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Machine Learning

Project Part 1

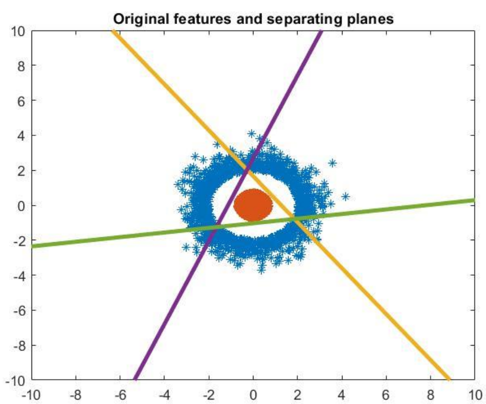
A. Forward Propagation

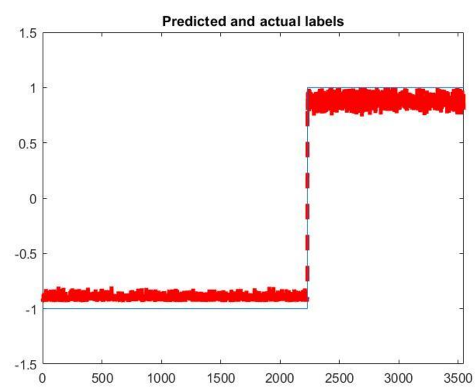
```
% Forward Propagation
%---------------------------

 B = W1 * X1;
 z = h(B);
 a = W2 * [z;ones(1,size(z,2))];
 y = h(a);
```

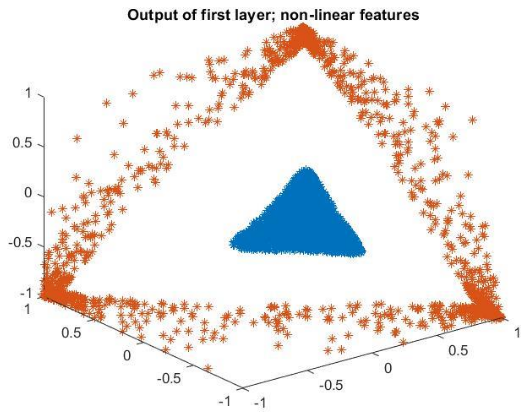
B. Backward Propagation

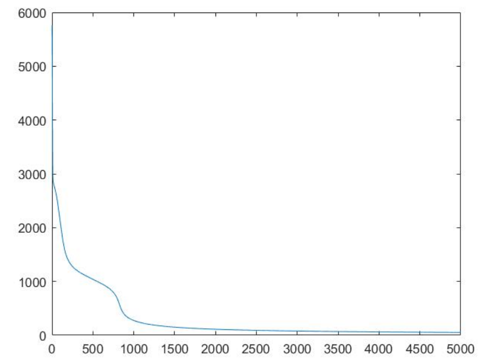
```
% Backward Propagation
%--------------------------

GradientA = 2 .* (y-s) .* dh(a);
GradW2 = GradientA * [z;ones(1,size(z,2))]';
GradientZ1 = W2' * GradientA;
GradientZ = GradientZ1(1:Nh,:);
GradientB = GradientZ .* dh(B);
GradW1 = GradientB * X1';
```

C. Training Data Figures



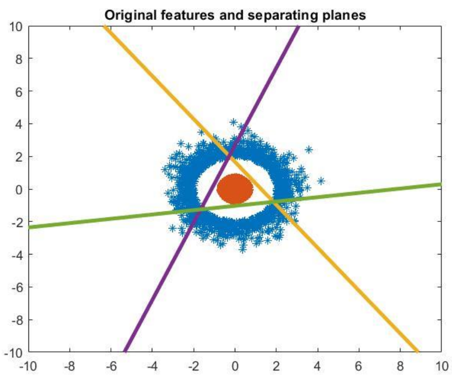




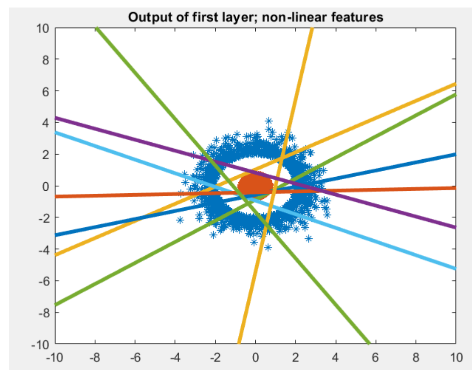


D. Training based on number of neurons in hidden layer:

$N_h = 3$



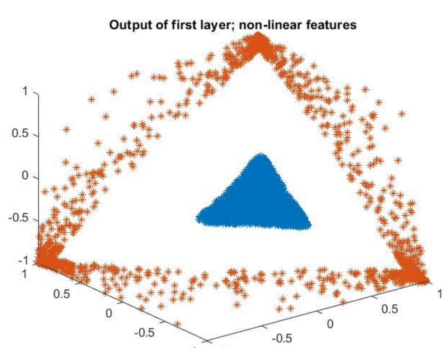
$N_h = 10$



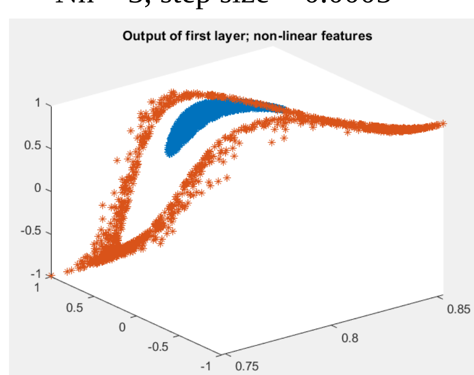
As the number of neurons in the hidden layer increases, it will cause the accuracy to decrease which leads to overfitting of the neural network training set. So, the network can learn the data, but cannot generalize it to new data. Based on this relationship, increasing the neurons will lead to training being harder.

E. How Step Size Changes Neural Network

Nh = 3, step size = 0.0001



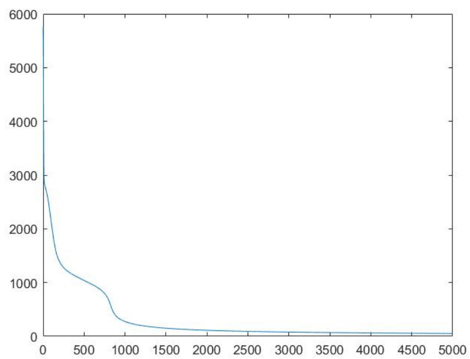
Nh = 3, step size = 0.0005



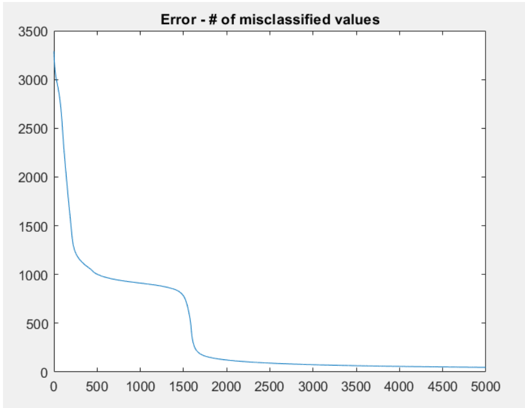
Increasing the step size mean the learning rate is higher which can cause undesirable divergent behavior in the loss function. It can be seen in the above 2 images that when the step size was increased, the gradient shifted since the learning rate was larger than normal.

F. Vary b and What Changes in Neural Network

1B



2B



As the 2 graphs above show increasing bias decreases the number of misclassified values. The purpose of bias is to increase the flexibility of the neural network model to fit the data and by increasing the bias, more of the data is fit into the model, making values being misclassified less likely.