Cyberbullying Detection and Prevention: Data Mining and Psychological Perspective

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***Abstract*— Bullying is defined as targeting an individual or a group of individuals and exposing them to ridicule and negative actions both physical and mental deliberately. This is a common but serious and demoralizing experience that every individual encounters at least once in his or her lifetime. With the advent of technology, a form of bullying known as cyberbullying has spread very quickly targeting masses of innocent people very easily. Cyberbullying involves the use of computers, mobile phones, etc. for bullying activities. In this paper we focus on the data mining and machine learning techniques which have been proposed to detect and prevent cyberbullying and implement one such machine learning technique to identify the presence or absence of cyberbullying using the dataset from a popular social networking website. We also discuss the psychological factors related to cyberbullying and how the problem can be tackled along those factors. A few proposals for the future algorithms for the detection and prevention of cyberbullying are also put forth.**

***Index Terms*—: cyberbullying, data mining, machine learning, psychological, perspectives, prevent, detect**

I. CYBERBULLYING AND ITS IMPACT

Cyberbullying involves sending harmful messages, posting defamatory comments or images using social networking websites, cell phones, e-mails, etc. Cyberbullying mainly targets children and adolescents, as they are the most active group when it comes to using technology for various purposes like collaborating, socializing etc. According to a research conducted by Symantec [1] only 25% of the parents in a test group were aware that their wards were involved in a cyberbullying incident. In most of the cases of cyberbullying, the younger individual involved becomes the victim, making the older individual, the perpetrator. A study [2] revealed that, cyberbullies are just as likely to be males as females and are more likely to be older teens. The same study concluded that they tend to have poor relationships with their family and friends. According to a survey [3], it has been identified that a significant number of suicides have been committed by teens who were exposed to cyberbullying. It also shows that a majority of cyberbullying is done through Facebook and around 55% of the youth exposed to cyberbullying have committed suicide. The seriousness of the problem and its consequences are illustrated in Fig.1.

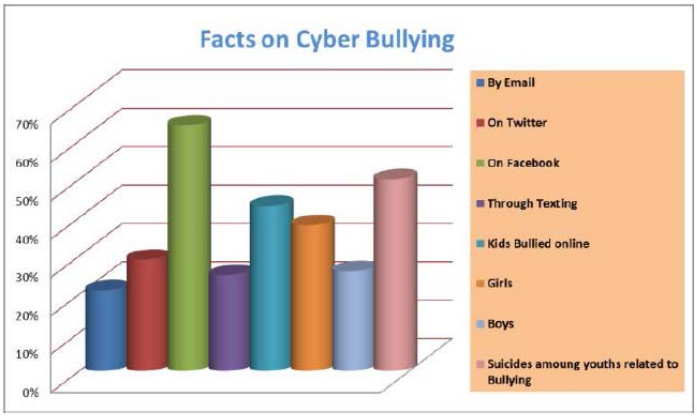

Fig.1 Paridhi Singhal and Ashish Bansal, *A graph showing analysis of impact of cyberbullying on suicides*.
Source: Improved Textual Cyberbullying Detection Using Data Mining (International Journal of Information and Computation Technology), 2013

II. TYPES OF CYBERBULLYING

Most cyberbullying activities are categorized into the following [4]:

- Flaming: Heated online arguments and fights using vulgar and abusive language via chat or e-mail.
- Harassment: Repeatedly sending cruel, offensive or threatening messages.
- Denigration: Exposing secrets of a person or posting gossips in order to destroy friendships or reputation of a person.
- Impersonation: Breaking into the victim`s account and sending mails that would start a fight or sending embarrassing e-mails.
- Trickery: Tricking the victim into revealing sensitive information and using it to cause inconvenience or passing the information to others.
- [5] Interactive gaming: Most gaming consoles allow players to connect and play online. This gives bullies to chance to abuse using chats and comments.

- Sending viruses: Bullies send mails with viruses attached to them to destroy their victims' systems or delete sensitive data.
- Blackmailing: Bullies claim that they have personal photos or private information to extort money or exert power.

