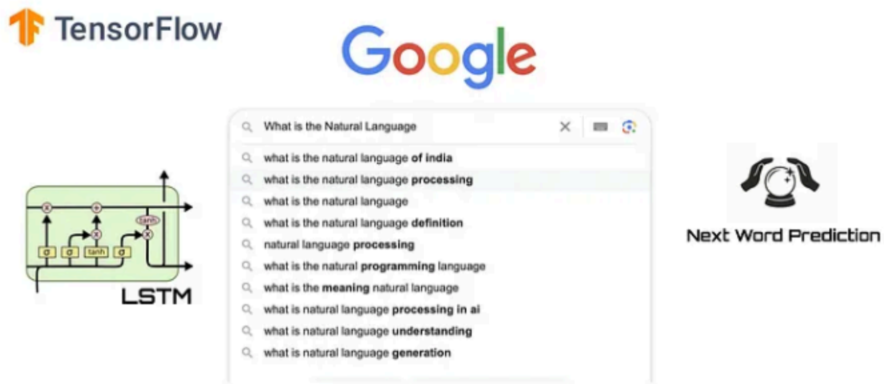
Next Word Prediction using LSTM (Long Short-Term Memory) Model



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Understanding LSTM Networks

Long Short-Term Memory (LSTM) is a type of recurrent neural network (RNN) specifically designed to handle long-term dependencies and overcome the limitations of traditional RNNs.

Architecture

An LSTM unit consists of four key components:

1. Cell: Stores information over time.

2. Forget Gate: Decides what information from the previous state should be discarded.

3. Input Gate: Determines what new information should be added to the cell state.

4 Output Gate: Selects what part of the information should be outpu

Each gate operates using a sigmoid function, assigning values between 0 and 1 to control information flow. This architecture enables the LSTM network to maintain useful context across extended sequences, which is crucial for accurate word prediction.

Applications of LSTM in NLP

LSTM networks are widely used in various NLP applications, including but not limited to:

1. Chatbots and virtual assistants

2. Healthcare time-series data analysis

3. Text prediction and auto-completion

4. Sentiment analysis

Their effectiveness in modeling temporal relationships makes them a cornerstone in modern language understanding systems.

Project Overwiew

The primary objective of this project is to develop a deep learning model capable of accurately predicting the next word in a sentence using an LSTM network. This involves:

Preprocessing a suitable text corpus

1. Tokenizing and vectorizing the input sequences

2. Training the LSTM model on sequential data

3. Evaluating its performance on unseen text inputs

4. Generating contextually appropriate next-word predictions

Through this project, we aim to demonstrate the ability of LSTM models to learn linguistic patterns and provide intelligent, context-aware word suggestions.

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text= """My neighbor reported X-ray scans etc.!
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My neighbor analyzed 20 samples with 95% accuracy!?
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A student generated A.I. models on Dec. 3rd, 2021.
This device completed errors, warnings, and logs e.g., images, texts!
AI observed the results according to rule #42;
My neighbor analyzed case no. 245B on Dec. 3rd, 2021;
My neighbor completed 12.5 kg of data in the U.S.A.!
A student completed X-ray scans etc....
John reported errors, warnings, and logs using method A or B.
The manager analyzed the results using method A or B;
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AI analyzed the results e.g., images, texts!
AI measured errors, warnings, and logs approx. 5 minutes later.
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My neighbor investigated X-ray scans according to rule #42!
This device measured the results on Dec. 3rd, 2021;
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AI analyzed A.I. models with 95% accuracy!?
The manager analyzed 3.14 units using method A or B!
Dr. Smith measured X-ray scans in the U.S.A..
The manager measured X-ray scans e.g., images, texts;
Dr. Smith calculated case no. 245B on Dec. 3rd, 2021...
Dr. Smith measured 20 samples with 95% accuracy!...
NASA measured A.I. models using method A or B.
The manager analyzed 3.14 units etc.?
A student generated errors, warnings, and logs according to rule #42...
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A student reported the results using method A or B?
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Dr. Smith reported 12.5 kg of data approx. 5 minutes later!
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John completed 20 samples in the U.S.A..
This device investigated 12.5 kg of data on Dec. 3rd, 2021.
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```

```
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A student calculated errors, warnings, and logs in the U.S.A.;
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My neighbor reported errors, warnings, and logs e.g., images, texts!
AI observed errors, warnings, and logs e.g., images, texts!
This device completed ZIP codes e.g., images, texts!
John analyzed case no. 245B with 95% accuracy!...
```

```
NASA investigated ZIP codes on Dec. 3rd, 2021.
NASA measured case no. 245B according to rule #42?
AI generated A.I. models etc....
My neighbor completed case no. 245B approx. 5 minutes later?
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John measured 12.5 kg of data etc....
My neighbor generated 12.5 kg of data e.g., images, texts?
This device calculated the results e.g., images, texts;"""
```

1. import tensorflow as tf

This line imports the TensorFlow library, which is a deep learning framework. TensorFlow provides tools to build and train neural networks, and it also includes the Keras API, which is used for natural language processing tasks like tokenization, text classification, and next-word prediction.

2. from tensorflow.keras.preprocessing.text import Tokenizer

This imports the Tokenizer class from TensorFlow's Keras preprocessing module. The Tokenizer is used to:

Process raw text

Split it into words (tokens)

Assign a unique number (index) to each word

Convert text into sequences of numbers, which are easier for machine learning models to understand

3. Tokenizer = Tokenizer()

This creates a new instance of the Tokenizer class.

By default, it:

Lowercases all text

Removes common punctuation

Splits sentences into individual words based on spaces

You can also customize it using parameters like:

num_words (limits vocabulary size)

oov_token (handles unknown words)

filters (custom punctuation removal)

4. Tokenizer.fit_on_texts([text])

This is where the actual text processing begins.

The function fit_on_texts takes your raw text (in string format) and:

Breaks it into individual words

Counts how many times each word appears

Builds a word dictionary (word_index) that maps each word to a unique number

For example, if your text is:

"I love AI and I love coding"

The tokenizer will find:

Unique words: ["i", "love", "ai", "and", "coding"]

Frequencies: {"i": 2, "love": 2, "ai": 1, "and": 1, "coding": 1}

Then it assigns indexes:

{'i': 1, 'love': 2, 'ai': 3, 'and': 4, 'coding': 5}

(The index starts at 1 by default.)

5. Tokenizer.word_index

This returns the word-to-index dictionary created from your text.

You can use this dictionary to:

Understand which index is assigned to which word

Later convert sentences into number sequences using .texts_to_sequences()


```
import tensorflow as tf
from tensorflow.keras.preprocessing.text import Tokenizer
Tokenizer=Tokenizer()
Tokenizer.fit_on_texts([text])
Tokenizer.word_index
```

```
{'a': 1,
 'the': 2,
 '5': 3,
 'using': 4,
 'method': 5,
 'or': 6,
 'b': 7,
 'calculated': 8,
 'etc': 9,
 'approx': 10,
 'minutes': 11,
 'later': 12,
 'this': 13,
 'device': 14,
 'according': 15,
 'to': 16,
 'rule': 17,
 '42': 18,
 'reported': 19,
 'john': 20,
 'analyzed': 21,
 'my': 22,
 'neighbor': 23,
 'generated': 24,
 'observed': 25,
 'nasa': 26,
 'on': 27,
 'dec': 28,
```

```
'3rd': 29,
'2021': 30,
'student': 31,
'completed': 32,
'investigated': 33,
'dr': 34,
'smith': 35,
'ai': 36,
'e': 37,
'g': 38,
'images': 39,
'texts': 40,
'manager': 41,
'errors': 42,
'warnings': 43,
'and': 44,
'logs': 45,
'zip': 46,
'codes': 47,
'i': 48,
'models': 49,
'with': 50,
'95': 51,
'accuracy': 52,
'in': 53,
'u': 54,
's': 55,
'x': 56,
'ray': 57,
'scans': 58,
```

This code is used to **break a large block of text into individual lines** or sentences, and then print each line one by one.

The function text.split('\n') divides the text wherever there is a new line character (i.e., \n). In many .txt files or long strings, each sentence or paragraph is separated by a new line.

For example, if your text looks like this:

css Copy Edit I love AI. You love Python. We love learning. Then text.split('\n') will break it into:

"I love AI."

"You love Python."

"We love learning."

The for loop then goes through this list one item at a time and prints each sentence.

So, this code is often used when you want to read or process each line from a text file or a string that contains multiple sentences.

```
for sentences in text.split('\n'):
  print(sentences)
```

```
My neighbor reported X-ray scans etc.!
John reported case no. 245B with 95% accuracy!;
My neighbor analyzed 20 samples etc.?
A student measured 20 samples on Dec. 3rd, 2021!
Dr. Smith observed 12.5 kg of data with 95% accuracy!?
Dr. Smith measured ZIP codes approx. 5 minutes later.
Dr. Smith analyzed 3.14 units approx. 5 minutes later;
NASA completed 12.5 kg of data using method A or B.
NASA calculated case no. 245B approx. 5 minutes later!
This device investigated X-ray scans approx. 5 minutes later...
My neighbor measured A.I. models according to rule #42...
John investigated ZIP codes on Dec. 3rd, 2021...
This device investigated case no. 245B etc.!
The manager generated the results with 95% accuracy!!
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The manager calculated A.I. models e.g., images, texts;
John calculated errors, warnings, and logs according to rule #42!
The manager analyzed 3.14 units in the U.S.A.;
Dr. Smith investigated ZIP codes according to rule #42;
The manager observed case no. 245B etc.!
```

```
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Dr. Smith measured 3.14 units using method A or B;
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This device observed 3.14 units on Dec. 3rd, 2021;
```

This code is used to convert each line of text into a sequence of numbers using a tokenizer.

