
Bilkent University

Department of Computer Engineering

# Senior Design Project

*Emolyst*

Analysis Report

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Analysis Report

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# 1. Introduction

In these days, people are the fundamental interface of all businesses. People's emotion and behavior affect their vital decisions which direct the businesses. If machines can know what a person is feeling, incredible insights can be unlocked. While detecting and analyzing one's feelings and comprehending results in a smart way, computer science comes into play. With the help of trusted algorithms, collected data is processed and rational inferences can be made. Hence, the value for any business can be created in an incisive way.

Emolyst application will detect emotion, gender, and age through the integration of several algorithms. Basically, real-time data that is collected through cameras will be analyzed. Later on, statistical results will be given to our clients to make them smart and profitable choices for their businesses. Since Emolyst will process images for only real-time data analysis under the Code of Ethics, it certainly won't break the Law for Protection of Personal Data. When all the benefits of Emolyst are considered, it can be said that the "mainstreaming" of emotion, gender and age recognition of Emolyst will enable companies to engage it in a multitude of profitable uses, across industries.

With Emolyst, we aim to analyze customers' reaction to a product or an offered service. With the help of resulted in customer reaction analysis, they could learn what is problematic and what is good for their customers. In this way, product or service providers can improve their business.

In this report, we aim to provide an overall analysis of the system that we will develop. First of all, the existing systems, their qualities, and the missing features of the current systems are described. Then the details of our system of Emolyst are listed. Functional, non-functional, and pseudo requirements are presented. Afterward, the system models of our system are included. Scenarios of Emolyst are explained in detail. These scenarios are generalized by common use case descriptions and the use case diagram is given. The object model and the dynamic models of the system are also provided and explained. Finally, the screen mock-ups and the navigational paths are included.

# 2. Proposed system

## 2.1. Overview

Emolyst is a CRM (Customer Relationship Management) application for legal entities and it provides analysis of their customers based on their emotional status and age-gender categories. Emolyst uses and integrates face detection, emotion recognition, age, and gender detection algorithms. It processes these data to provide analysis to our clients about their customers. Emolyst aims to improve customer services and quality standards of companies. For example, at a supermarket, cameras will be inserted over each aisle with an angle which it will be able to see faces of customers. Camera records will be processed and analyzed by Emolyst. Emolyst will introduce a report to the supermarket which includes information about their customers' behaviors such as the percentage of happy, sad, bored, angry or neutral users with an option of filters with respect to their age gaps and genders. A supermarket can use time, gender, age, emotion filters to get specific information about the analysis. This project will help supermarket to get real-time reliable data about their customers and increase their customer satisfaction. Customer ratings are valuable sources to understand their satisfaction and are critical for designing better customer experiences and recommendations. Companies generally work with survey companies to measure the satisfaction level of their customers. But satisfied customers do not tend to fill or answer surveys from these companies [1]. This behavior of satisfied customers causes false results in surveys. Also getting enough data from surveys may take time. One of the most innovative and useful functions of Emolyst is providing real-time analysis. It will analyze all customers' data in the given interval. While doing this, Emolyst will not keep or use any confidential data of people and will abide by personal data protection law. Any of the faces will not be recognized or sold to third parties. Each company can only see the analysis of their customers.

## 2.2. Functional Requirements

- The application will capture real-time frames using an installed camera.
- Recorded frames (not all) will be analyzed and customers' faces will be detected.
- The application will analyze the mood of customers at a moment.
- The application will also detect the gender and age range of a customer.
- The application will classify customer, based on detected parameters.
- According to the collected data, the application will generate some data for products or services. These data will be created based on customers reaction to the product or service.
- The user will be able to filter collected data by its contents like age range, gender, satisfaction, emotion, etc.
- The system will create user-user, item-item, item-user associations.

## 2.3. Nonfunctional Requirements

- **Performance**
    - The application should be capable of the analyze multiple streaming image data simultaneously. For example, camera data coming from all posters at poster exhibition.

- **Reliability**

    - Emotion recognition for application should have at least  70% accuracy for 3 three basic emotion (Like, Neutral, Dislike) and 50% for complex emotions (Anger, Disgust, Fear, Happy, Sad, Surprise) to be able to create consistent analysis.

    - Age recognition for application should have maximum +- 10-year error rate for consistent analysis.

    - Gender recognition for application should have at least 70% accuracy for consistent analysis.

- **Security**

    - Emolyst must ensure the security of personal data of the users.

- **Compatibility**

    - The application must be compatible with many web browsers.

