GPTGeorge_DiabloMedium

August 25, 2022

0.1 Fine-tune the DiabloGPT model based on characters from Seinfeld.

Inspired from https://towardsdatascience.com/make-your-own-rick-sanchez-bot-with-transformers-and-dialogpt-fine-tuning-f85e6d1f4e30

[1]:
```
# install transformers, preferably in a conda environment
#! pip  install transformers
#! pip install matplotlib
```

[2]:
```
import os
import matplotlib.pyplot as plt
from transformers import AutoModelForCausalLM, AutoTokenizer
import torch

os.chdir('..')
```

[3]:
```
!pwd
```

```
/data/isshamie/SeinChat
```

[4]:
```
character = "GEORGE" # "JERRY", "KRAMER", "ELAINE"
```

0.2 Load DiabloGPT-medium model and tokenizer

[5]:
```
tokenizer = AutoTokenizer.from_pretrained("microsoft/DialoGPT-medium")
model = AutoModelForCausalLM.from_pretrained("microsoft/DialoGPT-medium")
```

0.2.1 Uncomment the following to see what the dialogue looks like before fine-tuning

[6]:
```
# # Let's chat for 5 lines
# for step in range(5):
#     # encode the new user input, add the eos_token and return a tensor in␣
 ↪Pytorch
#     new_user_input_ids = tokenizer.encode(input(">> User:") + tokenizer.
 ↪eos_token, return_tensors='pt')

#     # append the new user input tokens to the chat history
#     bot_input_ids = torch.cat([chat_history_ids, new_user_input_ids], dim=-1)␣
↪if step > 0 else new_user_input_ids

#     # generated a response while limiting the total chat history to 1000␣
↪tokens
#     chat_history_ids = model.generate(
#     bot_input_ids, max_length=1000,
#     pad_token_id=tokenizer.eos_token_id
#     )

#     # pretty print last ouput tokens from bot
#     print("DialoGPT: {}".format(tokenizer.decode(chat_history_ids[:,␣
↪bot_input_ids.shape[-1]:][0], skip_special_tokens=True)))
```

0.3 Model initial configuration

Let's train our Seinfeld character chatbot. For start, we will need basic configuration and a dataset. Configuration and training scripts are mostly based on this script from Huggingface and great tutorial from Nathan Cooper.

[7]:
```
"""
Fine-tuning the library models for language modeling on a text file (GPT,␣
↪GPT-2, BERT, RoBERTa).
GPT and GPT-2 are fine-tuned using a causal language modeling (CLM) loss while␣
↪BERT and RoBERTa are fine-tuned
using a masked language modeling (MLM) loss.
"""

import glob
import logging
import os
import pickle
import random
import re
import shutil
import torch.optim as optim
from typing import Dict, List, Tuple
import pandas as pd
import numpy as np
import torch

from sklearn.model_selection import train_test_split

from torch.nn.utils.rnn import pad_sequence
from torch.utils.data import DataLoader, Dataset, RandomSampler,␣
↪SequentialSampler
from torch.utils.data.distributed import DistributedSampler
from tqdm.notebook import tqdm, trange

from pathlib import Path

from transformers import (
    MODEL_WITH_LM_HEAD_MAPPING,
    WEIGHTS_NAME,
    AdamW,
    AutoConfig,
    AutoModelForCausalLM,
    AutoTokenizer,
    PreTrainedModel,
    PreTrainedTokenizer,
    get_linear_schedule_with_warmup,
)



try:
    from torch.utils.tensorboard import SummaryWriter
except ImportError:
    from tensorboardX import SummaryWriter

# Configs
logger = logging.getLogger(__name__)

MODEL_CONFIG_CLASSES = list(MODEL_WITH_LM_HEAD_MAPPING.keys())
MODEL_TYPES = tuple(conf.model_type for conf in MODEL_CONFIG_CLASSES)
```

```
/data/isshamie/miniconda3/envs/sein/lib/python3.10/site-
packages/scipy/__init__.py:146: UserWarning: A NumPy version >=1.16.5 and
<1.23.0 is required for this version of SciPy (detected version 1.23.1
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

[8]:
```
# Args to allow for easy convertion of python script to notebook
class Args():
    def __init__(self):
        self.output_dir = 'output_diablomedium'
        self.model_type = 'gpt2'
        self.model_name_or_path = "microsoft/DialoGPT-medium"
        self.config_name = "microsoft/DialoGPT-medium"
        self.tokenizer_name = "microsoft/DialoGPT-medium"
        self.cache_dir = 'cached'
        self.block_size = 512
        self.do_train = True
        self.do_eval = True
        self.evaluate_during_training = False
        self.per_gpu_train_batch_size = 4
        self.per_gpu_eval_batch_size = 4
        self.gradient_accumulation_steps = 1
        self.learning_rate = 5e-5
        self.weight_decay = 0.0
        self.adam_epsilon = 1e-8
        self.max_grad_norm = 1.0
        self.num_train_epochs = 8
        self.max_steps = -1
        self.warmup_steps = 0
        self.logging_steps = 1000
        self.save_steps = 15000
        self.save_total_limit = None
        self.eval_all_checkpoints = False
        self.no_cuda = False
        self.overwrite_output_dir = True
        self.overwrite_cache = True
        self.should_continue = False
        self.seed = 42
        self.local_rank = -1
        self.fp16 = False
        self.fp16_opt_level = 'O1'

args = Args()
```

0.4 Prepare Dataset

[9]:
```
# Let's look at original dataset
all_sein = pd.read_csv('data/sein_scripts_kaggle/scripts.csv', index_col=0)
all_sein.head(10)
```

[9]:
```
  Character                                           Dialogue  EpisodeNo  \
0     JERRY  Do you know what this is all about? Do you kno…        1.0
1     JERRY  (pointing at Georges shirt) See, to me, that b…        1.0
2    GEORGE                                  Are you through?        1.0
3     JERRY                 You do of course try on, when you buy?        1.0
4    GEORGE  Yes, it was purple, I liked it, I dont actuall…        1.0
5     JERRY                                Oh, you dont recall?        1.0
6    GEORGE  (on an imaginary microphone) Uh, no, not at th…        1.0
7     JERRY  Well, senator, Id just like to know, what you …        1.0
8    CLAIRE                        Mr. Seinfeld. Mr. Costanza.        1.0
9    GEORGE  Are, are you sure this is decaf? Wheres the or…        1.0

