

trecs_exp_v3

December 19, 2022

```
[ ]: import pandas as pd
import matplotlib.pyplot as plt
from matplotlib import style
import numpy as np
import pickle
import os
from sklearn.decomposition import NMF, PCA
from sklearn.cluster import KMeans
from importlib import reload

import sys
sys.path.insert(1, '../t-recs/')
from trecs.metrics import Measurement
from trecs.metrics import MSEMeasurement, InteractionSpread, InteractionSpread,
    ↳InteractionSimilarity, RecSimilarity, RMSEMeasurement, InteractionMeasurement
from trecs.components import Users
import trecs.matrix_ops as mo
import src.globals as globals
import seaborn as sns

from wrapper.models.bubble import BubbleBurster
from src.utils import *
from src.plotting import plot_measurements
from src.scoring_functions import cosine_sim, entropy, content_fairness,
    ↳top_k_reranking
from wrapper.metrics.evaluation_metrics import *

random_state = np.random.seed(42)
plt.style.use("seaborn")

# import warnings filter
from warnings import simplefilter
# ignore all future warnings
simplefilter(action='ignore', category=FutureWarning)

globals.initialize()
```

/var/folders/sm/hcy50x855gvf2b1qwkjstnv0000gn/T/ipykernel_36490/2185722975.py:2

7: MatplotlibDeprecationWarning: The seaborn styles shipped by Matplotlib are deprecated since 3.6, as they no longer correspond to the styles shipped by seaborn. However, they will remain available as 'seaborn-v0_8-`<style>`'. Alternatively, directly use the seaborn API instead.

```
plt.style.use("seaborn")
```

1 RecommenderSystem on MovieLens

```
[ ]: n_attrs=20
max_iter=1000
n_clusters=25

[ ]: score_fn = 'top_k_reranking' #'entropy' #'content_fairness'
probabilistic = False
globals.ALPHA = 0.1 #0.01 # 0.1
alpha = globals.ALPHA

# User parameters
drift = 0.05
attention_exp=-0.8
```

1.1 Embeddings

```
[ ]: binary_ratings_matrix = load_and_process_movielens(file_path='data/ml-100k/u.
↳data')

[ ]: # Get user and item representations using NMF
user_representation, item_representation =
↳create_embeddings(binary_ratings_matrix, n_attrs=n_attrs, max_iter=max_iter)
```

Loaded embeddings.

```
[ ]: # Define topic clusters using NMF
item_cluster_ids, item_cluster_centers = get_clusters(item_representation.T,
↳name='item', n_clusters=n_clusters, n_attrs=n_attrs, max_iter=max_iter)
user_cluster_ids, user_cluster_centers = get_clusters(user_representation,
↳name='user', n_clusters=n_clusters, n_attrs=n_attrs, max_iter=max_iter)
```

Loaded clusters.

Loaded clusters.

```
/Users/madisonthantu/miniforge3/envs/fairRS/lib/python3.8/site-
packages/sklearn/base.py:329: UserWarning: Trying to unpickle estimator KMeans
from version 1.0.2 when using version 1.1.3. This might lead to breaking code or
invalid results. Use at your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-
limitations
warnings.warn(
```

/Users/madisonthantu/miniforge3/envs/fairRS/lib/python3.8/site-packages/sklearn/base.py:329: UserWarning: Trying to unpickle estimator KMeans from version 1.0.2 when using version 1.1.3. This might lead to breaking code or invalid results. Use at your own risk. For more info please refer to: https://scikit-learn.org/stable/model_persistence.html#security-maintainability-limitations

```
warnings.warn(
```

1.1.1 Model

```
[ ]: num_users = user_representation.shape[0] #len(user_representation)
      num_items = item_representation.shape[1] #len(item_representation)
      print(f'Number of items: {num_items}')
      print(f'Number of users: {num_users}')

      users = Users(actual_user_profiles=user_representation,
                    repeat_interactions=False,
                    drift=drift,
                    attention_exp=attention_exp)
```

