Teach a Neural Network to Read Handwriting

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Problem Statement

Neural networks and deep learning are two success stories in modern artificial intelligence. They've led to major advances in image recognition, automatic text generation, and even in self-driving cars. To get involved with this exciting field, you should start with a manageable dataset.

The **MNIST Handwritten Digit Classification Challenge** is the classic entry point. Image data is generally harder to work with than "flat" relational data. The MNIST data is beginner-friendly and is small enough to fit on one computer. Handwriting recognition will challenge you, but it doesn't need high computational power. Build a neural network from scratch that solves the MNIST challenge with high accuracy.

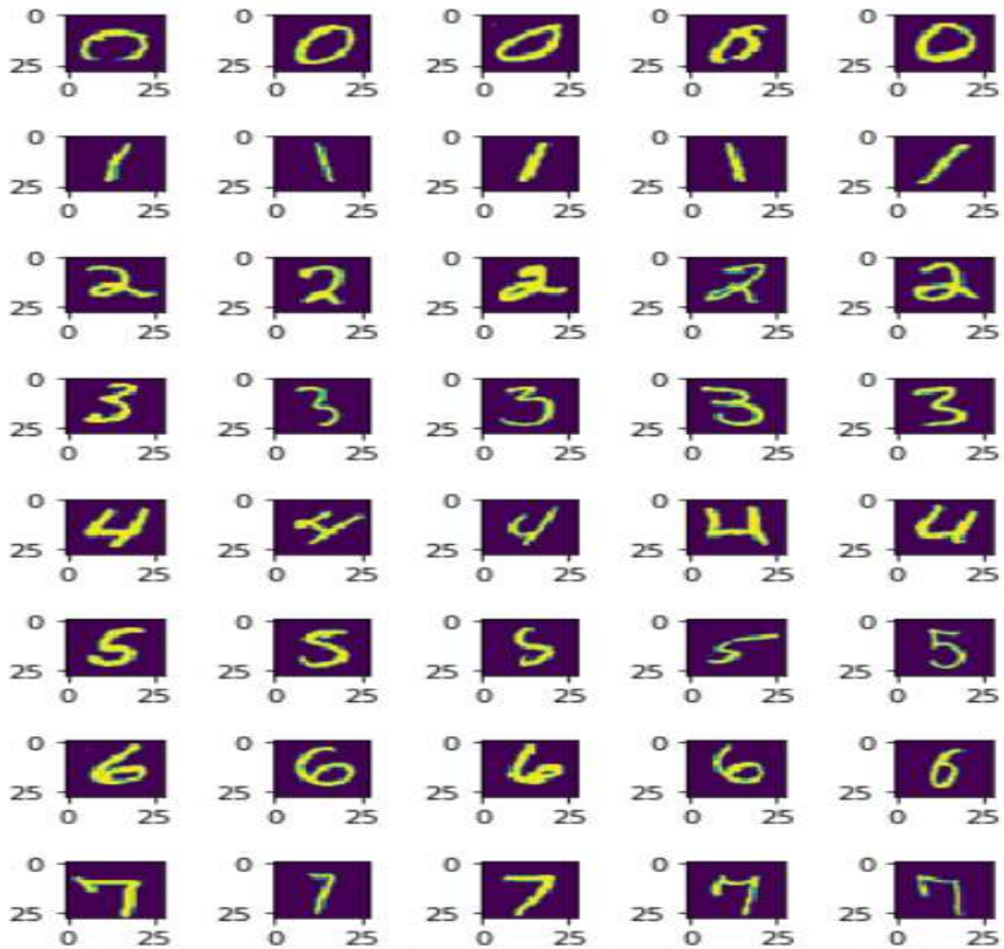
Data Sources **MNIST (http://yann.lecun.com/exdb/mnist/)** – MNIST is a modified subset of two datasets collected by the U.S. National Institute of Standards and Technology. It contains 70,000 labeled images of handwritten digits.

USING ARTIFICIAL NEURAL NETWORK

Algorithm

- Download/Extract the dataset and split the dataset into train, test and validation sets.
- Flatten the images using resize and use one-hot-encoding to give a unique ID to every group of unique digits.
- Set up a neural network architecture to identify the digits
- Check the validation error and model accuracy graph to check the performance of the neural network.
- Test the neural network using arbitrary image.

```python
    for j in range(num_classes):
        x_selected = X_train[y_train == j]
        axs[j][i].imshow(x_selected[random.randint(0, len(x_selected - 1)), :,:])
```



UNIQUE DIGITS

```
]: model = create_model()
print(model.summary())
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_1 (Dense)              (None, 10)                7850
_________________________________________________________________
dense_2 (Dense)              (None, 10)                110
_________________________________________________________________
dense_3 (Dense)              (None, 10)                110
_________________________________________________________________
dense_4 (Dense)              (None, 10)                110
=================================================================
Total params: 8,180
Trainable params: 8,180
Non-trainable params: 0
_________________________________________________________________
None
```

NNet Architecture

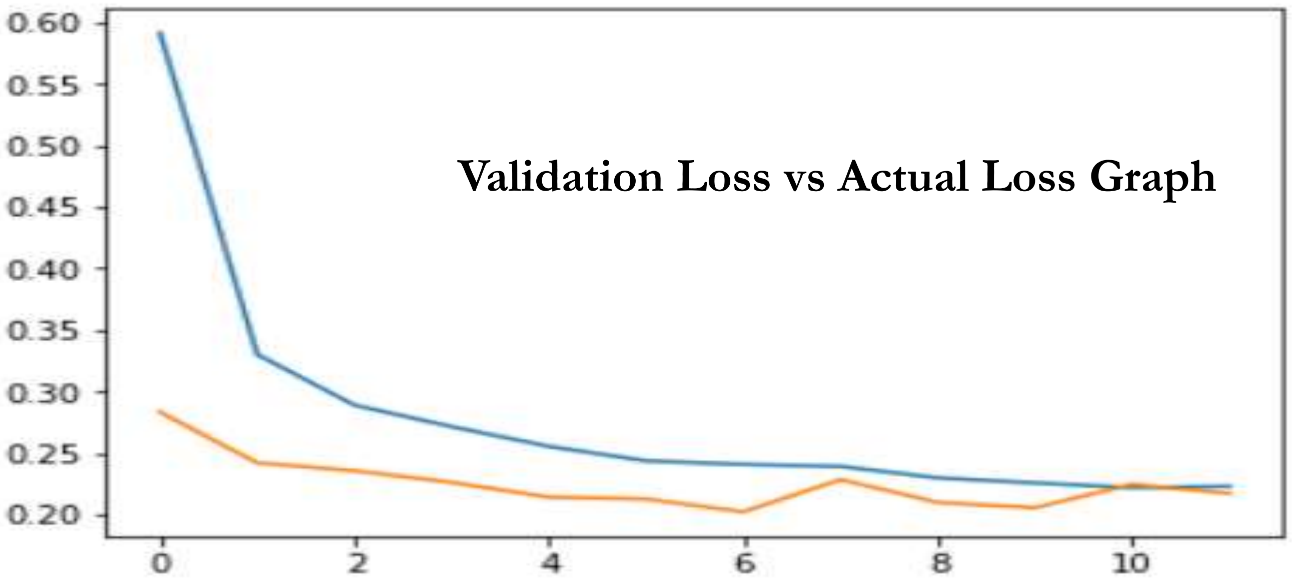
```
In [11]: history= model.fit(X_train,y_train, validation_split=0.1, epochs=12, batch_size=200, verbose = 1, shuffle = 1)
```

```
Train on 54000 samples, validate on 6000 samples
Epoch 1/12
54000/54000 [==============================] - 5s 84us/step - loss: 0.5914 - acc: 0.8159 - val_loss: 0.2833 - val_acc: 0.9158
Epoch 2/12
54000/54000 [==============================] - 2s 37us/step - loss: 0.3302 - acc: 0.9039 - val_loss: 0.2420 - val_acc: 0.9317
Epoch 3/12
54000/54000 [==============================] - 2s 36us/step - loss: 0.2889 - acc: 0.9151 - val_loss: 0.2356 - val_acc: 0.9317
Epoch 4/12
54000/54000 [==============================] - 2s 37us/step - loss: 0.2715 - acc: 0.9211 - val_loss: 0.2262 - val_acc: 0.9315
Epoch 5/12
54000/54000 [==============================] - 2s 36us/step - loss: 0.2554 - acc: 0.9254 - val_loss: 0.2141 - val_acc: 0.9387
Epoch 6/12
54000/54000 [==============================] - 2s 36us/step - loss: 0.2437 - acc: 0.9289 - val_loss: 0.2126 - val_acc: 0.9357
Epoch 7/12
54000/54000 [==============================] - 2s 34us/step - loss: 0.2408 - acc: 0.9288 - val_loss: 0.2022 - val_acc: 0.9417
Epoch 8/12
54000/54000 [==============================] - 2s 36us/step - loss: 0.2391 - acc: 0.9292 - val_loss: 0.2285 - val_acc: 0.9325
Epoch 9/12
54000/54000 [==============================] - 2s 39us/step - loss: 0.2299 - acc: 0.9322 - val_loss: 0.2099 - val_acc: 0.9390
Epoch 10/12
54000/54000 [==============================] - 2s 38us/step - loss: 0.2257 - acc: 0.9326 - val_loss: 0.2056 - val_acc: 0.9402
Epoch 11/12
54000/54000 [==============================] - 2s 30us/step - loss: 0.2219 - acc: 0.9339 - val_loss: 0.2247 - val_acc: 0.9325
Epoch 12/12
54000/54000 [==============================] - 2s 31us/step - loss: 0.2230 - acc: 0.9333 - val_loss: 0.2171 - val_acc: 0.9377
```

Final validation accuracy and validation loss after 12 epochs

```
In [12]: plt.plot(history.history['loss'])
         plt.plot(history.history['val_loss'])
```

```
Out[12]: [<matplotlib.lines.Line2D at 0x2e80e539e48>]
```




```
In [13]: score = model.evaluate(X_test, y_test, verbose=0)
         print('Test score: ' ,score[0])
         print('Test accuracy:', score[1])

         Test score:  0.24280881922841072
         Test accuracy: 0.9279
```

Test score and Accuracy of the NNet

In [14]:

```python
img= img/255
img= img.reshape(1,784)
prediction = model.predict_classes(img)
print('Predicted Digit: ', str(prediction))
```

```
Predicted Digit:  [6]
```

Prediction of the neural network on arbitrary image

USING MACHINE LEARNING

Algorithm

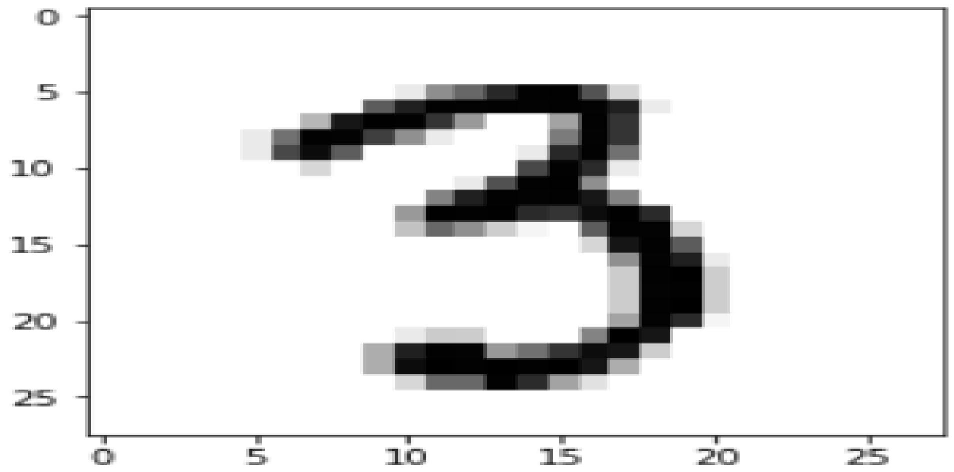
- Download/Extract the dataset(pixels) and split the dataset into features and labels.
- Set up a DecisionTreeClassifier or any classifier of your choice.
- Fit the data into the classifier.
- Check the accuracy by comparing the predicted labels with the true labels
- Test the algorithm using arbitrary image pixels(features).

```
In [3]: clf = DecisionTreeClassifier()
```

```
In [4]: xtrain = data[0:21000,1:]
        train_label = data[:21000,0]
```

```
In [5]: clf.fit(xtrain,train_label)
        xtest = data[21000:,1:]
        actual_label=data[21000:,0]
```

```
In [6]: #check
        d= xtest[5]
        d.shape = (28,28)
        plt.imshow(255-d, cmap='gray')
        plt.show()
```



Number to be predicted

```
In [7]: print(clf.predict([xtest[5]]))

[3]
```

Result

THANK YOU