🔹 **for sentences in text.split('\n'):** This line splits the full text into separate lines or sentences wherever there is a newline character (\n). Then, it loops through each line one by one. Each sentences value will be one line from the text.

🔹 **Tokenizer.texts_to_sequences([sentences])** This function takes a list of text (in this case, just one sentence at a time) and converts the words into a list of integers.

The tokenizer replaces each word with its corresponding index from the word dictionary it learned earlier using fit_on_texts().

🔹 **print(Tokenizer.texts_to_sequences([sentences])[0])** This prints the converted list of numbers for each sentence. We use [0] because texts_to_sequences() returns a list of lists, and we want the actual sequence.

✅ **Example:** If you have this text:

python Copy Edit text = "I love AI.\nAI is powerful." And the tokenizer has the following word index:

python Copy Edit {'ai': 1, 'love': 2, 'i': 3, 'is': 4, 'powerful': 5} Then the output of the loop will be:

cpp Copy Edit [3, 2, 1] # for "I love AI." [1, 4, 5] # for "AI is powerful." Each word is replaced by its index number.

```
for sentences in text.split('\n'):
  Tokenizer.texts_to_sequences([sentences])
  print(Tokenizer.texts_to_sequences([sentences])[0])
```

```
[22, 23, 19, 56, 57, 58, 9]
[20, 19, 65, 66, 67, 50, 51, 52]
[22, 23, 21, 62, 63, 9]
[1, 31, 64, 62, 63, 27, 28, 29, 30]
[34, 35, 25, 68, 3, 69, 70, 71, 50, 51, 52]
[34, 35, 64, 46, 47, 10, 3, 11, 12]
[34, 35, 21, 59, 60, 61, 10, 3, 11, 12]
[26, 32, 68, 3, 69, 70, 71, 4, 5, 1, 6, 7]
[26, 8, 65, 66, 67, 10, 3, 11, 12]
[13, 14, 33, 56, 57, 58, 10, 3, 11, 12]
[22, 23, 64, 1, 48, 49, 15, 16, 17, 18]
[20, 33, 46, 47, 27, 28, 29, 30]
[13, 14, 33, 65, 66, 67, 9]
[2, 41, 24, 2, 72, 50, 51, 52]
[20, 8, 59, 60, 61, 15, 16, 17, 18]
[36, 33, 2, 72, 27, 28, 29, 30]
[2, 41, 8, 59, 60, 61, 9]
[22, 23, 32, 59, 60, 61, 50, 51, 52]
[2, 41, 8, 1, 48, 49, 15, 16, 17, 18]
[26, 21, 2, 72, 50, 51, 52]
[22, 23, 8, 56, 57, 58, 27, 28, 29, 30]
[1, 31, 8, 59, 60, 61, 9]
[13, 14, 21, 46, 47, 10, 3, 11, 12]
[13, 14, 32, 62, 63, 15, 16, 17, 18]
```

```
[34, 35, 24, 1, 48, 49, 50, 51, 52]
[2, 41, 8, 1, 48, 49, 37, 38, 39, 40]
[20, 8, 42, 43, 44, 45, 15, 16, 17, 18]
[2, 41, 21, 59, 60, 61, 53, 2, 54, 55, 1]
[34, 35, 33, 46, 47, 15, 16, 17, 18]
[2, 41, 25, 65, 66, 67, 9]
[20, 8, 59, 60, 61, 15, 16, 17, 18]
[1, 31, 24, 56, 57, 58, 9]
[20, 21, 68, 3, 69, 70, 71, 9]
[1, 31, 24, 62, 63, 4, 5, 1, 6, 7]
[2, 41, 32, 56, 57, 58, 53, 2, 54, 55, 1]
[36, 24, 46, 47, 9]
[26, 21, 42, 43, 44, 45, 37, 38, 39, 40]
[26, 33, 42, 43, 44, 45, 53, 2, 54, 55, 1]
[20, 33, 65, 66, 67, 37, 38, 39, 40]
[26, 19, 2, 72, 9]
[1, 31, 64, 42, 43, 44, 45, 37, 38, 39, 40]
[22, 23, 24, 62, 63, 50, 51, 52]
[20, 24, 46, 47, 27, 28, 29, 30]
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[2, 41, 32, 68, 3, 69, 70, 71, 9]
[13, 14, 25, 59, 60, 61, 27, 28, 29, 30]
```

To create training sequences for a next-word prediction model.

