A Fashion Recommendation System Based on The Wisdom of Crowds

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Abstract

We believe what we wear reflects our manner, taste, or how we regard the events that we attend and the people that we interact with. However, some studies have shown that many people of us are much poorer at picking outfit than we think. They don't have enough confidence on their fashion senses, and puzzled by excessive options. In this study, I propose a new method to support personal decision making for those people who puzzled about clothing mix and match by *wisdom of crowds* [5].

There are many different types of fashion recommendation systems have been offered[1] , but they are all oriented toward searching based on concrete attributes (e.g. weather, magazine data, street photography...). Those systems only recommend some combinations as references to improve peoples' fashion sense, but ignored two important facts on the process of picking outfit. The first one is, why people puzzled on it? The other one is, those systems generally give different people the same suggestion based on concrete attributes as a reference. However, people prefer to receive customize solutions which involve their own items rather than only references.

From my online surveys and interviews, I found that in most cases, people actually have one item they want to use, and the problem confused them is how to mix and match it with other items. Thus, we propose a "change one item into combination" architecture to solve this issue. Users pick one item they want to use, then system return some combinations as advises. Moreover, items involved in those results are all belong to users themselves.

Different from most of fashion recommendation systems, I believe the wisdom of crowds is valuable, and properly use of crowds wisdom can be a feasible solution. Therefore, I attempt to establish a *crowdsourcing*[2] recommendation system to support personal decision making.

In additional, this research also attempts to gamified the process of decision making to mobilize user enthusiasm and enhance user experience.

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Chapter 1

Introduction

Nowadays, as people emphasis on fashion, outfit select difficulty became a serious problem in daily life. Thus, i attempt to establish a crowdsourcing recommendation system on mobile platforms, which can provide people a platform to get fashion advises from crowds by describing the *scenario of use* [3] of products.

Suppose you are planning to attend your friend's birthday party. You decide to wear a dress you bought recently, but you do not know how to mix and match it with other items in your wardrobe. In this case, it's no use just trying to ask for the location of specific clothing attributes (e.g. brands, styles, size or weather). Instead, you describe the situation of the party to your friends or other people (e.g.designers) and share your wardrobe to them. They may respond with "If i was going, i'd like to wear..." or "I think you can mix it with...". By your description, they can map to the attributes of the appropriate items by applying common sense.

Recently, personal devices(e.g. PCs, Mobiles) communicate wirelessly with each other and also with the various social media services in the cloud. This allows people share their wardrobes and communicate with others more easier. They can get suggestions at anywhere, any time.

Additionally, crowdsourcing describes the act of outsourcing tasks, It combines the efforts of crowds of self-identified volunteers or part-time workers, where each one on their own initiative adds a small portion that combines into a greater result. The tasks are typically ones that humans are good at, but machines are not(e.g. recognizing images, ranking search results). In the human-computer interaction (HCI) domain, crowdsourcing is also known as Human Computation[4], which is understood as the notion of solving difficult computational problems through human computing effort instead of machine algorithms. This notion is based on the fact that many cognitive tasks that are easy for humans remain extremely difficult for computers to perform.

Mixing mobile platforms and the crowdsourcing model potentially offer vast resources for computation.[6] My design principle is simple: build a recommendation system let people send a request with description through their mobile devices and get suggestions from crowds. In this research, i attempt to prove the wisdom of crowds can improve the quality of recommendations, and it also can promote the process of personal decision making.

1.1 Background

1.1.1 Recommendation System

Recommendation systems have become a ubiquitous feature on the World Wide Web. Today, most websites use some recommendation techniques to heighten their users ' experience or help alleviate the information overload problem. Over the last decade, vast advancements in recommendation have been done. The current generation of recommendation methods can be broadly classified into the following four categories: Collaborative Filtering Recommendation Systems, Content-based Recommendation Systems, Hybrid Recommendation Systems - which combine with both, and Mobile Recommendation Systems.

Collaborative Filtering Recommendation Systems

Collaborative filtering[7][8] recommends data that were given high ratings by a number of users who presumably possess similar preferences as the user who requested the recommendation. The biggest advantage of collaborative filtering is that it requires no previous knowledge of the content of the data, and systems for recommending various data have been developed, for example movies, music, etc. Many algorithms have been used in measuring user similarity or item similarity in recommendation system. For example, the *k-nearest neighborhood (k-NN)*[1] approach[11] and the *Pearson Correlation*[2].

Content-based Filtering Recommendation Systems

Content-based filtering[9][10] expresses the content of each data in a form that can be objectively evaluated, and filters out data whose content doesn ' t match the user ' s preferences. In the most common implementation, the content of each piece of data is expressed as a vector. The preferences of each user is also expressed as a vector, and filtering is done by comparing the similarities of the vectors. Content-based filtering is rarely used outside the recommendation of text data, due to the difficulty of defining effective content representations.

Hybrid Recommendation Systems

Recent researches have demonstrated that a hybrid approach, combining collaborative filtering and content-based filtering could be more effective in some cases. Hybrid approaches can be implemented in several ways. Several studies empirically compare the performance of the hybrid with the pure collaborative and content-based methods and demonstrate that the hybrid methods can gain better system optimization and fewer of the weaknesses than pure approaches. These methods can also be used to overcome some of the common problems in recommendation system such as cold start and the sparsity problem.

Mobile Recommendation Systems

With the increasing ubiquity of internet-accessing smart phones, mobile phones are becoming a primary platform for information access and when coupled with recommendation system tech-

[1] http://en.wikipedia.org/wiki/K-nearest_neighbor_algorithm

[2] http://en.wikipedia.org/wiki/Pearson_correlation

nologies, they can become key tools for mobile users both for leisure and business applications. Recommendation techniques can increase the usability of mobile systems, providing personalized and more focused content, hence limiting the negative effects of information overload. One example of a mobile recommender system is one that offers potentially profitable driving routes for taxi drivers in a city[12].

1.1.2 Mobile Crowdsourcing

Crowdsourcing, which is understood as the notion of solving difficult computational problems through human computing effort instead of machine algorithms. Extending this model to mobile devices and users can potentially further enhance the availability of contributors.

Nathan Eagle, of the Massachusetts Institute of Technology, and Benjamin Olding, of Harvard' s School of Engineering and UC Berkeley' s Department of Statistics, came up with a service called *txteagle*[13] which sends small jobs via text messages in return for small payments. This brings jobs to people who otherwise wouldn ' t have access to online work. Jobs offered by txteagle are small bits of larger jobs which have been divided into many small parts and offered to many people, thus using crowdsourcing to get the job done. Some of the jobs might include translations, street sign verification, price and data collection, or more. To date, txteagle has more than 220 operators and 2 billion subscribers in 80 countries worldwide. It boasts the largest labor force in Kenya and uses are evolving daily.

1.1.3 Incentive Contribution

The idea of crowdsourcing, that everyone anywhere will contribute to your world-improving project is a powerful concept. However, successful execution of such a project has proven to be very hard. Incentives are key. What sort of motivation does one have to participate in a crowdsourcing system? To do so means virtual anonymity, becoming a single name within a sea of many. It means a compromise of control, a sharing a managerial responsibility and credit that some may find disconcerting.

Previous studies in social and computer science have identified a list of approaches to motivate people in on-line system[14][15]. In this section, we introduce the background of three of them: the goodwill factor incentives, the social incentives and the game-based incentives.

Goodwill Factor Incentives

Some potential users will participate in a system not for any returns from the system, but simply for the sake of its success (with academic interest and charity motivation). *Wikipedia*[3] is the great benefactor from academic interest: while it has developed into a mature system where time invested by a user is time returned in some way, its initial growth was different. With a wiki, any knowledge you enter will itself be useless encyclopedic knowledge to you, given that it is something you already know. Wikipedia grew because users looked forward and imaged how delightful the system would be if it succeeded. A volunteer encyclopedia is not a new concept—the OED was started by hundred of volunteers, attempting to improve upon the lackluster documentation of the English language. Academic motivation, then, is motivation based on an ideological foresight. A motivation of charity

[3] http://www.wikipedia.org/

also is centered on the actual system, rather than particularly what it provides. An example of charity is participating in a well-polished product, out of appreciation for the quality put into it. Consider three social community sites: *Virb*[4], a design-centric re-imagination of Myspace, or *Tumblr*[5] and *Dopplr*[6], two sites with a small purpose but a solid implementation. Working against goodwill is the fact that few users actually do feel inclined to support something on those grounds. Also, such motivation is limited in time, and without more direct returns, people will eventually give up on supporting a system.

