

Sentiment Analysis and Summarization of Product Reviews using Deep Learning Techniques

Mid Term Evaluation

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Agenda

1. Introduction
2. Problem Statement
3. Literature Survey
4. High Level Design
5. Low Level Design
6. Dataset
7. Algorithms/Methodology
8. Implementation Details

Introduction

- As potential customers, people usually seek help from the online portals to gain knowledge on a particular product, and finally, decide if the purchase should be made or not.
- It takes several hours to read all the reviews, sometimes even leading to missing out the important ones, thus ending up making the wrong decision on purchasing the product.
- A more well defined and concise product review is proposed such that the user need not skim through all the reviews, thus saving their time and effort.
- As a solution to the ongoing problem that the customer experiences daily, automatic review summarization will be used to analyze the product reviews and convert them into a user-readable and in a more concise and precise format.

Problem Statement

Sentiment Analysis and Summarization of Product Reviews using Deep Learning Techniques

Objectives:

- To provide a brief abstractive summary of a product with a large number of reviews available in order to take a quick glance at both the pros and cons of any product.
- We will tackle the above problem using deep learning techniques like LSTM-attention mechanism and/or BERT.
- We will have 2 phases: classification and summarization

Literature Survey

Review Classification

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
1.	Business Intelligence Visualization Using Deep Learning Based Sentiment Analysis on Amazon Review Data	IEEE	2021	Decision Tree, Logistic Regression, Stochastic Gradient Descent, Multinomial NB, SVM, BERT, and LSTM	Large model of BERT can be used to achieve high accuracy, there are various irregularities and ambiguities like sarcasm, dialect differences, metaphors, lack of context, homonyms, idioms, etc., in human language which impairs the ability of algorithms to acquire better efficiency.

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
2.	Product Sentiment Analysis of Amazon reviews*	International Journal of Computer Science and IT (IJCSIT)	2021	BERT model, Bi-LSTM, NB, Random forest classification were used and compared.	Machine learning algorithms doesn't give good accuracy, sentimental analysis done on mobile reviews only, advanced feature extraction techniques can be used to achieve high accuracy.
3.	Sentiment Analysis of Ecommerce Product Review Data Based on Deep Learning	IEEE	2021	Convolutional Neural Network, BOW to perform Word Vector.	The model has been trained for chinese characters dataset and the implementation in english is yet to be done.

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
4.	Classification of Shopify App User Reviews Using Novel Multi Text Features	IEEE	2020	Feature engineering:- TF-IDF, Chi, Chi-2, Bag of Words ML Algorithms: Random Forest, Adaboost Classifier, Logistic Regression	Only been experimented on a single dataset (the Shopify app dataset) and also does not discuss about deep machine learning models on different text and categorical datasets for the purpose of user review classification.

Review Summarization

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
5.	Summarization and Prioritization of Amazon Reviews based on multi-level credibility attributes	IEEE	2021	LSTM, NLTK, TF-IDF	The paper discusses how we can find the credibility of reviews and summarizes the rest reviews based on positive and negative keywords.

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
6.	Text Summarization for Thai Food Reviews using Simplified Sentiment Analysis	IEEE	2021	Simplified Sentiment Analysis, Multi-dimensional lexicon.	Processes only on 1 comment and summarizes it. Applied to Thai language dataset.
7.	Automatic Text Summarization: A Comprehensive Survey	Science Direct	2021	Survey paper	

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
8.	Natural Language Processing based Abstractive Text Summarization of Reviews	IEEE	2020	Preprocessing techniques like Lemmatization, removal of stop words etc., TF-IDF vectorization technique, LSTM model is used.	Text summarization done on food reviews of amazon dataset, Summarized reviews results are not upto the mark it can be improved.
9.	Massive Multi-Document Summarization of Product Reviews with Weak Supervision*	ACM Chapter	2020	Weak Supervision, Clustering, Multi-Document Summarization.	The proposed work only gives the result in a single summarized manner and do not lists the pros and cons of the products by classifying positive and negative reviews.