III. Detecting and Tackling Cyberbullying

It is hard to detect and prevent cyberbullying because of the characteristics of the people involved in it i.e. the bullies and the victims. Most of the cyberbullies, if not all, remain anonymous at all times and, as stated above, only a small fraction of them are known to be participating in such activities. In spite of many measures like filtering traffic in schools, filing a complaint with the ISP etc. cyberbullying is still rampant among school and college-going youth. Detecting becomes even more difficult as most of the victims do confide in their parents, as they fear that the bullying might increase in response to the action taken against the offender.

Cyberbullying is best detected by observing the individual. It is very easy for a parent to detect if their kid is facing bullying when the kid stops using his/her cell phone or computer or any other form of communication, when the kid gets upset after taking a call or receiving a text or when he/she appears suddenly emotionally withdrawn. All these might indicate that the child is being cyberbullied according to a survey conducted by The Delete Cyberbullying Project [6]. Once a parent learns that his/her kid is being cyberbullied they may be able to tackle the problem by:

- Being supportive and not taking away computer privileges.
- Finding the root cause of the problem and trying to solve it by themselves and if not possible to do so, contact the concerned authorities to take appropriate action.
- Talking to their ward regularly to keep track of the issues.

If a parent discovers that his/her kid is the offender, he/she should:

- Explain the consequences in detail and help him/her understand how a victim feels when bullied rather than simply punishing.
- Find out if he/she had been bullied in the past and help heal emotional wounds.

Many monitoring softwares like cloud9 [7] are available to log and block or allow content on mobile phones.

IV. Text Mining in Cyberbullying Detection

Text mining is the process of extracting useful text patterns from a natural language text rather than a database. Text mining can help an organization to discover insights by analyzing multiple word documents, social network profiles, comments posted on social networks like Facebook, tweets on Twitter, etc. This process of applying data mining to find an efficient business solution is known as Text Analytics [8]. The data that we use i.e. word files and data gathered over the internet have no specific structure, hence they are called unstructured data and text mining is performed on unstructured data using machine learning techniques to extract knowledge from the text. Unstructured data contains ambiguities caused by inconsistent syntax and semantics including slang, language specific to vertical industries and age groups, double entries and sarcasm. Text mining includes some functionalities of many data processing technologies like Data Mining, Information Retrieval, Statistics, Web Mining, Computational Linguistics and Natural Language Processing which is best depicted in Fig.2.

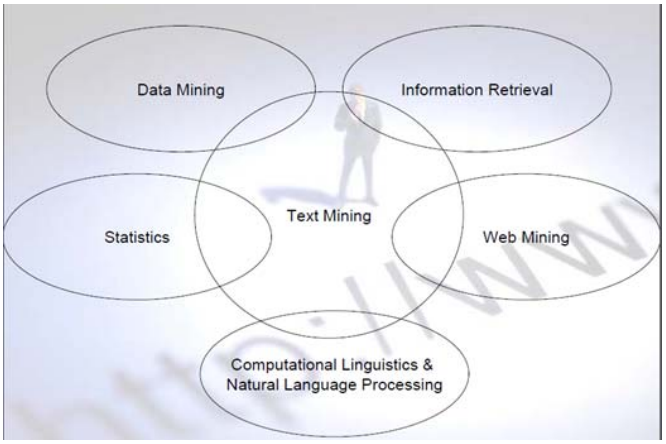

Fig.2 Courtesy: www.cs.sunysb.edu

Text mining is a multi-stage process. The first stage deals with document clustering and determining text characteristics i.e. collecting all the relevant documents as text mining can identify patterns in multiple documents. The following step deals with data pre-processing which involves breaking up a stream of text into meaningful words or tokens (Tokenization [9]), cleaning up the text, determining the relationship of the word with adjacent words to find their meaning (Grammatical tagging- corpus linguistics method [10]), determining the sense in which the word is used if there are multiple meanings of that word (Word sense disambiguation) and other features like semantic structures.

The third step deals with attribute generation where the text document is represented by words and the actual attributes are generated. In this step we use an in-built classifier to generate labels from the features we feed into it. Words and their occurrences are counted and a weight is assigned to each label, which can be used later for further analysis.

