Movie Recommend by Surprise with GridSearch

In this notebook, optimize hyperparameters of Surprise using GridSearchCV.

In [1]:

```
import sys
import random
from surprise import Dataset, Reader
from surprise import KNNBasic, SVD
from surprise import accuracy
from surprise.model_selection import train_test_split
from surprise.model_selection import cross_validate
from surprise.model_selection import GridSearchCV
from surprise.dataset import DatasetAutoFolds
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
import operator
import requests
from zipfile import ZipFile
```

In [17]:

```
df = pd.read_csv('/kaggle/input/movies-and-ratings-for-recommendation-system/rating
s.csv',
                          error_bad_lines=False,
                          warn_bad_lines=False,
                          skiprows=lambda i: i>0 and random.random() > 0.1)
df.columns=['user_id','item_id','rating','timestamp']
print(len(df))
```

```
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/opt/conda/lib/python3.7/site-packages/IPython/core/interactiveshell.p
y:3552: FutureWarning: The warn_bad_lines argument has been deprecated
and will be removed in a future version.


  exec(code_obj, self.user_global_ns, self.user_ns)
/opt/conda/lib/python3.7/site-packages/IPython/core/interactiveshell.p
y:3552: FutureWarning: The error_bad_lines argument has been deprecate
d and will be removed in a future version.


  exec(code_obj, self.user_global_ns, self.user_ns)
```

In [3]:

```
reader = Reader(rating_scale=(1,5))
data = Dataset.load_from_df(df[['user_id','item_id','rating']], reader)
print(type(data))
```

```
<class 'surprise.dataset.DatasetAutoFolds'>
```

```
# cross_validate

# Run 5-fold cross-validation and print results.
results = cross_validate(algo, data, measures=['RMSE', 'MAE'], cv=5, verbose
=True)
print(results)
```

GridSearchCV - algo to best_algo

In [4]:

```
algo = KNNBasic

param_grid = { 'k': [5,10,15,20,50], 'min_k': [2,3,4,5] }
gs = GridSearchCV(algo, param_grid, cv=5)
gs.fit(data)
```

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In [5]:

```
print(gs.best_params)
best_algo = KNNBasic(k=gs.best_params['rmse']['k'], min_k=gs.best_params['rmse']['m
in_k'])
print(best_algo.k, best_algo.min_k)
```

```
{'rmse': {'k': 15, 'min_k': 5}, 'mae': {'k': 15, 'min_k': 5}}
15 5
```

