A Review of Seven Applications of Neutrosophic Logic: In Cultural Psychology, Economics Theorizing, Conflict Resolution, Philosophy of Science, etc.

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Abstract: In this short communication, we review seven applications of NFL that we have explored in a number of papers: (1) Background: the purpose of this study is to review how neutrosophic logic can be found useful in a number of diverse areas of interest; (2) Methods: we use logical analysis based on NL; (3) Results: some fields of study may be found elevated after analyzed by NL theory; and (4) Conclusions: we can expect NL theory to be applied in many areas of research too, in applied mathematics, economics, and physics. Hopefully the readers will find a continuing line of thoughts in our research from the last few years.

1. Introduction

First, let us discuss a commonly asked question: what is Neutrosophic Logic? Here, we offer a short answer.

Vern Poythress argues that sometimes we need a modification of the basic philosophy of mathematics, in order to re-define and redeem mathematics [1]. In this context, allow us to argue in favor of Neutrosophic logic as a starting point, in lieu of the Aristotelian logic that creates so many problems in real world.

In Neutrosophy, we can connect an idea with its opposite and with its neutral and get common parts, i.e. <A> ∧ <non-A> = nonempty set. This constitutes the common part of the uncommon things! It is true/real—paradox. From neutrosophy, it all began: neutrosophic logic, neutrosophic set, neutrosophic probability, neutrosophic statistics, neutrosophic measures, neutrosophic physics, and neutrosophic algebraic structures [2].

It is true in a restricted case, i.e. Hegelian dialectics considers only the dynamics of opposites (<A> and <anti-A>), but in our everyday life, not only the opposites interact, but the neutrals < neut-A > between them too. For example, if you fight with a man (so you both are the opposites to each other), but neutral people around both of you (especially the police) interfere to reconcile both of you. Neutrosophy considers the dynamics of opposites and their neutrals.

So, neutrosophy means that: <A>, <anti-A> (the opposite of <A>), and < neut-A > (the neutrals between <A> and <anti-A>) interact among themselves. A neutrosophic set is characterized by a truth-membership function (T), an indeterminacy-membership function (I), and a falsity-membership function (F), where T, I, F are subsets of the unit interval [0, 1].

As particular cases we have a single-valued neutrosophic set {when T, I, F are crisp numbers in [0, 1]}, and an interval-valued neutrosophic set {when T, I, F are intervals included in [0, 1]}.

From a different perspective, we can also say that neutrosophic logic is (or "Smarandache logic") a generalization of fuzzy logic based on Neutrosophy (http://fs.unm.edu/NeutLog.txt). A proposition is t true, i indeterminate, and f false, where t, i, and f are real values from the ranges T, I, F, with no restriction on T, I, F, or the sum n = t + i + f. Neutrosophic logic thus generalizes:

- Intuitionistic logic, which supports incomplete theories (for 0 < n < 100 and i = 0, 0 < = t, i, f < = 100);
- Fuzzy logic (for n = 100 and i = 0, and 0 < = t, i, f < = 100);
- Boolean logic (for n = 100 and i = 0, with t, f either 0 or 100);
- Multi-valued logic (for 0 < = t, i, f < = 100);
- Paraconsistent logic (for n > 100 and i = 0, with both t, f < 100);
- Dialetheism, which says that some contradictions are true (for t = f = 100 and i = 0; some paradoxes can be denoted this way).

Compared with all other logics, neutrosophic logic introduces a percentage of "indeterminacy"—due to unexpected parameters hidden in some propositions. It also allows each component t, i, f to "boil over" 100 or "freeze" under 0. For example, in some tautologies t > 100, called "overtrue." Neutrosophic Set is a powerful structure in expressing indeterminate, vague, incomplete and inconsistent information.

In this short review article, we will review seven applications of NL theory in diverse fields of science.

We introduce a number of key terms here. For example, from a NL perspective, we can find a reconciliation between "push" and "pull" type of gravitation, by considering both forces are in place. To speak more plainly, pull force takes place on an astronomical scale, while push force takes place at geological scale, and this effect can be found for instance: a. the fact that the Moon is receding from Earth (around 4 cm/yr), b. the fact that the Earth is expanding caused by dissipative geodynamics process, and c. the Pangea hypothesis.

