

# Sentiment Analysis of Restaurant Reviews using Combined CNN-LSTM

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**Abstract**—The combination of machine learning approach and natural language processing is applied to analyze the sentiment of text for particular sentences. In this particular area lots of work done in recent times. Restaurant business was always a popular business in Bangladesh. These business is now Leaning towards online delivery services and the overall quality of restaurants are now judged by reviews of customers. One try to understand the quality of a restaurant by the reviews from other customers. These opinions of customers organizing in structured way and to understand perception of customers reviews and reactions is the main motto of our work. Collecting data was the first thing we have done for deploying this piece of work. Then making a dataset which we harvested from websites and tried to deploy with deep learning technique. In this piece of research, a combined CNN-LSTM architecture used in our dataset and got an accuracy of 94.22%. Also used some other performance metrics to evaluate our model.

**Index Terms**—Sentiment analysis, Combined CNN-LSTM, Text classification, Deep learning, Word embedding

## I. INTRODUCTION

Over the past few years it can be observed the upbringing of restaurants through multiple online platforms. Websites are becoming the most popular platform where the restaurants are justified on the basis of customers' opinions. The reflection of a customer sentiment brings out from those online reviews of customers which magnify the overall quality of a restaurant. The interaction between customers and owners through the on-line platform makes the opportunity to analyze the insights of the customer's reaction. So it's important to be able to analyze the sentiment of customers to step up the quality according to customer's expectations. Trained machine by labeled data would give the benefit of future analysis. Many works in this domain to be specific Bangla text reviews of restaurants have been done in the past few years. Works like CNN model for aspect extraction of Bangla reviews[16], Combined machine learning models for predicting the reviews[15] and few more. Our study stepped up by approaching it with a combined deep learning technique. The advantage of our study for owners will reflect on their business when one will take decisions

or upwards themselves on the basis of the analysis. What shows the solidarity of this approach is authenticity and the more scope of purification. Extracting the text from web, categorization of those text and the polarity bring out the best prediction. Talking about contribution the first thing comes out that's our dataset of 1000 reviews which taken from sources owned by Bangladesh. Categorizations besides polarity also a key factor.

From several researches we've seen that working with rule based and machine learning techniques can give an average accuracy but when it comes about best accuracy and in terms of purification deep learning techniques standouts. Research shows that these deeper networks performs better as recent dataset are more diverse. So, our main motivation is that to apply deep learning architecture in our work.

In our experiment we've introduced a combined CNN-LSTM architecture. Our main contributions are to build a new technique that will help us to get higher accuracy in sentiment analysis specially in Bengali language. We have collected 1000 reviews to check the performance power model. First reviews are unstructured and unlabeled data. so for that we will at first make our data into a structure and set the label as positive and negative. Then after some preprocessing stuff we will fed our data into our applied model. CNN used for learn representation of words and then LSTM learn higher representation of words that are specially used for our classification task. We have also set some hyperparameters before training our model to find better accuracy.

Rest of the paper structured as follows. In section II previous works and our technique described. Later in section III data collection, preprocessing techniques introduced. A pretrained word embedding used here. Then we've discussed our proposed model and hyper-parameters. In section IV our findings like- accuracy, loss and others described. Finally, section V conclusion and future work introduced.

## II. LITERATURE REVIEW

Sentiment analysis has always been Popular method to predict customer reviews. Some research has been done particularly on Bangla text but not that much efficiently. Author Gan Introduced a Sentiment Analysis model for rating of restaurants. They have done the rating on the basis of quality of food, Price, service, ambience and special context. They don't Give importance on score [1]. Author Susant( Sixue) Jia have introduced a model for classifying restaurant reviews. For estimating the rating review relation multilinear regression model was used [2]. Author Chinsha TC Proposed an aspect based opinion mining on reviews of restaurants [3]. Author Niphat Claypo developed an Sentiment analysis model using K-Means Clustering and MRF Feature Selection with data set of 1060. The best average Accuracy of K-Means came out 71.73% [4]. Author Perera Proposed an opinion mining model using dependency parser and Sentiwordnet with accuracy of 70%. Where the testing was Completed in two steps are Manually and systematically [5]. Author Niphat Claypo Introduced a neural network and mRMR Feature Selection based opinion mining model. Where mRMR was used for selecting the features And multilayer perceptron was used in opinion mining model Which bring out the accuracy of 93.5% [6]. Author Soujanya Poria introduced a CNN model for impression meaning by aspect uprooting. For tagging individual words multilayer CNN was applied . They used a data set of CBOW [7]. Author Hanhoon Kang tried a new approach where the impression inspection for customers inquest of eating places with combining INCB and Senti-lexicon. The experiment completed with the date set of around 7000 restaurant review documents [8]. Author Aye Introduced a sentiment analysis model based on lexicon. They worked on reviews of customers on the quality of a restaurant and their foods. Sentiment dictionary was used for classifying the sentiments . Though they work on their native language their model was able to identify the language with accuracy 96% on reviews of 500 customers [9]. Author Xing Fang introduced a sentiment analysis model for reviews of products, to do that they choose the process of sentiment polarity categorization. Categorization was done by implementing SVM, naive bayesian and random forest methods. The feature vector of a sentiment was generated by a sentiment score formula. On the basis of the score sentiment polarity categorization was implemented [10]. Author Ganu bring out that result of star ratings in numerical form is not better than textual document [11]. Author Silva introduced a method where using fuzzy logic model reviews of customer and its polarity was analyzed and new customer was assisted. Their Limitation of data and not having specipacaton is the new opportunity [12]. Author Omar developed a sentiment analysis model by implementing Multinomial Naive Bayes on online restaurant reviews in Bengali text. The best accuracy of the model for 6-fold cross validation [13]. Author Fabilha introduced vectorisation methods for opinion mining of Bangla and Bangla phonetic. They choose tokenization for break down each word and

hashing vectorisation was applied for converting the text documents. The best accuracy of experiment came in SVM classifier 75.58% [14]. Author Takbir introduced a machine learning model to predict the restaurant reviews. They have done the preprocessing of their date set of around 1000 reviews applying canonicalize and lexeme labeling. For classifying the model they used Sci-kit learn and applied four different algorithms to make the best model. With limited data the best accuracy they have from Logistic regression is 0.7779% [15]. Author Atikur introduce a CNN model for aspect extraction of bangla reviews. Where they used a single convolution layer on two different datasets. The accuracy of their proposed CNN model shows best in recall and Fi-score for both dataset but SVM is best for Precision [16].

From the literature survey we observed that rule based techniques, machine learning techniques performed well in sentiment classification. Recently deep learning method can apply for gaining better accuracy and better prediction. Inspired by this we've introduced a combined CNN-LSTM architecture in our problem set. First CNN applied than an LSTM layer used. This architecture gives better performance and also give better f1-score.

## III. METHODOLOGY

Tensorflow 2.2.0 used to train and evaluate our model. Before training we need some preprocessing stuff for our dataset. Then we'll introduce our proposed model. Fig-1 shows workflow and others described as below.

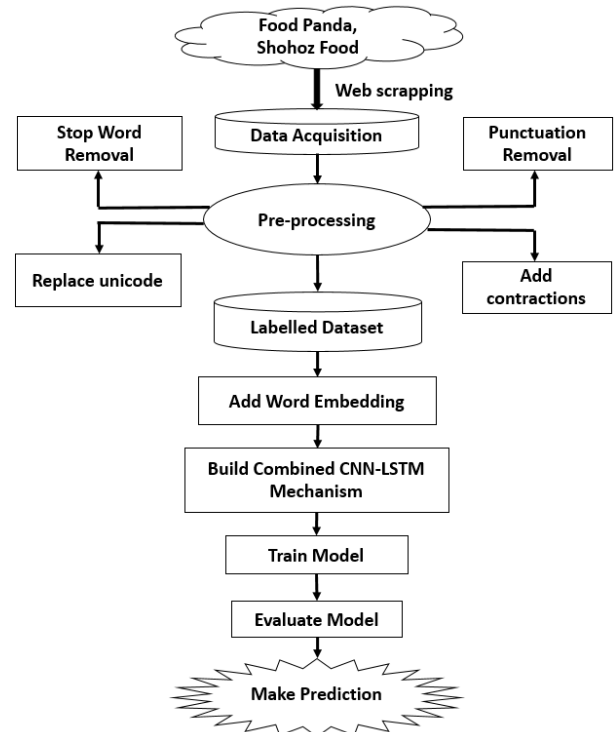


Fig. 1. Workflow of our problem.

### A. Dataset Preparation

The collection of Data is the process of convocating, estimating and inspecting the exact insights for research on the basis of an accepted system. Researcher can extract their proposition on the basis of gathered data. The importance of data collection is replacted to maintaining the solidarity of research and taking decisions on future of business. We collected our data using web scraping technique which is a popular and an accepted way of data collection. For uprooting vast amounts of data from websites Web Data Extraction is an effective method through which the data is uprooted and stored in a database as excel format. We collected our data from the web application with whom restaurants are associated as follows FoodPanda and Shohoz Food. We made a dataset of 1000 reviews with 500 labeled as positive and rest as negative. Later our dataset contains two columns i.e-review and category.

Preprocessing of data is an approach of data mining used to convert the raw data into functional and proficient format. It's too much important cleaning the data to bring out the quality data for our experiment which will help us to optimize our test errors. First, add contractions into our dataset and remove the short from of that contractions. Then split the texts that made the dataset into some tokens. From that tokens, we removed the unnecessary characters like "???" "/" from our dataset via regular expressions. In Bengali, there are also some Unicode characters we need to replace in a correct manner. Later we removed the stop words and finally got our well-furnished dataset.

### B. Word Embedding

Texts are represented as a word vector. There are numerous study for this representations. Word embedding is a powerful way to represent words that can learn from textual data. it is a vector representation of words and can give us a powerful semantic relationship between the words. But as far we are working with Bengali so we need our own word embedding. Sometimes it is good approach to working on pretrained embedding. So in our case "bn w2v model" used for our purpose. Before training, we need to finalize our vocabulary size. For this from the pre-process text we count the vocabulary.

### C. Model

There are several types of deep learning models out there. Each of them is used for a variety of purposes. Just like ConvNet is used to handle image data and video processing stuff. Another type of model that is used for text classification, language modeling. In our problem set we've used (i) Combined CNN-LSTM which is described below.

1) *Combined CNN-LSTM*: CNN is initially used for image processing tasks to perform image recognition and others. Recently, it has diversified used in NLP research. we have used combined CNN-LSTM architecture for our

problem. This architecture improves the accuracy of text classification. [16]- [17] Both CNN and LSTM layer used in this technique whereas CNN used for extracting low-level features and LSTM for high levels. The first sequential model has been created. In the input section, input texts are treated as a matrix. Each row of that matrix is a vector representation of a word also known as word embeddings or word2vec. This embedding layer with dimensions of 300 we've introduced. Next convolutional layer with 256 filters with the kernel size of 3 applied in the output of embedding layer to learn the lower level features from words. Convolutional layer can learn low-level features and short term dependencies from words. adding non-linearity ReLU activation function used. Max pooling layer used for reducing the dimensionality of the model. Next, up all this output are fed into an LSTM layer with a hidden size of 128. LSTM can learn long term dependencies and high level features from words because of their having a memory unit. These high-level features are further used for classification. Before that for reducing overfit dropout rate .25 introduced. Finally, a softmax function used to classify the reviews that are positive or negative. Combined CNN-LSTM architecture is shown in figure-2.

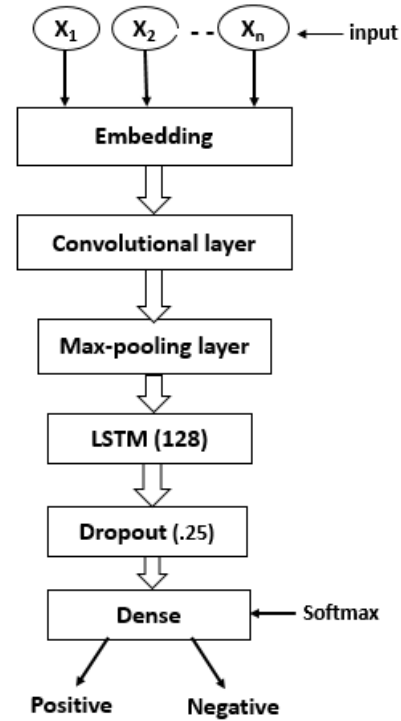


Fig. 2. Combined CNN-LSTM.

### D. Hyper-parameters Settings

In our study, we've predefined some parameters of our architecture that is also known as hyper-parameters. If we not declare these parameters into our model then our model isn't working. To find best accuracy we first need to tune them. Table-I shows the hyper-parameters of our model.

TABLE I  
HYPERPARAMETERS

Batch size	128
Epoch	75
learning rate	0.0001
CONV size	256
Conv Filters	3
LSTM's size	128

#### IV. RESULT & DISCUSSION

Tensorflow 2.0.1 used to train our model. First hyperparameters are set into our model. Then divided dataset into 80% data for training and rest for testing. Later compiled our model into adam [16] optimizer with a lower learning rate and binary cross entropy introduced as loss function. Then a Earlystopping callbacks introduced to monitor our validation loss. Afterwards .fit() method to start training. When our validation loss isn't improving using callbacks it'll stop training. After training for 50 epoch model got 94.22% accuracy. Fig-3 shows accuracy curve of our model. We've seen our training accuracy is 94.22% but validation accuracy stuck at 75.01%.

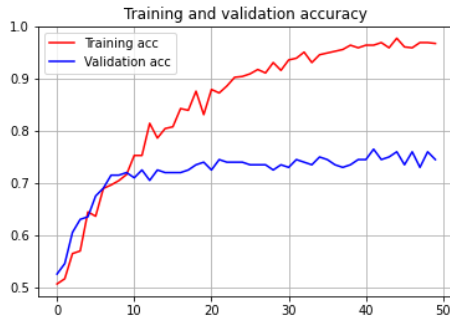


Fig. 3. Accuracy curve.

Fig-4 shows loss curve of our model. We've seen our training loss is 0.155 and validation accuracy is 0.722.

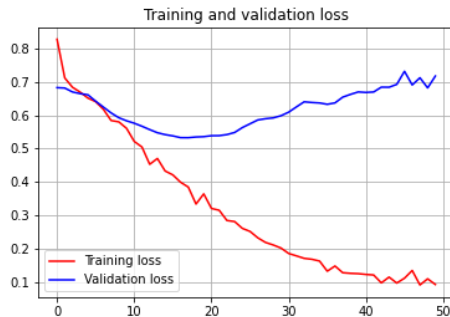


Fig. 4. Loss curve.

In Table-II the performance evaluation metrics of our work are shown. Our model achieves a good average f1-score of

both two classes.

TABLE II  
CLASSIFICATION REPORT

Category	Precision	Recall	f1-score
Positive	0.79	0.60	0.68
Negative	0.63	0.80	0.70
Average.	0.70	0.70	0.71

From above table we see that our average precision, recall, f1-score is quite good. Due to the fact that Bangla language is very diverse and complex, it is very difficult to get more accuracy into this type of task.

Fig-5 shows confusion matrix of our model. In here negative and positive are represented as 0,1 respectively.

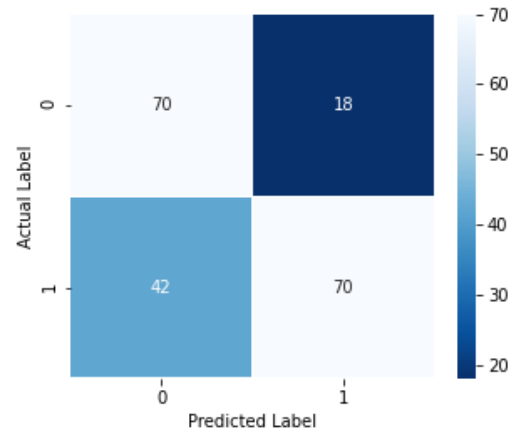


Fig. 5. Confusion matrix.

#### V. CONCLUSION & FUTURE WORK

In our study, a combined CNN-LSTM architecture used to deploy Sentiment analysis for Online restaurant reviews. That's the initial dive of ours to develop this Bangla review analysis system. Though we didn't achieve accuracy of a hundred percent through this model but still can give close to satisfactory accuracy on Bangla restaurant review. In our first approach we found new diversity regarding Bangla text review. This model can be reused for others Bangla text perspective also.

As this is our first approach, to bring out the best accuracy there are too many opportunities to improvise. Increasing the layers in our model will be one of the major improvements. As the following goes for the dataset as well. We've used a pretrained word2vec with 300 dimensions. Further others pretrained word vectors also used to compare the performance of our work. Therefore recently BERT is useful for text classification tasks. But its' resources are high. In future it'll be a good option for sentiment classification.

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