

# **CSP 502**

## **Computer Vision Project**

Signature Detection and Verification on Bank Cheques

Group 6

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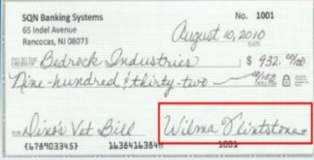
Harsh Shah (201501096)

Hardik Udeshi (201501113)


# Problem Statement

- Detecting signature, localizing signature, cropping the signature and verifying the authenticity of the signature in cheques.


**Suspect Check Image**




Extract Signature



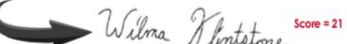
Clean Signature



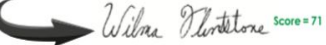
Compare Profile 1



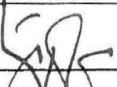
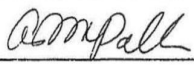

Compare Profile 2



Compare Profile 3



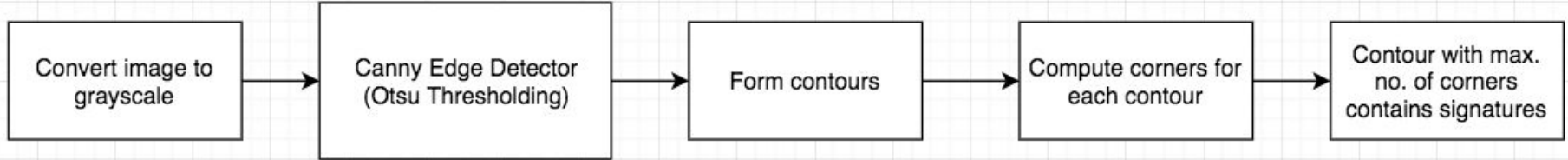
IN WITNESS WHEREOF, the parties hereto have hereunto subscribed their names as of the date first above written.

LESSOR	
SIGNATURE	NAME OF SIGNER
	Larry Taff
ADDRESS	
841 Bishop Street Suite 1700 Honolulu, HI 96813	
IN PRESENCE OF	
SIGNATURE	NAME OF SIGNER
	Anna M. Palla
ADDRESS	
UNITED STATES OF AMERICA	
SIGNATURE	NAME OF SIGNER
	ROBERT W. NIMMO
	OFFICIAL TITLE OF SIGNER
	Lease C.O.
AUTHORIZED FOR LOCAL REPRODUCTION Previous edition is not usable	
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# Signature Detection approaches

# Approach - 1: Contour features based

- Using edge detection, contours and corners

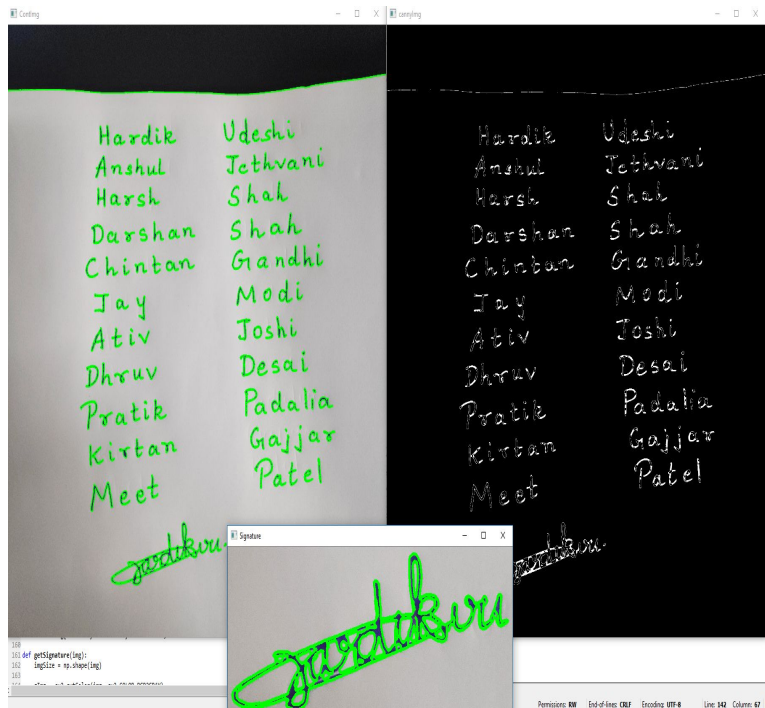


## Assumptions:

- Cursive handwriting not used except in signature.
- Signature is connected completely.

