Thought for 39 seconds思考了39秒

(a)（一个）

(i) Express the outputs in terms of inputs in vector-matrix form and scalar form.

(i) 用向量矩阵形式和标量形式的输入来表达输出。

Vector-Matrix Form:矢量矩阵形式：

$$\mathbf{y} = \mathbf{W}\mathbf{x} + \theta$$

Scalar Form:标量形式：

$$y_i = \sum_{j=1}^{100} w_{ij} x_j + \theta_i, \quad \text{for } i = 1, 2, \ldots, 98$$

(ii) Compute the number of trainable parameters and the number of multiplications and summations required in this layer to compute the outputs from the inputs.

(ii) 计算该层中可训练参数的数量以及计算输入输出所需的乘法和求和的数量。

Number of Trainable Parameters:可训练参数的数量：

- **Weights:** The weight matrix $\mathbf{W}$ has $98 \times 100 = 9{,}800$ elements.
  权重：权重矩阵 $\mathbf{W}$ 有 $98 \times 100 = 9{,}800$ 元素。
- **Biases:** The bias vector θ has 98 elements.**偏差：**偏差向量 θ 有 98 元素。
- **Total Parameters:** $9{,}800 + 98 = 9{,}898$**总参数：** $9{,}800 + 98 = 9{,}898$

Number of Multiplications and Summations:乘法和求和的次数：

- **Multiplications:** Each of the 98 outputs requires 100 multiplications.
  乘法：每个 98 输出需要 100 乘法。
  - **Total Multiplications:** $98 \times 100 = 9{,}800$**总乘法：** $98 \times 100 = 9{,}800$
- **Additions (Summations):补充（总结）：**
  - Summing 100 products requires 99 additions per output.
    求和 100 产品需要 99 每个输出的附加内容。
  - Adding the bias requires 1 additional addition per output.
    添加偏置需要 1 每个输出的额外添加。
  - **Total Additions per Output:** $99 + 1 = 100$**每个输出的总添加量：** $99 + 1 = 100$
  - **Total Additions:** $98 \times 100 = 9{,}800$**总添加量：** $98 \times 100 = 9{,}800$

(iii) What is the ratio of the number of outputs to the number of trainable parameters?

(iii) 输出数量与可训练参数数量的比率是多少？

$$\text{Ratio} = \frac{\text{Number of Outputs}}{\text{Number of Parameters}} = \frac{98}{9{,}898} = \frac{1}{101}$$

(b)(二)

(i) Express the outputs in terms of inputs in scalar form.(i) 用标量形式的输入来表达输出。

For $i = 2, 3, \ldots, 99$ and $k = 1, 2, \ldots, 20$:为了 $i = 2, 3, \ldots, 99$ 和 $k = 1, 2, \ldots, 20$：

$$y_i^k = w_{-1}^k x_{i-1} + w_0^k x_i + w_1^k x_{i+1} + \theta^k$$

(ii) Compute the number of trainable parameters and the number of multiplications and summations required in this layer to compute the outputs from the inputs.

(ii) 计算该层中可训练参数的数量以及计算输入输出所需的乘法和求和的数量。

Number of Trainable Parameters:可训练参数的数量：

- **Per Filter:** 3 weights (w_{-1}^k, w_0^k, w_1^k) and 1 bias $(\theta^k) \Rightarrow 4$ parameters.
  每个过滤器： 3 权重（ w_{-1}^k, w_0^k, w_1^k ） 和 1 偏见（ θ^k ） $\Rightarrow 4$ 参数。
- **Total Filters:** 20**总过滤器：** 20
- **Total Parameters:** $20 \times 4 = 80$**总参数：** $20 \times 4 = 80$

Number of Multiplications and Summations:乘法和求和的次数：

- **Outputs per Feature Map:** 98 outputs.**每个特征图的输出：** 98 输出。
- **Total Outputs:** $20 \times 98 = 1{,}960$**总产出：** $20 \times 98 = 1{,}960$
- **Multiplications per Output:** 3**每个输出的乘法：** 3
  - **Total Multiplications:** $1{,}960 \times 3 = 5{,}880$**总乘法：** $1{,}960 \times 3 = 5{,}880$
- **Additions per Output:每个输出的添加：**
  - Summing 3 products requires 2 additions.求和 3 产品需要 2 补充。
  - Adding the bias requires 1 additional addition.添加偏置需要 1 额外添加。
  - **Total Additions per Output:** $2 + 1 = 3$**每个输出的总添加量：** $2 + 1 = 3$
  - **Total Additions:** $1{,}960 \times 3 = 5{,}880$**总添加量：** $1{,}960 \times 3 = 5{,}880$

(iii) What is the ratio of the number of outputs to the number of trainable parameters?

(iii) 输出数量与可训练参数数量的比率是多少？

$$\text{Ratio} = \frac{\text{Number of Outputs}}{\text{Number of Parameters}} = \frac{1{,}960}{80} = 24.5$$

Answer Summary:答案摘要：

(a)（一个）

(i) Vector-matrix form: $\mathbf{y} = \mathbf{W}\mathbf{x} + \theta$; Scalar form: $y_i = \sum_{j=1}^{100} w_{ij} x_j + \theta_i$
(i) 向量矩阵形式： $\mathbf{y} = \mathbf{W}\mathbf{x} + \theta$;标量形式： $y_i = \sum_{j=1}^{100} w_{ij} x_j + \theta_i$

(ii) Trainable parameters: 9,898; Multiplications: 9,800; Additions: 9,800
(ii) 可训练参数：9,898；乘法：9,800；新增数量：9,800

(iii) Ratio of outputs to parameters: $\frac{98}{9{,}898} = \frac{1}{101}$(iii) 输出与参数的比率： $\frac{98}{9{,}898} = \frac{1}{101}$

(b)(二)

(i) Scalar form: $y_i^k = w^k{}_{-1} x_{i-1} + w_0^k x_i + w_1^k x_{i+1} + \theta^k$
(i) 标量形式： $y_i^k = w^k{}_{-1} x_{i-1} + w_0^k x_i + w_1^k x_{i+1} + \theta^k$

(ii) Trainable parameters: 80; Multiplications: 5,880; Additions: 5,880
(ii) 可训练参数：80；乘法：5,880；新增数量：5,880

(iii) Ratio of outputs to parameters: $\frac{1960}{80} = 24.5$(iii) 输出与参数的比率： $\frac{1960}{80} = 24.5$