STAT542: Statistical Learning

Final Project

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Basic Import

In [26]:
```
import pandas as pd
import numpy as np
from surprise import Dataset, Reader, SVD, NMF, KNNWithMeans
from surprise.model_selection import cross_validate
```

Reading Data

In [13]:
```
# Load the data
csv_data = pd.read_csv("Feedback.csv", index_col=0)
display(csv_data)
```

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15
1	3.0	NaN	NaN	3.0	NaN	3.0	3.0	NaN	NaN	3.0	3.0	NaN	4.0	NaN	3.0
2	NaN	3.0	3.0	NaN	NaN	NaN	3.0	3.0	NaN	NaN	3.0	NaN	5.0	NaN	3.0
3	NaN	NaN	3.0	3.0	3.0	3.0	3.0	3.0	NaN	NaN	NaN	4.0	3.0	3.0	NaN
4	4.0	4.0	NaN	NaN	3.0	NaN	NaN	3.0	NaN	2.0	NaN	4.0	NaN	4.0	NaN
5	5.0	NaN	5.0	5.0	NaN	NaN	5.0	NaN	5.0	NaN	NaN	5.0	NaN	NaN	5.0
6	1.0	NaN	4.0	2.0	NaN	NaN	4.0	NaN	4.0	2.0	NaN	3.0	NaN	NaN	NaN
7	NaN	NaN	3.0	4.0	NaN	3.0	NaN	NaN	3.0	NaN	1.0	5.0	NaN	NaN	3.0
8	2.0	NaN	NaN	NaN	4.0	NaN	NaN	2.0	1.0	2.0	NaN	3.0	1.0	NaN	2.0
9	3.0	NaN	3.0	NaN	NaN	5.0	NaN	3.0	3.0	NaN	3.0	NaN	3.0	4.0	3.0
10	NaN	4.0	NaN	5.0	NaN	NaN	NaN	NaN	5.0	NaN	NaN	5.0	NaN	4.0	5.0
11	NaN	3.0	3.0	3.0	5.0	3.0	NaN	3.0	NaN	NaN	NaN	NaN	NaN	NaN	3.0
12	2.0	NaN	NaN	NaN	4.0	2.0	3.0	2.0	NaN	NaN	NaN	2.0	4.0	NaN	NaN
13	NaN	3.0	5.0	5.0	3.0	NaN	NaN	5.0	4.0	NaN	NaN	NaN	5.0	3.0	NaN
14	NaN	3.0	3.0	3.0	NaN	NaN	NaN	3.0	NaN	NaN	3.0	NaN	4.0	NaN	NaN
15	NaN	NaN	NaN	NaN	3.0	2.0	NaN	2.0	NaN	2.0	NaN	2.0	NaN	2.0	2.0
16	4.0	1.0	1.0	1.0	NaN	NaN	NaN	NaN	3.0	NaN	NaN	NaN	NaN	NaN	2.0
17	NaN	NaN	NaN	2.0	NaN	2.0	NaN	2.0	NaN	1.0	1.0	NaN	5.0	NaN	NaN
18	3.0	3.0	3.0	3.0	3.0	5.0	4.0	5.0	NaN	NaN	NaN	NaN	3.0	NaN	NaN
19	NaN	4.0	NaN	NaN	NaN	NaN	4.0	3.0	NaN	NaN	5.0	NaN	NaN	NaN	3.0
20	NaN	NaN	4.0	4.0	NaN	NaN	3.0	NaN	2.0	2.0	NaN	5.0	NaN	4.0	5.0
21	NaN	1.0	3.0	3.0	NaN	NaN	NaN	5.0	1.0	5.0	1.0	2.0	NaN	4.0	3.0
22	5.0	5.0	NaN	5.0	5.0	5.0	NaN	5.0	NaN	5.0	5.0	5.0	5.0	5.0	NaN
23	NaN	4.0	4.0	NaN	NaN	1.0	5.0	2.0	NaN	NaN	3.0	NaN	NaN	2.0	NaN
24	4.0	NaN	2.0	2.0	NaN	NaN	NaN	2.0	2.0	2.0	2.0	NaN	NaN	NaN	3.0
25	3.0	NaN	3.0	NaN	NaN	3.0	NaN	NaN	5.0	NaN	2.0	5.0	NaN	4.0	NaN
26	1.0	1.0	1.0	2.0	1.0	1.0	1.0	NaN	NaN	NaN	1.0	1.0	1.0	NaN	NaN
27	5.0	NaN	NaN	3.0	NaN	NaN	NaN	3.0	NaN	3.0	NaN	NaN	5.0	3.0	3.0
28	NaN	NaN	3.0	1.0	NaN	4.0	5.0	NaN	2.0	4.0	4.0	NaN	3.0	NaN	NaN
29	NaN	NaN	3.0	NaN	3.0	NaN	3.0	NaN	5.0	5.0	3.0	NaN	NaN	NaN	NaN
30	4.0	NaN	NaN	NaN	3.0	NaN	NaN	3.0	NaN	2.0	3.0	3.0	NaN	NaN	3.0
31	2.0	NaN	4.0	NaN	3.0	NaN	2.0	NaN	1.0	NaN	NaN	3.0	2.0	2.0	NaN
32	5.0	NaN	NaN	NaN	4.0	3.0	NaN	3.0	4.0	3.0	NaN	NaN	5.0	NaN	3.0
33	NaN	NaN	4.0	NaN	NaN	3.0	NaN	NaN	2.0	NaN	5.0	NaN	2.0	2.0	NaN
34	5.0	3.0	NaN	NaN	5.0	4.0	NaN	2.0	NaN	NaN	2.0	NaN	5.0	NaN	NaN

	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15
35	NaN	4.0	3.0	4.0	NaN	NaN	NaN	2.0	5.0	NaN	4.0	4.0	3.0	NaN	NaN
36	NaN	NaN	3.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	3.0	5.0	5.0	5.0	NaN
37	5.0	NaN	3.0	NaN	NaN	3.0	NaN	3.0	5.0	3.0	NaN	NaN	3.0	NaN	3.0
38	NaN	NaN	3.0	NaN	NaN	2.0	3.0	3.0	NaN	NaN	NaN	NaN	5.0	NaN	3.0
39	NaN	3.0	NaN	4.0	5.0	NaN	NaN	3.0	5.0	3.0	3.0	NaN	5.0	NaN	1.0
40	5.0	2.0	1.0	3.0	NaN	3.0	2.0	1.0	NaN	NaN	NaN	NaN	NaN	4.0	2.0
41	5.0	3.0	NaN	3.0	5.0	4.0	3.0	3.0	NaN	NaN	NaN	4.0	3.0	NaN	NaN

Algorithm

Singular Value Decomposition (SVD)

