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COMP6065 – Artificial Intelligence (L5AC)

Final Project Report

Ferlix Yanto Wang	-	1901498435
Kensen	-	1901504785

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I. Introduction

Since 2016, the usage of chatbot for daily activities has been increasing quite significantly. These activities usually include ordering a food from a restaurant, providing daily news, setting up schedule, sending money, searching and tracking flights, checking the weather, providing customer support, and giving product suggestions. However, from those list, it can be seen that chatbot that serves as an entertainment is quite scarce. Therefore, in this project, we created a chatbot which is funny and conversable to entertain the users from their boredom.

The chatbot that we created is called EUC, which stands for "Emotionally Unstable Chatbot". EUC is a chatbot which conversation occurs in the command line. This chatbot is made possible by the guidance of Siraj Raval's tutorial video on Youtube titled "How to Make an Amazing TensorFlow Chatbot Easily". This video can be found at https://www.youtube.com/watch?v=SJDEOWLHYVo. In addition, Suriyadeepan Ram's explanation about Sequence to Sequence Chatbot at http://suriyadeepan.github.io/2016-06-28-easy-seq2seq/ is also very useful for the development of this chatbot. EUC has three versions: Full English, Full Bahasa, and Mixed version.

II. Solution Features

EUC uses Sequence to Sequence Model. The model is made up of two Gated Recurrent Units (GRU) which act as an encoder and a decoder. GRU is a type of Recurrent Neural Network, which is a type of neural network in which the trained data can be feedback into the input while training it in a recurring loop. We use GRU to allow the model to remember input from far back in the sequence so that EUC can give a more relevant reply. The encoder encodes the input into a context vector which is a statistical representation of the input. Then, the decoder decodes the context vector into the associated words.

III. Solution Design Architecture

To build this Emotionally Unstable Chatbot, we are using python programming language version 3.5.0 and Tensorflow 0.12.1. Tensorflow is an open-source software library for dataflow programming across a range of tasks, including machine learning applications such as neural network, which is written by Google Brain Team. In addition, we use Tensorflow GPU version to improve the learning performance of EUC. To use Tensorflow GPU, we have to first install CUDA Toolkit 8 (https://developer.nvidia.com/cuda-toolkit) and cuDNN 5.1 (https://developer.nvidia.com/cudnn).

The specification of the hardware that we use to train EUC is:

CPU: Intel(R) Core(TM) i7-7700HQ CPU @ 2.80GHz (8 CPUs), ~2.8GHz

Memory: 8192MB RAM

GPU: NVIDIA GeForce GTX 1050

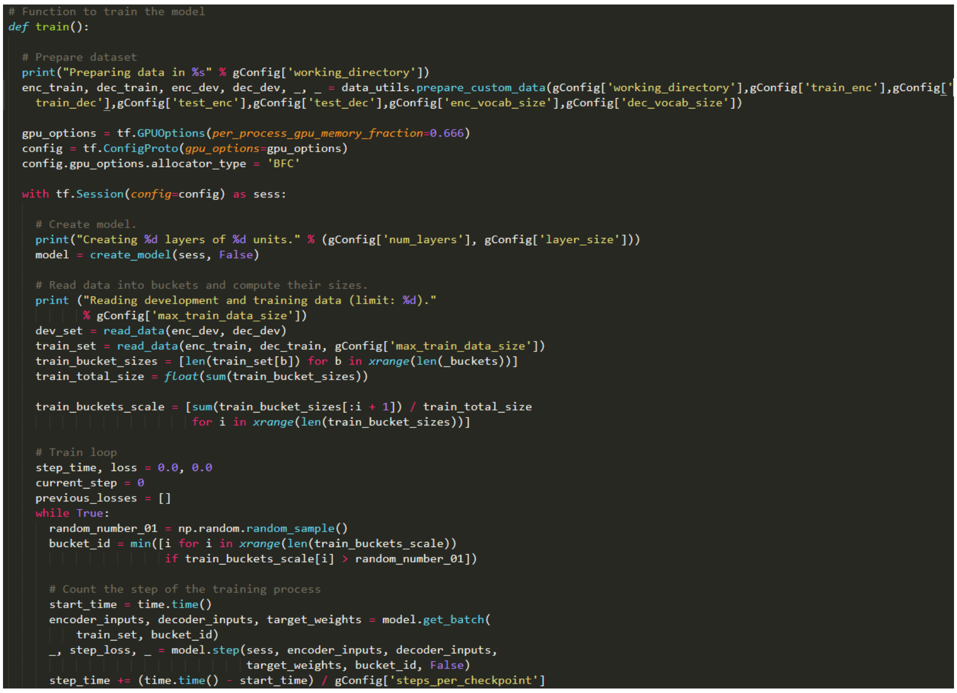
We have 3 different versions of EUC which use 3 different datasets to help them train how to converse. EUC Full English's dataset is Cornell Movie-Dialogues Corpus, a collection of movie dialogues from 617 different movies, compiled by Cornell University. EUC Full Indonesian's dataset is the translation of the first 50000 lines of conversation from the original Cornell Movie-Dialogues Corpus into Bahasa. While EUC Mixed dataset is the combination of EUC Full Indonesian's dataset and another 50000 lines from the original Cornell Movie-Dialogues Corpus.

EUC has 1 layer of GRU with 128 units. EUC English has a vocabulary size of 20000, EUC Indonesian has a vocabulary size of around 7000 and EUC Mixed has a vocabulary size of around 17000. The learning rate of these three are 0.5, 0.02, 0.05 respectively. We have a value to determine the accuracy of EUC which is called perplexity. Perplexity is the average number of output choices per word. The bigger the perplexity, the more random is the model output. The function of perplexity that we use is $\boxed{\text{Perplexity} = \exp(\text{loss})}$ where loss is the representation of number of misprediction between the correct outputs and the model outputs (in negative log value). When after 5 steps of training the perplexity is not decreasing, the learning rate will be reduced to 0.99 (decay rate) of its previous rate. These settings allow EUC to analyze the data more accurately at the cost of slower time. There is no size limit to its learning. We also implement checkpoint to allow EUC to save its training progress for every 300 steps.

