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Papers

Real time geodemographics: New services and business opportunities (and risks) from analysing people in time and space

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Abstract

Traditionally, geodemographics has been the description of people according to where they live, derived from the study of spatial information. New technologies such as GPS tracking and virtual worlds, however, provide an opportunity to describe people in much greater detail in terms of space and time. From the moment we wake up, our digital footprints provide a rich source of data for 'real time geodemographics', which can support some exciting new service and business opportunities — from pay-as-you-drive motor insurance to location-based social networking. This paper surveys the enabling technologies and illustrates what can be achieved with a series of case studies. We also examine the downside risks, especially the data protection and privacy issues that will impact public acceptance. Finally, we make a few predictions for how real time geodemographics will develop over the next few years.

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Introduction

Over the past quarter century, geodemographics has proved to be a valuable tool for customer analysis and market planning — in everything from predictive behaviour modelling to branch and store location assessment.¹

Originally, geodemographics was confined to the development and application of small-area classification systems, but has broadened since the early 1990s to include the classification of individuals using lifestyle and other personal data.² In this decade, the subject has evolved to encompass the analysis of a broad range of spatially referenced data, including transactional data, whether for the creation of new classification systems or for more general forms of analysis.³

Traditionally, the knowledge of where people were spatially located has been limited to a home address, possibly also a work address, and

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Beyond postcode analysis

perhaps to some retail sites used, based on postcode analysis. This situation is changing rapidly as new technologies make it possible to track people spatially in real time or near real time to a high degree of precision.

In this paper, we will survey these new technologies and illustrate the business implications of this new 'real time geodemographics' through a series of case studies. Here, we are using the word geodemographics in its broadest sense — to cover, potentially, any analysis of spatially referenced personal data, regardless of whether this might eventually end up as, or make use of, a geodemographic classification. The case studies include pay-as-you-drive motor insurance, traffic forecasting and congestion management, virtual (and parallel) worlds, retail planning and location-based services.

Privacy and data protection risks

These technologies also carry risks, especially in relation to the protection of personal data and privacy. We will examine what needs to be done in this area in order to win public acceptance. Finally, we will make a few predictions about how real time geodemographics will evolve over the next few years and the players most likely to seize the initiative in this exciting new field.

The technology

There are three main technologies that are relevant.

Tracking

There are several ways of tracking the location of a person (or an object associated with a person such as a car, a mobile phone or a shopping trolley) in space and time. Each has its own domain of applicability and merits in terms of cost, reliability and precision. In the near future, we expect these technologies to be combined in a generic, low-cost 'locator device' but we are not quite there yet.

Global navigation satellite systems

Perhaps the best-known technology is the global positioning system (GPS), which is currently the only operational example of a global navigation satellite system (GNSS).⁴ Operated by the US Air Force, GPS enables users to find their location (three dimensions of space and one of time) by referencing the position of several (normally four) satellites, which are within view from any point on, or close to, the earth's surface. A device that combines GPS referencing with a communication facility to transmit locational data to a central computer enables the device (and the person or object to which it is attached) to be tracked.

GPS is usually accurate to within a few metres, but reliability depends on a clear view of enough satellites (there are 24 satellites in near-earth orbit in the GPS constellation) and this can be a problem inside or near buildings, in tunnels, in hilly terrain or in woodland. Over the next few years, several new GNSS systems will come onstream, including Galileo (EU and ESA), GLONASS (Russia), COMPASS (China) and IRNSS (India) — and these may improve coverage and reliability, as well as security of service.

Tracking mobile phone handsets

Vehicle satellite navigation (SatNav) systems make use of GPS. They overcome the reliability problems of GPS by using the so-called ‘dead reckoning’ — so that if, for example, a car goes into a tunnel, the SatNav device can calculate, using data from accelerometers and from the car’s drive system, where the car has got to from the point it lost the GPS signals.^{5,6} Some systems will also take into account the fact that the car can be assumed to be somewhere on the road network, in order to improve the positioning calculation.

