Neutrosophic Sets and Systems

Volume 44 *Impact of Neutrosophic Scientific Publication in Latin American context*

Article 10

8-6-2021

Neutrosophic Sentiment Analysis in Transcriptions of in-depth Interviews for Action Research

Iruma Alfonso González
Regional Autonomous University of the Andes (UNIANDES), ua.irumaalfonso@uniandes.edu.ec

María Fernanda Latorre Barragán
Regional Autonomous University of the Andes (UNIANDES), ua.marialatorre@uniandes.edu.ec

Delia Marlene López Domínguez
Regional Autonomous University of the Andes (UNIANDES), ua.delialopez@uniandes.edu.ec

Adriana López Falcón
Regional Autonomous University of the Andes (UNIANDES), ua.adrianalopez@uniandes.edu.ec

Neutrosophic Sets and Systems
{Special Issue: Impact of neutrosophic scientific publication in Latin American context}, Vol. 44, 2021
University of New Mexico

Neutrosophic Sentiment Analysis in Transcriptions of in-depth Interviews for Action Research

Iruma Alfonso González[1], María Fernanda Latorre Barragán[2], Delia Marlene López Domínguez[3] and Adriana López Falcón[4]

[1] Regional Autonomous University of the Andes (UNIANDES); Ecuador. Email: ua.irumaalfonso@uniandes.edu.ec
[2] Regional Autonomous University of the Andes (UNIANDES); Ecuador. Email: ua.marialatorre@uniandes.edu.ec
[3] Regional Autonomous University of the Andes (UNIANDES); Ecuador. Email: ua.delialopez@uniandes.edu.ec
[4] Regional Autonomous University of the Andes (UNIANDES); Ecuador. Email: ua.adrianalopez@uniandes.edu.ec

Abstract. In-depth interviews are a method widely used by researchers, which are processed once transcribed. Currently, with the development of computer programming, the use of a natural language processing method to analyze such interviews has spread. There are dissimilar programs of various kinds, where lexicons offer highly useful benefits for researchers as they save time and increase efficiency. In essence, these expose how positive or negative a text related to a topic can be. Taking into consideration the usefulness of Neutrosophy for social phenomena and the treatment of indeterminacies, vagueness, and neutralities, it is convenient to establish as an objective of this paper: to develop a method for the sentiment analysis of the transcripts of in-depth interviews in Action Research based on natural language processing and Single Value Neutrosophic Numbers (SVNN). The most important characteristics to take into account in the in-depth interviews will be determined. Then the lexicon will be selected for the natural language processing of the research to fulfill its main objective.

Keywords: in-depth interviews, action research, SVNN, VADER.

1 Introduction

Action research is a form of collective introspective inquiry undertaken by the participant in social situations. It aims to improve the rationality and justice of these social or educational practices, as well as the understanding of the situations in which they take place. It is then said that the researcher mixes theoretical knowledge with knowledge of a specific context [1, 2]. This is especially important in the social sciences, where it is used in many investigations as a primary source of information to obtain meaningful knowledge and draw broad conclusions [3-5]. It generally sticks to the following process:

- Planning
- Action
- Observation
- Reflection
- Action Research Report

For its development, some techniques and instruments are included within the methodology such as:

- Participatory Research
- Thematic Concern
- Professional development
- Curricular Model
- In-depth interview
- Observation: field journal and interpretation

Among these, in-depth interviews are a method widely used by researchers since they allow collecting qualitative data and a large amount of information about the behavior, attitude, and perception of the interviewees. During in-depth interviews, researchers and participants are free to explore additional points and change the course of the process when necessary, as it is an independent research method that can be adopted by multiple disciplines depending on the research needs [6]. However, they have the following details [6]:

Advantages	Disadvantages
They allow the researcher and participants to have a comfortable relationship to generate more in-depth answers regarding sensitive topics.	They are time-consuming, as they must be transcribed, organized, analyzed in detail.
Researchers can ask follow-up questions, obtain additional information, and return to key questions	If the interviewer is inexperienced, the process can

to gain a better understanding of the attitudes of the participants.	be affected or slowed.
There is a lower quality of sampling compared to other data collection methods.	Participants must be chosen carefully to avoid bias, which can lengthen the process.
Researchers can monitor participants' changes in tone and word choice to gain a better understanding of opinions.	It is an expensive process compared to other methods.
Fewer participants are needed to obtain useful information.	Generally, participants decide to collaborate only when they receive an incentive in return.

