

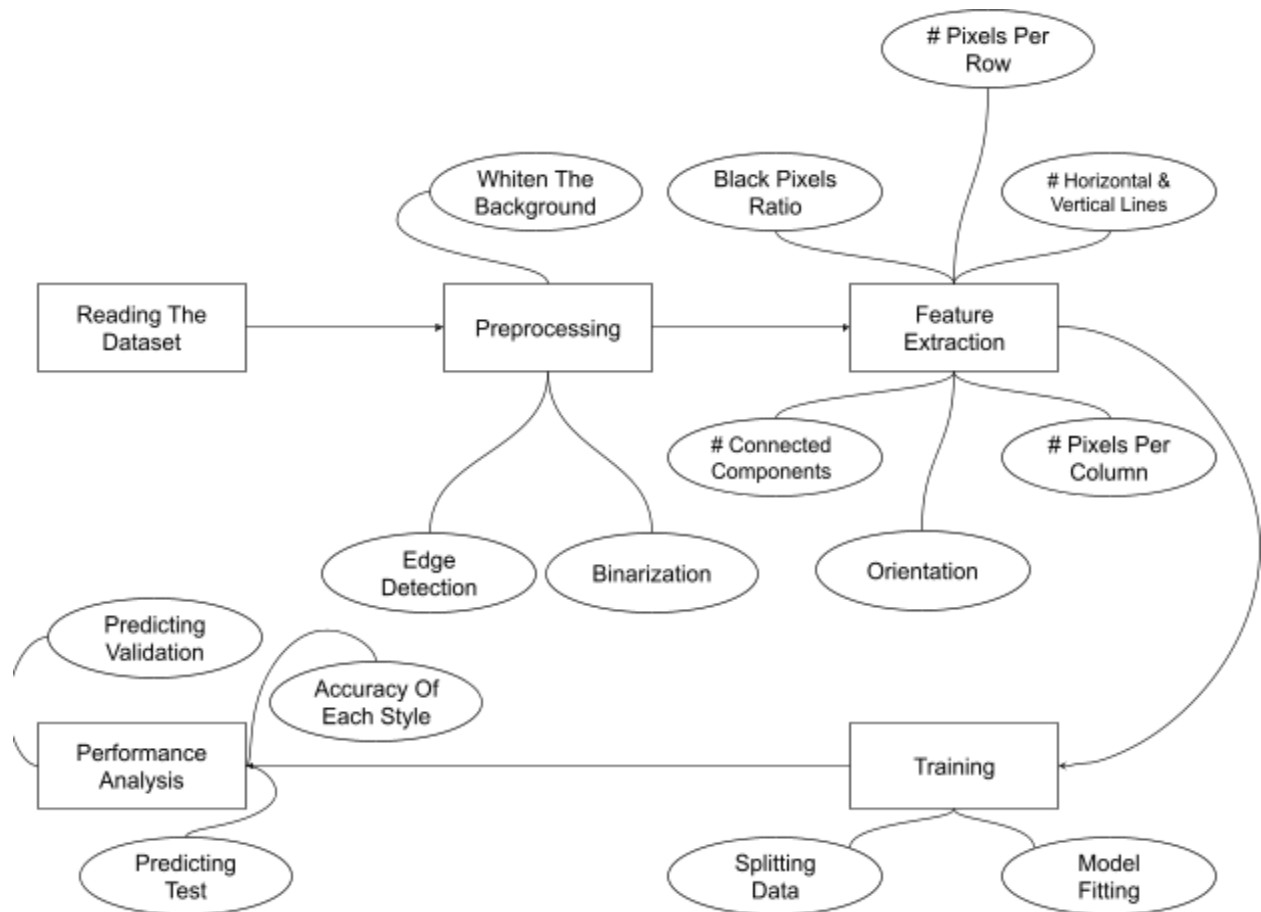


# Pattern Recognition

## Arabic Calligraphy Recognition

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## Pipeline



## Preprocessing

We have 3 steps in the preprocessing stage/module:

1. Binarization:
  - a. Convert RGB images into Grayscale.
  - b. Blur to reduce noise.
  - c. Thresholding to binarize images.
2. Background and text fix
  - a. Make sure that the background is white and text in black.

### 3. Edge Detection:

- a. Used later to get the number of vertical and horizontal lines.

## Feature Extraction

We extracted 6 features:

1. Black pixels Ratio: Get the number of black pixels with respect to all pixels in the image so we can determine the density of the text in the image.
2. Number of Vertical and Horizontal lines: This feature is very helpful in recognizing the Square-Kufi and Kufi Styles.
3. Number of black pixels per row because there are fonts where most of the pixels are clustered horizontally.
4. Number of black pixels per column because there font that most of the pixels are clustered vertically.
5. Gradient Orientation: get the orientation angle of text and this is the most helpful feature as Arabic styles are mostly described by their orientation.
6. Number of Connected components: this helps in getting diacritics as there are some styles specified by many diacritics.

## Model Selection

We tested different models and compared their accuracy on the given dataset and choosed the **Random Forest Model** which resulted in the best accuracy.

1. Splitting Data:
  - a. Split data into 3 sets which are:
    - i. Training Data.
    - ii. Validation Data.

- iii. Test Data.
2. Creating a Random Forest model and training it with the training data.

## Performance Analysis

We Checked out the performance of validation , Test , and different styles Data and the results were:

- Validation Accuracy: 95.92592592592592
- Test Accuracy: 96.73590504451039
- Accuracy of Diwani: 100.0
- Accuracy of Naskh: 100.0
- Accuracy of Parsi: 98.88888888888889
- Accuracy of Rekaa: 99.45945945945947
- Accuracy of Thuluth: 98.46153846153847
- Accuracy of Maghribi: 98.88888888888889
- Accuracy of Kufi: 100.0
- Accuracy of Mohaqiq: 98.42105263157895
- Accuracy of Square-kufic: 100.0

## Enhancement And Future Work

There are many enhancement that we can implement in the future:

- Optimized image resizing technique.
- Text Thickness: Stroke thickness plays an important role in defining the style.
- Horizontal Profile Projection: In some Arabic Calligraphy some styles, all words are written on a baseline, while others their words are not

subjected to a baseline. This feature is a descriptor that specifies how words are vertically spread within a text image.

## Workload Distribution

Ahmed Ashraf	<ol style="list-style-type: none"><li>1. Reading Data</li><li>2. Number of Black Pixels per row</li><li>3. Number of Black Pixels per column</li><li>4. Predict.py</li></ol>
Ahmed Sherif	<ol style="list-style-type: none"><li>1. Preprocessing</li><li>2. Number of Horizontal and Vertical Lines Feature</li><li>3. Black Pixel Ratio</li></ol>
Ahmed Magdy	<ol style="list-style-type: none"><li>1. Training</li><li>2. Performance Analysis</li><li>3. Predict.py</li></ol>
Abdulrahman Fadl	<ol style="list-style-type: none"><li>1. Preprocessing</li><li>2. Gradient Orientation Feature</li><li>3. Connected Component Feature</li></ol>