Hand-held GPS devices used by pedestrians do not, in general, have this dead reckoning functionality, so tracking is more hit and miss — as anyone who has used GPS in the mountains or in forests can testify.

Another tracking technology is the ‘Cell of Origin’ service provided by mobile phone companies,⁷ which enables a mobile handset to be tracked by referencing the wireless cells through which it links. While generally less accurate than GPS, this technology is lower in cost and more reliable in urban and indoor environments where satellite referencing is problematic.

Tracking within buildings

Another technology that addresses the problem of tracking within buildings and dense urban environments is Software Defined Radio (SDR).⁸ This makes use of fixed beacons that transmit radio waves that can penetrate concrete and steel. A special tracking device, developed for use with SDR, can compute a location by referencing signals from several SDR beacons.

RFID tags

A fourth important tracking technology is the radio frequency identification (RFID) tag.⁹ An RFID tag is a low-cost device, essentially a computer chip with a built-in radio receiver and transmitter, which can be attached to or incorporated into a product, animal or person for the purpose of identification using radio waves. The tags can be read using remote sensors to identify where the tagged object is and at what time.

All of the above tracking technologies have limitations and we can expect devices to be developed in the future that combine the technologies in a way that will call upon the most accurate at any particular point in space. This is beginning to happen with the embedding of GPS devices in some high-end mobile phones. Cost is an issue currently, but we confidently expect technical advances that will dramatically lower costs and enable the production of cheap and reliable tracking devices that will function anywhere and at any time.

Surveillance

CCTV and automated number plate recognition

This technology enables objects such as cars to be located in time and space by being ‘seen’ by a static network of surveillance devices such as closed circuit television (CCTV) cameras. In the case of vehicles, the ‘seeing’ is normally done by automated number plate recognition (ANPR), for example for the police National Surveillance Network¹⁰ and the London Congestion Charge.¹¹ Surveillance is also possible using remote sensing from satellites¹² or aircraft, although this is expensive and rarely used outside the military.

Smart dust

A more speculative surveillance technology is the so-called ‘smart dust’.¹³ This consists of hypothetical, very low-cost nano-scale devices that would be capable of sensing objects in their vicinity and communicating the sensory data wirelessly among themselves in a way that can be picked up by a few conventional fixed receivers. The idea is that smart dust would be scattered over a wide area and provide a low-cost alternative to conventional surveillance technologies such as CCTV.

Virtual representation of the real world**Virtual worlds**

It is one thing to track people or objects through time and space, but how is this information to be marshalled and applied for business value? One way is through the use of a ‘virtual world’ (or, rather, ‘parallel world’). This is a web-based representation of the real world populated by people, places and things whose location in time and space has been identified through tracking or surveillance. The pioneer in this area was HP Labs through its Cooltown Project,¹⁴ but this and other, more recent initiatives have morphed into the so-called Internet of Things.¹⁵

Of course, once we dip into virtual worlds, there is no need to restrict ourselves to representations of the real world. Applications such as Second Life^{®16} and ActiveWorlds¹⁷ and online gaming enable representations of people as ‘avatars’ inhabiting an entirely artificial world, but where real business activity and social interaction, even market research,¹⁸ can take place. While these artificial virtual worlds are fascinating, and offer many business opportunities, we shall restrict ourselves in this paper to representations of the real world.

Factoring additional risk data into insurance pricing**Case Study 1 — Pay-as-you-drive motor insurance**

The basic idea behind pay-as-you-drive motor insurance is that the risk of accident or damage depends on the roads travelled, speed and the time of day, as well as on the traditional risk-related characteristics of the driver (age, gender, previous history, etc). By factoring this additional risk data into the insurance pricing, and providing add-on services enabled by the technology, it is possible to offer a more competitive motor insurance product to some drivers.

