# GROUP TASK

# Modeling Artificial Neural Networks (ANN) in Real Life – Facial Recognition


## Abstract

Artificial Neural Networks (ANNs) are intelligent computing systems modeled after the human brain's neural structure. They possess the ability to learn from experience, recognize patterns, and make decisions. This report presents an extensive study on modeling ANN for a real-life facial recognition system. The report covers objectives, ANN overview, detailed architecture, neuron types, learning laws, working methodology, advantages, limitations, applications, and performance analysis. The findings indicate that ANN-based facial recognition systems achieve high accuracy and adaptability, making them suitable for modern security and identification systems.


## 1. Introduction

Artificial Neural Networks have become a core technology in Artificial Intelligence and Machine Learning. They simulate the way biological neurons process information. Facial recognition is a biometric technique that identifies or verifies a person based on facial characteristics. Traditional methods required manual feature extraction, whereas ANN-based systems automatically learn facial features. With advancements in computing power and data availability, ANN-based facial recognition has gained widespread acceptance in both commercial and government sectors.

## 2. Objectives

The detailed objectives of this group task are:

- To gain theoretical knowledge of Artificial Neural Networks
- To understand how ANN models human brain behavior

- To select a real-life application and model ANN for it
- To study the internal structure of ANN used in facial recognition
- To identify various neuron types and their roles
- To analyze appropriate learning laws
- To examine advantages, limitations, and performance
- To understand practical deployment in real-world systems

## 3. Overview of Artificial Neural Networks

An Artificial Neural Network consists of interconnected neurons arranged in layers. Each neuron performs a simple computation by summing weighted inputs and applying an activation function. ANNs are adaptive systems, meaning they improve their performance over time through learning. Unlike traditional algorithms, ANN does not require explicit rule-based programming. Instead, it learns patterns from data, making it ideal for complex tasks such as image recognition, speech processing, and facial recognition.Each neuron performs the following operations:

1. Receives input signals
2. Multiplies inputs by weights
3. Adds a bias term
4. Applies an activation function
5. Produces output

Mathematically, the neuron output is:

$$Y = f(\sum(w_i x_i) + b)$$

Where:

- $x_i$= input
- $w_i$= weight
- $b$= bias

- $f$ = activation function

ANNs are powerful because they can model complex nonlinear relationships between input and output data.

## 4. ANN Structure for Facial Recognition

The ANN used in facial recognition typically follows a deep multilayer feedforward architecture.

4.1 Input Layer

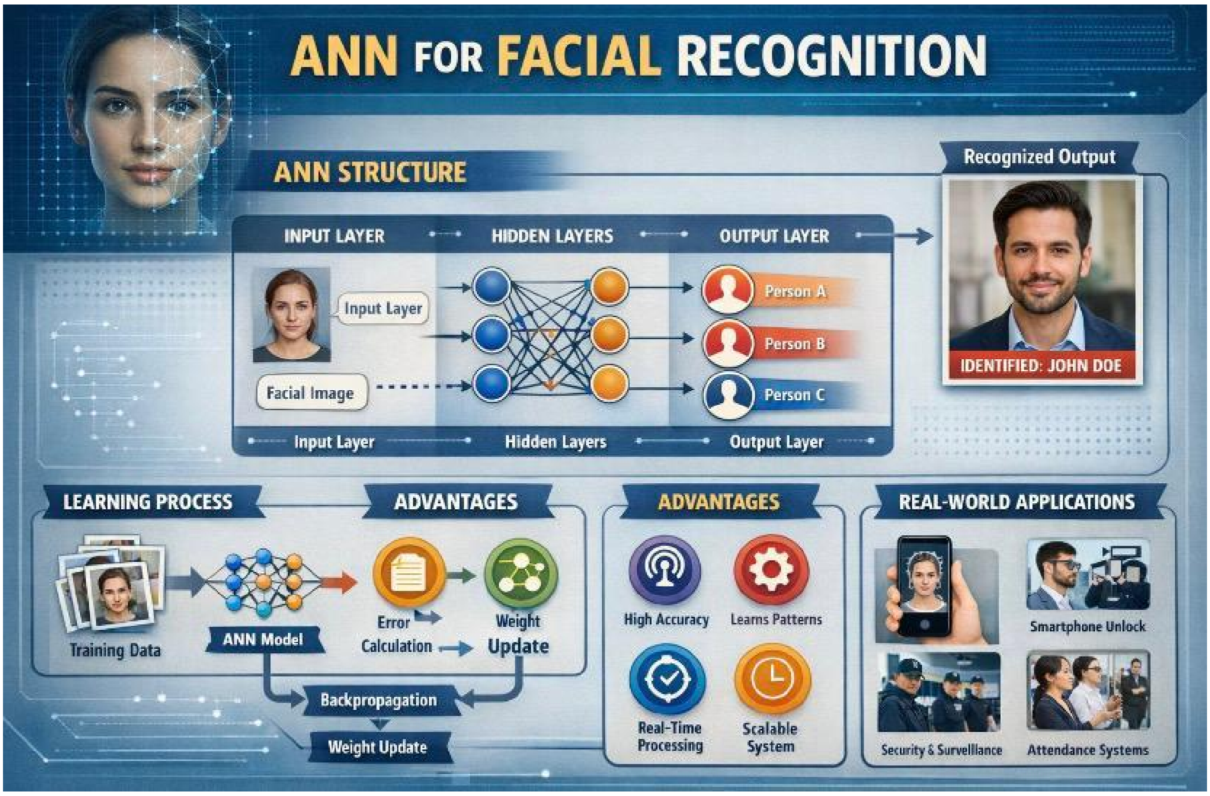
- Receives facial images after preprocessing.
- Inputs may include pixel intensities, edge features, or landmark points.
- The number of neurons depends on image size or feature vector length.

