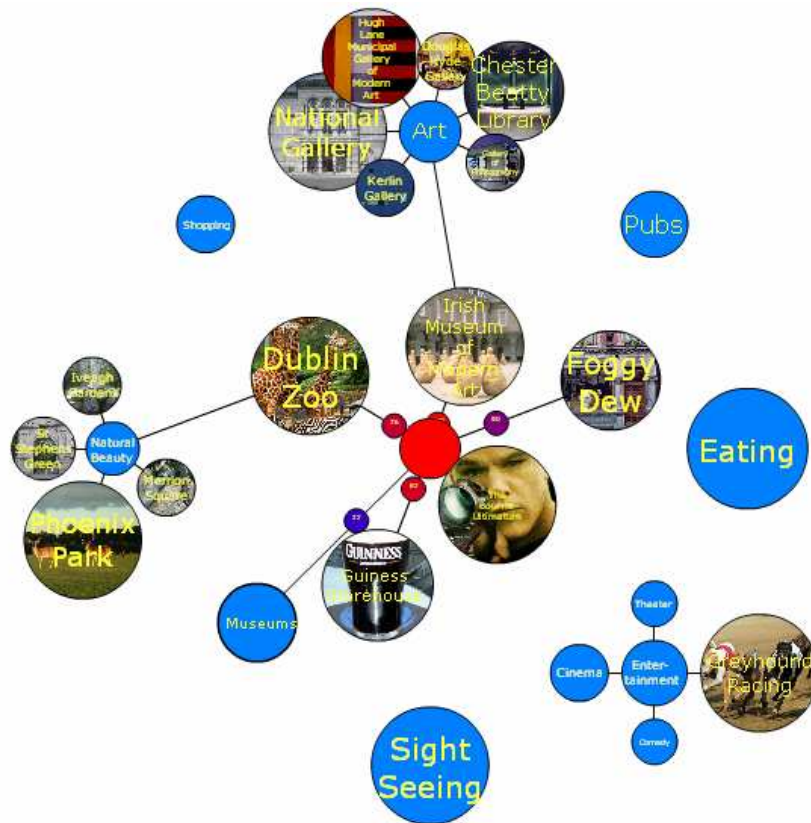


# A Novel Approach to User Interest and Preference Modelling in a Sightseeing Planner for Dublin



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*A dissertation submitted to the University of Dublin, in partial fulfilment of the requirements for the degree of Master of Science in Computer Science*

September 2007

## Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university.

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## Abstract

A tool has been designed, developed, implemented and evaluated that users can use in a playful manner to specify their interests and preferences. This tool that can be used to visually represent a categorized set of choices which manifest an approach for going from the generic to the specific and dynamically and visually model user interests in these choices within a certain constraint set. The tool can subsequently make suggestions to the user depending on the modelled interests of the user and the associated constraints while the user feels empowered when using the tool.

In this project, as a proof of concept, this generalized idea has been exemplified on building a visual Dublin Tourist Planner, taking the planning of a tourist's visit to Dublin into the digital age.

In particular, in this application, a potential Dublin tourist can access a visually intuitive, categorized and constantly updated knowledge space of Dublin's tourist attractions, restaurants, pubs, theatres, cinemas etc. over the Web. The application then allows him to choose a selection of potential attractions that he would like to see, thereby creating his own personal user interest model of Dublin's tourist attractions. Finally, this information is used to recommend to the tourist possible sensible visitation schedules that take into account the tourists interests.

The finalized schedule and associated personal tourist map with directions can be saved, printed out or downloaded onto various mobile devices, such as mobile phones, PDAs etc. and possibly integrated with other services, such as booking and reservation services.

The main gain for a tourist using this application is the dynamic, visual and playful nature of planning his visit to Dublin with the application dealing with the less interesting aspects associated with planning, such as the most suitable visiting order regarding opening times etc. This means that the user can concentrate solely on his interests and preferences while accessing the knowledge space of Dublin tourist attractions.

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# 1 INTRODUCTION

*“The traveller sees what he sees; the tourist sees what he has come to see.”*

G. K. Chesterton (English born Gabonese Critic,  
Essayist, Novelist and Poet, 1874-1936)

As G.K. Chesterton quote fittingly suggests, a tourist is a person who has expectations to what he wants to see on his visit to a new place. To find out about the place that he plans to visit, a tourist has several options. The conventional tourist would most certainly visit a well-equipped bookstore and acquire one of a choice of any 2007 edition of some Tourist Guidebook. The conventional tourist would then sit down, read or skim through the text, compare his travelling schedule with opening days and times, locate and compare attractions by consulting accompanying foldout maps at the end of the book, note down possible points of interest to visit, return to the textual information, rearrange the order of attractions several times while he is adding other interesting attractions etc. until he has negotiated a suitable schedule that satisfies his time, monetary and other constraints. He might then pick up the phone to call ahead to ask for availability, make reservations, buy tickets, or book seats.

However, with the rise of the internet and an always increasing connectivity, online awareness and increasing online content, the tourist has been offered new avenues of information acquisition and planning possibilities. He might now instead scan through the internet and google pages for “Tourist Information” or “10 top attractions” and “Best Nightclubs” for his destination. He would then be presented with a choice of hyperlinked web pages to browse through containing mainly textual and visual information about the specific attractions to see or even an overview. There he can also access information about more current events that are not contained in a tourist guide. In addition to this, he can easily locate attractions on online maps such as Google Maps with the addition of automatic way-finding and route planning as well as online services for checking availability, reservations and bookings.

A further development adding yet another new way of exploring a city has been opened up by the availability of mobile devices that are linked to the internet, such as mobile phones and PDAs and by the availability of global positioning systems on such mobile devices. While the first aspect allows for the spontaneous look up of information that is available on the internet while on the go, the real value of mobile devices in the tourist scenario has been realized by joining the mobile online device with a GPS device. Attaching tourist and other information to geographic locations, a process known as geo-tagging, has made possible a much more ad hoc mode of discovering a city, making tourist information available depending on the tourist's actual location.

Nonetheless, even a modern web and location aware tourist still has to solve the problem of how to best use his available time to do and see all the things that he is interested in. He still needs to determine the most satisfactory choice and visiting order of attractions by constantly negotiating between his interests, monetary budget and time to spend on each point of interest (POI) and the portion of time tolerable as travel time between POIs in consultation with maps of the area while also considering opening days and times. However, while the internet has made a whole lot more textual and visual information regarding tourist attraction to choose from available to the tourist, simplified ways of finding the locations and make reservations, there exists a deficit in the way that the tourist's interests are currently being captured, and sensibly used to help him negotiate and plan a satisfying visit to a new city. While there exist some experimental tourist planners, these are usually limited in the ways of either how they present the information on attractions available to the user, or capture user interests or use this information to plan the tourist's day. The information he is presented with is very static and it is up to the user to decide how to use it in planning his visit and there is only little support in helping him negotiating his schedule. It is believed that it is possible to develop a new and innovative way of presenting available information, capturing and modelling a user's interests which will then be used in planning his visit which is more enjoyable, efficient and personal.

Considering this scenario, it can also be seen that the problem of the tourist can be generalized into a more general problem situation, in particular any situation involving a choice of possible objects that are associated with one (or more) specific

constraint(s). Whereas in the case of the tourist, the choices are the tourist attractions and the most obvious limiting constraint would most likely be his available time or money, many other situations exist where a negotiation has to take place between the level of interest in a choice of objects and one (or more) specific constraint(s).

It has been noticed that there is a deficit in the way a user's interests are being captured and modelled in general and that these are most often limited to the use of textual information in combination with list style drop down boxes or tick boxes. It is the aim of this project to target these limitations in an innovative fashion exemplified on a tourist planning his visit to Dublin.

## **1.1 Goals**

The overall goal of this project is to design, develop, implement and evaluate an innovative user interface that users can use in a playful manner to specify their interests and preferences. The aim also includes that the user should feel empowered while using the tool; it should engage him and make him feel in control of his experience.

This tool will manifest an approach for going from the generic to the specific allowing users to describe their interest or preferences as appropriate.

This goal will then be realized on the specific example of a Dublin tourist, resulting in a tool that would help a tourist plan his own personalized sight seeing day in Dublin.

In detail, the first goal is to investigate a new way of an intuitive representation of available choices which could then be used to playfully and enjoyably capture a person's individual interests and preferences in these choices. Thereby care will be taken, that the information presentation is kept simple as to not overload the user with textual and visual information, but at the same time allow the user to browse through and delve into more detailed information at his wish. On the example of a tourist, these choices would represent tourist attractions etc. and his interest in them would represent how important is it to him to visit chosen attraction. In addition, the tool should be able to capture how long he would like to spend visiting it.

The innovative user interest capturing tool should also be able to capture his interest in a choice in comparison to all the other choices he has an interest in, i.e. in the tourist example, it should also be able to model how important is it to him to see this attraction in comparison to visiting other interesting attractions. This eventually comes down to how many of the other possible interesting attractions is he willing to sacrifice for this specific one and how much travel time between attractions does he tolerate to see this specific attraction.

It is important here that the user interest model is modifiable and adjustable by the user throughout the planning process.

The second goal of this project is to investigate the feasibility and usability of this new and innovative way in capturing and modelling a user's interests and preferences in the aforementioned choices by exposing it to real users and getting their feedback.

Thirdly, the user built interest model should also be consumable by another service, which can then dynamically and sensibly use the captured interest information to suggest a possible sensible outcome taking into account the interest levels of the choices and the specified limiting constraint. This service will most inevitably be specific towards the domain that this tool is being used for. In the example of the tourist this service would be a planner which will take over all the less interesting aspects of planning a tourist visit that the tourist would otherwise have to deal with himself, such as checking the opening times, finding comparing locations on maps to find the most suitable visiting order, enquire availability, make reservations etc. and suggest a possible visiting agenda. It is hoped that this new and innovate way of planning will give the user a more pleasant experience over the planning process. It is envisaged that this tool will allow the user to fully concentrate on and negotiate with his interests and preferences while enabling him to stay in total control over the decisions that are being taken.

Later on in the project, the scope of the project has been slightly expanded to include a suitable and useful output representation. In this specific case, the output for the user was to be integrated with a dynamic online mapping tool.

## **1.2 Approach**

Central to this dissertation project is an improved and personalized user experience with respect to interest modelling on the example of a Dublin tourist planning service. In this sense it is really important to achieve exceptional usability of the tool with the user keeping control over the decision taking process at all times while making the decision taking easier for the user.

Because the user experience and usability of the tool are so important for this project, it was decided to start by spending some time on thinking up suitable visual metaphors for firstly the representation of the availability of items, secondly for displaying a constraint associated with these items, and thirdly for the level of interest as expressed by the user.

Once some suitable concepts have been found and discussed, it was decided to create a mock-up in an easily accessible technology. The reason for creating this mock-up was to quickly introduce a test group to these new ideas, and to gather their opinions on the suitability of the metaphors and to determine the envisaged usability of the tool. It was anticipated that the evaluation would give an early feed-back of the ideas which can then be used to make necessary modifications in the design of the software before implementation was started. In parallel, a general architecture design was devised for the tool leaving open the details of the design until after the early evaluation, while considering and familiarizing with possible technologies for specific parts of the system. Once the design was finalized, and implementation was started, inevitable changes had to be made to the initial design due to issues encountered while implementing. The final tool then underwent a second round of evaluation by a sub-group of the original test group and an additional unexposed group to get a real sense of its usability and feasibility for capturing a user's interests and preferences.

Although some parts of the project are unavoidably geared towards a specific domain, in this example the tourism domain, it is envisaged that the visual interest modelling tool could be used for and applied to many domains. Therefore, care has been taken to

design and implement the tool with a view to keeping it as general as possible and only go into specifics where needed.

### **1.3 Roadmap**

Chapter 2 will describe the state of the art, firstly with respect to the concept of user interest modelling in general and then with respect to various modern online and mobile tourist planning services in specific, some of which have been implied already in this introduction.

Chapter 3 will then describe the steps from how the goal of creating a user interest modelling tool was converted into a specific design. I will particularly concentrate on an early mock-up of the tool, whose evaluation has been very helpful in designing the actual tool. In this chapter I will also discuss some of the key design decisions that have been taken.

The 4<sup>th</sup> chapter is concerned with how the aforementioned design of the tool has been transformed into an actual implementation, the problems encountered whilst implementing and the final solutions chosen.

In the 5<sup>th</sup> chapter, a critical evaluation will be recounted, exploiting the results of the final user experience evaluation of the application. In addition, due to the intertwining of the user evaluations and resulting improvement suggestions, this chapter will also contain a section detailing necessary and possible future work to be carried out.

And finally, in chapter 6, a conclusion will be drawn with regard to the success of the evaluation, the aims mentioned and the goals achieved and a discussion of the applicability of the tool for other examples.

Chapter 7 contains a list of resources and references that have been mentioned throughout the text.

Some security considerations can be found in Appendix D.

## **2 State of the Art**

This chapter first introduces the state of the art of user modelling with specific emphasize on user interest and preference modelling and then describes some of the available information sources and planning facilities for tourists with a specific view on Dublin if available. These will be described from traditional, to web-based planning ways to more interactive assisted planning to actually spontaneous techniques which involve minimal amounts of planning.

### ***2.1 State of the Art of User Interest and Preference Modelling***

A user model contains explicitly modelled assumptions that represent the characteristics of the user which have been deemed relevant to the system [Fink, Kobsa, and Nill, 1996]. A user interest and preference model, therefore, can be seen as a subset of a user model as it is only concerned with modelling the following two concepts with regard to a user: Firstly, it models the interests of a user in objects or concepts (this can be a qualitative or binary characteristic) and secondly, it models his preferences in these interests (a quantitative characteristic). This model can, however, be expanded to include further information, which would resulting in a more detailed user model. User interest and preference modelling allows the system to personalise the desired output.

Research has mainly concentrated on modelling a user with regards to some concept or area and how the information required for the specific model can best be extracted and collected from the user. Assumptions based on this information are then used for the desired purpose. The validity of these assumptions is determined by the technique used to acquire the information. Automatic modelling techniques by the system can be unreliable. Also, it needs to be emphasized that any inferences made by the system about user characteristics are ultimately a guess [Espinoza and Hook, 1995].

Information from the user model is then used to infer his goal; in the case of tourism the global goal is to construct an itinerary that best reflects his interests in a constraint situation.

A limiting factor towards constructing a complete user model is often associated with a large overhead in modelling these properties, e.g. through questionnaires etc. which is often a main limitation on creating a complete user model. Therefore, it is important to find those properties that have the largest impact on the personalization of the system. Several more or less accurate and invasive techniques are available to acquire the specific information needed to model users. One of the simplest ways of user modelling is to create fixed stereotypes [Rich, 1989]. New users are categorised and the system will personalise the output based on the category that has been set for the user. An example of how this could be used in tourism is to categorize the tourist by age, social standing and income. However, care has to be taken that the categorization is good, because a tourist is a multi-faceted person that might not be easily stereotyped.

Another way of modelling is by using an overlay model, which is widely used in adaptive hypermedia systems in the educational domain. In this approach, a model of the learner's knowledge is created on a concept-by-concept basis and updated as the learner progresses through the system. The estimation of a learner's knowledge is built up by examining the section the learner has read and the tests he has completed.

In many cases, the stereotype and overlay techniques of user modelling are combined in educational adaptive hypermedia systems. When this is the case, the learner will first be categorised as a stereotype and then this model is gradually refined as the overlay model is built from information acquired from the interaction of the learner with the system.

As the validity of assumptions taken depends on the technique used to acquire the information, collaborative and cooperative modelling is frequently used. This means that the user describes relevant characteristics directly and can provide feedback directly to the system by filling out questionnaires and forms.

Some more implicit approaches to acquire and refine the user model include observing the user's interaction with the system and scrutinizing the information which the user requests from a database or repository [Kass and Stadnyk, 1992]. For



example, in the eLearning domain, the system implicitly infers all information needed from the learner's interactions with the system. The drawbacks of this approach are the time required to build an appropriate learner model and the inherent lack of confidence in it as all information comes from inference of user actions. This can in some cases be alleviated by combining this approach with the stereotype approach and later refining the model using an Overlay Model.

Another approach is to explicitly ask the user for information [Kobsa, 1993] through means of questionnaires and tests which usually involve a lot of text, and may contain drop down boxes with choice of answers, click boxes, tick boxes, ratings on scales etc. which have to be carefully used without provoking impatience. This approach however can often yield more accurate results in a shorter time, but requires the user to interact with the system before the real purpose of the system can be enjoyed. However, on the up side, giving the user the ability to manipulate how the system adapts towards his needs, makes the user feels more in control of this process. Giving him more direct access to the user model gives him more confidence in the system and the personalization process and supports a feeling of ownership.

There is a delicate balance between the two types of modelling. The more properties of a user that can be modelled, the better personalization can be achieved. However, the overhead associated with explicit modelling may make the user impatient with the modelling process. On the other hand, if all information was modelled implicitly, the user may not have enough confidence in the system and become frustrated because he has no control over the modelling process, especially if the modelling inferences taken are not accurate enough.

In an eLearning application developed in TCD [Conlan, 2004] figuring out how much control the user would like in customization, approximately 40% of the students stated that they would like more control over the personalisation process and the content included as a result of this process. This result indicated how important it is for users of a system to feel in control.

Another group [Petrelli, De Angeli, and Conversion, 1999] has implemented a user modelling component supporting a task-based interface to a hypermedia information

system for hospitals and tested it under realistic conditions. Their approach for user modelling focuses on the tasks performed by users. It allows adaptive browsing support for users with different level of experience, and a level of adaptability. Their analysis showed that the differences in the information needs of users with different levels of experience are not only quantitative, but qualitative.

One group [Reiter, Sripada, and Williams, 2003] describes their experiences in acquiring and using limited user models in the domain of Natural Language Generation (NLG) in four different systems. Realizing the promises of NLG requires an accurate and detailed user model and in practice it can be difficult to obtain detailed information about the expertise, background, tasks, goals, and so forth of individual users. In each system they tried a different approach to acquiring information about users for NLG systems, which can be described as the following concepts: “User in Control”, “Ask the User for Key Information”, “Domain Expert Creates a Model”, “Obtain Model by Testing Users”. In the IDAS approach, the system generates an output from the limited information if available and lets then allow the user to request additional information, clarifications, etc. In STOP they used an explicit approach by asking the user to enter a model. Questionnaires were used to elicit the information needed. A problem with this approach was that it only works if the user understands and can answer the questions. Their found that a questionnaire can work well if only a small amount of well- structured information is needed and if it is believed that users have (and will provide) this information. In the SumTime-Mousam system they explicitly asked a domain expert to construct a model. A domain expert would meet with users and discuss their needs and constraints, and from this develop a user model for a software system. In GIRL, they tried to implicitly infer a model from a standard assessment test. To build a model of a user’s skills they tested the user’s performance on a set of tasks, using an independently developed assessment test. They concluded that similar to the questionnaire approach, the method is more suitable if only a small amount of information is needed.

In summary it was concluded that none of the approaches seemed generally applicable, but all would probably work better if users can easily understand their models, so that they can edit their model or at least better understand what the system is doing. Under some circumstances this could allow people to edit and thus directly

control their model; even if this is not possible, users are likely to be more helpful in the model acquisition process if they understand how the model is going to be used. Kay [Kay, 2001] suggests that user models should be “scrutable”, i.e. understandable and modifiable to the user, because (among other things) this allows users to understand what the system is doing and to correct mistakes.

Another group [Chin and Porage, 2001] that had also recognized how hard it is to build complete and accurate user models has implemented an approach for explicit information retrieval using a novel approach that cleverly reduces the amount of questions needing to be asked but still being able to create a sufficiently accurate user model. They applied this novel type of user preference acquisition to the mass customization domain which often uses multi-attribute utility theory (MAUT) to model customer preferences for products. In MAUT each attribute has an importance weight (the utility of the attribute relative to other attributes) and a value function (the relative utility of different values of the attribute). Using MAUT, the best product maximizes the utility of the variable choices while still satisfying global constraints, if any. Unfortunately, most methods of acquiring MAUT weights and utility functions require asking the user too many questions and therefore stretch their patience. As a solution, they came up with a tool called Iona, which uses approximation methods that determine which product specifications are most important to the client, identify the client type (stereotypes), and take into account the context (purchase situation). In Iona, the user is first queried for absolute/preferred constraints and categorical preferences (the most important product component specifications) to reduce the product pool by those components that violate these constraints. Next Iona selects queries to maximally reduce the utility uncertainty of the remaining product choices. These queries include stereotype membership (to refine the utility estimates of the choices) and contexts (the purchase situation). The stereotypes membership is used to determine people’s general preferences regarding a product. The usefulness of a query is based on the reduction in uncertainty weighted by the likelihood that the user belongs to a stereotype/context based on similarity to the current user model. The query with the highest usefulness is asked until the usefulness of the best query is below the threshold of user impatience, which is similar to the nuisance factor used in RADAR [Raskutti and Zukerman, 1994 & 1997]. A choice is selected for each part of the product when the usefulness of asking a query is less than the cost of querying.

Finally binary integer programming is used to select the best product for the user. They implemented their approach on an example of a travel planner in the domain of custom travel packages for Hawaii, where customization is concerned with lodging, restaurants, activities, and transportation. Constraints are divided into absolute/preferred constraints, categorical preferences, and inherent constraints. The user provides absolute/preferred constraints, such as the town where they want to stay or an activity they would like to pursue, e.g. kayaking. When the user does not provide absolute/preferred constraints that adequately reduce the set of alternatives, he is asked for categorical preferences (e.g. a type of preferred cuisine). Attributes have classification hierarchies such as districts are parts of towns which are parts of counties, which are parts of a country which is part of a continent etc. Inherent constraints include unary constraints for variable instances (e.g. availability of an activity at a location) and binary constraints between variable instances (e.g. restricting possible activities to the same location). The product constraints are transparent to the customer and allow users to customize products without extensive knowledge of the product. They also compared the Travel Planner prototype with actual face-to-face travel planning using the same database and found that the face-to-face planning took considerably longer than the Travel Planner interaction. A lot of face-to-face time was spent providing the client with attribute values so that the client could make decisions. In Iona, the program makes the decisions, so the client does not need to know attribute-level information such as which hotels have ocean views and the price of the different restaurants. Also, in the face-to-face interaction a lot of time was spent on determining the client's importance weights and value functions (e.g. the client's relative valuation of better food versus lower price, especially when the client's preferences did not agree with the agent's preferences). This is avoided in Iona, since Iona gets attribute weights and value functions by asking about stereotype membership.

## ***2.2 State of the Art of Planning a Sightseeing Itinerary***

### **2.2.1 Paper-based information**

Walking into any good book shop, you can usually find a good assortment of tourist guides from a selection of publishers of any continent, country or city, often with different focuses. Some would have a lot of text and others would have a lot of pictures, most would have both. All would contain information about points of interest, their opening days and time and entry fees and other information and most would come with some kind of maps printed throughout the book or attached at the end of the book. Some examples for Dublin would be the “The Lonely Planet Dublin City Guide” [Davenport, 2006], and “Dublin Encounter Guide” [O’Carroll, 2007] or “This Is Dublin: Pocket Guide & City Map” [Plunkett, 1999] or “Dublin” [Gallagher, 2005]. Other print media with tourist information involve leaflets available in tourist information offices detailing specific package guide tours or events that have not been available at the time of printing of tour guides, such as concerts, exhibitions, shows etc.

