Perceptron Classification for T_1

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1 Perceptron Model

A **perceptron** is a simple neural network unit that makes binary classifications using the equation:

$$z = w_1 x_1 + w_2 x_2 + b \tag{1}$$

The output is determined using the **activation function**:

$$y = \begin{cases} 1, & \text{if } z \geq 0, \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

1.1 Normalizing the Input

Neural networks perform best when inputs are normalized, typically using **Min-Max scaling**:

$$x' = \frac{x - x_{\min}}{x_{\max} - x_{\min}}. \tag{3}$$

Given the training dataset:

Feature	Range
Age	[28, 52]
CreditScore	[600, 780]

For T_1 (Age = 37, CreditScore = 705):

$$x'_1 = \frac{37 - 28}{52 - 28} = \frac{9}{24} = 0.375,$$
$$x'_2 = \frac{705 - 600}{780 - 600} = \frac{105}{180} = 0.5833.$$

1.2 Compute Perceptron Activation

Given weights $w_1 = 0.3$**,** $w_2 = 0.4$**, and bias** $b = 0.1$:

$$\begin{aligned} z &= (0.3 \times 0.375) + (0.4 \times 0.5833) + 0.1 \\ &= 0.1125 + 0.2333 + 0.1 \\ &= 0.4458. \end{aligned}$$

Applying the **activation function**:

$$y = \begin{cases} 1, & \text{if } 0.4458 \geq 0, \\ 0, & \text{otherwise} \end{cases} \tag{4}$$

Since $0.4458 > 0$, the perceptron **classifies** T_1 **as class 1 (High Risk)**.

2 Why Normalization is Necessary?

- **Improves Learning Stability:** Large numerical values can lead to unstable weight updates.
- **Prevents Bias Towards Larger Features:** Without normalization, larger features dominate smaller ones.
- **Enhances Training Efficiency:** Converges faster when inputs are on a uniform scale.
- **Avoids Numerical Overflow:** Prevents extreme values that could affect activation functions.

3 Conclusion

- Normalization ensured that **Age and CreditScore** were on a common scale. - The **perceptron classified** T_1 **as High Risk** based on weights and bias. - **Normalization is critical** in neural networks to improve learning efficiency and avoid unstable training.