

# **Development of a map-based web application showcasing the Dyfi Wildlife Centre**

CS39440 Major Project Report

Author: Michael Male (mim39@aber.ac.uk)  
Supervisor: Dr Edel Sherratt (eds@aber.ac.uk)

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Department of Computer Science  
Aberystwyth University  
Aberystwyth  
Ceredigion  
SY23 3DB  
Wales, U.K.

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Name Michael Male

Date 04/04/2020

## **Consent to share this work**

By including my name below, I hereby agree to this project's report and technical work being made available to other students and academic staff of the Aberystwyth Computer Science Department.

Name Michael Male

Date 04/04/2020

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## Abstract

The Dyfi Wildlife Centre is a visitor centre run by the Montgomeryshire Wildlife Trust. It is situated on the Cors Dyfi Nature Reserve in Powys, Wales. The Trust had approached the University, with a request for a solution to assist in showcasing the reserve's work, and its place as an osprey conservation, engagement, and research project. They had procured an 86-inch touchscreen monitor, in the hopes of presenting an application that aids in achieving the aforementioned goal.

The software created in this project takes the form of a map-based web application. The frontend makes use of the Google Maps for JavaScript API, as well as HTML, CSS and Thymeleaf, to show visitors a map of the centre and its surroundings. The map has various markers, and filters, that can be clicked on, showing further information about the point of interest. This is backed up by a RESTful API backend, created using the Spring Framework, a model-view-controller framework using Java Enterprise Edition. An administration panel was also developed, involving authentication, and allowing the authenticated user to add, edit, and delete points of interest. Data was stored in a PostgreSQL relational database.

Planning and development of this project took the form of an agile approach, with ideas from both Kanban and Extreme Programming used and adapted to fit a single-developer project. A meeting with the customer took place prior to development, and user stories and prioritisation of tasks had branched out from that meeting. The concept of test-driven development was a driving force for the development of this project, with various testing suites including JUnit, HTMLUnit and Selenium utilised when creating test cases. A key part of this project was ensuring that the customer was kept up-to-date, and supplementary documentation was created for this project that provided a brief overview of the required setup and how to use the web app.

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# Chapter 1

## Background & Objectives

### 1.1 Background

A number of key considerations were taken into place during the background planning stages of this project.

An initial meeting took place in February 2020 with the customer, the Montgomeryshire Wildlife Trust. The hardware implementation was discussed and it was understood that the customer would want to run the web application on an 86-inch touch screen monitor. They also expressed a preference for the web application to be run locally, and not published to a cloud service or the World Wide Web. Therefore, an important consideration of the project was enabling the web application to work using touch gestures, and use a responsive layout that would scale to a high resolution.

With the intention being that the application runs locally, therefore research had to be put into various technology stacks, and which web framework would work best for this kind of application. Research into this would have to take into account how much time needs to be allocated to performing spike work; ensuring a comprehensive understanding of the framework was achieved before work on the project began.

Another key consideration was the vendor for the maps API. A number of APIs were assessed for their usability as well as their licensing conditions.

In this section, the early investigative work into the project will be discussed, with an analysis of the steps taken to achieve a conclusion as to which technology stack to use.

#### 1.1.1 Web Development Frameworks and Tools

Early on in the project it was decided that the use of a comprehensive web framework would be beneficial to the usability and production quality of the web application. This was opposed to a simple HTML 5, CSS, and JavaScript stack. Whilst it was inevitable that portions of each language had to be used, a more robust framework provided specific advantages, such as a package manager and cleaner code.

Three primary web frameworks were assessed, through the use of research, prior reading, and spike work, these being the following:

- A JavaScript-based framework, utilising the Node.js and Express backend frameworks and either Vue.js or React as the frontend.
- Django, a Python-based model-template-view framework.
- The Spring Framework, a Java-based model-view-controller framework.

Further research took place into the CSS frameworks, as well as an appropriate database management system. Discussion into these are expanded upon in their relevant sections.

#### 1.1.1.1 JavaScript Frameworks

A full-stack JavaScript framework allowed for the benefit of the software being written in one programming language, which could reduce issues with the code's readability and maintenance. It would have also allowed for a single testing framework, such as Jest, a testing framework maintained by Facebook. The use of a runtime environment would be standard fare for a JavaScript framework, allowing server-side scripting and dynamic web pages to be run outside of the usual web browser environment that JavaScript runs on. A popular JavaScript runtime is Node.js, which has been touted as a resource-efficient framework, a benefit for a project that is designed to run on a local computer.

