Ensembling Ml Models for Advancement in Wmn

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Abstract

Wireless Mesh Networks have long been hailed as one of the most promising technologies for future high-bandwidth, high-coverage wireless networks. Consumer demand for such networks, on the other hand, has just recently caught up, making it more critical than ever to optimise WMNs to accommodate massive capacity and provide excellent QoS while being secure and fault-tolerant. Machine learning (ML) has lately gained popularity for addressing several design and administrative difficulties related to WMNs for this purpose. Key machine learning techniques are presented in this study, as well as prior attempts to apply them to WMNs, along with some known obstacles and prospective solutions. There are ideas on how machine learning could aid future research. There's also a discussion of the most current developments in the discipline.

Key Words: Wireless Mesh Networks, Quality of Services, Machine Learning, Computational Intelligence

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Introduction

Each node in the WMN network functions as a congregation and a router, promotion of packets on behalf of supplementary nodes that are not within unswerving wireless transmission range of their destination. Self-organization, self-configuration, and self-healing are dynamic aspects of WMN that enable faster deployment, easier maintenance, cheaper costs, and reliable services to improve network capacity, connectivity, resilience, and robustness. WMN is becoming a popular balancing approach for infrastructure-based wireless networks.

Related Work

Several writers have proposed[3] employing various approaches and procedures to avoid interference and maintain faster transmissions. Unlike the recommended approaches, they have attempted to avoid collisions, but this has resulted in a slew of issues, including packet loss and an increase in error rate. As a result, these strategies were unable to deliver the optimal answer. The advantages and uses of Tabu search have been proposed by Glover[1]. Genetic algorithms for channel selection have been discussed by a number of writers, including many has provided an excellent method for boosting throughput.

WMN Architecture

Despite the fact that nodes are mobile, there are multiple different paths between source and destination, using hop by hop transmission.

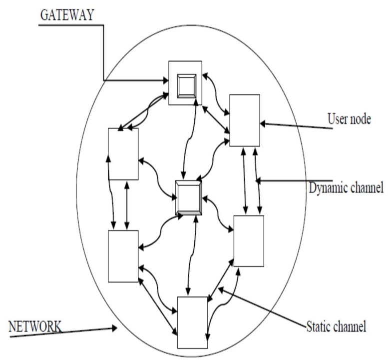

Fig 1.1 Sample WMN Architecture with Channel Assignments

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Channel Assignments

The term "static" refers to a way of allocating a channel indefinitely or for an extended length of time. Dynamic, on the other hand, allows any channel to communicate with any other or effortlessly transition from one to the next[2]. We lose node mobility and the capacity to apply reconstructive self-healing procedures when we select static. Control transmission isn't something that comes to mind when we think about dynamic transmission.

Interference In Channel Assignment

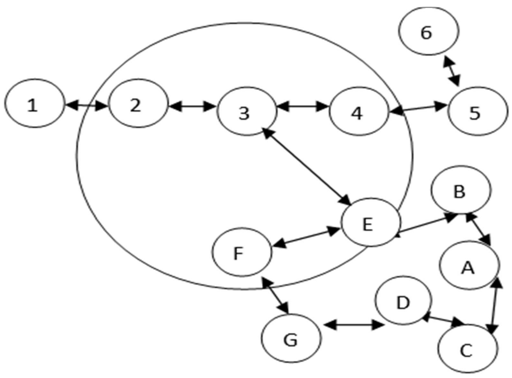

Fig 1.2 An simple interference example

Interference is simply a node that disrupts transmission. The current node can see it, but not the mesh network. The two types of interference are inter path interference and intra path interference. According to figure 1.2, node 3's coverage is fairly extensive; for example, if a message is sent from node 2 to node 6, it will be routed through node 3, but if node 4 also sends a message to node 3, inter route interference will occur. That is, node 2 sends a message to node 3 at the same time as node 4 sends a message to node 3, generating network interference in node 3. Intra route interference occurs when node 1 delivers a message to node 5 and node E, which is also under node 3's network coverage, sends a message to node 3. 2. When interference occurs on the same path, it is called inter path inter path interference; when interference occurs on a different path, it is called intra path inter path interference.

FORMULA FOR INTERFERENCE

Interference constraints are represented in a matrix format X

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1N} \\ x_{21} & x_{22} & \cdots & x_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ x_{N1} & x_{N2} & \cdots & x_{NN} \end{bmatrix} \text{-----------------------}1$$

According to our article, the channel starts at 1 and ends at N. If two channels can reuse a channel, we assign a value of 1; otherwise, we assign a value of 0.

