Perceptron_Model

March 26, 2018

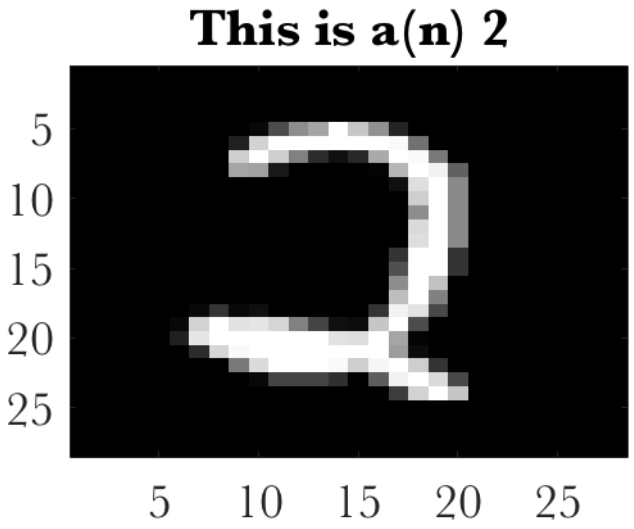
0.1 Perceptron Neural Network Model

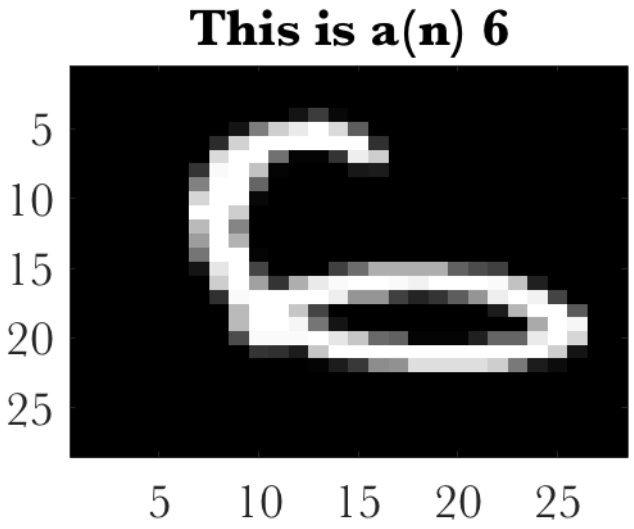
In [1]:
```
% Created: 2016/02/05, 24 Cummington, Boston
%  Byron Price
% Updated: 2016/02/08
%   By: Byron Price

% All functions called are placed in this directory.

%% This code will implement a perceptron that
%%  will be capable of recognizing handwritten text

%% Simple perceptron rule
%%   If w is a connection strength vector (or weight)
%%   and x is an input vector, then
%%     output = 0 if w*x + b <= 0
%%     output = 1 if w*x + b > 0
%%   where * is the dot product of all inputs by their
%%   respective weights

%% Sigmoid perceptron
%%  If x is an input vector and w a connection strength
%%  vector, then output = 1/(1+exp(-(w*x+b)))
%%
%% See www.neuralnetworksanddeeplearning.com for more information.
```

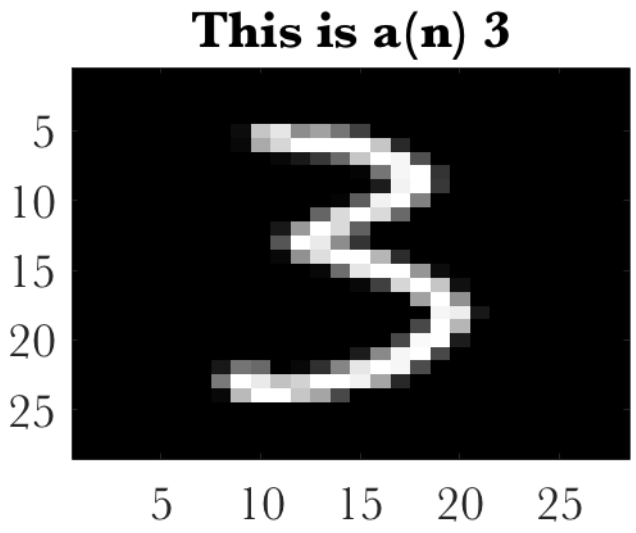
0.2 Draw a Few Figures of Digits from MNIST Training Dataset

