# 深度學習於醫學影像分析—Deep learning in medical image analysis
## Fall 2024

## Homework 1, due on 2024/9/23

1. In this homework, we will be analyzed the normalized handwritten digits, automatically scanned from envelopes by the U.S. Postal Service. The original scanned digits are binary and of different sizes and orientations; the images here have been deslanted and size-normalized, resulting in $16 \times 16$ grayscale images (Le Cun et al., 1990).

   The goal is to predict the digit id (0-9) by these $16 \times 16$ grayscale images.

2. The original data are 2 files, one for training (**zip.train.csv**) and one for testing (**zip.test.csv**). In the training file, each line consists of the image id and digit id (0-9) followed by the 256 grayscale values (i.e., pixel values). In the testing file, each line consists of the image id and 256 grayscale values (i.e., pixel values). The training file can be used to build up your prediction models and the testing file is for testing models' accuracy.

   These two datasets can be downloaded from e3 (https://e3.nycu.edu.tw/) under "Homework 1".

3. Show the number of images in each digit for the training dataset.

4. For each digit, plot 10 randomly selected images from your training dataset.

5. Possible neural network (NN) structures to be fitted:
   Net-1: One hidden layer with 12 nodes;
   Net-2: Two hidden layers with 64 and 16 nodes, respectively;
   Net-3: Three hidden layers with 64, 64, and 16 nodes, respectively;
   Net-4: Four hidden layers with 64, 64, 16, and 16 nodes, respectively;
   Net-5: Any structure you can think of.

   For your fitted NN structure, do

   a. Randomly split the training dataset in a $80:20$ ratio for training and validation, respectively.

b. Use the training part to train the model with different maximum steps for the training of the NN (i.e., numbers of epochs), and calculate their misclassification rates on the validation part. Plot numbers of epochs (x-axis: $10 \leq x \leq 30$) versus misclassification rates (y-axis). Decide the "best" number of epochs based on the plot.

6. Load your fitted NN prediction models with the testing dataset and generate their predicted probabilities for 10 digits and the predicted digit ids.

   Upload a file "**test.digit.csv**" for prediction results based on your fitted model. In "**test.digit.csv**", columns 1 is the image id and column 2 is for the predicted digit id.

   Please also upload the Python codes of your solution (saved as a .ipynb file) and its compiled html file.

7. Kaggle submission
   a. Kaggle link:
      https://www.kaggle.com/t/bbb1659f123643dfb5139dd59991cafb
   b. Display team name: <studentID>
   c. The scoring metric is accuracy.
   d. You can submit at most 5 times each day.

8. Report submission
   a. Number of images in each digit for the training dataset (Q3) (2 pts)
   b. Plots of 10 randomly selected images (Q4) (4 pts)
   c. Plot of numbers of epochs versus misclassification rates (Q5b) (4 pts)
   d. Reproductivity of the results (4 pts)
   e. Number of parameters (2 pts)
   f. The difficulty during training (8 pts)
   g. Explained model architecture (6 pts)
   h. You should submit compile HTML file and ipynb notebook with name prefix to e3 platform.
      - {studentID}.ipynb   {studentID}.html   {studentID}.pdf
   i. Note: make sure your ipynb file print out the number of parameters of the model.

9. Grading policy
   a. Kaggle (70 pts)

      The public leaderboard is calculated with approximately 50% of the test data. The final score will be based on the other 50% (private leaderboard), so the final scorings may be different.

      - Basic score (40 pts):

        Over baseline: 40 pts

      - Ranking score (30 pts):

        Accuracy: $\left(1 - \frac{rank-1}{num\_participated}\right) \times 20$ pts (the larger the accuracy, the higher the ranking)

        Number of parameters: $\left(1 - \frac{rank-1}{num\_participated}\right) \times 10$ pts (the smaller the number of parameters, the higher the ranking)

   b. Report (30 pts)

10. Error submission

    If you submit the wrong format of files to e3, your score may be reduced.

    a. Team name error: 0 pts
    b. Late submission: -10 pts per day