SENTIMENT ANALYSIS ON ONLINE PRODUCTS REVIEW USING DEEP LEARNING APPROACH

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11 SEPTEMBER 2021

APPROVAL

This Project/internship titled **"Sentiment Analysis on Online Products Review Using Deep Learning Approach"**, submitted by Md. Tarikul Aziz, ID No: 172-15-9721 and Huray Jannat Dipty, ID No: 172-15-9720 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 11 September 2021.

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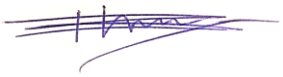

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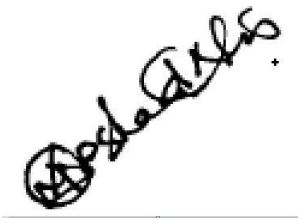

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We hereby declare that this project has been done by us under the supervision of **Mr. Narayan Ranjan Chakraborty, Assistant Professor, Department of CSE,** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ACKNOWLEDGEMENT

First we express our heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the final year project successfully.

We really grateful and wish our profound our indebtedness to **Mr. Narayan Ranjan Chakraborty**, **Assistant Professor**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of "*Field name*" to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to the Almighty Allah, Parents and **Dr. Touhid Bhuiyan Professor and Head, Department of CSE,** for his kind help to finish our project and also to other faculty member and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mate in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

The method of extracting feasible information from expression or text that helps in different fields to make decision is called sentiment analysis. Sentiment analysis is an important methodology for all the business organization to improve their service according to customer's demand. In this area a lots of techniques has been used for different researches. We have used deep learning approach to execute sentiment analysis with Bangla dataset in this work. As a developing country Bangladesh is getting more dependency on online shopping day by day. People try to judge the overall quality of products or service that are available on online from reviews of previous customers. In this work our main motive is to realize perception and organize the customer's opinion in structured scheme. The main challenge we have faced at the time of collecting data. Then after doing some necessary steps we have prepared our dataset appropriate for our model. In this piece of work, we have used LSTM and combined CNN-LSTM classifiers to find the polarity of a sentence. We measured the classifiers results in terms of Precision, F-measure, Recall and Accuracy. In our result it is shown that the current method can calculate better sentiment than previous method. We can also observe that our applied LSTM gives more accuracy than combined CNN-LSTM architecture and it achieved 82.54% accuracy. By comparing some results we can ensure that we have used a significant technique to calculate sentiment of sentence. The available online platforms of Bangladesh can use our developed model to separate the reviews according to the polarity of a sentence.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays internet becomes so available to everyone. Besides online business, e-commerce, online products buy and sell, digital marketing become also popular. In this field people gives review or opinion about products on the basis of quality of product and service. Amazon, ebay, Ali express, Walmart are some examples of online platform. In Bangladesh there are also available popular online platforms like Daraz, evaly, foodpanda, e-food, shohoz food, techshop BD etc. Using these platform customers also gives reviews. In present time clients and merchants are expressing more and more curiosity towards internet shopping. We can observe that in past few years a lots of business organizations are bringing up to abundant online platforms. People are using various online shop to purchase their necessary products. Merchants are also increasing their business area through the country as well as whole world. On the basis of digitalization many developing countries are using web platform for their daily needs. When a customer can complete their shopping they provide their review for specific item. From this survey of their review we can assume the polarity of product or service. Such as quality of products, services, customer satisfaction etc.

By this polarity of product or service new customers can make decision to buy products based on the past customers who had purchased this item or products before. Besides, organizations can take decision about the selling amount of products and about the improvement of products. As sentiment of customer is analyzed in this purpose this phenomena is known as sentiment analysis.

This online platform will be able to make an opportunity to extract the reactions of customers and analyze them by sentiment analysis. The method of extracting feelings, assessments and conclusion by programming language from comments or reviews is called sentiment analysis. A lots of works has been done by sentiment classification but most of them are for English language. There will be rarely found sentiment analysis related work for Bengali language.

No research papers were found by us that were separately worked for the reviews that are

written in Bengali language for those products available in online platform. For that reason we have decided to make a research for Bengali text analysis on the basis of sentiment classifiers. In our thesis, we have tried to find the polarity of Bengali review of online product date.

1.2 Motivation

The number of online platform user is increasing day by day for available internet, advanced technology and to save time. For that reason the user put their experience as user review against every product that they have purchased. A huge numbers of thesis can be found on review data that have been generated against online products. Although the number of organization that are available in online platform is increasing and user are also generating their reconsideration for online products, there are rarely found work for the e-commerce site where the reviews in Bengali language are available. The unavailability of work for Bengali language review is the main motivation behind our research work.

Sentiment classification or analysis basically works to check the polarity of user's opinion of product review available in online business. In our research we have proposed a model that will help new customer before buying products from online business site on the basis of previous customer's experience.

1.3 Rational of the study

As people are getting accustomed with smart technology and don't want to waste their time. So they prefer more online shopping than physical approach. Therefore dependency on online shopping is increasing day by day and getting more popular. So the merchants have to take some necessary steps to improve their business strategies if a customer can buy products safely.

From our research both customers and proprietor of online product or restaurants will be helped to get or provide better service. It is a noticeable point from which we gained inspiration that very few researches have been done for combining food and online product review dataset that are available in online platform. We think no one has done like this research previously.

1.4 Research Questions

- Which method will be followed to find the polarity of sentence using customer's opinion?
- Is this work beneficial for general people?

1.5 Expected Output

In this report we have discussed about our research work which is based on Deep learning method. So, we have promoted our motive to publish a research paper over our work. A research paper can make easier to find the answer of many questions. And in a research paper a lot of analysis can be found. Based on a research paper a developers can develop various tools and make them user-friendly. In our Research work we tried to develop a model that will work on Bangla sentence. We have applied some algorithms that will help our model to classify a sentence if is negative, positive or neutral. We have used LSTM and combined CNN-LSTM method to get the accuracy in numerical form with the value of percentages. It will help people to gain knowledge about a product before by buying this.

