DL hw1 Regression / Classification

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1. Regression

(b) Show your (1) network architecture (number of hidden layers and neurons), (2) learning curve, (3) training RMS error, (4) test RMS error, (5) regression result with training labels and (6) regression result with test labels

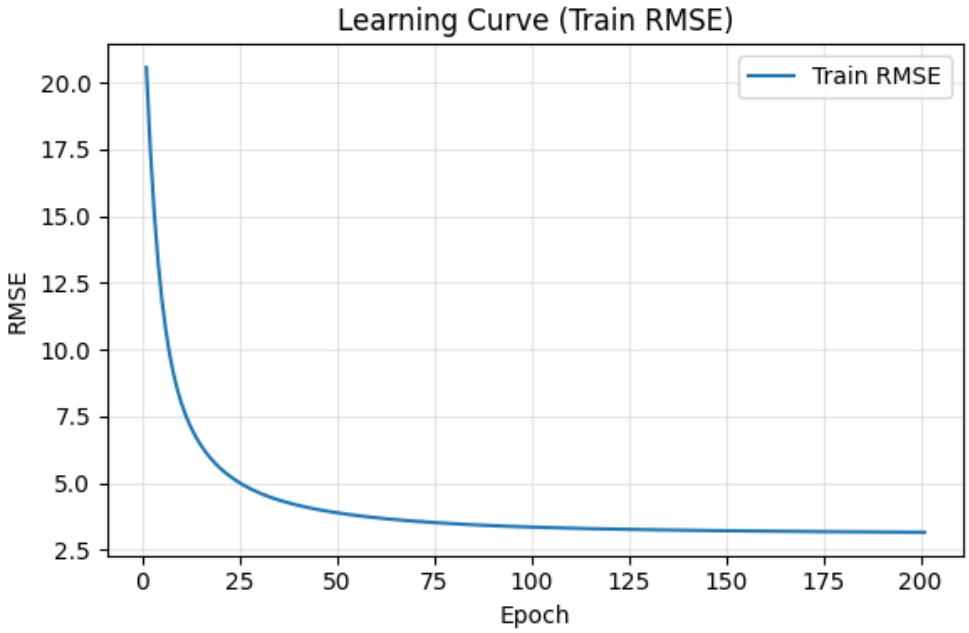
(1) network architecture (number of hidden layers and neurons)

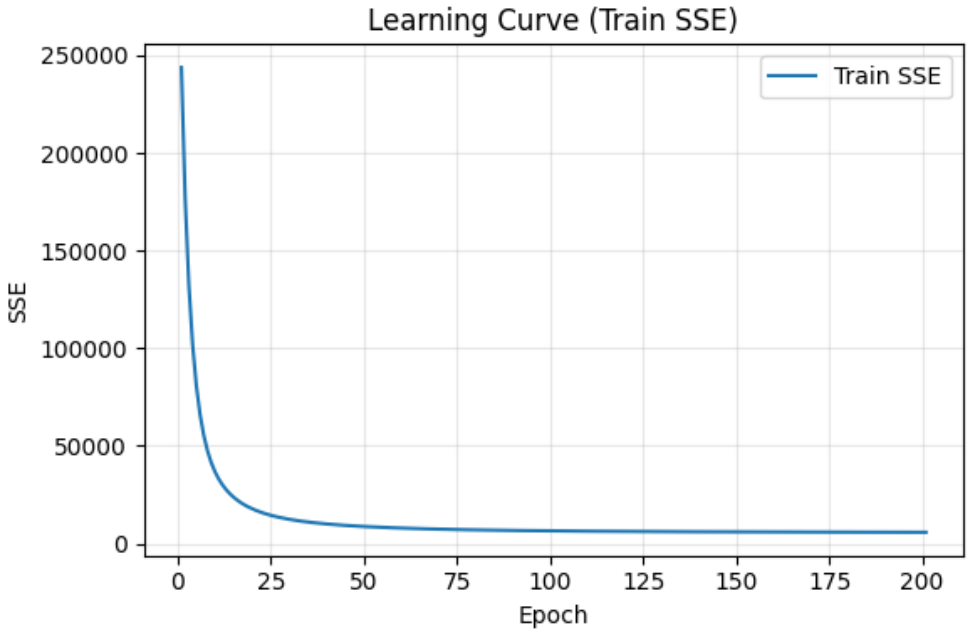
Input Layer	Hidden Layer	Output Layer
# of features: 8	# of layer: 1 # of neurons: 64 Activate Func: Sigmoid	# of neuron: 1 Activate Func: None(linear)

