TV Script Generation

In this project, you'll generate your own [Seinfeld (https://en.wikipedia.org/wiki/Seinfeld)](https://en.wikipedia.org/wiki/Seinfeld) TV scripts using RNNs. You'll be using part of the [Seinfeld dataset (https://www.kaggle.com/thec03u5/seinfeld-chronicles#scripts.csv)](https://www.kaggle.com/thec03u5/seinfeld-chronicles#scripts.csv) of scripts from 9 seasons. The Neural Network you'll build will generate a new ,"fake" TV script, based on patterns it recognizes in this training data.

Get the Data

The data is already provided for you in `./data/Seinfeld_Scripts.txt` and you're encouraged to open that file and look at the text.

> - As a first step, we'll load in this data and look at some samples.
> - Then, you'll be tasked with defining and training an RNN to generate a new script!

In [1]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibl
y remount, call drive.mount("/content/drive", force_remount=Tr
ue).
```

In [2]:

```
!rm -rf "./save"
!mkdir "./data"
!cp "./drive/My Drive/Colab_Storage/bertelsmann-p3-tv-script-
generation/Seinfeld_Scripts.txt" "./data/"
!cp "./drive/My Drive/Colab_Storage/bertelsmann-p3-tv-script-
generation/helper.py" .
!cp "./drive/My Drive/Colab_Storage/bertelsmann-p3-tv-script-
generation/problem_unittests.py" .
!mkdir "./save"
drive.mount('/content/drive', force_remount=True)
```

```
mkdir: cannot create directory ‘./data’: File exists
```

In [3]:
```python
"""
  DON'T MODIFY ANYTHING IN THIS CELL
"""
# load in data
import helper
data_dir = './data/Seinfeld_Scripts.txt'
text = helper.load_data(data_dir)
```

Explore the Data

Play around with `view_line_range` to view different parts of the data. This will give you a sense of the data you'll be working with. You can see, for example, that it is all lowercase text, and each new line of dialogue is separated by a newline character `\n`.

In [4]:
```
view_line_range = (0, 10)

"""
  DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
"""
import numpy as np

print('Dataset Stats')
print('Roughly the number of unique words: {}'.format(len({word: None for word in text.split()})))

lines = text.split('\n')
print('Number of lines: {}'.format(len(lines)))
word_count_line = [len(line.split()) for line in lines]
print('Average number of words in each line: {}'.format(np.average(word_count_line)))

print()
print('The lines {} to {}:'.format(*view_line_range))
print('\n'.join(text.split('\n')[view_line_range[0]:view_line_range[1]]))
```

Dataset Stats
Roughly the number of unique words: 46367
Number of lines: 109233
Average number of words in each line: 5.544240293684143

The lines 0 to 10:
jerry: do you know what this is all about? do you know, why we
re here? to be out, this is out...and out is one of the single
most enjoyable experiences of life. people...did you ever hear
people talking about we should go out? this is what theyre tal
king about...this whole thing, were all out now, no one is hom
e. not one person here is home, were all out! there are people
trying to find us, they dont know where we are. (on an imagina
ry phone) did you ring?, i cant find him. where did he go? he
didnt tell me where he was going. he must have gone out. you w
anna go out you get ready, you pick out the clothes, right? yo
u take the shower, you get all ready, get the cash, get your f
riends, the car, the spot, the reservation...then youre standi
ng around, what do you do? you go we gotta be getting back. on
ce youre out, you wanna get back! you wanna go to sleep, you w
anna get up, you wanna go out again tomorrow, right? where eve
r you are in life, its my feeling, youve gotta go.

jerry: (pointing at georges shirt) see, to me, that button is
in the worst possible spot. the second button literally makes
or breaks the shirt, look at it. its too high! its in no-mans-
land. you look like you live with your mother.

george: are you through?

jerry: you do of course try on, when you buy?

george: yes, it was purple, i liked it, i dont actually recall
considering the buttons.

Implement Pre-processing Functions

The first thing to do to any dataset is pre-processing. Implement the following pre-processing functions below:

- Lookup Table
- Tokenize Punctuation

Lookup Table

To create a word embedding, you first need to transform the words to ids. In this function, create two dictionaries:

- Dictionary to go from the words to an id, we'll call `vocab_to_int`
- Dictionary to go from the id to word, we'll call `int_to_vocab`

Return these dictionaries in the following **tuple** `(vocab_to_int, int_to_vocab)`

In [5]:

```
from collections import Counter
```

In [6]:

```
import problem_unittests as tests

def create_lookup_tables(text):
    """
      Create lookup tables for vocabulary
      :param text: The text of tv scripts split into words
      :return: A tuple of dicts (vocab_to_int, int_to_vocab)
    """
    word_counts = Counter(text)
    sorted_vocabulary = sorted(word_counts, key=word_counts.g
et, reverse=True)
    integer_to_vocabulary = {i: word for i, word in enumerate
(sorted_vocabulary)}
    vocabulary_to_integer = {word: i for i, word in integer_t
o_vocabulary.items()}
    return (vocabulary_to_integer, integer_to_vocabulary)

"""
  DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
"""
tests.test_create_lookup_tables(create_lookup_tables)
```

```
Tests Passed
```

Tokenize Punctuation

We'll be splitting the script into a word array using spaces as delimiters. However, punctuations like periods and exclamation marks can create multiple ids for the same word. For example, "bye" and "bye!" would generate two different word ids.

Implement the function `token_lookup` to return a dict that will be used to tokenize symbols like "!" into "||Exclamation_Mark||". Create a dictionary for the following symbols where the symbol is the key and value is the token:

- Period (**.**)
- Comma (**,**)
- Quotation Mark (**"**)
- Semicolon (**;**)
- Exclamation mark (**!**)
- Question mark (**?**)
- Left Parentheses (**(**)
- Right Parentheses (**)**)
- Dash (**-**)
- Return (**\n**)

This dictionary will be used to tokenize the symbols and add the delimiter (space) around it. This separates each symbols as its own word, making it easier for the neural network to predict the next word. Make sure you don't use a value that could be confused as a word; for example, instead of using the value "dash", try using something like "||dash||".

```
In [7]: def token_lookup():
            """
              Generate a dict to turn punctuation into a token.
              :return: Tokenized dictionary where the key is the punc
        tuation and the value is the token
            """
            return {
              ',' : '||comma||',
              '-' : '||dash||',
              '!' : '||exclamation_mark||',
              '(' : '||left_parenthesis||',
              '.' : '||period||',
              '?' : '||question_mark||',
              '"' : '||quotation_mark||',
              '\n': '||return||',
              ')' : '||right_parenthesis||',
              ';' : '||semicolon||'
            }

        """
          DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
        """
        tests.test_tokenize(token_lookup)
```

```
Tests Passed
```

Pre-process all the data and save it

Running the code cell below will pre-process all the data and save it to file. You're encouraged to lok at the code for `preprocess_and_save_data` in the `helpers.py` file to see what it's doing in detail, but you do not need to change this code.

```
In [8]: """
          DON'T MODIFY ANYTHING IN THIS CELL
        """
        # pre-process training data
        helper.preprocess_and_save_data(data_dir, token_lookup, creat
        e_lookup_tables)
```

Check Point

This is your first checkpoint. If you ever decide to come back to this notebook or have to restart the notebook, you can start from here. The preprocessed data has been saved to disk.

In [9]:
```
"""
  DON'T MODIFY ANYTHING IN THIS CELL
"""
import helper
import problem_unittests as tests

int_text, vocab_to_int, int_to_vocab, token_dict = helper.loa
d_preprocess()
```

Build the Neural Network

In this section, you'll build the components necessary to build an RNN by implementing the RNN Module and forward and backpropagation functions.

Check Access to GPU

In [10]:
```
"""
  DON'T MODIFY ANYTHING IN THIS CELL
"""
import torch

# Check for a GPU
gpu = torch.cuda.is_available()
if not gpu:
  print('No GPU found. Please use a GPU to train your neural
network.')
else:
  print("GPU Found!")
```