In [6]:

```
help(best_algo)
```

```
Help on KNNBasic in module surprise.prediction_algorithms.knns object:

class KNNBasic(SymmetricAlgo)
 |  KNNBasic(k=40, min_k=1, sim_options={'user_based': True}, verbose=
True, **kwargs)
 |  
 |  A basic collaborative filtering algorithm.
 |  
 |  The prediction :math:`\hat{r}_{ui}` is set as:
 |  
 |  .. math::
 |      \hat{r}_{ui} = \frac{
 |      \sum\limits_{v \in N^k_i(u)} \text{sim}(u, v) \cdot r_{vi}}
 |      {\sum\limits_{v \in N^k_i(u)} \text{sim}(u, v)}
 |  
 |  or
 |  
 |  .. math::
 |      \hat{r}_{ui} = \frac{
 |      \sum\limits_{j \in N^k_u(i)} \text{sim}(i, j) \cdot r_{uj}}
 |      {\sum\limits_{j \in N^k_u(i)} \text{sim}(i, j)}
 |  
 |  depending on the ``user_based`` field of the ``sim_options`` param
eter.
 |  
 |  Args:
 |      k(int): The (max) number of neighbors to take into account for
 |          aggregation (see :ref:`this note <actual_k_note>`). Defaul
t is
 |          ``40``.
 |      min_k(int): The minimum number of neighbors to take into accou
nt for
 |          aggregation. If there are not enough neighbors, the predic
tion is
 |          set to the global mean of all ratings. Default is ``1``.
 |      sim_options(dict): A dictionary of options for the similarity
 |          measure. See :ref:`similarity_measures_configuration` for
accepted
 |          options.
 |      verbose(bool): Whether to print trace messages of bias estimat
ion,
 |          similarity, etc.  Default is True.
 |  
 |  Method resolution order:
 |      KNNBasic
 |      SymmetricAlgo
 |      surprise.prediction_algorithms.algo_base.AlgoBase
 |      builtins.object
 |  
 |  Methods defined here:
 |  
 |  __init__(self, k=40, min_k=1, sim_options={'user_based': True}, ve
rbose=True, **kwargs)
 |      Initialize self.  See help(type(self)) for accurate signature.
 |  
 |  estimate(self, u, i)
 |  
 |  fit(self, trainset)
```

```
 |      Train an algorithm on a given training set.
 |      
 |      This method is called by every derived class as the first basi
c step
 |      for training an algorithm. It basically just initializes some 
internal
 |      structures and set the self.trainset attribute.
 |      
 |      Args:
 |          trainset(:obj:`Trainset <surprise.Trainset>`) : A training
 |              set, as returned by the :meth:`folds
 |              <surprise.dataset.Dataset.folds>` method.
 |      
 |      Returns:
 |          self
 |  
 |  ------------------------------------------------------------------
----
 |  Methods inherited from SymmetricAlgo:
 |  
 |  switch(self, u_stuff, i_stuff)
 |      Return x_stuff and y_stuff depending on the user_based field.
 |  
 |  ------------------------------------------------------------------
----
 |  Methods inherited from surprise.prediction_algorithms.algo_base.Al
goBase:
 |  
 |  compute_baselines(self)
 |      Compute users and items baselines.
 |      
 |      The way baselines are computed depends on the ``bsl_options`` 
parameter
 |      passed at the creation of the algorithm (see
 |      :ref:`baseline_estimates_configuration`).
 |      
 |      This method is only relevant for algorithms using :func:`Pears
on
 |      baseline similarty<surprise.similarities.pearson_baseline>` or 
the
 |      :class:`BaselineOnly
 |      <surprise.prediction_algorithms.baseline_only.BaselineOnly>` a
lgorithm.
 |      
 |      Returns:
 |          A tuple ``(bu, bi)``, which are users and items baselines.
 |  
 |  compute_similarities(self)
 |      Build the similarity matrix.
 |      
 |      The way the similarity matrix is computed depends on the
 |      ``sim_options`` parameter passed at the creation of the algori
thm (see
 |      :ref:`similarity_measures_configuration`).
 |      
 |      This method is only relevant for algorithms using a similarity 
measure,
 |      such as the :ref:`k-NN algorithms <pred_package_knn_inpired>`.
```

```
 |
 |      Returns:
 |          The similarity matrix.
 |
 |  default_prediction(self)
 |      Used when the ``PredictionImpossible`` exception is raised dur
