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Beyond Negation and Excluded Middle: An exploration to Embrace the Otherness Beyond Classical Logic System and into Neutrosophic Logic

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Abstract

As part of our small contribution in dialogue toward better peace development and reconciliation studies, and following Toffler & Toffler's *War and Antiwar* (1993), the present article delves into a realm of logic beyond the traditional confines of negation and the excluded middle principle, exploring the nuances of "Otherness" that transcend classical and Nagatomo logics. Departing from the foundational premises of classical Aristotelian logic systems, this exploration ventures into alternative realms of reasoning, specifically examining Neutrosophic Logic and Klein bottle logic (cf. Smarandache, 2005). The study challenges conventional boundaries and explores the implications of embracing paradoxes and self-reference in logic systems, aiming to redefine approaches to understanding truth and reasoning. The paper investigates how these alternative logics open avenues for philosophical inquiry, redefining entropy, and potentially influencing innovative perspectives in free energy systems. Through this exploration, it seeks to expand the discourse on logic, welcoming a broader spectrum of thought beyond established frameworks; and we also discuss shortly a number of possible implementations including in risk management and also Klein bottle entropy redefinition (Tang *et al*, 2018).

Keywords: Classical logic system; Nagatomo Logic; Lukasiewicz; Fuzzy logic; Klein bottle; Neutrosophic Logic

1. Introduction:

As part of our small contribution in dialogue toward better peace development and reconciliation studies, and following Toffler & Toffler's *War and Antiwar* (1993), the present article delves into a realm of logic beyond the traditional confines of negation and the excluded middle principle, exploring the nuances of "Otherness" that transcend classical and Nagatomo logics.

It is known, that classical Aristotelian logic has undeniably influenced Western thought profoundly. However, its limitations, particularly within the realm of negation and the excluded middle principle, have been subject to critical examination by various scholars. For instance, Paul Hiebert, in his article "*The Flaws of Excluded Middle*" (1981), sheds light on these limitations and invites us to consider the broader spectrum of logical reasoning beyond these principles.

The excluded middle principle asserts that a statement must either be true or false, with no middle ground or alternative possibilities. While this principle has been foundational in classical logic, its applicability in all contexts has been questioned. Hiebert, among others, points out that some situations may not neatly fit into such a simplistic framework. Real-world scenarios often present complexities and nuances that cannot be confined to a simple true/false dichotomy.

Consider the concept of negation, which implies the opposite of a proposition. Classical logic assumes that if a statement is false, its negation must be true, and vice versa. However, in certain cases, the negation of a proposition might not necessarily lead to its direct opposite truth value. For instance, in fuzzy logic or quantum mechanics, the truth value of a statement can exist in degrees between absolute truth and absolute falsity, challenging the rigid nature of classical logic.

Furthermore, Hiebert (1981) emphasizes that human experiences and cultural contexts often transcend the constraints of classical logic. Contextual factors, subjective viewpoints, and evolving perspectives contribute to a more complex understanding of truth and reasoning.

To overcome the limitations of classical logic, contemporary approaches like modal logic, paraconsistent logic, and non-classical logics have emerged. These systems acknowledge the limitations of the excluded middle principle and negation, offering alternative frameworks to address the intricacies of reasoning in different domains. In essence, while it is known that classical Aristotelian logic has been foundational in shaping Western thought, acknowledging its limitations opens doors to exploring richer and more nuanced forms of reasoning. Hiebert's insights remind us to embrace diverse logical frameworks that better accommodate the complexities of our world, transcending the confines of strict negation and the excluded middle principle.

Results:

Beyond Classical logic

Let's delve into the three different logical systems as mentioned above: multivalued logic, fuzzy logic, and Nagatomo logic, which all offer approaches beyond the strict true/false dichotomy.

