

## 02-Modelling-KNN

January 20, 2021

```
[1]: import pandas as pd
from surprise import SVD
from surprise import Dataset
from surprise import accuracy
from surprise.model_selection import train_test_split
from surprise import KNNBasic, KNNWithMeans, KNNBaseline
from surprise.model_selection import KFold
from surprise import Reader
from surprise import NormalPredictor
from surprise.model_selection import cross_validate
import matplotlib.pyplot as plt
import seaborn as sns
from surprise.model_selection import GridSearchCV
```

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[ ]:
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[2]: df_final = pd.read_csv("../data/Netflix_prize_data/df_final.csv")
```

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[3]: df_final.sample(10)
```

```
[3]:
```

|      | Cust_ID | Movie_ID | Rating | Date       | year | month | YearOfRelease | \ |
|------|---------|----------|--------|------------|------|-------|---------------|---|
| 3841 | 1705463 | 13370    | 4.0    | 2005-10-24 | 2005 | 10    | 2002          |   |
| 1205 | 2608958 | 4500     | 3.0    | 2004-03-28 | 2004 | 3     | 1945          |   |
| 3665 | 2305466 | 13369    | 2.0    | 2005-06-11 | 2005 | 6     | 2002          |   |
| 3121 | 1314655 | 13368    | 4.0    | 2005-01-27 | 2005 | 1     | 1999          |   |
| 1017 | 424958  | 4500     | 4.0    | 2005-08-02 | 2005 | 8     | 1945          |   |
| 1599 | 1349389 | 4501     | 3.0    | 2005-07-17 | 2005 | 7     | 2002          |   |
| 602  | 1743759 | 2        | 4.0    | 2005-01-30 | 2005 | 1     | 2004          |   |
| 2415 | 2077456 | 9211     | 1.0    | 2000-09-09 | 2000 | 9     | 1995          |   |
| 3550 | 1558516 | 13369    | 3.0    | 2005-06-24 | 2005 | 6     | 2002          |   |
| 2711 | 2172885 | 9212     | 1.0    | 2005-11-12 | 2005 | 11    | 1994          |   |

```
Movie
3841      Justice League: Paradise Lost
1205      Les Dames du Bois de Boulogne
3665  PRIDE Fighting Championships: Cold Fury 2
3121      Sarfarosh
```

|      |   |
|------|---|
| 1017 | Les Dames du Bois de Boulogne             |
| 1599 | Open Hearts                               |
| 602  | Isle of Man TT 2004 Review                |
| 2415 | Blue Juice                                |
| 3550 | PRIDE Fighting Championships: Cold Fury 2 |
| 2711 | Sailor Moon S                             |

```
[4]: reader = Reader(rating_scale=(1, 5))
# The columns must correspond to user id, item id and ratings (in that order).
data = Dataset.load_from_df(df_final[['Cust_ID', 'Movie_ID', 'Rating']], reader)
anti_set = data.build_full_trainset().build_anti_testset()
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[5]: anti_set
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```

```
[6]: movies = df_final[['Movie_ID' , 'Movie']].drop_duplicates(['Movie_ID' ,
↳ 'Movie'])
users = df_final[['Cust_ID']].drop_duplicates(['Cust_ID'])
```

```
[7]: movies.head()
```

```
[7]:
```

|      | Movie_ID | Movie                         |
|------|----------|-------------------------------|
| 0    | 1        | Dinosaur Planet               |
| 547  | 2        | Isle of Man TT 2004 Review    |
| 692  | 3        | Character                     |
| 997  | 4500     | Les Dames du Bois de Boulogne |
| 1255 | 4501     | Open Hearts                   |

KNNBasic is a basic collaborative filtering algorithm.

```
[8]: sim_options = { 'name': 'cosine' , 'user_based': True} # compute similarities
↳ between user
kf = KFold(n_splits=5)
```

```

algo = KNNBasic(k=3, sim_options = sim_options)
# Start the trainer
best_algo = None
best_rmse = 1000.0
best_pred = None
for trainset, testset in kf.split(data):
    # train and test algorithm.
    algo.fit(trainset)
    predictions = algo.test(testset)
    # Compute and print Root Mean Squared Error
    rmse = accuracy.rmse(predictions, verbose=True)
    mae = accuracy.mae(predictions, verbose=True)
    if rmse < best_rmse:
        best_algo = algo
        best_pred = predictions

```

```

Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2564
MAE: 1.0547
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.1897
MAE: 0.9995
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2859
MAE: 1.0873
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2238
MAE: 1.0275
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2344
MAE: 1.0423

```

