A systematic literature analysis of Cyberbullying Detection on social media using Text based Sentiment Analysis

NIRJARI DESAI, PROF. MAYURESH KULKARNI

Abstract - **Compared to last few years Internet users are increasing day by day and along with the straight up line teenagers and school children also become used to with Internet like one essential part of routine. Parallelly Cyber-crimes are growing at tremendous rate like Cyberbullying, Cyberstalking, Denigration, Trickery, Outing, Flaming, Impersonation and many more. Among all Cyberbullying is one of the major challenges facing by many school students, teenagers and adolescents especially. Actually, age is no bar for this type of crimes but people are neither following any netiquettes even after knowing well nor some of them have any knowledge regarding how to use Internet and Social Media securely. Social Media has now become one vital part of people as it connects many friends and relatives together and give them freedom to post and connect from anywhere, anytime to remove their loneliness. They publicly and freely express their emotions and opinions or reviews on social media like twitter which is very popular and maximum cases of Cyberbullying occurs on this platform, which is targeted by bully and trapped them in major crimes. Sentiment Analysis is playing important role to figure out whether tweets containing positive sentiment or negative that is major goal of this paper by literature review of about 32 papers and can try to mitigate this harmful challenge due to which people face many mental, emotional and physical loss using Machine Learning algorithm.**

Index Terms - **Cyberbullying Detection, Machine Learning, Sentiment Analysis, social media, Additional Key Words and Phrases: Lexicon dictionary, Neural Network.**

1.INTRODUCTION

CYBERBULLYING: online repetitive harassment on same type of thing
SOCIAL MEDIA: an online content/media/reviews sharing platform
Internet users are growing as it has become cheaper and easily available so people use it continuously as an essential part of life. School students use it for social media use as well as for their study, adults use it for connecting and sharing their emotions/views with their past friends as well as relatives and make circle of their new friends. Other people also use it in their daily life as per their needs. Due to more connectivity established on social media platform, it is also becoming popular and it has 2 sides like positive effects on one side and negative effects on other. Especially school students continuously explore social media for posting photos, chatting, sharing their status of every minute and likes - dislikes as well. Bullies take benefit of them and make them target for cyberbullying kind of disastrous crimes. Cyberbullying is an online crime occurs using various digital gadgets such as laptop, mobiles, tablet, computer etc. (Meisy Fortunatus, Patricia Anthony, Stuart Charters, H.R. 2020), on many popular social media platforms like Twitter, Facebook, YouTube, Instagram, forums, emails, messengers and repeatedly harass or torture individual or group frequently. Due to such problems victim suffers from various physical concerns like headache (Balakrishnan, V., Khan, S. and Arabnia 2020), food disorder, sleep disorder, mental concerns like depression, anxiety, loneliness and emotional concerns also. Sometimes at a stage people never think on committing suicide and lost their lives. Person who does this called Bullies and those who is suffering called Victims. According to Child Rights and You (CRY) 1 in 3 adults get bullied every day and most of them are aged between 13-18 years (www.outlookindia.com/newsscroll). According to the National Crime Records Bureau there is a 36% increase in cyber stalking and cyber bullying cases in India. (Legal Service India Journal Survey). Ritu Kohli, a student, was the first case of cyberstalking reported in India (www.docs.manupatra.in/newsline).

SENTIMENT ANALYSIS – natural language processing to categorize emotion/sentiments as positive or negative

Sentiment Analysis is one important part for cyberbullying detection. It uses natural language processing to classify sentiments of individual as positive, negative or neutral (www.monkeylearn.com/sentiment-analysis). It can be performed for textual data, image data or video data as well. Here focus is on text-based data. People share their opinions on social media regarding any products, politics, games or other accessories and these sentiments can be classified and intelligent outcomes can be gathered from their reviews. Sometimes their feelings may be maliciously used by bullies and trap them in cyberbullying. Using sentiment analysis these kinds of opinions can be categorized and cyberbullying can be detected.