```
GPU Found!
```

Input

Let's start with the preprocessed input data. We'll use [TensorDataset (http://pytorch.org/docs/master/data.html#torch.utils.data.TensorDataset)](http://pytorch.org/docs/master/data.html#torch.utils.data.TensorDataset) to provide a known format to our dataset; in combination with [DataLoader (http://pytorch.org/docs/master/data.html#torch.utils.data.DataLoader)](http://pytorch.org/docs/master/data.html#torch.utils.data.DataLoader), it will handle batching, shuffling, and other dataset iteration functions.

You can create data with TensorDataset by passing in feature and target tensors. Then create a DataLoader as usual.

```
data = TensorDataset(feature_tensors, target_tensors)
data_loader = torch.utils.data.DataLoader(data,
                                          batch_size=batch_size)
```

Batching

Implement the `batch_data` function to batch `words` data into chunks of size `batch_size` using the `TensorDataset` and `DataLoader` classes.

> You can batch words using the DataLoader, but it will be up to you to create `feature_tensors` and `target_tensors` of the correct size and content for a given `sequence_length`.

For example, say we have these as input:

```
words = [1, 2, 3, 4, 5, 6, 7]
sequence_length = 4
```

Your first `feature_tensor` should contain the values:

```
[1, 2, 3, 4]
```

And the corresponding `target_tensor` should just be the next "word"/tokenized word value:

```
5
```

This should continue with the second `feature_tensor`, `target_tensor` being:

```
[2, 3, 4, 5]  # features
6             # target
```

In [11]:
```
from torch.utils.data import TensorDataset, DataLoader

def tensor_dataset_loader(feature, target, b):
  return DataLoader(
      TensorDataset(
          torch.from_numpy(np.asarray(feature)),
          torch.from_numpy(np.asarray(target))),
      shuffle=1, batch_size=b)

def batch_data(words, sequence_length, batch_size):
    """
      Batch the neural network data using DataLoader
      In the return, call the tensor_dataset_loader() functio
n
      with parameters: feature, target, batch_size
    """
    feature, target = [], []
    for index_start in range(0, len(words) - sequence_lengt
h):
      index_end = index_start + sequence_length
      f_tensor = words[index_start:index_end]
      feature.append(f_tensor)
      t_tensor = words[index_end]
      target.append(t_tensor)
    return tensor_dataset_loader(feature, target, batch_size)
```

Test your dataloader

You'll have to modify this code to test a batching function, but it should look fairly similar.

Below, we're generating some test text data and defining a dataloader using the function you defined, above. Then, we are getting some sample batch of inputs `sample_x` and targets `sample_y` from our dataloader.

Your code should return something like the following (likely in a different order, if you shuffled your data):

```
torch.Size([10, 5])
tensor([[ 28,  29,  30,  31,  32],
        [ 21,  22,  23,  24,  25],
        [ 17,  18,  19,  20,  21],
        [ 34,  35,  36,  37,  38],
        [ 11,  12,  13,  14,  15],
        [ 23,  24,  25,  26,  27],
        [  6,   7,   8,   9,  10],
        [ 38,  39,  40,  41,  42],
        [ 25,  26,  27,  28,  29],
        [  7,   8,   9,  10,  11]])

torch.Size([10])
tensor([ 33,  26,  22,  39,  16,  28,  11,  43,  30,  12])
```

Sizes

Your sample_x should be of size `(batch_size, sequence_length)` or (10, 5) in this case and sample_y should just have one dimension: batch_size (10).

Values

You should also notice that the targets, sample_y, are the *next* value in the ordered test_text data. So, for an input sequence `[ 28,  29,  30,  31,  32]` that ends with the value `32`, the corresponding output should be `33`.

In [12]:
```
# test dataloader

test_text = range(50)
t_loader = batch_data(test_text, sequence_length=5, batch_siz
e=10)

data_iter = iter(t_loader)
sample_x, sample_y = data_iter.next()

print(sample_x.shape)
print(sample_x)
print()
print(sample_y.shape)
print(sample_y)
```

