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Sentiment Classification in Bengali News Comments using a hybrid approach with Glove

Uchchhwas Saha

Department of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
uchchhwas15-10842@diu.edu.bd

Md. Shihab Mahmud

Department of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
shihab15-10961@diu.edu.bd

Aisharjo Chakroborrtty

Department of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
aisharjo15-12334@diu.edu.bd

Mst.Tuhin Akter

Department of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
tuhin15-13208@diu.edu.bd

MD Rakib Islam

Department of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
rakib15-13081@diu.edu.bd

Ahmed Al Marouf

Department of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
marouf.cse@diu.edu.bd

Abstract—Sentiment analysis (SA) is a greater part of Natural Language Processing (NLP) in the research field. Previously a lot of work was done by SA in various languages. Most of the work was done in the English language. A little work was done in the Bengali language and it's increasing day by day. Nowadays, Bangla News comments are very demanding for research work in the Bangla language. The procedures of text categorization, classifying, and different techniques for extracting features in textual information were discussed in this paper. Some Bangla newspaper dataset is currently available in online platforms. This paper we analyzed Bangla news comments sentiment using a hybrid approach and a pre-trained deep learning classifier. This hybrid model we used an optimizer function "Adam" and also used a word embedding "Glove". Collecting our dataset from online platform Kaggle, the largest data science forum on the world. This dataset contains 13802 data. Using five different classes to our dataset. In model building, we apply preprocessing techniques for cleaning our dataset. And also we get a well formed dataset. Our hybrid model combined with two familiar deep learning methods, BiLSTM and CNN. Comparing these two methods, our hybrid model gained better accuracy than the FastText model. And hybrid model accuracy is 89.89%.

Keywords—Bengali News Comments, Sentiment Analysis, NLP, BiLSTM-CNN, FastText, Glove, Deep Learning.

I. INTRODUCTION

NLP is a wider part of Machine Learning (ML). SA is due to its wide [1] range of possible applications such as opinion mining, emotion extraction, and social media trend prediction have become popular research areas of NLP. SA is a technique that uses NLP, computer-assisted language translation (CLT), and analytical texts to extract subjective information from source material. SA is used to determine how an author feels about a given topic or situation. Example people's feelings, opinions, [2] attitudes and their characteristics of individuals, organizations, products, services, and problems in written or language. Users can now provide vast amounts of information about the current state of the product and express their opinions about the event as positive feedback thanks to the proliferation of social networking websites, blog posts, and review websites. The availability of large amounts of online information and the growth of ML systems in recent years has accelerated the development of various approaches to assessing moods and emotions from writing in [3] English, French, Arabic, and many other languages. Despite the reality that emotional classification in English has received a lot of attention in recent years, Bengali NLP is not as well developed

as English. Although Bangla is among the most widespread spoken languages around the world, slight study has been undertaken on it. There are approximately 250 million native speakers in the United States and 300 million speakers worldwide [4]. This is the world's seventh largest spoken language by native speakers and the eleventh most spoken by all speakers. Recently, researchers have [5] become interested in Bangla texts, news comments, and there are many articles based on mood and emotion analysis, topic identification, and a summary of topical opinions using data from various Bengali corpora. Data acquisition and preprocessing are the most painful periods of creating customized ML algorithms. Trying to connect Bengali to a computer is extremely difficult due to the number of obstacles that must be overcome. Searching for text in Bengali takes time, and estimating the cost within each list of questions is tricky.

In this paper, we use a familiar hybrid approach and a pretrained model to analyze news comment sentiment classification. We used a hybrid model and FastText model that is a pre-trained deep learning classifier. In the hybrid model, we used glove word embedding and Adam optimizer. The total amount of data collected from the internet is 13802. This data was divided into five categories.

The following is how [6] the remaining part of the paper is structured: Related works in Section II. Sections III go over methodology in greater depth. The experimental results and analysis are presented in Section V. Finally, Section VI brings this article to a close.

