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A Comparative Analysis of Social Communication Applications using Aspect Based Sentiment Analysis

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Abstract- **Google Play Store is a popular distribution channel with millions of applications. WhatsApp is the most downloaded communication application on Play Store. A few months ago, WhatsApp changed its privacy policy, triggering a wave of user reviews outrage. Privacy is essential in the application; users are worried about their data security and privacy. A computational system must be required to analyze the user's reviews for WhatsApp authority to make better policies. This study aims to develop a deep learning-based model for automatically assessing reviews that can be adapted for future data analysis. We proposed a deep learning methodology by using Aspect-based sentiment analysis (ABSA) utilizing the communication app reviews scraped from the Google play store using the Google Play scrapper application. This study uses the text mining technique for ABSA on the user's reviews. For Topic extraction, we have used Latent Dirichlet Allocation (LDA) and the deep learning method Long Short-Term Memory (LSTM) for topic classification. The results show that our proposed model gives us a promising outcome with 90% accuracy by using the LSTM model. WhatsApp authority can use the results to optimize communication applications by adding more efficient features and updating them.**

Index Terms-- **Aspects Extraction, Communication Application, Machine learning, Sentiment Analysis, LDA.**

I. INTRODUCTION

With the quick improvement of internet innovation, countless online reviews have been created via web-based media and the internet business stage, which contain important data. In this manner, analysis of sentiments has brought developing consideration in both scientific researchers and the business community. User opinion in mobile application reviews is essential for application and company developers. Consequently, opinion mining and sentiment analysis have earned importance in this field. Google Play Store is the most popular app distribution channel, with over 3.48 million apps available [1], allowing millions of apps to be installed every minute. Because of the enormous number of users, mobile communication application development has become an appealing subject for software engineers, but it has also resulted in competition among developers. Most popular communication applications, such as WhatsApp, get thousands of inspections. Open-source applications include fewer audits, but they still have limited assets, and hundreds of evaluations take time away from solving problems and implementing new features for the users. Therefore a system is required for machine-mechanized analysis of user evaluations. The chart will show downloads and reviews of certain messaging apps in Fig. 1.

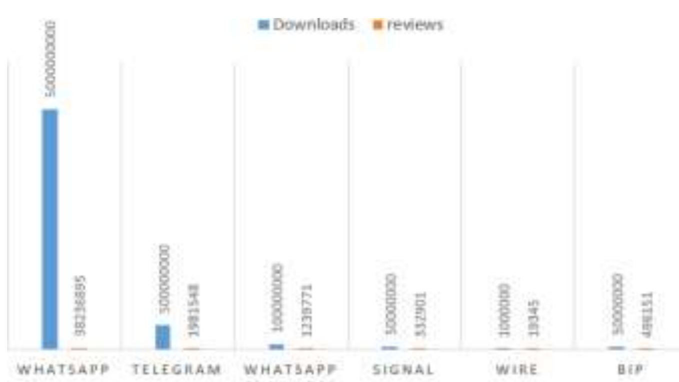


FIGURE 1. Statistics chart of messaging Apps about download and review

The new policy provoked WhatsApp users and triggered a wave of social media outrage resulting in people uninstalling

WhatsApp and switching to 'Signal' or 'Telegram' or too many other apps that offer more encryption.

Moreover, as a result, Signal App was downloaded 8.8 million times after WhatsApp changed its privacy policy. The WhatsApp privacy notification was issued on Tuesday, January 4, according to data from Sensor Tower [2-5]. In a message sent to all its users on Tuesday, Telegram said it now has 500 million active users [3, 6-10]. The Sensor tower recorded a 14% decrease in WhatsApp downloads [4, 11-14]. WhatsApp recorded 9.4 million downloads after the announcement compared with 11.7%. Aspect-based sentiment analysis (ABSA) has gained a rising concentration recently. This term refers to a subclass of sentiment analysis that identifies the sentiment polarity of a statement by determining whether it is positive, negative, or neutral. Target aspects are words or phrases that describe an aspect of an entity. Our study aspects define the actual reviews and label the review with extracted aspects. For model evaluation, we have used LSTM. LSTM is a special kind and updated version of RNN. In terms of performance on a broad spectrum of problems.