Each sequence represents a growing part of a sentence that ends just before the next word to predict.

🧩 Breakdown of the Code:

1. input_sequences = [] This initializes an empty list that will store all the input sequences.

2. for sentence in text.split('\n'): This loops through each line or sentence in the text variable.

The text is split at every new line (\n), assuming each line is one sentence.

3. tokenized_sentence = Tokenizer.texts_to_sequences([sentence])[0] This converts the sentence into a list of integers (word indices) using the tokenizer.

Example: "I love AI" might become [1, 2, 3].

4. for i in range(1, len(tokenized_sentence)): This loop generates partial sequences of increasing length from the tokenized sentence.

For example:

[1, 2]

[1, 2, 3]

5. input_sequences.append(tokenized_sentence[:i+1]) This appends each partial sequence to the input_sequences list.

Each sequence is a step toward the complete sentence, used to predict the next word.

✅ **Example:** Suppose a sentence is: "I love AI"

If tokenized as: [1, 2, 3]

Then the loop creates:

[1, 2] → used to predict 3

[1, 2, 3] → used if predicting next word after "AI"

So, input_sequences will contain:

python Copy Edit [[1, 2], [1, 2, 3]] This process is repeated for all lines in the text.

✅ **Why is this useful?** This is a standard method for preparing sequences for training models to predict the next word. Each sequence can be split into:

Input: all words except the last

Label: the last word (what the model should predict)

You can later use these in model training like this:

python Copy Edit X = padded_sequences[:, :-1] # input y = padded_sequences[:, -1] # output (target word)

```
input_sequences = []
for sentence in text.split('\n'):
  tokenized_sentence = Tokenizer.texts_to_sequences([sentence])[0]

  for i in range(1,len(tokenized_sentence)):
    input_sequences.append(tokenized_sentence[:i+1])
input_sequences
```

```
[[22, 23],
 [22, 23, 19],
 [22, 23, 19, 56],
 [22, 23, 19, 56, 57],
 [22, 23, 19, 56, 57, 58],
 [22, 23, 19, 56, 57, 58, 9],
 [20, 19],
 [20, 19, 65],
 [20, 19, 65, 66],
 [20, 19, 65, 66, 67],
 [20, 19, 65, 66, 67, 50],
 [20, 19, 65, 66, 67, 50, 51],
 [20, 19, 65, 66, 67, 50, 51, 52],
 [22, 23],
 [22, 23, 21],
 [22, 23, 21, 62],
 [22, 23, 21, 62, 63],
 [22, 23, 21, 62, 63, 9],
 [1, 31],
 [1, 31, 64],
 [1, 31, 64, 62],
 [1, 31, 64, 62, 63],
 [1, 31, 64, 62, 63, 27],
 [1, 31, 64, 62, 63, 27, 28],
 [1, 31, 64, 62, 63, 27, 28, 29],
 [1, 31, 64, 62, 63, 27, 28, 29, 30],
 [34, 35],
 [34, 35, 25],
 [34, 35, 25, 68],
 [34, 35, 25, 68, 3],
 [34, 35, 25, 68, 3, 69],
 [34, 35, 25, 68, 3, 69, 70],
 [34, 35, 25, 68, 3, 69, 70, 71],
 [34, 35, 25, 68, 3, 69, 70, 71, 50],
 [34, 35, 25, 68, 3, 69, 70, 71, 50, 51],
 [34, 35, 25, 68, 3, 69, 70, 71, 50, 51, 52],
 [34, 35],
 [34, 35, 64],
 [34, 35, 64, 46],
 [34, 35, 64, 46, 47],
 [34, 35, 64, 46, 47, 10],
 [34, 35, 64, 46, 47, 10, 3],
 [34, 35, 64, 46, 47, 10, 3, 11],
 [34, 35, 64, 46, 47, 10, 3, 11, 12],
 [34, 35],
 [34, 35, 21],
 [34, 35, 21, 59],
 [34, 35, 21, 59, 60],
 [34, 35, 21, 59, 60, 61],
 [34, 35, 21, 59, 60, 61, 10],
 [34, 35, 21, 59, 60, 61, 10, 3],
 [34, 35, 21, 59, 60, 61, 10, 3, 11],
 [34, 35, 21, 59, 60, 61, 10, 3, 11, 12],
 [26, 32],
 [26, 32, 68],
 [26, 32, 68, 3],
 [26, 32, 68, 3, 69],
 [26, 32, 68, 3, 69, 70],
```

🔍 What This Code Does (Step by Step):

✅ **1. max_len = max([len(x) for x in input_sequences])** This line finds the length of the longest input sequence.