II. RELATED WORKS

SA is a very important part to analyze people's emotion by using various classifiers. This part mainly focuses on some related work which was done previously to this specific topic. (Pallab Chowdhury et al., 2022) This paper showed the Bengali News classification using their proposed algorithm. They collected their dataset from Kaggle, the biggest data science community for researchers. This dataset news was from different renowned papers of Kolkata. This dataset contains almost 14000 data. For training purposes they used 11000 data and others were used for testing. This dataset had 10 classes. LSTM and CNN used for feature extraction and Glove used for better performance. They used various algorithms like Binary SVM, LSTM, ANN, BiLSTM etc. but the best accuracy came from their proposed model and it was 87% [7]. (Md. Akhter-Uz-Zaman Ashik et al., 2019) They

mainly presented their paper that they created a baseline bengaline news comments dataset for further research purposes. Collecting their news comments from well known 'Prothom Alo' Bangla newspapers. This dataset contains almost 13809 data, five classes and ten specific fields. Using three different classifiers LSTM, CNN and SVM. In these three classifiers, LSTM classifiers gained best results (78.83%) from others [8].

(Md. Abdul Awal et al., 2018) In this paper, they designed a classifier which detected whether the sentence is abusive or not. They used English comments which were taken from YouTube. Then the dataset translates from English to Bengali. Overall 2665 data were collected. 1451 data were positive or not abusive and 1214 were abusive or spam. They used a traditional classifier which was Naive Bayes classifier and it reported an overall accuracy of 80.57% [9].

(Abu Nowshed Chy et al., 2014) Representing Classification of Bangla News in traditional classifier Naive Bayes. They collected data from newspapers to apply web scraping techniques. Labeled and fresh data work better than others data. For better accuracy they removed stop words from the dataset. Applying Naive Bayes algorithms to Bangla news based on the specific code of IPTC (International Press Telecommunications Council) [10].

(Abdullah Aziz Sharfuddin et al., 2018) This paper presents the use of RNN to classify viewpoints in Bengali text. They collected almost 30000 data and all of the data were not usable. After labeling only 10000 data were (5000 Positive and 5000 Negative) usable and this data fetched from Facebook Bangla Comments. Using some traditional classifiers like SVM, LLR, DT etc. They used a proposed deep RNN model with BiLSTM. This proposed model achieved best accuracy from others [11].

(Sharmin Yeasmin et al., 2021) They classified Bangla News in different ML algorithms like Naive Bayes, SVM, LR and multi-layer dense neural networks. They used two specific dataset from Kaggle and this dataset made from Bangladeshi famous newspaper Prothom Alo. They applied a new stop-word for preprocessing, which was developed by them. In dataset I, Naive Bayes got the best result, which was 91.23% and the multi-layer neural network performed 92.63%. Dataset II shows that SVM gained more accurate results from others, it was 94.99% and the multi-layer neural network gained 95.55% [12].

(Md. Arid Hasan et al., 2020) They conducted tests in this paper using specific clarifies assumption datasets comprising Bangla content from social media. SVM and Random Forest are examples of classical algorithms, while CNN, Fast-Text, and transformer-based models are examples of deep learning algorithms. Their discovery points to transformer -based models. Four NVIDIA Tesla V100XM2-32GB GPU machines with 56 cores and 256GB CPU memory are used in the tests. The Adam optimizer is employed, with a highest number of iterations of 3,000. They discover that SVM outperforms all other classical algorithms [13].

(Mahfuz Ahmed Masum et al., 2020) They presented BAN-ABSA, a larger Bengali dataset that was manually processed and commented on, as well as three new Bengali speakers' perspectives on this paper. With an accuracy of 78.75% for angle phrase separation and a precision of 71.08% for sentiment categorization, the dataset consists 2,619 positive, 4,721 negative, and 1,669 neutral data tests from 9,009

special comments collected from some very well Bengali news entries. The CNN architecture outperforms the BAN-ABSA dataset in terms of effectiveness, according to tests. [14].

(Md Saiful Islam et al., 2020) They showed two Bengali SA datasets that had been manually labeled, as well as two Bengali SA datasets that had been manually tagged into two classes and three classes. They display the BERT model, which is multilingual. In comparison, the existing situation precision is only 68%. For 2-class supposition categorization, this deep learning algorithm acquires a 71% accuracy. They also introduce the world's first Bengali SA classifier, which accomplishes a 60% accuracy rate [15].

(Lutfun Nahar et al., 2019) This paper mainly focused on Bengali news text to classify sentiment categories. They collected 1000 long Bengali documents in various newspapers and social media. This data consists of political and sports related topics. Using Naive Bayes, SVM and Neural Network classifier to classify News or documents. TF-IDF feature extractor used in this paper for getting better results. All over performance, Naive Bayes classifier gained better accuracy from others [16].