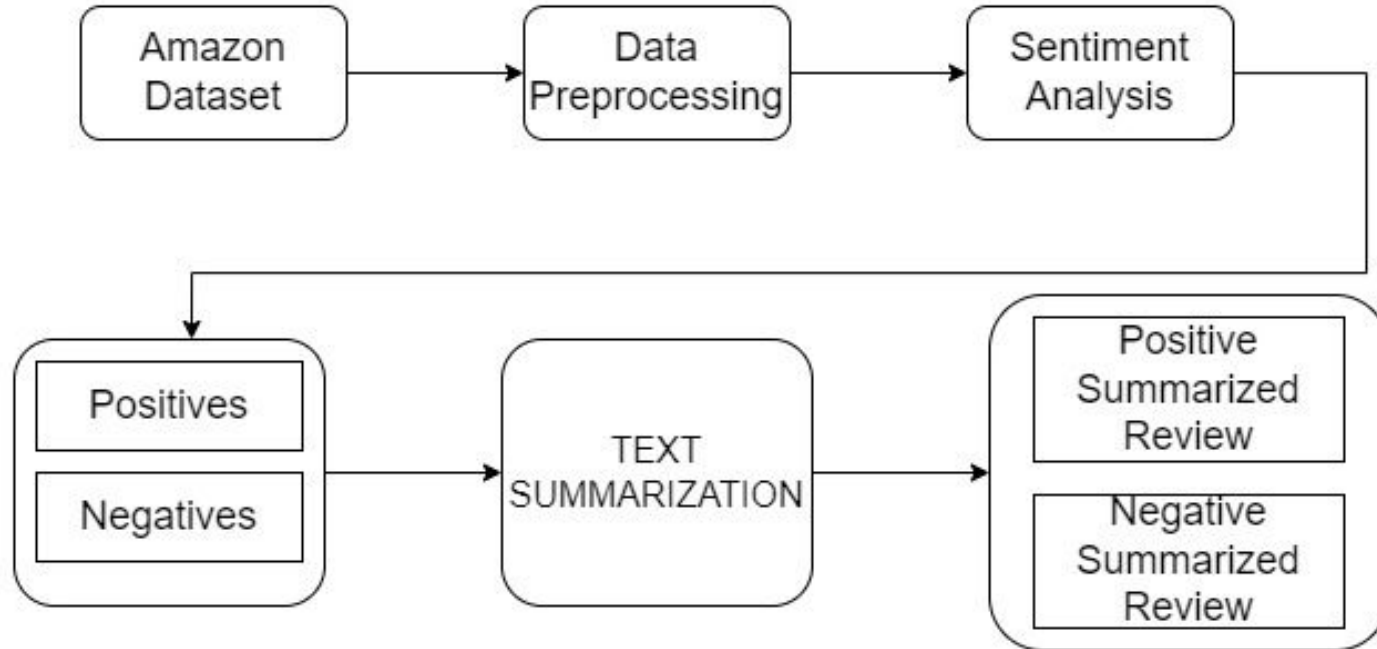
Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gap
10.	A Survey on NLP based Text Summarization for Summarizing Product Reviews	IEEE	2020	Survey paper	
11.	Summarizing Product Reviews Using NLP Based Text Summarization	IRJST	2019	Seq2seq model for summarization, used LSTM layers for encoding and decoding modules during the summarization.	Only 1 comment can be processed at a time and multi-document summarization is not compatible, Other models can be used to achieve high accuracy.

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
12.	Extractive Multi-document Summarization Using Multilayer Networks	Physical A Journal: Elsevier	2018	Extractive multi document summarization, multilayer networks, PageRank algorithm	Abstractive text summarization not explored and also sentiment analysis not looked into

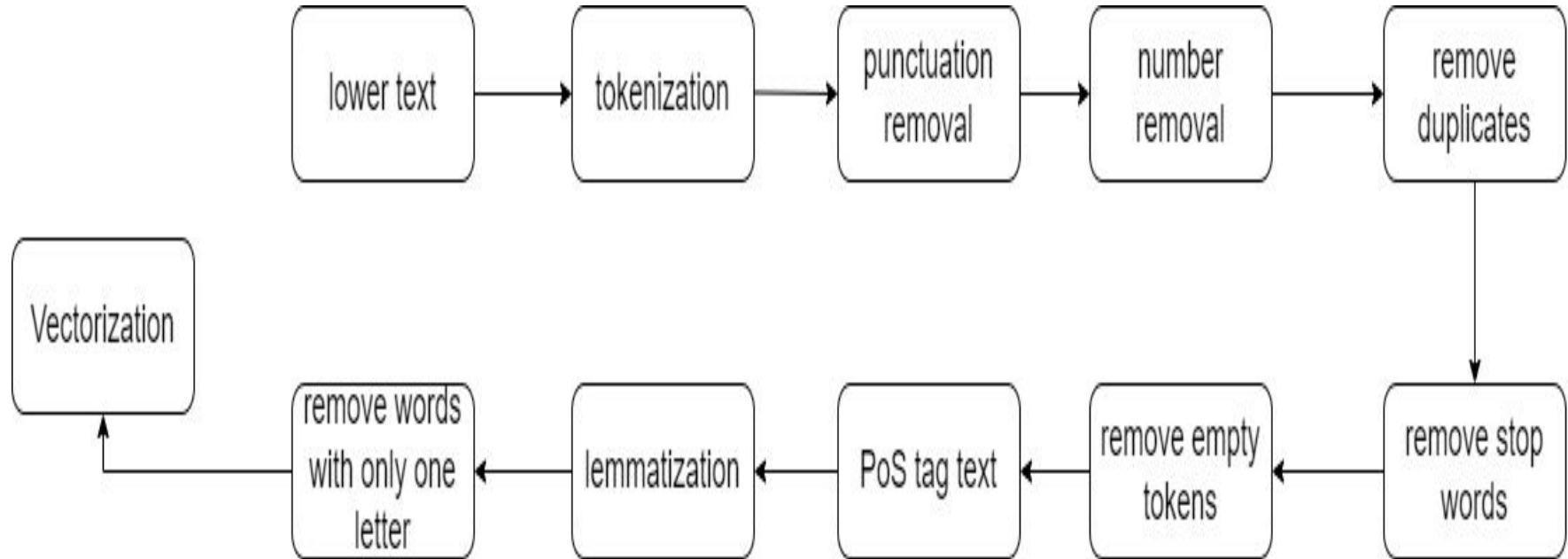
Review Classification + Summarization

Sr. No.	Paper Title	Publisher Name	Year of Publication	Technologies/ Algorithms used	Research Gaps
13.	A Unified Dual-view Model for Review Summarization and Sentiment Classification with Inconsistency Loss	ACM SIGIR	2020	Shared text encoder, summary decoder, Dual-view Sentiment Classification Module	Multi-document summarization is not been considered here, Results are not upto the mark.
14.	A Hierarchical End-to-End Model for Jointly Improving Text Summarization and Sentiment Classification	2018 International Joint Conference on Artificial Intelligence	2018	A hierarchical end-to end model, which consists of a summarization layer and a sentiment classification layer	Results are not satisfactory. Only 1 comment can be processed at a time and multi-document summarization is not compatible.

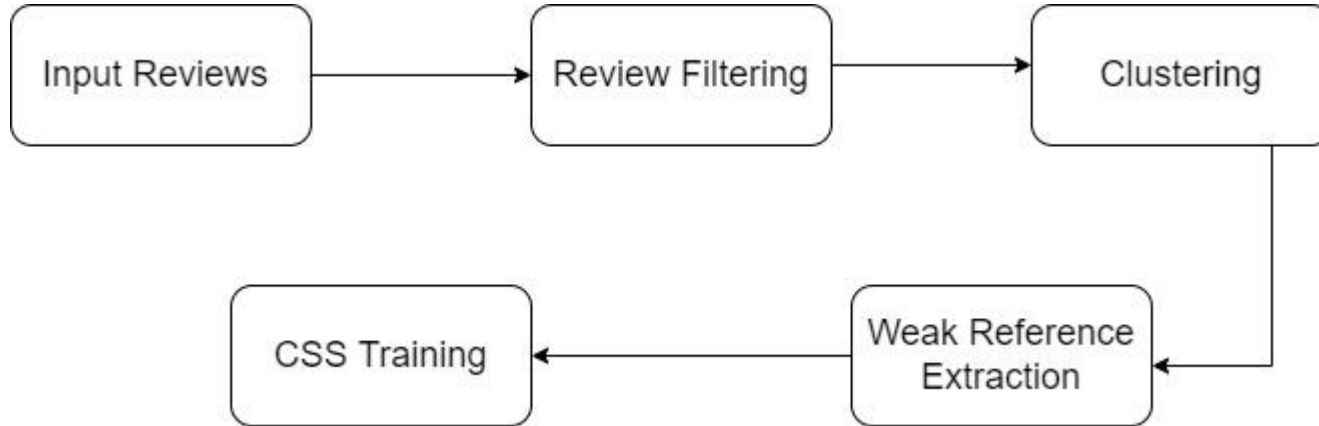
High Level Architecture Diagram



Low Level - Data Preprocessing



Low Level - Text Summarization



Dataset - Amazon Review Dataset - 2018

- This dataset includes reviews metadata like ratings, text, helpfulness, votes. Product metadata like descriptions, category information, price, brand, etc.
- The format of this dataset one review per line in JSON
- This dataset contains reviews of each categories of products like books, electronics, movies, sports etc.
- This dataset contains 42 gb of data and contains 233.1 million reviews.

Dataset - Sample Review

Sample Review:

```
{
  "reviewerID": "A2SUAM1J3GNN3B",
  "asin": "0000013714",
  "reviewerName": "J. McDonald",
  "vote": 5,
  "style": {
    "Format": "Hardcover"
  },
  "reviewText": "I bought this for my husband who plays the piano.
He is having a wonderful time playing these old hymns. The music is
at times hard to read because we think the book was published for
singing from more than playing from. Great purchase though!",
  "overall": 5.0,
  "summary": "Heavenly Highway Hymns",
  "unixReviewTime": 1252800000,
  "reviewTime": "09 13, 2009"
}
```

Algorithms/Methodology

- Preprocessing Techniques:-

1. **Lemmatization** : This is performed to bring the words in their root form so that if familiar words are used in different forms, they can be considered as same words.E.g -> doing, done, do
2. **Vectorization** : Method in which textual data is converted into a numerical form(binary, int, float) since machine learning algorithms cannot work with text form data
3. **Tokenization** : Tokenization is essentially splitting a phrase, sentence, paragraph, or an entire text document into smaller units, such as individual words or terms. Each of these smaller units are called tokens. E.g -> 'Natural language Processing' => ['Natural', 'language', 'processing'].

- Model to be used for training the dataset for Classification and Summarization - LSTM, BERT.

BERT Architecture

- Built a sentiment classifier using the base model, which is a 12-layer, 768-hidden, 12-heads, 110 million parameter neural network architecture.
- The pre-processed reviews were fed to the model using 'Adam' as the optimizer, 'SparseCategoricalAccuracy' as the accuracy metric, and 'CategoricalCrossentropy' as the loss function.
- For our dataset, we have fine-tuned the model up to 2 epochs, which gives us a validation accuracy of 98.51%.

LSTM Architecture

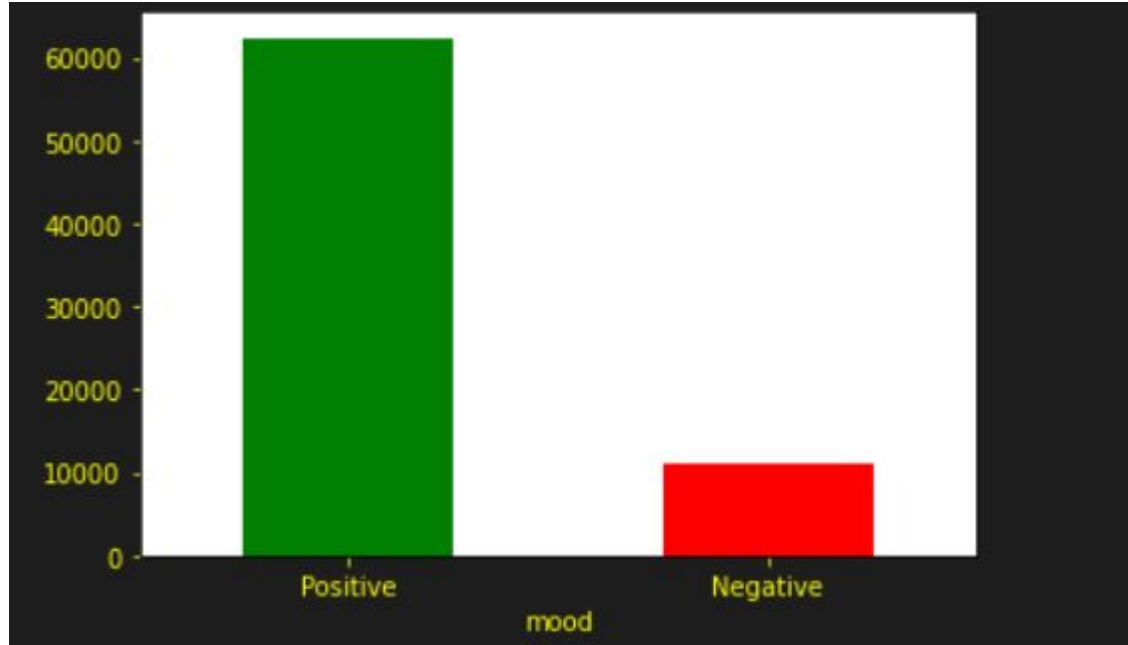
- Built our model on top of the Sequential class of keras, where we have used the LSTM layer as a bidirectional layer, which is added along with the Embedding and Dense layers on top of the Sequential class.
- The pre-processed reviews were fed to the model using 'Adam' as the optimizer, and 'binary_crossentropy' as the loss function.
- For our dataset, we have fine-tuned the model up to 20 epochs, which gives us a validation accuracy of 97.35%.