In natural language processing, the sentences (or tokenized word sequences) usually have different lengths.

To make them equal in length (required for model training), we find the maximum length among all sequences.

✅ **2. from tensorflow.keras.preprocessing.sequence import pad_sequences** This line imports the pad_sequences function from Keras, which is used to make all sequences the same length by adding padding (usually zeros).

✅ **3. padded_input_sequences = pad_sequences(input_sequences, maxlen=max_len, padding='pre')** This line pads each sequence so that it becomes the same length as the longest one (determined by max_len).

padding='pre' means the padding (zeros) is added at the beginning of each sequence.

🧩 **Example to Understand:** Suppose we have these input sequences (before padding):

csharp Copy Edit [1, 2] [3, 4, 5] [6, 7, 8, 9] The maximum length (max_len) is 4 (from [6, 7, 8, 9]).

After padding, the sequences will look like this:

csharp Copy Edit [0, 0, 1, 2] [0, 3, 4, 5] [6, 7, 8, 9] Now all the sequences have equal length (4), and the shorter ones have zeros added at the beginning.

```
max_len = max([len(x) for x in input_sequences])
from tensorflow.keras.preprocessing.sequence import pad_sequences
padded_input_sequences = pad_sequences(input_sequences, maxlen = max_len, padding='pre')
padded_input_sequences
```

```
array([[ 0,  0,  0, ...,  0, 22, 23],
       [ 0,  0,  0, ..., 22, 23, 19],
       [ 0,  0,  0, ..., 23, 19, 56],
       ...,
       [ 0,  0,  0, ..., 72, 37, 38],
       [ 0,  0,  0, ..., 37, 38, 39],
       [ 0,  0,  0, ..., 38, 39, 40]], dtype=int32)
```

✅ What Each Line Does:

🔹 **X = padded_input_sequences[:, :-1]** This line takes all columns except the last one from each sequence.

X will be your input data (i.e., the sequence of words the model will see).

Example:

If one sequence is [0, 1, 2, 3]

Then X will get [0, 1, 2]

🔹 y = padded_input_sequences[:, -1]

This line takes only the last word (last column) from each sequence.

y will be the target label (i.e., the word the model should predict next).

From the same example [0, 1, 2, 3], y will get 3

🧠 Why This Is Done:

In next-word prediction, the model is trained to:

Look at the first part of a sentence (X)

And learn to predict the next word (y)

So this split allows us to train the model in a way that mimics real language prediction.

🧩 Example:

Let's say we have this padded sequence:

csharp Copy Edit [0, 2, 4, 5] Then:

X = [0, 2, 4] (input words)

y = 5 (word to predict)

This is done for every sequence in your data.

```
X = padded_input_sequences[:,:-1]
y = padded_input_sequences[:,-1]
```

✅ What Each Line Does:

🔹 **print(f'Shape of X: {X.shape}')** This prints the shape (i.e., number of rows and columns) of the input data X.

X contains the input word sequences (excluding the last word of each sequence).

🔹 **print(f'Shape of y: {y.shape}')** This prints the shape of the output data y.

y contains the word the model should predict (i.e., the last word in each sequence).

🧠 **Why This Is Important:** It confirms that your input (X) and output (y) are aligned correctly.

This check helps you debug errors before training the model.

```
print(f'Shape of X: {X.shape}')
print(f'Shape of y: {y.shape}')
```

```
Shape of X: (19519, 12)
Shape of y: (19519,)
```

Next-word prediction model using an LSTM neural network in TensorFlow/Keras:

🔹 **1. One-hot encoding the output labels** python Copy Edit from tensorflow.keras.utils import to_categorical y = to_categorical(y, num_classes=283) This converts the integer-based target labels y into one-hot encoded format.

num_classes=283 means your vocabulary (number of unique words) has 283 words.

This is necessary because the output layer of the model uses softmax, which requires categorical labels for multi-class classification.

🔹 **2. Importing Required Libraries** python Copy Edit from tensorflow.keras.models import Sequential from tensorflow.keras.layers import Embedding, LSTM, Dense Sequential: Lets you build a model layer-by-layer.

Embedding: Turns word indices into dense vectors (word embeddings).

LSTM: Long Short-Term Memory layers, which are good at learning from sequences (like sentences).

Dense: Fully connected layer for output classification.

🔹 **3. Building the Model** python Copy Edit model = Sequential() This creates a blank model in which you can add layers.

** 🔹 4. Embedding Layer ** python Copy Edit model.add(Embedding(283, 100, input_length=56)) Turns word indices (from tokenizer) into dense 100-dimensional vectors.

283: Vocabulary size.

100: Size of the embedding vector.

input_length=56: The number of tokens in each input sequence (based on X.shape[1]).

