Extreme Learning Machine

Dang Vu Lam

University of Science and Technology of Hanoi

lam.dv@live.com

October 18, 2017

Overview

Introduction

- ELM is an algorithm designed to increase training speed of Single Layer Feedforward Neural network

Introduction

- ELM is an algorithm designed to increase training speed of Single Layer Feedforward Neural network
- Base on analytical method, ELM avoid major drawbacks posed by Backpropagation [1]

Mathematical Model

As a SLFN, ELM model are extremely simple:

$$\hat{Y} = w_o H = W_o F(w_i A + \beta) \tag{1}$$

$$Y = \hat{Y} + \varepsilon \tag{2}$$

Initialization[1]

- Non linear weights initialization
  During this stage, input weights matrix w_i are initialized

Initialization[1]

- Non linear weights initialization
  During this stage, input weights matrix w_i are initialized
- w_i is assigned randomly in range of $[-1, 1]$
- Linear weights learning
  Output weights matrix can then be learned using analytical method as following:

$$w_i = Y * H^{\dagger} \tag{3}$$

  where $H^{\dagger}$ is the Moore - Penrose psuedoinverse product of hidden layer output H

Experiment: Salary Dataset

Table: Sample from Salary Dataset

Gender	Rank	YOE	Degree	YOR	Salary
male	full	25	doctorate	35	36350
male	full	13	doctorate	22	35350
male	full	7	doctorate	13	27959
female	full	8	doctorate	24	38045
female	assistant	1	doctorate	1	16686
female	assistant	1	doctorate	1	15000
male	full	10	doctorate	23	28200

Experiment: Result

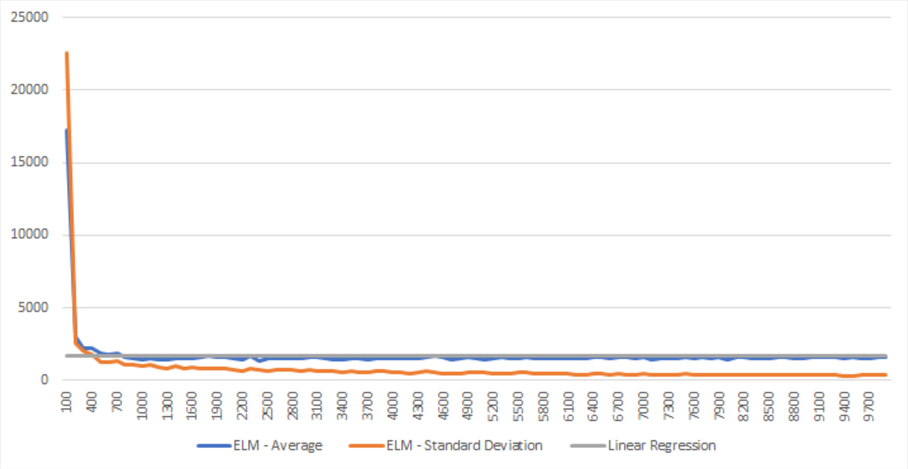


Figure: Result of ELM experiments on Salary Dataset

Overview

- Particle Swarm Optimization is a swarm optimization technique model after the movement of a swarm of animals such as a school of fish or a flock of bird.[2].

Overview

- Particle Swarm Optimization is a swarm optimization technique model after the movement of a swarm of animals such as a school of fish or a flock of bird.[2].
- Originally designed to model social behavior, it is later realized to be a powerful tool for optimization problem.

Algorithm

$$V_{t+1} = V_t + c1 * (global\_best - X_t) + c2 * (local\_best - X_t) \tag{4}$$

$$X_{t+1} = X_t + V_{t+1} \tag{5}$$

Result

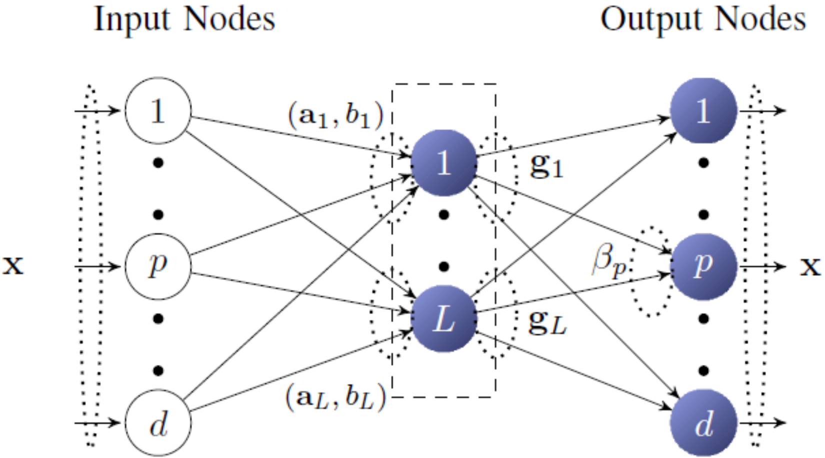
For a 100 neurons wide network, a 10 times repeated test yield