Social Incentives

One widely approaches to promoting increased contributions in digital services can be found is social psychology. Social psychology is the scientific study of how people's thoughts, feelings, and behaviors are influenced by the actual, imagined, or implied presence of others. Social facilitation and social loafing are, perhaps, the most commonly cited effects. *Social facilitation* is the tendency for people to do better on simple tasks when in the presence of other people. This implies that whenever people are being watched by others, they will do well on things that they are already good at doing.[16] On the other hand, *social loafing* is the phenomenon of people exerting less effort to achieve a goal when they work in a group than when they work alone.

Ways of taking advantages of the positive social facilitation and avoiding negatives social loafing in online collection systems were suggested in[17].

Game-based Incentives

Recently, digital designers begin to adopt ideas from game design to seek to incentivize desirable user behaviors. The concept of game-based incentives is basic: make it fun! *Game with a Purpse*[18], headed by Luis von Ahn at Carnegie Mellon, is an exploration of this method. It includes a series of games, most notably the *ESP Game*[7] and *Peekaboom*[19], that make semantic analysis into a game.

However, 'fun' is a hard concept to put in practice, and with so much competition online, it is likely that such games would very much fall back on the goodwill factor. Furthermore, to produce ‘ fun ’ within the constraints of crowdsourced purpose may very well be the most difficult task of all of these. It requires cleverness in competing mindsets: those who have large-scale human-computation tasks are likely the ones without a finely-tuned sense of what is fun for the masses, just like those who understand low-entry gaming probably won ’ t be looking to solve blue-sky problems.

1.1.4 Trust Mechanism

The semantic web, social networking, virtual communities and, of course recommendation systems and crowd sourcing systems: these are all examples of research areas where the issue of trust, reputation and reliability is becoming increasingly important. Across most current research,

[4] http://virb.com/

[5] https://www.tumblr.com/

[6] http://www.dopplr.com/

[7] http://www.esp-games.com/

definitions of trust fall into various categories. In this research, i focus on the trust in both recommendation systems and crowdsourcing systems.

Trust in recommendation systems

Trust plays a crucial role in the functioning of recommendation sysytems, not only by supporting the security of contracts between agents, but also because agents rely on the expertise of other trusted agents in their decision-making. Recently a number of researchers have tackled a related issue by using more directly available trust relationships.

For example, the work of [20] builds a trust model directly from trust data provided by users as part of the popular *Epinions.com*[8] service. Epinions.com is a web site that allows users to review various items (cars, books, music, etc.). In addition they can assign a trust rating to reviewers based on the degree to which they have found them to be helpful and reliable in the past. The basic idea of Epinions.com is to measure the distance between two users in terms of the number of arcs connecting the users in the trust-graph encoded by the Epinions.com trust data. They show that it is possible to compare far more users according to this method than by conventional forms of ratings similarity and argue that because of this trust-based comparisons facilitate the identification of more comprehensive communities of recommendation partners. However, it must be pointed out that while the research data presented does demonstrate that the trust data makes it possible to compare far more users to each other it has not been shown that this method of comparison maintains recommendation accuracy.

Trust in crowdsourcing systems

Over the years, different types of crowdsourcing systems have emerged. Some of the well-known systems with crowdsourcing features include Amazon's Mechanical Turk (AMT), 99designs, Mob4hire, Youtube, and Wikipedia, etc. In the other hand, A series of studies conducted in AMT has discovered that workers indeed lied more when given the opportunity[21][22][23].

Trust management mechanisms have been suggested by recent research[24] to be a viable way to address the problem of malicious workers in crowdsourcing systems. According to[25], trustworthiness is the subjective probability by which an individual, A, expects that another individual, B, performs a given action on which its welfare depends. Trust-aware Human Intelligence Tasks allocation mechanisms that can enhance the social welfare of the whole crowdsourcing system would be very useful [24].

1.2 Motivation

Fashion is a language. How we dress signals to others who we are and how we want to be perceived. The book *Dress for Success*[29] told readers that "make you look like a million so you can make a million". Our clothes can communicate details about ourselves to others. A punk rocker communicates rebellion, pink ruffles communicate feminine youth, and hats or scarfs worn a certain way can communicate gang affiliation. However, some studies have shown that many people of us are much poorer at picking outfit than we think. They don ' t have enough confidence on

[8] http://www.epinions.com/

their fashion senses, and puzzled by excessive options. According to *MATALAN*'s[9] study, “Women (20 60) average spend 16 minutes every weekday morning deciding what to wear. Deciding on what clothes to take on holiday uses up to 52 minutes each time.”

Existing researches and models have given us some inspirations of how to design a fashion recommendation systems. Nevertheless, they also exposed some common drawback. Therefore, in this study, i aim to propose a new method to support personal decision making for those people who puzzled about clothing mix and match by wisdom of crowds.

1.3 Structure of This Dissertation

In this section, i would like to introduce the structure of this dissertation.

Chapter 2 will be several existing researches and models relate to both of recommendation system field and crowdsourcing field. Chapter 3 will introduce the technologies I used to establish my system. In chapter 4, I will identify the problems i attempt to solve and the design of my system. Then, in chapter 5 will be the implementations of my system. Furthermore, in chapter 6, i would like to evaluate the results of the user study. Chapter 7 is about the discussion of the results printed in chapter 6. Further work will be discussed in chapter 8. Finally, chapter 9 is the conclusion of my thesis.

[9] http://www.matalan.co.uk/

Chapter 2

Related works

In this chapter, i would like to present several existing researches and models relate to both of recommendation system field and crowdsourcing field, integrate with discussions.

2.1 Fashion recommendation based on commonsense computing

[26] is a research proposed by Edward Shen and Francis Lam form MIT Media Laboratory. They designed a recommendation system based on commonsense reasoning technology.

This recommendation system can be viewed as a software agent comprising two sensors: a style sensor, and a function sensor. For any input text, the style sensor suggests a suit for attending a wedding or jeans for a movie, whereas the function sensor suggests a swimsuit for going to the beach or sneakers for jogging. Both of the sensors provide recommendations by performing spreading activation in ConceptNet [27] with the data in OMCS (Open Mind Common Sense)[28], and handcrafted templates that provide style and function information for a set of brands, types, materials, and occasions.

This research attempt to link the concepts to represent commonsense that everyone would know or agree by the technology of OMCS. The accuracy of OMCS will be a uncertainty.

2.2 Fashion recommendation based on concrete attributes

There are numerous recommendation systems have been proposed based on concrete attributes (e.g. weather, magazine data, street photography...).

DailyDressMe[1] is a website that tells you what to wear based on the weather. It simplifies your daily routine of getting ready by using weather conditions in your region to accordingly suggest suitable outfits.

LookBook.nu[2] is a fashion, youth culture, and community website. It was inspired by street fashion website and blogs such as the *The Sartorialist*[3] and designed for users to post their own street-fashion photography, featuring themselves and their outfits.

Those systems only recommend some combinations as references to improve peoples ’ fashion sense. They give different persons the same suggestion without using their own items. This leads

[1] http://dailydressme.com/

[2] http://lookbook.nu/

[3] http://www.thesartorialist.com/

to a problem, in most cases, even you think the suggestion is great for you, probably, you do not have those items(or the same style items) in your wardrobe. It makes the suggestion valueless.

2.3 Pinterest

Pinterest[4] is a pinboard-style photo-sharing website that allows users to create and manage theme-based image collections such as events, interests, and hobbies. Users can browse other pinboards for images, "re-pin" images to their own pinboards, or "like" photos.

Pinterest is a new kind of "recommendation engine." While Facebook and Twitter offer users the ability to add imagery to their posts, *Pinterest* is the first social media site to effectively combine visual content with outbound links as a “recommendation engine.” If the product you’ re marketing is one with immediate visual appeal, you may well see success with the eyeballs at *Pinterest*. It's a stark contrast to the data-mashing that powers most recommendation engines.

2.4 Style for Hire

Style for Hire[5], a fashion startup co-founded by celebrity stylist Stacy London and Cindy McLaughlin, is launching as a way to help the masses master the art of their own personal style. It allows users to find a vetted stylist in their city to help them choose clothing for a special event, or more. Users can search for stylists by type of style and more. The stylists goal is to help clients think about how to invest more strategically in their wardrobes, considering cost-per-wear, saving and spending habits and ultimately, to develop a wardrobe that is workable and wearable for any age, body type, lifestyle or budget.

Style for Hire is closer to monetary incentive crowdsourcing systems. The drawback of monetary incentive is, once with money being involved, quality control becomes a major issue due to the anonymous and distributed nature of crowdworkers. Although the quantity of work performed by participants can be increased, the quality can not, crowdworkers may tend to cheat the system in order to increase their overall rate of pay. Moreover, data of *Style for Hire* show that the rate per hour currently ranges from $65 to $300 and the average length of an appointment is 2.6 hours. not everyone can afford the payment of hiring a personal stylist.

