```
import pandas as pd
import torch
import torch.nn as nn
from torch.utils.data import Dataset, DataLoader, random_split
from transformers import DistilBertModel, DistilBertTokenizerFast
from torch.utils.data import DataLoader
from transformers import AdamW
```

Preparing dataset

```
!wget https://raw.githubusercontent.com/kyuz0/llm-
chronicles/main/datasets/restaurant_reviews.csv
```

```
--2024-11-13 09:35:33--  https://raw.githubusercontent.com/kyuz0/llm-
chronicles/main/datasets/restaurant_reviews.csv
Resolving raw.githubusercontent.com (raw.githubusercontent.com)...
185.199.108.133, 185.199.109.133, 185.199.110.133, ...
Connecting to raw.githubusercontent.com (raw.githubusercontent.com)|
185.199.108.133|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2861025 (2.7M) [text/plain]
Saving to: ‘restaurant_reviews.csv’

restaurant_reviews. 100%[===================>]   2.73M  --.-KB/s    in
0.05s

2024-11-13 09:35:34 (54.0 MB/s) - ‘restaurant_reviews.csv’ saved
[2861025/2861025]
```

```
# Load the dataset
df = pd.read_csv('restaurant_reviews.csv')


# Map sentiments to numerical labels
sentiment_mapping = {'negative': 0, 'neutral': 1, 'positive': 2}
df['Rating'] = df['Rating'].map(sentiment_mapping)

df.head()
```


```
{"summary":"{\n  \"name\": \"df\",\n  \"rows\": 9951,\n  \"fields\":
[\n    {\n      \"column\": \"Review\",\n      \"properties\": {\n
\"dtype\": \"string\",\n        \"num_unique_values\": 9357,\n
\"samples\": [\n          \"Loved the food here. I felt that the
ambience can be improved and that extra spice can be added with some
more colours. Felt a bit bland. However the food made up for it.\",\n
\"Too good..food taste is really awesome...taste was really
awesome...Amit..one of the cooks was really nice..really enjoyed..went
to celebrate 11 years of togetherness..thanks Marriott..will come
again\",\n          \"Ordered egg biryani for delivery...packing is
```

```
good...taste is good...biryani quantity is sufficient for one
person...but given only one egg...would have been better if given one
more...\"\n        ],\n        \"semantic_type\": \"\",\n
\"description\": \"\"\n      }\n    },\n    {\n      \"column\":
\"Rating\",\n      \"properties\": {\n        \"dtype\": \"number\",\n
\"std\": 0,\n        \"min\": 0,\n        \"max\": 2,\n
\"num_unique_values\": 3,\n        \"samples\": [\n          2,\n
0,\n          1\n        ],\n        \"semantic_type\": \"\",\n
\"description\": \"\"\n      }\n    }\n  ]\
n}","type":"dataframe","variable_name":"df"}

# Display the first few rows of the dataframe
print(df.head())

# Display statistics about the dataset
print("\nDataset Statistics:")
print(df['Rating'].value_counts())
```

```
                                              Review  Rating
0  The ambience was good food was quite good . ha...       2
1  Ambience is too good for a pleasant evening. S...       2
2  A must try.. great food great ambience. Thnx f...       2
3  Soumen das and Arun was a great guy. Only beca...       2
4  Food is good.we ordered Kodi drumsticks and ba...       2

Dataset Statistics:
Rating
2    6331
0    2428
1    1192
Name: count, dtype: int64
```

