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# This Python 3 environment comes with many helpful analytics
libraries installed
# It is defined by the kaggle/python Docker image:
https://github.com/kaggle/docker-python
# For example, here's several helpful packages to load

import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)

# Input data files are available in the read-only "../input/"
directory
# For example, running this (by clicking run or pressing Shift+Enter)
will list all files under the input directory

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))

# You can write up to 20GB to the current directory (/kaggle/working/)
that gets preserved as output when you create a version using "Save &
Run All"
# You can also write temporary files to /kaggle/temp/, but they won't
be saved outside of the current session

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/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_993.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_480.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_560.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_877.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_852.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_1096.wa
v
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_514.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_696.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_1234.wa
v
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_151.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_557.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_473.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_651.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_724.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_259.wav
/kaggle/input/shl-hiring-assessment/Dataset/audios/train/audio_795.wav

This is my submission for the Grammar scoring engine for spoken audios project as a part of SHL assessment

Basic procedure

data loading → EDA → preprocessing → feature extraction → model training → evaluation

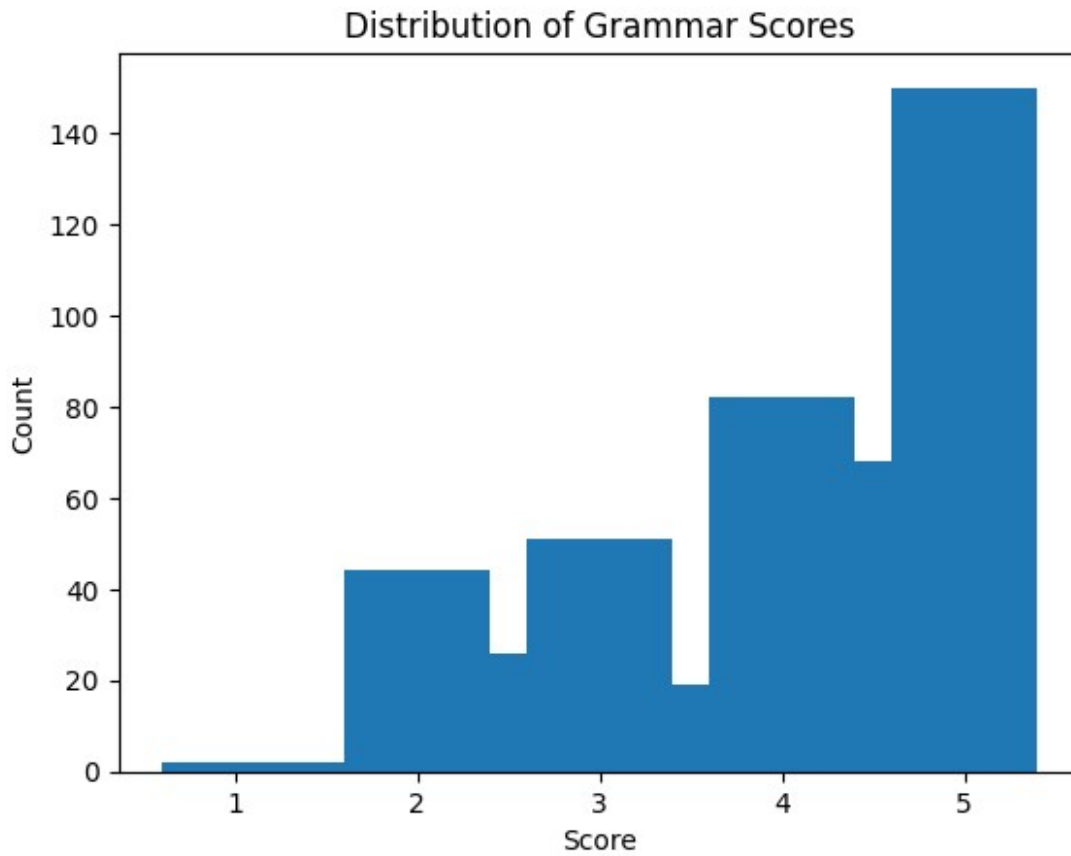
1. Data loading

```
import pandas as pd
df =
pd.read_csv('/kaggle/input/shl-hiring-assessment/Dataset/train.csv')
print(df.head())
```

	filename	label
0	audio_710.wav	1.0
1	audio_1265.wav	1.0
2	audio_1114.wav	1.5
3	audio_946.wav	1.5
4	audio_1127.wav	2.0

