PSYCHOMETRIC ANALYSIS TOOL

Submitted by:

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CONTRIBUTIONS

Apurva Bhargava:
Facial Expression Recognition Model, Sentiment Analysis Model, Automated Scoring Function, Graphical User Interface and Integration.

Pallavi Jain:
Speech Emotion Recognition Model, SQL database for adding questions and images.

INTRODUCTION

- Psychometrics is the science of assessment of mental capacities and processes.
- Psychometric Analysis Tool powers judgment based on the assessment of emotional state of an individual by using webcam, microphone and keyboard inputs.
- It acts as the interface between two interacting parties, one of which evaluates the other using the various modules provided by the software as mentioned further.

PROBLEM STATEMENT

Design a tool for interviewers and/or psychologists that powers judgement by determining the interviewee's psychological characteristics based on the detection and analysis of subjective factors such as facial expressions, speech emotions and opinions.

OBJECTIVES FOR DESIGN OF THE TOOL

- Facial expression recognition using images from video feed/ webcam
- Speech emotion recognition using audio feed
- Sentiment analysis of image based description to test the polarity of the attitude or outlook of a person
- Automated Scoring system for question/answers based on similarity measures
- Functionality to add questions and images for testing
- Result as the analysis of the inputs specific to each test

SOFTWARE MODULES

01 Graphical User Interface

02 Facial Expression Recognition

03 Speech emotion Recognition

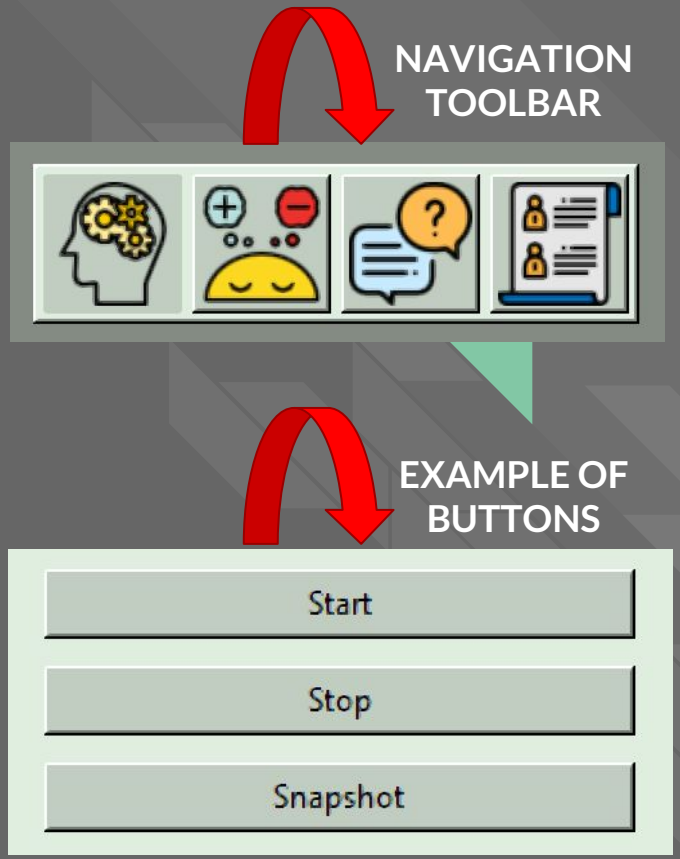
04 Image Description-based Sentiment Analysis

05 Questions/Answers Automated Scoring System based on Similarity

06 Database for storing images and questions/answers.

GRAPHICAL USER INTERFACE

- Four separate windows for the major functional modules.
- Non-interactive regions: Canvas encapsulating images or video capture. Non-editable text boxes containing questions. Labels displaying helper information.
- Interactive regions: Toolbar for navigating among the four screens. Buttons for interacting with the tool. Editable text boxes for writing responses.



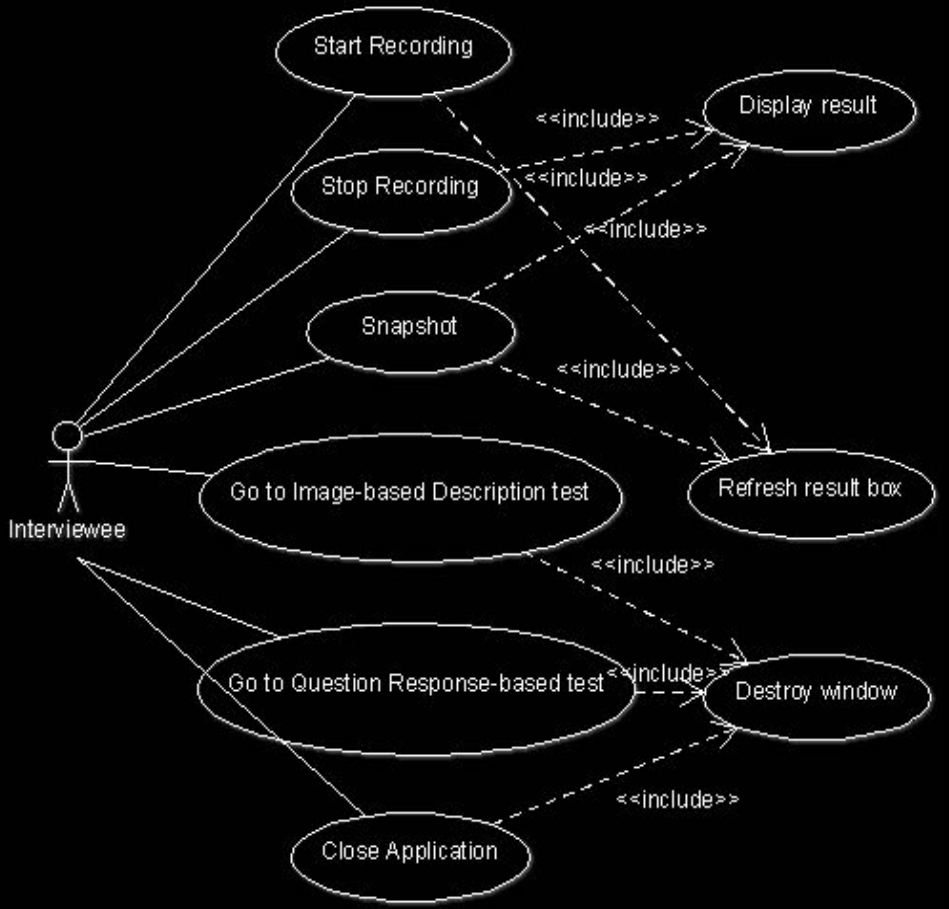
USE CASE: SCREEN 1

Actor:
Interviewee

Primary Scenarios:

1. Actor clicks on Start button to begin the response
2. Actor's response is recorded by the microphone and webcam
3. Actor clicks on Stop button to notify end of response

Preconditions:
The questions that compel responses are given to the actor beforehand.



Psychometric Analysis Tool

Emotion detection using webcam and microphone feed

Click on Start button to start analysis.
Click on Stop button to stop analysis.
Click on Screenshot to start facial expression based emotion recognition.

