

# MATHEMATICAL ASPECTS OF MACHINE LEARNING

REPORT

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## Digit Recognition with Support Vector Machine

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# Problem Statement

Our main goal is to correctly identify handwritten digits based on the MNIST ("Modified National Institute of Standards and Technology") data set. This data set consists of 42000 gray-scale images. Each image is 28 pixels in height and 28 pixels in width. Each pixel has a single pixel-value associated with it, indicating the lightness or darkness of that pixel (kag).

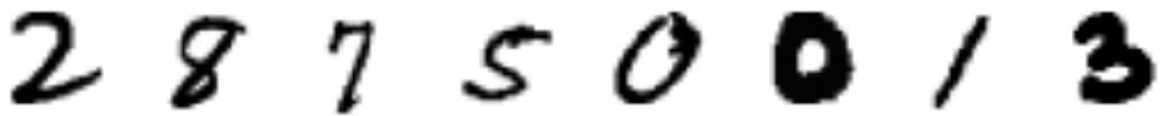


Figure 1: Visualization of eight of these images

# Support Vector Machine

The support vector machine (SVM) is a binary classifier designed to find the a separating hyperplane in the feature space resulting in a decision function of the form

$$f(x) = \text{sign}(w^T \cdot \Phi(x) + b)$$

where  $\Phi$  is the feature map.

The goal is now to maximize the margin while softly penalizing points that lie on the wrong side of the margin boundary. We want to penalize missclassified points and small distances to the decision boundary and thus obtain the following minimization problem:

$$\min a$$

In the case of non linearly separable classes, misclassified points and and small distances to the decision boundary are penalized and we obtain the following optimization problem:

SMO

ecoc

# Bibliography

[Bea00] BEARDON, Alan F.: *Iteration of Rational Functions: Complex Analytic Dynamical Systems*. Springer New York, 2000 (Graduate Texts in Mathematics). – ISBN 9780387951515

[kag] <https://www.kaggle.com/c/digit-recognizer/data>