Paper-based tourist guides have the advantage that you can easily take them with you and they can be accessed all the time, in the most remote places. However, as all printed information, they have one big disadvantage: even at the time of printing, some of the information might have already become out of date, such as a change in opening hours or entrance fees. It is very hard, if not impossible, to keep printed tourist guides accurate and up to date. Similarly, printed tourist guides usually do not contain information about events that have been planned after the time of print but might just as likely be of interest to tourists, such as concerts, exhibitions or other more spontaneous events. In addition, it is a lot harder to extend a given tourist guide to include new information or attractions or to modify it in any other way. Another disadvantage with print based tourist information is often that items that are described need then to be located on the map when putting together a sightseeing day to figure out where they are located and what the most appropriate visiting order is for all the things a tourist might want to try and see, i.e. there is often no continuity from the description of the tourist attraction to the location of the attraction on a map. Another disadvantage is that they usually do not provide much assistance in putting together a suitable sightseeing itinerary, but leave the process of figuring out what to see when, where, for how long and in which order totally up to the tourist.

## 2.2.2 Web-based information

Another source of tourist information that has become very popular over the recent years is web-based information. Many tourists have switched to gather tourist information on the World Wide Web before they leave or even while there are in the new location, or use this information in conjunction with a traditional tourist guide and printed maps. For Dublin itself you can find several more or less complete websites acting as portals of information to various Dublin tourist attractions.

One of the more recommendable Dublin tourist websites can be found at [Visit Dublin] The structure of the website follows a common technique: The website is logically divided into a top frame that contains a high-level list of items, in this case “Accommodation”, “Entertainment”, “Events”, “See and Do”, etc. as shown in Figure 1 below.

By clicking any of these items in the top list, a drop down list appears with hyperlinked items in this category, which will also be displayed in the left hand side frame. By clicking either any item in the drop down list or in the left hand side list, the actual tourist information about items in this category is presented in the main frame of the website.

For example, by clicking “Entertainment” in the top level list, this would result in a dropdown list displaying: “Cafes”, “Comedy Clubs”, “Nightclubs”, “Pubs”, “Restaurants”, etc. By clicking items on this list, one is presented with several pages containing short descriptions of a comprehensive listing of Restaurants, Pubs and clubs etc. in Dublin. The “Events” website also contains a large list of current events happening in Dublin. Or in “See & do”, the list that would be displayed includes: “Dublin Tourism Attractions”, “Historic Sites”, “Museums & Galleries”, etc. Clicking on any of these items in the list results in short information being displayed about items in this category in the main window.

This short information usually contains a picture, a customer rating and a hyperlink to a more detailed page. The detailed page then provides detailed background information about the tourist attraction as well as opening hours and entrance fees, how to get there and a link to the actual website of the attraction. A great feature of this webpage is that it is also integrated with Google Maps and by clicking on a

“Show this location on a map” button a pop-up window of Google Maps opens up displaying the location of the attraction on the map which is accompanied by a short description of the attraction. The website is also available on phones/PDAs etc. through iMode.

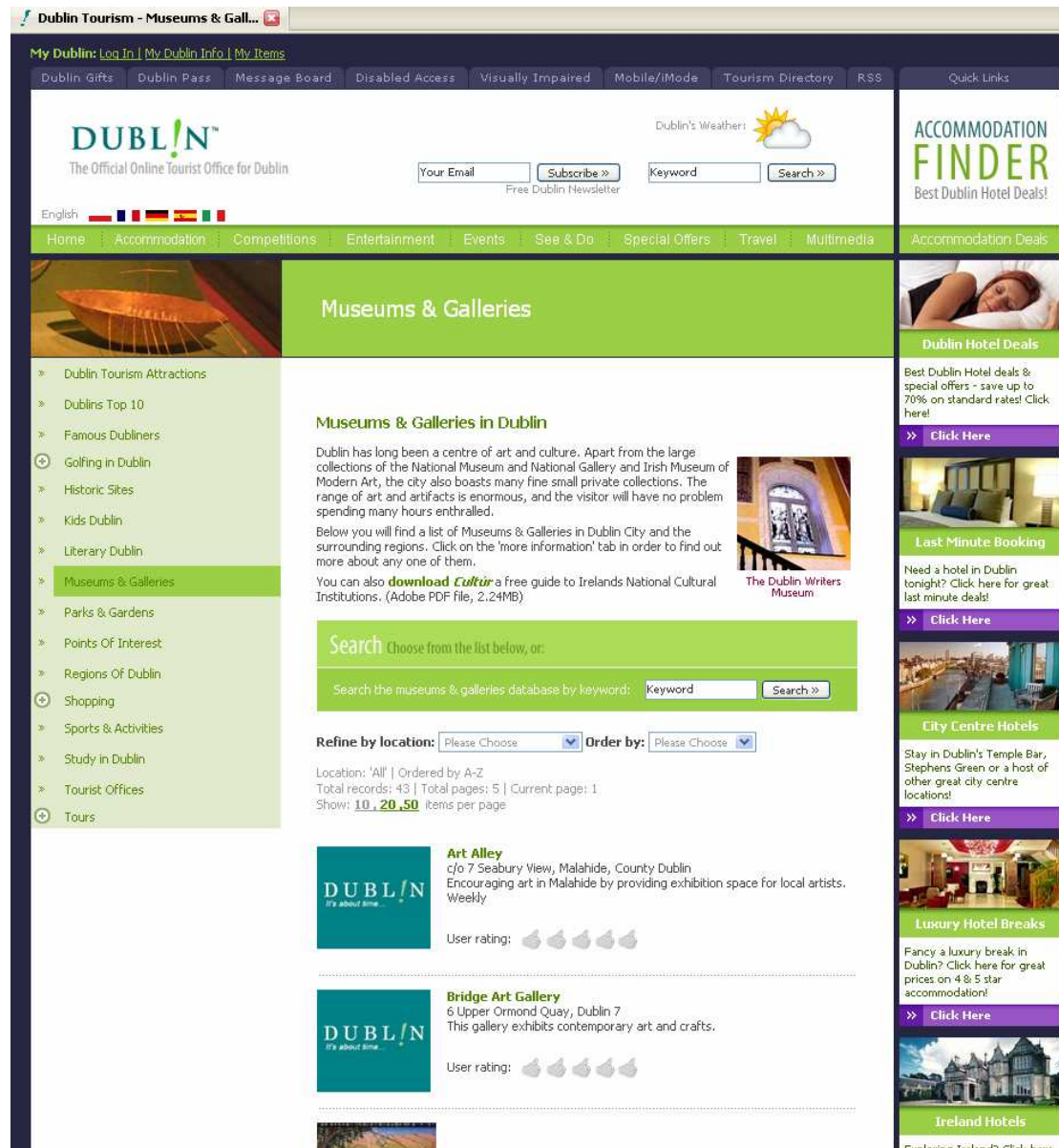


Figure 1 - A typical tourist information website

Another recommendable website can be found at [Dublin Tourist] which offers quite a large textual and pictorial information base aimed at tourists, including practical information about accommodation and hotels, car rentals, the Dublin Pass, transport

from and to the airport as well as information about Dublin's train bus and tram system and of course information about Dublin's tourist attractions and places to see or things to do.

The structure and content of the website is similar to the one above: The website is logically divided into a left hand side frame containing a clickable list of hyperlinked websites that contain the actual tourist information and which are presented in the main frame of the website

Some less appealing and/or less informative websites about Dublin's tourist attractions and things to do are shortly introduced in the following:

[Wiki Travel Dublin] is a website created and edited by the general public with snippets of information on how to get to Dublin and other transport information, what to see, do, buy, eat, drink, gay and lesbian friendly bars and clubs and information on accommodation with hyperlinks to the actual websites of the tourist attractions etc.

[Dublin Uncovered] is a website through which one can book accommodation, cars and tours around Dublin and Ireland, buy the Dublin Pass, guide books or maps. It also provides information on what to see while one visits Dublin in their tourist guide, restaurants, shopping and entertainment sections. Their tourist attraction website then offers another selection menu for Dublin History, City Tours, What to See, Day Trips, Museums, and Galleries, etc. Some of the resulting pages contain textual and pictorial information about the sites concerned or short snippets of information about the attractions with hyperlinks leading to their actual websites. Generally, no opening times, entrance fee or location information is provided on this website or at least only sporadically and non-consistently.

Other much less informative and accurate websites, usually with a less appealing presentation are [Living Dublin], [Tourist Information Dublin], [Lonely Planet Dublin], [Look Into Ireland], [Dublin City].

Other sources of tourist attraction information can be gathered online by searching for specific tourist attractions, blogs and message boards.



Although these web-based information portals show differences in what kind of information they supply, in the completeness of the information they supply or lack thereof and in their level of incorporation with maps, these websites have the advantage that they can be kept up to date a lot easier than paper based information. Similar to the print information, these websites also have the disadvantage that they usually do not provide much assistance in putting together a suitable sightseeing itinerary either, again leaving the process of comparing locations, opening times, lengths of visits etc. up to the tourist. Unfortunately, in most cases, the information is not yet remotely accessible anywhere and would have to be printed out or downloaded.

### **2.2.3 Static Tour Suggestions and Sightseeing Planners**

Some travel guides and websites come with suggestions on how to best spend a day. These are mostly in the form of walking tour suggestions. Especially the Lonely Planet guidebooks often has a page or two suggesting possible walking tours for different amounts of time available.

Of the websites described above, only [Dublin Tours] and [Visit Dublin] provides suggestions to some walking tours through Dublin. The former one only provides textual and pictorial information on some themed walking tours, such as “The Old City”, “The Georgian District” and “Literary Dublin” with a time estimate for each walking tour [Dublin Tourist Walks]. The latter one provides free podcast audio guides to Dublin, called iWalks developed by Dublin Tourism [Visit Dublin iWalks]. There are eleven different themes to choose from, including “Castles & Cathedrals”, “Viking & Medieval Dublin”, and “In the Steps of Ulysses”. The audio guides can be downloaded in mp3 format from their website and used as free walking tour guides to the city. Each iWalk comes with a free full colour brochure featuring maps and original illustrations. These brochures for the walks can also be downloaded from their website. Some of the walks are available in various languages.

In Stockholm, Sweden, a mobile guide service called “Talk of the town” can be purchased in conjunction with a map which is basically a downloadable audio guide to Stockholm’s attractions. A user can consult which sights he would like to visit on

the map and receive an audio guide about the attraction by dialling up to it [Talk of the Town].

IntelliTours is another interesting service being offered that combines static tour suggestions with global positioning devices for easier way finding [IntelliTours] IntelliTours creates audio and multimedia tours that are guided and triggered by GPS navigation. Blending satellite signals with old-fashioned storytelling, IntelliTours locates landmarks, recreates history, and recounts stories on the very spots where they were created. They also provide downloadable road tours for in car GPS devices.

While the above named websites and services contain some static itinerary suggestions, they do not take into account user preferences but rather offer a mixed choice from which he can then select the one that corresponds most with his interests and preferences.

#### **2.2.4 Interactive Tour Suggestions and Sightseeing Planners**

Some attempts have been made in more proactively assisting the potential tourist in choosing his own personal sightseeing itinerary.

One such attempt is INTRIGUE (Interactive TouRist Information GUIDe) [Ardissono et al, 2002] which was created to explore the provision of ubiquitous services accessible both from desktop environments and handset devices, either via remote connections to central servers, or through the local execution of tasks within the devices themselves. INTRIGUE's aim is to assist the potential tourist in the organization of a tour by providing personalized recommendations of tourist attractions and helping the user to schedule his itinerary. The available tourist information can be accessed on Web browsers and WAP phones and the generated interactive agenda can be accessed both remotely and locally on the user's device. The prototype has been implemented for the city of Torino and the surrounding Piedmont area and contains information about tourist attractions and other useful information, such as accommodation and food. The tourist can browse through a taxonomy of categories and select the desired geographical area by clicking on a map,

or by following the given hyperlinks. The tourist is then presented with a list of recommended items which can be clicked to view a page presenting information about the attraction. Finally, the user can include the item in the list of attractions to be scheduled in his itinerary by clicking an “add to agenda” button.

The personalization strategies used by this system are employed to recommend the attractions best suited to the preferences of the tourist. INTRIGUE generates optimized itineraries by taking the user’s temporal constraints, the attractions’ opening times and their location into account. Given the set of attractions selected by the user and the constraints he provided, the system tries to generate an itinerary that includes as many selected attractions as possible, complies with the user’s preferences, and minimizes the overall transfer time. The resulting itinerary can also be consulted and modified during different sessions and while visiting attractions, therefore extending the role of their system from a pure tourist information base to interactive tourist guide.

The authors remark that “shortest path” algorithms, such as the travelling salesman one, cannot be used because they do not guarantee that the generated permutations of attractions satisfy temporal constraints such as opening times of attractions. The authors also mention that users appreciated the possibility of saving itineraries and retrieving (and modifying) them in subsequent interactions, as this facility would enable them to use the interactive agenda during the tour.

Another proactive trip-planning service [Tomai, Spanaki, Prastacos, and Kavouras, 2005] has been developed for the prefecture of Heraklion, in the island of Crete. This approach explores the possibility of utilizing ontologies in assisting tourists to plan their trip in a web-based environment. Their methodology consists of building two separate ontologies, one for the users profile and another one dealing with tourism information of a specific area.

To gain access to the user’s interests, preferences and other personal information, on which the proposal of an itinerary will be based they propose to include a conceptual model of the user profile. The user profile is generated by presenting the tourist with a questionnaire through a web based interface, so that the user’s personal information, preferences, needs and interests can be extracted and recorded in a user profile ontology. The other ontology, the tourism ontology contains actual information on a

specific area of interest. The more users utilize the system, the more the user profile ontology gets populated.

The interface for eliciting the user's characteristics poses ontology-driven queries to retrieve information about the user whose answers are recorded by the system and included in the user profile ontology as an instance that has properties (characteristics) with specific values. Their system works as follows: First the tourist fills in the interface so that his profile is generated, then he asks a question. The system then runs a context matching algorithm between the two ontologies and returns the answer as a text but also locating the proposed places/ points of interest on the map.

In the step in which the user ontology is populated with instances for the concept user, an interface "resembling" a web-based questionnaire is presented to the user. The procedure of collecting and recording the actual user profiles is very much guided by the predefined user profile ontology. For example, when the user is asked to fill in his interests, he can only choose from a list of alternatives, given in the form of a drop-down menu, that correspond to the sub-concepts of the interests concept in the generic user profile ontology. This methodology has the characteristic that as more tourists use the system, the more the ontology gets populated.

The authors claim that the user profile ontology has been designed in a way so that the corresponding interface which records all user information does not request from them detailed information for his interests or tastes. Instead, the user is provided with a list of alternative answers on which he can make the final decision.

In Lancaster, the GUIDE system [Cheverest, Davies, Mitchell, Friday, and Efstratiou, 2000] is a service that provides city visitors with a hand-held context-aware tourist guide. The information presented to visitors is tailored based on the visitor's user profile and contextual information, including the unit's physical location. The context awareness constitutes two parts: personal, such as the visitors' interests, e.g. history, or architecture, the visitor's current location, attractions already visited and any refreshment preferences they might have and environmental, such as the time of day, and the opening times of attractions. In order to retrieve information the visitor is presented with a set of choices in the form of hypertext links. The GUIDE system is designed to enable visitors to request a structured tour of Lancaster based on a set of attractions that they wish to visit. In order to ascertain this set of attractions, visitors are asked to select attractions from a set of categories such as 'Historic' and

'Recreation'. Once a tour has been generated, the visitor is presented with a recommended sequence for visiting their chosen attractions. The visitor can then, either, agree to be taken to the next attraction in the suggested sequence, or, override this recommendation by selecting a different attraction to be their current destination. With regards to automatic rescheduling, the system regularly calculates whether or not the current order for visiting the remaining attractions is appropriate given current time constraints and takes appropriate action.

The great advantage of these types of services is that they create tours that take into account a tourist's interests and preferences, so that the tourist receives a personalized suggestion rather than a one-fits-all static tour.

### **2.2.5 Online mapping services**

Although these services do not supply tourist information as such and do not provide tour suggestions, they are worth mentioning due to the value that they provide to tourists: locating points of interest or even locating a whole category of interest, such as restaurants in Dublin.

The Dublin Map is a website which mainly acts as an advertising portal for shops, tours, pubs etc. is the website associated with a paper based map of Dublin, also known as "The Dublin Map" [The Dublin Map]. While the very limited information supplied on the website does not have much informative value and seems to be mainly of advertising purpose, they however provide a useful "map maker" function. All points of interest that are described on the website can be added to an integrated Google Map widget.

There is a good choice now available in online mapping services, e.g. Google Maps [Google Maps], Google Earth [Google Earth], Yahoo! Maps [Yahoo Maps], Map Quest [Map Quest], Map24 [Map 24], Ask.com [Ask.com], Multimap [Multi Map] and Live Search Maps [Maps Live]. Figure 2 shows an example of Yahoo! Maps when searched for Dublin, Ireland.

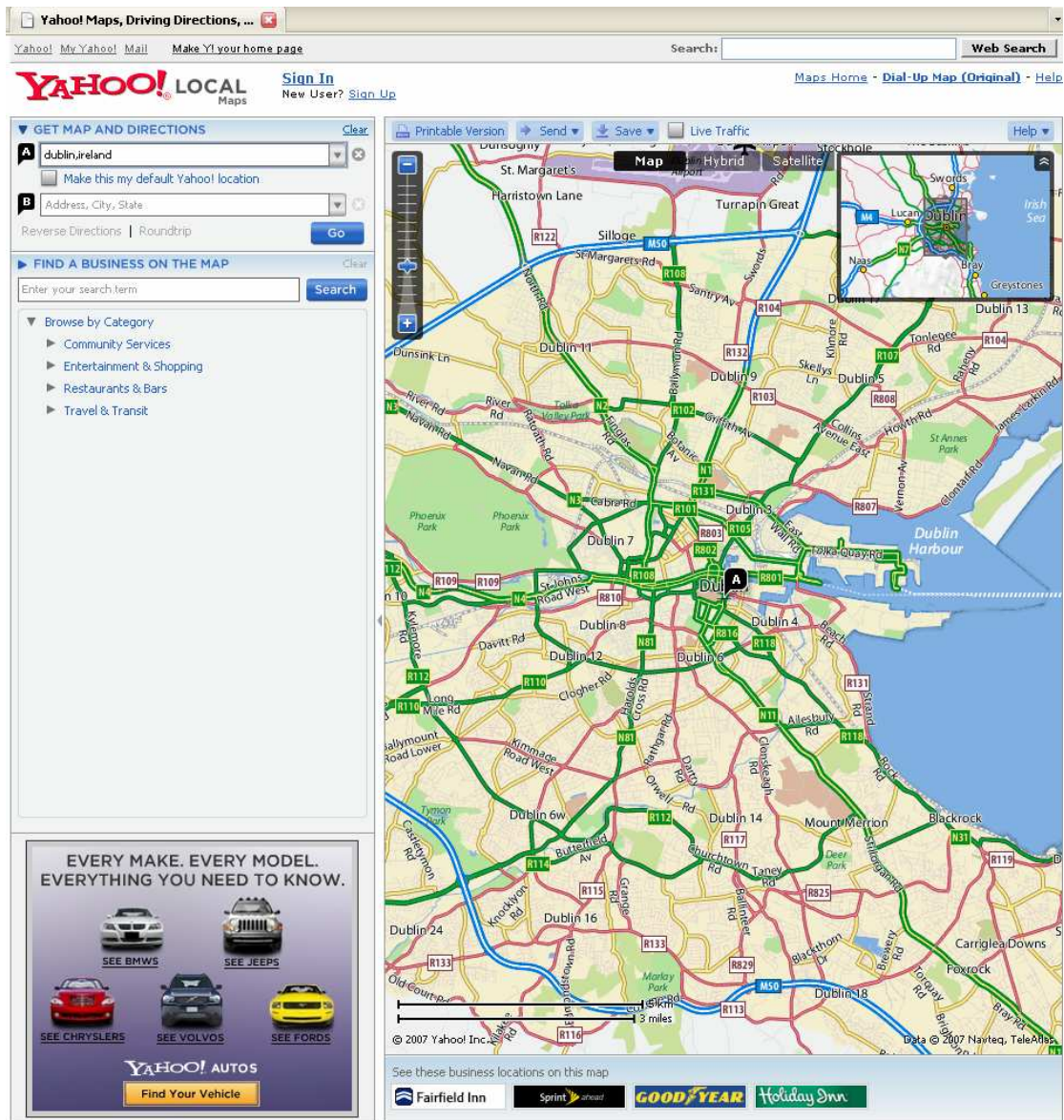


Figure 2 - Yahoo! Maps online mapping tool

Most of these come with options to search for and locate certain businesses or other points of interest, with varying degrees of success and completeness. In addition, most provide a direction service.

Some online mapping tools provide additional functionality, such as storing your maps, viewing pictures tagged by users to locations, gas prices, congestion information, 3D views, location dependent wikipedia articles etc.

## 2.2.6 Location aware services

In contrast to only a few pre-trip itinerary advisors, there has recently been a lot of research interest and progress in the development of location aware services, enabled through first the increased possibility and reduction in price of connecting to the internet from a mobile device as well as the increased incorporation of global positioning systems in mobile devices and allowing a more spontaneous and non-premeditated visit.

Many location aware applications are now available where this type of service is offered [Ordnance Survey, 2007] ranging from Automated mapping, i.e. digital map generation, car navigation applications, family or pet tracking for security purposes (look at implications of the Madeleine case!) or even Find-a-friend applications, where the location of one user can be displayed on the device of another. In addition, there is the classic yellow pages type application “Where’s the nearest...?”, which has in many cases been advanced to personal navigation and way finding applications and which most naturally lead to location-based tourist information applications, allowing tourists to leave a hardbound guidebook at home.

Other location-based services include traffic information, real time sensors for measuring environmental factors, weather information, public transport information, games, fleet management and applications to observe driver behaviour patterns and many others with new ones being developed all the time.

For example, in Wales, a WAP Service is currently being developed [Catling, Harris, James, and Simmons, 2001] which provides pre-trip traveller information, journey planning, route planning, tourist information, on-trip driver information, route guidance and floating car data applications.

In Hong Kong, the Hong Kong Tourism Board in conjunction with the CSL network offers a “Mobile Host Audio Tourist Information Service” [Hong Kong Audio Guide], a personal mobile audio guide. This service enables tourists to access the latest comprehensive tourist information including, sightseeing information, and hot

shopping news, dining recommendations, current events, weather information and useful numbers via their mobile phone anywhere.

In Siena, Italy, PALIO [PALIO, 2003] is a project that aims to ensure tourists always know where they are and where they're going which has been developed by a consortium of ten companies, research organisations and local administrations from four EU countries and tested in Siena and on the Greek island of Crete. Their system offers real-time access to tourist information from anywhere, anytime.

In the city of Karlskrona, in the southern part of Sweden, Ericsson has developed an “Instant Tourist Guide” offering mobile guides [Ericsson], interactive games, image services and postcard services. Tourists can access information, such as text, voice and pictures about tourist attractions through their mobile phone. While walking around the city, visitors can receive information about different locations through the phone and use positioning services through GPS. The program also tells you where the next attraction is.

In Singapore, a pre-paid real-time location-based service via a SIM card that can be purchased on arrival, called CitySim [City Sim], offers real-time location-based tourist information about the island. Information provided includes locations of restaurants, banks, nightlife attractions. The service also features a chat service that allows visitors to find, chat and share their experiences with other CitySim users in Singapore. Users of the service requesting location-based information are guided by menus, which then retrieve the requested information via a SIM-based browser from a central server.

A Stuttgart based group [Jenish, Orlamünder, Köstering, and Brügge, 2005] propose a communication system which allows a user equipped with a modern programmable mobile phone or PDA to receive information about an object of interest in a city when he approaches this object. For the communication the short range radio communication system “Bluetooth” is used.