Table 1. Advantages and disadvantages of in-depth interviews

As can be verified in Table 1, the transcriptions are an important part of this since it constitutes a disadvantage because, in addition to the inherent table work, the words used by each interviewee must be evaluated in terms of "measuring" the feelings. Therefore, the unconscious biases of the authors or researchers could affect the learning of each new interview and the proper use of the researchers' time. That is why for the present investigation we decided to apply Neutrosophy. This science is characterized by treating subjectivity and the concept of indeterminacy. Neutrosophic sets are used for interview sentiment analysis as a qualitative research tool [4, 5].

On the other hand, it is important to deal with the transcriptions, which raises a need to include a natural language processing method in the research. This discipline is convenient because its objective is to achieve communication between human beings and computers, obtaining the main idea of a text, document, or opinion, with the possibility of developing systems capable of carrying out tasks according to the language [7-14].

According to what has been proposed so far, the authors of this article agree on the need to include in the present investigation, the use of the benefits offered by Neutrosophy, a method of Natural Language Processing that exposes how positive or negative a sentiment can be. Consequently, the objective of the article is established to elaborate a method for the sentiment analysis for the transcriptions of in-depth interviews in action research based on natural language processing and the Single-Valued Neutrosophic Numbers (SVNN). The following specific objectives are established as a guideline for the investigation:

1. Determine the most important characteristics to take into consideration in in-depth interviews.
2. Select lexicon for research natural language processing
3. Develop a method for sentiment analysis in transcriptions including the selected lexicon fused with the SVNNs.

From now on, the document is developed in several sections: materials and methods where objectives 1 and 2 are met; then section 3, where the elaborated method is shown. Finally, the conclusions reached once the work is finished are presented and the bibliographic references are subsequently declared.

2 Materials and methods

2.1 In-depth Interview

The most important characteristics of in-depth interviews are [6]:

- In-depth interviews have a flexible structure. Although it is unstructured, it covers few topics based on a guide, which allows it to cover appropriate areas for the interviewee.
- This method is characterized by being interactive. The interview process, the material that is produced, and the interaction where the interviewer poses initial questions in a positive way for the respondent to be encouraged to answer.
- Many probing techniques are used in in-depth interviews, so understanding the results is achieved through exploration and explanation. The interviewer uses follow-up questions to gain a deeper perspective and understanding of the participants' meaning.
- The interview is generative, that is, new knowledge is developed. Researchers and participants present ideas for a specific topic and some solutions to the problems posed.

2.2 Natural language processing

Currently, we are working with the classification of the polarity of emotions since they can show the different points of view that a user has concerning what they are living in their current environment. They can be defined as "Agitations or states of mind produced by ideas, memories, desires, and feelings, helping people to react quickly to social or personal events, being positive or negative". [15] Mentions that natural language processing can be

applied to sentiment analysis to classify documents, texts, or opinions from the identification and extraction of subjective information.

Sentiment analysis is a task contemplated within natural language processing and machine learning, which allows opinions to be analyzed to know the main needs of users. There are several programs for word processing. On [16], a comparison between them is exposed as shown in the following figures.