ing a
 |      call to :meth:`predict()
 |      <surprise.prediction_algorithms.algo_base.AlgoBase.predict>`.
By
 |      default, return the global mean of all ratings (can be overrid
den in
 |      child classes).
 |
 |      Returns:
 |          (float): The mean of all ratings in the trainset.
 |
 |  get_neighbors(self, iid, k)
 |      Return the ``k`` nearest neighbors of ``iid``, which is the in
ner id
 |      of a user or an item, depending on the ``user_based`` field of
 |      ``sim_options`` (see :ref:`similarity_measures_configuration
`).
 |
 |      As the similarities are computed on the basis of a similarity
measure,
 |      this method is only relevant for algorithms using a similarity
measure,
 |      such as the :ref:`k-NN algorithms <pred_package_knn_inpired>`.
 |
 |      For a usage example, see the :ref:`FAQ <get_k_nearest_neighbor
s>`.
 |
 |      Args:
 |          iid(int): The (inner) id of the user (or item) for which w
e want
 |              the nearest neighbors. See :ref:`this note<raw_inner_n
ote>`.
 |
 |          k(int): The number of neighbors to retrieve.
 |
 |      Returns:
 |          The list of the ``k`` (inner) ids of the closest users (or
items)
 |          to ``iid``.
 |
 |  predict(self, uid, iid, r_ui=None, clip=True, verbose=False)
 |      Compute the rating prediction for given user and item.
 |
 |      The ``predict`` method converts raw ids to inner ids and then
calls the
 |      ``estimate`` method which is defined in every derived class. I
f the
 |      prediction is impossible (e.g. because the user and/or the ite
m is
 |      unknown), the prediction is set according to
 |      :meth:`default_prediction()
 |      <surprise.prediction_algorithms.algo_base.AlgoBase.default_pre
```

```
diction>`.
 |
 |      Args:
 |          uid: (Raw) id of the user. See :ref:`this note<raw_inner_n
ote>`.
 |          iid: (Raw) id of the item. See :ref:`this note<raw_inner_n
ote>`.
 |          r_ui(float): The true rating :math:`r_{ui}`. Optional, def
ault is
 |              ``None``.
 |          clip(bool): Whether to clip the estimation into the rating
scale.
 |              For example, if :math:`\hat{r}_{ui}` is :math:`5.5` wh
ile the
 |              rating scale is :math:`[1, 5]`, then :math:`\hat{r}_{u
i}` is
 |              set to :math:`5`. Same goes if :math:`\hat{r}_{ui} < 1
`.
 |              Default is ``True``.
 |          verbose(bool): Whether to print details of the prediction.
Default
 |              is False.
 |
 |      Returns:
 |          A :obj:`Prediction            <surprise.prediction_algorit
hms.predictions.Prediction>` object
 |          containing:
 |
 |          - The (raw) user id ``uid``.
 |          - The (raw) item id ``iid``.
 |          - The true rating ``r_ui`` (:math:`r_{ui}`).
 |          - The estimated rating (:math:`\hat{r}_{ui}`).
 |          - Some additional details about the prediction that might
be useful
 |            for later analysis.
 |
 |  test(self, testset, verbose=False)
 |      Test the algorithm on given testset, i.e. estimate all the rat
ings
 |      in the given testset.
 |
 |      Args:
 |          testset: A test set, as returned by a :ref:`cross-validati
on
 |              itertor<use_cross_validation_iterators>` or by the
 |              :meth:`build_testset() <surprise.Trainset.build_testse
t>`
 |              method.
 |          verbose(bool): Whether to print details for each predictio
ns.
 |              Default is False.
 |
 |      Returns:
 |          A list of :class:`Prediction            <surprise.predicti
on_algorithms.predictions.Prediction>` objects
 |          that contains all the estimated ratings.
 |
 |  ----------------------------------------------------------------------
```

```
 ----
 |  Data descriptors inherited from surprise.prediction_algorithms.alg
 o_base.AlgoBase:
 |
 |  __dict__
 |      dictionary for instance variables (if defined)
 |
 |  __weakref__
 |      list of weak references to the object (if defined)
```

