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Optimization of Campus Intranet Using an Enhanced Neuro-fuzzy and Adaptive Firefly Algorithm

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ABSTRACT: The study addressed Intranet issues in Tertiary Institutions, which include packet loss, congestion, poor Campus Intranet evaluation due to the absence of a firefly model, resulting in inaccurate routing metrics for improving performance, insecurity and latency in the routing process of the system. The vast and frequent usage of the Campus Intranet requires upgrade and improvement in network topologies and management techniques in order to maintain high Quality of Service (QoS). The use of nature-inspired or heuristic Algorithm, which may be combined with other optimization techniques for efficient Network Routing, is basically essential. Routing plays a significant role in directing network transmitted information or data packets and to provide quality service in Network, as it can be described as an astounding complicated task, and there are a number of diverse algorithms used to enhance the routing process. In this work, an optimized Campus Intranet System, using Neuro fuzzy technique and Adaptive Firefly Algorithm was developed. The Object Oriented Analysis and Design Methodology was adopted and implementation was done with Java programming language and MySQL as the backend. In addition, the datasets used were trained with Python programming language and Artificial Neural Network. The obtained results of the Enhanced Neuro-Fuzzy and Firefly Model (Proposed System) performed better than the existing system when compared in terms of Accuracy (A), Classification Error (CE), Processing Speed (PS), and Area Under Curve (AUC). The values obtained by the Proposed system after comparison are 96.00, 4.00, 10.22 and 0.97 respectively against 91.67, 8.33, 15.7 and 0.95 obtained by the existing system. The Enhanced Neuro Fuzzy Model will be beneficial to the management of the institution as it will serve as a model evaluator, capable of optimizing the routing process of the Campus Intranet. evaluated parameters and technological areas are as a result of the end-users' feedback survey of the existing and proposed systems. The benefit of the adopted method is the possibility of program re-use and maintenance.

KEYWORDS: Optimization, Campus Intranet, Neuro-fuzzy, Adaptive Firefly Algorithm

I. INTRODUCTION

The evolution of Technology brought about innovations in the industries, companies, government and tertiary institutions, which encompasses better and faster way of sharing resources, information and improvement of collaborations among users. One of such innovations is Computer Networking. Computer Networking refers to the interconnected computing devices that can exchange and share resources with each other. Computer networking enables devices and endpoints to be connected to each other on a Local Area Network or Wide Area Network (WAN). The concept of internet and intranet bare similarities and characterization. However, for the purpose of introduction, definition would be limited in scale.

Internet: The Internet is a global network of interconnected networks, connecting private, public, and university networks in one cohesive unit.

Intranet: is the miniature version of the Internet, it is a private enterprise network used by organizations to distribute communications and promote collaboration among the task force and it uses Internet and Web technologies for information gathering and distribution within an organization. The successful intranets have allowed organizations to: Save money; Increase employee productivity and employee retention; Empower the customer help desk personnel with intranet knowledge management systems, resulting in increased customer satisfaction and retention; Provide competitive advantage by making the product information, production schedules, and the product competitive analysis

only a click away. This empowers the sales, marketing, and support group, resulting in increased sales, added revenue, and customer retention.

The prerequisites for a successful deployment of an intranet are:

- i) Unified intranet strategy and architecture;
- ii) Secure and ubiquitous intra-enterprise connectivity;
- iii) Integration with legacy networks and applications (including mainframe);
- iv) Use of standards-based technology for network, security, and Web authoring;
- v) Common user interface based on a universal Web client, which helps in reducing the cost of maintaining each desktop; Implementation of enterprise-wide policies and guidelines on network access, security, content authoring, and management;
- vi) Management and user buy-in.

