MNIST Handwritten Digit Recognition

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Objective

To develop a neural network model to predict the label of a handwritten digit.

Involves these steps :

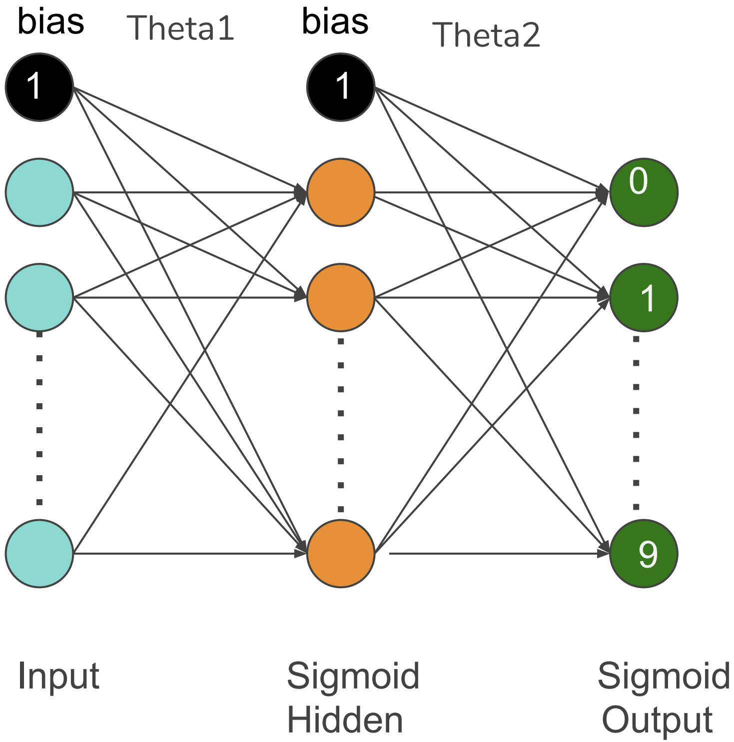
- Procure data for training and testing
- Develop neural network architecture
- Train the neural network
- Test the model

Data for Training and Testing

1. 5000 training examples from Yann Le Cun MNIST repository
2. Each image is a 20 pixel x 20 pixel grayscale image of a digit
3. 20x20 image is unrolled into 400-dimensional vector
4. Create training set matrix X of dimensions 5000x400
5. Each row of X is a training example.

X = input training matrix
X dimensions = (5000, 400)

Neural Network Architecture



Details:

- Input 400 units.
- Hidden layer 25 sigmoid units.
- Output 10 sigmoid units one for each digit 0-9.

Training the network

Variables:

Theta1 : Weight matrix for input-hidden layer - dimensions 25x401 (400 + 1 for bias)

Theta2 : Weight matrix for hidden-output layer - dimensions 10x26 (25 + 1 for bias)

X : Training example matrix - dimensions 5000x401

Training the network contd..

Forward Propagation :

A1 = X

Z2 = Theta1 * Transpose(A1) (Weighted linear sum for hidden layer)

A2 = Sigmoid (Z2) (Activation for hidden layer)

Z3 = Theta2 * Transpose(A2) (Weighted linear sum for output layer)

A3 = Sigmoid(Z3) = Output predictions for each digit

Cost function J = Sum(-Y*log(A3)-(1-Y)*log(1-A3)) + (lambda*/5000)Square(Theta1) + Square(Theta2)

lambda is regularization term

Training the network contd..

Backward propagation:

D3 = A3-Y

D2 = (Transpose(Theta2)*D3) .* Derivative(Sigmoid (Z2))

Delta2 = Delta2 + D3 * Transpose(A2)

Delta1 = Delta1 + D2 * Transpose(A1)

Theta1 = Theta1 - learning_rate * Delta1

Theta2 = Theta2 - learning_rate * Delta2

Accuracy

An accuracy of 95% is achieved with this neural network model.