Installing Modules

```
!pip install spacy==3
!python -m spacy download en_core_web_sm
!pip install pytorch_lightning torchmetrics tableprint
```

```
Collecting PyYAML<=5.4.1,>=5.1
  Downloading https://files.pythonhosted.org/packages/7a/a5/393c087efdc7809
     |████████████████████████████████| 645kB 31.7MB/s
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-pac
Requirement already satisfied: protobuf>=3.6.0 in /usr/local/lib/python3.7/
Requirement already satisfied: grpcio>=1.24.3 in /usr/local/lib/python3.7/d
Requirement already satisfied: google-auth<2,>=1.6.3 in /usr/local/lib/pyth
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/loc
Requirement already satisfied: six>=1.10.0 in /usr/local/lib/python3.7/dist
Requirement already satisfied: werkzeug>=0.11.15 in /usr/local/lib/python3.
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /usr/local/
Requirement already satisfied: absl-py>=0.4 in /usr/local/lib/python3.7/dis
Requirement already satisfied: wheel>=0.26; python_version >= "3" in /usr/l
Requirement already satisfied: requests<3,>=2.21.0 in /usr/local/lib/python
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/
Requirement already satisfied: setuptools>=41.0.0 in /usr/local/lib/python3
Collecting aiohttp; extra == "http"
  Downloading https://files.pythonhosted.org/packages/88/c0/5890b4c8b04a79b
     |████████████████████████████████| 1.3MB 31.4MB/s
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.
Requirement already satisfied: pyparsing>=2.0.2 in /usr/local/lib/python3.7
Requirement already satisfied: cachetools<5.0,>=2.0.0 in /usr/local/lib/pyt
Requirement already satisfied: rsa<5,>=3.1.4; python_version >= "3.6" in /u
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/pyth
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/p
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dis
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /
Requirement already satisfied: importlib-metadata; python_version < "3.8" i
Collecting multidict<7.0,>=4.5
  Downloading https://files.pythonhosted.org/packages/7c/a6/4123b8165acbe77
     |████████████████████████████████| 143kB 37.6MB/s
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.7/di
Collecting yarl<2.0,>=1.0
  Downloading https://files.pythonhosted.org/packages/f1/62/046834c5fc998c8
     |████████████████████████████████| 296kB 41.7MB/s
Collecting async-timeout<4.0,>=3.0
  Downloading https://files.pythonhosted.org/packages/e1/1e/5a4441be21b0726
Requirement already satisfied: pyasn1>=0.1.3 in /usr/local/lib/python3.7/di
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/

Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-p
Building wheels for collected packages: future
  Building wheel for future (setup.py) ... done
  Created wheel for future: filename=future-0.18.2-cp37-none-any.whl size=4
  Stored in directory: /root/.cache/pip/wheels/8b/99/a0/81daf51dcd359a9377b
Successfully built future
ERROR: tensorflow 2.5.0 has requirement tensorboard~=2.5, but you'll have t
Installing collected packages: tensorboard, multidict, yarl, async-timeout,
  Found existing installation: tensorboard 2.5.0
```

```
      Uninstalling tensorboard-2.5.0:
        Successfully uninstalled tensorboard-2.5.0
    Found existing installation: future 0.16.0
      Uninstalling future-0.16.0:
        Successfully uninstalled future-0.16.0
    Found existing installation: PyYAML 3.13
      Uninstalling PyYAML-3.13:
        Successfully uninstalled PyYAML-3.13
Successfully installed PyYAML-5.4.1 aiohttp-3.7.4.post0 async-timeout-3.0.1
```

Imports

```
# Import Library
import random
import torch, torchtext
# from torchtext.legacy import data
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim


import pandas as pd
import sys, os, pickle
import numpy as np
import math
import matplotlib.pyplot  as plt

import spacy

import pytorch_lightning as pl
import torchmetrics

from pytorch_lightning.loggers import CSVLogger
from pytorch_lightning.callbacks import ModelCheckpoint
import tableprint as tp

import collections
import re
from torchtext.vocab import vocab

# Manual Seed
SEED = 43
torch.manual_seed(SEED)
```

```
    <torch._C.Generator at 0x7f9d2f3c4bd0>
```