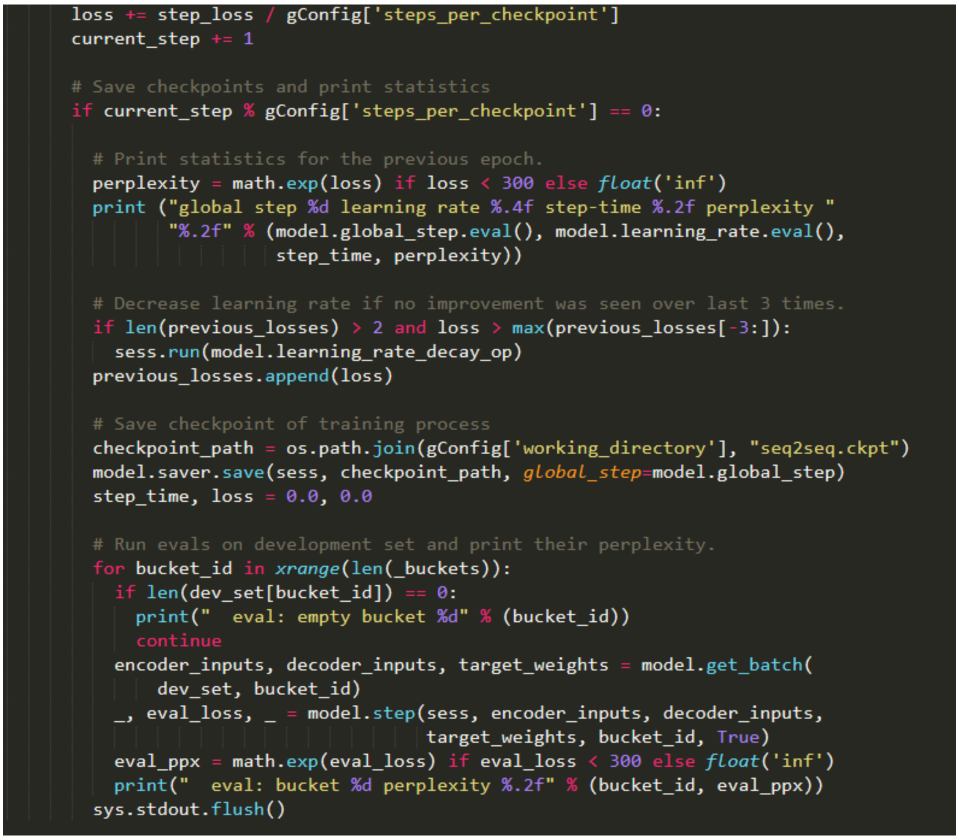
IV. Program Manual

A. Code Snippets

Train function

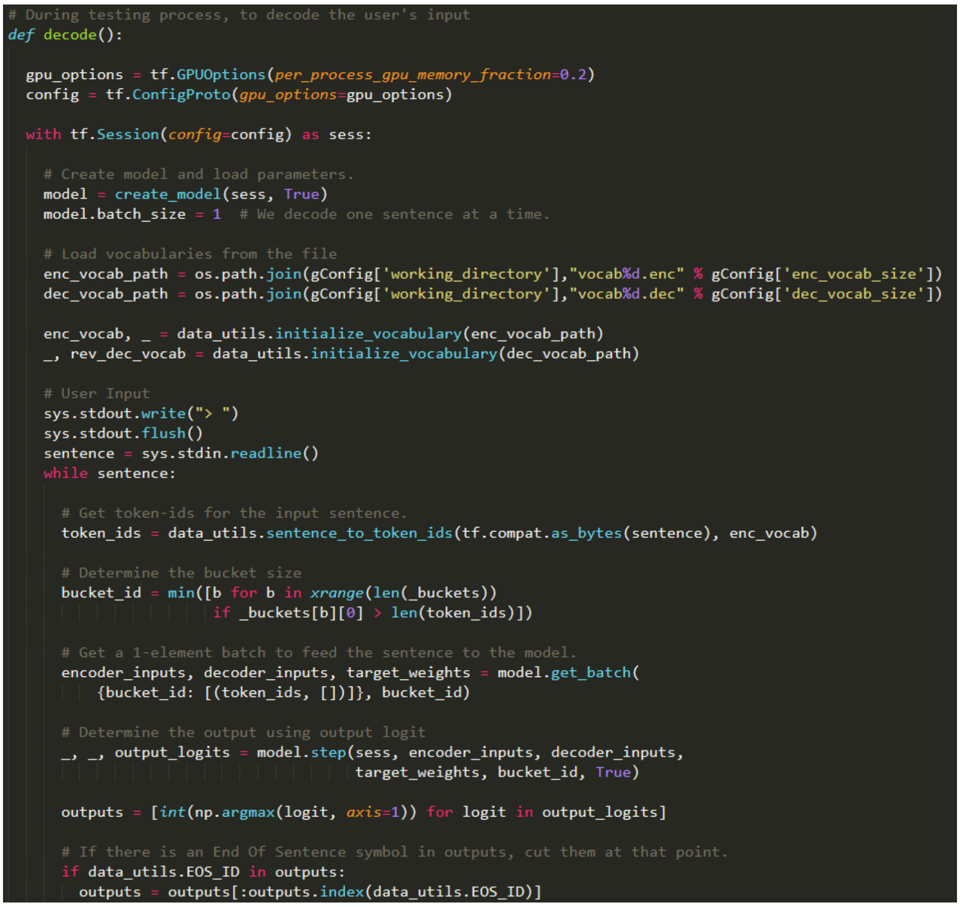


```
# Function to train the model
def train():

  # Prepare dataset
  print("Preparing data in %s" % gConfig['working_directory'])
  enc_train, dec_train, enc_dev, dec_dev, _, _ = data_utils.prepare_custom_data(gConfig['working_directory'],gConfig['train_enc'],gConfig['
    train_dec'],gConfig['test_enc'],gConfig['test_dec'],gConfig['enc_vocab_size'],gConfig['dec_vocab_size'])

  gpu_options = tf.GPUOptions(per_process_gpu_memory_fraction=0.666)
  config = tf.ConfigProto(gpu_options=gpu_options)
  config.gpu_options.allocator_type = 'BFC'

  with tf.Session(config=config) as sess:

    # Create model.
    print("Creating %d layers of %d units." % (gConfig['num_layers'], gConfig['layer_size']))
    model = create_model(sess, False)

    # Read data into buckets and compute their sizes.
    print ("Reading development and training data (limit: %d)."
           % gConfig['max_train_data_size'])
    dev_set = read_data(enc_dev, dec_dev)
    train_set = read_data(enc_train, dec_train, gConfig['max_train_data_size'])
    train_bucket_sizes = [len(train_set[b]) for b in xrange(len(_buckets))]
    train_total_size = float(sum(train_bucket_sizes))

    train_buckets_scale = [sum(train_bucket_sizes[:i + 1]) / train_total_size
                           for i in xrange(len(train_bucket_sizes))]

    # Train loop
    step_time, loss = 0.0, 0.0
    current_step = 0
    previous_losses = []
    while True:
      random_number_01 = np.random.random_sample()
      bucket_id = min([i for i in xrange(len(train_buckets_scale))
                       if train_buckets_scale[i] > random_number_01])

      # Count the step of the training process
      start_time = time.time()
      encoder_inputs, decoder_inputs, target_weights = model.get_batch(
          train_set, bucket_id)
      _, step_loss, _ = model.step(sess, encoder_inputs, decoder_inputs,
                                   target_weights, bucket_id, False)
      step_time += (time.time() - start_time) / gConfig['steps_per_checkpoint']
```

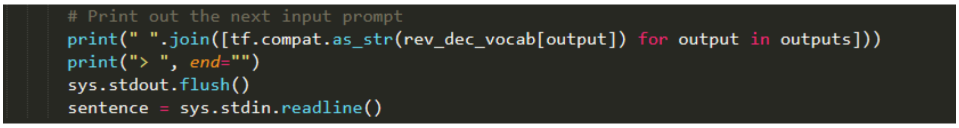


```
      loss += step_loss / gConfig['steps_per_checkpoint']
      current_step += 1

      # Save checkpoints and print statistics
      if current_step % gConfig['steps_per_checkpoint'] == 0:

        # Print statistics for the previous epoch.
        perplexity = math.exp(loss) if loss < 300 else float('inf')
        print ("global step %d learning rate %.4f step-time %.2f perplexity "
               "%.2f" % (model.global_step.eval(), model.learning_rate.eval(),
                         step_time, perplexity))

        # Decrease learning rate if no improvement was seen over last 3 times.
        if len(previous_losses) > 2 and loss > max(previous_losses[-3:]):
          sess.run(model.learning_rate_decay_op)
        previous_losses.append(loss)

        # Save checkpoint of training process
        checkpoint_path = os.path.join(gConfig['working_directory'], "seq2seq.ckpt")
        model.saver.save(sess, checkpoint_path, global_step=model.global_step)
        step_time, loss = 0.0, 0.0

        # Run evals on development set and print their perplexity.
        for bucket_id in xrange(len(_buckets)):
          if len(dev_set[bucket_id]) == 0:
            print("  eval: empty bucket %d" % (bucket_id))
            continue
          encoder_inputs, decoder_inputs, target_weights = model.get_batch(
              dev_set, bucket_id)
          _, eval_loss, _ = model.step(sess, encoder_inputs, decoder_inputs,
                                       target_weights, bucket_id, True)
          eval_ppx = math.exp(eval_loss) if eval_loss < 300 else float('inf')
          print("  eval: bucket %d perplexity %.2f" % (bucket_id, eval_ppx))
        sys.stdout.flush()
```

