Hierarchical Multiple Kernel Clustering

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Background
Current multiple kernel clustering (MKC) methods can be grouped into two categories, i.e.
- **Early-fusion** ones directly learn a consensus kernel or graph from multiple ones, afterwards generate the final partition. *Fig. (i) - (ii)*
- **Late-fusion** ones firstly obtain multiple partitions from each kernel independently with basic kernel clustering algorithms, then construct the final clustering assignments on them. *Fig. (iii)*

Problem and Solution

**Problem.** Both of them directly distill the clustering information from matrices of $\mathbb{R}^{n \times n}$ to $\mathbb{R}^{n \times k}$. This sudden drop of dimension would result in the loss of advantageous details for clustering.

**Solution.** We generate a sequence of intermediary matrices with size $\mathbb{R}^{n \times c_i}$, in which $n > c_1 > \cdots > c_s > k$. A consensus partition with size $\mathbb{R}^{n \times k}$ is simultaneously learned and conversely guides the construction of intermediary matrices. *Fig. (iv)*

Formulation

$$\max_{H_k, \beta} \sum_{p=1}^{m} \gamma_p Tr(H_p^y H_p^y^T) + \sum_{p=1}^{m} \beta_p Tr(H_p^y H_p^y^T H_k H_k^T)$$

$$+ \sum_{i=2}^{s} \sum_{p=1}^{m} \gamma_p Tr(H_p^{(i-1)} H_p^{(i-1)^T} H_p^{(i)} H_p^{(i)^T})$$

s.t. $H \in \mathbb{R}^{n \times k}$, $H_k H_p \in \mathbb{R}^{n \times c_i}$, $n \geq c_1 \geq \cdots \geq c_s \geq k$, $\beta \geq 0$, $\gamma \geq 0$.

Validation

**Setting.** According to the layer number of intermediary matrices, we instance the proposed model into HMKC-1 and HMKC-2.

**Intermediary matrix.** It can be seen that a more and more clear clustering structure is presented along with the clustering process. *Fig. (a) – (d)*

**Performance.** HMKC consistently and largely outperforms the other algorithms across all datasets. Especially, the proposed algorithm exhibits excellent performances on CCV, Flower17 and Flower102, where around 5%-10% increases are obtained. *Table*

Note

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Code: https://github.com/liujiyuan13/HMKC-code_release