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# The Golf Blueprint

A Smarter Way to Play Golf –

Driven by Analytics

## Table of Contents

Title Page .....	2
Glossary .....	7
1. Introduction.....	8
1.1 Problem Statement .....	8
1.2 Project Aims and Objectives .....	8
2. Methodology .....	10
2.1 Agile Methodology .....	10
2.2 Risks and Mitigation Strategies .....	12
2.2.1 Technical Risks .....	12
2.2.2 User Adoption Risks .....	12
2.2.3 Data Protection Risks .....	12
2.2.4 Project Management Risks.....	13
2.2.5 Version and Document Control Strategy.....	13
3. Project Research .....	14
3.1 Secondary Research .....	14
3.2 Primary Research.....	15
3.2.1 Current Understanding of Course Management .....	16
3.2.2 Current Use of Golf Apps or Technology.....	17
3.2.3 Interest Levels in an App/Website such as The Golf Blueprint .....	18
3.2.4 Willingness to Participate in the Required Data Collection.....	19
3.2.5 Desirable Features of The Resource .....	20

3.3 Key Findings.....	21
3.3.1 Research Limitations.....	21
4. Requirements.....	22
4.1 User Stories and Use Cases .....	22
4.2 Use Case Diagrams .....	24
4.2.1 System Overview.....	24
4.2.2 Contribute Shot Data.....	25
4.2.3 Heatmap Visualisation .....	26
4.2.4 Preview Course .....	27
4.2.5 Course Maintenance Analysis .....	28
4.2.6 Progress Tracking .....	29
4.3 Functional Requirements .....	30
4.4 Non-Functional Requirements .....	34
5 Software Design .....	36
5.1 Software Architecture.....	36
5.1.1 Software Architectural Pattern.....	36
5.1.2 Client-Side Architecture .....	38
5.1.3 Server-Side Architecture.....	39
5.1.4 Communication Protocol .....	39
5.2 Database Design .....	40
5.2.1 Database Schema.....	40
5.3 User Interface Design.....	41

5.3.1 Design Principles.....	41
5.3.2 Colour Palette .....	41
5.3.3 Wireframes .....	43
5.4 Key Algorithms and Technical Components.....	52
5.4.1 Shot Tracking Algorithm .....	52
5.4.2 Data Visualisation Algorithm .....	55
5.4.3 Security Implementation.....	57
6. Results.....	60
6.1 Implementation.....	60
6.1.1     SVG Image Creation.....	60
6.1.2     User Interface Implementation .....	64
6.1.3     User Login Page.....	65
6.1.4     User Profile Pages .....	67
6.1.5     Shot Data Collection System.....	69
6.1.6     Data Heatmap Visualisation and Analytics .....	71
6.2     System Testing .....	72
6.2.1     Test Approach.....	72
6.2.2     User Authentication .....	73
6.2.3     Profile Access .....	74
6.2.4     Hole/Shot Analysis .....	75
6.2.5     Round Recording.....	76
6.3     Requirements Traceability Matrix .....	77

7.	Conclusion and Next Steps.....	80
7.1	Conclusion.....	80
7.1.1	Description .....	80
7.1.2	Feelings.....	80
7.1.3	Evaluation .....	81
7.1.4	Analysis .....	81
7.1.5	Conclusion.....	82
7.2	Next Steps .....	83
7.2.1	Short-term Development Plans.....	83
7.2.2	Long-term Development Vision .....	83
8	References .....	84
9	Appendices .....	85

## Glossary

Abbreviation/Term	Explanation
<b>Course Management</b>	The strategic decision-making process during a round of golf, including club selection, target selection, and risk assessment. Good course management involves choosing safer options when appropriate and understanding when to take calculated risks.
<b>Green</b>	The closely mown area of grass where the hole is located
<b>Approach Shot</b>	A golf shot played toward the green, typically from a distance of 50-200 yards away
<b>Fairway</b>	The closely mown areas of grass between the tee and the green, providing the most advantageous position for the next shot
<b>Par</b>	The score that a golfer is supposed to get on a particular hole
<b>Birdie</b>	A birdie is a score of one less than par on any given hole
<b>Bogey</b>	A bogey is a score of one higher than par on any given hole
<b>Double Bogey</b>	A double bogey is a score of 2 over the par for any given hole
<b>SVG</b>	Scalable Vector Graphics. A vector format that uses XML to define two-dimensional graphics
<b>API</b>	Application Programming Interface. A software intermediary that allows two application to talk to each other
<b>The Kendleshire</b>	A golf club in north Bristol

## 1. Introduction

### 1.1 Problem Statement

Golf enjoys tremendous global popularity with over 42.7 million players worldwide (The R&A, 2024), yet players at all levels struggle with 'course management'—a crucial factor in scoring well. Drawing from my 13 years of experience and a handicap of 3, I've observed that whilst technical skills matter, strategic course management often determines performance.

Golf at every level is fundamentally a game of misses; no player hits perfect shots consistently, making it essential to manage where one misses. This creates a market opportunity for The Golf Blueprint to revolutionise amateur golfers' improvement through strategic guidance.

