Perceptron-Based Learning Tool: Project Proposal

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Course Title

CO542 Neural Networks and Fuzzy Systems

Project Domain and Research Proposal

This is the Project Domain and Research Proposal for Milestone 1.

1 Goal

The primary goal of this project is to identify a suitable domain and propose an application using neural networks. The focus is on developing a hardware-based learning tool to visualize the working of a perceptron.

2 Problem Definition

Understanding the internal workings of neural networks can be challenging, especially for beginners. Traditional software-based implementations do not provide an intuitive way to grasp the learning process. This project addresses the need for a tangible, hardware-based visualization tool that demonstrates how a perceptron updates its weights and makes decisions.

3 Scope

The project is designed as an educational tool for students and researchers interested in neural networks. It will focus on:

- Implementing a single-layer perceptron with three numerical inputs.
- Using an Arduino-based system to represent weight adjustments in real-time.
- Visualizing learning through LED indicators and variable resistors.
- Providing a mobile and accessible demonstration setup for lecture halls and workshops.

4 Justification for Using Perceptrons

Perceptrons are the simplest form of artificial neural networks and serve as a foundation for more complex models. They are suitable for binary classification tasks and provide an effective way to demonstrate weight adjustments through hands-on interaction. Using a perceptron allows for real-time visualization, making it easier to understand core concepts like weighted summation, activation functions, and training iterations.

5 Literature Review

The perceptron algorithm, introduced by Rosenblatt in 1958, is one of the earliest machine learning models used for classification tasks. Traditional perceptron implementations are software-based, but hardware-based educational tools have been explored in recent years.

Several research studies and open-source projects have demonstrated the feasibility of implementing perceptrons using microcontrollers like Arduino. These projects often use LEDs, voltage-sensitive components, and interactive visualizations to illustrate neural network concepts. Notable examples include:

- Arduino-based Perceptron Simulations : These use microcontrollers to process inputs and activate LEDs based on learned weights.
- Analog Circuit Perceptrons : Resistor networks are used to model weight adjustments in learning.
- Educational AI Tools : Some projects integrate microcontrollers with software simulations to teach AI fundamentals.

6 High-Level Design of the Proposed Model

The perceptron model for this project follows a single-layer architecture with three main inputs. The architecture consists of:

- **Input Layer**: Three numerical inputs (e.g., temperature, humidity, pressure)
- **Weights**: Represented by adjustable resistors or stored in an Arduino
- **Summation Function**: Computes weighted sum of inputs
- **Activation Function**: Step function (ON/OFF) or sigmoid function
- **Output Layer**: LED or display indicating classification

6.1 Block Diagram

The model will be implemented using an Arduino microcontroller to handle computations, while LEDs and resistors provide a physical visualization of learning. The system will train using predefined input-output pairs and adjust weights accordingly.

7 Conclusion

This hardware-based perceptron visualization tool will serve as an educational aid for understanding fundamental neural network concepts. The implementation will include Arduino integration, LED-based weight representation, and interactive real-time training feedback.