深度學習導論與應用
作業2 - ANN Regression & TS

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目錄

變數定義

Alphabet Inc. Class A Common Stock (GOOGL)

近5年資料 (2020-05-11 ~ 2025-05-08)

1256筆資料

6個變項

	Date	Close/Last	Volume	Open	High	Low
0	05/08/2025	$154.28	57498690	$155.00	$155.93	$152.90
1	05/07/2025	$151.38	127747600	$164.08	$165.00	$147.84
2	05/06/2025	$163.23	21277210	$162.17	$164.80	$161.19
3	05/05/2025	$164.21	21341810	$163.00	$165.39	$162.72
4	05/02/2025	$164.03	25715010	$163.405	$164.97	$161.87
...	...	...	...	...	...	...
1251	05/15/2020	$68.653	41543980	$67.413	$68.729	$66.95
1252	05/14/2020	$67.843	36660340	$66.676	$67.8685	$66.165
1253	05/13/2020	$67.4165	40368080	$68.808	$69.2665	$66.4005
1254	05/12/2020	$68.759	33917480	$70.411	$70.7165	$68.7255
1255	05/11/2020	$70.1795	32717120	$68.8395	$70.7765	$68.775

1256 rows × 6 columns

變數定義

	變數	定義	資料類型	說明
X1	Date	日期	文字	該筆資料所對應的交易日期
X2	Open	開盤價	文字	當天開盤時的股價
X3	High	最高價	文字	當天交易中的最高股價
X4	Low	最低價	文字	當天交易中的最低股價
X5	Volume	成交量	整數	當天的交易量（股數）
Y	Close/Last	收盤價	文字	當天收盤時的股價

資料前處理 & 敘述統計

資料前處理

1. 更改變數型態

- Date: object → datetime
- Close/Last: object → float (設為Y)
- Open: object → float

2. 日期由舊到新排列

3. 更改資料欄位

- Single-feature : Date, Y
- Multi-feature : Date, Y, open_float

4. 時間序列處理

- Single-feature : Date, Y, Lag_1, Lag_2, Lag_3
- Multi-feature : Date, Y,

  Op_Lag_1, Op_Lag_2, Op_Lag_3,

  Cl_Lag_1, Cl_Lag_2, Cl_Lag_3

5. 刪除缺失值、重設index、移除多餘欄位

- 資料筆數：1256 → 1253
- 資料欄位：6 → 5 (Single-feature) / 8 (Multi-feature)

敘述統計
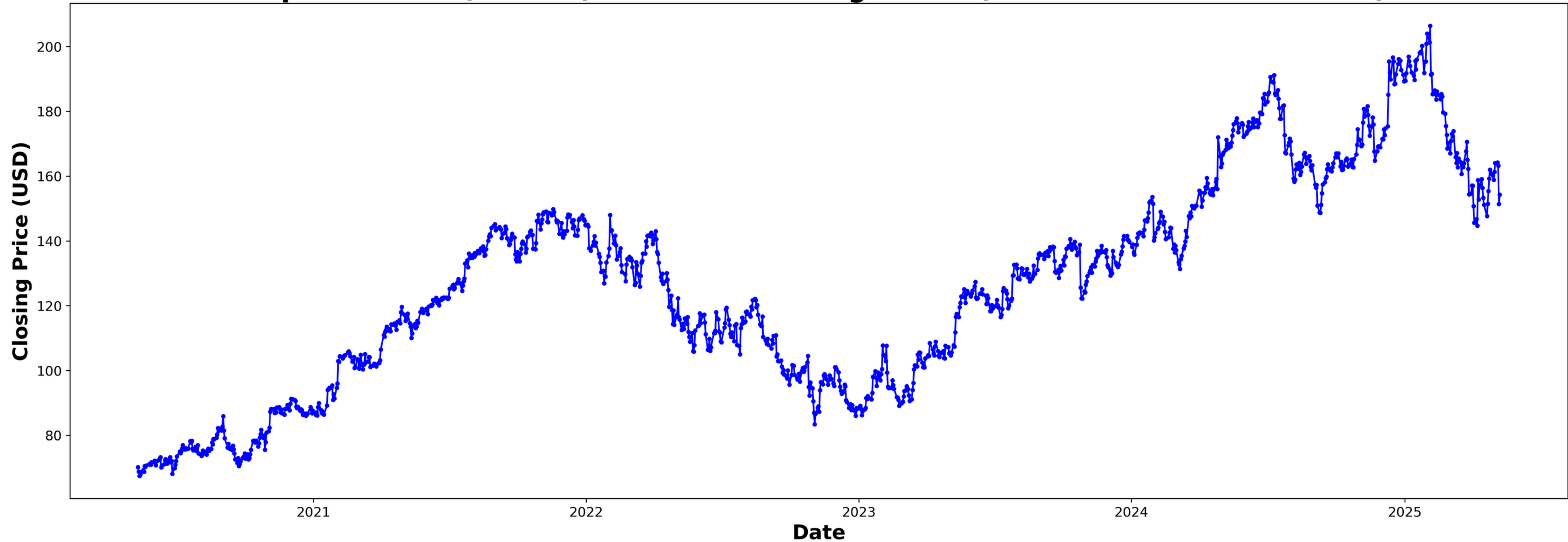
變項	平均數	標準差	min	Q1 (25%)	Q2 (50%)	Q3 (75%)	max
Y (close)	126.58	31.97	67.42	101.62	127.48	146.48	206.38
open	126.53	32.01	66.68	101.79	127.90	146.68	203.39

敘述統計

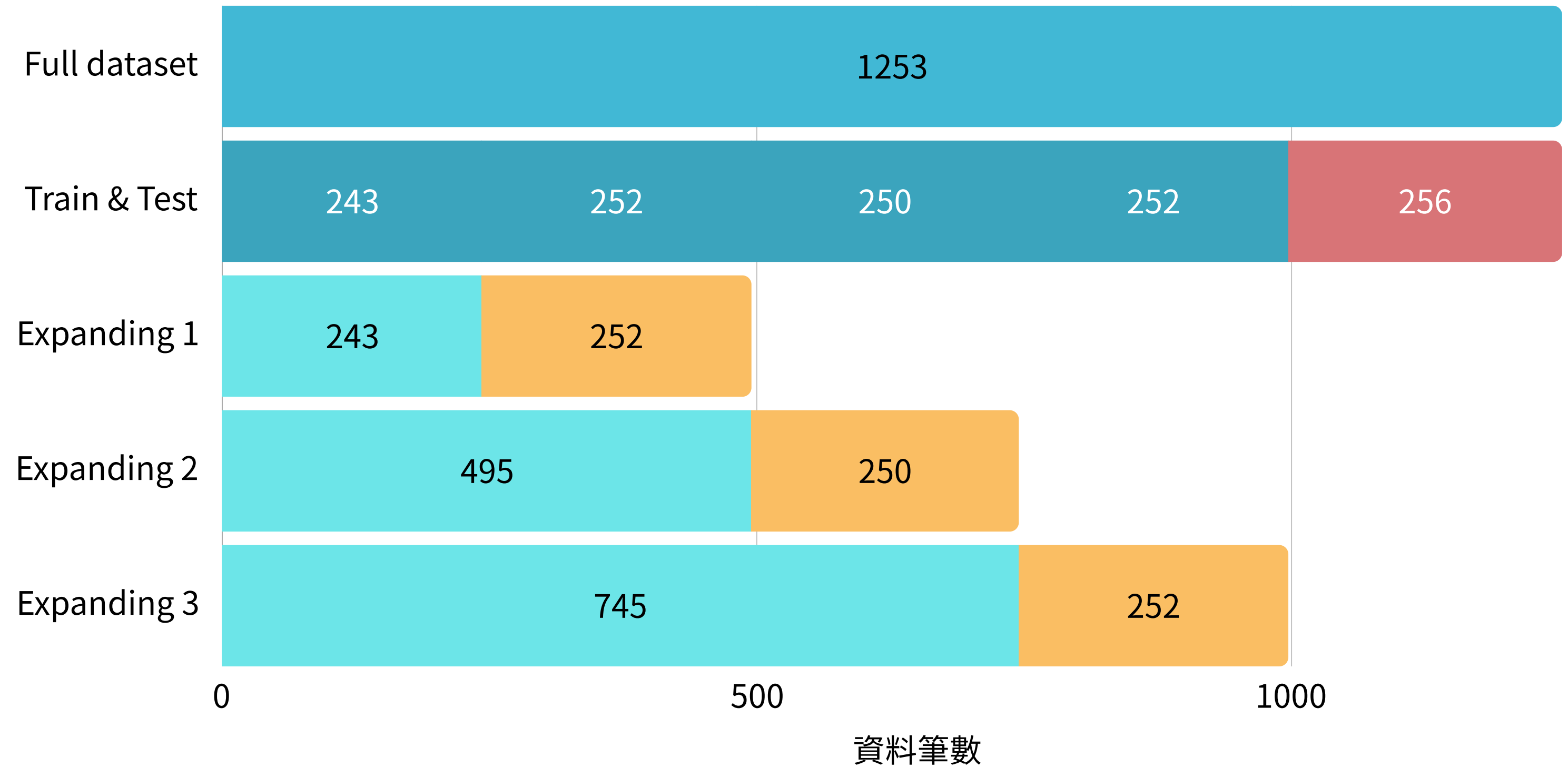Alphabet Inc. (GOOGL) Historical Closing Prices (2020-05-11 ~ 2025-05-08)

