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Anh Luong

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ClosetStylist: An Android app to manage closet and programmatically pick out the outfit

**APPROVED BY**

**SUPERVISING COMMITTEE:**

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ClosetStylist: An Android app to manage closet and programmatically pick out the outfit

by

Anh Luong, B.S.E.E.

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Report

Presented to the Faculty of the Graduate School of

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in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Engineering

HIDDEN TEXT: The degree sought must be worded in the form given in the Graduate Catalog, such as Doctor of Philosophy, Doctor of Musical Arts, Doctor of Education.

The University of Texas at Austin

May 2014

Dedication

To my parents and my wife.

Acknowledgements

First of all, I would like to thank all of my professors and teachers who have given me invaluable knowledge I have today. Especially, I would like to express my gratitude to my supervisor, Professor Adnan Aziz, who has offered guidance on the iTrak project, and to my reader Thangavel Subbu. I would also like to thank the friends I traveled with, who gave me the inspiration for iTrak. Most importantly, I want to thank my parents and my sister for all the hard work and sacrifices they have made to unconditionally support me with my studies.

ClosetStylist: An Android app to manage closet and programmatically pickout the outfit

Anh Luong, M.S.E.

The University of Texas at Austin, 2013

Supervisor: Adnan Aziz

iTrak is a combined mobile and web application that takes advantage of the GPS to allow travelers to share their experience while travelling. The application gathers GPS data and broadcasts it via a web interface or social networks such as Facebook to update user’s status during a trip. iTrak is also equipped with other features such as writing notes or recording video journals to offer a rich experience and provide an interactive diary, along with a real-time tracking ability, for travelers.

## 

## Chapter 1 Introduction

### Motivation

Wardrobe stylists are often hired by celebrities, models, public figures, or rich people to select their clothing for public appearances or by professionals in entertainment industry. Their services usually deem too expensive for majority. Most people love fashion and love to look fashionable, but not many people can afford these expensive types of services. Without the right taste of the stylists who can advise the right style for their clients, many people end up wearing badly and present themselves the wrong way. It would it be great if there is an app that can help us avoiding those awkward moments.

Another point is that spending a lot of money on clothes does not necessary make people look cool every day, nor many people have a lot of money to spend on clothes. How do we get the most out of our current closet? Hundreds of billions have been spent on clothes every year, but many of the clothes end up lost in our closets. How do we organize all the items in our closets? How do we mix match them wisely to utilize all items in our wardrobe without breaking our bank account for expensive consultation from costly stylists? Another often asked question is how do we monitor our laundry bag to avoid running out of clothes? Somebody does not have a washing machine at home and doing laundry will take several hours waiting in the Laundromat (if we don’t want to pay some extra bucks to have it done and folded, but we don’t know how careful the assistant would be to our clothes).

Another problem that I usually face myself is waking up in the morning, rushing to put on some clothes that you feel like or worse the first one I find in my closet. When I open the door, suddenly I realize the outfit I chose several minutes ago is either too hot or too cold because I forgot to check the weather when picking the outfit. The problem was I chose my outfit when I was inside my house with air condition on. At that time, I wish there is an app telling me what I should wear based on the weather at my location. Our lives are hurry, and our morning are usually busy to prepare ourselves for a working day, an app like this is really helpful.

### Vision

ClosetStylist is an Android app developed to address problems above. Its core functionalities includes assist women and men to pick the right outfit from their closets; organize their closet, manage their laundry bags, and keep track of their outfit history. The ultimate goal is to get the most fashion value for customers’ dollar by helping them to control their closets.

### Report organization

This report is organized as followings: chapter 1 provides an Introduction, chapter 2 discusses the user interface including mockups and workflow of the app, chapter 3 reviews the technology stack used in the app, chapter 3 describes the results and pain points, chapter 5 ends the report with summary, related and future work.

## Chapter 2 User Interface Design

### 2.1 Overview

In this section, we explain the user interface design by first providing some typical user stories guiding how users are going to use this app. We then describe in detail some use cases to clarify the UI/UX flow for the main features of the app. We end this section with some mockups to show the look and feel of the app.

### 2.2 User Stories

The below stories highlights some features that ClosetStylist has achieved:

* Users can easily flip through every item in their own clothing inventory.
* Users can find out how many dirty items are there to schedule for laundry.
* Users can go through their outfit history and look for what apparels they wore on any date in the past.
* Users can choose any outfits that the app has picked from their closets and programmatically recommended based on the weather at the current location.

### 2.3 Use Cases

[Amb] has illustrated an effective methodology to effectively model and document the structures and behavior of software projects. The use cases presented in this section followed this Agile modeling approach to depict the interaction between user and the ClosetStylist app. Each use case consists of a UML activity diagram between two actors - the user and the ClosetStylist Android app, a precondition that must be satisfied before starting this case, a purpose (or result) of this use case which describes the achievement after following the procedure, and the steps to achieve this result.

#### 2.3.1 Register



Figure 2.1: Register diagram

**The precondition**: ClosetStylist has already been installed on the device under test.

**The purpose**: show how the user can register an account to use the app the very first time and how to populate all the required fields.

**The steps**: the app has its own simple authenticating method to validate, independent of any social networks, so that the users can still use the app if they choose to not enable any social network feature. When this is the very first time the app is launched, users have to click on the “Don’t have account – register here” and fill in the required fields, one of which is the postal code. This field is mentioned here because it is treated as the default location that the app will use if there is failure in obtaining the current location. If users do not know their current zipcode, they can click on “Get Location” and the app will find the zip code based on the current location. Once the users have filled in all the required fields, they can click on the “Register” button to log in to the app. The users’ information is also persisted to the database so that users can login the next time without repeating the registration step.

#### 2.3.2 Login



Figure 2.2: Login diagram

**The precondition**: users have already registered.

**The purpose**: users have to enter username and password to login after registration step.

**The steps**: users launch the app and enter their credentials. The app will navigate to the main screen where users find helpful information such as the current location, date, weather, and they can to proceed to any of the four main pages: Outfit of the day, My Closet, My Laundry Bag, My Outfit History.

#### 2.3.3 Add new item



Figure 2.3: Add new item diagram

**The precondition**: users are logged in.

**The purpose**: users have to populate their closets with their clothes pictures taken by built-in camera so that the app can programmatically pick out the outfit for any day.

**The steps**: From the main screen, users click on “My Closet”. In the bottom of the My Closet page, there is “ADD ITEM” button. After filling in the required fields, users can take picture of the clothes by clicking on the camera icon. Once saved, users can crop the newly taken picture to get rid of the unnecessary parts. Users can choose either Reset all the fields or Save it. Clicking on “Save” button will save the detail of this item while clicking on “Reset” button will reset all the fields to the default values.

#### 2.3.4 View or edit an item



Figure 2.4: View or edit item diagram

**The precondition**: the item has been added to the closet.

**The purpose**: users can view the detail of an item and update the information if needed.

**The steps**: From the main screen, users click on “My Closet”. The wardrobe is categorized as “Outer”, “Top”, and “Bottom”. Users choose the tab that the wardrobe belongs to and click on the items they want to see. They can choose to change any of the fields, and can even mark an item is dirty to be sent to laundry.

#### 2.3.5 Pick an outfit

Figure 2.5: Pick an outfit diagram

**The precondition**: “My Closet” has been populated with some items in both Top and Bottom.

**The purpose**: the app suggests a list of outfits that best fit the user based on the weather and the occasion.

**The steps**: From the main screen, users click on “Outfit of the Day”. The app will display a list of suggested outfits based on the current weather and the Occasion set to “Casual”. There are 5 options for Occasion – “Formal”, “Semi\_Formal”, “Casual”, “Day\_Out”, “Night\_Out” and users can choose the appropriate Occasion. There are arrows to switch to another Top or Bottom. There are double-arrows to let the user traverse through the list of suggested outfits. Once the users decide to choose a particular outfit, they can click on the “WEAR” button at the bottom and they will be navigated to the “My Outfit History” page.

#### 2.3.6 View outfit history



Figure 2.6: View outfit history diagram

**The precondition**: users have already chosen to wear some outfits.

**The purpose**: the app displays the outfits that users have already worn on any particular day.

**The steps**: from the main screen, users click on “My Outfit History”. The page displays the outfits that users have worn on a particular day, starting from today. If users have worn several outfits on the same day, all of them will be listed in chronological order, starting with the one worn earliest on that day. User can click on any of them and they will be navigated to the “Outfit Preview” to see a more detail picture of the outfit.

