SIPC Summer 2025 PROJECT PLAN

PROJECT: Pattern Recognition and Labeling with Neural Networks

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SEMESTER: Summer 2025

STATEMENT OF WORK:

Task 1. Define Neural Network-Based Pattern Recognition Objectives

- Conduct a literature survey to understand the current techniques for pattern recognition using single- and multi-layer neural networks.
- Identify application domains, especially object detection in grayscale imagery.
- Select training labels (e.g., “car”, “not-car”) and appropriate dataset types.
- Determine evaluation metrics (accuracy, precision, recall, noise tolerance).
- Finalize use of 16×16 and 32×32 grayscale image inputs for classification.

Task 2: Agile Sprint Planning and Role Assignment

- Assign roles: Scrum Master, Developers, Dataset Manager, and Document Lead
- Set sprint-wise goals: dataset creation, model training, noise testing, final reporting.
- Set up GitHub for version control and Trello/JIRA for task tracking.

Task 3. Develop and Train Neural Network Models

- Collect and prepare a database of 12–24 grayscale images (16×16 to 32×32).
- Perform image preprocessing (resizing, normalization, labeling).
- Implement single- and multi-layer neural networks using PyTorch.
- Train the models on noiseless image-label tuples: ⟨image, label⟩.
- Apply sliding window method on larger images to test classification.

Task 4. Introduce Noise and Evaluate Model Robustness

- Perturb test images using additive Gaussian noise.
- Evaluate trained networks on both noisy and clean image inputs.
- Perform comparative analysis between: - Model trained on clean data only
    - Model trained on both clean and noisy data
- Analyze NN failure modes by testing on images not in the training set.
- Quantify drop in performance metrics due to noise introduction.

Task 5. Final Documentation and Presentation

- Document neural network architecture, training strategies, and testing workflows.
- Include visual outputs of pattern detection on images (clean and noisy).
- Prepare a final written report summarizing goals, methodology, results, and key insights.
- Present findings in final project session with live demonstration of model output.

DELIVERABLES:

1. Theory, Design, and Literature References

• Summary of neural network models, training methods, associative memory principles, and relevant sources from journals and tutorials.

2. Software

• Python-based implementation using PyTorch, SciKit, and NumPy.
• Supporting image manipulation tools using GIMP and image resizing utilities.
• All code written for image classification, noise injection, training, and performance analysis.

3. Dataset and Labels

• Curated training and testing image database (16×16 and 32×32 grayscale images) with labeled categories: “car” and “not-car”.
• Noisy image variants used for robustness testing.

4. Final Report

• Written in Microsoft Word-compatible format, including diagrams, confusion matrices, and performance graphs.
• Report will describe architecture design, implementation, and key learnings.