase in the number of channels as well as programs. This causes the user to search for the programs of his/her interest which consumes lot of time & sometimes user may get frustrated by changing the channels. So there is a need to predict the user intention & to recommend the programs of his interest. Predicting user intention in context aware TV application contributes to improve user satisfaction level & also to build social relationship between user & the device. A context aware system for a smart TV application can be designed for single user or multiple users. For example, consider a scenario where the user is *FATHER* who is sitting in *LIVING ROOM* & watching *ESPN cricket* at *9AM*, the day is *MONDAY* & mood is *NORMAL*. By storing this in the context history & by applying prediction technique we can predict that every MONDAY at 9AM FATHER is going to watch ESPN Channel. This illustrates single user context aware smart TV system. Multi-user context aware smart TV system which takes into account priority of the user is more complicated when compared with single-user context aware smart TV system. For example, consider a scenario where the family with four members is sitting on the sofa at living room & each member is associated with the priority. In this example it is assumed that father is assigned with higher priority & the channel of his interest will be displayed by the system based on his contextual attributes. Prediction techniques used rapidly in context aware smart TV application are as follows: Decision Tree Classifier, Naïve Bayesian Classifier, Back Propagation Neural Network, Case Based Reasoning Techniques, Content based Filtering Techniques, Score Based Recommendation Algorithm, Content based Recommender Algorithm, Collaborative Filtering Approach and Bayesian Belief Networks.

In Web mining application, prediction is necessary to infer user's future actions on computer. Prediction techniques are used for providing services like predicting the next page accessed by the user, for predicting user navigational patterns and usage needs on websites, to extract the users browsing behavior. Association Rule Mining, Modified Naïve Bayesian Classifier, Markov Model Techniques, Clustering Techniques, Sequential Patterns, Apriori algorithm are the most widely used intention prediction techniques in web mining application that fulfills the user needs & satisfaction level.

In Weather forecasting application it is necessary to predict the future climate conditions like predicting the occurrence of rain, temperature of the day, etc which will in turn helps the people who are involved in cultivation of agricultural crops & also to prevent the fisherman going into the sea for fishing in the situation of heavy rain. To minimize the impact of certain unusual events which are critical forecasting/prediction techniques provide early and accurate warnings. The two most widely used prediction techniques in weather forecasting application are Ensemble Kalman Filter2 (EnKF) and 4DVar3.

In Health-care application it is necessary to predict whether a person is suffering from the disease or not? For example a person may be suffering from the myasthenia gravis & to make prediction about this it is required to find out whether the genes associated with that disease exists in the body of the patient. Then only we can predict that the person is suffering from the disease. Prediction techniques used are Greedy approximation algorithm, Decision Trees, Naive Bayes, Neural Networks, Associative classification, Genetic Algorithm etc.

In Robotic application it is necessary to predict user intention to make implicit and human-like interactions possible by accepting implicit commands as well as not directly by observable desires. For example robot assisting the user in the house has to recognize when the user wants to eat the food, drink coffee, etc & provide the intended services to the user without his intervention. The two most widely used prediction techniques in robotic application are Hybrid Dynamic Bayesian Networks & Hidden Markov Model.

In Road Traffic application, prediction is necessary for accomplishing the following factors: 1) To understand the amount of traffic occurring at a particular location by making use of previous determinations 2) To avoid road accidents by understanding the driver's behavior & state of mind 3) To understand the road conditions which also results in accident of the vehicle. Least Squares Method, Artificial Neural Network (ANN), feed forward-back propagation algorithm, Regression analysis are different prediction techniques used for reducing the rates of road traffic accidents (RTA) in road traffic application.

