

**North South University**

Department of Electrical & Computer Engineering

**CSE465: Pattern Recognition and Neural Network**

**Section: 5**

| **Group Project: Fine-Tuning Large Language Models For Text Classification** |
| --- |

**Faculty : OISD**

**Group: 9**

| **Name** | ID |
| --- | --- |
| Souvik Pramanik | **2112471642** |
| S.M. Riaz Rahman Antu | **2121462642** |

**Problem Statement:**

We are working on SentNob bengali language datasets where we applied eight different LLM models and checked their performance. As we knew that, this dataset is very noisy to handle in a proper way. That’s why its performance is not good. This dataset is based on sentiment. Those are neutral, negative and positive. We studied lots on this and how to apply LLM models with these datasets. Before we took this work it’s better performance was nearly 71% accuracy which was not good but suitable for this datasets because of its noisy data. Finally we get the best performance in the BanglaBERT model. At the beginning, we got 73% accuracy while applying BanglaBERT. Then we applied LoRA, Grid Search, Hyper-parameter tuning. At the end, we got 76% accuracy which is our best performance.

**Objective:**

Our target is to compare LLM models performance on this dataset. That’s why we applied eight LLM models including BERT, Distil-BERT, RoBERTa, DeBERTa, ALBERT, XL-NET, Google-Electra and BanglaBERT. We checked which model performs best among all of these models.

Our target is to take any model’s performance near to 80%. After applying all those models, BanglaBERT performs better. That's why we took the decision to fine-tune the BanglaBERT model as there is a chance for taking this model’s performance nearly 80%.

We took this project after seeing its dataset. It's too noisy to get a better performance. So we decided to work on it and try to get a better output.

**Literature Review:**

We studied many research papers which are based on Bengali text classification and sentiment analysis. Then we get knowledge of how they work and their methodology. We applied the same types of procedures also. At the end, we selected almost 10 research papers which are suitable for our project and related to our works. Those are providing below :  
**Paper 1 :** ”Low-Rank Adaptation for Efficient Fine-Tuning of Large Language Models” focuses on the LoRA technique for efficiently fine-tuning transformer models.

**Paper 2 :** ”Multilingual Language Models for Text Classification” investigates multilingual LLMs’ effectiveness in text classification tasks, including Bengali.

**Paper 3:** ”A Comprehensive Study on Bengali Sentiment Analysis” explores sentiment analysis of Bengali text using traditional ML models and deep learning techniques.

**Paper 4:** ”BERT Fine-Tuning for Bengali Text Classification” discusses the fine-tuning of BERT models for Bengali classification tasks, highlighting challenges and performance evaluation.

**Paper 5:** ”BERT and Transformer Models for Code-Switching in Bengali” explores the application of transformer-based models in code switching scenarios, which is highly relevant to sentiment analysis of social media text.

**Paper 6:** ”Fine-Tuning DeBERTa for Low-Resource Language Tasks” investigates the adaptation of DeBERTa models for low-resource languages, including Bengali.

**Paper 7:** ”LoRA for Multilingual Text Classification” introduces the LoRA technique applied to multilingual models, with a specific focus on Bengali text classification.

**Paper 8:** ”An Efficient Approach to Bengali NLP with Transformer Models” presents transformer-based solutions for Bengali NLP tasks, including fine-tuning for sentiment analysis.

**Paper 9:** ”Quantized LoRA for Efficient Bengali Text Classification” focuses on the use of QLoRA in fine-tuning LLMs for Bengali text classification with a performance comparison.

**Paper 10:** A Study on Transformer Models for Bengali Text Processing provides an overview of transformer models used for Bengali NLP, with insights into fine-tuning strategies.

**Network Description:**

Need to mention here hyper-parameter tuning.