In the context of cosmology, we argue that neutrosophic logic is in agreement with Kant and Vaas's position, it offers a resolution to the long standing disputes between beginning and eternity of the Universe. In other words, in this respect we agree with Vaas: "how a conceptual and perhaps physical solution of the temporal aspect of Immanuel Kant's *first antinomy of pure reason*" is possible, i.e. how our universe in some respect could have both a beginning and an eternal existence. Therefore, paradoxically, *there might have been a time before time or a beginning of time in time*."

2. Seven Applications of Neutrosophic Logic in Diverse Fields of Science

2.1. Cultural Psychology

Culture is a shared meaning system, found among those who speak a particular language dialect, during a specific historic period, and in a definable geographic region. Collectivism is a cultural pattern found in most traditional societies, especially in Asia, Latin America, and Africa. It contrasts with individualism, which is a cultural pattern found mostly in America and Europe.

This theme was explored by Prof. Harry Triandis (https://www.researchgate.net/profile/Harry_Triandis). Triandis was born in Greece in 1926. During the Second World War, he learned four foreign languages and developed his curiosity about the differences that exist between cultures. His time getting to know people across various European nations inspired him to research cultural disparities in the way people think. This issue can be reconciled with the help of NL theory, which may be appropriate for socio-economics theorizing, as we will discuss in the next subsection.

2.2. Socio-Economics Theorizing [3]

In a series of papers, we outlined a more general approach to reconcile classical tensions between individualism and collectivism, between cooperation and competition, and so on. In our opinion,

our tendency to cooperate or compete is partly influenced by the culture that we inherit from our ancestors. One of us (VC) once lived for a while in Russia, and he found that many people there are rather cold and distant (of course *not all* of them, some are warm and friendly). He learned that such a trait may be found as quite common in many countries in Europe. They tend to be individual and keep certain distance from each other. In physics term, they are like fermions. Our proposed simplistic analogy of human behaviour, i.e. individualism and collectivism, is not uncommon. (Indeed such cultural psychology research has been reported since Harry C. Triandis et al. See, for example, (a) The Self and Social Behaviour in Differing Cultural Contexts, *Psychological Review*, vol. 96, no. 3; (b) Harry C. Triandis and Eunkook M. Suh, Cultural Influences on Personality, *Annu. Rev. Psychol*. 2002. 53:133–60; (c) J. Allik and A. Realo, Individualism-collectivism and social capital, *J. Cross-Cultural Psychology*, Vol. 35 No. 1, January 2004, 29–49. This last mentioned paper includes a quote from Emile Durkheim: "The question that has been the starting point for our study has been that of the connection between the individual personality and social solidarity. How does it come about that the individual, whilst becoming more autonomous, depends ever more closely upon society? How can he become at the same time more of an individual and yet more linked to society?")

There is a developmental psychology hypothesis suggesting that perhaps such a trait co-relates to the fact that many children in Europe lack nurturing and human touch from their parents in their childhood, which possibly make them rather cold and individual. Of course, whether this is true, is yet to be verified.

On the contrary, most people in Asia and Africa are *gregariously groupie* (except perhaps in large metropolitan areas). They tend to spend much time with family and friends, just like many Italians do. They attend religious rituals regularly or watch music festival together, and so on. In physics term, they are bosons. Of course, such a sweeping generalization may be oversimplifying. (After writing up this article, we found that Sergey Rashkovskiy also wrote on a quite similar theme, albeit with statistical mechanics in mind. The title of his recent paper is: "'*Bosons' and 'fermions' in social and economic systems*." Here is abstract from his paper: "We analyze social and economic systems with a hierarchical structure and show that for such systems, it is possible to construct thermostatistics, based on the intermediate Gentile statistics. We show that in social and economic hierarchical systems there are elements that obey the Fermi-Dirac statistics and can be called fermions, as well as elements that are approximately subject to Bose-Einstein statistics and can be called bosons. We derive the first and second laws of thermodynamics for the considered economic system and show that such concepts as temperature, pressure and financial potential (which is an analogue of the chemical potential in thermodynamics) that characterize the state of the economic system as a whole, can be introduced for economic systems." Url: https://arxiv.org/ftp/arxiv/papers/1805/1805.05327.pdf)

Therefore, it seems quite natural to us, that Adam Smith wrote a book on philosophy suggesting that individual achievement is the key to national welfare (because he was British and thus emphasized individualism). If only Adam Smith had been born in Bangkok or Manila, he would have probably written this book in a different way.

