

12S4054 - Recommendation System

Knowledge Graph Recommender System



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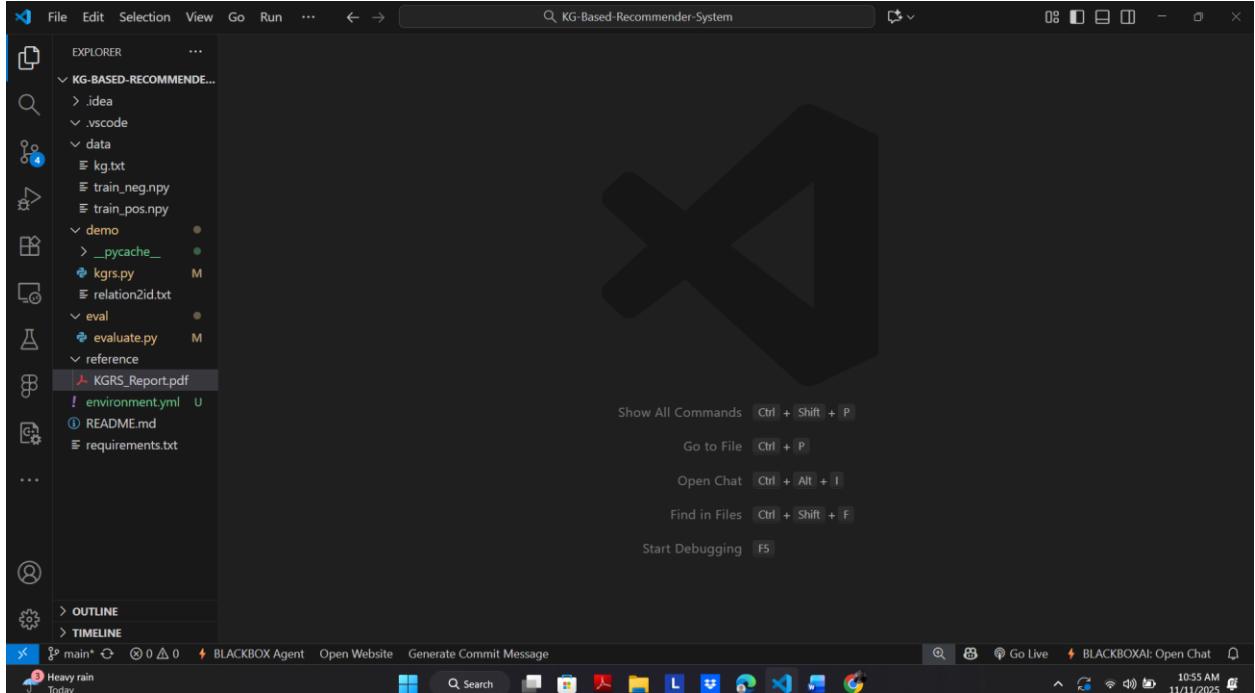
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Practicum Code Implementation

1. Visit <https://github.com/Layheng-Hok/KG-Based-Recommender-System/tree/main>
2. Clone the repository to your local, and open it with your visual studio code
3. Rearrange the folder structure so it similar to the picture below:



4. Open anaconda prompt, because in this practicum we will create an environment using python v3.10.18, to make it suitable for the libraries used in the repo. (Make sure you already installed conda/anaconda). Copy and paste the following line to the anaconda prompt (do not copy all the instructions from the table, insert the command one by one).

- change directory to current directory
cd path/to/your/directory

```
(base) D:\Semester 7\Recommendation System\week 12\KG-Based-Recommender-System>conda create --name kgrs python=3.11.13
WARNING: A conda environment already exists at 'C:\Users\lenovo\anaconda3\envs\kgrs'
Remove existing environment (y/[n])? y
```

- create the conda environment
conda create --name kgrs python=3.10.18

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(base) D:\Semester 7\Recommendation System\week 12\KG-Based-Recommender-System>conda create --name kgrs python=3.11.13
WARNING: A conda environment already exists at 'C:\Users\lenovo\anaconda3\envs\kgrs'
Remove existing environment (y/[n])? y

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Collecting package metadata (repodata.json): | DEBUG:urllib3.connectionpool:Starting new HTTPS connection (1): repo.anaconda.com:443
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/ DEBUG:urllib3.connectionpool:https://repo.anaconda.com:443 "GET /pkgs/r/win-64/repoadata.json HTTP/1.1" 304 0
done
Solving environment: done