The need to optimized the network signals cannot be over emphasized as Signal Optimization encompasses the complete set of technologies and strategies a business deploys to improve its network domain functionality. Network and network domain refer to your organization's set of hardware devices, plus the software and supportive technology allowing those devices to connect and communicate with one another. One of the primary goals of network signal optimization is to provide the best possible network experience for users. It enhances the speed, security and reliability of your company's IT ecosystem. Improving that ecosystem seems intuitive in theory, yet it is challenging to master. Signal optimization is essential for business activities that require 24/7 access and real-time usage of digital technology. The study is basically about optimization of the campus intranet using enhanced neuro-fuzzy and adaptive firefly algorithm, hence it pertinent to talk about the Neuro Fuzzy System and adaptive firefly algorithm.

A neuro-fuzzy system is a fuzzy system that uses a learning algorithm derived from or inspired by neural network theory to determine its parameters (fuzzy sets and fuzzy rules) by processing data samples. It is a system that is trained by a learning algorithm derived from neural network theory. The (heuristic) learning procedure operates on local information, and causes only local modifications in the underlying fuzzy system and can be viewed as a 3-layer feedforward neural network. The first layer represents input variables, the middle (hidden) layer represents fuzzy rules and the third layer represents output variables. Fuzzy sets are encoded as (fuzzy) connection weights. It is not necessary to represent a fuzzy system like this to apply a learning algorithm to it. However, it can be convenient, because it represents the data flow of input processing and learning within the model. Concept of Fuzzy Logic Boolean logic accepts only two values true or false (0 or 1). In this one can talk about low or high. It does not say anything between them that is it does not take the concept of medium. This can be done by the more extended concept that is by fuzzy logic as it takes values [0, 1]. Because of this concept one can talk about low, high and medium and also about very low, very high also. So it is the extended version of Boolean logic [1].

Furthermore, analysis of Campus Intranet (CAM-NET) performance showed that Network performance was merely determined by traffic flow and Bandwidth management in previous studies. However, quality of service is subjected to multiple factors in Network broadcast and transmission, especially Virtual Private Network. The World Wide Web and the Intranet are closely related but there are differences. The World Wide Web is designed to be used by everyone and is part of the Internet while the Intranet is used primarily by people of the same Institution or Corporation but employs the same technologies used on the Internet with cost effectiveness. Needless to say, as indispensable as the Internet is to any Organization or Institution, there is still the obvious problem of high cost of acquisition and maintenance of the technologies driving it especially in a developing economy like Nigeria. Hence, the need to evolve a vibrant and cost effective Intranet that will help in conserving the expensive Internet Bandwidth becomes inevitable [2]. The Intranet, which uses the World-Wide Web technologies to manage and deliver information locally in an efficient manner can now be improved.

This Study adopted Adaptive-Firefly Algorithm technique for improving the present Neuro-Fuzzy Campus Intranet System. The Firefly Algorithm (FA) is a nature-inspired meta-heuristic for solving continuous problems and has been motivated by the simulation of the social behaviour of Fireflies. The Two fundamental functions of its flashing lights are to attract mating partners (communication), and to attract potential prey. In essence, FA uses the Three following idealized rules:

- i) all fireflies are unisex;
- ii) attractiveness β is proportional to their brightness, in this way for any two flashing fireflies, the less bright one will move towards the brighter one;
- iii) the brightness of a firefly is affected or determined by the landscape of the objective.

II. RELATED WORK

A. Empirical Review

A Neuro-Fuzzy-based Dynamic Secure Routing Protocol for QoS Frameworks of MANET was Proposed [3]. The study proposed a routing algorithm “neuro fuzzy based dynamic secure routing (NFBDSR)”, in which routing is performed by using Fuzzy Logic Controller (FLC) with neural network. The proposed routing protocol calculated route metric value using four crisp input variables, Processing Capability (PC) of node, Available Bandwidth (AB), Node Mobility (NM), and Node Trust Value (NTV). To calculate the node trust value the authors used Neighbor node Surveillance method. The real world applications of our algorithm is that it consider MANET environment applications such as multimedia, audio/video, images, animations, graphics, video conferencing, VOIP and webcasting need uninterrupted, rigorous and inflexible Quality of Service (QoS). The NFBDSR routing algorithm detects malicious node that intends to attack the network.

