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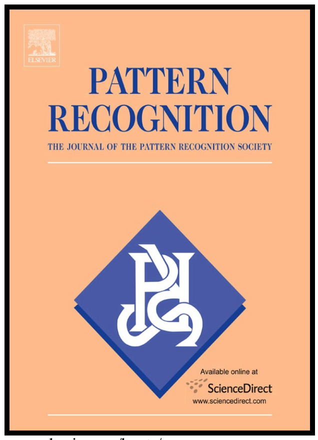

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Local Manifold Distance Based on Neighborhood Graph Reordering

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Abstract

In this paper we consider the problem of estimating pair-wise signals' dissimilarities through the comparison of the underlying local manifold structures. Aiming to confront with issues such as high geometrical complexity and significant overlap that characterize local manifold structures, we propose a novel dissimilarity measure which is based on the reordering of a neighborhood graph using a permutation of its nodes. In order to quantify the diversity between two manifolds, the dissimilarity function utilizes a measure of reordering efficiency, computed on each of the corresponding neighborhood graphs, using a permutation derived from the solution of an optimization problem on the opposite graph. We study the properties of the proposed measure, demonstrating its efficiency in a variety of applications, using both 1D and 2D signals. Additionally, by exploiting the links to previous findings from the field of random graphs, we introduce a generalization of the above measure based on the notion of multi-dimensional ordering. Finally, we perform a thorough evaluation on the problem of face recognition under various challenging conditions, obtaining state-of-the-art recognition accuracy with a competitive computational load.

Keywords— Face Recognition, Graph Reordering, Local Manifold, Manifold-Manifold Distance, Minimal Spanning Tree, Range-Dependent Graphs, Spectral Reordering.

1 Introduction

Several computer vision and machine learning applications rely on the comparison between single or multi-dimensional signals. The process of pairwise comparison aims to quantify the similarity (or dissimilarity) between two signals, constituting an essential part in several problems of pattern analysis including recognition, classification, clustering and retrieval applications. In many cases the involved signals depend on a small number of macroscopic parameters, thus lying on low-dimensional and usually non-linear manifold structures. In order to estimate the relationships between a set of such signals efficiently, we need to learn the underlying global parameterization which is imposed by the natural characteristics of the considered data. Although a large number of algorithms aiming to learn such parameterizations have been proposed in the literature, very often a significant problem lies on the availability of a sufficiently large learning dataset. For example, applications of human recognition based on biometric traits usually rely on a limited number of reference samples in order to identify a registered user.

An efficient solution to this problem can emerge if we focus on the local manifold structures of signals. According to this

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