Software Requirement Specification Document
Trajectory Analyzer "ESCORT"

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1 Introduction

1.1 Purpose of this document

The purpose of this document is to present a detailed description of the ESCORT system: a web-enabled system for the analysis of traffic trajectories and Escort will be built on HTML, PHP. It will consist of some web pages accessible with any web browser and will detect abnormal behaviors and traffic anomalies for automated ratings. This document will explain the purpose and features of the system, and describe its interfaces. The document will also explain what the system will do, the constraints under which is must operate, and how the system will react to user input. This software requirements specification (SRS) document is, therefore, intended for the stakeholders and developers of the ESCORT system.

1.2 Scope of the Project

Understanding traffic patterns and crowd motion is a challenging task for urban developers and law enforcement agencies. Spatial-temporal data collected through positioning systems and smart phones offer great opportunities for analyzing motion trajectories and identifying patterns. However, a challenge remains due to the large size and dimensionality of the collected data. This project aims to develop a web-based tool for the visualization and analysis of motion trajectories, which can improve decision making and urban planning. Specifically, the idea of the project is to study the traffic patterns in specific areas, and detect malicious vehicle behavior. Normal patterns will be identified using machine learning techniques. Detected patterns along with raw data will be fed to the visualization system to support high level inference.

1.3 Overview of this Document

This document targets the front end users like marketing companies and security solution companies that will use Escort system to satisfy their needs. It will also be beneficial and helpful for data analysts and developers that may work on the Escort system in the future.

The next Section of this document provides an overview of the system that is aimed to be understood by stakeholders. The remainder of this document addresses developers who will work on this system, and includes the more technical details.

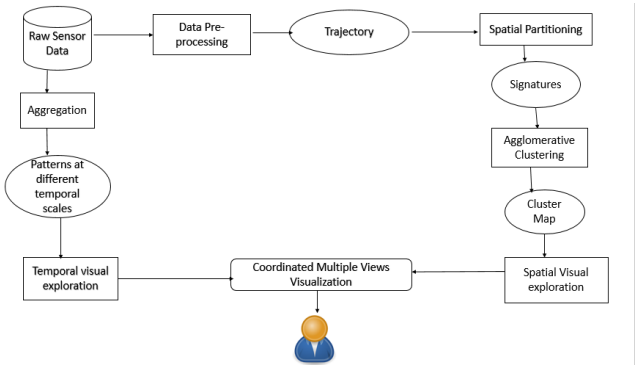

Figure 1: .

1.4 Business Context

We spoke with representatives from a major advertising company and a security systems company; both located in Cairo, Egypt. The value provided of our project was strongly expressed in the advertising context. The mission of the company is to help clients gain the highest level of visibility for their advertising campaign, by their intended audience. This raises the need to characterize normal traffic flows in order to support decisions on where and when to place advertising billboards. These types of decisions are typically made in an ad hoc manner, either based on clients' preferences or on the media experts' opinion, which sometimes leads to uninformed decisions. Therefore, backing these decisions with efficient analysis of traffic flow data can save money and effort.

In the context of security management, detecting abnormal traffic patterns and anomalous behaviors within certain territory can help forensic analysis in the event of theft or criminal activity.

Both contexts can benefit greatly from the features of the ESCORT system. The main difference lies in the scale of the geographic area covered by the analysis. The advertising company aims to perform the analysis at a larger scale, whereas the security company is more interested in smaller areas of interest.

2 General Description

2.1 Product Functions

This system will analyze the row data to detect unusual behavior of traffic patterns, which will be discussed in more detail below.

2.2 Similar System Information

2.2.1 Smart ADP

1. USER TASKS:
   (a) Finding proper areas to place billboards.
   (b) Selecting suitable locations in the specific areas.
   (c) Reforming a solution and persuasive customers.
   (d) Providing customers with multiple solutions.

2. OVERVIEW: SmartAdP is a web-based application developed under the full-stack framework of MEAN.js (i.e., MongoDB, ExpressJS, AngularJS, and Node.js). The visual analysis module is implemented using D3.js and Leaflet.js. We deployed the back-end part into our server with 2.40GHz Intel Xeon E5-2620 CPU and 64GB memory. Fig. 2 shows the SmartAdPs system architecture. The solution generator helps users formulate a candidate solution. Users need to select several target areas initially, and then two types of HeatMaps are provided to help users determine the befitting solution areas to place billboards (R1). When the solution areas are determined, users set the parameters of model and obtain a recommended solution from the location optimizer (R2). Meanwhile, users can assess whether the selected locations or the generated solutions are good enough (R3, R4) and make adjustments accordingly. To further explore and compare multiple solutions, users can switch to solution explorer that comprises three sub-views. The solution view shows a high-level overview of the basic information of each solution and the relationships among the solutions (R5, R6). The location view further assists users in identifying the relationships at a locational level (R5, R6). The ranking view visualizes the detailed performance related to the attributes of each solution (R4, R5, R7).