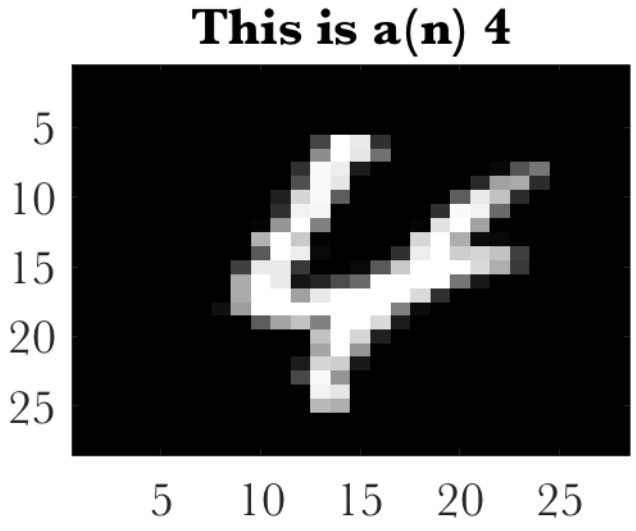
In [1]:
```
load('TrainingData.mat')

numImages = size(Images,2);
numPixels = size(Images,1);

for i=1:5
    index = round(rand*numImages);
    digit = Labels(index);
    image = reshape(Images(:,index),[28,28]);
```

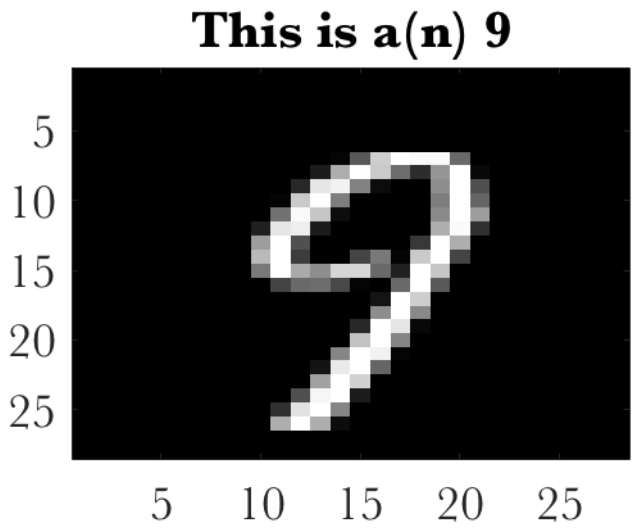
```
    figure();imagesc(image);title(sprintf('This is a(n) %i',digit));
    colormap gray;
end
```






This is a(n) 3
5
10
15
20
25
5
10
15
20
25


This is a(n) 4
5
10
15
20
25
5
10
15
20
25



0.3 Build a Network with Randomized Weights and Biases

```
In [2]: numDigits = 10;
        numHidden = 15;
        myNet = Network([numPixels,numHidden,numDigits]); % from a function
             % in this directory, builds a 3-layer network
```

```
In [3]: myNet
```

```
myNet =

    Weights: {[784x15 double]  [15x10 double]}
     Biases: {[15x1 double]  [10x1 double]}
```

0.4 Convert Labels Matrix to Format Suitable for Comparison to Network Output

```
In [4]: DesireOutput = zeros(numDigits,numImages);

        for ii=1:numImages
            numVector = zeros(numDigits,1);
            for jj=1:numDigits
                if Labels(ii) == jj-1
                    numVector(jj) = 1;
                    DesireOutput(:,ii) = numVector;
                end
            end
        end
```

```
In [5]: size(Images)
        size(DesireOutput)
```

```
ans =

         784       60000


ans =

          10       60000
```

0.5 Stochastic Gradient Descent

```
In [8]: batchSize = 10; % make mini batches and run the algorithm
             % on those "runs" times
        runs = 5e4;
        eta = 0.5; % learning rate
        lambda = 1; % for L2 regularization
        numCalcs = size(myNet.Weights,2);
        dCostdWeight = cell(1,numCalcs);
        dCostdBias = cell(1,numCalcs);

        for ii=1:runs
            indeces = ceil(rand([batchSize,1]).*(numImages-1));
            for jj=1:numCalcs
                layer1 = size(myNet.Weights{jj},1);
                layer2 = size(myNet.Weights{jj},2);
                dCostdWeight{jj} = zeros(layer1,layer2);
                dCostdBias{jj} = zeros(layer2,1);
            end
            for jj=1:batchSize
                index = indeces(jj);
                [costweight,costbias] = BackProp(Images(:,index),myNet,...
                DesireOutput(:,index));
                for kk=1:numCalcs
                    dCostdWeight{kk} = dCostdWeight{kk}+costweight{kk};
                    dCostdBias{kk} = dCostdBias{kk}+costbias{kk};
                end
            end
            [myNet] = GradientDescent(myNet,dCostdWeight,dCostdBias,batchSize,eta,r
        end
```