A. PROBLEM STATEMENT

This study reviews the communication app's security, performance, and resources. Nowadays, security is a significant issue for app users. It is tough to maintain the user's privacy. WhatsApp updated its privacy policy to allow sharing of WhatsApp data with Facebook a few days ago. Furthermore, it is a hot issue nowadays that WhatsApp will share its data with Facebook. The users are concerned with this and writing reviews about this privacy update. Due to this privacy issue, many users switch to other messaging apps. We will assess the user's review to update the developers about their new renovation [15-20]. Figure 2 shows the decrease in downloads after WhatsApp's new privacy policy.

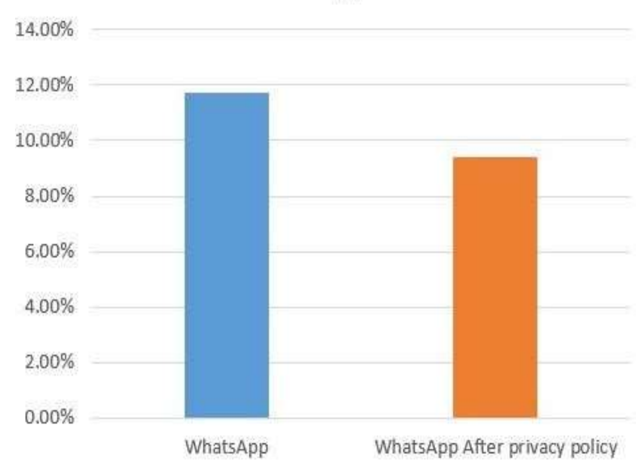


FIGURE 2. Decrease rate in WhatsApp Download

B. CONTRIBUTION

To overcome the problems mentioned above, we used deep learning technology, and our contributions are described below:

- Scrapped user feedback about WhatsApp from Google Play Store using the google play scrapper application.
- Performed pre-processing techniques such as (Tokenizing, removing punctuation marks, removing stop words, and POS Tagging) that helped structure our data.
- We used the LDA topic extraction model to extract dominant topics from the user's feedback.
- Further, we also performed sentiment classification using the LSTM model to analyze the user's sentiment about specific topics extracted from their WhatsApp feedback.
- We evaluated the performance of our approach with various evaluation metrics, and we obtained significant accuracy in analyzing the feedback.
- Our proposed model assists the authorities in understanding the user sentiment regarding their policy better.

II. RELATED WORK

The role and importance of data and its analysis gained attention globally. Exploring the meaningful hidden pattern from collected data is challenging and laborious. The analyses become complex when collected data is unstructured and heterogeneous. Currently, every well-known organization uses data mining and machine learning applications frequently to explore the meaningful hidden patterns from raw collected data [20][21][22]. Nowadays, machine learning is used in various aspects of life [23] [24] to perform complex analyses and explore hidden patterns from data points. Khursheed Aurangzeb et al. [5] Proposed a methodology related to our work in which they extracted aspects using a multi-labelling technique with a machine learning algorithm like SVM-based Ensemble. Omar Alqaryouti et al. [6] present a sentiment analysis method based on rule aspect and lexicon-based integration to cope with extracting government mobile applications' elements and organizing implicit and explicit sentiment.

The study [7] focuses on users' reactions to these ridesharing applications, and the model was evaluated using the CNN, LSTM, and DistilBERT algorithms, with DistilBERT.

Usman Wijaya et al. [8] evaluated a model using a machine learning algorithm like a random forest algorithm and logistic regression to analyze the sentiment of tracing the spread of COVID-19 applications in the South Asian Google play store.

Another related study to our research is that we analyze investment application reviews collected from the google play store. This study [9] used a machine learning algorithm random forest for the evaluation.

