FORENSIC SIGNATURE VERIFICATION

Automated signature verification tools based on Machine Learning techniques can provide a scientific & objective basis for signature verification.

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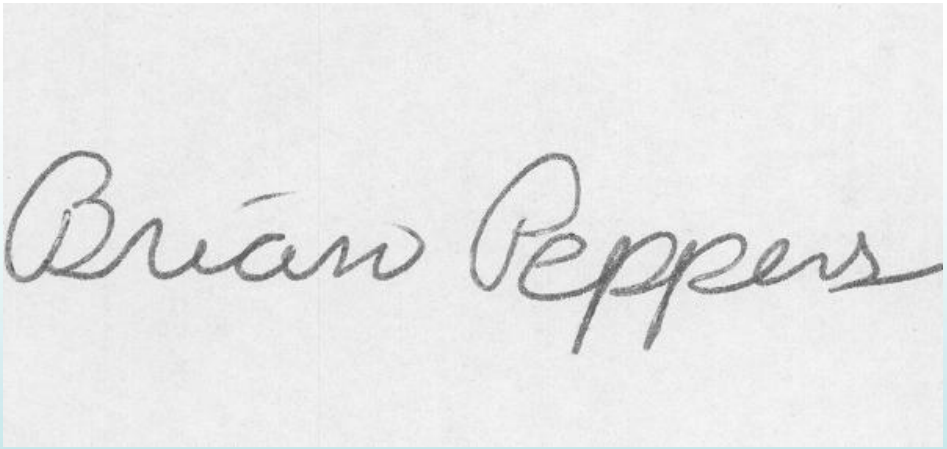
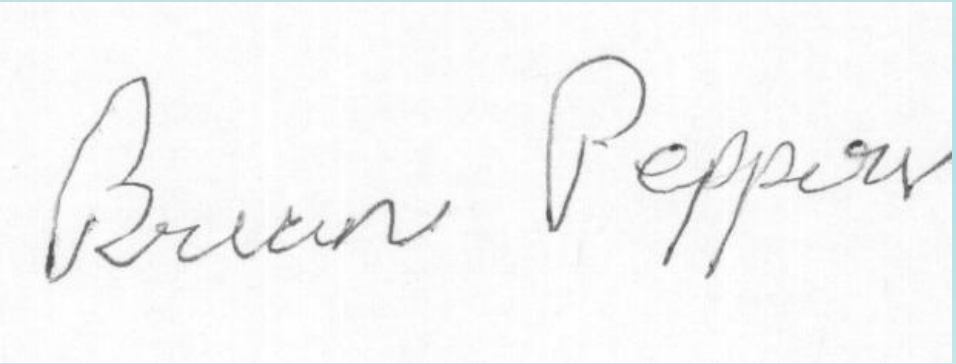
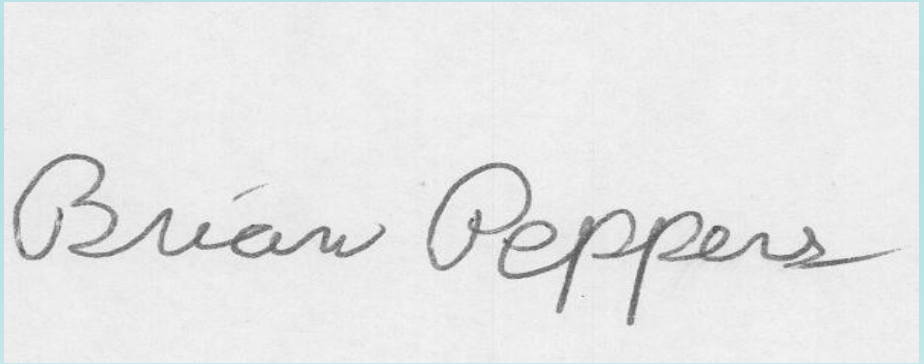
The Problem