Implementation Details - Preprocessing

1. The data is initially extracted from an independent source of Amazon review dataset manually.
2. Preprocessing steps have applied and explained earlier
3. Exploratory Data Analysis is performed
 - a. Creating a new column sentiment based on overall ratings
 - b. Dropped columns with unnecessary data
 - c. Created a word cloud
4. Feature Extraction is performed:
 - a. Label encoding of the ratings columns

Implementation Details - Application

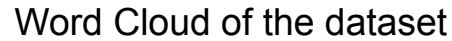
1. We are planning to develop a chrome extension. Whenever you're on an Amazon Product page or Flipkart product page, just clicking on that extension will give you a summarized review of that product
2. A web scraper will extract all the reviews of that particular product.
3. These reviews will be pre-processed as per our model requirements.
4. After, these reviews will be feeded to our model which will generate a summarized review.
5. This summarized review will be show on the extension UI.



Number of positive reviews with
negative reviews



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Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 750, 120)	60360
spatial_dropout1d (SpatialD ropout1D)	(None, 750, 120)	0
lstm (LSTM)	(None, 176)	209088
dense (Dense)	(None, 2)	354
Total params: 269,802		
Trainable params: 269,802		
Non-trainable params: 0		
None		

Summary of the model

References

- [1] Desai, Z., Anklesaria, K., & Balasubramaniam, H. (2021, July). Business Intelligence Visualization Using Deep Learning Based Sentiment Analysis on Amazon Review Data. In *2021 12th International Conference on Computing Communication and Networking Technologies (ICCCNT)* (pp. 1-7). IEEE.
- [2] AlQahtani, A. S. (2021). Product Sentiment Analysis for Amazon Reviews. *International Journal of Computer Science & Information Technology (IJCSIT) Vol, 13*.
- [3] L. Rong, Z. Weibai and H. Debo, "Sentiment Analysis of Ecommerce Product Review Data Based on Deep Learning," 2021 IEEE 4th Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC), 2021, pp. 65-68, doi: 10.1109/IMCEC51613.2021.9482223.
- [4] Aishwarya, N., Bhuvana, L. S., & Kayarvizhy, N. (2021, August). Summarization and Prioritization of Amazon Reviews based on multi-level credibility attributes. In *2021 International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT)* (pp. 5-9). IEEE
- [5] P. Porntrakoon, C. Moemeng and P. Santiprabhob, "Text Summarization for Thai Food Reviews using Simplified Sentiment Analysis," 2021 18th International Joint Conference on Computer Science and Software Engineering (JCSSE), 2021, pp. 1-5, doi: 10.1109/JCSSE53117.2021.9493839.

- [6] F. Rustam, A. Mehmood, M. Ahmad, S. Ullah, D. M. Khan and G. S. Choi, "Classification of Shopify App User Reviews Using Novel Multi Text Features," in *IEEE Access*, vol. 8, pp. 30234-30244, 2020, doi: 10.1109/ACCESS.2020.2972632.
- [7] J. Shah, M. Sagathiya, K. Redij and V. Hole, "Natural Language Processing based Abstractive Text Summarization of Reviews," 2020 International Conference on Electronics and Sustainable Communication Systems (ICESC), 2020, pp. 461-466, doi: 10.1109/ICESC48915.2020.9155759.
- [8] Shapira, O., & Levy, R. (2020). Massive multi-document summarization of product reviews with weak supervision. *arXiv preprint arXiv:2007.11348*.
- [9] Chan, H. P., Chen, W., & King, I. (2020, July). A unified dual-view model for review summarization and sentiment classification with inconsistency loss. In *Proceedings of the 43rd International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 1191-1200).
- [10] Ravali Boorugu, Dr. Gajula Ramesh, Dr. Karanam Madhavi (2019). Summarizing Product Reviews Using NLP Based Text Summarization. *International Journal of Scientific & Technology Research*
- [11] Ma, S., Sun, X., Lin, J., & Ren, X. (2018). A hierarchical end-to-end model for jointly improving text summarization and sentiment classification. *arXiv preprint arXiv:1805.01089*.
- [12] Tohalino, J. V., & Amancio, D. R. (2018). Extractive multi-document summarization using multilayer networks. *Physica A: Statistical Mechanics and its Applications*, 503, 526-539.

THANK YOU !!