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## Support Function Machine for Set-based Classification with Application to Water Quality Evaluation

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## Abstract

In some applications, measurement errors and multiple repeated measurements often lead to a set-based classification task where objects are represented with a set of samples, and the traditional support vector machines (SVMs) do not work in these settings. To deal with this problem, we construct a new classifier called support function machine (SFM) in this work. First, sets in d-dimensional Euclidean space  $\mathbb{R}^d$  are mapped into an infinite-dimensional Banach space C(S)(whose elements are functions) via support functions, and then set-based classification in  $\mathbb{R}^d$  is converted into function-based classification in C(S). Second, we define the hyperplane via the Riesz representation theorem in Banach space, and discuss the Hausdorff distance of hyperplanes and maximum margin principle (MMP) in C(S). Based on MMP, we construct an optimal problem and discuss some of its properties. Thereafter, we establish an SFM to solve setbased classification. Experiments about water quality evaluation and set-valued data classifications show the superiority of SFM.

Keywords: Support Vector Machine, Set-valued Data, Classification, Support Function, Water Quality Evaluation

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