Comparative Analysis on Joint Modeling of Emotion and Abuse Detection in Bangla Language

Afridi Ibn Rahman, Farhan, Zebel-E-Noor Akhand(✉), Md Asad Uzzaman Noor, Jubayer Islam, Md. Motahar Mahtab, Md Humaion Kabir Mehedi, and Annajiat Alim Rasel

Department of Computer Science and Engineering, Brac University, 66 Mohakhali, Dhaka 1212, Bangladesh
{afridi.ibn.rahman,farhan,zebel.e.noor.akhand,md.asad.uzzaman.noor, md.jubayer.islam,md.motahar.mahtab,humaion.kabir.mehedi}@g.bracu.ac.bd, annajiat@bracu.ac.bd

Abstract. Emotions are not linguistic entities, although they are easily articulated through language. Emotions influence our actions, ideas, and, of course, how we communicate. On the other hand, abusive text, such as undiscriminating slang, offensive language, and vulgarity, is more than just a message; it is a tool for very serious and brutal cyber violence. Hence, detection of such language has become very important in any language now-a-days. Therefore, many works and researches have been done on detecting emotional language, abusive language or both in many dialects including Bangla. This paper proposes to present a comparative analysis of different researches made on detecting emotional and abusive Bangla language. It further aims to present the best approach that tailors certain attributes of emotional and abusive language detection with respect to their prognosis performance and their implementation toughness in Bangla lingo. Potential enhancements for future study are presented in the paper, while the limitations of current researches are addressed and discussed. This work seeks to bring a fresh viewpoint to the joint modeling of emotional and abusive language detection in Bangla by examining and criticizing flaws and in order to offer future changes, poor design choices must be examined.

Keywords: NLP · CNN · RNN · MTL · BiGRU · LSTM · ICT · AI

1 Introduction

NLP is a branch of Machine Learning that concentrates on understanding and analyzing text or audio input that is analogous to human language [1]. While NLP is not an independent subject, it is a category of various fields like information engineering, computer science, linguistics and artificial intelligence (AI) [2]. As a concoction of artificial intelligence and linguistics in the 1950s, the journey

M. Singh et al. (Eds.): ICACDS 2022, CCIS 1614, pp. 199–209, 2022.
https://doi.org/10.1007/978-3-031-12641-3_17

of NLP began. In order to rapidly index and search large volumes of text, NLP was primarily separated from text information retrieval (IR), which makes use of scalable statistics-based methods [3]. NLP study has advanced from punch cards and batch processing (when processing a sentence took seven minutes) to the digital era of Google, where a huge number of web pages are prepared in less than a second [4]. This paper compares the performance of different Neural Network models on a specific NLP task: joint modelling of emotion and abuse detection in Bangla. This comparison includes the performance, accuracy, ease of implementation and complexity of each model that detects emotional and abusive Bangla language or both.

Aggressive and abusive online behavior can have substantial psychological consequences for victims [5]. 76.9% of victims endured psychological issues like anger, anxiety and agitation; 13.6% signified communal impacts; 4.1% showed corporeal effects while 2.0% claimed financial mislaying. Blocking the attacker was the most common victim response [6]. This emanates the necessity of automated systems in order to detect abusive language, an issue that, in recent times, aroused the natural language processing community's interest. Forms of abuse include racism, sexism, abusive remark, cyber bullying, harassment and other expressions that demonize or affront an individual or a group [7]. This is an evident fact that Facebook currently has over 2 billion monthly active users. Reddit, another social curation site, has over 330 million active members [8]. With such a high level of user interaction, internet conversation is prone to abuse and antisocial behavior. According to a recent poll, 41% of Americans have directly encountered internet harassment, with 18% having experienced severe kinds of harassment, such as violent threats and sexual harassment [9].

Emotional language is the usage of expressive words, frequently adjectives, to portray how an author perceives or feels about something, elicit an emotional reciprocation from the reader and persuade them. Emotions are not verbal beings, although they are easily articulated through words. Feelings impact our behaviors, ideas, and, of course, our communication style. It is imperative to understand that emotional language is biased, which signifies that even though the language is clear and concise, making it easier to grasp, the goal of the dialects is to subtly or explicitly alter our perspective about something [10]. As a result, the detection of emotions and evaluation is one of the most taxing and emanating problems in NLP. An active field of NLP studies include the detection of an individual's emotional condition [11].