[4] http://pinterest.com/

[5] http://www.styleforhire.com/

Chapter 3

Technology Requirement

Mobile application development is a process by which application software is developed for low-power handheld devices, such as personal digital assistants, enterprise digital assistants or mobile phones(in this study, is iPhone). These applications can be pre-installed on phones during manufacturing, downloaded by customers from various mobile software distribution platforms, or delivered as web applications using server-side or client-side processing to provide an "application-like" experience within a Web browser. Application software developers also have to consider a lengthy array of screen sizes, hardware specifications and configurations because of intense competition in mobile software and changes within each of the platforms. In this chapter, i would like to introduce some technology i used in this study.

3.1 iOS Development

To develop a iPhone application, it requires following elements:

Programming language

Objective-C is a general-purpose, object-oriented programming language that adds Smalltalk-style messaging to the C programming language. It is the main programming language for iOS application development.

Development environment

Xcode is an integrated development environment (IDE) containing a suite of software development tools developed by Apple for developing software for OS X and iOS. It includes the Xcode IDE, Instruments, iOS Simulator, the latest OS X and iOS SDKs, and more.

Developer license

Apple tools are free for an Intel-based Mac. Simulator testing is free, but installing on a device needs a fee for a developer signing key. Enrolling apple developer license costs $99/year.

3.2 Server Development

In this study, i selected *Ruby on Rails*[1] on sever development.

[1] http://rubyonrails.org/

3.2.1 Ruby on Rails

Ruby on Rails, often simply RoR or Rails, is an open source web application framework which runs on the Ruby programming language. It allows creating pages and applications that gather information from the web server, talk to or query the database, and render templates out of the box. As a result, Rails features a routing system that is independent of the web server. Ruby on Rails uses the model-view-controller (MVC) pattern to organize application programming.

Framework structure

Ruby on Rails is separated into various packages, namely *ActiveRecord*[2], *ActiveResource*, *ActionPack*, *ActiveSupport* and *ActionMailer*. Prior to version 2.0, Ruby on Rails also included the Action Web Service package that is now replaced by Active Resource.

Deployment

Many free Unix-like systems support installation of Ruby on Rails and its dependencies through their native package management system. In this study, i used *RubyGems*[3], a package manager which is included with current versions of Ruby.

3.2.2 MVC

Model-view-controller (MVC)[Figure 3.1] is a software architecture pattern which separates the representation of information from the user's interaction with it.

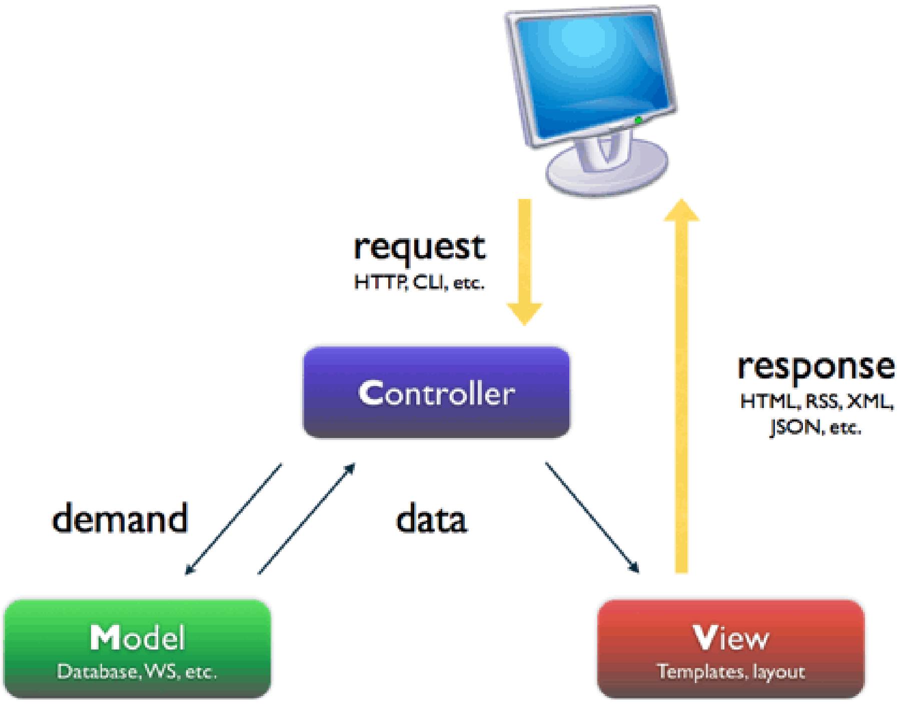


Figure 3.1: MVC

[2] http://en.wikipedia.org/wiki/Active_record_pattern
[3] http://rubygems.org/

- **Controller**. It can send commands to its associated view to change the view's presentation of the model. It can also send commands to the model to update the model's state.

- **Model**. It notifies its associated views and controllers when there has been a change in its state. This notification allows the views to produce updated output, and the controllers to change the available set of commands. A passive implementation of MVC omits these notifications, because the application does not require them or the software platform does not support them.

- **View**. It requests from the model the information that it needs to generate an output representation to the user.

3.2.3 Deployment

Nginx

In this study, i used *Nginx*[4] as a proxy server. Nginx is a free, open-source, high-performance HTTP server and reverse proxy, as well as an IMAP/POP3 proxy server. Nginx now hosts nearly 12.18% (22.2M) of active sites across all domains. It is known for its high performance, stability, rich feature set, simple configuration, and low resource consumption.

- **Basic HTTP features**
  1. Ability to handle more than 10,000 simultaneous connections with a low memory footprint (2.5 MB per 10k inactive HTTP keep-alive connections).
  2. Handling of static files, index files, and auto-indexing.
  3. Reverse proxy with caching.
  4. Load balancing with in-band health checks.
  5. Fault tolerance.
  6. TLS/SSL with SNI and OCSP stapling support, via OpenSSL.
  7. FastCGI, SCGI, uWSGI support with caching.
- **Mail proxy features** 1. TLS/SSL support.
  2. STARTTLS support.
  3. SMTP, POP3, and IMAP proxy.
  4. Authentication using an external HTTP server.

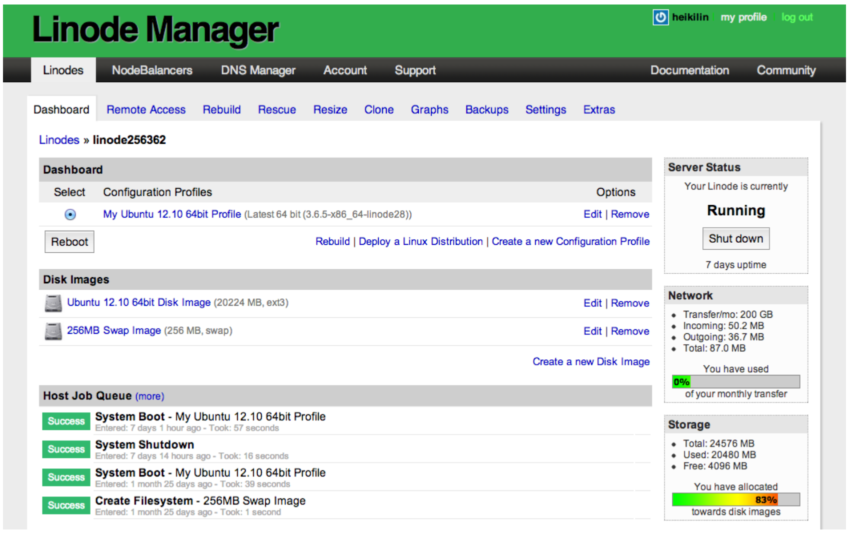
VPS

There are many virtual machines running on a single computer. In this study, i used *virtual private server*(VPS), which used by internet hosting services. Although a VPS runs in software on the same physical computer as other customers' virtual machines, it is in many respects functionally equivalent to a separate physical computer. A VPS is dedicated to the

[4] http://wiki.nginx.org/Main

individual customer's needs, has the privacy of a separate physical computer, and can be configured to run server software.

[Figure 3.2] is an example in my system:



Linodes » linode256362

Dashboard

Select	Configuration Profiles	Options
●	My Ubuntu 12.10 64bit Profile (Latest 64 bit (3.6.5-x86_64-linode28))	Edit | Remove

Reboot — Rebuild | Deploy a Linux Distribution | Create a new Configuration Profile

Disk Images

Ubuntu 12.10 64bit Disk Image (20224 MB, ext3)	Edit | Remove
256MB Swap Image (256 MB, swap)	Edit | Remove

Create a new Disk Image

Host Job Queue (more)

Success	**System Boot** - My Ubuntu 12.10 64bit Profile Entered: 7 days 1 hour ago - Took: 57 seconds
Success	**System Shutdown** Entered: 7 days 14 hours ago - Took: 16 seconds
Success	**System Boot** - My Ubuntu 12.10 64bit Profile Entered: 1 month 25 days ago - Took: 39 seconds
Success	**Create Filesystem** - 256MB Swap Image Entered: 1 month 25 days ago - Took: 1 second

Server Status

Your Linode is currently

Running

Shut down

7 days uptime

Network

- Transfer/mo: 200 GB
- Incoming: 50.2 MB
- Outgoing: 36.7 MB
- Total: 87.0 MB

You have used 0% of your monthly transfer

Storage

- Total: 24576 MB
- Used: 20480 MB
- Free: 4096 MB

You have allocated 83% towards disk images

Figure 3.2: VPS

3.3 Others

3.3.1 Database

A database is a structured collection of data. It may be anything from a simple shopping list to a picture gallery or the vast amounts of information in a corporate network. To add, access, and process data stored in a computer database, you need a database management system. In this study, i used *MySQL Server*[5].

MySQL

MySQL, the most popular Open Source SQL database management system, is developed, distributed, and supported by Oracle Corporation.

MySQL Server was originally developed to handle large databases much faster than existing solutions and has been successfully used in highly demanding production environments for several years. Although under constant development, *MySQL Server* today offers a rich and useful set of functions. Its connectivity, speed, and security make *MySQL Server* highly suited for accessing databases on the Internet.

3.3.2 Data interchange

To transfer data between server and mobile devices, i select *JSON*[6] as the data interchange language in my research.

[5] http://dev.mysql.com/

[6] http://www.json.org/

JSON

JSON (JavaScript Object Notation) is a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language. It is a text format that is completely language independent but uses conventions that are familiar to programmers of the C-family of languages, including C, C++, C#, Java, JavaScript, Perl, Python, and many others. These properties make JSON an ideal data-interchange language.

JSON is built on two structures:

A collection of name/value pairs. In various languages, this is realized as an object, record, struct, dictionary, hash table, keyed list, or associative array.

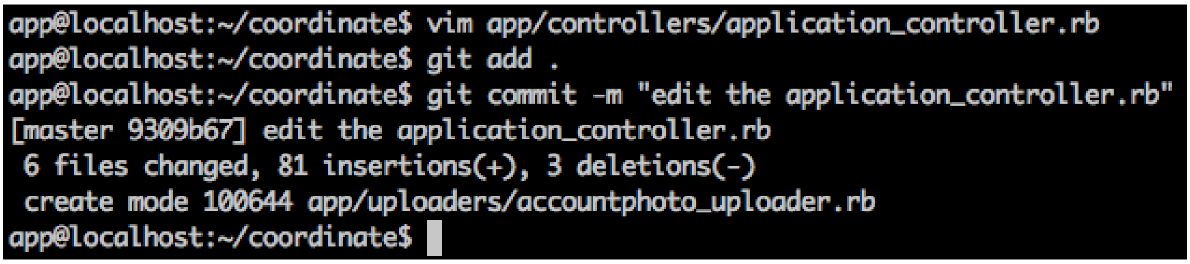
An ordered list of values. In most languages, this is realized as an array, vector, list, or sequence.

3.3.3 Source code management

Git

Git[7] is a free and open source distributed version control system designed to handle everything from small to very large projects with speed and efficiency.

[Figure 3.3] is an example in my system:



```
app@localhost:~/coordinate$ vim app/controllers/application_controller.rb
app@localhost:~/coordinate$ git add .
app@localhost:~/coordinate$ git commit -m "edit the application_controller.rb"
[master 9309b67] edit the application_controller.rb
 6 files changed, 81 insertions(+), 3 deletions(-)
 create mode 100644 app/uploaders/accountphoto_uploader.rb
app@localhost:~/coordinate$ 
```

Figure 3.3: Git

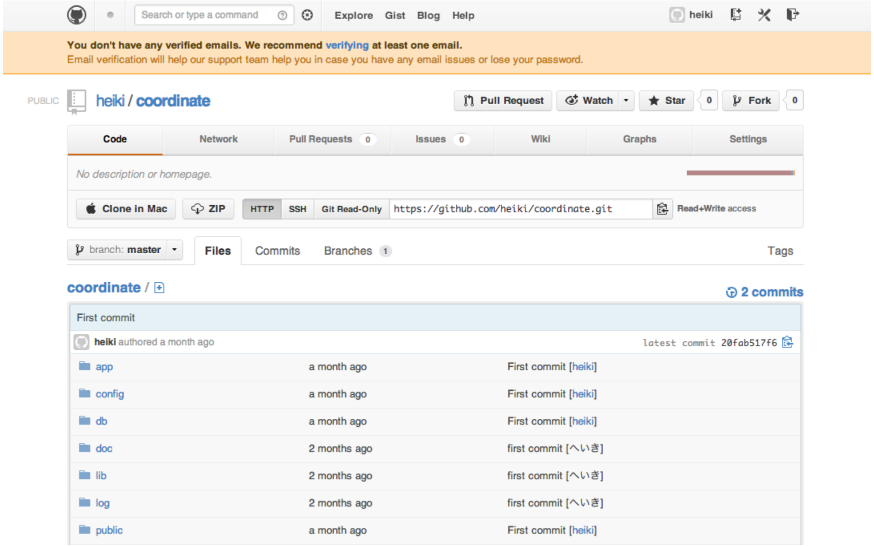
GitHub

GitHub [8] is a web-based hosting service for software development projects that use the Git revision control system. GitHub offers both paid plans for private repositories, and free accounts for open source projects.

[Figure 3.4] is an example in my system:

[7] http://git-scm.com/

[8] https://github.com/



You don't have any verified emails. We recommend verifying at least one email.
Email verification will help our support team help you in case you have any email issues or lose your password.

No description or homepage.

`https://github.com/heiki/coordinate.git`

First commit

heiki authored a month ago `latest commit 20fab517f6`

app	a month ago	First commit [heiki]
config	a month ago	First commit [heiki]
db	a month ago	First commit [heiki]
doc	2 months ago	first commit [へいき]
lib	2 months ago	first commit [へいき]
log	2 months ago	first commit [へいき]
public	a month ago	First commit [heiki]

Figure 3.4: GitHub

Chapter 4

System Design

4.1 Problem Identification

As i have been mentioned in Chapter 2, there are numbers of fashion recommendation systems have been offered. Nevertheless, they also exposed some common drawbacks. Systems based on concrete attributes only can recommend different persons the same suggestion without using their own items. Which means can not give personal suggestions, but only references. On the other hand, personalized systems such as *Style for Hire*, which use monetary incentives, the payment for normal people is luxury. Therefore, how to build a free, personalized recommendation system in a brand new way is the core issue in this study.

Furthermore, according to my online survey[1] among 25 participants. Over 60% people selected "clothing mix and match is difficult " option, and most of them want get suggestions from their friends, only 8% of them selected "get suggestions from strangers(fashion designers or other enthusiastic people want share their ideas online)" option. Therefore, how to support trust building between strangers is the second issue.

Additionally, according to my offline interviews. I found that, in most cases, people be confused with cloth mix and match are not because they do not have any idea of what to wear, actually, they have one item want to use, but they do not how to select other items to match it. Thus, how to solve this problem is the third issue.

4.2 Solutions

Recommendation system based on wisdom of crowds

Do not let fish climb the tree. If one person puzzled by picking outfit, why do not let someone(who good at cloth mixing and matching) to help? Crowdsourcing is a effective method let people do what they good at. Thus, in this study, i attempt to exploit the wisdom of crowds to support personal decision making. Only you need to do is share your wardrobe to others and describe your request.

Support trust building between strangers

In my system, a request can not only get suggestions from their friends, but also strangers. It

[1] http://adajo.wufoo.com/forms/opinion-research/

is a challenge to motivate the potential advisers to offer their help and to persuade requesters to trust the suggestions they get. From a design point of view, i concentrate on two aspects simultaneously: 1) how to establish trust among the requesters and advisers. 2) how to provide appropriate incentives to the candidate adviser.

Early studies suggest that a lack of trust can be identified as one of the greatest barriers that inhibit Internet transactions[30][31]. For support online trust building, the content of my system has been specially designed. The profile and wardrobe information of requesters is open to the candidate advisers, and i hope that this option helps the adviser to understand that this question is is a real request from a person who is seeking help. In the meantime, the profile and ranking information of advisers is a option helps the requester to understand that this a real suggestion from a person who really wants to help you.

I also utilize findings from social psychology as incentives in my system. Social Facilitation[33] and Social Loafing[32] are two commonly cited behaviors that can affect contributions on social sites. The Social facilitation effect refers to the tendency of people to perform better on simple tasks while someone else is watching, rather than while they are alone or when they are working alongside other people. The Social loafing effect is the phenomenon of people making less effort to achieve a goal when they work in a group than when they work alone because they feel that their contributions do not count or are not evaluated or valued as much. This consideration is seen as one of the main reasons that groups are less productive than the combined performance of members working alone. In my system, the accredited combination will be reposted to user's social network to gain applause from others.

