December 6, 2025

Learning Goal

See how a single neuron makes buy/sell decisions using a threshold.

This slide establishes the learning objective for this topic

Key Concept (1/2)

A single neuron acts as a **decision maker** by comparing its output to a **threshold**. For binary classification with sigmoid activation: - Output ¿ 0.5: Predict Class 1 (BUY) - Output ¡= 0.5: Predict Class 0 (SELL)
The neuron computes a weighted combination of inputs, transforms it through the sigmoid function, and produces a probability. The threshold converts this probability into a discrete decision.

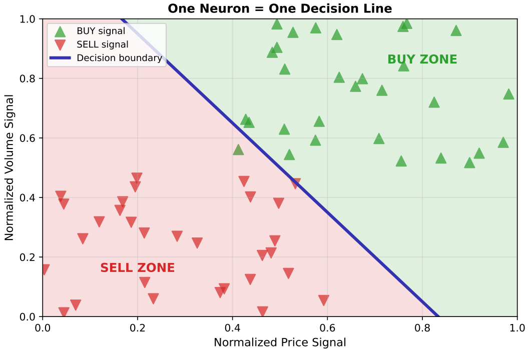
Understanding this concept is crucial for neural network fundamentals

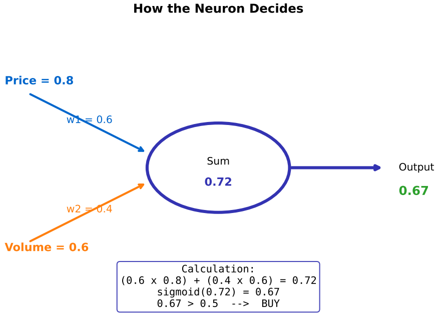
Key Concept (2/2)

In trading terms: if the neuron outputs 0.67 (67% confidence in price increase), the decision is BUY. If it outputs 0.33 (33% confidence), the decision is SELL.
The position of the decision boundary in feature space corresponds to where the neuron output equals exactly 0.5 - the point of maximum uncertainty.

Understanding this concept is crucial for neural network fundamentals

Visualization





Visual representations help solidify abstract concepts

Key Formula

Neuron computation:

$$z = w_1 x_1 + w_2 x_2 + b$$
$$\hat{y} = \sigma(z) = \frac{1}{1 + e^{-z}}$$

Decision rule:

$$\text{Decision} = \begin{cases} \text{BUY} & \text{if } \hat{y} > 0.5 \\ \text{SELL} & \text{if } \hat{y} \leq 0.5 \end{cases}$$

Boundary condition (y-hat = 0.5):

$$z = 0 \implies w_1 x_1 + w_2 x_2 + b = 0$$

Mathematical formalization provides precision

Intuitive Explanation

Think of the neuron as a judge weighing evidence:
1. **Gather evidence**: Each input (price, volume) provides information 2. **Weight importance**: Some evidence matters more (larger weights) 3. **Combine and evaluate**: Sum weighted evidence, adjust by bias 4. **Confidence level**: Sigmoid converts to 0-100% confidence 5. **Make decision**: If confidence ¿ 50%, rule in favor (BUY)
The weights encode what the neuron has learned about which inputs matter and how much.

Intuitive explanations bridge theory and practice

Practice Problem 1

Problem 1
A neuron has weights w1 = 0.6 (for price), w2 = 0.4 (for volume), and bias b = -0.3. Given price = 0.8 and volume = 0.5, what is the decision?

Solution

Step 1: Weighted sum

$$z = 0.6(0.8) + 0.4(0.5) + (-0.3)$$
$$z = 0.48 + 0.20 - 0.30 = 0.38$$

Step 2: Sigmoid activation

$$\hat{y} = \frac{1}{1 + e^{-0.38}} = \frac{1}{1 + 0.684} = 0.594$$

Step 3: Decision Since 0.594 ¿ 0.5: **Decision: BUY** (59.4% confidence in price increase)

Practice problems reinforce understanding

Practice Problem 2

Problem 2
Using the same neuron, what values of (price, volume) lie exactly on the decision boundary?

Solution

On the boundary, z = 0:

$$0.6 \cdot \text{price} + 0.4 \cdot \text{volume} - 0.3 = 0$$

Solving for volume:

$$\text{volume} = \frac{0.3 - 0.6 \cdot \text{price}}{0.4}$$
$$\text{volume} = 0.75 - 1.5 \cdot \text{price}$$

Example points on the boundary: - price = 0.0: volume = 0.75 - price = 0.5: volume = 0.0 - price = 0.3: volume = 0.3
These points all yield 50% confidence (maximum uncertainty).

Practice problems reinforce understanding

Key Takeaways

- A neuron outputs a probability via sigmoid activation
- Default threshold of 0.5 converts probability to binary decision
- The decision boundary is where output = 0.5 ($z = 0$)
- Threshold can be adjusted based on risk tolerance
- Single neuron = single linear decision boundary

These key points summarize the essential learnings