



Signature verification

Introduction

BIOMETRICS

- Biometric systems recognize individuals based on their characteristics:
 - physical characteristics (fingerprint, face, iris)
 - behavioral characteristics (voice, signature)
- Biometrical characteristic:
 - universal
 - unique
 - immutable
 - easily collectable
- Verification confirms a person's true identity

SIGNATURE

- Noninvasive
- Generally accepted means of individual verification
- Legal meaning
- Genuine or forged signature



Signature verification systems

COLLECTING

- Offline - collect ready-made signature after the signing process
- Online - collect signatures using devices that record changes in pen position in real time

SYSTEM

- Writer-independent system - one model classifies all signatures
- Writer-dependent system - one model for each individual



Goals

- Implement signature verification methods
- Feature extraction
- Compare the results using standard metrics:
 - accuracy
 - precision
 - recall

Challenges

- Signature changes depending on psychophysical condition and external conditions
- Small variability between genuine signatures and high-quality forgeries
- Often not enough signature samples

SIGCOMP2011

- Different approach but the same goal: signature verification
- Signatures in Latin and Chinese; static and dynamic dataset

	genuine signatures	forged signatures	authors
Training data	240	123	10
Testing data	648	638	54

- 6 institutions - 13 solutions
- Accuracy testing: comparing signatures with 12 reference signatures written by participants
- Different algorithms and geometry-based methods
- Other: open-source material with similar dataset and 20+ solutions

genuine signatures

Schmitt

Schmitt

Schmitt

Schmitt

forged signatures

Schmitt

Schmitt

Schmitt

Schmitt

Project team solution

Project Solution

DATASET

- ICDAR dataset offline dutch signatures with custom train/val/test split
- examples = pairs of two signatures (labels: 0 (true-genuine) / 1 (true-forged))
- Train/test/val split: 16402 examples (pairs of two images) - 2856 examples - 3948 examples
- 69 individuals' signatures