敘述統計
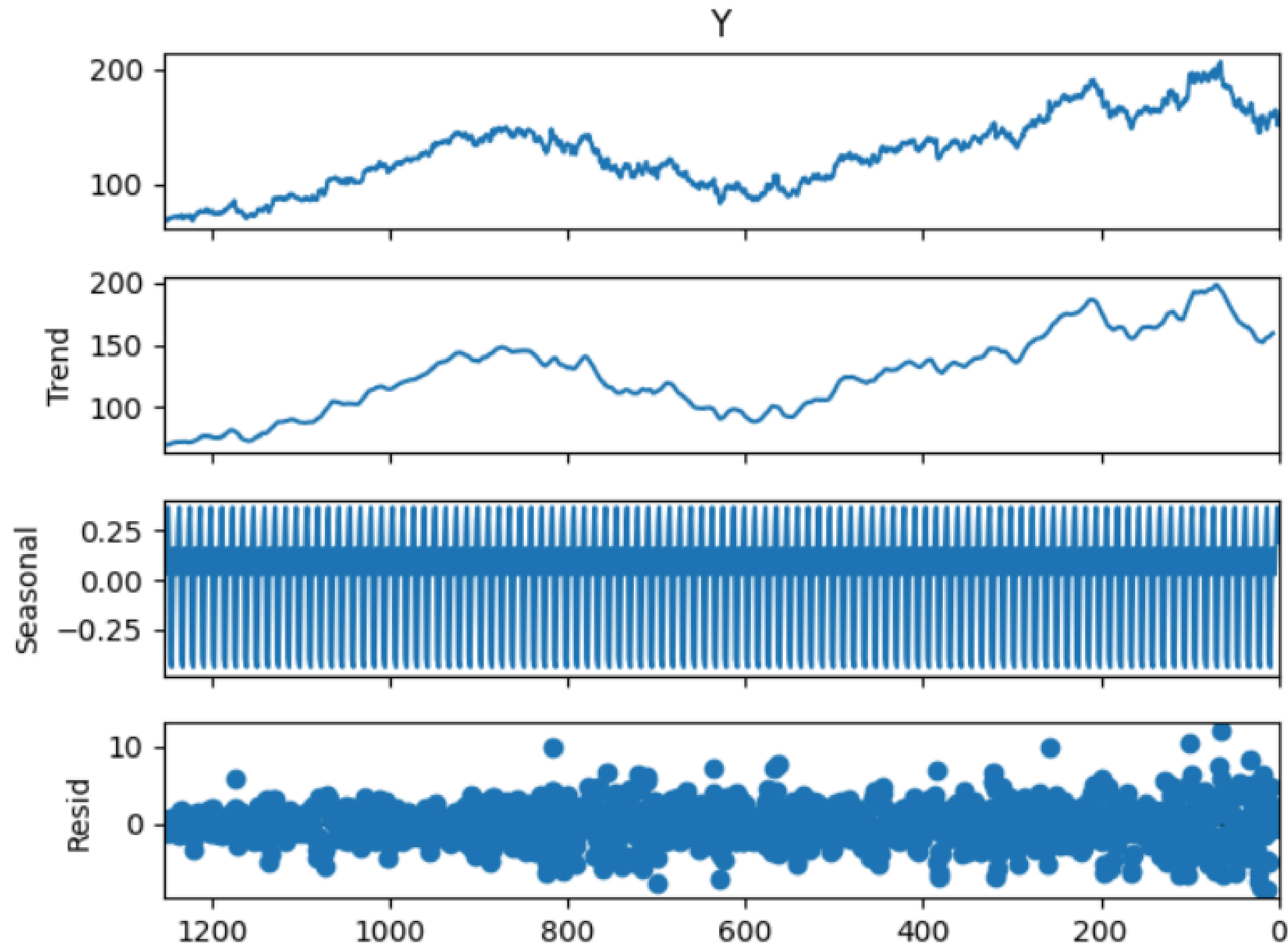
資料建模與結果

固定超參數

- Batch_size = 64

- Epoch = 200

- Activation function:

    - Hidden = relu

    - Output =

        - linear (ANN Regression, Model 1&3)

        - sigmoid (ANN Classification, Model 2&4)

改變的超參數組合

- layer = 3 / 4 / 5

- momentum = 0.5 / 0.7 / 0.9

- learning rate : 0.001 / 0.005 / 0.01

Model1 - ANN Regression

超參數組合

layer = 3			
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_loss=2.7521 RMSE=2.7604	val_loss=2.6092 RMSE=2.622	val_loss=2.4928 RMSE=2.518
learning rate = 0.005	val_loss=4.3774 RMSE=4.3972	val_loss=4.4829 RMSE=4.5105	val_loss=3.7058 RMSE=3.7279
learning rate = 0.01	val_loss=7.9338 RMSE=8.4872	val_loss=8.3730 RMSE=9.5485	val_loss=29.5008 RMSE=31.0343

Model1 - ANN Regression

超參數組合

layer = 4			
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_loss=2.5226 RMSE=2.5434	val_loss=2.5083 RMSE=2.528	val_loss=2.5257 RMSE=2.5518
learning rate = 0.005	val_loss=5.9472 RMSE=5.9807	val_loss=3.9411 RMSE=3.9645	val_loss=2.9274 RMSE=2.9591
learning rate = 0.01	val_loss=5.3502 RMSE=5.3911	val_loss=5.086 RMSE=5.1618	val_loss=29.4689 RMSE=31.0037

Model1 - ANN Regression

超參數組合

<table>
<tr><td colspan="4" align="center">layer = 5</td></tr>
<tr><td></td><td align="center">momentum = 0.5</td><td align="center">momentum = 0.7</td><td align="center">momentum = 0.9</td></tr>
<tr><td align="center">learning rate = 0.001</td><td align="center">val_loss=3.7426
RMSE=3.759</td><td align="center">val_loss=3.887
RMSE=3.9157</td><td align="center">val_loss=2.4855
RMSE=2.5114</td></tr>
<tr><td align="center">learning rate = 0.005</td><td align="center">val_loss=8.6447
RMSE=8.6507</td><td align="center">val_loss=8.5131
RMSE=8.5358</td><td align="center">val_loss=4.063
RMSE=4.0737</td></tr>
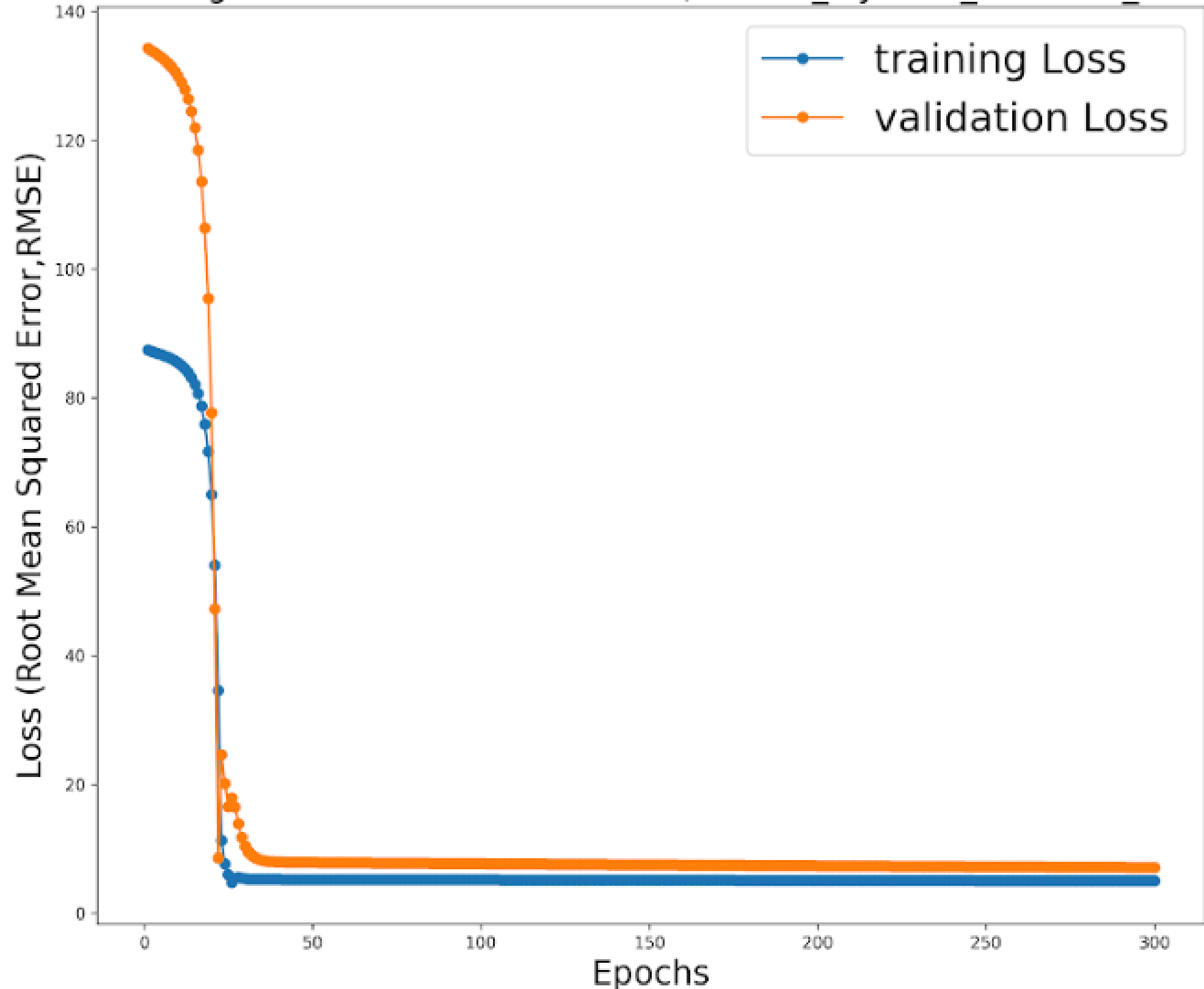<tr><td align="center">learning rate = 0.01</td><td align="center">val_loss=2.7598
RMSE=2.8382</td><td align="center">val_loss=3.8881
RMSE=3.9155</td><td align="center">val_loss=48.4571
RMSE=49.1057</td></tr>
</table>