In Educational Data Mining application, student performance prediction is necessary in educational

environments like schools & colleges to improve the learning behavior of the student. This can be achieved with the help of certain attributes so that the best quality education can be imparted among students to improve their performance. Student performance prediction also helps teachers to make following inferences such as: 1) To predict student success & failure rates in the examination 2) To identify potentially weak students. By making these inferences & by taking appropriate actions like giving proper advices, extra assignments, question banks etc. the student failure can be prevented. This helps in improving their performance in academic examinations to produce good results. Smooth Support Vector Machines (SSVM) classification, Kernel k-means clustering techniques, One Rule Learner, Decision Tree, Neural Network & K-Nearest Neighbor classification, Apriori algorithm are widely used prediction techniques to predict the student performance.

In Natural calamities application, prediction is necessary to estimate number of times floods, earthquakes & other natural disasters occur over a long period of time so that precautionary measures can be taken. Delphi method, last period demand, simple and weighted N-Period moving averages, simple exponential smoothing, and multiplicative seasonal indexes are widely used prediction techniques for predicting natural calamities.

In Retail Banking application, prediction is necessary to detect the fraud/false user trying to make the transaction in the name of genuine user, to identify customers who might be at risk of attrition, to maintain good relationship with existing customers so that they can be retained. This results in making the banks more profitable in the society. Prediction techniques used widely are classification algorithms like artificial-based model, Bayesian-based model, case-based model, tree-based model, regression-based model, rule-based model.

In E-commerce application it is necessary to predict the actions performed by the user/customer to improve the business. Consider the following examples: 1) Predicting whether the user will purchase a book at online store. 2) Predicting that the customer who buys milk also tend to buy bread by applying the association rule {milk} -> {bread}. As illustrated in the above two examples the prediction technique like association analysis can be applied to predict the items that are frequently bought by the user at the online store. Some of the other prediction techniques used for predicting the actions performed by the user are Decision Tree algorithm, clustering algorithm etc.

In Wireless Networks application prediction is necessary to detect & eliminate the intruder i.e. false user acting in the network. It is also used to understand the behavior of the attacker based on previous data & also to detect the time at which attacker transmits the data. Prediction techniques widely used are ARMA, ARIMA, Fractal forecasting, Neural networks, Mutual Information and Non parametric noise estimator.

In Social networking application, prediction is necessary to estimate whether content posted and shared in social networks is vulnerable to loss or change, to closely match social media navigation with implicit temporal intent of the users, to understand the mood transition information of users by using history information. For example in twitter application prediction techniques are used to estimate the mood of user based upon the tweets posted by him on the timeline by associating each tweet with mood label. Organizations will be able to judge the success & failure rates of their products by using the information provided by social media which in turn improve the performance & revenue rates. Some of the widely used prediction techniques are Isotonic, Linear, LMS, SVM regression algorithms.

In this paper we have presented a detailed analytical and comparative study as a survey report on different prediction techniques used till date in different ubiquitous computing applications. Most of the researchers have used the techniques based on Data Mining and Artificial Intelligence for predicting the user intent based services.

II. LITERATURE SURVEY

Robert LiKamWa, Yunxin Liu [1], proposed a mobile phone based service oriented approach that infers/predicts the user mood based on the information already available in the device. By providing clues about mental states of mobile user the proposed approach will enhance the context-awareness. Classification & Clustering algorithms were employed to make the approach more effective. According to the proposed approach the user mood can be inferred into four major types & the average accuracy is about 91%. From this approach it was suggested that most of the user tend to communicate with others when he is happy through some specific set of information like SMS, email, phone call, application usage, web browsing, and location. The results were preliminary & strongly suggested the feasibility of mood inference without using social devices like microphone and camera. As a future work more sophisticated predictors can be developed to infer/predict more fine-grained moods & also to reduce required mood input by users.

Yuanchao Ma, Bin Xu [2], proposed a novel framework called Mood Miner for assessing and predicting mood in daily life. It uses mobile phone communication & sensor data like acceleration, light, ambient sound, location & call log. This information will be utilized to extract human behavior pattern and assess/predict daily mood. The proposed approach is based on factor graph method which overcomes the problem of subjectivity and inconsistency faced by traditional mood assessment methods & also achieves a fairly good accuracy of 50% with minimal user intervention.

