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Кафедра «Системы обработки информации и управления»

Лабораторная работа №5
«Создание рекомендательной модели»

ИСПОЛНИТЕЛЬ:

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Группа ИУ5-21М

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"__"_____2022 г.

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Цель лабораторной работы: обучение работе с предварительной обработкой графовых типов данных и обучением нейронных сетей на графовых данных.

Требования к отчету:

Отчет по лабораторной работе должен содержать:

1. титульный лист;
2. описание задания;
3. текст программы;
4. экранные формы с примерами выполнения программы.

Задание:

1. Подготовить датасет графовых данных
2. Подобрать модель и гиперпараметры обучения для получения качества AUC > 0.65

Лабораторная работа №6:

"Разработка системы предсказания поведения на основании графовых моделей"

Цель: обучение работе с графовым типом данных и графовыми нейронными сетями.

Задача: подготовить графовый датасет из базы данных о покупках и построить модель предсказания совершения покупки.

Графовые нейронные сети

Графовые нейронные сети - тип нейронной сети, которая напрямую работает со структурой графа. Типичным применениями GNN являются:

- Классификация узлов;
- Предсказание связей;
- Графовая классификация;
- Распознавание движений;
- Рекомендательные системы.

В данной лабораторной работе будет происходить работа над **графовыми сверточными сетями**. Отличаются они от сверточных нейронных сетей нефиксированной структурой, функция свертки не является .

Подробнее можно прочитать тут: https://towardsdatascience.com/understanding-graph-convolutional-networks-for-node-classification-a2bfdb7aba7b

Тут можно почитать современные подходы к использованию графовых сверточных сетей https://paperswithcode.com/method/gcn

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Датасет

В качестве базы данных предлагаем использовать датасет о покупках пользователей в одном магазине товаров RecSys Challenge 2015 (https://www.kaggle.com/datasets/chadgostopp/recsys-challenge-2015).

Скачать датасет можно отсюда: https://drive.google.com/drive/folders/1gtAeXPTj-c0RwVOKreMrZ3bfSmCwl2y-?usp=sharing (lite-версия является облегченной версией исходного датасета, рекомендуем использовать её)

Также рекомендуем загружать данные в виде архива и распаковывать через пакет zipfile или/и скачивать датасет в собственный Google Drive и примонтировать его в колаб.

Установка библиотек, выгрузка исходных датасетов

```
# Slow method of installing pytorch geometric
# !pip install torch_geometric
# !pip install torch_sparse
# !pip install torch_scatter

# Install pytorch geometric
!pip install torch-sparse -f https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.html
!pip install torch-cluster -f https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.html
!pip install torch-spline-conv -f https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.h
!pip install torch-geometric -f https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.htm
!pip install torch-scatter==2.0.8 -f https://data.pyg.org/whl/torch-1.11.0%2Bcu113.html
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels
Looking in links: https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.html
Collecting torch-sparse
  Downloading https://data.pyg.org/whl/torch-1.11.0%2Bcu113/torch_sparse-0.6.13-cp
     |████████████████████████████████| 3.5 MB 4.9 MB/s
Requirement already satisfied: scipy in /usr/local/lib/python3.7/dist-packages (fr
Requirement already satisfied: numpy>=1.13.3 in /usr/local/lib/python3.7/dist-packa
Installing collected packages: torch-sparse
Successfully installed torch-sparse-0.6.13
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels
Looking in links: https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.html
Collecting torch-cluster
  Downloading https://data.pyg.org/whl/torch-1.11.0%2Bcu113/torch_cluster-1.6.0-cp
     |████████████████████████████████| 2.5 MB 5.1 MB/s
Installing collected packages: torch-cluster
Successfully installed torch-cluster-1.6.0
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels
Looking in links: https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.html
Collecting torch-spline-conv
  Downloading https://data.pyg.org/whl/torch-1.11.0%2Bcu113/torch_spline_conv-1.2.
     |████████████████████████████████| 750 kB 4.6 MB/s
Installing collected packages: torch-spline-conv
Successfully installed torch-spline-conv-1.2.1
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels
Looking in links: https://pytorch-geometric.com/whl/torch-1.11.0%2Bcu113.html
Collecting torch-geometric
  Downloading torch_geometric-2.0.4.tar.gz (407 kB)
     |████████████████████████████████| 407 kB 5.2 MB/s
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages (fro
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages (fr
Requirement already satisfied: scipy in /usr/local/lib/python3.7/dist-packages (fr
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: jinja2 in /usr/local/lib/python3.7/dist-packages (f
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: pyparsing in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: scikit-learn in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: MarkupSafe>=0.23 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packa
Requirement already satisfied: python-dateutil>=2.7.3 in /usr/local/lib/python3.7/
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.7/dist
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-packa
```

```
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/loca
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.7/dist-p
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-packag
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.7/dis
Building wheels for collected packages: torch-geometric
  Building wheel for torch-geometric (setup.py) ... done
  Created wheel for torch-geometric: filename=torch_geometric-2.0.4-py3-none-any.wh
  Stored in directory: /root/.cache/pip/wheels/18/a6/a4/ca18c3051fcead866fe7b85700e
Successfully built torch-geometric
Installing collected packages: torch-geometric
Successfully installed torch-geometric-2.0.4
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels
Looking in links: https://data.pyg.org/whl/torch-1.11.0%2Bcu113.html
Collecting torch-scatter==2.0.8
  Downloading torch_scatter-2.0.8.tar.gz (21 kB)
```

```
import numpy as np
import pandas as pd
import pickle
import csv
import os

from sklearn.preprocessing import LabelEncoder

import torch

# PyG - PyTorch Geometric
from torch_geometric.data import Data, DataLoader, InMemoryDataset

from tqdm import tqdm


RANDOM_SEED = 71 #@param { type: "integer" }
BASE_DIR = '/content/' #@param { type: "string" }
np.random.seed(RANDOM_SEED)

CUDA_LAUNCH_BLOCKING = "1"
```

RANDOM_SEED: 71

BASE_DIR: "/content/"

```
# Check if CUDA is available for colab
torch.cuda.is_available
```

```
<function torch.cuda.is_available>
```

```
# Unpack files from zip-file
import zipfile
with zipfile.ZipFile('/content/yoochoose-data-lite.zip', 'r') as zip_ref:
    zip_ref.extractall(BASE_DIR)
```

```
---------------------------------------------------------------------------
BadZipFile                                Traceback (most recent call last)
<ipython-input-3-5b7ba636a1ee> in <module>()
      1 # Unpack files from zip-file
      2 import zipfile
----> 3 with zipfile.ZipFile('/content/yoochoose-data-lite.zip', 'r') as zip_ref:
      4     zip_ref.extractall(BASE_DIR)

                                 1 frames
/usr/lib/python3.7/zipfile.py in _RealGetContents(self)
   1323             raise BadZipFile("File is not a zip file")
   1324         if not endrec:
-> 1325             raise BadZipFile("File is not a zip file")
   1326         if self.debug > 1:
   1327             print(endrec)
```

```
import os
cwd = os.getcwd()
cwd
```

```
'/content'
```

Анализ исходных данных

```
# Read dataset of items in store
df = pd.read_csv(BASE_DIR + 'yoochoose-clicks-lite.dat')
# df.columns = ['session_id', 'timestamp', 'item_id', 'category']
df.head()
```

	session_id	timestamp	item_id	category
0	9	2014-04-06T11:26:24.127Z	214576500.0	0.0
1	9	2014-04-06T11:28:54.654Z	214576500.0	0.0
2	9	2014-04-06T11:29:13.479Z	214576500.0	0.0
3	19	2014-04-01T20:52:12.357Z	214561790.0	0.0
4	19	2014-04-01T20:52:13.758Z	214561790.0	0.0

```
# Read dataset of purchases
buy_df = pd.read_csv(BASE_DIR + 'yoochoose-buys-lite.dat')
# buy_df.columns = ['session_id', 'timestamp', 'item_id', 'price', 'quantity']
buy_df.head()
```

	session_id	timestamp	item_id	price	quantity
0	420374	2014-04-06T18:44:58.314Z	214537888	12462	1
1	420374	2014-04-06T18:44:58.325Z	214537850	10471	1

```
# Filter out item session with length < 2
df['valid_session'] = df.session_id.map(df.groupby('session_id')['item_id'].size() > 2)
df = df.loc[df.valid_session].drop('valid_session',axis=1)
df.nunique()
```

```
session_id     24709
timestamp     141212
item_id        11476
category           1
dtype: int64
```

```
# Randomly sample a couple of them
NUM_SESSIONS = 10000 #@param { type: "integer" }
sampled_session_id = np.random.choice(df.session_id.unique(), NUM_SESSIONS, replace=False)
df = df.loc[df.session_id.isin(sampled_session_id)]
df.nunique()
```

NUM_SESSIONS: 10000

```
session_id    10000
timestamp     57081
item_id        7827
category          1
dtype: int64
```

```
# Average length of session
df.groupby('session_id')['item_id'].size().mean()
```

```
5.7085
```

```
# Encode item and category id in item dataset so that ids will be in range (0,len(df.item.
item_encoder = LabelEncoder()
category_encoder = LabelEncoder()
df['item_id'] = item_encoder.fit_transform(df.item_id)
df['category']= category_encoder.fit_transform(df.category.apply(str))
df.head()
```

	session_id	timestamp	item_id	category
0	9	2014-04-06T11:26:24.127Z	1717	0
1	9	2014-04-06T11:28:54.654Z	1717	0
2	9	2014-04-06T11:29:13.479Z	1717	0
3	19	2014-04-01T20:52:12.357Z	1496	0
4	19	2014-04-01T20:52:13.758Z	1496	0

```
# Encode item and category id in purchase dataset
buy_df = buy_df.loc[buy_df.session_id.isin(df.session_id)]
```

```
buy_df['item_id'] = item_encoder.transform(buy_df.item_id)
buy_df.head()
```

```
/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:3: SettingWithCopyWarnir
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  This is separate from the ipykernel package so we can avoid doing imports until
```

	session_id	timestamp	item_id	price	quantity
23	70529	2014-04-03T11:07:51.984Z	5714	2617	2
26	140973	2014-04-02T20:24:15.190Z	3619	15603	1
45	209936	2014-04-03T18:28:30.862Z	352	837	2
53	210076	2014-04-07T05:50:20.837Z	1636	313	12
54	210076	2014-04-07T05:50:20.879Z	7366	627	6

```
# Get item dictionary with grouping by session
buy_item_dict = dict(buy_df.groupby('session_id')['item_id'].apply(list))
buy_item_dict
```

```
{396: [6451],
 432: [5250],
 484: [4457, 4457],
 737: [6754],
 873: [6302],
 1167: [7448],
 1311: [394],
 1372: [6425, 6428, 6426, 6427],
 1426: [1977],
 1877: [6326],
 1896: [6502],
 2071: [6451, 6422, 6489, 6429],
 2168: [6375],
 3687: [6462, 6460, 192, 6435, 7425, 1788, 191, 68],
 4036: [1770, 2461],
 4761: [6188, 6188],
 4868: [144, 4718],
 4988: [7306],
 5296: [7419, 6040],
 5492: [2320],
 5761: [5921, 5994],
 5802: [4306, 6264],
 6016: [7522],
 6528: [6041, 6055, 1382],
 7054: [6422],
 7173: [6188],
 7176: [4189, 4189],
 7189: [7306],
 7742: [2319],
 7798: [5363],
 7866: [7419, 5181, 5123],
 8427: [353, 353],
```

```
  8793: [6434, 5846],
  9272: [1939],
  9787: [5709],
  10648: [6375, 6379],
  11311: [1314, 6331],
  11524: [6029],
  11527: [5779],
  11718: [6485, 6487, 6039],
  12017: [2497],
  12031: [129],
  12101: [6281, 6506],
  12184: [6434],
  12282: [6377,
   6379,
   6375,
   4475,
   6379,
   6377,
   6375,
   4475,
   6379,
   6377,
   6375,
   4475],
  12356: [641],
  13073: [5709, 5709],
```

Сборка выборки для обучения

```
# Transform df into tensor data
def transform_dataset(df, buy_item_dict):
    data_list = []

    # Group by session
    grouped = df.groupby('session_id')
    for session_id, group in tqdm(grouped):
        le = LabelEncoder()
        sess_item_id = le.fit_transform(group.item_id)
        group = group.reset_index(drop=True)
        group['sess_item_id'] = sess_item_id

        #get input features
        node_features = group.loc[group.session_id==session_id,
                                  ['sess_item_id','item_id','category']].sort_values('ses
        node_features = torch.LongTensor(node_features).unsqueeze(1)
        target_nodes = group.sess_item_id.values[1:]
        source_nodes = group.sess_item_id.values[:-1]

        edge_index = torch.tensor([source_nodes,
                                   target_nodes], dtype=torch.long)
        x = node_features

        #get result
        if session_id in buy_item_dict:
            positive_indices = le.transform(buy_item_dict[session_id])
```

```
            label = np.zeros(len(node_features))
            label[positive_indices] = 1
        else:
            label = [0] * len(node_features)

        y = torch.FloatTensor(label)

        data = Data(x=x, edge_index=edge_index, y=y)

        data_list.append(data)

    return data_list

# Pytorch class for creating datasets
class YooChooseDataset(InMemoryDataset):
    def __init__(self, root, transform=None, pre_transform=None):
        super(YooChooseDataset, self).__init__(root, transform, pre_transform)
        self.data, self.slices = torch.load(self.processed_paths[0])

    @property
    def raw_file_names(self):
        return []

    @property
    def processed_file_names(self):
        return [BASE_DIR+'yoochoose_click_binary_100000_sess.dataset']

    def download(self):
        pass

    def process(self):
        data_list = transform_dataset(df, buy_item_dict)

        data, slices = self.collate(data_list)
        torch.save((data, slices), self.processed_paths[0])
```

```
# Prepare dataset
dataset = YooChooseDataset('./')
```

Разделение выборки

```
# train_test_split
dataset = dataset.shuffle()
one_tenth_length = int(len(dataset) * 0.1)
train_dataset = dataset[:one_tenth_length * 8]
val_dataset = dataset[one_tenth_length*8:one_tenth_length * 9]
test_dataset = dataset[one_tenth_length*9:]
len(train_dataset), len(val_dataset), len(test_dataset)
```

```
(8000, 1000, 1000)
```

```
# Load dataset into PyG loaders
```

```
batch_size= 512
train_loader = DataLoader(train_dataset, batch_size=batch_size)
val_loader = DataLoader(val_dataset, batch_size=batch_size)
test_loader = DataLoader(test_dataset, batch_size=batch_size)
```

```
/usr/local/lib/python3.7/dist-packages/torch_geometric/deprecation.py:12: UserWarning
  warnings.warn(out)
```

```
# Load dataset into PyG loaders
num_items = df.item_id.max() +1
num_categories = df.category.max()+1
num_items , num_categories
```

```
(7827, 1)
```

Настройка модели для обучения

```
embed_dim = 128
from torch_geometric.nn import GraphConv, TopKPooling, GatedGraphConv, SAGEConv, SGConv
from torch_geometric.nn import global_mean_pool as gap, global_max_pool as gmp
import torch.nn.functional as F

class Net(torch.nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        # Model Structure
        self.conv1 = GraphConv(embed_dim * 2, 128)
        self.pool1 = TopKPooling(128, ratio=0.9)
        self.conv2 = GraphConv(128, 128)
        self.pool2 = TopKPooling(128, ratio=0.9)
        self.conv3 = GraphConv(128, 128)
        self.pool3 = TopKPooling(128, ratio=0.9)
        self.item_embedding = torch.nn.Embedding(num_embeddings=num_items, embedding_dim=e
        self.category_embedding = torch.nn.Embedding(num_embeddings=num_categories, embedd
        self.lin1 = torch.nn.Linear(256, 256)
        self.lin2 = torch.nn.Linear(256, 128)
        self.bn1 = torch.nn.BatchNorm1d(128)
        self.bn2 = torch.nn.BatchNorm1d(64)
        self.act1 = torch.nn.ReLU()
        self.act2 = torch.nn.ReLU()

    # Forward step of a model
    def forward(self, data):
        x, edge_index, batch = data.x, data.edge_index, data.batch

        item_id = x[:,:,0]
        category = x[:,:,1]


        emb_item = self.item_embedding(item_id).squeeze(1)
        emb_category = self.category_embedding(category).squeeze(1)
```

```
        x = torch.cat([emb_item, emb_category], dim=1)
        # print(x.shape)
        x = F.relu(self.conv1(x, edge_index))
        # print(x.shape)
        r = self.pool1(x, edge_index, None, batch)
        # print(r)
        x, edge_index, _, batch, _, _ = self.pool1(x, edge_index, None, batch)
        x1 = torch.cat([gmp(x, batch), gap(x, batch)], dim=1)

        x = F.relu(self.conv2(x, edge_index))

        x, edge_index, _, batch, _, _ = self.pool2(x, edge_index, None, batch)
        x2 = torch.cat([gmp(x, batch), gap(x, batch)], dim=1)

        x = F.relu(self.conv3(x, edge_index))

        x, edge_index, _, batch, _, _ = self.pool3(x, edge_index, None, batch)
        x3 = torch.cat([gmp(x, batch), gap(x, batch)], dim=1)

        x = x1 + x2 + x3

        x = self.lin1(x)
        x = self.act1(x)
        x = self.lin2(x)
        x = F.dropout(x, p=0.5, training=self.training)
        x = self.act2(x)

        outputs = []
        for i in range(x.size(0)):
            output = torch.matmul(emb_item[data.batch == i], x[i,:])

            outputs.append(output)

        x = torch.cat(outputs, dim=0)
        x = torch.sigmoid(x)

        return x
```

Обучение нейронной сверточной сети

```
# Enable CUDA computing
device = torch.device('cuda')
```

```
model = Net().to(device)
# Choose optimizer and criterion for learning
optimizer = torch.optim.Adam(model.parameters(), lr=0.01)
# optimizer = torch.optim.Adagrad(model.parameters(), lr=0.01)
crit = torch.nn.BCELoss()
```

```
# Train function
def train():
    model.train()

    loss_all = 0
    for data in train_loader:
        data = data.to(device)
        optimizer.zero_grad()
        output = model(data)

        label = data.y.to(device)
        loss = crit(output, label)
        loss.backward()
        loss_all += data.num_graphs * loss.item()
        optimizer.step()
    return loss_all / len(train_dataset)
```

```
# Evaluate result of a model
from sklearn.metrics import roc_auc_score
def evaluate(loader):
    model.eval()

    predictions = []
    labels = []

    with torch.no_grad():
        for data in loader:

            data = data.to(device)
            pred = model(data).detach().cpu().numpy()

            label = data.y.detach().cpu().numpy()
            predictions.append(pred)
            labels.append(label)

    predictions = np.hstack(predictions)
    labels = np.hstack(labels)

    return roc_auc_score(labels, predictions)
```

```
# model.to(device)
```

```
# Train a model
NUM_EPOCHS =   10#@param { type: "integer" }
for epoch in tqdm(range(NUM_EPOCHS)):
    loss = train()
    train_acc = evaluate(train_loader)
    val_acc = evaluate(val_loader)
    test_acc = evaluate(test_loader)
    print('Epoch: {:03d}, Loss: {:.5f}, Train Auc: {:.5f}, Val Auc: {:.5f}, Test Auc: {:.5
          format(epoch, loss, train_acc, val_acc, test_acc))
```

NUM_EPOCHS: 10

```
  0%|          | 0/10 [00:00<?, ?it/s]
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
<ipython-input-28-194a343510ba> in <module>()
      2 NUM_EPOCHS =   10#@param { type: "integer" }
      3 for epoch in tqdm(range(NUM_EPOCHS)):
----> 4     loss = train()
      5     train_acc = evaluate(train_loader)
      6     val_acc = evaluate(val_loader)

                                  5 frames
/usr/local/lib/python3.7/dist-packages/torch_geometric/data/data.py in <lambda>(x)
    215         only the ones given in :obj:`*args`."""
    216         return self.apply(
--> 217             lambda x: x.to(device=device, non_blocking=non_blocking), *args)
    218
    219     def cpu(self, *args: List[str]):

RuntimeError: CUDA error: device-side assert triggered
CUDA kernel errors might be asynchronously reported at some other API call,so the
stacktrace below might be incorrect.
For debugging consider passing CUDA_LAUNCH_BLOCKING=1.
```

Проверка результата с помощью примеров

```
# Подход №1 - из датасета
evaluate(DataLoader(test_dataset[40:60], batch_size=10))
```

```
/usr/local/lib/python3.7/dist-packages/torch_geometric/deprecation.py:12: UserWarning
  warnings.warn(out)
0.4639639639639639
```

```
# Подход №2 - через создание сессии покупок
test_df = pd.DataFrame([
      [-1, 15219, 0],
      [-1, 15431, 0],
      [-1, 14371, 0],
      [-1, 15745, 0],
      [-2, 14594, 0],
      [-2, 16972, 11],
      [-2, 16943, 0],
      [-3, 17284, 0]
], columns=['session_id', 'item_id', 'category'])

test_data = transform_dataset(test_df, buy_item_dict)
test_data = DataLoader(test_data, batch_size=1)

with torch.no_grad():
    model.eval()
    for data in test_data:
        data = data.to(device)
        pred = model(data).detach().cpu().numpy()
```

```
    print(data, pred)
```

```
100%|██████████| 3/3 [00:00<00:00, 216.61it/s]
/usr/local/lib/python3.7/dist-packages/torch_geometric/deprecation.py:12: UserWarning
  warnings.warn(out)
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
<ipython-input-32-d0e950e4242f> in <module>()
     17     model.eval()
     18     for data in test_data:
---> 19         data = data.to(device)
     20         pred = model(data).detach().cpu().numpy()
     21

 4 frames
/usr/local/lib/python3.7/dist-packages/torch_geometric/data/data.py in <lambda>(x)
    215         only the ones given in :obj:`*args`."""
    216         return self.apply(
--> 217             lambda x: x.to(device=device, non_blocking=non_blocking), *args)
    218
    219     def cpu(self, *args: List[str]):

RuntimeError: CUDA error: device-side assert triggered
CUDA kernel errors might be asynchronously reported at some other API call,so the
stacktrace below might be incorrect.
For debugging consider passing CUDA_LAUNCH_BLOCKING=1.
```