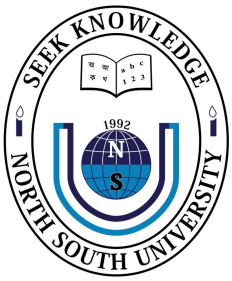

Department of Electrical and Computer Engineering
North South University

Senior Design Project

Enhancing Bengali Language Processing: LoRA-Driven Adaptation in BLOOM

Md Hasibullah Hasib ID# 1811451042

Samira Ali ID# 2011423042

Irfanuddin Ahmed ID #1813476642

Faculty Advisor:
Dr. Nabeel Mohammed (NbM)
Associate Professor
ECE Department

Summer, 2023

LETTER OF TRANSMITTAL

November 2023

To

Dr. Rajesh Palit
Chairman,
Department of Electrical and Computer Engineering
North South University, Dhaka

Subject: **Submission of Directed Research Report on "Enhancing Bengali Language Processing: LoRA-Driven Adaptation in BLOOM"**

Dear Sir,
With due respect, we would like to submit our Directed Research Report on "Enhancing Bengali Language Processing: LoRA-Driven Adaptation in BLOOM" as a part of our BSc program. The report deals with Natural Language Processing and Bangla text analysis using a fine-tuned approach for next-word prediction. This project is very valuable to us as it helped us gain experience in the practical field and apply it in real life. We tried to the maximum competence to meet all the dimensions required from this report.

We will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be our immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

.....
Md Hasibullah Hasib
ECE Department
North South University, Bangladesh

.....
Samira Ali
ECE Department
North South University, Bangladesh

.....
Irfanuddin Ahmed
ECE Department
North South University, Bangladesh

APPROVAL

Md Hasibullah Hasib (ID# 1811451042) , Samira Ali (ID# 2011423042) Irfanuddin Ahmed (ID# 1813476642) from the Electrical and Computer Engineering Department of North South University have worked at the Senior Design Project titled "Enhancing Bengali Language Processing: LoRA-Driven Adaptation in BLOOM" under the supervision of DR. NABEEL MOHAMMED and the partial fulfillment of the requirement for the degree of Bachelors of Science in Engineering and has been accepted as satisfactory.

Supervisor's Signature

.....

Dr. Nabeel Mohammed (NbM)

Associate Professor

Department of Electrical and Computer Engineering
North South University
Dhaka, Bangladesh.

Chairman's Signature

.....

DR. Rajesh Palit

Professor

Department of Electrical and Computer Engineering
North South University
Dhaka, Bangladesh.

DECLARATION

This is to declare that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. All project-related information will remain confidential and shall not be disclosed without the formal consent of the project supervisor. Relevant previous works presented in this report have been properly acknowledged and cited. The plagiarism policy, as stated by the supervisor, has been maintained.

Students' names & Signatures

1. Md Hasibullah Hasib

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2. Samira Ali

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3. Irfanuddin Ahmed

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ACKNOWLEDGEMENTS

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ABSTRACT

Enhancing Bengali Language Processing: LoRA-Driven Adaptation in BLOOM

In order to optimize a multilingual language model specifically for Bangla, this paper presents a novel method that uses LoRA (Low-Rank Adaptation) to significantly reduce model parameters without compromising performance. The article describes a thorough process that starts with quantizing the original model and ends with the use of LoRA configurations, which incorporate trainable rank decomposition matrices into the Transformer architecture while maintaining pre-trained weights. The astounding outcomes of this optimization show a significant decrease in the number of trainable parameters from 3 billion to 4.9 million, or just 0.16% of the original model. Interestingly, performance remains comparable to the larger, non-optimized version despite this reduction, suggesting that the model's effectiveness is unaffected. Optimizing the LoRA-configured model on various Bangla datasets demonstrates the model's flexibility and expertise even more. The Bangla2B+ Dataset, a proprietary conversational dataset, and a corpus of over 300,000 articles were used to tackle next-word prediction, question answering, and conversational tasks. Evaluation metrics showed a significant improvement, and perplexity scores decreased, outperforming the original model's performance. These developments demonstrate the effectiveness of LoRA in lowering computational complexity and improving the model's language comprehension abilities when it comes to the Bangla language. The work presents a new paradigm for effective and proficient language modeling in low-resource languages, demonstrating how LoRA can be used to simplify models for better performance without sacrificing computational efficiency. Given the dearth of multilingual models specifically designed for Bengali language processing, we aim to close a significant gap in language processing but also spur the development of customized NLP solutions in vital industries, improving accuracy and accessibility in domains centered around Bengali language.

Keywords: Bengali language processing, Low-Rank Adaptation (LoRA), Low-resource languages, Computational efficiency, Contextual understanding, Language model customization, Natural Language Processing (NLP), Parameter reduction