# Results

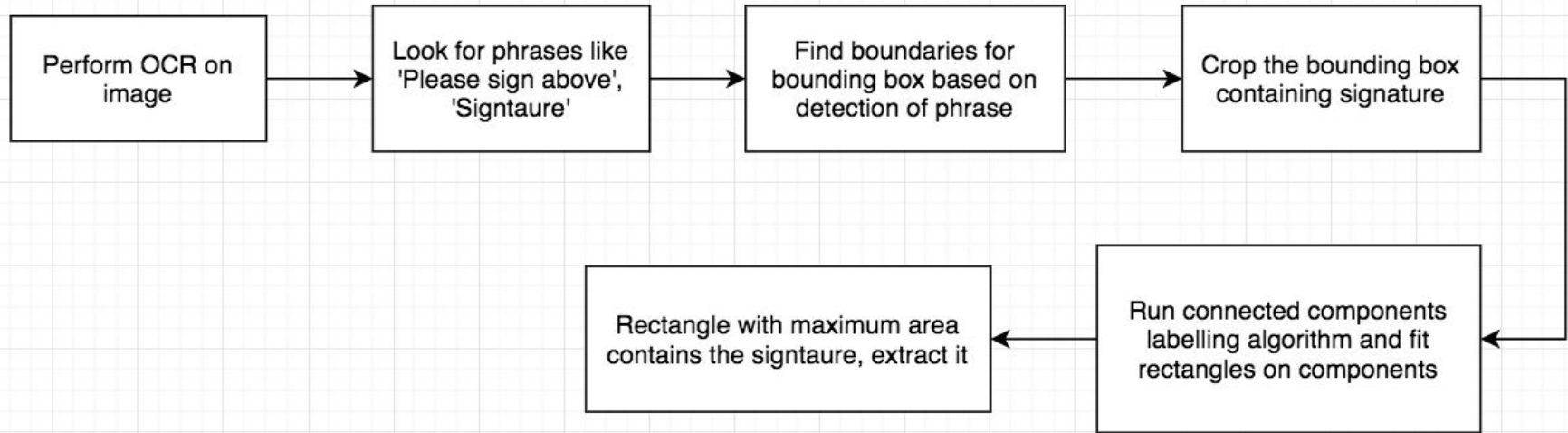
# Detected



## Failure scenario



## Approach - 2: OCR with connected components labelling [1]




### Assumptions:

- Cheques contain phrases such as 'Please sign above', 'Signature', etc.
- Signatures are well connected.

## Approach - 2 Cont'd ... [2]

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 **सिंडिकेट बैंक**  
**Syndicate Bank**  
बैंक समझ का प्रसारण - A Bank of India Understanding

14-1-320, अगपुरा, सितारामबाग, हैदराबाद - 500 001  
14-1-320, AGAPURA, SITARAMBAGH, HYDERABAD - 500001  
IFSC : SYNB0003011 (CBS)


1 3 0 3 2 0 1 6  
D D M M Y Y Y Y

Pay P. Shriv Kumar Roy या धारक को or Bearer

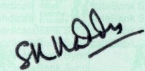
रुपये Rupees Twenty One lakh five thousands

अदा करें ₹ 2,05,000/-

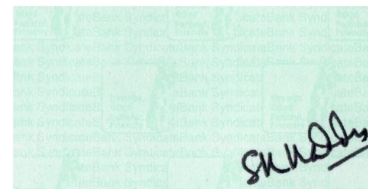
A/c. No. 30002010108841

 बैंक के सभी शाखाओं में सममूल्य पर प्रदेय  
Payable at par at all branches of our Bank

