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On $N_{*g\alpha}$- continuous in topological spaces of neutrosophy

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Abstract

This paper mainly focuses on incorporating the idea of $\mathcal{N}_{*g\alpha}$ continuous functions in neutrosophic topological spaces. We are also studying their features and looking at their properties.

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Keywords: $\mathcal{N}_{*g\alpha}$*-closed set,* $\mathcal{N}_{*g\alpha}$*-continuous.*

1. Introduction

The connotation of fuzzy set (FS) is implemented by Zadeh [1]. Next, the connotation of intuitionistic fuzzy set (IFS) is implemented by Atanassov [2]. In 1998, the notion of (IFS) was extended by Smarandache [3] to presented the neutrosophic set (NS) and study its applications. It is one of the non-classical sets, like fuzzy, nano, soft, permutation sets and so on, see ([4]-[26]).Some connotations like neutrosophic closed set (NCS) and neutrosophic continuous functions (NCF) in neutrosophic topological space (NTS) are given see ([27]). Arokiarani [28] has been introduced to α - closed set (α - CS) in (NTS). The fundamental sets like semi/pre/α/-open sets are defined in (NTS) then they are studied by many mathematicians, see ([29]). In 2017, Dhavaseelan and Saeid Jafari [30] introduced neutrosophic generalized closed sets. Vigneshwaran [31] defined a new closed set as ∗gα-closed sets in topological spaces, and it has been applied to define some topological functions as continuous functions, irresolute functions and homeomorphic functions with some separable axioms.

Recently, the connotation of neutrosophic using continuous and irresolute functions in (NTS) are implemented and discussed [32]. In this article, we introduce the $\mathcal{N}_{*g\alpha}$-continuous functions in neutrosophic topological spaces and investigate their properties.The basic definitions, which are used in the next section are referred from the references [2], [30], [32], [27], [31].

2. $\mathcal{N}_{*g\alpha}$-continuous function

Definition 2.1 : A function $\mathcal{T}$: $(\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ is called $\mathcal{N}_{g\alpha}$-continuous function ($\mathcal{N}_{g\alpha}$-CF) if $\mathcal{T}^{-1}(\mathcal{A})$ is a $\mathcal{N}_{g\alpha}$-closed set ($\mathcal{N}_{g\alpha}$-CS) of $(\psi, \mathcal{O})$ for any (NCS) $\mathcal{A}$ of $(\Upsilon, \mathcal{W})$.

Definition 2.2 : A function $\mathcal{T}$: $(\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ is called $\mathcal{N}_{*g\alpha}$-continuous function ($\mathcal{N}_{*g\alpha}$-CF) if $\mathcal{T}^{-1}(\mathcal{A})$ is a $\mathcal{N}_{*g\alpha}$-CS ($\mathcal{N}_{*g\alpha}$-CS) of $(\psi, \mathcal{O})$ for any (NCS) $\mathcal{A}$ of $(\Upsilon, \mathcal{W})$.

Theorem 2.3 : *Any neutrosophic continuous function (NCF) is $\mathcal{N}_{*g\alpha}$-CF .*

Proof : Assume $\boldsymbol{\mathcal{B}}$ is a (NCS) of $(\Upsilon, \mathcal{W})$. Since $\mathcal{T}$ is CF, $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}})$ is (NCS) in $(\psi, \mathcal{O})$. But any (NCS) is a $\mathcal{N}_{*g\alpha}$-CS. Hence $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}})$ is $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. Thus $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF.

The following example demonstrate reversal of this theorem is not necessary true.

Example 2.4 : Assume ψ ={u}, $\mathcal{O}$ ={ $0_{\mathcal{N}}$, $\mathcal{A}_1$, $1_{\mathcal{N}}$ } is a (NT) on $(\psi, \mathcal{O})$, $\mathcal{A}_1$=⟨ x, (0.3, 0.5, 0.3) ⟩ and Υ ={u}, $\mathcal{W}$ ={$0_{\mathcal{N}}$, $\boldsymbol{\mathcal{B}}_1$, $1_{\mathcal{N}}$ } is a (NT) on $(\Upsilon, \mathcal{W})$, $\boldsymbol{\mathcal{B}}_1$=⟨ y, (0.7, 0.4, 0.2) ⟩.