In [22]:
```
# Transform the data into a list of tuples (user_id, video_id, rating)
data = [
    (user_id, video_id, rating)
    for user_id, row in csv_data.iterrows()
    for video_id, rating in enumerate(row, start=1)
    if not pd.isna(rating)
]

# Define the reader to specify the rating_scale
reader = Reader(rating_scale=(1, 5))

# Create the dataset
dataset = Dataset.load_from_df(pd.DataFrame(data, columns=["user_id", "video

# Train the SVD algorithm
svd = SVD()
cross_validate(svd, dataset, measures=['RMSE', 'MAE'], cv=5, verbose=True)

# Train the SVD algorithm on the full dataset
trainset = dataset.build_full_trainset()
svd.fit(trainset)

# Fill the missing values in the dataset
filled_data = csv_data.copy()
for user_id, row in csv_data.iterrows():
    for video_id, rating in enumerate(row, start=1):
        if pd.isna(rating):
            prediction = svd.predict(user_id, video_id)
            filled_data.at[user_id, f'V{video_id}'] = prediction.est

print("Filled dataset:")
display(filled_data)

# Function to recommend videos
```

```python
def recommend_videos(user_id, n_recommendations=5):
    video_ids = set(range(1, 16))  # Assuming 15 videos
    rated_videos = {entry[1] for entry in data if entry[0] == user_id}
    not_rated_videos = video_ids - rated_videos

    # Predict the ratings for the not-rated videos
    predictions = [(video_id, svd.predict(user_id, video_id).est) for video_

    # Sort the predictions by estimated rating (descending order) and get th
    recommendations = sorted(predictions, key=lambda x: x[1], reverse=True)[

    return [f"Recommended Video: V{rec[0]}, Score: {rec[1]:.5f}" for rec in

# Get recommendations for all users
user_ids = csv_data.index.unique().tolist()
all_recommendations = [recommend_videos(user_id) for user_id in user_ids]

# Create a DataFrame with recommendations
recommendations_df = pd.DataFrame(all_recommendations, columns=[f'Rec_{i+1}'
recommendations_df.index.name = 'user_id'

print("\nRecommendations for all users:")
display(recommendations_df)
```

```
Evaluating RMSE, MAE of algorithm SVD on 5 split(s).

                  Fold 1  Fold 2  Fold 3  Fold 4  Fold 5  Mean    Std
RMSE (testset)    1.0988  1.2338  0.9610  1.1162  0.9372  1.0694  0.1089
MAE (testset)     0.8760  1.0564  0.7915  0.8500  0.7411  0.8630  0.1074
Fit time          0.00    0.00    0.00    0.00    0.00    0.00    0.00
Test time         0.00    0.00    0.00    0.00    0.00    0.00    0.00
Filled dataset:
```

	V1	V2	V3	V4	V5	V6	V7	V8	
1	3.000000	3.005719	3.102788	3.000000	3.385179	3.000000	3.000000	2.765354	3.3
2	3.712067	3.000000	3.000000	3.181224	3.588645	3.282479	3.000000	3.000000	3.5
3	3.258555	3.010464	3.000000	3.000000	3.000000	3.000000	3.000000	3.000000	3.1
4	4.000000	4.000000	3.286371	3.244385	3.000000	3.146300	3.440077	3.000000	3.2
5	5.000000	3.876326	5.000000	5.000000	4.539657	3.895656	5.000000	3.616120	5.0
6	1.000000	2.669299	4.000000	2.000000	3.256905	2.761122	4.000000	2.701494	4.0
7	3.683416	2.978011	3.000000	4.000000	3.556613	3.000000	3.359567	2.849597	3.0
8	2.000000	2.382837	2.402391	2.613240	4.000000	2.537513	2.583655	2.000000	1.0
9	3.000000	3.303669	3.000000	3.444061	3.837833	5.000000	3.469025	3.000000	3.0
10	4.009247	4.000000	3.520396	5.000000	4.221430	3.634683	3.742796	3.512801	5.0
11	3.464116	3.000000	3.000000	3.000000	5.000000	3.000000	3.428311	3.000000	3.4
12	2.000000	2.727587	2.972293	3.002442	4.000000	2.000000	3.000000	2.000000	3.0
13	4.005015	3.000000	5.000000	5.000000	3.000000	3.319327	3.846862	5.000000	4.0
14	3.576857	3.000000	3.000000	3.000000	3.480675	3.159278	3.305850	3.000000	3.0
15	3.145811	2.540093	2.627894	2.837514	3.000000	2.000000	2.805633	2.000000	2.9
16	4.000000	1.000000	1.000000	1.000000	2.834122	2.349574	2.886813	2.435880	3.0
17	3.232677	2.694840	2.553783	2.000000	3.109814	2.000000	2.804248	2.000000	2.1
18	3.000000	3.000000	3.000000	3.000000	3.000000	5.000000	4.000000	5.000000	3.5
19	3.658675	4.000000	3.153940	3.595903	3.820095	3.327794	4.000000	3.000000	3.7
20	3.607001	3.227377	4.000000	4.000000	3.621654	3.319884	3.000000	2.993603	2.0
21	3.244445	1.000000	3.000000	3.000000	3.242674	2.714988	3.105991	5.000000	1.0
22	5.000000	5.000000	4.142031	5.000000	5.000000	5.000000	4.609786	5.000000	4.3
23	3.305834	4.000000	4.000000	3.146757	3.273171	1.000000	5.000000	2.000000	3.3
24	4.000000	2.540651	2.000000	2.000000	2.998846	2.652493	2.905691	2.000000	2.0
25	3.000000	3.066721	3.000000	3.184023	3.677957	3.000000	3.441067	3.156489	5.0
26	1.000000	1.000000	1.000000	2.000000	1.000000	1.000000	1.000000	1.871552	1.8
27	5.000000	3.182321	3.357797	3.000000	3.678564	3.309264	3.613338	3.000000	3.4
28	3.618326	3.181555	3.000000	1.000000	3.545400	4.000000	5.000000	2.774926	2.0
29	3.744527	3.136387	3.000000	3.383645	3.000000	3.262828	3.000000	3.026885	5.0
30	4.000000	2.979155	3.026160	3.165979	3.000000	3.034182	3.147993	3.000000	3.0
31	2.000000	2.450186	4.000000	2.759068	3.000000	2.723496	2.000000	2.304232	1.0
32	5.000000	3.269806	3.209498	3.512691	4.000000	3.000000	3.718421	3.000000	4.0
33	3.398897	2.998940	4.000000	3.112124	3.450063	3.000000	3.162554	2.896755	2.0
34	5.000000	3.000000	3.294414	3.221928	5.000000	4.000000	3.692437	2.000000	3.7

	V1	V2	V3	V4	V5	V6	V7	V8	
35	3.645022	4.000000	3.000000	4.000000	3.660324	3.269166	3.444519	2.000000	5.0
36	3.956485	3.504884	3.000000	3.610195	3.862237	3.448359	3.455736	3.324315	3.
37	5.000000	3.252335	3.000000	3.245358	3.594205	3.000000	3.480956	3.000000	5.0
38	3.732531	2.965459	3.000000	2.958100	3.401516	2.000000	3.000000	3.000000	3.4
39	3.805761	3.000000	3.259345	4.000000	5.000000	3.368691	3.434136	3.000000	5.0
40	5.000000	2.000000	1.000000	3.000000	3.174145	3.000000	2.000000	1.000000	2.
41	5.000000	3.000000	3.376815	3.000000	5.000000	4.000000	3.000000	3.000000	3.

Recommendations for all users:

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
1	Recommended Video: V12, Score: 3.55117	Recommended Video: V5, Score: 3.38518	Recommended Video: V9, Score: 3.34827	Recommended Video: V14, Score: 3.29784	Recommended Video: V3, Score: 3.10279
2	Recommended Video: V1, Score: 3.71207	Recommended Video: V12, Score: 3.69512	Recommended Video: V5, Score: 3.58864	Recommended Video: V9, Score: 3.53071	Recommended Video: V6, Score: 3.28248
3	Recommended Video: V1, Score: 3.25856	Recommended Video: V11, Score: 3.16042	Recommended Video: V9, Score: 3.14969	Recommended Video: V15, Score: 3.01743	Recommended Video: V2, Score: 3.01046
4	Recommended Video: V13, Score: 3.68939	Recommended Video: V7, Score: 3.44008	Recommended Video: V3, Score: 3.28637	Recommended Video: V4, Score: 3.24438	Recommended Video: V9, Score: 3.23509
5	Recommended Video: V5, Score: 4.53966	Recommended Video: V13, Score: 4.50808	Recommended Video: V14, Score: 4.22030	Recommended Video: V6, Score: 3.89566	Recommended Video: V2, Score: 3.87633
6	Recommended Video: V13, Score: 3.34311	Recommended Video: V5, Score: 3.25691	Recommended Video: V14, Score: 3.17020	Recommended Video: V15, Score: 2.91309	Recommended Video: V11, Score: 2.87357
7	Recommended Video: V13, Score: 3.73112	Recommended Video: V1, Score: 3.68342	Recommended Video: V5, Score: 3.55661	Recommended Video: V7, Score: 3.35957	Recommended Video: V14, Score: 3.31238
8	Recommended Video: V14, Score: 2.75136	Recommended Video: V4, Score: 2.61324	Recommended Video: V7, Score: 2.58365	Recommended Video: V6, Score: 2.53751	Recommended Video: V11, Score: 2.52017
9	Recommended Video: V12, Score: 3.99161	Recommended Video: V5, Score: 3.83783	Recommended Video: V7, Score: 3.46903	Recommended Video: V4, Score: 3.44406	Recommended Video: V2, Score: 3.30367
10	Recommended Video: V5, Score: 4.22143	Recommended Video: V13, Score: 4.04570	Recommended Video: V1, Score: 4.00925	Recommended Video: V7, Score: 3.74280	Recommended Video: V11, Score: 3.71020
11	Recommended Video: V12, Score: 3.75169	Recommended Video: V13, Score: 3.70890	Recommended Video: V1, Score: 3.46412	Recommended Video: V7, Score: 3.42831	Recommended Video: V9, Score: 3.40195
12	Recommended Video: V14, Score: 3.19584	Recommended Video: V9, Score: 3.03905	Recommended Video: V4, Score: 3.00244	Recommended Video: V3, Score: 2.97229	Recommended Video: V15, Score: 2.77175
13	Recommended Video: V12, Score: 4.04546	Recommended Video: V1, Score: 4.00501	Recommended Video: V7, Score: 3.84686	Recommended Video: V10, Score: 3.37288	Recommended Video: V6, Score: 3.31933
14	Recommended Video: V1, Score: 3.57686	Recommended Video: V12, Score: 3.50780	Recommended Video: V5, Score: 3.48068	Recommended Video: V7, Score: 3.30585	Recommended Video: V14, Score: 3.26778
15	Recommended Video: V1, Score: 3.14581	Recommended Video: V13, Score: 2.99916	Recommended Video: V9, Score: 2.95951	Recommended Video: V4, Score: 2.83751	Recommended Video: V7, Score: 2.80563

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
16	Recommended Video: V12, Score: 3.35118	Recommended Video: V13, Score: 3.17135	Recommended Video: V7, Score: 2.88681	Recommended Video: V5, Score: 2.83412	Recommended Video: V14, Score: 2.68975
17	Recommended Video: V1, Score: 3.23268	Recommended Video: V5, Score: 3.10981	Recommended Video: V12, Score: 3.08648	Recommended Video: V14, Score: 3.02494	Recommended Video: V7, Score: 2.80425
18	Recommended Video: V12, Score: 3.79678	Recommended Video: V9, Score: 3.57086	Recommended Video: V14, Score: 3.38963	Recommended Video: V15, Score: 3.34739	Recommended Video: V11, Score: 3.30279
19	Recommended Video: V12, Score: 4.10101	Recommended Video: V13, Score: 4.00602	Recommended Video: V5, Score: 3.82010	Recommended Video: V9, Score: 3.70790	Recommended Video: V1, Score: 3.65868
20	Recommended Video: V13, Score: 3.67284	Recommended Video: V5, Score: 3.62165	Recommended Video: V1, Score: 3.60700	Recommended Video: V6, Score: 3.31988	Recommended Video: V11, Score: 3.28743
21	Recommended Video: V13, Score: 3.28107	Recommended Video: V1, Score: 3.24445	Recommended Video: V5, Score: 3.24267	Recommended Video: V7, Score: 3.10599	Recommended Video: V6, Score: 2.71499
22	Recommended Video: V7, Score: 4.60979	Recommended Video: V9, Score: 4.34492	Recommended Video: V15, Score: 4.29554	Recommended Video: V3, Score: 4.14203	None
23	Recommended Video: V13, Score: 3.53553	Recommended Video: V12, Score: 3.44250	Recommended Video: V9, Score: 3.32427	Recommended Video: V1, Score: 3.30583	Recommended Video: V5, Score: 3.27317
24	Recommended Video: V13, Score: 3.32470	Recommended Video: V12, Score: 3.12821	Recommended Video: V5, Score: 2.99885	Recommended Video: V14, Score: 2.95787	Recommended Video: V7, Score: 2.90569
25	Recommended Video: V13, Score: 3.71771	Recommended Video: V5, Score: 3.67796	Recommended Video: V7, Score: 3.44107	Recommended Video: V10, Score: 3.30212	Recommended Video: V4, Score: 3.18402
26	Recommended Video: V14, Score: 1.97902	Recommended Video: V8, Score: 1.87155	Recommended Video: V9, Score: 1.84861	Recommended Video: V10, Score: 1.72975	Recommended Video: V15, Score: 1.60647
27	Recommended Video: V12, Score: 3.83859	Recommended Video: V5, Score: 3.67856	Recommended Video: V7, Score: 3.61334	Recommended Video: V9, Score: 3.42919	Recommended Video: V3, Score: 3.35780
28	Recommended Video: V12, Score: 3.70635	Recommended Video: V1, Score: 3.61833	Recommended Video: V5, Score: 3.54540	Recommended Video: V14, Score: 3.50085	Recommended Video: V15, Score: 3.29190
29	Recommended Video: V12, Score: 3.94661	Recommended Video: V13, Score: 3.79281	Recommended Video: V1, Score: 3.74453	Recommended Video: V14, Score: 3.56310	Recommended Video: V4, Score: 3.38364
30	Recommended Video: V13, Score: 3.64882	Recommended Video: V14, Score: 3.39200	Recommended Video: V4, Score: 3.16598	Recommended Video: V7, Score: 3.14799	Recommended Video: V9, Score: 3.06615