2. Machine Learning In WMN

Machine learning aims to boost a system's performance by statistically analysing data collected during previous jobs. Supervised, unsupervised, and reinforcement learning are the three main types of machine learning methodologies. The term "supervised learning" refers to when a learner's incoming data has previously been labelled with human-driven supervisionIn contrast to supervised learning, in which learners are provided pre-labeled data, in RL, supervision is a reward delivered when a certain action is completed. Machine learning has sparked a lot of interest in wireless networks during the previous decade.These works intended to improve the stability and security of WMNs by optimising various components in order to escalate QOS.

2.1ML Applications in WMNs for Functional Desi gn Issues

While constructing a WMN, several challenges influencing the network's performance must be addressed.

2.1 Shortest Node Detection Using Tabu

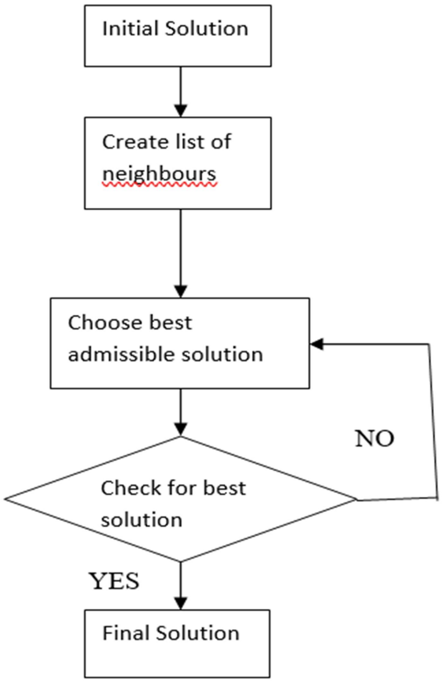

Figure 1.3 Tabu Routing Methodology

Tabu search is a meta heuristic method for locating the best explication by examining the nodes in your immediate vicinity[1][4].

2.2 Channel Assignment Solution Using ML

The channel allocation problem is concerned with distributing channels to wireless links among WMNs in such a way that interference is minimised and channel utilisation is maximised. Consider the following scenario, as depicted in Fig. 1.2.

1. Interpath interference
2- Intrapath interference
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2.2.1 Interflow Inference Avoidance Using Naïve Bayes

Based on the input features and the entire training dataset, Bayesian learning attempts to calculate the posterior probability distribution of a testing object's target features. For example, a wireless channel could be an object having measurement data on its signal, noise, and interference levels measured by a radio operating on that channel at a given node. What happens (likelihood) is observed, and the initial guess is amended based on what happens. The term assigned to the prior probability after it has been updated is called the posterior probability. Bayesian learning is a good choice when there are a limited number of data points and outliers must be properly controlled. Maximum likelihood estimation (MLE) and maximum a posteriori estimation are two instances of maximum likelihood estimation (MAP). MLE, which is a subset of MAP, employs a uniform prior distribution.

2.2.2 Intraflow Avoidance Using K Means Clustering

K-means clustering [5] separates a set of unlabeled data into a group of k clusters, with each observation being assigned to the cluster whose centroid has the closest Euclidean distance (the Euclidean distance is defined based on the attributes of the observations). The label for each cluster can be the centroid, which is often defined as the mean of the data points within that cluster. The most popular k-means clustering technique employs an iterative refinement procedure. This approach may have a channel assignment application, which should be emphasised.In order to divide and conquer channel allocation, several algorithms based on rule-based procedures cluster nodes into various groups . A common technique for providing inter-cluster connectivity would assign the same channel to nodes within the same cluster and provide a mechanism for assigning channels to radios at the cluster boundary. K-means clustering could be used to intelligently cluster the collection of nodes for this purpose. The majority of these methods require a cluster head to function; k-means clustering is ideal for this because the centroids of created clusters can be used as cluster heads.

2.2.3 Decesion Tree For Intrusion Detection Systems

A decision tree is a learning tree in which the leaf nodes reflect a class or feature of the input item and the internal (non-leaf) nodes indicate decision criteria (depending on whether classification or regression is performed). Iterating down the tree will bring you to a final conclusion. A variety of approaches, such as ID3 and its enhanced successor, C4.5, can be used to generate decision trees from class-labeled training tuples. It describes a cross-layer-based IDS that uses features from both the MAC and network layers to develop a normal profile. The four components are data gathering, profile training, anomaly detection, and alarm generation. Raw data is analysed and entered into the profile training module, which employs numerous classifiers, including C4.5.

2.2.4 SYM For Increasing QOS

Statistics on throughput, routing overhead, and end-to-end delay are collected first in both normal and attack conditions. After that, the normalised datasets for each of these characteristics are given into the SVM, which is then utilised to train the detection model. The trained model can predict attack scenarios in test settings; however, an alert threshold is set to prevent false positives before the user is notified in the response step.