1.6 Report Layout

We have arranged the following report in a proper way. This report contains 6 chapters. Each chapter holds different subparts. We have described every part in detail. In chapter 1, Introduction, Motivation, Rationale of the Study, Research Questions, Expected Output, Report Layout are discussed in detail. In chapter 2, we have discussed about Introduction, Related Works, Research Summary, Scope of the Problem and Challenges. In chapter 3, Introduction, Research Subject and Instrumentation, Data Collection Procedure, Statistical Analysis, and Implementation Assessments are discussed. In chapter 4, Introduction, Experimental Setup, Experimental Results & Analysis and Discussion are discussed. In chapter 5, we discussed about the Impact on Society, Impact on Environment, Ethical Aspects and Sustainability. In chapter 6, discussion about the Summary of the Study, Conclusions and Implication for Further Study are given.

CHAPTER 2

BACKGROUND

2.1 Introduction

In the present era a large number of people are being familiar with online shopping as it saves their time as well as it eliminates travel harassment. Usually merchants upload their product picture with detail information on online platform and buyer can compare the uploaded products with each other and as a result buyer can buy those products as their wish. Besides many advantages there are some disadvantages also. For example, a merchant can cheat a client with wrong information of a product. As there is no option to verify the quality of a product, so everyone have to depend on the faith of a merchant. But the previous comments of a buyer who purchased the product before is very important to the new buyer. By analyzing those opinions one can make his/her decision about purchasing that product. That important task of analyzing opinion can be done very easily by sentiment analysis using some deep learning algorithms.

In accordance with modern technology the research ability of sentiment analysis is increasing. A lot of researches and projects are currently acting in this field. Most of this works are done in English language because there are huge numbers of data available in internet. They worked with some particular mobile phone brand to analyze their popularity by using sentiment analysis [1] on English reviews about those brand. As the number of internet users who give their opinion in English language is huge, so it is easier to collect data in English language from internet. For this reason many researchers are able to apply different types of machine learning algorithm for sentiment analysis.

Although the number of e-commerce platform in Bangladesh has increased, very few researches has been done using Bangla language.

2.2 Related Works

According to their research, they worked with some particular mobile phone to analyze their popularity by using sentiment analysis. They considered sentiment score of those data of mobile phone to analyze popularity. To expedite their experiment they choose five mobile phone brands. They are: Samsung, nexus, iPhones, Motorola and Lenovo. R and

MongoDB were used to implement and popularity was estimated by using the lexicon-based method. Related to each phone brands was extracted from latest 500 tweets separately. Sentiment scores are between - 1 and +2 that gained from various Samsung phone tweets. The Sentiment of the people concerning cell phone purchasing are shown by this various scores. After analyzing the popularity people can make a special decision before buying a new phone brand [1].

A CNN architecture can be used to classify Bangla sentence. They proposed a CNN model to aspect based education of Bangla reviews. In that research they applied a single convolution layer for two different dataset. The used CNN for their research shows it better in recall and F1-score every dataset but for more clearness SVM is the best [2].

Author Aye and his team developed sentiment analysis model that works on the basis of lexicon. They focused on the quality of a restaurant and the taste of their food. They used Facebook to collect reviews of restaurants to make dataset. In their research they attempt dictionary and corpus Based approach. Although there was unavailability of annotated data of Myanmar Language they collected Reviews of 500 customers and their developed model could identify their native language with accuracy 96% [3].

Hanhoon kang et al. proposed a new approach of senti-lexicon for sentiment analysis. They worked on 70000 review documents of restaurants. By using their proposed Naive Bayes algorithm that is improved from the past version the gap between the positive accuracy and the negative accuracy was narrowed to 3.6% [4].

Xing Fang et al. tried to solve polarity categorization problem of those sentence that are generated from human sentiment. They worked for both review-level & sentence-level categorization with hopeful outcomes. They used Random Forest, SVM and Naive Bayesian classifier models for categorization and also used scikit-learn as helping software [5].

An analysis system to classify Bangla Reviews of restaurants is developed in this work. They classified Reviews in bad, good and excellent by using vectorizer and different Classifiers. As dataset of Bangla Review is rarely available in internet, they collected data manually. They converted their text documents using hashing vectorization and each word was divided using tokenization method. In their thesis they got the best accuracy by SVM and that was 76.58% [6].

Author Xingyou Wang and his team tried to develop architecture for sentiment analysis of short texts by joining CNN and RNN. In their thesis they got good result by using LSTM and GRU. They showed that their proposed model performing better with pre-trained vectors in spite of vectors that are randomly initialized. As their developed model takes advantage from CNN and RNN so it performs better than their separate performance [7].

M. Trupthi et al proposed that to accomplish multilingual analysis a CNN can be exploit [8].

According to their research, they tried to classify the reviews of electronic device. They collected only English data from various online platforms. They find the polarity as negative or positive. They applied machine learning approach to classify review data. They got the best accuracy of 98.17% from Naïve Bayes algorithm [9].

Saika and her team used Bangla microblog posts for sentiment analysis. They took huge data and adopted some NLTK features and preprocessed by polarity fixing either it is positive or negative. They used Maximum entropy and SVM but they got the accuracy of 93% from SVM [10].

In this research polarization of a large amount review of product by proposing a supervised learning model is discussed. They collected 48500 reviews of cell phones and accessories and also labeled them. They got 90% accuracy in their thesis by using SVM [11].

Geetika et al. worked for sentiment analysis of twitter data by using machine learning approach. They collected and labeled their data to find out the result on the basis of negative and positive approach. Comparing the classifiers they used in this thesis they got better accuracy from previous and the accuracy was 89.9% [12].