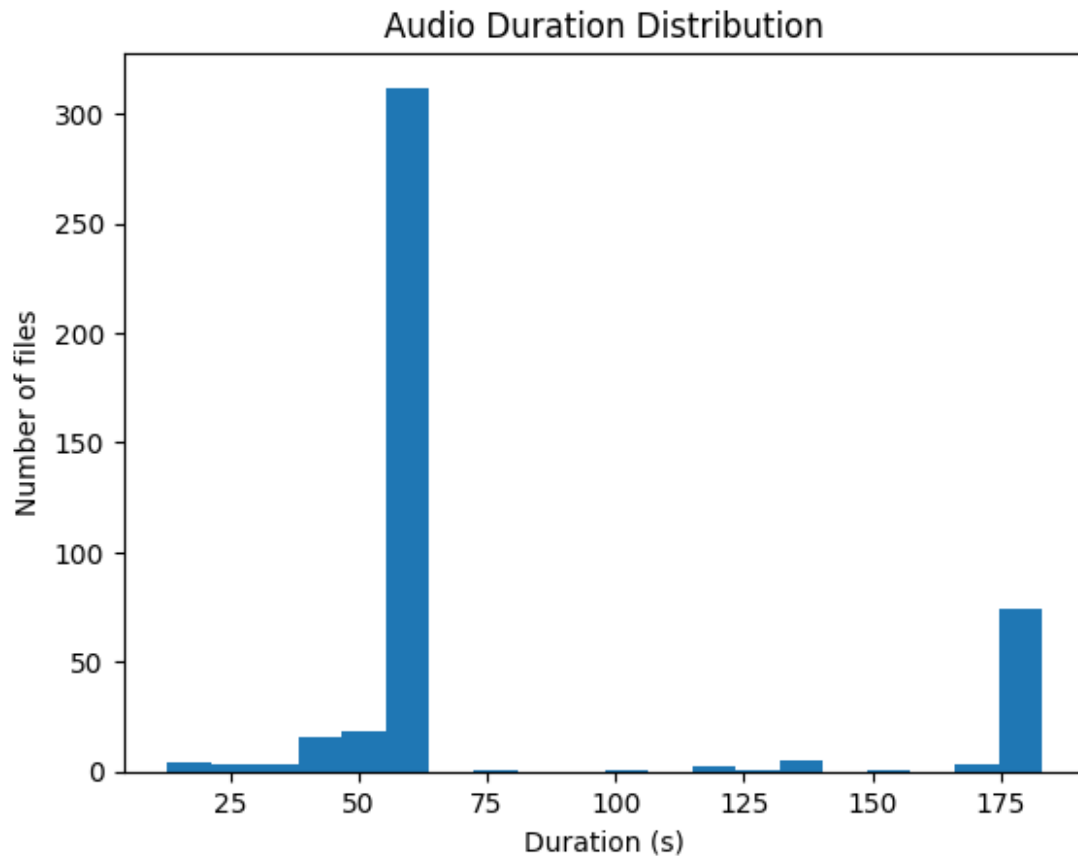
2. EDA

```
import matplotlib.pyplot as plt
score_counts = df['label'].value_counts().sort_index()
plt.bar(score_counts.index, score_counts.values); plt.xlabel('Score');
plt.ylabel('Count')
plt.title('Distribution of Grammar Scores')
Text(0.5, 1.0, 'Distribution of Grammar Scores')
```

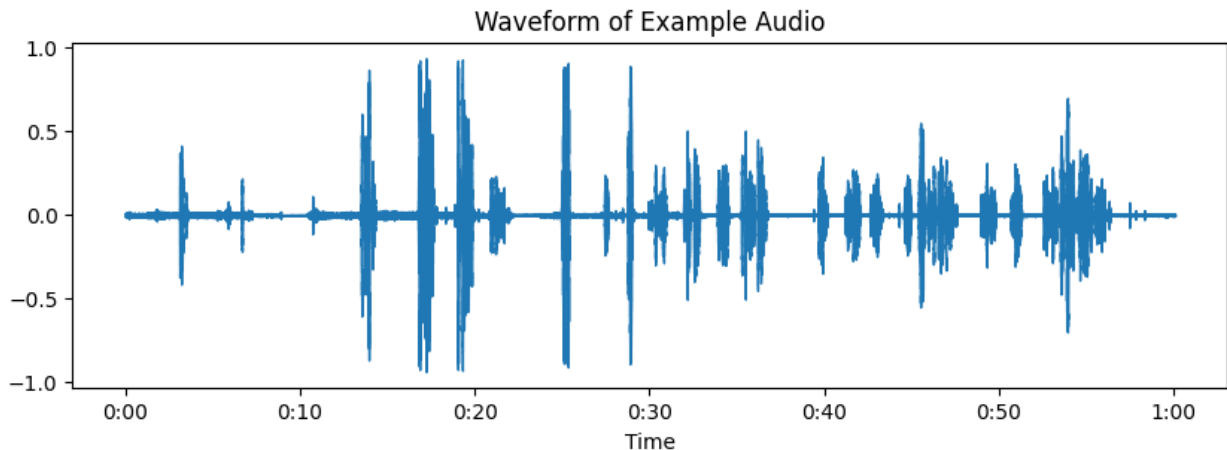


We will use librosa here, its a python package to visualise audio related files

```
import librosa
durations = []
for fname in df['filename']:
    y, sr = librosa.load(f'/kaggle/input/shl-hiring-assessment/Dataset/audios/train/{fname}', sr=None)
    durations.append(len(y)/sr)
plt.hist(durations, bins=20); plt.xlabel('Duration (s)');
plt.ylabel('Number of files')
plt.title('Audio Duration Distribution')
Text(0.5, 1.0, 'Audio Duration Distribution')
```



```
import numpy as np
import librosa.display
# Example: load one audio and plot waveform and spectrogram
y, sr =
librosa.load('/kaggle/input/shl-hiring-assessment/Dataset/audios/train
/'+df['filename'][0], sr=16000)
plt.figure(figsize=(10,3))
librosa.display.waveshow(y, sr=sr)
plt.title('Waveform of Example Audio')
Text(0.5, 1.0, 'Waveform of Example Audio')
```



3. Preprocessing

Since I'm not so familiar with audio processing techniques, I came across standardising the audio to same format, which is required by many pretrained models.

Before feature extraction:

- Resampling: We convert all audio to a common sample rate (16 kHz)
- Mono conversion: Ensure mono (single channel) audio.
- Trimming/Padding: We may pad shorter clips with zeros or trim very long clips to a max length so that inputs have uniform dimensions.

```
import soundfile as sf
MAX_LEN = int(60 * 16000)
new_y = []
for fname in df['filename']:
    audio, _ =
sf.read(f'/kaggle/input/shl-hiring-assessment/Dataset/audios/train/
{fname}')
```

```
    audio = librosa.resample(audio, orig_sr=_, target_sr=16000)
    if audio.ndim > 1:
        audio = librosa.to_mono(audio)

    if len(audio) < MAX_LEN:
        audio = np.pad(audio, (0, MAX_LEN - len(audio)))
    else:
        audio = audio[:MAX_LEN]
    new_y.append(audio)
X = np.stack(new_y) # shape: (n_samples, MAX_LEN)
```

We can also considering removal of noise from then images, but I will take it as a learning for future work scope.

4. Model training

There are many ways to convert audio into text, One very popular library is 'Whisper' by OpenAI. But we will use transformer models that is free to use and that is wav2vec2 available in Huggingface

Using a pretrained model reduces overhead as it may have been trained on millions of audios itself for this espeech to text task.