     SEID  Season
0  S01E01     1.0
1  S01E01     1.0
2  S01E01     1.0
3  S01E01     1.0
```

```
4  S01E01     1.0
5  S01E01     1.0
6  S01E01     1.0
7  S01E01     1.0
8  S01E01     1.0
9  S01E01     1.0
```

0.4.1 Remove the parenthesis in Dialogue

[10]:
```
import re
# text = "heyu (rherhe ) (rjerj)"
# print(str(re.sub("([\(\[]).*?([\)\]])", "\g<1>\g<2>", text)))

def rm_parenthesis(text):
    return str(re.sub("([\(\[]).*?([\)\]])", "\g<1>\g<2>", text)).replace("(",␣
↪"").replace(")", "")

all_sein['Dialogue'] = all_sein['Dialogue'].fillna("").apply(rm_parenthesis)
```

[11]:
```
all_sein.head()
```

[11]:
```
  Character                                          Dialogue  EpisodeNo  \
0     JERRY  Do you know what this is all about? Do you kno…        1.0
1     JERRY   See, to me, that button is in the worst possi…        1.0
2    GEORGE                                  Are you through?        1.0
3     JERRY              You do of course try on, when you buy?        1.0
4    GEORGE  Yes, it was purple, I liked it, I dont actuall…        1.0

     SEID  Season
0  S01E01     1.0
1  S01E01     1.0
2  S01E01     1.0
3  S01E01     1.0
4  S01E01     1.0
```

[12]:
```
all_sein["Character"] = all_sein["Character"].str.upper()
```

We will convert this dataset in a way that every responce row will contain **n** previous responces as a context. For our purposes seven previous responces will be enough. This runs for each character, so it gets a character response and the seven previous lines of dialogue

[13]:
```
n=7
```

[14]:
```
def run_context(character,  n=7, verbose=False):
    contexted = []
    # find the indices where the character speaks, break down for each episode␣
↪so no cross over
```

```
    episodes_groups = all_sein.groupby("SEID")
    for ep, ep_df in episodes_groups:
        ep_df = ep_df.reset_index()
        curr_char_inds = ep_df[ep_df["Character"] == character].index
        if verbose:
            print(f"number of {character} lines in episode {ep}:␣
↪{len(curr_char_inds)}")
        for i_line in curr_char_inds:
            if i_line <= n: # too early in episode.
                continue
            row = []
            prev = i_line - 1 - n # we additionally substract 1, so row will␣
↪contain current responce and 7 previous responces
            for j in range(i_line, prev, -1):
                row.append(ep_df['Dialogue'][j])
            contexted.append(row)
    return contexted
```

[15]:
```
# print('running jerry')
# jerry_contexted = run_context("JERRY", n=n, verbose=False)
# print('running george')
# george_contexted = run_context("GEORGE", n=n, verbose=False)

# jerry_contexted[:5]

# # Rick n mortys old was 1898
# contexted = george_contexted
# len(contexted)

# print(len(george_contexted))
# print(len(jerry_contexted))


contexted = run_context(character, n=n, verbose=False)
print(len(character))
```

```
6
```

[16]:
```
columns = ['response', 'context']
columns = columns + ['context/'+str(i) for i in range(n-1)]
columns
```

[16]:
```
['response',
 'context',
 'context/0',
 'context/1',
 'context/2',
 'context/3',
 'context/4',
 'context/5']
```

[17]:
```
df = pd.DataFrame.from_records(contexted, columns=columns)
df.head(5)
```

[17]:
```
                                            response  \
0  Are, are you sure this is decaf? Wheres the or…
1  How come youre not doin the second show tomorrow?
2  Wait a second, wait a second, what coming in, …
3                                     No, you didnt!
4                                                Ha.

                                             context  \
0                           Mr. Seinfeld. Mr. Costanza.
1  Trust me George. No one has any interest in se…
2     Well, theres this uh, woman might be comin in.
3  I told you about Laura, the girl I met in Mich…
4  I thought I told you about it, yes, she teache…

                                           context/0  \
0  Well, senator, Id just like to know, what you …
1  Can you relax, its a cup of coffee. Claire is …
2  How come youre not doin the second show tomorrow?
3  Wait a second, wait a second, what coming in, …
4                                     No, you didnt!

                                           context/1  \
0                            Uh, no, not at this time.
1  Its missing, I have to do it in my head decaf …
2  Trust me George. No one has any interest in se…
3     Well, theres this uh, woman might be comin in.
4  I told you about Laura, the girl I met in Mich…

                                           context/2  \
0                                 Oh, you dont recall?
1  Are, are you sure this is decaf? Wheres the or…
2  Can you relax, its a cup of coffee. Claire is …
3  How come youre not doin the second show tomorrow?
4  Wait a second, wait a second, what coming in, …

                                           context/3  \
0  Yes, it was purple, I liked it, I dont actuall…
1                           Mr. Seinfeld. Mr. Costanza.
2  Its missing, I have to do it in my head decaf …
3  Trust me George. No one has any interest in se…
```

```
4     Well, theres this uh, woman might be comin in.

