# LatYourLife: A Geo-Temporal Task Planning Application

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## Abstract

The aim of this research was to build a prototype application which uses state-of-the-art web-mapping and mobile technologies in order to connect people's daily tasks with geography and therefore serving them with a new perspective on task planning. This was achieved by implementing a spatial calendar, hence a scheduling application which not only stores the temporal information about each event, but also a spatial component. The major purpose was to explore the potential functionalities geo-temporal data could provide to improve task management. The application was field tested by users who responded positively, but simultaneously highlighted issues that an application like this would need to tackle, in order to be successful.

## 1.Introduction

A *Location-based-service* (LBS) is defined by Koeppel as: "*any service or application that extends spatial information processing, or GIS capabilities, to end users via the Internet and/or wireless network*" (Koeppel, 2000). Jiang and Yao argue that "*a true LBS application aims to provide personalised services to mobile users whose locations are in change*" (Jiang andYao, 2007).

Location-based services are often praised as the most promising application for the near future. Especially after the emergence of so called 'smart phones', which in many cases incorporate GPS sensors and considerable computing power, mobile users are equipped with technology which was recently exclusive to professionals.
The number of potential applications built upon these new possibilities of location aware devices is huge, and in fact there are already hundreds of *apps*[1] available for purchase in mobile stores, using location awareness as a tool to provide the user with context relevant information.
The range of topics covered by already existing or prototyped services include restaurant, cash machine or real estate search queries (e.g. Aloqa[2]), as well as social services (e.g. Hong *et al*., 2004; Sohn *et al*., 2005; Miluzzo *et al*., 2008) or even location based gaming (Lonthoff *et al*., 2007).
According to Jiang and Yao (2007) the questions a LBS-user is concerned about are: Where am I currently? What and where are the nearest Locations of interest? How to get there?

[1] Mobile applications
[2] Http://www.aloqa.com

Or as summarised by Frentzos *et al.* in 2007, the current LBS solutions consist of three fundamental services: *What-is-around, Routing and Find-the-Nearest*.
Nevertheless, it was stated that current services "…*are rather naïve, not exploiting current software capabilities and the recent advances in the research fields of spatial and spatio-temporal databases.*"
Research fields like predictive modelling and the exploration of data collected from LBS (e.g. Karimi and Xiong, 2003; Ashbrook and Starner, 2003; Thi Hong *et al.*, 2009; Nanni and Pedreschi, 2006) could significantly benefit from these advances.
Frentzos *et al.* proposed three extensions of the current services in order to ensure the development of next-generation LBS. Amongst those the *Get-together* proposal, in which a meeting point for several users is calculated based on the future projection of the calling user's trajectory, is probably the most relevant to this research. It points to the integration of location predictions into mobile computing.

The following pages talk about the LatYourLife-application (LYL), a LBS which uses web-mapping and mobile technology to assist people in their daily life task-planning and tackling. It connects tasks and events with geographical information and attempts to make innovative use of the geo-temporal data. Therefore the application not only deals with the three services listed above, but also attempts to create a *When-to-act*-service. This is achieved by integrating route time predictions as a basis for a pro-active alert feature. The main challenges of this application are (1) the design of a user interface that is focused around a map rather than a calendar (2) the constant monitoring of the users location and adaption of the system to it.

## 2. Background

The idea of using location as an assisting factor for managing tasks is not new and was pioneered by Lamming and Flynn in 1994 with the "forget-me-not" application, a tool which enables the user to store a "biography" consisting of information about personal location, encounters with others, workstation activities, file exchange, telephone calls and other information. Based on psychological theories, which say that physical context could be helpful for recalling information out of memory (Barsalou,1988) the application tries to mimic the so called episodic or autobiographical memory, which therefore should help people remember specific things.

More recent examples of such reminders are functionalities known as "*location based alerts*", which is basically an attempt to remind people of errands by invoking alarms according to the position rather then time.

ComMotion (Marmasse and Schmandt, 2000) for example, uses learning algorithms to determine frequent locations and enables the user to apply reminders to these points (e.g. a shopping list could be attached to a grocery store, which would then be alerted when passing by it).

CybreReminder (Dey and Abowd, 2000) tries to create complex situation reminders based on a combination of time, location and other criteria. Very explicit situations could be specified, such as a reminder which is triggered only in case you are at a

particular point at a particular time with or without particular weather conditions applied for example.
A user study conducted by Sohn et al. in 2005 revealed that, peoples reactions to the concept of location based reminders are quite positive. The study supplied 10 participants with mobile phones and a “Place-Its” application which “…is designed around the post-it note usage metaphor, and named for its ability to “place” a reminder message at a physical location (i.e. a place).”(Sohn et al.,2005)
Sohn et al. conclude that “*…the prevalence of mobile phones and the pervasiveness of their networks makes them a promising platform of personal ubiquitous computing. …On the whole it appears that the convenience and unbiquity of location-sensing provided by mobile phones outweights some of their current weaknesses as sensing platform*.”
By now plenty of such applications are available for purchase on the market. (e.g.: reQall[3]; Geominder[4]; Proxido[5]; Synchrospot[6])

In terms of personal task planning or scheduling, geographic information has not entered the mainstream applications yet. Typical calendar application like the Microsoft Outlook[7] or Google Calendar[8] are based on traditional time interfaces, with Google Calendar being able to show event locations on a map, given a provided address. The lack of creativity in incorporating GIS and LBS in such applications seems baffling, considering the benefit such integrations could bear. The mobile version of Google Calendar resembles a ported version of the web-app and does not make use of the potential so-called smart phones provide.

Potential which is probably best illustrated by the CenceMe-application (Miluzzo *et al.*, 2007; Miluzzo *et al.*, 2008), an app which makes comprehensive use of facilities offered by the devices and enables the users of social networks to share personal information sensed by the mobile phone, with their friends.
Besides the ability to share the current location, it uses algorithms to classify the sensed data and recognises whether the user is alone, attending a party or walking on the street, driving or running, etc. . The integration of such a service into a task planning application is interesting in terms of group or office management.

