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Channel Allocation Optimization using African Buffalo Optimization-Super Vector Machine for Networks

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Abstract: Recent technologies utilize the communication network effectively with respect to limited spectrum allocation. In order to perform proper communication, it is necessary to utilize the resource with minimum aspect since, if number of network user's increases then the interference also slightly increased. To avoid interference and to use minimum resource it is necessary to create a new hybrid channel allocation scheme and optimize the performance metrics. The proposed hybrid model applies the Super Vector Machine (SVM) classification to African Buffalo Optimization (ABO), it is compared in terms of "survival of the fittest" with Genetic Algorithm (GA) based SVM. Normally, SVM is a classification technique used to classify the nonlinear data and ABO is also an effective problem solving mechanism. Hence, the combination of ABO and SVM provides best fitness function in communication network by focusing on minimizing the interference in web traffic. The performance metrics considered for evaluation are energy, accuracy and processor utilization. Finally, the experimental results were shows that the proposed ABO-SVM method is best when compared with the GA-SVM.

Key words: Networks, African buffalo optimization, Genetic algorithm, super vector machine, utilization, communication

INTRODUCTION

Recent sensor networks are deployed randomly and self-governing the sensors to monitor any type of physical conditions. It consists of sensor array which is interconnected with base stations and to link several links. The unique problem in sensor network is energy consumption, apart from these factors the resource utilization, memory space, bandwidth, physical security and error rate are complex issues. Hence, with all these factors the data exchange rate takes place. The data rate is very low in sensor network but in Mobile Ad Hoc Network (MANET) the nodes are deployed randomly and each node is directly depends upon the battery of same node, it states the lifetime of that node.

Based on the given topology the sensors transmit the data to the next hop node. The network which is broadly classified over a geographic land areas, it is functioned based on the base station. In a network, each cell characteristically uses a different set of frequencies from all other neighboring cells to avoid interference but still the interference occurs due to the 'n' number of users communicating the channel.

The past research states some of the objective as the cost of service, the bandwidth requirement and interference reduction. These are important challenges that can be achieved by efficient reuse of scarce radio spectrum allocated to wireless mobile communication. This research coined out the channel allocation problem exists due to the traffic demand. The channel allocation is classified into several process such as Fixed Channel Allocation (FCA), Dynamic Channel Allocation (DCA) and Hybrid Channel Allocation (HCA). If fixed number of channels allocated permanently to each cell then it is termed as FCA. The channels are kept in the central pool to satisfy the dynamic traffic demand. HCA is the combination of both fixed and dynamic channels and the fixed sets are allocated to each cell and dynamic set is kept in a central pool as stated by Mishra and Sexena, (2012). In cellular networks to reduce the interference, a Channel Allocation Problem (CAP) is considered based on the selection of channels for all the wireless connections.

Many heuristic algorithms are used to optimize the available channel allocation techniques, such as Artificial Neural Network (ANN), Simulated Annealing (SA), Tabu Search (TS), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Genetic Algorithm (GA), etc. but still the traditional techniques has no assurance in optimal solution. Hence, the African buffalo optimization

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is considered here for processing the quality of solution and minimize the interference. SVM is a well-known binary classification method and produces better classification results as compared to other classifiers.

Literature review: Raniwala and Chiueh (2005) concentrated on network throughput by comparing with the conventional single-channel ad hoc network architecture. Most of the real time interface such as IEEE 802.11-based multi-hop ad hoc networks today use only a single channel. Hence, these networks rarely can fully exploit the aggregate bandwidth available in the radio spectrum provisioned by the standards. They proposed a multi-channel Wireless Mesh Network (WMN) architecture called as Hyacinth that equips each mesh network node with multiple 802.11 Network Interface Cards (NICs). Its main design issues in multi-channel WMN architecture are channel assignment and routing. They described that intelligent channel assignment is critical to Hyacinth's performance. The network throughput is improved by the factor of 6-7 when compared with the conventional single-channel ad hoc network architecture.

