

Programming assignment

Method:

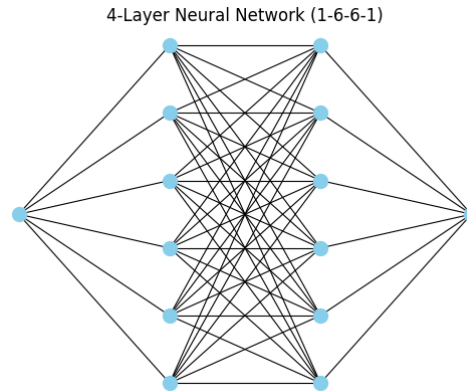
1.activation function: $\sigma(x) = \tanh(x)$

2.Network:

(1)Input layer: 1 neuron

(2)Inside layer: 2 layers, 6 neurons

(3)Output layer: 1 neuron



Hypothesis:

$$h_{\theta}(x) = W_3 \tanh\left(W_2 \tanh(W_1 x + b_1) + b_2\right) + b_3$$

3.Choosen Points:

Choose at $[-1,1]$

(1)Training: 10000

(2)Validation: 1500

4.loss function:

$$\mathcal{L}(\theta) = \underbrace{\text{MSE}(h_{\theta}(x), R(x))}_{\text{function loss}} + \lambda_{\text{deriv}} \underbrace{\text{MSE}\left(\frac{d}{dx} h_{\theta}(x), R'(x)\right)}_{\text{derivative loss}}.$$

5.optimizer: Adam

6.learning rate: 0.001

7.Epoch: 7000 times

Differential way:

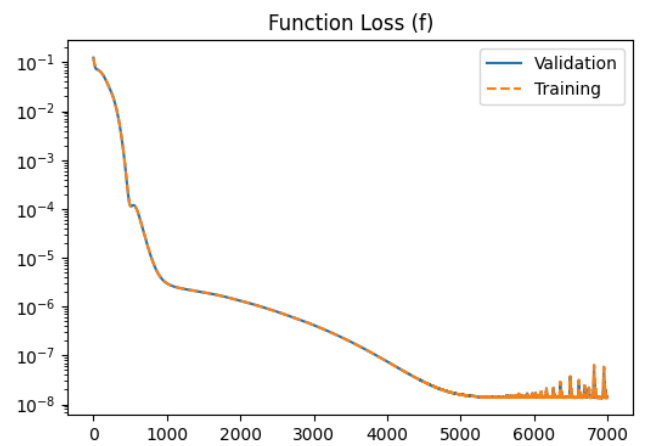
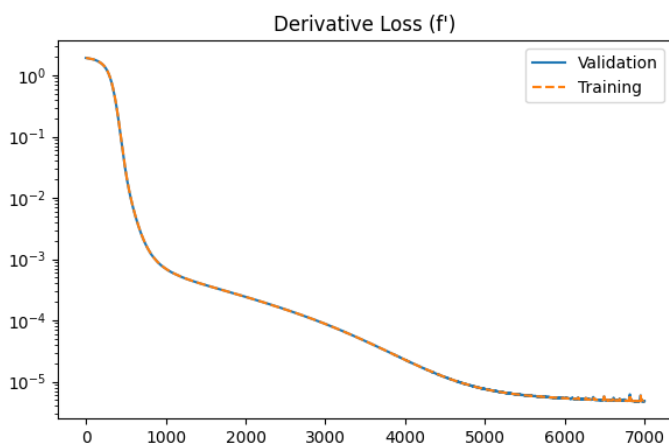
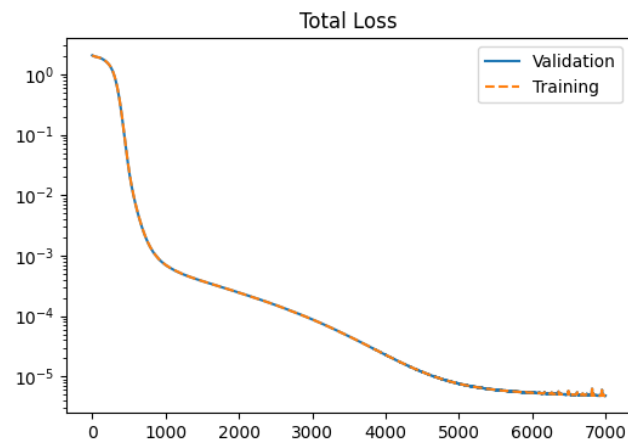
Runge function use $R'(x) = -\frac{50x}{(1 + 25x^2)^2}.$

Training data use $f'(x) \approx \frac{f(x+h) - f(x-h)}{2h}$, where $h = (1-(-1))/10000$

