# COT5390 Project 3 Chris Logan

# COT 5930 Project 3

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GCP Project Name: cot5390project1
GCP Project ID: https://console.cloud.google.com/welcome/new?project=cot5390project1
Github Repo: https://github.com/christopherjlogan/cot5390_project1
App URL: https://cot5390project1.uc.r.appspot.com/
* Even those these links say “project1”, it contains the functionality for Project 3.

## Assignment Instructions

Build upon your knowledge from project II and make the following adjustments: - Using the multimodal LLM APIs from Google Cloud, replace the previously used APIs with a single LLM API - Your app should, in a single call, ask for a transcript and the sentiment analysis of the uploaded audio. The response from the LLM should be presented as an audio response by sending it to the TTS API - The option for text input is no longer required and should be removed.

Provide a report of your application, architecture, code and design decisions, with a focus on what you learned.

## Introduction

This project is a proof of concept for the uploading, recording and automated bi-directional conversion of speech and text from a web application. On project 2, additional functionality includes sentiment analysis.

## Architecture

### Project Planning

#### Project 3

- Evaluated the shortcomings of project 2 architecture

- Researched how to use the multimodal LLM API
- Implement feedback from grader: “sentiment analysis should be triggered from python at upload time - not js”
- Implement feedback from grader: “please make links clickable”
- Change audio file upload to use LLM API for speech-to-text and sentiment analysis
- Change audio recording to use LLM API for speech-to-text and sentiment analysis
- Play audio transcription and sentiment response in browser using TTS API
- Removed text-to-speech functionality
- Disable/remove unused functionality

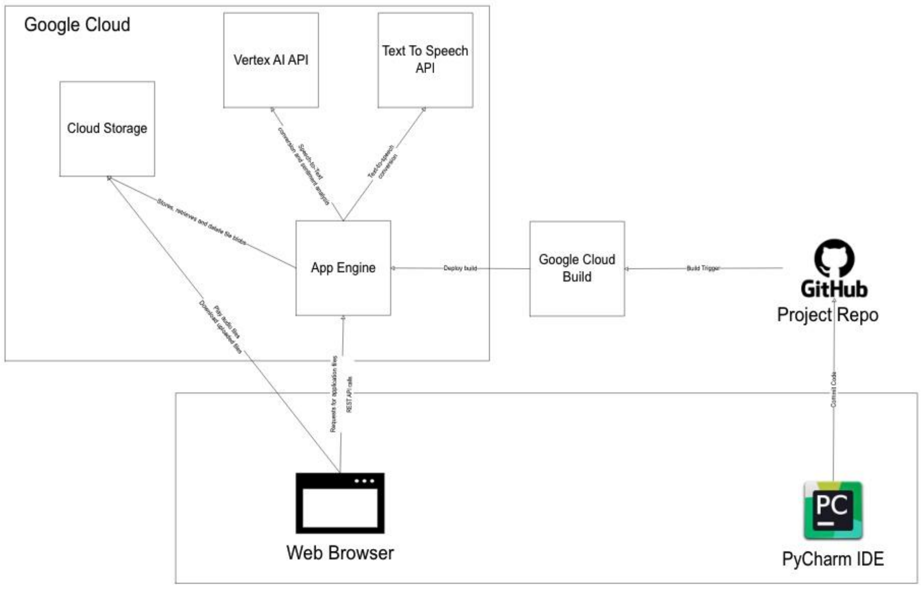
**Project 2**

In the implementation of Project 2, the following steps were followed. I followed the following steps: - Evaluated the shortcomings of project 1 architecture - Researched how to build Single Page Architecture (SPA) app using Python and JavaScript - Created and referenced JavaScript and Cascading Style Sheet (CSS) - Refactored HTML page and python app for SPA - Researched Language API usage for sentiment detection - Enabled Language API - Implemented sentiment detection API call - Added delete file API call - Enabled file deletion from web page - Designed and implemented extracting sentiment from uploaded sentiment files

