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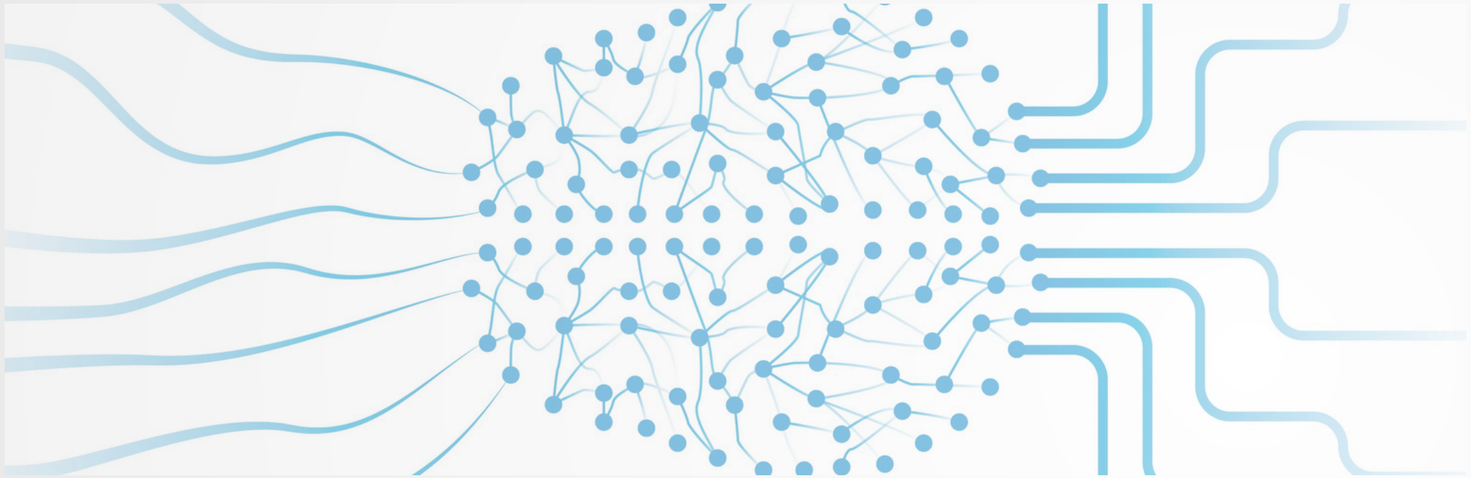