3. System Advantages
   (a) Smart ADP is good for finding good places to put the billboard.
   (b) Smart ADP is pretend.
   (c) Can find optimize solution.
   (d) Suggest many places.

4. System Disadvantages
   (a) Software.
   (b) Processing of hardware take along of time.
   (c) Manger take a lot of time to find a place.

2.2.2 PATTERNS AND SEQUENCE : Interactive Exploration of Click-streams to Understand Common Visitor Paths

1. USER TASKS:
   (a) Identify key customer journeys.
   (b) Drill down into individual sequences.
   (c) Bring dimensions into analysis.
   (d) Detect multiple occurrences of events

2. OVERVIEW: Companies and individuals collect huge amounts of click-stream data from websites and applications, in the hope that this data will allow them to better understand users behavior and intentions. These click-streams consist of series of ordered events triggered by user interaction. they present an analytic pipeline consisting of three stages: pattern mining, pattern pruning and harmonious exploration between patterns and sequences.

3. System Advantages: To support exploration across abstraction levels, they design novel visualization and interaction techniques in a dual view interface. Analysts can align and segment sequences based on key events in sequential patterns. discuss the behavior of the mining algorithm and present techniques to prune the output space for visual presentation.

4. System Disadvantages:: Analysts need to understand common paths taken by users, but doing so remains a significant challenge.

2.2.3 Many-to-Many Geographically-Embedded Flow Visualisation: An Evaluation

1. USER TASKS:
   (a) Flow visualisations should support by reviewing the geographical visualisation literature.
   (b) Comparison between location and single flows.
   (c) Determine the geographical or regional distribution of the flow.
   (d) Recognize between the certain area on the map.
2. OVERVIEW: The challenge of this system was the problem of visualization by solving the flow of people and resources in multiple geographic locations and study contrast a bundled node-link flow map representation and OD Maps with a new visualization .The second study contrast entrant rendering with OD Maps and MapTrix on larger data sets and found the rendering of the remarkably similar.
3. SYSTEM ADVANTAGES : Their flow maps present an origins and destinations on a map connected by lines or arrows.
4. SYSTEM DISADVANTAGES : They did not study the denser flow maps but adapt a state-of-the-art bundling technique from the field of network visualization and the rating of scaling data. no considerable difference between OD and mapTrix

2.2.4 SemanticTraj:

1. USER TASKS: SemanticTraj allows users to retrieve and visualize by explore a taxi trajectory dataset as mentioned such as:
   (a) Select a region enclosing the mall on the map to display drop-off points.
   (b) Taxi trips passing a street in a given time period.

(c) Brush to filter the points related to the mall.

(d) Display pick up points of passenger trips on the map.

(e) Supervise to find the heat location on the map.

(f) Taxi trips with single or multiple POIs.

(g) Taxi trajectories passing given streets and POIs.

2. USERTASK 2 (POLICEMAN):

   (a) Select region on the map.

   (b) Select time period from selection of time tool.

   (c) Brush to select all GPS points establish.

   (d) Show the GPS points in the same taxi trips with the selected points.

   (e) Find another street they also passed from.

3. OVERVIEW: They detect Taxis traveling over cities detect massive trajectory datasets. They record the data of taxi by detecting samples of the data of GPS location (longitude and latitude) in the interval of a few second in a given specific time to be like that (Car ID, speed, time, occupancy status, direction, and possibly other attributes) for one taxi of each trip which would be hired by the passengers.

4. SYSTEM ADVANTAGES:

   (a) The crimes that police officers have involved the taxi in it.

   (b) Any organization could use SemanticTraj system in improving any business marketing by knowing the major pick up locations of their customers.

   (c) Any taxi owner can use SemanticTraj to track the taxi after stolen.

5. SYSTEM DISADVANTAGES:

   (a) SemanticTraj system does not support an alarm or notification system for admin if a taxi route goes in an upnormal behavior, unexpected, or any bumpy road.

   (b) The system did not differentiate between users types. As it is not efficient for the police and the taxi owner to have the same interface. .

2.2.5 Urban Pulse: Capturing the Rhythm of Cities

1. USER TASKS:

   (a) Architects and urban designers from a leading firm used the urban pulse framework.

   (b) identify precedents for urban design .

   (c) study the human behavioral patterns used our framework to understand how the different between cultural communities.

2. OVERVIEW: The goal of this to understand the city in the context of the different data sets. They put forth the idea that a city is involved in the vital processes of the people who compose it, and is a product of nature and particularly of human nature. They suggest an identification between the process occurring within a city and the heart beat or pulsation of a human body

3. SYSTEM ADVANTAGES:

   (a) Urban Pulse helps to identify precedents for urban design and to better understand neighborhoods.