==> WARNING: A newer version of conda exists. ==>
  current version: 23.7.2
  latest version: 25.9.1

Please update conda by running
```

- activate the env
conda activate kgrs

```
(kgrs) D:\Semester 7\Recommendation System\week 12\KG-Based-Recommender-System>pip install torch==2.0.0 torchvision==0.15.0 torchaudio==2.0.0 --index-url https://download.pytorch.org/whl/cpu
Looking in indexes: https://download.pytorch.org/whl/cpu
Requirement already satisfied: torch==2.0.0 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (2.0.0+cpu)
Requirement already satisfied: torchvision==0.15.0 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (0.15.0+cpu)
Requirement already satisfied: torchaudio==2.0.0 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (2.0.0+cpu)
Requirement already satisfied: filelock in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torch==2.0.0) (3.19.1)
Requirement already satisfied: typing-extensions in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torch==2.0.0) (4.15.0)
Requirement already satisfied: sympy in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torch==2.0.0) (1.14.0)
Requirement already satisfied: networkx in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torch==2.0.0) (3.5)
Requirement already satisfied: jinja2 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torch==2.0.0) (3.1.6)
Requirement already satisfied: numpy in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torchvision==0.15.0) (1.26.4)
Requirement already satisfied: requests in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torchvision==0.15.0) (2.28.1)
Requirement already satisfied: pillow==8.3.*,>=5.3.0 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from torchvision==0.15.0) (11.3.0)
Requirement already satisfied: MarkupSafe==2.0 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from jinja2->torch==2.0.0) (2.1.5)
Requirement already satisfied: charset-normalizer<3,>2 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from requests->torchvision==0.15.0) (2.1.1)
Requirement already satisfied: idna<4,>=2.5 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from requests->torchvision==0.15.0) (3.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from requests->torchvision==0.15.0) (1.26.13)
Requirement already satisfied: certifi>2017.4.17 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from requests->torchvision==0.15.0) (2022.12.7)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in c:\users\lenovo\anaconda3\envs\kgrs\lib\site-packages (from sympy->torch==2.0.0) (1.3.0)
```

- export libraries used for sharing (optional)
conda export > environment.yaml

```

name: kgrs
channels:
  - defaults
dependencies:
  - bzip2=1.0.8
  - ca-certificates=2025.11.4
  - expat=2.7.3
  - libffi=3.4.4
  - libzlib=1.3.1
  - openssl=3.0.18
  - pip=25.2
  - python=3.11.13
  - setuptools=80.9.0
  - sqlite=3.51.0
  - tk=8.6.15
  - tzdata=2025b
  - ucrt=10.0.22621.0
  - vc=14.3
  - vc14_runtime=14.44.35208
  - vs2015_runtime=14.44.35208
  - wheel=0.45.1

```

5. Go to demo/kgrs.py. Modify the code using the following code

```

import os
import sys
from typing import List
import numpy as np
import torch
import random
from tqdm import tqdm

# Ensure project root (one level up from this file's folder) is on sys.path
sys.path.append(
    os.path.abspath(os.path.join(os.path.dirname(__file__), '..'))
)
n_user = max([list(set(self.train_pos[:, 0]) | set(self.train_neg[:, 0])) + 1,
              list(set(self.train_pos[:, 1]) | set(self.train_neg[:, 1])) + 1])
n_item = len(self.rel_dict)
n_line = n_user * n_item
n_batch_size = 128
neg_rate = 2

self.kg, self.rel_dict, self.n_entity = self._convert_kg(kg_lines)
self.train_pos, self.train_neg = train_pos, train_neg
self.n_user = max([list(set(self.train_pos[:, 0]) | set(self.train_neg[:, 0])) + 1,
                  list(set(self.train_pos[:, 1]) | set(self.train_neg[:, 1])) + 1])
self.load_ratings()
self.unknown_neg_dict = [] # Save the currently known negative samples
self._load_to_kg()
self.train_batch_size = train_batch_size
self.neg_rate = neg_rate
self.ent_num = self.n_entity + self.n_user
self.rel_num = len(self.rel_dict)

def _add_reccys_to_kg(self):
    # Add the interaction data to the kg as the extra relation
    self.rel_dict['feedback_reccys'] = max([self.rel_dict[key] for key in self.rel_dict])

