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ARTIFICIAL NEURAL NETWORKS WITH VERTICAL HANDOFF PREDICTION BASED ON USER BEHAVIOUR

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ABSTRACT

Wireless Data Network governed by radio waves deploys wireless medium for data communication. Mobility is the major challenge in integrating the wireless nodes. Handoff in mobile nodes demand uninterrupted data transmission while preserving the network integrity. Handoff process consumes lot of network resources, increases the network traffic and is also susceptible to data loss. Handoff prediction will foresee the handoff that is likely to occur in future so that the handover operations are done beforehand. This paper gives general overview of the vertical handoff prediction using Artificial Neural Networks (ANN) and Association Rule Mining (ARM). The proposed methodology uses ANNs to determine whether a handoff is necessary with the current network parameters, which is confirmed by Apriori algorithm. A detailed comparison is given between the ANN-Apriori and Support Vector Machine (SVM)-Apriori hybridization. The results indicate that the former performs better than the latter in terms of accuracy in prediction handoff.

Keywords-ArtificialNeural Networks (ANN), Association Rule Mining (ARM), Handoff, Mobility, Support Vector Machine (SVM), Vertical handoff, Wireless networks.

INTRODUCTION

Mobile communication is the process of performing computations on a portable device and transmitssion of data to single or many more devices [Arun and Prabu (2017)]. When there is a change in the geographical location of a mobile user, the wireless network must efficiently allow the mobile services to be continued without signifycant loss in signal quality and data. Yuan Qiao et al., (2017) stated that handoff is the process of handling the active call transfer between access points and is shown in Figure 1. Handoffs are broadly classified into two types based on the target: horizontal handoff and vertical handoff. Horizontal handoff occurswhen there is transfer between two equivalent set of connections (peers). In vertical handoff, the connections are transferred between several types of connections [Enrique Stevens-Navarro et al., (2007)]. Figure 2 portrays the types of handoffs.

According to Yang et al., (2015) handoffs involve transfer of data between the source and the target access points of the mobile agent resulting in building and managing very large databases. The databases are analysed using Association Rule Mining (ARM) to discover interesting relations between variables to facilitate smooth handoff. It helps recognise patterns in the data. Jeetesh Kumar Jain et al., (2013) used ARM technique to find the frequent data sets in the database.

Artificial Neural Networks: Sonali et al., (2014) stated Artificial Neural Network (ANN) can be deployed to process the information in the database thereby to predict the user behaviour. The handoff process is enabled, based on the decisions made by the ANN. The ANN receives input (data) from the first layer which in turn sends data through synapses to second layer (hidden layer) and the output nodes receives the data from the second layer via more synapses [Figure 3].

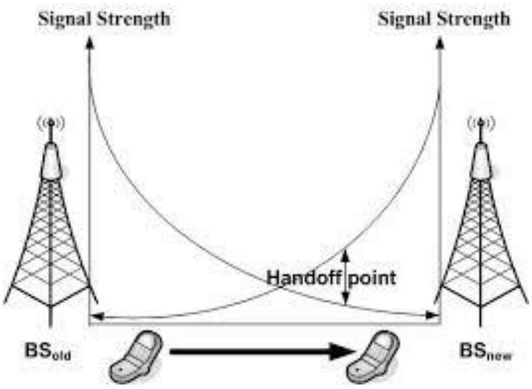

Figure 1: Handoff

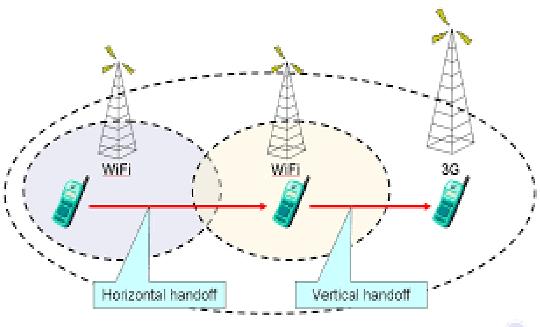

Figure 2: Veritcal and Horizontal Handoff

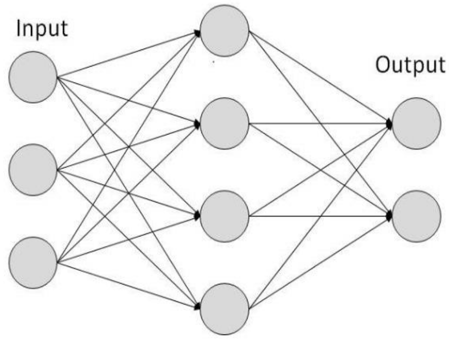

Figure 3: Architecture of Artificial Neural Networks

RELATED WORKS

Many works are done deploying the artificial intelligence techniques for smooth handover. Some of the significant milestones are discussed here. According to Yaw &Jhonson (2008) used an adaptive multiple attribute vertical handoff decision algorithm combining the features of Genetic Algorithm (GA) and Fuzzy Logic (FL) to enable the selection of wireless access network at a mobile terminal. The major parameters involved in the time of handoff and in the selection of access network are Quality of Service (QOS) requirements, mobile terminal conditions, user preferences, and service cost. The accuracy of this method is improved by using fuzzy logic, that primarily process the imprecise data which is also capable of processing multiple attributes simultaneously. This proved to be a much useful and economically feasible algorithm. The limitation of this algorithm is that it do not gives a promising precision in limited time.