Oh and Teha (1992) considered a dimensioning procedures for prioritized channel assignment in a network. The prioritized channel assignment procedures for a single cell and multi-cell system are formulated as nonlinear discrete capacity allocation problems under the cutoff priority discipline. Some of the incremental algorithms are based on the properties of the blocking probabilities of calls. They have made an algorithm to perform very fast and are appropriate for the fair allocation of frequency channels among cells (Table 1).

The wireless Mobile Ad-hoc NETwork (MANET) architecture has received a lot of attention recently. Wu *et al*. (2000) consider the access of multiple channels in a MANET with multi-hop communication behavior. They indicated several interesting issues when using multiple channels. They have proposed a new multi-channel MAC protocol which is characterized based on "on-demand" style to assign channels to mobile hosts, the number of channels required is independent of the network topology and degree, it flexibly adapts to host mobility and only exchanges few control messages to achieve channel assignment and medium access and no clock synchronization is required.

Raniwala *et al*. (2004) focused on wireless mesh networks that serve as the backbone for relaying end-user traffic from wireless access points to the wired network. The main idea of exploiting multiple channels is particularly appealing in wireless mesh networks because of their high capacity requirements to support backbone traffic. They developed a set of centralized channel assignment, bandwidth allocation and routing algorithms for multi-channel wireless mesh networks. Finally, the detail evaluation shows that intelligent channel and bandwidth assignment, most previous efforts that attempt to exploit multiple channels require modifications to the MAC protocol. They proposed and evaluated an one of the first multi-channel multi-hop wireless ad-hoc network architectures that can be built using standard 802.11 hardware by equipping each node with multiple Network Interface Cards (NICs) operating on different channels.

Table 1: Survey based on different optimization

Citation	Methodology	Performance metrics
Alicherry *et al*. (2005)	Joint channel assignment and routing	Throughput optimization
Skalli *et al*. (2007)	MesTiC which incorporates the mesh traffic pattern together with connectivity issues	To minimize the interference by improving the aggregate network capacity
Popovski and Yomo (2006)	Bi-Directional amplification of throughput (BAT-relaying)	Channel errors and throughput
Douglas *et al*. (2005)	Expected Transmission Count Metric (ETX), DSDV and DSR routing protocols	Throughput and packet delivery ratio
Jiang and Walrand (2010)	Adaptive Carrier Sense Multiple Access (CSMA) scheduling algorithm	Maximum throughput and achieve optimal utility

Some of the challenges presents in wireless network are bandwidth efficiency, overhead, Quality of Support (QoS) and synchronization. Apart from these factors lack of central coordination is occurred in distributed fashion for gaining access to the channel. The MAC protocol must make sure that the additional overhead in terms of bandwidth consumption, incurred due to this control information exchange is not very high.

MATERIALS AND METHODS

This study provides the solution for network problems such as interference and utilization. From the literature it is noticed that the natural evolutionary algorithms are used to solve the problems while transferring the data over a mobile network. For example, Genetic algorithm is one of the stochastic search technique that works on the process of natural selection. It consists of three fundamental operations such as selection, crossover and mutation. Genetic algorithm has some limitations such as poor fitness function results in generating bad chromosomes and it has no assurance that GA will produce a global optimum solution. Hence, this research focused on improving the fitness value of GA by SVM for binary classification, it is considered for evaluation. The proposed method constructed by ABO for evaluating the fitness instead of GA and for classification the SVM is normally implemented and the results were compared with GA-SVM.

Support Vector Machine (SVM) classification to Genetic Algorithm (GA-SVM): Ohatkar *et al*. (2016) proposed a hybrid channel allocation technique with co-channel and co-site constraints is proposed by applying Support Vector Machine (SVM) classification to Genetic Algorithm (GA). The combination of these network is finding the optimized channel allocation for a given demand with the available channels in the cellular area. It is necessary to satisfy and calculate the channel allocation with zero call blocking and zero interference. They have made a combination of GA with SVM for channel allocation. The results are directly depends upon the fitness value produced by GA. Hence, while implementing the GA in any concepts the performance of total network is depends upon its fitness function. They used SVM to design the fitness function for GA. SVM is a supervised machine learning that needs to train first and then it can be used to classify the data points. In this case, SVM is classifying the frequencies available into two classes which will decide what frequency will be allocated to which base station demand. The interference is greatly reduced by optimizing once again with the allocation of GA alone.