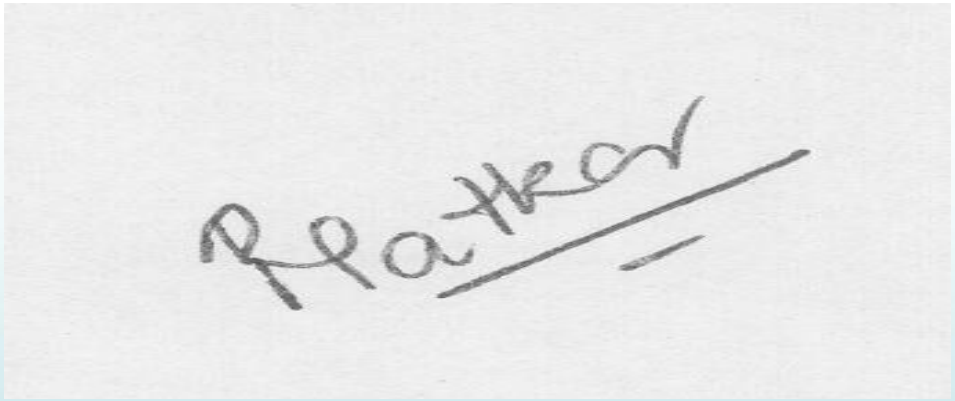


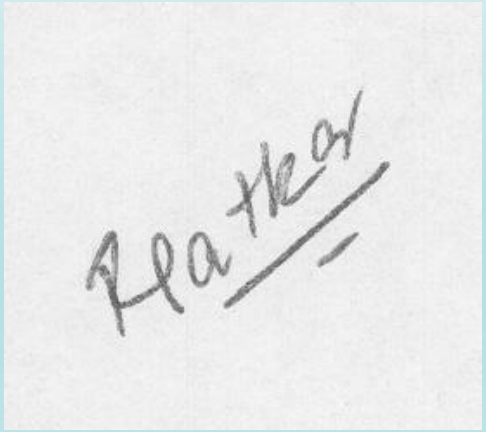
Forgery



Genuine

The Problem

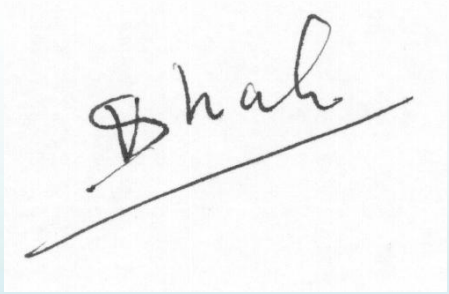


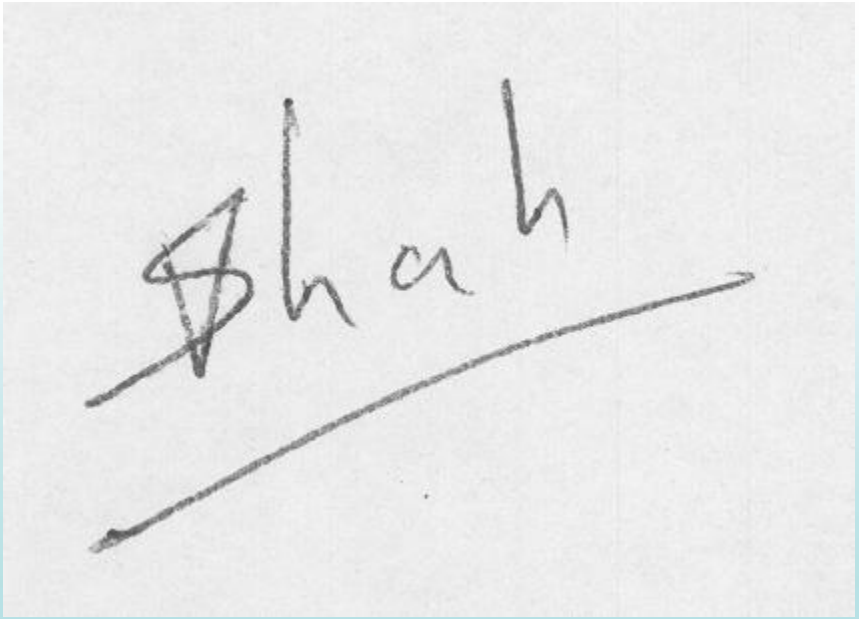


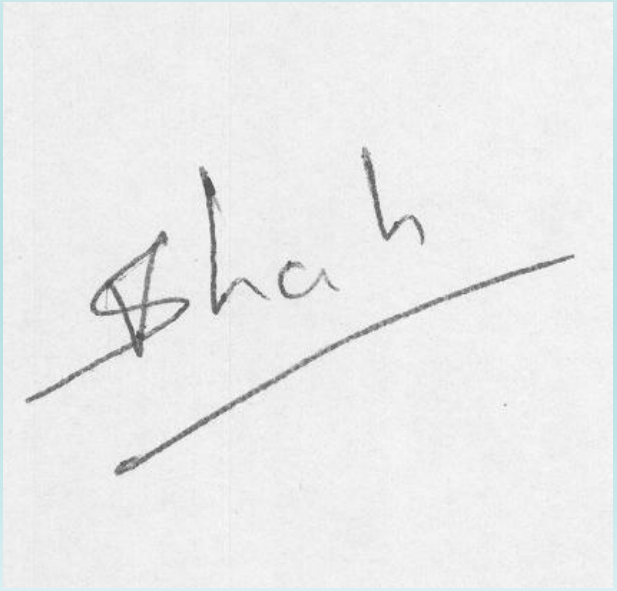
Genuine

Forgery

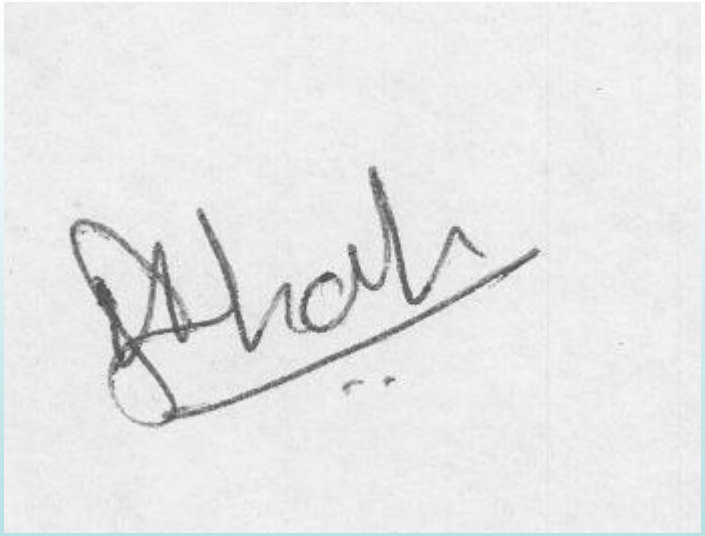
The Problem

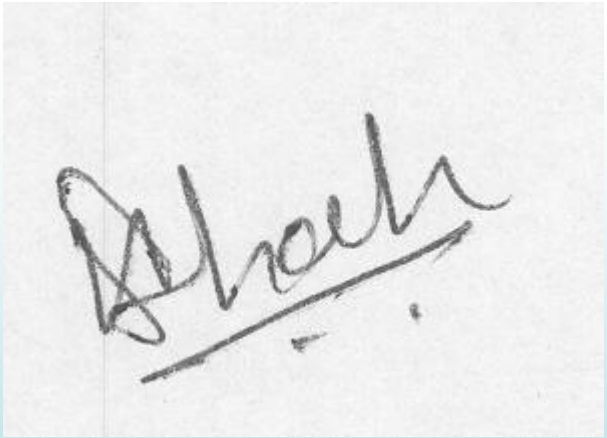




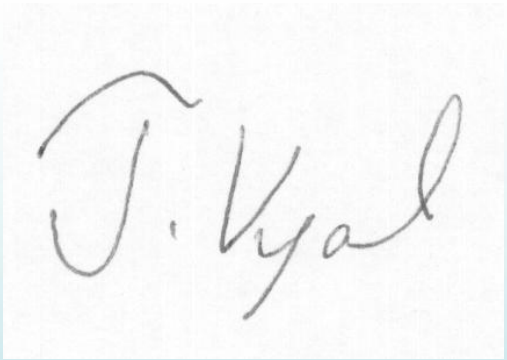


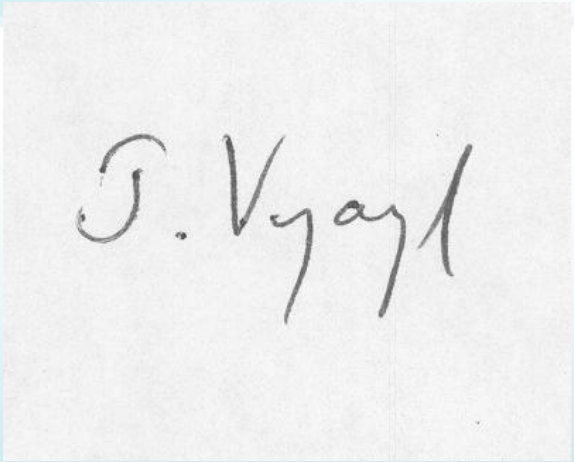
The Problem

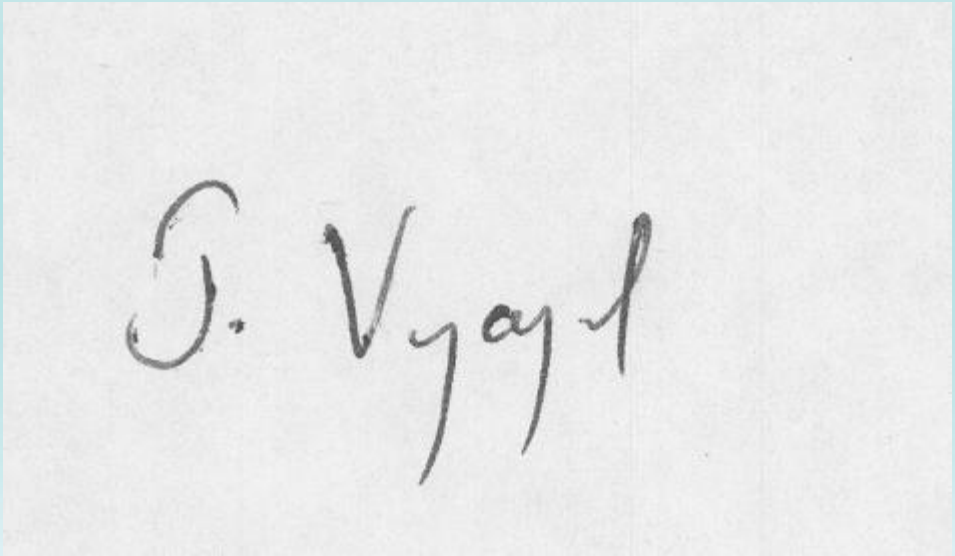




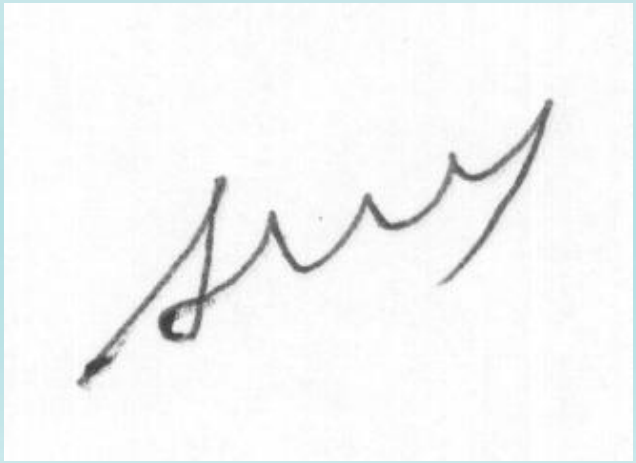
The Problem



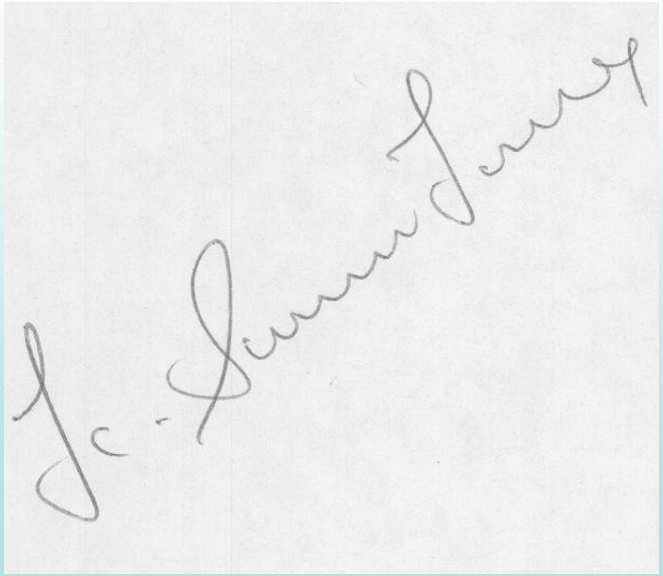


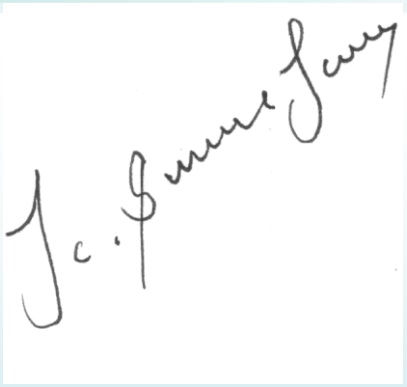


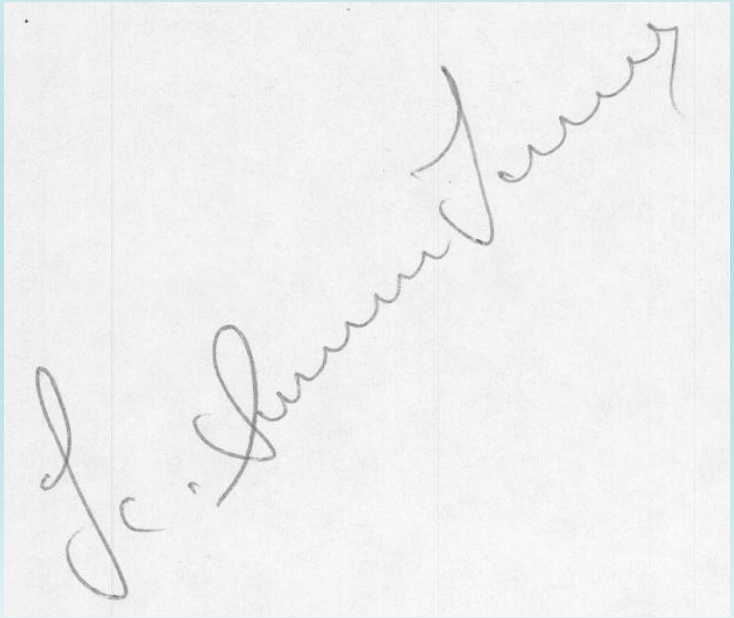
The Problem



The Problem







"Analysis of handwritten documents from the viewpoint of

determining

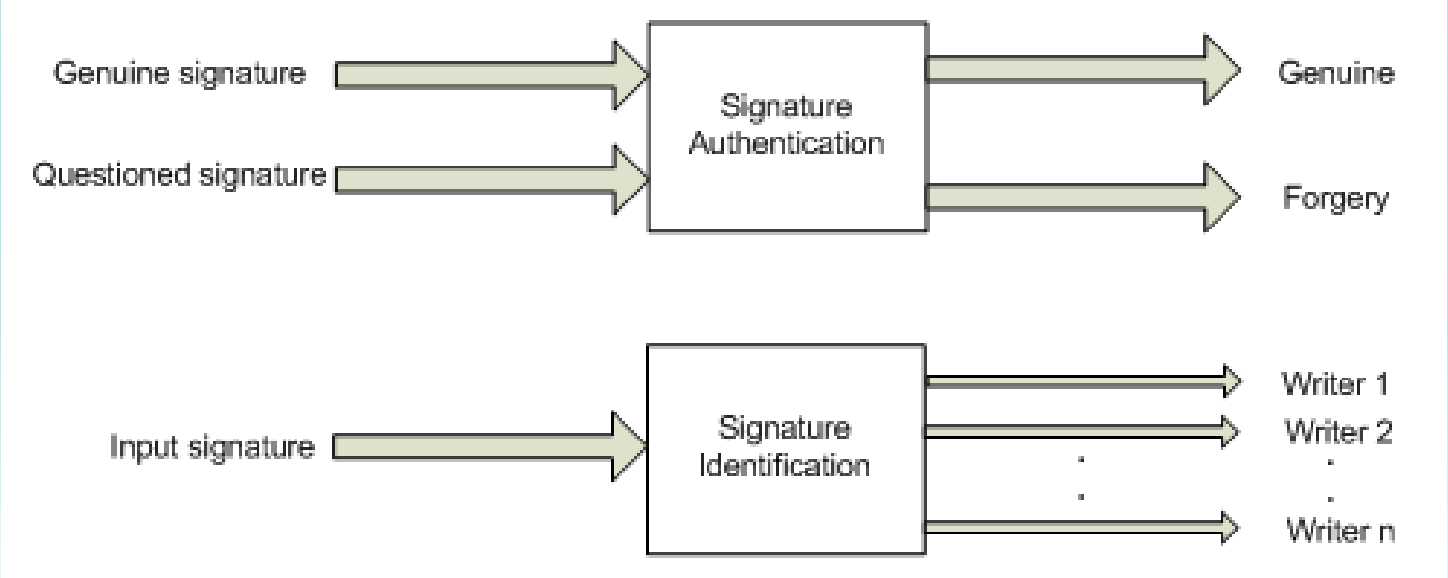
the writer has great bearing on the criminal justice system."

