Advances in Intelligent Systems and Computing 915

Mostafa Ezziyyani *Editor*

Advanced Intelligent Systems for Sustainable Development (AI2SD'2018)

Volume 5: Advanced Intelligent Systems for Computing Sciences

Springer

Advances in Intelligent Systems and Computing

Volume 915

The series "Advances in Intelligent Systems and Computing" contains publications on theory, applications, and design methods of Intelligent Systems and Intelligent Computing. Virtually all disciplines such as engineering, natural sciences, computer and information science, ICT, economics, business, e-commerce, environment, healthcare, life science are covered. The list of topics spans all the areas of modern intelligent systems and computing such as: computational intelligence, soft computing including neural networks, fuzzy systems, evolutionary computing and the fusion of these paradigms, social intelligence, ambient intelligence, computational neuroscience, artificial life, virtual worlds and society, cognitive science and systems, Perception and Vision, DNA and immune based systems, self-organizing and adaptive systems, e-Learning and teaching, human-centered and human-centric computing, recommender systems, intelligent control, robotics and mechatronics including human-machine teaming, knowledge-based paradigms, learning paradigms, machine ethics, intelligent data analysis, knowledge management, intelligent agents, intelligent decision making and support, intelligent network security, trust management, interactive entertainment, Web intelligence and multimedia.

The publications within "Advances in Intelligent Systems and Computing" are primarily proceedings of important conferences, symposia and congresses. They cover significant recent developments in the field, both of a foundational and applicable character. An important characteristic feature of the series is the short publication time and world-wide distribution. This permits a rapid and broad dissemination of research results.

**** Indexing: The books of this series are submitted to ISI Proceedings, EI-Compendex, DBLP, SCOPUS, Google Scholar and Springerlink ****

More information about this series at http://www.springer.com/series/11156

Mostafa Ezziyyani
Editor

Advanced Intelligent Systems for Sustainable Development (AI2SD'2018)

Volume 5: Advanced Intelligent Systems for Computing Sciences

Springer

Editor
Mostafa Ezziyyani
Faculty of Sciences and Techniques
Abdelmalek Essaâdi University
Tangier, Morocco

ISSN 2194-5357 ISSN 2194-5365 (electronic)
Advances in Intelligent Systems and Computing
ISBN 978-3-030-11927-0 ISBN 978-3-030-11928-7 (eBook)
https://doi.org/10.1007/978-3-030-11928-7

Library of Congress Control Number: 2018968381

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Single-Valued Neutrosophic Techniques for Analysis of WIFI Connection

Said Broumi[1(✉)], Prem Kumar Singh[2], Mohamed Talea[1], Assia Bakali[3], Florentin Smarandache[4], and V. Venkateswara Rao[5]

[1] Laboratory of Information Processing, Faculty of Science Ben M'Sik, University Hassan II, Sidi Othman, B.P 7955, Casablanca, Morocco
broumisaid78@gmail.com, taleamohamed@yahoo.fr
[2] Amity Institute of Information Technology, Amity University, Sector 125, Noida, Uttar Pradesh, India
premsingh.csjm@gmail.com
[3] Ecole Royale Navale, Boulevard Sour Jdid, B.P 16303, Casablanca, Morocco
assiabakali@yahoo.fr
[4] Department of Mathematics, University of New Mexico, 705 Gurley Avenue, Gallup, NM 87301, USA
fsmarandache@gmail.com
[5] Mathematics Division, Department of S&H, Chirala Engineering College, Chirala 523157, India
vunnamvenky@gmail.com

Abstract. Wireless ad hoc network (WANET) is self-configured networking. It does not rely on pre-existing routers or access points. Mobile ad hoc network (MANET) is an application of WANET where mobile devices are connected wirelessly without any infrastructure. Such networks are either considered as truly connected, not connected and may disconnected due to noise in network or some other uncertainty in connectivity. In this case, characterizing the truth, indeterminacy and falsity information communicated in the mobile network is difficult while utilizing the traditional mathematical set theories. To resolve this issue, in current paper authors' focus on estimating information processing in MANET via mathematics algebra of Single-Valued Neutrosophic Set (SVNS). In addition, an example is given for better understanding of MANET in the neutrosophic environment.

