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Who Controls the Past Controls the Future - Life Annotation in Principle and Practice

by

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ABSTRACT

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The fields of the Semantic Web and Ubiquitous Computing are both relatively new fields within the discipline of Computer Science. Yet both are growing and have begun to overlap as people demand ever-smaller computers with persistent access to the internet. The Semantic Web has the potential to become a global knowledge store duplicating the information on the Web, albeit in a machine-readable form. Such a knowledge base combined with truly ubiquitous systems could provide a great benefit for humans.

But what of personal knowledge? Information is generally of more use when linked to other information. Sometimes this information must be kept private, so integrating personal knowledge with the Semantic Web is not desirable. Instead, it should be possible for a computer system to collect and store private knowledge while also being able to augment it with public knowledge from the Web, all without the need for user effort.

This thesis begins with a review of both fields, indicating the points at which they overlap. It describes the need for semantic annotation and various processes through which it may be achieved. A method for annotating a human's life using a combination of personal data collected using an ubiquitous system and public data freely available on the Semantic Web is suggested and conceptually compared to human memory. Context-aware computing is described along with its potential to annotate the life of a human being and the hypothesis that today's technology is able to carry out this task is presented.

The work then introduces a portable system for automatically logging contextual data and describes a study which used this system to gather life annotations on one specific individual over the course of two years. The implementation of the system and its use is documented and the data collected is presented and evaluated. Finally the thesis offers the conclusion that one type of contextual data is not enough to answer most questions and that multiple forms of data need to be merged in order to get a useful picture of a person's life. The thesis concludes with a brief look into the future of the Semantic Web and how it has the potential to assist in achieving better results in this field of study.

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Chapter 1

Introduction

"An investment in knowledge always pays the best interest"
Benjamin Franklyn (1706-1790)

The World Wide Web revolutionised everyday life. Originally used mainly for academic purposes, the Web is now used daily by well over 1,000,000,000 people[1]. The Web was invented in the early 1990s as a hypertext system for storing and retrieving electronic documents. In essence, it is a very simplified version of Nelson's Xanadu system [Nelson, 1993]. The Semantic Web has been designed as an addition to the existing Web. It aims to create a web of knowledge around the existing web of documents, which may be queried and processed by agents, software applications designed to do the job of a human. The Semantic Web will essentially be a global database of information in a common, machine-readable format.

At the same time, computers are becoming more portable and information is becoming more sought-after. Most mobile telephones are more technologically capable than the computers of ten years ago and our endless quest for information is moving away from the desktop and surrounding us in everyday life. Sign boards on bus stops and train stations that update their status automatically are commonplace. A footballer scores a goal and within minutes, hundreds of fans all over the country know about it because their mobile phones have alerted them. Yet there are some who suggest these devices are a transitional step towards something far greater, the age of 'Ubiquitous Computing', in which "Specialised elements of hardware and software, connected by wired, radio waves and infra-red, will be so ubiquitous that no one will notice their presence" [Weiser, 1991].

There are two key issues that must be investigated when relating these two visions of the future. Firstly, for digital information to exist, it must first be created. Information can be created by either human or computer and there are benefits and drawbacks to

[1] Internet usage information comes from data published by Nielsen//NetRatings, the International Telecommunications Union, local NICs and other other reliable sources. Information obtained from http://www.internetworldstats.com/.

both. Secondly, not all information is useful but this is not measurable absolutely as information that may be of use to one person would be useless to another.

This chapter will outline the fields of both the Semantic Web and Ubiquitous Computing and provide an overview of the thesis and the work surrounding it.

1.1 Overview and Background

Ubiquitous Computing is a field that encompasses computers that work 'in the background'. They are there but invisible until we need them, at which point they serve their purpose and then once again blend into the background. A common example of an ubiquitous device is a mobile telephone; it is small enough to fit into a person's pocket until it is needed, when it is needed it is easily accessible and serves its purpose well and then returns to the pocket out of sight and mind until it is needed again.

The Semantic Web is Tim Berners-Lee's proposal [Berners-Lee et al., 2001] for a system running alongside the existing Web that is completely machine-readable, unlike the Web which is designed to be aesthetically pleasing for humans. Essentially the Semantic Web is intended to annotate the existing Web with meta-data but it has grown since its initial concept into a proposal for a web of knowledge that features logical inference, trust and provenance. This topic area forms an enormous base of study but also contains many specific issues, some more prominent than others.

In its most primitive form, the Semantic Web is based on the Resource Description Framework. RDF is a system of describing objects and data in a very simple format using 'triples'. Each triple consists of a subject, a predicate and an object. For example, if a certain person took a particular photograph, the person would be the subject, the photograph would be the object and the predicate would be the action of taking the photograph. This is the process of semantic annotation. Annotation is the appending of additional, meaningful meta-data to a resource without actually changing it in any way.

In its simplest possible form, the Semantic Web is a form of annotation. Semantic mark-up may be included within other documents in order to describe them better to a machine. For example, a website advertising a holiday destination may be viewable in a web browser by a human but also contain additional information not rendered by the browser that exposes raw data, such as the geographical location of the destination being advertised. A capable browser would be able to see this data and interpret it in its own way, such as passing it to a satellite navigation device which can guide the user to the location.

1.1.1 Objectives

The work described in this document seeks to investigate the feasibility and usefulness of an automatic 'Life Annotation' system. In doing so, the work describes the link between Ubiquitous Computing and the global knowledge base of the Semantic Web, through annotation of context. The thesis begins with a review of the fields of the Semantic Web and Ubiquitous Computing and explains how the two are linked. It then covers annotation, investigating the commonplace fields of text annotation and photograph annotation, before introducing the concept of Life Annotation. This is a process that seeks to create meta-data for a human's life, augmenting this data with public data available elsewhere and processing it internally so that the user's private data need not be shared. It is suggested that this system works in the same way as natural human memory; private information exists inside a user's memory and the user then uses this information, often in conjunction with outside information, in order to progress through his or her life.

1.2 Contributions

This thesis describes three original contributions not previously documented by existing literature.

Firstly, a portable and completely automatic 'Life Annotation' system, capable of storing the life of a human on digital media in a form that can be queried by the user in future, has been implemented, evaluated and documented. While such systems have been talked about since 1945 and various implementations have been completed [Gemmell et al., 2002, Ahmed et al., 2004, Tuffield et al., 2006], a portable, automatic system for the purpose of personal life annotation has not previously been developed.

Secondly, the aforementioned system has been used, in various ways, to annotate the life of a willing test subject[2] for a total of two years. This document contains an evaluation of the data collected, its usefulness and potential for further development in future systems. It explains the difference between collecting large amounts of data from one source and collecting data from multiple sources and shows that the latter is more useful in the context of a single user, giving examples of how different types of contextual data, both personal and general, may be exposed and combined using technologies such as the Semantic Web.

Finally, the work provides a rich insight into how the field of Life Annotation may be extended and assist human beings of the future in their day-to-day routines. The work suggests several different scenarios where such a system would be beneficial and pays

[2]The test subject is a white male in his late 20s who lives in Southampton, Hampshire. He wishes to remain anonymous for privacy reasons.

most attention to use of the technology as a memory aid. It concludes with various theoretical studies into issues including but not limited to ethics and security, particularly within the realm of data protection. It theorises that the personal information being collected may be combined and shared for various constructive purposes yet, while the sharing of various types of information may be beneficial, there are genuine security considerations if such data is merged with other data.

1.3 Document Structure

The main segment of the work involves the design and implementation of a portable automatic life annotation system that keeps track of a user's movements and activity. This implementation is then used for a test period in order to collect a large amount of life annotation data – spanning around two years – in the form of location, interaction and activity data. The collected data is then analysed in order to determine its effectiveness in working out what the user was doing and when. It is then used to answer a series of simple questions. Finally, suggestions for further development of such a system are made and the thesis is concluded.

1.3.1 Chapter-by-Chapter Analysis

Chapter 2 discusses the fields of Ubiquitous Computing and the Semantic Web. It presents a guide to the history and development of these fields from the perspective of the author, as well as a review of existing work.

Chapter 3 introduces the concept of annotation, specifically in the Semantic Web. It explains the processes of annotating data of different formats and discusses the problems associated with both. It concludes with a look into the concept of 'annotating' a human lifetime.

Chapter 4 presents the concept of using context sensors to gather data on a human's life. It suggests that a system which collects knowledge indiscriminately with no human interaction is more adept to assisting a user than a device with no prior knowledge and concludes with a hypothesis and a proposed test plan.

Chapter 5 describes the Imouto life annotation system and briefly documents its development and intended use. It explains the different methods for information collection and storage and which methods were chosen. It concludes with a description of the finished system and a critique of its limitations.

Chapter 6, the longest chapter of this thesis, looks at the data collected over the test period and analyses it. The analysis includes discussion on how useful, complete and accurate the data is. The chapter then goes on to explain how well the system and its collected data fared in the test plan and speculates on other forms of data that may be used to improve the knowledge base.

Finally, Chapter 7 concludes the thesis with a summary of the evaluation of the software and the data, a guide to the issues encountered and anticipated in future work and speculation on how the work may evolve in the future.

1.4 Declaration

The author declares that this thesis and the work presented within are his own and has been generated by the author as the result of his original research. Additionally, the author confirms that:

- This work was done wholly while in candidature for a research degree at the University of Southampton.
- Where the author has consulted the published work of others, this is always clearly attributed.
- Where the author has quoted from the published work of others, the source is always given. With the exception of such quotations, the thesis is entirely the author's own work.
- The author has acknowledged all main sources of help.
- None of this work has been published before submission.

Chapter 2

The Evolution of Information and Distributed Knowledge

> *"Scientia potentia est" (Knowledge is Power)*
> *Meditationes Sacrae*, Sir Francis Bacon, 1597

There now follows a review of the existing literature and practical examples that have influenced this work. As the work draws from various fields within the discipline of computer science, the chapter will be split into two main sections, the first outlining Ubiquitous Computing, the study of computers that run 'in the background', invisible until the services they provide are required. This will conclude with an investigation into the 'Mobile Web', the many uses of an always-accessible internet and how it may assist the field of Ubiquitous Computing. The second section will investigate the Semantic Web and the global 'database' it represents.

2.1 Ubiquitous Computing

Ubiquitous Computing (UbiComp) is a model of human-computer interaction which is, ideally, completely integrated into our everyday lives. One of the earliest and perhaps definitive works on UbiComp was written by Weiser in 1991. In the article, UbiComp is compared to writing; writing is everywhere in the modern world and does not demand our attention, yet is available at a glance should it be required.

The term 'Ubiquitous Computing' is, perhaps erroneously, compared to the field of Pervasive Computing, which refers to the use of computing devices for providing services to users in a non-intrusive manner. However, unlike 'UbiComp', Pervasive Computing does not necessarily require the devices to blend into the background. Not wishing to add to the debate on terminology, this document will use the term 'UbiComp' unless a specific distinction is required.

The Ubiquitous Computing Program was launched in 1988 at Xerox Palo Alto Research Centre (PARC) and was formed in order to "put computing back in its place, to reposition it into the environmental background" [Weiser et al., 1999]. PARC is, according to Weiser, a home for many devices based on the UbiComp paradigm, including Live Boards and Active Badges. However, there are many other similar projects which aim to bring Ubiquitous Computing closer to everyday life.

Nowadays, we are used to pervasive technology; mobile phones are commonplace but most carry additional functionality such as internet access, a camera and a personal organiser. Many vehicles are fitted with satellite navigation devices which calculate directions to a destination based on current geographical location. But these are not always truly ubiquitous. Mobile phones actually have no concept of context; despite being able to store the user's calendar and sense its current position, without manual user intervention the phone will ring when a call is received, whether the user is in a meeting or not. They do, however, serve one individual - many mobile devices can be customised by the user and it is becoming common for devices to learn their owner's habits, such as the predictive text feature on most modern phones that remembers the most commonly entered words.

But there are also less personal devices such as electronic timetables at bus stops that automatically update themselves if a bus is running late. These are context-sensitive public devices. They are not necessarily concerned with who they are serving, just that they are serving the correct information for the situation that the intended user is in.

Ubiquitous Computing is, therefore, grounded in the field of Human-Computer Interaction. Personal devices may serve the user and become more tailored to one individual as they are used and public displays convey information about the current context to a human. It is *context awareness* that makes UbiComp distinctive.

2.1.1 Contextual Systems

The word 'context' is defined, according to the American Heritage Dictionary, as the circumstances in which an event occurs. A contextual system is a system whose behaviour is dependent on its context [Schilit et al., 1994]. Dey [2001] defines context as "...any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves." Many ubiquitous systems revolve around some kind of context sensor. This may be as simple as a bedside light that dims if it detects that it is night, either through the time or by using a light sensor to see if the room is dark, or as complex as a computer system that tracks its user's lifestyle and adapts accordingly. Much work in the field has been done on devices that react to their surroundings and the people who use them, as well as information technology that differs in behaviour depending on the device's physical or geographical location.

Millard et al. [2005] suggests that in a contextual system there are four main areas to be considered that may be modelled in a computer system:-

- Location - The physical location of the system and its user.
- Task - The user's actions at the present time.
- Domain - Additional background information relating to the user and the task at hand.
- Device - The method of communication between the system and the user.

True to this analysis, many existing technologies and methods fall into one or more of these categories. Actually sensing people and their inner emotions is currently not feasible without great expense and some form of technology which only exists within the realms of science fiction. But there are other, more subtle ways of obtaining information about a user.

With these in mind, there now follows a review of the existing technology in the field, followed by a summary of how existing research fits into these four areas.

2.1.1.1 Infopad

The Infopad [Allan Christian Long et al., 1995] is a portable terminal with "multi-modal input and multimedia output". It serves as an interface to an existing wireless network and has the ability to play audio and video as well as accepting voice and handwritten input from the user. The system supports applications such as a web browser as well as personal information manager.

Although only a prototype, this technology has been widely adopted in today's society, with modern PDAs providing most of the functionality proposed for the Infopad. Therefore, it cannot be ignored as being the ancestor to modern mobile computer technology.

2.1.1.2 Cyberguide

Cyberguide [Abowd et al., 1997] is a family of prototypes based around a conceptual design. It is a system providing four services: cartographer, librarian, navigator and messenger. Through a combination of these services, Cyberguide aims to provide a useful tool for tourists. For example, the navigator knows the location of the user, the cartographer uses this information to determine what is around the user, based on this information the librarian looks for and presents information about the user's surroundings and the messenger allows the user to keep in touch with the human tour guide or the exhibit owner. It also allows the user to receive useful messages such as "The coach is leaving in 20 minutes".

2.1.1.3 Signage

"Forget About It" [Millard et al., 2003] is a system designed primarily for events such as university open days or conferences where numerous desks are set up in a hall. Traditionally, demonstrators at such events will provide handouts to give to people who show interest in their display but these may be easily lost or damaged. The system employs an array of 'iButtons', one per user, and each has a unique identifier. The user is required to register their iButton on entry and optionally enter their name and e-mail address. The user then walks around the displays until he/she comes to something of interest. The user then 'docks' their iButton in the docking station nearest the display in order to show their interest. Once all the displays have been visited, the user may enter their registration details on a web site and gain access to information about the displays visited, as well as suggestions for further research.

Although not truly automatic, this is an ubiquitous system in that the user is effectively controlling a virtual copy of themself which exists in the information-rich digital world. As the user visits exhibits, the server tracks which exhibits he or she has visited and collects virtual documentation on those exhibits which is available the next time the user is sat at a computer.

2.1.1.4 Active Badges

Active Badges [Want et al., 1992] are a concept influenced heavily by Hewkin [1989]. A badge is a small device, 55mm square and 7mm thick, that is worn by people who need to be tracked. A popular example is a specialist doctor in a hospital, who may need to be located immediately in times of emergency. Each Active Badge has a unique identifier which is broadcast every 15 seconds. This signal is picked up by various receivers located at strategic positions throughout the environment. These receivers are in turn polled by a central network which controls access to the information by other applications. The system running behind the scenes may be queried for the location of a particular badge, the badge closest to a given location, or even the other badges near a given badge, forming an abstract 'social network' in which people's interactions may be investigated. The initial use for this information was to provide a phone forwarding system; when a phone rings and the owner of the phone is not nearby, the call is automatically diverted to the nearest phone to the person in question.

Interestingly, although there are many privacy issues connected to the Active Badge system, according to Want et al. [1992], not many people who used the system expressed a concern afterwards. The test subjects were happy to continue wearing their badges after the trial period was over because of the additional benefit the system provides.

2.1.1.5 PARCTab

The PARCTab Mobile Computing System [Schilit et al., 1993] is a mobile device that works as a personal 'dumb terminal' to an ubiquitous network via infra-red communication. The network is self-contained and suited for use in an office environment or similar. Each 'tab' is a hardware device that has a corresponding agent on the main network, allowing the mobile hardware to use as little power as possible, increasing portability and battery life. Tabs are tracked by a network of infra-red transceivers which also provide the communication medium between the tabs and the main network.

The fact that the tabs are low power devices and the agents on the central network do all the main processing carries many benefits. For example, it is inefficient and difficult to store an entire dictionary and thesaurus on a device the size of a tab. But as the tabs can query the main network this functionality is possible. Other applications include a beeper, centralised calendar and weather reports. Additionally, the system allows for terminal migration functionality which allows the user's 'default' workstation desktop to 'follow' them and be shown on the nearest workstation display.

2.1.1.6 MyCampus

Gandon and Sadeh [2004] describes myCampus, an ubiquitous system currently deployed around the campus of Carnegie Mellon University in Pittsburgh. The system itself requires no additional environmental changes beyond the wi-fi network already in place. However, the user is required to carry a wi-fi enabled PDA, known as a Semantic E-Wallet, in order to use it.

The global system is primarily a data mining application but each individual PDA is an agent which learns from its user and stores information about him or her. It determines the user's regular behaviour, social interactions and preferences, both static (user's name, address, etc) and dynamic. The key element of the Semantic E-Wallet is that it is personal, unlike the PARC examples. The user's device is active, no central network is relied upon and although the device may share information with other devices, privacy and security are taken seriously.

Information sharing is handled in one of three ways. If a nearby device requests information that is public, the information is shared with no inconvenience to either user. If the information is private, it may be restricted in one of two ways: through access control rules or through obfuscation control. If a piece of information is on the access control list, it is refused explicitly. The other device will not be able to access anything. However, other information may be obfuscated. For example, if a user is out of the office for a dentist appointment the device may respond differently depending on context when his/her location is queried; if a family member requests the user's location it would tell the whole truth yet, if a client requested the same information, it would simply be told the user is temporarily out of the office. Information may also be falsified, so if a service requested the user's e-mail address for no good reason the agent will return a false address.

2.1.1.7 SenseCam

A SenseCam is a piece of wearable hardware [Gemmell et al., 2004]. It comprises of a small digital camera designed to be hung around the user's neck like a necklace and the device takes pictures at various points throughout the day. The device features sensors such as a tilt sensor, a thermometer and a light sensor in order to make decisions on when to take photos. For example, it is pointless to take a photograph when the user is in total darkness.

Advanced research into the SenseCam suggests that Bluetooth and GPS can be combined [Byrne et al., 2007] to annotate the images produced by the SenseCam. It is possible to categorise images by location very simply if they are geo-tagged, so it is possible once the images are stored to retrieve all images captured at the zoo, for example. Bluetooth allows the device to categorise images based on the people around it; in the modern world many people choose to walk around with their phones or portable devices set to 'discoverable' and it is possible to sense these devices passively and identify them uniquely.

2.1.2 Public Information Displays

A large amount of work in the field of Ubiquitous Computing is based around public information displays. Signboards are commonplace in most large cities but they usually just display a pre-defined sequence of information such as advertisements. Sign boards at train stations and bus stops are more intelligent as they display the time until the next train or bus arrives but this is still quite simple when current systems such as those described in Section 2.1.1 allow public information displays to change based on those present. If, for example, a sign board was aware that the person looking at it was interested in a certain style of music, it could display an advert for the latest CD that fits into that particular genre. There are two main types of display, passive and active. Active displays require human interaction, much like a public version of a personal computer, and passive displays do not.

Having roots grounded deeply in the field of Human-Computer Interaction, much existing research revolves not just around the development of such systems but also the way people interact with them [Brignull and Rogers, 2003, Brignull et al., 2004].

2.1.2.1 BluScreen

BluScreen is an intelligent, agent-based system for controlling advertisements on public displays [Payne et al., 2006]. Rather than require users to carry around devices that identify them to the system, as is the case with Signage, it relies on Bluetooth signatures, such as the ones emitted by mobile telephones in 'discoverable' mode. This has the advantage that a large number of people in the developed world already own Bluetooth-enabled mobile devices and, therefore, does not require any prior user registration. Interestingly, unlike all other ubiquitous systems investigated so far in this document, it does not require any prior knowledge of the user, nor does it require the user to register any particular piece of hardware. In fact, as many people carry phones with the Bluetooth switched on by default, the user may not even realise he/she is a 'user' of the system unless it is used, making BluScreen a truly ubiquitous system. BluScreen's job is to show as many different adverts to as many people as possible, without the need to know their personal preferences. It does this by attempting to reduce the number of repeat viewings. Every advertisement 'cycle', each advertisement 'bids' for screen time, based on the people present. If an advert realises that most of the people present have already seen it, then it will not bid as high as it would if it had not been seen by anyone.

2.1.2.2 Dynamo

Dynamo [Izadi et al., 2003] is a communal workspace comprising of one or more large public displays, which are accessible to all. The surface is similar to the desktop of a graphical operating system shell but is shared, allowing users to place media such as images and documents into a shared public space for others to use. Additionally, the system allows users to 'carve' areas of the shared space for their own use and that of the people with whom they are collaborating. Access to these carved areas is controlled by the user who originally carved the area and is a simple case of dragging and dropping a key icon on to the avatar of the user to whom they wish to give access. These carved areas may be temporary or archived and re-opened later. Users may plug in external devices such as laptops or PDAs via a USB connection, allowing them to move media between the device and the public display. They may also seal media in 'packages' which can be public, or only openable under certain circumstances, for example by only one particular user.

A subsequent user study [Brignull et al., 2004] which took place in a high school common room shows that Dynamo is a simple and intuitive system, despite the natural human tendency to be wary of new methods and technology.

2.1.2.3 The Personal Digital Historian

Personal Digital Historian (PDH) is a two-tier ubiquitous system for sharing experiences through photographs. The display on which the system runs is described in Vernier et al. [2002] and consists of a horizontally-mounted, circular visual display. The display uses polar co-ordinates, rather than the traditional cartesian method used by conventional visual displays, and allows several users to sit around the display and all have an equal view of the graphical output. The software system handling the content is described in Shen et al. [2002] and encourages 'story sharing' as opposed to 'story telling'; the feeling that the experience is communicated effectively between all participants, rather than one telling and the other merely listening and attempting to picture the event. The system is effectively an advanced media annotation and querying system but allows users to form queries graphically by having four context modes, 'Who', 'Where', 'What' and 'When', allowing for the sorting by participant, location, subject and time respectively, as well as combinations of two or more criteria. The result is a convenient tool for visually describing past experiences to others.

2.1.3 The Dark Side of UbiComp

Like many technologies, UbiComp may be used for unwanted purposes. All the time a user has his/her mobile phone switched on, he/she is broadcasting information about the location of the phone to the phone company. This information may be accessed by the police and other government bodies as shown in at least one high-profile case[1]. As wireless devices are becoming commonplace, so too is the potential for abuse.

LOCA [Humphries et al., 2007] is an art-based interdisciplinary project[2] investigating pervasive surveillance. Although the public documentation of the project does not go into technical details, it does describe the system as a network of nodes deployed throughout a city, mainly made from commercially available communications hardware. The nodes are disguised enough to make them blend in to their environment so that all but the most observant citizen would not notice their presence. The nodes log the presence of Bluetooth devices and communicate with each other in order to track the movement

[1] http://news.bbc.co.uk/1/hi/england/2178155.stm
[2] http://www.loca-lab.org/

of individual devices. Once the system has enough information about a device's movements it sends a message to the device, making its presence and intentions known. The project is mainly a social experiment and aims to discover how people would feel if, while going about their everyday lives, they suddenly became aware that they had been 'watched' for the past hour with no knowledge of the surveillance going on.

Despite the obvious portrayal of Bluetooth as an ominous technology capable of pervasive surveillance, the project also seeks to highlight Bluetooth's positive uses. The user has the choice to turn the Bluetooth on their phone off but in doing so they lose the many benefits of the technology.

In addition to Bluetooth, there are also problems with several other technologies in common use. Specifically the Nike iPod Sport Kit, a device for allowing an iPod media player to measure how much exercise a user is getting, and the Microsoft Zune, a media player with wireless networking capability. Saponas et al. [2007] shows how the Nike iPod attachment may be used to track a specific person without his/her knowledge, as well as outlining various security flaws in the Zune, showing how it may be used for unsolicited advertising or worse, personal abuse.

2.1.4 The Mobile Web - Ubiquitous Computing for All

The line between the physical world and the digital world is blurring more every year. Gone are the stereotypical images of computers being huge machines that fill entire rooms. Nowadays personal computers are affordable and compact and various other portable computational devices, such as PDAs and cellular telephones, are commonplace, at least in developed countries such as the United Kingdom. Laptop PCs are just as powerful as their desktop counterparts and wireless networking and Bluetooth allow peripheral access and data transfer without the need for a physical cable, as well as allowing nearby 'nodes' to sense presence. We walk around large cities and see bus stops with up-to-the-minute information on which services are running late and interactive tourist information kiosks. Most modern mobile telephone handsets are less phone and more personal organiser and entertainment device, with clock and calendar functionality, contacts lists, even integrated digital cameras and electronic games.

Yet all this technology is useful for one main purpose: the flow of knowledge. If this rapidly developing ubiquitous network can be combined with a global knowledge store such as the Semantic Web, humans may access an enormous wealth of knowledge from almost anywhere. As we continue into the information age, it is now possible to gain internet access from a mobile phone handset or PDA anywhere where it is possible to get a signal. Most modern laptops are wi-fi capable and the current generation of hand-held video game consoles all have wireless networking capabilities for multi-player games. Information is truly everywhere and technology is still progressing. But without some way of organising all this information, the risk of information overload is greatly magnified.

2.2 The Semantic Web

The World Wide Web was first developed in the late 80s and early 90s by Tim Berners-Lee and others at the Centre Europen de Recherche Nuclaire (CERN) in Switzerland [Berners-Lee, 1996]. The technology was finally announced in 1991. However, it was not until 1993 that Mosaic, the first graphical web browser, was released by a team from the National Center for Supercomputing Applications (NCSA), headed by Marc Andreeson. This was the event that kick-started the modern Web [Berners-Lee, 1996, 2000]. The Web continues to evolve but ultimately it is a collection of increasingly varied media that have little or no meaning to a computer.

Berners-Lee's vision of a web of knowledge [2001] rather than a web of documents has been dubbed The Semantic Web. Rather than have documents that may be searched for certain key words, the idea is to have collections of statements that the computer actually understands. It would then be possible to query the data much more effectively and even make the lives of humans much easier, as the computer would be doing most of the hard work.

2.2.1 Machine Readability

This is the key element that separates the Web from the Semantic Web. The Web is based on the HyperText Mark-up Language (HTML). This is a language derived from Standard Generalised Mark-up Language (SGML) and is focused primarily on presenting information to a human. The Semantic Web is aimed mainly at machine readability rather than that which is aesthetically pleasing for humans. It runs primarily on a framework known as the Resource Description Framework (RDF) [Manola and Miller, 2004] which is a system based on statements of triples. Each factual statement that makes up the Semantic Web comprises of a subject, a predicate and an object. For example, in the statement "The organisation has the title 'W3C'", 'the organisation' is the subject, 'has the title' is the predicate and "W3C" is the object. Using this simple syntax, it is possible to describe virtually anything in a form computers can be programmed to understand. An article by Berners-Lee that was published in Scientific American in May 2001 describes the Semantic Web as "an extension of the current [Web] in which information is given well-defined meaning, better enabling computers and people to work in co-operation."

But in order to actually communicate RDF, another key technology of the Semantic Web, the eXtensible Mark-up Language (XML, also derived from SGML) [Bray et al., 2004], is used. XML is a popular way of representing RDF on the Web due to its ability to represent any RDF data structure, its open specification and the ease of which it may be parsed.

2.2.2 Logic

The classic example of logic is "Socrates is a man, all men are mortal. So Socrates is mortal". In this simple statement, we know through inference that Socrates is mortal from two related facts. As the Semantic Web is a collection of factual statements, it is possible to infer information that is not explicitly stated in this way.

- Alice knows Bob
- Bob works at MIT

In the above situation, the question "Does Alice know anyone who works at MIT?" can return 'yes', even though there may be no statement anywhere that specifically states that this fact is true.

2.2.3 Trust

An important factor of producing a network of knowledge is trust. Considering the existing World Wide Web as an example, there are many pages that provide reliable factual information and many that do not. One cannot simply assume that because a statement is published that it is true. Religious or political sites may for example present opinions as fact. Satirical or humorous sites may present information that is clearly untrue to a reader with a sense of humour but would be interpreted as fact by any machine reading the article. There is also the unavoidable fact that all information written by humans is subject to mistakes, as all humans make them at some point in their lives. Therefore, an extra layer is required in order to document the source of the information being presented. There are five main trust strategies outlined for the Semantic Web.

- Optimism - the assumption that a source is trustworthy unless proven otherwise.
- Pessimism - the assumption that a source is not trustworthy unless proven otherwise.
- Centralisation - trust information is managed in centralised institutions.
- Investigation - the agent investigates the trustworthiness of each source.
- Transitivity - analysing trust networks.

O'Hara et al. [2004] suggests that the method selected should remain the choice of the agent in question. For example, a safety critical system would adopt a pessimistic approach. It would simply refuse to cooperate with an agent if the chance of failure was greater than zero, even when failure to comply would incur costs elsewhere. A less pessimistic system on the other hand might comply with another agent if the chance of failure was low in order to save costs. Information gathering would most likely use a combination of investigation and transitivity; it is normally possible to gain some insight into the trustworthiness of a source if other trusted sources trust it. If the only other agents that trust a source are untrustworthy themselves, it is probably not a good idea to trust the source.

2.2.4 Proof

Believability can be gained by trust or proof. Realistically there is no way of proving to a computer that a fact is true, although to a certain extent it is possible to prove who said what. It is simple in the current Web for a random stranger to create a web page and claim it is written by somebody else. Although it is reasonably simple for anyone with a little knowledge and the correct resources to determine the context by which it was uploaded, it is not so simple for a normal user to determine this. The Semantic Web blueprint includes methods for digitally signing information using public key cryptography, which is similar to methods employed by many online shopping sites as well as privacy applications such as PGP[3]. When producing a document for the Semantic Web, an author will have the opportunity to digitally sign his or her creation, ensuring that it is their own work and has not been modified by a third party.

2.2.5 Linked Data

Another, more recent property of the Semantic Web Vision is that of linked data [Shadbolt et al., 2006]. As the Web has evolved, so too have certain practices and it is common for sites to allow users to 'tag' content. This involves adding one or more keywords to content and is effectively a form of distributed annotation. Some users tag on a personal level but the more common tags are usually more general. For example, looking at Last.FM, a social website for people who listen to music, it is noticeable that the most popular tags[4] relate to genres of music, such as 'alternative rock' and 'jazz', which are useful and meaningful to all users. This approach has been suggested for the Semantic Web; people may organise their data in a way that suits them and, over time, a form of natural democracy will determine the 'standard'.

[3]Pretty Good Privacy - http://www.pgp.com/
[4]http://www.last.fm/tags/

2.2.6 Existing Technology

With the underlying Semantic Web technologies already in place, greater things can be built on top of them. Now the language has been defined, it is time to begin using it. Although the Semantic Web is still in a state of infancy, there are already a small number of systems using the technology in everyday use on the internet.

2.2.6.1 RSS

RSS [Beged-Dov et al., 2001, Winer, 2003] in simple terms is a machine-readable version of a web site. It is most useful for article-based sites such as blogs or news sites. The format is most commonly read using a program called a News Aggregator, which sometimes takes the form of a browser extension. Of course, being in machine readable format, the information can be read by a script and incorporated into other sites, or used in ways only limited by the imagination. RSS has a varied history. RSS itself unofficially stands for 'Really Simple Syndication' but it is actually a collection of nine different specifications, all incompatible with each other [Pilgrim, 2004]. RSS 0.90 was the first incarnation in 1999. Its header was RDF but everything else was plain XML. Over time it has evolved into two versions, RSS 2.0 (also known as Rich Site Summary) no longer contains any RDF. However, before this came RSS 1.0 (or RDF Site Summary), still in constant use, which is based entirely on RDF. The event of RSS 'splitting' in this way is now known as the RSS Fork and is a very painful story to recall, involving many petty arguments and a lot of evangelism [Pilgrim, 2002] and essentially results in two similar but different technologies with the same acronym. The main argument for removing RDF from RSS in version 2.0 is that it would make the specification much easier to understand by the average internet user. The argument against this action is that the 'average internet user' does not need to understand the RDF and that removing RDF from the specification would mean that it is 'not RSS any more'.

2.2.6.2 FoaF

FoaF [Dodds, 2004] is an abbreviation for "Friend of a Friend". It was a concept started by Dan Brickley in 1998, when he made a personal home page for himself that contained a description of himself in an RDF syntax. Originally a 'geeky' joke, the idea of using RDF to describe a person and his or her relationships to projects, workplaces and, most importantly, other people, evolved into FoaF. One of the drawbacks of FoaF is that although by definition the RDF document is expandable and the author can reference as many ontologies as he/she likes, more and more suggestions for FoaF are appearing on a daily basis. A good example of how this was a problem happened in the summer of 2003 when it was realised that there was no way of specifying 'gender' in FoaF. A considerable problem when one considers that FoaF is an ideal tool for a dating service.

It seems ironic that, since then, many different additions have been made to the ontology, most of which are interesting but ultimately useless, for example, the addition of the 'geek code', which will presumably only be used by a very small minority of users.

2.2.6.3 Semantic MediaWiki

Wikipedia[5] is a large Web-based encyclopaedia that is editable by its users. Volkel et al. [2006] suggests a 'semantic' Wikipedia that is easily creatable from the existing data with a few modifications to the way users work. Essentially, Wikipedia is organised into categories which make the automatic creation of semantic meta-data that much easier but users are encouraged to create 'typed' links while writing articles, rather than simply creating links in the normal way. As the software on which Wikipedia runs, MediaWiki, is open source, it is possible to develop extensions and custom versions of the software. This has led to the creation of Semantic MediaWiki[6], an extension of MediaWiki with enhanced semantic functionality for increased machine-readability. With embedded semantic data in all its articles, queries such as 'What are the hundred world-largest cities with a female mayor?' are answerable programatically where before the user would have had to search for all articles on large cities and go through them looking for the ones with female mayors.

2.2.6.4 Microformats

A stepping stone to true machine readability comes with Microformats. According to the website microformats.org, microformats are "a set of simple, open data formats built upon existing and widely adopted standards. Instead of throwing away what works today, microformats intend to solve simpler problems first by adapting to current behaviours and usage patterns (e.g. XHTML, blogging)."[7] In reality, microformats are a collection of loosely defined classes that represent meta-data within web pages.

For example, supposing a website maintainer was advertising an event on a corporate web page. The code produced may look like this:

```
<div>
 <h3>Press Conference</h3>
 <p>Event to unveil our new technology to the IT press</p>
 <p>To be held on 1st~April 2007 from 8:30am until 12:00pm</p>
 <p>Location: Seminar Room</p>
</div>
```

[5] http://www.wikipedia.org/
[6] http://semantic-mediawiki.org/
[7] http://microformats.org/about/

This conveys all information a human would need to know about the event. However, using the microformat known as 'hCalendar', an HTML-embedded derivative of the iCalendar format, it is possible to add meaningful meta-data to the mark-up without affecting how it is rendered within a web browser, yet making it possible for a parser script to understand:

```
<div class="vevent">
 <h3 class="summary">Press Conference</h3>
 <p class="description">Event to unveil our new technology to the IT press</p>
 <p>To be held on <abbr class="dtstart" title="2007-04-01T08:30:00+00:00">
    1st~April 2007 from 8:30am</abbr> until <abbr class="dtend"
    title="2007-04-01T12:00:00+00:00">12:00pm</abbr></p>
 <p>Location: <span class="location">Seminar Room</span></p>
</div>
```

There is already an extension for the Firefox web browser known as Operator[8] which interprets these microformats within the browser and allows the user to make use of them. For example, if a page contains information about an event that is marked up like the previous example, Operator can add the event to the user's calendar automatically with just a few clicks of the a mouse. In addition to this, microformat support is planned for upcoming versions of both Firefox and Internet Explorer, both very popular web browsers, and many web pages including Google have begun to incorporate microformat meta-data into their content.

2.2.7 Building the Semantic Web

In order for this new system to actually become reality, the data that makes up the Semantic Web needs to be organised. There is a great deal of information already out there but it is simply not in the format required for machine readability. However, rather than building a new Web from scratch, there is existing research into building it as a derivative of the data that already exists in some form on the Web.

Leonard and Glaser [2001] explains that many large web sites are generated from databases and although sites tend to structure their information differently from each other, within one site much of the information is arranged in a regular layout from which it is possible to extract information automatically. This method is commonly known as 'screen-scraping' and involves building a schema around a web site that allows each of its pages to be effectively reverse-engineered back into its original raw data form.

A more personal approach is presented in Huynh et al. [2005], which introduces a system known as Piggy Bank. This system provides a simple way for a user to write his or her

[8]https://addons.mozilla.org/en-US/firefox/addon/4106

own screen-scrapers and share them with other web users. Once installed, information may be scraped from web sites and imported into a personal RDF knowledge store. From here it may be shared on a communal server.

2.2.8 Related Technologies

As previously mentioned, the Semantic Web can be considered an enhancement of the existing Web. However, there are many technologies related to how we live our lives that could be enhanced in the same way and some that could already be classed as part of the ongoing Semantic Web vision. Web-based technologies such as blogs and wikis may be improved with semantic meta-data, but easily overlooked are other technologies such as personal organisers and e-mail clients.

2.2.8.1 Blogs

'Blog' is shorthand for 'weblog'. 'Blogging' is the act of writing a blog and a 'blogger' is a person who blogs. In short, a blog is merely an online diary but blogging has become an online craze in recent years. Many services, such as Blogger[9] and LiveJournal[10], allow even the novice user to create a free account and write and manage their own online journal. These range from technical journals documenting the ongoing progress of a particular project to humorous observations on life in general. Most blogs allow readers to comment on entries and these comments are publicly viewable alongside the main content.

In the context of semantics, Cayzer and Shabajee [2003] outlines a vision of Semantic Blogging by describing how it should be possible for blog entries to reference each other properly and be easily categorisable. But bloggers have another important purpose in the ongoing history of the Semantic Web, as they are the ones who have, so far, been most welcoming to the idea of semantic standards. Most blogs on the Web have RSS feeds, nearly all of which have 'RSS Auto Discovery' meta tags in the main HTML. Some blogging services even generate FoaF URLs for their users automatically and many community-based blogging services such as LiveJournal actually provide their users with very simple ways of combining the blogs of many other people so they are viewable on a single page with little or no technical knowledge. In addition, modern blogging software allows for blog entries to be categorised using 'tags' or keywords. This actually requires the blogger to enter keywords in order to classify the content but is in common use and is a very basic form of semantic linking.

Rothenberg [2003] actually portrays bloggers as a best hope for the Semantic Web. He notes that it was a blogger named Matt Griffith who originally wondered out loud on his

[9]http://www.blogger.com/
[10]http://www.livejournal.com/

blog one day whether the HTML link tag could be used for RSS auto discovery. Within a month the standard had been implemented and was active on hundreds of thousands of blogs all over the world. So not only do bloggers welcome the idea of semantic meta-data, they have also shown themselves to be keen adopters of new technology.

2.2.8.2 E-mail

m. c. schraefel et al. [2004] suggests that e-mail is already a hypertext system, albeit a rather inefficient one. It is common practice for a reply e-mail to have an almost complete copy of the original within it somehow, be it simply tagged on to the end as Microsoft Outlook does automatically, or cut-and-pasted throughout the reply in context. In addition, every e-mail sent across the internet has a unique identifier, represented in URI format in many modern e-mail clients, and a collection of header strings which may or may not be of some use to the recipient or any one of the servers through which the e-mail must pass in order to reach its destination.

However, there are other uses for 'Semantic E-mail', as McDowell et al. [2004a,b] explains. If semantic meta-data is added to e-mail, a compliant e-mail server could act on the instructions. McDowell describes an agent system that can deal with things that are normally conducted by a human via e-mail, such as planning an outing for multiple people, and suggests ways of using semantic meta-data in e-mail to automate such processes.

2.2.8.3 The Semantic Desktop

The Semantic Web contains a layer of RDF, which works by referring to everything as a resource and tracking the relationships between them. As most desktop systems (including Windows) already attempt to treat data files as objects, it would be sensible to extend the Semantic Web's functionality to the desktop by treating objects as resources. The Gnowsis application [Sauermann, 2003] and Haystack [Quan et al., 2003] already do this, although in Gnowsis all links must be created manually and Haystack is a multi-purpose environment, requiring the user to totally change the way he/she works. An alternative approach is the automated meta-search. Microsoft have a search function built into Windows that creates and stores file meta-data in an index for fast searching when the user needs it. Google has gone one step further and produced a tool called Google Desktop Search[11] which monitors the idle condition of the computer and if the computer remains idle for a specified length of time it begins creating meta-data for everything on the user's hard disk from data files and e-mail to instant messenger chat logs and the user's web cache, so that it may be found quickly later when the user needs to do so yet does not inconvenience the user by running an intensive scan on his or

[11] http://desktop.google.com/

her hard disk while it is in use. Although this is not necessarily machine knowledge in action, it is certainly the automatic creation of meta-data and involves treating many different data types as equals in the context of a search query. With so many vendors developing software to improve search times and better organise digital data, it implies that people's PCs are becoming increasingly disorganised if there is an audience for such technology.