0.6 Run Network Against Test Data

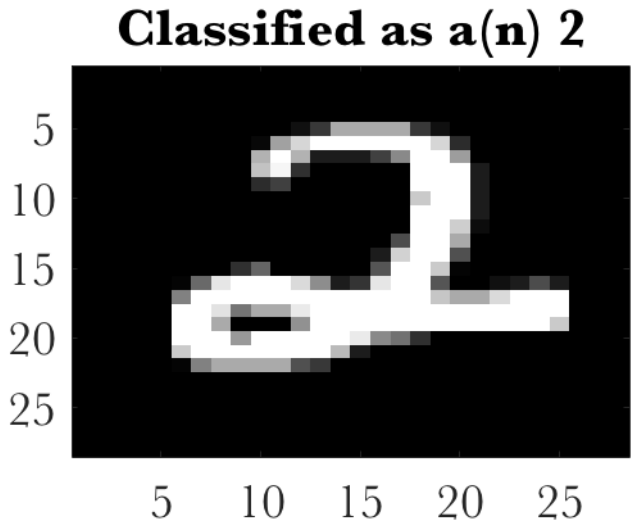
```
In [9]: clear Images Labels;
        load('TestData.mat')
        numImages = size(Images,2);
        numPixels = size(Images,1);
        numDigits = 10;
```

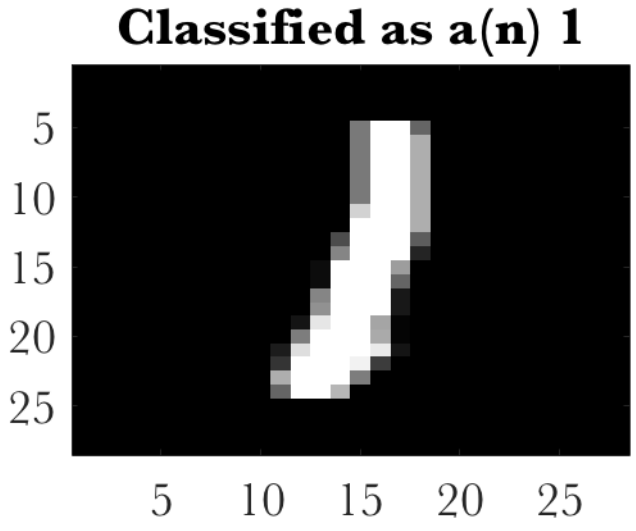
```
        DesireOutput = zeros(numDigits,numImages);

        for ii=1:numImages
            numVector = zeros(numDigits,1);
            for jj=1:numDigits
                if Labels(ii) == jj-1
                    numVector(jj) = 1;
                    DesireOutput(:,ii) = numVector;
                end
            end
        end

        classifiedVals = zeros(numImages,1);
        count = 0;
        for ii=1:numImages
            [Output,Z] = Feedforward(Images(:,ii),myNet);
            [~,realVal] = max(DesireOutput(:,ii));
            [~,netVal] = max(Output{2});
            classifiedVals(ii) = netVal-1;
            if realVal == netVal
            count = count+1;
            end
        end
        Accuracy = count/numImages
```