The first insurer in the UK to enter this market was Norwich Union in 2006,¹⁹ although they withdrew after two years due to low product take-up.²⁰ With their package, a tracking device, consisting essentially of a GPS system and mobile phone, is installed in the vehicle. Whenever the vehicle is driven, the device transmits a stream of data on the date, time of day, spatial location, direction of travel and speed along the journey. The insurer can link these data to the risk profiles of particular roads under particular driving conditions. Monthly premiums include a fixed fee to cover fire and theft, plus a variable amount based on mileage driven, roads used and time of day of each journey.

Additional service opportunities

Importantly, additional services are offered that can take advantage of the tracking technology. These include an emergency safety button

(so that emergency services can be informed of the precise location and time of an accident), stolen vehicle recovery and an optional satellite navigation service.

Another insurer in this market is More Th>n (part of Royal & SunAlliance) with its 'Drivetime™' product.²¹ This is aimed at young drivers aged 18–25 who will be driving between the hours of 11pm and 6am, when most serious accidents occur for this age group. In return for a 40 per cent discount on the company's standard premiums, drivers are asked not to use their cars between these times. A GPS-based tracking device is fitted free of charge, and sends messages to More Th>n whenever the engine is started or stopped. Penalties are imposed if the car is used between 11pm and 6am.

Telematics

Pay-as-you-drive motor insurance is one example of a broader class of applications for in-vehicle tracking and related technologies, generically known as 'Telematics'. The recent report by the Association of British Insurers²² sets the scene for how telematics will shape the future of motoring, both domestic and business. Other applications include road pricing, journey planning, the tracing of stolen vehicles and emergency service call-out.

Case Study 2 — Traffic forecasting and congestion management

Tracking technologies are revolutionising the fields of traffic forecasting and congestion management. GPS is perhaps the one most widely used, with services such as Trafficmaster,²³ the Floating Vehicle Data System from IT IS,²⁴ feeding into a multitude of route-planning and so-called 'personal journey management' systems. There are also services based on mobile phone cell of origin, such as TrafficAid from IntelliOne in Atlanta.²⁵

Integrating congestion data from multiple sources

Most current services provide information, often in real time, about traffic congestion by integrating data sampled from static roadside sensors, from sampling the current location and speed of a large number of commercial vehicles, or from a combination of both. Route-finding tools such as Smartnav²⁶ will track the user vehicle's location and integrate this with the congestion data in order to make route recommendations that steer the user around problem areas.

Inevitably, many current services limit congestion monitoring to major routes, leaving a large gap in information about minor roads and byways. An application that uses mathematical modelling to predict the congestion in all categories of road is ClearFlow from Microsoft Research, which has been trialled in Seattle.²⁷ This takes the form of a smart electronic map, which, for any particular road, models the status of that road by taking into account information on congestion on nearby roads as well as the day of the week, time and weather conditions. Crucially, ClearFlow can use road configurations it already knows about to predict how traffic on unfamiliar configurations will behave.

A bridge between the real world and a virtual world

Case Study 3 — Virtual worlds

There have been a number of initiatives aimed at creating a web-based infrastructure for presenting information about people, places and things in a spatial context. By integrating this information in a readily accessible form, it is possible to enable a wide variety of business and social applications.

One of the first initiatives was the Cooltown project, initiated by HP Labs¹⁴ in 2000. Cooltown seeks to develop an infrastructure to support web presence for people, places and things. By providing a bridge between the real world and a web-based virtual world, it will enable services to become more personalised, spontaneous and responsive to the wide variety of contexts in which people live their lives. Early applications include the 'Cooltown Museum', where a visitor to a real-world museum is tracked in a virtual representation of the museum and is served up with supplementary information and commentary according to their location. At the same time, the user can post electronic comments and messages into the virtual world, which are then accessible to other visitors as they move around the museum, or to others wanting remote access.

Another manifestation of technology bringing the real and virtual worlds together is the so-called 'Augmented Reality'.^{28,29} Essentially, this involves computer displays that add virtual information to a user's sensory perceptions. Already widely used in military applications (eg, head-up displays for pilots of battlefield and avionic data), the technology is moving rapidly into the mainstream with applications such as advertising and object tracking at televised sports events, and enhanced sightseeing made possible by a new generation of hand-held devices.