2.3 Research Summary

In our experimental work, we tried to categorize Bangla sentence. We have established a methodology to do this work. We have constructed this model by using our own dataset. The dataset that is used in our model was fully made by us by collecting only Bangla reviews or comments from various online platform. We have entered 1658 data in our dataset. The dataset was used to find the polarity of sentence. We have used two models to do our whole work. LSTM and combined CNN-LSTM model are used in our work. We found some researches complete their work with a single model. In the whole world a

global digitalization is running rapidly. People are getting more dependent on online shopping. It is a must for every online shop to ensure the best quality of their products. Everyone wants to verify a product quality before buying. In online platform the reviews of previous customers are the only one way to verify a product. There are some works can be found in English language. But no other work has been done for Bengali language. As online shopping is also growing in Bangladesh and maximum users write comments in Bangla language. So, we decided to do this work that will help customers to verify a product as well as the merchants to improve their service. We tried to find the polarity of a sentence by applying two algorithms. We also can find which algorithm is better by comparing the accuracy of those algorithms.

2.4 Scope of the Problem

At the time of collecting data from internet we could not use beautifulsoup4 because all the comments were not in single page and in one page there were both Bangla and English comments. As we worked for sentiment of Bangla reviews only so data collection by using beautifulsoup4 was not sufficient. That's why we had to collect data manually which was more time consuming. We faced some other problems also when collecting data such as incomplete comment, short forms of word, irrelevant comments, confusing opinions, miss spelled words, over length comments, sometimes people expressing negative sentiments using positive words this is really difficult for our system to efficiently detect the polarity. Sarcasm, irony and tone are others issue which we have faced when collecting data.

2.5 Challenges

We didn't have any built in good dataset of Bangla comments or reviews. It was so challenging to collect so much data for building an efficient dataset. We had to work hard for collecting 1658 Bengali comments from various web pages. At the moment of collecting data we carefully categorize slang words, miss-spelled words and irrelevant comments we had regularly updated this types of words with polarity and trained machines efficiently. We also faced some issues with the stop word of many comments, we have given stop words manually to this types of comments for the beneficiary of our polarities of comments. As we are working in Bengali language there is no sufficient built in library

which we can use to preprocess of our dataset.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Methodology is a significant methods or technique which is used to analyze, select, process and identify message about a subject.

For many research work there needs a particular methodology. Without methodology a research can't be fully done. In our research work we also use a significant research methodology to complete the work. In this section we are telling about our specific methodology in elaborate.

Every researcher's work is to solve problems or to invent new way to solve problems or to eradicate problems more efficiently from a previous technique of problem solving. In this work we have used methodology part for completing the above work.

We have used deep learning as core model to predict sentiment by using sentiment analysis. In our deep learning model, in particular we have used LSTM (Long Short Term Memory) which is used to pre-process the word with the prediction of next phase in deep learning approach. We have already determined our goal and we have clear knowledge about our vision. For exact outcomes an enriched dataset is necessary in order to run the algorithm correctly. It is very important to preprocess the dataset with care. In this part we will discuss about how our model performs better than other models. Accurate re-arrangement and rationalization of model improve the working efficiency and nobility of supply. In this methodology we have used mathematical equation, graphical view and flowchart.

Mathematical equation gives our model a strong logical aspect which is very important for building any model. Graphical view is very user friendly for understanding any complex subject easily. A common person can get ideas from this easily. That's why it is considered as very important part of methodology.

Transparent flowchart is also very important for describing the whole in a nut-shell. Anyone can have the good idea from a good transparent workflow of a research work. It is eye comfort and easy to understand. These are the very necessary steps which are discussed on this section briefly. In the next page the whole transparent workflow is given through Figure 3.1.

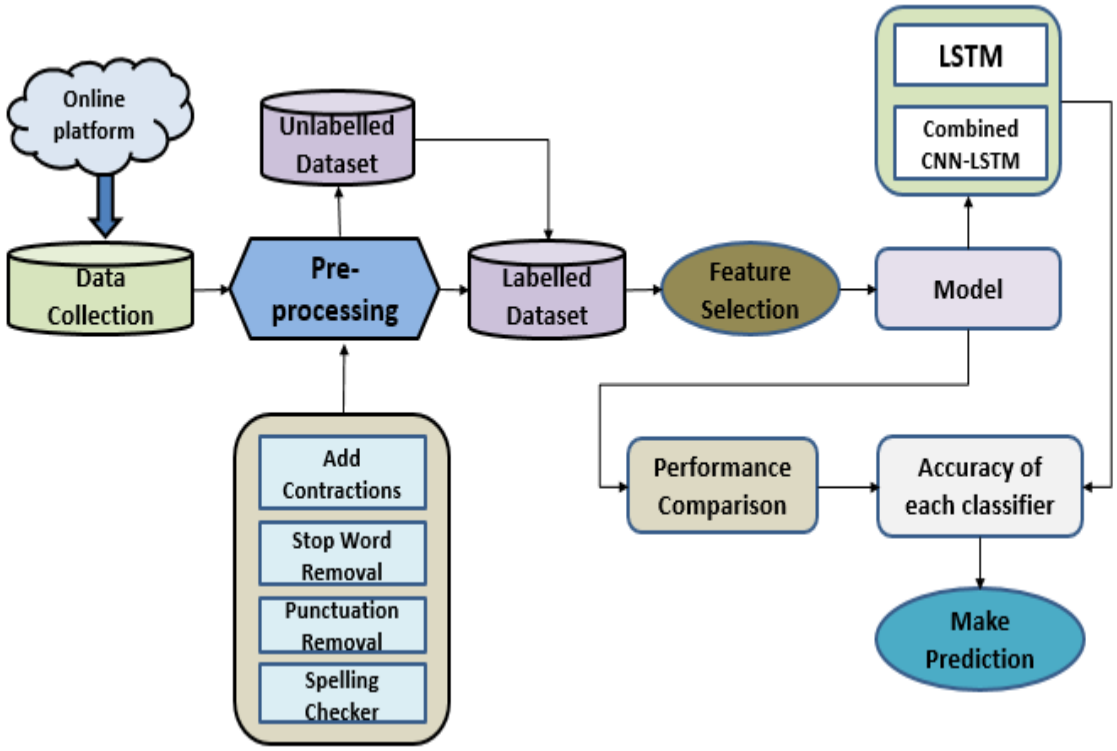

Figure 3.1: Workflow of polarity detection system

3.2 Research Subject and Instrumentation

In this research we have worked on predicting sentiment of those users who had used various online platforms to purchase any product that are available in Bangladesh. As we worked on review data that are created in Bangla language and used LSTM which is a part of deep learning, so we have chosen the title for our research work is "Sentiment Analysis on online products review using deep learning approach". As there were no available dataset and no website what containing only Bengali comments or opinion, so we were not able to apply any scraping algorithm to collect our required data. We gathered data manually and applied some development tools for tokenizing, drive away punctuation and as well as remove stop words. After completing the dataset we need to run a model on our prepared dataset based on deep learning method. It is important to keep the PC, GPU and other instruments with exalted configuration to run the model based on deep learning.