                                              context/4  \
0             You do of course try on, when you buy?
1  Well, senator, Id just like to know, what you …
2  Are, are you sure this is decaf? Wheres the or…
3  Can you relax, its a cup of coffee. Claire is …
4  How come youre not doin the second show tomorrow?

                                              context/5
0                                  Are you through?
1                         Uh, no, not at this time.
2                       Mr. Seinfeld. Mr. Costanza.
3  Its missing, I have to do it in my head decaf …
4  Trust me George. No one has any interest in se…
```

Split our dataset into a training and test parts.

[18]:
```python
trn_df, val_df = train_test_split(df, test_size = 0.1)
trn_df.head()
```

[18]:
```
                                               response  \
3687                                I can't tell anymore.
8079                                          Everything?
5760  Hu humm? i suppose we could go to Lincoln Cent…
772                                               Leslie.
8844                           God, you're like a rock star.

                                context  \
3687                      You don't know?
8079  Nonsense. You do everything wrong.
5760                           Not a wit.
772              Kramer, Kramer, Kramer..
8844                             Mm-hmm.

                                              context/0  \
3687                                        I think so.
8079                     Feel like I can't do anything wrong.
5760  I suppose I could just pull this out and walk …
772                                         About what?
8844                          And you threw it out the window?

                                              context/1  \
3687                                   So you like her?
8079                              Aw, come on there now.
5760                                That's right I don't.
772    George, don't even think about it! Don't even…
```

```
8844                          So Joe Mayo had the same coat.

                                                    context/2  \
3687                                                    Great.
8079                      Never thought I'd fail at failing.
5760     Of course not. You don't care what I look like.
772    Well, Leslie, sometimes the road less travelle…
8844                                              Oh. Uhhh…

                                                    context/3  \
3687                                              Is she nice?
8079                              How could they not fire you?
5760                                              It doesn't..
772    Jerry, what a surprise! I thought you sere out…
8844                         Hey, I got a coat just like this!

                                                    context/4  \
3687                                                    Karen.
8079   That he may be. But he's outta my life, starti…
5760    No…Why should that make any difference to you?
772    I can't believe you told Kramer it's okay to p…
8844                                                     What?

                                                context/5
3687                              So, what's her name?
8079             I gotta invite Jerry. He's my buddy.
5760                             Hey! Look , no shave.
772    The show was cancelled. There was a blizzard.
8844                  All right, let's hit the bricks.
```

Now will convert our dataset in a format suitable for our model. Basically we will concatenate responses in one string for each row (additionally we will add special 'end of string' token between responses, so the model will understand end of each response in a string).

[19]:
```python
def construct_conv(row, tokenizer, eos = True):
    flatten = lambda l: [item for sublist in l for item in sublist]
    conv = list(reversed([tokenizer.encode(x) + [tokenizer.eos_token_id] for x␣
 ↪in row]))
    conv = flatten(conv)
    return conv

class ConversationDataset(Dataset):
    def __init__(self, tokenizer: PreTrainedTokenizer, args, df,␣
 ↪block_size=512):
        block_size = block_size - (tokenizer.model_max_length - tokenizer.
 ↪max_len_single_sentence)
```

```
        #block_size = block_size - (tokenizer.max_len - tokenizer.
↪max_len_single_sentence)

        directory = args.cache_dir
        cached_features_file = os.path.join(
            directory, args.model_type + "_cached_lm_" + str(block_size)
        )

        if os.path.exists(cached_features_file) and not args.overwrite_cache:
            logger.info("Loading features from cached file %s",␣
↪cached_features_file)
            with open(cached_features_file, "rb") as handle:
                self.examples = pickle.load(handle)
        else:
            logger.info("Creating features from dataset file at %s", directory)

            self.examples = []
            for _, row in df.iterrows():
                conv = construct_conv(row, tokenizer)
                self.examples.append(conv)

            logger.info("Saving features into cached file %s",␣
↪cached_features_file)
            with open(cached_features_file, "wb") as handle:
                pickle.dump(self.examples, handle, protocol=pickle.
↪HIGHEST_PROTOCOL)

    def __len__(self):
        return len(self.examples)

    def __getitem__(self, item):
        return torch.tensor(self.examples[item], dtype=torch.long)
```

[20]:
```
# Cacheing and storing of data/checkpoints

def load_and_cache_examples(args, tokenizer, df_trn, df_val, evaluate=False):
    return ConversationDataset(tokenizer, args, df_val if evaluate else df_trn)


def set_seed(args):
    random.seed(args.seed)
    np.random.seed(args.seed)
    torch.manual_seed(args.seed)
    if args.n_gpu > 0:
        torch.cuda.manual_seed_all(args.seed)
```

```
def _sorted_checkpoints(args, checkpoint_prefix="checkpoint", use_mtime=False)␣
↪-> List[str]:
    ordering_and_checkpoint_path = []

    glob_checkpoints = glob.glob(os.path.join(args.output_dir, "{}-*".
↪format(checkpoint_prefix)))

    for path in glob_checkpoints:
        if use_mtime:
            ordering_and_checkpoint_path.append((os.path.getmtime(path), path))
        else:
            regex_match = re.match(".*{}-([0-9]+)".format(checkpoint_prefix),␣
↪path)
            if regex_match and regex_match.groups():
                ordering_and_checkpoint_path.append((int(regex_match.
↪groups()[0]), path))

    checkpoints_sorted = sorted(ordering_and_checkpoint_path)
    checkpoints_sorted = [checkpoint[1] for checkpoint in checkpoints_sorted]
    return checkpoints_sorted


def _rotate_checkpoints(args, checkpoint_prefix="checkpoint", use_mtime=False)␣
↪-> None:
    if not args.save_total_limit:
        return
    if args.save_total_limit <= 0:
        return

    # Check if we should delete older checkpoint(s)
    checkpoints_sorted = _sorted_checkpoints(args, checkpoint_prefix, use_mtime)
    if len(checkpoints_sorted) <= args.save_total_limit:
        return

    number_of_checkpoints_to_delete = max(0, len(checkpoints_sorted) - args.
↪save_total_limit)
    checkpoints_to_be_deleted = checkpoints_sorted[:
↪number_of_checkpoints_to_delete]
    for checkpoint in checkpoints_to_be_deleted:
        logger.info("Deleting older checkpoint [{}] due to args.
↪save_total_limit".format(checkpoint))
        shutil.rmtree(checkpoint)
```

0.5 Training and Evaluating

There will be quite a lot of code needed for training our model but don't worry, everything should work as is, the main thing is to give the model the dataset in the right format.