2.3 Ubiquitous Computing, the Semantic Web and Interdependency

As seen in previous sections, the field of Ubiquitous Computing is growing and context-sensitivity is a popular research subject, both in theory and in practice. Equally, the Semantic Web has the potential to revolutionise the way that machines share data in the same way that the Web revolutionised the way we humans communicate information today. However, the two fields have the potential to fit together very well; the knowledge provided by the Semantic Web is useless if it cannot be used and context-aware devices are not much use unless they have the knowledge to act upon their contexts. To use an analogy, context-aware devices are an engine and the Semantic Web is fuel; they become most useful when used together.

Jones [2005] suggests that a context-aware information delivery system should deliver information that is of specific relevance to the user and his/her current situation. This information must exist if it is to be delivered. Yet in order for the correct information to be presented to the user, the underlying system must at some point collect information from the user in order to determine the user's context. This is a novel system because it effectively has the potential to build itself. Gruber [2007] suggests that the Semantic Web and the 'Social Web' should be combined, so that the Semantic Web may be made of user-generated content and the Social Web may exist as a well-organised, collective knowledge system. This suggests a system similar to the web services of today, in which information may be traded invisibly. The difference is that the user gaining benefit from such a system may be in any context rather than sat in front of a PC. A user may enter an appointment in his or her calendar on a PDA or mobile phone one week but instead of storing this information and simply recalling it when required, the device should use this information to make the user's life simpler. Of course if a computer is intelligent enough, it may begin to learn information about its user without prompting. In order to better assist a user, a computer should know as much about the user as possible. The process of logging user context for the purpose of machine learning is discussed in the next chapter.

Chapter 3

Annotation For Life

> *"Memory... is the diary that we all carry about with us."*
> *The Importance of Being Earnest*, Oscar Wilde, 1895

Annotation is a general term given to the process of appending descriptive meta-data to existing information. This can be as simple as adding comments to a program listing, or as intricate as storing geographical co-ordinates in a JPEG image file. Crucially, an annotation adds extra properties to a resource without actually duplicating it or modifying its behaviour. Generally, annotations may be queried much quicker than the resources they describe and it is for this reason that it is common for indexing services and search engines to generate and store annotations of content [Mostafa, 2005][1]. While it is possible to run a search of a PC's hard disk for all files matching specific criteria, if the files are annotated in a particular way, in many cases the search engine can query the annotations to narrow down the search before searching a much smaller subset of the data. This chapter will explain the differences that must be considered when annotating different types of data and how existing systems tackle the problems. It will then investigate the possibility of annotating a person's life and the benefits of such a system.

3.1 Text Annotation and Indexing

Textual annotation is commonplace in today's computing environments. In a world where processor power dominates and storage space is sparse, text annotation would

[1] It is worth noting at this point the difference between annotations and indices. Generally, an index is short and queryable while an annotation is a more detailed description and does not necessarily need to be queried. It is arguable as to whether an annotation is a form of index or whether an index is a form of annotation but for the purposes of this document we will use the word 'annotation' to describe both, as in the field of machine-readable meta-data, it is unhelpful to have annotations that cannot be queried.

probably be of no real use. However, in today's computing world where storage space and data transfer rates are increasing faster than processor speed, it is more efficient to create an index for the data being stored and query this when searching for data, rather than query the data itself.

3.1.1 PageRank

A popular text annotation system in common use is the Google search engine [Brin and Page, 1998] which uses the PageRank system [Page et al., 1998] to automatically annotate web pages. It indexes sites by keyword but also annotates in order to classify pages by similarity to their peers and, most importantly, by referring links. Traditionally, search engines worked by simply analysing copies of pages and searching for keywords when a search was performed. Google categorises pages based on the number of web links to and from the page, as well as more traditional methods of keyword searching. To this end, the Google Search Engine annotates every page in its index with the rank of the page.

This method of web page annotation helps with evaluating the quality of a result, based on a democratic model. The system assumes that the more pages that link to the page in question, the more likely it is the page can be considered valuable. This is particularly useful for helping to reduce the amount of 'search engine spam', or pages which contain many instances of a particular keyword in order to fool the search engines into listing them. Theoretically, other high-ranking pages will not link to pages containing nothing but random keywords and, therefore, these 'spam pages' will receive a low ranking in the search listings. It is not possible to do this quickly on the fly; Google allows users to query its annotation database using a web interface but the core of the search engine is the 'GoogleBot', an agent that 'crawls' the Web automatically annotating the pages it finds. The web interface then searches these annotations very quickly without the need to re-crawl the entire web.

3.1.2 CiteSeer

CiteSeer [Bollacker et al., 1998] is an information agent designed for annotating and searching scientific literature. Using CiteSeer's web interface, it is simple to navigate various academic papers, scientific journals and technical documents by keyword searches and by following citations between documents. As scientific documents almost always cite other relevant documents, CiteSeer is a very useful tool for finding relevant information on a subject.

CiteSeer works by analysing BibTEX entries[2] and articles that are publicly available on

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

the Web and document repositories. The system uses many different text-processing algorithms to perform tasks such as detecting the same document referred to twice in two different ways and documents that are similar to other documents.

Brody [2003] presents a similar system and suggests that such information can be used to obtain 'impact' ratings for each author, rating material by the number of times it has been cited and by whom. This is very similar to PageRank but works in the less volatile context of scientific literature rather than web pages.

3.1.3 Annotea

Annotea [Kahan et al., 2001] is a manual annotation system for the Web. Its purpose is to allow users to create annotations as they work. These annotations, while stored internally in an RDF format, are essentially distributed human-readable comments that have the effect of turning the entire web into a blog. Interestingly, Annotea allows readers not just to create annotations for an entire document but also sections of a document. Annotations are stored on a remote server to which many users may have access and they may be viewed by other users of the same server. An Annotea-compatible browser (such as Amaya[3]) will download annotations for a document and display them alongside the document itself.

3.1.4 SemTag

Of course, although a computer can spot two text strings that look the same, it cannot determine whether or not they have the same meaning. SemTag [Dill et al., 2003] is a system that attempts to categorise documents semantically by automatically disambiguating keywords. It works by judging the context of the keyword from surrounding words and manually entered meta-data. The method learns from experience and becomes more and more accurate the more documents it processes.

It is worth noting at this point that despite the problem with semantics, text is the simplest medium to annotate and query, purely because it is parseable by a computer and also possible to input by a user in a format that matches stored data exactly. A search for "dinosaur" will return all terms that feature the word 'dinosaur', in or out of context. However, a search for "dinosaur" in an un-annotated collection of images will not return anything, because the computer does not know that the collection of pixels a human would interpret as being a picture of a dinosaur can be described by the eight-character string 'dinosaur'. For this reason, annotating or generating meta-data for an image collection without some kind of human interaction is at present far less trivial than the same task applied to text-based media.

[3]http://www.w3.org/Amaya/

3.2 Photo Annotation

Home photography has been popular since the invention of the compact camera. So in the modern world where digital cameras are cheap enough for most people to afford, ordinary non-technical people may keep large photo collections on their computers and there are many popular applications that allow a novice to do this. However, many people do not have the time or patience to annotate them manually, despite seeing the benefits of doing so [Frohlich et al., 2002].

The casual photographer may or may not see the point in annotating photographs. After all, the human memory is very good at remembering things such as the relative time and place a photograph was taken and who or what it depicts. However, there are several good reasons why one would want to annotate photographs. Firstly, memories deteriorate over time. Memory loss can occur even in young people and diseases such as Alzeimer's further hinder memory performance. But let us suppose a wildlife photographer takes a picture of an animal in a rainforest region of Brazil. The photographer can remember the time and place the photo was taken but if the photographer was not an expert, he/she could not tell exactly what species was in the photograph. A nature expert may be able to tell but only if given the exact information about what time of day and at what location the picture was taken. Supposing the photographer was not available, or worse, had passed away when the nature expert decides to classify the subject of the picture. This makes it much harder to make an informed guess.

An individual may also want to annotate a photograph for future reference. The possibility exists that someone may one day come across a photograph that they took but cannot remember, or maybe has never known, a certain detail about it, for example, when it was taken, or who the inconspicuous person at the back of the room is. It should also be noted that details that may have been irrelevant when the photo was taken may become more relevant later on.

All of the reasons for annotation mentioned so far can be satisfied with a simple natural-language description of the image stored in a text file along with the images. However, from a human's point of view, the annotation will provide no additional benefit. The adage "A picture tells a thousand words" rings true. The real benefit of indexing and indeed annotation is so that computers may search for and obtain information on photographs. Therefore, an annotation should ideally be in a machine-readable format, such as XML or RDF.

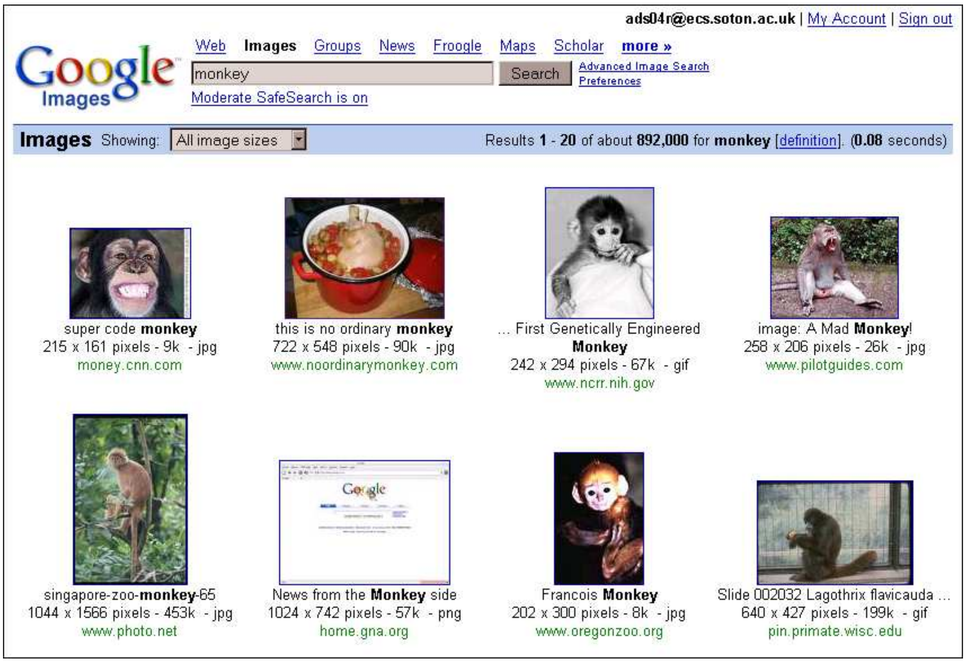

FIGURE 3.1: A Google Images search for the keyword 'monkey'. Note that only six of the first eight results are actually pictures of monkeys.

3.2.1 Google Images

A popular image search facility on the Web is Google Images[4]. Like Google's main search system, this is a software agent with a web interface for querying. The agent has access to the Google web page index and crawls the images linked to by pages in the index. It annotates the images with keywords found in the document that links to them and employs a system similar to PageRank for judging the quality of the results. Despite this, a Google Image search often returns unhelpful and sometimes bizarre results within the first page (see Figure 3.1) and has no idea about the semantics of the keywords, so searching for 'java' may return pictures of both coffee and the island that goes by that name.

3.2.2 PhotoNoter

PhotoNoter [Shneiderman and Kang, 2000] is a personal computer application. It works as a drag-and-drop annotation system that makes annotating photos very simple. It stores information in an Access database and is based mainly around the user interface, which is very intuitive and simple to use. It does a good job of making annotating a personal photograph collection very simple and allows the user to describe the photo in plain text as well as describing where the photo was taken (in plan text, rather than as latitude/longitude co-ordinates) and also who is in the photo. It supports batch

[4]http://images.google.com/

annotation and most annotations, once entered manually once, may be dragged and dropped very simply.

3.2.3 MiAlbum

MiAlbum [Wenyin et al., 2001] is a system that automatically generates keywords for images based on other images it deems similar. Interestingly, it actually analyses the content of the images, rather than rely on the context. If it discovers an un-annotated image it begins suggesting keywords and the user has the opportunity of accepting or declining the suggestions. It makes its guesses based on already annotated images that have been tagged with keywords and employs a pattern matching algorithm in order to guess keywords for other images. As the number of annotated images grows, the guesses become more accurate.

3.3 The Need for Automatic Annotation

Previous work on the annotation of textual data has shown how valuable annotation can be. It would be impossible, for example, for Google to return results to a search query had it not previously visited all the pages in its search index and annotated them with its own machine-readable meta-data. Additionally, despite the field of computer vision providing methods of content-based classification and querying [Hare and Lewis, 2005], it is still difficult for a computer to search a collection of images that are not annotated in some machine-readable form (see Section 3.2).

But it would be completely infeasible for a human being to search every page on the internet and make machine-readable annotations for all of them. Similarly, it would be tedious to go through a large photo collection and manually annotate each image. A study documented in Rodden et al. [2001] shows that people would appreciate some form of categorised storage facility for their photographs but are unwilling to categorise their photographs themselves. Similar results are shown in Frohlich et al. [2002]. Therefore, a large-scale annotation system should ideally be completely automatic. This is trivial in text-based media but not so if we were intending to annotate a photograph collection, a movie, or even events that took place in real life. Although various fanatical computer hobbyists and keen photographers may find it exciting to add meta-data to their photographs for a short period of time, adding meaningful meta-data to large collections of images is extremely time consuming and probably will not remain exciting for long, despite its many long-term benefits. In a world where inexpensive digital cameras can take hundreds of pictures on a single memory card and upload them to a PC in a matter of minutes, users are not likely to want to spend hours describing them all to a computer.

But it must be considered what complete annotation actually is and whether or not it is truly desirable, as opposed to merely a simple index system for making searches quicker. At least for the time being, it must be accepted that there is no way of completely describing anything to a computer. There will always be something that is missed. Therefore, it is necessary to consider the differences, not just between automatic and semi-automatic annotation but also between complete and semi-complete annotation.

3.3.1 Automatic vs Semi-Automatic

Many systems have been created that provide a method for the 'semi-automatic annotation' of images. Some are more 'automatic' than others. Photonoter contains no intelligence at all and relies on the user to annotate its photos by hand but makes it simple enough that it is convenient to the user. MiAlbum makes guesses as to the tags that should be placed on the images by using a weighting system which gradually learns and improves itself as more and more photographs are tagged. This is semi-automatic annotation insofar as it is inaccurate image annotation that becomes automatic image annotation with user intervention.

A truly automatic image annotation system would require the computer to produce annotations for a certain type of information with no user interaction whatsoever. In order to do this, the computer would need to be able to understand natural language in the context of text-based information and would need the ability to recognise items in images in order to annotate photographs. Both of these technologies are currently in development but, despite this, no automatic form of annotation that is 100% accurate currently exists.

3.3.2 Complete vs Semi-Complete

One of the most common complaints about internet search engines is the amount of false positives. Search engines such as Metacrawler[5], which search all the major search engines to return the results from all of them, provide a lot of results but do not refine them in any way. This often leads to a form of information overload. According to a survey by Standard and Poor [2004], Google is popular not just because of its simple, uncluttered interface but because of result accuracy. Many sites on the net are not included in the Google search listings for various reasons, intentional and unintentional, but users of the search engine are content with the small number of accurate results returned. From this we can assume that it is often more desirable to have no annotation at all than annotation that is inaccurate. This is obviously even more important when in a mission-critical situation; it would not be wise, for example, to present evidence based on potentially inaccurate annotations in a court of law.

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

3.3.3 A Happy Medium - Completely Automatic Semi-Complete Annotation

Generally, any annotation method that relies on a human user is potentially flawed. Humans make mistakes, or simply have no interest in annotating their data. Complete, automatic annotation is not always possible. Most annotation systems, particularly photograph annotation systems, have chosen to become semi-automatic. Photonoter requires the user to tell the computer which individuals are depicted by certain photographs, whether the user wants to or not. MiAlbum works when it has been trained properly but in the meantime the user must put up with a lot of false positives. Interestingly, we can observe that the more knowledge the software has, the better its guesses are.

When not using any annotation system at all, we get no automatic annotations. People are used to this, so a system that returns false positives is likely to be seen as more of a hindrance than nothing. However, if a system were to only return good results and false negatives, this would be better than no system at all. For this reason it can be assumed that an automatic but incomplete system is likely to be of more use than a semi-automatic system that returns questionable results unless a user intervenes.

3.4 Distributed Annotation

The Web is becoming less of a collection of documents and more of a collection of people [Berners-Lee et al., 2006]. Many popular sites are very user-driven. Flickr[6] allows its users to upload and share photographs with each other and YouTube[7] allows the same system for digital video. The most obvious examples of the 'social' web are networking sites such as MySpace[8], Bebo[9] and Facebook[10]. Most social networking sites allow the users to upload photos or videos and some allow tagging in various forms. Facebook has a novel distributed annotation system. If a user uploads a photo, he or she can tag it as containing another Facebook user. Equally, other users can tag other people's photos and remove tags for privacy reasons if they so wish. The result is that any user may search for photos containing him/herself and results are returned accordingly, even if the user did not upload the images in question. Allowing other users to tag photos they did not take shares the burden of annotation and allows for additional knowledge the photographer may not have. As an example scenario, Alice may take a photo of Bob at a conference. In the background of the photo are Charlie and Denise having a conversation but Alice does not know either of them. Bob gets an alert from Facebook

[6] http://www.flickr.com/
[7] http://www.youtube.com/
[8] http://www.myspace.com/
[9] http://www.bebo.com/
[10] http://www.facebook.com/

telling him he has been tagged and views the photo in question. Recognising Charlie, he tags him, causing Charlie to get a notification. Charlie views the photo, realises Denise has not been tagged and does the honours himself. So now all three people in the photo are tagged correctly despite the photographer herself not knowing two of them.

Another good example of distributed annotation is FreeDB[11], a music annotation service for tagging MP3 files as they are copied from audio CD. The first user to copy a particular CD tags the tracks correctly and uploads the CD's unique digital fingerprint along with a track listing to the shared database. From then on, whenever another user attempts to copy an identical CD the tracks may be named automatically by querying the database with the CD's digital fingerprint. The fingerprint is generated from the length, number of tracks and a checksum of the track indexes of a disc and is, therefore, almost globally unique but not guaranteed to be so. Of course the downside of this system is abuse, either intentionally or accidentally. It is entirely possible for a user to insert the wrong CD by mistake and send the wrong track list to the central server, or a malicious user might decide to intentionally send false information for selfish or political reasons. This can often be rectified, such as in the case of Wikipedia[12] whereby anyone can make an edit to the dataset, but anyone else may revert the edit if they see fit. Assuming that malicious users are a minority, the 'good' users will always win through sheer determination; one person will get bored quicker than ten people willing to share the workload.

In general, this concept of combining the Social Web and the Semantic Web is based on the observation that users are willing to contribute content. If the same system could be applied to the Semantic Web [Mikroyannidis, 2007], the Semantic Web would effectively build itself. In addition, if the collective intelligence provided by sites such as Wikipedia could be organised in a structured, well-defined way [Gruber, 2007], this could provide the 'killer application' that the Semantic Web needs to gain acceptance by the masses.

3.5 Knowledge-Based Annotations

So far, several methods of annotation and search have been discussed. Yet the principle of annotation can involve the indiscriminate collection of information with the intention of finding a use for it later. To this end there have been several 'knowledge-based' approaches to image annotation that involve the system collecting as much information as possible in order that the information may be used for annotation purposes later.

As discussed in Section 2.2.2, information may be derived from other information using logical inference. For this reason, we need make no guesses. Provided we store all the factual information about an object as we know, we can use knowledge that may only appear later or in a different place to complete the annotation at a later date.

[11] http://www.freedb.org/
[12] http://www.wikipedia.org/

Previous work [Smith et al., 2005] describes a method of personal image annotation. A somewhat ubiquitous system collects information on a particular user and uses this information to annotate his/her photos to a level of relative completeness. Specifically, the system links to the user's calendar and is most effective when used with a GPS device. It works by querying as much information as it possibly can and applying it to the user's photographs using a simple form of logic. This is effectively ubiquitous contextual annotation; a machine-readable description or annotation of the device's context is being constantly logged so that it may be queried later and used for a constructive purpose.

Photocopain [Tuffield et al., 2006] uses its 'Semantic Logger' as a data repository. This is a much more developed system that not only draws information from more sources, but also allows users to publish information and share it with other users for a richer, communal knowledge base. The Semantic Logger uses a common interface which allows information to be uploaded from most platforms and all information may be marked 'private' or 'public' as required.

Both these systems collect information that may or may not be useful in the future, completely ignoring any suggestions of information overload. The information is never disposed of, as it may become useful for the annotation of future images. But this still leaves a large amount of information dormant in the database that may never be used and as a typical human life involves more and more digital devices this information will increase, possibly exponentially. Although this could lead to a much more accurate implementation of knowledge-based image annotation, much of the information collected will remain redundant.

However, this information may be used for other purposes. Text annotation and image annotation have been explored and the annotation of other media has been mentioned. But if a computer system is storing information about a person in order to carry out these annotations, then the information is effectively a collection of annotations in itself; annotations of a person's life, essentially digital memories. As described in Section 2.3, if a context-based application has access to this data, it can assist the user or others in the future as and when it is necessary.

3.6 Life Annotation

Computer technology is becoming more and more integrated into our everyday routines and, as the technology becomes available, we come to rely upon it. The Web is now a rich source of information and the Semantic Web is a maturing technology with great potential for knowledge transfer. Increasingly, we are seeing existing technologies such as phones and internet becoming mobile, to the point whereby it is now possible to surf the Web on portable devices from most locations on the planet. But despite this, knowledge management still requires user intervention. If we wanted to make a note of what we know, we must manually enter it into a notebook or digital equivalent and information must be indexed properly if we hope to find it later, especially if we intend to make the knowledge available to others.

As a person goes about his or her daily routine, information is created about their life. People write documents, take photographs, record memos and videos and so on. All of these are capable of being stored in the digital world. Additionally, people listen to music, surf the Web and watch television. All of these pastimes are becoming more and more reliant on computer technology and are consequently possible to log in a digital storage system. Websites such as Amazon[13] are already logging user data for commercial reasons; all actions taken on the Amazon website are logged and stored indefinitely in order to compare them to other users with the same tastes. The Tivo system[14] keeps track of what the user watches on television and automatically records shows it thinks the user may also want to watch based on his or her viewing habits. There are also many PC music player applications, such as Amarok[15] and iTunes[16] that log the user's listening habits and a service known as Last.fm[17] which compares a user's listening history with that of other users in order to suggest other artists the user has not played. Some of this information may be useful when annotating media such as images and audio but the pieces of information being stored are effectively 'life annotations'; digital descriptions of small parts of the user's life. In time, as we perform more and more of our daily routine via computers, it will theoretically be possible for a computer to know more about us as individuals and naturally the computer should be able to use this information to assist us in ways it currently cannot.

3.6.1 Storing a Digital Life

In 1945, Vannevar Bush proposed a system he called a Memex. He described it as "a device in which an individual stores all his books, records and communications" that "may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory." Many of Bush's ideas have been implemented by Englebart and English [1968], Nelson [1993] and Berners-Lee [2000] among others, although his overall vision remains essentially in the realm of science fiction.

Several other projects exist with similar objectives. The MyLifeBits project [Gemmell et al., 2002] aims to collect every element of a human's life and store it digitally. It links items together and allows for annotations and transclusion. Perhaps most interesting about this work is the research into how much storage space is required to store a lifetime's worth of data. SemanticLIFE [Ahmed et al., 2004] aims to bring substance to

[13] http://www.amazon.com/
[14] http://www.tivo.com/
[15] http://amarok.kde.org/
[16] http://www.apple.com/itunes/
[17] http://www.last.fm/

the Memex vision by extracting meta-data from various communications and attempting to categorise using ontologies. Unlike MyLifeBits, SemanticLIFE shows consideration for a multi-user client-server system and discusses the security implications of storing ones life digitally.

However, the systems described above are for storing the results of human existence. Humans write documents and take photographs and keeping permanent copies of these are useful. All methods of life annotation that are derived from Bush [1945] are more concerned with the information a user creates during his or her lifetime, rather than the life itself. Gemmell et al. [2004] describes a method of recording visual data of a life, Gemmell et al. [2002] and Dix [2002] even go so far as to calculate the amount of disk space required to store complete video and audio recordings of people's lives. But there is much more information involved with the actual creation of the aforementioned media. A photograph may depict a scene but where was the photographer stood when the photograph was taken? Who is standing just out of shot? When a user writes a document and stores it, the completion date is stored in the file attributes. But when did the user begin writing the document? How did the user gather the information required that isn't mentioned in the document itself? How many revisions of the document have there been and what was changed or added on each revision? More importantly, if a user never writes a document or takes a photograph in his/her life, what record do we have of the user's life experiences?

3.6.2 The Unforeseeable Future

Every day, people discard artefacts and information that they deem irrelevant. But what is irrelevant at the time may not be quite so irrelevant in the future. The brain has a limited capacity to remember things, which may or may not be the reason that short-term memory declines with age, and every dwelling has a finite amount of physical space that may be used for storage. However, in the computer world we are not constrained by this problem due to digital storage space which is growing ever-larger in capacity as technology progresses. In the early 1990s, PCs without hard disks were still feasible, as an operating system would fit snugly on a small number of floppy disks. At the time of writing, however, a 200GB hard disk is considered normal and a 20GB hard disk is considered small and generally inadequate for today's storage-intensive applications. As digital storage media becomes cheaper and cheaper there is little reason *not* to store as much information as we possibly can. In the digital world, where we are not constrained by space limitations, it is in our interest to keep as much information as possible in case it becomes useful in the future.

Consider a traveller lost in London. The traveller may stop for a rest and eat at a particularly good restaurant before continuing on his or her way. The following month, the traveller may be involved in a conversation about good food and want to tell of the restaurant but not know where it is. The GPS logs will show the point of the break in the journey and allow the restaurant to be recommended. Likewise, if a businessman were to share a lift to a meeting and not really pay attention to the route taken and then later discover he must return to the same location alone, he can check his GPS logs for the time and date of the last meeting and work out where he must go. To use a less trivial example, most webmasters keep logs of all hits on their domains and archive their past logs rather than simply delete them. Supposing it is known that a criminal accessed a particular website before committing his or her crime. The police would be able to visit the maintainer of that website and ask to see copies of the logs. The logs will contain the IP address (and, therefore, the ISP) of the criminal. The police can then ask the ISP for the name and address of the individual that was allocated that particular IP address at the time of the access and, therefore, catch their suspect. The website owner and the ISP had no idea when they decided to keep their logs that their decision would one day help put a criminal behind bars.

3.6.3 Information Linking

Many people can remember where they were and what they were doing when President Kennedy was shot but not all of these can remember the actual date. However, we have access to news sites and online encyclopaedia articles that tell us such things. The human mind makes connections but works only at the higher level and does not worry about remembering low-level things like dates. So if a person was asked what they were doing on 22nd November 1963, they would not always know the answer. However, a quick look at a history book will tell them that this was the date of the Kennedy assassination and they have a greater chance of remembering what they were doing on that day.

It is more interesting to consider information that is stored with no knowledge of how it will eventually be used. For example, if an amateur photographer were to keep a GPS with him and on at all times and happened to take a particularly good picture on his travels, he may be asked in years to come where the photograph was taken. If the photograph was digital, it would have the time and date stamp embedded within the EXIF meta-data and so the photographer can match the timestamp up to his GPS logs and determine exactly where he was at the time the photo was taken. This can be taken further, if the photo had a particular stone formation within it that was of some significance yet completely unknown to the photographer, it should be possible to match the GPS co-ordinates of the photograph against a database of all known significant stone formations to determine which is the closest. It can then be assumed that this is the formation in the photo. In this way, a question can be answered by collating various facts that have little or no significance individually.

This method of information linking can be applied to life annotation by comparing it to the logic described in Section 2.2.2; if an intelligent agent representing a single person were to be asked the location of its human master on the day Kennedy was shot, assuming that it knows or can at least find out the date of Kennedy's death, it can respond with the user's location on the appropriate date.

3.6.4 Digital Memories

Memory itself could be interpreted as an annotation of a life. As we live out our daily routines, we do not store the things that happen to us in our heads, we merely store references to past events. These may be recalled at a later date but not actually relived. Our mind somehow creates links automatically and we constantly experience things which remind us of past events. It could, therefore, be argued that memories are the most basic and natural form of life annotation.

It is actually possible to draw many parallels between memory and life annotation. Complete inability to recall an event equates to not enough information being stored in the first place, as opposed to the infuriating situation of being able to vaguely remember something but not the specific details, which is comparable to information being stored and not indexed properly. Indeed, it is often easier to remember an event or piece of information if something else reminds us of it.

Much work into digital memories has been carried out as part of Memories for Life[18], an interdisciplinary network [O'Hara et al., 2006] researching the links between human and artificial memory and the use of technology as a memory aid. The project looks at all forms of digital memory, both personal and collective, and investigates the technologies available for aiding and enhancing both.

3.6.5 Too Much Information?

It is possible to store 3.6 million photographs, 1 million documents, 9,300 hours of audio or 1,600 hours of video in a terabyte [Gemmell et al., 2002]. Terabyte hard disks have already begun appearing and if the current trend continues they may be commonplace or even obsolete in five years time.

The idea of storing as much information as possible is not new; Glaser [2006] suggests the concept of the 'Semantic Squirrel', a small program or shell script that takes a permanent copy of all the user's personal data every day. It works on the assumption that, whether intentionally or unintentionally, we leave electronic 'footprints' wherever we go, so the complete state of the user's computer system is backed up daily so even the 'footprints' that are overwritten, changed or deleted may be recovered at any point in the future. Inefficiency aside, this system is very difficult to organise, although the author suggests

[18]http://www.memoriesforlife.org/

that the information does not need to be organised, indexed or annotated until it is needed.

However, most digital life storage methods assume the user wishes to keep all his or her documents in one place. Realistically, information is everywhere and we do not necessarily wish to store it all, provided we have easy reference to it when it is needed. A good example of this is the bookmark system seen in most web browsers. Provided we can access the data we need, we do not care where it is stored. In this respect, a life annotation system would require much less storage space than either MyLifeBits or the Memex because we do not wish to store any data as such, particularly as requiring the user to upload his/her data to such a system rather than continue using the system he/she has always used is against our desire for annotation to be as automatic as possible. Knowing where to find data is often more valuable than actually having the data in one's personal storage, particularly if the personal storage must be searched in a tedious fashion in order to access the knowledge required. In much the same way search engines such as Google merely link to web pages rather than duplicate them, there need be no universal data centre provided we have an easy way of locating the knowledge that is out there. We would only realistically need to store personal information which cannot be obtained anywhere else, along with annotations that describe our life by linking to other resources. This may one day be possible with an ubiquitous Semantic Web.

3.6.6 The Need to Forget

When modelling human memory, the ability to forget must be considered. It is all well and good to say we wish to keep a life on a disk in order to aid memory that has been involuntarily lost but there are some things people actually do not wish to remember and would prefer were lost in the past. War veterans who have seen horrific things on the battlefield, torture victims and even just public figures who have done things they later regret and would rather nobody ever found out are all cases where memory loss is actually desirable.

This may be approached in many different ways. It is possible to simply say that the events of the past are unerasable and must be preserved but it is possible to heed the wishes of those who wish their pasts to be forgotten. But this would attract a new kind of abuse, for if it were possible to effectively erase elements of the past, crime rates are likely to soar. A more sensible system would allow for memories to be marked as 'forgotten', rather than deleted. That way, the owner of the memory is not likely to stumble across bad memories by accident but they are still there if required.

3.7 Discussion

In this chapter, annotation has been introduced and various ways of applying it to everyday life have been suggested. It has yet to be suggested that there is much potential in the field of life annotation. Humans rely increasingly on technology as it becomes available and there may exist a time in the future when everyone will have one or more software agents living in a rich Semantic Web that do all their information gathering for them and perhaps even intelligent behaviour analysis allowing the agent to present this information even before the human realises the information is required.

The field of Ubiquitous Computing is of great value to the concept of life annotation. Not everyone has the ability to sit at a computer all day, or to manually enter his or her recent actions into a web site. With mobile devices becoming more prominent in society – mobile phones and PDAs are now an almost essential business tool not to mention a desirable social item – any conclusive life annotation system should be able to follow the user around wherever he or she may roam, silently recording as much information about the user's actions as physically possible and acting on these observations in order to assist the user.

But closer to the present, the feasibility of annotating a human life needs to be investigated. The first question that requires an answer is whether or not it is possible for a computer system to annotate a human life to a reasonable level of completeness. In order to answer this, a system for collecting and storing as much information as possible must be developed. With modern computing technology becoming more and more ubiquitous, it is anticipated that even with today's technology enough information can be gathered about the life of a person to accomplish this goal without the need to adapt to the technology.

Another conclusion that should be drawn from this chapter is that deleting information is rarely productive. Information that may seem irrelevant now may not be irrelevant in five years time, or even five minutes time. The future is unknown, it is wise to prepare for every possibility and due to the appearance of inexpensive digital storage devices of increasing capacity there is little need to delete anything, provided of course that it can be found when needed.

Using these techniques, it should be possible to develop an automatic system capable of annotating the life of a human being to the point that a computer can write his or her biography without inconveniencing the user in any way. The resultant annotations should be queryable and questions about the user's life should be able to be answered in a sensible way, through means of logical inference if necessary. These questions should not be answerable using only conventional means, such as an address book or a diary, for example:-

- How many miles does the subject travel (on average) per week?
- What percentage of the subject's time is spent in the pub?
- Which music concerts did the subject attend in the past year?
- How many times in the last year did the subject meet a particular colleague or friend?
- Which people does the subject interact with the most?

The intention is to annotate a life in much the same way as memories do, perhaps even better. Essentially, to outsource human memory to a computer. It has also been established that technology is becoming more mobile and, therefore, more ubiquitous. Mobile phones and PDAs are becoming essential business tools as well as powerful social tools and wireless internet coverage is increasing with every public hotspot created. This indicates that if agents are to become common, they are more likely to run on devices carried in the user's pocket, rather than on cumbersome home PCs. The internet is becoming mobile and as a web of knowledge evolves, it too will become ubiquitous. An always-available knowledge store has great potential for the future and the possibility of fusing different data sources together, whether they are generally available on the move or not, should be investigated.

Chapter 4

Personal Information Collection

"Care and Vigilance, with a very common Understanding, may preserve a Man's Goods from Thieves but Honesty has no fence against superior Cunning."
Gulliver's Travels, Jonathan Swift, 1726

In order to evaluate the correlation between a computer system's usefulness as a digital assistant and the amount of information to which it has access, it was determined that a study should be carried out in order to collect as much useful information about a human as possible. The information collected should then be analysed in order to determine exactly how useful it is, or will be in the future given various assumptions are true. This chapter will discuss the theory behind such a system, suggest the data it could collect and conclude with a hypothesis which will form the basis of this work.

4.1 The Benefits of Such a System

There are two major benefits to storing information about humans and their lives digitally. This section will outline both of these benefits through very speculative examples and discuss their potential for future use, given proper development.

The first benefit is the ability to 'outsource' memory. Humans have been outsourcing their own functions since we learned to write. As time went on, humans developed technology to do their work for them. However, although it is possible to record instances in a human's life using photographs and audio or video recordings, much information is not stored. A photograph may depict a person but without knowledge of the identity of the person depicted, it is merely a photograph. It only becomes special if linked with a memory. Media annotation is an ideal memory aid but this must be done manually. As shown in Smith et al. [2005], media such as photographs may be annotated automatically based on the context in which they were created. The more contextual information of this kind that we have, the better the annotations can be and the more information can be conveyed through existing media. A patient suffering from Alzeimer's disease, for example, may find a photograph of a family holiday useless if he/she cannot remember who the people in the picture are or where it was taken. However, if the patient views the image on a machine which reads out the meta-data contained in the image and the image is tagged with a description of who it depicts as well as the time and location it was taken, the memory may be maintained for longer. Even if the patient completely forgets the events depicted in the image, the 'memory' of what it depicts is stored in the annotation. Effectively, the memory has been outsourced.

The second benefit is information transmission. If annotations are stored digitally, they may be copied, moved, processed or shared with other systems. This would allow computer systems of the future better access to human personalities and actions, so that they may serve us better. If human memories and knowledge could be stored digitally with the minimum of fuss, it would be much simpler to act on them. If a person or agent needed to know a piece of information in order to complete a task but this information was only known to a few people, currently they would need to ask the person or people who have access to the information, possibly after locating them. If all information was stored digitally in a common format and all digital knowledge bases were inter-connected, such as in the grand scheme of the Semantic Web, nobody would need to be inconvenienced. Berners-Lee et al. [2001] suggests many situations where a future population of agents living in a web of knowledge would be useful but this can only go so far as to locate public information. Supposing a human told his/her agent to book a plane ticket to a certain destination. The agent would interact with various public services to determine times and book the most appropriate itinerary. However, if there were a choice of seating position, or a choice of meal on the flight, the agent would need to guess unless the human's preferences in such situations were made public. Even if the agent had access to such information for its own user, if the request were to book two seats, one for the user and one for a travelling companion, it would not be possible for the agent to make these decisions unless the preference information is stored digitally. In a world of intelligent agents that know all about their human users, it would be possible for the agent doing the booking to consult the other passenger's agent in order to determine their seating or meal preferences. Obviously a system that shares potentially private information about its user without confirmation is wide open to abuse, not to mention a legal and ethical minefield. Therefore, this thesis will concentrate primarily on the value of life annotation for the personal use of one individual.

4.2 Storing Context

As a human goes about his/her life, memories are stored - these are references to past events. By the same token, every time a user does something on a computer, little tell-tale signs are left that they have been there, be it their username a log of successful logins, or a web browser history. As previously discussed in Section 3.6.5, it is very common for a computer system to log the behaviour of its users. Life annotation is already possible when only considering actions in a digital world and this criteria is becoming more and more ubiquitous thanks to the increasing reliability on computer devices to carry out tasks that are traditionally done manually. However, there are still things that will most likely never be moved to the digital world, such as physical presence and actions, for which some kind of context sensor is needed. These are 'logged' in human beings as memories but if we wish to truly outsource our memories or augment them with digital enhancements, a method for storing this information must be devised.

In order to begin deciding what needs to be logged, methods of measuring context should be considered.

4.3 Types of Context

As mentioned in Section 2.1.1, Millard et al. [2005] classifies context into four main areas. This section will discuss each of these types individually.

4.3.1 Location

Possibly one of the most important contexts to consider when providing services to a user is that of location. It is usually completely overlooked outside the field of Ubiquitous Computing because the user is normally sat at a desk in front of a computer screen when using non-ubiquitous computer technology. A mobile system that seeks to assist the user in everyday life would be better suited to the task if it were aware of the user's location.

Location is also one of the easier contexts to sense and measure using commercially available hardware thanks to the popularity of GPS in mobile devices. However, depending on location, other methods may be used. Ladd et al. [2002] suggests a way of location sensing using nearby wireless networks but this is not useful in the middle of a field where there are no wireless networks for miles. ActiveBadges are a useful way of detecting position within a building but of course the building itself must support the technology. GPS is a global method of location sensing but even that is unreliable in certain situations, as will be shown later in Section 6.3.1.2.

4.3.2 Task

A user's life can also be split into a series of tasks, however a computer cannot realistically sense it's user's current task easily. Millard et al. [2005] notes that many tasks are recurring and it may be possible to determine the user's task based on other things, such as the user's location, the time of day, or with whom the user is interacting.

4.3.3 Domain

The domain is the environment in which a user currently resides. In terms of information we could define this as all the public information that currently appears on the Web. But in practice this could mean anything uncontrollable that is likely to have an effect on the user. For example, we can sense other individuals around the current user, or sense things such as temperature or air pressure. Even things such as whether it's currently light or dark are useful for getting a good idea of context and such information is quite easy to sense with devices such as digital thermometers or light sensors.

However, it is the information domain that is the most useful. It may be possible to determine the weather in the user's current context based on local sensor information but if a device has location information it can query a good weather service on the Web or Semantic Web in order to determine this information without needing to sense it.

4.3.4 Device

Finally, the actual interface between human and computer represents a context. It is possible to have a Semantic Web agent representing the user at all times but there needs to be a flow of information from the user to the agent in order for it to be useful. There are many different methods of transmitting data to a user in an ubiquitous system, as discussed in Section 2.1. These range from portable devices carried in the user's pocket to large public screens that display information based on who is nearby. Obviously some information is private and cannot be displayed on a public screen, so the device which is used in order to communicate with the user is a context in itself. Another example of the device as a context is exemplified by the Apple iPod Touch, which contains an orientation sensor allowing it to determine which way up it is being held. This allows applications running on the device to rotate their screen display so that they are always orientated correctly.

4.4 Sensing Context

Context awareness in the field of Ubiquitous Computing was first discussed in Schilit et al. [1994] and further defined in Dey [2001]. In order for a system to be useful based on context, it must obviously first be aware of its context and this is normally achieved through some kind of context sensor.

4.4.1 Measuring Whereabouts

There are actually various ways of locating a person in today's world of ubiquitous devices. Most of these methods involve the co-operation of large organisations. For example, it is possible to identify the whereabouts, past and present, of a person by viewing a city's CCTV cameras until they are found, or by tracing which cell(s) their mobile phone is close to. For the purposes of this study, it must be assumed that such co-operation is not available. Additionally, there are many places on earth where a mobile phone signal is not obtainable.