Andrei Papliatseyeu, Oscar Mayora [3], proposed a positioning system that recognizes & predicts the activities of the mobile user. Fusion of three wireless positioning methods were employed which results in achieving high availability & accuracy. This also helps in recognizing & predicting new types of user activities in both indoor & outdoor environments. The proposed approach also addresses open challenges in predicting the place & activity of the user like detecting behavior changes & prediction of unseen places. One of the limitation that exists in the proposed system is it does not takes into account other context attributes like mood, time, etc for predicting & recognizing the activities of the user which can be considered as future work.

Toon De Pessemier, Luc Martens [4], proposed a user profile based video content prediction & recommendation system. The user interactions with the system were continuously monitored & the corresponding user profile was constructed from the video metadata content. Data was stored in terms of three tuples: item content, field & user ratings/appreciations. The proposed recommendation system can further be improved & applied in the future algorithm designs as it had the following drawbacks: Firstly, the recommendation algorithm presented takes into account only user profile & ratings by which the system becomes incapable of correctly predicting & recommending the video content of user interest. Secondly, the algorithm uses fixed weights for each field. These drawbacks can be overcome by associating fields with random weights which leads to the increase in prediction & recommendation accuracy of the algorithm. Predicting & recommending TV programs of user interest by taking into account contextual parameters like mood, location, activity, time & role can be treated as future scope.

Fabio Santos da Silva, Luiz Gustavo PacolaAlves [5], proposed a software infrastructure to support the development of context aware recommender system for Digital TV. Recommender systems infers the contextual preferences with the help of TV programs filtering & by managing information regarding the context, user profile, TV programs and also cross context reasoning. Data mining and machine learning techniques such as decision tree classifier, naive Bayesian classifier, back-propagation (a neural network), and case-based reasoning technique are used for inferring contextual preferences. Experimental results illustrates that performance of a recommender system can be improved by exploiting both user's profile and context. Case-based reasoning technique provides best quality recommendations. As a future enhancement new data mining techniques such as Support Vector Machine (SVM) can be used to improve recommendation quality.

Liliana Ardissono, Cristina Gena [6], proposed a system called Personal Program Guide (PPG) which is capable of predicting & generating personalized Electronic Program Guides for smart TV. It recommends TV programs of user interest by integrating heterogeneous modeling techniques like Bayesian Belief Networks which was used to measure degree of user interest by taking into account contextual parameters like day & viewing time of the TV programs. The PPG system takes into account explicit user preferences, estimates of stereotypical information like user viewing preferences i.e., number of programs watched by him for each category, socio-demographic information like age, occupation, etc & information about the user's general interests and viewing habits. The advantage of the proposed system is the less suitable programs are filtered out and the most frequently viewed ones are shown at the top of the recommendation list. It also focuses on the personalization of the EPG to individual TV viewers which can be treated as one of the limitation. The generation of recommendation list based on group viewing preferences can be treated as the future scope.

DilpreetKaur, A.P. SukhpreetKaur [7], proposed a KFCM method of fuzzy clustering approach to predict the next webpage requested by the user. The experimental results obtained shows that KFCM pick more pages which has highest weightage and highest probability than FCM for opening in future by the user. In addition, KFCM clusters are better than FCM clusters and prediction is also better as it uses Kernel induced function instead of Euclidean distance function. Proposed method can be applied on different kinds of websites to evaluate its performance and effectiveness and it can also be applied on large data sets in future.

A.R.Patil, P.A.Jadhav [8], proposed an approach for predicting the next page to be accessed by Web users. The prediction techniques used by the proposed approach are Markov model and clustering which involves incorporating clustering with low order Markov model techniques.

Experimental results reveal that web page prediction accuracy can be improved by incorporating clustering of web documents according to web services with low order Markov model. By implanting higher order Markov model the proposed work can be enhanced in future.