Decode function

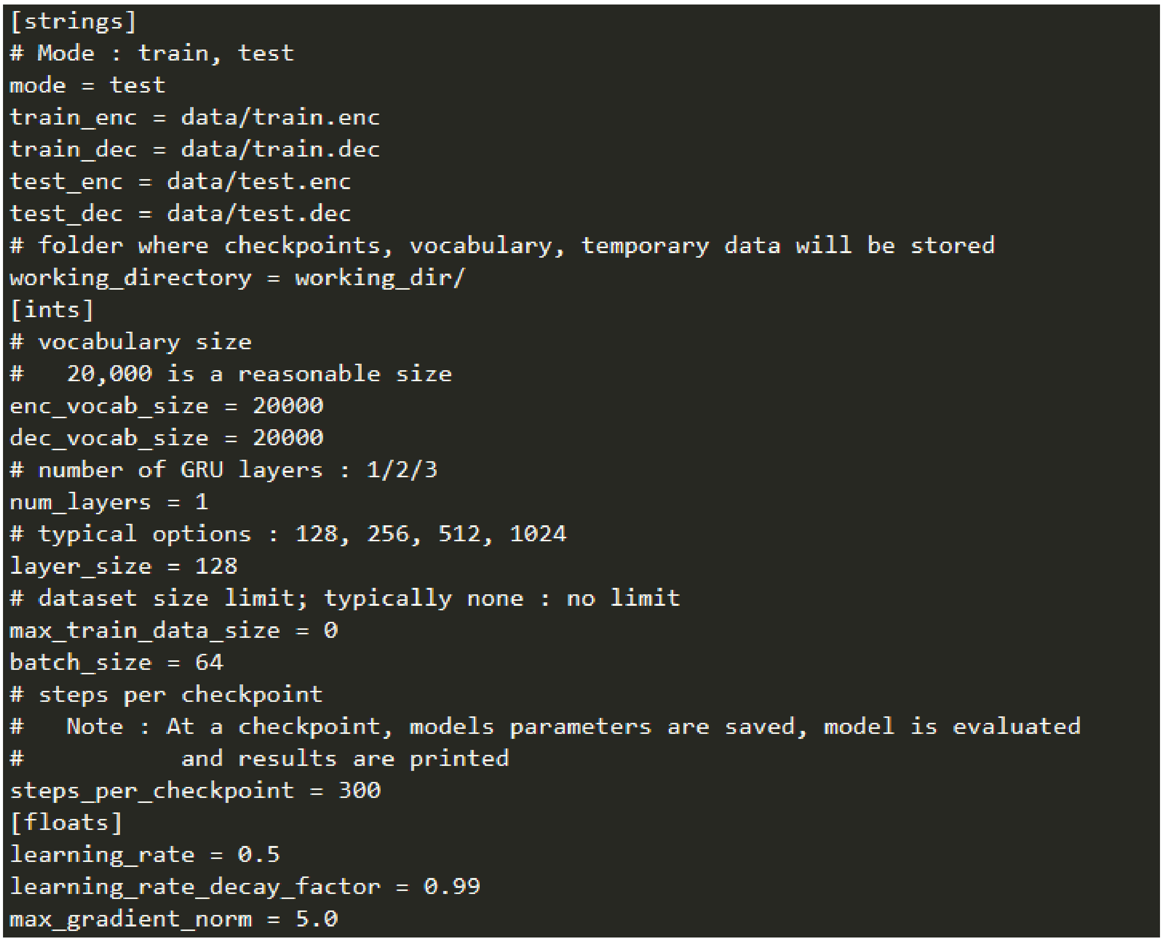


```python
# During testing process, to decode the user's input
def decode():

  gpu_options = tf.GPUOptions(per_process_gpu_memory_fraction=0.2)
  config = tf.ConfigProto(gpu_options=gpu_options)

  with tf.Session(config=config) as sess:

    # Create model and load parameters.
    model = create_model(sess, True)
    model.batch_size = 1  # We decode one sentence at a time.

    # Load vocabularies from the file
    enc_vocab_path = os.path.join(gConfig['working_directory'],"vocab%d.enc" % gConfig['enc_vocab_size'])
    dec_vocab_path = os.path.join(gConfig['working_directory'],"vocab%d.dec" % gConfig['dec_vocab_size'])

    enc_vocab, _ = data_utils.initialize_vocabulary(enc_vocab_path)
    _, rev_dec_vocab = data_utils.initialize_vocabulary(dec_vocab_path)

    # User Input
    sys.stdout.write("> ")
    sys.stdout.flush()
    sentence = sys.stdin.readline()
    while sentence:

      # Get token-ids for the input sentence.
      token_ids = data_utils.sentence_to_token_ids(tf.compat.as_bytes(sentence), enc_vocab)

      # Determine the bucket size
      bucket_id = min([b for b in xrange(len(_buckets))
                       if _buckets[b][0] > len(token_ids)])

      # Get a 1-element batch to feed the sentence to the model.
      encoder_inputs, decoder_inputs, target_weights = model.get_batch(
          {bucket_id: [(token_ids, [])]}, bucket_id)

      # Determine the output using output logit
      _, _, output_logits = model.step(sess, encoder_inputs, decoder_inputs,
                                       target_weights, bucket_id, True)

      outputs = [int(np.argmax(logit, axis=1)) for logit in output_logits]

      # If there is an End Of Sentence symbol in outputs, cut them at that point.
      if data_utils.EOS_ID in outputs:
        outputs = outputs[:outputs.index(data_utils.EOS_ID)]
```



```python
      # Print out the next input prompt
      print(" ".join([tf.compat.as_str(rev_dec_vocab[output]) for output in outputs]))
      print("> ", end="")
      sys.stdout.flush()
      sentence = sys.stdin.readline()
```

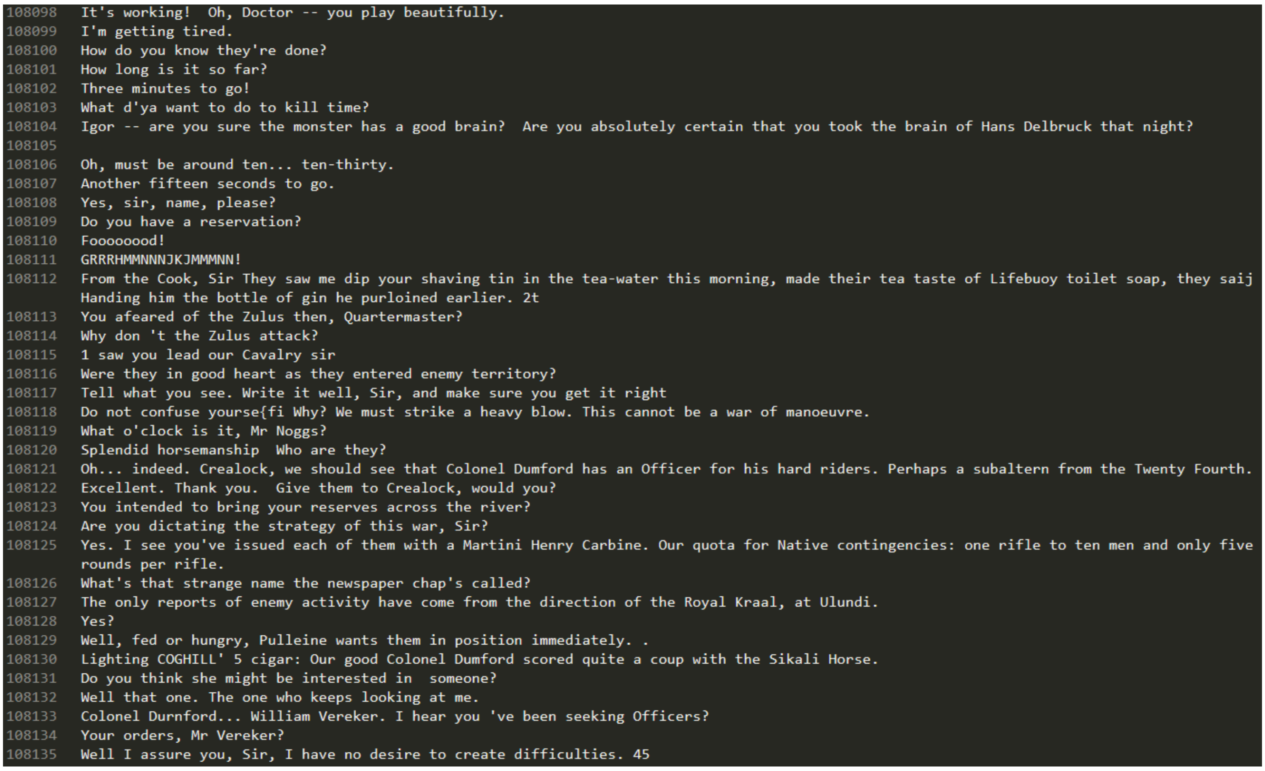
seq2seq.ini for EUC English



```
[strings]
# Mode : train, test
mode = test
train_enc = data/train.enc
train_dec = data/train.dec
test_enc = data/test.enc
test_dec = data/test.dec
# folder where checkpoints, vocabulary, temporary data will be stored
working_directory = working_dir/
[ints]
# vocabulary size
#   20,000 is a reasonable size
enc_vocab_size = 20000
dec_vocab_size = 20000
# number of GRU layers : 1/2/3
num_layers = 1
# typical options : 128, 256, 512, 1024
layer_size = 128
# dataset size limit; typically none : no limit
max_train_data_size = 0
batch_size = 64
# steps per checkpoint
#   Note : At a checkpoint, models parameters are saved, model is evaluated
#           and results are printed
steps_per_checkpoint = 300
[floats]
learning_rate = 0.5
learning_rate_decay_factor = 0.99
max_gradient_norm = 5.0
```