## 2.4. Pseudo requirements

### 2.4.1. Implementation Constraints

1. Machine learning and Computer Vision models will be developed in Python.

2. The application will have a web user interface.

3. Django framework will be used for web implementation.

4. Git will be used for version control.

5. Github will be used for code and document sharing.

### 2.4.2. Ethical Constraints

1. None of the data must be shared with any third parties.

2. The face data will not be used for biometric face identification analysis and all detected faces will be anonymous and private in the system.

3. The application will not know who is in the image.

4. We will abide to the Code of Ethics outlined by the National Society of Professional Engineers [2].

### 2.4.3. Time Constraints

1. The project should be completed before June 2019

## 2.5. System models

### 2.5.1. Scenarios

Scenario Name: Supermarket Aisle

Participating Actor Instances: Zeynep (CFO of Target Corporation): CLIENT

Flow of Events:

1. Zeynep finds out that Target has declined in sales. They decided to increase their sale rates and buy Emolyst to analyze customers' reaction to a product or an offered service. With the help of resulted in customer reaction analysis, they want to learn what is problematic and what is good for their customers.

2. After the setup, Zeynep starts to use the system.

3. She logins to the system and starts the detection system. A camera is opened and at a constant rate, frames are started to send to the system.

4. Sent frames are sampled and face detection is started.

5. Thanks to Emolyst algorithms, detection is done with 70% accuracy for 3 three basic emotion(Like, Neutral, Dislike) and %50 for complex emotions (Anger, Disgust, Fear, Happy, Sad, Surprise).

6. After the detection step, these data are sent to the database and then data analysis subsystem.

7. In this analysis system, the collected data is analyzed and interpreted.

8. Later on, the analysis is sent to Zeynep's computer and she opens the web browser. With the help of detailed analysis for every aisles and entrance of the supermarket, she starts to decide what to change.

9. She realizes that, at the entrance of the market, %82 of the women and %73 of the men are either neutral or dislike for the market. Also, she finds out that the ratio of going to bakery aisle is lower than the other aisles' rate.

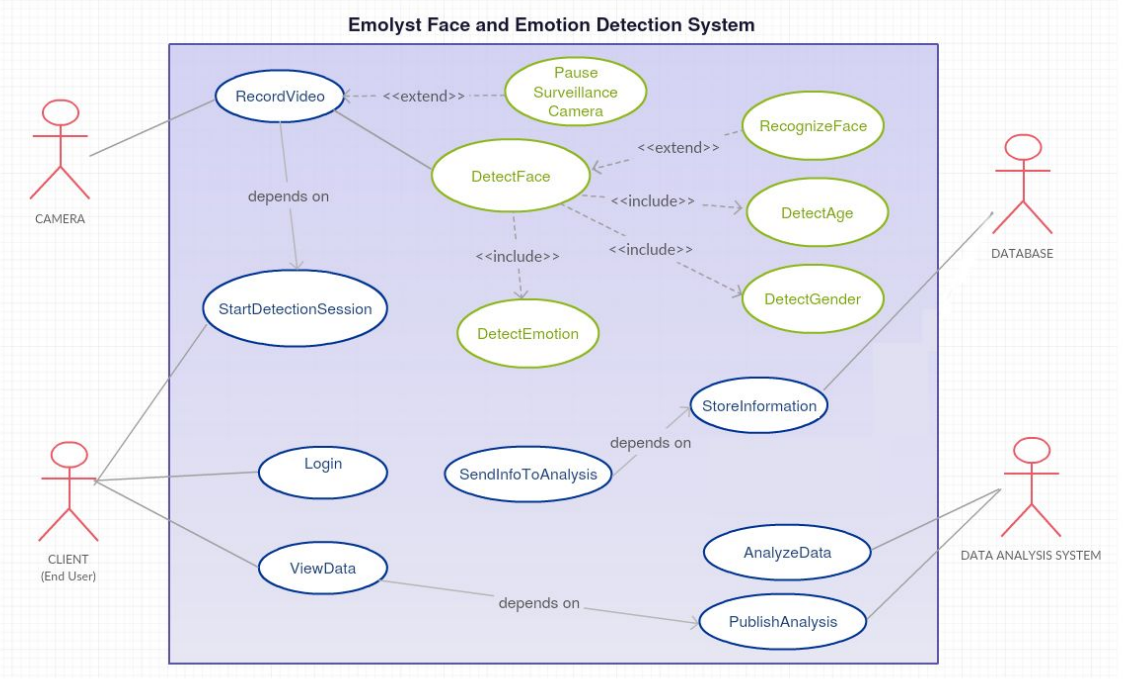
10. Then they decided to put flowers just inside of the entrance to enhance an image of the store since consumers walk into something that is pretty, smells great, and builds the notion of 'fresh.