Loading Data

Cornell Movie--Dialogs Corpus https://www.cs.cornell.edu/~cristian/Cornell_Movie-Dialogs_Corpus.html

```
!wget http://www.cs.cornell.edu/~cristian/data/cornell_movie_dialogs_corpus.zip
```

```
--2021-06-21 10:11:45--  http://www.cs.cornell.edu/~cristian/data/cornell_mov
Resolving www.cs.cornell.edu (www.cs.cornell.edu)... 132.236.207.36
Connecting to www.cs.cornell.edu (www.cs.cornell.edu)|132.236.207.36|:80... c
HTTP request sent, awaiting response... 200 OK
Length: 9916637 (9.5M) [application/zip]
Saving to: ‘cornell_movie_dialogs_corpus.zip’

cornell_movie_dialo 100%[===================>]   9.46M  11.1MB/s    in 0.9s

2021-06-21 10:11:46 (11.1 MB/s) - ‘cornell_movie_dialogs_corpus.zip’ saved [9
```

```
!unzip cornell_movie_dialogs_corpus
```

```
Archive:  cornell_movie_dialogs_corpus.zip
   creating: cornell movie-dialogs corpus/
  inflating: cornell movie-dialogs corpus/.DS_Store
   creating: __MACOSX/
   creating: __MACOSX/cornell movie-dialogs corpus/
  inflating: __MACOSX/cornell movie-dialogs corpus/._.DS_Store
  inflating: cornell movie-dialogs corpus/chameleons.pdf
  inflating: __MACOSX/cornell movie-dialogs corpus/._chameleons.pdf
  inflating: cornell movie-dialogs corpus/movie_characters_metadata.txt
  inflating: cornell movie-dialogs corpus/movie_conversations.txt
  inflating: cornell movie-dialogs corpus/movie_lines.txt
  inflating: cornell movie-dialogs corpus/movie_titles_metadata.txt
  inflating: cornell movie-dialogs corpus/raw_script_urls.txt
  inflating: cornell movie-dialogs corpus/README.txt
  inflating: __MACOSX/cornell movie-dialogs corpus/._README.txt
```

```
lines_file = 'cornell movie-dialogs corpus/movie_lines.txt'
conv_file = 'cornell movie-dialogs corpus/movie_conversations.txt'
```

Description from the README file

- movie_lines.txt
  - contains the actual text of each utterance
  - fields:
    - lineID
    - characterID (who uttered this phrase)
    - movieID
    - character name
    - text of the utterance
- movie_conversations.txt
  - the structure of the conversations
  - fields

- characterID of the first character involved in the conversation
- characterID of the second character involved in the conversation
- movieID of the movie in which the conversation occurred
- list of the utterances that make the conversation, in chronological order: ['lineID1','lineID2', ... ,'lineIDN']
    - has to be matched with movie_lines.txt to reconstruct the actual content

```
line_fields = ['line_id', 'char_id', 'movie_id', 'char', 'line']
lines = {}
with open(lines_file, 'r', encoding='iso-8859-1') as f:
  for line in f:
    values = line.split(" +++$+++ ")
    line_dict = {}
    for i, field in enumerate(line_fields):
      line_dict[field] = values[i]
    lines[line_dict['line_id']] = line_dict


conv_fields = ['char1_id', 'char2_id', 'movie_id', 'list_line']
conv = []
with open(conv_file, 'r', encoding='iso-8859-1') as f:
  for line in f:
    values = line.split(" +++$+++ ")
    conv_dict = {}
    for i, field in enumerate(conv_fields):
      conv_dict[field] = values[i]
    list_line = eval(conv_dict['list_line'])
    conv_dict['lines'] = []
    for line_id in list_line:
      conv_dict['lines'].append(lines[line_id])
    conv.append(conv_dict)



diag_pairs = []
for diag in conv:
  for i in range(len(diag['lines']) -1):
    diag1 = diag['lines'][i]['line'].strip()
    diag2 = diag['lines'][i+1]['line'].strip()
    if diag1 and diag2:
      diag_pairs.append([diag1, diag2])
df_raw = pd.DataFrame(diag_pairs, columns=['diag1', 'diag2'])


df_raw.head()
```

	diag1	diag2
0	Can we make this quick? Roxanne Korrine and	Well, I thought we'd start with pronunciation....

Preprocessing the Data

Here, we lower the text and remove contractions and 'weird' characters!