SAN : 290062083657

  
Please sign above

⑈083657⑈ 500025033⑈ 290062⑈ 31

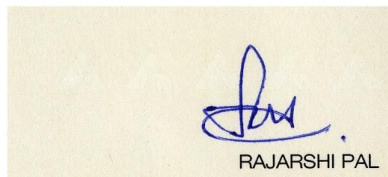


Cropped signature using OCR approach

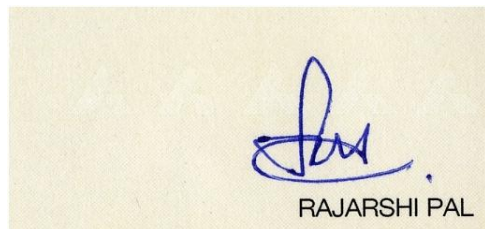
Cheque with a phrase “Please Sign Above”

## Approach - 2: Results

- Cropped image from OCR alone does not properly extract signatures. The cropped image may contain not useful information.



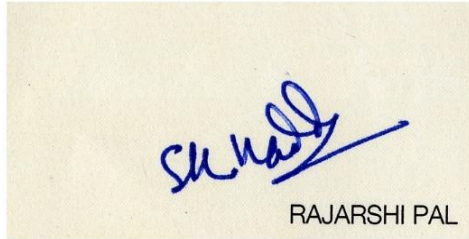
- After OCR, run connected component labelling algorithm to get a nice extraction of the signature.





## Approach - 2: Failure scenario

- When the components in signature are not connected. Complete signature will not be detected.