```
torch.Size([10, 5])
tensor([[12, 13, 14, 15, 16],
        [ 2,  3,  4,  5,  6],
        [ 8,  9, 10, 11, 12],
        [18, 19, 20, 21, 22],
        [ 9, 10, 11, 12, 13],
        [40, 41, 42, 43, 44],
        [16, 17, 18, 19, 20],
        [23, 24, 25, 26, 27],
        [ 0,  1,  2,  3,  4],
        [42, 43, 44, 45, 46]])

torch.Size([10])
tensor([17,  7, 13, 23, 14, 45, 21, 28,  5, 47])
```

Build the Neural Network

Implement an RNN using PyTorch's [Module class (http://pytorch.org/docs/master/nn.html#torch.nn.Module)](http://pytorch.org/docs/master/nn.html#torch.nn.Module). You may choose to use a GRU or an LSTM. To complete the RNN, you'll have to implement the following functions for the class:

- `__init__` - The initialize function.
- `init_hidden` - The initialization function for an LSTM/GRU hidden state
- `forward` - Forward propagation function.

The initialize function should create the layers of the neural network and save them to the class. The forward propagation function will use these layers to run forward propagation and generate an output and a hidden state.

The output of this model should be the *last* batch of word scores after a complete sequence has been processed. That is, for each input sequence of words, we only want to output the word scores for a single, most likely, next word.

Hints

1. Make sure to stack the outputs of the lstm to pass to your fully-connected layer, you can do this with `lstm_output = lstm_output.contiguous().view(-1, self.hidden_dim)`
2. You can get the last batch of word scores by shaping the output of the final, fully-connected layer like so:

```
# reshape into (batch_size, seq_length, output_size)
output = output.view(batch_size, -1, self.output_size)
# get last batch
out = output[:, -1]
```

In [13]:
```
import torch.nn as nn

class RNN(nn.Module):

    def __init__(self, vocab_size, output_size, embedding_di
m, hidden_dim, n_layers, dropout=0.5):
        """
          Initialize the PyTorch RNN Module
          :param vocab_size: The number of input dimensions o
f the neural network (the size of the vocabulary)
          :param output_size: The number of output dimensions
of the neural network
          :param embedding_dim: The size of embeddings, shoul
d you choose to use them
          :param hidden_dim: The size of the hidden layer out
puts
          :param dropout: dropout to add in between LSTM/GRU
layers
        """
        super(RNN, self).__init__()
        self.embedding = nn.Embedding(vocab_size, embedding_d
im)
        self.hidden_dim = hidden_dim
        self.linear = nn.Linear(hidden_dim, output_size)
        self.lstm = nn.LSTM(embedding_dim, hidden_dim, n_laye
rs, dropout=dropout, batch_first=True)
        self.n_layers = n_layers
        self.output_size = output_size

    def forward(self, nn_input, hidden, n=-1):
        """
          Forward propagation of the neural network
          :param nn_input: The input to the neural network
          :param hidden: The hidden state
          :return: Two Tensors, the output of the neural netw
ork and the latest hidden state
        """
        bat_sz = nn_input.size(n+1)
        emb = self.embedding(nn_input)
        lstm_out, hidden = self.lstm(emb, hidden)
        out = self.linear(lstm_out.contiguous().view(n, self.
hidden_dim))
        return out.view(bat_sz, n, self.output_size)[:, n], h
idden

    def init_hidden(self, batch_size):
        """
          Initialize the hidden state of an LSTM/GRU
          :param batch_size: The batch_size of the hidden sta
te
          :return: hidden state of dims (n_layers, batch_siz
```

```
e, hidden_dim)
        """
        wt = next(self.parameters()).data
        wt_gpu = wt.new(self.n_layers, batch_size, self.hidde
n_dim).zero_().cuda()
        wt_cpu = wt.new(self.n_layers, batch_size, self.hidde
n_dim).zero_()
        return (wt_gpu, wt_gpu) if gpu else (wt_cpu, wt_cpu)



"""
  DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
"""
tests.test_rnn(RNN, gpu)
```