Today, the majority of computer-based materials and technical magazines and researches are done on English. Because of the language barrier, the general public has significant challenges in reaping the full benefits of contemporary communication and information technology (ICT), as well as a vastly expanded English knowledge database throughout the world. The only technology that can be utilized to overcome this barrier is language processing in the native tongue [12]. Emotion identification and text abuse detection are two of the most prominent applications of Natural Language Processing (NLP). This is an important field of research to improve interactions between people and machine. Despite

the fact that these studies/topics have gotten a considerable amount of attention in the English language. In the Bangla language, it is yet a relatively untapped region. Bangla language is rated seventh in the world. Around 210 million people in the world speak in Bangla, the majority dwelling in Bangladesh and in two states of India [13]. As a result, recognizing both emotional and abusive Bangla language has proven critical.

2 Goals

This paper seeks to accomplish the following objectives in order to conduct a proper comparative analysis:

- **1. Evaluate and Describe the chosen Neural Network (NN) models:**
  To achieve our goal, the most advantageous Neural Network models must be identified and made suitable for deployment with thorough research. The models' performance on typical NLP tasks, the consistency of the proposed model architecture, and the accessibility of open source code with an acceptable license for use in the research business settings are all significant factors to consider in this study.
- **2. Evaluate and compare all the models' performance results:**
  The models need to be instructed and tested in an equivalent and citable way using appropriate criteria. As a result, consistent scripts must be built for each model, along with comparison methodologies. If the models perform differently, the causes for the contrasts need to be studied properly with the knowledge that lies within the extent of this research.
- **3. Present a final verdict for the models that will help us reach our objective:**
  The models must be evaluated in terms of their performance and usefulness in the context of this paper using the intuition acquired from the execution and evaluation. As this is a scientific study, the emphasis should be on generalized qualities that may be used for future, independent research initiatives rather than on specific business aspects.

3 Selected Researches for Comparison

This section discusses the selected researches that have been taken for comparative analysis for this study. At present, the detection of abuse and emotional language in Bangla has been a prevalent and extensive experimental domain. In 2019, for recognizing several sorts of abusive writing in Bengali, Emon et al. suggested a variety of approaches based on Machine Learning (ML) and Deep Learning (DL) [14]. They imposed stemming rules for Bangla language by measuring the effectiveness of algorithms using specific Bangla grammatical rules.

As a result, better accuracy is gained when these stemming rules are applied to a small dataset. Secondly, again in 2019, Chakraborty et al. presented a study on recognizing abusive language in Bengali on the social network. They employed a considerably higher amount of data in their proposed identification algorithm, and they accepted both emoticons as well as the Bengali unicode as genuine inputs. Furthermore, the use of successive exclamation and question marks is taken into account [15]. Next in 2017, Rabeya et al. has given a methodology for extracting emotion from Bengali literature at the sentence level. They evaluated two basic emotions, "happiness" and "sadness", in order to discern emotion from Bengali text. Their proposed approach identifies emotion by analyzing the sentiment of each line with which it is associated [16]. Then in 2020, Rayhan et al. has used BiGRU and CNN-BiLSTM for detecting multiple emotion in Bangla text [17]. Finally, Rajamanickam et al. in 2020 has made a presentation on joint modelling of abuse and emotion detection. They evaluate different MTL architectures for this purpose and achieve a good outcome through the shared parameters [7]. Table 1 shows an overview of the objective, method and accuracy review results obtained by the chosen papers.

Table 1. Overview of the selected researches

Paper	Accuracy	Objective
Emon et al. [14]	82.20%	Bangla Abuse Detection
Chakraborty et al.[15]	78%	Bangla Abuse Detection
Rabeya et al. [16]	77.16%	Bangla Emotion Detection
Rayhan er al. [17]	77.78%	Bangla Emotion Detection
Rajamanickam et al. [7]	78.40%	Modeling Abusive and Emotional Language Together

4 Analyse and Describe Selected Neural Network (NN) Models

Among the selected researches, Emon et al. has achieved the highest accuracy using a relatively small dataset in detecting abusive Bangla text. They have applied two neural networks in their research. One is a Recurrent Neural Network with Long Short Term Memory, and the other is an Artificial Neural Network. It is to be noted that they have used Stemming approach for data preprocessing to get root form of Bengali word, and then they trained the Neural Networks with CountVectorize. The outcome that they have achieved is proven to be the best among the other approaches selected in this study.