MACHINE LEARNING – subcategory of Artificial Intelligence (becominghuman.ai)

Machine Learning is one major subbranch of Artificial Intelligence. It is the study of different computer algorithms to train the machine by experience of its own without making programming for the machines to make them well trained. It is mainly divided in three categories: Supervised, Unsupervised and Reinforcement. Supervised machine learning is a type where machines are trained by feeding labelled class data and machine needs to classify the newly entered test data under the defined class label. Classification and Regression are main functionalities of this type. Unsupervised Machine Learning is a type where machines don't have labelled class data but by identifying patterns from data and making them trained, they can create cluster of data of objects who share same type of properties. Clustering is major functionality of this type. Reinforcement machine learning is a type where how actions can be taken based on maximization of rewards attained by machines themselves. This paper mainly concentrates on supervised machine learning approach as labelled tweets of input can be obtained from twitter API. Authors of various papers used various supervised and unsupervised machine learning algorithms and provided their results. The main objective of this literature review is to distinguish among empirical works done related to Cyberbullying detection on social media using textual sentiment analysis and

eventually helping in our work to be efficient by considering accuracy of various algorithms used. This paper reviews 32 articles and papers which uses machine learning approach and lexicon-based dictionary for cyberbullying detection. The articles used in this literature are published between the years 2017-2021. I read papers from reputed Journals, Conferences, and Books. Google Scholar has been very helpful in getting related articles and papers.

The rest of the paper is organized as follows: Section 2 defines common forms of Cyberbullying and methods available to detect it. Section 3 present data analysis about various research papers in tabular format to identify further research work and finally Section 4 provides conclusion and summary derived from the literature review together with showing directions for future scope.

2. FORMS/TECHNIQUES OF CYBERBULLYING

Various common forms and types of cyberbullying occurs online with people. Some of them are mentioned here.

CYBERSTALKING:
Frighten or harass someone on Internet using ICT tools over a period of time (https://brentmischnick.com/2019/09/19).
HARASSMENT:
One or more person works together repeatedly online to harass or verbally abuse individual for finite period of time (Balakrishnan, V., Khan, S. and Arabnia 2020).
DENIGRATION:
To spread negative or hurtful information about someone to spoil their relationship (Balakrishnan, V., Khan, S. and Arabnia 2020).
EXCLUSION:
Intentionally exclude person from group/team to make them feel lonely (www.shorelinecommunications.com).
IMPERSONATION:
Breaking someone's account and in their name posting cruel or vulgar comments to others pretending to be the victim (https://www.slideshare.net/jmmasucci).
TRICKERY:
Practice of doing tricks and by applying empathy receive confidential information from a person and

then posting it publicly (www.shorelinecommunications.com).
FLAMING:

Posting insulting or offensive messages online for individual or group (https://techterms.com/definition). There are various supervised and unsupervised Machine Learning algorithms used such as Support Vector Machines, Linear Regression, K-Nearest Neighbors, Logistic Regression, Random Forest, Naïve Bayes, Decision Tree(J48), Artificial Neural Network, Convolutional Neural Network, K-means clustering, KNN (k-nearest neighbor), Principal Component Analysis etc. Combination of any approaches called hybrid machine learning method,

and is also popular in detecting cyberbullying on social media chat messages.

3. DISSCUSION AND ANALYSIS

In this section we will discuss the statistics, analysis and performance obtained from this literature review. We have done some Data Analysis and Data Visualization. In Table I, we provide an outline of Cyberbullying Detection done using various algorithms, evaluation parameters used, datasets used, social media network used and a lot of other details based on performance examined whether it is "cyberbullying or no cyberbullying" and their used methods.

Table I: Performance Analysis based on various criteria from different literatures

Literature	Methodology/Model	Features	Social Media Network	Evaluation Metrics	Classification/ Text Mining
[Vimala Balakrishnan, Shahzaib Khan, Hamid R. Arabnia 2020]	Supervised Machine Learning Classifiers	Textual	Twitter	Accuracy, AUC, F-score, Kappa, RMSE	Classification
[Swaranjit Singh, Vivek Thapar, Sachin Bagga 2020]	NodeXL Plugin	Textual	Twitter	Degree Centrality, Betweenness Centrality, Eigenvector Centrality, Clustering Coefficient	Text Mining
[Meisy Fortunatus, Patricia Anthony, Stuart Charters 2020]	Lexicon based methodology	Textual	Facebook	Accuracy, Precision, Recall, F1-score	Classification
[Vimala Balakrishnan, Shahzaib Khan, Terence Fernandez, Hamid R. Arabnia 2019]	Big Five and Dark Traid Model, Supervised Machine Learning Classifiers	Textual	Twitter	Precision, Recall, F-measure	Classification
[Filippos Karolos Ventirozos, Iraklis Varlamis and George Tsatsaronis 2018]	Lexicon based methodology and Supervised Machine Learning Classifiers	Textual	MySpace Forum	Accuracy, ROC area	Classification