A pioneer diary study in 2000 (Colbert, 2000) examined the *rendezvousing* behaviour of students for a month and concluded that 21% of unsuccessful rendezvous were due to the lack of information about the other attendees and suggested that location information about them could enhance the ability to plan events.
An application derived from these conclusions and possibly the most similar work preceding the LYL-application, was designed and evaluated by Fithian et. al in 2003. The mobile Location-aware handheld event planner provided the user with basic event information and location details about users attending the event. The software already implemented *passive* route time predictions, such that users are able to see the

[3]http://www.reqall.com
[4]http://www.ludimate.com/products/geominder
[5]http://www.hollowire.com/proxido.
[6]http://synchrospot.com/android/home.do
[7]http://office.microsoft.com/en-us/outlook.
[8]http://www.google.com/calendar/.

estimated travel time to the event. The study though did not evaluate the benefit users could gain from such an application.
Talking about location tracking and awareness of mobile devices, privacy issues have to be part of the discussion. The idea of knowing where a person is at any time of the day raises justified concerns amongst academia and society.(Dobson and Fisher, 2003; Halliday, 2010)
The application built in this research holds very private and detailed information about the user's activities, but since there was a lot of work undertaken on the topic (Hong and Landay, 2004; Chow and Mokbel, 2009; Ghinita et. Al, 2009), this paper will not go into discussing the issue, although it is crucial to be aware of it when developing such applications.

## 3. User Requirements

The diary study undertaken by Colbert identified eight possible causes for rendezvous problems (Colbert, 2000). 37% of them were caused by the mode of travel, 25% were caused by the over-run of previous activities and 21% by the lack of information of other attendees. 10% were contributed by the lack of geographic information and 7% by the lack of travel information.
The statistics show that 17% of the problems with rendezvous were related to geography and could therefore be tackled by supplying the user with this kind of information. Thus the core purpose of the research was to explore and probably implement some of the new functionalities made possible by the geo-temporal information supplied by the users and address the 17% mentioned above.

Many studies have focused on the user requirements for LBS in terms of navigation in an urban area (e.g. Baus *et al.* 2002; Borntraeger *et al.* 2003) or the requirements for specific user groups (elderly people: Osman *et al*. 2003; blind people: Klante *et al*. , 2004). But a study particularly relevant for the LYL-application was conducted in 2008 by Nivala *et al.* and analysed the potential users and their tasks during a hike. The resulting user requirements were grouped into three different phases of the hike: *before*, *during* and *after*.
Thus the users need information to plan the hike in the *before*-phase, require services *during* the hike (e.g.: location of other hikers, navigation) and finally demand adequate functionalities *after* the hike (e.g.: sharing experiences).
Using the analogy of hiking, planning a day could be divided into the same three phases, which call for similar services. In the *before*-phase, the functionalities should help the user in his process of decision making, by providing useful (geographical) information incorporated into the planning interface.
The features in the second stage should assist users in their ambitions to achieve the aims mapped out for the day. In the last stage the user should be able to look back at past events and review information about it.

Dependent on the type of stage and its requirements, either a web- or mobile platform is more suited for implementing such services. A desktop-computer is not be the best mean to remind the user of something, as its static nature limits the occasions such a reminder could achieve its goal. A mobile device in comparison would be more appropriate, as it is in close proximity to the user and operates almost 24 hours a day. Hence the built System consists of three components:

1. A Web Interface (used in the *before*- and *after*-phase)

2. A Spatial Database (important for the *after*-phase)

3. A Mobile Application (mainly for the *during*-phase)

The decision to include a web-based interface was made in order to separate the mapping and planning of the events from the mobile application, based on the fact that "*…simplicity of use is a key issue. Currently, users rather refrain from using LBS if it requires manual data entries. Usage must be intuitive, results should be reachable within 3 clicks*"(Uhlirz, 2007)

Together the parts build a structure enabling the user to conveniently plan and map upcoming tasks on a desktop computer and then navigate through the day having the information carried away on the mobile device.

Since "*…users are central to LBS ... LBS applications should be designed based on a user-centred view*." (Jiang and Yao, 2007)

In order to comply with the above statement and investigate which functionalities are demanded for the *before*- and *during*-phase, a brief user study including 10 smart phone owners with different backgrounds and ages was conducted.

A questionnaire containing a list of three proposed features for the web interface and three for the mobile application, as well as a section for suggestions, was handed out. The participants were asked to assess the proposed functionalities according to what they thought is useful or not and urged to come up with their own ideas of what services could be useful for such an application.

**Table 1: The sorted list of functionalities according to the user assessment (1= very useful; 5 = not useful).**

| Functionality | Average |
|---|---|
| one click navigation to next appointment | 1.4 |
| geographic planning aid | 1.5 |
| punctuality alert | 1.7 |
| group calendar/map | 2.1 |
| share your location | 2.1 |
| location based reminder | 2.4 |

The outcome of the study showed that the participants were quite generous with their assessment, as no functionality exhibits an average rating higher than three, which leads to the conclusion that all of them are perceived as relatively useful.

Nevertheless the ability to share their location and event information, as well as location based alerts, were seen as less valuable.

The following points were suggested by the users:

- weather integration
- ability to view the event location (e.g. a picture of the location)
- telephone number of the venue
- navigation based on Google Street View

The Routing, Geographic Planning Aid and Punctuality Alert were implemented due to their high ranking in the list (see Table 1), whereas Weather Integration was chosen to be important because it was the only user suggestion which occurred twice.
Location Viewing, another user suggestion, was chosen to be incorporated due to the simplicity of its implementation.

## 4. Application Architecture

The application architecture was designed to provide the user with a web interface as well as a mobile component which are tied together through a database.