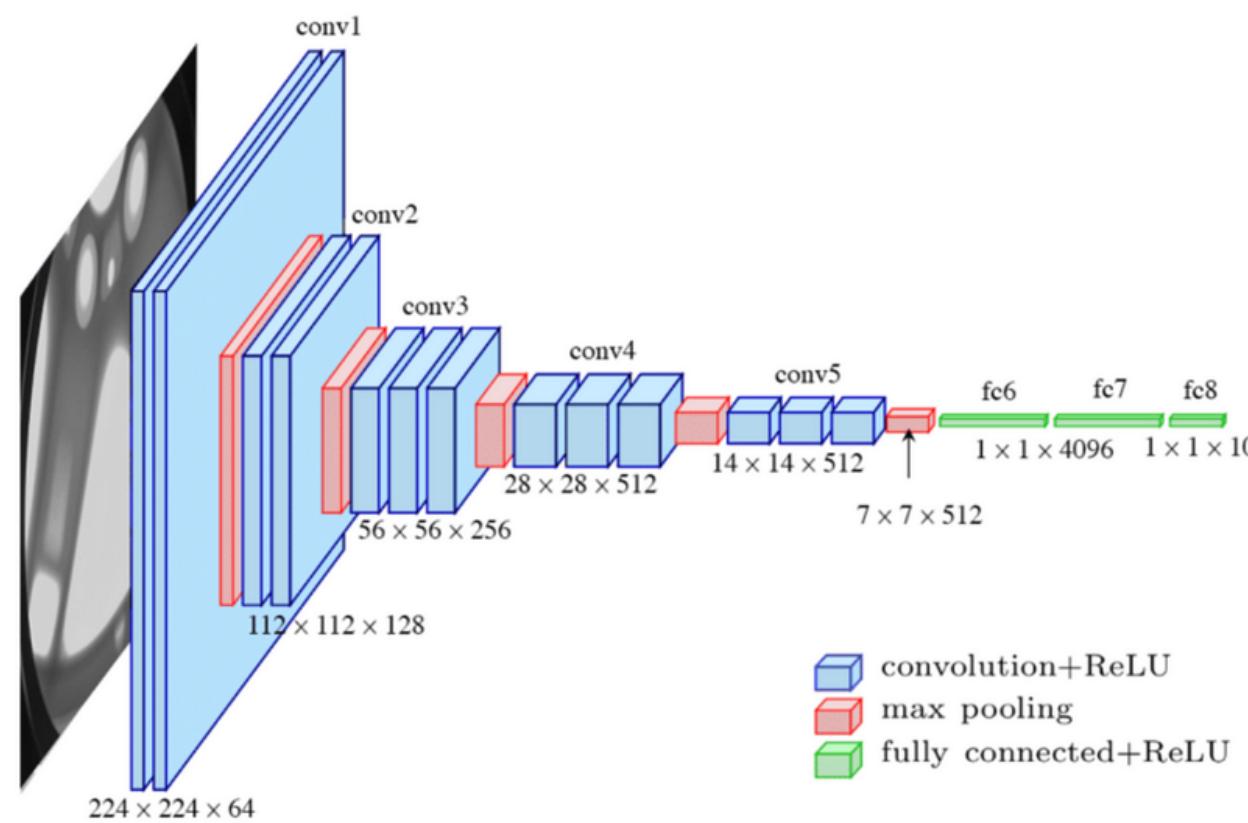
FEATURE EXTRACTION + CLASSIFICATION

fine-tuned pre-trained
VGG-16 model

histograms of
oriented gradients

Method 1: VGG-16

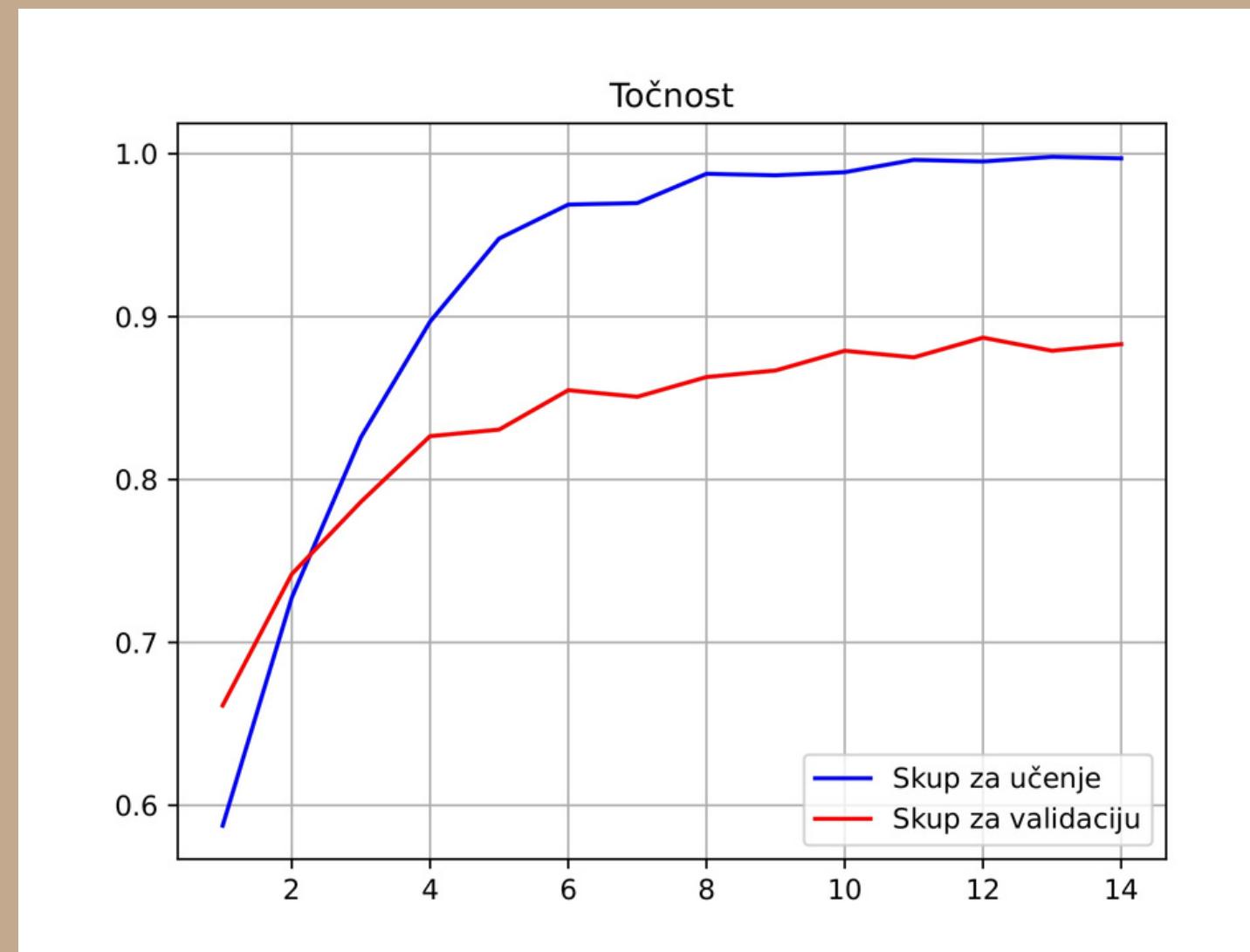
- Convolutional model
- Additionally trained using samples from the training and validation sets
- Only the last 4 layers have been trained
- 2 layers added to the end of the model:
 - 256 neurons; ReLu
 - 2 neurons; softmax



