Note：this project was started in UCSD DSC96 when introduced to audio processing. I did beyond after to further reach on some observations I was interested in

Noise's Impact on Performance of Speech Recognition mechanism

March 22, 2022

1 Noise's Impact on Performance of Speech Recognition mechanism

Project Description: Through analyzing a selected passage of *the Gettysburg Address*, this project models how the addition of noise impact the performance of Google Speech Recognition API and analyzes further into some specifics, including whether the speech recognition API produces varied output when given the same input and on keeping track of data to find out the most noise-resistant word.

Project Breakdown: 1. Collection of Data and Test (noise vs. performance of speech recognition mechanism) 2. Visualization of Noise vs. Performance of Speech Recognition 3. Test into the Variance of Speech recognition mechanism

```python
[1]: # import packages
     import soundfile as sf
     import random
     import speech_recognition as sr
     import numpy as np
     import pandas as pd
     import re
     import matplotlib.pyplot as mpl
     from scipy.io.wavfile import write
     from scipy.io.wavfile import read
     from IPython import display
```

1.1 Test Environment SetUp

Audio Source I decided to use an audio of passage selected from *The Gettysburg Address* by Abraham Lincoln, as attached below:

```python
[2]: display.Audio('data/gettysburg.wav') #display audio of gettyburg speech
```

```
[2]: <IPython.lib.display.Audio object>
```

Setup Reference Text: STATS By processing reference text, I found the following information about the (original) reference text of gettysburg speech:

```
- total words count: 52
- total unique words count: 43
```

```
[3]: #set original to the reference text from gettysburg speech (ref gettyspeech)
     original= 'Four score and seven years ago our fathers brought forth on this␣
      ↪continent, a new nation, \
     conceived in Liberty, and dedicated to the proposition that all men are created␣
      ↪equal. Now we are\
     engaged in a great civil war, testing whether that nation, or any nation so␣
      ↪conceived and so dedicated,\
     can long endure.'
     #split original into list of words with no comma or period
     lst_words =original.split(' ')
     for i in range(len(lst_words)):
         lst_words[i]=lst_words[i].strip(',').strip('.')

     #print the first five words in the ref gettyspeech
     lst_words[:5]
```

```
[3]: ['Four', 'score', 'and', 'seven', 'years']
```

```
[4]: # Words in total in ref gettyspeech (52)
     len(lst_words)
     # Unique Words in total in ref gettyspeech (43)
     uniq_lst = set(lst_words)
     unique_orig = len(set(lst_words))
```

Setup speech recognition on processing audio file

I setup the Google Speech Recognition API to read the gettysburg.wav audio file and was able to obtain the file's audio data *(in array)* and sampling rate *(int)*

```
[5]: recognizer = sr.Recognizer() #create a speech recognizer
```

```
[6]: #read gettysburg.wav file
     gettytext = read("data/gettysburg.wav")
     #get the array of gettysburg actual arrayed audio data -audiodata
     audioData = gettytext[1]
     #get sampling rate of audiodata (22050)
     samplingRate = gettytext[0]
```