Keywords: Neutrosophic sets · WANET · MANET · Network connection · Low-medium-high estimations

1 Introduction

Wireless ad hoc network (WANET) is a decentralized network which works without access points as compared to ordinary networks having an access point or router for their performance. WANET is further classified in MANET [1], VANET [2], smart phones ad hoc networks [3], army, air force, navy ad hoc networks [4–6], disaster rescue and hospital ad hoc networks [7, 8] etc.

M. Ezziyyani (Ed.): AI2SD 2018, AISC 915, pp. 405–412, 2019.
https://doi.org/10.1007/978-3-030-11928-7_36

A mobile ad hoc network (MANET) is wireless ad hoc network and it is incessantly self-configuring, infrastructure-less net of mobile devices. All node in a MANET can be dynamic or autonomously moves in different direction and alter the connectivity with distinct nodes regularly. Each of the node used to promote traffic unconnected to its own use, and therefore be a router. The most important challenge in building a MANET is equipping each device to constantly maintain the information required to properly route traffic [9].

There are many protocols which are related to this work one can refer to [10–12]. The growth of laptops and 802.11/Wi-Fi wireless networking has made MANETs a popular research topic since the mid-1990s. Similarly, the smart phone technology has made the MANET more popular since 2016 with high speed even for a common man. Even now a day's all members are using smart phone in that they use networks in travels from one place to another places. In that sometimes network connection signals are good or sometimes it's disconnected. This one explains clearly using fuzzy system but sometimes signals are appear while the data transformation contains uncertainty, which cannot be represented precisely using unipolar fuzzy environment. It used to become more complex when the given information contains acceptation, rejection and uncertain part based on information sent. In this case traditional fuzzy set cannot represent these information of MANET. Due to which, authors aimed at neutrosophic logic based MANET network information processing at given threshold.

Smarandache [13, 14] developed the mathematics of neutrosophic set (NS) as generalization of conventional fuzzy set (FS) [15] for handling the uncertainty in a better way. Single-valued neutrosophic set (SVNS for short) is proposed by Wang et al. [16] which is a discrete form of NS theory. So far, SVNSs have been applied extensively to different real-life challenges to measure the information based on three-way decision space [17–19] and its dynamic changes [20]. The single valued neutrosophic sets and their hybrid are applied on graph theory [21–28]. One of the suitable example is information communication through WIFI network is also based on three-way decision space. Many times the user unable to know the information is truly reached, not reached or uncertain. At moment, there is no mathematical model, which can precisely represent this scenario of information processing in WIFI network. To fulfil the objective, the current paper focuses on introducing the properties of single-valued neutrosophic set in MANET. The motivation is to find the confirmed, unconfirmed as well as uncertain information communicated in the MANET at user defined threshold. To accomplish this task, a mathematical model based on single-valued neutrosophic set and its logic is established in this paper. The article also described different situations of MANETs and its modelling at user defined threshold values. To analyze the sent, received, unreceived and uncertain information in the given WIFI connection. The obtained results are also compared with recently available approaches.

2 Single Valued Neutrosophic Sets

This section provides some basic notation about Single valued neutrosophic set as given below:

For a space X of objects, a SVNSs is of the form $A = \{x, \langle T(x), I(x), F(x)\rangle : x \in X\}$ where $T, I, F : X \rightarrow [0, 1]$ denote the truth, indeterminacy and falsity membership degrees respectively and $0 \leq T(x) + I(x) + F(x) \leq 3$. An ordinary FS describe fuzziness only by membership T whereas IFS [29] describe uncertainty with membership T as well as non-membership F under a constraint $0 \leq T + F \leq 1$ with uncertainty factor $\pi = 1 - T - F$. SVNS on the other hand describe not only membership and non-membership grades but also discussed indeterminacy degree I independently, with a condition that $0 \leq T + I + F \leq 3$. Hence, the concept of SVNS is more general than the existing tools and has the capability of dealing with uncertainty based on their acceptation, rejection and uncertain part more precisely in three-way decision space $[0, 1]^3$.