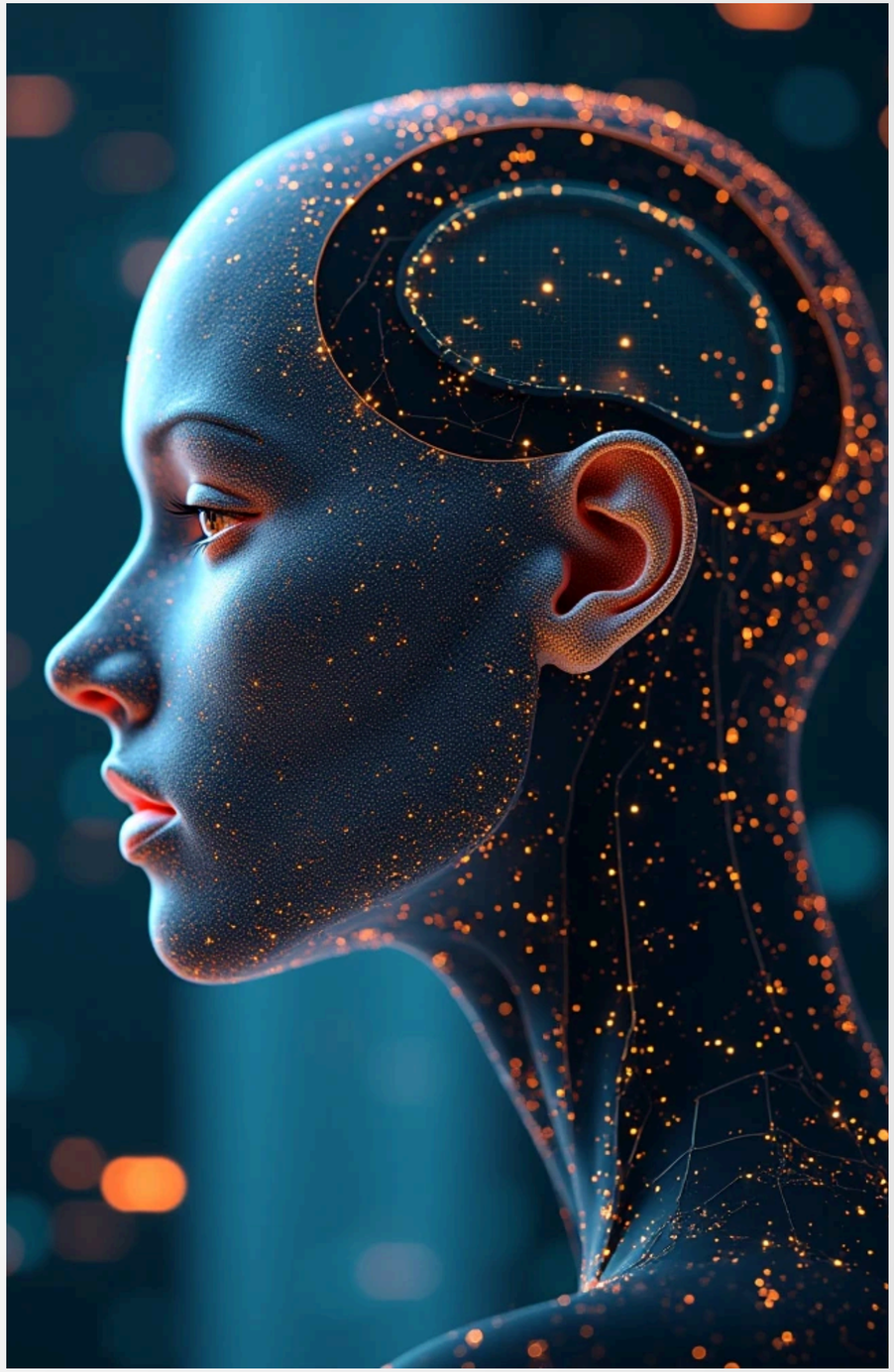
Université Abdelmalek Essaadi

