A new neutrosophic algebraic structures

Riad K. Al-Hamido

Department of Mathematics, College of Science, Al-Furat University, Deir-ez-Zor, Syria.
riad-hamido1983@hotmail.com

Abstract
A new approach of neutrosophic algebraic structure are discussed in the work, which will open the door in front of researchers to new research about neutrosophic algebraic structure. In this work, we define new neutrosophic groupoid (semigroup, monoid) and new neutrosophic subgroupoid(subsemigroup, submonoid) in a new way which is more natural than the previous versions and we discuss some properties of this new neutrosophic concepts. Also we discuss the relationship of new neutrosophic algebraic structures with other classical neutrosophic algebraic structure and prove some results. Finally, we introduced a new NeutroGroupoid and new NeutroSemiGroup.

Keywords: Neutrosophic algebraic structure**,** new neutrosophic groupoid**,** new neutrosophic semigroup**,** new neutrosophic monoid, new NeutroGroupoid and new NeutroSemiGroup.

1.Introduction:
A new branch of philosophy, "neutrosophic"[1] takes place in many sciences, especially in algebra and topology[2-10]. Recently, neutrosophic sets have applications in the medical field [11], [12].

Then many researchers generalizations the neutrosophic topological space to neutrosophic bi-topological space see [13-15]via neutrosophic sets which is more generalized than fuzzy set and classical sets.
In recent year, Agboola et al. studied many neutrosophic algebraic concept as "neutrosophic group" and "neutrosophic ring" in [16,17], and presented refined neutrosophic groups.
Also, Sumathi et al. in [18] defined the concept of "neutrosophic topological groups".
After this study, R. Al-Hamido, in 2021, in[19] studied neutrosophic bi-topological groups, and investigate its basic properties.
F. Smarandache in [20] in 2019, generalized "Algebraic Structures" to "NeutroAlgebraic Structures" (whose "axioms" and"operations" are (partially true, partially indeterminate, and partially falseg)). Also, in 2020, he continued to develop them [21].
The old idea of introduced neutrosophic algebraic structure is by additions indeterminacy I to the elements of set G where (G,$*$) is any algebraic structures as groupoid or group or semigroup,…ets, it means that if (G,$*$) is any algebraic structures (groupoid or group or semigroup,…ets), then (G(I)= < G $\cup$I>,$*$) is neutrosophic algebraic structures (groupoid or group or semigroup,…ets).
So in this idea many properties which hold in the classical algebraic structures, does not hold in neutrosophic algebraic structures, for example The neutrosophic group is not a group, the same holds for ring, module, ideals, victor space.
The neutrosophic groupoid is not a groupoid and also has many properties which hold in the classical groupoid, and that does not hold in neutrosophic groupoid theory. So, we think about defining a new neutrosophic groupoid (a new neutrosophic semigroup, a new neutrosophic monoid) which is different from the neutrosophic groupoid (a new neutrosophic semigroup, a new neutrosophic monoid).
In this work, we introduced and studied "a new neutrosophic groupoid" and "a new neutrosophic subgroupoid" for the first time. Also, we studied a new neutrosophic semigroup,

a new neutrosophic subsemigroup, and a new neutrosophic monoid, for the first time.This new neutrosophic algebraic structures opens the door to re-defining many neutrosophic algebraic structures. Moreover, we studied the properties of this new neutrosophic algebraic structure. Finally, the relations among new neutrosophic algebraic structure and algebraic structure is introduced. Moreover, we introduced a new NeutroGroupoid and new NeutroSemiGroup.

2.Preliminaries:

Remark 2.1: the symbol (I) is an indeterminate and where (I) is such that $I^2 = I$.

Definition 2.2. [14]

Let $(\dot{G}, \#)$ be any groupoid, the "neutrosophic groupoid" which generated by I and $\dot{G}$ under #

denoted by $N(\dot{G})=\{<\dot{G} \cup I>,\#\}$.

Definition 2.3. [17]

The operation if well-defned for some elements [degree of truth T], indeterminate for other elements [degree of indeterminacy I], and outer-defined for the other elements [degree of falsehood F], where(T; I; F) is diferent from (1, 0, 0) and from (0, 0, 1) (this is a NeutroOperation). Neutrosophically we write: NeutroOperation(T; I; F).