Here is a list of some technology and components that we used to run our model properly-

Software and Hardware:

- HDD 1 TB

- 350 GBRA with 12GB based Google colab
- Intel Core i5 8th generation containing 8GB RAM

Used development tools:

- Pandas
- Numpy
- NLTK
- Windows version 10
- Python 3.7

3.3 Data Collection Procedure

In recent time the use of online marketing is increasing rapidly. Everyone wants to compare products among some shops before buying which is difficult. But in an online platform anyone can do this easily. Even in this pandemic situation for covid-19 people of Bangladesh are being more dependent on online products. So it is important to make an enriched data set to get a good result. We collected 1658 data in Bengali language that are created by online consumers from Daraz Bangladesh, foodpanda and other online platform. We followed some necessary steps to prepare our collected data so that the dataset can be run well in our designed architecture.

In below by Figure 3.2 we are discussing those steps.

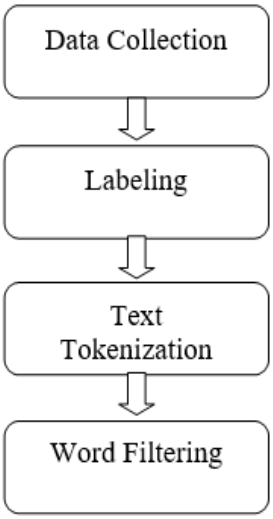

Figure 3.2: Data Collection Procedure

3.3.1 Data Collection

After deciding to start our research work we faced several problems at several times. A great level challenge was occurred when we started data collection. Huge amount of database were found in the internet but there was no dataset created in Bengali language.
So we collected data manually from various web pages.
As there is a great importance of the amount of data to have the excellent accuracy after applying any algorithm model, so we collected 1658 reviews in Bengali language what was a difficult task.
There is several number of different size and shape based organization that are familiar with online business. We selected some online platform which is used by different organization for their business purpose. Like: Daraz Bangladesg, Foodpanda and various online shops those are available in Facebook. As those sites maintain a massive number of buyers, so they create a huge amount of reviews in those pages.
The mentioned web platforms are fully dependable on e-commerce business according to Bangladesh. Everyone have to create an account on particular platform before buying any items. Only when a buyer purchases a product then they should be able to write a review against that particular product. As it is a must to be an owner of an account or need to buy something, so we can ensure the authenticity of those review. There are so many products available in online platform. Like: food products, makeup kit, dresses, shoes, watches, mobile phones etc. So we could able to gather data for multi categories products.

3.3.2 Data Processing

The stage data processing means conversion of information or raw data into desired and usable format if a machine can read it easily. As a result of any research work depends on the quality of a dataset, so it is must to process data sincerely. It helps to make accurate decision. Now a huge number of people use English words in Bengali comments. After completing data collection we checked and removed every English word and characters. In this step we found some spelling mistake also. We carefully corrected all the wrong spelling. Then we focused on punctuation marks and unnecessary space and removed all the exceptions. We divide our whole dataset into three levels. Although there were

insufficient data we balanced data as 620 positive and 620 negative reviews. We also took 417 reviews as neutral. In Figure 3.3 the whole processing system is shown.

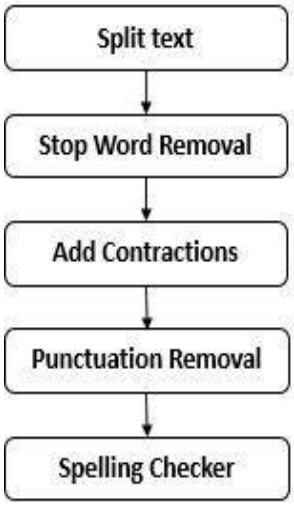

Figure 3.3: Data Processing System

Table-3.1 shows a sample of our dataset.

Table 3.1: Sample Dataset

Data	Label
যেমন ভেবেছিলাম তার থেকে বেশি ভালো সার্ভিস পেয়েছি। ধন্যবাদ দারাজ	**positive**
সচরাচরের থেকে অনেক বেশি সময় লেগেছে	**negative**
প্রোডাক্ট একদম যত্নের সাথেই এসেছে আমার কাছে	**positive**
তাদের পাঠানো লেন্স দিয়ে কয়টা ছবি তুলে পাঠালাম।	**neutral**
২ টা অর্ডার করেছিলাম কিন্তু ২ টাতেই সমস্যা ছিল। একটার গায়ে রং এর দাগ এবং বড় একটা স্ক্র্যাচ, আরেকটায় ময়লা ছিল মনে হয় এই জন্য ধুয়ে দিয়েছে। সেলাই এর কোয়ালিটি ও খারাপ। এদের মতো সেলার ডারাজ এ মোটেই কাম্য নয়। এর দায় নেবে কারা?	**negative**
কালার অরিজিনালের মত না, একটু শক্ত কোয়ালিটি,	**negative**