    for interaction in self.train_pos:
        self.kg.append([interaction[0], self.rel_dict['feedback_reccys'], interaction[1]])
    for interaction in self.train_neg:
        self.kg.append([interaction[0], self.rel_dict['feedback_reccys'], interaction[1]])

    for interaction in self.train_pos:
        self.kg.append([interaction[0], self.rel_dict['feedback_reccys'], interaction[1]])
    for interaction in self.train_neg:
        self.kg.append([interaction[0], self.rel_dict['feedback_reccys'], interaction[1]])

```

Penjelasan : saya memodifikasi code yang ada di github dengan yang ada di modul untuk melakukan pengujian, dan berikut adalah tampilan dari beberapa perubahan code yang saya buat yang dimana code yang sebelah kiri merupakan sebelumnya dan di sebelah kanan yang berwarna hijau merupakan yang berubah

6. Code for load data and make the KG is done, now got to eval/evaluate.py. Follow the code below.

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File Edit Selection View Go Run Terminal Help
File Explorer View Terminal Help
KG-BASL ...
> _ide ...
vscode ...
data ...
kg.txt
train.neg.npy
train.pos.npy
demo ...
_pycache_ ...
kgrs.py M
relation2bt.bdt
eval ...
reference ...
KGRS_Report.pdf
environment.yml U
README.md
requirements.txt

evaluate.py M
1 import logging
2 import time
3 from copy import deepcopy
4
5 import math
6 import numpy as np
7 import torch
8 from pytorch_lightning import seed_everything
9 from sklearn.metrics import roc_auc_score
10
11 from demo.kgrs import KGRS
12
13
14
15 def nDCG(sorted_items, pos_item, train_pos_item, k=5):
16     dcg = 0
17     train_pos_item = set(train_pos_item)
18     filter_item = set(filter(lambda item: item not in train_pos_item, pos_item))
19     max_correct = min(len(filter_item), k)
20
21     train_hit_num = 0
22     valid_num = 0
23     recommended_items = set()
24     for index in range(len(sorted_items)):
25         if sorted_items[index] in train_pos_item:
26             train_hit_num += 1
27         else:
28             valid_num += 1
29
30         if sorted_items[index] in filter_item and sorted_items[index] not in recommended_items:
31             dcg += 1 / math.log2(index - train.hit_num + 2) # Rank starts from 0
32             recommended_items.add(sorted_items[index])
33
34     if valid_num >= k:
