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import numpy as np
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense

text = "AI applications include advanced web search engines (e.g.,
Google Search), recommendation systems (used by YouTube, Amazon, and
Netflix), understanding human speech (such as Siri and Alexa), self-
driving cars (e.g., Waymo), generative or creative tools (ChatGPT and
AI art), automated decision-making, and competing at the highest level
in strategic game systems (such as chess and Go)"

tokenizer = Tokenizer()
tokenizer.fit_on_texts([text])
total_words = len(tokenizer.word_index) + 1

input_sequences = []
for i in range(1, len(text.split())):
    n_gram_sequence = text.split()[:i+1]
    input_sequences.append(" ".join(n_gram_sequence))

max_sequence_len = max([len(seq.split()) for seq in input_sequences])
input_sequences =
pad_sequences(tokenizer.texts_to_sequences(input_sequences),
              maxlen=max_sequence_len,
              padding='pre')

X, y = input_sequences[:, :-1], input_sequences[:, -1]
y = to_categorical(y, num_classes=total_words)

model = Sequential()
model.add(Embedding(total_words, 50, input_length=max_sequence_len-1))
model.add(LSTM(100))
model.add(Dense(total_words, activation='softmax'))
model.compile(loss='categorical_crossentropy', optimizer='adam',
              metrics=['accuracy'])

model.fit(X, y, epochs=150, verbose=1)

loss, accuracy = model.evaluate(X, y, verbose=0)
print(f'Dokładność w procentach: {accuracy * 100:.2f}')
```

Epoch 1/150  
2/2 [=====] - 2s 23ms/step - loss: 3.8915 -  
accuracy: 0.0370  
Epoch 2/150  
2/2 [=====] - 0s 25ms/step - loss: 3.8840 -  
accuracy: 0.1296

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Epoch 3/150
2/2 [=====] - 0s 23ms/step - loss: 3.8771 -
accuracy: 0.1481
Epoch 4/150
2/2 [=====] - 0s 23ms/step - loss: 3.8700 -
accuracy: 0.1111
Epoch 5/150
2/2 [=====] - 0s 23ms/step - loss: 3.8605 -
accuracy: 0.0926
Epoch 6/150
2/2 [=====] - 0s 24ms/step - loss: 3.8493 -
accuracy: 0.0926
Epoch 7/150
2/2 [=====] - 0s 24ms/step - loss: 3.8325 -
accuracy: 0.0926
Epoch 8/150
2/2 [=====] - 0s 24ms/step - loss: 3.7999 -
accuracy: 0.0926
Epoch 9/150
2/2 [=====] - 0s 23ms/step - loss: 3.7576 -
accuracy: 0.0926
Epoch 10/150
2/2 [=====] - 0s 23ms/step - loss: 3.7191 -
accuracy: 0.0926
Epoch 11/150
2/2 [=====] - 0s 23ms/step - loss: 3.6965 -
accuracy: 0.0926
Epoch 12/150
2/2 [=====] - 0s 24ms/step - loss: 3.6372 -
accuracy: 0.0926
Epoch 13/150
2/2 [=====] - 0s 22ms/step - loss: 3.5851 -
accuracy: 0.1296
Epoch 14/150
2/2 [=====] - 0s 27ms/step - loss: 3.5386 -
accuracy: 0.1296
Epoch 15/150
2/2 [=====] - 0s 23ms/step - loss: 3.4937 -
accuracy: 0.1296
Epoch 16/150
2/2 [=====] - 0s 23ms/step - loss: 3.4600 -
accuracy: 0.1296
Epoch 17/150
2/2 [=====] - 0s 30ms/step - loss: 3.3966 -
accuracy: 0.1296
Epoch 18/150
2/2 [=====] - 0s 28ms/step - loss: 3.4049 -
accuracy: 0.1111
Epoch 19/150
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2/2 [=====] - 0s 24ms/step - loss: 3.3414 -  
accuracy: 0.1296  
Epoch 20/150  
2/2 [=====] - 0s 23ms/step - loss: 3.2894 -  
accuracy: 0.1111  
Epoch 21/150  
2/2 [=====] - 0s 24ms/step - loss: 3.2720 -  
accuracy: 0.1111  
Epoch 22/150  
2/2 [=====] - 0s 23ms/step - loss: 3.2111 -  
accuracy: 0.1296  
Epoch 23/150  
2/2 [=====] - 0s 25ms/step - loss: 3.1958 -  
accuracy: 0.1296  
Epoch 24/150  
2/2 [=====] - 0s 23ms/step - loss: 3.1251 -  
accuracy: 0.1296  
Epoch 25/150  
2/2 [=====] - 0s 23ms/step - loss: 3.1070 -  
accuracy: 0.1111  
Epoch 26/150  
2/2 [=====] - 0s 23ms/step - loss: 3.0360 -  
accuracy: 0.1296  
Epoch 27/150  
2/2 [=====] - 0s 27ms/step - loss: 3.0019 -  
accuracy: 0.1296  
Epoch 28/150  
2/2 [=====] - 0s 23ms/step - loss: 2.9487 -  
accuracy: 0.1296  
Epoch 29/150  
2/2 [=====] - 0s 23ms/step - loss: 2.9035 -  
accuracy: 0.1296  
Epoch 30/150  
2/2 [=====] - 0s 23ms/step - loss: 2.8457 -  
accuracy: 0.1296  
Epoch 31/150  
2/2 [=====] - 0s 26ms/step - loss: 2.7955 -  
accuracy: 0.1296  
Epoch 32/150  
2/2 [=====] - 0s 24ms/step - loss: 2.7433 -  
accuracy: 0.1296  
Epoch 33/150  
2/2 [=====] - 0s 26ms/step - loss: 2.6875 -  
accuracy: 0.1481  
Epoch 34/150  
2/2 [=====] - 0s 25ms/step - loss: 2.6359 -  
accuracy: 0.1481  
Epoch 35/150  
2/2 [=====] - 0s 26ms/step - loss: 2.5815 -
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accuracy: 0.1667
Epoch 36/150
2/2 [=====] - 0s 26ms/step - loss: 2.5325 -
accuracy: 0.2037
Epoch 37/150
2/2 [=====] - 0s 26ms/step - loss: 2.4988 -
accuracy: 0.2037
Epoch 38/150
2/2 [=====] - 0s 24ms/step - loss: 2.4341 -
accuracy: 0.2778
Epoch 39/150
2/2 [=====] - 0s 27ms/step - loss: 2.3958 -
accuracy: 0.2222
Epoch 40/150
2/2 [=====] - 0s 26ms/step - loss: 2.3663 -
accuracy: 0.2593
Epoch 41/150
2/2 [=====] - 0s 25ms/step - loss: 2.3051 -
accuracy: 0.3148
Epoch 42/150
2/2 [=====] - 0s 25ms/step - loss: 2.2518 -
accuracy: 0.3333
Epoch 43/150
2/2 [=====] - 0s 25ms/step - loss: 2.2005 -
accuracy: 0.3704
Epoch 44/150
2/2 [=====] - 0s 24ms/step - loss: 2.1669 -
accuracy: 0.3704
Epoch 45/150
2/2 [=====] - 0s 27ms/step - loss: 2.1233 -
accuracy: 0.3889
Epoch 46/150
2/2 [=====] - 0s 24ms/step - loss: 2.0812 -
accuracy: 0.3889
Epoch 47/150
2/2 [=====] - 0s 23ms/step - loss: 2.0341 -
accuracy: 0.4074
Epoch 48/150
2/2 [=====] - 0s 23ms/step - loss: 2.0001 -
accuracy: 0.4444
Epoch 49/150
2/2 [=====] - 0s 23ms/step - loss: 1.9568 -
accuracy: 0.5185
Epoch 50/150
2/2 [=====] - 0s 24ms/step - loss: 1.9162 -
accuracy: 0.5185
Epoch 51/150
2/2 [=====] - 0s 24ms/step - loss: 1.8815 -
accuracy: 0.5556
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Epoch 52/150  
2/2 [=====] - 0s 24ms/step - loss: 1.8436 -  
accuracy: 0.5556  
Epoch 53/150  
2/2 [=====] - 0s 23ms/step - loss: 1.8155 -  
accuracy: 0.5370  
Epoch 54/150  
2/2 [=====] - 0s 29ms/step - loss: 1.7947 -  
accuracy: 0.5556  
Epoch 55/150  
2/2 [=====] - 0s 23ms/step - loss: 1.7804 -  
accuracy: 0.5370  
Epoch 56/150  
2/2 [=====] - 0s 24ms/step - loss: 1.7399 -  
accuracy: 0.5370  
Epoch 57/150  
2/2 [=====] - 0s 27ms/step - loss: 1.7167 -  
accuracy: 0.5000  
Epoch 58/150  
2/2 [=====] - 0s 26ms/step - loss: 1.6845 -  
accuracy: 0.5926  
Epoch 59/150  
2/2 [=====] - 0s 25ms/step - loss: 1.7260 -  
accuracy: 0.4074  
Epoch 60/150  
2/2 [=====] - 0s 23ms/step - loss: 1.6644 -  
accuracy: 0.5370  
Epoch 61/150  
2/2 [=====] - 0s 22ms/step - loss: 1.6295 -  
accuracy: 0.6111  
Epoch 62/150  
2/2 [=====] - 0s 23ms/step - loss: 1.6152 -  
accuracy: 0.5370  
Epoch 63/150  
2/2 [=====] - 0s 26ms/step - loss: 1.5997 -  
accuracy: 0.5741  
Epoch 64/150  
2/2 [=====] - 0s 24ms/step - loss: 1.5744 -  
accuracy: 0.5370  
Epoch 65/150  
2/2 [=====] - 0s 24ms/step - loss: 1.5426 -  
accuracy: 0.6481  
Epoch 66/150  
2/2 [=====] - 0s 26ms/step - loss: 1.5454 -  
accuracy: 0.5741  
Epoch 67/150  
2/2 [=====] - 0s 25ms/step - loss: 1.5097 -  
accuracy: 0.6481  
Epoch 68/150

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2/2 [=====] - 0s 24ms/step - loss: 1.4926 -  
accuracy: 0.6667  
Epoch 69/150  
2/2 [=====] - 0s 24ms/step - loss: 1.4747 -  
accuracy: 0.6852  
Epoch 70/150  
2/2 [=====] - 0s 26ms/step - loss: 1.4981 -  
accuracy: 0.6481  
Epoch 71/150  
2/2 [=====] - 0s 24ms/step - loss: 1.4627 -  
accuracy: 0.6852  
Epoch 72/150  
2/2 [=====] - 0s 24ms/step - loss: 1.4965 -  
accuracy: 0.5370  
Epoch 73/150  
2/2 [=====] - 0s 30ms/step - loss: 1.5710 -  
accuracy: 0.4444  
Epoch 74/150  
2/2 [=====] - 0s 38ms/step - loss: 1.5493 -  
accuracy: 0.5000  
Epoch 75/150  
2/2 [=====] - 0s 32ms/step - loss: 1.5436 -  
accuracy: 0.3704  
Epoch 76/150  
2/2 [=====] - 0s 40ms/step - loss: 1.5211 -  
accuracy: 0.4259  
Epoch 77/150  
2/2 [=====] - 0s 35ms/step - loss: 1.4250 -  
accuracy: 0.6667  
Epoch 78/150  
2/2 [=====] - 0s 34ms/step - loss: 1.4024 -  
accuracy: 0.6296  
Epoch 79/150  
2/2 [=====] - 0s 34ms/step - loss: 1.5145 -  
accuracy: 0.4259  
Epoch 80/150  
2/2 [=====] - 0s 35ms/step - loss: 1.4259 -  
accuracy: 0.5370  
Epoch 81/150  
2/2 [=====] - 0s 36ms/step - loss: 1.3538 -  
accuracy: 0.7407  
Epoch 82/150  
2/2 [=====] - 0s 41ms/step - loss: 1.4238 -  
accuracy: 0.5741  
Epoch 83/150  
2/2 [=====] - 0s 39ms/step - loss: 1.4083 -  
accuracy: 0.5741  
Epoch 84/150  
2/2 [=====] - 0s 34ms/step - loss: 1.3694 -
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accuracy: 0.6296
Epoch 85/150
2/2 [=====] - 0s 39ms/step - loss: 1.3432 -
accuracy: 0.6667
Epoch 86/150
2/2 [=====] - 0s 37ms/step - loss: 1.3873 -
accuracy: 0.5370
Epoch 87/150
2/2 [=====] - 0s 35ms/step - loss: 1.3591 -
accuracy: 0.5926
Epoch 88/150
2/2 [=====] - 0s 25ms/step - loss: 1.3076 -
accuracy: 0.8148
Epoch 89/150
2/2 [=====] - 0s 23ms/step - loss: 1.3447 -
accuracy: 0.6852
Epoch 90/150
2/2 [=====] - 0s 24ms/step - loss: 1.3123 -
accuracy: 0.7037
Epoch 91/150
2/2 [=====] - 0s 24ms/step - loss: 1.2663 -
accuracy: 0.8333
Epoch 92/150
2/2 [=====] - 0s 24ms/step - loss: 1.2905 -
accuracy: 0.7407
Epoch 93/150
2/2 [=====] - 0s 24ms/step - loss: 1.2934 -
accuracy: 0.7037
Epoch 94/150
2/2 [=====] - 0s 30ms/step - loss: 1.2362 -
accuracy: 0.7778
Epoch 95/150
2/2 [=====] - 0s 23ms/step - loss: 1.2669 -
accuracy: 0.7037
Epoch 96/150
2/2 [=====] - 0s 24ms/step - loss: 1.2480 -
accuracy: 0.7778
Epoch 97/150
2/2 [=====] - 0s 24ms/step - loss: 1.2117 -
accuracy: 0.7593
Epoch 98/150
2/2 [=====] - 0s 29ms/step - loss: 1.2138 -
accuracy: 0.7778
Epoch 99/150
2/2 [=====] - 0s 24ms/step - loss: 1.1962 -
accuracy: 0.8519
Epoch 100/150
2/2 [=====] - 0s 24ms/step - loss: 1.1707 -
accuracy: 0.8519
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Epoch 101/150  
2/2 [=====] - 0s 24ms/step - loss: 1.1690 -  
accuracy: 0.8704  
Epoch 102/150  
2/2 [=====] - 0s 26ms/step - loss: 1.1557 -  
accuracy: 0.8704  
Epoch 103/150  
2/2 [=====] - 0s 24ms/step - loss: 1.1362 -  
accuracy: 0.9259  
Epoch 104/150  
2/2 [=====] - 0s 24ms/step - loss: 1.1345 -  
accuracy: 0.9074  
Epoch 105/150  
2/2 [=====] - 0s 36ms/step - loss: 1.1244 -  
accuracy: 0.9259  
Epoch 106/150  
2/2 [=====] - 0s 25ms/step - loss: 1.1101 -  
accuracy: 0.8889  
Epoch 107/150  
2/2 [=====] - 0s 25ms/step - loss: 1.1089 -  
accuracy: 0.9074  
Epoch 108/150  
2/2 [=====] - 0s 25ms/step - loss: 1.0977 -  
accuracy: 0.9074  
Epoch 109/150  
2/2 [=====] - 0s 24ms/step - loss: 1.0874 -  
accuracy: 0.8889  
Epoch 110/150  
2/2 [=====] - 0s 26ms/step - loss: 1.0782 -  
accuracy: 0.9074  
Epoch 111/150  
2/2 [=====] - 0s 24ms/step - loss: 1.0739 -  
accuracy: 0.9074  
Epoch 112/150  
2/2 [=====] - 0s 25ms/step - loss: 1.0655 -  
accuracy: 0.9074  
Epoch 113/150  
2/2 [=====] - 0s 24ms/step - loss: 1.0624 -  
accuracy: 0.9444  
Epoch 114/150  
2/2 [=====] - 0s 26ms/step - loss: 1.0667 -  
accuracy: 0.9074  
Epoch 115/150  
2/2 [=====] - 0s 23ms/step - loss: 1.0415 -  
accuracy: 0.9259  
Epoch 116/150  
2/2 [=====] - 0s 25ms/step - loss: 1.0512 -  
accuracy: 0.8889  
Epoch 117/150



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2/2 [=====] - 0s 23ms/step - loss: 1.0651 -  