best_algo - fit & test

In [7]:

```
trainset, testset = train_test_split(data, test_size=0.25)

best_algo.fit(trainset)

predictions = best_algo.test(testset)
print(predictions[0:2])
```

```
Computing the msd similarity matrix...
Done computing similarity matrix.
[Prediction(uid=292, iid=1291, r_ui=4.5, est=3.5127262828365318, detai
ls={'was_impossible': True, 'reason': 'Not enough neighbors.'}), Predi
ction(uid=182, iid=3326, r_ui=2.5, est=3.5127262828365318, details={'w
as_impossible': True, 'reason': 'Not enough neighbors.'})]
```

In [8]:

```
import itertools

for uid, iid, rating in itertools.islice(trainset.all_ratings(), 5):
    print(f"User {uid} rated item {iid} with a rating of {rating}")

print()
for uid, iid, rating in testset[:5]:
    print(f"User {uid} rated item {iid} with a rating of {rating}")

print()
print(trainset.n_ratings,len(testset))
```

```
User 0 rated item 0 with a rating of 5.0
User 0 rated item 213 with a rating of 3.0
User 0 rated item 801 with a rating of 4.0
User 0 rated item 1018 with a rating of 3.0
User 0 rated item 1414 with a rating of 4.0

User 292 rated item 1291 with a rating of 4.5
User 182 rated item 3326 with a rating of 2.5
User 89 rated item 56367 with a rating of 2.0
User 200 rated item 5617 with a rating of 3.5
User 232 rated item 37720 with a rating of 3.0

7347 2450
```

In [9]:

```
for uid, iid, rating in testset[:5]:
    print(f"User {uid} rated item {iid} with a rating of {rating}")
```

```
User 292 rated item 1291 with a rating of 4.5
User 182 rated item 3326 with a rating of 2.5
User 89 rated item 56367 with a rating of 2.0
User 200 rated item 5617 with a rating of 3.5
User 232 rated item 37720 with a rating of 3.0
```

The 'predictions' is a list of tuples of the form (user, item, actual_rating, predicted_rating, details). The predicted_rating is est value.

In [10]:

```
for prediction in predictions[0:5]:
    print(prediction)
```

```
user: 292        item: 1291       r_ui = 4.50   est = 3.51   {'was_imp
ossible': True, 'reason': 'Not enough neighbors.'}
user: 182        item: 3326       r_ui = 2.50   est = 3.51   {'was_imp
ossible': True, 'reason': 'Not enough neighbors.'}
user: 89         item: 56367      r_ui = 2.00   est = 3.51   {'was_imp
ossible': True, 'reason': 'Not enough neighbors.'}
user: 200        item: 5617       r_ui = 3.50   est = 3.51   {'was_imp
ossible': True, 'reason': 'Not enough neighbors.'}
user: 232        item: 37720      r_ui = 3.00   est = 3.51   {'was_imp
ossible': True, 'reason': 'Not enough neighbors.'}
```

In [11]:

```
# Print the performance metrics
accuracy.rmse(predictions)
```

```
RMSE: 1.0626
```

Out[11]:

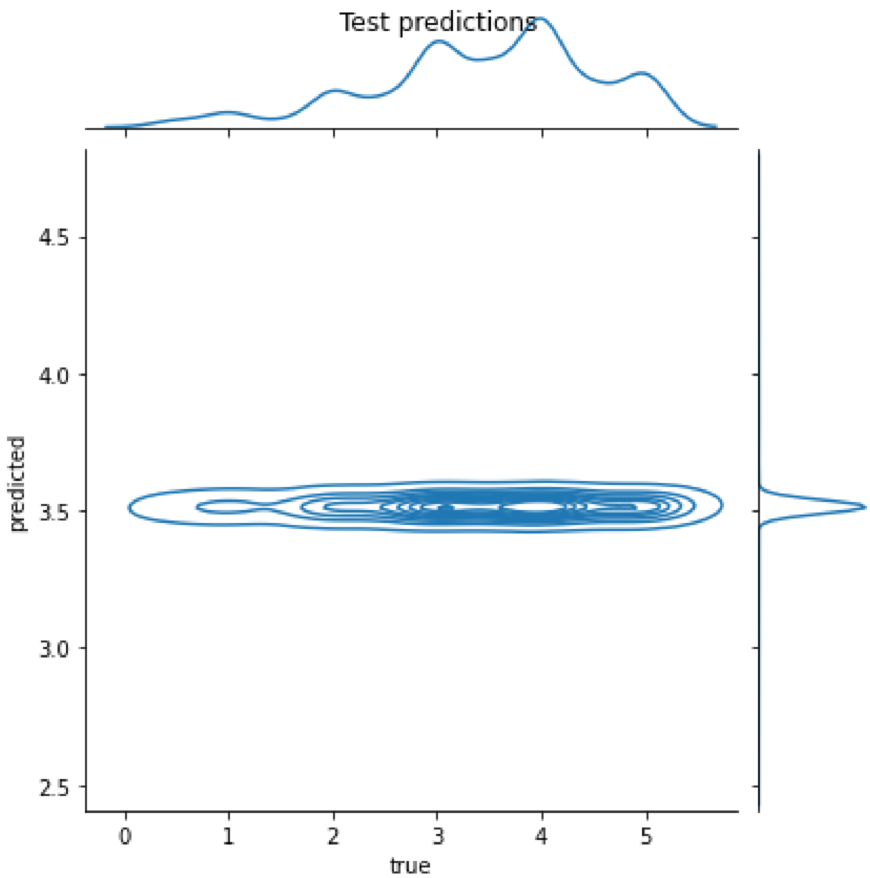
```
1.0626366532296367
```

In [12]:

```
true_ratings = [pred.r_ui for pred in predictions]
est_ratings = [pred.est for pred in predictions]
uids = [pred.uid for pred in predictions]
```

In [13]:

```
data=pd.DataFrame(columns=["true","predicted"])
data["true"]=true_ratings
data["predicted"]=est_ratings
g = sns.jointplot(data=data,x="true", y="predicted", kind="kde",)
g.fig.suptitle('Test predictions',fontsize=12)
plt.show()
```



Recommend unseen books for test set users

In [14]:

```
import pandas as pd
books=pd.read_csv('/kaggle/input/movies-and-ratings-for-recommendation-system/movie
s.csv')
#display(movies)
mapping = books.set_index("movieId")["title"].to_dict()
#print(mapping)
```

