Writer-dependent off-line signature verification system
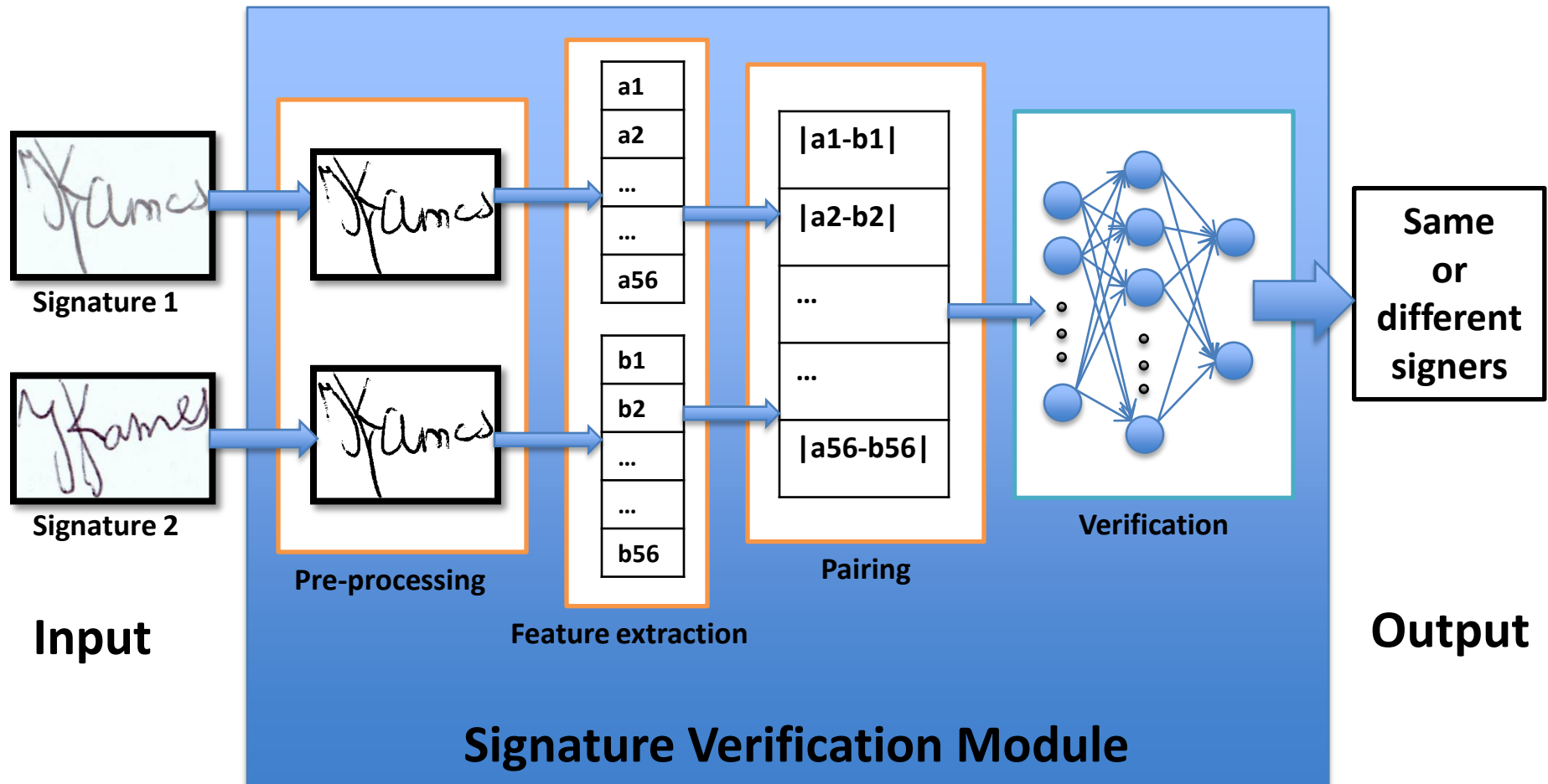
Kaihang Fu
