Neutrosophy, a Sentiment Analysis Model

Florentin Smarandache
Math. & Sciences Dept., University of New Mexico 705 Gurley Ave., Gallup, NM 87301, U.S.A., Email: smarand@unm.edu

Mirela Teodorescu
Neutrosophic Science International Association, New Mexico, USA, mirela.teodorescu@yahoo.co.uk

Daniela Gîfu
Institute of Computer Science Romanian Academy - Iasi Branch daniela.gifu@iit.academiaromana-is.ro

ABSTRACT

This paper describes the importance of Neutrosophy Theory in order to find a method that could solve the uncertainties arising on discursive analysis. The aim of this pilot study is to find a procedure to diminish the uncertainties from public discourse induced, especially, by humans (politicians, journalists, etc.). We consider that Neutrosophy Theory is a sentiment analysis specific case regarding processing of the three states: positive, negative, and neutral. The study is intended to identify a method to answer to uncertainties solving in order to support politician's staff, NLP specialists, artificial intelligence researchers and generally the electors.

KEYWORDS

neutrosophy, sentiment analysis, communication, true, false, uncertainty.

1. INTRODUCTION

This study is the first step of a research that points out the uncertainties solving in discursive analysis. The research is based on Neutrosophy Theory[1] (Smarandache, 2005), which studies the neutrality as an essentially disputed concept with a generous applicability in sciences, like artificial intelligence (Vlădăreanu et al., 2014). This article explains the role of neutrality starting from the political context and the voters' decision.

In fact, the novelty of neutrosophy[2] consists of approaching the indeterminacy status that we can associate to neutral class of sentiment analysis (SA) (Gîfu and Scutelnicu, 2013), usually ignored. Moreover, some researchers associate neutral class with objective class in SA, but they consider it being less informative, preferring subjective class. SA, known as *opinion mining* (Pang and Lee, 2008), is a very important task of Natural Language Processing (NLP), the most known SA classification of texts is a binary one: subjective and objective (Pang and Lee, 2002), most often more difficult to undertake than polarity classification (Mihalcea et al., 2007). For other researchers the neutrality is determined the first one and sentiment polarity is determined the second one (Wilson et al., 2005).

We believe that Neutrosophy Theory seen as SA model would be useful for NLP specialists, linguistics, journalists, politicians, PR, and other scientists interested to find a method of uncertainties solving.

The paper is structured as follows: after a brief introduction, section 2 describes the background related to neutrosophy applicability; section 3 discusses the annotations regarding Neutrosophy Theory described in transposed algebraic structures and algorithms, section 4 introduces the relation between neutrosophy and sentiment analysis and finally, section 5 depicts some conclusions and directions for the future work.

2. BACKGROUND

According to the Neutrosophy Theory (NT), the neutral (uncertainty) instances can be analyzed and accordingly, reduced. There are some spectacular results of applying neutrosophy in practical application such as artificial intelligence (Gal et al., 2011). Extending these results, neutrosophy theory can be applied for solving uncertainty on other domains; in Robotics there are confirmed results of neutrosophics logics applied to make decisions when appear situations of uncertainty (Okuyama el al., 2013; Smarandache, 2011).

The real-time adaptive networked control of rescue robots is another project that used neutrosophic logic to control the robot movement in a surface with uncertainties (Smarandache, 2014). Starting with this point, we are confident that Neutrosophy Theory can help to analyse, evaluate and make the right decision in discursive analysis taking into account all sources that can generate uncertainty, of not informed voters, lack of information in candidates' politic campaign, not a strong candidate's propaganda, etc.

3. THE FUNDAMENTALS OF NEUTROSOPHY

The specialty literature reveals Zadeh introduced the degree of membership/truth (t), so the rest would be $(1-t)$ equal to f, their sum being 1, and he defined the fuzzy set in 1965.

In 1986, Atanassov introduced the degree of nonmembership/falsehood (f) and defined the intuitionistic fuzzy set.

[1] This theory was revealed by Smarandache in 1995 (published in 1998) it also was defined the neutrosophic set. Smarandache has coined the words "neutrosophy" and "neutrosophic".

[2] The etymology of *Neutrosophy* [in French, neutre and Latin, neuter - neutral, and in Greek, sophia - skill/wisdom] means knowledge of neutral thought.

if

$$0 <= t+f <= 1$$

and

$$0 <= 1-t-f$$

would be interpreted as indeterminacy

$$t + f <= 1$$

Why was it necessary to extend the *fuzzy logic*?

