分類模型 (Classification model)

- 模型與說明：

data：從已轉換為 (經度, 緯度, label) 的 67×120 = 8040 筆資料中，隨機分成

Training data 5628 筆 (70%)

Validation data 1608 筆 (20%)

Test data 804 筆 (10%)

hypothesis： $f_\theta : \mathbb{R}^2 \longrightarrow \mathbb{R}^1$ ， (輸入經、緯度，輸出一個值)

number of hidden layer : 2

number of neuron in hidden layer : 12, 10

activation function :

Layer 2 → Layer 3 用 ReLu

Layer 3 → Layer 4 用 ReLu

Layer 4 輸出用 Sigmoid (表示機率，若大於 0.5，則判斷為 Label 1，反之則 Label 0)

loss function : Binary Cross Entropy

- 過程與結果分析：

最多訓練 200 個 epoch，

每個 epoch 為用 Traning set 計算 training loss，使用 Adam 更新參數，

再用 validation set 計算 validation loss

Stop criteria：

檢查當次的 validation loss 是否有比歷史最佳的 validation 好，若連續 20 次都沒有進步 10^{-6}，則停止訓練

結果：在第34個 epoch 提早停止訓練

以 test set 測試訓練出的模型的準確率最終為 56.47%

(準確率最高有到 61.5% 左右)