A programming tool (University Centre for Computer Corpus Research on Language) (UCREL) semantic analysis system (USAS) for automating English spoken and written data semantic analysis was used in this study. They also use techniques including part-of-speech tagging, general likelihood rating, multiword expression extraction, the domain of discourse identification, and contextual rules.

Afrin Jaman Bonny et al. [10] analyze the polarity of reviews on women's safety applications taken from the Google play store. The methodology uses machine learning algorithms like

Multinomial Naive Bayes (MNB), Logistic Regression (LR), Support Vector Machine (SVM), and k-nearest neighbor (k-NN). Nowadays, computational technologies are being used in various domains of life, including healthcare [25], security and also in safety purposes, disaster and situational awareness [26] in the educational domain [27] as well.

Authors of [11] look into a method for extracting lexical information bases from video records in a substantial multimodal dataset to deal with acquiring such knowledge (MuSe-CAR). To achieve this, they used SenticNet to extract natural language ideas and tweak a few component types on a subset of MuSe-CAR. They investigate the content of a film using these attributes, precisely as we do with emotional valence, enthusiasm, and speaker theme classes.

The authors [12] [27] show that sentiment analysis is utilized in various ways, including product and service audits. There is a tremendous measure of data about medical care accessible on the web, like individual online journals, web-based media, and pages about ailments positioning that are not used deliberately and frequently utilized in medical services. Notion investigation has various benefits, including using clinical information to get the best outcomes and improve medical care quality. This paper discusses strategies and methods for sentiment analysis in the medical domain.

Using Chinese word segmentation technology and two-mode social systems in this paper [13], the moment semantic analysis and input framework (ISAFS) is described in this study as a novel visualization apparatus for displaying the semantic systems of co- words and non-co-words used in learners' discussion forms and assisting learners in getting a handle on the discussion direction to improve online learning adequacy.

In this paper [14], they used the aspects to create an auxiliary sentence and convert ABSA into a sentence-pair classification job, such as Questioning Answering (QA) and Natural Language Inference (NLI). On the SentiHood and SemEval2014 Task 4 datasets, they update the pre-prepared model from BERT and achieve new state-of-the-art in-class outcomes. Kai Shuang et al. [15], the author developed a Feature refining network (FRN) for refining topic-relevant emotion features. Moreover, the double gate system was introduced, which carries out fine-grained connections between characteristics and their comparison contexts. They place a context nonlinear projection layer in front of the double gate mechanism for generating topic-specific word depictions, allowing a system (double gate) that precisely recognizes sentiment traits of a term in the context that matches the various aspects. Based on web-based media remarks, this study [16] [26] utilizes the machine learning technique to recognize uneasiness concerning government projects to avoid pandemics. This study [17] proposed a new method for detecting fuzzy sentiment in tweets using a feature ensemble model that considers the sentiment of word polarity, lexical, and word type. Baris Ozyurt et al. [18] proposed that Sentence Segment LDA (SS-LDA) is a unique technique for ABSA. For item topic or aspect extraction, SS- LDA is a fantastic transformation of the LDA method. The preliminary findings show that SS-LDA is quite good at differentiating item attributes. In this research [19] [25], for rating expectation tasks, they presented a new Multilingual Review-aware Deep Recommendation Model (MrRec). MrRec is divided into two sections: (1) the Multilingual aspect-based sentiment analysis module (MABSA), [27] which combines the extraction of aligned aspects and their related notions in various languages at the same time while only requiring in general survey appraisals (2) A multilingual recommendation module that understands the significance of the client and the thing while taking into account diverse languages' attention and evaluating aspect utility through a double intelligent consideration instrument incorporating aspect clear MABSA ideas. Finally, assessments can be acquired using a forecast layer that includes the aspect utility worth and perspective significance as data sources.