- **Hyperparameters:**

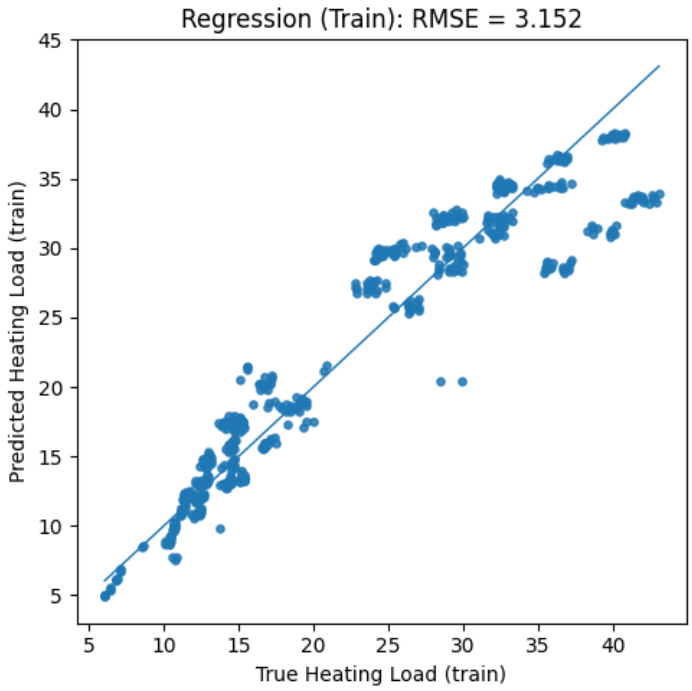
- Batch size = 32
- Learning rate = 1e-5
- Training epochs = 200
- Loss function = Sum of Squared Errors (SSE) / Root Mean Square Errors(RMS)
- Optimizer = Stochastic Gradient Descent (SGD)