# Adaline and Madaline Neural Networks





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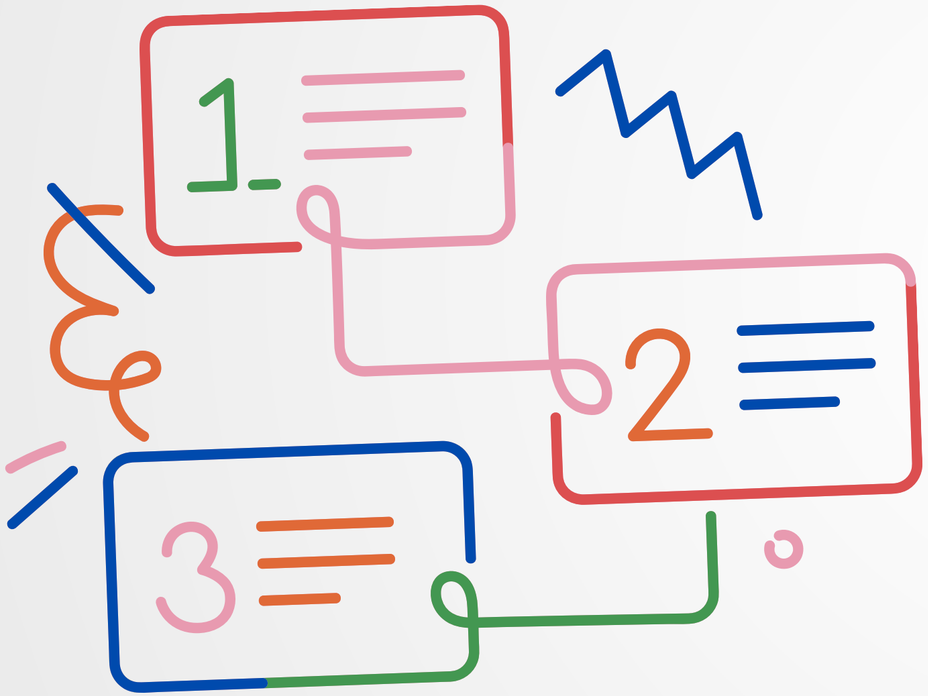
prepared by Benchelha Ayoub, Hajar Charkaoui, and Brahim Ouhammou.

# Sommaire



# Introduction

Neural networks have proven highly effective in shape recognition tasks through their ability to model complex, non-linear relationships in data.

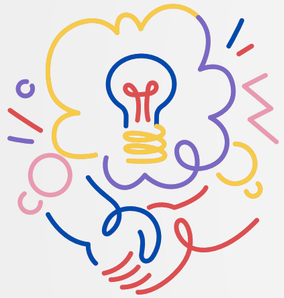
This presentation examines the implementation of Adaline (Adaptive Linear Neuron) and Madaline (Multiple Adaptive Linear Neurons) architectures for shape recognition, focusing on their applications in computer vision, robotics, and autonomous vehicles.

These foundational neural network models demonstrate the practical application of adaptive learning principles in pattern recognition systems.

# 02. Overview of Adaline and Madaline Neural Networks

# 1. Adaline Neural Network

**Adaline, short for Adaptive Linear Neuron, is a simple single-layer neural network. It was introduced by Bernard Widrow and Ted Hoff in the 1960s and is known for its use of gradient descent to adjust weights. The primary characteristics of Adaline include:**



## Architecture:

- A single-layer network with linear activation functions.
- Computes a weighted sum of inputs and applies a linear threshold to produce an output.

## Learning Process:

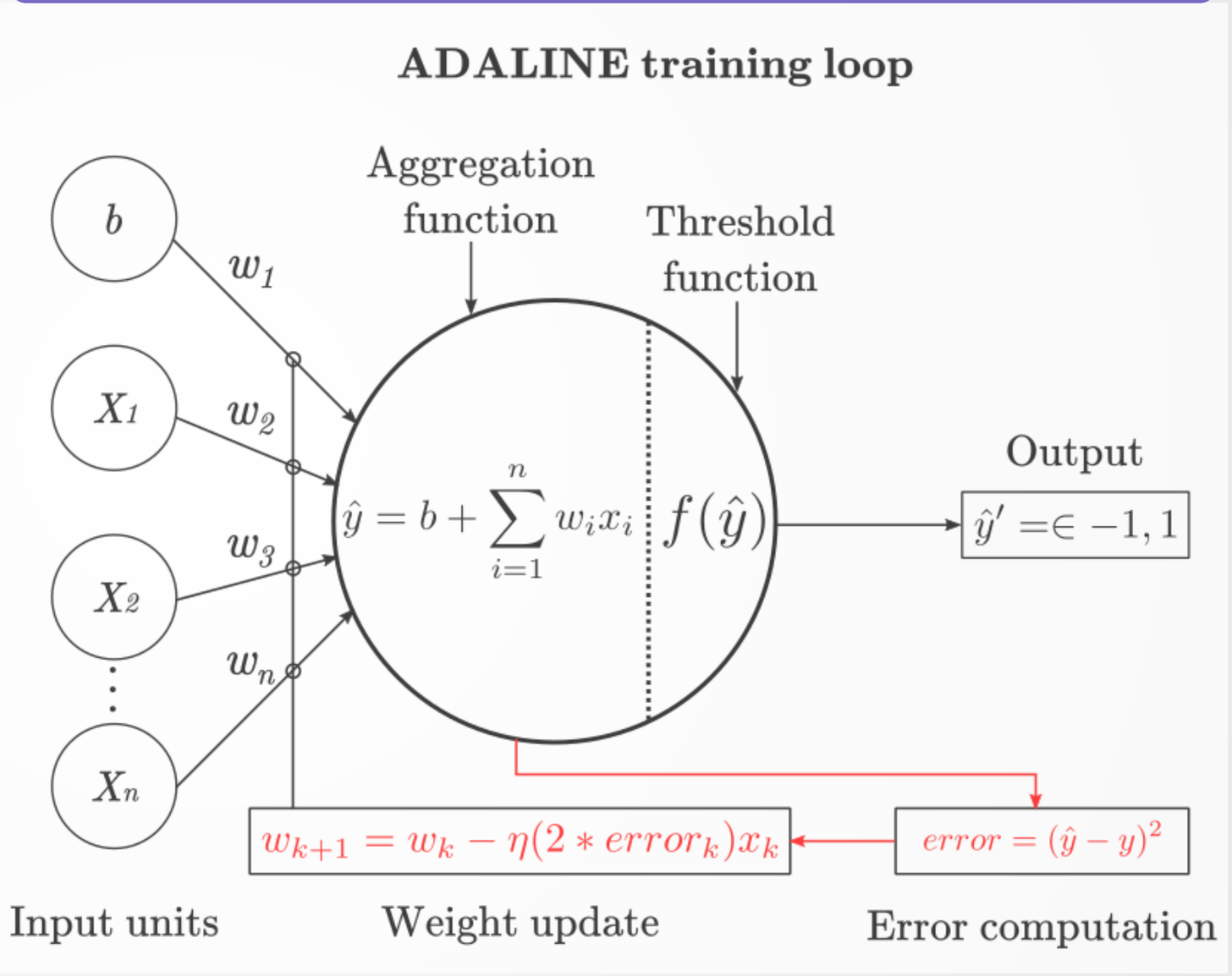
- Based on the Least Mean Squares (LMS) rule to minimize the error between the predicted output and the desired target output.

## Advantages:

- Efficient for linearly separable problems.
- Simple to implement and interpret.

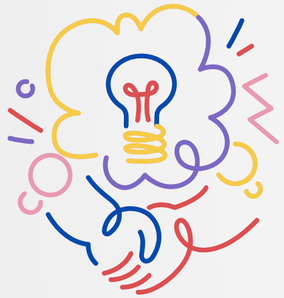
# Adaline Architecture and Training Algorithm

- INITIALIZE WEIGHTS AND BIAS WITH SMALL VALUES
- INPUT TRAINING DATA
- CALCULATE NET INPUT: Y = W * X + B
- APPLY ACTIVATION FUNCTION
- COMPUTE ERROR: E=T−Y
- UPDATE WEIGHTS AND BIAS
- CONVERGENCE CRITERIA MET?



## 2. Madaline Neural Network

**Madaline, short for Multiple Adaptive Linear Neurons, builds upon the Adaline model by introducing a multi-layer architecture. Developed as an extension to tackle non-linear problems, Madaline's key features include:**



### Architecture:

- Comprises multiple Adaline units in the input and intermediate layers.