Additionally, i also integrated game-based design as incentives in my system. I designed some award mechanisms to encourage and reward participants - both requesters and advisers.

The "change one to combinations" model

As i explain above, in most cases, people do have one item to use, but be puzzled on how to mix and match it with other items in their wardrobes. In order to solve this issue, i designed a "change one item into combinations" model(show as [Figure 4.1]). Which means, a requester select one item he want to use and send the request with description of scenario. On the other hand, an adviser need to offer a suggestion involve the item selected by the requester.

4.3 Architecture

I consider to building a one-to-many system, thus you can play with multi-opponent at the same time. Further more, this is not a real time system, what means user can enjoy/leave the application anytime they want.

In this system, you first need to take photos of your items to complete your wardrobe. After that, you can start with choosing one item you want to wear, and describe your requirement, and also you need to share your personal wardrobe data to others. Advisers who received this requirement will mix and match according to the description their received, and reply you their results. Then you need to choose from the recommendations for today ' s attire. The opponent for chosen attire will be awarded, and the combination of the chosen attire will be uploaded to the social network to accept praise from others(show as [Figure 4.2]).

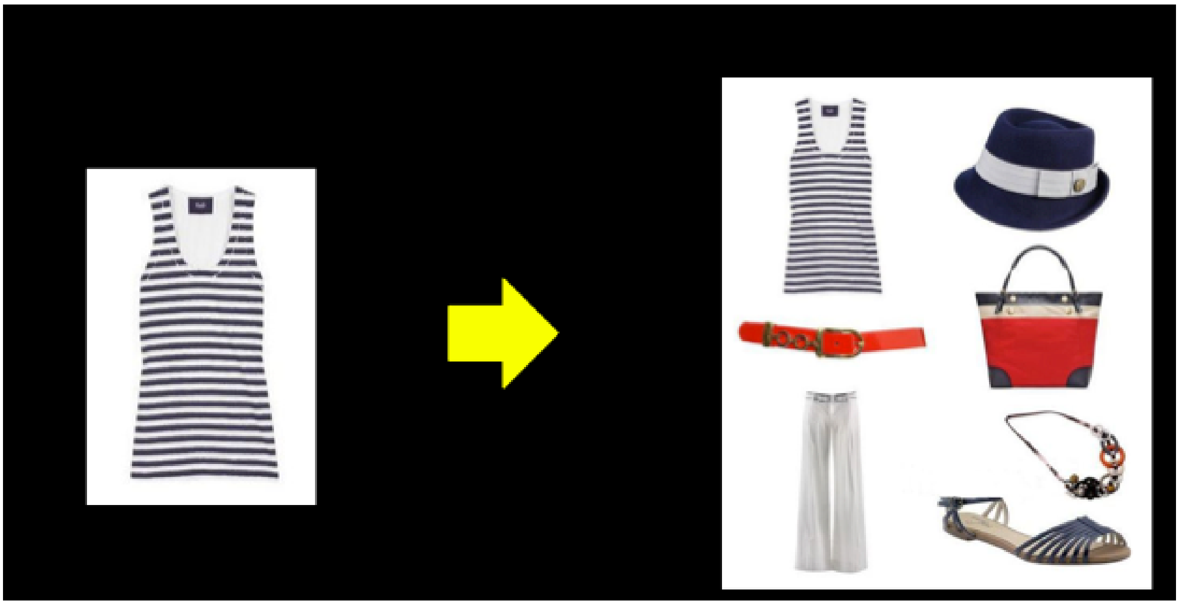


Figure 4.1: one to combinations model

There are three components of this model: Requester, Adviser, and Proxy server.

Requester: Use mobile application to pick one item, describe requirement, share personal wardrobe, and send it to sever.

Adviser: Mix and match according to description, send results.

Proxy server: Routes the requests to appropriate.

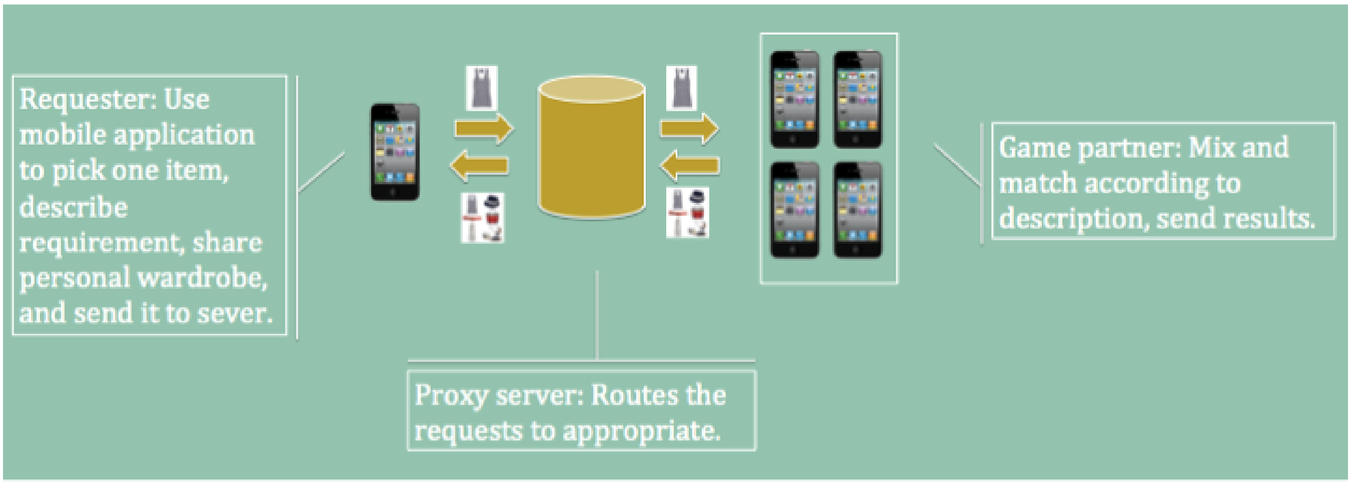

Requester: Use mobile application to pick one item, describe requirement, share personal wardrobe, and send it to sever.
Game partner: Mix and match according to description, send results.
Proxy server: Routes the requests to appropriate.

Figure 4.2: Architecture

4.4 UI Design

Recently, behold web and user interface designers, a new trend (or style) is taking the world of UI and website design by storm: *Flat UI Design*. It is a minimalistic approach and style to designing websites and UI where we take a step back, strip away all the 3D elements, gradients, shadows and effects to leave behind the bare necessities. In a nutshell, flat design removes the noise, the bells and whistles, the site accessories that overwhelm visitors and drive away peers. It's pure and simple, and fundamentally minimalistic. Thus, i also used this design style in my system.

The work flow of the application is show as [Figure 4.3].

4.5 Award Mechanisms Design

In order to encourage and reward participants - both requesters and advisers, i also designed some award mechanisms in this system.