1.2 Collection of data (Noise vs. Performance of speech recognition mechanism)

Ten trials of tests are ran below to model how the performance of speech recognition mechanism varies as noise increases. In each trial, a measure of performance of speech recognition on the original audio file is done first to set a control for the preceding measures of performance on audio file with increasing noise. Each measure of performance is done by counting how many unique words the speech recognition mechanism was able to capture correctly compared to the total unique words that the original reference(text) file contains

```python
[7]: '''the function below runs one time the simulation of testing and showing a␣
     ↪graph of how increased noise influences accuracy
     of speech recognition tool
     '''
     def onetime(track_words, randNoise ):
         #initialize the list data_noise (data_correct) to collect
         #the independent variable - noise data (dependent variable - correct data)
         data_noise = []
         data_correct = []


         #set up dictionary that keeps track of frequency of unique
         #words recognized by speech recognition mechanism
         track_words = track_words


         # speech recognition performed on gettysburg.wav
         with sr.AudioFile("data/gettysburg.wav") as source:
             audio_data = recognizer.record(source)
             recognizer.adjust_for_ambient_noise(source)

         #if we do not want random noisebase, we seed the array
         #we generate seeded array (same among trials) or varied base noise arrays
         if randNoise== False:
             np.random.seed(30)
         NoiseBase = np.random.randn(len(audioData))
         print('Noise Base: '+ str(NoiseBase))


         #simulate different strength of noises and how it influences accuracy-␣
     ↪quantified by how many numbers of words
         #the speech recognition tool got correctly in comparison to the original␣
     ↪transcription file
         for i in range(0,9000,500):

             # initialize a count for recognized text
             num_recognized = 0


             # simulate different strength of audio noise by multiplying increasing␣
     ↪i which increases to noise's volume
             #generate a random noise audio that's the same length as gettysburg␣
     ↪speech
             audioNoise = NoiseBase*i


             #print the max volume of audio data itself
```

```python
        print('max volume audio: '+str(np.max(np.abs(audioData))))
        #print the max volume of audio noise itself
        print('max volume noise: '+str(np.max(np.abs(audioNoise))))


        #overlap audio data and audio noise, store the audio with noise as a↵
→wav file,
        #and write and save the new gettysburg speech file that is accompanied↵
→by
        #certain strength of noise from background
        audioWithNoise = audioData +audioNoise
        scaled = np.int16(audioWithNoise/np.max(np.abs(audioWithNoise)) * 32767)
        write('data/output_with_noise1.wav', samplingRate, scaled)


        # when noise does not dominate over the gettysburg speech itself,
        #try transcripting the processed/noised audio
        try:

            with sr.AudioFile('data/output_with_noise1.wav') as source:
                audio_data = recognizer.record(source)
                recognizer.adjust_for_ambient_noise(source)
                text =recognizer.recognize_google(audio_data)
                print('Output: '+ text +'\n' )


            # save a list of unique set of words that could be
            #identified from processed/noised gettysburg speech
            lst_text = set(text.split(' '))


            '''
            loop through the recognized words to count
            how many there are that matches with the original file
            and keep track of what unique words are recognized by
            the speech recognition mechanism
            '''

            for word in lst_text:
                if word in uniq_lst:
                    num_recognized+=1
                if word not in track_words:
                    track_words[word] = 1
                else:
                    track_words[word] += 1

        # when noise does dominate over the gettysburg speech itself,
```

4

```
        #set number of words recognized to 0 to avoid error
        except sr.UnknownValueError:
            num_recognized = 0
            print('Output: N/A \n' )


        #append used audio noise / the certain strength of
        #noise used to data_noise
        data_noise.append(np.max(np.abs(audioNoise)))

        #append the number of unique words correctly transcripted depending on
        #certain used audio noise / certain strength of noise used to
→data_correct
        data_correct.append(num_recognized)

    #print final array of data noise collected during this trial
    print(np.array(data_noise))
    #print final array of collected data for words correctly transcripted
→during this trial
    print(np.array(data_correct))
    #plot data noise vs data num of words correctly identified - speech
→recognition capability
    mpl.plot(np.array(data_noise),np.array(data_correct))
    return track_words #new dict
```

```
[8]: '''The function below simulates specified num_trials of simulation of testing
     →and showing a graph of how increased
     noise influences accuracy of speech recognition tool '''
     def simulate_noisevcorrect(num_trials, randNoise=True):
         new_dict = dict()
         for i in range(num_trials):
             print('Trial: '+str(i+1))
             new_dict = onetime(new_dict, randNoise)
             new_dict = dict(sorted(new_dict.items(), key=lambda item: item[1]))
             mpl.title('Noise vs Performance of Speech Recognition')
             mpl.ylabel('Accuracy (unique correct/total unique)')
             mpl.xlabel('Noise')
             print('\n\n')
         return new_dict
```

```
[9]: #simulate ten trials of displaying relationship of strength of noise vs speech
     →recognition tool capability/accuracy
     freq_words= simulate_noisevcorrect(10, randNoise= True)
```

```
Trial: 1
Noise Base: [ 0.59218801 -0.22183622 -0.76156321 … -0.09189117  0.23011314
```

```
 -1.4450896 ]
```
max volume audio: 11643
max volume noise: 0.0
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 2660.102942275493
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 5320.205884550986
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and long India

