

## Project 2: Building an NLP-based doctor chatbot

[https://colab.research.google.com/drive/16HVFCg3yP0SowmHPNI-aU5w\\_U-uU4tXs?usp=sharing](https://colab.research.google.com/drive/16HVFCg3yP0SowmHPNI-aU5w_U-uU4tXs?usp=sharing)

### Problem 1: How well LSTM and GRU is better than the basic RNN model?

First of all, I read the file after downloading and the result was like below:

Context \

0 I'm going through some things with my feelings...

1 I'm going through some things with my feelings...

2 I'm going through some things with my feelings...

3 I'm going through some things with my feelings...

4 I'm going through some things with my feelings...

Response

0 If everyone thinks you're worthless, then mayb...

1 Hello, and thank you for your question and see...

2 First thing I'd suggest is getting the sleep y...

3 Therapy is essential for those that are feelin...

4 I first want to let you know that you are not ...

Then I tried to do some preprocessing on data, like change uppercase letters to lowercase, remove all non-alphabetical letters and delete spaces from the Context and Response.

After that creating tokenizer and pad sequence were done before splitting data to train a test, then I used simple and complex model RNN, LSRM and GRU and you can see in the code.

Finally, I put all of the models with same and different nodes for complex models and comment them as below.

Model: "RNN"

Layer (type)	Output Shape	Param #
=====		
embedding_9 (Embedding)	(None, 538, 100)	377800
simple_rnn_5 (SimpleRNN)	(None, 538, 128)	29312
simple_rnn_6 (SimpleRNN)	(None, 128)	32896
dense_15 (Dense)	(None, 64)	8256

dense\_16 (Dense) (None, 2479) 161135

=====  
Total params: 609399 (2.32 MB)  
Trainable params: 609399 (2.32 MB)  
Non-trainable params: 0 (0.00 Byte)

None  
Model: "LSTM"

Layer (type)	Output Shape	Param #
embedding_10 (Embedding)	(None, 538, 100)	377800
lstm_5 (LSTM)	(None, 538, 128)	117248
lstm_6 (LSTM)	(None, 128)	131584
dense_17 (Dense)	(None, 64)	8256
dense_18 (Dense)	(None, 2479)	161135

=====  
Total params: 796023 (3.04 MB)  
Trainable params: 796023 (3.04 MB)  
Non-trainable params: 0 (0.00 Byte)

None  
Model: "GRU"

Layer (type)	Output Shape	Param #
embedding_11 (Embedding)	(None, 538, 100)	377800
gru_5 (GRU)	(None, 538, 256)	274944
gru_6 (GRU)	(None, 256)	394752
dense_19 (Dense)	(None, 128)	32896
dense_20 (Dense)	(None, 2479)	319791

=====  
Total params: 1400183 (5.34 MB)  
Trainable params: 1400183 (5.34 MB)  
Non-trainable params: 0 (0.00 Byte)

I trained three different neural network (RNN) architectures (Basic RNN, LSTM, and GRU) for a text classification task using the dataset. Here's what I observed:

1. **Model Training:** All models were trained for 10 epochs, using the same training and validation data split.
2. **Performance Metrics:** The reported performance metrics (accuracy, precision, recall, and F1 score) varied significantly across the models:

- The Basic RNN model's performance was notably poor, with all metrics close to zero. This suggests it struggled to learn meaningful patterns or encountered issues like vanishing gradients.
- The LSTM model showed slightly better performance than the Basic RNN, but it still performed relatively poorly, indicating it may not effectively capture the data's complexities.
- The GRU model outperformed the others significantly, achieving higher metrics across the board. This implies it learned more meaningful representations and made better predictions.

In conclusion, the GRU model shows better, but further analysis and experimentation could enhance all models' performance.

Performance Metrics: Basic RNN - Accuracy: 0.0000, Precision: 0.0000, Recall: 0.0000, F1 Score: 0.0000

LSTM - Accuracy: 0.0100, Precision: 0.0078, Recall: 0.0100, F1 Score: 0.0085

GRU - Accuracy: 0.1766, Precision: 0.1565, Recall: 0.1766, F1 Score: 0.1623

The performance metrics show that the Basic RNN model achieved accuracy, precision, recall, and F1 score of 0.0000, indicating poor performance. The LSTM model performed slightly better with an accuracy of 0.0100 and precision, recall, and F1 score around 0.0085. However, the GRU model outperformed the others significantly with an accuracy of 0.1766 and precision, recall, and F1 score around 0.1565 to 0.1623. This suggests that the GRU model learned more meaningful representations and made better predictions compared to the Basic RNN and LSTM models.

