1

SVM for MNIST Handwritten Digits Classification

Adam Kosiorek

***Abstract*—This report describes classification of handwritten digits from the MNIST dataset by an SVM classifier.**

I. Introduction

THE first assignment was to explore the SVM classifier for the MNIST handwritten digits recognition.

II. Dataset

The MNIST dataset is comprised of 60000 training and 10000 testing samples [1]. Each sample is a 28x28 pixel black and white image of a single centered digit. It is widly used as a benchmark for comparing machine learning algorithms.

III. Experiments

All experiments were carried out on a notebook with Intel i7-2670QM quad core CPU and 8Gb RAM with Python SciPy package.

A. Dataset Preparation

It is known that processing input data prior to classification can improve results. In case of MNIST and SVM, however, state of the arts results have been achieved without preprocessing, that is, with raw pixels [3]. I compare the influence of mean intensity subtraction and ZCA-Whitening [6] on classification accuracy.

B. Classifier Tuning

The SVM classifier can be adapted to a particular task by choosing a kernel type and adjusting several parameters. Since the parameters might not be independent it is often necessary to perform an exhaustive grid search. Python's sklearn.grid_search.GridSearchCV is well suited for this task. I explored linear kernel, rbf kernel with gamma between 1e-6 and 1 and a polynomial kernel of degree between 2 and 9. For all kernels the C parameter was taken from the range between 1e-2 and 1e4

TABLE I
Simulation Parameters

Information message length	$k = 16000$ bit
Radio segment size	$b = 160$ bit
Rate of component codes	$R_{cc} = 1/3$
Polynomial of component encoders	$[1, 33/37, 25/37]_8$

Advisor: M.Sc. Caner Hazibras M.Sc. Phillip , Chair for Computer Vision, TUM, SS 2015.

Fig. 1. Simulation results on the AWGN channel. Average throughput k/n vs E_s/N_0.

IV. Results

V. Comparision with State of The Art

Gallia est omnis divisa in partes tres, quarum unam incolunt Belgae, aliam Aquitani, tertiam qui ipsorum lingua Celtae, nostra Galli appellantur. Gallos ab Aquitanis Garumna flumen, a Belgis Matrona et Sequana dividit. Horum omnium fortissimi sunt Belgae, propterea quod a cultu atque humanitate provinciae longissime absunt, minimeque ad eos mercatores saepe commeant atque ea quae ad effeminandos animos pertinent important, proximique sunt Germanis, qui trans Rhenum incolunt, quibuscum continenter bellum gerunt. Qua de causa Helvetii quoque reliquos Gallos virtute praecedunt, quod fere cotidianis proeliis cum Germanis contendunt, cum aut suis finibus eos prohibent aut ipsi in eorum finibus bellum gerunt. Eorum una, pars, quam Gallos obtinere dictum est, initium capit a flumine Rhodano, continetur Garumna flumine, Oceano, finibus Belgarum, attingit etiam ab Sequanis et Helvetiis flumen Rhenum, vergit ad septentriones. Belgae ab extremis Galliae finibus oriuntur, pertinent ad inferiorem partem fluminis Rheni, spectant in septentrionem et orientem solem.

VI. Discussion

This section summarizes the paper.

References

[1] Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner. "Gradient-based learning applied to document recognition." Proceedings of the IEEE, 86(11):2278-2324, November 1998.

[2] T. Mayer, H. Jenkac, and J. Hagenauer. Turbo base-station cooperation for intercell interference cancellation. *IEEE Int. Conf. Commun. (ICC)*, Istanbul, Turkey, pp. 356–361, June 2006.

[3] D. Decoste and B. Schlkopf. "Training invariant support vector machines." Machine learning 46, no. 1-3 (2002): 161-190.

[4] J. G. Proakis. *Digital Communications*. McGraw-Hill Book Co., New York, USA, 3rd edition, 1995.

[5] Y. LeCun, C. Cortes, C.J.C. Burges. The MNIST database of handwritten digits. http://yann.lecun.com/exdb/mnist/.

[6] A. Ng, J, Ngiam, C.Y. Foo, Y. Mai and C Suen. "Unsupervised Feature Learning and Deep Learning Tutorial." http://ufldl.stanford.edu/wiki/index.php/UFLDL_Tutorial.

[7] IEEE Transactions LaTeXand Microsoft Word Style Files. http://www.ieee.org/web/publications/authors/transjnl/index.html