Offline Signature Verification Using Feature Learning and One-Class Support Vector Machine

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Introduction

We, primarily, seek to solve certain challenges that arise in real-world writer-dependent classification by designing a model that would be able to significantly reduce computation while, at the same time, increase accuracy.

Experiments are performed using the Center of Excellence for Document Analysis and Recognition (CEDAR) dataset

We narrowed our down research to:

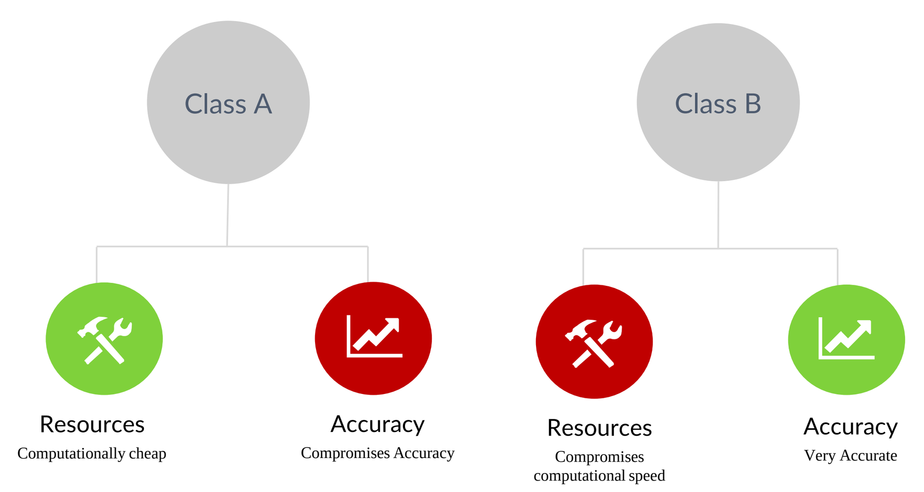
- Offline signature verification:

  Uses solely the 2-dimensional pixel information of a signature in order to classify it as either genuine or forged.

- Writer-dependent signature verification:

  Writer-dependent approaches assign each signer or writer a personal classifier (also called specific model) trained specifically on their signature

The Problem

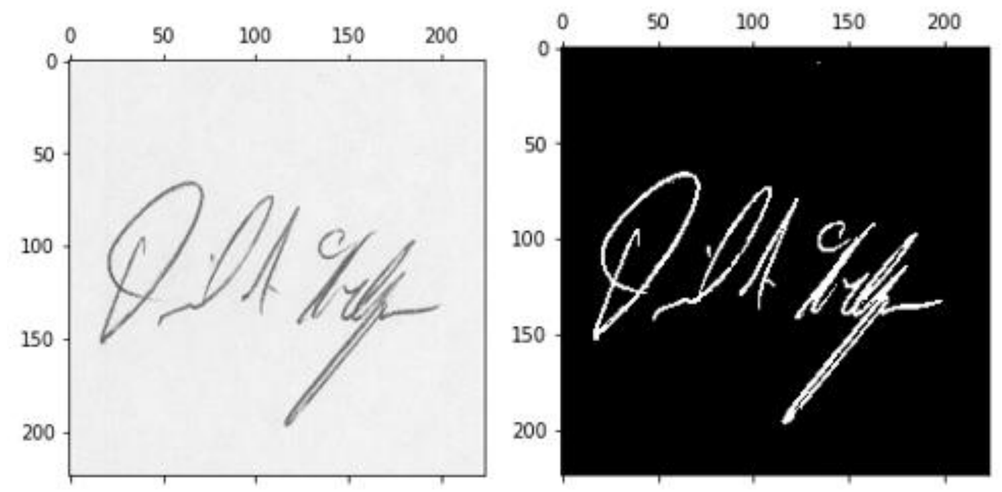


PREPROCESSING

Resizing: Resized all input images to a fixed dimension of 224x224 using bi-linear interpolation.