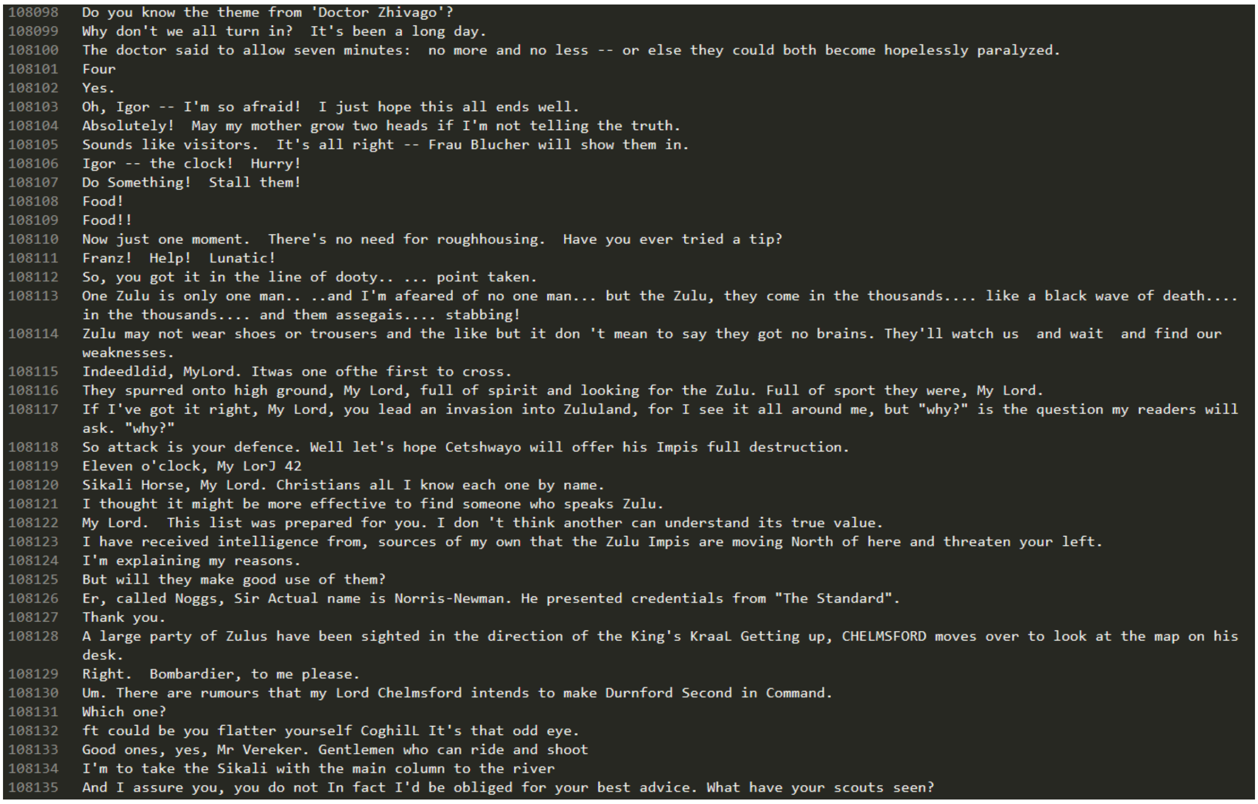
B. Data Set Training

Train Encoder for English EUC



```
108098   It's working!  Oh, Doctor -- you play beautifully.
108099   I'm getting tired.
108100   How do you know they're done?
108101   How long is it so far?
108102   Three minutes to go!
108103   What d'ya want to do to kill time?
108104   Igor -- are you sure the monster has a good brain?  Are you absolutely certain that you took the brain of Hans Delbruck that night?
108105
108106   Oh, must be around ten... ten-thirty.
108107   Another fifteen seconds to go.
108108   Yes, sir, name, please?
108109   Do you have a reservation?
108110   Foooooood!
108111   GRRRHMMNNNJKJMMMNN!
108112   From the Cook, Sir They saw me dip your shaving tin in the tea-water this morning, made their tea taste of Lifebuoy toilet soap, they saij
         Handing him the bottle of gin he purloined earlier. 2t
108113   You afeared of the Zulus then, Quartermaster?
108114   Why don 't the Zulus attack?
108115   1 saw you lead our Cavalry sir
108116   Were they in good heart as they entered enemy territory?
108117   Tell what you see. Write it well, Sir, and make sure you get it right
108118   Do not confuse yourse{fi Why? We must strike a heavy blow. This cannot be a war of manoeuvre.
108119   What o'clock is it, Mr Noggs?
108120   Splendid horsemanship  Who are they?
108121   Oh... indeed. Crealock, we should see that Colonel Dumford has an Officer for his hard riders. Perhaps a subaltern from the Twenty Fourth.
108122   Excellent. Thank you.  Give them to Crealock, would you?
108123   You intended to bring your reserves across the river?
108124   Are you dictating the strategy of this war, Sir?
108125   Yes. I see you've issued each of them with a Martini Henry Carbine. Our quota for Native contingencies: one rifle to ten men and only five
         rounds per rifle.
108126   What's that strange name the newspaper chap's called?
108127   The only reports of enemy activity have come from the direction of the Royal Kraal, at Ulundi.
108128   Yes?
108129   Well, fed or hungry, Pulleine wants them in position immediately. .
108130   Lighting COGHILL' 5 cigar: Our good Colonel Dumford scored quite a coup with the Sikali Horse.
108131   Do you think she might be interested in  someone?
108132   Well that one. The one who keeps looking at me.
108133   Colonel Durnford... William Vereker. I hear you 've been seeking Officers?
108134   Your orders, Mr Vereker?
108135   Well I assure you, Sir, I have no desire to create difficulties. 45
```

Train Decoder for English EUC

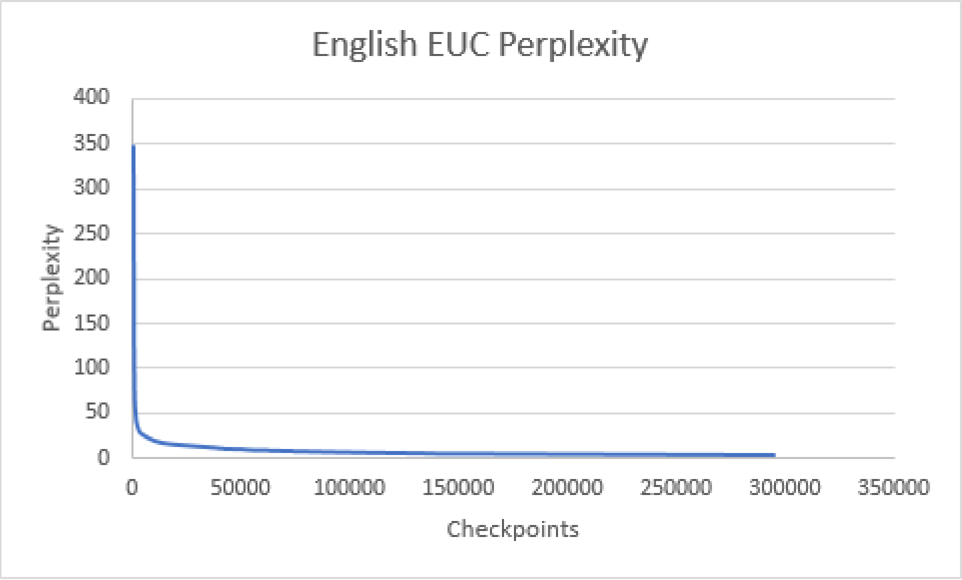


```
108098   Do you know the theme from 'Doctor Zhivago'?
108099   Why don't we all turn in?  It's been a long day.
108100   The doctor said to allow seven minutes:  no more and no less -- or else they could both become hopelessly paralyzed.
108101   Four
108102   Yes.
108103   Oh, Igor -- I'm so afraid!  I just hope this all ends well.
108104   Absolutely!  May my mother grow two heads if I'm not telling the truth.
108105   Sounds like visitors.  It's all right -- Frau Blucher will show them in.
108106   Igor -- the clock!  Hurry!
108107   Do Something!  Stall them!
108108   Food!
108109   Food!!
108110   Now just one moment.  There's no need for roughhousing.  Have you ever tried a tip?
108111   Franz!  Help!  Lunatic!
108112   So, you got it in the line of dooty.. ... point taken.
108113   One Zulu is only one man.. ..and I'm afeared of no one man... but the Zulu, they come in the thousands.... like a black wave of death....
         in the thousands.... and them assegais.... stabbing!
108114   Zulu may not wear shoes or trousers and the like but it don 't mean to say they got no brains. They'll watch us  and wait  and find our
         weaknesses.
108115   Indeedldid, MyLord. Itwas one ofthe first to cross.
108116   They spurred onto high ground, My Lord, full of spirit and looking for the Zulu. Full of sport they were, My Lord.
108117   If I've got it right, My Lord, you lead an invasion into Zululand, for I see it all around me, but "why?" is the question my readers will
         ask. "why?"
108118   So attack is your defence. Well let's hope Cetshwayo will offer his Impis full destruction.
108119   Eleven o'clock, My LorJ 42
108120   Sikali Horse, My Lord. Christians alL I know each one by name.
108121   I thought it might be more effective to find someone who speaks Zulu.
108122   My Lord.  This list was prepared for you. I don 't think another can understand its true value.
108123   I have received intelligence from, sources of my own that the Zulu Impis are moving North of here and threaten your left.
108124   I'm explaining my reasons.
108125   But will they make good use of them?
108126   Er, called Noggs, Sir Actual name is Norris-Newman. He presented credentials from "The Standard".
108127   Thank you.
108128   A large party of Zulus have been sighted in the direction of the King's KraaL Getting up, CHELMSFORD moves over to look at the map on his
         desk.
108129   Right.  Bombardier, to me please.
108130   Um. There are rumours that my Lord Chelmsford intends to make Durnford Second in Command.
108131   Which one?
108132   ft could be you flatter yourself CoghilL It's that odd eye.
108133   Good ones, yes, Mr Vereker. Gentlemen who can ride and shoot
108134   I'm to take the Sikali with the main column to the river
108135   And I assure you, you do not In fact I'd be obliged for your best advice. What have your scouts seen?
```

