Personal geographic Information Management

Amin Abdalla*and Andrew U. Frank†

Vienna University of Technology
Institute for Geoinformation and Cartography

Abstract

Traditionally personal information management (PIMs) tools support people in their daily tasks. While research around personal information management focuses on how to store and retrieve information efficiently, we focus on the use of spatial (geographic) aspects in personal information. Tasks and appointments are represented in calendars or todolists, often including temporal and sometimes even spatial information. Unfortunately the spatial information is seldom used for task planning or execution support. Therefore current PIM applications, e.g. on mobile phones, do not use the full power of the devices, and they too often simply resemble a piece of paper with the relevant information on it.

The research goal is to extend the possibilities of modern GIS and enable ubiquitous GPS technology to pro-actively support the user in his daily tasks.

1 Introduction

In the past GIS was a tool primarily used by professionals in administration, planning or science. The motivation behind the development of GIS at that time was, on the one hand academic curiosity and on the other the need of greater speed and efficiency in the manipulation of geospatial data (Coppock and Rhind, 1991). This was mainly due to the fact that these user groups were the only ones who (1) had access to computers and the required peripherals and (2) were in need of spatial information, since it was them who had to process and analyse spatial data.

Nowadays, with the emergence of GPS enabled mobile devices and volunteered geographic information ordinary people have become producers of spatial data. Citizens as sensors (Goodchild, 2007)describes the fact that people have now the ability to contribute to large spatial databases and the geographic information with others.

*abdalla@geoinfo.tuwien.ac.at
†frank@geoinfo.tuwien.ac.at

We believe that the next step in GIS development will be towards *geographic analysis of personal* information. By personal information we mean data collected and produced for personal use and not intended for general sharing with a wide public, as is the case of VGI. The research question is, how to structure such information, to combine it with sensor data (especially GPS) and present the result of analysis to the users. We expect further, that the construction of tools, which we plan to use on a daily base, will help to clarify the relations between abstract concepts like goals, tasks, plans etc.

2 Personal Geography

Personal Geography (PG) can be understood as a *personal* interpretation of the environment, based on the information we relate to it. This is not to confuse with a mental map (Gould and White, 1986), which is mainly about individual perception of the physical world. PG is about the meaning we see in places, defined by our knowledge about it. Think for example of a supermarket close to your home: you will have a picture of it in mind, some idea of what you can buy there, what the price level is, the opening hours and how you can get there; maybe there are currently tasks attached to it (e.g. "I have to buy milk."). Based on that information you can infer things like: The bread there is cheaper than at other places; or that you have to be there before a specific time in order to be able to buy milk. Some of the information maybe objective and even available from other sources (e.g. opening hours) others are purely personal judgment based on past experience.

The information we relate to places play a great role on how we behave and interact with our environment. Our minds are full of such information and we utilise tools to help organize and manage it. We use post-its, todolists, documents and increasingly electronic devices to handle the vast amount of information important for our daily life.

2.1 Personal Information Management

There is a field of research, studying the way we manage and handle personal information, referred to as Personal Information Management (PIM). Jones and Teevan define PIM as "*...the practice and the study of activities people perform to acquire, organize, maintain, retrieve, use, and control the distribution of information items such as documents, Web pages, email messages for everyday use to complete tasks (work-related and not) and to fulfill a person's various roles (as parent, employee, friend, member of community, etc...)*"(William and Jaime, 2007).

Although current research in PIM does not put much focus on "place" as an important factor, personal information can in the majority of cases be related to a geographic location. Some may have implicit spatial relations like a picture taken at a specific location or explicit ones, like a document talking about a place. Though the tools utilized by us are barely taking advantage of that fact.

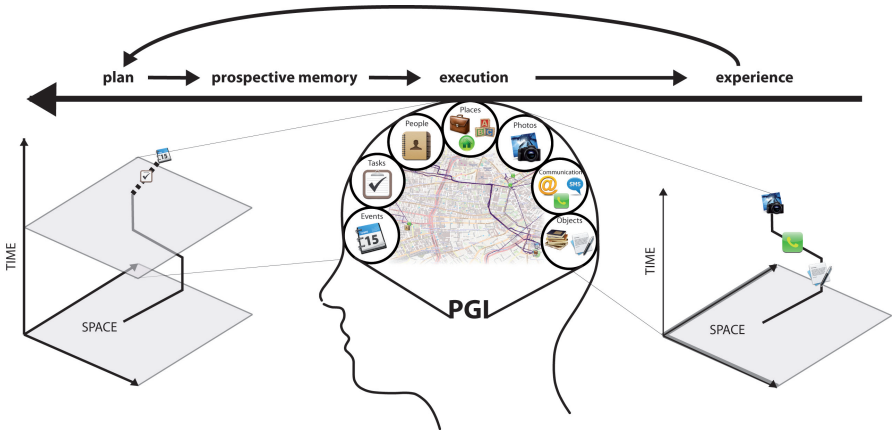

Figure 1: *A schematic view of our personal geography. The right side shows our past STP which forms our experience. An the left side we project our plans into the future. At the top the circle of plan-prospective memory-execution-experience-plan is visualised.*