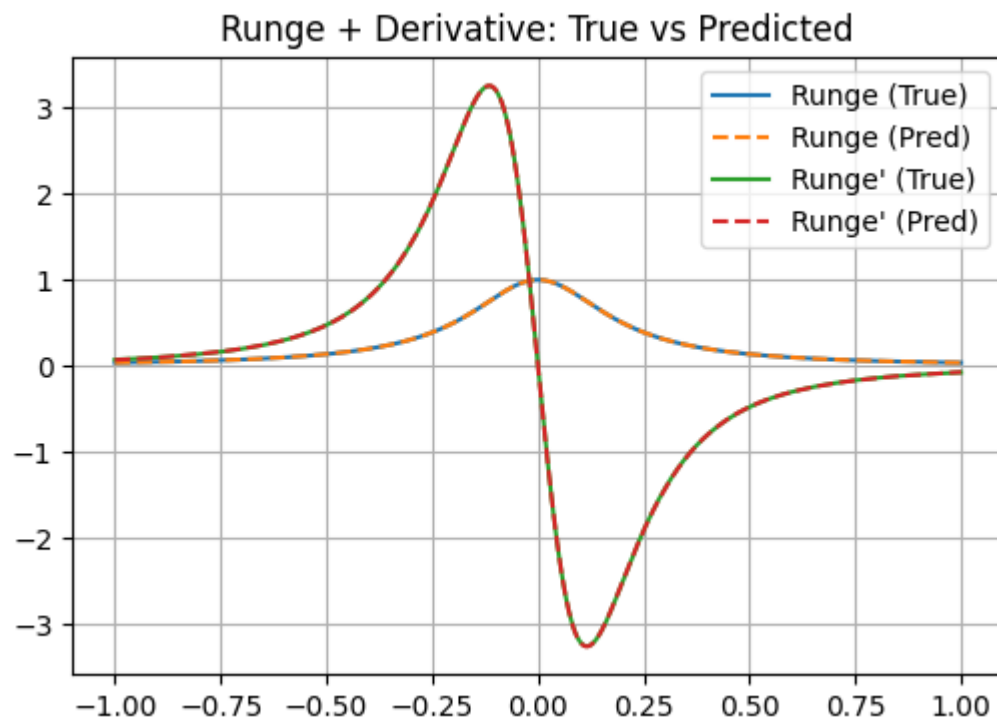
Result:

Loss(lambda = 1):

Epoch 500		Train Loss: 0.026777 (f: 0.000119, df: 0.026658)		Val Loss: 0.026266 (f: 0.000118, df: 0.026148)
Epoch 1000		Train Loss: 0.000703 (f: 0.000003, df: 0.000700)		Val Loss: 0.000701 (f: 0.000003, df: 0.000698)
Epoch 1500		Train Loss: 0.000380 (f: 0.000002, df: 0.000378)		Val Loss: 0.000379 (f: 0.000002, df: 0.000377)
Epoch 2000		Train Loss: 0.000244 (f: 0.000001, df: 0.000243)		Val Loss: 0.000244 (f: 0.000001, df: 0.000243)
Epoch 2500		Train Loss: 0.000152 (f: 0.000001, df: 0.000151)		Val Loss: 0.000152 (f: 0.000001, df: 0.000151)
Epoch 3000		Train Loss: 0.000088 (f: 0.000000, df: 0.000088)		Val Loss: 0.000088 (f: 0.000000, df: 0.000088)
Epoch 3500		Train Loss: 0.000046 (f: 0.000000, df: 0.000046)		Val Loss: 0.000046 (f: 0.000000, df: 0.000046)
Epoch 4000		Train Loss: 0.000023 (f: 0.000000, df: 0.000023)		Val Loss: 0.000023 (f: 0.000000, df: 0.000023)
Epoch 4500		Train Loss: 0.000012 (f: 0.000000, df: 0.000012)		Val Loss: 0.000012 (f: 0.000000, df: 0.000012)
Epoch 5000		Train Loss: 0.000008 (f: 0.000000, df: 0.000008)		Val Loss: 0.000008 (f: 0.000000, df: 0.000008)
Epoch 5500		Train Loss: 0.000006 (f: 0.000000, df: 0.000006)		Val Loss: 0.000006 (f: 0.000000, df: 0.000006)
Epoch 6000		Train Loss: 0.000005 (f: 0.000000, df: 0.000005)		Val Loss: 0.000005 (f: 0.000000, df: 0.000005)
Epoch 6500		Train Loss: 0.000005 (f: 0.000000, df: 0.000005)		Val Loss: 0.000005 (f: 0.000000, df: 0.000005)
Epoch 7000		Train Loss: 0.000005 (f: 0.000000, df: 0.000005)		Val Loss: 0.000005 (f: 0.000000, df: 0.000005)



Result:



MSE loss: 0.000000, Max Error: 0.000218