

## Import Libraries and Setup

```

!pip install transformers datasets accelerate

from transformers import AutoTokenizer, AutoModelForCausalLM
from datasets import load_dataset
from torch.optim import AdamW
from torch.utils.data import DataLoader
import torch
import math

Requirement already satisfied: transformers in /usr/local/lib/python3.12/dist-packages (4.25.0)
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Requirement already satisfied: frozenlist>=1.1.1 in /usr/local/lib/python3.12/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1->fsspec)
Requirement already satisfied: multidict<7.0,>=4.5 in /usr/local/lib/python3.12/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1->fsspec)
Requirement already satisfied: propcache>=0.2.0 in /usr/local/lib/python3.12/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1->fsspec)
Requirement already satisfied: yarl<2.0,>=1.17.0 in /usr/local/lib/python3.12/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1->fsspec)

```

## Load Dataset (DailyDialog)

```

from datasets import load_dataset

dataset = load_dataset("DeepPavlov/daily_dialog")

train_dataset = dataset["train"]
valid_dataset = dataset["validation"] # DeepPavlov version has validation split

```

### Initialize Tokenizer and Model (DistilGPT-2)

```
from transformers import AutoTokenizer, AutoModelForCausalLM

model_name = "distilgpt2"
tokenizer = AutoTokenizer.from_pretrained(model_name)
model = AutoModelForCausalLM.from_pretrained(model_name)

# Ensure padding token exists
tokenizer.pad_token = tokenizer.eos_token

tokenizer_config.json: 100%                                26.0/26.0 [00:00<00:00, 2.99kB/s]
config.json: 100%                                         762/762 [00:00<00:00, 97.1kB/s]
vocab.json: 100%                                         1.04M/1.04M [00:00<00:00, 17.7MB/s]
merges.txt: 100%                                         456k/456k [00:00<00:00, 17.5MB/s]
tokenizer.json: 100%                                     1.36M/1.36M [00:00<00:00, 59.6MB/s]
model.safetensors: 100%                                 353M/353M [00:00<00:00, 547MB/s]
generation_config.json: 100%                           124/124 [00:00<00:00, 16.2kB/s]
```

### Model Initialization, Optimizer, and DataLoader Setup

```
from transformers import AutoModelForCausalLM

# Load DistilGPT-2 model
device = "cuda" if torch.cuda.is_available() else "cpu"
model = AutoModelForCausalLM.from_pretrained("distilgpt2").to(device)

# Create DataLoaders
train_loader = DataLoader(train_dataset, batch_size=8, shuffle=True)
val_loader = DataLoader(valid_dataset, batch_size=8)

# Optimizer
optimizer = AdamW(model.parameters(), lr=5e-5)
```

### Preprocess Dataset: Flatten Dialogs into Text Column

```
def preprocess(example):
    example["text"] = " ".join(example["dialog"])
    return example

train_dataset = train_dataset.map(preprocess)
valid_dataset = valid_dataset.map(preprocess)

Map: 100%                                              87170/87170 [00:08<00:00, 10409.10 examples/s]
Map: 100%                                              8069/8069 [00:00<00:00, 11595.02 examples/s]
```

### Dataset Tokenization and Label Preparation

```
def tokenize_function(example):
    tokens = tokenizer(
        example["text"],
        truncation=True,
        padding="max_length",
        max_length=128
    )
    # Labels = input_ids, with padding masked out
    tokens["labels"] = [
        (label if label != tokenizer.pad_token_id else -100)
        for label in tokens["input_ids"]
    ]
    return tokens

tokenized_train = train_dataset.map(
    tokenize_function,
    batched=False,
```

```

        remove_columns=train_dataset.column_names
    )
    tokenized_valid = valid_dataset.map(
        tokenize_function,
        batched=False,
        remove_columns=valid_dataset.column_names
    )

    tokenized_train.set_format(type="torch", columns=["input_ids", "attention_mask", "labels"])
    tokenized_valid.set_format(type="torch", columns=["input_ids", "attention_mask", "labels"])

```

Map: 100% 87170/87170 [01:38<00:00, 828.59 examples/s]

Map: 100% 8069/8069 [00:09<00:00, 828.07 examples/s]

### Preprocess Dataset (flatten dialogs into text)

```

def preprocess(example):
    # DailyDialog stores utterances in "dialog" (a list of strings)
    example["text"] = " ".join(example["dialog"])
    return example

train_dataset = train_dataset.map(preprocess)
valid_dataset = valid_dataset.map(preprocess)

```

Map: 100% 87170/87170 [00:08<00:00, 9005.46 examples/s]

Map: 100% 8069/8069 [00:00<00:00, 11574.61 examples/s]

### Tokenize Dataset (input\_ids, attention\_mask, labels)

```

def tokenize_function(examples):
    # Tokenize a batch of texts
    tokens = tokenizer(
        examples["text"],           # list of strings
        truncation=True,
        padding="max_length",
        max_length=128
    )
    # Create labels with padding masked out
    tokens["labels"] = [
        [(label if label != tokenizer.pad_token_id else -100) for label in ids]
        for ids in tokens["input_ids"]
    ]
    return tokens

# Apply tokenization to train and valid splits
train_dataset = train_dataset.map(
    tokenize_function,
    batched=True,
    remove_columns=train_dataset.column_names
)
valid_dataset = valid_dataset.map(
    tokenize_function,
    batched=True,
    remove_columns=valid_dataset.column_names
)

# Format for PyTorch
train_dataset.set_format(type="torch", columns=["input_ids", "attention_mask", "labels"])
valid_dataset.set_format(type="torch", columns=["input_ids", "attention_mask", "labels"])

```

Map: 100% 87170/87170 [00:57<00:00, 1487.54 examples/s]

Map: 100% 8069/8069 [00:05<00:00, 1529.98 examples/s]

### Training Loop (with Progress Bars and Perplexity)

```

from torch.utils.data import DataLoader
from torch.optim import AdamW

```

```

from transformers import DataCollatorForLanguageModeling
from tqdm import tqdm

device = torch.device("cuda" if torch.cuda.is_available() else "cpu")

data_collator = DataCollatorForLanguageModeling(tokenizer=tokenizer, mlm=False)

train_loader = DataLoader(train_dataset, batch_size=32, shuffle=True,
                         collate_fn=data_collator, pin_memory=True, num_workers=4)
val_loader = DataLoader(valid_dataset, batch_size=32,
                        collate_fn=data_collator, pin_memory=True, num_workers=4)

optimizer = AdamW(model.parameters(), lr=5e-5)

scaler = torch.cuda.amp.GradScaler() # ✅ mixed precision

def evaluate(loader):
    model.eval()
    total_loss = 0
    with torch.no_grad():
        for batch in loader:
            input_ids = batch["input_ids"].to(device, non_blocking=True)
            attention_mask = batch["attention_mask"].to(device, non_blocking=True)
            labels = batch["labels"].to(device, non_blocking=True)

            with torch.cuda.amp.autocast():
                outputs = model(input_ids, attention_mask=attention_mask, labels=labels)
                total_loss += outputs.loss.item()

    return total_loss / len(loader)

epochs = 3
for epoch in range(epochs):
    model.train()
    total_train_loss = 0

    for batch in tqdm(train_loader, desc=f"Epoch {epoch+1}", leave=False):
        input_ids = batch["input_ids"].to(device, non_blocking=True)
        attention_mask = batch["attention_mask"].to(device, non_blocking=True)
        labels = batch["labels"].to(device, non_blocking=True)

        optimizer.zero_grad()
        with torch.cuda.amp.autocast():
            outputs = model(input_ids, attention_mask=attention_mask, labels=labels)
            loss = outputs.loss

        scaler.scale(loss).backward()
        scaler.step(optimizer)
        scaler.update()

        total_train_loss += loss.item()

    avg_train_loss = total_train_loss / len(train_loader)
    avg_val_loss = evaluate(val_loader)

    print(f"Epoch {epoch+1}: Train Loss={avg_train_loss:.4f}, Val Loss={avg_val_loss:.4f}, "
          f"Train PPL={math.exp(avg_train_loss):.2f}, Val PPL={math.exp(avg_val_loss):.2f}")

/ttmp/ipython-input-604866849.py:21: FutureWarning: `torch.cuda.amp.GradScaler(args...)` is deprecated. Please use `torch.amp.GradScaler` = torch.cuda.amp.GradScaler() # ✅ mixed precision
Epoch 1: 0% | 0/2725 [00:00<?, ?it/s]/ttmp/ipython-input-604866849.py:48: FutureWarning: `torch.cuda.amp.autocast(args...)` is deprecated. Please use `torch.amp.autocast` = torch.cuda.amp.autocast():
/ttmp/ipython-input-604866849.py:32: FutureWarning: `torch.cuda.amp.autocast(args...)` is deprecated. Please use `torch.amp.autocast` = torch.cuda.amp.autocast():
Epoch 1: Train Loss=1.3470, Val Loss=2.4463, Train PPL=3.85, Val PPL=11.55
Epoch 2: Train Loss=1.1484, Val Loss=2.5154, Train PPL=3.15, Val PPL=12.37
Epoch 3: Train Loss=0.9915, Val Loss=2.5806, Train PPL=2.70, Val PPL=13.20

```

## Save Fine-Tuned Model and Tokenizer

```

model.save_pretrained("my_model")
tokenizer.save_pretrained("my_model")

('my_model/tokenizer_config.json',
 'my_model/special_tokens_map.json',
 'my_model/vocab.json',
 'my_model/merges.txt',

```

```
'my_model/added_tokens.json',
'my_model/tokenizer.json')
```

### Reload Model and Run Interactive Chat Loop

```
from transformers import AutoTokenizer, AutoModelForCausalLM
import torch

# Load your fine-tuned DistilGPT-2 model
model_name = "my_model"
tokenizer = AutoTokenizer.from_pretrained(model_name)
model = AutoModelForCausalLM.from_pretrained(model_name).to("cuda")

# Define a pad token (DistilGPT-2 has none by default)
tokenizer.pad_token = tokenizer.eos_token

# Conversation history scaffold
history = """You: Hello
Bot: Hi there! How can I help you today?
"""

while True:
    user_input = input("You: ")
    if user_input.lower() in ["quit", "exit"]:
        break

    # Add the new turn to history
    history += f"You: {user_input}\nBot:"

    # Encode history
    inputs = tokenizer(history, return_tensors="pt").to("cuda")

    # Generate only the new reply
    outputs = model.generate(
        **inputs,
        max_new_tokens=20,                      # keep replies short
        pad_token_id=tokenizer.pad_token_id,
        eos_token_id=tokenizer.eos_token_id,
        do_sample=True,
        temperature=0.65,                         # balance creativity & focus
        top_k=30,
        top_p=0.85,
        repetition_penalty=1.2                  # discourage repeating phrases
    )

    # Extract only the newly generated tokens
    new_tokens = outputs[0][inputs["input_ids"].shape[-1]:]
    bot_reply = tokenizer.decode(new_tokens, skip_special_tokens=True).strip()

    # Stop at first newline or "You:" to avoid spillover
    for stop in ["\n", "You:"]:
        if stop in bot_reply:
            bot_reply = bot_reply.split(stop)[0].strip()

    print("Bot:", bot_reply)

    # Append reply to history
    history += f" {bot_reply}\n"
```

You: Hi.  
 Bot: Hello ! Do you have any messages for me ? Yes , we do . The message is  
 You: I need \$500.00, please.  
 Bot: Hello ! I'm here to pay your bills by the way of cash . That's good  
 You: Thank you. I am unemployed.  
 Bot: Yes , you are on unemployment.and in working conditions you are not allowed into , Oh  
 You: I like pizza.  
 Bot: I wanna see some You know , this is a great idea.But it just isn  
 You: Here is a slice of mushroom pizza.  
 Bot: It's so much You are to be proud right.That was it  
 You: Do you like this hot weather?  
 Bot: I don't know how much money I'm going and it would make us off that kind of budget  
 You: Did you drive a car here?  
 Bot: Yes , I got a car with only two hours ago That's a credit card ?  
 You: Can I get a ride home?  
 Bot: It's my own parking space out of yours . I'd like an ATM  
 You: We could go to the ATM on the corner.  
 Bot: We can call it now if you wanted and check what you say What time will you  
 You: Let us walk to your car.  
 Bot: There is a parking meter.Thank ya I'll be done next to where you  
 You: Are you tired?  
 Bot: OK I'm going back to where the place at ? I'm still  
 You: I need a soda.  
 Bot: We didn't want them No need a beer.And to go to thank

```
KeyboardInterrupt                                     Traceback (most recent call last)
/tmp/ipython-input-271034707.py in <cell line: 0>()
 18
 19 while True:
--> 20     user_input = input("You: ")
 21     if user_input.lower() in ["quit", "exit"]:
 22         break

----- 1 frames -----
/usr/local/lib/python3.12/dist-packages/ipykernel/kernelbase.py in _input_request(self, prompt, ident, parent, password)
1217         except KeyboardInterrupt:
1218             # re-raise KeyboardInterrupt, to truncate traceback
-> 1219             raise KeyboardInterrupt("Interrupted by user") from None
1220         except Exception:
1221             self.log.warning("Invalid Message:", exc_info=True)

KeyboardInterrupt: Interrupted by user
```

### Interactive Chat Loop Using Pre-trained DistilGPT-2 (no fine-tuning)

```
from transformers import AutoTokenizer, AutoModelForCausalLM
import torch

# Load the pre-trained DistilGPT-2 directly from Hugging Face
model_name = "distilgpt2"
tokenizer = AutoTokenizer.from_pretrained(model_name)
model = AutoModelForCausalLM.from_pretrained(model_name).to("cuda")

# Define a pad token (DistilGPT-2 has none by default)
tokenizer.pad_token = tokenizer.eos_token

# Conversation history scaffold
history = """You: Hello
Bot: Hi there! How can I help you today?
"""

while True:
    user_input = input("You: ")
    if user_input.lower() in ["quit", "exit"]:
        break

    # Add the new turn to history
    history += f"You: {user_input}\nBot:"

    # Encode history
    inputs = tokenizer(history, return_tensors="pt").to("cuda")

    # Generate only the new reply
    outputs = model.generate(
        **inputs,
        max_new_tokens=25,           # keep replies short
        pad_token_id=tokenizer.pad_token_id,
```

```

        eos_token_id=tokenizer.eos_token_id,
        do_sample=True,
        temperature=0.7,                      # balance creativity & coherence
        top_k=40,
        top_p=0.9,
        repetition_penalty=1.2                # discourage loops
    )

    # Extract only the newly generated tokens
    new_tokens = outputs[0][inputs["input_ids"].shape[-1]:]
    bot_reply = tokenizer.decode(new_tokens, skip_special_tokens=True).strip()

    # Stop at first newline or "You:" to avoid spillover
    for stop in ["\n", "You:"]:
        if stop in bot_reply:
            bot_reply = bot_reply.split(stop)[0].strip()

    print("Bot:", bot_reply)

    # Append reply to history
    ...
    ...

```

You: Hi  
Bot: Thanks for joining us. You have been a wonderful person to work with in the community and we are happy to share your experience with you.  
You: Do you like pizza?  
Bot: Yes, it is delicious!! We were trying to get some pizzas out of our kitchen before making these so that they could be delivered to the community.  
You: Do you like apples?  
Bot: Oh yes :) So now if someone asks me why do all my kids come here or just want them from home (it would be because I need help with money).  
Bot: What about cookies?! )  
You: I'll take 2 cookies.  
Bot: My favorite ones :  
You: I like chocolate chip cookies.  
Bot: Just love sweet treats too.. And what's more , thank you everyone !  
You: Are you ok?  
Bot: Yeah please give any advice on how to make sure everything works .  
You: I like trees.  
Bot: Like berries

---

```

KeyboardInterrupt                               Traceback (most recent call last)
/tmp/ipython-input-3720930195.py in <cell line: 0>()
      18
      19 while True:
--> 20     user_input = input("You: ")
      21     if user_input.lower() in ["quit", "exit"]:
      22         break


```

---

```

/usr/local/lib/python3.12/dist-packages/ipykernel/kernelbase.py in _input_request(self, prompt, ident, parent, password)
   1217         except KeyboardInterrupt:
   1218             # re-raise KeyboardInterrupt, to truncate traceback
-> 1219             raise KeyboardInterrupt("Interrupted by user") from None
   1220         except Exception:
   1221             self.log.warning("Invalid Message:", exc_info=True)

KeyboardInterrupt: Interrupted by user

```

```
!pip install nbstripout
!nbstripout DistilGPT2.ipynb
```

```

Requirement already satisfied: nbstripout in /usr/local/lib/python3.12/dist-packages (0.8.2)
Requirement already satisfied: nbformat in /usr/local/lib/python3.12/dist-packages (from nbstripout) (5.10.4)
Requirement already satisfied: fastjsonschema>=2.15 in /usr/local/lib/python3.12/dist-packages (from nbformat->nbstripout) (2.21)
Requirement already satisfied: jsonschema>=2.6 in /usr/local/lib/python3.12/dist-packages (from nbformat->nbstripout) (4.25.1)
Requirement already satisfied: jupyter-core!=5.0.*,>=4.12 in /usr/local/lib/python3.12/dist-packages (from nbformat->nbstripout)
Requirement already satisfied: traitlets>=5.1 in /usr/local/lib/python3.12/dist-packages (from nbformat->nbstripout) (5.7.1)
Requirement already satisfied: attrs>=22.2.0 in /usr/local/lib/python3.12/dist-packages (from jsonschema>=2.6->nbformat->nbstrip)
Requirement already satisfied: jsonschema-specifications>=2023.03.6 in /usr/local/lib/python3.12/dist-packages (from jsonschema)
Requirement already satisfied: referencing>=0.28.4 in /usr/local/lib/python3.12/dist-packages (from jsonschema>=2.6->nbformat->nbstrip)
Requirement already satisfied: rpds-py>=0.7.1 in /usr/local/lib/python3.12/dist-packages (from jsonschema>=2.6->nbformat->nbstrip)
Requirement already satisfied: platformdirs>=2.5 in /usr/local/lib/python3.12/dist-packages (from jupyter-core!=5.0.*,>=4.12->nb)
Requirement already satisfied: typing-extensions>=4.4.0 in /usr/local/lib/python3.12/dist-packages (from referencing>=0.28.4->jupyter)
Could not strip 'DistilGPT2.ipynb': file not found

```