PyTorch Dataset and Dataloader

```
class ReviewDataset(Dataset):
    def __init__(self, csv_file, tokenizer, max_length):
        self.dataset = pd.read_csv(csv_file)
        self.tokenizer = tokenizer
        self.max_length = max_length
        # Map sentiments to numerical labels
        self.label_dict = {'negative': 0, 'neutral': 1, 'positive': 2}

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

    def __getitem__(self, idx):
        review_text = self.dataset.iloc[idx, 0]  # Assuming reviewText
is the first column
        sentiment = self.dataset.iloc[idx, 1]  # Assuming sentiment is
the second column
```

```
        labels = self.label_dict[sentiment]  # Convert sentiment to
numerical label

        # Tokenize the review text
        encoding = self.tokenizer.encode_plus(
          review_text,
          add_special_tokens=True,  # Add [CLS] token at the start for
classification
          max_length=self.max_length,
          return_token_type_ids=False,
          padding='max_length',
          return_attention_mask=True,
          return_tensors='pt',
          truncation=True
        )

        return {
          'review_text': review_text,
          'input_ids': encoding['input_ids'].flatten(),
          'attention_mask': encoding['attention_mask'].flatten(), #
this is NOT self-attention!
          'labels': torch.tensor(labels, dtype=torch.long)
        }

tokenizer = DistilBertTokenizerFast.from_pretrained('distilbert-base-
uncased')
review_dataset = ReviewDataset('restaurant_reviews.csv', tokenizer,
512)
```

```
/usr/local/lib/python3.10/dist-packages/huggingface_hub/utils/
_auth.py:94: UserWarning:
The secret `HF_TOKEN` does not exist in your Colab secrets.
To authenticate with the Hugging Face Hub, create a token in your
settings tab (https://huggingface.co/settings/tokens), set it as
secret in your Google Colab and restart your session.
You will be able to reuse this secret in all of your notebooks.
Please note that authentication is recommended but still optional to
access public models or datasets.
  warnings.warn(
```


```
{"model_id":"8060a1ddc6f04ab08ebffccf3db4aadc","version_major":2,"vers
ion_minor":0}

{"model_id":"9ac8cec190ce4a6fa7815f31132529c2","version_major":2,"vers
ion_minor":0}

{"model_id":"2052f29dedd948a79b4c945b4d66f547","version_major":2,"vers
ion_minor":0}

{"model_id":"cd47584bbbeb48faba223d8feda38a3c","version_major":2,"vers
ion_minor":0}
```

```
review_dataset[0]
```

```
{'review_text': 'The ambience was good food was quite good . had
Saturday lunch which was cost effective . Good place for a sate
brunch. One can also chill with friends and or parents. Waiter Soumen
Das was really courteous and helpful.',
 'input_ids': tensor([  101,  1996,  2572, 11283,  5897,  2001,  2204,
2833,  2001,  3243,
          2204,  1012,  2018,  5095,  6265,  2029,  2001,  3465,
4621,  1012,
          2204,  2173,  2005,  1037,  2938,  2063,  7987,  4609,
2818,  1012,
          2028,  2064,  2036, 10720,  2007,  2814,  1998,  2030,
3008,  1012,
         15610,  2061, 27417,  8695,  2001,  2428,  2457, 14769,
1998, 14044,
          1012,   102,     0,     0,     0,     0,     0,     0,
0,     0,
             0,     0,     0,     0,     0,     0,     0,     0,
0,     0,
             0,     0,     0,     0,     0,     0,     0,     0,
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             0,     0,     0,     0,     0,     0,     0,     0,
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             0,     0,     0,     0,     0,     0,     0,     0,
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             0,     0,     0,     0,     0,     0,     0,     0,
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```

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0,     0,
                0,     0,     0,     0,     0,     0,     0,     0,
0,     0,
                0,     0,     0,     0,     0,     0,     0,     0,
0,     0,
                0,     0]),
 'attention_mask': tensor([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
          1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1,
          1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
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          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
          0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

```
0, 0, 0, 0,
         0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0,
         0, 0, 0, 0, 0, 0, 0, 0]),
 'labels': tensor(2)}
```

```
tokenizer.decode(review_dataset[0]['input_ids'])
```

```
{"type":"string"}
```

```
from torch.utils.data import DataLoader, random_split

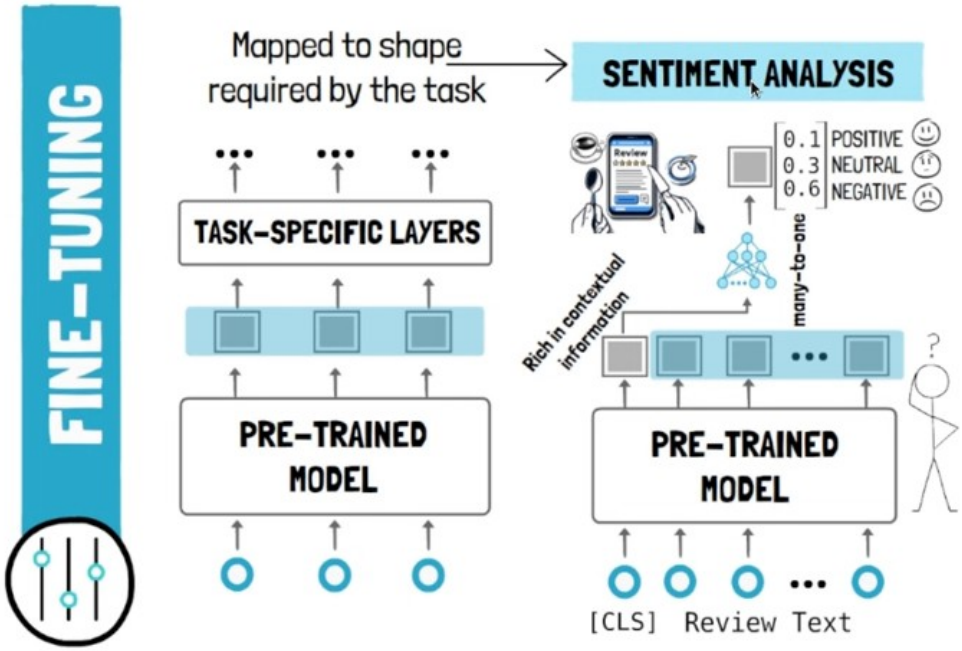
# Split dataset into training and validation
train_size = int(0.8 * len(df))
val_size = len(df) - train_size
train_dataset, test_dataset = random_split(review_dataset,
[train_size, val_size])

train_loader = DataLoader(train_dataset, batch_size=16, shuffle=True)
test_loader = DataLoader(test_dataset, batch_size=16)

# Show number of batches
len(train_loader), len(test_loader)
```

```
(498, 125)
```

Fine-tuning with custom classfier layer




```
class CustomDistilBertForSequenceClassification(nn.Module):
    def __init__(self, num_labels=3):
```

```
        super(CustomDistilBertForSequenceClassification,
self).__init__()
        self.distilbert = DistilBertModel.from_pretrained('distilbert-
base-uncased')  #base model from hugging face
        self.pre_classifier = nn.Linear(768, 768)  # DistilBERT's
hidden size is 768
        self.dropout = nn.Dropout(0.3)
        self.classifier = nn.Linear(768, num_labels)

    def forward(self, input_ids, attention_mask):
        distilbert_output = self.distilbert(input_ids=input_ids,
attention_mask=attention_mask)
        hidden_state = distilbert_output[0]  # (batch_size,
sequence_length, hidden_size)
        pooled_output = hidden_state[:, 0]  # we take the
representation of the [CLS] token (first token)
        pooled_output = self.pre_classifier(pooled_output)
        pooled_output = nn.ReLU()(pooled_output)
        pooled_output = self.dropout(pooled_output) # regularization
        logits = self.classifier(pooled_output)
        return logits

model = CustomDistilBertForSequenceClassification()
```

{"model_id":"8ddb9c71a02d489b990e95d0f959761f","version_major":2,"vers
ion_minor":0}

```
# Inspect DistilBERT
print(model.distilbert)
```

```
DistilBertModel(
  (embeddings): Embeddings(
    (word_embeddings): Embedding(30522, 768, padding_idx=0)
    (position_embeddings): Embedding(512, 768)
    (LayerNorm): LayerNorm((768,), eps=1e-12, elementwise_affine=True)
    (dropout): Dropout(p=0.1, inplace=False)
  )
  (transformer): Transformer(
    (layer): ModuleList(
      (0-5): 6 x TransformerBlock(
        (attention): DistilBertSdpaAttention(
          (dropout): Dropout(p=0.1, inplace=False)
          (q_lin): Linear(in_features=768, out_features=768,
bias=True)
          (k_lin): Linear(in_features=768, out_features=768,
bias=True)
          (v_lin): Linear(in_features=768, out_features=768,
bias=True)
          (out_lin): Linear(in_features=768, out_features=768,
bias=True)
```

```
        )
        (sa_layer_norm): LayerNorm((768,), eps=1e-12,
elementwise_affine=True)
        (ffn): FFN(
          (dropout): Dropout(p=0.1, inplace=False)
          (lin1): Linear(in_features=768, out_features=3072,
bias=True)
          (lin2): Linear(in_features=3072, out_features=768,
bias=True)
          (activation): GELUActivation()
        )
        (output_layer_norm): LayerNorm((768,), eps=1e-12,
elementwise_affine=True)
      )
    )
  )
)
```

Fine-tuning

```
device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
model.to(device)

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

model.train()
for epoch in range(5):
    for i, batch in enumerate(train_loader):
        input_ids = batch['input_ids'].to(device)
        attention_mask = batch['attention_mask'].to(device)
        labels = batch['labels'].to(device)

        optimizer.zero_grad()
        logits = model(input_ids=input_ids,
attention_mask=attention_mask)
        loss = nn.CrossEntropyLoss()(logits, labels)
        loss.backward()
        optimizer.step()

        if (i + 1) % 100 == 0:
            print(f"Epoch {epoch + 1}, Batch {i + 1}, Loss:
{loss.item():.4f}")

Epoch 1, Batch 100, Loss: 0.4197
Epoch 1, Batch 200, Loss: 0.3587
Epoch 1, Batch 300, Loss: 0.1825
Epoch 1, Batch 400, Loss: 0.1685
Epoch 2, Batch 100, Loss: 0.2091
Epoch 2, Batch 200, Loss: 0.2948
Epoch 2, Batch 300, Loss: 0.1590
```

```
Epoch 2, Batch 400, Loss: 0.0778
Epoch 3, Batch 100, Loss: 0.1450
Epoch 3, Batch 200, Loss: 0.1897
Epoch 3, Batch 300, Loss: 0.2143
Epoch 3, Batch 400, Loss: 0.0392
Epoch 4, Batch 100, Loss: 0.4496
Epoch 4, Batch 200, Loss: 0.0672
Epoch 4, Batch 300, Loss: 0.1173
Epoch 4, Batch 400, Loss: 0.0902
Epoch 5, Batch 100, Loss: 0.0152
Epoch 5, Batch 200, Loss: 0.0489
Epoch 5, Batch 300, Loss: 0.0172
Epoch 5, Batch 400, Loss: 0.0088
```

** Evaluation**

```
model.eval()
total_correct = 0
total = 0
for batch in test_loader:
    input_ids = batch['input_ids'].to(device)
    attention_mask = batch['attention_mask'].to(device)
    labels = batch['labels'].to(device)

    with torch.inference_mode():
        logits = model(input_ids=input_ids,
attention_mask=attention_mask)
    predictions = torch.argmax(logits, dim=1)
    total_correct += (predictions == labels).sum().item()
    total += predictions.size(0)

print(f'Test Accuracy: {total_correct / total:.4f}')

Test Accuracy: 0.8553

def predict_sentiment(review_text, model, tokenizer, max_length =
512):
    """
    Predicts the sentiment of a given review text.

    Args:
    - review_text (str): The review text to analyze.
    - model (torch.nn.Module): The fine-tuned sentiment analysis
model.
    - tokenizer (PreTrainedTokenizer): The tokenizer for encoding the
text.
    - max_length (int): The maximum sequence length for the model.

    Returns:
    - sentiment (str): The predicted sentiment label ('negative',
```

```
'neutral', 'positive').
    """

    # Ensure the model is in evaluation mode
    model.eval()

    # Tokenize the input text
    encoding = tokenizer.encode_plus(
          review_text,
          add_special_tokens=True,
          max_length=max_length,
          return_token_type_ids=False,
          padding='max_length',
          return_attention_mask=True,
          return_tensors='pt',
          truncation=True
    )

    input_ids = encoding['input_ids']
    attention_mask = encoding['attention_mask']

    # Move tensors to the same device as the model
    input_ids = input_ids.to(device)
    attention_mask = attention_mask.to(device)

    with torch.inference_mode():
        # Forward pass, get logits
        logits = model(input_ids=input_ids,
attention_mask=attention_mask)

    # Extract the highest scoring output
    prediction = torch.argmax(logits, dim=1).item()

    # Map prediction to label
    label_dict = {0: 'negative', 1: 'neutral', 2: 'positive'}
    sentiment = label_dict[prediction]

    return sentiment

# Test
review_1 = "We ordered from Papa Johns a so-called pizza... what to
say? I'd rather eat a piece of dry cardboard, calling this pizza is an
insult to Italians! "
review_2 = "I guess PizzaHut is decent but far from the Italian pizza.
This is not going to blow you away, but still quite ok in the end."
review_3 = "Gino's pizza is what authentical Neapolian pizza tastes
like, highly recommended."

print(predict_sentiment(review_1, model, tokenizer))
```

```
print(predict_sentiment(review_2, model, tokenizer))
print(predict_sentiment(review_3, model, tokenizer))
```

```
negative
neutral
positive
```