International Journal of
Science and Engineering Investigations vol. 2, issue 23, December 2013
ISSN: 2251-8843

Reliability Evaluation of Nephron Algorithm

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Abstract-This Due to resolving supplier selection problem, a different and innovative approach (Nephron algorithm) was proposed. It was to prioritize the suppliers based of their scores as well as their homogeneity with other suppliers. The algorithm was inspired based of nephron performance because of its intelligent screening. It can be applied as data mining technique in order to cluster as well as prioritize data according their attributes and scores respectively. Powerful discriminatory performance of this algorithm was claimed, in previous researches. For indicating power of its system, reliability of NA is evaluated. Therefore, to solve the problem, reliability theory is employed in order to assess the power of NA in discrimination and the large, multinational, and Telecommunication Company as suitable dataset was taken into account.

Keywords- *Reliability, Evaluation, Nephron algorithm*

I. INTRODUCTION

Several methods have been proposed and used for supplier evaluation and selection; most of them try to rank the suppliers from the best to the worst and to choose the appropriate supplier(s) (Keskin et al., 2010). This problem requires consideration of a variety of attributes. In other word, there are several models and methodologies such as MCDM (AHP, FAHP, and TOPSIS), SWOT, ART, and recently data mining techniques especially neuron-fuzzy, ANN, and DT integrated with DEA that was applied to resolve the supplier selection problem. Therefore, among these tools, data mining methods are suitable because of their well-known accuracy rate.

In one research conducted by Behmanesh & Rahimi, 2012, the methodology was employed in order to evaluate supplier as well as to cluster them according to mean score of supplier and their attributes respectively. The proposed algorithm was presented based upon natural nephron performance in kidney as a meta-heuristic in order to improve the clustering and ranking data step by step because of its discriminatory power and its excreting power for bad stuffs. Results show both prioritization and categorization were carried out precisely and accurately. The nephron algorithm was employed in order to separate the best suppliers from the worst suppliers according to their homogeneity as well as their rank for the first time. Ranking and clustering are two issues, which are taken into account in researches simultaneously, thus nephron is able to play key role in screening, discriminating, and ranking data in order to make rank-oriented categorizing. Consequently, the nephron clustered data to eight unsupervised and prioritized groups, which data within each cluster are more homogenous than to each other while clusters have least similarity to each other.

In this study, reliability of NA was taken into account as new problem, and the reliability theory was employed to answer this question whether NA is reliable in clustering the data points in the course of determined times.

The aim of this paper is to evaluate the reliability of the nephron as meta-heuristic technique for optimization and to improve the clustering and ranking data. In this scenario, the NA applies as an unsupervised DM approach because in unsupervised learning, there is no such supervisor and we only have input data. The aim is to find the regularities in the input. There is a structure to the input space such that certain patterns occur more often than others, and we want to see what generally happens and what does not.

II. PATTERN OF NEPHRON

In previous research, nephron algorithm was proposed in order to cluster as well as prioritize suppliers according their attributes and scores respectively. NA was inspired based on natural nephron performance so that data were clustered and ranked step by step. Role of nephron in separating and screening of data is important; this algorithm aided us to separate bad stuffs from good stuffs among whole data, correspondent with principals of nephron performance. The rules of nephron are able to discriminate bad and good stuffs step by step so that finally, the best stuffs will be deposited out of nephron and the rest will excreted by cluster in each stage.

In order to conduct the research, four-step methodology was proposed:

Filtration: according to rule of filtration in nephron, 20 percent of data must be input of it, randomly. However, the rest will be deposited in vein.

Reabsorption: Some existing data in nephron must be entered to vein based on rule of this operation.

Secretion: Some existing data in vein must be entered to nephron based on rule of this operation.

Excreting and repeating: according to this step, existing data of nephron must be excreted as bad data (lower rank) and the rest data of vein must be passed 3 previous steps till the best data is deposited in vein as first rank data.

Termination condition: if stopping criteria are met, then stop, else go to filtration step.

Assuming that data point is reabsorbed more than twice, it can be considered as a termination of clustering.

Provided that the filtration step cannot be fulfilled based on mathematical rules (there is no data in vein), as a result, there is no data to enter to nephron.

Two key components are called local intensification and global diversification that in nature-inspired meta-heuristic algorithms (Yang and et. al, 2013). Also, Nephron algorithm as a meta-heuristic uses diversification in filtration operation and intensification in reabsorption and secretion operations respectively.

Designing efficient optimization search techniques (meta-heuristics) requires a tactical interplay between diversification and intensification (Bouhmala, 2013). Their interaction can significantly affect the efficiency of a meta-heuristic algorithm (Yang and et. al, 2013).

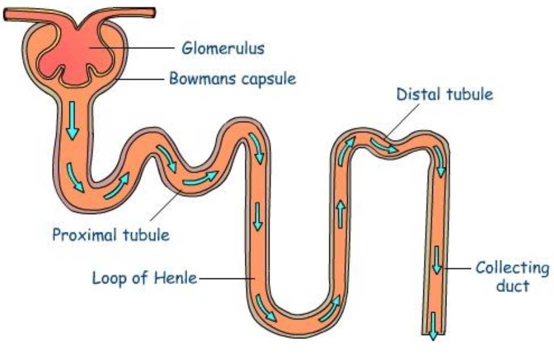

Figure 1. Biologic of nephron

The operations consist of filtration, reabsorption, secretion and excreting for clustering are shown in Figure 2.

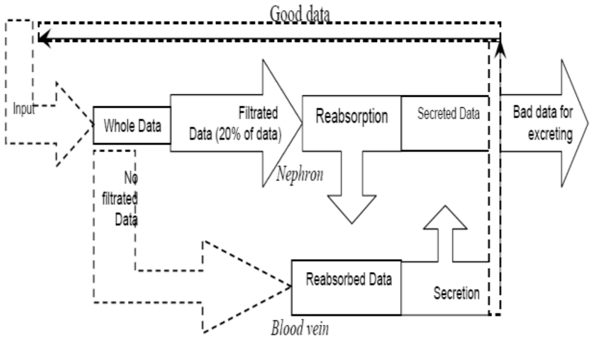

Figure 2. Framework of NA

It was indicated that to evaluate the results of the nephron model; the validation of it must be verified. So, R-Squared index (RS) of clusters is calculated according to Eq.3-6 (Momeni, 2011). Cj, d, n, indicate jth cluster, number of attributes, and number of data (suppliers), respectively. SSt ,SSw ,SSb show Square standard deviation of total data, within each cluster, and between each cluster, respectively. Also, x_{ij}, $\bar{x}_j$, $\bar{x}_{ij}$ show quantity of jth attribute of ith data, mean of jth attribute of data, and mean of jth attribute in ith cluster (Momeni, 2010).

$$SS_t = SS_b + SS_w \tag{1}$$

$$RS = SS_b / SS_t = (SS_t - SS_w) / SS_t \tag{2}$$

$$SS_w = \sum_{i=1}^{k} \sum_{x \in C_j} \sum_{j=1}^{d} (x_{ij} - \bar{x}_{ij})^2 \tag{3}$$

$$SS_t = \sum_{i=1}^{n} \sum_{j=1}^{d} (x_{ij} - \bar{x}_j)^2 \tag{4}$$

It was demonstrated that a RS near to 1 is regarded as acceptable validation for a clustering whereas, far from 1 is regarded as reject (Momeni, 2011). According to aforementioned equations, RS lower than 0.7 is a regarded as failure and greater than 0.7 is considered as survive.Maintaining the Integrity of the Specifications

III. METHODOLOGY

In this part, one multi steps algorithm is introduced for determining the failures and survives versus time period. In proposed algorithm, if RS of NA is more than 0.7, it is regarded survive and in contrary, if it is less than 0.7, NA will be failed in clustering. Computation of time period is in accordance with iterations of NA operations.

Below algorithm (Figure 3.) indicates the all operations in NA and consequently, presenting the results of Time intervals according to iterations in algorithm and failure numbers according to inability the NA in accurate clustering because of more iterations in algorithm.

Afterwards, failure density, hazard rate, reliability and unreliability were evaluated by using equations (1-4) in accordance with reliability theory and also number of failure in iterations interval of NA.