Frontend frameworks were also looked at, with varying levels of spike work being put into them. React, a Facebook-maintained JavaScript library, and Vue.js, were both considered. The two frameworks are rather similar, such that they rely on sending data directly to the browser's Document Object Model, however Vue.js takes a declarative approach to HTML scripting, whilst React uses JSX, an HTML syntax extension to JavaScript.

Ultimately, a lack of familiarity with JavaScript, as well as the relative complexities of the frameworks, proved to be a deciding factor in not going ahead with a JavaScript-driven application. During research, it was deemed that a large amount of time would have to be dedicated to following tutorials and learning JavaScript, and ECMAScript 6, from scratch, and this would have taken too much time and risked a less complete final product.

#### 1.1.1.2 Django

Django is an open-source framework based on the Python programming language. Its creators set the framework's primary philosophies as a quick approach to development, a view to not repeating the design and execution of concepts, and loose coupling - in this context being that the framework layers shouldn't be able to interface with each other unless necessary.

Django utilises the object-oriented programming paradigm with Python, and utilises a model-template-view approach. In short, these are three distinct layers of a web application: the model consists of a data structure, the view consists of a representation of

information on a web browser, and a controller allows access to this data with meaningful requests.

Whilst Django appeared to be a good choice due to its highly cohesive pattern, testing of the setup proved to be difficult on occasion, with design patterns that were particularly unique to Django. Whilst Python is a language that is known to utilise concepts that are simple to understand for users with greater knowledge in other programming languages, utilisation of Python at this level required a higher level of expertise than was had at the time. It was decided that there would be a greater chance of success with the project if attention was placed more towards frameworks with a more familiar language, to avoid an inordinate amount of time being spent on the intricacies of specific programming languages and frameworks.

### 1.1.1.3 Spring Framework

The Spring Framework is an open-source framework, where its web application features are based upon Java Enterprise Edition, an enterprise specification of the Java programming language that has modules specifically tailored towards web services.

Spring provides many of the benefits that Django also provides, and the two are often compared against each other. Similar to Django, Spring utilises a model-view-controller framework, and relies upon high cohesion. As Spring uses Java, it takes advantage of the object-oriented programming paradigm, and it is standard for classes to be written in such a way that they follow this concept. Spring is optimised to work with the Thymeleaf template engine, that provides server-side scripting and an interface between the controller and view layers.

Ultimately, a proficiency in Java from previous academic study and personal use made Spring an ideal choice for this project. Spring Boot, an addition to the platform that allows for automatic configuration of core dependencies, was also used, to reduce the amount of time spent studying elements of Spring that Spring Boot renders redundant. Spring also utilises Maven, a Java package manager, to provide a large number of dependencies; Spring Security was deemed a useful tool for an authentication layer, for example. An added benefit to Spring is its embedded Apache Tomcat server, that allows for the provision of an HTTP web server environment from opening the application, rather than having to take steps to deploy it into an existing web server environment.

### 1.1.1.4 CSS frameworks

It was decided in the planning stages of the project that it would be beneficial to use a CSS framework, rather than build a template with 'vanilla' implementations of HTML and CSS. CSS frameworks provide a large number of pre-built elements, many that are rather familiar to users, due to their prevalence in front-end web design. A review into three different CSS frameworks were performed.

Bootstrap, a framework initially developed for use with Twitter, provides elements that have been crafted with the User Experience at their forefront. It is used by a large variety of

web applications and websites, with the developers claiming it is 'the world's most popular front-end component library.' Whilst this would have been a good choice for a familiar user interface, the framework was assessed to have less customisability, which posed an issue with a unique implementation where the main aspect is a single-page application. Bootstrap is also intended to be mobile-first, a feature that is not required, as the application is designed to run on a desktop computer.

Fomantic UI, a community fork of Semantic UI, which had seen a lull in development, is a framework that defines itself as using 'human-friendly HTML.' Classes within Fomantic use syntax from the English language, for example, a user interface with three buttons could be classed simply as `<div class="ui three buttons">`. While Semantic is quite an elegant interface, different frameworks were deemed more familiar to a user, and the User Experience aspect of this project was tailored towards people who may not have a great amount of technical knowledge.

