NET Framework to deal with Neutrosophic -Closed Sets in Neutrosophic Topological Spaces

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.NET Framework to deal with Neutrosophic $b^*g\alpha$-Closed Sets in Neutrosophic Topological Spaces

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Abstract: This article introduces a new computer based application for finding the values of the complement of neutrosophic sets, union of neutrosophic sets, intersection of neutrosophic sets and the inclusion of any two neutrosopic sets by using the software .NET Framework, Microsoft Visual Studio and C# Programming Language. In addition to this, the application has produces the values of neutrosophic topology $\tau$, neutrosophic $\alpha$-closed set, neutrosophic $g\alpha$-closed set, neutrosophic $*g\alpha$-closed set and neutrosophic $b^*g\alpha$-closed set values in neutrosophic topological spaces. Also it generates the values of its complement sets.

Keywords: .NET framework; Microsoft Visual Studio; C# Application; Neutrosophic Set Operations; Neutrosophic Topology; Neutrosophic $\alpha$-Closed Set; Neutrosophic $g\alpha$-Closed Set; Neutrosophic $*g\alpha$-Closed Set; Neutrosophic $b^*g\alpha$-Closed Set

1. Introduction

Nowadays the word ‘topology' is being commonly used and getting popularity day by day in the field of modern mathematics. It seems to be derived from Greek words: topos means a surface and logos means a discourse. The use of word ‘Topology' was first occurred in the title of the book ‘Vorstudien Zur Topologie' by Johann Benedict Listing in 1847. The general topology got its real start in 1906 due to Riesz, Frechet and Moore. By using the concept of neutrosophic set, which was introduced by Smarandache [24, 25]. Salama et al. [17] were introduced neutrosophic topological spaces by using the two most important concepts of Topology and neutrosophic sets in 2012.

In the last few decades many researchers has applied this effective concept in neutrosophic topology and they have introduced many neutrosophic sets, namely Arockiarani et al. [10] were introduced neutrosophic $\alpha$-closed sets in neutrosophic topological spaces in 2017, which is the basic set for many researchers to produce various neutrosophic closed and neutrosophic open sets. In 2019, Saranya et al. [20] were introduced neutrosophic $g\alpha$-closed sets, neutrosophic $*g\alpha$-closed sets and neutrosophic $b^*g\alpha$-closed sets in neutrosophic topological spaces in and developed a new C# application to deal with neutrosophic $\alpha$-closed sets, neutrosophic $g\alpha$-closed sets; neutrosophic $*g\alpha$-closed sets in neutrosophic topology. In 2014, Salama et al. [19] has developed some software programs for dealing with neutrosophic sets. Salama et al. [16] has designed and implemented a neutrosophic data operations by using object oriented programming in 2014. Neutrosophic theory was applied by various authors in different fields to produce some real world applications like time series, forecasting, decision making, etc [1-9, 11-15, 18, 21-23].
To reduce the manual calculations for finding the values of the complement, union, intersection and the inclusion of two neutrosophic sets in a neutrosophic field, we have developed a C# application by using .NET Framework, Microsoft Visual Studio and C# Programming Language. In this application the user can calculate the values of neutrosophic topology, neutrosophic $\alpha$-closed set, neutrosophic $ga$-closed set, neutrosophic $*ga$-closed set and neutrosophic $b'ga$-closed set values in each resultant screens. Also it generates the values of its complement sets.

The present study introduces the C# application for finding the neutrosophic closed sets and neutrosophic open sets in neutrosophic topological spaces via .NET Framework, Microsoft Visual Studio and C# Programming Language. The overall working process of this application have been shown as a flow chart in Figure:1. Individual Flow Chart of neutrosophic topology, neutrosophic $\alpha$-closed sets, neutrosophic $ga$-closed sets, neutrosophic $*ga$-closed sets and neutrosophic $b'ga$-closed sets are given in Figure:2, Figure:13, Figure:16, Figure:20 and in Figure:23. Figure:3 shows the initial resultant page in this page, the user has to enter $0_N$, $1_N$ and the neutrosophic sets of $L$ and $M$ values. Also, the results of neutrosophic topology($\tau$), neutrosophic $\alpha$-closed set, neutrosophic $ga$-closed set, neutrosophic $*ga$-closed set and neutrosophic $b'ga$-closed set via C# application are shown in Figure:12, Figure:15, Figure:19, Figure:22 and in Figure:25. It also produces the values of its complements of each closed sets.

