

**COMS 6998: Topics in Computer Science**  
**Cloud Computing and Big Data**

**AUDIO-BASED SOCIAL MEDIA APPLICATION**  
**(MENTORED PROJECT)**

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## INTRODUCTION

Social Audio Companies are popping up and growing fast in this post-Covid time. Clubhouse, launched in April 2020, now has over 10MIL users, and with a valuation of \$1 BIL USD. The reason social audio is exploding is because it is an untapped medium that provides rich reward for the three human motivators of engaging with others, i.e., for meaning, communion, and agency "Toward a comprehensive taxonomy of human motives". Human speech evidently conveys an adaptive advantage, given its apparently rapid dissemination through the ancient world and global use today. "Instant messages vs. speech: hormones and why we still need to hear each other".

After reviewing this space, we do not see any company tackling the whitespace of allowing people to find and engage with other people for peer-to-peer conversations on specific topics of interest, that can lead to enriched dialog and trusted relationships over time. Due to the impact of the digital world, our time is more fragmented, where traditional social media has become "Attention Alcohol" and the need of having genuine, trusted, and meaningful conversations is a growing and unmet need.

By building an app which can allow us to ask questions as they come up in our heads, at any moment in time, using the hands free, eyeballs on screen free interface of voice, we can tap into this great and growing whitespace of human-to-human conversation.

- The voice driven interface in our smartphone to allow us to ask open ended questions of other humans, i.e., questions that a Siri, Alexa, or Google cannot answer as they require context, and the power of human voice with its ability to provide rich meaning based on the embedded audio queues
- A matching algorithm that connects questions with answer candidates in ways to optimize the fulfilment of the request with speed and accuracy. The inferred profile elements can be used for the matching and enhanced over time with the power of NLP insights extracted and mapped based on the Taxonomy of Human Motivators.
- The gamification construct of the app where there will be stickiness provided to ensure recency, frequency, and level of engagement, will be provided by incentivizing users with limits on how many questions or answers they can provide before reciprocating the effort, i.e., after so many questions, we must provide so many answers and vice versa.

## PROBLEM STATEMENT AND APPROACH





**Problem Statement:** To create an application which allows users to have a knowledge base of their desired topics (blogs, podcasts etc.) and where users can ask and answer questions on any given topic using an audio-recording mechanism. To also facilitate recommendations (questions and topics) based on user history. The application should also facilitate a discussions forum where the asker and the answer can interact based on the answers provided to a question. The application should use Machine Learning algorithm to find out the trending questions and to facilitate searching of questions.

**Approach:** The approach for this project has been to create an event driven application with an asynchronous architecture. The aim is to create a three-tier web application developed using ReactNative and AWS Lambda Functions and API Gateways.

**Clickable Prototype:** <https://www.figma.com/file/D50YuLOog6SjWdjSCKPaOI/ccbd-social-audio-app?node-id=0%3A1>



For the Machine Learning segment, ted talk medias are used as the meta data and each ted talk is used as an answer. Then, the implementation manually generates matching questions for each ted talk and each question is labeled with certain tags such as music, sports, etc. All questions and answers are stored in S3 as audio files and can be easily recalled in the subsequent steps.