	Correlation to ground truth (mean of 20 human raters)	3-class (positive, negative, neutral) Classification Accuracy Metrics			Ordinal Rank (by F1)		Correlation to ground truth (mean of 20 human raters)	3-class (positive, negative, neutral) Classification Accuracy Metrics		
		Overall Precision	Overall Recall	Overall F1 score				Overall Precision	Overall Recall	Overall F1 score
Social Media Text (4,200 Tweets)							**Movie Reviews (10,605 review snippets)**			
Ind. Humans	**0.888**	0.95	0.76	0.84	2	1	0.899	0.95	0.90	0.92
VADER	0.881	**0.99**	**0.94**	**0.96**	1*	2	0.451	0.70	0.55	0.61
Hu-Liu04	0.756	0.94	0.66	0.77	3	3	0.416	0.66	0.56	0.59
SCN	0.568	0.81	0.75	0.75	4	7	0.210	0.60	0.53	0.44
GI	0.580	0.84	0.58	0.69	5	5	0.343	0.66	0.50	0.55
SWN	0.488	0.75	0.62	0.67	6	4	0.251	0.60	0.55	0.57
LIWC	0.622	0.94	0.48	0.63	7	9	0.152	0.61	0.22	0.31
ANEW	0.492	0.83	0.48	0.60	8	8	0.156	0.57	0.36	0.40
WSD	0.438	0.70	0.49	0.56	9	6	0.349	0.58	0.50	0.52
Amazon.com Product Reviews (3,708 review snippets)							**NY Times Editorials (5,190 article snippets)**			
Ind. Humans	0.911	0.94	0.80	0.85	1	1	0.745	0.87	0.55	0.65
VADER	0.565	0.78	0.55	0.63	2	2	0.492	0.69	0.49	0.55
Hu-Liu04	0.571	0.74	0.56	0.62	3	3	0.487	0.70	0.45	0.52
SCN	0.316	0.64	0.60	0.51	7	7	0.252	0.62	0.47	0.38
GI	0.385	0.67	0.49	0.55	5	5	0.362	0.65	0.44	0.49
SWN	0.325	0.61	0.54	0.57	4	4	0.262	0.57	0.49	0.52
LIWC	0.313	0.73	0.29	0.36	9	9	0.220	0.66	0.17	0.21
ANEW	0.257	0.69	0.33	0.39	8	8	0.202	0.59	0.32	0.35
WSD	0.324	0.60	0.51	0.55	6	6	0.218	0.55	0.45	0.47

Figure 1. VADER results for other lexicons. Source:[16].

Best lexicons	Assessment
VADER	0.96
Emoticons	0.92
SentiStrength	0.84
SentiWordNet	58.99
SenticNet	74.65
Hu-Liu (opinion lexicon)	65.2
SO-Cal	78.74

Figure 2. Analysis of the lexicons. [15]

It can be seen that the VADER method shows better levels of association, sometimes even higher than that of the reference human experts. On [15], VADER is also shown to have the best evaluation among the lexicons. Therefore, it is convenient to choose this lexicon as the basis for the design of the method to be elaborated in this research since the references consulted allowed to determine that VADER is successful since it not only talks about the positive or negative score but also, about how positive or negative a sentiment can be [16].

2.2.1 VADER

Over the years it has been possible to observe the development of various computational methods of sentiment analysis such as the Valence Aware Dictionary for Sentiment Reasoning text sentiment analysis (VADER) [15, 17]. Completely open-source licensed under the MIT license, it was designed for sentiment analysis on social media. The VADER method is based on rules that classify the polarity of the emotions of opinions using a list of words called a lexicon (it is convenient to say a priori that a lexicon is defined as an ordered series of words of a language, a person, a region, a subject or a specific time) [18, 19].

Lexical knowledge that a speaker possesses about a language, to classify those expressed on Twitter initially, but its use has spread. This supervised method exposes a lexicon that evaluates lexical characteristics such as acronyms, emoticons, abbreviations, and initials by rules which determine the classification of the opinion by the number of negative or positive words that the opinion contains. The VADER lexicon contains 7,517 words

including emoticons, abbreviations, acronyms, and initials labeled by the valence of -4 to 4. The VADER lexicon was obtained by applying the Machine Learning methodology, Wisdom-of-Crowds (the group wisdom), and the use of lexicons (LIWC, ANEW, GI). Classification of the polarity (positive, negative, or neutral) of an opinion is done by the values of each word in the method lexicon.

2.3 Notions of Neutrosophy

Neutrosophy is a new branch of philosophy that studies the origin, nature, and scope of neutralities created by Professor Florentin Smarandache. Its incorporation guarantees that the uncertainty of decision-making is taken into account, including indeterminacies where experts will issue their criteria evaluating linguistic and non-numerical terms, which constitutes the most natural form of measurement in human beings [20-25]. Logic and neutrosophic sets, for their part, constitute a generalization of Zadeh's logic and fuzzy sets, and especially of Atanassov's intuitionist logic, with multiple applications in the field of decision-making and machine learning [21, 23, 26-28]. The truth value in the neutrosophic set is as follow [28-30]**:**

Let be $\boldsymbol{N} = \{(\boldsymbol{T}, \boldsymbol{I}, \boldsymbol{F}): \boldsymbol{T}, \boldsymbol{I}, \boldsymbol{F} \subseteq [\boldsymbol{0}, \boldsymbol{1}]\}\boldsymbol{n}$, be a neutrosophic evaluation of a mapping of a group of formulas propositional to $\boldsymbol{N}$, and for each sentence $\boldsymbol{p}$:

$$\boldsymbol{v}(\boldsymbol{p}) = (\boldsymbol{T}, \boldsymbol{I}, \boldsymbol{F}) \quad (1)$$

To facilitate the practical application in real-world problems [7], the use of Single-Value neutrosophic Sets (SVNS) was proposed, through which it is likely to use linguistic terms to obtain greater interpretability of the results[8]. Let X be a universe of discourse, an SVNS A over X has the following form [9]:

$$\boldsymbol{A} = \{\langle \boldsymbol{x}, \boldsymbol{u_a}(\boldsymbol{x}), \boldsymbol{r_a}(\boldsymbol{x}), \boldsymbol{v_a}(\boldsymbol{x})\rangle : \boldsymbol{x} \in \boldsymbol{X}\} \quad (2)$$

Where $\boldsymbol{u_a}(\boldsymbol{x}): \boldsymbol{X} \to [\boldsymbol{0}, \boldsymbol{1}], \boldsymbol{r_a}(\boldsymbol{x}): \boldsymbol{X} \to [\boldsymbol{0}, \boldsymbol{1}]\ \boldsymbol{y}\ \boldsymbol{v_a}(\boldsymbol{x}): \boldsymbol{X} \to [\boldsymbol{0}, \boldsymbol{1}]$

With

$$\boldsymbol{0} \leq \boldsymbol{u_a}(\boldsymbol{x}), \boldsymbol{r_a}(\boldsymbol{x}), \boldsymbol{v_a}(\boldsymbol{x}) \leq \boldsymbol{3}, \forall\, \boldsymbol{x} \in \boldsymbol{X} \quad (3)$$

The intervals denote the memberships related to true, indeterminate, and false from x in A, respectively$\boldsymbol{u_a}(\boldsymbol{x}), \boldsymbol{r_a}(\boldsymbol{x})\ \boldsymbol{y}\ \boldsymbol{v_a}(\boldsymbol{x})$[10]. For convenience reasons, a Single Value Neutrosophic Number (SVN) is expressed as A = (a, b, c), where a, b, c∈ [0.1] and $0 \leq a + b + c \leq 3$ [31].

Let A = (a, b, c) be a single-valued neutrosophic number, a score function S related to a single-valued neutrosophic value, based on the truth-membership degree, indeterminacy-membership degree, and falsity membership degree is defined [32]:

$$\boldsymbol{s}(\boldsymbol{V_i}) = \boldsymbol{2} + \boldsymbol{T_i} - \boldsymbol{F_i} - \boldsymbol{I_j} \quad (4)$$

3 Results

3.1 Model designed for the research

For this particular case, we developed the following model based on [7, 15-17].

Phase 1. Preparation of the data source

- Step 1.
  In-depth interviews: Interviews should not be structured; but facts, beliefs, feelings, norms of action, conscious reasons for beliefs, norms of conduct, and/or other aspects of interest to the researcher must be obtained with clarity. The use of a tape recorder or similar device is recommended, as well as a researcher's diary where both the information offered by the interviewee and the impressions of the interviewer are collected. It is important to maintain ethics throughout the process. For this purpose, you must:
  a) Make a script or list of topics of interest to obtain the necessary information about the respondent and the context in which he operates. All this is to add key and secondary questions as the interview takes place.
  b) Schedule the interview at a time and date that the interviewee chooses.
  c) Transmit security and confidence to the interviewee.
  d) Establish a maximum duration of the process.
  e) Observe and make notes on the body expressions and gestures of the interviewee. The annotations in the notebook, diary, or document must be made according to the rules.
- Step 2.
  Transcriptions: They are transcribed into text obtaining a set of data for training and tests related to implicit or explicit feelings according to the rules in table 3. The rules, as well as these conditions, must be strictly respected to normalize the transcription:
  a) Do not include emoticons or idiomatic phrases such as OMG (“Oh my God”) in their substitution, place the interviewer's impression or ask directly how it made them feel (euphoric, happy, sad, afraid, or furious). Although VADER works well with this type of character, it would imply great subjectivity if the transcriber is not the same person as the interviewer and errors could be inserted in the appreciation.

b) Transcribe the impressions of the popular Latin American slang of the region and of the social class of the interviewees, which many times replace the classic words of the Spanish language such as *chévere* or *divino*.

After those steps are taken, the authors of the research will verify the quality of the data, evaluations, and validations of collective origin.

Phase 2. Sentiment analysis processing

- Step 3.

Processing planning

a) Adaptation from [33]: the concepts will be divided into 6 and not 4 as the method exposes, but neutrosophic linguistic terms will be associated with each one as explained:

Examples of lexicons associated with polarity	Neutrosophic linguistic term for determining polarity	SVNN
Sharp capital letters, exclamation marks associated with phrases with positive words in the superlative (great, super, hyper, ultra, mega, terrific, incredible, phenomenal, amazing). Sentences that contain more than one word associated with these words or their family. Font size 12 points.	Extremely positive (EP)	(1,0,0)
Phrases that express positive feelings (good, well, pleasant, joy, wonderful, special, divine). Sentences that contain more than one word associated with these words or their family. Font size 10 points	Very positive (VP)	(0.8,0,15,0.20)
Phrases that express feelings of unhappiness (not very good, unpleasant, difficult, hard). Sentences that contain more than one word associated with these words or their family. Font size 10 points	Medium Negative Neutral (MNN)	(0.40,0.65,0.60)
Phrases that express feelings qualified as (bad, frightening, panic). Sentences that contain more than one word associated with these words or their family. Font size 10 points	Very negative (VN)	(0.20,0.85,0.80)
Sharp capital letters, exclamation marks associated with phrases with negative words, hate words in the superlative (lousy, terrible). Sentences that contain more than one word associated with these words or their family. Font size 12 points.	Extremely negative (EN)	(0,1,1)

Table 3. Association of SVNN to VADER

b) Classify the polarity of the transcripts: a categorization adapted from that shown by [34, 35]:

Figure 3. Adaptation of the polarities of the VADER method [34, 35]

c) Apply equation 4 for deneutrosophication as used in [19] to determine in a range of $\mathbf{0} \leq \boldsymbol{u_a(x), r_a(x), v_a(x)} \leq \mathbf{3}$, the level of sentiment and thus evaluate the process to reach conclusions.

- Step 4.
  Processing: develop a workflow in Orange Data mining [36] to analyze the sentiment in the interviews incorporating the sentiment analysis according to table 3. The opinion analysis component predicts the opinion of each document in a corpus and processes the information using VADER and the programmed rules.