🔹 **5. First LSTM Layer** python Copy Edit model.add(LSTM(150, return_sequences=True)) Has 150 memory units.

return_sequences=True: Outputs a sequence (used when stacking LSTM layers).

🔹 **6. Second LSTM Layer** python Copy Edit model.add(LSTM(150)) Another LSTM layer with 150 units.

This time return_sequences=False (by default), so it outputs just the final state.

🔹 **7. Dense Output Layer** python Copy Edit model.add(Dense(283, activation='softmax')) A dense layer with 283 units (equal to the number of classes/words in the vocabulary).

softmax: Used to predict a probability distribution over all words – the word with the highest probability is the predicted next word.

🔹 **8. Compiling the Model** python Copy Edit model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy']) loss='categorical_crossentropy': Used for multi-class classification.

optimizer='adam': Efficient optimizer for training.

metrics=['accuracy']: Evaluates model performance based on how often it predicts the correct word.

🔹 **9. Displaying the Model Summary** python Copy Edit model.summary() This prints a table showing:

Each layer's name and type

Number of parameters (weights)

Output shapes at each stage

```
from tensorflow.keras.utils import to_categorical
y = to_categorical(y,num_classes=283)
```

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense
```

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Embedding, LSTM, Dense
import numpy as np

model = Sequential()
model.add(Embedding(283, 100, input_length=56))
model.add(LSTM(150, return_sequences=True))
model.add(LSTM(150))
model.add(Dense(283, activation='softmax'))
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

# Build the model
model.build(input_shape=(None, 56))

model.summary()
```

Model: "sequential_1"

Layer (type)	Output Shape	Param #
embedding_1 (Embedding)	(None, 56, 100)	28,300
lstm_2 (LSTM)	(None, 56, 150)	150,600
lstm_3 (LSTM)	(None, 150)	180,600
dense_1 (Dense)	(None, 283)	42,733

Total params: 402,233 (1.53 MB)
Trainable params: 402,233 (1.53 MB)
Non-trainable params: 0 (0.00 B)

```
history = model.fit(X, y, epochs=100, verbose=1)
print("Training Accuracy:", history.history['accuracy'][-1])
print("Training Loss:", history.history['loss'][-1])
```

```
Epoch 1/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 41s 61ms/step - accuracy: 0.0989 - loss: 3.8572
Epoch 2/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 37s 55ms/step - accuracy: 0.6437 - loss: 1.1484
Epoch 3/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 42s 57ms/step - accuracy: 0.6813 - loss: 0.8356
Epoch 4/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 33s 54ms/step - accuracy: 0.6906 - loss: 0.7812
Epoch 5/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 42s 56ms/step - accuracy: 0.6854 - loss: 0.7775
Epoch 6/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 41s 56ms/step - accuracy: 0.6827 - loss: 0.7858
Epoch 7/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 40s 55ms/step - accuracy: 0.6863 - loss: 0.7748
Epoch 8/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 35s 57ms/step - accuracy: 0.6842 - loss: 0.7695
Epoch 9/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 36s 59ms/step - accuracy: 0.6907 - loss: 0.7582
Epoch 10/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 35s 58ms/step - accuracy: 0.6870 - loss: 0.7680
Epoch 11/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 40s 57ms/step - accuracy: 0.6824 - loss: 0.7815
Epoch 12/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 41s 57ms/step - accuracy: 0.6848 - loss: 0.7720
Epoch 13/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 41s 57ms/step - accuracy: 0.6842 - loss: 0.7716
Epoch 14/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 34s 56ms/step - accuracy: 0.6805 - loss: 0.7801
Epoch 15/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 42s 58ms/step - accuracy: 0.6858 - loss: 0.7732
Epoch 16/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 39s 55ms/step - accuracy: 0.6865 - loss: 0.7774
Epoch 17/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 42s 56ms/step - accuracy: 0.6868 - loss: 0.7637
```

```
Epoch 18/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 43s 60ms/step - accuracy: 0.6914 - loss: 0.7608
Epoch 19/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 35s 57ms/step - accuracy: 0.6866 - loss: 0.7715
Epoch 20/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 34s 56ms/step - accuracy: 0.6836 - loss: 0.7708
Epoch 21/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 34s 56ms/step - accuracy: 0.6900 - loss: 0.7657
Epoch 22/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 40s 55ms/step - accuracy: 0.6880 - loss: 0.7621
Epoch 23/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 36s 59ms/step - accuracy: 0.6874 - loss: 0.7715
Epoch 24/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 41s 59ms/step - accuracy: 0.6851 - loss: 0.7707
Epoch 25/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 36s 59ms/step - accuracy: 0.6844 - loss: 0.7740
Epoch 26/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 40s 58ms/step - accuracy: 0.6931 - loss: 0.7549
Epoch 27/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 39s 63ms/step - accuracy: 0.6910 - loss: 0.7601
Epoch 28/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 38s 59ms/step - accuracy: 0.6853 - loss: 0.7743
Epoch 29/100
610/610 ━━━━━━━━━━━━━━━━━━━━ 43s 63ms/step - accuracy: 0.6869 - loss: 0.7725
```

- 🔹 **What it does:** Predicts the next word after a given sentence using a trained LSTM model.
- 🔹 **How it works:**

Tokenizes the input text.