11. Then they put produce to immediately past the flowers since stores need to communicate to shoppers that produce is fresh or else people won't buy anything.

12. Lastly, they located the bakery in the corner beyond the entrance to make people feel hungry and buy more products.

13. After these changes, she starts the Emolyst again for one week period and sees that their income and customer's satisfaction are increasing with the help of analyzed data.

### 2.5.2. Use case model



**Use Case Name :** StartDetectionSession

**Participating Actors:** Initiated by CLIENT Communicates with CAMERA

**Flow of events :**

1. CLIENT(End user) starts detection session.

2. CAMERA responds by RecordVideo.

3. Until the pausing camera, it records.

**Entry Condition:** CLIENT is logged into Emolyst.

**Exit Condition:** Video record is stopped.

**Quality Requirements :**

- This use case **extends** the PauseSurveillanceCamera. It is initiated by the system whenever the connection between camera and client is lost or there is a privacy issue.

**Use Case Name:** DetectFace

**Participating Actors**: Communicates with CAMERA

**Flow of events:**

1. According to the sampling rate, the sample frame is received from video records by the system.

2. Emolyst detects the face, age, gender and emotion by its algorithms.

3. Required data is created in this way.

**Entry Condition:** Video is recorded and sampled.

**Exit Condition:** Detection algorithms run and stopped.

**Quality Requirements :**

- The sampling rate is no later than the ratio that is specialized.

- At any point during the flow of events, this use case can **include** the DetectGender, DetectAge, and DetectEmotion use cases.

**Use Case Name:** StoreInformation

**Participating Actors:** Initiated by DATABASE

**Flow of events:**

1. Feature vectors of detected faces are extracted by the classifier.

2.DATABASE stores information.

3. Send information to the DATA ANALYSIS SYSTEM.

**Entry Condition:** Images are converted to data.

**Exit Condition:** Information is sent to the DATA ANALYSIS.

**Quality Requirements:**

- The system does not know who is in the image by storing features for not violating personal data protection law.

**Use Case Name:** AnalyzeData

**Participating Actors:** Initiated by DATA ANALYSIS SYSTEM

**Flow of events:**

1. Data that is coming from the DATABASE is interpreted by the analysis subsystem.

2. Analyzed data is published by REST API.

**Entry Condition:** Data is received from the DATABASE.

**Exit Condition:** Analyzed data is published and sent to the client.

**Quality Requirements:**

- The analysis is done according to the client's specialization.