III. PROPOSED METHODOLOGY

Our methodology is a multi-step process that addresses two tasks. Firstly, we extracted the reviews of apps (WhatsApp, Wire, Signal, Bip, and Telegram) from the Google play store with the help of the Google Play scrapper and created a dataset for further processing. After extracting the reviews, we pre-processed and cleaned the text from stopwords, punctuation, numbers, and emoji to make well-formed data. After performing the pre-processing, we used the LDA topic modeling approach to extract the main contributing topics and their relevant terms. Moreover, we used a supervised machine learning approach to annotate each piece of feedback on a specific topic. Ultimately, we used the LSTM model to perform aspect-based sentiment classification. Our proposed framework for aspect-based sentiment analysis for communication apps is shown in Fig. 3.

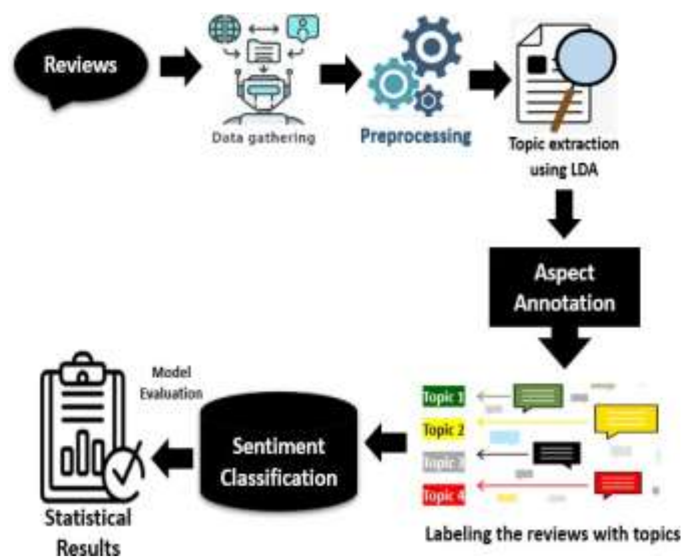
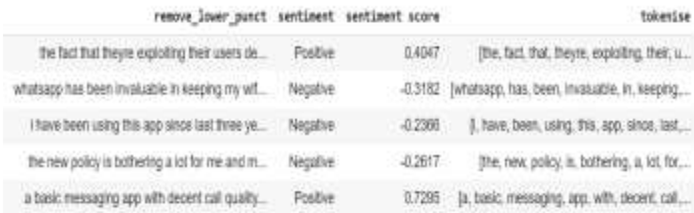


FIGURE 3. Proposed framework for Communication app reviews.

A. DATA ACCESSION FOR SCRAPPING THE DATASET

Data is one of the most significant chunks of a research study. For this, we have extracted the reviews of 5 communication applications from the Google play store with the help of Google play scrapper and converted them into CSV format, as shown in Fig. 4.



remove_lower_punct	sentiment	sentiment score	tokenise
the fact that theyre exploiting their users de...	Positive	0.4047	[the, fact, that, theyre, exploiting, their, u...
whatsapp has been invaluable in keeping my wif...	Negative	-0.3182	[whatsapp, has, been, invaluable, in, keeping,...
i have been using this app since last three ye...	Negative	-0.2366	[i, have, been, using, this, app, since, last,...
the new policy is bothering a lot for me and m...	Negative	-0.2617	[the, new, policy, is, bothering, a, lot, for,...
a basic messaging app with decent call quality...	Positive	0.7295	[a, basic, messaging, app, with, decent, call,...

FIGURE 4. Our prime dataset before pre-processing

The data set consists of (WhatsApp, Wire, Signal, Bip, and Telegram) app reviews. In the next stage, we ranked the reviews, which indicates which ones the Google Play store considers essential. Just in case, we have gathered a sample of the most recent reviews. To improve the accuracy of reviews, we have added the app id and sort order to each one, as shown in Fig. 6.

B. PRE-PROCESSING ON PRIME DATASET

We considered the review of communication applications for text mining. Pre-processing audits can be regarded as analytic methods, as it entails turning raw data in a well-formed manner. Text analysis is case-sensitive; converting text into lowercase is crucial. The frequency of each letter is counted in the probabilistic model. So “Word” and “word” are treated differently if the case conversion is not applied to text data. We also used pre-processing techniques (Tokenizing, removing punctuation marks, removing stop words, and POS Tagging) that helped structure our data. Removing punctuation is a general step in text mining techniques. The final pre-processed dataset is shown in Fig. 5.