Layer (type)	Output Shape	Param #
vgg16 (Functional)	(None, 7, 7, 512)	14714688
flatten (Flatten)	(None, 25088)	0
dense (Dense)	(None, 256)	6422784
dropout (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 2)	514
<hr/>		
Total params: 21,137,986		
Trainable params: 13,502,722		
Non-trainable params: 7,635,264		

Training metrics

ACCURACY FUNCTION

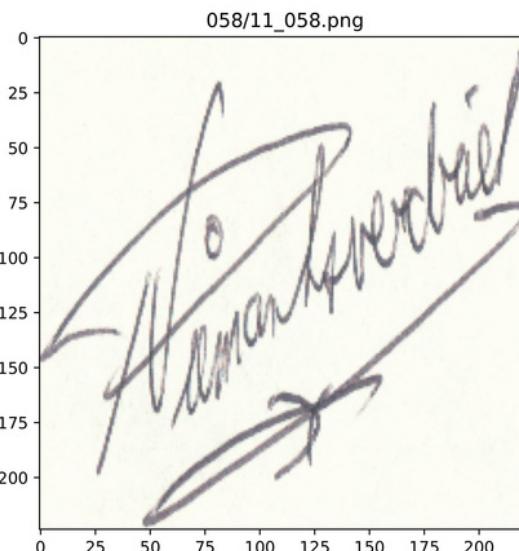
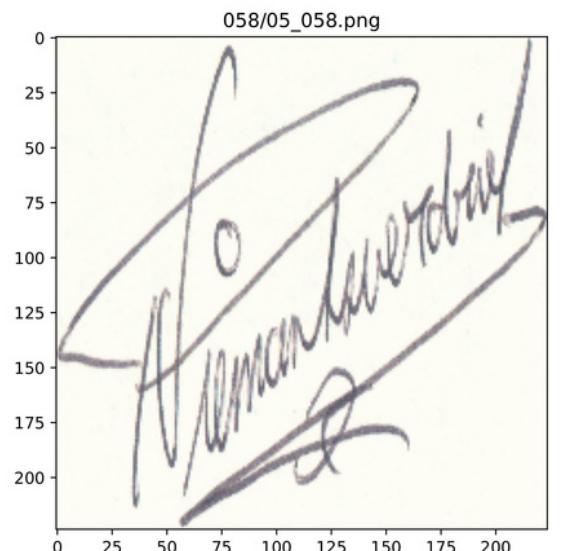