```
[21]: def train(args, train_dataset, model: PreTrainedModel, tokenizer:␣
      ↪PreTrainedTokenizer) -> Tuple[int, float]:
          """ Train the model """
          if args.local_rank in [-1, 0]:
              tb_writer = SummaryWriter()

          args.train_batch_size = args.per_gpu_train_batch_size * max(1, args.n_gpu)

          def collate(examples: List[torch.Tensor]):
              if tokenizer._pad_token is None:
                  return pad_sequence(examples, batch_first=True)
              return pad_sequence(examples, batch_first=True, padding_value=tokenizer.
      ↪pad_token_id)

          train_sampler = RandomSampler(train_dataset) if args.local_rank == -1 else␣
      ↪DistributedSampler(train_dataset)
          train_dataloader = DataLoader(
              train_dataset, sampler=train_sampler, batch_size=args.train_batch_size,␣
      ↪collate_fn=collate, drop_last = True
          )

          if args.max_steps > 0:
              t_total = args.max_steps
              args.num_train_epochs = args.max_steps // (len(train_dataloader) //␣
      ↪args.gradient_accumulation_steps) + 1
          else:
              t_total = len(train_dataloader) // args.gradient_accumulation_steps *␣
      ↪args.num_train_epochs

          model = model.module if hasattr(model, "module") else model  # Take care of␣
      ↪distributed/parallel training
          model.resize_token_embeddings(len(tokenizer))
          # add_special_tokens_(model, tokenizer)


          # Prepare optimizer and schedule (linear warmup and decay)
          no_decay = ["bias", "LayerNorm.weight"]
          optimizer_grouped_parameters = [
              {
                  "params": [p for n, p in model.named_parameters() if not any(nd in␣
      ↪n for nd in no_decay)],
                  "weight_decay": args.weight_decay,
              },
              {"params": [p for n, p in model.named_parameters() if any(nd in n for␣
      ↪nd in no_decay)], "weight_decay": 0.0},
          ]
```

```
    optimizer = optim.AdamW(optimizer_grouped_parameters, lr=args.
↪learning_rate, eps=args.adam_epsilon)
    scheduler = get_linear_schedule_with_warmup(
        optimizer, num_warmup_steps=args.warmup_steps,␣
↪num_training_steps=t_total
    )

    # Check if saved optimizer or scheduler states exist
    if (
        args.model_name_or_path
        and os.path.isfile(os.path.join(args.model_name_or_path, "optimizer.
↪pt"))
        and os.path.isfile(os.path.join(args.model_name_or_path, "scheduler.
↪pt"))
    ):
        # Load in optimizer and scheduler states
        optimizer.load_state_dict(torch.load(os.path.join(args.
↪model_name_or_path, "optimizer.pt")))
        scheduler.load_state_dict(torch.load(os.path.join(args.
↪model_name_or_path, "scheduler.pt")))

    if args.fp16:
        try:
            from apex import amp
        except ImportError:
            raise ImportError("Please install apex from https://www.github.com/
↪nvidia/apex to use fp16 training.")
        model, optimizer = amp.initialize(model, optimizer, opt_level=args.
↪fp16_opt_level)

    # multi-gpu training (should be after apex fp16 initialization)
    if args.n_gpu > 1:
        model = torch.nn.DataParallel(model)

    # Distributed training (should be after apex fp16 initialization)
    if args.local_rank != -1:
        model = torch.nn.parallel.DistributedDataParallel(
            model, device_ids=[args.local_rank], output_device=args.local_rank,␣
↪find_unused_parameters=True
        )

    # Train!
    logger.info("***** Running training *****")
    logger.info("  Num examples = %d", len(train_dataset))
    logger.info("  Num Epochs = %d", args.num_train_epochs)
    logger.info("  Instantaneous batch size per GPU = %d", args.
↪per_gpu_train_batch_size)
    logger.info(
        "  Total train batch size (w. parallel, distributed & accumulation) =␣
↪%d",
        args.train_batch_size
        * args.gradient_accumulation_steps
        * (torch.distributed.get_world_size() if args.local_rank != -1 else 1),
    )
    logger.info("  Gradient Accumulation steps = %d", args.
↪gradient_accumulation_steps)
    logger.info("  Total optimization steps = %d", t_total)

    global_step = 0
    epochs_trained = 0
    steps_trained_in_current_epoch = 0
    # Check if continuing training from a checkpoint
    if args.model_name_or_path and os.path.exists(args.model_name_or_path):
        try:
            # set global_step to gobal_step of last saved checkpoint from model␣
↪path
            checkpoint_suffix = args.model_name_or_path.split("-")[-1].split("/
↪")[0]
            global_step = int(checkpoint_suffix)
            epochs_trained = global_step // (len(train_dataloader) // args.
↪gradient_accumulation_steps)
            steps_trained_in_current_epoch = global_step %␣
↪(len(train_dataloader) // args.gradient_accumulation_steps)

            logger.info("  Continuing training from checkpoint, will skip to␣
↪saved global_step")
            logger.info("  Continuing training from epoch %d", epochs_trained)
            logger.info("  Continuing training from global step %d",␣
↪global_step)
            logger.info("  Will skip the first %d steps in the first epoch",␣
↪steps_trained_in_current_epoch)
        except ValueError:
            logger.info("  Starting fine-tuning.")

