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Neutrosophic (RWG) Continuous Mappings and Contra (RWG) Closed & Open Mappings

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Abstract:

Aim of this present paper is, we introduce and investigate about new kind of Neutrosophic mapping is called Neutrosophic Regular Weakly Generalized continuous mappings in Neutrosophic topological spaces and also discussed about properties and characterization Neutrosophic contra Regular Weakly Generalized closed &open mappings .

Keywords: (NS(R)WG open set, (NS(R)WG closed set ,(NS(R)WG continuous mappings, contra(NS(R)WG closed mappings and contra(NS(R)WG open mappings Neutrosophic topological spaces

I.INTRODUCTION

A.A.Salama presented Neutrosophic topological spaces by utilizing Smarandache's Neutrosophic sets. I.Arokiarani.[2] et al, presented Neutrosophic α-closed sets.P. Ishwarya, [8]et.al, presented and concentrated about on Neutrosophic semi-open sets in Neutrosophic topological spaces. Point of this current paper is, we present and research about new sort of Neutrosophic mapping is called Neutrosophic Regular Weakly Generalized consistent mappings in Neutrosophic topological spaces and furthermore examined about properties and portrayal Neutrosophic contra Regular Weakly Generalized closed &open mappings.

I. PRELIMINARIES

In this section, we introduce the basic definition for Neutrosophic sets and its operations.

Definition 2.1 [7]

Let X be a non-empty fixed set. A Neutrosophic set A is an object having the form

$A = \{<x, \eta_A(x), \sigma_A(x), \gamma_A(x)>: x \in X\}$

Where $\eta_A(x)$, $\sigma_A(x)$ and $\gamma_A(x)$ which represent Neutrosophic topological spaces the degree of membership function, the degree indeterminacy and the degree of non-membership function respectively of each element $x \in X$ to the set A.

Remark 2.2 [7]

A Neutrosophic set $A=\{<x, \eta_A(x), \sigma_A(x), \gamma_A(x)>: x \in X\}$ can be identified to an ordered triple $<\eta_A, \sigma_A, \gamma_A>$ in]-0,1+[on X.

Remark 2.3[7]

We shall use the symbol

$A = <x, \eta_A, \sigma_A, \gamma_A>$ for the Neutrosophic set $A = \{<x, \eta_A(x), \sigma_A(x), \gamma_A(x)>: x \in X\}$.

Example 2.4 [7]

Every Neutrosophic set A is a non-empty set in X is obviously on Neutrosophic set having the form $A=\{<x, \eta_A(x), 1-((\eta_A(x) + \gamma_A(x)), \gamma_A(x)>: x \in X\}$**.** Since our main purpose is to construct the tools for developing Neutrosophic set and Neutrosophic topology, we must introduce the Neutrosophic set 0_N and 1_N in X as follows:

0_N may be defined as:

(0_1) $0_N=\{<x, 0, 0, 1>: x \in X\}$

(0_2) $0_N=\{<x, 0, 1, 1>: x \in X\}$

(0_3) 0_N ={<x, 0, 1, 0 >:x∈X}
(0_4) 0_N={<x, 0, 0, 0>: x ∈X}
1_N may be defined as :
(1_1) 1_N ={<x, 1, 0, 0>: x∈X}
(1_2) 1_N ={<x, 1, 0, 1 >: x∈X}
(1_3) 1_N ={<x, 1, 1, 0 >: x∈X}
(1_4) 1_N ={<x, 1, 1, 1 >: x∈X}

Definition 2.5 [7]
Let $A=<\eta_A, \sigma_A,\gamma_A>$ be a Neutrosophic set on X, then the complement of the set A
A^C defined as
$A^C=\{<x , \gamma_A(x) ,1- \sigma_A(x), \eta_A(x) >: x \in X\}$

Definition 2.6 [7]
Let X be a non-empty set, and Neutrosophic sets A and B in the form
A ={<x, $\eta_A(x)$, σA(x), γA(x)>:x∈X} and
B ={<x, $\eta_B(x)$, $\sigma_B(x)$, $\gamma_B(x)$>: x∈X}.
Then we consider definition for subsets (A⊆B).
A⊆B defined as: A⊆B $\Leftrightarrow \eta_A(x) \le \eta_B(x)$, $\sigma_A(x) \le \sigma_B(x)$ and $\gamma_A(x) \ge \gamma_B(x)$ for all x∈X

