

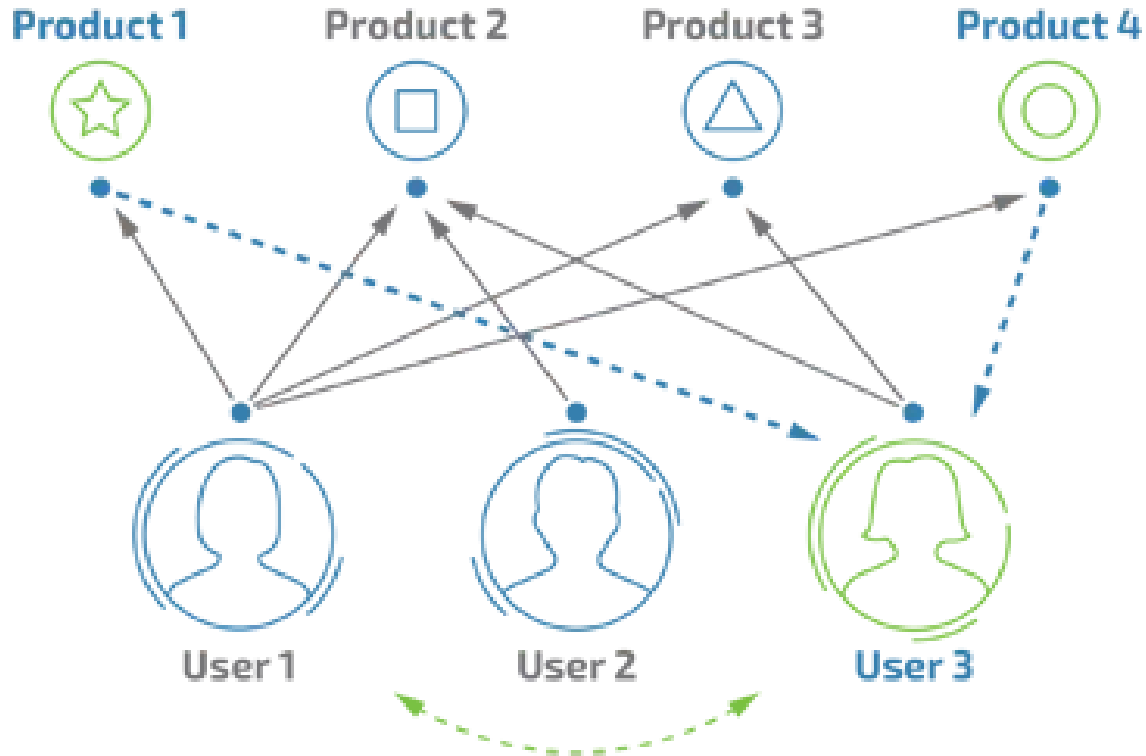
Collaborative Filtering Recommenders

David Yang
xdyang70@gmail.com

Key Idea of CF

- For Customer **X**
- Find a set **N** of other users whose historical ratings (behavior, tastes, ...) are **similar** to X's ratings
- Recommend item **i** to **X**
 - (1) Based on **i**'s **distance** to items viewed by X and users in **N**
 - (2) By estimating **X**'s rating of **i** based on ratings of users in **N**

Approach 1. User-User Similarity



Approach 1. User-User Similarity

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
A	5			5	2	
B	5	5	4	5		
C				4	1	5
D		3		1	4	