    tr_loss, logging_loss = 0.0, 0.0

    model.zero_grad()
    train_iterator = trange(
        epochs_trained, int(args.num_train_epochs), desc="Epoch", disable=args.
↪local_rank not in [-1, 0]
    )
    set_seed(args)  # Added here for reproducibility
    for _ in train_iterator:
        epoch_iterator = tqdm(train_dataloader, desc="Iteration", disable=args.
↪local_rank not in [-1, 0])
        for step, batch in enumerate(epoch_iterator):

            # Skip past any already trained steps if resuming training
            if steps_trained_in_current_epoch > 0:
                steps_trained_in_current_epoch -= 1
                continue

            inputs, labels = (batch, batch)
            if inputs.shape[1] > 1024: continue
            inputs = inputs.to(args.device)
            labels = labels.to(args.device)
            model.train()
            outputs = model(inputs, labels=labels)
            loss = outputs[0]  # model outputs are always tuple in transformers␣
↪(see doc)

            if args.n_gpu > 1:
                loss = loss.mean()  # mean() to average on multi-gpu parallel␣
↪training
            if args.gradient_accumulation_steps > 1:
                loss = loss / args.gradient_accumulation_steps

            if args.fp16:
                with amp.scale_loss(loss, optimizer) as scaled_loss:
                    scaled_loss.backward()
            else:
                loss.backward()

            tr_loss += loss.item()
            if (step + 1) % args.gradient_accumulation_steps == 0:
                if args.fp16:
                    torch.nn.utils.clip_grad_norm_(amp.
↪master_params(optimizer), args.max_grad_norm)
                else:
                    torch.nn.utils.clip_grad_norm_(model.parameters(), args.
↪max_grad_norm)
                optimizer.step()
                scheduler.step()  # Update learning rate schedule
                model.zero_grad()
                global_step += 1

                if args.local_rank in [-1, 0] and args.logging_steps > 0 and␣
↪global_step % args.logging_steps == 0:
```

```
                    # Log metrics
                    if (
                        args.local_rank == -1 and args.evaluate_during_training
                    ):  # Only evaluate when single GPU otherwise metrics may␣
↪not average well
                        results = evaluate(args, model, tokenizer)
                        for key, value in results.items():
                            tb_writer.add_scalar("eval_{}".format(key), value,␣
↪global_step)
                    tb_writer.add_scalar("lr", scheduler.get_last_lr()[0],␣
↪global_step)
                    #tb_writer.add_scalar("lr", scheduler.get_lr()[0],␣
↪global_step)
                    tb_writer.add_scalar("loss", (tr_loss - logging_loss) /␣
↪args.logging_steps, global_step)
                    logging_loss = tr_loss

                if args.local_rank in [-1, 0] and args.save_steps > 0 and␣
↪global_step % args.save_steps == 0:
                    checkpoint_prefix = "checkpoint"
                    # Save model checkpoint
                    output_dir = os.path.join(args.output_dir, "{}-{}".
↪format(checkpoint_prefix, global_step))
                    os.makedirs(output_dir, exist_ok=True)
                    model_to_save = (
                        model.module if hasattr(model, "module") else model
                    )  # Take care of distributed/parallel training
                    model_to_save.save_pretrained(output_dir)
                    tokenizer.save_pretrained(output_dir)

                    torch.save(args, os.path.join(output_dir, "training_args.
↪bin"))
                    logger.info("Saving model checkpoint to %s", output_dir)

                    _rotate_checkpoints(args, checkpoint_prefix)

                    torch.save(optimizer.state_dict(), os.path.join(output_dir,␣
↪"optimizer.pt"))
                    torch.save(scheduler.state_dict(), os.path.join(output_dir,␣
↪"scheduler.pt"))
                    logger.info("Saving optimizer and scheduler states to %s",␣
↪output_dir)

            if args.max_steps > 0 and global_step > args.max_steps:
                epoch_iterator.close()
                break
```

```
        if args.max_steps > 0 and global_step > args.max_steps:
            train_iterator.close()
            break

    if args.local_rank in [-1, 0]:
        tb_writer.close()

    plt.plot(tr_loss/global_step)

    return global_step, tr_loss / global_step

# Evaluation of some model

def evaluate(args, model: PreTrainedModel, tokenizer: PreTrainedTokenizer,␣
 ↪df_trn, df_val, prefix="") -> Dict:
    # Loop to handle MNLI double evaluation (matched, mis-matched)
    eval_output_dir = args.output_dir

    eval_dataset = load_and_cache_examples(args, tokenizer, df_trn, df_val,␣
 ↪evaluate=True)
    os.makedirs(eval_output_dir, exist_ok=True)
    args.eval_batch_size = args.per_gpu_eval_batch_size * max(1, args.n_gpu)
    # Note that DistributedSampler samples randomly

    def collate(examples: List[torch.Tensor]):
        if tokenizer._pad_token is None:
            return pad_sequence(examples, batch_first=True)
        return pad_sequence(examples, batch_first=True, padding_value=tokenizer.
 ↪pad_token_id)

    eval_sampler = SequentialSampler(eval_dataset)
    eval_dataloader = DataLoader(
        eval_dataset, sampler=eval_sampler, batch_size=args.eval_batch_size,␣
 ↪collate_fn=collate, drop_last = True
    )

