

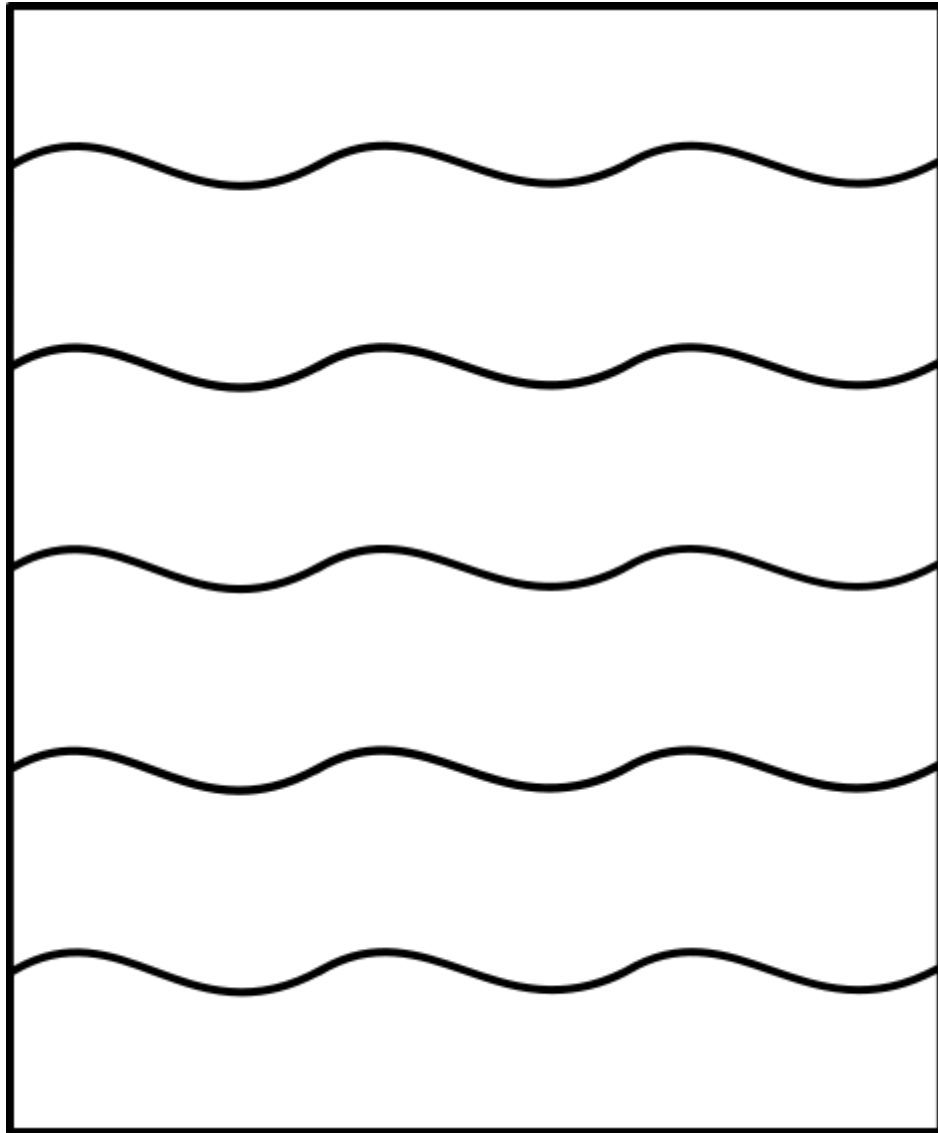
Chatbot Image adapted from <https://www.singlegrain.com/email-marketing/email-marketing-vs-chatbot-marketing-the-ultimate-showdown/>

FAQ CHATBOT WEB FRAMEWORK FOR COMPARISONS AND PERFORMANCE ANALYSIS

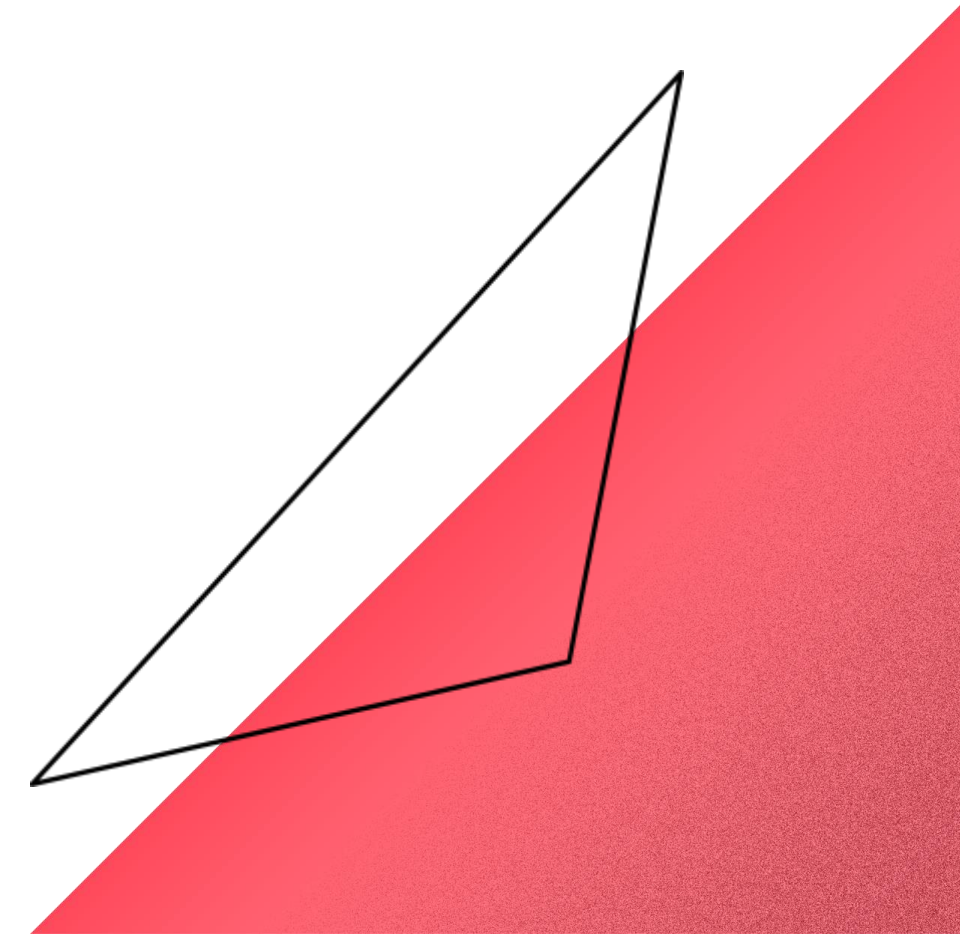
Presented By: Russell Chua Kui Hon
Supervisor: Associate Professor Chng Eng Siong
Examiner: Dr Smitha Kavallur Pisharath Gopi

OUTLINE

2

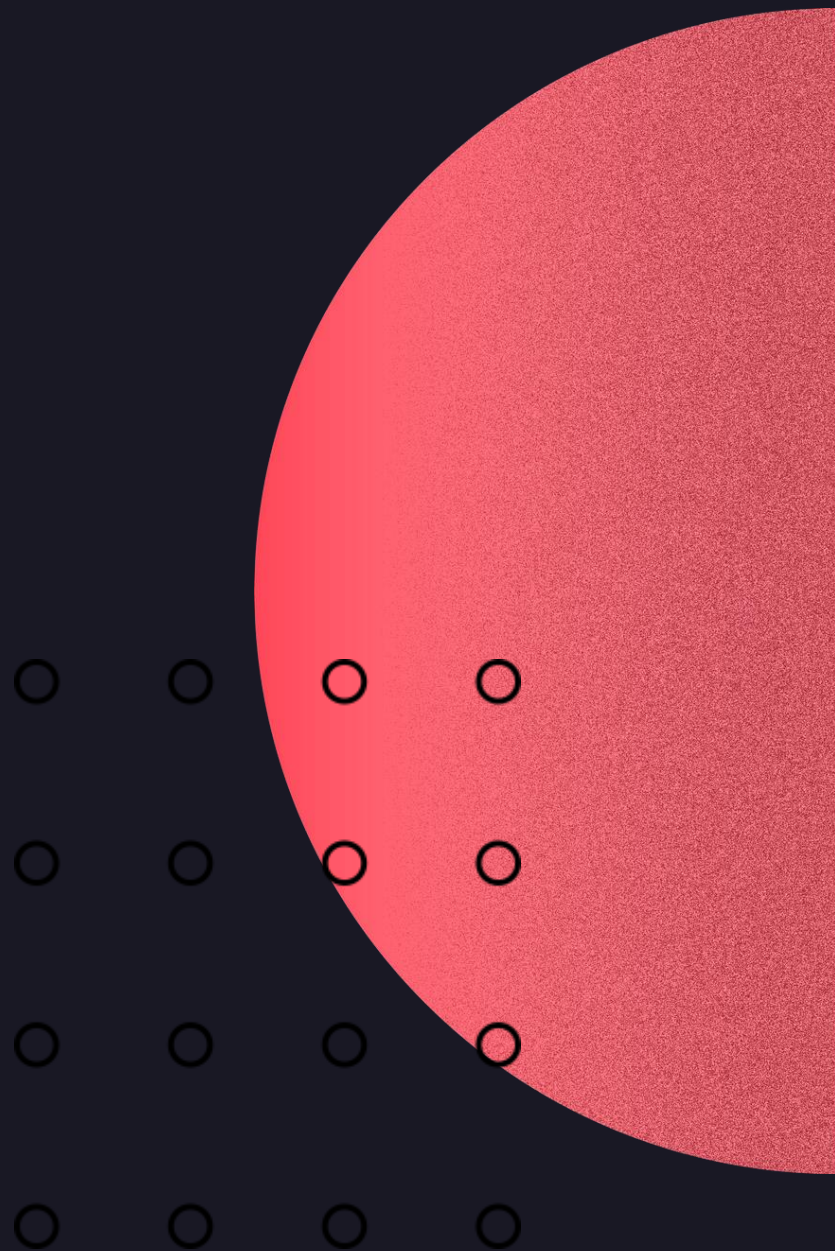


- INTRODUCTION
- CHATBOT SERVICES
- FRAMEWORK IMPLEMENTATION
- DATA PRE-PROCESSING
- FEATURES
- CONTRIBUTIONS
- FUTURE IMPLEMENTATIONS



Motivation

- To build a full stack web application that can support all types of Chat bot services
- Simulate various chat bot applications use cases
- Response Accuracy Comparisons
- Visual Assessment of Chatbot performance



INTRODUCTION

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Ask Jamie Banner adapted from
<https://www.profamilyleave.gov.sg/Pages/Virtual-Assistant.aspx>



Ask Jamie

- Virtual assistant developed by Gov tech agency
- Implemented across 70 government agency websites
- Used as a Benchmark model for other Chatbot services



Nanyang Technological
University Banner
adapted from
<https://www.ntu.edu.sg/>



Dialogflow Logo
adapted from
<https://dialogflow.com/>



Text Classification Model
adapted from
<https://medium.com/@bedigunjit/simple-guide-to-text-classification-nlp-using-svm-and-naive-bayes-with-python-421db3a72d34>

INTRODUCTION

5

Dashboard Chart

This is a Chatbot for MSF babybonus FAQ
Chatbot Framework for Babybonus FAQs, input via text
or real-time audio streaming to get responses from
different chatbots

Read
how can my organization apply for the baby bonus. [...tell me more about.]

START STREAMING STOP STREAMING

☒ Dialogflow ☐ MICL ☒ DNN

Ask Jamie

To join the Baby Bonus Scheme, please start by checking your child's eligibility on Baby Bonus Online. If your child qualifies, you may proceed to apply by following these steps.

STEP 1: Visit Baby Bonus Online.

STEP 2: Click "Join". It will...

Text Classification Model

You can check your organisation's eligibility to be a Baby Bonus Approved Institution on the Approved Institution Portal.