My experience at The Kendleshire Golf Club illustrates this concept perfectly. For instance, missing approach shots to the left of the second green typically yields higher scores than missing to the right, as recovery shots from the left are considerably more difficult. Many golfers overlook such subtle but significant details across the course. The Golf Blueprint aims to visually represent strategic insights for all 18 holes in an accessible format through utilising heatmaps, helping golfers of all abilities identify areas to target or avoid during their rounds, ultimately leading to lower scores through improved decision-making.

### 1.2 Project Aims and Objectives

The primary aim for this project is to develop a data-driven golf course management tool, that is specifically tailored to The Kendleshire Golf Club, allowing its members and others who may play there to make informed strategic decisions during their rounds of golf, allowing them to improve their scores and to greater their experience. The specific objectives are:

1. Design and create detailed animated top-down view recreations of every hole at The Kendleshire, which will not only be used to collect the shot data from the golfers at The Kendleshire, but to also display the findings from the data, in the form of heatmaps.
2. Design and implement a system to collect and analyse shot data from golfers. This system must be very simple, and easy to use to ensure that golfers will be happy to take the time to input their data, and to ensure that the data collected is as accurate as possible.
3. Create a secure database to store golf shot data, user account information and golf course information, complying to GDPR regulations. The database will be the foundation for the resource and is essential to make it possible to provide meaningful, data-driven course management recommendations to the users.
4. Design an intuitive, and good-looking user interface, which displays to the user all the features of The Golf Blueprint. This is a very important consideration as the user interface will serve as the main point of interaction between the users and the resource's functions and capabilities.
5. Ensure that the resource meets the needs of the users, by conducting testing with at least 10 users, and gather feedback from the users to gain an understanding of what elements of the resource they enjoy, and what could be improved.

## 2. Methodology

### 2.1 Agile Methodology

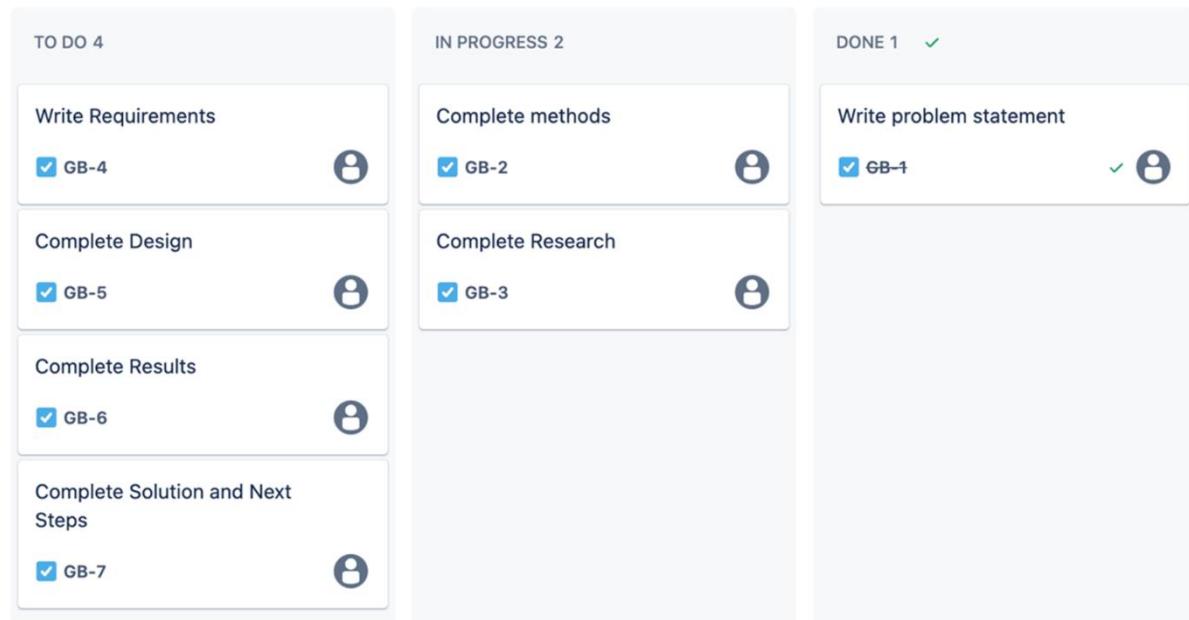
A suitable software development methodology is essential for project success. As Kute and Thorat (2014) explain, methodologies provide frameworks for planning and controlling software projects. Agile approaches suit The Golf Blueprint due to flexibility needed while balancing third-year university commitments, with Kanban emphasising visual work representation (Radigan, 2024).

Anderson (2010) stresses limiting work in progress (WIP) to maintain quality while preventing overload. Restricting to manageable task numbers enables higher work standards (Sjøberg, 2018), while Kanban's visual nature helps identify development bottlenecks (Lei et al., 2017) - crucial when prioritising alongside multiple commitments.

Ahmad et al. (2013) identify continuous delivery as a key Kanban advantage. Unlike methodologies requiring sprint cycle completion, Kanban permits immediate feature release, facilitating supervisor and client updates.

I've implemented Kanban via Jira (Figure 2.1) with three columns: To Do (prioritised features), In Progress (limited to three tasks preventing WIP), and Done (completed work record). Jira's additional features enhance project visibility, aligning with Anderson's (2010) principles of workflow visualisation and process management, providing clear project oversight alongside academic responsibilities.

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*Figure 2.1: Kanban project board.*

## 2.2 Risks and Mitigation Strategies

For The Golf Blueprint to succeed, identifying potential risks and developing appropriate mitigation strategies is essential.

### 2.2.1 Technical Risks

Data accuracy represents the primary technical risk, as insights depend entirely on user-submitted data. Mitigation includes multiple validation techniques: visual feedback for shot marking, intuitive instructions, outlier detection, limiting users to two rounds daily to prevent fabrication, and verification prompts for suspicious entries.

### 2.2.2 User Adoption Risks

Success requires consistent user engagement and data contribution. The risk of golfers finding data input too complex will be mitigated through intuitive interface design enabling efficient entry, clear instructions for shot marking, and an engaging experience encouraging regular participation.

### 2.2.3 Data Protection Risks

Storage of personal and golf shot data necessitates robust protection measures. These include secure authentication, encrypted storage, and SQL implementation with built-in security features ensuring data security.

#### 2.2.4 Project Management Risks

Balancing development with academic commitments presents the primary management risk.

Mitigation involves Jira Kanban board utilization for component tracking and time management, allowing identification of delays and schedule adjustments.

#### 2.2.5 Version and Document Control Strategy

Git hosted on GitHub will provide version control, with main branch (stable code) and development branch (ongoing work) structure. Feature branches will follow 'feature/description-of-change' naming convention, with structured commit messages ensuring project evolution tracking. Documentation will reside in a 'docs' directory with consistent naming conventions. GitHub cloud storage will maintain regular backups, safeguarding against data loss.

### **3. Project Research**

This project utilises primary and secondary research to develop understanding and validate the proposed solution. Secondary research explored existing golf analytics technology while identifying market gaps for The Golf Blueprint.

To ensure research quality and reliability, I searched UWE Library Database and Google Scholar using key terms: "golf analytics technology," "importance of course management," "global participation in golf," "strokes gained" and "data used in professional golf." This provided abundant, directly relevant information for my project.

#### **3.1 Secondary Research**

Golf at all levels continuously evolves, with technology and data analytics increasingly influencing player development and performance optimisation. The PGA Tour's ShotLink technology implementation in 2003 marked a significant turning point, collecting detailed data on every tournament shot (Broadie, 2014). Broadie demonstrates how analytics revolutionised golf performance understanding, introducing metrics like "strokes gained" which compares players' game facets (Plummer, 2024). These metrics serve as tools for professional analysis and for evaluating different strengths, such as exceptional ball-striking versus superior short game (Ehrlich and Kamimoto, 2024).

Research in the International Journal of Sports Science & Coaching shows launch monitors and ball tracking technology have fundamentally changed practice and competition approaches (Betzler et al., 2012). Professionals frequently utilise these resources to analyse performance and target weaknesses in their practice schedules.

Course management has become integral to modern professional golf and is utilised by top players seeking improvement (MacKenzie, 2023). Professionals invariably complete multiple 'practice rounds' before tournaments, identifying areas to avoid and utilise for score improvement (Stenzel, 2023). Understanding effective course management can help any golfer save strokes during play (Turner, 2023).

### **3.2 Primary Research**

To complement secondary research and validate the need for The Golf Blueprint, I conducted primary research targeting The Kendleshire Golf Club's specific user base. This research captured real-world insights, understood current course management approaches, and identified most-valued potential features.

I utilised a Qualtrics survey distributed between 15th February and 15th March 2025, using both digital channels (UWE Golf society WhatsApp group) and in-person recruitment at the clubhouse. This dual-distribution strategy ensured representation across different age groups and technology comfort levels, helping avoid sampling bias toward younger university golfers.

The survey (accessible at: [https://uwe.eu.qualtrics.com/jfe/form/SV\\_5vdeIIMs1zUsfc](https://uwe.eu.qualtrics.com/jfe/form/SV_5vdeIIMs1zUsfc)) followed UWE ethical guidelines, with questions carefully crafted to avoid leading participants whilst capturing both quantitative metrics and qualitative insights. The structure addressed:

- Informed consent and participant rights
- Demographic data and playing ability
- Current understanding and application of course management principles
- Usage patterns of existing golf technology solutions