   (b) Urban Pulse is an expert specialized in the data driven study of human behavioral patterns used our framework to better understand how the different cultural communities .

   (c) Urban Pulse opens up new opportunities for city governments and social scientists to engage in data-driven science to better understand cities, and improve the lives of their residents .

4. SYSTEM DISADVANTAGES: Urban Pulse collect its required data from integrations with other resources such as Flickr photos for data about tourism activities or transportation for analyzing people movement and behaviour; Therefore, In my point of view any problem might occur in Urban Pulse would be due to a problem in the source data that comes

from the integrations. Obviously Urban Pulse doesn't hold data by itself but it collect it dependently from the other resources. Incorrect source data will impact Urban Pulse results that will be incorrupted.

2.2.6 Hashedcubes: Simple, Low Memory, Real-Time Visual Exploration of Big Data

1. USER TASKS:

   (a) Advancing the state of the art especially with respect to implementation simplicity and memory usage.

   (b) Build time of the data structure on synthetic and real-world datasets

2. OVERVIEW: They propose Hashedcubes, a data structure that enables real-time visual exploration of large datasets that improves the state of the art by virtue of its low memory requirements, low query latencies, and implementation simplicity. In some instances, Hashedcubes notably requires two orders of magnitude less space than recent data cube visualization proposals. They describe the algorithms to build and query Hashedcubes, and how it can drive well-known interactive visualizations such as "linked histograms and heatmaps".

3. SYSTEM ADVANTAGES:

   (a) Hashedcubes enables Real Time Data-Driven Decision Making.

   (b) Hashedcubes uses data visualization which is going to change the way our analysts work with data. Theyre going to be expected to respond to issues more rapidly and directly. And theyll need to be able to dig for more insights and they will look at data differently, more imaginatively. Data visualization will promote that creative data exploration.

   (c) Hashedcubes will accelerate the understanding of the key business drivers.

   (d) Hashedcubes will applies any companys best practices.

4. SYSTEM DISADVANTAGE:

   (a) Hashedcubes data visualizations can be generated in real-time, they do not provide any explanations. Analysts look at data and then write reports. This process is too slow for the market and too costly for the company.

   (b) Hashedcubes expect the user to be an expert in all of the data and all of the corporate best practices.

   (c) Two different users who interact with the same data visualization may not draw the same conclusion, depending on their previous experiences and particular level of expertise. This presents several problems for companies. Also, certain users could be drawing conclusions Incorrectly which cost the company more money and put the company in more risk.

2.3 User Characteristics

2.3.1 Business intelligence analyst:

Observe the location solutions suggested by the system and pick up the solution that matches his needs, also have basic knowledge of using web browsers and map services.

2.3.2 Security officials:

Observe the system output and analysis and generate reports that help the officials to take action if an anomaly is detected, also have basic knowledge of using web browsers.

2.4 User Problem Statement

Improvement of accuracy of detecting vehicle abnormal behaviors and automatically generate the anomalies detected.

2.5 User Objectives(user tasks)

Our analysis reveals a number of objectives that each of the identified user classes wishes to achieve.

2.5.1 Business Intelligence (BI) analyst:

- **Objective 1:** Identify regular traffic patterns (e.g.: peak times) and average vehicle speeds.

- **Objective 2:** Identify long term changes in traffic flow.
- **Objective 3:** Detect most observed places by vehicle drivers and determine the optimum solutions for placing ads.

2.5.2 Security official:

- **Objective 1:** Detect vehicles' abnormal behaviors in traffic patterns.
- **Objective 2:** Identify Long term changes in vehicle behavior.

2.6 General Constraints

Escort System is a web based Application, So it's not specify a special constrains as all the process will be calculated on server side.

3 Functional Requirements

3.1 User Class 1-Business intelligence analyst

Table 1: FR1-SignUp

Description	Adding a BI analyst to the system's database records.
Input	Email,username,first name,password,address,phone number.
Action	Checks if all fields are filled and checks if so the data is previously entered in the database.
Output	Confirmation message or error that there are some fields not entered .
Pre-condition	None.
Post-condition	Database is updated with the new BI analyst account.
dependency	None

Table 2: FR2-Login

Description	User authentication to determine user's privileges in the system
Input	username,password.
Action	Checks if the data entered is present in the system's database records .
Output	Web-page with the user(BI analyst) privileges and a confirmation massage for the sucessful login.
Pre-condition	Homepage of the system.
Post-condition	the BI analyst web-page.
dependency	FR1.

