Lab 1 Back-propagation

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1. Introduction

2. Experiment setups

Hardware overview

```
Model Name: MacBook Pro
Model Identifier: Mac15,6
Model Number: MRX33TA/A
Chip: Apple M3 Pro
Total Number of Cores: 11 (5 performance and 6 efficiency)
Memory: 18 GB
```

Python version

```
Python 3.9.19
```

A. Sigmoid functions

B. Neural network

C. Backpropagation

3. Result of testing

A. Screenshot and comparison figure

B. Show the accuracy of your prediction

C. Learning curve (loss, epoch curve)

D. Anything you want to present

4. Discussion

1. 计算输出层的误差

定义输出层的误差：
$dZ3 = \frac{\partial L}{\partial Z3}$
对于均方误差损失函数，输出层的误差是：
dZ3 = A3 - y

2. 计算损失函数对权重的梯度

我们需要计算损失函数 (L) 对权重 (W3) 的梯度 (dW3 = \frac{\partial L}{\partial W3})。

由于 (Z3 = A2 \cdot W3 + b3)，我们可以将 (L) 对 (W3) 的偏导数写成：
\frac{\partial L}{\partial W3} = \frac{\partial L}{\partial Z3} \cdot \frac{\partial Z3}{\partial W3}

3. 应用链式法则

首先计算 (\frac{\partial Z3}{\partial W3})：
Z3 = A2 \cdot W3 + b3
\frac{\partial Z3}{\partial W3} = A2

将上面的结果代入链式法则：
\frac{\partial L}{\partial W3} = \frac{\partial L}{\partial Z3} \cdot A2

由于 (dZ3 = \frac{\partial L}{\partial Z3})，我们可以得到：
dW3 = dZ3 \cdot A2