Start

Stop

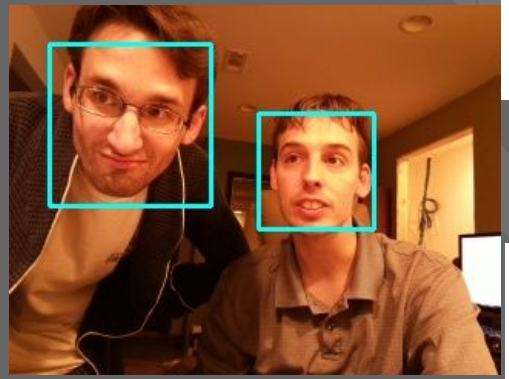
Snapshot

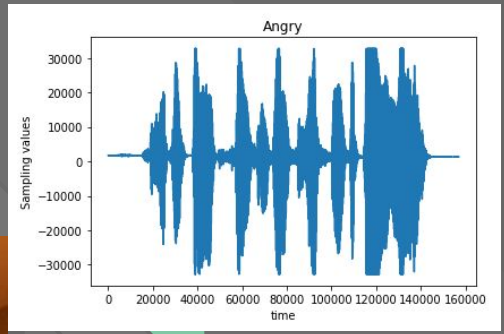
Emotion detection using webcam and microphone feed

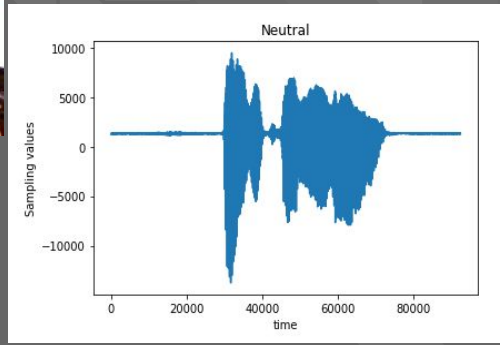
::Results::

FACE AND SPEECH EMOTION RECOGNITION

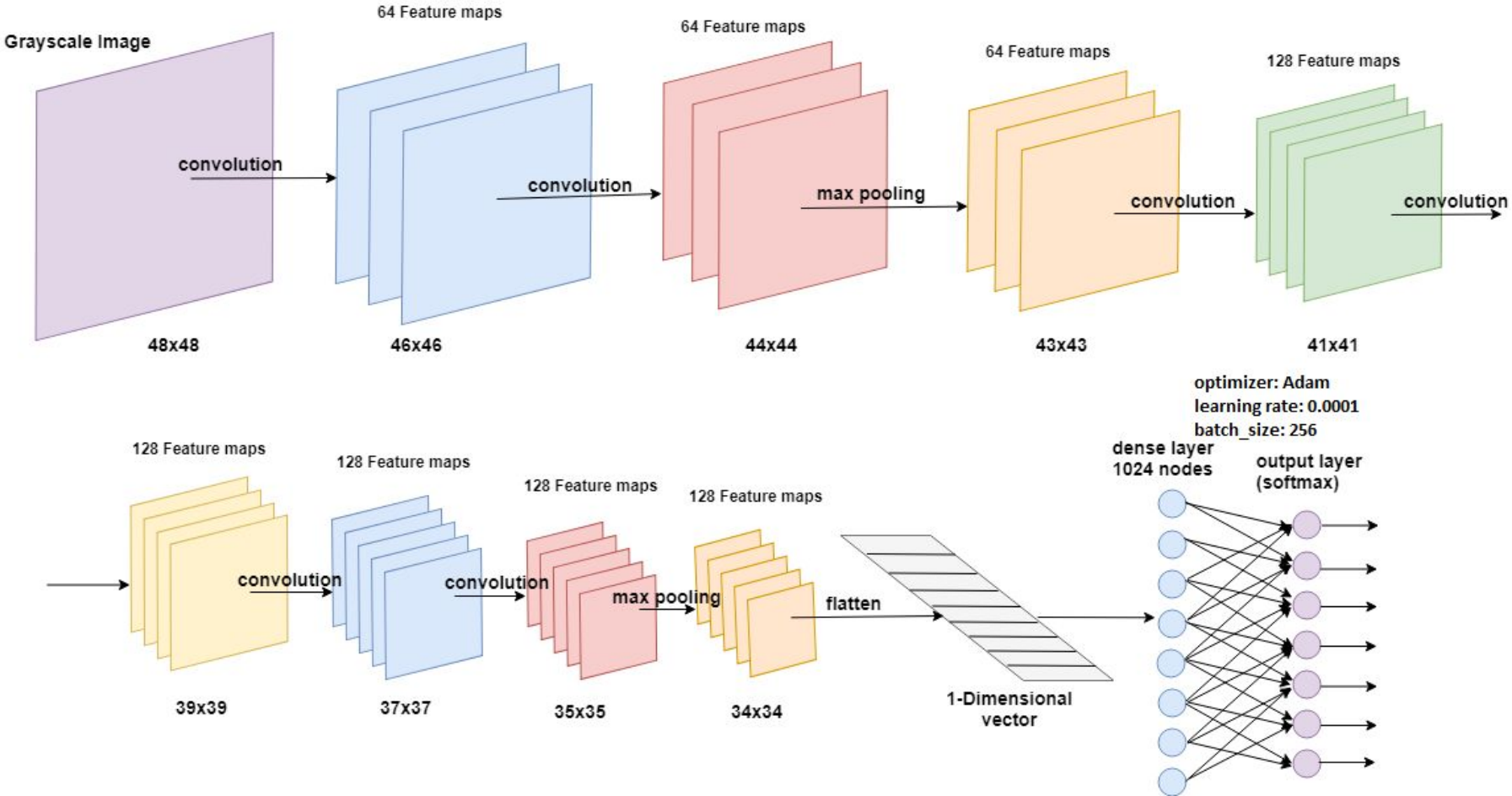
- FER model is trained using the FER2013 dataset. SER model is trained using the RAVDESS dataset. Both models are saved.
- Face detection is implemented using Haar-feature based cascade classifier. Rectangular frame is drawn around faces in real-time video capture feed from webcam. The microphone records the verbal response.
- FER and SER models are loaded and detected faces (resized to 48p x 48p) and recorded audio (cropped into sequences of 60000) are periodically fed to the respective models for classification (into anger, disgust, fear, happiness, surprise, sadness, neutrality).





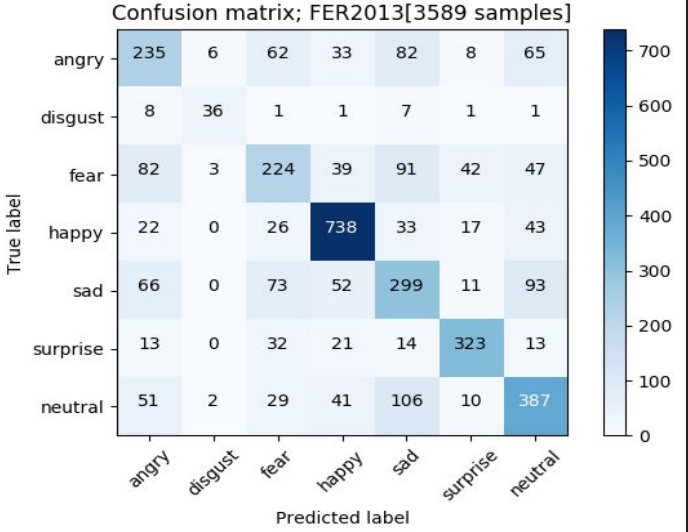


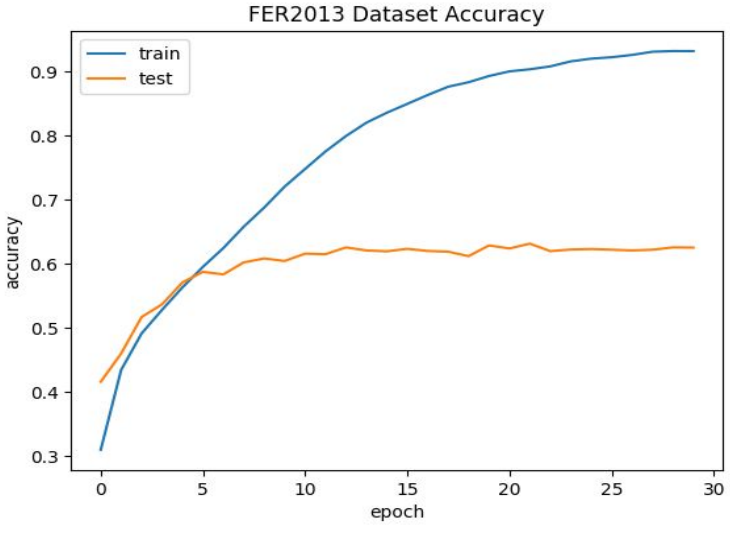
FACIAL EXPRESSION RECOGNITION MODEL

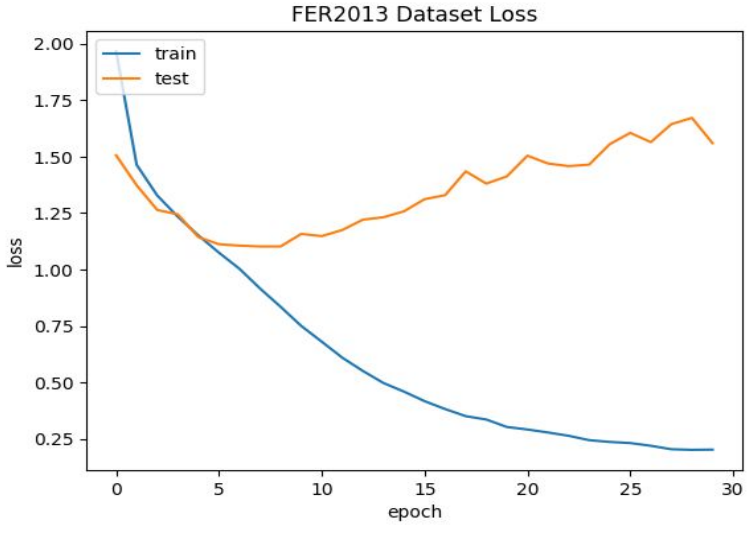


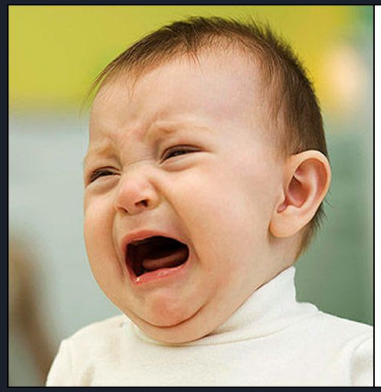
RESULTS

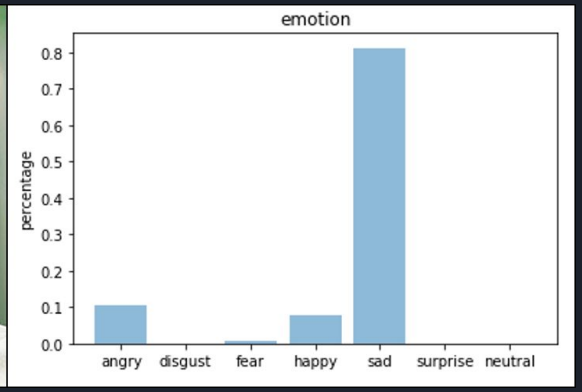
- Dataset: FER-2013 (grayscale images of faces with varied expressions)
- Training Samples: 28,709
- Validation Samples: 3,589
- Validation Accuracy: 63%