The Pepys system [Newman et al., 1991], developed at Xerox PARC, is a location tracking system based around the Active Badge system discussed in Section 2.1.1.4. The system views the movements of various badges around the PARC building and compiles a chronological list of activity. This information may be exported as a report and restricted to a certain individual, effectively creating a minimal 'biography' of an individual. The advantages to this system are that it will track not only individual users but also the way all users interact. However, this is only useful in an area that may be monitored by a central system, such as Xerox PARC. If a system was required to remind an individual when he or she last went shopping or to a restaurant, this is not enough. A more widespread location detection system is required.

The most common location system in current use is the Global Positioning System (GPS), which consists of a constellation of satellites orbiting the earth that may be used to triangulate position. They are arranged in such a way that there is no (outdoor) place on earth where it is not possible to triangulate a position. The most common civilian use for this technology is for personal navigation and consequently GPS is found in many inexpensive hand-held PDAs, as well as various stand-alone units. The ability to log position data is less common, especially in PDAs, but GPS receivers output a standard text-based data format (see Section 4.5.2) so custom software is not difficult to write. GPS also has the additional benefit that it returns co-ordinates, rather than a zonal or relational location [Dix et al., 2005], which is the most complete form of location system; co-ordinates can be converted to zonal or relational location data through mathematics, the same is not necessarily true in reverse.

4.4.1.1 Active vs Passive Tracking

It is worth mentioning at this point the difference between active and passive tracking devices. GPS is an active tracking device; the satellites themselves do no tracking, a user's individual device determines its own position based on the signals broadcast by the satellites in orbit. See Section 6.3.1.2 for a more detailed description of how this works. The key property is that the device in the user's possession is doing all the hard work calculating position and, as a consequence, the satellites themselves have no idea where the user is, or even how many trackable users exist. Active Badges, despite the name, are actually passive in the location detection system; they emit a signal which is picked up by an 'umbrella' network of sensors linked to a central system and it is this system which calculates the position of the user. The same is true for mobile phone tracking and CCTV surveillance. Not only does an active tracking device carry obvious privacy benefits, it is much more scalable as each device only needs to track itself and no central system needs to be upgraded every time the number of users being tracked increases.

4.4.2 Measuring Actions

This is less trivial. There is no obvious way for a portable device or computer system to determine what a user is doing. It may be possible to monitor certain elements of their actions, such as using a pedometer to determine whether they are walking, running or standing still, but a computer cannot realistically log a statement such as "On 2007-07-01 at 17:00:00 UTC the user was camping". It may be possible to infer from the location what the user is doing – for example, if the user is in a theatre, he/she is likely to be watching a show – but not always and not in any great detail.

Millard et al. [2005] explains that the actions of many people are regular or repetitive, particularly on working days. Each task carried out regularly may have a variety of common properties, such as time, location or resources in use, so that it may be possible to learn through pattern matching when a particular daily task is taking place.

There is one data source that can potentially give the computer a reasonable idea what the user is doing and that is the user's calendar. Many people keep a calendar, often digitally on computer, and this may be kept portably on a PDA. Assuming the user is going to enter all their appointments into the calendar is quite a large assumption but if the user uses their calendar regularly anyway, it is not requiring any additional effort for them to continue doing so, so that the software may rely on it in order to determine what they are doing at any given time.

4.4.3 Measuring Background Information

Background information is essentially everything around the user. This may be measured or inferred. For example, if the user needs to know the temperature, a system may obtain this information either from a digital thermometer, or if it knows its current location it may obtain this information elsewhere, such as from a weather website.

4.5 Logging Context

The benefits of logging information are that it may be used at some other time in the future, similar to the way a memory works. If this is to be accomplished, then a suitable method of storing contextual data is necessary. Of course, the form of storage we use is itself context-based, it must be accessible when needed. Additionally, it must be considered how much data is to be logged and how it is to be organised.

4.5.1 Storage

With the popularity of mobile computing devices such as PDAs, advanced mobile phones and ultra-mobile PCs, mobile data storage is becoming commonplace. Being able to transport data from one place to another by carrying it with you has been possible for years and dates back to punch-cards but the ability to query and even retrieve this data while it is in transit is a much more recent development. Devices such as the iPod made it possible for users to carry their entire music collections almost anywhere and nowadays when friends show each other photographs of their children, it is more likely to be on the screen of a mobile phone than a printed photo carried inside a wallet. It is, therefore, feasible for a mobile context logging system to store data that is carried with the user all the time.

Alternatively, device interconnectivity is also becoming common. Many portable devices have the ability to connect to the internet, either via a nearby wi-fi network or via a mobile data connection over a cellular network. Because of this, it is possible to store information on a server and access it from anywhere, rather than carry it around. Of course there are advantages and disadvantages to both of these methods of mobile data storage and retrieval.

4.5.1.1 Advantages of Portable Local Storage

Portable storage is always available as long as the device is. Remote storage is only available when network coverage is available, which may be all, some or none of the time. Additionally, if the coverage is available, it may require a payment in order to use

```
$GPGSV,3,2,10,02,40,227,31,13,39,068,36,04,21,192,23,24,15,321,22*77
$GPGSV,3,3,10,29,06,310,17,16,05,019,16*7C
$GPRMC,170321.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*6E
$GPGGA,170322.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*74
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPRMC,170322.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*6D
$GPGGA,170323.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*75
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPRMC,170323.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*6C
$GPGGA,170324.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*72
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPGSV,3,1,10,27,67,107,18,08,52,171,33,25,50,064,42,10,48,298,34*76
$GPGSV,3,2,10,02,40,227,31,13,39,068,36,04,21,192,23,24,15,321,22*77
$GPGSV,3,3,10,29,06,310,17,16,05,019,16*7C
$GPRMC,170324.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*6B
$GPGGA,170325.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*73
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPRMC,170325.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*6A
$GPGGA,170326.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*70
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPRMC,170326.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*69
$GPGGA,170327.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*71
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPGSV,3,1,10,27,67,107,25,08,52,171,33,25,50,064,42,10,48,298,34*78
$GPGSV,3,2,10,02,40,227,31,13,39,068,36,04,21,192,23,24,15,321,22*77
$GPGSV,3,3,10,29,06,310,16,16,05,019,16*7D
$GPRMC,170327.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*68
$GPGGA,170328.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*7E
$GPGSA,A,3,13,25,10,08,02,,,,,,,,7.4,1.4,7.3*3E
$GPRMC,170328.000,A,5055.9129,N,00123.2267,W,0.00,,170308,,,A*67
$GPGGA,170329.000,5055.9129,N,00123.2267,W,1,05,1.4,27.8,M,47.6,M,,0000*7F
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FIGURE 4.1: Sample NMEA data

it, so local storage is a cheaper option. Other than in the event of a device being lost or stolen, there are no security or data protection issues with individual portable storage and no encryption needs to be used as nothing is transmitted over a public network. Portable storage is also beneficial from a maintenance point of view, because there is no large server with internet connection to maintain.

4.5.1.2 Advantages of Remote Storage via Mobile Internet

Despite advances in technology, a portable device is still a portable device. It can only contain a fraction of the amount of storage space possible on a large server. Generally solid-state memory cards such as the ones found in digital cameras are around the 4GB mark at the time of writing, but many single hard disks can store up to 500GB, more if two or more disks are connected together in a RAID. Additionally, if the device is lost or damaged, all its data is usually lost with it, which is not an issue if the data is kept on a remote server. Worse yet, if the device is stolen, information stored on it is potentially in the hands of a wrongdoer. Again this is not a problem if the data is stored remotely, as the server can be instructed to refuse access to the device as soon as it is reported stolen.

4.5.2 Organisation

A key element of this approach, and one which differentiates this work from that of Glaser [2006], is the organisation of data. Rather than simply grab as much information as possible and store it in raw form within a file system in the hope that it may be useful some day, this work assumes that all or some it will be needed at random intervals in the very near future. If it is to be possible to ask the computer where the user was at a specific time, the computer needs to know where to find this information, as previously discussed in Chapter 3.

The output from a typical GPS receiver is a stream of 7-bit text data. This data is in a format conforming to a protocol known as NMEA[1] 0183. This data is made up of a series of sentences separated by new line sequences which, in turn, are made up of words separated by commas. An example NMEA data transmission from a GPS receiver is shown in Figure 4.1. If a system is to store its position, the most complete way of doing so is to simply dump all NMEA data to a text file. However, this has numerous disadvantages. Firstly, the data stream is continuous. Even if the receiver has no way of receiving a signal, it still transmits data. Secondly, most of the information is of no real use. Some sentences carry information such as satellite position and the subject's speed and bearing, which can be worked out by comparing the geographical co-ordinates and timestamps. The most obvious reason not to indiscriminately dump this information to a file is for organisational reasons. Each sentence has a timestamp but scanning the resulting text file looking for this information later is likely to be time-consuming. It is much more efficient to interpret and index the data as it is stored and store it in a way that can be easily queried in the future.

4.6 Summary and Hypothesis

In the previous chapters the two fields of the Semantic Web and Ubiquitous Computing have been discussed. It has been established that a key part of the Semantic Web is annotation and that annotations may refer to any form of media as well as real life events. It has been established that ubiquitous systems exist to store information about a human life with little need for any interaction on behalf of the human, thus providing the user with a useful digital companion. Various examples of context-aware devices that assist one or more users have been presented. It has also been suggested that the more a system knows about its user the more it can assist him/her and that provided the information is collected and organised correctly, there is no such thing as too much information and the only limit to how much can be collected is the storage capacity of the system in question.

[1] NMEA stands for the National Marine Electronics Association

It is, therefore, suggested that it is possible, with existing technology, to annotate a human's life. It should be possible for an ubiquitous system that requires no conscious user effort to keep a log of its user's actions for at least an entire year. This information should be useful enough at least to be able to answer queries posed by a lapse in the user's own memory, such as questions about activities on a certain date, or how many times in the past year a certain event has taken place. It is believed that in this way such a system could be programmed to write a small biography of the user for the time it has been active.

Chapter 5

The Development of a Personal Life Annotation System

> *"I have always wished for my computer to be as easy to use as my telephone; my wish has come true because I can no longer figure out how to use my telephone"*
> Bjarne Stroustrup, 1990

This chapter will introduce the software developed for use during the study and outline its use. It will also briefly describe how the software gathers information and how it is stored, before concluding with a description of the data collection process.

5.1 Contexts and Requirements

In previous chapters, context-awareness has been introduced. It has been established that a study is to be carried out involving the collection of contextual data about an individual. These contexts are to be location and task information.

The system's job will be to collect contextual information from various sources, store them and then use them to determine the answers to various questions about the past, as suggested in Section 3.7. In doing this, the system is effectively simulating normal subconscious human behaviour; the system will, without any conscious effort by the user, read from various contexts and store it in persistent storage. In real life the five senses are the human's contexts; sensory receptors such as the eyes and ears are the context sensors and the memory stores the information collected so that the human can recall sights, sounds and smells at a later date. It should also be noted that this information is not only stored but acted on in real-time and this information often affects future data collection. For example, if a human were to see a blinding flash of light, he or she will instinctively close their eyes, thus interrupting the collection of sight data. It is not the intention at this time to provide this kind of information but it is something that will be discussed in Chapter 7.

5.1.1 Ubiquitous Architecture

As shown in sections 2.1.1 and 2.1.2, there are generally two types of ubiquitous system architecture. There are public devices which gather information on their users and may share this information with other devices if necessary, forming an intelligent environment, and there are more personal systems, in which each user has a hardware or software agent acting on their behalf in a digital world of passive information. When designing any kind of ubiquitous system, the benefits and drawbacks of both must be considered.

5.1.1.1 Active Environment

If a life annotation system were to be deployed as an active environment, this carries the obvious benefit of reduced user interaction. Provided the user can be sensed, the user does not need to do any additional work other than to simply go about his or her life and the environment monitors the user's movements and interactions. Additionally, assuming the system does not crash, it is available all the time and may be closely monitored by technical support; the user does not have to go out of his or her way if the system develops a fault. But there are two main problems with this set-up.

Firstly, the user's life annotations are restricted to the environment in which the sensor network is deployed. Other than tracking presence within a single institution, or a city with the co-operation of the relevant authorities, this is only a small part of the user's life. A global intelligent environment is simply not feasible.

Secondly, the security of the system is a key issue. If an intelligent environment is tracking one or more users and is vulnerable to attack, all information relating to the user may be faked or stolen. It is also more difficult to obtain a user's co-operation if he or she does not have ultimate control over his or her own data. There is also a problem with scalability; if this system were to be expanded to tens or hundreds of users, the environment would need to be upgraded in order to keep up.

5.1.1.2 Active Agent

An active agent carried by the user at all times is a more useful way of ensuring the user's privacy and the security of the data. Also, by having an active device that determines the user's interactions and movements itself using outside information, such as GPS, and it keeps track of its own user with little or no need to communicate with similar devices, there is no scalability issue if more users need to be added to the system later. The downside to this system is that the user becomes responsible for keeping the device operational and ensuring that it is kept charged and free of defect. This is not as 'invisible' as the active environment model but carries many additional advantages. The system may be truly global rather than having to rely on a limited environment and the user's privacy is ensured. It is for these reasons that for the purpose of this project, as well as future work which may require expansion, a portable device is preferable.

5.1.2 Collection Process

As discussed in Section 4.2, it is possible to log a user's whereabouts using a GPS receiver and the user's actions by querying their calendar. Rather than require the user to download information from a GPS receiver onto the PC that they use to maintain their calendar, which would not really be completely automatic, it is worth noting that both these types of data can be measured and logged by a PDA. Therefore, for truly automatic operation, it would be beneficial to develop some custom software that will collate both these sources of information and run on a mobile device that may be carried by the user.

A truly comprehensive study would involve a large number of people and an average but the unfortunate fact remains that there is no such thing as an average life. For example, the head of a multinational company will typically have a much busier life and travel more miles in a year than an undergraduate student with limited income and no access to private transport. We cannot put together a truly representative sample of the human race within the time scale of this project and, therefore, for the purposes of this study, a single individual will be studied.

True to the statements made in Section 3.3, the system should be as automatic as possible. It would be a simple process if the user were required to write a summary of his/her actions on a daily basis but this is hardly useful or innovative as humans have been writing diaries and keeping manual logs for generations. The process of collecting information should not consciously involve the user unless entirely necessary.

The proposed study consists of one test subject using the custom-designed life annotation system for the period of at least one year. This is sufficient time to determine any problems with the system or the method and is a suitable length of time for an in-depth study, bearing in mind that an entire lifetime's worth of data is not feasible in the short time allowed for the study to take place.

During the course of the study, two forms of data will be logged; GPS data for location and calendar information for actions. In order for both of these pieces of information to be logged via the same device without the user having to do anything other than use his PDA as normal, custom software is required. The software needs to log GPS data in the background while making sure to keep track of all appointments that are created, moved or deleted. The study also requires minimal, if any, action to be taken by the user other than to go about his everyday life.

5.2 Intended Outcome

Once the year's worth of GPS and appointment data has been collected, the next task is to analyse it in order to determine its efficiency. The data will be evaluated for completeness and general usefulness. This will require a statistical analysis as well as a philosophical one. Both of the data sources will be analysed in order to determine which is the most complete and which the most useful for pinpointing the actions of the user at any point in the past. The data will be queried with the questions posed in Section 3.7 and the ability to answer these questions with the data currently available will be analysed.

It is anticipated that after the study, whether the GPS data and appointment data individually are not enough to pinpoint the user's locations and actions at any point during the year or not, the combined data will be sufficient for this task. Effectively it will be possible for the test subject to query what he was doing at any point in the past year and possibly instruct the computer to write a short biography for that time period.

This system varies from other, similar systems. It differs from many annotation systems purely for being automatic, if incomplete. It differs from MyLifeBits and SemanticLife in that it stores information about the user, rather than information representing the user such as photographs and documents. It also differs from Photocopain because it concentrates solely on one user rather than using one user's experiences to assist another. The most obvious comparison is with Pepys, the system developed at Xerox PARC in 1991 that keeps track of users and writes reports of their actions. It differs, however, because Pepys is a centralised system that only works in a very short range environment. The system being proposed is one that performs the same task but is not confined to one particular area or institution. It is also completely decentralised; all the information collected is held on a device kept by the user in question. No covert surveillance may take place without the user's knowledge and the user can turn the logging on or off whenever he or she likes.

5.3 Theory and Design

As decided in Section 5.1.1, the software is to run on a portable device. The device needs to have GPS and calendar functionality. There are two popular types of device that could serve the purpose: a Palm device and a Windows-based PocketPC. A mobile phone is out of the question, despite the obvious benefit to the test subject, because most phones do not yet come with GPS and with the exception of some newer smartphones they are generally more difficult to program than PDAs. The differences between a PocketPC and a Palm are trivial in the context of this project but due to the fact that PocketPCs synchronise with the popular desktop organiser software Outlook, as opposed to the proprietary Palm software, and the fact that most popular high-specification PDAs are PocketPCs, it was decided to use a PocketPC for the project.

The development environment chosen was Visual Studio 2005. Early prototypes were developed using Embedded Visual Basic but this was changed due to the lack of features or support for this now obsolete development environment. Visual Studio allows the developer to code in modified dialects of C or Basic and thanks to the .NET Compact Framework it allows very simple access to most areas of the hardware. It is a simple case of reading and parsing the information from a COM port to get the GPS data and the now discontinued PocketOutlook Object Model is still accessible thanks to new legacy support in Compact Framework v2.

5.3.1 Context Sensors

As introduced in Section 4.4, context sensors are devices designed to measure a particular context, usually communicating this information to a computer. There are many different types of sensor for sensing many different types of context. For example, it is possible to sense location with an ActiveBadge or a GPS. But there are also several technologies for which context sensing is a secondary function.

5.3.1.1 Clocks

The most primitive form of context sensor that already exists in most computer systems is a clock. It is common for devices to contain batteries in order to keep time while the device lacks any other form of power. Often these batteries may be charged from the primary power source. Personal computers have contained clocks since their inception and most modern day digital devices, such as cameras, phones, games consoles and hi-fis, contain clocks even if there is no obvious need for the device to do so. Additionally, it is becoming more common for computers to periodically adjust their time from a central source in order to remain synchronised with as many other clocks as possible. This allows information that is timestamped to be cross-referenced much more easily. For example, computer software such as Photo Mapper[1] has the ability to automatically add a geographical location tag (geo-tag) to a JPEG image file by querying the time and date of a digital photograph and comparing this to a GPS log.

[1] http://www.copiks.se/software/photomapper/

5.3.1.2 Multimedia Recordings

Multimedia recordings are in themselves a form of life annotation but cameras and microphones are also context sensors. Even without complex functions such as image and speech recognition, multimedia recordings can be used to deduce simple things about the user's situation. For example, the difference between a silent and a noisy background is obvious even with the minimal of sound processing and this can be the difference between being outside a building in a large city or inside the building in an office where the sound from outside is reduced. Additionally, images and video may be used to determine light levels.

5.3.1.3 Global Positioning Satellites (GPS)

The NAVSTAR Global Positioning System is currently the only constellation in use that has full global coverage. A complete technical guide to the workings of GPS is beyond the scope of this document and more detailed information may be found elsewhere [Brain and Harris], however a simplified description is necessary. GPS works by having at least twenty-six satellites[2] in a geosynchronous orbit of the planet which broadcast a radio signal, allowing receivers to determine their distance from all the satellites in view. Once a distance from at least three satellites has been received, the receiver's position may be triangulated.

This system works if there is no interference between the receiver and the satellite but this is hardly ever the case. Atmospheric interference is unavoidable and in built-up areas the radio signals can be blocked or bounce off nearby obstructions, giving inaccurate readings. The more satellites in view, the more accurate the position generally is but although most modern GPS receivers will return latitude and longitude co-ordinates in degrees to seven significant figures, theoretically allowing position measurement to the metre, in practice this figure is often inaccurate. It is even possible to intentionally jam GPS receivers with a simple radio device that emits random noise on the same frequency as the satellite signals [Phrack, 2002].

5.3.1.4 Bluetooth

Bluetooth is a short-range radio transmission system designed to send small amounts of data across short distances without the need for cables. Common uses include mobile file-sharing and human-computer interfaces such as wireless mice and video game controllers.

Like network cards, every Bluetooth-enabled device in the world has its own unique address. This is very useful in the realm of security. Two devices may 'pair' with each

[2]This number varies as satellites are introduced, replaced and retired but never drops below 26.

other using a shared passkey and this sets up a trusted relationship between the two devices allowing them to communicate and be certain they are both communicating with the correct device. In order to pair two devices, one device must be 'discoverable' and the other device must 'discover' it in order to send a pair request. Many Bluetooth devices are discoverable by default in order to simplify this process. In addition to a Bluetooth address, a device may also be assigned a 'friendly name' so that it may be identified more easily by a human; the pairing process is often manual and a user must select a target device from those around him/her. When in discoverable mode, a device will broadcast its Bluetooth address and its friendly name.

In addition to providing convenient short-range communication, the personal nature of many Bluetooth-enabled devices, such as mobile phones, mean that as a side-effect, a scan for discoverable devices can be used as a way of detecting nearby people [Lavelle et al., 2007a, Humphries et al., 2007]. During a scan, a Bluetooth device will enumerate all nearby devices, obtaining their unique address, their friendly name and their device type, and by querying a discoverable device it is possible to determine which services the device supports, such as data transfer, printing or human interface device services. Therefore, a simple piece of commercial Bluetooth hardware may serve as a context sensor.

In a study carried out in Lavelle et al. [2007b], it was determined that 34.39% of friendly names contained the actual name of their owner and five out of the 2105 devices in the study actually contained the mobile phone number of the device itself. This implies that if a person were to perform a Bluetooth scan in a crowd of known individuals, it would be possible to match over a third of devices to their users. From a completely automatic point of view, obviously a computer would not have this ability but as the address of a device never changes it is possible to determine when a device is seen and to analyse which devices are encountered the most, as shown in Lavelle et al. [2007a].

5.3.1.5 Wireless Networking and Cellular Networks

Similar to the way Bluetooth has the side effect of acting as a context sensor for other people and their devices, Ladd et al. [2002] describes a method of using wireless network access points to determine location. This system requires prior knowledge of where access points are located but as access points generally tend not to move, it is possible to determine a position using the signal strengths of the wireless networks. This can also be done with cellular networks, such as that used by mobile phones, as previously mentioned in Section 2.1.3.

5.3.2 Global Timezones

If using time as a reference point, as mentioned in Section 5.3.1.1, it is important to note that the time is different depending on geographical location. It is all very well logging a device's latitude and longitude alongside a timestamp, provided the timestamp also contains a reference to the timezone as well as whether or not the timezone in question is currently observing daylight saving time. Otherwise, it is entirely possible for a device to cross a timezone and suddenly find itself losing an hour in the logs, or worse, having two sets of conflicting geographical co-ordinates for the same point in time.

Thankfully, most modern hand-held devices store their current timezone alongside their device clock and the timestamps output by NMEA-compliant GPS receivers are all in Coordinated Universal Time (UTC), which is the same all over the world. Therefore, all logs produced by the system should have timestamps derived from the GPS receiver if it is available.

5.3.3 Data Logging

Section 4.5.1 described the different logging methods, both local and remote. As the device being used is portable, it is not always possible to gain access to a remote storage system and, therefore, the data being logged will be kept on the device, at least until it is synchronised with its host PC. But there are various different methods of storing this data.

The quickest and most efficient method of storing data is to keep it in the random access memory of the device, in an indexed data structure such as a hash table. This allows almost instantaneous modification and retrieval of the information, which is ideal for both storing contextual data and acting upon the stored information. When the software terminates, the data is written to a file in persistent storage and this file is read back into the active memory when the software is re-started. However, there is a significant technical disadvantage to this approach. If the program terminates unexpectedly without the opportunity to dump the memory first, all information since the program was last started will be lost in an instant. Due to the 'there when you need it' nature of PDAs combined with the 'in-development' nature of the software, this is clearly not acceptable.

Therefore, there are two realistic alternatives; a database or a text file. Databases may be relational or triple-based. At the time of writing there is currently no triple-based database system available for the PocketPC, meaning that, if this approach were to be taken, it would be necessary to write a database system before development on the actual software can begin. This is pointless when other database structures exist, despite the obvious benefit of collecting data in a format already compatible with the Semantic

Web. PocketPCs running Windows Mobile have a cut-down version of Microsoft Access, a relational database that accepts SQL queries, as part of their core operating system, so this is clearly the best option as it does not require any additional programming in order to use it.

Text files are a simpler alternative. It is simple and fast to append data sequentially and they can potentially take up less space than a relational database due to the low number of overheads required. The disadvantage is their lack of ability to index or query the information contained within. If everything were to be logged in a text file and the system needed to query whether or not it had seen a particular wireless network or Bluetooth device before, it would need to search through a massive text file for the information which could take minutes or even hours. A compromise involves using the device's file system in conjunction with text files. If there is a different text file for every day or every location, the search can be narrowed down quite quickly. For example, if there were a different text file for each Bluetooth device and the system needed to know if it had seen a particular device before, all it need do is search the filesystem for a file with the correct name and it will know immediately that the answer is yes. It can then search the one file to determine when it last saw the device, rather than have to trawl through a massive log file in order to find it.

5.4 Implementation

A system to collect life annotations in the style that we would like does not currently exist. There are various tools for measuring and storing contextual information but a complete and reasonably passive system for collecting and collating the multiple forms of data that would be ideal for the study does not yet exist. For this reason, the Imouto life annotation system was developed. Imouto[3] is a system that runs on a PDA. Currently a version for the Windows Mobile (PocketPC) operating system exists. The purpose of the Imouto software is to log as much information about its user as possible while remaining as burden-free as possible.

5.4.1 Technical Description

As mentioned in Section 5.3, the Imouto application is based on the .NET Compact Framework. This framework was chosen because of its simplicity when designing applications that rely heavily on a graphical user interface and its ability to easily interface

[3]The word 'Imouto' is a Japanese word meaning 'little sister'. While writing this software, it was decided that it did essentially what the Big Brother of George Orwell's 1984 does, albeit much less threateningly. Hence the slightly tongue-in-cheek name 'little sister' was coined and later revised to 'Imouto' purely for aesthetic reasons.

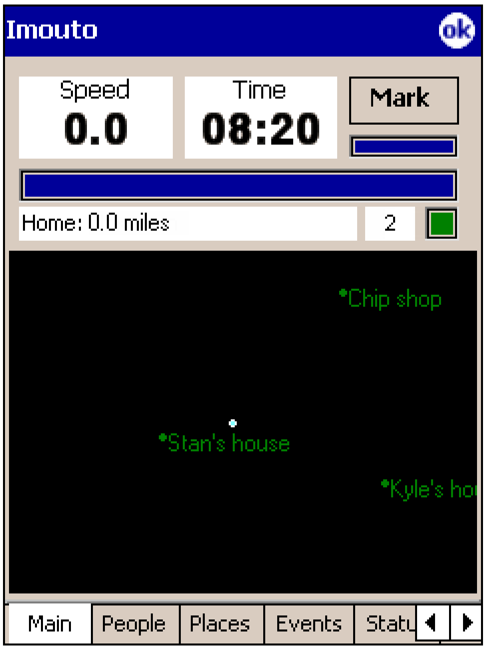

FIGURE 5.1: Imouto's main screen during typical usage.

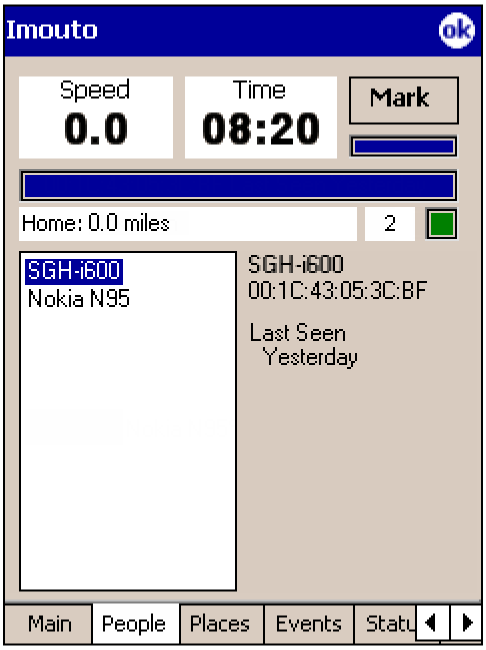

FIGURE 5.2: Imouto's 'People' screen, which shows all discoverable Bluetooth devices encountered.

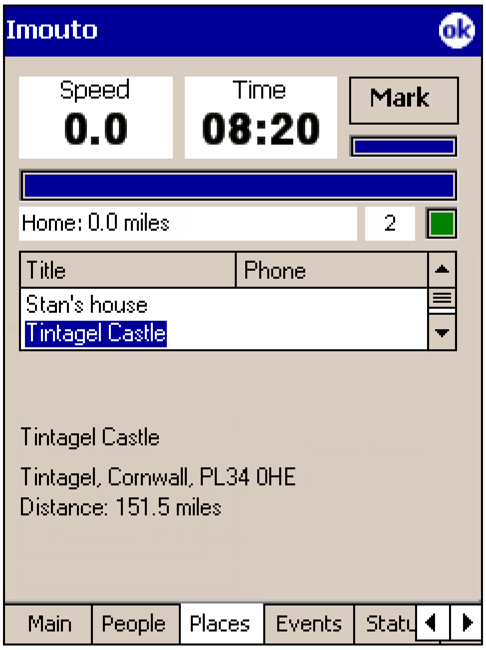

FIGURE 5.3: Imouto's 'Places' screen, which shows a list of places the user has manually entered and the distance to these places in miles, according to the GPS receiver.

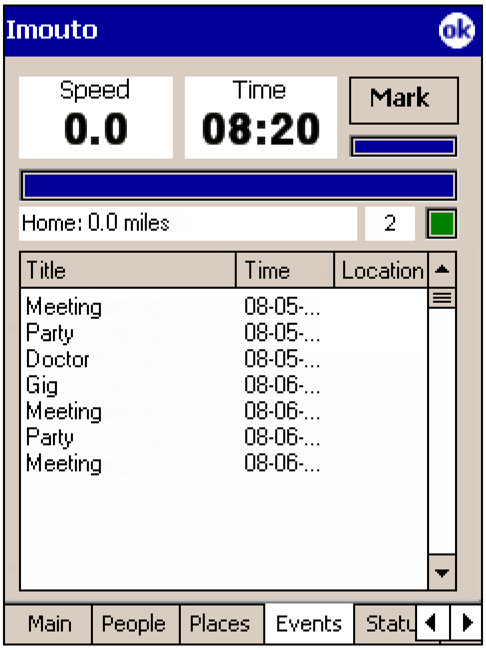

FIGURE 5.4: Imouto's 'Events' screen, which provides a handy 'at-a-glance' reference to the user's appointments.

with other software and hardware on the device, such as the calendar and the GPS receiver. The software's primary function is to log data but is capable of displaying useful information and accepting user input in order to refine what it already knows.

The software uses several existing APIs in order to obtain the data it needs to function. Specifically, it needs GPS data, Bluetooth data and appointment data. As integrated GPS receivers are accessible via the serial ports of a device, it was a simple case of implementing an NMEA parser class and using interrupts to pass all input from the GPS port to this class for further processing. The GPS co-ordinates and time may then be called from this class via the properties it exposes to the main program. Bluetooth is slightly more complicated, however there are many pre-written libraries, both free and commercial, available for accessing this information. The device on which the software is to run has a Widcomm Bluetooth stack rather than a Microsoft one and, therefore, requires a library compatible with this stack. The Bluetooth .NET library provided by Primeworks was used for this purpose as it provides a way of scanning for discoverable devices, the only functionality that is really required by the system. Finally, for accessing the user's Outlook calendar, the Microsoft PocketOutlook Object Model was used. This is a COM component designed for use with Embedded Visual Basic and Embedded Visual C, yet works fine in .NET Compact Framework version 2. It allows the programmer to enumerate the appointments, notes and contacts on a particular device in just a few lines of code.

5.4.2 User Interface and Additional Functionality

Although an ideal system for the study would be one that the user does not even have to think about, it is a fact that some effort on the user's part is necessary, even if it is to simply remember to ensure the PDA is charged and turned on at all times. In order to counter this inconvenience, a small number of additional features were added to the software to give the user some kind of benefit of using the system.

The main screen of the software is designed to be an 'at-a-glance' display and can be seen in Figure 5.1. It displays a speedometer and digital clock as well as a battery level indicator for the device, a 'radar'-style map of nearby locations and a progress meter that displays graphically how far away the user's destination is. The destination is determined automatically by querying the user's Outlook calendar, kept on the device. The 'Mark' button simply sets a flag on the current GPS position, marking it as a 'significant' point. This is convenient if the location needs to be re-located later, either literally or on a map, but serves no other purpose other than for debugging.

The 'People' screen, shown in Figure 5.2, shows the current state of the Bluetooth scan. Currently it does not map people to devices, although the potential for this functionality is covered in Section 7.4.4. It displays the currently visible devices, as well as devices that have been seen recently. Selecting a device shows its unique Bluetooth signature and when it was last seen. Scans are carried out approximately every minute by the software and all new devices found are added to the list as they are discovered. Devices that are no longer in range must be gone for at least two full minutes before they are considered 'not present', as on rare occasions a scan may take longer than a minute and be cut off before it can locate all nearby devices. This screen makes for interesting study after attending an event where a lot of people are present. For example, a visit to an airport check-in desk is likely to show hundreds of signatures.

The 'Places' screen is shown in Figure 5.3 lists all the places that the software knows about. Currently these need to be added manually but as they are all stored in a text file, the task of writing other applications that add to the known locations list is trivial, for example, a script may be written to pull data from the Semantic Web and convert it into the file format required for the Imouto software. The list also shows the current distance from each location, which may be used as a handy reference. It determines these values by calculating the distance (as the crow flies) between the location in question and the user's current location, obtained by querying the GPS.

The 'Events' screen (Figure 5.4) of the software contains a chronological list of all future appointments and their locations. This information is obtained by querying the user's calendar and is intended as a useful guide to the user's upcoming appointments that is simply not provided by the in-built Outlook software.

The program also contains a screen for viewing advanced GPS data and displays the raw output from the receiver itself. This is mostly used for debugging purposes but displaying the exact latitude and longitude co-ordinates is sometimes useful. The final screen is a configuration screen for configuring the port to which the GPS is connected and the local timezone. The timezone information may be obtained by querying the device itself but this allows the setting to be temporarily overridden in case the user wishes to determine the time elsewhere in the world.

5.5 The Data Collection Procedure

Once the system had been implemented it was put into use almost immediately. The test subject installed the software on his PDA with the intention of carrying it around for a year but this ended up becoming much longer for reasons explained in this section.

5.5.1 Evaluation

The actual data collection procedure is painless and relatively automatic. All GPS data is logged with no user interaction at all but there are various constraints with regards to the PDA itself - when in a building and not moving for any length of time it is sensible to turn the device off in order to save battery. Presumably as such devices become more ubiquitous this will change but for the time being it is an inconvenience.

Appointments need to be manually entered into the device's calendar but this is a practice with which the test subject is already familiar and this requirement should not alter the user's lifestyle in any way. Finally, the location data needs to be entered. This is not actually essential for merely keeping track of the user via GPS but if the data is to make any sense, some kind of reference point, such as the location of the user's home, is needed and if the process is to assist the user in any way, it is convenient to show nearby locations and how far the user must travel to reach the location of the next appointment. Location data is also essential during the data analysis phase when the calendar appointments need to be converted to latitude/longitude co-ordinates in order to determine location when no GPS is available. In time the entering of location information may not rely on manual input but this is beyond the scope of this chapter and is covered fully in Chapter 7.

5.5.2 Refinement for Additional Context Logging

After a preliminary analysis of the data recorded after the first year of study, it was noted that not all the questions in Section 3.7 could be answered with just the data available, particularly the questions involving social interaction. It was decided to continue with the collection until other subjects could be found, until it was noted that it was possible to determine the presence of many personal devices such as mobile phones by performing a Bluetooth scan. This functionality was incorporated into the software after it had already been in use for over a year and a half.

5.6 The Final System

The final system is a powerful mobile context logging system which runs without error for hours on end. It is simple to use and despite the simple interface designed to be familiar to a PocketPC user, if the additional features are not required, the user does not need to do anything other than turn it on and leave it on in his pocket. The system logs GPS and Bluetooth data, stores it in text files on the PDA and copies this data to the PC whenever the device is synchronised.

In addition to its primary function of logging contextual data, the system also provides useful information on the device's display. In addition to the features described in Section 5.4.2, it now displays a list of nearby Bluetooth devices together with information on where and when they were last encountered.

5.6.1 Limitations

There are several practical problems with Imouto, most are related to the fact that when programming a mobile device the developer must take more into consideration than when programming a full PC. The Imouto database is a plain text file, rather than a Microsoft PocketAccess database or a Triple Store. The reasons for not using a triple store are described in Section 5.3.3 but it was discovered during the early phases of the data collection that although a relational database can be queried using less processor power, PocketAccess tables are given identifiers as 16-bit integers in order to save storage space, so each table can hold a maximum of 65,536 entries before it cannot take any more. This is not a problem with locations or appointments as the average user is unlikely to visit over sixty five thousand significant locations in a lifetime, however assuming the device receives a steady GPS signal, logging the position once a second, the table will only take eighteen hours to fill to maximum capacity. Therefore, all data is written out to text files as it is collected and anything that needs to be queried often, such as known locations, are read into RAM on start up. However, the same data set may be represented in many different ways, as shown in the next chapter.

5.7 Data Storage and Representation

Although the data is being stored on the device in text files, it is stored in a MySQL relational database when the device is synchronised with its host PC. But the data itself remains unchanged; the data may be exported in any compatible format in order for it to be useful in some other context.

5.7.1 Calendars

The software developed for this project interacts seamlessly with the Outlook calendar system pre-installed on most PDAs. But what if the user were to use some other form of calendar system, or publish his or her calendar in a standard format for use elsewhere?

Once the data is in the database, it is possible to export it and convert it to any relevant format. For example, if the user were to use Google Calendar to publish information on his or her whereabouts, the information may be output and converted to the international standard format RFC 2445, popularly known as iCalendar. Figure 5.5 shows a portion of the collected calendar data output in the iCalendar format and Figure 5.6 shows the data being viewed in Lightning, Mozilla's calendar extension to the Thunderbird e-mail client. In addition to Lightning, the iCalendar format is understood by many desktop and web-based calendar systems and can even be embedded into web pages using a derivative microformat known as hCalendar. See Section 2.2.6.4 for more information about microformats.