The 'Internet of Things'

A recent example of a web-based infrastructure initiative is the so-called Internet of Things, which spawned a major international conference in Zurich in the spring of 2008.¹⁵ Quoting from the conference flyer, 'The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. Technologies like RFID, short-range wireless communications, real time localisation and sensor networks are now becoming increasingly common, bringing the Internet of Things into commercial use. They foreshadow an exciting future that closely interlinks the physical world and cyberspace — a development that is not only relevant to researchers, but to corporations and individuals alike'. Major sponsors of the conference included Siemens, Google and IBM.

Another example of a virtual representation of the real world is Real Time Rome.³⁰ This is the MIT SENSEable City Lab's contribution to the 2006 Venice Biennale. The project integrates data from cell phones, buses and taxis in Rome to better understand urban dynamics in real time. Information is presented in map form and also uses other, more advanced, visualisation techniques. By revealing the pulse of the city, the project aims to show how technology can help individuals make more informed decisions about their environment. In the long

run, for example, it might be possible to reduce the inefficiencies of present-day urban systems and open the way to a more sustainable urban future.

The ‘Semantic Web’

In parallel with the above developments, the web itself is also evolving into a form, the ‘Semantic Web’, in which the semantics of information and services on the web is defined, making it possible for the web to understand and satisfy the requests of people and machines who use the web content.³¹ The DBMedia project, led by the Universities of Berlin and Leipzig, is seeking to develop a semantic version of Wikipedia. Within the project is Mobile DBpedia, a tracking application (requiring a GPS-enabled mobile phone) that takes a user’s GPS position and displays Wikipedia articles on places in the vicinity, as well as showing them on a map.³²

Case Study 4 — Retail planning

So far, we have looked at applications involving the tracking of vehicles and people, over distances of the order of miles or even hundreds of miles. Tracking technologies are also being applied to much shorter distance scales, in particular to the way shoppers use a retail store.

Tracking shoppers around a grocery store

The Wharton Management School at the University of Pennsylvania, in association with Sorensen Associates, has been using RFID tags attached to shopping trolleys to follow grocery shoppers around stores.³³ Sorensen’s PathTracker® technology employs RFID tags in conjunction with video surveillance to map out the patterns followed by shoppers. Wharton then analysed the resultant data using a range of methods including cluster analysis.

The results challenged many perceptions about the way in which shoppers use a grocery store. Rarely, for example, do shoppers follow a systematic pattern up and down the aisles. There is a tendency to follow the perimeter ‘racetrack’ in an anti-clockwise direction, making short excursions into the aisles. There is also a tendency to shop more quickly on the approach to checkout. In principle, findings such as these can be used by both retailers and manufacturers to help plan shelf layouts and sales promotions to increase sales and enhance the customer experience.

Understanding shopper movements to improve displays and sell more goods

More recently, a dozen FMCG companies, including Proctor and Gamble, Coca Cola and Kellogg, have teamed up with 18 major retailers, including Walmart, Walgreens and Target, on ‘Project Prism’, an initiative led by AC Nielsen.³⁴ The objective is to understand how shoppers move around in a superstore in terms of their paths around the aisles, speed and time of day — and use this understanding to improve displays and, ultimately, sell more goods.

Prism (Pioneering Research for an In-Store Metric) uses infrared surveillance technology to track shoppers’ movements and correlate this with sales data. The project is described as ‘the first truly scientific measurement of the effectiveness of in-store sales tools such as shelf location and promotional displays’.

Case Study 5 — Location-based services

The provision of location-specific information to mobile phone users on the move is the generally accepted definition of location-based services (LBS).³⁵ One could argue that all the case studies we have looked at so far are really ‘location-based services’ in some sense, but we will stay with the more limited, mobile phone, definition for this section.

LBS has been enabled by the convergence of GPS, mobile telephony and the web. Major players in this market include Infinian, Google, Nokia and Trisent, and a range of services are being offered which include the following.

