Lecture 15: Matrix Factorization

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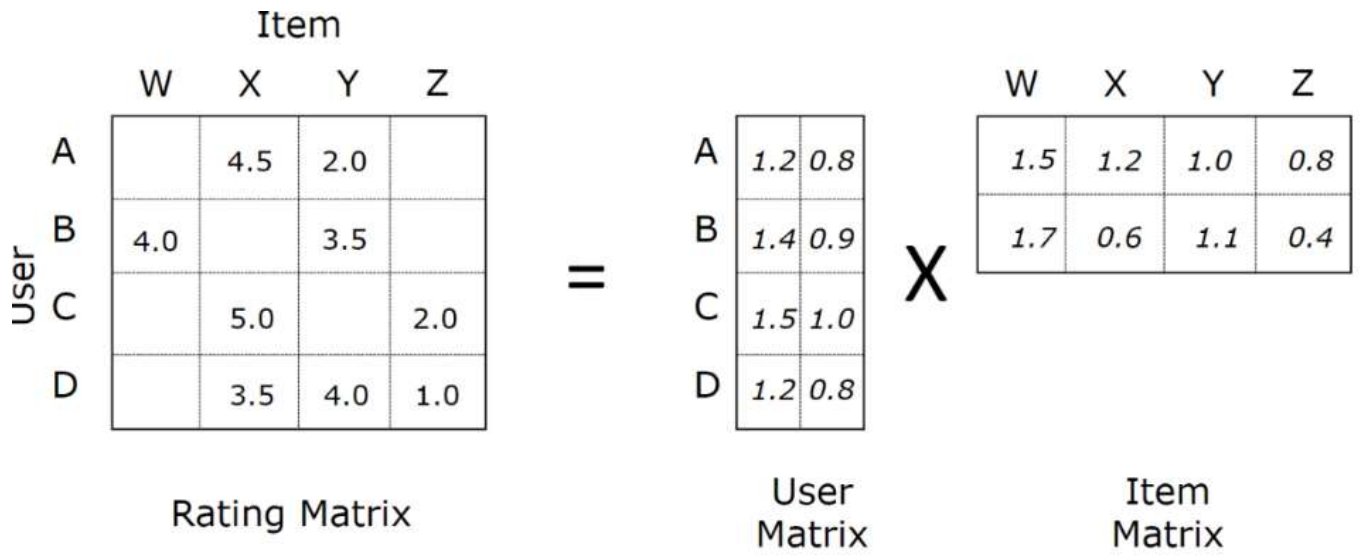
Factorization

- Latent factor e.g. genre thriller, fantasy



Formulation

- Factorization of data matrix

$$\mathbf{X}_{N\times M} \approx \mathbf{U}_{N\times K} \times \mathbf{V}^T_{K\times M}$$

$$x_{n,m} = \mathbf{u}_n^T \mathbf{v}_m = \sum_{k=1}^{K} u_{n,k} v_{m,k}$$

- Objective function

$$\mathcal{L} = \sum_{(m,n)\in\Omega} \left(x_{n,m} - \mathbf{u}_n^T \mathbf{v}_m\right)^2$$

$$\mathcal{L}^{reg} = \sum_{(m,n)\in\Omega} \left(x_{n,m} - \mathbf{u}_n^T \mathbf{v}_m\right)^2 + \sum_{n=1}^{N} \lambda_u \|\mathbf{u}_n\|_2^2 + \sum_{m=1}^{M} \lambda_v \|\mathbf{v}_m\|_2^2$$

Alternating Least Square

- Alternate among factors

$$\arg\min_{\mathbf{v}_m} \sum_{n \in \Omega_{c_m}} \left(x_{n,m} - \mathbf{u}_n^T \mathbf{v}_m\right)^2 + \lambda_v \|\mathbf{v}_m\|_2^2$$

$$\arg\min_{\mathbf{u}_n} \sum_{m \in \Omega_{r_n}} \left(x_{n,m} - \mathbf{u}_n^T \mathbf{v}_m\right)^2 + \lambda_u \|\mathbf{u}_n\|_2^2$$