CREATE A CHATBOT IN PYTHON

PHASE 5: Project Documentation & Submission

TEAM MEMBERS:

ABINAYA.R
PRIYADHARSHINI.J
PARKAVI.P
KARTHIKA.S

TOPIC: Document the Project and Prepare it for Submission.

INTRODUCTION:

A chatbot is a computer program that simulates and processes human conversation, allowing humans to interact with digital devices as if they were communicating with a real person.

Chatbots, also known as conversational agents, are designed with the help of AI software. They simulate a conversation (or a chat) with users in a natural language via messaging applications, websites, mobile apps, or phone.

OBJECTIVES:

Chatbot is a Python library that is developed to provide automated responses to user inputs. It makes utilization of a combination of Machine Learning algorithms in order to generate multiple types of responses.

DATA SOURCES:

With a data source, you can connect your Interfaces AI Chatbot to your own knowledge sources and tailor the responses for your business or project. You can restrict your bot from using its training information to provide answers and set custom responses when information doesn't exist.

TASKS:

1. Chat bot questions and answers preparing manually.
2. Storing questions and answers in database.
3. Connecting front page with questions and answers using python code.

DESIGN THINKING :

Design thinking is a human-centered method that aims to understand the user’s problems and generate ideas to solve them. It can be used for digital products and services, but also chatbots. Follow our lesson, learn the fundamentals of design thinking, and find out how to apply it to build user-friendly chatbots.

1.Environment Setup:

- Install Python: Make sure you have Python installed on your system.
- Choose an IDE or text editor for coding (e.g., VSCode, PyCharm, Jupyter Notebook).

2. Select a Chatbot Framework:
   - Choose a Python chatbot framework/library to work with, like ChatterBot, NLTK, or Rasa.

3. Data Collection:
   - Gather or create a dataset of conversation examples to train your chatbot. This data is crucial for teaching the chatbot how to respond.

4. Data Preprocessing:
   - Clean and preprocess the conversation data, including text normalization, tokenization, and stemming.

5. Training:
   - Use your chosen framework to train the chatbot on the preprocessed data. This involves teaching the chatbot how to understand and respond to user queries.

6. Integration with Natural Language Processing (NLP):
   - Implement NLP techniques to improve the chatbot's ability to understand and generate human-like responses. Libraries like spaCy or NLTK can be helpful here.

7. Create User Interfaces:
   - Develop a user interface for your chatbot. This can be a web app, a command-line interface, or an integration with a messaging platform.

8. Testing and Debugging:

- Test your chatbot thoroughly to identify and fix issues. Pay attention to both the chatbot's ability to understand input and generate coherent responses.

9. Deployment:

- Deploy your chatbot on a server or platform of your choice so that users can interact with it.

10. Continuous Improvement:

- Continuously collect user feedback and improve your chatbot's responses. You can also consider adding more features and capabilities over time.

PHASES OF DEVELOPMENT:

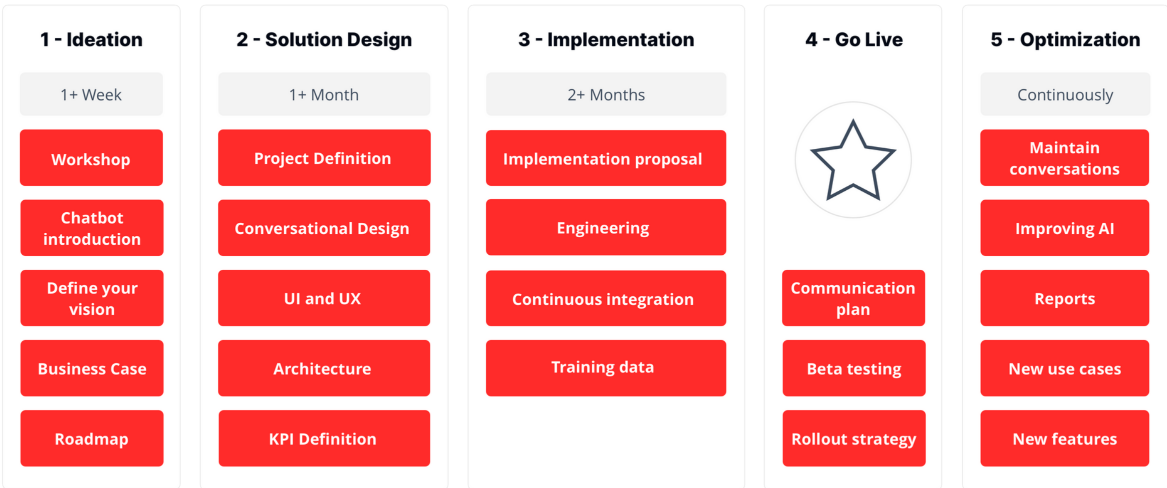
Step 1: Make a list of ideas and define business cases.

Step 2: Bring all the experts together and define the solution end to end.

Step 3: Build your ideas into the chatbot.

Step 4: From training to go-live.

Step 5: Optimization.



LIBRARIES USED IN CHATBOT:

Creating a chatbot in Python often involves using various libraries and frameworks to facilitate natural language processing, web interactions, and other essential functionalities. Here are some commonly used libraries and frameworks for building chatbots in Python:

1.Natural Language Processing (NLP) Libraries:

- NLTK (Natural Language Toolkit): NLTK is a popular library for NLP tasks, including tokenization, stemming, lemmatization, and sentiment analysis.
- spaCy: spaCy is a fast and efficient NLP library for various NLP tasks, such as part-of-speech tagging, entity recognition, and dependency parsing.
- TextBlob: TextBlob is a simple library for processing textual data, including sentiment analysis, translation, and text classification.

2.Machine Learning Libraries:

- Scikit-Learn: If your chatbot requires machine learning, Scikit-Learn is a powerful library for tasks like text classification and clustering.

- TensorFlow and Keras: These libraries are suitable for creating and training deep learning models for more complex chatbots.

3.Chatbot Frameworks:

- Rasa: Rasa is an open-source framework specifically designed for building conversational AI chatbots. It provides tools for dialogue management, intent recognition, and entity extraction.
- BotPress: BotPress is another open-source chatbot framework that offers a visual interface for building and managing chatbots.
- Microsoft Bot Framework: If you want to develop chatbots that work across multiple platforms (e.g., Microsoft Teams, Skype, Slack), the Microsoft Bot Framework is a valuable option.

4.Web Frameworks:

- Flask and Django: These web frameworks are commonly used for building web-based chatbots that interact with users via a web interface.

5.Database Libraries:

- SQLAlchemy and Django ORM: These libraries help in connecting your chatbot to databases to store and retrieve information.

6.API Libraries:

- Requests: The Requests library is used to make HTTP requests to external APIs, which can be valuable for integrating data and services into your chatbot.

7.Front-End Libraries:

- JavaScript libraries like React or Vue.js can be used if you're building a web-based chatbot with a front-end interface.

8.Deployment and Hosting:

- Docker: Docker can be used to containerize your chatbot application for easy deployment.
- Cloud Platforms (e.g., AWS, Azure, Google Cloud): These platforms provide hosting and serverless options for deploying your chatbot.

9.Version Control and Collaboration:

- Git and platforms like GitHub or GitLab are useful for version control and collaboration when developing chatbots with a team.

10.Other Specialized Libraries:

- OpenAI's GPT-3 (or its successors): These libraries can be used to integrate powerful natural language generation capabilities into your chatbot.

- Speech recognition libraries (e.g., SpeechRecognition) if your chatbot needs to handle voice interactions.

The choice of libraries and frameworks depends on your specific chatbot requirements and the technologies you are comfortable with. When developing a chatbot, it's crucial to select the tools that best match the objectives and capabilities you want to implement.

INTEGRATION OF NLP TECHNIQUES:

Integrating Natural Language Processing (NLP) techniques into a chatbot in Python is a fundamental aspect of building a chatbot that can understand and generate human-like text responses. Here are the key steps for integrating NLP techniques into a chatbot:

1.Text Preprocessing:

- Tokenization: Break the user's input and responses into individual words or tokens.
- Lowercasing: Convert all text to lowercase to ensure consistency.
- Stopword Removal: Remove common words like "a," "an," "the" to reduce noise.

- Lemmatization or Stemming: Reduce words to their base form to improve matching.

2.Intent Recognition:

- Use techniques like rule-based approaches, machine learning, or deep learning to determine the user's intent. This involves understanding what the user wants from their input.

3.Entity Recognition:

- Identify specific pieces of information (entities) in the user's input, such as dates, names, or locations. This is important for extracting actionable information from the user's request.

4.Response Generation:

- Given the recognized intent and entities, generate a response that is contextually appropriate and relevant. You can use templates, rule-based responses, or more advanced techniques like generative models (e.g., GPT-3).

5.Dialog Management:

- Keep track of the conversation's context and manage the flow of conversation. Ensure that the chatbot remembers the user's previous inputs and responses for context-aware interactions.

6.Sentiment Analysis:

- Analyze the sentiment of user input to understand the user's emotional state. This can be used to tailor responses accordingly.

7.Named Entity Recognition (NER):

- Identify and extract named entities, such as names of people, organizations, and locations, which can be crucial for understanding and responding to user queries accurately.

8.Word Embeddings:

- Utilize word embeddings like Word2Vec, FastText, or pre-trained embeddings (e.g., GloVe) to represent words in a dense vector space, enabling better understanding of word relationships.

9.Language Models:

- Employ pre-trained language models like BERT, GPT-2, or GPT-3 to improve the chatbot's language understanding and generation capabilities.

10.Conversational Memory:

- Maintain a memory of the conversation history to allow the chatbot to maintain context and provide more coherent responses.

11.Error Handling:

- Implement robust error handling to manage situations where the chatbot does not understand the user's input.

12. Testing and Fine-Tuning:
    - Continuously test and fine-tune the chatbot's NLP components using real user interactions to improve its performance and understanding over time.
13. Integration with APIs and Databases:
    - Integrate the chatbot with external data sources, APIs, and databases to fetch information or perform specific tasks.
14. User Experience (UX) Design:
    - Consider the user experience and design a conversational flow that guides users effectively and ensures a natural interaction.
15. Deployment:
    - Deploy the chatbot using a suitable web framework (e.g., Flask, Django) and host it on a web server or a cloud platform.

When integrating NLP techniques into a chatbot, you can use libraries like NLTK, spaCy, TextBlob, and machine learning frameworks (e.g., Scikit-Learn, TensorFlow) for the various NLP tasks mentioned above.

HOW THE CHATBOT INTERACTS WITH USERS AND THE WEB APPLICATION:

A chatbot interacts with users and a web application through a combination of frontend and backend components, communication protocols, and data exchange. Here's an overview of how this interaction typically works:

1. User Interface (Frontend):

- Users interact with the chatbot through a user interface on a web application. This can be a chat window embedded in a website, a messaging platform, or a dedicated chatbot app.

2. User Input:

- Users enter text or voice input in the chat interface, which serves as their communication with the chatbot.

3. Web Application (Frontend):

- The user input is typically collected and sent to the web application's frontend.

4. User Input Processing (Frontend):

- The frontend may perform basic preprocessing on the user input, such as removing extra whitespace or formatting.

5. Communication with Backend:

- The frontend communicates with the backend of the web application, where the chatbot logic resides. This communication can happen via HTTP requests or WebSocket connections, depending on the architecture.

6. Backend (Chatbot Logic):

- The backend is responsible for processing user input and generating responses. It contains the chatbot's core logic, which includes:
- Natural Language Processing (NLP): Understanding the user's intent and extracting entities from the input.
- Dialog Management: Maintaining the conversation context, tracking previous messages, and managing the flow of the conversation.
- Response Generation: Generating text or voice responses that are contextually relevant to the user's input.

- Interaction with External Services: If the chatbot needs to access external databases, APIs, or services, this is where the interaction happens.

7. Backend Response:

- The chatbot's backend generates a response based on the user's input and context.

8. Communication with Frontend:

- The backend sends the response back to the frontend using an appropriate protocol (e.g., HTTP or WebSocket).

9. Frontend Rendering:

- The frontend receives the response and renders it in the chat interface, displaying the chatbot's reply to the user.

10. User Interaction Continues: -

- The user can continue the conversation by providing further input, and the process repeats.

11. Context Maintenance: -

- The backend is responsible for maintaining the conversation context, allowing the chatbot to remember and refer to prior messages in a conversation, ensuring a coherent interaction.

12. Data Storage (if necessary): -

- Depending on the chatbot's design, the backend may store conversation history and user data in a database for later reference or analysis.

13. Error Handling: -

- The chatbot should have error-handling mechanisms to deal with cases where it cannot understand the user's input or when errors occur in external service interactions.

This interaction cycle continues as long as the user engages with the chatbot. The chatbot's ability to understand and respond to user input effectively, along with its ability to maintain context, is crucial for providing a seamless and natural user experience.

The specific implementation details, including the choice of programming languages, libraries, and frameworks, may vary based on the design and requirements of the web application and chatbot.

INNOVATIVE TECHNIQUES USED DURING THE DEVELOPMENT:

During the development of chatbots in Python, several innovative techniques and approaches can be applied to enhance the chatbot's functionality, interactivity, and user experience. Here are some innovative techniques and approaches that can be incorporated into chatbot development:

1.Conversational AI and Pre-trained Models:

- Leveraging state-of-the-art pre-trained language models like GPT-3, BERT, or T5 for more natural language understanding and generation.

2.Generative Chatbots:

- Developing chatbots that can generate creative and contextually relevant responses by using deep learning and generative models. These can create engaging and interactive conversations.

3.Multimodal Chatbots:

- Integrating both text and voice interactions, allowing users to communicate with the chatbot through both written messages and spoken language.

4.Personalization:

- Implementing personalization techniques to tailor responses and recommendations to individual users based on their past interactions and preferences.

5.Emotion Detection:

- Integrating sentiment analysis and emotion detection to recognize and respond to users' emotional states, providing empathetic and appropriate responses.

6.Contextual Memory:

- Enhancing the chatbot's ability to maintain context throughout a conversation, allowing it to recall previous messages and respond coherently.

7.Transfer Learning:

- Applying transfer learning techniques to adapt pre-trained models to specific chatbot tasks, reducing the need for extensive training data.

8.Behavior Analysis:

- Analyzing user behavior to gain insights into their preferences, patterns, and conversational history, enabling more personalized and effective interactions.

9.Interactive Learning:

- Implementing reinforcement learning and interactive learning techniques to improve the chatbot's performance over time through user feedback.