Dialogflow

For an organisation to become a Baby Bonus Approved Institution (AI), please visit the Baby Bonus Online Approved Institutions Portal and: Select "Join Using CorpPass". Complete all fields in capital letters. Ensure that the UEN or Unique Entity Number and...

Similarity Score 0.21

Similarity Score 0.33

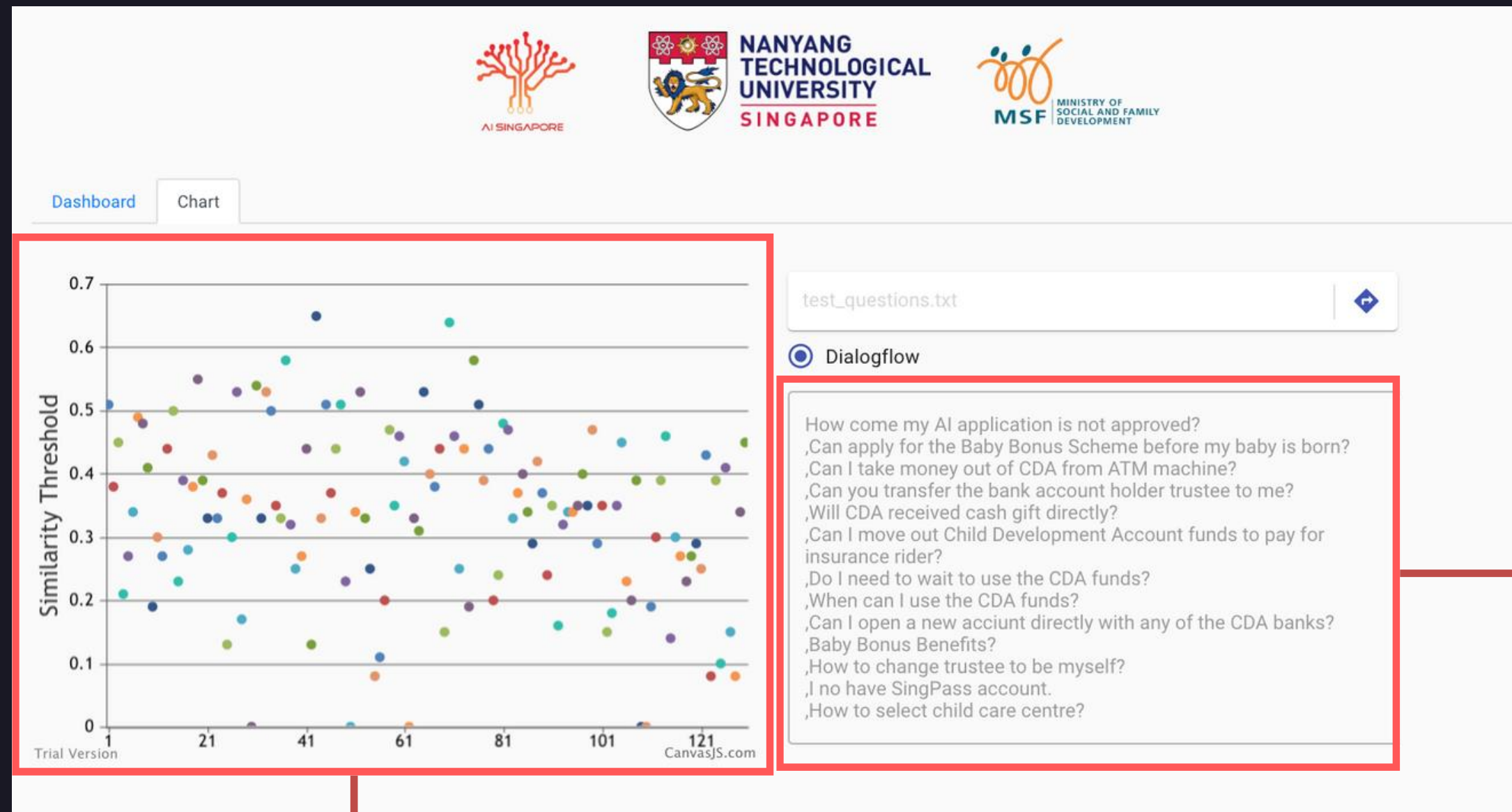
Input and Speech Solution

Modular Chatbot Service

Response Comparison

INTRODUCTION

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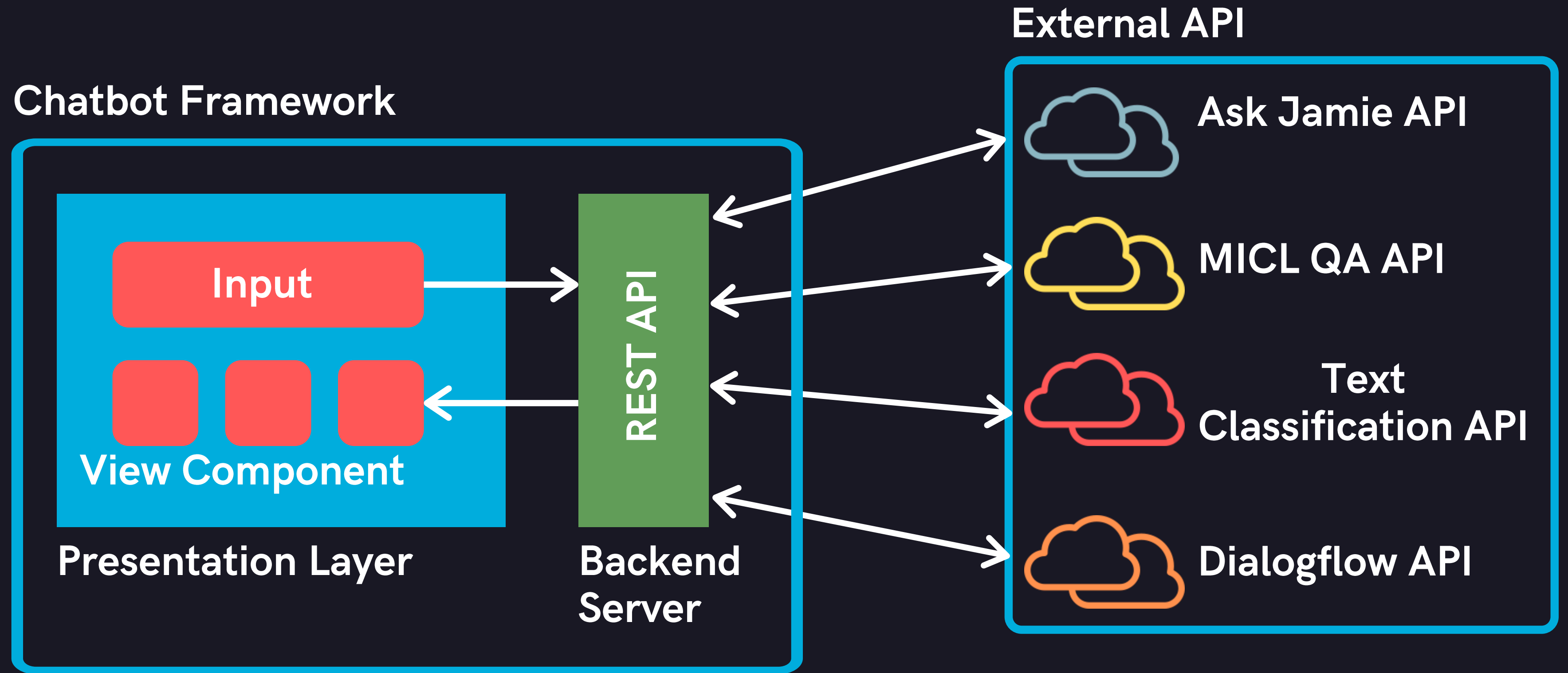


Batch Intent Upload

Chatbot Performance Visualization

INTRODUCTION

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CHATBOT SERVICES

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PROVIDED MODELS

- ASK JAMIE
- MICL LABS QA MODEL

SELF-TRAINED MODELS

- DIALOGFLOW
- TEXT CLASSIFICATION MODEL

CHATBOT SERVICES

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MSF Banner adapted from <https://www.msf.gov.sg/>



Ask Jamie Banner adapted from <https://www.babybonus.msf.gov.sg/>

Chatbot Context

- Ministry of social and family development's Baby Bonus
- Wider age group user base and varied English competency



MICL QA Matching

- QA matching model designed by graduate student
- Leveraging advanced Natural Language Processing model for QA matching
- Contacted through API service hosted in MICL Lab

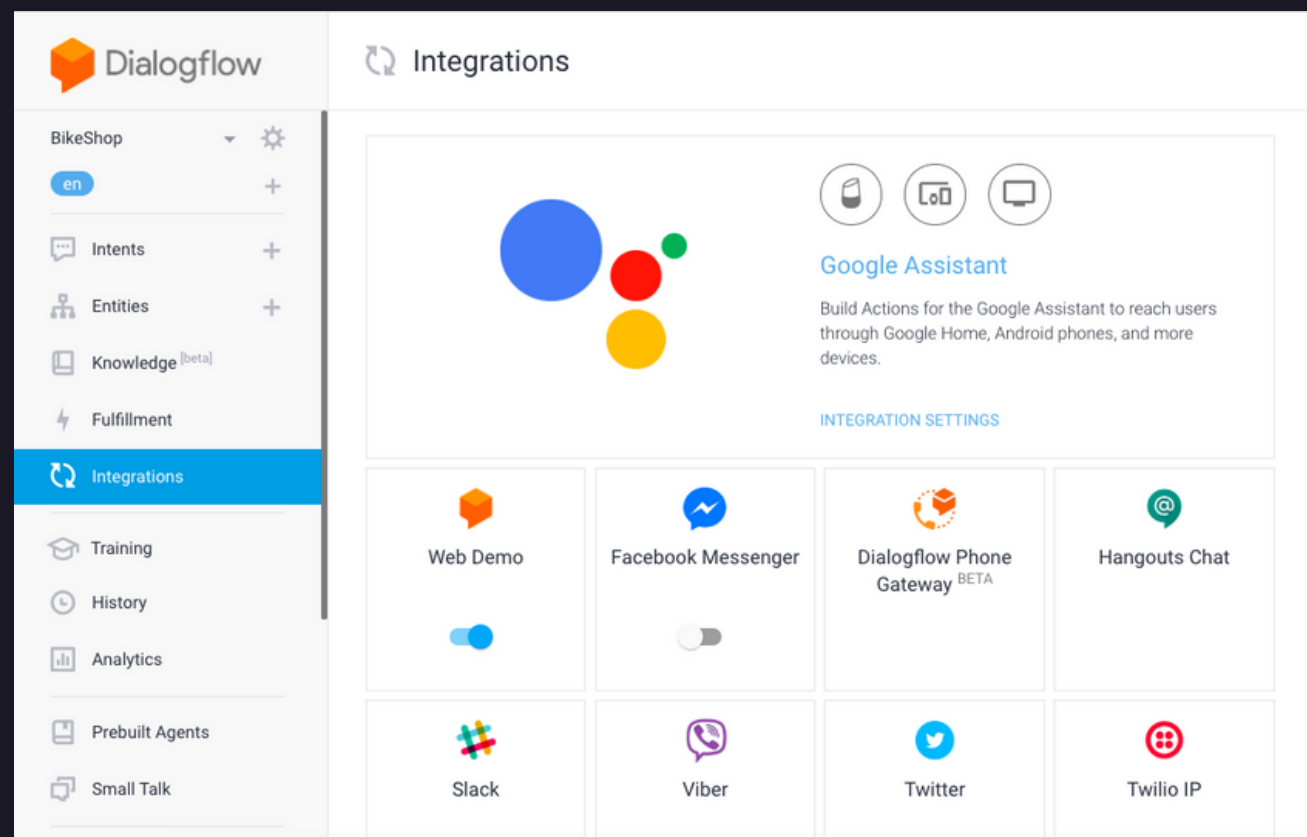
CHATBOT SERVICES

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Dialogflow

- Open source natural language processing platform developed by Google
- Client interface to build conversational applications
- Client API for intention uploading