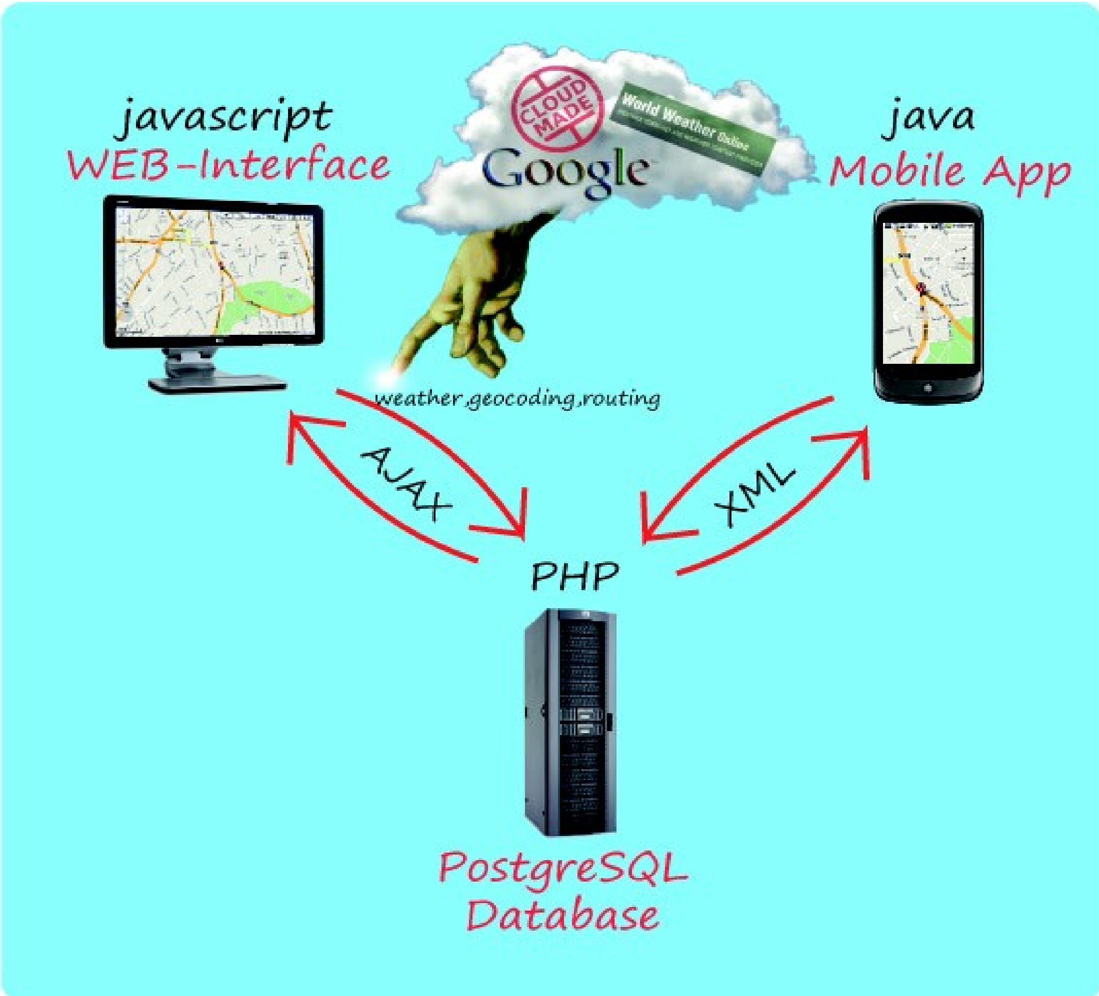


**Figure 1: An abstracted graphical illustration of the System Structure.**

The communication between the web interface and the database is achieved by using AJAX[9] requests, to keep the interface responsive and avoid loading times when updating the event information. PHP[10]-files are handling the interaction with the database and are chosen due to the open nature of the scripting language. Since the acquisition and management of routing or weather data is a rather complicated

[9] Asynchronous Javascript and XML
[10] Hypertext Pre Processing (PHP)

undertaking, Web APIs[11] are a convenient and elegant solution to acquire related information based on the geographic location.

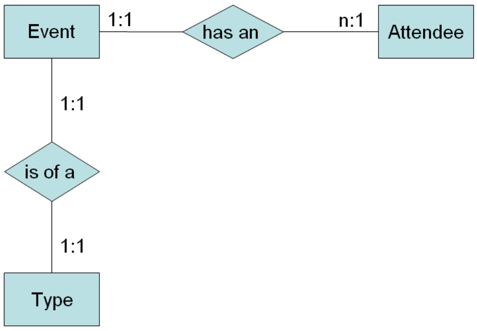


**Figure 2: A very simple, but satisfactory ER - model to store the basic information about the events.**

## 4.1 The Database

The underlying database was build with PostgreSQL, an open-source object-relational Database Management System (PostgreSQL, 2010). The open nature and the possible storage of geographic components in the DBMS were key factors for choosing the software. The data model designed to store the information was kept simple in order to avoid unnecessary complexity in further development of the application. An ER-diagram[12] was used to describe and design the model (see Fig.2). For the sake of simplicity, it is assumed that an Event could only be related to one User/Attendee, but the design could be expanded, so that users are able to share events with others.

## 4.2 The Web Interface

The core purpose of the interface is to plan and set events on the basis of a map as opposed to the traditional time based calendar interface. The display is divided into three different parts: a Sidebar, a Map and a Calendar. The Sidebar shows general information such as weather, date, time and details of the next upcoming Event. The Calendar is initially hidden and can be opened by the user.(see Fig. 3).

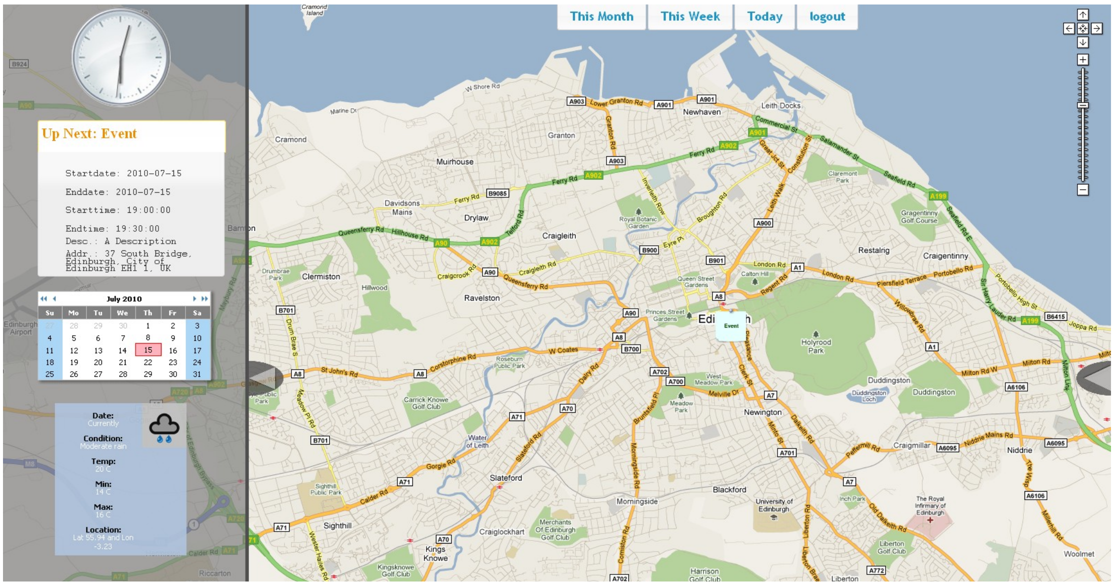


**Figure 3: The Web-Interface as it looks in its initial state. The Sidebar on the left contains general Information, the map in the centre shows the Events scheduled.**