2. Preliminaries

In this section, we recall some of the basic definitions which was already defined by various authors.

Definition: 2.1 [17]

Let $X$ be a non empty fixed set. A neutrosophic set $E$ is an object having the form

$$E = \{<x,\mu(x),\nu(x),\neg\mu(x)> \text{ for all } x \in X\},$$

where $\mu(E(x))$ represents the degree of membership, $\nu(E(x))$ represents the degree of indeterminacy and $\neg\mu(E(x))$ represents the degree of non-membership functions of each element $x \in X$ to the set $E$.

Definition: 2.2 [17]

Let $E$ and $F$ be two neutrosophic sets of the form,

$$E = \{<x,\mu(E(x)),\nu(E(x)),\neg\mu(E(x))> \text{ for all } x \in X\} \quad \text{and}$$

$$F = \{<x,\mu(F(x)),\nu(F(x)),\neg\mu(F(x))> \text{ for all } x \in X\}.$$

Then,

1. $E \subseteq F$ if and only if $\mu(E(x)) \leq \mu(F(x)), \nu(E(x)) \leq \nu(F(x))$ and $\neg\mu(E(x)) \geq \neg\mu(F(x))$ for all $x \in X$,
2. $A^c = \{<x,\neg\mu(E(x)),1-\nu(E(x)),\mu(E(x))> \text{ for all } x \in X\}$,
3. $E \cup F = \{x, \max[\mu(E(x)),\mu(F(x))], \min[\nu(E(x)),\nu(F(x))], \\min[\neg\mu(E(x)),\neg\mu(F(x))]\text{ for all } x \in X\}$,
4. $E \cap F = \{x, \min[\mu(E(x)),\mu(F(x))], \max[\nu(E(x)),\nu(F(x))], \\max[\neg\mu(E(x)),\neg\mu(F(x))]\text{ for all } x \in X\}$.

Definition: 2.3 [17]

A neutrosophic topology on a non-empty set $X$ is a family $\tau$ of neutrosophic subsets in $X$ satisfying the following axioms:

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i) \(0_N, 1_N \in \tau\),
ii) \(G_1 \cap G_2 \in \tau\) for any \(G_1, G_2 \in \tau\),
iii) \(\cup G_i \in \tau\) for all \(\{G_i : i \in J\} \subseteq \tau\).

Then the pair \((X, \tau)\) or simply \(X\) is called a neutrosophic topological space.

3. Results

In this section we have shown the working process of C# application for finding the values of the complement, union, intersection and the inclusion of any two neutrosophic sets. Also it produces the values of neutrosophic topology(\(\tau\)), neutrosophic \(\alpha\)-closed set, neutrosophic \(ga\)-closed set, neutrosophic \(\ast ga\)-closed set and neutrosophic \(b'ga\)-closed set values in neutrosophic topological spaces. The complements of neutrosophic \(\alpha\)-closed set, neutrosophic \(ga\)-closed set, neutrosophic \(\ast ga\)-closed set and neutrosophic \(b'ga\)-closed set values will be displayed at the end of the results of each sets.

Figure 1: Flow Chart of the Existence of Neutrosophic Sets
3.1. Existence of Neutrosophic Topology via C# Application

3.1.1. Algorithm: Neutrosophic Topology

<table>
<thead>
<tr>
<th>input</th>
<th>0N, 1N, L, M</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td>complement of L and M, union of L and M, intersection of L and M, inclusion of L and M, neutrosophic Topology</td>
</tr>
</tbody>
</table>

**STEPS:**
- step-1: check 0N and 1N is valid
- step-2: L and M should be a neutrosophic set
- step-3: calculate the complement of L and M
- step-4: calculate the union of L and M
- step-5 calculate the intersection of L and M
- step-6: check the inclusion of L and M
- step-7: if the union and the intersection conditions satisfied then go to step-8 else repeat step-2
- step-8: compute the neutrosophic topology for the assigned data.

Figure 2: Flow Chart of Neutrosophic Topology [FC-NT]
In the above resultant screen, the user has to enter all the values of $0_N$, $1_N$, L and M. Follow the below conditions to enter the values:

- $0_N$ and $1_N$ values should be any three values of $\{(0, 0, 0), (0, 0, 1), (0, 1, 0), (0, 1, 1)\}$ and $\{(1, 1, 1), (1, 1, 0), (1, 0, 1), (1, 0, 0)\}$.
- L and M values should be based on Definition 2.1 and Remark 2.2 of [20].
The above figure shows the entered values of the initial resultant screen. In this, some of the values are not entered by the user. So the following command box intimates the user to enter all the values.