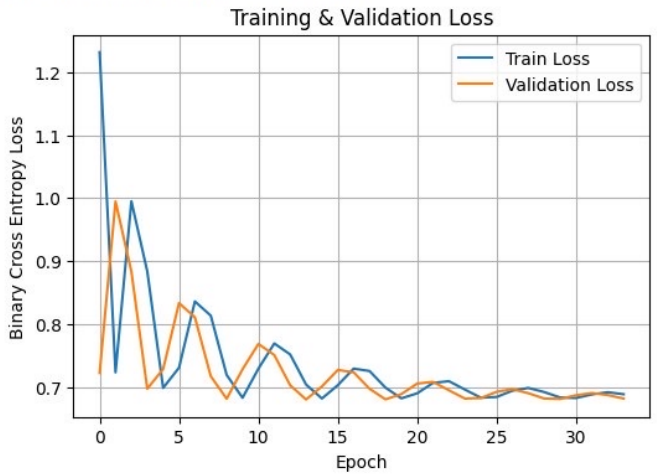
與用猜的(50%)差不多，顯示以此模型去預測此分類問題不太可行

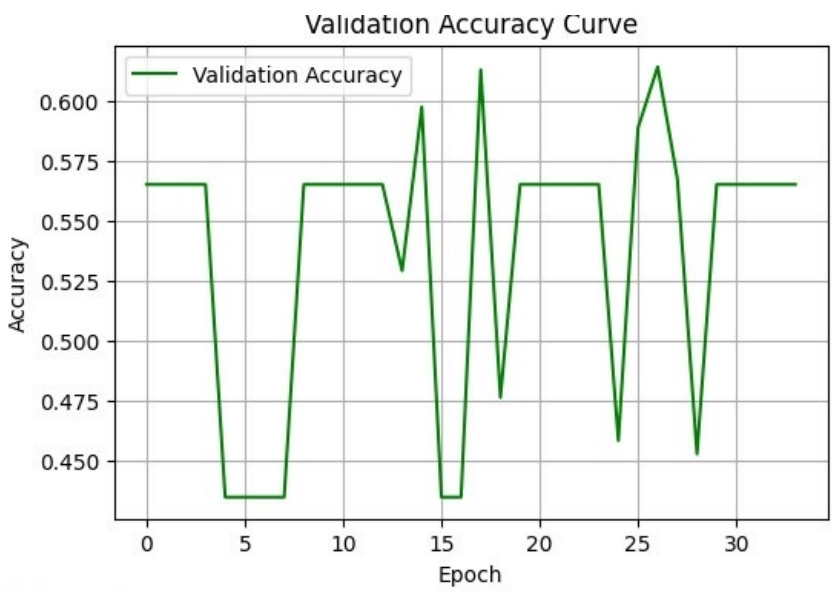
(與老師上課說的此問題不太能做相符)

```
Epoch   1/200 - Train Loss: 1.231450 - Val Loss: 0.722726 - Val Acc: 0.5653
Epoch   2/200 - Train Loss: 0.723762 - Val Loss: 0.994836 - Val Acc: 0.5653
Epoch   3/200 - Train Loss: 0.995077 - Val Loss: 0.883538 - Val Acc: 0.5653
Epoch   4/200 - Train Loss: 0.883992 - Val Loss: 0.697790 - Val Acc: 0.5653
Epoch   5/200 - Train Loss: 0.699019 - Val Loss: 0.728946 - Val Acc: 0.4347
Epoch   6/200 - Train Loss: 0.731136 - Val Loss: 0.833658 - Val Acc: 0.4347
Epoch   7/200 - Train Loss: 0.836266 - Val Loss: 0.811110 - Val Acc: 0.4347
Epoch   8/200 - Train Loss: 0.813644 - Val Loss: 0.717515 - Val Acc: 0.4347
Epoch   9/200 - Train Loss: 0.719620 - Val Loss: 0.681856 - Val Acc: 0.5653
Epoch  10/200 - Train Loss: 0.683337 - Val Loss: 0.728642 - Val Acc: 0.5653
Epoch  11/200 - Train Loss: 0.729630 - Val Loss: 0.768830 - Val Acc: 0.5653
Epoch  12/200 - Train Loss: 0.769624 - Val Loss: 0.751217 - Val Acc: 0.5653
Epoch  13/200 - Train Loss: 0.752086 - Val Loss: 0.703216 - Val Acc: 0.5653
Epoch  14/200 - Train Loss: 0.704379 - Val Loss: 0.680660 - Val Acc: 0.5292
Epoch  15/200 - Train Loss: 0.682244 - Val Loss: 0.701449 - Val Acc: 0.5976
Epoch  16/200 - Train Loss: 0.703407 - Val Loss: 0.727555 - Val Acc: 0.4347
Epoch  17/200 - Train Loss: 0.729700 - Val Loss: 0.723739 - Val Acc: 0.4347
Epoch  18/200 - Train Loss: 0.725857 - Val Loss: 0.697577 - Val Acc: 0.6132
Epoch  19/200 - Train Loss: 0.699491 - Val Loss: 0.680888 - Val Acc: 0.4764
Epoch  20/200 - Train Loss: 0.682491 - Val Loss: 0.689188 - Val Acc: 0.5653
Epoch  21/200 - Train Loss: 0.690497 - Val Loss: 0.705946 - Val Acc: 0.5653
Epoch  22/200 - Train Loss: 0.707078 - Val Loss: 0.708613 - Val Acc: 0.5653
Epoch  23/200 - Train Loss: 0.709723 - Val Loss: 0.695217 - Val Acc: 0.5653
Epoch  24/200 - Train Loss: 0.696449 - Val Loss: 0.682147 - Val Acc: 0.5653
Epoch  25/200 - Train Loss: 0.683596 - Val Loss: 0.682982 - Val Acc: 0.4583
Epoch  26/200 - Train Loss: 0.684665 - Val Loss: 0.692849 - Val Acc: 0.5889
Epoch  27/200 - Train Loss: 0.694697 - Val Loss: 0.697093 - Val Acc: 0.6144
Epoch  28/200 - Train Loss: 0.698987 - Val Loss: 0.690636 - Val Acc: 0.5678
Epoch  29/200 - Train Loss: 0.692454 - Val Loss: 0.682189 - Val Acc: 0.4527
Epoch  30/200 - Train Loss: 0.683844 - Val Loss: 0.681524 - Val Acc: 0.5653
Epoch  31/200 - Train Loss: 0.682992 - Val Loss: 0.687415 - Val Acc: 0.5653
Epoch  32/200 - Train Loss: 0.688742 - Val Loss: 0.690955 - Val Acc: 0.5653
Epoch  33/200 - Train Loss: 0.692230 - Val Loss: 0.687691 - Val Acc: 0.5653
Epoch  34/200 - Train Loss: 0.689012 - Val Loss: 0.682141 - Val Acc: 0.5653

■ Early Stopping triggered at epoch 34.
```

■ Early Stopping triggered at epoch 34.