The indeterminacy state, as proposition, cannot be described in fuzzy logic, is missing the uncertainty state; the neutrosophic logic helps to make a distinction between a 'relative truth' and an 'absolute truth', while fuzzy logic does not.

As novelty to previous theory, Smarandache introduced and defined explicitly the degree of indeterminacy/neutrality (i) as independent component, where:

$$0 <= t+i+f <= 3$$

a) if

$$t+i+f < 1$$

we have incomplete information;

b) if

$$t+i+f = 1$$

we have complete information (thus we get intuitionistic fuzzy set);

c) if

$$t+i+f > 1$$

we have paraconsistente information (contradictory).

In neutrosophy set, the three components t, i, f are independent because it is possible from a source to get (t), from another independent source to get (i) and from the third source to get (f). Smarandache goes further; he refined the range (Smarandache, 1995).

If there are some dependent sources (or respectively some dependent subcomponents), we can treat those dependent subcomponents together.

YSIS

A logic in which each proposition is estimated to have the percentage of truth in a subset T, the percentage of indeterminacy in a subset I, and the percentage of falsity in a subset F, where T, I, F are defined above, is called *Neutrosophic Logic*.

Similarly sentiment analysis defines states as positive, negative and neutral.

NT	**SA**
T	positive
I	neutral
F	negative

Statically T, I, F are subsets, but dynamically the components T, I, F are set-valued vector functions/operators depend- ing on many parameters, such as: time, space, etc. (some of them are hidden parameters, i.e. unknown parameters):

$$T(t, s, \ldots), I(t, s, \ldots),$$
$$F(t, s, \ldots)$$

where

$$t = time, s = space \ldots$$

that is why the neutrosophic logic can be used also in quantum physics. If the Dynamic Neutrosophic Calculus can be used in discursive analysis, neutrosophics tries to reflect the dynamics of things and ideas.

We try to show an example of neutrosophic set from socio-human sciences.

Example: During an election process with 2 candidates C1 and C2, we have the following options:

E = {E1, E2, E3, E4} where we define:

E1 – Poll voting candidate C1;
E2 – Poll voting candidate C2;
E3 – Hesitant Poll who generates uncertainties;
E4 – Absent poll.

The initial neutrosophic space looks like (see Figure 1):

E1- represents the poll voting the candidate C1:
E1 = (t_{11}, i_{11}, f_{11}) => (28.65, 0, 0)

E2- represents the poll voting the candidate C2:
E2 = (t_{21}, i_{21}, f_{21}) => (18.7, 0, 0)

E3- represents the hesitant, neutral, uncertainty poll:
E3 = (t_{31}, i_{31}, f_{31}) => (0, 11.3, 0)

E4- represents the absent poll from election process:
E4 = (t_{41}, i_{41}, f_{41}) => (10.1, 15.4, 15.3) – they can vote both C1 candidate and C2 candidate, but also can be undecided; we exclude this aggregate from discussion.

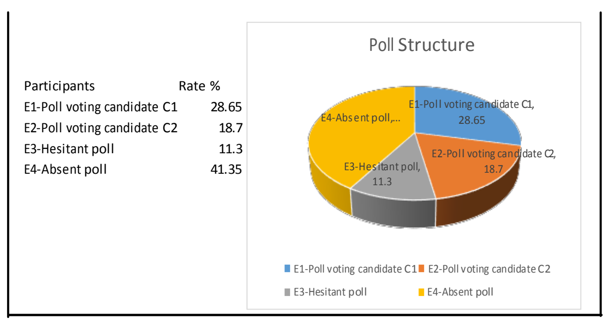

Figure 1. Initial Poll Structure

Analyzing these data, it can be summarized:

NT	C1	C2	SA
T	28.65	18.7	positive
I	7.2	4.1	neutral
F	18.7	28.65	positive

The purpose of neutrosophy is to investigate the uncertainties. In our case, the space generating uncertainties is E3 with its subset (t_{31}, i_{31}, f_{31}). Our purpose is to reduce the rate of "i_{31}" and to increase rate of "f_{31}" and "t_{31}", minimizing the uncertainties, this means a refining method for the process. Taking into account that we analyze a socio-human process belonging to politics communication, the applied techniques are methods of persuasion and conviction belonging to involved actors.

Through elective process we got data from ballot paper after refining uncertainties (see Figure 2):

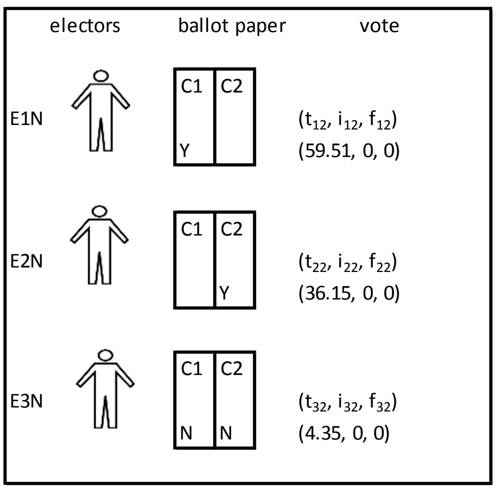

Figure 2. Elective process by ballot paper

Analyzing the process:

E1N(t_{12} =59.51, i_{12} =0, f_{12}=0) means that elector E1N voted only candidate C1 in rate of 59.51%;

E2N(t_{22}=36.15, i_{22} =0, f_{22}=0) means that elector E2N voted only candidate C2 in rate of 36.15%;

E3N(t_{32} =4.35, i_{32}=0.5, f_{32}=0) means that elector E3N gave a blind vote both for candidate C1 and C2 in rate of 4.35%.

In an election process, uncertainties reveal not only the null votes, blind votes, but also not participating voters to election process, because we cannot interpret their decision. There are situations when the percentage of this part of elector is high. The refined process proved that is possible to modify the rate of uncertainties, neutral status. We find the data in T and F as stable status (see Figure 3).

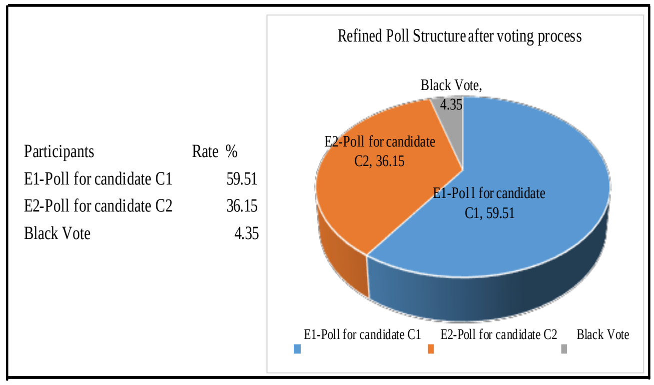

Figure 3. Refined Process

5. CONCLUSIONS AND FUTURE WORK

In this paper, it is presented a way of correcting the uncertainties arising in discursive analysis applying Neutrosophy Theory in relation with sentiment analysis. The Neutrosophy Theory could be considered a sentiment analysis model for solving the uncertainty (neutral), extended in IT applications, logistics, and human resource.

In the future work we will be oriented to find an algorithm to achieve the objectives to improve the percentage of stable statuses, by evaluation and interpret the neutrality/uncertainty state, in order to reduce it.

ACKNOWLEDGMENTS

This survey was published with the support of the grant of the Romanian National Authority for Scientific Research and Innovation, CNCS/CCCDI – UEFISCDI, project number PN-III-P2-2.1-BG-2016-0390, within PNCDI III.

REFERENCES

[1] Abbasi, A. 2007. *Affect intensity analysis of dark web forums*, in Proceedings of Intelligence and Security Informatics (ISI): 282–288.

[2] Agrin, N. 2006. *Developing a Flexible Sentiment Analysis Technique for Multiple Domains*, Available from: http://courses.ischool.berkeley.edu/i256/f06/projects/agrin.pdf.

[3] Bansal M., Cardie, C. and Lee, L. 2008. *The power of negative thinking: Exploiting label disagreement in the mincut classification framework, in Proceedings of the International Conference on Computational Linguistics (COLING)*, (poster paper).

[4] Batson, C.D., Shaw, L.L. and Oleson, K.C. 1992. *Differentiating affect, mood, and emotion: Toward functionally based conceptual distinctions*. In Margaret S. Clark (ed.), Emotion. Review of Personality and Social Psychology. Sage, Newbury Park, CA: 294-326.

[5] Berland, M. and Charniak, E. 1999. *Finding parts in very large corpora*. In Proceedings of the 37th Annual Meeting of the Association for Computational Linguistics: 57-64.

[6] Biber, D. and Finegan, E. 1988. *Adverbial stance types in English*. In Discourse Processes, 11(1): 1-34.