দারাজ থেকে বেশ কয়েকটা প্রডাক্ট অর্ডার করেছি, এখন অবদি কোনো নেগেটিভ পাইনি। এটাও তাই, যেটা অর্ডার করেছিলাম সেটাই পেয়েছি। ধন্যবাদ দারাজ,ধন্যবাদ ছেলার	**positive**
প্রডাক্ট অনেক ভালো এটা নিয়ে কোনো অভিযোগ নেই	**positive**
এটা আমার প্রথম অর্ডার ছিলো। যেমনটা চেয়েছিলাম ঠিক সেরকম ই পেয়েছি, খুব ভালো লাগলো, ডেলিভারি ম্যান খুবই আন্তরিক ছিলো। ধন্যবাদ দারাজ	**positive**
খুবই ভালো প্রোডাক্ট।বডি লাইট টানা ১ ঘন্টা জ্বলে।ফাস্ট ডেলিভারি। ক্লিপ ছারা থেকে ক্লিপ সিস্টেমের লাইট টা (যেটা আমি নিয়েছি) দেখতে বেশি সুন্দর	**positive**
চার্জিং ক্যাবল মিসিং, কেবল ছারা চার্জ দেব কিভাবে, একটু কেয়ারফুল্লী দিতে পারতেন। একদম বাজে সেলার।	**negative**
সয়াবিন তেল নিত্যপ্রয়োজনীয় পন্য	**neutral**
আগের রাউটার এখনো চলতেছে, দেখা যাক এইটা কেমন সার্ভিস দেয়।	**neutral**
আপনাদের থেকে আমি একটা রাউটার নিছি কানেক্ট হচ্ছে না।	**negative**
অরিজিনাল অথোরাইজড প্রোডাক্ট	**positive**

3.3.3 Tokenization

The process applied for transmitting sensorial data with unique character or identification that contains every information is called tokenization. Token does not change the length and format of the main data. In our research work we have used keras as tokenizer that

encoded words into numerical numbers and used the values as input.

3.3.4 Word Embedding

Our research is based on Bangla text. So the dataset that we created is also full in Bangla text. When we need to illustrate documents and texts, we took help of word embedding. It is a powerful and important way to complete illustrating task. The process of finding the word that have similar meaning for similar paradigm. To represent the documents and words this embedding system works as key factor in deep learning. There are some processes where a large dataset is used to train embedding and saved to use in other works that is called as pertained embedding. We can find more accuracy by using pre trained embedding for a dataset. We used "bnword2vec" as pre trained embedding's in our work to get better accuracy in short time.

3.4 Statistical Analysis

There are a large number of review data on various online platforms. As we decided to work on Bangla language so we have gathered only Bangla reviews. Then we classified them into positive, negative and neutral category. Then we used 80% of our dataset for training and 20% of data to check the validation. We selected Microsoft excel to save our dataset.

3.5 Implementation Assessments

Now-a-days deep learning has become very popular site for research. A lots of methods are developing rapidly that are useful for deep learning purpose. Every model does different tasks. Such as, the work related with image processing is usually done by CNN. We applied LSTM and combined CNN-LSTM models for our constructed dataset. In below we are describing those methods.

3.5.1 Long Short Term Memory

LSTM is a memory attached architecture. It contains memory which make it differ from RNN. RNN is also an architecture but it doesn't contain any memory. LSTM architecture

receives data as input and memories by its memory. After memorizing it makes decision on the basis of those data. LSTM is an architecture that can accept sequential data of larger size. It can capture a sentence with accurate feelings. As LSTM is an update version of RNN, so it can hold long time the previous activities than RNN. LSTM has 3 gates. It takes input by using input gate. It maintain the memory by controlling the amount of information. And generate output with the help of output gate.

We took some necessary steps to use the architecture constructed by LSTM. To feed the embedding layer we used our collected data as input. We added word2vec which was pre trained by 300 dimensions into embedding layer. We also used ReLU into embedding layer as activation function. To eliminate over fitting dropout rate 0.25 was added. A hidden layer in size of 128 of LSTM was used. Again a dropout rate 0.25 was added after the usage of ReLU activator.

Finally, by applying softmax function we were able to separate the positive, negative or neutral comments that we took as input. The working process of LSTM is given in below:

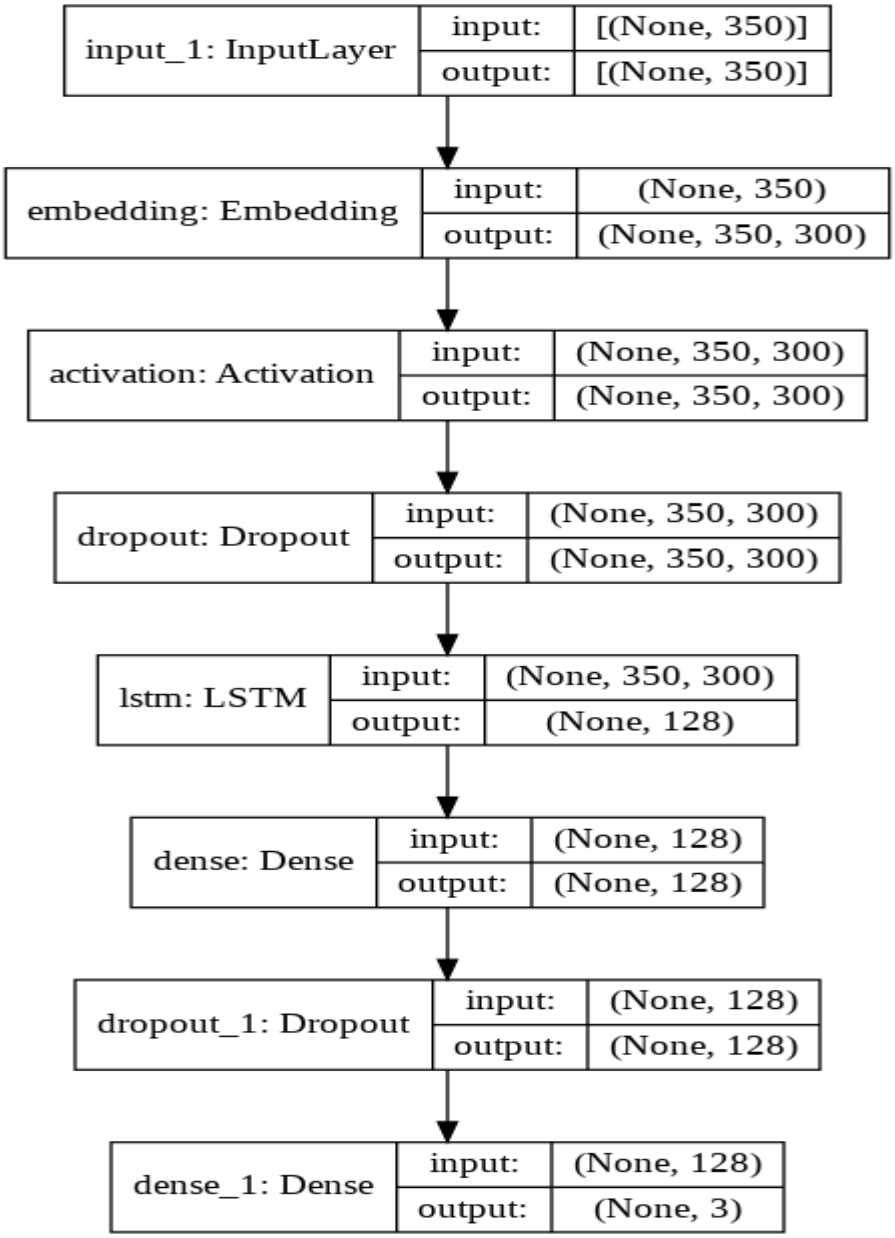

Figure 3.4: Working process of LSTM

3.5.2 Combined CNN-LSTM

Generally LSTM or CNN architecture provides different result for same dataset. The accuracy of text classification can be improved by using combine CNN-LSTM architecture. There are huge usages of combine CNN-LSTM architecture. It is also used for sequential prediction for some local input. In the architecture which is combined by

CNN and LSTM the target is to extract characteristic of data. For this task CNN layer does the whole work by taking support of LSTM.

Firstly as input we fed the embedding layer by the dataset that we created by gathering reviews. We used 0.25 rated dropout. Then a convolutional layer of CNN was added by us that containing 128 filters size of karnel 3 3, padding with validation and the function with ReLU activation. We also used different CNN convolutional layer that size of filter was 256 with same size karnel and same padding which was used in before. ReLU activation was also added here. After finishing the use of convolutional layer, a max pooling layer was used. We used max pooling layer if the computational power increase by reducing the dimension. After adding 256 sized LSTM layer we could completely connect 256 dimensional layer. Then ReLU activation was added. Again we used 0.25 rated dropout to overcome the over fitting problem.

Finally, we classified as previous architecture by using softmax function. The working process of combined CNN-LSTM architecture is given in below.

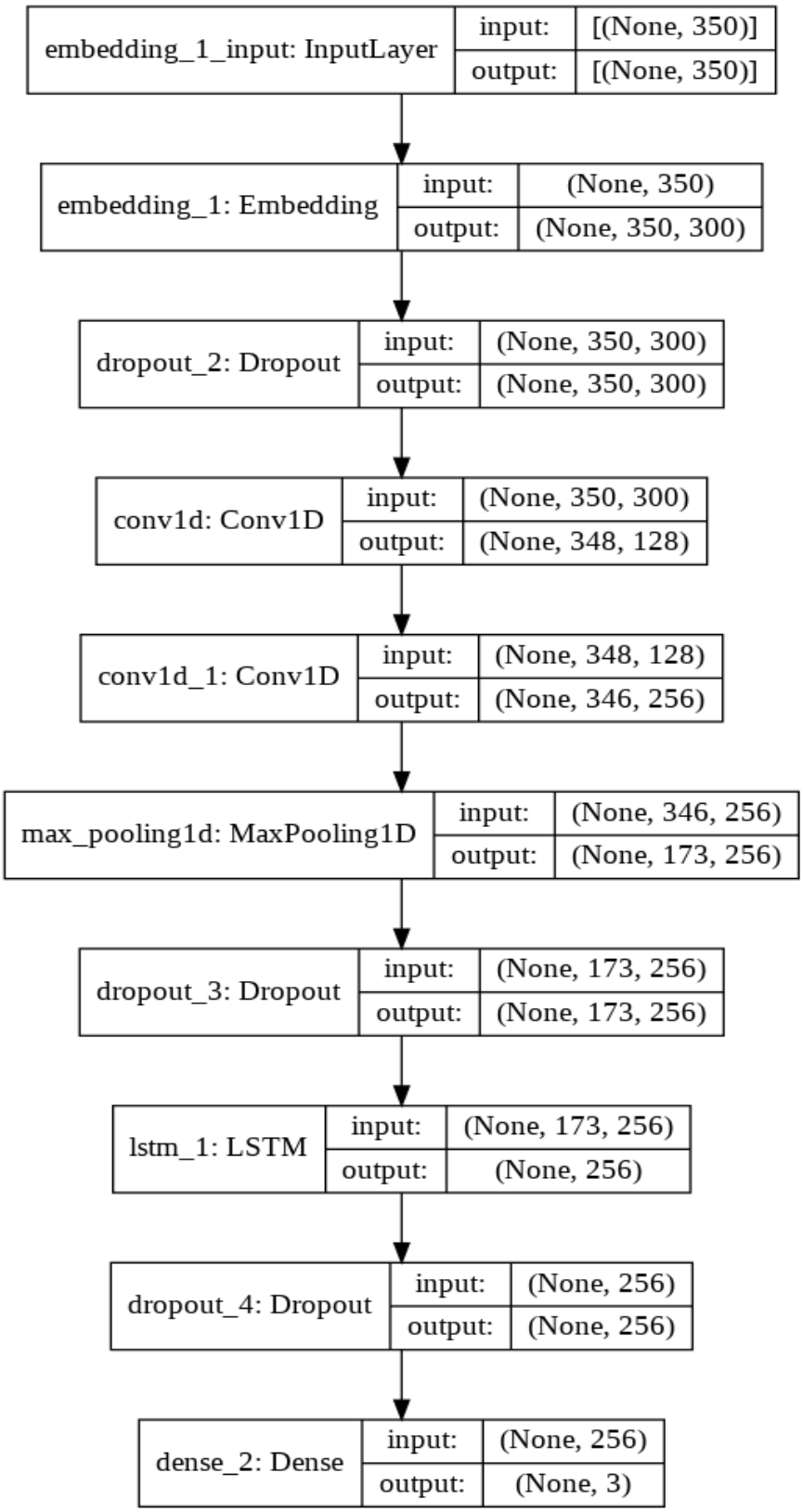

Figure 3.5: Working process of Combined CNN-LSTM

Classification results of these algorithms are shown in Table 3.2.

