Forum Discussions Categorization Report

CS_12

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Without Preprocessing:

```
df=df.dropna()
category_mapping = {
    'Politics': 0,
    'Sports': 1,
    'Media': 2,
    'Market & Economy': 3,
    'STEM': 4
}
df['Discussion'] = df['Discussion'].astype(str)
df['Category'] = df['Category'].map(category_mapping)
df=df.drop('SampleID',axis=1)
```

With Preprocessing:

```
def preprocess_text(text):
    lemmatizer = WordNetLemmatizer()
    # Remove NaN values
    if pd.isnull(text):
        return ""
    # Lowercase the text
    text = text.lower()
    # Remove punctuation
    text = re.sub(r'[^a-zA-Z\s]', ' ', text)
    # Tokenize and remove stopwords
    words = word_tokenize(text)
    stop_words = set(stopwords.words('english'))

    words = [word for word in words if word not in stop_words]
    # Lemmatization
    words = [lemmatizer.lemmatize(word) for word in words]
    # Join back into a single string
    return ' '.join(words)

# Apply preprocessing to the 'Discussion' column
df['Discussion']=df['Discussion'].astype(str)
df['Discussion'] = df['Discussion'].dropna().apply(preprocess_text)
```

Augmentation

We tested it and observed that it had no significant impact on accuracy.

```
from nltk.corpus import wordnet

def synonym_replacement(row):
    text = row['Discussion']
    words = text.split()
    augmented_text = []
    for word in words:
        # Get synonyms for each word
        synonyms = wordnet.synsets(word)
        if synonyms:
            # Replace the word with a synonym
            synonym = synonyms[0].lemmas()[0].name()
            augmented_text.append(synonym)
        else:
            augmented_text.append(word)
    return {'augmented': augmented_text, 'category': row['Category']}

random_sample = df.sample(n=5000, random_state=42)
augmented_data = random_sample.apply(synonym_replacement, axis=1)
augmented_df = pd.DataFrame(augmented_data.tolist())
augmented_df['augmented'] = augmented_df['augmented'].apply(lambda x: " ".join(x))
augmented_df.rename(columns={'augmented': 'Discussion', 'category': 'Category'}, inplace=True)
df = pd.concat([df, augmented_df], ignore_index=True)
```

Tokenizer

This code tokenizes text data using Keras' **`Tokenizer`**, converts text into padded sequences with a fixed length of 100, and handles out-of-vocabulary words using a placeholder (<OOV>). After testing various configurations, we found **`maxlen=100`** and **`vocab_size=30000`** to yield the best results.

```
#####Tokenization########
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences

vocab_size = 30000
oov_token = "<OOV>"
padding_type = "post"
trunc_type = "post"
tokenizer = Tokenizer(num_words=vocab_size, oov_token=oov_token)
tokenizer.fit_on_texts(df['Discussion'])
training_sequences = tokenizer.texts_to_sequences(df['Discussion'])
training_padded = pad_sequences(training_sequences, maxlen=100, padding=padding_type, truncating=trunc_t
X=np.array(training_padded)
labels = np.array(df['Category'])
```

Splitting

This code splits the dataset into training and validation sets (**`x_train`**, **`x_val`**, **`y_train`**, **`y_val`**) with an 80-20 ratio, using **`stratify=labels`** to ensure class distribution is maintained. Stratification improves model accuracy by preventing class imbalance in the splits.

```
from sklearn.model_selection import train_test_split

x_train, x_val, y_train, y_val = train_test_split(X, labels, test_size=0.2, random_state=42,stratify=lab
```

Word embedding

This code loads GloVe word embeddings from a specified file and stores them in a dictionary. It then initializes an embedding matrix of size（**`vocab_size, embedding_dim`**）and populates it with vectors corresponding to words in the tokenizer's vocabulary. Words not found in GloVe are represented by zero vectors.

```
# # Function to load GloVe vectors
def load_glove_vectors(filepath):
    embeddings_index = {}
    with open(filepath, encoding="utf8") as f:
        for line in f:
            values = line.split()
            word = values[0]
            vector = np.asarray(values[1:], dtype="float32")
            embeddings_index[word] = vector
    return embeddings_index

# Load GloVe embeddings
glove_path = "/content/drive/MyDrive/Glove/glove.6B.300d.txt"
glove_vectors = load_glove_vectors(glove_path)
# Parameters
vocab_size = len(tokenizer.word_index) + 1
embedding_dim = 300

# Initialize embedding matrix
embedding_matrix = np.zeros((vocab_size, embedding_dim))

# Populate embedding matrix
for word, i in tokenizer.word_index.items():
    if word in glove_vectors:
        embedding_matrix[i] = glove_vectors[word]
```

