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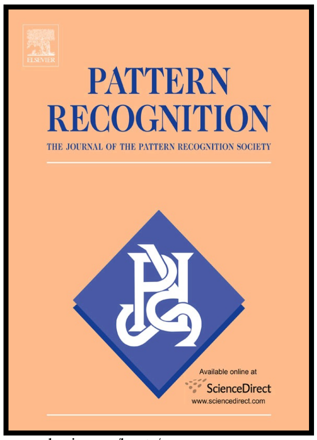

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Inexact Implementation Using Krylov Subspace Methods for Large Scale Exponential Discriminant Analysis with Applications to High Dimensionality Reduction Problems

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Abstract

Exponential discriminant analysis (EDA) is a generalized discriminant analysis method based on matrix exponential. It can essentially overcome the intrinsic difficulty of small sample size problem that exists in the classical linear discriminant analysis (LDA). However, for data with high dimensionality, one has to solve a large matrix exponential eigenproblem in this method, and the time complexity is dominated by the computation of exponential of large matrices. In this paper, we propose two inexact Krylov subspace algorithms for solving the large matrix exponential eigenproblem efficiently. The contribution of this work is threefold. First, we consider how to compute matrix exponential-vector products efficiently, which is the key step in the Krylov subspace method. Second, we compare the discriminant analysis criterion of EDA and that of LDA from a theoretical point of view. Third, we establish the relationship between the accuracy of the approximate eigenvectors and the distance to nearest neighbour classifier, and show why the matrix exponential eigenproblem can be solved approximately in practice. Numerical experiments on some real-world databases show the superiority of our new algorithms over their original counterpart for face recognition.

Index Terms

Dimensionality reduction, Linear discriminant analysis (LDA), Exponential discriminant analysis (EDA), Matrix exponential, Krylov subspace method.

I. Introduction

Dimensionality reduction is the process of reducing the number of random variables under consideration, via obtaining a set uncorrelated principle variables, which can be divided into feature selection and feature extraction. The advantages of dimensionality reduction include that it reduces the time and storage space required, improves the performance of the machine learning model, and it becomes easier to visualize the data when reduced to very low dimensions. In essence, dimensionality reduction is the transformation of high-dimensional data into a lower dimensional data space. Currently, one of the most extensively used dimensionality reduction methods is subspace transformation [10], [23], [24], [27], [40], [41], [43].

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