

1 Problem 1

We have linear regression model, which can be described by formula

$$r = \theta x$$

, where θ - learnable weights. As x encodes both user and item features, it can be viewed as vector

$$x = \begin{bmatrix} x_{user} \\ y_{item} \end{bmatrix}$$

, and weight vector then is :

$$\theta = \begin{bmatrix} \theta_{user} \\ \theta_{item} \end{bmatrix}$$

Thus we have linear regression formula as:

$$r_{ui} = \theta_{user}x_u + \theta_{item}y_i$$

So for two different items i, j difference in ratings will equal to:

$$r_{ui} - r_{uj} = \theta_{user}x_u + \theta_{item}y_i - \theta_{user}x_u - \theta_{item}y_j = \theta_{item}(y_i - y_j)$$

We can see, that user weights and features don't affect on difference of items ratings. So this is why content-based model provide low-level of personalization.

2 Problem 2

We have matrix of interactions of size users * items:

$$\begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 0 \end{bmatrix}$$

As we can see, users interactions are not intersect, all of them like different items. So we can't recommend new items to any of them, we don't have similar items or users.