It was more than a hundred years before mathematicians like John F. Nash, Jr. figured out that individual pursuit towards one's own goals does not lead to achieve a common goal as a society. (For example, let us imagine 10 players of a football team try simultaneously to score a goal against the opposite team, will they succeed? Of course no, they should arrange according to their coach's instruction: 1-4-4-2, or some other type of arrangement.)

At this point, some readers may ask: which is better, to be like fermions or bosons? Our opinion is as follows: just like in particle physics, both fermions and bosons are required. In the same way, fermion behavior and boson behavior are both needed to advance quality of life. Fermion people tend to strive toward human progress, while boson people are those who enrich our life.

This issue again can be reconciled with the help of NL theory, i.e. such a human tension is always there, but there does not need to be conflicts. Similarly, from such a fermion-boson perspective (which we propose a new term: *ferson*), a classic tension between capitalism (emphasizing individual

achievements) and socialism can be reconciled, for example by considering a range of possibilities, including a new term (possibly): *capicialism*. (This is reminiscent of a term introduced by Alvin Toffler in 70 s, in which he predicted as culture shock, that describes the combined behavior of consumerism and producers: *prosumerism*.)

2.3. Conflict Resolution [4]

Binary choices are another source of problems. As a one-liner joke says:

There are two kinds of people in the world: Those who think there are two kinds of people in the world and those who don't. (Plus some others who aren't sure.)

—(http://philippe.ameline.free.fr/humor/TwoKindOfPeople.htm)

A funnier joke on binary logic:

There are 10 kinds of people in the world: Those who understand binary and those who don't.

—(http://philippe.ameline.free.fr/humor/TwoKindOfPeople.htm)

As Phillipe Schweizer remarked:

"These two possibilities, these alternatives, are the basis of cognition, and allow choice and therefore action through the fact that a preference becomes possible: either I prefer there is X, or I prefer there is no X. Then autonomy appears. And indeed the valuation or affect too: "I like" or "I don't like", and it goes with it together. The stages described here are not as distinct as those of Piaget, they overlap, include and extend. The "there is no" is opposed to the "there is" forming the opposite. Thus the binary appears and the logic of the same name also: either "there is", or "there is not": X or non-X, one and the other being mutually exclusive.

. . . There is this and that and that again: a perception of the environment, a representation of a situation as a collection of objects. Our other most frequent and fundamental conception is opposition: there is or there is not. What also gives one thing and its opposite: day and night, hot and cold, big and small . . . The importance of this simplifying binary conception of two situations sliced diametrically away in opposite is the most prominent form of mental life. It is the emblematic *form of a choice.*"

(Quote from Phillipe Schweizer. Thinking on Thinking: The Elementary forms of Mental Life Neutrosophical representation as enabling cognitive heuristics. Submitted for review.)

In this regards, one of us (FS) recently published a new book, with the following title: Neutropsychic Personality [5]. In this book, FS described possible extension of Freudian mental model: id-ego-superego, using his neutrosophic logic theory. His definition of Neutropsychic is as follows:

"Neutropsyche is the psychological theory that studies the soul or spirit using the neutrosophy and neutrosophic theories. It is based on triadic neutrosophic psychological concepts, procedures, ideas, and theories of the form (<A>,< neut-A >,<anti-A>), such as (positive, neutral, negative), (good behavior, ignorant behavior, bad behavior), (taking the decision to act, pending, taking the decision not to act), (sensitive, moderate, insensitive), (under-reacting, normally reacting, over-reacting), (under-thinking, normal thinking, over-thinking), and so on, and their refinements as (< Aj >,< neut-Aj >,< anti-Aj >))." ([5], p.29)

Perhaps it is necessary to develop an improved model of the neutropsychic basis of decision making.

Another possible way to resolve this fundamental problem of human societies, is to accept otherness (cf. Milad Hanna, [6]), without being absorbed by the otherness. In other words, we should

try to find common trust, where people can engage in dialogue and reach peaceful co-existence. While this notion of peaceful co-existence belongs to social psychology, we can also think of this problem from the mathematical perspective of Kolmogorov's principle of contradiction, as we will discuss in next subsection.

2.4. Philosophy of Science

In a book currently under preparationwith a number of contributors, there is special chapter where two authors argued on empiricism vs. logicism [7]. During the writing process of that book, a logician mathematician argues among other things: "Typical experimental physicists does not want to discuss anything out of empiricism. They do not know the way how empiricism was developed. For them, empiricism became an absolute religion not to be questioned. As I pointed out the biggest founder of empiricism, Hume, admitted that empiricism is not just induction upon empirical data, it is standing upon some fundamentally important non-empirical truth such as mathematics." In essence, this is an old problem in theoretical physics, which is most significant: to meditate and observe, or to derive theory based on a few axioms? Perhaps the answer is not so easy to grasp, but both approaches are complementary. Such an intensity of this dialogue can be viewed as reflecting the message of this book: there are serious old problems which call for attention by modern physicists and mathematicians alike [7].

This deep problem in philosophy of science can be viewed as another case that calls for implementation of NL theory: whenever there are two opposite sides, there is always a choice to find a neutral side, in order to reconcile those two opposite sides. We can also think of them starting from the *principle of contradiction*, proposed by Kolmogorov (see Figure 1). To summarize, he argues that there is fundamental problem in developing complex arguments, they always lead to contradiction. This was proven later by Gödel, and it is called: Godel's incompleteness theorem.
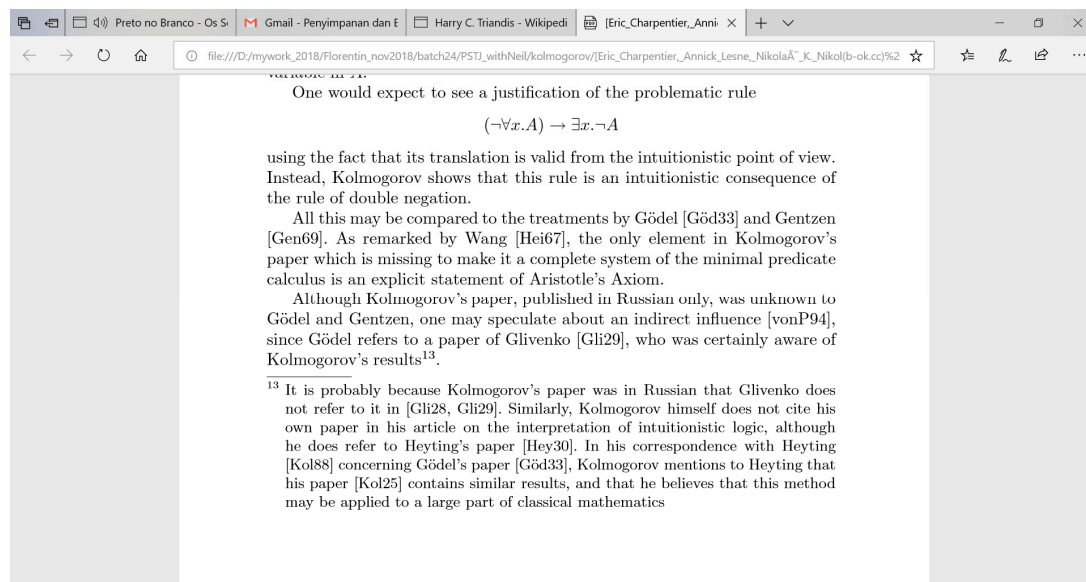

Figure 1. Kolmogorov's principle of contradiction. Source: ref. [8].

What can we conclude from Kolmogorov's principle of contradiction? It is quite simple, i.e. developing a complicated theory from a number of postulates will very likely lead to messy contradictions, which are often called "paradoxes," just like the twin paradox in general relativity, or the cat paradox in quantum wave function; see also [9,10].

To put this problem succinctly, we can paraphrase Arthur C. Clarke's famous saying: "Any sufficiently advanced technology is indistinguishable from magic," (Arthur C. Clarke, "Profiles of The Future", 1961 (Clarke's third law). url: http://www.quotationspage.com/quote/776.html)

to become "**Any sufficiently complicated theory will result in a number of contradictions and paradoxes.**"

Such a logical analysis derived from Kolmogorov's principle of contradiction eventually remind us of the following:

(a) To keep humble mind before Nature (God's creation), and perhaps we should not rely too much on our logic system and mathematical prowess;

(b) In developing a theory one should keep complications and abstractions to a minimum;

(c) To build theory in the nearest correspondence to the facts; it is the best if each parameter can be mapped to a measurable quantity.

We hope the above three criteria can be a useful set of practical guidelines for building mathematical models in theoretical physics or cosmology.

2.5. Cosmology [11]

Questions regarding the formation of the Universe and what was there before the existence of the Early Universe have been of great interest to mankind at all times. In recent decades, the Big Bang as described by the Lambda CDM-Standard Model Cosmology has become widely accepted by majority of physics and cosmology communities. Among other things, we can cite A.A. Grib and Pavlov who pointed out possible heavy particles creation out of vacuum and also other proposals such as *Creatio Ex-Nihilo theory* (CET).

However, philosophical problems remain, as Vaas pointed out: Did the universe have a beginning or does it exist forever, i.e. is it eternal at least in relation to the past? This fundamental question was the main topic in ancient philosophy of nature and the Middle Ages. Philosophically it was more or less banished then by Immanuel Kant's *Critique of Pure Reason*. However, it has been revived in modern physical cosmology both in the controversy between the big bang and steady state models some decades ago and in the contemporary attempts to explain the big bang within a quantum cosmological framework.

Interestingly, Vaas also noted that Immanuel Kant, in his *Critique of Pure Reason* (1781/1787), argued that it is possible to prove both that the world has a beginning and that it is eternal (first antinomy of pure reason, A426f/B454f). As Kant believed he could overcome this "self-contradiction of reason" ("*Widerspruch der Vernunft mit ihr selbst*", A740) by what he called "*transcendental idealism*", the question whether the cosmos exists forever or not has almost vanished in philosophical discussions.

In a paper accepted recently by *Asia Mathematika J.*, we take a closer look at Genesis 1:2 to see whether the widely-accepted notion of *creatio ex-nihilo* is supported by Hebrew Bible or not [11].

It turns out that neutrosophic logic is in agreement with Kant and Vaas's position, it offers a resolution to the long standing disputes between beginning and eternity of the Universe. In other words, in this respect we agree with Vaas: "how a conceptual and perhaps physical solution of the temporal aspect of Immanuel Kant's "*first antinomy of pure reason*" is possible, i.e. how our universe in some respect could have both a beginning and an eternal existence. Therefore, paradoxically, *there might have been a time before time or a beginning of time in time*."

Summarizing, neutrosophic logic studies the dynamics of opposites and neutralities; from this viewpoint, we can understand that it is indeed a real possibility that the Universe had both initial start but with eternal background (that may be called "primordial fluid"). This is exactly the picture we got after our closer look at Gen. 1:1-2.

2.6. American Football Game

(This section is after discussion with Robert Neil Boyd.)

Let us look at a situation in a football game (American style football).

The offense and the defense are lined up. The offense is in range to try kick a field goal to score 3 points. When the ball is passed from the center to the holder, so that the kicker may try to kick it

through the upright poles that are the goal posts, many different things may happen. This is not a simple situation of the ball going between the uprights or not. The defense may be able to get a man in position to block the kick.

If the kick is blocked, according to the rules, the defense may pick up the ball and carry it towards their side of the field. If the man who picked up the ball and ran with it, is not tackled to the ground before he crosses the goal line, the play results in a touchdown, a 6 point score for the defending players.

Or the player who picked up the ball after the kick attempt was blocked runs several yards towards his goal line, where he is tackled by one of the members of the kicking team, which causes him to lose the ball he was carrying. The kicking team recovers the fumble and the play is over.

Or the holder fails to catch the pass from the center, or the holder may drop the pass from center and either pick it up and run with it, or drops it to the ground before he can do anything, or the pass may sail over the head of everyone (whereupon, many things are possible), or the holder may fail to place the ball properly for the kicker, resulting in a failed attempt.

Or the defense may commit one of several possible rule infractions before, or during the kick, so that the result of the play is a penalty against the defending team. If the penalty is large enough, it can result in a new set of downs for the kicking team, so the place-kicker leaves the field so that the normal offense players can take 4 more tries to gain 10 yards.

Or there can be a penalty against the kicking team that may result in the kicking team being forced out of range to try the kick. So the kicker leaves the field without attempting to kick a field goal.

Or the offensive team has the ball lined up to try and score. When the ball is passed to the holder, it is a fake kick and the holder runs for a first down or a touch down or passes the ball to an offensive player for a first down or passes the ball and it is not caught, which means the defense obtains the ball at the spot where the ball was placed before the kick attempt.

Or the kicker attempts to kick the ball through the uprights and succeeds, scoring 3 points for his team.

The kicker can get the snap directly from the center and try to make a pass completion, or he can run while carrying the ball, which can result in interception or fumbling or touchdown or first down, or the kicker being tackled before he reaches the line. Or he completes a pass and the receiver makes a first down or a touch down or get tackled to the ground before the line to gain, or the receiver fumbles the ball as he is tackled, leading to a potential touchdown for the other team. Many additional possibilities exist, but most of them are very rare.

During any play in a football game, it is possible for any player on either team to score a touchdown for and gain 6 points for their team. This is possible because human beings are interacting in a game played with goals and goal lines and an oddly shaped biconvex bi-conical ball inflated with high pressure air that is surrounded by a rubber sack that is surrounded by a leather case which is held in place with stitches and laces. The shape of the ball causes it to bounce in unpredictable ways when it is dropped or kicked or thrown. In addition, hot temperatures make the ball softer and cold temperatures make the ball harder. Both of the factors cause the ball to behave in different ways. When the ball is harder, it is like kicking a rock. When the ball is harder, it becomes more slippery so it is harder to throw and harder to catch, and it hits you harder when you catch it.

So a field goal attempt does not merely involve two possibilities, but an almost infinite variety of events may happen, before the attempt, during the attempt, or after the attempt.

Neutrosophic logic may be expanded to more than three possible states, since in an infinite universe, an infinite number of things may happen. I understand the tri-state basis of it as being valuable in many circumstances. There should be ways to extend the logic into larger numbers of choices, so that there is a range of yesses, to 1000 kinds of maybes or almosts, or something elses, or something unexpected that was outside the starting point of the data set, and so on, to the No of the equation. The null-A of non-Aristotelian logic, which is what Neutrosophic logic is, can involve much more than just the simplistic null set.

Question: How to extend the center, null-A state, to provide for abnormalities or exigencies?

Right now, the easiest thing to do seems to be to widen the null state to include all the possibilities that are additional to, or contingent on one or more rules, internal to the null state. So now the null state becomes much broader, and able to handle much more complicated situations, such as a field goal attempt during an American football game.

It seems that the "expanded middle" would be a good option for problem structure in Neutrosophy.

2.7. Gravitation

Despite majority of physical theories of gravitation assuming it is a pull force, a number of researchers have begun to work out a push gravity, which is known as Le Sage/Laplace gravitation theory. An interesting remark on impetus to Le Sage gravitation theory can be found in article by the late Prof. Halton Arp on his work with Narlikar:

> *"Nevertheless the ball had started rolling down hill so to speak and in 1991, with Narlikar's help, I outlined in Apeiron the way in which particle masses growing with time would account for the array of accumulated extragalactic paradoxes. Later Narlikar and Arp (1993) published in the Astrophysical Journal Narlikar's original, 1977 solution of the basic dynamical equations along with the Apeiron applications to the quasar/galaxy observations.*
>
> *. . .*
>
> *The first insight came when I realized that the Friedmann solution of 1922 was based on the assumption that the masses of elementary particles were always and forever constant, m = const. He had made an approximation in a differential equation and then solved it. This is an error in mathematical procedure. What Narlikar had done was solve the equations for m = f(x, t). This a more general solution, what Tom Phipps calls a covering theory.*
>
> *. . .*
>
> *But Narlikar had overwhelmed me with the beauty of the variable mass solution by showing how the local dynamics could be recovered by the simple conformal transformation from t time (universal) to what we called τ time (our galaxy) time. The advertisement here was that our solution inherited all the physics triumphs much heralded in general relativity but also accounted for the non-local phenomena like quasar and extragalactic redshifts."* [12]

Therefore, there are many reasons to support Le Sage gravity, despite majority of physicists preferring Einsteinian view. Summarizing, there should be a hidden dynamical matter creation process, suggesting that Newton second law was actually not just F = ma, but it should be written in complete form: $F = d[mv]/dt = m[dv/dt] + v[dm/dt]$, therefore there is matter creation term. (In fact, it is known that Newton's second law was written originally as the momentum change over time, that is $F_g = dp/dt$.) All physics of Earth etc. assumes the Earth is static, but actually it is increasing in size and mass. This approach has been explored by both of us and also Robert Neil Boyd in a number of papers, see for instance [13,14].