Model1 - ANN Regression

最佳超參數組合

- **layer = 3**
- **momentum = 0.001**
- **learning rate = 0.9**

Training & Validation Loss

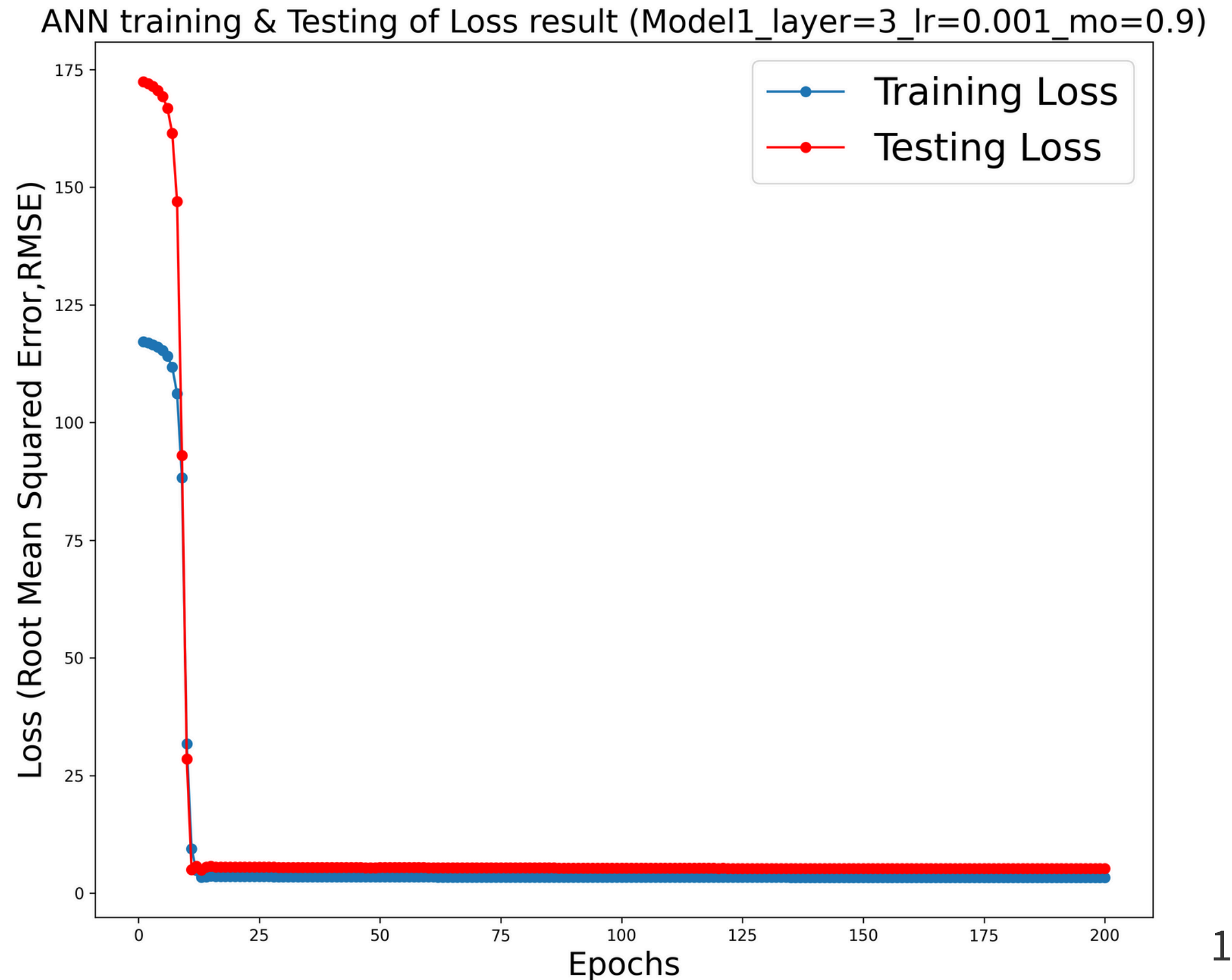ANN training & validation of Loss result (Model1_layer=3_lr=0.001_mo=0.9)
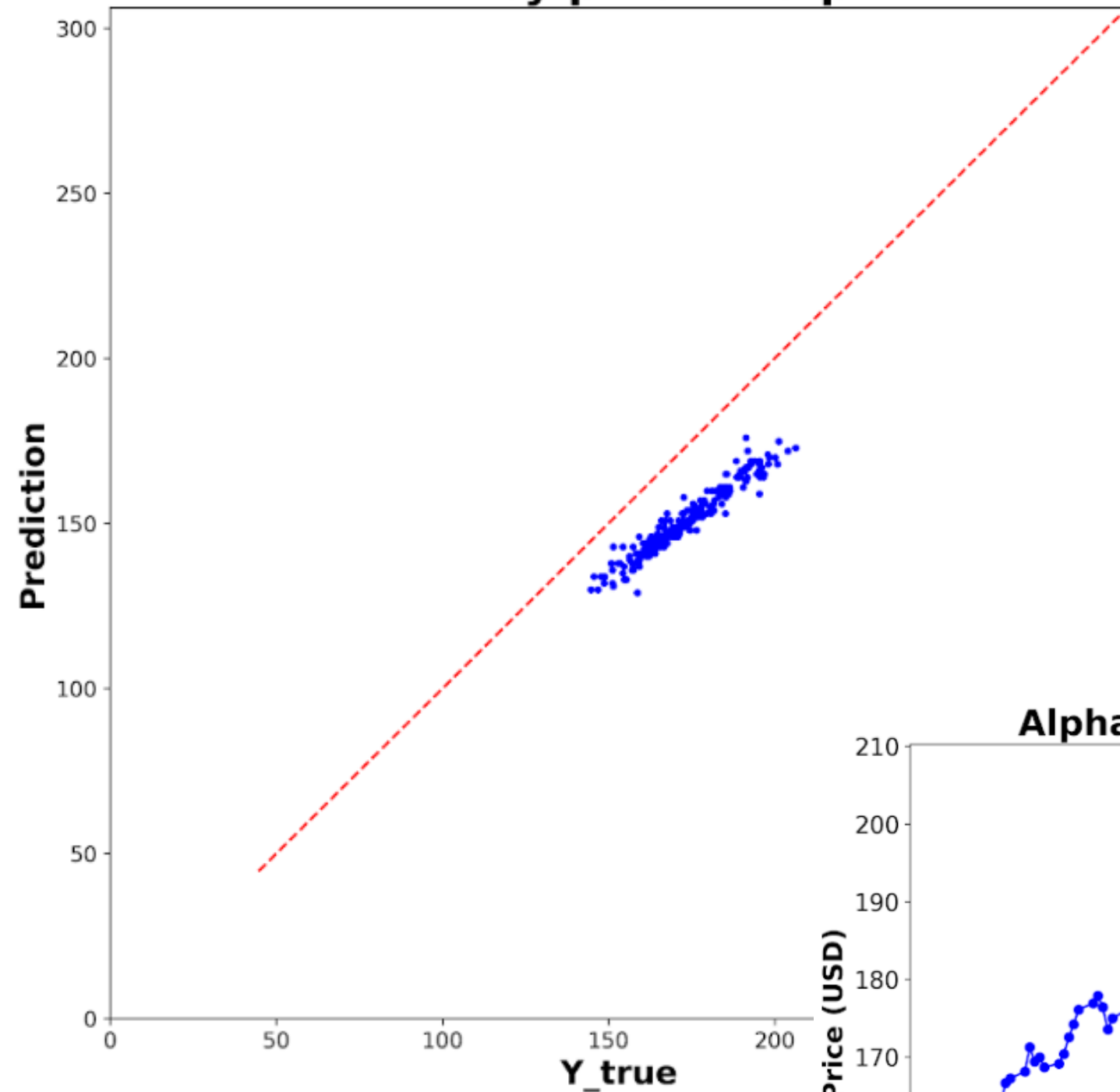
Model1 - ANN Regression

最佳超參數組合

- **layer = 3**
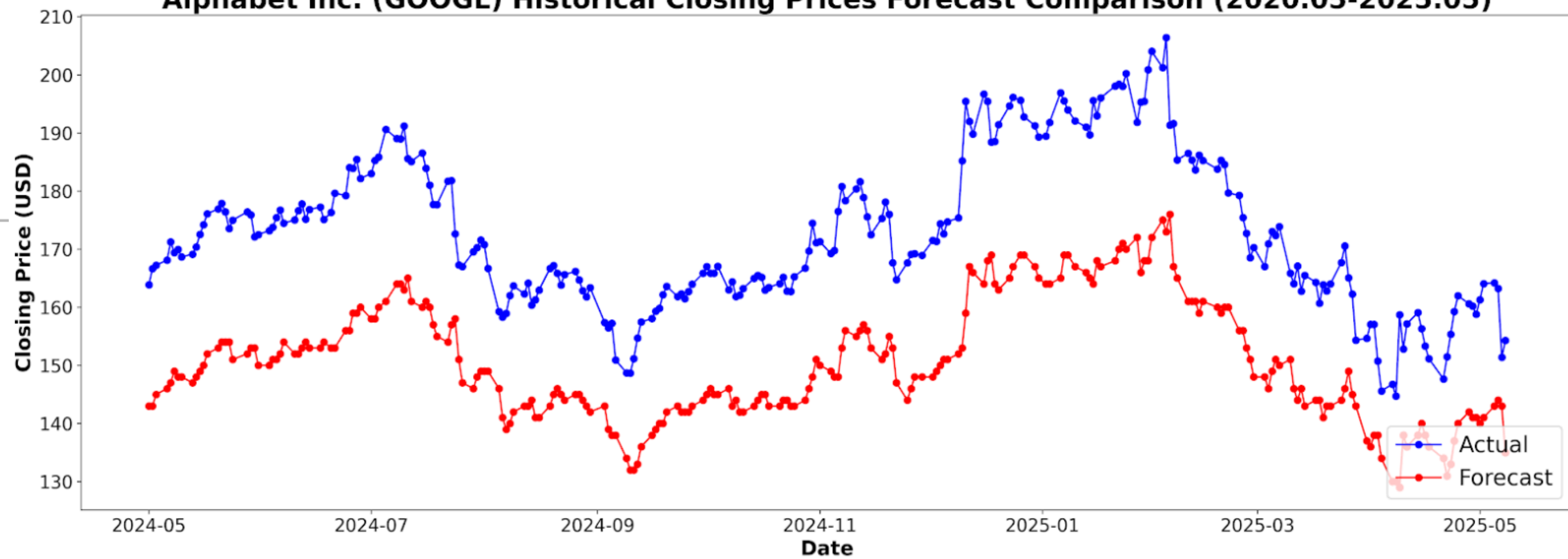- **momentum = 0.001**
- **learning rate = 0.9**

Training & Testing Loss

ANN training & Testing of Loss result (Model1_layer=3_lr=0.001_mo=0.9)

Actual by predicted plot

Alphabet Inc. (GOOGL) Historical Closing Prices Forecast Comparison (2020.05-2025.05)

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Model3 - ANN Regression with Multi-feature

超參數組合

	momentum = 0.5	momentum = 0.7	momentum = 0.9
layer = 3			
learning rate = 0.001	val_loss=2.8924 RMSE=2.901	val_loss=2.6405 RMSE=2.6586	val_loss=2.6788 RMSE=2.7112
learning rate = 0.005	val_loss=4.6671 RMSE=4.6934	val_loss=4.0193 RMSE=4.0435	**val_loss=2.4933** **RMSE=2.5299**
learning rate = 0.01	val_loss=6.1767 RMSE=6.4031	val_loss=10.7435 RMSE=10.818	val_loss=4.6957 RMSE=4.7327

Model3 - ANN Regression with Multi-feature

超參數組合

layer = 4	momentum = 0.5	momentum = 0.7	momentum = 0.9
learning rate = 0.001	val_loss=2.68 RMSE=2.6977	val_loss=2.5093 RMSE=2.5351	val_loss=2.5751 RMSE=2.6052
learning rate = 0.005	val_loss=6.4109 RMSE=6.4499	val_loss=4.1452 RMSE=4.1756	val_loss=3.6981 RMSE=3.7721
learning rate = 0.01	val_loss=6.3832 RMSE=6.4126	val_loss=5.1296 RMSE=5.2191	val_loss=29.6818 RMSE=31.2076

Model3 - ANN Regression with Multi-feature

超參數組合

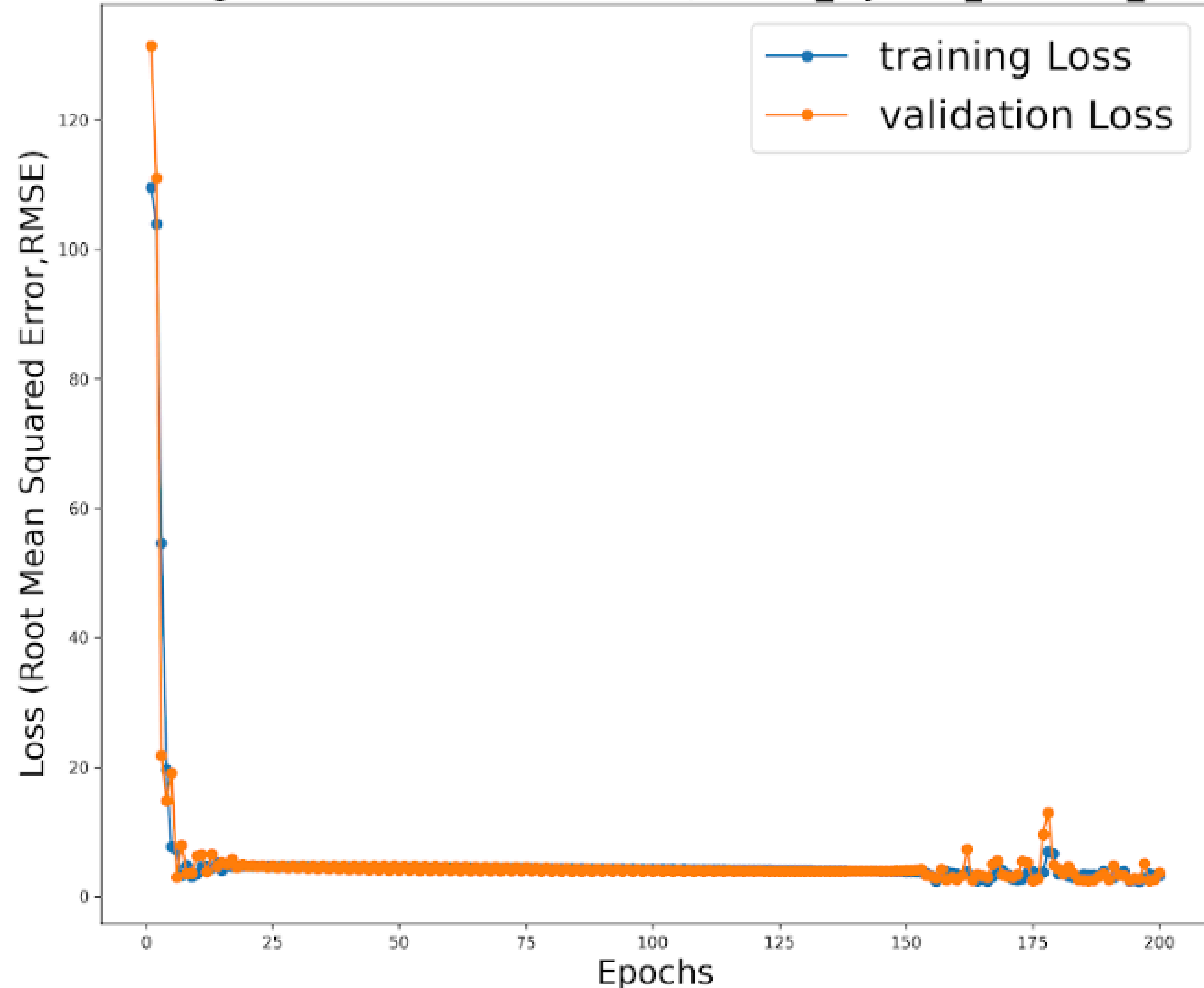| layer = 5			
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_loss=4.6694 RMSE=4.6923	val_loss=4.3761 RMSE=4.4024	val_loss=3.2441 RMSE=3.2797
learning rate = 0.005	val_loss=2.6974 RMSE=2.7174	val_loss=3.9277 RMSE=4.0126	val_loss=3.1405 RMSE=3.2279
learning rate = 0.01	val_loss=4.3478 RMSE=4.3699	val_loss=4.3366 RMSE=4.3748	val_loss=29.7978 RMSE=31.3186

