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# **Technical Documentation**

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## **Part I**

# **The Emotions Tool**



## QUICK START

### 1.1 Installation

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

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**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.

---

#### 1.1.1 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
```

### 1.2 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)



## CODE DOCUMENTATION

### 2.1 The Entry Point

The main file.

This file is the main file of the tool.

**Author** Andrea Esposito <[github.com/espositoandrea](https://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.

### 2.2 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.

## 2.3 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.

## 2.4 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 following syntax: `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.

## 2.5 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.

## **Part II**

# **The Browser Extension**



## THE BROWSER EXTENSION





## **Part III**

# **The Server**



## INTRODUCTION

### 4.1 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](#)).



## THE DATA PROCESSOR



## THE SURVEY

The survey is generated using the exported object defined in the module `survey-data.js`. Here is documented the structure of that 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*) – Whether or not the input is required.



# **Part IV**

## **The Data Analyzer**



## QUICK START

### 7.1 Installation

To install the tool, download the tool's folder and execute the following commands (replace `/path/to/analyzer/` with the path to the downloaded folder).

Listing 1: How to install the tool

```
cd /path/to/analyzer
python3 -m pip install .
```

### 7.2 Usage

#### 7.2.1 The Command Line Interface

Once installed you can use this tool from your terminal using the command `analyzer`.

Listing 2: The tool's CLI

```
analyzer [-h] [--version] [-v] file users
```

---

**Note:** You can execute the tool as a Python module, without installing it first. Download the tool's folder and execute the following commands (replace `/path/to/analyzer/` with the path to the downloaded folder).

Listing 3: How to execute the tool as a Python module

```
cd /path/to/analyzer
python3 -m analyzer --help
```

---

Process the JSON file

### Positional Arguments

**file** The file

**users** A JSON file containing the users

### Optional Arguments

<b>-h, --help</b>	show this help message and exit
<b>--version</b>	output version information and exit
<b>-v, --verbose</b>	increase output verbosity

### 7.2.2 The Code API

Once installed you can use the tool as a Python module. Read the [code documentation](#) for more information on the API.

## CODE DOCUMENTATION

### 8.1 Module: cli

This module defines the CLI of the tool.

This module contains the definition of the Command Line Interface (CLI) of the tool and its entry point.

```
analyzer.cli.main()
```

The main entry point.

### 8.2 Module: data

A module to deal with the data stored on the server.

This module is a collection of classes, functions, etc to deal with the collected data that's stored on the server.

### Examples

Listing 1: How to create an object from a JSON.

```
from data_processor.data import CollectedData, User
user_string = "[YOUR_USER_LIST]"
user_set = set(User.from_json(user_string))
json_string = "[YOUR_OBJECT]"
CollectedData.from_json(user_set, json_string)
# [CollectedData(...), ...]
```

