Institute of Business Administration
Introduction to Text Analytics
Assignment 05
Due Date: 12th June 2025 (11:55 PM)

Supervised and Preference Fine-Tuning of Decoder-Only Language Model (TinyLlama)

This is a group assignment where the group size can be of 2-3 members. This assignment aims to provide hands-on experience with **instruction tuning** and **preference fine-tuning** of **TinyLlama (base model)** for the **question answering** NLP task. In this assignment, your tasks include:

1. **Supervised Instruction Fine-Tuning**
    - Select or create an appropriate **prompt–response style** dataset (dialog datasets) other than the one used during class demonstrations. You can refer to HuggingFace platform for retrieving an appropriate dataset.
    - Using the selected dataset, perform supervised fine-tuning on the base model, implementing **LoRA** for efficient adaptation.
    - You must perform and report extensive experimentation with different:
        - LoRA configurations (rank, choice of matrices to modify, etc.)
        - Training Arguments (learning rate, batch size, number of epochs, etc.)
    - Report results from only five trials, ensuring that these trials collectively represent the wider range of configurations.
    - Select the best Supervised Fine-Tuned model (from the five trials) based on the performance evaluation mentioned in the third task below.
2. **Preference Fine-Tuning via DPO**
    - Select an appropriate dataset (other than the one used during class demonstrations) with human-preferred response rankings to perform **preference fine-tuning** using **Direct Preference Optimization (DPO)** on the Supervised Fine-tuned model from the previous step.
    - You must perform and report extensive experimentation with different:
        - LoRA configurations (rank, choice of matrices to modify, etc.)
        - DPO Configurations (beta, learning rate, batch size, number of epochs, etc.)
    - Report results from only five trials, ensuring that these trials collectively represent the wider range of configurations.
    - Select the best Preference Fine-Tuned model (from the five trials) based on the performance evaluation mentioned in the third task below.
3. **Performance Evaluation**
    - Perform intensive evaluation to analyze how models improve in terms of response quality. Use a combination of ten (10) distinct prompts (other than what was provided in the training data and covering a broad range of questions) along with their correct responses. You can use ChatGPT to get correct responses.
    - Using these selected prompts and target responses, evaluate the base model, Supervised Fine-tuned model (five versions/trials with different configurations), and Preference Fine-tuned model (five versions/trials with different configurations).
        - Compare the performance of the base and different versions of Supervised Fine-tuned models using BLEU score as evaluation metric.
        - Moreover, manually evaluate how the different versions of Preference Fine-tuned model enhance response quality compared to the selected best version of the Supervised Fine-Tuned model, focusing on the following criteria:
            - Helpfulness
            - Harmlessness
            - Relevance and alignment with the given instructions

Deliverables

1. Submit clean and well-documented Python code notebook(s) that were used for experimentation via GitHub or as a zipped folder.
2. A well-organized report, either in the docx or PDF format.

Report Guidelines

Organize your report into clearly defined sections. In your report, include discussion on:

1. **Platform Details**: Specify the platform used for experimentation (e.g., local machine, Kaggle, Colab). If multiple platforms were used, clarify where each stage was executed.
2. **Data Details**: Clearly state the sources of the datasets, including the size and number of samples used in the dataset. You may use subsets of these datasets as appropriate for your compute budget but justify your choices in the report. Describe the datasets selection and preprocessing steps
3. **Experimentation, Analysis, and Insight**: Clearly document the experimental setup and results, highlighting insights gained from multiple trials.
    - Model and tokenizer choice
    - Evaluation metrics
    - The impact of different LoRA and training configurations on the responses.
    - Differences in behavior between:
        - Base model
        - Instruction-tuned model
        - Preference-tuned model (after DPO)
    - List parameters of the best-performing models (e.g., LoRA rank, DPO beta, learning rate).
    - Output quality: include examples that illustrate improvement or degradation
    - Resource usage and training time
    - Strengths and weaknesses of SFT and DPO, the impact of hyperparameter choices, and scenarios where each approach excels.
    - Common failure cases or unexpected behaviors.
4. **Reproducibility**: Your report must provide enough detail to enable others to replicate your work. Include any information that is critical for reproduction, such as preprocessing steps, system configuration, or model fine-tuning techniques.

Additional Instructions:

- **Application Development (Optional)**: If you have developed a working application based on your system, include screenshots and relevant details in an appendix at the end of your report.
- **Figures and Tables**: Ensure that all figures and tables are properly numbered and cited in the text. Avoid vague references like "the figure below"; instead, use precise citations such as "Table 1 shows…" or "As shown in Figure 7…".
- **References**: If you have used external resources, such as blogs or GitHub repositories, ensure they are appropriately cited. Include a reference section before the appendix to acknowledge all sources and avoid any potential issues of plagiarism. Proper citation is a key part of your academic and professional training.
- **Submission File Name**: The file name should be as per the group members name and don't name it Assignment1 or Project1. So, if there are two group members, Aamna and Zaid, then name it Aamna_Zaid.docx.

NOTE: Do not submit Google Drive or shared document links, as they can be modified after submission. The report must be submitted as a **Word or PDF** file on the **LMS**. If other files exceed the size limit, they may be uploaded via Dropbox. However, any submission via shared links will be considered incomplete and will not be graded.