✅ 測試集準確率：56.47%

📉 測試集 Binary Cross Entropy Loss：0.685371

🔴 最佳模型出現在 Epoch 14，驗證損失為 0.680660

迴歸模型 (Regression model)

- 模型與說明:

data: 從已轉換為 (經度, 緯度, 溫度) 的 67×120 = 8040 筆資料中, 隨機分成

Training data 4824 筆 (60%)

Validation data 1608 筆 (20%)

Test data 1608 筆 (20%)

hypothesis: $f_\theta : \mathbb{R}^2 \longrightarrow \mathbb{R}^1$. (輸入經、緯度, 輸出一個值, 表示溫度)

number of hidden layer : 2

number of neuron in hidden layer : 20, 13

activation function :

Layer 2 $\longrightarrow$ Layer 3 用 Tanh

Layer 3 $\longrightarrow$ Layer 4 用 ReLu

loss function : Mean square error

- 過程與結果分析:

最多訓練 200 個 epoch,

每個 epoch 為用 Traning set 計算 training loss, 使用 Adam 更新參數,

再用 validation set 計算 validation loss

Stop criteria:

檢查當次的 validation loss 是否有比歷史最佳的 validation 好, 若連續

一次都沒有進步 10^{-5}, 則停止訓練

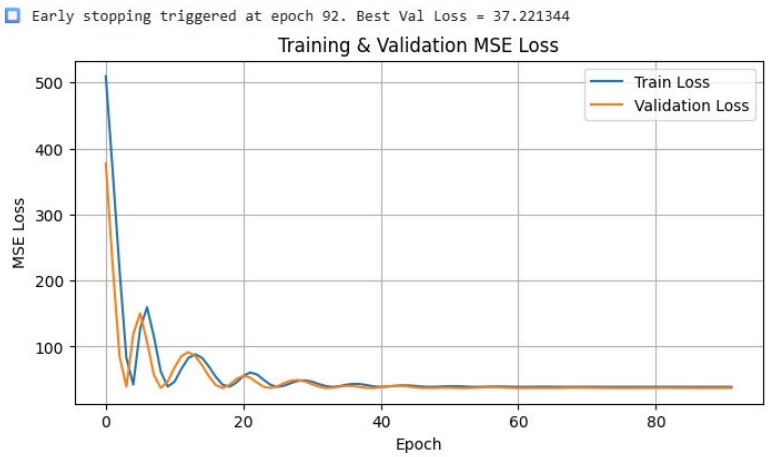
結果：在第92個 epcho 提早停止訓練

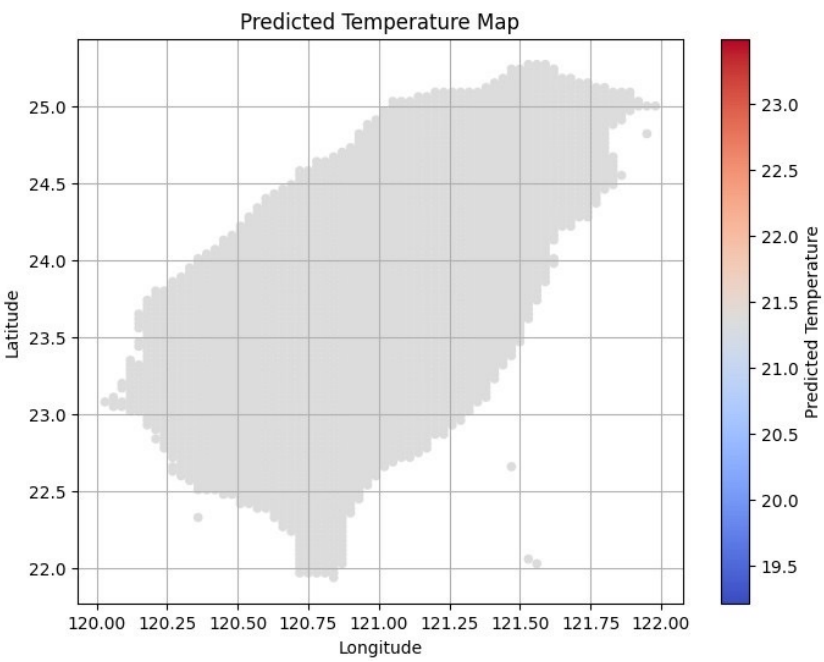
在前92個 epcho 中產生的最佳模型的 MSE = 34.36

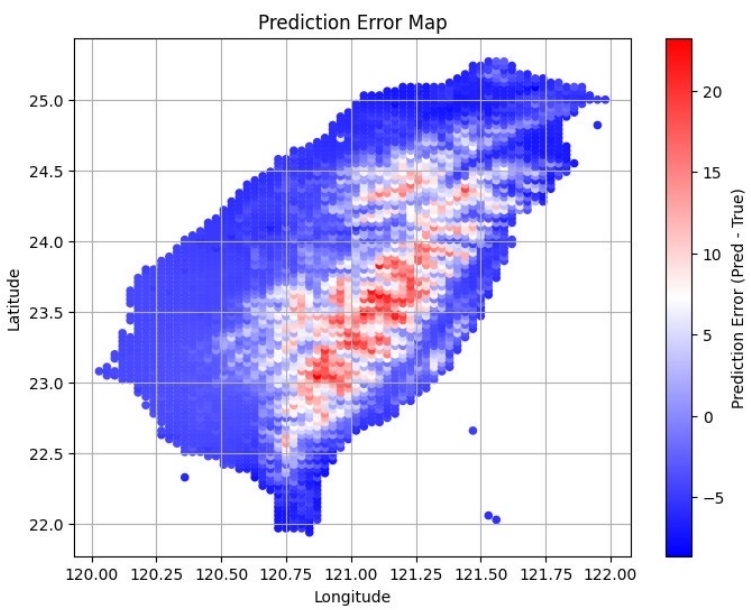
也就是模型預測的溫度與真實的溫度整體平均大約差了 $\sqrt{34.36} \approx 5.86°C$，是不太好的預測

由 Prediction Error Map 可看出在台灣中間的地方預測得較不準確而模型學到的是常數函數（從 Predicted Temperature map 可看出大約是在 21.5°C），可能跟原本全台的溫度分佈本來就差異不大所造成的