Lives depend on it...

The Problem

Offline signature verification in the Forensic Signature Verification domain.

The task of identifying whether a signature is genuine or forged given a genuine copy of the signature.



Conclusion

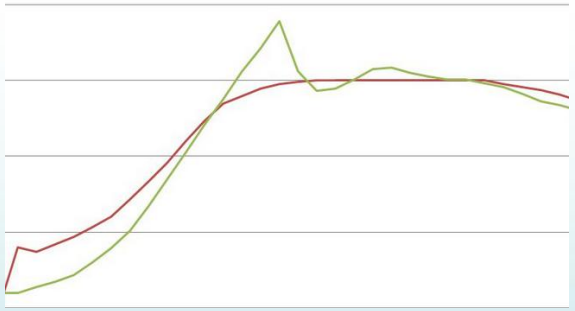
- Supervised learning techniques using "Macro Features" yields an accuracy of upto 97%.

- Comparing features in the distance space provides a robust criteria for distinguishing between genuines & forgeries.

What makes this a hard problem

The ML Perspective

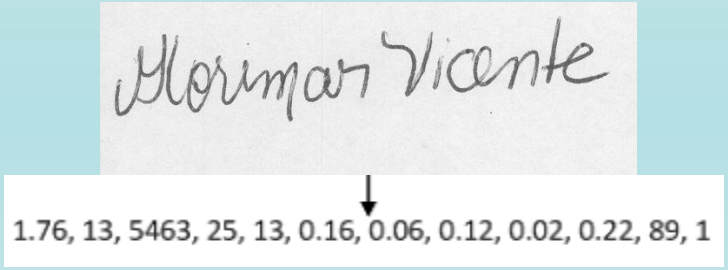
1. No Temporal Information.
2. Feature engineering.
3. Variance!!



Temporal signals – Pressure and speed

The Domain Perspective

1. The training of a document examiner involves years of learning.
2. People changes their writing styles.
3. External factors like pen choice, paper quality etc influence predictions.