(Yasir Babiker Hamdan et al., 2021) this paper presented the Handwritten Character Recognition (HCR) by a traditional classifier. They mainly used statistical SVM for their proposed article. They compare others models by handwritten images. The statistical SVM performed better than others and it was 91% for handwritten image documents [17].

(Milan Tripathi et al., 2021) In this paper showed about the Nepali Covid19 tweets sentiment of various classifiers. They collected dataset from Nepali tweeter API. Almost 4035 sentences are collected from twitter which positive sentences were 1899 and 2136 are negative sentences and labeled this dataset manually. Positive sentences labeled by '0' and Negative labeled by '1'. They used TFIDFTransformer vectorized to convert training data into vectors. Among this three classifiers, LSTM gained highest accuracy than others and it's 79% [18].

III. METHODOLOGY

This part consists of four sub parts. These parts are dataset, data preprocessing, word cloud and applied our models. Fig. 1 represents the overall work procedure of our proposed work.

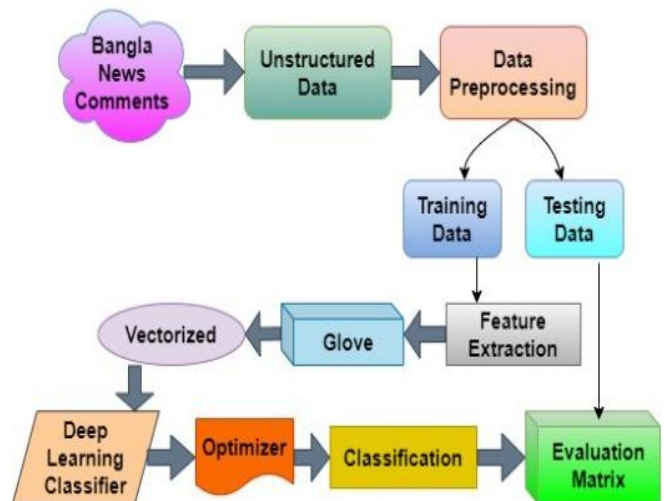


Fig. 1. Overall work procedure of our proposed work.

A. Data Collection

Data in the main part of a research paper. Without data, we cannot do anything. In our experiment, We collected our dataset from Kaggle [19], the biggest data science community. In our dataset, data collected from various Bengali newspapers like Prothom Alo and others.. This dataset consists of 13802 Bengali news text data. Five classes in this dataset and 3928 Positive data, 3198 Very Positive, 2951 Negative, 2280 Very Negative and 1445 Neutral data. Some sentences were unlabeled or missing, we structured those sentences. We used three columns in this dataset, first one is serial, second one is data and the last one is class.

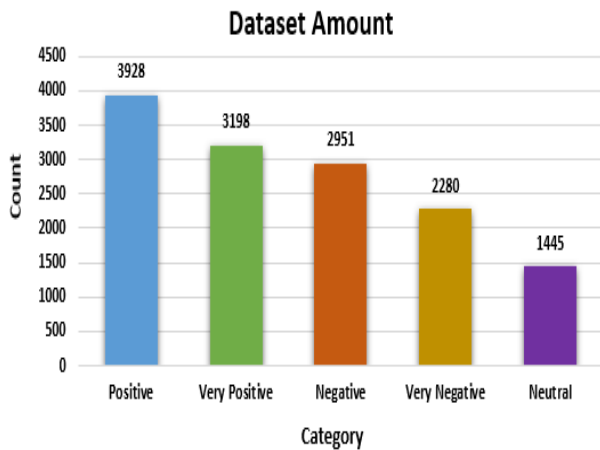


Fig. 2. Bar chart of our dataset.

Here we present that the percentage result of our dataset. We have used five categories. Firstly, Positive sentence is more than others. It's 28% then Very Positive sentence is 23%, Negative sentence is 21%, Very Negative sentence is 17% and the last one Neutral sentence is only 11%.

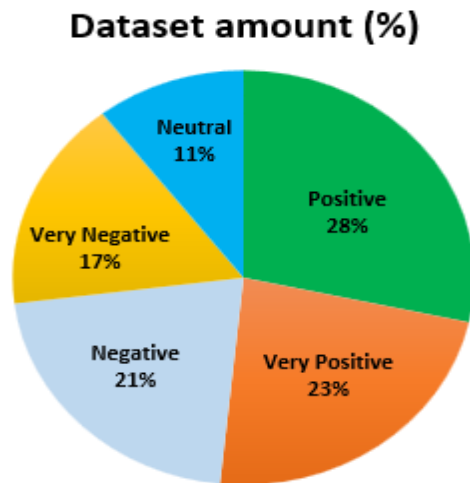


Fig. 3. Percentage for five category of our dataset.

