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# Enhancing Quality And Efficiency Of Service In Network Communication Using Rough Set Theory

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**Abstract –**

The routing table consists of information such as cost, metric, quality of service associated with the route and links to filtering criteria, access lists associated with the route apart from other information which are examined using routing algorithms. Using rough set theory rules are deduced in the form of if-then rules which can be used as a criterion for transferring data from one router to another. Such rules have a potential to reveal previously undiscovered patterns in the data. It also functions as a classifier for unseen data. In this paper we prove how rough set concept could be used to optimize the utility of transmission lines, router table utilization and hence increase the efficiency of routing management. This is made possible by improving the efficiency of the transmission line by extracting the features for transmission from one router to another using rough set theory.

**Keywords:** Rough set, reduct, discern ability, and feature extraction.

## I Introduction

Despite its relative 'youth' compared to other techniques, rough set theory provides a suitable method in applications like pattern recognition, information processing, business and finance, industry, environment engineering, medical diagnosis and medical data analysis[4][5], system fault diagnosis and monitoring and intelligent control systems and is considered one of the first non-statistical approaches in data analysis.

It is mainly used to discover patterns in data, data reduction and evaluation, etc. Data are often available in a form of data tables, known also as attribute-values tables or information systems. An information system is a table column of which are labeled by attributes, rows – by objects and entries of the table are attribute values.

Rough set theory is an intelligent technique for managing uncertainty that is used for the discovery of data dependencies, to evaluate the importance of attributes,

to discover patterns in data, to reduce redundancies, and to recognize and classify objects. It is used for the extraction of rules from database in if-then form.

Such rules are used to find previously undiscovered patterns in the data. It also collectively functions as a classifier for unseen samples. Unlike other computational intelligence techniques, rough set analysis requires no external parameters and uses only the information presented in the given data.

One of the other features of rough set theory is that it can tell whether the data is complete or not based on the data itself. If the data is incomplete, it will suggest that more information about the subjects is required. On the other hand, if the data is complete, rough sets are able to determine whether there are any redundancies in the data and find the minimum data needed for classification. This property of rough sets is very important for applications where domain knowledge is very limited or data collection is expensive / laborious because it makes sure the data collected is just sufficient to build a good classification model without sacrificing the accuracy or wasting time and effort to gather extra information about the objects.

In rough set theory, sample objects of interest are usually represented by a table called an information table. Rows of an information table correspond to objects and columns correspond to object features or attributes. Rough set theory identifies three approximation regions namely, lower approximation, upper approximation and boundary. The lower approximation of a set X contains all classes that are subsets of X, the upper approximation contains all classes with non-empty intersections with X, and the boundary is the set difference between the upper and lower approximations. The subset generated by lower approximations is characterized by objects that will definitely form part of an interest subset, whereas the upper approximation is characterized by objects that will possibly form part of an interest subset. Every subset defined through upper and lower approximation is known as Rough Set.

Section I deals with literature study. In section II we discuss with a sample data how rough set concepts are applied to improve the efficiency of transmission of data between routers. Section III we give the results and discussion.

## II Literature study

Rough set has thrown light on many research areas. Rough Set Theory, since it was put forward, has been widely used in Data Mining, and has important functions in the expression, study and conclusion of uncertain knowledge. It is a powerful tool, which sets up the intelligent decision system. Rough Set can be used in different phases of the knowledge discovery process, as attribute selection, attribute extraction, data reduction, decision rule generation and pattern extraction.

A. Mrozek and K. Cyran proposed a hybrid method of automatic diffraction pattern recognition based on Rough Set Theory and Neural Network. In this new method, the rough set is used to define the objective function and stochastic evolutionary algorithm for space search of a feature extractor, and neural networks are employed to model the uncertain systems. The features obtain end by optimized sampling of diffraction patterns are input to a semantic classifier and the pattern

recognition algorithm is performed with optimized and standard computer-generated holograms.