LOSS FUNCTION



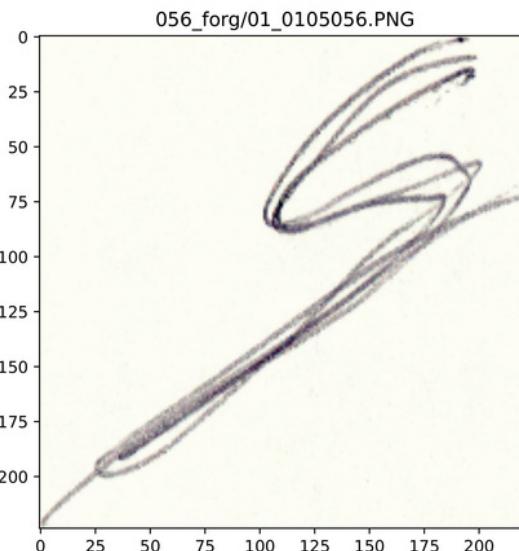
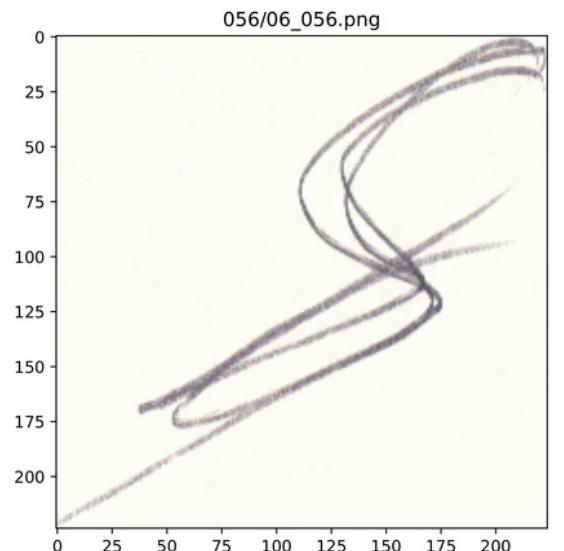
FALSE POSITIVE