B. Data Preprocessing

We know that every dataset is full of various kinds of data like unstructured, missing data, not labeled, grammatically incorrect etc. We collected this dataset online and this dataset was well formed. In this dataset, they used some steps to create this well-formed dataset. Below we mentioned these steps graphically.

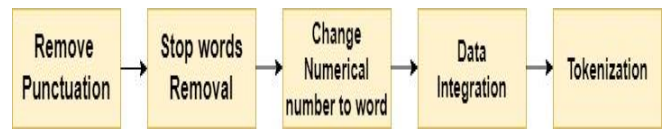


Fig. 4. Preprocessing steps of Hybrid (BiLSTM-CNN) Network.

C. Word Cloud

It's when a particular word has seemed in an origin of text information, the greater and brighter it would seem in the word cloud [20]. A word cloud is a grouping of words that are represented in differing shapes. The larger and brighter the word, the more frequently it looks likely in a text and more essential.

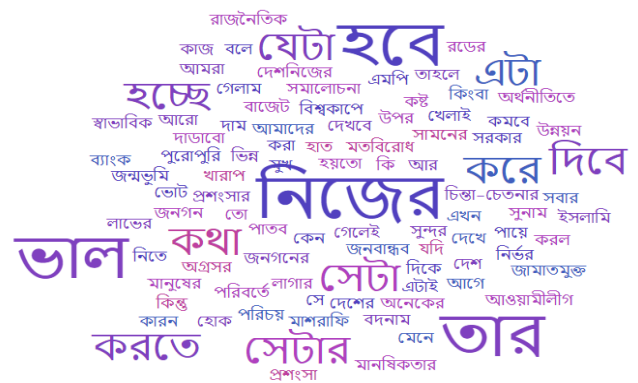


Fig. 5. Word Cloud of our total dataset.

D. Hybrid (BiLSTM-CNN) Model

A Bidirectional LSTM (also renowned as BiLSTM) is a sequential processing technique that uses two LSTMs, one forward and one backward. CNN is a very strong phrase in SA and information categorization, and it is also very good at viewpoint evaluation [21]. It's great for long articles, and extracting its features is still challenging. Two Bidirectional layers with a dropout value of 0.5 were added after the embedding layer, accompanied by a convolution layer with 32 filters, a kernel shape of 3, and a "relu" activation feature. The error function was "categorical cross entropy," and it was required to fill the technique around each other. This model was used by the "Adam" optimizer, and the layer dropout was 0.5. Finally, we trained this model with 80 epochs and 512 batch sizes. Maximum length of this model was 1000.

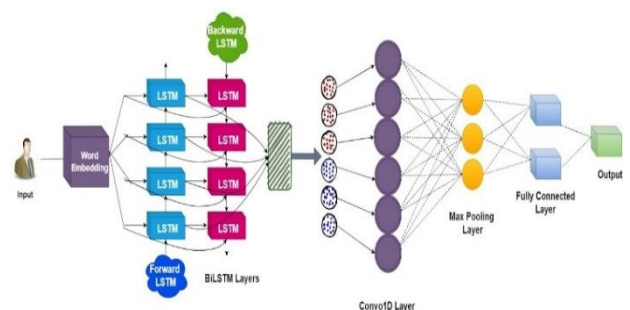


Fig. 6. Architecture of Hybrid (BiLSTM-CNN) model.

E. FastText Model

FastText is a user-friendly, lightweight program that enables students to understand text representations and

categorization. FastText is a two-layer NLP framework for text categorization and word embeddings [22]. It has two embedding layers and one linear layer. The hardware operates on very basic, generic principles. Methods could then be condensed to fit on even small mobile devices. Because of the eco-friendly guidance of word representations but nevertheless sentence categorization, FastText may also want to remain for a library built by the Facebook research group. FastText is well with its training efficiency and agility. To train our dataset, we used a FastText model with a maximum rate of 1000 and a studying rate of 0.0002. Then, with the help of ktrain library, we trained it with a batch size of 512 and 250 epochs.