The chosen CSS framework for the application was Materialize, a variation upon Google's Material Design language. Material Design is used in a large number of Android mobile phone applications, and on Google's services themselves. Similar to Fomantic, Materialize utilised the concept of human-friendly HTML, and was easy to integrate with Thymeleaf and Spring. Materialize utilises a twelve-column responsive grid system, which made it simple to create components that would scale with screen size. As the customer intends to run the application on a large monitor, this is an important design consideration.

#### 1.1.1.5 Database Management System

A database management system was a key component of this project. Points of Interest had to be persistent, and, in later iterations, a database for users had to be created. Whilst an in-memory database management system, H2, was used during the early stages of the project, it was quickly settled upon that a server independent from the application should be created. The investigation into this settled on either using PostgreSQL, an SQL-compliant system written in C, or MongoDB, a NoSQL document-oriented database that takes a JSON-like approach to storage of data.

It was decided upon to utilise PostgreSQL. Whilst there were various arguments for using MongoDB - a more readable schema, for example, studies have shown that PostgreSQL is generally faster in response times, and it is a popular implementation of SQL that sees good compatibility with Spring. A solid amount of background experience with PostgreSQL also contributed to the decision; whilst MongoDB has been described by its developers as similar to an object-oriented paradigm, the performance benefits of PostgreSQL negated any benefits of learning a new system.

#### 1.1.1.6 Programming Tools

After the technology stack was decided, a decision had to be made as to the best programming tools for the task at hand. The Spring Framework has widespread support within IDEs. An extension, called Spring Tools 4, had been created by the developers, which provided Spring-related functionality to Eclipse, Microsoft Visual Studio Tools, and

Eclipse Theia. A large number of PostgreSQL clients existed, with some examples being pgAdmin 4 and HeidiSQL. PostgreSQL could also be administrated via a command-line interface.

However, it was decided upon that the JetBrains' suite of software was to be used for development. JetBrains provides a free license to people with a University e-mail address, and its IntelliJ IDEA Java IDE has in-built support for Spring Boot projects, and also includes plugins for web development. DataGrip, a database IDE, was also used, as this allowed for a graphical representation of the database that resulted in the schema being easier to quickly understand. Various browsers, including Microsoft Edge, Google Chrome, and Mozilla Firefox, were used in order to test the web application on varying browsers. Mozilla's Firefox Browser Developer Edition was useful when debugging the web app, as it included useful tools pertinent to CSS and JavaScript debugging.

### 1.1.2 Mapping API

A crucial part of the application was the ability to present geographic data and information in a graphical format. A video had been provided by the customer, showing a map implementation on a similar nature reserve in Dorset. This used a satellite map with markers placed on the screen, and the intention was to take a similar approach.

As this application is web-based, a view towards a JavaScript API was adopted when assessing potential mapping solutions. The map must also take clickable markers and allow for quick downloading of satellite images. Two potential candidates were assessed:

- **OpenStreetMap** - A free and open-source map that allowed for users to request changes to be made, which has the potential to provide a more up-to-date map based on changes in geography. OpenStreetMap does not have an inbuilt satellite implementation or an API, however various free and paid sources are available and were assessed during this stage of the project.
- **Google Maps Platform** - Google provides a JavaScript API with a wide array of features attached to it, that uses data and imagery from Google Maps, hosted on Google's infrastructure. A potential hurdle in using Google Maps Platform, however, was its use of API keys and its pricing structure, an issue that is further discussed below.

#### 1.1.2.1 OpenStreetMap

OpenStreetMap is defined as a community-driven repository of map data, that can be contributed towards in a 'wiki-like' manner. It did not, however, appear to provide a JavaScript API, but many implementations of OpenStreetMap have been realised in JavaScript, with Leaflet being one of them.

OpenStreetMap did not appear to host aerial imagery, and freeware JavaScript APIs only appear to have implemented a standard map interface. It was considered that this is not what the customer had wanted, and, whilst Mapbox, a closed-source implementation

of OpenStreetMap with aerial imagery and a free tier, was briefly assessed, a lack of customisability and the low-quality resolution of the aerial imagery were deciding factors in not going ahead with this approach.

