Design of Advanced Intelligent Network Advisor Using Fuzzy Rule Base System

Sajjad Ahmed[1]*, Obed Ullah[1], Qaisar Nazir[2]
[1]School of information Technology, University of Lahore,
Blue Area Islamabad,Pakistan
[2]School of Electrical Engineering & Computer Science,
NUST, Islamabad, Pakistan

Abstract

Computer networks have become very important for businesses, organizations and institutions as the amount of network consumers, services, and submissions has improved along with developments in educational technology. Efforts have been put forward by researchers, designers, managers, analysts, and professionals to optimize network performance and assure the optimum network design. Moreover, the idea is to develop a new type of network that is capable of meeting the user needs and also can face the new challenges that users are facing now a days.

This research aims to develop a decision support system (DSS) for network planning and designing. A network plan or design is subject to a number of network components like transmission media, coverage area, cost etc and features like data rate, bandwidth, efficiency etc. That is why sometime it's really hard for a person to optimally choose the components of the network so that its usage can be optimized according to the users' need. A fuzzy rule base system (FRBS) is proposed and designed for the solution of above problem. Fuzzy system is suitable for the situations that are vague and missing certain information. The FRBS once designed would be able to suggest the most suitable most network model when a set of requirements will be given as input. Once the model is decided users can easily obtain the appropriate plan of action.

Key words: Advanced Research Projects Agency (ARPA), Digital Subscriber Line (DSL), Distributed Object Computing (DOC), Rule Base System (RBS), Wireless Local Area Networks (WLAN), Intelligent network Advisor (INA), Decision Support system (DSS), Input Output Pair (IOP)

1. Introduction

Planning and design problem of a network aims to define a network capable of handling communication requirements at a minimum cost. In this dissertation we proposed and designed a fuzzy rule base system (FRBS) as a decision support system (DSS) to help deciding about a network model based upon certain given requirements. The fundamental points that should be in mind when we are going to plan any type of network design are:

1. Classifying the applications that we propose to use a computer networks might be necessary in a variety of situations for example Enterprise Resource Management, for an Instant Messaging, and Email as well and so on. These software and hardware are used to approximate of user requirements.

2. Bandwidth necessities are also an important aspect that makes comfortable the user's quality of service demands. Some of points that consist of:

   a. Recognition and guarantee of most important transmitting resources.

   b. Categorization of flow data as limited, circulated, terminal/server, workstation/host and peer-to-peer.

   c. Estimation of the bandwidth that each user required.

   d. Dependability is also important.

   e. Quality of Service (QoS) that every program required to performed a task.

3. Scalability Support of network must be able to grow with user requirements.

4. Accessibility of a Network is also very important aspect. In this way one can say that network or services provided by the network must be available at any situation.

5. Geographical situation Local Area Network and Wide Area Network are concerned. Different offices that located by huge distance that can be interconnected together through a wide area network. Organizations and firms buildings and complexes can be connected through a local area network. Generally, the LAN connections have high band width that could be in Mbps to Gbps and WAN connections are that have lower bandwidth that could be in Kbps to Mbps. LANs are mostly used in the area of company, school, universities and organizations while WANs are normally used and sustained in the Telecom sectors. Hence, WAN seems expensive and required to be designed and intended with utmost concern to reduce resource consumption.

6. Security means to make a plan for protection of data and relevant things that needs to formulate the protection in any situation. We should identify:

   a. A catalog of supplied service that provide to the networks for example Web services and e-mail series, etc.

   b. These security service controlled by whom?

   c. Are the people well-known informed about security and protection policies that measure?

   d. Security breakdown, recovery plan does have effect.

7. Cost concern is also measured for LAN; the basic reason is to reduce the tackle cost. That's mean minimum the cost of cable, minimizing the cost on per port, added the employment cost. For the WANs the main purpose is to take full advantage of the bandwidth. The reason of this; the common expenses designed for bandwidth are usually very high than the tools or employment charges.

Consequently more strength is known to the faithful tools, and efficient deployment of the data rate. A number of reasons that manage cost are:

   a. Get better organization on WAN circuits by using characteristics such as compression, activity of a voice detection etc.

   b. Usage of technologies like an ATM that with passion allocates WAN data flow.

   c. Join together both voice and the circuit of data

   d. Reduce under-utilized flows.

8. No of users or PCs: Number of users is something very important in network design. Since this is the whole figure that can limit the data rate or the bandwidth efficiency.

These are few factors that must be kept in mind when we are going to design a network, no matter at what scale. So aim is to build a software tool that helps the users to choose an optimum network design based upon given set of requirements.