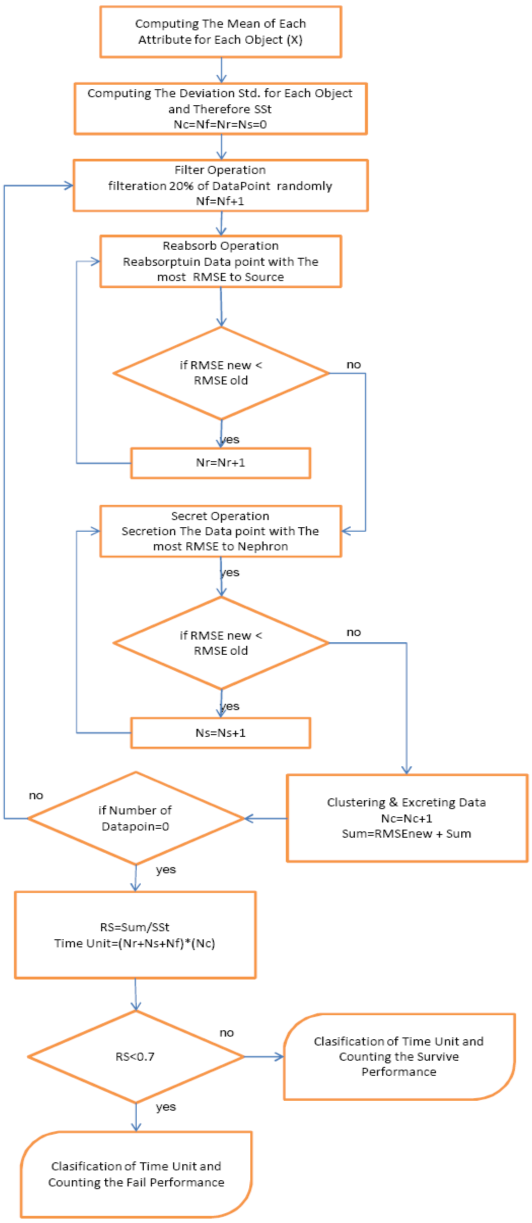

Figure 3. Reliability evaluation of NA

$$f_e(t) = \frac{n_f(t)}{n_o \Delta t} \quad (1)$$

$$h_e(t) = \frac{n_f(t)}{n_s \Delta t} \quad (2)$$

$$R_e(t) = \frac{f_e(t)}{h_e(t)} \quad (3)$$

$$F_e(t) = 1 - R_e(t) \quad (4)$$

IV. NUMERIC EXAMPLE AND RESULTS

A. *Data*

The numerical example was considered and it is indicated in table1 taken from Talluri and Narasimhan (2005). The data was derived from a large, multinational, and telecommunications company. On the other hand, the data was utilized by Wu (2009) also for supplier selection also. The data presents six input variables, which represent capabilities of each supplier to generate five output factors that represent the performance outcomes of suppliers in the measurement process. In this study, supplier was taken into account as data, with 11 attribute. The inputs and outputs are applied as attributes for clustering only and are determined as follows:

Inputs include: Quality management practices and systems (QMP), Documentation and self-audit (SA), Process/manufacturing capability (PMC), Management of the firm (MGT), Design and development capabilities (DD), Cost reduction capability (CR)

Outputs include: Quality, Price, Delivery, Cost Reduction Performance (CRP), other.

B. *Implementation, results and discussion*

In the first place, the data are feed to NA and operations are applied on data. The aforementioned algorithm is conducted on data and results were classified by running the experiments of NA performance in various iterations.

As shown in tables, failure data of NA in time interval 8 iterations were classified in table1 and results of failure density and hazard rate were shown in table2, and also, reliability and unreliability of NA in various time intervals were presented in table3. It is demonstrated in high iterations, the NA reliability is decreasing and best reliability is obtained in low iterations of algorithm.

TABLE I. FAILURE DATA OF THE NEPHRON ALGORITHM

Time Interval	**16-24**	**25-32**	**33-40**
N_f	37	12	1

TABLE II. CALCULATIONS FOR FE(T) AND HE(T)

Time Unit	16-24	25-32	33-40
$f_e(t)$	0.0925	0.03	0.0025
$h_e(t)$	0.0925	0.115385	0.1250

TABLE III. CALCULATIONS FOR RE(T) AND FE(T)

Time Unit	16-24	25-32	33-40
$R_e= f_e(t)/ h_e(t)$	100%	26%	2%
$F_e=1- R_e$	0%	74%	98%

Figures 4-7 shows plot of $f_e(t)$, $h_e(t)$, R and F versus time, respectively.

As it is indicated in Plot of f(t), and table2 statistics, failure density is decreasing versus time.

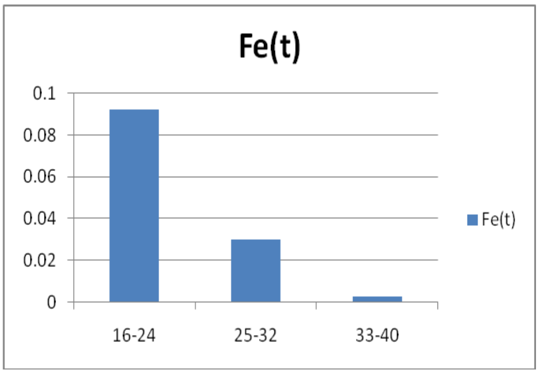

Figure 4. Plot of fe(t)

As it is shown in plot of h(t), and table2 statistics, hazard rate function versus time is very high and it is increasing with constant rate.

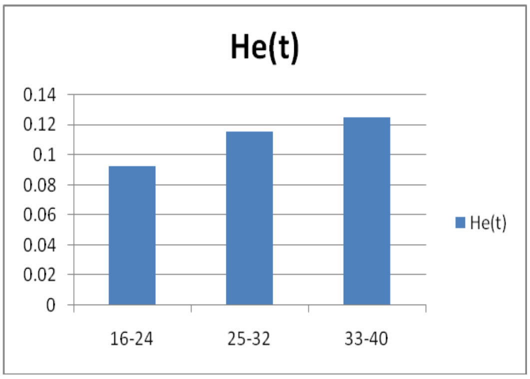

Figure 5. Plot of he(t)

The plot of R(t), and table3 statistics show, reliability function versus time is losing with sharp rate.

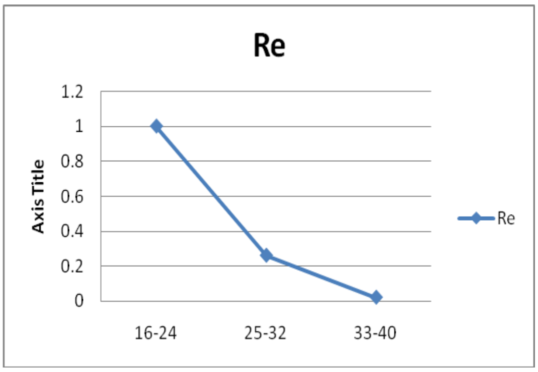

Figure 6. Plot of Re(t)

The below plot, and table3 statistics indicate, cumulative function of failure density versus time is increasing with sharp rate in iterations lower than 25.

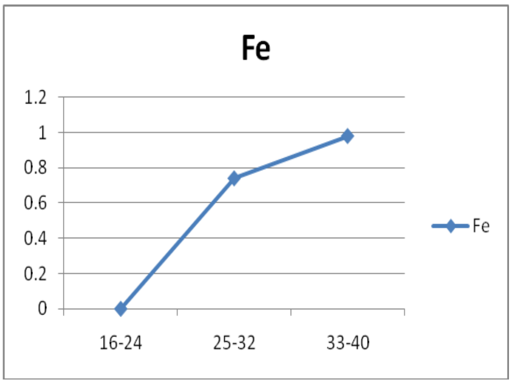

Figure 7. Plot of Fe(t)

V. CONCLUSSIONS

In this paper, we studied on reliability assessment of nephron algorithm because of effects algorithm iterations on its results in clustering of data. In this study, the methodology was employed in order to evaluate reliability of NA according to experiential observations. The proposed algorithm operated based upon natural nephron performance in kidney as a meta-heuristic in order to improve the clustering and ranking data step by step because of its discriminatory power and its excreting power for bad stuffs. The outputs of each operation in NA are RS coefficient and used iterations. As it is shown (fig 8.), the reliability of RS versus the iterations is decreasing.

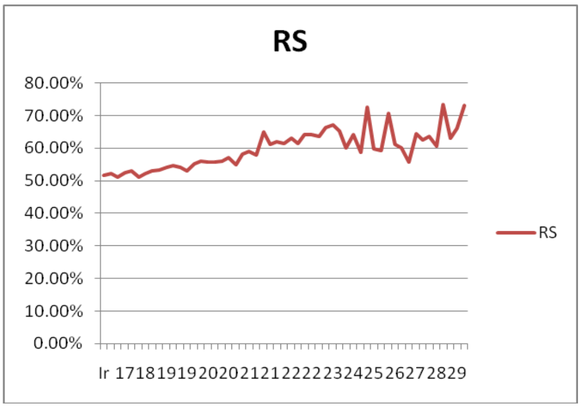

Figure 8. Plot of deviations of RS versus iteration

For presenting outputs, the MS Access 2010 was utilized as computation tools in this research. Results show both prioritization and categorization were carried out precisely and accurately in iterations lower than 25 times unit and NA performance with iterations more than 25 is deteriorating. Thus nephron is able to play key role in screening, discriminating, and ranking data in order to make rank-oriented categorizing with iterations lower than 24 and thereby reliability 90%. Consequently, with increasing percentage of filtration operation, we are observing the inability and unreliability of NA in accurate and précised discrimination. It is pointed out the reliability of nephron algorithm was measured experimentally. And thereby, this proposed model with capabilities such as reabsorption and secretion functions can be improved in next researches in order to enhance accuracy in clustering. Although RS is low in lower iterations but we can enhance the RS in NA with balancing between diversification and intensification for future researches.

Aim of this paper is to reliability evaluation of nephron meta-heuristic technique for optimization and to improve the clustering and ranking data in future. Furthermore, the NA can enhance its output and efficiency with running design of experiments for different parameters such as reabsorption and secretion formula in clustering. Therefore, it is suggested the balancing between intensification and diversification in NA can improve RS value in future researches.

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