Binarization: This produces a binarized image where only two types of pixels are present, which in our case are 0-pixels and 1-pixels

Inversion: We converted the color of each pixel to its opposite



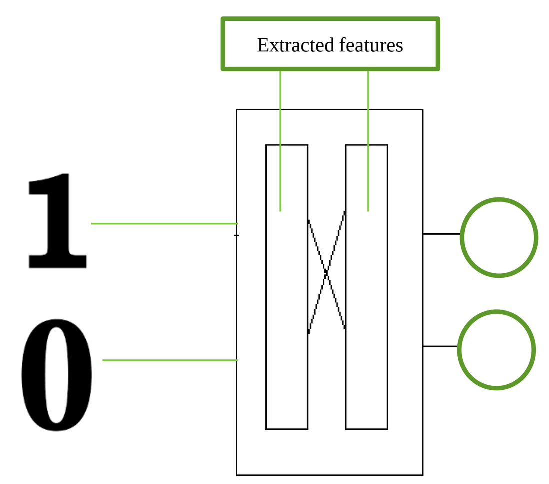
METHODOLOGY

We propose the use of the VGG-16 architecture for feature learning combined with OC-SVMs as a writer-dependent classifier

Feature Learning

Feature learning makes use of neural networks to extract features from an image by gathering outputs from the hidden layers.

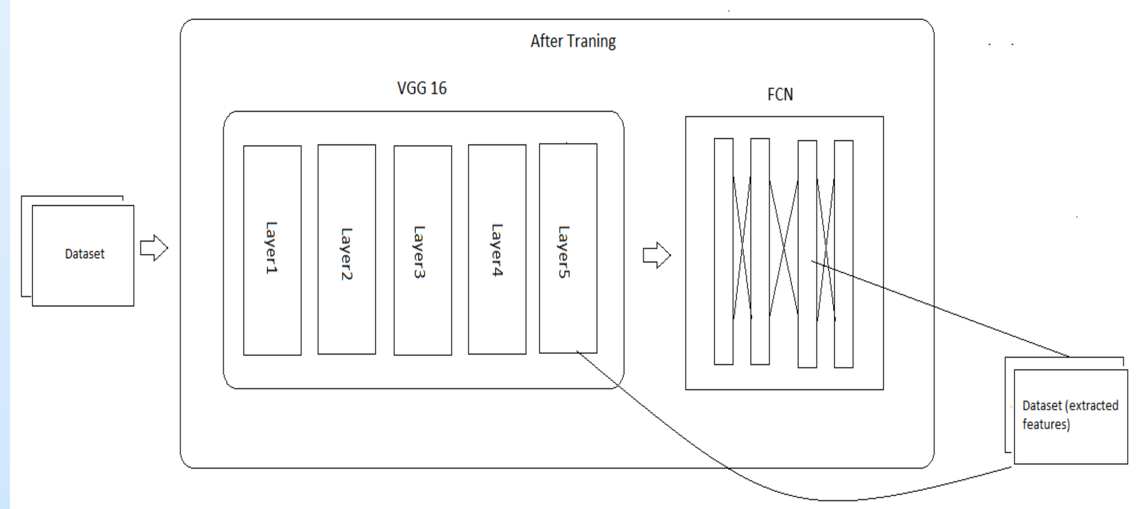
Neurons in the hidden layers output a specific value depending on what the input is. Those values can be thought of as features that indicate to the final layer whether the input is a zeros or a one



Surrogate classification

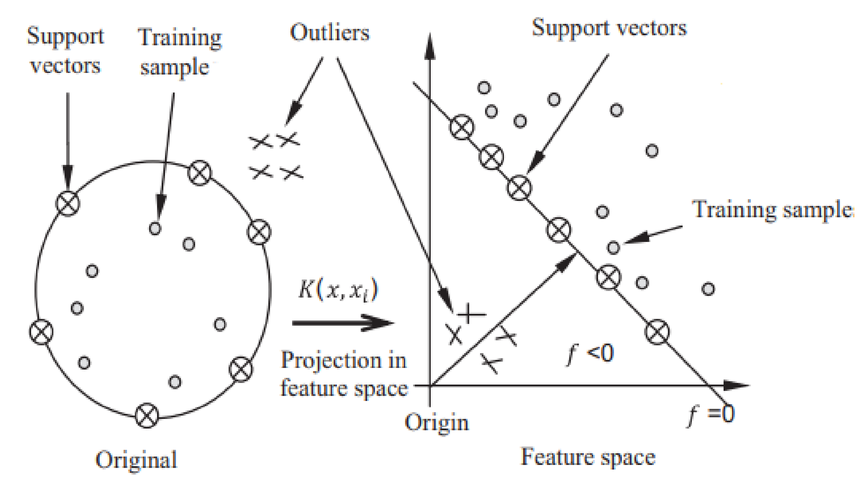
- Think of a surrogate classification task as a guide to which features the feature learner should be learning.
- In our case we want the model to extract features associated with forgery. Thus, our surrogate distinguishes forgeries from genuine signatures without regard to the identity of the writer (writer-independent).

