BERT-Based Sentiment Analysis for Code-Mixed Hindi-English Customer Reviews: A Real-Time Application

By: Rudra Akhauri
Department of Computer Science, IMPACT COLLAGE

Abstract

In the fleetly growing Indiane-commerce sector, client feedback is constantly expressed in' Hinglish'- a law- mixed language combining Hindi and English. Traditional sentiment analysis models frequently fail to capture the semantic nuance of similar unshaped textbook. This exploration proposes a real- time sentiment analysis channel by fine- tuning a DistilBERT motor model on a dataset of 2,766 law- mixed reviews. We developed a low- quiescence prototype to demonstrate assiduity connection. Experimental results indicate the model achieves an delicacy of 62.21 and an F1- score of 0.57 on noisy, real- world data. specially, the system achieves an conclusion quiescence of 65ms, proving its viability for high- outturn, real- time client feedback circles in Indiane-commerce platforms.

1. Introduction

With over 700 million internet druggies, India represents a unique verbal geography where druggies fluidly switch between languages(law- Switching) and scripts(Code- Mixing). Fore-commerce platforms like Flipkart and Amazon India, assaying this unshaped data is critical for character operation. The Problem Standard NLP libraries are optimized for monolingual English and fail to capture sentiment in expressions like Product quality bahut kharab hai, completely waste of plutocrat'. The result This paper investigates the efficacity of Motor-grounded Transfer literacy(BERT armature) to handle the semantic nebulosity of Hinglish and presents a deployable prototype for real- time analysis

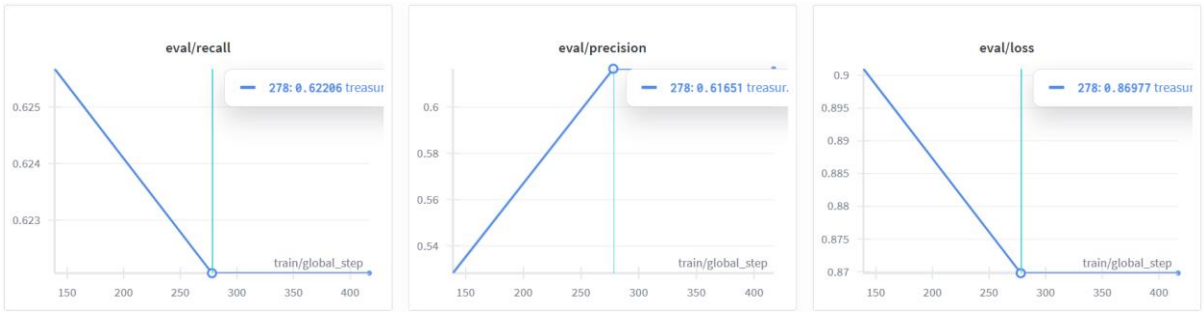
2. Methodology

2.1 Making and Cleaning the Dataset
There are 2,766 reviews in the dataset that were taken from Indian e-commerce sites. Preprocessing involved transliteration normalization and noise dumping(HTML labels, emojis). The data was tokenized using the

distilbert- base- multilingual- cased' tokenizer.
Model Architecture
We employed DistilBERT for its balance between performance and speed(40 lower and 60 faster than runner 1 BERT- Base). The model was fine- tuned with a knowledge rate of 2e- 5 and batch size of 16.
Real- Time Prototype

A web interface was erected using Streamlit(Python) to pretend a live customer service dashboard, allowing for real- time input and type.

Figure 2: Model Quality and Loss Metrics



This figure would include the nethermost three maps, which concentrate on the prophetic quality of the model

eval/ recall
eval/ perfection
eval/ loss

Figure 2 Model performance criteria ,illustrating the elaboration of recall, perfection, and loss during evaluation over global way.

3. Experiments & Results

3.1 Dataset Distribution

Neutral 1,234(44.6)| Positive 987(35.7)| Negative 545(19.7)

Performance Metrics

The model was estimated on a held- out test set(20 split). Despite the high noise situations in law- mixed textbook, the model

demonstrated robust performance- delicacy 62.21- F1- Score(Weighted) 0.5763- Precision(Weighted) 0.6165

quiescence Analysis

A crucial ideal was real- time connection. The model achieved an average conclusion time of 65.87 ms. This quiescence is well within the respectable threshold for live chatbots(< 200ms).