C. Data Training Progress

1. English EUC

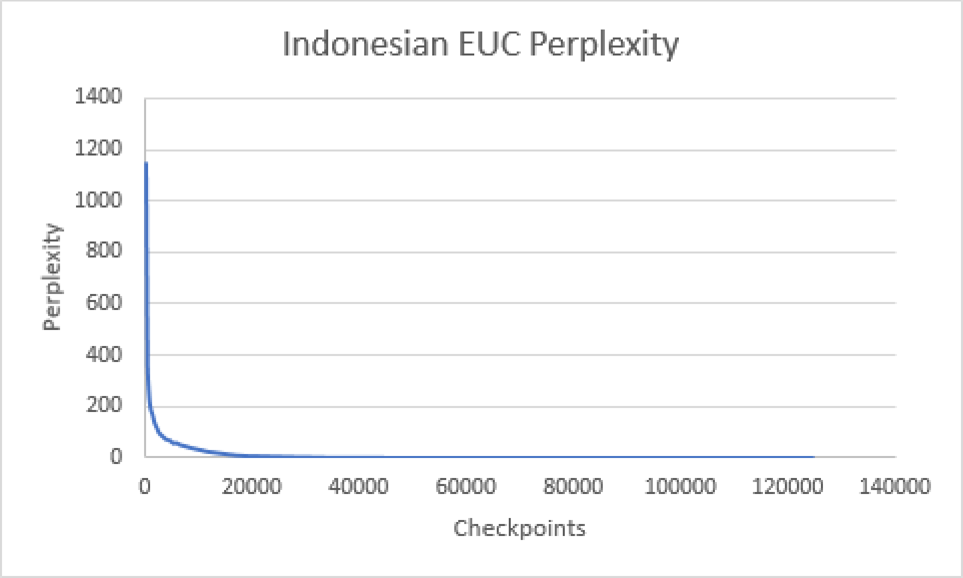
Checkpoints	Perplexity
300	348.41
600	113.69
900	63.56
1200	51.65
1500	42.91
1800	38.19
2100	35.27
2400	33.75
2700	30.88
3900	27.04
13200	17.17
38100	11.75
40200	10.99
41400	11.11
41700	10.88
42000	10.52
49800	10.14
50400	10
55000	9.21
62100	8.84
63000	8.58
72900	8.08
73800	7.99
74100	7.54
81000	7.45
93000	6.94
104100	6.48
137100	5.38
140700	5.11
160200	4.98
224100	4.32
272100	3.81
273300	3.75
294900	3.66



2. Indonesian EUC

Checkpoints	Perplexity
300	1144.66
600	353.54
900	233.18
1200	188.78
1500	169.88
1800	143.63
2100	127.2
2400	113.6
2700	98.98
3000	92.81
3300	86.07
3600	81.43
3900	74.54
4200	73.2
4500	70
4800	68.58
5100	62.71
5400	57.76
5700	59.1
6000	58.97

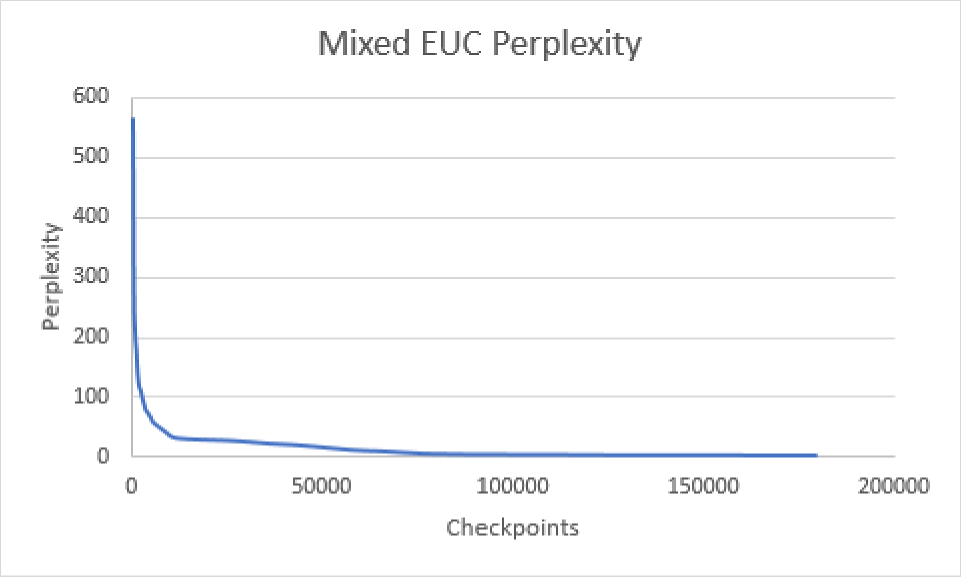
Checkpoints	Perplexity
6300	55.58
6600	51.98
6900	50.36
7500	47.08
8700	40.08
9600	35.72
10800	30.43
11700	25.76
17100	11.08
18000	10.19
18300	9.64
19200	8.45
34200	2.28
35100	2.08
44700	1.47
108900	1.02
122400	1.02
123900	1.02
124500	1.02



3. Mixed Indonesian-English EUC

Checkpoints	Perplexity
300	565.86
600	259.45
900	202.28
1200	177.21
1500	141.96
1800	122.25
2100	114.09
2400	109.53
2700	99.85
3000	93.6
3300	85.86
3600	78.74
4200	73.7
4500	69.78
4800	67.55
5100	64.12
5400	58.92

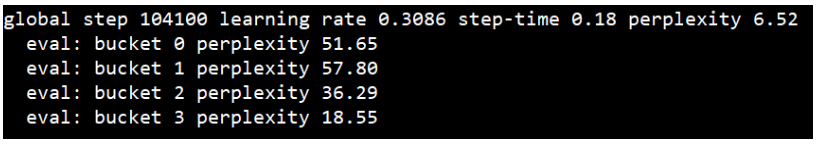
Checkpoints	Perplexity
5700	56.87
8700	42.18
11700	31.11
26700	26.54
36000	21.99
45300	18.43
57600	11.25
66600	8.74
76200	5.14
84300	4.1
85800	3.81
121800	2.71
123300	2.66
124500	2.46
179100	1.9
179400	1.87



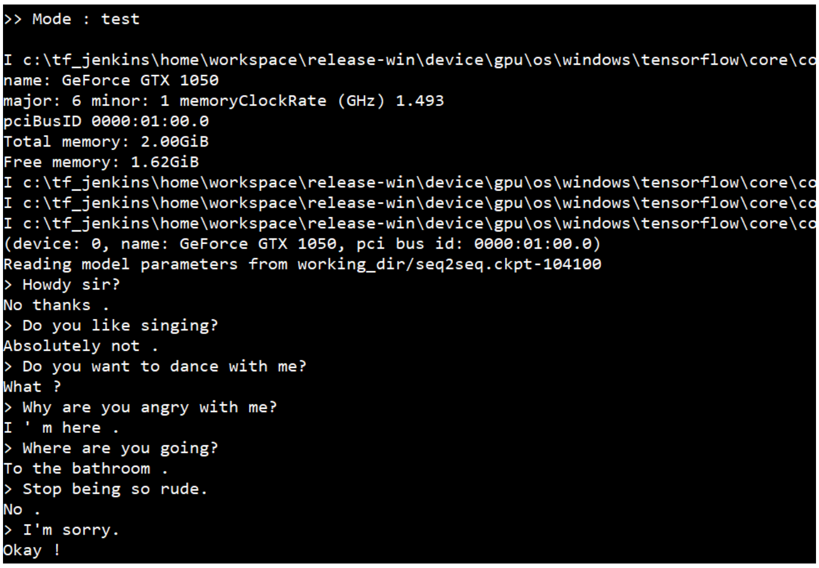
D. Results

1. English EUC

Global Step: 104100

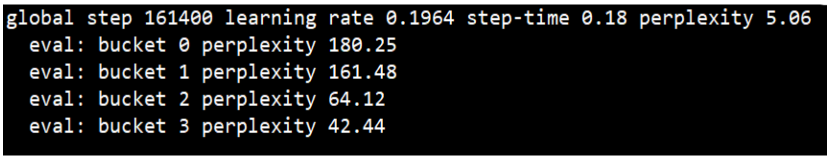


```
global step 104100 learning rate 0.3086 step-time 0.18 perplexity 6.52
  eval: bucket 0 perplexity 51.65
  eval: bucket 1 perplexity 57.80
  eval: bucket 2 perplexity 36.29
  eval: bucket 3 perplexity 18.55
```