Location-based social networking

- Identification and booking of local services — taxi, restaurant, medical, motoring, ticketing and other spatially distributed services.^{36,37}
- Location-based social networking where user interactions can be triggered by physical proximity: for example, friends or business colleagues in a social networking group can be alerted if another friend enters the same building or moves to within a short distance. The recent acquisition of the Helsinki-based company Jaiku.com by Google underlines the importance that the industry places on this area.³⁸
- Proximity-based marketing — where promotional offers are sent by SMS or voicemail to prospects in the vicinity of the service provider:^{39,40} the movie by Steven Spielberg, *Minority Report*, showed examples of how individual-specific messages and advertising might, in the future, be displayed in a shopping mall as surveillance devices recognise that individual.⁴¹

Privacy and data protection

Public awareness of the privacy and data protection issues associated with the technologies described above, especially tracking and surveillance, is increasing. In 2006, the UK’s Information Commissioner launched a public debate on the implications of living in a surveillance society with the release of a report, ‘A Surveillance Society’,⁴² which provides glimpses of society in 2016 and the surveillance technologies that may be in use then. The report warns about some of the undesirable implications of such surveillance and tracking, and underlines the dangers of ‘sleepwalking into a surveillance society’.

The public accepts that data have to be exchanged

Subsequent qualitative research commissioned by the Information Commissioner’s Office revealed the extent of public awareness and the concerns felt.⁴³ The research found that, as far as commercial organisations were concerned, there was general acceptance by the public that data have to be exchanged in order to receive innovative and cost-effective products and services. It also revealed anxieties about the potential for identity fraud and commercial data abuse. Another key concern was the need for greater transparency about commercial data sharing and the rules and penalties on holding data.

To underline concerns in this area, a recent report by the UK's House of Commons Home Affairs Committee, 'A Surveillance Society?',⁴⁴ examines the implications of the enabling technologies in great depth. It makes a number of recommendations for the tightening of data protection and additional overseeing of personal privacy protection, especially in the public sector.

Some predictions

Cheap tracking devices will be embedded in many everyday objects

One thing is clear — the technologies that enable real time geodemographics are evolving rapidly. Falling costs and increasing miniaturisation and sophistication are driving progress towards cheap tracking and surveillance devices that can be embedded in many everyday objects including mobile phones, motor vehicles, laptops, shopping trolleys, luggage, clothes, packaging and many others.

Applications such as those described in this paper will evolve rapidly alongside these technologies. Many new ones will be developed. Indeed, with applications such as location-based social networking, human behaviour itself may change to take advantage of the new opportunities, although there will be many risks.^{45,46}

New statistical and mathematical modelling methods will be needed

Underpinning real time geodemographics will be a vast new ocean of data. Making sense of these data will require the novel use of existing analytical tools as well as the development of new statistical and mathematical modelling methods. We expect that geodemographic classification systems will be developed that use the spatial footprint data as well as personal, neighbourhood and transactional data. We also anticipate the development of other forms of multidimensional analysis that will more effectively exploit the dynamic nature of the data involved.

We predict the emergence of new players specialising in analytics for the real time spatial world. Whether there are enough people with the right background and skills is another matter, given the current shortage of analytical skills in the more traditional marketing and customer service arenas.⁴⁷

Who will seize the initiative?

And what about the infrastructure that will enable access to all these data? Who is going to pick up the Cooltown 'baton' and seize the initiative to lay down a global infrastructure? Will it be Google, Microsoft, IBM, Nokia, Siemens — or none of these, perhaps a new player? Or will the infrastructure 'emerge' with the semantic web? Our money is on a combination of these.

Consumers will require that the benefits outweigh the risks

There will be problems along the way. Disasters with privacy and data protection are bound to occur, hopefully isolated and redeemable — as they have been with almost every other technology in its early days, from horse-drawn vehicles to aviation, or folk remedies to modern pharmaceuticals. The commercial and public sector organisations that exploit real time geodemographics must demonstrate to consumers that the benefits in terms of new and valuable services outweigh the potential risks.

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