

# Deep Belief Networks

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# 1 Introduction

The objective of this project is to study deep neural networks for the classification of hand-written numbers. We will compare the performances, in terms of rate of good classifications, of a pre-trained network (using Deep Belief Networks) and of a randomly initialized network, as a function of the number of training data, the number of layers of the network and finally the number the number of neurons per layer.

## 2 Data

### 2.1 AlphaDigits

This database from NYU<sup>1</sup>, contains binary digits of size 20x16 that represent character "0" through "9" and capital "A" through "Z".

There are 39 examples of each class, thus the data frame will contain 1,404 rows each representing an image (39 examples of 36 classes) and 320 variables taking binary values 1 or 0 (black =1 and white = 0 for each pixel value of a 20x16 alpha-numeric image).

Below, we plot some examples to get a closer look into the dataset.



Figure 1: AlphaDigits examples

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<sup>1</sup><http://www.cs.nyu.edu/~roweis/data.html>

## 2.2 MNIST

The MNIST<sup>2</sup> database (Modified National Institute of Standards and Technology database) is a large collection of handwritten digits. It has a training set of 60,000 examples, and a test set of 10,000 examples. The digits have been size-normalized and centered in a fixed-size image. They were also centered in a 28x28 image by computing the center of mass of the pixels, and translating the image so as to position this point at the center of the 28x28 field.

In our case, we will binarize the images in order to get 0/1 pixels representing the background (in black) and the digit (in white).

Also, we will transform the labels into a one hot encoded vector, i.e. vector of size 10 for each image with all zeros except one at the index of digit.

Below, we show some examples from the dataset after binarization.

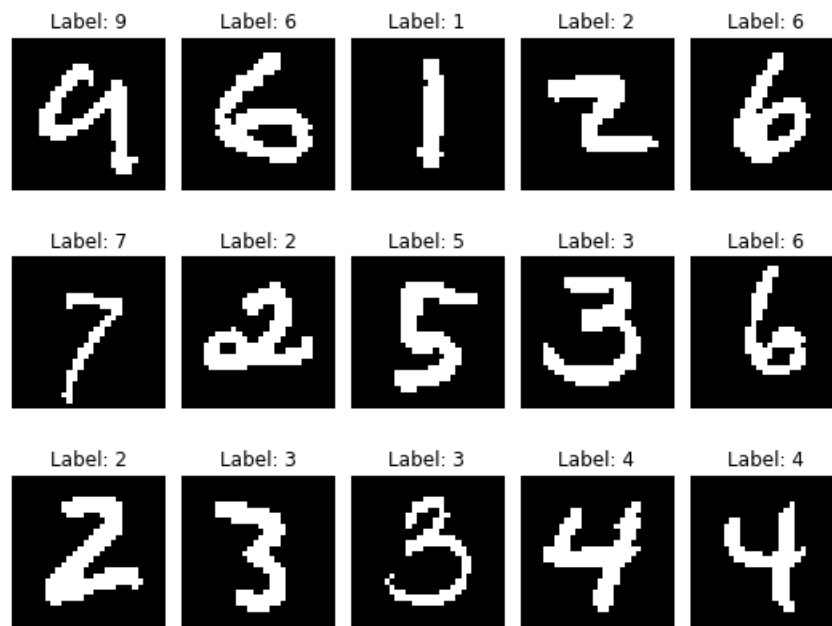


Figure 2: MNIST examples

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<sup>2</sup><http://yann.lecun.com/exdb>

### **3 Preliminary Work**

#### **3.1 Restricted Boltzmann Machine**

#### **3.2 Deep Belief Network**

### **4 Primary Work**

#### **4.1 Deep Neural Network**

#### **4.2 Results**

### **5 Conclusion**