3	You're asking me out. That's so cute. What's	Forget it

```
def diag_cleaner(diag):
  diag = diag.lower()
  diag = diag[:50]
  diag = re.sub(r"i'm", "i am", diag)
  diag = re.sub(r"it's", "it is", diag)
  diag = re.sub(r"he's", "he is", diag)
  diag = re.sub(r"she's", "she is", diag)
  diag = re.sub(r"that's", "that is", diag)
  diag = re.sub(r"what's", "what is", diag)
  diag = re.sub(r"where's", "where is", diag)
  diag = re.sub(r"\'ll", " will", diag)
  diag = re.sub(r"\'ve", " have", diag)
  diag = re.sub(r"\'re", " are", diag)
  diag = re.sub(r"\'d", " would", diag)
  diag = re.sub(r"won't", "will not", diag)
  diag = re.sub(r"can't", "can not", diag)
  diag = re.sub(r"[-()\"#/@;:<>{}+=~|.?,]", "", diag)
  return diag


df = df_raw.applymap(diag_cleaner)
df.head()
```

	diag1	diag2
0	can we make this quick roxanne korrine and andre	well i thought we would start with pronunciati...
1	well i thought we would start with pronunciati...	not the hacking and gagging and spitting part pl
2	not the hacking and gagging and spitting part pl	okay then how 'bout we try out some french cuis
3	you are asking me out that is so cute what is...	forget it

```
df.head()
```

	diag1	diag2
0	can we make this quick roxanne korrine and andre	well i thought we would start with pronunciati...
2	not the hacking and gagging and spitting part pl	okay then how 'bout we try out some french

```
from sklearn.model_selection import train_test_split

train_df, test_df = train_test_split(df[:120000], test_size=0.3)
```

Tokenization and Building Dataset/DataLoader

```
print(f'Number of Train Examples: {len(train_df)}')
print(f'Number of Test Examples: {len(test_df)}')
```

```
    Number of Train Examples: 84000
    Number of Test Examples: 36000
```

```
from torchtext.data.utils import get_tokenizer
en_tokenizer = get_tokenizer('spacy', language='en_core_web_sm')
```

```
# https://pytorch.org/tutorials/beginner/chatbot_tutorial.html?highlight=chatbot%2

class Voc:
    def __init__(self, name):
        self.name = name
        self.trimmed = False
        self.word2index = {}
        self.word2count = {}
        self.index2word = {PAD_token: "PAD", SOS_token: "SOS", EOS_token: "EOS"}
        self.num_words = 3  # Count SOS, EOS, PAD

    def addSentence(self, sentence):
        for word in sentence.split(' '):
            self.addWord(word)

    def addWord(self, word):
        if word not in self.word2index:
            self.word2index[word] = self.num_words
            self.word2count[word] = 1
            self.index2word[self.num_words] = word
            self.num_words += 1
        else:
            self.word2count[word] += 1

    # Remove words below a certain count threshold
    def trim(self, min_count):
        if self.trimmed:
            return
        self.trimmed = True

        keep_words = []
        for k, v in self.word2count.items():
            if v >= min_count:
                keep_words.append(k)

        print('keep_words {} / {} = {:.4f}'.format(
            len(keep_words), len(self.word2index), len(keep_words) / len(self.word2
        ))

        # Reinitialize dictionaries
        self.word2index = {}
        self.word2count = {}
        self.index2word = {PAD_token: "PAD", SOS_token: "SOS", EOS_token: "EOS"}
        self.num_words = 3 # Count default tokens

        for word in keep_words:
            self.addWord(word)


def readVocs(datafile, corpus_name):
    print("Reading lines...")
    # Read the file and split into lines
    lines = open(datafile, encoding='utf-8').\
        read().strip().split('\n')
    # Split every line into pairs and normalize
    pairs = [[normalizeString(s) for s in l.split('\t')] for l in lines]
    voc = Voc(corpus_name)
    return voc, pairs





def build_vocab(df, tokenizer, **vocab_kwarg):

    token_freqs = collections.Counter()

    for index, row  in df.iterrows():
        tokens1 = tokenizer(row['diag1'])
        token_freqs.update(tokens1)
        tokens2 = tokenizer(row['diag2'])
        token_freqs.update(tokens2)

    voc = torchtext.vocab.vocab(token_freqs, min_freq = 5)
    unk_token = '<unk>'
    default_index = 0
    if unk_token not in voc:
        voc.insert_token(unk_token, 0)
    voc.set_default_index(default_index)


    return voc


en_vocab = build_vocab(train_df, en_tokenizer)
```

```
en_vocab_itos = en_vocab.get_itos()


print('Size of input vocab : ', len(en_vocab))

     Size of input vocab :  8892


def data_process(df):
    data = []
    for index, row in df.iterrows():
      diag1_tensor_ = torch.tensor([en_vocab[token] for token in en_tokenizer(row[
                                dtype=torch.long)
      diag2_tensor_ = torch.tensor([en_vocab[token] for token in en_tokenizer(row[
                                dtype=torch.long)
      data.append((diag1_tensor_, diag2_tensor_))
    return data

train_dataset = data_process(train_df)
# val_dataset = data_process(val_df)
test_dataset = data_process(test_df)


PAD_IDX = en_vocab['<pad>']
print(PAD_IDX)

     0


class Collator:
    def __init__(self, pad_idx):

        self.pad_idx = pad_idx

    def collate(self, batch):
        src_batch, trg_batch = [], []
        for src_item, trg_item in batch:
          src_batch.append(torch.cat([src_item], dim=0))
          trg_batch.append(torch.cat([trg_item], dim=0))
        src_batch = nn.utils.rnn.pad_sequence(src_batch, padding_value=self.pad_id
        trg_batch = nn.utils.rnn.pad_sequence(trg_batch, padding_value=self.pad_id

        return src_batch, trg_batch


collator = Collator(PAD_IDX)


batch_size = 32

train_loader = torch.utils.data.DataLoader(train_dataset,
                                            batch_size,
                                            shuffle = True,
                                            collate_fn = collator.collate,
                                            drop_last=True
                                          )

test_loader = torch.utils.data.DataLoader(test_dataset,
                                            batch_size,
                                            shuffle = False,
                                            collate_fn = collator.collate,
                                            drop_last=True
                                          )
```

Initializing GPU as the device

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

Save the vocabulary for later use

```
# with open('en_tokenizer.pkl', 'wb') as tokens:
#     pickle.dump(en_vocab.stoi, tokens)
```

Defining Our Model

Boilerplate code

```
class TL(pl.LightningModule):
    def __init__(self):
        super(TL, self).__init__()

        self.train_acc =  torch.tensor(0.)
        self.avg_train_loss = torch.tensor(0.)
        self.table_context = None


    def training_step(self, batch, batch_idx):
        src, trg = batch
        output = self(src, trg)
        output_dim = output.shape[-1]
        output = output[1:].view(-1, output_dim)
        trg = trg[1:].view(-1)
        loss_train = self.loss(output, trg)
        return loss_train

    def validation_step(self, batch, batch_idx):
        src, trg = batch
        output = self(src, trg, 0)
        output_dim = output.shape[-1]
        output = output[1:].view(-1, output_dim)
        trg = trg[1:].view(-1)
        loss_valid = self.loss(output, trg)
        return {"loss": loss_valid}

    def training_epoch_end(self, outputs):
```

```
    def training_epoch_end(self, outputs):
        self.avg_train_loss = torch.stack([x['loss'] for x in outputs]).mean()

    def validation_epoch_end(self, outputs):
        if trainer.running_sanity_check:
            return
        avg_valid_loss = torch.stack([x['loss'] for x in outputs]).mean()
        metrics = {'epoch': self.current_epoch+1, 'Train PPL': math.exp(self.avg_t
        if self.table_context is None:
            self.table_context = tp.TableContext(headers=['epoch', 'Train PPL', 'T
            self.table_context.__enter__()
        self.table_context([self.current_epoch+1, math.exp(self.avg_train_loss.ite
        self.logger.log_metrics(metrics)
        if self.current_epoch == self.trainer.max_epochs - 1:
            self.validation_end(outputs)

    def validation_end(self, outputs):
        self.table_context.__exit__()
```

Encoder

```
class Encoder(pl.LightningModule):
    def __init__(self, input_dim, emb_dim, hid_dim, n_layers, dropout):
        super().__init__()

        self.hid_dim = hid_dim
        self.n_layers = n_layers

        self.embedding = nn.Embedding(input_dim, emb_dim)
        self.rnn = nn.LSTM(emb_dim, hid_dim, n_layers, dropout = dropout, batch_fi
        self.dropout = nn.Dropout(dropout)

    def forward(self, src):
        embedded = self.dropout(self.embedding(src))
        output, (hidden,cell) = self.rnn(embedded)

        return hidden,cell
```

Decoder

```
class Decoder(pl.LightningModule):
    def __init__(self, emb_dim, hid_dim, n_layers, dropout, output_dim):
        super().__init__()

        self.hid_dim = hid_dim
        self.n_layers = n_layers
        self.output_dim = output_dim
        self.embedding = nn.Embedding(output_dim, emb_dim)
        self.rnn = nn.LSTM(emb_dim, hid_dim, n_layers, dropout = dropout, batch_fi
        self.fc_out = nn.Linear(hid_dim, output_dim)
        self.dropout = nn.Dropout(dropout)
    def forward(self, input, hidden, cell):
        input = input.unsqueeze(0)
        embedded = self.dropout(self.embedding(input))
        output, (hidden,cell) = self.rnn(embedded, (hidden,cell))
        prediction = self.fc_out(output.squeeze(0))

        return prediction, hidden, cell
```

Seq2Seq Model

```
# Define the model

class Seq2Seq(TL):
    def __init__(self, encoder, decoder, device):
        super(Seq2Seq, self).__init__()

        TRG_PAD_IDX = en_vocab['<PAD>']
        self.loss = nn.CrossEntropyLoss(ignore_index=TRG_PAD_IDX)
        self.lr = 1e-3

        self.encoder = encoder
        self.decoder = decoder
        # self.device = device # Doesn't work in PyTorchLightning since it is alre

        assert encoder.hid_dim == decoder.hid_dim, "Hidden Dimensions of Encoder a
        assert encoder.n_layers == decoder.n_layers, "Encoder and Decoder must hav

    def forward(self, src, trg, teacher_forcing_ratio = 0.5):

        batch_size = trg.shape[1]
        trg_len = trg.shape[0]
        trg_vocab_size = self.decoder.output_dim
        outputs = torch.zeros(trg_len, batch_size, trg_vocab_size).to(self.device)

        hidden, cell = self.encoder(src)

        input = trg[0,:]

        for t in range(1, trg_len):

            output, hidden,cell = self.decoder(input, hidden, cell)

            outputs[t] = output

            teacher_force = random.random() < teacher_forcing_ratio

            top1 = output.argmax(1)

            input = trg[t] if teacher_force else top1

        return outputs
    def configure_optimizers(self):
        optim = torch.optim.Adam(self.parameters())
        return optim


INPUT_DIM = len(en_vocab)
OUTPUT_DIM = len(en_vocab)
ENC_EMB_DIM = 256
DEC_EMB_DIM = 256
HID_DIM = 512
N_LAYERS = 2
ENC_DROPOUT = 0.5
DEC_DROPOUT = 0.5

enc = Encoder(INPUT_DIM, ENC_EMB_DIM, HID_DIM, N_LAYERS, ENC_DROPOUT)
dec = Decoder(DEC_EMB_DIM, HID_DIM, N_LAYERS, DEC_DROPOUT, OUTPUT_DIM)

model = Seq2Seq(enc, dec, device).to(device)
```

Model Checkpoint

This saves the best model (best => model with lowest val loss)

```
checkpoint_callback = ModelCheckpoint(
    monitor='val_loss',
    dirpath='/content',
    filename='sst-{epoch:02d}-{val_loss:.2f}',
    mode='min'
)
```

```
!rm -rf csv_logs
csvlogger = CSVLogger('csv_logs', name='END2 Assign 7_2_TL', version=0)
trainer = pl.Trainer(max_epochs=50, num_sanity_val_steps=1, logger=csvlogger, gpus
trainer.fit(model, train_dataloader=train_loader, val_dataloaders=test_loader)
checkpoint_callback.best_model_path
```

```
GPU available: True, used: True
TPU available: False, using: 0 TPU cores
LOCAL_RANK: 0 - CUDA_VISIBLE_DEVICES: [0]

  | Name    | Type             | Params
---------------------------------------------
0 | loss    | CrossEntropyLoss | 0
1 | encoder | Encoder          | 6.0 M
2 | decoder | Decoder          | 10.5 M
---------------------------------------------
16.5 M    Trainable params
0         Non-trainable params
16.5 M    Total params
65.883    Total estimated model params size (MB)
```

```
Validation sanity check: 0%                                  0/1 [26:49<?, ?it/s]

Epoch 49: 100%              3750/3750 [04:40<00:00, 13.37it/s, loss=4.21, v_num=0]
```

```
|      epoch |  Train PPL | Train Loss |  Valid PPL | Valid Loss |
|------------|------------|------------|------------|------------|
|          1 |     315.81 |     5.7551 |     331.07 |     5.8023 |
|          2 |     225.28 |     5.4173 |     319.02 |     5.7652 |
|          3 |     198.15 |      5.289 |     312.05 |     5.7432 |
|          4 |     184.37 |      5.217 |     314.27 |     5.7502 |
|          5 |     172.48 |     5.1503 |     323.92 |     5.7805 |
|          6 |     163.25 |     5.0953 |     329.32 |      5.797 |
|          7 |      156.2 |     5.0512 |     329.13 |     5.7964 |
|          8 |     148.27 |      4.999 |     333.04 |     5.8083 |
|          9 |     142.62 |     4.9602 |     342.53 |     5.8364 |
|         10 |      136.2 |     4.9141 |     357.16 |     5.8782 |
|         11 |     131.68 |     4.8804 |     362.26 |     5.8924 |
|         12 |     127.42 |     4.8475 |     368.83 |     5.9103 |
|         13 |     124.48 |     4.8242 |     379.03 |     5.9376 |
|         14 |     121.49 |     4.7998 |     379.74 |     5.9395 |
|         15 |     118.16 |      4.772 |     398.14 |     5.9868 |
|         16 |     115.58 |       4.75 |     404.76 |     6.0033 |
|         17 |     111.86 |     4.7173 |     417.31 |     6.0338 |
|         18 |     108.97 |      4.691 |     422.01 |      6.045 |
|         19 |     106.56 |     4.6687 |        431 |     6.0661 |
|         20 |     104.03 |     4.6447 |     448.81 |     6.1066 |
|         21 |      102.6 |     4.6309 |     456.92 |     6.1245 |
|         22 |     100.45 |     4.6097 |     476.98 |     6.1675 |
|         23 |     97.978 |     4.5847 |     482.61 |     6.1792 |
|         24 |     96.184 |     4.5663 |      483.2 |     6.1804 |
|         25 |     94.037 |     4.5437 |     508.74 |     6.2319 |
|         26 |     91.388 |     4.5151 |     524.85 |     6.2631 |
|         27 |     91.037 |     4.5113 |     526.23 |     6.2657 |
|         28 |     89.147 |     4.4903 |     542.88 |     6.2969 |
|         29 |     87.207 |     4.4683 |     560.52 |     6.3289 |
|         30 |     85.346 |     4.4467 |     581.16 |      6.365 |
|         31 |     85.294 |     4.4461 |     588.61 |     6.3778 |
|         32 |     83.465 |     4.4244 |     595.14 |     6.3888 |
|         33 |     81.738 |     4.4035 |     617.28 |     6.4253 |
|         34 |     81.109 |     4.3958 |     611.05 |     6.4152 |
|         35 |      80.05 |     4.3827 |     636.79 |     6.4564 |
|         36 |     78.409 |     4.3619 |     649.12 |     6.4756 |
```

Training Log

```
|         40 |     74.412 |     4.3096 |     723.66 |     6.5835 |
```

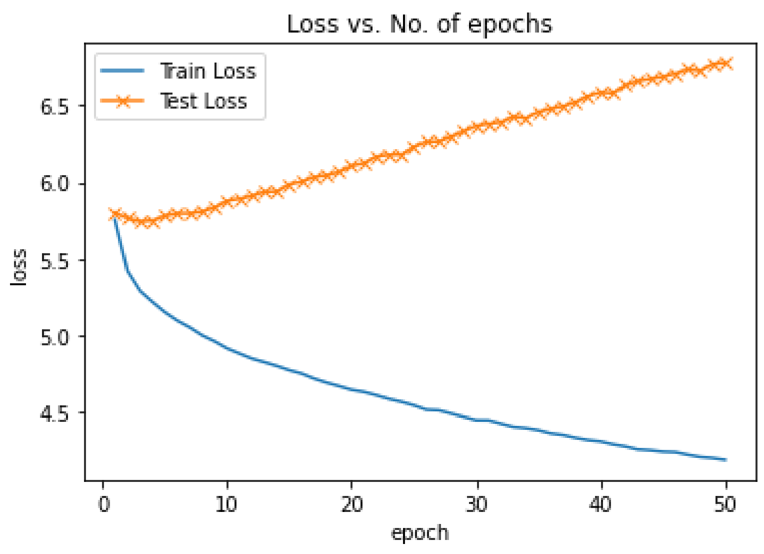
First define the optimizer and loss functions

```
    |          44 |      70.264 |      4.2523 |      790.37 |      6.6725 |
```

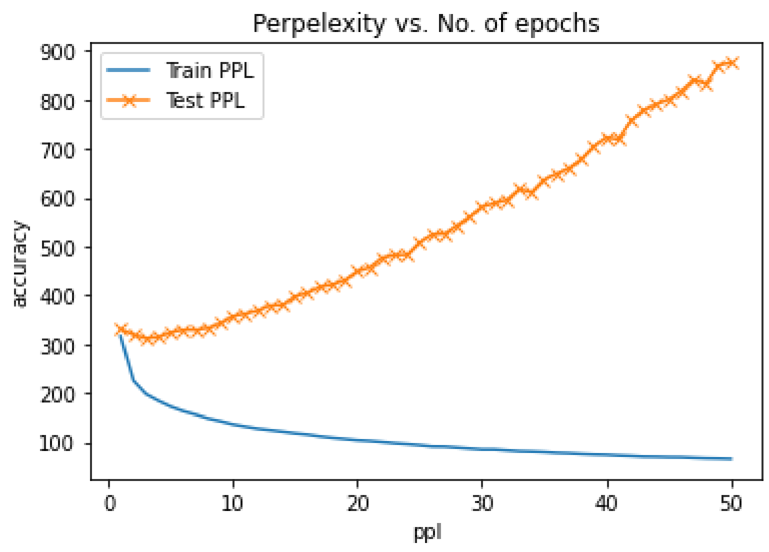
```
root='./csv_logs/' + 'END2 Assign 7_2_TL' + '/'
dirlist = [ item for item in os.listdir(root) if os.path.isdir(os.path.join(root,
metricfile = root + dirlist[-1:][0] + '/metrics.csv'
metrics = pd.read_csv(metricfile)
```

```
    |          50 |       66.01 |      4.1898 |      875.92 |      6.7753 |
```

```
plt.plot(metrics['epoch'], metrics['Train Loss'], label="Train Loss")
plt.plot(metrics['epoch'], metrics['Valid Loss'], '-x', label="Test Loss")
plt.xlabel('epoch')
plt.ylabel('loss')
plt.legend()
plt.title('Loss vs. No. of epochs');
```



```
plt.plot(metrics['epoch'], metrics['Train PPL'], label="Train PPL")
plt.plot(metrics['epoch'], metrics['Valid PPL'], '-x', label="Test PPL")
plt.xlabel('ppl')
plt.ylabel('accuracy')
plt.legend()
plt.title('Perpelexity vs. No. of epochs');
```



Inference on Random Samples from Test Data

```
model.to(device)
model.eval()
```

```
    Seq2Seq(
      (loss): CrossEntropyLoss()
      (encoder): Encoder(
        (embedding): Embedding(8892, 256)
        (rnn): LSTM(256, 512, num_layers=2, dropout=0.5)
        (dropout): Dropout(p=0.5, inplace=False)
      )
      (decoder): Decoder(
        (embedding): Embedding(8892, 256)
        (rnn): LSTM(256, 512, num_layers=2, dropout=0.5)
        (fc_out): Linear(in_features=512, out_features=8892, bias=True)
        (dropout): Dropout(p=0.5, inplace=False)
      )
    )
```

```
samp_que = ['What is your name?', 'How can I help you?', 'Are you feeling well', '
```

```
for i in range(len(samp_que)):
  src_sent = samp_que[i]
  trg_sent_tensor = torch.tensor([en_vocab[token] for token in en_tokenizer(src_ser
  src_sent_tensor = torch.tensor([en_vocab[token] for token in en_tokenizer(src_ser
  with torch.no_grad():
        output = model(src_sent_tensor, trg_sent_tensor, 1)
        out = output.squeeze(1)
        out = torch.argmax(out,dim=1)
        trans = []
        for c in out[1:]:
          trans.append(en_vocab_itos[c])
        st = " ".join(trans)
        start = "\033[1m"
        end = "\033[0;0m"
        print(f'{start}You: {end}{src_sent}')
        print(f'{start}Bot: {end}{st}')
        print()
```

```
    You: What is your name?
    Bot: ! n't friend 's

    You: How can I help you?
    Bot: ! not   me !

    You: Are you feeling well
    Bot: ! are n't

    You: I do not think you are qualified for this position
    Bot: ! n't be i are a   a is

    You: Please mind your own business
```

```
Bot: !   arm wrigley
```

✓ 0s completed at 7:06 PM