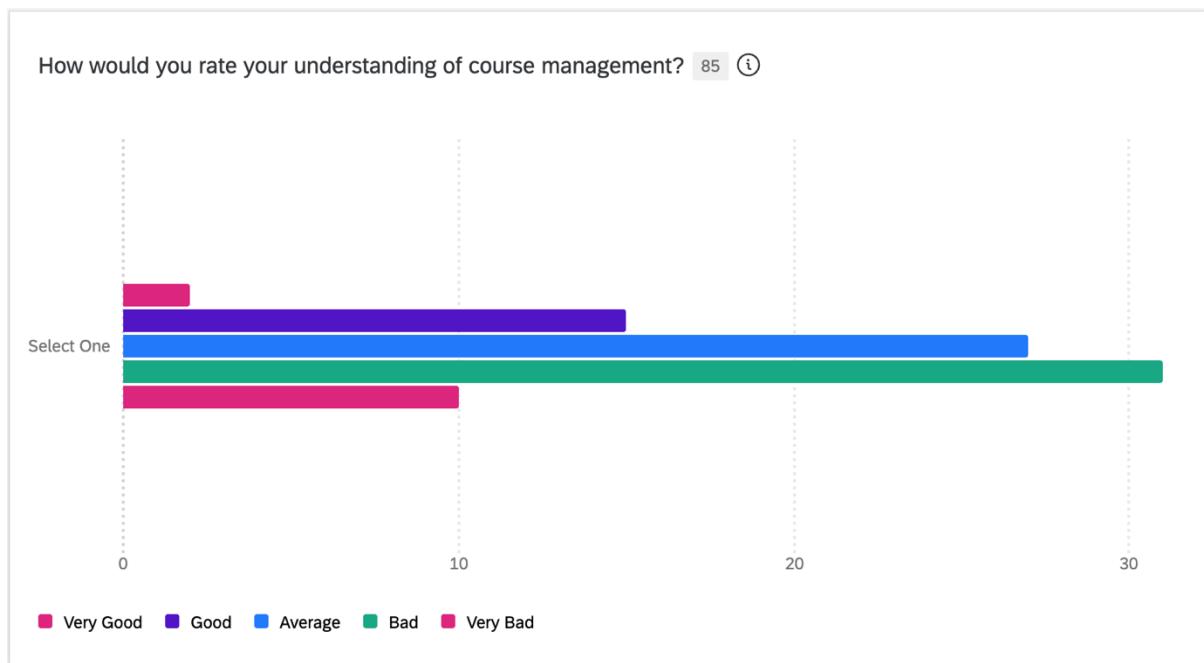
- Interest in The Golf Blueprint concept and data contribution willingness
- Feature preferences and priorities

The survey received 86 responses from Kendleshire Golf Club members. Respondents represented diverse playing abilities, with most players (55%) having a current handicap of 11-20. The data highlights good course familiarity amongst respondents, with 34% playing weekly and 38% playing fortnightly.

### 3.2.1 Current Understanding of Course Management

I asked respondents about their course management understanding, with options from 'Very Good' to 'Very Bad'. This information is relevant as The Golf Blueprint aims to improve users' understanding of good course management.

Survey results reveal 80% of respondents report having 'Average', 'Bad' or 'Very Bad' understanding of course management.



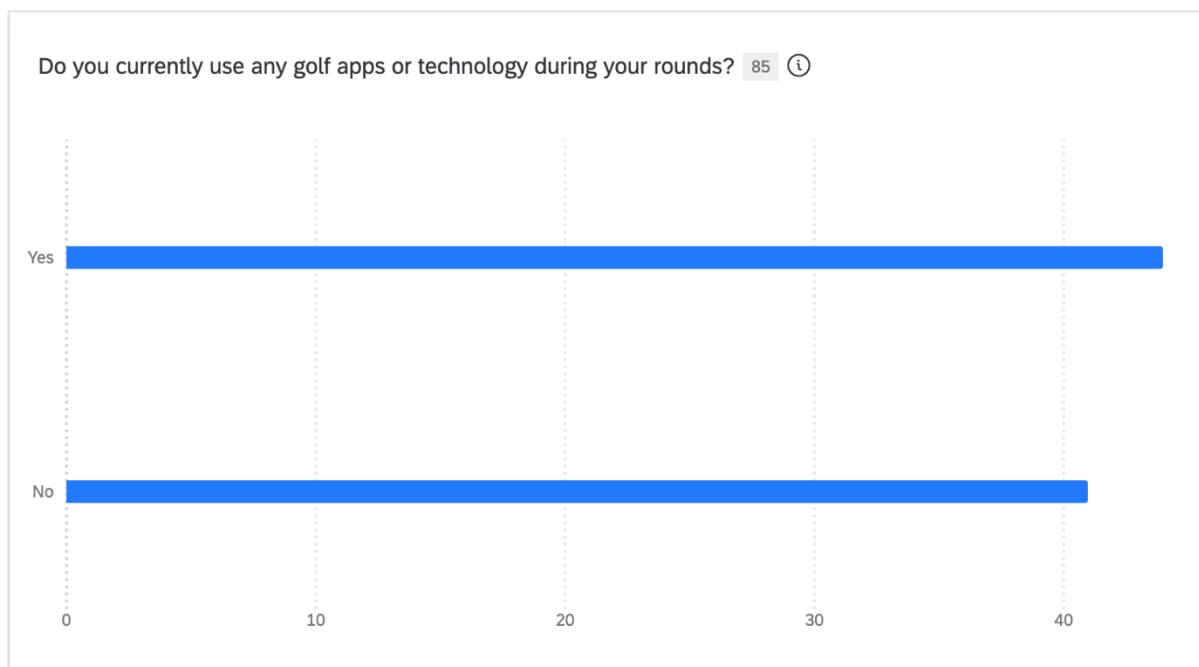
*Figure 1.2: Graph showcasing the current understanding of course management*

This data reveals a significant knowledge gap among Kendleshire players, representing an opportunity for The Golf Blueprint. As identified in secondary research, good course management effectively improves golf performance.

### 3.2.2 Current Use of Golf Apps or Technology

I asked whether respondents currently use golf-related applications or technology, seeking to understand if Kendleshire members might adopt a new resource like The Golf Blueprint based on existing habits.

The survey found a slight majority (52%) of respondents currently use golf-related apps or technology.



*Figure 1.3: Graph showcasing the data of current adoption of golf apps/technology*

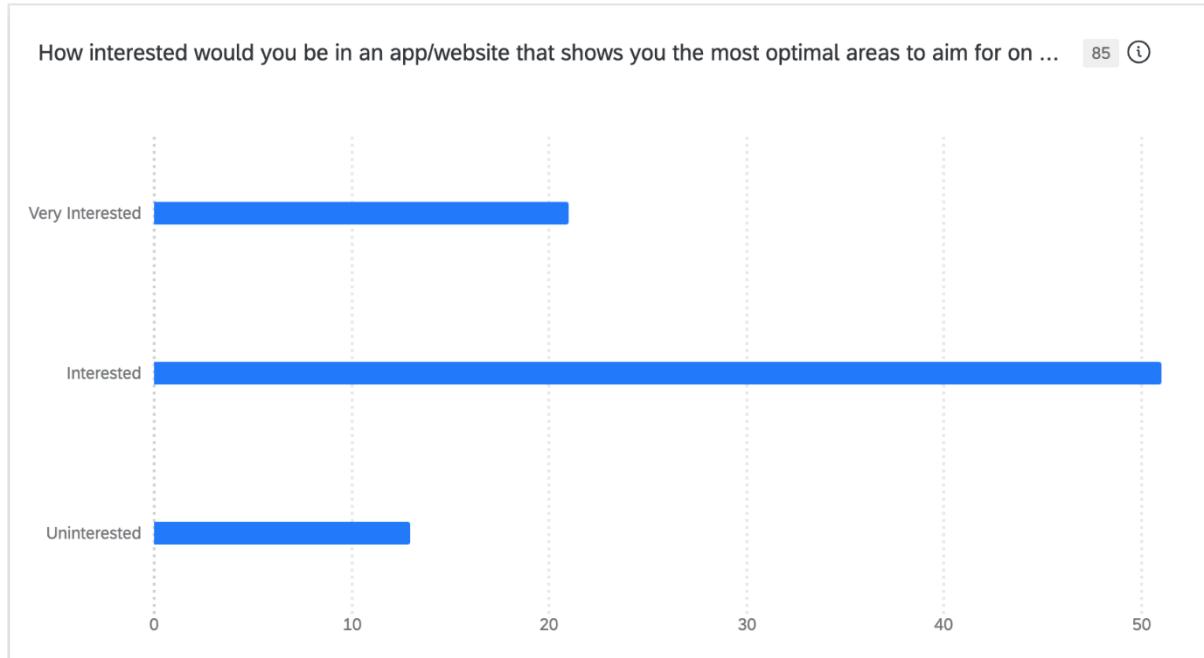
When asked what specific features of these apps respondents find most useful, 10 (12%) answered they utilise them for getting yardages for next shots during play. Additionally, 21 respondents (25%) reported using these apps for entering and tracking scores while playing.

These findings reveal a significant proportion of Kendleshire golfers regularly use golf applications or technology. This is positive for The Golf Blueprint, suggesting it could readily become part of these golfers' established routines.

### 3.2.3 Interest Levels in an App/Website such as The Golf Blueprint

I asked the respondents their interest levels in a resource such as The Golf Blueprint, with four options ranging from 'Very Uninterested' to 'Very Interested'. I wanted to ask this question to directly ask the prospective users whether they think it would be something that they would be likely to adopt.

The question provided very positive results, with 72 respondents (85%), responding with either 'Very Interested' or 'Interested'.