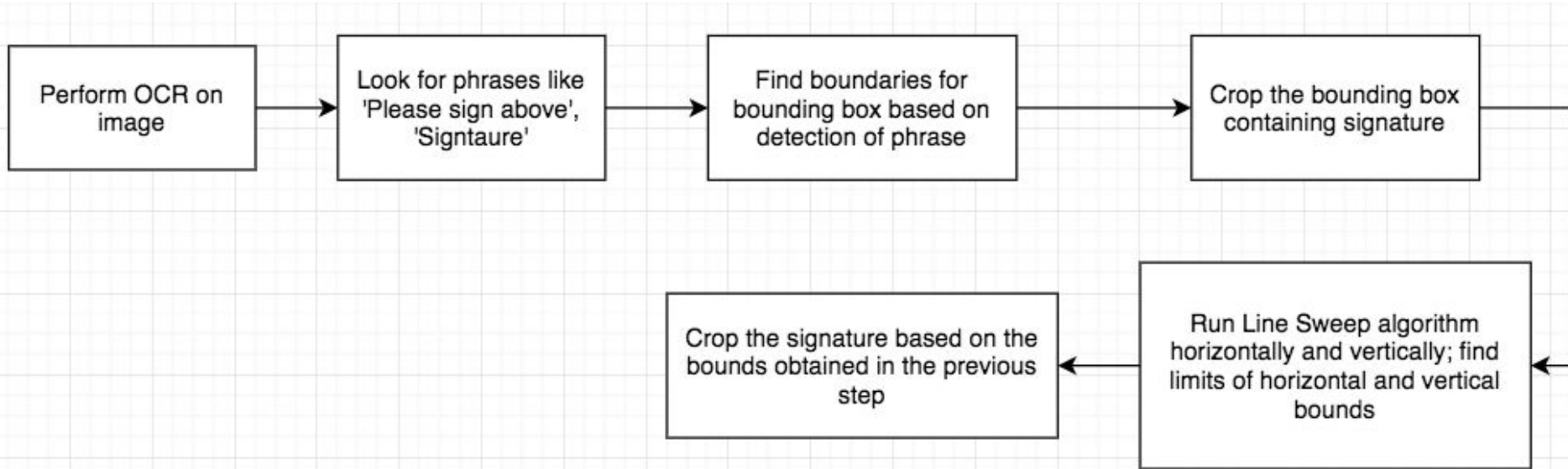


Unconnected Signature



Detected incomplete Signature

# Approach - 3: OCR with Line Sweep algorithm

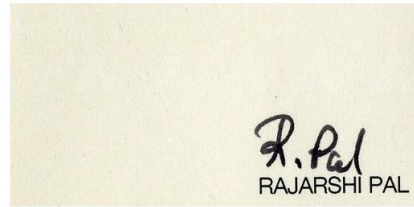
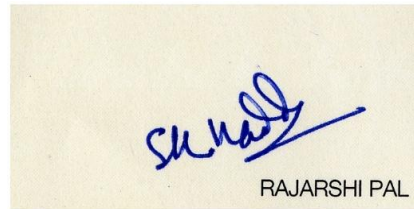


## Assumptions:

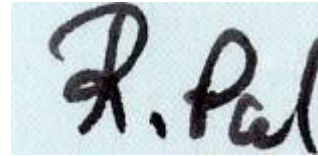
- Cheques contain phrases such as 'Please sign above', 'Signature', etc.
- The signature components should not be too separated otherwise it may be excluded from the cropping.

## Approach - 3: Results

- The algorithm properly removes the text information from cropped image after OCR.
- It is also more robust than connected component approach. Works even when signatures are not connected.



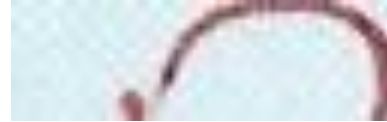
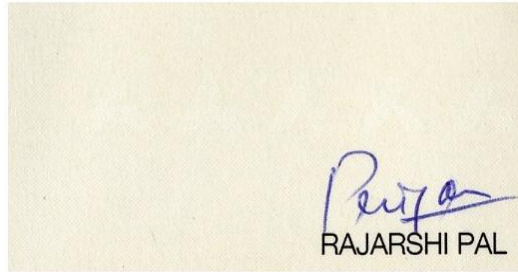
Cropped image after OCR



Cropped image after Line Sweep

## Approach - 3: Failure scenario

- This approach fails when signature components are vertically separated



- The assumption made in this approach is reasonable. We feel that this approach is the most practical compared to the other approaches.

# Signature verification approaches

## **Assignment 2**

Offline Signature verification using SVM and ANN  
approach

# Abstract

- We attempt to replicate the results of paper [3]:  
**"Offline signature recognition using neural networks approach." - Karouni, Ali, Bassam Daya, and Samia Bahlak**
- We incorporate additional features like convex hull area, contour area, aspect ratio, bounding rectangle area, etc. for better characterization of signatures.
- We use two classifiers: SVM and ANN and compare the results.

[3] Karouni, Ali, Bassam Daya, and Samia Bahlak. "Offline signature recognition using neural networks approach." *Procedia Computer Science* 3 (2011): 155-161.

# Pre-processing & Feature extraction [3,4]

- The cropped images after OCR or contour approach is converted to grayscale and then binarization is performed on the image to remove background noise and emphasize the signature to be verified.
- **Centroid:** Horizontal and vertical centres of signature region.
- **Eccentricity:** The ratio of the distance between the foci of the ellipse and its major axis length.
- **Solidity:** The Ratio of pixels in the region to pixels of the convex hull image.
- **Kurtosis:** It is a measure of flatness of distribution. High kurtosis denotes low noise.

[3] Karouni, Ali, Bassam Daya, and Samia Bahlak. "Offline signature recognition using neural networks approach." *Procedia Computer Science* 3 (2011): 155-161.

[4] Chandra, Subhash, and Sushila Maheskar. "Offline signature verification based on geometric feature extraction using artificial neural network." In *Recent Advances in Information Technology (RAIT), 2016 3rd International Conference on*, pp. 410-414. IEEE, 2016.



- **Skewness:** Measure of asymmetry of distribution. Hazy and smooth surfaces are more positively skewed.
- **Contour area:** Area of the contour formed around the signature region.
- **Convex hull area:** Area of tightly bounded region of the signature.
- **Aspect ratio:** Ratio of width and height of signature images.
- **Bounding rectangle area:** Area of the rectangle formed around the signature region; product of width and height in calculating aspect ratio.
- **SIFT Features:** To make up for the rotation and translation of signature present in image region.

