Andrea Esposito's Bachelor's Degree Thesis

Andrea Esposito

Apr 20, 2020

THE EMOTIONS TOOL

`emotions/` This folder contains the Emotion Analysis Tool (written in C++).

`extension/` This folder contains the source code of the browser extension (written in TypeScript).

`icon/` This folder contains the logo and the icons of the project.

`server/` This folder contains the server's source code (written in JavaScript).

`thesis/` This folder contains the thesis itself.

CHAPTER

ONE

THE BROWSER EXTENSION

A simple browser extension was created to collect data for the Thesis' research. The plugin is available for both Google Chrome and Mozilla Firefox.

The extension has the single goal of collecting the data that will be analyzed in the Thesis. A detailed list of what is collected can be found in *What data is collected?*.

1.1 The Structure of the Extension

This extension is structured in two main parts: the extension itself and a group of server-side scripts.

The extension itself collects the data (see *What data is collected?*). In this phase, in order to reduce the amount of work of the client's browser, the webcam snapshots are sent as raw images (as data URIs). The collected data (along with the pictures' URIs) are then sent to a server-side script.

The server receives the data sent by the extension and analyzes all available pictures. The pictures are then discarded and only the analysis results are saved.

1.2 The Survey

Right after the installation of the extension, the participant is asked to complete a short demographic survey. This survey (that is managed by a server-side script) is needed to search for correlations in groups of users with common age, experiences, knowledge, etc.

1.3 What data is collected?

- **Date/time data**
  - Date and time of the interaction
- **Keyboard data**
  - Pressed/released keys
- **Mouse data**
  - Mouse position in pixels (assumed to start from *(0,0)*)
  - Pressed/released mouse buttons
- **Navigation data**

  - Current URL (protocol and domain only)
  - **Current scroll position**
    * Absolute position in pixels
    * Relative position (measured from the lowest point of the screen)

- **User's emotions**
  - Data got from Affectiva, an Emotion Analysis engine, by analyzing a snapshot taken with the webcam

1.4 How to Build

Both the extension and the server-side scripts have been created as a node package. To build both, all the dependencies must be installed first. To install them, run *npm install* in both the folder `browser-extension/` and the folder `browser-extension/src/server/`.

Once all the dependencies have been installed, the extension as a whole (both the client-side plugin and the server-side scripts) can be built by running `npm run build` in the folder `browser-extension`.

To start the server, run `npm start` from the same folder (note: starting the server will trigger another build of the server-side scripts to ensure they're updated at the latest version).

1.4.1 Quick Start

Installation

To use the tool, download its compiled binary from the repository and execute it from a console.

Important: The tool has been tested on **Ubuntu Xenial 16.04**.

The Affdex SDK is only available on Windows and Ubuntu Xenial 16.04, so compatibility with other Operative Systems is not guaranteed.

From source with CMake

Clone and open the GitHub repository in a console, using the following commands:

```
git clone https://github.com/espositoandrea/Bachelor-Thesis.git
cd Bachelor-Thesis
```

Open the directory containing the tool's source code:

```
cd emotions
```

Finally, create and compile the CMakeProject:

```
mkdir bin
cd bin
cmake -G "CodeBlocks - Unix Makefiles" ..
make
```

Usage

Important: To use the tool you must have the Affdex SDK installed on your machine. Then, you have to add `/path/to/affdex-sdk/lib` to the variable `$LD_LIBRARY_PATH` (on Ubuntu).

```
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/path/to/affdex-sdk/lib/
```

The tool will then search, in its folder, for the folder `lib/affdex-sdk/data/` (that has to contain the data used by Affdex).

The tool can be used through CLI (or executed by another script).

```
./emotions [<option>...] IMAGE...
./emotions [<option>...] --file FILE
```

Where `IMAGE` is a *data URI*. The available options are:

-h, --help Get the help message

-f FILE, --file FILE The file containing the images to be analyzed (as a data URI)

1.4.2 Code Documentation

The Entry Point

The main file.

This file is the main file of the tool.

Author Andrea Esposito <github.com/espositoandrea>

Functions

int **main** (int *argc*, char ***argv*)

The main entry point.

This is the entry point of the tool.

Return An *exit code* based on the execution.

Parameters

- `argc`: The length of `argv`.
- `argv`: The array of arguments given through the command line.

The CLI

exit_codes **setup_options** (int *argc*, char *******argv*, std::vector<std::string> &*images*)
Set up the tool's options and arguments.

This function is responsible of the CLI API of the tool. It sets and handles the available options and arguments.

Return An *exit code*:

- *exit_codes::OK* If the given arguments are valid and no errors occurred.
- *exit_codes::HALT* If the given arguments are valid but the argument combination stops the execution.
- *exit_codes::ARGUMENT_ERROR* If the given arguments are invalid
- *exit_codes::UNKNOWN_ARGUMENT_ERROR* If an unknown error occurred.

Parameters

- `argc`: The length of `argv`.
- `argv`: The array of arguments passed via CLI.
- `images`: A variable that will contain the images passed through the CLI API.

The Exit Codes

enum exit_codes
A collection of all the exit codes of the tool.

This enum contains all the (expected) exit codes of the tool.

Values:

OK = 0
The tool exited with no error completing its tasks.

HALT = 1
The tool exited with no error, but without completing its tasks.

ARGUMENT_ERROR = 2
The tool exited due to errors in the given arguments.

UNKNOWN_ARGUMENT_ERROR = 3
The tool exited due to unknown errors while parsing the arguments.

The Data URI

class data_uri
A utility class to handle data URIs.

This class represents a data URI. A data URI is defined by MDN as a string with the followind sintax: `data:[<mediatype>][;base64],<data>`.

Public Functions

data_uri(**const** std::string &*s*)
The class constructor.

This constructor creates a *data_uri* from a string.

Parameters

- `s`: The string representing the data uri.

Exceptions

- *data_uri::string_not_uri*: if `s` is not a valid data URI.

std::string **get_type**() **const**
Get the media type.

This function returns the media type of the data URI.

Return The media type (`<mediatype>` in `data:<mediatype>;base64,<data>`).

std::string **get_data**() **const**
Get the data.

This function returns the data contained in the data URI.

Return The data (`<data>` in `data:<mediatype>;base64,<data>`).

std::string **get_uri**() **const**
Get the URI.

This function returns the entire URI as a string.

Return The URI as a string.

Public Static Functions

bool **is_data_uri**(**const** std::string &*s*)
Check if a string is a data URI.

The function checks if a string is in the format `data:<mediatype>;base64,<data>`.

Return True if `s` is a data URI, false otherwise.

Parameters

- `s`: The string to be checked

class string_not_uri : **public** exception
An exception raised if a string is not an URI.

This exception is thrown if a string, assumed to be one, is not a data URI.

The Base64 Utilities

namespace base64
Namespace for dealing with *base64* strings.

This namespace contains utilities to deal with *base64* strings.

Functions

std::string **encode**(**const** std::string &*s*)
Encode a string to *base64*.

This function encodes a string to a *base64* string.

Return The encoded string.

Parameters

- `s`: The string to be encoded.

std::string **encode**(unsigned char **const** **s*, unsigned int *len*)
Encode a string to *base64*.

This function encodes a string to a *base64* string.

Return The encoded string.

Parameters

- `s`: The string to be encoded.
- `len`: The length of the string `s`.

std::string **decode**(std::string **const** &*s*)
Decode a *base64* string.

This function decodes a *base64* string to a binary string.

Return The decoded string.

Parameters

- `s`: The string to be decoded.

1.4.3 The Browser Extension

1.4.4 Introduction

Folder Structure

The `server/` folder contains all the source code of the developed server. Its structure is the following (all described folders are subfolders of `server/`).

views/ This folder contains all the views developed for the server.

views/layouts/ This folder contains the layouts used to define the views.

survey/ This folder contains all the required data for the survey.

assets/ This folder contains all the static files that will be served without any modification.

assets/images/ A folder that contains all the images and illustrations used.

assets/js/ A folder that contains all the external JavaScript files (needed by the extension).

assets/style/ A folder that contains all the stylesheets of the server (written in SASS).

1.4.5 The Data Processor

class DataProcessor()
The data processor.

This class processes the collected data, by adding various features (that can be extracted by the existing fields).

DataProcessor.**_analyzeEmotions**(*data*)
Extract the emotions from the image field.

Arguments

- **data** (*Object*) – The data to work on.

Returns **Promise.<Array.<Object>>** – A promise that will be resolved once the analysis is completed. The returned parameter contains the modified data.

DataProcessor.**_minimumAcceptedValue**
Get the minimum accepted value for the emotions' fields. If the registered value is less than the returned value, the emotions' object can be safely discarded.

DataProcessor.**_roundValue**(*val*)
Round a value to two decimal places.

Arguments

- **val** (*number*) – The value to be rounded.

Returns **number** – The value rounded to two decimal places.

DataProcessor.**process**(*data*)
Process the data. This modify the passed data injecting various features in them.

Arguments

- **data** (*Object|Array.<Object>*) – The data to be processed.

Returns **Promise.<Array.<Object>>** – A promise that will be resolved once all the data have been processed. The promise's parameter holds the modified data.

1.4.6 The Survey

The survey is generated using the export defined in the module `survey/survey-data.js`. Here is documented the structure of the exported object.

class Survey()
The survey configuration object.

Arguments

- **introduction** (*string*) – The introduction to the survey. Treated as raw HTML.
- **sections** (*Array.<Section>*) – The survey's sections.

class Section()
A section of the survey.

Arguments

- **title** (*string*) – The section's title.
- **questions** (*Array.<Question>*) – The section's questions.

class Question()
A question of the survey. @extends BasicQuestion.

Arguments

- **type** (*string*) – The type of question.
- **rules** (*Object*) – Various additional rules. Can be any HTML attribute accepted by the current input type.
- **placeholder** (*string*) – The input placeholder.
- **choices** (*Array.<string>*) – A list of choices. Used only if type is 'choice'.
- **question** (*string|Array.<BasicQuestion>*) – If it's a string, the same as BasicQuestion.question. If an array of BasicQuestion, a list of questions used if type is 'likert'.

class BasicQuestion()
A basic question of the survey. This class contains all the required field of a question.

Arguments

- **question** (*string*) – The question that will be asked to the user.
- **name** (*string*) – The name of the GET/POST parameter.
- **required** (*boolean*) – Wether or not the input is required.

CHAPTER

TWO

INDICES AND TABLES

- genindex
- modindex
- search

INDEX