Intranet Network Principles was presented [4]. The authors presented the study as a set of intranet network principles, a discussion of the motivations for developing the principles, reviews of existing community practice, and a discussion of the requirements these principles would place upon different stakeholders. However, the authors failed to implement the discussed Intranet Network Principles with a machine learning model which would have provided more clarification and understanding.

The usage of Internet for Academic Purposes on University Students’ Achievement: A Literature Review was considered [5]. The study highlighted for understanding deeply on the effectiveness of internet usage among university students in their studies. This review found that socio economic status of students has both positive and negative significant effect on their academic achievement. Furthermore, students spend more than one hour online depended on the many factors that cause them to be online. The authors did a good job. However, the authors failed to implement the surveyed mining software repositories with a machine learning model which would have provided more clarification and understanding.

Intranet for Library Services was researched [6]. The author gave brief introduction about the Intranet, its history, need in an organization, merits and demerits, characteristics and current trends in internet technology. The use of intranet in providing library services like SDI, CAS and other information management explained with a schematic diagram. The author did a good job but failed to implement the discussed issues in his study with a machine learning model which would have further given more clarification.

A Neuro-Fuzzy Approach for Intrusion Detection in Energy Efficient Sensor Routing was studied [7]. Their study focused on intrusion detection in energy efficient Sensor Network using Neuro-Fuzzy approach. Their proposed Model also discussed how anomalies detection scheme is improved using Neuro-Fuzzy approach. According to the Authors, Wireless Sensor Network Systems (WSNs) have received noteworthy research consideration because of their elite qualities like broad capacity to detect the physical world phenomenon and their broad scope of utilizations, extensive variety of uses due to low cost. The Authors did a good job. However, a major limitation of their study is that the developed model was deficient in benchmarking and cost benefits analysis.

Neuro-Fuzzy sender recognition of email and email categorization was proposed [8]. Their system was developed to be able to identify spam emails even before the receiver opens the email. This was done by using the previous patterns of the emails to identify the actual sender of the email and to categorize the emails into ham and spam by using machine learning algorithm. Their result shows a high level of accuracy in email sender identification and email categorization but they could not perform feature extraction and selection.

A Neuro-Fuzzy Model for Determining Shortest Routing Path in a Computer Network was developed [9]. In their study, a neuro-fuzzy routing algorithm was proposed. According to the authors, neuro-fuzzy system was used to develop an efficient routing in a 10-nodes hypothetical network simulated with MATLAB software. In this case, they were able to determine the optimal cost and predict the shortest path. Their study also compared the efficiency of these neuro-fuzzy with open shortest path first (OSPF) and genetic algorithms for message routing based on delay time. Ten different messages of varying size were sent across the hypothetical network using the three approaches and the delay time calculated in each case. The implementations of models were carried out on MATLAB (2008a). The results from the simulation experiment showed that the delay from Dijkstra’s algorithm ranges from 1.92 to 44.32, that of neuro-fuzzy model ranges from 1.02 to 22.53 while that of genetic algorithm ranges from 1.03 to 20.99 implying that the performance of neuro-fuzzy is comparable to genetic algorithm in delay time. The authors did a good job. However, their obtained delay time result after comparative analysis carried out showed time complexity which is still due to the absence of an adaptive fire-fly algorithm that would enhance their system performance.

B. Direction of the Research Thesis

In all the reviewed related works, this research work has been narrowed down to the direction of the most current and closely related discussed issue. [3] proposed a Neuro-Fuzzy-based Dynamic Secure Routing Protocol for QoS Frameworks of MANET. The aforementioned work was analyzed using several system analysis diagrams; Activity model, Data Flow Diagram, Use Case Diagram. After which, we focused on the loopholes of their Existing Architecture. The Existing Architecture is void of an optimization technique, hence, was unable to improve or solve the latency in routing process as a result of poor or no evaluation due to the absence of firefly algorithm or optimization technique.

