① Read data$[x_1, x_2, x_3, x_4]$:

$L[T-3]$	$L[T-2]$	$L[T-1]$	$L[T]$
5551.822	4483.170	4888.396	5072.95
4983.17184	4888.39	5072.95	51.96125

② Data preprocessor using normalization

$4[T-3]$	$L[T-2]$	$L[T-1]$	$L[T]$
0.397	0.293	0.276	0.310
0.293	0.276	0.310	0.332

③ initialization $m_1 = 1, m_2 = 1, m_3 = 1$

  max iteration $= 1000$, eta $= 0.1$, $c = -1$

  epochs $= 1$

④ set iter $= 1$

⑤ set sample $= 1$

⑥ $x_1 = data['L[T-3]']$, $x_2 = data['L[T-2]']$

   $x_3 = data['L[T-1]']$, $y = data['L[T]']$

$$\frac{dE}{dm_1} = data - (y - m_1 x_i^i - m_2 x_j^j - m_3 x_j^i - c) x_i^i$$

$$= -(0.310 - 1(0.397) - 1(0.293) - 1(0.276) +$$

$$1) \, 0.397$$

$$= -0.136568$$

$$\frac{dE}{dm_2} = -(y - m_1 x_i^i + m_2 x_j^j - c) x_j^j$$

$$= -(0.310 - 1(0.397) - 1(0.293) - 1(0.276)$$

$$+ 1) 0.293$$

$$= -0.100792$$

$$\frac{dE}{dm_3} = -(0.310 - 1(0.397) - 1(0.293) - 1(0.276)$$

$$+ 1) 0.276$$

$$= -0.0949$$

$$\frac{dE}{dc} = -(y - m_1 x_i^i - m_2 x_j^j - m_3 x_j^i - c)$$

$$= -(0.310 - 1(0.397) - 1(0.293) - 1(0.276) + 1)$$

$$= -0.344$$

② $\Delta m_1 = -\eta \frac{dE}{dm_1} = -0.1(-0.136) = 0.0136$

$\Delta m_2 = -\eta \frac{dE}{dm_2} = -0.1(-0.100792) = 0.0$

$\Delta m_3 = -\eta \frac{dE}{dm_3} = -0.1(-0.094) = 9.4 \times 10^3$

$\Delta c = -\eta \frac{dE}{dc} = -0.1(-0.344) = 0.0344$

① $m_1 = m_1 + \Delta m_1 = 1 + 0.0136 = 1.0136$

$m_2 = m_2 + \Delta m_2 = 1 + 0.01 = 1.01$

$$m_3 = m_3 + \Delta m_3 = 1 + 9.4 \times 10^{-3} = 1.0094$$

$$c = c + \Delta c = -1 + 0.0344 = -0.9656$$

⑨ sample(i) = sample(i) + 1

$$i = 1 + 1 = 2$$

⑩ if (sample ≤ ns)

if $(2 \leq 2) \tau \Rightarrow$ step ⑥

sample = 2

⑥ $\dfrac{dE}{dm_1} = -((0.332) - (1.0136)(0.293)$

$\qquad - (0.01)(0.276) - 1.0094(0.310)$

$\qquad + 0.9656) 0.293$

$\qquad = -0.1205$

$\dfrac{dE}{dm_2} = - \left((0.332) - 1.0136(0.293) - 1.01(0.298)\right.$

$\qquad \left. - 1.009 (0.310) + 0.965 \right) 0.276$

$\qquad = -0.11355$

$\dfrac{dE}{dm_3} = -((0.332 - 1.0136(0.293) - 1.01(0.236)$

$\qquad - 1.009 (0.310) + 0.965) 0.310$

$\qquad = -0.127$

$\dfrac{dE}{dc} = -0.411$

$\Delta m_1 = -\eta \dfrac{dE}{dm_1} = -0.1(-0.1205) = 0.01205$

$\Delta m_2 = -\eta \dfrac{dE}{dm_2} = -0.1 (-0.11355) = 0.0113$

$\Delta m_3 = -\eta \dfrac{dE}{dm_3} = -0.1 (-0.127) = 0.0127$

$\Delta c = -\eta \dfrac{dE}{dc} = -0.1 (-0.411) = 0.0411$

(8) $m_1 = m_1 + \Delta m_1 = 1.025$

$m_2 = m_2 + \Delta m_2 = 1.021$

$m_3 = m_3 + \Delta m_3 = 1.012$

$c = c + \Delta c = -0.554$

(9) sample (i) = sample $(i) + 1$

$(1) = 2 + 1 = 3$

(10) if (sample $(i) \leq ns$)

if $(3 \leq 2)$ $F \rightarrow$ next step))

(11) iter = iter $+ 1 = 1 + 1 = 2$

(12) if (iter $\leq$ Epochs)

if $(2 \leq 1)$ $\rightarrow F \rightarrow$ next step