Text Generation in Shakespeare's Style

Import Dependencies

```python
import tensorflow as tf

from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.layers import Embedding, LSTM, Dense,
Bidirectional, Dropout
from tensorflow.keras.models import Sequential
from tensorflow.keras import regularizers
from tensorflow.keras.optimizers import Adam
import numpy as np
```

Pertama-tama, saya mengimpor semua library yang saya butuhkan. TensorFlow dan Keras saya gunakan untuk membangun model deep learning. Tokenizer dan pad_sequences saya gunakan untuk memproses teks menjadi angka dan menyamakan panjang input. Saya juga mengimpor layer seperti Embedding, LSTM, dan Dense untuk arsitektur model. NumPy saya pakai untuk manipulasi array.

Download Shakespeare Dataset

```python
# !wget --no-check-certificate \
#
https://storage.googleapis.com/laurencemoroney-blog.appspot.com/sonnet
s.txt \
#     -O sonnets.txt
```

Define Tokenizer and prepare training data

```python
tokenizer = Tokenizer()

data = open('sonnets.txt').read()

corpus = data.lower().split('\n')

tokenizer.fit_on_texts(corpus)
total_words = len(tokenizer.word_index) + 1

print(tokenizer.word_index)
print(total_words)

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3211
```

Saya membuat objek tokenizer untuk memetakan kata menjadi angka. Lalu saya membuka file sonnets.txt dan membaca seluruh isinya. Setelah itu, saya mengubah semua teks menjadi huruf kecil dan memecahnya menjadi sebuah list berdasarkan baris.

Di sini saya melatih tokenizer menggunakan seluruh corpus. Hasilnya berupa kamus kata–angka. Saya menghitung total jumlah kata unik, ditambah satu untuk menghindari konflik indeks. Lalu saya print untuk memastikan token berhasil dibuat.

```python
input_sequences = []

for line in corpus:
  token_list = tokenizer.texts_to_sequences([line])[0]
  # print("LIST = "+str(token_list))
  for i in range(1, len(token_list)):
    n_gram_sequence = token_list[:i+1]
    # print(n_gram_sequence)
    input_sequences.append(n_gram_sequence)

# print(len(input_sequences))

# pad sequences
max_sequence_len = max([len(seq) for seq in input_sequences])

print(max_sequence_len, total_words)

input_sequences = np.array(pad_sequences(input_sequences,
padding='pre', maxlen=max_sequence_len))

# create predictors and labels
xs, labels = input_sequences[:,:-1], input_sequences[:,-1]
```

```
ys = tf.keras.utils.to_categorical(labels, num_classes=total_words)

11 3211
```

Saya menyiapkan list kosong untuk menyimpan semua n-gram sequences yang akan digunakan sebagai data pelatihan model.

Saya memproses setiap baris teks: setiap baris saya ubah menjadi list angka. Lalu, untuk setiap kalimat, saya membentuk n-gram. Misalnya 10 22 48, maka saya buat [10,22] dan [10,22,48]. Semua sequence itu saya simpan sebagai data input untuk melatih model prediksi kata berikutnya.

Saya mencari panjang sequence terpanjang yang nantinya dipakai untuk kebutuhan padding. Kemudian saya menampilkannya untuk memastikan nilainya benar.

Saya melakukan padding pada semua sequence supaya panjangnya sama. Padding dilakukan di bagian depan (pre-padding). Setelah itu saya ubah menjadi array NumPy supaya mudah diproses oleh TensorFlow.

Saya memisahkan data menjadi dua bagian:

xs → semua angka kecuali yang terakhir (input)

labels → angka terakhir (target yang diprediksi)

Lalu saya ubah label menjadi one-hot encoding karena output model menggunakan softmax.

Define the Model Architecture and start training

```python
model = Sequential()
model.add(Embedding(input_dim=total_words, output_dim=100,
input_length=max_sequence_len-1))
model.add(Bidirectional(LSTM(150, return_sequences=True)))
model.add(Dropout(0.3))
model.add(Bidirectional(LSTM(96)))
model.add(Dense(total_words // 2, activation='relu',
kernel_regularizer=regularizers.l2(0.01)))
model.add(Dense(total_words, activation='softmax'))

model.summary()

/usr/local/lib/python3.12/dist-packages/keras/src/layers/core/
embedding.py:97: UserWarning: Argument `input_length` is deprecated.
Just remove it.
  warnings.warn(

Model: "sequential"
```

| Layer (type) | Output Shape |

```
Param #

| embedding (Embedding)          | ?              |        0
(unbuilt) |

| bidirectional (Bidirectional)  | ?              |        0
(unbuilt) |

| dropout (Dropout)              | ?              |
0 |

| bidirectional_1 (Bidirectional) | ?             |        0
(unbuilt) |

| dense (Dense)                  | ?              |        0
(unbuilt) |

| dense_1 (Dense)                | ?              |        0
(unbuilt) |


 Total params: 0 (0.00 B)

 Trainable params: 0 (0.00 B)

 Non-trainable params: 0 (0.00 B)
```