III. ANALYSIS

A. Analysis of the Existing System

The System to improve in the study is a Neuro-Fuzzy-based Dynamic Secure Routing Protocol for QoS Frameworks of MANET (Fig. 1). The study proposed a routing algorithm “neuro fuzzy based dynamic secure routing (NFBDSR)”, in which routing is performed by using Fuzzy Logic with neural network. The proposed routing protocol calculated route metric value using five crisp input variables, Processing Capability (PC) of node, Available Bandwidth (AB), Node Mobility (NM), and Node Trust Value (NTV). To calculate the node trust value the authors used Neighbor node Surveillance method. The real-world applications of our algorithm is that it consider MANET environment applications such as multimedia, audio/video, images, animations, graphics, video conferencing, VOIP and webcasting need uninterrupted, rigorous and inflexible Quality of Service (QoS). The NFBDSR routing algorithm detects malicious node that intends to attack the network.

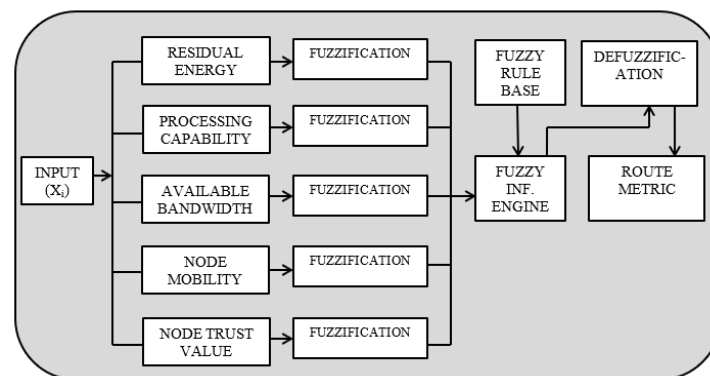


Fig. 1. Architecture of a Neuro-Fuzzy-based Dynamic Secure Routing Protocol for QoS Frameworks of MANET (Source: [3])

From Fig. 1, the parameters Residual Energy (RE), processing capability (PC), Available Bandwidth (ABW), Node Mobility of (NM), and Node Trust Value (NTV) are used to calculate Route Metrics (RM) value. The detail description of metrics used for RM calculation is given below.

(i) Residual Energy:

The Markov chains energy model is used to calculate the nodes residual energy. The residual energy E_r of a node at time t is computed as

$$E_r = E_i - E(t) \quad (1)$$

where E_i is the node i initial energy.

$$E() \text{ is the } E() = \varepsilon + \delta \quad (2)$$

Energy consumed by the node at time t

ε and δ are constants in the range (0, 1).

(ii) Processing Capability:

It is the number of instruction executed per second. Processing capability (PC) is the power of processing element which is measured in MHz or GHz.

(iii) Available Bandwidth:

When a node needs to transfer data, it has to be known the local bandwidth, interference and transmission range of the neighboring nodes.

(iv) Node Mobility:

Random Waypoint model was utilized in the Existing System. The versatility of node i regarding node j is evaluated dependent on the proportion of the got sign quality between two continuous parcel transmissions from a neighbor node

v) Node Trust Value:

To calculate the node trust value the Existing System utilized Neighbor node Surveillance method. When source nodes have packets to send then it store that packet in buffer and send it. After sending a packet source node waits for a fixed time of interval to overhear the neighbor node. When neighbor node forward that packet to next hope then source node compare the overheard packet to the buffered packet if packet is similar then source node assume that the corresponding node is the trusted node and increase the trust value by one of corresponding node in routing table. If source node don't overhear the send packet within fixed time interval then source node assume that the corresponding node is black hole or wormhole node and broadcast a message in whole network that particular node is black hole node.

When broadcast message is received by other node they update own routing table and decrease the trust value one of corresponding node. And if neighbor node change or alter the field of data packets then source node found that packet comparison is dissimilar and assume that corresponding node is malicious or selfish node and broadcast a message that particular node is malicious or selfish. By using this method we prevent the network by different types of attacks like black hole attack, wormhole attack, Dropping Attacks, etc.