```

[9]: sim_options = { 'name': 'cosine', 'user_based': True } # compute similarities
    ↪ between user
kf = KFold(n_splits=5)
algo = KNNWithMeans(k=3, sim_options = sim_options)
best_algo = None
best_rmse = 1000.0
best_pred = None
for trainset, testset in kf.split(data):
    # train and test algorithm.
    algo.fit(trainset)

```



```

predictions = algo.test(testset)
# Compute and print Root Mean Squared Error
rmse = accuracy.rmse(predictions, verbose=True)
if rmse < best_rmse:
    best_rmse= rmse
    best_algo = algo
    best_pred = predictions

```

```

Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2151
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2488
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2054
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.1806
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2258

```

[ ]:

[ ]:

```

[10]: sim_options = { 'name': 'cosine' , 'user_based': True} # compute similarities
      ↪ between user
kf = KFold(n_splits=5)
algo = KNNBasic(k =5 , sim_options = sim_options)
# Start the trainer
best_algo = None
best_rmse = 1000.0
best_pred = None
for trainset, testset in kf.split(data):
    # train and test algorithm.
    algo.fit(trainset)
    predictions = algo.test(testset)
    # Compute and print Root Mean Squared Error
    rmse = accuracy.rmse(predictions, verbose=True)
    mae = accuracy.mae(predictions, verbose=True)
    if rmse < best_rmse:
        best_algo = algo
        best_pred = predictions

```

```

Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2080
MAE: 1.0077
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2409
MAE: 1.0403
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2175
MAE: 1.0327
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2321
MAE: 1.0503
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2488
MAE: 1.0558

```

```

[11]: sim_options = { 'name': 'cosine' , 'user_based': True } # compute similarities
      ↪ between user
kf = KFold(n_splits=5)
algo = KNNWithMeans(k=5 , sim_options = sim_options)
best_algo = None
best_rmse = 1000.0
best_pred = None
for trainset, testset in kf.split(data):
    # train and test algorithm.
    algo.fit(trainset)
    predictions = algo.test(testset)
    # Compute and print Root Mean Squared Error
    rmse = accuracy.rmse(predictions, verbose=True)
    mae = accuracy.mae(predictions, verbose=True)
    if rmse < best_rmse:
        best_rmse= rmse
        best_algo = algo
        best_pred = predictions

```

```

Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2496
MAE: 1.0437
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2261
MAE: 1.0175

```

```

Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2015
MAE: 1.0082
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.1764
MAE: 0.9889
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2131
MAE: 1.0195

```

[ ]:

[ ]:

```

[12]: sim_options = { 'name': 'cosine' , 'user_based': True} # compute similarities
      ↪ between user
kf = KFold(n_splits=5)
algo = KNNBasic(k=7 , sim_options = sim_options)
# Start the trainer
best_algo = None
best_rmse = 1000.0
best_pred = None
for trainset, testset in kf.split(data):
    # train and test algorithm.
    algo.fit(trainset)
    predictions = algo.test(testset)
    # Compute and print Root Mean Squared Error
    rmse = accuracy.rmse(predictions, verbose=True)
    mae = accuracy.mae(predictions, verbose=True)
    if rmse < best_rmse:
        best_algo = algo
        best_pred = predictions

```

```

Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2385
MAE: 1.0400
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2203
MAE: 1.0157
Computing the cosine similarity matrix...
Done computing similarity matrix.
RMSE: 1.2150
MAE: 1.0294

```

Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.2163  
MAE: 1.0328  
Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.2892  
MAE: 1.0984

```
[13]: im_options = { 'name': 'cosine' , 'user_based': True } # compute similarities
      ↪ between user
kf = KFold(n_splits=5)
algo = KNNWithMeans(k =7 , sim_options = sim_options)
best_algo = None
best_rmse = 1000.0
best_pred = None
for trainset, testset in kf.split(data):
    # train and test algorithm.
    algo.fit(trainset)
    predictions = algo.test(testset)
    # Compute and print Root Mean Squared Error
    rmse = accuracy.rmse(predictions, verbose=True)
    mae = accuracy.mae(predictions, verbose=True)
    if rmse < best_rmse:
        best_rmse= rmse
        best_algo = algo
        best_pred = predictions
```

Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.2030  
MAE: 1.0131  
Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.2504  
MAE: 1.0488  
Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.2321  
MAE: 1.0330  
Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.2035  
MAE: 0.9979  
Computing the cosine similarity matrix...  
Done computing similarity matrix.  
RMSE: 1.1720  
MAE: 0.9810

