Integrating Context Aware Analysis for M-Commerce Application
Prototype

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EXECUTIVE SUMMARY

Nowadays computing becoming significantly mobile and pervasive, these important changes intend that applications and services must be aware and adapt to progressive environments. Especially, mobile commerce (m-commerce) is an up-and-coming research area because of its relative novelty, extreme growth, and high potential in business applications. Unfortunately, there are several mobile service applications that are lack of any appropriate recommender systems providing context-aware recommendations. Today, developing and building mobile based context-aware recommender system is a complex and time-consuming task due to a number of processes to be done such as analysis of appropriate context regarding application/service and its implementation, and defining its usage level. This thesis will introduce into context aware analysis in order to show you the opportunities with a prototype of context aware recommender system for existing service.
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1 INTRODUCTION

1.1 Background and Motivation of the Thesis

During the development and extension of Internet and its related technologies, the most important change of every user daily lives is the way of managing business. There is no doubt that Electronic commerce (E-commerce) is one of the most prosperous models to investigate opportunities and enlarge business into worldwide commercial market. It provides modern channels for business to conclusively and efficiently trade services over the Internet [1]. But, the traditional E-commerce is established on the client/server approach, which involves a steady and secure connection between client and server. Such a necessary requirement leads to some limitations on the spatial and temporal activities. With a different number of Internet-enabled mobile devices, such as PDA’s, mobile phones, pocket PC’s, etc., the mobile Internet is presenting the new way to numerous modern mobile applications and services that will support mobile users to gain time-critical, goal-driven tasks [2]. Mobile commerce has appeared and attracted an increasing number of research attempt recently. The main idea of mobile commerce is to manage business transaction with mobile devices and telecommunication/wireless networks, or directly and indirectly [3]. It can be of benefit to mobile users to move about a wide range of services over the Internet on an anywhere and anytime. Because of the mobility, personality and workability, M-commerce is going to become the basic business model in the following future [4].

As it was mentioned above Mobile commerce (M-commerce) is an attractive research area due to its relative novelty, rapid growth, and great potential in business applications. Unfortunately, there are a number of constraints effecting both performance and usability of mobile devices. One of the issues which must be taken into account in the design of context aware recommender systems in a mobile commerce applications is the ignoring any contextual information, such as time, place and other factors. In other words, traditional web applications, for instance immouscout24.ch, deal only with two types of entities such as users and services, and do not put the users into a context by avoiding the context aware recommendations. However, it may not be sufficient to count only users and services – it is also significant to develop and involve the contextual information into recommendation systems for web application like immouscout24.ch. In addition, existing e-commerce applications are lack of context aware RS for business processes and still require significant manual effort. In this paper we present a general solution of integrating context-aware RS for existing web application by developing mobile based context aware recommender system which compose services dynamically in real time. We will carry out an evaluation experiment and the results will be shown that our proposed solution is feasible and viable.
1.2 Research Questions
The following questions are significant for the development of mobile based applications. Due to the fact that the main aspects of the thesis are both software development and context-aware analysis.

1.2.1 Which requirements have to be implemented in recommender system to satisfy users?
Recommender systems usually provide a list of recommendations in two different ways such as collaborative or content-based filtering. In our recommender systems' prototype we are going to use second approach in order to satisfy users’ requirements and search. To be more precise, content-based filtering approach applies a number of discrete characteristics of an item in order to recommend another item with similar properties [5]. We are going to implement specific context aware techniques such as location, map, rating and agent due to the fact that recommender system is going to be developed for Immouscout24.ch Search engine for renting apartments. Therefore, in order to be more specific and define real user's needs we will also create questionnaire for about 100 human beings.