3. Architectural Diagram

The complete architecture of the workflow is

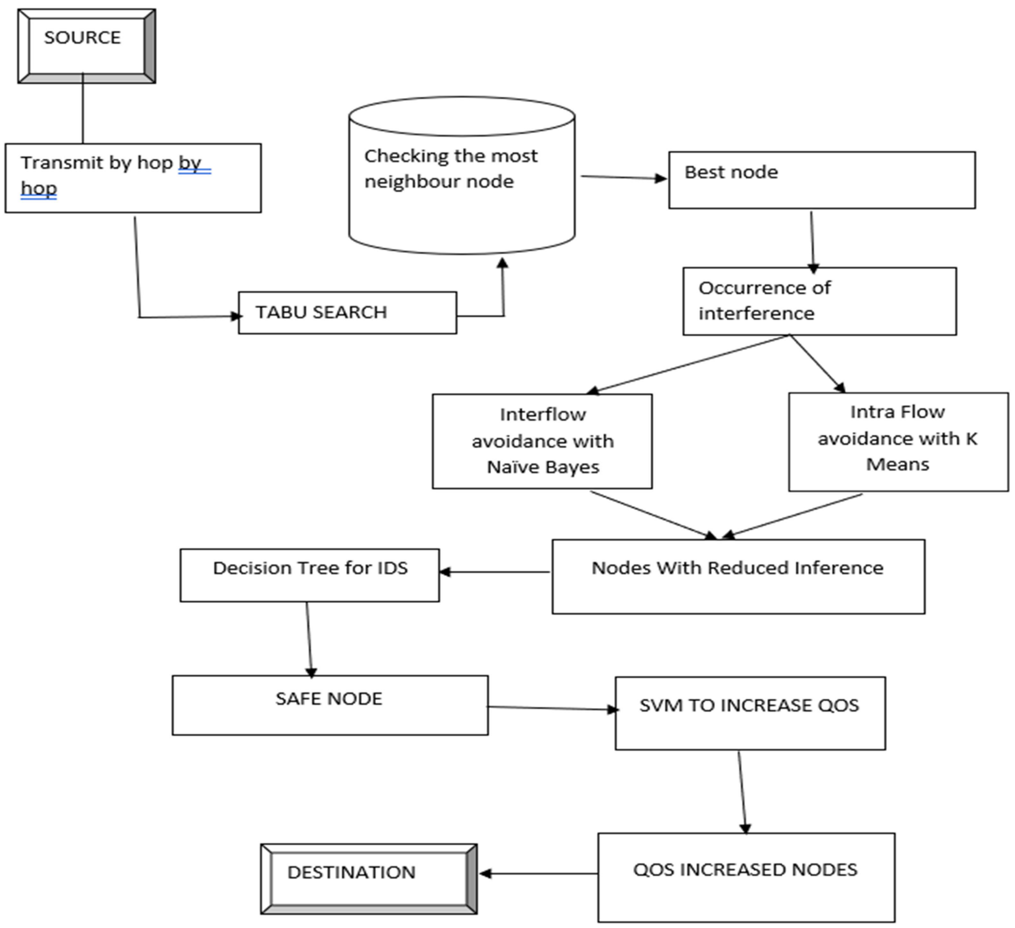

Figure 1.3 Architectural Diagram for the Overall Workflow

From the source the data is transmitted hop by hop through each and every node. Using Tabu Search the most nearing neighbouring node is selected for the best path transmission. Inference is avoided using 2 methods. Interflow avoidance using Naïve bayes and Intra flow avoidance using K means clustering. The nodes with reduced inference are passed to Decision Tree to remove the unwanted malicious nodes. The safer nodes are passed to SVM to increase the QOS such as end to end delay, increase in throughput and so on and finally reaches the destination.

4. Results And Discussion

From 20 to 100 nodes, the results are simulated using the NS 2 simulator. Because WMN is scalable, we can add as many nodes as we need. We used nodes that were 2500m * 2500m in size. The proposed completion algorithm is compared to Previous Max min fair flow optimized mesh networks.

4.1 Increase In Throughput

The volume of data successfully transported from source to destination in a certain period of time is referred to as throughput. Our TSA optimization of channel assignment increased throughput when compared to MMF. There are many interferences in the previous MMF, so throughput is low; however,

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in our TSA, we find the optimal solution, so throughput is significantly higher.

Table 1 Throughput Comparison of TSA and MMF

Node Count	MMF	Tabu
20	89	128
35	118	156
58	141	178
76	160	185
100	189	223

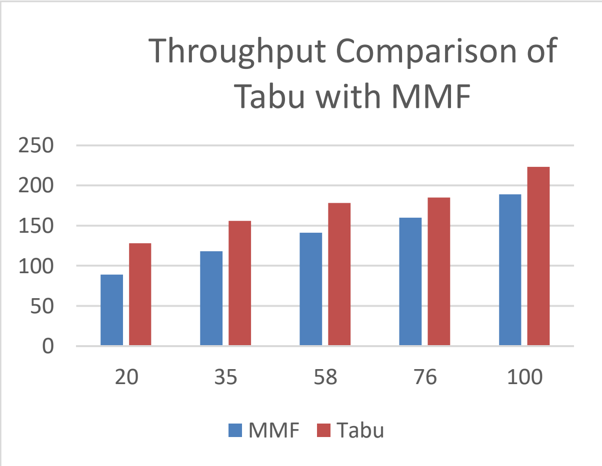

Fig 1.4 Throughput Comparison Graph of TSA and MMF

4.2 Decrease In Routing Overhead

The ratio of total routing packets created to total data packets successfully routed is known as routing overhead. When compared to MMF, TABU has a significantly lower routing overhead. This is due to the TSA's improved route and channel selection strategies. In Erlang, the cost of routing is calculated.

Table 2: Routing Overhead Comparison of TSA and MMF

Node count	MMF	Tabu
20	4.1	1.45
35	7.23	2.12
58	10.5	5.77
76	14.88	8.11
100	19.11	9.99

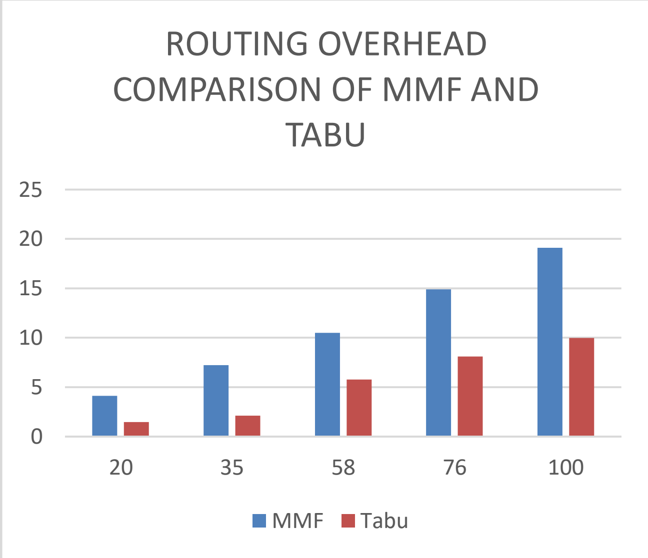

Fig 1.5 Routing Overhead Comparison Graph of MGA and MMF

4.3 Decrease In End To End Delay

For TSA and MMF, the average end-to-end delay is calculated. When shown in Fig.1.5, the average end-to-end delay of TSA is relatively low when compared to MMF; nevertheless, as the number of nodes rises, the data transmission delay increases as well.

Table 3: End to end relay Comparison of TSA and MMF

Node count	MGA	Tabu
20	2.1	0.9
35	4.12	1.8
58	7.6	3.4
76	12.1	6.4
100	19.2	8.2

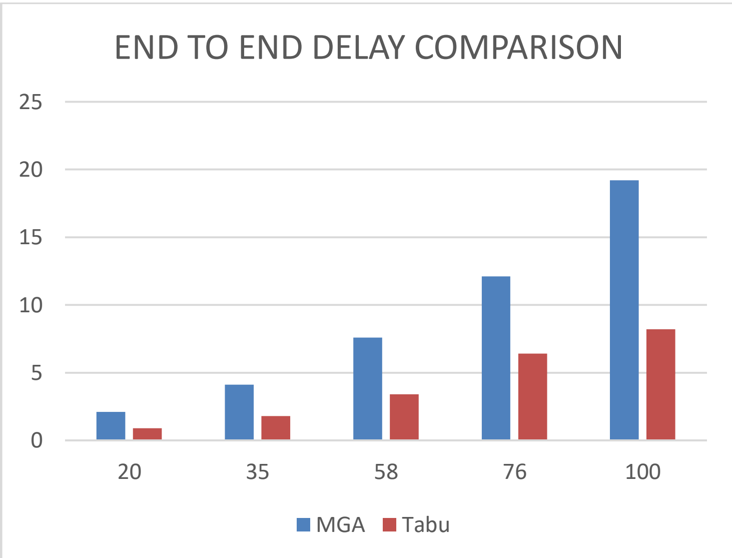

Fig 1.6 End to end delay Comparison Graph of MGA and MMF

Conclusion

WMN plays an important part in all types of network transmissions as a promising security and quicker transmission technology. When compared to all other previously discovered optimization techniques, WMN, in conjunction with Machine Learning algorithms, makes transmissions faster and faster while also avoiding dangerous nodes and making transmissions secure.

Declarations

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Conflicts of interest/Competing interests

The authors does not have any conflict of interest.

Availability of data and material

The needed data is simulated and attached in the tabular column.

Code availability

The code is readily available.

Authors' contributions

All authors have contributed the equal work for each and every algorithm.

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