Master's Thesis

A twin hyper-ellipsoidal model with a single quadratic constraint for multiclass classification

Guidance

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Abstract

Various types of the Support Vector Machine (SVM) type methods have been proposed for multi-class classifications. The classical SVMs classify data via hyperplanes. Recently, hypersphere and hyperellipsoid classifiers have attracted much attention since they outperform the existing hyperplane classifiers. The Twin Hypersphere Multi-Classification Support Vector Machine (THKSVM) is an effective SVM-based method that exploits multiple hyperspheres to classify data effectively. The THKSVM outperforms the existing methods based on the SVM in terms of computational time even though its prediction accuracy is competitive with the ones. The THKSVM adopts the "rest-versus-1" structure and constructs the hyperspheres by solving several nonconvex optimization problems, which have no guarantee that these problems have global optima.

In this thesis, we modify the THKSVM to get better classifiers in a reasonable time. First, we adopt hyperellipsoids instead of hyperspheres for classifications. Second, we substitute a certain single constraint for the numerous constraints in THKSVM. Then the proposed optimization model has a single nonconvex quadratic constraint and a convex quadratic objective function. Although the problem is still nonconvex optimization, we can obtain its global optimum analytically due to the singleness of the constraint. Consequently, we can expect that the proposed method is superior to the THKSVM in terms of computational time and prediction accuracy. Finally, some numerical experiments are conducted to show the effectiveness of the proposed method.