**Project 1**

In the implementation of this project, the following steps were followed. During each of the steps, iterative coding and test took place. - Researched how to build web apps in Python - Created and ran basic Flask app on local dev machine - Added file upload capability storing files on local dev machine - Added capability to display already uploaded files - Added speech recording capability - Researched Google Text-to-Speech API and how to integrate - Setup Google Cloud Project and IAM permissions - Added text-to-speech capability - Researched Google Speech API for speech-to-text - Added speech-to-text capability - Added language selection for conversion operations - Moved code to Github repo - Refactored code to use Google Cloud Storage for uploaded files - Setup Google App Engine and Admin - Setup Google Cloud Build with Trigger on Github Repo branch push - Tested and troubleshooted application running on Google App Engine

## Solution Components



COT5390 Project3 Architecture.jpg

# Implementation Details

## Python Web Application

The application's user interface and back-end business logic is implemented in Python within a Flask app.
Dependencies: - Flask - for defining app endpoints and template generation - gunicorn and werkzeug - for running the Flask app - Google Cloud APIs - these APIs are discussed later in this section

Files:

```
- credentials
 - service-account.json (secret not stored in source code repo)
- static
 - img
  - trash.png
 - app.js
 - styles.css
- templates
  - index.html
- README.md
- app.py
- app.yaml
- cloudbuild.yaml
- requirements.txt
```

### Google App Engine

Runs the Python web application. Configured to give the service account access to deploy applications. ### Google Cloud Storage API Storing speech audio files. Google Cloud Storage is needed because Google App Engine cannot store persistently store files. Converts text into speech audio. Converts text into speech audio. Configured to give access to the Google Cloud project service account. Configured to give public access to the stored files since users are not authenticated. ### Google Vertex AI API Large Language Model used to convert speech files to text and analyze its sentiment. ### Google Text-To-Speech API Converts text into speech audio. Configured to give access to the Google Cloud project service account. ### Google Language API Detects sentiment of provided text. Configured to give access to the Google Cloud project service account. ### Google Cloud Build Automatically builds and deploys the application to Google App Engine. Configured to trigger off a GitHut repo push. ### GitHub Stores source code. Configured as a public repo for sharing for grading.

## Pros and Cons

Discuss what are the problems of this solution, assuming it needs to handle multiple users and scale as discussed in class. Discuss what are the advantages of this solution as implemented in this project. ### Pros 1. Using Single Page Architecture with REST APIs created a separation of concerns making UI and API more flexible. 1. Using Google Cloud Build with push triggers allows for continuous deployment of the code. 1. Using Google Cloud Storage makes the application ephemeral and therefore more fault-tolerant. 1. Using Google App Engine, the application can be scaled since it is stateless. 1. Vertex AI API is a powerful tool for converting speech to text and analyzing sentiment.

### Cons

1. The current architecture only supports a single user because all of the uploaded files are stored in a single cloud storage bucket without user segmentation.
2. The user interface is very basic and would not work well with many features.
3. No tests are implemented so testing the application required deploying and troubleshooting.
4. More effective error handling should be implemented
5. It is confusing that the cloud project, repo and other resources are named as "project 1"
6. The sentiments are part of the whole transcription response so not easily separated logically from the transcription.

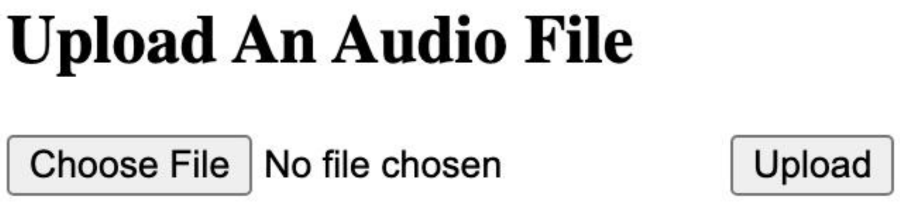
## Problems Encountered and Solutions

1. Refactoring out APIs from the previous project and replacing them with the LLM API. Required carefully analyzing what was being used and what could be removed.
2. Implementing the LLM API required understanding how to use the API and how to integrate it into the application.