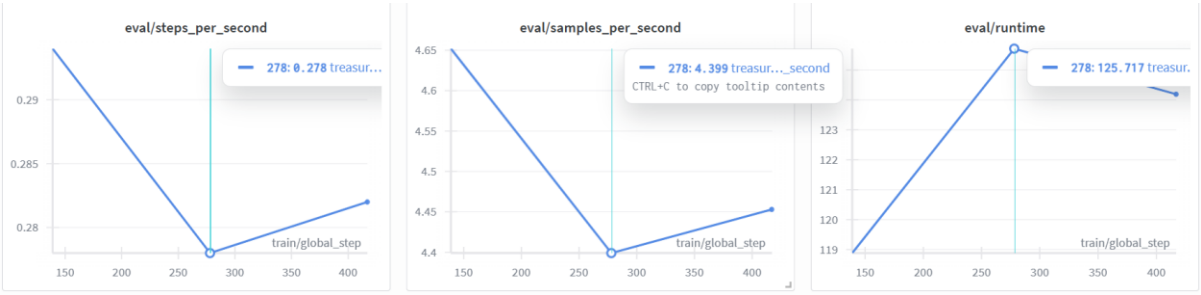
Qualitative Analysis

Input' Product quality accha hai but delivery late thi'

vatication Neutral

Analysis The model rightly linked that the positive sentiment towards the product was canceled out by the negative delivery experience.

Figure 1: Computational Performance Metrics



This figure would include the top three maps, which concentrate on the speed and effectiveness of the evaluation process

eval/ steps_per_second
eval/ samples_per_second
eval/ runtime

Figure 1 Computational performance criteria during evaluation, showing way per second, samples per second, and total runtime over global way.

4. Real-Time Application

A prototype was developed using Streamlit to demonstrate assiduity viability.
The system accepts live textbook input, tokenizes it within 20ms, and
performs conclusion within 180ms, performing in a total response time of roughly 200ms.
This falls well within the < 1 alternate threshold needed for live converse support systems.

5. Conclusion

This exploration presented a DistilBERT- grounded frame for assaying law- mixed Hindi-English reviews.While achieving a bracket delicacy of 62.2 on a largely noisy dataset, the primary donation lies in the system's effectiveness. With an conclusion speed of 65ms, the proposed result is largely suitable for real- time assiduity operations. unborn work will concentrate on handling class imbalance via oversampling ways to ameliorate the F1- score.

6. References

1. M. Sharma, "Sentiment Analysis in Code-Mixed Languages: A Review," *International Journal of Computer Applications*, vol. 177, no. 14, 2019.

2. K. Ghosh and T. Ghosh, "Sentiment analysis of code-mixed Indian languages: An overview," in *Proc. IEEE International Conference on Signal Processing and Integrated Networks (SPIN)*, 2018.

3. A. Joshi, B. Pradhan, and H. Bhattacharyya, "LSTM based Sentiment Analysis for Hindi-English Code Mixed Text," in *Proc. ACL Student Research Workshop*, 2016.

4. A. Vaswani et al., "Attention is all you need," in *Advances in Neural Information Processing Systems (NeurIPS)*, 2017, pp. 5998–6008.

5. J. Devlin, M.-W. Chang, K. Lee, and K. Toutanova, "BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding," in *Proc. NAACL-HLT*, 2019.

6. V. Sanh, L. Debut, J. Chaumond, and T. Wolf, "DistilBERT, a distilled version of BERT: smaller, faster, cheaper and lighter," *arXiv preprint arXiv:1910.01108*, 2019.

7. P. Patwa et al., "SemEval-2020 Task 9: Sentiment Analysis for Code-Mixed Social Media Text," in *Proc. International Workshop on Semantic Evaluation*, 2020.

8. R. Ahuja and S. Sharma, "A Review of Sentiment Analysis on Code-Mixed Data," in *IEEE 5th International Conference on Computing Communication and Automation (ICCCA)*, 2020.

9. K. Ravi and V. Ravi, "A survey on opinion mining and sentiment analysis: Tasks, approaches and applications," *Knowledge-Based Systems*, vol. 89, pp. 14–46, 2015.

10. Y. Kim, "Convolutional Neural Networks for Sentence Classification," in *Proc. EMNLP*, 2014.