```
[ ]:
```

```
[ ]:
```

## 0.1 Analysis

```
[14]: pred_df = pd.DataFrame(best_pred).merge(df_final , left_on = ['uid', 'iid'],  
      ↪right_on = ['Cust_ID', 'Movie_ID'])  
pred_df[['uid', 'iid', 'Cust_ID', 'Movie', 'Movie_ID', 'est', 'Rating']]
```

```
[14]:
```

|     | uid     | iid   | Cust_ID | Movie \                                   |
|-----|---------|-------|---------|---|
| 0   | 1268328 | 13368 | 1268328 | Sarfarosh                                 |
| 1   | 1508291 | 4500  | 1508291 | Les Dames du Bois de Boulogne             |
| 2   | 361073  | 13369 | 361073  | PRIDE Fighting Championships: Cold Fury 2 |
| 3   | 410078  | 9212  | 410078  | Sailor Moon S                             |
| 4   | 1029847 | 9212  | 1029847 | Sailor Moon S                             |
| ..  | ...     | ...   | ...     | ...                                       |
| 792 | 225765  | 1     | 225765  | Dinosaur Planet                           |
| 793 | 1998117 | 4503  | 1998117 | Grace of My Heart                         |
| 794 | 1408341 | 9212  | 1408341 | Sailor Moon S                             |
| 795 | 1637765 | 13370 | 1637765 | Justice League: Paradise Lost             |
| 796 | 1155747 | 1     | 1155747 | Dinosaur Planet                           |

  

|     | Movie_ID | est      | Rating |
|-----|----------|----------|--------|
| 0   | 13368    | 3.317455 | 3.0    |
| 1   | 4500     | 3.317455 | 4.0    |
| 2   | 13369    | 3.317455 | 4.0    |
| 3   | 9212     | 3.317455 | 3.0    |
| 4   | 9212     | 3.317455 | 3.0    |
| ..  | ...      | ...      | ...    |
| 792 | 1        | 3.317455 | 4.0    |
| 793 | 4503     | 3.317455 | 3.0    |
| 794 | 9212     | 3.317455 | 5.0    |
| 795 | 13370    | 3.317455 | 5.0    |
| 796 | 1        | 3.317455 | 3.0    |

```
[797 rows x 7 columns]
```

```
[15]: anti_pre = best_algo.test(anti_set)  
pred_df = pd.DataFrame(anti_pre).merge(df_final , left_on = ['iid'], right_on =  
      ↪['Movie_ID'])  
pred_df = pd.DataFrame(pred_df).merge(users , left_on = ['uid'], right_on =  
      ↪['Cust_ID'])
```

```
[16]: pred_df
```

```

[16]:
      uid  iid    r_ui    est  \
0      1488844    2  3.34002  3.317455
1      1488844    2  3.34002  3.317455
2      1488844    2  3.34002  3.317455
3      1488844    2  3.34002  3.317455
4      1488844    2  3.34002  3.317455
...
13455385 1272122    1  3.34002  5.000000
13455386 1272122    1  3.34002  5.000000
13455387 1272122    1  3.34002  5.000000
13455388 1272122    1  3.34002  5.000000
13455389 1272122    1  3.34002  5.000000

                                details  Cust_ID_x  \
0      {'was_impossible': True, 'reason': 'User and/o...  2059652
1      {'was_impossible': True, 'reason': 'User and/o...  1666394
2      {'was_impossible': True, 'reason': 'User and/o...  1759415
3      {'was_impossible': True, 'reason': 'User and/o...  1959936
4      {'was_impossible': True, 'reason': 'User and/o...  998862
...
13455385      {'actual_k': 5, 'was_impossible': False}    1790158
13455386      {'actual_k': 5, 'was_impossible': False}    1403184
13455387      {'actual_k': 5, 'was_impossible': False}    1535440
13455388      {'actual_k': 5, 'was_impossible': False}    1426604
13455389      {'actual_k': 5, 'was_impossible': False}    1815755

      Movie_ID  Rating    Date  year  month  YearOfRelease  \
0              2      4.0  2005-09-05  2005      9      2004
1              2      3.0  2005-04-19  2005      4      2004
2              2      4.0  2005-04-22  2005      4      2004
3              2      5.0  2005-11-21  2005     11      2004
4              2      4.0  2004-11-13  2004     11      2004
...
13455385      1      4.0  2005-05-17  2005      5      2003
13455386      1      3.0  2005-11-12  2005     11      2003
13455387      1      4.0  2005-08-18  2005      8      2003
13455388      1      4.0  2005-09-01  2005      9      2003
13455389      1      5.0  2004-07-20  2004      7      2003