Enrique stevens-Navvaro et al (2007) framed a mechanism to estimate the network resources consumed by the connection and identify the situation that demands vertical handoff. A stationary deterministic policy is applied on the geometrically distributed connection. The algorithm is based on Markov Decision Process involving three main phases (Nair et al., 2004, Chen et al., 2005), namely discovering system, decision to commence vertical handoff, and execution of handoff. The system discovery phase, the mobile terminal determines the target networks for the handoff by analyzing the data rates and QOS. The decision-making phase decides the necessity of handoff with respect to bandwidth, transmit power, user's preference and access cost. The rerouting mechanism from existing network to the new network by is done by Vertical handoff execution phase. This phase takes the additional responsibility of various security factors such as authentication, authorization, and transfer of a user's context information. The proposed scheme overruns the two other algorithms namely SAW (Simple Additive Weighting) and GRA (Grey Relational Analysis) to which it is compared.

User mobility pattern predictability in a wireless network is based on the information gathered about the user's recent location and switching speed as in Predictive distance based mobility management for multidimensional pcs networks by Ben Liang et al., (2013). A mobile's future or target location after handoff is predicted by the network. The Guass Markov model is used to estimate the cost of mobility management. The Personal Communication Service (PCS)is responsible for tracking, maintenance of information about mobile node's location. The prediction of future location of a mobile is done through calculating the Probability Density function (PDF) of the mobile's location.

Yu Zheng et al., (2010) introduced Geolife, a social networking service to track of details about user location (trajectories). This highlights the correlation between the current trajectories of the mobile terminal and the user generated trajectoryies. This work features the experience of the users based on GPS trajectories. This service uses three graphs formed from GPS trajectories: a location-location graph, a user-location graph, and a user-user graph. Location-location graph consists of nodes that represent geographic locations of the mobile terminal. The directions of movement by the mobile terminals are represented by the directed edges of the graph. The user location graph has two types of nodes namely locations and users. The weight of the edge is the count of the visiting times of the user. In user-user graph, the node is a user and an edge between two nodes represents that the two users have visited the same location in the real world for sometimes. The interesting locations can be found by knowing the travel experiences of the users.

Zhou et al., (2013) and Noulas et al., (2012) proposed a mechanism for extracting mobility model from user traces by exploring mobility characteristics among mobility users. The physical location of users is traced in association with the access points in wireless networks from mobile devices. A 13-month trace is conducted among users associated to wifi devices to determine the user mobility. The speed and pause time determines the course of movements which reflects the route of walkways and roads. Based on the results, the mobility among popular regions can be found efficiently. The opportunity to interact with users passing close to each other became the recent research trend in adhoc networks. A heuristic is developed to use mobile tracks by extracting mobility characteristics. In the model, initially hotspots among popular regions are determined and then classified. Later movements among those regions are categorized.

The studies made by Yuan Qiao et al., (2017) emphasis the significance of the traffic in mobile internet to predict the user behavior. Here the traffic in 2G/3G/4G networks are analyzed to predict the user behavior. This scheme has a number of advantages: more data to learn, high cost efficiency, low energy consumption etc. The analysis of so collected data is done through Mobility analytical framework, which uses cloud to handle the data. The construction of user trajectories is done through rules. Noise reduction and identification of hotspots is also a part of the work.

PROBLEM STATEMENT: The existing soft vertical handoff system guarantees efficient and reliable handoffs based on the channel availability and transmission cost. The performance of these systems can be further enhancedby considering the users behaviour that may result in the reduction of unnecessary additional handoffs. The reduction in the number of handoffs will obviously decreasethe energy loss, unwanted traffic and data loss.

PROPOSED FRAMEWORK: The proposed framework that helps reduces the unnecessary handoffs using neural networks. After the initiation of handoff decision making process, the neural network computes the handoff trigger point. The neural network works on the available signals and determines the best signal to which the call can be handed off. The choice of signal source is done using the association rule mining algorithm. The framework has a database to store the user trajectories and antenna details. The association rule mining principles are applied on the database to predict the user behaviour and the ANN is used to decide about the handoff necessity.

ASSOCIATION RULE MINING: Association rules are simple if-then statements that help to extract useful knowledge about the relationships between the unrelated data. The frequency of the nodes that tend to move to a different geographic location is the support for the association rules and the confidence value is the number of times the mobile terminal is moving from a source location to a destination location (Sonali et al., 2014). It is evident that the user behavior can be predicted from the support and confidence value estimated from the ARM. Support value is determined using Apriori algorithm and the confidence is estimated by the number of times a user from a source location moves to a destination location.

