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23MFWMFLLORMA4LWMFDCGASC56
??
$\mathbf{R}^h \mathcal{U}^h$
$\mathbf{R}_{um} \mathbf{R} h \mathbf{R}^h um^\top$
N, M
$K \ll \min(N, M)$
H
$\mathbf{R} \in R^{N \times M}$
$\mathbf{C}$ $\mathbf{R} \in R^{N \times M}$
$\mathbf{W}$
$\mathbf{P}, \mathbf{Q}$
$\mathbf{R}^h$ h
$\mathbf{C}^h$ h
$\mathbf{W}^h$ $\mathbf{C}^h$
$\mathbf{T}^h$ $\mathbf{C}^h \mathbf{C}^h$
$\mathcal{U}^h, \mathcal{V}^h$
$\mathbf{P}_u^h, \mathbf{Q}_m^h$ $\mathbf{R}^h$ $\mathcal{R}^h um \in R^K$
$\mathcal{A}$
$a_i = \langle u_i, m_i \rangle$ $\langle u_i, m_i \rangle \in \mathcal{A}$
$\mathcal{A}$ $\subset \mathcal{A}$
$\hat{a}_h = \langle \hat{u}_h, \hat{m}_h \rangle \in \mathcal{A}$
$E(a_i, a_j)$
?
?Netflix[1]
KDD2011[23] $\mathbf{R} \in R^{N \times M}$
$\mathbf{O} K \ll \min\{N, M\}$

$$\min_{\mathbf{P},\mathbf{Q}} \sum_{u=1}^{N} \sum_{m=1}^{M} \mathbf{O}_{um} (\mathbf{R}_{um} - \mathbf{P}_u^\top \mathbf{Q}_m)^2 \tag{1}$$

$\mathbf{R}_{um} um \mathbf{P}_u \mathbf{Q}_m um \mathbf{O}_{um} um$

$$\sum_{u=1}^{N} \sum_{m=1}^{M} \mathbf{O}_{um} (\mathbf{R}_{um} - \mathbf{P}_u^\top \mathbf{Q}_m)^2 + \lambda_{\mathbf{P}} \|\mathbf{P}\|_F^2 + \lambda_{\mathbf{Q}} \|\mathbf{Q}\|_F^2 \tag{2}$$

$\lambda_{\mathbf{P}} \lambda_{\mathbf{Q}}$
?$\mathbf{R}_{um}$ $_{uk} \leftarrow$
$\mathbf{P}_{uk} +$
$\iota((\mathbf{R}_{um} -$
$\mathbf{P}_u^\top \mathbf{Q}_m) \mathbf{Q}_{mk} -$
$\lambda_{\mathbf{P}} \mathbf{P}_{uk})$
$\mathbf{Q}_{mk} \leftarrow$
$\mathbf{Q}_{mk} +$
$\iota((\mathbf{R}_{um} -$
$\mathbf{P}_u^\top \mathbf{Q}_m) \mathbf{P}_{uk} -$
$\lambda_{\mathbf{Q}} \mathbf{Q}_{mk})$
$\iota \mathbf{P}_{uk} uk$
$\mathbf{Q}_{mk} mk$
?
?
?

$$\mathbf{W}_{um} = 1 + log(1 + \mathbf{R}_{um} \times 10^{\varepsilon}) \tag{3}$$

ε

$$\min \sum_{u=1}^{N} \sum_{m=1}^{M} \mathbf{W}_{um} (\mathbf{R}_{um} - \mathbf{P}_u^\top \mathbf{Q}_m)^2 + \lambda_{\mathbf{P}} \|\mathbf{P}\|^2 + \lambda_{\mathbf{Q}} \|\mathbf{Q}\|^2$$