Project Proposal

XiaoFish - Natural language executes terminal command system

Group Members:

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I. Introduction

With the rapid development of computers, the terminal command line interface (CLI) has become the preferred tool for many developers and system administrators with its efficient resource management and operational flexibility. However, the use of CLI is difficult and cumbersome for most non-technical users, and requires users to spend a lot of time learning and remembering complex terminal commands. This high threshold not only limits the convenience of use for ordinary users, but also increases the threshold for novices to get started. Therefore, this paper proposes to build a system for executing terminal commands in natural language, so that users can interact with the terminal through daily language, thereby greatly reducing the threshold for use and improving the user's operating experience.

This proposal is organized as follows. Section II will introduce some basic related work and methods, and Section III will introduce our ideas and the general implementation process. Section IV will introduce the features of our project. Section V will focus on the significance of our project. Finally, Section VI will introduce our work plan and the project management table.

II. Relate Work

Meta llama3: Llama 3 is Meta's latest open source large language model result, with more powerful language generation and understanding capabilities (Dubey et al., 2024). Since it is open source, we can easily deploy the model locally for reasoning

NLP interface: Natural language processing (NLP) interface refers to the interface that uses natural language as input or output in human-computer interaction. It enables users to communicate with computer systems through everyday language without having to master and remember any programming languages and commands. The core of the NLP interface is to enable the model to understand natural language, so that users can complete the interaction more conveniently and efficiently. (Lauriola et al., 2022)

Transformer: Vaswani et al. (2017) proposed a new neural network structure called Transformer. The design of Transformer abandons the calculation of sequence order in traditional recurrent neural networks (such as RNN and LSTM), and is completely based on the self-attention mechanism, which enhances the model's ability to model long-distance sequence dependencies. In addition, based on the self-attention mechanism, Transformer can flexibly handle sequences of different lengths, and Transformer can better reason based on contextual content.

III. Idea

The goal of our project is to build a conversational system that can execute terminal commands through natural language. We will use the nl2bash dataset to help generate our dataset. The nl2bash dataset provides 12k one-line Linux shell commands and natural speech descriptions of these commands provided by experts. However, one of the problems is that

each description corresponds to a command, and more different descriptions may help the model learn better. Therefore, we use Meta's LLama3 open-source model to help generate the dataset. The generation method gives several descriptions for each command to generate our dataset.
The next step is data cleaning. We will clean the generated data, especially the description. Since the user's input may contain spelling, grammar, and other errors, we want to minimize their impact on the model.
Then it is the construction and training of the model. We plan to use a transformer as the training model. The specific detailed parameters and architecture must be modified according to the data situation. We hope that the model can be as small as possible while maintaining performance.
Then it is testing and evaluation. We will calculate the accuracy of the model's reasoning for each test set command, and compare it with nl2bash as a baseline to verify our results.

IV. Features

1. Automated Command Generation
The model will be able to automatically translate natural language instructions into accurate Bash commands, simplifying the execution of complex command-line tasks. This model could help users, regardless of their proficiency with shell scripting, leverage command-line capabilities efficiently with minimal cost of studying.
2. Interactive Shell Assistant
By integrating a large language model, it is able to provide relevant command suggestions according to users' specific objectives. This interactive feature not only provides customized optimization output from the users' input but also helps users choose from alternative solutions, enhancing both the development process and user confidence.

3. Error Detection
The model can identify potential errors in user-written commands and suggest corrections or optimizations. This ensures that the generated commands are reliable and efficient. And it reduces debugging time and enhances overall experience for users from beginners to proficient bash commands programmers.

4. Lightweight Model
Our project will prioritize creating a lightweight model architecture, ensuring it can run efficiently on local machines without the need for extensive computational resources. This approach makes the model accessible to a broader user base without the need to purchase costly hardware nor running on expensive servers like AWS. Thus, this model could provide a real time response in the most economical way.

V. Significance
The significance of this project lies in its potential to revolutionize the interaction between users and command-line interfaces by enabling natural language execution of terminal commands. Traditional command-line usage requires users to possess deep technical expertise, often relying on memorized syntax and precise input, which creates a steep learning curve and limits accessibiliy for non-expert users. By leveraging the nl2bash dataset and generating additional diverse descriptions using Meta's Llama3 model, our project aims to create a more versatile and adaptive model capable of understanding varied natural language inputs. This approach addresses a key limitation of the current dataset, which offers a one-to-one mapping of descriptions to commands, by enriching it with multiple paraphrased

descriptions. Such data augmentation can significantly enhance the model's ability to generalize beyond memorized patterns, leading to improved performance in real-world scenarios.
Furthermore, this project contributes to the broader field of natural language processing (NLP) and conversational AI by tackling the complex challenge of interpreting diverse user inputs and translating them into precise shell commands. It advances the current state of NLP by employing innovative data augmentation techniques and leveraging transformer-based models tailored to balance performance with computational efficiency. The focus on building a smaller, yet effective, model architecture aligns with the growing demand for scalable, resource-efficient AI solutions. Overall, this project holds the potential to make command-line interfaces more accessible, reduce the technical barrier for users, and set a new standard in the development of natural language command execution systems.

VI. Work plan

In the subsequent work, our current tentative project time plan is as follows
The first step is to use the llama3 model to generate a dataset. This part is mainly responsible for YiFei Guo and is scheduled to be completed on Nov 10th.
The second step is to clean up the dataset we generated to reduce the impact of grammar, spelling, etc. on model reasoning. This part will be mainly responsible for ZiRui Liu and Qingyuan Mao and is scheduled to be completed on Nov 17th.
The third step is to build our own transformer model and use our dataset for training. This part is mainly responsible for Jingyuan Chen and YanChen Li and is scheduled to be completed on Nov 27th.
The fourth step is to evaluate our model and compare it with other models such as baseline models such as nl2bash. This part is mainly responsible for Wenzhe Ma and Shu Li and is scheduled to be completed on Dec 1st.
We will spend the rest of the time preparing speeches and papers together
The project management is in the table below:

Project Management

This project roadmap is for Xiao Fish - Natural Language Terminal Command System

Timeline | Table | Complated

Project Roadmap

Status	Name	Date	Assign
In progress	Project Proposal and planning discussion	November 4, 2024 → November 10, 2024	Teamwork
Not started	Preprocess Dataset - Set up development environment	November 11, 2024 → November 12, 2024	gyf
Not started	Preprocess Dataset - Generate multiple natural language descriptions	November 13, 2024 → November 15, 2024	gyf
Not started	Preprocess Dataset - Design prompt engineering	November 16, 2024 → November 17, 2024	gyf
Not started	Dataset Preprocess - Design preprocessing pipeline	November 18, 2024 → November 20, 2024	lzr&mqy
Not started	Dataset Preprocess - Implement data cleaning scripts	November 21, 2024 → November 24, 2024	lzr&mqy
Not started	Model Development - Design model architecture	November 25, 2024 → November 27, 2024	lzr&mqy
In progress	Documentation and Presentation	November 25, 2024 → December 1, 2024	Teamwork
Not started	Model Development - Train the model	November 28, 2024 → November 29, 2024	cjy&lyc
Not started	Model Development - Optimize model performance	November 30, 2024 → December 1, 2024	cjy&lyc
Not started	Testing and Evaluation - Design test cases	December 2, 2024 → December 3, 2024	mwz&ls
Not started	Testing and Evaluation - Conduct comparisons	December 4, 2024 → December 6, 2024	mwz&ls
Not started	Testing and Evaluation - Perform error analysis	December 7, 2024 → December 9, 2024	mwz&ls

Reference

Dubey, A., Jauhri, A., Pandey, A., Kadian, A., Al-Dahle, A., Letman, A., ... & Zhao, Z. (2024). The Llama 3 herd of models. arXiv. https://arxiv.org/abs/2407.21783

Lauriola, I., Lavelli, A., & Aiolli, F. (2022). An introduction to deep learning in natural language processing: Models, techniques, and tools. *Neurocomputing*, *470*, 443-456.

Vaswani, A. (2017). Attention is all you need. *Advances in Neural Information Processing Systems*.