(2) learning curve

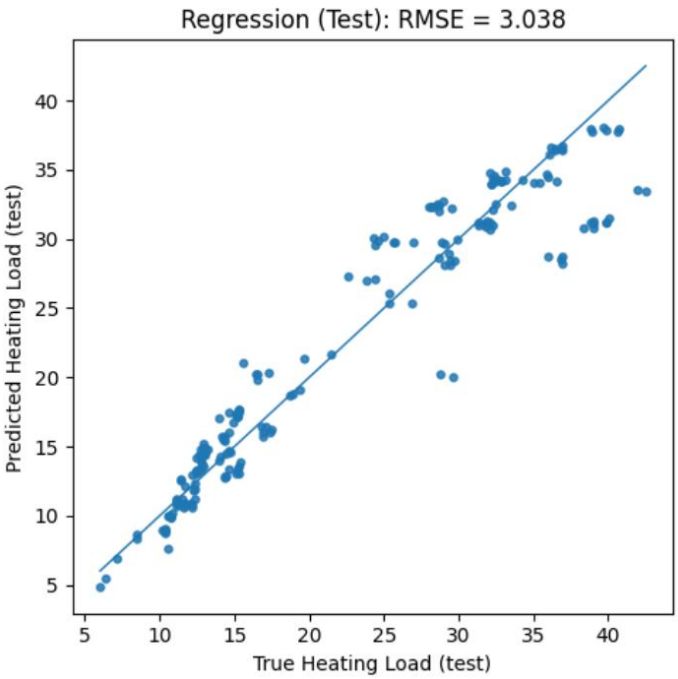




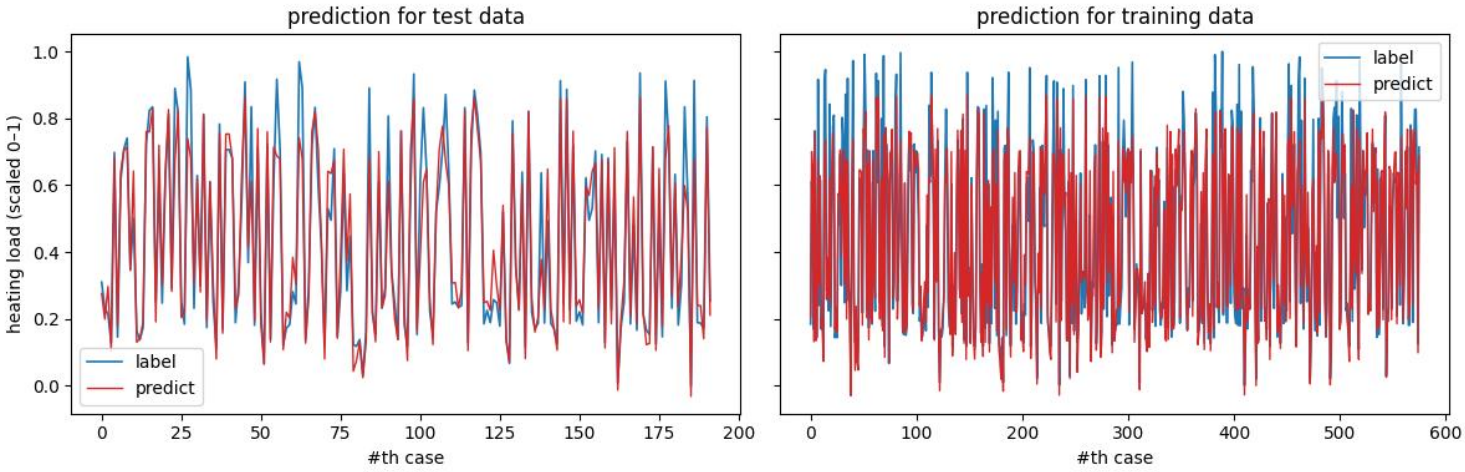
(3) training RMS error : Best=3.152



(4) testing RMS error : Best=3.038

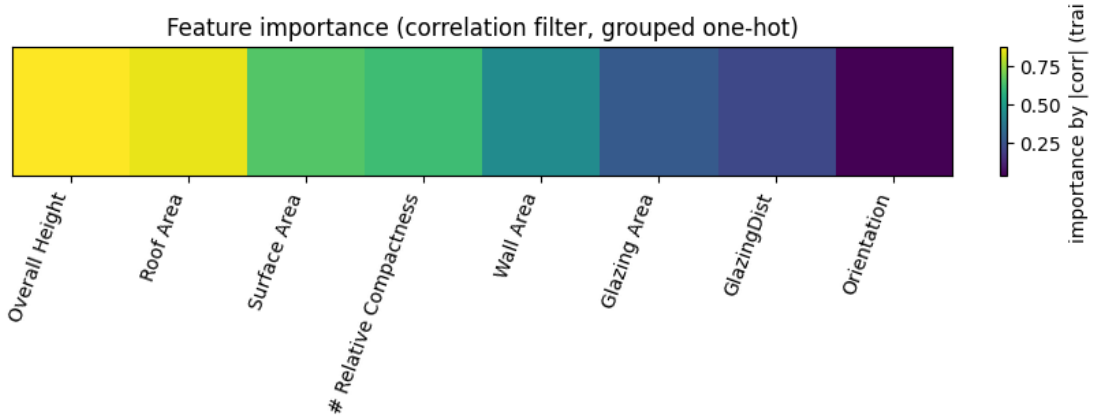


(5) (6) regression result with test labels / regression result with training labels



(c) Design a feature selection procedure to find out which input features influence the energy load significantly and explain why it works. You may compare the performance of choosing different features.

Method: Heatmap Visualization



1. I calculated **the absolute values of the Pearson correlation coefficients** between each input feature and the heating load, and then ranked them in descending order.

$$r = \frac{\sum (x - m_x)(y - m_y)}{\sqrt{\sum (x - m_x)^2 \sum (y - m_y)^2}}$$

(Pearson correlation coefficient)

2. A heatmap was plotted to **visualize the relative importance of each feature**, where features with higher absolute correlation values are considered to have a stronger influence on the target.

3. This method works because the **Pearson correlation coefficient measures the linear dependency** between two variables. - If a feature's value varies strongly with the target (either positively or negatively), it means that the feature contains more useful information for predicting the output.
4. By examining the correlation magnitude (|r|), we can effectively filter out features that have little to no linear relationship with the target, simplifying the model and improving interpretability.

