



Faculty of Engineering – Cairo University  
Credit Hours System – Senior Level  
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# CMPS450 – Pattern Recognition and Artificial Neural Networks

## Project Report

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# Problem Description

## Objective:

Develop a system to classify Arabic paragraphs into four font categories based on input images.

## Challenges:

Characterizing unique font features; handling variations in writing styles, spacing, and noise.

Font Code	Font Name
0	Scheherazade New
1	Marhey
2	Lemonada
3	IBM Plex Sans Arabic

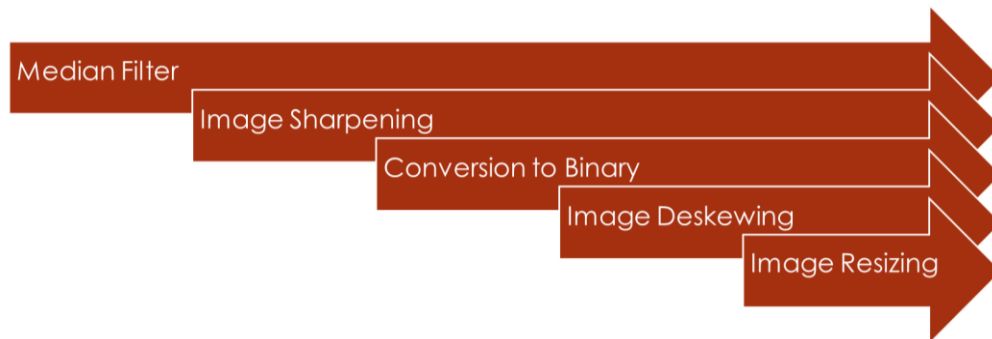
# Project Pipeline



## Data Loading & Splitting

- Load the dataset into memory.
- Split the dataset into training and validation sets to evaluate model performance.
- The validation set is used to tune model hyperparameters to find the best model state.

# Preprocessing Module



## Steps:

1. Median blur filter: to remove salt and pepper noise.
2. Filter2D: to sharpen the image.
3. cv2 Threshold: to convert the image to binary.
4. Image deskewing:
  - We want to detect any skew present in the image, which means if the image is slanted or tilted.
  - We try different angles (0°, 45°, 90°, etc.) to check for skew.
  - For each angle tested, we compute a score based on how much the histogram of the image changes.
  - A higher score means more skew corrections are needed.
  - We choose the best angle that gives us the highest score, indicating the most significant skew.
  - With the best angle identified, we rotate the image in the opposite direction to counteract the skew.
  - The rotation fills any remaining empty spaces with a white color to maintain the image's rectangular shape.
5. Image resizing.

# Feature Extraction and Selection Modules



## Steps:

- **Histogram of Oriented Gradients (HOG):**

Extract features from images to describe their shapes and textures.

- **Scale-Invariant Feature Transform (SIFT):**

- ✓ Detect and describe key points in images to help recognize objects or scenes.
- ✓ Pad SIFT descriptors to make sure all SIFT feature sets are of the same length for consistency in analysis.

