

Project : Word Prediction Using LSTM

```
In [ ]: with open('IndiaUS.txt','r',encoding='utf-8') as myfile:  
        mytext=myfile.read()
```

```
In [ ]: print(mytext)
```

Following a lavish state visit by Indian Prime Minister Narendra Modi to Washington, US President Joe Biden has called his country's partnership with India among the "most consequential in the world". The BBC's Vikas Pandey and Soutik Biswas explore the factors that contribute to the visit's potential in strengthening the ties between the two nations.

The US's relationship with India - the world's most populous country - is "stronger, closer and more dynamic than any time in history", Mr Biden said at the completion of a pomp-filled state visit by Mr Modi to the White House.

The remark may not be an exaggeration. "This summit suggests that the relationship has been transformed. It underscores just how broad and deep it has become in a relatively short time," says Michael Kugelman of The Wilson Center, an American think-tank.

A key reason is that Washington is keen to draw India closer so that it can act as a counterbalance to China's growing influence in the Indo-Pacific. India-US ties had not lived up to their promise following a landmark civilian nuclear deal in 2005 because a liability law passed by India three years later hobbled purchase of reactors.

"This followed a fading commitment to the relationship during [former prime minister] Manmohan Singh's second term as the leader of a coalition government. With Mr Modi there has been a lot more enthusiasm about embracing the US. Mr Biden has also given an overall broad directive to make it work," says Seema Sirohi, author of *Friends With Benefits: The India-US Story*.

Ms Sirohi says the US put in a "lot of effort to make Mr Modi's visit substantive and have a lot of deliverables". Defence-industrial cooperation and technology topped the list. Consider this:

General Electric and India's state-owned Hindustan Aeronautics Limited will make in India advanced fighter jet engines for the country's indigenous light combat aircraft. This means a "greater transfer of US jet engine technology than ever before" - a clear sign that Washington not only wants to sell arms to India but is also comfortable with sharing military technology.

India will proceed with a \$3bn purchase of the battle-tested MQ-9B Predator drones from General Atomics, which will also set up a facility in India. The drones will be assembled in India, which fits into Mr Modi's 'Make in India' campaign. The US supplies only 11% of India's arms - Russia is the biggest (45%) supplier - but hopes to become the primary provider in the coming years. Mr Kugelman says Washington's immediate goal is to "strengthen India's military capacity to counter China".

Mr Modi wants to make India a semiconductor base. US memory chip giant Micron Technology will invest up to \$825m to build a semiconductor assembly and test facility in India, creating thousands of jobs.

US semiconductor equipment maker Lam Research will train 60,000 Indian engineers through a network of interconnected labs and research centres to speed up India's semiconductor education and workforce development. Also Applied Materials, the biggest maker of machines for producing semiconductors, will invest \$400m to establish an engineering centre in India.

"It is all about the future now. Both sides are talking about cutting-edge technologies and how to seed and shape the future," says Ms Sirohi.

: U.S. President Joe Biden and first lady Jill Biden welcome India Prime Minister Narendra Modi to the White House on June 21, 2023 in Washington, DC

Mr Biden and Mrs Biden welcome Mr Modi to the White House

The India-US relationship has seen many ups and downs since the US seriously began courting India - first under President Bill Clinton and then under the George Bush administration. The response from India was measured, never overeager or too forthcoming.

The reason was the way India saw geopolitics and its own place in the global order. The strategy of nonalignment, started by India's first prime minister Jawaharlal Nehru, has always been deeply rooted into India's foreign policy.

India never wanted to be seen in one camp or the other, or to be seen as junior strategic partner to a global superpower. Mr Modi has not left the ideals of what some describe as "strategic altruism" in Indian foreign policy.

But Mr Modi is leading a different kind of India, one which has considerably more economic and geopolitical heft. He has owned the India-US relations - he formed close bonds with former presidents Barack Obama and Donald Trump and now with Mr Biden.

But India's "strategic autonomy" has not been sacrificed. Washington would have wanted India to go a step further on Russia and probably take a harder public stand on China.

But the Biden administration didn't seem disappointed as Mr Modi repeated his line that "this was not the era of war" without mentioning Russia. The Indian prime minister did speak about the importance of beefing up humanitarian assistance to Ukraine. He didn't mention China by name either but did talk about the importance of a free and prosperous Indo-Pacific.

This is how far Mr Modi could have pushed his administration's policy without compromising on strategic autonomy. It may not have been the ideal way for Washington but it didn't come in the way of making Mr Modi's visit a success.

The United States Air Force (USAF) and Indian Air Force (IAF) personnel are posing in front of a United States Air Force (USAF) F-15 Eagle fighter jet during the joint 'Exercise Cope India 2023' at the air force station in Kalaikunda, around 170 km west of Kolkata, on April 24th, 2023.

US and Indian air force personnel pose in front of a US fighter jet during a joint exercise in India in April

"The two militaries are working more closely together. They now have arrangements in place where they could use each other's facilities for refuelling and maintenance purposes

. They are holding joint exercises and they're sharing a lot more intelligence. Credit to Mr Modi for managing to really test the limits of strategic autonomy. In the sense that he is getting about as close as you can to a major power without signing on to a full-fledged alliance," Mr Kugelman says.

India and the US have had major trade differences in recent years over tariffs. Trade relations particularly suffered during the Trump administration.

The two sides were not expected to announce anything major in trade as it was understood that the discussions over that could continue later without overshadowing the visit.

But surprisingly, the two sides announced that six separate trade disputes at the World Trade Organization were resolved, including one that involved tariffs.

The US is now India's top trading partner at \$130bn in goods and Delhi is Washington's eighth largest partner. While these numbers are impressive, analysts and policymakers feel there is a huge untapped potential. India is also a burgeoning market with an expanding middle class and it's been positioning itself as an alternative to China to become a manufacturing hub for the world.

President Joe Biden and Indian Prime Minister Narendra Modi participate in an arrival ceremony on the South Lawn of the White House on Thursday, June 22, 2023 in Washington, D.C. President Biden is the first U.S. President to invite Prime Minister Modi for an official state visit

Some 2.7 million Indians live in the US

Many global firms and nations are interested in the proposal as they look to free the global supply chain from China's dominance. In that context, the resolution of trade disputes will give further impetus to unlocking the full potential of India-US trade ties. Mr Modi has said that "even sky is not the limit (for India-US) ties".

Critics in Washington have questioned India's "democratic backsliding" under Mr Modi and his Hindu nationalist Bharatiya Janata Party (BJP). Mr Obama, in a television interview this week, emphasised the significance of addressing the "protection of the Muslim minority in a predominantly Hindu India" during discussions between Mr Biden and Mr Modi. "The progressives in the Democratic Party are disturbed by what is happening in India. The realists and centrists are all for strengthening the relationship because of the China factor," says Ms Sirohi.

But on the whole, there is a bipartisan agreement to make the relationship deeper and broader. "The India-US strategic partnership has certainly moved to the next level. It's one of mutual need and mutual benefit," says Ms Sirohi.

```
In [ ]: #first line by line split
        #then tokenize - numbers
        #n- gram sequence
        #bi - gram
        #padding (extra space ulla bakam fill cheyya)
        #embedding words(size okke kurakan (higher dimension to lower dimension convert aaka))
        #model building
```

```
In [ ]: import tensorflow as tf
        from tensorflow.keras.preprocessing.text import Tokenizer
        from tensorflow.keras.preprocessing.sequence import pad_sequences
        from tensorflow.keras.models import Sequential
        from tensorflow.keras.layers import Embedding,LSTM,Dense
        import numpy as np
        import pickle
```

Tokenizing

```
In [ ]: mytokenizer=Tokenizer()
```

```
In [ ]: mytokenizer.fit_on_texts([mytext])
```

```
In [ ]: #total no.of unique words
        total_words=len(mytokenizer.word_index)+1 #extra words verumbo adhpole predict cheyyin word padsquence cheymboulla word hold cheyyan oru index value hold cheyyum adhan +1
```

```
In [ ]: total_words
```

```
Out[ ]: 599
```

```
In [ ]: mytokenizer.word_index
```

```
Out[ ]: {'the': 1,
        'to': 2,
        'in': 3,
        'a': 4,
        'and': 5,
        'india': 6,
        'of': 7,
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```
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'benefit': 598}
```

```
In [ ]: with open('tokenizer.pickle','wb') as handle:
```

```
pickle.dump(mytokenizer,handle,protocol=pickle.HIGHEST_PROTOCOL)
```

```
#converting to bi-gram sequence
my_input_sequences=[]
#line by line split
for line in mytext.split('\n'):
#tokenize to lines
    token_list=mytokenizer.texts_to_sequences([line])[0]
    #print(token_list)
#line by line to word by word
    for i in range(1,len(token_list)):
        my_n_gram_sequence=token_list[:i+1] #bi-gram, i+2=tri gram, i+3=qudra gram
        my_input_sequences.append(my_n_gram_sequence)
```

```
max_sequence_len=max(len(seq) for seq in my_input_sequences)
max_sequence_len
```

```
#(image aayalum text data ayalum)input data same size(shape) aayirikanam same size allenkil padding use cheyth same size aaka
#text data ye padding 0 vech fill cheyyum image aaneki 0pixels vech fill cheyyum athinte boundarik
```

```
'\n[1,2,3,4] =4\n[3,5,6] =3\n[1,5,8,9,2] =5\n\nnmax=5\n\nnpre padding\n[0,1,2,3,4]\n[0,0,3,5,6]\n\nnpost padding\nlast fill 0s\n'
```

Padding

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

```
input_sequences[0]
```

[illegible]

Separate X and Y

```
#x = includes all rows and all columns except last one
x=input_sequences[:, :-1]
```

```
#y = last column
y=input_sequences[:, -1]
```

```
In [ ]: #one hot encoding
y=np.array(tf.keras.utils.to_categorical(y,num_classes=total_words))
```

Model architecture building

```
In [ ]: model=Sequential()
#embedding=higher dimensional space to lower dimensional space
model.add(Embedding(total_words,100,input_length=max_sequence_len-1))
model.add(LSTM(150))
model.add(Dense(total_words,activation='softmax')) #more categories undaneki softmax use cheyya more than 10 (correct probability nokit ath distribute cheyth namuk venda vala)
```

Compile

```
In [ ]: model.compile(optimizer='adam',loss='categorical_crossentropy')
```

```
In [ ]: model.fit(x,y,epochs=100)
```

Epoch 1/100
43/43 [=====] - 10s 163ms/step - loss: 6.2033
Epoch 2/100
43/43 [=====] - 4s 103ms/step - loss: 5.7967
Epoch 3/100
43/43 [=====] - 3s 72ms/step - loss: 5.7209
Epoch 4/100
43/43 [=====] - 2s 47ms/step - loss: 5.6725
Epoch 5/100
43/43 [=====] - 2s 44ms/step - loss: 5.5947
Epoch 6/100
43/43 [=====] - 2s 53ms/step - loss: 5.4918
Epoch 7/100
43/43 [=====] - 1s 30ms/step - loss: 5.3633
Epoch 8/100
43/43 [=====] - 1s 19ms/step - loss: 5.1916
Epoch 9/100
43/43 [=====] - 1s 11ms/step - loss: 4.9797
Epoch 10/100
43/43 [=====] - 0s 11ms/step - loss: 4.7362
Epoch 11/100
43/43 [=====] - 1s 17ms/step - loss: 4.4976
Epoch 12/100
43/43 [=====] - 0s 11ms/step - loss: 4.2479
Epoch 13/100
43/43 [=====] - 1s 30ms/step - loss: 4.0056
Epoch 14/100
43/43 [=====] - 1s 15ms/step - loss: 3.7655
Epoch 15/100
43/43 [=====] - 1s 12ms/step - loss: 3.5306
Epoch 16/100
43/43 [=====] - 1s 18ms/step - loss: 3.3023
Epoch 17/100
43/43 [=====] - 1s 14ms/step - loss: 3.0682
Epoch 18/100
43/43 [=====] - 1s 14ms/step - loss: 2.8588
Epoch 19/100
43/43 [=====] - 1s 14ms/step - loss: 2.6503
Epoch 20/100
43/43 [=====] - 1s 17ms/step - loss: 2.4460
Epoch 21/100
43/43 [=====] - 0s 10ms/step - loss: 2.2510
Epoch 22/100
43/43 [=====] - 1s 18ms/step - loss: 2.0712
Epoch 23/100
43/43 [=====] - 0s 10ms/step - loss: 1.8985
Epoch 24/100
43/43 [=====] - 0s 10ms/step - loss: 1.7432
Epoch 25/100
43/43 [=====] - 0s 6ms/step - loss: 1.5853
Epoch 26/100
43/43 [=====] - 0s 6ms/step - loss: 1.4440
Epoch 27/100
43/43 [=====] - 1s 14ms/step - loss: 1.3132
Epoch 28/100
43/43 [=====] - 1s 14ms/step - loss: 1.1951
Epoch 29/100
43/43 [=====] - 1s 18ms/step - loss: 1.0897
Epoch 30/100
43/43 [=====] - 0s 10ms/step - loss: 0.9943

Epoch 31/100
43/43 [=====] - 0s 6ms/step - loss: 0.9056
Epoch 32/100
43/43 [=====] - 1s 13ms/step - loss: 0.8207
Epoch 33/100
43/43 [=====] - 0s 10ms/step - loss: 0.7493
Epoch 34/100
43/43 [=====] - 0s 9ms/step - loss: 0.6843
Epoch 35/100
43/43 [=====] - 0s 8ms/step - loss: 0.6276
Epoch 36/100
43/43 [=====] - 1s 14ms/step - loss: 0.5746
Epoch 37/100
43/43 [=====] - 1s 15ms/step - loss: 0.5278
Epoch 38/100
43/43 [=====] - 0s 11ms/step - loss: 0.4887
Epoch 39/100
43/43 [=====] - 0s 10ms/step - loss: 0.4502
Epoch 40/100
43/43 [=====] - 0s 6ms/step - loss: 0.4134
Epoch 41/100
43/43 [=====] - 0s 10ms/step - loss: 0.3847
Epoch 42/100
43/43 [=====] - 0s 10ms/step - loss: 0.3569
Epoch 43/100
43/43 [=====] - 0s 6ms/step - loss: 0.3306
Epoch 44/100
43/43 [=====] - 0s 10ms/step - loss: 0.3102
Epoch 45/100
43/43 [=====] - 0s 7ms/step - loss: 0.2887
Epoch 46/100
43/43 [=====] - 0s 6ms/step - loss: 0.2707
Epoch 47/100
43/43 [=====] - 0s 6ms/step - loss: 0.2534
Epoch 48/100
43/43 [=====] - 0s 6ms/step - loss: 0.2381
Epoch 49/100
43/43 [=====] - 0s 6ms/step - loss: 0.2254
Epoch 50/100
43/43 [=====] - 0s 10ms/step - loss: 0.2128
Epoch 51/100
43/43 [=====] - 0s 6ms/step - loss: 0.2003
Epoch 52/100
43/43 [=====] - 0s 6ms/step - loss: 0.1894
Epoch 53/100
43/43 [=====] - 0s 6ms/step - loss: 0.1781
Epoch 54/100
43/43 [=====] - 0s 6ms/step - loss: 0.1699
Epoch 55/100
43/43 [=====] - 0s 6ms/step - loss: 0.1615
Epoch 56/100
43/43 [=====] - 0s 6ms/step - loss: 0.1547
Epoch 57/100
43/43 [=====] - 0s 6ms/step - loss: 0.1473
Epoch 58/100
43/43 [=====] - 0s 6ms/step - loss: 0.1411
Epoch 59/100
43/43 [=====] - 0s 6ms/step - loss: 0.1349
Epoch 60/100
43/43 [=====] - 0s 6ms/step - loss: 0.1302

