NIB 7088 ARTIFICIAL NEURAL NETWORK COURSE WORK

Coursework: Design and Development of Specialized Artificial Neural Networks for Industry-Specific Applications

Introduction

This coursework aims to provide students with an in-depth understanding of Artificial Neural Network. The project will guide students through the key stages of identifying a specific problem, preparing and preprocessing the necessary dataset, architecting and training a neural network model, and rigorously evaluating its performance. By the conclusion of this coursework, students will have developed the skills to design, implement, and optimize ANNs tailored to real-world challenges.

Tasks

1. **Identifying problem**: Select a specific application that requires the development of a specialized artificial neural network (ANN) system.
   a. You may consider problems across various industries such as:
      i. **Medical AI:** Developing models for diagnostics, predictive analytics, or personalized medicine.
      ii. **Educational AI:** Creating intelligent tutoring systems, automated grading, or personalized learning platforms.
      iii. **Legal AI:** Designing systems for legal document analysis, case prediction, or contract management.
      iv. **Mathematical AI:** Implementing systems for symbolic reasoning, automated theorem proving, or numerical analysis.
      v. **Enterprise AI:** Building solutions for customer relationship management (CRM), supply chain optimization, or financial forecasting.
2. **Dataset Collection and Preparation**: Gather, preprocess, and prepare a dataset that aligns with the chosen problem.
3. **Model Development**: Design and develop artificial neural networks tailored to solve the chosen problem.
4. **Model Evaluation**: Evaluate the model's performance and refine it using advanced neural network optimization techniques.
5. **Deployment**: Develop a system or application that integrates the developed ANN model, enabling intended users to interact with it.
6. **Explainable AI**: Incorporate explainable AI methodologies to help users understand the model's behavior and decision-making process.
7. **GENAI**: Explore the application of Generative AI models for the chosen problem and evaluate their effectiveness.

Deliverables

1. **Code**: All scripts and notebooks used for data preprocessing, model training, and evaluation, along with clear documentation.
2. **Dataset**: The full dataset that you used for this project.
3. **Video Recording**: Screen recording of the working demo.
4. **Report**: A detailed report outlining the problem statement, model architecture, model development, optimization techniques employed, evaluation results, and any experimentation conducted.
5. **Presentation**: A presentation summarizing the project's objectives, methodology, results, and conclusions.

Assessment

1. Question 1: Datasets and EDA (10 marks)
   a. Dataset Preparation (10 Marks):
      i. Collect, preprocess, and prepare a dataset for the custom task.
      ii. Describe the nature and characteristics of the collected datasets and provide a comprehensive EDA of the dataset.
2. Question 2: Solution Design (20 marks)
   a. Design and architect a suitable artificial neural network for your chosen problem. (10 marks)
   b. Discuss the different approaches that you considered for solving the chosen problem, and clearly articulate why you selected the specific approach over the alternatives. (10 marks)
      i. Why is an artificial neural network necessary to solve the chosen problem?
      ii. Explain why classical machine learning techniques are inadequate for solving the problem, necessitating a deep learning approach.
      iii. Explain why your design is ideal for your chosen problem.
3. Question 3: Model Development and Evaluation (20 marks)
   a. Discuss your model development and optimization process. Explain the initial (baseline) model you developed and how you improved its performance. (10 marks)
   b. Perform an in-depth study on optimization techniques for artificial neural networks. (10 marks)
      i. Discuss the strengths and weaknesses of the optimization techniques, providing a detailed comparison.

ii. Specifically, Discuss the critical role of hyperparameter tuning—such as adjusting the learning rate, batch size, and network depth—in optimizing the model's performance.

4. Question 4: Web Application Implementation (10 Marks)
   a. Implement a simple web application (frontend/backend) that interacts with the fine-tuned model, allowing users to input and receive generated responses from the model.
   b. Conduct thorough testing to ensure the system functions as intended and is user-friendly.

5. Question 5: Explainable AI (20 marks)
   a. Discuss explainable AI methodologies and provide an in-depth comparison of these methodologies. (5 marks)
   b. Implement an explainable AI feature for the model you developed. (15 marks)
      i. Ensure users can access explanations for each prediction or decision made by the model.
      ii. Design the UI/UX to present explanations in an intuitive and easily interpretable manner, enhancing transparency and trust in the AI system.

6. Question 6: GenAI (20 marks)
   a. Explain the transformer architecture and the internal workings of LLMs with a clear theoretical explanation. (5 Marks)
   b. Implement the chosen problem using the latest GenAI models, such as GPT (Generative Pre-trained Transformer) or other large language models (LLMs). (10 marks)
   c. Analyze the performance, pros, and cons of using GenAI models compared to traditional neural networks. Identify opportunities where GenAI models could offer novel solutions or enhance existing AI systems. (5 marks)

Marking Scheme

Question	Sub-part	Marks
Question 1 - Datasets and EDA	1.a. Datasets and EDA	10
Question 2 – Solution Design	2.a. Design and architect a suitable artificial neural network	10
	2.b. Discuss the different approaches	10
Question 3 – Model Development and Evaluation	3.a Discuss your model development and optimization process	10
	3.b. Perform an in-depth study on optimization techniques	10

Question 4: Web Application Implementation	4.a. Implement a simple web application	10
Question 5: Explainable AI	5.a. Discuss explainable AI methodologies	5
	5.b. Implement an explainable	15
Question 6: GEN AI	6.a. Explain the transformer architecture	5
	6.b. GENAI implementation	10
	6.c. Analyze the performance and identifying the innovation opportunities	5
Total		**100**

Summary

This coursework provides students with a comprehensive journey through the process of developing specialized Artificial Neural Networks (ANNs) for industry-specific applications. By engaging in tasks ranging from problem identification and dataset preparation to model development, evaluation, and deployment, students gain hands-on experience in creating robust and effective AI solutions. The emphasis on hyperparameter tuning, optimization techniques, and explainable AI underscores the importance of refining and understanding neural networks to ensure they are both high-performing and transparent. Additionally, exploring the capabilities of Generative AI models highlights the potential for innovation in AI applications. By the end of this coursework, students are well-equipped with the knowledge and skills needed to design, implement, and optimize neural networks for real-world challenges, laying a strong foundation for their future work in the field of AI.