Number of items: 20
Number of users: 943

```
[ ]: # Create user_pairs by pairing users only with others that are not in the same
      ↪ cluster
      user_item_cluster_mapping = user_topic_mapping(user_representation,
      ↪ item_cluster_centers) # TODO: Remove?
      experiment_name = 'users_by_topic'
      # Create user_pairs by pairing users only with others that are not in the same
      ↪ cluster
      inter_cluster_user_pairs, intra_cluster_user_pairs =
      ↪ create_cluster_user_pairs(user_item_cluster_mapping)
```

```
[ ]: mse = MSEMeasurement()
      measurements = [
          InteractionMeasurement(),
          MSEMeasurement(),
          InteractionSpread(),
          InteractionSimilarity(pairs=inter_cluster_user_pairs,
          ↪ name='inter_cluster_interaction_similarity'),
          InteractionSimilarity(pairs=intra_cluster_user_pairs,
          ↪ name='intra_cluster_interaction_similarity'),
          RecSimilarity(pairs=inter_cluster_user_pairs,
          ↪ name='inter_cluster_rec_similarity'),
          RecSimilarity(pairs=intra_cluster_user_pairs,
          ↪ name='intra_cluster_rec_similarity'),
          UserMSEMeasurement(),
          SerendipityMetric(),
```

```

    DiversityMetric(),
    NoveltyMetric(),
    RecallMeasurement(),
    MeanNumberOfTopics(),
]

```

```

[ ]: # Model
config = {
    'actual_user_representation': users,
    'actual_item_representation': item_representation,
    'item_topics': item_cluster_ids,
    'num_attributes': n_attrs,
    'num_items_per_iter': 10,
    'seed': 42,
    'record_base_state': True,
}

model_name='myopic'
requires_alpha = False

if score_fn:
    if score_fn == 'cosine_sim':
        config['score_fn'] = cosine_sim
        requires_alpha = True
    elif score_fn == 'entropy':
        config['score_fn'] = entropy
        requires_alpha = True
    elif score_fn == 'content_fairness':
        config['score_fn'] = content_fairness
    elif score_fn == 'top_k_reranking':
        config['score_fn'] = top_k_reranking
    else:
        raise Exception('Given score function does not exist.')
    model_name = score_fn

if probabilistic:
    config['probabilistic_recommendations'] = True
    model_name += '_prob'

```

```

[ ]: model = BubbleBurster(**config)

model.add_metrics(*measurements)

```

1.2 Simulation

```
[ ]: # Fair Model
train_timesteps=10
model.startup_and_train(timesteps=train_timesteps)
```

```
100%|      | 10/10 [00:44<00:00, 4.43s/it]
```

```
[ ]: run_timesteps=100
model.run(timesteps=run_timesteps)
```

```
100%|      | 100/100 [20:27<00:00, 12.28s/it]
```

```
[ ]: def create_measurements_df(model, model_name, train_timesteps, file_path):
    measurements = model.get_measurements()
    df = pd.DataFrame(measurements)
    df['state'] = 'train' # makes it easier to later understand which part was
    ↪ training
    df.loc[df['timesteps'] > train_timesteps, 'state'] = 'run'
    df['model'] = model_name

    return df
```

```
[ ]: import src
    reload(src.utils)
    from src.utils import *

    # Determine file name based on parameter values
    parameters = ''
    ↪ f'_{train_timesteps}trainTimesteps_{run_timesteps}runTimesteps_{n_attrs}nAttrs_{n_clusters}'
    if requires_alpha:
        parameters += f'_{alpha}Lambda'

    # Save actual user preferences
    final_preferences_dir = 'artefacts/supplementary/final_preferences/'
    file_prefix = f'{model_name}_final_preferences'
    final_preferences_path = final_preferences_dir + file_prefix + parameters + '.
    ↪ npy'
    np.save(final_preferences_path, model.users.actual_user_profiles.value,
    ↪ allow_pickle=True)

    # Save measurements
    measurements_dir = f'artefacts/supplementary/measurements/'
    file_prefix = f'{model_name}_measurements'

    measurements_path = measurements_dir + file_prefix + parameters + '.csv'
    # np.set_printoptions(threshold=sys.maxsize)
```

```

measurements_df = create_measurements_df(model, model_name, train_timesteps,
↳ measurements_path)
# measurements_df['interaction_histogram'] =
↳ measurements_df['interaction_histogram'].tolist()
# saving interaction histogram
path_interaction_histogram =
↳ f'{measurements_dir}{model_name}_interaction_histogram{parameters}.csv'
interaction_hist = measurements_df['interaction_histogram'].copy()
interaction_hist[0] = np.repeat(np.nan, interaction_hist[1].shape[0], axis=0)
interaction_hist = np.stack(interaction_hist.values)
test = pd.DataFrame(interaction_hist)
test.to_csv(path_interaction_histogram, index=False)
# saving use_mse histogram
path_user_mse_histogram =
↳ f'{measurements_dir}{model_name}_user_mse_histogram{parameters}.csv'
user_mse = measurements_df['user_mse'].copy()
user_mse = np.stack(user_mse.values)
test = pd.DataFrame(user_mse.T)
test['clusterID'] = user_cluster_ids
test.to_csv(path_user_mse_histogram, index=False)
# saving all measurements
measurements_df.to_csv(measurements_path, index=False)
print('Measurements saved.')