Model3 - ANN Regression with Multi-feature

最佳超參數組合

- **layer = 3**
- **momentum = 0.005**
- **learning rate = 0.9**

Training & Validation Loss

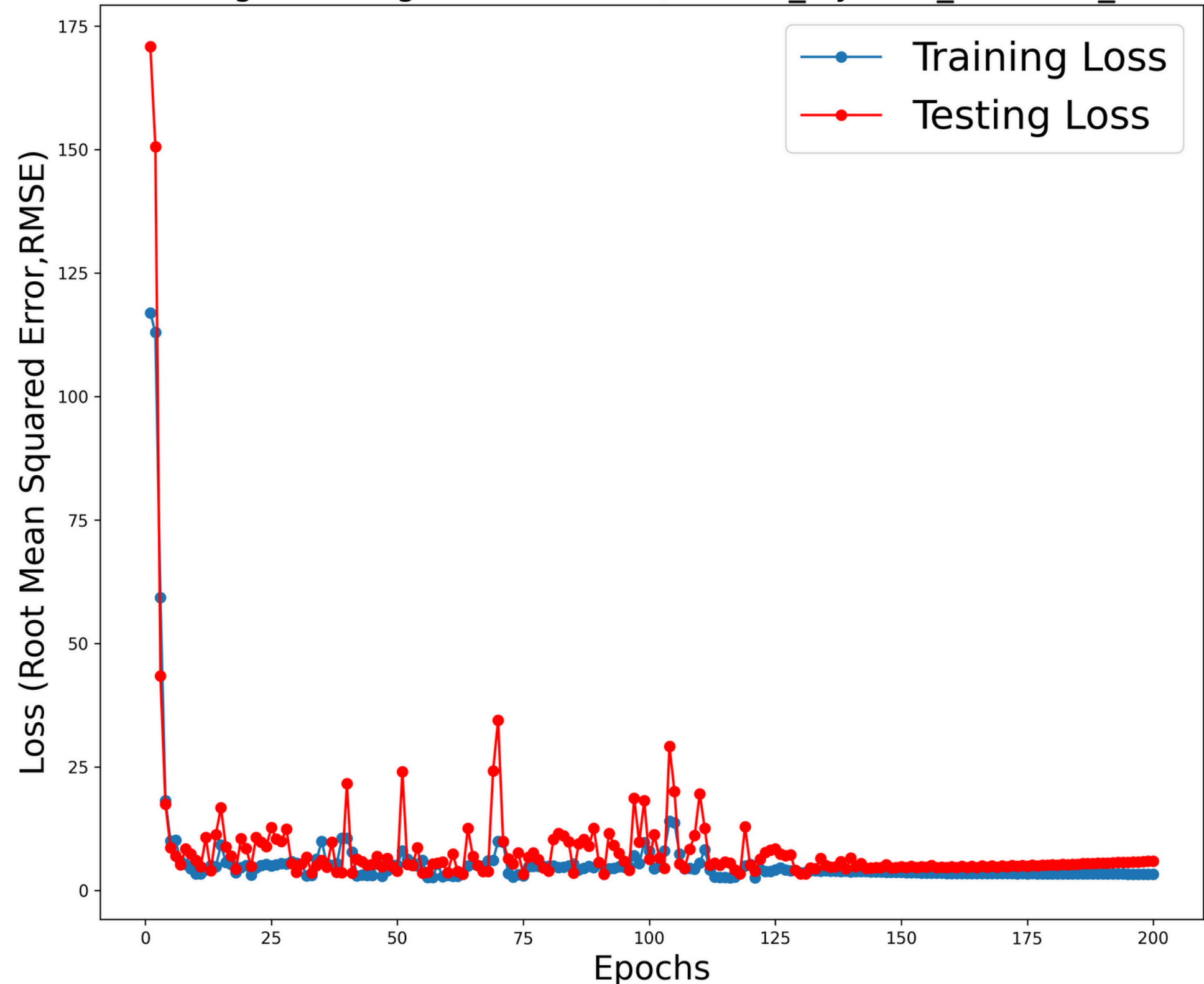ANN training & validation of Loss result (Model3_layer=3_lr=0.005_mo=0.9)
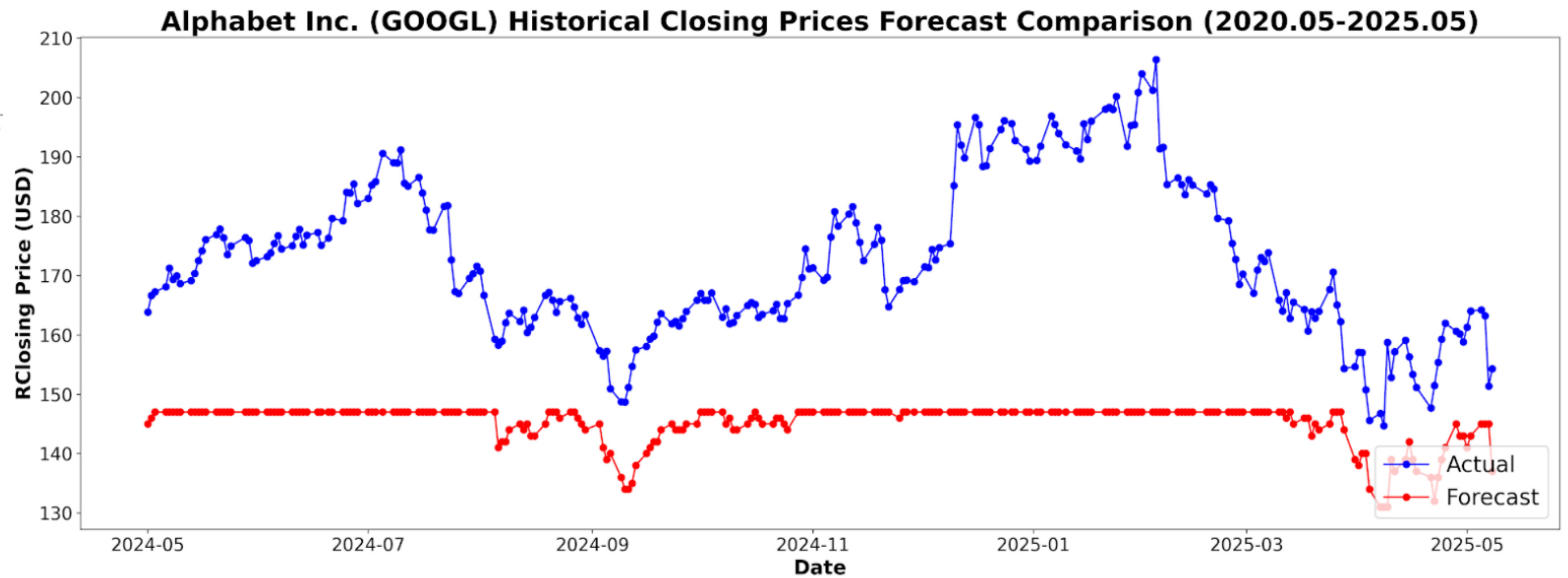
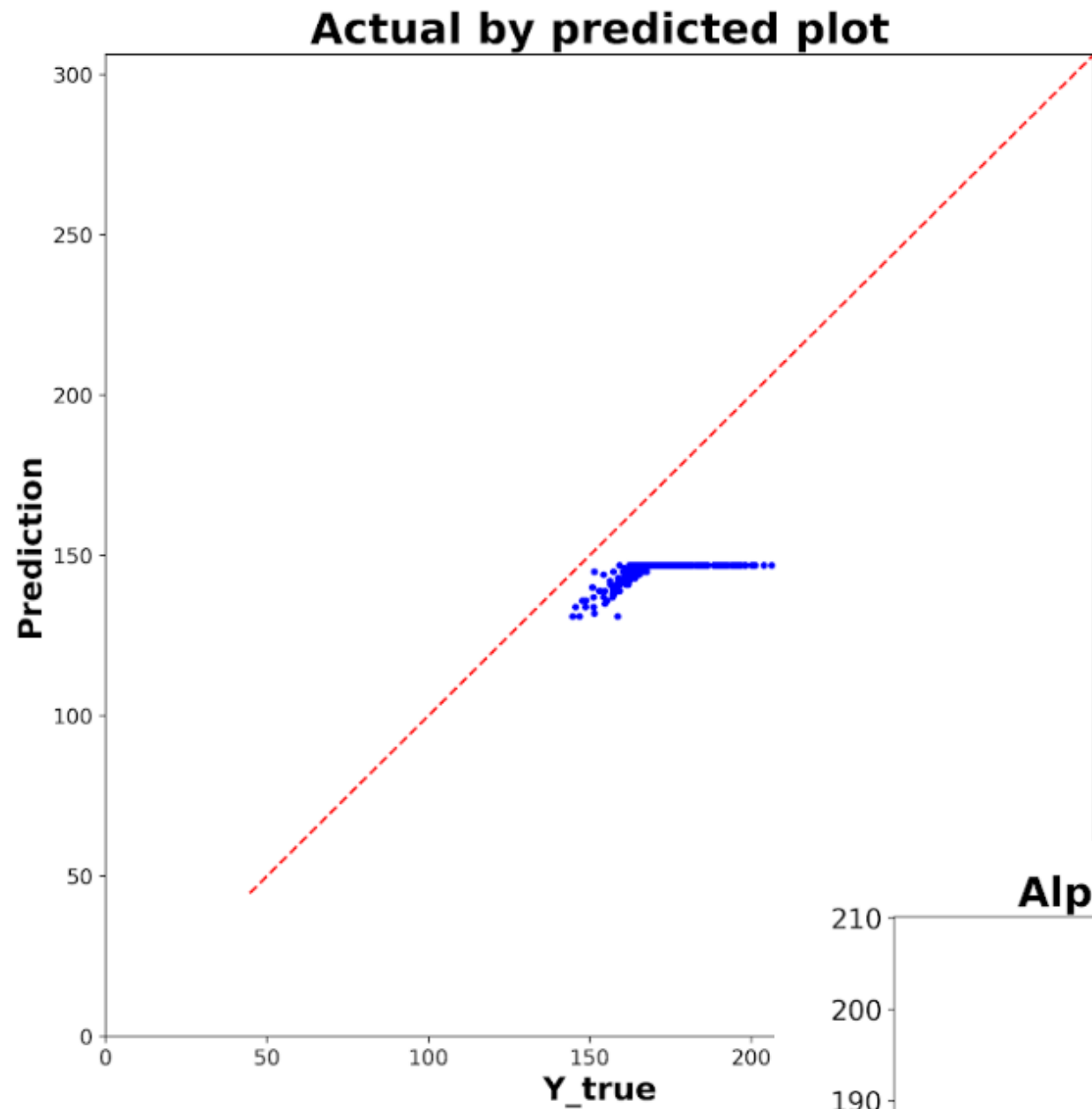# Model3 - ANN Regression with Multi-feature

最佳超參數組合

- **layer = 3**
- **momentum = 0.005**
- **learning rate = 0.9**

Training & Testing Loss

ANN training & Testing of Loss result (Model3_layer=3_lr=0.005_mo=0.9)

Actual by predicted plot

Alphabet Inc. (GOOGL) Historical Closing Prices Forecast Comparison (2020.05-2025.05)

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測試結果與比較

- Model1_選用的超參數組合：
  - layer = 3
  - momentum = 0.001
  - learning rate = 0.9

- Model3_選用的超參數組合：
  - layer = 3
  - momentum = 0.005
  - learning rate = 0.9

	Model1	Model3
MAE	22.151	27.3
RMSE	22.535	29.474
SMAPE	13.658 %	16.91 %
MdRAE	2.272 bench: 172.581	2.618 bench: 172.581
RRSE	1.734	2.269

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Model2 - ANN Classification

超參數組合

	layer = 3		
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_accuracy=0.5675 val_loss=0.6893	val_accuracy=0.5675 val_loss=0.688	val_accuracy=0.5675 val_loss=0.6883
learning rate = 0.005	val_accuracy=0.4921 val_loss=0.6938	val_accuracy=0.4722 val_loss=0.6939	val_accuracy=0.5397 val_loss=0.6912
learning rate = 0.01	val_accuracy=0.4841 val_loss=0.6946	val_accuracy=0.4881 val_loss=0.6952	val_accuracy=0.4802 val_loss=0.6952

Model2 - ANN Classification

超參數組合

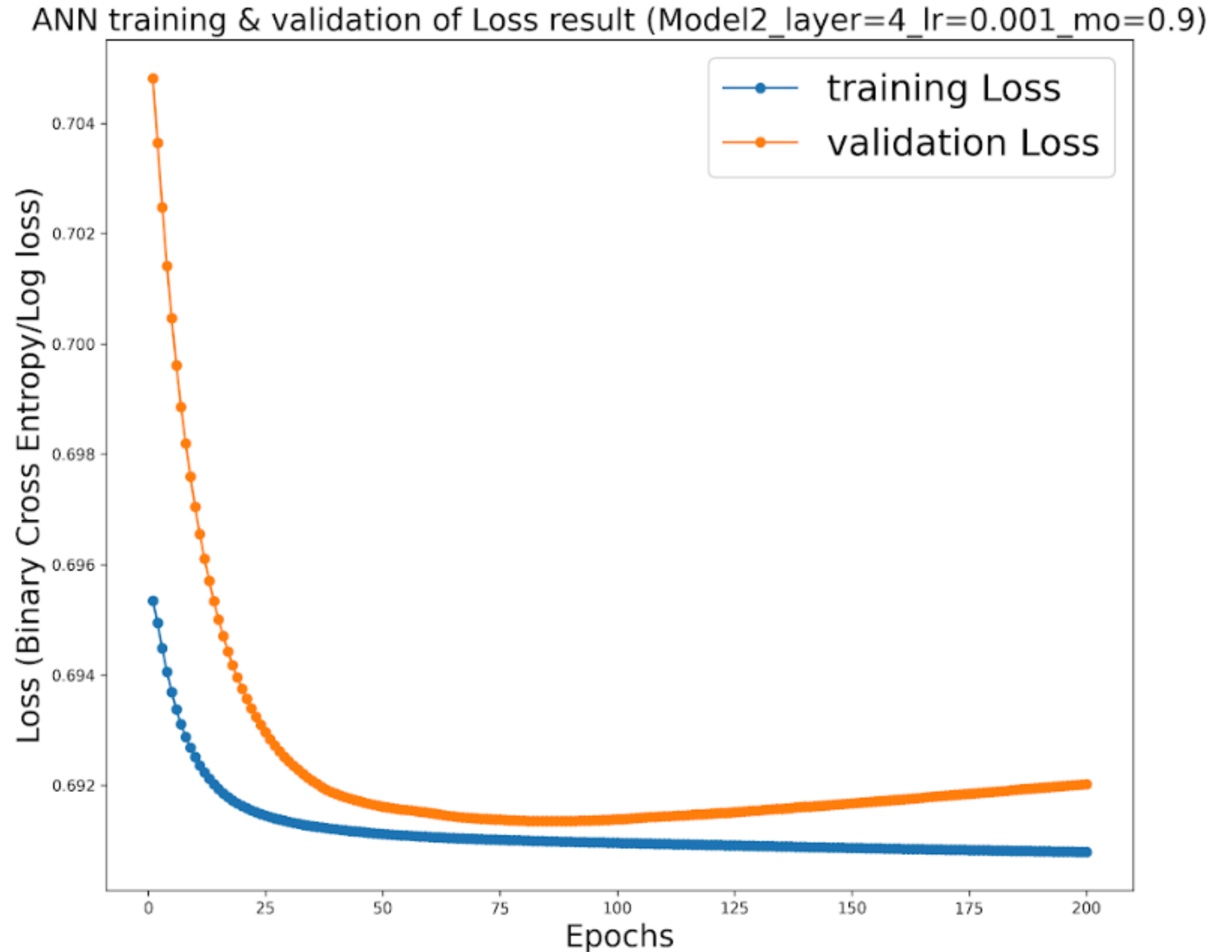|	layer = 4		
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_accuracy=0.5675 val_loss=0.6902	val_accuracy=0.5357 val_loss=0.6915	val_accuracy=0.5714 val_loss=0.6904
learning rate = 0.005	val_accuracy=0.5635 val_loss=0.6905	val_accuracy=0.4802 val_loss=0.6941	val_accuracy=0.4802 val_loss=0.694
learning rate = 0.01	val_accuracy=0.4802 val_loss=0.695	val_accuracy=0.5595 val_loss=0.6927	val_accuracy=0.4722 val_loss=0.6946