```
Epoch 5/200 - Train Loss: 42.562923 - Val Loss: 118.923058
Epoch 10/200 - Train Loss: 39.540684 - Val Loss: 47.040058
Epoch 15/200 - Train Loss: 83.117462 - Val Loss: 71.983879
Epoch 20/200 - Train Loss: 45.585529 - Val Loss: 50.962055
Epoch 25/200 - Train Loss: 41.874523 - Val Loss: 37.311520
Epoch 30/200 - Train Loss: 48.959278 - Val Loss: 47.096958
Epoch 35/200 - Train Loss: 40.165642 - Val Loss: 39.356831
Epoch 40/200 - Train Loss: 39.775208 - Val Loss: 37.322720
Epoch 45/200 - Train Loss: 41.237774 - Val Loss: 39.579617
Epoch 50/200 - Train Loss: 39.774433 - Val Loss: 37.726181
Epoch 55/200 - Train Loss: 39.066757 - Val Loss: 37.790279
Epoch 60/200 - Train Loss: 39.306068 - Val Loss: 37.514507
Epoch 65/200 - Train Loss: 39.359833 - Val Loss: 37.227917
Epoch 70/200 - Train Loss: 39.190674 - Val Loss: 37.776997
Epoch 75/200 - Train Loss: 39.078728 - Val Loss: 37.232632
Epoch 80/200 - Train Loss: 39.068970 - Val Loss: 37.395206
Epoch 85/200 - Train Loss: 39.084473 - Val Loss: 37.372822
Epoch 90/200 - Train Loss: 39.086994 - Val Loss: 37.283531
```







✅ 測試集 MSE Loss：34.356136
✅ 使用 Early Stopping，最佳驗證 MSE Loss 為：37.221344