Dimensionality Reduction using Neural Networks

Autoencoder

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Outline

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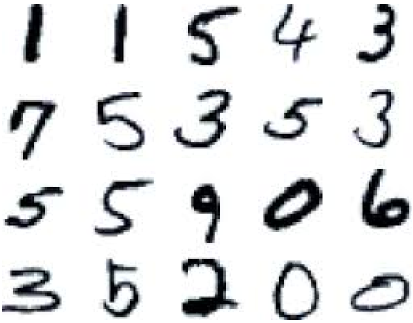
Problem and Motivation

- Problem - How to use neural nets to reduce the dimensionality and make it efficient
- Motivation - Reducing the dimensionality of data can be extremely beneficial as it can cause magnitudes of reduction in data saving costs, transmission costs and computation time for various tasks.

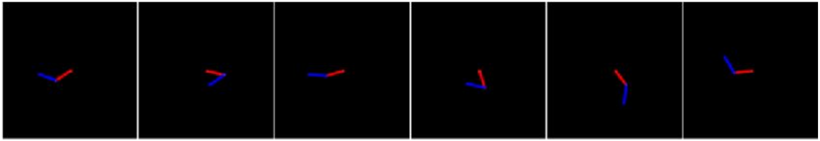
Dataset - MNIST

- It consists of 70,000 binary images of size 28 X 28 having 10 different classes each corresponding to a digit from 0-9.
- The complete data is split into 3 sets - training set having 50,000 images, validation set having 10,000 images and test set having 10,000 images.

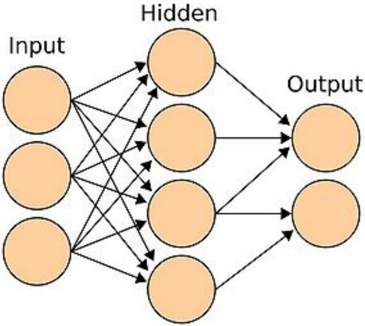


Dataset - 2D-Robot Arm

- The dataset contains 23,968 binary images of size 100 X 100 pixels.
- In this dataset, while the first arm is allowed to be in any position, the 2nd arm was restricted to have an angle between -105°and 105°with 0 being taken in the direction of first arm.
- This was done to avoid any significant overlap between the 2 arms.
- The training-validation-test split for this dataset was kept at (80,10,10).

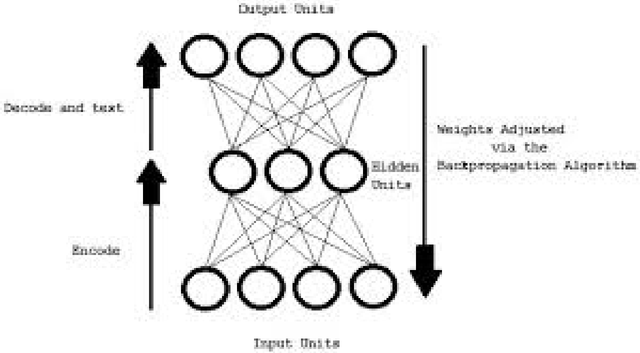


What is Neural Networks



- Backpropogation
- How Backpropogation Work

Autoencoders



- Loss Function

$$L_H(\mathbf{x},\mathbf{z}) = -\sum_{k=1}^{d}[\mathbf{x}_k \log \mathbf{z}_k + (1-\mathbf{x}_k)\log(1-\mathbf{z}_k)]$$

Problems and How to overcome them

- Problems in training a deep autoencoder or a deep neural network
  1 - Vanishing gradient descent problem(under-fitting)
  2 - stuck in local minima(overfitting)
- Pre-training and then fine-tuning

Pre-training

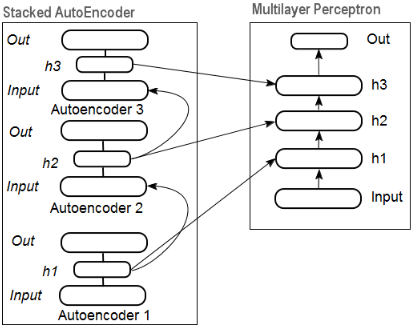
- What is pre-training and how to do it

  1 - Stacked RBM

$$E(v,h) = -\sum_i a_i v_i - \sum_j b_j h_j - \sum_i \sum_j v_i w_{i,j} h_j$$

$$P(v,h) = \frac{1}{Z} e^{-E(v,h)}$$

  2 - Stacked shallow autoencoder



Questions?