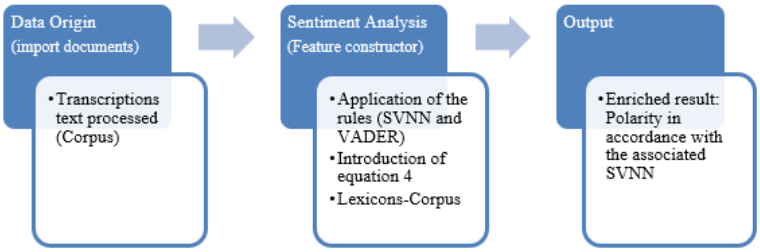

Figure 4. Workflow to be programmed in Orange Data mining. Source: Adapted from [15]

- Step 5.
  Final classification: the score function for single-valued neutrosophic sets is proposed to make the distinction between numbers in this scale $\mathbf{0} \leq \boldsymbol{u_a(x), r_a(x), v_a(x)} \leq \mathbf{3}, \forall\, \boldsymbol{x} \in \boldsymbol{X}$. The designed method should show the sentiment score for every interview, that score function allows ranking single-valued neutrosophic numbers and gives a single numerical value. The authors processed a written interview transcript with observations and insights and quantified it using neutrosophy in conjunction with other research methods.

Phase 3. Method programming

As can be seen in figure 5, initially the dataset is loaded through a widget file, then it is processed by applying the single value neutrosophic numbers and the relevant equations through a Python Script and the Features Constructor. Finally, the results are shown in a Box Plot, to see in detail the values at the output of the process, a Data Table was placed to better analyze the results: apply filters, count, sort, etc.

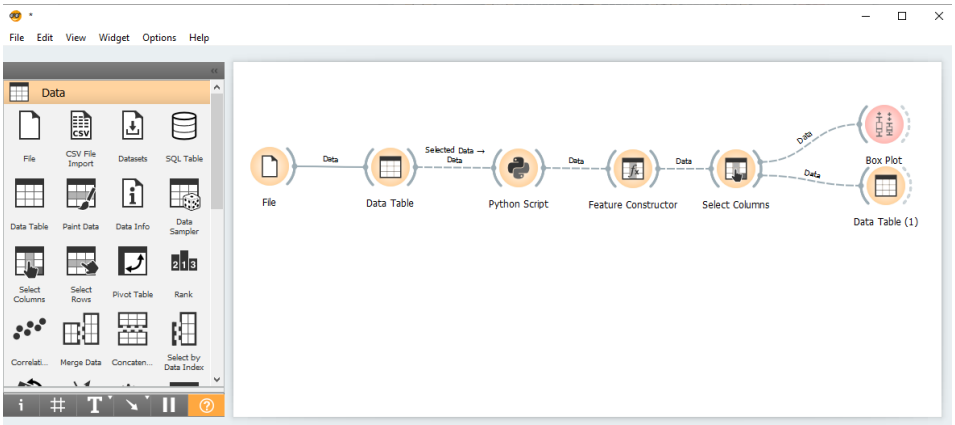

Figure 5. Workflow in Orange Data mining.

Conclusion

- During the conduct of the research, the importance of sentiment analysis in the metadata managed to carry out the action research methodology was verified. All this is due to the inherent subjectivity of the process. Its examination due to the amount of data processed requires a lot of time and resources that researchers often do not have. For this reason, the automated processing of this is extremely convenient since it can respond to the theoretical and epistemological foundations of action research as a type of qualitative research.
- An important part of qualitative research is the inductive logic of processes and the flexibility of their

application to recommend alternative processes in solving social problems in their professional environment. The foregoing is given in the verification carried out in this investigation, since for the analysis of feelings in the opinion mining process, thanks to this logic, it could be determined that VADER is very appropriate. In the same way, due to its programming, it is compatible with Neutrosophy, which is why it is fused for its enrichment with the single-valued neutrosophic numbers.

- In the present work, an opinion mining analysis was carried out where the results to be obtained with the VADER extension in a neutrosophic environment showed that it is more advantageous since metadata may partially belong to a segment of the indicated interval and its level of membership can be determined.
- The main rules, as well as the conditions of the study, were established taking into account the limitations of colloquial language.
- The methods show a sentiment score for every interview. That score function allows to rank single-valued neutrosophic numbers and offers a single numerical value. The researchers processed a written interview transcript with observations and insights and quantified it using neutrosophy in conjunction with other research methods.