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
31	Recommended Video: V4, Score: 2.75907	Recommended Video: V6, Score: 2.72350	Recommended Video: V15, Score: 2.47859	Recommended Video: V11, Score: 2.46966	Recommended Video: V2, Score: 2.45019
32	Recommended Video: V12, Score: 4.17144	Recommended Video: V7, Score: 3.71842	Recommended Video: V14, Score: 3.58150	Recommended Video: V4, Score: 3.51269	Recommended Video: V2, Score: 3.26981
33	Recommended Video: V12, Score: 3.56988	Recommended Video: V5, Score: 3.45006	Recommended Video: V1, Score: 3.39890	Recommended Video: V7, Score: 3.16255	Recommended Video: V15, Score: 3.11680
34	Recommended Video: V12, Score: 3.81946	Recommended Video: V9, Score: 3.77739	Recommended Video: V14, Score: 3.72093	Recommended Video: V7, Score: 3.69244	Recommended Video: V3, Score: 3.29441
35	Recommended Video: V5, Score: 3.66032	Recommended Video: V1, Score: 3.64502	Recommended Video: V14, Score: 3.48281	Recommended Video: V7, Score: 3.44452	Recommended Video: V6, Score: 3.26917
36	Recommended Video: V1, Score: 3.95648	Recommended Video: V5, Score: 3.86224	Recommended Video: V9, Score: 3.78920	Recommended Video: V4, Score: 3.61019	Recommended Video: V2, Score: 3.50488
37	Recommended Video: V12, Score: 3.79003	Recommended Video: V5, Score: 3.59420	Recommended Video: V7, Score: 3.48096	Recommended Video: V14, Score: 3.47639	Recommended Video: V11, Score: 3.29890
38	Recommended Video: V1, Score: 3.73253	Recommended Video: V12, Score: 3.53071	Recommended Video: V9, Score: 3.41065	Recommended Video: V5, Score: 3.40152	Recommended Video: V14, Score: 3.25836
39	Recommended Video: V12, Score: 3.89640	Recommended Video: V1, Score: 3.80576	Recommended Video: V14, Score: 3.66621	Recommended Video: V7, Score: 3.43414	Recommended Video: V6, Score: 3.36869
40	Recommended Video: V12, Score: 3.32462	Recommended Video: V13, Score: 3.31514	Recommended Video: V5, Score: 3.17415	Recommended Video: V9, Score: 2.75109	Recommended Video: V10, Score: 2.59283
41	Recommended Video: V14, Score: 3.76787	Recommended Video: V9, Score: 3.71172	Recommended Video: V15, Score: 3.38043	Recommended Video: V3, Score: 3.37681	Recommended Video: V11, Score: 3.28758

Non-Negative Matrix Factorization (NMF)

In [25]:
```
# Transform the data into a list of tuples (user_id, video_id, rating)
data = [
    (user_id, video_id, rating)
    for user_id, row in csv_data.iterrows()
    for video_id, rating in enumerate(row, start=1)
    if not pd.isna(rating)
]

# Define the reader to specify the rating_scale
reader = Reader(rating_scale=(1, 5))
```

```python
# Create the dataset
dataset = Dataset.load_from_df(pd.DataFrame(data, columns=["user_id", "video

# Train the NMF algorithm
nmf = NMF()
cross_validate(nmf, dataset, measures=['RMSE', 'MAE'], cv=5, verbose=True)

# Train the NMF algorithm on the full dataset
trainset = dataset.build_full_trainset()
nmf.fit(trainset)

# Fill the missing values in the dataset
filled_data = csv_data.copy()
for user_id, row in csv_data.iterrows():
    for video_id, rating in enumerate(row, start=1):
        if pd.isna(rating):
            prediction = nmf.predict(user_id, video_id)
            filled_data.at[user_id, f'V{video_id}'] = prediction.est

print("Filled dataset:")
display(filled_data)

# Function to recommend videos
def recommend_videos(user_id, n_recommendations=5):
    video_ids = set(range(1, 16))  # Assuming 15 videos
    rated_videos = {entry[1] for entry in data if entry[0] == user_id}
    not_rated_videos = video_ids - rated_videos

    # Predict the ratings for the not-rated videos
    predictions = [(video_id, nmf.predict(user_id, video_id).est) for video_

    # Sort the predictions by estimated rating (descending order) and get th
    recommendations = sorted(predictions, key=lambda x: x[1], reverse=True)[

    return [f"Recommended Video: V{rec[0]}, Score: {rec[1]:.5f}" for rec in

# Get recommendations for all users
user_ids = csv_data.index.unique().tolist()
all_recommendations = [recommend_videos(user_id) for user_id in user_ids]

# Create a DataFrame with recommendations
recommendations_df = pd.DataFrame(all_recommendations, columns=[f'Rec_{i+1}'
recommendations_df.index.name = 'user_id'

print("\nRecommendations for all users:")
display(recommendations_df)
```

```
Evaluating RMSE, MAE of algorithm NMF on 5 split(s).

                  Fold 1  Fold 2  Fold 3  Fold 4  Fold 5  Mean    Std
RMSE (testset)    1.2974  1.1226  1.0549  1.1186  0.9430  1.1073  0.1151
MAE (testset)     1.0041  0.8328  0.7732  0.8495  0.7027  0.8325  0.1001
Fit time          0.00    0.00    0.00    0.00    0.00    0.00    0.00
Test time         0.00    0.00    0.00    0.00    0.00    0.00    0.00
Filled dataset:
```

	V1	V2	V3	V4	V5	V6	V7	V8	
1	3.000000	2.446402	3.043937	3.000000	3.196241	3.000000	3.000000	3.053830	2.5
2	4.067205	3.000000	3.000000	3.315836	4.256078	3.150842	3.000000	3.000000	2.9
3	3.164511	2.632369	3.000000	3.000000	3.000000	3.000000	3.000000	3.000000	3.0
4	4.000000	4.000000	3.127432	3.353714	3.000000	3.844202	3.347098	3.000000	2.8
5	5.000000	4.333718	5.000000	5.000000	5.000000	5.000000	5.000000	5.000000	5.0
6	1.000000	2.545995	4.000000	2.000000	2.511871	2.056226	4.000000	2.384503	4.0
7	3.640519	2.549037	3.000000	4.000000	3.990463	3.000000	3.389609	2.320521	3.0
8	2.000000	2.165126	1.927289	1.351975	4.000000	2.871812	2.460451	2.000000	1.0
9	3.000000	3.420995	3.000000	3.397840	4.233218	5.000000	3.418979	3.000000	3.0
10	4.647606	4.000000	4.853047	5.000000	4.581578	4.548826	5.000000	4.769177	5.0
11	4.044074	3.000000	3.000000	3.000000	5.000000	3.000000	3.366043	3.000000	2.7
12	2.000000	2.557273	2.630832	2.372502	4.000000	2.000000	3.000000	2.000000	2.6
13	3.934909	3.000000	5.000000	5.000000	3.000000	3.694455	4.196888	5.000000	4.0
14	3.439823	3.000000	3.000000	3.000000	3.313058	2.822760	3.512809	3.000000	2.7
15	2.228724	1.910064	1.962881	1.881006	3.000000	2.000000	2.129099	2.000000	1.9
16	4.000000	1.000000	1.000000	1.000000	2.319922	1.531382	1.328936	1.468284	3.0
17	4.207170	1.695608	1.915198	2.000000	3.699089	2.000000	1.791842	2.000000	2.2
18	3.000000	3.000000	3.000000	3.000000	3.000000	5.000000	4.000000	5.000000	3.5
19	2.784837	4.000000	3.710190	3.087461	4.610547	3.059379	4.000000	3.000000	3.2
20	3.914484	3.494627	4.000000	4.000000	3.820394	3.796823	3.000000	3.613802	2.0
21	3.088990	1.000000	3.000000	3.000000	2.350667	3.249546	2.493574	5.000000	1.0
22	5.000000	5.000000	4.734408	5.000000	5.000000	5.000000	5.000000	5.000000	4.4
23	2.386987	4.000000	4.000000	2.925151	3.616155	1.000000	5.000000	2.000000	2.8
24	4.000000	2.036242	2.000000	2.000000	2.768279	2.407505	2.173679	2.000000	2.0
25	3.000000	2.608560	3.000000	3.666453	4.086503	3.000000	3.767876	2.905174	5.0
26	1.000000	1.000000	1.000000	2.000000	1.000000	1.000000	1.000000	1.029430	1.2
27	5.000000	2.341674	2.795848	3.000000	3.892599	2.816950	2.945015	3.000000	3.4
28	3.021407	2.587887	3.000000	1.000000	4.284907	4.000000	5.000000	3.222365	2.0
29	3.788793	2.738540	3.000000	4.239801	3.000000	3.460459	3.000000	4.291200	5.0
30	4.000000	2.655412	2.614169	2.663570	3.000000	2.981695	2.528512	3.000000	2.6
31	2.000000	2.672818	4.000000	2.654297	3.000000	2.378776	2.000000	2.240001	1.0
32	5.000000	2.620518	2.858264	3.516072	4.000000	3.000000	2.808851	3.000000	4.0
33	2.326603	3.818278	4.000000	2.734005	3.536593	3.000000	3.860174	2.663116	2.0
34	5.000000	3.000000	2.643917	3.349722	5.000000	4.000000	3.302564	2.000000	3.1