1.2.2 Advantages of mobile commerce based applications in comparison with e-commerce based applications?
Mobile commerce reclines on the e-commerce, the divergence being that the transactions are realized from mobile devices such as smart phones or tablets. Today, with increasing number and usage of such mobile devices, the service that does not have a mobile optimized website is simple out of the market. Despite the small screen, having something that can do so much through m-commerce is absolutely an impressive thing and huge help. When user is lack of time or persuades the comfort of doing things wherever he is, mobile commerce is the most appropriate choice. Certainly there is a steady growth in the usage of mobile we. Recent reports show that worldwide cellular networks are experiencing a major boost. In fact, there are even suspicious that the current infrastructure won’t be able to keep up with the new demands. 3G traffic in market will increase by 20% by the end of 2015. There is a forecast which reveals that more than a third of Europeans will be using mobile internet by 2015 [4]. However, the main advantages that mobile commerce will definitely bring to users are flexible accessibility, easy connectivity, time efficiency, in-store rewards and mobility.
1.2.3 What are the benefits of using content-based approach for recommender system?

In comparison with collaborative filtering, there are several advantages of content-based filtering approach such as user independence: collaborative filtering needs other users’ ratings to find the similarity between the users and then give the suggestion. Instead, content-based method only has to analyze the items and user for recommendation; transparency: collaborative method gives to user recommendation because some unknown users have the same taste like the former one, but content-base method can tell to user they recommend to user the items based on what features; no cold start: opposite to collaborative filtering, new items can be suggested before being rated by a substantial number of users [7].

1.2.4 What are the scenario, management and technology for intended recommender system?

The scenario is mobile commerce based for the recommender system prototype developed for existing service (Immouscout24.ch) which purpose is to provide search for renting apartments. Our recommender system prototype will provide to users two different options such as renting the service according to different features (location, agent, etc.) and receive appropriate rated information and recommendation according to the search the users have done.

According to the scenario, user will be able to rate the chosen apartment in respect to the provided criteria's on the web site. There is no need to register, the ratings and viewings are provided through usage specific Immous-code, this code is unique and attached to specific apartment in the database. Using this code the user can easily obtain the significant information such as rating done by previous users, visitors; rate the visited/rented apartment; and receive appropriate recommendation from the system regarding their search (location, number of room, price, etc). All above specified options are not provided by Immouscout24.ch, therefore it is reasonably important and appropriate scenario.

In order to develop above described recommender system we have used following technologies: C# programming language (filtering algorithm), recommendation engine developed in .NET (C#).

2 MOBILE COMMERCE APPLICATIONS

Mobile Commerce has obtained increasing acceptance amongst various sections of the society in previous years. The main reasons for its upward trend can be traced back to the technological and demographical developments that have had an effect on many aspects of the socio-cultural behaviour in today’s world. The need for mobility seems to be the driving force behind Mobile
Commerce. The launch of UMTS technology has provided Mobile Commerce with the necessary verve. Mobile Services gives an opportunity for much commerce to retain their existing, technology-savvy customer base by offering value-added, innovative services and to attract new customers from corresponding sections of the society. The customer survey provides evidence that such sections in the meanwhile include the affluent and financially relevant groups of the society in Europe [8].

2.1 Mobile commerce analysis
Prior to enter the mobile applications market with new product, it is essential to define the real volume of the market and its potential. Mobile commerce is an absolutely popular trend, therefore it is significant to identify classified information on following:
- Who are the key market players;
- How big is the market is in terms of money;
- How much you can earn in the mobile application market;
- Why a business should op for mobile applications in general;
- Ways to make a mobile application;

1.1.1 How profitable is the mobile market?
The mobile application economy was worth $56 billion in 2012, and the forecast for 2016 is that it will grow to $143 billion. The figures vary slightly from researcher to researcher but the fact is that mobile is really big. Revenue is generated through in-app purchases, in-app ads, and big data accumulation. The most promising sections are social networks, utility, advertising, and productivity. The fastest growing markets are APAC and Latin America.
The estimated number of mobile application developers is 2.3 million, which means that one developer out of eight is dealing with mobile applications. Apple, during its World Wide Developer Conference, talked about 1.25 million applications in the App Store accounting for 50 billion downloads and $5 billion paid developers in 2013 [9]. The average revenue for a developer is shown in the table below.

