## MODELING AND NANOTECHNOLOGY

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# ALGORITHM OF CLASSIFICATION OF MEDICAL OBJECTS ON THE BASIS OF NEUTROSOPHIC NUMBERS

***Abstract.*** *The obscure set is a useful mathematical tool for dealing with uncertainty. However, sometimes these theories may not be sufficient to model the vague and contradictory information encountered in the real world. To overcome this shortcoming, it has been suggested to work with neutrosophic set theory and neutrosophic numbers, which are useful in practical applications. In this paper, Gauss's concepts of neutrosophic numbers, cross-section, and parametric shape are defined. A decision-making algorithm using Gauss's neutrosophic number operations was developed and applied to the problem of classification of medical emblems.*

***Keywords****: neutrosophic sets, Gaussian neutrosophic numbers,* $\alpha$ *- cut, classify.*

Many scientists want to find the right solution to some mathematical problem that cannot be solved by traditional methods. The reason for these problems is that traditional methods cannot solve economics, technology, medicine, decision making problems, and other uncertainty problems. The article contains many studies and applications related to special tools such as fuzzy set theory [1,11], rough set theory, vague set theory, intuitionistic fuzzy set theory and interval mathematics[6].

Diagnosis is useful for automating the initial stages of diagnosis, which does not require the intervention of an experienced physician. A neutrosophic kit is one that has all the features needed to encode a medical database and retrieve medical information. Medical diagnosis requires the processing of large amounts of information, much of which is quantitative, as well as the process of intuitive thinking involves the unconsciously rapid processing of data and the average law of available data. combines Thus, contradictions, inconsistencies, uncertainties, and uncertainties must be accepted as inevitable because they are integrated into the behavior of biological systems, as well as in their description. To model an experienced physician, uncertainty must be avoided because you have to have uncertain or incomplete knowledge that may lead to the risk of making a mistake due to incorrect accuracy . Because medical diagnosis involves many uncertainties and an increase in information available to physicians on new medical technologies, the process of classifying different sets of symptoms into a single disease name becomes more complicated. In some practical cases, each element may have different reality membership, ambiguous, and incorrect membership functions. a distinctive feature of the neutrosophically purified set is that it contains many true members, vague and false members. After a one-time examination, there may be an error in the diagnosis. Thus, the best diagnosis that allows multiple examinations by taking samples of a patient at different times. Thus, neutrosophic purified kits and their application play a crucial role in medical diagnostics. In 1965, the uncertainty set theory, used in many real applications to solve uncertainty, was first given by Zade. Then Turksen, Atanassov, and Atanassov and Gargov introduced an indeterminate set of interval value, a theory of intangible indeterminate sets, and an indeterminate set of interval value sensitivity. These theories can only process incomplete information, not inaccurate information and non-uniform information that exists in belief systems.

**Problem statement:** Suppose that a set of poorly formed processes and objects (learning sample) is expressed as follows: $x_{p1}, x_{p2}, \ldots, x_{pm_p} \in X_p, p = \overline{1,r}$ . Here is the object $x_{pi} = \left(x_{pi}^1,\ x_{pi}^2, \ldots x_{pi}^n\right), i = \overline{1,m_p}$, $n$ - viewed in the space of dimensional characters, $X_p$, $p=\overline{1,r}$ denoting a set of classes, it is $m_p$ $x_{p1},\ldots,x_{p_{m_p}}$ consists of objects.

Class unknown $x^1_{m+t},\ldots,x^n_{m+t}$ it is required to determine to which class the object belongs in the given study sample.

X in the field of detection $\tilde{a}$ the neutrosophic set is described as follows:

$$\tilde{a}=\{\langle x,a_t(x),a_i(x),a_f(x)\rangle : x\in X\}$$

Here $a_t,a_i,a_f : X\to ]^-0,0^+[$ va $^-0\le a_t(x)+a_i(x)+a_f(x)\le 3^+$.

neutrosophic set (NS) $\tilde{a}$ characterized by three functions, $a_t(x)$ truth-membership function, $a_i(x)$ indeterminacy-membership function va $a_f(x)$ falsity-membership function , $a_t(x),a_i(x),a_f(x)\in[0,1]$ for all $x\in X$.

If $X$ continuous, neutrosophic set $\tilde{a}$ can be written as follows:

$$\tilde{a}=\int_X \langle a_t(x),a_i(x),a_f(x)\rangle / x$$, for all $x\in X$.

If $X$ clearly installed, neutrosophic set $\tilde{a}$ can be written as follows:

$$\tilde{a}=\sum_x \langle a_t(x),a_i(x),a_f(x)\rangle / x$$, for all $x\in X$.

Here $0\le a_t(x)+a_i(x)+a_f(x)\le 3$, for all $x\in X$. Neutrosophic numbers for convenience (NN) $\tilde{a}=\langle a_t(x),a_i(x),a_f(x)\rangle$ determined by.

**Gauss** neutrosophic **number.**

Neutrosophic number Gauss neutrosophic number deb aytiladi. $GNN\left(\left(\overline{\mu}_t,\sigma_t\right),\left(\overline{\mu}_i,\sigma_i\right),\left(\overline{\mu}_f,\sigma_f\right)\right)$ truth-membership function, indeterminacy-membership function and falsity-membership function:

$$\varphi(x_t)=\exp\left(-\frac{1}{2}\left(\frac{x_t-\overline{\mu}_t}{\sigma_t}\right)^2\right)$$

$$\varphi(x_i)=1-\left(\exp\left(-\frac{1}{2}\left(\frac{x_i-\overline{\mu}_i}{\sigma_i}\right)^2\right)\right)$$

$$\varphi(x_f)=1-\left(\exp\left(-\frac{1}{2}\left(\frac{x_f-\overline{\mu}_f}{\sigma_f}\right)^2\right)\right)$$

Here $\overline{\mu}_t(\overline{\mu}_i,\overline{\mu}_f)$ truth-membership (indeterminacy-membership, falsity-membership) indicates the value. $\sigma_t(\sigma_i,\sigma_f)$ truth-membership (indeterminacy-membership, falsity-membership) indicates the standard deviation of the value distribution.

Then their $\alpha$-cuts are as follows:

$$A_{t_\alpha}=\left\lfloor\overline{\mu}_t-\left(\sigma_t\sqrt{-2\log\alpha}\right),\overline{\mu}_t+\left(\sigma_t\sqrt{-2\log\alpha}\right)\right\rfloor,$$

$$A_{i_\alpha}=\left\lfloor\overline{\mu}_i-\left(\sigma_i\sqrt{-2\log(1-\alpha)}\right),\overline{\mu}_i+\left(\sigma_i\sqrt{-2\log(1-\alpha)}\right)\right\rfloor,$$

$$A_{f_\alpha}=\left\lfloor\overline{\mu}_f-\left(\sigma_f\sqrt{-2\log(1-\alpha)}\right),\overline{\mu}_f+\left(\sigma_f\sqrt{-2\log(1-\alpha)}\right)\right\rfloor$$

determined.

$P=\{p_1,p_2,...,p_p\}$ - patients, $S=\{s_1,s_2,...,s_p\}$ - symptoms, $D=\{d_1,d_2,...,d_p\}$ - let the disease complex. Patients $p_i(i=1,2,...,p)$ the indicators are each by experts $s_j(j=1,2,...,s)$ the symptoms are evaluated using Table 1, and the patient-symptom (PS) matrix is given as follows:

$$PS=\begin{pmatrix} m_{11} & m_{12} & \cdots & m_{1s}\\ m_{21} & m_{22} & \cdots & m_{2s}\\ \vdots & \vdots & \vdots & \vdots\\ m_{p1} & m_{p2} & \cdots & m_{ps}\end{pmatrix}$$

Here $m_{ij}=\left\langle m_{t_{ij}},m_{i_{ij}},m_{f_{ij}}\right\rangle$ $s_j$ indicates the neutrosophic value of the patient $p_i$ associated with the symptom.

*Table 1*

**Neutrosophic numbers for linguistic terms**

| Linguistic terms | Linguistic values of neutrosophic numbers |
|---|---|
| Absolutely low(AL) | (0.05, 0.95, 0.95) |
| Low(L) | (0.20, 0.75, 0.80) |
| Fairly low(FL) | (0.35, 0.60, 0.65) |
| Medium(M) | (0.50, 0.50, 0.50) |

*Table continuation 1*

| | |
|---|---|
| Fairly high(FH) | (0.65, 0.40, 0.35) |
| High(H) | (0.80, 0.25, 0.20) |
| Absolutely high(AH) | (0.95, 0.10, 0.05) |

$s_i (i=1,2,...,s)$ symptoms each $d_k (k=1,2,...,k)$ for the disease is evaluated by Gaussian neutrosophic numbers, and the disease (SD) matrix is given as follows:

$$SD=\begin{pmatrix} n_{11} & n_{12} & \cdots & n_{1d} \\ n_{21} & n_{22} & \cdots & n_{2d} \\ \vdots & \vdots & \vdots & \vdots \\ n_{s1} & n_{s2} & \cdots & n_{sd} \end{pmatrix}$$

Here $n_{jk}=GNS\left\langle \left(n_{t_{jk}},\sigma_t\right),\left(n_{i_{jk}},\sigma_i\right),\left(n_{f_{jk}},\sigma_f\right)\right\rangle$ $s_j$ indicates the Gaussian neutrosophic value associated with.

$$PD=\begin{pmatrix} q_{11} & q_{12} & \cdots & q_{1d} \\ q_{21} & q_{22} & \cdots & q_{2d} \\ \vdots & \vdots & \vdots & \vdots \\ q_{p1} & q_{p2} & \cdots & q_{pd} \end{pmatrix}=\begin{pmatrix} m_{11} & m_{12} & \cdots & m_{1s} \\ m_{21} & m_{22} & \cdots & m_{2s} \\ \vdots & \vdots & \vdots & \vdots \\ m_{p1} & m_{p2} & \cdots & m_{ps} \end{pmatrix}\circ\begin{pmatrix} n_{11} & n_{12} & \cdots & n_{1d} \\ n_{21} & n_{22} & \cdots & n_{2d} \\ \vdots & \vdots & \vdots & \vdots \\ n_{s1} & n_{s2} & \cdots & n_{sd} \end{pmatrix}$$

Here $q_{ik}=\left(i=1,2,...,p;k=1,2,...,d\right)$ is calculated as follows

$$\begin{aligned}&\left(\left\langle u_t,u_i,u_f\right\rangle GNN\left\langle \left(n_{t_{jk}},\sigma_t\right),\left(n_{i_{jk}},\sigma_i\right),\left(n_{f_{jk}},\sigma_f\right)\right\rangle\right)(x)=\\&\left\langle\left(u_t n_{t_{jk}}-u_t\sigma_t\sqrt{-2\ln(\alpha)},u_t n_{t_{jk}}+u_t\sigma_t\sqrt{-2\ln(\alpha)}\right),\right.\\&\left(u_i n_{i_{jk}}-u_i\sigma_i\sqrt{-2\ln(1-\alpha)},u_i n_{i_{jk}}+u_i\sigma_i\sqrt{-2\ln(1-\alpha)}\right),\\&\left.\left(u_f n_{f_{jk}}-u_f\sigma_f\sqrt{-2\ln(1-\alpha)},u_f n_{f_{jk}}+u_f\sigma_f\sqrt{-2\ln(1-\alpha)}\right)\right\rangle.\end{aligned}$$

To be brief $\left(\left\langle u_t,u_i,u_f\right\rangle GNN\left\langle \left(n_{t_{jk}},\sigma_t\right),\left(n_{i_{jk}},\sigma_i\right),\left(n_{f_{jk}},\sigma_f\right)\right\rangle\right)(x)$ $\left\langle\left(\underline{a},\overline{a}\right),\left(\underline{b},\overline{b}\right),\left(\underline{c},\overline{c}\right)\right\rangle$ is denoted by:

The evaluation function for the parametric forms of the obtained Gaussian neutrosophic numbers is defined as follows:

$$S_{q_{ik}}=\frac{4+(\underline{a}-\underline{b}-\underline{c})+(\overline{a}-\overline{b}-\overline{c})}{6}$$

If $1\le t\le k$ for max $S_{q_{ik}}=S_{q_{it}}$ if, so, $p_i$ patient $d_t$ suffers from the disease, if max $S_{q_{ik}}$ $1\le t\le k$ can be re-evaluated if it corresponds to more than one value.

**Algorithm.**

Introduction: PS matrix (patient-symptom) is obtained according to the expert opinion (decision maker).

Output: Diagnosis of the disease.

1. Using Table 1, construct a PS matrix according to experts;
2. Create an SD matrix using GNN;
3. Calculate the PD decision matrix;
4. Calculate the estimated values of the elements of the PD decision matrix;
5. $1 \le t \le k$ and max $S_{q_{ik}} = S_{q_{it}}$ find t for.

## Conclusion

In this paper, neutrosophic numbers, -sections of GNNs, parametric forms of GNNs were identified. A decision-making method used in medical diagnostics was also proposed based on the operations between the parametric forms of the GNN and the composition of the matrices. The algorithm is based on the study of the most common heart diseases in the process of making medical diagnostic decisions. The problem of classification of medical emblems is expressed in a series of problems based on Gaussian neutrosophic numbers, and using the theoretical results obtained, a programming tool in the Java object-oriented programming language was developed.

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