$$\text{sim}(A,B) = |r_A \cap r_B| / |r_A \cup r_B|$$

$$\text{sim}(A,B) = \cos(r_A, r_B)$$

User-User Similarity

	A	B	C	D
A	-	0.8	0.6	-0.5
B		-	0.1	-0.2
C			-	-0.8
D				-

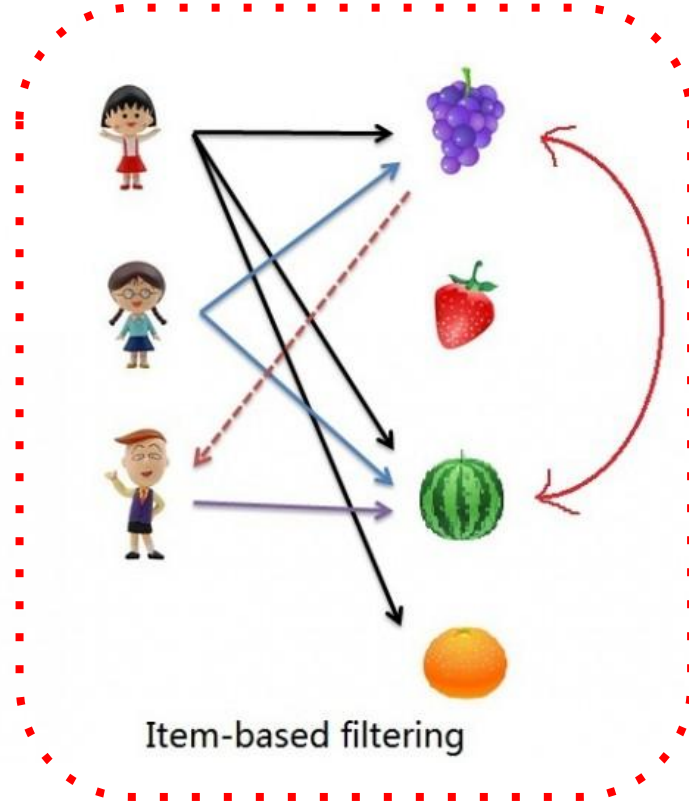
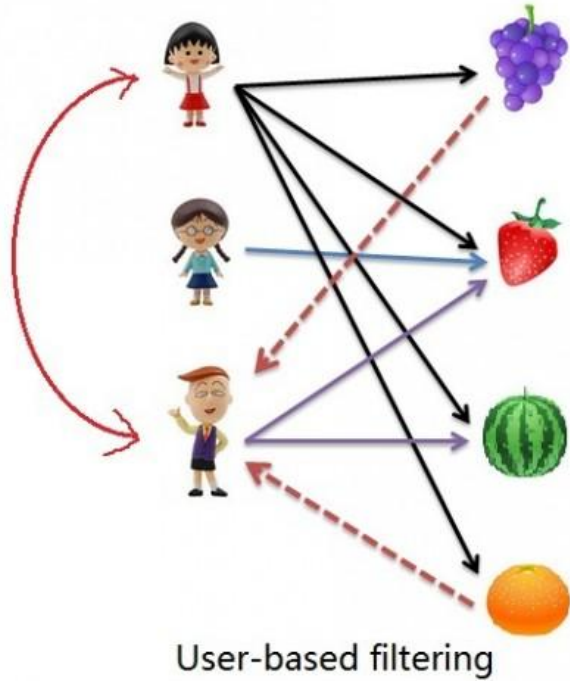
Rating Predictions

User \mathbf{x} 's rating of the \mathbf{i} -th item

$$r_{xi} = \sum_{y \in N} s_{xy} r_{yi} / \sum_{y \in N} s_{xy}$$

where $s_{xy} = \text{sim}(x, y)$

Approach 2. Item-Item Similarity



Approach 2. User-User Similarity

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
A	5			5	2	
B	5	5	4	5		
C				4	1	5
D		3		1	4	

$$\text{Sim}(1, 4) = \cos(R_1, R_4)$$

Item-Item Similarity

	1	2	3	4	5	6
1	-	0.6	0.3	0.9	-0.1	na
2		-	0.3	0.9	0.1	na
3			-	0.6	na	na
4				-	-0.8	0.7
5					-	-0.5
6						-

Rating Predictions

User \mathbf{x} 's rating of the i -th item

$$r_{xi} = \frac{\sum_{j \in N(i; \mathbf{x})} s_{ij} \cdot r_{xj}}{\sum_{j \in N(i; \mathbf{x})} s_{ij}}$$

s_{ij} ... similarity of items i and j

r_{xj} ... rating of user \mathbf{x} on item j

$N(i; \mathbf{x})$... set items rated by \mathbf{x} similar to i

Summary of CF Recommenders

Pros

- Usually more powerful than content-based recommenders
- Can handle cases where no features available
- Fully utilize information available in the user-item interaction matrix

Cons

- “Cold Start”: new user/item has no historical data to use.
- Require more computing effort: $O(n*n)$ vs $O(m*m)$.

Example 2

In this example, we will learn how to recommend songs to users using Item-based and User-Based Collaborative Filters.

See “Example 2 Collaborative Filtering Recommender.ipynb”