And also with using `df = df.sample(frac=0.5, random_state=1)`, I again did the process for simple RNN, LSTM and GRU and the results were the same. You can see in the code after first part.

I did with different settings on models and attached in the name of MLDP\_Project2-1.ipynb but I put final part in the MLDP\_Project2.ipynb and Google colab link.

## Problem 2: Benchmark an LLM with LSTM and GRU model.

Before applying LLM gpt2, I used the code in the relevant lecture for LSTM and GRU to see the result for train.csv file, but for speedy process, I limited the data to 500 pairs records and the results were like below.

### LSTM

Read 500 sentence pairs

Counting words...

Counted words:

Context 252

Response 3063

4m 12s (- 163m 58s) (5 2%) 5.1530

6m 27s (- 122m 38s) (10 5%) 1.2582

.

.

.  
87m 28s (- 2m 14s) (195 97%) 0.4797

89m 36s (- 0m 0s) (200 100%) 0.4480

The results, if we check with train.csv, it is acceptable.

> I have so many issues to address. I have a history of sexual abuse; I'm a breast cancer survivor and I am a lifetime insomniac. I have a long history of depression and I'm beginning to have anxiety. I have low self-esteem but I've been happily married for almost 35 years.

I've never had counselling about any of this. Do I have too many issues to address in counselling?

= Absolutely not. I strongly recommend working on one issue/need at a time. In therapy you will set smart goals and objectives that will help you reach your goals. I see you as a survivor and not a victim. Best wishes to you.

< SOS

> I'm going through some things with my feelings and myself. I barely sleep and I do nothing but think about how I'm worthless and how I shouldn't be here.

I've never tried or contemplated suicide. I've always wanted to fix my issues, but I never get around to it.

How can I change my feeling of being worthless to everyone?

= You are exhibiting some specific traits of a particular temperament type. Seek out a counsellor who provides NCCA temperament therapy and discover the joy of being you -- God loves you as you are!

< SOS

## **GRU**

Read 500 sentence pairs

Counting words...

Counted words:

Context 252

Response 3063

3m 14s (- 126m 19s) (5 2%) 4.5540

5m 3s (- 96m 10s) (10 5%) 1.1753

.

.

72m 28s (- 1m 51s) (195 97%) 0.3794

74m 17s (- 0m 0s) (200 100%) 0.3637

The results, it is acceptable considering the output especially in < part(means this function), although the time or running was the same for LSTM and GRU:

```
def evaluateRandomly(encoder, decoder, pairs, input_lang, output_lang,
n=10):
    for i in range(n):
        pair = random.choice(pairs)
        print('>', pair[0])
        print('=', pair[1])
        output_words, _ = evaluate(encoder, decoder, pair[0],
input_lang, output_lang)
        output_sentence = ' '.join(output_words)
        print('<', output_sentence)
        print('')
```

> I struggle with depression as well as pretty intense mood swings throughout the month. I experience highs where I feel amazing and energetic and then lows where I lack focus, energy, and generally have a more dark outlook on my life. How can I live a more balanced life?

= You may already be living a balanced life because you are aware of your ups and downs due to hormonal changes of your menstrual cycle. As much as possible, schedule activities around your expected mood swings. This way you'll avoid feeling even more tired from a busy scheduled during a low energy time in the month. The hormonal cycle is normal. Opinions vary as to taking natural, homeopathic supplements or Pharma drugs which will influence your cycle and make your mood more even. There are side effects to at least the Pharma drugs, which is a consideration as to the value of taking them. Reflect on which is your style of living and what will make you feel successful in handling this problem. Sticking to a system which mirrors the type of person you are, means more than any one particular answer anyone gives you.

< It sounds like you have too many issues for counselling. In fact, most people have a deeply-rooted base in your life can help you get to work on in the way they sound. Now, your feelings and depression

> I have so many issues to address. I have a history of sexual abuse; I'm a breast cancer survivor and I am a lifetime insomniac. I have a long history of depression and I'm beginning to have anxiety. I have low self-esteem but I've been happily married for almost 35 years.

I've never had counselling about any of this. Do I have too many issues to address in counselling?

= Hi! Many people begin their therapeutic journey with histories just like yours and experience transformative shifts in their quality of life. I hope you are able to find a counsellor you feel comfortable working with and do the work if you feel called. Best of luck on your journey!