3. new neutrosophic group:

In this part we introduced new neutrosophic groupoid and new neutrosophic subgroupoid and

studied its basic properties.

Theorem 3.1 : If $(G,*)$ be an groupoid, $G(I)=\{a+bI : a,b\in G\}$, And ' $\check{*}$ ' is a "binary operation" in G(I) defined as following:
$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha*\gamma) + (\beta*\delta)I \quad \forall\, \alpha, \beta, \gamma, \delta \in G$

Then : $(G(I),\check{*})$ is an groupoid we called it new neutrosophic groupoid.

Proof:

$\forall\, (\alpha + \beta I), (\gamma + \delta I) \in G(I)$ then $(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha*\gamma) + (\beta*\delta)I \in G(I)$ implies that G is closed under $\check{*}$.

Definition 3.2 : If $(G,*)$ be an groupoid, $G(I)=\{ (\alpha + \beta I) : \alpha, \beta \in G \}$, And ' $\check{*}$ ' is a "binary operation" in G(I) defined as following:

$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha*\gamma) + (\beta*\delta)I \quad \forall\, \alpha, \beta, \gamma, \delta \in G$

Then : $(G(I),\check{*})$ is a new neutrosophic groupoid.

Example 3.3:

Let $\breve{R}$=R-{0} then **(**$\breve{R}$,.) be an group, $G(I)=\{ (\alpha + \beta I) : \alpha, \beta \in \breve{R} \}$, And ' $\check{*}$ ' is a "binary operation" in G(I) defined as following:
$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha.\gamma) + (\beta.\delta)I \quad \forall\, \alpha, \beta, \gamma, \delta \in \breve{R}$

Then : $(\breve{R}(I),\check{*})$ is a new neutrosophic groupoid.

Remark 3.4:

We now that a neutrosophic groupoid is not groupoid, but new neutrosophic groupoid is groupoid.

Definition 3.5 :

Suppose that $(G(I),\check{*})$ be a new neutrosophic groupoid then:

If $\check{*}$ be a "commutative binary operation" in G(I) Then :

$(G(I),\check{*})$ is called commutative new neutrosophic groupoid.

-When $(G,*)$ be a "commutative groupoid", what about $(G(I),\check{*})$. The following remark answer.

Remark 3.6:

Let $(G,*)$ be a "commutative groupoid", then $(G(I),\check{*})$ is a "commutative new neutrosophic groupoid".

Proof:

Since $(G,*)$ be a commutative groupoid and ' $\check{*}$ ' be a "binary operation" in G(I) defined as following:
$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta)I \quad \forall\, \alpha, \beta, \gamma, \delta \in \breve{R}$.

Then : $(G(I),\check{*})$ is an commutative new neutrosophic groupoid, because

$$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta)I = (\gamma * \alpha) + (\delta * \beta)I$$
$$= (\gamma + \delta I) * (\widetilde{\alpha + \beta} I) \ \forall\, \alpha, \beta, \gamma, \delta \in \breve{R}$$

Definition 3.7 :
A subset $(M,\check{*})$ of a new neutrosophic groupoid $(G(I),\check{*})$ is called a "new neutrosophic subgroupoid" in G(I) if $(M,\check{*})$ is also a "new neutrosophic groupoid".
Theorem 3.8:

Let $(N,*)$ is subgroupoid of $(G,*)$ then:
A subset $(N(I),\check{*})$ is called a new neutrosophic subgroupoid in $(G(I),\check{*})$.
Proof:
Since $(N,*)$ is subgroupoid of $(G,*)$ then $(N,*)$ is also groupoid, therefore $(N(I),\check{*})$ is new neutrosophic groupoid, so $(N(I),\check{*})$ is a new neutrosophic subgroupoid of $(G(I),\check{*})$.

