0. Connected to Drive

```
# Mount with gdrive
from google.colab import drive
drive.mount('/content/gdrive')
```

```
    Mounted at /content/gdrive
```

```
# open existing text file
get_postags = "/content/gdrive/My Drive/MSBA_Spring2020/IDS576_DeepLearning/Project/get_postags.txt"
get_postags_list = open(get_postags).readlines()
# open existing text file
get_dependencies = "/content/gdrive/My Drive/MSBA_Spring2020/IDS576_DeepLearning/Project/get_dependencies.tx
get_dependencies_list = open(get_dependencies).readlines()
```

```
print(get_postags)
print(get_dependencies)
```

```
    /content/gdrive/My Drive/MSBA_Spring2020/IDS576_DeepLearning/Project/get_postags.txt
    /content/gdrive/My Drive/MSBA_Spring2020/IDS576_DeepLearning/Project/get_dependencies.txt
```

1. Spacy

```
# SPACY
import spacy
import string
from sklearn.preprocessing import FunctionTransformer
from spacy import displacy
```

```
from spacy.lang.en import English
nlp = English()
nlp.add_pipe(nlp.create_pipe('sentencizer'))
```

```
def split_in_sentences(text):
    doc = nlp(text)
    return [str(sent).strip() for sent in doc.sents]
```

```
path = "/content/gdrive/My Drive/MSBA_Spring2020/IDS576_DeepLearning/Project/The_Wizard_of_Oz.txt"
file = open(path, "r")
line = file.read().replace("\n","  ")
print(type(line))
```

```
    <class 'str'>
```

```
sents=split_in_sentences(line)
print(sents)
```

```
    ['INTRODUCTION.', 'Folk lore, legends, myths and fairy tales have fol-   lowed childhood through the ag
```

```
import re
def preprocessor_final(text):
    if isinstance((text), (str)):
        text = re.sub('<[,^>.!]*>', ' ', text)
        text = re.sub('[\W]+', ' ', text.lower())
        return text
    if isinstance((text), (list)):
        return_list = []
        for i in range(len(text)):
            temp_text = re.sub('<[^>]*>', ' ', text[i])
            temp_text = re.sub('[\W]+', ' ', temp_text.lower())
            return_list.append(temp_text)
        return(return_list)
    else:
        pass

def all_in_one(text):
    preprocessed = preprocessor_final(text)
    nlp = spacy.load('en_core_web_sm')
    doc = nlp(preprocessed)
    #displacy.serve(doc, style='dep')
    list1= []
    list2= []
    for token in doc:
        list1.append(token.pos_)
    for token in doc:
        list2.append(token.dep_)
    #print(list1)
    return (list1, list2)
```

```
# Test on one sentence
test = "Apple, This is first sentence."
get_postags, get_dependencies = all_in_one(test)
```

```
apple this is first sentence
```

```
# See the result
print("This is get_postags"+ str(get_postags))
print("This is get_dependencies"+ str(get_dependencies))
```

```
This is get_postags['PROPN', 'DET', 'AUX', 'ADJ', 'NOUN']
This is get_dependencies['npadvmod', 'nsubj', 'ROOT', 'amod', 'attr']
```

```
# Print get_postags, get_dependencies of test sentence
print("This is get_postags:\n"+ str(get_postags))
print("\nThis is get_dependencies:\n"+ str(get_dependencies))
```

```
This is get_postags:
['PROPN', 'DET', 'AUX', 'ADJ', 'NOUN']

This is get_dependencies:
['npadvmod', 'nsubj', 'ROOT', 'amod', 'attr']
```

```
# gutenburgtextdata
get_postags = []
get_dependencies =[]
for i in sents:
    postags, dependencies = all_in_one(i)
    get_postags.append(postags)
    get_dependencies.append(dependencies)
```

```
cried dorothy clasping her tands together in diwa t he house must hava f llen on hgr
wjialever shall vc do
 1
 there s nothiag te bc done said the little woman dorothy
the wicked witch f the east as f aid answered the little woman
```

```
 she has held all
the munchkins in bondage for
the wonderful wizard of oz
23 many years making them slave for her night and day
now they are all set free and are grateful to you for the favour
 who are the munchkins
enquired dorothy
 they are the people who live in this land of the east where the wicked witch ruled
 are you a munchkin
asked dorothy
 no but i am their friend although i live in the land of the north
when they saw the witch of the east was dead the munchkins sent a swift messenger to me and i came at
 oh gracious
