Miniproject:

Neural Network-Based Image Recognition with Multilayer Perceptron

Project Title:

Cat Image Recognition using Backpropagation in a Multilayer Perceptron

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Objective

Introduce students to the concepts of neural networks, including the **multilayer perceptron (MLP)** and the **backpropagation algorithm (BPA),** by implementing a basic image recognition system that distinguishes between **cat images** and **non-cat images**.
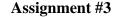

Project Overview

1. **Task**:
   - Train a simple neural network using the backpropagation algorithm to classify images as either "Cat" or "Not a Cat."
   - Use a **Multilayer Perceptron (MLP)** with one hidden layer.
2. **Input**:
   - Grayscale images of cats and non-cats, resized to 64×64 pixels (4096 features).
3. **Output**:
   - Binary classification: y=1 (Cat), y=0 (Not a Cat).
4. **Steps**:
   - Preprocess the dataset (resize, normalize images).
   - Design an MLP with one hidden layer.
   - Implement forward propagation, calculate loss, and update weights using backpropagation.
   - Train the network on the dataset.
   - Evaluate its performance on test images.

Tasks

1. Dataset Preparation

- Collect and preprocess a small dataset of cat and non-cat images.
- Resize images to 64×64.
- Normalize pixel values to the range [0, 1].

- Label the images: 1 for "Cat" and 0 for "Not a Cat."

2. Neural Network Design

- **Architecture**:
    - Input layer: 4096 neurons (one for each pixel).
    - Hidden layer: 16 neurons.
    - Output layer: 11 neurons (Sigmoid activation).
- **Learning Parameters**:
    - Learning rate: 0.01.
    - Loss function: Binary Cross-Entropy.

3. Implementation in MATLAB

- Write code to:
    1. Initialize weights and biases.
    2. Perform forward propagation.
    3. Compute the loss and gradients using backpropagation.
    4. Update weights using gradient descent.
    5. Train the network over multiple epochs (up to 1,000).

4. Evaluate and Test

- Test the trained network on unseen images
    - What's the initial loss?
    - What's the final loss (after 1,000 epochs)?
    - What's the test accuracy (in %)?
- Display predictions alongside the original images.