#### 2.3.7 Laundry bag

Figure 2.7: Laundry bag diagram

**The precondition**: users have already chosen to wear some outfits.

**The purpose**: the app displays the dirty items so that the users can schedule to wash them.

**The steps**: from the main screen, users click on “My Laundry Bag”. The page will display all the dirty items as a list. Users can click on any of them to view more detail.

### 2.4 Mockups

Balsamiq [Bal] was initially used to create mockups as it was user friendly and its online version was free for students. Bellows is an example of original screens:



Figure 2.8: Balsamiq user login mockups.

As the development continued, some limitations of Balsamiq such as the limitations of Android UI elements and difficulty in sharing feedbacks showed up. We turned to InVision App [Inv], an extremely powerful design tool to create a fully interactive prototypes and wireframes, as well as collaborate to share vision and gain feedbacks from all stakeholders. All of the mockups from InVision App will be illustrated in the following section together with a storyboard created to help visualize the workflow of the app.

#### 2.4.1 Registration and Login

|  |  |
| --- | --- |
|  |  |

Figure 2.9: User login and registration mockups.

To begin with, the new user will register with the app their username, password, default location. After registration is done, the user can login and logout of the app.

#### 2.4.2 Main Screen and Side Menu

Figure 2.10: Main Screen and Side Menu mockups.

After registration for the first time and after login afterwards, users will be navigated to the main screen in Figure 2.10 which displays useful information about the current location, date, temperature. It also provides options to navigate to the main features of the app such as suggesting Outfit of the Day, organizing My Closet, managing Laundry bag, or viewing My Outfit History.

To make navigation between screens in the app easier, user can take advantage of the provided a side menu (or drawer as Android term).

#### 2.4.3 My Closet and Add Item

Figure 2.10: My Closet and Add Item mockups.

In order to use the app, user needs to import photos of clothes from the smartphone’s built-in camera and enter additional information about the items. Each item will be categorized as either top or bottom, together with its corresponding styles, materials, color.

After the item is saved in the closet, user can also edit or delete the item from the closet. Once the closet is fully populated with all the items, my closet should look like the mockup in figure 2.10.

#### 2.4.4 Outfit of the Day and Laundry bag

Figure 2.11: Outfit of the Day and Outfit Preview mockups.

When the user is ready to pick the outfit, he/she can navigate to the Outfit of the Day shown in Figure 2.11 and find the list of suggested outfits based on today’s weather and the occasion. The selection algorithm ranks different outfits (combination of top, bottom, and may be outer if the weather is cold). User can choose among different occasions including formal, semi-formal, casual, day-out, night-out and different outfits will be recommended. A mix match option is also provided through the arrows next to top and bottom if user wants a different piece in the recommended outfit. User can move back and forth between suggested outfits by pressing double arrows at the bottom of the screen.

User decides to wear the outfit by clicking on the “Wear” button, and items will be processed to be dirty and placed in laundry bag based on its style and material as shown in Figure 2.11. The reason for processing an item instead of moving it to the laundry bag right away because there are certain pieces of clothes that we can wear more than one times such as jackets or jeans.

#### 2.4.5 Outfit History and Outfit Preview

Figure 2.12: Outfit History and Outfit Preview mockups.

When the user clicks on the “Wear” button as described in the previous section, the app will take the user to the Outfit History screen which lists all the outfits have been chosen today and before as in Figure 2.12. This screen can also be accessed from the main screen or the side menu.

Once the user is in the Outfit History screen, outfit worn today is shown first and if there is more than one outfit, they will be displayed in chronicle order. User can find what he/she wore on any day in the past by moving to the tab for that day, clicking on an outfit entry in the list, and the outfit will be displayed in the Outfit Preview screen as in Figure 2.12.

## Chapter 3 Implementation

### 3.1 Technology stack

ClosetStylist is an Android app and hence Java is used as the main programming language. Table 3.1 below shows a summary of my development environment.

|  |  |
| --- | --- |
| Language | Java |
| IDE | Eclipse Juno 4.2, Kepler 4.3 |
| Additional code editor | GVIM |
| SDKs | JDK 1.6, Android 2.3.3, Facebook 3.0, JSON |
| Test equipment | Samsung S3 |
| System | Windows 7 64-bit, Ubuntu 12.04 32-bit, Ubuntu 12.10 64-bit. |

Table 3.1: Development environment.

The app was initially development on a powerful laptop with Intel i7-3720 2.6GHz, 16GB RAM, Windows 64-bit to run on the Android simulator. When I needed to run the app on real Samsung S3 device, the development was moved to a laptop with Intel Core 2 duo, 4GB RAM, Ubuntu 12.10 32-bit, and a desktop with AMD Quad-Core, 16GB RAM, Ubuntu 12.04 64-bit.

In addition to the development environment, several technologies have been applied in this app, some are open source while some are proprietary. We describe each of the main technologies next and the reason why we choose them over the others and how do we deploy them.

#### 3.1.1 Location Service

In this app, GeoNames database was used as a service to convert between postal code and the geographic coordinates (the longitude and latitude) of a location. Geonames has been chosen over Yahoo service (Yahoo BOSS PlaceFinder) because it was free and Yahoo service used proprietary WOEID (Where On Earth Identification number). Besides, the later was subject to change from Yahoo and would cause problem later if we want to switch to another service later.

Geonames provided a lot of services in many formats such as XML, JSON, etc. In this app, we employed the service that converted geographic coordinates to postal code (and then city and country) and vice versa through the followings URLs: <http://api.geonames.org/postalCodeSearchJSON?postalcode=78758&maxRows=10&username=demo> , <http://api.geonames.org/findNearbyPostalCodes?lat=30.4883997&lng=-97.7175117&username=demo>. The response was in JSON format and our tasks were collecting and parsing the response, then displaying it in the main screen of the app.

#### 3.1.2 Weather Service

We looked at several weather services including Yahoo Weather, World Weather Online, Open Weather Map. [SWA] provided the sample code to retrieve weather information from Open Weather Map and made it an ideal choice for our weather service. The weather response consisted of a lot of information including but not limiting to geographic coordinates, temperatures, humidity, pressure, wind, rain. As of this writing, only a subset of this was used including geographic coordinates, temperatures, and rain.

#### 3.1.3 Clothes Matching Service

This smart service is our proprietary methodology to provide suggestions on which wardrobe users should put on based on the available items in their closets, the current weather information, and the occasion of the event, and gender.

##### 3.1.3.1 High-level design



Figure 3.1: 5-step clothes matching algorithm.

There are five steps to create the list of suggested outfits. Each step is an essential part of the algorithm and must be executed in the same order described in Figure 3.1. The inputs to the algorithm are all of the factors mentioned above and the output is a list of outfit in descending order of score. Each outfit consists of a top, bottom, and an optional outer if the temperature is low. While the first two steps are used to obtain a valid set of items to work on, the last 3 steps are used to score points for each outfit based on several factors. An overview of each step is given below.

Laundry Filter: eliminate dirty items out of the process.

Temperature Filter: eliminate items that do not cover the range of today’s maximum temperature and minimum temperature of the current location.

Occasion Matching: each item is given a score for the chosen occasion. For example, a short will be graded low for the “Formal” occasion but it will get a high point in the “Day\_Out” occasion.

Pair Matching: each combination of a top item with a bottom item (and optionally an outer) will be scored based on its category. This point is added together with the point of each item in the previous step to the outfit.

Color Matching: the color combination of the top, the bottom, and the outer of the outfit will be given a score. This is added to the points from the previous steps to produce the final score. The result is a list of outfits in the order of descending points.

##### 3.1.3.2 Low-level design: need more detail on the different lists created in each stage

###### 3.1.3.2.1 Laundry Filter

This step is pretty simple, given that each item has a “dirty” attribute to specify an item is clean or dirty. The implementation can simply query the database of clothes in the closet and return a list of clean items.

###### 3.1.3.2.2 Temperature Filter

Each item is assigned a range of temperature in which it can be worn. Among different attributes of an item, material and style are the two that we think the temperature can be based on. After consideration, style was chosen over material because it is more related to temperature. The rationale of this choice is that if an item of a specific material does not keep the keep warm enough, then another item of the same material can still be worn outside. Regarding style, once a particular style is chosen, it is more difficult to match with another style to keep warm.