cried dorothy are you a real witch
 yes indeed answered the little woman
but i am a good witch and the people love me
i am not as powerful as the wicked witch was who ruled here or i should have set the people free myse
 but i thought all witches were wicked said the girl who was half frightened at facing a real witch
 oh no that is a great mistake
there were only four witches in all the land of oz and two of them those who live in the north and th
i know this is true for i am one of them myself and cannot be mistaken
those who dwelt in the east and the west were indeed wicked witches but now that you have killed one
 but said dorothy after a moment s thought aunt 24 the wonderful wizard of oz
em has told me that the witches were all dead years and years ago
 who is aunt em
inquired the little old woman
 she is my aunt who lives in kansas where i came from
the witch of the north seemed to think for a time with her head bowed and her eyes upon the ground
then she looked up and said i do not know where kansas is for i have never heard that country mentio
but tell me is it a civilized country
 oh yes replied dorothy
 then that accounts for it
in the civilized countries i believe there are no witches left nor wizards nor sorcer esses nor magi
but you see the land of oz has never been civilized for we are cut off from all the rest of the worl
therefore we still have witches and wizards amongst us
 who are the wizards
asked dorothy
 oz himself is the great wizard answered the witch sinking her voice to a whisper
he is more power ful than all the rest of us together
he lives in the city of emeralds
dorothy was going to ask another question but just then the munchkins who had been standing silently
the wonderfui
wizard of oz what is it
asked the little old woman and looked and began to laugh
the feet of the dead witch had disappeared entirely and nothing was left but the silver shoes
 she was so old ex plained the witch of the north that she dried up quickly in the sun
that is the end of her
but the silver shoes are yours and you shall have them to wear
she reached down and picked up the shoes and after shaking the dust out of them handed them to doroth
 the witch of the east was proud of those silver shoes said one of the munchkins and there is some ch
dorothy carried the shoes into the house and placed them on the table
then she came out again to the munchkins and said i am anxious to get back to my aunt and uncle for i
can you help me find my way
the munchkins and the witch first looked at one 26 the wonderful wizard of oz
```

```python
# Print get_postags, get_dependencies of gutenburgtextdata
print("This is get_postags:\n"+ str(get_postags))
print("\nThis is get_dependencies:\n"+ str(get_dependencies))
print(len(get_postags))
print(len(get_dependencies))
```

```
This is get_postags:
[['NOUN'], ['PROPN', 'NOUN', 'NOUN', 'NOUN', 'CCONJ', 'NOUN', 'NOUN', 'AUX', 'PROPN', 'VERB', 'NOUN',

This is get_dependencies:
[['ROOT'], ['compound', 'nsubj', 'ccomp', 'dobj', 'cc', 'compound', 'conj', 'aux', 'advmod', 'ROOT', '
2394
2394
```

2. Vectorization

```
from sklearn.preprocessing import OneHotEncoder
import numpy as np
import tensorflow as tf
import torch


from ast import literal_eval

def createLookUpDict(train_d):
  look_up_dict = {}
  index = 0
  for i in range(len(train_d)):
    #temp = literal_eval(train_d[i])
    temp = train_d[i]
    for k in temp:
        look_up_dict, index = addword(k, look_up_dict, index)
  return look_up_dict


def addword(word, look_up_dict, ind):
    if word in look_up_dict:
        return [look_up_dict, ind]
    else:
        ind += 1
        look_up_dict.update({word: ind})
    return [look_up_dict, ind]


get_dependencies_list = get_dependencies
get_postags_list = get_postags

print(get_dependencies_list)
print(get_postags_list)
dep_look_up = createLookUpDict(get_dependencies_list)
post_look_up = createLookUpDict(get_postags_list)
print(dep_look_up)
print(post_look_up)
```

```
[['ROOT'], ['compound', 'nsubj', 'ccomp', 'dobj', 'cc', 'compound', 'conj', 'aux', 'advmod', 'ROOT', '