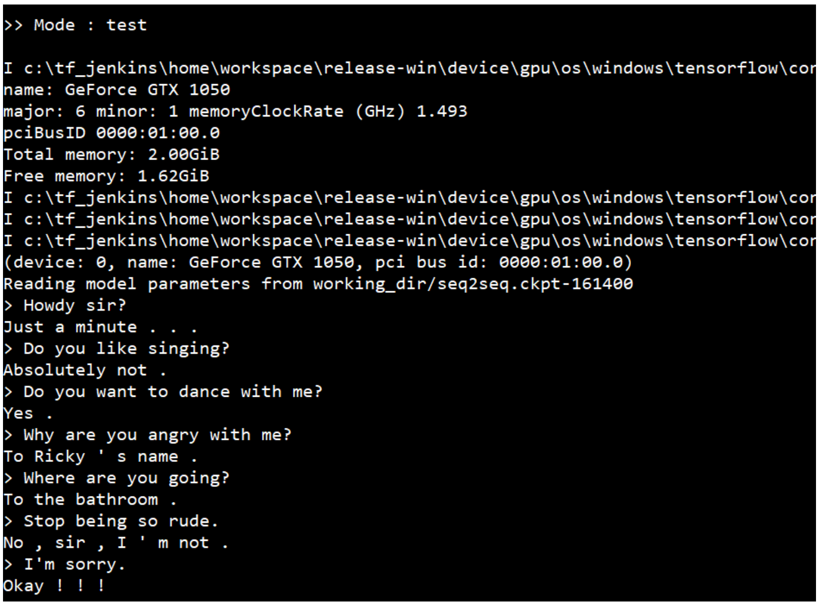


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core\co
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core\co
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core\co
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core\co
(device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-104100
> Howdy sir?
No thanks .
> Do you like singing?
Absolutely not .
> Do you want to dance with me?
What ?
> Why are you angry with me?
I ' m here .
> Where are you going?
To the bathroom .
> Stop being so rude.
No .
> I'm sorry.
Okay !
```

Global Step: 161400

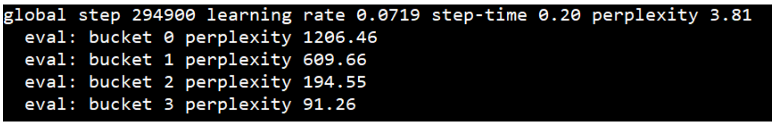


```
global step 161400 learning rate 0.1964 step-time 0.18 perplexity 5.06
  eval: bucket 0 perplexity 180.25
  eval: bucket 1 perplexity 161.48
  eval: bucket 2 perplexity 64.12
  eval: bucket 3 perplexity 42.44
```

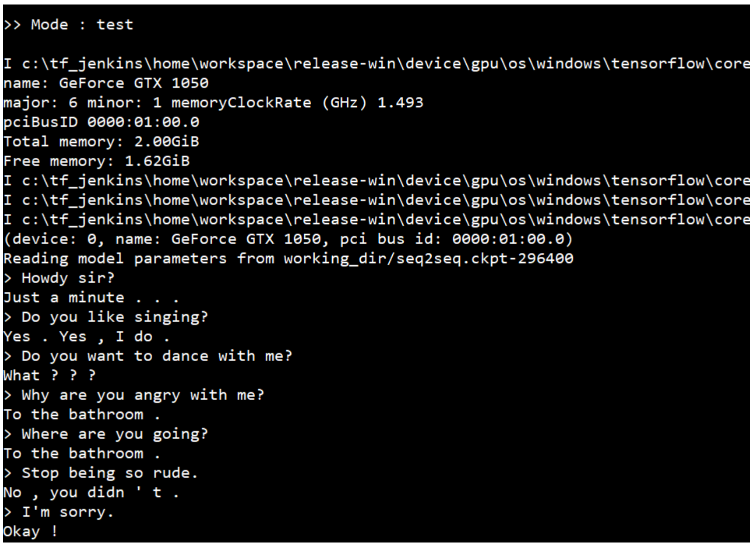


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\cor
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\cor
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\cor
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\cor
(device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-161400
> Howdy sir?
Just a minute . . .
> Do you like singing?
Absolutely not .
> Do you want to dance with me?
Yes .
> Why are you angry with me?
To Ricky ' s name .
> Where are you going?
To the bathroom .
> Stop being so rude.
No , sir , I ' m not .
> I'm sorry.
Okay ! ! !
```

Global Step: 294900



```
global step 294900 learning rate 0.0719 step-time 0.20 perplexity 3.81
  eval: bucket 0 perplexity 1206.46
  eval: bucket 1 perplexity 609.66
  eval: bucket 2 perplexity 194.55
  eval: bucket 3 perplexity 91.26
```

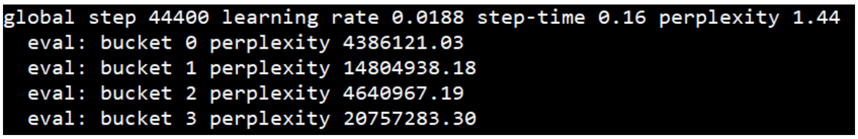


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\core
(device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-296400
> Howdy sir?
Just a minute . . .
> Do you like singing?
Yes . Yes , I do .
> Do you want to dance with me?
What ? ? ?
> Why are you angry with me?
To the bathroom .
> Where are you going?
To the bathroom .
> Stop being so rude.
No , you didn ' t .
> I'm sorry.
Okay !
```

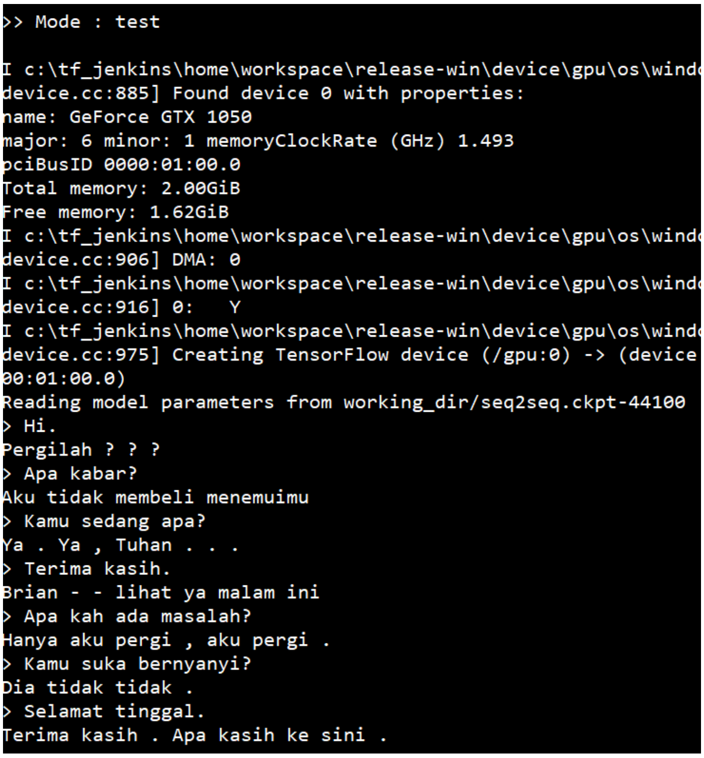
2. Indonesian EUC

Even though the perplexity of this EUC version is the smallest compared to the other versions (the lower the perplexity, the better the chatbot should be), the responses given are the worst of all because the training data are translated from the original dataset using Google Translate. That’s why the translation is not accurate.

Global Step: 44400

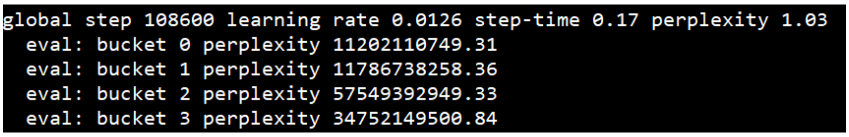