Result: Overall Height, **Roof Area**, and **Surface Area** *show* **stronger correlation** with the heating load → They may contribute the most to energy consumption prediction.

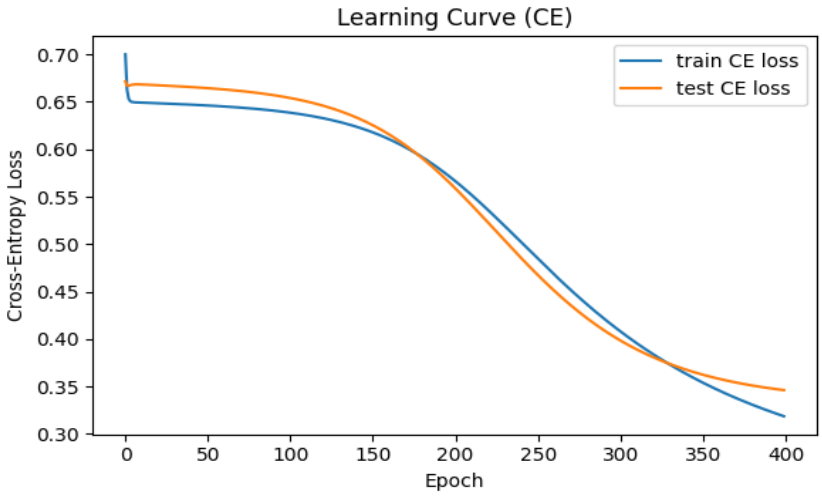
2. Classification

(b) Show your (1) network architecture (number of hidden layers and neurons), (2) learning curve, (3) training error rate, (4) test error rate

(1) network architecture (number of hidden layers and neurons)

Input Layer	Hidden Layer	Output Layer
# of features: 34	# of layer: 1 # of neurons: 8 Activate Func: Sigmoid	# of neuron: 2 Activate Func: Softmax

(2) learning curve



(3) training error rate: Best 0.107

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=== Final Results ===
Train CE Loss : 0.3187
Train Error   : 0.1071
Test  CE Loss : 0.3462
Test  Error   : 0.1286
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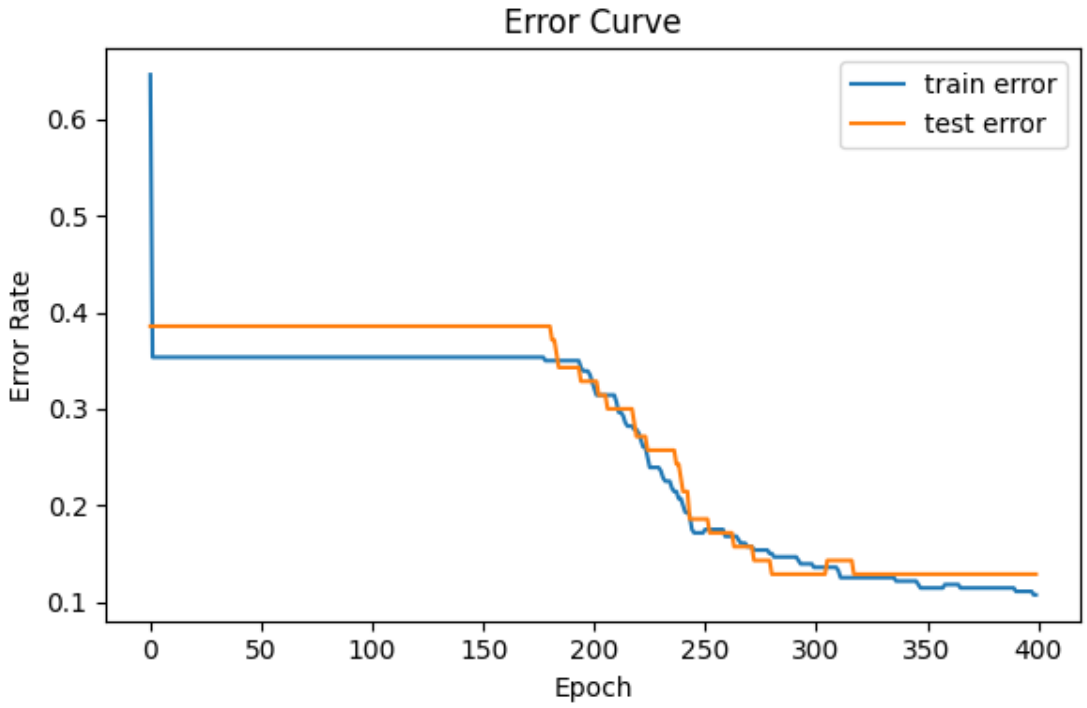
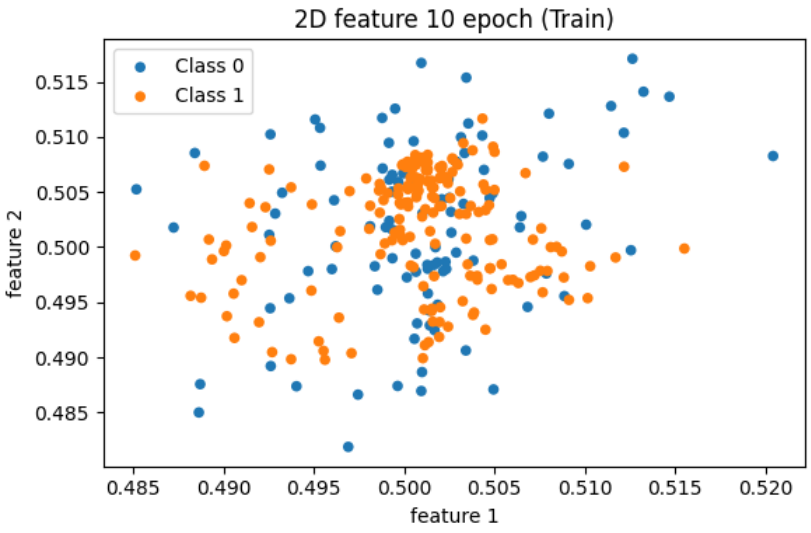
(4) test error rate: Best 0.129