In Ireland, a system called Gulliver’s Genie [O’Hare and O’Grady, 2003] is a context-aware tourist guide that assists roaming tourists. Their approach is to use intelligent agents, which collectively determine the user context and retrieve and assemble multi-



media presentations that are wirelessly transmitted and displayed on a Personal Digital Assistant (PDA).

User context is considered in terms of position, orientation and user profile. With regards to capturing a user profile, all users of the Genie must first register and create their user profile which takes into account language, nationality, age, gender and interest profile which is concerned with the users interests such as art, literature, etc. The service is basically a push service that acts when a tourist walks towards some tourist attraction it will show his location on a map and then disseminate information in form of a presentation.

### ***2.3 Comparison of the User Interest and Preference Modelling Tool for Dublin Sightseeing with State of the Art***

The most important difference of the tool developed as part of this project to the user preference acquisition methods mentioned above is the way that the available choice information is presented to the user and how the user interests and preferences are retrieved. While all methods used above used textual, choice list and tick box style approaches for eliciting user interest and preferences amongst other information, the approach presented in this project is completely different in that it uses a graphical representation of the available choices, a graphical representation of interest and a graphical representation of preferences. The idea was that an interface like this would be received as more appealing and therefore keeps the user interested in it longer so that enough interest and preference information can be elicited in a more enjoyable manner from which a sufficiently accurate and complete user model can be constructed.

It is similar to some techniques mentioned above in that it uses a concept in going from abstract or general to specific to give the user the choice of assigning interest on different levels of abstraction.

Another difference is that the tool allows not just the binary decision of interest to be taken, but also allows to easily assign and modify preferences in one item over another.

The planning does not employ a stereotype approach but rather translates the user's interests and preferences directly into a suitable outcome.

The proposed system has been implemented for a web interface, but could easily be adapted for mobile phones and as such be opened up for the integration of location-aware functionality.

### **3 ARCHITECTURE DESIGN**

The purpose of this project was to come up with a generally applicable, innovative and intuitive graphical user interface tool that could represent multiple choices in a manner that allows the user to traverse from generic to specific, and that would allow the user to assign an interest and qualitative preferences to these choices in a playful and enjoyable way. The interest and preference level associated with each choice should also be represented in a graphical manner. Similarly, a visual solution needed to be found to represent the limiting factors on these items. At the same time this user interest model should be consumable in real-time by another outside service which consumes the user interest data in conjunction with other information to produce a sensible and personalized output. As part of good usability, the tool needs to be dynamic and reactive so that interest levels and limiting factors can be modified and adjusted throughout the process. Finally, the tool should represent the resulting output from the service that consumes and processes the user interest model in a suitable and useful output format. In this project, as proof of concept and to illustrate its usefulness, the tool was applied on the example of a sightseeing planner for Dublin.

Most important was to first find possible visual metaphors to represent choices, interests, preferences and constraints graphically. Once an acceptable visual concept was established, candidate technologies were considered and the most appropriate ones were chosen for realizing the visual part of the system. In parallel to developing the visual side of the system, a high level architecture for the whole system needed to be devised, considering suitable information transfer, and backend technologies for storing and manipulating the information.

Throughout implementation, further modifications and refinements in design were carried out to add to the value of the final system.

#### ***3.1 Design Influences from State of the Art***

The main lesson learned from analyzing the state of the art with regards to user profiling is that it is hard to elicit important information for personalization purposes. Asking too many questions abuses the patience of the user, whereas asking too few questions might result in an unsuitable result. However, research has shown that it is often better to use approximations rather than tiring out the user before he can enjoy the fruits of the personalization process. Therefore, an emphasis has been placed on making the user interest and preference setting tool an enjoyable tool.

In addition, research has shown, that better outcomes are usually achieved if the user feels in control over the modelling process, so the tool developed should empower the user in taking decisions rather than decide for him.

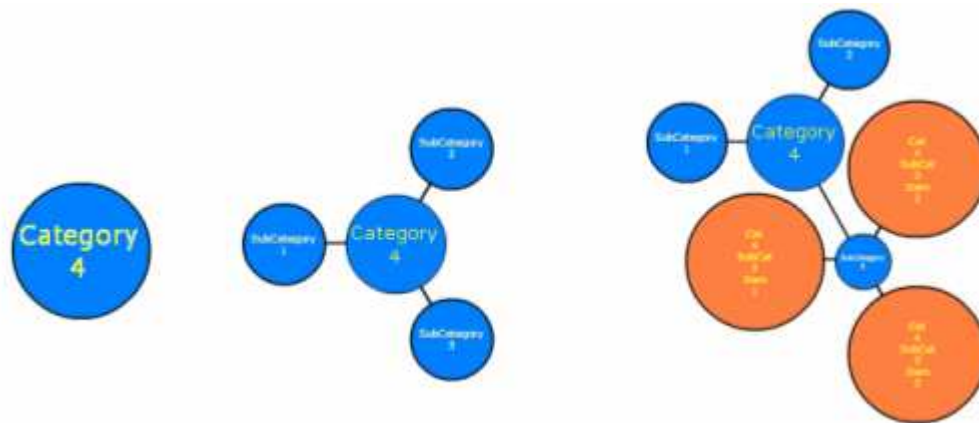
A lesson learned from tourism domain is that the tool needs to be easy to use and make access to further information easy. In addition, it needs to be visually appealing and display pictorial information. Another important point is to integrate the tool with a mapping function, so that continuity is achieved from choosing the attractions to displaying them on a map. This map could then be printed or downloaded onto a phone etc.

### **3.2 *Visual Metaphors***

After sketching up and experimenting with several graphical ideas, the following visual metaphors were found to be the most promising:

Firstly, to reduce the visual clutter and information overload that inevitably arises with a large amount of possible items of interest, it has been decided to employ a visual concept of going from abstract to specific (Figure 3). Specific items would then be retrievable through the abstract items, e.g. by clicking on the item that represents an abstract category. This action would expand it to show specific circles, such as “French Baguette” or “Spaghetti”, or subcategories, like “Pastas” or “Breads” or a mixture of both specific items and sub-categories that are contained in the clicked abstract category. The subcategories then again could be clicked to expand to show further subcategories and/or specific items contained in this category and so forth. To

graphically distinguish abstract and specific items it has been decided that a specific shape, e.g. a circle of monochrome colour should represent an abstract category, e.g. “Carbohydrates” in the example of food and specific item would be represented with a different shape, e.g. a rectangle, that would also have a background picture associated with it if possible.



**Figure 3 - Going from General to Specific**

In addition, the concept of going from abstract to specific can be used in a different way. For example, if one was visiting Dublin but did not really know much about Dublin and wanted to get a tour suggested according to his high level. E.g. one tourist might be very interested in going to some art galleries, in doing some shopping and in going to some museums but does not really care about which individual choices are taken. In this case, instead of just specifying an interest in any specific item, an interest could be specified in a whole category and let the system figure out suitable items to visit. In the case of tourism, the software could then decide on popularity and location etc. which attractions would be the best ones to visit and in which order. In addition, the user could specify a specific item of a general category and in addition designate an interest in the parent category. This would make sure that this specific item will take priority in planning if the interest is indicated higher than for the category to which it belongs, but that any remaining time can be filled up with items from the general category.

Secondly, to represent a limited factor, it was decided to use the area of a shape, e.g. a circle, or square or rectangle etc. I.e., the bigger the shape, the more of the factor or constraint is available or possible, depending on the situation (Figure 4). For example,

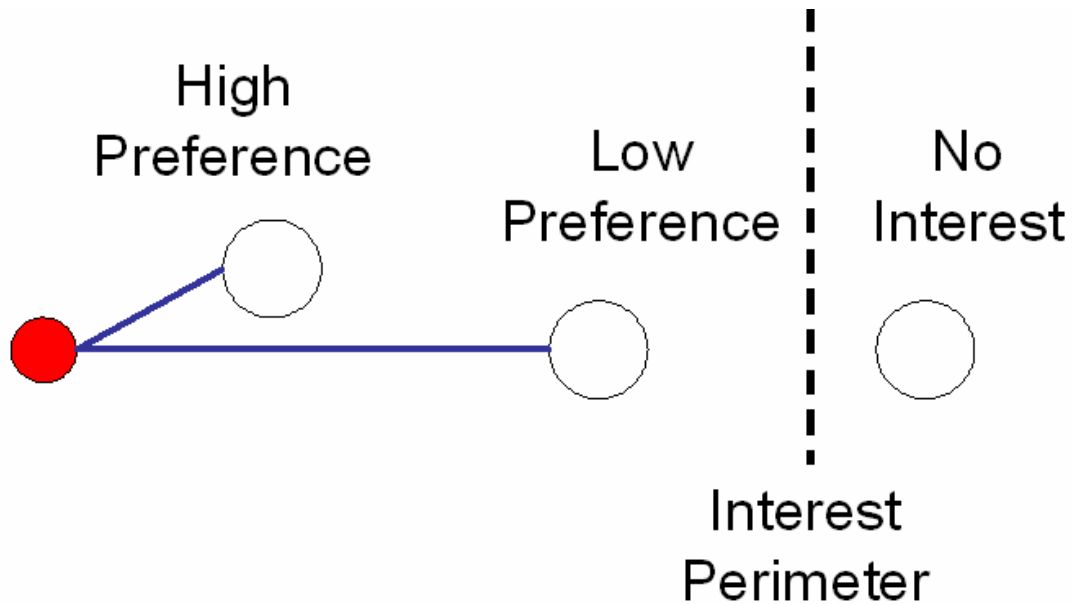
in the tourist scenario, with time being one of the possible limiting factors, the shape could represent a possible attraction to see or activity to do and the area of the shape would represent time, for example the average time that tourists spend on visiting this attraction. The bigger the shape, the more time tourists spend visiting this attraction on average and vice versa. If the limiting factor was money, the size of the shape could represent the price of an item, or in a culinary example it could represent the amount of calories in a specific item of food. In addition, the shape should be easily resizable by the user so as to increase or decrease the area of it to indicate that the user would like to increase or decrease the amount of limiting factor associated with it. For example, he could increase the size of a shape representing a tourist attraction to indicate that he would like to spend more time at it.



**Figure 4 - Size/Constraint Metaphor**

Thirdly, to represent an interest in a specific item and in addition, to represent the preference in this item in comparison to the preferences in other items, it was decided to use the concept of distance to a static reference point (Figure 5). Once a perimeter has been crossed an interest will be associated with the item and the nearer the item is being placed to the reference point, the more preference would be associated with it and vice versa. This means that items outside this perimeter have an interest of zero associated with them and that items within the perimeter have an interest associated with them proportional to their distance from the central reference point. It is envisaged that the user can playfully register his interest and preference in any of the

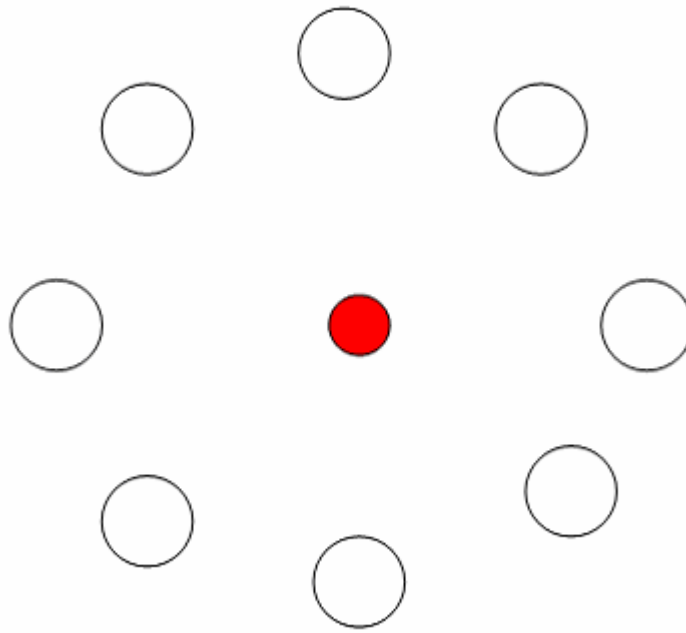
available items and specify the amount of constraint he wishes to associate with them by moving items into an interest area to different amounts, thereby creating a personal user interest model in the specific domain.



**Figure 5 - Distance/preference metaphor**

It is important here to see that although the level of interest and the amount of constraint associated with it often correlates, but that they are not the same. For example, in the case of money, even though a person might be highly interested in one item over another, the amount of money that he would spend on it might be much lower than on the other item. E.g. in the tourist example, even though somebody might absolutely want to see the Dublin Spire, he would be hard pressed to spend much more than 15 minutes admiring it. Or on the other hand, if one had only expressed a fair interest in seeing Trinity College but would be interested to see it if it was on the way to another more interesting attraction, it would be hard to visit it in less than half an hour, especially if one decided to follow a Trinity Tour guide or wanted to see the “Book of Kells”.

The reference point was chosen to be in the middle of the visualization, and the choices are then equally placed on an invisible perimeter around this central reference point (Figure 6).

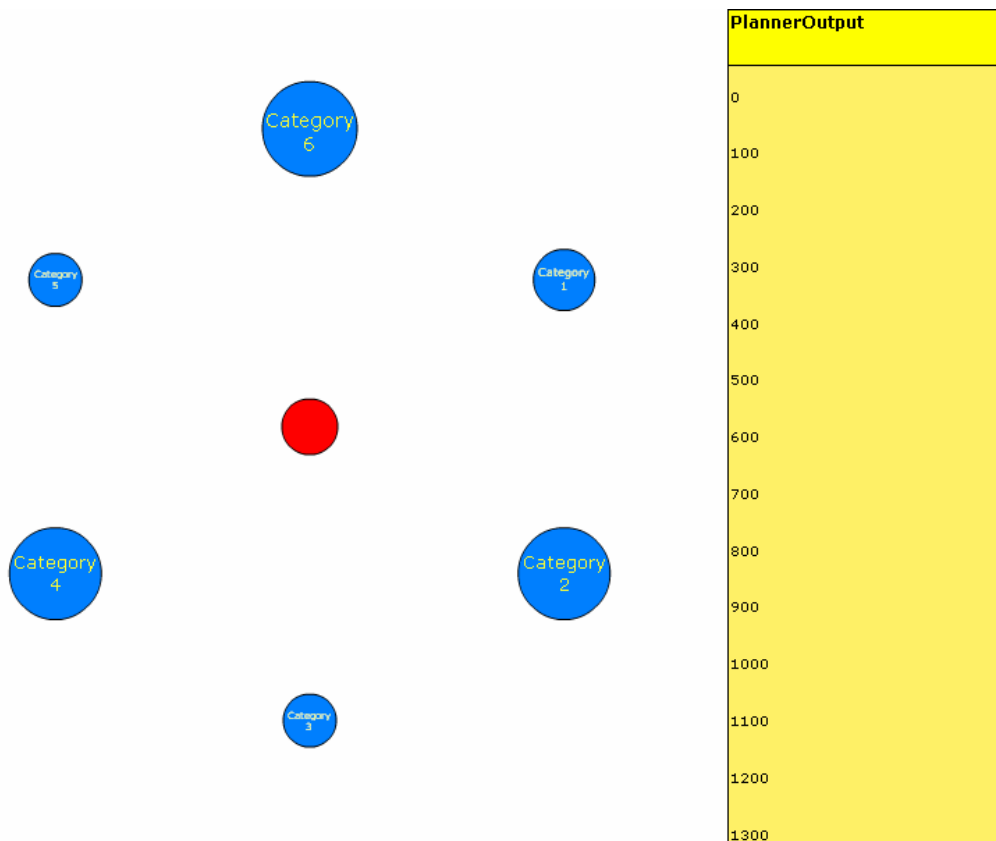


**Figure 6 - Reference point and choice locations on startup**

It was imagined that when the user wants to show his interest in an item, he can pull the item towards the static middle reference point, thereby reducing the distance between the item and the reference point and entering the perimeter of interest. The more items are being pulled towards the central reference point, the more crowded the area would get, reflecting the amount of desired choices the user would like to be satisfied. In the tourist example, it would loosely reflect the amount of available time the tourist is filling up with items he would like to visit. Any time the user adds another circle, the other circles already pulled into the “interest perimeter” are being pushed out of the way around the middle circle, keeping at the same distance from the middle circle that the user has placed them. However, if the area between the perimeter and the reference point has been filled up so much that no space is left for more circles in that area but the user decides he still wants to add more items, items that are least interesting are being pushed further out at the same time as he tries to pull in more items. It is the aim of this visualization that none of the interesting items overlap each other, so that the area within the interest perimeter can be filled up only with so many items.



The final graphical interface is divided into an area where the interest and preference modelling takes place and an area which would show the suggested output after the information has been processed by another service (Figure 7). In the diet example, the visualization would capture a user's interests in certain foods or categories of foods and the output side would represent a suggested diet plan. This graphical divide would also represent a logical divide with the visualization representing the side of the user's desires and wishes, and the output side representing the reality of what is possible and can be achieved. It could easily be imagined that there is a conflict in a users desires and the availability of the limiting factor. It is envisaged that if the user desires more than he can realize the planner will make the most sensible selection from the attractions that he is interested in.



**Figure 7 - Division between desire (bubble display) and reality (planner output)**

As mentioned in the introduction, because user experience and usability are so important in this project and part of the aforementioned goals, a mock-up using an accessible technology was first created and then evaluated. The purpose of the

evaluation at this stage was to determine if the proposed concepts would at all be accepted by the end-users as useful and therefore worth implementing.

To this effect, a mock-up of the tool, consisting of 188 PowerPoint slides was created. This mock-up was designed to explain the idea and the concepts behind this idea and to give a preview about how the final implementation might work and look like. Twelve people were individually led through the PowerPoint mock-up and then asked to fill out a questionnaire (Appendix B) followed by a discussion with the aim to expose possible pitfalls, problems and improvements.

The following pictures display some representative slides of the initial mock-up. A more extensive collection of slides can be found in Appendix A.

### **3.2.1 Design Changes from the Evaluation of the Mock-up**

Although the graphical concepts were received positively during the evaluation of the mock-up, some issues were highlighted that warranted some changes in the initial design.

One of the issues was that there needs to be more notification to the user, in form of tool tips or in form of pop up windows, so that for example the time represented by the size of a shape will be represented in real terms, i.e. in hours and minutes.

Due to difference in opinions about if the distance alone would be a clear enough graphical representation of preference it was decided to introduce a red-blue colour coded that is to be displayed on the line equidistant between the interesting item and the reference point. This circle can also display the level of interest as a percentage number.

There were more suggestions of improvements; however, these did not concern the visual concepts mentioned above but rather details of the application and therefore were not included in the general design of the system. However, it was envisaged, that

if time allowed, as many of the sensible suggestions could be incorporated in the application.

### **3.3 System Requirements**

From the idea of the system as imagined above, the technical requirements that the system poses are identified and are described in the following sections.

#### **3.3.1 Generality**

It is envisaged that this graphical user interest and preference setting tools can be applied to many other domains than tourism. With this in mind, care has been taken to use a data-agnostic design where possible and to employ platform independent technologies such as Java where possible.

#### **3.3.2 User Interface Requirements**

Firstly, the user interface needs to be able to read from an input and visually display its content accordingly. In addition, it has to be dynamic, interactive and be able to respond to user actions. Specifically, displayed items need to be clickable, draggable and resizable dynamically at run time and in real time by the user. Also, it needs to be able to determine overlapping items and be able to react appropriately. The user interface also needs to be able to assist in recording and outputting changes made by the user. And finally, it needs to be able to display a suggested outcome after the interest model has been consumed and processed by a planner.

#### **3.3.3 Concurrent User Requirements for the System**

As the system is envisaged to be a service available to many people over the worldwide web, most likely through a gateway website, the system has to be able to

deal with many concurrent user requests. This means that the system has to be designed in such a way as to be able to accept multiple incoming requests at the same time and have the back end database and planning functionality be able to deal with different user requests without interfering with each other. In addition, the website displaying the mapping output needs to be customized to each user so that each concurrent user of the system will be able to easily retrieve his personal map.

### **3.3.4 Requirements for the Planner**

On a high level, the planner needs to be able to accept input from the user regarding changes in his interest levels and react to it as well as being able to read from the information database that is being presented to the user. The planner then needs to be able to take these two sources of information and combine them in a manner that produces a sensible output. This output then needs to be sent back to the user interface for interpretation. In addition, the planner needs to be able to accept multiple concurrent requests without interference.

The planner and its associated output are obviously domain specific and depend on the purpose of the planner and the desired output, if the planner in anyway has to have any intelligence associated with it.

Regardless of the implementation technology, the intelligence of the planner has to be designed. The following paragraphs suggest a general and a tourist specific planning algorithm that could be realized in the project's implementation.

However, one could think of a general planning algorithm that could then later be extended to include functionality and planning logic towards the specific domain. The simplest planner would have to be able to produce the following output from the interest input and the information database: First of all it would have to be able to order the items that the user has expressed an interest in by interest in descending order, starting with the most interesting item. Then the planner would have to be able to list as many items as possible until the constraint is used up and no more of the interesting items can be added as it would overflow the constraint limit.

The requirements for a tourism specific planner and the desired output would be the following. The planner is basically a mechanism for combining the different attractions a tourist would like to visit in a sensible manner. A sensible manner includes to favour a near, high-rated attraction before a far away low-rated attraction if the user has chosen a general category of things to do. Another good idea would be to find a sensible visiting order for the attractions, e.g. to visit the attractions in an order that minimizes travelling time between them, i.e. to find an acceptable solution for the travelling salesman problem. The planner has to take into account the following bits of information: the start and end time of the tourist's day, his start and end location, his interests, opening times of tourist attractions, the location of the tourist attractions, the rating of tourist attractions, either the average time that tourists spend on the attraction or the user specified time and possibly even the entrance fees of the specific attractions.

Of the general or specific items that the user has expressed an interest in, the items with the highest interest should be considered first and planned into the day first for the period of time that the user has indicated by the size of the shape. This means that an item with higher interest will take precedence over an item with lower interest. The planner should take into account other items already planned into the day and fill the specific item into the available slot that expends least walking time and has the closest possible fit. If the given item is of a general category, then the planner should find a compromise between the given rating for the item and its location and plan the best possible items into the best fitting slots, again trying to aim for the smallest walking time. As the tourist has only indicated the amount he would like to spend on this general category, the average time of tourists spend on the specific attractions are taken as the guideline when planning in these items. So if the item is general, the day should be filled up in a way that the total time planned for this category corresponds to size of the circle. The planning should go on until either the day has filled up, or the available time slots are too small to fill them up or all interesting items have already been planned into the day.

### **3.3.5 Requirements for the General Information Database**

The general information database is the database that contains the data that describes the categories and the items contained in the categories. It is important that the description of these items be flexible, extensible and capable of describing the system as a whole. Flexibility is needed to enable the metadata author to describe a broad range of elements that might be necessary for the specific domain. For example, the metadata description of the items in the domain of tourism would be metadata describing specific tourist attractions, e.g. GPS coordinates, opening hours, average/minimum/maximum visiting time, a description of the attraction, entry fees, associated rating, a photograph of the attraction etc. It also needs to be extensible, to allow the metadata author to add more elements, e.g. in the case of tourism the author might want to add the description if the attraction is suitable for kids under 12 or if it is accessible to wheelchair users. The data from this database needs to be accessible concurrently. However, it is not planned that the user can change this database, only system administrators etc., so it is basically a static database which makes concurrent access less of an issue.

### **3.3.6 Requirements for the User Interest Modelling Database**

The User Interest Modelling database only needs to contain the following data for each user: the item that the user has expressed an interest in, the interest level that he has expressed for this item and the amount for the associated constraint. In addition, the database has to be able to provide concurrent access to multiple user interest models without causing interference. In addition, the interest models should be stored persistently, so that the user can go back to his initial models and modify it.

