Neighborhood methods

Friday, 16 April 2021 08:46

Interaction matrix

$[r_{ui}]$

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

5 users

6 items

Interaction vectors as features

Users

$r_0 = [1,1,0,0,1,0]$ $r_1 = [0,0,1,1,0,0]$

$r_2 = [1,0,0,1,1,1]$ $r_3 = [0,0,1,0,0,1]$

$r_4 = [0,1,1,0,1,1]$

Items

$i_0 = [1,0,1,0,0]$ $i_1 = [1,0,0,0,1]$

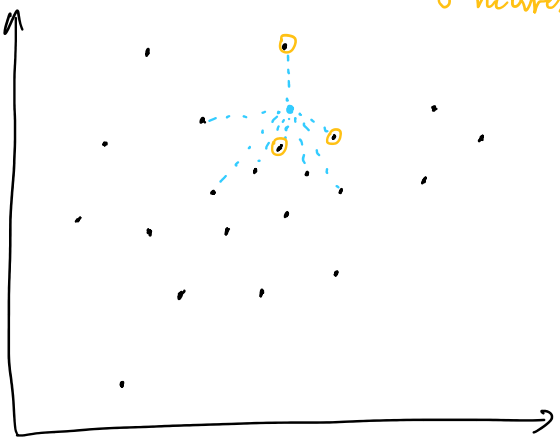
$i_2 = [0,1,0,1,1]$ $i_3 = [0,1,1,0,0]$

$i_4 = [1,0,1,0,1]$ $i_5 = [0,0,1,1,1]$

These features can directly be treated as input for an ML algorithm

Neighborhood

3 nearest neighbors



User-based neighborhood methods

1. Find k-nearest neighbors to the active user.
2. Identify items those neighbors interacted with.
3. For every such item calculate its score as an average neighbor similarity.
4. Output items with the highest score

as an average neighbor similarity.

4. Recommend items with the highest score the active user has not interacted with

Example

neighbor 1: similarity = 0.9 items = {item 1, item 3}
neighbor 2: similarity = 0.7 items = {item 2}
neighbor 3: similarity = 0.4 items = {item 2, item 3}

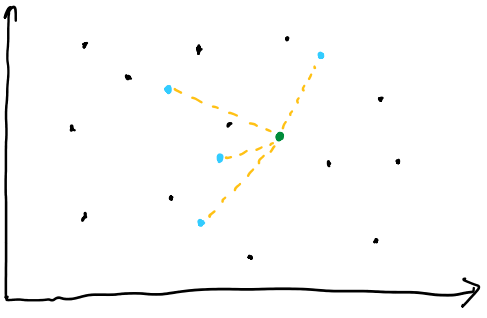
$$\text{item 1 score} = \frac{0.9}{0.9+0.7+0.4} = 0.45$$

$$\text{item 2 score} = \frac{0.7+0.4}{0.9+0.7+0.4} = 0.55$$

$$\text{item 3 score} = \frac{0.9+0.4}{0.9+0.7+0.4} = 0.65$$

Item-based neighborhood methods

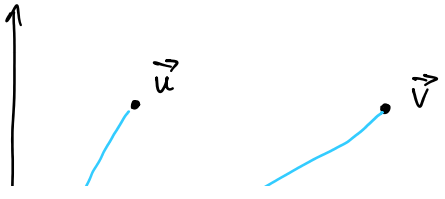
1. For every item the active user has not interacted with find its overall similarity (sum of similarities) to items the active user has interacted with.
2. Recommend items with the highest score.

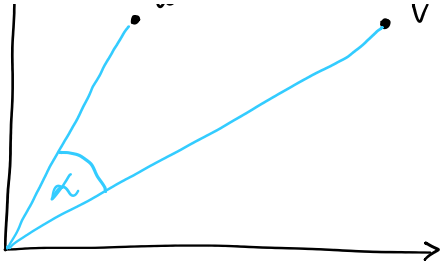


How to find neighbors?