Theorem 3.9:
If $(N,*)$ is a subgroupoid of $(M,*)$ and $(M,*)$ is "a subgroupoid" in $(G,*)$ then: $(N(I),\check{*})$ is a new neutrosophic subgroupoid in $(G(I),\check{*})$
Proof:
Since $(N,*)$ is a subgroupoid in $(M,*)$ and $(M,*)$ is a subgroupoid of $(G,*)$ then: $(N,*)$ is "a subgroupoid" of $(G,*)$. Therefore $(N(I),\check{*})$ is a new neutrosophic subgroupoid of $(G(I),\check{*})$.

Theorem 3.10:
If $(N(I),\check{*})$ is "a new neutrosophic subgroupoid" in $(M(I),\check{*})$ and $(M(I),\check{*})$ is "a new neutrosophic subgroupoid" in $(G(I),\check{*})$then: $(N(I),\check{*})$ is "a new neutrosophic subgroupoid" in $(G(I),\check{*})$

Proof:
Follow from theorem 3.9.

Definition 3.11: A new neutrosophic groupoid G(I) have an "identity Element" (e+eI) in G(I) if

$(\alpha + \beta I) ⩮ (e + eI) = (e + eI) ⩮ (\alpha + \beta I) = (\alpha + \beta I)$; $\alpha + \beta I \in G(I)$.

Definition 3.12: If G be a nonempty set, $* : G\times G \to G$ be a" binary NeutroOperation" in G. Then (G,*) is called a NeutroGroupoid.

Definition 3.13 : If $(G,*)$ be an neutroGroupoid, $G(I)=\{ \alpha + \beta I : \alpha, \beta \in G \}$, And ' ⩮ ' be a "binary operation" in G(I) defined as following:

$(\alpha + \beta I) ⩮ (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I \quad \forall\, \alpha, \beta, \gamma, \delta \in G$

Then : (G(I),⩮) is a new NeutroGroupoid.

Example 3.14:

Let (G,+); G={1,0,-1} is NeutroGroupoid, since:
the law + is Neutro-well-defned, i.e.

- partially true, because $\exists$ (a=1, b=-1$\in$G) such that (a+b$\in$ G); degree of truth T >0.
- degree of "indeterminacy" (I = 0) since no indeterminacy exists.
- and partially false, because $\exists$ (a=-1, b=-1$\in$G) such that (a+b=-2$\notin$ G); so degree of "falsehood" (F > 0).

Let $G(I)=\{ \alpha + \beta I : \alpha, \beta \in G \}$, And ' ⩮ ' is "a binary operation" in G(I) defined as following:
$(\alpha + \beta I) ⩮ (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I \quad \forall\, \alpha, \beta, \gamma, \delta \in G$

Then : (G(I),⩮) is "a new neutroGroupoid".

4. A new neutrosophic semigroup:

Theorem 4.1 : Let $(G,*)$ is an "semigroup", $G(I)=\{ \alpha + \beta I : \alpha, \beta \in G \}$, And ' ⩮ ' is a "binary operation" in G(I) defined as following:
$(\alpha + \beta I) ⩮ (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I \quad \forall\, \alpha, \beta, \gamma, \delta \in G$

Then : (G(I),⩮) is a semigroup we called it new neutrosophic semigroup.

Proof:

i. $\forall\, (\alpha + \beta I) ⩮ (\gamma + \delta I) \in G(I) \text{then} (\alpha + \beta I) ⩮ (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I \; \forall\, \alpha, \beta, \gamma, \delta \in G$

implies that G is closed under ⩮ .

ii. $\forall\, (\alpha + \beta I), (\gamma + \delta I), (e + fI) \in G(I)$ then $[(\alpha + \beta I) ⩮ (\gamma + \delta I)] ⩮ (e + fI) =$
$[(\alpha * \gamma) + (\beta * \delta) I\,] ⩮ (e + fI) = [(\alpha * \gamma) * e] + [(\beta * \delta) * f] I$ (since $*$ such that associative Law)

$= [\alpha * (\gamma * e)] + [\beta * (\delta * f)] I = (a + bI) ⩮ [(c * e) + (d * f) I]$
$= (\alpha + \beta I) ⩮ [(\gamma + \delta I) ⩮ (e + fI)]$
(associative law).