It is expected that application downloads will grow to 200 billion while mobile app revenues in 2017 will be as huge as $63.5 billion. The transaction value for global mobile payments is projected to grow from $235 billion in 2013 to $721.3 billion in 2017. The main trigger behind rocketing mobile app usage is the growing sales of tablets, smart phones and other mobile devices.

<table>
<thead>
<tr>
<th></th>
<th>Google</th>
<th>Apple</th>
<th>Microsoft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of users (in millions)</td>
<td>900</td>
<td>600</td>
<td>12</td>
</tr>
<tr>
<td>Number of apps (in thousands)</td>
<td>800</td>
<td>1250</td>
<td>160</td>
</tr>
<tr>
<td>Number of developers (in thousands)</td>
<td>150</td>
<td>235</td>
<td>45</td>
</tr>
<tr>
<td>Number of downloads (in billions)</td>
<td>48</td>
<td>50</td>
<td>65</td>
</tr>
</tbody>
</table>
Figure 2: The average calculations of revenues [10]

<table>
<thead>
<tr>
<th>Paid to developers (in millions)</th>
<th>900</th>
<th>5000</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average revenue per app</td>
<td>$1125</td>
<td>$4000</td>
<td>$625</td>
</tr>
<tr>
<td>Average revenue per developer</td>
<td>$6,000</td>
<td>$21,276</td>
<td>$2,222</td>
</tr>
</tbody>
</table>

Figure 3 and 4: The growth of mobile app categories [11]

The increase is evident in all app categories. It is clear to mobile researchers that mobile applications are turning into huge distribution channels themselves, rather than saying as independent instruments of marketing communication. The reach, the frequency, and the retention rate are fascinating for mobile applications. It is significant that mobile application usage dominates the overall time spent on daily media consumption at 82%. The majority of available applications are B2C since B2B mobile applications are only now starting to enter the mobile app market. The potential for growth is enormously big. Moreover, the forecasts and the statistics from each research company are slightly different; it is still possible to conclude that the application market is significantly bigger.

1.1.2 Who can you reach through mobile apps?

In the United States, 67% of people use smartphones to access the Internet every day, and the majority would not leave home without their phone. As the PewResearch Internet Project indicates [12], about half of all cell phone users have mobile applications installed, and two-thirds are regular mobile application users. Most users of mobile apps are between 25 and 30 years old, are married, live in suburban areas, and have had at least four years of college education. Mobile apps users
are generally younger; more educated and have higher income than other cell phone holders. Businesses that integrate mobile into their strategy can engage an entirely new type of customer – an instantly connected one. Smartphone users generally prefer to multi-task and be on-the-go. Users who you can reach through mobile applications are more engaged and ready to communicate with your business as long as the channel of communication is accessible and they can find all the product information needed [12].

2.2 The comparison between m-commerce and e-commerce

E-commerce or electronic commerce, is the process of buying and selling goods, products and services over electronic systems such as internet, telephone and e-mail. M-Commerce or mobile commerce is process of buying and selling products and services through wireless handheld devices such as cell phones or PDAs. Compared to M-commerce, E-commerce is more limited as it requires the use of a computer and internet connection, while mobiles work on satellites. Video conferencing is now available on mobile phones with 3G and 4G networks, without the hassle of internet. M-commerce however is costly compared to E-commerce.

With the increase of competition in the business environment companies are striving to keep up with the pace, else they might face the dire consequences of getting devoured by a stronger player. In order to sustain this competition companies are developing better and newer products and services for the clients and customers. With advancement of cutting-edge technologies and state-of-the-art tools, traditional commerce is facing titanic shifts with respect to customer behaviours. One such behavioural change which has taken shape in the businesses and services environment has been the demand for portability and mobility. This would help the customers enjoy services and access information wherever and whenever they want. With the recent emergence of the wireless and mobile networks, a new platform for companies to trade their products and services, known as m-commerce is beginning to gather attentions from businesses. The access of internet is necessary for e-commerce but m-commerce connectivity can be established wirelessly in a mobile environment using mobile devices.