Let us consider a universal set region R is given, one of the neutrosophic geometrical interpretation is shown using the Fig. 1. The diversity of SVNS and IFS is illustrated in the Figs. 1 and 2 to understand their graphical comparison. The space of SVNS is described geometrically and SVN region is shown in Fig. 1 while the space of IFS is presented in Fig. 2.

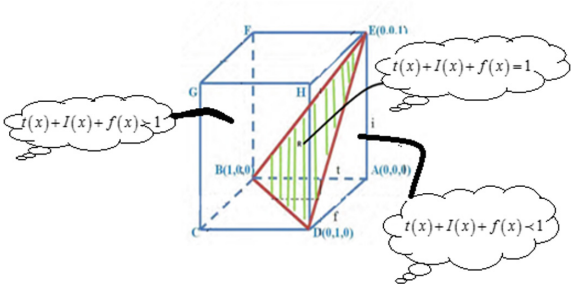

Fig. 1. An understanding of three distinct regions using neutrosophic cube

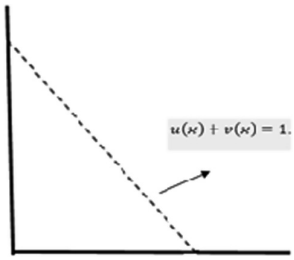

Fig. 2. Intuitionistic fuzzy space

In MANET, there are three types of regions. One region is where receiver received all the information without any disruption due to shadowing, path loss or multi-path propagation. The second region is where the receiver may receive data sometime but could not receive at other time i.e. there are some sort of fluctuations in receiving data

due to above mentioned reasons like shadowing etc. The third region is no coverage area i.e. receiver did not receive any information. These three regions are independent to each other and can be precisely characterized via properties of neutrosophic set as shown in Fig. 1. The IFS does not allow representing the uncertainty independently when compared to neutrosophic set which can be observed from Fig. 2. Hence, the mathematical paradigm of SVNN to deal with information processing in WIFI connection as shown in Fig. 3. It can be observed that the first region exists inside the network; second region is indeterminate or uncertain whereas the third region exists outside of the network which is also popularly known as out-off coverage area as shown in the Fig. 3 in context of MANET.

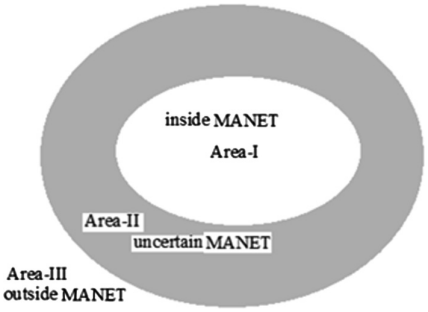

Fig. 3. Communication areas according to MANET

The proposed method in this paper establishes following three-distinct regions for information processing in MANET based on Fig. 3:

Area-I is inside of the MANET, which is the truth or acceptation membership region for the sent information.

Area-II is in between Area-I and Area-III of the MANET represents the information which are not reached and uncertain. It can be represented as indeterminacy region of a defined SVNS.

Area-III is outside of the MANET which is the non-membership region which is also well known as out-off coverage area. It can be represented by falsity membership-value for the defined SVNS.

3 Estimation for Information Transformation of MANET by Using CRC-16

Traditionally the information processing and its estimation based on Cyclic Redundancy Check (CRC). In which, the initial message was used to converted into series of bytes and register then final out puts check different parameters width, poly serial order register and receiver then only send the data from one node to another node. During the transformation of the data via MANET, there are three possibilities.

1. The sent data is confirmed that the receiver has received it. This information can be considered as truth membership.
2. The data is transmitted but no confirmation from the other end. This information can be considered as false membership.
3. At this situation, it is sure that the data cannot be reached. This information can be considered as indeterminacy membership.