[Harsh Dani, Jundong Li, and Huan Liu 2017]	Unsupervised Machine Learning Model	Textual	Twitter, MySpace	F1-measure, AUC	Classification
[Jiale Wu, Mi Wen, Rongxing Lu, Beibei Li, Jinguo Li 2019]	Supervised Machine Learning Model and Neural Network	Textual	Weibo	Precision, Recall, F1-measure	Classification
[Nargess Tahmasbi, Elham Rastegari 2018]	Supervised Machine Learning Model	Textual	Twitter	Accuracy, Precision, Recall, ROC area	Text Mining
[Despoina Chatzakou, Ilias Leontiadis, Jeremy Blackburn, Emiliano DE Cristofaro, Gianluca Stringhini, Athena Vakali, Nicolas Kourtellis 2019]	Supervised Machine Learning Model and Neural Network	Textual	Twitter	Precision, Recall, F1-score, Area under Curve (AUC)	Text Mining
[Walisa Romsaiyud, Kodchakorn na Nakornphanom, Pimpaka Prasertsilp, Piyaporn Nurarak, Pirom Konglerd 2017]	Mixed Machine Learning Model	Textual	Twitter	Accuracy	Text Mining
[Semiu Salawu, Yulan He, Joanna Lumsden 2017]	Supervised Machine learning approach, Lexicon based approach, Rules based approach, Mixed approach	Textual	MySpace, YouTube	Accuracy, Precision, Recall, F-measure	Classification
[Akshi Kumar, Nitin Sachdeva 2020]	Mixed Machine Learning Model and Neural Network	Textual	Twitter, Facebook	AUC-ROC Curve, Accuracy	Classification
[Sayanta Paul, Sriparna Saha 2020]	Supervised Machine Learning Model and Neural Network	Textual	Formspring, Twitter, Wikipedia	F1- score	Classification
[Monirah A. Al-Ajlan, Mourad Ykhlef 2018]	Neural Network	Textual	Twitter	Accuracy, Precision, Recall	Classification
[Akshi Kumar, Nitin Sachdeva 2019]	Mixed Machine Learning Model and Neural Network	Multimedia	Twitter, MySpace,	No. of Key Performance Indicators	Classification

			Facebook, Formspring.me		
[Lu Cheng, Ruocheng Guo, Huan Liu 2019]	Supervised Machine Learning Model	Textual	Formspring.me, twitter	F1 Score	Text Mining
[Rohit Pawar, Rajeev R. Raje 2019]	Mixed Machine Learning Model and Neural Network	Textual	Multiple Platforms	Accuracy, Precision, Recall, F1 Score	Classification
[Anman Zhang, Bohan Li, Shuo Wan, and Kai Wang 2019]	Neural Network	Textual	Twitter, Formspring, Myspace	Accuracy	Classification
[Charalampos Chelmis, Daphney–Stavroula Zois, Mengfan Yao 2017]	Supervised Machine learning and Lexicon based methods	Textual	Twitter	Clustering coefficient, Accuracy	Classification
[Vivek K. Singh, Connor Hofenbitzer 2019]	Supervised	Textual	Twitter	AUC ROC, TPR, FPR	Text Mining
[Mengfan Yao, Charalampos Chelmis, Daphney–Stavroula Zois 2018]	Supervised Machine Learning Model and Neural Network	Textual	Instagram	Accuracy, Precision, Recall, F-measure, AUCROC	Classification
[Vivek K. Singh, Souvick Ghosh, Christin Jose 2017]	Supervised Machine Learning Model	Visual features, Textual features	Instagram	Accuracy, ROC Area	Classification
[Daphney–Stavroula Zois, Angeliki Kapodistria, Mengfan Yao, Charalampos Chelmis 2018]	Supervised Machine Learning Model	Textual	Twitter	Accuracy, error probability	Classification
[I-Hsien Ting, Wun Sheng Liou, Dario Liberona, Shyue-Liang Wang, Giovanny Mauricio Tarazona Bermudez 2017]	Supervised Machine Learning Model	Textual	Facebook, Twitter, Ptt, CK101	Precision, Recall	Text Mining & Classification