On the other hand, Chakraborty et al. has also considered using unicode and emoticons. Moreover, they also gave extra attention to the exclamation and question marks for their detection system. To do so, they have made CNN-LSTM network to treat each phrase, emoticon, or series of exclamation or question marks as a symbol. The dataset is transformed to an integer value before being sent to the network. The model is then enhanced with four layers: an embedding layer, a convolution layer, an LSTM layer, and a fully connected layer. Finally, they employed different colors to differentiate each succeeding layer.

For Bangla emotional language detection, Rabeya et al. has focused more on lexicon backtracing than focusing more on any neural network. But the accuracy they have achieved is still as good as the other approaches.

Rayhan et al., on the other hand, proposed the CNN-BiLSTM model, which specifies the CNN model of two 1D CNN layers, trailed by a regularization dropout layer, and finally a max pooling layer. The output of the max pooling layer was then used as an input to the BiLSTM layer, which was then followed by a dropout layer. They also developed the Bidirectional Gated Recurrent Unit (BiGRU), a Recurrent Neural Network version (RNN) [17]. The feature extraction method was utilized as that of the BiGRU model's input. Following that, the embedding, vocabulary size, sequence length and maximum input embedding dimension, and maximum input are all set to zero. The BiGRU cell units were estimated based on the information supplied. A RELU activation function and also a dropout were used in the calculation.

After thoroughly analysing, describing and deeply comparing all the selected Neural Network, this paper is proposing the following Fig. 1. Methodology to achieve its aim detecting both abusive and emotional Bangla language detection in a joint model which has been created on the basis of the above comparison.

5 Analyse and Compare All the Models' Performance Results

This section depicts the performance comparison analysis of the researches that this study has selected. Table 2 represents, recall, F-1 Score and precision of RNN in abuse detection done by Emon et al.

Table 3 shows that the accuracy of Chakraborty et al.'s LSTM network increased with the size of the dataset, with a 77.5% accuracy for 5644 data points. We achieved 65.5% accuracy with 3604 data and 73% accuracy with 4933 data. It should be observed that this CNN-LSTM model performs better as the dataset size increases, which bodes well for constructing the joint model that this study is looking for.