According to the Akyildiz (2002), what should be the planning if we are going to describe or suggesting a network. What should be the properties and what are the main characteristics to keep in mind before going to elaborate the networks. Some years back it was not a big deal in such a situation that if a person want to install a network for a company or organization and even for a school that they can easily plan a network, but now in this technology era where everything is increasing in massive amount, companies or an organizations extended over cities and even countries. In this condition we must need to plan a proper network, a network that fulfills our all necessary requirements.

The main purpose of this research is to design a decision support system (DSS) to facilitate the user to choose among the network models when he/she wants to plan a network based upon the requirements. Optimum network design is

requirement of almost every network administrator since in this way one can optimally utilizes the available resources.

2. Literature Review

Artificial intelligence is a type of intelligence of software and hardware that is used to create for the specific purpose. According to the books of AI " it is a field of study and model to design intelligent things as a agent " where agent is a system which take some input from the environment and show output after processing on it that make sure of maximum success. John McCarthy, a person who used the term first time in 1956s, elaborates it as a part of science and development that make intelligent machines.

Gary V. M. et al., (March 2000) reasoning has been obtainable by the majority researchers in AI as the foundation ability of an intelligent being. By environment, reasoning is closely coupled with knowledge demonstration i.e. the reasoning process must accurately know how the knowledge is reserved to control and extract new knowledge from it. As I'm yet to work out the exact representation of knowledge in normal intelligent beings like humans, I have based our knowledge representation and therefore reasoning on man-made logical demonstration namely logic i.e. predicate logic and family.

There are some advantages discussed by Becerra-F. (2000), in RBS like a large variety of people can get human expert knowledge. Furthermore to detain the knowledge of any special field, any strength of knowledge cannot lost in case of withdraw or leave the firm. At the given of an agenda, all rules at the left hand side must be matched. In case of picked the rule of an agenda because there is no way to predicting,

then its right hand side will be execute after that the agenda from the left hand side will be removed. Afterwards, using rete algorithm a type of special algorithm, the agenda will be updated. After that new rules will be selected for execution, and this process will continue till there will be no agenda remained.

Through detailed history of Artificial Intelligent, by Buchanan, B. G. (2005), the name Artificial intelligence invented near about mid 1950's. At present it is known as "subfield of computer science concerned with the concepts and methods of symbolic conclusion by computer." A first development develop in 1955, traced back AI, when Carnegie Mellon a researcher, in university, purposed a computer program that can work by proof in theorems by resulting. After 1950's, a computer programming language LISt Process that is known LcISP was developed by McCarthy. LcISP used in most of the projects in artificial intelligence. Roundabout mid 1960's still artificial intelligence was used in small development projects. Probably in the surge of AI. self-assurance was at its paramount and human competition was taken too lightly and very simpler.

3. Proposed Approach

A Fuzzy Rule Base System (FRBS) is proposed and designed as a decision support system that helps in optimizing the network model based upon various inputs and considering certain constraints. This problem is considered as a constrained optimization problem in which certain parameters are optimized using the proposed fuzzy rule base system.

There are various approaches for designing a fuzzy rule base system. We have chosen a table lookup scheme as the approach for proposed FRBS. Following are the steps involved in creation of a fuzzy rule base system. In subsequent sections these steps are explained in detail.

- Raw Facts
- Data Acquisition
- Rule Formulation
- Eliminating of conflicting rules
- Completion of lookup table
- Creation of fuzzy rule base system.
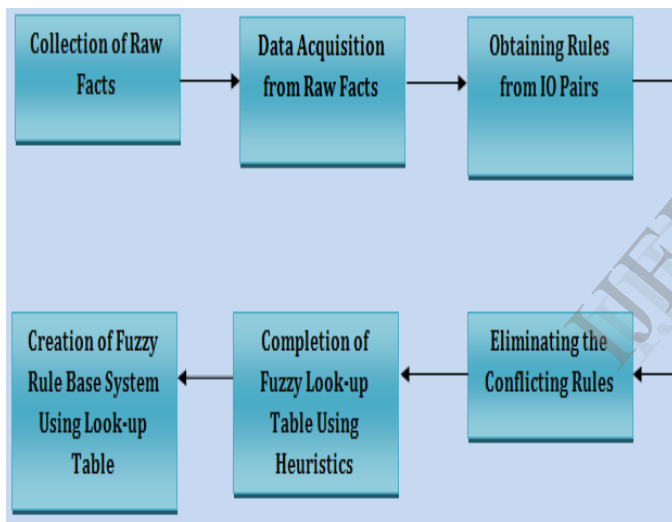
Steps for designing Network Advisor using fuzzy rule base system

In order to design the proposed fuzzy rule base system, we have employed a look up table technique. This technique is suitable for the situation where major amount of facts are known about the system and some portion of knowledge is missing. In fact the fuzzy rule base system interpolates the unknown space with suitable most options based upon the available knowledge.

The knowledge being provided can be obtained from expert or designer who wants a system for supporting his/her decisions. The detail about the steps is given below

3.1. Raw Facts

The knowledge based upon which we want to build up the fuzzy rule base system can be obtained from the user or the expert. This data may be in raw format so we need to eliminate the unnecessary details. This process is also referred as data fusion.

3.2. Data Acquisition

From the facts gathered in the previous steps the data is arranged in terms of input output pairs. These are refined and written facts that would later be input as rules in the rule base. Now pertaining to our system such refined facts can be written in the following way.

$$(x_1^p, x_2^p; y^p); p = 1, 2, 3 ...... M$$

In this equation x's represent the inputs combination and y represent the known output. Superscript p represents the number of facts being collected. We can also refer these facts as input output pairs (IOPs). In our case these facts are formulated in terms of input outputs like the inputs are 'area', 'cost', 'security', 'no_of_pcs', 'data_rate' and output is a 'model'. So in total M number of instances are obtained from the given refined facts.

3.3. Rules Formulation

Now from the IOP obtained from the previous step, rules are formulated. Roughly, one rule from each IOP. Now the rule structure can be defined as;

{IF (AREA=VAL1,

COST=VAL2,

SEC=VAL3,

NOPC=VAL4,

DR=VAL5;

OUP=MOD1)}

Here this rule represents if the input variables have a certain set of values then which model is suggested as suitable. This fact is added into the table namely the look up table. In this way we need sufficient number of rules to be stored in the lookup table so that the knowledge is not lacked. Since this is a starting point of physically designing the fuzzy rule base system. As the table is a logical design and due to number of inputs its dimension is five we cannot visualize it as such, but for sake of reader's convenience a two dimensional lookup table is given.

This table show the logical knowledge representation where there are two input variables namely SNR and QoS. The possible range of values of SNR is from L1 to L9 and range of values for QoS is poor, medium, good and high. Both represent IF part of the rules. Ps represent the output or THEN part of the rule namely a Pair. So an example cane be quoted like *{IF (QoS = POOR and SNR = L5) THEN Pair = P8}*

3.4. Eliminating the Conflicting Rules

Conflicting rules can be defined as "two or more rules with same IF part but different THEN part". So during the rules formulation we might have the situation where two or more rules are conflicting. So in order to remove the conflict we have to choose exactly one rule while eliminating rest of the rules. Now which rule to keep and which to discard, is purely on the basis of heuristics. For example, we have to make sure that two combinations of input variables have same values.

SNR--\>\>	Poor	Med	Good	High
L1	P2	P2	P1	P1
L2	P4	P3	P2	P2
L3	P6	P5	P5	P2
L4	P7	P7	P6	P5
L5	P8	P10	P10	P6
L6	P15	P12	P12	P7
L7	P17	P14	P15	P9
L8	P17	P16	P17	P11
L9	P18	P18	P18	P13

QoS--\>\>

An example of a Lookup table.

3.5. Completion of the Look up table

From the available knowledge we may not have sufficient number of rules to fill the lookup table and few entries may be left empty. This situation is called logical desert. These desert must not be left during the design for a fool proof FRBS.

3.6. Creation of Fuzzy Rule Base System

Now the stage is set and all we have to do is to put up this information into the rule base. For this sake, MATLAB Fuzzy System Toolbox is used. The rule editor is build in the

system for inferring the results. There are more than seven hundred rules added in this system that covers almost entire rule space.

4. Conclusion

Fuzzy Rule Base System is proposed in this paper and design for intelligent network advisory. In this way we have incorporated all the requirements in terms of rules in the rule base. Then appropriate inference method (Mamdani inference method) makes it possible to infer for each input combination. System has been tested for various input values and it is found that system is pretty able to suggest the most suitable model under the given specifications. Fuzzy Rule Base System infers in a precise way the scenario being queried. From above, it is clearly indicate that DSS used to support to make decision in any case. That means we can takeout help in such a condition when we make decisions. In network design advisory and planning decision making is very important to design a network. Here we used five variables as a input that are cost, area, No of pc's, security, bandwidth. Almost twenty outputs on basis of standard, frequency, models and specifications. Also there are four possibilities in every parameter like cost (low, medium, high, very high), area (near, medium, far, and very far), security (none, poor, normal, good), no of pc's (less, medium, more and most) and data rate (poor, average, good and excellent). So, these are different parameters that make 772 combinations.

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