10. Dynamic Responses:
    - Creating dynamic and context-aware responses by integrating data from real-time sources, such as live news feeds or weather updates.
11. Knowledge Graphs:
    - Building and utilizing knowledge graphs to enhance the chatbot's understanding of complex topics and relationships between entities.
12. Conversational Flow Control:
    - Implementing advanced conversational flow control techniques that guide users through complex interactions, such as multi-step tasks or decision trees.
13. Content Generation and Summarization:
    - Integrating content generation and summarization techniques to provide users with concise information or to create detailed responses from extensive text.
14. Multi-Language Support:

- Supporting multiple languages and enabling translation capabilities, allowing users to interact with the chatbot in their preferred language.

15. Privacy and Security Measures:
    - Implementing advanced privacy and security features to protect user data and ensure compliance with data protection regulations.
16. Voice Biometrics:
    - Integrating voice biometric recognition for secure authentication and user identification in voice-enabled chatbots.
17. Augmented Reality (AR) Integration:
    - Exploring AR integration for chatbots, allowing them to provide information or guidance in augmented reality environments.
18. Human-Agent Hybrid Chatbots:
    - Combining human agents with chatbots in a seamless manner, where chatbots assist and collaborate with human agents to provide better customer support.

GIVEN DATASET:

Dataset.CSV

CHATBOT IMPLEMENTATION:

- Preparing the Dependencies.
- The right dependencies need to be established before we can create a chatbot.
- Creating and Training the Chatbot.
- Once the dependence has been established, we can build and train our chatbot.

PROGRAM:

In[1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import tensorflow as tf
import keras
from keras.layers import Dense
import json
import re
import string
from sklearn.feature_extraction.text import TfidfVectorizer
import unicodedata
from sklearn.model_selection import train_test_split
```

In[2]:

```
question  =[]
answer = []
with open("../input/simple-dialogs-for-chatbot/dialogs.txt",'r') as f :
    for line in f :
```

```
        line  =  line.split('\t')
        question.append(line[0])
        answer.append(line[1])
print(len(question) == len(answer))
```

True

In[3]:

```
Question[:5]
```

Out[3]:

```
['hi, how are you doing?',
 "i'm fine. how about yourself?",
 "i'm pretty good. thanks for asking.",
 'no problem. so how have you been?',
 "i've been great. what about you?"]
```

In[4]:

```
Answer[:5]
```

Out[4]:

```
["i'm fine. how about yourself?\n",
 "i'm pretty good. thanks for asking.\n",
 'no problem. so how have you been?\n',
 "i've been great. what about you?\n",
 "i've been good. i'm in school right now.\n"]
```

In[5]:

```
answer = [ i.replace("\n","") for i in answer]
```

In[6]:

```
Answer[:5]
```

Out[6]:

```
["i'm fine. how about yourself?",
 "i'm pretty good. thanks for asking.",
 'no problem. so how have you been?',
 "i've been great. what about you?",
 "i've been good. i'm in school right now."]
```

In[7]:

```
data = pd.DataFrame({"question" : question ,"answer":answer})
data.head()
```

	question	answer
0	hi, how are you doing?	i'm fine. how about yourself?
1	i'm fine. how about yourself?	i'm pretty good. thanks for asking
2	i'm pretty good. thanks for asking.	no problem.so how have you been?
3	no problem. so how have you been?	i've been great. what about you?
4	i've been great. what about you?	i've been good.i'm in school right now.

In[8]:

```
def unicode_to_ascii(s):
   return ''.join(c for c in unicodedata.normalize('NFD', s)
     if unicodedata.category(c) != 'Mn')
```

In[9]:

```
def clean_text(text):
   text = unicode_to_ascii(text.lower().strip())
   text = re.sub(r"i'm", "i am", text)
   text = re.sub(r"\r", "", text)
   text = re.sub(r"he's", "he is", text)
   text = re.sub(r"she's", "she is", text)
   text = re.sub(r"it's", "it is", text)
   text = re.sub(r"that's", "that is", text)
   text = re.sub(r"what's", "that is", text)
   text = re.sub(r"where's", "where is", text)
   text = re.sub(r"how's", "how is", text)
   text = re.sub(r"\'ll", " will", text)
   text = re.sub(r"\'ve", " have", text)
   text = re.sub(r"\'re", " are", text)
   text = re.sub(r"\'d", " would", text)
   text = re.sub(r"\'re", " are", text)
   text = re.sub(r"won't", "will not", text)
   text = re.sub(r"can't", "cannot", text)
   text = re.sub(r"n't", " not", text)
   text = re.sub(r"n'", "ng", text)
   text = re.sub(r"'bout", "about", text)
```

```
    text = re.sub(r"'til", "until", text)
    text = re.sub(r"[-()\"#/@;:<>{}`+=~|.!?,]", "", text)
    text = text.translate(str.maketrans('', '', string.punctuation))
    text = re.sub("(\\W)"," ",text)
    text = re.sub('\S*\d\S*\s*','', text)
    text =  "<sos> " +  text + " <eos>"
    return text
```

In[10]:
```
Data["question"][0]
```

Out[10]:
```
'hi, how are you doing?'
```

In[11]:
```
data["question"] = data.question.apply(clean_text)
```

In[12]:
```
Data["question"][0]
```

Out[12]:
```
'<sos> hi how are you doing <eos>'
```

In[13]:
```
data["answer"] = data.answer.apply(clean_text)
```

In[14]:
```
question  = data.question.values.tolist()
answer =  data.answer.values.tolist()
```

In[15]:
```
def tokenize(lang):
    lang_tokenizer = tf.keras.preprocessing.text.Tokenizer(
      filters='')
    lang_tokenizer.fit_on_texts(lang)
    tensor = lang_tokenizer.texts_to_sequences(lang)

    tensor = tf.keras.preprocessing.sequence.pad_sequences(tensor,
                                                           padding='post')
```

```
        return tensor, lang_tokenizer
```

In[16]:
```
input_tensor , inp_lang  =  tokenize(question)
```

In[17]:
```
target_tensor , targ_lang  =  tokenize(answer)
```

In[18]:
```
 #len(inp_question) ==  len(inp_answer)
```

In[19]:
```
def remove_tags(sentence):
    return sentence.split("<start>")[-1].split("<end>")[0]
```

In[20]:
```
max_length_targ, max_length_inp = target_tensor.shape[1],
input_tensor.shape[1]
```

In[21]:
```
# Creating training and validation sets using an 80-20 split
input_tensor_train, input_tensor_val, target_tensor_train, target_tensor_val =
train_test_split(input_tensor, target_tensor, test_size=0.2)
```

In[22]:
```
#print(len(train_inp) , len(val_inp) , len(train_target) , len(val_target))
```

In[23]:
```
BUFFER_SIZE = len(input_tensor_train)
BATCH_SIZE = 64
steps_per_epoch = len(input_tensor_train)//BATCH_SIZE
embedding_dim = 256
units = 1024
vocab_inp_size = len(inp_lang.word_index)+1
vocab_tar_size = len(targ_lang.word_index)+1

dataset = tf.data.Dataset.from_tensor_slices((input_tensor_train,
target_tensor_train)).shuffle(BUFFER_SIZE)
dataset = dataset.batch(BATCH_SIZE, drop_remainder=True)
```

example_input_batch, example_target_batch = next(iter(dataset))
example_input_batch.shape, example_target_batch.shape

2022-10-20 06:33:56.495284:
 I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:56.619975: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:56.620805: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:56.624402: I tensorflow/core/platform/cpu_feature_guard.cc:142] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: AVX2 AVX512F FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
2022-10-20 06:33:56.624816: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:56.625829: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:56.626693: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:59.460823: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero

```
2022-10-20 06:33:59.461762: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be at
least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:59.462456: I
tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful
NUMA node read from SysFS had negative value (-1), but there must be at
least one NUMA node, so returning NUMA node zero
2022-10-20 06:33:59.463056: I
tensorflow/core/common_runtime/gpu/gpu_device.cc:1510] Created device
/job:localhost/replica:0/task:0/device:GPU:0 with 15401 MB memory:  ->
device: 0, name: Tesla P100-PCIE-16GB, pci bus id: 0000:00:04.0, compute
capability: 6.0
```

Out[23]:

```
(TensorShape([64, 22]), TensorShape([64, 22]))
```

In[24]:

```
class Encoder(tf.keras.Model):
  def _init_(self, vocab_size, embedding_dim, enc_units, batch_sz):
    super(Encoder, self)._init_()
    self.batch_sz = batch_sz
    self.enc_units = enc_units
    self.embedding = tf.keras.layers.Embedding(vocab_size,
embedding_dim)
    self.gru = tf.keras.layers.GRU(self.enc_units,
                                   return_sequences=True,
                                   return_state=True,
                                   recurrent_initializer='glorot_uniform')

  def call(self, x,hidden):
    x = self.embedding(x)
    output, state = self.gru(x, initial_state = hidden)
    return output, state

  def initialize_hidden_state(self):
    return tf.zeros((self.batch_sz, self.enc_units))
```

In[25]:

```
encoder = Encoder(vocab_inp_size, embedding_dim, units, BATCH_SIZE)
```

```
# sample input
sample_hidden = encoder.initialize_hidden_state()
sample_output, sample_hidden = encoder(example_input_batch,
sample_hidden)
print ('Encoder output shape: (batch size, sequence length, units)
{}'.format(sample_output.shape))
print ('Encoder Hidden state shape: (batch size, units)
{}'.format(sample_hidden.shape))
```

```
2022-10-20 06:34:00.854919: I
tensorflow/stream_executor/cuda/cuda_dnn.cc:369] Loaded cuDNN version
8005

Encoder output shape: (batch size, sequence length, units) (64, 22, 1024)
Encoder Hidden state shape: (batch size, units) (64, 1024)
```

In[26]:

```
class BahdanauAttention(tf.keras.layers.Layer):
  def _init_(self, units):
    super(BahdanauAttention, self)._init_()
    self.W1 = tf.keras.layers.Dense(units)
    self.W2 = tf.keras.layers.Dense(units)
    self.V = tf.keras.layers.Dense(1)

  def call(self, query, values):
    # query hidden state shape == (batch_size, hidden size)
    # query_with_time_axis shape == (batch_size, 1, hidden size)
    # values shape == (batch_size, max_len, hidden size)
    # we are doing this to broadcast addition along the time axis to calculate
the score
    query_with_time_axis = tf.expand_dims(query, 1)

    # score shape == (batch_size, max_length, 1)
    # we get 1 at the last axis because we are applying score to self.V
    # the shape of the tensor before applying self.V is (batch_size,
max_length, units)
    score = self.V(tf.nn.tanh(
      self.W1(query_with_time_axis) + self.W2(values)))
```

```
        # attention_weights shape == (batch_size, max_length, 1)
        attention_weights = tf.nn.softmax(score, axis=1)

        # context_vector shape after sum == (batch_size, hidden_size)
        context_vector = attention_weights * values
        context_vector = tf.reduce_sum(context_vector, axis=1)

        return context_vector, attention_weights
```

In[27]:

```
attention_layer = BahdanauAttention(10)
attention_result, attention_weights = attention_layer(sample_hidden,
sample_output)

print("Attention result shape: (batch size, units)
{}".format(attention_result.shape))
print("Attention weights shape: (batch_size, sequence_length, 1)
{}".format(attention_weights.shape))
Attention result shape: (batch size, units) (64, 1024)
Attention weights shape: (batch_size, sequence_length, 1) (64, 22, 1)
```

In[28]:

```
class Decoder(tf.keras.Model):
    def _init_(self, vocab_size, embedding_dim, dec_units, batch_sz):
        super(Decoder, self)._init_()
        self.batch_sz = batch_sz
        self.dec_units = dec_units
        self.embedding = tf.keras.layers.Embedding(vocab_size,
embedding_dim)
        self.gru = tf.keras.layers.GRU(self.dec_units,
                                       return_sequences=True,
                                       return_state=True,
                                       recurrent_initializer='glorot_uniform')
        self.fc = tf.keras.layers.Dense(vocab_size)

        # used for attention
        self.attention = BahdanauAttention(self.dec_units)

    def call(self, x, hidden, enc_output):
        # enc_output shape == (batch_size, max_length, hidden_size)
```

```
        context_vector, attention_weights = self.attention(hidden, enc_output)

        # x shape after passing through embedding == (batch_size, 1,
embedding_dim)
        x = self.embedding(x)

        # x shape after concatenation == (batch_size, 1, embedding_dim +
hidden_size)
        x = tf.concat([tf.expand_dims(context_vector, 1), x], axis=-1)

        # passing the concatenated vector to the GRU
        output, state = self.gru(x)

        # output shape == (batch_size * 1, hidden_size)
        output = tf.reshape(output, (-1, output.shape[2]))

        # output shape == (batch_size, vocab)
        x = self.fc(output)

        return x, state, attention_weights
```

In[29]:

```
decoder = Decoder(vocab_tar_size, embedding_dim, units, BATCH_SIZE)

sample_decoder_output, _, _ = decoder(tf.random.uniform((BATCH_SIZE, 1)),
                                      sample_hidden, sample_output)

print ('Decoder output shape: (batch_size, vocab size)
{}'.format(sample_decoder_output.shape))
```

Decoder output shape: (batch_size, vocab size) (64, 2347)

In[30]:

```
optimizer = tf.keras.optimizers.Adam()
loss_object = tf.keras.losses.SparseCategoricalCrossentropy(
    from_logits=True, reduction='none')

def loss_function(real, pred):
    mask = tf.math.logical_not(tf.math.equal(real, 0))
    loss_ = loss_object(real, pred)
```

```
    mask = tf.cast(mask, dtype=loss_.dtype)
    loss_ *= mask

    return tf.reduce_mean(loss_)
```

In[31]:

```
@tf.function
def train_step(inp, targ, enc_hidden):
    loss = 0

    with tf.GradientTape() as tape:
        enc_output, enc_hidden = encoder(inp, enc_hidden)

        dec_hidden = enc_hidden

        dec_input = tf.expand_dims([targ_lang.word_index['<sos>']] *
BATCH_SIZE, 1)

        # Teacher forcing - feeding the target as the next input
        for t in range(1, targ.shape[1]):
            # passing enc_output to the decoder
            predictions, dec_hidden, _ = decoder(dec_input, dec_hidden,
enc_output)

            loss += loss_function(targ[:, t], predictions)

            # using teacher forcing
            dec_input = tf.expand_dims(targ[:, t], 1)

    batch_loss = (loss / int(targ.shape[1]))

    variables = encoder.trainable_variables + decoder.trainable_variables

    gradients = tape.gradient(loss, variables)

    optimizer.apply_gradients(zip(gradients, variables))

    return batch_loss
```

In[32]:
```
EPOCHS = 40

for epoch in range(1, EPOCHS + 1):
    enc_hidden = encoder.initialize_hidden_state()
    total_loss = 0

    for (batch, (inp, targ)) in enumerate(dataset.take(steps_per_epoch)):
        batch_loss = train_step(inp, targ, enc_hidden)
        total_loss += batch_loss

    if(epoch % 4 == 0):
        print('Epoch:{:3d} Loss:{:.4f}'.format(epoch,
                                          total_loss / steps_per_epoch))
```

```
2022-10-20 06:34:22.115124: I
tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:185] None of the
MLIR Optimization Passes are enabled (registered 2)

Epoch:  4 Loss:1.5734
Epoch:  8 Loss:1.3385
Epoch: 12 Loss:1.1549
Epoch: 16 Loss:0.9987
Epoch: 20 Loss:0.8251
Epoch: 24 Loss:0.6379
Epoch: 28 Loss:0.4403
Epoch: 32 Loss:0.2550
Epoch: 36 Loss:0.1160
Epoch: 40 Loss:0.0544
```

In[33]:
```
def evaluate(sentence):
    sentence = clean_text(sentence)

    inputs = [inp_lang.word_index[i] for i in sentence.split(' ')]
    inputs = tf.keras.preprocessing.sequence.pad_sequences([inputs],
                                                        maxlen=max_length_inp,
                                                        padding='post')
    inputs = tf.convert_to_tensor(inputs)
```

```
    result = ''

    hidden = [tf.zeros((1, units))]
    enc_out, enc_hidden = encoder(inputs, hidden)

    dec_hidden = enc_hidden
    dec_input = tf.expand_dims([targ_lang.word_index['<sos>']], 0)

    for t in range(max_length_targ):
        predictions, dec_hidden, attention_weights = decoder(dec_input,
                                                             dec_hidden,
                                                             enc_out)

        # storing the attention weights to plot later on
        attention_weights = tf.reshape(attention_weights, (-1, ))

        predicted_id = tf.argmax(predictions[0]).numpy()

        result += targ_lang.index_word[predicted_id] + ' '

        if targ_lang.index_word[predicted_id] == '<eos>':
            return remove_tags(result), remove_tags(sentence)

        # the predicted ID is fed back into the model
        dec_input = tf.expand_dims([predicted_id], 0)

    return remove_tags(result), remove_tags(sentence)
```

In[34]:

```
questions  =[]
answers = []
with open("../input/simple-dialogs-for-chatbot/dialogs.txt",'r') as f :
    for line in f :
        line  =  line.split('\t')
        questions.append(line[0])
        answers.append(line[1])
print(len(question) == len(answer))
```

True

In[35]:

```
def ask(sentence):
    result, sentence = evaluate(sentence)
    print('Question: %s' % (sentence))
    print('Predicted answer: {}'.format(result))
ask(questions[100])
```

Out[35]:

```
Question: <sos> i believe so <eos>
Predicted answer: good good you are hot <eos>
```

In[36]:

```
ask(questions[50])
```

```
Question: <sos> i wish it would cool off one day <eos>
Predicted answer: that is how i feel i want winter to come soon <eos>
```

In[37]:

```
print(answers[50])
```

```
that's how i feel, i want winter to come soon.
```

CHATBOT WEB APPLICATION:

- Creating a chatbot web application involves combining web development and chatbot development to offer a chatbot interface within a web application.
- A chatbot is software that simulates human-like conversations with users via chat. Its key task is to answer user questions with instant messages.

PROGRAM:

In[1]:

```
import tensorflow as tf
import numpy as np
```

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from tensorflow.keras.layers import TextVectorization
import re,string
from tensorflow.keras.layers import
LSTM,Dense,Embedding,Dropout,LayerNormalization
```

In[2]:

```
df=pd.read_csv('/kaggle/input/simple-dialogs-for-chatbot/dialogs.txt',s
ep='\t',names=['question','answer'])
print(f'Dataframe size: {len(df)}')
df.head()
```

```
Dataframe size: 3725
```

Out[2]:

	question	answer
0	hi, how are you doing?	i'm fine. how about yourself?
1	i'm fine. how about yourself?	i'm pretty good. thanks for asking.
2	i'm pretty good. thanks for asking.	no problem. so how have you been?
3	no problem. so how have you been?	i've been great. what about you?

4	i've been great. what about you?	i've been good. i'm in school right now.

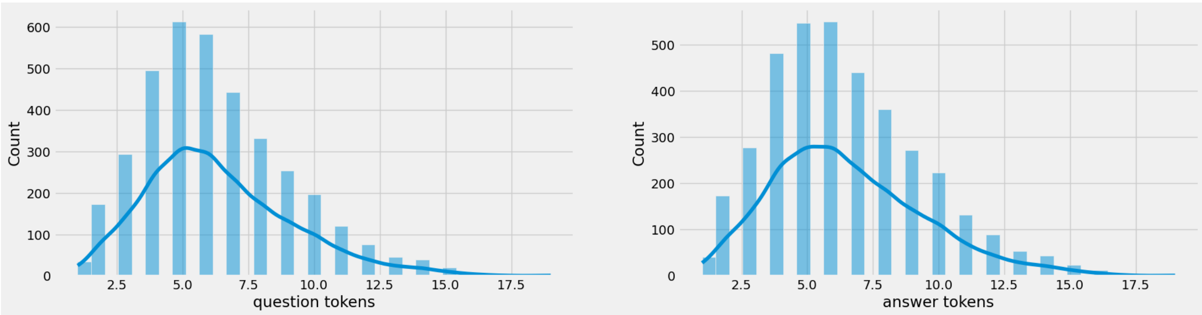
Data Preprocessing:

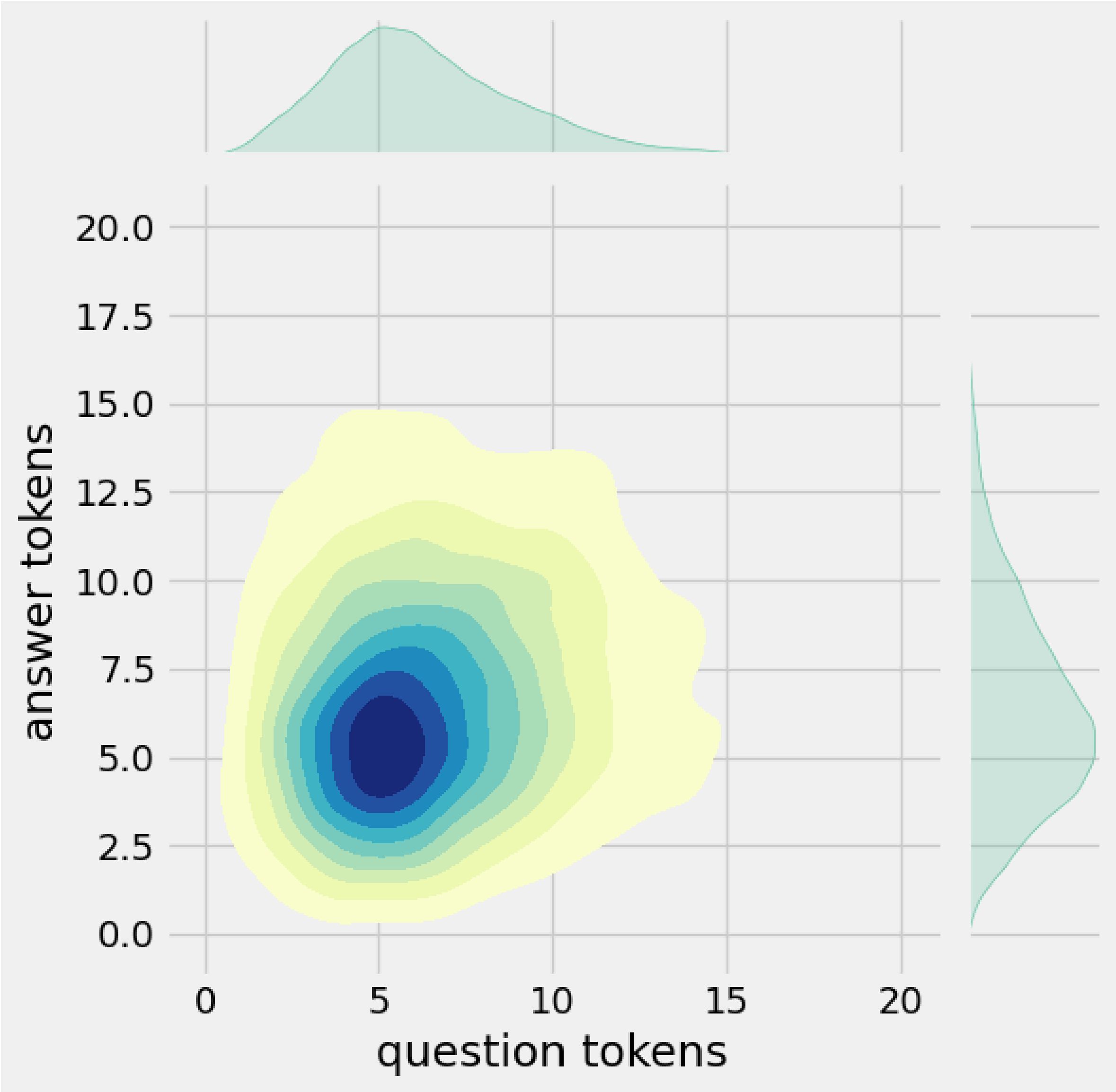
Data Visualization:

In[3]:

```
df['question tokens']=df['question'].apply(lambda x:len(x.split()))
df['answer tokens']=df['answer'].apply(lambda x:len(x.split()))
plt.style.use('fivethirtyeight')
fig,ax=plt.subplots(nrows=1,ncols=2,figsize=(20,5))
sns.set_palette('Set2')
sns.histplot(x=df['question tokens'],data=df,kde=True,ax=ax[0])
sns.histplot(x=df['answer tokens'],data=df,kde=True,ax=ax[1])
sns.jointplot(x='question tokens',y='answer
tokens',data=df,kind='kde',fill=True,cmap='YlGnBu')
plt.show()
```

Out[3]:





Text Cleaning:

In[4]:

```
def clean_text(text):
    text=re.sub('-',' ',text.lower())
    text=re.sub('[.]',' . ',text)
    text=re.sub('[1]',' 1 ',text)
    text=re.sub('[2]',' 2 ',text)
    text=re.sub('[3]',' 3 ',text)
    text=re.sub('[4]',' 4 ',text)
    text=re.sub('[5]',' 5 ',text)
    text=re.sub('[6]',' 6 ',text)
    text=re.sub('[7]',' 7 ',text)
    text=re.sub('[8]',' 8 ',text)
```

```
    text=re.sub('[9]',' 9 ',text)
    text=re.sub('[0]',' 0 ',text)
    text=re.sub('[,]',' , ',text)
    text=re.sub('[?]',' ? ',text)
    text=re.sub('[!]',' ! ',text)
    text=re.sub('[$]',' $ ',text)
    text=re.sub('[&]',' & ',text)
    text=re.sub('[/]',' / ',text)
    text=re.sub('[:]',' : ',text)
    text=re.sub('[;]',' ; ',text)
    text=re.sub('[*]',' * ',text)
    text=re.sub('[\']',' \' ',text)
    text=re.sub('[\"]',' \" ',text)
    text=re.sub('\t',' ',text)
    return text

df.drop(columns=['answer tokens','question
tokens'],axis=1,inplace=True)
df['encoder_inputs']=df['question'].apply(clean_text)
df['decoder_targets']=df['answer'].apply(clean_text)+' <end>'
df['decoder_inputs']='<start> '+df['answer'].apply(clean_text)+' <end>'

df.head(10)
```

Out[4]:

	question	answer	encoder_inputs	decoder_targets	decoder_inputs
0	hi, how are you doing?	i'm fine. how about yourself?	hi , how are you doing ?	i ' m fine . how about yourself ? <end>	<start> i ' m fine . how about yourself ? <end>
1	i'm fine. how about yourself?	i'm pretty good. thanks for asking.	i ' m fine . how about yourself ?	i ' m pretty good . thanks for asking . <end>	<start> i ' m pretty good . thanks for asking...

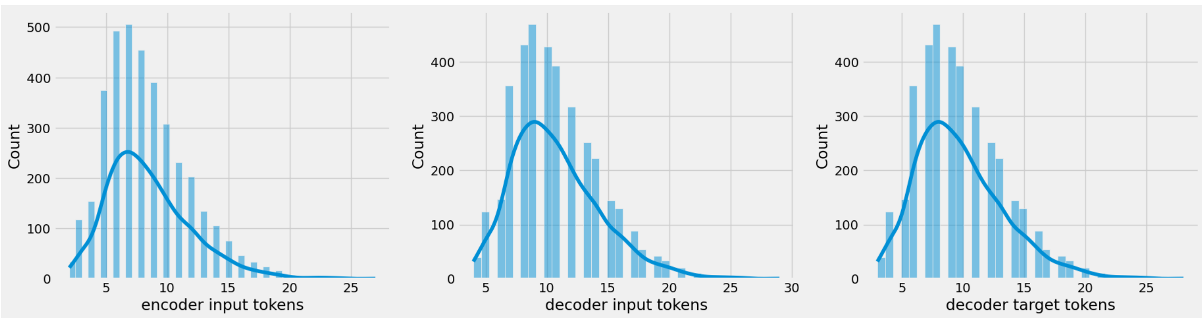
2	i'm pretty good. thanks for asking.	no problem. so how have you been?	i ' m pretty good . thanks for asking .	no problem . so how have you been ? <end>	<start> no problem . so how have you been ? ...
3	no problem. so how have you been?	i've been great. what about you?	no problem . so how have you been ?	i ' ve been great . what about you ? <end>	<start> i ' ve been great . what about you ? ...
4	i've been great. what about you?	i've been good. i'm in school right now.	i ' ve been great . what about you ?	i ' ve been good . i ' m in school right now ...	<start> i ' ve been good . i ' m in school ri...
5	i've been good. i'm in school right now.	what school do you go to?	i ' ve been good . i ' m in school right now .	what school do you go to ? <end>	<start> what school do you go to ? <end>
6	what school do you go to?	i go to pcc.	what school do you go to ?	i go to pcc . <end>	<start> i go to pcc . <end>
7	i go to pcc.	do you like it there?	i go to pcc .	do you like it there ? <end>	<start> do you like it there ? <end>
8	do you like it there?	it's okay. it's a really big campus.	do you like it there ?	it ' s okay . it ' s a really big campus . <...	<start> it ' s okay . it ' s a really big cam...