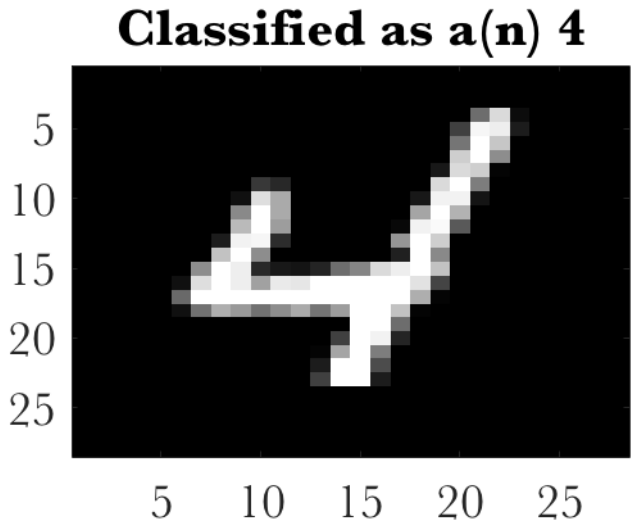
```
Accuracy =

    0.9632
```

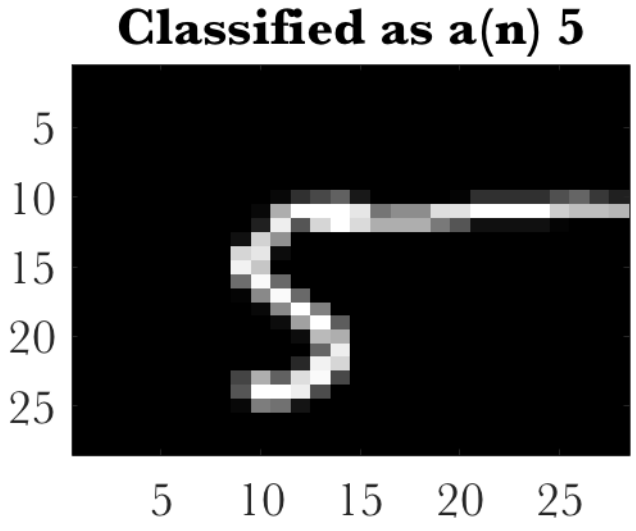
0.7 Display Figures for the Network's Classification of the Novel Test Data

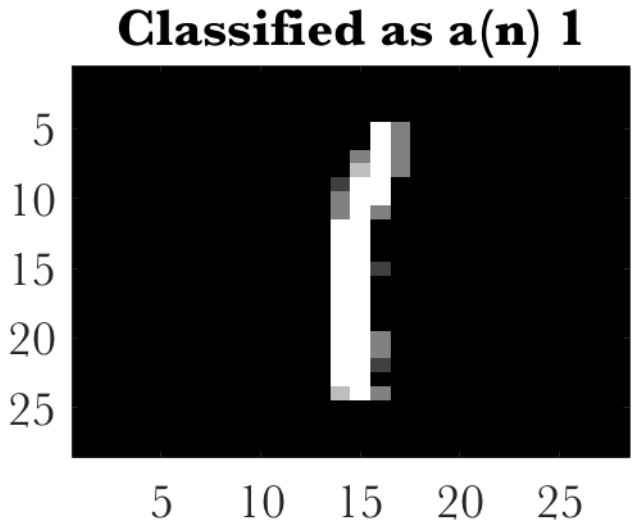
```
In [10]: for ii=1:10
             index = ceil(rand*(numImages-1));
             digit = classifiedVals(index);
             image = reshape(Images(:,index),[28,28]);
             figure();imagesc(image);title(sprintf('Classified as a(n) %i',digit));
             colormap gray;
         end
```