osoba 58 / pred: lažno predstavljanje / true: ispravni potpisi

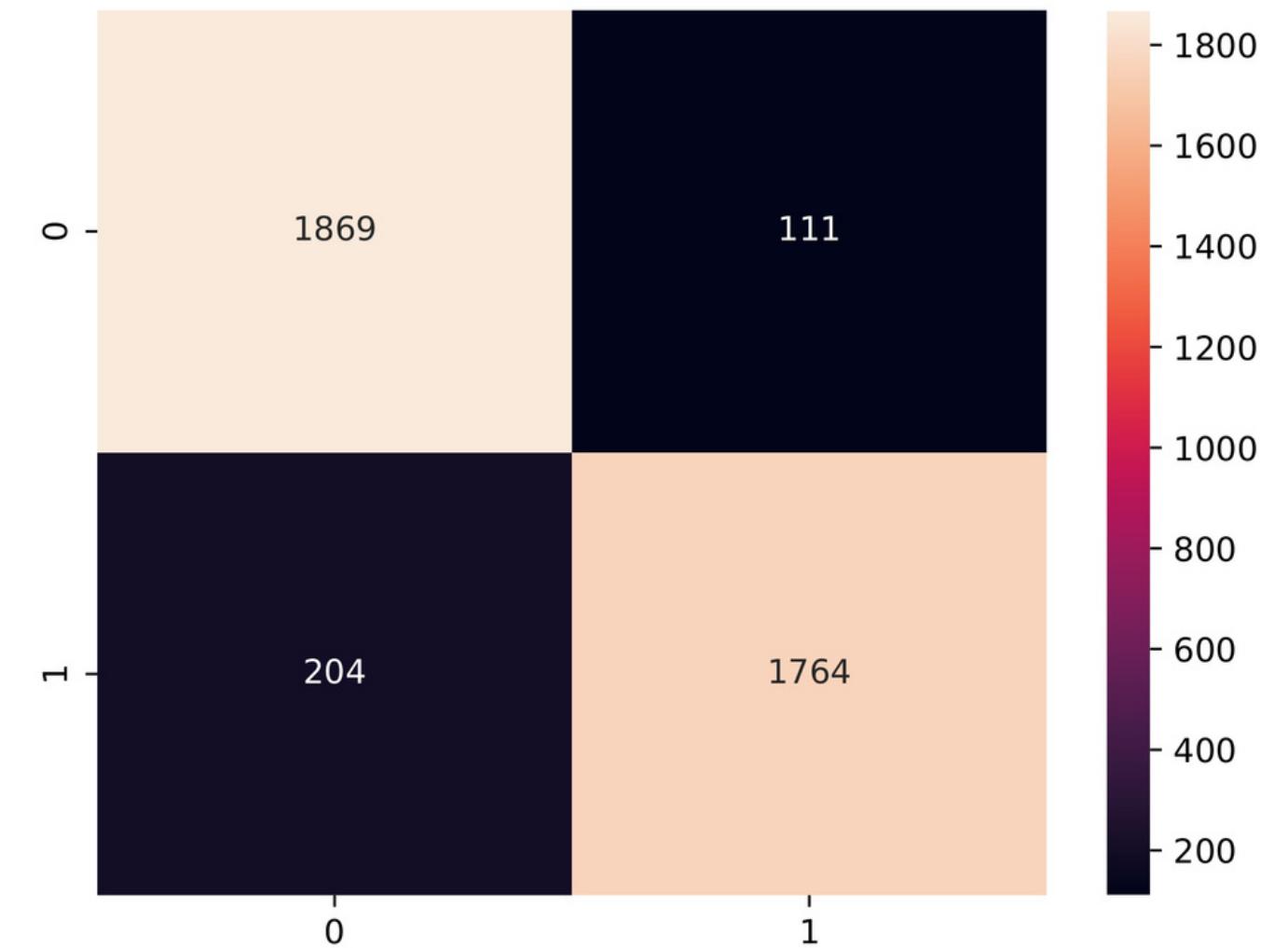


FALSE NEGATIVE

osoba 56 / pred: ispravni potpisi / true: lažno predstavljanje

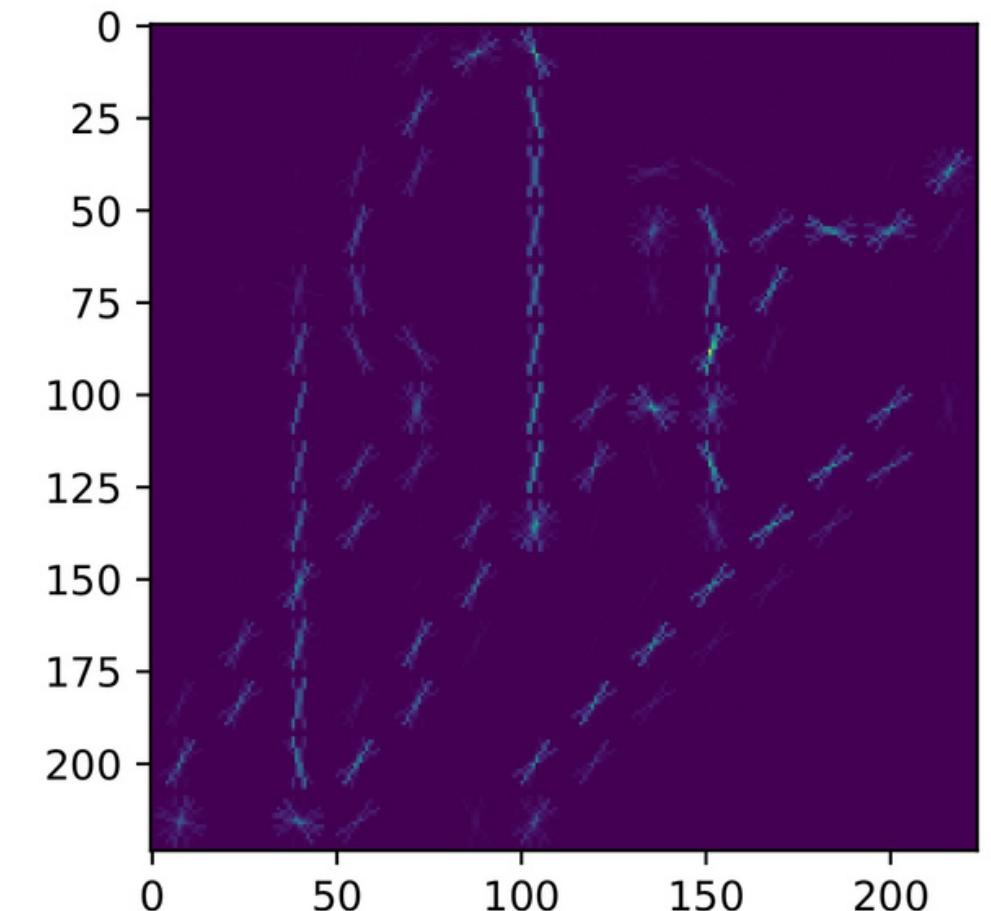
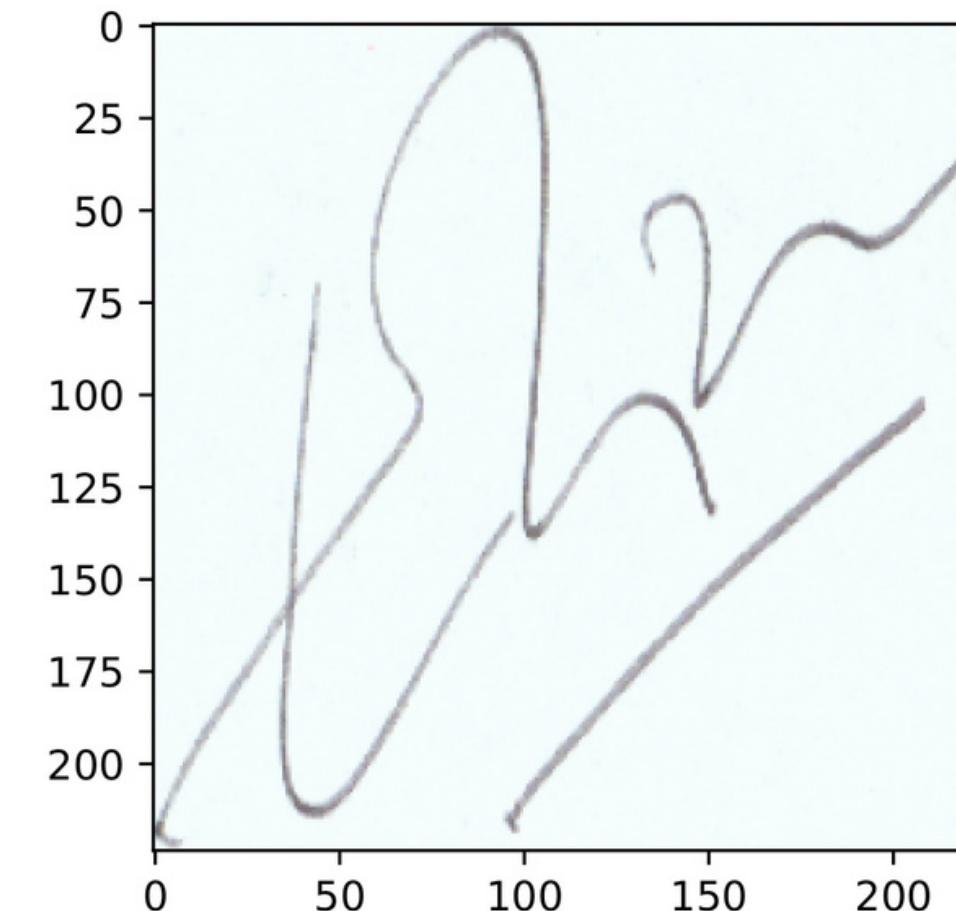


CONFUSION MATRIX



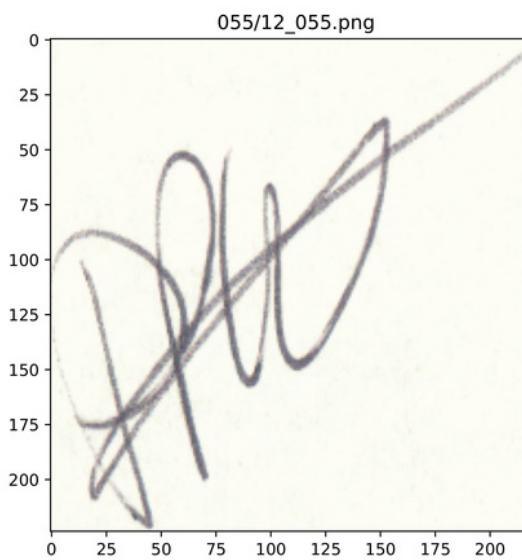
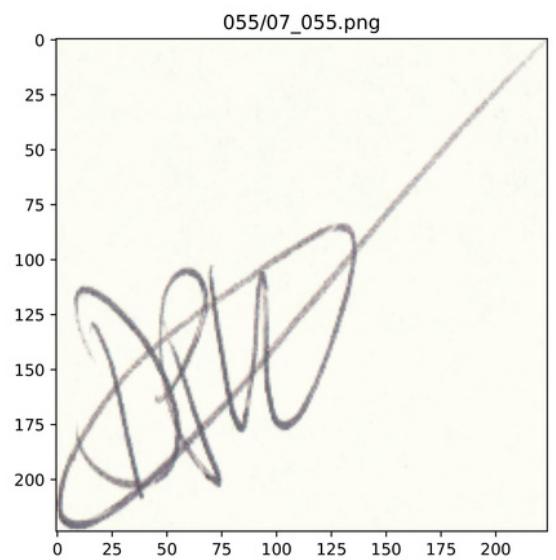
Method 2: HOG

- Histogram of Oriented Gradients
- Counts gradient orientation occurrences in a localized image portion
- Extracted using Python skimage library



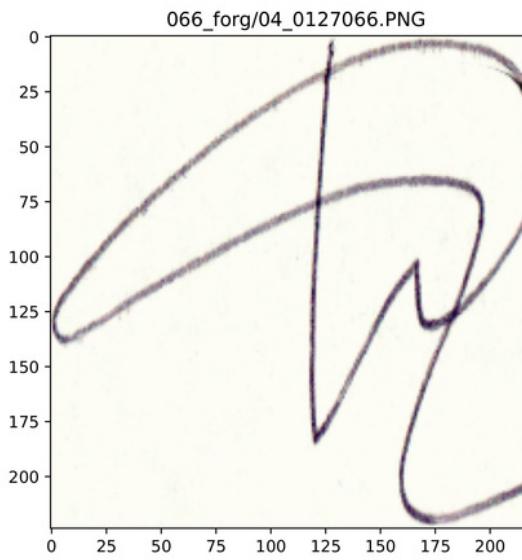
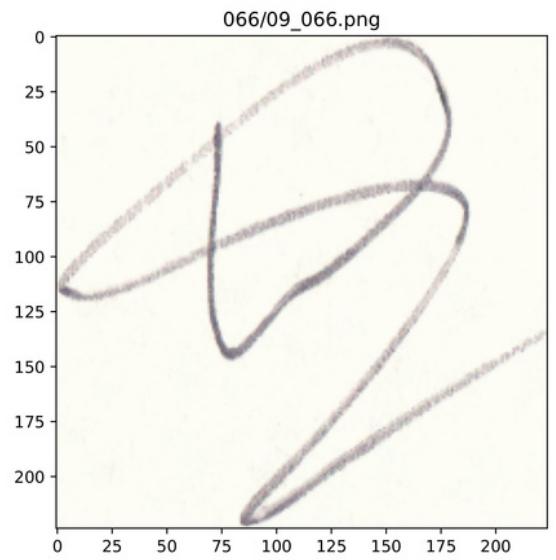
FALSE POSITIVE