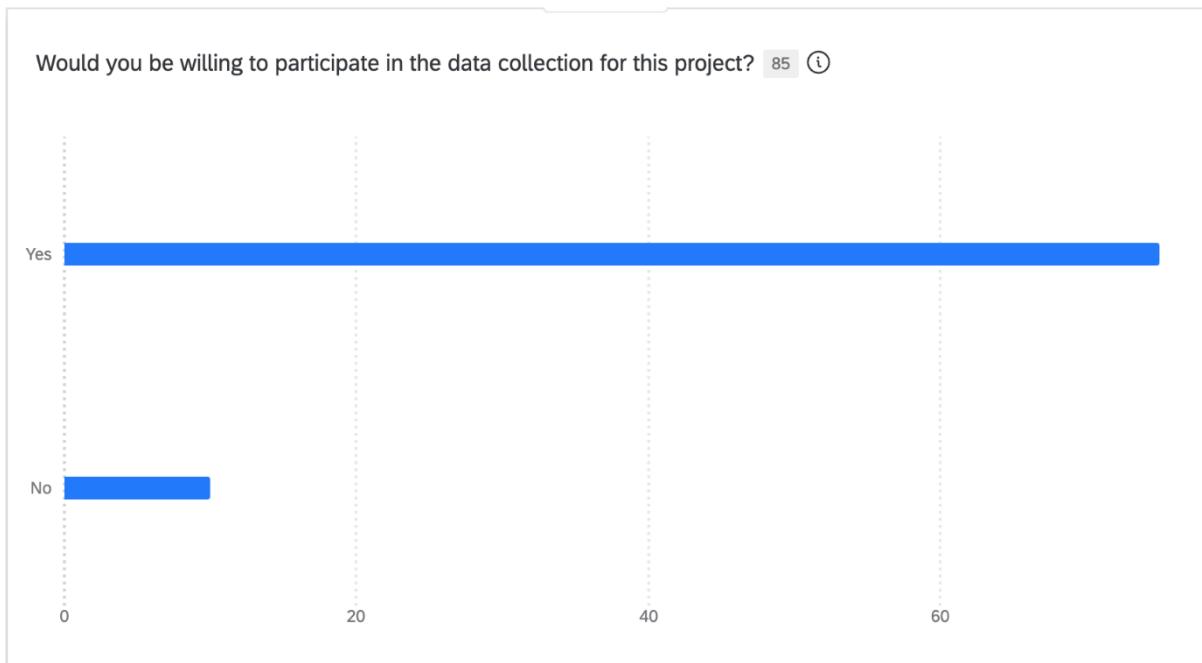
*Figure 1.4: Graph showcasing the data of interest levels in The Golf Blueprint.*

This data shows a very high level of interest from the respondents towards The Golf Blueprint. This supports my own beliefs that the resource would be very popular.

### 3.2.4 Willingness to Participate in the Required Data Collection

Finally, I wanted to gain some insight into whether the respondents would be willing to contribute their own data from their rounds of golf towards the resource. This is an important consideration because the success of the resource will rely on users supplying the database with accurate data for trends to begin to form.

This question also provided very positive results, with 75 respondents (88%), saying that they would be willing to provide data to benefit The Golf Blueprint's accuracy and usefulness.



*Figure 1.5: Graph showcasing the data of willingness to participate in data collection.*

This strongly suggests that the potential future users of The Golf Blueprint would be happy to contribute their own data, which would help to create a sustainable resource.

### 3.2.5 Desirable Features of The Resource

The final survey question asked respondents specifically what features they would like to see on the website/resource. I wanted to directly consult the target audience about important features to inform my design phase.

The qualitative data revealed that 12 respondents (14%) specifically mentioned wanting the resource to be easy/simple to use. This represents a crucial consideration, as I will be targeting a wide age range of users with differing technological capabilities. This finding highlights the necessity to create an intuitive interface to ensure user satisfaction.

### **3.3 Key Findings**

Research findings clearly validate The Golf Blueprint concept and provide development direction.

Primary research identifies a significant gap in golf technology offerings: 80% of respondents report 'Average' or worse course management understanding despite 52% using golf technology. Current applications primarily support distance measurement (12%) and score tracking (25%) rather than strategic decision-making. The 85% interest level in The Golf Blueprint validates the core project premise.

A well-designed, intuitive interface is essential as user data input drives resource value.

Efficient shot data entry will maximize user retention by minimizing time commitment.

#### **3.3.1 Research Limitations**

Despite strong validation for The Golf Blueprint concept, research limitations exist. Though diverse participation was sought, the sample likely over-represents engaged members, with 46% playing weekly. This suggests different approaches may be needed for less frequent players.

The participant count presents another limitation. With only 86 respondents from over 600 active members, this small sample may inadequately represent the entire membership's views and preferences.

## 4. Requirements

### 4.1 User Stories and Use Cases

User stories capture what the users of the resource will want to be able to accomplish. They use the following format: “As a [type of user], I want [an action] so that [benefit/value].”

1. As a golfer who has limited knowledge of course management, I want to be able to see heatmap visualisations of every hole so that I can make better decisions during my rounds.
2. As a regular golfer at The Kendleshire, I want to be able to contribute my own data towards the database so that I can help to build an accurate and useful resource for all to use.
3. As a low-handicap golfer, I want to be able to study the heatmap visualisations so that I can identify any areas of the course that may be beneficial that I have not considered before.
4. As a high-handicap golfer, I want to be able to try and identify which areas of the course are danger areas, so that I can begin to improve my scores when I play.
5. As a golfer who is planning to visit The Kendleshire for a golfing holiday, I want to be able to study the course before I arrive so that I can gain an advantage over my peers.
6. As a golf coach at The Kendleshire, I want to be able to access the heatmap visualisations during my lessons, so that I can give the best advice to students as possible.

7. As a grounds maintenance staff member, I want to be able to see the heatmap visualisations so that we can address whether certain areas are too unfair, or too forgiving.
8. As a new golfer, I am not so interested in course management. I want to be able to enter my scores into the database so that I can track my progress as I improve.

## 4.2 Use Case Diagrams

### 4.2.1 System Overview

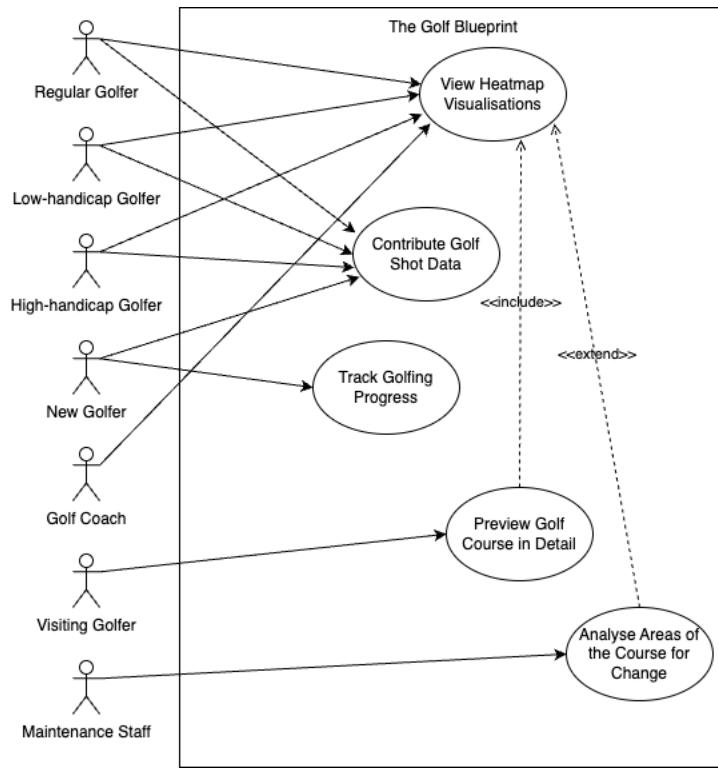
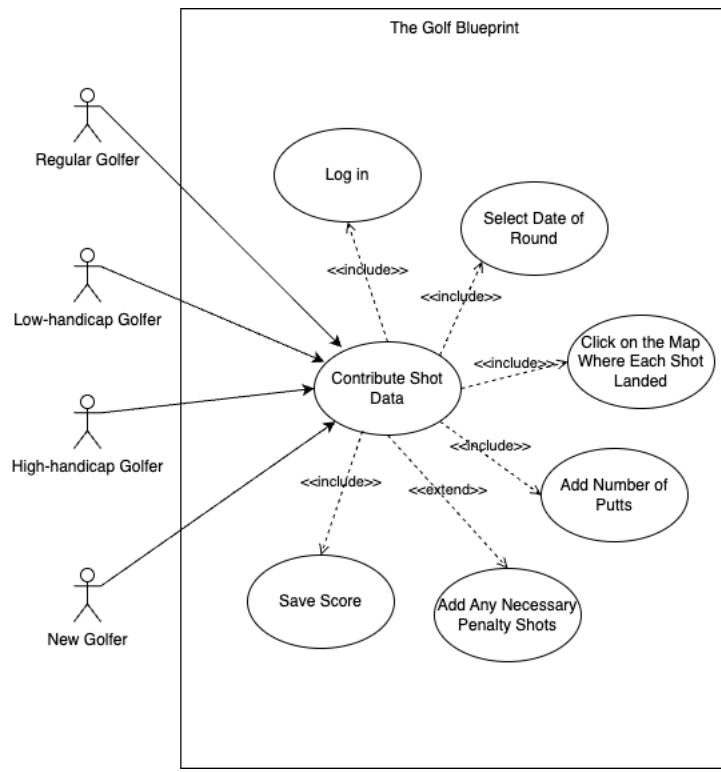


Figure 4.1: The Overview Use Case Diagram

This diagram provides an overview of the entire program. It displays all user types and main functions and how they interact with each other.

