Speech Transcription and Information Retrieval

for Question-Answer Systems

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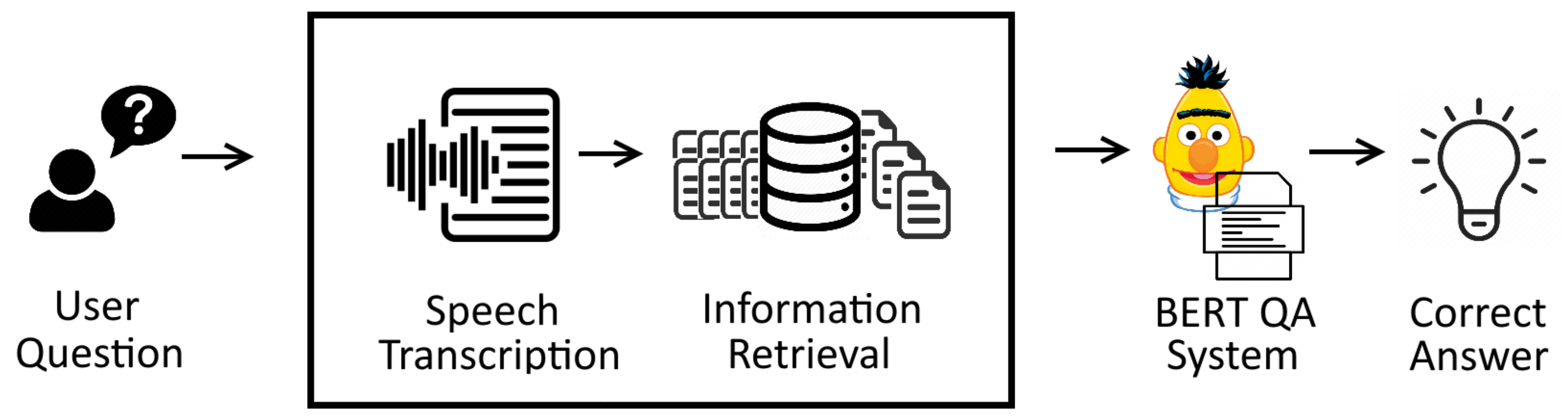
How We Use Speech Transcription and Info Retrieval

Project Goal

Create a **Question and Answering (QA) system** that can answer a driver's questions **accurately and efficiently** using the information provided from **the car's user manual**.