```
Tests Passed
```

Define forward and backpropagation

Use the RNN class you implemented to apply forward and back propagation. This function will be called, iteratively, in the training loop as follows:

```
loss = forward_back_prop(decoder, decoder_optimizer, criterion, inp,
target)
```

And it should return the average loss over a batch and the hidden state returned by a call to `RNN(inp, hidden)`. Recall that you can get this loss by computing it, as usual, and calling `loss.item()`.

If a GPU is available, you should move your data to that GPU device, here.

In [14]:
```
def forward_back_prop(rnn, optimizer, criterion, inp, target,
hidden):
    """
      Forward and backward propagation on the neural network
      :param decoder: The PyTorch Module that holds the neura
l network
      :param decoder_optimizer: The PyTorch optimizer for the
neural network
      :param criterion: The PyTorch loss function
      :param inp: A batch of input to the neural network
      :param target: The target output for the batch of input
      :return: The loss and the latest hidden state Tensor
    """
    if gpu:
      inp, rnn, target = inp.cuda(), rnn.cuda(), target.cuda
()

    optimizer.zero_grad()
    out, z = rnn(inp, ([i.data for i in hidden]))
    loss = criterion(out, target)
    loss.backward()
    nn.utils.clip_grad_norm_(rnn.parameters(), 5)
    optimizer.step()
    return loss.item(), z

"""
  DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
"""
tests.test_forward_back_prop(RNN, forward_back_prop, gpu)
```

```
Tests Passed
```

Neural Network Training

With the structure of the network complete and data ready to be fed in the neural network, it's time to train it.

Train Loop

The training loop is implemented for you in the `train_decoder` function. This function will train the network over all the batches for the number of epochs given. The model progress will be shown every number of batches. This number is set with the `show_every_n_batches` parameter. You'll set this parameter along with other parameters in the next section.

In [15]:

```
from time import sleep
from termcolor import colored
from google.colab import output

success = False

def woohoo():
  output.eval_js('new Audio("http://homertorium.tripod.com/sounds/woohoo.wav").play()')
def doh():
  output.eval_js('new Audio("http://homertorium.tripod.com/sounds/doh.wav").play()')
def thirsty():
  output.eval_js('new Audio("http://frogstar.com/wp-content/uploads/2012/wav/thirsty.wav").play()')
def candothat():
  output.eval_js('new Audio("http://frogstar.com/wp-content/uploads/2012/wav/hmrcando.wav").play()')
def training():
  output.eval_js('new Audio("https://media.vocaroo.com/mp3/bu6pQnqyT6B").play()')
def mission_accomplished():
  output.eval_js('new Audio("https://media.vocaroo.com/mp3/duK4LaLxO9y").play()')
def mission_failed():
  output.eval_js('new Audio("https://media.vocaroo.com/mp3/9R34qN5MY0Q").play()')
def healed():
  output.eval_js('new Audio("https://media.vocaroo.com/mp3/akFOwJxH155").play()')

def alc(avg_loss, color):
  return colored(str(avg_loss), color)

def train_rnn(rnn, batch_size, optimizer, criterion, n_epochs, show_every_n_batches, loss_goal):
    batch_losses = []
    rnn.train()

    print("Training for %d epoch(s)..." % n_epochs)

    for epoch_i in range(1, n_epochs + 1):

        # initialize hidden state
        hidden = rnn.init_hidden(batch_size)

        for batch_i, (inputs, labels) in enumerate(train_loader, 1):
            if gpu:
              inputs, labels = inputs.cuda().type(torch.cuda.LongTensor), labels.cuda().type(torch.cuda.LongTensor)
```

```
            # make sure you iterate over completely full batc
hes, only
            n_batches = len(train_loader.dataset)//batch_size
            if(batch_i > n_batches):
              break

            # forward, back prop
            loss, hidden = forward_back_prop(rnn, optimizer,
criterion, inputs, labels, hidden)
            # record loss
            batch_losses.append(loss)