[11] Application Programming Interface
[12] Entity Relationship

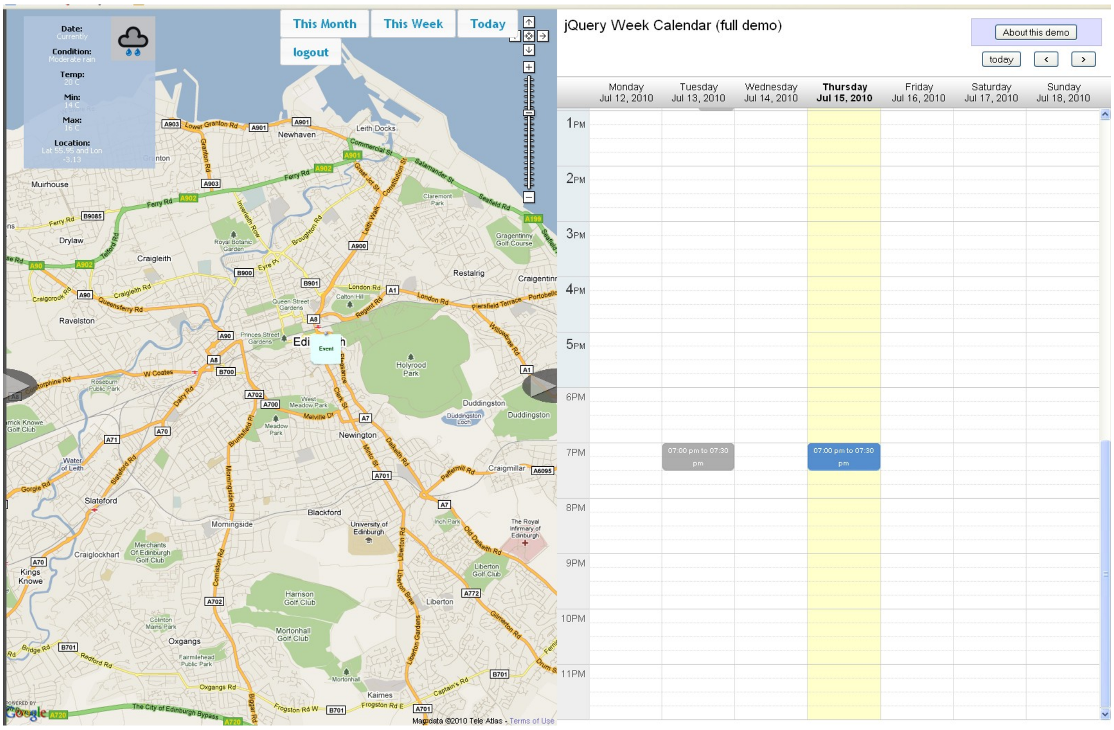


**Figure 4: The Web Interface with the calendar opened on the right side. Events are visualised geographically and temporally.**

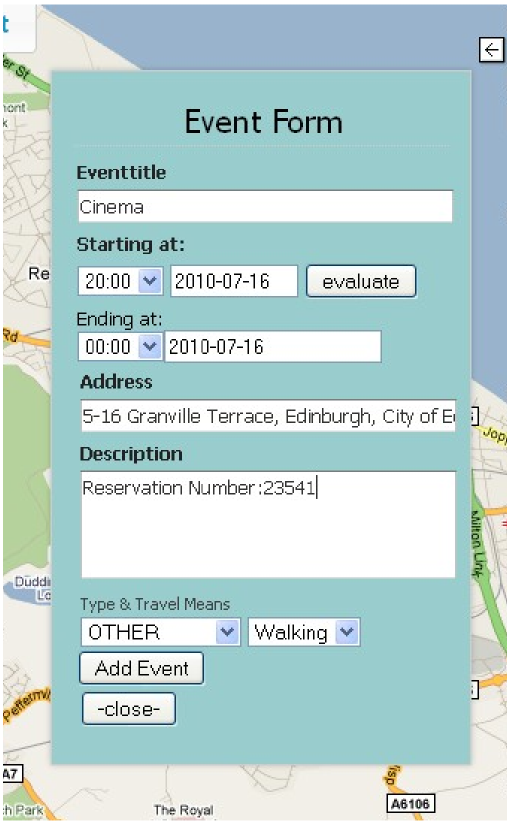


**Figure 5: The input form is used to store the event details once it was located at the map**

Events can be added onto the map and the week calendar on the right allows the user to edit time and information about them. An input form stores, updates or deletes the events in the database.

## 4.3 The Mobile Application

The mobile application was developed for the Android Platform[13], an open source software stack created for mobile phones and other devices. The platform was chosen due to its accessibility and coding in the java programming language. The mobile application is built out of four different user interfaces and a "service" running in the background evaluating the user's position, downloading route information and setting the time for notifications.

The application takes its information directly from the database, utilising php-generated xml-files.

[13]http://developer.android.com/index.html

Figure 6 shows three of the four views of the mobile application, from left to right the first view provides information about the next scheduled event, the middle view shows a list of all events scheduled for the current day and the last window contains a map with all today's events and the users current location mapped. The fourth view is simply an interface which enables the user to edit some of the event details.