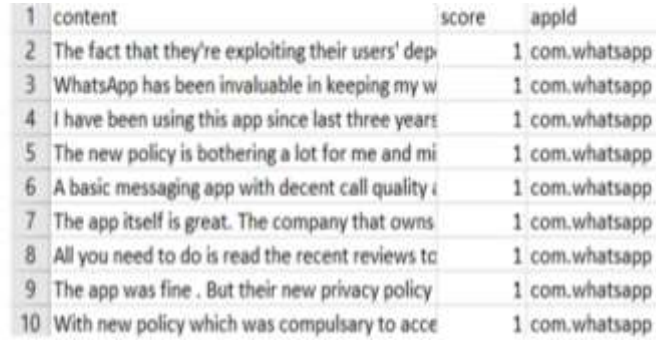
content	feedback_clean
The fact that they're exploiting their users' ...	the fact that they're exploiting their users d...
WhatsApp has been invaluable in keeping my wif...	whatsapp has been invaluable in keeping my wif...
I have been using this app since last three ye...	have been using this app since last three year...
The new policy is bothering a lot for me and m...	the new policy is bothering lot for me and mil...
A basic messaging app with decent call quality...	basic messaging app with decent call quality a...

FIGURE 5. Dataset after performing the pre-processing

C. PREPARING DATA FOR TOPIC MODELING

After pre-processing, the upgraded dataset has a lot of potential and unique properties. The method of feature extraction extracts the dataset characteristic (adjective). This adjective will be used later. In a sentence, it is utilized to show the positive and negative polarity. It is beneficial in determining individual opinions utilizing the unigram model.

NLTK (Natural Language Toolkit) is a set of modules based on python that processes the natural statistical language in English. Figure 6 shows the tokenized reviews.



1	content	score	appId
2	The fact that they're exploiting their users' dep	1	com.whatsapp
3	WhatsApp has been invaluable in keeping my w	1	com.whatsapp
4	I have been using this app since last three years	1	com.whatsapp
5	The new policy is bothering a lot for me and mi	1	com.whatsapp
6	A basic messaging app with decent call quality a	1	com.whatsapp
7	The app itself is great. The company that owns	1	com.whatsapp
8	All you need to do is read the recent reviews to	1	com.whatsapp
9	The app was fine . But their new privacy policy	1	com.whatsapp
10	With new policy which was compulsary to acce	1	com.whatsapp

FIGURE 6. Sentiment, sentiment score, and tokenization on textual data.

D. POS TAGGING

The Stanford POS Tagger is a tool that has been widely used to associate words with the parts of speech to which category they belong. The reviews are linked to their proper parts of speech via POS. This creates a precise tag from the Natural Language Toolkit (NLTK) library for individual words. Table I reported the POS Tagging according to our dataset. Moreover, we also visualized the word cloud to represent the topics in our dataset, as shown in Fig. 7.

FIGURE 7. Word cloud of review dataset.