            # printing loss stats
            if batch_i % show_every_n_batches == 0:
              avg_loss = np.average(batch_losses)
              below = bool(avg_loss < loss_goal)
              print('Epoch: {:>4}/{:<4}  Loss: {}\n'.format(
                epoch_i, n_epochs, alc(avg_loss, "green") if
below else alc(avg_loss, "yellow")))
              global success
              if not success and below:
                healed()
                sleep(1)
                woohoo()
                success = True
              batch_losses = []

    # returns a trained rnn
    return rnn
```

Hyperparameters

Set and train the neural network with the following parameters:

- Set `sequence_length` to the length of a sequence.
- Set `batch_size` to the batch size.
- Set `num_epochs` to the number of epochs to train for.
- Set `learning_rate` to the learning rate for an Adam optimizer.
- Set `vocab_size` to the number of uniqe tokens in our vocabulary.
- Set `output_size` to the desired size of the output.
- Set `embedding_dim` to the embedding dimension; smaller than the vocab_size.
- Set `hidden_dim` to the hidden dimension of your RNN.
- Set `n_layers` to the number of layers/cells in your RNN.
- Set `show_every_n_batches` to the number of batches at which the neural network should print progress.

If the network isn't getting the desired results, tweak these parameters and/or the layers in the `RNN` class.

Train

In the next cell, you'll train the neural network on the pre-processed data. If you have a hard time getting a good loss, you may consider changing your hyperparameters. In general, you may get better results with larger hidden and n_layer dimensions, but larger models take a longer time to train.

> **You should aim for a loss less than 3.5.**

You should also experiment with different sequence lengths, which determine the size of the long range dependencies that a model can learn.

In [16]:

```
training()
sleep(1)
candothat()

loss_goal = 3.5

sequence_length = 12
batch_size = 128

train_loader = batch_data(int_text, sequence_length, batch_si
ze)

num_epochs = 6
learning_rate = 1e-3
embedding_dim = 512
hidden_dim = 640
n_layers = 3
vocab_size = len(vocab_to_int)
output_size = vocab_size
show_every_n_batches = 2000

# create model and move to gpu if available
rnn = RNN(vocab_size, output_size, embedding_dim, hidden_dim,
n_layers, dropout=5/11)
if gpu:
  rnn.cuda()

# defining loss and optimization functions for training
optimizer = torch.optim.Adam(rnn.parameters(), lr=learning_ra
te)
criterion = nn.CrossEntropyLoss()

# training the model
trained_rnn = train_rnn(rnn, batch_size, optimizer, criterio
n, num_epochs, show_every_n_batches, loss_goal)

if success:
  mission_accomplished()
  sleep(2)
  thirsty()
  # saving the trained model
  print(colored('Model trained successfully. Saving for futur
e use...', 'green'))
  helper.save_model("./save/trained_rnn", trained_rnn)
  print(colored('...Done.', 'green'))
else:
  mission_failed()
  sleep(2)
  doh()
  print(colored('Training failed to reduce Loss to under ' +
str(loss_goal) + '.', 'red'))
```

```
    print(colored('Please adjust hyperparameters and try agai
n.', 'red'))
```