# Results



Binary Image of the Genuine Signature



Boundary Box of the Genuine Signature



Convex Hull of the Genuine Signature



Contour formation around the  
Genuine Signature

```
anshul@anshul: ~/Desktop/cv/verification/Signature-Verification
File Edit View Search Terminal Help
anshul@anshul:~/Desktop/cv/verification/Signature-Verification$ python nn.py
Enter person's id : 011
Enter path of signature image : forged_11.png
2018-10-30 22:57:43.040541: I tensorflow/core/platform/cpu_feature_guard.cc:140]
Your CPU supports instructions that this TensorFlow binary was not compiled to
use: AVX2 FMA
Forged Image
anshul@anshul:~/Desktop/cv/verification/Signature-Verification$
```

```
anshul@anshul: ~/Desktop/cv/verification/Signature-Verification
File Edit View Search Terminal Help
anshul@anshul:~/Desktop/cv/verification/Signature-Verification$ python nn.py
Enter person's id : 011
Enter path of signature image : genuine_11.png
2018-10-30 22:48:23.369745: I tensorflow/core/platform/cpu_feature_guard.cc:140] Your CPU
supports instructions that this TensorFlow binary was not compiled to use: AVX2 FMA
Genuine Image
anshul@anshul:~/Desktop/cv/verification/Signature-Verification$
```

- We implemented SVM and ANN classification approaches on our own dataset of cheques.

Genuine



A genuine signature in red ink, written on a yellowish background with a repeating pattern. The signature is stylized and appears to be 'Kapal'.



A genuine signature in black ink, written on a yellowish background with a repeating pattern. The signature is stylized and appears to be 'Kapal'.



A genuine signature in red ink, written on a light blue background. The signature is stylized and appears to be 'Kapal'.

Forged



A forged signature in black ink, written on a white background. The signature is stylized and appears to be 'Kapal'.

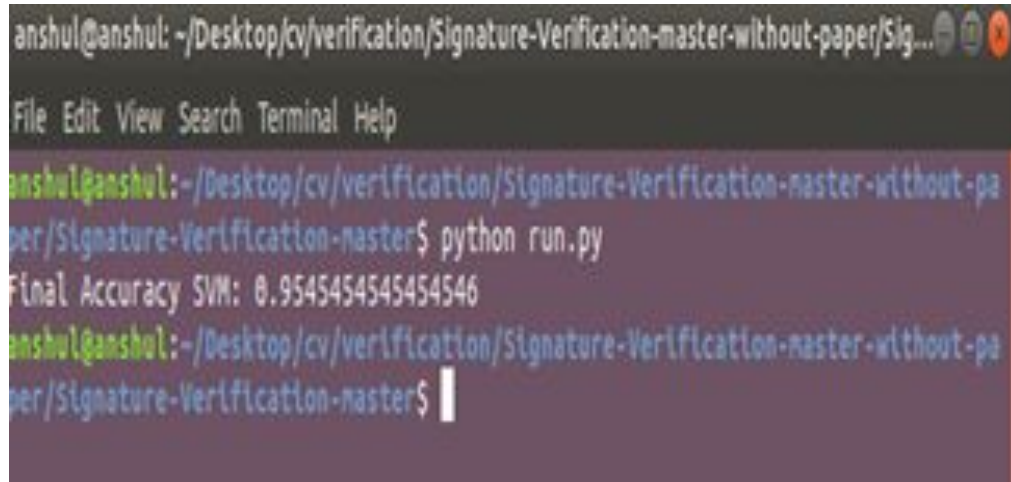


A forged signature in black ink, written on a white background. The signature is stylized and appears to be 'Kapal'.



A forged signature in black ink, written on a white background. The signature is stylized and appears to be 'Kapal'.