    # multi-gpu evaluate
    if args.n_gpu > 1:
        model = torch.nn.DataParallel(model)

    # Eval!
    logger.info("***** Running evaluation {} *****".format(prefix))
    logger.info("  Num examples = %d", len(eval_dataset))
    logger.info("  Batch size = %d", args.eval_batch_size)
    eval_loss = 0.0
    nb_eval_steps = 0
    model.eval()
    for batch in tqdm(eval_dataloader, desc="Evaluating"):
        inputs, labels = (batch, batch)
        inputs = inputs.to(args.device)
        labels = labels.to(args.device)

        with torch.no_grad():
            outputs = model(inputs, labels=labels)
            lm_loss = outputs[0]
            eval_loss += lm_loss.mean().item()
        nb_eval_steps += 1

    eval_loss = eval_loss / nb_eval_steps
    perplexity = torch.exp(torch.tensor(eval_loss))

    result = {"perplexity": perplexity}

    output_eval_file = os.path.join(eval_output_dir, prefix, "eval_results.txt")
    with open(output_eval_file, "w") as writer:
        logger.info("***** Eval results {} *****".format(prefix))
        for key in sorted(result.keys()):
            logger.info("  %s = %s", key, str(result[key]))
            writer.write("%s = %s\n" % (key, str(result[key])))

    return result
```

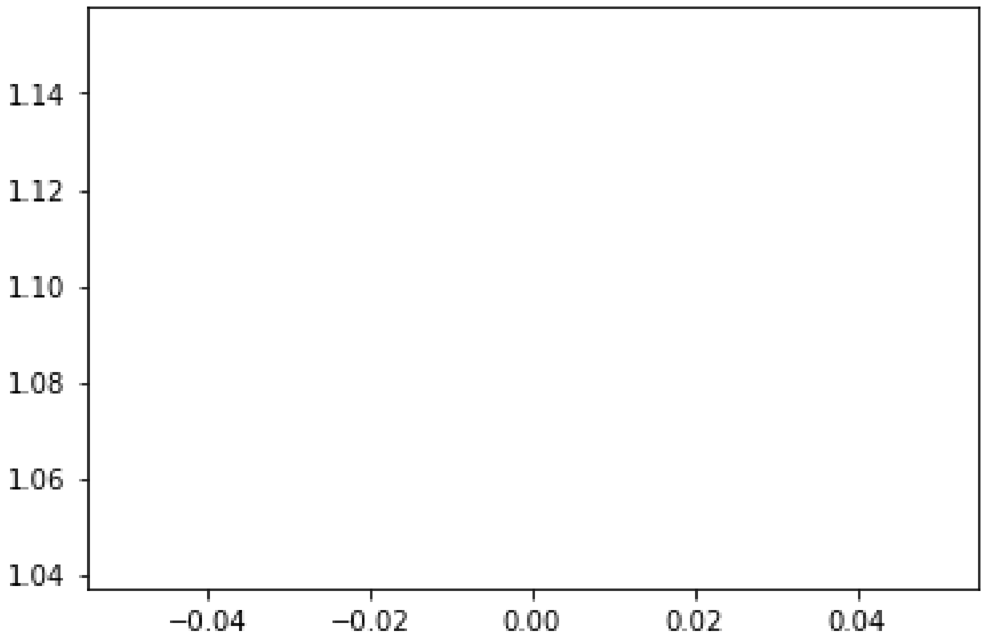
[22]:
```
# Main runner

def main(df_trn, df_val):
    args = Args()

    if args.should_continue:
        sorted_checkpoints = _sorted_checkpoints(args)
        if len(sorted_checkpoints) == 0:
            raise ValueError("Used --should_continue but no checkpoint was␣
 ↪found in --output_dir.")
        else:
            args.model_name_or_path = sorted_checkpoints[-1]

    if (
        os.path.exists(args.output_dir)
        and os.listdir(args.output_dir)
        and args.do_train
        and not args.overwrite_output_dir
        and not args.should_continue
    ):
        raise ValueError(
            "Output directory ({}) already exists and is not empty. Use␣
↪--overwrite_output_dir to overcome.".format(
                args.output_dir
            )
        )

    # Setup CUDA, GPU & distributed training
    device = torch.device("cuda")
    args.n_gpu = torch.cuda.device_count()
    args.device = device

    # Setup logging
    logging.basicConfig(
        format="%(asctime)s - %(levelname)s - %(name)s -   %(message)s",
        datefmt="%m/%d/%Y %H:%M:%S",
        level=logging.INFO if args.local_rank in [-1, 0] else logging.WARN,
    )
    logger.warning(
        "Process rank: %s, device: %s, n_gpu: %s, distributed training: %s,␣
↪16-bits training: %s",
        args.local_rank,
        device,
        args.n_gpu,
        bool(args.local_rank != -1),
        args.fp16,
    )

    # Set seed
    set_seed(args)

    config = AutoConfig.from_pretrained(args.config_name, cache_dir=args.
↪cache_dir)
    tokenizer = AutoTokenizer.from_pretrained(args.tokenizer_name,␣
↪cache_dir=args.cache_dir)
    model = AutoModelForCausalLM.from_pretrained(
        args.model_name_or_path,
        from_tf=False,
        config=config,
        cache_dir=args.cache_dir,
    )
    model.to(args.device)

    logger.info("Training/evaluation parameters %s", args)

    # Training
    if args.do_train:
        train_dataset = load_and_cache_examples(args, tokenizer, df_trn,␣
↪df_val, evaluate=False)

        global_step, tr_loss = train(args, train_dataset, model, tokenizer)
        logger.info(" global_step = %s, average loss = %s", global_step,␣
↪tr_loss)

    # Saving best-practices: if you use save_pretrained for the model and␣
↪tokenizer, you can reload them using from_pretrained()
    if args.do_train:
        # Create output directory if needed
        os.makedirs(args.output_dir, exist_ok=True)

        logger.info("Saving model checkpoint to %s", args.output_dir)
        # Save a trained model, configuration and tokenizer using␣
↪`save_pretrained()`.
        # They can then be reloaded using `from_pretrained()`
        model_to_save = (
            model.module if hasattr(model, "module") else model
        )  # Take care of distributed/parallel training
        model_to_save.save_pretrained(args.output_dir)
        tokenizer.save_pretrained(args.output_dir)