[7] Conrad, S. and Biber, D. 2000. *Adverbial marking of stance in speech and writing*. In Geoff Thompson (ed.), Evaluation in Text: Authorial Distance and the Construction of Discourse. Oxford University Press, Oxford: 56-73.

[8] Chafe, W. and Nichols, J.1986. *Evidentiality: The Linguistic Coding of Epistemology*. Ablex, Norwood, NJ.

[9] Gal, A., Vlădăreanu, L., Smarandache, F., Hongnian Yu, Mincong Deng 2012. *Neutrosophic Logic Approaches Applied to "RABOT" Real Time Control*.

[10] Gîfu, D. 2007. *Utilization of technologies for linguistic processing in an electoral context: Method LIWC2007* in Proceedings of the Communication, context, interdisciplinarity Congress, 2010, vol. 1, Ed. "Petru Maior" University, Târgu-Mureș: 87-98.

[11] Gîfu, D., Topor, R. 2014. *Recognition of discursive verbal politeness.* In Proceedings of the 11th International Workshop on Natural Language Processing and Cognitive Science NLPCS 2014, by the Publisher, De Gruyter, Venice, Italy: 27-29.

[12] Gîfu, D. and Scutelnicu, L. 2013. *Natural Language Complexity. Sentiment Analysis in Studies On Literature, Discourse and Multicultural Dialogue*, Iulian Boldea (coord.), Ed. Arhipelag XXI, Târgu-Mures: 945-955.

[13] Gîfu, D. 2013. *Temeliile Turnului Babel*, Ed. Academiei Române, Bucuresti.

[14] Hunston, S. and Thompson, G. 2001. *Evaluation in Text: Authorial stance and the construction of discourse.* Oxford University Press, Oxford.

[15] Mihalcea,R., Banea, C., and Wiebe, J. *Learning Multilingual Subjective Language via Cross-Lingual Projections*. 45th Annual Meeting of the Association for Computational Linguistics (ACL-2007).

[16] Okuyama, K., Anasri, M., Smarandache, F., Kroumov, V. 2013. *Mobile Robot Navigation Using Artificial Landmarks and GPS*, Bulletin of the Research Institute of Technology, Okayama University of Science, Japan, No. 31: 46-51.

[17] Pang, B. and Lee, L. 2008. *Opinion mining and sentiment analysis*. Foundations and Trends in Information Retrieval 2, 1-2: 1-135.

[18] Pang, B. and Lee, L. 2004. *A sentimental education: Sentiment analysis using subjectivity summarization based on minim cuts*. In Proceedings of the 42nd annual meeting on Association for Computational Linguistics: 271.

[19] Scheibman, J. 2002. *Point of View and Grammar: Structural Patterns of Subjectivity in American English.* John Benjamins, Amsterdam and Philadelphia.

[20] Smarandache, F. 2005. *A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy*, Neutrosophic Set, Neutrosophic Probability. Infinite Study.

[21] Smarandache, F., Vlădăreanu, L. 2014. *Applications of Neutrosophic Logic on Robots, Neutrosophic Theory and its Applications*, Collected papers Vol.1, Brussels.

[22] Smarandache, F., Vlădăreanu, L. 2011. *Applications of neutrosophic logic to robotics: An introduction, abstract*, 2011 IEEE International Conference on Granular Computing, GrC-2011, Kaohsiung, Taiwan, November: 8-10

[23] Smarandache, F. 2015. *(T, I, F)-Neutrosophic Structures*, Neutrosophic Sets and Systems, Vol. 8.

[24] Stone, P.J., Dunphry, D.C., Smith, M.S., and Ogilvie, D.M. 1966. *The General Inquirer: A Computer Approach to Content Analysis*. Cambridge, MA: MIT Press.

[25] Vlădăreanu, L., Tont, G., Vlădăreanu, V., Smarandache, F., Capitanu, L. 2012. *The Navigation Mobile Robot Systems Using Bayesian Approach Through the Virtual Projection Method*, Proceedings of the International Conference on Advanced Mechatronic Systems [ICAMechS 2012], Tokyo, Japan: 498-503.

[26] Vlădăreanu, V., Tont, G., Vlădăreanu, L., Smarandache, F. 2013. *The navigation of mobile robots in non-stationary and non-structured environments*, by Inderscience Publishers, Int. J. Advanced Mechatronic Systems, Vol. 5: 232- 243.

[27] Wiebe, J. 1994. *Tracking point of view in narrative. In Computational Linguistics*, 20(2): 233-287.