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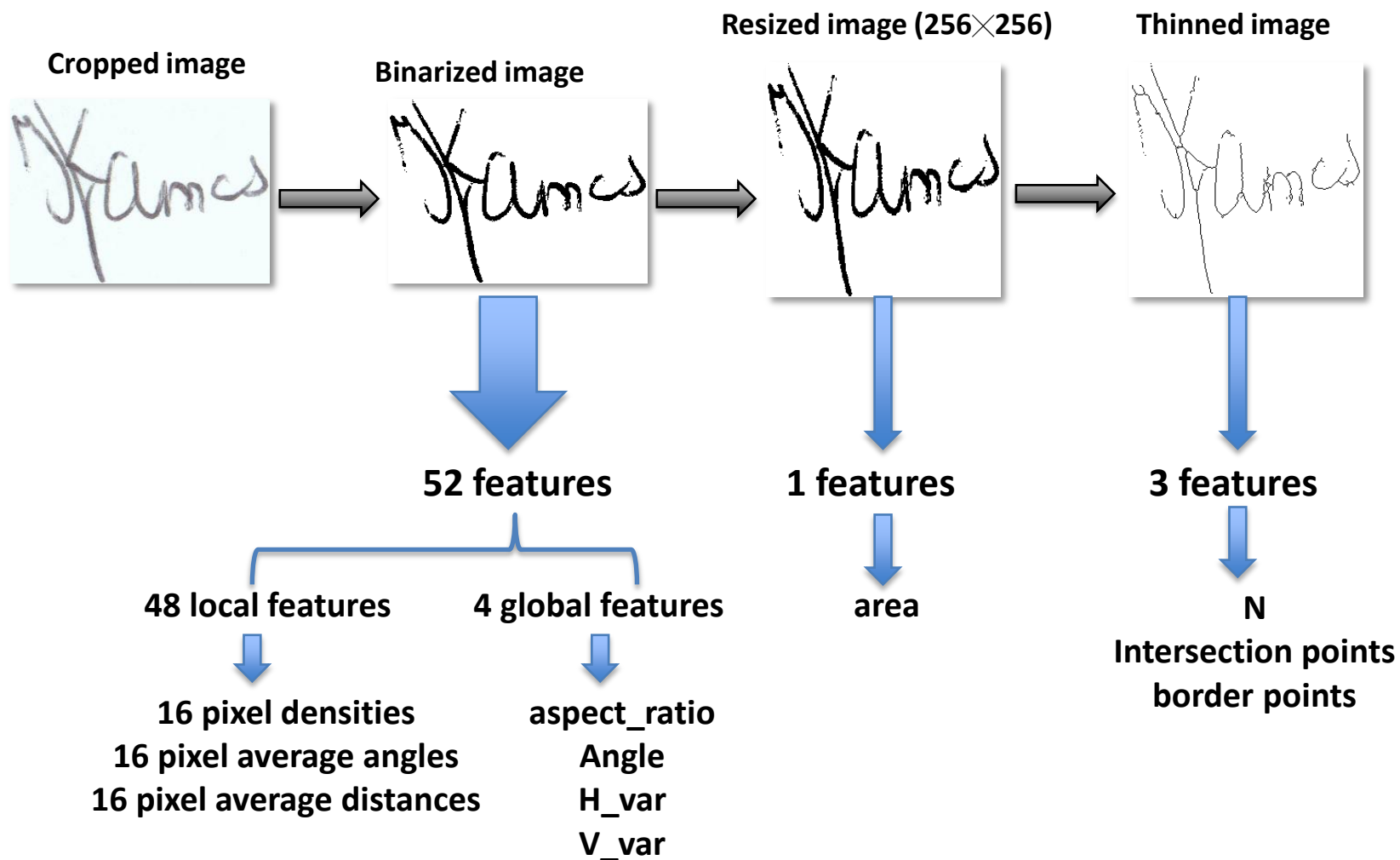
Spring 2018