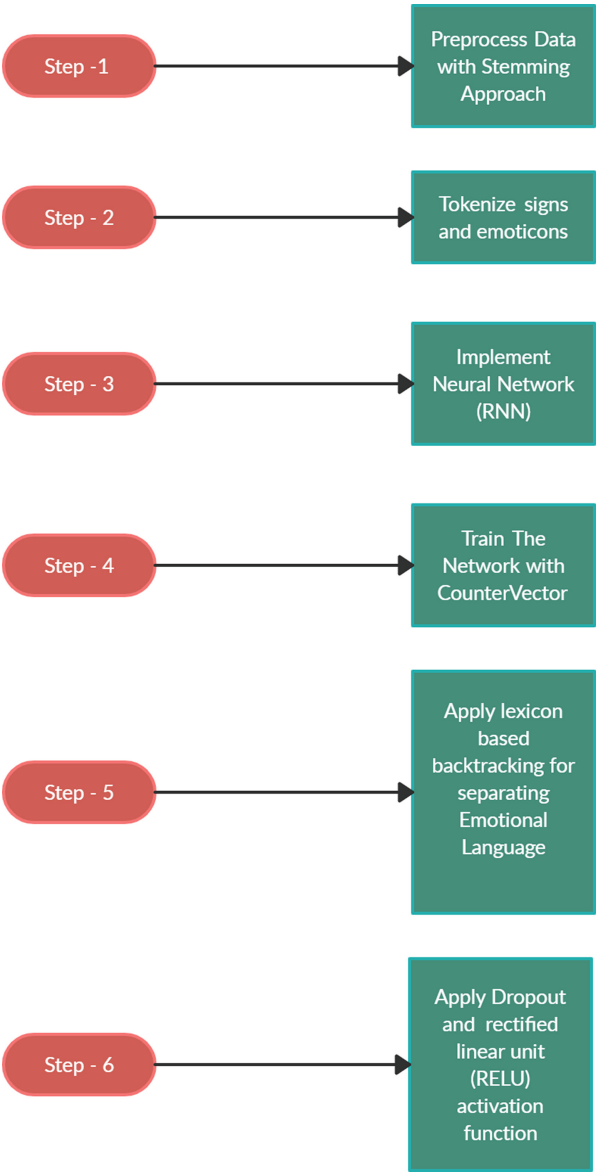

Fig. 1. Proposed methodology based on the comparative analysis.

Table 2. The overall class chart RNN recall, F-1 Score and precision [14]

Class name	Precision	Recall	F1 score	Support
Slang	0.89	0.92	0.91	89
Religious Hatred	0.83	0.84	0.84	70
Personal Attack	0.80	0.80	0.80	56
Politically Violated	0.78	0.89	0.83	65
Anti Feminism	0.91	0.67	0.77	30
Positive	0.88	0.81	0.84	112
Neutral	0.62	0..66	0.64	50

Table 3. Accuracy of CNN-LSTM [15]

Data	Accuracy %
3604	65.5
4933	73.0
5644	77.5

Table 4 shows the performance of the CNN-BiLSTM for detecting emotional Bangla language from Rayhan et al. study which has done better than the approach they have followed with Bigru.

Table 4. CNN-BiLSTM evaluation [17]

Emotion		Precision	Recall	F1-Score
Bangla	English			
আনন্দ	Happy	52.35	71.20	60.34
বিষন্নতা	Sad	62.60	56.62	59.46
ভয়	Fear	72.50	72.59	72.50
রাগ	Angry	71.43	63.43	67.19
ভালোবাসা	Love	77.78	68.75	72.99
আশ্চর্য	Surprise	72.55	67.27	69.81

Table 5 displays the results of the BiGRU model. According to the statistics, the maximum precision is 72.38%, which is greater than the other emotion classifications. The lowest accuracy, on the other side, is 53.42%.

Table 5. BiGRU evaluation [17]

Emotion		Precision	Recall	F1-Score
Bangla	**English**			
আনন্দ	Happy	62.50	64.00	63.24
বিষন্নতা	Sad	53.42	57.35	55.32
ভয়	Fear	69.01	73.75	71.30
রাগ	Angry	72.38	56.72	63.60
ভালোবাসা	Love	70.00	68.75	69.37
আশ্চর্য	Surprise	64.52	72.73	68.38

6 Proposing a Final Verdict for Joint Modelling

After deeply analyzing the performances and usability of all models, we can conclude that a hybrid approach will give a better result for our study. Since each of the selected researches have their own unique approach to meet their goals, we are combining those unique approaches to achieve our desired output.

Firstly, from Emon et al.'s approach, we can apply stemming preprocessing which adds more to the accuracy for both small dataset and large dataset which will help us greatly in whichever size of Bangla dataset we use for our study.

Usage of exclamatory signs, question marks and the newly rising phenomenon among the millennials and the gen z of using 'emoji' which is essentially a graphical symbol in computer mediated communication hold a great significance in both abusive and emotional texts. These signs and emojis have unique semantic and emotional features. As a result, they provide contextualization cues, such as markers of positive or negative attitudes in the texts. Hence it is imperative to take these signs and emojis into account while detecting both abuse and emotions in texts. Therefore, employing Chakraborty et al.'s approach of considering emoticons, Bangla unicodes, and punctuations such as exclamation and question marks as genuine inputs will increase the possibility of achieving great results in detecting abusive and emotional Bangla language.

Again, for emotion detection, the approach from Rayhan et al. can be followed. To distinguish emotion from Bengali text, two primary emotions, "happiness" and "sadness", were used. The suggested method determines emotion by examining the sentiment of each line to which it is linked.