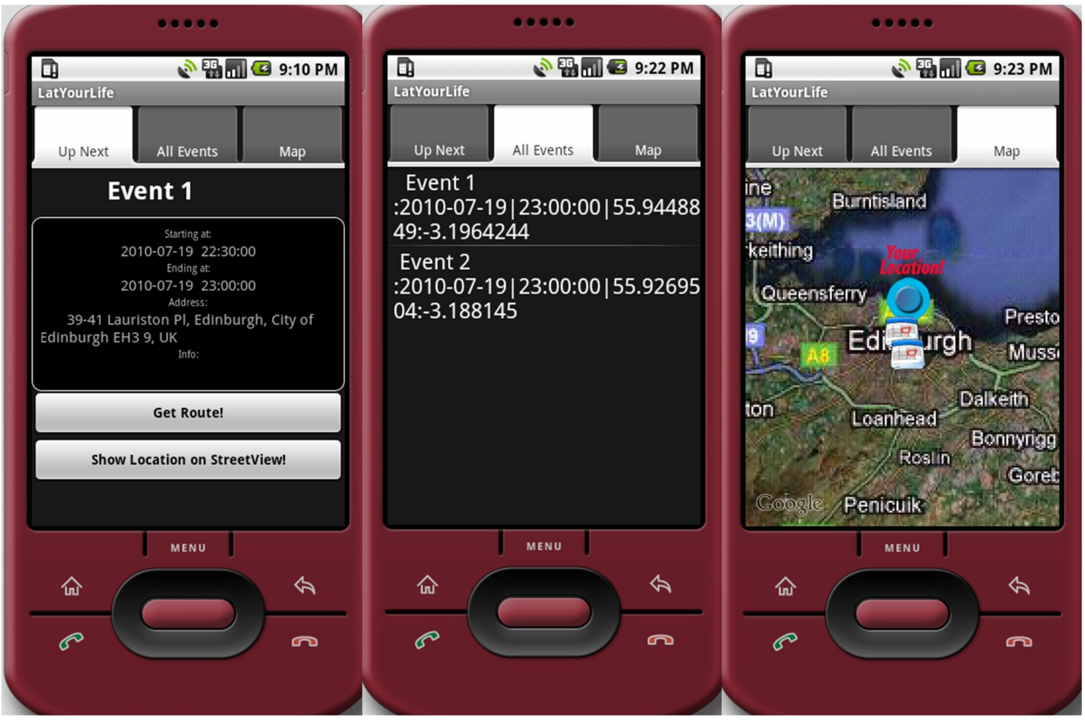


**Figure 6: Three of the four different views from the mobile application interface**

Since the application is very much a prototype implementation, interface design and information display remains a matter of improvement.

## 5. Implemented Functionalities

The features implemented in the application were chosen upon their ranking in the user study and considerations in terms of technical complexity.

### 5.1 Geographical Planning Aid

This particular functionality was meant to support the user when taking decisions about setting events at different locations and time. So if it takes 30 minutes for the user to get from Event A to Event B, but the time available to be there is less than that, the application will signal the user about possible problems.
To execute such an algorithm specific information is needed:

- The time when Event A is ending
- The time when Event B is starting
- The time it will take to travel from A to B (this implies the intended mean of travel)

Once the information is provided an algorithm for evaluating the decision taken by the user can be executed.

$$\text{If } (TT < AT) \{ \text{ TRUE } \} \text{ else } \{ \text{ FALSE } \}$$

$AT_{AB} = ST_B - ET_A$
$TT_{AB}$ = Estimated minimum travel time between Event A&B
$ET_A$ = End time of Event A
$ST_B$ = Start time of Event B

The equation above is a formalisation of how the geographical planning aid is implemented. If the application detects a contradiction in the planning of events, e.g. the time to get to from event A to B takes longer than the time available, it alerts the user by overlaying a red coloured polyline to the map.

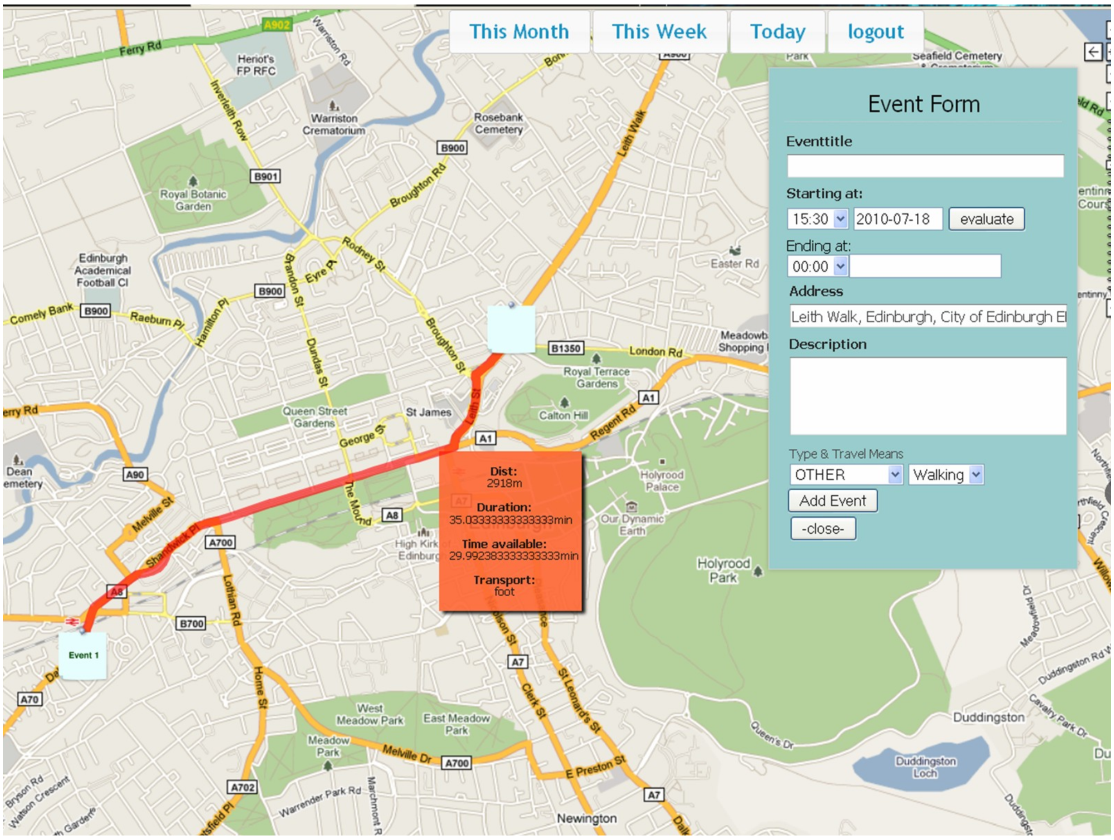


**Figure 6: The estimated travel time for walking from Event 1 to the next planned Event exceeds the time available.**

In such a case the user does have the ability to alter one or more of three parameters in order to reach Event B on time:

- Location
- Time
- Travel Mean

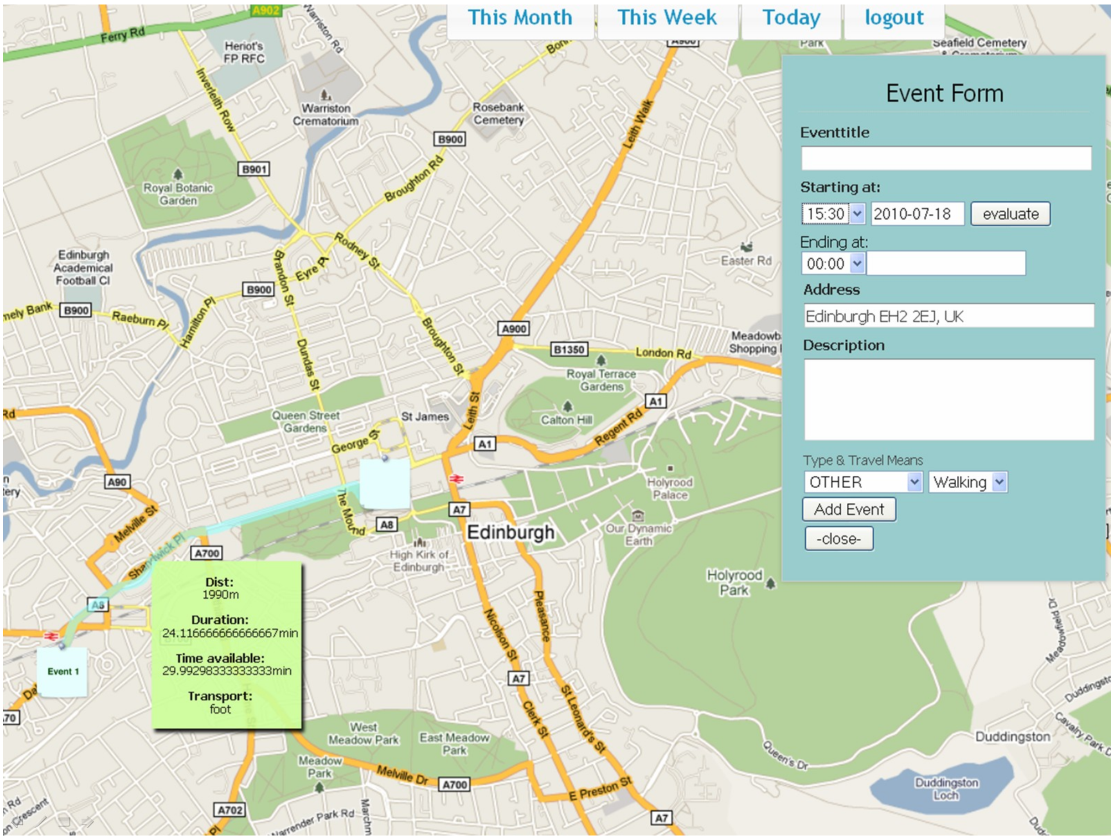

**Figure 7: Changing the location of one of the events is a possible solution to solve the problem.**

By having a visual feedback from the system the user is able to assess travel times between events and therefore plan them according to it.

## 5.2 Weather Information

The integration of weather information was suggested by two of the ten participants and therefore prioritised. Weather information could potentially change behaviour in terms of space, time or transportation. Rain might deter the user from using a bike for example, or even erase the event completely from the map. Although weather information could potentially be acquired by the user from other web sources, the tight integration of the information into the application transforms it into an integral part of the planning process.

Ideally the weather information would be added to each of the events according to time and venue, but for the sake of simplicity the web component shows weather details only for the location the map is centred on. The weather data is acquired by using an API[14]. The implementation showed that weather information could easily be tied into such an application on the basis of geographical coordinates and temporal details.

[14] http://www.worldweatheronline.com

## 5.3 Routing & Location Viewing

The ability to get instant routing information on your mobile device was assessed to be the most useful feature in the application. One of the main advantages of using the android platform for mobile development is its design which "…encourages the concept of reuse…"(Meier, 2010) . The platform allows the developer to use other applications data or functionalities. Therefore the Google Maps-App[15], which is very likely to be preinstalled on android devices, was integrated to handle navigation and showing event locations on Google Street View.

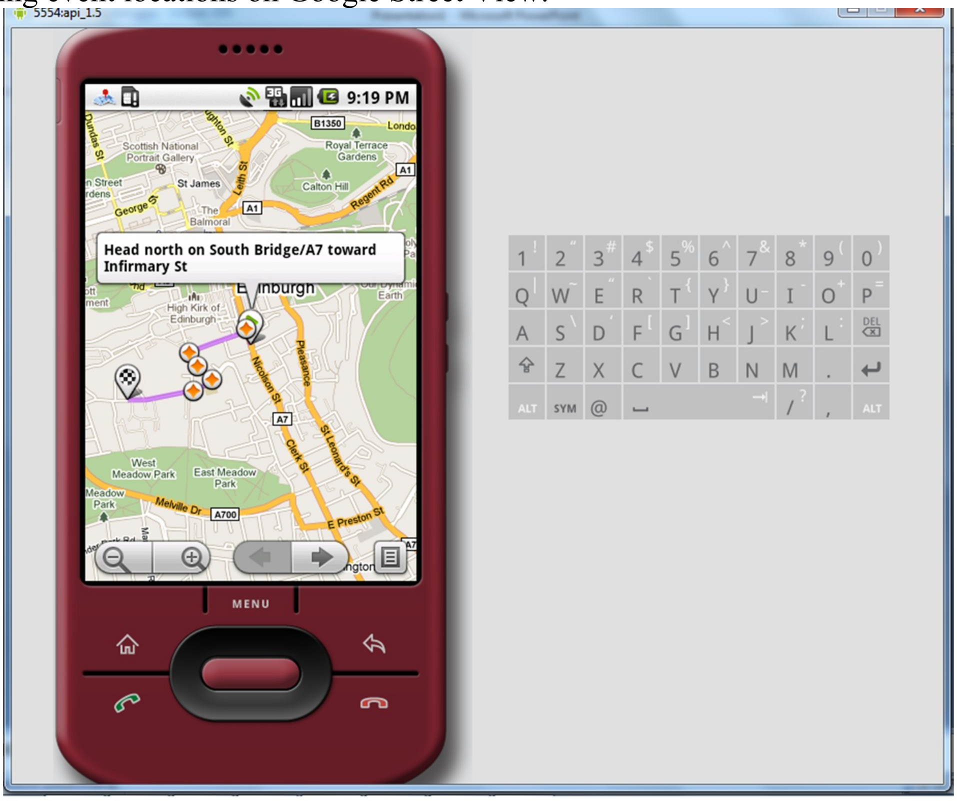


**Figure 7: Directions are fetched and displayed by the Google Maps Application on the device**

The application automatically recognises which event the user is supposed to be heading towards and gets the directions to it from the current location.