Define $\mathcal{T}$: $(\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ by $\mathcal{T}(u) = u$. $\mathcal{N}_{*g\alpha}$-CS of $(\psi, \mathcal{O})$ = ⟨ x, (0.2, 0.6, 0.7) ⟩. Here $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}}_1)^c$ is not (NCS) in $(\psi, \mathcal{O})$. Therefore $\mathcal{T}$ is not (NCF). However $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF.

Theorem 2.5 : *Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_g$-CF.*

Proof : Assume $\boldsymbol{\mathcal{B}}$ is a (NCS) of $(\Upsilon, \mathcal{W})$. Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}})$ is $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_g$-CS. Hence $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}})$ is $\mathcal{N}_g$-CS in $(\psi, \mathcal{O})$. Thus $\mathcal{T}$ is $\mathcal{N}_g$-CF.

The following example demonstrate reversal of this theorem is not necessary true.

Example 2.6 : Assume ψ ={u}, $\mathcal{O}$ ={ $0_{\mathcal{N}}$, $\mathcal{A}_1$, $1_{\mathcal{N}}$ } is a (NT) on $(\psi, \mathcal{O})$, $\mathcal{A}_1$=⟨ x, (0.8, 0.5, 0.7) ⟩ and Υ ={u}, $\mathcal{W}$ ={$0_{\mathcal{N}}$, $\boldsymbol{\mathcal{B}}_1$, $1_{\mathcal{N}}$ }is a (NT) on $(\Upsilon, \mathcal{W})$, $\boldsymbol{\mathcal{B}}_1$=⟨ y, (0.8, 0.3, 0.7) ⟩.

Define $\mathcal{T}$: $(\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ by $\mathcal{T}(u) = u$. $\mathcal{N}_g$-CS of $(\psi, \mathcal{O})$ =⟨ x, (0.7, 0.7, 0.8) ⟩. Here $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_g$-CF.

Theorem 2.7 : *Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_{g\alpha}$-CF.*

Proof : Assume $\boldsymbol{\mathcal{B}}$ is a (NCS) of $(\Upsilon, \mathcal{W})$. Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}})$ is $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_{g\alpha}$-CS. Hence $\mathcal{T}^{-1}(\boldsymbol{\mathcal{B}})$ is $\mathcal{N}_{g\alpha}$-CS in $(\psi, \mathcal{O})$. Thus $\mathcal{T}$ is $\mathcal{N}_{g\alpha}$-CF. The following example demonstrate reversal of this theorem is not necessary true.

Example 2.8 : Assume ψ ={u}, $\mathcal{O}$ ={ $0_{\mathcal{N}}$, $\mathcal{A}_1$, $1_{\mathcal{N}}$ } is a (NT) on (ψ, $\mathcal{O}$), $\mathcal{A}_1$ =⟨ x, (0.4, 0.6, 0.7) ⟩ and Υ ={u}, $\mathcal{W}$ ={$0_{\mathcal{N}}$, $\mathcal{B}_1$, $1_{\mathcal{N}}$ }is a (NT) on (Υ, $\mathcal{W}$), $\mathcal{B}_1$ =⟨ y, (0.7, 0.4, 0.6) ⟩.

Define $\mathcal{T}$: (ψ, $\mathcal{O}$) → (Υ, $\mathcal{W}$) by $\mathcal{T}(u) = u$. $\mathcal{N}_{g\alpha}$-CS of (ψ, $\mathcal{O}$) =⟨ x, (0.6, 0.6, 0.7) ⟩. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in (ψ, $\mathcal{O}$). Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{g\alpha}$-CF.

Theorem 2.9 : *Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_{\alpha g}$-CF.*

Proof : Assume $\mathcal{B}$ is a (NCS) of (Υ, $\mathcal{W}$). Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{*g\alpha}$-CS in (ψ, $\mathcal{O}$). But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_{\alpha g}$-CS. Hence $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{\alpha g}$-CS in (ψ, $\mathcal{O}$). Thus $\mathcal{T}$ is $\mathcal{N}_{\alpha g}$-CF.

The following example demonstrate reversal of this theorem is not necessary true.

Example 2.10 : Assume ψ ={u}, $\mathcal{O}$ ={$0_{\mathcal{N}}$, $\mathcal{A}_1$, $1_{\mathcal{N}}$ } is a (NT) on (ψ, $\mathcal{O}$), $\mathcal{A}_1$ =⟨ x, (0.2, 0.2, 0.3) ⟩ and Υ ={u}, $\mathcal{W}$ ={$0_{\mathcal{N}}$, $\mathcal{B}_1$, $1_{\mathcal{N}}$ } is a (NT) on(Υ, $\mathcal{W}$), $\mathcal{B}_1$ =⟨ y, (0.4, 0.8, 0.6) ⟩.

Define $\mathcal{T}$: (ψ, $\mathcal{O}$) → (Υ, $\mathcal{W}$) by $\mathcal{T}(u) = u$. $\mathcal{N}_{\alpha g}$-CS of (ψ, $\mathcal{O}$) =⟨ x, (0.6, 0.2, 0.4) ⟩. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in (ψ, $\mathcal{O}$). Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{\alpha g}$-CF.

Theorem 2.11 : *Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_{gs}$-CF.*

Proof : Assume $\mathcal{B}$ is a (NCS) of (Υ, $\mathcal{W}$). Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{*g\alpha}$-CS in (ψ, $\mathcal{O}$). But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_{gs}$-CS. Hence $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{gs}$-CS in (ψ, $\mathcal{O}$). Thus $\mathcal{T}$ is $\mathcal{N}_{gs}$-CF.

The following example demonstrate reversal of this theorem is not necessary true.

Example 2.12 : Assume ψ ={u}, $\mathcal{O}$ ={$0_{\mathcal{N}}$, $\mathcal{A}_1$, $1_{\mathcal{N}}$ } is a (NT) on (ψ, $\mathcal{O}$), $\mathcal{A}_1$ =⟨ x, (0.8, 0.6, 0.7) ⟩ and Υ ={u}, $\mathcal{W}$ ={$0_{\mathcal{N}}$, $\mathcal{B}_1$, $1_{\mathcal{N}}$ } is a (NT) on (Υ, $\mathcal{W}$), $\mathcal{B}_1$ =⟨ y, (0.7, 0.5, 0.7) ⟩

Define $\mathcal{T}$: (ψ, $\mathcal{O}$) → (Υ, $\mathcal{W}$) by $\mathcal{T}(u) = u$. $\mathcal{N}_{gs}$-CS of (ψ, $\mathcal{O}$) =⟨ x, (0.7, 0.5, 0.7) ⟩. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in (ψ, $\mathcal{O}$).Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{gs}$-CF.

Theorem 2.13 : *Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_{gsp}$-CF.*

Proof : Assume $\mathcal{B}$ is a (NCS) of $(\Upsilon, \mathcal{W})$. Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_{gsp}$-CS. Hence $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{gsp}$-CS in $(\psi, \mathcal{O})$. Thus $\mathcal{T}$ is $\mathcal{N}_{gsp}$-CF.

The following example demonstrate reversal of this theorem is not necessary true.

Example 2.14 : Assume $\psi=\{u\}$, $\mathcal{O}=\{0_{\mathcal{N}}, \mathcal{A}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\psi, \mathcal{O})$, $\mathcal{A}_1=\langle$ x, (0.5, 0.5, 0.6) $\rangle$ and $\Upsilon=\{u\}$, $\mathcal{W}=\{0_{\mathcal{N}}, \mathcal{B}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\Upsilon, \mathcal{W})$, $\mathcal{B}_1=\langle$ y, (0.7, 0.3, 0.6) $\rangle$.Define $\mathcal{T}: (\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ by $\mathcal{T}(u) = u$. $\mathcal{N}_{gsp}$-CS of $(\psi, \mathcal{O}) =\langle$ x, (0.6, 0.7, 0.7) $\rangle$. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{gsp}$-CF.

Theorem 2.15 : *Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_{gpr}$-CF.*

Proof : Assume $\mathcal{B}$ is a (NCS) of $(\Upsilon, \mathcal{W})$. Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_{gpr}$-CS. Hence $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{gpr}$-CS in $(\psi, \mathcal{O})$. Thus $\mathcal{T}$ is $\mathcal{N}_{gpr}$-CF. The following example demonstrate reversal of this theorem is not necessary true.

Example 2.16 : Assume $\psi=\{u\}$, $\mathcal{O}=\{0_{\mathcal{N}}, \mathcal{A}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\psi, \mathcal{O})$, $\mathcal{A}_1=\langle$ x, (0.5, 0.3, 0.6) $\rangle$ and $\Upsilon=\{u\}$, $\mathcal{W}=\{0_{\mathcal{N}}, \mathcal{B}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\Upsilon, \mathcal{W})$, $\mathcal{B}_1=\langle$ y, (0.7, 0.9, 0.2) $\rangle$.

Define $\mathcal{T}: (\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ by $\mathcal{T}(u) = u$. $\mathcal{N}_{gpr}$-CS of $(\psi, \mathcal{O}) =\langle$ x, (0.2, 0.1, 0.7) $\rangle$. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{gpr}$-CF.

Theorem 2.17 : Any $\mathcal{N}_{*g\alpha}$-CF is $\mathcal{N}_{gp}$-CF.

Proof : Assume $\mathcal{B}$ is a (NCS) of $(\Upsilon, \mathcal{W})$. Since $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF, $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. But any $\mathcal{N}_{*g\alpha}$-CS is a $\mathcal{N}_{gp}$-CS. Hence $\mathcal{T}^{-1}(\mathcal{B})$ is $\mathcal{N}_{gp}$-CS in $(\psi, \mathcal{O})$. Thus $\mathcal{T}$ is $\mathcal{N}_{gp}$-CF.

The following example demonstrate reversal of this theorem is not necessary true.

Example 2.18 : Assume $\psi=\{u\}$, $\mathcal{O}=\{0_{\mathcal{N}}, \mathcal{A}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\psi, \mathcal{O})$, $\mathcal{A}_1=\langle$ x, (0.4, 0.4, 0.6) $\rangle$ and $\Upsilon=\{u\}$, $\mathcal{W}=\{0_{\mathcal{N}}, \mathcal{B}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\Upsilon, \mathcal{W})$, $\mathcal{B}_1=\langle$ y, (0.6, 0.8, 0.2) $\rangle$.

Define $\mathcal{T}: (\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ by $\mathcal{T}(u) = u$. $\mathcal{N}_{gp}$-CS of $(\psi, \mathcal{O}) =\langle$ x, (0.2, 0.2, 0.6) $\rangle$. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. Therefore $\mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{gp}$-CF.

Remark 2.19 : The composition of two $\mathcal{N}_{*g\alpha}$-CF need not be a $\mathcal{N}_{*g\alpha}$-CF. It can be seen from the following example.

Example 2.20 : Assume $\psi=\{u\}$, $\mathcal{O}=\{0_{\mathcal{N}}, \mathcal{A}_1, 1_{\mathcal{N}}\}$ is a (NT) on $(\psi, \mathcal{O})$, $\mathcal{A}_1=\langle$ x, (0.4, 0.5, 0.6) $\rangle$ and $\Upsilon = X=\{u\}$, $\mathcal{W}=\{0_{\mathcal{N}}, \mathcal{B}_1, 1_{\mathcal{N}}\}$, $\mathcal{Z}=\{0_{\mathcal{N}}, \mathcal{C}_1, 1_{\mathcal{N}}\}$is a (NT) on $(\Upsilon, \mathcal{W})$, $(X, \mathcal{Z})$, $\mathcal{B}_1=\langle$ y, (0.3, 0.5, 0.4) $\rangle$ $\mathcal{C}_1=\langle$ z, (0.6, 0.5, 0.3) $\rangle$ respectively. Define $\mathcal{T}$: $(\psi, \mathcal{O}) \to (\Upsilon, \mathcal{W})$ by $\mathcal{T}(u) = u$ and $\mathcal{S}$: $(\Upsilon, \mathcal{W}) \to (X, \mathcal{Z})$ by $\mathcal{S}(u) = u$. The $\mathcal{T}$ and $\mathcal{S}$ are $\mathcal{N}_{*g\alpha}$-CF. But $\mathcal{S} \circ \mathcal{T}$ is not $\mathcal{N}_{*g\alpha}$-CF.

Remark 2.21 : $\mathcal{N}_{*g\alpha}$-continuity is independent of $\mathcal{N}$semi-CF and $\mathcal{N}_{\alpha}$-CF. The proof is based on the following examples.

Example 2.22 : From Example 2.4. It can be seen that $\mathcal{N}_{*g\alpha}$-CS of $(\psi, \mathcal{O})$ $=\langle$ x, (0.2, 0.6, 0.7) $\rangle$. Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}$ semi-CS and $\mathcal{N}_{\alpha}$-CS in $(\psi, \mathcal{O})$. Therefore $\mathcal{T}$ is not $\mathcal{N}$ semi-CF and $\mathcal{N}_{\alpha}$-CF. However $\mathcal{T}$ is $\mathcal{N}_{*g\alpha}$-CF.

Example 2.23 : From Example 2.6. It can be seen that NCS of $(\psi, \mathcal{O})$ $=\langle$ x, (0.7, 0.7, 0.8) $\rangle$.Here $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is not $\mathcal{N}_{*g\alpha}$-CS in $(\psi, \mathcal{O})$. But $\mathcal{T}^{-1}(\mathcal{B}_1)^c$ is $\mathcal{N}$ semi-CS and $\mathcal{N}_{\alpha}$-CS in $(\psi, \mathcal{O})$. Therefore T is not $\mathcal{N}_{*g\alpha}$-CF. However $\mathcal{N}$ semi-CF and $\mathcal{N}_{\alpha}$-CF.

Remark 2.24 : The figure 1 shows the relationship between $\mathcal{N}_{*g\alpha}$-CF and other CF's stated in the above theorems. A $\to$ B represents A implies B. Where the other one represents the independent relation.

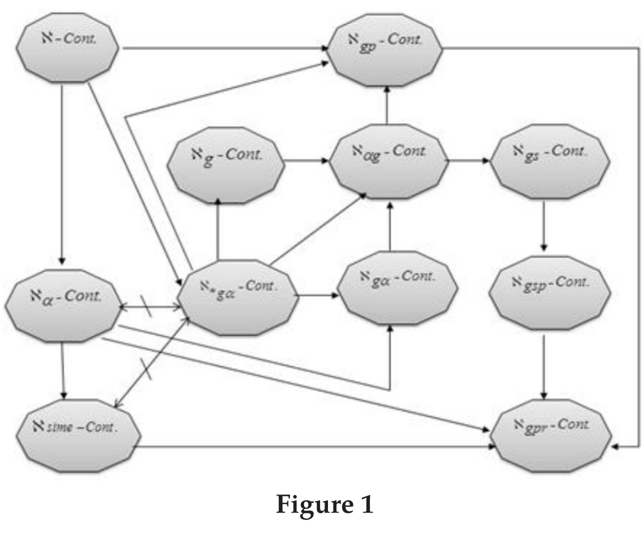

Figure 1

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