        # Good practice: save your training arguments together with the trained␣
↪model
        torch.save(args, os.path.join(args.output_dir, "training_args.bin"))

        # Load a trained model and vocabulary that you have fine-tuned
        model = AutoModelForCausalLM.from_pretrained(args.output_dir)
        tokenizer = AutoTokenizer.from_pretrained(args.output_dir)
        model.to(args.device)

    # Evaluation
    results = {}
    if args.do_eval and args.local_rank in [-1, 0]:
        checkpoints = [args.output_dir]
        if args.eval_all_checkpoints:
            checkpoints = list(
                os.path.dirname(c) for c in sorted(glob.glob(args.output_dir +␣
↪"/**/" + WEIGHTS_NAME, recursive=True))
            )
            logging.getLogger("transformers.modeling_utils").setLevel(logging.
↪WARN)  # Reduce logging
        logger.info("Evaluate the following checkpoints: %s", checkpoints)
        for checkpoint in checkpoints:
            global_step = checkpoint.split("-")[-1] if len(checkpoints) > 1␣
↪else ""
            prefix = checkpoint.split("/")[-1] if checkpoint.find("checkpoint")␣
↪!= -1 else ""

            model = AutoModelForCausalLM.from_pretrained(checkpoint)
            model.to(args.device)
            result = evaluate(args, model, tokenizer, df_trn, df_val,␣
↪prefix=prefix)
            result = dict((k + "_{}".format(global_step), v) for k, v in result.
↪items())
            results.update(result)

    return results
```

[23]:
```
main(trn_df, val_df)
```

```
08/24/2022 19:31:40 - WARNING - __main__ -   Process rank: -1, device: cuda,
n_gpu: 1, distributed training: False, 16-bits training: False
08/24/2022 19:31:47 - INFO - __main__ -   Training/evaluation parameters
<__main__.Args object at 0x7f17acc9f2e0>
08/24/2022 19:31:47 - INFO - __main__ -   Creating features from dataset file at
cached
08/24/2022 19:31:51 - INFO - __main__ -   Saving features into cached file
cached/gpt2_cached_lm_512
08/24/2022 19:31:51 - INFO - __main__ -   ***** Running training *****
08/24/2022 19:31:51 - INFO - __main__ -     Num examples = 8443
08/24/2022 19:31:51 - INFO - __main__ -     Num Epochs = 8
08/24/2022 19:31:51 - INFO - __main__ -     Instantaneous batch size per GPU = 4
08/24/2022 19:31:51 - INFO - __main__ -     Total train batch size (w. parallel,
distributed & accumulation) = 4
08/24/2022 19:31:51 - INFO - __main__ -     Gradient Accumulation steps = 1
08/24/2022 19:31:51 - INFO - __main__ -     Total optimization steps = 16880

Epoch:   0%|          | 0/8 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]

Iteration:   0%|          | 0/2110 [00:00<?, ?it/s]
```

```
08/24/2022 20:19:27 - INFO - __main__ -   Saving model checkpoint to
output_diablomedium/checkpoint-15000
08/24/2022 20:19:50 - INFO - __main__ -   Saving optimizer and scheduler states
to output_diablomedium/checkpoint-15000
08/24/2022 20:25:46 - INFO - __main__ -    global_step = 16880, average loss =
1.0974718067547862
08/24/2022 20:25:46 - INFO - __main__ -   Saving model checkpoint to
output_diablomedium
08/24/2022 20:26:00 - INFO - __main__ -   Evaluate the following checkpoints:
['output_diablomedium']
08/24/2022 20:26:03 - INFO - __main__ -   Creating features from dataset file at
cached
08/24/2022 20:26:03 - INFO - __main__ -   Saving features into cached file
cached/gpt2_cached_lm_512
08/24/2022 20:26:03 - INFO - __main__ -   ***** Running evaluation  *****
08/24/2022 20:26:03 - INFO - __main__ -     Num examples = 939
08/24/2022 20:26:03 - INFO - __main__ -     Batch size = 4

Evaluating:   0%|          | 0/234 [00:00<?, ?it/s]

08/24/2022 20:26:13 - INFO - __main__ -   ***** Eval results  *****
08/24/2022 20:26:13 - INFO - __main__ -     perplexity = tensor(2.6779)
```

```
[23]: {'perplexity_': tensor(2.6779)}
```



1 Chatting with the character!

The model is ready, so it's time to chat.

```
[25]: tokenizer = AutoTokenizer.from_pretrained("microsoft/DialoGPT-medium")
model = AutoModelForCausalLM.from_pretrained('output_diablomedium')

# Let's chat for 5 lines
for step in range(5):
    # encode the new user input, add the eos_token and return a tensor in␣
 ↪Pytorch
    new_user_input_ids = tokenizer.encode(input(">> User:") + tokenizer.
 ↪eos_token, return_tensors='pt')
    # print(new_user_input_ids)

    # append the new user input tokens to the chat history
    bot_input_ids = torch.cat([chat_history_ids, new_user_input_ids], dim=-1)␣
 ↪if step > 0 else new_user_input_ids

    # generated a response while limiting the total chat history to 1000␣
 ↪tokens,
    chat_history_ids = model.generate(
        bot_input_ids, max_length=200,
        pad_token_id=tokenizer.eos_token_id,
        no_repeat_ngram_size=3,
        do_sample=True,
        top_k=1000,
        top_p=0.7,
        num_beams=10,
        temperature = 0.9,
        #num_beams=5,
    )