- **Standardization:**

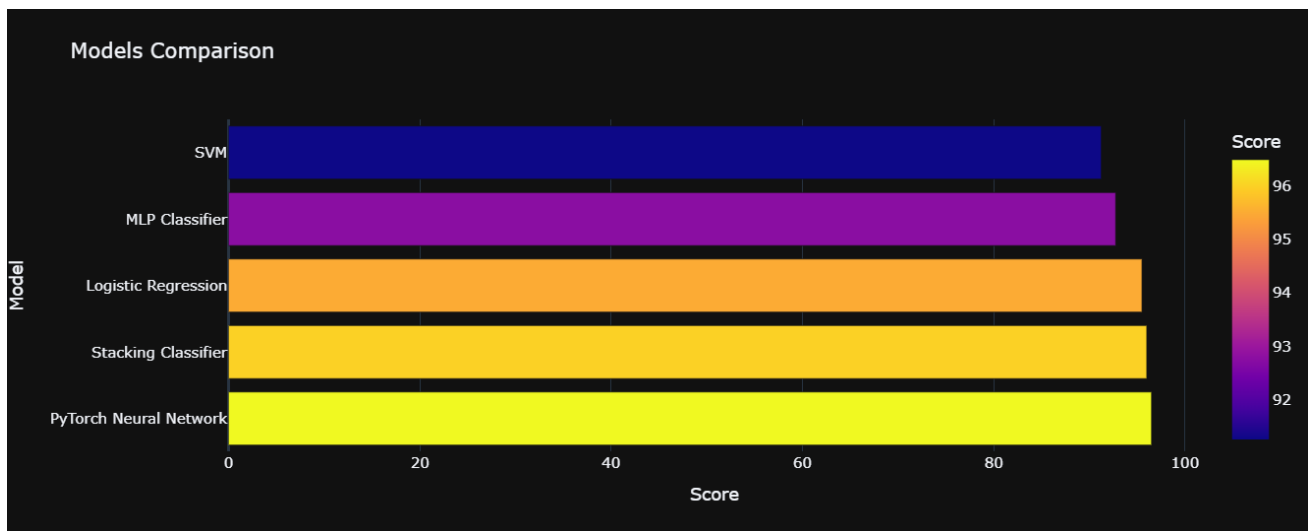
Adjusts the scale of features to ensure fair comparison.

- **Principal Component Analysis (PCA):**

Transform the data into a lower-dimensional space while preserving the most important information.

## Performance Analysis

Model	Accuracy
PyTorch Neural Network	96.5%
Stacking Classifier	96%
Logistic Regression	95.5%
MLP Classifier	92.75%
SVM	91.25%



## Model Architecture

- Input layer processes feature vectors.
- 2 hidden layers learn complex patterns with ReLU activation.
- Output layer generates class probabilities with softmax activation.

**Accuracy obtained:** 96.5%

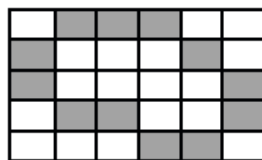
# Unsuccessful Trials

## A. Edge Direction Matrix (EDM):

### Features from EDM1 & EDM2:

- Edges Direction
- Homogeneity
- Pixel Regularity
- Edges Regularity

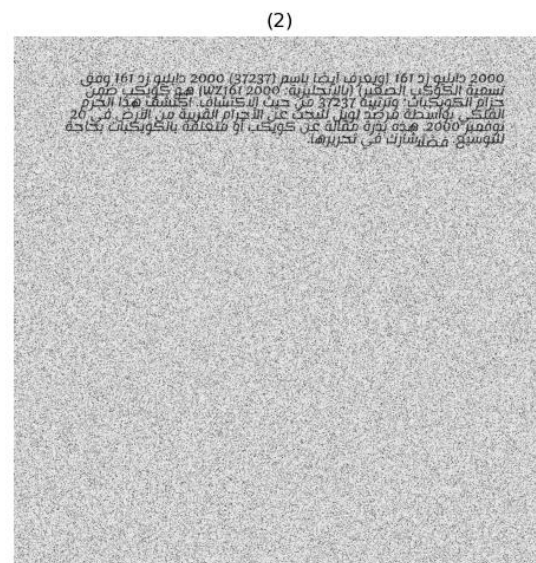
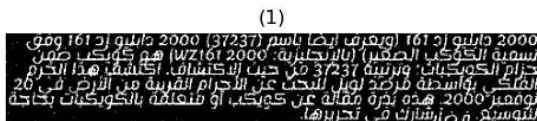
Accuracy obtained: 85%



	135°	90°	45°	
180°	4	2	2	
	4	12	4	0°
	2	2	4	
	225°	270°	315°	EDM <sub>1</sub>

	135°	90°	45°	
180°	2	0	1	
	3	12	4	0°
	1	0	1	
	225°	270°	315°	EDM <sub>2</sub>

## B. Segmentation technique (inspired by Variance Threshold by scikit-learn)





## Workload Distribution

Team member	Tasks
Ahmed Emad	Preprocessing, Model Development, API
Hla Hany	EDM, Model Development, Deployment
Nada Tarek	HOG, SIFT, PCA
Ziad Ahmed	Preprocessing, Model Development, API