I tried to use the wav2vec2 base model itself, but the size was so large that kaggle couldnt allocate the ram to it and restarted the kernel TT Edit- turns out even 960h that is trained on 960 hrs of audio data is bigger than 29 gb that is kaggle ram, so it wont run

Trying my luck on distilled model (seaching on huggingface), i heard this word many times since the release of deepseek r1

EDIT 2- No luck. still not working

- Googled my issue to find smaller models, then i found Hidden Unit BERT or HuBERT

Whisper for the go !! i hesitated to use it at the start because i thought openai models are not free

```
# from transformers import WhisperProcessor,
WhisperForConditionalGeneration
# import torch
# import numpy as np

# # load model and processor
# processor = WhisperProcessor.from_pretrained("openai/whisper-tiny")
# model =
WhisperForConditionalGeneration.from_pretrained("openai/whisper-tiny")
# encoder = model.get_encoder() # Get the encoder part of the Whisper
model

# batch_size = 32 # Adjust based on memory limits
# num_samples = len(X)

# all_embeddings = []

# for i in range(0, num_samples, batch_size):
#     batch_X = X[i:i + batch_size]
#     inputs = processor(batch_X, sampling_rate=16000,
return_tensors="pt", padding=True)
#     with torch.no_grad():
#         encoder_outputs =
encoder(inputs.input_features.to(encoder.device))
#         batch_embeddings =
encoder_outputs.last_hidden_state.mean(dim=1).cpu().numpy()
#     all_embeddings.append(batch_embeddings) # Append the batch
embeddings
```

```

# final_embeddings = np.concatenate(all_embeddings, axis=0)

# X_emb = final_embeddings # Assign the complete embeddings to X_emb
# y = df['label'].values
# X_train, X_val, y_train, y_val = train_test_split(X_emb, y,
# test_size=0.2, random_state=42)

# import torch.nn as nn
# import torch.optim as optim

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

# reg = nn.Sequential(
#     nn.Linear(X_train.shape[1], 64),
#     nn.ReLU(),
#     nn.Linear(64, 32),
#     nn.ReLU(),
#     nn.Linear(32, 1)
# ).to(device).float()

# Block 1: Feature Extraction (Whisper)
from transformers import WhisperProcessor,
WhisperForConditionalGeneration
import torch
import numpy as np

# load model and processor
processor = WhisperProcessor.from_pretrained("openai/whisper-tiny")
model =
WhisperForConditionalGeneration.from_pretrained("openai/whisper-tiny")
encoder = model.get_encoder() # Get the encoder part of the Whisper
model

batch_size = 32 # Adjust based on memory limits
num_samples = len(X)

all_embeddings = []

for i in range(0, num_samples, batch_size):
    batch_X = X[i:i + batch_size]
    inputs = processor(batch_X, sampling_rate=16000,
return_tensors="pt", padding=True)
    with torch.no_grad():
        encoder_outputs =
encoder(inputs.input_features.to(encoder.device))
        batch_embeddings =
encoder_outputs.last_hidden_state.mean(dim=1).cpu().numpy()
        all_embeddings.append(batch_embeddings) # Append the batch

```

embeddings

```
final_embeddings = np.concatenate(all_embeddings, axis=0)

X_emb = final_embeddings # Assign the complete embeddings to X_emb

print("Embeddings extracted. Shape:", X_emb.shape) # Print shape for
user information
```

Embeddings extracted. Shape: (444, 384)

Block 2: Model Definition and Training

```
from sklearn.model_selection import train_test_split
import torch.nn as nn
import torch.optim as optim
import torch
```

Assuming X_emb and df are available from the previous block

```
y = df['label'].values
X_train, X_val, y_train, y_val = train_test_split(X_emb, y,
test_size=0.2, random_state=42)
```

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

```
reg = nn.Sequential(
    nn.Linear(X_train.shape[1], 64),
    nn.ReLU(),
    nn.Linear(64, 32),
    nn.ReLU(),
    nn.Linear(32, 1)
).to(device).float()
```

```
criterion = nn.MSELoss()
optimizer = optim.Adam(reg.parameters(), lr=1e-4)
```

Convert data to PyTorch tensors and move to device

```
X_train_tensor = torch.tensor(X_train, dtype=torch.float32,
device=device)
X_val_tensor = torch.tensor(X_val, dtype=torch.float32, device=device)
y_train_tensor = torch.tensor(y_train, dtype=torch.float32,
device=device).float()
y_val_tensor = torch.tensor(y_val, dtype=torch.float32,
device=device).float()
```

```
for epoch in range(50):
    reg.train()
    preds = reg(X_train_tensor).squeeze()
    loss = torch.sqrt(criterion(preds, y_train_tensor))
    optimizer.zero_grad()
```

```

loss.backward()
optimizer.step()

# Evaluate on val
reg.eval()
with torch.no_grad():
    val_preds = reg(X_val_tensor).squeeze()
    val_rmse = torch.sqrt(criterion(val_preds, y_val_tensor))
print(f"Epoch {epoch}: Train RMSE={loss.item():.4f}, Val
RMSE={val_rmse.item():.4f}")

