Nature Inspired Computation Final Project

Overview

This project integrates Nature-Inspired Computation (NIC) with Deep Learning and Explainable AI (XAI). You will apply multiple metaheuristic algorithms to enhance model performance and interpretability.

The goal is to deliver ONE final, fully optimized, and explainable deep learning model.

The project is divided into two phases and must be conducted in teams of two students.

Data Modality Requirement

You must use a challenging and high-dimensional dataset (either image or text-based (NLP), not tabular) that is appropriate for deep learning.

- The dataset should be large enough to demonstrate the scalability of metaheuristic optimization.
- It must include at least 7,000 samples.
- Datasets with clear interpretability or clinical relevance (e.g., biomedical imaging, social media text, medical reports) are strongly encouraged.
- The same dataset must be used consistently throughout all phases.

Project Steps (Mandatory)

Each project must include three major steps, with four metaheuristic algorithms applied per step.

At the end of the project, your team must deliver one final model that:

Step	Description
1. Model Parameter Optimization	Tune model hyperparameters (learning rate, filters, layers, dropout, etc.) using 6 metaheuristics
2. Feature Selection	Using Ant Colony Algorithm Refer to: https://www.sciencedirect.com/science/article/pii/S0165168412003842
3. Algorithm parameters optimization	Select two algorithms from the six that have parameters to tune (e.g., C1 and C2 for PSO), and tune the parameters using one metaheuristic algorithm. Example: Using Hill Climbing to optimize C1 and C2 of PSO.
4. Explainability Optimization (XAI)	Use 4 metaheuristics to optimize SHAP/LIME/Grad-CAM parameters to enhance clarity or stability

Across all steps, the team must use at least 7–9 unique algorithms (no repetitions across stages)

Phase Breakdown

Phase 1: Dataset & Parameter Optimization (2.5 Marks)

Deadline: Week 7

Objectives:

1. Select and justify a challenging dataset.
2. Build baseline deep learning model (CNN, Transformer, etc.).
3. Feature Selection using Ant Colony Algorithm.
4. Apply 4 metaheuristic algorithms for model optimization.
5. Evaluate and compare the outputs

Deliverables:

1. Dataset description and preprocessing summary.
2. Comparative analysis (accuracy, computation time, loss, etc)
3. Short presentation (5-10 minutes)

Phase 2: Parameter & Explainability Optimization (7.5 Marks)

Deadline: Week 14

Objectives:

1. Apply another 1 metaheuristic algorithm for another two metaheuristic algorithms that have parameters, and use one metaheuristic algorithm to optimize the optimizer parameters. Example: Using Hill Climbing to optimize C1 and C2 of PSO.
2. Select the best configurations and apply 4 metaheuristic algorithms for XAI optimization (e.g., SHAP, LIME, Grad-CAM).
3. Compare all results and integrate findings.

Deliverables:

1. Optimized model results and comparison
2. XAI visualizations and explanation quality metrics

3. Full project report + GitHub code
4. Final presentation (10–12 minutes)

Evaluation Summary (Total 10 Marks)

Category	Marks
Dataset selection & problem definition	1
Feature selection	0.5
Model parameter optimization (6 metaheuristics)	3
XAI optimization (4 metaheuristics)	1.5
Presenting the best model	2
Reporting & presentation	2
Total	**10 Marks**