Project – COSC 6324

School of Engineering & Computer Sciences
A & M University at Corpus Christi
Fall 2023

Points: 20
Out: Oct 19, Due: Nov 28.

Objective: Build a system to classify an object of a RGB image

It is a group(of five) project.

Given data set $\mathcal{D}$: **data.csv**, where $\mathcal{D} = \{\mathbf{x^i}|\mathbf{i = 1...10000}\}$, s.t. each of x is a RGB image with a dimension of $\mathbf{32 \times 32 \times 3 = 3072}$. Given class label set $\mathbf{y}$: **classLabel.csv**, where $\mathbf{y} = \{\mathbf{y^i}|\mathbf{i = 1...10000}\}$, s.t each of $\mathbf{y} \in \{\mathbf{0, 1, ..., 9}\} = \{\textit{airplane}, \textit{automobile}, \textit{bird}, \textit{cat}, \textit{deer}, \textit{dog}, \textit{frog}, \textit{horse}, \textit{ship}, \textit{truck}\}$. Your task is to create a system to classify the object of an image.

Design and Implementation (8 points)

- Preprocessing Procedure
  - Convert a RGB image into the grayscale image
  - Divide the data set into two sets: training set $\mathbf{D_{train}}$ (70%) and testing set $\mathbf{D_{test}}$ (30%)
- Build a convolutional neural network satisfying
  1. Feature extraction
     - The number of neurons in the input layer should be $\mathbf{32 \times 32 = 1024}$
     - The number of convolution and pooling layers should be at least **5**
     - The number features (the output from the last convolution layer or pooling layer) should be at least **512**
  2. Classification
     - The number of neurons in the classification input layer should be the size of the feature vector.
     - The number of layers for the classification should be at least **2**
     - The number of neurons in the output should be **10**
- Training Procedure
  - Define the system loss function
  - Define the stop criteria of the training procedure
  - Train your neural network based on the back propagation algorithm
- Testing Procedure
  - Evaluate your classifier by the accuracy measurement on $\mathbf{D_{test}}$

$$\mathbf{ACC}_{\mathcal{D}_{\mathbf{test}}} = \frac{\mathbf{1}}{|\mathcal{D}_{\mathbf{test}}|} \sum_{\mathbf{i=1}}^{\mathbf{T}} \mathbf{L}(\hat{\mathbf{y}}^{\mathbf{i}}, \mathbf{y}^{\mathbf{i}})$$

where $\hat{\mathbf{y}}^{\mathbf{i}}$ is the assigned class label by the classifier and $\mathbf{y}^{\mathbf{i}}$ is the true class label of a data instance $\mathbf{x}^{[\mathbf{i}]}$ in $\mathcal{D}_{\mathbf{test}}$ and $\mathbf{T}$ is the number of data instances in $\mathcal{D}_{\mathbf{test}}$.

$$\mathbf{L}(\hat{\mathbf{y}}^{\mathbf{i}}, \mathbf{y}^{\mathbf{i}}) = \begin{cases} 1 & \text{if } \hat{\mathbf{y}}^{\mathbf{i}} = \mathbf{y}^{\mathbf{i}} \\ 0 & \text{if } \hat{\mathbf{y}}^{\mathbf{i}} \neq \mathbf{y}^{\mathbf{i}} \end{cases}$$

Report (8 points)

- Write a 10 page of report for each of the groups. The report should have
  - Names of the group members as well the corresponding task of each of the group members
  - Introduction
  - Project description
    - The filters and examples
    - The size of the feature vector obtained from CNN
    - The number convolution and pooling layers for feature extraction
    - The number full connected layers for classification
    - The system loss function and the reason of why you choose it
    - The activation functions and reasons of why you choose them
    - The pooling functions and reasons of why your choose them
    - The stop criteria on the training procedure
  - Experiments and results discussions
    - The reason of determining the learning rate η
    - How long the training procedure is?
    - The accuracy of the system
  - Pros and cons of the system
  - Further improvements

Oral Presentation (4 points)

- 20 slides of power point for a 20 minutes of oral presentation for each of the groups
- Demonstrate the project in front of the class
- Presentation Date:
  - Nov 28. 3 - 4 groups
  - Nov 30. 3 - 4 groups
  - Dec 5. 3 - 4 groups
  - Dec 7 (Reading day: optional). 3 - 4 groups

Project Submission

Each of groups only needs to have one submission. The submission should be in the project-submission-entry of the leader on Bb. The submission should include the following items:

- ReadMe.txt – how to run your system
- Project source codes
- The screen shots of the data structure and the outputs of your system
- Presentation slides
- Report