20 - Recommender Systems - 1

Data Science Practicum 2021/22, Lesson 20

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Recommender Systems

- Goal: recommend best items (Netflix, Amazon . . .)
- What are best items?
  - Highest rated (highly questionable!!!)
- New goal:
  - Predict unseen (unknown) items ratings
  - Recommend highest-rated (obvious)

Recommender Systems

- Goal: recommend best items (Netflix, Amazon . . .)
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  - Recommend highest-rated (obvious)

- User-item Matrix

	Matrix	Godfather	Titanic	Avatar	Fight Club	Fantozzi
John	5		3			1
Paul		4	3		2	
Mary	4	1		3		
Anna	2				2	2

Default Data Structure

user_id	item_id	rating
1	1	5
1	3	3
2	2	3
3	4	1

- Often we have additional columns
  - user characteristics (age, gender, personality . . .)
  - item characteristics (genre, year, author . . .)
  - context/interaction (weather, social, location . . .)

Exercise

- Load the CoMoDa dataset
- Inspect the dataset
- How would you proceed with predicting missing ratings?

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- Inspect the dataset
- How would you proceed with predicting missing ratings?

```
import pandas as pd
df_comoda = pd.read_csv("LDOS-CoMoDa.csv", sep=";")
df_comoda.head()
```

	userID	itemID	rating	age	sex	city	country	time	daytype	season	...	movieCountry	movieLanguage	movieYear	genre1	genre2	genre3	ac
0	23	14	5	33	1	20	2	3	2	2	...	36	9	2007	7	-1	-1	1
1	21	5	3	28	1	10	3	2	2	2	...	37	9	1998	7	6	10	1
2	21	6	4	28	1	10	3	4	2	2	...	37	9	2008	7	10	18	1
3	22	13	4	28	1	20	2	3	2	3	...	37	9	2010	1	14	19	1
4	21	7	3	28	1	10	3	4	2	2	...	37	9	2003	3	10	18	

5 rows × 30 columns

Exercise

- Predict the ratings using some regressor
- 80/20 split
- MSE

Exercise

- Predict the ratings using some regressor
- 80/20 split
- MSE

```
## Load dataset
import pandas as pd
df_comoda = pd.read_csv("LDOS-CoMoDa.csv", sep=";")
df_X = df_comoda
df_y = df_comoda["rating"]
del df_X["rating"]
X = df_X.values
y = df_y.values
# test/train splitting
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = \
    train_test_split(X, y, test_size=0.20, random_state=1)
#use RandomForestRegressor to predict ratings
from sklearn.ensemble import RandomForestRegressor
clf = RandomForestRegressor().fit(X_train, y_train)
y_pred = clf.predict(X_test)
mean_squared_error(y_test, y_pred)
```

```
0.7793109321231162
```

Is this a good result?

Exercise

- Make the predicted ratings equal to the average rating

Exercise

- Make the predicted ratings equal to the average rating

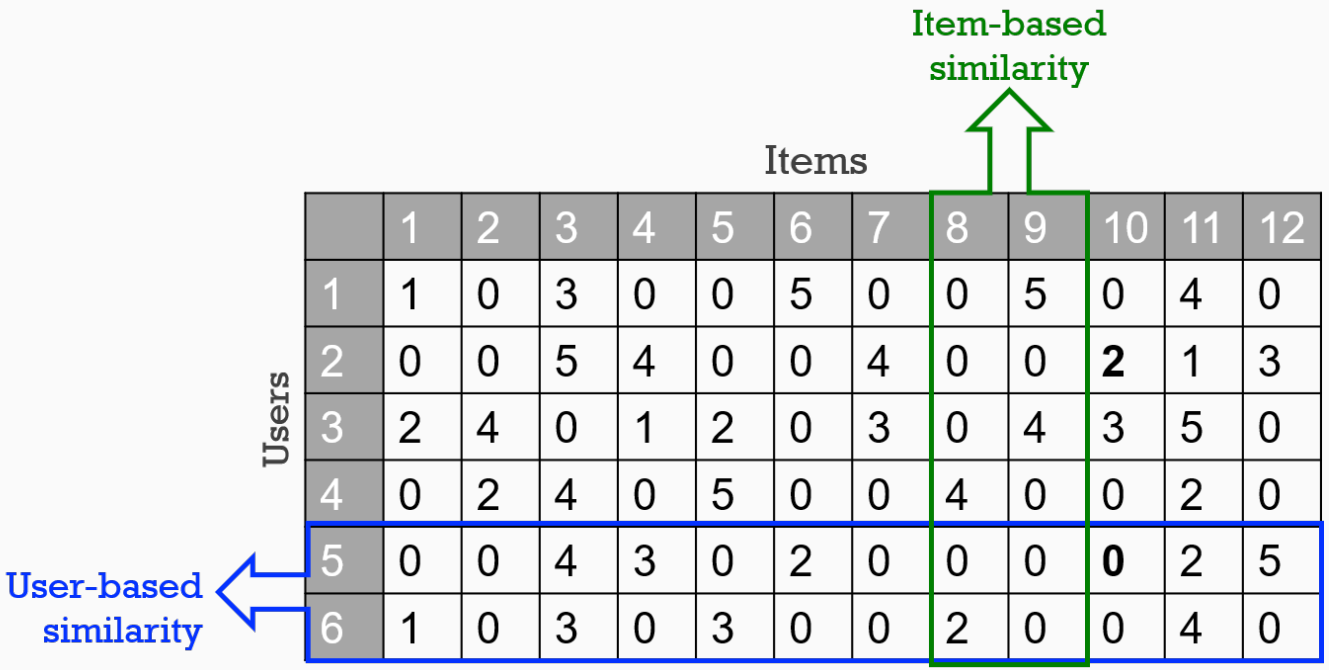
```
# predicted rating as average of all ratings
import numpy as np

a = np.mean(y_train)
y_pred = np.full(y_test.shape,a)
mean_squared_error(y_test, y_pred)
```

```
1.1553692755769438
```