![Figure 5: Similarity and differences between E-commerce vs. M-commerce](image-url)
There has been an exodus from e-commerce to m-commerce due to a number of inherent factors, such as:

- **Time cost:** In case of m-commerce services are provided at the point of need but in case of a traditional e-commerce, customers had to move from a work environment to a computing environment.
- **Convenience cost:** Due to the fact that the different m-commerce platforms are integrated to the work environment there is no transition required. One can access it from anywhere. Since mobile devices are easy to carry it offers more ubiquity and convenience. Moreover text messages through mobiles are considered to be powerful marketing medium compared to web marketing as it never requires any internet connectivity.
- **Customizable:** Given that mobile devices are usually owned by individuals and not shared between different users, m-commerce allows the services to be catered towards the users' needs (e.g. ring tones).
- **Increase in number of devices:** With the sales of iPhones and Galaxy tabs the potential mass market for m-commerce is sky rocketing. With a shift in the medium of communication from PC's to tablets and smart phones there is a parallel transition from e-commerce to m-commerce [13].

**Limitations of M-Commerce over E-Commerce**

Although the M modes of commerce are gaining popularity there are still a few areas of adjustments which would give it further acceptance among the customer fraternity when compared to the E modes of commerce:

- **Attraction:** Since the customers are not fixed to a single location while browsing for a particular commodity they look for the nearest store and also for any special offer which prevail in the nearest store. So it very important for the retail stores to clearly mention about the locations and the prevalent offers while promoting their stores on the m-commerce platforms.
- **Visibility:** Since the screen/visibility and scope of a mobile device is limited as compared to that of a PC, the app (applications) should also be different. Most of the times it is difficult for a customer to browse through the entire catalogues using a mobile app, hence it should be compact, the focus should be more on the important aspects of the catalogue and the impact should be more.
- **Light pages:** Compared to the e-commerce communication channels, the m-commerce channels suffer from latency and low band width. Hence the page should be lighter so that it can be opened and accessed even when the connections/signals are weak.
- **Payment:** The payment transactions and the exchange of sensitive data should be made more secure. Online payments are a great deterrent in the successful path of online
purchase platforms. If it can be ingrained in the minds of customers that the transactions are safe and secure there might be a significant increase in the number of customers using the online route rather than the in-store purchase route [13].

2 CONTEXT AWARE ANALYSIS

The significance of contextual information has been determined by researchers and practitioners in number of different disciplines such e-commerce personalization, mobile commerce, information retrieval, ubiquitous and mobile computing, data mining, marketing, and management. While a substantial amount of research has already been performed in the area of recommender systems, most existing approaches focus on recommending the most relevant items to users without taking into account any additional contextual information, such as time, location, or the company of other people (e.g., for watching movies or dining out). No doubt that relevant contextual information does matter in recommender systems and that it is important to take this information into account when providing recommendations [6].

3.1 Context awareness and Recommendation Systems

Context aware recommender systems generate more relevant recommendations by adapting them to the specific contextual situation of the users. Palmisano et al. [14] use the intent of a purchase made by a customer in an electronic and mobile commerce application as contextual information. Different purchasing intents may lead to different types of behavior. For example, the same customer may buy from the same online account different products for different reasons: a book for improving her personal work skills, a book as a gift, or an electronic device for her hobby. To deal with different purchasing intentions, Palmisano et al. [14] build a separate profile of a customer for each purchasing context, and these separate profiles are used for building separate models predicting customer’s behavior in specific contexts and for specific segments of customers. Such contextual segmentation of customers is useful, because it results in better predictive models across different e-commerce applications [14]. Recommender systems are also related to e-commerce personalization, since personalized recommendations of various products and services are provided to the customers. The importance of including and using the contextual information in recommendation systems has been demonstrated in [15], where the authors presented a multidimensional approach that can provide recommendations based on contextual information in addition to the typical information on users and items used in many recommendation applications. It was also demonstrated by Adomavicius et al. [15] that the contextual information does matter in recommender systems: it helps to increase the quality of recommendations in certain settings. Similarly, Oku et al. [16] incorporate additional contextual dimensions (such as time, companion, and weather) into the recommendation process.
and use machine learning techniques to provide recommendations in a restaurant recommender system. They empirically show that the context-aware approach significantly outperforms the corresponding non-contextual approach in terms of recommendation accuracy and user’s satisfaction with recommendations.

