

CSE443 – CE471 AI For Intelligent Built Environment Systems

Fall 2025 - Assignment#2

(Due date: 28/12/2025 Sunday, at 23:59)

This assignment has two parts. The first part is applying hyperparameter tuning on the Artificial Neural Network (ANN) structure that you've already built in your first project. The second part is implementing feature selection on the dataset and analyzing its performance.

Use the Urban Building Energy Stock Dataset [1]. Remove all data features those cause leakage. The only output feature is Simple_Building_Energy_Rating, ignore other outputs. Prepare a detailed report.

- Draw a table of accuracy, precision, recall, F1 results for each class.
- Represent the confusion matrix, training/validation loss and training/validation accuracy graphs.
- Show the validation and test results by commenting on them.
- Calculate Cohen's Kappa score and print as output as in [2].
- Draw precision recall and AUC-ROC curve as in [2].

Part 1 (45 pts)- Apply Hyperparameter optimization on ANN

This part of the project aims to provide students with experience in using metaheuristic algorithms for hyperparameter optimization. You need to apply two different meta-heuristic algorithms or Hypeopt engine to optimize the hyperparameters of ANN. You can use one of the Hypeopt engines those are mentioned in the reference study [3] including OPTUNA, HYPEROPT, BAYESOPT.

Table 1. Sample ANN Hyperparameter Space

Hyperparameter	Search Space
Learning Rate	Continuous: [0.0001, 0.1]
Batch Size	Discrete: {16, 32, 64, 128, 256}
Number of Convolutional Layers	Integer: [1, 5]
Number of Filters/Layer	Integer: [8, 128] (e.g., 8, 16, 32...)
Kernel Size	Categorical: {(3, 3), (5, 5)}
Activation Function	Categorical: {ReLU, tanh, sigmoid}
Pooling Type	Categorical: {MaxPooling, AveragePooling}
Optimizer	Categorical: {SGD, Adam, RMSProp}

The sample implementation in the article [4] clears the basic concepts. Sample hyperparameter space of the dataset is given in Table 1. These values are only examples. You may use different values in hyperparameter space instead. Please read the article carefully. A sample chromosome seems like $C_1 = (0.1, 16, 4, 8, (3, 3), \text{ReLU}, \text{MaxPooling}, \text{Adam})$. In this individual the very first gene 0.1 is the learning rate, second gene is the batch size and so on.

Part 2 (45 pts)- Meta heuristic implementation for Feature Selection

The aim is to select optimal subset of the features that enables maximizing the **accuracy** value.

As feature selection technique:

- Apply a meta-heuristic algorithm. You can use mealpy library [5].
- Apply BorutaPY [6]
- Apply one filter based feature selection technique (Chi-square, information gain and Gini index is suitable for tabular data) [7].

For finding the accuracy you can apply one of the classification techniques that you have learned before.

Report/Code Submission [10 pts]

- Prepare a word/pdf file that summarizes the outputs of your project. Check the attached report file template.
- Run all possibilities for iteration number 1000.

Submission Details

- ❖ This assignment effects overall 60% of your final grade.

- ❖ Source codes and the report must be compressed as a **single zip** file and must be submitted via **Google Classroom Group**.
- ❖ Zip file must be named with all group members' student numbers (example→ 2007900011_2007900012.zip).
- ❖ All group members' names must exist in the report file.
- ❖ One of the group members may submit the assignment.
- ❖ In any forms of copying and cheating all parties will get zero grade.

Good Luck!

[1] <https://data.mendeley.com/datasets/m6vv9k9gcd/5>

[2] <https://github.com/naomifridman/Neural-Network-Churn-Prediction>

[3] Kegl, B. (2023). A systematic study comparing hyperparameter optimization engines on tabular data. *arXiv preprint arXiv:2311.15854*.

[4] <https://medium.com/@burak96egeli/optimizing-machine-learning-models-with-genetic-algorithm-based-hyperparameter-tuning-76d6f15fde6c>

[5] https://mealpy.readthedocs.io/en/latest/pages/models/mealpy.swarm_based.html

[6] <https://medium.com/@tyagi.lekhansh/automating-feature-selection-with-borutapy-3de6674002fa>

[7] Tiryaki, H., & Uysal, A. K. (2023). Dengesiz Metin Sınıflandırımda Öz nitelik Seçim Yöntemlerinin Etkililiği. *Afyon Kocatepe Üniversitesi Fen Ve Mühendislik Bilimleri Dergisi*, 23(2), 370-379.