accuracy: 0.8889  
Epoch 118/150  
2/2 [=====] - 0s 27ms/step - loss: 1.3943 -  
accuracy: 0.7593  
Epoch 119/150  
2/2 [=====] - 0s 24ms/step - loss: 1.4966 -  
accuracy: 0.7963  
Epoch 120/150  
2/2 [=====] - 0s 23ms/step - loss: 1.3990 -  
accuracy: 0.6481  
Epoch 121/150  
2/2 [=====] - 0s 25ms/step - loss: 1.4293 -  
accuracy: 0.7222  
Epoch 122/150  
2/2 [=====] - 0s 26ms/step - loss: 1.4546 -  
accuracy: 0.6296  
Epoch 123/150  
2/2 [=====] - 0s 32ms/step - loss: 1.4031 -  
accuracy: 0.5556  
Epoch 124/150  
2/2 [=====] - 0s 23ms/step - loss: 1.3288 -  
accuracy: 0.6111  
Epoch 125/150  
2/2 [=====] - 0s 27ms/step - loss: 1.2831 -  
accuracy: 0.6296  
Epoch 126/150  
2/2 [=====] - 0s 26ms/step - loss: 1.2417 -  
accuracy: 0.6852  
Epoch 127/150  
2/2 [=====] - 0s 23ms/step - loss: 1.2175 -  
accuracy: 0.7407  
Epoch 128/150  
2/2 [=====] - 0s 27ms/step - loss: 1.1818 -  
accuracy: 0.7222  
Epoch 129/150  
2/2 [=====] - 0s 25ms/step - loss: 1.1599 -  
accuracy: 0.7963  
Epoch 130/150  
2/2 [=====] - 0s 29ms/step - loss: 1.1184 -  
accuracy: 0.7963  
Epoch 131/150  
2/2 [=====] - 0s 24ms/step - loss: 1.1044 -  
accuracy: 0.8704  
Epoch 132/150  
2/2 [=====] - 0s 24ms/step - loss: 1.0757 -  
accuracy: 0.8704  
Epoch 133/150  
2/2 [=====] - 0s 25ms/step - loss: 1.0581 -
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accuracy: 0.9074
Epoch 134/150
2/2 [=====] - 0s 27ms/step - loss: 1.0298 -
accuracy: 0.9259
Epoch 135/150
2/2 [=====] - 0s 26ms/step - loss: 1.0186 -
accuracy: 0.9074
Epoch 136/150
2/2 [=====] - 0s 25ms/step - loss: 1.0271 -
accuracy: 0.9074
Epoch 137/150
2/2 [=====] - 0s 24ms/step - loss: 1.0179 -
accuracy: 0.9259
Epoch 138/150
2/2 [=====] - 0s 27ms/step - loss: 0.9872 -
accuracy: 0.9630
Epoch 139/150
2/2 [=====] - 0s 27ms/step - loss: 0.9785 -
accuracy: 0.9259
Epoch 140/150
2/2 [=====] - 0s 24ms/step - loss: 0.9742 -
accuracy: 0.9444
Epoch 141/150
2/2 [=====] - 0s 28ms/step - loss: 0.9615 -
accuracy: 0.9259
Epoch 142/150
2/2 [=====] - 0s 35ms/step - loss: 0.9663 -
accuracy: 0.9259
Epoch 143/150
2/2 [=====] - 0s 25ms/step - loss: 0.9587 -
accuracy: 0.9630
Epoch 144/150
2/2 [=====] - 0s 24ms/step - loss: 0.9550 -
accuracy: 0.9074
Epoch 145/150
2/2 [=====] - 0s 23ms/step - loss: 0.9300 -
accuracy: 0.9444
Epoch 146/150
2/2 [=====] - 0s 25ms/step - loss: 0.9263 -
accuracy: 0.9259
Epoch 147/150
2/2 [=====] - 0s 24ms/step - loss: 0.9090 -
accuracy: 0.9444
Epoch 148/150
2/2 [=====] - 0s 27ms/step - loss: 0.9090 -
accuracy: 0.9630
Epoch 149/150
2/2 [=====] - 0s 25ms/step - loss: 0.8981 -
accuracy: 0.9259
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Epoch 150/150

2/2 [=====] - 0s 24ms/step - loss: 0.8846 -

accuracy: 0.9630

Dokładność w procentach: 96.30