Offline information processing

How we did it…

Walkthrough of the experiment…

Raw Image Set…

55 writers

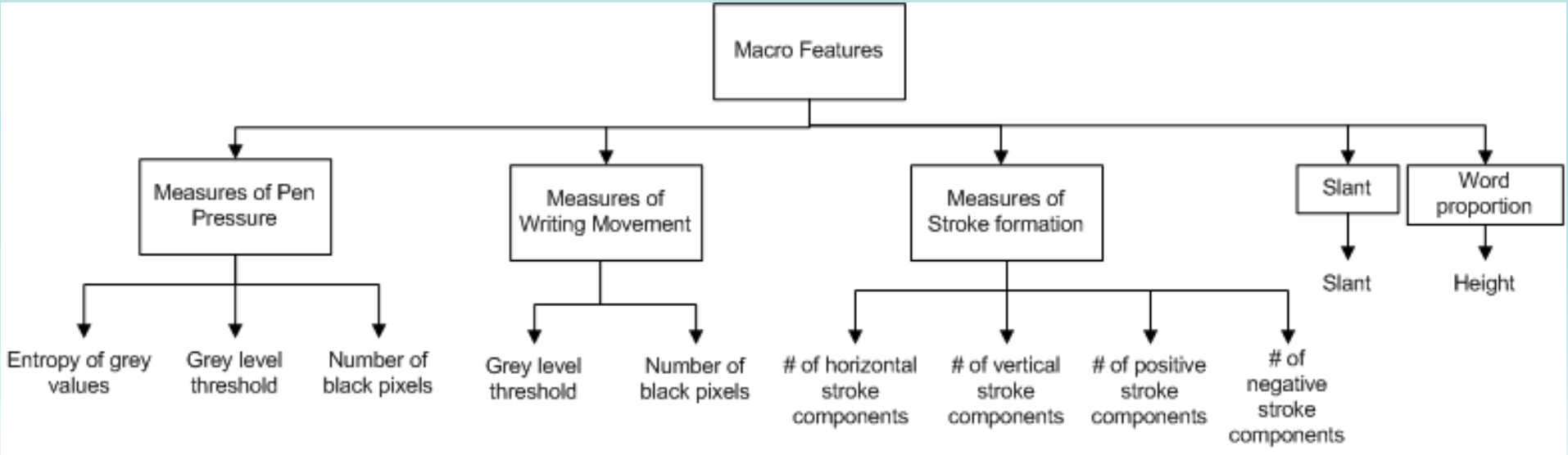
- 24 genuines
- 24 forgeries

Images scanned at 300 DPI.

Computational Features…

We choose 11 Macro Features.

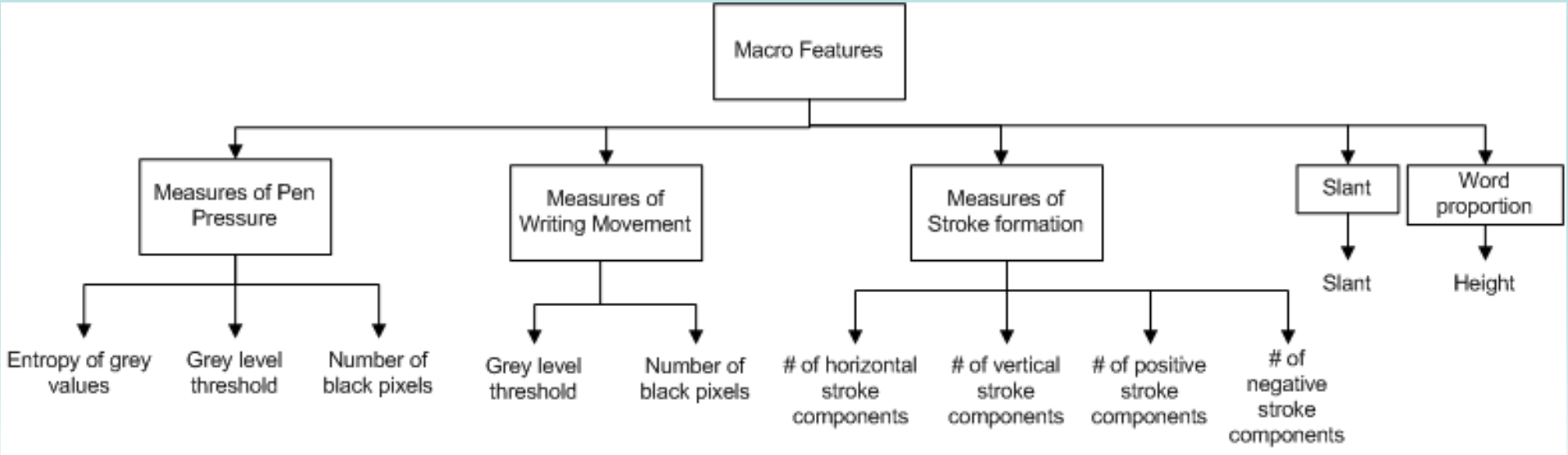
•These features capture information globally over the image sample.



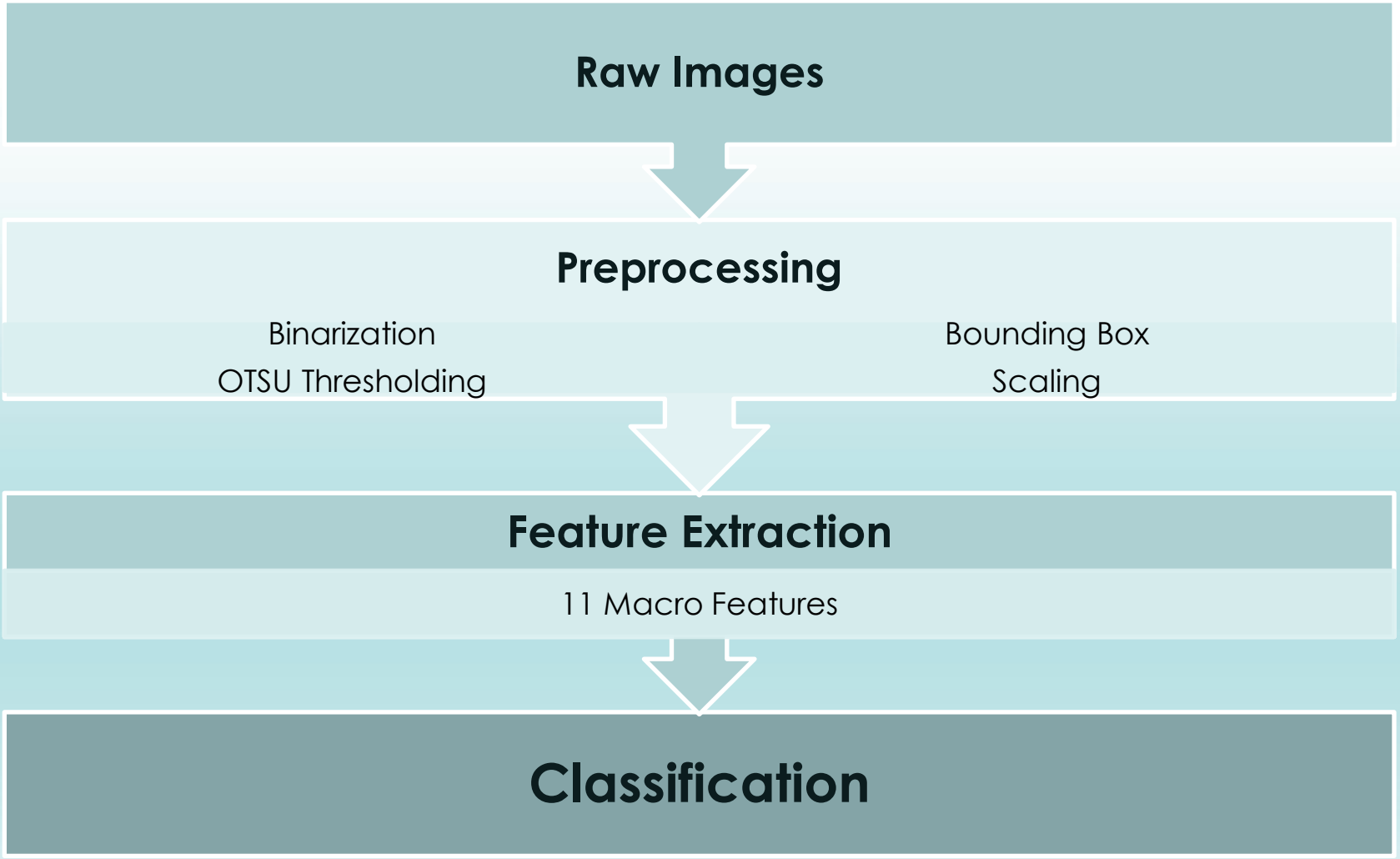
Computational Features…

They capture :