Model2 - ANN Classification

超參數組合

	layer = 5		
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_accuracy=0.5675 val_loss=0.688	val_accuracy=0.5675 val_loss=0.6875	val_accuracy=0.5635 val_loss=0.691
learning rate = 0.005	val_accuracy=0.5675 val_loss=0.6883	val_accuracy=0.5079 val_loss=0.6928	val_accuracy=0.5 val_loss=0.694
learning rate = 0.01	val_accuracy=0.5317 val_loss=0.6926	val_accuracy=0.4762 val_loss=0.6947	val_accuracy=0.4841 val_loss=0.6949

Model2 - ANN Classification

最佳超參數組合

- **layer = 4**
- **momentum = 0.9**
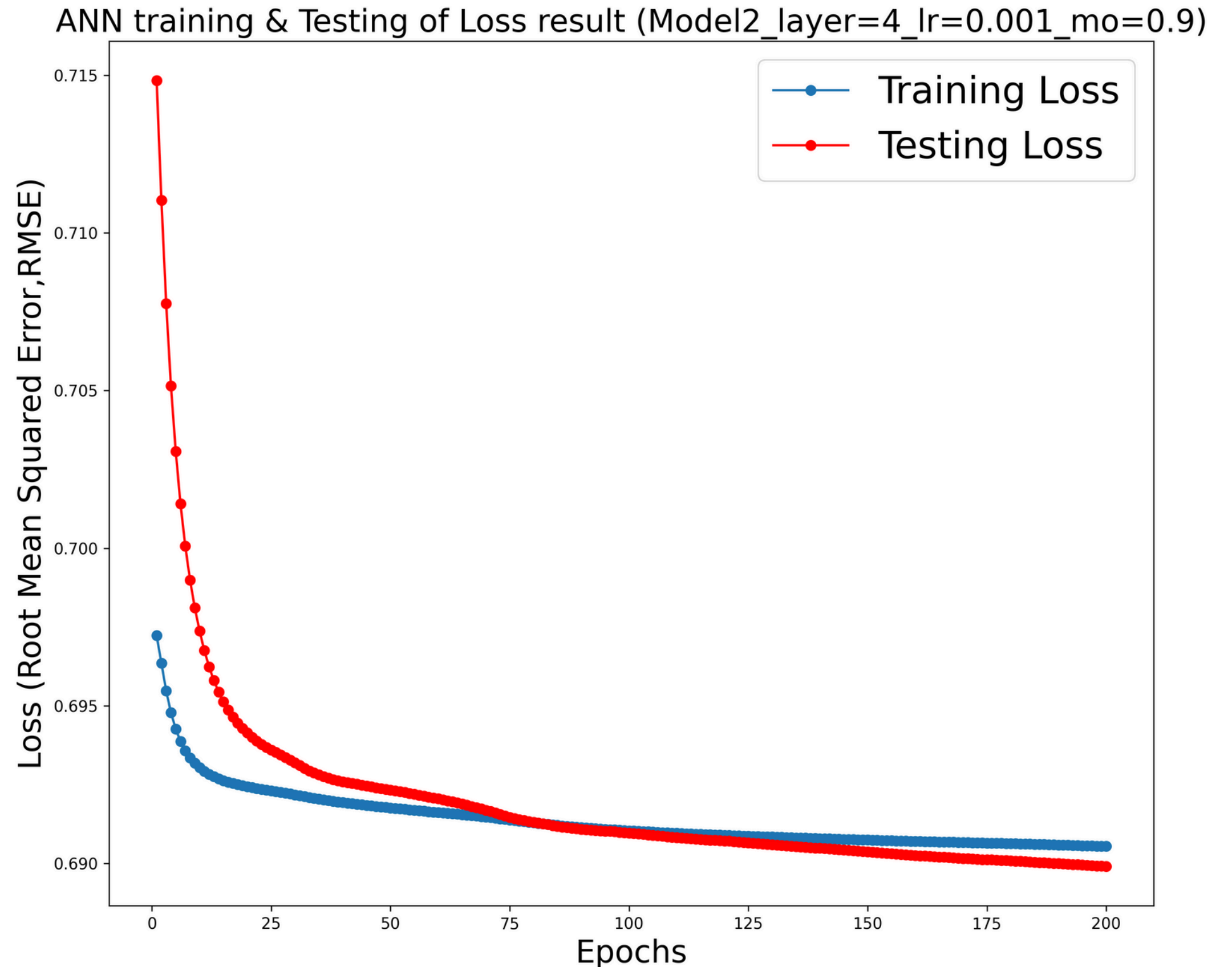- **learning rate = 0.001**

Training & Validation Loss

ANN training & validation of Loss result (Model2_layer=4_lr=0.001_mo=0.9)

Model2 - ANN Classification

最佳超參數組合

- **layer** = 4
- **momentum** = 0.9
- **learning rate** = 0.001

Training & Testing Loss

ANN training & Testing of Loss result (Model2_layer=4_lr=0.001_mo=0.9)

Model4 - ANN Classification with Multi-feature

超參數組合

	layer = 3		
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_accuracy=0.6907 val_loss=0.5794	val_accuracy=0.6885 val_loss=0.5675	val_accuracy=0.6914 val_loss=0.5437
learning rate = 0.005	**val_accuracy=0.6952 val_loss=0.4643**	val_accuracy=0.689 val_loss=0.5357	val_accuracy=0.6923 val_loss=0.5159
learning rate = 0.01	val_accuracy=0.6944 val_loss=0.4921	val_accuracy=0.6930 val_loss=0.5119	val_accuracy=0.6948 val_loss=0.4881

Model4 - ANN Classification with Multi-feature

超參數組合

	layer = 4		
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_accuracy=0.6923 val_loss=0.5317	val_accuracy=0.6879 val_loss=0.5675	val_accuracy=0.6906 val_loss=0.5635
learning rate = 0.005	val_accuracy=0.6931 val_loss=0.5198	val_accuracy=0.6888 val_loss=0.5357	val_accuracy=0.6945 val_loss=0.4881
learning rate = 0.01	val_accuracy=0.6924 val_loss=0.5476	val_accuracy=0.6943 val_loss=0.5079	val_accuracy=0.6921 val_loss=0.5595