                                Movie  Cust_ID_y
0      Isle of Man TT 2004 Review    1488844
1      Isle of Man TT 2004 Review    1488844
2      Isle of Man TT 2004 Review    1488844
3      Isle of Man TT 2004 Review    1488844
4      Isle of Man TT 2004 Review    1488844
...
13455385      Dinosaur Planet    1272122

```

|          |                 |         |
|----------|-----------------|---------|
| 13455386 | Dinosaur Planet | 1272122 |
| 13455387 | Dinosaur Planet | 1272122 |
| 13455388 | Dinosaur Planet | 1272122 |
| 13455389 | Dinosaur Planet | 1272122 |

[13455390 rows x 14 columns]

[ ]:

### 0.1.1 Find a recommendation for a user

```
[17]: # est
pred_df[(pred_df['est']>3.0)&(pred_df['Cust_ID_x']==1535440)]
```

```
[17]:
```

|          | uid     | iid | r_ui    | est      | \ |
|----------|---------|-----|---------|----------|---|
| 1838727  | 1025579 | 1   | 3.34002 | 4.000000 |   |
| 1842410  | 712664  | 1   | 3.34002 | 3.317455 |   |
| 1846093  | 1331154 | 1   | 3.34002 | 4.000000 |   |
| 1849776  | 2632461 | 1   | 3.34002 | 3.317455 |   |
| 1853459  | 44937   | 1   | 3.34002 | 5.000000 |   |
| ...      | ...     | ... | ...     | ...      |   |
| 13440015 | 803752  | 1   | 3.34002 | 3.317455 |   |
| 13443858 | 1581265 | 1   | 3.34002 | 3.317455 |   |
| 13447701 | 1824543 | 1   | 3.34002 | 3.317455 |   |
| 13451544 | 1283204 | 1   | 3.34002 | 3.264286 |   |
| 13455387 | 1272122 | 1   | 3.34002 | 5.000000 |   |

  

|          | details   | Cust_ID_x | \ |
|----------|---|-----------|---|
| 1838727  | {'actual_k': 1, 'was_impossible': False}          | 1535440   |   |
| 1842410  | {'was_impossible': True, 'reason': 'User and/o... | 1535440   |   |
| 1846093  | {'actual_k': 1, 'was_impossible': False}          | 1535440   |   |
| 1849776  | {'was_impossible': True, 'reason': 'User and/o... | 1535440   |   |
| 1853459  | {'actual_k': 1, 'was_impossible': False}          | 1535440   |   |
| ...      | ...   | ...       |   |
| 13440015 | {'was_impossible': True, 'reason': 'User and/o... | 1535440   |   |
| 13443858 | {'was_impossible': True, 'reason': 'User and/o... | 1535440   |   |
| 13447701 | {'was_impossible': True, 'reason': 'User and/o... | 1535440   |   |
| 13451544 | {'actual_k': 5, 'was_impossible': False}          | 1535440   |   |
| 13455387 | {'actual_k': 5, 'was_impossible': False}          | 1535440   |   |

  

|         | Movie_ID | Rating | Date       | year | month | YearOfRelease | \ |
|---------|----------|--------|------------|------|-------|---------------|---|
| 1838727 | 1        | 4.0    | 2005-08-18 | 2005 | 8     | 2003          |   |
| 1842410 | 1        | 4.0    | 2005-08-18 | 2005 | 8     | 2003          |   |
| 1846093 | 1        | 4.0    | 2005-08-18 | 2005 | 8     | 2003          |   |
| 1849776 | 1        | 4.0    | 2005-08-18 | 2005 | 8     | 2003          |   |
| 1853459 | 1        | 4.0    | 2005-08-18 | 2005 | 8     | 2003          |   |
| ...     | ...      | ...    | ...        | ...  | ...   | ...           |   |

|          |   |     |            |      |   |      |
|----------|---|-----|------------|------|---|------|
| 13440015 | 1 | 4.0 | 2005-08-18 | 2005 | 8 | 2003 |
| 13443858 | 1 | 4.0 | 2005-08-18 | 2005 | 8 | 2003 |
| 13447701 | 1 | 4.0 | 2005-08-18 | 2005 | 8 | 2003 |
| 13451544 | 1 | 4.0 | 2005-08-18 | 2005 | 8 | 2003 |
| 13455387 | 1 | 4.0 | 2005-08-18 | 2005 | 8 | 2003 |

|          | Movie           | Cust_ID_y |
|----------|-----------------|-----------|
| 1838727  | Dinosaur Planet | 1025579   |
| 1842410  | Dinosaur Planet | 712664    |
| 1846093  | Dinosaur Planet | 1331154   |
| 1849776  | Dinosaur Planet | 2632461   |
| 1853459  | Dinosaur Planet | 44937     |
| ...      | ...             | ...       |
| 13440015 | Dinosaur Planet | 803752    |
| 13443858 | Dinosaur Planet | 1581265   |
| 13447701 | Dinosaur Planet | 1824543   |
| 13451544 | Dinosaur Planet | 1283204   |
| 13455387 | Dinosaur Planet | 1272122   |

[2506 rows x 14 columns]