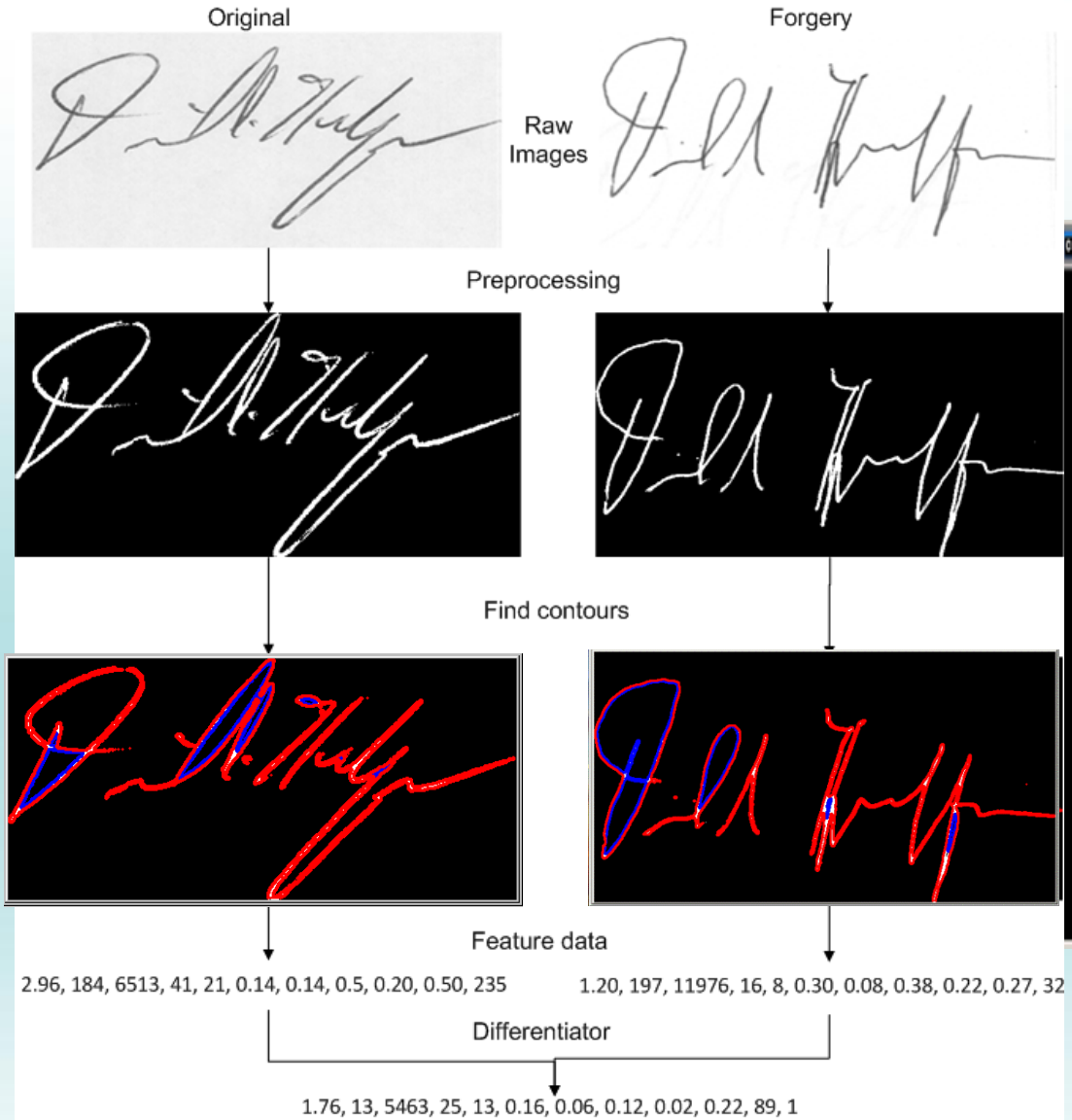
1. Measures of Pen Pressure
2. Measures of Writing Movement
3. Measures of Stroke Formation
4. Slant
5. Word Proportion

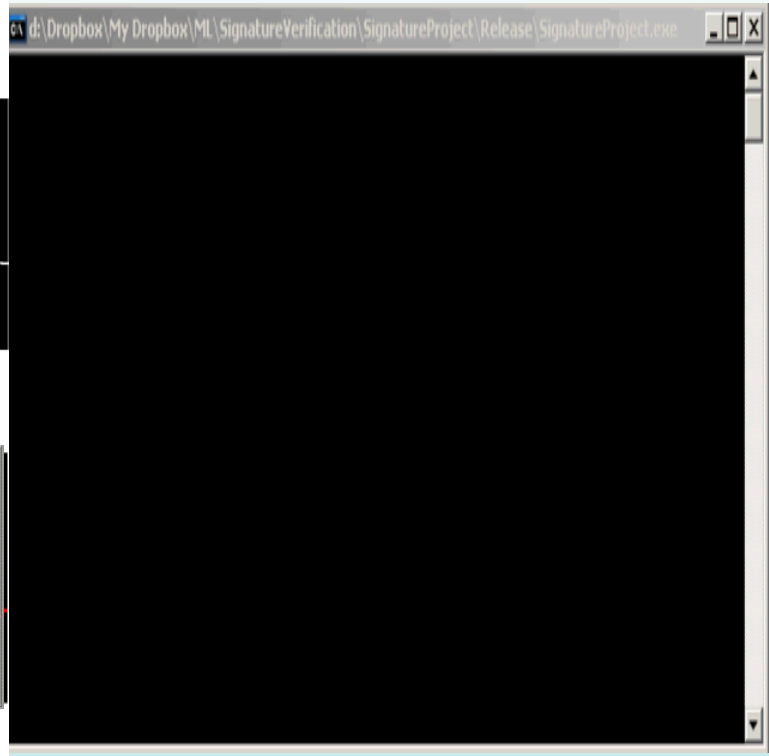


How we did it…

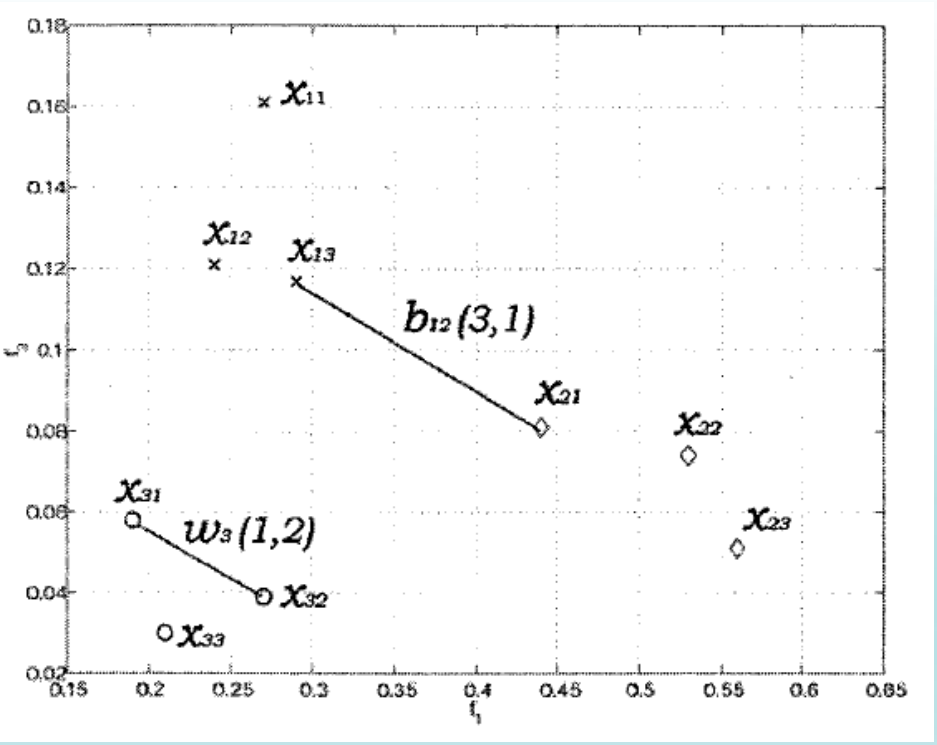

Raw Images
Preprocessing
Binarization
OTSU Thresholding
Bounding Box
Scaling
Feature Extraction
11 Macro Features
Classification