```

```

Epoch 0: Train RMSE=4.2553, Val RMSE=4.1247
Epoch 1: Train RMSE=4.2478, Val RMSE=4.1174
Epoch 2: Train RMSE=4.2404, Val RMSE=4.1101
Epoch 3: Train RMSE=4.2330, Val RMSE=4.1027
Epoch 4: Train RMSE=4.2256, Val RMSE=4.0954
Epoch 5: Train RMSE=4.2183, Val RMSE=4.0882
Epoch 6: Train RMSE=4.2110, Val RMSE=4.0810
Epoch 7: Train RMSE=4.2037, Val RMSE=4.0739
Epoch 8: Train RMSE=4.1965, Val RMSE=4.0668
Epoch 9: Train RMSE=4.1893, Val RMSE=4.0597
Epoch 10: Train RMSE=4.1822, Val RMSE=4.0527
Epoch 11: Train RMSE=4.1751, Val RMSE=4.0458
Epoch 12: Train RMSE=4.1681, Val RMSE=4.0390
Epoch 13: Train RMSE=4.1612, Val RMSE=4.0323
Epoch 14: Train RMSE=4.1543, Val RMSE=4.0256
Epoch 15: Train RMSE=4.1475, Val RMSE=4.0191
Epoch 16: Train RMSE=4.1409, Val RMSE=4.0127
Epoch 17: Train RMSE=4.1343, Val RMSE=4.0064
Epoch 18: Train RMSE=4.1279, Val RMSE=4.0003
Epoch 19: Train RMSE=4.1216, Val RMSE=3.9943
Epoch 20: Train RMSE=4.1154, Val RMSE=3.9884
Epoch 21: Train RMSE=4.1092, Val RMSE=3.9825
Epoch 22: Train RMSE=4.1031, Val RMSE=3.9766
Epoch 23: Train RMSE=4.0969, Val RMSE=3.9707
Epoch 24: Train RMSE=4.0908, Val RMSE=3.9648
Epoch 25: Train RMSE=4.0847, Val RMSE=3.9588
Epoch 26: Train RMSE=4.0786, Val RMSE=3.9527
Epoch 27: Train RMSE=4.0724, Val RMSE=3.9465
Epoch 28: Train RMSE=4.0661, Val RMSE=3.9403
Epoch 29: Train RMSE=4.0598, Val RMSE=3.9341
Epoch 30: Train RMSE=4.0534, Val RMSE=3.9278
Epoch 31: Train RMSE=4.0470, Val RMSE=3.9215
Epoch 32: Train RMSE=4.0405, Val RMSE=3.9151
Epoch 33: Train RMSE=4.0340, Val RMSE=3.9087
Epoch 34: Train RMSE=4.0274, Val RMSE=3.9023
Epoch 35: Train RMSE=4.0208, Val RMSE=3.8958
Epoch 36: Train RMSE=4.0141, Val RMSE=3.8892
Epoch 37: Train RMSE=4.0074, Val RMSE=3.8826
Epoch 38: Train RMSE=4.0006, Val RMSE=3.8759

```



```
Epoch 39: Train RMSE=3.9938, Val RMSE=3.8692
Epoch 40: Train RMSE=3.9869, Val RMSE=3.8625
Epoch 41: Train RMSE=3.9800, Val RMSE=3.8556
Epoch 42: Train RMSE=3.9730, Val RMSE=3.8488
Epoch 43: Train RMSE=3.9659, Val RMSE=3.8418
Epoch 44: Train RMSE=3.9587, Val RMSE=3.8348
Epoch 45: Train RMSE=3.9515, Val RMSE=3.8278
Epoch 46: Train RMSE=3.9442, Val RMSE=3.8206
Epoch 47: Train RMSE=3.9369, Val RMSE=3.8134
Epoch 48: Train RMSE=3.9294, Val RMSE=3.8061
Epoch 49: Train RMSE=3.9219, Val RMSE=3.7987
```

Added more layers because 50 epochs were trained in one seconds

```
# from transformers import Wav2Vec2FeatureExtractor, HubertModel
# import torch
# import numpy as np

# processor =
Wav2Vec2FeatureExtractor.from_pretrained("facebook/hubert-base-ls960")
# model = HubertModel.from_pretrained("facebook/hubert-base-ls960")

# batch_size = 32 # Adjust based on memory limits
# num_samples = len(X)
# all_embeddings = []

# for i in range(0, num_samples, batch_size):
#     batch_X = X[i:i + batch_size]
#     inputs = processor(batch_X, sampling_rate=16000,
return_tensors="pt", padding=True)
#     with torch.no_grad():
#         outputs = model(inputs.input_values.to(model.device))
#         embeddings = outputs.last_hidden_state.mean(dim=1).cpu().numpy()

#     all_embeddings.append(embeddings)

# final_embeddings = np.concatenate(all_embeddings, axis=0)

# print(f"Shape of final embeddings: {final_embeddings.shape}")

# from transformers import Wav2Vec2Processor, Wav2Vec2Model
# import torch
# from transformers import Wav2Vec2Processor, Wav2Vec2Model

# processor = Wav2Vec2Processor.from_pretrained("facebook/wav2vec2-
base")
# model = Wav2Vec2Model.from_pretrained("facebook/wav2vec2-base")

# # Extract features (batch inference)
```

```

# inputs = processor(X, sampling_rate=16000, return_tensors="pt",
padding=True)
# with torch.no_grad():
#     outputs = model(inputs.input_values) # last_hidden_state:
# [batch, time, dim]
# embeddings = outputs.last_hidden_state.mean(dim=1) # mean-pool over
time -> [batch, dim]
# # Extract features (batch inference)
# inputs = processor(X, sampling_rate=16000, return_tensors="pt",
padding=True)
# with torch.no_grad():
#     outputs = model(inputs.input_values)
# embeddings = outputs.last_hidden_state.mean(dim=1)

```

Using a very simple neural network with just 1 layer and mean squared error as criterion

```

# from sklearn.model_selection import train_test_split
# X_emb = embeddings
# y = df['label'].values
# X_train, X_val, y_train, y_val = train_test_split(X_emb, y,
test_size=0.2, random_state=42)

# import torch.nn as nn
# import torch.optim as optim

# reg = nn.Sequential(
#     nn.Linear(X_emb.shape[1], 1)
# ).to(device)
# criterion = nn.MSELoss()
# optimizer = optim.Adam(reg.parameters(), lr=1e-4)

-----
-----
ValueError                                Traceback (most recent call
last)
/tmp/ipykernel_31/1784195549.py in <cell line: 0>()
      2 X_emb = embeddings
      3 y = df['label'].values
----> 4 X_train, X_val, y_train, y_val = train_test_split(X_emb, y,
test_size=0.2, random_state=42)
      5
      6 import torch.nn as nn

/usr/local/lib/python3.11/dist-packages/sklearn/model_selection/_split
.py in train_test_split(test_size, train_size, random_state, shuffle,
stratify, *arrays)
    2557         raise ValueError("At least one array required as
input")
    2558