```
BEGIN:VCALENDAR
VERSION:2.0
PRODID:-//mhb//calendar//ash
CALSCALE:GREGORIAN
BEGIN:VEVENT
DTSTART:20080126T210000Z
DTEND:20080126T235900Z
SUMMARY:Gig
LOCATION:Swanage
END:VEVENT
BEGIN:VEVENT
DTSTART:20080127T100000Z
DTEND:20080127T140000Z
SUMMARY:Band Practice
LOCATION:Waterlooville
END:VEVENT
BEGIN:VEVENT
DTSTART:20080209T190000Z
DTEND:20080209T235900Z
SUMMARY:Gig
LOCATION:Elmer
END:VEVENT
BEGIN:VEVENT
DTSTART:20080216T140000Z
DTEND:20080216T235900Z
SUMMARY:Party
LOCATION:Fareham
END:VEVENT
BEGIN:VEVENT
DTSTART:20080218T160000Z
DTEND:20080218T170000Z
SUMMARY:Seminar
LOCATION:Building 32, ECS
END:VEVENT
BEGIN:VEVENT
DTSTART:20080222T190000Z
DTEND:20080222T235900Z
SUMMARY:Gig
LOCATION:Woolston
END:VEVENT
BEGIN:VEVENT
DTSTART:20080223T190000Z
DTEND:20080223T235900Z
SUMMARY:Gig
LOCATION:Swanage
END:VEVENT
END:VCALENDAR
```

Figure 5.5: A portion of the test subject's calendar data converted to iCalendar format.

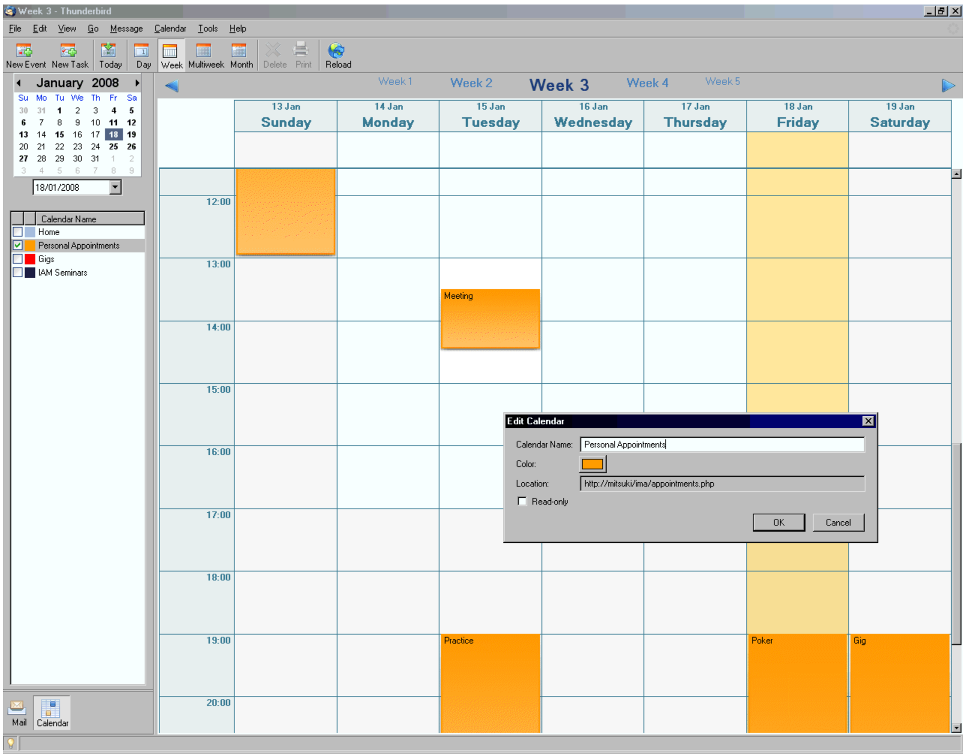

FIGURE 5.6: The test subject's calendar being viewed in Mozilla Lightning. The data is being obtained from the development server in real-time via a PHP script, as seen in the location URL.

5.7.2 Location Mapping

In addition to exporting the calendar data in virtually any format, the potential exists to output the GPS data into a wealth of different formats for different uses. Common formats that may be read by popular mapping software includes raw NMEA data and GPX, an XML representation of GPS data which may include fixed points, routes and timestamped 'waypoints'. Google Earth also has its own similar format, KML[4]. Several websites expose geographical data in this format for purposes that include mapping and sightseeing, including Google Maps[5], Microsoft Virtual Earth[6] and Flickr[7].

Figure 5.7 shows Google Earth displaying a portion of the test subject's location data which has been imported into the software after being exported from the database in GPX format. The GPS data collected has another use as shown in Figure 5.8. This shows the user using the data to automatically annotate his photograph collection using Microsoft Pro Photo Tools. This application allows the user to batch annotate photographs from location data in GPX format not only in latitude and longitude co-

[4]KML stands for 'Keyhole Mark-up Language', Keyhole being the company that developed early versions of Google Earth before being acquired by Google in 2004.
[5]http://maps.google.co.uk/
[6]http://www.microsoft.com/virtualearth/
[7]http://www.flickr.com/

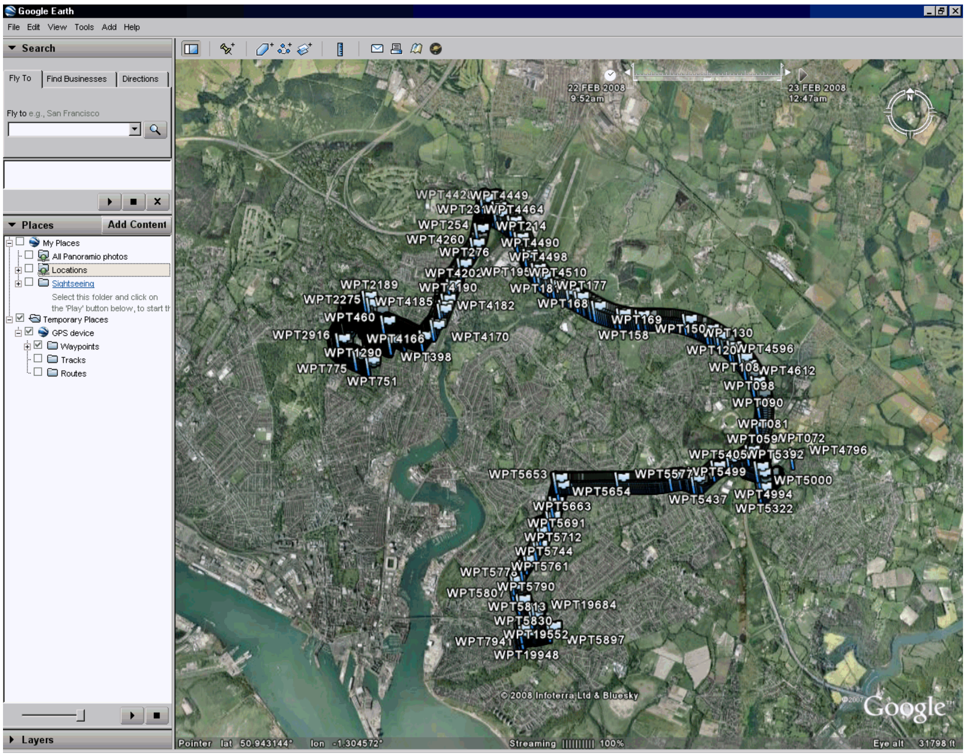

FIGURE 5.7: A screen capture of the software application Google Earth displaying a GPX file generated from the user's location data.

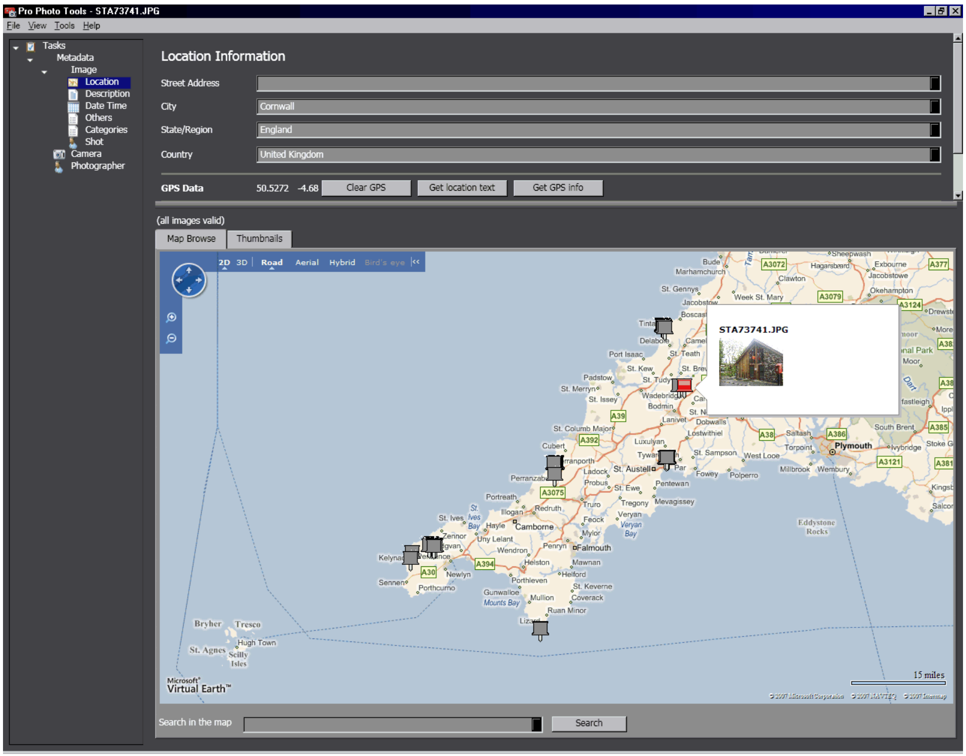

FIGURE 5.8: A screen capture of the software application Microsoft Pro Photo Tools being used to geo-tag photographs using a GPX file generated from the user's location data.

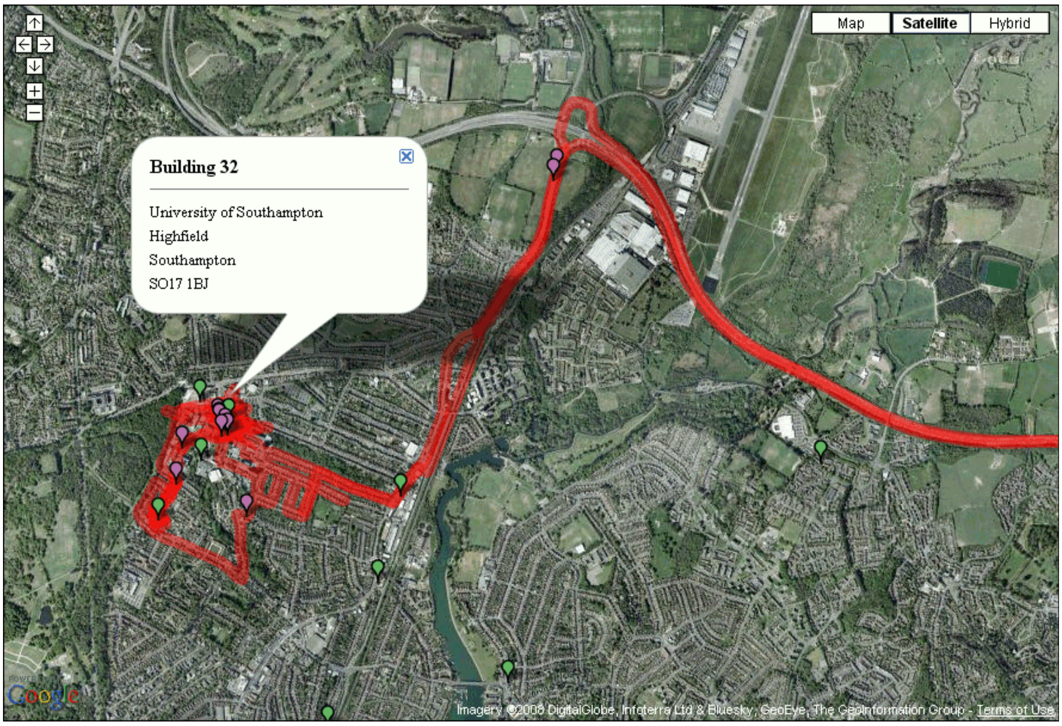

FIGURE 5.9: A 'mash-up' in action. The user's route is shown on a Google map and all relevant locations and Bluetooth device encounters are overlaid.

ordinates but also in human-readable location descriptions by querying a remote location database for the nearest road, landmark, town or city.

5.7.3 Mash-Ups

Of course the user is not limited to using only one form of contextual data. It is entirely possible to combine numerous forms of data either manually or using a script. If, for example, the user wishes to know the location of his last encounter with a certain Bluetooth device, he needs only to query the time of his last encounter in the Bluetooth and match this time up to the corresponding location in the GPS data. Likewise he can determine which contacts were present at a particular appointment in the same way. Producing an output based on information from many different sources is known as a "mash-up".

Figure 5.9 shows a screen dump of a crudely written web script that displays the user's daily route on a Google map, overlaying known locations and encounters with Bluetooth devices. The locations marked are manually entered into the database but could theoretically be screen-scraped from websites such as Wikipedia. Additionally, as the Semantic Web becomes more widespread, the data may be output in an RDF notation in order to merge it with other, similarly formatted information.

Chapter 6

Life Analysis - An Evaluation of the Collected Data

"Everything that we see is a shadow cast by that which we do not see."
Martin Luther King Jr., 1959

This chapter will introduce the data collected over the test period and present an analysis of how useful it may be. After a section describing the scope of the analysis, it will begin proper by evaluating the data quantity and quality, before expanding into theoretical situations in order to suggest how the data may be used. It will then attempt to explain how each of the questions in Section 3.7 may be answered using the data currently available and suggest other types of data which may be used to refine the results. The chapter concludes with a critique of the system used to collect the data and ideas about how it may be improved based on the analysis of the data collected.

6.1 Scope and Purpose of Analysis

The scope of this analysis remains in the realm of memory outsourcing. It may be interesting to discuss methods of data transfer and the sharing of personal information for other purposes but this will all be covered in Chapter 7. Primarily this analysis seeks to evaluate the process of collecting the data and its usefulness rather than the data itself but an analysis of the data itself is included as a prelude to the analysis in-depth.

Additionally, the analysis only looks at the data from the point of view of the person to whom it is relevant. It is possible for the information to be useful to others but, in the single-user system developed as part of this work, it is only relevant to discuss the one user. Obviously, with the addition of interaction data, it is tempting to stray into the realm of analysing the behaviour of others close to the test user but for the sake of both complexity and ethics, this type of analysis will be omitted from this thesis and an analysis of the actual encounters will be presented, rather than an analysis of the people or devices with whom the encounters took place.

6.2 Summary of Results

The data collected is over two year's worth of location, interaction and appointment data on one individual. This information takes the form of GPS, appointment and Bluetooth logs. The information may be used to gain insight into the context that they each represent. The GPS logs feature a list of timestamped latitude/longitude pairs. With this data it is possible to determine the location of the device collecting the logs at any point in the past that it was turned on. So, assuming that the user carried the device all the time, it is possible to determine where the user was at these times as well. The appointment data is actually completely manual, although from the point of view of the test user it still counts as being generated automatically without interfering with lifestyle, as the subject was used to using a PDA as a calendar before the study began. This allows us to determine what the user was doing at any time, provided he is consistent with entering appointments into his calendar. Finally, the interaction data is represented by a log of the Bluetooth devices that came within range of the user's device, again these are datestamped. The globally unique Bluetooth signature of the device as well as its friendly name are logged. This means that it is not possible to determine who owns a device unless some kind of manual intervention is employed, although it is possible to identify specific devices and calculate the probability that the user knows each device's owner, similar to the method described in Lavelle et al. [2007a].

The information is stored as many plain text files which are all lists of tab-separated values. There is one file for appointments, one file per day for GPS and one file per day, per device for Bluetooth. For the purposes of the analysis, this data has been imported into a relational database with a table for each type of information that was collected. The GPS table has columns for date and time, latitude, longitude and the number of satellites used to obtain the fix. The latter column is useful for deciding how much to trust the result later on; a fix obtained with ten satellites is likely to be more accurate than a fix obtained with only three. The table contains one row for each unique GPS fix and the timestamp value is unique to the row. A portion of the data can be seen in Appendix B. The appointment table contains columns for description, location, start time and end time and can be seen in Appendix C. Finally the Bluetooth table contains columns for time of encounter, unique Bluetooth signature of a device and the friendly name of the device, with one row for every unique encounter so that the time or Bluetooth signature may be duplicated but not both together. A portion of this information is included in Appendix D.

Of course the data is merely a collection of numbers with little or no value to a human reader and is far too much information to present in a recognisable format in the pages of this thesis. However, a summary of this data will be presented and discussed before the analysis proper.

6.2.1 A Typical and Atypical Day

Figure 6.3 shows a map of all the locations visited by the test subject throughout the course of the study but this does not distinguish between places the subject visits regularly and infrequently. It also does not show activity or interaction data. Therefore, for the purposes of the initial analysis, the data will be split into day-long segments and the average or most typical values will be analysed in depth. Due to the different time periods that the different data formats cover, a most and least typical day overall is not possible to determine, so it was decided to determine 'typical' based on each individual data type.

6.2.1.1 Location Data

The sample data for the images shown in Figures 6.1 and 6.2 was selected to represent the most and least typical days throughout the test data. In order to determine a 'typical' day, the total distance travelled and the distance the subject is from home were calculated for each day of the test period and a mean average per day taken. The 'typical' day was then determined to be the day that was closest to this average, which happened to be the 26th of January 2007, shown in Figure 6.1. This day was a Friday, so the subject attended work throughout the day and went out to a favourite public house in the evening. The inset images show zoomed in views of the subject's place of work (bottom-left) and the pub (top-right). The day that differed the most from the average was determined to be the best example of an atypical day. This day happened to be the 9th of May 2007, shown in Figure 6.2, when the subject was travelling back to his home in Southampton from a holiday in Cornwall. The inset image shows a zoomed in view of a popular tourist attraction where the subject spent several hours in the morning before returning home.

In the images it is possible to see the subject's position at various times of the day and with a bit of knowledge into the life of the subject it is also possible to determine what he was doing at any particular point. On the typical day shown in Figure 6.1, the numbered markers in the image show hourly markers denoting the subject's position over time. From these it can be determined that the subject left home in the morning just before 8:00am and had left for home by 4:00pm, where he stayed until after 6:00pm, as the '18' marker is right over the subject's home.

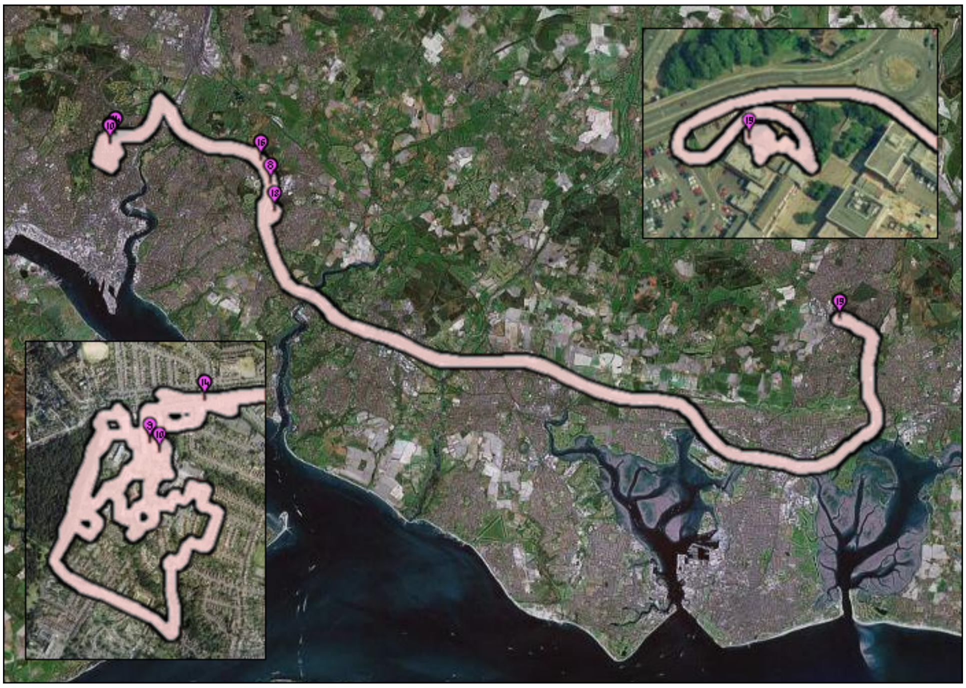

FIGURE 6.1: A satellite map showing the locations covered by the test subject during a typical day. Satellite imagery from Google Earth.

FIGURE 6.2: A satellite map showing the locations covered by the test subject during an atypical day. Satellite imagery from Google Earth.

Figure 6.3: A satellite map showing all areas covered by the subject during the test period. Satellite imagery from Google Earth.

6.2.1.2 Interaction Data

In order to determine a 'typical' day in this sense, the total number of device encounters and the total number of unique devices was calculated for each individual day of the test period and compared to the mean averages presented in Appendix A. The closest match to the average was chosen as the typical day and the day that differs the most was chosen as the atypical day. In this case, the typical day is the 11th September 2007 and the atypical day is the 22nd February 2008.

Figure 6.5 shows the typical day as a timeline. The horizontal axis shows time and each bar indicates the subject's proximity to a particular Bluetooth device. On the day illustrated, the subject went shopping in the morning to a local electronics store, before going home and then going out with a small number of friends in the evening. The main thing to note is the clustering around certain areas of the day. The subject was at the shop between the hours of 1pm and 2pm and there are two devices that appear and disappear at the same time in the timeline, together with lots of other devices appearing for a smaller amount of time around the same period in the day. It can be guessed from this that the two larger bars represent either staff in the shop, or people with whom the subject was shopping. The others are simply chance encounters in the shop. Figure 6.4 shows that the devices are clustered geographically as well, adding support to this theory.

Figure 6.6 shows the atypical day. This was a Friday and the subject attended work during the day and went out to a pub with some friends in the evening. Although there are many more devices than encountered in the typical day, it is clear that the devices are also clustered in a very similar way to the typical day. In fact, they are clustered at similar times, one cluster in the evening and one cluster in the day. This is a common trend in most days in the subject's life and can be seen on a more general scale over the entire dataset in Figure 6.13.

6.2.2 Overview of Complete Data Set

Now that the data's representation of individual days has been discussed, there now follows a more general view of the data over the two-year test period. This will help identify the user's behaviour through the course of the entire period.

See Appendix A for some general statistics relating to the data set.

6.2.2.1 Location Data

For a wider view of the dataset, Figure 6.3 shows a map of the southern half of the United Kingdom and the subject's paths over the course of the test period. Most of the

FIGURE 6.4: A satellite map showing the subject's route and encounters with Bluetooth devices on a typical day. Satellite imagery from Google Earth.

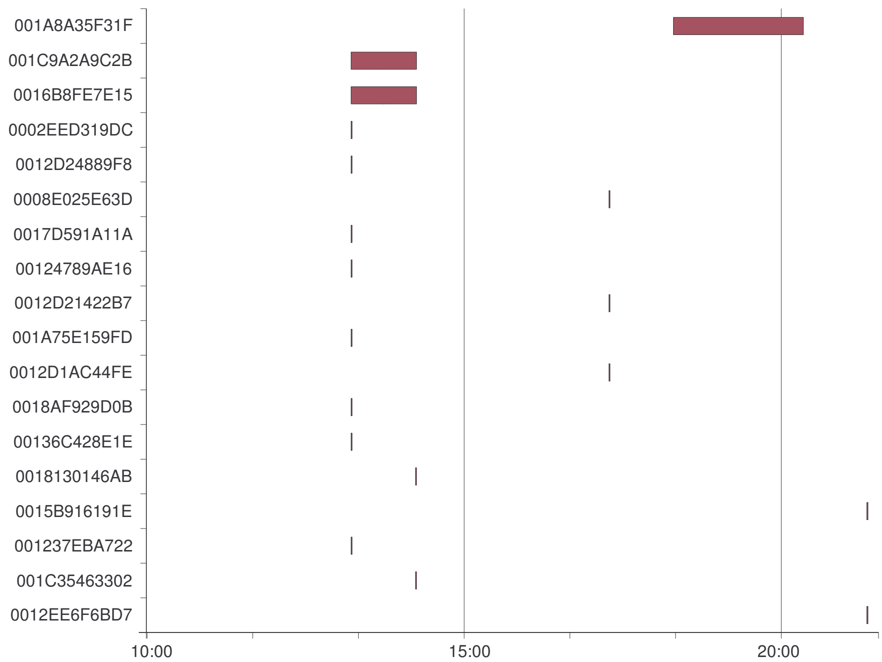

FIGURE 6.5: A time chart showing the subject's proximity to various Bluetooth devices on a typical day.

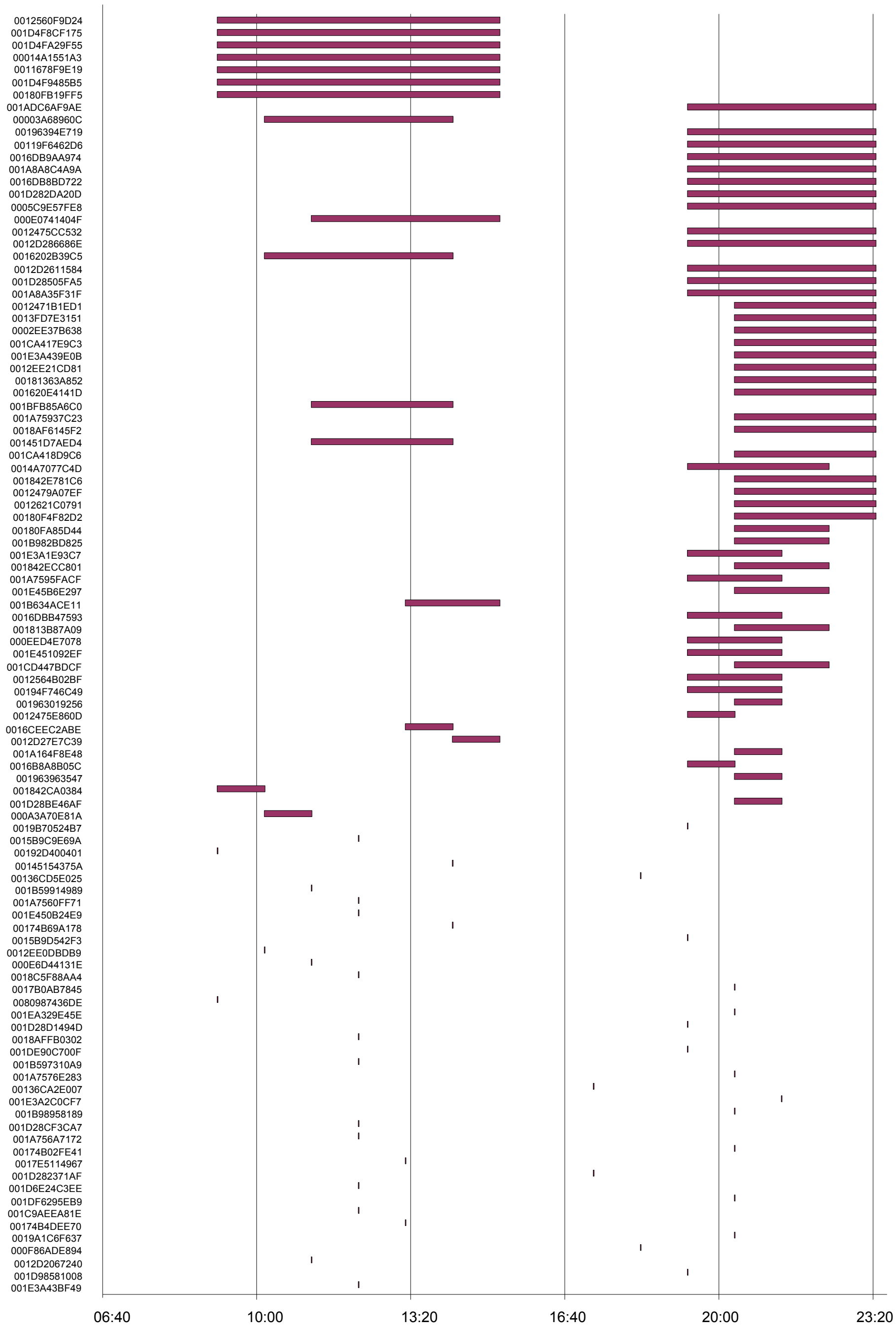

Figure 6.6: A time chart showing the subject's proximity to various Bluetooth devices on an atypical day

Week beginning	Miles travelled	Week beginning	Miles travelled
2007-01-01	183.63	2007-07-02	246.02
2007-01-08	221.23	2007-07-09	242.05
2007-01-15	187.04	2007-07-16	205.43
2007-01-22	239.95	2007-07-23	307.21
2007-01-29	281.81	2007-07-30	243.18
2007-02-05	339.18	2007-08-06	131.86
2007-02-12	300.21	2007-08-13	239.05
2007-02-19	353.01	2007-08-20	234.67
2007-02-26	332.81	2007-08-27	446.44
2007-03-05	460.27	2007-09-03	149.61
2007-03-12	410.52	2007-09-10	145.52
2007-03-19	349.36	2007-09-17	397.15
2007-03-26	296.92	2007-09-24	249.94
2007-04-02	193.45	2007-10-01	334.91
2007-04-09	307.22	2007-10-08	491.17
2007-04-16	110.26	2007-10-15	433.07
2007-04-23	287.39	2007-10-22	196.17
2007-04-30	440.83	2007-10-29	365.40
2007-05-07	650.61	2007-11-05	192.11
2007-05-14	187.94	2007-11-12	428.94
2007-05-21	221.91	2007-11-19	130.22
2007-05-28	401.25	2007-11-26	160.00
2007-06-04	203.72	2007-12-03	248.50
2007-06-11	281.99	2007-12-10	414.33
2007-06-18	148.08	2007-12-17	413.95
2007-06-25	378.49	2007-12-24	275.70

TABLE 6.1: Miles travelled per week by test subject in 2007

Type of appointment		Total length	Average length
Medical appointments	2	1:00	0:30
Holidays	5	237:58	47:36
Jobs / Favours	79	296:45	3:45
Socialising	10	91:15	9:08
Meetings	19	16:20	0:52
Live Music	131	648:31	4:57
Misc trips	11	46:59	4:16
Parties	34	164:55	4:51
Weddings	1	9:30	9:30
Work-related	10	24:30	2:27

TABLE 6.2: A summary of the user's appointments

Device ID	Encounters	Known	Device ID	Encounters	Known
00116736AFB2	24109	Yes	0017D596BBD8	1981	
001D4F9485B5	18898		001D9842D798	1974	
00014A1551A3	16955		0012D2967EA6	1794	
0011678F9E19	14371		00145154375A	1754	
00196394E719	14157	Yes	0017E3273C23	1486	Yes
001A8A35F31F	13606	Yes	0014A48F0379	1464	
001D4F8CF175	7609		001DF62998B3	1423	Yes
000D9348066E	5724		001BAF07BD0B	1310	
00180FB19FF5	5607		001C26E7F7C9	1301	Yes
0005C94E857E	5112	Yes	001BFB85A6C0	1119	
001E458CC6E4	5100		0018AF36D3DB	1099	
0012D2B1A512	4783	Yes	0019B704B705	1042	
0017B015C160	4412	Yes	001D285B2A1C	964	
0017D506EEBC	4167	Yes	0012EE65DC6C	938	
0019B77ED2D8	4103		0002C7E69092	929	
00196393087F	3980		00196346026B	914	
0012D27E7C39	3809		0017D595CB47	903	
001B634ACE11	3403		001237F276DC	900	
001D4FA29F55	2802		00180F50C9F1	890	
0014A7035BBA	2579	Yes	001E451879E1	876	
0016202B39C5	2333		000E0741404F	869	
00037A279288	2320		000F86B1951A	835	Yes
0016B8FEF9FD	2291	Yes	00180F56775E	711	
00003A68960C	2200		001C436C4C46	680	
001CA49ED0AB	2022	Yes	001BFB1DF860	680	

Table 6.3: Top 50 Bluetooth devices encountered by subject and whether or not the subject can identify the device from the 'friendly' name

activity is concentrated around central Hampshire, where the subject lives and works, but there are various branches to places such as London, South Wales and Cornwall, all places that the subject occasionally visits. The outlines of various major roads can be seen, including the M3, M4, M27 and A30, which can be identified by comparing the image to a map of the country. This indicates that the subject used these roads while getting about. In addition, Appendix B shows a portion of the data set in its raw form.

Appendix A shows a much more concise summary of the collected data. With regards to the location data, it is shown that the furthest distance the subject travelled from his home was 199.5 miles. This occurred on the 8th May 2007. Checking the subject's diary shows that he was on holiday in Cornwall for a few days and chose the 8th to visit St. Just, which is very close to the west coast of the country. However, the furthest the subject travelled in a day was the journey to Cornwall two days earlier. On this day, the subject had an appointment in Portsmouth, east of his home in Southampton, in the morning and left for Cornwall in the afternoon.

6.2.2.2 Activity Data

The activity data is unique in the collected context data because it relies on the user to enter it manually. The test subject is already used to entering reminders of future dates into a calendar so, despite the reliance on manual intervention, the requirement does not add any extra burden to the user's life, at least in the case of the test subject. There is, however, the possibility that the user may miss an appointment out but this is exactly the type of case suggested in Section 3.3.3, in which semi-complete information is better than nothing.

There are 303 appointments in the user's calendar during the test period. It is interesting to note the varying detail in which items are entered. For example, in some cases the user has entered items such as "Meeting with supervisor, building 32" and some, usually more social events, are simply labelled "Holiday". Table 6.2 shows these appointments in categories and how much time the subject spent in each activity type throughout the test period.

It is also worth noting that the information may not be entirely accurate. For example, if a meeting over-runs past the scheduled finish time, the user is unlikely to go back and edit the entry in his calendar.

6.2.2.3 Interaction Data

As the Bluetooth logging functionality was added to Imouto much later than the ability to log the other two types of contextual data discussed, there is obviously much less of this information than anything else. However, the logging of Bluetooth data generally takes much more disk space than logging GPS or appointment data. The reason for this is that at any point in time, the user can only be in one position but may have hundreds of people around him. So if the user were to visit an open-air concert, his GPS location would keep filling up disk space at a constant rate but the device would also be repeatedly logging the presence of all the other devices currently in possession of the many other people in the crowd and, therefore, the memory will fill much faster in this type of situation than it would if the user was miles away from the nearest person.

The information stored represents the devices the user has been in close proximity to during the test period and the 50 devices most often encountered by the subject can be seen in Table 6.3. But the devices encountered, despite most being personal devices such as mobile phones, cannot realistically be mapped to their users with today's technology. It is possible to assign a 'friendly' name to a device and this is typically set to something personal to the device's owner. This allows a human looking at a list of nearby devices in a crowded area to determine which device to connect to in order to carry out a task manually. But friendly names are of little use to a computer, at least in terms of identifying the device's owner; the friendly name may be changed on a regular basis or maybe the owner does not wish to use his or her real name as the device's Bluetooth ID. It is, however, possible to differentiate between different devices and identify devices seen before, thanks to each device's unique Bluetooth signature. This means that if a user is willing to manually assign one or more devices to each of their contacts, it would be possible for a system like Imouto to detect the presence of individual people. Table 6.3 also shows which of the devices are known to belong to genuine acquaintances of the test subject, according to the subject himself.

Appendix A shows a summary of the entire data set and from this it can be determined that the user encountered around 17 devices per day on average. But on the 7th November 2007, he encountered 149 devices. On this day the user went to a large fireworks display at a local playing field, followed by a drink in a busy pub afterwards, which explains the high number of devices encountered, as the fireworks display was very busy. Also, because there was a fun fair at the event, the subject was spending small amounts of time in one place and then moving to the next, where he would spend another small amount of time in the presence of a completely different set of people. In contrast, the highest number of non-unique device encounters in a day was on 22nd February 2008. On this day, the subject spent the day at work and then participated in the running of a live music event in a local pub in the evening. On this day the subject was surrounded by large numbers of people almost constantly throughout the day but they were typically the same people for most of the time.

One other thing to note is that not only portable devices support Bluetooth. In many shops and pubs the cash registers use Bluetooth for the small-scale wireless network needed for communication and many PCs use Bluetooth to communicate wirelessly with portable devices and peripherals. This fact taints the data slightly because not every unique Bluetooth device is necessarily a unique individual.

6.3 Analysis of Results

When analysing the results, there are two different approaches that may be taken. A low-level analysis will analyse the data collected and how thorough it is. This is raw data being analysed in the context of completeness and accuracy, without any further processing or assumptions being made from it. Following this, a high-level analysis is required in order to evaluate how the data may be used to fulfil various purposes; effectively determining how useful it is.

6.3.1 Low Level Analysis

A low level analysis of the data requires it to be assessed in terms of both quantity and quality. For the quantity analysis it must be decided whether or not the data is sufficient for the complete annotation of the time period specified and if there are any gaps in the data. For the quality analysis the accuracy of the data must be assessed.

6.3.1.1 Data Quantity

For the first analysis, the amount of data obtained was compared to the time over which it was collected. Specifically, the percentage of time over the course of the test period that the user's whereabouts could be determined was calculated and the results may be seen in Figure 6.7. All the time the GPS is active in the device, a reading is taken every second. Therefore, in order to produce the pie chart of results, the number of seconds worth of GPS data was taken as a percentage of the number of seconds in the period.

It is worth noting that there is another kind of location data being logged as part of this study – part of the user's calendar. The PocketPC calendar allows the user to specify a location for each appointment and this may also be used as a location marker, albeit a descriptive one rather than a specific latitude/longitude pair.

The sample set contains 3,926,828 GPS fixes. This information may then be augmented with the data extracted from the user's calendar by comparing each second of the year and determining whether or not it falls inside a calendar entry for which the 'location' field has been filled in. There are 5,535,780 seconds within the sample set which can be accounted for by querying the user's calendar. Interestingly, only 791,217 seconds (9.12% of the combined data) are overlaps, meaning that there is a GPS fix for the second as well as it being part of an appointment. This is understandable as many appointments are likely to take place in buildings where a GPS signal cannot be reliably obtained. Combining the two totals and subtracting the number of overlaps returns a figure of 8,671,391. As a percentage of the full 650-day test period, this is 15.44%.

However, this does not necessarily mean that the data is only useful for 15.44% of the time. As shown in Figure 6.9, the results vary a lot depending on the frequency of samples taken. If during a 30 second period a GPS fix only appeared every two seconds, an analysis would suggest only a 50% success rate, despite the fact that any human looking at the data could realistically determine where the subject is at any time, it really depends on what level of detail is required. If attempting to follow a subject's exact route through a complex road network at high speed then a per-second GPS log would be much more accurate. However, if we simply want to know what the subject was doing at a particular time, we only need to know where he/she was to the nearest half hour or so. 15.44% averaged over the period is effectively one fix every 14.3 seconds.

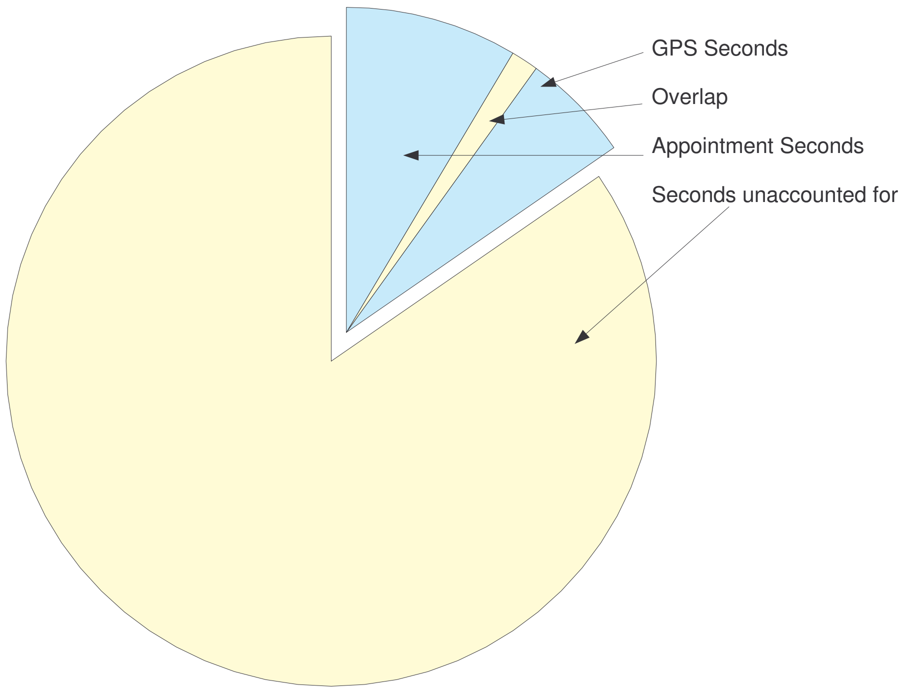

FIGURE 6.7: Percentage of time over a year represented by collected data, based on one-second intervals.

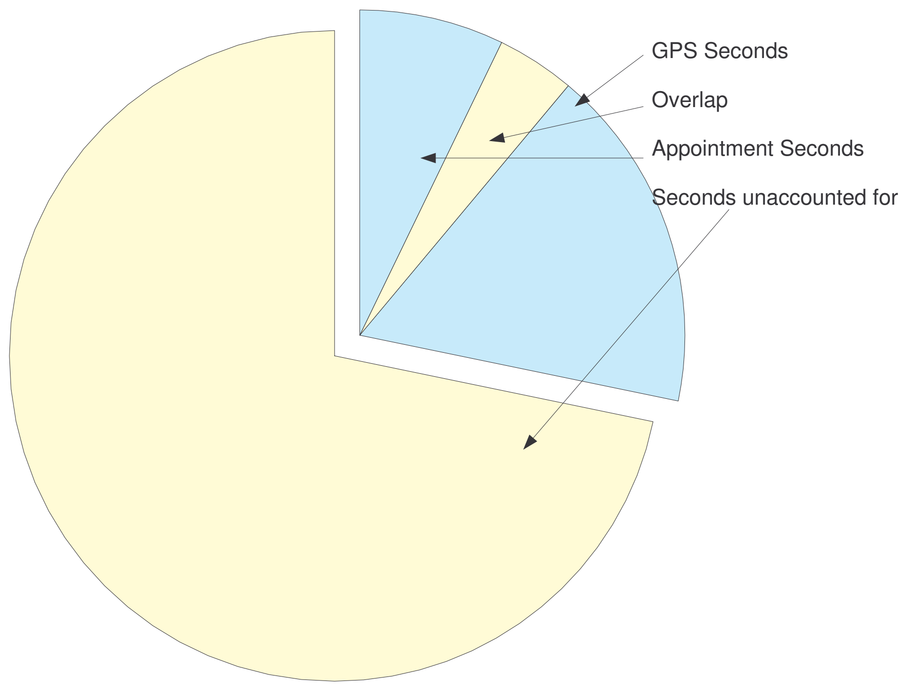

FIGURE 6.8: Percentage of time over a year represented by collected data, based on one-hour intervals.

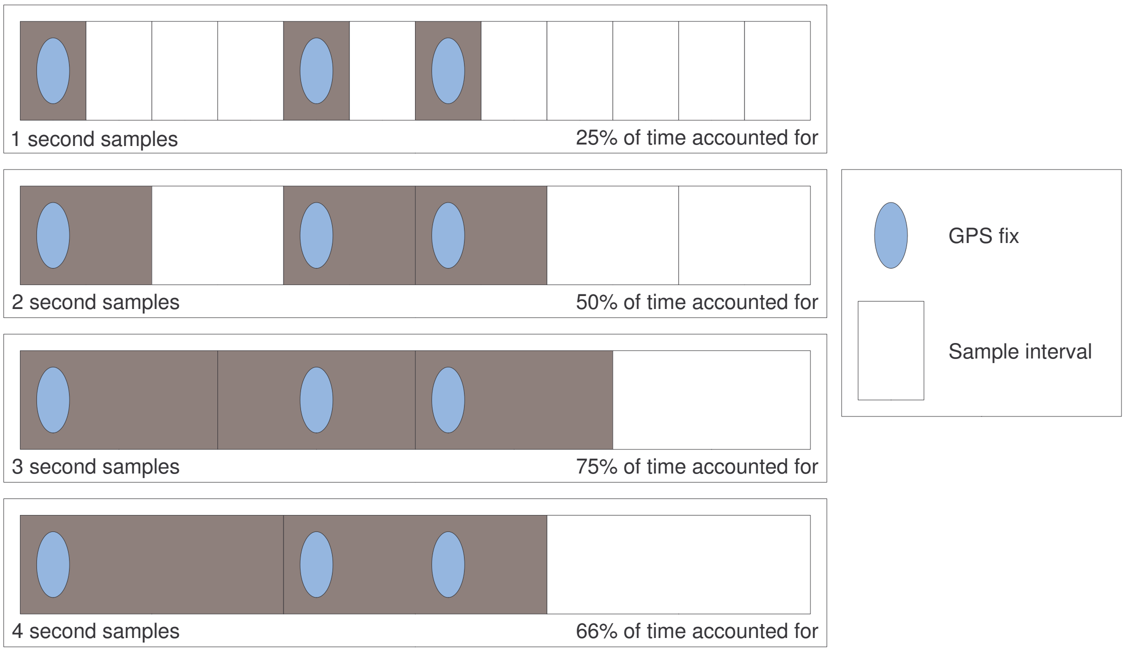

Figure 6.9: Diagram illustrating the difference in results depending on length of time intervals for GPS data.

Figure 6.8 shows a similar analysis by the hour. The year is split into intervals as before, except this time each interval is an hour long rather than a second. We mark the entire hour as accounted for if there is one or more GPS fix or appointment within that hour. As expected, the amount of time that may be accounted for has increased to 28.14%, 4,322 intervals out of 15,360. The time accountable by calendar data has risen slightly to 5.54% compared to 4.73% but nowhere near as much as the GPS data, suggesting that the GPS data contains many gaps and the appointment data does not. This makes sense, as GPS fixes are single points in time which may contain gaps between them and appointments are ranges of time which the user enters manually by specifying the start and end time of each appointment.

Statistically the chance of locating a fix within a particular time is directly proportional to the length of the time interval. However, there are certain situations where this is not necessarily the case, as shown in Figure 6.9.

Regarding Bluetooth quantity, a scan for nearby devices typically takes up to 30 seconds but may even take up to a minute depending on the number of devices in the vicinity. This of course means that it is only possible to measure nearby devices every minute or so. Therefore, it is theoretically possible that a person walking past the user every minute shows up in the logs more than someone who leaves for a few seconds once a minute, despite the latter being in range for more of the time. There is also a problem with people who do not leave their devices set to discoverable all the time. Obviously if people wish to remain private it is their choice and they will not show up at all in the logs. However, Bluetooth is a large drain on battery life and as such many phones and mobile devices disable Bluetooth after a few seconds of inactivity in order to conserve power. This is a problem because a device may show up some times but not others, leading to a wrong conclusion that the owner of the device was around a lot less than he or she actually was. Worse yet, there is no way of distinguishing these devices from all others within the logs.

6.3.1.2 Data Quality

The accuracy of GPS is variable and based on context, as discussed in Section 5.3.1.3. However, it is possible to 'clean' the data with a carefully-constructed script, as shown in Figures 6.10 and 6.11. Figure 6.10 displays the route apparently taken by the test subject on the 1st September 2007, overlayed on to a map of the area. Obviously this is very wrong; the subject is unlikely to have suddenly run in a straight line across fields for miles before returning to the point he was at previously and the logs show that this would not be humanly possible anyway, as the subject would have to have covered this distance in less than a second. Results such as this are often due to poor GPS reception in a particular area. Figure 6.11 shows the actual route the subject took. Fortunately, the inaccurate GPS data was all so outrageous that it is not physically possible for the data to be accurate. Therefore, the data was 'cleaned' with a script that measures the acceleration and speed of the subject at every point in the test data. If the subject travels faster than a certain speed or accelerates faster than would normally be possible in the fastest of vehicles, the data is dismissed as inaccurate and removed from the database. Consequently, we lose a GPS fix from our data set but this is clearly much more preferable than having wildly inaccurate data.

With regards to calendar data, this is obviously dependent on the user. Some people have good memories, making the task of manually entering appointments into a PDA counter-productive and unnecessary. However, others rely on personal organisers in order to organise their lives and are, therefore, more likely to enter their appointments into a PDA. Nonetheless, not every event in a life is noteworthy. Attending work, unless the user works shifts and needs to keep track of when to work and when not to, is unlikely to appear in a calendar.

Another point worth considering is the likelihood that the user will delete a cancelled appointment from the calendar. If a user makes plans to attend an event and then, for whatever reason, decides not to go, ideally he/she will remove the event from the calendar. In practice, this is not always the case. It does not help that the calendar application built into Windows Mobile does not display past appointments unless the user specifically requests them. This means that if the user cancels an appointment on a whim and then does not consult the calendar until after the scheduled event has passed, the appointment will remain in the calendar and probably never be deleted.

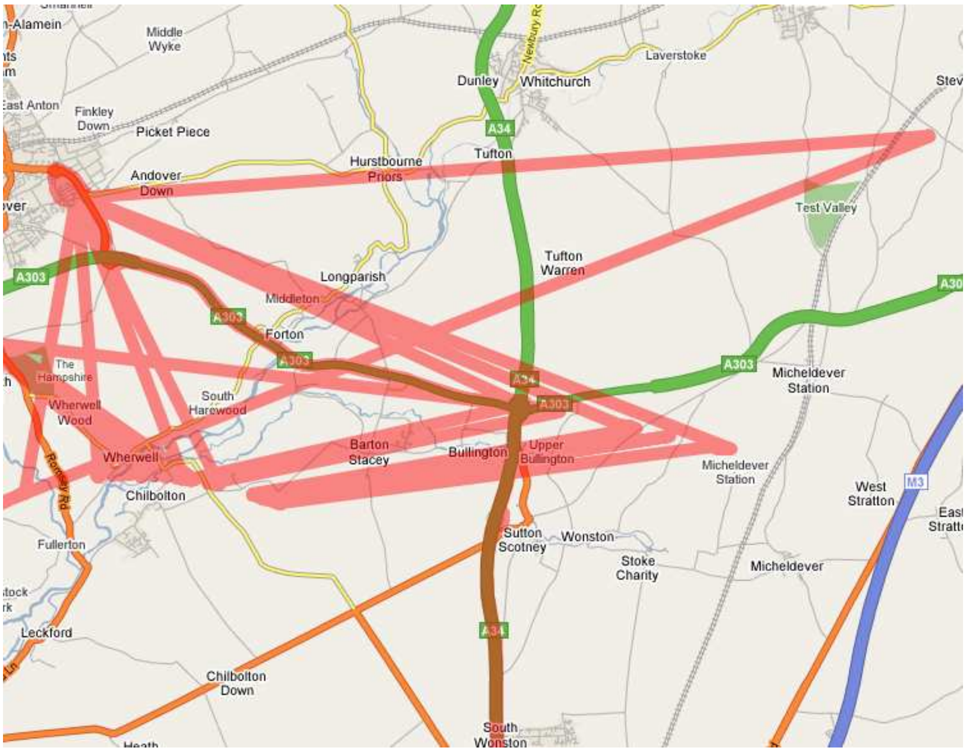

FIGURE 6.10: The effect of poor GPS signal on a perceived route. Map image courtesy of Google Maps.

FIGURE 6.11: The same route after being 'cleaned'. This more accurately reflects the route taken by the test subject. Map image courtesy of Google Maps.

Lavelle et al. [2007a] introduces a method for determining familiarity in Bluetooth signatures. The approach takes into account many things not considered by previous work [Nicolai et al., 2006] including a scalable algorithm that takes into account the regularity of device encounters as well as their frequency. However, the work also outlines several disadvantages of using a radio technology such as Bluetooth as a location sensor; even the short-range signals of Bluetooth can penetrate walls and operate in a three-dimensional plane. Therefore, for example, if the subject were to live in a flat, a Bluetooth familiarity sensor will assume that he/she is familiar with the neighbour living on the floor above, despite the possibility that they may never have met.

6.3.2 High Level Analysis

Casual examination of the results in Section 6.3.1 could suggest that the process of carrying a GPS around is actually of very little use. However, this is short-sighted. The data is only really of any use once fused with other data. Most ordinary people would have no need to know the exact latitude and longitude at which they were stood at a precise moment in time but may have need of a location relative to some other location, such as “100 yards from the cinema”. Obviously the mobile software does not know where every cinema is but the user’s most significant locations can be programmed in manually and the location of most public venues can be found on the Web. The automatic harvesting of location information will theoretically become simpler as the Semantic Web evolves and becomes more widespread. This is covered in more depth in Section 7.1.

As shown in Section 6.3.1.1, the percentage of the year that may be accounted for generally increases with the length of sample interval. If we wish to know a user’s position at a precise second in time, we may not have the data available. However, if we wish to know what the user was doing during a particular hour, there is a much greater chance that we have this information. This is convenient, as there are few instances where an exact position to the second is required, yet there are many instances where one may wish to query the area in which a user was located within a much longer time frame, such as half an hour, or an hour.

Of the two types of location sensing methods used, it can be concluded that neither is perfect. GPS data is not exhaustive and is often full of gaps and appointment data relies far too much on manual intervention from the user to be of any real use beyond current technologies. But as suggested in Section 3.3, incomplete but accurate annotations are generally more useful than complete annotations that are unreliable.

6.3.2.1 Data Fusion

So far, each type of data has been discussed individually, although GPS and appointment data were used together briefly. There is not much detailed analysis that can be done with only one type of contextual data and it is certainly not possible to write any kind of biography using only this information. What makes up an event in a life is a combination of contexts, so although GPS, appointment or Bluetooth data alone may not be sufficient to annotate a life, together or combined with other information they have the potential to describe the actions of an individual with much greater accuracy. This combination of different kinds of data is known as data fusion and is already used in various practical applications. Section 5.3.1.1 describes various ways of synchronising different data formats to a time stamp but there are also much more subtle ways of using information types in unison, such as using nearby wireless networks to determine position when GPS is impractical or impossible [Ladd et al., 2002].

Data fusion is becoming a trend in the evolving world of the Web. As more web sites provide APIs or XML feeds for syndicating their content, more of these so-called "mash-ups" are appearing. Examples include Earth Album[1], a combination of Google Maps and Flickr that allows the user to search for photographs geographically, VBay[2], an eBay/Google Maps mash-up allowing the user to view where auction items are located on a map, and iPhone Maniacs[3], a site collating information from multiple sources in order to provide the most comprehensive site dedicated to the Apple iPhone. Even big players such as Yahoo! have realised the significance of mash-ups and have provided a web application called Pipes[4] which serves as a simple user interface for producing mash-ups from various different sources.

In terms of the data collected as part of this study, it is entirely possible that more information about the subject's life can be derived from a combination of two or more types of contextual data and this must also be investigated.

6.4 Querying the Data

In section 3.7 a series of example questions was posed and this section will attempt to explain how one would go about answering them, firstly with only the individual types of collected data as a reference.

As discussed in Section 6.1, this analysis is conducted from the point of view of the test user and, therefore, the sample queries have been selected as the sort of things he would

[1]http://www.earthalbum.com/
[2]http://vbay.info/
[3]http://iphonemaniacs.com/
[4]http://pipes.yahoo.com/

normally want to know or find interesting. But they also include suggestions from the test subject's family.

How many miles does the subject travel (on average) per week?

Using GPS information this is theoretically very simple. However, Section 6.3.1.1 shows that GPS cannot be relied upon as a conclusive data source. Although GPS data may prove where the user *has* been, the user must have a GPS receiver nearby and turned on at all times in order to be able to prove where he/she has *not* been. If the user could have a GPS on his/her person 24 hours a day and prove this to be the case then we could rely on this data due to the impossible nature of being in two places at once.

Regardless, if we assume that the user did not travel any considerable distance without a GPS, we can easily answer the question posed using just the GPS data, by simply totalling up the distances between consecutive points in the GPS logs and averaging them. This works well because even if no fixes are logged for hours, the distance travelled is still the same and the total distance between two points 20 miles apart and 21 points each one mile apart will still be 20 miles, provided they are in a reasonably straight line.

In the case of the test subject, 15,205.42 miles were travelled within the 52.143 weeks of 2007. This is a mean average of 291.61 miles per week. A more detailed breakdown of the different weeks making up the year can be seen in Table 6.1. Note that the standard deviation is quite large, indicating a relatively irregular lifestyle.

What percentage of the subject's time is spent in the pub?

This problem may be used as an example of data fusion. Although GPS allows the software to determine the user's position relative to the planet, it does not allow the user to determine his position relative to the nearest pub. This sort of query requires additional location information. It is a simple query to process for the simple reason that pub locations are generally published in the media and on the Web. Assuming we had a list of every pub within the area that the user had travelled within the target timeframe, which is not infeasible and is likely to become easier in the future as the Semantic Web becomes widespread, we could attempt to work out how much time the user has spent at each of these locations.

The problem mentioned in Section 6.3.1.1 relating to the difficulty in obtaining a GPS signal indoors must also be taken into consideration. However, in this case it is slightly easier; assuming the subject does not live in a pub, or leave the GPS turned off for long periods of time, we can safely assume that if one second in time the user is in a pub and then the GPS does not obtain a reliable position for several hours before finally calculating that the user is still in the same pub, the user has been in the pub all the time no fix was obtained. This is important because it could make the difference between being in a pub for two seconds in a day and two hours in a day.

In order to answer this question in the context of the test subject, the subject was asked to note the name and location of all the pubs he knows of and has visited and compile them into a text file. Next this information was combined with the appointment data; there were several occasions that the subject had actually entered an appointment at one of the locations classed as pubs into his calendar. Finally, every GPS fix throughout the year was compared with each of the locations known to contain a pub. The number of seconds known to be spent in a pub thanks to the GPS and appointment data were then counted and taken as a percentage of the number of seconds in a calendar year. The test subject spent a total of at least 1,103,138 seconds (approximately 12 days, 18 hours and 26 minutes) of 2007 in a location designated as a pub, which is 3.498% of the 31,536,000 seconds in a standard calendar year.

Which music concerts did the subject attend in the past year?

This could be as simple as checking the user's calendar and employing a pattern matching algorithm based on the assumption that the user is going to describe such an appointment as "[name of band] concert" but in practice this is unlikely. The test subject used the terms "[name of band] concert", "[name of band] gig" and simply "[name of band]" to describe these events. It is also assumed that the user enters the full name of the band rather than just using a familiar abbreviation; for example, many AC/DC fans often refer to the band as simply 'DC'. Finally, it is assumed the user will add these events to a calendar, ignoring the possibility of spur-of-the-moment attendance or the user simply not entering the date in the calendar.

Thankfully, in the case of the test subject, the data was quite consistent, which may be because the subject is a keen fan of live music and attended 131 gigs during the test period. If this information was not available, however, it would be necessary to combine multiple types of information, as described in Section 7.1.

How many times in the last year did the subject meet a particular colleague or friend?

If the colleague carries a Bluetooth-enabled device at all times, it may be tracked by its unique signature, assuming it is known in the first place. If the colleague is not willing or able to disclose this, it may be obtained either by manually deducing the device from its friendly name, or by pattern matching, possibly after using the method described in Lavelle et al. [2007a] to determine a shortlist of familiar devices. It is then possible to simply count the number of periods that the subject's device was in proximity of the target device. But the simple fact is that it is not possible to derive identity information from Bluetooth signatures without manual intervention.

Table 6.3 shows the 50 devices that were most often encountered by the subject during the test period. Each device is mappable to its 'friendly' name in the logs and the subject was asked to look through the list and note which devices have names that allow him to identify its owner. One of these devices, the device with the signature '00196394E719', was then chosen at random for this investigation. The number of times this signature appeared in the Bluetooth logs was then counted.

Of course, as mentioned in Section 6.3.1.1, a Bluetooth scan takes up to 30 seconds depending on how many devices are in range. For this reason, we cannot assume that because a device disappears for a few minutes that the owner has left, it may simply be that the device was not picked up on one particular scan. So in order to answer the question of how many times the device's owner was seen by the subject, the device's logs were joined together into groups. If the device disappeared for more than 30 minutes, it was assumed that the owner left and any future encounters with the device were deemed to be new meetings. Using this method it was determined that the subject met the owner of the device 36 times within the period of testing for which Bluetooth logs were taken.

Which people does the subject interact with the most?

If the question were asking only about physical interaction, then Table 6.3 already provides the answer to this question. However, interaction is not limited to physical presence. Part of the additional data collected by the test subject over the test period that was not part of the study includes his entire e-mail history, including sent and received mail. As the subject obviously knows the e-mail address of many of the people he knows who own portable devices, this task is trivial and levels of interaction may be determined by simply counting the number of e-mails sent to a particular contact. The same may be done for instant messenger applications and, thanks to modern phones which interface with computers, phone calls.

6.5 Combined Data Analysis

So far, the only analysis has been of either GPS, Bluetooth or appointment data. But as mentioned in Section 6.3.2.1, it is possible to combine different types of contextual data in order to gain a much richer understanding of the user's scenario.

Section 6.4 refers to an acquaintance of the test subject and determines that since the subject has been logging Bluetooth signatures, they have met 36 times. But this does not tell us anything about their relationship, we just know that they are in the vicinity of each other rather a lot and may never have spoken to each other or actively 'interacted' in any way. In order to help us understand these relationships more, the Bluetooth data may be merged with other data that shares common properties. As all of the contextual data stored in this study has a time stamp, it is possible to determine where the user was and what he was doing when he met the owner of the device with the signature '00196394E719'.

As all the data is stored in a relational database, it is a simple case of querying this database based on time stamp. For example, a query such as:

```
SELECT DISTINCT Appointments.*
FROM Appointments,BTLogs
WHERE BTLogs.Time>=Appointments.StartDate
  AND BTLogs.Time<=Appointments.EndDate
  AND BTLogs.BTID='00196394E719'
```

The result of this query is a table of appointments that coincide with encounters with the device in question. Looking at the data in the case of the test subject, of the 14,157 encounters with the device, 12,698 coincide with appointments in the calendar. 85 of these are jobs or favours, 280 are holidays, 10,031 are music-related events such as concerts and 2,302 are parties of some kind. There are no work-related appointments that coincide with this device, therefore, it can be assumed from this data alone that the subject knows the owner of the device in a personal capacity. He has been on holiday with them, has done them jobs or favours, has attended parties with them and frequently attends music events with them.

6.6 Analysis In Depth

In previous sections, it has been determined that although the data collected is in no way sufficient for describing an individual's life completely, it is indeed valuable when answering queries later on, such as the location of an individual within a particular time period lasting between half an hour and an hour. But it must also be considered that the ability to recall what latitude and longitude a person was at various points in their life is not necessarily all that useful. What we currently possess is raw data, it is not until this data has been interpreted in context that it becomes truly useful. As described in Section 6.3.2, it is rarely essential that we want to know a user's whereabouts to the second but we may need to know when they last visited a specified location, or how often they carry out a specific task. Section 6.4 shows that by combining the collected data with other information available elsewhere many more questions may be answered. This actually emulates the way human thinking works; if one were to ask a colleague "Where were you last night?" and receive the answer "I went to see the latest Bond movie", we already have prior knowledge that tells us that movies are watched at cinemas and we may also know where the local cinema is. Using the example of the GPS data collected, by analysing an individual's GPS logs we only really get a list of numbers but, if combined with local business data, we can see the individual visited the cinema and, by querying the time and location information against local cinema listings, we can even make a guess at which movie the individual was watching.

There are other reasons why location logs of 100% of a human's life are not necessarily required or possible. By looking at the data represented in Figures 6.12 and 6.13, it is notable that there is no record of what the subject was doing between the hours of 2.45am and 5.30am any day of the test period and this is a significant 11.46%. But consider that many people are asleep at this time of day, it may be assumed that this is the case; after all, why would the individual leave a GPS turned on while he/she is asleep when this would be the ideal time to charge its battery? And why would the individual specifically make a diary entry about being in bed asleep? It should be noted that this is an assumption that may be made by human analysis of the data and cannot be carried out by the computer alone. So a query to determine the most common hours of the day that the subject is asleep will fail without some kind of manual processing.

6.6.1 Negative Proof

Although lack of data has been trivialised thus far, it is a valid concern. The main reason is because if there is no calendar or GPS data for a particular time window, it is not possible to prove that the user was anywhere. Consequently, it is also not possible to prove that the user was *not* in a particular place at a particular time. So a query such as "did the user visit Cornwall?" is rarely answerable if there are gaps in the GPS data that are longer than the length of time that would be required to travel to Cornwall and back again. Obviously if the answer is yes and there is GPS data to prove this then we have our answer. But just because there is no GPS data that specifically states the subject was in Cornwall, it does not prove that he or she was not there at some point. Absence of proof is not proof of absence.

Another point worth making is that the device collects information about where it is, not where the user is. We assume for the purposes of the study described in this document that the user will always carry the device on him/her. However, if the user were to leave the device on somewhere and then walk away for an hour and forget it is turned on, our life annotations become inaccurate.

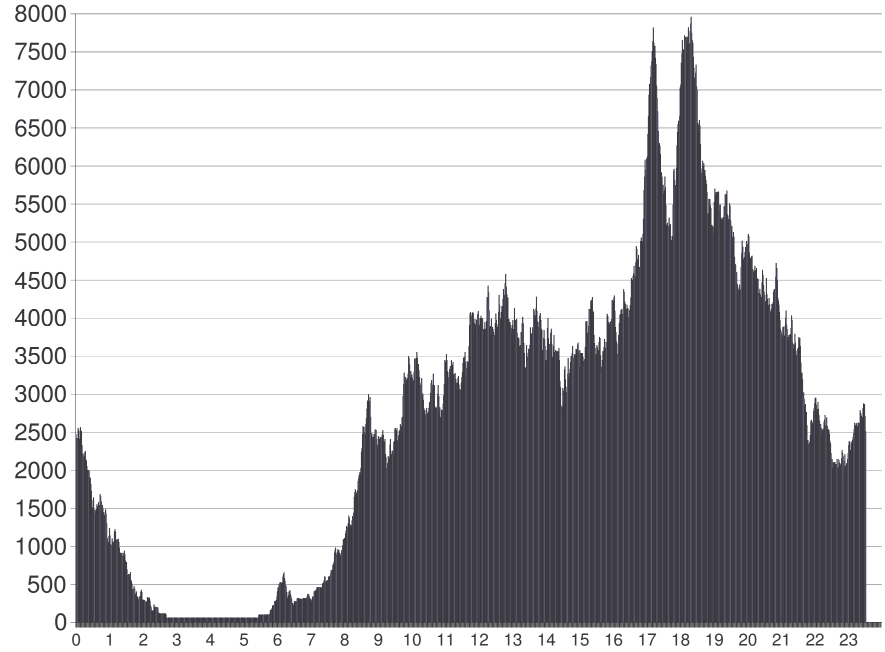

Figure 6.12: Number of valid GPS fixes, by time of day.

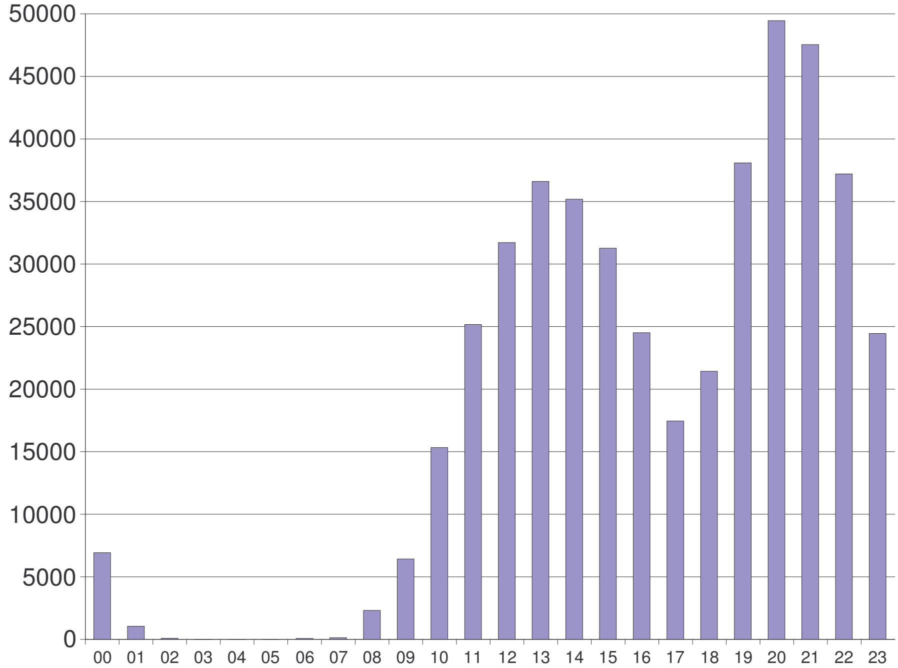

Figure 6.13: Number of Bluetooth device encounters, by time of day.

6.7 Critique and Summary

The analysis presented in this chapter suggests that the data currently being collected by the system is not enough for complete life annotation. If the aim is to determine the whereabouts and actions of the user at any point in time, then the data is provably inefficient, as shown in Section 6.3.1. But having said that, as shown in Section 6.3.2, it is not always necessary or even desirable to know to the latitude and longitude where a person is at any second. Provided the system has a rough idea of what the user is doing and where, this is sufficient for most realistic cases. Additionally, even if the individual contextual data types are not sufficient to answer any questions we may have, we can augment it with other data in order to determine a much clearer picture of the user's life. Many more queries are possible if multiple data sources are available at the same time and more so if the computer is able to collate them automatically. Logging context data indefinitely does make it easier for a human to discover additional information after the event by manually collating various data sources as shown in Section 6.5 but if a computer cannot do this then the system becomes too complex for most people to use.

An ideal system is one which is not only able to log personal information about its user but also gather public or shared data from elsewhere, comparing the data to its local knowledge store. Otherwise, the system can only output the information it has collected. In the case of location data for example, Imouto only stores latitude and longitude co-ordinates. A typical human user would find a zonal response such as "At half past five yesterday you were in the cinema" or a relative response such as "At half past five yesterday you were 23 yards from the dock" much more useful than "On 2007-08-19 16:30 +0100 you were at 50.8947°N, 1.39306°W", despite the latter being much more specific.

6.7.1 The Semantic Web

In collecting this additional data, we assume either manual user interaction or that the Semantic Web will grow as time goes on. The existing web contains a wealth of information that could work in synergy with the personal data collected by systems such as Imouto. The problem is that web sites are typically designed for humans and not computers, meaning the data must be 'screen-scraped' or manually entered in order to be of any use to a life annotation system.

However, some large content providers such as the BBC are exposing huge amounts of data in RDF[5] and other content providers such as The Weather Channel[6] and XE Currency Converter[7] provide web services that return their content in machine-parsable

[5]http://catalogue.bbc.co.uk/catalogue/infax/
[6]http://www.weather.com/services/xmloap.html
[7]http://www.xe.com/dfs/

XML format. It is also a common trait of user-provided content sites such as YouTube and Flickr to provide APIs for users to query. These trends imply that machine-readable data access is desirable and suggest that a Semantic Web is likely to succeed. Assuming that this is the case, a completely automatic life annotation system is feasible for the near future but sustainable in the present with a certain amount of user interaction.

The system of augmenting private, personal data with public, researched information models normal human behaviour. A person goes through his or her daily life absorbing information relating to them personally and uses this combined with external information to make decisions. For example, a driver may use a satellite navigation device to find the way through an unknown area but must also watch for road signs, traffic lights and use plain common sense to avoid turning on to pavements or hitting parked cars. Therefore, the driver is combining his/her own knowledge with the knowledge provided by the sat-nav. In the context of life annotation, it is entirely possible with the existing system to determine exactly what a user was doing at any one time using a combination of the personal data collected by the system and public information available on the Web but it still requires a level of manual interaction in order to link the two. It is not, for example, possible to read the GPS position of the user and know exactly what the user was doing. However, it is possible to enter the co-ordinates into Google Maps[8] and search for the closest public point of interest, as well as comparing the user's address book with the location in question in order to determine nearby locations. It is then possible to look up said locations on the Web in order to determine what the user might have been doing, for example, if the location corresponds to that of a shop then, presumably, the user was shopping at the time. In a world where the Semantic Web is accessible, it will be possible to do all this automatically. The shop in which the user was located at the time in question will have a URI and meta-data explaining that it is of type 'Shop' together with its address and/or geographical co-ordinates. At this point it is only required to write a logical statement declaring that if a user's location is the same as the location of a shop, then the user is shopping. To summarise, all the information is there, it just takes a little detective work.

[8]http://maps.google.co.uk/

Chapter 7

From the Past to the Future

> *"Who controls the past controls the future; who controls the present controls the past."*
> The Party Slogan, *Nineteen-Eighty-Four*, George Orwell, 1949

The hypothesis of the study was that it is possible to annotate a human life with no conscious user effort. It was suggested that the information should be useful enough to be able to answer queries normally posed by a lapse in the user's own memory, effectively 'outsourcing' memory, and potentially write a small biography of the user.

The sample data is in no way exhaustive. It covers a year in the life of a single individual, meaning many conclusions cannot be drawn from it, as other people will have different lifestyles. Despite this, Chapter 6 shows that enough data has been collected to suggest that it is indeed possible to annotate a life to a certain degree of completion with today's technology. But for truly complete life annotation, more work is yet to be done. With the current information set, it is not realistically possible to write a biography, although it is possible to answer certain types of question provided a little human intervention to collate different types of data is employed. However, in doing this, it can be concluded that there is much more use in combining different types of contextual data than there is in merely logging large amounts of data about one particular context.

Another emphasis made by this work is the value of Bluetooth device signatures as a form of context analysis, especially when combined with other contextual data. Although there is currently no way of determining an individual's identity from the Bluetooth signature of their portable device, each device is uniquely identifiable, making it possible to determine when and where a device was last encountered.

Bearing in mind these conclusions, this chapter will be mainly speculative. However, it will provide insight into how the data collection process may be expanded in order to gain additional data that we do not yet have, using the data already collected as reference.

7.1 Expanding the Answers

As shown in Section 6.4, it is possible to answer most of the simple queries posed in a round about way using only one of the types of context data collected. However, the answers are more accurate if data types are combined. But there are ways of obtaining yet more data.

For example, in order to answer the question about how many times the user has been late to an appointment, we need to know where the appointments in the calendar are located in the real world. These may be entered manually or obtained from public sources but if a user has several appointments in the calendar that are supposed to take place at “Dave’s house”, obviously the physical position of this location cannot be determined using public data sources such as the Web. But it is possible to check the GPS position that corresponds to the appointment. Supposing every time the calendar contained an appointment at Dave’s house the user was in the same general area, it can be assumed that the area in question is, in fact, Dave’s house. Once we have this information we may even be able to derive its address; latitude and longitude may be converted to a post code and if this particular post code appears in the user’s contacts list in an ‘address’ field, we can assume not only that the rest of the address is valid but that the person whose address field contains the post code is the person who lives at the location known as “Dave’s house”.

A major problem with using GPS for location sensing is how to determine whether or not the user actually ‘visited’ the location in question. Although it is possible to determine roughly how long the user spends in the pub, it is feasible, for example, that the user knows the doorman of a particular establishment and on the way past one afternoon stops for a chat. This chat may last longer than the time taken to have a drink in the pub but the user did not technically ‘visit’ the pub, he merely stopped outside or just inside the door while having a spur-of-the-moment conversation. Without manual intervention or an advanced probability algorithm taking into account lots of variables, we cannot realistically answer the question of whether the user actually visited the pub or not. We can, however, make an educated guess based on ‘stopovers’, as shown by Newman et al. [1991]. This is still not an exact measure but, regardless of the uncertainty, for the purposes of this study if the user is actually in the pub, or at least stopped in the doorway of the pub for more than a few minutes, we can assume that this is time spent ‘in a pub’ and, therefore, added to our cumulative total of time spent in such circumstances. On a more optimistic note, GPS data is not the only data logged in this investigation. Appointment data has also been used and although it is not typical to explicitly enter “Drink in pub” into a calendar, it may sometimes be the case that a non-standard, pre-arranged appointment happens to take place in a pub. For example, a member of a pub’s bar staff may work shifts and, in order to remember which shifts he/she is working, the shifts may be entered into the calendar of a PDA. This information may be used to refine the accuracy of our total. The more information we have, the better guess we can make as to what the user was doing at the time.

The same may be applied to concert venues. They too have fixed positions which are made public, so it is trivial to determine where local venues are. Additionally, bands and venues advertise event dates on their websites. Interestingly, in the case of live music, the website Last.fm[1] currently lists events in a standard format and makes the data available in machine-readable XML format. This effectively allows a computer to determine the times and locations of local events and match this information up with the user's calendar. If the date is the same and the name of the band or location can be found in the appointment description, the user intends to attend the event. Additionally, with the user's GPS logs we can make better judgements. Considering the example of the 'spur-of-the-moment' scenario, the user's GPS will pick up that he/she is near a music venue. A simple query can determine which artist is performing on that particular evening and using the user's music preference data, also available in XML format from last.fm, it can be determined whether or not the user is likely to want to attend this particular event. If everything matches, it can be assumed that the user is at the concert. This allows us to answer the question about how many live music events the user attended, without the need to rely on accurate calendar data.

But in summary, computers are currently hindered in the task of obtaining information about their users by the fact that they are not able to be proactive. All potential scenarios mentioned within this chapter are fine, provided a life annotation system has access to lots of additional data related to the user's context, in a format it understands. It's all very well writing, for example, a script to scrape the gig guide to a local music venue if it becomes apparent that the user visits it regularly but it requires a human to analyse the data first to determine that such a script needs to be written. If it were possible for a software agent to collect all information about nearby places of interest, then follow all related links to other semantic information with the intention of 'learning' this as well, it would be possible to ask a question such as "what bands did I see on Friday night?" and have a reasonably sensible answer returned. The query may be processed by returning everything relevant to the user's contexts on the previous Friday night and then looking for a list of resources within that data that can be described as 'bands'. Locating all the data in the first place can of course be achieved through one of two means; scraper scripts for as many informative websites as possible, or widescale adoption of the Semantic Web.

[1]http://www.last.fm/

7.2 Issues

An ideal analysis that will be addressed in future work will involve multiple test subjects keeping logs for longer than two years but obviously this cannot be completed within the time scale of a PhD thesis. However, the work already done has outlined various issues that must be addressed if an expanded study is to take place.

7.2.1 Scalability

There are various scalability issues to consider that have not been answered by the study carried out as part of this work. It is important to note that although the purpose was to study the quality of the data rather than its application to the general population, this study has still only featured one test subject. It must, therefore, be considered what would happen if there were multiple subjects; how would the functionality of the system be affected and what additional potential would the system have if it were distributed? Investigation into different types of people would also be of value. It is notable from looking at the test user data that the user did not once leave the United Kingdom during the test period and the user averaged three appointments per week. The system may work better or worse if the user is more or less busy, or if the user frequently travels further afield. Finally, although the user did not leave the country within the year test period, that does not mean he has never left the country. Therefore, we cannot make ‘average’ queries such as “How many times a month does the subject leave the UK?” with only a single year’s data.

7.2.1.1 A Year in a Lifetime

While the sample appointment data is small and requires a trivial amount of storage capacity, the sample GPS data takes up roughly 45 megabytes of disk space per calendar year. This could be multiplied by 79.4 (the average life expectancy of a human in the UK [United Nations, 2007]) to get 3.6 gigabytes. But as shown in Figure 6.7, only a small percentage of the year is actually logged; it is theoretically possible for a different test subject to leave the GPS on 24 hours a day 7 days a week and the GPS to obtain a fix every second. In this case, a year’s data would occupy 1.45 gigabytes of disk space and a lifetime would be 116 gigabytes. This is a scalability issue that requires the consideration of storage space. There is little point in developing a life annotation system that does not have the technical capacity to store the maximum possible amount of data. Even with today’s limitations, 116GB is not much and a good quality 120GB hard disk retails in the UK at under £30 at many outlets. This will be sufficient to store complete GPS logs of the life of any human for the foreseeable future. In terms of other forms of data, Dix [2002] calculates that if a human were to walk around with a camera on his or her head, to store what a human sees and hears in a lifetime would take 200 terabits (25 terabytes) of digital storage capacity. This is a lot by today's standards but when it is considered that 10 years ago 1 gigabyte was a large hard drive and today manufacturers are producing hard drives of 1,000 times this amount, presumably it will not take long for 25 terabyte drives to appear.

7.2.1.2 Global Coverage

GPS is a useful technology as it is available all over the world. But during development a few problems relating to data types were uncovered. The original version of the software used a Microsoft PocketAccess Database to store information, until it was discovered that, as described in Section 5.6.1, only 65,536 entries can be made in a table because the table index is an unsigned 16-bit integer. The data format was quickly revised to text files but the error prompted the developer to check all other values and discovered that the unit was liable to crash if taken too far from the home location due to the real-time arithmetic used to calculate distances from various points. This was also quickly refined and the home location set to a position exactly the other side of the world from the device in order to test it.

It should also be noted that, as shown in Section 6.3.1.2, GPS is not a flawless method of location sensing. Despite its global nature, its accuracy reduces if it receives a bad signal from the satellites, which may happen any time the receiver is placed indoors or in a particularly built-up area. In future work it may be beneficial to investigate the use of other methods of location sensing, working in parallel with GPS, such as using Active Badges for indoor location sensing and GPS when this system is not available.

In terms of logging other information, there is the potential for problems with national format standards. For example, if a device designed to be chargeable from a UK mains supply is taken abroad, it cannot be charged without some kind of voltage adapter. A less easily resolved problem is that of standards governed by legislation. For example, in 2001 the French government decided to remove the regulation of the 2.4GHz radio frequency range used by wireless technologies such as Wi-fi and Bluetooth [Thorel and Broersma, 2000]. This happened before Bluetooth devices became widespread but should a technology emerge in the future that allows for better life annotation, it may be illegal in some countries, despite being perfectly legal in its country of origin or the rest of the world. This is especially true if the technology is not backed by multiple international companies, as Bluetooth was, or if the technology contravenes local privacy laws, a very real danger in this particular field.

7.2.2 Ubiquity

A large problem with the existing system is that it is not truly automatic. As there is currently no truly ubiquitous Semantic Web in existence, much information still needs to be entered manually. Due to the design of the software, this is a simple case of standing in a specific location and pressing the 'Mark' button to store it as a point of interest, followed by the brief task of assigning the position a name once the user returns to the host PC. However, this is still a long way from the ultimate goal of a truly automatic life annotation system. Additionally, the software currently runs only on a PocketPC, a device designed only for occasional use, which despite being one of the few devices suitable for the study referred to in this document, is actually not ideal for an everyday life annotation system. PDAs, particularly ones with integrated GPS and Bluetooth, are traditionally quite large in size and as the devices are designed primarily to remain off for the vast majority of the time and only turn on when in use, the battery life is not long. For reasons of accuracy and battery life it is, therefore, impractical for a user to leave the PDA on with the logging software running all day in a pocket, as is possible with a mobile phone.

7.2.2.1 Screen Scraping

Section 2.2.7 introduced the concept of screen-scraping. This is a method for extracting data from the existing web automatically. It was mentioned previously that Imouto does not have any kind of location-sensing ability beyond GPS but can approximate a human-friendly relative location description from a list of locations manually entered by the user. It would be nice if this information did not have to be manually entered but until a true Semantic Web exists, this information can be screen-scraped.

A good example is Wikipedia[2] which currently contains geographical co-ordinates for many of its articles about places and landmarks. If these articles were indexed by geographical co-ordinates, it would be possible to query the user's current location without the need to manually enter a list of known places. Obviously, more local locations such as shops and pubs cannot be found with Wikipedia but Google Maps is useful for such things and, at the time of writing, has already begun to incorporate semantic meta-data, such as the hCard microformat[3], into its search results.

7.2.2.2 Personal Bluetooth Networks

With the popularity of wireless mobile devices increasing, it can be argued that many people have a personal wireless network on them at all times. People drive around wear-

[2] http://www.wikipedia.org/
[3] http://microformats.org/wiki/hcard

ing a Bluetooth-enabled earpiece which is wirelessly linked to their mobile phone, located in their pocket. Meanwhile, they may have a PDA in a cradle on the dashboard which is also linked to the phone and checks for news stories and traffic reports periodically via the phone's cellular modem. This same PDA may also be linked via Bluetooth to the car's GPS receiver and an application running on the PDA could collate the traffic reports and the GPS signal in order to warn of any impending hold-ups.

As this trend continues, the potential for a less cumbersome system increases. Currently the software relies on a PDA with in-built GPS and Bluetooth functionality. Theoretically, if the device also contains a Wi-Fi receiver, then we can log this information as well in order to determine location in relation to local access points as well as in relation to other devices. It should also be mentioned that for the most accurate signal, the signals received by the device should be unobstructed by clothes and nearby objects. A device with maximum functionality could be relied upon but, as this reliance increases, the more catatrophic a potential malfunction becomes. A more convenient model would be for a user to carry around a small digital storage device, such as a cheap PDA, in his/her pocket and have it communicate with other known sensor devices via Bluetooth. For example, a user's hat, wristwatch or necklace could contain a small but reasonably accurate GPS receiver which communicates with the device in the user's pocket. This would be a much more accurate position sensor without the requirement of the user holding the device in his/her hand all the time.

Of course this still requires that the user have a PDA on and working in his/her pocket all the time and with the additional Bluetooth functionality required, the battery drain is increased. This problem is likely to be solved in time, as many electronics and mobile phone manufacturers turn to so-called 'Smartphones', which are effectively hybrids of mobile phones and PDAs, providing most of the benefits of both. ter Hofte [2007] discusses using Smartphones for collecting user data, both contextual and otherwise, in an entirely ubiquitous way for scientific studies and, as many Smartphones conveniently run a variant of Windows Mobile, the task of porting Imouto to a Smartphone is trivial. A Smartphone running Imouto, connected via Bluetooth to a GPS receiver clipped to the user's belt or in a shirt pocket will provide all the functionality of having Imouto running on a GPS-enabled PDA, with much less inconvenience to the user. Having the software running on the user's phone has additional benefit that the software may be further developed to gather additional information not available to a normal PDA, such as the user's phone call history and SMS inbox.

7.3 Privacy and Security

Human nature is not transparent. There are things that we would rather not tell certain people, often with very good reason. The main problem with attempting to apply some kind of security to the system described in Chapter 5 is that the system has no concept of identity. There is currently no security at all in the software but the only reason that this is acceptable is because it is intended to be used by one person and one person alone. If the system were to be developed further so that it allowed the sharing of information with other individuals, there would need to be some kind of identity checking in order to be useful. There may be times when it may be beneficial to share data. Wikipedia[4] is a good example of how a communal knowledge store can become a world-renowned information centre. But in order for something to appear on Wikipedia it must be manually entered by a human being and humans are clever enough to not enter information about themselves that could compromise their own security or well-being onto a public forum. A computer may not be as clever and there may be information that can and should be shared among the general public as well as information that should remain private. For example, a local politician may wish to share information on his/her recent activities with a doctor who is attempting to diagnose an illness, yet would not wish to reveal those whereabouts to a competing party who could use the information against him/her. Information on its own is harmless, provided it stays out of the wrong hands.

7.3.1 Data Protection

We live in a time when identity theft is common in the news. A popular high street bank was fined £980,000 sterling after a laptop containing the personal details of eleven million customers was stolen [BBC News Online 2007b] and many businesses, including twelve UK banks, have been criticised in the press for not disposing of people's personal data properly [BBC News Online 2007a]. People are being urged to shred their junk mail rather than throwing it away, especially if it contains personal information such as names and addresses, for fear of identity fraud. According to a survey by *Which?* Magazine in 2005, 25% of adults in the UK have been a victim of identity fraud or know someone who has and, according to a press release by the Home Office dated 2nd February 2006, identity fraud costs the UK economy £1.7 billion per year.

When dealing with any life data, we need to be sure it remains in the right hands. With a single user system the responsibility is placed entirely on the user and it is the user who is solely at risk of repercussions if the information is lost or stolen. However, when dealing with data relating to others, the user is suddenly responsible for the information of other people besides him/herself. The question is whether or not others may be willing to make their information available to other people who may, possibly through no fault of their own, lose their data or make it available to undesirable characters.

Obviously, if a small device that may be easily lost or stolen is storing such a large amount of personal information, security is a large concern. At present the software

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

contains no protection against loss or theft other than the device's own password functionality. However, this is just one device; if the devices are to be distributed and able to communicate with each other, even if just being able to detect the presence of each other, the user's security must be taken seriously. The device must not give out more information than necessary as if a device is lost a serious breach of privacy may occur.

To argue this concern, we need only look at mobile phones as personal organisers. In the last five years, mobile phones have gone from being a gadget for the rich to an essential item for anyone. Modern phones also work as personal organisers and media centres, most with built-in cameras, and users store large amounts of personal data on them, both their own and other people's. Losing a mobile phone five years ago was an expensive mistake but easily rectified. Nowadays if a phone is lost, a large amount of data will most likely be lost with it. This data may be backed up elsewhere but not having access to the data is often less worrying than the thought of someone else having access to it. If a phone is found, or worse, stolen, a stranger has access to the photos, text messages and contacts lists of the legitimate owner. Despite this risk, people are still willing to give their contact details to others, ignoring, or perhaps unaware of the risks of doing so. The rise of social networks indicates that people are more than happy to release some of their personal data onto the Web for anyone to see, again despite the risks this action implies. Therefore, we can reasonably assume that people will be as liberal when it comes to sharing life annotations, especially if there is a personal benefit in doing so.

7.3.2 Distributed Security

Aside from personal privacy issues, security in the context of data sharing is also a large concern. Any time a user shares information he or she must determine that they are happy to allow the information to be shared with the third party in question. This is not as simple as it seems and most security issues stem from the simple fact that absolute proof of identity is inconceivable. An example scenario: Alice is a computer expert and has, therefore, taken every precaution to safeguard the information stored on her personal device from hacking attempts. Bob is a malicious user with a grudge against Alice and would like to access restricted information on her computer system. The most logical method for Bob to take is to attempt to hack into Alice's computer to retrieve the data but this proves difficult due to sufficient security on the device. However, consider the fact that Alice may have a trusted friend, Charlie, who also has his own computer. Charlie is in no way concerned with security as he believes he has nothing to hide. Bob's task is, therefore, made much simpler, as all he now has to do is compromise Charlie's device in order to masquerade as him and request the information from Alice's device. As Alice trusts Charlie, she releases the information, completely unaware that she is actually sharing the information with Bob, who is effectively 'hacking by proxy'. This scenario can be applied to a personal life annotation system such as Imouto. Obviously, a user should be able to disable GPS logging if the occasion called for it but as Imouto is able to detect the presence of nearby devices then turning GPS logging off is not a secure way of covering tracks if other users are also able to run the software. If Alice is in a location and wishes to keep her presence there a secret, she can turn off her GPS logging. However, if Charlie lives next door and has not turned off GPS logging, it may be possible to determine from Charlie's device that Alice was in close proximity at the time, therefore, making her act of disabling logs futile. This risk can be thwarted simply by Alice turning Bluetooth off as well but, as more methods of tracking people's behaviour are appearing, one must keep ahead of the game in order to protect personal privacy and many may simply not bother.

7.3.3 Attitudes to Security

It is almost impossible, without some kind of user study, to predict whether the potential breach in personal security that Imouto carries will be acceptable to the general population or not. As soon as one mentions tracking and the storing of data, many people immediately question the moral and ethical issues. The proxy method mentioned in Section 7.3.2 is already a risk when using social networking sites such as Facebook; if looking for information on a user who has chosen to make their profile private, one need only look at the profiles of the people they list as 'friends' that have chosen not to take such precautions and much of the information, such as photographs or opinions on various issues, is often duplicated there.

Despite this apparent apathy towards security when putting personal information on a publicly accessible place, there is still a great deal of controversy in the press relating to new technology that may be used to spy on people, such as RFID tags[5] and national identity cards[6]. The only real conclusion that can be drawn from this apparent conflict in interest is that if a company were to attempt to produce and sell a life annotation system, it would need to be marketed very carefully; if there is a pattern in people's attitudes to personal security it is that people are more likely to trust devices which have an obvious benefit to the individual. National identification cards and RFID are hot topics of debate and scare stories about the risks involved are commonly in newspapers and other media. Yet mobile phone location tracking and Bluetooth discovery do not seem to provoke the same reaction.

7.3.4 Inaccurate Information - Blessing or Curse?

Gandon and Sadeh [2004] describes a novel solution to the security problem. The My-

[5]http://news.bbc.co.uk/1/hi/technology/6691139.stm
[6]http://www.no2id.net/

Campus system may obfuscate restricted data. Either it will be intentionally vague about information, or in some cases, such as if an unauthorised system attempts to query a user's private e-mail address for no good reason, the system will simply lie and return false information. This provides an interesting study point.

Supposing a system is designed only to store verifiable, factual information, refuse access to unknown devices or users and assume that all data is reliable. Obviously, it is desirable that no potentially false information is incorporated into the system for it to maintain its integrity. However, if the intention is to model real life, then lying may actually be healthy. Considering the example of Alice, Bob and Charlie. If Charlie's personal device were to pick up the presence of Alice and the system only ever stored factual information, we have conclusive proof of Alice's location at that time. However, supposing it were possible for a device to lie, this is supporting evidence but not conclusive proof in the slightest. Perhaps the classmate has a grudge against the child and wishes to frame him/her. It would be naive and foolish to assume all data collected on everyone's devices was reliable, as no consumer device is safe from tampering. So, even if the ability to lie was not built into the system at the manufacturer, the reliability of the data shared from other devices cannot be trusted 100%. But rather than viewing this as a flaw, it is also possible to view it as an additional security feature. This would encourage the source of all information to be tracked; it is unwise to trust information from an unknown source, as shown in Section 2.2.3.

7.4 Future Work

This section will investigate real-world uses for both the software and the data produced as part of this work. Collecting data is all well and good but, as suggested in Section 2.3, unless the data has a use it is merely data. Section 5.6 describes the Imouto software and the benefits it presents to its user alongside its logging functionality and these need to be developed in order to provide instant gratification to the user. Particularly from a commercial point of view, people are unlikely to purchase or use a system which may become useful some time in the future but they are likely to purchase a device that provides real benefit in the present. However, if it is possible to build a comprehensive life annotation system capable of writing a biography of the user as suggested in Section 4.6, then it should be noted that the user may stop using the system, or worse, suddenly die at any point in time, so there should not realistically be a minimum amount of data required for the system to function.

The current implementation is designed for one specific user. It runs on a Windows Mobile PDA, which is sufficient for the test subject because he relies on his PDA to keep his appointments. Therefore, the appointment data collected over the past two years has been correct and up-to-date. It should also be noted that the information collected so far has been personal; only one person is described by the data and the additional information such as the 'known location' data that allows the map function to work must be input manually. Finally, test subject was required to leave the device turned on and this was not always possible or desirable, as shown in Section 6.3.1.1.

The first step towards improving the system itself is to get it running on a familiar and already ubiquitous device such as a mobile phone. In today's society a phone is seen by many as an essential tool and is rarely absent or off. Therefore, it would be an ideal platform on which to run life annotation software. Additional benefits include logging of calls and messages in order to better identify social interactions. This will allow the development of a social annotation tool that assists the user whenever possible, as a mobile phone already does. It will also theoretically allow a similar study to the one presented in this thesis to be run, returning much more contextual data. But it also opens the door for several tools that are useful to ordinary, non-academic people.

7.4.1 Mobile Data Access and Processing

The method of analysing much of the data happened on the host PC. The role of the mobile device was simply to gather data and, despite a small amount of number-crunching taking place in order to draw the 'radar' and calculate the user's speed, there is not much going on besides data collection. This is beneficial due to the low processing power of the majority of hand-held devices and lack of mobile internet access but as processor power increases and ubiquitous internet access becomes a reality, the potential for greater levels of data processing on the move increases and the need for a host PC to store and analyse the user's life is reduced.

For example, a mobile device knows where the user is located through GPS data but may also note that the user has no pressing appointments in the near future and lunch time is approaching. The mobile device may then take the liberty of using its internet connection to locate a nearby restaurant based on the user's tastes in food. If the device detects any similar devices nearby and notes them as being owned by regular contacts of the user, it may also take the other person's tastes in food into account and suggest a food establishment that suits everyone. This example is important, because it adds additional beneficial purpose to life annotation besides simply 'outsourcing' memories.

7.4.2 Trusted Data Transfer

So far throughout this thesis, the emphasis has been on storing personal data for personal use and augmenting it with public data in order to gain more understanding of it. But of course, an additional benefit of keeping 'memory' on a digital medium is that it can be transferred easily using the methods described in Section 5.7, among others. This is useful because virtually any profession that involves sorting out other people's problems involves diagnosis, which is usually the hardest part of the job. A good example is a doctor trying to diagnose a patient. If a patient picked up an illness on holiday but did not develop symptoms until a few weeks later, the patient may not think to tell the doctor about the holiday and the doctor may not be able to diagnose the problem correctly without all the information. If it were possible to allow the doctor temporary access to a summary of the patient's actions for the last six months, the doctor would spot that the patient had been to an area and not had the proper immunisation first, thus diagnosing the problem without the doctor having to ask the patient any questions. If the system were to log health issues it may not even be necessary for the doctor to make the diagnosis; a computer could analyse the patient's actions and health status and notice that the health diminished at the time of being on holiday, enabling the computer to alert the doctor immediately to the problem.

Of course, as discussed previously in Section 7.3.2, if the transfer of personal data is mentioned, it must be decided exactly how much of this information may be shared. If dealing with information from multiple sources, it must be determined what may be classed as information personal to the user in question and how much non-personal information may be redistributed without explicit permission. To some extent, the existing Imouto system already stores some personal data of others without explicit permission, in the form of Bluetooth device signatures. However, it could also be argued that it is the *encounters* with these devices that is being logged, rather than information about the devices themselves. From an RDF point of view, the devices being sensed are the object of a triple rather than the subject. Therefore, it can be realistically claimed that Imouto as it stands raises no ethical issues, especially when one considers that the owners of devices being sensed may easily render themselves invisible to such contextual scans by disabling Bluetooth on their portable devices unless it is being used. But although it can be argued that the owners of the devices were implicitly allowing a user of the Imouto system to store a record of their interaction, it certainly can not be argued that they are also giving permission for the user to share it with others or combine it with other data, especially if the amount of information involved is high. To use an analogy: it is perfectly reasonable for Alice to say to Bob "I saw my mate Charlie in the bar yesterday evening" but not reasonable for her to then give out Charlie's full name, address, phone number and current whereabouts for no good reason. The sharing of information gained from other sources or sharing of information that has been refined so that it is not raw data any more has the potential to be dangerous, immoral, or even illegal. More research is required in the field, perhaps collaborating with lawyers and human rights groups, but this is beyond the scope of this thesis and is the main reason that the system developed as part of the work has had a strong emphasis on personal life annotation.

7.4.3 An Ubiquitous Social Network

Social networks are a relatively new trend that have been mentioned several times throughout the text of this document. According to Berners-Lee et al. [2006], the Web is actually evolving, becoming less of a web of documents and more of a web of people. Many sites such as MySpace[7], FaceBook[8] and Bebo[9] have begun to produce networks of people, all interconnected. Users adding people to their own social network are able to keep track of these people and what they do. Most social networking sites provide ways of sharing photos and video as well as determining who was online and when. Facebook in particular describes itself as an application platform and has a rich API for developers to use in order to build social applications. This has already given way to an application created as part of the Cityware Project[10], which allows people who know each other online to track their positions in the real world using their Bluetooth-enabled mobile devices. This is similar to Loca [Humphries et al., 2007] but aims to showcase the benefits of ubiquitous device tracking, rather than the privacy risks. Additionally, there is a software application known as Sensor[11] by Nokia, designed to run on many of the organisation's phone handsets. The system allows users to make public a large amount of personal information via Bluetooth, rather than simply a friendly name, encouraging spontaneous social communication amongst its users.

There is already work being carried out [O'Neill et al., 2006, Humphries et al., 2007] in the field of ubiquitous social networking, mostly passive. There is much potential for this to increase with the use of personal mobile technology. For example, if looking for a friend in a large area, it could be possible for a user to query their friend's location sensor device and compare it to their own. Additionally, there is much work [Humphries et al., 2007, Payne et al., 2006] that uses non-portable sensor networks to detect nearby Bluetooth devices and react accordingly, yet this is an ideal application for a mobile device. If a system like Imouto were to log all nearby Bluetooth signatures and store them for future reference, it would be possible to determine not only where the user was at any given time but also who else was around them. This would be useful both in the present, to determine the presence of nearby friends or colleagues, and in the future, for determining the last time you encountered a particular person.

7.4.4 A Portable Digital Nomenclator

The word 'Nomenclator' means 'name caller' in Latin. In modern times a person described as a nomenclator will be assigned the job of inventing names for products, processes or terminology. However, during the Roman Empire a nomenclator was an

[7] http://www.myspace.com/
[8] http://www.facebook.com/
[9] http://www.bebo.com/
[10] http://www.cityware.org.uk/
[11] http://www.nokia-asia.com/A4416020

individual who remembered names and basic personal information on behalf of a VIP. The job of the nomenclator was to follow his master around and inform him of the people he meets.

Now that many roles and, indeed, basic human functions such as memory have been outsourced to computers, this would be the ideal application for a portable device and one for everyone rather than just VIPs. As previously discussed, it is possible to use Bluetooth to determine the location of familiar devices. This allows development of such a system to begin immediately without the need for other people to own similar systems, as Bluetooth devices are already widespread. A drawback to this system is the lack of available data on who owns which device.

7.4.4.1 Identification by Bluetooth

If a system were to log the signatures of any Bluetooth devices encountered, alongside other contextual data, it could inform the user of the presence of any device seen previously as well as the context in which the device was last seen, such as where, when or what the user's calendar says he or she was doing at the time. But these are still just numbers. If the device were to log the friendly names of nearby devices as well as keeping a 'top 20' list of the most commonly encountered devices, it is not unreasonable to request the user checks the list every now and then in order to match device to user. If the functionality were to be actually built into a mobile phone, there is a good chance that the user already has his or her contacts stored in there anyway, thus removing the need to manually enter them. Once the user has identified a device's owner, the system should create a link between the two, allowing the user to determine the presence of his/her contacts.

As the Semantic Web grows, information about people's devices may become public. For example, if an extension to the Friend of a Friend vocabulary were proposed that would allow individuals to publish their devices' Bluetooth signatures, the truly mobile devices of the future could scan the local area to determine the names of people present. Even if this were not the case, it may still be possible to identify the owners of any nearby devices. Supposing the user meets a colleague who he/she has met several times before. If, for example, all the previous encounters were at conferences or public events, the device would be able to search the attendance lists and build a shortlist of the people who were at all of them, in an attempt to make an educated guess as to who the person is. It may even be possible to combine this information with GPS data and semantic data already available online in order to do this automatically. For example, the user has an appointment in his/her calendar which is set to occur at 'Dave's house'. As shown in Section 7.1, it is theoretically possible to determine by comparing the GPS data to the user's address book that the user is visiting the residence of 'Dave', a contact. Supposing one Bluetooth signature was visible to the user's device every time he/she had an appointment at Dave's house – there is a very good chance that this signature is Dave's.

A more advanced system would be one that maps Bluetooth signatures to Facebook profiles. With mobile internet a reality, it is possible to access information from the Web from almost anywhere and Facebook already has a reasonably robust security system for personal information. It is possible to make a profile public or private, so those looking to pick up a date can do so in the same way they would with Sensor, by making their Facebook profile public, but those who do not wish to be known to anyone other than their 'approved' contacts can set their profile to private. This means that although a user's friends can know the time and location of their last encounter, nobody else can. Interestingly, Facebook allows users to limit the people who can see their profile to their own 'networks'. These can be regional or institutional, so if a user was the president of a university's students union he or she can make their profile public only to people in that particular university. This allows the unique scenario whereby both the union president and another user from his/her university may be visiting another university. The two visiting students may see each other but not necessarily anyone else. Equally, people travelling abroad could be made aware of people from their regional network nearby.

The obvious disadvantage to such a system is data protection. Facebook is free to use and relies on advertising for income. But the Facebook servers contain a massive amount of personal information, which is all controlled by one company. If this company decided to stealthily change their terms of use to allow their advertisers access to this information, or worse, if the company were to be hacked and all this information stolen, it becomes a one-stop shop for identity fraud and information theft. A more distributed system is preferable in this case. However, according to Facebook's own statistics[12] at time of writing, they have 70 million active users and all of these are individuals who clearly trust Facebook with some or all of their personal information.

7.5 Concluding Remarks

To conclude, a summary of the study and its findings will now be presented.

7.5.1 Findings of the Study

The main lesson learned by the study presented in this work is that Life Annotation is indeed possible and will become more efficient as technology improves and more data becomes available. The analysis of the study shows that the three data sources are much more complete and useful than either of them on their own, as explained in Section 6.4. Although all the data sources together are still not enough to give complete intricate

[12] http://www.facebook.com/press/info.php?statistics

detail on a user's life history, the amount of information is sufficient to answer simple questions and certainly more useful than any of the three data sources individually.

7.5.1.1 Data Fusion

The main emphasis of this study has been the value of data fusion, or "mash-ups". As shown in Section 6.3.2.1, there is an increasing trend in combining various different types of data and this study has shown that the more sources of data used to produce a result, the more useful a result is likely to be. On the other hand, this also gives a stern warning that as the amount of data collected increases, so too does the potential for abuse of this data. The focus of this thesis has been to collect publically available information and merge them with the personal data of the user. There is currently no intention to share or make available to anyone else the personal data of the user or any derivative, yet this may be beneficial in future work, although such practices would need to be closely monitored for reasons of data protection and ethics.

7.5.1.2 Data Organisation and Representation

Another lesson learned during the collection of the data is that there need be no standard storage format for the data. The data stored on the device is stored in a plain text file, the most capacity-efficient storage format available, and is imported into a relational database when the device is synchronised with a host PC. The database is a good place in which to store the data as it may be queried easily. Querying the last time the user was near a particular land mark is simple in an indexed table, more so than a collection of text files which must be checked from beginning to end in order to find the data needed. This echoes a claim made in Chapter 3 that there is no such thing as too much information, provided it is organised in a way that makes it easy to query later. Organising the data in a raw form also gives us the opportunity to output it in many different formats when required, as shown in Section 5.7, allowing the user to make the best use of his own life annotations as possible.

7.5.2 Contributions

The contributions of this study are:

- An ubiquitous automatic life annotation system for a single user.
- The use of this system to collect a large amount of personal life annotations for a test user.

- An analysis of that data and how useful it is to its owner, both now and in the future.

This work has covered the development and use of the system. It presents statistical analysis as well as providing insight into how the system may be developed in a world where information is becoming more readily available to all.

7.5.2.1 Additional Suggestions

It has been proposed in the concluding chapter of this work that more studies should be carried out in order to investigate which sources are of more use than others and what sources may be merged together. It has been suggested in Section 7.4, echoing previous work [Smith et al., 2005] on automatic photo annotation, that other additional information such as local news and weather reports may be used to augment our own annotations. It has also been proposed that GPS and Bluetooth may be used in conjunction with each other to determine the location of other individuals. This is influenced by the work described in Humphries et al. [2007] and O'Neill et al. [2006] and takes the work further towards a truly ubiquitous, distributed system albeit one that has many security and privacy implications, as shown in Section 7.3. Finally, it has been suggested that, as always, the balance between convenience and security be carefully considered before developing this work further.

Appendix A

Summary of Collected Data

This appendix contains a summary of the complete data set collected as part of the study.

Location Data

Number of days logged	650 days
Total distance	28,665.18 miles
Maximum distance from home	(2007-05-08) 199.5 miles
Furthest travelled in a day	(2007-05-06) 237.28 miles
Average daily distance from home	14.42 miles
Average distance per day	44.1 miles
Average fixes per day	6041.27
Total fixes	3,926,828

Activity Data

Number of days logged	650 days
Maximum length of appointment	262,800 seconds (3 days)
Minimum length of appointment	300 seconds (5 minutes)
Average length of appointment	18,269.9 seconds (5.07 hours)
Total appointments in log	303

Interaction Data

Number of days logged	229 days
Average unique devices per day	17.47
Average encounters per day	1987.37
Maximum unique devices per day	(2007-11-07) 149
Maximum encounters per day	(2008-02-22) 16,766
Maximum encounters per device	93827
Average encounters per device	113.78
Total unique devices	4,000
Total encounters logged	455,107

Appendix B

Location Data

This appendix contains a selection of raw data from the collected GPS data set. Ideally, the complete data set would be included here but this would require tens of thousands of pages. For this reason, a week of data has been provided and it has been slightly modified from its original form. Firstly, the data has been condensed to minutes rather than seconds by taking an average by the minute. Secondly the data has been censored slightly for reasons of privacy - all data within an arbitrary distance from the subject's home has been removed.

B.1 Tuesday 4th December 2007

18:24	50.89600, -1.30978	18:25	50.88540, -1.28928
18:26	50.87745, -1.26780	18:27	50.87245, -1.24655
18:28	50.86785, -1.22071	18:29	50.86769, -1.19252
18:30	50.86243, -1.16574	18:31	50.85658, -1.13965
18:32	50.85461, -1.11573	18:33	50.84427, -1.09532
18:34	50.83750, -1.07267	18:35	50.83494, -1.04702
18:36	50.84095, -1.02573	18:37	50.85206, -1.01389
18:38	50.86883, -1.01573	18:39	50.87753, -1.01840
18:40	50.88104, -1.02824	18:41	50.88538, -1.02692
18:42	50.89111, -1.02255	18:43	50.89258, -1.02617
18:44	50.89244, -1.02648	18:45	50.89244, -1.02648
18:46	50.89244, -1.02648	18:47	50.89244, -1.02648
18:48	50.89244, -1.02648	18:49	50.89244, -1.02648
18:50	50.89244, -1.02648	18:51	50.89244, -1.02648
18:52	50.89244, -1.02648	18:53	50.89244, -1.02648
18:54	50.89244, -1.02648	18:55	50.89244, -1.02648
18:56	50.89244, -1.02648	18:57	50.89244, -1.02648
18:58	50.89244, -1.02648	18:59	50.89244, -1.02648
19:00	50.89244, -1.02648	19:01	50.89244, -1.02648
19:02	50.89244, -1.02648	19:03	50.89244, -1.02648
19:04	50.89244, -1.02648	19:05	50.89244, -1.02648
19:06	50.89244, -1.02648	19:07	50.89244, -1.02648
19:08	50.89244, -1.02648	19:09	50.89244, -1.02648
19:10	50.89244, -1.02648	19:11	50.89244, -1.02648
19:12	50.89244, -1.02648	19:13	50.89244, -1.02648
19:14	50.89244, -1.02648	19:15	50.89244, -1.02648
19:16	50.89244, -1.02648	19:17	50.89244, -1.02648
19:18	50.89231, -1.02644	19:19	50.89229, -1.02643
19:20	50.89231, -1.02646	19:21	50.89233, -1.02649
19:22	50.89233, -1.02649	19:23	50.89226, -1.02653
19:24	50.89224, -1.02654	19:25	50.89224, -1.02643
19:26	50.89226, -1.02650	19:27	50.89237, -1.02650
19:28	50.89236, -1.02649	19:29	50.89237, -1.02647
19:30	50.89237, -1.02647	19:31	50.89237, -1.02647
19:32	50.89237, -1.02647	19:33	50.89237, -1.02647
19:34	50.89237, -1.02647	19:35	50.89237, -1.02647
19:36	50.89237, -1.02647	19:37	50.89237, -1.02647
19:38	50.89237, -1.02647	19:39	50.89237, -1.02647
19:40	50.89237, -1.02647	19:41	50.89238, -1.02642

19:42	50.89242, -1.02634	19:43	50.89242, -1.02634
19:44	50.89242, -1.02634	19:45	50.89242, -1.02634
19:46	50.89242, -1.02634	19:47	50.89242, -1.02634
19:48	50.89242, -1.02634	19:49	50.89242, -1.02634
19:50	50.89224, -1.02654	19:51	50.89222, -1.02656
19:52	50.89222, -1.02656	19:53	50.89222, -1.02656
19:54	50.89222, -1.02656	19:55	50.89222, -1.02656
19:56	50.89222, -1.02656	19:57	50.89222, -1.02656
19:58	50.89222, -1.02656	19:59	50.89222, -1.02656
20:00	50.89222, -1.02656	20:01	50.89222, -1.02656
20:02	50.89222, -1.02656	20:03	50.89222, -1.02656
20:04	50.89222, -1.02656	20:05	50.89223, -1.02643
20:06	50.89221, -1.02629	20:07	50.89222, -1.02621
20:08	50.89221, -1.02616	20:09	50.89221, -1.02616
20:10	50.89221, -1.02616	20:11	50.89221, -1.02616
20:12	50.89221, -1.02616	20:13	50.89225, -1.02635
20:14	50.89229, -1.02663	20:15	50.89229, -1.02663
20:16	50.89229, -1.02663	20:17	50.89229, -1.02663
20:18	50.89229, -1.02663	20:19	50.89229, -1.02663
20:20	50.89229, -1.02663	20:21	50.89229, -1.02663
20:22	50.89229, -1.02663	20:23	50.89229, -1.02663
20:24	50.89229, -1.02663	20:25	50.89229, -1.02661
20:26	50.89229, -1.02640	20:27	50.89229, -1.02640
20:28	50.89229, -1.02640	20:29	50.89229, -1.02640
20:30	50.89229, -1.02640	20:31	50.89229, -1.02640
20:32	50.89229, -1.02640	20:33	50.89229, -1.02640
20:34	50.89229, -1.02640	20:35	50.89229, -1.02640
20:36	50.89229, -1.02640	20:37	50.89229, -1.02640
20:38	50.89229, -1.02640	20:39	50.89229, -1.02640
20:40	50.89229, -1.02640	20:41	50.89229, -1.02640
20:42	50.89229, -1.02640	20:43	50.89229, -1.02640
20:44	50.89229, -1.02640	20:45	50.89229, -1.02640
20:46	50.89229, -1.02640	20:47	50.89229, -1.02640
20:48	50.89229, -1.02640	20:49	50.89229, -1.02640
20:50	50.89229, -1.02640	20:51	50.89229, -1.02640
20:52	50.89229, -1.02640	20:53	50.89229, -1.02640
20:54	50.89229, -1.02640	20:55	50.89229, -1.02640
20:56	50.89229, -1.02640	20:57	50.89229, -1.02640
20:58	50.89229, -1.02640	20:59	50.89229, -1.02641
21:00	50.89251, -1.02690	21:01	50.89251, -1.02690
21:02	50.89251, -1.02690	21:03	50.89251, -1.02690

21:04	50.89251, -1.02690	21:05	50.89251, -1.02690
21:06	50.89251, -1.02690	21:07	50.89251, -1.02690
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21:10	50.89251, -1.02690	21:11	50.89236, -1.02670
21:12	50.89226, -1.02658	21:13	50.89226, -1.02658
21:14	50.89226, -1.02658	21:15	50.89226, -1.02658
21:16	50.89226, -1.02658	21:17	50.89226, -1.02658
21:18	50.89226, -1.02658	21:19	50.89226, -1.02658
21:20	50.89226, -1.02658	21:21	50.89226, -1.02658
21:22	50.89226, -1.02658	21:23	50.89226, -1.02658
21:24	50.89226, -1.02658	21:25	50.89226, -1.02658
21:26	50.89226, -1.02658	21:27	50.89226, -1.02658
21:28	50.89226, -1.02658	21:29	50.89226, -1.02658
21:30	50.89226, -1.02658	21:31	50.89226, -1.02658
21:32	50.89226, -1.02658	21:33	50.89226, -1.02658
21:34	50.89226, -1.02658	21:35	50.89226, -1.02658
21:36	50.89226, -1.02658	21:37	50.89226, -1.02658
21:38	50.89226, -1.02658	21:39	50.89226, -1.02658
21:40	50.89226, -1.02658	21:41	50.89226, -1.02658
21:42	50.89226, -1.02658	21:43	50.89226, -1.02658
21:44	50.89226, -1.02658	21:45	50.89227, -1.02657
21:46	50.89245, -1.02638	21:47	50.89244, -1.02638
21:48	50.89244, -1.02638	21:49	50.89244, -1.02638
21:50	50.89244, -1.02638	21:51	50.89244, -1.02638
21:52	50.89244, -1.02638	21:53	50.89244, -1.02638
21:54	50.89244, -1.02638	21:55	50.89244, -1.02638
21:56	50.89259, -1.02636	21:57	50.89220, -1.02269
21:58	50.88668, -1.02571	21:59	50.88064, -1.02629
22:00	50.87666, -1.01513	22:01	50.86537, -1.01589
22:02	50.84854, -1.01431	22:03	50.83771, -1.03324
22:04	50.83569, -1.06072	22:05	50.84088, -1.08868
22:06	50.85285, -1.11073	22:07	50.85658, -1.13965
22:08	50.86284, -1.16783	22:09	50.86772, -1.19667
22:10	50.86812, -1.22628	22:11	50.87427, -1.25415
22:12	50.88172, -1.28124	22:13	50.89252, -1.30487
22:14	50.90791, -1.31728		

B.2 Wednesday 5th December 2007

14:43	50.93101, -1.32308	14:44	50.93712, -1.34869
14:45	50.94578, -1.36569	14:46	50.94648, -1.37218
14:47	50.94006, -1.37892	14:48	50.93851, -1.38760
14:49	50.93830, -1.39312	14:50	50.93816, -1.39466
14:51	50.93805, -1.39515	14:52	50.93566, -1.39617
14:53	50.93411, -1.39443	14:54	50.93341, -1.39245
14:55	50.93250, -1.39395	14:56	50.93255, -1.39399
14:57	50.93327, -1.39370	14:58	50.93387, -1.39392
14:59	50.93418, -1.39498	15:00	50.93425, -1.39534
15:01	50.93401, -1.39542	15:02	50.93421, -1.39583
15:03	50.93410, -1.39560	15:08	50.93424, -1.39604
15:09	50.93433, -1.39526	15:10	50.93399, -1.39405
15:11	50.93332, -1.39364	15:12	50.93257, -1.39397
15:13	50.93232, -1.39447	15:14	50.93580, -1.39624
15:15	50.93841, -1.39127	15:16	50.93900, -1.38190
15:17	50.94318, -1.37547	15:18	50.94946, -1.37057
15:19	50.94238, -1.36025	15:20	50.93490, -1.33519
15:21	50.92490, -1.31639	18:42	50.91631, -1.29193
18:43	50.91869, -1.28811	18:44	50.92189, -1.27721
18:45	50.91617, -1.27073	18:46	50.91427, -1.26987
18:47	50.91361, -1.27071	18:48	50.91398, -1.27053
18:49	50.91450, -1.27035	18:50	50.91452, -1.27024
19:26	50.91443, -1.27039	19:27	50.91396, -1.27060
19:28	50.91388, -1.27061	19:29	50.91579, -1.27061
19:30	50.92107, -1.27608	19:31	50.92911, -1.28151
19:32	50.93874, -1.28863	19:33	50.94009, -1.29871
19:34	50.93384, -1.30715	19:35	50.92715, -1.31013
19:36	50.92317, -1.31340		

B.3 Thursday 6th December 2007

16:06	50.89877, -1.31193	16:07	50.89620, -1.31831
16:08	50.89388, -1.32054	16:09	50.89410, -1.32018
16:10	50.89455, -1.31985	16:22	50.89452, -1.32012
16:23	50.89412, -1.32012	16:24	50.89389, -1.32020
16:25	50.89343, -1.32053	16:26	50.89340, -1.32062
16:27	50.89334, -1.32068	16:28	50.89341, -1.32072

16:29	50.89340, -1.32097	16:30	50.89344, -1.32083
16:31	50.89358, -1.32113	16:32	50.89517, -1.32119
16:33	50.89621, -1.32052	16:34	50.89768, -1.31607
16:35	50.90668, -1.31705	19:12	50.93516, -1.33759
19:13	50.94208, -1.36059	19:14	50.94661, -1.37169
19:15	50.94157, -1.37641	19:16	50.93401, -1.38139
19:17	50.92621, -1.38624	19:18	50.92305, -1.38951
19:19	50.92250, -1.38877	19:20	50.92239, -1.38861
19:21	50.92220, -1.38837	19:22	50.92230, -1.38841
19:23	50.92237, -1.38850	19:24	50.92243, -1.38869
19:25	50.92249, -1.38877	19:26	50.92264, -1.38863
19:27	50.92255, -1.38869	19:28	50.92251, -1.38863
19:29	50.92264, -1.38869	19:30	50.92278, -1.38880
19:31	50.92263, -1.38872	19:32	50.92243, -1.38870
19:33	50.92249, -1.38873	19:34	50.92277, -1.38881
19:35	50.92246, -1.38874	19:36	50.92246, -1.38873
19:37	50.92234, -1.38872	19:38	50.92250, -1.38874
19:39	50.92246, -1.38876	19:40	50.92245, -1.38876
19:41	50.92245, -1.38876	19:42	50.92238, -1.38874
19:43	50.92243, -1.38873	19:44	50.92241, -1.38876
19:45	50.92233, -1.38873	19:46	50.92241, -1.38873
19:47	50.92253, -1.38873	19:48	50.92253, -1.38868
19:49	50.92253, -1.38867	19:50	50.92253, -1.38867
19:51	50.92253, -1.38867	19:52	50.92253, -1.38867
19:53	50.92253, -1.38867	19:54	50.92253, -1.38867
19:55	50.92254, -1.38867	19:56	50.92258, -1.38875
19:57	50.92253, -1.38874	19:58	50.92254, -1.38874
19:59	50.92237, -1.38872	20:00	50.92245, -1.38872
20:01	50.92256, -1.38873	20:02	50.92264, -1.38865
20:03	50.92248, -1.38862	20:04	50.92251, -1.38867
20:05	50.92224, -1.38873	20:06	50.92233, -1.38874
20:07	50.92245, -1.38877	20:08	50.92247, -1.38877
20:09	50.92247, -1.38877	20:10	50.92247, -1.38877
20:11	50.92242, -1.38866	20:12	50.92234, -1.38859
20:13	50.92238, -1.38869	20:14	50.92238, -1.38874
20:15	50.92235, -1.38872	20:16	50.92241, -1.38872
20:17	50.92241, -1.38876	20:18	50.92233, -1.38881
20:19	50.92072, -1.39041	20:20	50.92313, -1.38818
20:21	50.92794, -1.38513	20:22	50.93436, -1.38126
20:23	50.93989, -1.37798	20:24	50.94183, -1.37482
20:25	50.93869, -1.36496	20:26	50.93621, -1.35407

20:27	50.93202, -1.34680	20:28	50.92881, -1.34253
20:29	50.92758, -1.33531	20:30	50.92740, -1.33411
20:31	50.92731, -1.33435	20:32	50.92736, -1.33421
20:33	50.92721, -1.33411	20:34	50.92718, -1.33413
20:35	50.92759, -1.33403	20:36	50.92775, -1.33395
20:37	50.92776, -1.33395	20:38	50.92776, -1.33395
20:39	50.92776, -1.33395	20:40	50.92729, -1.33393
20:41	50.92717, -1.33409	20:42	50.92737, -1.33384
20:43	50.92741, -1.33382	20:44	50.92741, -1.33306
20:45	50.92684, -1.32276	20:46	50.92331, -1.31230

B.4 Friday 7th December 2007

12:13	50.93387, -1.33064	12:14	50.93938, -1.35590
12:15	50.94775, -1.36803	12:16	50.94374, -1.37470
12:17	50.94035, -1.37815	12:18	50.93870, -1.38486
12:19	50.93842, -1.39184	12:20	50.93837, -1.39251
12:21	50.93817, -1.39441	12:22	50.93805, -1.39490
12:23	50.93643, -1.39551	12:24	50.93634, -1.39539
12:25	50.93625, -1.39549	12:26	50.93602, -1.39591
12:27	50.93616, -1.39594	12:28	50.93651, -1.39590
12:29	50.93639, -1.39584	12:30	50.93635, -1.39566
12:31	50.93639, -1.39582	12:32	50.93649, -1.39585
12:33	50.93647, -1.39600	12:34	50.93644, -1.39592
12:35	50.93627, -1.39611	12:36	50.93626, -1.39611
12:37	50.93628, -1.39609	12:38	50.93645, -1.39589
12:39	50.93644, -1.39592	12:40	50.93644, -1.39592
12:41	50.93644, -1.39592	12:42	50.93644, -1.39592
12:43	50.93644, -1.39594	12:44	50.93640, -1.39588
12:45	50.93641, -1.39578	12:46	50.93642, -1.39585
12:47	50.93642, -1.39585	12:48	50.93642, -1.39585
12:49	50.93641, -1.39587	12:50	50.93642, -1.39599
12:51	50.93650, -1.39619	12:52	50.93639, -1.39622
12:53	50.93634, -1.39599	12:54	50.93639, -1.39610
12:55	50.93650, -1.39643	12:56	50.93651, -1.39640
12:57	50.93659, -1.39637	12:58	50.93642, -1.39623
12:59	50.93641, -1.39606	13:00	50.93645, -1.39598
13:01	50.93635, -1.39596	13:02	50.93624, -1.39560
13:03	50.93636, -1.39569	13:04	50.93638, -1.39575

13:05	50.93640, -1.39576	13:06	50.93653, -1.39576
13:07	50.93593, -1.39558	13:08	50.93603, -1.39576
13:09	50.93605, -1.39576	13:10	50.93620, -1.39573
13:11	50.93633, -1.39598	13:12	50.93649, -1.39630
13:13	50.93658, -1.39615	13:14	50.93648, -1.39582
13:15	50.93643, -1.39565	13:16	50.93640, -1.39564
13:17	50.93628, -1.39567	13:18	50.93681, -1.39627
13:19	50.93651, -1.39621	13:20	50.93646, -1.39596
13:21	50.93626, -1.39578	13:22	50.93642, -1.39580
13:23	50.93679, -1.39587	13:24	50.93658, -1.39589
13:25	50.93640, -1.39586	13:26	50.93640, -1.39582
13:27	50.93620, -1.39586	13:28	50.93639, -1.39591
13:29	50.93674, -1.39592	13:30	50.93644, -1.39586
13:31	50.93629, -1.39587	13:32	50.93653, -1.39577
13:33	50.93615, -1.39600	13:34	50.93624, -1.39585
13:35	50.93632, -1.39589	13:36	50.93625, -1.39587
13:37	50.93641, -1.39584	13:38	50.93638, -1.39582
13:39	50.93627, -1.39584	13:40	50.93622, -1.39586
13:41	50.93611, -1.39579	13:42	50.93618, -1.39579
13:43	50.93615, -1.39580	13:44	50.93621, -1.39579
13:45	50.93651, -1.39585	13:46	50.93624, -1.39589
13:47	50.93631, -1.39588	13:48	50.93636, -1.39587
13:49	50.93594, -1.39577	13:50	50.93614, -1.39584
13:51	50.93620, -1.39592	13:52	50.93615, -1.39593
13:53	50.93645, -1.39579	13:54	50.93587, -1.39591
13:55	50.93609, -1.39586	13:56	50.93579, -1.39591
13:57	50.93582, -1.39594	13:58	50.93579, -1.39596
13:59	50.93570, -1.39590	14:00	50.93608, -1.39590
14:01	50.93571, -1.39590	14:02	50.93575, -1.39590
14:03	50.93636, -1.39589	14:04	50.93597, -1.39587
14:05	50.93578, -1.39590	14:06	50.93602, -1.39587
14:07	50.93515, -1.39603	14:08	50.93637, -1.39578
16:34	50.93650, -1.39559	16:35	50.93530, -1.39618
16:36	50.93165, -1.39246	16:37	50.93020, -1.38636
16:38	50.93137, -1.38314	16:39	50.93902, -1.37842
16:40	50.94099, -1.37713	16:41	50.94777, -1.37215
16:42	50.94945, -1.36934	16:43	50.94032, -1.35717
16:44	50.93527, -1.33682	16:45	50.92685, -1.31813
19:29	50.90987, -1.29854	19:30	50.90811, -1.29590
19:31	50.90831, -1.29579	19:32	50.90830, -1.29585
19:33	50.90837, -1.29595	19:34	50.90843, -1.29595

19:35	50.90832, -1.29618	19:36	50.90832, -1.29622
19:37	50.90855, -1.29613	19:38	50.90859, -1.29611
19:39	50.90859, -1.29611	19:40	50.90841, -1.29614
19:41	50.90839, -1.29616	19:42	50.90837, -1.29610
19:43	50.90842, -1.29604	19:44	50.90849, -1.29591
19:45	50.90849, -1.29591	19:46	50.90849, -1.29591
19:47	50.90849, -1.29591	19:48	50.90849, -1.29591
19:49	50.90849, -1.29591	19:50	50.90849, -1.29591
19:51	50.90847, -1.29605	19:52	50.90844, -1.29604
19:53	50.90841, -1.29601	19:54	50.90821, -1.29609
19:55	50.90821, -1.29609	19:56	50.90821, -1.29609
19:57	50.90821, -1.29609	19:58	50.90821, -1.29609
19:59	50.90821, -1.29609	20:00	50.90821, -1.29609
20:01	50.90821, -1.29609	20:02	50.90821, -1.29609
20:03	50.90821, -1.29609	20:04	50.90821, -1.29609
20:05	50.90821, -1.29609	20:06	50.90824, -1.29613
20:07	50.90842, -1.29617	20:08	50.90852, -1.29619
20:09	50.90852, -1.29619	20:10	50.90852, -1.29619
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20:13	50.90840, -1.29614	20:14	50.90829, -1.29632
20:15	50.90828, -1.29633	20:16	50.90828, -1.29633
20:17	50.90828, -1.29633	20:18	50.90829, -1.29636
20:19	50.90847, -1.29630	20:20	50.90841, -1.29620
20:21	50.90836, -1.29623	20:22	50.90836, -1.29626
20:23	50.90839, -1.29620	20:24	50.90836, -1.29622
20:25	50.90839, -1.29617	20:26	50.90846, -1.29616
20:27	50.90850, -1.29616	20:28	50.90849, -1.29615
20:29	50.90849, -1.29615	20:30	50.90849, -1.29615
20:31	50.90841, -1.29610	20:32	50.90838, -1.29608
20:33	50.90839, -1.29626	20:34	50.90839, -1.29633
20:35	50.90845, -1.29622	20:36	50.90848, -1.29617
20:37	50.90844, -1.29619	20:38	50.90841, -1.29622
20:39	50.90841, -1.29627	20:40	50.90841, -1.29627
20:41	50.90844, -1.29625	20:42	50.90858, -1.29616
20:43	50.90848, -1.29618	20:44	50.90840, -1.29618
20:45	50.90837, -1.29641	20:46	50.90839, -1.29628
20:47	50.90843, -1.29603	20:48	50.90840, -1.29608
20:49	50.90840, -1.29608	20:50	50.90840, -1.29608
20:51	50.90840, -1.29608	20:52	50.90838, -1.29626
20:53	50.90843, -1.29615	20:54	50.90839, -1.29609
20:55	50.90839, -1.29609	20:56	50.90844, -1.29614

20:57	50.90854, -1.29605	20:58	50.90853, -1.29606
20:59	50.90853, -1.29606	21:00	50.90853, -1.29606
21:01	50.90853, -1.29606	21:02	50.90855, -1.29601
21:03	50.90855, -1.29601	21:04	50.90855, -1.29601
21:05	50.90855, -1.29601	21:06	50.90855, -1.29601
21:07	50.90856, -1.29603	21:08	50.90852, -1.29608
21:09	50.90854, -1.29604	21:10	50.90854, -1.29604
21:11	50.90854, -1.29605	21:12	50.90852, -1.29611
21:13	50.90856, -1.29614	21:14	50.90858, -1.29615
21:15	50.90850, -1.29610	21:16	50.90853, -1.29605
21:17	50.90853, -1.29605	21:18	50.90853, -1.29605
21:19	50.90853, -1.29605	21:20	50.90843, -1.29616
21:21	50.90836, -1.29614	21:22	50.90839, -1.29606
21:23	50.90779, -1.29630	21:24	50.90786, -1.29623
21:25	50.90840, -1.29610	21:26	50.90845, -1.29615
21:27	50.90836, -1.29617	21:28	50.90851, -1.29630
21:29	50.90846, -1.29630	21:30	50.90836, -1.29641
21:31	50.90834, -1.29604	21:32	50.90839, -1.29605
21:33	50.90841, -1.29613	21:34	50.90841, -1.29613
21:35	50.90841, -1.29613	21:36	50.90841, -1.29613
21:37	50.90861, -1.29613	21:38	50.90854, -1.29621
21:39	50.90850, -1.29616	21:40	50.90847, -1.29621
21:41	50.90857, -1.29604	21:42	50.90851, -1.29609
21:43	50.90851, -1.29620	21:44	50.90849, -1.29624
21:45	50.90853, -1.29630	21:46	50.90849, -1.29624
21:47	50.90841, -1.29608	21:48	50.90840, -1.29619
21:49	50.90842, -1.29617	21:50	50.90832, -1.29624
21:51	50.90854, -1.29612	21:52	50.90843, -1.29621
21:53	50.90830, -1.29622	21:54	50.90834, -1.29620
21:55	50.90847, -1.29614	21:56	50.90847, -1.29614
21:57	50.90847, -1.29614	21:58	50.90844, -1.29615
21:59	50.90843, -1.29615	22:00	50.90826, -1.29626
22:01	50.90823, -1.29628	22:02	50.90825, -1.29617
22:03	50.90851, -1.29612	22:04	50.90832, -1.29613
22:05	50.90851, -1.29620	22:06	50.90852, -1.29601
22:07	50.90858, -1.29612	22:08	50.90819, -1.29627
22:09	50.90892, -1.29624	22:10	50.90876, -1.29623
22:11	50.90831, -1.29619	22:12	50.90861, -1.29633
22:13	50.90850, -1.29621	22:14	50.90872, -1.29623
22:15	50.90817, -1.29623	22:16	50.90815, -1.29627
22:17	50.90883, -1.29642	22:18	50.90842, -1.29606

22:19	50.90853, -1.29613	22:20	50.90822, -1.29612
22:21	50.90827, -1.29614	22:22	50.90843, -1.29611
22:23	50.90866, -1.29619	22:24	50.90852, -1.29595
22:25	50.90865, -1.29610	22:26	50.90863, -1.29607
22:27	50.90840, -1.29606	22:28	50.90807, -1.29605
22:29	50.90841, -1.29603	22:30	50.90842, -1.29614
22:31	50.90845, -1.29608	22:32	50.90835, -1.29607
22:33	50.90852, -1.29614	22:34	50.90856, -1.29612
22:35	50.90861, -1.29621	22:36	50.90871, -1.29614
22:37	50.90839, -1.29609	22:38	50.90871, -1.29598
22:39	50.90863, -1.29599	22:40	50.90826, -1.29613
22:41	50.90826, -1.29610	22:42	50.90833, -1.29615
22:43	50.90840, -1.29620	22:44	50.90835, -1.29610
22:45	50.90837, -1.29622	22:46	50.90831, -1.29629
22:47	50.90799, -1.29621	22:48	50.90764, -1.29599
22:49	50.90762, -1.29599	22:50	50.90799, -1.29608
22:51	50.90840, -1.29617	22:52	50.90842, -1.29616
22:53	50.90875, -1.29602	22:54	50.90838, -1.29599
22:55	50.90830, -1.29601	22:56	50.90833, -1.29592
22:57	50.90829, -1.29587	22:58	50.90828, -1.29597
22:59	50.90835, -1.29605	23:00	50.90842, -1.29621
23:01	50.90838, -1.29619	23:02	50.90845, -1.29607
23:03	50.90844, -1.29603	23:04	50.90833, -1.29611
23:05	50.90839, -1.29580	23:06	50.90840, -1.29572
23:07	50.90828, -1.29607	23:08	50.90834, -1.29612
23:09	50.90830, -1.29607	23:10	50.90841, -1.29608
23:11	50.90837, -1.29603	23:14	50.90848, -1.29600
23:15	50.90864, -1.29655	23:16	50.90844, -1.29613
23:17	50.90834, -1.29599	23:18	50.90833, -1.29602
23:19	50.90850, -1.29601	23:21	50.90863, -1.29611
23:22	50.90855, -1.29609	23:23	50.90840, -1.29617
23:24	50.90836, -1.29607	23:25	50.90826, -1.29605
23:26	50.90841, -1.29613	23:27	50.90841, -1.29613
23:28	50.90853, -1.29587	23:29	50.90855, -1.29608
23:30	50.90855, -1.29615	23:31	50.90850, -1.29615
23:32	50.90839, -1.29618	23:33	50.90842, -1.29625
23:34	50.90841, -1.29611	23:35	50.90839, -1.29613
23:36	50.90852, -1.29599	23:37	50.90850, -1.29601
23:38	50.90832, -1.29632	23:39	50.90852, -1.29607
23:40	50.90838, -1.29614	23:41	50.90819, -1.29605
23:42	50.90843, -1.29612	23:43	50.90854, -1.29616

23:44	50.90850, -1.29618	23:45	50.90844, -1.29605
23:46	50.90850, -1.29590	23:47	50.90824, -1.29624
23:48	50.90835, -1.29610	23:49	50.90824, -1.29684
23:50	50.90827, -1.29683	23:51	50.90845, -1.29634
23:52	50.90841, -1.29626	23:53	50.90836, -1.29625
23:54	50.90836, -1.29625	23:55	50.90836, -1.29624
23:56	50.90842, -1.29612	23:57	50.90846, -1.29590
23:58	50.90835, -1.29610	23:59	50.90855, -1.29588

B.5 Saturday 8th December 2007

00:00	50.90845, -1.29624	00:01	50.90839, -1.29527
00:02	50.90849, -1.29388	00:05	50.90842, -1.29763
00:06	50.90842, -1.29439	00:10	50.90838, -1.29595
00:11	50.90835, -1.29595	00:12	50.90921, -1.29747
00:13	50.91282, -1.30343	14:48	50.90609, -1.30750
14:49	50.89940, -1.31103	14:50	50.90770, -1.31714
14:52	50.93567, -1.34007	14:53	50.94409, -1.36354
14:54	50.94475, -1.37376	14:55	50.93956, -1.37793
14:56	50.93400, -1.38130	14:57	50.92831, -1.38470
14:58	50.92236, -1.38865	14:59	50.91976, -1.39535
15:00	50.91790, -1.40180	15:01	50.91370, -1.40299
15:02	50.91281, -1.40823	15:03	50.90992, -1.41063
15:04	50.91001, -1.41187	15:05	50.90914, -1.41256
15:06	50.90830, -1.41246	15:07	50.90753, -1.41224
15:08	50.90722, -1.41250	15:09	50.90716, -1.41336
15:10	50.90716, -1.41339	15:11	50.90716, -1.41339
15:12	50.90716, -1.41339	15:13	50.90716, -1.41339
15:14	50.90716, -1.41339	15:15	50.90716, -1.41339
15:16	50.90719, -1.41347	15:18	50.90716, -1.41367
15:19	50.90715, -1.41369	15:20	50.90711, -1.41366
15:21	50.90723, -1.41366	15:22	50.90724, -1.41366
15:23	50.90724, -1.41366	15:24	50.90724, -1.41366
15:25	50.90720, -1.41361	15:26	50.90714, -1.41282
15:27	50.90726, -1.41211	15:28	50.90780, -1.41229
15:29	50.90834, -1.41274	15:30	50.90901, -1.41248
15:31	50.90965, -1.41228	15:32	50.91018, -1.41167
15:33	50.91078, -1.41068	15:34	50.91285, -1.40689
15:35	50.91496, -1.40363	15:36	50.91845, -1.40320

15:37	50.91964, -1.39783	15:38	50.91989, -1.39501
15:39	50.92266, -1.38865	15:40	50.92676, -1.38597
15:41	50.93645, -1.37998	15:42	50.94320, -1.37529
15:43	50.94976, -1.37074	15:44	50.94202, -1.35966
15:45	50.93485, -1.33495	15:46	50.92349, -1.31640
17:27	50.93423, -1.33195	17:28	50.94026, -1.35709
17:29	50.94886, -1.37821	17:30	50.95219, -1.40313
17:31	50.95928, -1.42896	17:32	50.95407, -1.45709
17:33	50.94573, -1.48275	17:34	50.94610, -1.51243
17:35	50.94368, -1.54060	17:36	50.93361, -1.56232
17:37	50.92321, -1.58384	17:38	50.91321, -1.60112
17:39	50.90700, -1.61769	17:40	50.90312, -1.63790
17:41	50.89679, -1.65566	17:42	50.88661, -1.66908
17:43	50.87686, -1.68831	17:44	50.86623, -1.70728
17:45	50.85672, -1.72564	17:46	50.85110, -1.74574
17:47	50.84929, -1.77000	17:48	50.84825, -1.79328
17:49	50.84087, -1.80896	17:50	50.82901, -1.81077
17:51	50.81257, -1.81370	17:52	50.79519, -1.81497
17:53	50.77780, -1.80948	17:54	50.76302, -1.81126
17:55	50.75167, -1.82098	17:56	50.74453, -1.83372
17:57	50.73705, -1.84362	17:58	50.73112, -1.85670
17:59	50.72578, -1.86870	18:00	50.72339, -1.88310
18:01	50.72310, -1.89647	18:02	50.72370, -1.90654
18:03	50.71833, -1.90882	18:04	50.71163, -1.90953
18:05	50.70634, -1.91274	18:06	50.70454, -1.92309
18:07	50.69972, -1.92966	18:08	50.69476, -1.93219
18:09	50.68979, -1.93836	18:10	50.68484, -1.94509
18:11	50.68347, -1.94853	18:12	50.68347, -1.94853
18:13	50.68347, -1.94853	18:14	50.68347, -1.94853
18:15	50.68347, -1.94853	18:16	50.68347, -1.94853
18:17	50.68298, -1.94866	18:18	50.68261, -1.94883
18:19	50.68261, -1.94883	18:20	50.68261, -1.94883
18:21	50.68261, -1.94883	18:22	50.68261, -1.94883
18:23	50.68198, -1.94902	18:24	50.68093, -1.94952
18:25	50.68036, -1.94984	18:26	50.67745, -1.95149
18:27	50.67370, -1.95523	18:28	50.66329, -1.96567
18:29	50.65412, -1.96039	18:30	50.64572, -1.95468
18:31	50.63947, -1.95697	18:32	50.63663, -1.96752
18:33	50.63167, -1.97480	18:34	50.62546, -1.96686
18:35	50.62017, -1.95918	18:36	50.61339, -1.95778
18:37	50.60832, -1.95592	18:38	50.60737, -1.95411

18:39	50.60758, -1.95521	18:40	50.60743, -1.95506
18:41	50.60743, -1.95506	18:42	50.60750, -1.95504
18:43	50.60609, -1.95498	18:44	50.60774, -1.95531
18:49	50.60753, -1.95528	18:50	50.60758, -1.95519
18:51	50.60750, -1.95506	18:52	50.60754, -1.95506
18:53	50.60773, -1.95476	18:54	50.60761, -1.95526
18:55	50.60780, -1.95502	18:56	50.60727, -1.95524
18:57	50.60735, -1.95526	18:58	50.60767, -1.95459

B.6 Sunday 9th December 2007

11:49	50.61206, -1.95837	11:50	50.61197, -1.95789
12:29	50.60752, -1.95515	12:30	50.60796, -1.95649
12:31	50.60807, -1.96304	12:32	50.60954, -1.97119
12:33	50.61173, -1.97459	12:34	50.61230, -1.96403
12:35	50.61469, -1.95791	12:36	50.62038, -1.95952
12:37	50.62478, -1.96582	12:38	50.63043, -1.97439
12:39	50.63588, -1.96958	12:40	50.63880, -1.95954
12:41	50.64366, -1.95376	12:42	50.65139, -1.95843
12:43	50.65918, -1.96466	12:44	50.66833, -1.96235
12:45	50.67606, -1.95270	12:46	50.67901, -1.95059
12:47	50.67981, -1.95013	12:48	50.67981, -1.95013
12:49	50.67981, -1.95013	12:50	50.67981, -1.95013
12:51	50.67981, -1.95013	12:52	50.67981, -1.95013
12:53	50.67981, -1.95013	12:54	50.67981, -1.95013
12:55	50.67981, -1.95013	12:56	50.67981, -1.95013
12:57	50.67981, -1.95013	12:58	50.67981, -1.95013
12:59	50.67981, -1.95013	13:00	50.67981, -1.95013
13:01	50.67981, -1.95013	13:02	50.67981, -1.95013
13:03	50.67981, -1.95013	13:04	50.67981, -1.95013
13:05	50.67988, -1.95011	13:06	50.68059, -1.94980
13:07	50.68063, -1.94978	13:08	50.68063, -1.94978
13:09	50.68063, -1.94978	13:10	50.68063, -1.94978
13:11	50.68070, -1.94973	13:12	50.68143, -1.94932
13:13	50.68229, -1.94896	13:14	50.68277, -1.94880
13:15	50.68278, -1.94879	13:16	50.68441, -1.94900
13:17	50.68737, -1.94469	13:18	50.68949, -1.93905
13:19	50.69387, -1.93275	13:20	50.69919, -1.93055
13:21	50.70360, -1.92471	13:22	50.70584, -1.91526

13:23	50.70891, -1.90968	13:24	50.71615, -1.90943
13:25	50.72034, -1.90821	13:26	50.72396, -1.90813
13:27	50.72384, -1.90071	13:28	50.72295, -1.88922
13:29	50.72409, -1.87549	13:30	50.72804, -1.86445
13:31	50.73382, -1.85057	13:32	50.74190, -1.83759
13:33	50.75010, -1.82382	13:34	50.76168, -1.81237
13:35	50.77690, -1.80916	13:36	50.79250, -1.81483
13:37	50.80971, -1.81424	13:38	50.82713, -1.81132
13:39	50.83980, -1.81122	13:40	50.84779, -1.79467
13:41	50.84953, -1.76811	13:42	50.85206, -1.74031
13:43	50.86185, -1.71659	13:44	50.87386, -1.69361
13:45	50.88615, -1.67072	13:46	50.89875, -1.65086
13:47	50.90591, -1.62679	13:48	50.91333, -1.60145
13:49	50.92612, -1.57833	13:50	50.93782, -1.55479
13:51	50.94583, -1.52737	13:52	50.94566, -1.49614
13:53	50.94979, -1.46724	13:54	50.95832, -1.44379
13:55	50.95815, -1.41926	13:56	50.95002, -1.39506
13:57	50.94711, -1.36916	13:58	50.93682, -1.34602
13:59	50.92899, -1.32024		

B.7 Monday 10th December 2007

09:39	50.93604, -1.34273	09:40	50.94380, -1.36326
09:41	50.94923, -1.37090	09:42	50.95091, -1.36727
09:43	50.95097, -1.36312	09:44	50.95096, -1.36307
09:45	50.95079, -1.36310	09:46	50.95079, -1.36309
09:47	50.95034, -1.36329	09:48	50.95021, -1.36334
09:49	50.95020, -1.36337	09:50	50.95073, -1.36323
09:51	50.95104, -1.36312	09:52	50.95104, -1.36312
09:53	50.95104, -1.36312	09:54	50.95091, -1.36386
09:55	50.94964, -1.36962	09:56	50.94244, -1.37565
09:57	50.94029, -1.37830	09:58	50.93868, -1.38496
09:59	50.93816, -1.39421	10:00	50.93795, -1.39621
10:01	50.93690, -1.39584	10:02	50.93588, -1.39601
10:03	50.93471, -1.39410	10:04	50.93344, -1.39239
10:05	50.93370, -1.39227	10:06	50.93140, -1.39467
10:07	50.93035, -1.39785	10:08	50.93293, -1.40101
10:09	50.93264, -1.40058	10:10	50.93264, -1.40058
10:11	50.93264, -1.40058	10:12	50.93264, -1.40058

10:13	50.93291, -1.40028	10:14	50.93345, -1.39948
10:15	50.93364, -1.39873	10:16	50.93378, -1.39795
10:17	50.93390, -1.39724	10:18	50.93439, -1.39650
10:19	50.93508, -1.39611	10:20	50.93585, -1.39589
10:21	50.93621, -1.39563	10:22	50.93620, -1.39567
17:21	50.93261, -1.40056	17:22	50.93261, -1.40056
17:23	50.93124, -1.39990	17:24	50.93101, -1.39504
17:25	50.93116, -1.39087	17:26	50.93004, -1.38576
17:27	50.92984, -1.38517	17:28	50.92760, -1.38295
17:29	50.92614, -1.38165	17:30	50.92563, -1.38132
17:31	50.92505, -1.38119	17:32	50.92460, -1.37999
17:33	50.92410, -1.37663	17:34	50.92152, -1.36951
17:35	50.92181, -1.35980	17:36	50.92149, -1.35345
17:37	50.92280, -1.34467	17:38	50.92394, -1.33943
17:39	50.92344, -1.33800	17:40	50.91782, -1.33092
17:41	50.91634, -1.32325	20:50	50.93517, -1.33730
20:51	50.94305, -1.36177	20:52	50.94883, -1.38353
20:53	50.95596, -1.39702	20:54	50.96938, -1.37939
20:55	50.98507, -1.36480	20:56	51.00182, -1.35520
20:57	51.01712, -1.34026	20:58	51.03207, -1.32538
20:59	51.04388, -1.30708	21:00	51.05154, -1.30357
21:01	51.05664, -1.30627	21:02	51.05889, -1.30629
21:03	51.05863, -1.30649	21:04	51.05831, -1.30665
21:05	51.05795, -1.30714	21:07	51.05766, -1.30736
21:08	51.05774, -1.30718	21:09	51.05790, -1.30718
21:10	51.05793, -1.30720	21:11	51.05788, -1.30715
21:12	51.05788, -1.30718	21:13	51.05785, -1.30713
21:14	51.05786, -1.30711	21:15	51.05792, -1.30718
21:16	51.05792, -1.30714	21:17	51.05792, -1.30712
21:18	51.05788, -1.30713	21:19	51.05790, -1.30714
21:20	51.05786, -1.30713	21:21	51.05780, -1.30711
21:22	51.05805, -1.30717	21:23	51.05786, -1.30717
21:24	51.05784, -1.30710	21:25	51.05782, -1.30721
21:26	51.05778, -1.30720	21:27	51.05777, -1.30719
21:28	51.05778, -1.30720	21:29	51.05778, -1.30720
21:30	51.05778, -1.30720	21:31	51.05778, -1.30720
21:32	51.05778, -1.30720	21:33	51.05778, -1.30720
21:34	51.05782, -1.30721	21:35	51.05771, -1.30727
21:36	51.05760, -1.30743	21:37	51.05796, -1.30713
21:38	51.05787, -1.30708	21:39	51.05778, -1.30710
21:40	51.05778, -1.30710	21:41	51.05778, -1.30710

21:42	51.05778, -1.30710	21:43	51.05778, -1.30710
21:44	51.05778, -1.30710	21:45	51.05778, -1.30710
21:50	51.05766, -1.30683	21:51	51.05779, -1.30700
21:52	51.05787, -1.30718	21:53	51.05786, -1.30719
21:54	51.05786, -1.30719	21:55	51.05786, -1.30719
21:56	51.05786, -1.30719	21:57	51.05786, -1.30719
21:58	51.05786, -1.30719	21:59	51.05786, -1.30719
22:00	51.05786, -1.30719	22:01	51.05786, -1.30719
22:02	51.05786, -1.30719	22:03	51.05786, -1.30719
22:04	51.05786, -1.30719	22:05	51.05786, -1.30719
22:06	51.05786, -1.30719	22:07	51.05786, -1.30719
22:14	51.05752, -1.30693	22:15	51.05770, -1.30719
22:16	51.05771, -1.30717	22:18	51.05790, -1.30715
22:19	51.05794, -1.30717	22:20	51.05796, -1.30721
22:21	51.05788, -1.30710	22:22	51.05786, -1.30702
22:23	51.05795, -1.30712	22:24	51.05787, -1.30717
22:25	51.05763, -1.30735	22:26	51.05785, -1.30724
22:27	51.05781, -1.30715	22:28	51.05796, -1.30717
22:29	51.05785, -1.30719	22:30	51.05788, -1.30709
22:31	51.05788, -1.30716	23:13	51.05799, -1.30697
23:14	51.05814, -1.30657	23:15	51.05836, -1.30660
23:16	51.05850, -1.30636	23:17	51.05405, -1.30549
23:19	51.03713, -1.31920	23:20	51.02974, -1.32740
23:21	51.01475, -1.34259	23:22	50.99861, -1.35681
23:23	50.98146, -1.36740	23:24	50.96649, -1.38274
23:25	50.95383, -1.39686	23:26	50.94886, -1.37705
23:27	50.93984, -1.35583	23:28	50.93384, -1.32980
23:29	50.92161, -1.31599		

Appendix C

Activity Data

This appendix contains a complete list of all the appointments in the subject's calendar with start and end dates and brief descriptions.

Start time	End time	Description
2006-03-11 19:00:00	2006-03-11 23:59:00	Gig
2006-03-31 18:00:00	2006-03-31 22:59:00	Gig
2006-04-01 18:00:00	2006-04-01 22:59:00	Gig
2006-04-15 11:00:00	2006-04-15 22:59:00	Gig
2006-04-23 18:00:00	2006-04-23 22:59:00	Gig
2006-04-28 18:00:00	2006-04-28 22:59:00	Gig
2006-05-05 18:00:00	2006-05-05 22:59:00	Gig
2006-05-12 09:00:00	2006-05-15 09:00:00	Holiday (Warmwell)
2006-05-20 18:00:00	2006-05-20 22:59:00	Gig
2006-05-21 18:00:00	2006-05-21 22:59:00	Gig
2006-05-26 18:00:00	2006-05-26 22:59:00	Gig
2006-06-10 18:00:00	2006-06-10 22:59:00	Holiday (Chepstow)
2006-06-16 18:00:00	2006-06-16 22:59:00	Gig
2006-06-17 18:00:00	2006-06-17 22:59:00	Gig
2006-06-23 18:00:00	2006-06-23 22:59:00	Gig
2006-06-30 18:00:00	2006-06-30 22:59:00	Gig
2006-07-07 18:00:00	2006-07-07 22:59:00	Gig
2006-07-08 18:00:00	2006-07-08 22:59:00	Gig
2006-07-14 14:00:00	2006-07-14 22:59:00	Music festival
2006-07-15 18:00:00	2006-07-15 22:59:00	Gig
2006-07-16 13:00:00	2006-07-16 18:00:00	Band audition
2006-07-18 11:15:00	2006-07-18 11:45:00	Dentist
2006-07-19 18:00:00	2006-07-19 21:00:00	Visit a friend
2006-07-21 15:00:00	2006-07-21 18:00:00	Departmental Summer Party
2006-07-22 18:00:00	2006-07-22 22:59:00	Gig
2006-07-23 11:15:00	2006-07-23 13:00:00	House party
2006-07-27 10:30:00	2006-07-27 11:00:00	Meeting with supervisor
2006-07-28 08:30:00	2006-07-28 09:30:00	Tutor session
2006-07-28 18:00:00	2006-07-28 22:59:00	Gig
2006-07-29 18:00:00	2006-07-29 22:59:00	Gig
2006-07-30 13:00:00	2006-07-30 15:00:00	Carnival
2006-08-04 15:00:00	2006-08-04 16:00:00	Colleague's leaving party
2006-08-05 18:00:00	2006-08-05 22:59:00	Gig
2006-08-07 13:00:00	2006-08-07 13:30:00	Meeting with Wendy
2006-08-11 18:00:00	2006-08-11 22:59:00	Gig
2006-08-12 15:00:00	2006-08-12 22:59:00	Barbecue at home
2006-08-13 18:00:00	2006-08-13 22:59:00	Gig
2006-08-18 16:30:00	2006-08-18 19:30:00	Cinema
2006-08-19 12:00:00	2006-08-19 16:00:00	Birthday Party
2006-08-19 19:00:00	2006-08-19 22:59:00	Gig

2006-08-25 18:00:00	2006-08-25 22:59:00	Gig
2006-08-27 19:00:00	2006-08-27 22:59:00	gig
2006-08-31 07:30:00	2006-08-31 09:30:00	Take parents to airport
2006-09-01 18:00:00	2006-09-01 22:59:00	Gig
2006-09-02 18:00:00	2006-09-02 22:59:00	Gig
2006-09-12 10:00:00	2006-09-12 11:00:00	Mini-Viva
2006-09-15 07:00:00	2006-09-15 09:00:00	Collect parents from airport
2006-09-17 11:00:00	2006-09-17 15:00:00	Fun day at IBM
2006-09-20 12:00:00	2006-09-20 14:00:00	ECS/MIT Seminar
2006-09-20 18:00:00	2006-09-20 22:59:00	Gig
2006-09-21 18:00:00	2006-09-21 21:00:00	Band practice
2006-09-23 18:00:00	2006-09-23 22:59:00	Gig
2006-09-29 18:00:00	2006-09-29 22:59:00	Gig
2006-10-01 18:00:00	2006-10-01 22:59:00	Gig
2006-10-03 15:00:00	2006-10-03 17:00:00	Give welcome lecture
2006-10-03 18:00:00	2006-10-03 21:00:00	Band Practice
2006-10-05 15:00:00	2006-10-05 17:00:00	Give welcome lecture
2006-10-06 09:00:00	2006-10-06 10:00:00	Give web tutorial
2006-10-06 18:00:00	2006-10-06 22:59:00	Gig
2006-10-07 18:00:00	2006-10-07 22:59:00	Gig
2006-10-08 09:00:00	2006-10-08 12:00:00	Band practice
2006-10-10 16:00:00	2006-10-10 16:00:00	House party
2006-10-12 18:00:00	2006-10-12 21:00:00	Band practice
2006-10-16 19:00:00	2006-10-16 21:00:00	Pub Quiz
2006-10-19 18:00:00	2006-10-19 21:00:00	Band Practice
2006-10-20 18:00:00	2006-10-20 22:59:00	Gig
2006-10-21 18:00:00	2006-10-21 22:59:00	Gig
2006-10-22 14:00:00	2006-10-22 17:00:00	Birthday party
2006-10-27 18:00:00	2006-10-27 22:59:00	Gig
2006-11-03 19:00:00	2006-11-03 23:59:00	Gig
2006-11-11 19:00:00	2006-11-11 23:59:00	Gig
2006-11-12 19:00:00	2006-11-12 23:59:00	Gig
2006-11-16 10:00:00	2006-11-16 11:00:00	Meeting with supervisor
2006-11-18 13:00:00	2006-11-18 16:00:00	Band practice
2006-11-18 19:00:00	2006-11-18 23:59:00	Gig
2006-11-19 19:00:00	2006-11-19 23:59:00	House party
2006-11-20 12:30:00	2006-11-20 13:00:00	Meeting with Wendy
2006-11-20 19:00:00	2006-11-20 23:59:00	Gig
2006-11-23 19:00:00	2006-11-23 23:59:00	Gig
2006-11-24 19:00:00	2006-11-24 23:59:00	Gig
2006-11-25 19:00:00	2006-11-25 23:59:00	Birthday party

2006-11-26 10:00:00	2006-11-26 14:00:00	Band practice
2006-12-01 11:00:00	2006-12-01 12:00:00	Meeting with supervisor
2006-12-01 19:00:00	2006-12-01 23:59:00	Gig
2006-12-10 19:00:00	2006-12-10 23:59:00	Gig
2006-12-12 08:30:00	2006-12-12 17:30:00	Colloquium
2006-12-13 19:00:00	2006-12-13 23:59:00	Gig
2006-12-16 19:00:00	2006-12-16 23:59:00	Gig
2006-12-29 19:00:00	2006-12-29 23:59:00	Gig
2007-01-19 19:00:00	2007-01-19 23:59:00	Gig
2007-01-20 19:00:00	2007-01-20 23:59:00	Gig
2007-01-26 10:30:00	2007-01-26 11:00:00	Meeting with supervisor
2007-01-26 11:00:00	2007-01-26 14:00:00	Meeting with partners
2007-01-26 19:00:00	2007-01-26 23:59:00	Gig
2007-01-28 10:00:00	2007-01-28 13:00:00	Band practice
2007-01-28 19:00:00	2007-01-28 23:59:00	Gig
2007-01-31 19:00:00	2007-01-31 23:00:00	Band practice
2007-02-02 19:00:00	2007-02-02 23:59:00	Gig
2007-02-03 21:00:00	2007-02-03 23:00:00	Gig
2007-02-04 12:00:00	2007-02-04 13:00:00	Birthday party
2007-02-05 09:30:00	2007-02-05 23:00:00	Gig
2007-02-06 19:15:00	2007-02-06 22:15:00	Band practice
2007-02-09 19:00:00	2007-02-09 23:59:00	Gig
2007-02-10 10:00:00	2007-02-10 13:00:00	Band practice
2007-02-10 19:00:00	2007-02-10 23:59:00	Gig
2007-02-11 16:00:00	2007-02-11 18:30:00	CD listen through
2007-02-12 19:00:00	2007-02-12 22:00:00	Band practice
2007-02-13 10:00:00	2007-02-13 21:00:00	Studio
2007-02-15 19:00:00	2007-02-15 22:00:00	Band practice
2007-02-16 19:00:00	2007-02-16 23:59:00	Gig
2007-02-17 19:00:00	2007-02-17 23:59:00	Games evening
2007-02-19 19:00:00	2007-02-19 22:00:00	Band practice
2007-02-22 19:00:00	2007-02-22 23:00:00	Band practice
2007-02-23 19:00:00	2007-02-23 23:59:00	Gig
2007-02-24 19:00:00	2007-02-24 23:59:00	Gig
2007-02-25 10:00:00	2007-02-25 13:00:00	Band practice
2007-02-27 19:00:00	2007-02-27 22:30:00	Band practice
2007-03-01 19:00:00	2007-03-01 22:00:00	Band practice
2007-03-02 19:30:00	2007-03-02 21:00:00	Birthday party
2007-03-03 19:30:00	2007-03-03 23:00:00	Birthday party
2007-03-04 20:30:00	2007-03-04 22:30:00	Gig
2007-03-06 19:15:00	2007-03-06 22:00:00	Band practice

2007-03-08 10:00:00	2007-03-08 21:00:00	Studio
2007-03-09 19:00:00	2007-03-09 23:59:00	Games evening
2007-03-10 19:00:00	2007-03-10 23:59:00	Gig
2007-03-11 10:00:00	2007-03-11 13:00:00	Band practice
2007-03-13 19:00:00	2007-03-13 23:00:00	Practice
2007-03-14 17:00:00	2007-03-14 19:00:00	Lecture
2007-03-15 15:00:00	2007-03-15 18:30:00	Convention
2007-03-15 19:30:00	2007-03-15 22:30:00	Band practice
2007-03-16 09:00:00	2007-03-16 22:00:00	Convention
2007-03-17 19:00:00	2007-03-17 23:59:00	Gig
2007-03-18 19:00:00	2007-03-18 23:00:00	Gig
2007-03-19 10:20:00	2007-03-19 10:40:00	Meeting with supervisor
2007-03-20 19:00:00	2007-03-20 23:00:00	Band practice
2007-03-23 19:00:00	2007-03-23 23:59:00	Gig
2007-03-24 10:00:00	2007-03-24 13:00:00	Band practice
2007-03-24 19:30:00	2007-03-24 23:59:00	Games evening
2007-03-25 18:00:00	2007-03-25 22:59:00	Gig
2007-03-27 18:00:00	2007-03-27 22:59:00	Miss gig
2007-03-30 18:00:00	2007-03-30 22:59:00	Gig
2007-03-31 18:00:00	2007-03-31 22:59:00	Gig
2007-04-07 11:30:00	2007-04-07 22:59:00	Gig
2007-04-09 13:00:00	2007-04-09 22:59:00	Barbecue at home
2007-04-13 18:00:00	2007-04-13 22:59:00	Gig
2007-04-14 09:00:00	2007-04-14 12:00:00	Band practice
2007-04-14 18:00:00	2007-04-14 22:59:00	Gig
2007-04-16 17:30:00	2007-04-16 22:00:00	Games evening
2007-04-20 19:00:00	2007-04-20 22:00:00	Gig
2007-04-21 18:00:00	2007-04-21 22:59:00	Games evening
2007-04-23 19:00:00	2007-04-23 22:59:00	Gig
2007-04-24 14:00:00	2007-04-24 15:00:00	Meeting with supervisor
2007-04-24 18:00:00	2007-04-24 21:00:00	Band practice
2007-04-25 17:00:00	2007-04-25 22:00:00	Band Practice
2007-04-27 07:00:00	2007-04-27 16:00:00	Car delivery
2007-04-27 18:00:00	2007-04-27 22:59:00	Gig
2007-04-28 18:00:00	2007-04-28 22:59:00	Gig
2007-04-29 09:00:00	2007-04-29 12:00:00	Band practice
2007-05-01 18:00:00	2007-05-01 22:00:00	Band practice
2007-05-04 09:00:00	2007-05-04 10:00:00	Meeting with supervisor
2007-05-04 18:00:00	2007-05-04 22:59:00	Gig
2007-05-05 18:00:00	2007-05-05 22:59:00	Poker
2007-05-06 09:00:00	2007-05-06 12:00:00	Band practice

2007-05-06 14:00:00	2007-05-09 15:00:00	Holiday (Cornwall)
2007-05-11 18:00:00	2007-05-11 22:59:00	Gig
2007-05-12 18:00:00	2007-05-12 22:59:00	Gig
2007-05-13 09:00:00	2007-05-13 12:00:00	Band practice
2007-05-15 16:00:00	2007-05-15 18:00:00	Tech support
2007-05-15 18:00:00	2007-05-15 22:59:00	Miss gig
2007-05-17 16:00:00	2007-05-17 17:00:00	Lecture
2007-05-18 09:00:00	2007-05-21 10:00:00	Holiday (Warmwell)
2007-05-22 13:30:00	2007-05-22 14:30:00	Meeting with supervisor
2007-05-25 18:00:00	2007-05-25 22:59:00	Gig
2007-05-26 08:00:00	2007-05-26 16:00:00	Help friend move house
2007-05-26 19:00:00	2007-05-26 21:30:00	Cinema
2007-05-29 18:00:00	2007-05-29 21:00:00	Band practice
2007-05-31 07:00:00	2007-05-31 11:00:00	Mum and Dad to airport
2007-06-01 18:00:00	2007-06-01 22:59:00	Gig
2007-06-02 18:00:00	2007-06-02 22:59:00	Gig
2007-06-05 18:00:00	2007-06-05 21:00:00	Band practice
2007-06-09 17:00:00	2007-06-09 22:00:00	Party
2007-06-10 12:00:00	2007-06-10 16:30:00	Birthday party
2007-06-12 18:00:00	2007-06-12 21:30:00	Band practice
2007-06-15 05:30:00	2007-06-15 09:30:00	Mum and Dad from airport
2007-06-15 20:00:00	2007-06-15 22:30:00	Gig
2007-06-16 08:00:00	2007-06-16 16:00:00	Paintball
2007-06-19 18:00:00	2007-06-19 21:30:00	Band practice
2007-06-23 18:00:00	2007-06-23 22:59:00	Birthday party
2007-06-29 18:00:00	2007-06-29 22:59:00	Gig
2007-06-30 11:00:00	2007-06-30 14:00:00	Winchester Hat Fair
2007-06-30 18:00:00	2007-06-30 22:59:00	Gig
2007-07-01 09:00:00	2007-07-01 12:00:00	Band practice
2007-07-02 09:30:00	2007-07-02 10:30:00	Meeting with supervisor
2007-07-03 18:00:00	2007-07-03 21:30:00	Band practice
2007-07-06 18:00:00	2007-07-06 22:59:00	Poker
2007-07-07 18:00:00	2007-07-07 22:59:00	Gig