![Figure 5: Screenshot of Dialog Box-1](image1)

The above figure shows the entered values of the initial resultant screen. Here some of the values are not properly entered by the user. For this incorrect data the following command box intimate the user to enter the values in the non-standard unit interval 0 and 1 also the user did not follow the conditions to enter L and M. Both L and M should be a neutrosophic values.

![Figure 6: Screenshot of Invalid Data in the Resultant Screen](image2)

![Figure 7: Screenshot of Dialog Box-2](image3)
In the above figure, the entered values of $0_N$ are not followed by the conditions of $0_N$. For this incorrect data the following command box intimate the user to enter the valid data in the $0_N$-th place.
In the above figure, the entered values of $1_n$ are not followed by the conditions of $1_N$. For this incorrect data the following command box intimate the user to enter the valid data in the $1_n$th place.

![Figure 11: Screenshot of Dialog Box-4](image)

The following figure shows the results of the complement of two neutrosophic sets $L'$ and $M$, union of two neutrosophic sets $L\cup M$, intersection of two neutrosophic sets $L\cap M$ and the inclusion of two neutrosophic sets $L\subseteq M$. Also it shows the result of neutrosophic topology.

![Figure 12: Screenshot of the Existence of Neutrosophic Topology via C# Application](image)

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3.2. Existence of Neutrosophic \(\alpha\)-Closed Set via C# Application

3.2.1. Algorithm: Neutrosophic \(\alpha\)-Closed Set

<table>
<thead>
<tr>
<th>input</th>
<th>neutrosophic set (C)</th>
</tr>
</thead>
</table>
| output         | neutrosophic \(\alpha\)-closed set;  
|                | neutrosophic \(\alpha\)-open set |

**STEPS:**

step-1: check \(C\) is valid

step-2: find \(\text{Ncl}(C)\), if \(\text{Ncl}(C)\) satisfies the neutrosophic closure condition then go to step-3 else repeat step-1

step-3: find \(\text{Nint}[\text{Ncl}[C]]\), if \(\text{Nint}[\text{Ncl}[C]]\) satisfies the neutrosophic interior of neutrosophic closure condition then go to step-4 else repeat step-1

step-4: find \(\text{Ncl}[\text{Nint}[\text{Ncl}[C]]]\), if \(\text{Ncl}[\text{Nint}[\text{Ncl}[C]]]\) satisfies the neutrosophic closure of neutrosophic interior of neutrosophic closure condition then go to step-5 else repeat step-1

step-5: if \(\text{Nacl}[C] = C\) then produce neutrosophic \(\alpha\)-closed set else repeat step-1

step-6: compute the neutrosophic \(\alpha\)-open set \([D]\) for the assigned data.

![Flow Chart of Neutrosophic \(\alpha\)-Closed Set](image)

**Figure.13:** Flow Chart of Neutrosophic \(\alpha\)-Closed Set \([FC-NaCS]\)
The above figure shows that the entered neutrosophic set $C$ and it is not satisfy the definition of neutrosophic $\alpha$-closed set. To get a neutrosophic $\alpha$-closed set and a neutrosophic $\alpha$-open set, the user has to enter some other neutrosophic values. Repeat this process until to get the values of neutrosophic $\alpha$-closed sets.

Figure 15: Screenshot of the Existence of Neutrosophic $\alpha$-Closed Set $[N\alpha CS]$ via C# Application

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3.3. Existence of Neutrosophic $g\alpha$-Closed Set via C# Application

3.3.1. Algorithm: Neutrosophic $g\alpha$-Closed Set

<table>
<thead>
<tr>
<th>input</th>
<th>neutrosophic set $E$</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>neutrosophic $g\alpha$-closed set;</td>
</tr>
<tr>
<td></td>
<td>neutrosophic $g\alpha$-open set</td>
</tr>
</tbody>
</table>

**STEPS:**

step-1: check $E$ is valid
step-2: check $E \subseteq D$ then go to step-3 otherwise repeat step-1
step-3: find $\text{Ncl}(E)$, if $\text{Ncl}(E)$ satisfies the neutrosophic closure condition then go to step-4 else repeat step-1
step-4: find $\text{Nint}[\text{Ncl}[E]]$, if $\text{Nint}[\text{Ncl}[E]]$ satisfies the neutrosophic interior of neutrosophic closure condition then go to step-5 else repeat step-1
step-5: find $\text{Ncl}[\text{Nint}[\text{Ncl}[E]]]$, if $\text{Ncl}[\text{Nint}[\text{Ncl}[E]]]$ satisfies the neutrosophic closure of neutrosophic interior of neutrosophic closure condition then go to step-6 else repeat step-1
step-6: calculate $\text{NacI}[E]$
step-7: if $\text{NacI}[E] \subseteq D$ then produce neutrosophic $g\alpha$-closed set else repeat step-1
step-8: compute the neutrosophic $g\alpha$-open set $[F]$ for the assigned data.

**Figure 16:** Flow Chart of Neutrosophic $g\alpha$-Closed Set $[\text{NgaCS}]$

The following two figures [Figure 17 & Figure 18] shows that the neutrosophic set $E$ is not satisfy the definition of neutrosophic $g\alpha$-closed sets.
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Figure 17: Screenshot of Dissatisfaction of the Definition of Neutrosophic $g\alpha$-Closed Set

\[
E = \{(0.7, 0.3, 0.1), (0.3, 0.3, 0.4), (0.8, 0.8, 0.8)\}
\]

E is not satisfied the definition of neutrosophic $g\alpha$-closed set.

Figure 18: Screenshot of Dissatisfaction of the Definition of Neutrosophic $g\alpha$-Closed Set

\[
E = \{(0.7, 0.3, 0.1), (0.3, 0.3, 0.3), (0.7, 0.7, 0.7)\}
\]

\[
\text{NC}(E) = \{(0.7, 0.7, 0.7), (0.7, 0.7, 0.8), (0.5, 0.4, 0.5)\}
\]

\[
\text{NInt}[\text{NC}(E)] = \{(0.7, 0.7, 0.7), (0.3, 0.3, 0.2), (0.5, 0.6, 0.5)\}
\]

\[
\text{NC}[\text{NInt}[\text{NC}(E)]] = \{(0.7, 0.7, 0.7), (0.7, 0.7, 0.8), (0.5, 0.4, 0.5)\}
\]

\[
\text{NA}(E) = \{(0.7, 0.7, 0.7), (0.3, 0.3, 0.3), (0.5, 0.4, 0.5)\}
\]

E is not satisfied the definition of neutrosophic $g\alpha$-closed set.
3.4 Existence of Neutrosophic $g\alpha$-Closed Set via C# Application

3.4.1. Algorithm: Neutrosophic $g\alpha$-Closed Set

<table>
<thead>
<tr>
<th>input</th>
<th>neutrosophic set $G$</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td>neutrosophic $g\alpha$-closed set; neutrosophic $g\alpha$-open set</td>
</tr>
</tbody>
</table>

**STEPS:**
step-1: check $G$ is valid
step-2: check $G \subseteq F$ then go to step-3 otherwise repeat step-1
step-3: find $Ncl(G)$, if $Ncl(G)$ satisfies the neutrosophic closure condition then go to step-4 else repeat step-1
step-4: calculate $Ncl[G]$  
step-5: if $Ncl[G] \subseteq F$ then produce neutrosophic $g\alpha$-closed set else repeat step-1
step-6: compute the neutrosophic $g\alpha$-open set $[H]$ for the assigned data.

Figure 19: Screenshot of the Existence of Neutrosophic $g\alpha$-Closed Set $[NgaCS]$ via C#
The following figure shows that the neutrosophic set $G$ does not satisfy the definition of neutrosophic $^{*}g\alpha$-closed sets.

\[
G = \{ (0.2, 0.7, 0.1), (0.1, 0.1, 0.1), (0, 0.6, 0.5) \}
\]

$G$ is not satisfied the definition of neutrosophic $^{*}g\alpha$ closed set.

**Figure.21:** Screenshot of Dissatisfaction of the Definition of Neutrosophic $^{*}g\alpha$-Closed Set

\[
NC(G) = \{(0.7,0.7,0.7),(0.7,0.7,0.8),(0.5,0.4,0.5)\}
\]

$NC(G)$ Contained in $F$ = True

$G$ is a neutrosophic $^{*}g\alpha$ closed set.