TABLE I: POS TAGGING

Review	Review after POS
I have been using this app since last three years, I had a really good experience with it and the privacy policy that they are providing it was good everything is end to end encrypted till December 2020. But I n 2021 I have been facing lots of privacy issues. And it’s very hurting for me to switch to a pp named signal by these days. So one star to WhatsApp.	[('I', 'PRP'), ('have', 'VBP'), ('been', 'VBN'), ('using', 'VBG'), ('this', 'DT'), ('app', 'NN'), ('since', 'IN'), ('last', 'JJ'), ('three', 'CD'), ('years', 'NNS'), (',', ','), ('I', 'PRP'), ('had', 'VBD'), ('a', 'DT'), ('really', 'RB'), ('good', 'JJ'), ('experience', 'NN'), ('with', 'IN'), ('it', 'PRP'), ('and', 'CC'), ('the', 'DT'), ('privacy', 'NN'), ('policy', 'NN'), ('that', 'IN'), ('they', 'PRP'), ('are', 'VBP'), ('providing', 'VBG'), ('it', 'PRP'), ('was', 'VBD'), ('good', 'JJ'), ('everything', 'NN'), ('is', 'VBZ'), ('end', 'JJ'), ('to', 'TO'), ('end', 'VB'), ('encrypted', 'VBN'), ('till', 'IN'), ('December', 'NNP'), ('2020', 'CD'), ('.', '.'), ('But', 'CC'), ('In', 'IN'), ('2021', 'CD'), ('I', 'PRP'), ('have', 'VBP'), ('been', 'VBN'), ('facing', 'VBG'), ('lots', 'NNS'), ('of', 'IN'), ('privacy', 'NN'), ('issues', 'NNS'), ('.', '.'), ('And', 'CC'), ('it', 'PRP'), ("'s", 'VBZ'), ('very', 'RB'), ('hurting', 'VBG'), ('for', 'IN'), ('me', 'PRP'), ('to', 'TO'), ('switch', 'VB'), ('to', 'TO'), ('app', 'VB'), ('named', 'VBN'), ('signal', 'JJ'), ('by', 'IN'), ('these', 'DT'), ('days', 'NNS'), ('.', '.'), ('So', 'RB'), ('one', 'CD'), ('star', 'NN'), ('to', 'TO'), ('WhatsApp', 'VB')]

The app is damn good. But i dunno about the new policy. If its just for the ads, then it ain’t a trouble. But peeping into personal data cannot be tolerated.	[('The', 'DT'), ('app', 'NN'), ('is', 'VBZ'), ('damn', 'RB'), ('good', 'JJ'), ('.', '.'), ('But', 'CC'), ('i', 'JJ'), ('dunno', 'VBP'), ('about', 'IN'), ('the', 'DT'), ('new', 'JJ'), ('policy', 'NN'), ('.', '.'), ('If', 'IN'), ('its', 'PRP$'), ('just', 'RB'), ('for', 'IN'), ('the', 'DT'), ('ads', 'NNS'), (',', ','), ('then', 'RB'), ('it', 'PRP'), ('ai', 'VBP'), ("n't", 'RB'), ('a', 'DT'), ('trouble', 'NN'), ('.', '.'), ('But', 'CC'), ('peeping', 'VBG'), ('into', 'IN'), ('personal', 'JJ'), ('data', 'NNS'), ('can', 'MD'), ('not', 'RB'), ('be', 'VB'),

E. ILLUSTRATION OF LDA TOPICS

To train LDA model, we provide a fixed number of topics from our corpus. The material’s multinomial distribution is utilized to select a theme. The word is chosen based on the topic’s multinomial distribution. In large-scale web mining, topic models like (LDA) have been used widely. The experimental results in terms of extracted topics, their relevant terms and coherence scoreare shown in Table II.

TABLE II: Extracted Topics with Relevant Terms and Coherence Score

Topics	Topic Term	Relevance Score
Topic 0	privacy	0.031
	update	0.024
	security	0.038
Topic 1	update	0.038
	app	0.03
	great	0.046
	work	0.038
Topic 2	feature	0.033
	message	0.024
	online	0.017
Topic 3	app	0.062
	call	0.041
	chat	0.031
	notification	0.022

F. ASPECT MAPPING

After extracting the topics using LDA further, we must map each aspect label to each feedback review. For this purpose, we have used a supervised machine learning approach for auto-labelling the aspect against each review. Finally, we have our data with separate annotations, as shown in Fig. 8.

	feedback_clean	categories
0	the fact that they're exploiting their users dependency on the app for more money is detestable ...	privacy
1	whatsapp has been invaluable in keeping my wife and in touch the past years when we are in diffe...	chat
2	have been using this app since last three years had really good experience with it and the priva...	chat
3	the new policy is bothering lot for me and millions of other users please take this matter serio...	chat
4	basic messaging app with decent call quality and video sharing capability however nowadays that...	chat

FIGURE 8. Dataset after annotations

G. SENTIMENT CLASSIFICATION

For sentiment classification, we have used the deep learning approach LSTM. The hyperparameter details of the deep learning model are also shown in Table III. We have also calculated precision, recall and f-measure against each topic, as shown in Table IV. Using LSTM, we achieved 90% accuracy, and we plotted the accuracy and loss graph, as shown in Fig. 9.