### Learning Process:

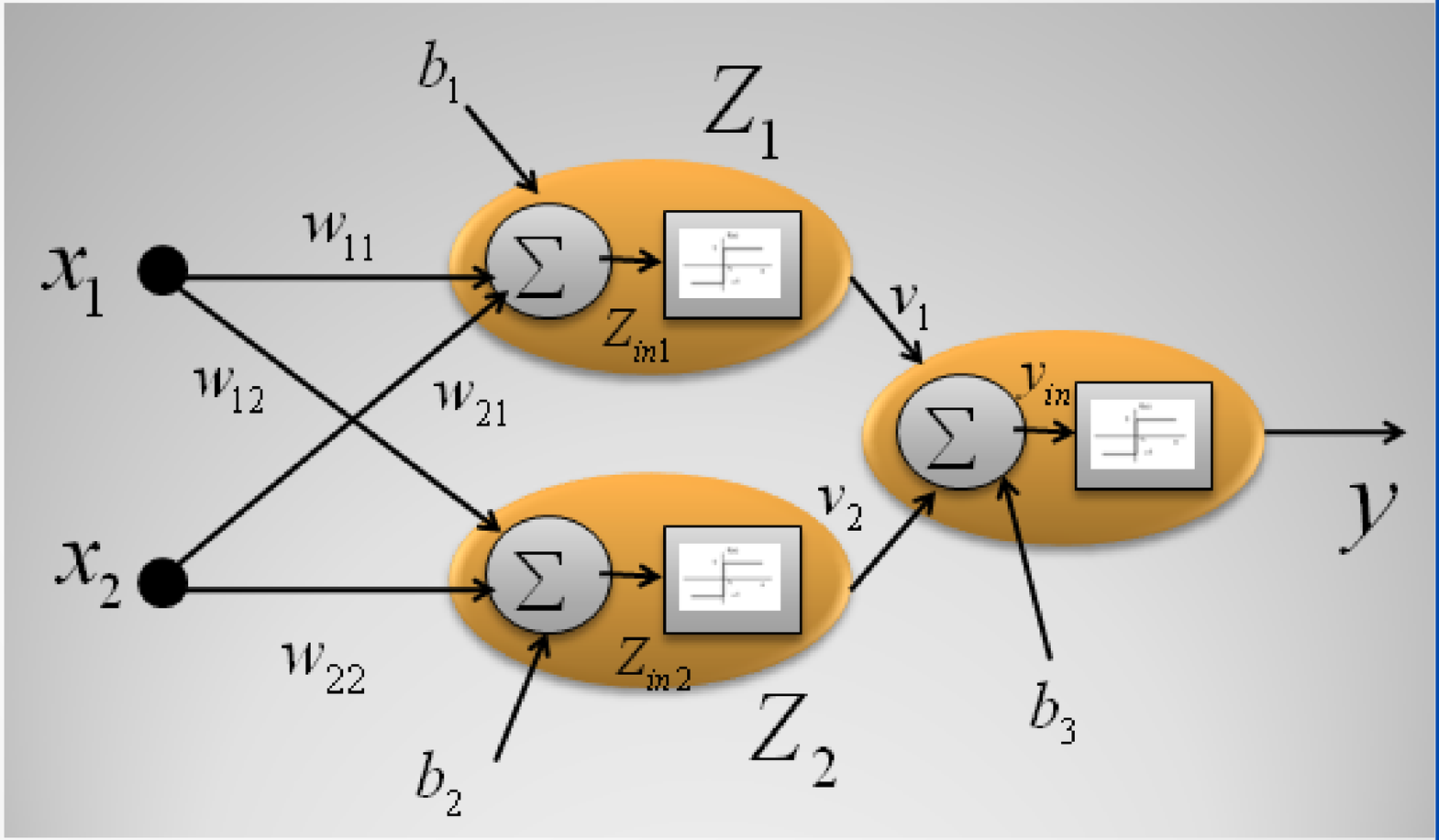
- Madaline uses a unique training algorithm called the "Madaline Rule" to adjust weights.

### Advantages:

- Effective for non-linear classification problems.

# Madaline Architecture

- INITIALIZE WEIGHTS AND BIAS
- SPLIT INPUT FEATURES
- PARALLEL ADALINE PROCESSING
- COMBINE ADALINE OUTPUTS
- APPLY FINAL THRESHOLD
- UPDATE ALL WEIGHTS
- CHECK CONVERGENCE



# ⊙3. Shape Recognition Project

# Objectifs

The objective of this project is to design and implement a system that can accurately recognize geometric shapes, such as circles, triangles, squares, and rectangles, using Adaline and Madaline neural networks.

