

Assignment 3
CSCI 6515 – Fall 2023
Posting date: Nov 13, 2023
Due Date: Nov 27, 2023, 11:59 PM (Halifax Time)

Background Information

A vision system should be able to identify what are the main objects in the scene while navigating in an environment. Suppose that the client wants to create a chatbot that can communicate using sign language. For this system, one task that the chatbot should be able to accomplish is the recognition of the signs. In this assignment, you will conduct experiments on the Sign Language MNIST dataset, which contains images of hand signs and the respective alphabet letter.

To access and collect the Sign Language MNIST dataset:

[Sign Language MNIST | Kaggle](https://www.kaggle.com/datasets/datamunge/sign-language-mnist?resource=download)
(<https://www.kaggle.com/datasets/datamunge/sign-language-mnist?resource=download>)

Note that you may use open-source libraries such as SK-learn, Keras, Torch, NumPy, and Pandas. However, feel free to use other open-source libraries.

Your Tasks:

**Numbers on the right side of the questions indicate the weights of the individual questions.*

[1] Prepare the dataset by applying data transformation. Which method of transformation did you choose? Explain your rationality behind it. 2

[2] Apply the k-means algorithm to Sign Language MNIST dataset.

- a.** Change the number of clusters from 10 to 200 with the step size of 10. Show the performance of the algorithm based on accuracy and the objective function value for each cluster number. 6
- b.** What is the optimal number of clusters? Justify your answer. 2

[3] Apply the fuzzy k-means algorithm to Sign Language MNIST dataset.

- a.** Change the number of clusters from 10 to 200 with the step size of 10. Show the performance of the algorithm based on accuracy and the objective function value for each cluster number. 6
- b.** Show the performance of the algorithm based on accuracy and the objective function value by changing the fuzzifier value from 1 to 5 with the step size of 1. 2
- c.** Compare k-means and FCM based on the results that you achieved. 2

[4] Implement a feedforward neural network and train the network. This network will be trained and tested using the train and test sets of the dataset. Specifically, given an input image ($28 \times 28 = 784$ pixels) from the Sign-MNIST dataset, the network will be trained to classify the image into 1 of 24 classes.

- a.** Develop a simple Convolutional Neural Network with maximum 10 hidden layers composed of convolutional, pooling and fully connected layers. Design and build your model. Specify kernel sizes, number of filters, activation functions, learning rate, optimization, and loss functions of your model. 6
- b.** Plot the confusion matrix and evaluate the performance of your classification model. 4

Instructions:

1. Completing Assignment:

- Use **Jupyter Notebook** for Assignment 3.
- Follow the provided *Jupyter notebook template with the assignment in Brightspace's*. You can create as many code and markdown cells necessary for program executions and answering the questions following the template format.
- **Retain all the cell outputs** of Jupyter notebook.
- If there is any manual calculation instructed in question, do it in notebook or attach images of the calculation in the notebook. For safety purposes, you can attach images in the zip file as well.
- Include a list of all references used in this assignment in the reference section. Follow *APA referencing format* for the references.

2. Submission Guideline:

- **Preparing File:** Your submission should be a **ZIP (.zip)** file containing two files:
 - i. A Jupyter notebook file (**.ipynb**) with cell execution results.
 - ii. A **PDF** of the Jupyter notebook with cell execution results.
- **Naming the Submissions:** As part of the final printout, name your files as follows:
 - i. *Naming **Individual** Files*
Jupyter Notebook: A3_<banner_id>.ipynb
PDF file: A3_<banner_id>.pdf
 - ii. *Naming the **ZIP** file*
A3_<your_first_name>_<your_banner_id>.zip
- **Submission Process: Submissions** should be made through Brightspace, adhering to the due date and time specified time.
- **Late Submission Policy:** Late submission will follow the following policy-
 - Day 1 (within first 24 hours) – 5% reduction of the total marks
 - Day 2 (24-48 hours) – 10% reduction of the total marks
 - Day 3 (48-72 hours) – 15% reduction of the total marks

Notes:

- **No submissions will be accepted after the specified time; resulting in zero (0) points for the assignment.**
- **Failure to follow the naming convention may result in a deduction of up to 2 points.**
- **Failing to provide both required files (.ipynb and .pdf) will result in a score of zero (0) for the assignment. Any file other than notebook and/or pdf will result in 0 points. No word file or its pdf will be accepted.**
- **Failing to follow the template will result in a deduction of up to 2 points.**
- **Failing to retain cell outputs raises suspicions of cheating and will result in point deductions.**

- *Any suspicion of plagiarism will be subjected to penalty and may lead to a score of 0 points.*
- *Submissions that do not follow the instructions and/or format of answering will not be graded.*

Good luck!