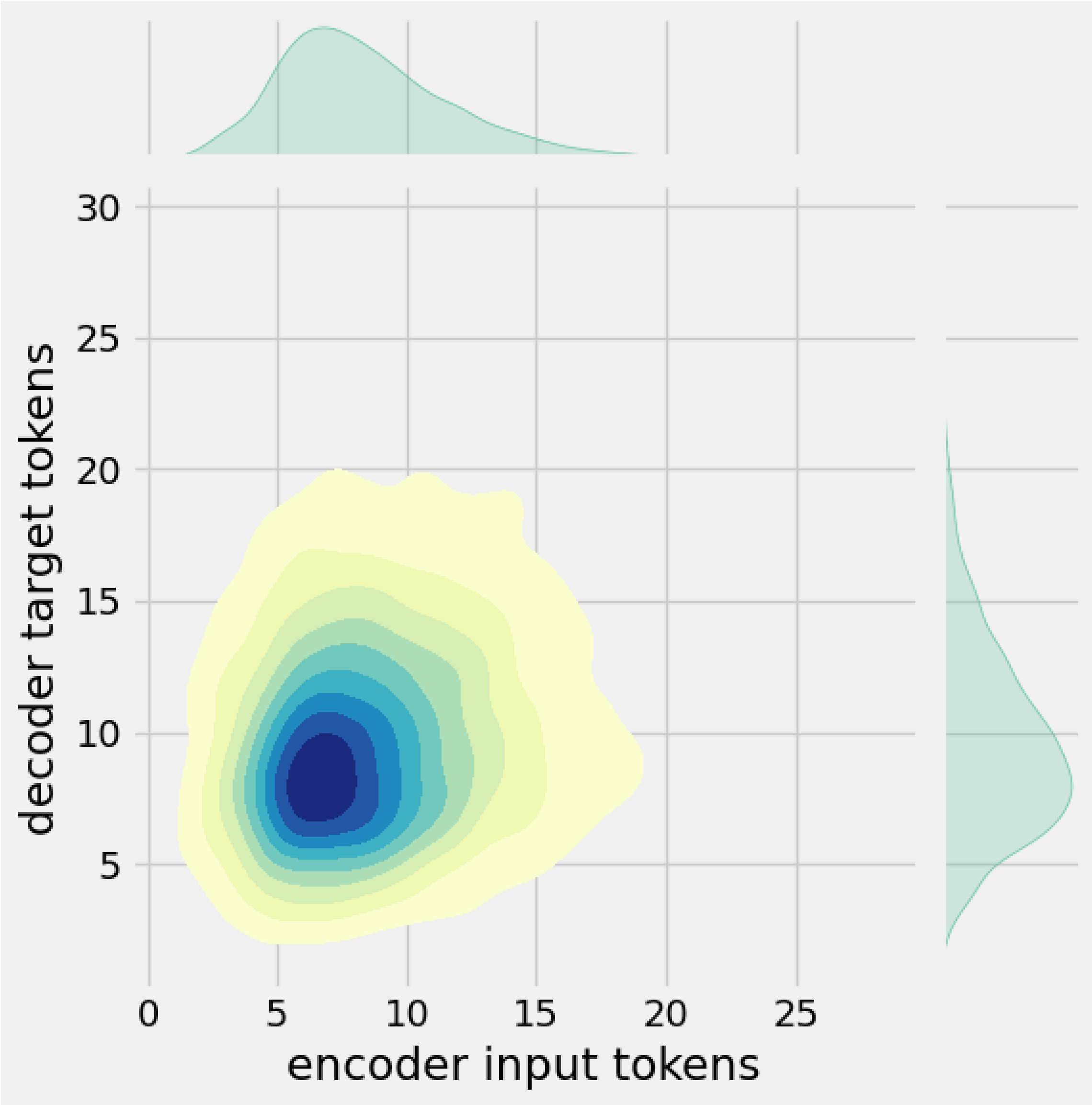
9	it's okay. it's a really big campus.	good luck with school.	it ' s okay . it ' s a really big campus .	good luck with school . <end>	<start> good luck with school . <end>

In[5]:

```
df['encoder input tokens']=df['encoder_inputs'].apply(lambda
x:len(x.split()))
df['decoder input tokens']=df['decoder_inputs'].apply(lambda
x:len(x.split()))
df['decoder target tokens']=df['decoder_targets'].apply(lambda
x:len(x.split()))
plt.style.use('fivethirtyeight')
fig,ax=plt.subplots(nrows=1,ncols=3,figsize=(20,5))
sns.set_palette('Set2')
sns.histplot(x=df['encoder input tokens'],data=df,kde=True,ax=ax[0])
sns.histplot(x=df['decoder input tokens'],data=df,kde=True,ax=ax[1])
sns.histplot(x=df['decoder target tokens'],data=df,kde=True,ax=ax[2])
sns.jointplot(x='encoder input tokens',y='decoder target
tokens',data=df,kind='kde',fill=True,cmap='YlGnBu')
plt.show()
```

Out[5]:





In[6]:

```
print(f"After preprocessing: {' '.join(df[df['encoder input
tokens'].max()==df['encoder input
tokens']]['encoder_inputs'].values.tolist())}")
print(f"Max encoder input length: {df['encoder input tokens'].max()}")
print(f"Max decoder input length: {df['decoder input tokens'].max()}")
print(f"Max decoder target length: {df['decoder target
tokens'].max()}")

df.drop(columns=['question','answer','encoder input tokens','decoder
input tokens','decoder target tokens'],axis=1,inplace=True)
params={
    "vocab_size":2500,
    "max_sequence_length":30,
```

```
    "learning_rate":0.008,
    "batch_size":149,
    "lstm_cells":256,
    "embedding_dim":256,
    "buffer_size":10000
}
learning_rate=params['learning_rate']
batch_size=params['batch_size']
embedding_dim=params['embedding_dim']
lstm_cells=params['lstm_cells']
vocab_size=params['vocab_size']
buffer_size=params['buffer_size']
max_sequence_length=params['max_sequence_length']
df.head(10)
```

```
After preprocessing: for example ,  if your birth date is january  1  2
,  1  9  8  7  ,  write  0  1  /  1  2  /  8  7  .
Max encoder input length: 27
Max decoder input length: 29
Max decoder target length: 28
```

Out[6]:

	encoder_inputs	decoder_targets	decoder_inputs
0	hi , how are you doing ?	i ' m fine . how about yourself ? <end>	<start> i ' m fine . how about yourself ? <end>
1	i ' m fine . how about yourself ?	i ' m pretty good . thanks for asking . <end>	<start> i ' m pretty good . thanks for asking...
2	i ' m pretty good . thanks for asking .	no problem . so how have you been ? <end>	<start> no problem . so how have you been ? ...

3	no problem . so how have you been ?	i ' ve been great . what about you ? <end>	<start> i ' ve been great . what about you ? ...
4	i ' ve been great . what about you ?	i ' ve been good . i ' m in school right now ...	<start> i ' ve been good . i ' m in school ri...
5	i ' ve been good . i ' m in school right now .	what school do you go to ? <end>	<start> what school do you go to ? <end>
6	what school do you go to ?	i go to pcc . <end>	<start> i go to pcc . <end>
7	i go to pcc .	do you like it there ? <end>	<start> do you like it there ? <end>
8	do you like it there ?	it ' s okay . it ' s a really big campus . <...	<start> it ' s okay . it ' s a really big cam...
9	it ' s okay . it ' s a really big campus .	good luck with school . <end>	<start> good luck with school . <end>

Tokenization:

In[7]:

```
vectorize_layer=TextVectorization(

    max_tokens=vocab_size,
    standardize=None,
    output_mode='int',
    output_sequence_length=max_sequence_length
```

```
)
vectorize_layer.adapt(df['encoder_inputs']+' '+df['decoder_targets']+'
<start> <end>')
vocab_size=len(vectorize_layer.get_vocabulary())
print(f'Vocab size: {len(vectorize_layer.get_vocabulary())}')
print(f'{vectorize_layer.get_vocabulary()[:12]}')
Vocab size: 2443
['', '[UNK]', '<end>', '.', '<start>', "'", 'i', '?', 'you', ',',
'the', 'to']
```

In[8]:

```
def sequences2ids(sequence):
    return vectorize_layer(sequence)

def ids2sequences(ids):
    decode=''
    if type(ids)==int:
        ids=[ids]
    for id in ids:
        decode+=vectorize_layer.get_vocabulary()[id]+' '
    return decode

x=sequences2ids(df['encoder_inputs'])
yd=sequences2ids(df['decoder_inputs'])
y=sequences2ids(df['decoder_targets'])

print(f'Question sentence: hi , how are you ?')
print(f'Question to tokens: {sequences2ids("hi , how are you
?")[:10]}')
print(f'Encoder input shape: {x.shape}')
print(f'Decoder input shape: {yd.shape}')
print(f'Decoder target shape: {y.shape}')
```

Out[8]:

```
Question sentence: hi , how are you ?
Question to tokens: [1971    9   45   24    8    7    0    0    0    0]
Encoder input shape: (3725, 30)
Decoder input shape: (3725, 30)
Decoder target shape: (3725, 30)
```

In[9]:

```
print(f'Encoder input: {x[0][:12]} ...')
```

```python
print(f'Decoder input: {yd[0][:12]} ...')    # shifted by one time step of the target as input to decoder is the output of the previous timestep
print(f'Decoder target: {y[0][:12]} ...')
```

Out[9]:

```
Encoder input: [1971    9   45   24    8  194    7    0    0    0    0
0] ...
Decoder input: [  4   6   5  38 646   3  45  41 563   7   2   0] ...
Decoder target: [  6   5  38 646   3  45  41 563   7   2   0   0] ...
```

In[10]:

```python
data=tf.data.Dataset.from_tensor_slices((x,yd,y))
data=data.shuffle(buffer_size)

train_data=data.take(int(.9*len(data)))
train_data=train_data.cache()
train_data=train_data.shuffle(buffer_size)
train_data=train_data.batch(batch_size)
train_data=train_data.prefetch(tf.data.AUTOTUNE)
train_data_iterator=train_data.as_numpy_iterator()

val_data=data.skip(int(.9*len(data))).take(int(.1*len(data)))
val_data=val_data.batch(batch_size)
val_data=val_data.prefetch(tf.data.AUTOTUNE)

_=train_data_iterator.next()
print(f'Number of train batches: {len(train_data)}')
print(f'Number of training data: {len(train_data)*batch_size}')
print(f'Number of validation batches: {len(val_data)}')
print(f'Number of validation data: {len(val_data)*batch_size}')
print(f'Encoder Input shape (with batches): {_[0].shape}')
print(f'Decoder Input shape (with batches): {_[1].shape}')
print(f'Target Output shape (with batches): {_[2].shape}')
```

Out[10]:

```
Number of train batches: 23
Number of training data: 3427
Number of validation batches: 3
Number of validation data: 447
Encoder Input shape (with batches): (149, 30)
Decoder Input shape (with batches): (149, 30)
Target Output shape (with batches): (149, 30)
```

Build Models:

Build Encoder:

In[11]:

```
class Encoder(tf.keras.models.Model):
    def __init__(self,units,embedding_dim,vocab_size,*args,**kwargs) ->
None:
        super().__init__(*args,**kwargs)
        self.units=units
        self.vocab_size=vocab_size
        self.embedding_dim=embedding_dim
        self.embedding=Embedding(
            vocab_size,
            embedding_dim,
            name='encoder_embedding',
            mask_zero=True,
            embeddings_initializer=tf.keras.initializers.GlorotNormal()
        )
        self.normalize=LayerNormalization()
        self.lstm=LSTM(
            units,
            dropout=.4,
            return_state=True,
            return_sequences=True,
            name='encoder_lstm',
            kernel_initializer=tf.keras.initializers.GlorotNormal()
        )

    def call(self,encoder_inputs):
        self.inputs=encoder_inputs
        x=self.embedding(encoder_inputs)
        x=self.normalize(x)
        x=Dropout(.4)(x)
        encoder_outputs,encoder_state_h,encoder_state_c=self.lstm(x)
        self.outputs=[encoder_state_h,encoder_state_c]
        return encoder_state_h,encoder_state_c

encoder=Encoder(lstm_cells,embedding_dim,vocab_size,name='encoder')
encoder.call(_[0])
```

Out[11]:

```
(<tf.Tensor: shape=(149, 256), dtype=float32, numpy=
 array([[ 0.16966951, -0.10419625, -0.12700348, ..., -0.12251794,
          0.10568858,  0.14841646],
        [ 0.08443093,  0.08849293, -0.09065959, ..., -0.00959182,
          0.10152507, -0.12077457],
        [ 0.03628462, -0.02653611, -0.11506603, ..., -0.14669597,
          0.10292757,  0.13625325],
        ...,
        [-0.14210635, -0.12942064, -0.03288083, ...,  0.0568463 ,
         -0.02598592, -0.22455114],
        [ 0.20819993,  0.01196991, -0.09635217, ..., -0.18782297,
          0.10233591,  0.20114912],
        [ 0.1164271 , -0.07769038, -0.06414707, ..., -0.06539135,
         -0.05518465,  0.25142196]], dtype=float32)>,
 <tf.Tensor: shape=(149, 256), dtype=float32, numpy=
 array([[ 0.34589   , -0.30134732, -0.43572   , ..., -0.3102559 ,
          0.34630865,  0.2613009 ],
        [ 0.14154069,  0.17045322, -0.17749965, ..., -0.02712595,
          0.17292541, -0.2922624 ],
        [ 0.07106856, -0.0739173 , -0.3641197 , ..., -0.3794833 ,
          0.36470377,  0.23766585],
        ...,
        [-0.2582597 , -0.25323495, -0.06649272, ...,  0.16527973,
         -0.04292646, -0.58768904],
        [ 0.43155715,  0.03135502, -0.33463806, ..., -0.47625306,
          0.33486888,  0.35035062],
        [ 0.23173636, -0.20141824, -0.22034441, ..., -0.16035017,

         -0.17478186,  0.48899865]], dtype=float32)>)
```

Build Encoder## Build Decoder

In[12]:

```python
class Decoder(tf.keras.models.Model):
    def __init__(self,units,embedding_dim,vocab_size,*args,**kwargs) ->
None:
        super().__init__(*args,**kwargs)
        self.units=units
        self.embedding_dim=embedding_dim
        self.vocab_size=vocab_size
        self.embedding=Embedding(
```

```
            vocab_size,
            embedding_dim,
            name='decoder_embedding',
            mask_zero=True,
            embeddings_initializer=tf.keras.initializers.HeNormal()
        )
        self.normalize=LayerNormalization()
        self.lstm=LSTM(
            units,
            dropout=.4,
            return_state=True,
            return_sequences=True,
            name='decoder_lstm',
            kernel_initializer=tf.keras.initializers.HeNormal()
        )
        self.fc=Dense(
            vocab_size,
            activation='softmax',
            name='decoder_dense',
            kernel_initializer=tf.keras.initializers.HeNormal()
        )

    def call(self,decoder_inputs,encoder_states):
        x=self.embedding(decoder_inputs)
        x=self.normalize(x)
        x=Dropout(.4)(x)

x,decoder_state_h,decoder_state_c=self.lstm(x,initial_state=encoder_sta
tes)
        x=self.normalize(x)
        x=Dropout(.4)(x)
        return self.fc(x)

decoder=Decoder(lstm_cells,embedding_dim,vocab_size,name='decoder')
decoder(_[1][:1],encoder(_[0][:1]))
```

Out[12]:

```
<tf.Tensor: shape=(1, 30, 2443), dtype=float32, numpy=
array([[[3.4059247e-04, 5.7348556e-05, 2.1294907e-05, ...,
         7.2067953e-05, 1.5453645e-03, 2.3599296e-04],
        [1.4662130e-03, 8.0250365e-06, 5.4062020e-05, ...,
         1.9187471e-05, 9.7244098e-05, 7.6433855e-05],
        [9.6929165e-05, 2.7441782e-05, 1.3761305e-03, ...,
```

```
         3.6009602e-05, 1.5537882e-04, 1.8397317e-04],
        ...,
        [1.9002777e-03, 6.9266016e-04, 1.4346189e-04, ...,
         1.9552530e-04, 1.7106640e-05, 1.0252406e-04],
        [1.9002777e-03, 6.9266016e-04, 1.4346189e-04, ...,
         1.9552530e-04, 1.7106640e-05, 1.0252406e-04],
        [1.9002777e-03, 6.9266016e-04, 1.4346189e-04, ...,

         1.9552530e-04, 1.7106640e-05, 1.0252406e-04]]],
dtype=float32)>
```

Build Training Mode:

In[13]:

```python
class ChatBotTrainer(tf.keras.models.Model):
    def __init__(self,encoder,decoder,*args,**kwargs):
        super().__init__(*args,**kwargs)
        self.encoder=encoder
        self.decoder=decoder

    def loss_fn(self,y_true,y_pred):
        loss=self.loss(y_true,y_pred)
        mask=tf.math.logical_not(tf.math.equal(y_true,0))
        mask=tf.cast(mask,dtype=loss.dtype)
        loss*=mask
        return tf.reduce_mean(loss)

    def accuracy_fn(self,y_true,y_pred):
        pred_values = tf.cast(tf.argmax(y_pred, axis=-1),
dtype='int64')
        correct = tf.cast(tf.equal(y_true, pred_values),
dtype='float64')
        mask = tf.cast(tf.greater(y_true, 0), dtype='float64')
        n_correct = tf.keras.backend.sum(mask * correct)
        n_total = tf.keras.backend.sum(mask)
        return n_correct / n_total

    def call(self,inputs):
        encoder_inputs,decoder_inputs=inputs
        encoder_states=self.encoder(encoder_inputs)
        return self.decoder(decoder_inputs,encoder_states)
```

```
    def train_step(self,batch):
        encoder_inputs,decoder_inputs,y=batch
        with tf.GradientTape() as tape:
            encoder_states=self.encoder(encoder_inputs,training=True)

y_pred=self.decoder(decoder_inputs,encoder_states,training=True)
            loss=self.loss_fn(y,y_pred)
            acc=self.accuracy_fn(y,y_pred)


variables=self.encoder.trainable_variables+self.decoder.trainable_varia
bles
        grads=tape.gradient(loss,variables)
        self.optimizer.apply_gradients(zip(grads,variables))
        metrics={'loss':loss,'accuracy':acc}
        return metrics

    def test_step(self,batch):
        encoder_inputs,decoder_inputs,y=batch
        encoder_states=self.encoder(encoder_inputs,training=True)

y_pred=self.decoder(decoder_inputs,encoder_states,training=True)
        loss=self.loss_fn(y,y_pred)
        acc=self.accuracy_fn(y,y_pred)
        metrics={'loss':loss,'accuracy':acc}
        return metrics
```

In[14]:

```
model=ChatBotTrainer(encoder,decoder,name='chatbot_trainer')
model.compile(
    loss=tf.keras.losses.SparseCategoricalCrossentropy(),
    optimizer=tf.keras.optimizers.Adam(learning_rate=learning_rate),
    weighted_metrics=['loss','accuracy']
)
model(_[:2])
```

Out[14]:

```
<tf.Tensor: shape=(149, 30, 2443), dtype=float32, numpy=
array([[[3.40592262e-04, 5.73484940e-05, 2.12948853e-05, ...,
         7.20679745e-05, 1.54536311e-03, 2.35993255e-04],
        [1.46621116e-03, 8.02504110e-06, 5.40619949e-05, ...,
         1.91874733e-05, 9.72440175e-05, 7.64339056e-05],
        [9.69291723e-05, 2.74417835e-05, 1.37613132e-03, ...,
```

```
         3.60095728e-05, 1.55378671e-04, 1.83973272e-04],
        ...,
        [1.90027885e-03, 6.92659756e-04, 1.43461803e-04, ...,
         1.95525470e-04, 1.71066222e-05, 1.02524005e-04],
        [1.90027885e-03, 6.92659756e-04, 1.43461803e-04, ...,
         1.95525470e-04, 1.71066222e-05, 1.02524005e-04],
        [1.90027885e-03, 6.92659756e-04, 1.43461803e-04, ...,
         1.95525470e-04, 1.71066222e-05, 1.02524005e-04]],

       [[9.24730921e-05, 3.46553512e-04, 2.07866033e-05, ...,
         3.65934626e-04, 7.63039337e-04, 5.52638434e-04],
        [8.46863186e-05, 3.65541164e-05, 2.54740953e-05, ...,
         7.12379551e-05, 3.62201303e-04, 4.16714087e-04],
        [2.30146630e-04, 3.91469621e-06, 2.72463716e-04, ...,
         9.26126595e-05, 1.03836363e-04, 1.40792166e-04],
        ...,
        [6.84961735e-04, 9.07644513e-04, 2.86691647e-04, ...,
         3.87946144e-04, 6.09236558e-05, 1.12995331e-05],
        [6.84961735e-04, 9.07644513e-04, 2.86691647e-04, ...,
         3.87946144e-04, 6.09236558e-05, 1.12995331e-05],
        [6.84961735e-04, 9.07644513e-04, 2.86691647e-04, ...,
         3.87946144e-04, 6.09236558e-05, 1.12995322e-05]],

       [[1.19036995e-03, 8.10516722e-05, 2.42324077e-05, ...,
         4.99442758e-05, 6.67208573e-04, 9.55566764e-04],
        [1.53046989e-04, 9.76863957e-05, 4.96972689e-06, ...,
         3.24743196e-05, 2.12563842e-04, 1.18708890e-03],
        [9.40205529e-04, 1.80782794e-04, 7.26205144e-06, ...,
         1.96355060e-04, 8.16940737e-05, 1.38416886e-03],
        ...,
        [3.52622545e-03, 1.26781175e-03, 1.02695449e-04, ...,
         2.35450850e-03, 3.25187625e-06, 9.46984728e-05],
        [3.52622545e-03, 1.26781175e-03, 1.02695449e-04, ...,
         2.35450850e-03, 3.25187625e-06, 9.46984728e-05],
        [3.52622545e-03, 1.26781175e-03, 1.02695449e-04, ...,
         2.35450850e-03, 3.25187625e-06, 9.46984728e-05]],

       ...,

       [[9.03617911e-05, 1.57651404e-04, 1.02747028e-04, ...,
         2.20922651e-04, 3.61504179e-04, 2.32456136e-03],
        [1.55469708e-04, 1.53608169e-04, 1.14945491e-04, ...,
         1.88878359e-04, 5.11967926e-04, 5.13108505e-04],
```

```
         [8.27641197e-05, 2.83437112e-05, 6.29429938e-04, ...,
          2.15980137e-04, 3.02832137e-04, 1.77760507e-04],
         ...,
         [2.41102395e-03, 1.29279669e-03, 9.11735406e-05, ...,
          4.06600971e-04, 7.58682154e-06, 6.05909081e-05],
         [2.41102395e-03, 1.29279669e-03, 9.11735406e-05, ...,
          4.06600971e-04, 7.58682154e-06, 6.05909081e-05],
         [2.41102395e-03, 1.29279669e-03, 9.11735406e-05, ...,
          4.06600971e-04, 7.58682154e-06, 6.05909081e-05]],

        [[3.99837241e-04, 2.36026899e-05, 6.89777007e-05, ...,
          5.94239136e-05, 4.32556757e-04, 4.60232928e-04],
         [3.88111075e-04, 8.31133584e-05, 1.11861555e-04, ...,
          3.03280340e-05, 2.54765386e-04, 2.82170397e-04],
         [2.12516752e-03, 7.19837190e-05, 1.88700986e-04, ...,
          1.86366087e-04, 7.02239413e-05, 2.54370330e-04],
         ...,
         [4.56329063e-03, 2.23812275e-03, 2.37343236e-04, ...,
          2.64523784e-04, 4.05454011e-05, 1.55662783e-04],
         [4.56329063e-03, 2.23812275e-03, 2.37343236e-04, ...,
          2.64523784e-04, 4.05454011e-05, 1.55662783e-04],
         [4.56329063e-03, 2.23812275e-03, 2.37343236e-04, ...,
          2.64523784e-04, 4.05454011e-05, 1.55662783e-04]],

        [[3.24600202e-04, 9.31067043e-05, 4.60048941e-05, ...,
          6.66230699e-05, 5.76460850e-04, 1.52416309e-04],
         [7.51478728e-05, 7.63997741e-05, 2.09082973e-05, ...,
          2.55555002e-04, 2.28998848e-04, 4.37303359e-04],
         [1.03114333e-04, 1.55743372e-04, 9.97955431e-06, ...,
          1.12485175e-03, 4.80950950e-03, 6.83143327e-04],
         ...,
         [5.20280097e-03, 3.23211338e-04, 2.47709468e-05, ...,
          3.07609705e-04, 6.09844255e-06, 8.61325825e-05],
         [5.20280097e-03, 3.23211338e-04, 2.47709468e-05, ...,
          3.07609705e-04, 6.09844255e-06, 8.61325825e-05],
         [5.20280097e-03, 3.23211338e-04, 2.47709468e-05, ...,

          3.07609705e-04, 6.09844255e-06, 8.61325825e-05]]],
dtype=float32)>
```

Train Model:

In[15]:

```
history=model.fit(
    train_data,
    epochs=100,
    validation_data=val_data,
    callbacks=[
        tf.keras.callbacks.TensorBoard(log_dir='logs'),

tf.keras.callbacks.ModelCheckpoint('ckpt',verbose=1,save_best_only=True
)
    ]
)
```