MIN-MAX ALGORITHM: The database constructed for handoff contains a wide range of data. It is very important to fix the call duration within a lower and upper bound time limit. Min-Max normalization is used to fix the scale of call limit within the range [0.0, 1.0]. The expression for calculating the limits is given by

$$new_{calllimit} = \frac{old_{calllimit} - \min(old_{calllimit})}{\max(old_{calllimit}) - \min(old_{calllimit})}$$

The above expression will scale the value to a new value expressed within the range. The new value is normalized using the expression

RESULTS AND DISCUSSION

The following table 1 shows the values from the experiments

Table 1: Min and max values

Maximum duration calls	55001
Minimum duration calls	24999
Min Short Message Service	23
Max Short Message Service	33
Maximum consume data	8
Minimum consume data	3

The following table 2 gives the data range after normalization.

TABLE 2: DATA SET AFTER NORMALIZATION

User id	Call duration (mins)	SMS (Total)	Data Counter (MB)
1	0.0000333	0.1000000	0.2000000
2	0.50000000	0.4000000	0.4000000
3	1.0000000	0.9000000	0.8000000
4	0.0700000	0.2000000	0.4000000
5	0.9300000	0.7000000	0.4000000

ANNs are used to determine the necessity of handoff. The parameters throughput, delay, cost and bandwidth are given as inputs to the ANN [Saravanan (2016)]. These are the training data sets. A reference threshold value is estimated based on the training data. The new dynamic values of the parameters being monitored is fed inside the ANN and it the current output is less than the reference threshold value, then no handoff is required. In the next phase the handoff decision is confirmed by the support value derived from the association rule mining. The user behavior is also determined using ANN. The apriori algorithm is used to find the support value and confirm the handoff.

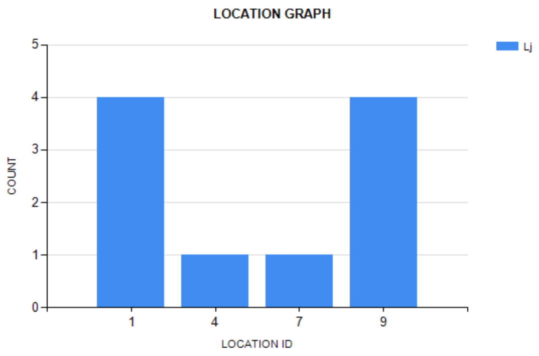

Figure 4: Location Graph

The Location graph shown in Figure 4 represents the behaviour of the user by analysing the source and target location visited by the user. The height of the vertical bar in the Figure 4 corresponds to the frequency of visit by a user (A) to a location. The graph shows that user A is visiting location 1 four times, location 4 one time, location 7 one time and location 9 four times. Figure 5 compares the performance of Apriori algorithm and Frequent Pattern (FP) growth algorithm with different confidence levels. Though the FP growth algorithm promises better performance for small data sets, the computational complexity of FP growth algorithm for processing large dynamically generated dataset such as wireless signal data is under question.

Another interesting comparison is done between accuracy in predicting the necessity of handoff between the neural network and Support Vector Machine (SVM). For the dataset of size 100, ANNs predicts the handoff necessity better than SVM. At 1000 size dataset the accuracy of neural networks is 89% and accuracy of SVM is 84%. This infers that the ANNs perform well for small size data but as the size of data increases, SVM offers better result.The combination of Apriori–ANN and Apriori –SVM shows that the former gives better outputs with accuracy.

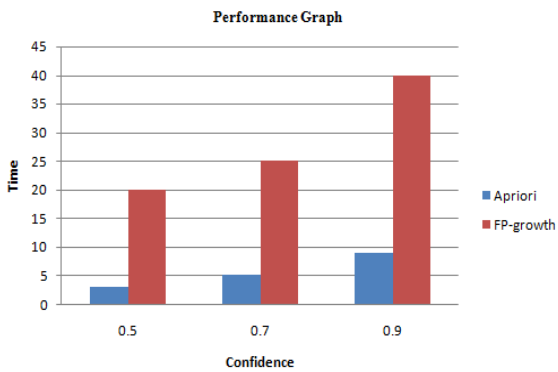

Figure 5: Performance of apriori and FP growth

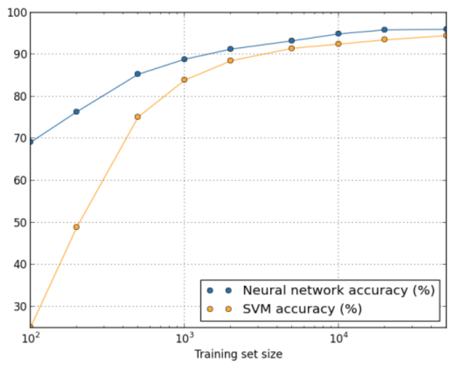

Figure 6: Accuracy of Apriori-ANNs vsApriori-SVM

CONCLUSION

The paper begins with briefing about the handoffs and predictive handoffs. Handoffs involve the usage of network resources, so predictive handoff can prepare the wireless network for a handoff beforehand, thus reducing loss in data. The proposed method uses normalized Min-Max algorithm to scale the network parameter values. It deploys Apriori algorithm to confirm the decision made by ANNs for determining the necessity for handoff. The paper also compares Apriori algorithm with its rival FP-growth algorithm and Apriori combined with ANN and SVM separately. The hybridization of Apriori with ANN excels the performance of Apriori with SVM.

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