Below is the look-up table we use to define the range of each style per gender.

|  |  |  |
| --- | --- | --- |
| **Style - Men** | Temp Min | Temp Max |
| Pants | -999 | 999 |
| Jeans | -999 | 999 |
| Shorts | -999 | 999 |
| Dress\_Shirt | -999 | 999 |
| Casual\_Button\_Down\_Shirt | -999 | 999 |
| Polo | -999 | 999 |
| T\_Shirt\_Short\_Sleeve | -999 | 999 |
| T\_Shirt\_Long\_Sleeve | -999 | 999 |
| Sweater\_And\_Sweatshirt | -999 | 999 |
| Coat\_And\_Jacket\_Light | -999 | 75 |
| Coat\_And\_Jacket\_Heavy | -999 | 40 |
| **Style - Women** | Temp Min | Temp Max |
| Pants | -999 | 999 |
| Jeans | -999 | 999 |
| Legging\_Skinny | -999 | 999 |
| Shorts | -999 | 999 |
| Skirts | -999 | 999 |
| Collared\_And\_Button\_Down | -999 | 999 |
| Blouse\_Short\_Sleeve | -999 | 999 |
| Blouse\_Long\_Sleeve | -999 | 999 |
| Blouse\_Sleeveless | -999 | 999 |
| T\_Shirt\_Long\_Sleeve | -999 | 999 |
| T\_Shirt\_Short\_Sleeve | -999 | 999 |
| Tank\_Camisoles | -999 | 999 |
| Party\_Top | -999 | 999 |
| Tunic | -999 | 999 |
| Pull\_Over | -999 | 999 |
| Cardigan | -999 | 999 |
| Sweater\_And\_Sweatshirt | -999 | 999 |
| Vest | -999 | 999 |
| Coat\_And\_Jacket\_Light | -999 | 75 |
| Coat\_And\_Jacket\_Heavy | -999 | 40 |

###### 3.1.3.2.3 Occasion Matching

Each item is given different point based on gender, category, style, and occasion. In this step, the score has higher weight than pair and color matching steps because occasion matching more important to the final outfit in our opinions.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Point | | | | |
| **Category** | **Style** | **Formal** | **Semi\_Formal** | **Casual** | **Day\_Out** | **Night\_Out** |
| Bottom | Pants | 40 | 40 | 5 | 0 | 20 |
| Bottom | Jeans | 5 | 20 | 40 | 20 | 40 |
| Bottom | Shorts | 0 | 0 | 20 | 40 | 0 |
| Top | Dress\_Shirt | 40 | 40 | 5 | 0 | 5 |
| Top | Casual\_Button\_Down\_Shirt | 5 | 20 | 20 | 20 | 40 |
| Top | Polo | 5 | 20 | 40 | 5 | 20 |
| Top | T\_Shirt\_Short\_Sleeve | 0 | 0 | 20 | 40 | 5 |
| Top | T\_Shirt\_Long\_Sleeve | 0 | 5 | 20 | 5 | 20 |
| Top | Sweater\_And\_Sweatshirt | 0 | 5 | 20 | 20 | 5 |
| Top | Coat\_And\_Jacket\_Light | 40 | 40 | 5 | 0 | 20 |
| Top | Coat\_And\_Jacket\_Heavy | 5 | 5 | 5 | 5 | 20 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | Point | | | | |
| **Category** | **Style** | **Formal** | **Semi\_Formal** | **Casual** | **Day\_Out** | **Night\_Out** |
| Bottom | Pants | 40 | 40 | 5 | 0 | 20 |
| Bottom | Jeans | 5 | 20 | 40 | 20 | 20 |
| Bottom | Legging\_Skinny | 0 | 5 | 20 | 20 | 40 |
| Bottom | Shorts | 0 | 0 | 5 | 40 | 5 |
| Bottom | Skirts | 5 | 20 | 20 | 20 | 20 |
| Top | Collared\_And\_Button\_Down | 40 | 20 | 0 | 0 | 5 |
| Top | Blouse\_Short\_Sleeve | 20 | 40 | 20 | 20 | 20 |
| Top | Blouse\_Long\_Sleeve | 40 | 40 | 5 | 5 | 20 |
| Top | Blouse\_Sleeveless | 5 | 20 | 20 | 40 | 20 |
| Top | T\_Shirt\_Long\_Sleeve | 5 | 20 | 40 | 5 | 5 |
| Top | T\_Shirt\_Short\_Sleeve | 0 | 5 | 40 | 40 | 5 |
| Top | Tank\_Camisoles | 0 | 0 | 5 | 40 | 20 |
| Top | Party\_Top | 0 | 0 | 5 | 20 | 40 |
| Top | Tunic | 0 | 5 | 20 | 20 | 20 |
| Top | Pull\_Over | 0 | 0 | 20 | 20 | 0 |
| Top | Sweater\_And\_Sweatshirt | 20 | 20 | 5 | 5 | 20 |
| Top | Coat\_And\_Jacket\_Light | 40 | 20 | 0 | 0 | 20 |
| Top | Cardigan | 40 | 40 | 20 | 5 | 20 |
| Top | Vest | 40 | 20 | 5 | 0 | 20 |
| Top | Coat\_And\_Jacket\_Heavy | 5 | 5 | 5 | 5 | 20 |

###### 3.1.3.2.4 Pair matching

Similar to previous steps, we create a big look-up table for each combination of a top item and a bottom item, and optionally an outer based on the weather, gender. One thing to notice here is the point is smaller than the occasion matching step because this step is not as important as that one.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Bottom** | **Top** | **Mild Weather Outer** | **Cold Weather Outer** |  | **Bottom** | **Top** | **Point** | **Outer** |
| Pants | Dress\_Shirt | Sweater\_And\_Sweatshirt | Coat\_And\_Jacket\_Heavy |  | Pants | Dress\_Shirt | 20 | No |
| Jeans | Casual\_Button\_Down\_Shirt | Coat\_And\_Jacket\_Light | (temp range <40) |  | Pants | Casual\_Button\_Down\_Shirt | 5 | No |
| Shorts | Polo | (temp range <70) |  |  | Pants | Polo | 20 | No |
|  | T\_Shirt\_Short\_Sleeve |  |  |  | Jeans | Casual\_Button\_Down\_Shirt | 5 | No |
|  | T\_Shirt\_Long\_Sleeve |  |  |  | Jeans | Polo | 16 | No |
|  |  |  |  |  | Jeans | T\_Shirt\_Short\_Sleeve | 20 | No |
|  |  |  |  |  | Jeans | T\_Shirt\_Long\_Sleeve | 20 | No |
|  |  |  |  |  | Shorts | Casual\_Button\_Down\_Shirt | 6 | No |
|  |  |  |  |  | Shorts | Polo | 6 | No |
|  |  |  |  |  | Shorts | T\_Shirt\_Short\_Sleeve | 20 | No |
|  |  |  |  |  | Shorts | T\_Shirt\_Long\_Sleeve | 5 | No |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Bottom** | **Top** | **Outer** | **Cold Weather Outer** |  | **Bottom** | **Top** | **Point** | **Outer** |
| Pants | Collared\_And\_Button\_Down | Cardigan | Coat\_And\_Jacket\_Heavy |  | Pants | Collared\_And\_Button\_Down | 20 | No |
| Jeans | Blouse\_Short\_Sleeve | Sweater\_And\_Sweatshirt | (temp range <40) |  | Pants | Blouse\_Short\_Sleeve | 16 | No |
| Legging\_Skinny | Blouse\_Long\_Sleeve | Vest |  |  | Pants | Blouse\_Long\_Sleeve | 16 | No |
| Shorts | Blouse\_Sleeveless | Coat\_And\_Jacket\_Light |  |  | Pants | Blouse\_Sleeveless | 16 | Yes |
| Skirts | T\_Shirt\_Long\_Sleeve | (temp range <70) |  |  | Pants | Tank\_Camisoles | 10 | Yes |
|  | T\_Shirt\_Short\_Sleeve |  |  |  | Pants | Party\_Top | 10 | No |
|  | Tank\_Camisoles |  |  |  | Jeans | Blouse\_Short\_Sleeve | 10 | Yes |
|  | Party\_Top |  |  |  | Jeans | Blouse\_Long\_Sleeve | 10 | No |
|  | Tunic |  |  |  | Jeans | Blouse\_Sleeveless | 10 | Yes |
|  | Pull\_Over |  |  |  | Jeans | T\_Shirt\_Long\_Sleeve | 20 | No |
|  |  |  |  |  | Jeans | T\_Shirt\_Short\_Sleeve | 20 | No |
|  |  |  |  |  | Jeans | Tank\_Camisoles | 16 | Yes |
|  |  |  |  |  | Jeans | Party\_Top | 16 | No |
|  |  |  |  |  | Jeans | Pull\_Over | 16 | No |
|  |  |  |  |  | Legging\_Skinny | Blouse\_Short\_Sleeve | 10 | No |
|  |  |  |  |  | Legging\_Skinny | Blouse\_Long\_Sleeve | 10 | No |
|  |  |  |  |  | Legging\_Skinny | Blouse\_Sleeveless | 10 | Yes |
|  |  |  |  |  | Legging\_Skinny | T\_Shirt\_Long\_Sleeve | 6 | No |
|  |  |  |  |  | Legging\_Skinny | T\_Shirt\_Short\_Sleeve | 6 | Yes |
|  |  |  |  |  | Legging\_Skinny | Tank\_Camisoles | 6 | Yes |
|  |  |  |  |  | Legging\_Skinny | Party\_Top | 20 | No |
|  |  |  |  |  | Legging\_Skinny | Tunic | 20 | No |
|  |  |  |  |  | Legging\_Skinny | Pull\_Over | 6 | No |
|  |  |  |  |  | Legging\_Skinny | Collared\_And\_Button\_Down | 6 | No |
|  |  |  |  |  | Shorts | Blouse\_Short\_Sleeve | 10 | No |
|  |  |  |  |  | Shorts | Blouse\_Long\_Sleeve | 10 | No |
|  |  |  |  |  | Shorts | Blouse\_Sleeveless | 10 | Yes |
|  |  |  |  |  | Shorts | T\_Shirt\_Long\_Sleeve | 16 | No |
|  |  |  |  |  | Shorts | T\_Shirt\_Short\_Sleeve | 20 | Yes |
|  |  |  |  |  | Shorts | Tank\_Camisoles | 20 | Yes |
|  |  |  |  |  | Shorts | Party\_Top | 6 | No |
|  |  |  |  |  | Shorts | Pull\_Over | 10 | No |
|  |  |  |  |  | Skirts | Collared\_And\_Button\_Down | 10 | No |
|  |  |  |  |  | Skirts | Blouse\_Short\_Sleeve | 20 | No |
|  |  |  |  |  | Skirts | Blouse\_Long\_Sleeve | 16 | No |
|  |  |  |  |  | Skirts | Blouse\_Sleeveless | 20 | Yes |
|  |  |  |  |  | Skirts | T\_Shirt\_Long\_Sleeve | 16 | No |
|  |  |  |  |  | Skirts | T\_Shirt\_Short\_Sleeve | 16 | Yes |
|  |  |  |  |  | Skirts | Tank\_Camisoles | 10 | Yes |
|  |  |  |  |  | Skirts | Party\_Top | 20 | No |
|  |  |  |  |  | Skirts | Pull\_Over | 6 | No |

###### 3.1.3.2.5 Color matching

There are too many colors and it is impossible to list every single color existing. We decide to divide color into twelve basic colors: beige, black, blue, brown, gray, green, orange, pink, red, violet, white, and yellow. Another one is also added for the multicolor or pattern item. Hence, we have a total of 13 colors to deal with. These 13 colors can further be divided into two groups – “Color” and “Neutral”. Some colors can be matched together, while others cannot. Also, “Neutral” colors can be easily matched with other while the “Color” colors are more restricted. These relations are expressed through the points given to each combination of these colors as shown below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Color** | **Group** |  | **Bottom** | **Top** | Point | **Top-Bottom** | **Outer** |
| Blue | Color |  | Beige | Black | 2 | Beige-Black | Color |
| Green | Color |  | Beige | Blue | 4 | Beige-Blue | Any |
| Violet | Color |  | Beige | Brown | 22 | Beige-Brown | Color |
| Red | Color |  | Beige | Gray | 24 | Beige-Gray | Color |
| Yellow | Color |  | Beige | Green | 20 | Beige-Green | Any |
| Orange | Color |  | Beige | Multicolor\_Pattern | 6 | Beige-Multicolor\_Pattern | Neutral |
| Pink | Color |  | Beige | Orange | 10 | Beige-Orange | Any |
| Multicolor\_Pattern | Color |  | Beige | Pink | 8 | Beige-Pink | Any |
| Gray | Neutral |  | Beige | Red | 16 | Beige-Red | Any |
| White | Neutral |  | Beige | Violet | 18 | Beige-Violet | Any |
| Black | Neutral |  | Beige | White | 12 | Beige-White | Color |
| Brown | Neutral |  | Beige | Yellow | 14 | Beige-Yellow | Any |
| Beige | Neutral |  | Black | Beige | 4 | Black-Beige | Color |
|  |  |  | Black | Blue | 6 | Black-Blue | Any |
|  |  |  | Black | Brown | 24 | Black-Brown | Color |
|  |  |  | Black | Gray | 20 | Black-Gray | Color |
|  |  |  | Black | Green | 18 | Black-Green | Any |
|  |  |  | Black | Multicolor\_Pattern | 8 | Black-Multicolor\_Pattern | Neutral |
|  |  |  | Black | Orange | 10 | Black-Orange | Any |
|  |  |  | Black | Pink | 12 | Black-Pink | Any |
|  |  |  | Black | Red | 22 | Black-Red | Any |
|  |  |  | Black | Violet | 14 | Black-Violet | Any |
|  |  |  | Black | White | 2 | Black-White | Color |
|  |  |  | Black | Yellow | 16 | Black-Yellow | Any |
|  |  |  | Blue | Beige | 6 | Blue-Beige | Any |
|  |  |  | Blue | Black | 8 | Blue-Black | Any |
|  |  |  | Blue | Brown | 10 | Blue-Brown | Any |
|  |  |  | Blue | Gray | 12 | Blue-Gray | Any |
|  |  |  | Blue | Orange | 2 | Blue-Orange | Neutral |
|  |  |  | Blue | White | 4 | Blue-White | Any |
|  |  |  | Brown | Beige | 2 | Brown-Beige | Color |
|  |  |  | Brown | Black | 16 | Brown-Black | Color |
|  |  |  | Brown | Blue | 10 | Brown-Blue | Any |
|  |  |  | Brown | Gray | 12 | Brown-Gray | Color |
|  |  |  | Brown | Green | 8 | Brown-Green | Any |
|  |  |  | Brown | Multicolor\_Pattern | 8 | Brown-Multicolor\_Pattern | Neutral |
|  |  |  | Brown | Orange | 10 | Brown-Orange | Any |
|  |  |  | Brown | Pink | 12 | Brown-Pink | Any |
|  |  |  | Brown | Red | 18 | Brown-Red | Any |
|  |  |  | Brown | Violet | 14 | Brown-Violet | Any |
|  |  |  | Brown | White | 4 | Brown-White | Color |
|  |  |  | Brown | Yellow | 6 | Brown-Yellow | Any |
|  |  |  | Gray | Beige | 24 | Gray-Beige | Color |
|  |  |  | Gray | Black | 20 | Gray-Black | Color |
|  |  |  | Gray | Blue | 10 | Gray-Blue | Any |
|  |  |  | Gray | Brown | 18 | Gray-Brown | Color |
|  |  |  | Gray | Green | 12 | Gray-Green | Any |
|  |  |  | Gray | Multicolor\_Pattern | 8 | Gray-Multicolor\_Pattern | Neutral |
|  |  |  | Gray | Orange | 2 | Gray-Orange | Any |
|  |  |  | Gray | Pink | 6 | Gray-Pink | Any |
|  |  |  | Gray | Red | 4 | Gray-Red | Any |
|  |  |  | Gray | Violet | 14 | Gray-Violet | Any |
|  |  |  | Gray | White | 22 | Gray-White | Color |
|  |  |  | Gray | Yellow | 16 | Gray-Yellow | Any |
|  |  |  | Green | Beige | 14 | Green-Beige | Any |
|  |  |  | Green | Black | 12 | Green-Black | Any |
|  |  |  | Green | Brown | 10 | Green-Brown | Any |
|  |  |  | Green | Gray | 8 | Green-Gray | Any |
|  |  |  | Green | White | 6 | Green-White | Any |
|  |  |  | Green | Yellow | 4 | Green-Yellow | Neutral |
|  |  |  | Green | Blue | 2 | Green-Blue | Neutral |
|  |  |  | Multicolor\_Pattern | Beige | 2 | Multicolor\_Pattern-Beige | Neutral |
|  |  |  | Multicolor\_Pattern | Black | 4 | Multicolor\_Pattern-Black | Neutral |
|  |  |  | Multicolor\_Pattern | Brown | 10 | Multicolor\_Pattern-Brown | Neutral |
|  |  |  | Multicolor\_Pattern | Gray | 8 | Multicolor\_Pattern-Gray | Neutral |
|  |  |  | Multicolor\_Pattern | White | 6 | Multicolor\_Pattern-White | Neutral |
|  |  |  | Orange | Beige | 10 | Orange-Beige | Any |
|  |  |  | Orange | Black | 4 | Orange-Black | Any |
|  |  |  | Orange | Blue | 2 | Orange-Blue | Neutral |
|  |  |  | Orange | Brown | 6 | Orange-Brown | Any |
|  |  |  | Orange | Gray | 12 | Orange-Gray | Any |
|  |  |  | Orange | White | 8 | Orange-White | Any |
|  |  |  | Pink | Beige | 6 | Pink-Beige | Any |
|  |  |  | Pink | Black | 2 | Pink-Black | Any |
|  |  |  | Pink | Brown | 4 | Pink-Brown | Any |
|  |  |  | Pink | Gray | 10 | Pink-Gray | Any |
|  |  |  | Pink | White | 8 | Pink-White | Any |
|  |  |  | Red | Beige | 6 | Red-Beige | Any |
|  |  |  | Red | Black | 10 | Red-Black | Any |
|  |  |  | Red | Brown | 8 | Red-Brown | Any |
|  |  |  | Red | Gray | 4 | Red-Gray | Any |
|  |  |  | Red | White | 2 | Red-White | Any |
|  |  |  | Violet | Beige | 8 | Violet-Beige | Any |
|  |  |  | Violet | Black | 10 | Violet-Black | Any |
|  |  |  | Violet | Brown | 12 | Violet-Brown | Any |
|  |  |  | Violet | Gray | 14 | Violet-Gray | Any |
|  |  |  | Violet | White | 4 | Violet-White | Any |
|  |  |  | Violet | Yellow | 2 | Violet-Yellow | Neutral |
|  |  |  | Violet | Pink | 6 | Violet-Pink | Neutral |
|  |  |  | White | Beige | 10 | White-Beige | Color |
|  |  |  | White | Black | 2 | White-Black | Color |
|  |  |  | White | Blue | 12 | White-Blue | Any |
|  |  |  | White | Brown | 8 | White-Brown | Color |
|  |  |  | White | Gray | 24 | White-Gray | Color |
|  |  |  | White | Green | 20 | White-Green | Any |
|  |  |  | White | Multicolor\_Pattern | 4 | White-Multicolor\_Pattern | Neutral |
|  |  |  | White | Orange | 18 | White-Orange | Any |
|  |  |  | White | Pink | 16 | White-Pink | Any |
|  |  |  | White | Red | 6 | White-Red | Any |
|  |  |  | White | Violet | 14 | White-Violet | Any |
|  |  |  | White | Yellow | 22 | White-Yellow | Any |
|  |  |  | Yellow | Beige | 8 | Yellow-Beige | Any |
|  |  |  | Yellow | Black | 4 | Yellow-Black | Any |
|  |  |  | Yellow | Brown | 6 | Yellow-Brown | Any |
|  |  |  | Yellow | Gray | 10 | Yellow-Gray | Any |
|  |  |  | Yellow | Green | 12 | Yellow-Green | Neutral |
|  |  |  | Yellow | Violet | 2 | Yellow-Violet | Neutral |
|  |  |  | Yellow | White | 14 | Yellow-White | Any |

###### 3.1.3.2.6 Pre-load to the app

All of these look-up tables were created in Excel. To preload these tables in the app, we first export these tables in CSV format and save them in res/raw folder of the project. Several methods were implemented to read these tables and create SQLite tables to be preloaded with the app at built time.

The goal of doing this is future change to the point for certain combinations will be integrated into our code without any code modifications. The steps include exporting CSV files, updating the files in the res/raw folder, rebuilding the project.

#### 3.1.4 Robotium

[Rob] Robotium is a powerful Android test automation tool on both emulator and real devices. It was applied to run several ClosetStylist’s unit test cases that do not span over two applications due to limitation of Robotium. The test cases including register, log in, verify main screen displaying correct information, check “My Closet”, pick “Outfit of the Day”, manage “Laundry Bag”, traverse “Outfit History”.

This tool has been very helpful to catch bugs and unexpected behavior every time our code was modified or new features were added.

### 3.2 Architecture

ClosetStylist design is composed of three main layers: presentation layer, application layer, and data layer. The layer design is mainly for code reusability and portability. In addition, multiple design patterns have been applied to provide flexibility to switch between different services.

Figure 3.3 shows the top-level architectural design of ClosetStylist.

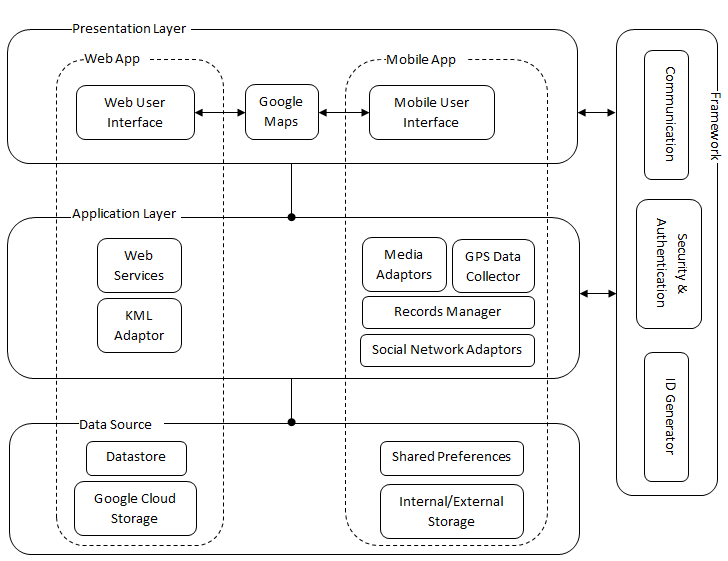


Figure 3.3: iTrak top-level architecture.

#### 3.2.1 Core

The core code includes common classes, common interfaces, helper classes, enum classes that are used to glue different layers together. The purpose of this layer is connecting different layers through common interfaces and features so that upper layers can work seamlessly with the information of the lower layers.

#### 3.2.2 Presentation layer

This layer contains UI and UX modules of the app. The purpose of this layer is to implement the behavior logic and provide the good user experience of the app flow as well as look and feel of the app. The design of this layer strictly follows that of Android design. We first draft our own design, and then we consulted with professionals UI/UX designer and UI developer.

#### 3.2.3 Application layer

The application layer consists of all the services employed in this app, including weather service, location service, and clothes matching service. The purpose of this layer is to implement application logic and provide all the functionalities of the app including but not limiting to organizing user’s closet, programmatically suggest outfits, keep track of outfit history, and managing laundry bag.

#### 3.2.4 Data layer

This layer includes two main components: the storage to store pictures and database to store smaller information about the user’s profile, clothing items, outfit history, and look-up tables for matching service. The purpose of this layer is to provide data management for the app. SD card was chosen over Cloud storage as for picture because we want to keep the picture-retrieving latency low which will help the responsiveness of the app. For small information, we use Android built-in database SQLite to manage. One thing to note is for each item, only the path to the SD card is saved in the SQLite of the item table and this is how we link the information in the SQLite database and the pictures in SD card.

An overview of the data structures used with the above data storages can be seen in Figure 3.8.