It follows from this that the database will contain data from different user sources. To discern the data input from the different users, a unique identifier needs to be attached to each user using the tool concurrently.

### **3.3.7 Communication Requirements**

As it is planned to make the Dublin Tour planner available as an online service, there is the need to decide on appropriate communication between the user front end, which will be displayed in the client's browser, and the backend technology and intelligence. The backend technology and intelligence as well as the website need to be hosted by a suitable server. The communication technology then has to be able to relay changes in the user interface on the client side to the planner on the server side and then be able to send the planner output back to the user.

### **3.3.8 Mapping Output Requirements**

After the tourist has planned his sightseeing day to his satisfaction, his schedule then needs to be overlaid on a dynamic mapping tool for his use to either print out, store electronically on his computer or download onto a mobile phone. The map should preferably be able to display pedestrian routes rather than obey the one way system or use motorways.

## ***3.4 Designing the system***

### **3.4.1 High Level Architecture**

The following Figure shows the system architecture:

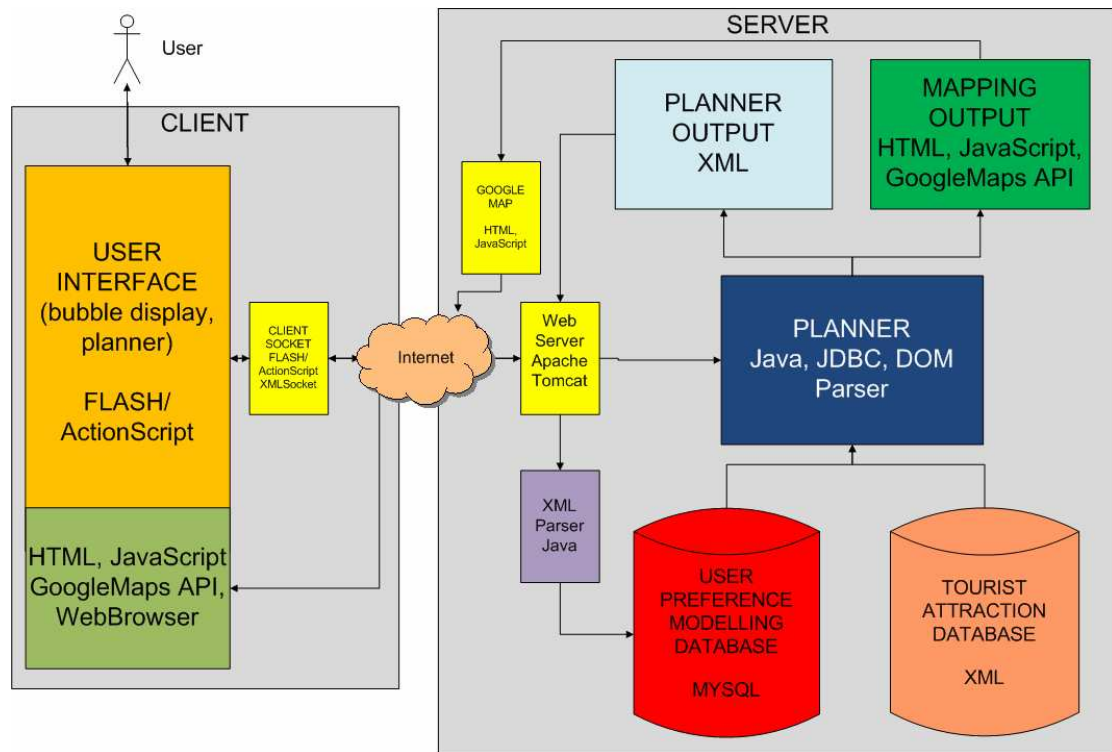


Figure 8 - System Architecture Diagram

### 3.4.2 Visualization/Front End/GUI Technology

The most obvious choices that come to mind when thinking of dynamic and interactive user interfaces on a website are Adobe Flash and Java Applets using Java Swing. Due to the following reasons, the decision has been taken to realize the user interface with Flash rather than Java applets:

Flash movies have the advantage over Java applets in that they are compatible with most platforms. In addition, 99.3% of internet enabled PCs have the Flash plug-in installed [Adobe Flash Player], more than Java or any other player.

Also, since Flash is vector-based, Adobe Flash binaries (SWF files) are very small and quick to load across even the slowest Internet connections. [Adobe Java] and it also means that loading for different screen sizes works better than in Java applets. Flash player also has a much smaller runtime than Java [Burdette, 2007].

Additionally, Flash supports dynamic loading of additional resources like images, sounds, video, and additional pieces of Flash, so the application can load assets on demand [Adobe Java].



ActionScript, the Flash object-oriented scripting language already comes with libraries for creating shapes, the ability to click these and dragging them around as well as libraries to see if two shapes overlap.

In addition, Flash provides libraries that can easily access and manipulate XML documents (see below) which support ECMAScript for XML (E4X) standard. E4X is a programming language extension that adds native XML support to ECMAScript (which includes ActionScript, DMDScript, JavaScript, JScript). It provides access to XML documents in a way that imitates XML syntax with the aim to provide an alternative to the DOM interfaces by using a simpler syntax. Previously, XML documents were always accessed at an object level, but with the release of E4X, the XML document is treated as a primitive. This leads to faster access, better support and acceptance as a building block (data structure) of a program.

In summary, while Java does provide more versatility and flexibility than ActionScript, ActionScript has been found to contain all functionality and library support needed for the purposes of this project. Therefore, Flash has been deemed a suitable technology for implementing the interface.

### **3.4.3 Planner**

To be useful, the tourism specific planner needs to contain a lot of intelligence and process the input information in a sensible way. After some consideration, it has been found that the using the Adaptive Engine, which has been developed by the KDEG group of Trinity College as part of a multi-model metadata-driven approach to content and layout adaptation in the domain of eLearning would be very suitable to implement the tourism specific planner. Although the engine has been developed for the purpose of generating personalized eLearning content, the system is data-agnostic due to the multi-model meta-driven design and therefore can easily be applied to other adaptive hypermedia domains.

The core of the system is the Adaptive Engine which is responsible for outputting personalized content based on the user interest input.

The other parts of the system are separated into discrete models, namely the user model, the adaptation model (or narrative as it is called in this approach) and content model [Conlan, Brady, and Wade, 2004]. The key technology used for the description of the models is XML and it is the task of the adaptive engine to reconcile the different XML elements in the models. In short, the adaptive engine uses the content, user and narrative models in a way that produces personalized content.

The most important part of this multi-model, metadata-driven approach is the adaptation model, or narrative. The narrative is thought to encapsulate the sequencing or adaptive logic in the engine [Conlan, 2004]. It contains the rule set and the metadata representing the features of that rule set. It is these rule sets that are executed in the rule engine to reconcile the other model information to produce the personalised output.

To be able to execute the rules of the adaptive model, the adaptive engine contains a narrative interpreter and a candidate selector which are rule engines that can interpret and execute rule sets.

The candidate selector is responsible for selecting possible candidates from a group of candidates which are like models grouped together. In this way, a layer of abstraction is maintained between the narrative and the content model, in that the narrative does not refer to content directly. These models are kept conceptually separate so that the narrative does not need to be concerned with the actual content that will realize the concepts described in the narrative.

Thanks to this independence between content model and narrative, individual pieces of content can be replaced or substituted without having to modify the narrative.

Then, to fulfil the concept described in the narrative the candidate selector can select one or more appropriate candidates from a number of possible candidate pieces with the help of the metadata describing the candidates.

It is envisaged that the three models used in the adaptive engine could be applied to the domain of tourism planning. While in the eLearning context this narrative would contain rules concerned with how to put together a course module, in the tourism

domain the narrative would be concerned with putting together a sensible sightseeing itinerary. Whereas in eLearning applications narratives are the embodiment of pedagogy, in a tourism application narratives would be rules governing the best way of putting together a visiting schedule. So, the narrative model in the tourism example should describe a mechanism for combining the different attractions a tourist would like to visit in a sensible manner. The candidate selector in the adaptive engine would then select the most suitable candidate from the group of possible candidates, e.g. possible tourist attractions that reflect the interests and preferences of the tourist. Similarly, while in the eLearning application the content model would represent the pedagogical qualities of the learning content [Conlan, 2000], the content model in the case of tourism would contain metadata descriptions of Dublin tourist attractions, such as opening days and hours, rating, average time spent at the attraction, entrance fees etc. Finally, whereas in the eLearning domain the user model is a learner model which describes the pertinent learner characteristics, the user interest and preference model in the tourism example represents the user's interests and preferences in specific tourist attractions and/or general categories of attractions.

The Adaptive engine prescribes that the models are being described using XML.

Using this approach and the adaptive engine it was hoped the knowledge about and experience of the KDEG group with the Adaptive Engine could be salvaged and simplify the implementation of a sophisticated tourism specific planner.

### **3.4.4 User Interest Modelling Database**

As described above, the user interest modelling database needs to be concurrently accessible by many users without interference as well as show persistence so that previous data can be accessed again at a later stage. MySQL is a multithreaded, multi-user SQL database management system. It uses SQL (Simple Query Language) to access and manipulate the databases and the data present in these databases.

The choices for the unique user ID are HTTP cookies, IP address, URL (query string), hidden form fields, HTTP authentication, Adobe Flash Local Stored Objects (LSO) or

client-side persistence [Wikipedia HTTP Cookies]. While all methods have their own drawbacks, e.g. using IP address is unreliable if more than one person accesses the same computer or if the connection goes through a NAT router or proxy, URL/query strings and client side persistence have inherent security vulnerabilities, or because the method is just not appropriate to the aim, e.g. hidden form fields which are only really useful for session tracking rather than longer term storage, the three most appropriate options are HTTP cookies, HTTP authentication and LSOs. From these three, HTTP authentication has the disadvantage of requiring the user to register for a username and password first. The choice therefore has to be made between HTTP cookies or LSOs. Since the user is expected to have a Flash player to visit the site, there is a good cause to use LSOs rather than HTTP cookies.

### **3.4.5 General Information Database Design**

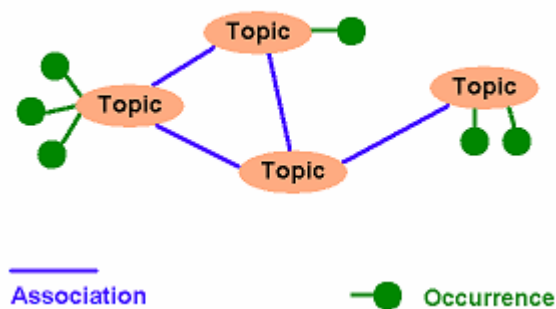
There was a question as to what kind of technology would be the most appropriate for the general information description and storage, or content model. Two main technologies that spring to mind are ontologies and topics maps.

An ontology can be described as the definition of a set of concepts, their taxonomy, interrelations and rules that govern such concepts in a way that can be interpreted by machines. Ontologies are used in the artificial intelligence domain, the Semantic Web, and in software engineering and information architecture as a form of knowledge representation about the world or some part of it. Their nature allows a computer to reason about the information and relationships contained in the ontology.

Topic Maps (Figure 9) is an ISO standard (ISO/IEC 13250:2003) for the representation and interchange of knowledge, with an emphasis on the findability of information.

Topics are basically abstract subjects with names, resources, and relationships as their characteristics. A topic map can represent information about the structure of information resources used to define topics, (which can be any concept, e.g. people, countries, organization, software modules, files, events...), and the relationships

between topics. In general, the structural information conveyed by topic maps also links the topics to specific information resources relevant to these topics (i.e. occurrences), and relationships between topics (i.e. associations). In addition, information objects can have properties (called facet types), as well as values for those properties. A topic map can be imagined as a multidimensional topic space - a space in which the locations are topics, and in which the distances between topics are measurable in terms of the number of intervening topics which must be traversed to be able to get from one topic to another. Also, two topics may be connected through an association, but they can also be connected by virtue of sharing an occurrence. Topic maps are thus quite similar to semantic networks and both concept and mind maps in a lot of ways. They can be thought of as overlays on sets of information objects [ISO/IEC 13250:2003].



**Figure 9 - Topic Map [Wikipedia Topic Maps]**

Both ontologies and topic maps provide a richness in the description of information objects and relationships between these objects (or occurrences in topic map language) that is unparalleled by traditional databases such as relational databases. This metadata richness and the possibility to describe complex relationships plus the possibility to reason about them when using ontologies also provides more appealing ways of accessing and manipulating data and relationships than provided by any traditional database system. In summary, both ontologies and topic maps represent suitable technologies to describe the domain of tourism with instances of tourist attractions.

However, the higher complexity of the design of the system by using ontologies or topic maps over other possible technologies is only justifiable if one exploits the way that relationships are defined and reasoned about in ontologies or topic maps.

However, early on in the project it became clear that a sophisticated planner which would benefit from the added functionality provided by ontologies or topic maps was out of scope of this project due to time restraints and therefore a simpler background information representation needed to be found, without the richness in the description of relationships. It was decided that the metadata describing sightseeing concepts and their containing tourist attractions could easily be represented with a treelike structure of information.

Therefore, it was decided to represent the content model and data using XML. XML (Extensible markup language) is a W3C initiative that allows information and services to be encoded with meaningful structure and semantics that computers and humans can understand. XML is extensible and flexible in that users can define their own metadata description tags and the XML document can be changed and modified at a later stage without having to change any other components of the system. The syntax and form of an XML document is usually described by its schema written in a schema definition language such as DTD or XSD which define the structure, content and semantics of XML documents in more detail, i.e. in terms of constraints upon what elements and attributes may appear in the XML document, their relationship to each other, what types of data may be in them, and other things. Therefore, in the tourism example, the tourism/general content, rules on how to plan a day and the user's interests are described in an XML. XML also has the advantage of providing a universal format for transferring information over the internet.

The general XML schema for the initializing XML needs to contain the following information: the names of the categories and subcategories and the names of the leaf items that the (sub-) categories contain and the initial constraint amount associated with it.

### **3.4.6 Server hosting and Information Relay Technology over the Internet**

It has been decided to use Apache Tomcat 6's servlet technology to host the backend technology and website on which the tool will be available. Apache Tomcat is a web container, or application server that provides an environment for Java code to run in cooperation with a web server [Apache Tomcat].

### **3.4.7 Mapping Output**

There is a choice to be made of which mapping software to use. The most common ones are Multi map, Map Quest Mobile, MSN/Windows Live Search Maps, Ask Maps, Yahoo!'s Yahoo! Maps and Google's Google Maps. Most online mapping services offer a developers API to facilitate incorporation of their maps in websites or other online applications. Ask Maps, does not provide a developer API while Multi map and Map Quest charge a fee for the incorporation of the map on a website and only allow free linking to the mapping websites. In addition, Map Quest does not offer satellite imagery although they do offer the provision of maps and driving directions to any Web-enabled mobile phone or PDA through Map Quest mobile. Windows Live, in addition to providing an overly complex API, does not provide high quality. Yahoo Maps and Google Maps are the two remaining choices. Reading reviews and articles about the two, both services were rated equally on performance, usability and popularity. It was the personal choice of the author to use Google Maps rather than Yahoo! Maps in this application as the cartographic interface of Google Maps seemed to be more appealing to the author. An example screenshot of the output is shown in Figure 10.

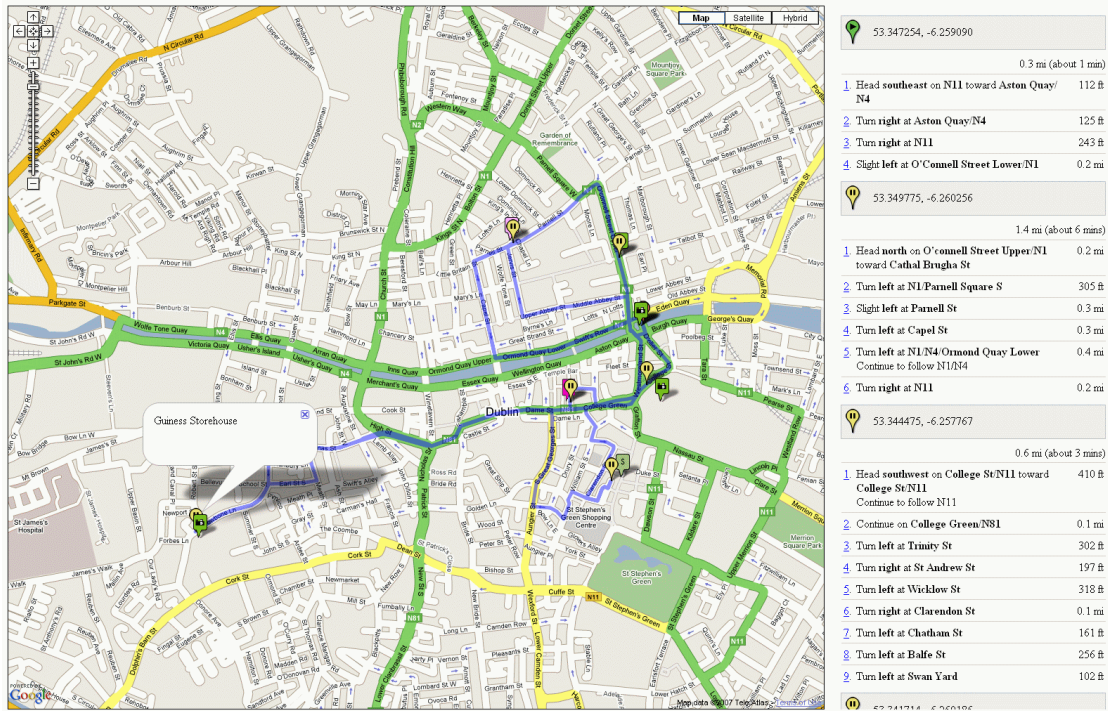


Figure 10 - Mapping output in Google Maps



## **4 Architecture Implementation**

All of the development and implementation was carried out on a Dell Latitude D400 laptop which comes with 512 MB of RAM and an Intel Pentium M processor with 1.4GHz processor speed.

The technologies used in the implementation are Flash 9.0, ActionScript 3.0 – both in the Flash CS3 Professional development environment, XML, XPath, Java 1.6, JDBC, JDOM – supported through the Eclipse environment, MySQL in conjunction with MySQL Administrator and Query Browser, Google Maps API [Google Maps API], JavaScript, HTML, and HTTP.

### ***4.1 Software Implementation History***

After installing the necessary software, setting up the various development environments and familiarization with some of the new technologies, especially Flash 9.0 and ActionScript 3.0, it was decided early in the implementation prioritise getting the information flow between all important components functional and then to concentrate on implementing these components.

This meant that information flow in both directions needed to be set up, firstly between the Flash interface on the client side and the Planner on the server side, followed by linking up the Planner with the User Preference Modelling Database and the Tourist Attraction Database. The integration of the planner with the mapping module was the last step in the implementation phase.

The next step was to implement the components in order of importance and risk. As the graphical user interface is such an important aspect of the project and most likely to change after user feedback, it was the first component implemented. Within the user interface, focus was first placed on the preference setting tool and then on the calendar/planner output view.

Initially, and for more efficient testing purposes, the Flash/ActionScript UI did not use any data input but rather employed a dummy data generation function for the initialization of the UI. Further into the implementation a database of real Dublin tourist attractions was slowly built up until it had achieved a size that was usable to demonstrate the potential of the tool in the context of a Dublin tourist.

As the Planner and therefore the generation of sensible output were only secondary in importance after the user interface, a dummy planner was used throughout this process that had no intelligence associated with it but could generate the correct output format that was to be fed back into user interface. It was envisaged to leave the implementation of the planner until the implementation of the user interface had reached a high level of completion.

It was initially planned to use the Adaptive Engine 3 to realize the planning and an attempt was made to do so, but when the implementation of the planner had begun and the demonstration deadline drew closer, it became apparent that a satisfactory standard of the planner could not be reached in time. This was due to the considerable learning curve associated with using, developing for and designing a sensible rule model and narrative for the Adaptive Engine, especially if one is not familiar with the logic programming concept. Instead, to show at least the potential that a planner could have, it was decided to then concentrate on the development of a more lightweight planner without using the AE, which arrived at a planner solely written in Java. The reason why this was deemed to be a tolerable decision was because the planner was not the focus of this project and that it would have been possible to realize the planner with the Adaptive Engine and therefore use the full potential and functionality offered by the Adaptive Engine if time had allowed it.

Finally, the mapping output was implemented using the Google Maps API resulting in a complete end-to-end system with the data flow completed from server to presentation layer to input, into planning and over output back to the presentation layer.

### 4.1.1 General Database Format

As explained in the design, the general database at a minimum has to contain the metadata that describes the categories and the items contained in the categories. Optionally, each instance in a category may contain further information, for example a link to an image file or a description

The format of the minimal general database XML file has to adhere to the following schema (Figure 11):

```
<?xml version="1.0" encoding="utf-8"?>
<Categories domain="domain">
  <SubCategory level="number of level" name="categoryname">
    <LeafItem>
      <Name>Cat 1 Item 1</Name>
      <Constraint>90</Constraint>
    </LeafItem>
  </SubCategory>
</Categories>
```

**Figure 11 - Minimal General Database XML format**

The example XML file (Figure 12) used for the purpose of illustrating the general concept has the following format:

```

<?xml version="1.0" encoding="utf-8"?>
<Categories domain="general" >
  <SubCategory level="0" name=" Category 1" >
    <LeafItem>
      <Name>Cat 1 Item 1</Name>
      <Constraint>90</Constraint>
      <Image>Picture2.jpg</Image>
      <Description>BLA</Description>
    </LeafItem>
    <LeafItem>
      <Name>Cat 1 Item 2</Name>
      <Constraint>90</Constraint>
      <Image>Picture2.jpg</Image>
      <Description>BLA</Description>
    </LeafItem>
    <LeafItem>
      <Name>Cat 1 Item 3</Name>
      <Constraint>90</Constraint>
      <Image>Picture2.jpg</Image>
      <Description>BLA</Description>
    </LeafItem>
    <LeafItem>
      <Name>Cat 1 Item 4</Name>
      <Constraint>90</Constraint>
      <Image>Picture2.jpg</Image>
      <Description>BLA</Description>
    </LeafItem>
  </SubCategory>
  <SubCategory level="0" name=" Category 2" >
    <SubCategory level="1" name=" Sub Category 1" >
      <LeafItem>
        <Name>Cat 2 Sub Cat 1 Item 1</Name>
        <Constraint>90</Constraint>
        <Image>Picture3.jpg</Image>
        <Description>BLA</Description>
      </LeafItem>
      :
      :
      :
    </SubCategory>
  </Categories>

```

**Figure 12 - Example General Purpose XML**

#### **4.1.2 Dublin Tourism Attraction Database Extensions**

In addition to the information mentioned above, the tourist specific XML needs to contain additional data that accommodates for the information needed by the planner to create sensible output, such as opening days and times, entrance fees, possible maximum or minimum visiting times, the latitude and longitude of each tourist

attraction, a rating, an image and a description of the item. An example of the tourism specific XML file is shown below (Figure 13):

```

<?xml version="1.0" encoding="utf-8" ?>
<Categories domain="tourism">
  <SubCategory level="0" name="Art" letter="C">
    <Leafitem>
      <Name>National Gallery </Name>
      <OpeningTimes>
        <DaysOpen>1,2,3,4</DaysOpen>
        <HoursOpen timeUnit="min">570-1080</HoursOpen>
        <DaysOpen>5,6</DaysOpen>
        <HoursOpen timeUnit="min">570-1020</HoursOpen>
        <DaysOpen>7</DaysOpen>
        <HoursOpen timeUnit="min">660-1020</HoursOpen>
      </OpeningTimes>
      <EntranceFee>
        <Adult currency="EUR">0.0</Adult>
        <Student currency="EUR">0.0</Student>
        <Child currency="EUR">0.0</Child>
        <Senior currency="EUR">0.0</Senior>
        <Family currency="EUR">0.0</Family>
      </EntranceFee>
      <Constraint unit="min">120</Constraint>
      <Minimum unit="min">NA</Minimum>
      <Maximum unit="min">NA</Maximum>
      <GPSLocation><Latitude>53.340873</Latitude><Longitude>-
6.252557</Longitude></GPSLocation>
      <Rating>4.9</Rating>
      <Image>NationalGalleryOfIreland.jpg</Image>
      <Description>National Gallery....</Description>
    </Leafitem>
    <Leafitem>
      <Name>Hugh Lane Municipal Gallery of Modern Art</Name>
      <OpeningTimes>
        <DaysOpen>2,3,4</DaysOpen>
        <HoursOpen timeUnit="min">570-1080</HoursOpen>
        <DaysOpen>5,6</DaysOpen>
        <HoursOpen timeUnit="min">570-1020</HoursOpen>
        <DaysOpen>7</DaysOpen>
        <HoursOpen timeUnit="min">660-1020</HoursOpen>
      </OpeningTimes>
      <EntranceFee>
        <Adult currency="EUR">0.0</Adult>
        <Student currency="EUR">0.0</Student>
        <Child currency="EUR">0.0</Child>
        <Senior currency="EUR">0.0</Senior>
        <Family currency="EUR">0.0</Family>
      </EntranceFee>
      <Constraint unit="min">90</Constraint>
      <Minimum unit="min">0</Minimum>
      <Maximum unit="min">360</Maximum>
      <GPSLocation>
        <Latitude>53.354174</Latitude>
        <Longitude>-6.264724</Longitude>
      </GPSLocation>
      <Rating>5.0</Rating>
      <Image>HughLaneGallery.jpg</Image>
      <Description>The Hugh Lane Gallery has a fine collection....</Description>
    </Leafitem>
    :
    :
  </SubCategory>
</Categories>

```

**Figure 13 - Example Tourism Specific XML file**

## **4.2 Planner**

### **4.2.1 Java Planner**

Due to the reasons outlined above, the planner was implemented as a Java class. This implementation decision was taken due to its platform independence, and its straightforward integration with existing web and database technologies. For example, libraries for the interaction with relational databases, such as MySQL are readily available, namely JDBC as well as libraries for accessing and manipulating XML documents, namely JDOM. JDOM is a Java-based wrapper implementation of the Document Object Model (DOM) that provides a complete solution for accessing, manipulating, and outputting XML from Java code [JDOM]. The main advantage for using JDOM rather than accessing XML files directly as text files is performance gain as it is much faster to access and manipulate a DOM loaded into memory than to read the XML file in as text file and manipulate it that way. In addition, XPath can be used to uniquely reference or query any node of an XML document or DOM. XPath [XPath] is a small query language that can be used to address parts of an XML document which it models as a tree of nodes. For example, XPath can be used to retrieve specific information from elements within the metadata models. XPath also allows the use of wildcards in query expressions to find partial matches. Another great feature of XPath is that it allows querying complex relationships, e.g. it can search for all the ancestors, descendants, siblings etc. of a specific node.

### **4.2.2 Planning Algorithms**

If the planner has to have any intelligence associated with it, it will inevitably have to be specifically designed towards the domain of the interest and preference setting tool. However, a very basic general planner with very limited intelligence is still possible and will be described in the following section followed by a section describing a possible tourism specific planner.

### **4.2.3 General Planning Algorithm**

The general planning algorithm has been designed in the following way: All the data for this specific user in the interest modelling database will be retrieved, i.e. the items that the user has expressed an interest in, the level of his interest in these items and the amount of constraint associated with this item. These items will then be ordered by interest, starting with the item with the highest level of interest associated with it downwards to the item with the lowest interest.

Assuming a start value of 0 and supplying a maximum value for the constraint, the planner iterates through the items starting from the highest interest and fills up the plan with these items one by one until the next item to be added to the plan exceeds the constraint to over the maximum allowed. At this stage, this item is discarded and the next interesting item is tested if it fits into the plan without exceeding the supplied maximum constraint value. So, either when all items have been added to the plan or if the plan is full and no further items fit into it, then the algorithm stops.

While this planner has only very limited intelligence, it still serves the purpose to output a plan with items ordered by interest until a certain limit has been reached. It is envisaged that this planner could be used as a base planner that could be extended to a more intelligent planner.

### **4.2.4 Tourism Specific Planning Algorithm**

The tourism specific planner is basically an extension to the basic planner and is envisaged to work as follows: First of all it retrieves all the information from this user from the user interest modelling database as before. This information contains the (sub-) categories of or specific tourist attractions, the level of his interest he has expressed in visiting these attractions or groups of attractions and the amount of time he plans to spend on each attraction/ (sub-) category of attraction. These tourist attractions will then be ordered by interest level, starting from the highest going to lowest. A tourist's day will have a given start time and location as well as end time and location as supplied by the user.

If the current most interesting item is a specific attraction, the planner will try and schedule a visit for this attraction as described further below. However, if the item is a

general (sub-) category, the planner shall go off and retrieve all the specific items below this node in the data tree. For each of the specific attractions under this node, the planner shall go off and calculate the travel times to each attraction and from each attraction to the following one in the schedule in the first available slot. Taking the total travel time for each item in the first slot, and taking into account the rating for each attraction, a formula should be employed which will determine the best compromise between total travel time and rating for this attraction and therefore choose which attraction should be attempted to be scheduled into this slot first. The planner shall then iterate through all the possible specific attractions under the given general category in order of best travel time/rating compromise and try to fit the attractions into the given available slot by the algorithm as described further below until either all the time that the tourist would like to spend on this category has been planned out or none of the possible attractions fit into the given slot. If the planner is successful in scheduling an attraction into the available slot, the attraction shall be removed from the list of possible attractions under this general node and the time the tourist would like to spend on this general category shall be reduced by the time planned for this attraction. The planner shall then move on to the next best specific possible attraction in this general category with regards to total travel time and rating and tries to schedule it into the remainder of it does not exceed the time to be spent on this category. If the planner is not successful in scheduling this attraction into the available slot, the planner shall go on to take the next best attraction from this general node in terms of total travel time and rating and tries to schedule it into the available slot.

The way that an attraction is being scheduled into an available slot has been implemented as follows: the planner takes the current attraction and the first available slot in the tourist's schedule and if it is not contained in the tourist's schedule yet, subsequently calculate an approximate travel time to this attraction from the previous location as well as the travel time to the following location. The next thing that needs to be checked are the opening times of the specific attraction and if the attraction can be visited within the slot available, taking into account the opening times of the attraction, the amount of time the tourist would like to spend there or the average time spent there if the attraction is one of a list of general attractions as well as the travel times from the previous location to this attraction as well as from this attraction to the



following location. If the attraction is open long enough during the available slot and the travel time there and to the next attraction together with the spending time there fit into the available slot, it will be planned into this available slot. If the slot is too small, the amount of time planned to be spent there shall be reduced incrementally if the attraction does allow for a time reduction and the planner then shall attempt to fill this attraction again into the current slot. If up to a certain time reduction limit is reached and the attraction still does not fit into the available slot, the planner shall move on to the next available slot in the day and repeat the scheduling process as before. If the given specific attraction came from a list of possible specific attractions under a general node, then the list of possible specific attractions shall be re-populated with all possible specific attractions under this node.

If the given attraction cannot be planned into any of the available slots even after possibly reducing the time to be spent there because of the attraction not being open or not open for long enough during these slots or the slot being too small or the travel times taking up too much of the slot time that not enough time is left to visit the attraction in the open times, then the attraction is discarded from the list of interesting attractions/possible specific items under the given general category.

#### **4.2.5 Output Format for User Interface Output and Mapping Output**

A general output XML only needs to contain the following information: the start constraint value of a scheduled item (e.g. time, or money), the amount of constraint it takes up and the order of these scheduled items. An example is shown below in Figure 14:

```
<?xml version="1.0" encoding="utf-8"?>
<PlannerOutput>
  <InterestItem>
    <InterestName>InterestName</InterestName>
    <StartValue>0</StartValue>
    <Amount>29</Amount>
  </InterestItem>
  <InterestItem>
    <InterestName>InterestName</InterestName>
    <StartValue>29</StartValue>
    <Amount>10</Amount>
  </InterestItem>
</PlannerOutput>
```

Figure 14 - Example planner output XML

In the tourism case, a second output XML file generated that is interpreted by the Google Maps API to display the items on a map with directions on how to get from one item to the next. An example XML file for interpretation by the JavaScript for the Google Maps display is shown below in Figure 15

```
<?xml version="1.0" encoding="utf-8"?>
<PlannerOutput>
  <InterestItem>
    <InterestName>OConnell Bridge</InterestName>
    <StartValue>0</StartValue>
    <Amount>0</Amount>
    <letter>A</letter>
    <marker>
      <Latitude>53.347254</Latitude>
      <Longitude>-6.25909</Longitude>
    </marker>
  </InterestItem>
  <InterestItem>
    <InterestName>TravelTime</InterestName>
    <StartValue>541</StartValue>
    <Amount>82</Amount>
  </InterestItem>
  :
  :
</PlannerOutput>
```

Figure 15 - XML for Google MAP display

### **4.3 Use case scenario**

An example of how a user could use the tool is described in the following.

Upon loading the interactive UI the user is presented with categories of items, in the case of the tourism example with categories of sightseeing attractions such as Museums, Art, Shopping etc. The user can then drag these circles toward the reference circle if he has an interest in them or he can expand these circles and drag subcategory or specific leaf items towards the day according to his interests. Items that he is more interested in he should drag nearer to the reference circle. The user interface will make sure that other circles are pushed out of the way in two different ways depending on the situation. In one situation there is much space left around the reference circle, then any other attached circles will be moved around the reference circle to make space for the dragged circle. However, if the area around the reference circle is so crowded that the dragged circle will not easily fit into that area even by pushing the other attached circles around, then the least interesting attached circle that is in the way is being pushed further away from the reference circle. If the user would like to delete an option from the middle reference circle, he would drag the item out of the interest area until the connecting line breaks. If the circle being deleted was a specific circle and its parent category was not expanded at the time of dragging, the circle will just disappear, in any other case it will just stay wherever the user dragged it to. In addition, the user can change the size of the circles before or after dragging them into or out of the interest area to indicate a different amount of the constraint, in the case of tourism more or less time to be planned for visiting the specific attraction. When the user is happy with the preference and constraint settings he can push the reference button in the middle to call the planner. A moment later a possible schedule will appear on the right hand side of the screen. He can then access all the attractions overlaid onto Google maps which will also give him the directions in the order of his visit. If the user is not happy with it, he can change preferences, times and add or delete more items to the day and then call the planner again. He can do this until he has found a satisfactory plan. Some screenshots of this progress are provided below:

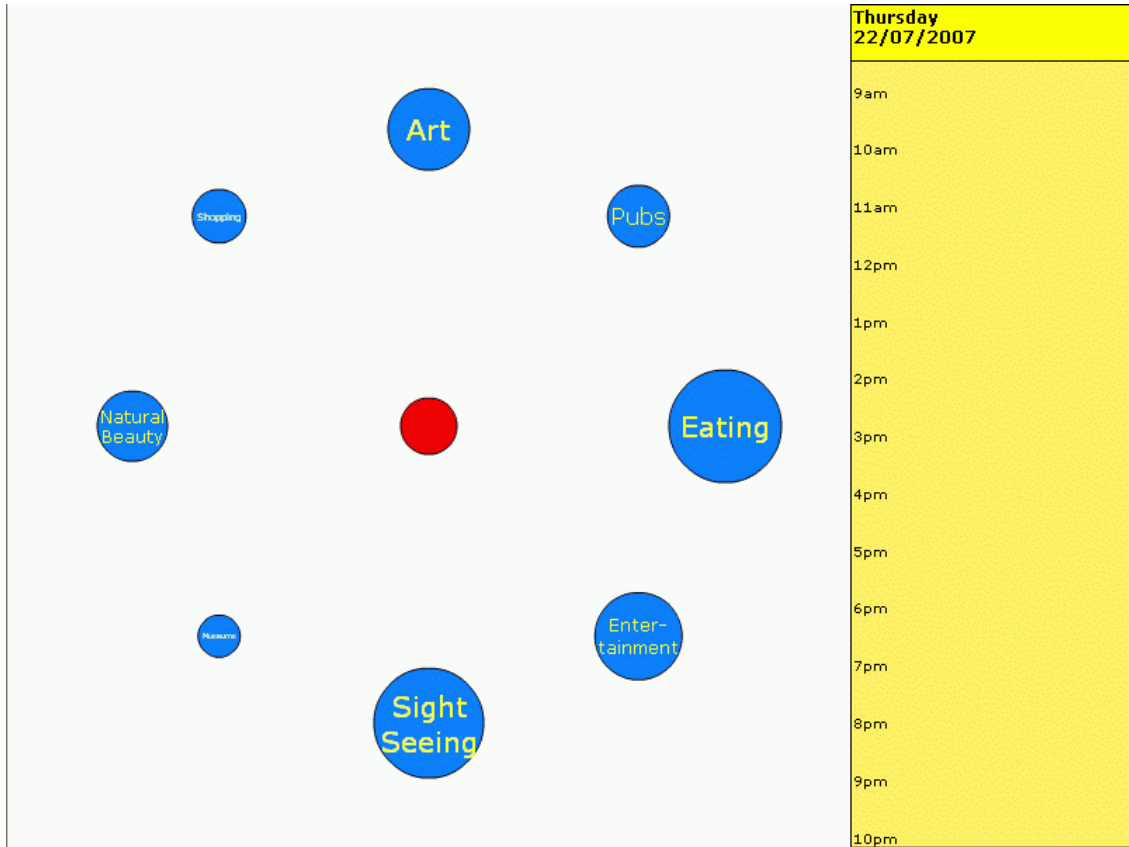


Figure 16 - Tourism Tool Start-up Screen

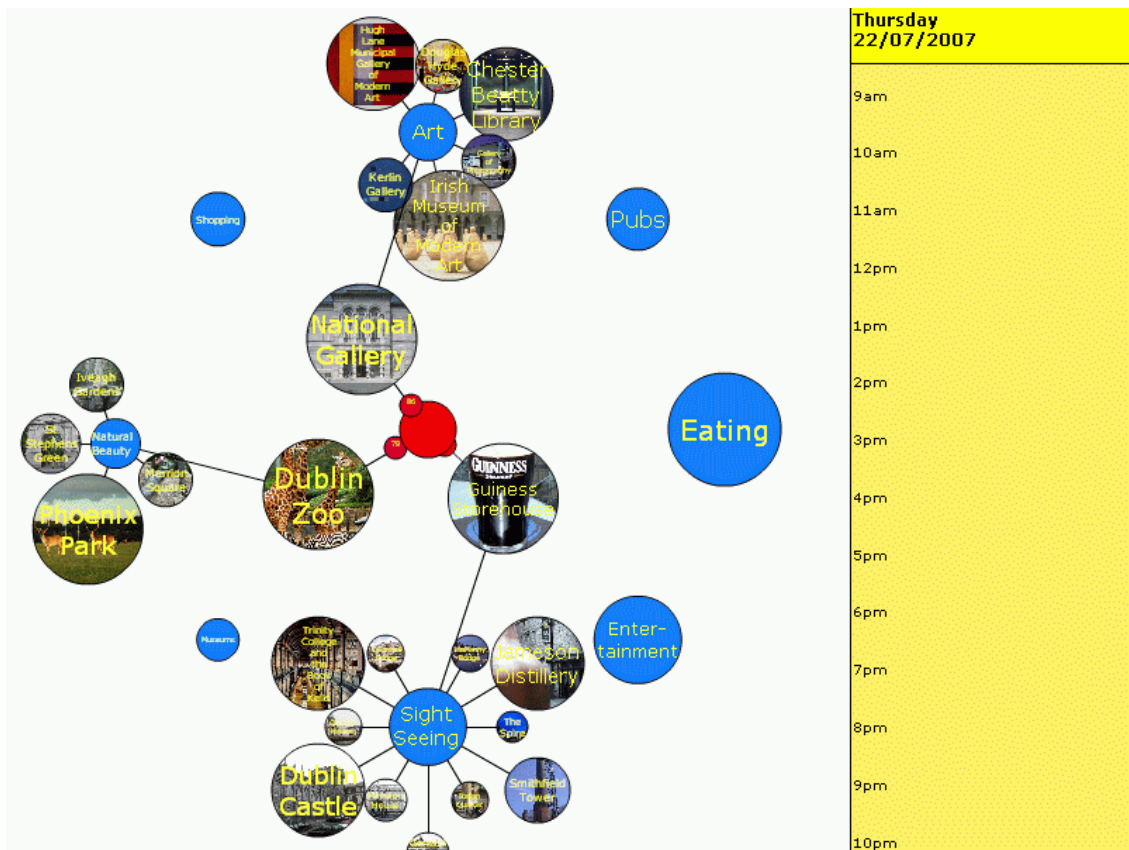


Figure 17 - Exploring options, specifying interests and preferences

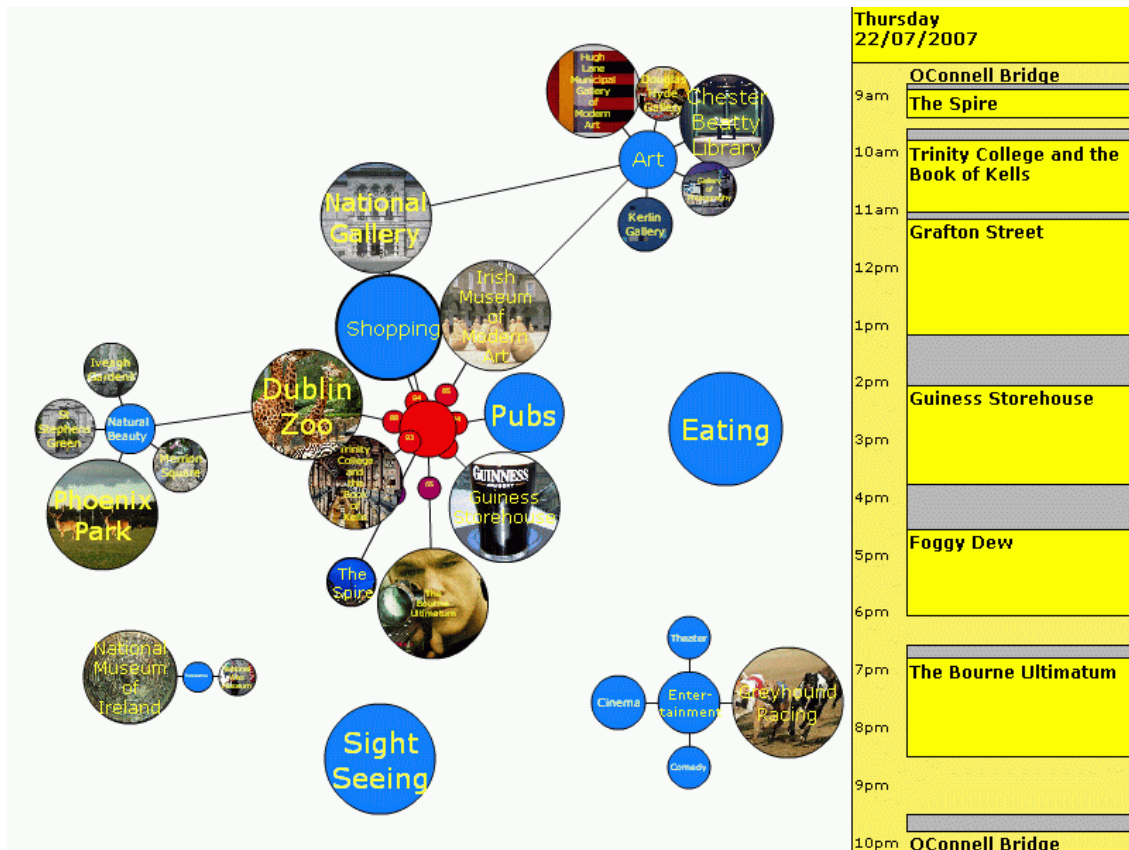


Figure 18 - Planning in progress

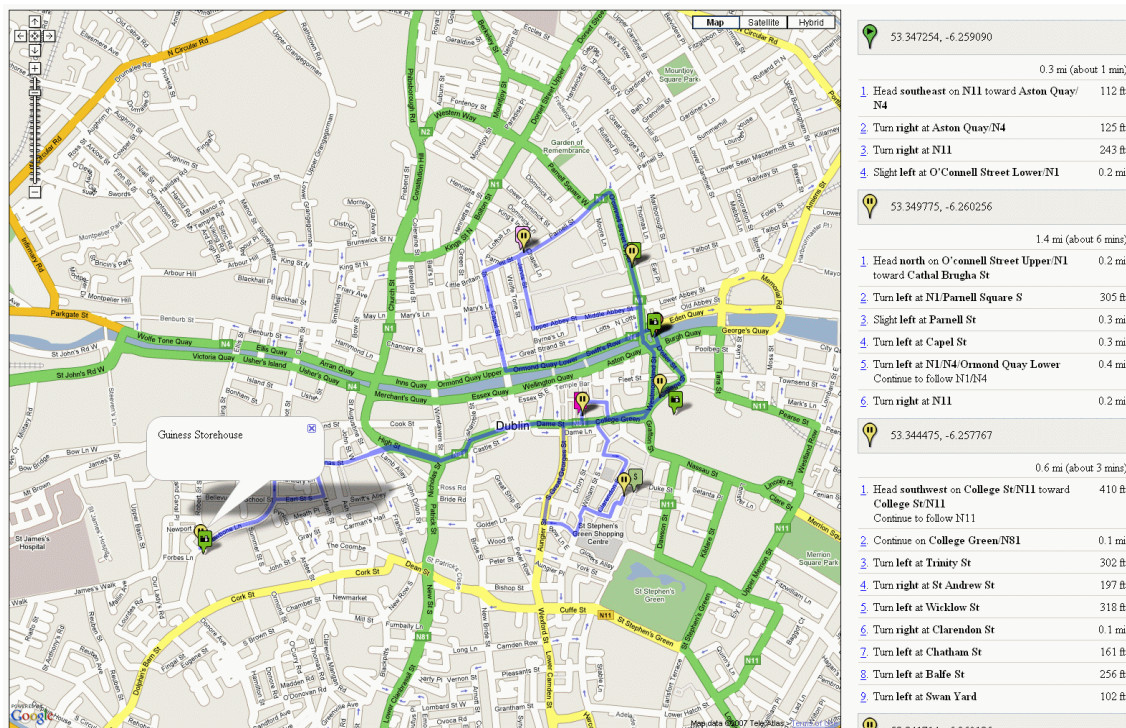


Figure 19 - Google Maps Output

#### **4.4 Implemented Functionalities of the tool**

The final tool contains the following functionalities:

- Any (sub-) category circles can be expanded to leaf item level. When the circle expands to show the next level circles, a line is being formed between the category circle and the child circles.
- If the user un-expands the category circle, all children circles that have no interest associated with them will disappear, but the children circles of this category that have an interest associated with them will stay in their original position.
- Any circles can be dragged around the screen with the mouse apart from the reference circle in the middle.
- If a (sub-) category circle is expanded, and the user drags the (sub-) category circle, then all circles that have no interest associated with them will be dragged with it. Circles of this category that have an interest associated with them will remain in their original position.
- A double click on a specific item leads to the appearance of a more detailed description about this item in the left hand corner of the screen which will initially have screen focus or retain screen focus when the mouse is hovered over it.
- Upon clicking the reference circle, the planner will be called to fill the schedule and in the case of the tourism domain a Google map will be overlaid with the items in the tourist's schedule.
- Any circle will receive screen focus and be put in front when hovered over it.
- All circles apart from the reference circle display a name describing the entity they represent.
- Leaf items, i.e. instances of the category show a background picture, whereas (sub-) category circles are coloured uniformly.
- All circles can be resized apart from the reference circle.