Table 3.2: Classification Result

Text	LSTM Prediction	Combined CNN-LSTM Prediction	ssification Result
এই খাবারে আমি হতাশ, স্বাদ ভাল ছিল না, শুধু ঝাল	**negative**	negative	**negative**
পারফেক্ট, সাইজটা আমার জন্য পার ফেক্ট ছিল	positive	**positive**	**positive**
তাদের অল্প তেল ব্যবহার করা দরকার	**neutral**	negative	**neutral**

In the Table-3.2 we can see our system is able to find the polarity of a sentence. The LSTM architecture can define the polarity more accurately.

CHAPTER 4

EXPERIMENTAL RESULT AND DISCUSSION

4.1 Introduction

Online e-commerce platform is a place where buyer and seller can communicate virtually. It doesn't matter where they are staying and nobody have to present physically in a certain market place. A buyer can buy any product that are available in online platform from home, office or another place. So there is no chance to examine a product by taking in hand. Check the reviews against a product is the single way to make decision about a product. We fixed our research topic as "Sentiment analysis on online product review in Bangla using LSTM". The citizens of whole Bangladesh are getting dependency on online product rapidly. We tried in our research to determine a products quality or service if it is good or bad from the comments of previous buyers. Several algorithms were used to predict the quality of those products. We used LSTM and combined CNN-LSTM to make decision about a product whether it is perfect for one's demand or not.

4.2 Experimental Setup

The main motive of our research is to make a decision about a product if it is useful or not by analyzing the comments of previous buyers in Bangladesh. For that reason we collected data from Bangla comments that are available in various e-commerce sites. Then our data set was created. By applying some operations we created a data set. We preprocessed data by using pandas, numpy library. Using this setup which contains various algorithms we tried to get better result. We also used tensorflow, tokenization and word embedding for the best accuracy.

4.3 Experimental Results and Analysis

4.3.1 Hyper-Parameter Tuning

Hyper-Parameter in generally used to upgrade some selected defined variable. The variable which is defined before is called the Hyper-Parameter metric. Some parameters which was predefined named Hyper-Parameter was used to complete our work. We used this

parameters if the architecture can work smoothly. To get the better performance of the parameters we need to tune those properly. We used word2vec that contain 5000 vocabularies. We used 75, 128 of batch size and 0.001 learning rate as Hyper-Parameter for the purpose of gaining the accuracy of the architecture that we used.

4.3.2 Result Comparison and Analysis

As our work fully depends on dataset, so after complete the whole dataset we started to run our algorithms. We divided the whole dataset into training and testing part. To train our model 80% of data that we collected from various platform was used. We saved another part of the dataset for testing issue. We completed some necessary steps to compile the architecture that we used. Hyper parameters were defined in that architecture. The compilation of the architecture was started. We applied some functions and optimizer to run our architecture. We mainly used categorical cross entropy loss function and Adam optimizer. We started the training by with the help of .fit() technique. And by using this technique we prepared 20% of data for checking validity. When all of our proposed architecture were completed their training the best accuracy was provided by LSTM and that was 82.54%. The classification report that we gained from LSTM architecture is shown in table 4.1. By calculating this classification it can be seen that the average precision of our model is 0.84 where the average of Recall and f1-score is 0.64 and 0.72 respectively. We get better precision than f1-score and Recall. Again we can see for positive data the value of precision is 0.84, Recall is 0.55 and f1-score is 0.67. For negative data the value of Precision, Recall and f1-score is 0.98, 0.72 and 0.83 respectively. Again for neutral data the value of Precision is 0.71, Recall is 0.66 and f1-score is 0.68. Here we can notice that the precision, Recall and f1-score of negative is better than Positive and neutral.

Table 4.1: Classification Report of LSTM

Architecture	**Precision**	**Recall**	**f1-score**
Negative	**0.84**	0.55	0.67
Positive	**0.98**	0.72	0.83

Neutral	**0.71**	0.66	0.68

We got another classification report by applying combined CNN-LSTM architecture. We have shown the classification report in Table 4.2. After executing combined CNN-LSTM architecture we get the best average precision 0.57. Where 0.21 and 0.28 are the average value of Recall and f1-score. As we divided our data into three category, we get three different values of Precision, Recall and f1-score. In this result we can see the value of Precision for neutral data is better than the value of positive and negative data. Again the value of Recall is better for positive data than negative or neutral value.

Table 4.2: Classification Report of CNN-LSTM

Architecture	**Precision**	**Recall**	**f1-score**
Negative	**0.47**	0.36	0.41
Positive	**0.57**	0.13	0.21
Neutral	**0.67**	0.14	0.23

The table 4.3 below shows average precision, recall, f1-score of LSTM, CNN, combined CNN-LSTM.

Table 4.3: Average Comparison of precision, recall and f1-score

Architecture	**Precision**	**Recall**	**f1-score**
LSTM	0.83	0.64	0.72
Combined CNN-LSTM	0.57	0.21	0.28

The performance comparison of our used architectures is shown in Table 4.4.We used LSTM and combined CNN-LSTM architectures. We got the best accuracy of 82.54% using LSTM. Where combined CNN-LSTM architecture gives 73.21% accuracy.