**Use Case Name:** ViewAnalysis

**Participating Actors:** Initiated by CLIENT communicates with DATA ANALYSIS SYSTEM.

**Flow of events:**

1. An interpretation that is published by ANALYSIS SYSTEM is sent to the CLIENT device.

2. CLIENT views this analysis from the web application.

**Entry Condition:** Analyzed data is published and sent to the client.

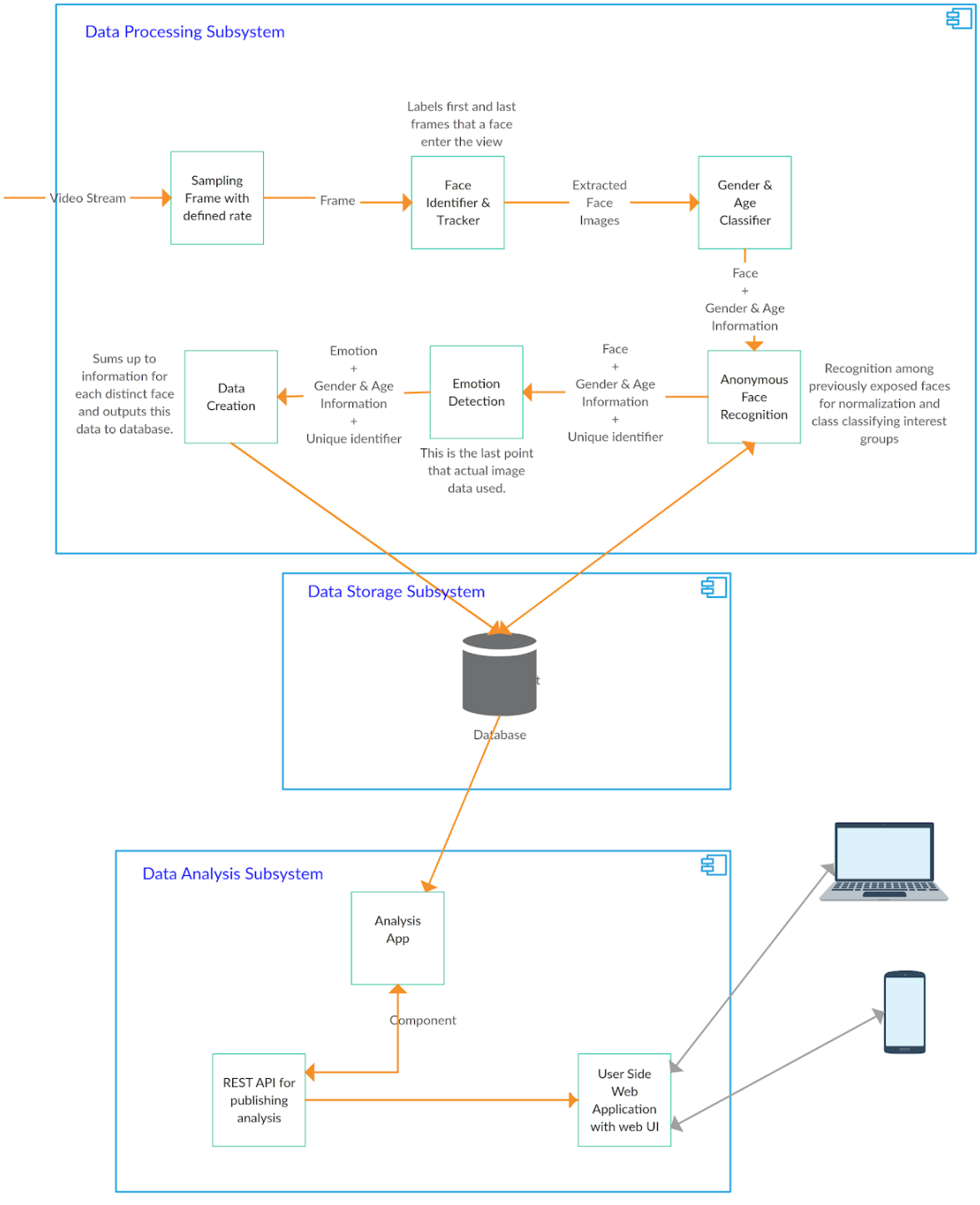
**Exit Condition:** Data analysis is seen in CLIENT's device.

**Quality Requirements:**

- Data analysis arrives no longer than the time period that is specified by the CLIENT.

## 2.5.3. Component diagram

The structure of our system is as follows.



## Data Processing Subsystem

Data processing subsystem includes a data pipeline that has an input of video stream and outputs for each frameset that includes the same face consecutively :

- Unique identifier of a face image.
- Set of emotions detected over time with time labels.
- Estimated Age of the person.
- Gender of the person.

## Data Storage Subsystem

Data storage subsystem stores unique face identifier vectors that system exposed before, which are not related by any means with the real identity of the person. Those identifiers are used for normalization and keeping track of the distinct count of viewers. Data storage subsystem also stores output created by data processing subsystem.