[['NOUN'], ['PROPN', 'NOUN', 'NOUN', 'NOUN', 'CCONJ', 'NOUN', 'NOUN', 'AUX', 'PROPN', 'VERB', 'NOUN',
{'ROOT': 1, 'compound': 2, 'nsubj': 3, 'ccomp': 4, 'dobj': 5, 'cc': 6, 'conj': 7, 'aux': 8, 'advmod':
{'NOUN': 1, 'PROPN': 2, 'CCONJ': 3, 'AUX': 4, 'VERB': 5, 'ADP': 6, 'DET': 7, 'ADJ': 8, 'ADV': 9, 'PART
```

```
# One-hot matrix of first to last letters (not including EOS) for input
def inputTensor(line, Max_Sent_length, look_up_dict):
    tensor = torch.zeros(Max_Sent_length, 1, len(look_up_dict))
    for li in range(len(line)):
        word = line[li]
        if word in look_up_dict.values():
            tensor[li][0][look_up_dict[word]] = 1
        else:
          tensor[li][0][len(look_up_dict)-1] = 1
    return tensor.int()

def sent_to_num(dep_line, d_up_dict, post_line, p_up_dict):
    length = len(dep_line)
    out = np.zeros((2, length))
    for i in range(length):
        if dep_line[i] in d_up_dict.keys():
            out[0][i] = d_up_dict[dep_line[i]]
            out[0][i] = d_up_dict[dep_line[i]]
        if post_line[i] in p_up_dict.keys():
            out[1][i] = p_up_dict[post_line[i]]
    return out

def sent_to_num_fixed(dep_line, d_up_dict, post_line, p_up_dict, outsize):
    length = outsize
    line_size = len(dep_line)
    out = np.zeros(length*2)
    if line_size <= length:
        for i in range(line_size):
            if dep_line[i] in d_up_dict.keys():
                out[i] = d_up_dict[dep_line[i]]
            if post_line[i] in p_up_dict.keys():
                out[length + i] = p_up_dict[post_line[i]]
    else:
        for i in range(length):
            if dep_line[i] in d_up_dict.keys():
                out[i] = d_up_dict[dep_line[i]]
            if post_line[i] in p_up_dict.keys():
                out[length + i] = p_up_dict[post_line[i]]
    return out


Sent_length = 64
a = sent_to_num_fixed(get_dependencies_list[1], dep_look_up, get_postags_list[1], post_look_up, Sent_length)
print(a.shape)
```

```
     (128,)
```

```
outputs = []
#outputs = sent_to_num_fixed(get_dependencies[0], dep_look_up, get_postags[0], post_look_up, Sent_length)
Sent_length = 64
for i in range(len(get_dependencies)):
  input = sent_to_num_fixed(get_dependencies[i], dep_look_up, get_postags[i], post_look_up, Sent_length)
  outputs.append(input)
rawTrainingData =  np.array(outputs)
print(rawTrainingData)
```

```
     [[ 1.  0.  0. ...  0.  0.  0.]
      [ 2.  3.  4. ...  0.  0.  0.]
      [11. 14.  3. ...  0.  0.  0.]
      ...
      [ 3.  1. 11. ...  0.  0.  0.]
      [11. 17. 19. ...  0.  0.  0.]
      [ 0.  0.  0. ...  0.  0.  0.]]
```

```
from torchvision.transforms import transforms
# define transforms
transform = transforms.Compose(
    [transforms.ToTensor(),
     transforms.Normalize((0.5, ), (0.5, ))
])

#################################### Mai's ####################################

# Load library
# Create a vector as a row

training_data = np.array([[1, 2, 3, 4, 5, 6, 7, 8, 9, 10],[1, 2, 3, 4, 5, 6, 7, 8, 9, 10],[1, 2, 3, 4, 5, 6,
num_sen_trn = training_data.shape[0] # number of sentences in training data
dp_sen = training_data.shape[1] # sentence length x2 (dependency,postag)
```

```
# vector_row = np.array([[1, 2, 3],[4, 5, 6]]) ; 3[postag,dependency] * 2sentences
vector_row = np.array([1, 2, 3, 4, 5, 6, 7, 8, 9, 10])
```

```
from torch.utils.data import Dataset
from torch.utils.data import DataLoader

class CustomDataset(Dataset):
    def __init__(self, data, transforms=None):
        self.data = data
        self.transforms = transforms

    def __len__(self):
        return len(self.data)

    def __getitem__(self, idx):
        data = self.data[i, :]
        #data = np.asarray(data).astype(np.uint8)
        if self.transforms:
            data = self.transforms(data)
        else:
            data = data/50
        return data.astype(np.float32)
```

```
print(rawTrainingData)
#train_data = CustomDataset(rawTrainingData, transform)
train_data = CustomDataset(rawTrainingData)

# dataloaders
trainloader = DataLoader(train_data, batch_size=32, shuffle=True)
```

```
[[ 1.  0.  0. ...  0.  0.  0.]