### 1.1.2.2 Google Maps Platform

Google Maps Platform is one of the features offered with Google Cloud; a suite of cloud-based applications and APIs hosted centrally by Google. Google Maps is a popular mapping interface, and regular input from various countries' national mapping agencies allows it to be reasonably up-to-date. Google Maps Platform's main offering for non-mobile applications is the Maps JavaScript API, and a thorough amount of documentation has been provided for this.

Ultimately, a decision was made as to go ahead with using Google Maps Platform. The platform's high-resolution aerial imagery was key to this decision, along with the general reliability and uptime of Google's Cloud infrastructure. Unlike OpenStreetMap, the platform was not free, however includes a free tier that permits for up to USD \$200 of free usage a month. After reviewing their pricing scheme it was decided that this would be enough for a locally-hosted application; the geo-coding API was not being used and a levy of USD \$2 is placed on every one thousand static map requests, meaning that one hundred thousand requests a month would have to be made to exceed the free tier, which is not likely.

### 1.1.3 Version Control

An effective Version Control System was imperative for the successful completion of the project. The use of branches, and rollback features, were key to ensuring that each part of the project was clearly indicated. An external version control host, GitHub, was used, which uses the Git version control system. This was mainly due to personal experience with both Git and GitHub, the added features that GitHub offers, and the benefit of an externally-hosted backup location, should data loss occur at any point on a local development machine.

## 1.2 Software Development Process

An important part of the planning for development of this software centred around having a meaningful development process, so as to ensure that the project remained on track and all deliverables could be met. A number of different approaches to software development were researched, including the Waterfall model, a linear, sequential approach that focuses on a series of categories and tasks towards the completed product. It was, however, decided to take an agile approach to software development. An agile approach would allow for changes and improvements to be made to the product as the development process continued and ensure there was more freedom attributed to the implementation of the product.

### 1.2.1 Agile Development

An important aspect into choosing an agile methodology was the ability to easily adapt it to a one-person project. Most agile methodologies are tailored towards small team projects, and many of the principles behind the Agile Manifesto - conveying information to and within a development team through face-to-face conversation, for example - are rendered irrelevant. Ultimately, I decided upon an adapted version of the core tenets of eXtreme Programming for the brunt of the development process, which I have detailed below. I also decided upon the use of Kanban as a workflow management tool. A few tools for this were assessed, including Trello and Jira, however, as the project was being hosted on the GitHub , GitHub Projects was instead used.

#### 1.2.1.1 Adapted XP principles

A number of studies focused on adapting XP and Agile for one person were consulted when deciding upon its implementation. Implementing a fully-compliant XP approach would have been difficult. It is a complicated framework, and requires multiple roles. Instead, a relaxed version of XP, that loosely followed the twelve core practices, was adopted.

1. **The Planning Game** - This was adapted from the initial meeting of a customer, where a series of notes on the type of features the customer wants in the product was compiled. Planning took an approach of user epics and stories, the epics being:
  - As a volunteer, I want to have a web interface where I can show people information about the nature reserve on a map.
  - As an administrator, I want to be able to add and edit information about the nature reserve, and change anything that I want to change.

The system metaphor became '*A web application that uses a map to show interesting things around the Dyfi Wildlife Centre*'. Appendix A of this report provides the copy of the document used to design user stories, define the technology stack, and prioritise each user story.

2. **Small Releases** - An iterative approach was taken to the development of this project. Releases, each including more features than the last, were tied into the tasks created in the planning game.
3. **Metaphors** - This practice was realised through the aforementioned system metaphor and user stories.
4. **Simple Design** - Attention was placed on the design of the application not becoming too complex, with this being assessed in every release.
5. **Testing** - As will be discussed later in this chapter, test-driven development was used throughout the project. This often involved verification of an interface before its implementation.