Di sini saya membangun arsitektur model. Pertama saya gunakan layer Embedding untuk mengubah angka menjadi vektor representasi 100 dimensi. Dua layer LSTM bidirectional digunakan untuk memahami konteks dua arah. Dropout membantu mengurangi overfitting. Lalu saya menambahkan dense layer dengan regularizer L2, dan terakhir softmax untuk memprediksi kata berikutnya dari seluruh daftar kata.

```python
model.compile(loss='categorical_crossentropy', optimizer='adam',
metrics=['acc'])
history = model.fit(xs, ys, epochs=10, verbose=1)

Epoch 1/10
484/484 ━━━━━━━━━━━━━━━━━━ 18s 16ms/step - acc: 0.0208 - loss:
7.5432
Epoch 2/10
484/484 ━━━━━━━━━━━━━━━━━━ 6s 13ms/step - acc: 0.0225 - loss: 6.4810
Epoch 3/10
```

```
484/484 ──────────────────── 7s 14ms/step - acc: 0.0231 - loss: 6.4181
Epoch 4/10
484/484 ──────────────────── 6s 13ms/step - acc: 0.0283 - loss: 6.2752
Epoch 5/10
484/484 ──────────────────── 10s 13ms/step - acc: 0.0334 - loss:
6.1650
Epoch 6/10
484/484 ──────────────────── 10s 13ms/step - acc: 0.0368 - loss:
6.0971
Epoch 7/10
484/484 ──────────────────── 7s 15ms/step - acc: 0.0396 - loss: 6.0180
Epoch 8/10
484/484 ──────────────────── 6s 13ms/step - acc: 0.0444 - loss: 5.9050
Epoch 9/10
484/484 ──────────────────── 7s 14ms/step - acc: 0.0489 - loss: 5.7953
Epoch 10/10
484/484 ──────────────────── 7s 14ms/step - acc: 0.0604 - loss: 5.6770
```

Saya meng-compile model menggunakan loss categorical crossentropy karena output adalah klasifikasi multi-kelas. Optimizer Adam saya pakai karena stabil. Setelah itu saya latih model selama 10 epoch.

Generate 100 next words with an initial sample sentence

```python
def predict_next_words(seed_text, next_words):
  for _ in range(next_words):
    token_list = tokenizer.texts_to_sequences([seed_text])[0]
    token_list = pad_sequences([token_list], maxlen=max_sequence_len-
1, padding='pre')
    predict_x=model.predict(token_list)
    predicted=np.argmax(predict_x,axis=1)
    # predicted = model.predict_classes(token_list, verbose=0)
    output_word = ""
    for word, index in tokenizer.word_index.items():
      if index == predicted:
        output_word = word
        break
    seed_text += " " + output_word

  print(seed_text)
  return seed_text
```

Saya membuat fungsi untuk memprediksi kata berikutnya. Setiap loop, saya mengubah seed_text menjadi token, melakukan padding, lalu memprediksi kata berikutnya melalui model dan mengambil argmax-nya.

Saya mencari kata mana yang sesuai dengan indeks hasil prediksi. Begitu ketemu, saya simpan kata itu sebagai output_word.

Kata yang berhasil diprediksi saya gabungkan kembali ke seed_text. Proses ini dilakukan berulang sesuai jumlah next_words. Setelah selesai, saya cetak hasilnya.

```
seed_text = "1THREEPIO"
next_words = 10

generated_text = predict_next_words(seed_text, next_words)

1/1 ───────────────────── 0s 464ms/step
1/1 ───────────────────── 0s 43ms/step
1/1 ───────────────────── 0s 44ms/step
1/1 ───────────────────── 0s 47ms/step
1/1 ───────────────────── 0s 46ms/step
1/1 ───────────────────── 0s 46ms/step
1/1 ───────────────────── 0s 48ms/step
1/1 ───────────────────── 0s 47ms/step
1/1 ───────────────────── 0s 28ms/step
1/1 ───────────────────── 0s 29ms/step
1THREEPIO and thou my love and i my heart ' '
```

Saya mencobakan model dengan seed pertama, yaitu "1THREEPIO", dan meminta model menambahkan 10 kata berikutnya.

```
seed_text = "why lovest thou that which thou receivest not gladly,"
generated_text = predict_next_words(seed_text, next_words)

1/1 ───────────────────── 0s 34ms/step
1/1 ───────────────────── 0s 29ms/step
1/1 ───────────────────── 0s 29ms/step
1/1 ───────────────────── 0s 28ms/step
1/1 ───────────────────── 0s 29ms/step
1/1 ───────────────────── 0s 34ms/step
1/1 ───────────────────── 0s 29ms/step
1/1 ───────────────────── 0s 29ms/step
1/1 ───────────────────── 0s 29ms/step
1/1 ───────────────────── 0s 29ms/step
why lovest thou that which thou receivest not gladly, ' ' ' be be is
be be be be
```

Saya mencoba lagi dengan seed kedua yang lebih mirip gaya tulisan Shakespeare untuk melihat hasil prediksi yang lebih natural.