*Dialogflow Interface Screenshot adapted from
<https://dialogflow.com/>*



Text Classification Model

- Question prediction platform written in python
- Trains permutations of questions and builds a model to predict question given different inputs

CHATBOT FRAMEWORK IMPLEMENTATION



React

*React Logo adapted from
<https://reactjs.org/>*



*Node Logo adapted from
<https://nodejs.org/>*

Express



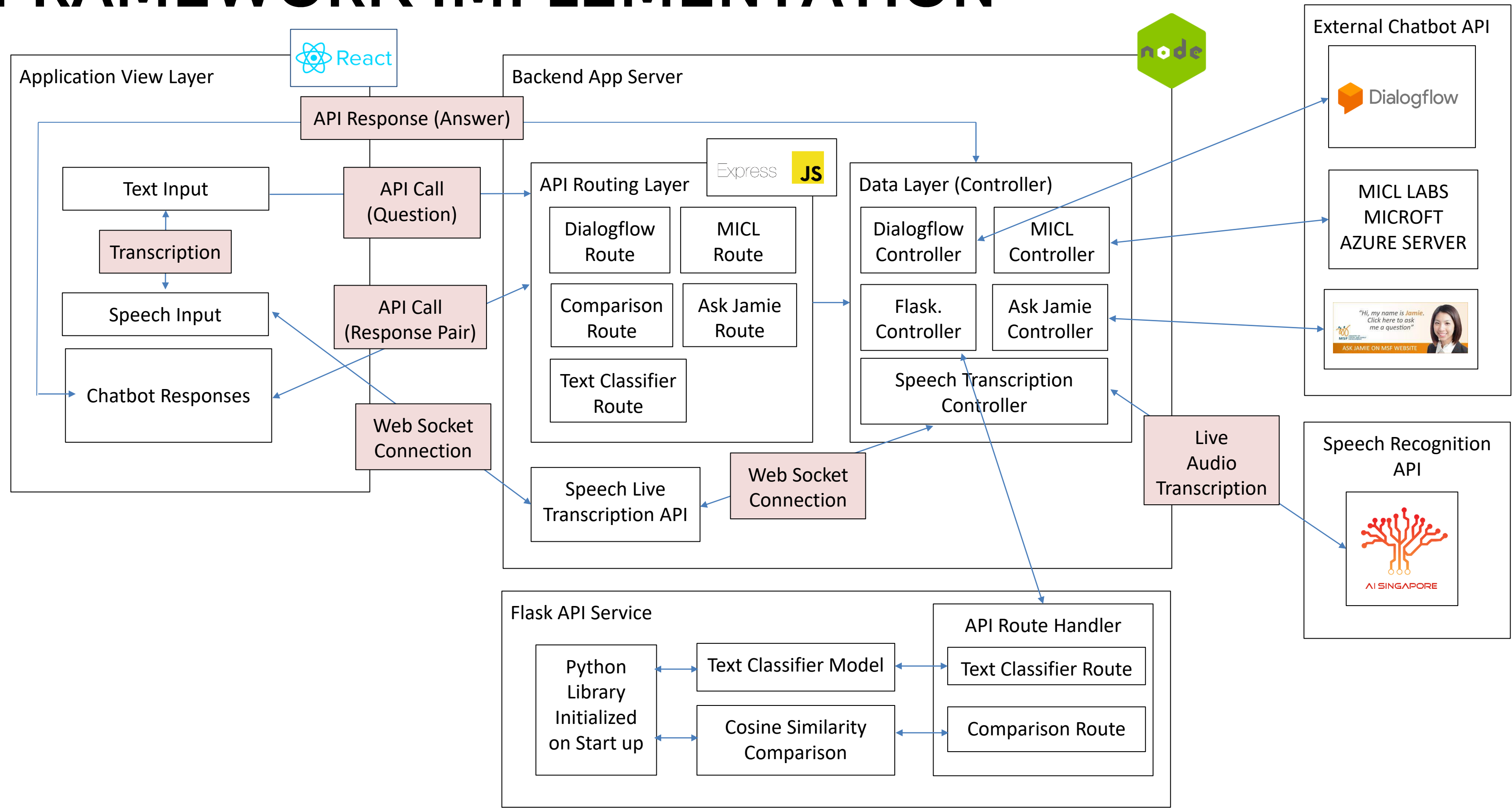
*Express Logo adapted from
<https://expressjs.com/>*



Flask

*Flask Logo adapted from
<https://flask.palletsprojects.com/>*

FRAMEWORK IMPLEMENTATION



FRAMEWORK IMPLEMENTATION

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Application View

State

Component 1 [DOM]

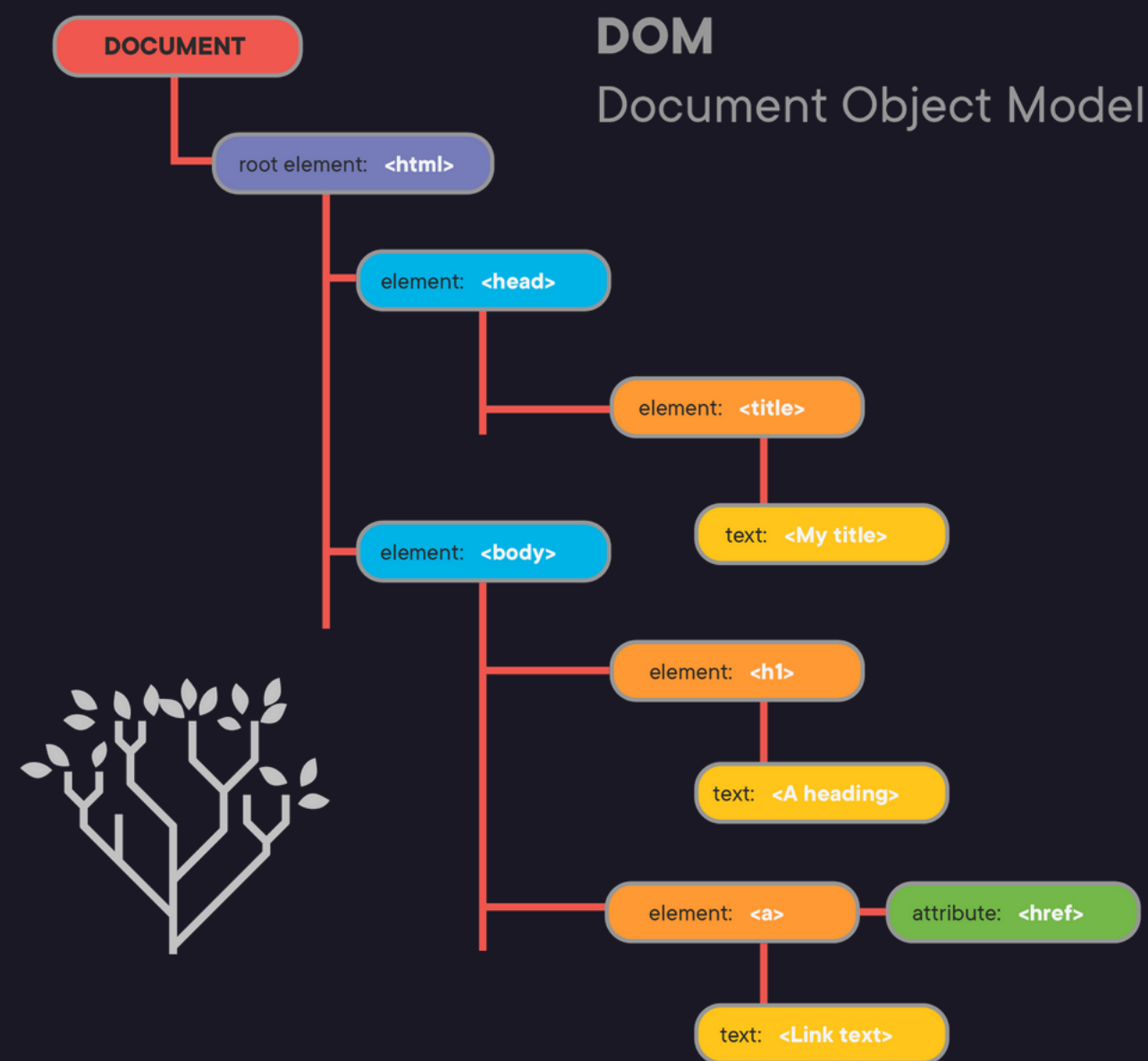
Component 2 [DOM]

React JS Front End

- Anchor of the stack
- Provides the overall view for the application
- Chosen for Virtual Document Object Model

Document Object Model

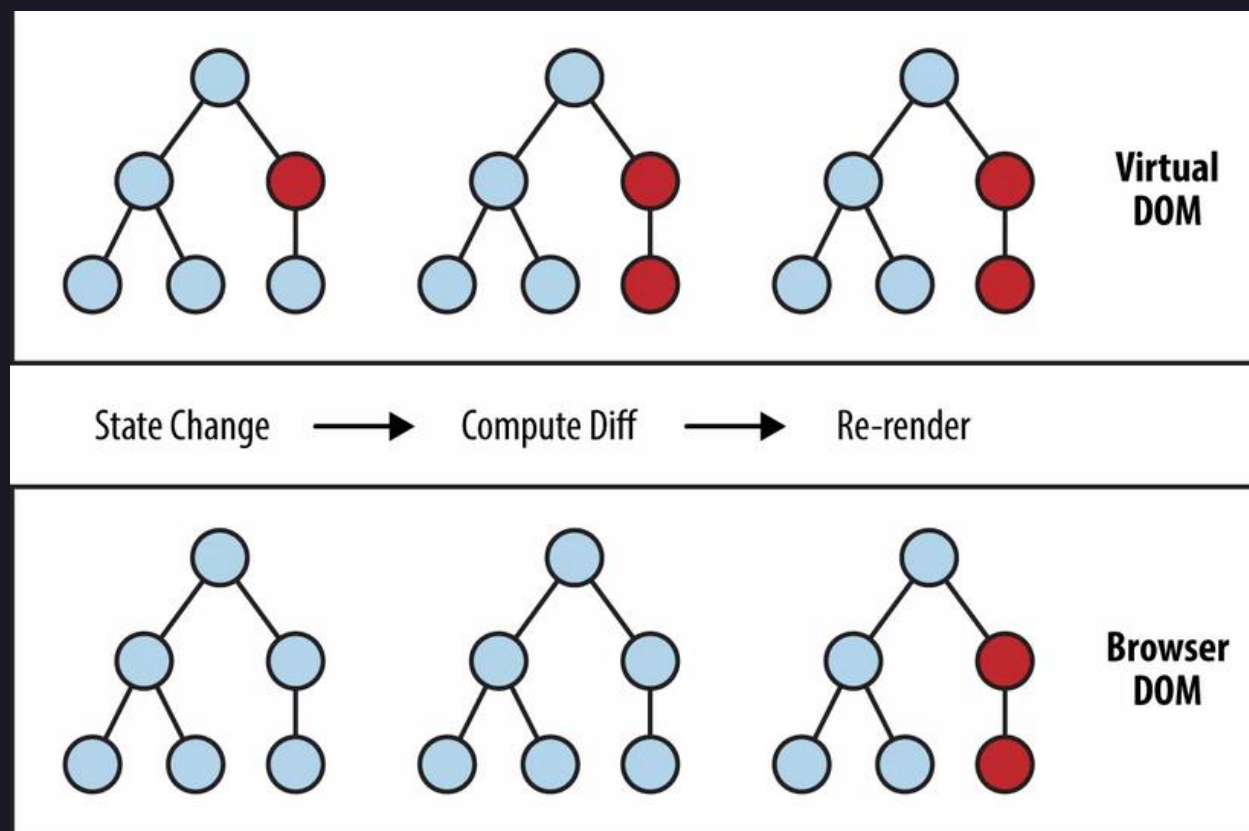
- Tree Data structure for fast and efficient manipulation
- Allows for dynamic page updates without web page refresh
- Heavy pages requires constant updating of nodes