# Results: SVM with SIFT (11 distinct signatures)

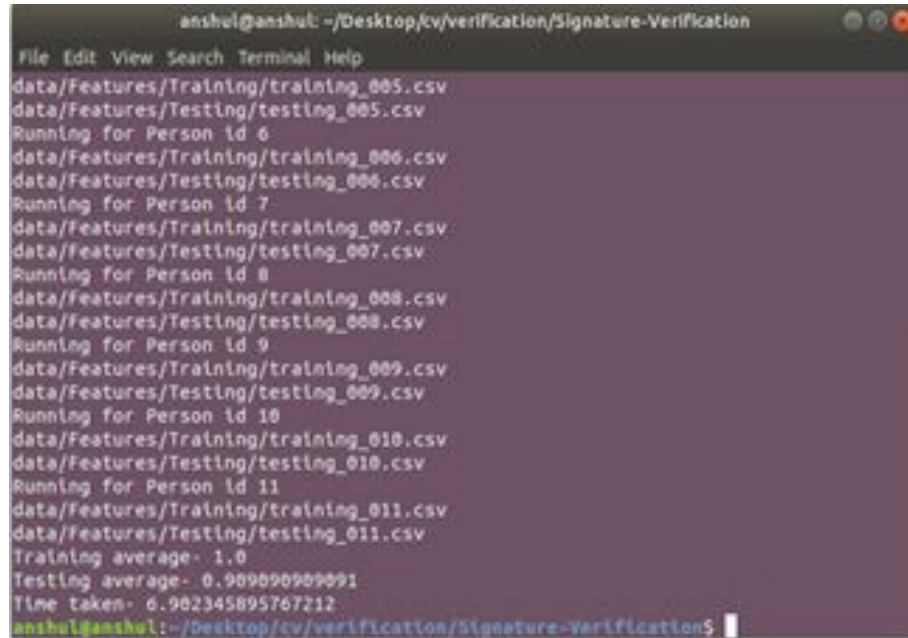
A screenshot of a Linux terminal window. The title bar shows the user 'anshul' and the directory path. The terminal content shows the execution of a Python script 'run.py' which outputs the final SVM accuracy as 0.9545454545454546. The prompt is a green 'anshul@anshul' followed by the directory path.

```
anshul@anshul: ~/Desktop/cv/verification/Signature-Verification-master-without-paper/Sig...  
File Edit View Search Terminal Help  
anshul@anshul:~/Desktop/cv/verification/Signature-Verification-master-without-pa  
per/Signature-Verification-master$ python run.py  
Final Accuracy SVM: 0.9545454545454546  
anshul@anshul:~/Desktop/cv/verification/Signature-Verification-master-without-pa  
per/Signature-Verification-master$
```

SVM Final Accuracy (with SIFT): 95.45%

# Result: ANN with SIFT features (11 distinct signatures)

- ANN classifier: 3 layer neural net - input layer, 7 neuron hidden layer, 1 neuron output layer
- Outputs 1 if the signature is genuine or forged
- For the test dataset, genuine and forged signatures are input to the ANN and the predicted and actual labels are matched to compute the accuracy.