References

[1] C. Pérez, "¿Qué es la investigación de acción?," in *CALAMEO*, CALAMEO, Ed., ed. España, 2021.

[2] J. E. Ricardo, V. M. V. Rosado, J. P. Fernández, and S. M. Martínez, "Importancia de la investigación jurídica para la formación de los profesionales del Derecho en Ecuador," *Dilemas Contemporáneos: Educación, Política y Valores*, 2020.

[3] F. Sasangohar, A. Dhala, F. Zheng, N. Ahmadi, B. Kash, and F. Masud, "Use of telecritical care for family visitation to ICU during the COVID-19 pandemic: an interview study and sentiment analysis," *BMJ Qual. Saf.*, 2020.

[4] I. Kandasamy, W. B. Vasantha, J. M. Obbineni, and F. Smarandache, "Sentiment analysis of tweets using refined neutrosophic sets," *Comput. Ind.*, 2020.

[5] F. Smarandache, B. Teodorescu, and M. Teodorescu, "Uncertainty Communication Solution in Neutrosophic Key," *SSRN Electron. J.*, 2018.

[6] A. Velázquez. (2020). *¿Qué son las entrevistas a profundidad?* Available: https://www.questionpro.com/blog/es/analisis-de-datos-de-una-investigacion-cualitativa/

[7] M. Alberich, "Procesamiento del Lenguaje Natural Guía Introductoria," 2018.

[8] A. Cortez, H. Vega, and J. Pariona, "Procesamiento de lenguaje natural," *Universidad Nacional Mayor de San Marcos*, 2018.

[9] A. Glebukh, "Procesamiento del lenguaje natural," *Sociedad Mexicana de Inteligencia Artificial* 2018.

[10] A. L. S. Pillajo, M. A. C. Cabrera, R. A. D. Vásquez, and J. L. A. Espinoza, "Sistema experto para el diagnóstico y tratamiento de enfermedades y plagas en plantas ornamentales," *Universidad y Sociedad*, vol. 13, pp. 505-511, 2021.

[11] M. Tello Cadena, M. F. Jaramillo Burgos, and M. J. Jiménez Montenegro, "Neutrosophic Case-Based Reasoning Method to Determine the Profitability of the Tourism Sector in the City of Riobamba," *Neutrosophic Sets and Systems*, vol. 37, pp. 108-114, 2020.

[12] M. Q. Martinez, A. B. Quirumbay, and M. L. Vazquez, "ESTUDIO CUALITATIVO DE RECONOCIMIENTO DE EMOCIONES EN TIEMPO REAL PARA ATENCIÓN AL CLIENTE UTILIZANDO DEEPLENS FACE DETECTION," *Investigación Operacional*, vol. 42, pp. 63-73, 2021.

[13] A. S. Molina, W. A. C. Calle, and J. D. B. Remache, "The application of Microsoft Solution Framework Software Testing using Neutrosophic Numbers," *Neutrosophic Sets and Systems*, vol. 37, pp. 267-276, 2020.

[14] M. Y. L. Vazquez, "An Analysis of Deep Learning Architectures for Cancer Diagnosis," *Artificial Intelligence, Computer and Software Engineering Advances: Proceedings of the CIT 2020 Volume 1*, vol. 1326, p. 19, 2021.

[15] K. Mejía González, "Enriquecimiento del modelo basado en reglas VADER a través de lexicones," *Universidad Autónoma Del Estado De México Unidad Académica Profesional Tianguistenco. Ingeniería En Software* 2018.

[16] C. Hutto and E. Gilbert, "VADER: A Parsimonious Rulebased Model for Sentiment Analysis of Social Media Text," *Georgia Institute of Technology, Atlanta*, 2018.

[17] A. Borg and M. Boldt, "Using VADER sentiment and SVM for predicting customer response sentiment," *Expert Syst. Appl*, 2020.

