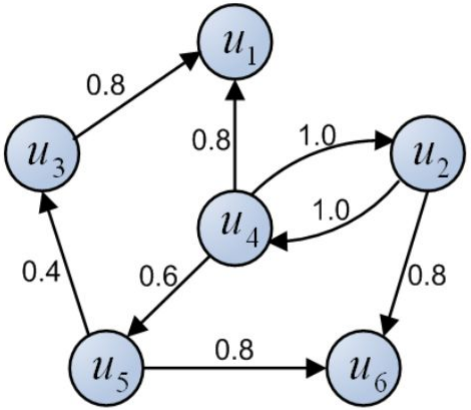
Trust Aware Recommendation Systems

Problem



(a) Social Network Graph

	i_1	i_2	i_3	i_4	i_5	i_6	i_7	i_8
u_1	5	2		3		4		
u_2	4	3			5			
u_3	4		2				2	4
u_4								
u_5	5	1	2		4	3		
u_6	4	3		2	4		3	5

(b) User-Item Matrix

	i_1	i_2	i_3	i_4	i_5	i_6	i_7	i_8
u_1	5	2	**2.5**	3	**4.8**	4	**2.2**	**4.8**
u_2	4	3	**2.4**	**2.9**	5	**4.1**	**2.6**	**4.7**
u_3	4	**1.7**	2	**3.2**	**3.9**	**3.0**	2	4
u_4	**4.8**	**2.1**	**2.7**	**2.6**	**4.7**	**3.8**	**2.4**	**4.9**
u_5	5	1	2	**3.4**	4	3	**1.5**	**4.6**
u_6	4	3	**2.9**	2	4	**3.4**	3	5

(c) Predicted User-Item Matrix

Sorec

$$\min \sum_{i=1}^{n} \sum_{u_k \in \mathcal{F}_i} (\mathbf{S}_{ik} - \mathbf{U}_i^{\top} \mathbf{Z}_k)^2,$$

$$\min_{\mathbf{U},\mathbf{V},\mathbf{Z}} \|\mathbf{W} \odot (\mathbf{R} - \mathbf{U}^{\top}\mathbf{V})\|_F^2 + \alpha \sum_{i=1}^{n} \sum_{u_k \in \mathcal{F}_i} (\mathbf{S}_{ik} - \mathbf{U}_i^{\top} \mathbf{Z}_k)^2 + \lambda(\|\mathbf{U}\|_F^2 + \|\mathbf{V}\|_F^2 + \|\mathbf{Z}\|_F^2),$$

Testing

$$c_{ik}^{*} = \sqrt{\frac{d^{-}(v_k)}{d^{+}(v_i) + d^{-}(v_k)}} \times c_{ik}, \tag{4}$$

where $d^{+}(v_i)$ represents the outdegree of node v_i, while $d^{-}(v_k)$ indicates the indegree of node v_k.

$$MAE = \frac{\sum_{i,j} |r_{i,j} - \widehat{r}_{i,j}|}{N},$$

- 80% Train, 20% Test
- With weight : MAE: 0.93
- Without weight: MAE: 0.87

Testing

- 80% Train, 20% Test

$$f(x) = (x - 1)/(R_{max} - 1).$$: 0.87

$$f(x) = x/R_{max}$$: 0.83

Time and Efficiency

User/Items	Time: Initially	Time: After
7000/21000	10-12 Hours	20 Sec

Time and Efficiency

Users/Items	Run Time	Mean Absolute Error	MAE in paper	Training Data
49290/139738	29 min	0.82	0.90	99%
49290/139738	26 min	0.83	0.932	80%
7000/21000	20 sec	0.93	0.932	80%
3000/9000	5 sec	0.90	0.932	80%
7000/21000	20 sec	0.88	0.90	99%
3000/9000	4 sec	0.87	0.90	99%

STE

$$\hat{\mathbf{R}}_{ij} = \mathbf{u}_i^\top \mathbf{v}_j + \beta \sum_{u_k \in \mathcal{F}_i} \mathbf{S}_{ik} \mathbf{U}_k^\top \mathbf{V}_j,$$

$$\min_{\mathbf{U},\mathbf{V}} \|\mathbf{W} \odot ((\mathbf{R} - \mathbf{U}^\top \mathbf{V}) - \beta \mathbf{S}\mathbf{U}^\top \mathbf{V}))\|_F^2 + \lambda(\|\mathbf{U}\|_F^2 + \|\mathbf{V}\|_F^2).$$

STE

$$\mathcal{L}(R, S, U, V)$$
$$= \frac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{n} I_{ij}^{R} (R_{ij} - g(\alpha U_i^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(i)} S_{ik} U_k^T V_j))^2$$
$$+ \frac{\lambda_U}{2} \|U\|_F^2 + \frac{\lambda_V}{2} \|V\|_F^2, \qquad (13)$$

STE

$$
\begin{aligned}
\frac{\partial \mathcal{L}}{\partial U_i} =& \alpha \sum_{j=1}^{n} I_{ij}^{R} g'(\alpha U_i^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(i)} S_{ik} U_k^T V_j) V_j \\
& \times (g(\alpha U_i^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(i)} S_{ik} U_k^T V_j) - R_{ij}) \\
& + (1-\alpha) \sum_{p \in \mathcal{B}(i)} \sum_{j=1}^{n} I_{pj}^{R} g'(\alpha U_p^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(p)} S_{pk} U_k^T V_j) \\
& \times (g(\alpha U_p^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(p)} S_{pk} U_k^T V_j) - R_{pj}) S_{pi} V_j + \lambda_U U_i, \\
\frac{\partial \mathcal{L}}{\partial V_j} =& \sum_{i=1}^{m} I_{ij}^{R} g'(\alpha U_i^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(i)} S_{ik} U_k^T V_j) \\
& \times (g(\alpha U_i^T V_j + (1-\alpha) \sum_{k \in \mathcal{T}(i)} S_{ik} U_k^T V_j) - R_{ij}) \\
& \times (\alpha U_i + (1-\alpha) \sum_{k \in \mathcal{T}(i)} S_{ik} U_k^T) + \lambda_V V_j, \qquad (14)
\end{aligned}
$$

STE

Users/Items	Run Time	Mean Absolute Error	MAE in paper	Training Data
7000/21000	19m	0.93	0.859	80%
3000/9000	10m	0.93	0.859	80%
7000/21000	18m	0.90	0.837	90%
3000/9000	11 m	0.89	0.837	90%

Thanks!

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