```

```

-> 2559     arrays = indexable(*arrays)
    2560
    2561     n_samples = _num_samples(arrays[0])

/usr/local/lib/python3.11/dist-packages/sklearn/utils/validation.py in
indexable(*iterables)
    441
    442     result = [_make_indexable(X) for X in iterables]
--> 443     check_consistent_length(*result)
    444     return result
    445

/usr/local/lib/python3.11/dist-packages/sklearn/utils/validation.py in
check_consistent_length(*arrays)
    395     uniques = np.unique(lengths)
    396     if len(uniques) > 1:
--> 397         raise ValueError(
    398             "Found input variables with inconsistent numbers
of samples: %r"
    399             % [int(l) for l in lengths])

ValueError: Found input variables with inconsistent numbers of
samples: [28, 444]

X_train_tensor = torch.tensor(X_train, dtype=torch.float32,
device=device)
X_val_tensor = torch.tensor(X_val, dtype=torch.float32, device=device)
y_train_tensor = torch.tensor(y_train, dtype=torch.float32,
device=device).float() # Ensure y_train is float32
y_val_tensor = torch.tensor(y_val, dtype=torch.float32,
device=device).float() # Ensure y_val is float32

train_losses = [] # To store training losses
val_losses = []

# Training loop
for epoch in range(200):
    reg.train()
    preds = reg(X_train_tensor).squeeze()
    loss = torch.sqrt(criterion(preds, y_train_tensor))
    optimizer.zero_grad()
    loss.backward()
    optimizer.step()

    # Evaluate on val
    reg.eval()
    with torch.no_grad():
        val_preds = reg(X_val_tensor).squeeze()
        val_rmse = torch.sqrt(criterion(val_preds, y_val_tensor))
    train_losses.append(loss.item()) # Append to the list

```

```
val_losses.append(val_rmse.item()) # Append to the list
print(f"Epoch {epoch}: Train RMSE={loss.item():.4f}, Val
RMSE={val_rmse.item():.4f}")
```

```
Epoch 0: Train RMSE=0.8252, Val RMSE=0.9938
Epoch 1: Train RMSE=0.8243, Val RMSE=0.9926
Epoch 2: Train RMSE=0.8233, Val RMSE=0.9915
Epoch 3: Train RMSE=0.8223, Val RMSE=0.9904
Epoch 4: Train RMSE=0.8213, Val RMSE=0.9893
Epoch 5: Train RMSE=0.8203, Val RMSE=0.9881
Epoch 6: Train RMSE=0.8194, Val RMSE=0.9870
Epoch 7: Train RMSE=0.8184, Val RMSE=0.9859
Epoch 8: Train RMSE=0.8174, Val RMSE=0.9848
Epoch 9: Train RMSE=0.8165, Val RMSE=0.9837
Epoch 10: Train RMSE=0.8155, Val RMSE=0.9826
Epoch 11: Train RMSE=0.8146, Val RMSE=0.9815
Epoch 12: Train RMSE=0.8136, Val RMSE=0.9804
Epoch 13: Train RMSE=0.8127, Val RMSE=0.9794
Epoch 14: Train RMSE=0.8117, Val RMSE=0.9783
Epoch 15: Train RMSE=0.8108, Val RMSE=0.9772
Epoch 16: Train RMSE=0.8098, Val RMSE=0.9762
Epoch 17: Train RMSE=0.8089, Val RMSE=0.9751
Epoch 18: Train RMSE=0.8080, Val RMSE=0.9740
Epoch 19: Train RMSE=0.8070, Val RMSE=0.9730
Epoch 20: Train RMSE=0.8061, Val RMSE=0.9719
Epoch 21: Train RMSE=0.8052, Val RMSE=0.9709
Epoch 22: Train RMSE=0.8043, Val RMSE=0.9698
Epoch 23: Train RMSE=0.8033, Val RMSE=0.9688
Epoch 24: Train RMSE=0.8024, Val RMSE=0.9677
Epoch 25: Train RMSE=0.8015, Val RMSE=0.9667
Epoch 26: Train RMSE=0.8006, Val RMSE=0.9656
Epoch 27: Train RMSE=0.7997, Val RMSE=0.9646
Epoch 28: Train RMSE=0.7988, Val RMSE=0.9635
Epoch 29: Train RMSE=0.7979, Val RMSE=0.9625
Epoch 30: Train RMSE=0.7970, Val RMSE=0.9615
Epoch 31: Train RMSE=0.7961, Val RMSE=0.9605
Epoch 32: Train RMSE=0.7952, Val RMSE=0.9595
Epoch 33: Train RMSE=0.7943, Val RMSE=0.9585
Epoch 34: Train RMSE=0.7934, Val RMSE=0.9575
Epoch 35: Train RMSE=0.7925, Val RMSE=0.9564
Epoch 36: Train RMSE=0.7917, Val RMSE=0.9554
Epoch 37: Train RMSE=0.7908, Val RMSE=0.9544
Epoch 38: Train RMSE=0.7899, Val RMSE=0.9534
Epoch 39: Train RMSE=0.7890, Val RMSE=0.9524
Epoch 40: Train RMSE=0.7882, Val RMSE=0.9515
Epoch 41: Train RMSE=0.7873, Val RMSE=0.9505
Epoch 42: Train RMSE=0.7864, Val RMSE=0.9495
Epoch 43: Train RMSE=0.7856, Val RMSE=0.9485
Epoch 44: Train RMSE=0.7847, Val RMSE=0.9475
```

