SYNOPSIS

PSYCHOMETRIC ANALYSIS WEB TOOL

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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SP-2019

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Semester VIII

1. Introduction

Psychometrics is a field of study concerned with the assessment of mental capacities and processes. Psychometric Analysis Web Tool is an online tool that 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 test phases (face/speech emotion detection, sentiment analysis and Chatbot interview).

Emotion recognition is the process of identifying human emotion and involves the analysis of human expressions in multimodal forms such as texts, audio, or video. Sentiment analysis refers to the systematic classification of the polarity of a given text at the document, sentence, or feature/aspect level—whether the expressed opinion is positive, negative, or neutral. Both emotion recognition and sentiment analysis leverage techniques from multiple areas, such as signal processing, machine learning, natural language processing (NLP) and computer vision.

Artificial neural network (ANN) is crudely based on the structure of the biological neural networks in the human brain. It can be trained through input assignment via forward propagation and weight adjustment via backward propagation, using a gradient descent optimization algorithm to adjust the weight of neurons by calculating the gradient of the loss function at each network layer and propagating it back. Long short-term memory (LSTM) is an artificial recurrent neural network (RNN) architecture used for deep learning. Unlike standard feedforward neural networks, LSTM has feedback connections that make it a "general purpose computer". It can not only process single data points (such as images), but also entire sequences of data (such as speech or video). A common LSTM unit is composed of a cell, an input gate, an output gate and a forget gate. The cell remembers values over arbitrary time intervals and the three gates regulate the flow of information into and out of the cell. A Convolutional neural network (CNN) is a deep learning model used for visual imagery. The layers of a CNN consist of an input layer, an output layer and a hidden layer that includes multiple convolutional layers (receptive neuron processing input for sliding windows), pooling layers, fully connected layers and normalization layers.

A Chatbot is a program which conducts a conversation via auditory or textual methods. It may be a sophisticated NLP system, or a simpler one which scans for keywords within the input, then pull a reply with the most matching keywords, or the most similar wording pattern, from a database. Question answering (Q/A) is a computer science discipline within the fields of information retrieval and NLP, which is concerned with building systems that automatically respond to natural language inputs by humans. Chatbot or Q/A models are called adaptive if they alter their structures or workings according to user input.

2. Problem Statement

Design a web 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, polarity of written opinion and question-answering (powered by Chatbot).

3. Objectives

Following objectives have been defined for the required problem:

i. Facial expression recognition using images from video feed/ webcam in response to a question or prompt
ii. Speech emotion recognition using audio feed in response to the same question or prompt
iii. Sentiment analysis of image based description to test the polarity of the attitude or outlook of a person
iv. Adaptive Interviewing Chatbot for holding conversations and selecting questions for the interview according to user response and difficulty.
v. Transferral of the entire application to web using Bootstrap for UI, ReactJS for frontend and NodeJS and Django (Python) for backend.
vi. Segregation of user types into test administrators and test takers for securing test conduction and managing access.

4. Implementation

4.1 Real-time Emotional State Determination

MODELS: FER model (CNN) trained using FER-2013 to 63% accuracy and SER model (LSTM) trained using RAVDESS to 83% accuracy. Emotion classes: angry, fearful, disgusted, happy, surprised, sad and neutral.
FRONTEND: React modules: react-webcam and react-mic for video and audio feed.
BACKEND: The feed from frontend is sent to Django API which does the processing and returns the percentages of the 7 emotion classes.

4.2 Image Description-based Sentiment Analysis

MODEL: Sentiment classification model (ANN) trained using Amazon product reviews, Stanford movie reviews and Twitter Airline tweets to 93% accuracy. Sentiment classes: positive, neutral and negative.
FRONTEND: The images from the database (Node Server) are fetched from the file system and displayed. A text area where the description can be written.
BACKEND: The input from frontend is sent to the API (Django Server) for processing and it return the sentiment scores of three classes.

4.3 Adaptive Interview Chatbot

MODEL: Chatbot is trained using .yml files containing conversations, and later consults sqlite database generated from the .yml files. The administrator's questions, answers, difficulties, and maximum scores from file system are used to generate a .json file. For each question, multiple similar answers are generated using the expected answer. Question Answering or Q/A system parses the .json file to select questions and match responses. A

confidence value (using context) is used to decide which system responds. Questions are chosen based on difficulty and user's performance.
FRONTEND: A scrollable chat window
BACKEND: User's response is sent to server and bot's response is fetched and displayed.

4.4 Web Implementation

LANDING PAGE OR HOME PAGE: It is the first page which lands the visitor to discover the features and concept of the tool. From Register page, a user/ admin account can be created, saved and File Storage System initialized. From the Sign-in page, the user/ admin can sign in with credentials verification and access the database and tests.
LOGGED-IN PAGE (FOR ADMIN): The test administrator can create a test (add test name and test description, questions, answers and images), modify the test (modify test description, questions, answers and images), specify the test takers and see their responses and results.
DASHBOARD PAGE (FOR USER): The user can select a test (using test name and test admin), give the test and see the results.
TEST PHASES:
Phase 1: For several questions/ prompts, the test taker's images will be periodically captured from webcamera and the audio recorded for emotion recognition using Facial Expression Recognition and Speech Emotion Recognition models.
Phase 2: For all images, the user has to write a description in the given box. The sentiment classification model analyses the description and assign percentages to the sentiment classes.
Phase 3: Bot starts the conversation and asks questions. User responds in a message box below the conventional scrollable chat window. Response is submitted by pressing Enter key.
Each phase has its individual results and analyses section.

5. Expected Outcome

It is expected to make use of datasets to train machine learning models for real-time prediction, as well as design an adaptive chatbot for conducting interviews. The website provides the users and administrators functionalities for setting and taking tests. The models and chatbot instances are accessed through APIs for determining results.

The end product is an online-accessible 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. It can be used by psychologists or interviewers as a virtual analysis tool.