This is then followed by attribute removal in which irrelevant attributes are removed and classic data mining algorithms are applied to this data whichever is best suited as per the

requirement. The process is best understood by looking at Fig.3.

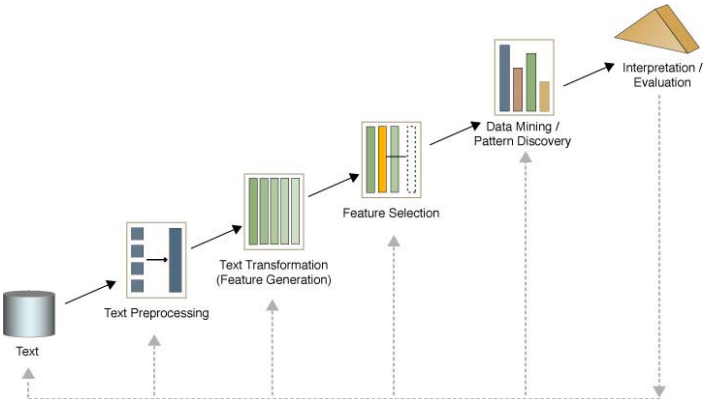

Fig.3 Courtesy: www.cs.sunysb.edu

The same method can be applied to tackle the cyberbullying problem. In our study we obtained datasets from the Myspace social networking website, which were manually marked as cyberbullying. This data was then extracted into multiple XML files and stored in a folder. Using the RapidMiner data mining tool, the data from multiple documents was then read into local repositories. In the next step we extracted all the individual words from the file and found out their frequency of occurrence. The frequency of occurrence enables us to identify abusive words in the texting lingo, which might not have any meaning otherwise. The analysis performed over thousands of comments on the dataset downloaded from Myspace shows significant frequencies of many abusive words used as shown in Fig.4.

Word	Attribute Name	Total Occurences
the	the	7560
to	to	5073
US	US	4042
a	a	3688
M	M	3610
I	I	3476
of	of	3199
and	and	2943
that	that	2672
it	it	2452
is	is	2440
in	in	2237
Ã	Ã	2230
Â	Â	2093
you	you	1904
s	s	1641
t	t	1606
for	for	1495
F	F	1418

Fig.4 Text Analytics on Myspace dataset

We can observe that the words like F, U are used most often letter like these make no sense if they are used individually on the other hand these maybe curses being exchanged in the texting lingo. In this manner, text mining can help us determine or estimate the nature of the comments.

While the method discussed above is useful it cannot predict the presence of bullying if texting lingo is not used or if bullying is done in non-curse words which when stringed together make up an offensive comment or a threatening message. This is where sentiment analysis helps us to improve the process to pick out offensive texts more efficiently.

This shortcoming paves the way for the utilization of sentiment analysis in detecting cyberbullying. Sentiment analysis is the process of determining the tone of the given text, this method is widely employed in the areas of product reviews and movie reviews. In the application of sentiment analysis to detecting cyberbullying, two classes of data are considered one with the positive tone/emotion and the other with the negative tone/emotions. These are stored into a vector and used to train a supervised learning algorithm. The new or test data is classified into positive or negative based on its similarity or dissimilarity to the data that the supervised algorithm was trained with.

We implemented sentiment analysis using the above dataset with two classes of data: one class was positively identified as an occurrence of cyberbullying while the other was identified as not being an occurrence of cyberbullying. Since textual data is unstructured, it doesn't find a place in the usual databases and is stored in the form of text files. In our process, we first extracted the text from these text files while ignoring their XML or HTML contents.

