Multimedia Cloud Computing and Machine Learning

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Homework 4 : Neural Network

Deadline: 12/17 pm 10:00

Digits Classification

1. Implement two neural networks with (a) wide hidden layer (25%) and (b) deep hidden layer (25%) to classify the digits in MNIST dataset. In the report, you have to show the accuracy and loss curve of the testing data for each model.

The details of the wide model:
(# of parameters: 203530)

Wide Model	Neurons	Activation
Input Layer	784	-
Hidden Layer	256	ReLU
Output Layer	10	Softmax

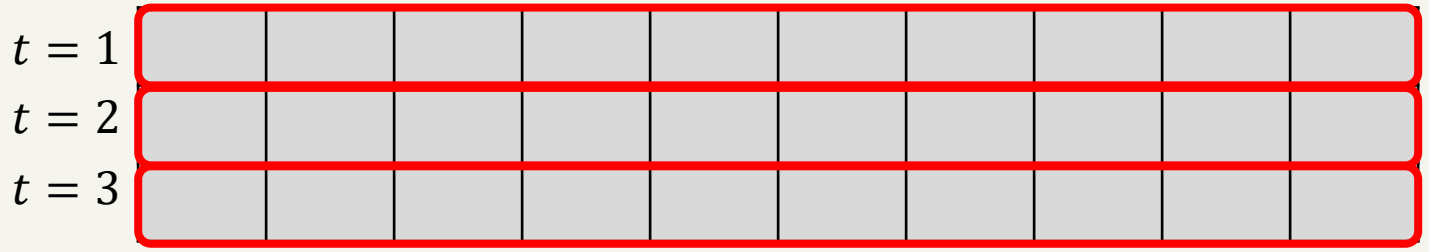
The details of the deep model:
(# of parameters: 203170)

Deep Model	Neurons	Activation
Input Layer	784	-
Hidden Layer 1	204	ReLU
Hidden Layer 2	202	ReLU
Output Layer	10	Softmax

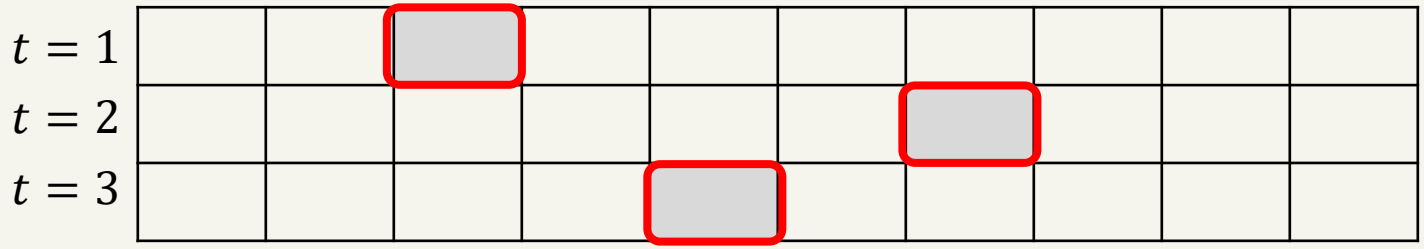
MNIST utility tools:
https://gist.github.com/jerrywiston/05eaf6978e9e25393372b7ce0d2c2934

Digits Classification

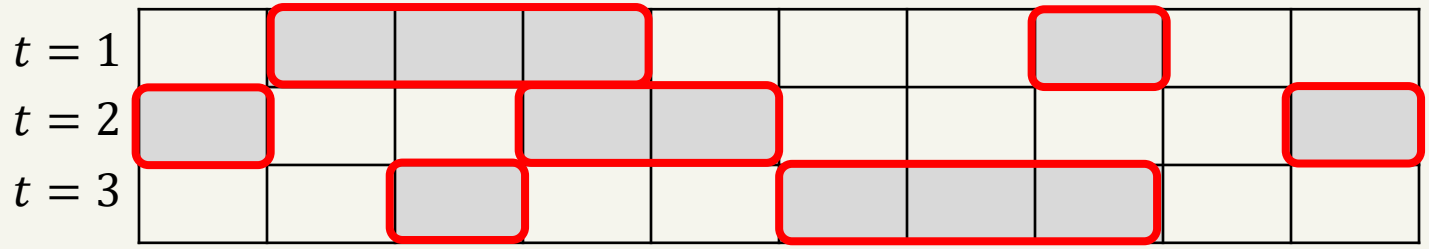
- Batch Gradient Descent



- Stochastic Gradient Descent



- Mini-Batch Gradient Descent



Digits Classification

Cross entropy : $$E = -\sum_{i}^{nclass} t_i \log(y_i)$$

BP for Sigmoid activation + Cross entropy loss

$$y_i = \frac{1}{1+e^{-s_i}} \qquad s_i = \sum_{j=1} h_j w_{ji}.$$

$$\frac{\partial E}{\partial y_i} = \frac{-t_i}{y_i} + \frac{1-t_i}{1-y_i}, \qquad = \frac{y_i - t_i}{y_i(1-y_i)},$$

$$\frac{\partial y_i}{\partial s_i} = y_i(1-y_i) \qquad \frac{\partial s_i}{\partial w_{ji}} = h_j$$

BP for Softmax activation + Cross entropy loss

$$y_i = \frac{e^{s_i}}{\sum_c^{nclass} e^{s_c}} \qquad s_i = \sum_{j=1} h_j w_{ji}. \qquad \frac{\partial E}{\partial s_i} = y_i - t_i$$

- Reference: https://www.ics.uci.edu/~pjsadows/notes.pdf

Digits Classification

2. Implement an autoencoder (AE) to learn the representation of the MNIST datasets.

(a) Show the results of the AE-based dimension reduction such as HW3-A. (25%)

(b) Visualize the reconstruction results and the filters. (25%)

(c) Apply denoise and dropout mechanism, and visualize the reconstruction results and the filters. (10%, Bonus)

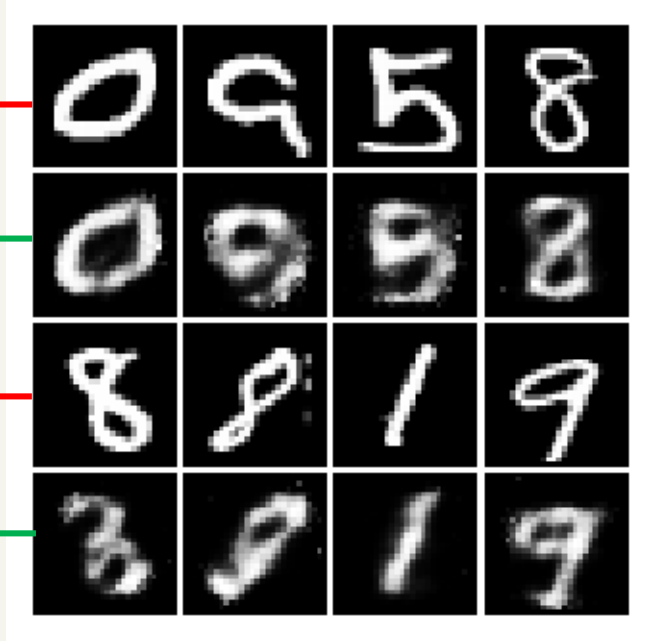
The details of the autoencoder:

	Neurons	Activation
Input Layer	784	-
Hidden Layer	128	ReLU
Output Layer	784	Sigmoid

Autoencoder

- Visualization example

Reconstruction Results



Filters (dAE + dropout)