Definition 2.7 [7]
Let X be a non-empty set, and $A=<x, \eta_B(x),\sigma_A(x), \gamma_A(x)>$, $B =<x, \eta_B(x), \sigma_B(x), \gamma_B(x)>$ be two Neutrosophic sets. Then
(i) A∩B defined as :$A\cap B =<x, \eta_A(x)\wedge\eta_B(x), \sigma_A(x)\wedge\sigma_B(x),\gamma_A(x)\vee\gamma_B(x)>$
(ii) A∪B defined as :$A\cup B =<x, \eta_A(x)\vee\eta_B(x), \sigma_A(x)\vee\sigma_B(x), \gamma_A(x)\wedge\gamma_B(x)>$

Proposition 2.8 [7]
For all A and B are two Neutrosophic sets then the following condition are true:
(i) $(A\cap B)^C=A^C\cup B^C$
(ii) $(A\cup B)^C=A^C\cap B^C$.

Definition 2.9 [11]
A Neutrosophic topology is a non-empty set X is a family τ_N of Neutrosophic subsets in X satisfying the following axioms:
(i) $0_N, 1_N \in\tau_N$,
(ii) $G_1\cap G_2\in\tau_N$ for any $G_1, G_2\in\tau_N$,
(iii) $\cup G_i\in\tau_N$ for any family $\{G_i | i\in J \}\subseteq\tau_N$.
the pair (X, τ_N) is called a Neutrosophic topological space.

The element Neutrosophic topological spaces of τ_N are called Neutrosophic open sets.
A Neutrosophic set A is closed if and only if A^C is Neutrosophic open.

Example 2.10[11]
Let X={x} and
A_1= {<x, 0.6, 0.6, 0.5>:x∈X}
A_2= {<x, 0.5, 0.7, 0.9>:x∈X}
A_3= {<x, 0.6, 0.7, 0.5>:x∈X}
A_4= {<x, 0.5, 0.6, 0.9>:x∈X}
Then the family $\tau_N=\{0_N, 1_N, A_1, A_2, A_3, A_4\}$is called a Neutrosophic topological space on X.

Definition 2.11[11]
Let (X, τ_N) be Neutrosophic topological spaces and $A=\{<x,\eta_A(x),\sigma_A(x),\gamma_A(x)>:x\in X\}$ be a Neutrosophic set in X. Then the Neutrosophic closure and Neutrosophic interior of A are defined by
Neu-cl(A)=∩{K:K is a Neutrosophic closed set in X and A⊆K}
Neu-int(A)=∪{G:G is a Neutrosophic open set in X and G⊆A}.

Definition 2.12
Let (X, τ_N) be a Neutrosophic topological space. Then A is called
(i) Neutrosophic regular Closed set [2] (Neu-RCS in short) if A=Neu-Cl(Neu-Int(A)),
(ii) Neutrosophic α-Closed set[2] (Neu-αCS in short) if Neu-Cl(Neu-Int(Neu-Cl(A)))⊆A,
(iii) Neutrosophic semi Closed set [8] (Neu-SCS in short) if Neu-Int(Neu-Cl(A))⊆A ,
(iv) Neutrosophic pre Closed set [12] (Neu-PCS in short) if Neu-Cl(Neu-Int(A))⊆A,

Definition 2.13
Let (X, τ_N) be a Neutrosophic topological space. Then A is called
(i). Neutrosophic regular open set [2](Neu-ROS in short) if A=Neu-Int(Neu-Cl(A)),
(ii). Neutrosophic α-open set [2](Neu-αOS in short) if A⊆Neu-Int(Neu-Cl(Neu-Int(A))),
(iii). Neutrosophic semi open set [8](Neu-SOS in short) if A⊆Neu-Cl(Neu-Int(A)),
(iv).Neutrosophic pre open set [13] (Neu-POS in short) if A⊆Neu-Int(Neu-Cl(A)),