1. You will be rewarded accordance to the number of photos you add to your wardrobe per day.(10 photos, 20 photos···)

2. You will be ranked and be rewarded accordance to accumulated plays.(10 times, 20 times···)

3. Rank will be listed according to the number of times of successful recommendation, top rankers will be highlighted.

4. The image of successful recommendation will be posted in social network for appraisal.

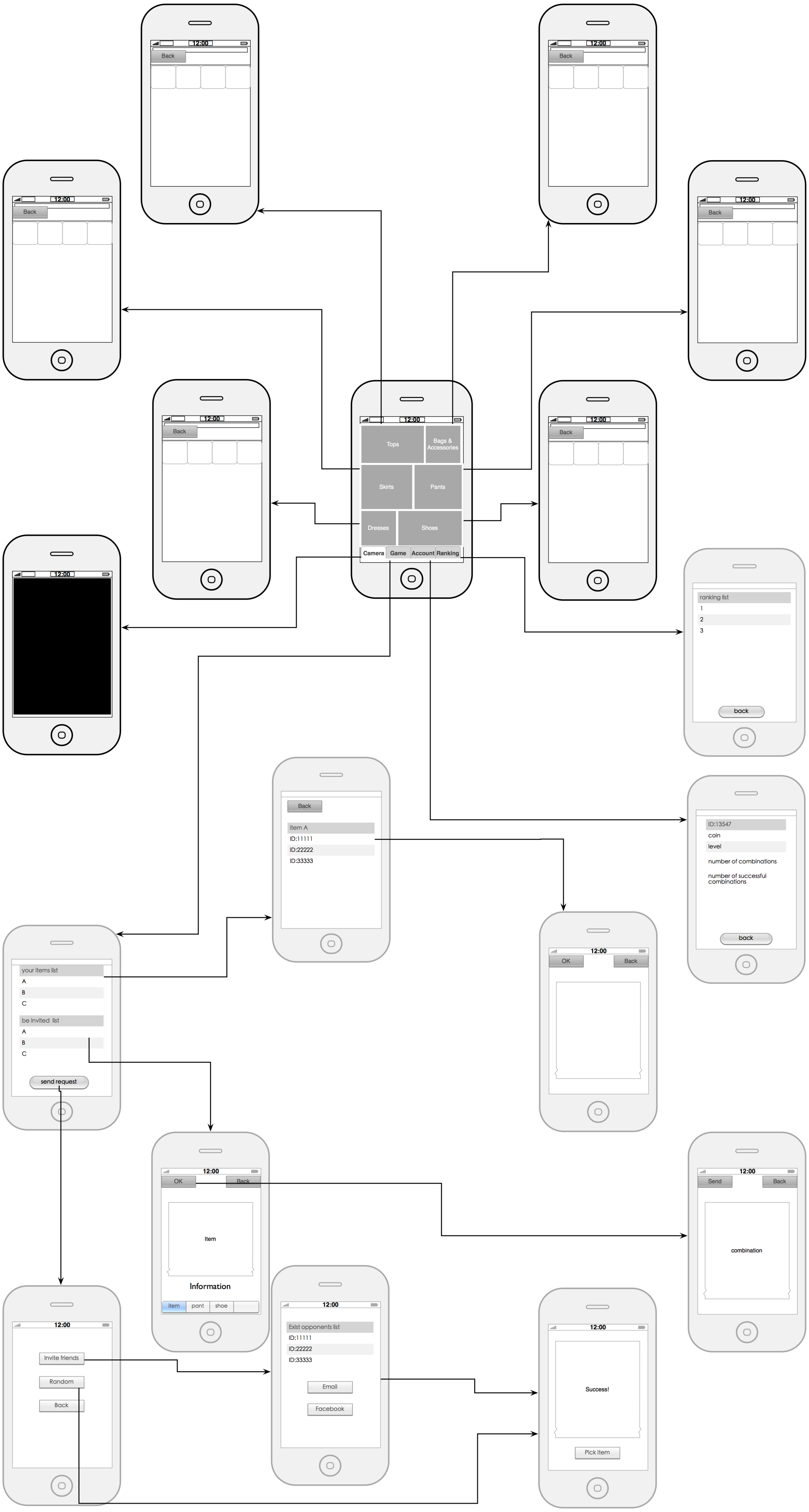


Figure 4.3: Flow

Chapter 5

Implementation

This Chapter is about the implementation of chapter 3 and chapter 4.

5.1 UI implementation

This application constitute by three tabviews: “My wardrobe”, “Account”, “Ranking”(show as [Figure 5.1]).

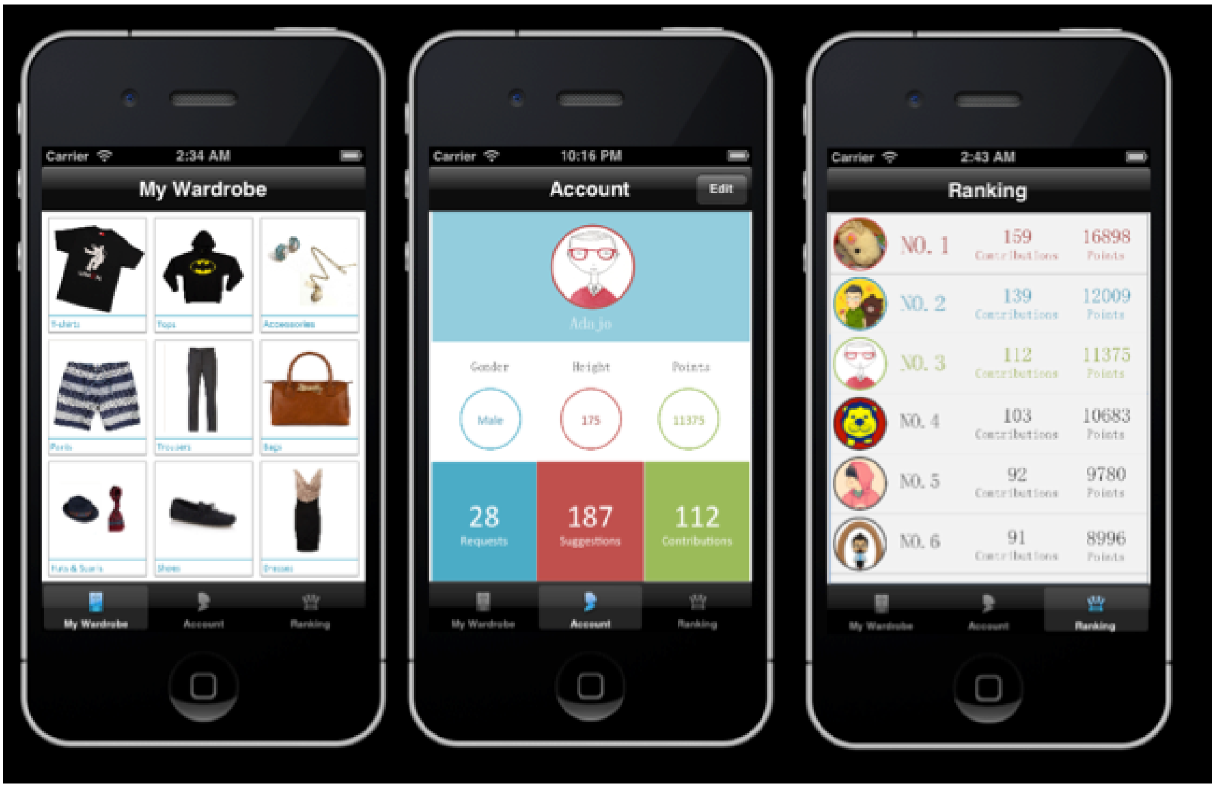


Figure 5.1: UI design

My wardrobe

This is the main page of the application, for people to manage their wardrobes. I classified clothes into 9 categories in the application. Once you push any type of them, it will bring you to the detail view of items. In the detail view, you can easily add/select/search/delete an item.

Account

Account view constitute by two parts. One is user's profile, the other one is the activity of this user.

User's profile information is a option helps the requester/adviser to understand that this a real suggestion/request from a person who really wants to help/help you. I didn't use real name/profile photo in the system, because the online survey shows people don't want public their privacy to strangers.

The activity shows how many request a user sent? how many suggestions he received? how many advises he made? Also you can go to the detail view to look through those informations by push specific block.

Ranking

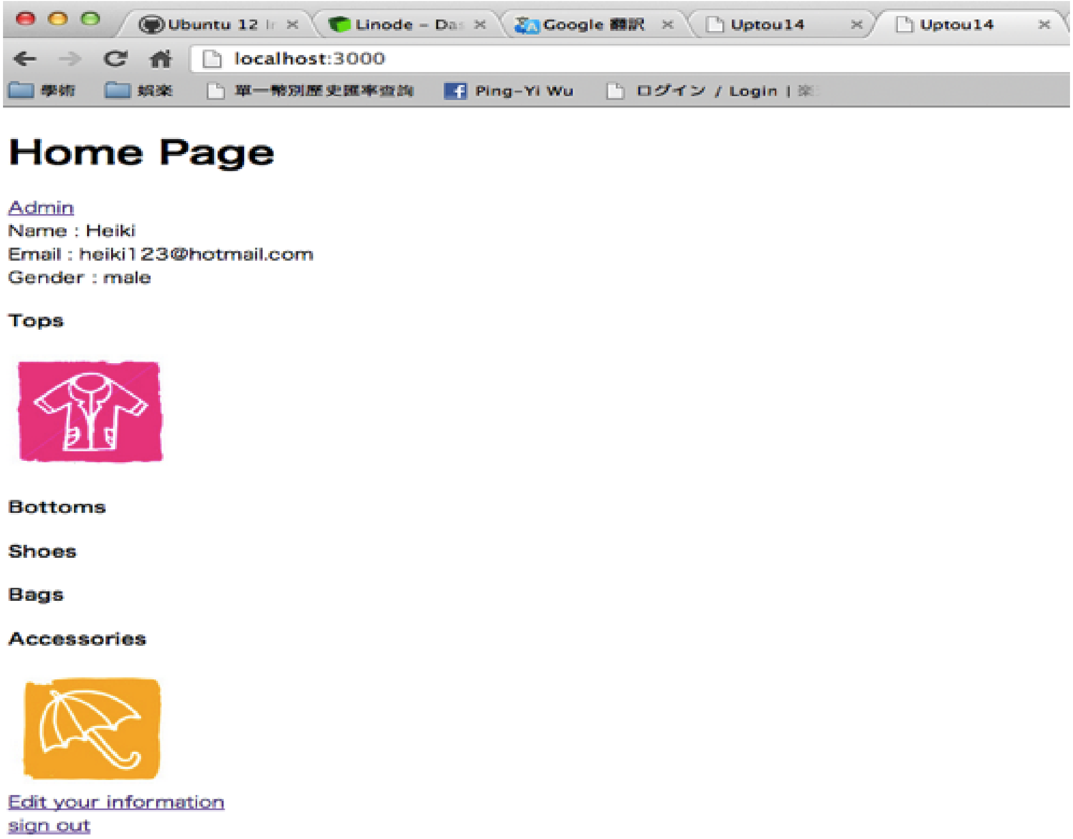
Ranking view shows the rank of this system order by points. The top 3 will be highlighted with different colors, furthermore no.1 will be highlighted with a bigger font.

5.2 Sever implementation

As mentioned in chapter3, i selected Ruby on rails on sever development. [Figure 5.2] is an example in my system:

5.3 Data interchange

As mentioned in chapter 3, i selected JSON as the data interchange language between iPhone and sever. [Figure 5.3] is an example in my system:



Home Page

Admin
Name : Heiki
Email : heiki123@hotmail.com
Gender : male

Tops

Bottoms

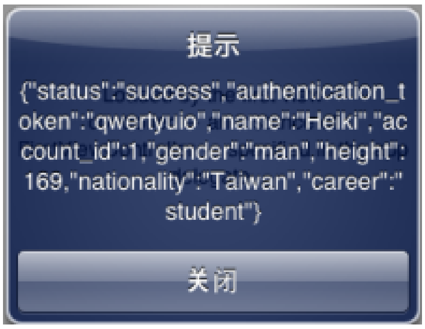
Shoes

Bags

Accessories

Edit your information
sign out

Figure 5.2: Sever development



{"status":"success","authentication_token":"qwertyuio","name":"Heiki","account_id":1,"gender":"man","height":169,"nationality":"Taiwan","career":"student"}

Figure 5.3: JSON

Chapter 6

Evaluation

After the system was implemented, i launched a field user study with 25 participants for 2 weeks. The user study is designed to find out if this recommendation system could provide recommendations of satisfactory quantity, and the differences of satisfactions between different groups.

6.1 Participants

25 participants(10 men, 15 women) in this study came from 5 countries. They have different ages, culture background, and careers (show as [Figure 6.1]).

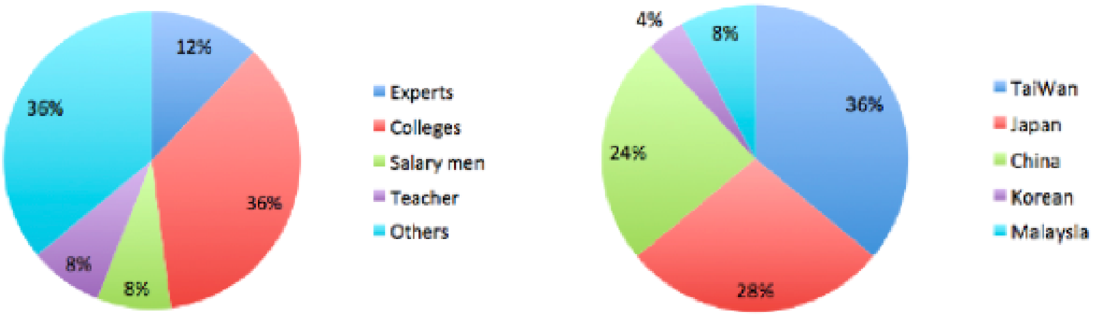
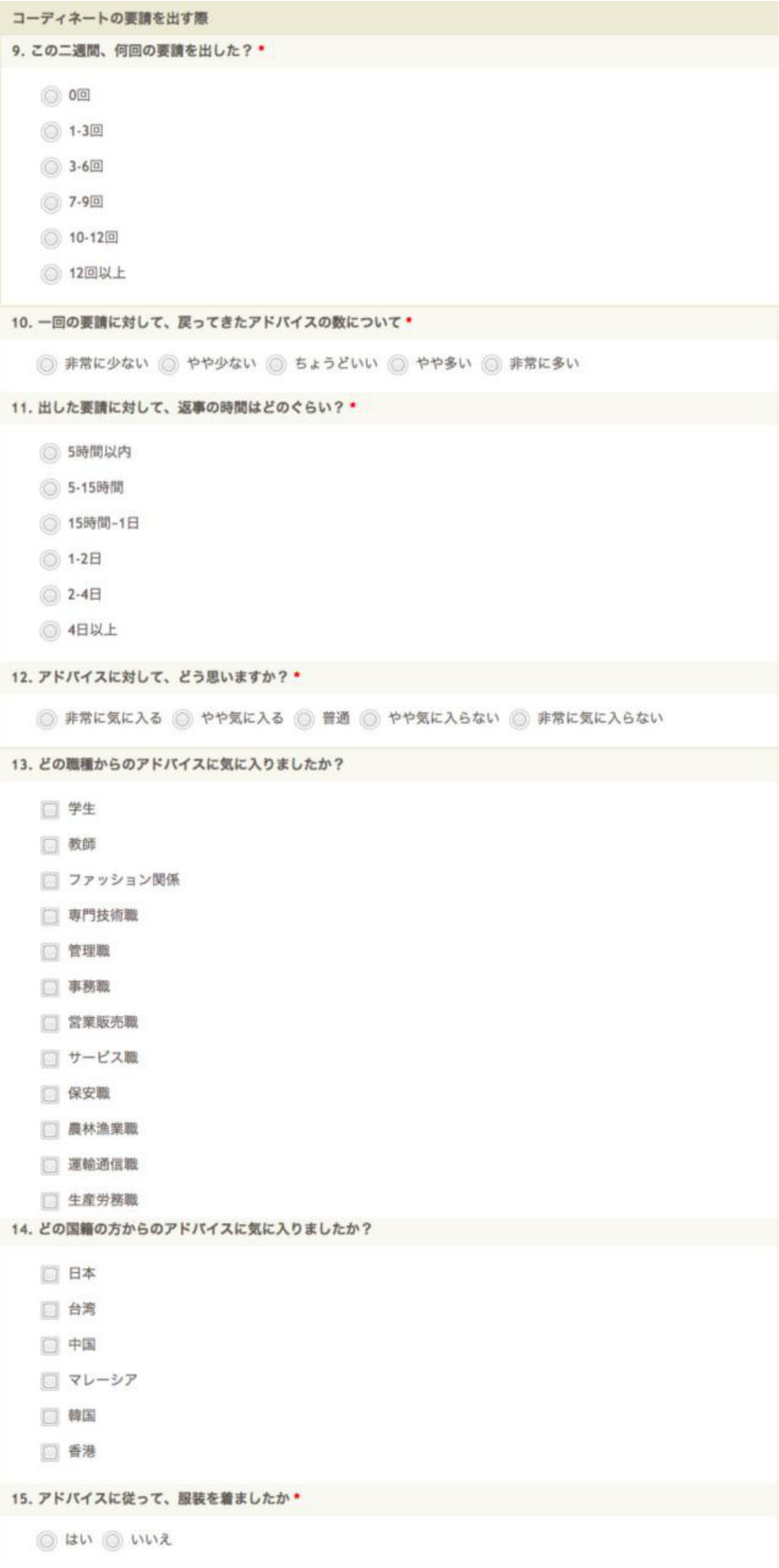


Figure 6.1: Distribution of countries and career

6.2 Procedure

During the user study, participants were required to send at least one request per day. Respond a request or not is depended on advisers themselves. In order to statistic and analyze the result, when participants finished their two weeks' user study, they were invited to fill a online survey (show as [Figure 6.2]). The questions covered typical usage patterns, content ’ s quality, features preferences, likes, dislikes, and suggestions.



コーディネートの要請を出す際

9. この二週間、何回の要請を出した？ •

○ 0回

○ 1-3回

○ 3-6回

○ 7-9回

○ 10-12回

○ 12回以上

10. 一回の要請に対して、戻ってきたアドバイスの数について •

○ 非常に少ない ○ やや少ない ○ ちょうどいい ○ やや多い ○ 非常に多い

11. 出した要請に対して、返事の時間はどのぐらい？ •

○ 5時間以内

○ 5-15時間

○ 15時間-1日

○ 1-2日

○ 2-4日

○ 4日以上

12. アドバイスに対して、どう思いますか？ •

○ 非常に気に入る ○ やや気に入る ○ 普通 ○ やや気に入らない ○ 非常に気に入らない

13. どの職種からのアドバイスに気に入りましたか？

□ 学生

□ 教師

□ ファッション関係

□ 専門技術職

□ 管理職

□ 事務職

□ 営業販売職

□ サービス職

□ 保安職

□ 農林漁業職

□ 運輸通信職

□ 生産労務職

14. どの国籍の方からのアドバイスに気に入りましたか？

□ 日本

□ 台湾

□ 中国

□ マレーシア

□ 韓国

□ 香港

15. アドバイスに従って、服装を着ましたか •

○ はい ○ いいえ

Figure 6.2: Evaluation Survey

6.3 Results

In this subsection, we present the main findings from the user study.

In all, the system recorded 1620 interactions, covering 359 requests and 1261 suggestions, average per request got 3-4 recommendations (show as [Figure 6.3]), 289 suggestions accepted by requesters.We expected to see a much greater number of requests and suggestions. However, eventually one participant hadn't finished the requirement of sending one request per day. On the other hand, 3 (12%) experts responded at least 100 requests . Of the 1261 suggestions, 9 colleges provided 633 of them. The seven most active participants provided for nearly 70% of the suggestions. The requests are relatively equally distributed across the day expect early in the morning and mid-night.

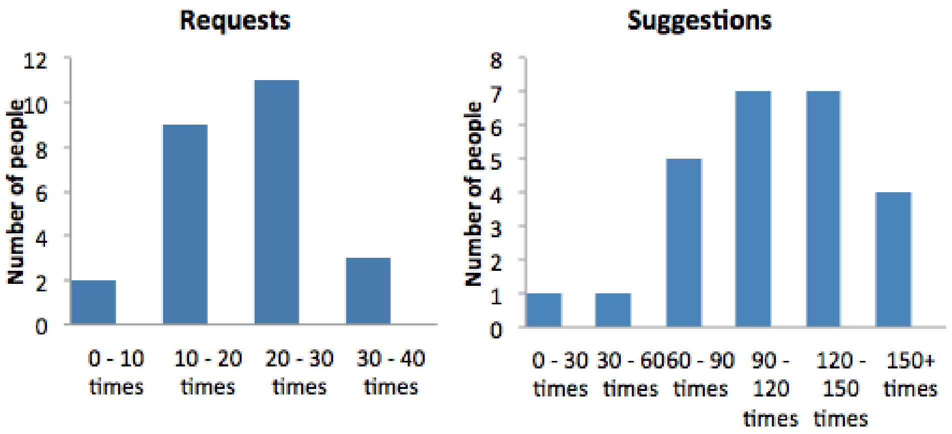


Figure 6.3: Requests&Suggestions

Furthermore, i emphatically analyzed the satisfaction of recommendations among different careers and relationships (show as [Figure 6.4]). Of the 289 successfully accepted suggestions, 3 experts provided 63% of them. 55% accepted suggestions were provided among friends, only 9% of them came from strangers.

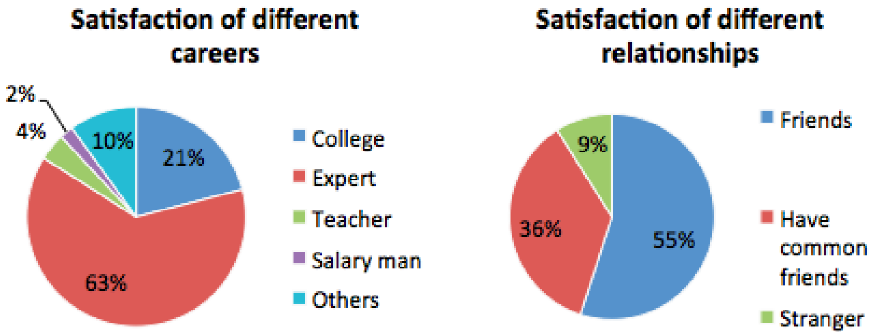


Figure 6.4: Satisfaction of different careers and relationships

It is true that results data were collected under an experiment setting and the end-users may behave differently if the service was deployed in the real world environment. But it is also necessary to point out that during the user study, users didn't be required to respond any request. They provided suggestions only because they want to do that.

Chapter 7

Discussion

This chapter is about the discussion of the results presented in chapter 6.

7.1 Analysis of the results

7.1.1 Completion

According the result of chapter 6, only one person didn't finished the requirement of send one request per day. Three reasons were found, one is he does not puzzle with how to pick outfit and he even doesn't care about how himself looks like. Second reason is, he thought upload the photos of his items is bothering. Moreover the third reason is the categories of clothes also confused him.

It is true that some people really do not have any obsession on clothes mixing and matching or do not have interests of fashion. To those people, fashion recommendation system is no necessary. On the other hand, the other reasons are worth to notice. How to solve the problem of upload user's wardrobe data and the classification mechanism of fashion items are common issues in fashion recommendation system design.

In my study, I already designed an award mechanism to enhance the motivation of upload photos by rewarding them accordance to the number of photos you add to your wardrobe per day. However, it seems not enough. More about user centre design need to be involved in the further design.

Additionally, the clothes categories in my system did have some problems. In my design, I didn't distinguish some concrete attitudes like gender/season. Especially, the difference of wen's and women's item is huge. It needs to be solved in next version.

7.1.2 Incentive mechanisms comparison

From the results of online survey, I also found the most frequent participants might be more motived by intrinsic incentives, the effectiveness of the designed extrinsic incentives to the rest of less self-motived users was still verified. Nevertheless, based on the results, we could hardly come to the conclusion that the proposed game-based incentive has a greater impact than the social psychological incentives and goodwill incentives. We believe that it is not only because the game may not very interesting for the local experts, but also because the expected fierce competition did not happen due to insufficient requests ’ number.

7.1.3 Credibility

Results show that suggestions provided by experts obvious more credible because of experts' professional and authority. On the other hand, we also can easily find that more intimate relationship have more higher credibility.

Chapter 8

Further Work

In this chapter, we discuss the future directions of the proposed fashion recommendation system.

8.1 Trust mechanisms between strangers

According to the results of our user study, only 9% of successfully accepted suggestions came from strangers even other side is an expert. It shows that the credibility between strangers affects the user's judgment. How to design trust mechanisms to enhance the credibility between strangers will be a key issue in the future.

8.2 Cultural differences and incentives

Many studies have been conducted on the topic of designing incentive mechanisms in on-line systems, however, only a handful of research have insight into how the difference of the people ' cultural backgrounds may influence their preferences and decisions. Chandler et al. [34] conducted a natural field experiment that investigates the meaningfulness of a task and people ' s willingness to work. They compared the outcomes from crowdworkers from different countries (e.g., US and Indian). The results reported that USA workers were induced to work at higher proportion when given cues that their task was meaningful, while Indian users were not. Ross et al. ' s research[35] further explained the results by exploring the worker population and usage behaviors in Amazon Mechanical Turk. They found that, unlike moderate- income US-based workers who were more likely doing tasks for fun, there were increasing numbers of International workforce from lower-income countries (e.g., Indian) who treat the micro tasks as one of their major income source and actually rely on it to make ends meet.

8.3 Category management

In modern society, people usually dressed according to the appropriate occasion and purposes to look and feel good. Different systems have different classifications of fashion categories. I consider to design a classification mechanism combine with concrete attributes in the future work. First, I would like to divide system into two version by gender because the categories between men and women are completely different. Further more, in order to mitigate the load of synchronous users' wardrobe date to others, it is necessary to classify items by season or weather.

8.4 User-user communication

My current design does not involve any means for establishing a direct link between requesters and advisers, but the necessity of such a communication link is worthy to be discussed. From the study results, we noticed a trend of requiring worker-to-requester communication. It also can enhance the social incentives, thus building a communication link brings obvious drawbacks as well.

Chapter 9

Conclusion

In this study, I introduced a fashion recommendation system based on the wisdom of crowds. I have described the design circle, the architecture of the system, and the findings of a qualitative formative experiment. Moreover, I presented the results of two weeks quantitative field study of my system.

The user study results show average per request could get 3-4 recommendations, the requests and suggestions are relatively equally distributed across the day expect early in the morning and mid-night. Furthermore, Of the 289 successfully accepted suggestions, 3 experts provided 63% of them. 55% accepted suggestions were provided among friends, only 9% of them came from strangers. Additionally, I also investigated the participation motivation of crowdworkers. I found the top active users were more driven by intrinsic motivations rather than any of the extrinsic incentives (i.e., game-based incentives and social incentives) we provided. But the effectiveness of designed extrinsic incentives to the less self-motived users was still verified. However, based on this study we could not come to any conclusion that can suggest the comparison result between the game-based incentives and the social psychological incentives.

At the last part, I also discussed the future directions of the proposed fashion recommendation system. Design the trust mechanisms and links between strangers will be big challenge in the future fashion recommendation system design.

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