F. Parameter Settings

This table shows which parameters we used for our model. These parameters act as knobs that you can adjust while training our model. To get the best results for our model, We need to identify the ideal benefits of these parameters.

TABLE I. PARAMETER TUNING OF MODELS

Parameter	Glove+BiLSTM-CNN	FastText
Batch Size	512	512
Epochs	80	250
MaxLn	1000	1000

IV. RESULT ANALYSIS AND DISCUSSION

With optimization, the model's performance deteriorates or improves, as indicated by the loss value [23]. Precision metrics are used to accurately measure the algorithm's efficiency in a meaningful way. After parameterization, the accuracy of the strategy is usually calculated and measured as a percentage.

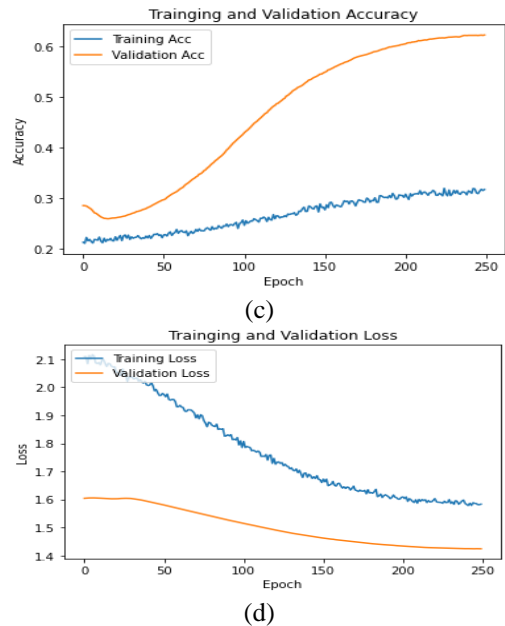
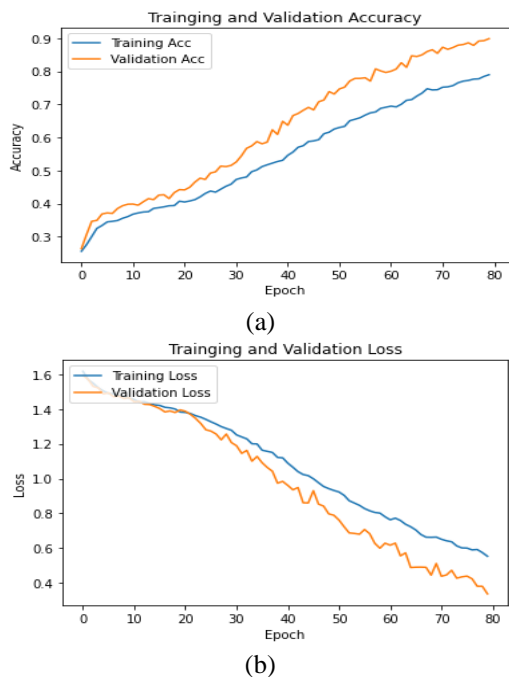


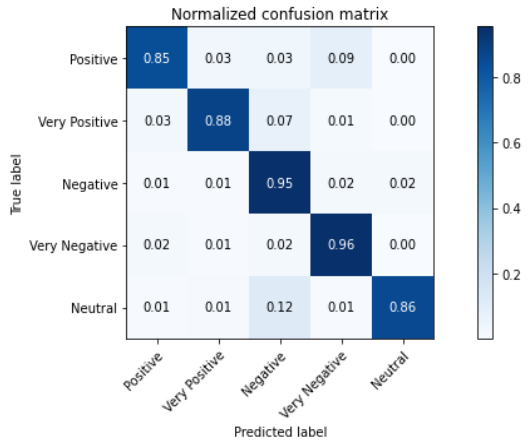
Fig. 7. (a) (b) Glove+BiLSTM-CNN Accuracy and Loss Curve, and (c) (d) FastText Accuracy and Loss curve.

Table (II) contains the precision, recall, and f1-score for BiLSTM-CNN and FastText are different for five defined categories, as shown in the table. In separate situations, these outcomes vary from one another [24]. Furthermore, these values vary for every model's specified categories. It's a confusion matrix categorization summary. Here we classified it category wise. FastText is showing a very poor result than the Hybrid model [25].