Feature Extraction

Pre-processing results:

Cropped image

Binarized image

Resized image (256×256)

Thinned image

52 features

1 features

3 features

48 local features

4 global features

area

**N
Intersection points
border points**

**16 pixel densities
16 pixel average angles
16 pixel average distances**

**aspect_ratio
Angle
H_var
V_var**

Verification Process

Others writers or computer program

M $\times$ **forged signature**

writer

N $\times$ **Genuine signature**

pairing

Train set

training

Questioned signature

Signature Verification Module

Neural Network

Same (1) or Different (0) signers

$\times N = \begin{bmatrix} 1 & 1 & 0 & 1 & \cdots & 1 & 1 & 1 \end{bmatrix}$

N results

If "1" $>$ "0", then **Genuine**

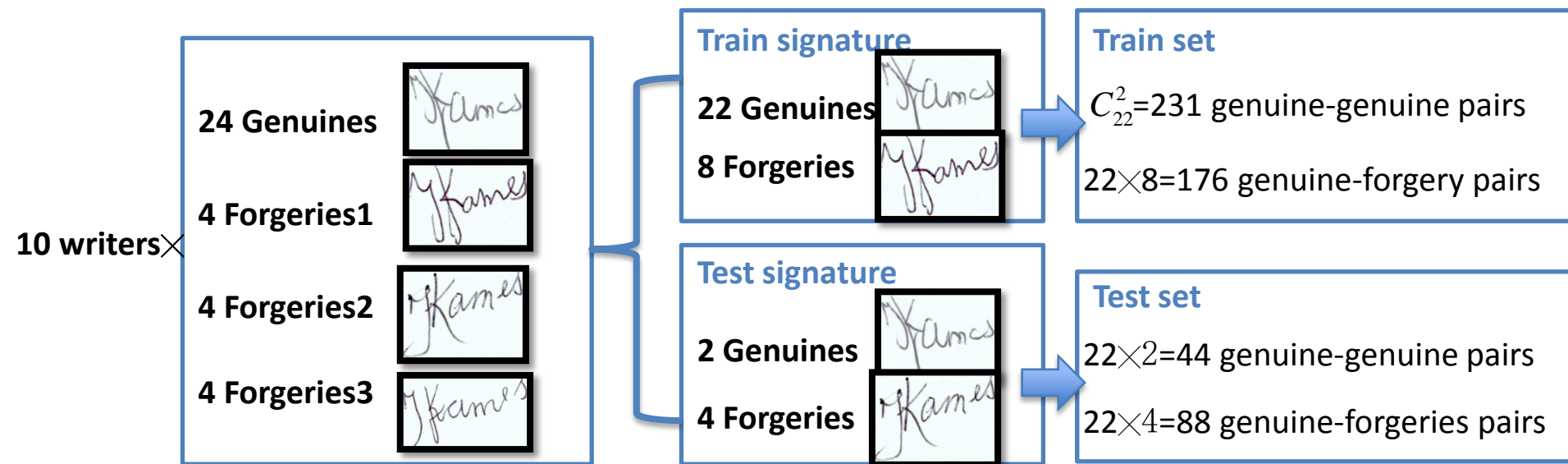If "1" $<$ "0", then **Forgery**

Dataset

- International Conference on Document Analysis and Recognition (ICDAR) 2011 SigComp international signature verification competition

- The Dutch training set:

  Total of 361 images for 10 writers

  About 24 genuine signatures and 12 forged signatures for each writer

  12 forged signatures come from 3 others forgery-writers, each one writes 4 forged signatures