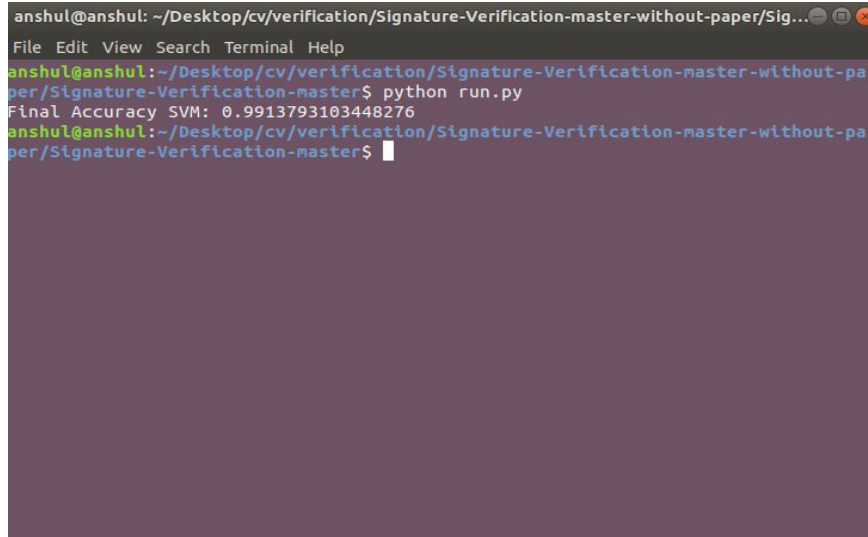


```
anshul@anshul: ~/Desktop/cv/verification/Signature-Verification
File Edit View Search Terminal Help
data/Features/Training/training_005.csv
data/Features/Testing/testing_005.csv
Running for Person id 6
data/Features/Training/training_006.csv
data/Features/Testing/testing_006.csv
Running for Person id 7
data/Features/Training/training_007.csv
data/Features/Testing/testing_007.csv
Running for Person id 8
data/Features/Training/training_008.csv
data/Features/Testing/testing_008.csv
Running for Person id 9
data/Features/Training/training_009.csv
data/Features/Testing/testing_009.csv
Running for Person id 10
data/Features/Training/training_010.csv
data/Features/Testing/testing_010.csv
Running for Person id 11
data/Features/Training/training_011.csv
data/Features/Testing/testing_011.csv
Training average- 1.0
Testing average- 0.909090909091
Time taken- 6.902345895767212
anshul@anshul:~/Desktop/cv/verification/Signature-Verification$
```

ANN Final Accuracy (with SIFT): 90.9 %

# Result: SVM with SIFT (29 distinct signatures)

- SVM based : Feature vector is passed to an SVM with a linear kernel. For the test dataset, genuine and forged signatures are input to the SVM and the predicted and actual labels are matched to compute the accuracy.

A terminal window with a dark background and light-colored text. The window title is 'anshul@anshul: ~/Desktop/cv/verification/Signature-Verification-master-without-paper/Sig...'. The menu bar shows 'File Edit View Search Terminal Help'. The command prompt shows 'anshul@anshul:~/Desktop/cv/verification/Signature-Verification-master-without-paper/Signature-Verification-master\$ python run.py'. The output of the command is 'Final Accuracy SVM: 0.9913793103448276'. The prompt is followed by a cursor.

```
anshul@anshul: ~/Desktop/cv/verification/Signature-Verification-master-without-paper/Sig...
File Edit View Search Terminal Help
anshul@anshul:~/Desktop/cv/verification/Signature-Verification-master-without-paper/Signature-Verification-master$ python run.py
Final Accuracy SVM: 0.9913793103448276
anshul@anshul:~/Desktop/cv/verification/Signature-Verification-master-without-paper/Signature-Verification-master$
```

SVM Final Accuracy (with SIFT): 99.13%

# Result: ANN without SIFT (29 distinct signatures)

```
anshul@anshul: ~/Desktop/cv/verification/Signature-Verification
File Edit View Search Terminal Help
data/Features/Testing/testing_023.csv
Running for Person id 24
data/Features/Training/training_024.csv
data/Features/Testing/testing_024.csv
Running for Person id 25
data/Features/Training/training_025.csv
data/Features/Testing/testing_025.csv
Running for Person id 26
data/Features/Training/training_026.csv
data/Features/Testing/testing_026.csv
Running for Person id 27
data/Features/Training/training_027.csv
data/Features/Testing/testing_027.csv
Running for Person id 28
data/Features/Training/training_028.csv
data/Features/Testing/testing_028.csv
Running for Person id 29
data/Features/Training/training_029.csv
data/Features/Testing/testing_029.csv
ANN Accuracy
Training average- 0.994252872878
Testing average- 0.801724137931
Time taken- 18.059519052505493
anshul@anshul:~/Desktop/cv/verification/Signature-Verification$
```

ANN final accuracy (without SIFT): 80.17%



# Conclusion

- Line-Sweeping algorithm after OCR detection works best for our dataset for exact localization of signatures in cheques.
- SIFT features are extremely important for characterization of signatures because it handles rotated images, shear images and other illumination scenarios.

THANK YOU