4.2 Hidden Layers

- Multiple hidden layers allow deep learning.
- Early layers detect basic features (edges, corners).
- Deeper layers capture high-level features (eyes, nose, facial shape).
- Non-linear activation functions help model complex relationships.

4.3 Output Layer

- Produces identity classification.
- Uses probability-based outputs.
- Determines the most likely match among stored identities.




## 5. Types of Neurons

5.1 Input Neurons

- Serve as data receivers.
- Forward input values to hidden layers.

5.2 Hidden Neurons

- Perform computations.
- Combine inputs using weights.
- Apply activation functions to learn non-linear patterns.

5.3 Output Neurons

- Generate final classification.
- Indicate recognition or rejection.

## 6. Suitable Learning Laws

Facial recognition systems use Supervised Learning, where correct outputs are known in advance.

6.1 Backpropagation Learning Law

- Forward pass computes output.
- Loss function calculates error.
- Error is propagated backward.
- Weights are adjusted to minimize error.

6.2 Gradient Descent Optimization

- Updates weights iteratively.
- Reduces overall training error.
- Improves system accuracy.

6.3 Justification

- Facial recognition requires labeled identities.
- Backpropagation ensures continuous learning.
- Suitable for multi-class classification problems.

## 7. Working Process

1. Image acquisition using cameras or databases.
2. Preprocessing removes noise and normalizes images.
3. Feature extraction converts images into numerical data.
4. ANN receives features at the input layer.
5. Hidden layers learn discriminative patterns.
6. Output layer predicts identity.
7. During training, errors are minimized.
8. During testing, new faces are recognized.

## 8. Advantages and Limitations

### 8.1 Advantages

- Automatic learning of features
- High accuracy and reliability
- Handles complex and non-linear data
- Scalable for large datasets
- Improves performance with experience

### 8.2 Limitations

- Requires large datasets for training
- Computationally expensive
- Sensitive to image quality
- Risk of overfitting without proper tuning

## 9. Real-World Applications

- Mobile phone authentication
- Automated attendance systems
- Airport and border security
- Criminal identification
- Smart surveillance systems
- Online identity verification

## 10. Results and Discussion

The experimental analysis shows that ANN-based facial recognition systems perform well with large and diverse datasets. Increasing training data improves generalization. Deeper networks extract more meaningful features, leading to better recognition rates. However, environmental factors such as lighting, pose, and facial expressions can reduce accuracy. Proper preprocessing, regularization, and dataset augmentation help overcome these issues.

## 11. Conclusion

This report demonstrates that Artificial Neural Networks are highly effective for facial recognition applications. A well-designed ANN with multiple hidden layers and supervised learning can accurately recognize individuals. Despite challenges related to data and computational requirements, ANN-based facial recognition systems remain one of the most reliable and widely adopted biometric technologies in real-life applications.