Revolutionizing Healthcare Delivery through a Medical Chatbot System: Using BioBert and GPT-2

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Agenda:

1 Business Case

2 Data and EDA

3 Modeling

4 Results

5 Deployment

6 Demo

Business Case :

Majority of Americans are dissatisfied with the current healthcare system.

NRC Health's 2019 Healthcare Consumer Trends Report, most patients surveyed negatively perceived support staff, wait times, and billing.
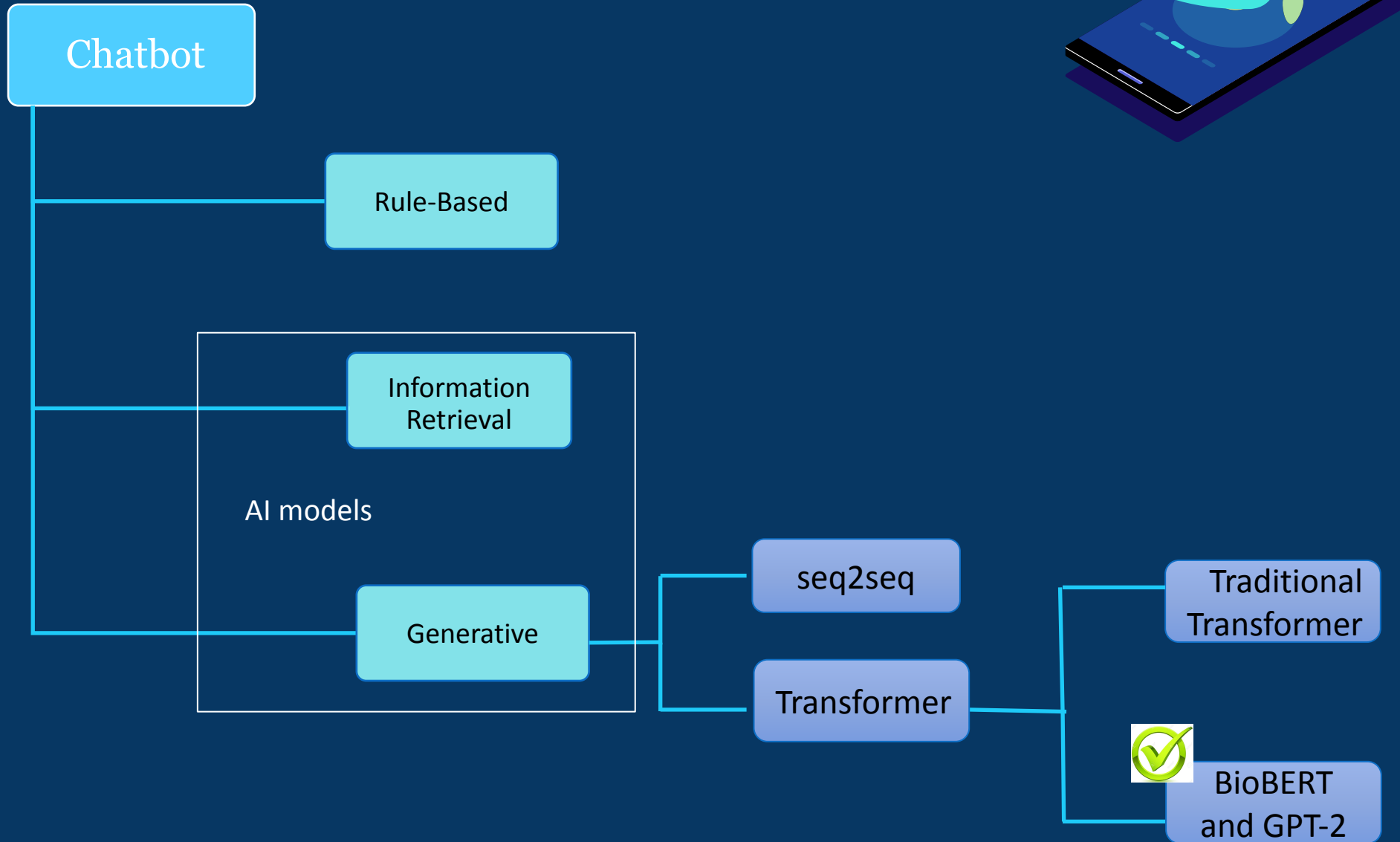
Kaufman Hall survey of 200 hospitals and healthcare executives found that 90% of respondents felt improving patient experience was a top priority.