10 writers✕

24 Genuines	
4 Forgeries1	
4 Forgeries2	
4 Forgeries3	

Train signature

22 Genuines

8 Forgeries

Train set

C_{22}^2=231 genuine-genuine pairs

22✕8=176 genuine-forgery pairs

Test signature

2 Genuines

4 Forgeries

Test set

22✕2=44 genuine-genuine pairs

22✕4=88 genuine-forgeries pairs
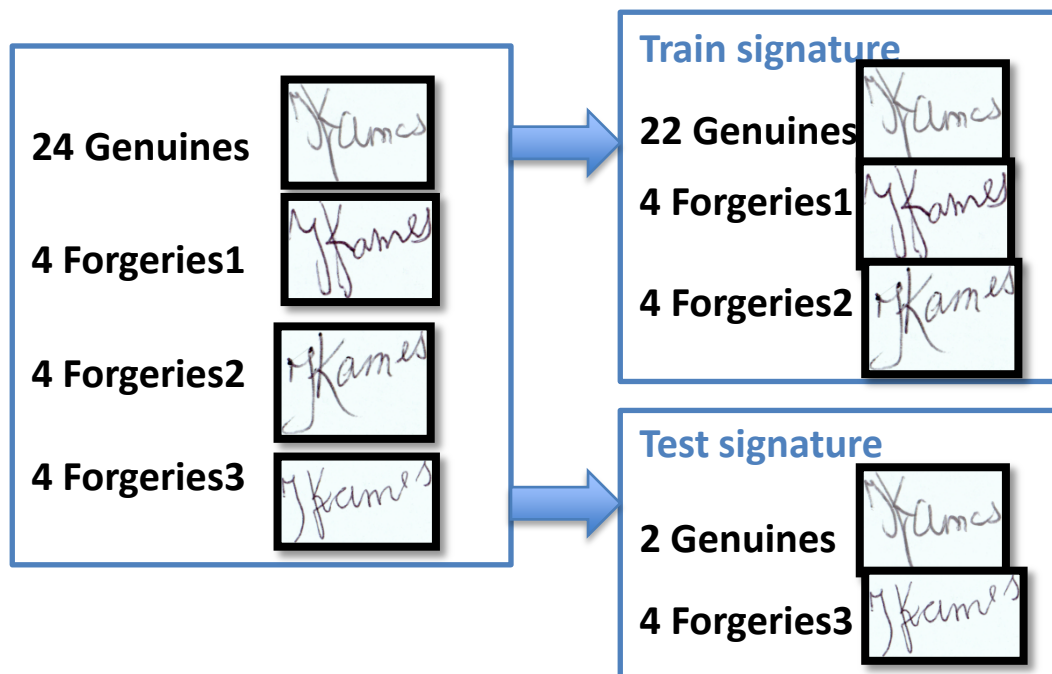
Experiment Result

Evaluation Metrics:

$$\text{Forgeries Test Accuracy} = \frac{\text{True \_forgeries}}{\text{True \_forgeries } + \text{False \_forgeries}}$$

