

ANN

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1 Introduction to Perceptrons

The Perceptron is the foundational simple artificial neuron, originally introduced by Frank Rosenblatt in 1958. It is specifically designed for linear classification tasks.

1.1 Logistic Regression Dataset

The model uses features such as Age, Cholesterol, and BP to predict the presence of heart disease.

Sample	Age (x_1)	Cholesterol (x_2)	BP (x_3)	Heart Disease (y)
1	28	110	110	1
2	36	120	90	0
3	42	180	160	1

2 Neural Network Architecture

2.1 Forward Propagation

In a multi-layer network, weights (w) and biases (b) are applied to inputs (x) to produce an output (\hat{y}).

Forward Pass Formula

The weighted sum z is calculated as:

$$z = \sum_{i=1}^n (x_i w_i) + b$$

This is then passed through the Sigmoid activation:

$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

2.2 Numerical Example from Notes

Given inputs $[2.0, 1.0, 3.0]$ and bias $b_1 = 0.1$:

- $z = (2.0 \times 0.5) + (1.0 \times 2.0) + (3.0 \times 0.1) + 0.1 = 1.6$
- $\sigma(1.6) \approx 0.8320$

3 Backpropagation & The Chain Rule

Backpropagation is the process of updating weights to minimize the loss function.

3.1 The Chain Rule Derivation

To update a specific weight w_7 , we must find the partial derivative of the Loss (L) with respect to that weight:

$$\frac{\partial L}{\partial w_{7,old}} = \left(\frac{\partial L}{\partial O/P} \right) \times \left(\frac{\partial O/P}{\partial w_{7,old}} \right)$$

3.2 Optimizer Update Rule

The new weight is determined by subtracting the gradient multiplied by the learning rate (η):

$$w_{new} \leftarrow w_{old} - \eta \left(\frac{\partial L}{\partial w_{old}} \right)$$

4 Training Summary

- **Loss Reduction:** Initial Loss 4.32 → Optimized Loss 0.344.
- **Convergence:** 1 Epoch consists of 1 Forward and 1 Backward propagation.
- **Performance:** Accuracy increases from 62% (Epoch 1) to 96% (Epoch 50).