 [ 2.  3.  4. ...  0.  0.  0.]
 [11. 14.  3. ...  0.  0.  0.]
 ...
 [ 3.  1. 11. ...  0.  0.  0.]
 [11. 17. 19. ...  0.  0.  0.]
 [ 0.  0.  0. ...  0.  0.  0.]]
```

3. GAN

https://github.com/udacity/deep-learning-v2-pytorch/blob/master/gan-mnist/MNIST_GAN_Solution.ipynb

italicized text## Create dummy vector

xxxxx

Function, Discriminator, Generator

```
#Discriminator
import torch.nn as nn
import torch.nn.functional as F

class Discriminator(nn.Module):

    def __init__(self, input_size, hidden_dim, output_size):
        super(Discriminator, self).__init__()
        # define hidden linear layers
        self.fc1 = nn.Linear(input_size, hidden_dim)
        self.fc2 = nn.Linear(hidden_dim, hidden_dim)

        # final fully-connected layer
        self.fc3 = nn.Linear(hidden_dim, output_size)

        # dropout layer
        self.dropout = nn.Dropout(0.3)


    def forward(self, x):
        # all hidden layers
        x = F.leaky_relu(self.fc1(x), 0.2) # (input, negative_slope=0.2)
        x = self.dropout(x)
        x = F.leaky_relu(self.fc2(x), 0.2)
        x = self.dropout(x)
        # final layer
        out = self.fc3(x)

        return out


#Generator
class Generator(nn.Module):

    def __init__(self, input_size, hidden_dim, output_size):
        super(Generator, self).__init__()

        # define hidden linear layers
        self.fc1 = nn.Linear(input_size, hidden_dim)
        self.fc2 = nn.Linear(hidden_dim, hidden_dim)

        # final fully-connected layer
        self.fc3 = nn.Linear(hidden_dim, output_size)

        # dropout layer
        self.dropout = nn.Dropout(0.3)

    def forward(self, x):
        # all hidden layers
        x = F.leaky_relu(self.fc1(x), 0.2) # (input, negative_slope=0.2)
        x = self.dropout(x)
        x = F.leaky_relu(self.fc2(x), 0.2)
        x = self.dropout(x)
        # final layer with tanh applied
        out = F.tanh(self.fc3(x))

        return out


# Discriminator hyperparams
# Size of input sentence to discriminator
input_size = Sent_length*2
# Size of discriminator output (real or fake)
d_output_size = 1
# Size of last hidden layer in the discriminator
d_hidden_size = 16

# Generator hyperparams
# Size of latent vector to give to generator
z_size = 60
# Size of discriminator output (generated image)
g_output_size = Sent_length*2
# Size of first hidden layer in the generator
g_hidden_size = 16
g_hidden_size = 16


# Check Discriminator and Generator
D = Discriminator(input_size, d_hidden_size, d_output_size)
G = Generator(z_size, g_hidden_size, g_output_size)
print(D)
print(G)
```

```
Discriminator(
  (fc1): Linear(in_features=128, out_features=16, bias=True)
  (fc2): Linear(in_features=16, out_features=16, bias=True)
  (fc3): Linear(in_features=16, out_features=1, bias=True)
  (dropout): Dropout(p=0.3, inplace=False)
)
Generator(
  (fc1): Linear(in_features=60, out_features=16, bias=True)
  (fc2): Linear(in_features=16, out_features=16, bias=True)
  (fc3): Linear(in_features=16, out_features=128, bias=True)
  (dropout): Dropout(p=0.3, inplace=False)
)
```

```
# Calculate losses
def real_loss(D_out, smooth=False):
    batch_size = D_out.size(0)
    # label smoothing
    if smooth:
        # smooth, real labels = 0.9
        labels = torch.ones(batch_size)*0.9
    else:
        labels = torch.ones(batch_size) # real labels = 1

    # numerically stable loss
    criterion = nn.BCEWithLogitsLoss()
    # calculate loss
    loss = criterion(D_out.squeeze(), labels)
    return loss

def fake_loss(D_out):
    batch_size = D_out.size(0)
    labels = torch.zeros(batch_size) # fake labels = 0
    criterion = nn.BCEWithLogitsLoss()
    # calculate loss
    loss = criterion(D_out.squeeze(), labels)
    return loss
```

```
#Optimizer
import torch.optim as optim

# Optimizers
lr = 0.00002

# Create optimizers for the discriminator and generator
d_optimizer = optim.Adam(D.parameters(), lr)
g_optimizer = optim.Adam(G.parameters(), lr)
```

Training

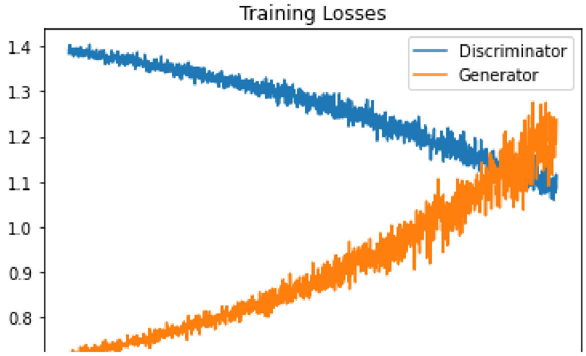
```
#
import pickle as pkl

# training hyperparams
num_epochs = 20
num_epochs = 20

# keep track of loss and generated, "fake" samples
samples = []
losses = []

print_every = 400

# Get some fixed data for sampling. These are images that are held
# constant throughout training, and allow us to inspect the model's performance
sample_size = 8
fixed_z = np.random.uniform(-1, 1, size=(sample_size, z_size))
fixed_z = torch.from_numpy(fixed_z).float()

# train the network
D.train()
G.train()

for epoch in range(num_epochs):

  #for batch_i, (real_sent, _) in enumerate(trainloader):
  for batch_i, data in enumerate(trainloader):
    batch_size = data.size(0)
    # ============================================
    #            TRAIN THE DISCRIMINATOR
    # ============================================

    d_optimizer.zero_grad()

    # 1. Train with real images

    # Compute the discriminator losses on real images
    # smooth the real labels
    D_real = D(data)
    d_real_loss = real_loss(D_real, smooth=True)

    # 2. Train with fake images

    # Generate fake images
    # gradients don't have to flow during this step
    with torch.no_grad():
      z = np.random.uniform(-1, 1, size=(batch_size, z_size))
      z = torch.from_numpy(z).float()
      fake_vectors = G(z)

    # Compute the discriminator losses on fake images
    D_fake = D(fake_vectors)
    d_fake_loss = fake_loss(D_fake)

    # add up loss and perform backprop
    d_loss = d_real_loss + d_fake_loss
    d_loss.backward()
    d_optimizer.step()


    # =========================================
    #            TRAIN THE GENERATOR
    # =========================================
    g_optimizer.zero_grad()

    # 1. Train with fake images and flipped labels

    # Generate fake images
    z = np.random.uniform(-1, 1, size=(batch_size, z_size))
    z = torch.from_numpy(z).float()
    fake_images = G(z)

    # Compute the discriminator losses on fake images
    # using flipped labels!
    D_fake = D(fake_vectors)
    g_loss = real_loss(D_fake) # use real loss to flip labels

    # perform backprop
    g_loss.backward()
    g_optimizer.step()

    # Print some loss stats
    if batch_i % print_every == 0:
      # print discriminator and generator loss
      print('Epoch [{:5d}/{:5d}] | d_loss: {:6.4f} | g_loss: {:6.4f}'.format(
            epoch+1, num_epochs, d_loss.item(), g_loss.item()))


    ## AFTER EACH EPOCH##
    # append discriminator loss and generator loss
    losses.append((d_loss.item(), g_loss.item()))

    # generate and save sample, fake images
    G.eval() # eval mode for generating samples
    samples_z = G(fixed_z)
    samples.append(samples_z)
    G.train() # back to train mode
```

```
/usr/local/lib/python3.7/dist-packages/torch/nn/functional.py:1698: UserWarning: nn.functional.tanh is
  warnings.warn("nn.functional.tanh is deprecated. Use torch.tanh instead.")
