LAWS OF THOUGHT AND FUZZY LOGIC: DELINEATING PRECISION AND IMPRECISION IN MORAL REASONING.

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Abstract

The aim of this paper is an investigation into the ethical implications of fuzzy logic and laws of thought in moral reasoning. In order to address the aim as stated, expository and analytical methods of research are employed to understand the ethical implications of imprecision and precision of fuzzy logic and laws of thought respectively in moral reasoning/judgment. By expository method, this paper explores the logical definitions and scope of fuzzy logic, laws of thought and moral reasoning. By analytical method, this paper makes a critical appraisal of ethical implications of laws of thought and fuzzy logic to determine their limits of precision and imprecision in moral reasoning/judgment. Fuzzy logic is a multi-valued logic which describes the possibility of many truth values beyond just two-valued logic of yes or/and no. The laws of thought refer to principles guiding valid thought process or justification for valid inference and which all valid deduction is reducible. The implication of fuzzy logic in moral reasoning is the attack on precision or exactness hence creating leeway for relativism and other moral dangers while the laws of thought pursue exactness in moral definitions leading to order in the civil society. In conclusion, moral reasoning ought to align with laws of thought in judgment in order to preserve morality and societal order while avoiding the dangers of imprecision and ambiguity in moral definitions capable of causing disorder and chaos in the civil society.

Keywords: Fuzzy logic, laws, thought, Ethics, precision, imprecision, etc.

Understanding Laws of Thought in Logic.

Logic deals with the science of correct reasoning, hence there ought to be fundamental principles or laws guiding reasoning to make it scientific. This is because something can only be scientific when it obeys/guided by some reasonable principles, laws/rules, methods, etc. Generally there are very many rules/laws in logic whereas this section is only interested in rules as relating to thought process, hence referred as laws of thought. Fundamentally the laws of thought are laws or principles by which in accordance valid thought proceeds or justify valid inference and which all valid deduction is reducible[1]. Laws of thought can also be referred as propositions of formal ontology. They can be said to mean axiomatic rules upon which rational discourse are considered. They are the laws that guide thought, expression, discussions, etc. These laws include; Law of Identity (ID), Law of Non-contradiction (NC) and Law of Excluded Middle (EM).

The law of Identity (ID) states that, "each thing is identical with itself". This is alternatively referred as tautological statement. Thus it claims at stating that, "what is, is"[2]. The implication of this claim is that for all x: x=x which means that x is the same as x whenever x implies x as stated. Similarly, identity is an equivalence such that between A=B is possible if and only if A and B define the same functions. Where they do not mean the same thing or define the same function then, A is not B. Law of identity explicitly explains that reality is definite since there cannot be two identities for one identity. Thus every object that exists consists of its own unique and special features.

Aristotle was interested in uniqueness or one meaning as a characteristic definition of the law of identity. In his claim that concepts have one meaning, Aristotle has the following to say about identity;

> First then this at least is obviously true, that the word "be" or "not be" has a definite meaning, so that not everything will be "so and not so". Again, if "man" has one meaning, let this be "two-footed animal"; by having one meaning I understand this:—if "man" means "X", then if A is a man "X" will be what "being a man" means for him. (It makes no difference even if one were to say a word has several meanings, if only they are limited in number; for to each definition there might be assigned a different word. For instance, we might say that "man" has not one meaning but several, one of which would have one definition, viz. "two-footed animal", while there might be also several other definitions if only they were limited in

number; for a peculiar name might be assigned to each of the definitions. If, however, they were not limited but one were to say that the word has an infinite number of meanings, obviously reasoning would be impossible; for not to have one meaning is to have no meaning, and if words have no meaning our reasoning with one another, and indeed with ourselves, has been annihilated; for it is impossible to think of anything if we do not think of one thing; but if this is possible, one name might be assigned to this thing.)[3]

For Aristotle, 'to say of what is that it is not or of what is not that it is, is false while to say of what is that it is and what is not that it is not is true'[4].

Similarly, the Law of Non-Contradiction or law of contradiction states that, "Nothing can both be and not be as the same time". This implies that two or more contradictory statements cannot both be in the same sense and at the same time. Thus: $\neg(A \underline{\wedge} \neg A)$. In the words of Aristotle, "one cannot say that something is and that it is not in the same respect and at the same time". This means that it is impossible that "being a man" is equivalent to "not being a man". This cannot be true if "man here so defined signifies something about one subject and has one significance. Thus it is not possible to be and not to be the same thing without falling or relapse to ambiguity. More so should we presume or imagine its possibility in name; its possibility is non existential in fact[5].

In accordance with the law of Excluded Middle or Excluded Third, 'every proposition is either true or false'[6]. Thus every proposition is either positive or negative and there is no opportunity for the third or middle course, hence $A \underline{\vee} \neg A$. A proposition cannot both be true and false at the same time rather it must be either true or false. To Excluded middle, Aristotle claimed that there cannot be an intermediate between contradictories rather one subject must either affirm or deny any defined predicate. Aristotle enounced, 'it is impossible that there should exist any medium between contradictory opposites rather, it is necessary either to affirm or to deny everything'[7].

On the Concept of Fuzzy Logic.

From the ancient time, the basic discussion on logic focused on the works of Aristotle, laws of thought; identity, excluded middle and non-contradiction, etc. It was in the modern time that logic developed to other forms such as symbolic logic, fuzzy logic, etc. Fuzzy logic as one of the major areas of modern logic is popularly known as multi-valued logic. It is a multi-valued logic

because it describes the possibility of many variables (values) about particular situations. These variables can be referred as truth values which can be truth variables of real numbers between 0 and 1 such that reality must not either be yes (1) or no (0)[8]. In situations where words are to replace mathematical numerals, fuzzy logic accepts descriptions of reality in such a manner that words describe partial truth and partial false in cases where truth values may have ranges between completely true and completely false. Thus fuzzy logic solves problems by consideration of all available variables of data/information within defined range.

Fuzzy logic has possibilities of values between 0 and 1 such as; 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9. In logic, if 0 means 'no' and 1 means 'yes', then 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 cannot be said to mean 'yes' or 'no' rather these numbers will either describe the degree of 'yes' or the degree of 'no'. Here variables ≤0.5 (variables less that 0.5) show different degrees of a 'no' answer while variables ≥0.5 (variables more than 0.5) show degrees of a 'yes' answer. This form of logic is a direct attack on absolutism of truth, hence leading to the possibility of many truths. Similarly, it attacks the absolutism of falsehood, hence leading to partial truth and partial falsehood. Quite unlike Fuzzy logic, Boolean logic is interested in defining truth values that have the exclusive sets of two integers or values of 1 or 0 that is, yes or no.

An Iranian mathematician, Lotfi Zadeh (1965) is said to be the founder of fuzzy logic in his study of fuzzy set theory[9]. Fuzzy set was informally defined as uncertain sets. It is referred as uncertain set because it contains sets whose elements have different degrees of membership, hence making the set itself highly imprecise. The membership set function can be designated as µA. The sign or designate µA implies all the different variables in numeric or textual forms that are components of the set of A. All the numeric or textual values that form a set are referred as the membership set. It is characteristically ambiguous and indistinctive. Fuzzy logic can be referred as bioinformatics, bivalent, crisp set or imprecise because the set can be defined from the different membership functions of the set.

Fuzzy logic was developed from the background of the decisions people make based upon partial and imprecise data/information. Thus this form of logic represents, interprets, manipulates or recognizes vague or uncertain information.[10] In analyzing the concept or value of 'yes", one can say, "strongly yes" another would say, "perhaps yes" another may say, "I think yes" [11]. A typical

numerical application of a fuzzy logic can be used to describe weather condition of rain fall as follows:

- ✓ Heavy rainfall with thunder and lightning (0.9)
- ✓ Heavy rainfall with mild thunder (0.8)
- ✓ Moderate rainfall (0.7)
- ✓ Drizzles of rain (0.5)
- ✓ Very cloudy but no rain (0.4)
- ✓ Dry cloud/atmosphere and sunny (0.1)

The fuzzy sets above show the possible values to be considered in order to develop an integral or holistic understanding of the weather situation in various conditions. Thus the range of numbers from 0.1 to 0.9 shows the range of possible outcomes of rainfall and no rainfall. It is raining heavily with thunder and lightning when the variable is 0.9 but moderate rainfall when the variable is 0.7. Its mere drizzles when the variable is 0.5. However, it's very cloudy but no rain when the variable is 0.4 and dry weather when the variable is 0.1. In these cases, the weather can be said to be either raining or not raining even when there are different degrees of rainfall as shown in the membership set.

Concept of Moral Reasoning.

No doubt different philosophers allude different motivations to moral actions. For Hume, human actions are significantly borne from sentiment or man's emotional capacities for sympathy, feelings, beliefs, etc.[12] In the same vain, the social intuitionist model of Jonathan Haidt places moral emotions as responsible for choice of actions[13]. Social intuitionist model de-emphasizes rationalist model to moral actions but emphasizes social and cultural factors such that moral judgment becomes a result of quick and automatic emotional evaluations (intuitions). Here moral decisions can be informed or motivated by orientations or factors such as; punishment-obedient orientation, personal reward, good boy-nice girl, etc. It was Kant who radicalized moral judgments philosophically in his *Groundwork of the Metaphysics of Morals,* hence making a shift away from moral emotivism to moral reasoning.

In the *Groundwork of the Metaphysics of Morals,* Kant developed his categorical imperatives that are anchored on moral reasoning. Thus he opined that moral judgment is based on pure

reason and on the standards of universality, humanity, autonomy and kingdom of ends. Thus the choice of moral actions must be reasoned in such a manner that we act only according to that maxim whereby one acts and at the same time wills that it should become a universal law. Also, one ought to act in such a way that one treats humanity, whether in ones' own person or in the person of any other, never merely as a means to an end but always at the same time as an end.[14]

Moral reasoning is simply the judgments about right or wrong. It concerns the decisions we make before, during (in) or after moral dilemma or moral conditions/situations. Moral reasoning refers to practical reasoning demanded in daily life activities in which our decisions or choices of actions are cognately required before moral dilemma/situations/questions. These moral questions arise explicitly in daily family life, work places, relationships, health conditions, experiences, etc. Moral reasoning is an attempt to reach a well-supported answer to moral questions.[15] Moral reasoning applies critical analysis to specific events to determine what is right or wrong and what people ought to do in particular situations.

It is undoubtable that every human person with reason makes different choices/judgments before moral questions. This is the point of intersection between the fields of logic and moral reasoning. Here comes a typical application of logic and moral theories to specific situations. These decisions motivate us to act or not in particular life situations or before a moral dilemma. In these situations, the knowledge of moral theories would help us defend such actions borne from moral reasoning. Nevertheless, one is referred as morally doubfounded when one lacks the capacity or right knowledge to logically defend ones moral actions or conclusions. Put succinctly, moral reasoning is interested in how people think about right and wrong and how they acquire and apply moral rules in daily life choices and before moral dilemma.

Imprecision of Fuzzy Logic Models and the Precision of Laws of Thought in Moral Reasoning

Fuzzy logic has been described as one of the major areas of modern logic and it is popularly known as multi-valued logic because it describes the possibility of many truth values about particular issues. Worthy of note is that truth values here imply truth variables of real numbers between 0 and 1 such that reality must not either be yes (1) or no (0)[16]. Here considerations are made of truth and/or false such that truth and false may be partial and not absolute. Similarly,

laws of thought are laws by which in accordance valid thought proceeds or justify valid inference and which all valid deduction is reducible[17]. These laws include identity, contradiction as opposed to dialetheism and excluded middle. These laws of thought are guides towards precision, definiteness and exactness in reasoning. In the same vain, moral reasoning was defined as the practical reasoning demanded in daily life activities in which our decisions or choices of actions follow from sound judgment. Amidst these conceptual clarifications, the primary concern of this paper is an attempt to understand the laws of thought and fuzzy logic and their ethical dynamisms of precision and imprecision in moral reasoning/judgment.

The use of fuzzy logic in different areas of scientific study; ecology, nuclear science, stock market, weather, geography, behavioral sciences, etc[18] can never be overemphasized. Particularly, fuzzy logic has been of great importance in medical diagnosis and treatment[19]. For the most part, fuzzy logic is chiefly characterized by imprecision in judgments. The application of fuzzy logic in moral reasoning implies that the method of fuzzification be used to form the inclusive or membership sets (μA) of moral decisions. Thus this implies that the application of practical reason in order to make a moral decision before, during (in) or after moral dilemma or moral conditions/situations would be considered on fuzzy sets of membership. Moral principles regarding stealing can be fuzzified thus;

Not stealing 0
Minor stealing $0.1 < x < 0.4$
Moderate stealing $0.4 < x < 0.6$
Severe stealing/robbery $0.6 < x < 0.8$
Very Severe stealing/armed robbery $0.8 < x > 1.0$
The interpretation of the fuzzy membership set shows that one who steals can be rated as to have done what is minor/negligible, moderate, server and very severe. Nevertheless, it is very difficult to place the standard measurement of x to yield these variables of negligible, moderate, server and very severe. More so these variables can only reflect on the degree of punishment to stealing but morality defines the material **ACT AS STEALING**. It becomes obvious that fuzzy logic introduces some challenges of ambiguity in moral reasoning.

One of the unavoidable dangers of fuzzification in moral reasoning is the fallacy of slippery slope and trivialization of morality. Slippery slope fallacy is the type of fallacy where a small

first step encourages a chain of related events or regress culminating to a significant and unusual or negative effect[20]. Thus allowing the possibility of fuzzy set in moral reasoning will certainly lead moral agents to fall into regress of imprecision and assumptions in the use of fuzzy sets. This situation makes morality to become a matter of personal definitions and relativity, hence trivializing morality.

No doubt the modern wave of liberalism is a great support to fuzzy logic. Liberalism in the modern time has emphasis on rights of individuals, choice of actions/freedom, liberty, consent, same-sex marriage, reproductive rights, etc. The expression of freedom in liberalists' model introduces multi-valued definitions and membership set in morality. In the modern time, this level of freedom of choice permeates all fields of human endeavor; and particularly of ethics though not without creating corresponding challenges to morality such as relativity and abuse of situation ethics.

On the other hand, the laws of thought are interested in valid thought process expressed in the laws of identity, contradiction or excluded middle. These laws of thought are guides towards precision in moral reasoning. The law of identity insists that "each thing is identical with itself" such that moral reasoning on particular moral principles ought to be definite. Thus the law of identity claims that "what is, is"[21] such that x: x=x which means that x is the same as x whenever x implies x as stated. In this case the value of x being a moral principle is such that the moral principle ought to be definite and unambiguously defined. Where the value of x is the moral principle on stealing, there is no ambiguity in the definition such that stealing is stealing and defined as unacceptable. The introduction of fuzzy membership set to stealing would trivialize the moral definition of the act and vitiate the seriousness of the moral content.

Furthermore, the law of non contradiction insists on precise definitions such that "Nothing can both be and not be as the same time". Thus the value of x as stealing cannot at the same time be stealing and not stealing. Also, the law of excluded middle insists that 'every proposition is either true or false'[22] or either positive or negative and there is no opportunity for the third or middle course, hence $A \lor \neg A$. Where the value of x is stealing, it is either stealing or not stealing such that there is no middle course or considerations of minor or severe stealing. It is obvious from the definitions of laws of thought that moral reasoning demands precision, exactness and definiteness in moral judgment and actions. Laws of thoughts adopt the common saying, 'call a

spade a spade', hence precision/exactness is the definition laws of thought bring to moral reasoning.

Conclusion

As earlier stated, this paper attempts to appraise the ethical implication of laws of thought and fuzzy logic in moral reasoning leading to precision and imprecision respectively. To a great extent, this aim can be said to have been properly addressed. In this paper, moral reasoning is defined as the practical assessment demanded in daily life activities in which our decisions or choices of actions follow from sound judgment. In the course of moral reasoning, while fuzzy logic shows the possibility of multiple values/variables leading to inexactness/imprecision, laws of thought is interested in exactitude/precision in moral reasoning/judgment.

Unlike Boolean logic, fuzzy logic is a multi-valued logic which describes the possibility of many truth values beyond just two-valued logic of yes or no. In moral reasoning, it is obvious that fuzzy logic comes with imprecisions in ethical definitions, judgment of actions and decision making. This imprecision brings conflicts and divergence in moral judgment and ethical decision making, hence leading to ethical relativism, bastardization of moral values, ethical compromise, liberalism, fallacy of slippery slope in ethical behavior, etc. No doubt, this situation would impose great dangers to morality in the society as it has the capacity of returning the society to the Hobbesian state of nature where everyone is a law maker unto oneself. Thus life would become unregulated and in Hobbes definitions; 'no arts; no letters; no society; and worst of all, continual fear, and danger of violent death; and the life of man, solitary, poor, nasty, brutish and short".[23]

Furthermore, the laws of thought are concerned with precision in valid thought process. According to the law of identity, moral principle ought to be identical to itself and unambiguous in definitions. Also, the law of contradiction insists that moral principle ought not to contradict itself. In the same vain, the law of excluded middle eschews every form of ambiguity such that moral principle can either be yes or no but not a middle course. Generally the laws of thought are

guides towards precision and exactness in moral judgment and actions. The application of laws of thought in moral reasoning will boost morality and instill order in the civil society. In practice, the possibility of Kantian Categorical ethical imperatives is realizable with the application of laws of thought in moral reasoning whereupon moral reasoning/judgment is based on the standards of universality, humanity, autonomy and kingdom of ends.

Notable is that fuzzy logic attacks the law of identity and absolutism in moral reasoning, hence leading to partial truth and partial falsehood. This form of logic creates a leeway for inexactness, vagueness, uncertainties, imprecision, bivalent or crisp set, hence leading to relativism and other ethical dangers. On the contrary, the laws of thought in moral reasoning make ethical principles explicit, precise, unambiguous, univocal and distinct, leading to order in the civil society.

End Notes

[1] Robert Audi, (ed). "Laws of thought" in *The Cambridge Dictionary of Philosophy.* (Cambridge: Cambridge University Press, 1990). P. 489.

[2] Bertrand Russell, *The Problems of Philosophy.* (New York: Oxford University Press, 1997). P. 72.

[3] Aristotle, *Metaphysics,* Book IV, Part 4. (trans. By W.D Ross)

[4] Aristotle, *Metaphysics,* Book IV, Part 7. (trans. By W.D Ross)

[5] Aristotle, *Metaphysics,* Book IV, Part 4. (trans. By W.D Ross)

[6] Bertrand Russell, (1997) *The Problems of Philosophy,* 490

[7] Aristotle, *Metaphysics,* (l. iii. (iv.) c.7.), *Analytics*, both Prior (l. i. c. 2) and Posterior (1. i. c. 4).

[8] V. Novak, I. Perfilieva, J. Mocker, "Mathematical Principles of Fuzzy Logic", *Dordrecht Kluwer Academic Journal.* 4(2), 2019. 24-40.

[9] L. A. Zadeh, "Fuzzy Sets", *Information and Control,* Vol. 8, no., 3, 338-353, June 1965.

[10] R. Babuska, "Fuzzy Modelling for Control", *Springer Science & Business Media.* 8(12). 2020. 231-349

[11] L. A. Zadeh, et. al. *Fuzzy Sets, Fuzzy Logic, Fuzzy Systems.* (Toronto: World Scientific Press, 1996), 32.

[12] Bucciarelli, Monica; Khemlani, Sangeet; Johnson-Laird, P.N. (2008), "The Psychology of Moral Reasoning" in *Judgment and Decision Making,* Vol. 3,No. 2.3(2): 121-139.

[13] Haidt, Jonathan, (2001). "The Emotional Dog and Its Rational Tail: A Social Intuitionist Approach to Moral Judgment" in *Psychological Review.* 108(4): 814-834.

[14]I. Kant, (1785), *Groundwork of the Metaphysics of Moral*. Trans. By Ellington James (3rd ed.), (Oxford: University Press, 1785), p.30

[15] P. Hieronyimi, (2013). "The Use of Reason in Though and the Use of Earmarks in Arguments" in *Ethics,* 124: 124-127.

[16] V. Novak, I. Perfilieva, J. Mocker, "Mathematical Principles of Fuzzy Logic", *Dordrecht Kluwer Academic Journal.* 4(2), 2019. 24-40.

[17] Robert Audi, (ed). "Laws of thought" in *The Cambridge Dictionary of Philosophy.* (Cambridge: Cambridge University Press, 1990). P. 489.

[18] I. Vlachos, K. Sergiadis, "Intuitionistic Fuzzy Information –Application to Pattern Recognition". *Pattern Recognition Letters.* 28(2): 2007, 197-206

[19] M. Rana & R. R. Sedamkar, "Design of Expert System for Medical Diagnosis Using Fuzzy Logic", *International Journal of Scientific & Engineering Research,* vol. 4, Issue 6, June 2013. 2914-2921.

[20] Uduma O. Uduma, *Logic and Critical Thinking.* 2nd edi., (Accra: Africa Analytica Publications, 2015), 216.

[21]Bertrand Russell, (1997) *The Problems of Philosophy,* 72
[22]Bertrand Russell, (1997) *The Problems of Philosophy,* 72
[23] Thomas Hobbes, *Leviathan,* (Oxford: University Press, 1561). Pg 34