Out[15]:

```
Epoch 1/100
```

```
23/23 [==============================] - ETA: 0s - loss: 1.6590 -
accuracy: 0.2180
Epoch 1: val_loss improved from inf to 1.21875, saving model to ckpt
23/23 [==============================] - 68s 3s/step - loss: 1.6515 -
accuracy: 0.2198 - val_loss: 1.2187 - val_accuracy: 0.3072
Epoch 2/100
23/23 [==============================] - ETA: 0s - loss: 1.2327 -
accuracy: 0.3087
Epoch 2: val_loss improved from 1.21875 to 1.10877, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 1.2287 -
accuracy: 0.3092 - val_loss: 1.1088 - val_accuracy: 0.3415
Epoch 3/100
23/23 [==============================] - ETA: 0s - loss: 1.1008 -
accuracy: 0.3368
Epoch 3: val_loss did not improve from 1.10877
23/23 [==============================] - 22s 973ms/step - loss: 1.0984
- accuracy: 0.3370 - val_loss: 1.1161 - val_accuracy: 0.3315
Epoch 4/100
23/23 [==============================] - ETA: 0s - loss: 1.0209 -
accuracy: 0.3536
Epoch 4: val_loss improved from 1.10877 to 0.95189, saving model to
ckpt
```

```
23/23 [==============================] - 53s 2s/step - loss: 1.0186 -
accuracy: 0.3540 - val_loss: 0.9519 - val_accuracy: 0.3718
Epoch 5/100
23/23 [==============================] - ETA: 0s - loss: 0.9622 -
accuracy: 0.3673
Epoch 5: val_loss did not improve from 0.95189
23/23 [==============================] - 23s 979ms/step - loss: 0.9672
- accuracy: 0.3670 - val_loss: 0.9642 - val_accuracy: 0.3666
Epoch 6/100
23/23 [==============================] - ETA: 0s - loss: 0.9159 -
accuracy: 0.3801
Epoch 6: val_loss improved from 0.95189 to 0.94015, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.9182 -
accuracy: 0.3796 - val_loss: 0.9401 - val_accuracy: 0.3598
Epoch 7/100
23/23 [==============================] - ETA: 0s - loss: 0.8737 -
accuracy: 0.3908
Epoch 7: val_loss improved from 0.94015 to 0.83293, saving model to
ckpt
23/23 [==============================] - 52s 2s/step - loss: 0.8746 -
accuracy: 0.3900 - val_loss: 0.8329 - val_accuracy: 0.4180
Epoch 8/100
23/23 [==============================] - ETA: 0s - loss: 0.8389 -
accuracy: 0.4013
Epoch 8: val_loss improved from 0.83293 to 0.77748, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.8395 -
accuracy: 0.4013 - val_loss: 0.7775 - val_accuracy: 0.4305
Epoch 9/100
23/23 [==============================] - ETA: 0s - loss: 0.8148 -
accuracy: 0.4094
Epoch 9: val_loss did not improve from 0.77748
23/23 [==============================] - 23s 983ms/step - loss: 0.8187
- accuracy: 0.4084 - val_loss: 0.8608 - val_accuracy: 0.3830
Epoch 10/100
23/23 [==============================] - ETA: 0s - loss: 0.7889 -
accuracy: 0.4200
Epoch 10: val_loss improved from 0.77748 to 0.73131, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.7923 -
accuracy: 0.4188 - val_loss: 0.7313 - val_accuracy: 0.4515
Epoch 11/100
```

```
23/23 [==============================] - ETA: 0s - loss: 0.7624 -
accuracy: 0.4284
Epoch 11: val_loss did not improve from 0.73131
23/23 [==============================] - 22s 965ms/step - loss: 0.7615
- accuracy: 0.4282 - val_loss: 0.8036 - val_accuracy: 0.4472
Epoch 12/100
23/23 [==============================] - ETA: 0s - loss: 0.7433 -
accuracy: 0.4361
Epoch 12: val_loss did not improve from 0.73131
23/23 [==============================] - 23s 984ms/step - loss: 0.7452
- accuracy: 0.4354 - val_loss: 0.7384 - val_accuracy: 0.4623
Epoch 13/100
23/23 [==============================] - ETA: 0s - loss: 0.7246 -
accuracy: 0.4493
Epoch 13: val_loss did not improve from 0.73131
23/23 [==============================] - 23s 988ms/step - loss: 0.7281
- accuracy: 0.4488 - val_loss: 0.8017 - val_accuracy: 0.4449
Epoch 14/100
23/23 [==============================] - ETA: 0s - loss: 0.7080 -
accuracy: 0.4513
Epoch 14: val_loss did not improve from 0.73131
23/23 [==============================] - 23s 995ms/step - loss: 0.7080
- accuracy: 0.4509 - val_loss: 0.7568 - val_accuracy: 0.4259
Epoch 15/100
23/23 [==============================] - ETA: 0s - loss: 0.6853 -
accuracy: 0.4620
Epoch 15: val_loss did not improve from 0.73131
23/23 [==============================] - 22s 974ms/step - loss: 0.6826
- accuracy: 0.4616 - val_loss: 0.7376 - val_accuracy: 0.4502
Epoch 16/100
23/23 [==============================] - ETA: 0s - loss: 0.6731 -
accuracy: 0.4673
Epoch 16: val_loss did not improve from 0.73131
23/23 [==============================] - 23s 983ms/step - loss: 0.6733
- accuracy: 0.4672 - val_loss: 0.7646 - val_accuracy: 0.4538
Epoch 17/100
23/23 [==============================] - ETA: 0s - loss: 0.6576 -
accuracy: 0.4732
Epoch 17: val_loss improved from 0.73131 to 0.66131, saving model to
ckpt
23/23 [==============================] - 52s 2s/step - loss: 0.6539 -
accuracy: 0.4738 - val_loss: 0.6613 - val_accuracy: 0.4714
Epoch 18/100
```

```
23/23 [==============================] - ETA: 0s - loss: 0.6468 -
accuracy: 0.4807
Epoch 18: val_loss improved from 0.66131 to 0.65303, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.6458 -
accuracy: 0.4805 - val_loss: 0.6530 - val_accuracy: 0.4993
Epoch 19/100
23/23 [==============================] - ETA: 0s - loss: 0.6353 -
accuracy: 0.4881
Epoch 19: val_loss did not improve from 0.65303
23/23 [==============================] - 23s 994ms/step - loss: 0.6357
- accuracy: 0.4876 - val_loss: 0.7331 - val_accuracy: 0.4677
Epoch 20/100
23/23 [==============================] - ETA: 0s - loss: 0.6194 -
accuracy: 0.4968
Epoch 20: val_loss improved from 0.65303 to 0.55054, saving model to
ckpt
23/23 [==============================] - 54s 2s/step - loss: 0.6188 -
accuracy: 0.4967 - val_loss: 0.5505 - val_accuracy: 0.5221
Epoch 21/100
23/23 [==============================] - ETA: 0s - loss: 0.6160 -
accuracy: 0.4978
Epoch 21: val_loss did not improve from 0.55054
23/23 [==============================] - 23s 987ms/step - loss: 0.6182
- accuracy: 0.4965 - val_loss: 0.6790 - val_accuracy: 0.4979
Epoch 22/100
23/23 [==============================] - ETA: 0s - loss: 0.6011 -
accuracy: 0.5052
Epoch 22: val_loss did not improve from 0.55054
23/23 [==============================] - 23s 996ms/step - loss: 0.6011
- accuracy: 0.5051 - val_loss: 0.6221 - val_accuracy: 0.5277
Epoch 23/100
23/23 [==============================] - ETA: 0s - loss: 0.5950 -
accuracy: 0.5079
Epoch 23: val_loss did not improve from 0.55054
23/23 [==============================] - 23s 987ms/step - loss: 0.5934
- accuracy: 0.5081 - val_loss: 0.6142 - val_accuracy: 0.5198
Epoch 24/100
23/23 [==============================] - ETA: 0s - loss: 0.5810 -
accuracy: 0.5160
Epoch 24: val_loss did not improve from 0.55054
23/23 [==============================] - 22s 971ms/step - loss: 0.5803
- accuracy: 0.5170 - val_loss: 0.5759 - val_accuracy: 0.5137
```

```
Epoch 25/100
23/23 [==============================] - ETA: 0s - loss: 0.5716 -
accuracy: 0.5227
Epoch 25: val_loss did not improve from 0.55054
23/23 [==============================] - 23s 986ms/step - loss: 0.5733
- accuracy: 0.5229 - val_loss: 0.6344 - val_accuracy: 0.5169
Epoch 26/100
23/23 [==============================] - ETA: 0s - loss: 0.5676 -
accuracy: 0.5225
Epoch 26: val_loss did not improve from 0.55054
23/23 [==============================] - 22s 963ms/step - loss: 0.5708
- accuracy: 0.5210 - val_loss: 0.6254 - val_accuracy: 0.4882
Epoch 27/100
23/23 [==============================] - ETA: 0s - loss: 0.5616 -
accuracy: 0.5291
Epoch 27: val_loss did not improve from 0.55054
23/23 [==============================] - 23s 988ms/step - loss: 0.5624
- accuracy: 0.5280 - val_loss: 0.6774 - val_accuracy: 0.5379
Epoch 28/100
23/23 [==============================] - ETA: 0s - loss: 0.5531 -
accuracy: 0.5318
Epoch 28: val_loss did not improve from 0.55054
23/23 [==============================] - 22s 949ms/step - loss: 0.5543
- accuracy: 0.5310 - val_loss: 0.7284 - val_accuracy: 0.5302
Epoch 29/100
23/23 [==============================] - ETA: 0s - loss: 0.5398 -
accuracy: 0.5389
Epoch 29: val_loss did not improve from 0.55054
23/23 [==============================] - 23s 1s/step - loss: 0.5391 -
accuracy: 0.5398 - val_loss: 0.7385 - val_accuracy: 0.5193
Epoch 30/100
23/23 [==============================] - ETA: 0s - loss: 0.5375 -
accuracy: 0.5416
Epoch 30: val_loss improved from 0.55054 to 0.50346, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.5384 -
accuracy: 0.5417 - val_loss: 0.5035 - val_accuracy: 0.5411
Epoch 31/100
23/23 [==============================] - ETA: 0s - loss: 0.5270 -
accuracy: 0.5481
Epoch 31: val_loss did not improve from 0.50346
23/23 [==============================] - 22s 958ms/step - loss: 0.5262
- accuracy: 0.5477 - val_loss: 0.5805 - val_accuracy: 0.5457
```

```
Epoch 32/100
23/23 [==============================] - ETA: 0s - loss: 0.5304 -
accuracy: 0.5447
Epoch 32: val_loss did not improve from 0.50346
23/23 [==============================] - 22s 963ms/step - loss: 0.5329
- accuracy: 0.5435 - val_loss: 0.5374 - val_accuracy: 0.5725
Epoch 33/100
23/23 [==============================] - ETA: 0s - loss: 0.5196 -
accuracy: 0.5520
Epoch 33: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 975ms/step - loss: 0.5211
- accuracy: 0.5518 - val_loss: 0.6217 - val_accuracy: 0.5066
Epoch 34/100
23/23 [==============================] - ETA: 0s - loss: 0.5129 -
accuracy: 0.5558
Epoch 34: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 1000ms/step - loss: 0.5129
- accuracy: 0.5556 - val_loss: 0.6070 - val_accuracy: 0.5653
Epoch 35/100
23/23 [==============================] - ETA: 0s - loss: 0.5059 -
accuracy: 0.5620
Epoch 35: val_loss did not improve from 0.50346
23/23 [==============================] - 22s 966ms/step - loss: 0.5081
- accuracy: 0.5614 - val_loss: 0.6153 - val_accuracy: 0.5452
Epoch 36/100
23/23 [==============================] - ETA: 0s - loss: 0.5037 -
accuracy: 0.5619
Epoch 36: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 980ms/step - loss: 0.5063
- accuracy: 0.5617 - val_loss: 0.5328 - val_accuracy: 0.5873
Epoch 37/100
23/23 [==============================] - ETA: 0s - loss: 0.4977 -
accuracy: 0.5682
Epoch 37: val_loss did not improve from 0.50346
23/23 [==============================] - 22s 969ms/step - loss: 0.4980
- accuracy: 0.5682 - val_loss: 0.5976 - val_accuracy: 0.5693
Epoch 38/100
23/23 [==============================] - ETA: 0s - loss: 0.4939 -
accuracy: 0.5704
Epoch 38: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 993ms/step - loss: 0.4953
- accuracy: 0.5687 - val_loss: 0.5937 - val_accuracy: 0.5236
Epoch 39/100
```

```
23/23 [==============================] - ETA: 0s - loss: 0.4860 -
accuracy: 0.5758
Epoch 39: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 986ms/step - loss: 0.4868
- accuracy: 0.5746 - val_loss: 0.6155 - val_accuracy: 0.5457
Epoch 40/100
23/23 [==============================] - ETA: 0s - loss: 0.4809 -
accuracy: 0.5778
Epoch 40: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 1s/step - loss: 0.4821 -
accuracy: 0.5760 - val_loss: 0.5046 - val_accuracy: 0.5662
Epoch 41/100
23/23 [==============================] - ETA: 0s - loss: 0.4781 -
accuracy: 0.5817
Epoch 41: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 990ms/step - loss: 0.4782
- accuracy: 0.5821 - val_loss: 0.5256 - val_accuracy: 0.5907
Epoch 42/100
23/23 [==============================] - ETA: 0s - loss: 0.4713 -
accuracy: 0.5836
Epoch 42: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 982ms/step - loss: 0.4729
- accuracy: 0.5824 - val_loss: 0.6387 - val_accuracy: 0.5456
Epoch 43/100
23/23 [==============================] - ETA: 0s - loss: 0.4641 -
accuracy: 0.5904
Epoch 43: val_loss did not improve from 0.50346
23/23 [==============================] - 23s 1s/step - loss: 0.4627 -
accuracy: 0.5908 - val_loss: 0.5668 - val_accuracy: 0.5741
Epoch 44/100
23/23 [==============================] - ETA: 0s - loss: 0.4608 -
accuracy: 0.5921
Epoch 44: val_loss improved from 0.50346 to 0.49920, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.4618 -
accuracy: 0.5920 - val_loss: 0.4992 - val_accuracy: 0.5768
Epoch 45/100
23/23 [==============================] - ETA: 0s - loss: 0.4592 -
accuracy: 0.5902
Epoch 45: val_loss did not improve from 0.49920
23/23 [==============================] - 22s 970ms/step - loss: 0.4599
- accuracy: 0.5887 - val_loss: 0.5423 - val_accuracy: 0.5854
Epoch 46/100
```

```
23/23 [==============================] - ETA: 0s - loss: 0.4535 -
accuracy: 0.5978
Epoch 46: val_loss improved from 0.49920 to 0.48429, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.4552 -
accuracy: 0.5966 - val_loss: 0.4843 - val_accuracy: 0.6049
Epoch 47/100
23/23 [==============================] - ETA: 0s - loss: 0.4528 -
accuracy: 0.5987
Epoch 47: val_loss improved from 0.48429 to 0.47868, saving model to
ckpt
23/23 [==============================] - 54s 2s/step - loss: 0.4537 -
accuracy: 0.5990 - val_loss: 0.4787 - val_accuracy: 0.5906
Epoch 48/100
23/23 [==============================] - ETA: 0s - loss: 0.4441 -
accuracy: 0.6016
Epoch 48: val_loss did not improve from 0.47868
23/23 [==============================] - 23s 982ms/step - loss: 0.4439
- accuracy: 0.6025 - val_loss: 0.5746 - val_accuracy: 0.5542
Epoch 49/100
23/23 [==============================] - ETA: 0s - loss: 0.4436 -
accuracy: 0.6041
Epoch 49: val_loss did not improve from 0.47868
23/23 [==============================] - 22s 951ms/step - loss: 0.4432
- accuracy: 0.6045 - val_loss: 0.5058 - val_accuracy: 0.5753
Epoch 50/100
23/23 [==============================] - ETA: 0s - loss: 0.4435 -
accuracy: 0.6033
Epoch 50: val_loss did not improve from 0.47868
23/23 [==============================] - 22s 949ms/step - loss: 0.4441
- accuracy: 0.6043 - val_loss: 0.6037 - val_accuracy: 0.5473
Epoch 51/100
23/23 [==============================] - ETA: 0s - loss: 0.4382 -
accuracy: 0.6069
Epoch 51: val_loss did not improve from 0.47868
23/23 [==============================] - 22s 957ms/step - loss: 0.4383
- accuracy: 0.6067 - val_loss: 0.5206 - val_accuracy: 0.6154
Epoch 52/100
23/23 [==============================] - ETA: 0s - loss: 0.4293 -
accuracy: 0.6125
Epoch 52: val_loss did not improve from 0.47868
23/23 [==============================] - 23s 971ms/step - loss: 0.4284
- accuracy: 0.6123 - val_loss: 0.4997 - val_accuracy: 0.5840
```

```
Epoch 53/100
23/23 [==============================] - ETA: 0s - loss: 0.4309 -
accuracy: 0.6109
Epoch 53: val_loss improved from 0.47868 to 0.42987, saving model to
ckpt
23/23 [==============================] - 52s 2s/step - loss: 0.4317 -
accuracy: 0.6094 - val_loss: 0.4299 - val_accuracy: 0.6062
Epoch 54/100
23/23 [==============================] - ETA: 0s - loss: 0.4292 -
accuracy: 0.6120
Epoch 54: val_loss did not improve from 0.42987
23/23 [==============================] - 22s 980ms/step - loss: 0.4309
- accuracy: 0.6115 - val_loss: 0.6996 - val_accuracy: 0.5592
Epoch 55/100
23/23 [==============================] - ETA: 0s - loss: 0.4225 -
accuracy: 0.6115
Epoch 55: val_loss did not improve from 0.42987
23/23 [==============================] - 22s 976ms/step - loss: 0.4224
- accuracy: 0.6102 - val_loss: 0.5500 - val_accuracy: 0.5769
Epoch 56/100
23/23 [==============================] - ETA: 0s - loss: 0.4220 -
accuracy: 0.6180
Epoch 56: val_loss did not improve from 0.42987
23/23 [==============================] - 23s 995ms/step - loss: 0.4236
- accuracy: 0.6169 - val_loss: 0.5689 - val_accuracy: 0.5817
Epoch 57/100
23/23 [==============================] - ETA: 0s - loss: 0.4173 -
accuracy: 0.6210
Epoch 57: val_loss did not improve from 0.42987
23/23 [==============================] - 22s 976ms/step - loss: 0.4161
- accuracy: 0.6217 - val_loss: 0.4614 - val_accuracy: 0.6048
Epoch 58/100
23/23 [==============================] - ETA: 0s - loss: 0.4183 -
accuracy: 0.6198
Epoch 58: val_loss did not improve from 0.42987
23/23 [==============================] - 23s 1s/step - loss: 0.4183 -
accuracy: 0.6201 - val_loss: 0.4372 - val_accuracy: 0.6067
Epoch 59/100
23/23 [==============================] - ETA: 0s - loss: 0.4120 -
accuracy: 0.6251
Epoch 59: val_loss did not improve from 0.42987
23/23 [==============================] - 23s 994ms/step - loss: 0.4136
- accuracy: 0.6237 - val_loss: 0.6183 - val_accuracy: 0.5948
```

```
Epoch 60/100
23/23 [==============================] - ETA: 0s - loss: 0.4090 -
accuracy: 0.6239
Epoch 60: val_loss did not improve from 0.42987
23/23 [==============================] - 23s 980ms/step - loss: 0.4101
- accuracy: 0.6225 - val_loss: 0.5042 - val_accuracy: 0.6161
Epoch 61/100
23/23 [==============================] - ETA: 0s - loss: 0.4051 -
accuracy: 0.6314
Epoch 61: val_loss did not improve from 0.42987
23/23 [==============================] - 23s 1s/step - loss: 0.4077 -
accuracy: 0.6296 - val_loss: 0.5100 - val_accuracy: 0.6128
Epoch 62/100
23/23 [==============================] - ETA: 0s - loss: 0.4016 -
accuracy: 0.6326
Epoch 62: val_loss did not improve from 0.42987
23/23 [==============================] - 24s 1s/step - loss: 0.4029 -
accuracy: 0.6322 - val_loss: 0.5295 - val_accuracy: 0.6005
Epoch 63/100
23/23 [==============================] - ETA: 0s - loss: 0.4049 -
accuracy: 0.6323
Epoch 63: val_loss did not improve from 0.42987
23/23 [==============================] - 23s 981ms/step - loss: 0.4069
- accuracy: 0.6316 - val_loss: 0.5103 - val_accuracy: 0.6088
Epoch 64/100
23/23 [==============================] - ETA: 0s - loss: 0.3951 -
accuracy: 0.6335
Epoch 64: val_loss did not improve from 0.42987
23/23 [==============================] - 22s 981ms/step - loss: 0.3943
- accuracy: 0.6341 - val_loss: 0.5366 - val_accuracy: 0.5869
Epoch 65/100
23/23 [==============================] - ETA: 0s - loss: 0.3967 -
accuracy: 0.6344
Epoch 65: val_loss improved from 0.42987 to 0.40702, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.3972 -
accuracy: 0.6352 - val_loss: 0.4070 - val_accuracy: 0.6452
Epoch 66/100
23/23 [==============================] - ETA: 0s - loss: 0.3942 -
accuracy: 0.6351
Epoch 66: val_loss did not improve from 0.40702
23/23 [==============================] - 22s 961ms/step - loss: 0.3954
- accuracy: 0.6337 - val_loss: 0.4963 - val_accuracy: 0.6039
```

```
Epoch 67/100
23/23 [==============================] - ETA: 0s - loss: 0.3884 -
accuracy: 0.6409
Epoch 67: val_loss did not improve from 0.40702
23/23 [==============================] - 22s 951ms/step - loss: 0.3879
- accuracy: 0.6424 - val_loss: 0.4651 - val_accuracy: 0.6276
Epoch 68/100
23/23 [==============================] - ETA: 0s - loss: 0.3876 -
accuracy: 0.6398
Epoch 68: val_loss improved from 0.40702 to 0.38016, saving model to
ckpt
23/23 [==============================] - 52s 2s/step - loss: 0.3870 -
accuracy: 0.6388 - val_loss: 0.3802 - val_accuracy: 0.6614
Epoch 69/100
23/23 [==============================] - ETA: 0s - loss: 0.3897 -
accuracy: 0.6394
Epoch 69: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 961ms/step - loss: 0.3895
- accuracy: 0.6395 - val_loss: 0.4046 - val_accuracy: 0.6587
Epoch 70/100
23/23 [==============================] - ETA: 0s - loss: 0.3855 -
accuracy: 0.6433
Epoch 70: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 967ms/step - loss: 0.3870
- accuracy: 0.6432 - val_loss: 0.4162 - val_accuracy: 0.6475
Epoch 71/100
23/23 [==============================] - ETA: 0s - loss: 0.3828 -
accuracy: 0.6422
Epoch 71: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 986ms/step - loss: 0.3828
- accuracy: 0.6423 - val_loss: 0.4099 - val_accuracy: 0.6612
Epoch 72/100
23/23 [==============================] - ETA: 0s - loss: 0.3825 -
accuracy: 0.6460
Epoch 72: val_loss did not improve from 0.38016
23/23 [==============================] - 24s 1s/step - loss: 0.3831 -
accuracy: 0.6449 - val_loss: 0.5160 - val_accuracy: 0.6117
Epoch 73/100
23/23 [==============================] - ETA: 0s - loss: 0.3795 -
accuracy: 0.6451
Epoch 73: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 1s/step - loss: 0.3797 -
accuracy: 0.6448 - val_loss: 0.4963 - val_accuracy: 0.6231
```

```
Epoch 74/100
23/23 [==============================] - ETA: 0s - loss: 0.3769 -
accuracy: 0.6479
Epoch 74: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 975ms/step - loss: 0.3783
- accuracy: 0.6459 - val_loss: 0.4888 - val_accuracy: 0.6084
Epoch 75/100
23/23 [==============================] - ETA: 0s - loss: 0.3719 -
accuracy: 0.6541
Epoch 75: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 971ms/step - loss: 0.3724
- accuracy: 0.6538 - val_loss: 0.5175 - val_accuracy: 0.6032
Epoch 76/100
23/23 [==============================] - ETA: 0s - loss: 0.3697 -
accuracy: 0.6555
Epoch 76: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 1s/step - loss: 0.3687 -
accuracy: 0.6548 - val_loss: 0.4598 - val_accuracy: 0.6059
Epoch 77/100
23/23 [==============================] - ETA: 0s - loss: 0.3702 -
accuracy: 0.6552
Epoch 77: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 954ms/step - loss: 0.3713
- accuracy: 0.6540 - val_loss: 0.5650 - val_accuracy: 0.5824
Epoch 78/100
23/23 [==============================] - ETA: 0s - loss: 0.3685 -
accuracy: 0.6548
Epoch 78: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 982ms/step - loss: 0.3675
- accuracy: 0.6557 - val_loss: 0.4115 - val_accuracy: 0.6292
Epoch 79/100
23/23 [==============================] - ETA: 0s - loss: 0.3659 -
accuracy: 0.6584
Epoch 79: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 970ms/step - loss: 0.3662
- accuracy: 0.6577 - val_loss: 0.3868 - val_accuracy: 0.6516
Epoch 80/100
23/23 [==============================] - ETA: 0s - loss: 0.3626 -
accuracy: 0.6628
Epoch 80: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 994ms/step - loss: 0.3627
- accuracy: 0.6638 - val_loss: 0.4733 - val_accuracy: 0.6388
Epoch 81/100
```

```
23/23 [==============================] - ETA: 0s - loss: 0.3623 -
accuracy: 0.6578
Epoch 81: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 970ms/step - loss: 0.3621
- accuracy: 0.6577 - val_loss: 0.5189 - val_accuracy: 0.5979
Epoch 82/100
23/23 [==============================] - ETA: 0s - loss: 0.3603 -
accuracy: 0.6612
Epoch 82: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 982ms/step - loss: 0.3600
- accuracy: 0.6614 - val_loss: 0.4210 - val_accuracy: 0.6280
Epoch 83/100
23/23 [==============================] - ETA: 0s - loss: 0.3608 -
accuracy: 0.6604
Epoch 83: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 1s/step - loss: 0.3627 -
accuracy: 0.6592 - val_loss: 0.5621 - val_accuracy: 0.6082
Epoch 84/100
23/23 [==============================] - ETA: 0s - loss: 0.3605 -
accuracy: 0.6640
Epoch 84: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 998ms/step - loss: 0.3628
- accuracy: 0.6634 - val_loss: 0.4241 - val_accuracy: 0.6462
Epoch 85/100
23/23 [==============================] - ETA: 0s - loss: 0.3498 -
accuracy: 0.6713
Epoch 85: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 976ms/step - loss: 0.3484
- accuracy: 0.6713 - val_loss: 0.4425 - val_accuracy: 0.6489
Epoch 86/100
23/23 [==============================] - ETA: 0s - loss: 0.3537 -
accuracy: 0.6663
Epoch 86: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 1s/step - loss: 0.3543 -
accuracy: 0.6656 - val_loss: 0.4006 - val_accuracy: 0.6716
Epoch 87/100
23/23 [==============================] - ETA: 0s - loss: 0.3503 -
accuracy: 0.6698
Epoch 87: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 987ms/step - loss: 0.3493
- accuracy: 0.6697 - val_loss: 0.4375 - val_accuracy: 0.6527
Epoch 88/100
```

```
23/23 [==============================] - ETA: 0s - loss: 0.3497 -
accuracy: 0.6714
Epoch 88: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 986ms/step - loss: 0.3495
- accuracy: 0.6710 - val_loss: 0.5339 - val_accuracy: 0.6160
Epoch 89/100
23/23 [==============================] - ETA: 0s - loss: 0.3500 -
accuracy: 0.6671
Epoch 89: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 970ms/step - loss: 0.3501
- accuracy: 0.6666 - val_loss: 0.4148 - val_accuracy: 0.6438
Epoch 90/100
23/23 [==============================] - ETA: 0s - loss: 0.3494 -
accuracy: 0.6661
Epoch 90: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 995ms/step - loss: 0.3529
- accuracy: 0.6647 - val_loss: 0.4992 - val_accuracy: 0.6324
Epoch 91/100
23/23 [==============================] - ETA: 0s - loss: 0.3479 -
accuracy: 0.6718
Epoch 91: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 986ms/step - loss: 0.3482
- accuracy: 0.6715 - val_loss: 0.6037 - val_accuracy: 0.6195
Epoch 92/100
23/23 [==============================] - ETA: 0s - loss: 0.3436 -
accuracy: 0.6767
Epoch 92: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 964ms/step - loss: 0.3452
- accuracy: 0.6764 - val_loss: 0.4368 - val_accuracy: 0.6462
Epoch 93/100
23/23 [==============================] - ETA: 0s - loss: 0.3377 -
accuracy: 0.6793
Epoch 93: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 984ms/step - loss: 0.3372
- accuracy: 0.6795 - val_loss: 0.5267 - val_accuracy: 0.6275
Epoch 94/100
23/23 [==============================] - ETA: 0s - loss: 0.3433 -
accuracy: 0.6743
Epoch 94: val_loss did not improve from 0.38016
23/23 [==============================] - 22s 964ms/step - loss: 0.3453
- accuracy: 0.6736 - val_loss: 0.4532 - val_accuracy: 0.6314
Epoch 95/100
```

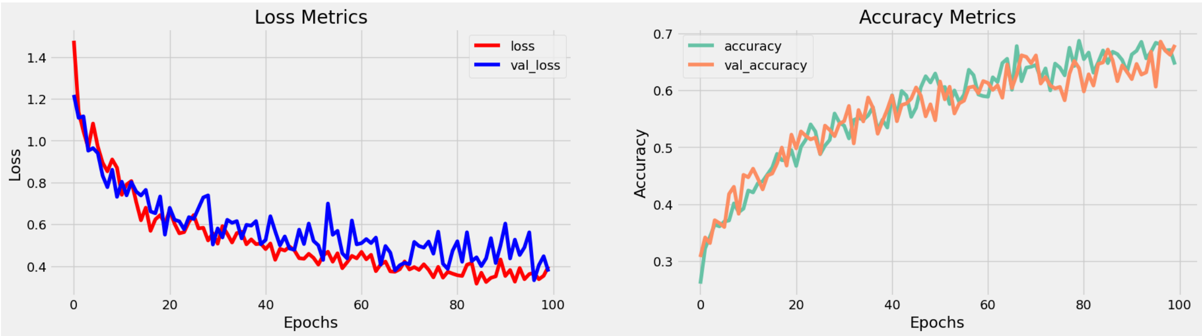
```
23/23 [==============================] - ETA: 0s - loss: 0.3409 -
accuracy: 0.6780
Epoch 95: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 987ms/step - loss: 0.3407
- accuracy: 0.6775 - val_loss: 0.4901 - val_accuracy: 0.6680
Epoch 96/100
23/23 [==============================] - ETA: 0s - loss: 0.3378 -
accuracy: 0.6791
Epoch 96: val_loss did not improve from 0.38016
23/23 [==============================] - 23s 991ms/step - loss: 0.3388
- accuracy: 0.6793 - val_loss: 0.5620 - val_accuracy: 0.6063
Epoch 97/100
23/23 [==============================] - ETA: 0s - loss: 0.3389 -
accuracy: 0.6763
Epoch 97: val_loss improved from 0.38016 to 0.33265, saving model to
ckpt
23/23 [==============================] - 53s 2s/step - loss: 0.3402 -
accuracy: 0.6765 - val_loss: 0.3327 - val_accuracy: 0.6854
Epoch 98/100
23/23 [==============================] - ETA: 0s - loss: 0.3408 -
accuracy: 0.6768
Epoch 98: val_loss did not improve from 0.33265
23/23 [==============================] - 22s 974ms/step - loss: 0.3407
- accuracy: 0.6766 - val_loss: 0.4046 - val_accuracy: 0.6695
Epoch 99/100
23/23 [==============================] - ETA: 0s - loss: 0.3388 -
accuracy: 0.6795
Epoch 99: val_loss did not improve from 0.33265
23/23 [==============================] - 23s 985ms/step - loss: 0.3394
- accuracy: 0.6791 - val_loss: 0.4475 - val_accuracy: 0.6622
Epoch 100/100
23/23 [==============================] - ETA: 0s - loss: 0.3358 -
accuracy: 0.6787
Epoch 100: val_loss did not improve from 0.33265
23/23 [==============================] - 22s 968ms/step - loss: 0.3385
- accuracy: 0.6773 - val_loss: 0.3742 - val_accuracy: 0.6796
```

Visualize Metrics:

In[16]:

```python
fig,ax=plt.subplots(nrows=1,ncols=2,figsize=(20,5))
ax[0].plot(history.history['loss'],label='loss',c='red')
ax[0].plot(history.history['val_loss'],label='val_loss',c = 'blue')
ax[0].set_xlabel('Epochs')
ax[1].set_xlabel('Epochs')
ax[0].set_ylabel('Loss')
ax[1].set_ylabel('Accuracy')
ax[0].set_title('Loss Metrics')
ax[1].set_title('Accuracy Metrics')
ax[1].plot(history.history['accuracy'],label='accuracy')
ax[1].plot(history.history['val_accuracy'],label='val_accuracy')
ax[0].legend()
ax[1].legend()
plt.show()
```

Out[16]:



Save Model:

In[17]:

```python
model.load_weights('ckpt')
model.save('models',save_format='tf')
```

In[18]:

```python
for idx,i in enumerate(model.layers):
    print('Encoder layers:' if idx==0 else 'Decoder layers: ')
    for j in i.layers:
        print(j)
    print('----------------------')
```

Out[18]:

```
Encoder layers:
<keras.layers.core.embedding.Embedding object at 0x782084b9d190>
<keras.layers.normalization.layer_normalization.LayerNormalization
object at 0x7820e56f1b90>
<keras.layers.rnn.lstm.LSTM object at 0x7820841bd650>
---------------------
Decoder layers:
<keras.layers.core.embedding.Embedding object at 0x78207c258590>
<keras.layers.normalization.layer_normalization.LayerNormalization
object at 0x78207c78bd10>
<keras.layers.rnn.lstm.LSTM object at 0x78207c258a10>
<keras.layers.core.dense.Dense object at 0x78207c2636d0>
---------------------
```

Create Inference Model:

In[19]:

```
class ChatBot(tf.keras.models.Model):
    def __init__(self,base_encoder,base_decoder,*args,**kwargs):
        super().__init__(*args,**kwargs)

self.encoder,self.decoder=self.build_inference_model(base_encoder,base_
decoder)

    def build_inference_model(self,base_encoder,base_decoder):
        encoder_inputs=tf.keras.Input(shape=(None,))
        x=base_encoder.layers[0](encoder_inputs)
        x=base_encoder.layers[1](x)
        x,encoder_state_h,encoder_state_c=base_encoder.layers[2](x)

encoder=tf.keras.models.Model(inputs=encoder_inputs,outputs=[encoder_st
ate_h,encoder_state_c],name='chatbot_encoder')

        decoder_input_state_h=tf.keras.Input(shape=(lstm_cells,))
        decoder_input_state_c=tf.keras.Input(shape=(lstm_cells,))
        decoder_inputs=tf.keras.Input(shape=(None,))
        x=base_decoder.layers[0](decoder_inputs)
        x=base_encoder.layers[1](x)
```

```
x,decoder_state_h,decoder_state_c=base_decoder.layers[2](x,initial_stat
e=[decoder_input_state_h,decoder_input_state_c])
        decoder_outputs=base_decoder.layers[-1](x)
        decoder=tf.keras.models.Model(

inputs=[decoder_inputs,[decoder_input_state_h,decoder_input_state_c]],

outputs=[decoder_outputs,[decoder_state_h,decoder_state_c]],name='chatb
ot_decoder'
        )
        return encoder,decoder

    def summary(self):
        self.encoder.summary()
        self.decoder.summary()

    def softmax(self,z):
        return np.exp(z)/sum(np.exp(z))

    def sample(self,conditional_probability,temperature=0.5):
        conditional_probability =
np.asarray(conditional_probability).astype("float64")
        conditional_probability = np.log(conditional_probability) /
temperature
        reweighted_conditional_probability =
self.softmax(conditional_probability)
        probas = np.random.multinomial(1,
reweighted_conditional_probability, 1)
        return np.argmax(probas)

    def preprocess(self,text):
        text=clean_text(text)
        seq=np.zeros((1,max_sequence_length),dtype=np.int32)
        for i,word in enumerate(text.split()):
            seq[:,i]=sequences2ids(word).numpy()[0]
        return seq

    def postprocess(self,text):
        text=re.sub(' - ','-',text.lower())
        text=re.sub(' [.] ','. ',text)
        text=re.sub(' [1] ','1',text)
        text=re.sub(' [2] ','2',text)
```

```
        text=re.sub(' [3] ','3',text)
        text=re.sub(' [4] ','4',text)
        text=re.sub(' [5] ','5',text)
        text=re.sub(' [6] ','6',text)
        text=re.sub(' [7] ','7',text)
        text=re.sub(' [8] ','8',text)
        text=re.sub(' [9] ','9',text)
        text=re.sub(' [0] ','0',text)
        text=re.sub(' [,] ',', ',text)
        text=re.sub(' [?] ','? ',text)
        text=re.sub(' [!] ','! ',text)
        text=re.sub(' [$] ','$ ',text)
        text=re.sub(' [&] ','& ',text)
        text=re.sub(' [/] ','/ ',text)
        text=re.sub(' [:] ',': ',text)
        text=re.sub(' [;] ','; ',text)
        text=re.sub(' [*] ','* ',text)
        text=re.sub(' [\'] ','\'',text)
        text=re.sub(' [\"] ','\"',text)
        return text

    def call(self,text,config=None):
        input_seq=self.preprocess(text)
        states=self.encoder(input_seq,training=False)
        target_seq=np.zeros((1,1))
        target_seq[:,:]=sequences2ids(['<start>']).numpy()[0][0]
        stop_condition=False
        decoded=[]
        while not stop_condition:

decoder_outputs,new_states=self.decoder([target_seq,states],training=Fa
lse)
#
index=tf.argmax(decoder_outputs[:,-1,:],axis=-1).numpy().item()
            index=self.sample(decoder_outputs[0,0,:]).item()
            word=ids2sequences([index])
            if word=='<end> ' or len(decoded)>=max_sequence_length:
                stop_condition=True
            else:
                decoded.append(index)
                target_seq=np.zeros((1,1))
                target_seq[:,:]=index
                states=new_states
```

```
        return self.postprocess(ids2sequences(decoded))

chatbot=ChatBot(model.encoder,model.decoder,name='chatbot')
chatbot.summary()
```

Out[19]:

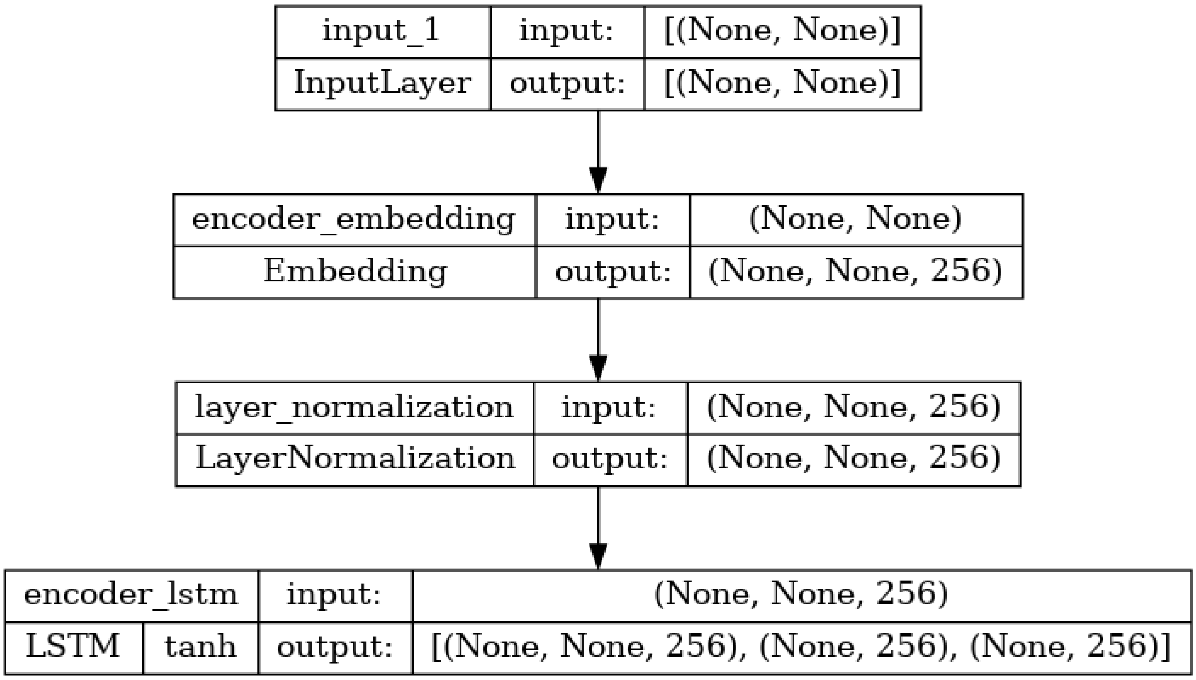
```
Model: "chatbot_encoder"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 input_1 (InputLayer)        [(None, None)]            0         
                                                                 
 encoder_embedding (Embeddin  (None, None, 256)        625408    
 g)                                                              
                                                                 
 layer_normalization (LayerN  (None, None, 256)        512       
 ormalization)                                                   
                                                                 
 encoder_lstm (LSTM)         [(None, None, 256),       525312    
                              (None, 256),                       
                              (None, 256)]                       
                                                                 
=================================================================
Total params: 1,151,232
Trainable params: 1,151,232
Non-trainable params: 0
_________________________________________________________________
Model: "chatbot_decoder"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to                     
==================================================================================================
 input_4 (InputLayer)           [(None, None)]       0           []                               
                                                                                                  
 decoder_embedding (Embedding)  (None, None, 256)    625408      ['input_4[0][0]']                
                                                                                                  
 layer_normalization (LayerNorm  (None, None, 256)   512         ['decoder_embedding[0][0]']      
 alization)                                                                                       
```

```
 input_2 (InputLayer)           [(None, 256)]        0           []

 input_3 (InputLayer)           [(None, 256)]        0           []

 decoder_lstm (LSTM)            [(None, None, 256),  525312
['layer_normalization[1][0]',
                                 (None, 256),
'input_2[0][0]',
                                 (None, 256)]
'input_3[0][0]']

 decoder_dense (Dense)          (None, None, 2443)   627851
['decoder_lstm[0][0]']

========================================================================
===========================
Total params: 1,779,083
Trainable params: 1,779,083
Non-trainable params: 0
________________________________________________________________________
___________________________
```

In[20]:

```
tf.keras.utils.plot_model(chatbot.encoder,to_file='encoder.png',show_sh
apes=True,show_layer_activations=True)
```

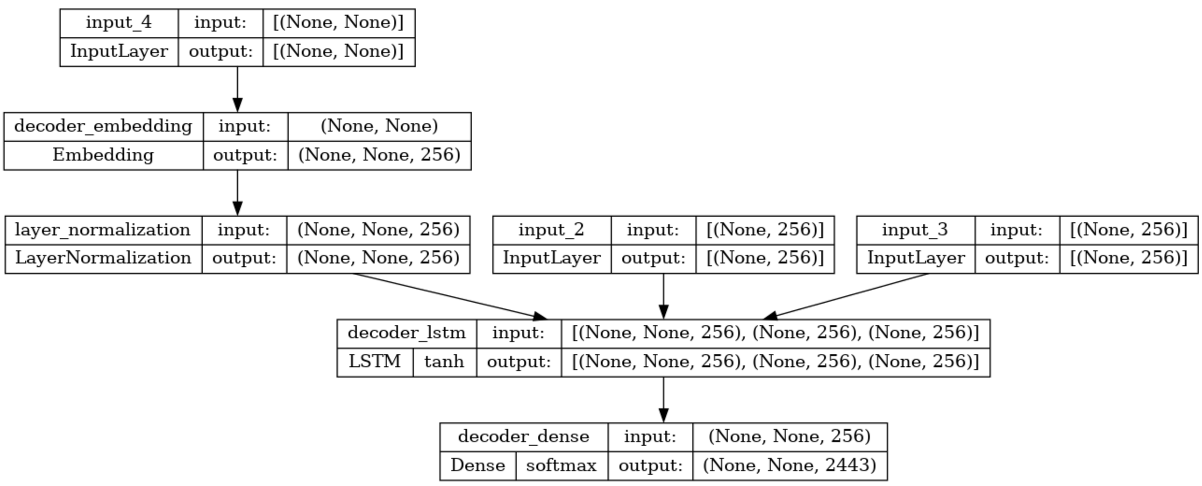
Out[20]:



In[21]:

```
tf.keras.utils.plot_model(chatbot.decoder,to_file='decoder.png',show_shapes=True,show_layer_activations=True)
```

Out[21]:



Time to Chat:

In[22]:

```
def print_conversation(texts):
```

```python
    for text in texts:
        print(f'You: {text}')
        print(f'Bot: {chatbot(text)}')
        print('========================')
```

In[23]:

```python
print_conversation([
    'hi',
    'do yo know me?',
    'what is your name?',
    'you are bot?',
    'hi, how are you doing?',
    "i'm pretty good. thanks for asking.",
    "Don't ever be in a hurry",
    '''I'm gonna put some dirt in your eye ''',
    '''You're trash ''',
    '''I've read all your research on nano-technology ''',
    '''You want forgiveness? Get religion''',
    '''While you're using the bathroom, i'll order some food.''',
    '''Wow! that's terrible.''',
    '''We'll be here forever.''',
    '''I need something that's reliable.''',
    '''A speeding car ran a red light, killing the girl.''',
    '''Tomorrow we'll have rice and fish for lunch.''',
    '''I like this restaurant because they give you free bread.'''
])
```

Out[23]:

```
You: hi
Bot: i have to go to the bathroom.
========================
You: do yo know me?
Bot: yes, it's too close to the other.
========================
You: what is your name?
Bot: i have to walk the house.
========================
You: you are bot?
Bot: no, i have. all my life.
========================
You: hi, how are you doing?
Bot: i'm going to be a teacher.
========================
```

```
You: i'm pretty good. thanks for asking.
Bot: no problem. i'll have to give you the english assignments from my
mind.
========================
You: Don't ever be in a hurry
Bot: it's not a great.
========================
You: I'm gonna put some dirt in your eye
Bot: that's a good idea.
========================
You: You're trash
Bot: the tv news is reporting a bank robbery.
========================
You: I've read all your research on nano-technology
Bot: it's the weather. i've gone around the world.
========================
You: You want forgiveness? Get religion
Bot: no, i'll be my.
========================
You: While you're using the bathroom, i'll order some food.
Bot: don't order for me. i've been a cheater.
========================
You: Wow! that's terrible.
Bot: never park your car under the house.
========================
You: We'll be here forever.
Bot: we'll be there in half an hour.
========================
You: I need something that's reliable.
Bot: you need a car with low mileage.
========================
You: A speeding car ran a red light, killing the girl.
Bot: what happened?
========================
You: Tomorrow we'll have rice and fish for lunch.
Bot: i'll make a sandwich.
========================
You: I like this restaurant because they give you free bread.
Bot: well, i think that's a good idea.
========================
```

Chatbot benefits for businesses:

- Improve service with every interaction.
- Collect customer feedback.
- Reduce customer requests.
- Detect customer intent for added context.
- Boost customer engagement.
- Streamline service with routing and triage.
- Boost sales.
- Increase lead generat.

CONCLUSION:

- Chatbots are conversational tools that perform routine tasks efficiently. People like them because they help them get through those tasks quickly so they can focus their attention on high-level, strategic, and engaging activities that require human capabilities that cannot be replicated by machines.
- Users can easily type their query in natural language and retrieve information.
- AI chatbots offered personalized, real-time feedback and on-demand support to users continuously and indefinitely.