The above three cases estimate the rate of the good connection (U), the non- good connection (V) and uncertain connection (I) of the information obtained in the MANET. It will be helpful in analyzing the intelligent of MANETs network by considering the information processing as one of the parameters. This information is represented by triplet (U, I, V) of real numbers from the neutrosophic set defined in three-way decision space $[0, 1]^3$.

It can be observed that the uncertain information in the MANET used to exist due to indeterminate or uncertain error exists in the obtained information. It means that the uncertainty connection contains the transformation of data is coming with wrong CRC. Everywhere the triplet (U, I, V) has been defined in the neutrosophic sets as defined above.

All the fields in the protocol are protected with the CRC-16 frame check sequence (FCS). For more details about CRC-16, the readers can see the ref. [10–12, 30, 31].

Initially when no information is obtained all values become (0, 0, 0) in Fig. 4. In case, $k \geq 0$, the current $(k+1)th$ estimation can be calculated based on previous estimations using the recurrence relation.

Fig. 4. Model of working CRC-16

$(U_{k+1}, I_{k+1}, V_{k+1}) = \left(\frac{U_k k+p}{k+1}, \frac{I_k k+q}{k+1}, \frac{V_k k+r}{k+1}\right)$ where (U_k, I_k, V_k) is the previous estimation, and (p, q, r) is the estimation of the latest message, for $p, q, r \in [0, 1]$ and $0 \leq p+q+r \leq 3$. In this way, final estimation of information can be computed. To achieve this goal, the proposed method considers following threshold values for the U, I and V as follows:

$$U(p+, p-), I(q+, q-), V(r+, r-)$$

If $U \geq p+$, $I \leq q-$, $V \leq r-$, then the data is transformation received is confirmed.
If $U \leq p-$, $I \geq q+$, $V \leq r-$, then the data is transformation received is uncertain.
If $U \leq p-$, $I \leq q-$, $V \geq r+$, then the data is transformation not received is confirm.

In rest of the cases, the received data may be incorrect which may contain wrong CRC. It should be noted that the proposed method utilizes the properties of CRC only for checking the error. The following are the steps for the proposal:

Step 1. Initially when still no information has been obtained, all estimations are given initial values of (0, 0, 0).

Step 2. Characterize the truly confirmed information, uncertain information and rejected information as the previous estimation (U, I, V) about sent information.

Step 3. The current $(k+1)th$ estimation is calculated based on the previous estimations according to the recurrence relation.

$$(U_{k+1}, I_{k+1}, V_{k+1}) = \left(\frac{U_k k + p}{k+1}, \frac{I_k k + q}{k+1}, \frac{V_k k + r}{k+1}\right)$$

Step 4. Define the threshold value to find the reliability of given WIFI network as follows $U(p+, p-), I(q+, q-), V(r+, r-)$.

Step 6. If $U \geq p+$, $I \leq q-$, $V \leq r-$.

It shows that acceptance rate of sent information crossed the threshold of defined its truth, indeterminacy and falsity values. Hence, in this case the data transformation and received is confirmed.

Step 7. If $U \leq p-$, $I \geq q+$, $V \leq r-$.

It shows that truth membership-values about the sent information is less than the given threshold, the indeterminacy about them is maximum from the defined threshold, whereas the falsity values is less than the given threshold. It means the data transformation and received is indeterminate or uncertain.

Step 8. If $U \leq p-$, $I \leq q-$, $V \geq r+$.

It shows that the truth and indeterminacy values about the sent information is less than the given threshold whereas the falsity values is more than the defined threshold. In this case, the data transformation is confirmed as not received.

Step 9. The most interesting part about the proposed method is that it provides flexibility to refine or coarser the given information for analysis of defined WI-FI network.

Step 10. The obtained neutrosophic values provide an information that how much data can be sent, rejected or uncertain while choosing the given network as its reliability. This can be decided totally based on user required threshold values.

