POLI TECHNIKA Czestochowa University of Technology

Faculty of Mechanical Engineering and Computer Science

Computer vision, pattern recognition and image retrieval

Laboratory 9

Topic: *Convolutional Neural Networks (CNN) - classification*

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Technical support for Matlab is available on the website: http://www.mathworks.com/

At Laboratory 09, you will learn the basic structure of a convolutional neural network. The essential components include:

1. Dataset
2. Network model architecture
3. Parameters for the training process
4. Execution of the learning proces
5. Testing
6. Presentation of the results

The **dataset** should be adequately representative. In Matlab there are functions for creating stores, e.g. „imageDatastore".

The **architecture** of the model can vary significantly, but each one consists of layers. Below is a basic example that you can freely expand upon.

```
layers = [ ...
    imageInputLayer([28 28 1])
    convolution2dLayer(5,20)
    reluLayer
    maxPooling2dLayer(2,'Stride',2)
    fullyConnectedLayer(10)
    softmaxLayer
    classificationLayer];
```

The **parameters** of the training process should be appropriately tailored to the objectives of the network model. Below, you'll find an example of the most crucial parameters.

```
options = trainingOptions('sgdm', ...
    'MaxEpochs',20,...
    'MiniBatchSize', MiniBatchSize, ...
    'InitialLearnRate',1e-4, ...
    'Shuffle','every-epoch',...
```

```
    'Verbose',false, ...
    'Plots','training-progress');
```

Model training can be initiated using the 'trainNetwork' function.

Model testing is conducted on a set of test data. In MATLAB, we use the 'classify' function for classification.

Presenting the results can be done in various ways. You may review randomly selected sample images and their responses. Accuracy can also be calculated.

Exercise 1

There is a '...\toolbox\nnet\nndemos\nndatasets\DigitDataset' dataset on the computer, containing images divided into 10 classes numbered from 0 to 9.

Below is the code for the simplest example with the CNN classifier. Please copy the code into a new script named 'Lab09a.m'. Next, locate the dataset, copy it to your working folder 'Baza', adjust the paths, and continue the learning process.

```
imds = imageDatastore('Baza\', ...
    'IncludeSubfolders',true, ...
    'LabelSource','foldernames');

[imdsTrain, imdsTest]=splitEachLabel(imds,0.7);

lenTrain=length(imdsTrain.Labels);
lenTest=length(imdsTest.Labels);
layers = [ ...
    imageInputLayer([28 28 1])
    convolution2dLayer(5,20)
    reluLayer
    maxPooling2dLayer(2,'Stride',2)
    fullyConnectedLayer(10)
    softmaxLayer
    classificationLayer];

MiniBatchSize=200;
options = trainingOptions('sgdm', ...
    'MaxEpochs',20,...
    'MiniBatchSize', MiniBatchSize, ...
    'InitialLearnRate',1e-4, ...
    'Shuffle','every-epoch',...
    'Verbose',false, ...
    'Plots','training-progress');

net = trainNetwork(imdsTrain,layers,options);

[YPred,probs] = classify(net,imdsTest);
YTest = imdsTest.Labels;

accuracy = sum(YPred == YTest)/numel(YTest);
```

Please display 25 randomly selected images from the test set along with the result of the prediction obtained for them.

Required commands:

readimage - function to read images from datastore

randperm - randomizing function

Exercise 2

Create a new script 'Lab09b.m'. Utilize the program code from the previous exercise. Make the necessary changes in the available program code to create a classifier for two digits '0' and '1'. Prepare a suitable dataset named 'Baza2'. Then, proceed with the learning and testing process.

Please display 16 randomly selected images from the test set along with the results of the predictions obtained for them.

As an answer, please send the files 'Lab09a.m' and 'Lab09b.m', along with a screenshot of the testing results from the second task.