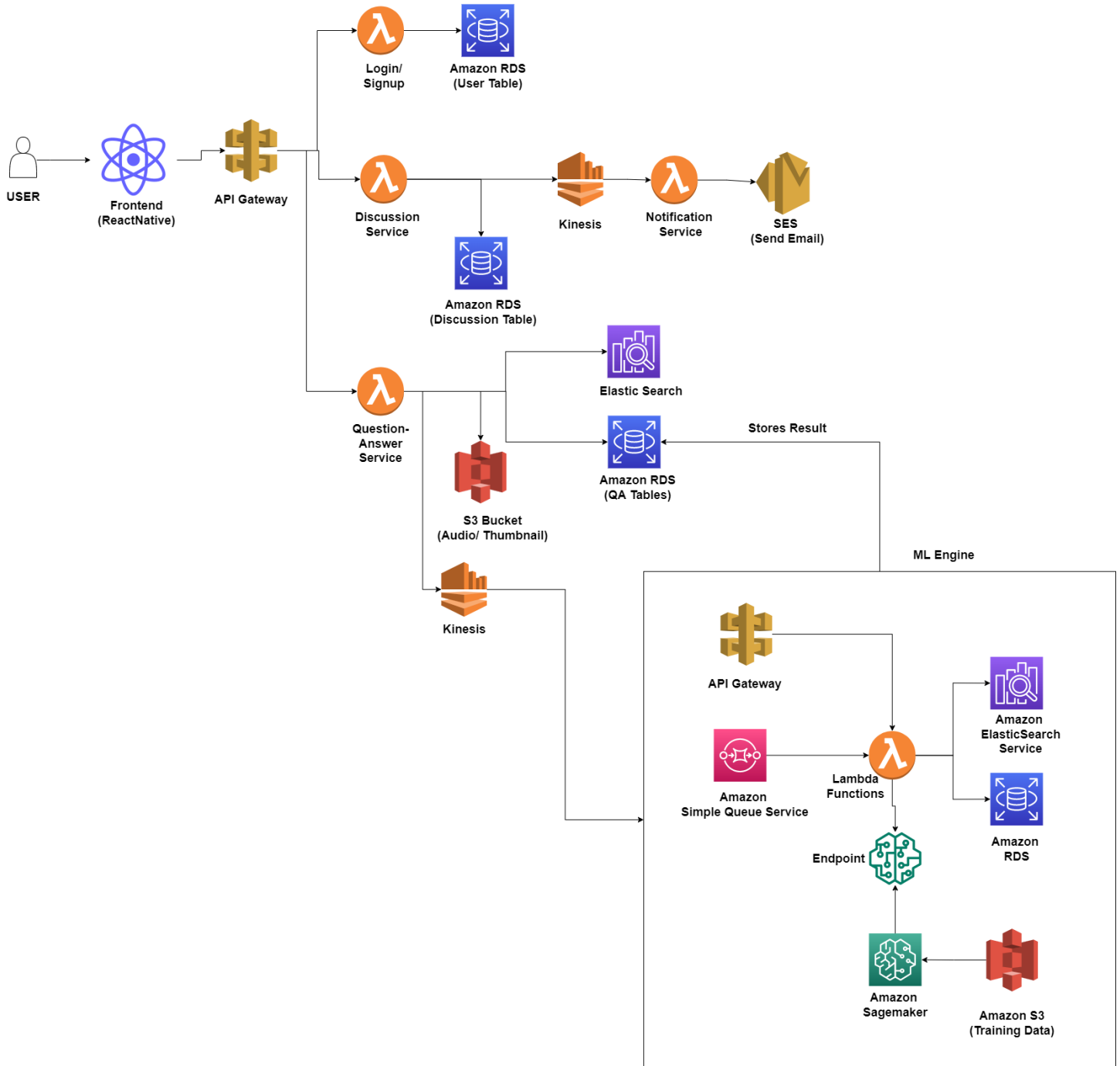
|  |     |  |         |          |
|--|-----|--|---------|----------|
|  meta_ans_000.sph | sph | December 3, 2021, 14:41:51 (UTC-05:00) | 18.0 MB | Standard |
|  meta_ans_001.sph | sph | December 3, 2021, 14:41:52 (UTC-05:00) | 25.8 MB | Standard |
|  meta_ans_002.sph | sph | December 3, 2021, 14:41:53 (UTC-05:00) | 32.4 MB | Standard |
|  meta_ans_003.sph | sph | December 3, 2021, 14:41:53 (UTC-05:00) | 30.4 MB | Standard |
|  meta_ans_004.sph | sph | December 3, 2021, 14:41:54 (UTC-05:00) | 16.9 MB | Standard |
|  meta_ans_005.sph | sph | December 3, 2021, 14:41:55 (UTC-05:00) | 36.6 MB | Standard |
|  meta_ans_006.sph | sph | December 3, 2021, 14:41:56 (UTC-05:00) | 10.9 MB | Standard |
|  meta_ans_007.sph | sph | December 3, 2021, 14:19:54 (UTC-05:00) | 26.5 MB | Standard |
|  meta_ans_008.sph | sph | December 3, 2021, 14:20:00 (UTC-05:00) | 20.7 MB | Standard |