A solution to this problem is a Medical Chabot that responds to patient inquiries with **Accuracy & Empathy**
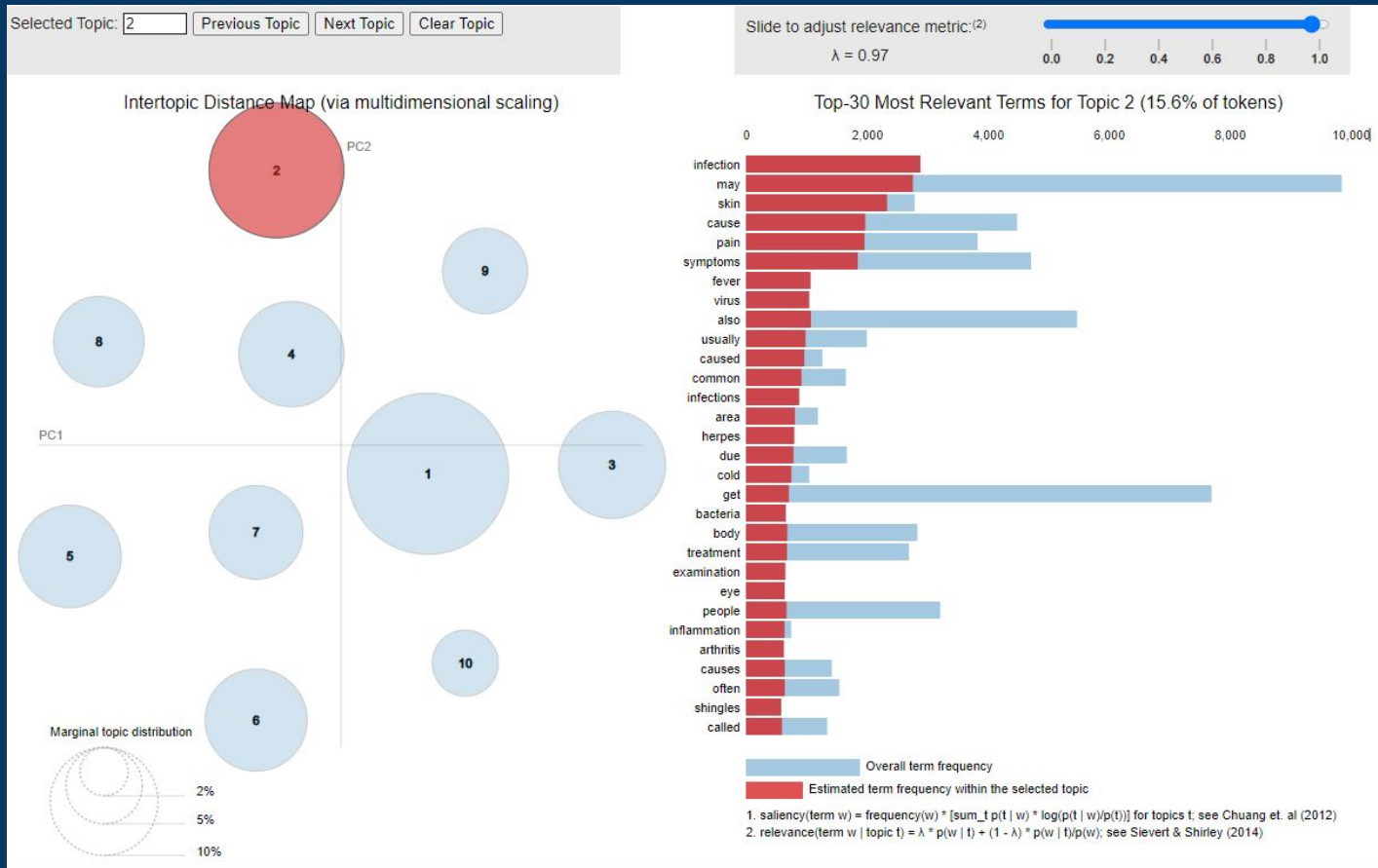
- Establish natural communication for engagement and communication

- Predict diseases based on symptoms

- Diagnosis based on X-Ray images

Model selection:

Chatbot

Rule-Based

AI models

Information Retrieval

Generative

seq2seq

Transformer

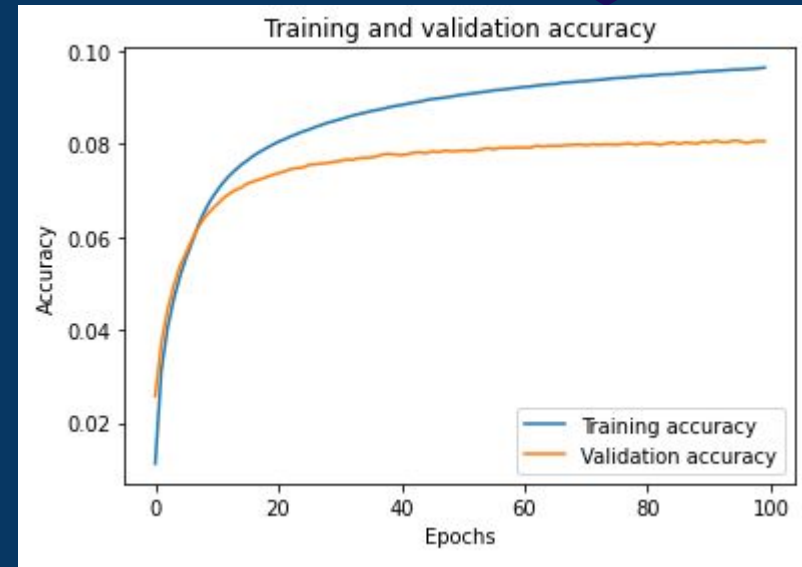Traditional Transformer

BioBERT and GPT-2

Data and Exploratory Data Analysis

- 26,417 questions and answer set from WebMD, eHealth Forum
- NLP techniques applied
- Topic Model performed

Transformer

- ~9M total params

- 100 Epochs

- ~3 hrs training time with TPU

- Results:
 - loss: 0.4039 - accuracy: 0.0964 - val_loss: 0.5956 - val_accuracy: 0.0806

Prediction Example:

```
predict("why is my head hurting")

'hi i think you should consult a doctor for a physical examination and a complete
course of antibiotics and then get a complete course of antibiotics and then get
a complete blood count done and take antiseptic like paracetamol and give it a da
y thanks'
```

BioBERT and GPT-2 : Architecture

- Fine tuned BioBERT model to convert text input of questions and answers to an embedding representation

- FAISS searches for similarity search and clustering

- The question and answers are sorted and concatenated based on similarity

- The question and answers are sorted and concatenated

- The concatenated top similar questions and answers are then fed to GPT-2 to generate an output answer.
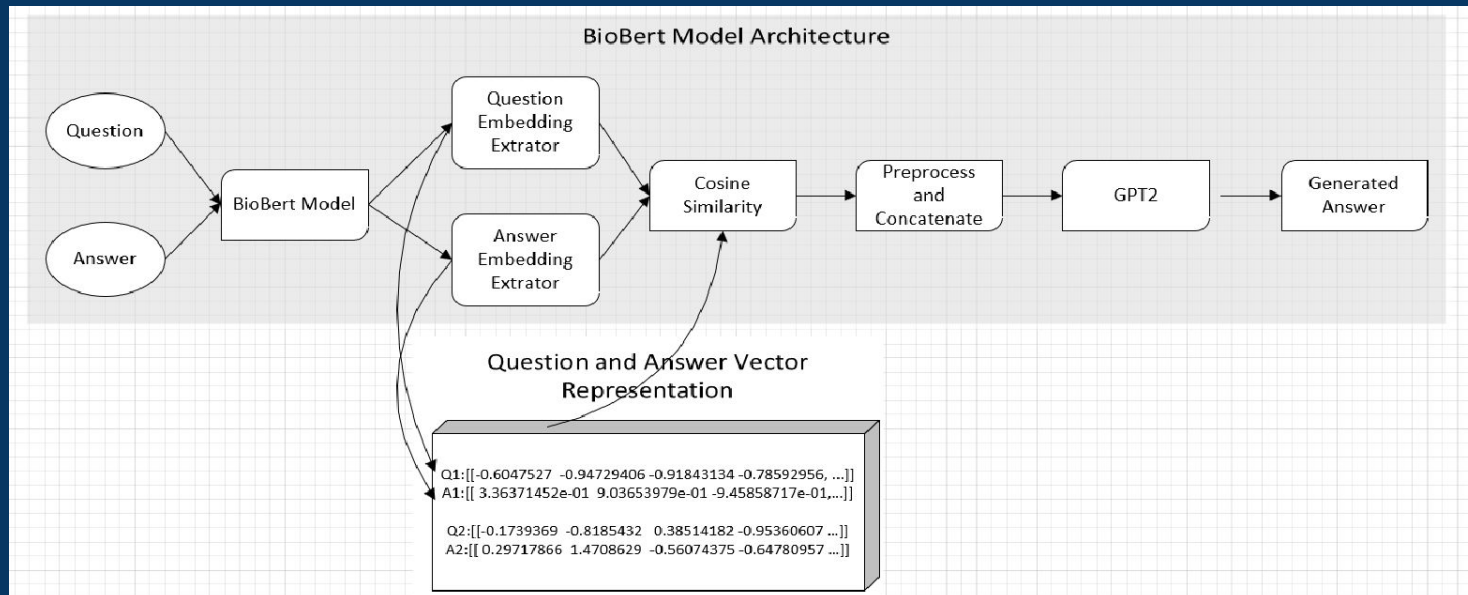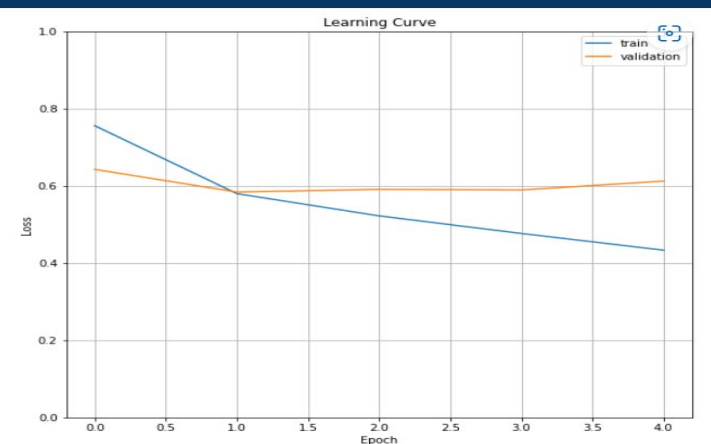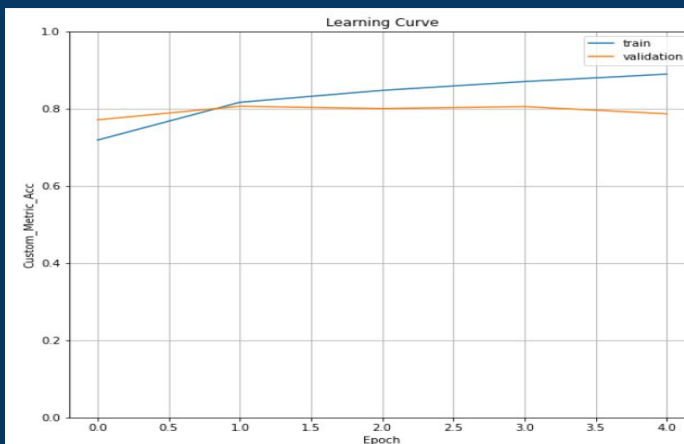
BioBERT (Bidirectional Encoder Representations from Transformers for Biomedical Text Mining)

- PreTrained BioBERT weights for extracting representations from text

- ~109M parameters

- 5 Epochs

- ~7 hrs training time with premium GPU in Google Colab.

- Results-

	Accuracy	Loss
Train	0.8895	0.4434
Validation	0.7867	0.6124

GPT-2 (Generative Pretrained Transformer 2)

- PreTrained GPT2 Model with 1.5B parameters for generating answers.

- 5 Epochs

- ~15 hrs training time with GPU

- Results -
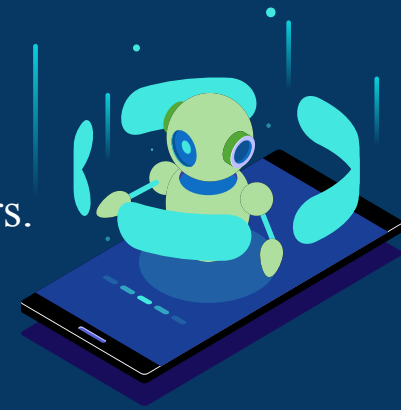
  Bleu Score

```python
metric=calc_bleu_score('why my eyes hurts sometimes?','you are having an allergic reaction to something')
print(metric)
```
```
0.0656676176790682
```

Greedy Search Prediction -

```python
answer=predict_answer('why my eyes hurt', 50)
print(answer)
```
```
('`ANSWER: i do not know what causes your eyes to hurt but it is possible that your eyes are being affected by a virus that causes them to burn i would suggest you to see your doctor for a medical evaluation and treatment for your condition`',)
```

GPT-2 (Generative Pretrained Transformer 2) Continued ..

GPT-2 Results Continued…

Beam Search Prediction -

```
answer=predict_answer('what are the signs of heart attack?')
print("answer:",answer)

answer: heart attacks are often caused by a combination of several factors including a viral infection or an underlying heart disease the most common ca
use of death is the inability of blood vessels to move in and out of your heart vessels in addition to being unable to breathe or move your arms or legs
it can also be a result of an enlarged heart or a heart defect in one or both of those vessels there is no way to diagnose or treat the disease in any w
ay other than to see your medical provider for an examination
```

Top K Sampling with 3 similar Answers-

```
In [ ]: answer=predict_answer('what are the alzheimer disease treatment')
        print(answer)

        Output:
        --------------------------------------------------------------------------------------
        0: `ANSWER: alzheimer is disease is an extremely rare disease diagnosed with a combination of drugs that are both effective and
        preventative of disease and are associated with a lower risk population of being affected by other diseases the treatment usual
        ly involves using steroids and a prescription medication...

        1: `ANSWER: there are many different treatments available to treat your symptoms and symptoms of alzheimer disease treatment is
        not always the most effective treatment because many patients with alzheimer disease often have symptoms similar to the symptom
        s of the disease and often do not respond to...

        2: `ANSWER: it depends on the severity of the disease and whether the treatment is given to your particular type of disease or
        to other people in the same condition i recommend a biopsy for a blood test and for the blood test if possible if you are unsur
        e about...
```
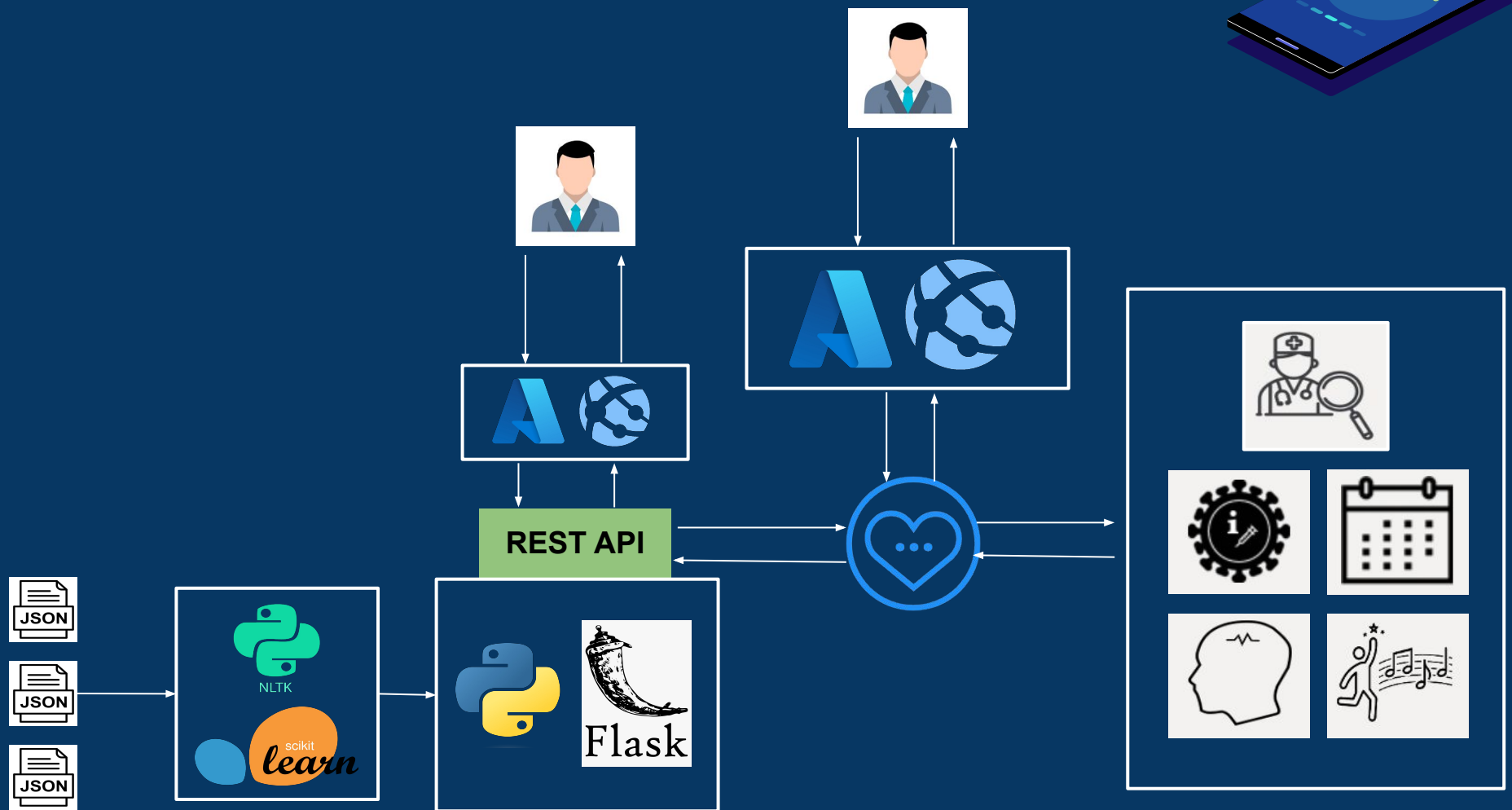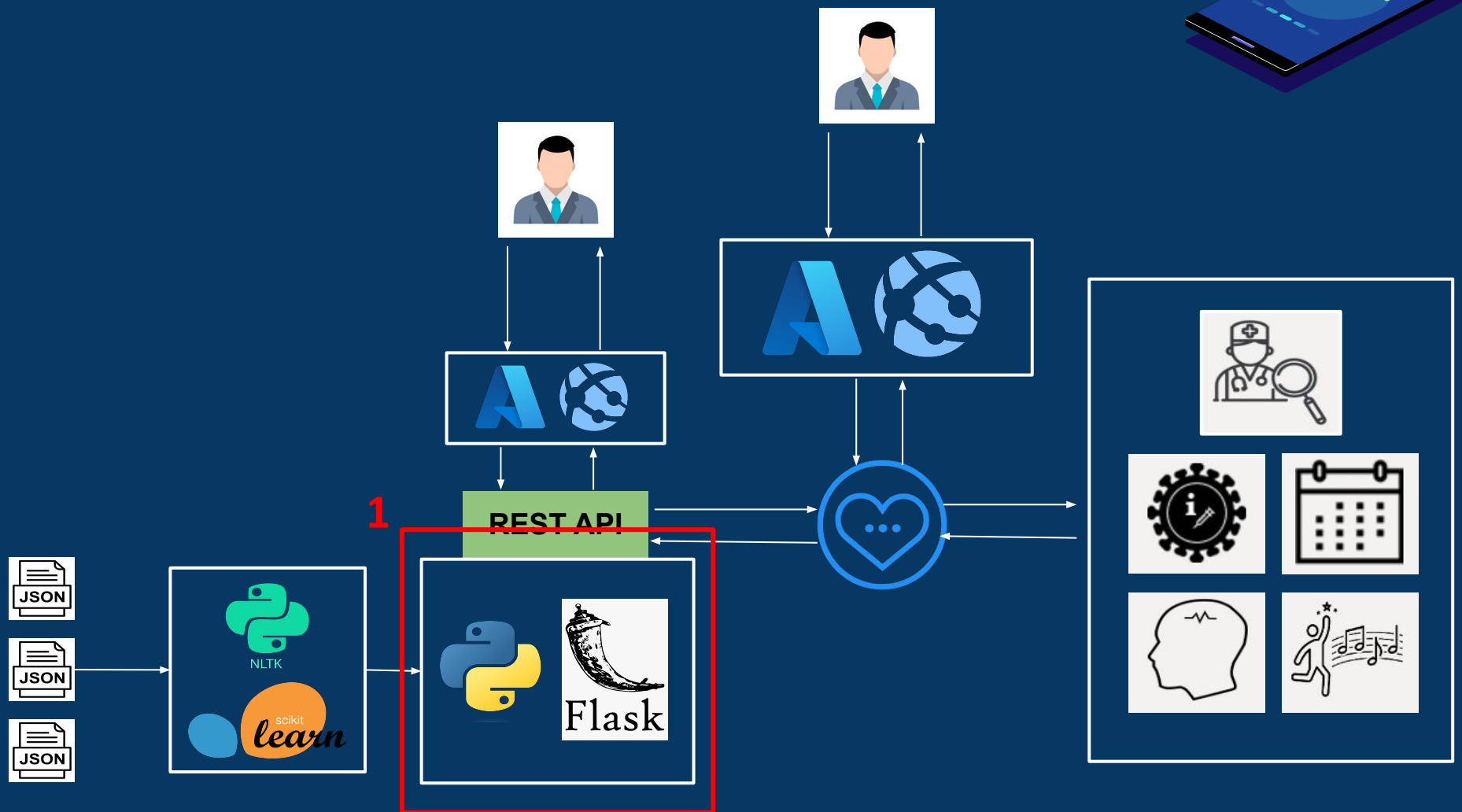
Experiments /observations

Model Type	Training Accuracy	Training loss	Validation Accuracy %	Validation Loss	Time
Seq 2 Seq	19.7%	0.7	5.1%	1.9	2 hrs
Traditional Transformer	40.4%	0.01	8.1%	0.6	3 hrs
BioBert with GPT2	88.9%	0.4	78.6%	0.6	22 hrs

Architecture

Architecture

JSON

NLTK
scikit learn

1

REST API

Flask

Architecture

Architecture

3

REST API

Demonstration

Link: https://healthbot498.azurewebsites.net/
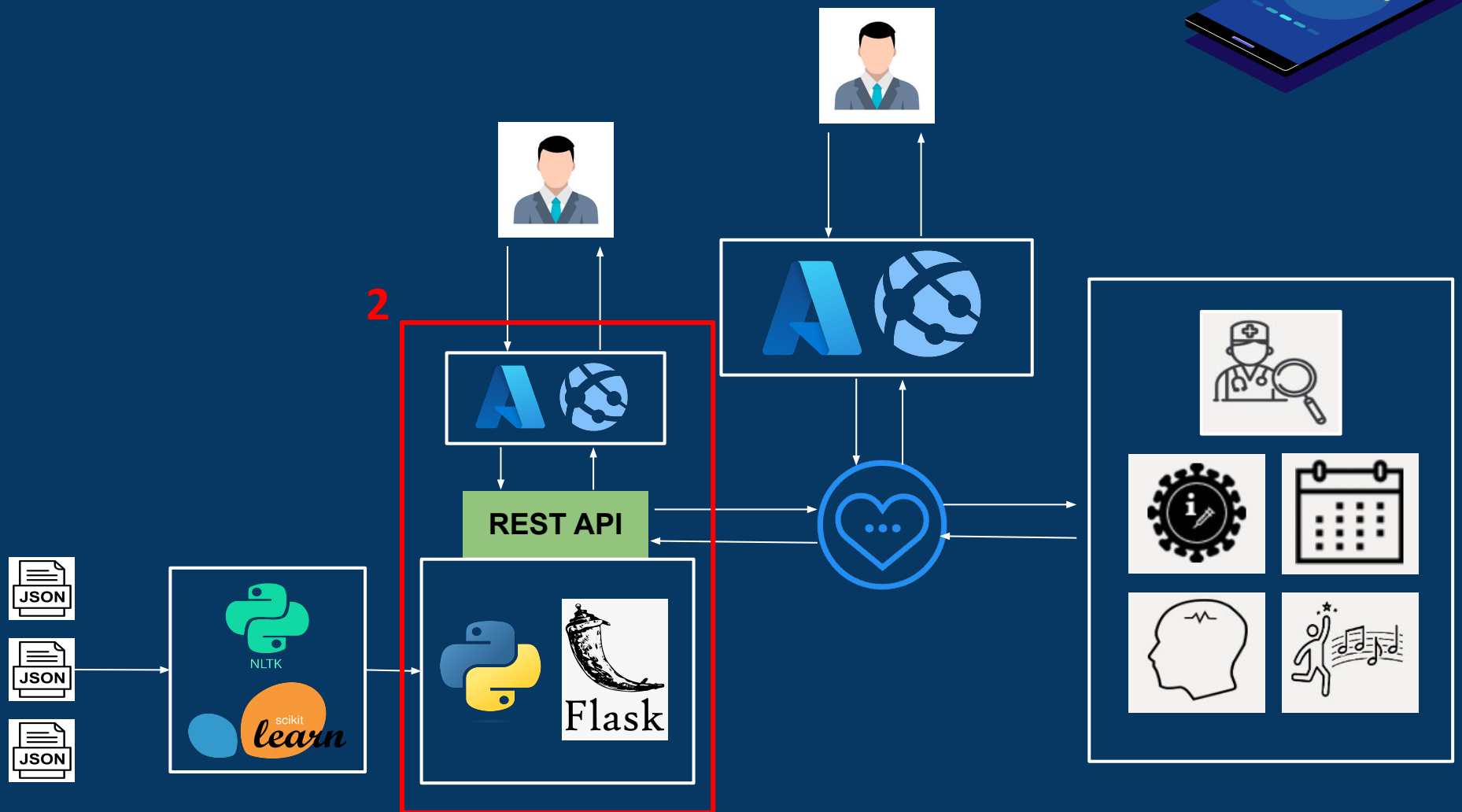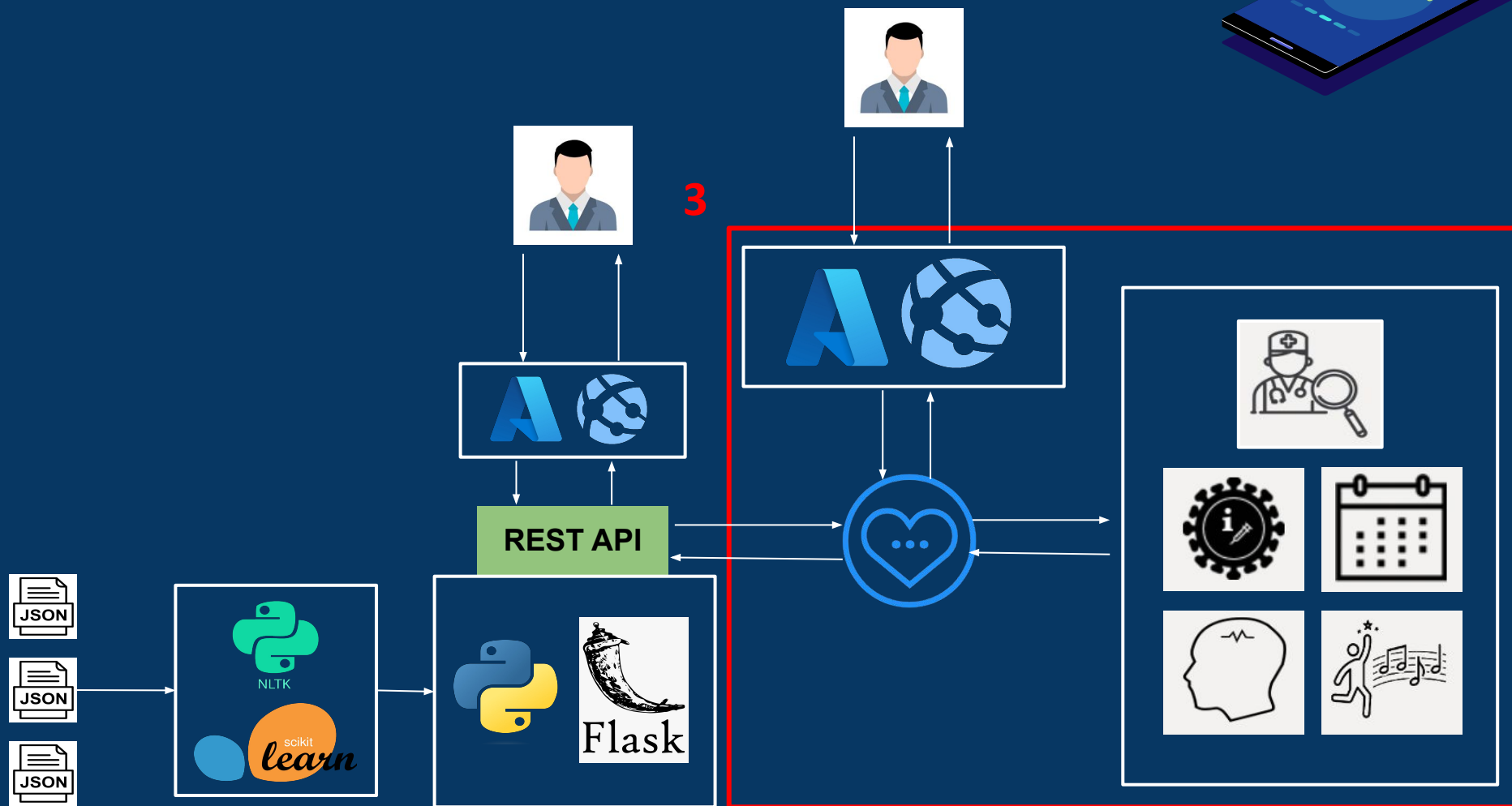
Analysis

Highlights

- Application is publicly accessible on the internet
- Simple, responsive, and RESTful application
- Digitally native interaction with both text and image recognition models
- Modular and cloud supported architecture for easy development and scalability

Areas for Future Development

- Deploy web app with trained medbot model files
- Determine singular chat interface
  - Work with Azure to enhance configurability
  - Develop in house product to suite specific needs
- Improved user experience with modern feel
- Integrate application with a medical practices provider network and scheduling software
- Turing approved - more natural user engagement