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Definition 2.14
Let (X, τ_N) be a Neutrosophic topological space. Then A is called
(i).Neutrosophic generalized closed set[4](Neu-GCS in short) if Neu-cl(A)⊆U whenever A⊆U and U is a Neu-OS in X ,
(ii).Neutrosophic generalized semi closed set[12] (Neu-GSCS in short) if Neu-scl(A)⊆U Whenever A⊆U and U is a Neu-OS in X,
(iii).Neutrosophic α generalized closed set [9](Neu-αGCS in short) if Neu-αcl(A)⊆U whenever A⊆U and U is a Neu-OS in X ,
(iv).Neutrosophic generalized alpha closed set [5] (Neu-GαCS in short) if Neu-αcl(A)⊆U whenever A⊆U and U is a Neu-αOS in X .
The complements of the above mentioned Neutrosophic closed sets are called their respective Neutrosophic open sets.

II. NEUTROSOPHIC REGULAR WEAKLY GENERALIZED CONTINUOUS MAPPINGS

In this chapter we have introduced Neutrosophic regular weakly generalized continuous mapping and studied some of its properties.

Definition 3.1: A mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is called an *Neutrosophic regular weakly generalized continuous* (NS(RWG)CTS in short) if f^{-1}(A) is a NS(RWG)CS in (N_X^*, NS_τ) for every NSCS A of (N_Y^*, NS_σ).

Example 3.2: Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= ⟨r, $\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right),\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)$⟩

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.
Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$. Then f is a NS(RWG)CTS mapping.

Theorem 3.3:
Every NS continuous mapping is a NS(RWG)CTS mapping but not conversely.

Proof:
Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) is a NS continuous mapping. Let A is a NSCS in N_Y^*. Since f is a NS continuous mapping, f^{-1}(A) is a NSCS in N_X^*. Since every NSCS is a NS(RWG)CS ,
f^{-1}(A) is a NS(RWG)CS in N_X^*. Hence f is a NS(RWG)CTS mapping.

Example 3.4:
Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= ⟨r, $\left(\frac{1}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right)$⟩

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.
Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.
The NSS A= ⟨s, $\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)$⟩is NSCS in N_Y^*. Then f^{-1}(A) is NS(RWG)CS in N_X^* but not an NSCS in N_X^*. Therefore f is a NS(RWG)CTS mapping but not an NS continuous mapping.

Remark 3.5:
The converse of the above theorem is true if N_X^* is a NS(rw)T1/2 space.

Proof:
Let A is a NSCS in N_Y^*. Then f^{-1}(A) is a NS(RWG)CS in N_X^*, by hypothesis. Since N_X^* is a NS(rw)$_{T1/2}$ space, f^{-1}(A) is a NSCS in N_X^*. Hence f is a NS continuous mapping.

Theorem 3.6:
Every NS(P) continuous mapping is a NS(RWG)CTS mapping but not conversely.

Proof:
Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) is a NS(P) continuous mapping. Let A is a NSCS in N_Y^*. Then by hypothesis f^{-1}(A) is a NS(P)CS in N_X^*. Since every NS(P)CS is a NS(RWG)CS, f^{-1}(A) is a NS(RWG)CS in N_X^*. Hence f is a NS(RWG) continuous mapping.

Example 3.7: Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*} and

$N_{T_1}^*$= ⟨r, $\left(\frac{1}{10},\frac{5}{10},\frac{9}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{4}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right)$⟩

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Then NS_τ = {0_{NS}, $N^*_{T_1}$, 1_{NS} } and NS_σ = {0_{NS}, $N^*_{T_2}$, 1_{NS} } are NSTs on N^*_X and N^*_Y respectively.

Define a mapping N^*_f: (N^*_X, NS_τ) → (N^*_Y, NS_σ)by $N^*_f(r^*_1) = s^*_1$ and $N^*_f(r^*_2) = s^*_2$.

The NSS A= $\langle$s, $\left(\frac{5}{10},\frac{5}{10},\frac{4}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right)\rangle$ is NSCS in N^*_Y. Then f^{-1}(A) is NS(RWG)CS in N^*_X but not an NS(P)CS in N^*_X. Therefore f is a NS(RWG) continuous mapping but not an NS(P) continuous mapping.

Remark 3.8: The converse of the above theorem is true if N^*_X is a NS(RWG)T1/2 space.