Hence $H = \{(0.5,0.6,0.5),(0.8,0.8,0.9),(0.7,0.7,0.7)\}$ is a neutrosophic $^{*}g\alpha$ open set.

**Figure.22:** Screenshot of the Existence of Neutrosophic $^{*}g\alpha$-Closed Set [N$^{*}g\alpha$CS] via C# Application
3.5. Existence of Neutrosophic $b^g_a$-Closed Set via C# Application

Algorithm: Neutrosophic $b^g_a$-Closed Set

<table>
<thead>
<tr>
<th>input</th>
<th>neutrosophic set I</th>
</tr>
</thead>
<tbody>
<tr>
<td>output</td>
<td></td>
</tr>
<tr>
<td></td>
<td>neutrosophic $b^g_a$-closed set;</td>
</tr>
<tr>
<td></td>
<td>neutrosophic $b^g_a$-open set</td>
</tr>
</tbody>
</table>

**STEPS:**

step-1: check $I$ is valid
step-2: check $I \subseteq H$ then goto step-3 otherwise repeat step-1
step-3: find $\text{Ncl}(I)$, if $\text{Ncl}(I)$ satisfies the neutrosophic closure condition then go to step-4 else repeat step-1
step-4: find $\text{Nint}[I]$, if $\text{Nint}[I]$ satisfies the neutrosophic interior condition then go to step-5 else repeat step-1
step-5: find $\text{Nint}[\text{Ncl}[I]]$, if $\text{Nint}[\text{Ncl}[I]]$ satisfies the neutrosophic interior of neutrosophic closure condition then go to step-6 else repeat step-1
step-6: find $\text{Ncl}[\text{Nint}[I]]$, if $\text{Ncl}[\text{Nint}[I]]$ satisfies the neutrosophic closure of neutrosophic interior condition then go to step-7 else repeat step-1
step-7: calculate $[\text{Ncl}[\text{Nint}[I]]] \cup [\text{Nint}[\text{Ncl}[I]]]$ step-8: if $[\text{Ncl}[\text{Nint}[I]]] \setminus \cup [\text{Nint}[\text{Ncl}[I]]] \subseteq I$ then goto step-9 else repeat step-1 step-9: calculate $\text{Nbcl}(I)$ step-10: if $\text{Nbcl}[I] \subseteq H$ then produce neutrosophic $b^g_a$-closed set else repeat step-1 step-11: compute the neutrosophic $b^g_a$-open set $[F]$ for the assigned data.

![Flow Chart of Neutrosophic $b^g_a$-Closed Set](image-url)

Figure 23: Flow Chart of Neutrosophic $b^g_a$-Closed Set [FC-Nb$^g_a$CS]

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The following figure shows that the neutrosophic set $I$ is not satisfies the definition of neutrosophic $g*a$-closed sets.

$I = \{ (0.5, 0.6, 0.5), (0.3, 0.3, 0.2), (0.6, 0.7, 0.7) \}$

$I$ is not satisfied the definitions of neutrosophic $b$ closed and neutrosophic $b^*g$ alpha closed set.

Figure.24: Screenshot of Dissatisfaction of the Definition of Neutrosophic $b^*g*a$-Closed Set

$I = \{ (0.5, 0.6, 0.5), (0.3, 0.3, 0.2), (0.7, 0.7, 0.7) \}$

NCI(D) = \{(0.5,0.6,0.5),(0.7, 0.7, 0.8),(0.7,0.7,0.7)\}
NInt[I] = \{(0.5, 0.4, 0.5),(0.3,0.3,0.2),(0.7,0.7,0.7)\}
NInt[NCI(D)] = \{(0.5, 0.4, 0.5),(0.3,0.3,0.2),(0.7,0.7,0.7)\}
NCI[NInt(D)] = \{(0.5,0.6,0.5),(0.7, 0.7, 0.8),(0.7,0.7,0.7)\}
[NCI[NInt(D)] U NInt[NCI(D)]] Contained in $I$ - True
NbCI(D) = \{(0.5, 0.6, 0.5),(0.3,0.3,0.2),(0.7,0.7,0.7)\}
Therefore $I$ is a neutrosophic $b^*g$ alpha closed set.
Hence $I$ = \{(0.7,0.7,0.7),(0.7, 0.7, 0.8),(0.5,0.6,0.5)\} is a neutrosophic $b^*g$ alpha open set.