	V1	V2	V3	V4	V5	V6	V7	V8	
35	2.714822	4.000000	3.000000	4.000000	3.776826	2.902776	4.240892	2.000000	5.0
36	5.000000	3.456602	3.000000	3.948665	4.832444	4.080216	3.437293	3.370627	3.5
37	5.000000	2.756236	3.000000	3.085315	3.748202	3.000000	3.549449	3.000000	5.0
38	3.564588	2.352877	3.000000	2.808233	3.429420	2.000000	3.000000	3.000000	2.4
39	4.751353	3.000000	2.579473	4.000000	5.000000	3.807843	3.500277	3.000000	5.0
40	5.000000	2.000000	1.000000	3.000000	3.464648	3.000000	2.000000	1.000000	2.7
41	5.000000	3.000000	2.586667	3.000000	5.000000	4.000000	3.000000	3.000000	3.5

Recommendations for all users:

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
1	Recommended Video: V12, Score: 3.39812	Recommended Video: V5, Score: 3.19624	Recommended Video: V14, Score: 3.08048	Recommended Video: V8, Score: 3.05383	Recommended Video: V3, Score: 3.04394
2	Recommended Video: V5, Score: 4.25608	Recommended Video: V1, Score: 4.06721	Recommended Video: V14, Score: 3.80078	Recommended Video: V12, Score: 3.73173	Recommended Video: V4, Score: 3.31584
3	Recommended Video: V1, Score: 3.16451	Recommended Video: V15, Score: 3.12790	Recommended Video: V9, Score: 3.05793	Recommended Video: V2, Score: 2.63237	Recommended Video: V11, Score: 2.56904
4	Recommended Video: V6, Score: 3.84420	Recommended Video: V15, Score: 3.52371	Recommended Video: V4, Score: 3.35371	Recommended Video: V7, Score: 3.34710	Recommended Video: V11, Score: 3.16060
5	Recommended Video: V5, Score: 5.00000	Recommended Video: V6, Score: 5.00000	Recommended Video: V8, Score: 5.00000	Recommended Video: V13, Score: 4.70622	Recommended Video: V14, Score: 4.61551
6	Recommended Video: V13, Score: 2.57947	Recommended Video: V2, Score: 2.54600	Recommended Video: V5, Score: 2.51187	Recommended Video: V8, Score: 2.38450	Recommended Video: V15, Score: 2.33870
7	Recommended Video: V13, Score: 4.86268	Recommended Video: V5, Score: 3.99046	Recommended Video: V14, Score: 3.93939	Recommended Video: V1, Score: 3.64052	Recommended Video: V7, Score: 3.38961
8	Recommended Video: V6, Score: 2.87181	Recommended Video: V11, Score: 2.71275	Recommended Video: V7, Score: 2.46045	Recommended Video: V14, Score: 2.16686	Recommended Video: V2, Score: 2.16513
9	Recommended Video: V5, Score: 4.23322	Recommended Video: V12, Score: 4.22825	Recommended Video: V2, Score: 3.42100	Recommended Video: V7, Score: 3.41898	Recommended Video: V4, Score: 3.39784
10	Recommended Video: V7, Score: 5.00000	Recommended Video: V13, Score: 5.00000	Recommended Video: V3, Score: 4.85305	Recommended Video: V8, Score: 4.76918	Recommended Video: V1, Score: 4.64761
11	Recommended Video: V13, Score: 4.29222	Recommended Video: V1, Score: 4.04407	Recommended Video: V12, Score: 3.69062	Recommended Video: V7, Score: 3.36604	Recommended Video: V14, Score: 3.30055
12	Recommended Video: V9, Score: 2.64790	Recommended Video: V3, Score: 2.63083	Recommended Video: V2, Score: 2.55727	Recommended Video: V4, Score: 2.37250	Recommended Video: V10, Score: 2.22773
13	Recommended Video: V10, Score: 4.43117	Recommended Video: V15, Score: 4.40072	Recommended Video: V7, Score: 4.19689	Recommended Video: V1, Score: 3.93491	Recommended Video: V12, Score: 3.91370
14	Recommended Video: V7, Score: 3.51281	Recommended Video: V1, Score: 3.43982	Recommended Video: V12, Score: 3.33112	Recommended Video: V5, Score: 3.31306	Recommended Video: V15, Score: 3.24270
15	Recommended Video: V13, Score: 2.58014	Recommended Video: V1, Score: 2.22872	Recommended Video: V7, Score: 2.12910	Recommended Video: V9, Score: 1.96831	Recommended Video: V3, Score: 1.96288

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
16	Recommended Video: V13, Score: 2.56031	Recommended Video: V5, Score: 2.31992	Recommended Video: V12, Score: 2.07686	Recommended Video: V14, Score: 1.71568	Recommended Video: V6, Score: 1.53138
17	Recommended Video: V1, Score: 4.20717	Recommended Video: V5, Score: 3.69909	Recommended Video: V12, Score: 2.86332	Recommended Video: V14, Score: 2.75170	Recommended Video: V15, Score: 2.64404
18	Recommended Video: V10, Score: 4.07600	Recommended Video: V14, Score: 3.76275	Recommended Video: V9, Score: 3.53590	Recommended Video: V15, Score: 3.50806	Recommended Video: V12, Score: 3.44966
19	Recommended Video: V5, Score: 4.61055	Recommended Video: V12, Score: 3.75791	Recommended Video: V3, Score: 3.71019	Recommended Video: V9, Score: 3.22479	Recommended Video: V4, Score: 3.08746
20	Recommended Video: V1, Score: 3.91448	Recommended Video: V13, Score: 3.84530	Recommended Video: V5, Score: 3.82039	Recommended Video: V6, Score: 3.79682	Recommended Video: V8, Score: 3.61380
21	Recommended Video: V13, Score: 4.76119	Recommended Video: V6, Score: 3.24955	Recommended Video: V1, Score: 3.08899	Recommended Video: V7, Score: 2.49357	Recommended Video: V5, Score: 2.35067
22	Recommended Video: V7, Score: 5.00000	Recommended Video: V3, Score: 4.73441	Recommended Video: V15, Score: 4.61538	Recommended Video: V9, Score: 4.43980	None
23	Recommended Video: V13, Score: 3.83065	Recommended Video: V12, Score: 3.68103	Recommended Video: V5, Score: 3.61615	Recommended Video: V4, Score: 2.92515	Recommended Video: V15, Score: 2.91617
24	Recommended Video: V13, Score: 3.31271	Recommended Video: V5, Score: 2.76828	Recommended Video: V12, Score: 2.71496	Recommended Video: V14, Score: 2.68106	Recommended Video: V6, Score: 2.40751
25	Recommended Video: V13, Score: 4.26499	Recommended Video: V5, Score: 4.08650	Recommended Video: V7, Score: 3.76788	Recommended Video: V4, Score: 3.66645	Recommended Video: V10, Score: 3.12068
26	Recommended Video: V9, Score: 1.27210	Recommended Video: V14, Score: 1.14569	Recommended Video: V10, Score: 1.12815	Recommended Video: V8, Score: 1.02943	Recommended Video: V15, Score: 1.00000
27	Recommended Video: V5, Score: 3.89260	Recommended Video: V9, Score: 3.45150	Recommended Video: V12, Score: 3.35524	Recommended Video: V7, Score: 2.94502	Recommended Video: V6, Score: 2.81695
28	Recommended Video: V5, Score: 4.28491	Recommended Video: V12, Score: 3.35631	Recommended Video: V8, Score: 3.22237	Recommended Video: V1, Score: 3.02141	Recommended Video: V15, Score: 2.63471
29	Recommended Video: V8, Score: 4.29120	Recommended Video: V13, Score: 4.27589	Recommended Video: V4, Score: 4.23980	Recommended Video: V1, Score: 3.78879	Recommended Video: V14, Score: 3.76603
30	Recommended Video: V13, Score: 3.04493	Recommended Video: V6, Score: 2.98170	Recommended Video: V14, Score: 2.90825	Recommended Video: V4, Score: 2.66357	Recommended Video: V2, Score: 2.65541