## 5.4 Punctuality alert

This functionality is the second feature (after the Geographic Planning Aid) which attempts to make use of the geo-temporal data provided. The aim is to notify the user ahead of the next scheduled event, in order to ensure punctuality. The notification time is set according to the user location, so that the alert would be triggered earlier if the user is located further away than it would be the case if near by.

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[15]http://www.google.com/mobile/maps/

The required information for implementing such an algorithm are:

- Current Location of the user
- Starting Time of the next Event
- Travel Time from the current position to the Event position (implies knowledge of the travel mean)

The equation below formalises the procedure necessary to acquire the time for scheduling the alert. In order to provide the user with some time to prepare for the departure additional 10 minutes are subtracted. For this prototypic implementation it is assumed to be sufficient, but ideally this amount will be chosen by the users themselves.

$$AT = ST_{NE} - TT_{CE} - 10$$

$AT$ = Alerttime

$ST_{NE}$ = Event Starttime

$TT_{CE}$ = Traveltime from Current Position to the Event

**Figure 7: illustrates the algorithm implemented in the mobile application.**

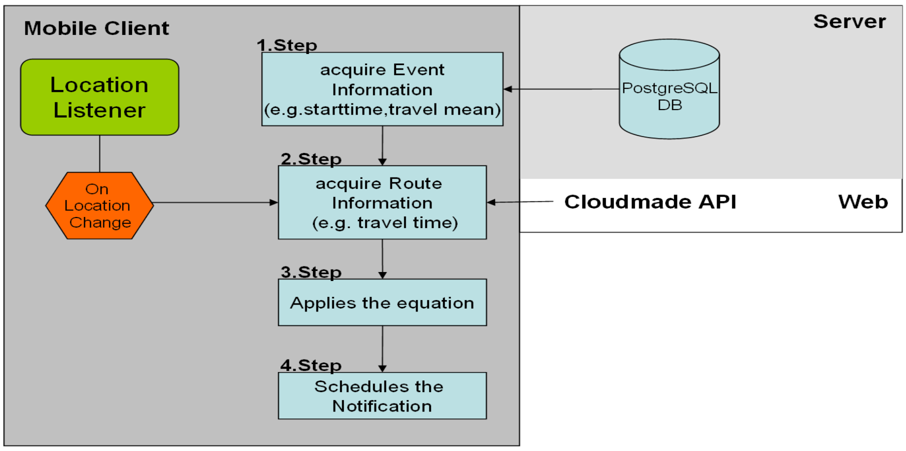


**Figure 8: Visualisation of the evaluation process applied for the Punctuality alert**

It shows that the process is done in four steps:

1. Fetch the necessary event details from the database
2. Acquire the travel time through the API used to gain route information
3. Apply the above quoted equation
4. Set the Alert

The location listener, shown in green, is integrated to track the user movement and restarts the algorithm from step 2 in case a location change of more than 50 metres is detected. Having the algorithm rerun again, Step four will then update the alert time according to the new location and travel time.
The application in this research is restricted to walking, cycling and driving times, since public transport information is difficult to acquire and monitor. Ideally a genuine public transport web API would be provided, which services could query according to geographic location and time.

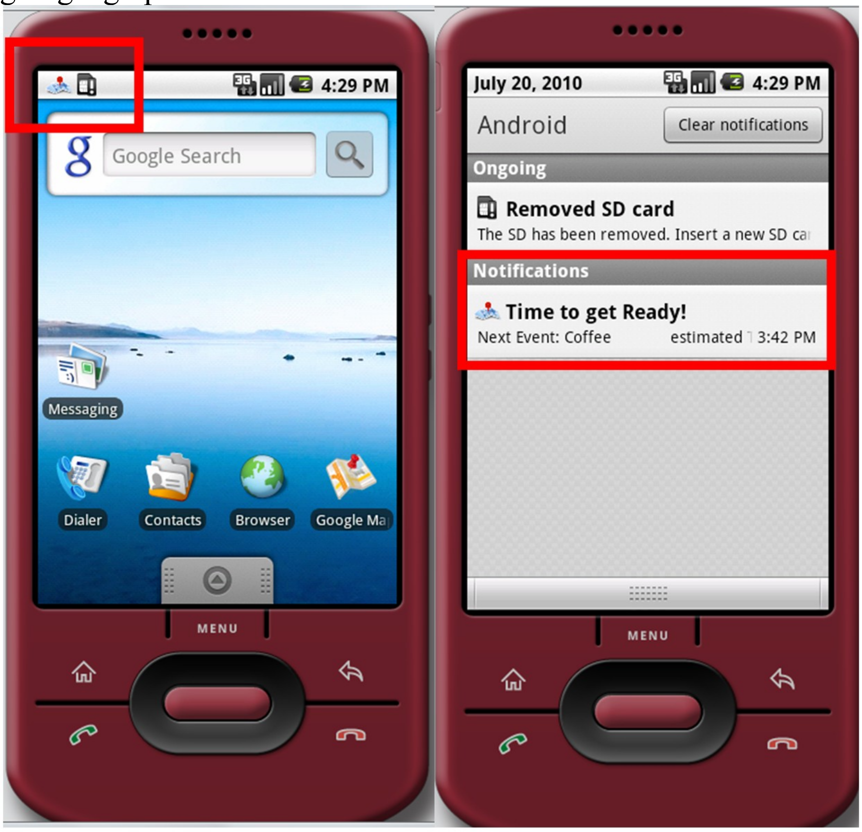


**Figure 9: The user is notified in the notification bar (upper left frame) when it is time to depart.**

## 6. User Feedback

User feedback was crucial to evaluate the functionalities and benefits of the application, unfortunately due to the lack of resources and time, no comprehensive user study was conducted. Thus a usability study with five participants, three of them smart phone owners, was undertaken. The participants were between 20 and 30 years old and students. Three of the participants used their own phones for testing the application, the other two were equipped with a compatible mobile device and had never possessed smart-phones before. They were asked to choose a particular day, which they thought to be adequate for testing such an application. All users confirmed that walking or cycling was their main mean of transport.
The following are summaries containing the core points of the interviews conducted with the participants after their field testing.