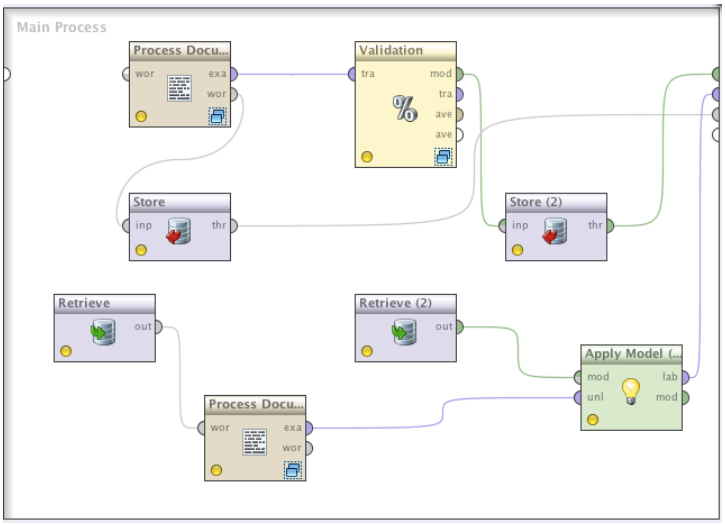

Fig. 5 The Sentiment Analysis process implemented in RapidMiner

Next, a word vector was generated, as shown in Fig.6, using the extracted text. Constructing the word vector involved the following 4 operations:

1. Tokenize: In this operation, the extracted text is broken into a set of words or tokens, where a token is the most basic unit of a text.

2. Filter Tokens: The tokens are filtered depending upon their length. In this step the max and min parameters chosen depend upon the context of the application. Since the usual "chat lingo" consists of relatively smaller word lengths, the parameters were chosen appropriately.

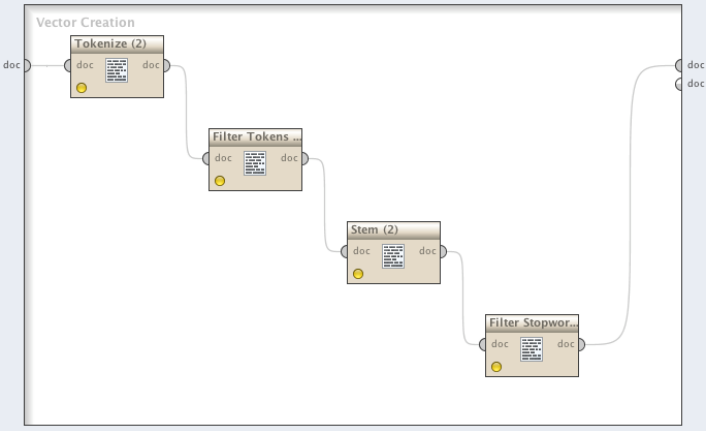

Fig. 6 Word Vector generation process in RapidMiner

3. Stem: The stemming operation involves reducing words to their root-words, [11] for example stemming the word "computation" to its root "comput". This process facilitates the identification of similar tokens.

4. Filter Stop words: This operation eliminates the common words in the English language since they form the noise in the data.

We next used the X-Validation operator in RapidMiner to perform cross-validation, [12] which is a statistical method of evaluating and comparing learning algorithms by dividing data into two segments: one used to learn or train a model and the other used to validate the model. The X-Validation operator we used consisted of a linear SVM (Support Vector Machine) with its default parameters as shown in Fig.7.

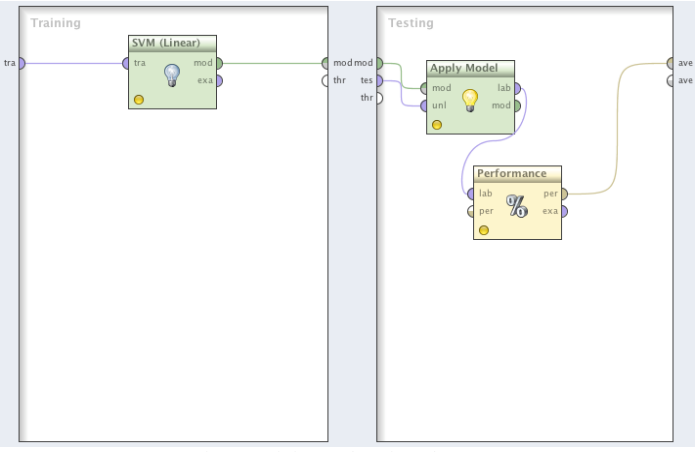

Fig. 7 Training and testing phases

The next phase of the implementation was identifying whether a new text data consisted of an occurrence of cyberbullying or not. For this we generated the word vector using the same process as above and used the model generated using SVM in the above process to classify the given text as a positive or negative occurrence of cyberbullying. The results for two different texts with their positive and negative confidences were as shown in Fig. 8 and Fig. 9.