TABLE III: DEEP LEARNING MODELS PARAMETERS

The deep learning approach used	Batch	Epochs
LSTM	56	20

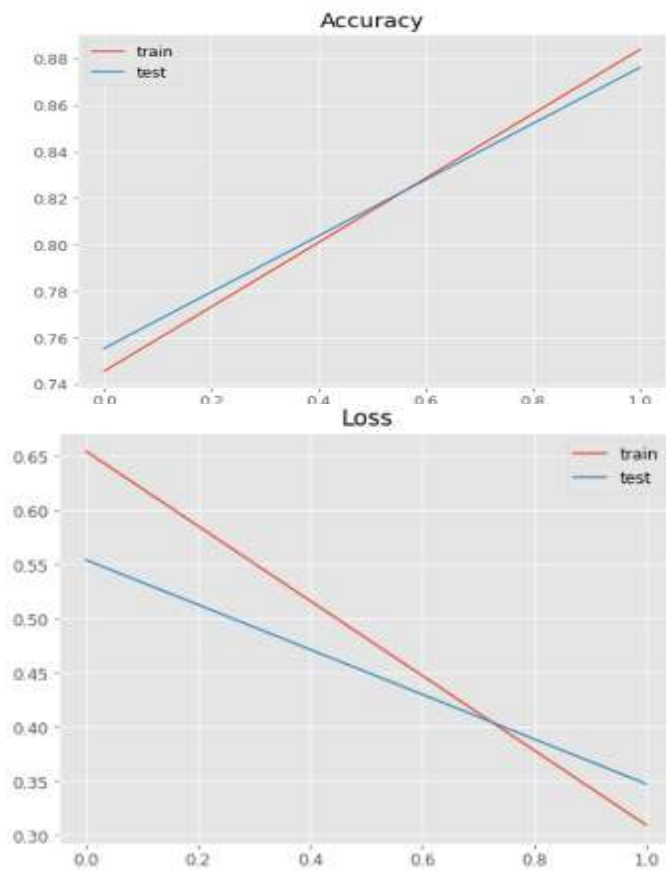


FIGURE 9. Loss and accuracy of the LSTM model

TABLE IV: PERFORMANCE METRIX OF EACH SENTIMENT CLASS

Class	Accuracy	Precision	Recall	F-measure
1	94%	0.91	0.91	0.91
2	94%	0.93	0.89	0.91
3	93.333%	0.88	0.92	0.90

The confusion matrix is primarily used in machine learning and deep learning classification problems to visualize the representation of statistical values obtained through experiments. Moreover, we plotted a confusion matrix to represent our model’sperformances, as shown in Fig. 10.

FIGURE 10. Confusion matrix for sentiment classification

Hence, we scrapped users' reviews of different communication apps from the Google Play store in this research. We used different topic modeling approaches to extract topic terms for annotation on unlabeled user reviews. Moreover, we also used the deep learning model to annotate the reviews.

V. CONCLUSION

Users' concerns for application privacy and other features are increasing nowadays, and they are writing about their experience on many platforms. Aspect-Based Sentiment Analysis is today's need. So we developed a system to analyze review data. Firstly, we have extracted the review, and for topic extraction, we have used LDA and LSTM for the Topic Classification. Our system gives us the best results with 90% Accuracy. Our study determines whether an opinion word is negative or positive based on polarity. Our study analysis will help the developers for better updates and feature future work. The analysis highlights the topics of the user review and gives them the sentiments according to the sentiment polarity. It's observed that the topics are helpful in finding solutions for the developers.

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CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest to report regarding the present study.

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