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
31	Recommended Video: V15, Score: 2.83787	Recommended Video: V11, Score: 2.71892	Recommended Video: V2, Score: 2.67282	Recommended Video: V4, Score: 2.65430	Recommended Video: V6, Score: 2.37878
32	Recommended Video: V14, Score: 3.68953	Recommended Video: V12, Score: 3.56648	Recommended Video: V4, Score: 3.51607	Recommended Video: V3, Score: 2.85826	Recommended Video: V7, Score: 2.80885
33	Recommended Video: V7, Score: 3.86017	Recommended Video: V2, Score: 3.81828	Recommended Video: V5, Score: 3.53659	Recommended Video: V12, Score: 3.22210	Recommended Video: V15, Score: 2.76364
34	Recommended Video: V14, Score: 4.20079	Recommended Video: V12, Score: 4.12451	Recommended Video: V4, Score: 3.34972	Recommended Video: V7, Score: 3.30256	Recommended Video: V9, Score: 3.18968
35	Recommended Video: V7, Score: 4.24089	Recommended Video: V5, Score: 3.77683	Recommended Video: V14, Score: 3.03962	Recommended Video: V6, Score: 2.90278	Recommended Video: V10, Score: 2.78640
36	Recommended Video: V1, Score: 5.00000	Recommended Video: V5, Score: 4.83244	Recommended Video: V6, Score: 4.08022	Recommended Video: V4, Score: 3.94866	Recommended Video: V15, Score: 3.87251
37	Recommended Video: V5, Score: 3.74820	Recommended Video: V12, Score: 3.74820	Recommended Video: V7, Score: 3.54945	Recommended Video: V11, Score: 3.21031	Recommended Video: V4, Score: 3.08532
38	Recommended Video: V1, Score: 3.56459	Recommended Video: V5, Score: 3.42942	Recommended Video: V12, Score: 3.01772	Recommended Video: V10, Score: 2.97822	Recommended Video: V14, Score: 2.91800
39	Recommended Video: V1, Score: 4.75135	Recommended Video: V14, Score: 4.40373	Recommended Video: V12, Score: 3.94298	Recommended Video: V6, Score: 3.80784	Recommended Video: V7, Score: 3.50028
40	Recommended Video: V13, Score: 4.31437	Recommended Video: V5, Score: 3.46465	Recommended Video: V12, Score: 3.06460	Recommended Video: V9, Score: 2.77846	Recommended Video: V10, Score: 2.06584
41	Recommended Video: V14, Score: 3.85672	Recommended Video: V9, Score: 3.53625	Recommended Video: V15, Score: 3.37025	Recommended Video: V11, Score: 2.86982	Recommended Video: V3, Score: 2.58667

K-Nearest Neighbors (KNN)

In [28]:
```
# Transform the data into a list of tuples (user_id, video_id, rating)
data = [
    (user_id, video_id, rating)
    for user_id, row in csv_data.iterrows()
    for video_id, rating in enumerate(row, start=1)
    if not pd.isna(rating)
]

# Define the reader to specify the rating_scale
reader = Reader(rating_scale=(1, 5))
```

```python
# Create the dataset
dataset = Dataset.load_from_df(pd.DataFrame(data, columns=["user_id", "video

# Train the KNNWithMeans algorithm
knn = KNNWithMeans()
cross_validate(knn, dataset, measures=['RMSE', 'MAE'], cv=5, verbose=True)

# Train the KNNWithMeans algorithm on the full dataset
trainset = dataset.build_full_trainset()
knn.fit(trainset)

# Fill the missing values in the dataset
filled_data = csv_data.copy()
for user_id, row in csv_data.iterrows():
    for video_id, rating in enumerate(row, start=1):
        if pd.isna(rating):
            prediction = knn.predict(user_id, video_id)
            filled_data.at[user_id, f'V{video_id}'] = prediction.est

print("Filled dataset:")
display(filled_data)

# Function to recommend videos
def recommend_videos(user_id, n_recommendations=5):
    video_ids = set(range(1, 16))  # Assuming 15 videos
    rated_videos = {entry[1] for entry in data if entry[0] == user_id}
    not_rated_videos = video_ids - rated_videos

    # Predict the ratings for the not-rated videos
    predictions = [(video_id, knn.predict(user_id, video_id).est) for video_

    # Sort the predictions by estimated rating (descending order) and get th
    recommendations = sorted(predictions, key=lambda x: x[1], reverse=True)[

    return [f"Recommended Video: V{rec[0]}, Score: {rec[1]:.5f}" for rec in

# Get recommendations for all users
user_ids = csv_data.index.unique().tolist()
all_recommendations = [recommend_videos(user_id) for user_id in user_ids]

# Create a DataFrame with recommendations
recommendations_df = pd.DataFrame(all_recommendations, columns=[f'Rec_{i+1}'
recommendations_df.index.name = 'user_id'

print("\nRecommendations for all users:")
display(recommendations_df)
```

```
Computing the msd similarity matrix...
Done computing similarity matrix.
Computing the msd similarity matrix...
Done computing similarity matrix.
Computing the msd similarity matrix...
Done computing similarity matrix.
Computing the msd similarity matrix...
Done computing similarity matrix.
Computing the msd similarity matrix...
Done computing similarity matrix.
Evaluating RMSE, MAE of algorithm KNNWithMeans on 5 split(s).

                  Fold 1  Fold 2  Fold 3  Fold 4  Fold 5  Mean    Std
RMSE (testset)    1.2009  1.1575  0.9091  1.0927  0.9502  1.0621  0.1142
MAE (testset)     0.8761  0.8777  0.6927  0.8633  0.7432  0.8106  0.0775
Fit time          0.00    0.00    0.00    0.00    0.00    0.00    0.00
Test time         0.00    0.00    0.00    0.00    0.00    0.00    0.00
Computing the msd similarity matrix...
Done computing similarity matrix.
Filled dataset:
```

	V1	V2	V3	V4	V5	V6	V7	V8	
1	3.000000	2.809166	2.905171	3.000000	3.664251	3.000000	3.000000	2.790687	3.
2	3.854401	3.000000	3.000000	3.123764	3.741844	3.078360	3.000000	3.000000	3.(
3	3.581587	2.874658	3.000000	3.000000	3.000000	3.000000	3.000000	3.000000	3.3
4	4.000000	4.000000	3.262161	3.392911	3.000000	3.292006	3.443913	3.000000	3
5	5.000000	4.723659	5.000000	5.000000	5.000000	4.799763	5.000000	4.562219	5.(
6	1.000000	2.725854	4.000000	2.000000	3.404417	2.629970	4.000000	2.537123	4.(
7	3.787392	2.761599	3.000000	4.000000	3.639333	3.000000	3.127083	2.798591	3.(
8	2.000000	2.078617	2.310871	1.930730	4.000000	1.835214	2.526810	2.000000	1.(
9	3.000000	3.029047	3.000000	3.097408	3.688080	5.000000	3.461360	3.000000	3.(
10	5.000000	4.000000	4.433756	5.000000	4.750527	4.522141	4.627641	4.257578	5.(
11	3.837276	3.000000	3.000000	3.000000	5.000000	3.000000	3.340276	3.000000	3.4
12	2.000000	2.475056	2.653017	2.562455	4.000000	2.000000	3.000000	2.000000	2.5
13	4.486146	3.000000	5.000000	5.000000	3.000000	4.000356	4.179319	5.000000	4.(
14	3.655251	3.000000	3.000000	3.000000	3.649377	3.040635	3.219989	3.000000	3.4
15	2.687582	1.888663	2.166747	1.913676	3.000000	2.000000	2.383682	2.000000	2.1
16	4.000000	1.000000	1.000000	1.000000	2.538913	1.984996	2.088589	1.681852	3.(
17	2.707464	1.866887	1.975102	2.000000	2.834158	2.000000	2.348644	2.000000	2.4
18	3.000000	3.000000	3.000000	3.000000	3.000000	5.000000	4.000000	5.000000	3.5
19	4.267759	4.000000	3.814832	3.505075	4.290550	3.622124	4.000000	3.000000	3.
20	3.996007	3.367358	4.000000	4.000000	3.898229	3.612601	3.000000	3.404752	2.(
21	3.202196	1.000000	3.000000	3.000000	3.198800	2.818996	2.865196	5.000000	1.(
22	5.000000	5.000000	4.821500	5.000000	5.000000	5.000000	5.000000	5.000000	5.(
23	3.299264	4.000000	4.000000	2.886284	3.699272	1.000000	5.000000	2.000000	3.1
24	4.000000	2.066448	2.000000	2.000000	2.983848	2.290377	2.445755	2.000000	2.(
25	3.000000	3.240260	3.000000	3.528759	4.006072	3.000000	3.560565	3.228776	5.(
26	1.000000	1.000000	1.000000	2.000000	1.000000	1.000000	1.000000	1.000000	1.(
27	5.000000	3.289009	3.372602	3.000000	4.152694	3.333408	3.625275	3.000000	3.1
28	3.685054	2.918618	3.000000	1.000000	3.749430	4.000000	5.000000	2.953202	2.(
29	3.924486	3.355932	3.000000	3.611312	3.000000	3.515043	3.000000	3.355453	5.(
30	4.000000	2.779982	2.840170	2.814706	3.000000	2.820413	3.113006	3.000000	3.
31	2.000000	2.004712	4.000000	2.240095	3.000000	2.347237	2.000000	2.235932	1.(
32	5.000000	3.448611	3.455960	3.641039	4.000000	3.000000	3.766099	3.000000	4.(
33	3.268582	2.782095	4.000000	2.706793	3.666079	3.000000	3.175287	2.657880	2.(
34	5.000000	3.000000	3.392192	3.611867	5.000000	4.000000	3.719983	2.000000	3.9

	V1	V2	V3	V4	V5	V6	V7	V8	
35	4.119069	4.000000	3.000000	4.000000	4.023646	3.436884	3.743643	2.000000	5.0
36	4.747583	3.861066	3.000000	4.128701	4.686607	4.021427	4.152756	3.809243	4.5
37	5.000000	3.283089	3.000000	3.369387	4.016996	3.000000	3.528247	3.000000	5.0
38	3.741073	2.929715	3.000000	3.044096	3.546796	2.000000	3.000000	3.000000	3.
39	4.091237	3.000000	3.302833	4.000000	5.000000	3.328734	3.734243	3.000000	5.0
40	5.000000	2.000000	1.000000	3.000000	3.172736	3.000000	2.000000	1.000000	2.7
41	5.000000	3.000000	3.476684	3.000000	5.000000	4.000000	3.000000	3.000000	3.7

Recommendations for all users:

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
1	Recommended Video: V5, Score: 3.66425	Recommended Video: V12, Score: 3.60239	Recommended Video: V9, Score: 3.31702	Recommended Video: V14, Score: 3.28364	Recommended Video: V3, Score: 2.90517
2	Recommended Video: V1, Score: 3.85440	Recommended Video: V5, Score: 3.74184	Recommended Video: V12, Score: 3.73398	Recommended Video: V9, Score: 3.61854	Recommended Video: V14, Score: 3.39763
3	Recommended Video: V1, Score: 3.58159	Recommended Video: V9, Score: 3.30929	Recommended Video: V15, Score: 2.89835	Recommended Video: V2, Score: 2.87466	Recommended Video: V10, Score: 2.79231
4	Recommended Video: V13, Score: 3.99425	Recommended Video: V9, Score: 3.53110	Recommended Video: V7, Score: 3.44391	Recommended Video: V4, Score: 3.39291	Recommended Video: V6, Score: 3.29201
5	Recommended Video: V5, Score: 5.00000	Recommended Video: V13, Score: 5.00000	Recommended Video: V6, Score: 4.79976	Recommended Video: V14, Score: 4.78424	Recommended Video: V2, Score: 4.72366
6	Recommended Video: V13, Score: 3.47798	Recommended Video: V5, Score: 3.40442	Recommended Video: V14, Score: 2.75704	Recommended Video: V2, Score: 2.72585	Recommended Video: V11, Score: 2.69293
7	Recommended Video: V1, Score: 3.78739	Recommended Video: V13, Score: 3.76694	Recommended Video: V5, Score: 3.63933	Recommended Video: V14, Score: 3.24558	Recommended Video: V7, Score: 3.12708
8	Recommended Video: V7, Score: 2.52681	Recommended Video: V3, Score: 2.31087	Recommended Video: V2, Score: 2.07862	Recommended Video: V11, Score: 2.07221	Recommended Video: V14, Score: 1.94827
9	Recommended Video: V12, Score: 3.81970	Recommended Video: V5, Score: 3.68808	Recommended Video: V7, Score: 3.46136	Recommended Video: V4, Score: 3.09741	Recommended Video: V2, Score: 3.02905
10	Recommended Video: V1, Score: 5.00000	Recommended Video: V13, Score: 5.00000	Recommended Video: V5, Score: 4.75053	Recommended Video: V7, Score: 4.62764	Recommended Video: V6, Score: 4.52214
11	Recommended Video: V12, Score: 3.86978	Recommended Video: V13, Score: 3.86489	Recommended Video: V1, Score: 3.83728	Recommended Video: V9, Score: 3.49689	Recommended Video: V14, Score: 3.36735
12	Recommended Video: V9, Score: 2.92999	Recommended Video: V14, Score: 2.66841	Recommended Video: V3, Score: 2.65302	Recommended Video: V4, Score: 2.56245	Recommended Video: V2, Score: 2.47506
13	Recommended Video: V12, Score: 4.56603	Recommended Video: V1, Score: 4.48615	Recommended Video: V7, Score: 4.17932	Recommended Video: V6, Score: 4.00036	Recommended Video: V15, Score: 3.88450
14	Recommended Video: V1, Score: 3.65525	Recommended Video: V5, Score: 3.64938	Recommended Video: V12, Score: 3.61161	Recommended Video: V9, Score: 3.48774	Recommended Video: V14, Score: 3.26303
15	Recommended Video: V13, Score: 2.71144	Recommended Video: V1, Score: 2.68758	Recommended Video: V7, Score: 2.38368	Recommended Video: V9, Score: 2.19544	Recommended Video: V3, Score: 2.16675

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
16	Recommended Video: V13, Score: 2.60108	Recommended Video: V5, Score: 2.53891	Recommended Video: V12, Score: 2.28160	Recommended Video: V14, Score: 2.19993	Recommended Video: V7, Score: 2.08859
17	Recommended Video: V5, Score: 2.83416	Recommended Video: V1, Score: 2.70746	Recommended Video: V12, Score: 2.55370	Recommended Video: V9, Score: 2.46835	Recommended Video: V7, Score: 2.34864
18	Recommended Video: V12, Score: 4.04897	Recommended Video: V14, Score: 3.67752	Recommended Video: V9, Score: 3.54619	Recommended Video: V10, Score: 3.44600	Recommended Video: V15, Score: 3.38892
19	Recommended Video: V5, Score: 4.29055	Recommended Video: V1, Score: 4.26776	Recommended Video: V12, Score: 4.15164	Recommended Video: V13, Score: 4.14250	Recommended Video: V9, Score: 3.97592
20	Recommended Video: V13, Score: 3.99661	Recommended Video: V1, Score: 3.99601	Recommended Video: V5, Score: 3.89823	Recommended Video: V6, Score: 3.61260	Recommended Video: V8, Score: 3.40475
21	Recommended Video: V13, Score: 3.21337	Recommended Video: V1, Score: 3.20220	Recommended Video: V5, Score: 3.19880	Recommended Video: V7, Score: 2.86520	Recommended Video: V6, Score: 2.81900
22	Recommended Video: V9, Score: 5.00000	Recommended Video: V7, Score: 5.00000	Recommended Video: V3, Score: 4.82150	Recommended Video: V15, Score: 4.77144	None
23	Recommended Video: V5, Score: 3.69927	Recommended Video: V13, Score: 3.44867	Recommended Video: V12, Score: 3.38583	Recommended Video: V1, Score: 3.29926	Recommended Video: V9, Score: 3.14463
24	Recommended Video: V13, Score: 3.04338	Recommended Video: V5, Score: 2.98385	Recommended Video: V12, Score: 2.82024	Recommended Video: V14, Score: 2.55356	Recommended Video: V7, Score: 2.44576
25	Recommended Video: V13, Score: 4.24909	Recommended Video: V5, Score: 4.00607	Recommended Video: V7, Score: 3.56057	Recommended Video: V4, Score: 3.52876	Recommended Video: V15, Score: 3.28100
26	Recommended Video: V14, Score: 1.32669	Recommended Video: V10, Score: 1.11725	Recommended Video: V8, Score: 1.00000	Recommended Video: V9, Score: 1.00000	Recommended Video: V15, Score: 1.00000
27	Recommended Video: V5, Score: 4.15269	Recommended Video: V12, Score: 4.06805	Recommended Video: V9, Score: 3.70780	Recommended Video: V7, Score: 3.62528	Recommended Video: V3, Score: 3.37260
28	Recommended Video: V5, Score: 3.74943	Recommended Video: V12, Score: 3.68856	Recommended Video: V1, Score: 3.68505	Recommended Video: V14, Score: 3.30851	Recommended Video: V15, Score: 3.00455
29	Recommended Video: V13, Score: 4.23021	Recommended Video: V12, Score: 4.15619	Recommended Video: V1, Score: 3.92449	Recommended Video: V14, Score: 3.70065	Recommended Video: V4, Score: 3.61131
30	Recommended Video: V13, Score: 3.58848	Recommended Video: V9, Score: 3.13270	Recommended Video: V7, Score: 3.11301	Recommended Video: V14, Score: 3.02428	Recommended Video: V3, Score: 2.84017

user_id	Rec_1	Rec_2	Rec_3	Rec_4	Rec_5
31	Recommended Video: V6, Score: 2.34724	Recommended Video: V11, Score: 2.28809	Recommended Video: V15, Score: 2.27916	Recommended Video: V4, Score: 2.24010	Recommended Video: V8, Score: 2.23593
32	Recommended Video: V12, Score: 4.29424	Recommended Video: V14, Score: 3.83303	Recommended Video: V7, Score: 3.76610	Recommended Video: V4, Score: 3.64104	Recommended Video: V3, Score: 3.45596
33	Recommended Video: V5, Score: 3.66608	Recommended Video: V12, Score: 3.46546	Recommended Video: V1, Score: 3.26858	Recommended Video: V7, Score: 3.17529	Recommended Video: V2, Score: 2.78210
34	Recommended Video: V12, Score: 4.15587	Recommended Video: V9, Score: 3.99961	Recommended Video: V14, Score: 3.82861	Recommended Video: V7, Score: 3.71998	Recommended Video: V4, Score: 3.61187
35	Recommended Video: V1, Score: 4.11907	Recommended Video: V5, Score: 4.02365	Recommended Video: V7, Score: 3.74364	Recommended Video: V14, Score: 3.60992	Recommended Video: V6, Score: 3.43688
36	Recommended Video: V1, Score: 4.74758	Recommended Video: V5, Score: 4.68661	Recommended Video: V9, Score: 4.53459	Recommended Video: V7, Score: 4.15276	Recommended Video: V4, Score: 4.12870
37	Recommended Video: V5, Score: 4.01700	Recommended Video: V12, Score: 4.00511	Recommended Video: V14, Score: 3.53845	Recommended Video: V7, Score: 3.52825	Recommended Video: V4, Score: 3.36939
38	Recommended Video: V1, Score: 3.74107	Recommended Video: V12, Score: 3.64166	Recommended Video: V5, Score: 3.54680	Recommended Video: V9, Score: 3.45818	Recommended Video: V14, Score: 3.31608
39	Recommended Video: V1, Score: 4.09124	Recommended Video: V12, Score: 4.02268	Recommended Video: V7, Score: 3.73424	Recommended Video: V14, Score: 3.65921	Recommended Video: V6, Score: 3.32873
40	Recommended Video: V13, Score: 3.20891	Recommended Video: V5, Score: 3.17274	Recommended Video: V12, Score: 3.04300	Recommended Video: V9, Score: 2.76537	Recommended Video: V10, Score: 2.17392
41	Recommended Video: V9, Score: 3.79265	Recommended Video: V14, Score: 3.74115	Recommended Video: V3, Score: 3.47668	Recommended Video: V15, Score: 3.40146	Recommended Video: V11, Score: 3.36831