1) Disadvantages of Existing System

Performance evaluation carried out on the Neuro-Fuzzy model showed latency in the routing process of the current Neuro-fuzzy system due to the absence of an adaptive fire-fly algorithm that would enhance the process. Secondly, the developed NFBDSR routing algorithm of the Neuro-Fuzzy model is only limited to the detection of malicious threat to the network and fails to provide deep generative firewalls which will also prevent the detected threat to the network in the long-run. In other words, the Proposed Enhanced Neuro-Fuzzy Model in the study will improve the adopted framework of the Neuro-Fuzzy model through the application of a Controller for the Performance Evaluation and Optimization of Campus Intranet Services.

B. Proposed System (Enhanced Neuro-Fuzzy Model)

The Enhanced Neuro-Fuzzy Model of the study encompasses the design of a Controller for optimizing intranet performance using Deep Generated Firewalls and Adaptive Firefly Algorithm (Fig. 2). The Controller will enable robust evaluation of intranet performance through fuzzy-based rules such as if-then, which would further aid the utilization of human experience and expertise when harnessing the performance of intranet services in wide areas. Furthermore, the Controller can also be utilized in the controlling of machines. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as the "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans. The design process consists of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on.

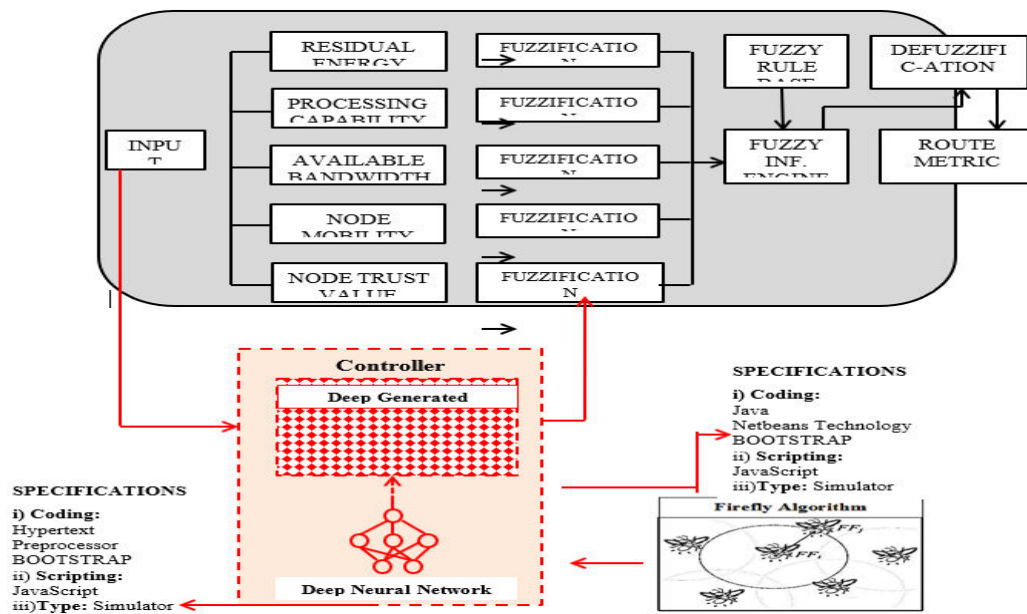


Fig. 2. Proposed System (Enhanced Neuro-Fuzzy Model) Architecture

1) Advantages of the Proposed System

The designed Controller will enable reduction of latencies when evaluating intranet routing performance. This is because; the Controller generates fuzzy rules that use the truth values of the inputted crisp datasets. In practice, the fuzzy rule sets of the designed system have several antecedents that are combined using fuzzy operators, such as AND, OR, and NOT, though again the definitions tend to vary: AND, in one popular definition, simply uses the minimum weight of all the antecedents, while OR uses the maximum value. There is also a NOT operator that subtracts a membership function from 1 to give the "complementary" function.

IV. METHODOLOGY

The study adopted the Object Oriented Analysis and Design (OOAD) Methodology for analyzing the Existing System and also designing the New System. The Object Oriented Analysis and Design Methodology is a software engineering approach that models a system as a group of interacting objects. Analysis involves understanding, finding and describing concepts in the problem domain while design has to do with understanding and defining software solution/objects that represent the analysis concepts and will be implanted in code.