DOM tree structure adapted from
<https://learn.co/lessons/fewpjs-the-dom-tree>

React Virtual DOM

- Virtual copy of the DOM structure
- New Virtual DOM will be created on every update
- Node differences will be computed and only affected nodes will be updated on DOM



Virtual DOM vs DOM adapted from
<https://programmingwithmosh.com/react/react-virtual-dom-explained/>

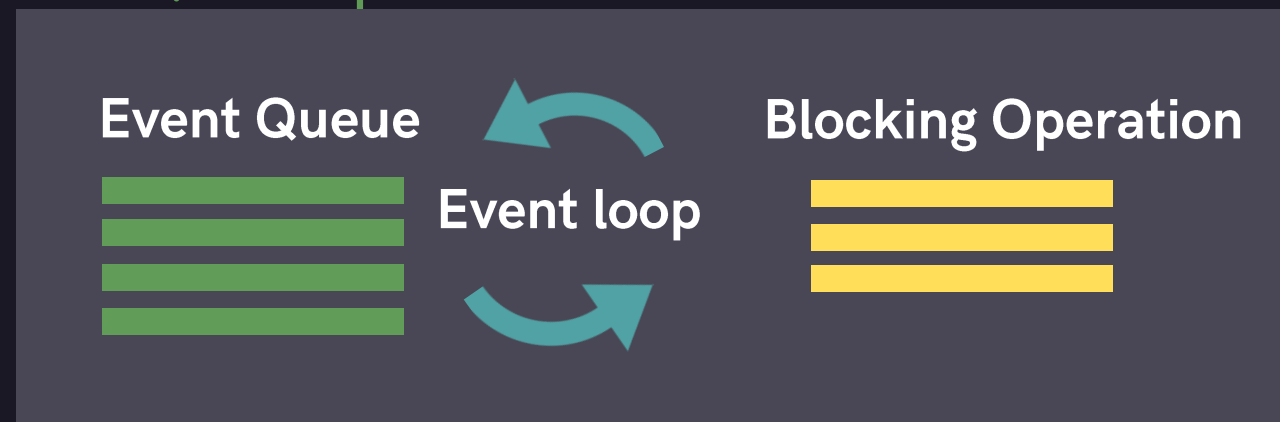
FRAMEWORK IMPLEMENTATION

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JavaScript Engine

Node JS Binding

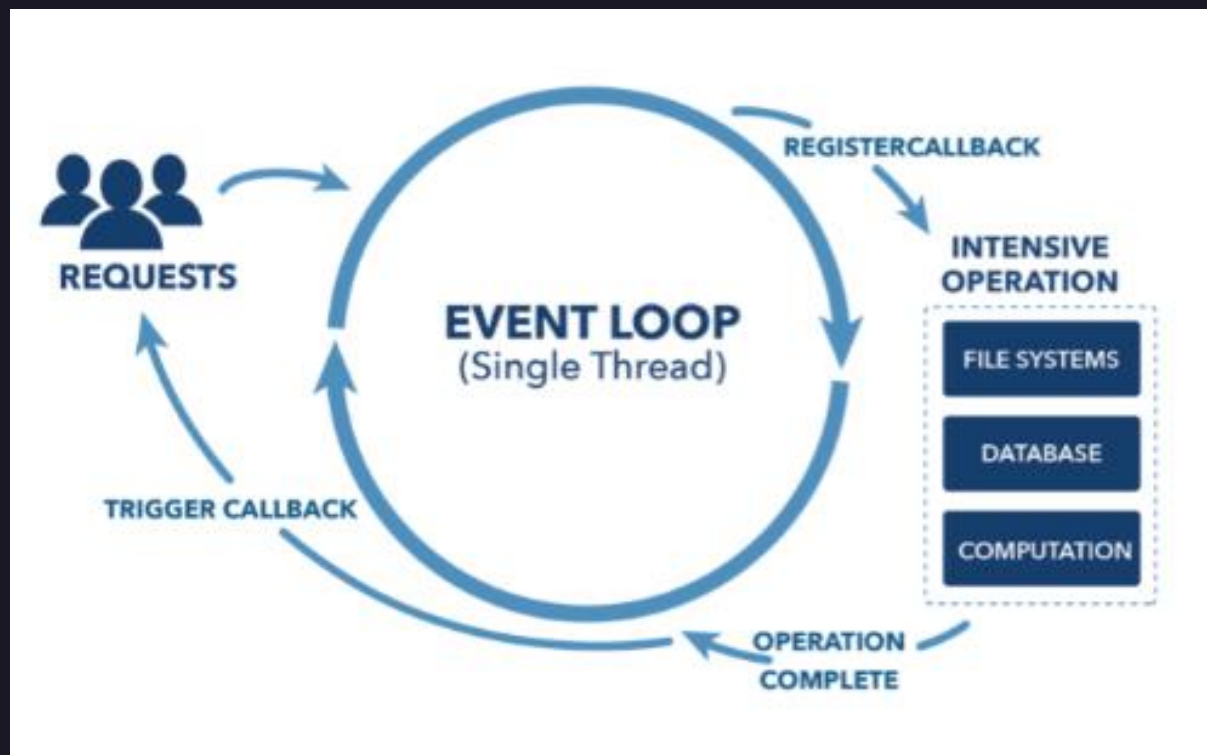


**Achieve Asynchronous
Communication**

Node JS Back End

- Light-weight, event driven model to handle data intensive requests
- Capable of providing persistent and real time data streaming
- Highly Scalable

Node Asynchronous Model

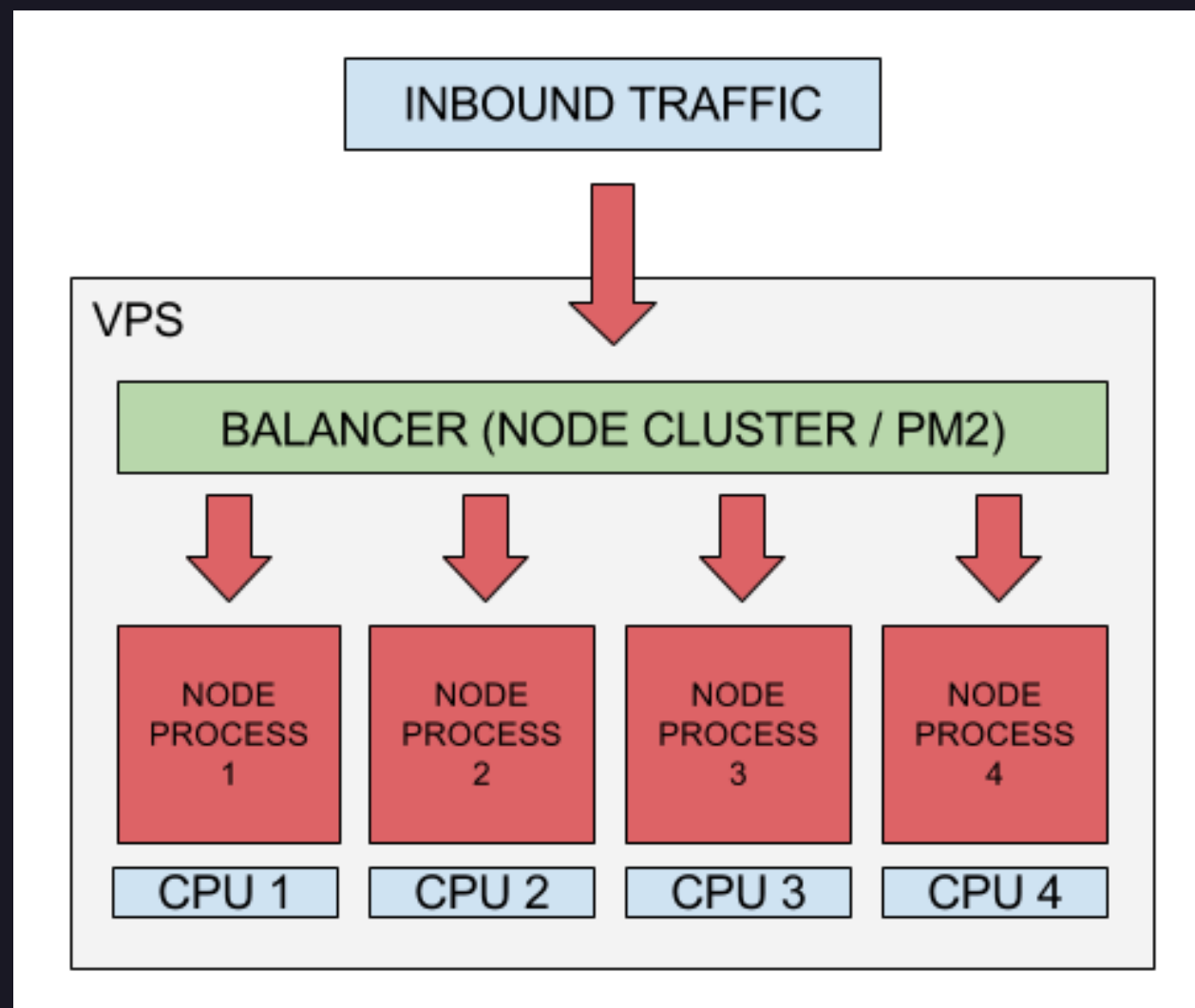


Event Loop adapted from
<https://webapplog.com/event-loop/>

- Single threaded and event driven
- Efficient concurrency management of requests
- Event loops to simulate non-blocking events eliminating use of threads

Performance and Scalability

- Horizontal Scaling
- Internal load balancing for parallel processing on the same machine



Scalability Practices adapted from
<https://medium.com/iqiii/good-practices-for-high-performance-and-scalable-node-js-applications-part-1-3-bb06b6204197>

FRAMEWORK IMPLEMENTATION

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REQUEST



API ENDPOINT

ROUTE 1

ROUTE 2

ROUTE 3

Express JS Middle-ware

- Minimal Node JS web application framework
- Light-weight REST API middle-ware to handle data intensive requests
- Route management for HTTP requests



API REQUEST



API ENDPOINT

RESPONSE
COMPARATOR

QA
MODELS

PYTHON LIBRARIES

Flask Micro Framework

- Python web application framework
- Leverage Python Natural language processing libraries
- Responsible for response comparator service written in Python

DATA PRE-PROCESSING

SELF-TRAINED MODELS

- DIALOGFLOW
- TEXT CLASSIFICATION MODEL

FAQ Input Permutations

Permutations of 'How can my organisation apply to be a Baby Bonus Approved Institution?':

Where should my organisation apply to be a Baby Bonus Approved Institution?
What does my organisation need to apply to be a Baby Bonus Approved Institution?
Where could my organisation apply to be a Baby Bonus Approved Institution?
Where can my organisation apply to be a Baby Bonus Approved Institution?
How should my organisation apply to be a Baby Bonus Approved Institution?
How could my organisation apply to be a Baby Bonus Approved Institution?
What do my organisation have to do to apply to be a Baby Bonus Approved Institution?
Where shall my organisation apply to be a Baby Bonus Approved Institution?
How does my organisation apply to be a Baby Bonus Approved Institution?
What do my organisation need to apply to be a Baby Bonus Approved Institution?
How shall my organisation apply to be a Baby Bonus Approved Institution?
What does my organisation have to do to apply to be a Baby Bonus Approved Institution?
How do my organisation apply to be a Baby Bonus Approved Institution?
Where do my organisation apply to be a Baby Bonus Approved Institution?
Where does my organisation apply to be a Baby Bonus Approved Institution?

- Input Permutation of 300 baby bonus FAQ model questions
- Each model question consist of thousands of possible permutations

Model Question Answer

0	How can my organisation apply to be a Baby	For an organisation to become a Baby Bonus Approved Institution (AI), please visit the Baby Bonus
1	I have entered the Unique Entity Number (UEN)	If the system does not have a record of your Unique Entity Number (UEN), you can still proceed to
2	I have entered the Unique Entity Number (UEN)	To join as an Approved Institution (AI), please verify your Unique Identity Number or UEN again if
3	Is there a validity period to be a Baby Bonus	There is no validity period to be a Baby Bonus Approved Institution (AI). However, the approval
4	How much does an organisation need to pay to	No payment is required to register as an Approved Institution (AI) with the Ministry of Social and
5	Why is my Approved Institution (AI) application	If your institution has been licensed or registered with the relevant governing body but your
6	Who do I contact for enquiries and feedback on	For enquiries and feedback on Approved Institutions (AI), you may write to us using this form.
7	Where can I find the list of optical shops, which	To find the list of optical shops which allow the use of Child Development Account funds, you can
8	How do I find out more information about	To find more about Approved Institutions (AIs), please visit our Approved Institution Portal.
9	If an AI makes a refund into the CDA, how long	You may want to check with the AI directly on the processes and when the refund will be
10	My centre is an Approved Institution. Can I	If you would like to request for an additional or higher-resolution Baby Bonus Approved Institution

- Model question and answer pairs obtained from Baby bonus
- Used for direct retrieval of responses given identified intentions

DATA PRE-PROCESSING

Permutations of 'How can my organisation apply to be a Baby Bonus Approved Institution?':

Where should my organisation apply to be a Baby Bonus Approved Institution?
What does my organisation need to apply to be a Baby Bonus Approved Institution?
Where could my organisation apply to be a Baby Bonus Approved Institution?
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Where do my organisation apply to be a Baby Bonus Approved Institution?
Where does my organisation apply to be a Baby Bonus Approved Institution?

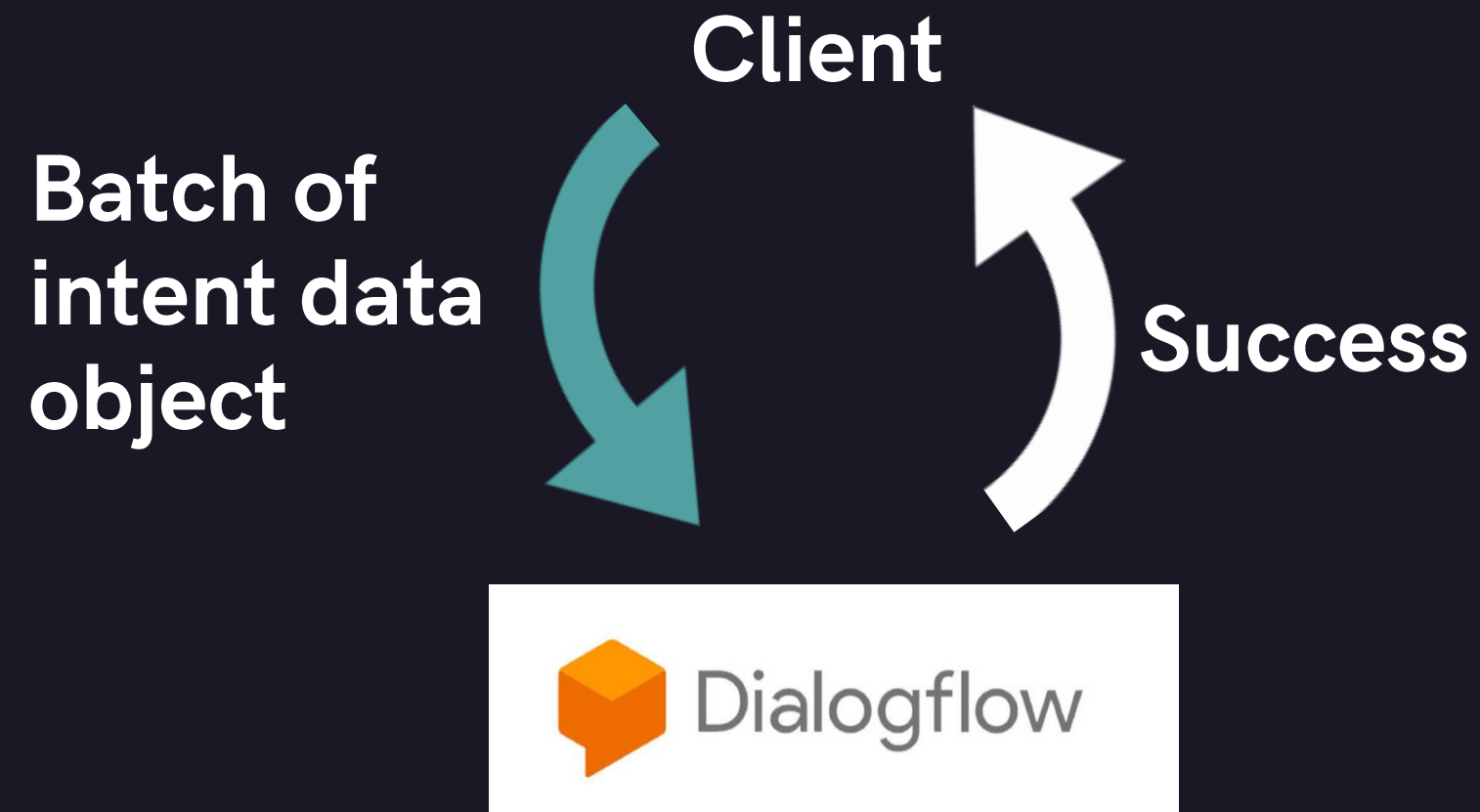


0	How can my organisation apply to be a Baby	For an organisation to become a Baby Bonus Approved Institution (AI), please visit the Baby Bonus
1	I have entered the Unique Entity Number (UEN)	If the system does not have a record of your Unique Entity Number (UEN), you can still proceed to
2	I have entered the Unique Entity Number (UEN)	To join as an Approved Institution (AI), please verify your Unique Identity Number or UEN again if
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10	My centre is an Approved Institution. Can I	If you would like to request for an additional or higher-resolution Baby Bonus Approved Institution

Intent Permutation

Model QA

{
Intent: Model Question,
Pattern: [Permutation,...],
Response: Model Answer
}



Training of Dialogflow

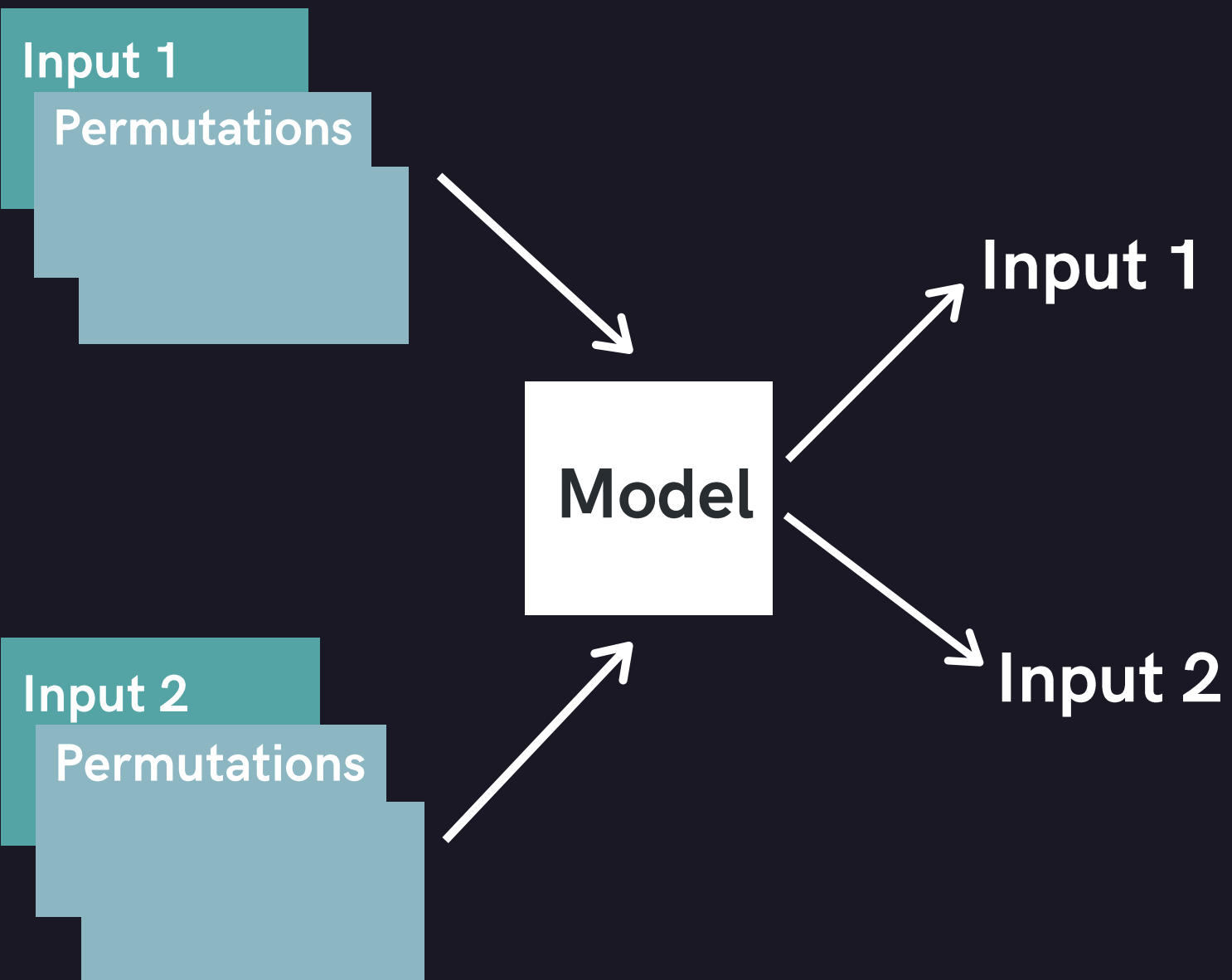
- Usage of Dialogflow API for intent uploading
- Batch uploading of intent object due to request restrictions

DATA PRE-PROCESSING

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```
train_x: [0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,  
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,  
0, 0, 0, 0, 1, 0, 0, 0, 1]
```

```
train_y: [0, 0, 1, 0, 0, 0, 0, 0, 0]
```



Training of Text Classification Model

- Tokenization of permutations
- Unionization of unique tokenized words
- Bag of words vectors developed for each permutation

FEATURES

TEXT INPUT

SPEECH INPUT

RESPONSE COMPARISON

PERFORMANCE ANALYSIS

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Input
FAQ

SUBMIT

☐

Speech to Text Disabled.
Select switch to enable speech

Read
<unk> [...]tell me more about.]

☐ Dialogflow ☐ MICL ☐ DNN

Start

Starts listening for speech, i.e. starts recording and transcribing.

☒ Dialogflow ☐ MICL ☒ DNN

Ask Jamie

For an organisation to be a Baby Bonus AI, please apply through the Baby Bonus Online AI Portal by following these steps:- Select 'Join Using CorpPass'. Complete all fields in capital letters. Ensure that the UEN and Institution Code are...

Similarity Score 0.28

Feed Forward Neural Network

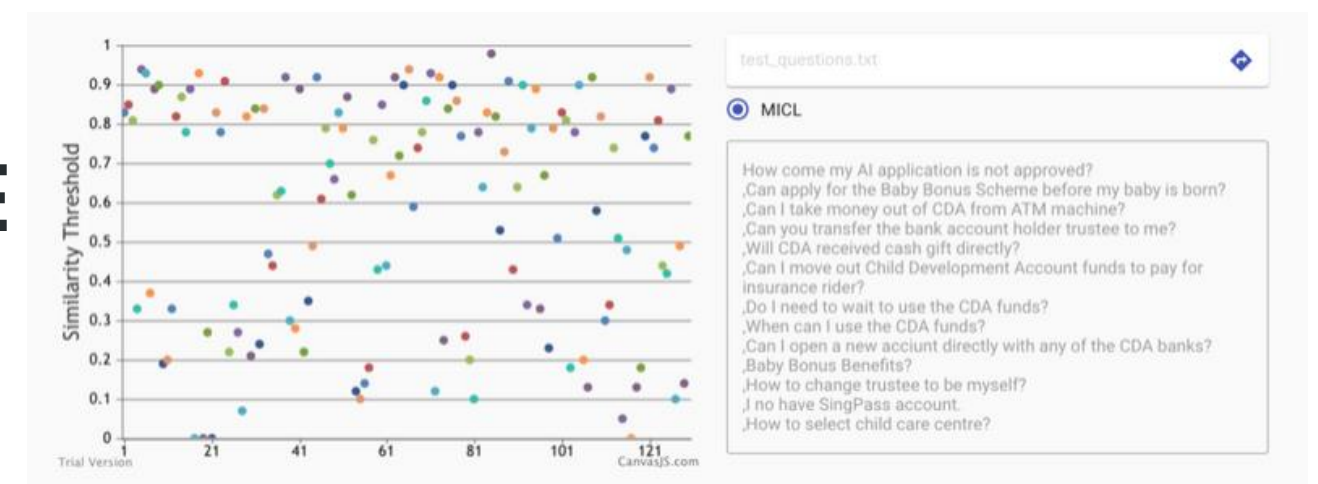
You can check your organisation's eligibility to be a Baby Bonus Approved institution on the Approved Institution Portal.

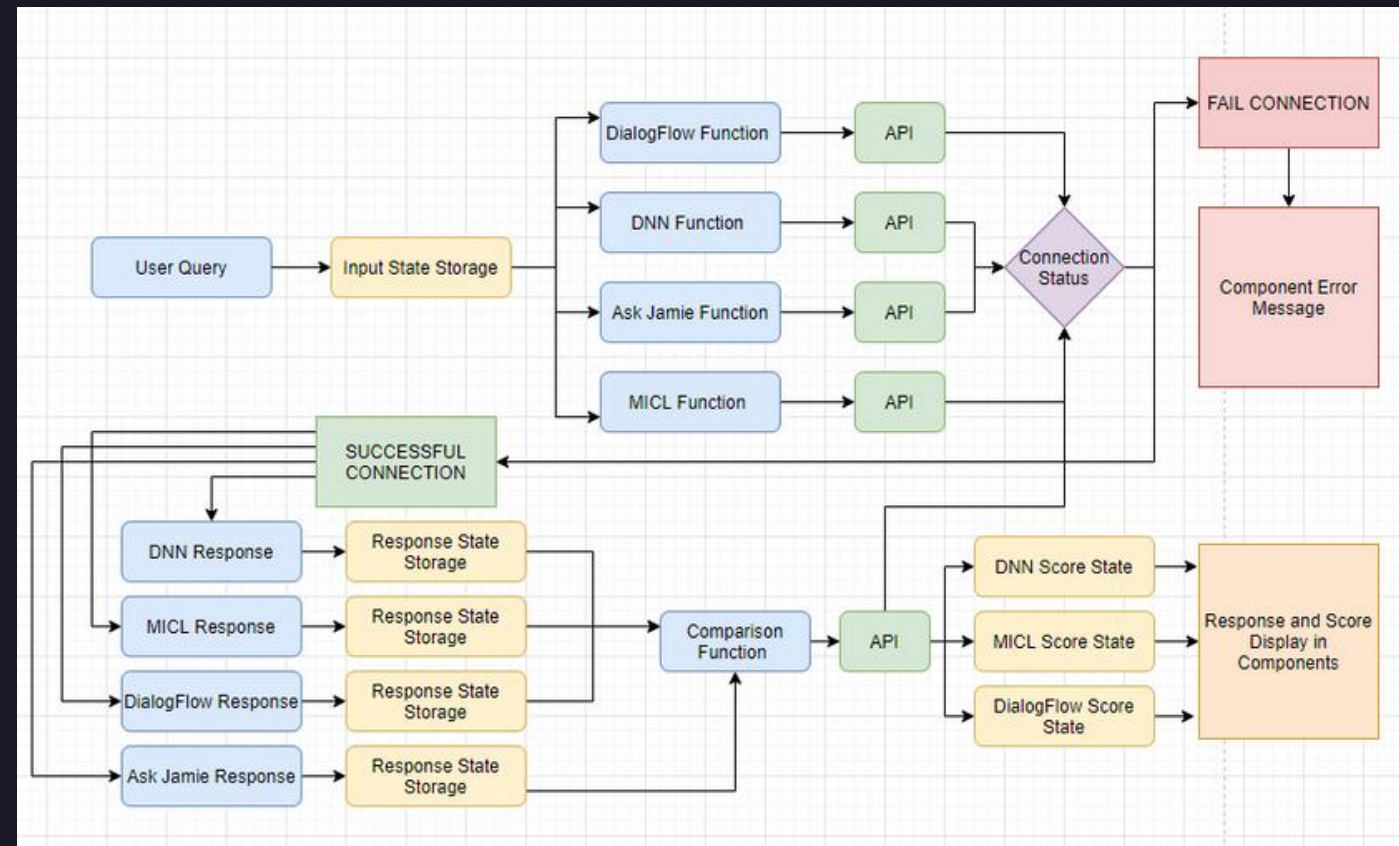
Similarity Score: 0.67

Dialogflow

For an organisation to become a Baby Bonus Approved Institution (AI), please visit the Baby Bonus Online Approved Institutions Portal and: Select "Join Using CorpPass". Complete all fields in capital letters. Ensure that the UEN or Unique Entity Number and...

Similarity Score: 0.67



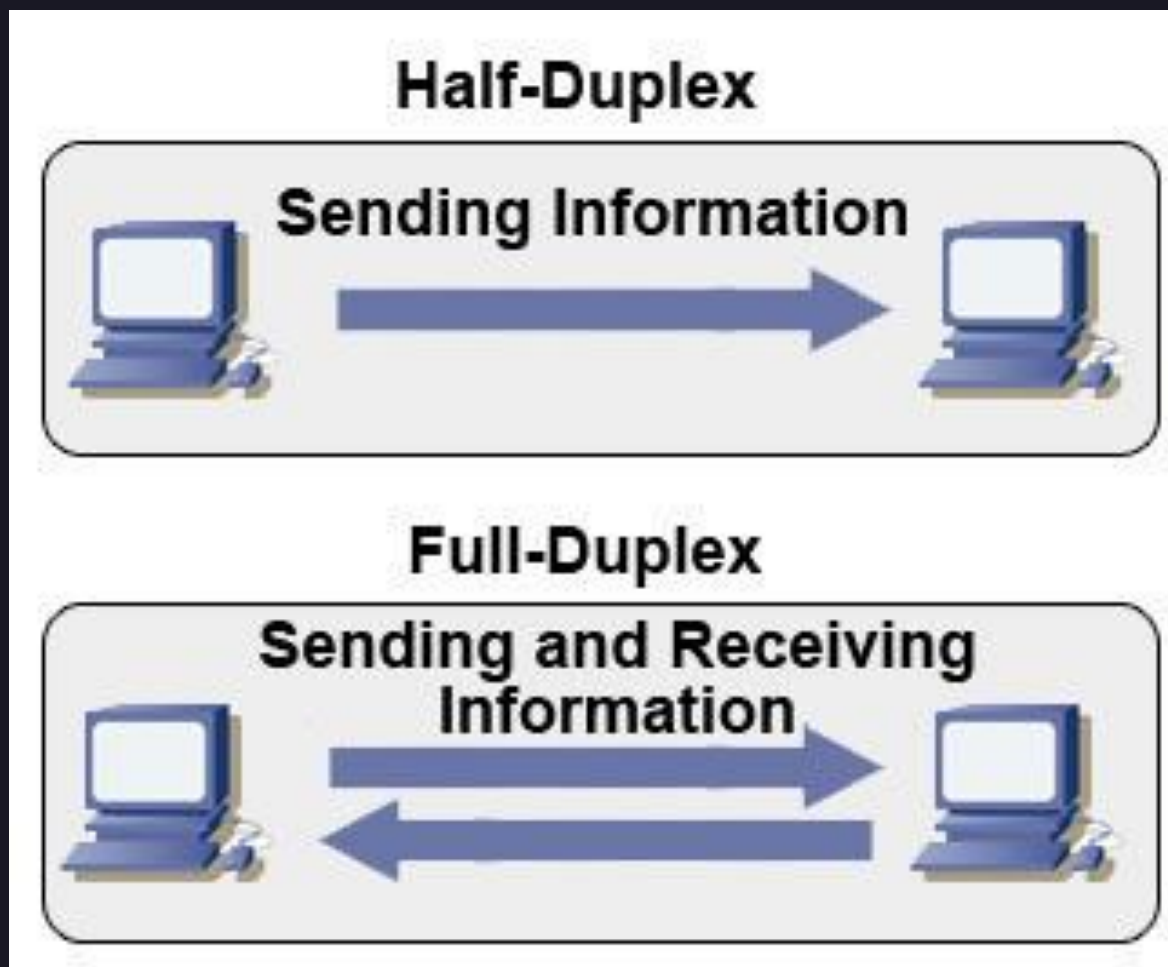


Text Input Handling

- Text input are stored in a state and passed to respective Chat bot services
- Use of JavaScript promises to ensure asynchronous execution of Chat bot request

Speech Input Handling

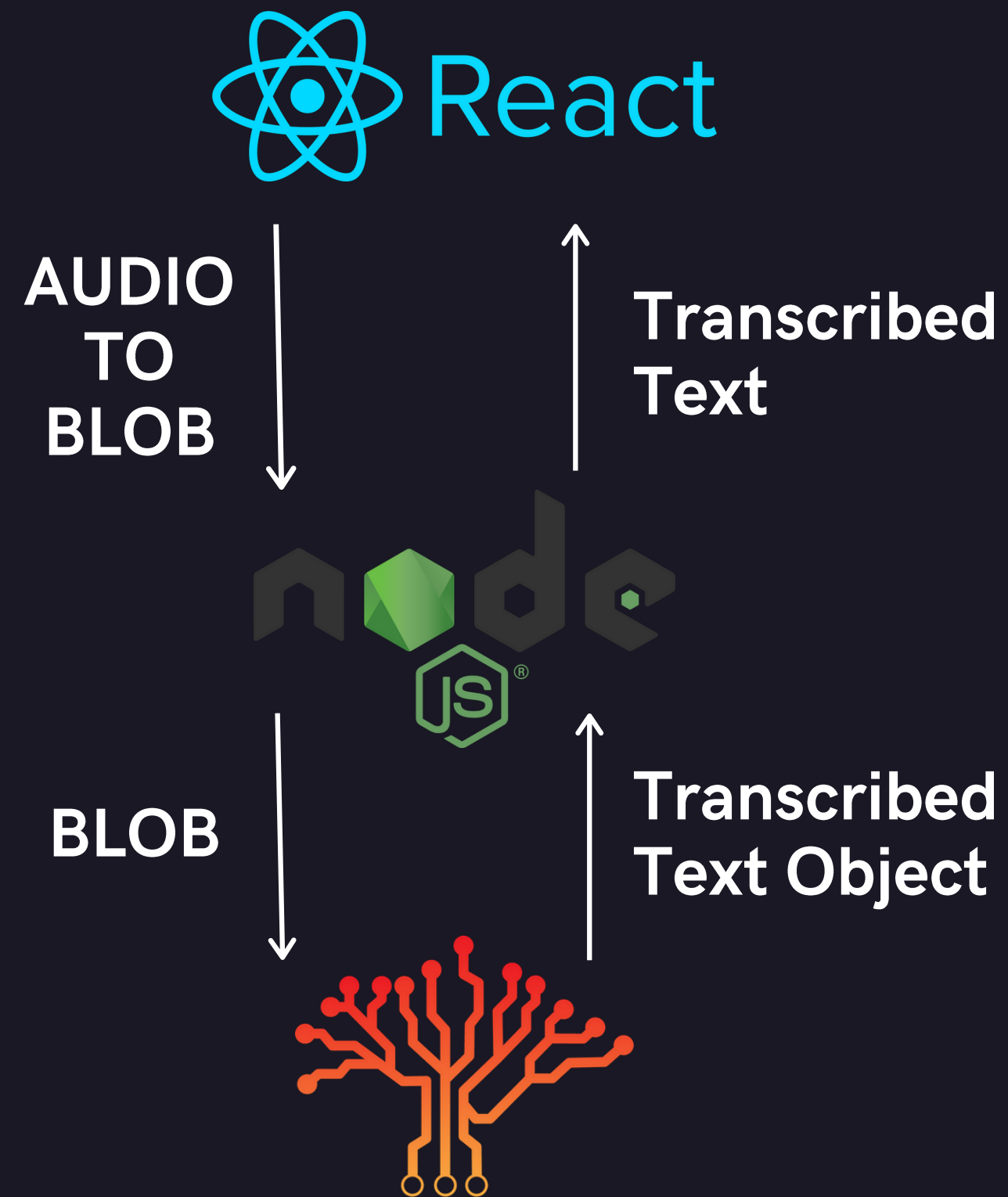
- Audio streaming between client and server
- Web sockets to establish full duplex communication channel
- Persistent communication over single TCP connection



*Half Duplex vs Full Duplex Diagram adapted from
<https://www.ccna-study.com/2019/05/half-duplex-and-full-duplex.html>*

FEATURES

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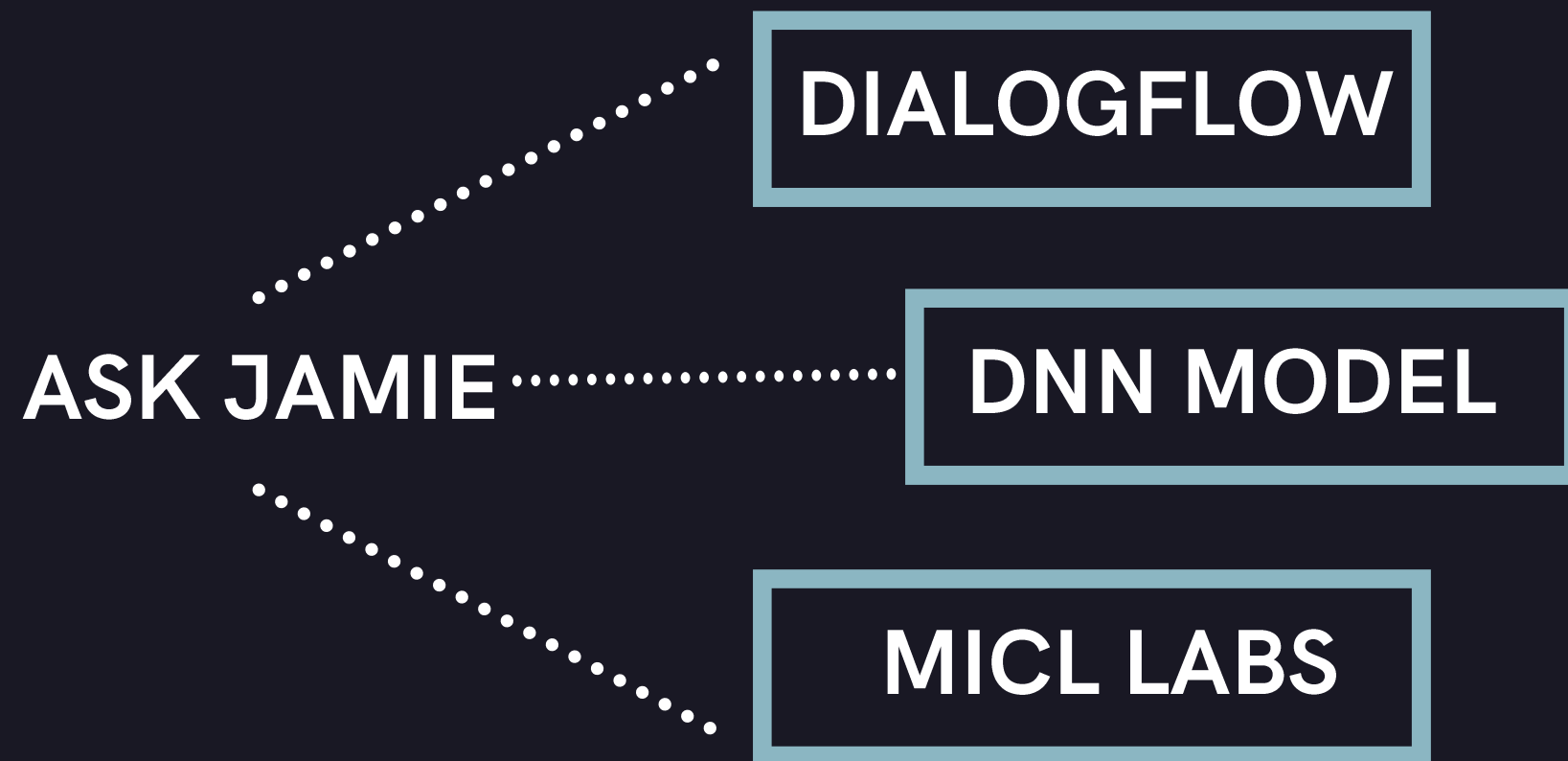


AI SINGAPORE

AI Singapore Logo adapted from
<https://www.aisingapore.org/>

Transcription Service

- AISG Speech to Text API
- Node Server forwards socket link to AISG
- BLOB audio data streamed and sent to STT API for decoding and transcription



Response Comparison

- Chat bot response comparisons with Ask Jamie Chatbot benchmark
- Client keeps states of benchmark response and test chatbot response pair
- Sends response pairs to comparator API served by Flask

FEATURES

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- Response Pair

1. Baby bonus is a government payment to parents with baby
2. Parents with baby is entitled to baby bonus

2. Tokenization

1. ['Baby', 'bonus', 'government', 'payment', 'parents', 'baby']
2. ['Parents', 'baby', 'entitled', 'baby', 'bonus']

3. Union of Token

```
['Baby', 'bonus', 'government', 'payment', 'parents', 'baby',  
'entitled',]
```

4. Bow vector

Vector 1 = [1,1,1,1,1,1,0]

Vector 2 = [1,1,0,0,1,1,1]

Sentence to Vector

- Tokenization of each response
- Stop word removal to keep keywords
- Union of tokens to create a unique vocabulary list
- Bag of words vector for each sentence

$$\frac{\mathbf{v}_1 \cdot \mathbf{v}_2}{\|\mathbf{v}_1\| \cdot \|\mathbf{v}_2\|}$$

```
For index i in range of bag of words  
Product += V1[i] × v2[i]
```

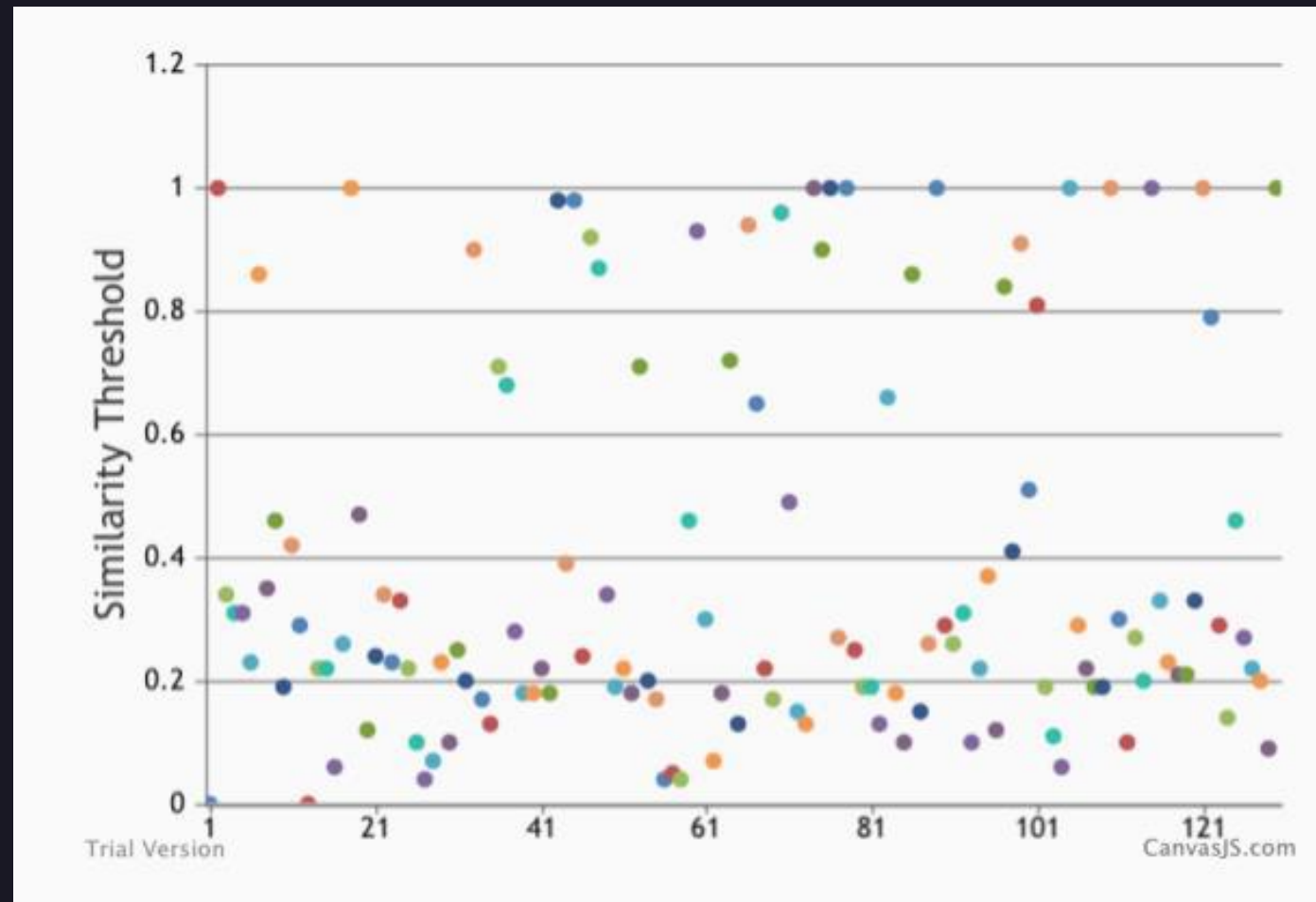
$$\sqrt{\text{Sum}(V1)} \times \sqrt{\text{Sum}(V2)}$$

Cosine Similarity

- Quantification of similarity of sequences by treating them as vectors
- Apply cosine similarity on obtained vector pairs to obtain similarity
- 0 represents mismatch, 1 represents complete match

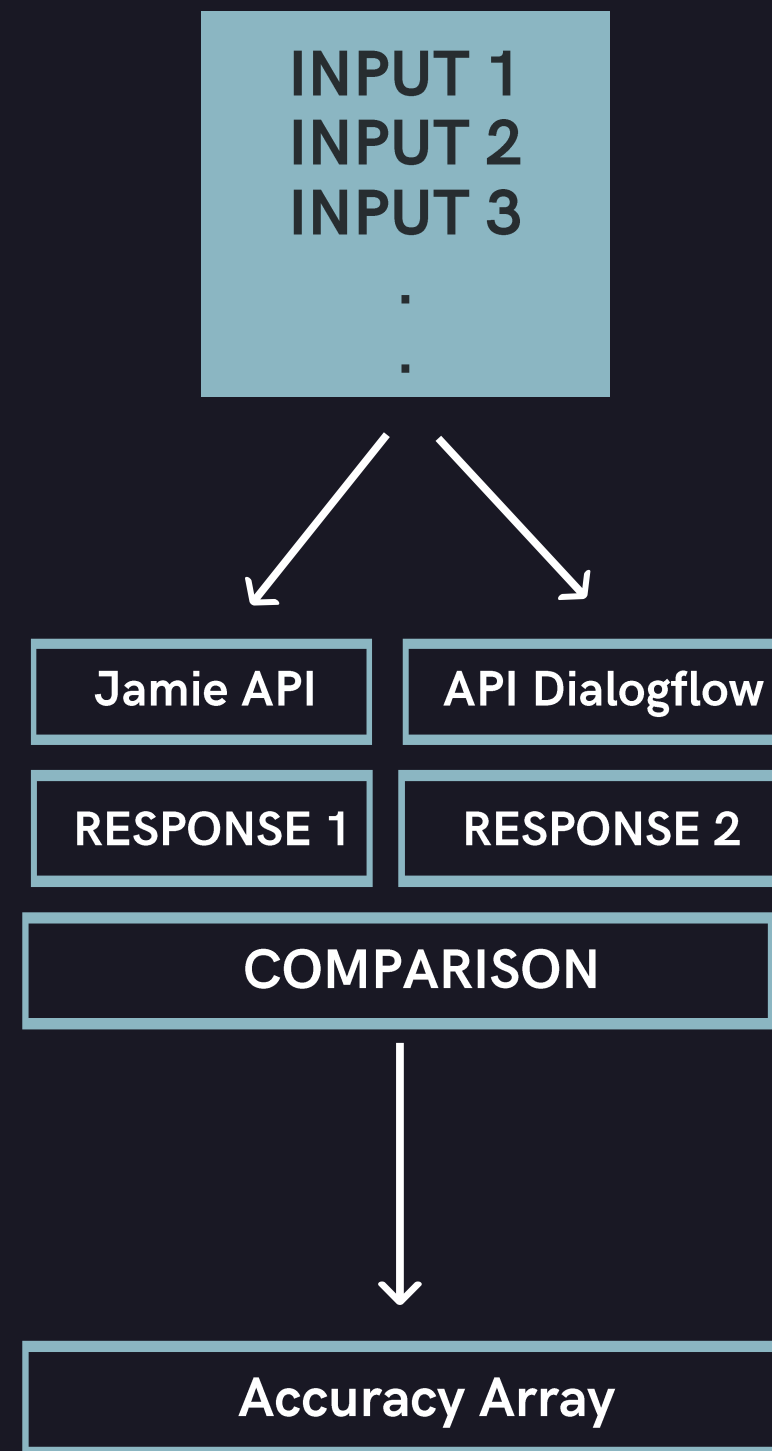
Performance Analysis

- Graphical analysis of Chat bot response accuracy against benchmark
- Mass query sending for large scale visualization



FEATURES

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Bulk Data Processing

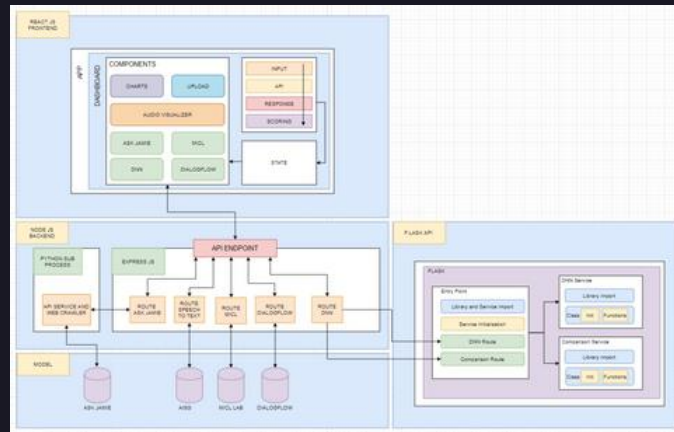
- Mass sending of inputs to chatbot and Ask Jamie service
- Collection of response pairs for posting to comparison service
- Asynchronous solution implemented to queue API call events

DEMO

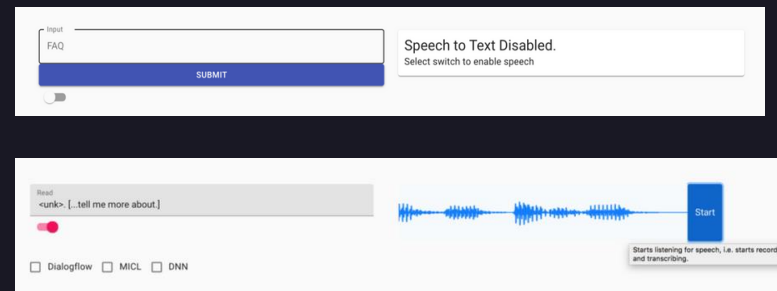


CONTRIBUTIONS

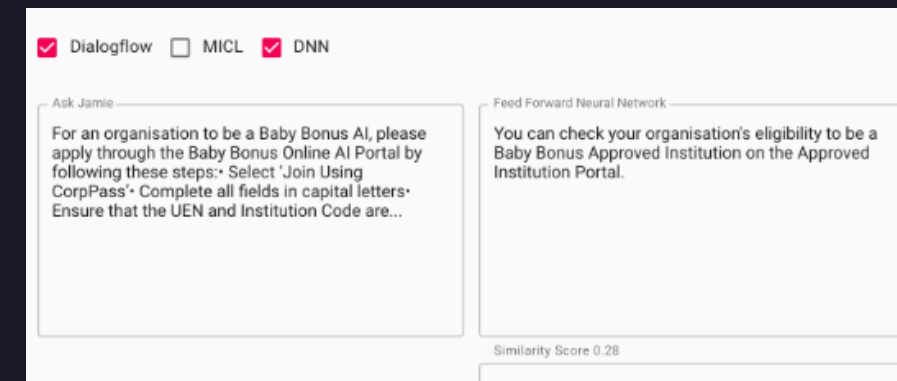
39



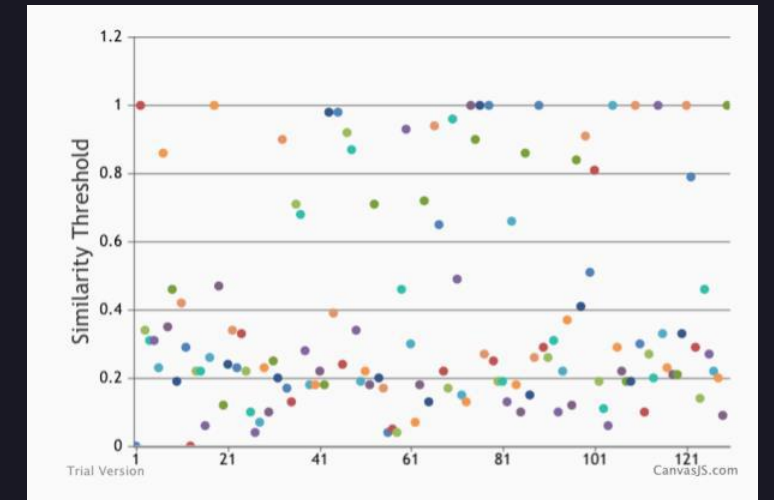
Web Chatbot Framework



Text and Speech Based input



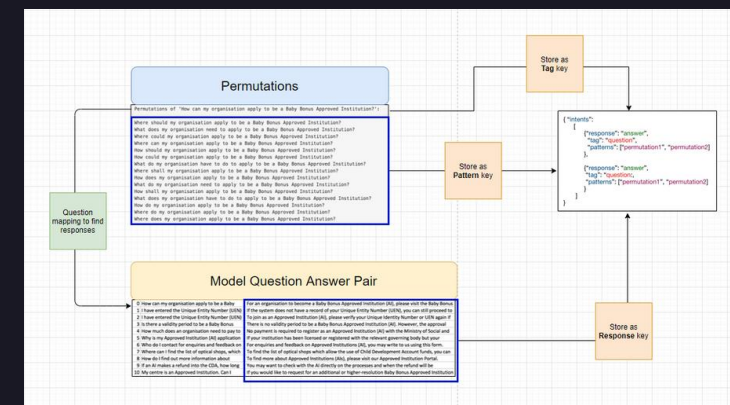
Response Comparison Service



Performance Visualization



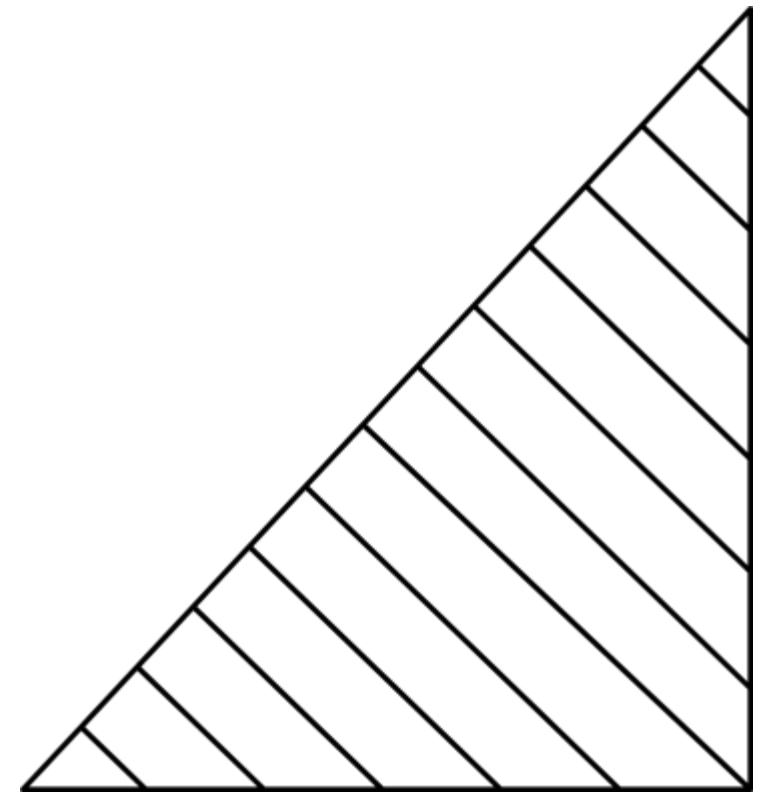
Dialogflow Integration



Training Data Pre-processing

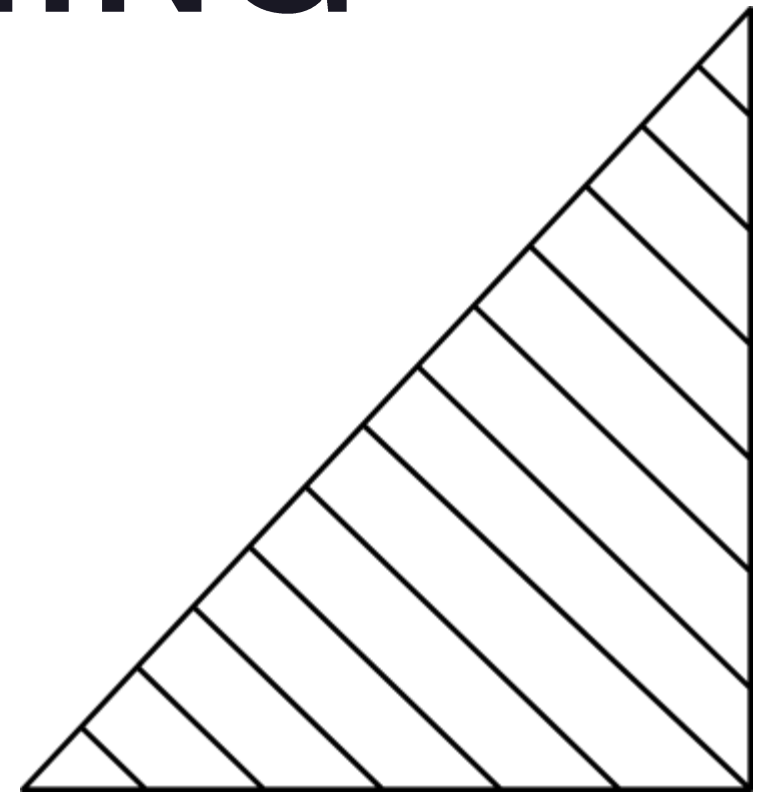
FUTURE IMPLEMENTATIONS

MODULAR INTEGRATION OF CHATBOT SERVICE



FUTURE IMPLEMENTATIONS

**DYNAMIC
DATABASE STORE
FOR CHATBOT
RE-TRAINING**



The image features a white background with the text 'END OF PRESENTATION' centered. In the top-left and bottom-right corners, there are red geometric shapes. Each shape is a right-angled triangle with a black outline, pointing towards the center of the slide.

END OF PRESENTATION