Proof: Let A is a NSCS in N^*_Y. Then f^{-1}(A) is a NS(RWG)CS in N^*_X, by hypothesis. Since N^*_X is a NS(RWG)$T_{1/2}$ space, f^{-1}(A) is a NS(P)CS in N^*_X. Hence f is a NS(P) continuous mapping.

Theorem 3.9:

Every NS(α) continuous mapping is a NS(RWG) continuous mapping but not conversely.

Proof:

Let N^*_f: (N^*_X, NS_τ) → (N^*_Y, NS_σ) is a NS(αG)continuous mapping. Let A is a NSCS in N^*_Y. Then by hypothesis f^{-1}(A) is a NS(α)CS in N^*_X. Since every NS(α)CS is a NS(RWG)CS, f^{-1}(A) is a NS(RWG)CS in N^*_X. Hence f is a NS(RWG) continuous mapping.

Example 3.10:

Let N^*_X={r^*_1, r^*_2} , N^*_Y={s^*_1, s^*_2}and

$N^*_{T_1}$= $\langle$r, $\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$

$N^*_{T_2}$= $\langle$s, $\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{8}{10},\frac{5}{10},\frac{1}{10}\right)\rangle$

Then τ = {0_{NS}, $N^*_{T_1}$, 1_{NS} } and σ = {0_{NS}, $N^*_{T_2}$, 1_{NS} } are NSTs on N^*_X and N^*_Y respectively. Define a mapping N^*_f: (N^*_X, NS_τ) → (N^*_Y, NS_σ)by $N^*_f(r^*_1) = s^*_1$ and $N^*_f(r^*_2) = s^*_2$.

The NSS A = $\langle$s, $\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right),\left(\frac{1}{10},\frac{5}{10},\frac{8}{10}\right)\rangle$is a NSCS in N^*_Y.

Then f^{-1}(A) is a NS(RWG)CS in N^*_X but not an NS(α)CS in N^*_X.

Theorem 3.11: Every NS(αG)continuous mapping is a NS(RWG) continuous mapping but not conversely.

Proof: Let N^*_f: (N^*_X, NS_τ) → (N^*_Y, NS_σ) is a NS(αG)continuous mapping. Let A is a NSCS in N^*_Y. Then by hypothesis f^{-1}(A) is a NS(α)GCS in N^*_X. Since every NS(α)GCS is a NS(RWG)CS,
f^{-1}(A) is a NS(RWG)CS in N^*_X. Hence f is a NS(RWG) continuous mapping.

Example 3.12: Let N^*_X={r^*_1, r^*_2} , N^*_Y={s^*_1, s^*_2}and

$N^*_{T_1}$= $\langle$r, $\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right)\rangle$

$N^*_{T_2}$= $\langle$s, $\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N^*_{T_1}$, 1_{NS} } and NS_σ = {0_{NS}, $N^*_{T_2}$, 1_{NS} } are NSTs on N^*_X and N^*_Y respectively.

Define a mapping N^*_f: (N^*_X, NS_τ) → (N^*_Y, NS_σ) by $N^*_f(r^*_1) = s^*_1$ and $N^*_f(r^*_2) = s^*_2$.

The NSS A= $\langle$s, $\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)\rangle$ is NSCS in N^*_Y.

Then f^{-1}(A) is NS(RWG)CS in N^*_X but not NS(α)GCS in N^*_X.

Theorem 3.13:

Every NS(R) continuous mapping is a NS(RWG) continuous mapping but not conversely.

Proof:

Let A is a NSCS in N^*_Y. Then f^{-1}(A) is a NS(R)CS in N^*_X. Since every NS(R)CS is a NS(RWG)CS, f^{-1}(A) is a NS(RWG)CS in N^*_X. Hence f is a NS(RWG) continuous mapping.

Example 3.14: Let N^*_X={r^*_1, r^*_2} , N^*_Y={s^*_1, s^*_2}and

$N^*_{T_1}$= $\langle$r, $\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{7}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$

$N^*_{T_2}$= $\langle$s, $\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right),\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N^*_{T_1}$, 1_{NS} } and NS_σ = {0_{NS}, $N^*_{T_2}$=, 1_{NS} } are NSTs on N^*_X and N^*_Y respectively.