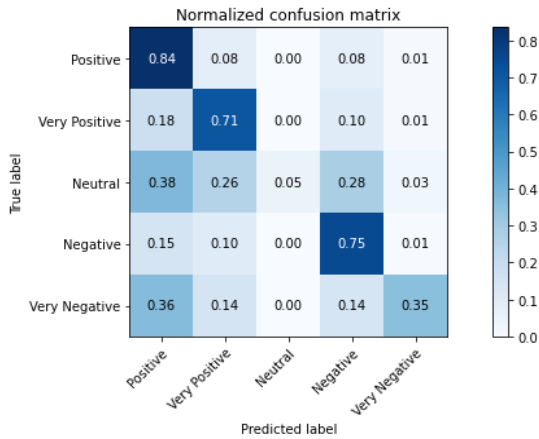
TABLE II. EVALUATION MATRIX OF MODELS

Model	Category	Precision (%)	Recall (%)	F1-score (%)
Glove+BiLSTM-CNN	Positive	0.94	0.85	0.89
	Very Positive	0.94	0.88	0.91
	Negative	0.67	0.95	0.79
	Very Negative	0.91	0.96	0.93
	Neutral	0.98	0.86	0.92
FastText	Positive	0.52	0.84	0.64
	Very Positive	0.61	0.71	0.66
	Negative	0.70	0.75	0.72
	Very Negative	0.87	0.35	0.50
	Neutral	0.94	0.05	0.10

Fig 8 shows that the matrix calculation graphical view of our two modes, Glove-BiLSTM-CNN and FastText. It's a 5x5 dimensional matrix. Confusion matrices are divided into two categories [26]. The actual value is one, and the predicted value is the other. The confusion matrix can help us determine whether the classification model is correct or if it is incorrect.



(a)



(b)

Fig. 8. Confusion matrix of (a) BiLSTM-CNN (b) FastText models.

When calculating losses, macro estimation weights each forecast result; however, if the data is unevenly distributed and you need to predict a weight, the user uses a “weighted average”. Table (III) shows the macro and weighted average of our two models with precision, recall and f1- score. This two models, Glove+BiLSTM-CNN performs better form other one.

TABLE III. MACRO AND WEIGHTED AVERAGE CALCULATION [28]

Model	Macro/Weighted Average	Precision (%)	Recall (%)	F1-score (%)
Glove+ BiLSTM-CNN	Macro average	0.94	0.85	0.89
	Weighted average	0.94	0.88	0.91
FastText	Macro average	0.73	0.54	0.52
	Weighted average	0.69	0.62	0.59

Sensitivity means the total positive prediction divided by the total positive values. Specificity is totally opposite of sensitivity [27]. Graphically shows our model sensitivity and specificity. This graphical view shows that, Sensitivity and Specificity of Glove+BiSTM-CNN result is better than FastText. The better Sensitivity and Specificity is 0.97% and 0.96%.

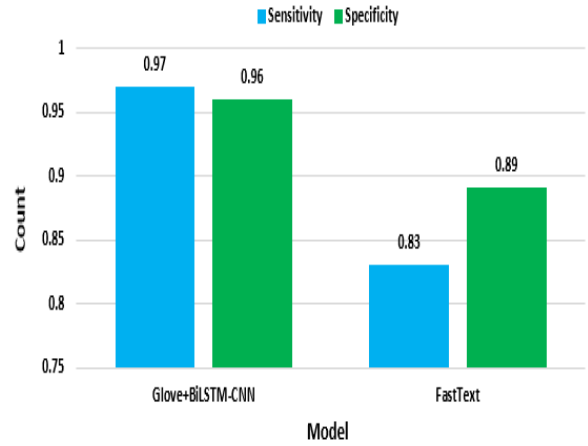


Fig. 9. Sensitivity and Specificity of our models.

This table (IV) presents the performance measure matrix calculation for two models. Various type of calculation show in this performance likes FPR, FNR, NPV, FDR, MAE, MSE, RMSE. This table mainly present that how our models works. **Here Glove+BiLSTM-CNN evaluation matrix result is better than FastText pretrained model.**

TABLE IV. PERFORMANCE MEASURE MATRIX OF MODELS [28].

Models	FPR	FNR	NPV	FDR	MAE	MSE	RMSE
Glove+ BiLSTM-CNN	0.04	0.29	0.97	0.04	0.09	0.03	0.19
FastText	0.11	0.16	0.79	0.09	0.30	0.14	0.38

Fig 10 shows the accuracy comparison of our models. Here the Hybrid model performs better than the FasText model. This Hybrid model accuracy is 89.89%. **In this hybrid model we use an Adam optimizer for improving performance. We changed the epoch and batch because improve the model accuracy.**

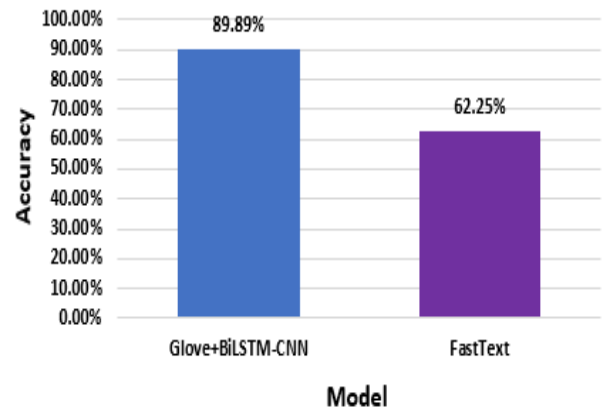


Fig. 10. Comparison of our models Accuracy.

Table (V) represent that Which model is better for predict the result. We check actually one specific sentence for prediction result. **Here Glove+BiLSTM-CNN model prediction is very good than FastText. In FastText Positive category is predicting Neutral sentence and Very Negative sentence predict Negative.**

TABLE V. PREDICTION TESTING TABLE OF DIFFERENT SENTENCES

Model	Sentence	Actual Category	Predict Category
Glove+BiLSTM-CNN	এটা ভুলে গেলে চলবে না যে ব্যাংকটিতে নুতন পরিচালনা পর্ষদ এসেছে তাদের ব্যাংকটির সব কিছু বুঝে উঠতে একটু সময় লাগবে এটাই স্বাভাবিক	Positive	Positive
	জনসংখ্যা আর আয়তনের হিসাবে পাকিস্তানই বেশী পেয়েছে	Very Positive	Very Positive
	বিগত কয়েক বছরের অভিজ্ঞতা বলে ব্যাংকসহ শ্যেনদৃষ্টি যেখানে সর্বনাশ সেখানে	Negative	Negative
	তাহলে তো রডের দাম আরো কমবে	Very Negative	Very Negative
	আমি চাইতে সমস্যা কি দাম চাইলাম যা দ্যান	Neutral	Neutral
FastText	এটা ভুলে গেলে চলবে না যে ব্যাংকটিতে নুতন পরিচালনা পর্ষদ এসেছে তাদের ব্যাংকটির সব কিছু বুঝে উঠতে একটু সময় লাগবে এটাই স্বাভাবিক	Positive	Neutral
	জনসংখ্যা আর আয়তনের হিসাবে পাকিস্তানই বেশী পেয়েছে	Very Positive	Very Positive
	বিগত কয়েক বছরের অভিজ্ঞতা বলে ব্যাংকসহ শ্যেনদৃষ্টি যেখানে সর্বনাশ সেখানে	Negative	Negative
	তাহলে তো রডের দাম আরো কমবে	Very Negative	Negative
	আমি চাইতে সমস্যা কি দাম চাইলাম যা দ্যান	Neutral	Neutral

V. CONCLUSION AND FUTURE WORKS

Because of the fast expansion of social networks and internet news portals, filtration has become an absolute necessity for identifying specific news comments in the smallest period of time. In this paper we try to present that Bangla news comments sentiment in five different classes. Here our dataset comes from online and this dataset was well formed. We used two deep learning classifiers for our proposed work, one was a hybrid model which was combined by BiLSTM and CNN technique and another was FastText classifier, which was a pretrained model. Our hybrid model gained 89.89% and FastText gained 62.25%. We used Glove word

embedding for our hybrid network and also using an optimizer function called Adam.

In doing so, I found some limitations, such as no experience with restricted domains and inadequate data sources. As you know, all models are designed to improve over time. Because any kind of experimental research is a never-ending process that gets better every day. After completing this study, you need to extend the model. This project used only one combinatorial model with one word embedding.. This featured design used five main categories: Positive, Very Positive, Negative, Very Negative and Neutral. Next, try to use more classes and data. Research is being conducted using various hybrid models and neural network-based models such as ANN, LSTM, RNN, and BERT, and others will be conducted in the future.

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