max volume audio: 11643
max volume noise: 7980.30882682648
Output: 44 and seven years ago our fathers brought forth on this continent a new
nation conceived in liberty and dedicated to the proposition that all men are
created equal now we are engaged in a great civil war testing whether that
Nation or any Nation so conceived and so dedicated and long India

max volume audio: 11643
max volume noise: 10640.411769101973
Output: 44 and seven years ago our fathers brought forth on this continent a new
nation conceived in liberty and dedicated to the proposition that all men are
created equal now we are engaged in a great civil war testing whether that
Nation or any Nation so conceived and so dedicated and longing

max volume audio: 11643
max volume noise: 13300.514711377467
Output: 44 and seven years ago our fathers brought forth on this continent a new
nation dedicated to the proposition that all men are created equal now we are
engaged in a great civil war question whether that Nation or any Nation so
conceived and so dedicated and login

max volume audio: 11643
max volume noise: 15960.61765365296
Output: 447 Michigan Ave Swarthmore 174 question whether that Nation

max volume audio: 11643

```
max volume noise: 18620.720595928455
Output: 447 Michigan Ave Swarthmore 174

max volume audio: 11643
max volume noise: 21280.823538203946
Output: 447 East Alcott is 1 / 170

max volume audio: 11643
max volume noise: 23940.92648047944
Output: 4475 father's Baltimore number

max volume audio: 11643
max volume noise: 26601.029422754935
Output: 4475 father's Baltimore number

max volume audio: 11643
max volume noise: 29261.132365030426
Output: 44 175

max volume audio: 11643
max volume noise: 31921.23530730592
Output: how tall is Johnny Orlando

max volume audio: 11643
max volume noise: 34581.338249581415
Output: how tall is North Carolina

max volume audio: 11643
max volume noise: 37241.44119185691
Output: how tall is North Carolina

max volume audio: 11643
max volume noise: 39901.544134132404
Output: N/A

max volume audio: 11643
max volume noise: 42561.64707640789
Output: N/A

max volume audio: 11643
max volume noise: 45221.750018683386
Output: N/A

[    0.           2660.10294228   5320.20588455   7980.30882683
  10640.4117691   13300.51471138  15960.61765365  18620.72059593
  21280.8235382   23940.92648048  26601.02942275  29261.13236503
  31921.23530731  34581.33824958  37241.44119186  39901.54413413
  42561.64707641  45221.75001868]
```

```
[38 38 37 36 35 34  2  0  0  0  0  0  0  0  0  0  0  0  0]
```

Trial: 2
Noise Base: [-0.15737875 0.7179696 -0.39006503 … 0.75794617 -1.30467253
  0.21611457]
max volume audio: 11643
max volume noise: 0.0
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 2420.359445817102
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 4840.718891634204
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and long India

max volume audio: 11643
max volume noise: 7261.078337451306
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and long a

max volume audio: 11643
max volume noise: 9681.437783268408
Output: for 47 years ago our fathers brought forth on this continent a new
nation conceived in liberty and dedicated to the proposition that all men are
created equal now we are engaged in a great civil war Nation or any Nation so
conceived