*Meta Data Sample 1*

| questionId  | questionContent   | answerId     | answerFile                   | postedBy | hashtag1        | hashtag2             | hashtag3  | questionStat | loc |
|-------------|---|--------------|------------------------------|----------|-----------------|----------------------|-----------|--------------|-----|
| meta_qn_000 | How to live after your relatives passed away?                           | meta_ans_000 | 911Mothers_2010W.sph         | meta_ted | relative        | pass away            |           | Answered     | NY  |
| meta_qn_001 | What is it like to experience a disaster?                               | meta_ans_000 | 911Mothers_2010W.sph         | meta_ted | disaster        |                      |           | unanswered   | NY  |
| meta_qn_002 | Have anyone gone through 9/11?  | meta_ans_000 | 911Mothers_2010W.sph         | meta_ted | 911             |                      |           | unanswered   | NY  |
| meta_qn_003 | How to promote equal opportunity?                                       | meta_ans_001 | YassminAbdelMagied_2014X.sph | meta_ted | equal           | opportunity          |           | unanswered   | NY  |
| meta_qn_004 | How to find new ways of supporting others?                              | meta_ans_001 | YassminAbdelMagied_2014X.sph | meta_ted | support others  |                      |           | unanswered   | NY  |
| meta_qn_005 | Does everyone have unconscious bias?                                    | meta_ans_001 | YassminAbdelMagied_2014X.sph | meta_ted | unconscious bia | bias                 |           | Answered     | NY  |
| meta_qn_006 | How to help women in war-torn regions rebuild their lives?              | meta_ans_002 | ZainabSalbi_2010G.sph        | meta_ted | women           | worn-torn region     | life      | unanswered   | NY  |
| meta_qn_007 | How do people live and cope in the midst of violent conflict?           | meta_ans_002 | ZainabSalbi_2010G.sph        | meta_ted | violent         | conflict             |           | unanswered   | NY  |
| meta_qn_008 | How life continues in the midst of war?                                 | meta_ans_002 | ZainabSalbi_2010G.sph        | meta_ted | war             | life                 |           | Answered     | NY  |
| meta_qn_009 | How to educate children in the developing world?                        | meta_ans_003 | ZiauddinYousafzai_2014.sph   | meta_ted | child           | developing work      | educate   | Answered     | NY  |
| meta_qn_010 | Why women and men deserve equal opportunities for education?            | meta_ans_003 | ZiauddinYousafzai_2014.sph   | meta_ted | education       | equal opportunity    |           | unanswered   | NY  |
| meta_qn_011 | Why it is important for young girls to develop an independent identity? | meta_ans_003 | ZiauddinYousafzai_2014.sph   | meta_ted | girl            | independent identity |           | unanswered   | NY  |
| meta_qn_012 | Can you choose a different path of your life?                           | meta_ans_004 | ZakEbrahim_2014.sph          | meta_ted | life            | path                 |           | unanswered   | NY  |
| meta_qn_013 | How to reject a path of violence?                                       | meta_ans_004 | ZakEbrahim_2014.sph          | meta_ted | reject          | violence             |           | unanswered   | NY  |
| meta_qn_014 | How to find a path to peace?  | meta_ans_004 | ZakEbrahim_2014.sph          | meta_ted | peace           |                      |           | unanswered   | NY  |
| meta_qn_015 | What is cancer treatment via angiogenesis?                              | meta_ans_005 | WilliamLi_2010.sph           | meta_ted | cancer          | angiogenesis         | treatment | unanswered   | NY  |
| meta_qn_016 | What is the new way to fight against cancer?                            | meta_ans_005 | WilliamLi_2010.sph           | meta_ted | cancer          | fight against        |           | Answered     | NY  |
| meta_qn_017 | How the food we eat influence our health?                               | meta_ans_005 | WilliamLi_2010.sph           | meta_ted | food            | health               |           | unanswered   | NY  |
| meta_qn_018 | How to harness the wind?  | meta_ans_006 | WilliamKamkwamba_2009G.sph   | meta_ted | wind            | harness              |           | unanswered   | NY  |
| meta_qn_019 | How to build windmill to power my village?                              | meta_ans_006 | WilliamKamkwamba_2009G.sph   | meta_ted | windmill        | power                |           | unanswered   | NY  |
| meta_qn_020 | How does a invention change people's life?                              | meta_ans_006 | WilliamKamkwamba_2009G.sph   | meta_ted | invention       | life                 |           | Answered     | NY  |
| meta_qn_021 | How to talk to veterans about wars?                                     | meta_ans_007 | WesMoore_2014S.sph           | meta_ted | veteran         | war                  |           | unanswered   | NY  |
| meta_qn_022 | How can we help for such as Iraqis war?                                 | meta_ans_007 | WesMoore_2014S.sph           | meta_ted | war             | such as Iraqis       |           | unanswered   | NY  |

*Meta Data Sample 2*

# ARCHITECTURE AND APIs



*Architecture (User Experience + ML Segment)*

## APIs

1. POST /signup  
Post the details of a new user
2. GET /login?email={email}&password={password}  
To verify the login details and allow the user to proceed
3. GET /dashboard/relevantquestionsforhomepage  
Get the Home page data like Trending questions, latest questions, based on location
4. GET /dashboard/relevantquestionsforUser?email={email}  
Get specific questions for the user based on category and preferences
5. GET /searchquery?query={query}  
Get the questions matching the search query
6. POST /question  
Post the question to RDS tables
7. GET /question?qid={questionID}  
Get specific questions
8. POST /answer  
Post answers to RDS tables
9. GET /answer?aid={answerID}  
Get specific answer
10. POST /discusiion/pending  
Post the discussion with the pending status
11. POST /discussion/acceptRequest  
On acceptance change the status
12. POST /discussion/accepted  
Post the discussions with the accepted status
13. POST /requestchat  
Facilitate the sending of email via SES after acceptance

## DESIGN DETAILS AND CODE STRUCTURE

As the project was divided into two parts, Mobile App Development Part and the Machine Learning Part, the design details and the code structure pertain to different solutions to the problem statement provided.

### Mobile App Development / User Experience Segment

- The entire frontend of the mobile application was designed using ReactNative.
- The backend implementation of each of pages of the application was written in Python as AWS Lambda functions, which was triggered via individual API Gateways.
- Signup page allows to create new users, which are stored in the RDS tables, and subsequently Login page queries them to allow the user to proceed.
- Before login into the app, the Home Page / Dashboard is populated via a lambda function which queries the Amazon RDS to get three categories of questions: Trending (given by the ML Team), Latest (based on Time Stamp), Location (based on user location).
- After login, the Dashboard retains its properties with an additional section ForYou. This page shows the user suggested questions as determined by the application, questions which are most suitable for the users to answers. Based on categories and preferences, the corresponding lambda functions queries RDS to get the result.
- There is also the feature of searching for questions, facilitated by the machine learning algorithm.
- The application allows users to ask a question by recording it and then inputting the meta data like the thumbnail, question caption, location etc. Once the question is saved, the image and the audio get dumped into S3, and this URL is stored in the RDS along with the rest of the questions. These are the questions fetched by the dashboard lambda function.
- To answer a question, a user can click on a question and answer the same. As the answer is saved, it gets stored in the answer table in RDS along with the question id which makes the querying process easier.
- There is My QA page which shows the questions that have been answered by the user and posted by the user.



- For each question, there are a set of answers. For each answer, the user has an option of asking for a discussion (denoted by the green symbol beside the answered question). Once this button is pressed, a pending request is created in the answerer's login (polled via SQS and then stored in RDS). Now this user has an option of accepting or rejecting the request. On acceptance, the requester gets a email saying that his request has been accepted with a link to a video chat.

### Machine Learning Segment

The core implementations include SQS trigger lambda function, SageMaker endpoint for labeling questions, SageMaker endpoint for creating embedding, and KNN-based search.

- For SQS trigger lambda, when a user creates a new question in the front end, the question id is put into SQS, and the corresponding lambda function is invoked. This lambda gets the question id and invokes two Sagemaker endpoints: one for calculating embedding and the other for assigning categories (labeling) for a question. Then, lambda gets the embedding of the input question caption returned from the first endpoint and saves it in OpenSearch. The second endpoint returns corresponding categories predicted by the ML model. Next, the lambda function updates the question that is stored in RDS with its categories.
- The model used for labeling questions is BlazingText, which is a highly optimized implementation of the word2vec and text classification algorithm. The model is trained and hosted on a SageMaker endpoint. We use news dataset [1] to train the model and predict the top 3 categories based on question captions. The dataset has 41 labels and 100k+ data. Each data is labeled with one category. We then divided the dataset into 80% of the training set and of 20% test set. We used Sagemaker finetuning method to yield the optimal hyperparameters.
- For embedding creation, we use a pre-trained BERT model, specifically distillbert-base-nli-stsb-mean-tokens, from HuggingFace and this model is hosted on SageMaker endpoint. The model extracts a 768 features vector or embedding for each question, and stores it as a KNN index in OpenSearch domain. The main idea of the embedding is that similar data points exist in close proximity in the vector space. For example, “How to learn machine learning technology?” and “What are ways to study machine learning?” are similar questions and their embedding are collocated.

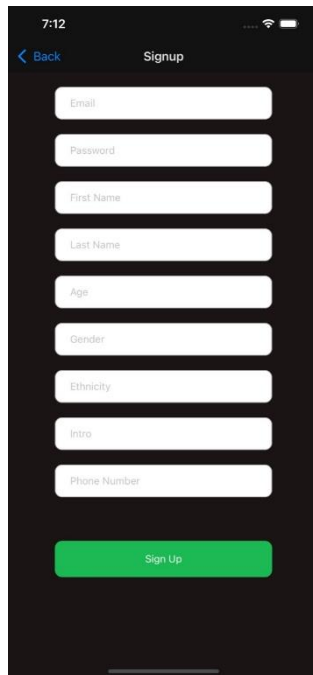
- For KNN-based search, we implemented it in two steps. The first step is to create a KNN reference index, which is discussed in the above (embedding creation part). The second step of KNN-based search is to search KNN index query. When there is an input search query, it will be passed through our model to extract the feature vector, which is a 768-dimensional vector of numerical features that represents the input search query. Then, we use this fixed-length vector to query the KNN index in OpenSearch. OpenSearch searches for points in a vector space and finds the nearest neighbors for those points in cosine similarity. After the nearest neighbor vectors are found based on the input seary query, OpenSearch returns the top five (k = 5 nearest neighbors) corresponding questions. For example, if we have “How to live a life?” as an input, it returns similar questions such as “How to make money?”.

Github Repository:

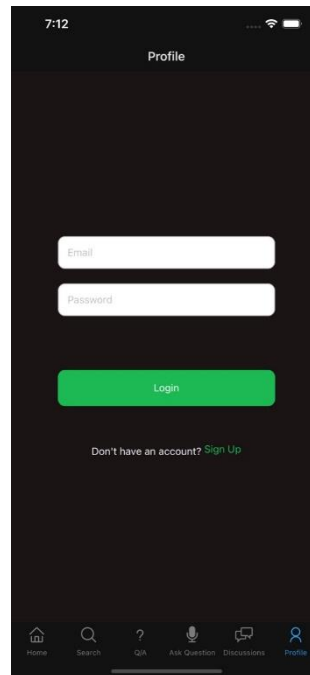
<https://github.com/gottacodeemall/social-audio-app-frontend>

# RESULTS

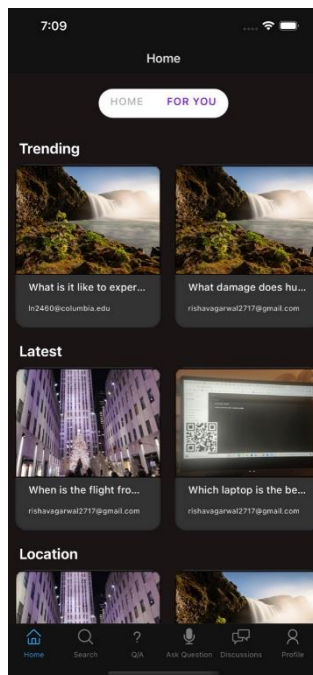
## Results for the Mobile Development / User Experience Segment



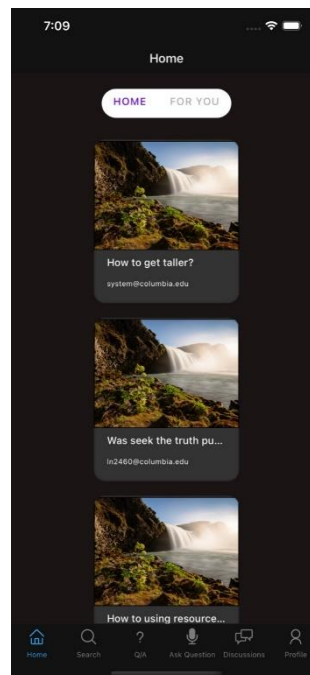
*Page1: Signup*



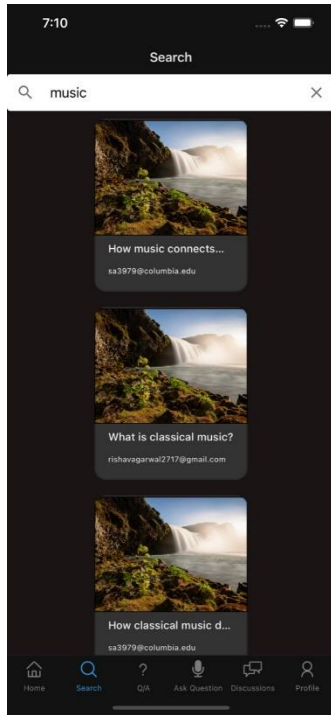
*Page2: Login*



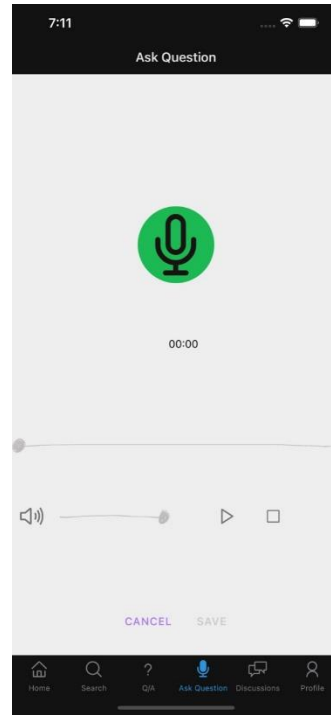
*Page3: Dashboard-Home*



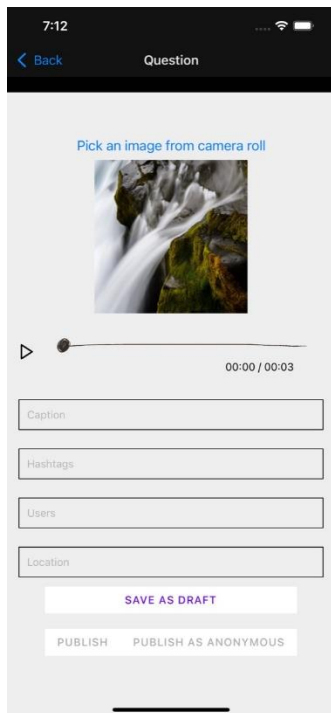
*Page4:Dashboard- For User*



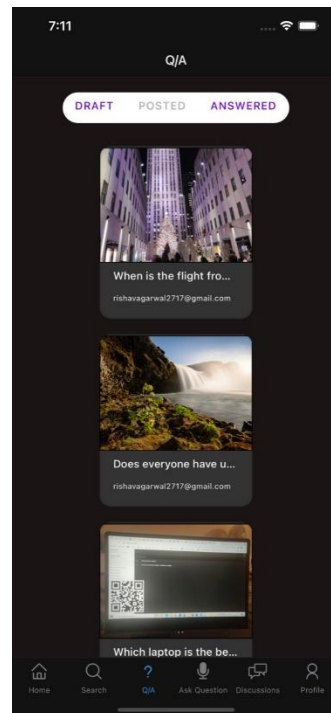
Page5: Searching



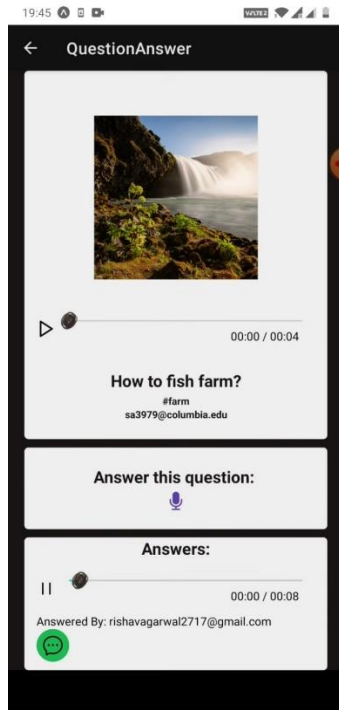
Page6: Microphone to ask and answer



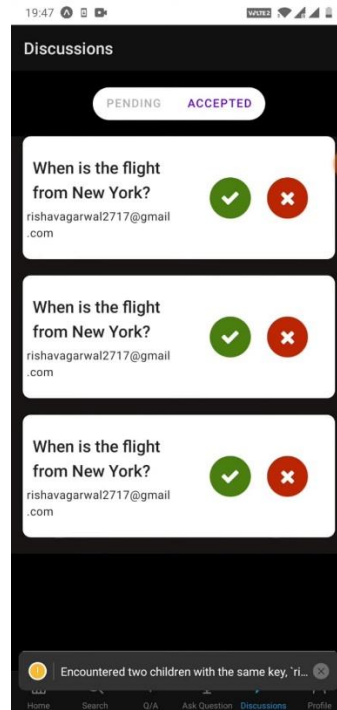
Page7: Providing data to the question



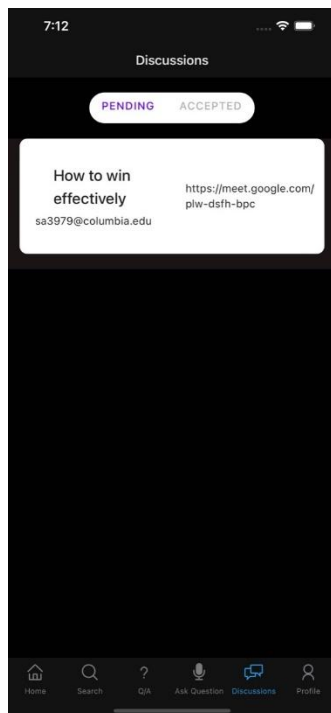
Page8: My QA Page



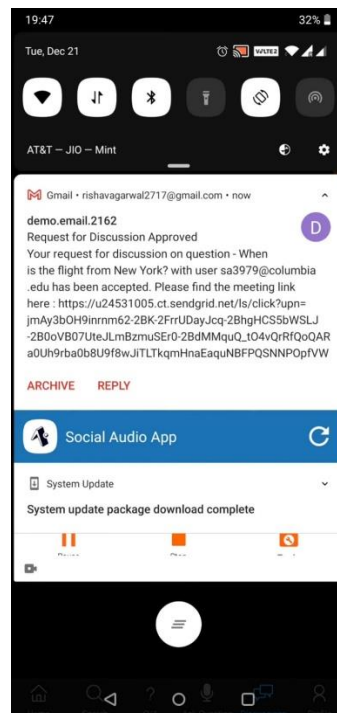
Page9: On Clicking a Question



Page10: Pending Discussions



Page11: Accepted Discussions



Page12: Email on acceptance

## Results for the Machine Learning Segment

### SQS Trigger Lambda

After fine tuning, the accuracy on the test set is 0.5, which is not good though. We can use a more powerful model like BERT but it will cost more time and training fees. Also, the model will generate more meaningful results if we use our own question captions for training after thousands of questions are generated and manually give categories for them from users. However, this task is currently out of scope of our project.

### Trending questions

This API searches for top 10 trending questions based on the posted time of questions. Below is a test result of the function.

```
Test Event Name
1
Response
[
  [
    [
      "0f205667-fbb0-474e-be4b-42fb1ea6e5de",
      "Which gloves are the best for winter?",
      "rishavagarwal2717@gmail.com",
      "https://ccbd-social-audioapp.s3.amazonaws.com/images%2F3a687551-21e2-458a-8b23-6e6fcad3e4bc.jpg"
    ]
  ],
  [
    [
      "11b23cce-9759-4115-bc90-daf1bb85a818",
      "What is a microphone?",
      "rishavagarwal2717@gmail.com",
      "https://ccbd-social-audioapp.s3.amazonaws.com/images%2F48e65817-efcc-42ce-84f1-1ec7265a2b81.jpg"
    ]
  ],
  [
    [
      "11b23cce-9759-4115-bc90-daf1bb85a818",
      "What is a microphone?",
      "rishavagarwal2717@gmail.com",
      "https://ccbd-social-audioapp.s3.amazonaws.com/images%2F48e65817-efcc-42ce-84f1-1ec7265a2b81.jpg"
    ]
  ]
]
```

### Questions for user

This API gets a user as an input, then it gets the user's preferences, match the most relevant questions for this user based on the categories of the questions and the user's preferences. It will return questions to show on the For You page in the front end. Below is the result of a test run.

|   |  |
|---|--|
| <b>Test Event Name</b><br>1<br><br><b>Response</b><br>{<br>"isBase64Encoded": false,<br>"statusCode": 200,<br>"headers": {<br>"Access-Control-Allow-Origin": "*"   },<br>"body": "[{"\homePageCategory\": \"ForYou\", \"questions\": [{"questionId\": \"meta_qn_119\", \"caption\": } ] }   |  |
| <b>Function Logs</b><br>START RequestId: a488c154-1176-4329-92b2-f66b209080ea Version: \$LATEST<br>Hello {'queryStringParameters': {'email': 'sa3979@columbia.edu'}}<br>ENTERTAINMENT%<br>user question is [(('meta_qn_119', 'Why music can lead emotion?', 'system@columbia.edu', 'https://ccbd-social-a<br>END RequestId: a488c154-1176-4329-92b2-f66b209080ea<br>REPORT RequestId: a488c154-1176-4329-92b2-f66b209080ea Duration: 96.62 ms Billed Duration: 97 ms Memory Siz |  |
| <b>Request ID</b>   |  |

## Search questions

This API gets a search query, invokes the SageMaker endpoint and gets search query embedding. Then it passes the search query embedding for a KNN model to search in OpenSearch to get 5 similar questions. The test result for the query ‘How to live?’. It returns ‘How to live after your relatives passed away?’, ‘How to make money?’, ‘What does the veteran life look like?’, ‘How do people live and cope in the midst of violent conflict?’, ‘How to find new ways of supporting others?’.

```

# Test our predictor
features = predictor.predict("How to live?")
embedding = json.loads(features)

endpoint = host + '/vector_questions/_search'
doc = {'size': 5,
      'query': {'knn': {'question_vector': {'vector': embedding, 'k': 5}}}}
response = requests.get(endpoint, headers=headers, auth=("metadata", "Meta123!"), json=doc)
response = response.json()
for res in response['hits']['hits']:
    result = res['_source']['question']
    print(result)
#print(response)

How to live after your relatives passed away?
How to make money?
What does the veteran life look like?
How do people live and cope in the midst of violent conflict?
How to find new ways of supporting others?

```

## **VIDEO PRESENTATIONS**

Mobile Development Segment: <https://www.youtube.com/watch?v=YavDVPdB2eo>

Machine Learning Segment: <https://www.youtube.com/watch?v=khj-xE-X-7w>

## **SUMMARY**

The end product is an event driven application which facilitates a social media experience of asking and answering questions on various topics. The user can ask questions on any topics and answer questions they feel they have an expertise on. The application also provides for a discussion forum which lets the asker and the answerers connect based on the data provided. There is a section specific to the user where they can see questions relevant to them and their preferences.

The frontend work was successfully implemented using ReactNative and AWS Services. The work also implements machine learning technology to personalize questions for users and generate labels, and completed three APIs for the front-end team. In addition, the accuracy of machine learning algorithms is within a reasonable range. For future work, more metadata can be imported, therefore this project will not be limited to using ted talk as answer samples. In this way, we can improve the accuracy of the word embedding and label assigned. More data can also give us more diversity.

This project can be further optimized by using automation of answers and questions where the quality of those are also evaluated.