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Beyond PCA: Deep learning approaches for object modeling and longitudinal changing

Khoa Luu
Carnegie Mellon University, USA

Modeling objects, e.g. faces, human bodies, cars, etc., with large variations has been a challenging task in computer vision. These variations such as illumination, poses and occlusions are usually complex and non-linear. Moreover, unseen object images also come with their own characteristic artifacts greatly diverse. Therefore, a good object modeling approach needs to be carefully designed for flexibly adapting to these challenging issues. Recently, deep learning approach has gained significant attention as one of the emerging research topics in both higher-level representation of data and the distribution of observations. Thanks to the nonlinear structure of deep learning models and the strength of latent variables organized in hidden layers, it can efficiently capture variations and structures in complex data. Inspired by this motivation, we present our recent deep learning approaches, i.e. deep appearance models (DAM) and robust deep appearance models (RDAM) based on deep Boltzmann machines (DBM), to accurately capture both shape and texture of face images under large variations. In addition, the second part of the work focuses on novel deep models, i.e. temporal restricted Boltzmann machines (TRBM) and tractable temporal non-volume preserving (TNVP) approaches, to further model face sequences. By exploiting the additional temporal relationships presented in sequence data, the proposed models have their advantages in predicting the future of a sequence from its past. The structure of TNVP can be transformed into a deep convolutional network while keeping the advantages of probabilistic models with tractable log-likelihood density estimation. The proposed approach is evaluated, in face related applications, in terms of synthesizing age-progressed faces and cross-age face verification. It consistently shows the state-of-the-art results in various face-aging databases, i.e. FG-NET, MORPH, our collected large scale aging database named AginG Faces in the Wild (AGFW), and Cross-Age Celebrity Dataset (CACD). Large-scale face verification on mega face challenge 1 is also performed to further show the advantages of our proposed approach.

kluu@andrew.cmu.edu