[Rahat Ibn Rafiq, Homa Hosseinmardi, Richard Han, Qin Lv, Shivakant Mishra 2018]	Supervised Machine Learning Model and Neural Network	Textual	Vine	Precision, Recall, F1-score, Time (seconds)	Classification
[Kaige Wang, Qingyu Xiong, Chao Wu, Min Gao, Yang Yu 2020]	Supervised	Multimedia	Instagram, Vine	F1-score, Accuracy	Classification
[Hugo Rosa, Joao P Carvalho, P´avel Calado, Bruno Martins, Ricardo Ribeiro, Luisa Coheur 2018]	Supervised Machine Learning Model	Textual	Formspring	Precision, Recall, F-measure	Classification
[David Van Bruwaene, Qianjia Huang, Diana Inkpen 2020]	Supervised Machine Learning Model and Neural Network	Textual	Twitter, Instagram, Facebook, Tumblr, Pinterest, YouTube, Gmail	F-measure, ROC, Accuracy	Classification
[Patricio Zambrano, Jenny Torres, A´ngel Ya´nez, AlexandraMacas, Luis Tello-Oquendo 2020]	Neural Network	Textual	Twitter	Accuracy	Classification
[Madhura Vyawahare, Madhumita Chatterjee 2020]	Supervised Machine Learning Model	Textual	Twitter, Ask.fm Facebook, YouTube, Instagram,	Precision, Recall, F-measure	Classification
[Junyi Chen, Shankai Yan, Ka-Chun Wong 2018]	Supervised Machine Learning Model and Neural Network	Textual	Twitter	Accuracy, AUC ROC	Classification
[Zufan Zhang, Yang Zou, Chenquan Gan 2017]	Neural Network	Textual	Sentiment Tree Bank (SST), Twitter	Accuracy, F1-score	Classification
[ManuelF.López-Vizcaíno, FranciscoJ.Nóvoa, VictorCarneiro, FidelCacheda 2021]	Supervised Machine Learning models	Multimedia	Vine	Precision, Recall, $F_{latency}$, Early Risk Detection Error(ERDE)	Text Mining and Classification

Table I provides behavioral details of cyberbullying detection from different input parameters like models used, features considered, evaluation criteria etc. and from table I clearly, we can understand cyberbullying detection is a harmful activity happens online mostly on twitter social media platform with no age bar and with censored and abusive comments on Twitter. To detect this challenge majority of the papers are using sentiment analysis to classify the message as cyberbullying or non-cyberbullying and then suitable actions can be applied to prevent it. It is monitored from almost all papers that authors had preferred machine learning algorithms, especially Support Vector Machine, Naïve bayes and Logistic Regression, Random Forest, Decision Tree in most cases by achieving improved accuracy in performance compared to lexicon based and neural network approach. Here literature survey is done by choosing 32 research papers from reputed journals and conference of ACM, IEEE, Springer, Elsevier, ScienceDirect, ResearchGate etc.

4. CONCLUSION AND FUTURE SCOPE

This is a review paper which gathers data from 32 different research papers of journal and conference of fame from google scholar. Detection of cyberbullying is really needed and unavoidable cybercrime probably in all social media network as it humiliates person of any age and target them to become victim of this crime. Victims suffer from mental, emotional and physical imbalance and sometimes it may lead to suicidal attempts in few cases. Lot of examples of teenagers and even adults are there of cyberbullying cases since bullies focus on shy and reserved personality persons and trap them in crimes like this. Mostly such cases occur in schools, colleges, Online forums, Games, special Community's platform, Ecommerce websites and social media where people publicly placing their opinions, feedbacks and emotions about almost anything openly. During the review, I observed that most of the papers are using Supervised Machine Learning approach and achieved growth in accuracy to detect cyberbullying in comparison with lexicon-based dictionaries approach (Meisy Fortunatus, Patricia Anthony, Stuart Charters, H.R. 2020) and neural networks. Particularly SVM, Naïve Bayes, Random Forest and decision tree classifiers are choices of authors for good performance

retrieval in cyberbullying detection. Sentiment analysis (Singh, S., Thapar, V., & Bagga, S. 2020) is prioritised against mining as it is unique method of classifying any textual message as cyberbullying or non-cyberbullying. Most popular social media platform employed by people is Twitter as it is in top 5 social network where most cases of cyberbullying take place (Balakrishnan, V., Khan, S. and Arabnia 2020). After observing the serious impacts of cyberbullying on human life, I found it crucial to detect it and protect the society from its adverse effects on teens, adults and school going children. For future work I can suggest, censored or vulgar contents should be spotted and notification about instant alert should be delivered once a person found to be victim so that post effects of this crime can be reduced to a significant extent. Many machine learning classifiers (Chelmis, C., Zois, D.-S., & Yao, M. 2017) can be explored for better performance accuracy. Comparative study for cyberbullying detection on social media using sentiment analysis for text-based comments is very beneficial for any online community.

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