- The user can add specific items or general circles or a mix of both, even of the same category to the day by dragging the appropriate circle(s) into the interest parameter.
- When dragging items towards the centre circle and the interest perimeter is traversed, then a line is being formed between the reference circle and the dragged circle. This line visualizes the interest the user expresses on this item. In addition, a small circle will appear in the middle of this line that changes colour depending on distance of the dragged circle and the reference point. It will be blue when the distance is big and the interest is low and change incrementally over purple to red with reducing the distance.
- When the dragged circle touches the reference circle, the interest in this item is 100%.

## **4.5 Implementation issues**

### **4.5.1 Coordinates**

To retrieve the coordinates for the Dublin tourist attractions, each tourist attraction needed to be found on Google Earth, the mouse placed over it and then the latitude and longitude displaying the mouse position on the map needed to be manually written down for this attraction and input into the Dublin tourist attractions database. These were then displayed on Google Maps and checked for accuracy and correctness. This tedious process was completed for more than 50 Dublin tourist attractions, enough to demonstrate the potential of the planner and mapping output.

### **4.5.2 Estimation of Distance and Walking Time**

The calculation of distance did not employ Google Maps routing functionality because of the issues described below. Instead, the direct distance between two locations was calculated using Pythagoreans formula from the latitudes and longitudes of the coordinates in decimal forma. The resulting unit-less number was then

multiplied by a factor of 2000 which produced the final walking time estimate. This factor was chosen by estimating what time a potential tourist might take to leisurely walk from one location another and comparing the time with the distance between those locations. The factor was then calculated by dividing the time estimate by the direct distance as calculated before from the coordinates.

### **4.5.3 Google Maps routing functionality**

Unfortunately the Google Maps API does not support directions and routing for non-motorized or non-vehicular traffic such as bicycling or walking. Instead it adheres to the one-way system and chooses going along bigger or main roads before smaller distance for the routing.

### **4.5.4 Rating versus Travel Time Compromise**

When the tourist indicates an interest in a whole category of tourist attractions, such as “Art”, then any of the attractions contained in this category could potentially be planned into the tourist’s day. In a given slot, to find out which of the possible “Art” attractions to try and fill into the slot, for each attraction the travel time to it and from it to the following location will be calculated as described in the design section. Then, for each attraction the rating for this attraction will be multiplied by 10 and then the resulting value divided by the total travel time as in following formula:

```
ratingVSTravelTimeValue = attraction.getRating() * 10 / totalTravelTime;
```

The attraction with the highest resulting value will be deemed the best attraction for this slot in terms of distance from the current location and the rating. This formula was determined by trial and error and is an arbitrary approximation. It might be useful research how much influence rating has in comparison to total travel time to get a better compromise.



#### **4.5.5 Time Reduction Limit**

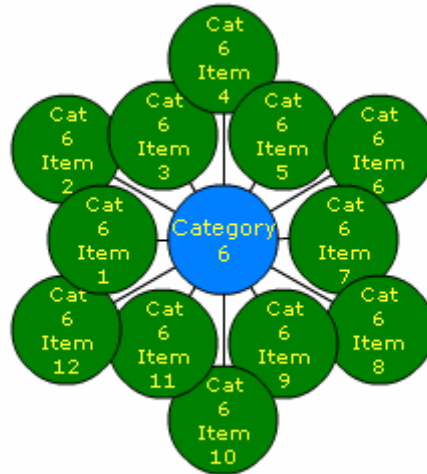
As mentioned in the design, if the given attraction does not fit into a given slot, either due to the slot time being too small to fit in walking there, visiting the attraction and walking to the next attraction, or because the opening times start too late before the slot ends or end too early after the slot starts, then the time for this attraction will be reduced incrementally by one minute and another attempt will be made to try to fit in the attraction into the given slot if the attraction allows for a time reduction. This will be repeated until the time reduction has reached a limit of 85% of the original time, at which stage a further attempt to fit in this attraction into the given slot will be abandoned. Again, this limit has been chosen arbitrarily and it would be useful to find out how much of a time reduction would be tolerated by a tourist.

#### **4.5.6 Start and End Times and Locations for Tourism Specific Planner**

The day of a Dublin tourist has been chosen to start at 9am at O'Connell Bridge in the city centre of Dublin and end at 10pm again back at O'Connell Bridge. While these times and locations are not configurable in the program for now, it is planned that these be administered dynamically by the user in the future.

#### **4.5.7 Cluttering Problem**

It appeared that if there were many leaf items/subcategories attached to one circle, that the area would be very cluttered and that the individual leaf items would be more difficult to see. It has therefore been decided that if there are more than 10 items attached to a (sub-) category circle that these would fan out in an alternating manner, so that every other item would fan out by a smaller distance than the other half (Figure 20). In addition, the circle that is being hovered over gets the focus, i.e. it will be in put in front of every other item on the screen.



**Figure 20 – De-cluttered**

#### **4.5.8 Meaning of the Size of the Circle**

It was later decided that the size of the general items should indicate the amount of specific items that it contains, i.e. if there are only few “Museums” to visit, then the general “Museums” circle should be smaller than if there were many museums to visit.

#### **4.5.9 Distinction between General and Specific Items**

In addition, it was later decided to have all items in the shape of a circle. General categories of items, i.e. which are expandable and contain further items/subcategories of items, and specific leaf items are only distinguished by the background of the circle. General (sub-) categories are coloured uniformly blue, whereas the specific items have a pictures displaying the specific item as a background.

## **5 Evaluation and Future Work**

### **5.1 Evaluation of the Mock-up**

As mentioned in the design section, a mock-up of the tool was created early in the project phase using PowerPoint before implementation had commenced. This mock-up was developed to test the proposed system and specifically the visualization metaphors for acceptance and usability and to get feedback on the idea. It was intended to be a qualitative test rather than a quantitative test to get a first idea and also to elicit further ideas and suggestions for improvements and changes. The design could then be modified accordingly to accommodate any necessary changes. This mock-up was presented to and evaluated by a group of 12 people.

#### **5.1.1 The Test Group**

The test group consisted of twelve volunteers, comprised of seven male and five female volunteers and of which ten were in the age range from 24 to 28. One male was 47 and one female was 35. With regards to competence in using technical devices such as computers, mobile phones or PDAs, ten volunteers indicated that they would be very familiar with using computers and two female volunteers indicated that they would be using computers quite a lot and moderately.

With regards to frequency of travel per year, there was a difference of a magnitude found in the answers, ranging from one time per year to ten times per year.

However, when asked about how often these would include city breaks, the answers given were quite homogeneous, ranging from 2-4 times a year. With regards to how many days they would on average spend on a city break, the most common answer was 3 days with 2 individuals indicating longer time periods (5 days and 5-8 days respectively) and two individuals indicating shorter time periods (2 days each). Finally, most people specified that they would spend about 2-3 days on average

sightseeing when on a city break, with one individual indicating a shorter time of 1 day and another indicating a longer time of 3-6 days.

There has been observed no remarkable difference between genders in the answers in most cases. The reasons for this could be that male and female users mostly agree in their answers or that the test group is too small to expose any gender specific differences or both. In addition, the group is quite a homogeneous group with regards to age (apart from two people of significantly older age) and comfort in using technical interfaces. Because of these reasons, the results are being presented without test group stratifications and only where there was a noticeable difference in answers, this will be acknowledged.

### **5.1.2 Results of the Mock-up Evaluation**

#### *System Understanding*

All people agreed or strongly agreed that it is clear what the system is trying to achieve, except for one person who did not agree, so the system was explained in more detail to this person. Similarly, all people agreed or strongly agreed that it is understandable how the system could be useful in helping to plan a sightseeing day in Dublin. These answers were used to see that the system was explained to them in enough detail to be able to answer the following questions. Finally, all people understood that the items in the visualization corresponded with items displayed in the calendar.

#### *General User Interface Acceptance*

11 out of 12 people did not think that the system was too complicated to use, whereas one person thought it was too complicated. The person who thought it was too complicated gave explanation that he thinks it would be too complicated to use if its purpose was to be placed on a terminal in an airport or hotel lobby, but that he could envisage that people would be able to use it as a web application on a website. He bases his opinion on the assumption that people would rather learn to use such a novel interface in a surrounding when they are not pressured for time as in an airport.

Obviously, only real usability tests of the final product would be able to answer the question if people think it is too complicated to use, but most people thought that once the fundamental concepts were explained it is very clear how it works.

With regards to how intuitive the interface is, 8 people thought that it was intuitive to use, 3 people were not sure and 1 person did not give an answer. It might be worth remarking that all of the women thought it was intuitive to use, whereas the men were of more mixed opinions. One of the people who were not sure about the intuitiveness of the tool noted that the interface has great potential for intuitive use but that he thinks it is not there yet and that the two main panels need to be more obviously linked.

11 out of 12 people also agree or strongly agree that the visualization is useful for planning a sight seeing day. The one person that did not agree commented that whereas he thinks that the visualization is not useful for visualizing a plan, it is a very useful, intuitive way of entering the data and that the right-hand side is the most intuitive way of seeing the resulting schedule. This result confirms the applicability of this tool to the tourism domain.

#### *Acceptance of Visualization Metaphors*

With regards to the two main concepts, i.e. to visualize the amount of an entity with the size of a shape and to visualize the interest in an entity by the distance of this shape to another shape, the questionnaire gave mainly positive feedback.

Participants unanimously agreed that the size/time relationship is a good metaphor for displaying the amount of a constraint, with 3 people even strongly agreeing to the usefulness of the concept. One participant noted that the size/time relationship needs to be consistent, e.g. by using a logarithmic scale for scaling the circles. Another participant mentioned that a pop up that would indicate in real terms, how long the item is now set to be, i.e. 45 minutes etc. It can be concluded from this result that visually representing the amount of some property by the size of an object seems to be a useful visualization.

The result of the questionnaire with regards to the distance/interest relationship was more controversially received however. 8 out of 12 people thought that this concept was useful, whereas 2 people disagreed that the concept was useful, the rest being undecided. Some people thought it might be hard to judge the distance and somehow preference levels needed to be emphasized more, but it was hard to tell at this stage due to the static nature of the mock-up.

However, when asked if it would be helpful to use another metric, e.g. a counter to show preference levels in addition to the distance, the field was much divided in their answers. Whereas 3 people strongly disagreed that a secondary metric should be used, the rest thought it would be good to use a secondary metric. Suggestions to what kind of secondary visual clue or metric could be used, they suggested

- thickness of lines depending on distance, i.e. the nearer and therefore more important the object the thicker the connecting line and the further and therefore less important the object, the thinner the connecting line
- a counter displaying the level while the mouse hovers over an item
- a gauge that changes when you move the item around
- a thermometer like object changing temperature and therefore visualizing importance (the concept of the hotter, the more wanted and the colder, the less wanted)
- using dashed concentric circles around the middle reference point
- a colour system for the connecting line, the darker the connection, the more it is wanted
- the colour of the circle border

However, different people preferred different secondary clues and disliked others, so that no decision could be taken as to if and which secondary clue to use.

On the question if the difference between general, high-level categories, which are represented as grey circles and specific, lower-level items, which are represented as rectangles, is clear, 10 people thought it was clear and 2 people thought it was not. One of the people who disagreed commented that a possibly more intuitive item for high level container, e.g. a box that opens up or a sac or a folder or some other item that is generally used for this would make the difference clearer.

### Interface Functionality Acceptance

9 out of 12 people thought the add/delete mechanisms are easy to understand, whereas 2 people disagreed and one person was not sure. Many people however thought that the use of a trashcan for the deleting of items would be a very useful and general concept to use and would add intuitiveness to how to delete items.

All people agreed or strongly agreed that that it is clear that changes in the visualization are reflected in the plan on the right hand side. E.g. by adding/deleting an option in the visualization, the item will be added/deleted from the plan on the right. It seems that the trashcan metaphor should be taken into account when designing the final implementation.

Similarly, almost all (9 out of 12) people strongly agreed and 2 people agreed that the calendar should also allow changes, which will then be reflected in the visualization. E.g. changing the time spent on attractions on your right will adjust the size of the circle/rectangle in the visualization. The remaining person could not make up her mind. One person even thought that you should be able to type in items into the schedule that should then appear in the visualization.

With regards to the functionality that items are dragged away from the central "My Day" circle when one tries to add another item to an already full day, 9 out of 12 people thought it was clear to them why the items are being dragged out, whereas 2 people were not sure and one person did not give an answer. One person commented that this concept is good, as it reinforces the priority/distance metaphor. However, he also thought that activities should not disappear because everything else is higher priority but should be greyed out etc. as it is against what the user expects to happen. Of the 2 people who were not sure, one thought that more visual clues are needed, such as flashing the item to be deleted or pop up a tool tip the first time a deletion happens or otherwise highlight the item visually. In summary, it seems that the general feeling was that it is good that the items are moved out of the way, but the user should be alerted of the deletion through some means, e.g. a tool tip or that the

item should not disappear at all, but rather become greyed out or nothing should happen at all. This feeling was confirmed in further discussions.

### Planner Functionality

All people thought that the concept of high-level planning, i.e. adding a whole category and letting the planner choose the best options is a very useful concept.

Also, all people agreed that it would be useful or very useful to have a time lock so that items would not be moved around any more by the system to a different time in the day. One person commented that a locked item could be marked with a clock icon to visualize the time lock.

On a related issue, i.e. the usefulness of being able to specify a time range for specific items/high level categories of when it should happen during the day, e.g. afternoon, 1pm-6pm, etc. most people agreed or agreed strongly that this would be useful with 2 people not being sure and even 1 person disagreeing. It might be worth noting that the latter 3 people were all female. One person commented that it would be sufficient to specify morning, afternoon, evening. Another person thought that encoding of rules like "keep these items as far apart as possible" for example for meals, by using some kind of spring-weighted constraint would be very useful.

All apart from 2 people who were not sure thought that it would be beneficial to be able to add items to the other categories, e.g. a specific restaurant that is not in the list. One person pointed out that the usefulness of this functionality is debatable since the system won't have any metadata about the new location unless the user is expected to enter this metadata, but that's probably not realistic and that it would be unlikely that the user (a stranger to the city) will have sufficient knowledge for the system to benefit from user generated content. Another person thought it depends on the purpose of the application. E.g. if it was at a kiosk, then it would not be useful. In summary, most people do find this functionality useful, especially in situations where a person meets a friend who lives in the city they visit and they could specify the address and time they meet so that this will be planned into the day and not overridden by their sightseeing.



### *Applicability to Other Situations*

On the question if they could imagine any other situations in which such a visualization would be useful, most people did not come up with a situation spontaneously, but when other possible situations to which the interface could be applied to, they did see the potential in its generality.

### *Improvement Suggestions*

During the presentation and in the discussion of what improvements could be made, many more issues were highlighted by the participants and some of the ideas are summarized in the following:

The most important ideas that came up frequently are:

- some kind of optional mini-tutorial or introduction video and/or tool tips are needed as the concepts are not immediately obvious but make sense as a concept once explained
- a better continuity between the visualization and the calendar, some visual clue to link the item in the calendar with the items in the visualization, possibilities are for example to highlight both the entry in the calendar and the visualization upon hovering over either item or connecting the items in the calendar with the items in the visualization with a line on hovering over either side; or one person came up with the idea that items from selected circles should fly into the planner on the right, similar to how the MAC interface minimizes objects into the browser bar
- Represent items on the map
- Output should include a map and other details
- Any text should be minimized where possible
- Transitions between items, i.e. the travel time between two attractions should be made visible in the calendar

- Include a budget limit
- Clicking on an item should make the description of the item appear immediately, no separate clicking for detailed description should be required
- Expanded options should un-expand automatically when another category is clicked

Other less frequent ideas that were mentioned were:

- Order the circles around the day in order of activity
- Connections from the specific items to their parent circles should be hidden and only shown when one hovers over the specific item or the parent category
- Use a clock face for the central day circle
- The circle/square distinction for categories of items and specific items could be the same
- The central "My Day" circle should look very different. So there should be different looks for the "My Day" circle, general activity, concrete activity
- Be able to select the top 10 sights of Dublin
- One person thought that it would be useful if the right hand side of "my day" would expand and contract as items were added and removed from my itinerary. This way you could pick a starting time, and one would have another visualization of when activities are occurring and for how long in your day.
- Create pop-up windows that adaptively suggest stuff
- Be able to share the plan with other people, be able to look at other people's plans
- Be able to collaboratively plan a day on the same interface in a distributed manner.

### **5.1.3 Summary of the Mock-up Evaluation:**

All in all, the user interface and the visual metaphors utilized in it have received a mostly positive feedback. This was the reason why the design only needed to be adjusted slightly, as all the important concepts have been mostly accepted and the

recommendations considered more intricate details rather than the large-scale design of the interface.

The results to the most important concepts are summarized in the following paragraph:

While the size/constraint metaphor was unanimously accepted, the distance/preference metaphor has received more criticism with regards to how intuitive it would be to judge ones preference from the distance. However, the participants largely disagreed as to how this could be improved, so it was decided to keep the design with regards to this metaphor and the users decide again when the tool is functional. It was later decided, during the course of implementation, to introduce a red-blue colour coded circle in the connecting line that can also display the level of interest as a percentage number. It was hoped that this visual clue would be an additional visual clue that is not too intrusive but yet helpful.

The concept of going from general to specific and being able to add a whole category and let the system decide, was greatly accepted.

Some advice taken into the design that came up in the above evaluation were:

- Show the time in real terms upon hovering over the shape border and while resizing an item
- It was mentioned by some people that the shape of the items did not really matter and that they did not necessarily needed to be different if there was another visual clue that would differentiate general from specific items, so during the design it was decided to use circles only for objects and to differentiate them by making general circles monochrome in colour and making specific circles display a picture of the specific item.
- Pop-ups and advice windows should be made use of where possible to add clarity to actions and reactions of the system

## ***5.2 Evaluation Results of the Final Implementation***

A second round of evaluation was initiated on the implemented tool. Due to time constraints not all functionality proposed in the mock-up and design could be implemented to the full or to a perfected standard, but all of the important concepts had been realized, so that a second evaluation could be carried out. The accompanying questionnaire can be found in Appendix C.

### **5.2.1 The Test Group**

This test group consisted of 13 volunteers of which eight had acted as participants in the previous mock-up evaluation and therefore would be familiar with the concepts. The other five had no prior knowledge of the project or its aims. It has been decided to test the project on these five people to see if the concepts used in the visualization are easily accepted by people who were unfamiliar with the concepts applied in this interface.

The age range of this group was from 22 to 35 years, with the majority (eight people) between the ages 24-26. The group of previous testers consisted of six men and two women, whereas the group of new testers consisted of four women and one man. The travelling behaviour of the new test group with that of the previous testers is higher in terms of how often they would travel (average of 6.5 times a year in comparison of 4.7 times a year for the previous group) and how often they would go on a city break when travelling (average of 5.7 days in comparison to 2.5 days for the previous group). However, with regards to how many days on average they would spend in a city (new: 3.7 days, previous: 3.3 days) and how many of these days they would spend sightseeing (new: 2 days, previous: 2.6 days), the new and previous testers were comparable. With regards to familiarity with technical interfaces, 7 out of the 8 participants indicated a high level of comfort and one female indicating moderate level of familiarity. In the new tester group, one person had had high exposure to technical interfaces, three had quite a lot of interaction and one person indicated a moderate level of experience with technical interfaces.

No noticeable differences have been found in the answers given to in the questionnaire with regards to gender or between the new and previous testers. Again, because the rest of the characteristics of the group were quite similar, the results are

presented with regards to the whole group and if differences are noted between genders or test groups, then these will be mentioned.

Both the test group that had previously seen the mock-up and the new testers received a short demonstration of the tools functionality. It is envisaged that in a final live version this task would have been taken over by a mini-tutorial, introductory video clip or other.

## **5.2.2 Evaluation Results of the Implemented Tool**

### *General User Interface Acceptance*

After having used the tool for several minutes, all test group participants indicated that they did not think that the tool was too complicated to use, which indicates that the tool might be acceptable by the larger public.

With regards to intuitiveness, five of the people strongly agreed that the tool was intuitive to use, another five agreed that the tool was intuitive to use and the remaining three people were not sure, only one of which was from the new group. Interestingly, two of the people who were not sure were people who previously indicated that they were not sure, whereas two other people, who were previously not sure, now are convinced that the tool is intuitive to use. However, it seems that the usage of the tool was received as natural by most people.

7 out of the 8 previous testers think that the tool works as they expected it.

All of the participants were convinced (54%) or strongly convinced (46%) that the visualization is useful for planning a sightseeing day. This result shows clearly the applicability of the tool to the tourism domain.

10 out of the 13 people strongly agreed that it is clear that changes in the visualization on the left influence the planning output on the right, the remaining 3 people were not sure. It had been mentioned previously in the evaluation of the mock-up, that a better continuity should be achieved between the visualization and the calendar. At the time

of planning, this was not considered an issue, but it has been realized that the system could be improved in this area.

With regards to how to add and delete items from the visualization, 9 people thought that it was very easy to understand, 5 people thought it was easy to understand and one person was not so sure. One person commented that once you the concept, it is very intuitive and therefore very powerful.

### Acceptance of Visualization Metaphors

With regards to one of the main concepts, i.e. using distance of items from the central "My Day" circle as visualization of preference, all but one person who was still not sure that the concept is useful. Interestingly, previously this person did think that this concept was useful, whereas another person who was not sure previously is now convinced by its usefulness. One person from the new tester group in particular thought that this preference setting tool gives you more control over the decision taking process as you can quantitatively specify your preferences – otherwise it would only be a binary yes/no decision.

As there was such a difference in opinions with regards to using a secondary visual clue to make the preference levels clearer, the red-blue range interest circle had been introduced. When asked if the evaluation participants found this clue useful, the opinions ranged from very useful (4/13) useful (5/13), not sure (3/13) to not useful (1/13).

The 3 people who were not sure commented that the circle was a little small, but could be useful, or that it would not make a difference as to if the circle was there or not. One person in particular was of the opinion that the use of a circle is repetitive given that everything is a circle and does not give any visual cue that it represents preference. He did not think the colour change is enough on its own to indicate preference as desired. Instead, he suggested, one could make use of arrows – up, up/right, right, right/down, down – to indicate importance. These arrows could be coloured in green through orange through red (or red through blue as in the current tool. However, he does not think that red through blue is a great colour range for

indication of preference). One person who thought it was useful to have this circle, also thought that it should also probably be an element that you can interact with, otherwise it might as well not be there. The person who did not think it was useful indicated that he did not really notice the colour change and that it should either be more obvious or should be removed. In conclusion it seems however that most people do like the circle as another preference visualization clue that is not too intrusive.

With regards to using another or additional metric or visual clue to make the preference settings clearer, the opinions again were much divided: 5 people were strongly against and 4 people against using a second metric. One person was not sure, 1 person thought another metric should be used in addition and 2 people thought that another metric should definitely be used in addition. This result is similar to the test result received from the mock-up where opinions were divided as well.

The people who did not think that adding another visual clue to distance as a measure of preference gave the comments that numbers should be kept out as it would either just not add value to the application or that it would be getting too cluttered or even that another metric, especially a counter would defeat the purpose of the visualization.

Of the people who thought that an additional metric should be used, one person thought the interest percentage should always be visible in the circle, not only on hovering over it. Another two people thought that the percentage of interest should be made visible on hovering over the interest circle, so it would only be displayed to the user if he explicitly requests it. It seems that the latter is a good compromise that should be tested further.

Not surprisingly, all people agreed (3/13) or agreed strongly (10/13) that the use of the size of the circle as a measure of time is useful. One person commented that although he thinks that the concept is useful, he also thinks that the size (and hence duration) needs to be capped to something reasonable. He also pointed out that the UI concept does not really adequately deal with the case where an activity is set to 24 hours (or however long the day is counted as). I.e. No matter how large the activity circle is, because it is always tangential to the “My Day” circle it will always be possible to add another activity. He suggests that a 24 hour activity could possibly be

concentric with the “My Day” circle. He also pointed out that a balance needs to be found so that items are not too small that they are almost un-noticeable whereas others might take up too much screen real-estate and still be intuitive. Another person had the clever idea that the cursor should change to a double headed arrow for the resizing process as to emphasize the resizing process.

In the implementation, the method of defining categories as circles and specific items as rectangles had been abandoned as it had been indicated in the mock up that this distinction was not needed. That means, in the implementation, both general and specific items were visualized as circles, but with the difference that category circles were monochrome coloured whereas specific items contained a background picture of the item that it represents. The opinions on this matter were again divided: All of the people who had not been exposed to the mock up strongly agreed that the distinction as implemented in the tool is enough to define a general and a specific circle.

However, of the test group who had previously evaluated the mock-up, 3 people were of the opinion that it was enough, 3 people were not sure and 2 people did not think that this distinction was enough.

In detail, the people who were not sure thought that the current distinction is probably sufficient, but that using different shape could possibly be useful, like a square or rounded rectangle or hexagon, similar to the mock-up. Of the two people who thought that another distinction should be used, one person also suggested using different shapes. The other person was of the opinion that the interactive behaviour should also be distinct: as the general circle is a clickable circle, this should be visualized, i.e. to make it more button like. However, it is worth mentioning that in an informal test where the tool was shown to people without an introduction, people automatically clicked on the category circles.

In the mock-up all category circles had the same size, but during the implementation phase it was decided to make the size of the category circles depending on the amount of items it contains. Test participants were asked if they thought it is too confusing to have the 2 different size concepts for general circles (initially how many specific items it contains and when you add the general category to your day the size is taken as an estimate of the time you would like to spend on it which can be resized)? This was another issue on which opinions divided. One person thought it was totally too



confusing as she did not realize that the meaning of the size changes and therefore should be explained better. 3 people agreed that it was a little confusing with one of these 3 suggesting that the initial size of the general category circles should be proportional to the amount of time the average person spends on that category. In this way it would be properly consistent and analogous to the specific circles. Another 3 people were not sure. One of these people thought that although it is confusing to have different sized circles, this could be useful in a different way, e.g. to draw users to some activity groups over others (e.g. because they're more popular) by making the categories different items. Another person within this group pointed out that inconsistency like the above is usually a sign of bad UI and therefore a huge flaw. He thinks that the size of the circle should only represent one concept – i.e. the time the tourist would like to spend at the attraction as this is also consistent with the other parts of the UI. 4 people did not think that it was confusing and that it could be figured out very quickly while playing with the tool and 2 people were not available to give an answer.

In the second question, i.e. if the person thinks that the general circles should all have the same size when the application loads, opinions were just as divided as in the previous question: 3 thought it should not have the same size, 3 were not sure, 4 thought they should have the same size, and one person strongly advocated that they all had the same size on loading. One of the people, who advocated the use of different sizes, i.e. reflecting the amount of available sub-choices, thought that it would be far less attractive if the circles were the same size.

Of the people who thought that they should all have the same size, one commented that although the concept was easily enough understood, but that it might be easier if when you add a general category that maybe it should not have a default time determined by the number of items in it. Another proponent for same size mentioned that because the whole thing is a new concept with using circles rather than tables, then the number of new things you can do needs to be slightly limited. One person came up with a simple but effective solution to the problem: the circles could all be the same size, but the number of sub-items could be displayed as a number on the circle.

### Interface Functionality Acceptance

Only one person did not think that it was clear that in a crowded area the least interesting circle is being pushed out from the central "My Day" circle when one tries to add another item to a crowded area. One person was not sure if it was clear and the remaining 11 people thought it was either clear or very clear.

With regards to high-level planning, where the user adds a general category to the day but does not specify individual items from this category, the whole group was convinced by its usefulness. 9 people even thought that this concept was very useful.

### **5.2.3 Additional comments**

When asked what people liked most about the tool was described in the following terms:

- It's much nicer than using a text based tool
- The speed at which one can create a day plan.
- I like the route planner most. It provides a very handy output from the program for the tourist
- Very interesting concept; seems powerful, easy to use.
- makes planning easier
- fun tool
- “really cool”, looks easy to use, in control of your day
- It’s fun! People enjoy it, attractive on website, funky, up-to-date, very easy to use, anybody can understand it, figure out easily. Curiosity. Clicking for more info is very good.
- I like the bubbles. I thought the interface was cute and fun to play with.
- bit more fun
- quick and handy

- Its very handy because instead of guessing how much you can fit into a day, this tool includes walking time and opening hours to let the tourist know what is and isn't possible.
- Good proof of concept of a compelling UI idea. Would be interesting to see it taken further.
- Novelty, new thing, fun, better than drop down lists etc. visually very attractive. Great feeling of control, you have a feeling of importance; looks lovely, deciding your own day and looks nice while you do it.
- If it had a big backend dataset the UI would be a very powerful way of choosing from the dataset effectively.

When asked if they think this tool would be useful to a Dublin tourist, all people unanimously agreed and most even strongly agreed. One person however pointed out that it would only be useful to certain types of tourists, not all, e.g. not to a group of "hen-night" girls.

All people also emphasized the need of a quick introduction, tutorial video clip and increased usage of user notification, e.g. in form of tool tips that can be switched off or will not come up any more after a while in cases of clashes, compromises taken, items being removed by the tool etc.

With regards to the ultimate question, i.e. whether the test group participants could imagine using this tool for planning their holiday, 10 answered definitely and 3 answered with yes, proving just how influential the power of visualization is.

Giving reasons for answers, the most common reason given was the time that could be saved in planning a trip to a city (5 times). Other reasons given are listed below:

- The tool gives you a suggestion of options, organizes tours, and finds locations, all in one!
- It's useful and fun to use.
- It's very handy!
- It's fun to use, a novelty.

One person indicated that she would use it for creating a visit plan, but not necessarily follow the schedule in terms of times and another person indicated that she would use it but still verify the information in a book.

One person still thought that the initial learning curve might be too high for certain people.

#### **5.2.4 Summary of the Evaluation of the Implemented Tool**

In summary, the interface concepts and final implementation have been positively received by most people. The results acquired in the second evaluation confirmed most of the results acquired in the evaluation of the mock-up. Unfortunately time did not allow carrying out more extensive user evaluations or test the tool with more people. It is obvious however, to prove a final acceptance of the ideas presented in this project, that a much more extensive and formal evaluation would need to be carried out with a much larger sample of testers. However, the results presented above can be taken as an indication, that a tool like this would add usability and enjoyment in eliciting users' interests and preferences in comparison with standard methods. The evaluation showed, that although the visualization does mean that the user will have to go through a short learning process, the concepts used in this tool are intuitive enough and easy enough to use, that they are picked up fast enough, at least by people of this stratification. However, it might be worth mentioning that in an informal test carried out with a small test group, users who would describe themselves as technophobes expressed their like in the system. Obviously more tests need to be carried out to see if people of the general public are not deterred by the initial learning curve.

Interestingly, the people who had not seen the mock-up before seeing the final implementation seemed to be much more enthusiastic about the tool. Some of their comments were “Why did nobody else ever think of this?” or “This is really cool and

useful!” This could of course be due to the difference of the nature of people having taken part in the two groups, as the groups were very small.

## **5.3 Future Work**

Many ideas have been mentioned during the evaluation, and some have been incorporated in the future work proposals below.

### **5.3.1 Summary of Improvement Suggestions to the Current Implementation**

#### *More User Feedback*

In general, some people thought that there needs to be a lot more user feedback when things happen (e.g. something like a tool tip popup when things disappear or when things are not included in the itinerary). The user should be given the option to switch off tool tips.

#### *Improvements for User Interaction with the Interface*

The user interface needs to be polished to perfection, i.e. the resizing of the circles, the moving out of way need to be smoother. In addition, people suggested that when the text on circles is too small, hovering over the circle should display a tool tip beside the circle with the text of the circle.

One criticism that came across concerns the behaviour of what happens when an activity is been dragged too far away from the day. Currently it disappears entirely when moved too far away. During discussions it became apparent that most people would prefer this behaviour and therefore should be modified appropriately. It was suggested that the link line should disappear, but the activity should remain visible so that the activity could be dragged back towards the day. Doing this would reconnect the activity to the day again. Only when the mouse button is released and the activity is sufficiently far away from the day should the activity itself then disappear back into its category. This issue had previously been mentioned during the mock-up but as it

did not affect the main visualization metaphors, this was not included in the design. However, it seems that this issue does negatively affect the interface and should be addressed in a future release of the tool.

#### *Auto-updating of Planner*

Some people mentioned that it would be great if the planner could auto-update in real time and that the planner needs to be improved. During the design phase this feature was considered to be out of scope for this project. However, it is envisaged, that a future release would have this functionality.

#### *Output View Improvements*

One person thought that the image that is displayed in the bubble should also be displayed in the output view so as to add more continuity between the desire visualization and the reality of what is possible in the calendar. Another person mentioned that the importance level should also be indicated in the output view.

#### *Storage and Retrieval of Old Plans*

Another useful functionality would be the storage of several possible plans for one user and the possibility to retrieve an earlier made plan and display it in the output plan as well as the visualization part of the preference tool so that the user could go back and modify an earlier plan without having to start the plan from scratch.

#### *Visualization of desire vs. reality in the same Bubble Visualization*

An interesting idea would be once the planner has created an output, to visualize in the bubble display, how the planned output differs from the desired one as indicated by the user.

#### *Secondary Constraint*

In addition to having one constraint, which is reflected in the size of the circles, it could be imagined that more than one constraint could be implemented in the system. How this should be done without complicating the current user interface has not been determined yet.

#### *Automatic De-cluttering*

Another useful feature for the tool's interface would be to automatically de-clutter, i.e. close expanded circles when a certain clutter threshold has been reached.

### **5.3.2 Tourism Specific**

There are many possibilities that could be imagined for future work in a tourism specific implementation, in addition to the suggestions mentioned above. Some of the more interesting are described below.

#### ***Specific to Dublin/Ireland***

##### *Increase Tourism Data in Database for Dublin*

The data currently in the tourism specific database for Dublin is not complete and could be expanded to encompass many more of Dublin's attractions. At the same time, attractions further removed from Dublin could be incorporated. However, it could also be imagined that the database could be extended to take in attractions and point of interest of the whole country, so that a tourist could also plan his whole holiday in Ireland rather than just his sight seeing day in Dublin.

##### *Increase in Time to be scheduled for Tourist*

The current tourism specific tool can only plan for one day of a Dublin tourist. However, it is easily imagined that the tool could be expanded to help planning a whole holiday of a tourist coming to Ireland assuming that the databases contain a more extent selection of tourist attractions all over Ireland.

#### ***General for Tourism***

##### *Integration of Location Awareness*

One of the most intriguing opportunities is presented by the integration of this tool with location awareness on a mobile agent such as a web-enabled mobile phone or PDA with GPS. This integration would open up many more possibilities:

One opportunity would be to let the system monitor the progress of the tourist in his schedule and reschedule the day if the tourist decides to spend more or less time than planned at a certain attraction or is visiting some attraction he came across while on the go which was not planned in his day. So the idea is that if there is some large enough deviation from where the tourist is supposed to be at a certain time to give the tourist the option to reschedule the day for him, possibly having to cut out a few attractions or adding more depending on the situation. However, if this is the case, a more heavyweight backend with more functionality, for example an ontology would be a great advantage.

Another opportunity is to incorporate the option to receive tourist-related advertisement and offers on the run depending on the tourist's interest profile, so for example if he seems to be very interested in Art and there was an art sale advertised by some way of geo-tagging, then this advertisement might be relayed to the tourist. Again, a more intelligent backend technology would most likely be needed for this option.

In addition, the data gathered through location awareness could be used to get more accurate estimates of average times spent at locations and be fed back into the database.

#### *Incorporate Web Services for Information Gathering*

The database could use services offered on the internet to pull information from other websites, such as event listings or movie listings. This would avoid the need for constant updating of the database.

#### *Refinements for Current Estimation Functions*

An obvious possibility would be to refine the planner for the tourism specific domain. This would also entail to find better estimates for the rating versus travel time compromise as well as for how much reduction in visiting time tourists generally tolerate.

#### *User Feedback for Rating*

It is envisaged, that in future, the user rating would be based on real user ratings.



## *Extra Functionalities for Current Tourist Specific Tool*

### Publication of Tours

A nice extension would also be to publish a tour that a tourist is planning to do or that a tourist has followed and found nice so that other tourists could just follow that tour instead of making up their own. It needs to be mentioned that there is a certain danger associated with knowing the exact time and location of a specific tourist in the future, but care could be taken in the design to take out the information that would show the specific day of when the tourist plans to do his personal tour.

### Entrance Cost Calculator

A very useful extension to the current tourism specific planner would be to incorporate a way of calculating entrance costs. Also, it could be imagined that in addition to a time constraint a tourist might have a monetary constraint and a way could be found to incorporate this secondary constraint into the visualization interface.

### Search Function

It can be imagined that a simple text input search function that allowed a tourist to search for a specific attraction leading to the category that contains the attraction to expand to the appropriate level and display the searched for attraction would be useful. It would avoid that the tourist would have to manually search through the categories to find the specific attraction as some attractions could possibly be categorized as belonging to several different categories and might not have been categorized under the category that the tourist would have categorized it.

In addition, a more complicated search function could possibly be employed where the user could search for a term such as “James Joyce” and all attractions that have some connection to James Joyce would be displayed, possibly from very different categories. However, a search function like this would most likely require a more complicated tourism data backend than currently employed, e.g. more in the direction of an ontology that would be more suitable to discern connections between attractions from different categories.

### Filter Function

Another simple add-on would be a filter function that would allow the tourist to only see a subset of the available attractions, e.g. only attractions that have a rating of 3 or higher, or only attractions that have free entrance or only items that are in a specific radius around city centre etc.

### Reservation/Booking Functionality

Another extension to the tourism specific tool would be to incorporate a reservation and booking facility directly through the tool for attractions that can be booked online. This would avoid the tourist having to look up each of the attractions' websites himself to book a seat or a tour and evolve the service even more into a one-stop-shop for Dublin tourists. Clearly, the security model would have to be reviewed and security increased if such functionality was added to protect the tourist of the dangers involved in e-commerce operations.

### Private/Public Transport Incorporation

The tool, as implemented, assumes that potential tourists walk from attraction to attraction. While this is in general a correct assumption for attractions in Dublin city centre, attractions that are placed further away from the city centre, such as the Dublin Zoo or the Irish Museum of Modern Art are often more conveniently reached by public transport, such as Luas or bus. Therefore, it would be of great benefit to incorporate public transport opportunities into the scheduling process to potentially reduce travel times between attractions.

### Reminder Function

Another extension to the current tourism specific tool would be to create an optional reminder function that would remind a tourist of his schedule, e.g. when he should leave for the next attraction.

### Add your own Attraction

It might be useful to allow a tourist to add additional attractions to his day, such as meeting a friend for coffee in a certain Café or going to a conference etc.

### **5.3.3 Summary of Future work**

A selection of possibilities for improvements and further avenues of development to the user interest and preference setting tool and to the application of the tool to tourism have been illustrated. This list is not complete, but should rather act as an inspiration to the possibilities of the many different directions of future work that have been opened up and discovered in the course of the project.

## 6 Conclusion

*A picture is worth a thousand words.*

Proverb

Upon consulting current technological support on planning a tourists itinerary and originating from the personalization needs of tourists, the need for a simple, easy to use interface arose. This interface should be able to capture the interest of the user long enough to be able to sufficiently solicit his interests and preferences from him to be able to plan a customized sightseeing day. It was recognized that this need is more universal and does not only apply to the domain of tourism, but is evident in many other areas where personalization is required. After consulting the state of the art of several different approaches to user modelling, the goal of this project had been defined as the following:

The overall goal of this project is to design, develop, implement and evaluate an innovative user interface that users can use in a playful manner to specify their interests and preferences. The tool will include an approach for going from the generic to the specific allowing users to describe their interest or preferences as appropriate.

The first goal was to find an innovative way of intuitively representing alternative choices with which the user could interact with to assign individual interest levels and preferences in an enjoyable manner. Towards this aim a novel graphical and interactive user interface idea was evolved and designed. An inspiration to this design was the proverb mentioned in the beginning, “A picture is worth a thousand words” or in this case, visualization over text. The text in the visualization was kept to a minimum and would only be displayed if the user explicitly asks for it. As with any novel kind of interface, it is really important to find out at an early stage if it the ideas would be acceptable by the potential users.

Therefore, to satisfy the second goal as stated in the introduction, i.e. to investigate the feasibility and usability of this new and innovative way in capturing and modelling a user's interests and preferences, these new ideas had to be evaluated.

To this purpose, the idea and its associating concepts were illustrated in a mock-up in an accessible technology. This mock-up was then used to evaluate the acceptance and usability of the idea by presenting it to a group of people and asking them their opinions. The results of this initial evaluation provided mostly positive feedback on the ideas and provided further inspiration for the refinement of the design.

Due to the positive feedback received, it was decided to go ahead with the refined initial ideas and concepts and design the whole system. In the system design, care has been taken to keep the specification of the design as general as possible and to enforce data agnosticism where possible, so that the tool can be applied to many other domains with minimal adjustments. This also translated into using platform independent and universal technologies in the implementation, such as Java or XML. After considering suitable candidate technologies for all parts of the system, the user interface was implemented using Flash technology.

It was a third goal that the user specific interest model should also be consumable by another service. In detail this service should be able to dynamically consume and sensibly use the captured interest and preferences information to suggest a possible sensible outcome based on this information.

As this service is specific to the domain to which this tool is being applied, this service has been implemented in a Java planner that helps a Dublin tourist plan his sightseeing itinerary. In more detail, the planner consumes the interest in, preferences between and desired time to be spent at Dublin's tourist attractions as provided by the user and employs a planning algorithm that schedules the items into the tourist's day in a way that it satisfies his given interests and preferences to the maximum. The planner takes opening times and locations and ratings into account when arranging the itinerary and aims at reducing overall transfer times.

The system should also include a suitable and useful output representation. With regards to the tourism application, the output was implemented as a calendar view of

the suggested sightseeing agenda and was integrated with Google Maps online mapping facility. This proved to be quite popular and added to the perceived value of the system.

It was hoped that this new and innovative way of planning would give the user a more pleasant experience over the planning process as it allows the user to fully concentrate on and negotiate with his interests and preferences while enabling him to stay in total control over the decisions that are being taken. It was also hoped that the user feels empowered while using the tool. The tourist should be engaged and feel in control of their experience.

To find out if this aim had been achieved, a second round of user evaluations has been carried out on the complete implementation with a sub-group of the test group and a previously unexposed group. The results of this evaluation essentially confirmed the results achieved during the mock-up evaluation. The implemented tool provides an easy and fun to use interface that empowers the user by giving him a feeling of control over the process of the usage of the information that he supplies. In addition, the area of tourism has been found to be a good proof for the concept and was very well received, with all testers admitting that they would use the tool if it was available, mainly because it is fun to use and would save time in planning ones visit.

The test group was of quite homogeneous nature, and the mostly positive feedback could also mean that the target group most likely to use this tool would be young, computer literate people. However, there is an indication that even technophobes could be compelled into using this tool. Obviously, more extensive user testing with a bigger and less homogeneous group would need to be carried out to get a sense of the usability of the tool in the general public.

Furthermore, some thoughts with regards to possible security vulnerabilities have been mentioned.

Finally, future research directions, i.e. improvements to the current system and additional functionalities to a tourism specific system have been described showing the potential of this innovative design.

As a conclusion, it seems that the goals set out at the start have been achieved to a high level of satisfaction. In summary, the system provides a powerful and compelling interface that can dynamically capture a user's interests and preferences and other constraints while giving the user a feeling of engagement and empowerment throughout the subsequent usage of this information. In conjunction with the planning service and output representation, an end-to-end system has been achieved, that is both enjoyable and practical to use in a domain in which personalization is immensely important.

Although some parts of the project are unavoidably geared towards a specific domain, in this example the tourism domain, it is envisaged that the implemented visual interest modelling tool could be used for and applied to many domains. Some of which are proposed below:

### **6.1.1 Application of the Tool to Other Domains**

The preference modelling tool has been developed in a general way so that it could be applied to other domains. While the basic tool might be enough for some domains, in most cases where the input is to be used in a sensible way, a custom planner would need to be created for this domain. However, the general design does allow for a custom planner to be plugged in easily into the current design.

Other domains where the application of the adaptive preference setting tool might be useful, would be other time management areas apart from tourism, e.g. executive, managerial, project planning, where the constraint could be either time or time and money.

Another time-management area where this tool could prove useful would be in the development of a study plan, where the items represent areas of interest with associated courses or other e-learning applications and the constraint could be time. Another domain would be the shopping domain in general, especially in situations where budget is limited and the shop componential from a list of categorized items.

Yet another application would be a diet composer where the categories could represent different food categories such as vegetable, fruit, breads, ... and the constraint would be calories to be contained in the given meal(s).

In addition it could be imagined that the tool is applicable to domains without a constraint restriction, i.e. abandoning the size/constraint relationship. One could imagine for example in countries of many parties to create a political election advisor that would take into account your preferences in certain areas and then tell you with which political party's agenda you have most in common.

Another area would be for example in buying a house and to select a suitable house from the seller's portfolio, one could indicate preferences such as how important it is to have a balcony or be located on a quiet street.

One person in the evaluation mentioned that because of the tool's novel way of showing tree structures, it could be applied to game menus or information menus in general.



