Sentiment Analysis in Healthcare: A Methodological Review

S.Punithavathy[1], Dr.J.M.Dhayashankar[2]

[1]Ph.D Research Scholar Department of Computer Science SRMV College of Arts and Science   Coimbatore, India.
[2]Associate Professor Department of Computer Science SRMV College of Arts and Science Coimbatore, India.

Email: [1]punithavathy26@gmail.com, [2]Email:dayal.jm@gmail.com

Abstract: Social media has both positive and negative impacts on society, affecting social life significantly. Data mining in social media plays a vital role in finding the needs of day-to-day life like buying products, getting medical assistance, ordering food, etc,. Sentiment analysis, a key component of natural language processing (NLP), automatically extracts opinions and emotions from this data to provide insightful information. The rise of online health information and social media has created a rich source of unstructured text data, including patient reviews, social media discussions, and clinical notes. Sentiment analysis in healthcare, applied in the fields of encompassing patient satisfaction analysis, treatment efficacy evaluation, and public health monitoring. This paper gives an overview on sentiment analysis, its types and various methods involved including lexicon – based, Machine Learning, etc., and techniques employed in approaching the healthcare data. The applications and advantages of sentiment analysis in health care sector and highlighting its potential and paving the way for future research directions.

Keywords: Sentiment Analysis, Natural Language Processing (NLP), Healthcare, Machine learning.

1. Introduction

Sentiment analysis, the process of converting unstructured texts into structured texts , the application of natural language processing techniques[17], which is a interdisciplinary field of computer science which understands human language in all the forms like written, spoken etc,. Sentiment analysis also known as opinion mining [1], involves identifying and categorizing users' emotions or opinions as positive, negative, or neutral regarding various services like movies, products, events, or attributes. The analysis draws its data from various social communication channels, including websites, comprising reviews, forum discussions, blogs, micro-blogs, Twitter, and more.

Sentiment analysis falls into five categories as Graded sentiment analysis, Aspect Based [6], Emotion Detection [7], Intent Analysis and Multilingual sentiment analysis. Different investigation levels [8] in sentiment analysis include document level, sentence level and entity or aspect level analysis. Several classification techniques are used in sentiment analysis. Two main categories are Lexicon- based method and Machine Learning methods. The Sentiment Classification (SC) techniques [9] is illustrated in the below fig 1. Which briefs the sub categories of classification methods comes under these two methods.

1.1 Steps in Sentiment Analysis: Data given to process using sentiment analysis passes through the steps of (i) Data collection (ii) Data processing (iii) Data analysis (iv)Data visualization to get the results.

1.2 Advantages of Sentiment Analysis: Sentiment Analysis is applied in broad range of fields, as it can help in classifying the text, emotions easily.
a)   It allows you to remove human bias from the analysis.
b)   Process data at scale.
c)   Get real-time analysis and insight.

Sentiment analysis in healthcare [4] is categorized based on the source of text (such as medical websites, biomedical publications, clinical notes), the method used (including polarity-based, classification, rules-based, machine learning), and the type of analysis conducted (like outcome classification). Moreover, sentiment analysis can also be categorized based on the level of analysis, such as word-level or sentence-level analysis.

People with certain intolerable problems [10], serious illnesses, addictions to something etc., use social networks, health websites, and other web portals to share their sentiments. These represent vital data outlets for analyzing sentiments concerning health. Emotion detection systems utilize facial expressions, including joy, sadness, surprise, and anger, while also capturing nuanced "micro-expressions" and controlled body language as primary data sources.
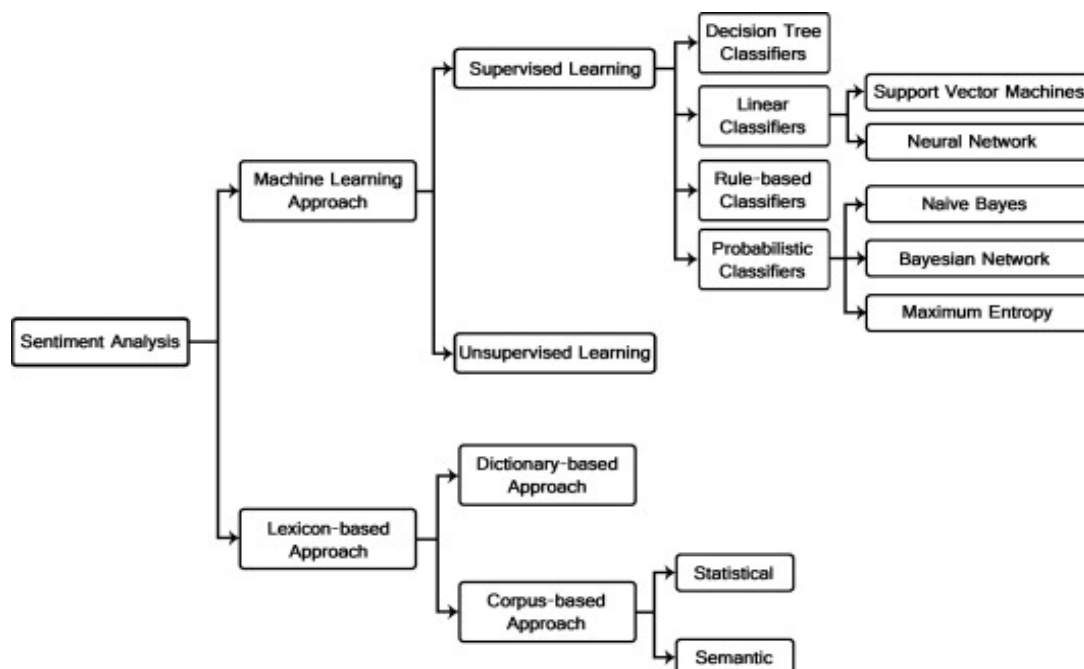