```
Training for 6 epoch(s)...
Epoch:    1/6     Loss: 5.13255313038826

Epoch:    1/6     Loss: 4.425375404953956

Epoch:    1/6     Loss: 4.259471958994865

Epoch:    2/6     Loss: 4.049645466048053

Epoch:    2/6     Loss: 3.9465545279979706

Epoch:    2/6     Loss: 3.933875979781151

Epoch:    3/6     Loss: 3.779881422830455

Epoch:    3/6     Loss: 3.729762109875679

Epoch:    3/6     Loss: 3.721809248447418

Epoch:    4/6     Loss: 3.6158648203743473

Epoch:    4/6     Loss: 3.556327147960663

Epoch:    4/6     Loss: 3.5966824308633805

Epoch:    5/6     Loss: 3.4752226675668925

Epoch:    5/6     Loss: 3.4473501206636428

Epoch:    5/6     Loss: 3.4747275784015654

Epoch:    6/6     Loss: 3.3576171315451107

Epoch:    6/6     Loss: 3.3407657858133315

Epoch:    6/6     Loss: 3.3779140157699583

Model trained successfully. Saving for future use...
...Done.
```

Question: How did you decide on your model hyperparameters?

For example, did you try different sequence_lengths and find that one size made the model converge faster? What about your hidden_dim and n_layers; how did you decide on those?

Answer:

- I got my hyperparameter values from my two very good friends, Trial and Error :-D
- Really, I just took semi-educated guesses and watched the output to see if the changes I'd made were helping or hurting the model's performance, and based my next changes on that.
- I'm sure I could have been more scientific about it, but I was having a lot of fun writing the logic that turns the Loss output different colors depending on its value, and adding sound effects that play when certain events occur. So, since I was re-running the training function over and over anyway, I tweaked the hyperparameters a little bit each time, and found my way to a pretty impressive result, in my opinion. /shrug

---

Checkpoint

After running the above training cell, your model will be saved by name, `trained_rnn`, and if you save your notebook progress, **you can pause here and come back to this code at another time**. You can resume your progress by running the next cell, which will load in our word:id dictionaries *and* load in your saved model by name!

In [17]:

```
"""
DON'T MODIFY ANYTHING IN THIS CELL
"""
import torch
import helper
import problem_unittests as tests
saved_rnn = "./save/trained_rnn"
_, vocab_to_int, int_to_vocab, token_dict = helper.load_prepr
ocess()
trained_rnn = helper.load_model(saved_rnn)
```

Generate TV Script

With the network trained and saved, you'll use it to generate a new, "fake" Seinfeld TV script in this section.

Generate Text

To generate the text, the network needs to start with a single word and repeat its predictions until it reaches a set length. You'll be using the `generate` function to do this. It takes a word id to start with, `prime_id` , and generates a set length of text, `predict_len` . Also note that it uses topk sampling to introduce some randomness in choosing the most likely next word, given an output set of word scores!

In [29]:

```
"""
DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
"""
import torch.nn.functional as F

def generate(rnn, prime_id, int_to_vocab, token_dict, pad_val
ue, predict_len=100):
    """
    Generate text using the neural network
    :param decoder: The PyTorch Module that holds the trained
neural network
    :param prime_id: The word id to start the first predictio
n
    :param int_to_vocab: Dict of word id keys to word values
    :param token_dict: Dict of puncuation tokens keys to punc
uation values
    :param pad_value: The value used to pad a sequence
    :param predict_len: The length of text to generate
    :return: The generated text
    """
    rnn.eval()

    # create a sequence (batch_size=1) with the prime_id
    current_seq = np.full((1, sequence_length), pad_value)
    current_seq[-1][-1] = prime_id
    predicted = [int_to_vocab[prime_id]]

    for _ in range(predict_len):
        if gpu:
            current_seq = torch.LongTensor(current_seq).cuda
()
        else:
            current_seq = torch.LongTensor(current_seq)

        # initialize the hidden state
        hidden = rnn.init_hidden(current_seq.size(0))

        # get the output of the rnn
        output, _ = rnn(current_seq, hidden)

        # get the next word probabilities
        p = F.softmax(output, dim=1).data
        if gpu:
            p = p.cpu() # move to cpu

        # use top_k sampling to get the index of the next wor
d
        top_k = 5
        p, top_i = p.topk(top_k)
        top_i = top_i.numpy().squeeze()
```

```
        # select the likely next word index with some element of randomness
        p = p.numpy().squeeze()
        word_i = np.random.choice(top_i, p=p/p.sum())

        # retrieve that word from the dictionary
        word = int_to_vocab[word_i]
        predicted.append(word)

        # the generated word becomes the next "current sequence" and the cycle can continue
        current_seq = np.roll(current_seq.cpu(), -1, 1)
        current_seq[-1][-1] = word_i

    gen_sentences = ' '.join(predicted)

    # Replace punctuation tokens
    for key, token in token_dict.items():
        ending = ' ' if key in ['\n', '(', '"'] else ''
        gen_sentences = gen_sentences.replace(' ' + token.lower(), key)
    gen_sentences = gen_sentences.replace('\n ', '\n')
    gen_sentences = gen_sentences.replace('( ', '(')