Rubin et al., research, rough sets are used to support diagnosis by distinguishing between three disposition categories: discharge, observation/further investigation, and consultation. Preliminary results show that the system gives accuracy comparable to doctors, though it is dependent on a suitably high data quality Kotek, shows how Rough Set was applied for the assessment of concert hall acoustics. Rough set algorithms are applied to the decision table containing subjectively quantified parameters and the results of www.intechopen.comRough Set Theory – Fundamental Concepts, Principals, Data Extraction, and overall subjective preference of acoustical objects described by the parameters. Fuzzy membership functions map the test results to approximate the tested parameter distribution, which is determined on the basis of the separate subjective test of individual parameter underlying overall preference. A prototype system based on the rough set theory is used to induce generalized rules that describe the relationship between acoustical parameters of concert halls and sound processing algorithms

Lambert-Torres et al., says Rough Set is a systematic approach used to help knowledge engineers during the extraction process of facts and rules of a set of examples for power system operation problems. This approach describes the reduction the number of examples, offering a more compact set of examples to the user

Nguyen et al., approach studies on some categories of sunspot groups are associated with solar flares. Observatories around the world track all visible sunspots in an effort to detect flares early, the sunspot recognition and classification are currently manual and labor intensive processes which could be automated if successfully learned by a machine. The approach employs a hierarchical rough set based learning method for sunspot classification. It attempts to learn the modified Zurich classification scheme through rough set-based decision tree induction. The resulting system has been evaluated on sunspots extracted from satellite images, with promising results

Shen & Jensen, gives A new application of rough set theory for classifying meteorological radar data has been introduced. Volumetric radar data is used to detect storm events responsible for severe weather. Classifying storm cells is a difficult problem as they exhibit a complex evolution throughout their lifespan. Also, the high dimensionality and imprecision of the data can be prohibitive. Rough set approach is employed to classify a number of meteorological storms.

Xie et al., reveals an important application field of rough set theory is that of intelligent control systems especially when incorporated with fuzzy theory There are infinite possibilities in the development of methods based on Rough Set Theory such as nonstandard analysis, nonparametric statistics and qualitative. In this paper we present how rough set theory concepts could be used to optimize the efficiency of transfer of data between two routers can be enhanced by framing rules and extracting features.

## III SYSTEM MODEL

Lower Approximation (LA) is a description of the domain objects that are known with certainty to belong to the subset of interest. The Lower Approximation Set of a set X, with regard to R is the set of all of objects, which certainly can be classified with X regarding R, that is, set LA.

Upper Approximation (UA) is a description of the objects that possibly belong to the subset of interest. The Upper Approximation Set of a set X regarding R is the set of all of objects which can be possibly classified with X regarding R, that is, set UA.

Boundary Region (BR) is description of the objects that of a set X regarding R is the set of all the objects, which cannot be classified neither as X nor -X regarding R. If the boundary region is a set X =Empty, then the set is considered "Crisp", that is, exact in relation to R; otherwise, if the boundary region is a set X ≠ empty the set X "Rough" is considered. In that the boundary region is BR = UA - LA.

Mathematically speaking, let a set $X \subseteq U$, R be an equivalence relation and a knowledge base K = (U,R).

Two subsets can be associated:

$$LA = \cup \{Y \in U/R : Y \subseteq X\}$$

$$UA = \cup \{Y \in U/R : Y \cap X \neq \emptyset\}$$

In the same way, POS(X), BR(X) and NEG(X) are defined below.

$POS(X) = LA \Rightarrow$ certainly member of X

$NEG(X) = U - LA \Rightarrow$ certainly non-member of X

$BR(X) = UA - LA \Rightarrow$ possibly member of X

It is interesting to compare definitions of classical sets, fuzzy sets and rough sets. Classical set is a primitive notion and is defined intuitively or axiomatically. Fuzzy set is defined by employing the fuzzy membership function, which involves advanced mathematical structures, numbers and functions. Rough set is defined by topological operations called approximations, thus this definition also requires advanced mathematical concepts.


**Fig. 1 An ordinary set**


**Fig. 2 Fuzzy set**

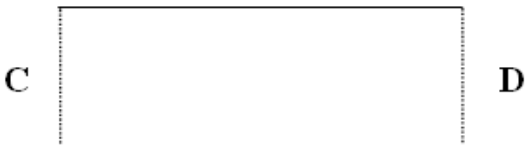


**Fig. 3 Rough set**

A decision table contains two types of attributes designated as the condition attribute and decision attribute. Each row of a decision table determines a decision rule, which specifies the decisions (actions) that must be taken when conditions are indicated by condition attributes are Satisfied.

The process of reducing an information system such that the set of attributes of the reduced information system is independent and no attribute can be eliminated further without losing some information from the system, the result is known as reduct or core attributes.

Subnet consists of routers and transmission lines. Routers are used to connect multiple networks and forward packets destined either for its own networks or other networks. A routing table is a data table, which is used to decide where data is travelling over an internet.

A routing table contains information necessary to forward a packet along the best path toward its destination. Each packet contains information about its origin and destination. When a packet is received, a network device examines the packet and matches it to the routing table entry providing the best match for its destination. The table then provides the device with instructions for sending the packet to the next hop on its route across the network. The routing table consists of information such as cost/metric, quality of service associated with the route and links to filtering criteria/access lists associated with the route apart from other information which are

examined using routing algorithms. Using rough set theory rules are deduced in the form of if-then rules which can be used as a criterion for transferring data from one router to another. Such rules have a potential to reveal previously undiscovered patterns in the data. It also functions as a classifier for unseen data.

The routing table consists of at least three information fields:

1. the network id: i.e. the destination subnet
2. cost/metric: i.e. the cost or metric of the path through which the packet is to be sent
3. next hop: The next hop, or gateway, is the address of the next station to which the packet is to be sent on the way to its final destination
4. Quality of service associated with the route. For example, the U flag indicates that an IP route is up.
5. links to filtering criteria/access lists associated with the route
6. Interface: such as eth0 for the first Ethernet card, eth1 for the second Ethernet card, etc.

The routing table also contains information about the topology of the network immediately around it.

Transmission lines are used to connect two routers.

## IV ALGORITHM

In this section, a sample network with data set for transferring packets from one to another is shown. Using a Rough Set approach for the elimination of redundant attributes and the development of a set of rules that it can help in selecting a transmission line is determined. The following algorithms of rough set theory with threshold values in algorithm1 are used to determine core attributes.

Algorithm 1 to find core:
Form groups based on decision attribute.
1. Let g=number of groups
2. N=number of attributes
3. T=threshold
4. For i= 1 to n
5. Repeat steps 5 to 7
6. Choose $(n-i)^{th}$ attributes
7. If ((g remains the same) or (g=g-{t}))
8. Then $i^{th}$ attribute is redundant

Else

8. core=core + $i^{th}$ attribute
9. End

Then reduct is the core where redundant attributes would be removed.

Algorithm 2 to find rules:
1. Let X be given set
2. N=number of objects, l=number of attributes
3. Form upper approximation UA and Lower approximation LA
4. LA contains definite objects
5. UA contains probable objects selected using Markov theory
6. BR=UA-LA
7. If (BR not equal to {})
8. Then X is a rough set.
9. Reduced set = X- objects which are inconsistent
10. i=2.
11.Repeat steps 12 to 15 until i=l-1
12. Choose nCi attributes and decision attribute
13. Form table
14. Remove redundant objects
15. i=i+1
16. Find common objects from the tables formed above
17. Derive rules from the above common objects
17. End

## V EXPERIMENTAL SIMULATION

The mathematical model is explained with an example of a subnet consisting of 11 nodes as case study. Consider the following sample network with 11 transmission lines with parameters bandwidth, waiting, jitter, and cost and queue length, connecting the routers.

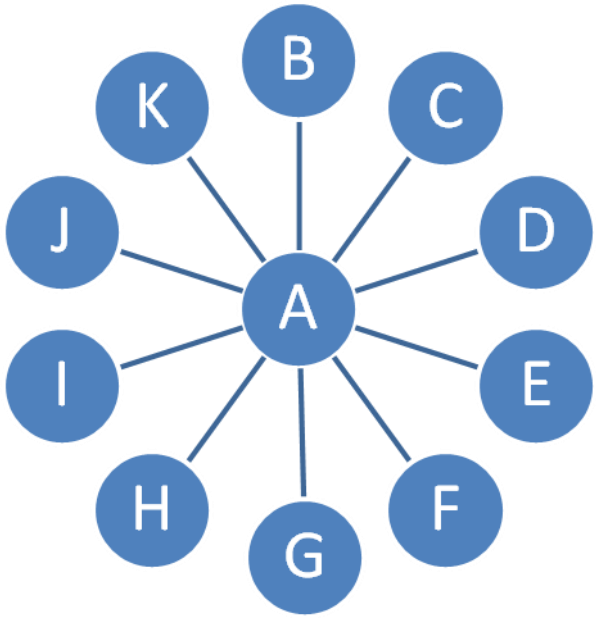


**Figure: 4 An example subnet**

**Table: 1**

| Edge | Band width | Waiting | Jitter | Queue length | Cost of the line | Select path |
|---|---|---|---|---|---|---|
| 1 | 500 | Yes | High | 2 | 10 | No |
| 2 | 500 | No | Low | 0 | 10 | Yes |
| 3 | 100 | Yes | High | 2 | 5 | No |
| 4 | 100 | Yes | High | 2 | 5 | No |
| 5 | 500 | No | Medium | 0 | 10 | Yes |
| 6 | 300 | Yes | High | 2 | 7 | No |
| 7 | 500 | No | High | 4 | 10 | Yes |
| 8 | 300 | No | Low | 0 | 7 | Yes |
| 9 | 500 | Yes | Medium | 4 | 10 | Yes |
| 10 | 500 | No | Low | 0 | 10 | Yes |
| 11 | 300 | No | Low | 0 | 7 | Yes |

Applying algorithms1 and algorithm2 for the above data we get the following.
Lines connecting the Routers in the net are {1,2,3,4,5,6,7,8,9,10,11}
Conditional attributes are {bandwidth, waiting, jitter}
Decision attributes are {transfer}
Values of the attribute bandwidth are {100,300,500}
Values of the attribute waiting are {yes, no}
Values of the attribute jitter are {high, medium, low}
Lower approximation LA={2,5,8,10,11}
Upper approximation UA= {2, 5, 7, 8, 9, 10, 11}
BR=UA-LA= {7, 9}
We cannot make any decision based on the data for 7 and 9
Hence removing 7 and 9 from the table we get the reduced set as
{1, 2, 3, 4, 5, 6, 8, 10, 11}
Forming tables by grouping two attributes at a time and removing redundant rows we can frame the following rules.
If bandwidth=500, waiting=yes and jitter=high then transfer=no.
If bandwidth=500, waiting=no and jitter=low then transfer=yes.
If bandwidth=100, waiting=yes and jitter=high then transfer=no.

When data arrives at a router to forward it to the next router which lies on the path of source to destination, the above rules can be applied to take the decision. In the above example there are two lines for which decision is not feasible. These can be used as threshold value to determine whether the data needs to be transferred or not. Using neural network efficient tool can be developed for this purpose. When these rules are applied for a simulated subnet with 100 routers and 1,00,000 packets we see an improvement of 18.8% quality of service compared to other protocols.

## III Conclusion:

Using rough set theory rules are deduced in the form of if-then rules which can be used as a criterion for transferring data from one router to another. Such rules have a potential to reveal previously undiscovered patterns in the data. It also functions as a classifier for unseen data. In this paper we prove how rough set concept could be used to optimize the utility of transmission lines, router table utilization and hence increase the efficiency of routing management. This is made possible by improving the efficiency of the transmission line by extracting the features for transmission from one router to another using rough set theory. In this paper we have also shown how rough set theories concept minimizes the table size of the routers and reduces the complexity which arises due to incomplete data. Using the rules derived we see that the efficiency is improved by 18%. For future work the values derived can be used as a threshold value and using neural network a tool can be developed to implement rule based system in subnet to improve efficiency in real time system.

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