For proper planning of daily tasks, both temporal and spatial aspects must be considered. Most PIM handle temporal data and include records of activities, but seldom space is considered. Therefore Hagerstrands time-geography (Hägerstrand, 1970) and its concept of a space-time path (STP) are fundamental. A person can only be at one place at a time and this constraints the PG tremendously, what leads to the notion of "activity space" (Johnston, 2000) Figure 1 attempts to illustrate the inter dependencies existent between our STP and behaviour within the PG. On the right side the graphic shows our past STP and the activities/information we attached to it along our way. When we take a picture for example we can map it to that STP, but also when we make a phone call or receive a document. The right side forms our experience and forms the basis of the information we hold about the world. Based on that we project our STP into the future (left side) such that we can estimate when and where we are going to do what, or to put it differently we "plan". Having such a plan we can derive tasks and events which need to be executed in order to achieve our goals. This kind of information is referred to as "prospective memory" (Roedinger, 1996; Graf and Uttl, 2001). The figure essentially visualises the process of how *personal geographic information* is produced and how it is used in our daily lives. In brief our personal geography is the physical environment in our own and personal context, which is not only about the past but also about the future.

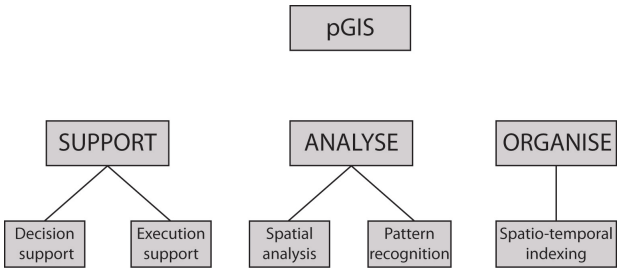

Figure 2: *The three pillars divide into sub-nodes*

3 Personal GIS

Tools to manage "personal geographic information" must combine the current PIM services with spatial analysis and spatial planning tools from GIS. A "personal GIS" (pGIS) is a GI-system designed for the very purpose of supporting the user with personal information management (PIM), navigation, planning and plan-execution. PIM research put great emphasis on the "finding, keeping and refinding" issue, hence how do we store our data best to be able to refind it again (Barreau and Nardi, 1995; Teevan et al., 2007). Geographic context is not really considered. Thus we believe that traditional PIM tools do not sufficiently take space into account and therefore do not match the users reality. The users reality involves always a location in space and often movement through time and space, therefore different context and restrictions.

Raubal et al. (2004) suggested a theory for a decision support system which essentially gives the user instructions about how and in what order to finish the tasks set for a day. By knowing historical data of the users gps-trajectories and activity logs, many more functionalities can be thought of like place recommendations for example. Janowicz (2010) pointed to the role space and time or in other words *context* plays in knowledge organisation. This can help organising and understanding personal information.

Figure 2 shows our suggestion of three basic pillars a pGIS should stand upon. These are the operations to:

- Support;
- Analyse;
- Organise.

Each of these points has child nodes that pose considerable challenges to the research community, but we like to focus on one particular point, namely: execution support.

4 Planning and Execution Support

PIM research pays attention on how we manage information. Some acknowledge the role of tasks in our daily life and suggest the term "task information management" (TIM)(Lepouras et al., 2006), which essentially tries to organise our data around the tasks that are relevant for it - integrating temporal aspects. Still from this perspective PIM or TIM look very much like fields only concerned with historic information. Psychologists might refer to it as "retrospective memory", hence information we encountered in the past. The project "MyLifeBits"(Gemmell et al., 2002) is maybe one of the more extreme examples of how research tries to capture this kind of information.

Personal information also involves the information we have about our future, e.g. calendar, events, errands, appointments, etc... This kind of information is essentially produced as soon as we start planning. There is substantial work done on how we plan (Hayes-Roth and Hayes-Roth, 1979; Hammond, 1986) that impacted on the field of artificial intelligence(AI).

For proper planning of tasks, the spatial location where they have to be executed adds constraints. Using current PIM tools, one often finds that meetings are arranged properly in time, but the time for movement between the meeting locations had not been taken into account (not to speak of the difficulties to deal with arrangements which span multiple time zones!). But integrating such constraints can be valuable when multiple people try to arrange meetings/appointments as shown in the work of Espeter and Raubal (2009).

Besides that GIS research developed optimizing methods for spatio-temporal planning (Malczewski, 2006). Less effort is evident when it comes to the question of how we deal with the tasks and errands after we planned them. Sellen and Whittaker (2010) argue that too less effort is put on how PIM can help to support people with their "prospective memory", that is the remembering of things needed to be done in future. Additionally the spatial perspective misses the incorporation of geographic context in the PIM field, since personal information is in most cases very much geographic information as well. Although place as a factor is acknowledged in prospective memory research (Sellen et al., 1997) it is not seen as a major determinant in the discussions surrounding PIM. But our core hypothesis is that if we modell tasks in their spatio-temporal context we can build a system that pro-actively supports the users to minimise the risk of failure and remind them at the right time and place of important things to do. Therefore we need to consider past, present and future information as well as the non-linear and hierarchical nature of tasks (Sacerdoti et al., 1975).

5 Vision and Challenges

Our vision is to have a system that helps users not only plan and organise their tasks and information but also executing their plans. The users should be able to put information about a planned appointment into the system and it will wake them up, trigger an alert when it is time to move towards it, advice about

best choice of transportation and guide them along the way, remind them about important things that were forgotten when leaving and alert them in case other tasks are related to the places visited. We want the system to take context into account, such that it suggests to take an umbrella if the path is outside and the weather-forecast predicts rain. In brief, we hope that in future mobile devices can function as tools that not only passively provide information, but pro-actively support the users in daily life. Thus we want PIM-tools to transform from a "digital piece of paper" into more "digital intelligent and spatially aware advisors". The novel thing about our approach is that we do not only want to provide the users with information when it is demanded, but pro-actively push information to them when the system concludes it is necessary or an opportunity to achive a plan.

Along with such a vision comes a list of technical as well as theoretic challenges.

5.1 Conceptual design challenges

Raubal (2009) stated that in order to be able to design and develop useful (GI) tools we have to consider the principles of human cognition in respect to spatial and temporal properties. Our intention is to investigate the role of space and time in daily life task planning and execution. We hope to gain insights about how a system can effectively support people with their prospective memory as well as the execution of the tasks and errands they aim to achieve. Therefore we need to investigate the following questions:

- What are the spatio-temporal properties of tasks and errands?
- When and where are the crucial points in our space time path, that enable a system to act at the right time and place?
- What scale and granularity do we need to adapt in order to model the objects and actions relevant for our daily life?
- What is the contribution of external factors (e.g. weather, persons, traffic, etc...) to our chance of accomplishing a task?

We think that cognitive engineering can give reasonably good answers to the posed questions.

5.2 Technical challenges

One of the problems of building usable systems is the difference between the user model and the design model (Norman, 1986). We argue that by building the system for our personal usage we can overcome the gap between the two, since the designer becomes the user as well. Experience in other fields show, that understanding of tasks and building of tools is much accelerated if the researchers are also actual users of what they research.

Personal geographic information must be available to the user in the geography, not only in the office and not only at places where there is a web connection available. Eventhough the information is personal and not intended for wide sharing, a limited sharing in strictly controlled environments (family, workgroup, rescue team) must be possible. On the other hand if we want the system to remind the users effectively of objects needed for tasks, we have to think about ways that make these objects visible to it. Objects like books, wallets, documents, etc... The technical enablers seem to be available, but need to be integrated - we consider here ubiquitous availability of GPS position sensors, RFID readers and tags, pocket size computers in form of 'smart phones', NOSQL databases[1] (Anderson et al., 2009) and tools for effective interaction with users. Not only that NoSQL databases provide the necessary flexibility, but also they can pose a solution for the problem of internet connectivity since they provide the possibility to store data locally rather than online and synchronize it when needed. As for the issue of making personal objects visible to PIMs we propose the use of RFID technology as such sensors are already incorporated in some of the latest 'smart phones'. By tagging the objects important for us, we can potentially make them sensable for mobile devices and start integrating them into PIMs.

6 Conclusion

In the field of PIM space and time has not achieved a great deal of attention until now. But recent work in GIScience has shown that it can, once integrated well, open doors to new functionalities and applications in the field. Specifically we argue that it can help to avoid unpleasant situations by reminding users about things they need to remember or consider, at the right time and place. In general we hope that discussion will emerge, both around the conceptual as well as the technical challenges and help solving some of the issues raised in the paper.

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[1] http://couchdb.apache.org/

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