Kernel Mean p Power Error Loss for Robust Two-Dimensional SVD

Miaohua Zhang[1], Yongsheng Gao[1], Changming Sun[2], and Michael Blumenstein[3]

[1]Griffith University; [2]CSIRO Data61; [3]University of Technology Sydney

Introduction

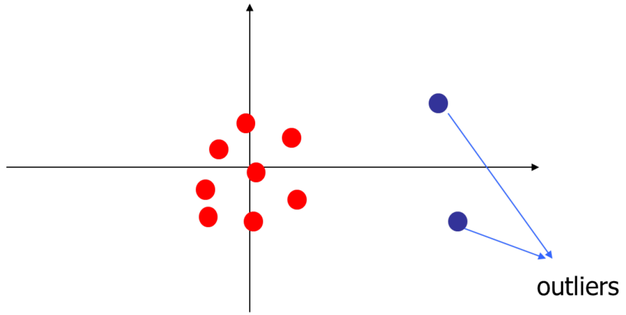

Fig.1 Data with outliers.

Motivations

- Traditional matrix-based dimensional reduction methods, e.g., two-dimensional principal component analysis **(2DPCA)** and two-dimensional singular value decomposition **(2DSVD),** minimize mean square errors **(MSE), which is sensitive to outliers**.

Contributions

- We proposed a robust 2DSVD method based on the kernel mean p power error loss (KMPE-2DSVD) which is based on the non-second order statistics in the kernel space, and thus is more flexible in controlling the representation error.
- The proposed method can update the data mean automatically, and is also rotational invariant.
- The proposed method significantly improves the accuracy of facial image clustering in the presence of outliers.

Proposed method

KMPE-loss:

$$J_{\mathrm{KMPE-loss}}(A-B) = 2^{-p/2}E[\|\varphi(A)-\varphi(B)\|_H^p] = E[\left(1-k_\sigma(A-B)\right)^{p/2}]$$

KMPE-SR:

$$J_{\mathrm{KMPE-loss}}(L,R) = \frac{1}{N}\sum_{i=1}^{N}\left(1-k_\sigma(\sqrt{\|\bar{X}_i - LM_iR^T\|^2})\right)^{p/2} = \frac{1}{N}\sum_{i=1}^{N}\left(1-k_\sigma(E_i)\right)^{p/2}$$

Implementation details

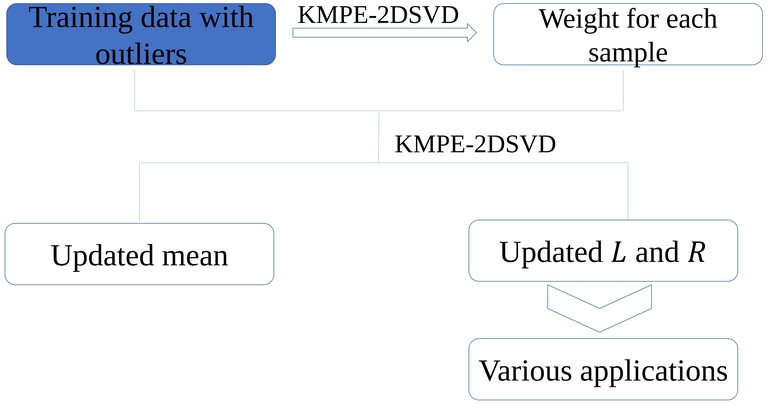

Fig.2 A simple overview of the proposed method.

Experimental results

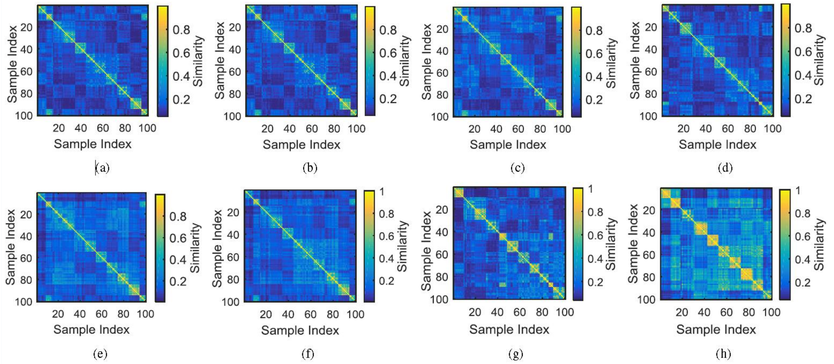

Fig. 3 Visualization of the similarity matrices for different algorithms. (a) 2DPCA, (b) L_1-2DPCA, (c) 2DSVD, (d) R_1-2DSVD, (e) N-2DNPP, (f) S-2DNPP, (g) Proposed method (p=4), proposed method (p=7)

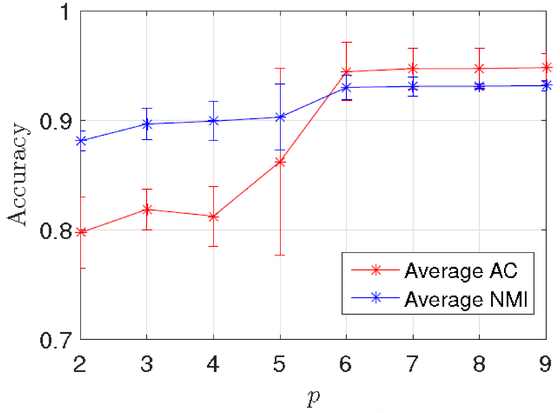

Fig.4 Average clustering accuracy (AC) and Average normalized mutual information (NMI) of the proposed method under different p values.

Contact: lena.zhang@griffithuni.edu.au