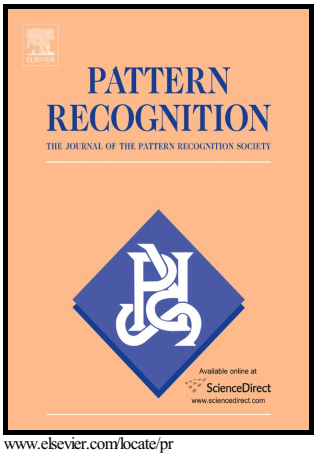

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Collaborative Probabilistic Labels for Face Recognition from Single Sample per Person

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Abstract: Single sample per person (SSPP) recognition is one of the most challenging problems in face recognition (FR) due to the lack of information to predict the variations in the query sample. To address this problem, we propose in this paper a novel face recognition algorithm based on a robust collaborative representation (CR) and probabilistic graph model, which is called Collaborative Probabilistic Labels (CPL). First, by utilizing label propagation, we construct probabilistic labels for the samples in the generic training set corresponding to those in the gallery set, thus the discriminative information of the unlabeled data can be effectively explored in our method. Then, the adaptive variation type for a given test sample is automatically estimated. Finally, we propose a novel reconstruction-based classifier for the test sample with its corresponding adaptive dictionary and probabilistic labels. The proposed probabilistic graph based model is adaptively robust to various variations in face images, including illumination, expression, occlusion, pose, etc., and is able to reduce required training images to one sample per class. Experimental results on five widely used face databases are presented to demonstrate the efficacy of the proposed approach.

1. Introduction

Over the past three decades, as one of the most visible applications in computer vision, face recognition (FR) has been receiving significant attention [1] and a large number of algorithms have been proposed in recent years [2-25]. Representative and popular algorithms include principal component analysis (PCA) [13], linear discriminant analysis (LDA) [2], locality preserving projections (LPP) [8], sparse representation based classification (SRC) [19] and their weighted, kernelized, and two-dimensional variants [10,11,15,17,25]. Recently, it has been proved that it is the collaborative representation (CR) [23-24] but not the l_1-norm sparsity that makes SRC powerful for face classification. What's more, CR has significantly less complexity. However, because it is usually difficult, expensive and time-consuming to collect sufficient labeled samples, many traditional methods, including collaborative representation based classification (CRC), usually suffer from the scenario that only few labeled samples per person are available. To solve this problem, some semi-supervised learning (SSL) algorithms [43-47], which utilize a large number of unlabeled data to help build a better classifier from the labeled data, have been proposed in recent years.

The performance of above methods in face recognition, however, is heavily influenced by the number of training samples per person [26-27]. Especially in many practical applications of FR (e.g., law enforcement, e-passport, surveillance, ID card identification, etc.), we can only have a single sample per person. This makes the problem of FR particularly hard since the information used for prediction is very limited while the variations in the query sample are abundant, including background illumination, pose, and facial corruption/disguise such as makeup, beard, and occlusions (glasses and scarves). Practically, this problem is called single sample per person (SSPP) classification. To address the problem of SSPP, many specially designed FR methods have been developed, which can be generally classified into three categories [26]: image partitioning, virtual sample generation and generic learning.

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