Pads it to the right length.

Predicts the next word index using the model.

Finds the matching word from the tokenizer.

- 🔹 **Example Output:** Input: "This is an" → Predicted next word: "example" ✅

```python
import numpy as np

text = "your text goes here" # Replace with the actual text used for training

def predict_next_word(model, tokenizer, text, max_len):
    """
    Predicts the next word based on the input text.

    Args:
        model (tf.keras.Model): The trained Keras model.
        tokenizer (tf.keras.preprocessing.text.Tokenizer): The tokenizer used for training.
        text (str): The input text to predict the next word for.
        max_len (int): The maximum sequence length used for padding during training.

    Returns:
        str: The predicted next word.
    """
    token_list = tokenizer.texts_to_sequences([text])[0]
    padded_token_list = pad_sequences([token_list], maxlen=max_len-1, padding='pre')
    predicted_probabilities = model.predict(padded_token_list, verbose=0)
    predicted_word_index = np.argmax(predicted_probabilities)

    for word, index in tokenizer.word_index.items():
        if index == predicted_word_index:
            return word
    return None # Should not happen if the index is in the tokenizer vocabulary

# Example usage:
# Assuming 'model', 'Tokenizer', and 'max_len' are available from the preceding code
input_text = "This is an example"
predicted_word = predict_next_word(model, Tokenizer, input_text, max_len)
print(f"Input text: '{input_text}'")
print(f"Predicted next word: '{predicted_word}'")

input_text_2 = "another test sentence"
predicted_word_2 = predict_next_word(model, Tokenizer, input_text_2, max_len)
print(f"Input text: '{input_text_2}'")
print(f"Predicted next word: '{predicted_word_2}'")
```

```
Input text: 'This is an example'
Predicted next word: 'device'
```

```
Input text: 'another test sentence'
Predicted next word: 'device'
```

🔍 Goal of the Code

To generate a longer sentence by predicting one word at a time using the current sentence as input to a trained model.

🔢 **Step-by-Step Explanation**

✅ **1. Initial Text** python Copy Edit text = "what is the fee" This is the starting input sentence.

The model will add one word at a time to this base.

✅ **2. Loop to Generate Words** python Copy Edit for i in range(10): The loop runs 10 times, meaning 10 new words will be added.

You can change the number to generate more or fewer words.

✅ **3. Tokenize the Current Sentence** python Copy Edit token_text = Tokenizer.texts_to_sequences([text])[0] Converts the sentence into a sequence of integers based on the Tokenizer.

Example: "what is the fee" → [14, 7, 2, 98]

✅ **4. Pad the Sequence** python Copy Edit padded_token_text = pad_sequences([token_text], maxlen=56, padding='pre') Pads the sequence so that it has the same length (56) as used during training.

Padding is added at the beginning to make the sequence the correct size.

✅ **5. Predict the Next Word** python Copy Edit pos = np.argmax(model.predict(padded_token_text)) Feeds the padded sequence into the model to get the prediction.

model.predict() returns a list of probabilities for all words in the vocabulary.

np.argmax() finds the index of the word with the highest probability — this is the predicted next word.

✅ **6. Find the Word from Tokenizer** python Copy Edit for word, index in Tokenizer.word_index.items(): if index == pos: ... Goes through the tokenizer's dictionary to find the word that matches the predicted index.

✅ **7. Append the Word to the Sentence** python Copy Edit text = text + " " + word Adds the predicted word to the sentence.

✅ **8. Print and Pause** python Copy Edit print(text) time.sleep(2) Prints the updated sentence after adding each word.