Please note that here "positive" refers to presence of cyberbullying in the test data, while "negative" refers to absence of cyberbullying in the test data.

Data View | Meta Data View | Plot View | Advanced Charts | Annotations

ExampleSet (1 example, 7 special attributes, 26 regular attributes)

Row No.	label	metadata_file	confidence(negative)	confidence(positive)	prediction(label)
1	tbd	test.rtf	0.385	0.615	positive

Fig. 8 Screenshot of Result 1

Data View | Meta Data View | Plot View | Advanced Charts | Annotations

ExampleSet (1 example, 7 special attributes, 26 regular attributes)

Row No.	label	metadata_file	confidence(negative)	confidence(positive)	prediction(label)
1	tbd	test.rtf	0.500	0.500	negative

Fig. 9 Screenshot of Result 2

VI. Related Works

Patchin and Hinduja define “Cyberbullying as willful and repeated harm inflicted through the medium of electronic text messages” [13]. Few other research teams like Feinberg and Robey (2010) [2], are working on the psychological aspects of bullying and preventing them using simple measures like careful observation, monitoring, setting up school environments that discourage cyberbullying as most of the individuals affected are younger teens, by encouraging anti-bullying programs, monitoring internet traffic in the school premises and counselling of the individuals. Their paper also discusses the characteristics, impacts and measures to be taken to prevent and correct cyberbullying from a psychological perspective. Efforts are being made to understand the effectiveness of cyberbullying preventive strategies; Kraft and Wang [14] discuss the preventive strategies based on a survey conducted by them on 713 teenagers. These teenagers were divided into four groups: pure victim, pure offender, both victim and offender and neither victim nor offender to improve analysis.

In a study that employed machine learning to detect cyberbullying (Kelly Reynolds and April Kontosthatis, 2011) [1] a sample set of data was downloaded from FormSpring.me, a social networking site, where interaction takes place in a question and answer format, and is notorious for its high bullying content. The data was labelled using an Amazon Web Service called Turk. Further, a list of swear words (bad words) was downloaded from www.noswearing.com, and the words were assigned severity levels depending upon their meaning by the research team. The number of bad words and the density of bad words were used as features to develop the learning tool. The data was normalized by dividing the number of words at

each severity level by the total number of words in the post, and then multiplying by 100 to get an integer value (for example, if there were 6 100-level words in a 10 word post, the 100-level would be reported as 60). Overall bad words were calculated and stored as a feature. A decision tree used in this process was created using J48 [15] algorithm with the features determined earlier in the process, then JRIP [16], a rule based algorithm was used to reduce the dataset till it contained the smallest set with the same success rates. The data was then classified using SMO (a function based vector support algorithm), which was later subjected to class weighing. By following this process the team successfully identified 78.5 % of posts to contain cyberbullying texts in the given sample data set.

Efforts were made to detect cyberbullying using computer software (Bayzick, Kontosthatis and Edwards, 2011) known as Bully Tracer [4]. It is a program designed to detect the presence of different types of cyberbullying in a chat room conversation. The software has a dictionary of bad words like swear words, second pronouns and it matches the post in the window to these bad words using rule-based algorithms and also detects the presence of capital letters as offensive text. This approach was found to detect windows containing bullying content 85% of the time and innocent content 52% of the time thereby detecting the victim and perpetrator with accuracy.