3.2 Content-based filtering in recommender systems

There are two basic architectures for a recommendation system:

1. **Content-Based systems** focus on properties of items. Similarity of items is determined by measuring the similarity in their properties.

2. **Collaborative-Filtering systems** focus on the relationship between users and items. Similarity of items is determined by the similarity of the ratings of those items by the users who have rated both items.

In the development of the Recommender system prototype we are going to use first approach which suits better into the scope of the objectives we pursue. These are the provision of appropriate recommendation related to the search scope run by the users, the provision of strong rating systems which will allow users to get true suggestions and comments from previous real users (the features are obtained through survey in order to satisfy users needs as much as possible).

There are number of advantages of content-based filtering for recommender systems in comparison with collaborative-filtering approach. These are:

- **User independence**: collaborative filtering needs other users’ rating to find the similarity between the users and then give the suggestion. Instead, content-based method only have to analyze the items and user search categories for recommendation.

- **Transparency**: collaborative method gives you the recommendation because some unknown users have the same taste like you, but content-based method can tell you they recommend you the items based on what features.

- **No cold start**: opposite to collaborative filtering, new items can be suggested being rated by a substantial number of users.

3 RECOMMENDER SYSTEM PROTOTYPE

We aimed to develop mobile based recommender system we have made research which service is better and features we have to implement in order to succeed. We had revised a number of internet services to choose the most relevant one, one of them became our choice as the case, it is ImmouScout24.ch web-site that provides users the most popular service in Switzerland – renting or buying houses, apartments, rooms and so on. It is well designed and well known service, where users can run a search for above mentioned object regarding their personal needs, and the service
is provided in four different languages such as English, German, French and Italian. But the main disadvantage of the following service that is does not provide any recommendations. In order to solve this issue we have decided to develop recommender system dedicated to the ImmouScout24.ch. Our recommender system will provide recommendations to users according to the search they have made, and it will show all relevant information regarding the searched object. Also, it is also possible to read comments and suggestions from previous users, renters and other people who have had any relation to the object. Moreover, users are able to rate appropriate features presented in the recommender system.

![Image of ImmouScout24.ch Prototype Case](image)

Figure 6: ImmouScout24.ch Prototype Case

### 4.1 Intention of the prototype

In order to define the features that will be appropriate and will satisfy users needs we decided to make a survey among people in Bern city. What kind of recommendations they need more when they search for an apartment or house? The survey was done among the people living in Bern in the age range from 18 to 55 whose occupation varies from students, professor, social workers, and so on. The survey was done in the main train station of Bern (HauptBahnhof) where is a big number of people run every day. The overall number of people who answered our questions equals to 100.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratings to Location of the flat (house, apartment, studio)</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>Ratings to Agent</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>Ratings to House (truthfulness of the photos)</td>
<td>92</td>
<td>8</td>
</tr>
<tr>
<td>Other (Ratings of neighbours; Near Facilities; etc.)</td>
<td>63</td>
<td>37</td>
</tr>
</tbody>
</table>

![Table of survey results](table)

Figure 7: The results of the survey
4.2 Development environment

The following development tools have been used during the development and implementation of RS: Visual Studio 2013, Microsoft SQL Express Server, Microsoft SQL Management Studio. ASP.NET, C# Mobile Application, jQuery, Bootstrap, CSS and Google maps API, Google geocoding API, Google Analytics API, Entity Framework, ASP.net artificial intelligence algorithms.