Waits 2 seconds before predicting the next word (optional, for readability).

```python
import time
text = "what is the fee"

for i in range(10):
  # tokenize
  token_text = Tokenizer.texts_to_sequences([text])[0]
  # padding
  padded_token_text = pad_sequences([token_text], maxlen=56, padding='pre')
  # predict
  pos = np.argmax(model.predict(padded_token_text))

  for word,index in Tokenizer.word_index.items():
    if index == pos:
      text = text + " " + word
      print(text)
      time.sleep(2)
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 422ms/step
what is the fee manager
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 234ms/step
what is the fee manager reported
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 91ms/step
what is the fee manager reported errors
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 66ms/step
what is the fee manager reported errors warnings
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 67ms/step
what is the fee manager reported errors warnings and
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 69ms/step
what is the fee manager reported errors warnings and logs
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 63ms/step
what is the fee manager reported errors warnings and logs results
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 85ms/step
what is the fee manager reported errors warnings and logs results using
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 69ms/step
what is the fee manager reported errors warnings and logs results using method
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 69ms/step
what is the fee manager reported errors warnings and logs results using method a
```

🔧 !pip install -q gradio

This installs the Gradio library (quietly). It's used for building quick, shareable UIs for machine learning models.

💡 **Function: gradio_predict_next_word**

python Copy Edit def gradio_predict_next_word(input_text): Defines a function that Gradio will use to process user input.

python Copy Edit predicted_word = predict_next_word(model, Tokenizer, input_text, max_len) Calls your previously defined predict_next_word() function using:

model (your trained model)

Tokenizer (your tokenizer object)

input_text (what the user types)

max_len (the sequence length used during training)

python Copy Edit if predicted_word: return f"Predicted next word: {predicted_word}" else: return "Could not predict the next word." If a prediction is returned, it formats the response; otherwise, it returns a fallback message.

🌐 **Gradio Interface**

python Copy Edit interface = gr.Interface(fn=gradio_predict_next_word, inputs=gr.Textbox(lines=2, placeholder="Enter text here..."), outputs="text", title="Next Word Prediction", description="Enter a sequence of words and the model will predict the next word.") fn: the function to call when the user submits input.

inputs: a text box with 2 lines.

outputs: a string of text.

title and description: for display on the web page.

🚀 **Launch the Web UI**

python Copy Edit interface.launch() This opens a local Gradio app (and optionally shares it via a public link). Users can now interactively enter a sentence and see the model's predicted next word.

✅ **What You Must Ensure Before Running:**

You must already have a trained model (model), tokenizer (Tokenizer), and max_len value.

You must import missing parts:

python Copy Edit from tensorflow.keras.preprocessing.sequence import pad_sequences

```
import gradio as gr

css = """
body {
  font-family: 'Segoe UI', Tahoma, Geneva, Verdana, sans-serif;
  background: linear-gradient(to right, #a1c4fd, #c2e9fb);
  margin: 0;
  padding: 0;
}

.gradio-container {
  background-color: #ffffff;
  border-radius: 12px;
  box-shadow: 0 6px 16px rgba(0, 0, 0, 0.15);
  padding: 15px; /* Reduced */
  margin: 30px auto; /* Reduced */
  max-width: 500px; /* Reduced */
  border: 2px solid #6fb1fc;
}

.gradio-input label {
  font-weight: bold;
  color: #2c3e50;
  font-size: 0.9em; /* Reduced */
}

textarea {
```

```
  border: 1px solid #6fb1fc !important;
  border-radius: 6px !important;
  padding: 6px !important;
  font-size: 0.9em !important;
  background-color: #f8faff !important;
  color: #34495e !important;
}

.gradio-output {
  margin-top: 15px;
  padding: 10px;
  border-radius: 6px;
  background: linear-gradient(to right, #d4fc79, #96e6a1);
  color: #2d3436;
  font-weight: bold;
  font-size: 1em; /* Reduced */
  border: 1px solid #81ecec;
}
"""


# Prediction function (requires model, Tokenizer, and max_len to be defined)
def gradio_predict_next_word(input_text):
    """
    Gradio interface function to predict the next word.
    """
    # Replace this with your actual prediction logic
    predicted_word = predict_next_word(model, Tokenizer, input_text, max_len)
    if predicted_word:
        return f"Predicted next word: {predicted_word}"
    else:
        return "Could not predict the next word."

# Build the Gradio interface
interface = gr.Interface(
    fn=gradio_predict_next_word,
    inputs=gr.Textbox(lines=2, placeholder="Enter text here...", label="Input Text"),
    outputs=gr.Text(label="Prediction"),
    title="Next Word Prediction",
    description="Enter a sentence and let the model predict the next word based on context using LSTM.",
    css=css
)

# Launch the interface
interface.launch()
```

```
It looks like you are running Gradio on a hosted Jupyter notebook, which requires `share=True`. Automatically setting `share=True` (you

Colab notebook detected. To show errors in colab notebook, set debug=True in launch()
* Running on public URL: https://f4e218fbfdbd9b3c17.gradio.live
```

Input Text

John generated A.I.

Clear | Submit

Prediction

Predicted next word: models

Flag

Use via API · Built with Gradio · Settings

```
radio deploy` from the terminal in the working dir
```

now

Double-click (or enter) to edit

THE END!