< It sounds like you have too many issues for counselling. In fact, most people have a deeply-rooted base in your life can help you get to work on in the way they sound. Now, your feelings and have the opportunity to help you with a therapist who is a great way to address in your life and what you can be a great way to address in your life can help you to find the issues you to address first and work with a therapist who is a great place that are a holistic standpoint can help you to find a therapist who is a great way to address in your life and what you can

be a great way to address in your life can help you to find the issues you to address first and work with a therapist who is a great place that are a good tool to help you.

## LLM, GPT2

I used GPT2 for LLM model on whole train.csv, running with TPU in google colab and the result was:

```
/usr/local/lib/python3.10/dist-packages/huggingface_hub/utils/_token.py:88: 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/)
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(
tokenizer_config.json: 100% ██████████ 26.0/26.0 [00:00<00:00, 1.76kB/s]
vocab.json: 100% ██████████ 1.04M/1.04M [00:00<00:00, 5.80MB/s]
merges.txt: 100% ██████████ 456k/456k [00:00<00:00, 2.78MB/s]
tokenizer.json: 100% ██████████ 1.36M/1.36M [00:00<00:00, 4.83MB/s]
config.json: 100% ██████████ 665/665 [00:00<00:00, 49.8kB/s]
model.safetensors: 100% ██████████ 548M/548M [00:02<00:00, 217MB/s]
generation_config.json: 100% ██████████ 124/124 [00:00<00:00, 6.01kB/s]
/usr/local/lib/python3.10/dist-packages/transformers/optimization.py:429: FutureWarning: This implement
warnings.warn(
Epoch 1/3
100%|██████████| 4390/4390 [12:01<00:00, 6.09it/s]
Epoch 2/3
100%|██████████| 4390/4390 [11:57<00:00, 6.12it/s]
Epoch 3/3
100%|██████████| 4390/4390 [11:57<00:00, 6.12it/s]
('fine_tuned_mental_health_gpt2_model/tokenizer_config.json',
'fine_tuned_mental_health_gpt2_model/special_tokens_map.json',
'fine_tuned_mental_health_gpt2_model/vocab.json',
'fine_tuned_mental_health_gpt2_model/merges.txt',
'fine_tuned_mental_health_gpt2_model/added_tokens.json')
```

I saved the model for testing in next step:

Model Details:

```
GPT2LMHeadModel(
  (transformer): GPT2Model(
    (wte): Embedding(50257, 768)
    (wpe): Embedding(1024, 768)
    (drop): Dropout(p=0.1, inplace=False)
    (h): ModuleList(
      (0-11): 12 x GPT2Block(
        (ln_1): LayerNorm((768,), eps=1e-05, elementwise_affine=True)
        (attn): GPT2Attention(
          (c_attn): Conv1D()
          (c_proj): Conv1D()
          (attn_dropout): Dropout(p=0.1, inplace=False)
          (resid_dropout): Dropout(p=0.1, inplace=False)
        )
        (ln_2): LayerNorm((768,), eps=1e-05, elementwise_affine=True)
        (mlp): GPT2MLP(
          (c_fc): Conv1D()
          (c_proj): Conv1D()

```

```

        (act): NewGELUActivation()
        (dropout): Dropout(p=0.1, inplace=False)
    )
)
(In_f): LayerNorm((768,), eps=1e-05, elementwise_affine=True)
)
(lm_head): Linear(in_features=768, out_features=50257, bias=False)
)

```

This GPT-2 language model consists of a series of transformer layers, each containing embedding layers for tokens and positional information, dropout regularization to prevent overfitting, attention mechanisms to focus on relevant parts of the input, feedforward neural networks for processing, and layer normalization for stabilizing training. The model's `lm_head` serves as the final layer, predicting the next token in a sequence based on the hidden states of the transformer, enabling effective generation of text sequences.

The output was almost acceptable:

The attention mask and the pad token id were not set. As a consequence, you may observe unexpected behavior. Please pass your input's `'attention_mask'` to obtain reliable results.

Setting `'pad_token_id'` to `'eos_token_id':50256` for open-end generation.

Generated Text: How can I get to a place where I can be content from day to day? I love that you are so thoughtful and proactive about this! If only every client came in as solution focused as you, my job would be so much easier

Perplexity: 283.3677978515625

I changed `attention_mask` and the result were the same.

Although, after take a deep look on data, there are repetitive sentences in Context columns and if we can use n-grams technique, it should come to better result but anyway I did not have time to do and solve the errors, just add at the end of the codes.