# Methodology

01

**Data Preprocessing:**

- Extract geometric features (e.g., angles, perimeter, area).
- Normalize the data to improve model performance.

02

**Adaline Training:**

- Train each Adaline on a subset of features.
- Update weights using gradient descent.

03

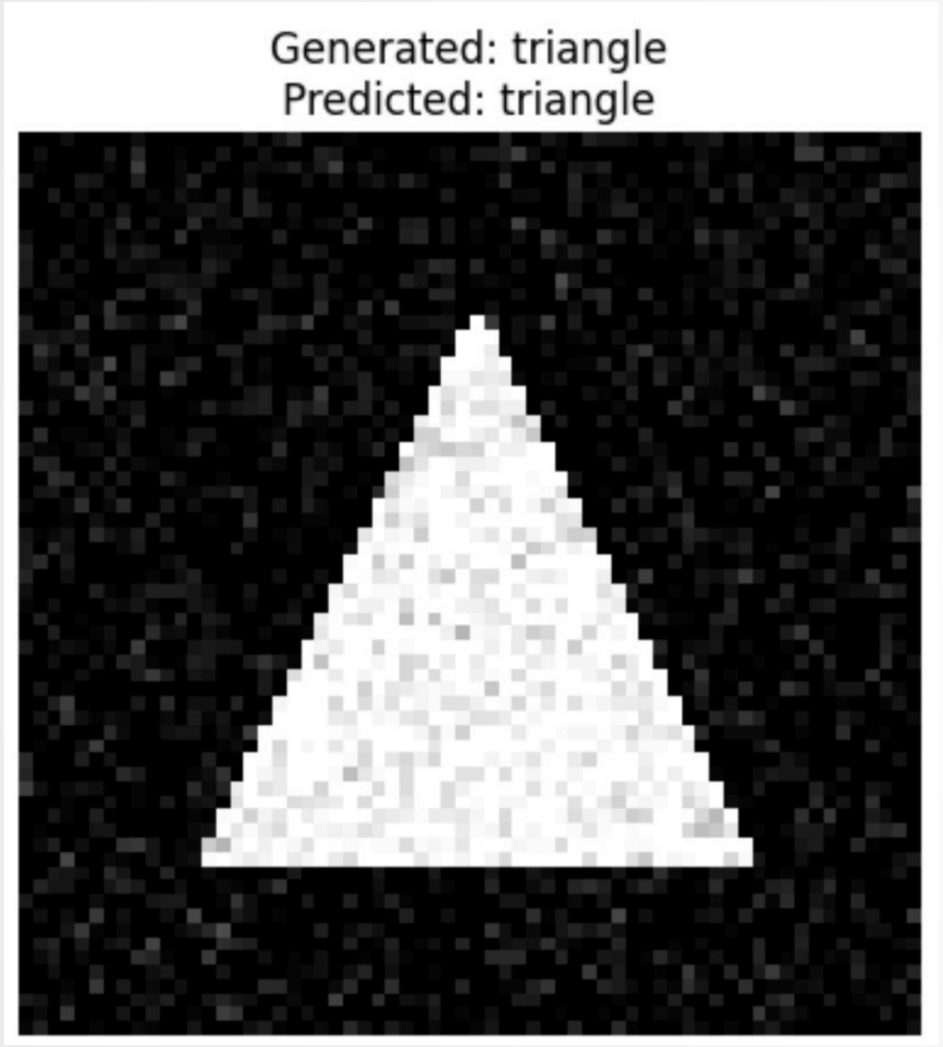
**Madaline Training:**

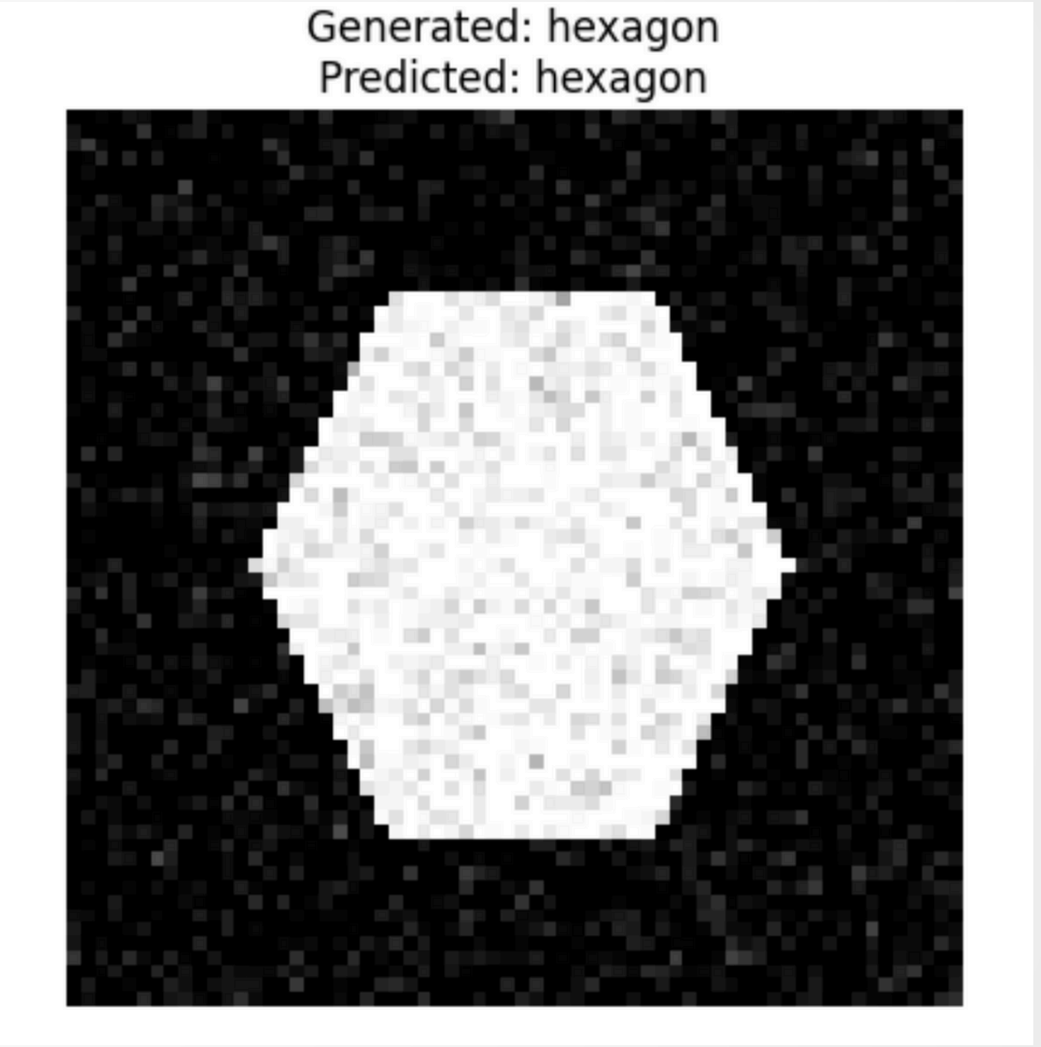
- Combine predictions from multiple Adalines.
- Use majority voting for final shape classification.

04

**Evaluation:**

Use metrics like accuracy and MSE to evaluate model performance.


Generated: triangle
Predicted: triangle


Generated: hexagon
Predicted: hexagon

# ⊙4. Conclusion

This project underscores the historical importance of Adaline and Madaline neural networks in the evolution of machine learning. While modern neural networks have largely superseded these models, they remain fundamental for understanding adaptive learning principles.

Shape recognition using Adaline and Madaline provides valuable insights into how early networks process patterns and form decisions, making it a stepping stone for more advanced research.

# I appreciate your attention.