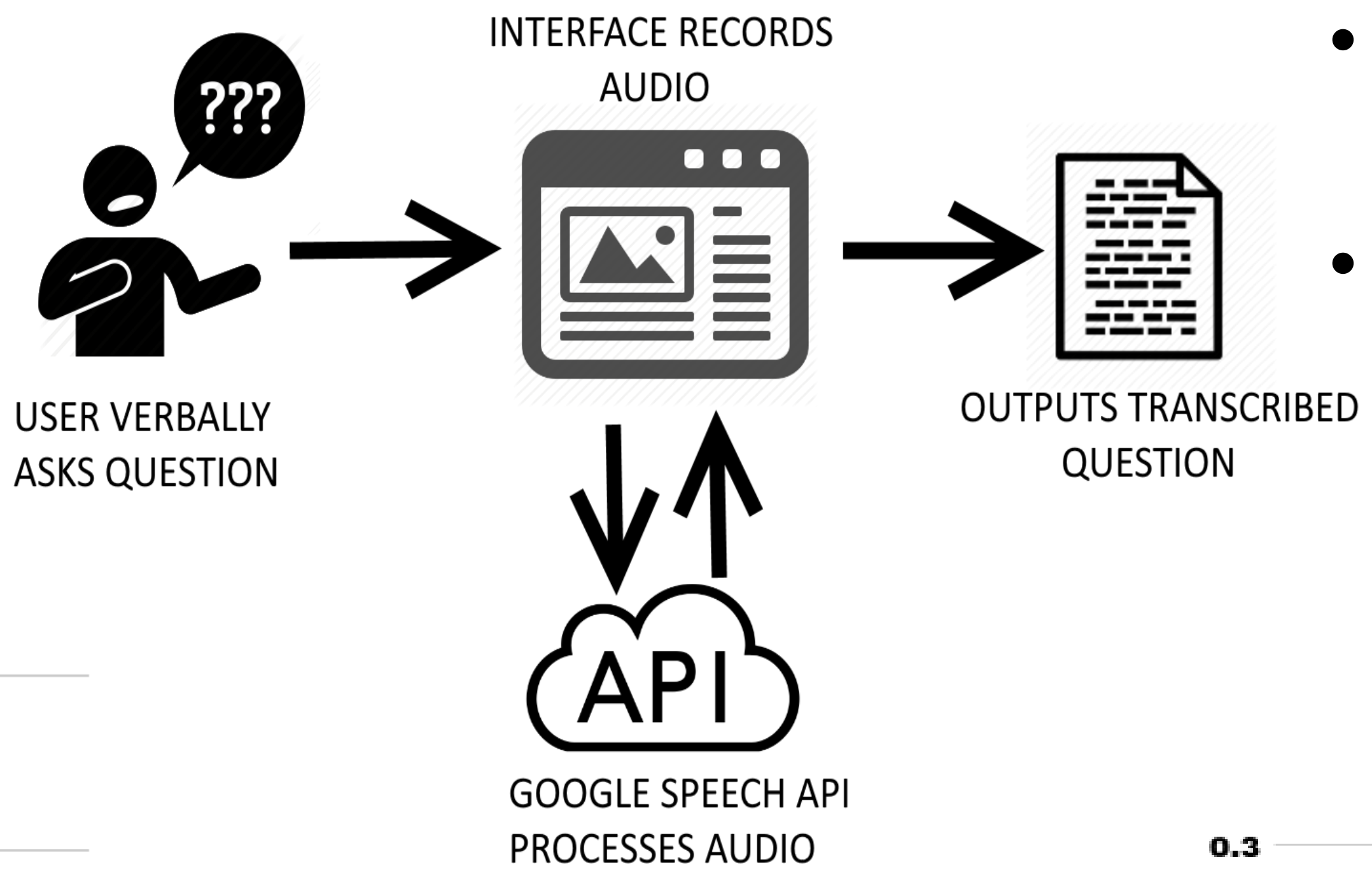


How Speech Transcription and Info Retrieval fit into the QA Pipeline

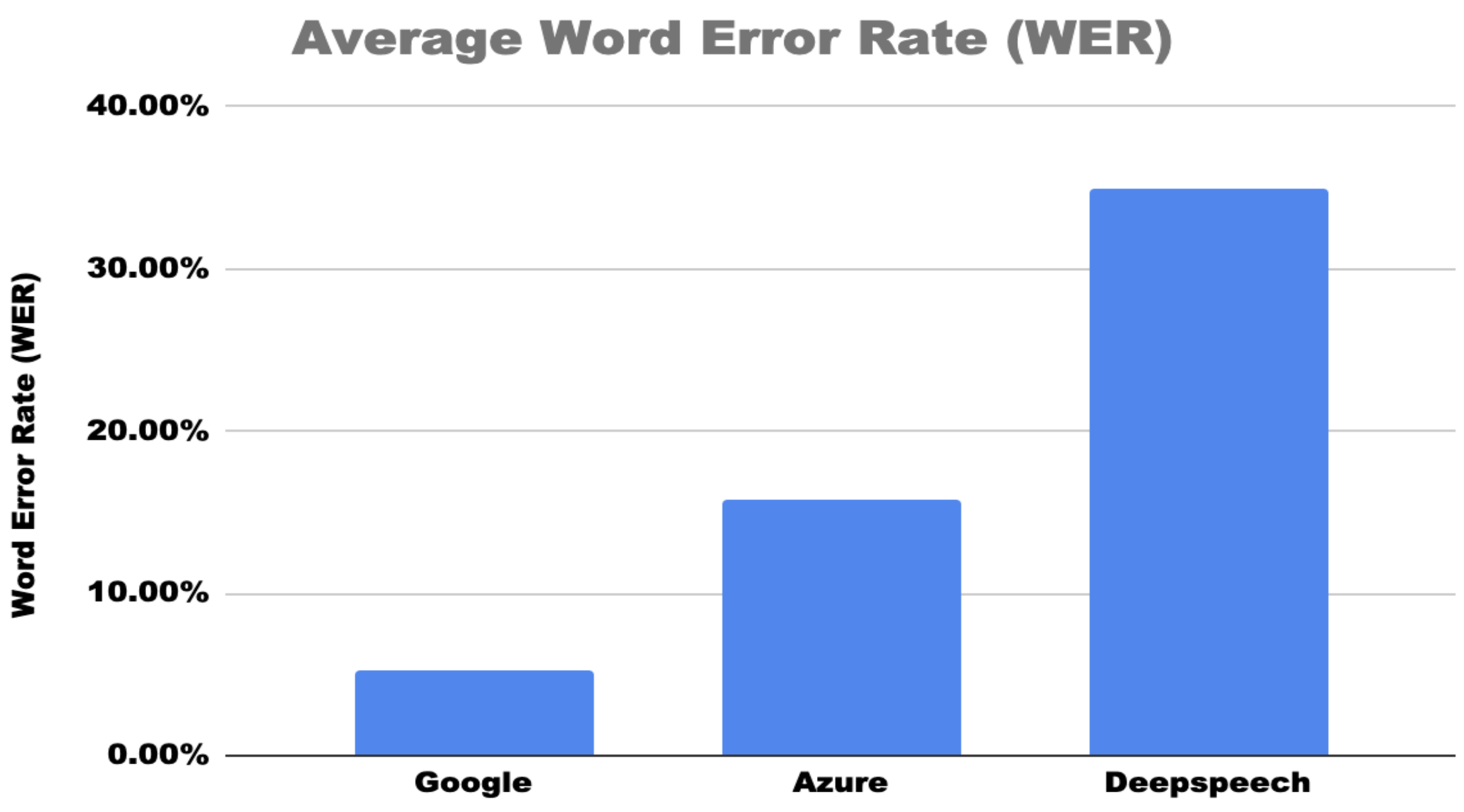
- Speech-to-text transcribes the spoken question
- IR narrows down the full document to paragraphs which most likely contain the answer

Speech to Text

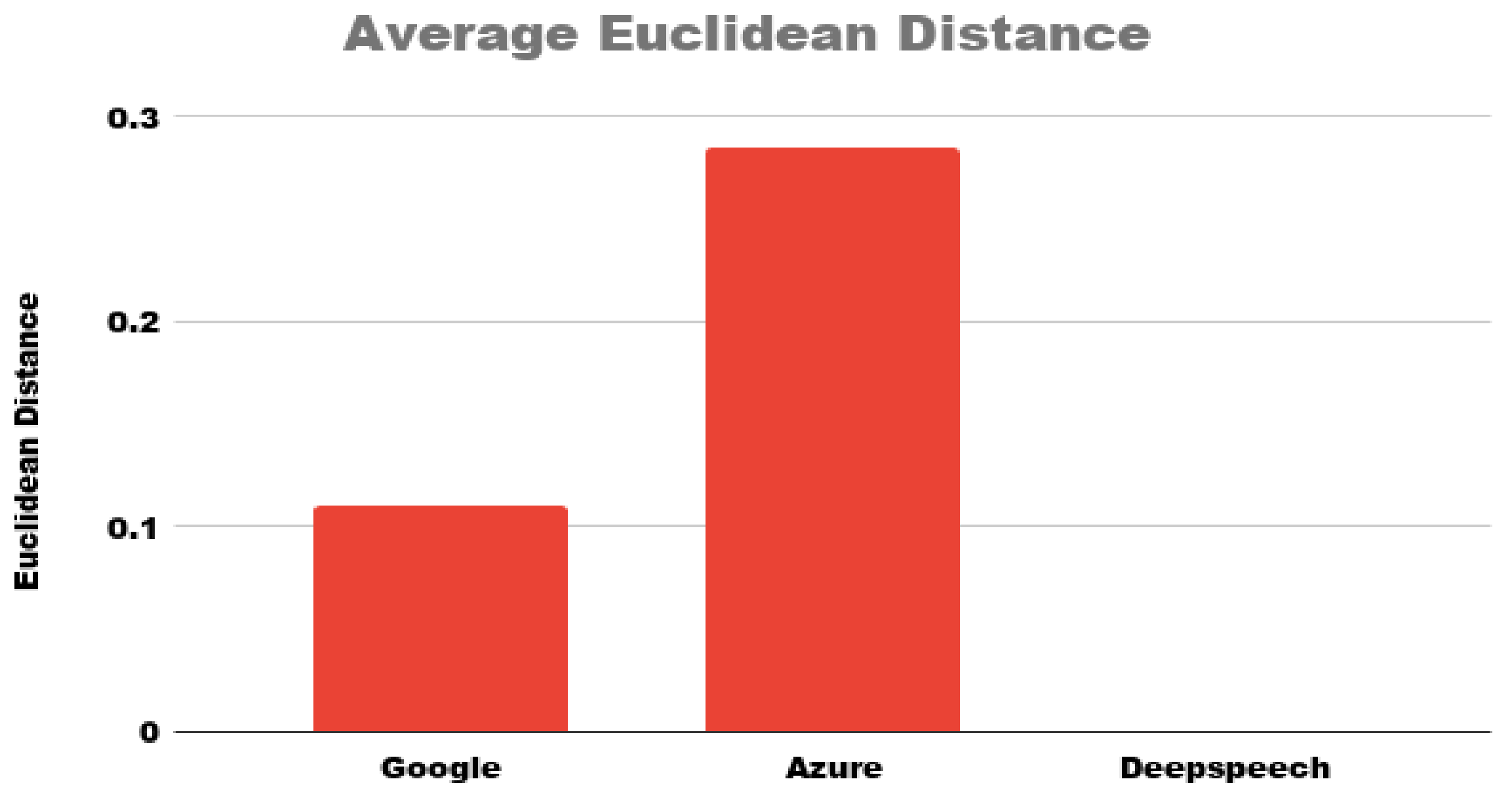
Experimented with Deep Speech, Microsoft Azure and Google's API to select the best possible one


???
USER VERBALLY ASKS QUESTION
INTERFACE RECORDS AUDIO
OUTPUTS TRANSCRIBED QUESTION
API
GOOGLE SPEECH API PROCESSES AUDIO

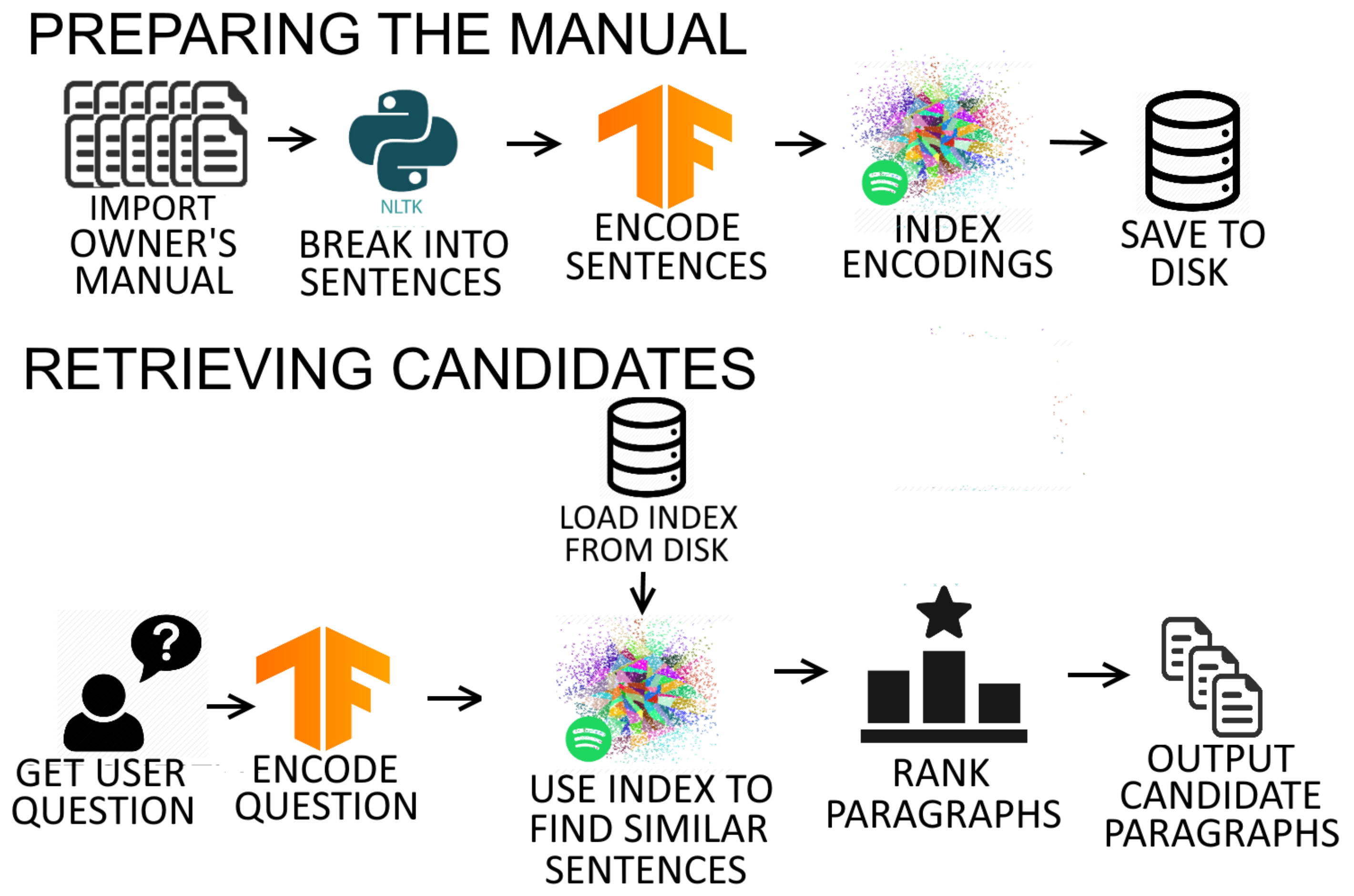
- Word Error Rate (WER): # of changes / # of words
- Euclidean Distance: Difference between the meaning of two texts. Not calculated for DeepSpeech since it already showed a very high WER