Epoch 61/100
43/43 [=====] - 0s 10ms/step - loss: 0.1249
Epoch 62/100
43/43 [=====] - 0s 7ms/step - loss: 0.1192
Epoch 63/100
43/43 [=====] - 0s 6ms/step - loss: 0.1145
Epoch 64/100
43/43 [=====] - 1s 13ms/step - loss: 0.1110
Epoch 65/100
43/43 [=====] - 0s 10ms/step - loss: 0.1068
Epoch 66/100
43/43 [=====] - 0s 6ms/step - loss: 0.1036
Epoch 67/100
43/43 [=====] - 0s 7ms/step - loss: 0.1011
Epoch 68/100
43/43 [=====] - 1s 14ms/step - loss: 0.0969
Epoch 69/100
43/43 [=====] - 0s 9ms/step - loss: 0.0936
Epoch 70/100
43/43 [=====] - 1s 16ms/step - loss: 0.0909
Epoch 71/100
43/43 [=====] - 0s 8ms/step - loss: 0.0884
Epoch 72/100
43/43 [=====] - 0s 7ms/step - loss: 0.0851
Epoch 73/100
43/43 [=====] - 0s 6ms/step - loss: 0.0834
Epoch 74/100
43/43 [=====] - 0s 6ms/step - loss: 0.0817
Epoch 75/100
43/43 [=====] - 0s 6ms/step - loss: 0.0786
Epoch 76/100
43/43 [=====] - 0s 6ms/step - loss: 0.0760
Epoch 77/100
43/43 [=====] - 0s 6ms/step - loss: 0.0753
Epoch 78/100
43/43 [=====] - 1s 14ms/step - loss: 0.0732
Epoch 79/100
43/43 [=====] - 0s 6ms/step - loss: 0.0717
Epoch 80/100
43/43 [=====] - 0s 6ms/step - loss: 0.0699
Epoch 81/100
43/43 [=====] - 0s 6ms/step - loss: 0.0681
Epoch 82/100
43/43 [=====] - 0s 10ms/step - loss: 0.0673
Epoch 83/100
43/43 [=====] - 0s 7ms/step - loss: 0.0662
Epoch 84/100
43/43 [=====] - 0s 10ms/step - loss: 0.0634
Epoch 85/100
43/43 [=====] - 0s 10ms/step - loss: 0.0625
Epoch 86/100
43/43 [=====] - 0s 7ms/step - loss: 0.0625
Epoch 87/100
43/43 [=====] - 0s 10ms/step - loss: 0.0602
Epoch 88/100
43/43 [=====] - 0s 10ms/step - loss: 0.0588
Epoch 89/100
43/43 [=====] - 0s 10ms/step - loss: 0.0574
Epoch 90/100
43/43 [=====] - 0s 6ms/step - loss: 0.0563

```
Epoch 91/100
43/43 [=====] - 0s 6ms/step - loss: 0.0565
Epoch 92/100
43/43 [=====] - 0s 6ms/step - loss: 0.0544
Epoch 93/100
43/43 [=====] - 0s 7ms/step - loss: 0.0542
Epoch 94/100
43/43 [=====] - 0s 10ms/step - loss: 0.0542
Epoch 95/100
43/43 [=====] - 0s 6ms/step - loss: 0.0527
Epoch 96/100
43/43 [=====] - 0s 7ms/step - loss: 0.0525
Epoch 97/100
43/43 [=====] - 0s 6ms/step - loss: 0.0509
Epoch 98/100
43/43 [=====] - 0s 6ms/step - loss: 0.0517
Epoch 99/100
43/43 [=====] - 0s 7ms/step - loss: 0.0504
Epoch 100/100
43/43 [=====] - 0s 6ms/step - loss: 0.0489
```

```
Out[ ]: <keras.src.callbacks.History at 0x7e63b059d090>
```

```
In [ ]: model.save('word_prediction_model.h5')
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/engine/training.py:3103: UserWarning: You are saving your model as an HDF5 file via `model.save()`. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(
```

Copy to drive (word_prediction_model.h5)

```
In [ ]: !mkdir -p drive/MyDrive/word_prediction_model
        !cp word_prediction_model.h5 drive/MyDrive/word_prediction_model
```

Model Prediction System

```
In [ ]: import numpy as np
        from tensorflow.keras.preprocessing.text import Tokenizer
        from tensorflow.keras.preprocessing.sequence import pad_sequences
        import pickle
        from tensorflow.keras.models import load_model
```

```
In [ ]: with open('/content/tokenizer.pickle','rb') as handle:
        mytokenizer=pickle.load(handle)
```

```
In [ ]: print(mytokenizer)

<keras.src.preprocessing.text.Tokenizer object at 0x7e644c618d60>
```

```
In [ ]: model=load_model('/content/word_prediction_model.h5')
```

```
In [ ]: input_text='prime minister'
```

```
In [ ]: predict_next_words=5
```

```
In [ ]: for i in range(predict_next_words):
        token_list=mytokenizer.texts_to_sequences([input_text])[0]
        token_list=pad_sequences([token_list],maxlen=model.input_shape[1],padding='pre')
        predicted=model.predict(token_list)
```

```
predicted=np.argmax(predicted,axis=-1)
predicted_word=mytokenizer.index_word[predicted[0]]
input_text+=" "+predicted_word

print(input_text)
```

```
1/1 [=====] - 0s 20ms/step
1/1 [=====] - 0s 18ms/step
1/1 [=====] - 0s 19ms/step
1/1 [=====] - 0s 18ms/step
1/1 [=====] - 0s 17ms/step
prime minister narendra modi to the white
```

In []: