LIB-BOT: A SMART LIBRARIAN-CHATBOT ASSISTANT

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2136

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01

INTRODUCTION

- Problem Statement
- Objectives

INTRODUCTION

- Library = Knowledge Warehouse
- Librarians may not be at counter all the time
- Good to avoid physical contacts

Librarian Chatbot Assistant can:

- Instantly answer library-related questions
- Search or recommend books
- Save plenty of time

PROBLEM STATEMENT

1 Library Assistant May Not Be Available At Counter All The Time

2 Existing Chatbot Applications do not Support Voice Input

3 Admin Does Not Know What Question Is Not Able To Be Answered By The Chatbot

OBJECTIVES

1. To develop a library chatbot assistant in a mobile application for answering queries and recommending books based on user preferences

2. To integrate speech-to-text recognition for the chatbot in the application

3. To create a dashboard at the admin portal site to show the chatbot's unsolved problems for future enhancements

02

LITERATURE REVIEW

- Background of Chatbot
- Chatbot Development Frameworks
- ML & DL In Chatbot Development
- Similar Existing Applications

BACKGROUND STUDY

Background of Chatbot:

- Types of chatbot:
    - ❑ Rule-based chatbot
    - ❑ Retrieval-based chatbot
    - ❑ Generative-based chatbot
- Popular Chatbots:
    - ❑ Siri & Google Assistant
    - ❑ ELIZA chatbot(first chatterbot in the mid-1960s)
    - ❑ ALICE or alicebot(Loebner Prize in 2000, 2001 and 2004)
    - ❑ Xiaotu(library assistant AI chatbot in Tsing Hua University, China)

CHATBOT DEVELOPMENT FRAMEWORKS

DialogFlow 1

2 RASA

Amazon Lex 3

4 Watson Assistant

LITERATURE REVIEW

Machine learning classification algorithms:

- **Naive Bayes Algorithm:**
  - ❑ Intent Classification Model (Helmi Setyawan, Awangga, & Efendi, 2018) **&** (Anggraeni, Syafrullah, & Damanik, 2019) **&** (Sai Vikas, Kumar, Shareef, Roy, & Geetha, 2021)
- **Support Vector Machine(SVM) algorithm:**
  - ❑ Disease Classification Model(Tamizharasi, Livingston, & Rajkumar, 2020)
  - ❑ Illness Prediction Model(S, S, B, & Reshma, 2022)
  - ❑ Intent Classification Model(Ouerhani, Maalel, Ben Ghezala, & Chouri, 2020)

LITERATURE REVIEW

Deep Learning algorithms:

- **Recurrent Neural Network(RNN):**
  - ❑ Intent Classification Model(Prasetyo & Santoso, 2021)
  - ❑ Deep Recurrent Neural Network(DRNN) based Seq2Seq model(Nuruzzaman & Hussain, 2020)
  - ❑ Bidirectional Recurrent Neural Network(BRNN)(Dhyani & Kumar, 2021)
- **Long Short-Term Memory(LSTM):**
  - ❑ Bi-directional LSTM (Bi-LSTM) based Mood Detection Model(Yin, Chen, Zhou, & Yu, 2019)
  - ❑ Seq2Seq LSTM Depression Detection Model(Chauhan, Rastogi, & Singh, 2022)
  - ❑ Intent Classification Model (Kasthuri & Balaji, 2021a) **&** (Kasthuri & Balaji, 2021b) **&** (Dharani, Jyostna, Sucharitha, Likitha, & Manne, 2020)
- **Bidirectional Encoder Representations from Transformers (BERT):**
  - ❑ Intent Classification Model (Amer et al., 2021) & (Yu, Chen, & Zaidi, 2021)
  - ❑ Question Answering Model using CoQA dataset (Kanodia, Ahmed, & Miao, 2021)
  - ❑ Question Answering Model (Kapočiūtė-Dzikienė, 2020)

CHATBOT-RELATED APPLICATIONS

- Woebot

- Domino’s Order Chatbot

- Wysa

- Freddy

- Andy(English Speaking Bot)

- Amy(HSBC Bank)

Features and Functions	Application Names						
	Woebot	Freddy	Domino	Wysa	Amy	Andy	Lib-Bot
Free of charge	✔	✔	✔	✔	✔	✔	✔
Text-to-speech Recognition	✘	✘	✘	✘	✘	✔	✘
Speech-to-text Recognition	✘	✘	✘	✘	✘	✘	✔
Provide quick recommended replies option for the user	✔	✔	✔	✔	✘	✔	✔
Attractive user interface	✔	✔	✔	✔	✘	✘	✔
Having limit on the length of input messages	✘	✘	✘	✘	✔	✘	✔
Allow typing all the time even though certain chat topic is started	✘	✔	✔	✘	✔	✔	✔
Support multiple languages	✘	✘	✘	✘	✔	✘	✘

03

PROPOSED METHODOLOGY

- Presumption
- Use Case Diagram
- Flowcharts
- Chatbot Overall Design

PROPOSED METHODOLOGY

Library Mobile Application:

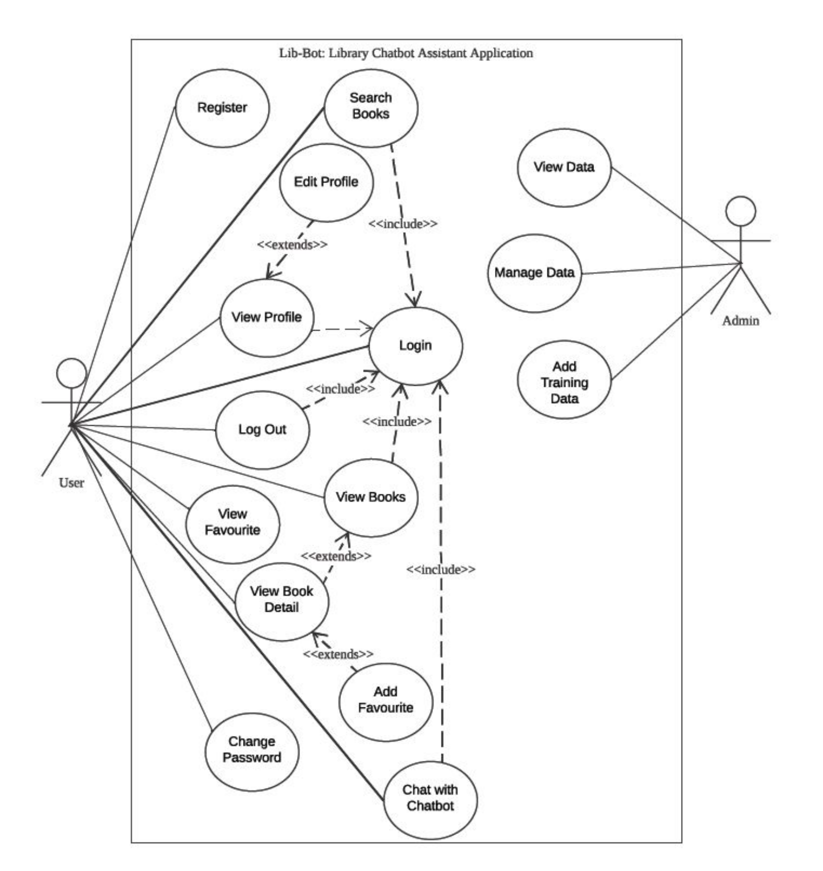
- **Integrated with a smart AI chatbot**
  - **Answer library-related question**
  - **Search and recommend books to user according to their book preferences**
  - **Speech-to-text recognition for user to input voice instead of typing**

PRESUMPTION

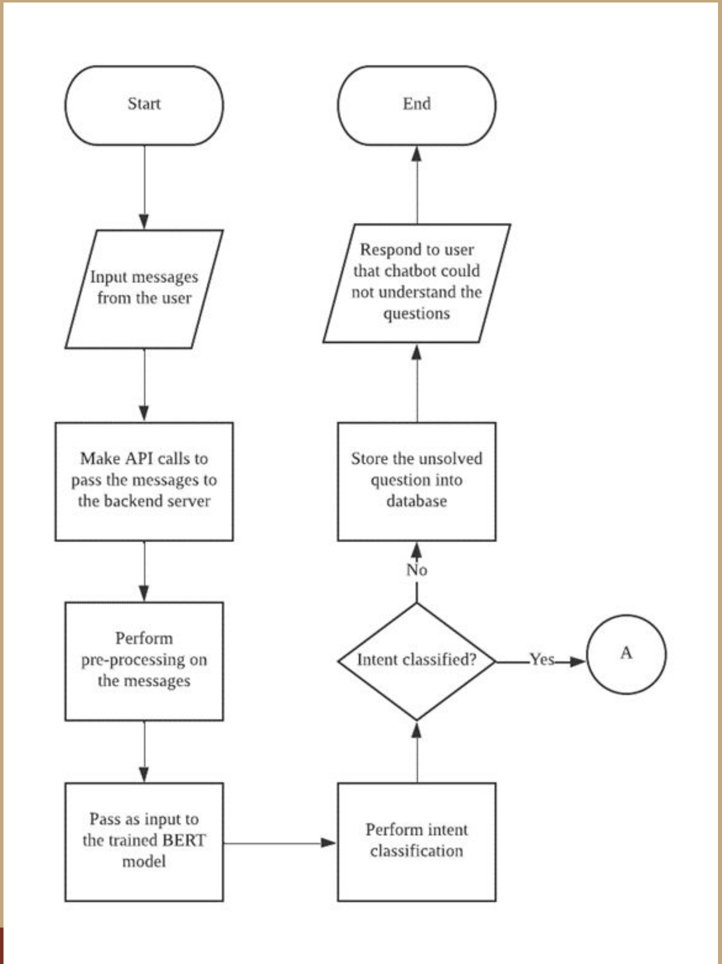
- **Input Messages:**
  - ❑ The length preferred to be as short as possible
  - ❑ One input message contain only one question
  - ❑ The language of the input messages must be English
  - ❑ Internet connection is required
  - ❑ The answer from the chatbot may be inaccurate

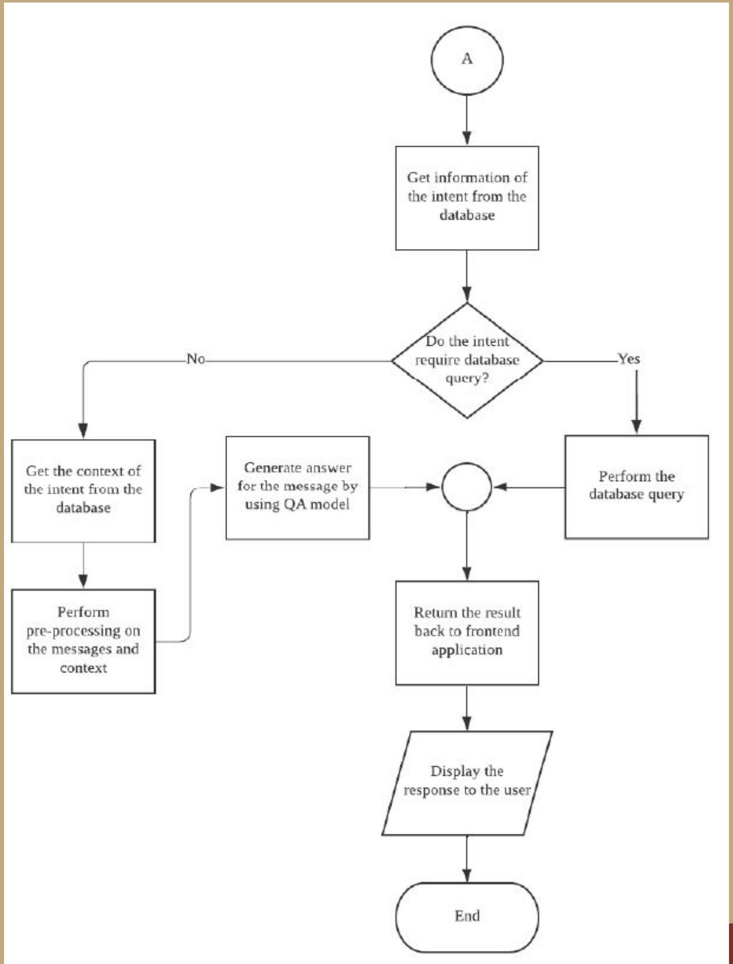
- **Speech-to-Text:**
  - ❑ A quiet environment is required
  - ❑ The converted input may need some manual correction from the user
  - ❑ The microphone access permission for the application needs to be granted

USE CASE DIAGRAM

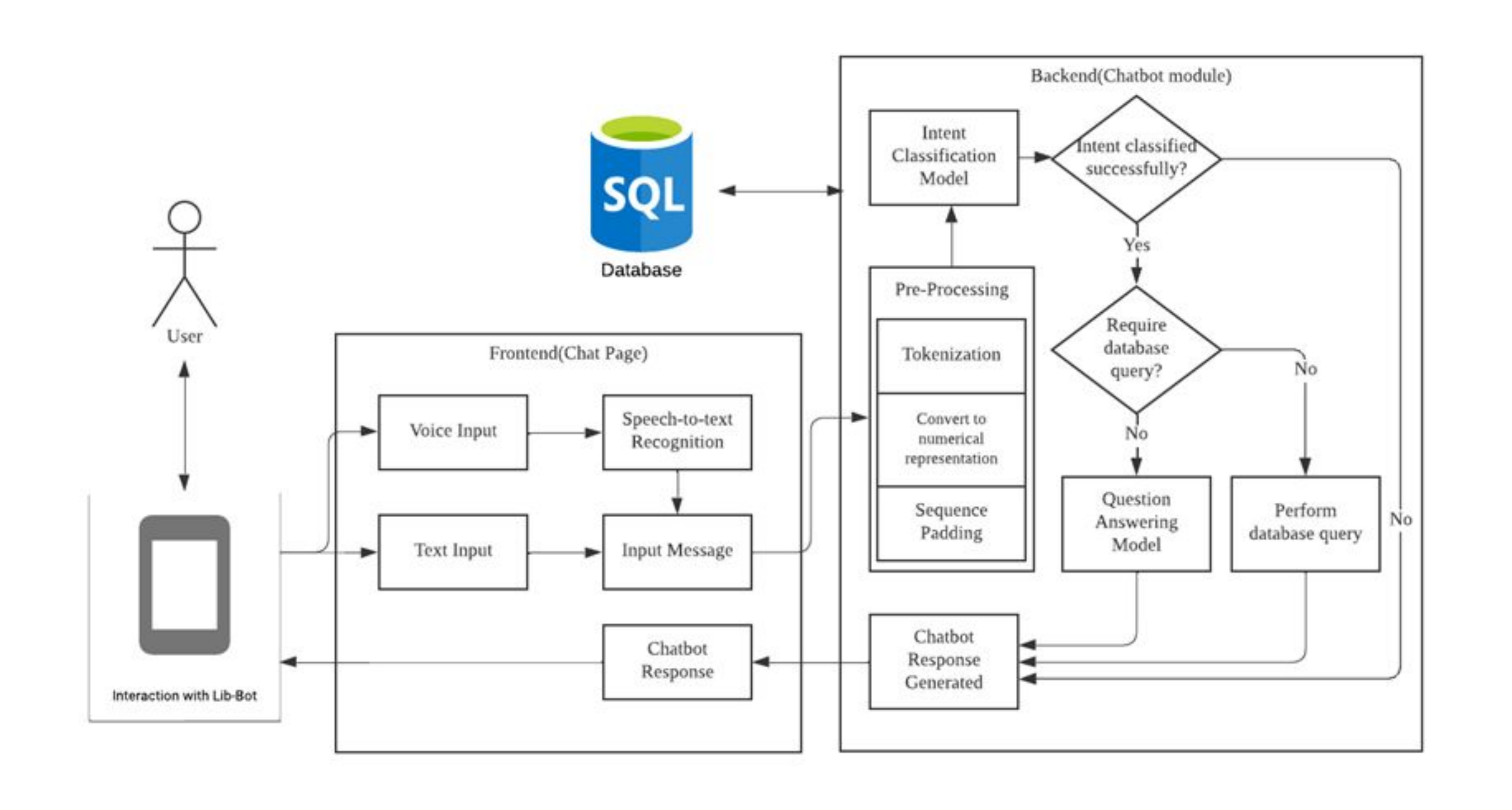


FLOWCHART OF GENERATING CHATBOT RESPONSE


Start
Input messages from the user
Make API calls to pass the messages to the backend server
Perform pre-processing on the messages
Pass as input to the trained BERT model
Perform intent classification
Intent classified?
Yes
A
No
Store the unsolved question into database
Respond to user that chatbot could not understand the questions
End


A
Get information of the intent from the database
Do the intent require database query?
No
Yes
Get the context of the intent from the database
Perform pre-processing on the messages and context
Generate answer for the message by using QA model
Perform the database query
Return the result back to frontend application
Display the response to the user
End

OVERALL DESIGN OF THE CHATBOT(LIB-BOT)



04

PROTOTYPE IMPLEMENTATION

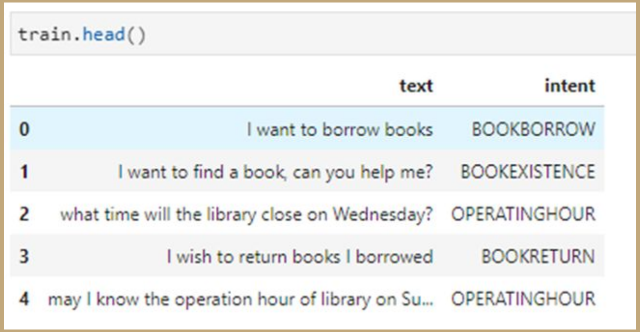
- Development Tools
- BERT Intent Classification Model
- Question Answering Model

DEVELOPMENT TOOLS

- **Flutter(Dart)**
  - ❑ Develop IOS and Android application with single codebase
  - ❑ Speech-to-text Recognition Plugin
  - ❑ Library mobile application
- **Anaconda JupyterLab:**
  - ❑ Tensorflow library version 2.5.0
  - ❑ Dataset Pre-processing(Tokenization, Convert to numeric representation, Padding)
  - ❑ Training of intent classification model
- **MySQL Database:**
  - ❑ Store data for the application(users, books) and for chatbot(unsolved queries, intents)
- **Backend:**
  - ❑ Python
  - ❑ Admin portal website(Python Flask Application)

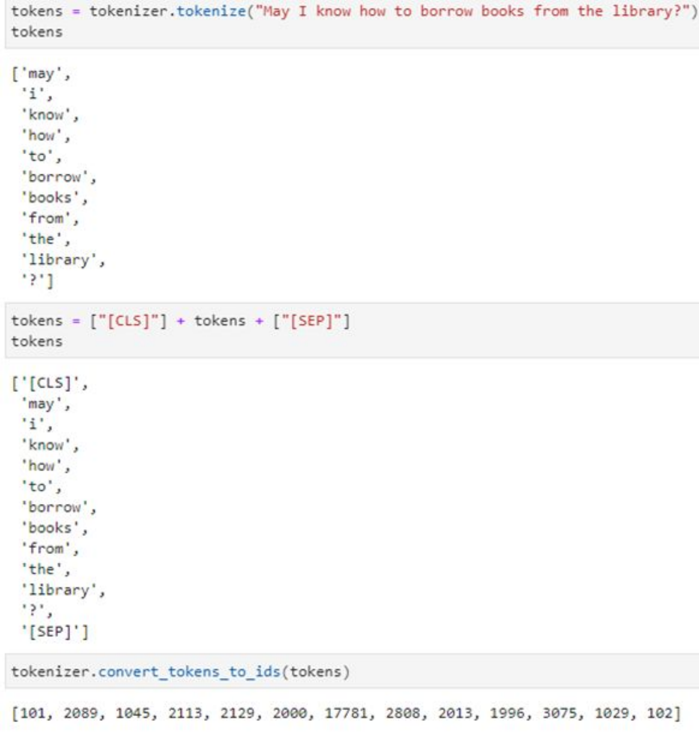
INTENT CLASSIFICATION MODEL

- **BERT algorithm**
  - ❑ Language model from Google
  - ❑ Masked Language Modelling (MLM) & Next Sentence Prediction(NPS)
- **Pre-processing:**
  - ❑ Tokenize
  - ❑ Add “[CLS]” and “SEP”
  - ❑ Convert to numeric representation
  - ❑ Add padding



```
train.head()
```

	text	intent
0	I want to borrow books	BOOKBORROW
1	I want to find a book, can you help me?	BOOKEXISTENCE
2	what time will the library close on Wednesday?	OPERATINGHOUR
3	I wish to return books I borrowed	BOOKRETURN
4	may I know the operation hour of library on Su...	OPERATINGHOUR



```
tokens = tokenizer.tokenize("May I know how to borrow books from the library?")
tokens
```

```
['may',
 'i',
 'know',
 'how',
 'to',
 'borrow',
 'books',
 'from',
 'the',
 'library',
 '?']
```

```
tokens = ["[CLS]"] + tokens + ["[SEP]"]
tokens
```

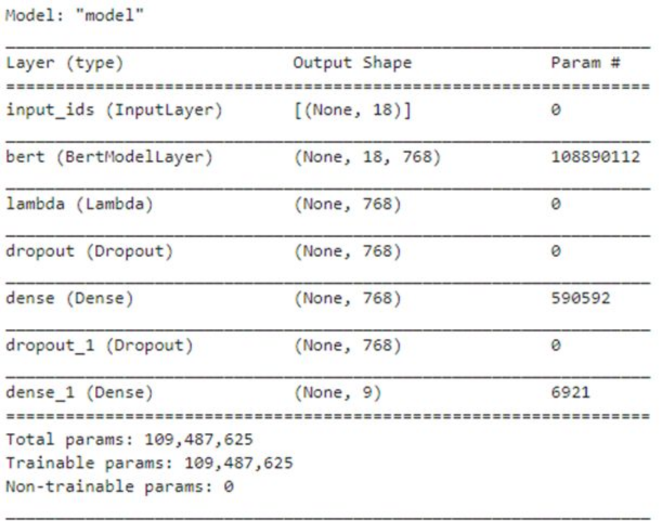
```
['[CLS]',
 'may',
 'i',
 'know',
 'how',
 'to',
 'borrow',
 'books',
 'from',
 'the',
 'library',
 '?',
 '[SEP]']
```

```
tokenizer.convert_tokens_to_ids(tokens)
```

```
[101, 2089, 1045, 2113, 2129, 2000, 17781, 2808, 2013, 1996, 3075, 1029, 102]
```

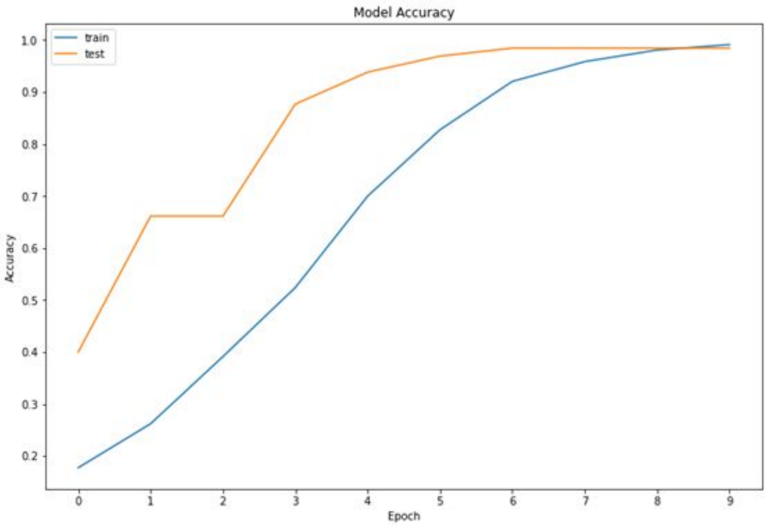
INTENT CLASSIFICATION MODEL

❑ Model Overview

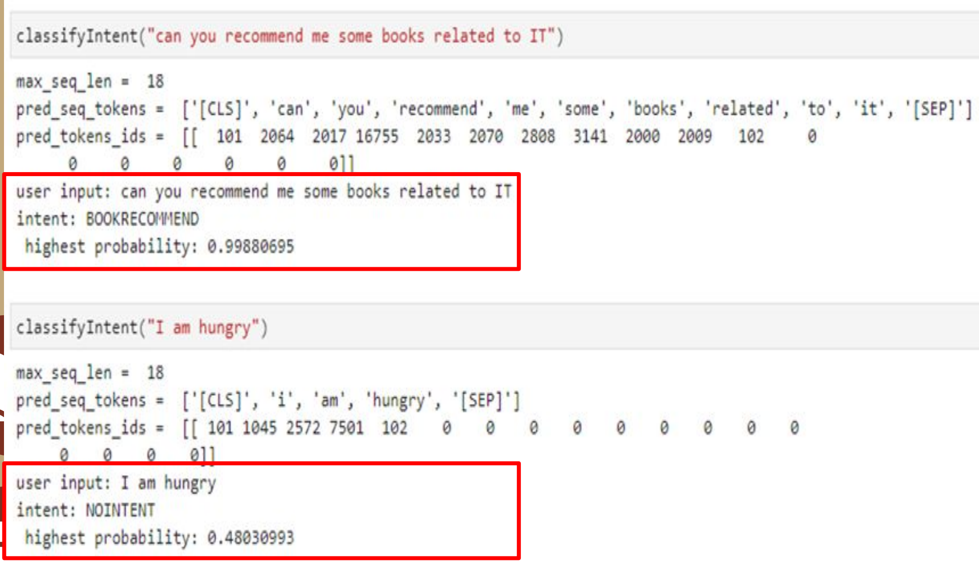


```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_ids (InputLayer)       [(None, 18)]              0
_________________________________________________________________
bert (BertModelLayer)        (None, 18, 768)           108890112
_________________________________________________________________
lambda (Lambda)              (None, 768)               0
_________________________________________________________________
dropout (Dropout)            (None, 768)               0
_________________________________________________________________
dense (Dense)                (None, 768)               590592
_________________________________________________________________
dropout_1 (Dropout)          (None, 768)               0
_________________________________________________________________
dense_1 (Dense)              (None, 9)                 6921
=================================================================
Total params: 109,487,625
Trainable params: 109,487,625
Non-trainable params: 0
_________________________________________________________________
```

❑ Result Evaluation

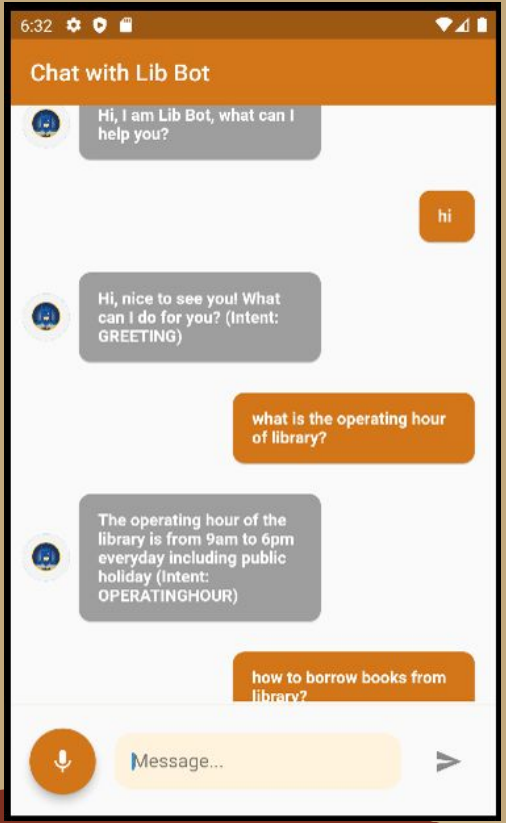


Application & Sample Output



```
classifyIntent("can you recommend me some books related to IT")

max_seq_len =  18
pred_seq_tokens =  ['[CLS]', 'can', 'you', 'recommend', 'me', 'some', 'books', 'related', 'to', 'it', '[SEP]']
pred_tokens_ids =  [[  101  2064  2017 16755  2033  2070  2808  3141  2000  2009   102     0
      0     0     0     0     0     0]]
user input: can you recommend me some books related to IT
intent: BOOKRECOMMEND
 highest probability: 0.99880695
```

```
classifyIntent("I am hungry")

max_seq_len =  18
pred_seq_tokens =  ['[CLS]', 'i', 'am', 'hungry', '[SEP]']
pred_tokens_ids =  [[ 101 1045 2572 7501  102    0    0    0    0    0    0    0    0    0
     0    0    0    0]]
user input: I am hungry
intent: NOINTENT
 highest probability: 0.48030993
```



Hi, I am Lib Bot, what can I help you?

hi

Hi, nice to see you! What can I do for you? (Intent: GREETING)

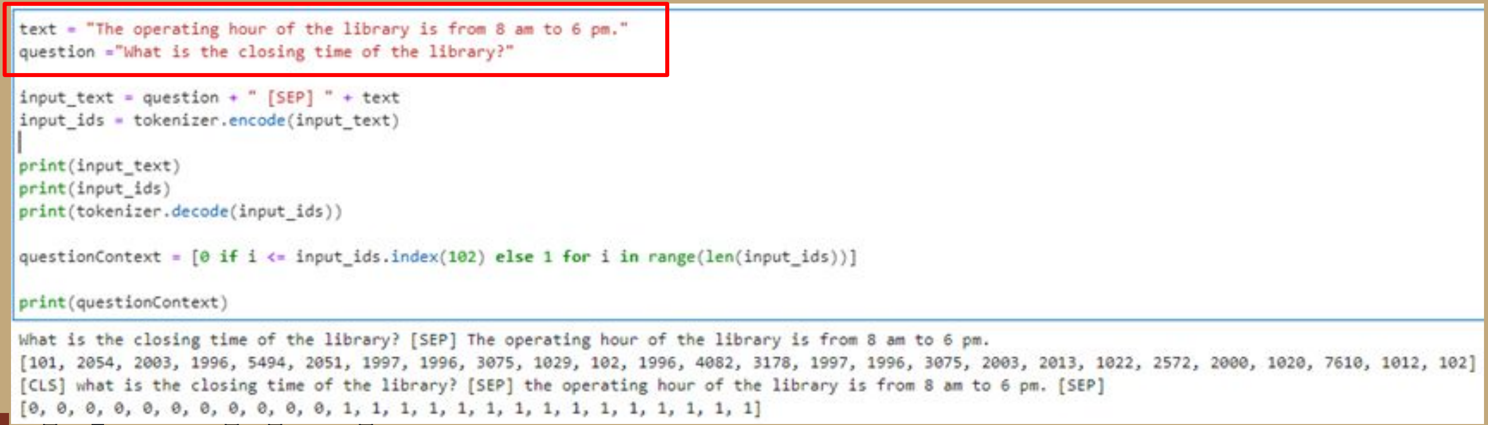
what is the operating hour of library?

The operating hour of the library is from 9am to 6pm everyday including public holiday (Intent: OPERATINGHOUR)

how to borrow books from library?

QUESTION ANSWERING MODEL

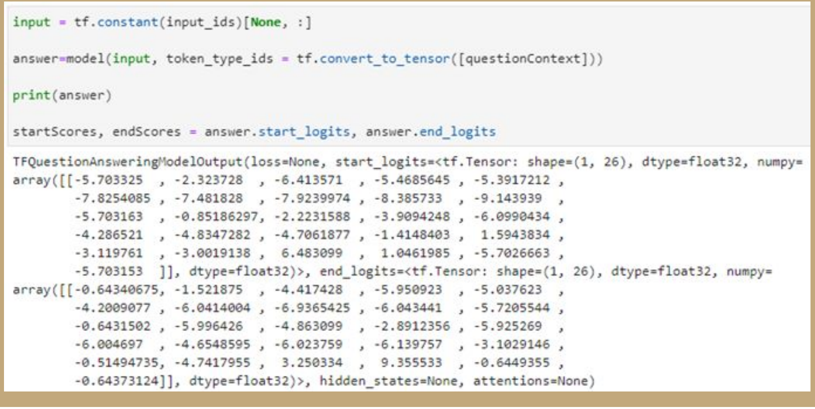
- **Uncased BERT QA Model Finetuned on SQUAD Dataset(Hugging Face)**
  - ❏ Generate answer of the question according to the given context
- **Pre-processing:**
  - ❏ Concatenate question and context
  - ❏ Add “[CLS]” symbol at beginning
  - ❏ Add “[SEP]” symbol between question and context and at the end



```
text = "The operating hour of the library is from 8 am to 6 pm."
question ="What is the closing time of the library?"

input_text = question + " [SEP] " + text
input_ids = tokenizer.encode(input_text)

print(input_text)
print(input_ids)
print(tokenizer.decode(input_ids))

questionContext = [0 if i <= input_ids.index(102) else 1 for i in range(len(input_ids))]

print(questionContext)
```

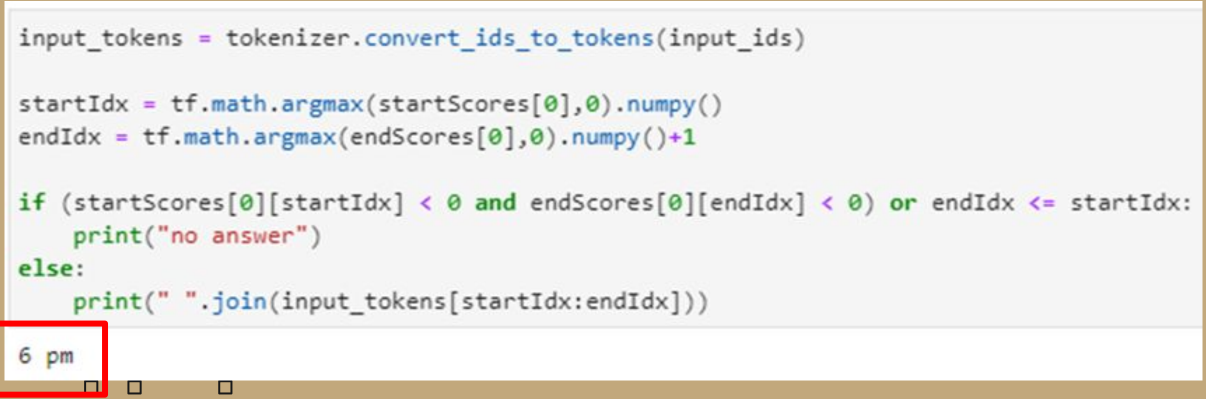
```
What is the closing time of the library? [SEP] The operating hour of the library is from 8 am to 6 pm.
[101, 2054, 2003, 1996, 5494, 2051, 1997, 1996, 3075, 1029, 102, 1996, 4082, 3178, 1997, 1996, 3075, 2003, 2013, 1022, 2572, 2000, 1020, 7610, 1012, 102]
[CLS] what is the closing time of the library? [SEP] the operating hour of the library is from 8 am to 6 pm. [SEP]
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
```

QUESTION ANSWERING MODEL



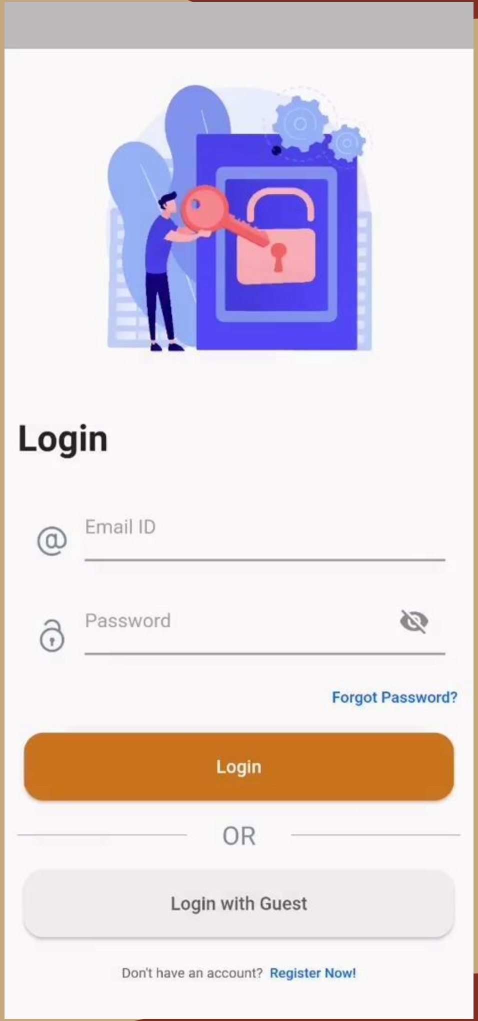
```
input = tf.constant(input_ids)[None, :]

answer=model(input, token_type_ids = tf.convert_to_tensor([questionContext]))

print(answer)

startScores, endScores = answer.start_logits, answer.end_logits
```

```
TFQuestionAnsweringModelOutput(loss=None, start_logits=<tf.Tensor: shape=(1, 26), dtype=float32, numpy=
array([[-5.703325  , -2.323728  , -6.413571  , -5.4685645 , -5.3917212 ,
        -7.8254085 , -7.481828  , -7.9239974 , -8.385733  , -9.143939  ,
        -5.703163  , -0.85186297, -2.2231588 , -3.9094248 , -6.0990434 ,
        -4.286521  , -4.8347282 , -4.7061877 , -1.4148403 ,  1.5943834 ,
        -3.119761  , -3.0019138 ,  6.483099  ,  1.0461985 , -5.7026663 ,
        -5.703153  ]], dtype=float32)>, end_logits=<tf.Tensor: shape=(1, 26), dtype=float32, numpy=
array([[-0.64340675, -1.521875  , -4.417428  , -5.950923  , -5.037623  ,
        -4.2009077 , -6.0414004 , -6.9365425 , -6.043441  , -5.7205544 ,
        -0.6431502 , -5.996426  , -4.863099  , -2.8912356 , -5.925269  ,
        -6.004697  , -4.6548595 , -6.023759  , -6.139757  , -3.1029146 ,
        -0.51494735, -4.7417955 ,  3.250334  ,  9.355533  , -0.6449355 ,
        -0.64373124]], dtype=float32)>, hidden_states=None, attentions=None)
```



```
input_tokens = tokenizer.convert_ids_to_tokens(input_ids)

startIdx = tf.math.argmax(startScores[0],0).numpy()
endIdx = tf.math.argmax(endScores[0],0).numpy()+1

if (startScores[0][startIdx] < 0 and endScores[0][endIdx] < 0) or endIdx <= startIdx:
    print("no answer")
else:
    print(" ".join(input_tokens[startIdx:endIdx]))
```

```
6 pm
```



Login

@
Email ID
Password
Forgot Password?
Login
OR
Login with Guest
Don't have an account? Register Now!

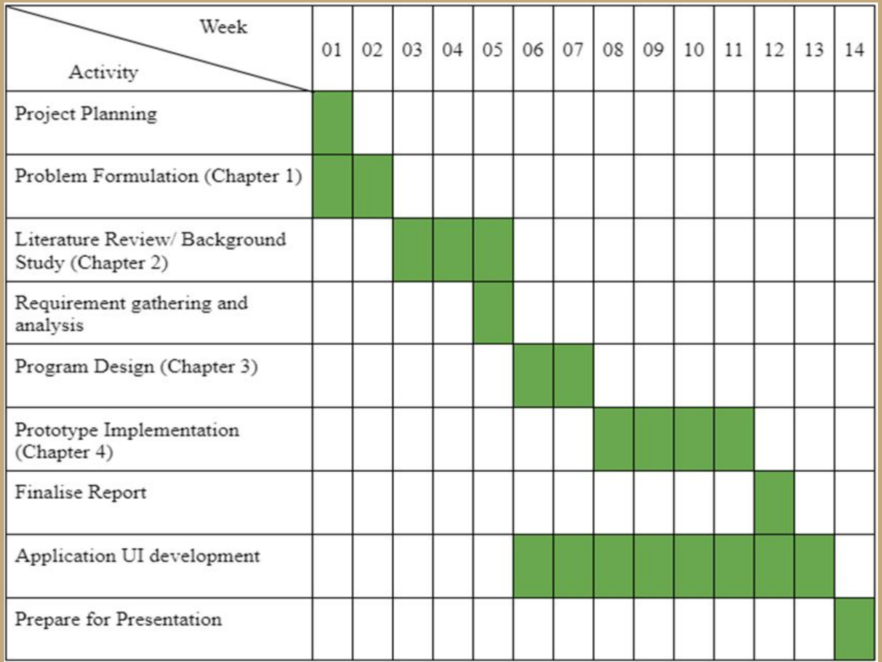
05

CONCLUSION

- Gantt chart
- What is achieved
- What need to be achieved

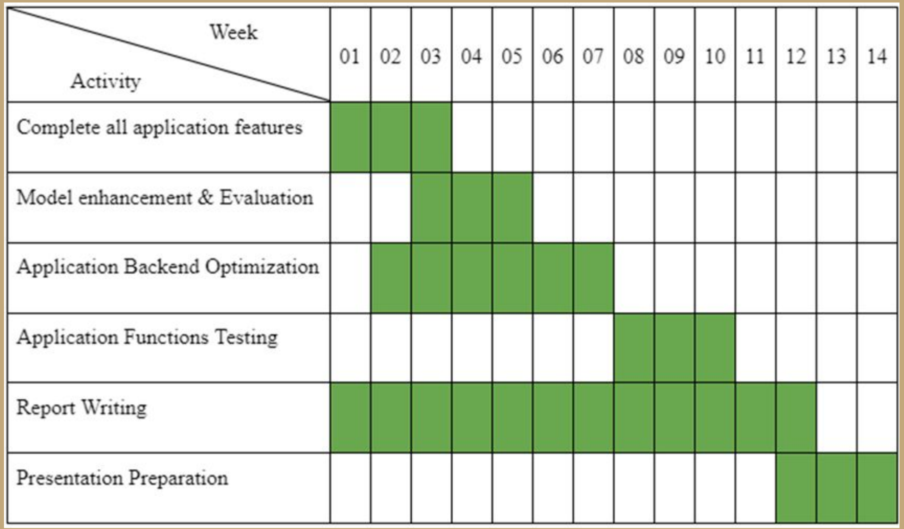
Gantt Chart

❑ FYP 1



Week Activity	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Project Planning	🟩													
Problem Formulation (Chapter 1)	🟩	🟩												
Literature Review/ Background Study (Chapter 2)			🟩	🟩	🟩									
Requirement gathering and analysis					🟩									
Program Design (Chapter 3)						🟩	🟩							
Prototype Implementation (Chapter 4)								🟩	🟩	🟩	🟩			
Finalise Report												🟩		
Application UI development						🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	
Prepare for Presentation														🟩

❑ FYP 2



Week Activity	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Complete all application features	🟩	🟩	🟩											
Model enhancement & Evaluation			🟩	🟩	🟩									
Application Backend Optimization		🟩	🟩	🟩	🟩	🟩	🟩							
Application Functions Testing								🟩	🟩	🟩				
Report Writing	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩		
Presentation Preparation												🟩	🟩	🟩

WHAT IS ACHIEVED

- Study on different chatbot development frameworks
- Research on machine learning & deep learning algorithms for chatbot development
- Find out pros and cons of existing chatbot-related applications
- Identified problem statements and objectives of the project
- Design and proposed methodology
- Trained BERT model for intent classification
- Completed the user interface of the application

WHAT NEED TO BE ACHIEVED

- Correct and complete the report
- Complete all application features especially backend functions
- Enhance the chatbot model
- Test all functionalities of the application

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THANK YOU
Q&A