Define a mapping N^*_f: (N^*_X, NS_τ) → (N^*_Y, NS_σ)by $N^*_f(r^*_1) = s^*_1$ and $N^*_f(r^*_2) = s^*_2$.

The NSS A= $\langle$s, $\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right)\rangle$ is a NSCS in N^*_Y. Then f^{-1}(A) is NS(RWG)CS in N^*_X but not NS(R)CS in N^*_X.

Proposition 3.15: NS(RWG) continuous mapping and NS(S) continuous mapping are independent to each other.

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Example 3.16:

Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right), \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$

Then $NS_\tau = \{0_{NS}, N_{T_1}^*, 1_{NS}\}$ and $NS_\sigma = \{0_{NS}, N_{T_2}^*, 1_{NS}\}$ are NSTs on N_X^* and N_Y^* respectively.

Define a mapping $N_f^*: (N_X^*, NS_\tau) \to (N_Y^*, NS_\sigma)$ by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

The NSS A= $\langle s, \left(\frac{8}{10}, \frac{5}{10}, \frac{2}{10}\right), \left(\frac{7}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$ is a NSCS in N_Y^*.

Then $f^{-1}(A)$ is a NS(RWG)CS in N_X^* but not an NS(S)C in N_X^*.

Example 3.17:

Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{6}{10}, \frac{5}{10}, \frac{2}{10}\right)\rangle$

Then $NS_\tau = \{0_{NS}, N_{T_1}^*, 1_{NS}\}$ and $NS_\sigma = \{0_{NS}, N_{T_2}^*, 1_{NS}\}$ are NSTs on N_X^* and N_Y^* respectively.

Define a mapping $N_f^*: (N_X^*, NS_\tau) \to (N_Y^*, NS_\sigma)$by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

The NSS A= $\langle s, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$ is a NSCS in N_Y^*.

Then $f^{-1}(A)$ is a NS(S)C in N_X^* but not an NS(RWG)CS in N_X^*.

Proposition 3.18:

NS(RWG) continuous mapping and NS(GS) continuous mapping are independent to each other.

Example 3.19:

Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right), \left(\frac{9}{10}, \frac{5}{10}, \frac{1}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$

Then $NS_\tau = \{0_{NS}, N_{T_1}^*, 1_{NS}\}$ and $NS_\sigma = \{0_{NS}, N_{T_2}^*, 1_{NS}\}$ are NSTs on N_X^* and N_Y^* respectively.

Define a mapping $N_f^*: (N_X^*, NS_\tau) \to (N_Y^*, NS_\sigma)$by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

The NSS A= $\langle s, \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right), \left(\frac{7}{10}, \frac{5}{10}, \frac{3}{10}\right)\rangle$ is an NSCS in N_Y^*.

Then $f^{-1}(A)$ is an NS(RWG)CS in N_X^* but not an NS(GS)C in N_X^*..

Example 3.20:

Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right)\rangle$

Then $NS_\tau = \{0_{NS}, N_{T_1}^*, 1_{NS}\}$ and $NS_\sigma = \{0_{NS}, N_{T_2}^*, 1_{NS}\}$ are NSTs on N_X^* and N_Y^* respectively.

Define a mapping $N_f^*: (N_X^*, NS_\tau) \to (N_Y^*, NS_\sigma)$by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

The NSS A= $\langle s, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$ is a NSCS in N_Y^*.

Then $f^{-1}(A)$ is NS(GS)C in N_X^* but not an NS(RWG)CS in N_X^*.

Theorem 3.21:

If the mapping $N_f^*: (N_X^*, NS_\tau) \to (N_Y^*, NS_\sigma)$is a NS(RWG) continuous then the inverse image of each NSOS in N_Y^* is a NS(RWG)OS in N_X^*.

Proof:

Let A is a NSOS in N_Y^*. This implies Ac is NSCS in N_Y^*. Since f is NS(RWG) continuous, $f^{-1}(A^C)$ is NS(RWG)CS in N_X^*. Since $f^{-1}(A^C) = (f^{-1}(A))^C$, $f^{-1}(A)$ is a NS(RWG)OS in N_X^*.