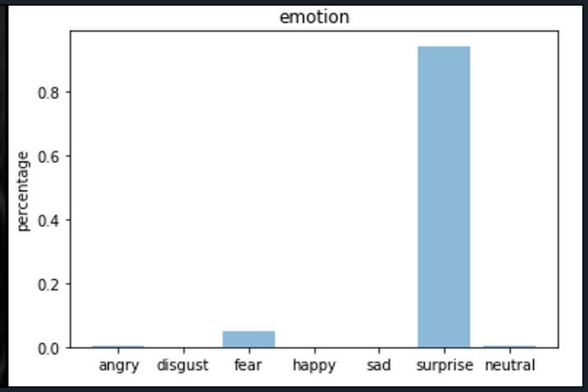


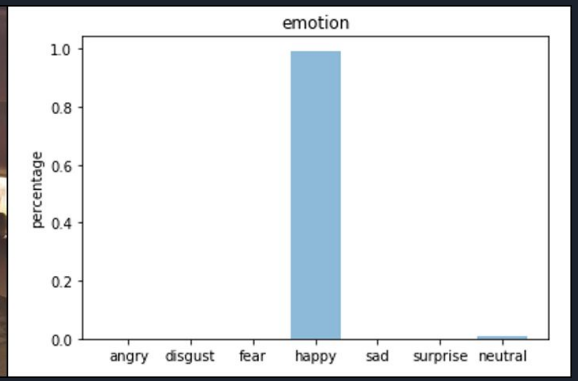


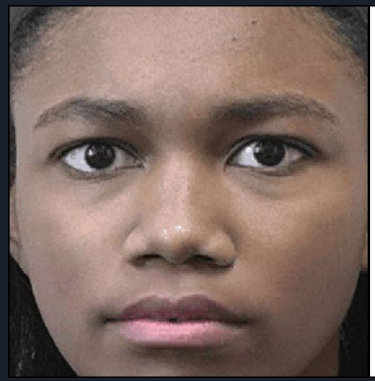


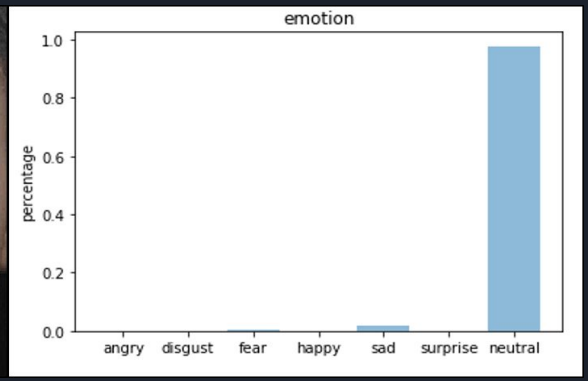






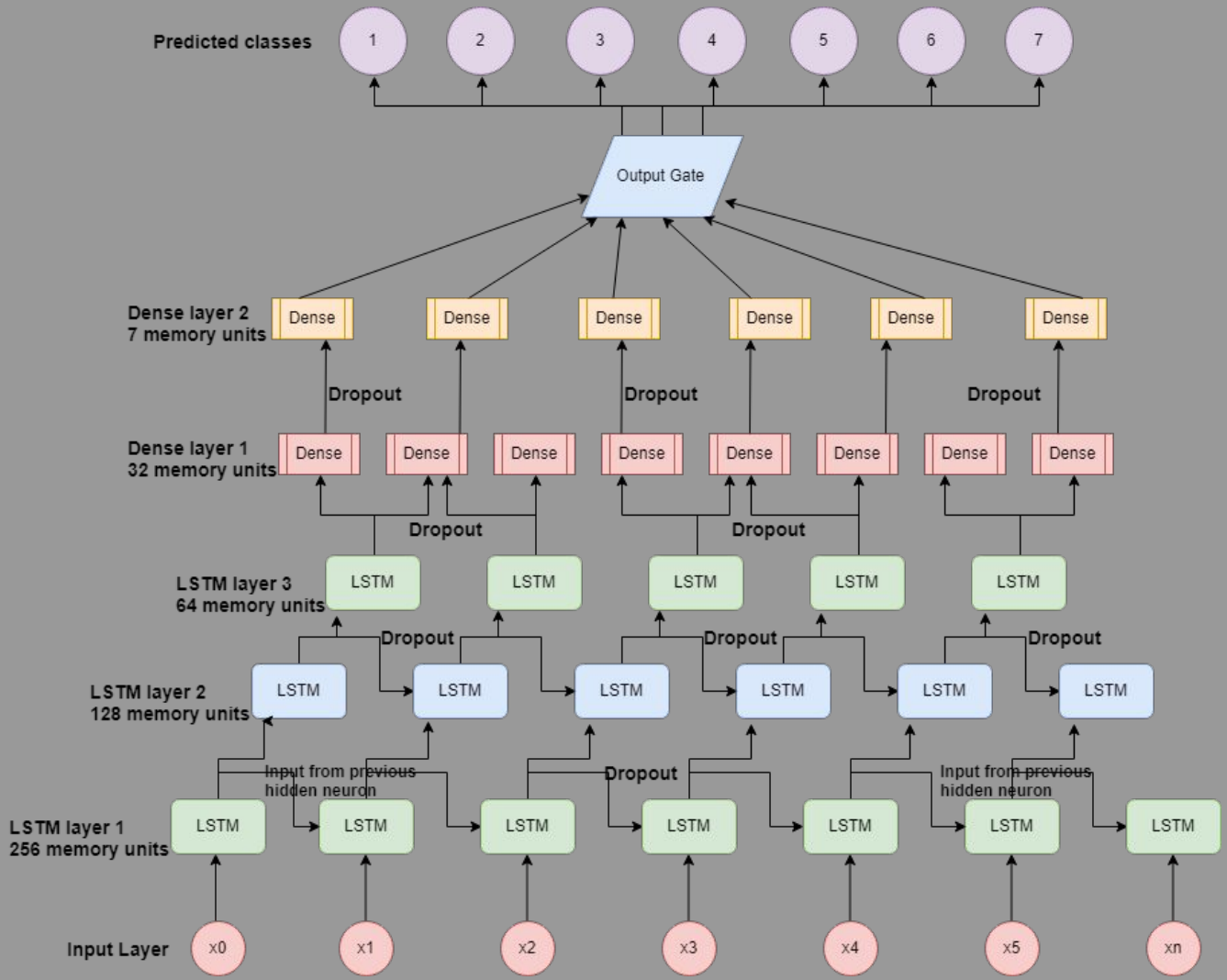






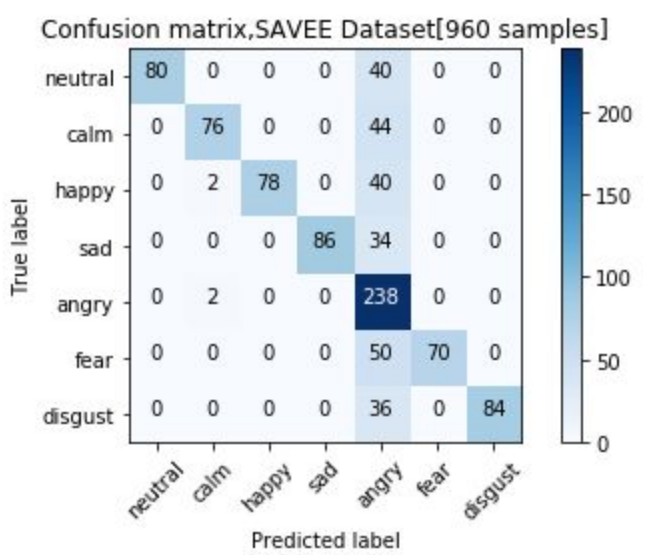
Testing the model on images not in dataset

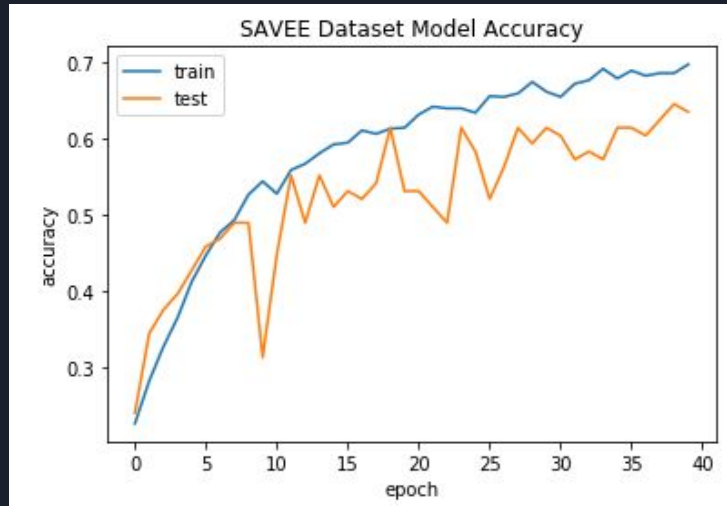
SPEECH EMOTION RECOGNITION MODEL



RESULTS

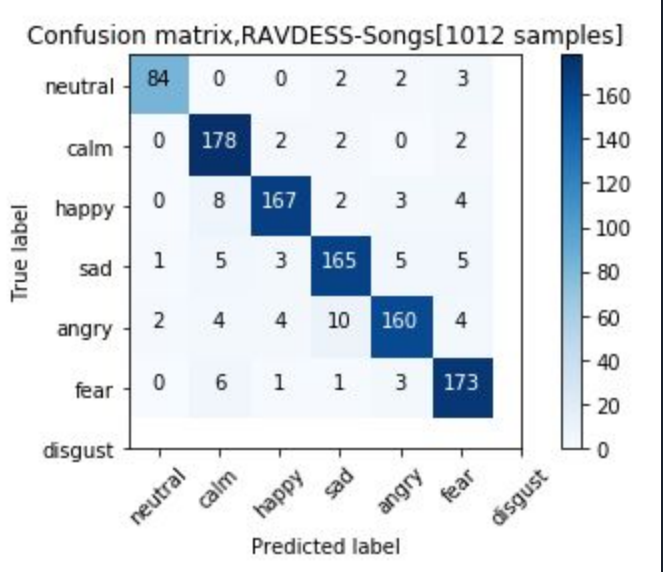
- Dataset: Surrey Audio-Visual Expressed Emotion (SAVEE); 4 actors speaking different sentences in various emotions
- Training Samples: 864
- Validation Samples: 96
- Validation Accuracy: 63.54%

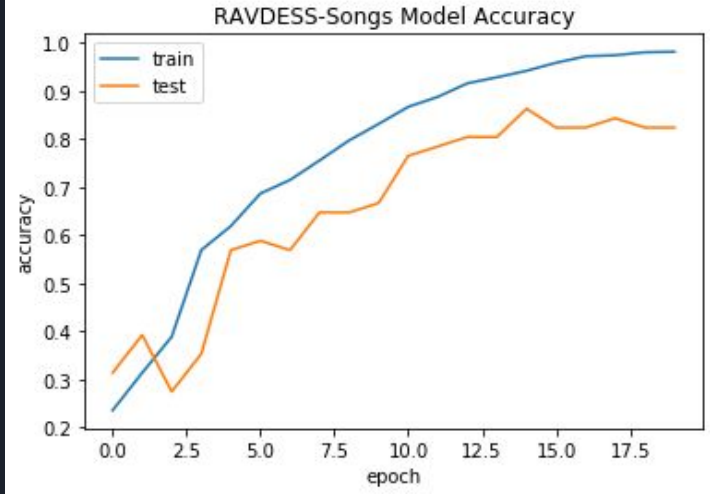


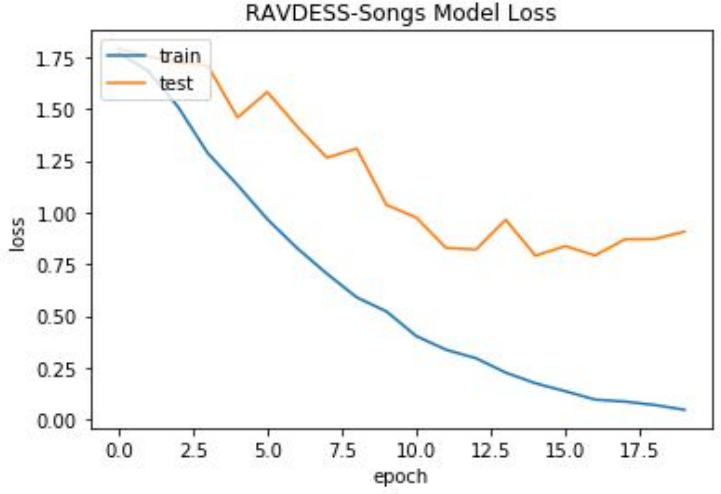


RESULTS

- Dataset: Audio songs subset of Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS)
- Training Samples: 960
- Validation Samples: 52
- Validation Accuracy: 82.35%







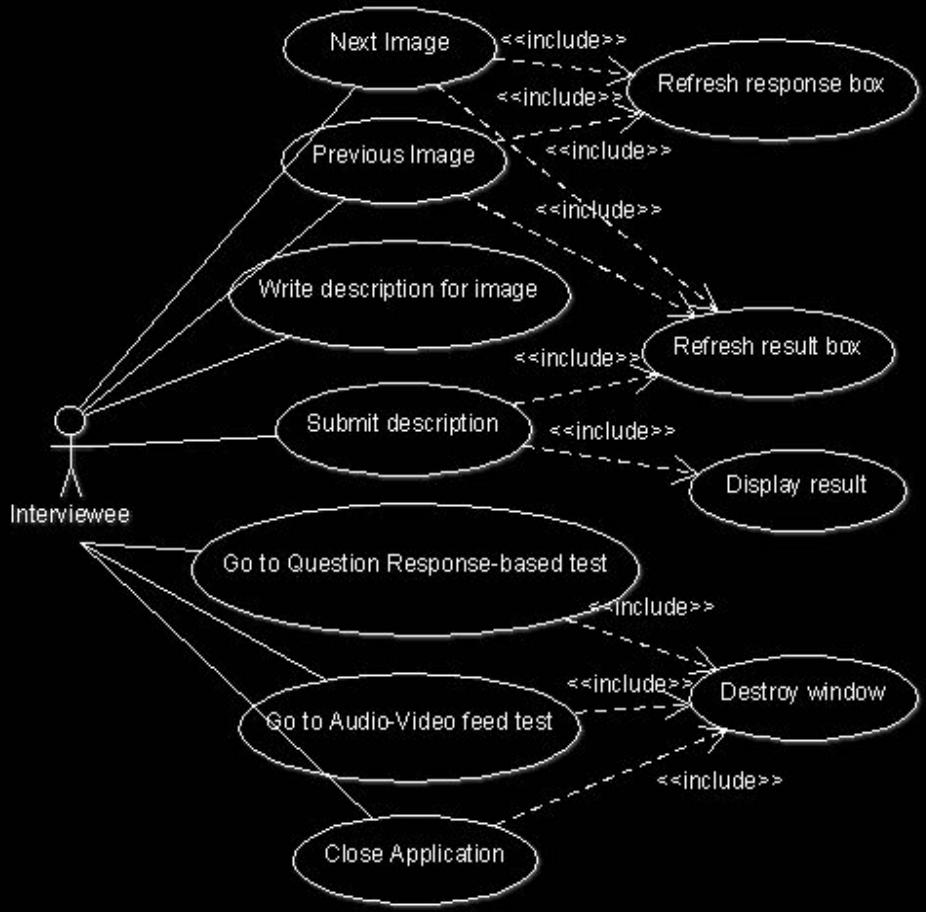
USE CASE: SCREEN 2

Actor:
Interviewee

Primary Scenarios:

1. Actor clicks on Next and Previous buttons to navigate through the images.
2. Actor writes description of image in provided text area.
3. Actor clicks on Submit button to submit response.

Preconditions:
Images are fed in the required order by test administrator.



Psychometric Analysis Tool

Picture description based test

Click on Next button to go to next picture.
Click on Previous button to go to previous picture.

<< Previous

Next >>

Picture description based test

Submit

::Results::

IMAGE DESCRIPTION BASED SENTIMENT ANALYSIS

- Sentiment Analysis model is trained using Amazon Product Review dataset, Stanford Sentiment Treebank dataset and Twitter airline sentiment dataset. The model is saved for use.
- The description of a (usually cryptic) image is written down by the interviewee.
- On submission of response, the model is loaded and employed in classifying the response as positive, negative or neutral.

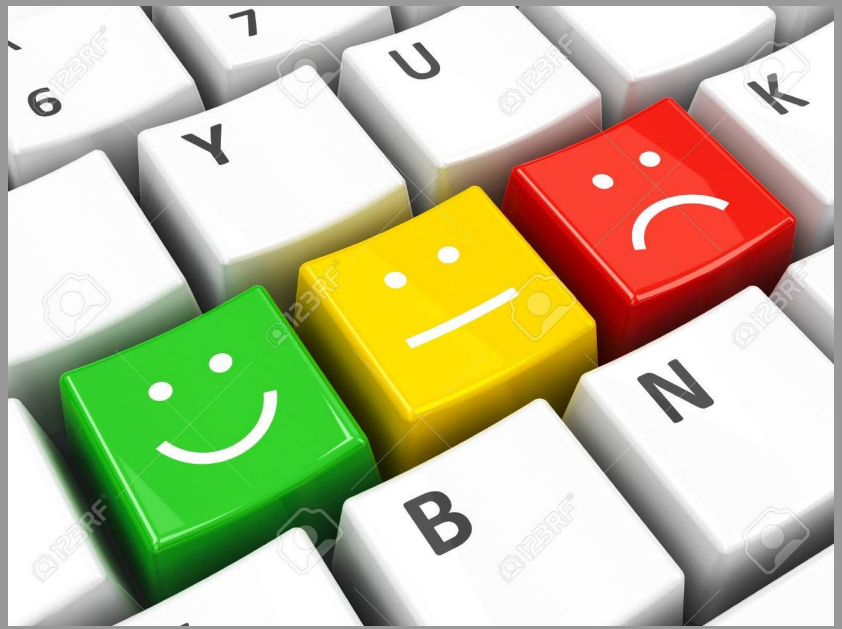
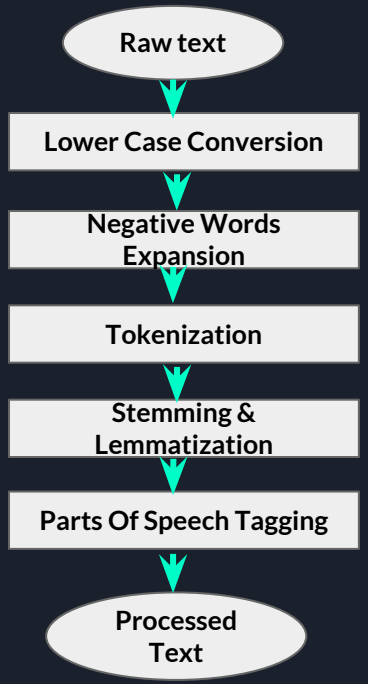
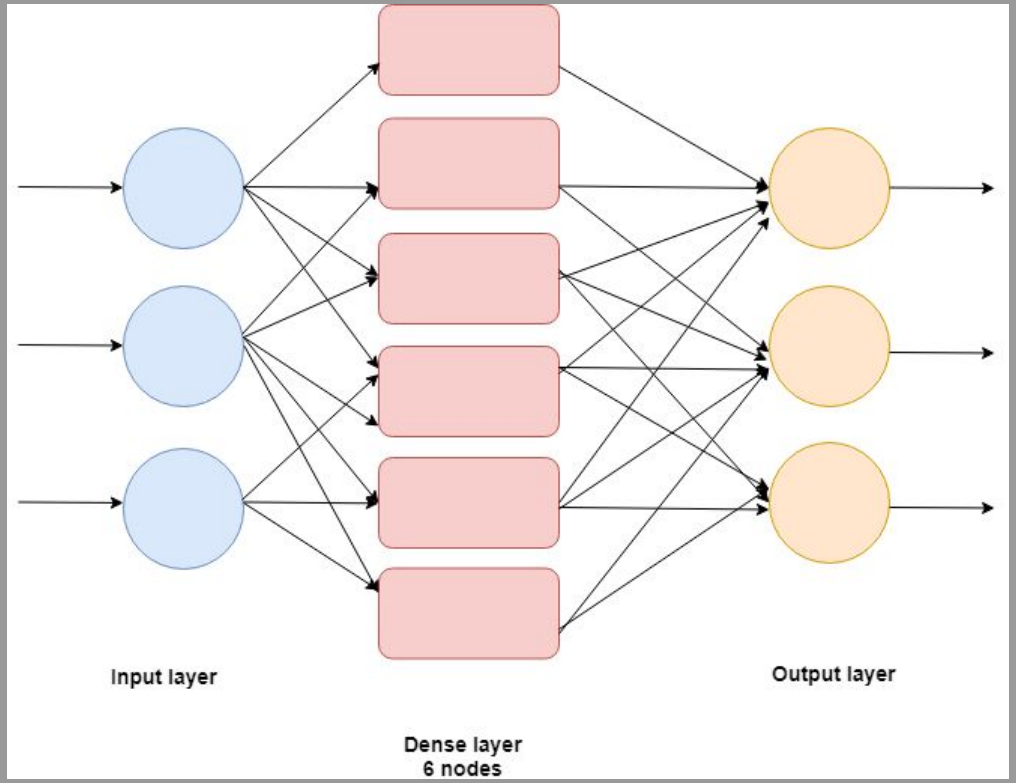