Moreover, from a NL perspective, we can find a reconciliation between "push" and "pull" type of gravitation, by considering both forces are in place. To speak more plainly, pull force takes place at astronomical scale, while push force takes place at geological scale, and this effect can be found for instance: a. the fact that the Moon is receding from Earth (at a constant rate of around 4 cm/yr), b. the fact that the Earth is expanding, caused by dissipative geodynamics process, c. Pangea hypothesis. We will present our result in a paper to be presented in forthcoming 5th *EuroSciCon* 2019.

Allow us to introduce another new term in order to reconcile push and pull gravitational force, pullsh force. Such an idea is presently under investigation.

3. Results

Some fields of science are improved by being analyzed by NL theory; therefore we can expect NL theory will be applied in many areas of research too, in applied mathematics, economics, and also physics. For example, we also explored on how NL theory may be used to reconcile the "push" and "pull" gravitation theories. This is still a preliminary exploration, so we include this topic in discussion section.

In the context of cosmology, we argued that neutrosophic logic is in agreement with Kant and Vaas's position, it offers a resolution to the long standing disputes between beginning and eternity of the Universe. In other words, in this respect we agree with Vaas: "how a conceptual and perhaps physical solution of the temporal aspect of Immanuel Kant's *"first antinomy of pure reason"* is possible, i.e. how our universe in some respect could have both a beginning and an eternal existence. Therefore, paradoxically, *there might have been a time before time or a beginning of time in time*."

4. Discussion

We have discussed among other things, a few applications of NL theory in a number of fields, such as cultural psychology and economics theory. The essence of our discussion is that NL allows one to study the dynamics of opposites and neutralities. It is a generalization of dialectics.

Moreover, from a NL perspective, we can find a reconciliation between "push" and "pull" type of gravitation, by considering both forces are in place. To speak more plainly, pull force takes place at astronomical scale, while push force takes place at geological scale, and this effect can be found for instance: a. the fact that the Moon is receding from Earth (at a constant rate of around 4 cm/yr), b. the fact that the Earth is expanding, caused by dissipative geodynamics process, c. Pangea hypothesis. We will present our result in a paper to be presented in forthcoming 5th *EuroSciCon* 2019. Such an idea will be investigated later on.

We hope these discussions will be found useful in other areas as well; for instance in international relations and peace keeping efforts.

5. Conclusions

In this short article, we review seven applications of NFL that we have explored in a number of papers. Hopefully the readers will find a continuing line of thoughts in our research in the last few years, emphasizing our improved understanding of various branches of human knowledge. All of these branches have been enhanced and elevated to a higher level through applications of NL theory.

To summarize our results: we introduced a number of key terms here. For example, from a NL perspective, we can find a reconciliation between "push" and "pull" types of gravitation, by considering both forces. To speak more plainly, pull force takes place at astronomical scale, while push force takes place at geological scale, and this effect can be found for instance: a. the fact that the Moon is receding from Earth (at a constant rate of around 4 cm/yr), b. the fact that the Earth is expanding, caused by dissipative geodynamics process, c. Pangea hypothesis.

In the context of cosmology, we argue that neutrosophic logic is in agreement with Kant and Vaas's position; it offers a resolution to long-standing dispute between the beginning and the eternity of the Universe. In other words, in this respect we agree with Vaas: "how a conceptual and perhaps physical solution of the temporal aspect of Immanuel Kant's *"first antinomy of pure reason"* is possible, i.e. how our universe in some respect could have both a beginning and an eternal existence. Therefore, paradoxically, *there might have been a time before time or a beginning of time in time*."

for expressing his opinions on possible extension to "expanded middle" in Section 2.6 (American football game). And both of us are grateful to anonymous reviewers for their comments and suggestions, as well as editorial help to proofread our manuscript.

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