Recommender Systems Taxonomy

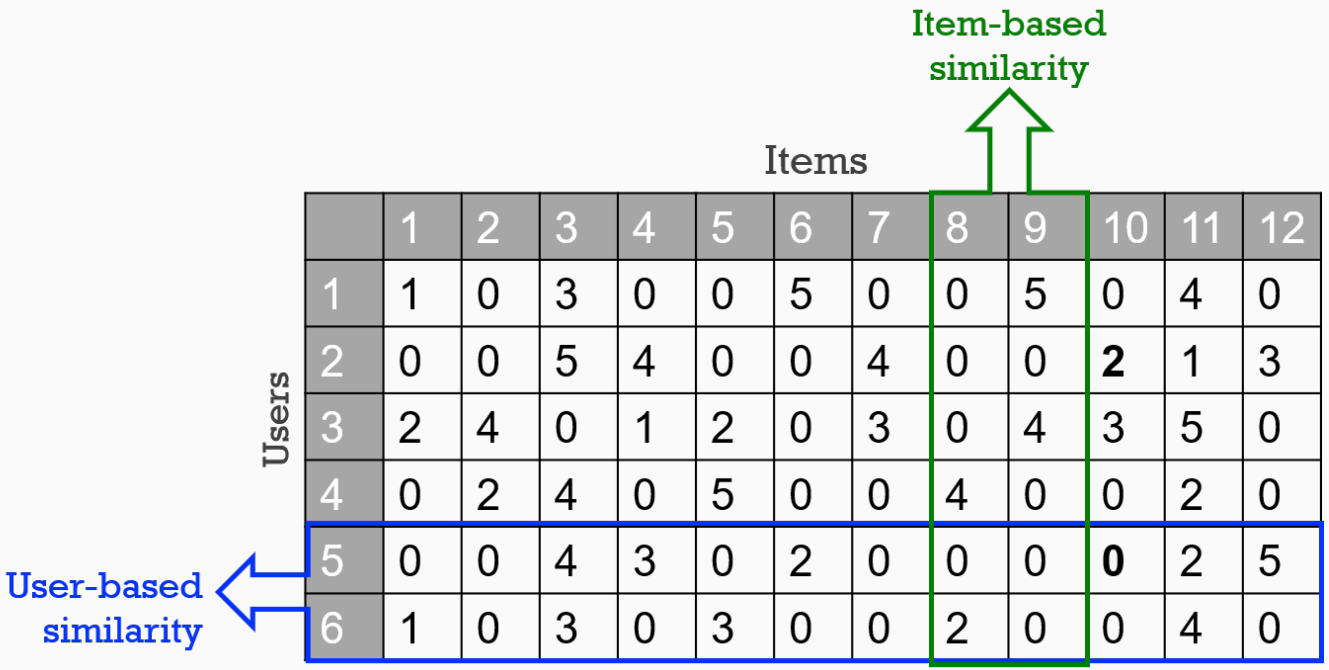
- Content-based
  - User profile
  - Item profile
- Collaborative Filtering
  - Memory-based (neighborhood-based)
  - Model-based (e.g. Matrix Factorization)
- Hybrid

k-Nearest Neighbors



	1	2	3	4	5	6	7	8	9	10	11	12
1	1	0	3	0	0	5	0	0	5	0	4	0
2	0	0	5	4	0	0	4	0	0	**2**	1	3
3	2	4	0	1	2	0	3	0	4	3	5	0
4	0	2	4	0	5	0	0	4	0	0	2	0
5	0	0	4	3	0	2	0	0	0	**0**	2	5
6	1	0	3	0	3	0	0	2	0	0	4	0

k-Nearest Neighbors



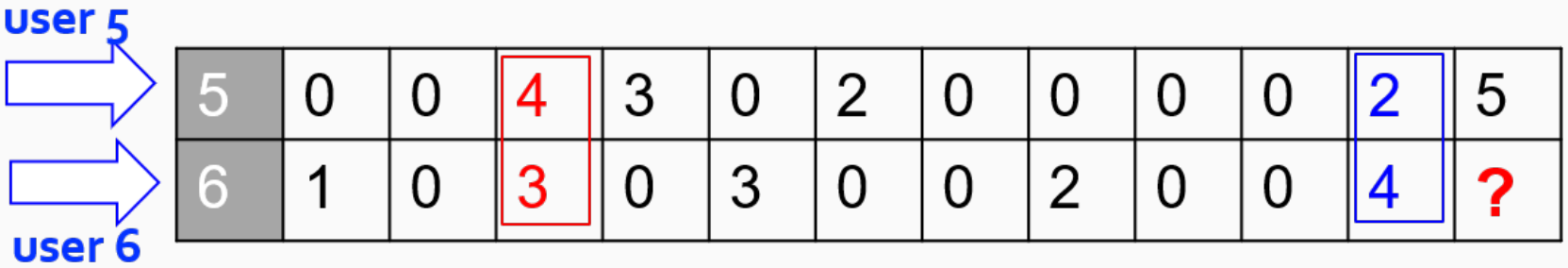
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	0	3	0	0	5	0	0	5	0	4	0
2	0	0	5	4	0	0	4	0	0	**2**	1	3
3	2	4	0	1	2	0	3	0	4	3	5	0
4	0	2	4	0	5	0	0	4	0	0	2	0
5	0	0	4	3	0	2	0	0	0	**0**	2	5
6	1	0	3	0	3	0	0	2	0	0	4	0

- Distance metrics
- Similarity metrics
  - Cosine similarity
  - Pearson correlation

```
from scipy import spatial
v1 = [0,0,1]
v2 = [3,2,1]
s = spatial.distance.cosine(v1,v2)
```

Cosine similarity

- Compute only on items that both users have rated



k-Nearest Neighbors

- Rating Prediction for user u and item j

$$\hat{r}_{uj} = r_u + \frac{1}{\sum |w_{uv}|} \sum w_{uv}(r_{vj} - r_v)$$

- predicted rating $\hat{r}_{uj}$
- average user rating r_u
- user similarity w_{uv}
- rating r_{vj}
- average user rating r_v

Exercise

- Write a function that calculates the cosine similarity between two vectors of users

Exercise

- Write a function that calculates the cosine similarity between two vectors of users

```
# cosine similarity
# only on items both have rated
from scipy import spatial

def cos_sim(u1,u2):
    v1 = []
    v2 = []
    for i in range(len(u1)):
        if (u1[i] != 0) and (u2[i] != 0):
            v1.append(u1[i])
            v2.append(u2[i])
    if (len(v1) == 0):
        return 0
    else:
        return 1- spatial.distance.cosine(v1,v2)

u1 = [0,0,0,1,0,0,5,0,0,4,0,0,3,0,0,2]
u2 = [0,2,0,3,1,0,0,2,0,5,0,0,0,5,0,0]

#u1 = [0,1]
#u2 = [1,0]

cos_sim(u1,u2)
```

Exercise

- From the comoda dataset create a user-item matrix

Exercise

- From the comoda dataset create a user-item matrix

```
# create user-item matrix
import pandas as pd
import numpy as np

df_comoda = pd.read_csv("LDOS-CoMoDa.csv", sep=";")
users = np.sort(df_comoda["userID"].unique())
items = np.sort(df_comoda["itemID"].unique())
df_users_items_ratings = pd.DataFrame(index = users, columns = items )
df_users_items_ratings = df_users_items_ratings.fillna(0)

## test/train splitting
cutoff = round(0.8 * len(df_comoda))
df_comoda_train = df_comoda[:cutoff]
df_comoda_test = df_comoda[cutoff:]

for index, row in df_comoda_train.iterrows():
    df_users_items_ratings.loc[row["userID"],row["itemID"]] = row["rating"]

np_users_items_ratings = df_users_items_ratings.values
```

Exercise

- Calculate a matrix with user-user similarities

Exercise

- Calculate a matrix with user-user similarities

```
# create user-user similarities
df_users_users =  pd.DataFrame(index = users, columns = users )
df_users_users = df_users_users.fillna(0)
for u1 in users:
    for u2 in users:
        u1_vector = np_users_items_ratings[:,u1]
        u2_vector = np_users_items_ratings[:,u2]
        d = cos_sim(u1_vector,u2_vector)
        df_users_users.loc[u1,u2] = d

df_users_users.describe()
```

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References

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