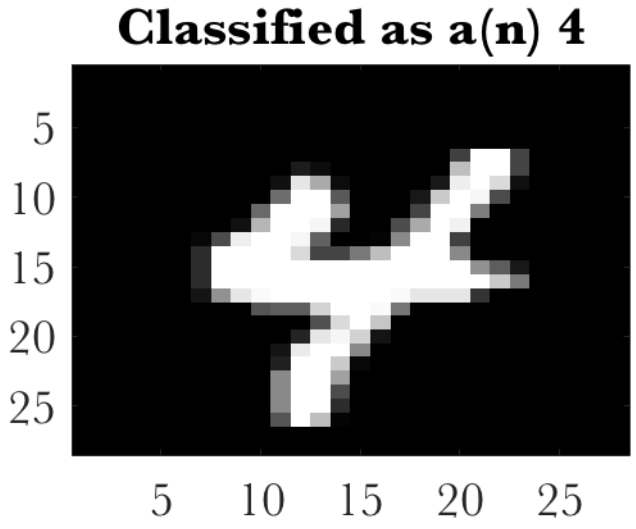

Classified as a(n) 2
5
10
15
20
25
5
10
15
20
25

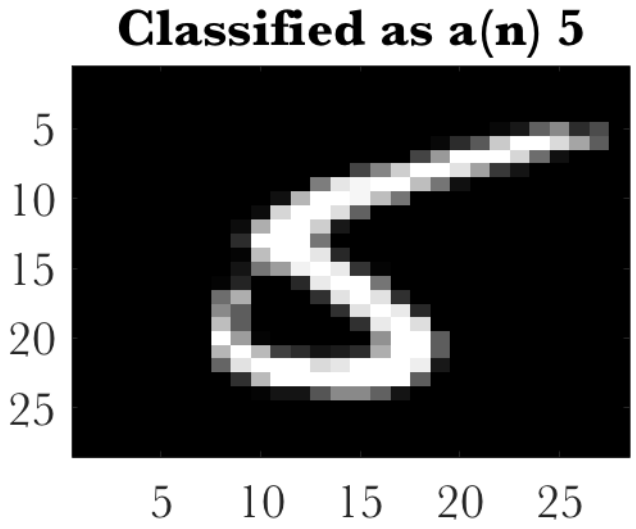

Classified as a(n) 1
5
10
15
20
25
5
10
15
20
25

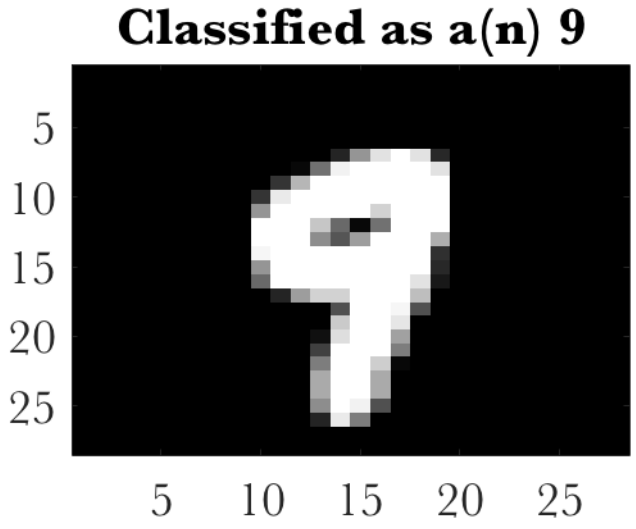

Classified as a(n) 4
5
10
15
20
25
5
10
15
20
25

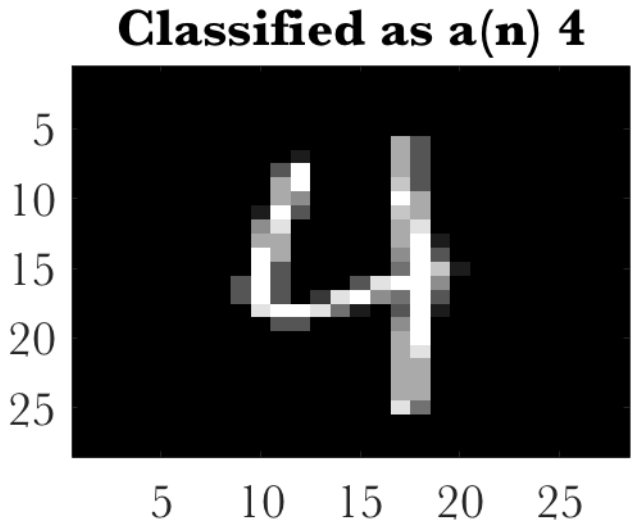

Classified as a(n) 5
5
10
15
20
25
5
10
15
20
25

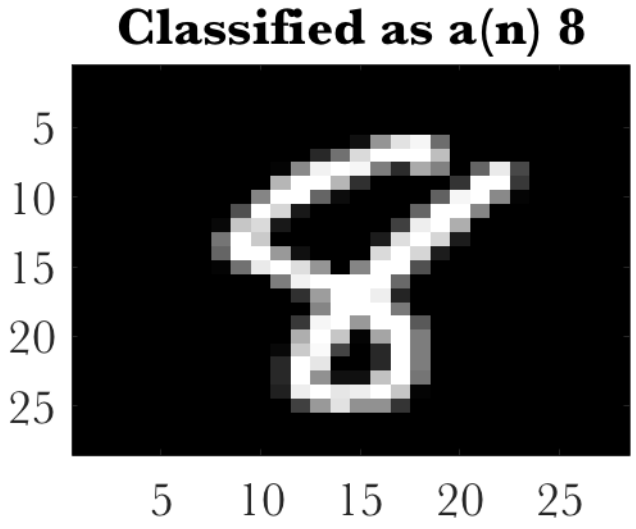

Classified as a(n) 1
5
10
15
20
25
5
10
15
20
25


Classified as a(n) 4
5
10
15
20
25
5
10
15
20
25


Classified as a(n) 5
5
10
15
20
25
5
10
15
20
25


Classified as a(n) 9
5
10
15
20
25
5
10
15
20
25


Classified as a(n) 4
5
10
15
20
25
5
10
15
20
25


Classified as a(n) 8
5
10
15
20
25
5
10
15
20
25