V. EXPERIMENTAL RESULTS

A. Performance Evaluation Matrix Table for the Enhanced Neuro Fuzzy Model

	Accuracy	Precision	Recall	Specificity	F1 Score	Classification Error
Good network	96%	1	0.9	1	0.95	4%
Poor network	96%	0.94	1	0.9	0.97	4%
Overall Accuracy for the Enhanced Neuro Fuzzy Model is 96% with a classification error of 4%						

Percentage of Trained Data	Accuracy	Classification Error
	77%	23%
	70%	

B. Implemented the Enhanced Neuro-fuzzy model and Adaptive Firefly Algorithm with Java programming language and MySQL

The program started with the Netbeans IDE (Integrated Development Environment) startup for Java Application program codes. The IDE enabled Java applications to be developed through series of program components known as modules. Fig. 3, shows the landing page of the proposed system. The landing page contains two buttons identified as “students’ registration” (Fig. 4) and “Camnet evaluation page” (Fig. 5). The user clicks on the “register student” button, it navigates to the “New Student’s Registration page”. The registration page enables the user to input vital registration details such as first name, last name, gender, email, address, phone number, username and password. Furthermore, the registration page also consist of submit and clear buttons. The submit button sends the inputted data to the backend, while the clear button erases the previous datasets entered by the user. The registration page of the Proposed System is designed in such a way that it prompts the user to not submit an empty field. The registration page is designed in such a way that it prompts the user not to submit an empty field. It also alerts the user on whether the registration process is successful or not. After successfully registering with the system, the user navigates to validate access through inputting the username and corresponding password. Fig. 6, shows the Firefly Model result (i.e. the routing metrics after evaluation).

