Project Instructions for

CS251 Artificial Intelligence

Submission Deadline

22 April 2024

- **Group Members:** Max 2
- **Project Weightage:** 10% (5% for Implementation, 5% for Report, and Presentation)
- There should not be more than **10% plagiarism** in your project report
- Submit the report in soft + hard form

Introduction:

This project delves into the application of advanced neural network architectures for classification tasks in artificial intelligence. You will explore the power of combining (hybrid) or ensembling different neural network models to achieve superior results compared to single models. Throughout the project, you will utilize a dataset of your choice (text, images, etc.) and implement your chosen approach to solve a classification problem.

Objectives:

- Select and explore a real-world dataset suitable for classification.
- Apply and compare the performance of hybrid or ensemble neural network architectures for the chosen classification task.
- Evaluate the models using various metrics such as accuracy, precision, F1-score, AUC-ROC curve, confusion matrix, and heat matrix then visualize the results effectively.
- Gain practical experience in neural network design, training, and evaluation.

1. Dataset Selection:

- Choose a publicly available dataset that aligns with your interests. Examples include:
  - **Image classification** (MNIST handwritten digits, CIFAR-10 object classification)
  - **Text classification** (sentiment analysis datasets, spam detection)
  - **Other domains** (sensor data analysis, financial forecasting)
- Ensure that you know all details about the dataset (total instances, features, and other details)

2. Model Design and Implementation:

- Select two or more neural network architectures (variants of CNNs, RNNs, etc.) that are NOT covered in your class curriculum. Research and understand the chosen architectures.
- Explore approaches like:
    - Feature extraction with one model and classification with another.
    - Stacking models where one model's output becomes the input for another.
    - Bagging or boosting techniques to create an ensemble of multiple models.
- Implement your model architecture using a deep learning framework like TensorFlow or PyTorch.
- Perform all preprocessing steps as well.

3. Training and Evaluation:

- Preprocess the chosen dataset for your model's requirements (normalization, data augmentation, etc.)
- Train the hybrid/ensemble model, splitting the data into training, validation, and testing sets.
- Evaluate the model's performance using various metrics:
    - Accuracy: Overall correctness of classification.
    - Precision: Proportion of true positives among predicted positives.
    - Recall: Proportion of true positives identified by the model.
    - F1-score: Harmonic mean of precision and recall.
    - AUC-ROC (Area Under the Receiver Operating Characteristic Curve): Measures model performance for imbalanced classes.
    - Confusion Matrix: Visualizes the model's performance in each class.
    - Heatmap (for image classification): Visualizes model predictions for specific data points.
- Analyze the evaluation results and interpret them in the context of your chosen dataset and classification task.

4. Reporting:

- Submit a comprehensive report that includes:
    - Introduction outlining the project's purpose and objectives.
    - Detailed description of the chosen dataset.
    - Explanation of the selected neural network architectures and the hybrid/ensemble approach.
    - Clear documentation of your model implementation with code snippets (commented).
    - Training procedure and hyperparameter tuning (if applicable).
    - Presentation of the evaluation results including metrics, visualizations (confusion matrix, heatmap, etc.), and clear interpretations.
    - Discussion of the model's performance, limitations, and potential improvements.
    - Conclusion summarizing the project's findings and takeaways.

5. <u>Grading Rubric:</u>

- **Total:** 10%
- 5% for Implementation
- 5% for Report and Presentation