6. **Refactoring** - It was ensured this was the last task, after all tests passed, so as to provide as clean, readable and efficient code as possible.
7. **Pair Programming** - For obvious reasons, it was not possible to replicate this practice. However, a benefit of pair programming is being able to have a 'birds' eye' view of the code, and find bugs early. This was achieved through use of the Pomodoro Technique, a time management technique similar to timeboxing, where work is broken down into 25-minute intervals. After three intervals, all code that had been written was tested and reviewed, to see if there were any bugs.
8. **Collective Code Ownership** - As the project had a single developer there was no need to find an adaptation to this, as the entire codebase is owned by the developer.
9. **Continuous Integration** - Use of the Travis CI tool was prevalent throughout the project. Whilst conflicts between different branches were not likely, it ensured that testing was being carried out repeatedly, and did not have to be performed manually.
10. **40-Hour Week** - It was ensured that too much work over one period did not occur, as this may have caused more buggy code due to stress and fatigue.
11. **On-site customer** - This wasn't possible with this project, particularly during the second half. Therefore, any communication with the customer tended to be carried out via e-mail and telephone.
12. **Coding standard** - A coding standard was self-imposed, and kept consistent throughout each iteration of the project.

### 1.2.2 Test-driven development

While researching testing strategies, it was decided that the concept of test-driven development should be incorporated into this project. The main benefit of such an approach was the ability to create a detailed specification for the code, and ensure that thought took place into what was really required from it. It also ensured that feedback was quick, a useful tool in a single-person project where you are not easily able to request constant feedback from your code. Errors and problems become identified more quickly. Overall, this was to be implemented through the use of Java interfaces, with an outline of a class written and tests to achieve what was wanted from each class. Testing suites were created for each class which required them, and the use of technologies such as Selenium was crucial to testing the front-end.



## Chapter 2

# Design

You should concentrate on the more important aspects of the design. It is essential that an overview is presented before going into detail. As well as describing the design adopted it must also explain what other designs were considered and why they were rejected.

The design should describe what you expected to do, and might also explain areas that you had to revise after some investigation.

Typically, for an object-oriented design, the discussion will focus on the choice of objects and classes and the allocation of methods to classes. The use made of reusable components should be described and their source referenced. Particularly important decisions concerning data structures usually affect the architecture of a system and so should be described here.

How much material you include on detailed design and implementation will depend very much on the nature of the project. It should not be padded out. Think about the significant aspects of your system. For example, describe the design of the user interface if it is a critical aspect of your system, or provide detail about methods and data structures that are not trivial. Do not spend time on long lists of trivial items and repetitive descriptions. If in doubt about what is appropriate, speak to your supervisor.

You should also identify any support tools that you used. You should discuss your choice of implementation tools - programming language, compilers, database management system, program development environment, etc.

Some example sub-sections may be as follows, but the specific sections are for you to define.

### 2.1 Overall Architecture

### 2.2 Some detailed design

### **2.2.1 Even more detail**

## **2.3 User Interface**

## **2.4 Other relevant sections**

## Chapter 3

# Implementation

The implementation should discuss any issues you encountered as you tried to implement your design. During the work, you might have found that elements of your design were unnecessary or overly complex; perhaps third-party libraries were available that simplified some of the functions that you intended to implement. If things were easier in some areas, then how did you adapt your project to take account of your findings?

It is more likely that things were more complex than you first thought. In particular, were there any problems or difficulties that you found during implementation that you had to address? Did such problems simply delay you or were they more significant?

You can conclude this section by reviewing the end of the implementation stage against the planned requirements.

## Chapter 4

# Testing

Detailed descriptions of every test case are definitely not what is required here. What is important is to show that you adopted a sensible strategy that was, in principle, capable of testing the system adequately even if you did not have the time to test the system fully.

Provide information in the body of your report and the appendix to explain the testing that has been performed. How does this testing address the requirements and design for the project?

How comprehensive is the testing within the constraints of the project? Are you testing the normal working behaviour? Are you testing the exceptional behaviour, e.g. error conditions? Are you testing security issues if they are relevant for your project?

Have you tested your system on “real users”? For example, if your system is supposed to solve a problem for a business, then it would be appropriate to present your approach to involve the users in the testing process and to record the results that you obtained. Depending on the level of detail, it is likely that you would put any detailed results in an appendix.

Whilst testing with “real users” can be useful, don’t see it as a way to shortcut detailed testing of your own. Think about issues discussed in the lectures about unit testing, integration testing, etc. User testing without sensible testing of your own is not a useful activity.

The following sections indicate some areas you might include. Other sections may be more appropriate to your project.

### 4.1 Overall Approach to Testing

### 4.2 Automated Testing

#### 4.2.1 Unit Tests

#### **4.2.2 User Interface Testing**

#### **4.2.3 Stress Testing**

#### **4.2.4 Other types of testing**

### **4.3 Integration Testing**

### **4.4 User Testing**

## Chapter 5

# Evaluation

Examiners expect to find a section addressing questions such as:

- Were the requirements correctly identified?
- Were the design decisions correct?
- Could a more suitable set of tools have been chosen?
- How well did the software meet the needs of those who were expecting to use it?
- How well were any other project aims achieved?
- If you were starting again, what would you do differently?

Other questions can be addressed as appropriate for a project.

The questions are an indication of issues you should consider. They are not intended as a specification of a list of sections.

The evaluation is regarded as an important part of the project report; it should demonstrate that you are capable not only of carrying out a piece of work but also of thinking critically about how you did it and how you might have done it better. This is seen as an important part of an honours degree.

There will be good things in the work and aspects of the work that could be improved. As you write this section, identify and discuss the parts of the work that went well and also consider ways in which the work could be improved.

In the latter stages of the module, we will discuss the evaluation. That will probably be around week 9, although that differs each year.

# Appendices

The appendices are for additional content that is useful to support the discussion in the report. It is material that is not necessarily needed in the body of the report, but its inclusion in the appendices makes it easy to access.

For example, if you have developed a Design Specification document as part of a plan-driven approach for the project, then it would be appropriate to include that document as an appendix. In the body of your report you would highlight the most interesting aspects of the design, referring your reader to the full specification for further detail.

If you have taken an agile approach to developing the project, then you may be less likely to have developed a full requirements specification. Perhaps you use stories to keep track of the functionality and the 'future conversations'. It might not be relevant to include all of those in the body of your report. Instead, you might include those in an appendix.

There is a balance to be struck between what is relevant to include in the body of your report and whether additional supporting evidence is appropriate in the appendices. Speak to your supervisor or the module coordinator if you have questions about this.

## Appendix A

# User Stories

### 1.1 Purpose of this file

This file is intended to provide user stories as part of a modified XP approach to this project. It will be modified into tasks and sub-tasks that will be created through GitHub's issue tracker.

### 1.2 System metaphor

**A web application that uses a map to show interesting things around the Dyfi Wildlife Centre**

### 1.3 Epics

1. As a volunteer, I want to have a web interface where I can show people information about the nature reserve on a map.
2. As an administrator, I want to be able to add and edit information about the nature reserve, and change anything I want to change.

### 1.4 Priorities

#### 1.4.1 Legend

Using MoSCoW analysis.

- **M: Must** - Non-negotiable, must be satisfied for the project to be considered a success.



- **S: Should have** - High priority, a critical requirement that should be included if at all possible. However, it can be implemented in other ways if necessary.
- **C: Could have** - A desirable requirement but not necessary, will be included if there's enough time.
- **W: Won't** - A requirement identified as not necessary to be implemented at this stage in planning, but may be considered during future stages.

Each story in the following section is marked with its priority by a letter corresponding to each priority.

## 1.5 Stories

1. As a volunteer, I want to be able to view points of interest on a map, so that I'll be able to tell visitors what is around the centre. (M)
2. As an administrator, I want to be able to login to an authenticated administration panel, so that I can ensure that only authorised people can change information about the points of interest. (S)
3. As an administrator, I want to be able to add and edit information about points of interest, so that I can ensure that there is up-to-date information about the wildlife centre. (M)
4. As a volunteer, I want the ability to showcase the information in both the medium of English and of Welsh, so that I can accommodate for all people who visit the centre, regardless of their preferred language. (C)
5. As an administrator, I want to be able to add images to different points of interest, so that I'll be able to show a visual representation of the point of interest. (C)
6. As a visitor, I want to be able to find directions to and from the centre using the application, so that I'll be able to find out how to get back home, and find out how to get to the centre by another form of transport if I want to visit again. (C)
7. As a visitor, I want to be able to find out about local businesses that are featured in the application, so that I can get more a feel for what is around the wildlife centre, and potentially visit some interesting businesses. (S)
8. As a visitor, I want to be able to be told about what the wildlife centre is doing, so that I can get more of a feel and be able to appreciate the area around me. (M)
9. As a visitor, I want to be able to look at webcams of the Ospreys that live at the wildlife centre. (W - This has been implemented separately by the project manager on the Dyfi Wildlife Centre's side)
10. As a volunteer, I want to be able to filter the map by different defining features, and also press a button in case I go too far from the centre. (S)

## 1.6 Tasks

Tasks will be stored as GitHub issues which will be broken down into further subtasks. Each subtask will have its own branch that will merge onto the task branch. Tasks will be carried out sequentially. Each story has a task attached to it, but it is broken down and interpreted in a software engineering sense.