$$\text{Genuine Test Accuracy} = \frac{\text{True \_genuines}}{\text{True \_genuines } + \text{False \_genuines}}$$
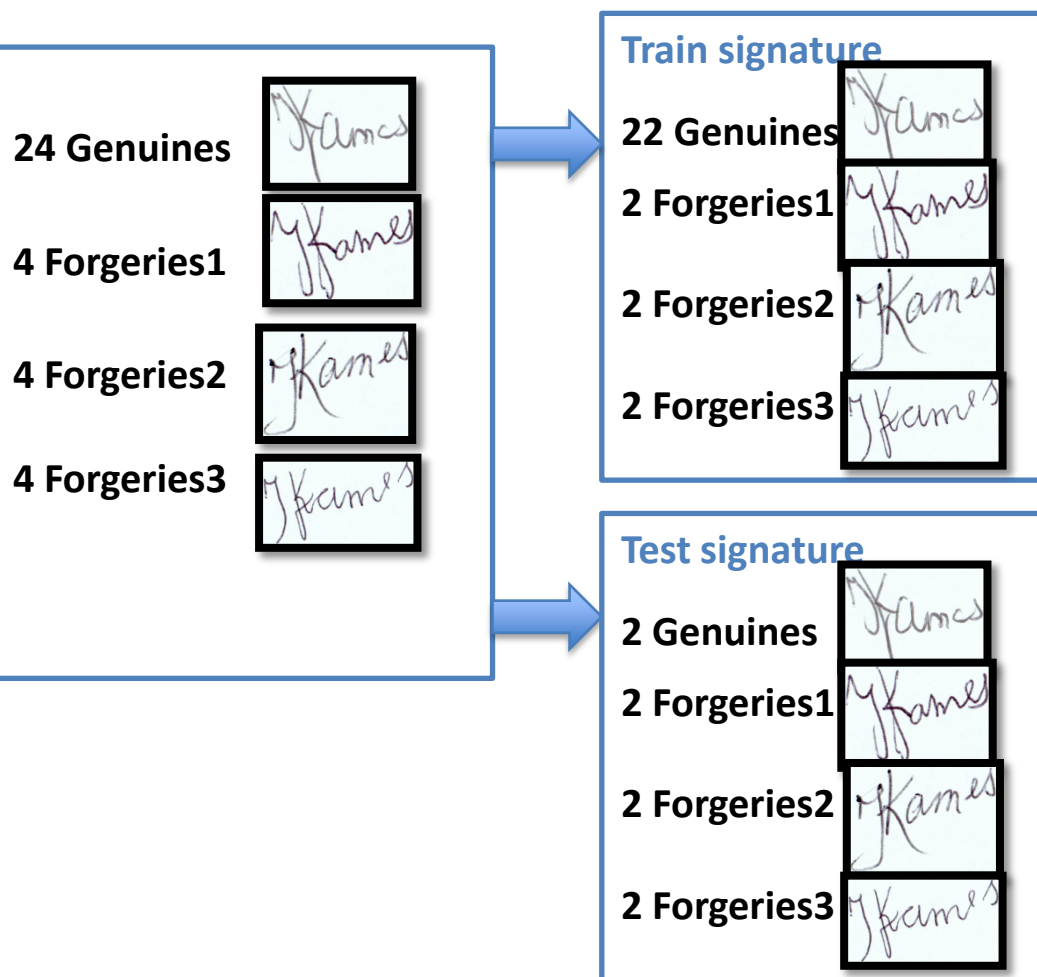
$$\text{Total Accuracy} = \frac{\text{True \_genuines } + \text{True \_forgeries}}{\text{Total \_test \_signature}}$$

Unseen forgery-writer signature test results

24 Genuines

4 Forgeries1

4 Forgeries2

4 Forgeries3

Train signature

22 Genuines

4 Forgeries1

4 Forgeries2

Test signature

2 Genuines

4 Forgeries3

	F_random	F_worst	F_middle	F_best
FTA	**90% = 36/40**	**95% = 38/40**	**85% = 34/40**	**77.5% = 31 /40**
GTA	**100% = 20/20**	**100% = 20/20**	**100% = 20/20**	**100% = 20/20**
TA	**93.3% = 56/60**	**96.7% = 58/60**	**90% = 54/60**	**85% = 51/60**

All forgery-writers signature test results

24 Genuines

4 Forgeries1

4 Forgeries2

4 Forgeries3

Train signature

22 Genuines

2 Forgeries1

2 Forgeries2

2 Forgeries3

Test signature

2 Genuines

2 Forgeries1

2 Forgeries2

2 Forgeries3

	F_all
FTA	**93.3% = 56/60**
GTA	**100% = 20/20**
TA	**95% = 76/80**

Future works

- Produce more genuine signatures and forged signatures as train set
  More train data, more accurate!

- Design better feature
  More representative features, more accurate!

- Improve structure of Neural Network
  Better classifier, more accurate!

Open question

User6

Training accuracy: 100.0000%

TestF1 predictions:	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0]	True
TestF2 predictions:	[0 0 0 1 0 0 0 1 1 1 1 1 0 0 0 1 1 0 0 1 1 0]	True (12-10)
TestF3 predictions:	[0 0 0 0 0 0 0 1 1 1 1 1 0 0 0 1 1 0 0 1 0 1]	True (13-9)
TestF4 predictions:	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]	True
TestG1 predictions:	[1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1]	True
TestG2 predictions:	[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1]	True

Test overall accuracy: 84.0909%

For second and third forged signature, after comparing with all 22 genuine signatures, produce more negative (0) results than positive (1) results, so system decide they are forged signature, that is true

But the number of negative (0) results and positive (1) results is very close

If for a questioned signature, the number of negative (0) results and positive (1) results is very close, how much can I trust the system's decision ?