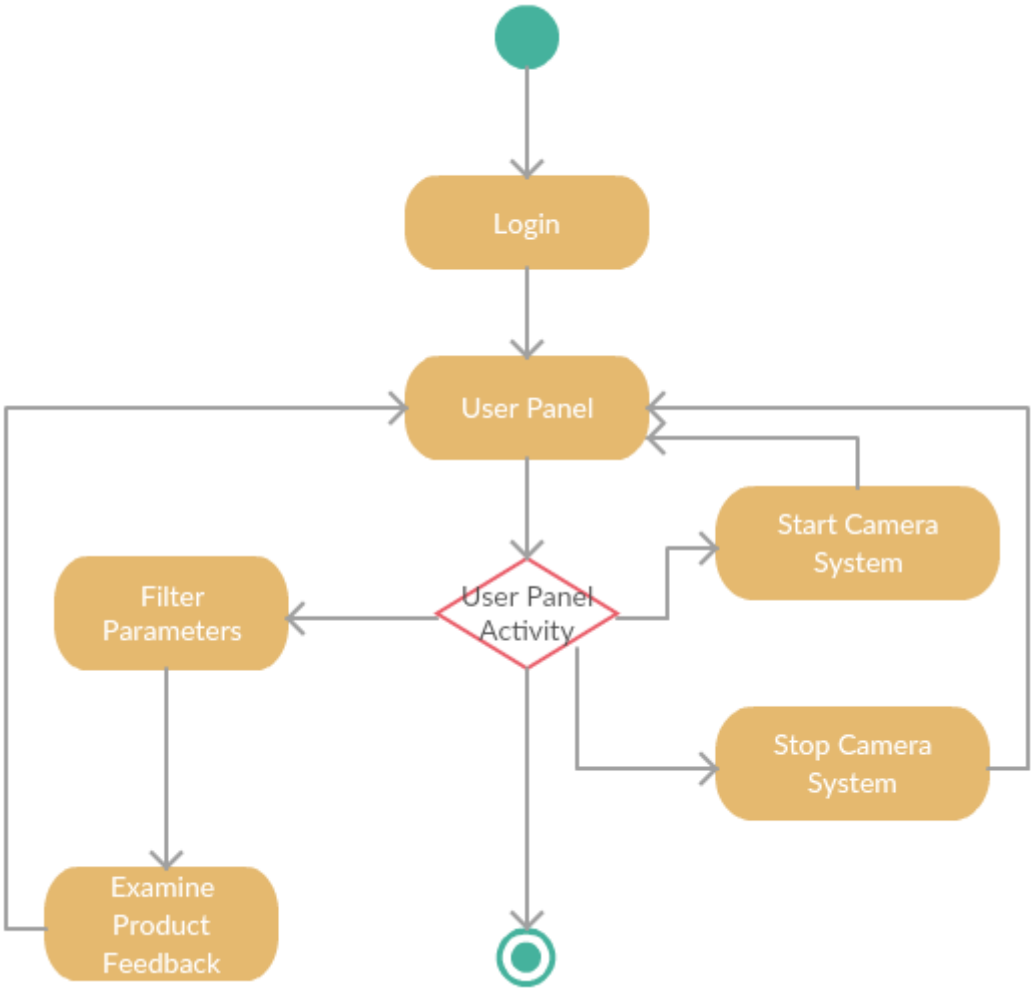
In data processing subsystem multiple database technologies can be used for at the same time to be able to meet with nonfunctional requirements specified.

## Data Analysis Subsystem

Data analysis subsystem consists of methods that create analyze data in order to satisfy use cases as well as the REST API backend and web UI that serves analysis results with convenient graphs and charts.

### 2.5.4. Dynamic models

Activity Diagram




In this diagram, the user logs into the system initially. After a successful login, the user will have several options to do. One of them is starting analyzing system which activates cameras and rest of the analyzing algorithms. This process also creates more feedback for specified products. Another option is stopping this system. This basically suspends camera and analyzing system. The user also can view product feedback and can filter them via feedback and product parameters.

### 2.5.5. User interface - navigational paths and screen mock-ups

- Emolyst Main Page

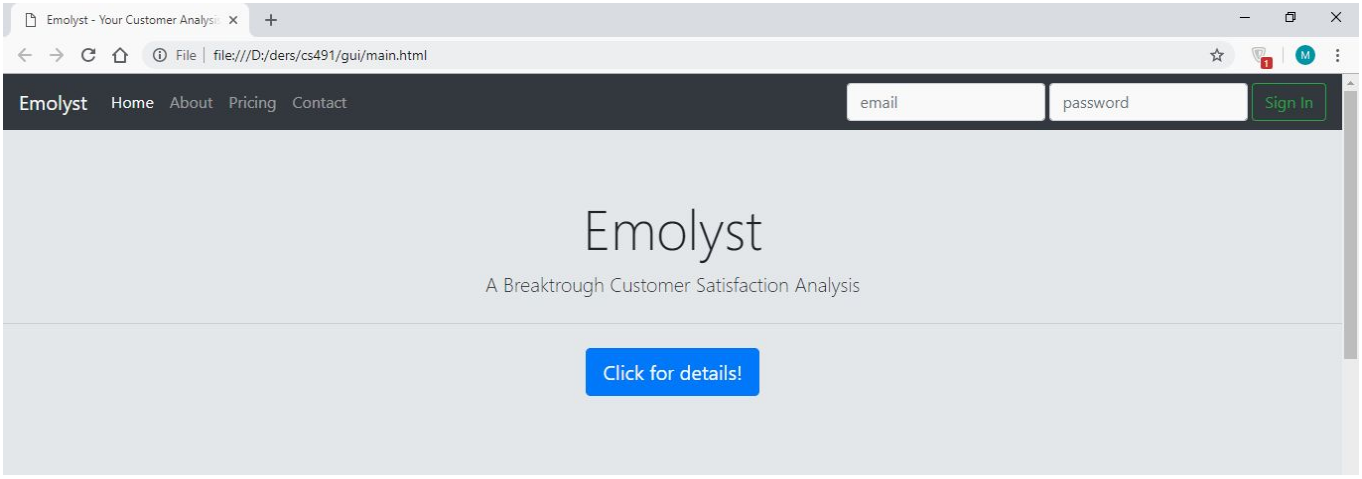



Figure 1: Main Page

Clients need to access the website and log in. Also, companies that want to our client can learn what Emolyst does and contact us for membership using this website.

- User Home Page

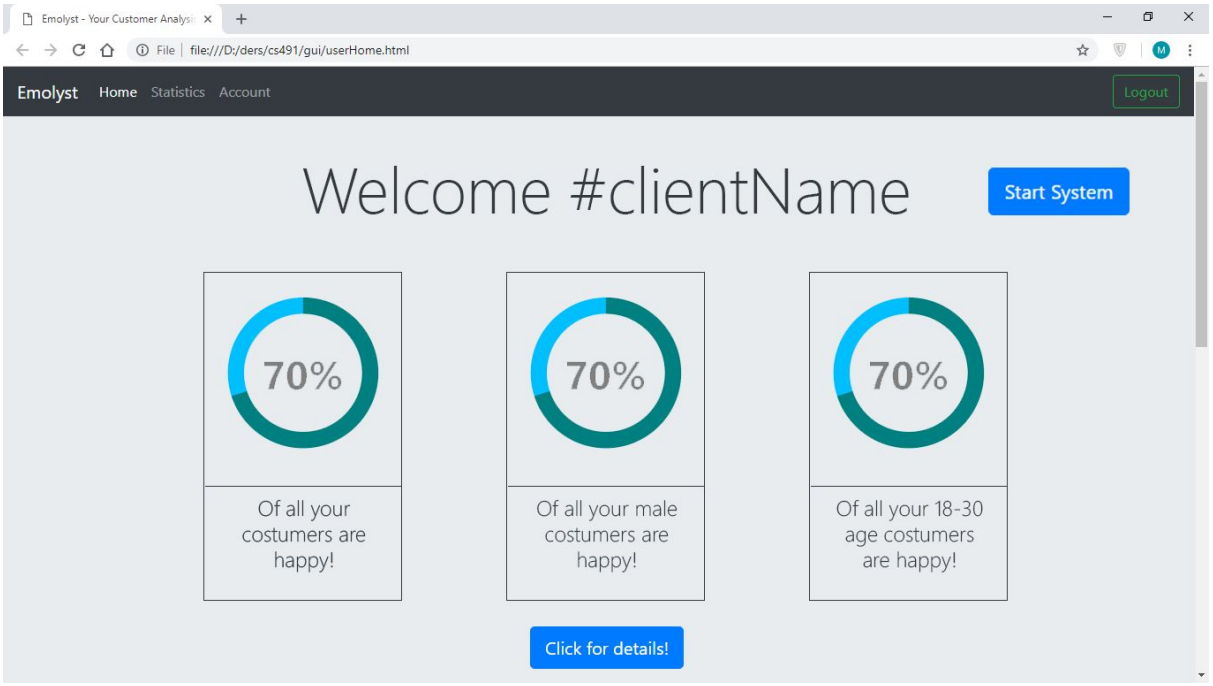



Figure 2: User Home Page

When a user logs in to the system, at their homepage they can see all data samples from their membership started. They can start the system here, also they can make detailed filter the statistics.

- User Statistics Page

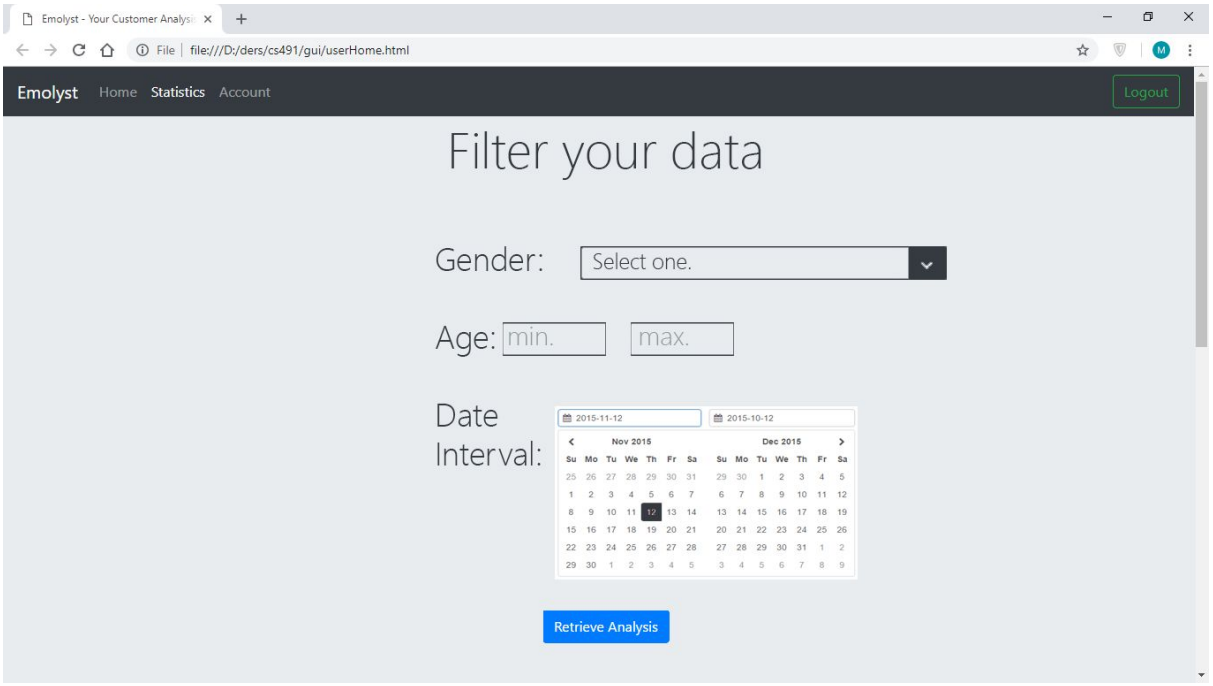



Figure 3: User Filter Page

In this page, the user can filter the customer satisfaction data with respect to age and gender in any time interval they want.

- Item-Item Association Graph based on User Attributes

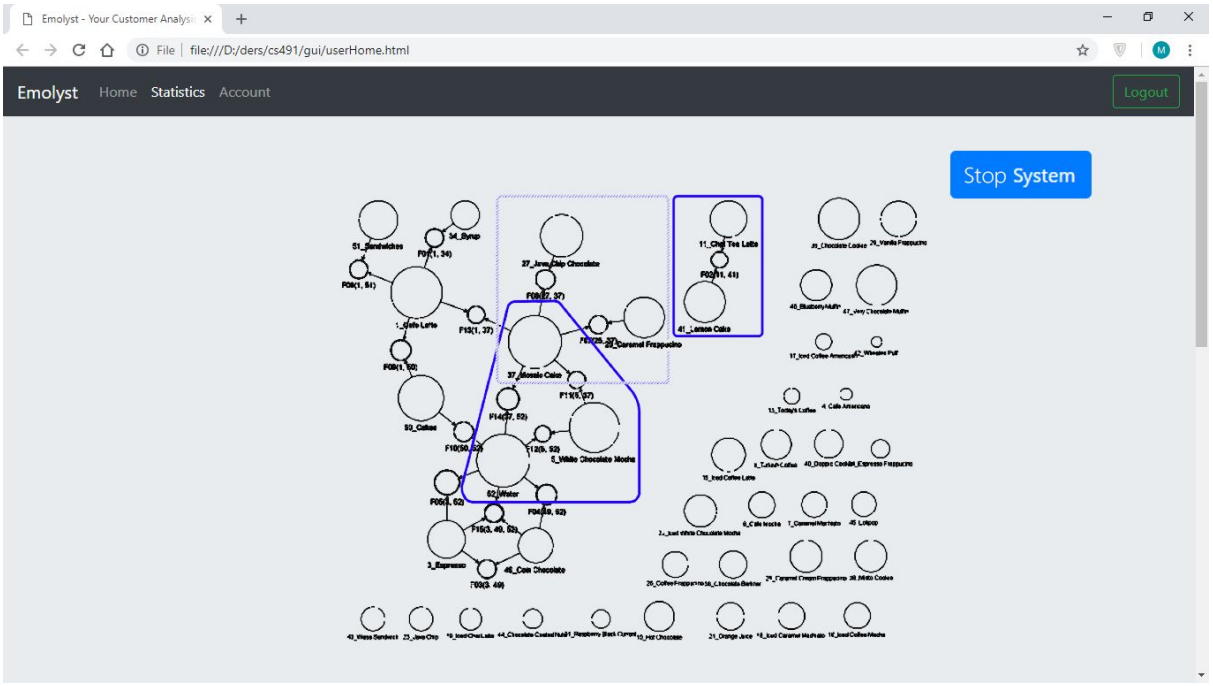



Figure 4: Association Graph[3]

In this page, the user can see the association between items based on user's reaction to items from similar demographic groups to obtain correlation between items.

- User Filtered Data

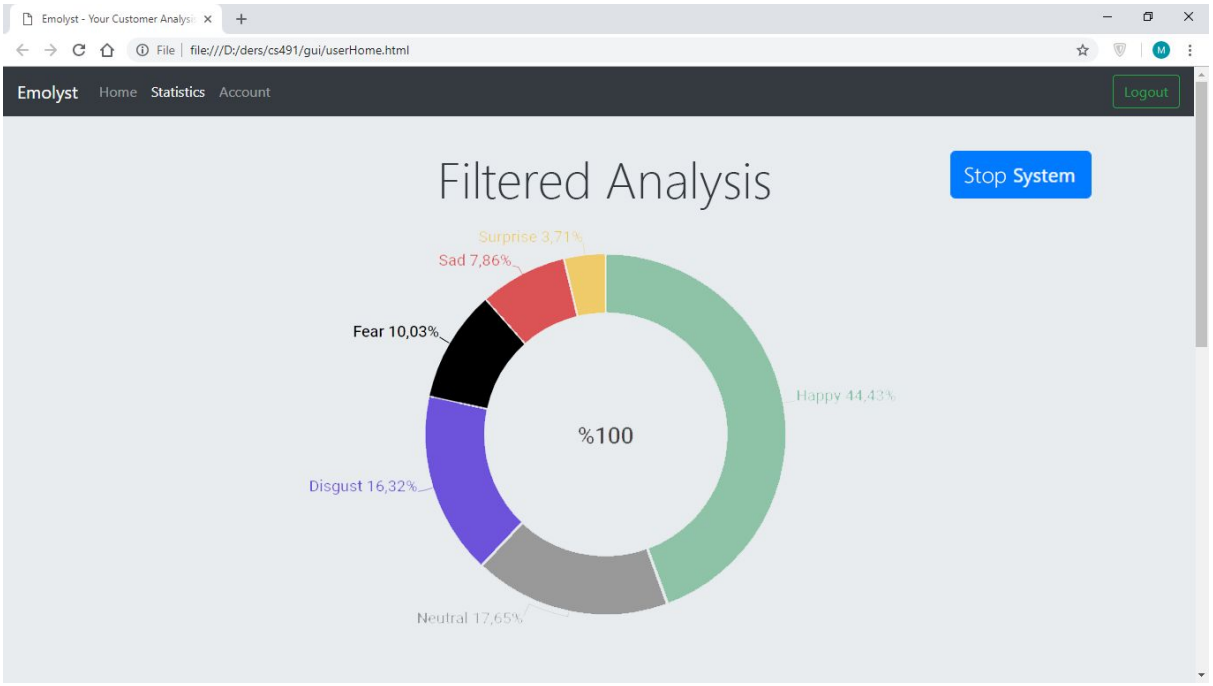



Figure 4: User Filtered Data Page

A user can see the results of filtering here.

# 3. References

[1] G. Nicolini and L. D. Valle , "Errors in Customer Satisfaction Surveys and Methods to Correct Self-Selection Bias ," *Quality Technology & Quantitative Management*, vol. 8, no. 2, pp. 167-181, 2011, [Online]. Available: Semantic Scholar, https://pdfs.semanticscholar.org/ca52/b6f284e5ac4bec2f1341e04d69a8a81e3014.pdf. [Accessed: 13.10.2018].

[2] Code of Ethics | National Society of Professional Engineers", Nspe.org, 2017. [Online]. Available: https://www.nspe.org/resources/ethics/code-ethics. [Accessed: 12- Nov- 2018]

[3] Ertek, Gurdal & Demiriz, Ayhan & Cakmak, Fatih. (2012). Linking Behavioral Patterns to Personal Attributes Through Data Re-Mining. 10.1007/978-1-4471-2969-1_12.