Fig. 1.1: Sentiment classification techniques

Whether expressing positivity or negativity, patient feedback offers valuable insights for enhancing the patient experience and driving better business results [25]. Utilizing sentiment analysis in patient communication, allows healthcare providers to assess patient satisfaction levels and pinpoint areas necessitating improvement. This approach aids in categorizing patient feedback, especially concerning interactions with healthcare professionals, providing detailed insights into communication tactics and patient viewpoints.

1.3 Applications of Sentiment analysis in healthcare
Five impactful and game-changing ways sentiment analysis is revolutionizing the healthcare field [26]:
1. Enhancing Patient Experience and Satisfaction.
2. Real-time Monitoring of Health-related Social Media.
3. Predicting Disease Outbreaks and Public Health Trends.
4. Identifying Adverse Drug Reactions.
5. Analyzing Healthcare Provider Feedback.

2. Literature Survey

M Wankhade et al. [2] investigated different classification methods for sentiment analysis, weighing their strengths and weaknesses. Supervised machine learning methods, known for their simplicity and high accuracy, are widely

favored in this field. Algorithms like Naive Bayes (NB) and Support Vector Machines (SVM) are commonly used as benchmarks for new approaches.

Pooja metha et al. [3] stated that sentiment analysis utilizes both supervised and unsupervised learning techniques to offer various methods for different purposes. It involves advanced processes with a distinct set of tasks, including sentiment classification (supervised or unsupervised), subjective or objective analysis, and opinion extraction.

Issam Aattouchi et al [4] said feelings in medical texts go beyond simple positive or negative polarity. They encompass opinions about doctors, drugs, and treatments, personal sentiments about health conditions, complications, facts, and experiences. Sentiments are multifaceted, expressed through symptoms and pathological terms.

Ankita Bansal et al [5] developed a system that analyzes online reviews of hospitals in aspect – based rating method. By focusing on specific areas like doctor care or cleanliness, the system will create detailed reports on each hospital. This information will be helpful for both patients choosing a hospital and the hospitals themselves for improvement

B K Bhavitha et al [11] compared different machine learning techniques in sentiment analysis and found that supervised techniques to have higher accuracy (85%) than unsupervised techniques. Also for accurate results, Support Vector Machine (SVM) identified as the best classifier.

Shu –Lin Wang et al [12] has developed a usability evaluation model to assess users' intention to use the system through experiments based on the Health Belief Model (HBM) and the Technology Acceptance Model (TAM). The Mobile Emotion Healthcare system, developed through the integration of machine learning and sentiment analysis techniques, offers emotional support accessible through users' smartphones.

D. S. Panchal, et al [13] created a patient's feedback about a hospital based on patients' feedback from websites, Twitter, blogs and government health-care websites. These comments on websites were analyzed and classified as positive, negative and neutral using sentiment analysis. The results are produced to find out which hospital is better for patients' health improvement.

Lorenzo Mascii et al [14] presented a framework for scheduled and corrective maintenance data for retrieving Real World Data (RWD). Core concentration of the analysis is to automatically extract features from maintenance work orders, which calculates Key Performance Indicators of medical devices' maintenance operations for Health Technologies Assessment purposes.

Anastazia Zunic et al [15] established the review on sentiment analysis related to health and well-being focused on mainstream data collection from social media platforms, analysis of patients discussing treatments and services and utilization of a wide range of methods for sentiment analysis.

