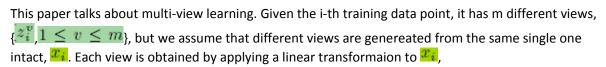
## **Multi-view Intact Space Learning**

Xu, C.; Tao, D.; Xu, C.

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We want to find the hidden  $v_i$  from observed m views,  $v_i$ ,  $1 \le v \le m$ , and use  $v_i$  as the new presenation of the i-th data point.

Thus we want to learn both  $\frac{w_v}{w}$  and  $\frac{x_i}{w}$  to resonce truct the observed  $\frac{x_i}{w}$ , and the reconstruction error is measured by the loss function of

Cauchy estimator 
$$\rho(x) = \log(1 + (x/c)^2)$$

$$\min_{x,W} \log \left( 1 + \frac{\|z_i^v - W_v x_i\|^2}{c^2} \right)$$

Considering n data points of m views,

$$\min_{x,W} \frac{1}{mn} \sum_{v=1}^{m} \sum_{i=1}^{n} \log \left( 1 + \frac{\|z_i^v - W_v x_i\|^2}{c^2} \right)$$

$$\bigcap$$
 We also went to regularized both  $\widehat{W_v}$  and  $\widehat{x_i}$ 

$$\min_{x,W} \frac{1}{mn} \sum_{v=1}^{m} \sum_{i=1}^{n} \log \left( 1 + \frac{\|z_{i}^{v} - W_{v}x_{i}\|^{2}}{c^{2}} \right) + C_{1} \sum_{v=1}^{m} \|W_{v}\|_{F}^{2} + C_{2} \sum_{i=1}^{n} \|x_{i}\|_{2}^{2}$$

$$\min_{x,W} \frac{1}{mn} \sum_{v=1}^{m} \sum_{i=1}^{n} \log \left( 1 + \frac{\|z_{i}^{v} - W_{v}x_{i}\|^{2}}{c^{2}} \right) + C_{1} \sum_{v=1}^{m} \|W_{v}\|_{F}^{2} + C_{2} \sum_{i=1}^{n} \|x_{i}\|_{2}^{2}$$

We also use alternate optimization strategy to opimize this problem:

• Fix W, solve x for the i-th data point:

$$\min_{x} \mathcal{J} = \frac{1}{m} \sum_{v=1}^{m} \log \left( 1 + \frac{\|z^{v} - W_{v}x\|^{2}}{c^{2}} \right) + C_{2} \|x\|_{2}^{2}.$$

Setting the gradient of  $\mathcal J$  with respect to x to 0

$$\sum_{v=1}^{m} -\frac{2W_v^T(z^v - W_v x)}{c^2 + ||z^v - W_v x||_2^2} + 2mC_2 x = 0$$

$$\left(\sum_{v=1}^{m} \frac{W_v^T W_v}{c^2 + \|z^v - W_v x\|_2^2} + mC_2\right) x = \sum_{v=1}^{m} \frac{W_v^T z^v}{c^2 + \|z^v - W_v x\|_2^2}$$

$$x = \left(\sum_{v=1}^{m} \frac{W_v^T W_v}{c^2 + \|z^v - W_v x\|_2^2} + mC_2\right)^{-1} \left(\sum_{v=1}^{m} \frac{W_v^T z^v}{c^2 + \|z^v - W_v x\|_2^2}\right)$$

$$x = \left(\sum_{v=1}^{m} W_{v}^{T} Q_{v} W_{v} + mC_{2}\right)^{-1} \sum_{v=1}^{m} W_{v}^{T} Q_{v} z^{v}$$

$$\overline{\prod}$$

for 
$$k=1,\cdots$$
 do

Weight function Q is chosen through Eq. (13)

$$Q = \left[\frac{1}{c^2 + \|r^1\|^2}, \cdots, \frac{1}{c^2 + \|r^m\|^2}\right], \tag{13}$$
 Using Eq. (14) to obtain the estimate  $x^k$ 

$$x = \left(\sum_{v=1}^{m} W_{v}^{T} Q_{v} W_{v} + mC_{2}\right)^{-1} \sum_{v=1}^{m} W_{v}^{T} Q_{v} z^{v}. \quad (14)$$

Update the residuals  $\{r_v\}_{v=1}^m$ 

$$r^v = z^v - W_v x$$

end for

• Fix x, solve W

$$\min_{W} \mathcal{J} = \frac{1}{n} \sum_{i=1}^{n} \log \left( 1 + \frac{\|z^{i} - Wx_{i}\|^{2}}{c^{2}} \right) + C_{1} \|W\|^{2}$$

$$\sum_{i=1}^{n} \operatorname{Still, we set the gradient of J with regard to W to 0}$$

$$\sum_{i=1}^{n} \frac{1}{1 + \frac{|z^{i} - Wx_{i}|}{|z^{i} - Wx_{i}|}} + C_{1} |W|^{2}$$

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Hallas!

## Inspirations:

- 1. Intact space learning for multiview learning provides a new multiview repsresentation method. It can be easily extende to supervised learning problems, but adding a hinge loss, or a multiview loss to the objective.
- 2. When we have a close form solution of x, but in the right hand, there is an inverse matrix x, we can play tricks and fix the x in inverse matrix.