max volume audio: 11643
max volume noise: 12101.797229085509
Output: for 47 years ago our fathers brought forth on this continent has
dedicated to the proposition that all men are created equal now we are engaged
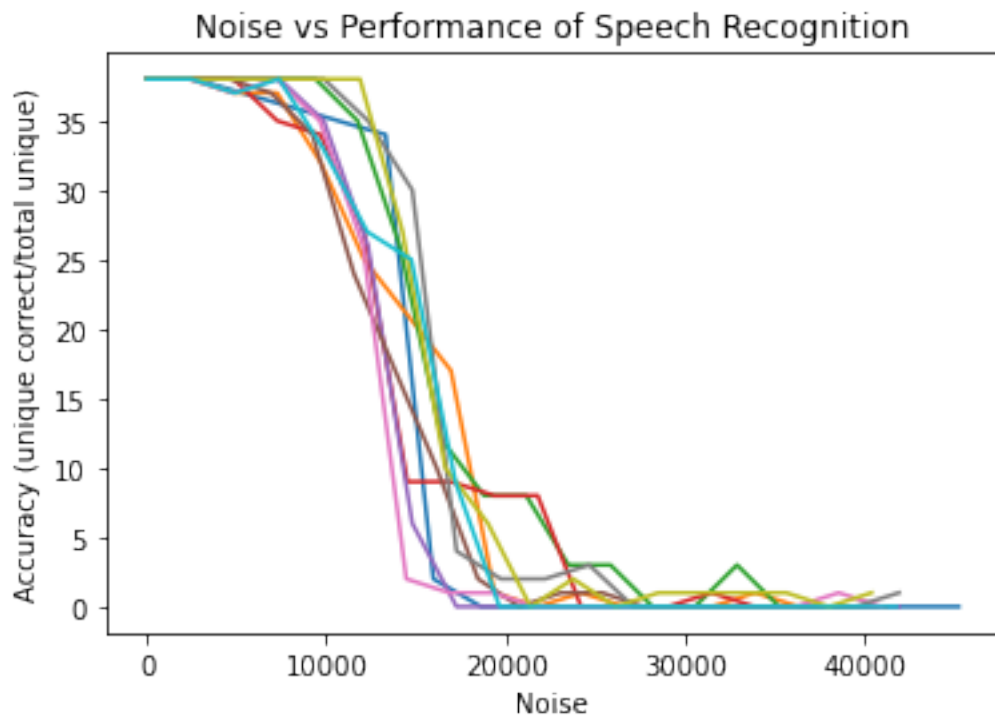in a great civil war

```
max volume audio: 11643
max volume noise: 36832.18699967089
Output: N/A

max volume audio: 11643
max volume noise: 39287.66613298229
Output: N/A

max volume audio: 11643
max volume noise: 41743.14526629368
Output: N/A

[    0.          2455.47913331   4910.95826662   7366.43739993
  9821.91653325 12277.39566656 14732.87479987 17188.35393318
 19643.83306649 22099.3121998   24554.79133311 27010.27046643
 29465.74959974 31921.22873305 34376.70786636 36832.18699967
 39287.66613298 41743.14526629]
[38 38 37 38 33 27 25  9  0  0  0  0  0  0  0  0  0  0]
```