```
global step 44400 learning rate 0.0188 step-time 0.16 perplexity 1.44
  eval: bucket 0 perplexity 4386121.03
  eval: bucket 1 perplexity 14804938.18
  eval: bucket 2 perplexity 4640967.19
  eval: bucket 3 perplexity 20757283.30
```

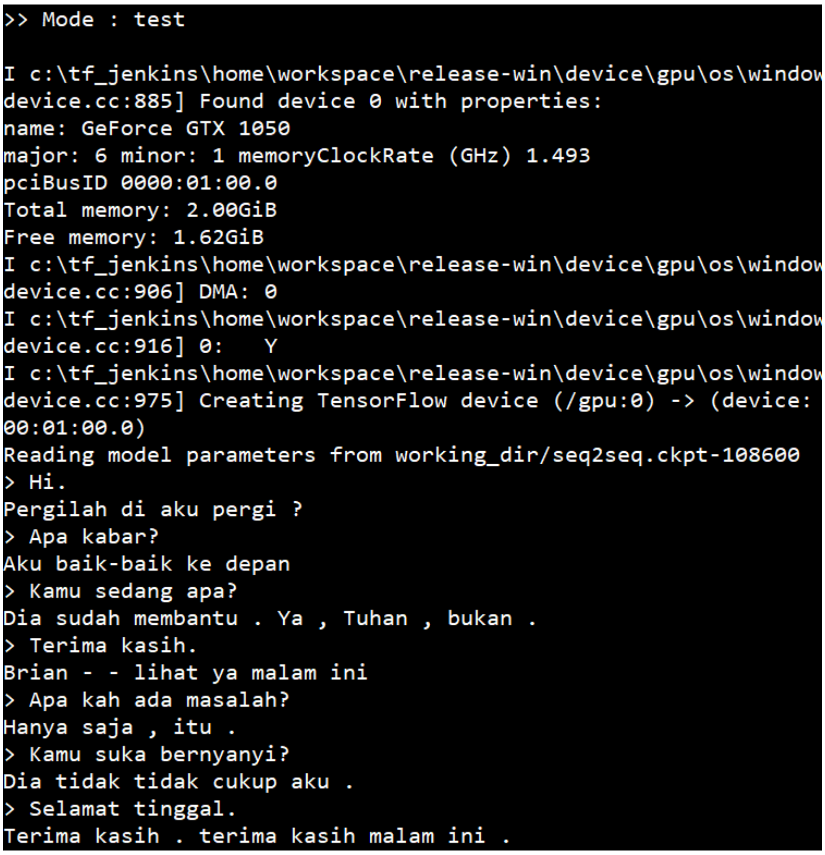


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\wind
device.cc:885] Found device 0 with properties:
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\wind
device.cc:906] DMA: 0
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\wind
device.cc:916] 0:   Y
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\wind
device.cc:975] Creating TensorFlow device (/gpu:0) -> (device
00:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-44100
> Hi.
Pergilah ? ? ?
> Apa kabar?
Aku tidak membeli menemuimu
> Kamu sedang apa?
Ya . Ya , Tuhan . . .
> Terima kasih.
Brian - - lihat ya malam ini
> Apa kah ada masalah?
Hanya aku pergi , aku pergi .
> Kamu suka bernyanyi?
Dia tidak tidak .
> Selamat tinggal.
Terima kasih . Apa kasih ke sini .
```

Global Step: 108600

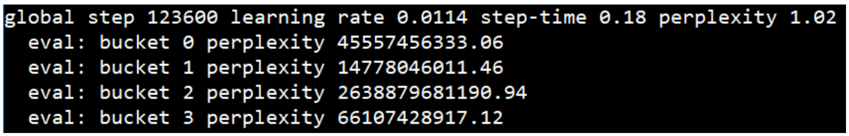


```
global step 108600 learning rate 0.0126 step-time 0.17 perplexity 1.03
  eval: bucket 0 perplexity 11202110749.31
  eval: bucket 1 perplexity 11786738258.36
  eval: bucket 2 perplexity 57549392949.33
  eval: bucket 3 perplexity 34752149500.84
```

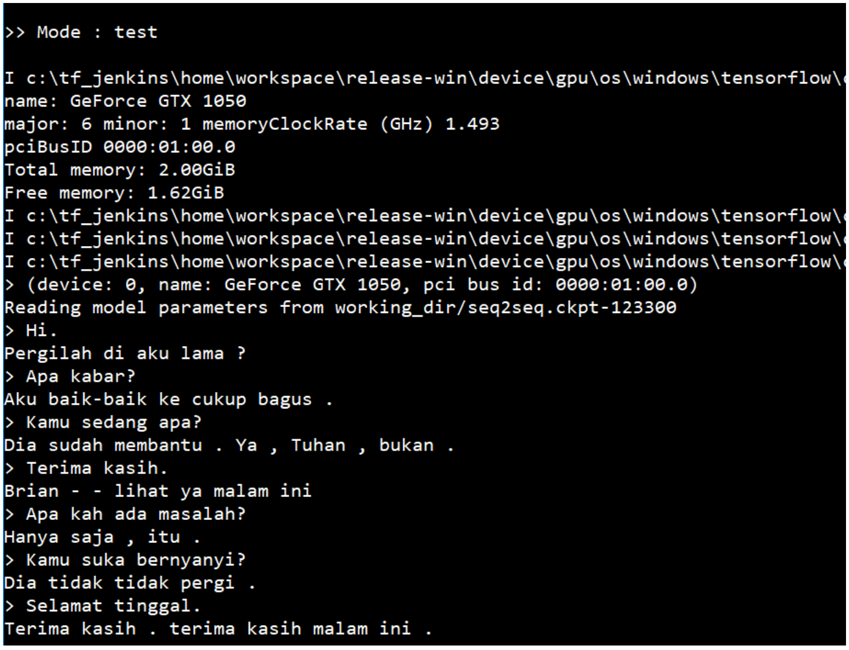


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
device.cc:885] Found device 0 with properties:
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
device.cc:906] DMA: 0
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
device.cc:916] 0:   Y
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
device.cc:975] Creating TensorFlow device (/gpu:0) -> (device:
00:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-108600
> Hi.
Pergilah di aku pergi ?
> Apa kabar?
Aku baik-baik ke depan
> Kamu sedang apa?
Dia sudah membantu . Ya , Tuhan , bukan .
> Terima kasih.
Brian - - lihat ya malam ini
> Apa kah ada masalah?
Hanya saja , itu .
> Kamu suka bernyanyi?
Dia tidak tidak cukup aku .
> Selamat tinggal.
Terima kasih . terima kasih malam ini .
```

Global Step: 123600



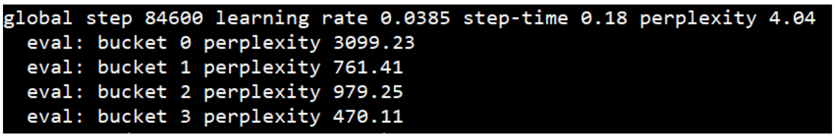
```
global step 123600 learning rate 0.0114 step-time 0.18 perplexity 1.02
  eval: bucket 0 perplexity 45557456333.06
  eval: bucket 1 perplexity 14778046011.46
  eval: bucket 2 perplexity 2638879681190.94
  eval: bucket 3 perplexity 66107428917.12
```



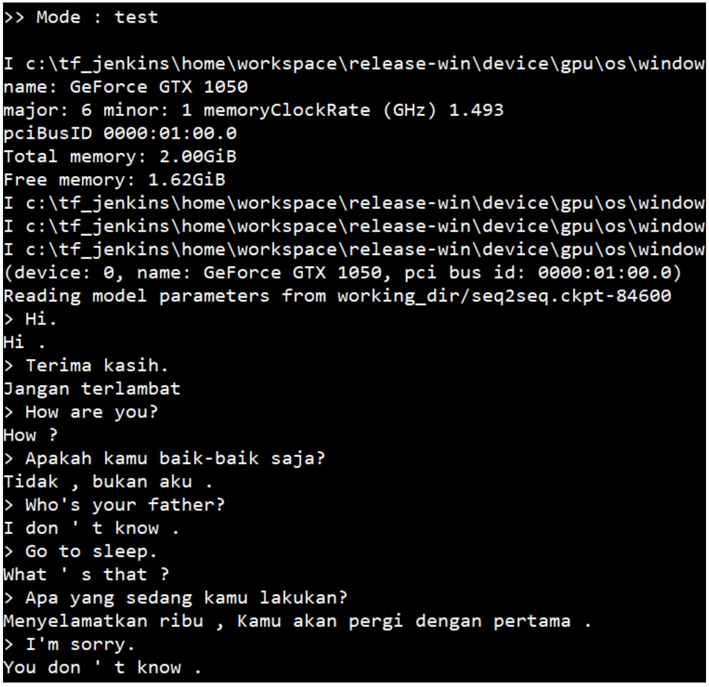
```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windows\tensorflow\
> (device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-123300
> Hi.
Pergilah di aku lama ?
> Apa kabar?
Aku baik-baik ke cukup bagus .
> Kamu sedang apa?
Dia sudah membantu . Ya , Tuhan , bukan .
> Terima kasih.
Brian - - lihat ya malam ini
> Apa kah ada masalah?
Hanya saja , itu .
> Kamu suka bernyanyi?
Dia tidak tidak pergi .
> Selamat tinggal.
Terima kasih . terima kasih malam ini .
```

3. Mixed Indonesian-English EUC

Global Step: 84600

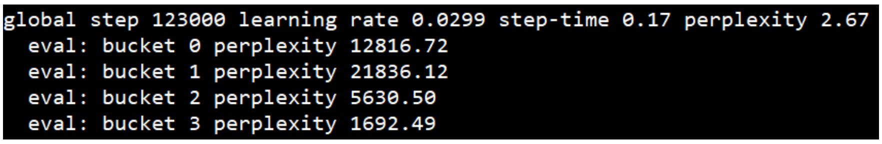