Google's API displayed the highest accuracy



Information Retrieval



Spotify Annoy

- Builds data structure to efficiently find most similar vectors to any given vector
- Data Structure can be saved for later use

Why use IR?

In order to not overload the BERT QA System with too many paragraphs

How the IR System Works

- Prepare the manual (done only once)
  - Sentence tokenization (**NLTK Punkt**)
  - Encoding sentences (**Univ. Sent. Encoder QA**)
  - Indexing embeddings (**Spotify's Annoy**)
- Retrieve candidates (each time a question is asked)
  - Encode user question (**Univ. Sent. Encoder QA**)
  - Find its nearest-neighbor sentences using the prebuilt index
  - Paragraphs are weighted and ranked higher based on paragraph mean distance

Results

- **99.5% accuracy** when retrieving 400 paragraphs
- **Median ranking of 4** for the correct answer among candidate paragraphs
- **63% reduction** in paragraphs sent to downstream BERT model

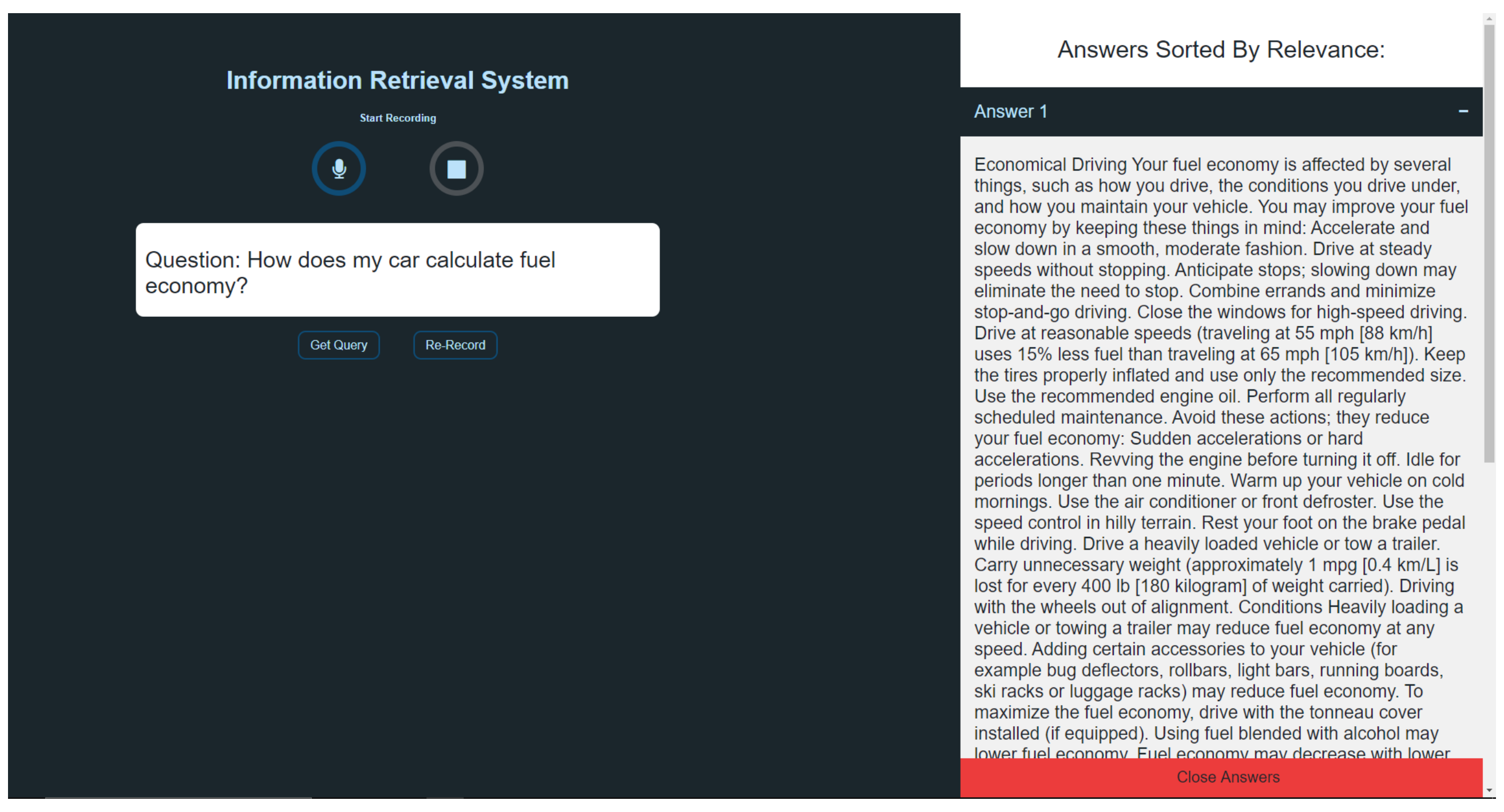
User Interface

How It Works

1. Record and transcribe question
2. Run IR with the transcribed question
3. Displays top 10 answers

What We Used

- Frontend: HTML5/CSS3/JavaScript/Jquery
- Recording Audio: Recorder.js
- Backend: Python Flask



Question: How does my car calculate fuel economy?

Economical Driving Your fuel economy is affected by several things, such as how you drive, the conditions you drive under, and how you maintain your vehicle. You may improve your fuel economy by keeping these things in mind: Accelerate and slow down in a smooth, moderate fashion. Drive at steady speeds without stopping. Anticipate stops; slowing down may eliminate the need to stop. Combine errands and minimize stop-and-go driving. Close the windows for high-speed driving. Drive at reasonable speeds (traveling at 55 mph [88 km/h] uses 15% less fuel than traveling at 65 mph [105 km/h]). Keep the tires properly inflated and use only the recommended size. Use the recommended engine oil. Perform all regularly scheduled maintenance. Avoid these actions; they reduce your fuel economy: Sudden accelerations or hard accelerations. Revving the engine before turning it off. Idle for periods longer than one minute. Warm up your vehicle on cold mornings. Use the air conditioner or front defroster. Use the speed control in hilly terrain. Rest your foot on the brake pedal while driving. Drive a heavily loaded vehicle or tow a trailer. Carry unnecessary weight (approximately 1 mpg [0.4 km/L] is lost for every 400 lb [180 kilogram] of weight carried). Driving with the wheels out of alignment. Conditions Heavily loading a vehicle or towing a trailer may reduce fuel economy at any speed. Adding certain accessories to your vehicle (for example bug deflectors, rollbars, light bars, running boards, ski racks or luggage racks) may reduce fuel economy. To maximize the fuel economy, drive with the tonneau cover installed (if equipped). Using fuel blended with alcohol may lower fuel economy. Fuel economy may decrease with lower