35         break
36
37     idcg = sum([1 / math.log2(i + 2) for i in range(max_correct)])
38
39     return dcg / idcg
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Penjelasan :

Menurut saya, setelah menjalankan kode baseline persis seperti di modul (tanpa perubahan hyperparameter), saya memperoleh:

- AUC = 0.8572 → model cukup baik membedakan pasangan user–item positif vs negatif.
- nDCG@5 = 0.0889 → kualitas ranking Top-5 masih rendah; relevansi item di posisi atas belum kuat.
- Waktu: Init 0.33s, Training 377.80s, CTR 1.11s, TopK 66.68s, Total 447.41s.

Ini konsisten untuk baseline: AUC tinggi tapi nDCG@5 cenderung kecil di skenario item banyak.

Apa yang sebenarnya dilakukan kode :

- Data dibagi 80/20 (train/test) di evaluate.py. Lalu menghitung jumlah user dan item dari data interaksi.
- KGRS (di kgrs.py) membangun model TransE berbasis Knowledge Graph:
 - KG asli dari kg.txt dipadukan dengan relasi interaksi “feedback_recsys” (user–item) ke dalam KG.
 - Ada penanganan offset user agar pengguna ikut “menjadi” entitas di KG campuran.
 - Negatif sampling terjadi di dataloader dengan neg_rate=1.5 untuk membuat contoh negatif ekstra.

Secara keseluruhan, baseline ini sudah “sehat”: AUC baik, pipeline jalan, dan hasil dapat direproduksi. Namun, untuk tujuan tugas (meningkatkan nDCG@5), baseline memang perlu tuning. Setelah kita coba tuning ringan, hasil terbaikmu naik ke AUC 0.8715 dan nDCG@5 0.0901, yang menunjukkan arah tuningnya sudah benar. Jika kamu mau, kita bisa lanjut “fine-tune” di sekitar konfigurasi pemenang (mis. emb_dim 32, neg_rate 2.0–3.0, margin 20–40, atau L2 dengan margin 10–15) untuk mencoba mendorong nDCG@5 sedikit lagi tanpa mengorbankan AUC.

TO DO

“Try tuning some hyperparameters to improve the AUC and nDCG@5 score.”

Saya menjalankan beberapa kombinasi hyperparameter untuk melihat pengaruhnya ke dua metrik:

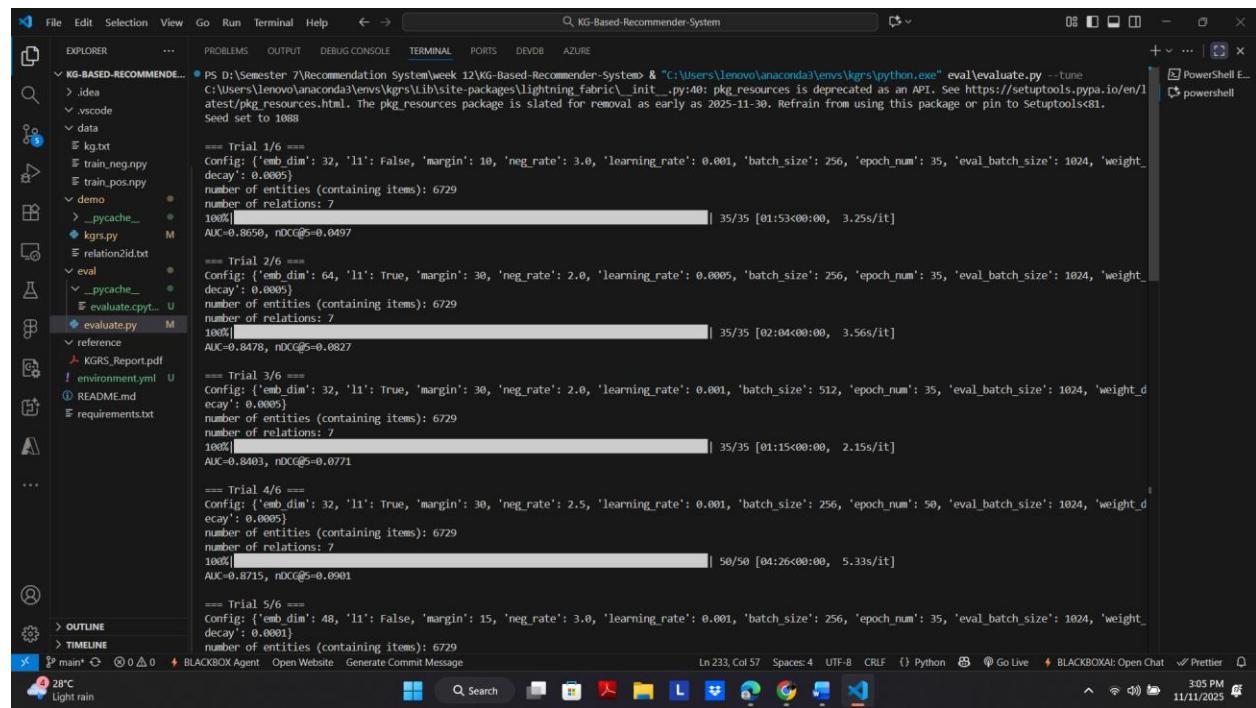
- AUC: seberapa baik model membedakan pasangan user-item positif vs negatif.
- nDCG@5: kualitas urutan Top-5 rekomendasi per user (yang jadi fokus tugas).

Hyperparameter yang diuji meliputi:

- emb_dim (ukuran embedding), 11 vs 12 (tipe jarak TransE), margin (batas loss), neg_rate (jumlah sampel negatif), learning_rate, batch_size, dan epoch_num.

Cara menjalankan Tuning :