[18] M. A. Q. Martinez, H. F. V. Espinoza, M. Y. L. Vazquez, and M. D. G. Rios, "Feasibility Analysis Proposal for an IoT Infrastructure for the Efficient Processing of Data in Agriculture, Case Study on Cocoa," *Revista Ibérica de Sistemas e Tecnologias de Informação*, pp. 413-426, 2020.

[19] M. Y. L. Vazquez, B. S. M. Arteaga, J. A. M. López, and M. A. Q. Martinez, "Design of an IoT Architecture in Medical Environments for the Treatment of Hypertensive Patients," *Revista Ibérica de Sistemas e Tecnologias de Informação*, pp. 188-200, 2020.

[20] Q. Li, Y. Ma, and S. Zhu, "Single valued Neutrosophic clustering algorithm Based on Tsallis Entropy Maximization," *MDPI*, 2018.

[21] F. Samarandache, "Introduction to Neutrosophic Statistics," *Sitech & Education Publishing* 2014.

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

[23] M. Leyva Vázquez and F. Smarandache, "Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre," *Pons, Bruselas.* , 2018.

[24] J. L. a. F. S. Salmerona, "Redesigning Decision Matrix Method with an indeterminacy-based inference process. Multispace and Multistructure. ," *Neutrosophic Transdisciplinarity (100 Collected Papers of Sciences),* vol. 4, p. 151, 2010.

[25] M. Ali, Shabir, M., Smarandache, F., and Vladareanu, L. , "Neutrosophic LA-semigroup Rings," *Neutrosophic Sets and Systems,* vol. 7, pp. 81-88, 2015.

[26] W. B. Vasantha, I. Kandasamy, and F. Smarandache, "Algebraic Structure of Neutrosophic Duplets in Neutrosophic Rings < Z U I>,< Q U I> and < R U I.> " *Neutrosophic Sets and Systems, ,* vol. 23, pp. 85-95, 2018.

[27] F. Smarandache, *Neutrosophy, a new Branch of Philosophy*: Infinite Study, 2002.

[28] A. Sleem, M. Abdel-Baset, and I. El-henawy, "PyIVNS: A python based tool for Interval-valued neutrosophic operations and normalization," *SoftwareX,* 2020.

[29] F. Smarandache, M. A. Quiroz-Martínez, J. E. Ricardo, N. B. Hernández, and M. Y. L. Vázquez, "Application of neutrosophic offsets for digital image processing," *Investig. Operacional,* 2020.

[30] J. E. Ricardo, D. F. C. Flores, J. A. E. Díaz, and K. P. Teruel, "An Exploration of Wisdom of Crowds using Neutrosophic Cognitive Maps," *Neutrosophic Sets and Systems,* vol. 37, pp. 08-15, 2020.

[31] R. Şahin and M. Yiğider, "A Multi-criteria neutrosophic group decision making metod based TOPSIS for supplier selection," *arXiv preprint arXiv:1412.5077. ,* 2014.

[32] M. Leyva-Vázquez, M. A. Quiroz-Martínez, Y. Portilla-Castell, J. R. Hechavarría-Hernández, and E. González-Caballero, "A New Model for the Selection of Information Technology Project in a Neutrosophic Environment," *Neutrosophic Sets Syst., p. 344*.

[33] A. Balahur, S. Mohammad, and E. v. d. Goot, "Workshop on Computational Approaches to Subjectivity, Sentiment and Social Media Analysis," *Codalab,* 2018.

[34] P. Gonçalves, M. Araújo, F. Benevenuto, and M. Cha, "Comparing and Combining Sentiment Analysis Methods," *UFMG,* 2018.

[35] H. Cho, J. Lee, and S. Kim, "Enhancing Lexicon-Based Review Classification by Merging and Revising Sentiment Dictionaries," *Technology, Yonsei University,* 2018.

[36] J. Demšar, "Orange: Data mining toolbox in python," *J. Mach. Learn. Res,* 2013.

Received: February 15, 2021. Accepted: April 21, 2021