SUBSPACE CLUSTERING VIA INDEPENDENT SUBSPACE ANALYSIS NETWORK
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Introduction
As well known, subspace clustering has important significance in the field of machine learning and computer vision. In particular, the effect of subspace clustering on the face recognition task can be better to implementation the AI monitoring. However, most of existing methods based on independent subspace analysis network ignore many useful information embedded in original data.

Interest of recent studies
- independent subspace analysis network method
- spectral clustering-based method

Problem and motivation
Different from the existing methods, we adopt the ISA to learn local translation invariant feature from data and integrate a prior subspace information into the output of the network simultaneously.

We recast the task of extracting the low-dimensional feature into solving an optimization problem of the orthogonal constraint.

Our Formulation
Given the patches from an image as column vectors to form a new matrix X, and x_i denotes one column of X. We want to extract the feature Y:
\[
\min_{W} \frac{1}{2} \|Y - Yc\|_F^2, \quad s.t. \ WW^T = I.
\]

W need to be learned from data, but V is fixed.

Optimization
Obtaining prior structural information
\[
\min_{\theta} \sum_{i=1}^{N} \|x_i - Xc \|_2^2 + \alpha \|c\|_1, \quad s.t. c = 0.
\]
\([\|\|]_2\) denotes 2-norm that is usually used to achieve sparsity.

Formula supplementation
\[
y_i(x; W, V) = \sqrt{\sum_{j=1}^{k} V_{ij}^2 (\sum_{m=1}^{r} W_{jm} x_m)^2}
\]
ortho-regular constraint
\[
W = (WW^T)^{-\frac{1}{2}}
\]
Algorithm summarization

Proposed method

Simulation experiments

Test image data
CMU PIE and ORL

Fig. 2. Samples on the PIE_pose27 (a) and ORL (b) database.

Parameter selection test

Fig. 3. Accuracy and NMI (%) (y-axis) of ISASP with different \(\alpha\) (x-axis) on PIE_pose27(a) and ORL(b) dataset.

Objective quality test

Table 1. Clustering results in terms of Accuracy (%) and NMI (%) on PIE_pose27 dataset (mean ± standard deviation).

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Accuracy</th>
<th>NMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-means</td>
<td>18.33 ± 0.85</td>
<td>40.62 ± 0.79</td>
</tr>
<tr>
<td>SSC</td>
<td>82.10 ± 2.30</td>
<td>94.77 ± 0.61</td>
</tr>
<tr>
<td>ISAk</td>
<td>58.26 ± 2.78</td>
<td>74.43 ± 1.37</td>
</tr>
<tr>
<td>ISAs</td>
<td>84.72 ± 1.60</td>
<td>95.74 ± 0.60</td>
</tr>
<tr>
<td>ISASPk</td>
<td>59.68 ± 2.85</td>
<td>75.67 ± 0.89</td>
</tr>
<tr>
<td>ISASPs</td>
<td>86.54 ± 2.92</td>
<td>96.38 ± 0.77</td>
</tr>
</tbody>
</table>

Table 2. Clustering results in terms of Accuracy (%) and NMI (%) on ORL dataset (mean ± standard deviation).

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Accuracy</th>
<th>NMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-means</td>
<td>58.25 ± 3.56</td>
<td>78.84 ± 1.69</td>
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<tr>
<td>SSC</td>
<td>73.93 ± 2.03</td>
<td>88.09 ± 0.61</td>
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<tr>
<td>ISAk</td>
<td>48.85 ± 2.39</td>
<td>68.86 ± 2.14</td>
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<tr>
<td>ISAs</td>
<td>72.53 ± 1.50</td>
<td>84.66 ± 0.45</td>
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<tr>
<td>ISASPk</td>
<td>52.43 ± 2.24</td>
<td>71.46 ± 1.58</td>
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<tr>
<td>ISASPs</td>
<td>75.00 ± 2.01</td>
<td>86.48 ± 0.67</td>
</tr>
</tbody>
</table>

Results

In this paper, we presented a novel approach that learns features from original data using ISA network incorporated the sparsity subspace prior. By this, the segmentation of the data can be effectively performed. The experimental results, on two real world datasets, show that our method remarkably outperforms the state-of-the-art methods.

Conclusion

References