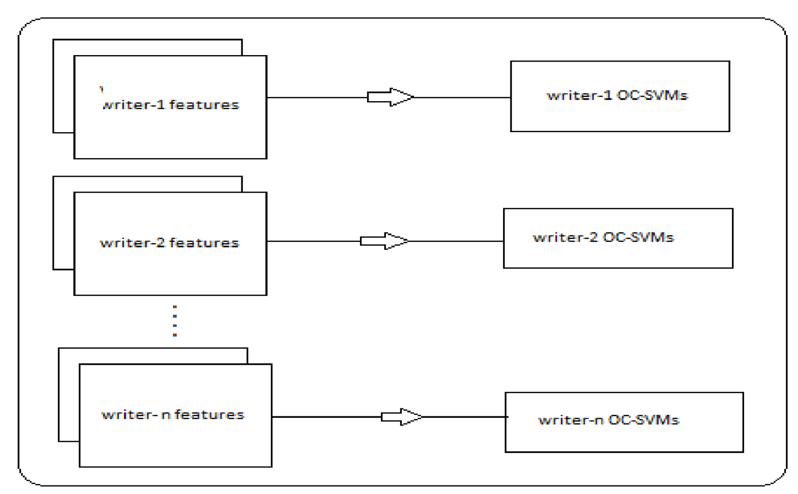
VGG-16 for feature learning



One-class Support Vector Machine

A sample presented to an OC-SVM classifier is accepted or rejected according to its resemblance to the training set





Evaluation Metrics

False Rejection Rate (FRR) and False Acceptance Rate for skilled forgeries (FAR). FRR is the fraction of genuine signatures that are classified as forgery, while FAR is the fraction of forgeries that are classified as genuine signatures. Other metrics include the Average Error Rate, which is the average of the FAR and the FRR scores. For our results, we report these three metrics and the Accuracy metric.

RESULTS

I. RESULTS IN PERCENTAGE (%) OF OUR MODEL JUXTAPOSED WITH OTHER PROPOSALS

TYPE	Method	FARskilled	FRR	AER	EER	Accuracy
WI	SigNet [6]	0.00	0.00	0.00	0.00	100
WI	Kumar et al. [16]	11.23	12.39	11.81	11. 59	-
WI	Yasmine Guerbai et al. [1]	7.41	8.25	7.83	-	-
WI	Sourya et al.[9]	-	-	-	-	100
WD	Hafeman et al. [15](BRAZILIAN PUC-PR)	13.00	2.17	3.96	4.17	
WI	Hafeman et al. [8]	-	-	-	4.63	-
WD	**Our model (CEDAR)**	**3.6**	**13.1**	**8.35**	**-**	**94.3**

References

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[2] A. Kumar and K. Bhatia, “K-NN based Writer Independent Offline Signature Verification System,” in *Proceedings of International Conference on Technological Advancements and Innovations, ICTAI 2021*, 2021, pp. 612–616. doi: 10.1109/ICTAI53825.2021.9673479.

[3] J. Coetzer, B. Herbst, and J. du Preez, “Off-line signature verification: A comparison between human and machine performance,” *Tenth International Workshop on …*, 2006, [Online]. Available: http://hal.inria.fr/IWFHR10/inria-00103737

[4] V. L. F. Souza, A. L. I. Oliveira, and R. Sabourin, “A writer-independent approach for offline signature verification using deep convolutional neural networks features.” [Online]. Available: http://en.etsmtl.ca/Unites-de-recherche/LIVIA/Recherche-et-

[5] G. Alvarez, B. Sheffer, and M. Bryant, “Offline Signature Verification with Convolutional Neural Networks.” [Online]. Available: https://github.com/Lasagne/Recipes/blob/master/modelzoo/vgg16.py