Noise vs Performance of Speech Recognition

[25]: `print(freq_words)`

{'longing': 1, '170': 1, '/': 1, 'Alcott': 1, 'East': 1, '1': 1, '175': 1,
'Orlando': 1, 'Johnny': 1, 'has': 1, 'one': 1, '403': 1, '44w': 1, 'W': 1,
'Godfather': 1, 'Amino': 1, 'major': 1, 'completely': 1, '400m': 1, 'emo': 1,
'1408': 1, 'review': 1, 'future': 1, 'as': 1, 'unlock': 1, 'after': 1, 'Barack':
1, 'Obama': 1, 'working': 1, 'Chatsworth': 1, 'Olivia': 1, 'Andrews': 1,
'David': 1, 'video': 1, 'meaning': 1, 'Newman.': 1, 'dr.': 1, '2017.': 1,
'alcohol': 1, '420': 1, 'up': 1, 'here': 1, 'proposition.': 1, 'Now': 1,
'divorce': 1, 'LeBron': 1, 'James': 1, 'Thunder': 1, 'All': 1, 'Hyundai': 1,
'welfare': 1, 'Court': 1, 'number.': 1, 'longer': 1, 'oil': 1, 'vegetable': 1,
'4:00': 1, 'definitely': 1, 'open': 1, '4:30': 1, '4438': 1, '474': 1, '4449':
1, 'Father': 1, 'destination': 1, 'got': 1, 'Some': 1, 'nation.': 1,
'continent.': 1, 'timer.': 1, 'minute': 1, 'crossword': 1, 'hungry': 1,
'Longview': 1, 'almond': 1, 'reversible': 1, 'almost': 1, 'week': 1, 'Grant': 1,
'448': 1, 'Jack': 1, '4/4': 1, '+': 1, '441': 1, '100': 2, 'Bethlehem': 2,
'do.': 2, 'weekend': 2, 'understand': 2, '174': 2, 'Swarthmore': 2, 'Michigan':
2, 'Ave': 2, 'Baltimore': 2, 'North': 2, 'Carolina': 2, '1413': 2, '484': 2,
'fourth-quarter': 2, '4400': 2, 'hot': 2, '4417': 2, 'forthcoming': 2,
'wallpaper.': 2, '104': 2, 'Rock': 2, 'I': 2, 'will.': 2, 'something': 2, '434':
2, 'route': 2, 'undo.': 2, 'minutes': 2, 'death.': 2, 'years.': 2, "Obama's": 2,
'President': 2, '404': 3, 'Bluff': 3, 'Alcovy': 3, 'Our': 3, 'equal.': 3, 'do':
3, 'it': 3, 'login': 3, 'number': 3, 'of': 3, 'definition': 3, 'death': 3,
'fathers.': 4, 'you': 4, 'far': 4, 'other': 4, 'Mark': 4, 'Wahlberg': 4,
'question': 4, 'more': 4, 'India': 5, '447': 5, 'Lesnar': 5, 'Brock': 5,
'Texas': 5, '4478': 6, '400': 6, '4471': 7, 'Rockwall': 7, '44': 8, '4475': 8,
"father's": 13, 'tall': 16, '47': 22, 'is': 24, 'for': 25, 'how': 33, 'endure':
39, 'can': 42, 'score': 48, 'four': 48, 'long': 51, 'equal': 53, 'seven': 53,
'testing': 55, 'liberty': 56, 'whether': 58, 'so': 59, 'conceived': 60, 'or':
60, 'any': 60, 'created': 60, 'Nation': 62, 'great': 62, 'all': 62, 'men': 62,
'civil': 63, 'nation': 64, 'proposition': 64, 'new': 65, 'the': 65, 'and': 65,
'engaged': 65, 'now': 65, 'to': 66, 'dedicated': 66, 'in': 66, 'that': 67, 'we':
67, 'ago': 67, 'war': 68, 'years': 71, 'continent': 72, 'are': 72, 'a': 73,
'on': 75, 'this': 75, 'forth': 75, 'our': 82, 'brought': 84, 'fathers': 92}

```
[28]: most_freq= list(freq_words.keys())[-1]
num_most_freq = 0
for word in freq_words:
    if most_freq.strip('s') in word.lower():
        num_most_freq+= freq_words[word]

(most_freq,num_most_freq)
```

[28]: ('fathers', 111)

1.3 Conclusion- Visualization

From the visualization above, it's suggested that as noise increases and is layered onto the original audio file, the performance of speech recognition mechanism is impacted negatively or, in other words, it is changed in a way that a lower accuracy is obtained.

It can also be observed from the dictionary (most_freq) that I set up for counting frequency of unique words recognized by speech recognition on the selected gettysburg passage that the most noise-resistant word is 'father', which were counted for 111 times.

1.4 Test Existence of Variation

By setting a seed to produce the same array of noise base (NoiseBase), we can test and understand more about how the google speech recognition mechanism works or, specifically, on whether variation occurs among trials when we use the exactly same different noise inputs to model two trials of how performance of speech recognition mechanism changes as noise increases.

```
[11]: var_test = simulate_noisevcorrect(2, randNoise= False)
```

```
Trial: 1
Noise Base: [-1.26405266  1.52790535 -0.97071094 …  0.85130204  0.56328672
   1.73439333]
max volume audio: 11643
max volume noise: 0.0
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 2350.1355867052257
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 4700.271173410451
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and long and do
it

max volume audio: 11643
max volume noise: 7050.406760115677
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and long and do
it

max volume audio: 11643
max volume noise: 9400.542346820903
```