Theorem 3.22:

Let $N_f^*: (N_X^*, NS_\tau) \to (N_Y^*, NS_\sigma)$ is a NS(RWG) continuous mapping and $N_g^*: (N_Y^*, NS_\sigma) \to (N_Z^*, NS_\delta)$ is NS continuous, then N_g^* o N_f^* : $(N_X^*, NS_\tau) \to (N_Z^*, NS_\delta)$ is a NS(RWG) continuous.

Proof:

Let A is a NSCS in N_Z^*. Then $g^{-1}(A)$ is a NSCS in N_Y^*, by hypothesis. Since f is a NS(RWG) continuous mapping, $f^{-1}(g^{-1}(A))$ is a NS(RWG)CS in N_X^*. Hence N_g^* o N_f^* is a NS(RWG) continuous mapping.

III. NEUTROSOPHIC CONTRA REGULAR WEAKLY GENERALIZED OPEN MAPPINGS

In this section we introduce Neutrosophic contra regular weakly generalized open mappings. We investigate some of their properties.

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Definition 4.1: A mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)from an NSTS (N_X^*, NS_τ) into an NSTS (N_Y^*, NS_σ)is called an Neutrosophic contra regular weakly generalized open mapping (NSc(RW)GOM in short) if f(A) is a NS(RWG)CS in N_Y^* for every NSOS A in N_X^*.

Example 4.2: Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right), \left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{4}{10},\frac{5}{10},\frac{5}{10}\right), \left(\frac{6}{10},\frac{5}{10},\frac{5}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

Then f is a NSc(RW)GOM.

Theorem 4.3:

Every NScOM is a NSc(RW)GOM but not conversely.

Proof:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NScOM. Let A is a NSOS in N_X^*. Then f (A) is a NSCS in N_Y^*. Since every NSCS is a NS(RWG)CS , f(A) is a NSc(RWG)CS in N_Y^*. Hence f is a NSc(RW)GOM.

Example 4.4:

Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right), \left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{4}{10},\frac{5}{10},\frac{5}{10}\right), \left(\frac{6}{10},\frac{5}{10},\frac{5}{10}\right)\rangle$

Then NS_τ= {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively. Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

Then f is NSc(RW)GOM but not an NScOM since NSS A= $\langle r, \left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right), \left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is a NSOS in N_X^* but f(A) = $\langle s, \left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right), \left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$is not an NSCS in N_Y^*, since cl(f(A)) = 1_{NS} ≠ f(A).

Theorem 4.5:

Every NSc(α)OM is a NSc(RW)GOM but not conversely.

Proof:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NScαOM. Let A is a NSOS in N_X^*. Then f(A) is a NSαCS in N_Y^*. Since every NSαCS is a NS(RWG)CS , f(A) is a NS(WG)CS in N_Y^*. Hence f is a NSc(RW)GOM.

Example 4.6:

Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right), \left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right), \left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

Then f is NSc(RW)GOM but not an NS(α)CM since NSS A= $\langle r, \left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right), \left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$ is a NSOS in X but f(A) =$\langle r, \left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right), \left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)\rangle$ is not an NSαCS in N_Y^*, since cl(int(cl(f(A)))) = 1_{NS} ⊈ f(A).

Theorem 4.7: Every NSc(P)OM is a NSc(RW)GOM but not conversely.

Proof: Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NSc(P)OM. Let A is a NSOS in N_X^*. Then f(A) is a NS(P)CS in N_Y^*. Since every NS(P)CS is a NS(RWG)CS , f(A) is a NS(RWG)CS in N_Y^*. Hence f is a NSc(RW)GOM.

Example 4.8: Let $N_X^*=\{r_1^*, r_2^*\}$, $N_Y^*=\{s_1^*, s_2^*\}$and

$N_{T_1}^* = \langle r, \left(\frac{1}{10},\frac{5}{10},\frac{9}{10}\right), \left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$

$N_{T_2}^* = \langle s, \left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right), \left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

Then f is NSc(RW)GOM but not an NS(P)CM since NSS A= $\langle r, \left(\frac{1}{10},\frac{5}{10},\frac{9}{10}\right), \left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is a NSOS in N_X^* but f(A) = $\langle s, \left(\frac{1}{10},\frac{5}{10},\frac{9}{10}\right), \left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right)\rangle$ is not an NS(P)CS in N_Y^*, since cl(int(f(A))) = 0_{NS} ⊈f(A).

Theorem 4.9:

Every NSc(αG)OM is a NSc(RW)GOM but not conversely.

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Proof:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NSc(αG)CM. Let A is a NSOS in N_X^*. Then f(A) is a NS(αG)CS in N_Y^*. Since every NS(αG)CS is a NS(RWG)CS , f(A) is a NS(RWG)CS in N_Y^*. Hence f is a NSc(RW)GOM.

Example 4.10:

Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= ⟨r, $\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right)$⟩

Then $N_{T_1}^*$ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and $N_{T_2}^*$ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

Then f is NSc(RW)GOM but not an NS(αG)CM since NSS A= ⟨r, $\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)$⟩ is a NSOS in N_X^* but f(A) = ⟨s, $\left(\frac{6}{10},\frac{5}{10},\frac{3}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)$⟩ is not an NS(αG)CS in N_Y^*, since NSαcl(f(A)) = 1_{NS} ⊈ $N_{T_2}^*$.

IV. NEUTROSOPHIC CONTRA REGULAR WEAKLY GENERALIZED CLOSED MAPPINGS

In this section we introduce Neutrosophic contra regular weakly generalized closed mappings and investigate some of their properties.

Definition 5.1:

A mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)from an NSTS (N_X^*, NS_τ) into an NSTS (N_Y^*, NS_σ)is called an Neutrosophic contra regular weakly generalized closed mapping (NSc(RWG)CM in short) if f(A) is a NSRWGOS in N_Y^* for every NSCS A in N_X^*.

Example 5.2: Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= ⟨r, $\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right),\left(\frac{7}{10},\frac{5}{10},\frac{2}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)$⟩

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$. Then f is a NSc(RWG)CM.

Theorem 5.3:

Every NScCM is a NSc(RWG)CM but not conversely.

Proof: Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) is a NScCM. Let A is a NSCS in N_X^*. Then f (A) is a NSOS in N_Y^*. Implies $(f(A))^C$is NSCS in N_Y^*. Since every NSCS is a NS(RWG)CS , $(f(A))^C$ is a NS(RWG)CS in N_Y^*. Hence f(A) is NSRWGOS in N_Y^*. Hence f is a NSc(RW)GOM.

Example 5.4:

Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= ⟨r, $\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right),\left(\frac{7}{10},\frac{5}{10},\frac{3}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{4}{10},\frac{5}{10},\frac{6}{10}\right),\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right)$⟩

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$.

Then f is NSc(RWG)CM but not an NSCM since NSS A= ⟨r, $\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)$⟩ is a NSCS in N_X^* but f(A) =⟨s, $\left(\frac{2}{10},\frac{5}{10},\frac{8}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)$⟩ is not an NSCS in N_Y^*, since cl(f(A)) = ${N_{T_2}^*}^C$ ≠ f(A).

Theorem 5.5:

Every NSc(α)CM is a NSc(RWG)CM but not conversely.

Proof:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NSc(α)CM. Let A is a NSCS in N_X^*. Then f (A) is a NS(α)OS in N_Y^*. This implies $(f(A))^C$ is a NSαCS in N_Y^*. Since every NSαCS is a NS(RWG)CS , $(f(A))^C$ is a NS(RWG)CS in N_Y^*. i.e f(A) is a NSRWGOS in N_Y^*. Hence f is a NSc(RW)GOM.

Example 5.6: Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= ⟨r, $\left(\frac{6}{10},\frac{5}{10},\frac{4}{10}\right),\left(\frac{8}{10},\frac{5}{10},\frac{2}{10}\right)$⟩

$N_{T_2}^*$= ⟨s, $\left(\frac{5}{10},\frac{5}{10},\frac{5}{10}\right),\left(\frac{3}{10},\frac{5}{10},\frac{7}{10}\right)$⟩

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively. Define a

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mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$. Then f is NSc(RWG)CM but not an NS(α)CM since NSS A= $\langle r, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right)\rangle$ is a NSCS in N_X^* but f(A) = $\langle s, \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{2}{10}, \frac{5}{10}, \frac{8}{10}\right)\rangle$ is not an NSαCS in N_Y^*, since cl(int(cl(f(A)))) = ${N_{T_2}^*}^C \nsubseteq$ f(A).

Theorem 5.7:

Every NSc(P)CM is a NSc(RWG)CM but not conversely.

Proof:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NSc(P)CM. Let A is a NSCS in N_X^*. Then f (A) is a NS(P)OS in N_Y^*. This implies $(f(A))^C$is a NS(P)CS in N_Y^*. Since every NS(P)CS is a NS(RWG)CS , (f(A))c is a NS(RWG)CS in N_Y^*. i.e f(A) is a NSRWGOS in N_Y^*. Hence f is a NSc(RWG)CM.

Example 5.8:

Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= $\langle r, \left(\frac{1}{10}, \frac{5}{10}, \frac{9}{10}\right), \left(\frac{6}{10}, \frac{5}{10}, \frac{3}{10}\right)\rangle$

$N_{T_2}^*$= $\langle s, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{7}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively. Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}. Then f is NSc(RWG)CM but not an NS(P)CM since NSS A= $\langle r, \left(\frac{9}{10}, \frac{5}{10}, \frac{1}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$ is a NSCS in N_X^* but f(A) = $\langle s, \left(\frac{9}{10}, \frac{5}{10}, \frac{1}{10}\right), \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$ is not an NS(P)CS in N_Y^*, since cl(int(f(A))) = $N_{T_2}^*$C ⊈f(A).

Theorem 5.9:

Every NSc(αG)CM is a NSc(RWG)CM but not conversely.

Proof:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ) is a NSc(αG)CM. Let A is a NSCS in N_X^*. Then f (A) is a NS(α)GOS in N_Y^*. This implies (f(A))c is a NS(αG)CS in N_Y^*. Since every NS(αG)CS is a NS(RWG)CS , $(f(A))^C$ is a NS(RWG)CS in N_Y^*. Hence f(A) is a NSc(RWG)CM.

Example 5.10:

Let N_X^*={r_1^*, r_2^*} , N_Y^*={s_1^*, s_2^*}and

$N_{T_1}^*$= $\langle r, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{4}{10}, \frac{5}{10}, \frac{6}{10}\right)\rangle$

$N_{T_2}^*$= $\langle s, \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right), \left(\frac{6}{10}, \frac{5}{10}, \frac{4}{10}\right)\rangle$

Then NS_τ = {0_{NS}, $N_{T_1}^*$, 1_{NS} } and NS_σ = {0_{NS}, $N_{T_2}^*$, 1_{NS} } are NSTs on N_X^* and N_Y^* respectively.

Define a mapping N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)by $N_f^*(r_1^*) = s_1^*$ and $N_f^*(r_2^*) = s_2^*$Then f is NSc(RWG)CM but not an NS(αG)CM since NSS A= $\langle r, \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ A is a NSCS in N_X^* but f(A) = $\langle s, \left(\frac{3}{10}, \frac{5}{10}, \frac{6}{10}\right), \left(\frac{5}{10}, \frac{5}{10}, \frac{5}{10}\right)\rangle$ is not an NS(αG)CS in N_Y^*, since NSαcl(f(A)) = $1_{NS} \nsubseteq N_{T_2}^*$.

Theorem 5.14:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NSc(RWG)CM. Then for every NSS A of N_X^*, f(cl(A)) is a NSc(RWG)CS in N_Y^*.

Proof: Let A be any NSS in N_X^*. Then cl(A) is a NSCS in N_X^*. By hypothesis, f(cl(A)) is a NSRWGOS in N_Y^*. Hence f(cl(A)) is a NSc(RWG)CS in N_Y^*

Theorem 5.15:

Let N_f^*: (N_X^*, NS_τ) → (N_Y^*, NS_σ)is a NSc(RWG)CM where N_Y^* is a NS(rw)$T_{1/2}$ space. Then f is a NSOM.

Proof: Let f is a NSc(RWG)CM. Then for every NSCS A of N_X^*, f(A) is a NSRWGOS in N_Y^*. This implies $(f(A))^C$ NS(RWG)CS in N_Y^* is Since N_Y^* is a NS(rw)$T_{1/2}$ space, $(f(A))^C$ is a NSCS in N_Y^*. i.e f(A) is a NSOS in N_Y^*. Hence f is a NSOM.

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