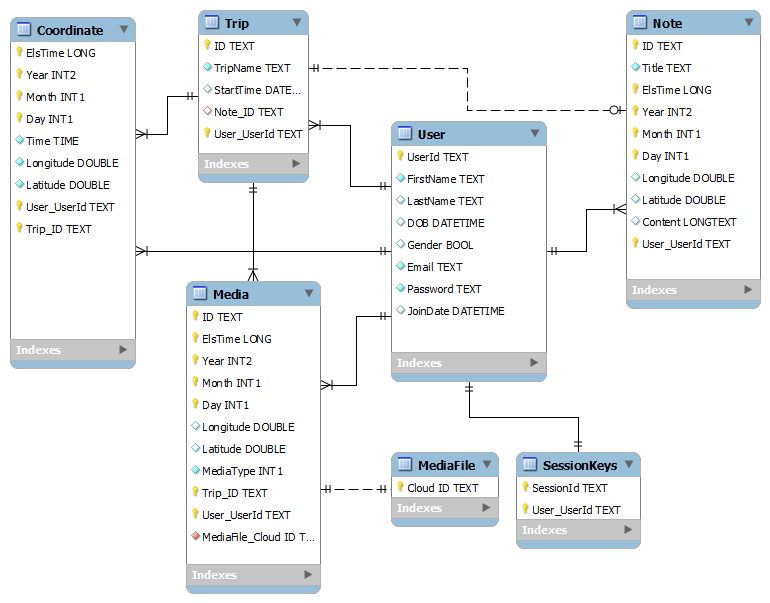


Figure 3.8: Database structures.

#### 3.2.5 Design patterns

##### 3.2.5.1 Factory Method Pattern

This pattern is applied to create different concrete storage types. SD card is chosen at the moment is the main storage for pictures, but the design is opened to use another type of storage with much of the code intact because the creator class is written without knowledge of the actual products that will be created. In other words, the implementation of the product is decoupled with its use. In addition, new storage it will not affect Creator class.

Below is the design



The abstract Creator class is StorageFactory and the concrete Creator classes are SDCardStorageFactory and GoogleAppEngineStorageFactory. The Product is StorageInterface and the concrete Product classes implementing this interface are SDCardStorage and GoogleAppEngineStorage.

##### 3.2.5.2 Abstract Factory Pattern

Clothes Matching service comprises of five steps. While step one and two can be filtered by querying the database, steps three to five require more complicated implementation based on gender (limited to male and female for now). Abstract Factory pattern was applied to provide an interface to create a family of matching steps: occasion matching, pair matching, color matching. Writing code that uses this interface helps us decouple our code from actual factory that creates these concrete matching steps (i.e., object classes). This also lets us expand to a variety of genders if we need to in the future. Once the users have registered their genders, we can substitute assign the correct matching steps.

In our design, the AbstractFactory interface is the ClothesMatchingComponentFactory, and the ConcreteFactory classes are ClothesMatchingComponentFactoryMale, and ClothesMatchingComponentFactoryFemale. There are several AbstractProduct classes OccasionMatching, PairMatching, ColorMatching and the corresponding concrete Product classes are OccasionMatchingMale, OccasionMatchingFemale, PairMatchingMale, PairMatchingFemale, ColorMatchingDefault.

Figure … shows the diagram of AbstractFactory classes and ConcreteFactory classes.



Figure … shows the diagram of AbstractProduct classes and ConcreteProduct classes of OccasionMatching, PairMatching, and ColorMatching.







##### 3.2.5.2 Template Pattern

This pattern is applied to the ClothesMatching class to encapsulate the five-step algorithm described above. ClothesMatchingMale and ClothesMatchingFemale are the two subclasses of ClothesMatching and we can modify the implementation steps if we need to tailor our need for each gender. This provides a framework to plug in new gender in the future. Besides the algorithm lives in one place (ClothesMatching class) and it is easy for code change later. ClothesMatching focuses on the algorithm and let subclasses such as ClothesMatchingMale and ClothesMatchingFemale redefine certain steps of that algorithm without changing the algorithm’s five-step structure.

##### 3.2.5.2 Other Design Patterns

Other design patterns applied in this app including strategy pattern, command pattern, etc. Some of these are inherited from Android architecture (e.g., AsyncTask for Command Pattern), while some others are used to implement features in this app.

#### 3.2.6 Mock-ups

### 3.3 Class diagrams

As mentioned in Section 3.2, iTrak employs the concept of separation of concerns. Therefore, separate modules for specific needs were created to maximize flexibility and extensibility. In the mobile class diagram (see Figure 3.9), the Activity classes are responsible for the presentation of the application, the Adapter and Listener classes handle internal data and events, and the Comms class allows communication between the mobile app and the web services.

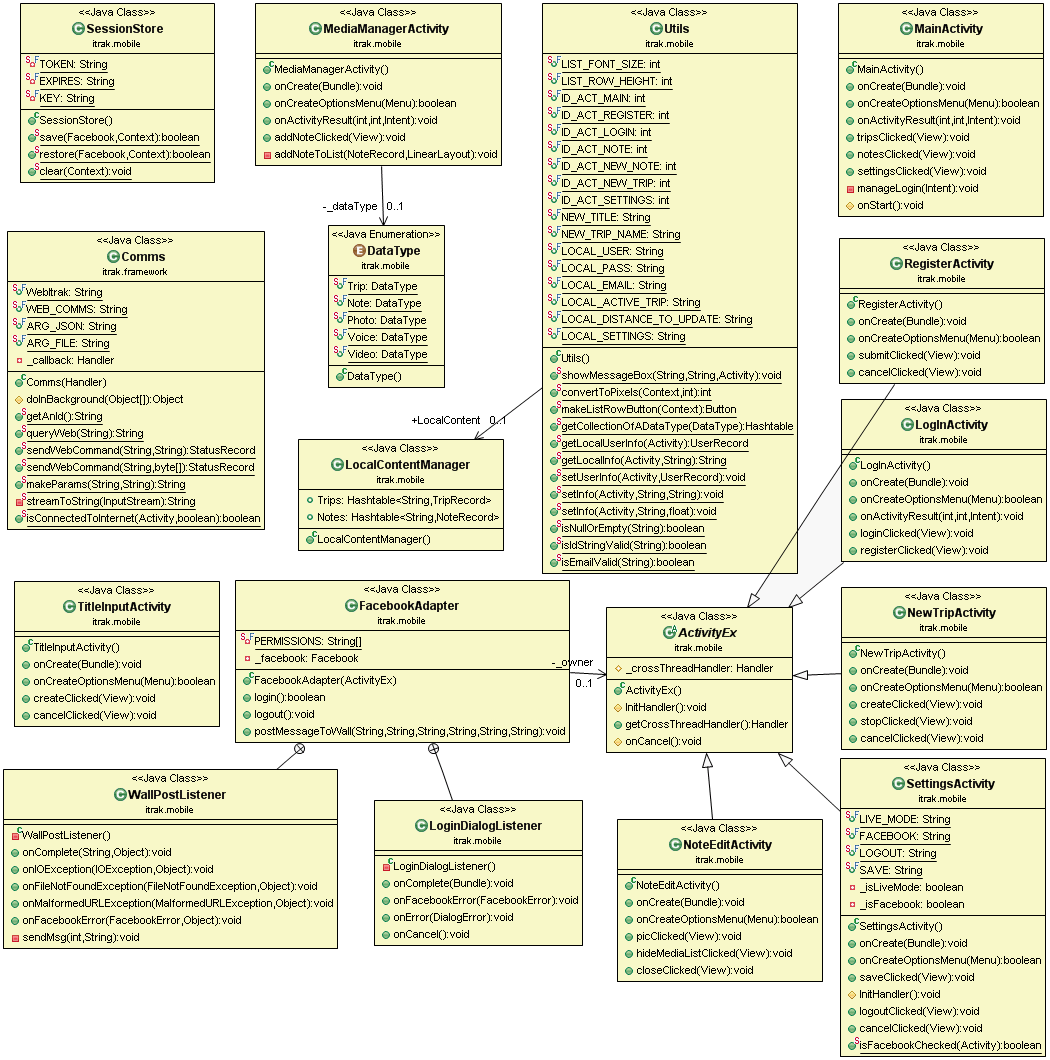


Figure 3.9: Mobile class diagram.

On the other hand, Figure 3.10 shows the web class diagram where the record classes hold persistent data. The IdGenerator class generates unique ID’s for both mobile app and web app. The Comms class filters requests that are sent to the web services and forwards valid requests to the Data Adapter. Finally, the DataAdapter class does the actual processing of these requests.

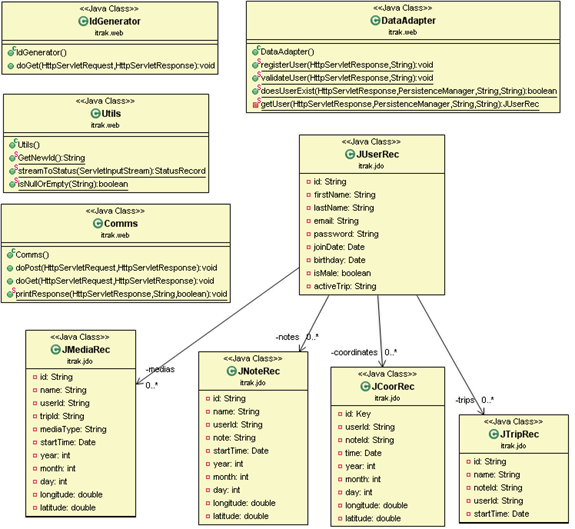


Figure 3.10: Web class diagram.

## Chapter 4 Results

iTrak involves a wide range of technologies and services, from GPS data acquisition to integration with social networks. Therefore, it would be vital to assure that the application delivers accurate data, operates correctly, and has reasonable performance. The following sections describe the main tests conducted for iTrak.

### 4.1 Outfit Of The Day Result

First let’s take a look at our implementation for this five-step algorithm.

Step 1 and 2: based on the current maximum and minimum temperature, we made two queries the database of wardrobes to obtain the two separate lists of clean items in our closet, one for top and one for bottom.

Step 3: each list together with the selected occasion is processed by the methods of the OccasionMatching object, the result is two lists of items with score, one for top and one for bottom.

Step 4: each of the item in the top list will be paired with an item in the bottom list, and optional an outer item picked from the top list if the temperature is in certain ranges by running methods of the PairMatching object. At the end of this step, we obtain a single list, in which each entry contains a combination of a top item, a bottom item, optionally an outer, and the total score of this combination.

Step 5: the list above will be run with the ColorMatching object to create a final list of the same object as in step 4, with the score has been accounted for the color.

This is one of the most important features of this app, if not the most important one. Therefore, many different trials were run to change the knobs of the five-step clothes matching service. We tried to make the temperature filter dependent on both style and material, but material turned out not to be a good factor (as explained above, because we could layer it up). When we found the suggested list does not change too much while switching among Occasion options, we tried to increase the scale of Occasion matching and it was helpful to make the algorithm match what we expect.

There are certain limitations to the algorithm:

If the closet does not have many items, the service will offer very similar outfits.

If there are many items with the same style, the algorithm does not work quite well????

At the moment, there is not much difference between Formal and Semi\_Formal, Day\_Out and Night\_Out.

When the weather is cold, the outer item is not changed drastically when traversing through the suggested outfit list.

Below are suggestions for cold day and hot day

Figure of hot day, no outer

Figure of cold day, with outer

### 4.2 Picture Display

Presenting images of different pieces of clothes is critical to every functionality of this app. To display the picture taken by the cell phones bears a lot of problem that we did not anticipate when started this app. Android has a limitation on 4KB memory each activity can use due to the limit of memory on handheld device. Images taken by cell phones are usually in the range of MB. As a result, images must be processed before being displayed in the app to workaround this problem.

We followed the guidelines in …. To crop the images first using AsyncTask to run on a different thread from UI thread. Once the image has been resized, we display the newly processed images on the screen.

Below is how the list of items in closet are shown

### 4.3 Weather service and location service latency

The app use the location service from geonames to find the city and country based on current location, and then obtain the weather information from Open Weather Map service.

The location is acceptable as it gives the correct city and country, although the zip code is not quite exact. This result is acceptable for our app because we do not need exact location as other tracking app as we can assume the weather within a city does not change much.

Regarding the weather, we compare with the weather.com information and it is within the -5 to +5 Farenheit range. This is acceptable because the granularity in our algorithm is bigger than this.

### 4.4 Nothing here

.

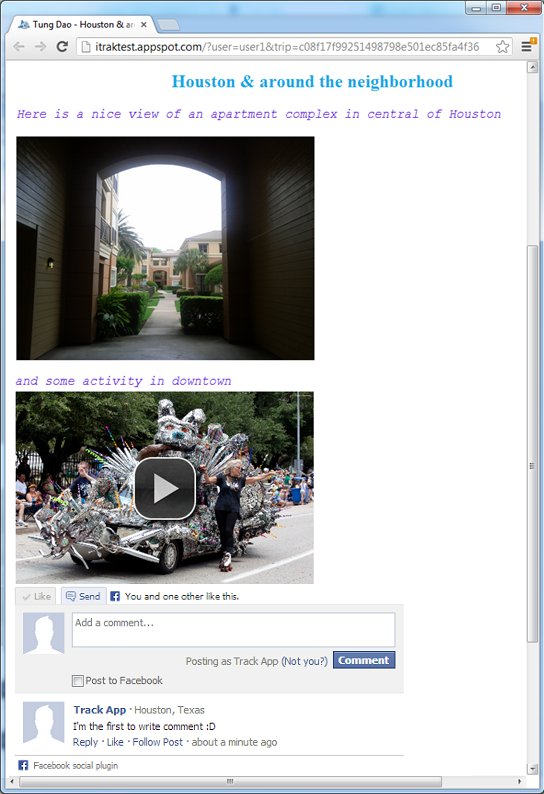


Figure 4.4: Web app screenshot with one Facebook Like and one comment.

### 4.4 Costs and level of effort

During development, GitHub was used as the source control tool, and the project was left as public to be used for free. Table 4.1 shows the cost of equipment and services purchased for the ClosetStylist app.

|  |  |
| --- | --- |
| Item | Costs |
| Samsung S3 | Free |
| UI/UX Design | $150 |
| UI Development | $500 |
|  |  |
|  |  |

Table 4.1: iTrak prototype development costs.

The app has been developed from March to August of 2014. The following section shows how many hours were spent on different aspects of the projects:

* 40 hours for architecture design.
* 30 hours for original UI design.
* 10 hours for final UI design.
* 20 for UI development collaboration.
* 340 hours for studying Android, researching, coding, and testing (18 weekends\*10 hours + (26+27 + 25 + 25 + 20)weekdays\*1hour). Started in April 20
* 30 hours for writing the report.

4040 lines of code were written for the mobile client and 1588 lines of code were added for the web services. Figures 4.5 and 4.6 show the code metrics of the mobile client and the web services for further details. These metrics were calculated using the CodePro Analytix plugin [Cpro]. A red item shows an area that exceeds the metric threshold and may need improvement. For example, if average cyclomatic complexity is red, there may be too many nested IF statements or nested FOR loop statements in the code.

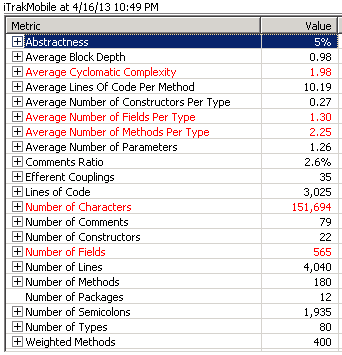


Figure 4.5: Metrics for mobile client.

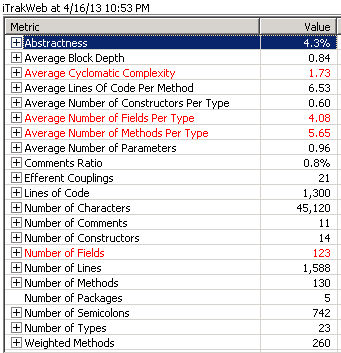


Figure 4.6: Metrics for web services.

### 4.4 Lessons learned

Android is a very powerful framework and it takes people a lot of time to use it efficiently. Starting to learn Android from the beginning of 2014, I have encountered quite a few challenges while implementing the app. Nevertheless, as Android is being used in hundreds of millions of devices, the eco system is huge and it is easy to find the answer to overcome almost every obstacles. Stackoverflow and Android developer website are my companions throughout the project.

Git is another new thing I learned in this project. Although I am familiar with using SVN, I did take the chance to learn Git and use it as the source control for this project. It did take me a lot of time to get used to running Git on command line because I often work with TortoiseSVN on Windows system, which is very user-friendly.

Below are the most highlighted things to do and not to do

Do:

* Design UI/UX carefully to avoid missing any features, especially missing features near the release
* Desi

Don’t:

* Decouple UI with the core. Android architecture has provided somewhat tightly couple between UI and core. A lot of effort is needed to design code to separate these out.
* Social media integration, especially Facebook, takes a lot of time. For simple post, it is straightforward with the provided sample code. For customized post including pictures, mastermind their sample code and their API is necessary.
* Be careful when That
* Taking pictures of clothes is not an easy job and it takes a lot of time even with the camera phone. It is difficult to find a good place to put the clothes on, hanging the clothes on will make the sleeve looks bad because gravity pulls them down. We ended laying them on the floor and the couch to take picture, but then we need to be careful not to include the shadow in the picture. If we want to release this app, we must figure out how to do this easier.

## Chapter 5 Conclusion

### 5.1 Summary

The prototype has been implemented closely to the architecture requirements. Separate modules for specific concerns were created to maximize flexibility and extensibility. The prototype delivered the features as defined in the scope of the report. It also demonstrated the technology and techniques used in the original design. The following captures the key items achieved from the prototype:

* Demonstrated the main workflow to show how the GPS location data and travel journal can associate with each other, and how social network can interact with iTrak to enhance the travel experience.
* Implemented the communication interface using GSON/JSON and proved that this interface significantly reduced effort in handling data exchange between mobile client and web services.
* Experimented with various technologies, including Android, Google App Engine and Google Maps, and showed how they worked together.

Although the prototype has incorporated a variety of technology and integrated a number of exciting features, there is still room to improve. While the UI of the mobile app is well organized, the UI of the web app is still very basic and needs more styling. Existing features such as recording video or recording sound can also be enhanced. More details about related improvements are discussed in Section 5.3.

In conclusion, with a dynamic architecture and a set of features that pick up current trends such as social network and GPS services, the outcomes of this report and the prototype have provided a good foundation for future implementation of iTrak in a full scale.

### 5.2 Related work

As mentioned earlier, one of the advantages of iTrak is to avoid the hassle of maintaining separate applications for different activities a traveler may perform. The following applications are examples that demonstrate the related features supported in iTrak as well as the features in iTrak that these applications do not have.

#### 5.2.1 Stylebook and Stylebook Men

This is an iOS app (quote <http://www.stylebookapp.com/>). This has the most similar functionalities with our ClosetStylist app. Their goal is to curate customers wardrobe’s and choose new pieces that fit into their current closet.

The app provides much neat functionalities: match other pieces in the closet with a specific top, make quick outfit collage, search for the right items to buy by using shopping features, mix match different pieces in the outfit editor, suggest which items in closet should be replaced.

Although our ClosetStylist app offers some similar features, we differentiate from this app by programmatically suggesting outfits based on the current weather.

#### 5.2.2 The Closet Stylist

Although this has the same name, the way it works is quite different (quote <http://www.theclosetstylist.com/testimonials.html>). For an hour rate of $150, the service offers many packages from 2 to 6 hours and additional services.

There are three main steps: first, evaluating customer’s closet, second, audit the wardrobe items, and third, shop for new clothes. This service does not assist customers picking the outfit on daily basis, not even mentioning taking into account of weather.

#### 5.2.3 My Private Stylist

This is an online program that offers women guide of clothing style (quotehttp://www.myprivatestylist.com/ ) . First of all this is not a smart phone app but it’s more an online program. By inputting user’s physical characteristic into computing, it provides guidance on what garments to wear and what to shop for. This does not let users to create their own closet and hence many features are not the same as our app. They also let image consultants to work with users to suggest users what items will fit them.

This app does not provide mix match between top and bottom, nor suggest what to wear based on current weather. Managing closet is something that this program does not offer either.

### 5.3 Future work

This original work on ClosetStylist serves multiple purposes: a proof of concept, to learn how to program Android, to learn how to manage a smart phone app development with professionals UI/UX design and UI developer. Although we were successfully developed a prototype, the features offered at the moment is still a very small subset to the full feature set in order to make this app a popular one that can attract more users. Some of them are discussed in the following sections.

#### 5.3.1 Integration with social networks such as Facebook

We were able to login to Facebook but we did not have enough time to implement sharing the outfit on Facebook because sharing images of the outfit is a complicated. Given that this app requires displaying pictures, Twitter may not be a good social network to share, Instagram may be a better choice.

Without social media, it is very difficult to promote app, and that is why this is pretty high priority in the to-do list.

#### 5.3.2 Detect the item’s color automatically

Manually entering color is not too much work, but it would be nice if we can detect the color of the item and fulfill it automatically. The challenge is with multi-color items. Another obstacle is how to distinguish between the item and the background. Although this is a nice feature to have, the effort would be massive unless we can find a library or tools out there that already support this.

#### 5.3.3 Support more items

Currently, the app can handle regular “Tops” items, such as blouse, shirt, t-shirt, etc. but not dress. Other things users would like to put together when going out including hats, shoes, bags, belts are not supported. These bears a lot of work because not only displaying them will make the phone screen too crowded but also the algorithm to choose pick an outfit will be much more complex. Nevertheless, these are needed to make a fully functional app.

#### 5.3.4 Add support for travel by letting customer choose what to wear in the future (by recommending based on future forecast)

Adding support for travelers to pick the items for their trip is another functionality that we would like to add in the future. User will enter their destination or a list of destination together with the begin and end date, the app will programmatically suggest the outfits they should pack to be most efficient for their trip based on the weather forecast at the destinations.

#### 5.3.5 Create app for iPhone and iPad

Although Android powers 70 percent of the mobile device, iOS is still a very big player in this area, especially in terms of revenue.

## Appendix: Balsamiq Mockups

Mockups used in this report were created by using the Balsamiq Mockups software. Balsamiq Mockups is a commercial application that offers a user friendly interface for creating mockups. The interface of the application is intuitive and fast. The application also provides a good set of features to export the mockups into different formats, including XML, PNG, or PDF. Figure A.2 shows the Balsamiq interface with the iTrak mobile app mockups loaded.

The trial version of the software lasts only seven days. After the trial period, user would not be able to save and load the mockups. However, Balsamiq still allows loading a design through the XML importing/exporting interface. Therefore, for academic purpose, a student can continue using Balsamiq after the trial period has expired, by manually saving the design as in the following steps:

1. To save a design, export the design to XML and save the XML onto a file. If changes are made later for the design, export the XML again and overwrite the content of the file with the new XML.
2. To load a design, open the saved XML file and copy the content to the clipboard. Then, paste the XML to the import dialog in Balsamiq. Figure A.1 shows the import interface with the XML content pasted into the import dialog.

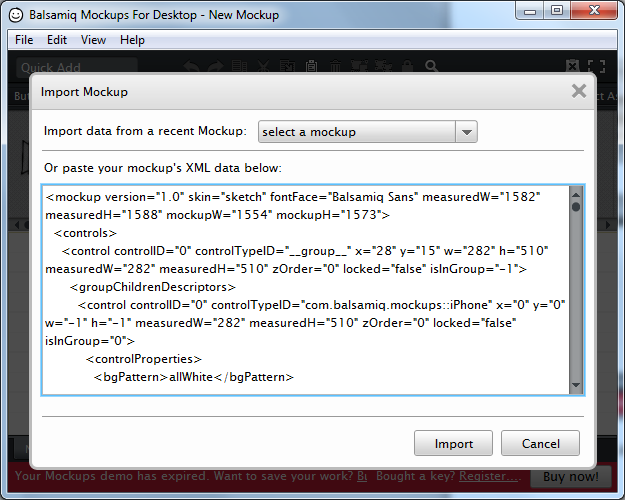
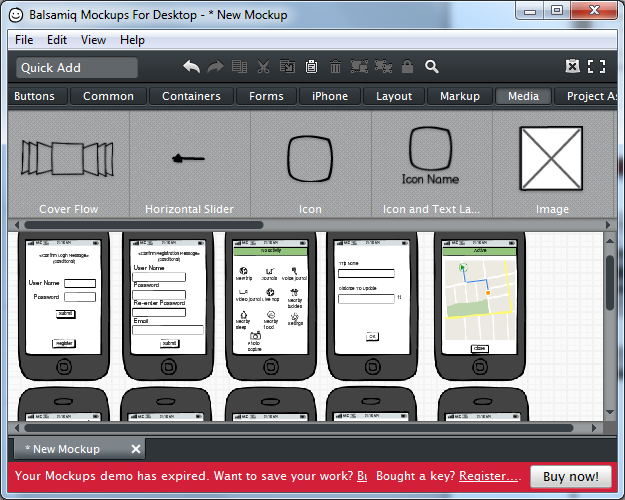


Figure A.1: Balsamiq Mockups XML import interface screenshot.



Tools ribbon to build up mockups

iTrak mockups

Figure A.2: Balsamiq Mockups screenshot.

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