Table 3: FR3- Enter preferred location range

Description	the BI analyst enter the spatial range that would be analyzed by the system.
Input	X and Y coordinates, radius R, trajectory data.
Action	system checks if the input fields are entered correctly and starts to analyze the traffic patterns in the location entered by the user.
Output	visual display of traffic trajectories within the selected range.
Pre-condition	None
Post-condition	all system views get updated to show the selected data range.
Dependencies	FR2,FR1

Table 4: FR4: Run analysis

Description	the system runs analysis and returns suggested solutions for advertising billboards.
Input	location range, clustering parameters, trajectory data.
Action	system runs clustering analysis and displays results.
Output	system updates views to show clustering results and suggested solutions.
Pre-condition	At least one location is entered in the system.
Post-condition	None.
Dependencies	FR3

Table 5: FR5: Add filter brush

Description	filter brush specific subsets of the displayed results in any view and link other views to the selected subset.
Input	mouse click or drag over selected region of interest.
Action	system accepts user selection of a spatial-temporal region of interest (ROI) and updates all views.
Output	system updates views to show results for the selected ROI.
Pre-condition	preliminary analysis results are displayed.
Post-condition	None.
Dependencies	FR3, FR4

Table 6: FR6: Write report.

Description	the BI analyst annotates visualizations and writes a report about the suggested solutions by the system and a rating for the suggested solution.
Input	report written by the BI analyst.
Action	System store the report written in the database records.
Output	confirmation message that the report is uploaded successfully
Pre-condition	view if any previous reports were added
Post-condition	database is updated with the new record.
Dependencies	FR2, FR3, FR4

3.2 User Class 2-Security official

Table 7: FR6: Signup.

Description	Adding a Security official analyst to the system's database records.
Input	Email, username, first name,password,address,phone number.
Action	Checks if all fields are filled and checks if so the data is previously entered in the database.
Output	Confirmation message or error that their are some fields not entered .
Pre-condition	None.
Post-condition	Database is updated with the new BI analyst account.
Dependencies	None

Table 8: FR7: Login

Description	User authentication to determine user's privileges in the system.
Input	username,password
Action	Checks if the data entered is present in the system's database records .
Output	Webpage with the user(Security officials) privileges and a confirmation message for the sucessful login.
Pre-condition	At least one user Record is stored in the system.
Post-condition	the Security official web page.
Dependencies	FR6

Table 9: FR8: Analyze data

Description	System starts to analyze the raw data entered in the database to extract the regular patterns and the anomalies if present from the data.
Input	Data format that is compatible with the system(X,Y coordinates,Time of each record-car type , car id).
Action	system retrieve the data from the database and start analyzing it with traclus cluster technique.
Output	frame containing the regular traffic patterns and anomalies if detected.
Pre-condition	Raw data in the database (not analyzed).
Post-condition	analyzed data is stored in the database records.
Dependencies	None

Table 10: FR9: Draw trajectory

Description	Sytem start to draw connected lines that represent the path of every car
Input	X , Y coordinates
Action	Draw Lines between the points which share the same trajectory ID within entered time interval.
Output	Trajectory will be drawn
Pre-condition	Dataset contains at least one trajectory.
Post-condition	trajectories will be rendered in one of the views.
Dependencies	FR8

Table 11: FR10: Trajectory partitioning

Description	Apply spatial partitioning on trajectory data.
Input	Single Trajectory or a set of Trajectories.
Action	Convert raw trajectory data to signature vectors.
Output	a set of representative signature vectors is built for the raw trajectories to facilitate clustering and reduce data size.
Pre-condition	at least one trajectory is entered
Post-condition	line signatures will be ready for clustering and are stored in the database for later use.
Dependencies	FR9

Table 12: FR11: Clustering line signatures

Description	Grouping line signatures with similar characteristics.
Input	adjacency matrix for distances between line signatures (Min lines)
Action	Grouping of similar Line signatures with similar properties and group them in one cluster
Output	a highlighted group of line segments.
Pre-condition	trajectories must be converted to line signatures and their coordinates stored in database.
Post-condition	cluster is generated and stored in the database records.
Dependencies	FR10

Table 13: FR12: View Anomalies

Description	a Button to view all the anomalies present in the database records.
Input	None
Action	System retrieve the anomalies recorded in the database.
Output	frame containing all the anomalies detected by the system.
Pre-condition	At least one anomaly is present in the database.
Post-condition	Anomalies are viewed to the user.
Dependencies	FR11

Table 14: FR13: View statistics

Description	Button that view the statistics for an abnormal action in an specific place over the (year, month, week or day)
Input	None
Action	System draw statistics on the screen based on the data retrived from the data base records.
Output	frame containing statistics of the past year, month, week or day.
Pre-condition	none
Post-condition	Statistics are stored in the database records.
Dependencies	FR11

4 Interface Requirements

Escort will show the results of post processing on screens in security rooms Also, Escort will show a patterns of Trajectories and clusters of Usual behaviors and unusual behaviors of trajectory patterns.

4.1 User Interfaces

4.1.1 GUI

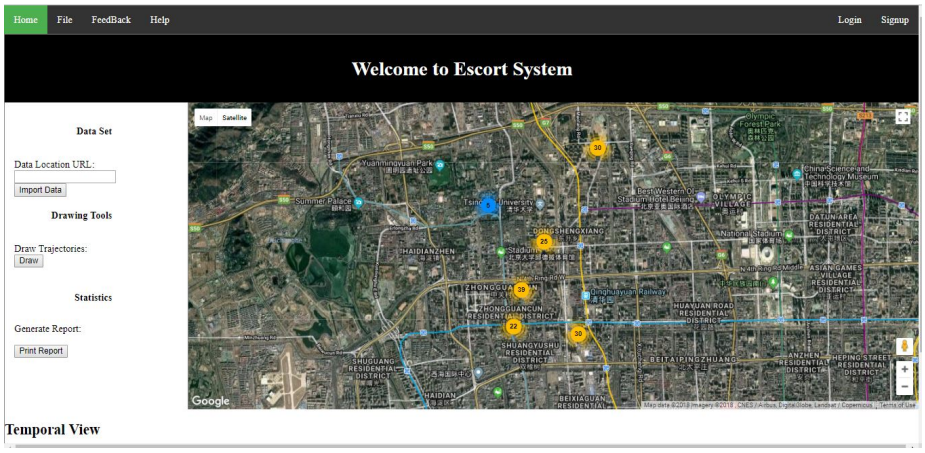

Figure 2: .

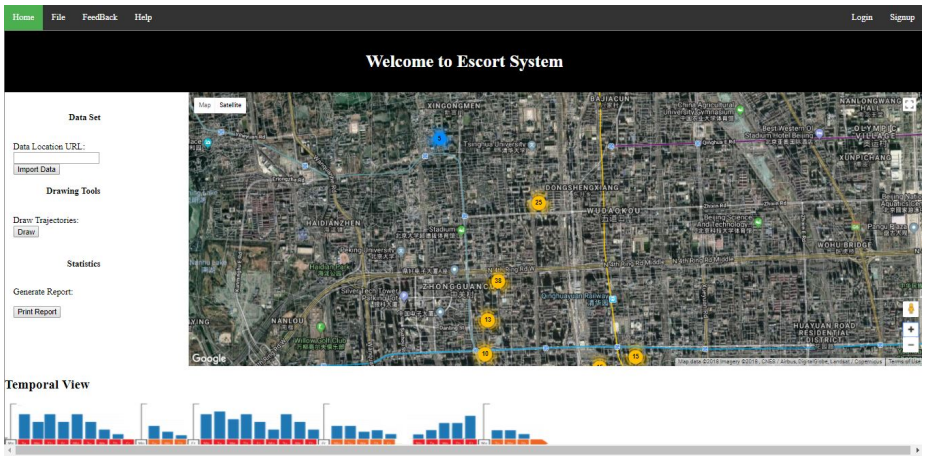

Figure 3: .

The System is CMV model of web-based, have three views of Aggregate view, Time view and Trajectory view, The system also include a Dashboard on the left of the home page to let the user select what the system should display on the other screens.

4.1.2 CLI

N/A.

4.1.3 API

Google Maps API

4.1.4 Diagnostics or ROM

N/A

4.2 Hardware Interfaces

N/A

4.3 Communications Interfaces

Escort must run on connected device with Internet.

4.4 Software Interfaces

4.4.1 GUI

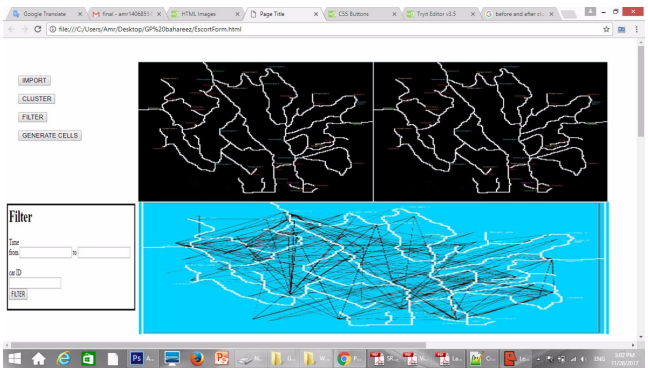

Figure 4: .

5 Performance Requirements

Data would be sent to server every 0.6 seconds

5.1 Hardware Limitations

Escort system is not required special Hardware options as it is a web based application and all the process is on server-site

6 Other Non-Functional Attributes

6.1 Security

The raw data of detected cars should be secured and personal information of the user (Security guards, Business intelligent analyst) such as (user name, password, ID, phone number...) all of these must be protected by the Encryption function in the class diagram in class security; that this function will take the string of password and all personal information of the user. Also Data transfer or information transmission should be securely transferred and received without any changes.

6.2 Performance and Speed

Escort must be fast and be without delays. Because in every action of Escort, there will be no delays occurring. Data view such as the trajectories of cars needs to be viewed with very high speed, partitioning, also the clustering must be done without delaying, And it will done by reducing the complexity of the code to be very simple and work in parallel.

6.3 Reliability

Escort must be reliable in its operation. Significantly this would be appears in the detection and classification of the normal and abnormal patterns. When Escort detects a behavior it will be classified, so it is necessary for the classifier to identify the behavior type correctly without errors. And it will appear in the class diagram in the Class data that the user will import his own data to work in both the privies data and the new data which entered by the user. By this way the user will be able to trust that Escort cant fail in the representative trajectory of the system.

6.4 Portability

Escort has the ability to run on a variety of computers. All Escort operations and methods (collecting data, drawing trajectories, partitioning, grouping and clustering) does not depend on a particular type of hardware. As Escort use multiple of languages combined in HTML language to be easily change the sizes when it opened on different platforms. So Escort will be easy to deploy on multiple platforms.

7 Preliminary Object-Oriented Domain Analysis

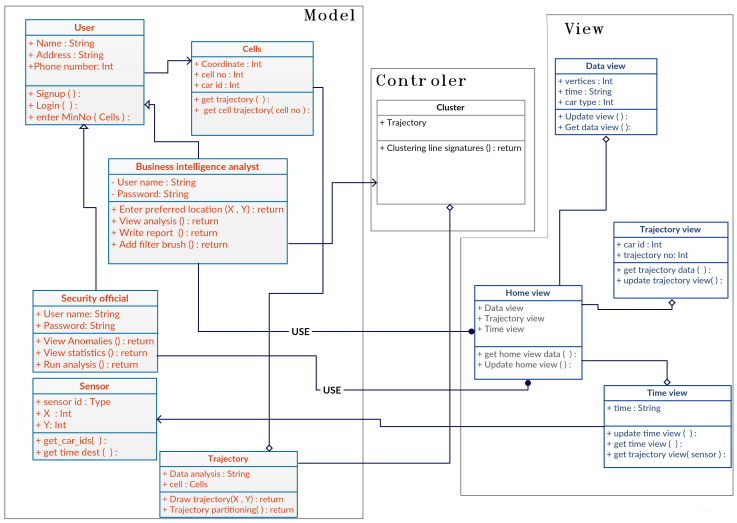

Figure 5: .

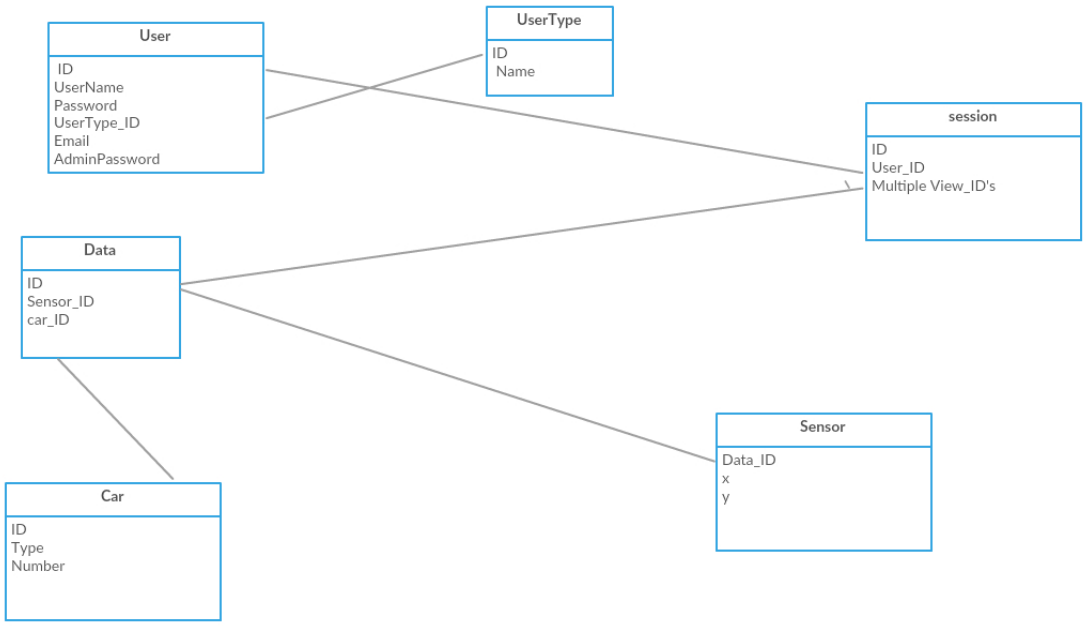

Figure 6: .

7.1 Inheritance Relationships

Business Intelligence and Security Official are inhere from User Class.
Business Intelligence is assisted by Cluster class, Trajectory View.
Security Official is assisted by Data View, and aggregate with Trajectory class.
Trajectory is Aggregate with Custer, Sensor.
Sensor is aggregate by Cell, Trajectory.

7.2 Class descriptions

7.2.1 Classes name

Concrete: User
Concrete: Security Official
Concrete: Business Intelligence Analyst
Concrete: Sensor
Concrete: Cell
Concrete: Trajectory
Concrete: Cluster
Concrete: View Signup
Concrete: View Login
Concrete: View HomePage
Concrete: TimeView

Concrete: View Trajectory
Concrete: Data View

7.2.2 Purpose:

User: Handles the Login and Signup classes of the BI and Security official.
Security Official: Handle the Security Official tasks.
Business Intelligence Analyst: Handle the Business Intelligence tasks.
Sensor: Handle the data of this place of sensor.
Cell: It is handles the cells of all trajectories.
Trajectory: It is handles the car trajectory.
Cluster: It handle the clusters of Trajectories.
View Signup: Handles the form of Signup.
View Login: Handles the form of Login.
View HomePage: Handles the form of Home Page of the BI and the Security Official.
TimeView: Handles the part of the home view of Time View.
View Trajectory: Handles the part of the home view of Trajectories View.
Data View: Handles the part of the home view of Data View.

7.2.3 Collaborations:

Inheritance: User and BI and Security Official.
Aggregation: Sensor aand Cells, Trajectory, Cell and Trajectory.
Assosiation: BI and Cluster, Security Official and data view.
Also the relation between Model and view and Controller.

7.2.4 Attributes:

User: BI or Security Official user.
Security Official, Business Intelligence Analyst, View Signup, View Login: Username and Password.
Sensor, Cell: Row data.
View HomePage: Login or Signup.
Trajectory, Cluster, TimeView, View Trajectory, Data View: Request for preview.

7.2.5 Operations

: Lists each operation that can be invoked upon instances of this class. For each operation, the arguments (and their type), the return value (and its type), and any side effects of the operation should be specified.

8 Operational Scenarios

This section should describe a set of scenarios that illustrate, from the user's perspective, what will be experienced when utilizing the system under various situations. In the article Inquiry-Based Requirements Analysis (IEEE Software, March 1994), scenarios are defined as follows: In the broad sense, a scenario is simply a proposed specific use of the system. More specifically, a scenario is a description of one or more end-to-end transactions involving the required system and its environment. Scenarios can be documented in different ways, depending up on the level of detail needed. The simplest form is a use case, which consists merely of a short description with a number attached. More detailed forms are called scripts. These are usually represented as tables or diagrams and involved identifying an action and the agent (doer) of the action. For this reason, a script can also be called an action table. Although scenarios are useful in acquiring and validating requirements, they are not themselves requirements, because the describe the system's behavior only in specific situations; a specification, on the other hand, describes what the system should do in general.

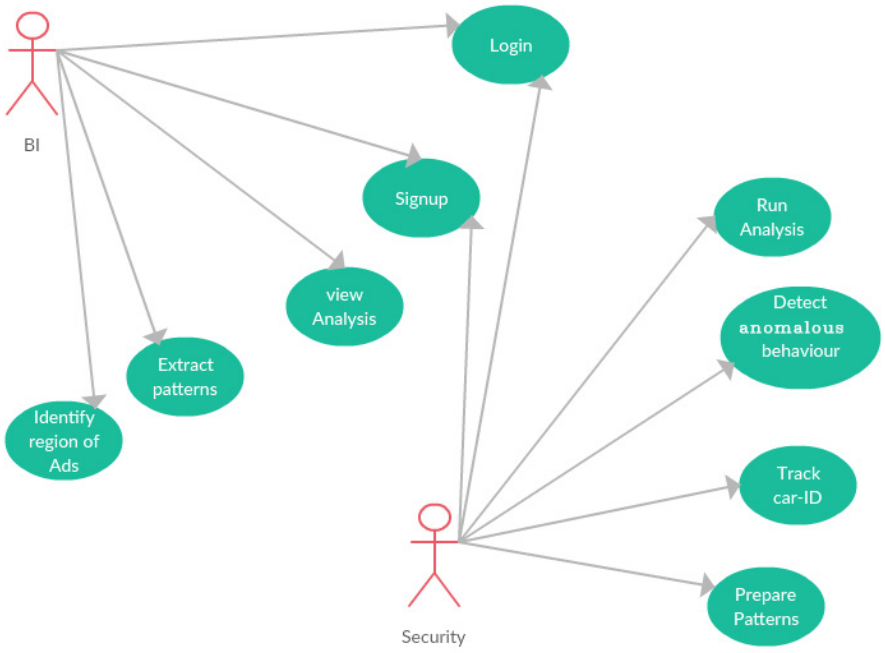
BI
Login
Signup
view Analysis
Extract patterns
Identify region of Ads
Run Analysis
Detect anomalous behaviour
Track car-ID
Prepare Patterns
Security

Figure 7: .

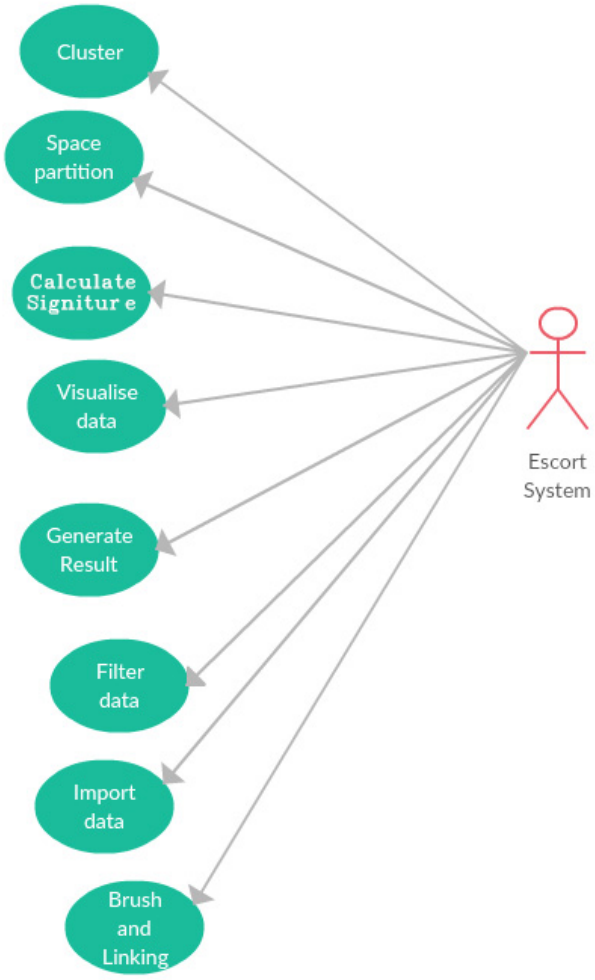
Cluster
Space partition
Calculate Signitur e
Visualise data
Generate Result
Filter data
Import data
Brush and Linking
Escort System

Figure 8: .

9 Preliminary Schedule Adjusted

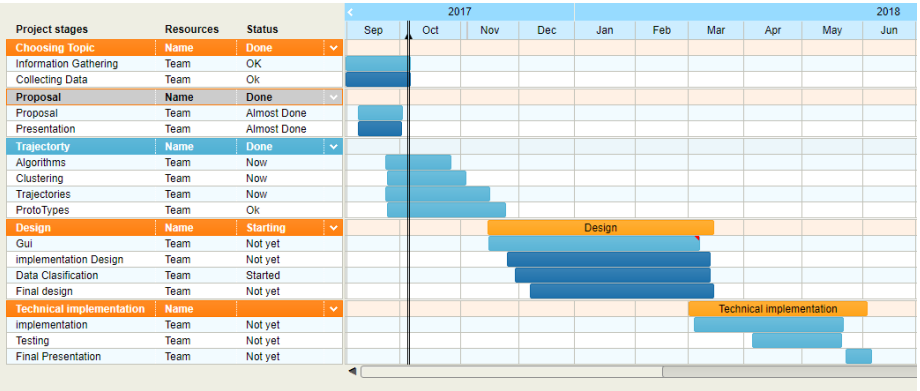

Figure 9: .

10 Preliminary Budget Adjusted

N/A

11 Appendices

11.1 Definitions, Acronyms, Abbreviations

1-PHP : Personal Home Page.
2-HTML: Hyper Text Markup Language.
3-FR : Functional Requirement.

11.2 Collected material

A ready made dataset from a similar system(vast Challenge 2017)

12 References

1- **http://vacommunity.org/VAST+Challenge+2017+MC1**

2- **http://www.mcs.anl.gov/papers/P5498-1215.pdf**

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4- **http://www.diva-portal.org/smash/get/diva2:440646/FULLTEXT02.pdf**

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