```
[18]: # for user
pred_df[(pred_df['est']>3.0)&(pred_df['Cust_ID_x']==1815755)]
```

```
[18]:      uid  iid  r_ui  est  \
1838729  1025579    1  3.34002  4.000000
1842412    712664    1  3.34002  3.317455
1846095  1331154    1  3.34002  4.000000
1849778  2632461    1  3.34002  3.317455
1853461    44937    1  3.34002  5.000000
...
13440017  803752    1  3.34002  3.317455
13443860  1581265    1  3.34002  3.317455
13447703  1824543    1  3.34002  3.317455
13451546  1283204    1  3.34002  3.264286
13455389  1272122    1  3.34002  5.000000
```

|          | details   | Cust_ID_x \ |
|----------|---|-------------|
| 1838729  | {'actual_k': 1, 'was_impossible': False}          | 1815755     |
| 1842412  | {'was_impossible': True, 'reason': 'User and/o... | 1815755     |
| 1846095  | {'actual_k': 1, 'was_impossible': False}          | 1815755     |
| 1849778  | {'was_impossible': True, 'reason': 'User and/o... | 1815755     |
| 1853461  | {'actual_k': 1, 'was_impossible': False}          | 1815755     |
| ...      | ...   | ...         |
| 13440017 | {'was_impossible': True, 'reason': 'User and/o... | 1815755     |
| 13443860 | {'was_impossible': True, 'reason': 'User and/o... | 1815755     |
| 13447703 | {'was_impossible': True, 'reason': 'User and/o... | 1815755     |



```
13451546      {'actual_k': 5, 'was_impossible': False}      1815755
13455389      {'actual_k': 5, 'was_impossible': False}      1815755
```

|          | Movie_ID | Rating | Date       | year | month | YearOfRelease | \ |
|----------|----------|--------|------------|------|-------|---------------|---|
| 1838729  | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 1842412  | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 1846095  | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 1849778  | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 1853461  | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| ...      | ...      | ...    | ...        | ...  | ...   | ...           |   |
| 13440017 | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 13443860 | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 13447703 | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 13451546 | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |
| 13455389 | 1        | 5.0    | 2004-07-20 | 2004 | 7     | 2003          |   |

|          | Movie           | Cust_ID_y |
|----------|-----------------|-----------|
| 1838729  | Dinosaur Planet | 1025579   |
| 1842412  | Dinosaur Planet | 712664    |
| 1846095  | Dinosaur Planet | 1331154   |
| 1849778  | Dinosaur Planet | 2632461   |
| 1853461  | Dinosaur Planet | 44937     |
| ...      | ...             | ...       |
| 13440017 | Dinosaur Planet | 803752    |
| 13443860 | Dinosaur Planet | 1581265   |
| 13447703 | Dinosaur Planet | 1824543   |
| 13451546 | Dinosaur Planet | 1283204   |
| 13455389 | Dinosaur Planet | 1272122   |

[2506 rows x 14 columns]

```
[ ]:
```

## 0.2 Find NN for user

```
[19]: tsr_inner_id = best_algo.trainset.to_inner_iid(1)
tsr_neighbors = best_algo.get_neighbors(tsr_inner_id, k=1)
df_final[df_final.Cust_ID.isin([algo.trainset.to_raw_iid(inner_id)
                                for inner_id in tsr_neighbors])]
```

```
[19]: Empty DataFrame
Columns: [Cust_ID, Movie_ID, Rating, Date, year, month, YearOfRelease, Movie]
Index: []
```

```
[ ]:
```