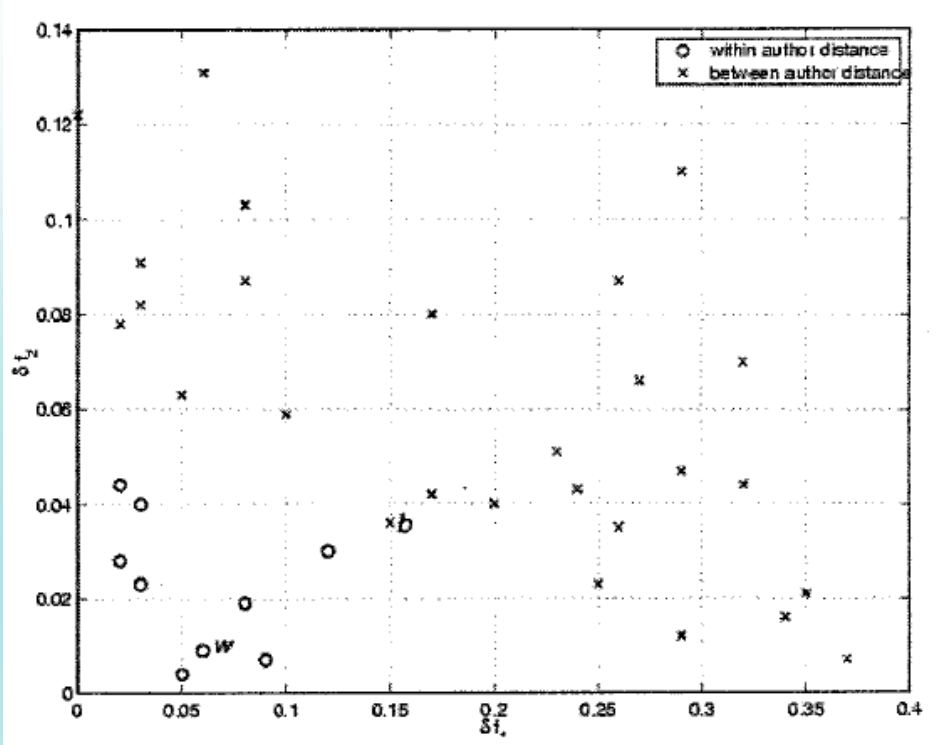
How we did it…


Original
Forgery
Raw Images
Preprocessing
Find contours
Feature data
2.96, 184, 6513, 41, 21, 0.14, 0.14, 0.5, 0.20, 0.50, 235
1.20, 197, 11976, 16, 8, 0.30, 0.08, 0.38, 0.22, 0.27, 32
Differentiator
1.76, 13, 5463, 25, 13, 0.16, 0.06, 0.12, 0.02, 0.22, 89, 1


d:\Dropbox\My Dropbox\ML\SignatureVerification\SignatureProject\Release\SignatureProject.exe

Transformation from feature space to distance space

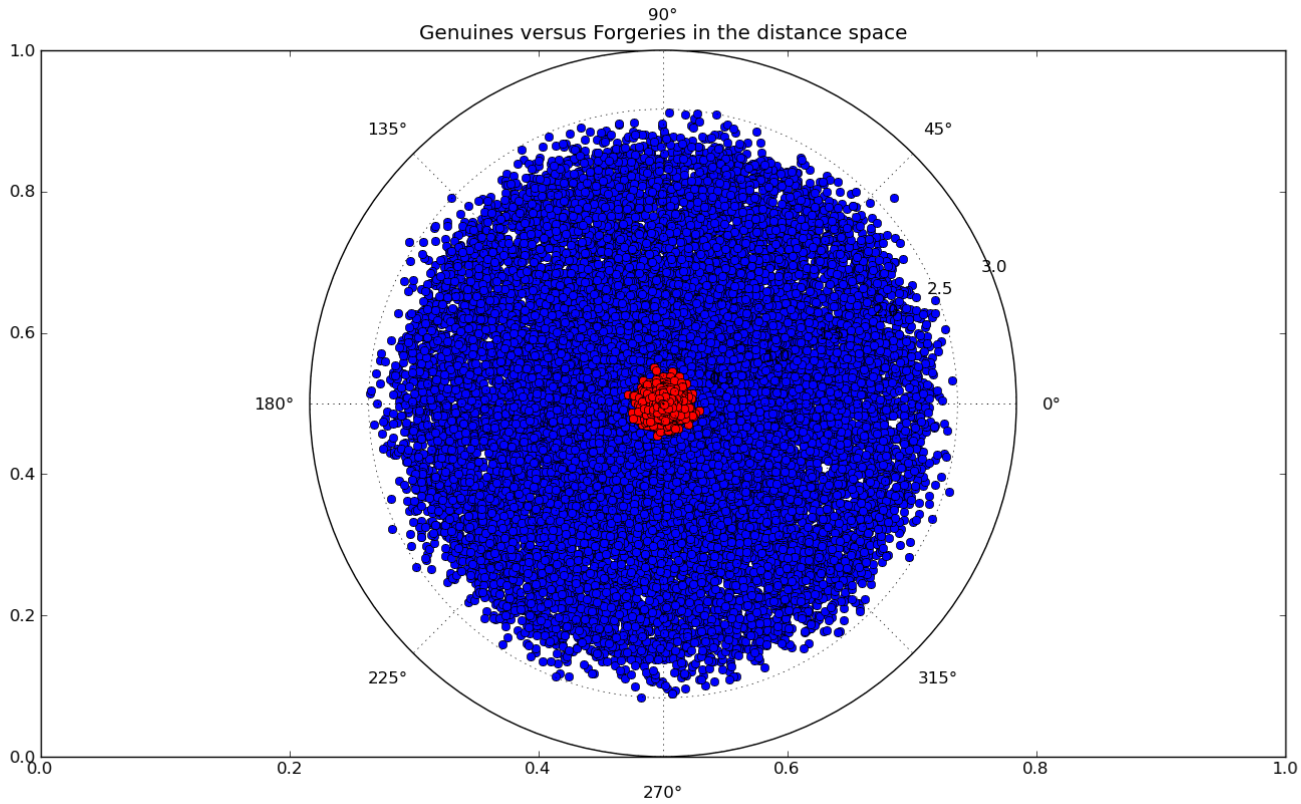




Feature Space

Distance Space

Differences captured by our model
(In distance space)



Experimental setup

Scenario 1

Training set = **12 original**, **12 forged** from each of the **55 writers.**

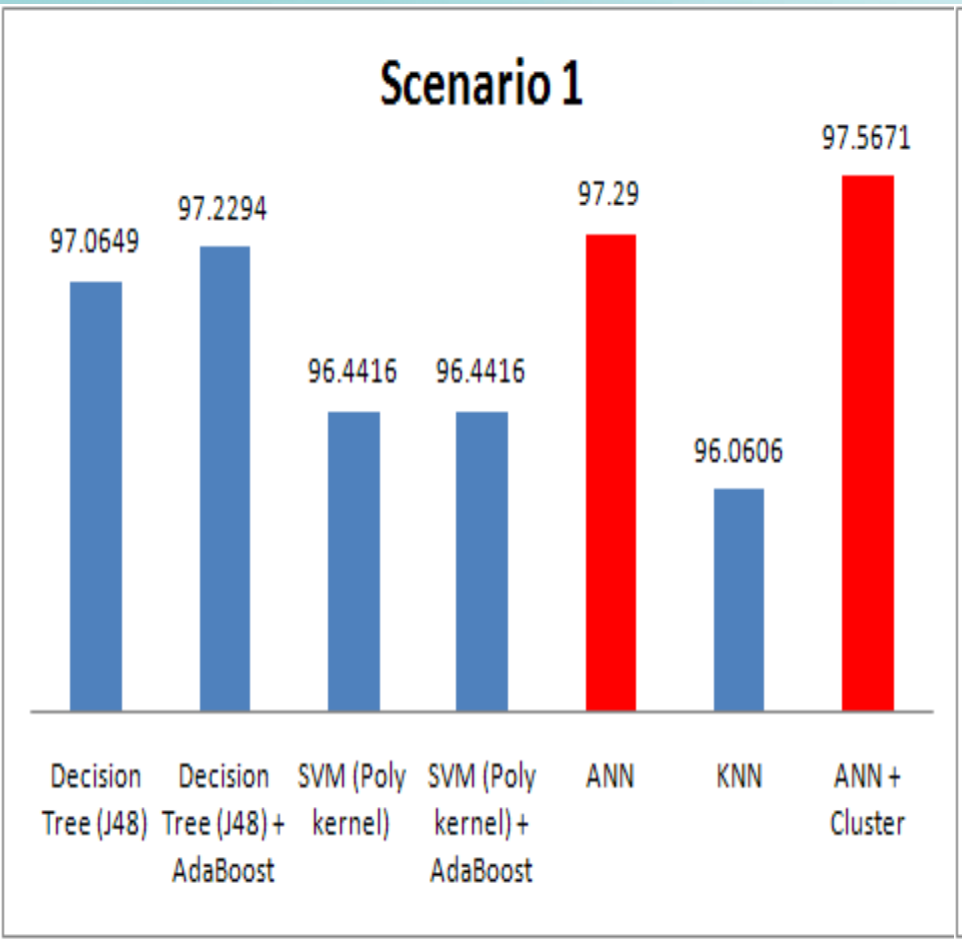
Testing set = **12 original**, **12 forged** of each of the **55 writers.**

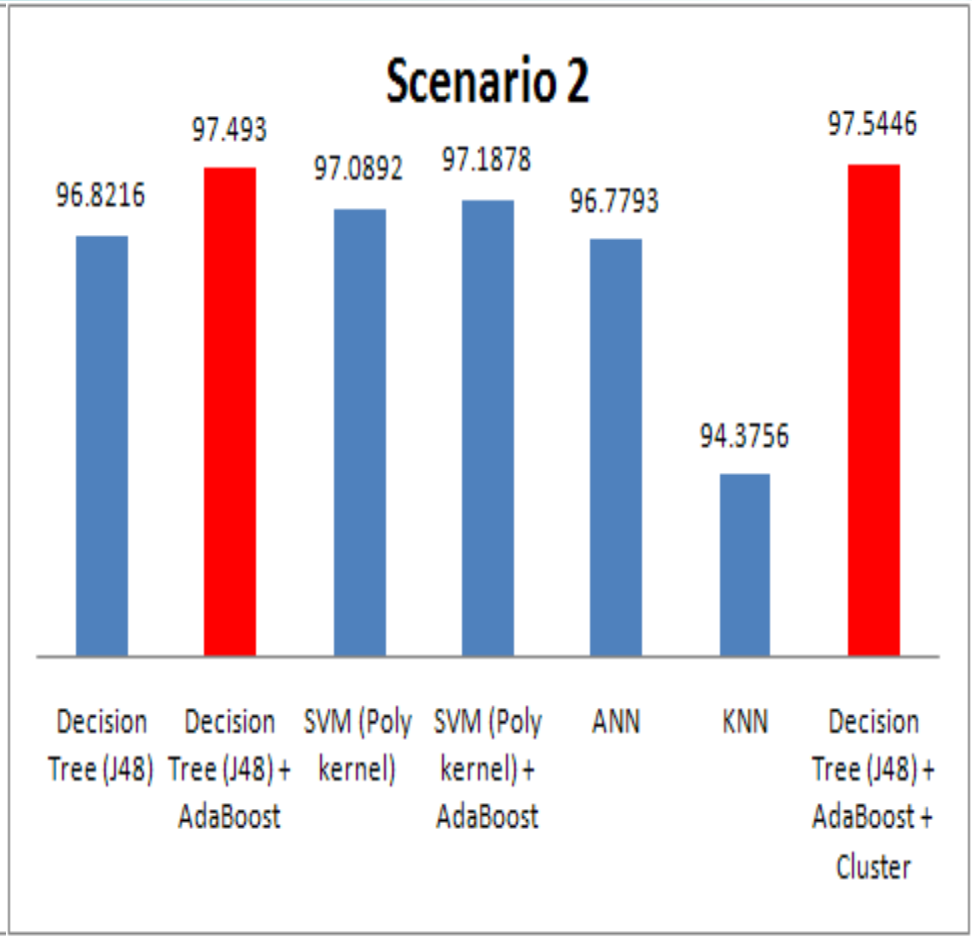
Scenario 2

Training set = 24 original, **24 forged** from each of the **30 writers.**

Testing set = 24 original, **24 forged** for each of the remaining **25 writers**.

Results





"Interesting Observation: re-using clustering information boosted accuracy"

Experimental setup

Scenario 3

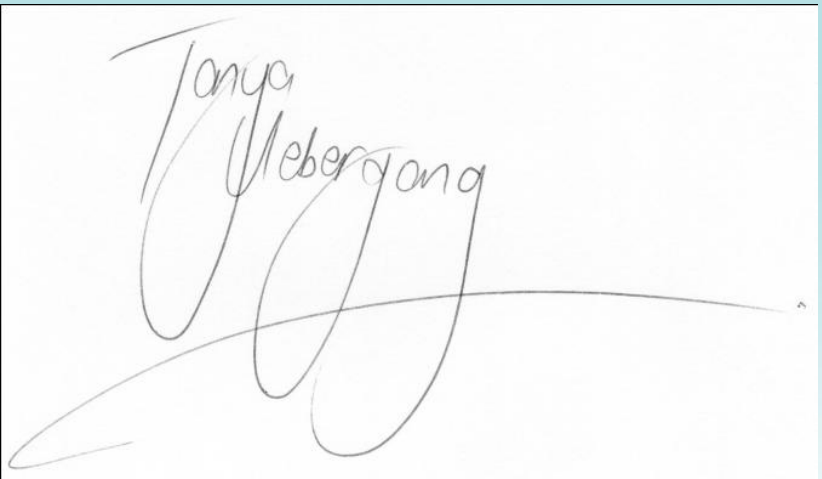
- We tested averages of the genuine sets.
- Although they were correctly detected, we got ~4% false positives.

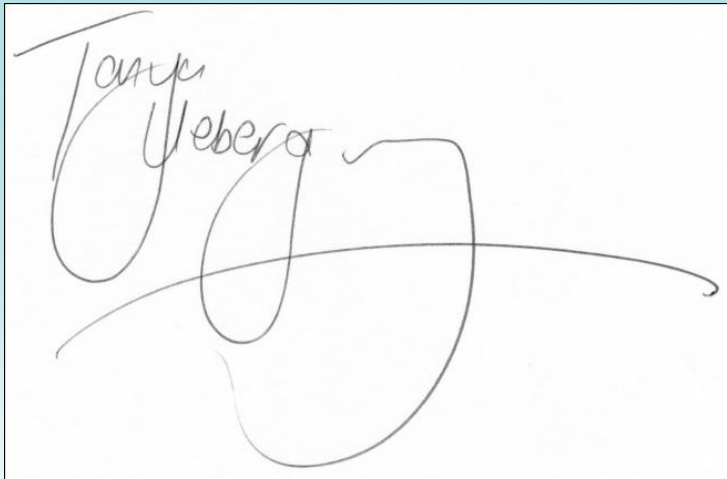
Scenario 4

- We tested our models on an entirely new image-set obtained from ICFHR. (~80.81% accuracy for ANN)
- (almost 5 times higher resolution)