osoba 55 / pred: lažno predstavljanje / true: ispravni potpisi

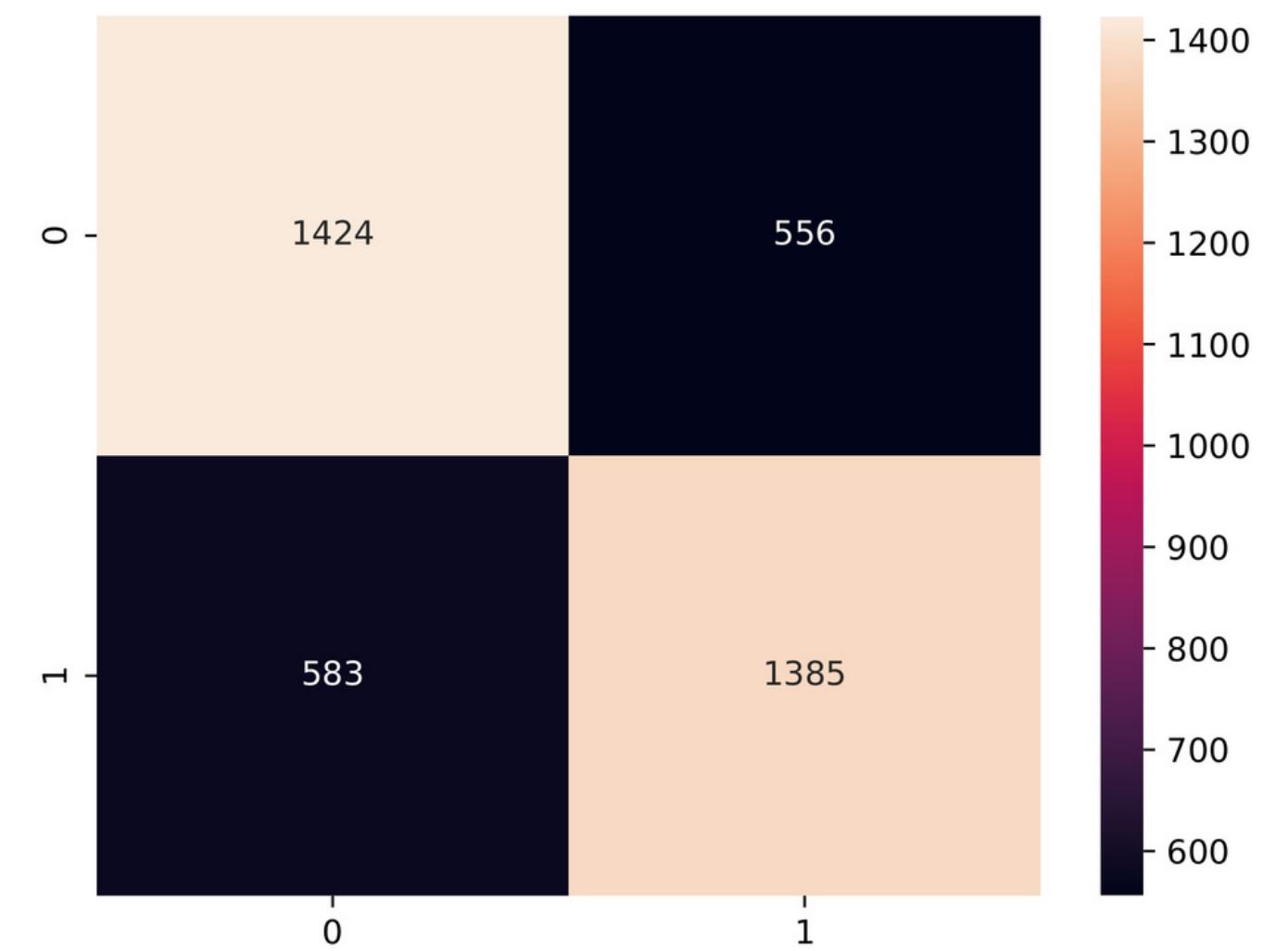


FALSE NEGATIVE

osoba 66 / pred: ispravni potpisi / true: lažno predstavljanje



CONFUSION MATRIX



METHOD1

Model	Accuracy
Logistic Regression	0.9083
Random Forest	0.9202
Linear SVM	0.8982
RBF SVM	0.9192

METHOD2

Model	Accuracy
SGDClassifier	0.6781
Random Forest	0.7115

CONCLUSION

- Solution for signature verification using 2 types of feature extraction: a CNN and HOG
- Best accuracy for extraction using VGG16 model = 92.02%
- Our results are comparable to cited literature
- Future work may include longer training and/or on a better machine, or a different approach

THANK YOU

FOR LISTENING!

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MATEJ LOPOTAR
LUCIJA MARINČIĆ
ZRINKA PEĆANIĆ
ANA VLADIĆ

