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Joint Gender Classification and Age Estimation by Nearly Orthogonalizing Their Semantic Spaces

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Abstract

In human face-based biometrics, gender classification and age estimation are two important research topics. Although a variety of approaches have been proposed to handle them, just a few of them are solved jointly, even so, these joint methods do not specifically concern the semantic difference between human gender and age, which is intuitively helpful for joint learning, consequently leaving us a room of further improving their performance. To this end, in this work we firstly propose a general learning framework for jointly estimating human gender and age by attempting to formulate such semantic relationships as a form of near-orthogonality regularization and then to incorporate it into the objective of the joint learning framework. In order to evaluate the effectiveness of the proposed framework, we exemplify it by respectively taking the widely used binary-class SVM for gender classification, and two threshold-based ordinal regression methods (i.e., the discriminant learning for ordinal regression and support vector ordinal regression) for age estimation, and crucially coupling both through the proposed semantic formulation. Moreover, we construct its nonlinear counterpart by deriving a representer theorem for the joint learning strategy. Finally, extensive experiments on four aging datasets, i.e., FG-NET, Morph Album I, Album II and Images of Groups demonstrate the effectiveness and superiority of the proposed strategy.

Keywords: Gender classification; Age estimation; Nearly orthogonal semantic spaces; Support vector ordinal regression; Discriminant learning for ordinal regression

1. Introduction

Human face conveys rich biometric characteristics, such as gender, age, ethnicity and expression, in which the estimation of face-based gender and/or age has attracted extensive attentions due to its wide applications in recommendation systems [1], [2], security access control [3], [4], [5], biometrics [6], [7], entertainment [8], [9], [10], [11] and cosmetology [12], [13], etc. Consequently, in this work we concentrate on the research of estimating human gender and age simultaneously. Before introducing our approach, we first review research references on human gender and age estimations below.

1.1. Separate naive estimation of human facial gender or age

The concept of separate *naive* estimate of human facial gender or age means estimating the facial gender or age separately without considering the interrelationship between them. Along this line, large amount of works have been proposed to estimate them below.

Gender classification (GC) is typically addressed as a binary classification problem due to its binariness of male or female. Along this line, the Bayesian classifier [14], [15], [16], SVM classifier [17], [18], [19], [20], [21], [22], [23], [24], [25], Random Forest classifier [26], Boosting classifier [27], [28], [29], [30], and ELM classifier [31] have successfully been adopted to handle the problem of GC. More recently, due to the wide success of deep convolutional

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