The Recommender Systems Application was developed step by step according to the plan, starting from the notion of the user interface, then followed by low fidelity prototyping and eventually testing. Our RS application will provide more dynamic interaction with the usage web services technologies. The user is able to check the chosen apartments, the algorithm runs in the following order: request is sent to the web service which requests to the corresponding Immoscout24.ch page, parse it, extract data from ImmoRate database, aggregate all information and sent it back to the client. It provides non-visibility for the client and at the same time makes calculations more powerful on the server, also database sides and results are quicker, more efficient and usable for user interaction.

4.3 Software architecture, methodologies and system functionality

ImmoRS is the web application which has standard three-tier architecture: database server/logic, application server/business logic and the web client/user interface. The postback or json request from the client side calls the application server. If stored data is needed than the request to Immoscout24 or ImmoRS database is initiated. Data are processed at each of three levels.

Figure 8: ImmoRS Prototype Architecture [17]  
Figure 9: Use Case Diagram
Immoscout24.ch is one of the most popular platforms for the property search in Switzerland where people and agencies can publish the information about available properties online, such as flat, rooms, houses, etc. But unfortunately there is lack of recommender system that can help users, and the platform is very simple in the using of database. It would be really useful for the citizens, and all users who is searching for an apartment, if they had a Smart Recommender System for quality-improvement of the Apartments, for insurance of truthiness of information regarding Location, Map, House itself, etc. learned from experience of past users in order of collecting historical information about user satisfaction. ImmoRS is a mobile, smart, web-based Recommender System for the crowd in Switzerland. For now, it uses available data from Immoscout24.ch. Each house, apartment and agent has a unique Immoscout24-Code which is used for the data consistency. ImmoRS user interface (figure 16) has five main provisions: check, rate, map, smart search and agent information respectively - to check the apartments, rate the apartments, view the apartments on map and also check the agent rating, and system suggested apartments in the places where you are looking for. One more element of the web site is the main page which is presented in figure 17 and has two main blocks. First one is the map which shows houses and apartments of properties around current user location. Second presents the current ImmoRS statistics: amount of rated apartments and locations, agents, users and total amount of ratings, smart search using AI methods which lets users to have more options, for instance when the users are looking for apartments in Bern for instance, then ImmoRS will not only recommand the apartments in the region Bern, but also will recommand the nearest houses or apartments in bound of the Bern, which is in distance of only two or five minutes from Bern for the users. For this the system uses AI method (knn) algorithm or What's called k-nearest neighbors algorithm. The workflow of the algorithm is: K=1 is the nearest neighbour of elements for defining class, and in order to represent it in feature space each traning vectore defines a region in that feature space, and each region are defined by equation (figure 10):

$$R_i = \{x : d(x, x_i) < d(x, x_j), i \neq j\}$$

Figure 10: Equation for K nearest neighbour

R(i) is a region, X:d, (x) is element and (d) is distance between element, so (x,xi) should be smaller for same distance for each order element, in this case we must define a Voronoi (N) partition of the dimensionl space defined by property of knn algorithm, which mean for each Canton or village in Switzerland will be R(i)=R1,R2,R3,R4 region as first step in figure(11), because users searching in specific area for renting apartments and houses. After we specified each regions in space, we must compute the distances between feature spaces. This is done because if user looking for an apartment in one Region as Bern, so the system should be smart enough to not only tell the user about all apartments exactly in Bern, but also there are might be many apartments that located near to Bern, which is not far away (from five to ten minutes) via Bus or bicycle and it might be interesting for user, as instance there are many apartments located around of Bern and are
cheaper, bigger and in terms of distance take only few minute. Therefore we need to compute distances between spaces and use API timetable data (transport) of Switzerland. So, how is training vectors knn algorithm nearest neighbour’s works? For example, we have K=4 neighbours which are four classes (a, b, c, d), and have R3 one area, which is an order feature vector that we want to estimate its class according to labels, so R3 going to compute distance to each neighbor and define the nearest apartment to R3, as we see in figure (12), (d) is nearest neighbor (apartment) to R3, so R3 will be equal to training vectors knn algorithm nearest neighbours, figure (13) shows illustration of supervised learning in more detailed.

Figure 11: Regions of training vector in space nearest neighbours [18]

Figure 12: Training vectors knn algorithm for

Figure 13: Illustration of supervised learning [18]

ImmoRS does not request registration for users who want to rate or view ratings. The user is tracked by Google Analytics User Id stored in cookies. The reason of using this solution is to attract more users by simplifying the interaction with application. The user has to enter the unique Immoscout24-Code in order to see all the information about the apartment and at the same time the system will recommend some others apartments in same areas and also will offer all similar flats that user looking for because here we are using AI algorithm: User-User Collaborative
Filtering recommender systems. This method matches a user against other users with similar preferences and then combines the preferences of those “nearest neighbour” users to form predictions and recommendations, similarities between different flats in the dataset are calculated by using one of a number of similarity measures, the parameters is adjusted cosine-based similarity, minimum number of users for each item-item pair and Number of similar flats store and offers more suggestion for users, in the following figure (14) you can clearly see the similarities between the angle vectors and model to predictions.

If another ImmoRS user has already rated current apartment, location, agent or property - corresponding aggregated rating would be also presented. The rate provision gives functionality to rate the apartments. The user can give ratings for the overall quality of the flats (how genuine the apartment is), location of the apartment/house, agent and the quality of the property. There are four rating options available such as: Awesome, Good, Mediocre or Bad. The map page does not only show the geographical distribution of apartments, but also provides heat maps. Each heat map is an overview of users rating over one of characteristics: apartments or houses, location, or quality of property. The map also has a function of pop-up info-box which presents the summary of the certain apartments. The agent functionality is used to rate and view total rating of agent. Immoscout24.ch website also displays an agent code corresponding to an agent. This agent code can be copied and applied in the ImmoRS application to view the agent details and also to rate them, or leave comments. In addition to ratings, the users can also provide reviews as justification to their ratings. The last thing we used is Swiss applications public timetable data, the aim here when users searching for flats, the system will tell them how much each place far away from one place to another place by (Bus, walk, bicycle). In the following figure you can see the data transport and request parameters information used in the development.
4.4 The prototype of recommender system

The following chapter presents the results of RS prototype development, including short description and screen shots of the ImmoRS application.

In figure 16, you can see the main page of the system. When user proceeds from the ImmoScout24.ch platform into the recommender system ImmoRS, the user will be able to choose one of the main options presented on the top side of the application such as rate, check, map, agent and smart search. Also, there are some small statistical information about amount of apartments, agents, ratings and users, which will gradually increase.

One of the main options of the ImmoRS is to provide information in the heating map (figure 16), so users can appropriately see the exact location of the chosen apartment in the map, and also those apartments that had been recommended to him according to their zone of location. Moreover, the
user will obtain additional information related to each apartment on the map, these are code of the apartment, the address, the latest general rating and ratings of location and house.

![Image](image1.png)

**Figure 17: The user interface for recommended apartments**

The below presented figure 18 shows the *Rate* option which provides opportunity to users to rate according to the quality of advertisement, agent, house and location. Also, users can leave comments about their experience with the following criteria's. During above described steps, users will be able to see the information about the apartment, view photos and its location on map accordingly.

In figure 19, you can see the most important option of the ImmoRS, which is *Check* option, where users can check their chosen apartment from ImmoScout.ch. By providing unique code of the apartment taken from the ImmoScout platform, user can obtain following information such as ratings, comments, general house information, photos and additionally recommended apartments related to the chosen apartment.

![Image](image2.png)

**Figure 18: The Rating in ImmoRS**
In figure 20, there are options for ImmoRS users to obtain information about the Agent such as general information (Agent code, name, and address), immorate rating and users comments. This is done to help users to obtain before meeting knowledge what to wait, and know what the experience of the agent is.

In figure 21, there is final option of our ImmoRS system, which allows users to make smart search. This means that the system will not only recommend similar flats to the chosen one by user, but will also provide additional recommendation of flats according to their distance. In the check option, the user searches for the exact apartment using its unique code, and then get some recommendations which is similar to the searched flat (location, number of room, price). But in smart search, it will both recommend above mentioned apartment and additionally recommend other flats. Additional recommended flats show following details such as how far is the nearest flat away from you (from 2 min with bus or 5 min walk), in order to achieve this we have used Swiss data transport places in our application.
4.5 Problems during the development

During the development of the prototype we have had several problems; the most significant one was the lack of access to the database of Immoscout24.ch platform. The reason is that ImmouScout24.ch does not allow accessing the server for third party without any sufficient reasons. Also, Immoscout24 does not provide any mobile API script in their server, due to this it has poor mobile application. The step of gathering requirements was not easy, because we have implemented many requirements in our mobile application such as checking immoscout24 code, recommender system apartments, rating apartments and agent with unique code. We also used AI Algorithm for making the application smart and learn from experience, and also we applied Map API in order to see the comments of user by clicking on the map and zoom it.

4.6 Evaluation

After the implementation of objected features we have conducted an evaluation of the developed ImmoRS recommender system based on ImmoSvout24.ch Platform. We have provided an opportunity to the student of Universities if Bern, Fribourg and Neuchâtel to use and experience the recommender system for the first time. Almost all students were familiar with ImmoScout apartments search platform before, therefore they were exited to evaluate new recommender system based on that platform. The number of student who used and evaluated ImmoRS web application is 50, they are enrolled to Master courses. The evaluation ran in the period from 20 March 2015 to 29 March 2015.

We have had three different estimation marks that student had to give for the system. As it can be from the below presented figure, the application was successful and understandable to use. However, some students were not satisfied and gave some suggestions, such as:
• To provide instructions page or guideline
• To implement some “small definitions” per option
• To provide small video demo how to use RS

<table>
<thead>
<tr>
<th>Estimation (Understandability)</th>
<th>Number of people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>42</td>
</tr>
<tr>
<td>Average</td>
<td>8</td>
</tr>
<tr>
<td>Bad</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 22: The evaluation of ImmoRS

5 CONCLUSION

We have developed Recommender System application which provides the most necessary options for the users who is looking for inhabitation such as checking the defined apartment in RS to get other recommendation or to view independent information from previous users who have already been or live in that apartment, rate the apartments, get suggestions, read or write comments and run smart search using AI algorithm which provides precise search. In the current system, the crowd can rate any apartment, agent, locations, as bad, awesome, mediocre and good. The extreme conditions (Awesome and Bad) comment becomes more valid and trustworthy when a justification is provided along with it. Also the Crowd has the opportunity of view comments about houses from previous users. We assume, as extensions in the future it would be great to provide filtering for the comment content, since not all users are well behaved and give right suggestions. Our Application is independent and mobile web application and do not interrupt with Immomscout24 application. Our application possesses several heat maps that show the distribution of apartments and quality of properties, locations. We used Google heat map API algorithm which creates a heat map based on average over equals but not on summarization over all. Such heat map would be able to give a better clarity of vision and understanding for the users, both viewing and rating the apartments via the map. The heat map which shows distribution of apartments can use over all' algorithm and rating heat map-'over equal' to highlight negative zones. By doing this project, we realized that incorporating of public can bring big changes in perceiving useful websites like Immomscout24.ch with more clarity. Even if Immomscout24.ch is considered to be one of the most popular, reliable and dependent sites, it does not provide any an opportunity to justify the apartments. Our application has made the website more intelligent, credible and efficient by including the recommender system. Finally, we used Swiss public time data for exploring the timetable data for help users when searching for apartments, telling them how much houses far away by bus, bicycle, or walk. By this we have developed fully mobile API script platform which was not valid in Immomscout24.ch.
REFERENCES


[19] Source: Recommender systems. A Computer Science Comprehensive Exercise, Carleton College,Northfield,MN.
http://www.cs.carleton.edu/cs_comps/0607/recommend/recommender/itembased.html