```
global step 84600 learning rate 0.0385 step-time 0.18 perplexity 4.04
  eval: bucket 0 perplexity 3099.23
  eval: bucket 1 perplexity 761.41
  eval: bucket 2 perplexity 979.25
  eval: bucket 3 perplexity 470.11
```

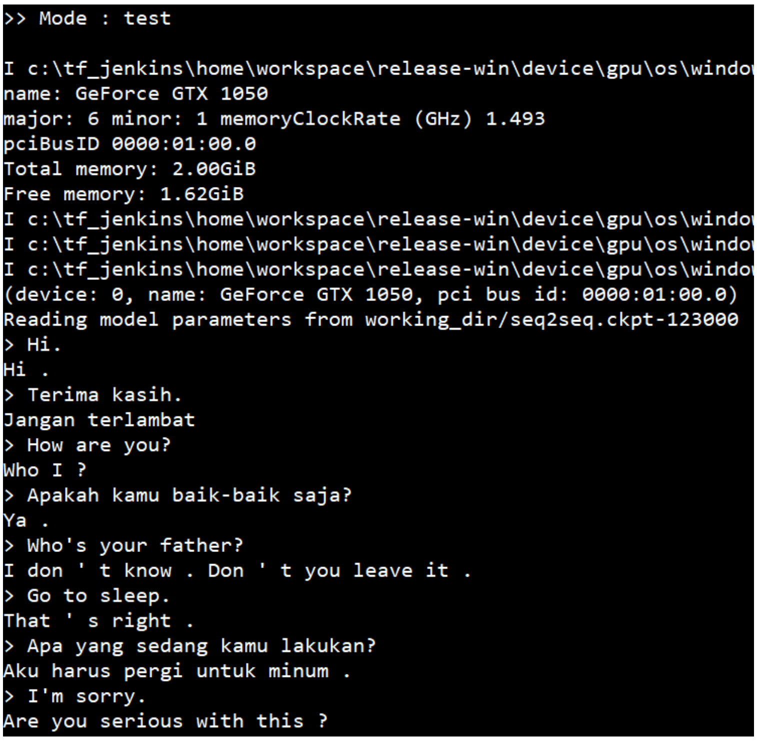


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\window
(device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-84600
> Hi.
Hi .
> Terima kasih.
Jangan terlambat
> How are you?
How ?
> Apakah kamu baik-baik saja?
Tidak , bukan aku .
> Who's your father?
I don ' t know .
> Go to sleep.
What ' s that ?
> Apa yang sedang kamu lakukan?
Menyelamatkan ribu , Kamu akan pergi dengan pertama .
> I'm sorry.
You don ' t know .
```

Global Step:123000

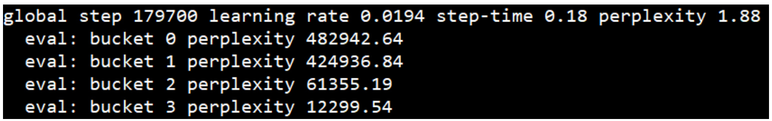


```
global step 123000 learning rate 0.0299 step-time 0.17 perplexity 2.67
  eval: bucket 0 perplexity 12816.72
  eval: bucket 1 perplexity 21836.12
  eval: bucket 2 perplexity 5630.50
  eval: bucket 3 perplexity 1692.49
```

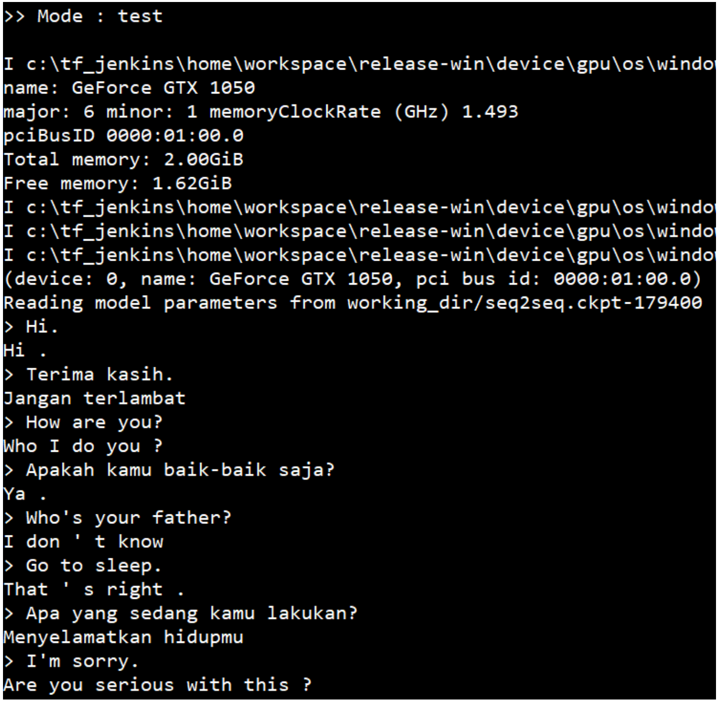


```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
(device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-123000
> Hi.
Hi .
> Terima kasih.
Jangan terlambat
> How are you?
Who I ?
> Apakah kamu baik-baik saja?
Ya .
> Who's your father?
I don ' t know . Don ' t you leave it .
> Go to sleep.
That ' s right .
> Apa yang sedang kamu lakukan?
Aku harus pergi untuk minum .
> I'm sorry.
Are you serious with this ?
```

Global Step: 179700



```
global step 179700 learning rate 0.0194 step-time 0.18 perplexity 1.88
  eval: bucket 0 perplexity 482942.64
  eval: bucket 1 perplexity 424936.84
  eval: bucket 2 perplexity 61355.19
  eval: bucket 3 perplexity 12299.54
```



```
>> Mode : test

I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
name: GeForce GTX 1050
major: 6 minor: 1 memoryClockRate (GHz) 1.493
pciBusID 0000:01:00.0
Total memory: 2.00GiB
Free memory: 1.62GiB
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
I c:\tf_jenkins\home\workspace\release-win\device\gpu\os\windo
(device: 0, name: GeForce GTX 1050, pci bus id: 0000:01:00.0)
Reading model parameters from working_dir/seq2seq.ckpt-179400
> Hi.
Hi .
> Terima kasih.
Jangan terlambat
> How are you?
Who I do you ?
> Apakah kamu baik-baik saja?
Ya .
> Who's your father?
I don ' t know
> Go to sleep.
That ' s right .
> Apa yang sedang kamu lakukan?
Menyelamatkan hidupmu
> I'm sorry.
Are you serious with this ?
```

V. Conclusion

In conclusion, training time, learning rate, and the size of the data sets are several major factors in creating a conversable chatbot. Even though the size of the data sets is quite enormous, if it is not trained for quite a long time, the perplexity of the chatbot will be very high and it will result in the lack of ability for the chatbot to give the appropriate response to the given arguments. In addition, as the training goes on, the learning rate will be reduced in order to avoid the local minima so that the chatbot will get the best result.

VI. Bibliography

Github Repositories

https://github.com/suriyadeepan/easy_seq2seq

https://github.com/suriyadeepan/practical_seq2seq

Our Github URL

https://github.com/kensentjoa/AI-FinalProject-Chatbot

Development Tools, Software, APIs, Libraries, Data sets

https://www.tensorflow.org/

https://developer.nvidia.com/cuda-toolkit

https://developer.nvidia.com/cudnn

https://www.cs.cornell.edu/~cristian/Cornell_Movie-Dialogs_Corpus.html

https://www.tensorflow.org/tutorials/seq2seq

Helpful Articles and Videos

https://www.youtube.com/watch?v=SJDEOWLHYVo

http://suriyadeepan.github.io/2016-06-28-easy-seq2seq/

http://www.wildml.com/2015/10/recurrent-neural-network-tutorial-part-4-implementing-a-grulstm-rnn-with-python-and-theano/

Demo Video

https://youtu.be/jluWeW8HhSM