Model4 - ANN Classification with Multi-feature

超參數組合

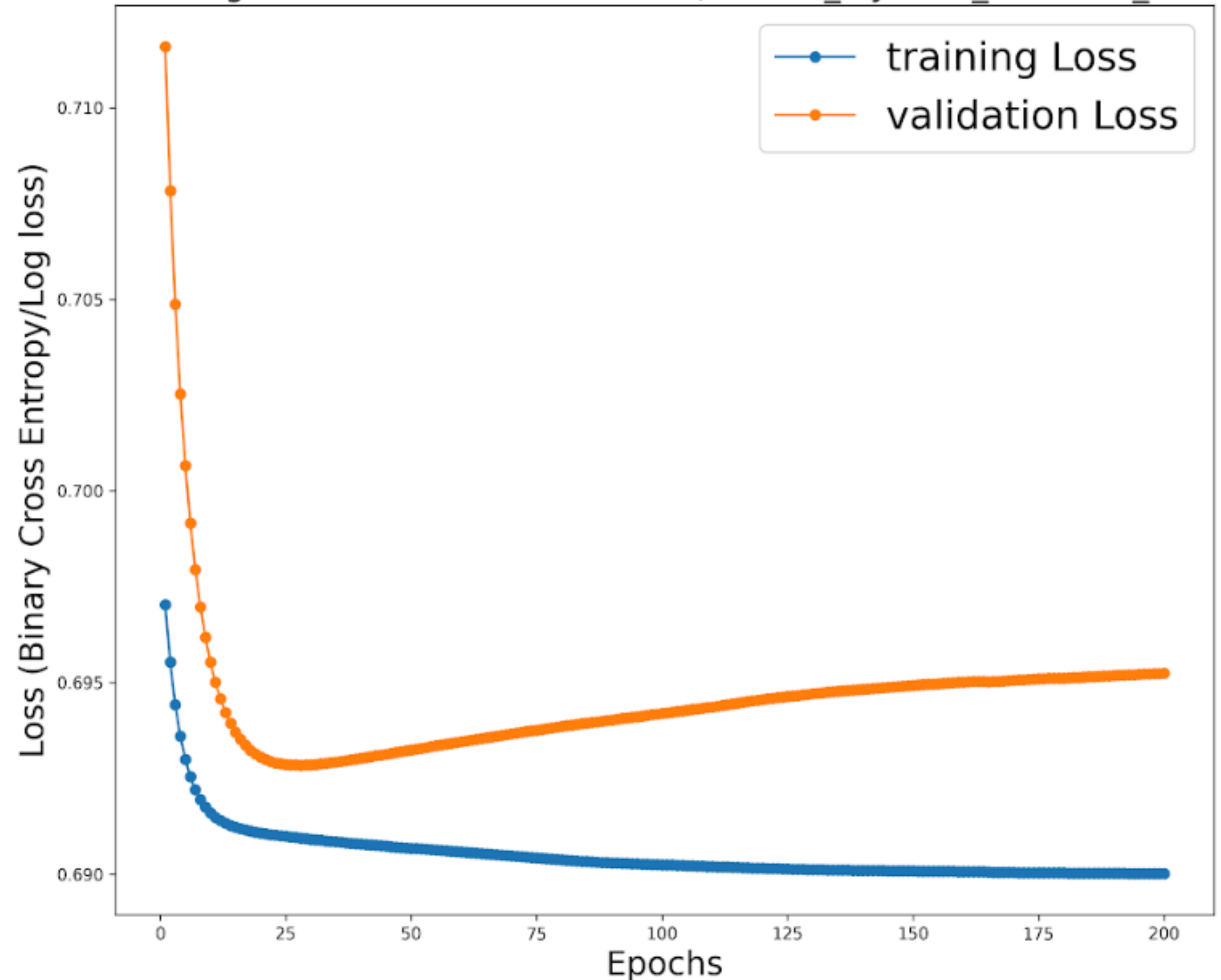| layer = 5		
	momentum = 0.5	**momentum = 0.7**	**momentum = 0.9**
learning rate = 0.001	val_accuracy=0.6906 val_loss=0.5675	val_accuracy=0.6887 val_loss=0.5675	val_accuracy=0.6932 val_loss=0.5
learning rate = 0.005	val_accuracy=0.6904 val_loss=0.5675	val_accuracy=0.6887 val_loss=0.5675	val_accuracy=0.6945 val_loss=0.4881
learning rate = 0.01	val_accuracy=0.6948 val_loss=0.4762	val_accuracy=0.695 val_loss=0.4802	val_accuracy=0.6931 val_loss=0.5317

Model4 - ANN Classification with Multi-feature

最佳超參數組合

- **layer = 3**
- **momentum = 0.5**
- **learning rate = 0.005**

Training & Validation Loss

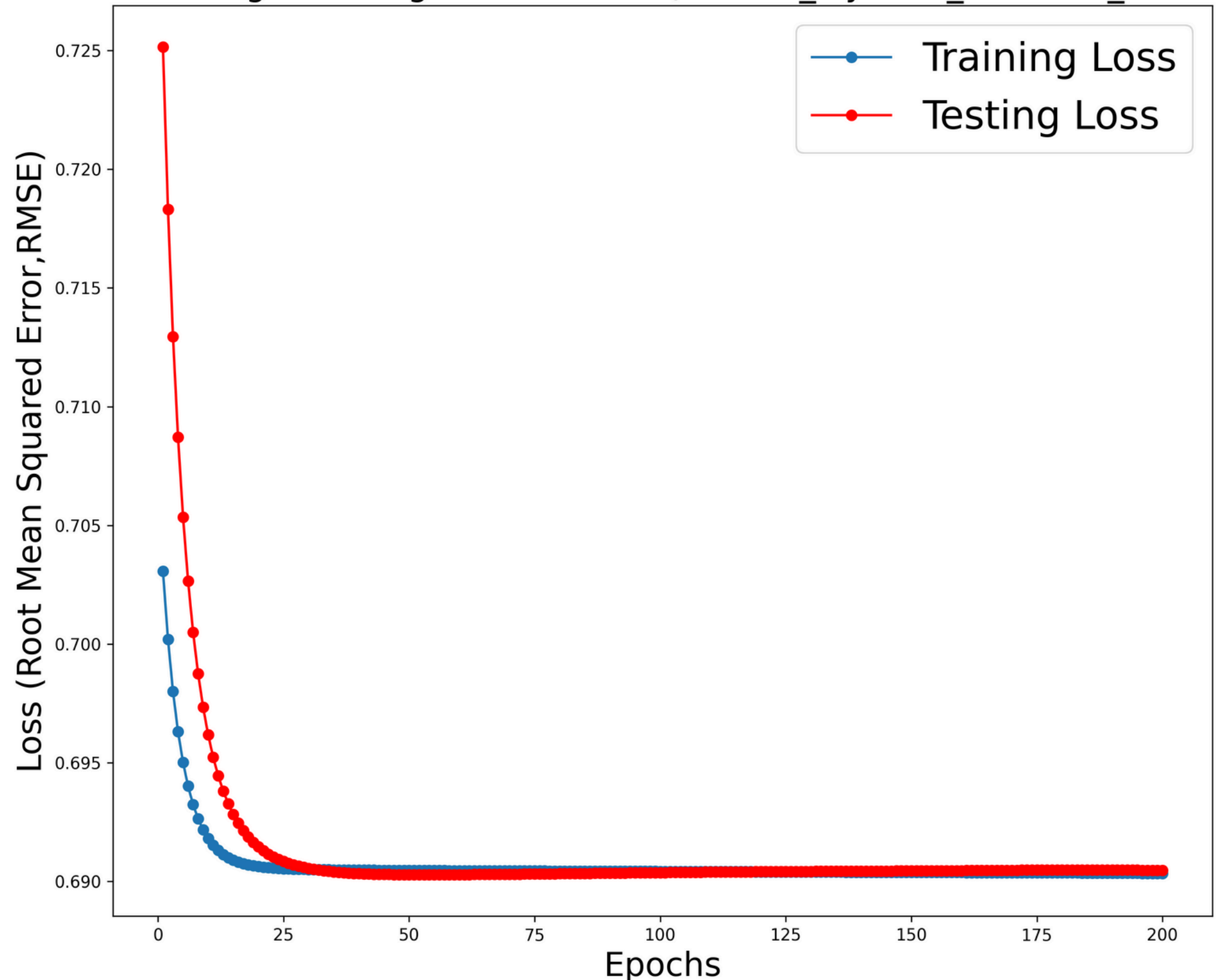ANN training & validation of Loss result (Model4_layer=3_lr=0.005_mo=0.5)

Model4 - ANN Classification with Multi-feature

最佳超參數組合

- **layer = 3**
- **momentum = 0.5**
- **learning rate = 0.005**

Training & Testing Loss

ANN training & Testing of Loss result (Model4_layer=3_lr=0.005_mo=0.5)

測試結果與比較 Performance Metrics – Testing

- Model2_選用的超參數組合：
  - layer = 4
  - momentum = 0.9
  - learning rate = 0.001

- Testing RMSE: 0.7315
- Testing f1s: 5.52
- Testing AUC: 51.0

	Predicted : Positive	**Predicted : Negative**	
Actual : Positive	(TP) 4	(FN) 136	Sensitivity (sen) 2.86
Actual : Negative	(FP) 1	(TN) 115	Specificity (spe) 99.14
	Precision (pre) 80.0		Accuracy (ACC) 46.48

測試結果與比較 Performance Metrics – Testing

- Model4_選用的超參數組合：
  - layer = 3
  - momentum = 0.5
  - learning rate = 0.005

- Testing RMSE: 0.6731
- Testing f1s: 70.71
- Testing AUC: 50.0

	Predicted : Positive	**Predicted : Negative**	
Actual : Positive	(TP) 140	(FN) 0	Sensitivity (sen) 100.0
Actual : Negative	(FP) 116	(TN) 0	Specificity (spe) 0.0
	Precision (pre) 54.69		Accuracy (ACC) 54.69

結論

- ANN Regression 較 ANN Classification佳

- ANN Regression 中，Single-feature較 Multi-feature佳

THANK YOU