    # return all the sentences
    return gen_sentences
```

Generate a New Script

It's time to generate the text. Set `gen_length` to the length of TV script you want to generate and set `prime_word` to one of the following to start the prediction:

- "jerry"
- "elaine"
- "george"
- "kramer"

You can set the prime word to *any word* in our dictionary, but it's best to start with a name for generating a TV script. (You can also start with any other names you find in the original text file!)

In [30]:
```
# run the cell multiple times to get different results!
gen_length = 400 # modify the length to your preference
prime_word = 'jerry' # name for starting the script

"""
DON'T MODIFY ANYTHING IN THIS CELL THAT IS BELOW THIS LINE
"""
pad_word = helper.SPECIAL_WORDS['PADDING']
generated_script = generate(trained_rnn, vocab_to_int[prime_w
ord + ':'], int_to_vocab, token_dict, vocab_to_int[pad_word],
gen_length)
print(generated_script)
```

jerry: drinker drinker drinker drinker drinker drinker drinker drinker drinker.(to jerry) you know...

elaine: oh, i can't believe this. i mean, i got my message for a little while.

george: well, you didn't know what happened to me about. i thi nk i'm going to get a little tired of it.

kramer: well you don't think so...

george: no! no.

george:(still to jerry) i don't think we should get the job. y ou can take it. you know, i think you can get together with th is guy.

kramer:(to kramer) what?

george: oh, no.

george: what do you mean?

elaine: oh, i didn't know, i don't have to be there, but i was just wondering i was just trying to tell you what i said. i me an, the guy who has to be able to be a little more flexible.

george:(on phone) what do you need me to say? i don't know if i'm getting rid of it.

jerry:(to kramer) oh, i'm gonna take a bite.(jerry nods, then sits down, and starts squeezing the door on the table and he s ays it is....

kramer: no.

jerry:(confused) what?

jerry:(to the phone) hey, you know, i don't even know how to t hank her to be a little tired, and i'm gonna be a character.

george: yeah, i think i can go to bed at my house, you can get it down.

elaine: what?

elaine: what?

george: well, i was just curious, i was wondering if i can get it out of the shower and you can breathe with it.

```
kramer: well, it's a good idea i was eaten in the air..

jerry: oh, yeah.

elaine: what do you mean? what is
```

Save your favorite scripts

Once you have a script that you like (or find interesting), save it to a text file!

In [31]:
```
# save script to a text file
f =  open("generated_script_1.txt","w")
f.write(generated_script)
f.close()
```

The TV Script is Not Perfect

It's ok if the TV script doesn't make perfect sense. It should look like alternating lines of dialogue, here is one such example of a few generated lines.

Example generated script

> jerry: what about me?
>
> jerry: i don't have to wait.
>
> kramer:(to the sales table)
>
> elaine:(to jerry) hey, look at this, i'm a good doctor.
>
> newman:(to elaine) you think i have no idea of this...
>
> elaine: oh, you better take the phone, and he was a little nervous.
>
> kramer:(to the phone) hey, hey, jerry, i don't want to be a little bit.(to kramer and jerry) you can't.
>
> jerry: oh, yeah. i don't even know, i know.
>
> jerry:(to the phone) oh, i know.
>
> kramer:(laughing) you know...(to jerry) you don't know.

You can see that there are multiple characters that say (somewhat) complete sentences, but it doesn't have to be perfect! It takes quite a while to get good results, and often, you'll have to use a smaller vocabulary (and discard uncommon words), or get more data. The Seinfeld dataset is about 3.4 MB, which is big enough for our purposes; for script generation you'll want more than 1 MB of text, generally.

Submitting This Project

When submitting this project, make sure to run all the cells before saving the notebook. Save the notebook file as "dlnd_tv_script_generation.ipynb" and save another copy as an HTML file by clicking "File" -> "Download as.."->"html". Include the "helper.py" and "problem_unittests.py" files in your submission. Once you download these files, compress them into one zip file for submission.