Above proposals shows that the neutrosophic set gives more general way to deal with indeterminacy in WIFI connection when compared to intuitionistic fuzzy sets [32]. In the same time, it uses the threshold value for precise measurement of path based on user requirement which concordant with [18]. However, the proposed method is unable to provide any analysis when the dynamic changes happens in the given MANET at the particular interval of time. It means the proposed method unable to process the information when the observed mobile network in different areas, or even we are traveling which will be our future research.

4 Conclusion

This paper aimed at precise mathematical representation of Wi-Fi connection and its quality based on neutrosophic logic. One of the proposition is also introduced based on previous (U_k, I_k, V_k), and latest message (p, q, r) estimation where $p, q, r \in [0, 1]$ and

$0 \leq p+q+r \leq 3$. Moreover, the neutrosophic logic based estimation is introduced based on defined threshold values on previous (U_k, I_k, V_k) and sent information (p, q, r). Hence, the introduced method in this paper helps more precisely towards quality analysis of MANET in term of information transformation characterized by its acceptation, rejection and uncertain part. In near future, we will focus on introducing a real life example to extract some useful information using the proposed method and its applications in various fields for providing an intelligent MANET.

References

1. Toh, C.K.: Ad hoc mobile wireless networks: protocols and systems. Pearson Education (2001)
2. Eze, E.C., Zhang, S., Liu, E.: Vehicular ad hoc networks (VANETs): current state, challenges, potentials and way forward. In: Automation and Computing (ICAC), 2014 20th International Conference on IEEE. pp. 176–181 (2014)
3. Alam, T., Aljohani, M.: Design and implementation of an Ad Hoc network among android smart devices. In: Green Computing and Internet of Things (ICGCIoT), 2015 International Conference on. pp. 1322–1327, IEEE (2015)
4. Fossa, C.E., Macdonald, T.G.: Internet working tactical manets. In: Military Communications Conference, 2010-Milcom IEEE. pp. 611–616 (2010)
5. Rosati, S., Krużelecki, K., Heitz, G., Floreano, D., Rimoldi, B.: Dynamic routing for flying ad hoc networks. IEEE Trans. Veh. Technol. **65**(3), 1690–1700 (2016)
6. Meagher, C., Olsen, R., Cirullo, C., Ferro, R.C., Stevens, N., Yu, J.: Directional ad hoc networking technology (DANTE) performance at sea. In: Military Communications Conference, 2011-Milcom IEEE, pp. 950–955 (2011)
7. Reina, D.G., Toral, S.L., Barrero, F., Bessis, N., Asimakopoulou E.: Evaluation of ad hoc networks in disaster scenarios. In: Intelligent Networking and Collaborative Systems (INCoS), IEEE Third International Conference on. pp. 759–764 (2011)
8. Bader, R., Pinto, M., Spenrath, F., Wollmann, P., Kargl, F.: Bignurse: A wireless ad hoc network for patient monitoring. In: Pervasive Health Conference and Workshops IEEE. pp. 1–4 (2006)
9. Djenouri, D., Kheladi, L., Badache, N.: A survey of security issues in mobile Ad hoc and sensor networks. IEEE Commun. Surv. Tutorials. **7**, 4 (2005)
10. IEEE Std. 802.11–1999, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, Reference number ISO/IEC 8802-11:1999(E), IEEE Std 802.11, 1999 edition (1999)
11. IEEE Std. 802.11a, Supplement to Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: High-speed Physical Layer in the 5 GHZ Band, IEEE Std. 802.11a- (1999)
12. IEEE 802.11 g/D3.0, Draft Supplement to Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Further Higher-Speed Physical Layer Extension in the 2.4 GHz Band, July (2002)
13. Smarandache, F.: Neutrosophy. neutrosophic probability, set, and logic. In: ProQuest Information & Learning, Ann Arbor, Michigan, USA (1998)
14. Atanassov, K.: Intuitionistic Fuzzy Sets. Springer, Heidelberg (1999)
15. Zadeh, L.A.: Fuzzy sets. In: Fuzzy Sets, Fuzzy Logic, And Fuzzy Systems: Selected Papers by Lotfi A Zadeh. pp. 394–432 (1996)