Figure.25: Screenshot of the Existence of Neutrosophic $b^*g*a$-Closed Set $[Nb^*g*aCS]$ via C# application
We have assumed the values of neutrosophic sets $0_N, 1_N, L, M$ as follows: If

$$0_N = \{(0, 0, 0), (0, 0, 1), (0, 1, 0)\}, \quad 1_N = \{(1, 1, 1), (1, 1, 0), (1, 0, 1)\},$$

$$L = \{(0.3, 0.2, 0.3), (0.1, 0.1, 0), (0.5, 0.5, 0.5)\}$$

and

$$M = \{(0.5, 0.5, 0.5), (0.1, 0.1, 0), (0.3, 0.4, 0.3)\}. $$

After entered all the values of the above in the user screen, the current application has produced the complement set of $L$ and $M$, that is, $L'$ and $M'$. Also it has executed the union of $L$ and $M$, that is $[L \cup M]$. Moreover, it has checked out the inclusion of $L$ and $M$, that is, whether $L$ is contained in $M$ or not. Finally it has produces the neutrosophic topology $[\tau]$.

$$L' = \{(0.5, 0.5, 0.5), (0.9, 0.9, 1), (0.3, 0.2, 0.3)\},$$

$$M' = \{(0.3, 0.4, 0.3), (0.9, 0.9, 1), (0.5, 0.5, 0.5)\},$$

$$L \cup M = \{(0.5, 0.5, 0.5), (0.1, 0.1, 0), (0.3, 0.4, 0.3)\},$$

$$L \cap M = \{(0.3, 0.2, 0.3), (0.1, 0.1, 0), (0.5, 0.5, 0.5)\},$$

$L \subseteq M = \text{True}.$

Then the Neutrosophic Topology $[\tau] = \{0_N, L, M, L \cup M, L \cap M, 1_N\}.$

By using this application we have checked out the following neutrosophic sets as neutrosophic $\alpha$-closed set in neutrosophic topological spaces.

<table>
<thead>
<tr>
<th>$N_{\alpha}CS$</th>
<th>Membership</th>
<th>Indeterminacy</th>
<th>Non-Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.5, 0.5, 0.6)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_2$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.5, 0.7, 0.7)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_3$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.9, 0.9, 0.9)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_4$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.1, 0.2, 0.9)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_5$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.4, 0.4, 0.4)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_6$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.5, 0.4, 0.4)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_7$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.5, 0.9, 0.4)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_8$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.2, 0.9, 0.4)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_9$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.35, 0.46, 0.39)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$C_{10}$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0.09, 0.04)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
</tbody>
</table>

By using this application we have checked out the following neutrosophic sets as neutrosophic $g\alpha$-closed set in neutrosophic topological spaces.
Table 2: Neutrosophic $g\alpha$-Closed Sets

<table>
<thead>
<tr>
<th>$N_{g\alpha}CS$</th>
<th>Membership</th>
<th>Indeterminacy</th>
<th>Non-Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_1$</td>
<td>(0.3, 0.213, 0.3)</td>
<td>(0.6594, 0.1, 0.517)</td>
<td>(0.671, 0.627, 0.5137)</td>
</tr>
<tr>
<td>$E_2$</td>
<td>(0.3, 0.4, 0.3)</td>
<td>(0, 0, 0)</td>
<td>(0.5, 0.5, 0.5)</td>
</tr>
<tr>
<td>$E_3$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.1, 0.1, 0)</td>
<td>(0.6, 0.6, 0.5)</td>
</tr>
<tr>
<td>$E_4$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.11, 0.1, 0)</td>
<td>(0.6, 0.6, 0.5)</td>
</tr>
<tr>
<td>$E_5$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.5, 0.1, 0.5)</td>
<td>(0.6, 0.6, 0.5)</td>
</tr>
<tr>
<td>$E_6$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.5, 0.1, 0.5)</td>
<td>(0.66, 0.6, 0.5)</td>
</tr>
<tr>
<td>$E_7$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.68, 0.1, 0.52)</td>
<td>(0.66, 0.63, 0.5)</td>
</tr>
<tr>
<td>$E_8$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.69, 0.1, 0.57)</td>
<td>(0.67, 0.67, 0.57)</td>
</tr>
<tr>
<td>$E_9$</td>
<td>(0.3, 0.2, 0.3)</td>
<td>(0.659, 0.1, 0.57)</td>
<td>(0.671, 0.627, 0.57)</td>
</tr>
<tr>
<td>$E_{10}$</td>
<td>(0.3, 0.213, 0.3)</td>
<td>(0.6594, 0.1, 0.57)</td>
<td>(0.671, 0.627, 0.57)</td>
</tr>
</tbody>
</table>

We have assumed the values of neutrosophic sets $0_N, 1_N, L, M$ as follows:
If $0_N = \{(0, 0, 0), (0, 1, 0), (0, 0, 1)\}$, $1_N = \{(1, 1, 1), (1, 1, 0), (1, 0, 1)\}$,
$L = \{(0.5, 0, 4, 0.5), (0.3, 0.3, 0.2), (0.7, 0.7, 0.7)\}$ and
$M = \{(0.7, 0.7, 0.7), (0.3, 0.3, 0.2), (0.5, 0.6, 0.5)\}$.

After entered all the values of the above in the user screen, the current application has produced the
complement set of $L$ and $M$, that is, $L'$ and $M'$. Also it has executed the union of $L$ and $M$, that is
$[L \cup M]$ and the intersection of $L$ and $M$, that is $[L \cap M]$. Moreover, it has checked out the inclusion
of $L$ and $M$, that is, whether $L$ is contained in $M$ or not. Finally it has produces the neutrosophic
topology $[\tau]$.
$L' = \{(0.7, 0.7, 0.7), (0.7, 0.7, 0.8), (0.5, 0.4, 0.5)\}$,
$M' = \{(0.5, 0.6, 0.5), (0.7, 0.7, 0.8), (0.7, 0.7, 0.7)\}$,
$L \cup M = M$
$L \cap M = L$
$L \subseteq M = True$,
Then the Neutrosophic Topology $[\tau] = \{0_N, L, M, 1_N\}$.
$NatCS = \{(0.5, 0.6, 0.5), (0.7, 0.7, 0.7), (0.7, 0.7, 0.7)\}$,
$NatOS = \{(0.7, 0.7, 0.7), (0.3, 0.3, 0.3), (0.5, 0.6, 0.5)\}$,
$Ng\alpha CS = \{(0.5, 0.4, 0.5), (0.3, 0.3, 0.2), (0.8, 0.8, 0.7)\}$ and
$Ng\alpha OS = \{(0.8, 0.8, 0.7), (0.7, 0.7, 0.8), (0.5, 0.4, 0.5)\}$.

By using this application we have checked out the following neutrosophic sets as neutrosophic $g\alpha$-
closed set in neutrosophic topological spaces.

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Table 3: Neutrosophic $\mathbf{g^a}$-Closed Sets

<table>
<thead>
<tr>
<th>Neutrosophic $CS$</th>
<th>Membership</th>
<th>Indeterminacy</th>
<th>Non-Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>$G_1$</td>
<td>(0.1, 0.2, 0.3)</td>
<td>(0.23, 0.56, 0)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$G_2$</td>
<td>(0.13, 0.27, 0.3)</td>
<td>(0.23, 0.516, 0.4)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$G_3$</td>
<td>(0.13, 0.27, 0.35431)</td>
<td>(0.23, 0.516, 0.4)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$G_4$</td>
<td>(0.1113, 0.27, 0.35)</td>
<td>(0.23, 0.516, 0.4)</td>
<td>(0.72, 0.73, 0.7)</td>
</tr>
<tr>
<td>$G_5$</td>
<td>(0.1113, 0.27, 0.35)</td>
<td>(0.23, 0.516, 0.4)</td>
<td>(0.812, 0.83, 0.771)</td>
</tr>
<tr>
<td>$G_6$</td>
<td>(0.1113, 0.27, 0.35)</td>
<td>(0.23, 0.516, 0.456)</td>
<td>(0.812, 0.83, 0.771)</td>
</tr>
<tr>
<td>$G_7$</td>
<td>(0.1113, 0.25677, 0.35465)</td>
<td>(0.23, 0.516, 0.456)</td>
<td>(0.812, 0.83, 0.771)</td>
</tr>
<tr>
<td>$G_8$</td>
<td>(0.1113, 0.25677, 0.3567805)</td>
<td>(0.23, 0.516, 0.456)</td>
<td>(0.812, 0.82233, 0.771)</td>
</tr>
<tr>
<td>$G_9$</td>
<td>(0.2113, 0.256177, 0.3567805)</td>
<td>(0.23, 0.526, 0.55555)</td>
<td>(0.812, 0.82233, 0.771)</td>
</tr>
<tr>
<td>$G_{10}$</td>
<td>(0.2113, 0, 0.5)</td>
<td>(0.23, 0.526, 0.55555)</td>
<td>(0.812, 0.82233, 0.771)</td>
</tr>
</tbody>
</table>

By using this application we have checked out the following neutrosophic sets as neutrosophic $\mathbf{b^g a}$-closed set in neutrosophic topological spaces.

Table 4: Neutrosophic $\mathbf{b^g a}$-Closed Sets

<table>
<thead>
<tr>
<th>Neutrosophic $CS$</th>
<th>Membership</th>
<th>Indeterminacy</th>
<th>Non-Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_1$</td>
<td>(0.5, 0.5, 0.5)</td>
<td>(0.31, 0.32, 0.22)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_2$</td>
<td>(0.5, 0.5, 0.5)</td>
<td>(0.341, 0.362, 0.272)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_3$</td>
<td>(0.5, 0.432789, 0.5)</td>
<td>(0.341, 0.362, 0.272)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_4$</td>
<td>(0.5, 0.43279, 0.5)</td>
<td>(0.341, 0.329, 0.22)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_5$</td>
<td>(0.5, 0.43279, 0.5)</td>
<td>(0.4, 0.39, 0.22)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_6$</td>
<td>(0.5, 0.43, 0.5)</td>
<td>(0.6, 0.3897, 0.3)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_7$</td>
<td>(0.5, 0.4309, 0.5)</td>
<td>(0.6, 0.37, 0.37777)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_8$</td>
<td>(0.5, 0.4309, 0.5)</td>
<td>(0.6123, 0.3123, 0.4123)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_9$</td>
<td>(0.5, 0.4309, 0.5)</td>
<td>(0.612223, 0.314717, 0.418923)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
<tr>
<td>$I_{10}$</td>
<td>(0.5, 0.4309, 0.5)</td>
<td>(0.3, 0.387906, 0.418)</td>
<td>(0.7, 0.7, 0.7)</td>
</tr>
</tbody>
</table>
Figure 26: Statistical Representation of Neutrosophic Closed Sets

**Linear Regression Line / Trend line Equations:**

- Neutrosophic $\alpha$-closed set: $y = 0.025x + 0.5194$  
  $R^2 = 0.6027$
- Neutrosophic $g\alpha$-closed set: $y = 0.0417x + 0.2917$  
  $R^2 = 0.2604$
- Neutrosophic $^*g\alpha$-closed set: $y = -0.0267x + 0.6$  
  $R^2 = 0.0928$
- Neutrosophic $b^*ga$-closed set: $y = 0.025x + 0.3861$  
  $R^2 = 0.1507$

Figure 27: Linear Regression Lines of Neutrosophic Closed Sets

In statistics, a linear regression line represents a straight line it describes how a response variable $y$ changes as an explanatory variable $x$ changes in the graph. Sometimes it is called as a trend line and its respective equations are denoted as a trend line equation. These type of trend lines are used in business to predict $y$ value for the given value of $x$. Here we have used this regression line and its equations to predict the neutrosophic points in the non-standard interval to get the $n$-number of neutrosophic $\alpha$ closed sets, neutrosophic $g\alpha$ closed sets, neutrosophic $^*g\alpha$-closed sets and neutrosophic $b^*ga$-closed sets in neutrosophic topological spaces. Also we can check the stronger and weaker sets among the existing sets by using $R^2$ value.
4. Conclusion

This paper has introduced a new computer application for finding the neutrosophic closed sets and neutrosophic open sets in neutrosophic topological spaces via .NET Framework, Microsoft Visual Studio and C# Programming Language. Flow Chart’s and the algorithm of neutrosophic topology, neutrosophic \( a \)-closed set, neutrosophic \( g\alpha \)-closed set, neutrosophic \( \ast \, g\alpha \)-closed set and neutrosophic \( b^* g\alpha \)-closed set were presented. Also the existence of its results via C# application was shown in each figure. The complement sets were executed through this application. In future it will be extended to produce the values of the same in the neutrosophic supra topological spaces.

References


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