1. Create an interface that includes a map, which has markers that can be added to it. The markers should link to a popup containing information about the point of interest. At this stage, the POIs can be hard-coded.
2. Create an API that allows for information about points of interest to be stored in a database. Program this API to automatically update the Google Maps API with markers and create a page to allow for this to be edited in a textbox and posted to the database. Focus on not having to 'hack' through the HTML or database, similar to a CMS. Worst case: use something like WordPress headless.
3. Re-visit the interface created in task 1 to ensure that the information popup is easy to present to someone. Ensure that the interface is easily-readable, for example by having marker clusters. Consider performing user surveys and informal user testing with friends, and even the customer if possible.
4. Re-visit the interface created in task 2 and use a simple authentication algorithm, such as OAuth 2.0. This should include some sort of user/password table and the ability to create new users. It does not necessarily have to have enterprise-grade encryption but should be taken seriously enough to disallow any simple attacks on the web server.
5. Create a list of filters that can be selected by the volunteer on the main screen. This will filter out some markers based upon specific boolean values. Will require some further spike work through online tutorials.
6. In the admin panel, allow for addresses to be entered and geocoded into coordinates, so that local businesses and places such as educational institutions can be added.
7. Enable I18N internationalisation, creating a basic Welsh version of the web page. Ensure that the admin panel accepts name and description information in both English and Welsh. Don't worry about the accuracy of Welsh as this can be corrected by the customer or by Welsh-speaking staff in the University.
8. Include the ability to upload images to the web server, or, failing that, hotlink images. Have them show up with each POI. A card component could be useful for this.
9. Ensure that forms of public transport are clearly marked on the map, if they haven't been already. Potentially import the directions API and allow visitors to ask the volunteer for driving and public transport directions back to wherever they live to be displayed on the screen.

- Potential task to implement bus and train times through an open source transport times API. Examples include the NextBuses API, Transport API and Darwin, but this is of C priority.
10. Get the links for video feeds for the customer and implement them as buttons that open up an HTML5 video component.

## Appendix B

# Ethics Submission

**Date:** 20th February 2020 **Reference:** 15221

**AU Status**

Undergraduate or PG Taught

**Your aber.ac.uk email address**

mim39@aber.ac.uk

**Full Name**

Michael Male

**Please enter the name of the person responsible for reviewing your assessment.**

Reyer Zwiggelaar

**Please enter the aber.ac.uk email address of the person responsible for reviewing your assessment**

rrz@aber.ac.uk

**Supervisor or Institute Director of Research Department**

CS

**Module code (Only enter if you have been asked to do so)**

CS39440

**Proposed Study Title**

Development of a map-based web application to be used by visitors and staff at the Dyfi Wildlife Centre

**Proposed Start Date**

27 January 2020

**Proposed Completion Date**

1 June 2020

**Are you conducting a quantitative or qualitative research project?**

Mixed Methods

**Does your research require external ethical approval under the Health Research Authority?**

No

**Does your research involve animals?**

Yes

**Does your research involve human participants?**

Yes

**Are you completing this form for your own research?**

No

**Does your research involve human participants?**

Yes

**Institute**

IMPACS

**Please provide a brief summary of your project (150 word max)**

A web application that provides information about specific points of interest around the Cors Dyfi Nature Reserve on a Google Maps API, with persistent data stored in a PostgreSQL database. The application will be accessed on a computer based at the Dyfi Wildlife Centre; its intention is for staff to more easily explain the work that the centre carries out. Proposed data collection includes regular user experience surveys and collaboration with staff at the Montgomeryshire Wildlife Trust regarding information about the centre and local businesses/transport they wish to showcase. There has also been a proposed task to include geospatial data from GNSS trackers that were placed on western ospreys prior to the beginning of this project. The ospreys live at the nature reserve and migrate to Africa during the winter.