```

Measurements saved.

1.3 Analysis

```

[ ]: # Create df for parameters
numeric_cols = ['trainTimesteps', 'runTimesteps', 'nAttrs', 'nClusters',
↳ 'Lambda']
columns = ['model_name'] + numeric_cols

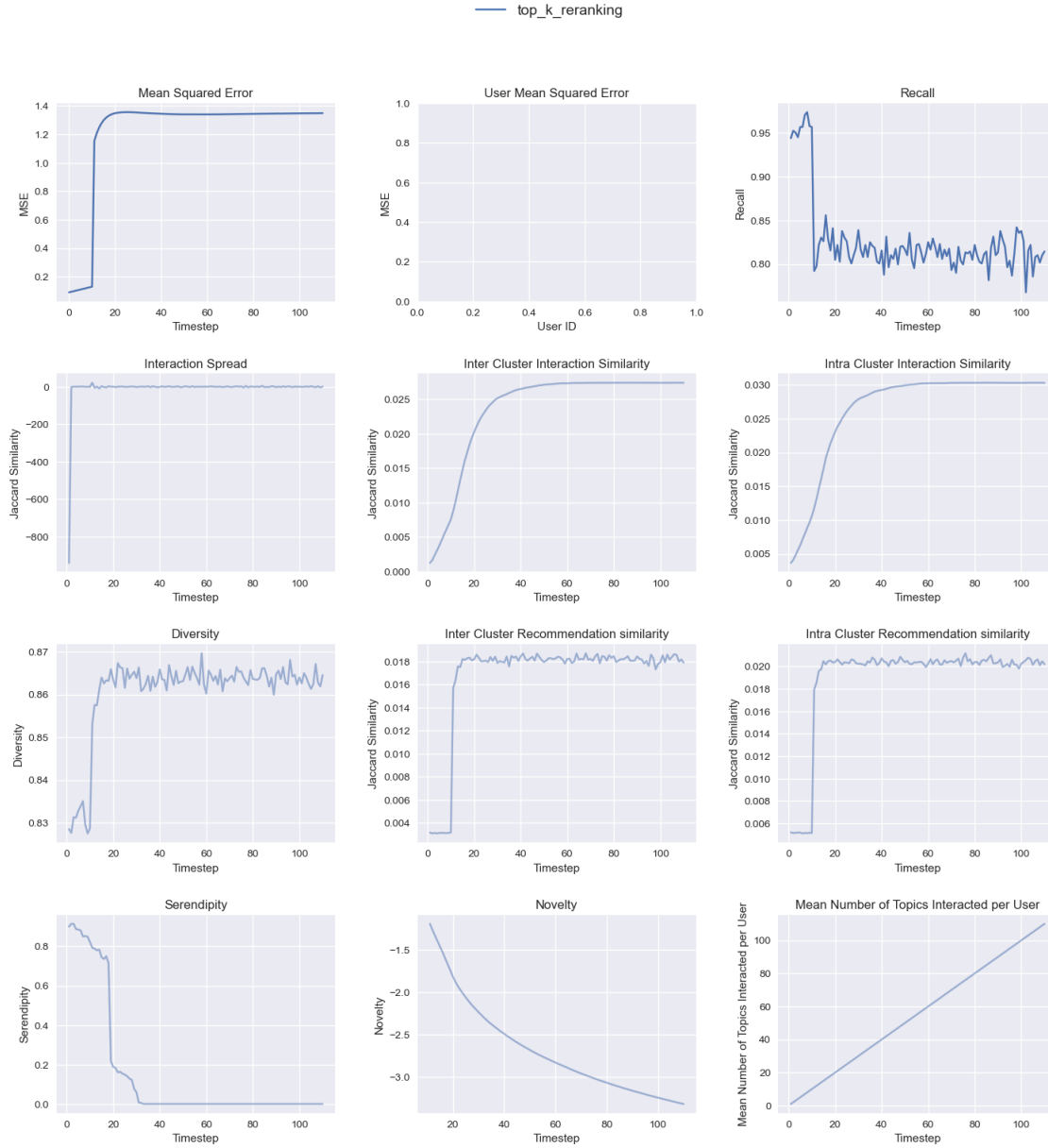
data = [[model_name, train_timesteps, run_timesteps, n_attrs, n_clusters, None]]
if requires_alpha:
    data = [[model_name, train_timesteps, run_timesteps, n_attrs, n_clusters,
↳ alpha]]

parameters_df = pd.DataFrame(data,
                             columns = columns)

for col in numeric_cols:
    parameters_df[col] = pd.to_numeric(parameters_df[col])

[ ]: plot_measurements([measurements_df], parameters_df)

```



2 Experiments

```
[ ]: def plot_histograms(measurements_df, column_name):
    # for every 10 timesteps plot line in different color
    fig= plt.figure(figsize=(5, 5))

    timesteps = len(measurements_df)
    items = np.arange(len(measurements_df[column_name][1]))
    for i in range(10, timesteps+1, 10):
```

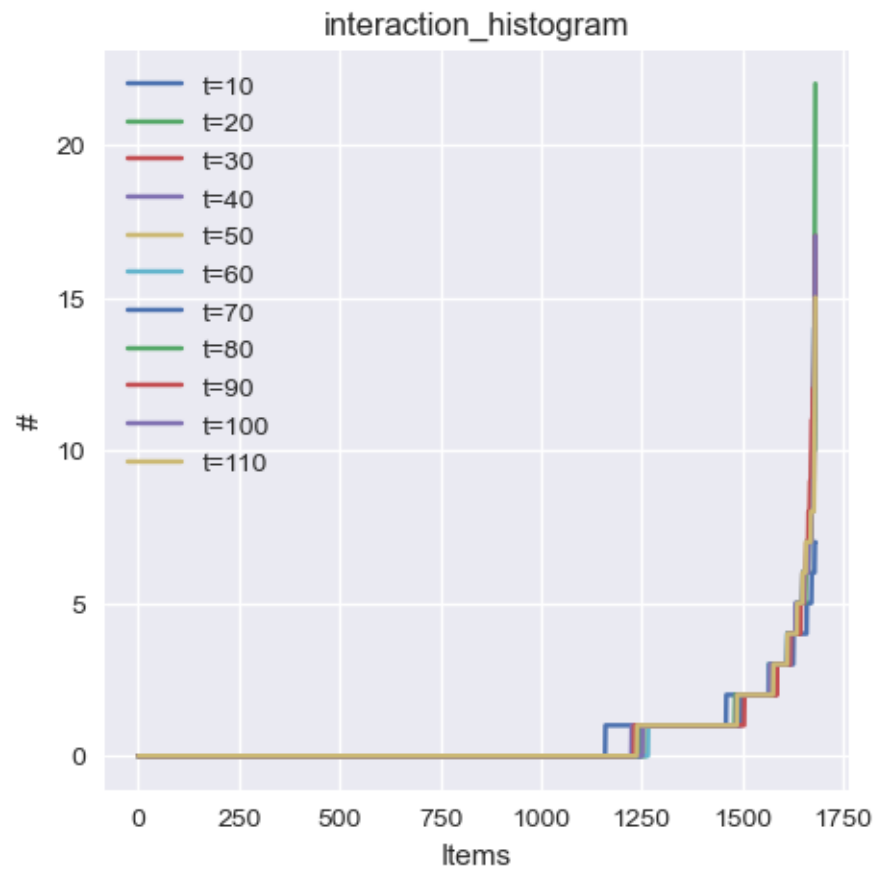
```

        counts = measurements_df[column_name][i]
        plt.plot(items, sorted(counts), label=f't={i}')

    plt.title(column_name)
    plt.xlabel('Items')
    plt.ylabel('#')
    plt.legend()

plot_histograms(measurements_df, 'interaction_histogram')

```



```

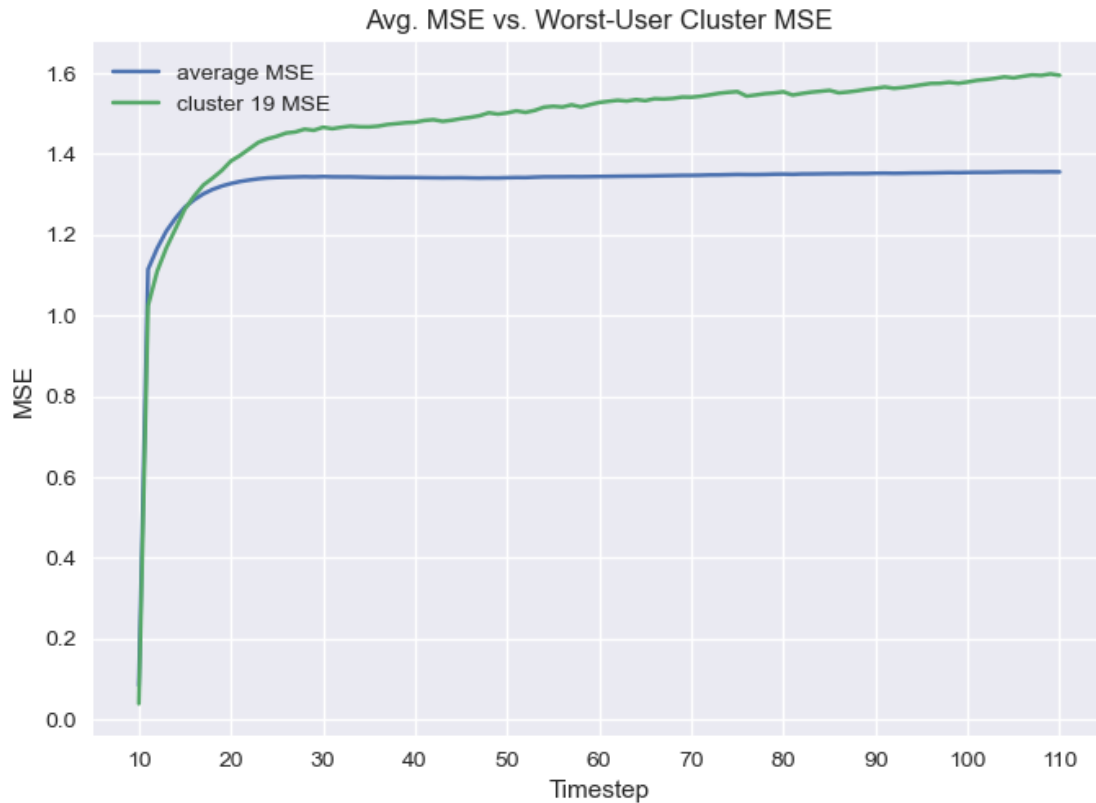
[ ]: # df_user_mse = pd.DataFrame(user_mse)
      # df_user_mse['clusterID'] = user_cluster_ids
      import src
      reload(src.utils)
      from src.utils import *
      df_user_mse = pd.read_csv(path_user_mse_histogram)
      analyze_user_mse(df_user_mse, train_timesteps)

```

```

[ 0  10  20  30  40  50  60  70  80  90 100]

```

```
[ ]: path_user_mse_histogram
```

```
[ ]: 'artefacts/supplementary/measurements/top_k_reranking_user_mse_histogram_10train
Timesteps_100runTimesteps_20nAttrs_25nClusters_0.05Drift_-0.8AttentionExp.csv'
```

```
[ ]: model.score_fn
```

```
[ ]: <function src.scoring_functions.top_k_reranking(predicted_user_profiles,
predicted_item_attributes)>
```

```
[ ]: from numpy.random import RandomState
rs = RandomState(42)
k = 10

pred_scores = mo.inner_product(model.predicted_user_profiles, model.
    ↪predicted_item_attributes)
top_k_idx = mo.top_k_indices(matrix=pred_scores, k=k, random_state=rs)
print(top_k_idx.shape)
print(top_k_idx[0,:])
```

```
(943, 10)
```

```
[1201  100  818  938 1033  812 1253  539 1246 1637]
```

```
[ ]: print(model.predicted_user_item_scores.shape)
pred_top_k = mo.top_k_indices(matrix=model.predicted_user_item_scores, k=k,
    ↪ random_state=rs)
print(pred_top_k.shape)
print(pred_top_k[0,:])
print(model.predicted_user_item_scores[0,pred_top_k[0,:]])

(943, 1682)
(943, 10)
[ 432 1448  523  816  379  598 1335  240  837  757]
[2.23154768 2.23154768 2.23154768 2.23154768 2.23154768 2.23154768
 2.23154768 2.23154768 2.23154768 2.23154768]

[2.23154768 2.23154768 2.23154768 2.23154768 2.23154768 2.23154768 2.23154768 2.23154768
 2.23154768 2.23154768]
```

```
[ ]: pred_scores = mo.inner_product(model.predicted_user_profiles, model.
    ↪ predicted_item_attributes)
top_k_idx = mo.top_k_indices(matrix=pred_scores, k=k, random_state=rs)
print(top_k_idx.shape)
print(top_k_idx[0,:])
print(pred_scores[0,:10])

(943, 10)
[ 432 1448  523  816  379  598 1335  240  837  757]
[1.31782349 0.84397485 1.77802267 1.77376666 0.84823086 1.31782349
 1.84109785 0.86004246 0.9137242  0.39044984]
```

```
[ ]: print(pred_top_k.shape)
print(pred_top_k[0,:])

(943, 10)
[ 379 1350  696 1448 1231  250 1672  938 1637  530]
```

```
[ ]: # (943, 10)
# [ 938 1448  420  543 1661  783  185  696  539 1033]
```

```
[ ]: model.predicted_user_profiles
```

```
[ ]: array([[0.04525504, 0.          , 0.04434978, ..., 0.          , 0.04411674,
           0.          ],
          [0.          , 0.          , 0.          , ..., 0.          , 0.03245337,
           0.03462626],
          [0.03613176, 0.03281997, 0.03367626, ..., 0.          , 0.03152846,
           0.02725485],
          ...,
          [0.          , 0.03803795, 0.          , ..., 0.          , 0.          ,
           0.          ],
          [0.03795104, 0.          , 0.03926978, ..., 0.          , 0.03973666,
```

```
0.      ],  
[0.      , 0.03407797, 0.03836365, ..., 0.      , 0.      ,  
0.      ]])
```

[]: