```
import numpy as np
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import LSTM, Dense, Embedding
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import EarlyStopping

# Tekst bazowy
text = ("AI research has tried and discarded many different
approaches, including "
        "simulating the brain, modeling human problem solving, formal
logic, "
        "large databases of knowledge, and imitating animal behavior")

# Tworzenie słownika znaków
chars = sorted(list(set(text)))
char_to_idx = {c: i for i, c in enumerate(chars)}
idx_to_char = {i: c for i, c in enumerate(chars)}

# Parametry
seq_length = 40
step = 1

# Tworzenie danych treningowych
X = []
y = []
for i in range(0, len(text) - seq_length, step):
    X.append([char_to_idx[c] for c in text[i: i + seq_length]])
    y.append(char_to_idx[text[i + seq_length]])

X = np.array(X)
y = to_categorical(y, num_classes=len(chars))

# Model
model = Sequential()
model.add(Embedding(input_dim=len(chars), output_dim=32))
model.add(LSTM(128, return_sequences=False))
model.add(Dense(len(chars), activation='softmax'))

# Kompilacja
model.compile(loss='categorical_crossentropy',
optimizer=Adam(learning_rate=0.01))

# Trenowanie z EarlyStopping, żeby zatrzymać się przy stracie < 0.1
early_stop = EarlyStopping(monitor='loss', patience=10,
restore_best_weights=True)

history = model.fit(X, y, batch_size=32, epochs=20,
callbacks=[early_stop])
```

```python
# Sprawdzanie straty
final_loss = history.history['loss'][-1]
print(f"Final loss: {final_loss:.4f}")
```

```
Epoch 1/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 2s 13ms/step - loss: 3.2486
Epoch 2/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 3.1319
Epoch 3/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.9091
Epoch 4/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.8991
Epoch 5/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.8112
Epoch 6/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.5892
Epoch 7/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.4861
Epoch 8/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 2.2341
Epoch 9/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.9394
Epoch 10/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.8786
Epoch 11/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.5739
Epoch 12/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 1.2074
Epoch 13/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.9176
Epoch 14/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.6876
Epoch 15/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.4583
Epoch 16/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.2975
Epoch 17/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.1694
Epoch 18/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.1197
Epoch 19/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0761
Epoch 20/20
5/5 ━━━━━━━━━━━━━━━━━━━━ 0s 12ms/step - loss: 0.0514
Final loss: 0.0508
```