Epoch [    1/   20] | d_loss: 1.3843 | g_loss: 0.7164
Epoch [    2/   20] | d_loss: 1.3813 | g_loss: 0.7254
Epoch [    3/   20] | d_loss: 1.3887 | g_loss: 0.7478
Epoch [    4/   20] | d_loss: 1.3630 | g_loss: 0.7428
Epoch [    5/   20] | d_loss: 1.3478 | g_loss: 0.7591
Epoch [    6/   20] | d_loss: 1.3448 | g_loss: 0.7866
Epoch [    7/   20] | d_loss: 1.3322 | g_loss: 0.7748
Epoch [    8/   20] | d_loss: 1.3307 | g_loss: 0.8089
Epoch [    9/   20] | d_loss: 1.3149 | g_loss: 0.8370
Epoch [   10/   20] | d_loss: 1.3109 | g_loss: 0.8560
Epoch [   11/   20] | d_loss: 1.2672 | g_loss: 0.9212
Epoch [   12/   20] | d_loss: 1.2407 | g_loss: 0.9119
Epoch [   13/   20] | d_loss: 1.2638 | g_loss: 0.9321
Epoch [   14/   20] | d_loss: 1.2171 | g_loss: 0.9606
Epoch [   15/   20] | d_loss: 1.1995 | g_loss: 0.9558
Epoch [   16/   20] | d_loss: 1.1893 | g_loss: 1.0707
Epoch [   17/   20] | d_loss: 1.1554 | g_loss: 1.0243
Epoch [   18/   20] | d_loss: 1.1701 | g_loss: 1.1080
Epoch [   19/   20] | d_loss: 1.1309 | g_loss: 1.1614
Epoch [   20/   20] | d_loss: 1.0998 | g_loss: 1.1054
```

Analysis

```
import matplotlib.pyplot as plt
fig, ax = plt.subplots()
losses = np.array(losses)
plt.plot(losses.T[0], label='Discriminator')
plt.plot(losses.T[1], label='Generator')
plt.title("Training Losses")
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f11a5d22e90>
```



```
def nums_to_Sent(sent):
  indexes = unnormalize(sent)
  depend, postag = sent_to_num_fixed(indexes, dep_look_up, post_look_up, Sent_length)
  return depend, postag

def unnormalize(sent):
  out = []
  sent = sent.detach().numpy().tolist()
  for i in sent:
    temp = round(i*50)
    if temp < 0:
      temp = 0
    out.append(temp)
  return out

def sent_to_num_fixed(index, dep_look_up, post_look_up, Sent_length):
  depend = []
  postag = []

  dep_key_list = list(dep_look_up.keys())
  dep_val_list = list(dep_look_up.values())

  post_key_list = list(post_look_up.keys())
  post_val_list = list(post_look_up.values())

  for i in range(Sent_length):
    if index[i] in dep_val_list:
      position = dep_val_list.index(index[i])
      depend.append(dep_key_list[position])
    else:
      depend.append('N/A')

    if index[i+Sent_length] in post_val_list:
      position = post_val_list.index(index[i+Sent_length])
      postag.append(post_key_list[position])
    else:
      postag.append('N/A')

  return depend, postag



# randomly generated, new latent vectors
sample_size=16
rand_z = np.random.uniform(-1, 1, size=(sample_size, z_size))
rand_z = torch.from_numpy(rand_z).float()

G.eval() # eval mode
# generated samples
new_vectors = G(rand_z)
```

```
depend, postag = nums_to_Sent(new_vectors[0])
print(depend)
print(postag)
```

```
    ['compound', 'dobj', 'N/A', 'ROOT', 'N/A', 'appos', 'amod', 'amod', 'N/A', 'N/A', 'amod', 'prep', 'det
    ['N/A', 'N/A', 'CCONJ', 'CCONJ', 'N/A', 'N/A', 'N/A', 'N/A', 'NUM', 'ADP', 'AUX', 'N/A', 'DET', 'N/A',
    /usr/local/lib/python3.7/dist-packages/torch/nn/functional.py:1698: UserWarning: nn.functional.tanh is
      warnings.warn("nn.functional.tanh is deprecated. Use torch.tanh instead.")
```