Neha G. Sharma [9] proposed an approach to survey & analyze some of the popular web log mining strategies that can be used to predict visitor intent. Data cleaning, identification & re-construction of user sessions, content & structure retrieval & data formatting are the phases involved in web logs pre-processing. To analyze web usage data & to discover web navigation patterns the data mining & knowledge discovery techniques like association rules, sequential patterns, and clustering were used. Some of the algorithms like PrefixSpan, Apriori, Web Access Pattern (WAP) tree, User Access Matrix (UAM), PNT, Intentional Browsing Data (IBD) & Throughout Surfing Pattern (TSP) were discussed by the authors to track the intent of website visitors.

Zheng Chen, Fan Lin [10], proposed an approach for inferring & modeling user's actions in a computer. Based on the features extracted from the user interaction such as user's typed sentences and viewed content the authors mainly focus on predicting action intention. For intention modeling two linguistic features such as keyword and concept features were extracted from the semantic context. By using association rule mining proper concept of corresponding keyword can be found & by using modified Naive Bayes classifier intention modeling was achieved. Experimental results reveal that the proposed approach achieved 84% average accuracy in predicting user's intention, which is close to the human prediction precision of 92%.

Joseph Cessna, Chris Colburn [11], proposed Ensemble Variational Estimation (EnVE) algorithm to predict the future weather conditions. It is a hybrid method based on EnKF and 4DVar algorithms. EnVE maximizes the sequential preconditioning of the batch optimization steps and is consistent with kalman filter when the system is linear.

Shaul Karni, Hermona Soreq [12], proposed a gene prediction approach which predicts whether the person is suffering from the disease myasthenia gravis. It is based on integrating protein-protein interaction network data with gene expression data which can be used to derive a set of disease-related genes. To identify a small set of genes that best covers the disease-related genes the proposed method applies a set-cover-like heuristic. This is used to find out the possible genes that are involved in causing the disease myasthenia gravis.

Gabriela Serban, Istvan-Gergely Czibula [13], proposed a programming interface that can be used for assisting physicians in medical diagnosis. By using relational association rules & a supervised learning method the interface provides accurate diagnosis of the disease. The interface was tested for diagnosing cancer & it provided the prediction accuracy of 90% for the testing data set. By this it was proved that the proposed interface can be used for diagnosing any disease.

Darcy A. Davis, Nitesh V. Chawla [14], proposed an approach called *CARE*- Collaborative Assessment and Recommendation Engine which predicts future diseases risk by relying on patient's medical history using ICD-9-CM codes & also by combining collaborative filtering methods with clustering. *ICARE*, the iterative version of *CARE* is also described which incorporates ensemble concepts for improving the performance. Experimental results on a huge medicare dataset illustrates that the proposed systems performs well at predicting future disease risks.

Gianluca Dell'Acqua, Francesca Russo [15], proposed two accident prediction models: First model is associated with two-lane rural roads & second is associated with multilane roads. Explanatory variables used in the proposed models include roadway segments length, curvature change rate, vertical slope, traffic flow, lane width. The procedure based on Least square method was used to analyze the accidental data. The t-test method was used to compare the predicted values obtained by calibration procedure with several other models.

Francisca Nonyelum Ogwueleka, Sanjay Misra [16], proposed Artificial Neural Network (ANN) model for the analysis and prediction of accident rates. The parameters used by the proposed model were: the number of vehicles, accidents, and population. A feed forward-back propagation algorithm with linear & sigmoid active functions was used for predicting accident rates. The experimental results illustrated that the proposed ANN model is better than other statistical models in achieving road accident prediction.

D. Magdalene Delighta Angeline [17], proposed Apriori algorithm which analyzes the given data & extract the set of rules specific to each class to classify the students based on their performance in academics. Based on their attendance, internal assessment tests & involvement in doing assignment the students are classified. The pattern extracted from the educational database by using association rules helps in predicting the performance of the student & in identifying

good, average & below average students. Other data mining algorithms can be applied to predict student performance which is considered as future scope.

Jemuel Dalino, John Sixto Santos [18], proposed an approach which compares the performance of Decision Trees, Artificial Neural Network & Support Vector Machines. These techniques were used as predictive models for testing the success of students. It was observed that the decision tree algorithm is best suited for predicting the student's success rates.

Chady El Moucary, Marie Khair [19], proposed a hybrid procedure based on Neural Networks (NN) and Data Clustering which enables academicians to predict students' GPA using two stages 1) Based on their foreign language performance 2) Classifying the student in a well-defined cluster for further advising. The objective of the proposed approach is twofold as it allows meticulous advising during registration thereby helping to maintain acceptable GPA & high retention rate. A high level of efficiency & accuracy was demonstrated by the experimental results as it clearly identified fast, moderate & slow learners.

Saptarsi Goswami, Sanjay Chakraborty [20], proposed an approach that reviews the application of analytical & data mining techniques to predict natural disasters. It involves three steps based on the data collected from disasters: 1) Prediction 2) Detection and 3) Development of appropriate disaster management strategy.

Zhang, Xiao Yu, Xiang Li, and Xiao Lin [21], proposed Particle Swarm Optimization approach for predicting the magnitude of the earth quake. The seismological data for achieving the prediction was taken from laboratory in china.

Sahay, Rajeev Ranjan, and Ayush Srivastava [22], proposed a model based on wavelet transform, genetic algorithm & artificial neural networks to predict monsoon flood. This gave better results than existing auto regressive models. The hydrological time series data was taken from laboratory in India.

LiatAntwarg, LiorRokach, BrachaShapira [23] presents a novel approach for generating an intention prediction model of user interactions with systems. Personal aspects such as user characteristics that can increase prediction accuracy have been included as part of this new approach. According to the user's fixed attributes (e.g., demographic data such as age and gender) and the user's sequences of actions in the system the model is automatically trained. The generated model has a tree structure. To predict user intentions an attribute-driven model tree algorithm has been used. Users with different attributes (such as age, gender) were given as input test data to the generated model & as a result it was observed that users behave differently when trying to accomplish various tasks. Compared to Hidden Markov Model the proposed method exhibited the capability for discovering the correct user intention model and increasing intention prediction accuracy. Proposed algorithm encountered one of the limitations that it cannot handle multitasking. Extending the proposed algorithm to support multitasking applications & testing the algorithm on non-fixed user attribute values can be considered as the future research work.

Fan Li, Juan Lei [24] proposed an approach for addressing customer attrition prediction problem based on the data collected from real-world retail banking environment. Four model selection principles were used by authors. The experimental results illustrates that although none of the models are perfect the REBC • LR- which solves the classification problem by using Logistic Regression (LR), TBC • DT- which solves the classification problem by using greedy algorithm like Decision Tree (DT) and RUBC •RIPPER- which solves the problem of classification by using Association Rules (IF-THEN). These models/approaches are recommended for customer attrition prediction in retail banking. Development of improved classification model that satisfies all the proposed model selection principles is treated as the future scope.

Carsten Magerkurth, Martin Strohbach [25], proposed an approach called dynamic pricing which uses mobile & IoT technologies to predict value added services within retail store environment based on product quality. The future scope of this research work is to facilitate the prediction by simplifying the complex processes of real-world integration.

T.Shanmugapriyan [26], proposed an approach called Smart cart which supports customers involved in shopping. This approach focuses on features & functionalities that have to be integrated for achieving smart shopping by acquiring user intention. It helps shoppers in finding & handling groceries. It is better when compared with traditional trolley shoppers as it exhibits uniform behavior which makes shoppers easier to find products with shorter distances.

Manju Bhaskar [27], proposed an approach which involves three level structure as follows: 1) Media level 2) Content level 3) Presentation level for predicting the learner's context. The proposed learning path algorithm is considered as genetic algorithm as it generates a learning path which accommodates the entire context of the learner. By this author concludes that for handling multiple constraint

satisfaction problems genetic algorithms are best suited as provides alternate solutions.

Jianming He, Wesley W. Chu [28], proposed a Social Network-Based Recommender System (SNRS) which utilizes information in social networks including influence from social friends, user preferences & item's general acceptance to predict & recommend the item based on the ratings given by the user. The analysis of large dataset obtained from a real online social network indicates that friends have a tendency to give similar ratings & to select the same items. Experimental results on this dataset reveal that the proposed system yields 17.8% more prediction accuracy than collaborative filtering technique. The performance of the proposed system can still be improved by applying semantic filtering of social networks which demonstrates relationship between friends & their ratings.

Hany M. SalahEldeen[29], proposed a model to detect and predict the user's temporal intention after sharing contents like flash news, videos in the form of links in the social network & also of the reader after going through the shared content. The proposed model addresses the problem of inconsistency that occurs among the state of a resource when an author creates a link and the state of the resource when a reader follows the link. It also provides two important benefits: Firstly, the way in which user navigates the social media will more closely match his/her implicit temporal intent. Secondly, by creating web archives, personalized shortened URIs & usage patterns the user's temporal intent can be made explicit to provide a seamless integration of the current and past web.

Sitaram Asur, Bernardo A. Huberman[30], proposed an approach that makes use of linear regression analysis & ranking algorithms to predict real-world outcomes like box-office revenues for movies with the help of social media twitter.com. The proposed approach makes use of chatter which keeps track of rate at which movie tweets are made by the user to predict the revenue that may be generated by a particular movie in advance of its release. This approach outperforms existing market-based predictors like Hollywood Stock Exchange & also exhibits how the user sentiments extracted from twitter can be utilized to improve the prediction power of social media. The proposed approach can be extended to other topics like predicting future rating of products, election outcomes etc which according to the author could be treated as future scope.

Aditya Mogadala, Vasudeva Varma[31], proposed an approach to predict the mood transition of a user on social media like twitter by taking into account tweets posted over time line using SVM regression analysis. Experimental results reveal that the proposed approach attained less root-mean-square error of about 2.72 & relative absolute error of about 98.36% compared to other regression approaches like isotonic, linear, etc for mood transition prediction. More robust features & techniques can be used to predict the mood transition of the user in future to improve the accuracy rate & to reduce the error rate.

Chindamani J, Preethi D[32], proposed an approach that include survey on the various methodologies and techniques used in online social networking for contextual search. By applying ranking algorithms, semantic similarity checker, POS tagging etc the contextual search can be achieved. According to the proposed architecture the user will give the query in contextual search, the query processing is done with multiple search engine and search logs. The ranking is done with the algorithm of semantic similarity checking after query processing. Depending on this ranking search engine will process with some techniques like clustering, segmentation, pos-tagging and all these are done in the information extraction of contextual web search. From this the user will get what they need. To produce efficient results to the user's query & to improve the web search engine proposed methods were applied.

III. COMPARISON OF EXISTING PREDICTION TECHNIQUES

The table below shows the discussed applications, algorithms & their purpose, parameters used for achieving prediction in each application.

Table 1: Applications & their Prediction Techniques

Sl.No	Prediction Techniques	Application	Purpose	Parameters used for measuring the Performance
1	Classification & Clustering algorithms	Smart Mobile	For predicting mood of the mobile user	• Mental states of the mobile user • acceleration, light, ambient sound, location & call log
2	Data mining and machine learning techniques such as Decision tree classifier, Naive	Smart TV	For predicting the channel/TV program of user	• User profile, user context & user ratings • User preferences,

	Bayesian classifier, Back-propagation (a neural network), and Case-based reasoning technique, Support Vector Machine (SVM), Bayesian Belief Network (BBN)		interest	watching habits, age, occupation, etc
3	Fuzzy clustering algorithms like KFCM, FCM, Markov models, Prefix Span, Apriori, WAP-tree, UAM, PNT, IBD, etc	Web mining	For predicting the web user intent & their navigational patterns	• User web context history(web logs) • Keyword & concept features
4	EnKF, EnVE, 4DVar	Weather forecasting	For predicting the future weather conditions	• Temperature • Pressure • Humidity
5	Heuristic method, Association rules, Supervised learning method, Collaborative filtering with clustering	Medical/Health care	For predicting future disease risks	• Genes • Medical history
6	Least Square Method, t-test method, Artificial Neural Network	Road Traffic	For predicting the occurrence of road accidents, road accident rates & to take precautionary measures	• Explanatory variables like roadway segments length, curvature change rate, vertical slope, traffic flow, lane width • Number of vehicles, population & number of accidents
7	Classification based Apriori algorithm, Decision trees, Artificial neural networks, Support vector machines	Educational Data Mining	For predicting student performance in academics	• Attendance, • Internal assessment tests & • Involvement in doing assignment
8	Particle Swarm Optimization, genetic algorithm, wavelet transform	Natural Calamities	For predicting the magnitude of earth quake, monsoon flood	• Seismological data • Hydrological data
9	Classification based Logistic regression, Decision tree, Association rules	Retail Banking	For customer attrition prediction	• Customer data
10	Association analysis based decision tree & clustering algorithms	E-commerce	For predicting the actions performed by the user	• Association rule based context history
11	ARMA, ARIMA, Fractal forecasting, Neural networks, Non-parametric noise estimation	Wireless Networks	For detecting and eliminating the intruder acting in the network	• Time based context history
12	Isotonic, linear, LMS, SVM regression algorithms	Social Networking	For predicting mood transition information, matching social media navigation with the temporal intent of the user	• Tweets posted by the user • Context information of the user
13	Hybrid Dynamic Bayesian Networks & Hidden Markov Model.	Robotics	For making implicit & human like interactions possible	• Implicit commands

IV. CONCLUSION

Predicting user intentions with respect to different applications like smart mobile, smart television, web mining, weather forecasting, health-care/medical, robotics, road-traffic, educational data mining, natural calamities, retail banking, e-commerce, wireless networks & social networking has become an emerging & significant area of research in Ubiquitous Computing. Providing the personalized services or products based on user's

preferences or interests by predicting the preferences of users were the important issues discussed in this survey report. Moreover, in context-aware computing the research for offering the personalized services by considering the user's preferences is relatively insufficient research field. Most researches on context-aware computing have focused on inference of high-level context such as user's current activity from sensor data. This paper discusses usage of data mining & machine learning techniques to predict user intentions & to provide personalized services. As specified, different prediction algorithms are used in different applications. The prediction techniques discussed in this survey report are as follows: Classification & Clustering algorithms for predicting user intentions in smart mobile application. Data mining and machine learning techniques such as Decision tree classifier, Naive Bayesian classifier, Back-propagation (a neural network), and Case-based reasoning technique, Support Vector Machine (SVM), Bayesian Belief Network (BBN) for predicting user favorite TV program in smart TV application. Fuzzy clustering algorithms like KFCM, FCM, Markov models, Prefix Span, Apriori, WAP-tree, UAM, PNT, and IBD for predicting user navigational patterns in the web mining application. EnKF, EnVE, 4DVar algorithms for predicting future weather conditions like temperature, humidity, etc in weather forecasting application. Heuristic method, Association rules, Supervised learning method, Collaborative filtering with clustering for predicting whether the person is suffering from the disease in medical/health care application. Least Square Method, t-test method, Artificial Neural Network for predicting the mental state of the driver, road conditions & preventing the road accidents in road traffic application. Classification based Apriori algorithm, Decision trees, Artificial neural networks, Support vector machines for predicting the student performance in educational data mining application. Particle Swarm Optimization, genetic algorithm, wavelet transform for predicting the occurrence of earth quakes, floods in natural calamities application. Classification based Logistic regression, Decision tree, Association rules for predicting customer attrition in retail banking application. Association analysis based decision tree & clustering algorithms for predicting the actions performed by the user in e-commerce application. ARMA, ARIMA, Fractal forecasting, Neural networks, Non-parametric noise estimation for detecting & eliminating the intruder in wireless networking application. Isotonic, linear, LMS, SVM regression algorithms for predicting mood transition information in social networking application.

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