**Challenges:**

We faced lots of challenges while doing this project. Main issue of this challenge is to handle this noisy dataset. We actually didn't have any devices at the beginning. In that time we used colab which took a lot of time to execute and it gave us a time limit of using so we can’t train a model properly. After that we take devices and work on that which saves lots of time.   
We run a single model at a time. We had to deal with many dependencies. Every model is not suitable for the same libraries and we also need hugging face access for models also.   
So, we need to wait to get access. After that the model works properly. Then we need to wait in the training period. It takes a long time for training purposes. Sometimes it takes more than 6/7 hours to train a model and show its performance. That’s why we need to wait for this. Many times we faced problems at the end of the training part. Then we fixed the problem and ran it. So, every time we are facing a problem to run our models within a short time.   
While we apply the BanglaBERT model with some fine-tune techniques then we get a bad result. But at the end we apply hyper-parameter tuning. And we designed the code as it will give us better performance. At the first time we provided 20 trails. But after running more than 6 hours, it provides an error. Then we fix it and again run the code. This problem is happening with us multiple times. Finally, we provided 2 trails only and checked its performance. Then it shows 76% of accuracy which is our best performance result for all the applied models.

**Conclusion:**In this project, we focused on evaluating the performance of various LLM models on the SentNob Bengali sentiment dataset, which is known for its high level of noise and complexity. Despite the initial challenges, including limited resources, hardware issues, and dataset noise, we systematically applied and compared eight different models: BERT, Distil-BERT, RoBERTa, DeBERTa, ALBERT, XL-NET, Google-Electra, and BanglaBERT. Through careful experimentation and optimization, particularly using LoRA and hyperparameter tuning techniques, BanglaBERT emerged as the best-performing model. We successfully improved the accuracy from an initial 73% to 76%, surpassing the previously reported 71% benchmark. Although our target was to reach 80% accuracy, the achieved performance is significant given the dataset’s limitations. This work highlights the importance of model selection, fine-tuning, and resilience in handling real-world noisy datasets for Bengali sentiment analysis. Future work may involve exploring more advanced fine-tuning strategies, data cleaning techniques, or using larger pre-trained models to further improve performance.

**References:**

[1] Md. Saiful Islam, Muntasir Wahed, Mahbuba Yesmin, and M Sohel Rahman,

”BanglaBERT: Transformer Based Pre-trained Model for Bengali Language

Understanding,” arXiv preprint arXiv:2101.00204, 2021.

[2] Jacob Devlin, Ming-Wei Chang, Kenton Lee, and Kristina Toutanova,

”BERT: Pre-training of Deep Bidirectional Transformers for Language Un-

derstanding,” Proceedings of NAACL-HLT, 2019.

[3] Denny Britz, Anna Goldie, Minh-Thang Luong, and Quoc Le, ”Massively

Multilingual Neural Machine Translation in the Wild: Findings and Challenges,” arXiv preprint arXiv:1907.05019, 2019.

[4] Author(s), ”A Comprehensive Study on Bengali Sentiment Analysis,” IEEE,

2024.

[5] Author(s), ”Low-Rank Adaptation for Efficient Fine-Tuning of Large Language Models,” arXiv, 2024.

[6] Author(s), ”Multilingual Language Models for Text Classification,” arXiv,

2024. Available: <https://arxiv.org/pdf/2407.00416>

[7] Author(s), ”BERT Fine-Tuning for Bengali Text Classification,” arXiv,

2024. Available: <https://arxiv.org/pdf/2309.13173>

[8] Author(s), ”BERT and Transformer Models for Code-Switching in Ben-

gali,” ScienceDirect, 2024. Available: https://www.sciencedirect.com/

science/article/pii/S2949719124000232

[9] Author(s), ”LoRA for Multilingual Text Classification,” OpenReview, 2024.

Available: <https://openreview.net/pdf?id=Z0zfZ4bn4x>

[10] Author(s), ”Quantized LoRA for Efficient Bengali Text Classification,”

arXiv, 2024. Available: <https://arxiv.org/pdf/2311.12735>