Another approach proposed by Nahar, Li and Pang [17], focusses on effective detection and identification of the victim and the perpetrator. The complete process is divided into two phases; the first phase aims to detect harmful messages by employing semantic and weighted features in the feature selection process. Semantic features use the L.D.A. [18] algorithm to extract the latent features i.e. the implied meaning and the weighted features utilize a bad word library set to identify the occurrence of explicitly defined bullying references. The L.D.A. (Latent Dirichlet Allocation) algorithm then determines the word usage to detect underlying topic as bullying or non-bullying. After the detection, weighted features are extracted from these posts, which gives a rough idea about the severity of bullying. In the second phase, the predators and victims over a network are identified. The predators and victims are linked to each other by posts and are identified by their respective usernames. The person sending the highest bullying content is considered as the bully and the person who receives at least one such message is considered as the victim and scores are assigned accordingly to enable ranking. To identify predator and the victim HITS [19] algorithm is employed to calculate the victim and the predator score. Gephi [20] is used to visualize the groups and connectivity between them. As shown in Fig. 10, using modularity algorithm [21], nine groups or communities, depicted by different colors are formed by considering users that are densely linked within the community as compared to between communities. Density of messages is computed for each post, which represents the "badness" embedded within the post. Density of a post is calculated as the total count of the bad words within the post divided by the total number of the words in the post. In this process it is assumed that each user sends one message and the one who sends messages to multiple users is always the predator this is determined by the HITS[19] algorithm and is depicted in the graph in Fig.11. This approach effectively identifies victim and predator but based on the assumption that predator is the person who sends messages to multiple users. A drawback of this technique is that the bad-word set used is a static set which needs to be updated.

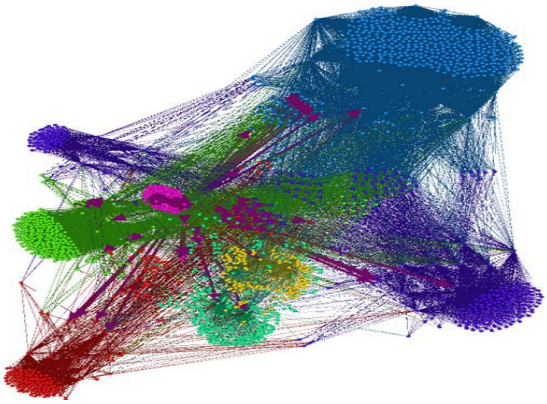

Fig. 10 Vinitha Nahar, Xue Li and Chaoyi Pang, *Bullying network - User groups are formed based on the densely interconnected links (bullying post)* Source: An effective approach for cyberbullying detection. (Communications in Information Science and Management Engineering) 2013

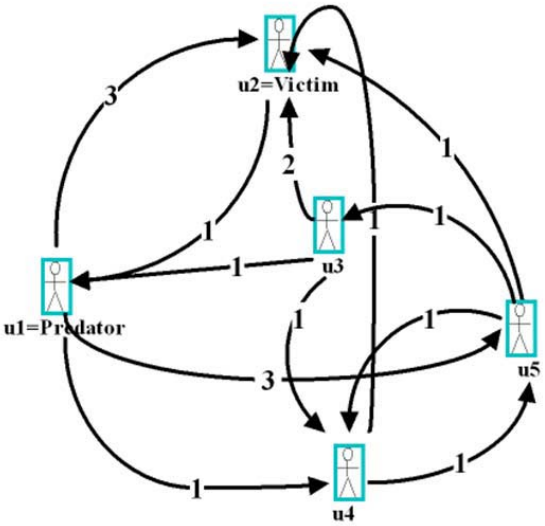

Fig. 11 Vinitha Nahar, Xue Li and Chaoyi Pang, *Predator and victim identification graph.* Source: An effective approach for cyberbullying detection. (Communications in Information Science and Management Engineering) 2013

In an effort to model the detection of textual cyberbullying (Dinakar, Reichart and Lieberman, 2011) [21], it has been found that detecting cyberbullying using individual topic-sensitive classifiers is more effective after experimenting on a corpus of 450,000 YouTube comments. The overall problem here, is decomposed into detection of sensitive topics where text classification comes into play. After preprocessing the data

where the stop words, repeated sequences etc. were removed, the comments were annotated by educators who worked with middle school along the lines of:

Sexuality: Any comments of sexist nature.

Race and culture: comments involving explicit or implicit reference to race or religion, for example comments containing the word "Jew".

Intelligence: Any comment attacking the mental capabilities of the victim.

Based on the kappa (reliability measure of a classifier) rating the annotated comments were collected under a label. Then, the training sets and the test sets were divided as required. Feature space was selected and populated using a Naïve Bayes classifier, the datasets were repeatedly pruned and were subjected to J48 and Support Vector classifier algorithm. Binary classifiers were trained on the resulting datasets under different labels and later in the process they were combined to form multi-class classifiers. However, the experiment proved that binary classifiers outperformed multi-class classifiers to detect comments referring to sensitive topics. They also concluded that it is easier to model blatant verbal abuses that expressions containing sarcasm, implicit bullying and euphemisms.