16. Wang, H., Smarandache, F., Zhang, Y., Sunderraman, R.: Single valued Neutrosophic Sets. In: Multisspace and Multistructure 4. pp. 410–413 (2010)
17. Singh, P.K.: Three-way fuzzy concept lattice representation using neutrosophic set. Int. J. Mach. Learn. Cybernet. **8**(1), 69–79 (2017). https://doi.org/10.1007/s13042-016-0585-0
18. Singh, P.K.: Interval-valued neutrosophic graph representation of concept lattice and its (α, β, γ)-decomposition. Arab. J. Sci. Eng. 43(2), 723–740 (2018). https://doi.org/10.1007/s13369-017-2718-5, ISSN: 2193-567X
19. Singh, P.K.: Complex vague set based concept lattice. Chaos, Solitons Fractals **96**, 145–153 (2017). https://doi.org/10.1016/j.chaos.2017.01.019
20. Singh, P.K.: m-polar fuzzy graph representation of concept lattice. Eng. Appl. Artif. Intell. **67**, 52–62 (2018)
21. Broumi, S., Bakali, A., Talea, M., Smarandache, F., Kumar, P.K.: Shortest Path Problem on Single Valued Neutrosophic Graphs. In: 2017 International Symposium on Networks, Computers and Communications (ISNCC) (2017)
22. Broumi, S., Smarandache, F., Talea, M., Bakali, A.: Decision-making method based on the interval valued neutrosophic graph. In: Future Technologie. pp. 44–50, IEEE (2016)
23. Broumi, S., Talea, M., Smarandache, F., Bakali, A.: Single valued neutrosophic graphs: degree, order and size. In: IEEE International Conference on Fuzzy Systems (FUZZ), pp. 2444–2451 (2016)
24. Broumi, S., Dey, A., Bakali, A., Talea, M., Smarandache, F., Son, L.H., Koley, D.: Uniform Single Valued Neutrosophic Graphs". Neutrosophic Sets Syst. **17**, 42–49 (2017)
25. Broumi, S., Bakali, A., Talea, M., Smarandache, F.: A matlab toolbox for interval valued neutrosophic matrices for computer applications. Uluslararası Yönetim Bilişim Sistemleri ve Bilgisayar Bilimleri Dergisi **1**(1), 1–21 (2017)
26. Broumi, S., Bakali, A., Talea, M., Smarandache, F., Dey, A., Son, L.H.: Spanning tree problem with neutrosophic edge weights. Procedia Comput. Sci. **127**, 190–199 (2018)
27. Broumi, S., Bakali, A., Talea, M., Smarandache, F., Vladareanu, L.: Computation of shortest path problem in a network with SV-trapezoidal neutrosophic numbers. In: Proceedings of the 2016 International Conference on Advanced Mechatronic Systems. pp. 417–422, Melbourne, Australia (2016)
28. Broumi, S., Bakali, A., Talea, M., Smarandache, F., Vladareanu, L.: Applying dijkstra algorithm for solving neutrosophic shortest path problem. In: Proceedings of the 2016 International Conference on Advanced Mechatronic Systems, pp. 412–416. Melbourne, Australia, 30 Nov–3 Dec (2016)
29. Smarandache, F.: Neutrosophic logic-generalization of the intuitionistic fuzzy logic. arXiv preprint math/0303009 (2003)
30. Behrouz, F.: Data Communications and Networking. McGraw Hill, 5th edition (2013)
31. Myung, S., Yang, K., Kim, J.: Quasi-cyclic LDPC codes for fast encoding. IEEE Trans. Inform. Theor. 51(8), pp. 2894–2901 (2005)
32. Atanassov, K., Sotirov, S., Kodogiannis, V.: Intituionistic fuzzy estimations of the wifi connections. In: First International Conference on IFSs, GNs, KEs. pp. 76–79, London (2006)