Finally, Rajamanickam et al.'s approach should be used for combined modeling of both abusive and emotional language. Multi-Task Learning (MTL) is the name of the approach, and it contains two optimization goals: one for identifying abuse and one for recognizing emotion. The two objectives for abuse detection and emotion recognition are weighted by a hyperparameter (Beta), which regulates the relevance allocated to each task.

The Fig. 2 depicts a visual representation of the final verdict for the join modelling.

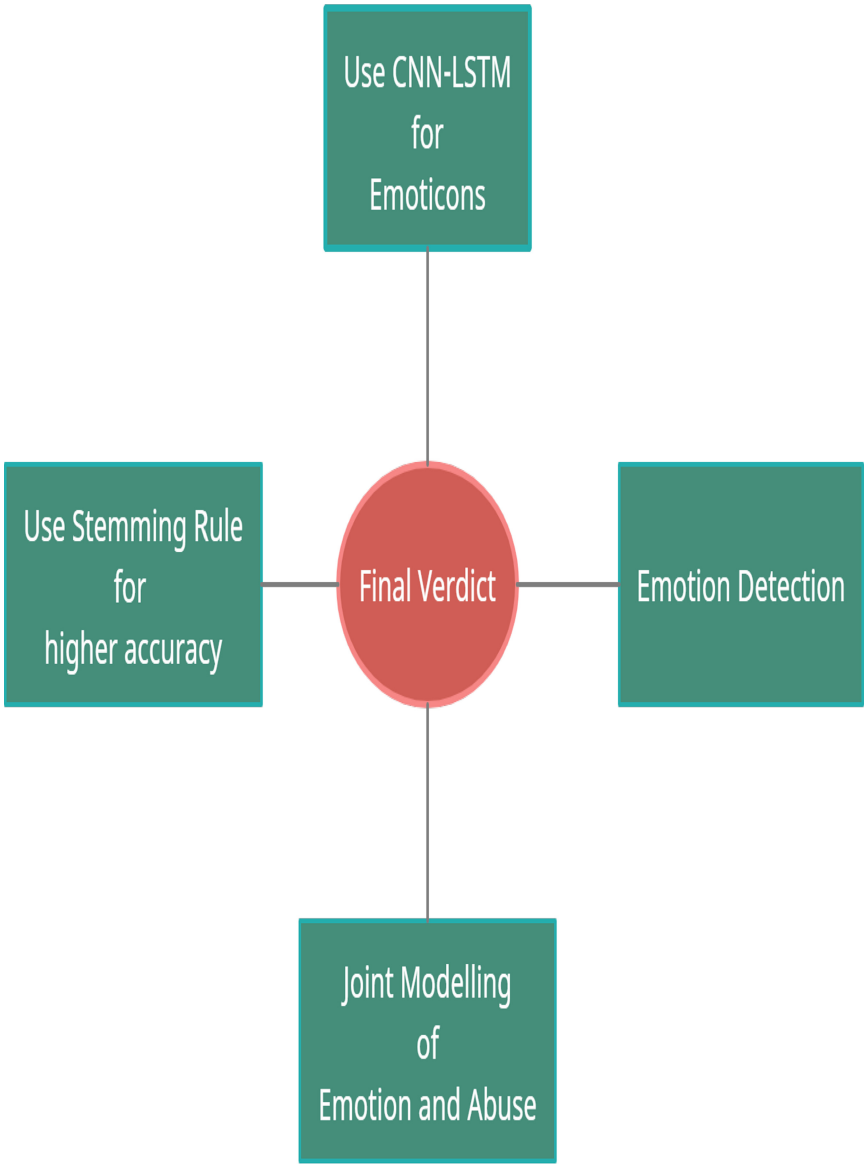

Fig. 2. Different approaches for higher accuracy

7 Conclusion

Through a comparative analysis in Bangla Language from the studies of other researchers, a new approach for both abuse identification and emotion detection has been provided in this paper. The researches analyzed, yielded accuracies as

high as 82.2%, 78%, 77.16%, 77.78% and 78.40%. Therefore, the joint modeling of emotion and abuse detection in Bangla Language is logically viable. Finally, the research discusses joint modeling, which makes use of both emotive characteristics and abusive contents to gather supplementary information via an MTL framework. The paper intends to implement the study comprehensively in the future and anticipates that it will be beneficial in various ways. One of the key benefits include paving the way out for new methods to detect emotion and abuse in Bangla and also for future NLP research. In addition, the paper should motivate people of different countries to come forth and conduct computer based research for their own native language. This can prove to be an asset for people who constantly face cyber violence, as it holds the potential to prevent its consequences and one day, completely eradicate this problem globally.

References

1. Buz, T.: Comparative analysis of neural NLP models for information extraction from accounting documents. Ph.D. thesis, ETSI_Informatica (2018)
2. Johri, P., Khatri, S.K., Al-Taani, A.T., Sabharwal, M., Suvanov, S., Kumar, A.: Natural language processing: history, evolution, application, and future work. In: Abraham, A., Castillo, O., Virmani, D. (eds.) Proceedings of 3rd International Conference on Computing Informatics and Networks. LNNS, vol. 167, pp. 365–375. Springer, Singapore (2021). https://doi.org/10.1007/978-981-15-9712-1_31
3. Nadkarni, P.M., Ohno-Machado, L., Chapman, W.W.: Natural language processing: an introduction. J. Am. Med. Inform. Assoc. **18**(5), 544–551 (2011)
4. Cambria, E., White, B.: Jumping NLP curves: a review of natural language processing research. IEEE Comput. Intell. Mag. **9**(2), 48–57 (2014)
5. Munro, E.R.: The protection of children online: a brief scoping review to identify vulnerable groups. Childhood Wellbeing Research Centre (2011)
6. Hassan, F.M., Khalifa, F.N., El Desouky, E.D., Salem, M.R., Ali, M.M.: Cyber violence pattern and related factors: online survey of females in Egypt. Egypt. J. Forensic Sci. **10**(1), 1–7 (2020)
7. Rajamanickam, S., Mishra, P., Yannakoudakis, H., Shutova, E.: Joint modelling of emotion and abusive language detection. arXiv preprint arXiv:2005.14028 (2020)
8. Bagga, S.: Detecting Abuse on the Internet: It's Subtle. McGill University (Canada) (2020)
9. Duggan, M.: Online harassment 2017 (2017)
10. Stone, L.: Emotional Language in Literature - Writing Review (Video) – mometrix.com. https://www.mometrix.com/academy/express-feelings/. Accessed 05 Apr 2022
11. Murthy, A.R., Anil Kumar, K.M.: A review of different approaches for detecting emotion from text. In: IOP Conference Series: Materials Science and Engineering, vol. 1110, p. 012009. IOP Publishing (2021)
12. Islam, M.S.: Research on Bangla language processing in Bangladesh: progress and challenges. In: 8th International Language and Development Conference, pp. 23–25 (2009)
13. Mehedy, L., Arifin, N., Kaykobad, M.: Bangla syntax analysis: a comprehensive approach. In: Proceedings of International Conference on Computer and Information Technology (ICCIT), Dhaka, Bangladesh, pp. 287–293 (2003)

14. Emon, E.A., Rahman, S., Banarjee, J., Das, A.K., Mittra, T.: A deep learning approach to detect abusive Bengali text. In: 2019 7th International Conference on Smart Computing and Communications (ICSCC), pp. 1–5. IEEE (2019)
15. Chakraborty, P., Seddiqui, M.H.: Threat and abusive language detection on social media in Bengali language. In: 2019 1st International Conference on Advances in Science, Engineering and Robotics Technology (ICASERT), pp. 1–6. IEEE (2019)
16. Rabeya, T., Ferdous, S., Ali, H.S., Chakraborty, N.R.: A survey on emotion detection: a lexicon based backtracking approach for detecting emotion from Bengali text. In: 2017 20th International Conference of Computer and Information Technology (ICCIT), pp. 1–7. IEEE (2017)
17. Rayhan, M.M., Al Musabe, T., Islam, M.A.: Multilabel emotion detection from Bangla text using BiGRU and CNN-BiLSTM. In: 2020 23rd International Conference on Computer and Information Technology (ICCIT), pp. 1–6. IEEE (2020)