$$\overline{RMSE} = 1209.35099702$$

$$\overline{\sigma} = 775.870695031$$

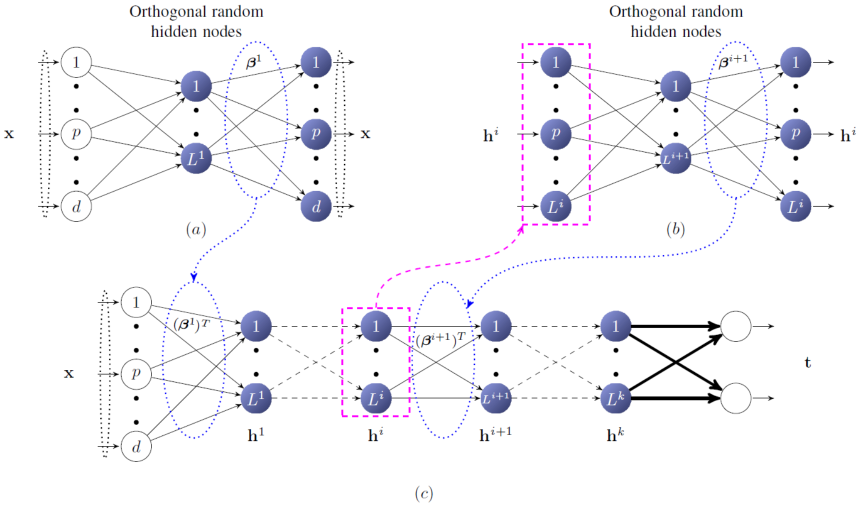
Deep ELM frameworks

- Autoencoder - ELM[3]



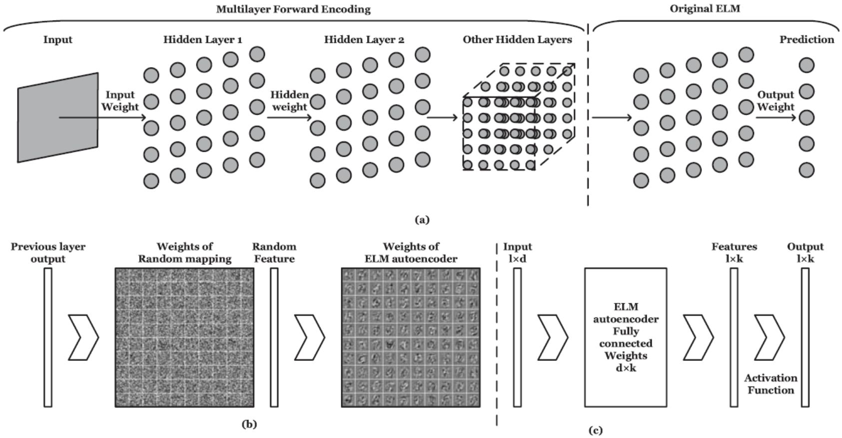
Deep ELM frameworks

- Deep ELM - Stacked Autoencoder [3]



Deep ELM frameworks

- Hierarchical ELM [4]



PSO Optimized Deep ELM

- We project that it is possible to tune each layer of the network individually using the method covered in this thesis.

PSO Optimized Deep ELM

- We project that it is possible to tune each layer of the network individually using the method covered in this thesis.
- Such algorithm will have the extra benefit of being able to tune just part of the network rather than the whole network, thanks to the fact that H-ELM is autoencoders stack on top of each other [4].

PSO Optimized Deep ELM

- We project that it is possible to tune each layer of the network individually using the method covered in this thesis.
- Such algorithm will have the extra benefit of being able to tune just part of the network rather than the whole network, thanks to the fact that H-ELM is autoencoders stack on top of each other [4].
- Since autoencoders transform the input into itself, we also propose a novel method to train each layer separately, independent from each other thus ultilize the capabilities of high performance computing to train all the layer at once, and recombine them according to [3].

References

Guang-Bin Huang, Qin-Yu Zhu, and Chee-kheong Siew.
Extreme learning machine: Theory and applications.

R. Eberhart and J. Kennedy.
A new optimizer using particle swarm theory.
pages 39–43. IEEE.

Le-le Cao, Wen-bing Huang, and Fu-chun Sun.
Building feature space of extreme learning machine with sparse denoising stacked-autoencoder.
174:60–71.

Jiexiong Tang, Chenwei Deng, and Guang-Bin Huang.
Extreme learning machine for multilayer perceptron.
27(4):809–821.

Thank you for your attention