    # pretty print last ouput tokens from bot
    print("SeinBot: {}".format(tokenizer.decode(chat_history_ids[:,␣
 ↪bot_input_ids.shape[-1]:][0], skip_special_tokens=True)))
```

```
>> User:Who are you?
SeinBot: I'm him.
>> User:What do you do for a living?
SeinBot: Im just a guy who loves watches.
>> User:What kind of watch is your favorite?
SeinBot: An alarm clock.
>> User:That's cool. Do you think Stacy will like the alarm clock you got her?
SeinBot: Oh yeah.
>> User:But she asked you for Broadway tickets. What are you going to tell her?
SeinBot: !!!,!!?!!.!!…!!..!!
```

[27]:
```
tokenizer = AutoTokenizer.from_pretrained("microsoft/DialoGPT-medium")
model = AutoModelForCausalLM.from_pretrained('output_diablomedium')

# Let's chat for 5 lines
for step in range(5):
    # encode the new user input, add the eos_token and return a tensor in␣
 ↪Pytorch
    new_user_input_ids = tokenizer.encode(input(">> User:") + tokenizer.
 ↪eos_token, return_tensors='pt')
    # print(new_user_input_ids)

    # append the new user input tokens to the chat history
    bot_input_ids = torch.cat([chat_history_ids, new_user_input_ids], dim=-1)␣
 ↪if step > 0 else new_user_input_ids

    # generated a response while limiting the total chat history to 1000␣
 ↪tokens,
    chat_history_ids = model.generate(
        bot_input_ids, max_length=200,
        pad_token_id=tokenizer.eos_token_id,
        no_repeat_ngram_size=3,
        do_sample=True,
        top_k=10000,
        temperature = 0.7,
    )

    # pretty print last ouput tokens from bot
    print("SeinBot: {}".format(tokenizer.decode(chat_history_ids[:,␣
 ↪bot_input_ids.shape[-1]:][0], skip_special_tokens=True)))
```

```
>> User:What is your name?
SeinBot: ..Alaines Costanza.
>> User:What do you do for a living?
SeinBot: I'm an architect.
>> User:What buildings have you designed?
SeinBot: Uh, the library, uh.
>> User:Oh wow, that's so cool. Which library was it?
SeinBot: !!! remindme 3 days
>> User:Tell me a joke
SeinBot: ! remind me 3 days!
```

[28]:
```
tokenizer = AutoTokenizer.from_pretrained("microsoft/DialoGPT-medium")
model = AutoModelForCausalLM.from_pretrained('output_diablomedium')

# Let's chat for 5 lines
for step in range(5):
    # encode the new user input, add the eos_token and return a tensor in␣
 ↪Pytorch
    new_user_input_ids = tokenizer.encode(input(">> User:") + tokenizer.
 ↪eos_token, return_tensors='pt')
    # print(new_user_input_ids)

    # append the new user input tokens to the chat history
    bot_input_ids = torch.cat([chat_history_ids, new_user_input_ids], dim=-1)␣
 ↪if step > 0 else new_user_input_ids

    # generated a response while limiting the total chat history to 1000␣
 ↪tokens,
    chat_history_ids = model.generate(
        bot_input_ids, max_length=200,
        pad_token_id=tokenizer.eos_token_id,
        no_repeat_ngram_size=3,
        do_sample=True,
        top_k=500,
        top_p=0.7,
        temperature = 0.9,
        #num_beams=5,
    )

    # pretty print last ouput tokens from bot
    print("SeinBot: {}".format(tokenizer.decode(chat_history_ids[:,␣
 ↪bot_input_ids.shape[-1]:][0], skip_special_tokens=True)))
```

```
>> User:Who are you?
SeinBot: I'm the guy who lives here.
>> User:What do you do for a living?
SeinBot: I sell bras.
>> User:Oh wow, that's an interesting job. Do you meet a lot of women at that
job?
SeinBot: Yeah, I've been going there for 10 years.
>> User:Are you seeing anyone now?
SeinBot: !!!?!!,!!
>> User:Tell me a joke
SeinBot: !?,!,,!
```

[31]:
```
tokenizer = AutoTokenizer.from_pretrained("microsoft/DialoGPT-medium")
model = AutoModelForCausalLM.from_pretrained('output_diablomedium')

# Let's chat for 5 lines
for step in range(5):
    # encode the new user input, add the eos_token and return a tensor in␣
 ↪Pytorch
```

```
    new_user_input_ids = tokenizer.encode(input(">> User:") + tokenizer.
↪eos_token, return_tensors='pt')
    # print(new_user_input_ids)

    # append the new user input tokens to the chat history
    bot_input_ids = torch.cat([chat_history_ids, new_user_input_ids], dim=-1)␣
↪if step > 0 else new_user_input_ids

    # generated a response while limiting the total chat history to 1000␣
↪tokens,
    chat_history_ids = model.generate(
        bot_input_ids, max_length=200,
        pad_token_id=tokenizer.eos_token_id,
        no_repeat_ngram_size=3,
        do_sample=True,
        top_k=10000,
        num_beams=15,
        temperature = 0.7,
    )

    # pretty print last ouput tokens from bot
    print("SeinBot: {}".format(tokenizer.decode(chat_history_ids[:,␣
↪bot_input_ids.shape[-1]:][0], skip_special_tokens=True)))
```

```
>> User:How is your day going George?
SeinBot: Actually, it's going pretty good.
>> User:Oh nice. Did you talk to Steinbrenner in the end?
SeinBot: Yeah, it was very nice.
>> User:Which trade proposal did he like?
SeinBot: The one about the car.
>> User:No did he like the Jeter or the O'neill trade?
SeinBot: I don't know.
>> User:So what did you talk about in the meeting?
SeinBot: !!!?!!,!!
```

[ ]:

[ ]:

[ ]: