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Jennifer Richards

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Jennifer Richards

Date

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Research Paper:

Creating Customisable Tourist Guides for Scottish Settlements

Abstract

Increasing numbers of tourists to Scotland are in need of more specific guides for their local destinations. The current tourist guides available are either too general or too specific so are unsuitable for travellers who want to see more than the major tourist attractions. This was confirmed by a survey of Gazetteer for Scotland users, which also revealed users would benefit from a route taking in features of their personal interest.

This study builds upon the work done by Farrar (2011) in order to create customised local guides for Scottish settlements. The Gazetteer for Scotland provides the database for guide information whilst Ordnance Survey Open Data supplies maps for feature location.

The guide creation program was made more efficient to both run and maintain, with additional functionality incorporated effectively. Parameters given to the program select the location of interest, whether to include sections of the guide with local history, industry, geography, famous people, historical events and surrounding towns. Including an additional argument filters the type of features included to only those of interest to the user. The result is a condensed guide with only information relevant to the specific user.

A user interface is hosted on the Gazetteer for Scotland website where the visitor is able to select a destination and chapters to be included in their guide. The completed guide is offered as a PDF via a web link for users to download to a mobile device for use on location.

Research Paper – Creating Customisable Tourist Guides for Scottish Settlements

Introduction

Tourists have increasing amounts of time and more money than in recent history (Han et al, 2014). However, many people are choosing to look after their money and holiday within the UK; as a result, tourists to Scotland have exceeded a million per year (Visit Scotland, 2014). Many of these visitors have differing interests so making it difficult for tourist boards to provide guided routes acceptable for everyone (Souffriau and Vansteenwegen, 2010). The concept of tourist space which includes the points of interest (POIs) and the continuous space chain connecting each section of the landscape is discussed by Han et al, 2014. This leads to the tourist wanting the most interesting and relevant route through the city, ideally provided via their personal planned route. The development of this project will aid tourists in having a more enjoyable guided route experience.

‘Personalisation is becoming one of the main requisites of the tourism sector’ (Almeida, 2009). A key issue for tourists visiting a new place is what to see in the limited time available. General information is found in guide books but much of this information is often obsolete and of no interest to the particular individual. Therefore, to improve the experience, a tailored journey plan (according to the interests of the individual) would be an optimum solution.

There are many websites offering suggestions of POIs such as Trip Advisor and Visit Scotland. However, these types of site do not offer a site ordering service to create a logical route and often are sponsored by businesses to promote certain attractions. This is not an ideal situation for the user so making a route of POIs hosted by the neutral Gazetteer for Scotland (GfS) (Gittings, 2014) a better alternative.

Tourists who have input into their own guided tour experience a more interactive and less passive trip than those who follow a set route and guide (Larsen and Meged, 2013). Planning stages of a trip can form a significant part of the holiday experience, so the greater the availability of information, the better the holiday can become (Brown et al, 2001). Information access can determine where the person visits, so an online route planner based on the GfS database can facilitate the linkage of information and potential tourists. The GfS is an accessible database incorporating the spatial locations of a large proportion of Scottish sites of interest (Gittings, 2009). This database can be searched and queried in order to retrieve the appropriate information for tourist guides.

This research utilises the GfS database to provide an online tourist route planning experience resulting in a personalised guided route made available offline as a PDF. This paper argues that the GfS is a suitable basis for creating personalised tourist guides for visitors to Scotland, providing a service which is not currently available.

Context and previous work

There are numerous web services for tourist route planning available (Zhao and Di, 2010); however there are many issues with these systems. The primary problem is that they are city specific, such as the GUIDE system for Lancaster, UK (Davies et al, 2010), so not suitable for many locations across Scotland. The second problem is that they are web-based; this is acceptable for areas with good 3G or 4G coverage but most of the land area of Scotland is not served by these networks. There are numerous route planning tools for tourists but nearly all of these require an internet connection (Corchado et al, 2004), a problem for mobile device users with limited connectivity. An example of this is the system developed by Anacleto et al, 2010 which has a high level of user interactivity and so large volumes of data. Therefore, a practical tourist planning system must have the ability to make the routes available offline for users to access the guide outside of network coverage.

There are many route planner applications available online but they vary in process and functionality. The most commonly found is the Google Maps route planning tool, utilised by many websites (Trip Advisor, 2014 and Visit Scotland, 2014). However, the basic functionality of this does not order points but keeps them in the input order. The lack of location ordering is a drawback of many of the available planners. Such an example is the Wikipedia function to create a book out of a sequence of its web pages; for obscure features, the typical Wikipedia problems of inaccuracy and systematic bias prevail (Kittur and Kraut, 2008). The book guide requires manual selection of pages which is slow and the pages are loaded in order of choice not by type or geographic proximity. There is potential for suggestions of related pages indicating some intelligent searching but the user interface is awkward and not at all obvious to a standard user. The interface used by Terzis (2010) was also not designed for rapid comprehension, so highlighting the need for a clear and simple user interface from this project.

The application is aimed at fully independent travellers, described in Lau and McKercher (2006) as tourists who purchase their own travel and accommodation separately and do not travel in a group. As a result of this independence, they demonstrate a more flexible travel pattern based on personal preferences, so making them perfect users for a personalised route planner.

This study will focus on creating an improved version of the guides created by Farrar, 2011. Potential areas for improvement include adding Application Program Interfaces (APIs) to a variety of online services allowing the inclusion of travel and dining information into the Gazetteer and town guides. However, it is likely that these services will cost so may not be feasible without a charge to the user. Map clarity is a significant issue, but additional pre-processing would need to be undertaken on the OS maps by EDINA. Currently, the maps could be improved by clearer labelling and a more appropriate scale. Attributing an importance weighting to each feature may reduce the issue of map over-crowding, similarly the weighting would focus the map onto the local area of interest and not a larger town nearby (Farrar, 2011). This issue can be solved by filtering the features to only include those of interest to the specific user.

Justification

Not all tourists want a traditional guided tour based around their destination (Larsen and Meged, 2013). This can be for a variety of reasons ranging from logistical issues and price to social preferences. Using a guidebook can negate some of these potential problems although still contribute to the issue of cost.

Standard tours and guidebooks often assume standard tourists (Larsen and Meged, 2013), which is not the case in reality. Each tourist is an individual, so whilst many can find a tour or guidebook which generally fits their needs, many more require a specific interest route. 'As personalized trend is increasingly evident, every tourist has its own psychological preferences and demand so that the same travel route design cannot meet all tourists' demand' (Han et al, 2014).

Integration of different modes of transport, local services and attractions is crucial for a smoothly functioning tourism service (Almeida, 2009). Similarly, combining multiple information sources into a single interface can aid tourists in planning their entire journey.

There are guided walking tours around Edinburgh but these are rigid with no user interaction. There are comprehensive tourist guides available, but much of the information is obsolete for the individual; similarly, Farrar's guide includes all the places of interest within the town. This project aims to create a user orientated guide with an ordered route to visit selected sites.

Research Questions

Using previous work as a base upon which to improve, the aim of this project is:

'Can the GfS be used as a base for creating a personalized route map and guide for tourists in Scotland?'

This aim leads to research questions:

- Can the Local Guides created by Farrar be improved?
- What are the user requirements for a personalised guide?
- Can people be navigated through the complex data to only select sites of interest to them?
- Can the GfS be used as a database for effective route planning for tourists?
- Can features listed in GfS be linked to the geometry of the road network to create routes?
- What is the best method for displaying the guided route to the user?

Data Requirements

Scottish features of interest

The Gazetteer for Scotland is a descriptive (long-form) Gazetteer created by Bruce Gittings and David Munro in 1995. The data contained within the GfS includes all of the settlements in Scotland, along with many of their features and tourist attractions. Information concerning historical events and famous people is also included. Whilst remaining a work in progress, this represents a rich mine of information ideal for extracting data to be used in tourist guides for Scotland.

The data used for the guides is obtained from the GfS, as the data is freely available for research purposes (Gittings, 2014). All entries in the GfS have a spatial coordinate location, precise up to 1m, however not everything has a textual description (especially features). With the ever expanding Gazetteer database, feature filtering is becoming more important; Farrar noted this in 2011 and since then the feature list has increased from just fewer than 20,000 entries to over 22,200. The interactivity available to the user via the customisable guides described here will help in this filtering process; similarly, including the length of description or adding a tourist rating will aid in ranking the importance of the feature. As the more interesting features have a longer description and the cities have more places of interest, the GfS database is a manageable size for this project. A visualisation of the interrelationships within the GfS database aided in the understanding of database construction and therefore how best to utilise the large volume of data.

Maps

The features are displayed on Ordnance Survey (OS) maps of Scotland (at the appropriate scale) provided by the EDINA web mapping service (WMS). OS is Britain's national mapping authority and the largest creator of maps in the UK (Ordnance Survey, 2014). The familiar symbology and layout allows for easy user comprehension, making the OS maps a suitable choice. Not only are OS maps incredibly popular with users, the OS is held in high regard for data standards so is an ideal candidate for providing the base maps for the tourist guides.

EDINA is the JISC-designated national data centre at the University of Edinburgh and therefore able to provide free OS data for research projects. To ensure the maps are up-to-date and of a suitable customised scale and extent, for each guide creation the maps will be taken as required using the EDINA WMS. This dynamic response each time a guide is created ensures that the map is at the appropriate scale for the number of features that need to be included.

Routing

Due to the nature of the rapidly changing transport network, it is necessary for routing between features to be done on demand. Many providers offer this service (discussed in Richards, 2014); Google Direction API is a suitable supplier, using the Google Maps road network and routing algorithm. Allowing the user to choose driving or walking as their mode of travel permits their optimum route to be calculated. If by foot, the available footpaths can be utilised whilst driving directions make appropriate use of single direction roads.

Assessment of User Requirements

The results found in the work of Terzis, 2010, Farrar, 2011, and Souffriau and Vansteenwegen, 2010, indicate the most important aspects of a website and route planner. The initial assessment of user requirements allows the extraction of key features needed in the website. The prototype built according to user requirements will be tested on a focus group to influence the further work and adaptation of the route planner interface.

Online Questionnaire

A questionnaire to assess user requirements was hosted on the Gazetteer for Scotland website, totalling 112 returns in the 15 week period. A summary of the answers to each question is shown below; the expanded results are detailed in Richards, 2014.

People from a variety of countries answered the questionnaire, with most responses coming from residents in Great Britain (predominantly Scotland and England). A significant number of USA and Australia residents also responded. This range of respondents indicates the breadth of typical GfS users and so the breadth of typical users of the tourist guides. The results demonstrated the range of interests exhibited by large groups of people; most people would like a personalised guide which contains sites not typically included in traditional tourist guides. The preferred form of the guide is a downloadable document which can be printed. More users indicated they wanted a sequence of stops to visit in the given order rather than a specific route plotted between attractions. The mode of transport varied, often dependent upon the distances involved. Due to anticipated complexities of guide creation, half of the respondents indicated they would be willing to wait 15 minutes or longer for their guide to be produced.

Respondents were given the option to offer any additional comments not covered by the questionnaire. Many people indicated they would be interested in family history being included; personal family histories are not included in the GfS and also are often too complex for inclusion in a short tourist guide. This criterion will not be met by the tourist guide as other services offer a greater amount of specific information relating to each family.

The need for a clear map has been stated in the suggested improvements to Farrar's guides as well as by current GfS site visitors. User requirements for the map include an indication of time required to travel the route, preferably produced from information on road type and elevation change.

Over 25% of Gazetteer users are over the age of 65, with another 38% being between 41 and 65 so indicating an older audience for the tourist route guides. As a result of this user demographic, the guide will be adapted to accommodate the needs of older people in unfamiliar environments (such as including permanent features and alternative titles if places have been renamed), as described in Phillips et al, 2013. To decrease unease in the new place, unfamiliarity should be mitigated with additional directions and reference to local significant landmarks. This is especially important for those people who are revisiting past destinations where local development and regeneration may have significantly altered the urban landscape.

Assessment of user requirements has revealed key criteria needed in the guide, similar to those discovered by Farrar, 2011. The guide needs to be generated automatically, using up-to-date information but also needs to be portable. The space needs to be visually represented, with the features of interest plotted in the correct location. The information contained within the guide needs to be relevant to the specific user and individually customised to show features of interest suitably connected.

User interface

User input of preferences needs to be easy and quick to encourage positive reactions (Davies et al, 2001), and designed for rapid user comprehension (Golombisky and Hagan, 2010). These base components have been identified based on user feedback and suggested improvements for other guide systems. The concise list of selection criteria allows the user to make rapid decisions and so limit the number of additional queries to the GfS database.

- Pick a location in Scotland
- Select the general type of their feature-of-interest
- Additional selection of sub-categories within the interest type reinforces the selection of particularly interesting attractions
- Select the mode of transport
- Select chapters to be included in their guide (geography/history/industry, famous people, historical events, nearby towns)

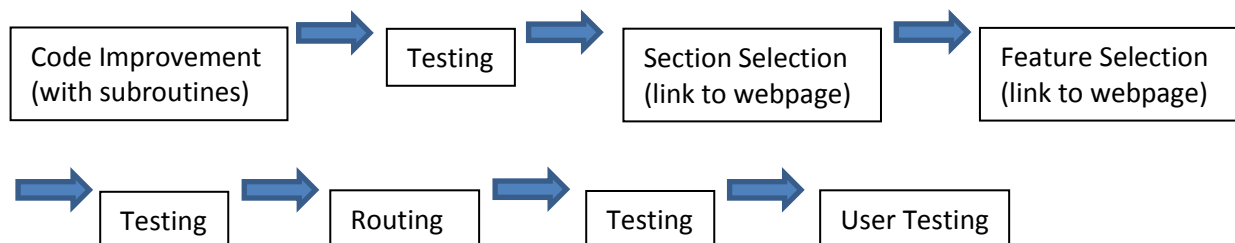
Entering personal preferences to the website and clicking submit triggers a PERL (Practical Extraction and Report Language (Schwartz and Christiansen, 1997)) script. This script initiates the guide creation program (with appropriate arguments) which queries the GfS database and creates a suitable presentation of the results.

System implementation

Traditionally, 'program' was used to indicate something written in a programming language and had to be compiled whilst a 'script' was written in a scripting language and had to be interpreted (Callender, 2002). Over time, especially in the case of Perl, these distinctions have become less defined so 'program' and 'script' are used interchangeably.

Structure of the application is guided by specific user requirements; the program is accessible via a webpage (similarly to Vansteenwegen et al, 2011) on the GfS site. User interaction with the webpage is scripted using HTML but the program is scripted using PERL. The dynamic querying of the GfS Oracle database ensures that features are current with maintenance done via GfS updating. The results are produced as a PDF so that it can be saved onto a mobile device or printed for easy reference in the field where internet access may not be reliable.

General development process diagram



Development

The initial step ensures the guide works to produce a PDF for tourists. Farrar's code from the 2011 project needed dramatic condensing before additional functionality could be added. The inclusion of sub-routines allowed the reduction by 50% to fewer than 3500 lines; this improved performance and reduced the number of errors generated (Richards, 2014).

Testing

The personalised guide is developed with the users as a priority, therefore thorough testing of the final product is vital to successful service provision. Testing is done continuously whilst adapting code routines and at each major stage of production. Potential users will be asked to test the guides to ensure the maps are useable for those without mapping experience.

Due to the feature density variation between large cities and small towns, a range of map types are defined within the guide program. The map type is defined by the area of the settlement and the number of features contained within that area (Farrar, 2011). To ensure consistency between the guides, testing of places of each map type was necessary (Richards, 2014; summarized by Table 1).

Table 1

Example of each map type and the name and ID number of the location. Each of these places had guides generated at each stage of development to ensure the program works for locations of a variety of sizes and feature densities.

Map Type	Settlement	Place ID Number
1	Glasgow, City of Glasgow	338
2	Gourock, Inverclyde	339
3	Clackmannan, Clackmannanshire	189
4	Edinburgh, City of Edinburgh	337
5	Rutherglen, South Lanarkshire	417
6	Aberdour, Fife	2
7	Invershin, Highland	2068

Section Selection

The key function of generating a local guide for a specified place is preserved from Farrar, 2011. Primary additional functionality is comprised of user selection of chapters to be included in the guide. As not everyone is interested in the geography, history or industry of the area (and these sections can take up a number of pages), the user has the option to select chapter inclusion via the webpage form. Similarly, the user is able to select the inclusion of nearby towns and famous people or historical events relating to the area. The default option is to exclude these sections.

Feature Selection

Including an interest type condition into the feature selection statements limits the attractions returned in the guide to only those of interest to the user. The generated guides are shorter as they only contain information useful to the reader. The map is also clearer as it is not cluttered with unnecessary features. The map for a feature filtered guide for historical buildings of Edinburgh is shown in Figure 1. Due to the reduced number of features, the attractions of the town can be shown on one map instead of the nine map tiles found in the general guide (Figure 2).



Features of Interest

- 1 Balmoral Hotel
- 2 Donaldson's College
- 3 Royal College of Physicians
- 4 Scotsman Hotel
- 5 Sciennes Hill House
- 6 No.5 Charlotte Square
- 7 Warriston Crematorium
- 8 Salisbury Green
- 9 Governor's House

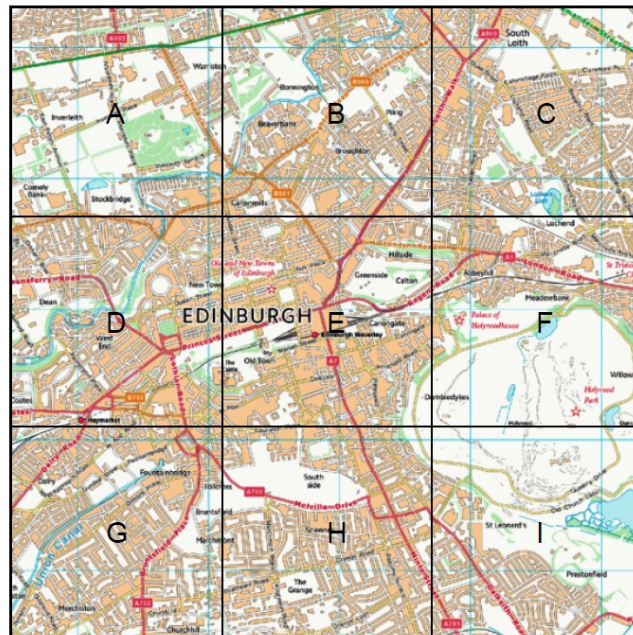


Visitor Attractions

- 1 Gladstone's Land
- 2 The Sheep Heid Inn
- 3 Tailor's Hall
- 4 Radisson Blu Hotel
- 5 Queen Mary's Bath House
- 6 The Signal Tower

Figure 1

Map showing the fifteen features of interest and visitor attractions within the city of Edinburgh. This example shows the overview page for a user interested in historic buildings. Nearly three hundred original features have been reduced significantly for a clearer and more efficient guide that is easier for tourists to use.



Map of Central Edinburgh (E)

Map of Central Edinburgh (E)

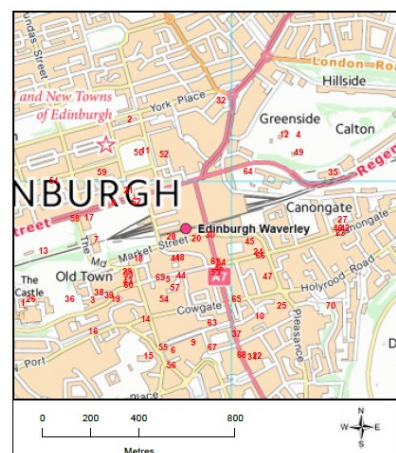


- 39 Netherbow Port
- 40 Rainy Hall
- 41 Panmure Close
- 42 Whiteford House
- 43 High Street Hostel
- 44 Governor's House
- 45 High Court of Justiciary
- 46 Midlothian County Buildings
- 47 Dunbar's Close
- 48 Canongate Manse
- 49 Waverley Court
- 50 Portsburgh
- 51 Institute of Geography
- 52 Chisholm House
- 53 Edinburgh Bus Station
- 54 Roman Eagle Hall
- 55 Playfair Steps
- 56 Kirk o' Field
- 57 Gayfield

Features of Interest

- 1 University of Edinburgh
- 2 National Library of Scotland
- 3 St Andrew's House
- 4 The Mound
- 5 McEwan Hall
- 6 Balmoral Hotel
- 7 George Heriot's School
- 8 Register House
- 9 Lady Yester's Kirk
- 10 New College
- 11 Adam House
- 12 North Bridge
- 13 Queensberry House
- 14 Waverley Station
- 15 Panmure House
- 16 Archdiocese of St Andrews and Edinburgh
- 17 The Signet Library
- 18 Parliament House

- 20 Old High School
- 21 George IV Bridge
- 22 South Bridge
- 23 Royal College of Physicians
- 24 Old Surgeons' Hall
- 25 Mowbray House
- 26 Dumbiedykes
- 27 Dance Base
- 28 Scotsman Hotel
- 29 St James' Centre
- 30 Advocate's Library
- 31 Assembly Hall
- 32 Assembly Hall
- 33 Braid's Street
- 34 Bristo
- 35 Lady Stair's Close
- 36 Waverley Bridge
- 37 Bristo Square
- 38 The Vennel



- 39 The Edinburgh Festival Centre
- 40 People's Story Museum
- 41 Mary King's Close
- 42 The Canongate
- 43 Gladstone's Land
- 44 The Mercat Cross
- 45 Brass Rubbing Centre
- 46 Tron Kirk
- 47 St Patrick's Church
- 48 City Chambers
- 49 Nelson Monument
- 50 Melville Monument
- 51 Assembly Rooms
- 52 Dundas House
- 53 Hunter Square
- 54 James Braidwood Statue
- 55 Greyfriars' Bobby
- 56 Bedlam Theatre
- 57 Parliament Square
- 58 Floral Clock
- 59 The Dome
- 60 Lawnmarket
- 61 The High Street
- 62 Scott Monument
- 63 Chambers Street
- 64 Old Calton Burial Ground
- 65 Cowgate
- 66 Museum of Childhood
- 67 Talbot Rice Gallery
- 68 Festival Theatre
- 69 The Heart of Midlothian
- 70 James Hutton Memorial Garden

Visitor Attractions

- 1 Edinburgh Castle
- 2 Scottish National Portrait Gallery
- 3 The Scotch Whisky Experience
- 4 Calton Hill
- 5 St Giles Kirk
- 6 The Museum of Scotland
- 7 National Gallery of Scotland
- 8 Princes Street
- 9 The Royal Museum
- 10 Dovecot Studios
- 11 St Andrew Square
- 12 City Observatory
- 13 Princes Street Gardens
- 14 Magdalen Chapel
- 15 Greyfriars Kirk
- 16 Grassmarket
- 17 Royal Scottish Academy
- 18 Bank of Scotland Head Office
- 19 Old Town
- 20 City Art Centre
- 21 Jenners Department Store
- 22 Museums of the Royal College of Surgeons
- 23 The Museum of Edinburgh
- 24 John Knox's House
- 25 Surgeons' Square
- 26 St Margaret's Chapel
- 27 Canongate Church
- 28 The Edinburgh Dungeon
- 29 Lady Stair's House
- 30 Scotsman Steps
- 31 Royal College of Surgeons of Edinburgh
- 32 St Mary's Metropolitan Cathedral
- 33 The Writers' Museum
- 34 The Royal Mile
- 35 New Parliament House
- 36 Castle Esplanade
- 37 Old College
- 38 Outlook Tower and Camera Obscura

Figure 2

Extract from the general Edinburgh guide showing the initial map and central zones maps. There are so many features that Edinburgh is split into nine sections, occasionally with two maps per area.

Filtering the features to only those of interest cuts the number of pages included in the guide, making it more user and printer friendly. Reducing the number of maps required increases clarity and convenience to users. Visualising all of the destinations on the same map, rather than swapping between numerous map pages, facilitates the logical creation of a route between features.

This issue of POI selection is of utmost importance; accuracy of the GfS database is assumed. The maximum number of sites available to be selected depends on the region the tourist wants to visit, for example Edinburgh has many more attractions listed than Stornoway. As a result, the routes created may have too many sites to visit so making the route impossibly long. An alternate route version may have to be created to limit the number of attractions or to split the route into multiple days. Conversely, an expansion to include POIs in surrounding areas may be needed if the route is too short.

The limited options for feature selection are a significant improvement on the online route planner implemented by Terzis, 2010. Users prefer a simple interface that is quick to use rather than a long list containing all the options. A list offers too many options which can return too many features and thereby creating an incredibly complex route. Offering fewer choices limits the number of features returned enabling a simpler route.

Implementation of the guide online

The user interface is designed to match other GfS pages with a simple layout for rapid user comprehension (Figure 3).

This user interface is found at: <http://www.scottish-places.info/customisedguidebook.html>

Full implementation of the guide online is not possible due to the security restrictions placed by the University of Edinburgh. As a result of this, the WMS from EDINA is not accessible from web servers and the guide creation program cannot be run with all arguments specified by the user. To provide users with a customised guide, the most popular destinations in Scotland have pre-generated guides stored for online access. Options for selecting all six sections would require sixty-four guides per location to be pre-generated; therefore only four sections (history, geography, industry and surrounding towns) are available for individual selection as this requires sixteen guides per location. Personalised feature selection, and therefore also route planning, are not currently possible due to the wide variety of combinations.

The screenshot shows a web page titled "Customised Guidebook Questionnaire". On the left is a yellow sidebar with navigation links: "Gazetteer for Scotland", "Help Glossary", "Background Bookshop Copyright Credits Disclaimer Feedback Gaz Stats Sources Sponsors", "Any Word Search", and "Member's Area". The main content area has a heading "Customised Guidebook Questionnaire" and a greeting "Dear Visitor,". Below this is a paragraph explaining that the website creates a personalised guide for selected towns in Scotland based on user interests, with the final product available as a PDF. A "Thank you for your time!" message is followed by a horizontal line. The "Personal" section is optional and for statistical purposes or feedback. It contains fields for "Name" (optional), "E-mail" (optional), and "Age" (a dropdown menu). Below these is another horizontal line. The questionnaire consists of four numbered questions: 1. "What Country are you from?" with a text input field. 2. "Where are you going in Scotland?" with radio button options for Aberdeen, Ayr, Dundee, Edinburgh, Glasgow, Inverness, Perth, and Stirling. 3. "What information would you like included within your local guide?" with radio button options for "History?", "Geography?", "Industry?", and "Surrounding towns?", each with "Yes" and "No" choices. 4. "Please feel free to add any further comments (thoughts, ideas, etc.)" with a large text area. At the bottom left is a "Submit" button.

Figure 3

Image of the user interface on the GfS website. This page allows users to register their interests before linking them to their customised guide with appropriate sections included.

If online initiation of guide generation was possible, then guide would have the extended functionality of feature ordering and route creation.

Feature Ordering

The guide will be formed to create a logical order of features, encapsulated in a pleasing layout for ease of use for the tourist. This is the preliminary stage to routing between points; the spatial ordering of the locations and will act as a back-up if routing is not possible.

Route Map

Cost of transport and attraction tickets, as discussed by Han et al, 2014, is a constraint faced by tourists, as well as time and physical ability. Whilst these are important considerations, the guided route will not be taking these into account directly (Richards, 2014). The selection of modes of transport will allow the user to choose appropriately for their own circumstances.

The route map will be designed following Bertin's (1983) Principles of Design (Heywood et al, 2011), taking consideration of the limitations of printed maps and human perception of colour (Avelar, 2008). The primary aim of the map is to show the tourists their ideal route through the area of interest. This will be achieved by ensuring the map has a high level of topographic detail, as recommended by Brown et al, 2001. The map and route may ignore irrelevant details or allow users to create their own route through green spaces, as communication through what is omitted as well as what is included is very important (Golombisky and Hagan, 2010).

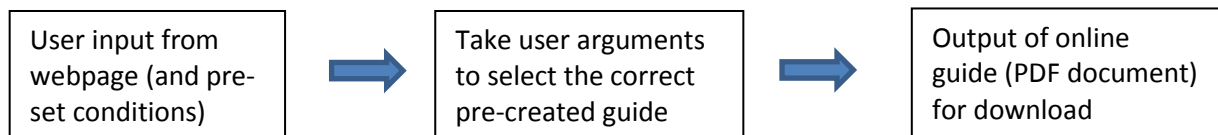
Including a time aspect is important, to give tourists an idea of scale and how much they can fit in per day. However, maximum speed may differ from that assumed by the road type, for example lower or higher local speed limits or extremes of gradient. Scale, both in distance and time, is important (as highlighted by user feedback) to give people realistic expectations of their journey. The distance and approximate time between attractions is calculated by the Google Directions API so is included for user reference.

As the map would be included in the PDF, no secondary user interaction will be available after the initial choice of features. The POIs are displayed as a number marker indicating the order of travel between the points as well as linking to the key. If a route plotting engine can display the route between the features without any detriment to the quality of the map, then the linking route sections will be provided for the user, otherwise a route map separate to the initial feature map may aid user comprehension.

Key Findings

Guide creation

General implementation diagram of completed guided route planner:



The key finding of this research is that a personalized guide for tourists can be automatically generated using the GfS database. GfS information provides textual descriptions and coordinate locations of interesting features whilst EDINA WMS provides a visual context map. Providing arguments to the guide generation program allows sections of the guide to be included or excluded according to the preferences of the user. Limiting the guide to features of a certain type is possible and creates shorter guides of greater relevance to the user.

The guides created by Farrar have been improved, both in the code to generate the guide and in the layout of the completed work. Offering an element of user interactivity greatly improved the functionality of the guide and user satisfaction. Filtering the features reduced the list of attractions to a manageable length and a simpler layout within the guide.

User requirements for a personalised guide are offline availability and a comprehensive selection of all tourist attractions, not just the most popular. If the guide contained a route suggestion, primarily it should be an ordered sequence of stops with a specific route as a second option.

The program created does allow only the feature type of interest to be selected, however this functionality is not yet available online due to the security limitations.

Whilst there is potential for creating personalised guided routes via the Google Directions API, this has not yet been possible to execute due to the security limitations preventing online implementation. Including spatial data concerning the road network improves the functionality of the application as the distances between features are realistic as opposed to straight line Euclidean distances. Similarly, the issue of impassable features, such as rivers and hills, is solved by using the routing API.

Limitations

Web mapping

Due to a security restriction placed upon the University of Edinburgh web server, it is not currently possible to initiate and run the Perl guide creation program via online initiation. Similarly, feature of interest selection, and so routing, is not available via the online interface. To offer user choice, the guides must be created manually and stored for web access; the full dynamic capacity of the guide cannot be fulfilled. Whilst a selection of guides can be individually created, it is not feasible for all sixty-four combinations of the current six optional sections to be generated for each location. As a result, the webpage for users is adapted to allow the history, geography and surrounding towns sections to be included for each location.

Performance

The performance of the site will need to be optimal as users often get impatient; a performance issue is apparent in other route planners (such as the Wikipedia book) as it can take over 30 minutes to create a guidebook. Due to the questionnaire feedback, it is apparent that a rapid performance time is not an issue, but people do not want to have to wait for guide generation on a particular web page for longer than necessary.

Suggestions for Future Work

Further work is required to refine the program code; although considerable work was done, more subroutines could be created for a more efficiently coded program. Currently, users access the website via a computer and then save the resulting PDF to their choice of device. This process could be adapted to create a mobile application to access the GfS and save the guide directly to the device, similarly to the planner created by Anacleto et al, 2014.

For guides within a specific city, route creation could be achieved offline, such as through GIS layer files. A Manhattan distance calculation would be needed as Euclidean distance is not always appropriate for urban walks; adjustments to account for geographical interruptions such as dramatic changes in elevation or impassable water courses would also be included. To improve efficiency of the runtime, a pre-calculated accessibility measure between attractions could be stored within a database table.

Creation of a descriptive route plan would aid user understanding while reaching their destination. A textual description of visual icons seen along the route would confirm the user was travelling the correct route and also allow additional information concerning local sites to be given. This route description would include reference to top attractions which are likely to be key landmarks in the area or well-signposted. Similarly, the local tourist office could also be included for the user to find additional information or a local map.

Other studies, such as those done by Han et al (2014) and Dye and Shaw (2007), had the time and resources to analyse each tourist attraction in order to establish the effective residence time. This minimum time to be spent at each attraction has a significant impact upon the length of the guided route. Further work would involve using an API to attraction websites to grab opening hours and suggested visit time.

Conclusion

Analysis of the current availability of route planners and guide books revealed a lack of customisable guided routes for the general interest user. The majority of available guides were too general with only the top attractions listed, or so specific that they are no longer relevant. Investigation of user requirements revealed the diversity of interests and range of travel arrangements. As this breadth is unable to be accommodated by standard tourist guidebooks and tours, a customisable guide would be of great benefit.

The developed solution allows the user to select their features and information of interest, in combination with their destination, to return a personal interest guide. The webpage interface allows the user to select location and interests. This interface can link to the Perl program used to generate the guides but currently creates a link to the pre-generated guide most suitable for the specific user interests.

The Gazetteer for Scotland has previously been used to successfully generate multi-purpose local guides which were expanded upon to allow user interactivity. Effective use of sub-routines and a simple intuitive user interface has allowed the route planner to surpass previous endeavours. Further work could increase the levels of user interaction and plot route maps for use on location.

This paper argued that the GfS can be used as a suitable base for creating personalised guides, providing a service not currently offered, but full service provision is still only attainable in the future.

References

Gazetteer for Scotland. <http://www.scottish-places.info/>

Ordnance Survey. <http://www.ordnancesurvey.co.uk/>

Trip Advisor. <http://www.tripadvisor.co.uk/>

Visit Scotland. <http://www.visitscotland.com/>

Almeida, A. 2009. Personalised Sightseeing Tours Recommendation System. In: The 13th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI 2009, Florida, USA.

Anacleto, R., Figueiredo, L., Almeida, A. and Novais, P. 2014. Mobile application to provide personalized sightseeing tours. Journal of Network and Computer Applications. Vol 41. P56-64.

Anacleto, R., Luz, N. and Figueiredo, L. 2010. Personalized Sightseeing Tours Support Using Mobile Devices. In: Proceedings of HCIS. P301-304.

Avelar, S. 2008. Visualizing public transport networks: an experiment in Zurich. Journal of Maps. Vol 4(1). P134-150.

Bertin, J. 1983. Semiology of Graphics: Diagrams, Networks, Map. University of Wisconsin Press, Madison, USA.

Brown, A., Emmer, N. and van den Worm, J. 2001. Cartographic Design and Production in the Internet Era: The Example of Tourist Web Maps. The Cartographic Journal. Vol 38(1). P61-72.

Callender, J. 2002. Perl for Web Site Management. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Corchado, JM., Pavón, J. Corchado, ES. and Castillo, LF. 2004. Development of CBR-BDI Agents: A Tourist Guide Application. LNAI 3155. P547-559.

Davies, N., Cheverst, K., Mitchell, K. and Efrat, A. 2001. Using and determining location in a context-sensitive tour guide. Institute of Electrical and Electronics Engineers (IEEE) Computer: Special Issues on Location Aware Computing. Vol 34(8). P35-41.

Dye, AS. and Shaw, SL. 2007. A GIS-based spatial decision support system for tourists of Great Smokey Mountains National Park. Journal of Retailing and Consumer Services. Vol 14(4). P269-278.

Farrar, A. 2011. Automated Encyclopaedic Tourist Guide Generation for the Settlements of Scotland: A Static Document Approach. Unpublished MSc Thesis, University of Edinburgh.

Gittings, BM. 2009. Reflections on Forty Years of Geographical Information in Scotland: Standardisation, Integration and Representation. Scottish Geographical Journal. Vol 125(1). P78-94.

Gittings, BM. 2014. The Gazetteer for Scotland. Accessed at <http://www.scottish-places.info/>

Golombisky, K. and Hagan, R. 2010. White Space is Not Your Enemy: A Beginner's Guide to Communicating Visually Through Graphic, Web and Multi-media Design. Elsevier Inc, Oxford, UK.

Han, Y., Guan, H. and Duan, J. 2014. Tour Route Multi-objective Optimisation Design Based on the Tourist Satisfaction. Discrete Dynamics in Nature and Society. Vol 2014. P1-8.

Heywood, I., Cornelius, S. and Carver, S. 2011. *An Introduction to Geographical Information Systems*. Pearson Education Limited, Harlow, UK.

Kittur, A. and Kraut, R. 2008. Harnessing the Wisdom of Crowds in Wikipedia: Quality Through Coordination. In: *Proceedings of the 2008 ACM conference on Computer supported cooperative work*. P37-46.

Larsen, J. and Meged, JW. 2013. Tourists Co-producing Guided Tours. *Scandinavian Journal of Hospitality and Tourism*. Vol 13(2). P88-102.

Lau, G. and McKercher, B. 2006. Understanding Tourist Movement Patterns in a Destination: A GIS Approach. *Tourism and Hospitality Research*. Vol 7(1). P39-49.

Luz, N., Anacleto, R., Almeida, A. and Figueiredo, L. 2010. Recommendation & Mobile Systems – A State of the Art for Tourism. In: *International Conference on e-Learning, e-Business, Enterprise Information Systems, and e-Government: EEE2010, Las Vegas, USA*.

Phillips, J., Walford, N., Hockey, A., Foreman, N. and Lewis, M. 2013. Older people and outdoor environments: Pedestrian anxieties and barriers in the use of familiar and unfamiliar spaces. *Geoforum*. Vol 47. P113-124.

Richards, J. 2014. *Creating Customisable Tourist Guides for Scottish Settlements*. Unpublished MSc Thesis, University of Edinburgh.

Schwartz, RL. and Christiansen, T. 1997. *Learning Perl*. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Souffriau, W. and Vansteenwegen, P. 2010. Tourist Trip Planning Functionalities: State-of-the-Art and Future. *ICWE 2010 Workshops, LNCS 6385*. P474-485.

Taylor, P. 2007. *Creating Regional Guides for Scotland using Encyclopaedic data: Combining the Gazetteer for Scotland Database and Google Mapping*. Unpublished MSc Thesis, University of Edinburgh.

Terzis, P. 2010. *Web Tourist Route Description Tool*. Unpublished MSc Thesis, University of Edinburgh.

Vansteenwegen, P., Souffriau, W., Vanden Berghe, G. and Van Oudheusden, O. 2011. The City Trip Planner: An Expert System for Tourists. *Expert Systems with Applications*. Vol 38. P6540-6546.

Zhao, P. and Di, L. 2010. *Geospatial Web Services: Advances in Information Interoperability*. IGI Global, Hershey, Pennsylvania, USA.

Technical Report – Creating Customisable Tourist Guides for Scottish Settlements

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Section 1 – Assessment of user requirements

Initial Online Questionnaire

An online questionnaire was used to investigate GfS user requirements regarding personalised tourist guides. This questionnaire was scripted in HTML making use of radio buttons, check boxes and text boxes for users to record their thoughts. The HTML script to generate the questionnaire page closely follows the layout of the other GfS pages allowing the questionnaire to be effectively incorporated into the site. This HTML code is found in Appendix B, whilst the online visualisation of the questionnaire is shown in Figure 1.

Gazetteer for Scotland

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Tourism and Climate Questionnaire

Dear Visitor,

We are researching the possibility of creating personalised guided routes automatically from the Gazetteer for Scotland which will extract information tailored to your particular interests. The final product will be distributed as a pdf document that can be downloaded to your computer, mobile or cell phone. Additionally, we would like to include information about the average climates of Scottish settlements, and would appreciate your thoughts on this idea.

Thank you for your time!

Personal - this section is optional. Your details will only be used for statistical purposes or to allow us to give feedback.

Name: - *Optional*

E-mail: - *Optional*

Age:

- What Country are you from?
- When visiting Scottish destinations, would you like a personalised guided route through the area/town/city?
☐ Yes
☐ No
- Which sites would you like included in the guide?
☐ Most popular tourist attractions ☐ Less well-known tourist attractions ☐ Non-tourist sites of historical or architectural interest
☐ Everything
- What form of personalised guide would you prefer?
☐ A customised web page
☐ A downloadable guide (as a PDF) which can be used on your home computer or mobile device, without needing a data connection
- Would you print a hard copy of such a guide?
☐ Yes
☐ Maybe
☐ No
- If you answered maybe to question 5, please state any contributing factors that would influence your decision to print the guide?
- In a personalised route guide, would you like the specific route plotted or an ordered sequence of stops?
☐ Specific route to follow
☐ Ordered sequence of stops
- Which mode of transport are you most likely to use to reach the sequence of sites?
☐ Foot
☐ Bicycle
☐ Car
☐ Public Transport
☐ Other, please specify:
- Considering that a more detailed guide would take longer to produce, how long would you be willing to wait for a personalised guide?
☐ 30 seconds
☐ 5 minutes
☐ 15 minutes or longer
- Do you think the inclusion of climate details for Scottish settlements would be a valuable addition to the Gazetteer for Scotland?
☐ Yes
☐ No
- If climate details were provided for Scottish settlements, which types of settlements should include them? (Select all that apply)
☐ Large Settlements ☐ Small Settlements ☐ Farms ☐ Geographical Features (such as mountains) ☐ Tourist Attractions
- If average monthly climate details were included for places, what climate characteristics would you find useful?
☐ High Temperature ☐ Low Temperature ☐ Precipitation ☐ Days with Precipitation ☐ Days with Air Frost ☐ Hours of Sunshine
- If climate details were included for settlements, how would you like them to be described?
☐ A table detailing the average values of each characteristic for every month
☐ A series of graphs displaying the patterns throughout the year
☐ A textual description
- Please feel free to add any further comments (thoughts, ideas, etc.)

Submit

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Supported by: The Robertson Trust, The Royal Scottish Geographical Society,
The Institute of Geography, University of Edinburgh.

Figure 1

The initial questionnaire hosted on the GfS used to gather user requirements. Additional climate questions were included for other research purposes.

A Perl file, using the CGI module, was used to collect the answers received and return a 'Thank you for submission message'. The Perl script to store the answers is found in Appendix C and the successful submission page is shown in Figure 2.

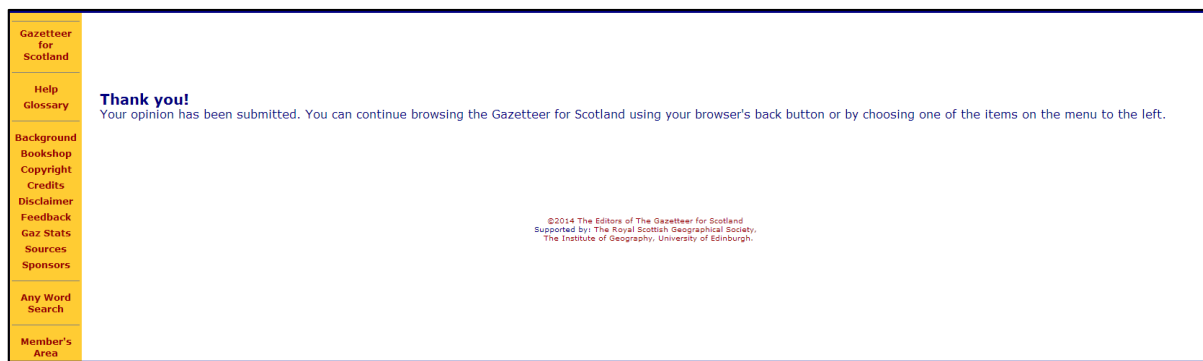


Figure 2

The thank you for submitting your opinion informs the user that their thoughts have been recorded and directs them back to the general GfS website.

The questionnaire results from each user submission were sent to the Perl script via the POST method (Musciano and Kennedy, 2002). Once sent, the answers were incorporated within the script using the CGI module. The Perl script opened a text file before appending the new answer set. Each new sequence of question responses was indicated by a new line character so allowing easy decoding into Excel. Similarly, each individual answer was separated by a '|' character. Using this delimiting character permitted easy extraction of the answers and matching to the corresponding questions. Information regarding the browser of the user and the time and date of completion was appended to each answer set.

Questionnaire Results

The questionnaire was hosted on the Gazetteer for Scotland website from April until mid-July 2014 to allow a large number of responses. These totalled 112 in the 15 week period so permitted the answers to be analysed with the potential for statistically significant results. Details of all the results collected are found in Appendix D.

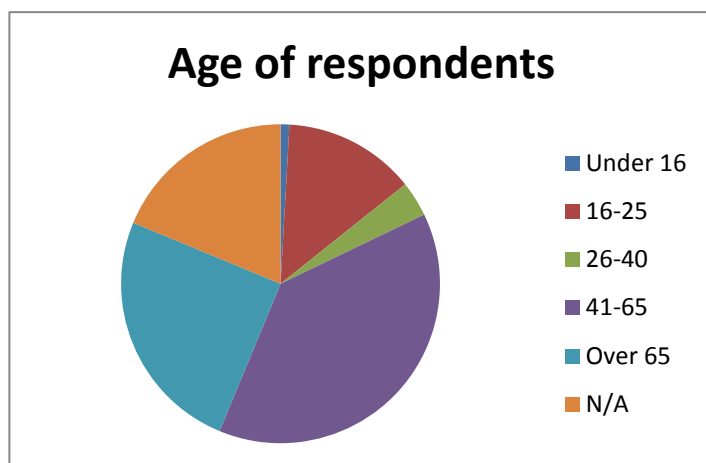


Figure 3

The demography of the respondents indicates a broad range of users, with the significant majority being over 40 years old. Due to the older age of the typical GfS users, the guide and interface must be intuitive and simple to use.

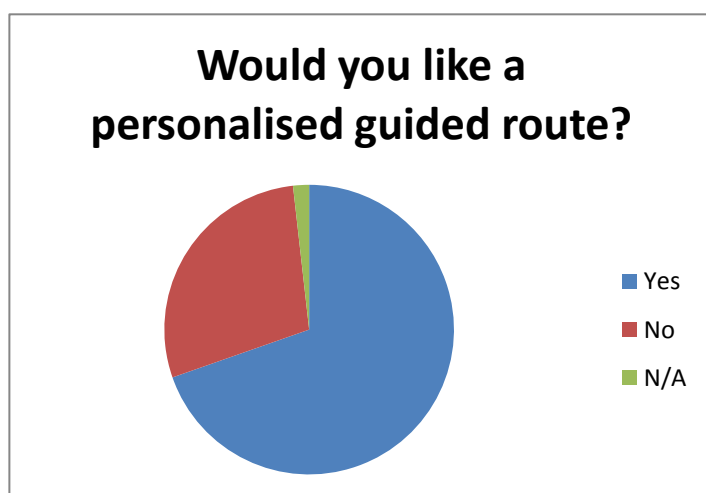


Figure 4

This result indicates that although a guided route may not be the right choice for everyone, the majority of people would like to have the guide so providing justification for the project. Some people that indicated they would not like a guide explained their decision in the comments, usually due to a limited visit time with prior commitments.

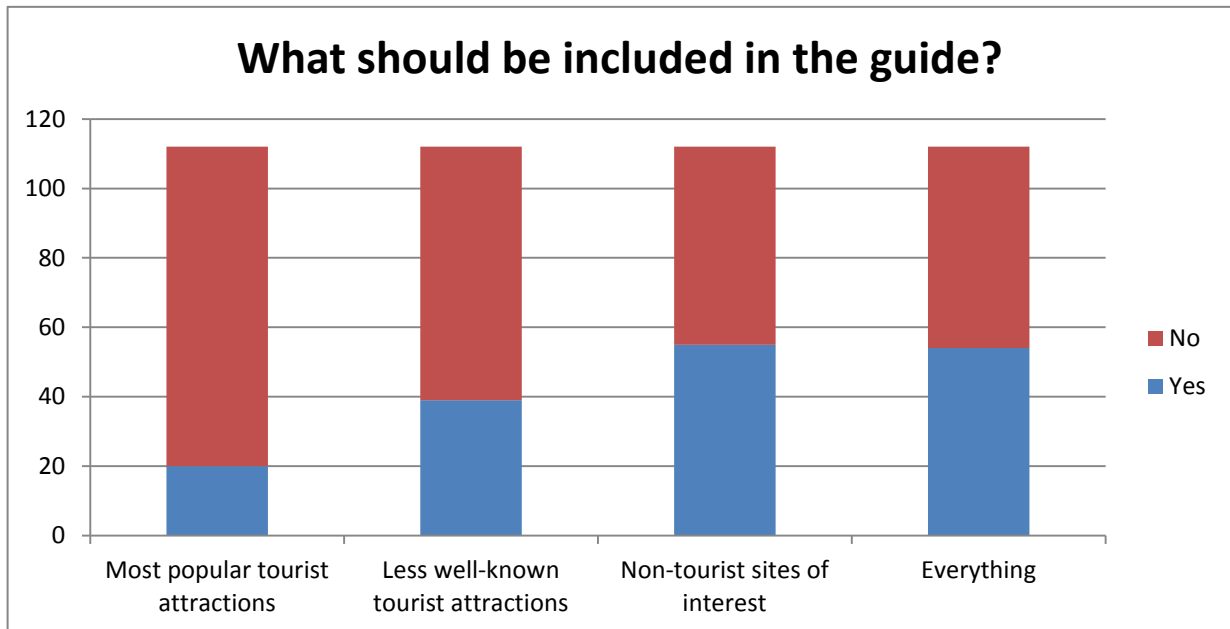


Figure 5

The range of answers regarding what should be included in the guide supports the argument that people have individual preferences for their trip and so need personalised guides. The large proportion of people who do not want the most popular tourist attractions indicates that these should not be included; the information is readily available elsewhere so unless the attraction is also included in another category (such as Edinburgh castle also being a castle), it will not be in the guide.

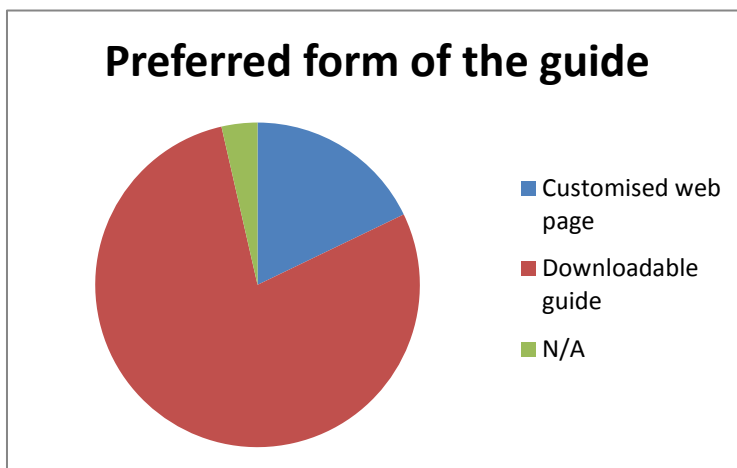


Figure 6

A few people would prefer a customised web page, but the majority would like a downloadable guide. This result is in keeping with the preliminary research and is convenient for the limited wireless data accessibility across Scotland.

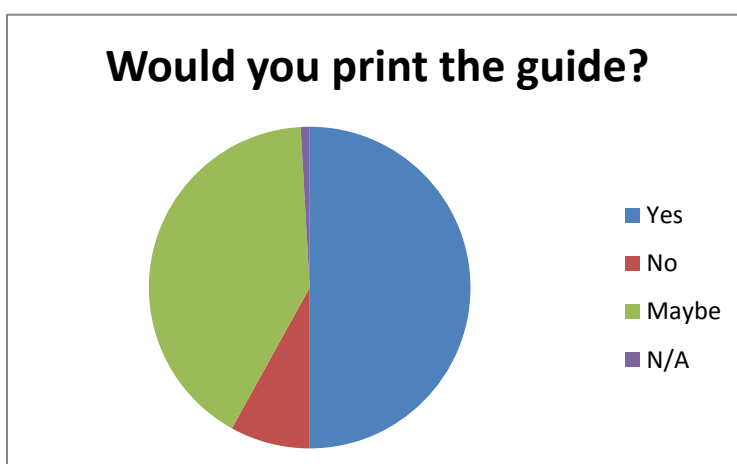


Figure 7

Due the proportion of people who would print, or consider printing the guide, it is of great importance that the guide be concise (without additional obsolete spacing) for printing and viewing efficiency. It is possible that the route and locations of features be combined into a summary page for efficient printing.

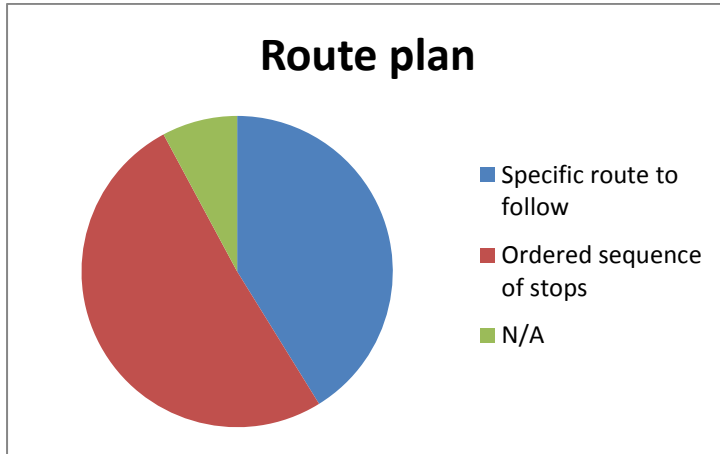


Figure 8

More people would prefer an ordered sequence of stops rather than a specific route. Therefore, the aim will be to create a sequence of stops but also to provide people with a choice of which option to have in their guide. An ordered sequence of stops will be the default setting, as the specific route has more associated difficulties.

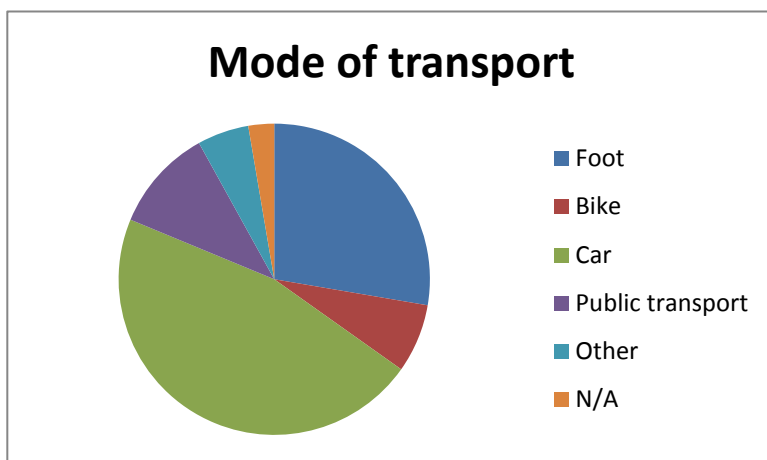


Figure 9

People would be using a variety of travel methods, often depending on availability of public transport and distance covered. The main split in answers between foot and car indicates that it would be a helpful addition for the public to be able to choose their method of transport whilst creating their guide. Due to the greater number of car users, the default method of travel will be driving.

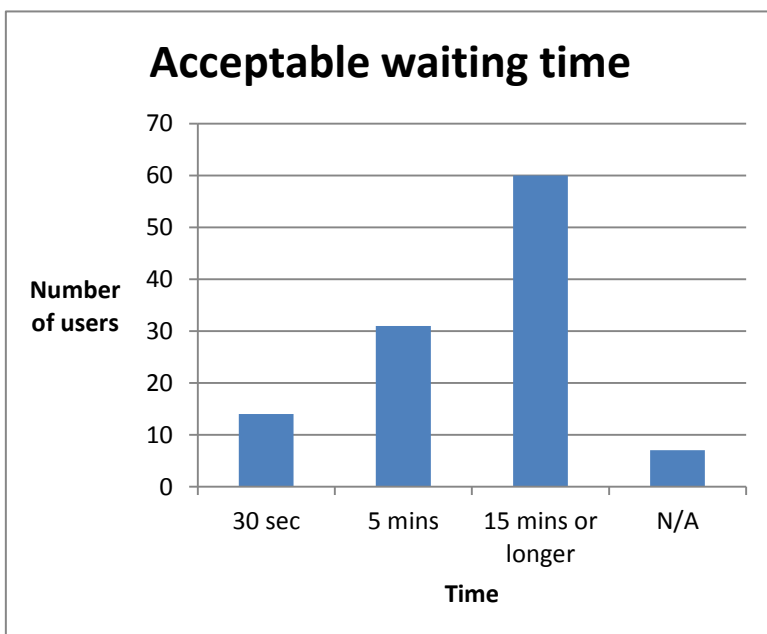


Figure 10

Approximately half of the respondents would be willing to wait 15 minutes or longer for their guide to be produced so speed of production will not be an issue. An efficient website and programme will be more attractive to users, but the lack of an immediate time limit will allow the guide to be tailored more specifically to better fit the individual user requirements. This flexibility is useful in permitting routing engines to plot a specific route (if applicable).

Additional comments

Visitors were offered the opportunity to provide any extra comments regarding the questionnaire, guided route project and GfS. Many people offered their support for the project and the GfS as a whole. Those offering more detailed relevant comments on the project are quoted below:

‘Born in Glasgow many years ago, it is completely different now as a tourist. All of the above questions are relevant for a traveller to plan a different kind of 'off the beaten track' visit.’

This comment is in line with the concept of the independent traveller (discussed in Lau and McKercher, 2006). Similarly, the nature of the visitor demands a trip which takes in attractions not covered by the traditional tourist routes. The guide would be useful in facilitating this user in planning their visit taking in features of interest skipped by the general guide books.

‘Presence of local bed-and-breakfast lodging. Indication of local archaeological work in hand. And, of course, the ubiquitous skirling o' the 'pipes!’

The inclusion of local establishments such as Bed and Breakfast accommodation would make the guide considerably larger and more complex than necessary. There are many other sources of accommodation information which would be more applicable to the situation. Whilst the GfS is a vast mine of information, it cannot include all current events (such as archaeological investigations). Ideally the user will be able to combine the GfS guided route with other sources of information for accommodation and current events near to the selected area.

‘Useful to have any local bus services destinations etc’
‘Local accomodation and transport details - to avoid the need to carry additional paperwork.’

As above, ideally the user can combine information sources for details concerning local accommodation and transportation. This would maintain the functionality of the guide without it becoming overwhelmed and impractical for easy reference.

‘I've not answered q2 as I might not use it so much, because I do my own research and most of this can be found on the web - if you know where to look. If, however, you don't know where to look, such a thing would be very useful. I've also not included large settlements and well known tourist destinations/places as nowadays these usually are well covered by their own websites, and generally have a reasonably comprehensive Wikipedia entry too. I'd also consider that maybe some general geological information as well as a potted history info might be of use for the area(s) to be covered.’

Some people who can perform effective internet searches will have less use for guided routes due to the volume of information available from other sources, but this highlights the fact that most people do need guidance through the vast quantity of information available. It is not feasible for the GfS to keep up to date with specific details of all the major tourist attractions across Scotland. As suggested by the user above, these features usually have their own websites and relatively accurate Wikipedia entries, so it is not necessary for them to take up space in the personalised guides.

‘It would be nice to have some advice about road conditions, road signs etc. Travelling tips: advice about interactions with people: etiquette, customs, etc’

The information requested is very specific to the local area so generally it is not feasible to include it within the GfS or guides. Travel tips and advice for visiting Scotland is too general for both the guides and GfS. Whilst some local customs are included within the town Gazetteer page, so can be included within the personalised guides, gaining extra information for this purpose will not be a priority.

'My travels are largely family oriented ie looking for places my parents would have known, and certain historical- particularly Church related places. I congratulate you on this project'

Personalised guides would be ideal for this user as they are interested in historical buildings, particularly churches. It is difficult to procure traditional guide books of such a specific nature, especially at a reasonable cost.

'Very easy site to navigate. Very important for us older people!'

This user highlights the importance of a simple webpage without unnecessary complications. As many of the GfS users are older and possibly less technologically skilled, the interface should be uncluttered and intuitive.

'Re Question 7, an indication of distance between sites & estimated time to cover said distance (or type of road) would be useful. Re question 9, I'd be happy to wait 24 hours.'

All of the maps contained within the guide have a scale indicating distance. To gain a more accurate estimation, certain routing engines not only produce a route but also give an indication of distance and travel time of each section of the journey. Including this information in the guide would satisfy the needs of this (and other) users.

People largely are willing to wait for a personalised guide but 24 hours is the longest time specified that someone would be willing to wait, but matches the general trend of people not demanding an instant return.

'Maps, however simple, and diagrams are more useful than text. Some idea of heights/contours/inclines (especially as I am getting older) would give a better idea of time to allow rather than a flat distance. Best of luck with your work and analysis of results - not an easy task!'

Similarly to other users, an indication of distance and travel time would be useful; in this case, the change in elevation would also be useful in journey planning. Although contours are shown on standard Ordnance Survey maps, for a non-technical audience observing largely urban areas, these are not shown to aid in map understanding and clarity. For users worried about the elevation change along the route, it is recommended that they check the route before departing or select driving as a transport method for easy access.

'I am most interested in good maps that show details such as hiking trails and rights-of-way'

As the guides are focussed around settlements, hiking trails are scarce in the areas covered. Due to the Scottish Right to Roam (Scottish Natural Heritage, 2014), rights of way are not of such importance as in other countries with stricter access laws. For more extreme walking, a countryside map would be more suitable.

'Whilst you may be absolutely clear what various terms mean, consider that your readers, especially those from abroad, may not. Consequently, some of the questions are not clear and need refining; eg: Q7: what is 'an ordered sequence of stops'? Also, Q3 there are many other things I would want included in the personalised guided route through the area/town/city, including good places to eat en route; green spaces where you could take a breather etc etc. Good luck with the project!'

Taking the above comments into account, the user interface will use clear language to ensure comprehension from non-native English speakers. Restaurants, similarly to accommodation, can have a very high turnover rate so are not included in the GfS. The maps of the town show locations of parks and gardens. As these are often visitor attractions, they are included within the GfS and so could be incorporated into the guided route.

'If I was able to visit the Orkneys would like to know how to get information on my ancestors who come from there, my great grandparents and grandmother are from Orkneys coming to Queensland in the 1880s. To be able to see where they had lived etc. Thanks'

Information regarding famous people from the town is included in the GfS and so will be optionally includable in the personalised guides. However, ordinary people are not included so for information people may need to be directed to another website.

'Links to audio descriptions of sites would be good'

Currently, there are not audio descriptions available for sites in the GfS; this may be of possibility for further work in the future once the local guides have been established. There is the future option for linking the GfS to attraction websites which indicate that audio tours are available.

Additionally, some people offered explanations as why they did not want a personalised guide. The reasons for this were generally that they did not feel the guide was relevant to them or they would not be visiting Scotland with time and resources to enjoy locations as a tourist.

Interpretation

Ideal components of the user interface

These ideal components have been identified based on work by numerous authors (including Farrar, 2011 and Vansteenwegen et al, 2011) and user feedback. However, due to limitations of the methodology and the need for a concise interface, not all of these elements could be included.

- Pick a location in Scotland (either city or area)
- Pick a start and end location, within the area specified (can be the same place)
- Pick a category of interest for feature and attraction selection
- Ask for degrees of interest in different POI types. As there are many types of attraction, this route planner could ask for a selection of primary (and secondary) interests of the user
- Allow additional selection of sub-categories within the interest type to reinforce selection of particularly interesting attractions
- Timings of sections of journey, including allowances for gradient changes
- Opening times and other info about the attractions to visit
- Allow inclusion of a lunch break? Include stops for refreshments and allow time for such
- Suggestions for refreshments and accommodation near the route
- Mode of travel. Complexity added by distance dependence. Offer a suggestion for recommended mode of travel dependent on number of features in close proximity
- Present route for user approval? Option for user to remove POIs before final route

Section 2 – System Development

Detailed Methodology

Using guidance from the O'Reilly book collection, (as well as numerous other sources found in the Bibliography), Perl code was created to undertake the majority of the solution implementation.

The basis for the Perl code is found in Farrar (2011) who implemented static regional guides across Scotland. The program is called with the single argument of a desired location; the steps undertaken to create these Local Guides is described extensively in Farrar, 2011. These guides can be improved upon to include interactivity for the user. However, the additional functionality could not be included until the code by Farrar was shortened and simplified.

Refinement of Farrar's code

Subroutines

Subroutines are a good method of condensing program code when the same process is used multiple times in the script. Subroutines are stated at the start of the Perl script, ready to be called at multiple points later in the program. Depending on the subroutine, it can be called independently as a section of script, or with variables to be substituted into the subroutine script. Both types of subroutine are used in the program.

Eliminate superfluous lines of code

Using the subroutines, the code written by Farrar was able to be condensed by approximately 50% from 7650 to fewer than 3500. This shortened program is now slightly longer due to commenting (Appendix E). Good commenting is essential to a clear program that can be utilised by others in the future. If Farrar had commented the original code well, the editing process would have been significantly quicker and further improvements would have been possible.

Testing

Whilst editing code, the new subroutines were tested thoroughly at each stage of implementation. As each map type has specific sections of code with subtle differences, it is of great importance to test the new features with each type of location. The map type is defined by the area of the settlement and the number of features contained within that area (Farrar, 2011). The map type, and so density of features, determines what should be included within the PDF guide. Types one and four have the greatest density of features so are displayed as a nine-tile map whereas the other types are shown with an inset map and surrounding towns.

Significant issues were found when attempting to implement changes, usually concerning map types one and four. These map types were more problematic due to the nine tiles comprising the settlement. In Farrar's code, each of these tiles was controlled by repeating chunks of code with minor variations. When converting these to one single subroutine, discrepancies were noticed in the guide output. The original poor coding by Farrar initiated these errors, often caused by mis-referenced or repeating variables. This issue became a recurring problem with further adaptations but due to effective subroutines is no longer an issue. Fixing the errors took considerable time and effort that had not been anticipated, but still was a better choice than restarting. Many attempts have been made to achieve a guided route, mostly unsuccessfully due to starting from scratch every time. Despite the issues with the base code for Farrar, this stepping stone to further research was vital to the completion of this project.

Performance

With a significantly shorter program, it was expected that performance would improve. The performance of multiple locations was tested using both the long and short programs (before any additional functionality was included). Edinburgh was used as the ultimate test of performance due to it being the largest guide containing the most information; smaller locations containing fewer features were also compared.

Performance for small towns remained fairly consistent when compared with Farrar, 2011. However, the time to generate a guide for Edinburgh improved dramatically from 1.5 minutes down to 35 seconds; a similarly quick runtime was found for Glasgow at 29 seconds.

Farrar's version had no subroutines, so the program was loaded line by line and executed as such. Although the code is very inefficient and takes a lot of lines, the computer is able to read the file in order and so execute the file quite quickly for small places with a single map. My code is much shorter but takes slightly longer to run for small locations. Due to the subroutines used, the computer is not able to process the lines of code as quickly; jumping between code sections is slower for processing and execution. However, as subroutines allow easy code maintenance and the difference in runtime is only a few seconds, this option is preferable.

The significant improvement for the larger towns, such as Edinburgh and Glasgow, is down to the efficient use of subroutines. Performing the database query once and storing the results in a variable for future use cuts the running time drastically allowing the significant reduction.

Gazetteer for Scotland database

The GfS database is a relational database with reference to spatial data and therefore composed of a series of inter-related tables with coordinate locations stored within table columns. The structure of the database is summarized in Farrar, 2011. Due to the nature of the database, the related tables can be queried using SQL SELECT statements (Gittings et al, 2004); data retrieved is then used in the regional guides. An example of such a statement is shown in Figure 11.

```
my $sth = $dbh->prepare("select towns.name, towns.introduction,
(xcoord*100)+nvl(xcoord_ext,0), (ycoord*100)+nvl(ycoord_ext,0),
towns.conv_lat, towns.conv_long, council_areas.name, towntypes.tytext, towns.touristatt,
towns.geography, towns.history, towns.industry, towns.altname
from towns, twnc_rel, council_areas, towntypes
where council_areas.seqno = twnc_rel.caseqno
and twnc_rel.tseqno = towns.seqno
and towntypes.type = towns.towntype
and towns.seqno = ?")
or die "Couldnt prepare statement: ".$dbh->errstr;
$sth->execute($seqno);

while (my @data = $sth->fetchrow_array()) {
    $townname = $data[0];
    &sortname($townname);
    $townintroduction = &stripfunnychars($data[1]);
    $mapx = $data[2];
    $mapy = $data[3];
    $lat = $data[4];
    $long = $data[5];
    $councilareaname = $data[6];
    $settlementtype = $data[7];
    $touristint = $data[8];
    $geography = &stripfunnychars($data[9]);
    $history = &stripfunnychars($data[10]);
    $industry = &stripfunnychars($data[11]);
    if ($settlementtype eq 'abandoned sett/farm') {
        $settlementtype = 'abandoned sett';
    }
    $altname = $data[12];
}
$sth->finish;
```

Figure 11

Section of code showing a SELECT statement to retrieve information from the GfS database. This selects information regarding the town for use later in the program code.

For the specified location in Scotland, information regarding geographical features, historical events and famous people is linked to the town, usually via the coordinate reference. The features of interest are linked in a similar manner so the query to return features in and nearby the town needs to include the coordinates of the town and features (Figure 12).

```
&getfeatures("select name,seqno,((xcoord*100)+nvl(xcoord_ext,0)),((ycoord*100)+nvl(ycoord_ext,0)),touristint from geofeatures
where ((xcoord*100)+nvl(xcoord_ext,0)) BETWEEN ? AND ?
AND ((ycoord*100)+nvl(ycoord_ext,0)) BETWEEN ? and ?
AND LIVE = 'Y'
AND touristint in ('N')
order by seqno ASC",$gf,$lowxcoord+25,$highxcoord-25,$lowycoord+25,$highycoord-25);

@geofeaturesnames = @fnames;
@geofeaturesintroductions = @fintroductions;
@geofeaturesseqnos = @fseqnos;
@geofeaturesgridxs = @fgridxs;
@geofeaturesgridys = @fgridys;
@geofeaturescounter = @fnamecount;
$geofeaturescount = $fcount;
@geofeaturesseqnos1 = @fseqnos1;
```

Figure 12

Query to select the features of interest within the range of the desired town.

Creation of new code

Once the existing code became a manageable length, increasing functionality made for significant improvement. This could not be done to the original code due to the excessive length and repetition in the main code body. Using the base code, the first step to increasing functionality was to include 'IF' statements for significant sections of the outputted guides in order to allow user specification of the information included in the final guide.

To allow the user to specify what is included in their guide, the inclusion of sections was made conditional. This was done with the use of IF statements within the main code, with the IFs referring to the initial arguments of the Perl script. The code to undertake the IF statement and to assign the initial arguments to appropriate variables is shown below in Figure 13.

```
if (not @ARGV) { print "Need argument of TOWN SEQNO: e.g. perl good.pl 265\n"; exit; }
my $seqno = $ARGV[0];
my $includehistory = $ARGV[1];
print $includehistory;
my $includegeography = $ARGV[2];
print $includegeography;
my $includeindustry = $ARGV[3];
print $includeindustry;
my $includesurroundingtowns = $ARGV[4];
print $includesurroundingtowns;
my $includepeople = $ARGV[5];
print $includepeople;
my $includeevents = $ARGV[6];
print $includeevents;
my $desiredfeaturetype = $ARGV[7];
print $desiredfeaturetype;

print 'above arguments have been provided';
```

Figure 13

Section of code showing the process for assigning the provided arguments to appropriate variables for use in the program. If no argument for the location is provided then the program is terminated. The variables are used later in the code to determine the location the guide covers, and whether certain sections are included within the final guide.

The use of these additional arguments allows personalisation of the guide without complex subscripts to extract, decode and insert results from the relevant questionnaire answers. The sections able to be optionally included are history, geography and industry of the town, historical events and famous people relating to the area and other nearby towns. The final three sections are stand alone on individual pages allowing the entire section to be skipped if the user does not want them included. However, the paragraphs concerning the history, geography and industry of the area are combined into an introductory section within the PDF. This causes some complications as all three sections come under the same heading and are included on the same page. An extra statement needs to be included to check that at least one section is selected for inclusion by the user and also that the selected section contains an entry within the GfS, shown in Figure 14.

```
if ($includehistory == '1' || $includegeography == '1' || $includeindustry == '1'){
    print 'not skipped';
    if ($geography ne '' && $includegeography == '1' || $history ne '' && $includehistory == '1' || $industry ne '' && $includeindustry == '1') {
        $pagetitle = ("Introduction to the $settlementtype of $townname");
        $newpage;

        if ($includegeography == '1'){
            print 'not skipped';
        }
    }
}
```

Figure 14

Section of code showing the multiple IF statements used to include or exclude sections of the guide, dependent of whether a database entry exists for the required section.

The first statement checks to see if any of the sections have been selected; if not then the whole section of code is skipped for greater efficiency. If a section is wanted for inclusion, the second IF statement checks that the desired section contains an entry. If both conditions are satisfied for any of the three sections then the Introduction title is printed on a new page and the following conditions ensure that the desired sections are printed into the PDF guide.

If the user is not interested in the surrounding towns, then the list of surrounding towns is not included in the primary location map. This is done by another multiple IF clause, shown in Figure 15. Each of these conditions is provided in the second to seventh input arguments to the program. Ideally these arguments link to the user interface webpage so the guide can be created exactly as the user desires.

```
if ($includesurroundingtowns == 1){
  if ($maptype == 2 || $maptype == 3 || $maptype == 5 || $maptype == 6 || $maptype == 7){
    my $sth = $dbh->prepare("select towns.seqno, towns.name, ((towns.xcoord*100)+nvl(towns.xcoord_ext,0)),
      ((towns.ycoord*100)+nvl(towns.ycoord_ext,0))
    from towns
    where towns.LIVE = 'Y'
    and ((towns.xcoord*100)+nvl(towns.xcoord_ext,0)) BETWEEN ? AND ?
    AND ((towns.ycoord*100)+nvl(towns.ycoord_ext,0)) BETWEEN ? and ?
    and towns.seqno <> ?
    order by length(towns.introduction) desc")
    or die "Couldnt prepare statement: " . $dbh->errstr;
    $sth->execute(($lowxcoord + 25), ($highxcoord - 25), ($lowycoord + 25), ($highycoord - 25), $seqno);

    $townsseqno2 = 0;
    $townsname2 = 0;
    my $i = 0;
    while (my @data = $sth->fetchrow_array()){
      $townsseqno2 = $data[0];
      $townsname2 = $data[1];
      $townsgridx2 = $data[2];
      $townsgridy2 = $data[3];
      &sortname($townsname2);

      push (@townsname2, $townsname2);
      push (@townsseqnos2, $townsseqno2);
      push (@townsgridxs2, $townsgridx2);
      push (@townsgridys2, $townsgridy2);

      $i++;
    }
    $sth->finish;
  }
}
```

Figure 15

Code showing the statement to print the list and locations of any towns surrounding the place of interest. The initial IF statement confirms the user's interest in surrounding towns before allowing the towns to be included within the guide.

Feature selection

An additional argument is included for the user to specify the type of feature to be included within the guide. The desired feature type is specified as the 8th argument given to the Perl script. The variable assigned to the argument is incorporated into all of the 'SELECT from geofeature' statements to limit the type of attractions returned, shown in Figure 16. The follow through of this is that only the features of the selected type will be printed on the map making the map less cluttered and therefore easier for the average user to interpret correctly.

```

&getfeatures("select name,segno,((xcoord*100)+nvl(xcoord_ext,0)),((ycoord*100)+nvl(ycoord_ext,0)),touristint, typea
from geofeatures
where ((xcoord*100)+nvl(xcoord_ext,0)) BETWEEN ? AND ?
AND ((ycoord*100)+nvl(ycoord_ext,0)) BETWEEN ? and ?
AND LIVE = 'Y'
AND typea = '$desiredfeaturetype'
and length(introduction) > 450
AND touristint in ('Y','1','2','3','4','5' )
order by segno ASC",$ta,$lowxcoords+25,$highxcoords-25,$lowycoords+25,$highycoords-25);

@attractionsnames = @fnames;
@attractionsintroductions = @fintroductions;
@attractionsseqnos = @fseqnos;
@attractionsgridxs = @fgridxs;
@attractionsgridys = @fgridys;
@attractionscounter = @fnamecount;
$attractionscount = $fcounter;

@attractionsseqnos1 = @fseqnos1;

our @allfeatures2 = (@allfeatures2, @geofeaturesseqnos1, @attractionsseqnos1);

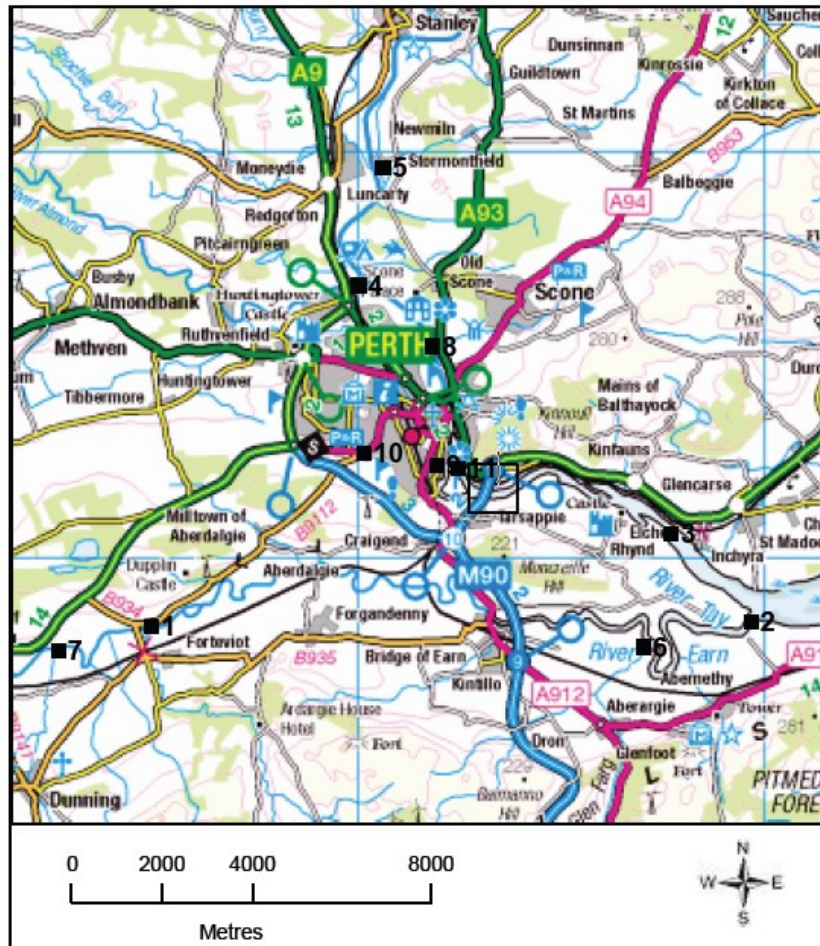
```

Figure 16

Section of code showing the adapted SELECT query to limit the features returned to only those of the desired type. 'Typea' is the column of the geofeature table which specifies the general feature type. Information about the features selected is stored in Perl variables for use outside the query statement.

Including this feature filter within the initial determination of map type often re-assigns the location to a different map type, so dramatically restructuring the guide. An example of this is filtering the attractions of Edinburgh to only show the historic buildings or the natural water features of Perth (shown in Figure 17, with the comparison of unfiltered Perth shown in Figure 18).

Map of Perth and Surrounding Areas



Features of Interest

- 1 Water of May
- 2 River Earn
- 3 River Tay
- 4 River Almond
- 5 Ordie Burn
- 6 River Farg
- 7 Dunning Burn
- 8 Annaty Burn
- 9 Craigie Burn
- 10 Scouring Burn
- 11 Willowgate



Figure 17

Map showing the filtered features of Perth reducing the original list of nearly 80 down to these 11 sites of interest to the user who wants information regarding the rivers and natural water features.



Map of Central Perth (E)

Map of Central Perth (E)

**Visitor Attractions**

- | | |
|------------------------------------|--------------------------|
| 1 St John's Kirk | 20 Hal o' the Wynd House |
| 2 The Fair Maid's House | 21 Prince Albert Statue |
| 3 Fergusson Gallery | 22 Red Brig |
| 4 Perth Concert Hall | 23 Playhouse Cinema |
| 5 North Inch | 24 The Ring |
| 6 Smeaton's Bridge | |
| 7 Perth Museum and Art Gallery | |
| 8 Town Lade | |
| 9 Greyfriars Cemetery | |
| 10 Perth Theatre | |
| 11 Dewars Centre | |
| 12 Perth Leisure Pool | |
| 13 51st Highland Division Monument | |
| 14 Lynedoch Monument | |
| 15 Boomerang Play Park | |
| 16 Ramada Hotel | |
| 17 Lower City Mills | |
| 18 King Edward VII Monument | |
| 19 Fair Maid Sculpture | |

**Features of Interest**

- | | |
|--|-----------------|
| 1 King James VI Hospital | 20 The Stanners |
| 2 Rose Terrace | 21 Old Ship Inn |
| 3 The Old Academy | |
| 4 St Leonard's Church (Former) | |
| 5 A.K. Bell Library | |
| 6 Perth Railway Station | |
| 7 Lord John Murray's Stables | |
| 8 St Leonards-in-the-Fields & Trinity Church | |
| 9 Queen's Bridge | |
| 10 Tay Viaduct | |
| 11 Skinnergate | |
| 12 Perth Sheriff Court | |
| 13 Perth City Hall | |
| 14 Pullar House | |
| 15 St Ninian's Cathedral | |
| 16 Caledonian Road Primary School | |
| 17 St John's Shopping Centre | |
| 18 Salvation Hotel | |

Figure 18

Map showing all the features of central Perth, with the overview map shown above. This long list contains far too many attractions for tourists to visit within their time in Perth; in addition many are not of interest to the user.

Section 3 – Hosting the guide online

Web interface

As the customisable guide is strongly linked to the GfS, the webpage is included in the GfS website. Therefore, the basic layout of the page matches the standard GfS format, with internal site links on the left page border. The link to the customisable guidebook interface can be included onto every GfS webpage to reach a wider audience.

The webpage offers users the opportunity to select the elements included within their guide. The webpage is scripted in HTML with another Perl script storing the given answers into a file. This Perl script is also utilised by my code to select the desired sections to print into the guide.

Firstly, the user selects the desired location of their guided route and triggers the program. This answer links to the unique ID of the selected town, so allowing the database to be queried for related entities. The user is able to select whether or not to include specific sections of the town information. The geography, history and industry sections of the guide are all independently selectable. Similarly, the sections concerning famous people and historical events relating to the town are also able to be selectable by the user. All of these sections are selectable for inclusion via yes/no radio buttons. Once the submit button is clicked, the True (1)/False (0) answers are used in the program code to initiate section inclusion.

The ideal method of hosting the guide online is via a web form which collects the user specific requirements, such as the location and sections to be included within the guide, before sending these parameters as arguments to the guide creation program. The guide would be created immediately and stored within the Public-html folder of the GfS allowing the guide to be published online. Once complete, the user is provided with a hyperlink to the PDF file which they can then download and print or save to an appropriate device. This fully functioning version of the interface and guide would also allow the user to select their location from a much more generous selection; the sections to include would offer famous people and historical events; and people would be able to filter their guide to only include features of interest. If this was all possible then a routing API could be used within the guide creator and so the interface could offer the choice of modes of transportation.

The interface web page is part of the GfS website for easy user access, with the full code shown in Appendix F. The user is limited to only selecting the place of interest and six sections which may (or may not) be included within their guide. This restricts the complexity of the webpage and guide creation. Due to limitations of the EDINA WMS, the guide creation code cannot be run via a web browser. Whilst this restriction is in place, the user interactivity element is severely limited. Guides can be created via the Unix command line and stored for use on the internet, but they cannot be initiated by internet users. As the map generation is such a vital part of the guide, if EDINA cannot be contacted by the program then the guide is not created and the program is terminated.

To still provide an interactive service to offer personalised guides, some of the largest and most popular destination cities in Scotland have pre-generated guides. These places are shown in the table below:

Table 1

Popular destinations for tourists in Scotland, as found from user requirements and tourist guide books (Rough Guide, 2014 and Lonely Planet, 2013).

Location	ID number
Aberdeen	617
Ayr	478
Dundee	399
Edinburgh	337
Glasgow	338
Inverness	2064
Perth	155
Stirling	538

Users are able to select their location and have a guide presented for their personal interest. Each of the above places has been tested to ensure that the webpage links the user answer to return the guide of the correct location. If the place the user wants to visit is not included, then a comment box is provided for the user to register their preference so the location can be included in the future. Every location option (Table 1) has multiple options of the guide stored to allow the user to select some of their interest chapters to be included or irrelevant chapters to be excluded. This is achieved by naming each option of guide with a section code sequence so allowing the user answers to be taken into account when presenting the final guide.

The user answers are stored via the same method as used to store the questionnaire answers (full code found in Appendix G); all answers are stored for monitoring purposes in order to improve the guide and website in the future. For the instant return of a guide, the location selection of the user is captured in the \$place variable as well as being stored as a value in the answer file, as demonstrated in Figure 18.

```
# Location
$value = $query->param('r8');
$place = $value;
$value = "NA" unless $query->param('r8');
$row .= "$value|";
```

Figure 19

Code to retrieve the answer to the question 'r8' and assign the value to the variable \$place. If no answer was given then the default 'NA' will be the response.

Due to the naming process within the guide creation code, the guide is generated with the file name of LocalGuide followed by the ID number of the specific location. This ID number is the answer given when a location is selected by the user so the guide can be referred to as LocalGuide followed by \$place. This \$place variable is attached to the end of the link to the local guide to link to the correct area; this shortcut is used within the hyperlink presented to the user once the questionnaire has been submitted, as in Figure 19. The online visualisation of the message and hyperlink is shown in Figure 20. The user can click on the link to obtain the guide of the relevant location as an online PDF to be saved as appropriate.

```

<h1>Thank you!</h1>
Your opinion has been submitted. You can continue browsing the Gazetteer for Scotland using your browser's back button

END

print qq(or by choosing one of the items on the menu to the left. <a href="http://www.scottish-places.info/dynamic/test3/LocalGuide$place.pdf">This is your guide.</a><br><br>);
print << 'END2';

```

Figure 20

Code showing the message presented to the user once the form was submitted. \$place is replaced by the ID number of the settlement the user selected. The second half of the Thank You message is scripted in Perl because of the variable replacement within the hyperlink.



Figure 21

Example of the Thank You message and hyperlink to the guide displayed once the user has submitted their selection of location. As the GfS website is hosting the guides, the layout and sidebar links are in keeping with the general GfS layout.

The guide was offered to a selection of users for testing and feedback. The guide is produced quickly, so although the extent of personalisation is not fully reached, the speed of access to the guide counteracts this. The interface is simple to use with the only problem being people not selecting 'No' for areas they are not interested in.

Initially, although the default value of each variable is 0, the process to record the user answers reassigned the default to 'NA' if the question was not answered. As a result, when attempting to automatically select the correct guide if a question was not answered, the variable was not stated and the guide could not be presented to the user. To combat this, the default answer was set to 0 instead of NA ensuring that a usable variable was provided to the guide retrieval statement even if section inclusion questions were not answered (Figure 21).

```

$value = $query->param('r12b');
$value = "0" unless $query->param('r12b');
$geography = $value;
$row .= "$value|";

```

Figure 22

Adapted code showing the assigning of the user answer to a Perl variable and the default option if the user does not give an answer.

Section 4 – Routing

There are many routing engines available online, with both benefits and drawbacks of using each.

PgRouting

Pgrouting provides routing functionality as well as other network analysis tools. It can be run offline directly from the host computer; to do this the requirement is that the data is stored locally and set up via the command line. As a result, this can be slow to initiate and the data is not dynamic; changes to the road network need to be manually updated. However, such considerations as distance cost and terrain could be incorporated into the road network. The process to create the network involves loading the data, building the connectivity graph and therefore topology and then creating routes. While pgRouting is a useful tool, it is more applicable to a smaller study area, not the whole of Scotland. The limitation of loading and configuration time in combination with runtime excludes pgRouting from being used in the personalised guides.

Open Route Service

This open source service requires an input via a HTTP request with the output being offered in multiple formats. The input needs specified start and end points with additional waypoints and a method of transport being optional extras. However, the website offers a slow and unreliable service when investigated using Scottish locations during the testing stage of program development. This is due to the service being updated but means that it is not suitable for this project. As Open Route Service works in the same manner as the Google API, in the future, when the service is more stable and reliable, this can be used in preference to Google Directions API.

Other options

Potential options for routing services were briefly investigated but considered to be unsuitable for further analysis. These include Cycle Streets which only offers cycle routes via the website. CGTK and Communications from Elsewhere both convert points into files for use on a GPS but need manual input by the user; once a route is created, these services could allow the user to convert their route for use on their personal GPS device.

Google

Google Maps offers many API web services; amongst these is the Directions API, a service that calculates directions between locations using an HTTP request. After comparing the potential routing options, it was found that the Google Directions API offers the best service and therefore was used for routing the features in the guide.

Google offers a choice between modes of transport; these include driving and walking, the 2 most popular modes of transport with questionnaire respondents. Directions may specify points as either text strings or as latitude/longitude coordinates; the locations within the GfS have latitude/longitude coordinates stored. The Directions API can return multi-part directions using a series of waypoints, but is not designed to respond to user inputs in real time. Although not intended for this purpose, the relatively low site traffic of the GfS website (when compared to Google) would allow this API to be used effectively. The free API is limited to 2500 direction requests per 24 hour period with a maximum of 10 requests per second; each request can contain up to 8 waypoints to be included in the route. This limits the complexity of a route but as the number of features to visit will also be limited there is little issue.

A Directions API request takes the following form, where the output may be either JavaScript Object Notation (JSON) or XML.

<http://maps.googleapis.com/maps/api/directions/output?parameters>

The Directions API can return the route in either XML or JSON format. The JSON format is recommended and can be incorporated into the Perl script using LWP: Simple (Wong, 1997), therefore will be the option used. The route is returned as an array, each element of which contains a single result from the specified origin and destination. This route may consist of one or more legs depending on whether any waypoints were specified.

Within the request, the only required parameters are origin and destination. An additional parameter can be added to enforce region biasing so place names are interpreted as being within the correct country. Optional parameters include mode of travel (driving is the default, with options for walking or cycling or transit) and waypoints (not for transit directions). The parameter for route optimisation offers opportunity for a better route by allowing the waypoints to be reordered, however during testing it was found that only three waypoints could be included within this optimisation.

The Directions API uses degrees of latitude and longitude as the coordinate system; GfS also stores locations in degrees of latitude and longitude as well as OS GB coordinates. This similarity makes for easy extraction of coordinates from the database for use in the routing engine. Also, the Google Directions API offers the service to generate routes using place names as the input parameters, so both options can be produced by GfS database queries.

Potential Implementation of Routing

For simplicity, the feature names were used in the routing requests (due to only one field being needed per parameter). However, during the initial testing, it was found that Google did not recognise some of the older or more obscure features that were required. Google offers the option to include region biasing within the HTTP request. The code for the Scotland (and the rest of Great Britain) is 'uk'; this parameter is included within all requests in order to not have to include Scotland or UK within each feature location.

Using coordinate locations overcame the issue of ambiguity by giving a specific location for the feature in question. The coordinate input to each waypoint parameter is comprised of the measurement of degrees of latitude and longitude. The precise composition of each coordinate location parameter is specified as only the number with unlimited decimal places (in most cases four decimal places are used). Only a comma separates the two numbers, with no spacing required. To differentiate between degrees North and South, and between East and West, the requirement is a minus symbol (-) preceding any South and West coordinates.

For clarity, the start point is always the point indicated as the centre of town in the general town entry within the GfS. The start and end locations were specified, along with up to eight waypoints and the chosen mode of travel. As transit requests require a starting time, this option will not be given to users to maintain the simplicity of the web page. Similarly, certain route characteristics (such as avoid road types and metric or imperial units) are optional but not included to keep the user interface simple and easy to use.

The standard HTTP routing request is included in the Perl program with variables in place of each parameter. These variables take the place of the start and end points as well as each of the eight waypoints that may be included. The values to be inserted into these positions of the request are obtained from a database query which returns features of the user-desired type. For smaller settlements with few attractions, this limited route plot is of no issue. However, for larger and more

interesting places, such as Edinburgh and Glasgow, being able to include only ten points to visit is significantly limiting.

As only ten features can be included in the route, the query can order the returned features by tourist rating. This process would ensure that the most popular attractions (within the feature category) are included and such features that are not considered tourist attractions (or not open to visitors) are not. Another option for this would be to order the features by the length of their entry within the GfS, so ensuring that the most interesting features with the largest volume of information would be included. Neither of these solutions is ideal but whilst the routing is limited to eight waypoints, these offer an adequate compromise.

Another potential solution is to create a route for each section of the nine-part maps. This would enable regions of the larger settlements to be visited as part of a multiple route sequence and include features from all areas of the city.

The problem of which features to include would ideally be solved by including all the selected features within the route and offering the user the option to exclude those which do not interest them. However, a more achievable solution is to select a series of features close together to give the user the appropriate information for the cluster of attractions. This can then be developed by selecting one feature in the cluster (as well as others further away) to allow the user to be guided between the less-central attractions and the general attraction cluster. As information for all relevant features is included within the guide, this option may be of greater benefit to the user.

The Directions API request returns a JSON file which needs to be adapted for use within the code. The first stage of this process is to capture the script within a Perl variable, done using the LWP::Simple module. This module works quickly to retrieve URL data and import it into Perl. Once imported, the return JSON can be assigned to a variable for future use within the code. This could be plotted as points and lines onto the OS maps already included within the guide, or the written directions can be printed into the guide near to the map of attractions (Wong, 1997).

Point selection and ordering

As the GfS is not a typical spatial database with stored geometry, the points-nearby selection must be done manually. This involves a database query to select attractions with both of the coordinate values within a specified range to the initial point. The initial point can be taken as the central point of the town, which is the coordinate stored in the Towns table. The query tests to see if the initial coordinates, subtracted from each of x and y coordinates of each feature is within the tolerance boundary. This tolerance boundary can be specified depending on the mode of transport used by the tourist; driving can cover a much greater distance than walking so the tolerance boundary can be set higher to include more features of interest. The example of this query is shown in Figure 22.

```
my $sth = $dbh->prepare("select conv_long, conv_lat from geofeatures
    where ((conv_long+$townlong)<$distancelimit)
    and ((conv_long+$townlong)>-$distancelimit)
    and ((conv_lat-$townlat)<$distancelimit)
    and ((conv_lat-$townlat)>-$distancelimit)
    ")
    or die "Couldnt prepare statement: " . $dbh->errstr;
$sth->execute;
```

Figure 23

Example of query to show nearby feature selection. The distance limit is stated as a Perl variable, determined by the intended mode of transport.

The most Easterly point of the Scottish mainland is Keith Inch, Aberdeenshire (as stated by the Ordnance Survey), with a longitude of 1.7697 degrees West. However, the most Easterly point including the Scottish Islands is Bound Skerry of the Shetland Islands at 0.7287 degrees West. Using these locations as the basis, it is clear that all Scottish locations are Westerly of the Prime Meridian and so have negative degrees longitude.

For easier testing, the query was adapted with specified variables in the code. Instead of subtracting longitude values taken from the database, the – was changed to a + so there was no issue of stating a negative number as a variable in the code.

To order points by closest distance to the origin (town centre), the distance between each point and the town centre must be calculated. This is done using the lat/long coordinate locations of each feature and the origin. Most distance calculations concerning lat/long are over a considerable range (usually international) so need to take account of the curvature of the Earth. This requires a complex formula which is not easily supported by Perl.

Using Pythagorean Theorem, it is calculated that the curvature of the Earth is approximately 8 inches per mile, which corresponds to approximately 12.5cm per km. The distance across Edinburgh, one of the larger Scottish settlements, is only approximately 10 miles (16km); therefore it can be assumed that the curvature of the Earth is 80 inches (200cm). Due to the guides having the wider limit of Scotland and the closer limit of the town itself, the Earth curvature does not need to be taken into consideration. The height difference of only 2m is not of any significance at this scale so does not need to be included in these intra-town calculations. Therefore, the distance between attractions can be calculated using simple trigonometry without needing the Haversine formula (Robusto, 1957).

Using the Pythagorean Theorem of right-angled triangles (summarized below), the distance between 2 known locations can be calculated. The formula can be rearranged to find the distance of the hypotenuse (C) which will give the distance between the 2 points.

Pythagorean Theorem:	$A^2 + B^2 = C^2$
Rearranged expression:	$C = \sqrt{A^2 + B^2}$
Substituted values:	Distance = $\sqrt{(\text{distance in } y^2 + \text{distance in } x^2)}$

As the location for each feature is recorded in coordinates of latitude and longitude, consideration must be made for this when returning the final distance. The conversion between degrees and km is taken from Snyder (1997); each degree of latitude is roughly equal to 110km, whilst each degree of longitude varies from 111km at the equator to 0km at the poles. Taking this conversion and distance variation into account, the extended expression is shown below.

Distance (km) = $\sqrt{((\text{feature latitude} - \text{town latitude})^2 / 110) + ((\text{feature longitude} - \text{town longitude})^2 / (111 * \cos(\text{town latitude})))}$

Using these distances, the features to be visited can be ordered by increasing distance away from the centre of town and therefore become the start of an ordered sequence of stops for the tourist to visit.

Section 5 – Further technical work

Due to security restrictions implemented by the University of Edinburgh, it is not currently possible to offer online feature selection and routing options to the user. Future work may find another method for hosting guides online as an interactive service. Once the full online implementation is possible, the guide program can be extended to incorporate dynamic routing using the Google Directions API.

There is potential for further improvements to the guide maps. The overall map may need to be combined with a more localised route map to show the user their route in the context of the wider location and in relation to other features that may be of interest.

In some guides, there is duplication of images; a picture of a feature may be re-used as the picture of the town. Similarly, pictures can show more than one feature and therefore be reproduced for multiple features within the guide. When filtering out features and excluding surrounding towns, this duplication is reduced. However, there is potential for reducing the image re-use further by including a condition to only include the image if it has not already been used within the guide.

Once the PDF guide is created according to user specifications, it is stored in the web folder for publishing online. This method is satisfactory for the current situation. However, once the extent of user interactivity increases, this will become less feasible due to the volume of individual guides that would need to be stored. To combat this, a possible solution is for the guides to be sent to the individual user by email; Perl offers the automated email solution as a standard function.

Section 6 – References and Bibliography

References

CGTK. <http://www.cgk.co.uk/navigation/gpx>

Communications from Elsewhere. <http://www.elsewhere.org/journal/gmaptogpx/>

Cycle Streets. <http://www.cyclestreets.net/api/journey/>

Open Route Service. <http://openrouteservice.org/>

PgRouting. <http://pgrouting.org/documentation.html>

Scottish Natural Heritage. <http://www.snh.gov.uk/>

Farrar, A. 2011. Automated Encyclopaedic Tourist Guide Generation for the Settlements of Scotland: A Static Document Approach. Unpublished MSc Thesis, University of Edinburgh.

Gittings, BM., Hill, C. and Jamieson, SSR. 2004. An Introduction to the Oracle Database Management System. School of Geosciences, University of Edinburgh. 5th Edition. ISBN 0900475323

Lau, G. and McKercher, B. 2006. Understanding Tourist Movement Patterns in a Destination: A GIS Approach. Tourism and Hospitality Research. Vol 7(1). P39-49.

Lonely Planet. 2013. Lonely Planet Scotland. Lonely Planet Publications Pty Ltd, London, UK.

Musciano, C. and Kennedy, B. 2002. HTML and XHTML: The Definitive Guide, Fifth Edition. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Robusto, C. 1957. The Cosine-Haversine Formula. American Mathematical Monthly. Vol 64(1). P38-40.

Rough Guide. 2014. Rough Guide to Scotland. Rough Guides Ltd, London, UK.

Scottish Natural Heritage. 2014. Scottish Outdoor Access Code. Accessed from <http://www.snh.gov.uk/>

Snyder, J. 1997. Flattening the Earth: Two Thousand Years of Map Projections. University of Chicago Press, Chicago, USA.

Vansteenwegen, P., Souffriau, W., Vanden Berghe, G. and Van Oudheusden, O. 2011. The City Trip Planner: An Expert System for Tourists. Expert Systems with Applications. Vol 38. P6540-6546.

Wong, C. 1997. Web Client Programming with Perl. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Bibliography

Callender, J. 2002. Perl for Web Site Management. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Christiansen, T. and Torkington, N. 1998. Perl Cookbook. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Eckstein, R. and Casabianca, M. 2001. XML: Pocket Reference. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Flanagan, D. 2002. JavaScript: Pocket Reference. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Hall, JN. and Schwartz, RL. 1998. Effective Perl Programming: Writing Better Programs with Perl. Addison Wesley Longman, Inc. Reading, Massachusetts, USA.

Lowery, JW. and Fletcher, M. 2011. HTML 5 24-Hour Trainer. Wiley Publishing, Inc. Indianapolis, Indiana, USA.

Maruyama, H., Tamura, K. and Uramoto, N. 1999. XML and Java: Developing Web Applications. Addison Wesley Longman, Inc. Reading, Massachusetts, USA.

Patwardhan, N., Siever, E. and Spainhour, S. 2002. Perl in a Nutshell, Second Edition. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Schwartz, RL. and Christiansen, T. 1997. Learning Perl, Second Edition. O'Reilly & Associates, Inc. Sebastopol, California, USA.

Appendix A

Index of Data and Programs

Data is accessed as needed from the Gazetteer for Scotland database, via the user account Scotgaz with the Oracle Relational Database Management System.

Maps are Ordnance Survey Open Data, accessed as needed from the EDINA web mapping service.

Initial user questionnaire HTML code is called questionnaire2014.html and stored in:

User: Scotgaz web/public_html/questionnaire2014.html

The purpose is to gather user requirements for customised tourist guides.

This program is found in Appendix B.

The program to collect the responses is a Perl file called quest2014.pl and stored in:

User: Scotgaz web/public_html/cgi-bin/ryland/quest2014.pl

This program is found in Appendix C.

The complete results of the initial questionnaire are stored in an Excel file called questionnaireresponses.xlsx and stored in:

M:/dissfinal/questionnaireresponses.xlsx

The file was created on 14/07/2014.

This file is found in Appendix D.

Guide creation file is a Perl file called guidecreation.pl and stored in:

User: Scotgaz web/public_html/cgi-bin/jenni/guidecreation.pl

The purpose of this program is to create specific guides for visitors to Scottish settlements, with the final version created on 29/07/2014.

This program is found in Appendix E.

This program should be run from UNIX, as user Scotgaz. The program needs to be initiated with 8 arguments: the ID number of the desired location; a 1 or 0 indicating the inclusion or exclusion of each section (history, geography, industry, surrounding towns, famous people, and historical events); the ID number of the desired feature type. The output PDF is found in:

User: Scotgaz web/public_html/dynamic/test4/LocalGuide\$seqno-argumentcode.pdf

The user interface to access complete guides is called customisedguidebook.html and stored in:

User: Scotgaz web/public_html/customisedguidebook.html

The purpose is to provide users with easy access to personalised guides on the GfS website.

This program is found in Appendix F.

The program to collect the responses and return a complete guide is called customisedguide.pl and stored in:

User: Scotgaz web/public_html/cgi-bin/ryland/customisedguide.pl

This program is found in Appendix G.