Below is the curve of error rate:

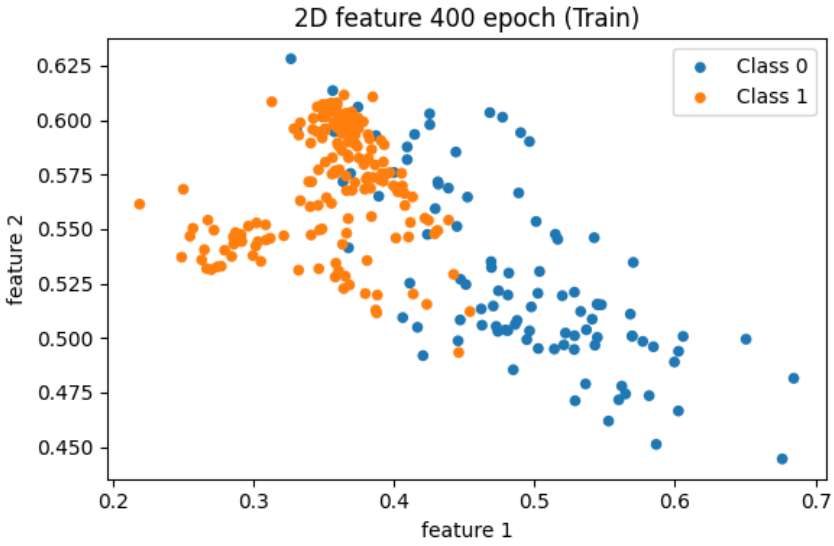


(c) Compare the results of choosing different numbers of nodes in the layer before the output layer by plotting the distribution of latent features at different training stage.

1. 10 epochs (Testing result is in ionosphere.ipynb)



3. **400 epochs (Testing result is in ionosphere.ipynb)**



Analysis:

As the training progresses, the latent features in the hidden layer become increasingly separable. At **epoch 10**, the two classes are **mixed together** in the 2D feature space, showing that the model has not yet learned a clear boundary. By **epoch 400**, the features of the two classes form distinct clusters, indicating that the network has learned discriminative representations and the data become **nearly linearly separab**le.

→ **As training continues, the latent features become more linearly separable**

3. Reference

[1] Image of Pearson correlation coefficient

https://www.geeksforgeeks.org/python/python-pearson-correlation-test-between-two-variables/

[2] 2025 HW1 guild lines