In [15]:

```
users=list(set(uids))
```

In [16]:

```
# items which the user not yet evaluate
items = trainset.build_anti_testset()
for user in users[0:30]:
    user_items = list(filter(lambda x: x[0] == user, items))
    # generate recommendation
    recommendations = best_algo.test(user_items)
    if len(recommendations)>0:
        recommendations.sort(key=operator.itemgetter(3), reverse=True)
        print(f"For User {user}:")
        for r in recommendations[0:5]:
            try:
                print(f"  {mapping[r[1]]} : [{round(r[3],3)}]")
            except:
                continue
```

```
For User 1:
  American Beauty (1999) : [4.442]
  Raiders of the Lost Ark (Indiana Jones and the Raiders of the Lost A
rk) (1981) : [4.286]
  Silence of the Lambs, The (1991) : [4.276]
  Ghostbusters (a.k.a. Ghost Busters) (1984) : [4.26]
  Shawshank Redemption, The (1994) : [4.247]
For User 2:
  Space Jam (1996) : [3.513]
  Mrs. Doubtfire (1993) : [3.513]
  Brazil (1985) : [3.513]
  Braveheart (1995) : [3.513]
  Ravenous (1999) : [3.513]
For User 3:
  Space Jam (1996) : [3.513]
  Mrs. Doubtfire (1993) : [3.513]
  Brazil (1985) : [3.513]
  Braveheart (1995) : [3.513]
  Ravenous (1999) : [3.513]
For User 4:
  Star Wars: Episode V - The Empire Strikes Back (1980) : [4.738]
  Alien (1979) : [4.337]
  Lord of the Rings: The Two Towers, The (2002) : [4.311]
  Bourne Identity, The (2002) : [4.22]
  Lord of the Rings: The Return of the King, The (2003) : [4.215]
For User 6:
  Fugitive, The (1993) : [4.184]
  Batman (1989) : [3.79]
  Space Jam (1996) : [3.513]
  Mrs. Doubtfire (1993) : [3.513]
  Brazil (1985) : [3.513]
For User 7:
  Forrest Gump (1994) : [4.702]
  Lord of the Rings: The Fellowship of the Ring, The (2001) : [4.56]
  Blade Runner (1982) : [4.285]
  Raiders of the Lost Ark (Indiana Jones and the Raiders of the Lost A
rk) (1981) : [4.244]
  Shawshank Redemption, The (1994) : [4.23]
For User 9:
  Space Jam (1996) : [3.513]
  Mrs. Doubtfire (1993) : [3.513]
  Brazil (1985) : [3.513]
  Braveheart (1995) : [3.513]
  Ravenous (1999) : [3.513]
For User 10:
  Space Jam (1996) : [3.513]
  Mrs. Doubtfire (1993) : [3.513]
  Brazil (1985) : [3.513]
  Braveheart (1995) : [3.513]
  Ravenous (1999) : [3.513]
For User 11:
  Space Jam (1996) : [3.513]
  Mrs. Doubtfire (1993) : [3.513]
  Brazil (1985) : [3.513]
  Braveheart (1995) : [3.513]
  Ravenous (1999) : [3.513]
For User 12:
  Space Jam (1996) : [3.513]
```

```
    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
    Ravenous (1999) : [3.513]
  For User 14:
    Matrix, The (1999) : [3.925]
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
  For User 17:
    Pulp Fiction (1994) : [4.65]
    Stargate (1994) : [4.343]
    Star Wars: Episode VI - Return of the Jedi (1983) : [4.195]
    Fifth Element, The (1997) : [4.103]
    Léon: The Professional (a.k.a. The Professional) (Léon) (1994) : [4.
  036]
  For User 18:
    Matrix, The (1999) : [4.487]
    Spirited Away (Sen to Chihiro no kamikakushi) (2001) : [4.471]
    Pulp Fiction (1994) : [4.453]
    Saving Private Ryan (1998) : [4.38]
    Beauty and the Beast (1991) : [4.329]
  For User 19:
    Usual Suspects, The (1995) : [4.733]
    Princess Bride, The (1987) : [4.706]
    Braveheart (1995) : [4.508]
    Lord of the Rings: The Fellowship of the Ring, The (2001) : [4.493]
    Pulp Fiction (1994) : [4.438]
  For User 20:
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    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
    Ravenous (1999) : [3.513]
  For User 21:
    Princess Bride, The (1987) : [4.743]
    Inception (2010) : [4.612]
    Silence of the Lambs, The (1991) : [4.448]
    Gladiator (2000) : [4.389]
    American Beauty (1999) : [4.38]
  For User 22:
    Lord of the Rings: The Fellowship of the Ring, The (2001) : [4.379]
    Star Wars: Episode V - The Empire Strikes Back (1980) : [3.691]
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
  For User 23:
    Jurassic Park (1993) : [4.004]
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
    Braveheart (1995) : [3.513]
    Ravenous (1999) : [3.513]
  For User 24:
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    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
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    Ravenous (1999) : [3.513]
  For User 25:
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    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
    Ravenous (1999) : [3.513]
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    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Ravenous (1999) : [3.513]
    Payback (1999) : [3.513]
  For User 27:
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    Terminator 2: Judgment Day (1991) : [3.833]
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
  For User 28:
    Star Wars: Episode VI - Return of the Jedi (1983) : [4.58]
    Toy Story 2 (1999) : [4.53]
    Fight Club (1999) : [4.455]
    Silence of the Lambs, The (1991) : [4.446]
    Gladiator (2000) : [4.408]
  For User 29:
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
    Ravenous (1999) : [3.513]
  For User 31:
    Silence of the Lambs, The (1991) : [4.657]
    Pulp Fiction (1994) : [4.42]
    Terminator 2: Judgment Day (1991) : [3.688]
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
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    Mrs. Doubtfire (1993) : [3.513]
    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
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  For User 33:
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    Brazil (1985) : [3.513]
    Braveheart (1995) : [3.513]
    Ravenous (1999) : [3.513]
  For User 34:
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    American History X (1998) : [4.1]
    Space Jam (1996) : [3.513]
    Mrs. Doubtfire (1993) : [3.513]
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  For User 36:
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  Braveheart (1995) : [3.513]
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For User 37:
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In [ ]:

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