- A. *Multivalued Logic* (Polish Logician - Łukasiewicz, 1918): This logic system extends classical logic by allowing more than just two truth values (true and false). Łukasiewicz introduced a three-valued logic system, which typically includes the truth values of "true," "false," and an additional value often termed "indeterminate" or "neither true nor false." This extension permits reasoning in scenarios where propositions might not have a clear-cut true or false value, acknowledging uncertainties or incomplete information.
- B. *Fuzzy Logic* (Zadeh): Fuzzy logic, introduced by Lotfi Zadeh in the 1960s, aims to handle vagueness and uncertainty in reasoning. Unlike classical logic's binary true/false assignments, fuzzy logic allows for truth values between completely true (1) and completely false (0). It deals with degrees of truth, enabling a more nuanced representation of concepts that are not strictly black or white but exist in shades of gray. This approach finds applications in various fields, especially in systems where imprecise data or human-like reasoning is involved, such as artificial intelligence, control systems, and decision-making processes.
- C. *Nagatomo Logic*: it is an alternative to Aristotelian classical logic that introduces a more extensive set of truth values and rules. It aims to represent reasoning in contexts where strict bivalence might be limiting. Nagatomo's logic extends beyond the true/false framework by incorporating multiple truth values, allowing for a more flexible representation of propositions that may not neatly fit into classical binary logic. This 'logic' is called the 'logic of not'. It is stated in a propositional form: '*A is not A, therefore it is A*'.¹ Since this formulation is contradictory or paradoxical when it is read in light of Aristotelean logic, one might dismiss it as nonsensical. In order to show that it is neither nonsensical nor meaningless, the paper will articulate the philosophical reasons why the *Sutra* makes its position in this contradictory form. (Nagatomo, 1979; Nagatomo, 2000; Tanabe, 2016).
- D. Smarandache's *Neutrosophic Logic* is another alternative based on examining Zadeh's Fuzzy Logic. He once wrote that according to this theory every idea $\langle A \rangle$ tends to be neutralized and balanced by $\langle \text{anti}A \rangle$ and $\langle \text{non}A \rangle$ ideas - as a state of equilibrium. In a classical way $\langle A \rangle$, $\langle \text{neut}A \rangle$, $\langle \text{anti}A \rangle$ are disjoint two by two. But, since in many cases the borders between notions are vague, imprecise, Sorites, it is possible that $\langle A \rangle$, $\langle \text{neut}A \rangle$, $\langle \text{anti}A \rangle$ (and $\langle \text{non}A \rangle$ of course) have common parts two by two, or even all three of them as well. He also extends the Law of Included Multiple-Middles to the Law of Infinitely-Many-Middles, the Law of Included Multiple-Middle (as extension of the Law of Included Middle) ($\langle A \rangle$; $\langle \text{neut}A_1 \rangle$, $\langle \text{neut}A_2 \rangle$, ..., $\langle \text{neut}A_n \rangle$; $\langle \text{anti}A \rangle$). Also, he discusses Aristotle's Syllogism, Principle of Identity, and Principle of Non-Contradiction. Elsewhere, Smarandache Refined / Split the Neutrosophic Components (T, I, F) into Neutrosophic SubComponents (T1, T2, ...; I1, I2, ...; F1, F2, ...) (Smarandache, 2005; Smarandache, 2023).

Each of these systems expands the scope of logical reasoning beyond the traditional binary framework, acknowledging the inherent complexities and nuances present in real-world scenarios. By introducing additional truth values or accommodating degrees of truth, these systems offer more sophisticated tools for modeling and dealing with uncertainties, vague concepts, and situations where the true/false dichotomy falls short.

These alternative logics have found applications in various fields where precision is essential, but strict binary logic might not capture the richness of real-world scenarios. By incorporating negation and embracing a broader range of truth values, they provide valuable frameworks for handling complex and ambiguous information in a way that classical logic cannot.

¹ Source: <https://philpapers.org/rec/NAGTLO> (accessed online, 1st Dec. 2023).

Exploring limitation of fuzzy logic and Nagatomo logic

Exploring the limitations of fuzzy logic and Nagatomo logic within Mathematica could involve creating scenarios where these systems might struggle or where their outcomes differ significantly from classical logic/Boolean logic. While Mathematica might not directly support Nagatomo logic as it's a specialized system, we can illustrate limitations of fuzzy logic within Mathematica's capabilities. Let's consider an example where fuzzy logic's handling of truth values could diverge significantly from classical logic:

Example Scenario - Fuzzy Logic Limitation:

Imagine a scenario where we're evaluating the temperature of water and determining whether it's "hot," "warm," or "cold" based on different temperature ranges. Fuzzy logic allows for gradual transitions between these linguistic values based on degrees of truth.

```
(* Define temperature ranges *)

hot[x_] := Piecewise[{{1, x >= 80}, {(x - 70)/10, 70 <= x < 80}, {0, x < 70}}]

warm[x_] := Piecewise[{{(x - 60)/10, 60 <= x < 70}, {1, 70 <= x < 80}, {(90 - x)/10, 80 <= x < 90}, {0, x < 60 || x >= 90}}]

cold[x_] := Piecewise[{{1, x < 60}, {(70 - x)/10, 60 <= x < 70}, {0, x >= 70}}]

(* Evaluate temperature *)

temperature = 75; (* Example temperature *)

{hot[temperature], warm[temperature], cold[temperature]}
```

In this code, the temperature is set to 75. The functions hot, warm, and cold represent the fuzzy definitions for these temperature ranges. Running this code will provide the degrees to which the given temperature belongs to each category: hot, warm, and cold.

The limitation here lies in the subjectivity of defining these linguistic values. While fuzzy logic allows for a smooth transition between categories based on degrees of truth, the exact boundaries and membership functions are somewhat arbitrary and can vary based on interpretation. This subjectivity might lead to different categorizations based on how these linguistic values are defined.

For Nagatomo logic, which incorporates multiple truth values beyond the true/false framework, implementing it directly in Mathematica might be more complex, as it's not a standard logic system within the Mathematica environment. This system typically involves specialized truth values and rules that extend beyond the typical binary or fuzzy logic.

By illustrating scenarios like the one above within Mathematica package, we can highlight the potential limitations of fuzzy logic, especially in its reliance on subjective linguistic values and interpretations. Exploring how these systems handle ambiguous or uncertain situations can showcase where they might struggle or provide outcomes that diverge significantly from classical logic/Boolean logic.

Another alternative way to logic

For instance, in Nagatomo it is written *A is non-A therefore A*, but it can be thought of as also implying Klein-bottle logic or self-referential logic. As it is known from history, in 1882 Felix Klein imagined sewing two Möbius Loops together to create a single sided bottle with no boundary. Its inside is its outside; it contains itself.

Take a rectangle and join one pair of opposite sides -- you'll now have a cylinder. Now join the other pair of sides with a half-twist. That last step isn't possible in our universe. A true Klein Bottle requires 4-dimensions because the surface has to pass through itself without a hole. It's closed and non-orientable, so a symbol on its surface can be slid around on it and reappear backwards at the same place.²

The concept of alternative logics expands far beyond classical and fuzzy logics. Self-referential or paradoxical logics, such as Klein-bottle logic, delve into intriguing realms where propositions can reference themselves, challenging traditional logical structures. While such logics might not have direct applicability in everyday human

² Source: https://www.kleinbottle.com/whats_a_klein_bottle.htm

interactions or biology systems in their purest forms, they offer fascinating theoretical constructs that push the boundaries of conventional reasoning (cf. Rapoport, 2013).

-Klein-Bottle Logic: Exploring Self-Reference and Paradox

Klein-bottle logic, inspired by the mathematical concept of a Klein bottle—a non-orientable surface—introduces self-reference and paradoxes within logical systems. One of its propositions, often referred to as "*A is non-A, therefore A*," embodies self-reference and contradiction simultaneously.

- Mathematica Exploration:

While Mathematica doesn't have a built-in Klein-bottle logic framework, we can illustrate a self-referential paradox using Mathematica's symbolic manipulation capabilities.

Self-Referential Paradox Illustration:

(* Self-referential paradox *)

paradox = Not[paradox]

In this simple code, we attempt to create a self-referential paradox by defining a statement (paradox) that negates itself. However, in a standard logical framework, this leads to an irresolvable paradox—the statement asserts its own negation, creating a contradiction.

Example in Real-Life Systems

A. A few Implications in Real-Life:

The direct application of Klein-bottle logic in day-to-day human interactions or biological systems might seem abstract. However, the exploration of self-reference and paradoxes has implications in understanding complexity, recursion, and the limits of formal systems.

B. Complexity and Recursive Systems:

Real-life biological systems often exhibit recursive and self-referential properties, such as DNA encoding proteins, neural networks, or feedback loops in biological processes. While not directly applying Klein-bottle logic, these systems share elements of self-reference and complexity that challenge traditional logical frameworks.

C. Limits of Formal Systems:

Klein-bottle logic, despite its theoretical nature, highlights the limitations of formal systems when dealing with self-reference and paradoxes. Understanding these limits is crucial in various fields, including philosophy, computer science (in handling recursive algorithms), and even psychology (in studying self-reference and cognitive processes).

Discussion: Further possible implications to risk management, entropy, free energy systems:

Self-referential Klein-bottle logic, known for its paradoxical and self-referential nature, might seem abstract when discussing implications for redefining entropy and exploring free energy systems. However, its conceptual framework challenges traditional logical structures and could offer intriguing avenues for reconsidering established scientific principles like entropy and the limitations set by Carnot's theorem in thermodynamics.

A. Implication of Neutrosophic Logic to Risk management

In a world characterized by Volatility, Uncertainty, Complexity, and Ambiguity (VUCA), traditional risk assessment and management approaches often fall short. The inherent limitations of classical logic/Boolean logic, which relies on clear-cut "true" or "false" values, can fail to capture the nuanced and often ambiguous nature of risk in complex systems. Enter neutrosophic logic, a powerful tool developed by one of us (FS) that offers a promising alternative for navigating the uncertainties of the VUCA world.

Neutrosophic logic, by introducing a third truth value, "*indeterminate*," can represent incomplete or unknown information in a better way. This allows for a more accurate representation of reality, where certainty is often elusive and information may be incomplete or contradictory. This is particularly relevant in VUCA environments, where rapid change, complex interactions, and limited information make risk assessment and management challenging (cf. Patrick, 2022).

Several key features of neutrosophic logic hold significant promise for risk assessment and management:

- **Modeling Uncertainty:** Neutrosophic sets can effectively capture and represent uncertainty associated with risk factors and their potential impacts. This allows for a more comprehensive and realistic assessment of risk scenarios.
- **Handling Incomplete Information:** In situations with limited data or conflicting information, neutrosophic logic can still provide valuable insights into potential risks. By explicitly acknowledging the "indeterminate" aspects of risk, decision-makers can avoid making inaccurate or misleading conclusions.
- **Facilitating Decision-Making:** Neutrosophic logic tools and operators can help analyze complex risk scenarios, identify critical risk factors, and prioritize mitigation strategies. This can lead to more informed and effective decision-making under uncertainty.
- **Improving Communication:** Neutrosophic logic provides a common language for stakeholders with diverse perspectives to discuss and analyze risk. This can foster collaboration and improve the overall effectiveness of risk management efforts.

Several studies have already demonstrated the potential of Neutrosophic Logic in various risk assessment and management applications. These include supply chain risk management, financial risk assessment, safety modelling of complex systems, and risk assessment in the food-store supply chain. While still in its early stages of adoption, neutrosophic logic holds significant promise for transforming the way we approach risk in the VUCA world. By providing a more nuanced and flexible framework for dealing with uncertainty, ambiguity, and incomplete information, neutrosophic logic can equip organizations and individuals with the tools needed to navigate the challenges of a rapidly changing and unpredictable environment.

However, further research and development are needed to fully unlock the potential of neutrosophic logic in risk assessment and management. This includes the development of standardized methodologies, user-friendly tools, and educational programs to promote awareness and understanding of this powerful approach.

B. Redefining Entropy through Self-Reference; Klein-Bottle Logic and Entropy:

Entropic principles, foundational in thermodynamics, describe the measure of disorder or randomness in a system. Traditional understandings of entropy revolve around statistical mechanics, where disorder tends to increase over time in isolated systems—a concept tied to the second law of thermodynamics (cf. Tang *et al*, 2018).

Klein-bottle logic introduces self-reference and paradoxes. While seemingly unrelated to thermodynamics, this type of logic touches upon the concept of self-reference and contradiction—elements that challenge conventional reasoning (cf. Tang *et al*, 2018).

Implication: Exploring entropy through a self-referential lens might prompt reconsideration of the conventional understanding of disorder in systems. Could self-reference and paradoxes offer new insights into the nature of disorder or randomness in complex systems?

C. Beyond Carnot's Theorem and Free Energy:

Carnot's theorem, a cornerstone of thermodynamics, sets theoretical limits on the efficiency of heat engines. In principle, Carnot's theorem states that: Heat engines that are working between two heat reservoirs are less efficient than the Carnot heat engine that is operating between the same reservoirs. Irrespective of the operation details, every Carnot engine is efficient between two heat reservoirs.³ It establishes that no engine can surpass the efficiency of a reversible engine operating between the same heat reservoirs.

D. Klein-Bottle Logic and Free Energy Systems:

While Klein-bottle logic doesn't directly relate to Carnot's theorem, its examination of self-reference challenges established paradigms. This prompts consideration: could the paradoxical nature of self-reference inspire novel approaches to circumvent theoretical limits in energy systems?

Implication: Exploring alternative logics might inspire fresh perspectives on energy systems, potentially redefining theoretical boundaries set by Carnot's theorem. Could unconventional reasoning spark innovations in creating more efficient energy conversion systems?

Concluding remark:

The present article, inspired partly by Toffler & Toffler's *War and antiwar*, delves into a realm of logic beyond the traditional confines of negation and the excluded middle principle, exploring the nuances of "Otherness" that

³ Source: <https://byjus.com/physics/carnots-theorem>

transcend classical and Nagatomo logics. Departing from the foundational premises of classical logic systems, this exploration ventures into alternative realms of reasoning, specifically examining Neutrosophic Logic and Klein bottle logic. We discuss shortly of implications of neutrosophic logic in risk management and risk assessment especially in VUCA world. In conclusion, the implications of Smarandache's Neutrosophic Logic for risk assessment and management are quite profound. By offering a framework that can effectively deal with the complexities of the VUCA world, neutrosophic logic has the potential to revolutionize how we assess, manage, and mitigate risk in the 21st century.

Several studies have already demonstrated the potential of Neutrosophic Logic in various risk assessment and management applications. These include supply chain risk management, financial risk assessment, safety modeling of complex systems, and risk assessment in the food-store supply chain. While still in its early stages of adoption, neutrosophic logic holds significant promise for transforming the way we approach risk in the VUCA world. As research and development continue, we can expect to see neutrosophic logic become an increasingly valuable tool for organizations and individuals seeking to thrive in an ever-changing world.

Moreover, Klein-bottle logic, with its self-referential and paradoxical nature, extends the boundaries of conventional reasoning. While not directly applicable in practical human interactions or biology, its exploration sheds light on the limitations and complexities of formal logical systems, offering insights into recursive structures and the boundaries of what can be logically expressed.

In Mathematica package, while there are of course difficulties to directly implement a full-fledged Klein-bottle logic, the simple demonstration of self-referential paradoxes showcases the challenges posed by such concepts in traditional logical frameworks. Exploring these alternative logics opens doors to understanding the intricacies and limitations of formal reasoning systems, despite their abstract nature.

The application of self-referential Klein-bottle logic to redefining entropy and exploring free energy systems represents a speculative yet intriguing avenue of inquiry. While abstract in its nature, the challenges posed by self-reference and paradoxes could stimulate unconventional thinking in understanding disorder in systems and potentially redefining the limitations set by established theorems in thermodynamics.

While directly applying Klein-bottle logic to redefine entropy or challenge Carnot's theorem remains a conceptual exercise, the exploration of alternative logics prompts us to question established scientific principles and encourages creative thinking in pushing the boundaries of traditional scientific thought. In the meantime, it is worth noting here that Klein bottle entropy has been discussed by Tu *et al*, and also Tang *et al*. (2018).

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FS, VC

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