A complementary method, which focusses on preventing cyberbullying even before it takes place (Bosse and Stam, 2011) [23] unlike the methods and approaches discussed above where the main aim is detection of cyberbullying after it happens, employs normative agents that support the victim against attacks and which are physically present in the virtual network. These normative agents, based on BDI [24] model, use a number of techniques to detect the violation of predefined norms such as insulting or detection of swear words etc. The agents then enforce the desired behavior by awarding reward or punishments depending on the behavior. The authors claim that this has been implemented in a real world application called the Club Time Machine in which the participants were children of age group 6-12 years and found the role of normative agents to be effective in preventing bullying. However, this method assumes that the participants will learn to adhere to the norms defined over time, which might not be successful in all cases.

VII. Future Trends And Scope in Cyberbullying Detection and Prevention

1. Detecting new lingo used in bullying

Traditional cyberbullying detection methods employed till now detect bad words such as swear words, capital letters or words that do not make any sense as cyberbullying text. Efficiency of detection will decrease due to a constrained word set because new swear words and acronyms are created by bullies as they try and avoid easy detection by text monitoring tools. Improvements to the existing algorithms are to be made to improve text mining speed and the bad word set needs to be updated on a daily basis to improve the learning ability of the classifier.

2. Handling Anonymity

Cyberbullies thrive on the fact that they remain anonymous while bullying and their chances of getting caught are very less. Tools must be designed and deployed on the web, which identify bullying and report the IP address to the ISP or to a mobile device so as to remove the anonymity factor. It has been found that individuals under invigilation do not tend to bully 51% of the time and as most cyberbullies are physically weak and fearful according to Feinberg [2], the bullying can be effectively controlled in direct confrontation.

3. Creating awareness

This paper deals with both the psychological and technological methods of detecting, correcting and preventing cyberbullying. It is important to note that the kids who get bullied at home or at school at a younger age are most likely to become bullies in the future. We have considered all the external factors that can cause bullying but in most of the cases, bullying starts at home. Bullying is generally defined as repeated negative actions (i.e., physical, verbal, and/or psychological) directed at a target over time, where there is a power differential (either real or perceived) between the target and the bully [25] [26]. This can happen without the person even knowing it that he/she is hurting others feelings. Hence, care is to be taken to avoid such behavior at home. Bullying is not only limited to conversation among people and may sometimes involve indirect mediums like motion pictures, songs, games etc. which may also offend the victim. In such cases care is to taken by the guardian to choose the appropriate content for their dependents to watch. Finally, it is an unavoidable fact that bullying still prevails in spite of all the efforts being made to detect and prevent it. To be safe, one has to gain awareness and understand the nuances of their world, which can be done through counseling or by taking good advice.

4. Improving existing algorithms

We propose a hybrid process in which the first stage involves computing and recording the frequencies of words in a dataset over a time period for the high-activity hours of teenagers on the internet. In the second stage, sentiment analysis is applied to the dataset to identify offensive texts with certain degree of certainty in order to avoid false positives. We use the stemming process to facilitate the identification of similar tokens and remove the stop words to eliminate the noise in the data.

VIII. Conclusion

In this paper, we review cyberbullying, its impacts and characteristics in detail. We surveyed various attempts made to analyze and understand a bully's behavior and ways to correct them personally. Since the application of data mining and machine learning is the focus of this paper, we discuss the

various approaches utilizing their constituent techniques to identify and sometime prevent future cyberbullying. We implemented the sentiment analysis technique to identify the presence or absence of cyberbullying with the help of a dataset from a popular social network website and we conclude that though knowledge discovery has taken us to an era where the implicit meaning, and not just the explicit meaning, of a text can be understood and these techniques can be further improved with the introduction of dynamic bad words set, since cyberbullying occurs in an extremely personal and vulnerable sphere, appropriate actions need to be taken regarding generation of awareness and counseling in order to eradicate this social evil.

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