Epoch 45: Train RMSE=0.7839, Val RMSE=0.9465
Epoch 46: Train RMSE=0.7830, Val RMSE=0.9456
Epoch 47: Train RMSE=0.7822, Val RMSE=0.9446
Epoch 48: Train RMSE=0.7813, Val RMSE=0.9436
Epoch 49: Train RMSE=0.7805, Val RMSE=0.9427
Epoch 50: Train RMSE=0.7796, Val RMSE=0.9417
Epoch 51: Train RMSE=0.7788, Val RMSE=0.9408
Epoch 52: Train RMSE=0.7779, Val RMSE=0.9398
Epoch 53: Train RMSE=0.7771, Val RMSE=0.9389
Epoch 54: Train RMSE=0.7763, Val RMSE=0.9379
Epoch 55: Train RMSE=0.7754, Val RMSE=0.9370
Epoch 56: Train RMSE=0.7746, Val RMSE=0.9361
Epoch 57: Train RMSE=0.7738, Val RMSE=0.9351
Epoch 58: Train RMSE=0.7729, Val RMSE=0.9342
Epoch 59: Train RMSE=0.7721, Val RMSE=0.9333
Epoch 60: Train RMSE=0.7713, Val RMSE=0.9324
Epoch 61: Train RMSE=0.7705, Val RMSE=0.9314
Epoch 62: Train RMSE=0.7697, Val RMSE=0.9305
Epoch 63: Train RMSE=0.7688, Val RMSE=0.9296
Epoch 64: Train RMSE=0.7680, Val RMSE=0.9287
Epoch 65: Train RMSE=0.7672, Val RMSE=0.9278
Epoch 66: Train RMSE=0.7664, Val RMSE=0.9269
Epoch 67: Train RMSE=0.7656, Val RMSE=0.9260
Epoch 68: Train RMSE=0.7648, Val RMSE=0.9251
Epoch 69: Train RMSE=0.7640, Val RMSE=0.9242
Epoch 70: Train RMSE=0.7632, Val RMSE=0.9233
Epoch 71: Train RMSE=0.7624, Val RMSE=0.9224
Epoch 72: Train RMSE=0.7616, Val RMSE=0.9215
Epoch 73: Train RMSE=0.7608, Val RMSE=0.9206
Epoch 74: Train RMSE=0.7600, Val RMSE=0.9197
Epoch 75: Train RMSE=0.7593, Val RMSE=0.9188
Epoch 76: Train RMSE=0.7585, Val RMSE=0.9180
Epoch 77: Train RMSE=0.7577, Val RMSE=0.9171
Epoch 78: Train RMSE=0.7569, Val RMSE=0.9162
Epoch 79: Train RMSE=0.7561, Val RMSE=0.9154
Epoch 80: Train RMSE=0.7554, Val RMSE=0.9145
Epoch 81: Train RMSE=0.7546, Val RMSE=0.9137
Epoch 82: Train RMSE=0.7538, Val RMSE=0.9128
Epoch 83: Train RMSE=0.7531, Val RMSE=0.9120
Epoch 84: Train RMSE=0.7523, Val RMSE=0.9111
Epoch 85: Train RMSE=0.7515, Val RMSE=0.9103
Epoch 86: Train RMSE=0.7508, Val RMSE=0.9095
Epoch 87: Train RMSE=0.7500, Val RMSE=0.9086
Epoch 88: Train RMSE=0.7493, Val RMSE=0.9078
Epoch 89: Train RMSE=0.7485, Val RMSE=0.9070
Epoch 90: Train RMSE=0.7478, Val RMSE=0.9062
Epoch 91: Train RMSE=0.7470, Val RMSE=0.9054
Epoch 92: Train RMSE=0.7463, Val RMSE=0.9045
Epoch 93: Train RMSE=0.7455, Val RMSE=0.9037

Epoch 94: Train RMSE=0.7448, Val RMSE=0.9029
Epoch 95: Train RMSE=0.7440, Val RMSE=0.9021
Epoch 96: Train RMSE=0.7433, Val RMSE=0.9013
Epoch 97: Train RMSE=0.7426, Val RMSE=0.9005
Epoch 98: Train RMSE=0.7418, Val RMSE=0.8997
Epoch 99: Train RMSE=0.7411, Val RMSE=0.8989
Epoch 100: Train RMSE=0.7404, Val RMSE=0.8982
Epoch 101: Train RMSE=0.7396, Val RMSE=0.8974
Epoch 102: Train RMSE=0.7389, Val RMSE=0.8966
Epoch 103: Train RMSE=0.7382, Val RMSE=0.8958
Epoch 104: Train RMSE=0.7375, Val RMSE=0.8950
Epoch 105: Train RMSE=0.7367, Val RMSE=0.8942
Epoch 106: Train RMSE=0.7360, Val RMSE=0.8934
Epoch 107: Train RMSE=0.7353, Val RMSE=0.8926
Epoch 108: Train RMSE=0.7346, Val RMSE=0.8919
Epoch 109: Train RMSE=0.7339, Val RMSE=0.8911
Epoch 110: Train RMSE=0.7332, Val RMSE=0.8903
Epoch 111: Train RMSE=0.7325, Val RMSE=0.8896
Epoch 112: Train RMSE=0.7318, Val RMSE=0.8888
Epoch 113: Train RMSE=0.7311, Val RMSE=0.8880
Epoch 114: Train RMSE=0.7303, Val RMSE=0.8873
Epoch 115: Train RMSE=0.7296, Val RMSE=0.8866
Epoch 116: Train RMSE=0.7289, Val RMSE=0.8858
Epoch 117: Train RMSE=0.7282, Val RMSE=0.8851
Epoch 118: Train RMSE=0.7276, Val RMSE=0.8844
Epoch 119: Train RMSE=0.7269, Val RMSE=0.8836
Epoch 120: Train RMSE=0.7262, Val RMSE=0.8829
Epoch 121: Train RMSE=0.7255, Val RMSE=0.8822
Epoch 122: Train RMSE=0.7248, Val RMSE=0.8814
Epoch 123: Train RMSE=0.7241, Val RMSE=0.8807
Epoch 124: Train RMSE=0.7234, Val RMSE=0.8800
Epoch 125: Train RMSE=0.7227, Val RMSE=0.8793
Epoch 126: Train RMSE=0.7221, Val RMSE=0.8786
Epoch 127: Train RMSE=0.7214, Val RMSE=0.8779
Epoch 128: Train RMSE=0.7207, Val RMSE=0.8772
Epoch 129: Train RMSE=0.7200, Val RMSE=0.8764
Epoch 130: Train RMSE=0.7193, Val RMSE=0.8757
Epoch 131: Train RMSE=0.7187, Val RMSE=0.8750
Epoch 132: Train RMSE=0.7180, Val RMSE=0.8743
Epoch 133: Train RMSE=0.7173, Val RMSE=0.8736
Epoch 134: Train RMSE=0.7167, Val RMSE=0.8729
Epoch 135: Train RMSE=0.7160, Val RMSE=0.8722
Epoch 136: Train RMSE=0.7153, Val RMSE=0.8716
Epoch 137: Train RMSE=0.7147, Val RMSE=0.8709
Epoch 138: Train RMSE=0.7140, Val RMSE=0.8702
Epoch 139: Train RMSE=0.7133, Val RMSE=0.8695
Epoch 140: Train RMSE=0.7127, Val RMSE=0.8689
Epoch 141: Train RMSE=0.7120, Val RMSE=0.8682
Epoch 142: Train RMSE=0.7114, Val RMSE=0.8675

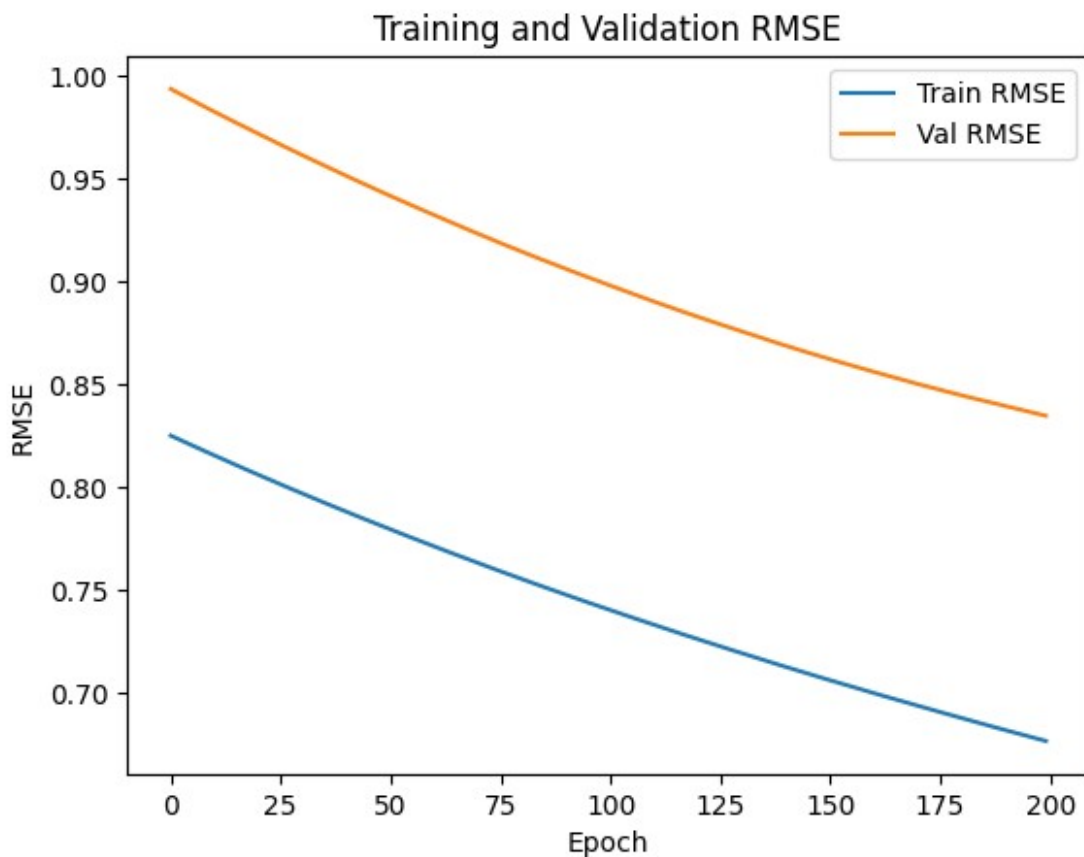
Epoch 143: Train RMSE=0.7107, Val RMSE=0.8669
Epoch 144: Train RMSE=0.7101, Val RMSE=0.8662
Epoch 145: Train RMSE=0.7094, Val RMSE=0.8655
Epoch 146: Train RMSE=0.7088, Val RMSE=0.8649
Epoch 147: Train RMSE=0.7082, Val RMSE=0.8643
Epoch 148: Train RMSE=0.7075, Val RMSE=0.8636
Epoch 149: Train RMSE=0.7069, Val RMSE=0.8630
Epoch 150: Train RMSE=0.7062, Val RMSE=0.8623
Epoch 151: Train RMSE=0.7056, Val RMSE=0.8617
Epoch 152: Train RMSE=0.7050, Val RMSE=0.8611
Epoch 153: Train RMSE=0.7043, Val RMSE=0.8605
Epoch 154: Train RMSE=0.7037, Val RMSE=0.8598
Epoch 155: Train RMSE=0.7031, Val RMSE=0.8592
Epoch 156: Train RMSE=0.7024, Val RMSE=0.8586
Epoch 157: Train RMSE=0.7018, Val RMSE=0.8580
Epoch 158: Train RMSE=0.7012, Val RMSE=0.8574
Epoch 159: Train RMSE=0.7006, Val RMSE=0.8568
Epoch 160: Train RMSE=0.6999, Val RMSE=0.8562
Epoch 161: Train RMSE=0.6993, Val RMSE=0.8556
Epoch 162: Train RMSE=0.6987, Val RMSE=0.8550
Epoch 163: Train RMSE=0.6981, Val RMSE=0.8543
Epoch 164: Train RMSE=0.6975, Val RMSE=0.8538
Epoch 165: Train RMSE=0.6969, Val RMSE=0.8532
Epoch 166: Train RMSE=0.6963, Val RMSE=0.8526
Epoch 167: Train RMSE=0.6956, Val RMSE=0.8520
Epoch 168: Train RMSE=0.6950, Val RMSE=0.8515
Epoch 169: Train RMSE=0.6944, Val RMSE=0.8509
Epoch 170: Train RMSE=0.6938, Val RMSE=0.8503
Epoch 171: Train RMSE=0.6932, Val RMSE=0.8497
Epoch 172: Train RMSE=0.6926, Val RMSE=0.8491
Epoch 173: Train RMSE=0.6920, Val RMSE=0.8486
Epoch 174: Train RMSE=0.6914, Val RMSE=0.8480
Epoch 175: Train RMSE=0.6908, Val RMSE=0.8475
Epoch 176: Train RMSE=0.6902, Val RMSE=0.8469
Epoch 177: Train RMSE=0.6896, Val RMSE=0.8463
Epoch 178: Train RMSE=0.6890, Val RMSE=0.8458
Epoch 179: Train RMSE=0.6884, Val RMSE=0.8452
Epoch 180: Train RMSE=0.6878, Val RMSE=0.8447
Epoch 181: Train RMSE=0.6872, Val RMSE=0.8442
Epoch 182: Train RMSE=0.6866, Val RMSE=0.8437
Epoch 183: Train RMSE=0.6860, Val RMSE=0.8431
Epoch 184: Train RMSE=0.6854, Val RMSE=0.8426
Epoch 185: Train RMSE=0.6848, Val RMSE=0.8421
Epoch 186: Train RMSE=0.6842, Val RMSE=0.8416
Epoch 187: Train RMSE=0.6837, Val RMSE=0.8411
Epoch 188: Train RMSE=0.6831, Val RMSE=0.8406
Epoch 189: Train RMSE=0.6825, Val RMSE=0.8401
Epoch 190: Train RMSE=0.6819, Val RMSE=0.8395
Epoch 191: Train RMSE=0.6813, Val RMSE=0.8390

```
Epoch 192: Train RMSE=0.6808, Val RMSE=0.8385
Epoch 193: Train RMSE=0.6802, Val RMSE=0.8380
Epoch 194: Train RMSE=0.6796, Val RMSE=0.8374
Epoch 195: Train RMSE=0.6790, Val RMSE=0.8369
Epoch 196: Train RMSE=0.6785, Val RMSE=0.8364
Epoch 197: Train RMSE=0.6779, Val RMSE=0.8359
Epoch 198: Train RMSE=0.6773, Val RMSE=0.8354
Epoch 199: Train RMSE=0.6768, Val RMSE=0.8349
```

Graphs n ol to see training quality

5. Evaluation

```
plt.plot(train_losses, label='Train RMSE')
plt.plot(val_losses, label='Val RMSE')
plt.legend(); plt.xlabel('Epoch'); plt.ylabel('RMSE');
plt.title('Training and Validation RMSE')
Text(0.5, 1.0, 'Training and Validation RMSE')
```



ITS REDUCINGGGGG!!!! Validation loss being consistently higher than train loss shows no overfitting or underfitting

Storing

```
import pandas as pd
import torch
import numpy as np
from transformers import WhisperProcessor,
WhisperForConditionalGeneration

# Load test data
test_df =
pd.read_csv('/kaggle/input/shl-hiring-assessment/Dataset/sample_submis
sion.csv')

# 1. Feature Extraction for Test Data (Similar to training)
processor = WhisperProcessor.from_pretrained("openai/whisper-tiny")
model =
WhisperForConditionalGeneration.from_pretrained("openai/whisper-tiny")
encoder = model.get_encoder() # Get the encoder

batch_size = 32
test_audio_paths =
['/kaggle/input/shl-hiring-assessment/Dataset/audios/test/' + fname
for fname in test_df['filename']] #create path

test_embeddings = []
MAX_LEN = int(60 * 16000)

for i in range(0, len(test_audio_paths), batch_size):
    batch_audio_paths = test_audio_paths[i:i + batch_size]
    batch_audio = []
    for audio_path in batch_audio_paths:
        audio, _ = sf.read(audio_path)
        audio = librosa.resample(audio, orig_sr=_, target_sr=16000)
        if audio.ndim > 1:
            audio = librosa.to_mono(audio)
        if len(audio) < MAX_LEN:
            audio = np.pad(audio, (0, MAX_LEN - len(audio)))
        else:
            audio = audio[:MAX_LEN]
        batch_audio.append(audio)

    batch_X = np.stack(batch_audio)
    inputs = processor(batch_X, sampling_rate=16000,
return_tensors="pt", padding=True)

    with torch.no_grad():
        encoder_outputs =
encoder(inputs.input_features.to(encoder.device))
        batch_test_embeddings =
encoder_outputs.last_hidden_state.mean(dim=1).cpu().numpy()
```

```

    test_embeddings.extend(batch_test_embeddings)

test_embeddings = np.array(test_embeddings) # Convert to numpy array

# 2. Prediction on Test Embeddings
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
reg.eval() # Set the model to evaluation mode
with torch.no_grad():
    test_preds = reg(torch.tensor(test_embeddings,
dtype=torch.float32, device=device)).cpu().numpy().squeeze()

# 3. Create Submission File
test_df['label'] = test_preds
test_df.to_csv('/kaggle/working/submission.csv', index=False) # Save
to /kaggle/working/
print("Submission file saved to /kaggle/working/submission.csv")

Submission file saved to /kaggle/working/submission.csv

```

Note- Could use whisper medium or large for better accuracies