Table 4.4: Performance Comparison of Architectures

Architecture	**Technique**	**Top accuracy**
LSTM	word2vec	82.54%
Combined CNN-LSTM	word2vec	73.21%

4.4 Discussion

For every work the result depends on the working process. Every steps which are followed to do a research work are called the part of process. Those steps are very important to get the result of any research. We also followed those Steps. Such as data collection, data processing, applying algorithms to get better result or output. We could gather a few numbers of Bangla comments, so we could execute our work in smaller scale. We have used 1658 Bangla comments in total. They were divided into three category. From previous work experience we understand that the Deep Learning Model is suitable for our work. We applied LSTM and combined CNN-LSTM on this works dataset. We got two different accuracy after applying this two algorithms. We took help from training and testing part of our dataset to get the accuracy. The best accuracy was generated by LSTM which was 82.54%. Where the accuracy of combined CNN-LSTM was 73.21%. It is possible to get better accuracy by using more enrich dataset.

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

There is no research work will be found that has no impact on society. Every work provide great impact for our society. In our research we worked to predict the polarity of Bangla reviews for online products. As from everywhere and every ages people in our county uses online marketplace for their expected product, so all of them will be beneficial by our work. There are found some works like this for another language but in Bengali there are rarely found. So our merchants can take a chance to make fraud with their consumers or write false information in products advertisements. If it would possible to verify reviews properly, it will be easy to determine which review is positive, negative or neutral. Then anyone can have clear knowledge about a product. Many people are getting dependency on online product. If any online platform can achieve the faith of customers they can attract more customers. And the customers will be also benefited by purchase product from online platform.

5.2 Impact on Environment

It is commonly seen that some customers are cheated by merchants. Sometimes the customers complain that given products are different from the picture which was shown in their online sites. Even it is also seen that some fraud people take some money by saying that they are taking advance for the product as a costing charge but send nothing and disconnect contact. When the customers realize that they are cheated, they contact with police which grows anarchy in society. On the other hand as there is rarely any platform which can make difference between reliable online sites and fraud online sites, so some fraud people take advantages. And as it is an easy way to make money so the number of this kind of people is increasing day by day which impacts on environment badly. It is a common scenario that the deceiver who has confessed wants to make up for his loss at any cost. Then the possibility of his involvement in various crime increases. From this background we can say that from a silly matter a crisis can be happened, which is not good for the environment. Our work will take a place to make decision before buying a product

and make people happy to have their desired products.

5.3 Ethical Aspects

As we worked with a lots of comments that was written by a large number of peoples. We took data from various platforms, where everyone must have an account to write a comment. We choose those sites if all the comments are authentic. In addition to collecting accurate information, we make sure that our collected data and work process will not be harmful for human privacy and right. At the time of collecting data we avoid people's personal information, like name, phone number or address. So by using our collected data it is not possible to identify or take action against anyone. To complete our work we strictly avoid same work methodology or dataset of other organization. As the result of our work fully depends on data, so we were more careful to collect and store data. Our main purpose was to do a good job, not to ruin a person's personal life. We collected data randomly which were isolated. So that, no one's comments get any priority. As our dataset was fully created by us so we can ensure nobody will be harmed by our work. We avoided the other equipment which was used before by another person.

5.4 Sustainability Plan

The main objective of our research is to make online business more credible. Nowadays the people of our country are very conscious to save time. Beside this our shopkeepers are also updating their business policy. They are turning their business into online platform. Our proposed model will help those organizations to change their business policy in future. Our developed model mainly depends on dataset, so by collecting more data, many advance and suitable work can be done in future. And other researcher can also take help from our research. By constructing enrich dataset, if we can improve our model it can be used in large size. By using this model e-commerce business can gain more trustworthy of the customers.

CHAPTER 6

SUMMARY, CONCLUSION AND IMPLICATION FOR FUTHER STUDY

6.1 Summary of the Study

To complete our whole work we strictly followed Bangla NLP process. The motive of our work to find the polarity of Bangla reviews. By analyzing reviews with help of our project one can realize if a product is suitable or not. We didn't find any work that directly matched with our work. No other work has been done previously, using Bangla comments and deep learning methodology. We manually gathered 1658 comments to create our dataset. Then we modified LSTM and combined CNN-LSTM to work with our dataset which contains three categories of data. Our model provided a good accuracy. Other researchers can take help from our model who wants to work in Bangla NLP area. We took about five months

To complete our work, we have completely done our work by following some necessary steps. In below we are summarizing the steps that we followed -

Step 1: Bangla review data collection from various online platform.

Step 2: Store data in .xlsx file.

Step 3: Process the data.

Step 4: Counting vocabulary.

Step 5: Pad sequencing for data sequence length.

Step 6: Encoding and Decoding with LSTM and combined CMM-LSTM.

Step 7: Training and Testing model.

Step 8: Review the result.

We completed all those steps to construct our proposed model. Our model will play a significant role in the development of Bangla NLP.

6.2 Conclusion

In this paper we have discussed the architecture that is based on deep learning. In our work we tried to find the polarity of a sentence. To do this Bengali reviews were collected from different web platform. After applying some processing steps we created a clear dataset which we used as input for our model. We revised some related work on different language.

From those work we got the inspiration to work with Bengali language. Because of unavailability of data we could not make a big dataset. We collected only 1658 data for our work. Although our dataset was not so bigger but we got a good accuracy from the machine by using our model. Between our used LSTM and combined CNN-LSTM we got the best accuracy from LSTM. We used word2Vec with 300 dimensions as pre-trained element. Bengali data processing is so difficult than English language. Because there are insufficient library is found to process Bangla language. Although there were so many limitations, our model provided good output. Our proposed LSTM model gave 82.54% accuracy which is a great result. Although our polarity predicting system has some limitations, we hope that in future it will help a lot for Bengali language work.

6.3 Implication for further Study

At the time of executing our implemented model we faced some limitations. As it is known to us that every research method in an ongoing process, so in future our model will overcome those limitations. We will use larger dataset and another algorithm to get better validity. It is just a beginning of Bangla review categorization. In future we will work in deep level based on this research. In this work we just worked with sentence. We will try to add emoji with this work.

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