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Mathematical Foundation of Big Data Analytics (SS 2019)
Recommendation System I

Ex. 1 Recall the sparse rating matrix given in the lecture

$$\begin{bmatrix} 5 & 3 & - & 1 \\ 4 & - & - & 1 \\ 1 & 1 & - & 5 \\ 1 & - & - & 4 \\ - & 1 & 5 & 4 \end{bmatrix}$$

a) Calculate the similarity of the users based on the cosine measure

$$S(i,\ell) = \frac{\sum\limits_{j \in U(i) \cap U(l)} (a_{ij} - \bar{a}_i) \cdot (a_{\ell j} - \bar{a}_\ell)}{\sqrt{\sum\limits_{j \in U(i) \cap U(\ell)} (a_{ij} - \bar{a}_i)^2} \cdot \sqrt{\sum\limits_{j \in U(i) \cap U(\ell)} (a_{\ell j} - \bar{a}_\ell)^2}}$$

b) Based on a), estimate the missing ratings by KNN-Algorithm.

c) Evaluate the method and compare the results to matrix factorization approach.

Ex. 2 Calculate the singular value decomposition (SVD) of the following matrix:

$$A = \begin{bmatrix} 2 & 2 \\ 1 & 1 \end{bmatrix}$$

Suppose A is a rating matrix. How many relevant features are there?

Ex. 3 Let $L \in \mathbb{R}^{n,k}$ and $R \in \mathbb{R}^{k,m}$ are two matrices, with $rank(L) = rank(R) = k.$, where $k < m, n$. Show that the matrix $L \cdot R$ has rank k.

Ex. 4 Use the LR factorization in order to solve

$$\min_{rank(A_k)=k} ||A - A_k||_F^2$$

by gradient methods and give the formula for the gradient steps.