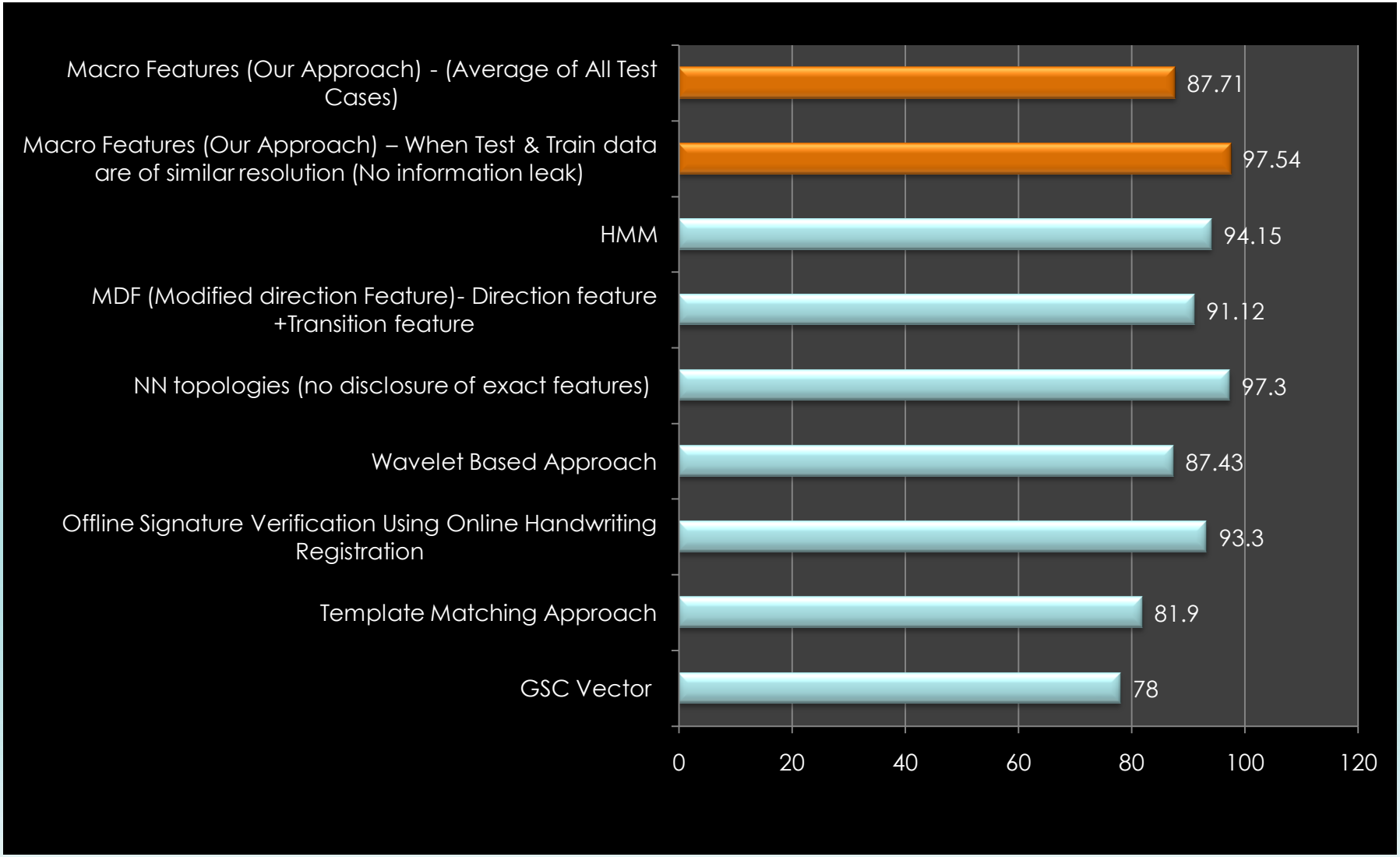
Reviews

- Comparisons
- New Datasets
  - We have obtained a new image-set and will be receiving more images from the ICFHR committee.
- Explaining keywords like chaincodes and zernike moments.
- Example of system failure.





Comparison to other techniques



Take aways…

1. Factors like image resolution, DPI etc affect information capture and thus influence accuracy.
2. Writer’s own variance plays a very important role.
3. Feature engineering is a very crucial component of applied machine learning.
4. Designing test cases is tricky

Take aways…

Know thy domain…

Future Work

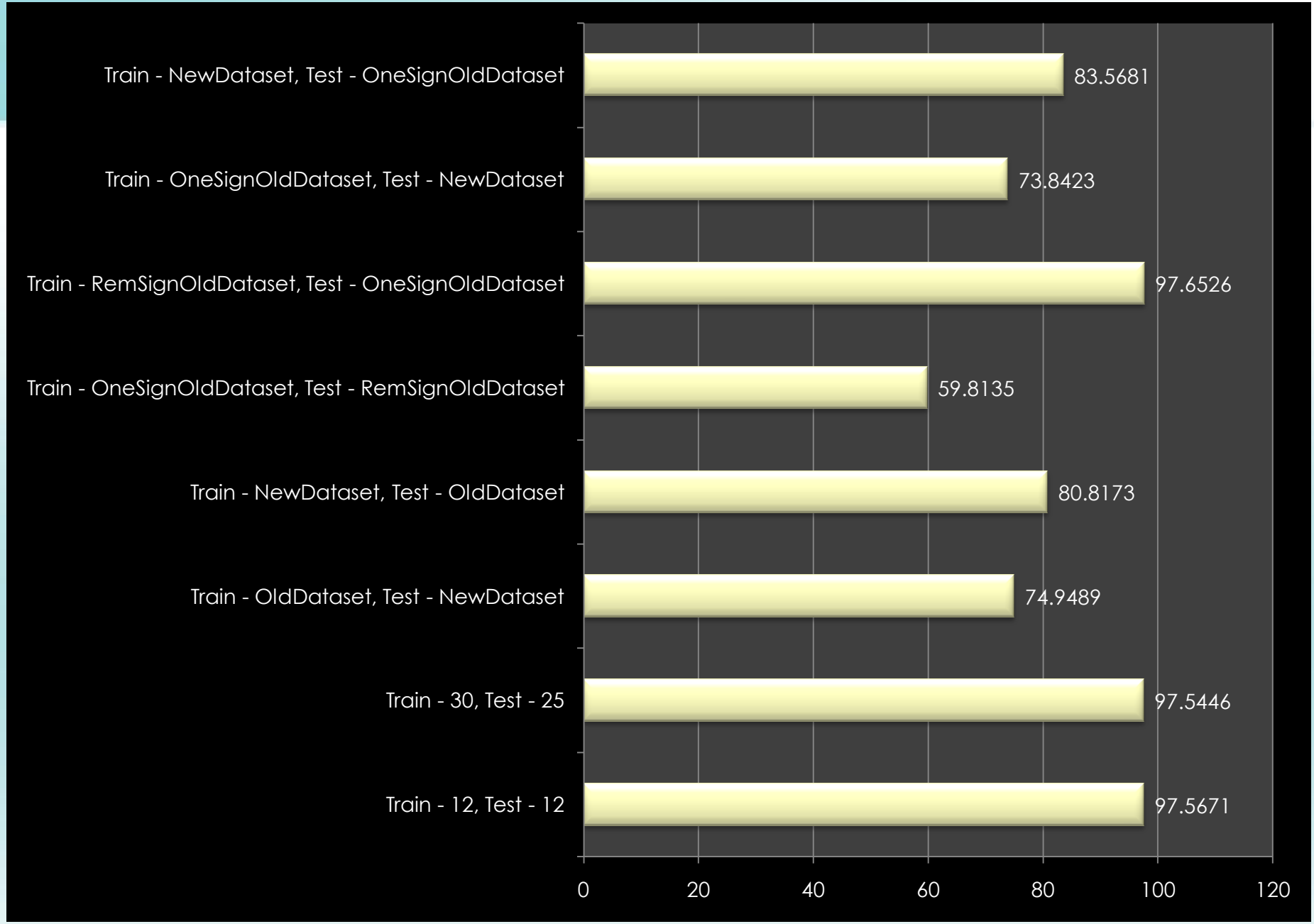
1. Extracting other features like GSC <Gradient, Structure, Concavity>.

2. Incorporating approaches like DTW which simulate temporal-like information capture.

3. Testing our system on signatures written in different languages.

4. To train our model on the higher resolution images.

5. Explore models like HMMs etc.


Train - NewDataset, Test - OneSignOldDataset
83.5681
Train - OneSignOldDataset, Test - NewDataset
73.8423
Train - RemSignOldDataset, Test - OneSignOldDataset
97.6526
Train - OneSignOldDataset, Test - RemSignOldDataset
59.8135
Train - NewDataset, Test - OldDataset
80.8173
Train - OldDataset, Test - NewDataset
74.9489
Train - 30, Test - 25
97.5446
Train - 12, Test - 12
97.5671
0
20
40
60
80
100
120