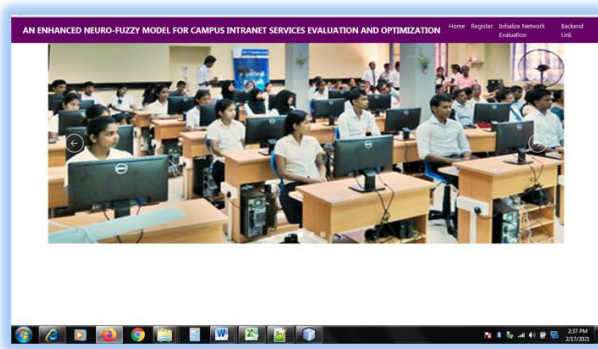


Fig. 3. Welcome Page

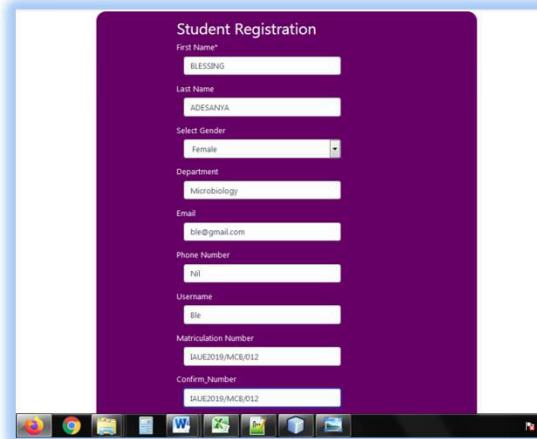


Fig. 4. Registration Page

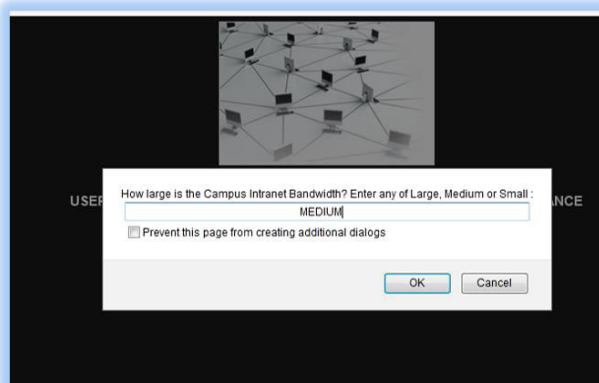
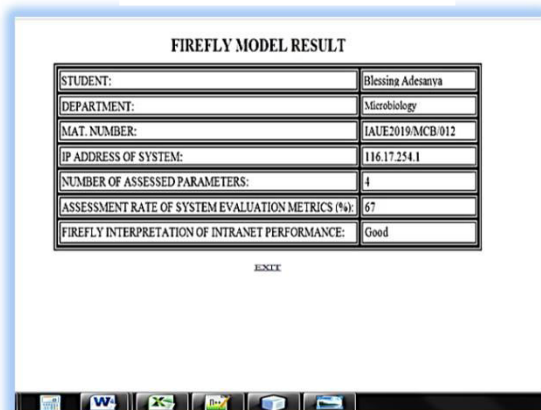


Fig. 5. Test-set Input



FIREFLY MODEL RESULT	
STUDENT:	Blessing Adesanya
DEPARTMENT:	Microbiology
MAT. NUMBER:	IAUE2019/MCB/012
IP ADDRESS OF SYSTEM:	116.17.254.1
NUMBER OF ASSESSED PARAMETERS:	4
ASSESSMENT RATE OF SYSTEM EVALUATION METRICS (%):	67
FIREFLY INTERPRETATION OF INTRANET PERFORMANCE:	Good

Fig. 6. Firefly Model

Comparative Analysis charts respectively (Fig. 7). Furthermore, accurate evaluation of both systems was carried out with aid of the Receiver Operating Characteristic (ROC), which is a graphical plot that illustrates the diagnostic ability of a binary classifier system as its discrimination threshold is varied. The first two diagonal cells show the number and percentage of correct classifications by the trained network. The Area Under the Curve (AUC) for the Neuro-Fuzzy System is 0.95, while Area Under the Curve for the Enhanced Neuro-Fuzzy System is 0.9688. In evaluating a system,

performance metrics is required in order to know the strength of the system in terms of usage, and for obtaining an accurate result.

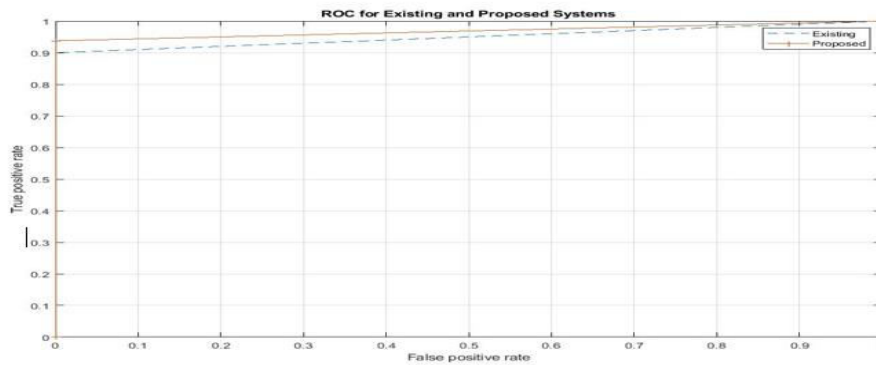


Fig. 7. ROC for the NFBDSR and Enhanced Neuro-Fuzzy Model

VI. CONCLUSION

In this study, we developed an enhanced model for performance evaluation of Neuro-Fuzzy and Adaptive Firefly for routing optimization in campus intranet (CAM-NET). This will enable users enjoy more effective and efficient way of running the Institution and to have a robust Intranet web portal that will enhance collaboration among its users, as information and documents will be access easily. A fully functional Intranet can incorporate electronic messaging and chat room which will make learning and collaboration faster and cost effective without the need to go through the Internet. The Intranet can serve as a repository of academic materials gotten from the Internet or other sources and will be available off line on the department's LAN. The only time to go on the Internet will be when new materials are available for downloads on to the file or proxy server.

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