Rezaul Haque et al [16] stated the essentials of user-generated content of healthcare perception, the importance of drug evaluations, steps to improve drug review categorization using machine learning algorithms, and concluded that the Random Forest (RM) model trained on Count Vectorizer (CV) performed with an accuracy of 96.65% over other algorithms.

Ibrahim Rosul et al [17] evaluated various classification methods using sentiment analysis, the application of natural language processing (NLP) on a drug review system. The proposed system involves a process of converting unstructured data into structured drug review texts. Results concluded that the random forest model gives a high prediction accuracy of 92%.

Nhan Cach Dang et al [18] compared various methods and approaches of sentiment analysis using different datasets, deep learning models and feature extraction techniques, mainly on sentiment polarity analysis. The results showed that datasets containing tweets and IMDB movie reviews outperformed other datasets with better yields.

Francisco Javier Ramírez-Tinoco et al [19] emphasized how sentiment analysis is really helpful in healthcare, showing its advantages for spotting bad reactions to drugs, watching public health, understanding how patients feel, and helping people make smart decisions.

Adnan Muhammad Shah et al [20] analyzed the patient opinion in assessing the quality of healthcare service delivery by combining written descriptions with photographs; this multimodal approach provides a more comprehensive understanding of patients' perspectives on healthcare delivery and the impact of online visual posting and sharing in exchanging experiences and opinions.

Shweta Yadav et al [21] introduced a new patient – assisted healthcare system, for miming patient opinions from medical forums, and created a deep deep convolutional neural network (DCNN) model for classifying medical sentiments in connection with medications and medical conditions.

Dr. K. Jayasakthi Velmurugan, et al [22] proposed a drug recommendation system, which suggests the best medicine by looking at patient reviews and analyzing emotions. It uses a neural network to improve accuracy. Benefits include faster computation, predicting side effects well, and helping doctors make better decisions.

Satvik Garg [23] presented a drug recommender system based on the LinearSVC classifier using TF-IDF vectorization outperformed all other models with 93% accuracy in predicting sentiment.The evaluation metrics used included precision, recall, f1score, accuracy, and AUC score.

A Mahmoudi et al [24] used a data-driven model to show how people's feelings change over time and how social media helps us understand their behavior better. They studied 18 million tweets about COVID-19 and its related topics to find out how people behave during the pandemic.

3.   Problem Definition

There are several methodologies used to collect posts from social media, figure out if they're positive or negative, identify what they're talking about, and show the results in easy-to-understand charts.

As the main objective is to analyze the existing issues, here we list out the major research areas to be concentrated as below

1. Improve the quality of patient experience through the identification of requiring enhancement in communication care delivery, and overall.
2. Obtain insights into how patients view particular treatments, medications, or healthcare providers.
3. Monitor the public sentiment regarding healthcare policies and programs.
4. Create focused strategies for patients who are at risk of not adhering to treatments or feeling dissatisfied.

For this focus, new classification models can be created that outperform the existing models in form of different datasets and metrics.

4.   Conclusion

This methodological review has proved that, through the application of sentiment analysis and machine learning, one can identify the factors of patient opinion on hospitals, drug recommendation for diseases, how to treat at-risk patients, how to improvise healthcare services like medical assistance, nursing and other facilities. Enormous data is available on social media regarding healthcare sentiment analysis. By applying them to proper machine learning algorithms and classification methods, the best end results can be achieved. Furthermore, this study emphasized the classification methods, advantages and applications of sentiment analysis in healthcare.

5.   References

1.   Adil Rajput Natural Language Processing, Sentiment Analysis and Clinical Analytics Innovation in health informatics, 2020 – Elsevier

2. Mayur Wankhade, Annavarapu Chandra Sekhara Rao, Chaitanya Kulkarni A survey on sentiment analysis methods, applications,and challenges Artificial Intelligence Review (2022) Springer 55:5731–5780.

3. Pooja Mehta, Dr.Sharnil Pandya A Review On Sentiment Analysis Methodologies, Practices And Applications International Journal Of Scientific & Technology Research Volume 9, Issue 02, February 2020 Issn 2277-8616 601 IJSTR©2020

4. Issam Aattouchi, Saida Elmendili, Fatna Elmendili Sentiment Analysis of Health Care: Review E3S Web of Conferences 319, 01 (2021) VIGISAN 2021 064 https://doi.org/10.1051/e3sconf/202131901064

5. Ankita Bansal, Niranjan Kumar Aspect-Based Sentiment Analysis Using Attribute Extraction of Hospital Reviews New Generation Computing (2022) 40:941–960

6. Ambreen Nazir, Yuan Rao, Lianwei Wu, Ling Sun Issues and Challenges of Aspect-based Sentiment Analysis: A Comprehensive Survey IEEE Transactions On Affective Computing 2020, ieeexplore.ieee.org

7. MD Group. Using Data To Predict Patient Sentiment In Clinical Trials. 2020. https://mdgroup.com/blog/using-data-to-predict-patient-sentiment-in-clinical-trials/

8. Liu, B.: Sentiment analysis and opinion mining. Synth. Lect. Hum. Lang. Technol. 5(1),1–167 (2012)

9. Walaa Medhat , Ahmed Hassan , Hoda Korashy Sentiment analysis algorithms and applications: A survey Ain Shams Engineering Journal, Volume 5, Issue 4, December 2014, Pages 1093-1113.

10. Sathish Kumar, Rama Prabha & Selvakumar Samuel Sentiment Analysis and Emotion Detection with Healthcare Perspective 20 April 2022 part of book - Studies in Computational Intelligence ((SCI,volume 1024)).

11. B. K. Bhavitha, Anisha P. Rodrigues, Niranjan N. Chiplunkar Comparative study of machine learning techniques in sentimental analysis 2017 International Conference on Inventive Communication and Computational Technologies (ICICCT 2017).

12. Shu-Lin Wang; I-En Chiang Honours; Alex Kuo; Jing-Ya Lin Mobile Emotion Healthcare System Applying Sentiment analysis 2022 IEEE Explore.

13. D. S. Panchal, S. S. Kawathekar, S. N. Deshmukh Sentiment Analysis of Healthcare Quality International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-3, January 2020.

14. Lorenzo Mascii, Alessio Luschi & Ernesto Iadanza Sentiment Analysis for Performance Evaluation of Maintenance in Healthcare International Conference on Medical and Biological Engineering CMBEBIH 2021 pp 359–367.

15. Anastazia Zunic, Padraig Corcoran, Irena Spasic Sentiment Analysis in Health and Well-Being: Systematic Review 2020 JMIR Med Inform. 2020 Jan 8; 8 (1): e16023. doi: 10.2196/16023.

16. Rezaul Haque, Th Swakshar, Das Amarth, Th Katura, Gania Khushbu Improving Drug Review Categorization using Sentiment Analysis and Machine Learning 2023. International Conference on Data Science and Network Security (ICDSNS).

17. Ibrahim Rosul, Kazim, Enas Fadhil Preprocessing of Drugs Reviews and Classification Techniques Journal of Al-Qadisiyah for Computer Science and Mathematics Vol. 15(3) 2023, pp Comp. 1–10.

18. Nhan Cach Dang, María N Moreno-García, Fernando De la Prieta Sentiment Analysis Based on Deep Learning: A Comparative Study Electronics *2020*, *9*(3), 483;

19. Francisco Javier Ramírez-Tinoco, Giner Alor-Hernández, José Luis Sánchez-Cervantes, María Del, Pilar Salas-Zárate, Rafael Valencia-García, F J Ramírez-Tinoco, Á M Del Pilarsalas-Zárate, J L Sánchez-Cervantes Use of Sentiment Analysis Techniques in Healthcare Domain 2019.

20. Adnan Muhammad Shah, Xiangbin Yan, Syed Asad, Ali Shah, Gulnara Mamirkulova Mining patient opinion to evaluate the service quality in healthcare: a deep-learning approach 2019 Journal of Ambient Intelligence and Humanized Computing

21. Shweta Yadav, Asif Ekbal, Sriparna Saha, and Medical Sentiment Analysis using Social Media: Towards building a Patient Assisted System 2018.

22. Dr. K. Jayasakthi Velmurugan, Elakkiya J Drug Recommendation Techniques Based on Aspect Level Reviews Using Machine Learning Algorithms 2022

23. Satvik Garg Drug Recommendation System based on Sentiment Analysis of Drug Reviews using Machine Learning 2021 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence). arXiv:2104.01113v2 [cs.IR] 5 Apr 2021.

24. A Mahmoudi, VW Yeung, EWK See-To User Behavior Discovery in the COVID-19 Era through the Sentiment Analysis of User Tweet Texts - arXiv preprint arXiv:2104.08867, 2021 - arxiv.org.
25. The Importance of Sentiment Analysis In Healthcare. (2021). Well Health. In WELLhealth https://wellapp.com/blog/sentiment-analysis-in-healthcare/.
26. 5 powerful applications of sentiment analysis in health care. https://www.voxco.com/blog/5-powerful-applications-of-sentiment-analysis-in-healthcare/