

Exercise for MA-INF 2213 Computer Vision II SS21

11.06.2021

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1. Convolutional Neural Networks

Install **pytorch** library for convolutional neural networks. The library provides a python interface. You may also need to install some dependencies such as **numpy** and **scipy**, if needed. In this task, you are requested to train a small CNN on the MNIST dataset for digit recognition. The dataset is very small, so even on a CPU the CNN can be trained quickly.

- Implement CNN named 'Shallow Model' with the following architecture.
2D CONVOLUTION LAYER ($outChannel = 10, kernelSize = 3, stride = 1$)
2D CONVOLUTION LAYER ($outChannel = 20, kernelSize = 3, stride = 1$)
MAXPOOL ($kernelSize = 2, stride = 2$)
LINEAR LAYER ($NumClasses = 10$)
(2 Points)
- Implement CNN named 'Wider Model' with the following architecture:
 $4 \times$ parallel 2D CONVOLUTION LAYER ($outChannel = 10, kernelSize = 3, stride = 1$)
Concatenate above outputs as a whole along feature dimension ($dim=1$)
MAXPOOL ($kernelSize = 2, stride = 2$)
(3 Points)
- Implement CNN named 'Deeper Model' with the following architecture.
2D CONVOLUTION LAYER ($outChannel = 10, kernelSize = 3, stride = 1$)
2D CONVOLUTION LAYER ($outChannel = 20, kernelSize = 3, stride = 1$)
MAXPOOL ($kernelSize = 2, stride = 2$)
2D CONVOLUTION LAYER ($outChannel = 40, kernelSize = 3, stride = 1$)
2D CONVOLUTION LAYER ($outChannel = 80, kernelSize = 3, stride = 1$)
MAXPOOL ($kernelSize = 2, stride = 2$)
LINEAR LAYER (200)
LINEAR LAYER ($NumClasses = 10$)
(3 Points)
- Implement the training and testing procedure in the *main* function using cross entropy loss. Use Adam optimizer with a learning rate of 0.0001.
(4 points)
- Introduce Batch Normalization (only for 'Deeper Model') after each convolution layer.
(2 Point)
- Train the following networks for 10 epochs i) Shallow Model ii) Wider Model iii) Deeper Model and iv) Deeper Model with Batch Normalization. Share all the 4 model weights after training (ie. after 10 epochs) in your solution.
(3 Point)

Implement your solutions in python 'Sheet04.py'. TODOs indicate where code has to be added. You can take help from Pytorch MNIST example on github.

2. **Meaning of the cross-entropy criterion** The squared error criterion aims to minimize (as the name says) the squared error of the network output compared to the ideal output defined by the training data. Which quantity is minimized/maximized by the cross-entropy criterion?
(3 Points)

If you write neatly you may upload a scan of your solutions for the theoretical exercises. Of course, you may as well use LATEX if you like.³