**I can confirm that the study does not involve vulnerable participants including participants under the age of 18, those with learning/communication or associated difficulties or those that are otherwise unable to provide informed consent?**

Yes

**I can confirm that the participants will not be asked to take part in the study without their consent or knowledge at the time and participants will be fully informed of the purpose of the research (including what data will be gathered and how it shall be used during and after the study). Participants will also be given time to consider whether they wish to take part in the study and be given the right to withdraw at**

any given time.

Yes

**I can confirm that there is no risk that the nature of the research topic might lead to disclosures from the participant concerning their own involvement in illegal activities or other activities that represent a risk to themselves or others (e.g. sexual activity, drug use or professional misconduct).**

Yes

**I can confirm that the study will not induce stress, anxiety, lead to humiliation or cause harm or any other negative consequences beyond the risks encountered in the participant's day-to-day lives.**

Yes

**Please include any further relevant information for this section here: Where appropriate, do you have consent for the publication, reproduction or use of any unpublished material?**

Not applicable

**Will appropriate measures be put in place for the secure and confidential storage of data?**

Yes

**Does the research pose more than minimal and predictable risk to the researcher?**

No

**Will you be travelling, as a foreign national, in to any areas that the UK Foreign and Commonwealth Office advise against travel to?**

No

**Please include any further relevant information for this section here: If you are to be working alone with vulnerable people or children, you may need a DBS (CRB) check. Tick to confirm that you will ensure you comply with this requirement should you identify that you require one.**

Yes

**Declaration: Please tick to confirm that you have completed this form to the best of your knowledge and that you will inform your department should the proposal significantly change.**

Yes

**Please include any further relevant information for this section here:**

N/A

## Appendix C

# Code Examples

For some projects, it might be relevant to include some code extracts in an appendix. You are not expected to put all of your code here - the correct place for all of your code is in the technical submission that is made in addition to the Project Report. However, if there are some notable aspects of the code that you discuss, including that in an appendix might be useful to make it easier for your readers to access.

As a general guide, if you are discussing short extracts of code then you are advised to include such code in the body of the report. If there is a longer extract that is relevant, then you might include it as shown in the following section.

Only include code in the appendix if that code is discussed and referred to in the body of the report.

### 3.1 Random Number Generator

The Bayes Durham Shuffle ensures that the psuedo random numbers used in the simulation are further shuffled, ensuring minimal correlation between subsequent random outputs [?].

```
#define IM1 2147483563
#define IM2 2147483399
#define AM (1.0/IM1)
#define IMM1 (IM1-1)
#define IA1 40014
#define IA2 40692
#define IQ1 53668
#define IQ2 52774
#define IR1 12211
#define IR2 3791
#define NTAB 32
#define NDIV (1+IMM1/NTAB)
#define EPS 1.2e-7
```

```

#define RNMX (1.0 - EPS)

double ran2(long *idum)
{
    /*-----*/
    /* Minimum Standard Random Number Generator */
    /* Taken from Numerical recipes in C */
    /* Based on Park and Miller with Bays Durham Shuffle */
    /* Coupled Schrage methods for extra periodicity */
    /* Always call with negative number to initialise */
    /*-----*/

    int j;
    long k;
    static long idum2=123456789;
    static long iy=0;
    static long iv[NTAB];
    double temp;

    if (*idum <=0)
    {
        if (-(*idum) < 1)
        {
            *idum = 1;
        }else
        {
            *idum = -(*idum);
        }
        idum2=(*idum);
        for (j=NTAB+7; j>=0; j--)
        {
            k = (*idum)/IQ1;
            *idum = IA1 *(*idum-k*IQ1) - IR1*k;
            if (*idum < 0)
            {
                *idum += IM1;
            }
            if (j < NTAB)
            {
                iv[j] = *idum;
            }
        }
        iy = iv[0];
    }
    k = (*idum)/IQ1;
    *idum = IA1*(*idum-k*IQ1) - IR1*k;
    if (*idum < 0)
    {

```



```
    *idum += IM1;
}
k = (idum2)/IQ2;
idum2 = IA2*(idum2-k*IQ2) - IR2*k;
if (idum2 < 0)
{
    idum2 += IM2;
}
j = iy/NDIV;
iy=iv[j] - idum2;
iv[j] = *idum;
if (iy < 1)
{
    iy += IMM1;
}
if ((temp=AM*iy) > RNMX)
{
    return RNMX;
}else
{
    return temp;
}
}
```