Neural Network and Applications
Homework 2

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1 回归预测股票价格：利用给定的 20 天股票数据来预测第 21 到 25 天的股票价格

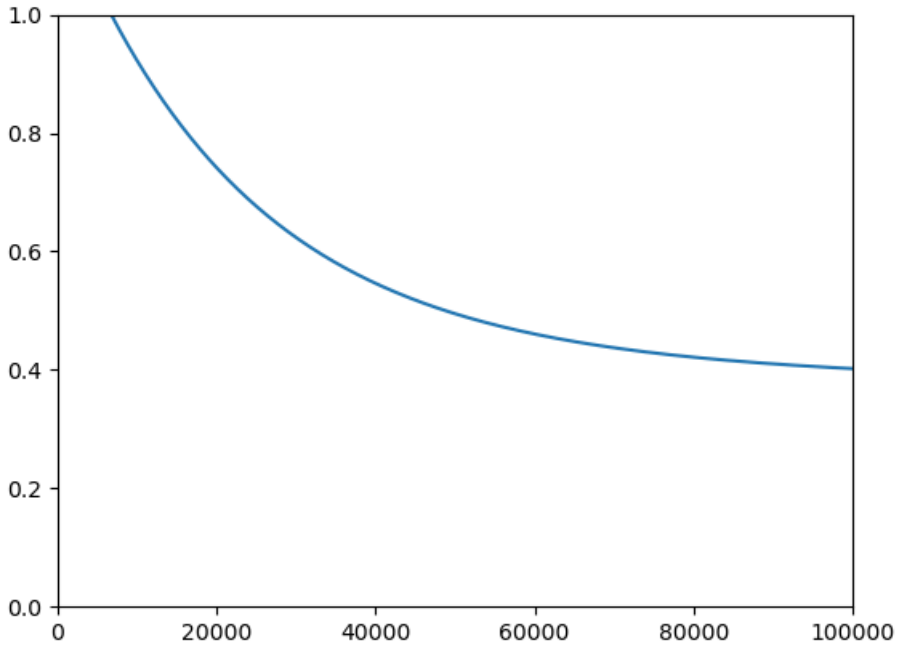
使用梯度下降法来预测后五天的股票数据，利用 python 实现单神经元的学习：

```
class singleNN:
        def __init__(self, input_size, lr, iterations, train_data, train_label):
                self.size = input_size
                self.lr = lr
                self.iterations = iterations

                self.x_train = train_data
                self.y_label = train_label
                self.y_train = None

                self.W = np.random.randn(self.size, 1)
                self.B = np.random.randn(1)

                self.loss_list = []

        def loss(self):
                self.y_train = self.x_train.dot(self.W) + self.B
                temp = (self.y_train-self.y_label)**2 / 2
                loss = np.sum(temp, axis=0)/temp.shape[0]
                return loss

        def train(self):
                for i in range(self.iterations):
                        self.loss_list.append(self.loss())
                        self.y_train = self.x_train.dot(self.W) + self.B
                        dy = self.y_train - self.y_label
                        dW = self.x_train.T.dot(dy)
                        dB = np.sum(dy, axis=0)
```

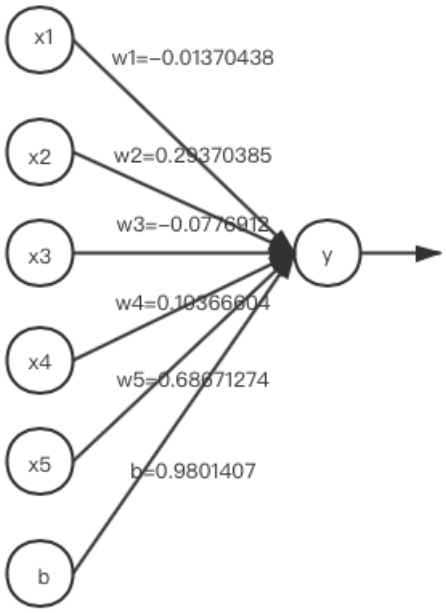
```
29                          self.W -= self.lr * dW
30                          self.B -= self.lr * dB
31                  return self.W, self.B, self.loss_list
32
33          def predict(self, x_test):
34                  y_test = x_test.dot(self.W) + self.B
35                  return y_test
```

将输入神经元的数据规模定义为 5，学习率为 1e-5，迭代次数为 1e5，损失函数为均方误差，初始化模型并进行训练:
$network = singleNN(input\_size = 5, lr = 0.000001, iterations = 100000, train\_data = x\_data, train\_label = y\_label)$

训练过程中记录损失函数:



通过学习得到参数:
$W = [-0.01370438, 0.29370385, -0.0776912, 0.10366604, 0.68671274]^T$ $B = [0.9801407]$



利用学习得到的参数对之后天数的股价进行预测：

Table 1: 第 21 天到 25 天预测数据

日期	21	22	23	24	25
价格	60.96	60.57	62.14	62.39	62.40

2 ”损坏的”LED 灯问题

由题意可知，当 $s=2$ 时，状态 x 能正确表达的概率为

$$p(x|s=2)=\Pi_{j=1}^{7}p(x_j=c_j(2)|s=2)=(1-f)^7 \tag{2.1}$$

同理，对于 s=3

$$p(x|s=3)=\Pi_{j=1}^{7}p(x_j=c_j(3)|s=3)=(1-f')^7 \tag{2.2}$$

于是，对于给定的 x，其能正确显示的概率为

$$\begin{aligned} p(s=2|x) &= \frac{p(s=2)p(x|s=2)}{p(x)} \\ &= \frac{p(s=2)p(x|s=2)}{p(s=2)p(x|s=2)+p(s=3)p(x|s=3)} \\ &= \frac{\frac{1}{2^7}(1-f)^7}{\frac{1}{2^7}(1-f)^7+\frac{1}{2^7}(1-f')^7} \\ &= \frac{1}{1+(\frac{1-f'}{1-f})^7} \end{aligned} \tag{2.3}$$

同理可得

$$p(s=3|x) = \frac{1}{1+(\frac{1-f}{1-f'})^7} \tag{2.4}$$

综上，显示数字 2 或 3 的概率为

$$p(s=2 \cup s=3|x) = \frac{1}{1+(\frac{1-f}{1-f'})^7} + \frac{1}{1+(\frac{1-f'}{1-f})^7} \tag{2.5}$$