IMAGE DESCRIPTION BASED SENTIMENT ANALYSIS MODEL



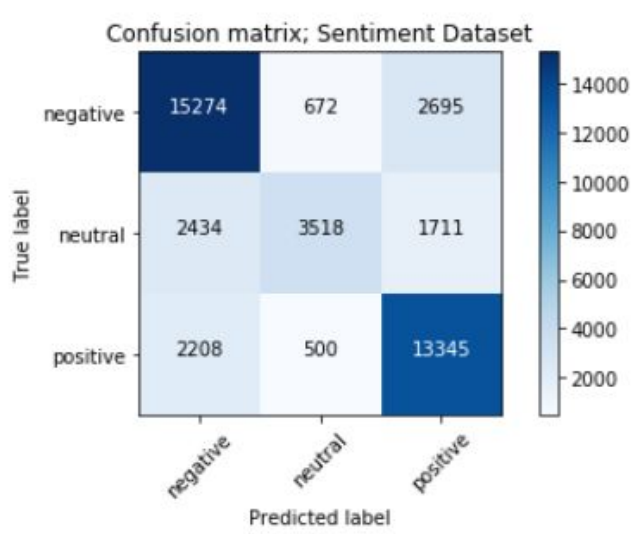

```
for each word w:

if (count of w in class X = 0)
      rv(w, X) = 0
else if (count of w in class X = total count of w in all classes)
      rv(w, X) = 2.5 * count of w in class X
else
      rv(w, X) = 1/log10(total count of w in all classes/ count of
w in class X)
```

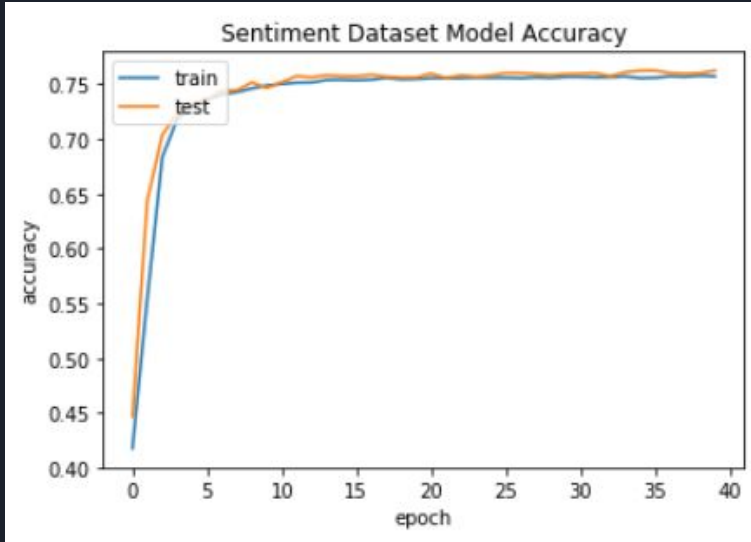
IMAGE DESCRIPTION BASED SENTIMENT ANALYSIS MODEL (continued)

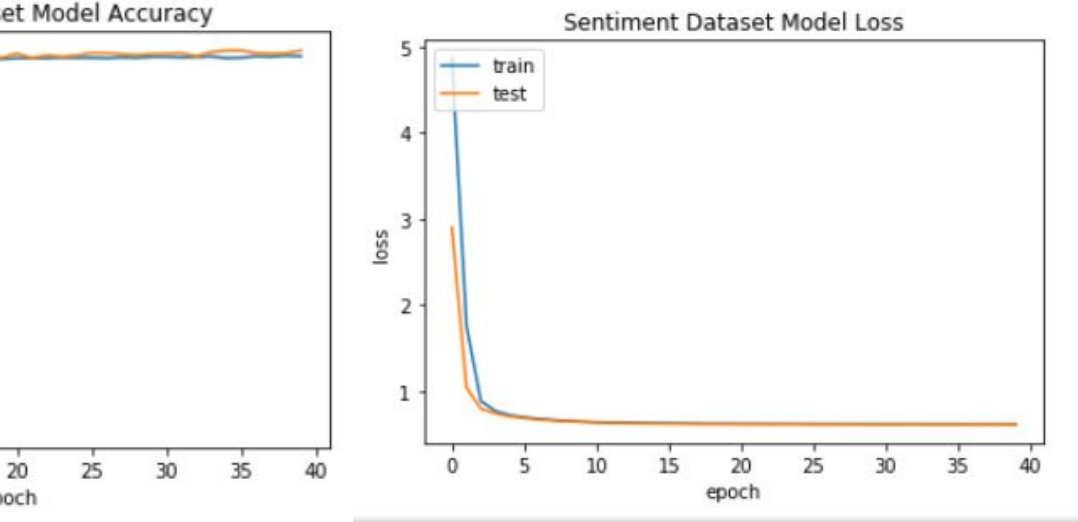


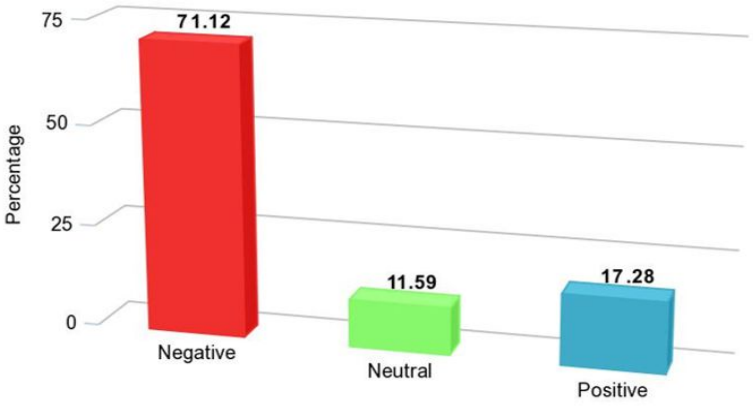
RESULTS

- Dataset: Amazon Reviews, Sentiment Movie Reviews, Twitter Airline Sentiment
- Training Samples: 36, 003
- Validation Samples: 6, 354
- Validation Accuracy: 76.24%



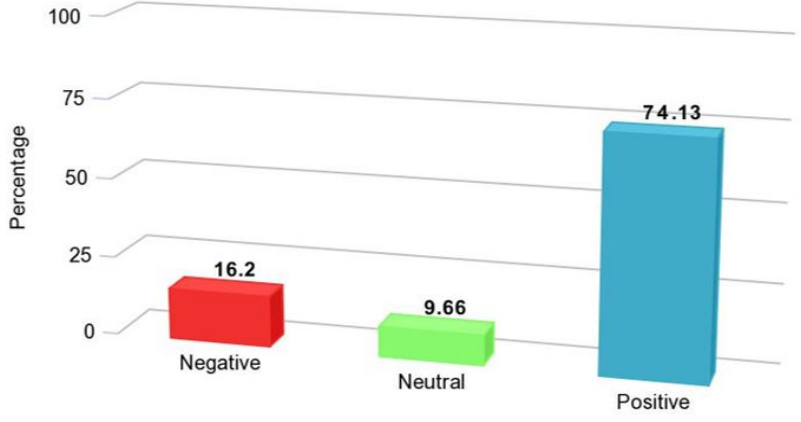






Text example 1
The lion is cowering before the hyenas, tired, weak and afraid.

Testing the model on texts not in dataset



Text example 2
A cheerful bird, sitting in the rain and enjoying every minute of it.

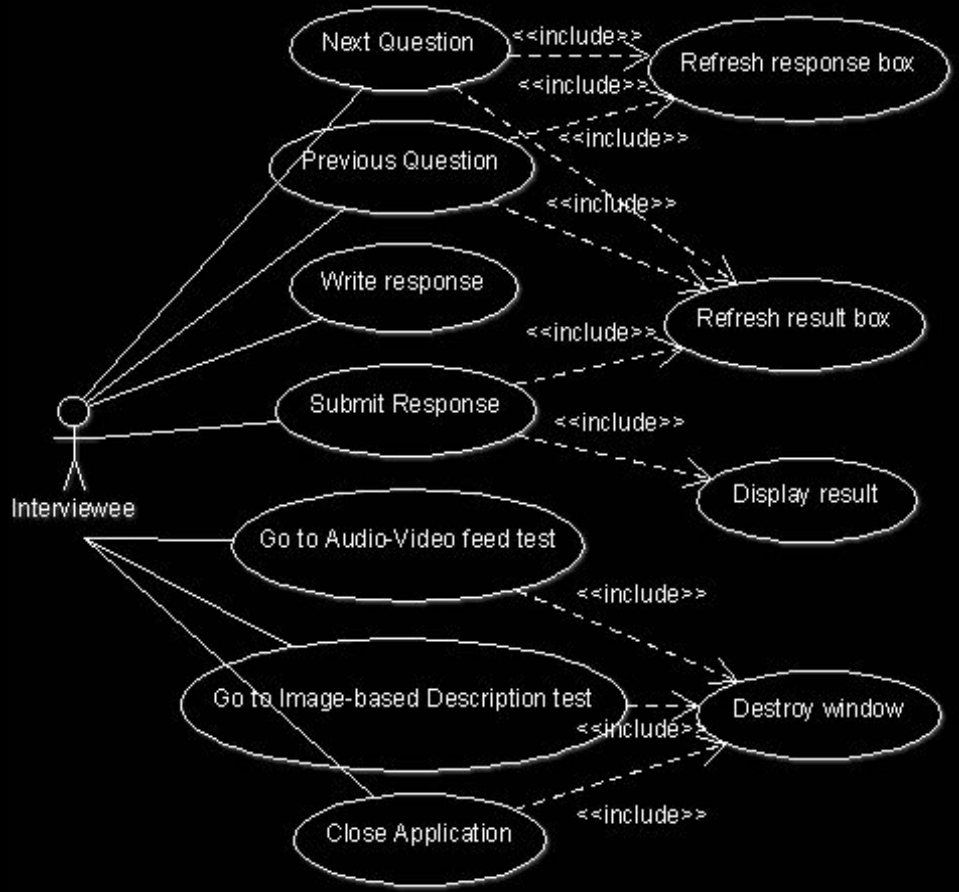
USE CASE: SCREEN 3

Actor:
Interviewee

Primary Scenarios:

1. Actor clicks on Next and Previous buttons to navigate through the questions.
2. Actor writes response to the question in provided text area.
3. Actor clicks on Submit button to submit response.

Preconditions:
Questions and answers are fed in the required order by test administrator.



Psychometric Analysis Tool

Question

Answer

Situational judgement based test

Click on Next button to go to next question.
Click on Previous button to go to previous question.

Display answer

<< Previous

Next >>

Situational judgement based test

Submit

::Results::

QUESTIONS/ANSWERS AUTOMATED SCORING

- A response to a question is scored by testing its similarity with the response already stored in the database, using cosine and jaccard similarity measures.
- Cosine Similarity: Given and actual responses are count-vectorized to A and B, and the cosine of angle between the two vectors is calculated. This is done for 1-grams, 2-grams and 3-grams.
- Jaccard Similarity: It determines the ratio of common words (or n-grams) to total words.
- Weights are assigned to the four values obtained to calculate the final scores.

$$similarity = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|_2 \|\mathbf{B}\|_2}$$

$$\frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|_2 \|\mathbf{B}\|_2} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \sqrt{\sum_{i=1}^{n} B_i^2}}$$

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

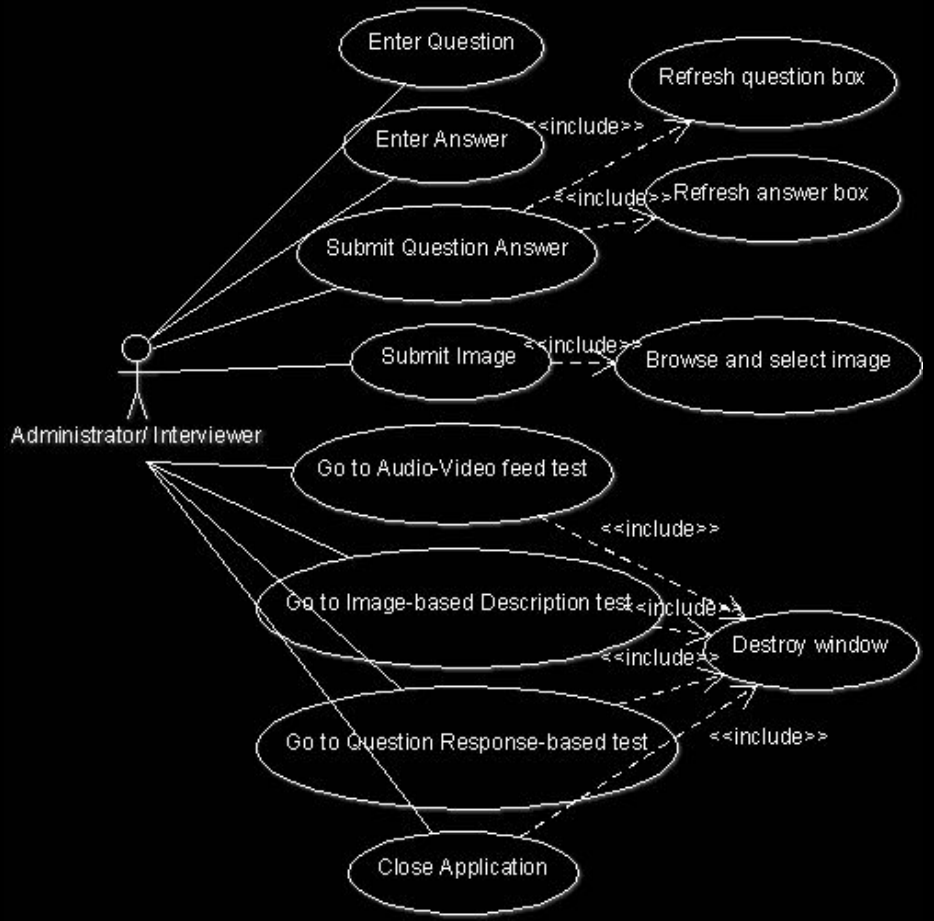
```
function final_score(string1, string2) {
      cosine1 = cosine_similarity_1gram(string1, string2)
      cosine2 = cosine_similarity_2gram(string1, string2)
      jaccard = jaccard_similarity(string1, string2)
      score = (cosine1 x 60) + (cosine2 x 16) + (jaccard x 24)
      if (0.1 ≤ cosine2 ≤ 0.2)
            score += 3
      else if (0.2 ≤ cosine2 ≤ 0.4)
            score += 6
      else if (0.4 ≤ cosine2 ≤ 0.6)
            score += 6
      else if (0.6 ≤ cosine2 ≤ 0.8)
            score += 3
      else if (0.8 ≤ cosine2)
            score += 16 * (1 - cosine2)
      return score
}
```

USE CASE: SCREEN 4

Actor:
Test Administrator/ Interviewer

Primary Scenarios:

1. Actor writes the question and its response in the text areas.
2. Actor clicks on Submit Q/A button to store the question/answer in database.
3. Actor clicks on Submit Image button to browse through images on system.
4. Actor selects required images and clicks on OK to enter them into the database.



Psychometric Analysis Tool

Enter question to be submitted

Enter answer for the question

Submit Q/A

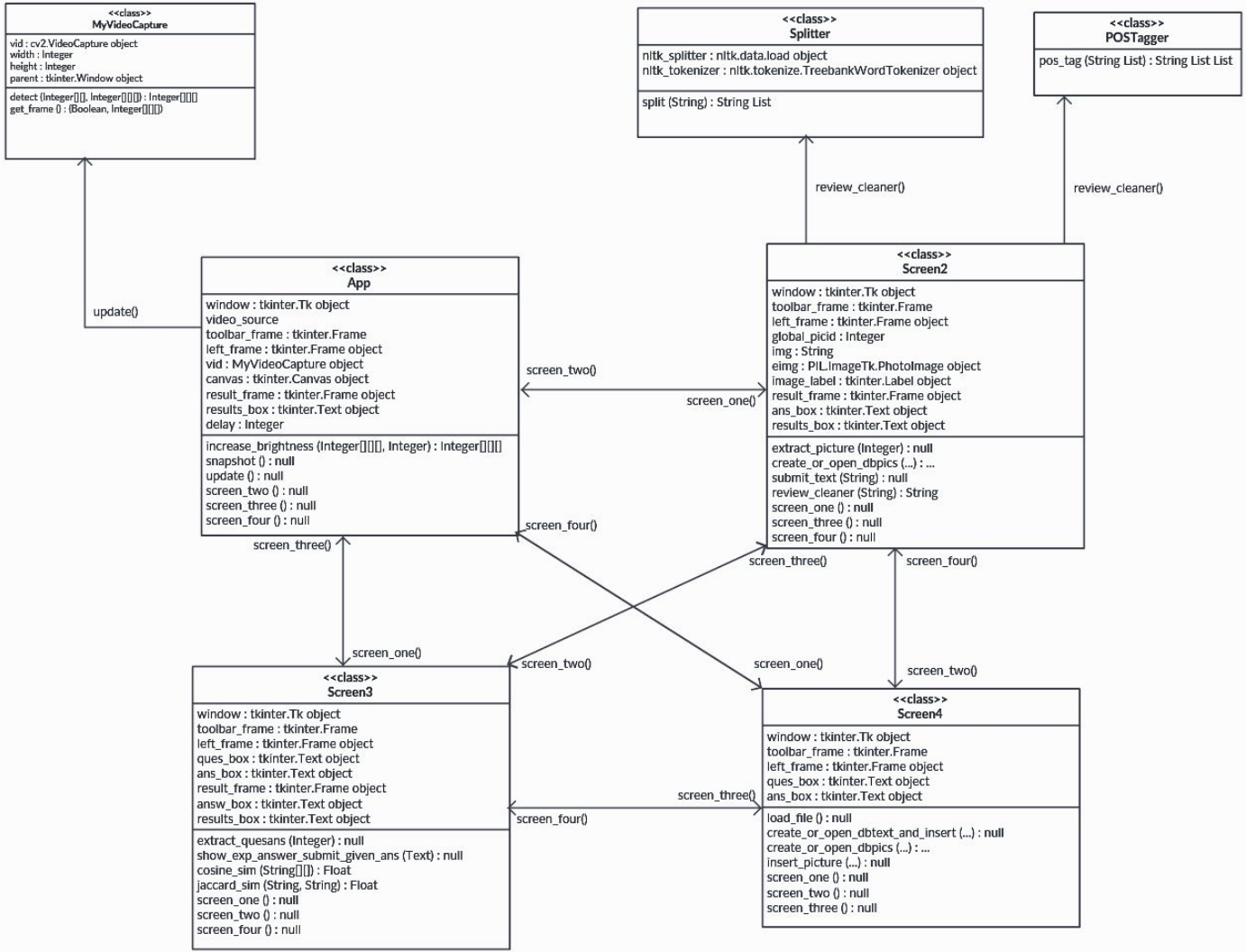
Select image(s) to be submitted

Submit Image

DATABASE FOR THE APPLICATION

- Two separate databases- for images and questions/answers.
- A sqlite database file is created which stores the filename and picture information in the form of BLOB.
- Another database records list of questions and their respective answers entered by the administrator.
- The previous and next buttons in the GUI window initiates the query in the database by maintaining a connection to it and returns respective data.
- Data can be accessed and modified by querying the database by making a connection request to it.

CLASS DIAGRAM



RESULTS

We have created a psychometric analysis tool that assists the assessment performed by psychologists by automating the discernment of psychological state from face, speech and text input.

Psychometric tests can be used to measure candidates' suitability for a role based on the required personality characteristics and aptitude or cognitive abilities.

FUTURE SCOPE

- Registration and login for security and restricted using an API server
- Interaction in audio/webcam emotion detection through some visual cues that prompt response
- Flexibility in setting tests, ordering restrictions and time constraints
- Gelling of components and all-inclusive results
- Adaptive, interactive chatbot for questioning and answering by context detection
- Adding other CRUD operations for database

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Thank you