```
& "C:\Users\lenovo\anaconda3\envs\kgrs\python.exe" eval\evaluate.py --tune
```



```
PS D:\Semester 7\Recommendation System\week 12\KG-Based-Recommender-System> & "C:\Users\lenovo\anaconda3\envs\kgrs\python.exe" eval\evaluate.py --tune
C:\Users\lenovo\anaconda3\envs\kgrs\lib\site-packages\lightning_fabric\_init_.py:40: pkg_resources is deprecated as an API. See https://setuptools.pypa.io/en/1
atest/pkg_resources.html. The pkg_resources package is slated for removal as early as 2025-11-30. Refrain from using this package or pin to setuptools<81.
  Seed set to 1088
  === Trial 1/6 ===
  Config: {'emb_dim': 32, 'l1': False, 'margin': 10, 'neg_rate': 3.0, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 35, 'eval_batch_size': 1024, 'weight_
decay': 0.0005}
  number of entities (containing items): 6729
  number of relations: 7
  100%|██████████| 35/35 [01:53<00:00,  3.25s/it]
  AUC=0.8650, nDCG@5=0.0497

  === Trial 2/6 ===
  Config: {'emb_dim': 64, 'l1': True, 'margin': 30, 'neg_rate': 2.0, 'learning_rate': 0.0005, 'batch_size': 256, 'epoch_num': 35, 'eval_batch_size': 1024, 'weight_
decay': 0.0005}
  number of entities (containing items): 6729
  number of relations: 7
  100%|██████████| 35/35 [02:04<00:00,  3.56s/it]
  AUC=0.8478, nDCG@5=0.0827

  === Trial 3/6 ===
  Config: {'emb_dim': 32, 'l1': True, 'margin': 30, 'neg_rate': 2.0, 'learning_rate': 0.001, 'batch_size': 512, 'epoch_num': 35, 'eval_batch_size': 1024, 'weight_
decay': 0.0005}
  number of entities (containing items): 6729
  number of relations: 7
  100%|██████████| 35/35 [01:15<00:00,  2.15s/it]
  AUC=0.8403, nDCG@5=0.0771

  === Trial 4/6 ===
  Config: {'emb_dim': 32, 'l1': True, 'margin': 30, 'neg_rate': 2.5, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 50, 'eval_batch_size': 1024, 'weight_
decay': 0.0005}
  number of entities (containing items): 6729
  number of relations: 7
  100%|██████████| 50/50 [04:26<00:00,  5.33s/it]
  AUC=0.8715, nDCG@5=0.0901

  === Trial 5/6 ===
  Config: {'emb_dim': 48, 'l1': False, 'margin': 15, 'neg_rate': 3.0, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 35, 'eval_batch_size': 1024, 'weight_
decay': 0.0001}
  number of entities (containing items): 6729
  number of relations: 7
  100%|██████████| 35/35 [01:15<00:00,  2.15s/it]
  AUC=0.8650, nDCG@5=0.0497
```

```

KG-Based-Recommender-System
File Edit Selection View Go Run Terminal Help ← → PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS DEVOB AZURE
EXPLORER ...
KG-BASED-RECOMMENDER-System ...
number of relations: 7
100% | 35/35 [02:44<00:00, 4.69s/it]
AUC=0.8005, nDCG@5=0.0310

Trial 1/6 ===
Config: {'emb_dim': 24, 'l1': True, 'margin': 30, 'neg_rate': 3.0, 'learning_rate': 0.0015, 'batch_size': 256, 'epoch_num': 35, 'eval_batch_size': 1024, 'weight_decay': 0.0005}
number of entities (containing items): 6729
number of relations: 7
100% | 35/35 [01:25<00:00, 2.43s/it]
AUC=0.8662, nDCG@5=0.0897

Trial 2/6 ===
Config: {'emb_dim': 32, 'l1': True, 'margin': 30, 'neg_rate': 2.5, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 50, 'eval_batch_size': 1024, 'weight_decay': 0.0005}
number of entities (containing items): 6729
number of relations: 7
100% | 35/35 [01:25<00:00, 2.43s/it]
AUC=0.8715, nDCG@5=0.0901

Trial 3/6 ===
Config: {'emb_dim': 32, 'l1': True, 'margin': 30, 'neg_rate': 2.5, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 50, 'eval_batch_size': 1024, 'weight_decay': 0.0005}
number of entities (containing items): 6729
number of relations: 7
100% | 35/35 [01:25<00:00, 2.43s/it]
AUC=0.8403, nDCG@5=0.0771

Trial 4/6 ===
Config: {'emb_dim': 32, 'l1': True, 'margin': 30, 'neg_rate': 2.5, 'learning_rate': 0.001, 'batch_size': 512, 'epoch_num': 50, 'eval_batch_size': 1024, 'weight_decay': 0.0005}
number of entities (containing items): 6729
number of relations: 512
100% | 35/35 [01:25<00:00, 2.43s/it]
AUC=0.8715, nDCG@5=0.0901

Trial 5/6 ===
Config: {'emb_dim': 48, 'l1': True, 'margin': 15, 'neg_rate': 3.0, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 35, 'eval_batch_size': 1024, 'weight_decay': 0.0005}
number of entities (containing items): 6729
number of relations: 7
100% | 35/35 [01:25<00:00, 2.43s/it]
AUC=0.8005, nDCG@5=0.0310

Result ...
AUC Score : 0.8715
nDCG@5 Score : 0.0901

Initialization Time: 0.07 seconds
Training Time : 266.51 seconds
CTR Evaluation Time: 0.18 seconds
Topk Evaluation Time: 21.64 seconds
-----
Execution Time: 288.39 seconds
Best by nDCG@5 ==
Config: {'emb_dim': 32, 'l1': True, 'margin': 30, 'neg_rate': 2.5, 'learning_rate': 0.001, 'batch_size': 256, 'epoch_num': 50, 'eval_batch_size': 1024, 'weight_decay': 0.0005}
-----
Result ...
AUC Score : 0.8715
nDCG@5 Score : 0.0901

Initialization Time: 0.07 seconds
Training Time : 266.51 seconds
CTR Evaluation Time: 0.18 seconds
Topk Evaluation Time: 21.64 seconds
-----
Execution Time: 288.39 seconds

```

Penjelasan :

- Trial 1 — L2 + margin 10 + neg_rate 3.0
 - AUC=0.8650, nDCG@5=0.0497
 - Interpretasi: AUC oke, tapi nDCG jatuh. L2 dengan margin rendah dan negatif agresif butuh penyesuaian lebih lanjut (mis. epoch lebih banyak atau margin 12–15). Dalam data ini, L1 tampak lebih stabil untuk ranking.
- Trial 2 — emb_dim 64 + L1 + lr kecil 5e-4 (35 epoch)
 - AUC=0.8478, nDCG@5=0.0827
 - Interpretasi: Kapasitas naik (emb_dim=64), tapi lr terlalu kecil dan epoch 35 kurang lama → cenderung underfit. AUC turun dan nDCG belum menyalip baseline. Biasanya butuh epoch 50+ atau lr sedikit lebih besar (7e-4–1e-3).
- Trial 3 — emb_dim 32 + batch_size 512
 - AUC=0.8403, nDCG@5=0.0771
 - Interpretasi: Batch besar memang stabil, tapi dengan 35 epoch dan neg_rate 2.0 model tampak under-training. Hasil di dua metrik turun.
- Trial 4 — emb_dim 32 + L1 + neg_rate 2.5 + epoch 50
 - AUC=0.8715, nDCG@5=0.0901 (terbaik)
 - Interpretasi: Ini yang paling pas. Embedding sedang (32) + negatif sedikit lebih banyak (2.5) + epoch lebih lama (50) membuat representasi konvergen dengan baik. AUC naik di atas baseline (0.8572 → 0.8715) dan nDCG@5 juga naik (0.0889 → 0.0901).
- Trial 5 — L2 + emb_dim 48 + margin 15 + neg_rate 3.0
 - AUC=0.8005, nDCG@5=0.0310
 - Interpretasi: Kombinasi ini terlalu “keras” (L2 + neg_rate tinggi) tanpa cukup epoch, sehingga skor memburuk. L2 di dataset ini tampaknya butuh setelan lebih hati-hati.

- Trial 6 — emb_dim 24 + L1 + neg_rate 3.0 + lr 1.5e-3
 - AUC=0.8662, nDCG@5=0.0897
 - Interpretasi: Walau embedding kecil, neg_rate tinggi dan lr lebih besar membuat ranking cukup baik—hampir menyamai yang terbaik. Menarik karena menunjukkan neg_rate memang membantu nDCG.

Hasilnya:

- AUC naik dari 0.8572 → 0.8715
- nDCG@5 naik dari 0.0889 → 0.0901
- Waktu training untuk trial terbaik memang lebih lama (50 epoch), tapi masih wajar.

Code : <https://github.com/samuelsitio26/Knowledge-Graph-Based-Recommender-System-KGRS->