AIN422 Introduction to Deep Learning Laboratory

Assignment 1: Image Classification
Date Issued : 24.03.2023
Date Due : 07.04.2023

Aim of the Experiment

In this assignment, we will focus on image classification, which is the process of categorizing and labeling groups of pixels or vectors within an image based on specific rules. You are required to implement the k-Nearest Neighbor (KNN), Support Vector Machine (SVM) and Neural Network (NN) classification algorithms. The assignment should be implemented as a single Jupyter Notebook. Your notebook should be clearly documented, using comments and Markdown cells to explain the code and results. At the end of this exercise, you will become familiar with basic Image Classification pipeline.

Classification

Classification is a supervised machine learning process that involves predicting the class of given data points. Those classes can be targets, labels or categories. In classification, a program uses the dataset or observations provided to learn how to categorize new observations into various classes or groups. For instance, 0 or 1, red or blue, yes or no, spam or not spam, etc. Targets, labels, or categories can all be used to describe classes.

K-Nearest Neighbor

K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique. K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories. K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm. K-NN is a non-parametric algorithm, which means it does not make any assumption on underlying data.

Support Vector Machine

The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane. SVM chooses the extreme points/vectors that help in creating the

hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine.

Neural network

Neural networks are a set of algorithms, modeled loosely after the human brain, that are designed to recognize patterns. They interpret sensory data through a kind of machine perception, labeling or clustering raw input. The patterns they recognize are numerical, contained in vectors, into which all real-world data, be it images, sound, text or time series, must be translated.

Optimization

Optimization is the process where we train the model iteratively that results in a maximum and minimum function evaluation. It is one of the most important phenomena in Machine Learning to get better results. Below are some optimization algorithms:

- Gradient Descent
- Stochastic Gradient Descent
- Momentum
- Adagrad
- Adam

Activation Function

The activation function decides whether a neuron should be activated or not by calculating the weighted sum and further adding bias to it. The purpose of the activation function is to introduce non-linearity into the output of a neuron. Below are some activation functions:

- Sigmoid
- Tanh
- ReLU
- Leaky ReLU

Experiment

1. Download the CIFAR-10 dataset or load using keras.
2. Perform preprocessing steps that may be necessary to clean or filter the data.
3. Analyze the dataset using tables and graphs.
4. Clearly explain analysis results.
5. Split the datasets into training and test sets.
6. Apply the KNN and SVM classification algorithm.(apply cross-validation)
7. Design your own Neural Network model:
    a. decide the number of layers, hidden units(neurons), and select the activation function.
    b. try different optimization functions and select one.
    c. decide the number of epochs
8. Present the classification results (classification accuracy, precision, recall, F1 measure and confusion matrix).
9. Compare the performance of classification algorithms using tables and graphs.
10. In your report, clearly describe your neural network model and interpret the results.
11. You should submit your codes as .ipynb format (use Jupyter or Colab Notebook) and your report file as pdf format in a single zip file.

Background information

We provide with you some references.

- https://www.datacamp.com/blog/classification-machine-learning
- https://www.v7labs.com/blog/image-classification-guide
- https://www.geeksforgeeks.org/python-image-classification-using-keras/
- https://www.ibm.com/topics/knn
- https://towardsdatascience.com/support-vector-machine-introduction-to-machine-learning-algorithms-934a444fca47
- https://towardsdatascience.com/optimizers-for-training-neural-network-59450d71caf6
- https://www.geeksforgeeks.org/activation-functions-neural-networks/

Grading

- Import dataset and Preprocessing (%15)
- Visualization (%15)
- Implementing methods (%40)
- Report (%30)

REMARKS:

- Submission format:
    - <studentID.zip>
        - studentID_name_surname_hw1.ipynb (Required)
        - studentID_name_surname_hw1_report.pdf (Required)

- Your submission should be matched with the format above**. 10 point** penalty will be applied on mismatched submissions.
- You will use an online submission system to submit your experiments.
- https://submit.cs.hacettepe.edu.tr/ Deadline is 23:59. No other submission method (such as; CD or email) will be accepted.
- Do not submit any file via email related to this assignment.
- The assignment must be original, INDIVIDUAL work. Duplicate or very similar assignments are both going to be punished. General discussion of the problem is allowed, but DO NOT SHARE answers, algorithms, or source codes.
- You can ask your questions through the course's Piazza group and you are supposed to be aware of everything discussed in the group.