USER A:

User A positively mentioned the fact that "…*you can have a diary of all the places you have to go*", which allegedly gave him a different perspective and better geographic understanding of his schedule.
An issue raised by this participant was that of the event geometry. This was identified when the user planned a drive from University to the user's hometown. The application currently only supports the storage of events in form of single-points, this means the starting time of an event represents the time the user should be at the mapped location.
Instead the user mapped the event at the location of his final destination, but set the start time to be the time intended to leave from University. This made the application assume that the user has to be there at the time he wants to head off and notified him far too early.
This confusion highlighted the fact that events might start and end at different geographic locations. Therefore a double-point representation of those would be more appropriate.

USER B:

User B reported an occasion on which the device did not notify him about when to leave until he reached the events location. The situation highlighted a second unaddressed matter of the application, the *approaching user*.
The Punctuality Alert updates its notification time according to the position of the user. Once the user is notified it will not trigger another notification for the same event again. The issue originated in the fact, that the user started walking towards the event before receiving a notification, which led to a constant update and postponement of the notification time. Departing before the notification lets the user potentially reach the location 10 minutes earlier to the appointment. Once the user reached the location the application stops updating the alert time and will then trigger the notification although the user is already there.

USER C:

The User utilised the application for a trip to an unfamiliar city. Since it was the first time the user visited the place and as there were several appointments to meet the day appeared to be an ideal setting for testing the application. Time was spent to map out the appointments the night before, in which weather and geographical information allegedly gave a good basis for planning the day. The geographic planning aid was utilised by the user to estimate travel times from one point to the other.
When the user arrived in the city at a bus station several hours time were left until the next bus was departing from the same location. Having the application made it possible for the user to conveniently explore the surroundings of the place. The application allegedly gave the user the ability to see how long it will take to the next appointment and therefore allowed the assessment of how far the user could move away from it. "*The application gave me the convenience of moving freely through the city, having in mind that it will tell me when to head back and being able to easily navigate to my next appointment*"

On the other hand the user criticised that the notification is very short and might be overheard in a noisy environment such as a street. It was also mentioned that in some occasions the notification was not triggered at all, which made the user very suspicious about the reliability of the feature.

USER D:

User D was similar to user E in that they were not smart phone owners. The user was therefore provided with an android phone. Nevertheless the user was able to immediately understand and interact with the mobile application which proved the simplicity of the interface design.
The weather information was perceived positively since the user planned an outdoors activity. Criticism was issued due to the fact that the web interface does not exhibit an address search functionality which, according to the user, is crucial for locating some of the event positions. It was stated that "*the punctuality alert is a very useful feature, but is in its current stage just not reliable enough*".

USER E:

User E was the second participant who had no significant experience with smart phones but similar to User D did not come across difficulties to interact with the application. The participant found the web and mobile interface to be easy understandable and liked the fact that both were not over loaded with information and buttons.
Similar to prior users an address search was missed in the web interface, as well as event input functionalities for the mobile application.
The user was intrigued by the map as a basis for arranging events and likened the fact that the application could potentially save time and stress by taking away the need of looking up directions prior to the head-off. What the user found most beneficial was that the application lets you focus on other things prior to an appointment since it does the work of monitoring the time for you.
It was stated that **"…***the application has great potential as it saves time and takes away a lot of worries you usually have before an appointment.***"**

## 7. Feedback Summary

Most users agreed that a web interface is a useful planning tool, but insisted that the mobile application should provide planning abilities, since events could be changed or cancelled during the day. The web interface was perceived by most of the users as clear and easy to use, while some added that it lacked the ability to provide address searches, since they were not able to find particular locations simply by looking at the map. All users did mention problems with the reliability of the alert, which in the author's point of view was mostly due to the lack of gps-reception indoors. Another common point of criticism was, that the permanent usage of gps drained the battery and resulted in a total shut down of the phone by the end of the day.

## 8. Conclusion

The research project implemented a prototype geo-temporal task planning application, which provided the users with new abilities to manage their tasks and errands. It was successful in addressing a *When?*-question, using simple route time estimations.

The survey demonstrated that the main benefit of the punctuality alert is not improved punctuality but the convenience the user gains by not being forced to continually verify the time. Simultaneously there was a major concern about reliability of the functionality. The notification did not prove to be stable, as the majority of the users reported missed or misplaced notifications. The issue highlighted some of the limitations which were present in the technical implementation of the idea, such as location data accuracy and data acquisition (e.g. public transport data). The study proved that precise location information is not easy to get hold of. Ideal GPS reception is not always given and the accuracy of it might vary from a few metres to a several ten meters, which could lead to inaccurate alert times. Other matters included the estimation times of the routes and the usage of several transport modes to reach an event. Overall the punctuality alert is a feature in need of deeper exploration to enhance efficiency and reliability, which potentially involves the incorporation of predictive modelling (e.g. Karimi and Xiong, 2003; Ashbrook and Starner, 2003; Thi Hong *et al.*, 2009) as mentioned in the introduction, or the integration of contextual traffic information.

An important point highlighted by the interviews is that the application was perceived most useful in unfamiliar environments. But especially when abroad users often do not have an internet connection available. Therefore it is necessary to think about what parts of the services can be provided offline.

Whilst the application proved to be of great value to the users, questions of technical and theoretic nature remain. Issues like (1) How can we model "tasks" in a more appropriate way, (2) and what are their spatio-temporal properties? Related to this is the cartographic presentation of events. (3) How can temporal factors be visualised on a map and (4) would size for example be an appropriate means to help the user distinguish between closer events or events further away in time?

In future research we hope to gain answers to these question.

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