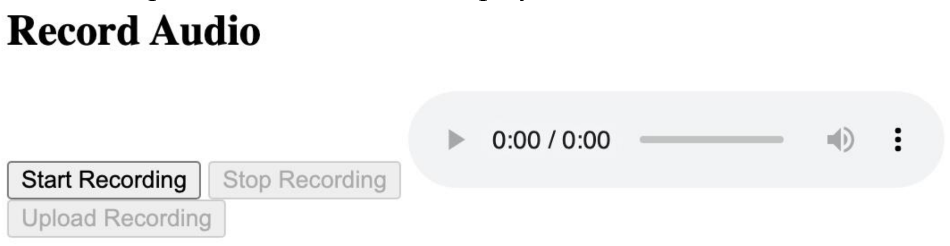
3. Playing the audio response required understanding how to base64 encode the audio response and play it in the browser.

## Application Instructions

1. Uploading Speech Audio Files
    - To upload a file, click the “Choose File” button and select the audio file. Once selected, click the Upload button.
    - The file will be uploaded and processed.
    - The file that was uploaded and its transcription will be displayed in the Uploaded Files section.
    - The transcription of the file will be played in the browser.

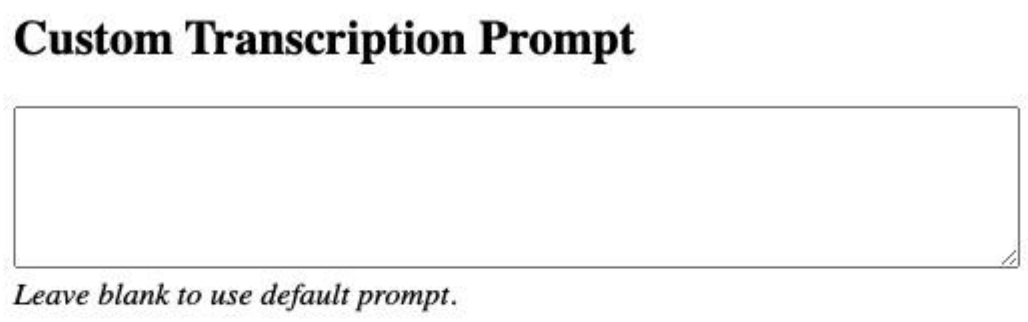


2. Recording Speech Audio
    - To record speech, click the “Start Recording” button
    - Once done speaking, click the “Stop Recording” button
    - Click the “Upload Recording” button to upload your recorded audio
    - The audio will be uploaded and processed.
    - The audio that was uploaded and its transcription will be displayed in the Uploaded Files section.
    - The transcription of the audio will be played in the browser.



3. Play Transcription Audio
    - To play the transcription audio again, click the Play Transcription audio player control

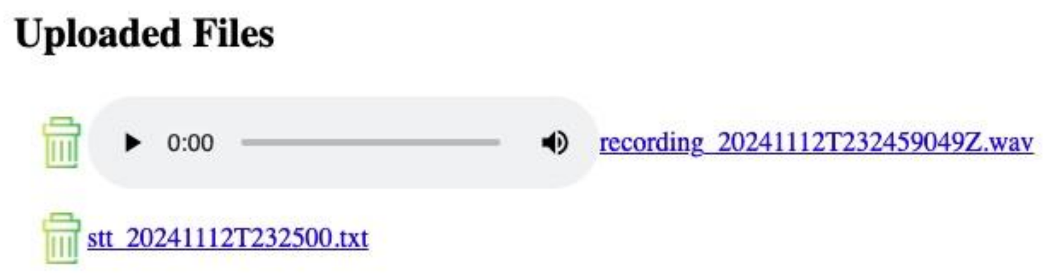
1. Customize Transcription Prompt - To customize the transcription prompt, enter your custom prompt in the text box - The prompt will be used for future transcriptions until the web page is reloaded



## Custom Transcription Prompt

*Leave blank to use default prompt.*

1. Playing Uploaded Speech Audio - Uploaded audio files are listed under the Uploaded Files section - To play previously uploaded audio files, click the play button audio player control

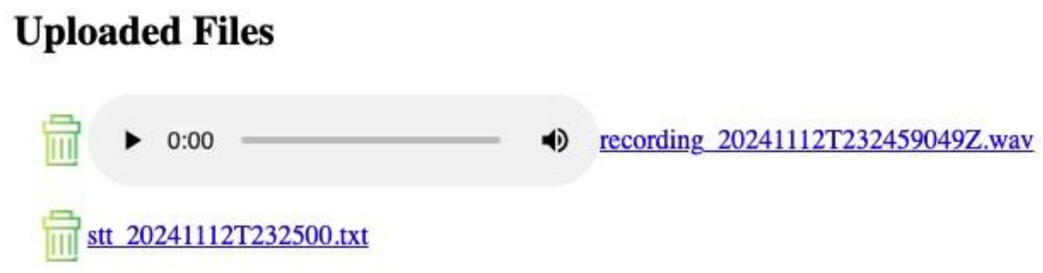


## Uploaded Files

0:00 recording_20241112T232459049Z.wav

stt_20241112T232500.txt

1. Download Audio File - To download an uploaded audio file, click the link on the name of the file to download it.

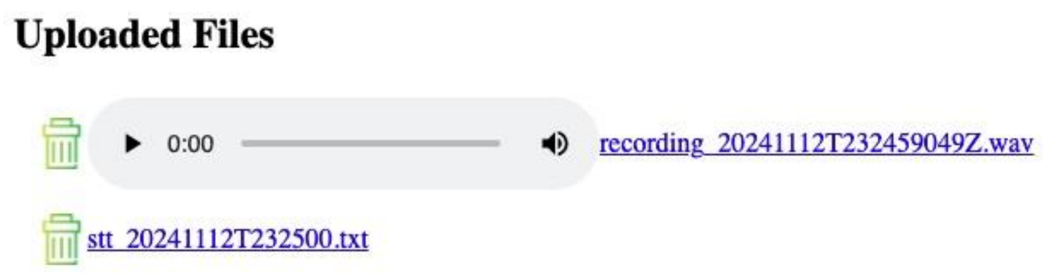


## Uploaded Files

0:00 recording_20241112T232459049Z.wav

stt_20241112T232500.txt

1. Download Transcription File - To download a text file, click the link on the name of the file to download it.

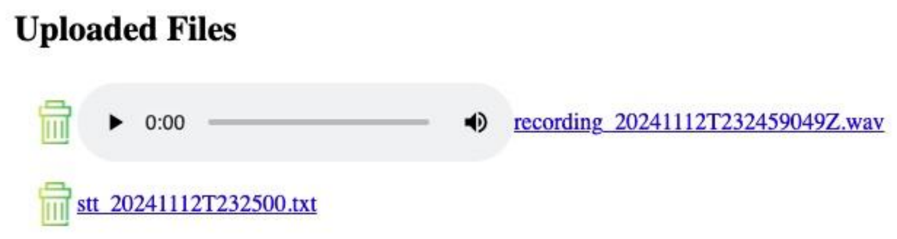


## Uploaded Files

0:00 recording_20241112T232459049Z.wav

stt_20241112T232500.txt

1. Delete Uploaded File - To delete a file, click the trash icon next to the file - The list of files will refresh - The file will be deleted from the cloud storage



## Uploaded Files

0:00 recording_20241112T232459049Z.wav

stt_20241112T232500.txt

screenshot_uploaded_files.jpg

## Lessons Learned

1. How to call the Vertex AI API
2. How to return encoded audio in a JSON response
3. How to play audio in the browser