By i) and ii) $(G(I), \check{*})$ is a semigroup, we called it new neutrosophic semigroup.
Definition 4.2 : Let $(G,*)$ be an "semigroup", $G(I)=\{ \alpha + \beta I : \alpha, \beta \in G \}$, And ' $\check{*}$ ' be a binary operation in G(I) defined as following:

$$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I \ \forall \ \alpha, \beta, \gamma, \delta \in G$$

Then : $(G(I), \check{*})$ is a semigroup we called it new neutrosophic semigroup.

Example 4.3:

Let (G,+); G={1,0,-1} be an "semigroup", $G(I)=\{a+bI : a,b \in R \}$, And ' $\check{*}$ ' be a "binary operation" in G(I) defined as following:

$$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha + \gamma) + (\beta + \delta) I \ \forall \ \alpha, \beta, \gamma, \delta \in R$$

Then : $(G(I), \check{*})$ is a new neutrosophic semigroup.

Definition 4.4 :

Let $(G(I), \check{*})$ be a "new neutrosophic semigroup" then if $\check{*}$ be a "commutative binary operation" in G(I) Then :

$(G(I), \check{*})$ is said to be "commutative new neutrosophic semigroup".

-If $(G,*)$ be a "commutative semigroup", what about $(G(I), \check{*})$. The following remark answer

Remark 4.5:

If $(G,*)$ be a "commutative semigroup", then $(G(I), \check{*})$ is a "commutative new neutrosophic semigroup".

Proof:

Since $(G,*)$ be a "commutative semigroup", ' $\check{*}$ ' be a "binary operation" on G(I) defined as following:
$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I \ \forall \ \alpha, \beta, \gamma, \delta \ \in \breve{R}$

Then : $(G(I), \check{*})$ is an commutative new neutrosophic semigroup, because

$$(\alpha + \beta I) \check{*} (\gamma + \delta I) = (\alpha * \gamma) + (\beta * \delta) I = (\gamma * \alpha) + (\delta * \beta) I$$
$$= (\gamma + \delta I) \check{*} (\alpha + \beta I) \ \forall \ \alpha, \beta, \gamma, \delta \in \breve{R}$$

Definition 4.6 :
A subset $(M, \check{*})$ of a new neutrosophic semigroup $(G(I), \check{*})$ is called "a new neutrosophic subsemigroup" in G(I) if $(M, \check{*})$ is also "a new neutrosophic semigroup".
Theorem 4.7:
If $(N, *)$ is subsemigroup of $(G, *)$ then:
A subset $(N(I), \check{*})$ is called "a new neutrosophic subsemigroup" in $(G(I), \check{*})$.
Proof:
Since $(N, *)$ is subsemigroup of $(G, *)$ then $(N, *)$ is also semigroup, therefore $(N(I), \check{*})$ is new neutrosophic semigroup, so $(N(I), \check{*})$ is a new neutrosophic subsemigroup of $(G(I), \check{*})$.

- Now we defined the notion of "neutrosophic monoid".

DEFINITION 4.8: A new neutrosophic semigroup $(G(I), \circledast)$ which has an element (e+eI) in G(I) such that

$(\alpha + \beta I) \circledast (e + eI) = (e + eI) \circledast (\alpha + \beta I) = (\alpha + \beta I)$; $\alpha + \beta I \in G(I)$,

is called as "a new neutrosophic monoid".

Theorem 4.9: If $(G, *)$ be a monoid then:
a subset $(G(I), \circledast)$ is "a new neutrosophic monoid".

Proof:

If $(G, *)$ be a "monoid", then $(G, *)$ is a semigroup and has an element e in G such that $\alpha * e = e * \alpha = \alpha$ *for all* $\alpha \in G$. Therefore $(G(I), \circledast)$ is new neutrosophic semigroup which has an element e+eI in G(I) such that

$(\alpha + \beta I) \circledast (e + eI) = (\alpha * e) + (\beta * e)I = \alpha + \beta I$ ... (i)

$(e + eI) \circledast (\alpha + \beta I) = (e * \alpha) + (e * \beta)I = \alpha + \beta I$ ... (ii)

By (i) and (ii), we have $(\alpha + \beta I) \circledast (e + eI) = (e + eI) \circledast (\alpha + \beta I) = \alpha + \beta I$ for all $\alpha + \beta I \in G(I)$, therefore $(G(I), \circledast)$ is "a new neutrosophic monoid".

Defintion 4.10:

If G(I) be "a new neutrosophic groupoid" (or a new neutrosophic semigroup or a new neutrosophic monoid). The center of the a new neutrosophic groupoid(or a new neutrosophic semigroup or a new neutrosophic monoid)N-C (G) = $\{x+yI \in G(I): (\alpha + \beta I) \circledast (x + yI) = (x + yI) \circledast (\alpha + \beta I)$ for all $\alpha + \beta I \in G(I)\}$.

Theorem 4.11 :

Let $(G, *)$ be a groupoid (or a semigroup or a monoid), C (G) = $\{x \in G: a * x = x * a$ for all $a \in G\}$and $(G(I), \circledast)$ be a new neutrosophic groupoid (or a new neutrosophic semigroup or a new neutrosophic monoid). The center of the a new neutrosophic groupoid(or a new neutrosophic semigroup or a new neutrosophic monoid)N-C (G) = $\{ x + yI \in G(I): x, y \in C(G)\}$.

Proof:

Let $(G, *)$ be a groupoid (or a semigroup or a monoid), C (G) = $\{x \in G: \alpha * x = x * \alpha \ \forall \alpha \in G\}$.

$\forall$ x,y $\in$C (G), $(\alpha + \beta I) \circledast (x + yI) = (a * x) + (b * y)I$ (since $x, y \in C(G)$)

$= (x * a) + (y * b)I = (x + yI) \circledast (\alpha + \beta I)$; $\forall \alpha + \beta I \in G(I)$

Therefore N-C (G) = $\{x + yI \in G(I): x, y \in C(G)\}$.

Theorem 4.12:

If $(G(I), \circledast)$ be "a commutative new neutrosophic groupoid" (or a new neutrosophic semigroup or a new neutrosophic monoid). The center of the "a new neutrosophic groupoid"(or a new neutrosophic semigroup or a new neutrosophic monoid)N-C (G) = {G(I)}.

Proof:

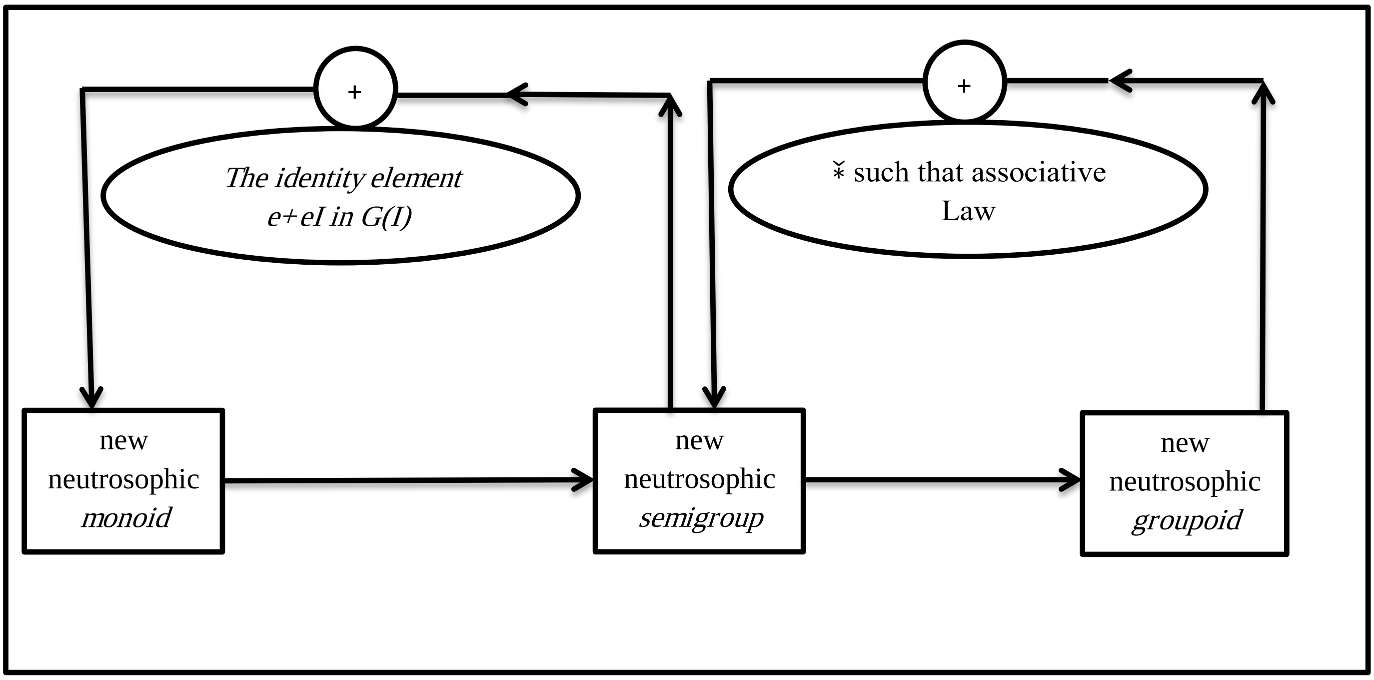
Since $(G(I), \circledast)$ be "a commutative new neutrosophic groupoid" (or a new neutrosophic semigroup or a new neutrosophic monoid) then

$\forall x + yI \in G(I)$, $(\alpha + \beta I) \circledast (x + yI) = (x + yI) \circledast (\alpha + \beta I) \ \forall \ \alpha + \beta I \in G(I)$

Therefore *N-C (G) = {G(I)}*.

Remark 4.13:

The relations among new neutrosophic algebraic structures in the following diagonal:



Definition 4.14:

Let G≠ϕ be a set, * : G×G → G be a "binary NeutroOperation" or a "binary Operation" on G. Then (G,*) is called a "NeutroSemiGroup" if the following condition is satisfied:
*is NeutroAssociative that is, ∃ (ξ,ζ,χ) ∈G such that
ξ *(ζ *χ) = (ξ *ζ)*χ and ∃ (ą,ĕ,ķ) ∈G such that
ą *(ĕ * ķ) ≠ (ą * ĕ)* ķ.

Definition 4.15 : Let (G,⁎) be a "NeutroSemiGroup", G(I)={ α + βI : α, β∈G }, And ' ⁎̆ ' be a binary operation on G(I) defined as following:

$(\alpha + \beta I)\ \breve{*}\ (c + dI) = (\alpha * \gamma) + (\beta * \delta)I \quad \forall\ \alpha, \beta, \gamma, \delta \in G$

Then : (G(I),⁎̆) is a new NeutroSemiGroup.

Example 3.16:

Let G={1,2,3} and *defined on G ass following; 1*1=1, 1*2=3,1*3=1, 2*1=1, 2*2=2, 2*3=1 and 3*1=2, 3*2=3,3*3=1,
(G,*) be a "NeutroSemiGroup", since:
the associativity law is a NeutroAssociativity, i.e.

- partially true, because ∃ ξ=1, χ=2, ĕ =3∈G such that (ξ*χ)*ĕ =3*3=1=ξ*(χ* ĕ)=1*1=1; the degree of "truth" T >0.
- degree of "indeterminacy" I = 0 since no "indeterminacy" exists.
- and partially false, because ∃ ξ=3, χ=3, ĕ =3∈G such that (ξ*χ)*ĕ =1*3=1≠ ξ*(χ* ĕ)=3*1=2; so degree of "falsehood" F > 0.

Let G(I)={a+bI :a,b∈G }, And ' ⁎̆ ' be a "binary operation" on G(I) defined as following:
$(\alpha + \beta I)\ \breve{*}\ (c + dI) = (\alpha * \gamma) + (\beta * \delta)I \quad \forall\ \alpha, \beta, \gamma, \delta \in G$

Then : (G(I),⁎̆) is a "new neutroSemiGroup".

4.Conclusion

In this work, we have defined "new neutrosophic structures" as "new neutrosophic groupoid" (semigroup, monoid) and new neutrosophic subgroupoid (subsemigroup, submonoid) in a new way. Finally, new neutrosophic structures is the first step for a new neutrosophic algebraic structure.

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