

ML Programming assignment VI

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1 Description of the Problem

In this assignment, two separate models were trained for different purposes:

- A **classification model** $C(x)$ based on Support Vector Machine (SVM), which determines whether an input sample belongs to a valid region or category.
- A **regression model** $R(x)$ built using a deep neural network (Keras Sequential model), which predicts a continuous output value for valid samples.

1.1 Definition of the Combined Function

The piecewise model $h(x)$ is defined as follows:

$$h(x) = \begin{cases} R(x), & \text{if } C(x) = 1, \\ -999, & \text{if } C(x) = 0. \end{cases}$$

This definition enforces a conditional mechanism, where the regression model $R(x)$ is only executed for samples classified as valid by $C(x)$. For all other samples, a constant value of -999 is returned.

2 Implementation Details

The implementation of $h(x)$ can be summarized as:

- (i) Predict class labels using the trained classifier $C(x)$.
- (ii) For all samples with $C(x) = 1$:
 - Scale the input features with the same normalization used in $R(x)$.
 - Feed them into the neural network to obtain $R(x)$ predictions.
 - Inversely transform the predicted values back to the original scale.
- (iii) Assign $h(x) = -999$ for all samples where $C(x) = 0$.

This design ensures that $R(x)$ is applied only when $C(x)$ confirms the input is within the valid region.

3 Verification

To validate the correctness of the definition, the following checks were performed on the test set:

- For all data points with $C(x) = 0$, the output $h(x)$ was verified to be -999 .
- For all data points with $C(x) = 1$, the output $h(x)$ was verified to match the regression result $R(x)$.

4 Visualization

A scatter plot was generated to visualize $h(x)$ on the test set:

- Points with $C(x) = 0$ are shown as red circles, each corresponding to $h(x) = -999$.
- Points with $C(x) = 1$ are displayed as colored crosses, where color intensity represents the predicted value of $R(x)$.

This visual representation illustrates how the piecewise model behaves across the feature space, clearly separating the two regimes defined by $C(x)$ and $R(x)$.

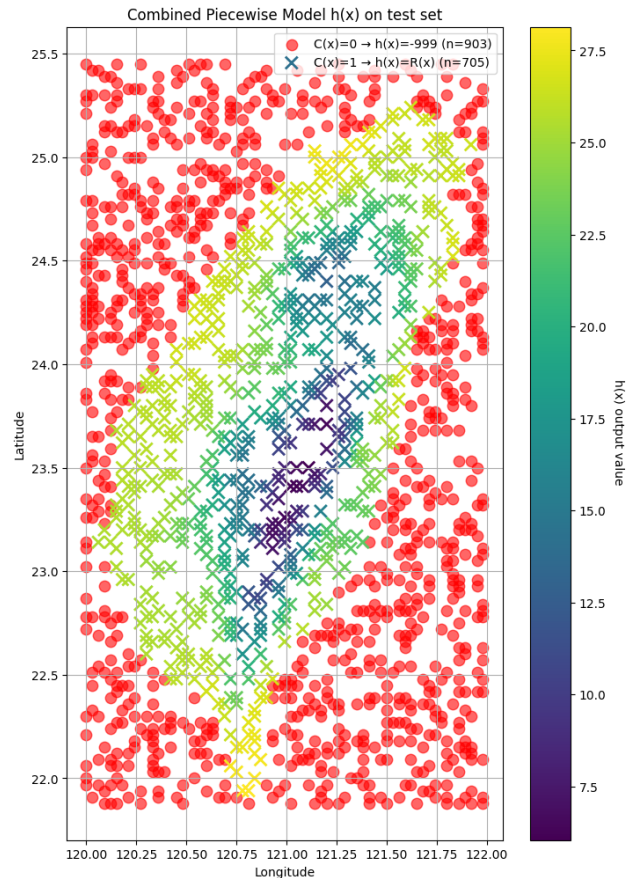


Figure 1: $h(x)$ result

References

- [1] Chat-GPT(Apply GPT to revise and correct the English content of the report, and ask about some programming techniques)
- [2] Python 機器學習-多元分類的 5 種模型
[https://medium.com/@imirene/Python 機器學習-多元分類的 5 種模型-f7b6026c5ce6](https://medium.com/@imirene/Python-機器學習-多元分類的-5-種模型-f7b6026c5ce6)
- [3] 白話文講解支持向量機 (二) 非線性 SVM
[https://notes.andywu.tw/2020/白話文講解支持向量機二-非線性 svm/](https://notes.andywu.tw/2020/白話文講解支持向量機二-非線性-svm/)