Output: four score and seven years ago our fathers brought forth on this continent a new nation conceived in liberty and dedicated to the proposition that all men are created equal now we are engaged in a great civil war testing whether that Nation or any Nation so conceived and so dedicated and Longview

max volume audio: 11643
max volume noise: 11750.677933526127
Output: for 47 years ago our fathers brought forth on this continent a new nation dedicated to the proposition that all men are. Now we are engaged in a great civil war testing whether that Nation or any Nation so conceived and so dedicated and losses

max volume audio: 11643
max volume noise: 14100.813520231353
Output: 447 Michigan Ave Swarthmore Thunder dedicated to the proposition that all men are. Now we are engaged in a great civil war testing whether that Nation or any Nation so conceived and so dedicated and losses

max volume audio: 11643
max volume noise: 16450.94910693658
Output: 4471 All fathers brought forth a dedicated to the proposition that all men are. Now we are engaged to Jacob or just another destination or any Nation so conceived and say that it's unlocked

max volume audio: 11643
max volume noise: 18801.084693641806
Output: 4471 how fathers brought forth a reasonable now we own Jason Jason. Whenever that may change running is so confusing

max volume audio: 11643
max volume noise: 21151.22028034703
Output: 4471 how fathers Route 404 that's another destination

max volume audio: 11643
max volume noise: 23501.355867052254
Output: 4475 father's Route 404

max volume audio: 11643
max volume noise: 25851.49145375748
Output: 4475 father's macaroni

max volume audio: 11643
max volume noise: 28201.627040462707
Output: how far is Las Vegas

max volume audio: 11643
max volume noise: 30551.762627167933
Output: how far is Las Vegas

max volume audio: 11643
max volume noise: 32901.89821387316
Output: Godfathers

max volume audio: 11643
max volume noise: 35252.033800578385
Output: N/A

max volume audio: 11643
max volume noise: 37602.16938728361
Output: N/A

max volume audio: 11643
max volume noise: 39952.30497398884
Output: N/A


```
[    0.            2350.13558671   4700.27117341   7050.40676012
   9400.54234682  11750.67793353  14100.81352023  16450.94910694
  18801.08469364  21151.22028035  23501.35586705  25851.49145376
  28201.62704046  30551.76262717  32901.89821387  35252.03380058
  37602.16938728  39952.30497399]
[38 38 37 37 36 33 22 19  7  1  0  0  0  0  0  0  0  0]
```


Trial: 2
Noise Base: [-1.26405266   1.52790535 -0.97071094 …   0.85130204   0.56328672
    1.73439333]
max volume audio: 11643
max volume noise: 0.0
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 2350.1355867052257
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated can long endure

max volume audio: 11643
max volume noise: 4700.271173410451
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing

whether that Nation or any Nation so conceived and so dedicated and long and do
it

max volume audio: 11643
max volume noise: 7050.406760115677
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and long and do
it

max volume audio: 11643
max volume noise: 9400.542346820903
Output: four score and seven years ago our fathers brought forth on this
continent a new nation conceived in liberty and dedicated to the proposition
that all men are created equal now we are engaged in a great civil war testing
whether that Nation or any Nation so conceived and so dedicated and Longview

max volume audio: 11643
max volume noise: 11750.677933526127
Output: for 47 years ago our fathers brought forth on this continent a new
nation dedicated to the proposition that all men are. Now we are engaged in a
great civil war testing whether that Nation or any Nation so conceived and so
dedicated and losses

max volume audio: 11643
max volume noise: 14100.813520231353
Output: 447 Michigan Ave Swarthmore Thunder dedicated to the proposition that
all men are. Now we are engaged in a great civil war testing whether that Nation
or any Nation so conceived and so dedicated and losses

max volume audio: 11643
max volume noise: 16450.94910693658
Output: 4471 All fathers brought forth a dedicated to the proposition that all
men are. Now we are engaged to Jacob or just another destination or any Nation
so conceived and say that it's unlocked

max volume audio: 11643
max volume noise: 18801.084693641806
Output: 4471 how fathers brought forth a reasonable now we own Jason Jason.
Whenever that may change running is so confusing

max volume audio: 11643
max volume noise: 21151.22028034703
Output: 4471 how fathers Route 404 that's another destination

max volume audio: 11643
max volume noise: 23501.355867052254

```
Output: 4475 father's Route 404

max volume audio: 11643
max volume noise: 25851.49145375748
Output: 4475 father's macaroni

max volume audio: 11643
max volume noise: 28201.627040462707
Output: how far is Las Vegas

max volume audio: 11643
max volume noise: 30551.762627167933
Output: how far is Las Vegas

max volume audio: 11643
max volume noise: 32901.89821387316
Output: Godfathers

max volume audio: 11643
max volume noise: 35252.033800578385
Output: N/A

max volume audio: 11643
max volume noise: 37602.16938728361
Output: N/A

max volume audio: 11643
max volume noise: 39952.30497398884
Output: N/A

[    0.          2350.13558671  4700.27117341  7050.40676012
   9400.54234682 11750.67793353 14100.81352023 16450.94910694
  18801.08469364 21151.22028035 23501.35586705 25851.49145376
  28201.62704046 30551.76262717 32901.89821387 35252.03380058
  37602.16938728 39952.30497399]
[38 38 37 37 36 33 22 19  7  1  0  0  0  0  0  0  0  0]
```
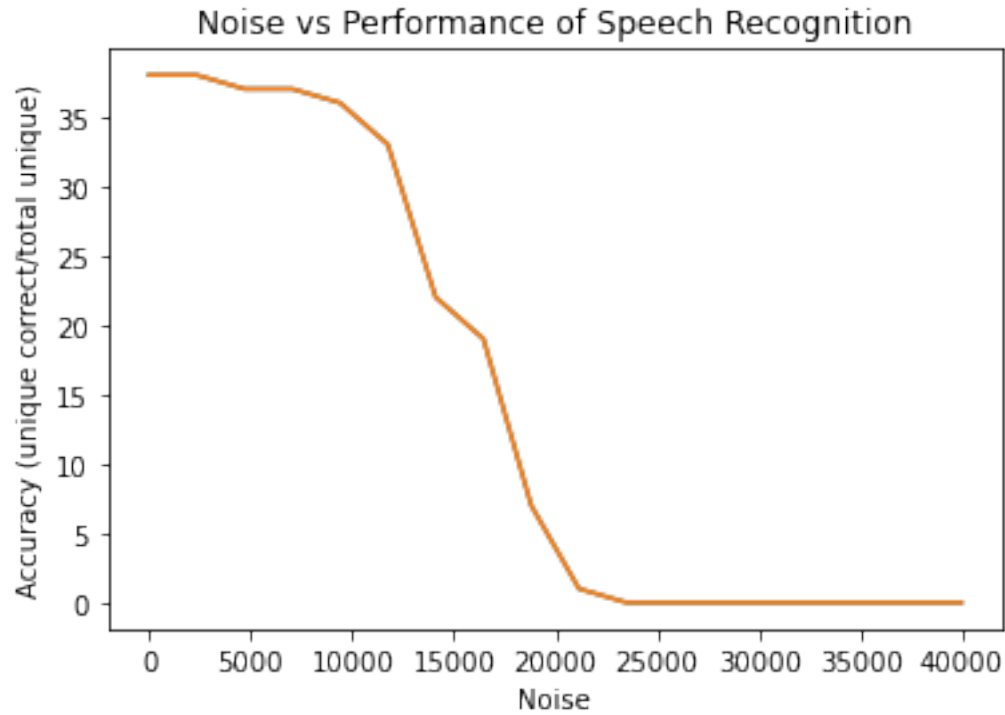
Noise vs Performance of Speech Recognition

1.5   Additional Discussion- Existence of Variance

From the result above, we may conclude that when given the same base noise array among different trials, the models produced to describe performances of speech recognition machanism in respect to increasing noise do not show inconsistency, which allows us to conclude that the google API use techniques that ensure consistency in speech recognition.