Similarity measures

Cosine similarity



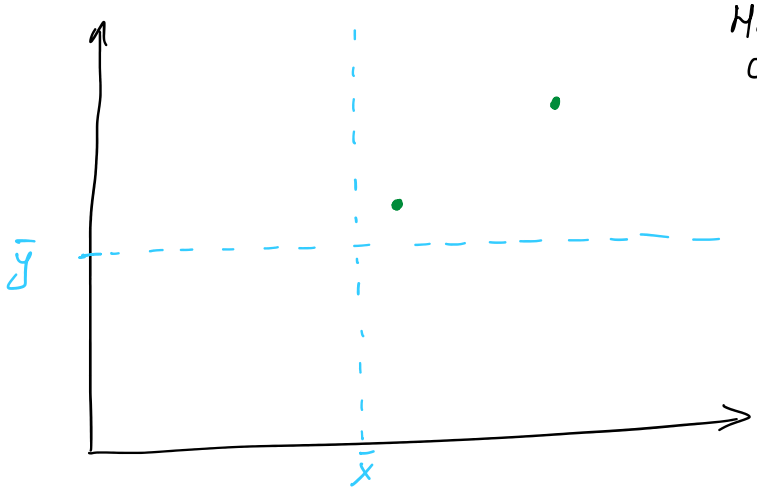


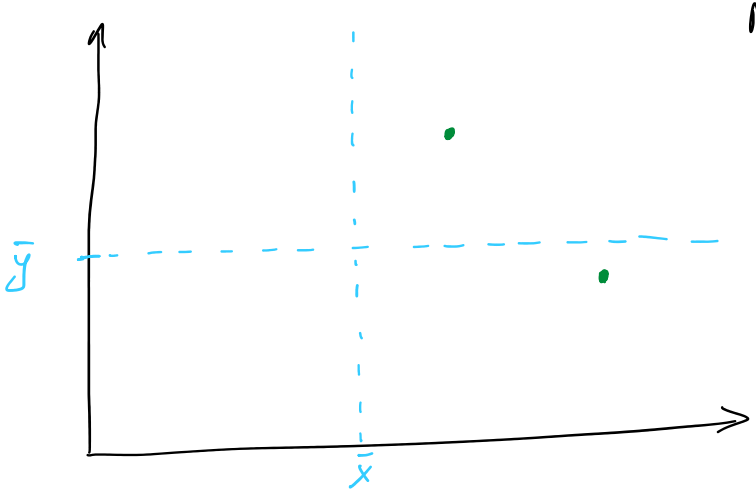
$$Sim(u, v) = Cos(u, v) = \frac{\vec{u} \cdot \vec{v}}{\|\vec{u}\| \cdot \|\vec{v}\|}$$

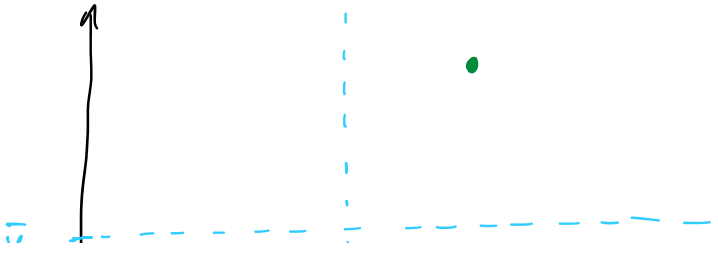
Especially useful for ratings

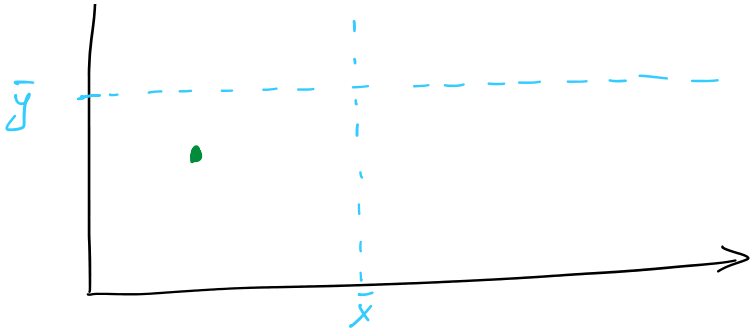
Pearson similarity (Pearson correlation)

Based on entire population of vectors (x, y)








$\bar{y}$
$\bar{x}$