2007-07-08 09:00:00	2007-07-08 12:00:00	Band practice
2007-07-08 18:00:00	2007-07-08 22:59:00	Gig
2007-07-10 18:00:00	2007-07-10 21:30:00	Band practice
2007-07-11 18:30:00	2007-07-11 21:00:00	Band practice
2007-07-12 16:00:00	2007-07-12 22:00:00	Miss gig
2007-07-14 18:00:00	2007-07-14 22:59:00	Gig
2007-07-17 19:30:00	2007-07-17 22:00:00	Cinema
2007-07-21 18:00:00	2007-07-21 22:59:00	Gig

2007-07-24 18:00:00	2007-07-24 21:00:00	Band Practice
2007-07-27 18:00:00	2007-07-27 22:59:00	Gig
2007-07-28 18:00:00	2007-07-28 22:59:00	Gig
2007-07-29 13:00:00	2007-07-29 15:00:00	Carnival
2007-07-31 18:00:00	2007-07-31 21:00:00	Band practice
2007-08-03 18:00:00	2007-08-03 22:59:00	Gig
2007-08-04 18:00:00	2007-08-04 22:59:00	Gig
2007-08-11 08:30:00	2007-08-11 16:00:00	Help a friend move
2007-08-12 09:00:00	2007-08-12 12:00:00	Band practice
2007-08-14 18:30:00	2007-08-14 21:00:00	Cinema
2007-08-16 13:00:00	2007-08-16 15:00:00	Brewery trip
2007-08-18 13:00:00	2007-08-18 22:59:00	Barbecue at home
2007-08-21 18:00:00	2007-08-21 21:00:00	Band practice
2007-08-24 18:00:00	2007-08-24 22:59:00	Gig
2007-08-25 18:00:00	2007-08-25 22:59:00	Gig
2007-08-26 21:00:00	2007-08-26 23:00:00	Gig
2007-08-28 18:00:00	2007-08-28 21:00:00	Rollerblading
2007-08-30 18:30:00	2007-08-30 21:00:00	Band practice
2007-08-31 18:00:00	2007-08-31 22:59:00	Gig
2007-09-01 18:00:00	2007-09-01 22:59:00	Gig
2007-09-02 09:00:00	2007-09-02 20:00:00	Trip to Legoland
2007-09-03 10:00:00	2007-09-03 11:00:00	Meeting with supervisor
2007-09-04 18:00:00	2007-09-04 21:00:00	Band practice
2007-09-08 20:00:00	2007-09-08 22:30:00	Gig
2007-09-09 17:00:00	2007-09-09 22:59:00	Games evening
2007-09-11 06:00:00	2007-09-11 21:00:00	Band practice
2007-09-14 13:30:00	2007-09-14 14:30:00	Meeting with supervisor
2007-09-14 18:00:00	2007-09-14 22:59:00	Poker
2007-09-15 18:00:00	2007-09-15 22:59:00	Games night
2007-09-18 18:00:00	2007-09-18 21:00:00	Band practice
2007-09-21 12:00:00	2007-09-21 22:00:00	Wedding
2007-09-23 08:00:00	2007-09-23 12:00:00	Band practice
2007-09-23 18:00:00	2007-09-23 22:59:00	Gig
2007-09-25 16:30:00	2007-09-25 17:30:00	Tech support
2007-09-25 18:00:00	2007-09-25 21:00:00	Band practice
2007-09-28 18:00:00	2007-09-28 22:59:00	Gig
2007-09-29 08:00:00	2007-09-29 22:59:00	Holiday (Wareham)
2007-10-02 13:00:00	2007-10-02 14:00:00	Meeting with supervisor
2007-10-02 18:00:00	2007-10-02 21:00:00	Band practice
2007-10-05 14:50:00	2007-10-05 15:20:00	Doctor
2007-10-05 18:00:00	2007-10-05 22:59:00	Gig

2007-10-06 20:00:00	2007-10-06 22:30:00	Gig
2007-10-09 18:00:00	2007-10-09 21:00:00	Band practice
2007-10-10 10:00:00	2007-10-10 10:05:00	Visit friend
2007-10-12 18:00:00	2007-10-12 22:59:00	Poker
2007-10-13 18:00:00	2007-10-13 22:59:00	Gig
2007-10-16 16:00:00	2007-10-16 18:00:00	Gig setup
2007-10-19 18:00:00	2007-10-19 21:00:00	Gig setup
2007-10-20 18:00:00	2007-10-20 22:59:00	Gig
2007-10-23 18:00:00	2007-10-23 21:00:00	Band practice
2007-10-26 18:00:00	2007-10-26 22:59:00	Gig
2007-10-27 18:00:00	2007-10-27 22:59:00	Poker
2007-10-30 19:00:00	2007-10-30 22:00:00	Band practice
2007-11-02 12:00:00	2007-11-02 13:00:00	Meet with supervisor
2007-11-02 19:00:00	2007-11-02 23:59:00	Gig
2007-11-03 19:00:00	2007-11-03 23:59:00	Gig
2007-11-06 19:00:00	2007-11-06 22:00:00	Band practice
2007-11-07 18:00:00	2007-11-07 23:59:00	Fireworks
2007-11-09 19:00:00	2007-11-09 23:59:00	Poker
2007-11-10 19:00:00	2007-11-10 23:59:00	Gig
2007-11-11 19:00:00	2007-11-11 23:59:00	Gig
2007-11-13 12:00:00	2007-11-13 23:59:00	Visit friend
2007-11-16 15:00:00	2007-11-16 16:00:00	Meet with supervisor
2007-11-16 19:00:00	2007-11-16 23:59:00	Gig
2007-11-22 11:00:00	2007-11-22 12:00:00	Meet with supervisor
2007-11-30 19:00:00	2007-11-30 23:59:00	Gig
2007-12-01 20:00:00	2007-12-01 23:59:00	Gig
2007-12-04 19:00:00	2007-12-04 22:00:00	Band practice
2007-12-07 12:30:00	2007-12-07 14:00:00	Meeting
2007-12-07 19:00:00	2007-12-07 23:59:00	Poker
2007-12-08 19:00:00	2007-12-08 23:59:00	Gig
2007-12-11 19:00:00	2007-12-11 22:00:00	Band practice
2007-12-13 19:30:00	2007-12-13 23:00:00	Curry with ex-boss
2007-12-14 19:00:00	2007-12-14 23:59:00	Gig
2007-12-15 19:00:00	2007-12-15 23:59:00	Gig
2007-12-20 17:00:00	2007-12-20 17:45:00	Visit friend
2007-12-20 19:00:00	2007-12-20 23:59:00	Christmas party
2007-12-22 19:00:00	2007-12-22 23:59:00	Poker
2007-12-27 17:30:00	2007-12-27 21:00:00	Birthday party
2007-12-28 19:00:00	2007-12-28 23:59:00	Gig
2007-12-30 17:00:00	2007-12-30 23:59:00	Visit friend
2007-12-31 15:00:00	2008-01-01 02:00:00	New Years Eve Party

2008-01-04 12:00:00	2008-01-06 13:00:00	Visit Friend
2008-01-11 19:00:00	2008-01-11 23:59:00	Gig
2008-01-12 19:00:00	2008-01-12 23:59:00	Gig
2008-01-13 10:00:00	2008-01-13 13:00:00	Band practice
2008-01-15 13:30:00	2008-01-15 14:30:00	Meeting with supervisor
2008-01-15 19:00:00	2008-01-15 22:00:00	Band practice
2008-01-18 19:00:00	2008-01-18 23:59:00	Poker
2008-01-19 19:00:00	2008-01-19 23:59:00	Gig
2008-01-25 19:00:00	2008-01-25 23:59:00	Gig
2008-01-26 21:00:00	2008-01-26 23:59:00	Gig
2008-01-27 10:00:00	2008-01-27 14:00:00	Band practice
2008-02-09 19:00:00	2008-02-09 23:59:00	Gig
2008-02-16 14:00:00	2008-02-16 23:59:00	Housewarming Party
2008-02-18 16:00:00	2008-02-18 17:00:00	Seminar
2008-02-22 19:00:00	2008-02-22 23:59:00	Gig
2008-02-23 19:00:00	2008-02-23 23:59:00	Gig

Appendix D

Interaction Data

This appendix contains a selection of raw data from the collected Bluetooth data set. Ideally, the complete data set would be included here but this would require tens of thousands of pages. For this reason, a week of data has been provided and it has been slightly modified from its original form. Firstly, the data has had the test subject's mobile phone removed. This is because the device was on and discoverable all the time, next to the PDA doing the logging. As we are using device IDs primarily as presence identification, knowing that the user is near his own phone is not helpful. Secondly, the data has been anonymised slightly for reasons of privacy - although the system logged the 'friendly' names as well as unique addresses of the devices it encountered, many people choose to use their own name or some kind of name that identifies them personally as their device's friendly name. For this reason, friendly names have been omitted from this thesis, as it may constitute the publishing of personal data without permission.

D.1 Tuesday 4th December 2007

18:31	0016B86F1781	19:03	001A8A35F31F
19:04	001A8A35F31F	19:05	001A8A35F31F
19:06	001A8A35F31F	19:07	001A8A35F31F
19:08	001A8A35F31F	19:09	001A8A35F31F
19:10	001A8A35F31F	19:11	001A8A35F31F
19:12	001A8A35F31F	19:13	001A8A35F31F
19:14	001A8A35F31F	19:15	001A8A35F31F
19:16	001A8A35F31F	19:17	001A8A35F31F
19:18	001A8A35F31F	19:19	001A8A35F31F
19:20	001A8A35F31F	19:21	001A8A35F31F
19:22	001A8A35F31F	19:23	001A8A35F31F
19:24	001A8A35F31F	19:25	001A8A35F31F
19:26	001A8A35F31F	19:27	001A8A35F31F
19:28	001A8A35F31F	19:29	001A8A35F31F
19:30	001A8A35F31F	19:31	001A8A35F31F
19:32	001A8A35F31F	19:33	001A8A35F31F
19:34	001A8A35F31F	19:35	001A8A35F31F
19:36	001A8A35F31F	19:37	001A8A35F31F
19:38	001A8A35F31F	19:39	001A8A35F31F
19:42	001A8A35F31F	19:43	001A8A35F31F
19:44	001A8A35F31F	19:45	001A8A35F31F
19:46	001A8A35F31F	19:47	001A8A35F31F
19:48	001A8A35F31F	19:49	001A8A35F31F
19:50	001A8A35F31F	19:51	001A8A35F31F
19:53	001A8A35F31F	19:54	001A8A35F31F
19:55	001A8A35F31F	19:56	001A8A35F31F
19:57	001A8A35F31F	19:58	001A8A35F31F
19:59	001A8A35F31F	20:00	001A8A35F31F
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20:03	001A8A35F31F	20:04	001A8A35F31F
20:06	001A8A35F31F	20:07	001A8A35F31F
20:08	001A8A35F31F	20:09	001A8A35F31F
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20:13	001A8A35F31F	20:14	001A8A35F31F
20:15	001A8A35F31F	20:16	001A8A35F31F
20:17	001A8A35F31F	20:18	001A8A35F31F
20:19	001A8A35F31F	20:20	001A8A35F31F
20:21	001A8A35F31F	20:22	001A8A35F31F
20:23	001A8A35F31F	20:24	001A8A35F31F

20:25	001A8A35F31F	20:26	001A8A35F31F
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21:01	001A8A35F31F	21:02	001A8A35F31F
21:03	001A8A35F31F	21:04	001A8A35F31F
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21:15	001A8A35F31F	21:16	001A8A35F31F
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21:19	001A8A35F31F	21:20	001A8A35F31F
21:21	001A8A35F31F	21:22	001A8A35F31F
21:23	001A8A35F31F	21:24	001A8A35F31F
21:25	001A8A35F31F	21:26	001A8A35F31F
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21:29	001A8A35F31F	21:30	001A8A35F31F
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21:33	001A8A35F31F	21:34	001A8A35F31F
21:35	001A8A35F31F	21:36	001A8A35F31F
21:38	001A8A35F31F	21:39	001A8A35F31F
21:41	001A8A35F31F	21:42	001A8A35F31F
21:43	001A8A35F31F	21:44	001A8A35F31F
21:45	001A8A35F31F	21:53	001A8A35F31F
21:54	001A8A35F31F	21:55	001A8A35F31F

D.2 Wednesday 5th December 2007

14:50	001842F04F29	15:01	0060578A1FD9
15:03	00119FB9881E	15:03	001A75F932A8
15:04	001A75F932A8	15:05	001A75F932A8
15:06	001A75F932A8	15:10	001B59DF2F95
15:11	0019797B5ABC	15:14	00196316E5E5
15:22	0017E48B7733	15:23	0017E48B7733
15:24	001B59C075A5	18:35	0012D2B1A512
18:36	0012D2B1A512	18:36	001CA49ED0AB
18:37	0012D2B1A512	18:38	0012D2B1A512
18:38	001CA49ED0AB	18:39	0012D2B1A512
18:40	0012D2B1A512	18:41	0012D2B1A512
18:42	0012D2B1A512	18:43	0012D2B1A512
18:44	0012D2B1A512	18:45	0012D2B1A512
18:46	0012D2B1A512	18:47	0012D2B1A512
18:48	0012D2B1A512	18:49	0012D2B1A512
18:49	0018AF61CF07	18:50	0012D2B1A512
18:51	0012D2B1A512	18:52	0012D2B1A512
18:53	0012D2B1A512	18:54	0012D2B1A512
18:55	0012D2B1A512	18:56	0012D2B1A512
18:57	0012D2B1A512	18:58	0012D2B1A512
18:59	0012D2B1A512	19:00	0012D2B1A512
19:01	0012D2B1A512	19:02	0012D2B1A512
19:03	0012D2B1A512	19:04	0012D2B1A512
19:05	0012D2B1A512	19:06	0012D2B1A512
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19:27	0012D2B1A512	19:28	0012D2B1A512
19:29	0012D2B1A512	19:30	0012D2B1A512

19:31	0012D2B1A512	19:32	0012D2B1A512
19:33	0012D2B1A512	19:34	0012D2B1A512
19:35	0012D2B1A512	19:36	0012D2B1A512
19:37	0012D2B1A512	19:38	0012D2B1A512
19:39	0012D2B1A512	19:39	001D2815BF54
19:40	000E6D37B11A	19:40	0012D2B1A512
19:40	001D2815BF54	19:41	0012D2B1A512
19:41	0014A758245B	19:41	001813BF5CEA
19:42	0012D2B1A512	19:42	0014A758245B
19:42	0017B0660CFB	19:42	001813950954
19:42	0018AFE4CF92	19:42	0019B7BBAC2D
19:43	0012D2B1A512	19:43	001813950954
19:43	0019B7BBAC2D	19:43	001BAF0A9160
19:43	001D3BB09C6E	19:44	0012D2B1A512
19:44	001B9803C73C	19:44	001C35558597
19:44	001C43D9224F	19:44	001CBD0047F5
19:44	001D28258FD2	19:44	0800284E1222
19:45	0012D2B1A512	19:45	0013FD71AAD0
19:46	0012D2B1A512	19:46	0013FD71AAD0
19:46	001979DABA91	19:47	0012D2B1A512
19:47	0013FD71AAD0	19:48	0012D2B1A512
19:48	0016B8ADB921	19:48	00196345C012
19:48	001CD44AB2A3	19:48	0800284E1222
19:49	0012D2B1A512	19:49	00174B014C23
19:49	00196345C012	19:49	0019634D3663
19:49	001C354D7423	19:49	001D3BA2B5DE
19:49	0800284E1222	19:50	0012D2B1A512
19:50	0014A758245B	19:50	00196345C012
19:50	0019634D3663	19:50	001C354D7423
19:50	001C35558597	19:51	0012D2B1A512
19:51	0014A758245B	19:51	00196345C012
19:51	0019634D3663	19:52	0012D2B1A512
19:52	001813950954	19:52	001C354C72CA
19:52	001C354D7423	19:52	001C43E05B7F
19:52	001D3BA2B5DE	19:53	0012D2B1A512
19:53	0014A70345F2	19:53	0015B918F0EB
19:53	0016209C612C	19:53	0016B824A578
19:53	001C354C72CA	19:53	001C43E05B7F
19:54	0005C9468BE6	19:54	0012D2B1A512
19:54	0012EE9C063C	19:54	0015B918F0EB
19:54	0015B9E9AEB4	19:54	0016B824A578

19:54	001C354C72CA	19:54	001C354D7423
19:54	001D3BA2B5DE	19:55	0012D2B1A512
19:55	001C354D7423	19:56	0012D2B1A512
19:57	0012D2B1A512	19:58	0012D2B1A512
19:59	0012D2B1A512		

D.3 Thursday 6th December 2007

16:10	001262C603AE	16:11	000E0791E06C
16:11	00124715C101	16:11	0012D23474D8
16:11	00174B17A0A0	16:11	0017D5996CB6
16:11	00192D484C22	16:11	001963F47230
16:11	001C43C385A7	16:11	001CA486782A
16:12	000E0791E06C	16:12	0012D23474D8
16:12	0016DBEA8D49	16:12	00174B17A0A0
16:12	0017D5996CB6	16:12	001963F47230
16:12	001B98FFB915	16:12	001CA486782A
16:13	000E0791E06C	16:13	0012D23474D8
16:13	0016DBEA8D49	16:13	00174B17A0A0
16:13	0017D5996CB6	16:13	001963F47230
16:13	001B98FFB915	16:14	0012D23474D8
16:14	0016B81DE8EA	16:14	0016DBEA8D49
16:14	00174B17A0A0	16:14	001B98FFB915
16:14	001BEE340759	16:14	001C35628293
16:15	00124715C101	16:15	0016B81DE8EA
16:15	00174B17A0A0	16:15	001B596ADB5F
16:15	001B98FFB915	16:15	001BEE340759
16:15	001C35628293	16:16	0005C9414584
16:16	0012472C47A0	16:16	0016B8414101
16:16	00180FA4C742	16:16	001B98FFB915
16:17	001262DB029E	16:17	0015B9E16D71
16:17	00196316FCE7	16:17	001BAF0A92D4
16:18	0012472C47A0	16:18	001262DB029E
16:18	0015B9E16D71	16:18	0017D5F108F4
16:18	001A162FC780	16:18	001BAF0A92D4
16:19	0012472C47A0	16:19	0017D5996CB6
16:19	0017D5F108F4	16:19	00196316FCE7
16:19	001A162FC780	16:20	0012472C47A0
16:20	0015B9E16D71	16:20	0017D5996CB6

16:20	0018AF320E8B	16:20	00196316FCE7
16:20	0019635554F9	16:20	001A162FC780
16:20	001A8A09C1E8	16:21	000A3A6DB6A5
16:21	001262C603AE	16:21	001620719297
16:21	0016B81DE8EA	16:21	0017D5996CB6
16:21	0017D5F108F4	16:21	0017E4165632
16:21	001BEE340759	16:21	001BEE35858B
16:22	000A3A6DB6A5	16:22	0012D218FAD1
16:22	0012EE3795AD	16:22	001620719297
16:22	0016B81DE8EA	16:22	0017D5F108F4
16:22	0017E4165632	16:22	0018C53B3473
16:22	001BEE340759	16:22	001BEE35858B
16:22	001D251E4B5A	16:22	001D9811E55C
16:23	0015A03E7F8A	16:25	001B59678687
16:26	001256146BD1	16:30	001C436943DB
16:33	00196336CA9A	16:33	001CA461C8DE
19:07	001CA49ED0AB	19:09	0012D2B1A512
19:09	001CA49ED0AB	19:10	0012D2B1A512
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19:19	001CA49ED0AB	19:20	001256F6FF4B
19:20	0012D2B1A512	19:20	001CA49ED0AB
19:21	0012D2B1A512	19:21	001CA49ED0AB
19:22	001256F6FF4B	19:22	0012D2B1A512
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19:53	001CA49ED0AB	19:54	0012D2B1A512
19:54	00152A2182AF	19:54	0018C5FD5C8B
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19:55	001CA49ED0AB	19:55	001DE904A6DC
19:56	0012D2B1A512	19:56	0018C5FD5C8B
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19:57	0018C5FD5C8B	19:57	001CA49ED0AB
19:58	0012D2B1A512	19:58	0018C5FD5C8B
19:58	001CA49ED0AB	19:58	001DE904A6DC
19:59	0012D2B1A512	19:59	00152A2182AF
19:59	0018C5FD5C8B	19:59	001CA49ED0AB
19:59	001DE904A6DC	20:00	0012D2B1A512
20:00	00152A2182AF	20:00	0018C5FD5C8B
20:00	001CA49ED0AB	20:00	001DE904A6DC
20:01	0012D2B1A512	20:01	00152A2182AF

20:01	0018C5FD5C8B	20:01	001CA49ED0AB
20:01	001DE904A6DC	20:02	0012D2B1A512
20:02	0018C5FD5C8B	20:02	001CA49ED0AB
20:03	0012D2B1A512	20:03	00152A2182AF
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20:04	0012D2B1A512	20:04	00152A2182AF
20:04	0018C5FD5C8B	20:04	001CA49ED0AB
20:05	0012D2B1A512	20:05	00152A2182AF
20:05	0018C5FD5C8B	20:05	001CA49ED0AB
20:05	001DE904A6DC	20:06	0012D2B1A512
20:06	00152A2182AF	20:06	0018C5FD5C8B
20:06	001CA49ED0AB	20:07	0012D2B1A512
20:07	00152A2182AF	20:07	0018C5FD5C8B
20:07	001CA49ED0AB	20:07	001DE904A6DC
20:08	0012D2B1A512	20:08	00152A2182AF
20:08	0018C5FD5C8B	20:08	001CA49ED0AB
20:09	0012D2B1A512	20:09	00152A2182AF
20:09	0018C5FD5C8B	20:09	001CA49ED0AB
20:10	0012D2B1A512	20:10	00152A2182AF
20:10	0018C5FD5C8B	20:10	001CA49ED0AB
20:11	0012D2B1A512	20:11	00188D7A4CDF
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20:12	0012D2B1A512	20:12	00152A2182AF
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D.4 Friday 7th December 2007

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D.5 Saturday 8th December 2007

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D.6 Sunday 9th December 2007

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D.7 Monday 10th December 2007

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16:21	00014A1551A3	16:21	00116736AFB2
16:21	0018C53D5395	16:21	001D4F9485B5
16:22	00014A1551A3	16:22	00116736AFB2
16:22	001D4F9485B5	16:23	00014A1551A3
16:23	00116736AFB2	16:23	0018C53D5395
16:23	001D4F9485B5	16:24	00014A1551A3
16:24	00116736AFB2	16:24	0012D2967EA6
16:24	001D4F9485B5	16:25	00014A1551A3
16:25	00116736AFB2	16:25	001D4F9485B5
16:26	00014A1551A3	16:26	00116736AFB2
16:26	0012D27E7C39	16:26	001D4F9485B5
16:27	00014A1551A3	16:27	00116736AFB2
16:27	0012D27E7C39	16:27	001D4F9485B5
16:27	001D4FA29F55	16:28	00014A1551A3
16:28	00116736AFB2	16:28	001D4F9485B5
16:28	001D4FA29F55	16:29	00014A1551A3
16:29	00116736AFB2	16:29	0012D27E7C39
16:29	001D4F9485B5	16:29	001D4FA29F55
16:30	00014A1551A3	16:30	00116736AFB2
16:30	001D4F9485B5	16:30	001D4FA29F55

16:31	00014A1551A3	16:31	00116736AFB2
16:31	001D4F9485B5	16:31	001D4FA29F55
16:32	00014A1551A3	16:32	00116736AFB2
16:32	001D4F9485B5	16:32	001D4FA29F55
16:33	00014A1551A3	16:33	000D9348066E
16:33	00116736AFB2	16:33	001D4F9485B5
16:33	001D4FA29F55	16:34	00014A1551A3
16:34	000D9348066E	16:34	00116736AFB2
16:34	001D4F9485B5	16:34	001D4FA29F55
16:35	00014A1551A3	16:35	00116736AFB2
16:35	001D4F9485B5	16:35	001D4FA29F55
16:36	00014A1551A3	16:36	00116736AFB2
16:36	0012D27E7C39	16:36	001D4F9485B5
16:36	001D4FA29F55	16:37	00116736AFB2
16:37	0012D27E7C39	16:37	001D4F9485B5
16:37	001D4FA29F55	16:38	00014A1551A3
16:38	00116736AFB2	16:38	0012D27E7C39
16:38	001B634ACE11	16:38	001D4F9485B5
16:38	001D4FA29F55	16:39	00014A1551A3
16:39	00116736AFB2	16:39	0012D27E7C39
16:39	001B634ACE11	16:39	001D4F9485B5
16:39	001D4FA29F55	16:40	00014A1551A3
16:40	00116736AFB2	16:40	0012D27E7C39
16:40	001B634ACE11	16:40	001D4F9485B5
16:41	00014A1551A3	16:41	00116736AFB2
16:41	0012D27E7C39	16:41	001B634ACE11
16:41	001D4F9485B5	16:41	001D4FA29F55
16:42	00014A1551A3	16:42	00116736AFB2
16:42	0012D27E7C39	16:42	001B634ACE11
16:42	001D4F9485B5	16:42	001D4FA29F55
16:43	00014A1551A3	16:43	00116736AFB2
16:43	001B634ACE11	16:43	001D4F9485B5
16:43	001D4FA29F55	17:26	0017D5F07D91
17:29	001124B058E4	17:42	00194F71B6B7
17:43	001247BA38B1	17:43	0017D554E0AC

Bibliography

Gregory D. Abowd, Christopher G. Atkeson, Jason Hong, Sue Long, Rob Kooper, and Mike Pinkerton. Cyberguide: a mobile context-aware tour guide. *Wireless Networks*, 3(5):421–433, 1997.

M Ahmed, H H Hoang, M S Karim, S Khusro, M Lanzenberger, K Latif, E Michlmayr, K Mostofa, H T Nguyen, A Rauber, A Schatten, M N Tho, and A M Tjoa. Semanticlife - a framework for managing information of a human lifetime. In *Proceedings of the 6th International Conference on Information Integration and Web-based Applications and Services (iiWAS)*, Jakarta, Indonesia, September 2004.

Jr. Allan Christian Long, Shankar Narayanaswamy, Andrew Burstein, Richard Han, Ken Lutz, Brian Richards, Samuel Sheng, Robert W Brodersen, and Jan Rabaey. A prototype user interface for a mobile multimedia terminal. In *CHI 1995: Conference Companion on Human Factors in Computing Systems*, pages 81–82, New York, New York, USA, 1995. ACM.

Gabe Beged-Dov, Dan Brickley, Rael Dornfest, Ian Davis, Leigh Dodds, Jonathan Eisenzopf, David Galbraith, R V Guha, Ken MacLeod, Eric Miller, Aaron Swartz, and Eric Van Der Vlist. *RDF Site Summary (RSS) 1.0*, 2001. URL `http://purl.org/rss/1.0/spec`.

Tim Berners-Lee. The world wide web: Past, present and future. Technical report, 1996.

Tim Berners-Lee. *Weaving the Web: The Origins and Future of the World Wide Web*. Texere Publishing, 2000. ISBN 1-58799-018-0.

Tim Berners-Lee, James Hendler, and Ora Lassila. The Semantic Web. *Scientific American*, pages 35–43, May 2001.

Tim Berners-Lee, Wendy Hall, James Hendler, Nigel Shadbolt, and Daniel J. Weitzner. Creating a science of the web. *Science*, Volume 313, Number 5788:769–771, August 2006.

Kurt D Bollacker, Steve Lawrence, and C Lee Giles. CiteSeer: An autonomous web agent for automatic retrieval and identification of interesting publications. In *Proceedings of the Second International Conference on Autonomous Agents*, pages 116–123, New York, 1998.

Marshall Brain and Tom Harris. How gps receivers work. *How Stuff Works*. URL `http://www.howstuffworks.com/gps.htm`. Accessed 26th July 2007.

Tim Bray, Jean Paoli, C M Sperberg-McQueen, Eve Maler, and Francois Yergeau. *Extensible Markup Language (XML) 1.0 (Third Edition) Specification*, February 2004.

Harry Brignull and Yvonne Rogers. Enticing people to interact with large public displays in public spaces. In *Proceedings of the Ninth International Conference on Human-Computer Interaction (INTERACT 2003)*, pages 17–24, Zurich, Switzerland, September 2003.

Harry Brignull, Shahram Izadi, Geraldine Fitzpatrick, Yvonne Rogers, and Tom Rodden. The introduction of a shared interactive surface into a communal space. In *Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work (CSCW04)*, Chicago, Illinois, USA, November 2004.

Sergey Brin and Larry Page. The anatomy of a large-scale hypertextual web search engine. *Computer Networks and ISDN Systems*, Volume 30:107–117, 1998.

Tim Brody. Citebase search: Autonomous citation database for e-print archives, 2003. URL `http://www.citebase.org/cgi-bin/citations?id=oai:eprints.ecs.soton.ac.uk:10677`.

Vannevar Bush. As we may think. *The Atlantic Monthly*, July 1945.

Daragh Byrne, Barry Lavelle, Aiden R Doherty, Gareth J F Jones, and Alan F Smeaton. Using bluetooth and gps metadata to measure event similarity in sensecam images. In *Proceedings of the 5th International Conference on Intelligent Multimedia and Ambient Intelligence (IMAI07)*, Salt Lake City, Utah, United States, July 2007.

Steve Cayzer and Paul Shabajee. Semantic blogging and bibliography management. Technical report, Digital Media Systems Laboratory, HP Laboratories Bristol, July 2003.

Malcolm Coles. One in four adults come into contact with id fraud. *Which? Magazine*, March 2005.

Anind K. Dey. Understanding and using context. *Personal Ubiquitous Computing*, 5(1): 4–7, 2001.

S. Dill, N. Eiron, D. Gibson, D. Gruhl, and R. Guha. Semtag and seeker: Bootstrapping the semantic web via automated semantic annotation. In *Proceedings of the 12th World Wide Web Conference*, 2003.

Alan Dix. The ultimate interface and the sums of life. *Interfaces*, Issue 50:16, 2002.

Alan Dix, Adrian Friday, Boriana Koleva, Tom Rodden, Henk Muller, Cliff Randell, and Anthony Steed. *Managing Multiple Spaces*. Kluwer, 2005.

Leigh Dodds. The Friend of a Friend Project - an introduction to FoaF. 2004. URL `http://www.foaf-project.org/~~nicole/FOAF/2004/us/about.html`.

Douglas C Englebart and William K English. A research centre for augmenting human intellect. In *Proceedings of the Fall Joint Computer Conference*, pages 395–410, December 1968.

David Frohlich, Celine Pering, Abbe Don, and Steven Ariss. Requirements for photoware. In *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work (CSCW02)*, pages 166–175, New Orleans, Louisiana, USA, November 2002.

F. Gandon and N. Sadeh. Semantic web technologies to reconcile privacy and context awareness. *Web Semantics Journal*, Volume 1, Number 3, 2004.

Jim Gemmell, Gordon Bell, Roger Lueder, Steven Drucker, and Curtis Wong. Mylifebits: Fulfilling the memex vision. In *Proceedings of ACM Multimedia 2002*, pages 235–238, Juan-les-Pins, France, December 2002.

Jim Gemmell, Lyndsay Williams, Ken Wood, Roger Lueder, and Gordon Bell. Passive capture and ensuing issues for a personal lifetime store. In *Proceedings of the 1st ACM workshop on Continuous archival and retreival of personal experiences*, pages 45–55, New York, New York, United States, 2004.

Hugh Glaser. Semantic squirrels. In *Proceedings of the 5th International Semantic Web Conference (ISWC 2006)*, Athens, Georgia, USA, November 2006.

Tom Gruber. Collective knowledge systems: Where the social web meets the semantic web. *Web Semantics: Science, Services and Agents on the World Wide Web*, December 2007. doi: 10.1016/j.websem.2007.11.011.

Jonathon S Hare and Paul H Lewis. Saliency-based models of image content and their application to auto-annotation by semantic propagation. In *Proceedings of the Second European Semantic Web Conference (ESWC2005)*, Heraklion, Crete, May 2005.

Peter Hewkin. Smart tags-the distributed-memory revolution. *IEE Review*, 35(6):203–206, 1989.

Theo Humphries, John Evans, Drew Hemment, and Mika Raento. Loca: Location oriented critical arts. Technical report, 2007. URL `http://www.loca-lab.org/documents/Texts/Full+text`.

David Huynh, Stefano Mazzocchi, and David Karger. Piggy bank: Experience the semantic web inside your web browser. In *Proceedings of the Fourth International Semantic Web Conference (ISWC2005)*, Galway, Ireland, November 2005.

Shahram Izadi, Harry Brignull, Tom Rodden, Yvonne Rogers, and Mia Underwood. Dynamo: A public interactive surface supporting the cooperative sharing and exchange of media. In *Proceedings of User Interfaces and Software Technologies (UIST03)*, pages 159–168, Vancouver, Canada, 2003.

Gareth J F Jones. Challenges and opportunities of context-aware information access. In *Proceedings of the International Workshop on Ubiquitous Data Management (UDM 2005)*, pages 53–60, Tokyo, Japan, April 2005.

Jos Kahan, Marja-Riitta Koivunen, Eric PrudHommeaux, and Ralph R. Swick. Annotea: An open RDF infrastructure for shared web annotations. In *Proceedings of the 10th International World Wide Web Conference (WWW2001)*, pages 689–714, Hong Kong, May 2001.

Andrew M Ladd, Kostas E Bekris, Algis Rudys, Guillaume Marceau, Lydia E Kavraki, and Dan S Wallach. Robotics-based location sensing using wireless ethernet. In *Proceedings of the Eighth International Conference on Mobile Computing and Networking (MobiCom 2002)*, Atlanta, Georgia, USA, September 2002.

Barry Lavelle, Daragh Byrne, Cathal Gurrin, Alan F Smeaton, and Gareth J F Jones. Bluetooth familiarity: Methods of calculation, applications and limitations, September 2007a.

Barry Lavelle, Daragh Byrne, Gareth Jones, and Alan F Smeaton. Bluetooth friendly names: Bringing classic hci questions into the mobile space. In *Proceedings of the 21st British Computer Society HCI Group Conference (HCI2007)*, September 2007b.

Thomas Leonard and Hugh Glaser. Large scale acquisition and maintenance from the web without source access. In *Workshop 4, Knowledge Markup and Semantic Annotation, First International Conference on Knowledge Capture (K-CAP 2001)*, pages 97–101, Victoria, British Columbia, Canada, October 2001.

m. c. schraefel, Leslie Carr, David DeRoure, and Wendy Hall. You've got Hypertext. *Journal Of Digital Information*, Volume 5, July 2004.

Frank Manola and Eric Miller. *RDF Primer*, February 2004. URL `http://www.w3.org/TR/rdf-primer/`.

Luke McDowell, Oren Etzioni, and Alon Halevy. Semantic email: Theory and applications. *Web Semantics: Science, Services and Agents on the World Wide Web*, Volume 2:153–183, December 2004a.

Luke McDowell, Henry Levy, Oren Etzioni, and Alon Halevy. Semantic email. In *Proceedings of the 13th International WWW Conference (WWW2004)*, New York, May 2004b.

Alexander Mikroyannidis. Toward a social semantic web. *IEEE Computer*, 40(11): 113–115, November 2007.

I. C. Millard, G. V. Hughes, D. T. Michaelides, D. E. Millard, m. c. schraefel, M. K. Thompson, and M. J. Weal. 'Forget About It': Signage at preview day 2003. Technical report, Electroincs and Computer Science, University of Southampton, 2003.

Ian Millard, David DeRoure, and Nigel Shadbolt. Contextually aware information delivery in pervasive computing environments. In *Proceedings of the 2005 International Workshop on Location and Context Awareness (LOCA 2005)*, Oberpfaffenhofen, Munich, Germany, May 2005.

Javed Mostafa. Seeking Better Web Searches. *Scientific American*, February 2005.

Theodor Holm Nelson. *Literary Machines 93.1*. Mindful Press, 1993. ISBN 0-89347-062-7.

William M Newman, Margery A Eldridge, and Michael G Lamming. Pepys: Generating autobiographies by automatic tracking. Technical report, Amsterdam, The Netherlands, September 1991.

Tom Nicolai, Nils Behrens, and Eiko Yoneki. Wireless rope: Experiment in social proximity sensing with bluetooth. In *Proceedings of the Fourth Annual IEEE International Conference on Pervasive Computing and Communications (PerCom 2006)*, Pisa, Italy, March 2006.

The Home Office. Identity fraud puts 1.7bn hole in britain's pocket, February 2006. URL `http://press.homeoffice.gov.uk/press-releases/identity-fraud-puts-1.7bn-hole`.

Kieron O'Hara, Harith Alani, Yannis Kalfoglou, and Nigel R Shadbolt. Trust strategies for the semantic web. In *Proceedings of Workshop on Trust, Security, and Reputation on the Semantic Web, 3rd International Semantic Web Conference (ISWC2004)*, Hiroshima, Japan, November 2004.

Kieron O'Hara, Richard Morris, Nigel Shadbolt, Graham J. Hitch, Wendy Hall, and Neil Beagrie. Memories for life: A review of the science and technology. *Journal of The Royal Society Interface*, Volume 3, Number 8:351–365, June 2006.

E O'Neill, V Kostakos, T Kindberg, A Fatah gen. Scheik, A Penn, D Stanton Fraser, and T Jones. Instrumenting the city: developing methods for observing and understanding the digital cityscape. In *Proceedings of the Eighth International Conference on Ubiquitous Computing*, California, USA, September 2006.

BBC News Online. Firms breaching data protection. July 2007a. URL `http://news.bbc.co.uk/1/hi/business/6289410.stm`. Accessed 10th August 2007.

BBC News Online. Nationwide fine for stolen laptop. February 2007b. URL `http://news.bbc.co.uk/1/hi/business/6360715.stm`. Accessed 10th August 2007.

Larry Page, Sergey Brin, R Motwani, and T Winograd. The pagerank citation ranking: Bringing order to the web. Technical report, Stanford Digital Library Technologies Project, 1998.

T. R. Payne, E. David, N. R. Jennings, and M. Sharifi. Auction mechanisms for efficient advertisment selection on public display. In *Proceedings of European Conference on Artificial Intelligence*, 2006.

Phrack. Low cost and portable GPS jammer. *Phrack*, 11(60), 2002. URL `http://www.phrack.org/archives/60/p60-0x0d.txt`.

Mark Pilgrim. History of the RSS Fork. 2002. URL `http://diveintomark.org/archives/2002/09/06/history_of_the_rss_fork`.

Mark Pilgrim. The Myth of RSS Compatibility. February 2004. URL `http://diveintomark.org/archives/2004/02/04/incompatible-rss`.

Dennis Quan, David Huynh, and David R Karger. Haystack: A platform for authoring end user semantic web apps. In *Proceedings of the Second International Semantic Web Conference (ISWC2003)*, Sanibel Island, Florida, October 2003.

Kerry Rodden, Wojciech Basalaj, David Sinclair, and Kenneth Wood. Does organisation by similarity assist image browsing? In *Proceedings of the Conference on Human Factors in Computing Systems (CHI)*, pages 190–197, Seattle, Washington, April 2001.

Matthew Rothenberg. Weblogs, metadata and the semantic web. In *Proceedings of the 4th Association of Internet Researchers Conference (AOIR 4.0)*, Toronto, October 2003.

T. Scott Saponas, Jonathan Lester, Carl Hartung, Sameer Agarwal, and Tadayoshi Kohno. Devices that tell on you: Privacy trends in consumer ubiquitous computing. In *Proceedings of the 16th USENEX Security Symposium*, 2007.

Leopold Sauermann. The gnowsis - using semantic web technologies to build a semantic desktop. Master's thesis, Vienna University of Technology, 2003.

Bill Schilit, Norman Adams, and Roy Want. Context-aware computing applications. In *IEEE Workshop on Mobile Computing Systems and Applications*, Santa Cruz, CA, US, 1994. URL `citeseer.ist.psu.edu/schilit94contextaware.html`.

Bill N. Schilit, Norman Adams, Rich Gold, Michael M. Tso, and Roy Want. The PARCTAB mobile computing system. In *Proceedings of the Fourth Workshop on Workstation Operating Systems*, pages 34–39, October 1993.

Nigel Shadbolt, Tim Berners-Lee, and Wendy Hall. The semantic web revisited. *IEEE Intelligent Systems*, 21(3):96–101, 2006.

Chia Shen, Neal B. Lesh, Frederic Vernier, Clifton Forlines, and Jeana Frost. Sharing and building digital group histories. In *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work (CSCW02)*, pages 324–333, New Orleans, Louisiana, USA, November 2002.

Ben Shneiderman and Hyunmo Kang. Direct annotation: A drag-and-drop strategy for labeling photos. In *Proceedings of the IEEE Conference of Information Visualisation (IV2000)*, pages 88–98, London, UK, July 2000.

Ashley Smith, Leslie Carr, and Wendy Hall. An opportunistic approach to adding value to a photograph collection. In *Proceedings of the Fourth International Semantic Web Conference*, Galway, Ireland, November 2005.

Standard and Poor. Search engine usage, attitudes and intentions, June 2004.

G. H. ter Hofte. What's that hot thing in my pocket? socioxensor, a smartphone data collector. In *Proceedings of the Third International Conference on e-Social Science*, Ann Arbor, MI, USA, October 2007.

Jerome Thorel and Matthew Broersma. France legalises bluetooth. *ZDNet.co.uk*, July 2000. URL `http://news.zdnet.co.uk/hardware/0,1000000091,2080188,00.htm`.

M. Tuffield, S. Harris, D. P. Dupplaw, A. Chakravarthy, C. Brewster, N. Gibbins, K. O'Hara, F. Ciravegna, D. Sleeman, Y. Wilks, and N. R. Shadbolt. Image annotation with photocopain. In *Proceedings of the First International Workshop on Semantic Web Annotations for Multimedia (SWAMM 2006)*, Edinburgh, United Kingdom, 2006.

Population Division United Nations, Department of Economic & Social Affairs. World population prospects: The 2006 revision, highlights. Technical Report ESA/P/WP.202, United Nations, 2007.

Frederic Vernier, Neal B. Lesh, and Chia Shen. Techniques for circular tabletop interfaces. In *Proceedings of the 2002 Conference on Advanced Visual Interfaces (AVI02)*, pages 257–266, Trento, Italy, May 2002.

Max Volkel, Markus Krotzsch, Denny Vrandecic, Heiko Haller, and Rudi Studer. Semantic wikipedia. May 2006.

Roy Want, Andy Hopper, Veronica Falcao, and Jonathan Gibbons. The active badge location system. *ACM Trans. Inf. Syst.*, 10(1):91–102, 1992. ISSN 1046-8188. doi: http://doi.acm.org/10.1145/128756.128759.

M. Weiser, R. Gold, and J. S. Brown. The origins of ubiquitous computing research at parc in the late 1980s. *IBM Systems Journal*, 38(4):693–696, 1999. ISSN 0018-8670.

Mark Weiser. The computer for the 21st century. *Scientific American*, September 1991.

Liu Wenyin, Susan Dumais, Yanfeng Sun, and HongJiang Zhang. Semi-automatic image annotation. In *Proceedings of Interact: Conference on HCI*, pages 326–333, Tokyo, Japan, July 2001.

Dave Winer. *RSS 2.0 Specification*, 2003. URL `http://www.rssboard.org/rss-specification`.