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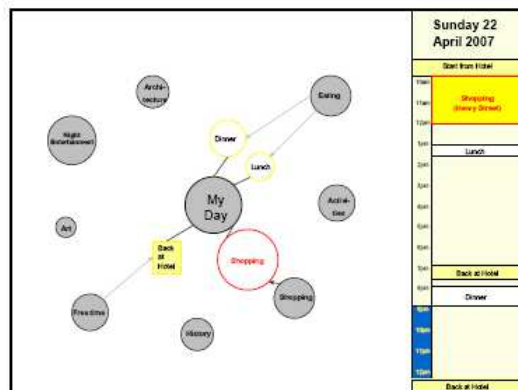
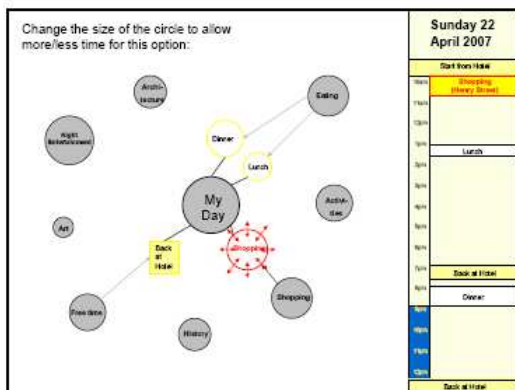
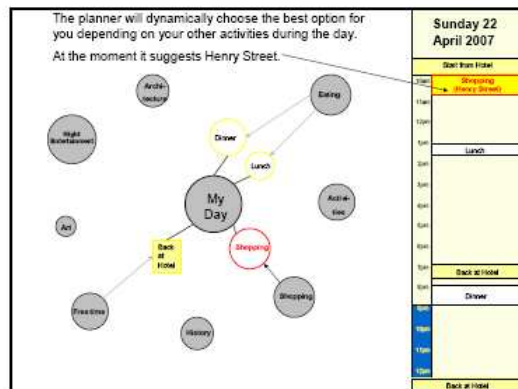
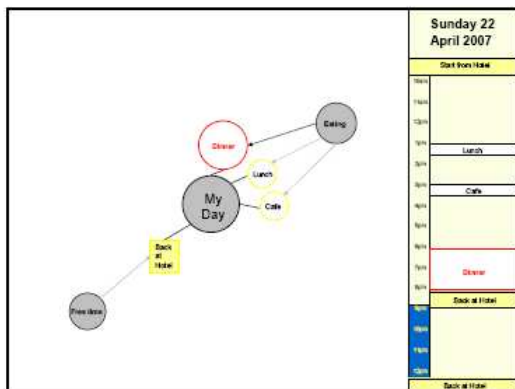
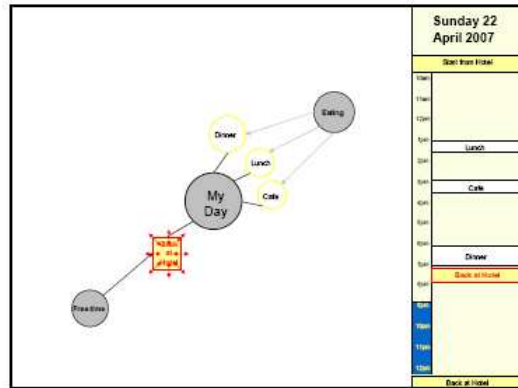
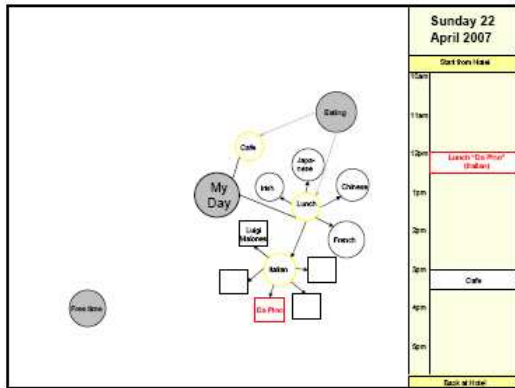
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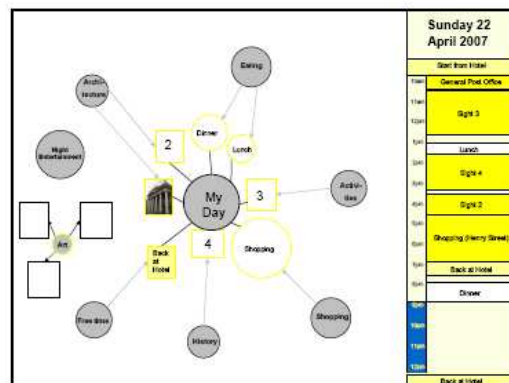
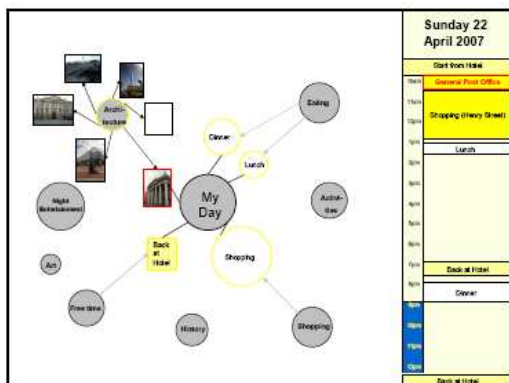
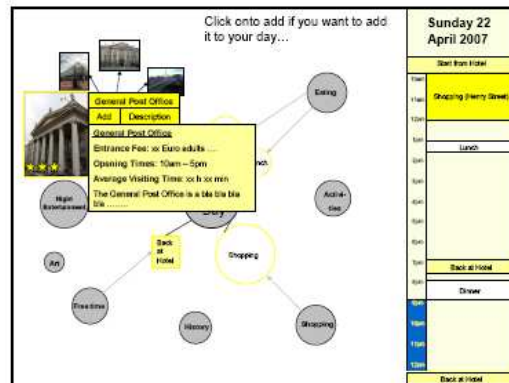
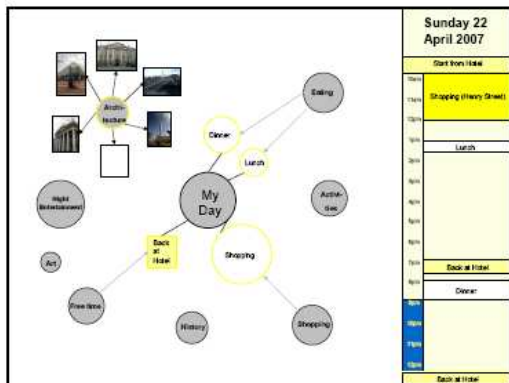
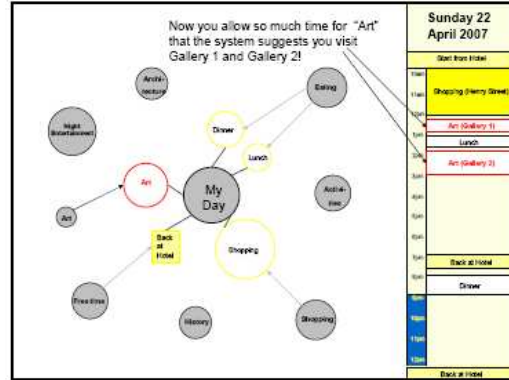
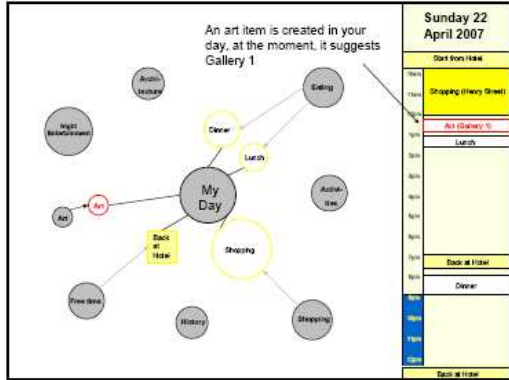
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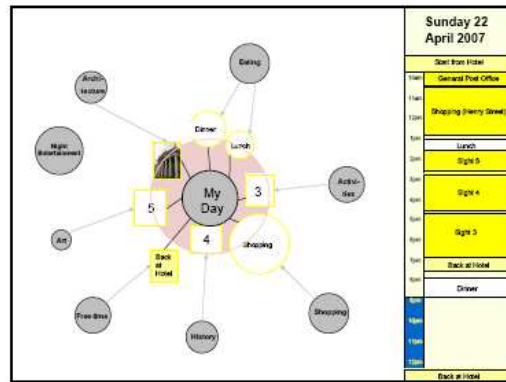
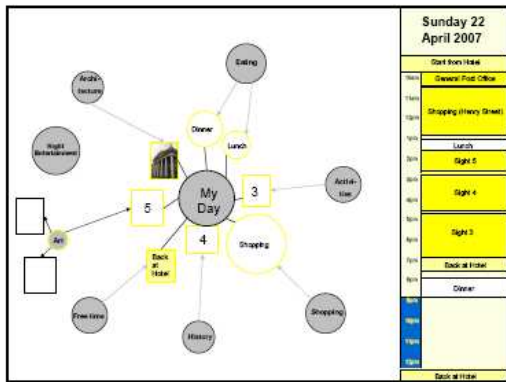
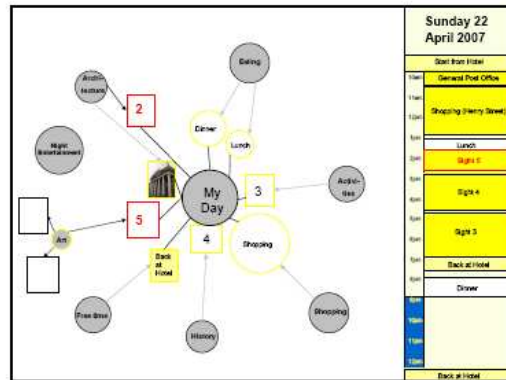
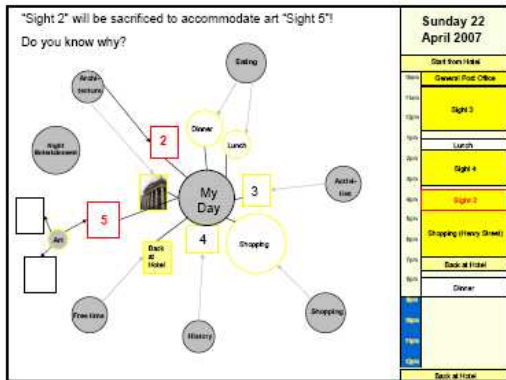
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# Appendix A Screenshots of the Mock-up









## Appendix B Mock-up Questionnaire

### User Profile Questions:

1. How old are you?
2. Male/female?
3. How much do you travel? (times per year)
4. How often on your travel do you go on city breaks?
5. How many days do you usually spend on a city break?
6. When on a city break, please specify the days you would (plan to) spend on average sightseeing:
7. How comfortable are you with using computers/PDAs/mobile phones? (Circle appropriate):  
 Very much – Quite a lot – Moderately – Somewhat – Just a little  
 – Not at all

### Project related specific questions:

8. It is understandable what the system is trying to achieve.
9. It is clear how the system could help to plan a sightseeing day in Dublin.
10. The system is too complicated to use.
11. The system is intuitive to use.
12. The left hand side is a useful visualization that can be used for planning a sight seeing day.  
 - If you disagree, please give a reason why. How could it be done better?
13. It is clear that the items in the day on the right hand side correspond to items (circles and rectangles) attached to the central circle "My Day" in the visualization on the left.
14. It is unclear that the grey circles in the visualization represent general, high-level categories.
15. It is clear that changes in the

| I agree strongly | I agree | Not sure | I dis-agree | I dis-agree strongly |
|------------------|---------|----------|-------------|----------------------|
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |



**Project related specific questions:**

- 22. The concept of high-level planning ("Shopping", "Art" etc) is too unclear.
- 23. The concept of high-level planning ("Shopping", "Art" etc) is not useful.
- 24. It is clear that specific items (associated with a location) are represented as rectangles, whereas circles are used to represent more general/high-level categories.
- 25. It would be useful to have a time lock so that items would not be moved around any more by the system to a different time in the day.
- 26. It would be useful to be able to specify a time range for specific items/high level categories of when it should happen during the day, e.g. afternoon, 1pm-6pm, etc.
- 27. It would be beneficial to be able to add items to the other categories, e.g. a specific restaurant that is not in the list.

| I agree strongly | I agree | Not sure | I dis-agree | I dis-agree strongly |
|------------------|---------|----------|-------------|----------------------|
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |
|                  |         |          |             |                      |

**Open Ended/Discussion Questions**

- 28. Which of the following features do you think are most important to implement, please specify in order of decreasing importance:  
Search box    Selection criteria    Colour schemes    Time lock    Time range
- 29. Which other features do you think would be useful to add?
- 30. Can you imagine any other situations in which such a visualization would be useful?
- 31. How could the system be improved overall?
- 32. Anything else? Questions, comments, ideas...

## Appendix C Evaluation Questionnaire

### User Profile Questions:

1. Name:
2. How old are you?
3. Male/female?
4. How much do you travel? (times per year)
5. How often on your travel do you go on city breaks?
6. How many days do you usually spend on a city break?
7. When on a city break, please specify the days you would (plan to) spend on average sightseeing:
8. How comfortable are you with using computers/PDAs/mobile phones? (Circle appropriate):  
     Very much – Quite a lot – Moderately – Somewhat – Just a little – Not at all

### Project related specific questions:

|   | <b>I strongly agree</b> | <b>I agree</b> | <b>Not sure</b> | <b>I disagree</b> | <b>I strongly disagree</b> |
|---|-------------------------|----------------|-----------------|-------------------|----------------------------|
| 9. The system is too complicated to use.  |                         |                |                 |                   |                            |
| 10. The system is intuitive to use.   |                         |                |                 |                   |                            |
| 11. Does the tool work as expected (if you have seen the mock-up)?  |                         |                |                 |                   |                            |
| 12. Seeing the implementation, do you think that the left hand side (bubbles) is a useful visualization that can be used for planning a sight seeing day?<br><br>i. If you disagree, please give a reason why. How could it be done better? |                         |                |                 |                   |                            |
| 13. The difference between general, high-level categories and specific items is visually recognizable.  |                         |                |                 |                   |                            |
| 14. It is clear that changes in the visualization on the left influence the planning output on the right.   |                         |                |                 |                   |                            |

**Project related specific questions:**

15. It is hard to understand how to add/delete options from the visualization.
16. In the visualization, using distance of items from the central "My Day" circle is a useful visualization of preference.
- a. If you disagree, please give a reason why. How could it be done better?
17. It would be helpful to use another metric, e.g. a counter to show preference levels.
- a. Could any other metric be used?  
Any suggestions
18. The little circle with the colour distinction (red for very interested, blue for little interest) is useful as a second preference visualization metric.
- a. If you disagree, please give a reason why. How could it be done better?
19. The use of the size of the circle as a measure of time is useful. The bigger the item, the more time you plan to spend on it!
- a. If you disagree, please give a reason why. How could it be done better?
20. It is clear that in a crowded area the least interesting circle is being pushed out from the central "My Day" circle when I try to add another item to a crowded area.

| I strongly agree | I agree | Not sure | I disagree | I strongly disagree |
|------------------|---------|----------|------------|---------------------|
|                  |         |          |            |                     |
|                  |         |          |            |                     |
|                  |         |          |            |                     |
|                  |         |          |            |                     |
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|                  |         |          |            |                     |
|                  |         |          |            |                     |
|                  |         |          |            |                     |

**Project related specific questions:**

- 21. The concept of high-level planning ("Shopping", "Art" etc) is not useful.
- 22. In the implementation specific attractions and categories of attractions are both represented in circles. The only difference is that the categories have no background picture associated with it. Do you think this difference is big enough for the distinction? Or do you think that there should be another distinction and what should it be?
- 23. It is too confusing to have the 2 different size concepts for general circles (initially how many specific items it contains and when you add the general category to your day the size is taken as an estimate of the time you would like to spend on it).
- 24. The general circles should all have the same size when the application loads

| I strongly agree | I agree | Not sure | I disagree | I strongly disagree |
|------------------|---------|----------|------------|---------------------|
|                  |         |          |            |                     |
|                  |         |          |            |                     |
|                  |         |          |            |                     |
|                  |         |          |            |                     |

**25. Open Ended/Discussion Questions**

- 26. What do you think are the most significant remaining usability issues?
- 27. What do you like most/least about the tool?
- 28. Do you think the tool would be useful to a Dublin tourist?
- 29. Do you think a quick introduction on how to use the tool would help its usability?
- 30. Could you imagine using this tool? Why? Why not?
- 31. Which other features do you think would be useful to add?
- 32. Can you imagine any other situations in which such a visualization would be useful?
- 33. How could the system be improved overall?
- 34. Anything else? Questions, comments, ideas...

## **Appendix D Security Considerations**

This chapter shortly introduces some thoughts regarding security issues relevant to this project. Security issues with respect to a possible payment scheme for this system are not considered. The service is expected to be freely available on the internet. If a payment service were to be added, then it is recommended to use a separate trusted third party payment system.

The resources most sensitive to an attack in terms of confidential information are username/password files, and user specific generated information, e.g. preferences, visitors itineraries etc during transmission and storage. Static, publicly accessible information stored at the server is also sensitive to attack in terms of its integrity but not confidentiality. An attacker could modify static information with various consequences as described below. Finally, computing capability by misusing the server would be a possible attack point.

In this security considerations document the internet threat model is assumed, i.e. that the end-systems engaging in a protocol exchange have not themselves been compromised. By contrast, it is assumed that the attacker has nearly complete control of the communications channel over which the end-systems communicate.

### ***Out of Scope Attacks***

#### **Non-Repudiation**

Non-repudiation is also regarded not an issue for this system as there are no situations in which it is important that the receiver can prove the sender's identity and that he is receiving the data that the sender meant to send. Upon registration, the user of the application is informed that the system makes no guarantees as to the correctness or actuality of the supplied information. Therefore, no precautions need be considered on this issue.

#### ***In scope attacks***



This section describes possible attacks that the protocol is susceptible to and how they could be counteracted.

### **Communications security issues**

Communication security in this application refers to the secure communication between the remote clients and the central server over the Internet. Information that is communicated between the client and server are user preferences, visitor itinerary information and live location information which act as feedback and refinement information upon which the application reacts accordingly (e.g. adjust the order of points of interest to visit or even create/delete some points of interest from the list).

#### **Active attacks**

The integrity as well as confidentiality of the client/server communication needs to be preserved. Possible communication security attacks are described in the following paragraphs:

##### *Eavesdropping*

Eavesdropping could potentially be used by an attacker to find out with a certain probability a tourist's location to launch a physical attack on him. Or he could find out the user's preferences and then spam him with advertisement.

##### *Replay Attacks*

Replay attacks could become a potential nuisance. However, it is envisaged to use HTTP over a reliable TCP connection, so the sequence numbers would be out of date anyway and the replayed message would be dropped.

##### *Message Insertion*

Message insertion is only really a problem in relation to Denial of Service attacks and is discussed in the Denial of Service section below.

##### *Message Deletion*

This attack could be another potential nuisance. However, as it is envisaged to use HTTP over TCP, the deleted message would be resent most likely anyway.

### Message Modification

Message modification attacks could be used by a specific tourist attraction wants to get more visitors and therefore changes the message so that it contains a higher rank.

### Man-In-The-Middle Attack

In this attack, an attacker could impersonate the server and try to lure people to specific tourist attractions to have more people visit his attraction. Or he could make up some fake tourist attraction in a lonely area and therefore know with a certain probability the tourist's location and can launch a physical attack on him.

To counteract all of the above named communication attacks, SSL/TLS could be used to encrypt all application traffic. SSL/TLS provides adequate channel security for a TCP connection at the application level and it can be easily deployed (one could include a TLS implementation in the package).

## **Passive Attacks**

### Confidentiality Violations

Client information is confidential and needs to be protected in storage and in transit, i.e. it should be encrypted. SSL/TLS can be used for all communication between the remote device and the server to leverage the various properties of SSL to create reasonably confidential communication.

### Password Sniffing

Client and especially the administrator password need to be kept secret, e.g. by keeping a hash file of the passwords instead of the password itself.

## **Systems Security**

Systems Security is concerned with protecting one's machines and data: "Machines should be used only by authorized users and for the purposes that the owners intend. Furthermore, they should be available for those purposes. Attackers should not be able to deprive legitimate users of resources."

## **Physical Security**

The back end can store two types of information: static information that is publicly accessible and user specific information e.g. passwords, preferences etc created by users that should only be accessible to the user that created it.

The publicly accessible static data is envisaged to be administered centrally by an administration unit and therefore needs to be protected against unauthorized modification and tampering that would destroy its integrity.

The user specific data generated upon registration (username/password pairs, user data, preferences etc) and subsequent service requests by a client contains confidential information that needs to be protected. So this information needs to be not only integrity protected but also be kept confidential. This information for each user could alternatively be stored on the server side or at the client side or even both sides. The strategies for protecting the integrity and confidentiality of this information are different depending on where the information is being stored.

During registration the user will be informed that his data will be used anonymously for statistical and feedback purposes (e.g. the most popular chosen tourist attractions – which will then be ranked higher in the suggested lists of points of interest). This does add another security complication which needs to be considered: it needs to be avoided that a particular tourist attraction can misuse the system to achieve a higher ranking.

To protect the data on the disks from damage or inappropriate usage the server could be run on an encrypted volume (e.g. TrueCrypt). In addition, the server itself could be placed in a certified secure environment to provide additional levels of physical security. E.g., a service like hosting365 could be used. Access to the server could be made available from the local network (through the use of a VPN) or on the machine itself only. Therefore, a remote attacker would have to surmount either the VPN or physical security and the local machine security in order to have access.

### **Unauthorized Usage**

A user that uses the application from his remote device should only be able to request services from the system and receive replies. A user should not be able to modify any of the static data or be able to access any other user's private data but be sure that his

own private data is protected from other users/attackers. If his data is accessible by an attacker, then the attacker might be able to pose as the user in the real world, impersonating the user in a pre-booked show for example.

To make this possible, user authentication using simple username/password could be used. Upon registration a user chooses a username and a reusable password – simple checks are performed upon choosing the password to choose a secure enough password (e.g. it must be long enough, contain letters, numbers and signs, not be a dictionary word etc). When the user wishes to use the service, he logs in using his username and password. A timeout for entering the wrong password several times in a row makes it harder to guess passwords as would a delay between login attempts. This system is vulnerable to a simple passive attack where the attacker sniffs the password off the wire and then initiates a new session, presenting the password. This threat can be mitigated by hosting the protocol over an encrypted connection such as SSL/TLS.

Upon login (to the server) a user will be restricted to what they can do by their unique user identification. There will also be only a small set of well defined operations that user is able to perform. The application will be run in user space of the server to avoid a user being able to hijack control over the server.

### **Inappropriate Usage**

An application system administrator has access to and can modify the static information in the application system (e.g. add new tourist attractions, delete obsolete ones, update changes in opening times etc.). To avoid inappropriate usage by an insider, it is important that administrators of the systems are trusted individuals that are not injecting viruses into system, not exploiting the system, not selling data, user info, not ranking tourist attractions higher if they pay him etc.

### **Denial of service attacks**

“The system should be available to legitimate users.” Because of the broad variety of possible attacks, e.g. to consume machine resources or cause the target machine to crash it is difficult to provide protection against DoS attacks.

Due to its nature, the system is vulnerable to Denial of Service attacks, e.g. blind denial of service attacks as well as Distributed Denial of Service attacks during sign up/login process. The consequences of either attack depend on economical value lost

in revenue when the service is being denied which could be considerable. It is assumed that a DDoS attack is less probable.

To make a TCP SYN flood attack harder, a cookie mechanism could be used. Similarly, to avoid bots signing up for the service and trying to strangle the service that way, simple gotchas could be employed upon sign in.

### ***Residual risk after threat mitigation***

Although precautions can be taken, vulnerabilities still exist.

E.g. TLS is susceptible to IP layer attacks, e.g. some form of denial of service attacks or connection assassination. TLS has mechanisms to detect truncation attacks but these merely allow the victim to know he is being attacked and do not provide connection survivability in the face of such attacks.

### ***The system as integrated web service using other web services***

The systems could possibly also be further developed into a web service requests services from other web services for information retrieval e.g. about tourist attractions, their location, opening times, entrance prices, the weather forecast, etc. In this case the communication security consideration between the main application web server and the client and the user specific information storage is as described above. However, in this system additional security issues are concerned with the communication security between the primary web server and the services it uses as well as the integrity and validity of the services and data that are requested from the secondary (ternary, quaternary ...) web services.

### ***Summary***

The biggest threads identified are the compromise of user privacy, database integrity and denial of service. Ways to avoid these attacks have been mentioned and include the use of SSL/TLS for communication security, username/password for authentication and some general encryption mechanism for storage.