Normal Models

BILSTM

Architecture

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 100, 300)	14,587,200
bidirectional (Bidirectional)	(None, 100, 512)	1,140,736
global_average_pooling1d (GlobalAveragePooling1D)	(None, 512)	0
dense (Dense)	(None, 128)	65,664
dropout (Dropout)	(None, 128)	0
dense_1 (Dense)	(None, 64)	8,256
dropout_1 (Dropout)	(None, 64)	0
dense_2 (Dense)	(None, 5)	325

Total params: 15,802,181 (60.28 MB)

Trainable params: 1,214,981 (4.63 MB)

Non-trainable params: 14,587,200 (55.65 MB)

Accuracy

- Model Accuracy (training and validation) with preprocessing:

```
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 146s 930ms/step - accuracy: 0.7354 - loss: 0.6975 - val_accuracy: 0.7281 - val_loss: 0.7273
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 138s 880ms/step - accuracy: 0.7449 - loss: 0.6710 - val_accuracy: 0.7315 - val_loss: 0.7241
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 140s 891ms/step - accuracy: 0.7500 - loss: 0.6554 - val_accuracy: 0.7261 - val_loss: 0.7333
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 139s 888ms/step - accuracy: 0.7600 - loss: 0.6295 - val_accuracy: 0.7331 - val_loss: 0.7332
```

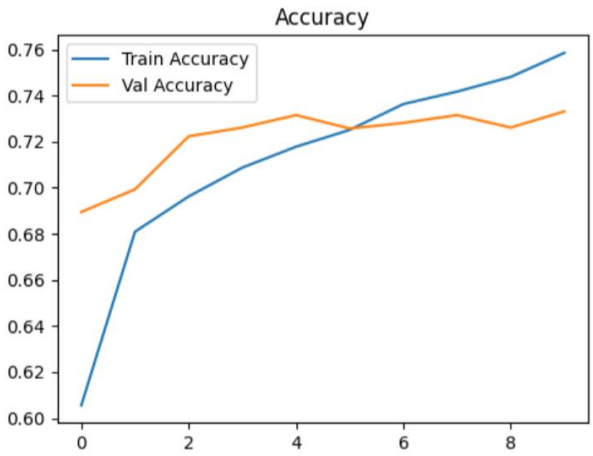
- Model Accuracy (training and validation) without preprocessing:

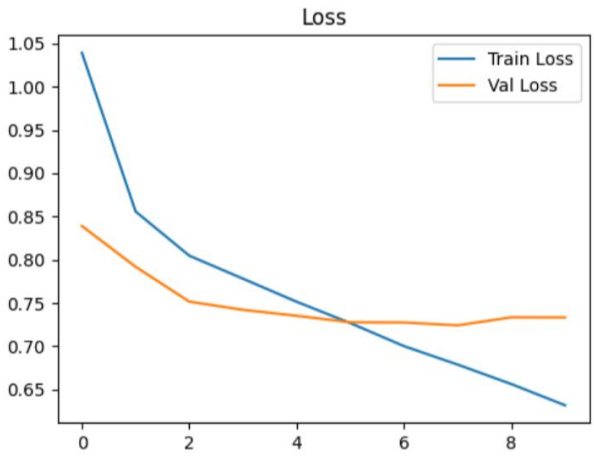
```
Epoch 8/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 82s 320ms/step - accuracy: 0.7432 - loss: 0.6808 - val_accuracy: 0.7231 - val_loss: 0.7339
Epoch 9/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 48s 311ms/step - accuracy: 0.7475 - loss: 0.6713 - val_accuracy: 0.7274 - val_loss: 0.7227
Epoch 10/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 48s 310ms/step - accuracy: 0.7624 - loss: 0.6347 - val_accuracy: 0.7278 - val_loss: 0.7559
```

Model evaluation: (74%)

```
bilstmModel.evaluate(x_val,y_val)
```

```
157/157 ━━━━━━━━━━━━━━━━━━━━ 20s 128ms/step - accuracy: 0.7407 - loss: 0.7111
[0.7240527272224426, 0.7314925789833069]
```





GRU

Architecture

Layer (type)	Output Shape	Param #
embedding_1 (Embedding)	(None, 100, 300)	14,587,200
gru (GRU)	(None, 100, 256)	428,544
dropout_2 (Dropout)	(None, 100, 256)	0
global_max_pooling1d (GlobalMaxPooling1D)	(None, 256)	0
dense_3 (Dense)	(None, 128)	32,896
dropout_3 (Dropout)	(None, 128)	0
dense_4 (Dense)	(None, 64)	8,256
dropout_4 (Dropout)	(None, 64)	0
dense_5 (Dense)	(None, 5)	325

Total params: 15,057,221 (57.44 MB)
Trainable params: 470,021 (1.79 MB)
Non-trainable params: 14,587,200 (55.65 MB)

- Model Accuracy (training and validation) without preprocessing:

```
Epoch 6/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 5s 20ms/step - accuracy: 0.7763 - loss: 0.6125 - val_accuracy: 0.7124 - val_loss: 0.7615
Epoch 7/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - accuracy: 0.7848 - loss: 0.5806 - val_accuracy: 0.7108 - val_loss: 0.7721
Epoch 8/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 5s 22ms/step - accuracy: 0.7883 - loss: 0.5752 - val accuracy: 0.7231 - val loss: 0.7593
```

- Model Accuracy (training and validation) with preprocessing:

```
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - accuracy: 0.7554 - loss: 0.6539 - val_accuracy: 0.7241 - val_loss: 0.7459
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 3s 22ms/step - accuracy: 0.7729 - loss: 0.6081 - val_accuracy: 0.7241 - val_loss: 0.7353
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 3s 21ms/step - accuracy: 0.7968 - loss: 0.5496 - val_accuracy: 0.7037 - val_loss: 0.7770
```

Model evaluation

```
✓ 1s [62] gruModel.evaluate(x_val,y_val)

155/155 ━━━━━━━━━━━━━━━━━━━━ 1s 5ms/step - accuracy: 0.7230 - loss: 0.7459
[0.7402076721191406, 0.7210953235626221]
```

Transformer

Architecture

Layer (type)	Output Shape	Param #	Connected to
input_layer_17 (InputLayer)	(None, 100)	0	-
embedding_14 (Embedding)	(None, 100, 300)	18,212,700	input_layer_17[0][0]
multi_head_attention_18 (MultiHeadAttention)	(None, 100, 300)	308,268	embedding_14[0][0], embedding_14[0][0]
add_12 (Add)	(None, 100, 300)	0	multi_head_attention_…, multi_head_attention_…
layer_normalization_26 (LayerNormalization)	(None, 100, 300)	600	add_12[0][0]
flatten_4 (Flatten)	(None, 30000)	0	layer_normalization_2…
dense_28 (Dense)	(None, 64)	1,920,064	flatten_4[0][0]
dropout_27 (Dropout)	(None, 64)	0	dense_28[0][0]
dense_29 (Dense)	(None, 5)	325	dropout_27[0][0]

Total params: 20,441,957 (77.98 MB)
Trainable params: 2,229,257 (8.50 MB)
Non-trainable params: 18,212,700 (69.48 MB)

Accuracy

- Model Accuracy (training and validation) without preprocessing:

```
Epoch 8/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 3s 14ms/step - accuracy: 0.6971 - loss: 0.7983 - val_accuracy: 0.7006 - val_loss: 0.8325
Epoch 9/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 2s 13ms/step - accuracy: 0.6930 - loss: 0.8105 - val_accuracy: 0.7053 - val_loss: 0.8219
Epoch 10/10
155/155 ━━━━━━━━━━━━━━━━━━━━ 2s 14ms/step - accuracy: 0.7001 - loss: 0.7692 - val_accuracy: 0.6890 - val_loss: 0.8353
```

Bert

```
Total params: 108,600,581 (414.28 MB)
Trainable params: 108,600,581 (414.28 MB)
Non-trainable params: 0 (0.00 B)
```

Roberta

```
Total params: 124,253,957 (473.99 MB)
Trainable params: 124,253,957 (473.99 MB)
Non-trainable params: 0 (0.00 B)
```

Ensemble

Other trials

RoBERTa + DistilRoBERTa

1. We tried removing the alpha, with max Length=128,Learning rate 0.00003,batch size=32, weight decay= 0.01 and weights= [1,0.6] with Accuracy : 77.1%

2. We tried, with max Length=512 ,Learning rate 0.00002,batch size=32, weight decay= 0.01 and weights= [1,0.7] with Accuracy : 77.6%

3. We tried removing the alpha, with max Length=128,Learning rate 0.00003,batch size=16, weight decay= 0.01 and weights= [1,0.6] with Accuracy : 77.1%

RoBERTa + BERT

1. We tried removing the alpha, with max Length=128,Learning rate 0.00003,batch size=32, weight decay= 0.01 and weights= [1,0.6] with Accuracy : 78.2%

2. We tried, with max Length=512 ,Learning rate 0.00002,batch size=32, weight decay= 0.01 and weights= [1,0.7] with Accuracy : 78.6%

3. We tried removing the alpha, with max Length=128,Learning rate 0.00003,batch size=16, weight decay= 0.01 and weights= [1,0.6] with Accuracy : 78.1%

Conclusion

Finally, what got us the highest accuracy was : Learning rate 0.00002, Weights[1,0.5] for RoBERTa and BERT respectively, with 4 epochs and batch size = 32,Max length =128