```
class analyzer.data.CollectedData (data_id: str, user: analyzer.data.user.User, timestamp: int =
None, url: str = None, mouse: analyzer.data.common.MouseInformation
= None, scroll: analyzer.data.common.ScrollInformation
= None, window: analyzer.data.common.ScreenCoordinates
= None, keyboard: analyzer.data.common.KeyboardInformation
= None, emotions: analyzer.data.common.Emotions = None)
```

The collected data.

This class represents the data collected from the server.

**data\_id**

The object's id.

**Type** str

**user**

The user that produced this data.

**Type** *User*

**timestamp**

The timestamp on which this data was produced.

**Type** int

**url**

The visited URL.

**Type** string

**mouse**

Various data regarding the mouse.

**Type** *MouseInformation*

**scroll**

Various data about the scroll position.

**Type** *ScrollInformation*

**window**

Data about the browser's window's dimensions.

**Type** ScreenCoordinates;

### **keyboard**

Data about the pressed keys.

**Type** *KeyboardInformation*

### **emotions**

The emotions value, fetched from Affectiva.

**Type** *DotMap*

**static from\_json** (*users: Set[analyzer.data.user.User], data: str*) → *List[analyzer.data.collected\_data.CollectedException]*

Create a list of data from a JSON string.

This method can be used to generate a list of data starting from a JSON string.

#### **Parameters**

- **users** (*set [User]*) – The set of users that generated this data.
- **data** (*str*) – The JSON string. It must represent a valid JSON array.

**Returns** The list of users represented by the JSON array.

**Return type** *list [CollectedException]*

**static to\_dataframe** (*data: List[CollectedException]*)

Convert a list of CollectedException to a DataFrame.

This function converts a list of CollectedException to a pandas DataFrame.

**Parameters data** (*list [CollectedException]*) – The list of data to be converted.

**Returns** The data converted into a DataFrame

**Return type** *pandas.DataFrame*

**class analyzer.data.Emotions** (*joy: float = None, fear: float = None, disgust: float = None, sadness: float = None, anger: float = None, surprise: float = None, contempt: float = None, valence: float = None, engagement: float = None*)

Encapsulates all the information extracted by Affectiva [1].

### **joy**

The joy value. May be *None* if no value was registered.

**Type** *float*

### **fear**

The fear value. May be *None* if no value was registered.

**Type** *float*

### **disgust**

The disgust value. May be *None* if no value was registered.

**Type** *float*

### **sadness**

The sadness value. May be *None* if no value was registered.

**Type** *float*

**anger**

The anger value. May be *None* if no value was registered.

**Type** float

**surprise**

The surprise value. May be *None* if no value was registered.

**Type** float

**contempt**

The contempt value. May be *None* if no value was registered.

**Type** float

**valence**

The valence value. May be *None* if no value was registered.

**Type** float

**engagement**

The engagement value. May be *None* if no value was registered.

**Type** float

## References

**class** analyzer.data.Gender

A gender enumerator.

An enumerator of all the valid gender values.

**class** analyzer.data.KeyboardInformation (*alpha: bool, numeric: bool, symbol: bool, function: bool*)

Encapsulates various information regarding the keyboard's state.

**alpha**

Is an alphabetic key pressed?

**Type** bool

**numeric**

Is a numeric key pressed?

**Type** bool

**symbol**

Is a symbol key pressed?

**Type** bool

**function**

Is a function key pressed?

**Type** bool

**class** analyzer.data.MouseInformation (*position: analyzer.data.common.ScreenCoordinates, buttons: dotmap.DotMap*)

Encapsulates various data regarding the mouse.



**position**

The mouse position

**Type** *ScreenCoordinates*

**buttons**

The mouse buttons. The keys are the following.

**l** Is the left button pressed?

**m** Is the middle button pressed?

**r** Is the right button pressed?

**bN** Is the button  $N$  ( $N \in \mathbb{N}, N \geq 4$ ) pressed?

**Type** `DotMap [str, bool]`

**buttons\_list** ()  $\rightarrow$  `List[int]`

Convert the mouse button objects to a list.

This function converts the data on the mouse buttons to a list of ID. The ID are assigned as in the HTML's `MouseEvent` [\[1\]](#).

**Returns** A list of mouse buttons' IDs.

**Return type** `list [int]`

## References

**class** `analyzer.data.ScreenCoordinates`

Represents a pair of screen coordinates.

**x**

The coordinate on the x axis.

**Type** `int`

**y**

The coordinate on the y axis.

**Type** `int`

**x**

Alias for field number 0

**y**

Alias for field number 1

**class** `analyzer.data.ScrollInformation` (*relative:* *analyzer.data.common.ScreenCoordinates,*  
*absolute:* *analyzer.data.common.ScreenCoordinates*)

Encapsulates various information regarding the scroll state of the window.

**absolute**

The absolute scroll position.

**Type** *ScreenCoordinates*

**relative**

The relative scroll position (from the bottom right of the screen).

**Type** *ScreenCoordinates*

**class** analyzer.data.**User** (*user\_id: str, age: int = None, gender: analyzer.data.common.Gender = None, internet: int = None*)

A user.

This class represents a user as seen for this study.

**user\_id**

The user's ID.

**Type** int

**age**

The user's age.

**Type** int

**gender**

The user's gender.

**Type** *Gender*

**internet**

The average time the user spend a day on the internet.

**Type** int

**static from\_json** (*data: str*) → List[analyzer.data.user.User]

Create a list of users from a JSON string.

This method can be used to generate a list of users starting from a JSON string.

**Parameters** **data** (*str*) – The JSON string. It must represent a valid JSON array.

**Returns** The list of users represented by the JSON array.

**Return type** list [*User*]

## 8.3 Module: plotting

A module to plot data.

This module contains various definition of various function that plot the data on various graph types.

analyzer.plotting.**convert\_collection** (*collection: List[analyzer.data.collected\_data.CollectedData]*)  
 → Dict[analyzer.data.user.User,  
 List[Dict[str, Any]]]

Convert a collection to a dictionary.

This function converts a collection of CollectedData to a dictionary that has users as key and all their related data (grouped by URL and visit) as values.

**Returns** A dictionary that, for each user, holds all the collected data grouped by URL an time of visit. This means that two visit in two different times to the same website, will result in two different objects in this dictionary's value.

**Return type** dict [*User*, list [dict [str, any]]]

`analyzer.plotting.get_common_urls` (*collection*: List[*analyzer.data.collected\_data.CollectedExceptionData*])  
→ Set[str]

Get all the urls visited by all the users in a collection.

**Parameters** *collection* (list [*CollectedExceptionData*]) – A list of data.

**Returns** A set of URLs visited by all the users in the *collection*.

**Return type** set [str]

`analyzer.plotting.plot_mouse_on_common_websites` (*collection*:  
List[*analyzer.data.collected\_data.CollectedExceptionData*])  
→ None

Plot various graph containing the mouse movement on websites commonly used by all users.

**Parameters**

- **user** (set [*User*]) – The users.
- **collection** (list [*CollectedExceptionData*]) – The collected data.



# **Part V**

## **License**



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**Note:** This documentation is released under the *GNU FDLv1.3*. All the source code (both in this document and in the entire repository) is released under the *GNU GPLv3*.

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