The GA-SVM method is simulated for standard benchmark problems, namely 49 cell benchmark problem indicated by Chia *et al*. (2011) and Kunz (1991) benchmark problem. With the help of 49 cell benchmark, the call blocking probability is calculated for three combinations of HCA that is 21:49, 35:35 and 49:21. Out of the three, 21:49 has minimum call blocking probability for uniform and nonuniform traffic demands. Also, overall call blocking probability for uniform traffic is less than that for non-uniform. The detailed working of the genetic algorithm with SVM is discussed in following steps:

- Step 1: plot the scenario of hexagonal cells and divide the channels into fixed and dynamic sets
- Step 2: divide the cells into independent sets according to the reuse factor
- Step 3: initially allocate the demand from the fixed set of channels
- Step 4: plot the frequency allocation matrix and check for the demand greater than a fixed set of channels or not
- Step 5: if the demand is less than the fixed set, then continue allocating from the fixed set
- Step 6: if the demand is greater than fixed set, then allocate channels from the dynamic set of channels optimized by GA-SVM
- Step 7: GA selects the initial population in the first step and performs crossover and mutation
- Step 8: SVM classifies the base station and frequency vectors and these are stored in variable "d1"
- Step 9: if set in both variables is equal, then those are allocated otherwise the sets produced by GA are iterated for at least 50 generations

African Buffalo Optimization-Super Vector Optimization (ABO-SVM): The African buffalo optimization is one of the swarm-intelligence technique used for solving various continuous problem with respect to the benchmarks. It is evolved from the animal's instincts and search techniques that utilize in the American forests and savannahs. It is intelligent, cooperative and democratic attitude in its search for the optimal path. The Metaheuristic algorithm employ global search mechanism and local search mechanism, it has several advantages when compared with many others algorithms such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO) algorithm, Bee Colony Optimization (BCO) and so on the decision making and search candidates are best in this type of algorithm. Several key feature of a good algorithm is it has an ability to identify the best solution in real time streaming or iteration. The survival of fittest solution is one of the best way to represent the current best found as discussed by Yang (2011). Hence, by several factors the african buffalo optimization is attempted to complement the existing algorithms to solve the problems of delay and inefficiency. The ABO pseudo code is shown is Algorithm 1.

Algorithm 1: African buffalo optimization pseudo code

Step1: Objective function f(x) $x = (x_1, x_2, \ldots\ldots\ldots x_n)^T$
Step2: Initialization: randomly place buffalos to nodes at the solution space;
Step3: Update the buffalos fitness values by following equation
$W.k+1 = w._k + lpr_1 (bg_{maxt.k} - m._k) + lpr_2 (bp_{max.k} - m._k)$
Where $w._k$ and $m._k$ represents the exploration and exploitation moves respectively of the k^{th} buffalo (k = 1, 2…N); lp_1 and lp_2 are learning factors; r_1 and r_2 are random numbers between [0, 1];
bg_{max} is the herd's best fitness and bp_{max}, the individual buffalo's best
Step4: Update the location of buffalo k in relation to $bp_{max.k}$ and $bg_{max.k}$ using $m._k+1 = \lambda (w._k + m._k)$. Where 'λ' is a unit of time
Step 5: Check bg_{max} is updating or not. If yes, go to 6. else, go to 2
Step 6: If the stoping criteria is not met, go back to alogrithm step 3
Step 7: Output best solution

Flow diagram for hybrid channel allocation using ABO-SVM is shown in Fig. 1, initially, the algorithm starts with finding the demand and frequency pairs from ABO and parallel training the SVM classifier. The first step of ABO comprises of randomly considering a set of population (buffalos) and performing crossover and mutation on that population to produce the solutions. The crossover rate and the mutation rate is considered after these operations, the ABO produces set of buffalos location and tested it in channel allocation process.

African Buffalo Optimization (ABO)-SVM is proposed for channel allocation in mobile cellular communication with an aim of minimizing the interference to a satisfactory level. The detail view of ABO-SVM is shown in Fig. 2. The Traditional algorithm such as Genetic algorithm and traditional optimum search methods are applied alone for channel allocation gives the set of demand and frequencies which will be allocated. The limitation of Genetic algorithm is it fails to solve certain problems due to poorly designed fitness function. SVM is highly accurate binary classification method best suitable for non-linear data. The fitness function of ABO is designed with the help of SVM classification and results for channel allocation with the combined method are explored.

The fitness function is the most important part in the combination of the two techniques. Hence, ABO-SVM a combined method is used for channel allocation in wireless communication network with an aim of getting an optimized solution that includes moderate call blocking, calculating the interference in terms of co-channel and co-site edges and Signal to Interference Ratio (SIR). The two techniques are combined and advantages of both

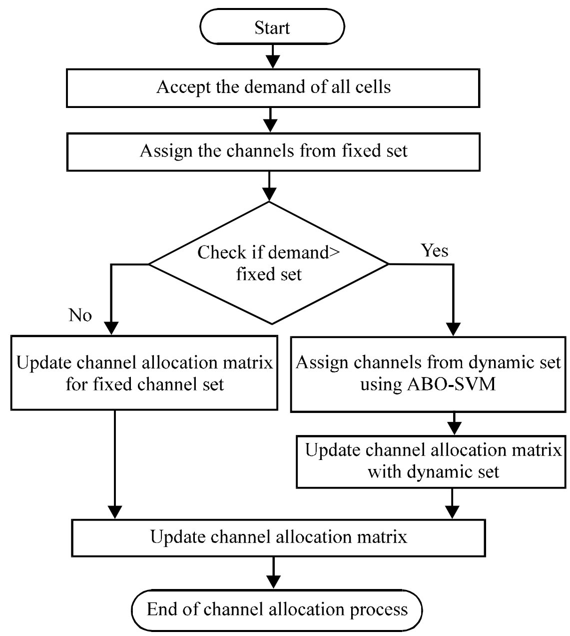

Fig. 1: Flow diagram for hybrid channel allocation using ABO-SVM

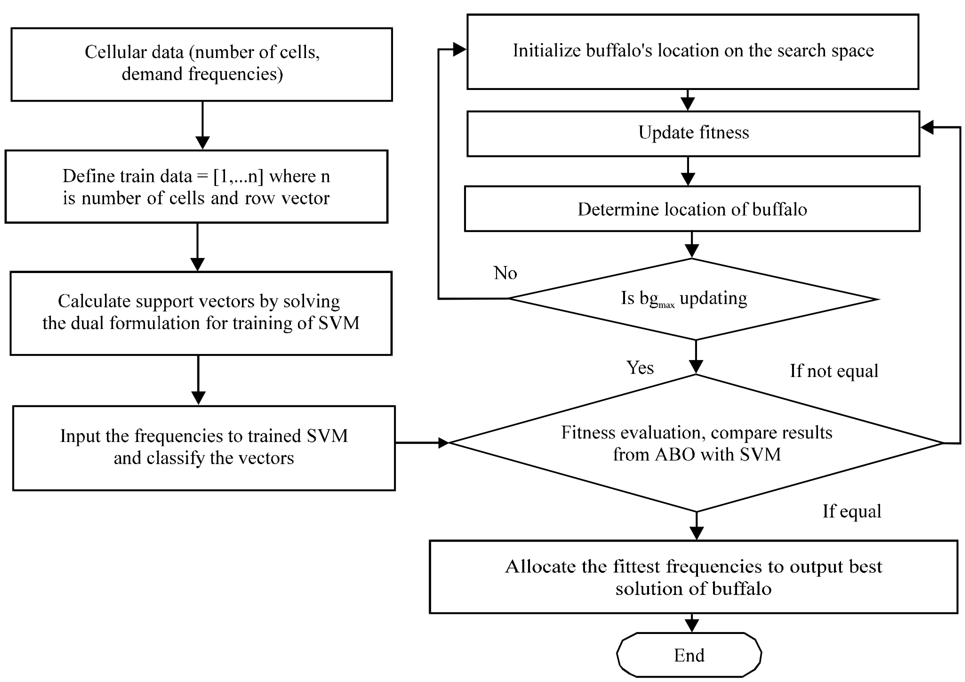

Fig. 2: Flowchart of detailed working of ABO-SVM

are used to achieve the desired allocation with minimum possible interference and moderate blocking. The simulation results are generated for Hybrid Channel Allocation (HCA) using the proposed method.

RESULTS AND DISCUSSION

The proposed method ABO-SVM is simulated for several problems and compared it with GA-SVM for performance evaluation in terms of energy and utilization in web traffic. The energy inefficiency in wireless networks is due to the mobility or due to the inefficient cooling factors in some cases, it occurs due to the classification of data. The total network models efficiency is depends upon the actual fitness value of the algorithm. Hence, the fitness values are calculated by:

$$\text{Fitness} = \tau + c * \rho$$

The classification rate is one of the main goal for optimization, if the data is separated then the value belongs τ and ρ to [0, 1] and c must be a real number represented as [0, 1]. The utilization of optimization process is given by

$$U_p = \sum_{i=1}^{n} \frac{C_i}{T_i} \leq 1$$

Where:

Ci = Worst-case computation-times of the 'n' processes

T_i = The respective inter-arrival periods which is assumed to be equal to the relative deadlines

The network lifetime is the important metric for battery operated networks. It is also defined by Tang and Xu (2008), as amount of time until the sensor runs out of energy. It is given by :

$$T_k = \frac{\text{Initial energy}}{\text{Energy consumption per unit time}} = \frac{E_0}{E_k}$$

The network lifetime is given by:

$$T = \min T_k$$

From Fig. 3 and 4, it is shown that the implementation of the proposed ABO-SVM method is implemented in a network simulator. To evaluate the effectiveness of the ABO-SVM, the GA-SVM made by Ohatkar *et al.* (2016) is considered. From the experimental

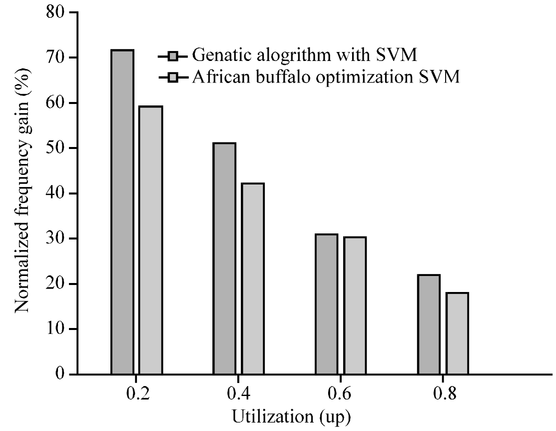

Fig. 3: Representation of GA-SVM and proposed ABO-SVM in terms of energy

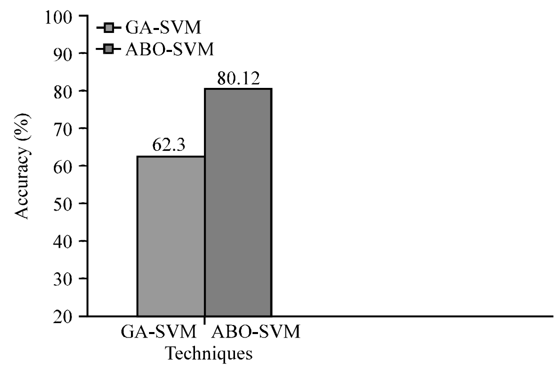

Fig. 4: Accuracy for GA-SVM and ABO-SVM

results it is well defined that the proposed model has 17.2% accuracy difference when compared with GA-SVM.

CONCLUSION

In networks, the overall performance factor is depends upon the data transmission rate and resource utilization. To improve this factor several research were made but still the problem occurs due to the interference and channel allocation and bandwidth constraint. The designs of effective wireless networks were based on large user throughput and high service provider capacity, not with the power or energy efficiency. In order to address these parameters, this research identified the sources of energy inefficiency in these networks. Hence, the proposed method solves these issues by vector classification with an African Buffalo Optimization (ABO). In future, implement this proposed design in a real time environment to test the web traffic blocking in cellular networks.

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