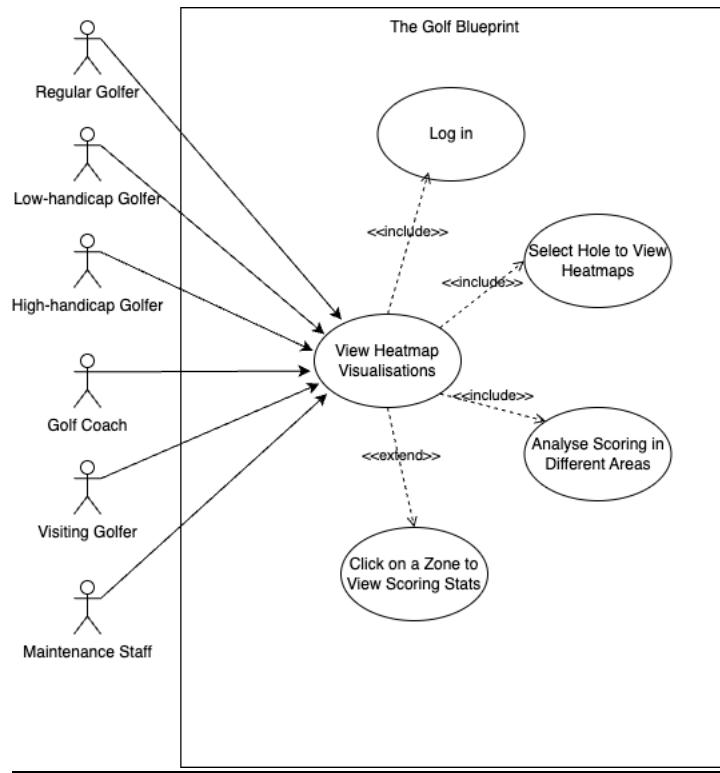
#### 4.2.2 Contribute Shot Data



*Figure 4.2: The Contribute Shot Data Use Case Diagram*

This shows how different types of golfers input their data from their rounds of golf into the system including the required steps of logging in, selecting dates, marking shot locations, and recording scores.

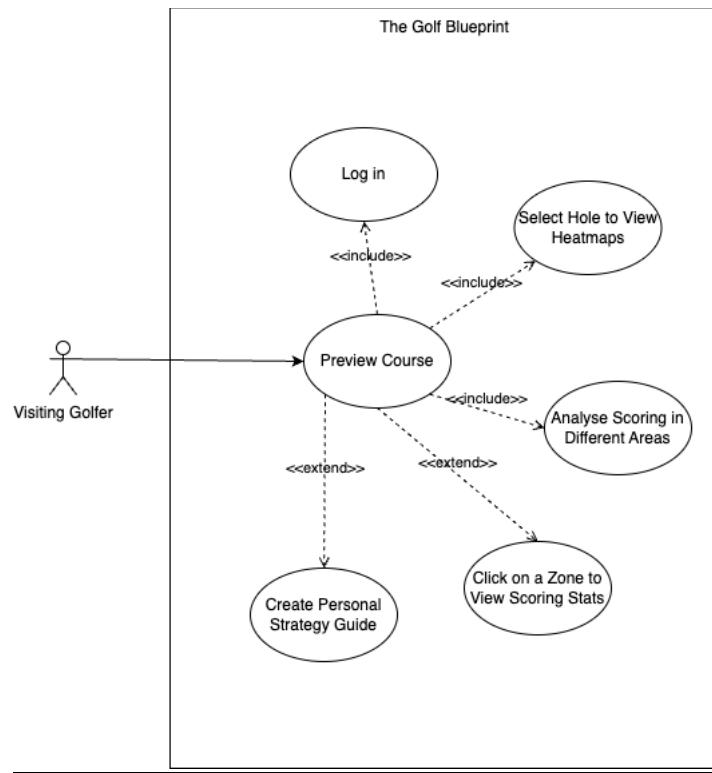
### 4.2.3 Heatmap Visualisation



*Figure 4.3: The Heatmap Visualisation Use Case Diagram*

This diagram shows all of the users who are able to access the heatmap visualisations and the associated functions, including hole selection, and viewing detailed statistical analysis of different areas of the course.

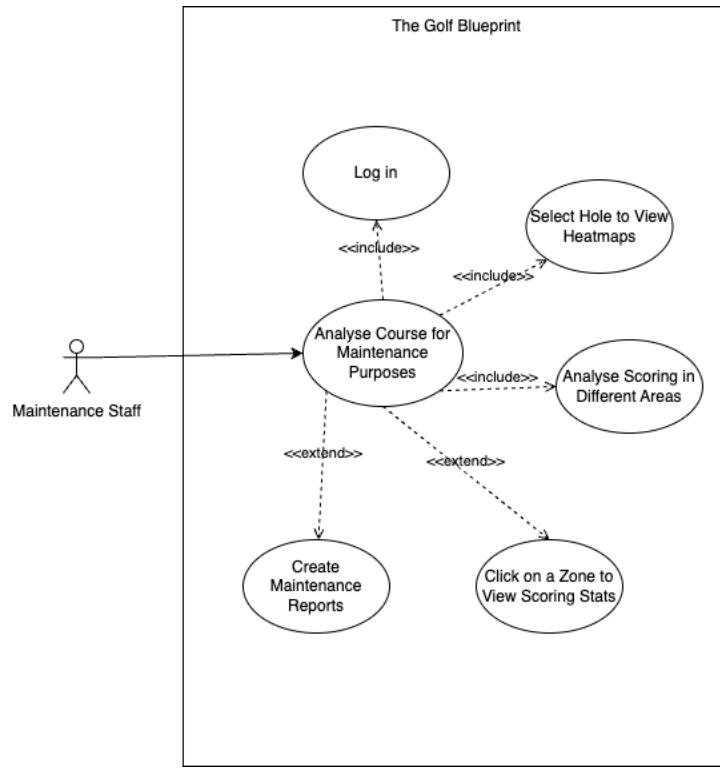
#### 4.2.4 Preview Course



*Figure 4.4: The Preview Course Use Case Diagram*

This diagram shows how golfers who are planning on visiting The Kendleshire would be able to use the resource to remotely preview the course. It includes viewing hole heatmaps, analysing scoring patterns and creating personalised strategy guides for their visit.

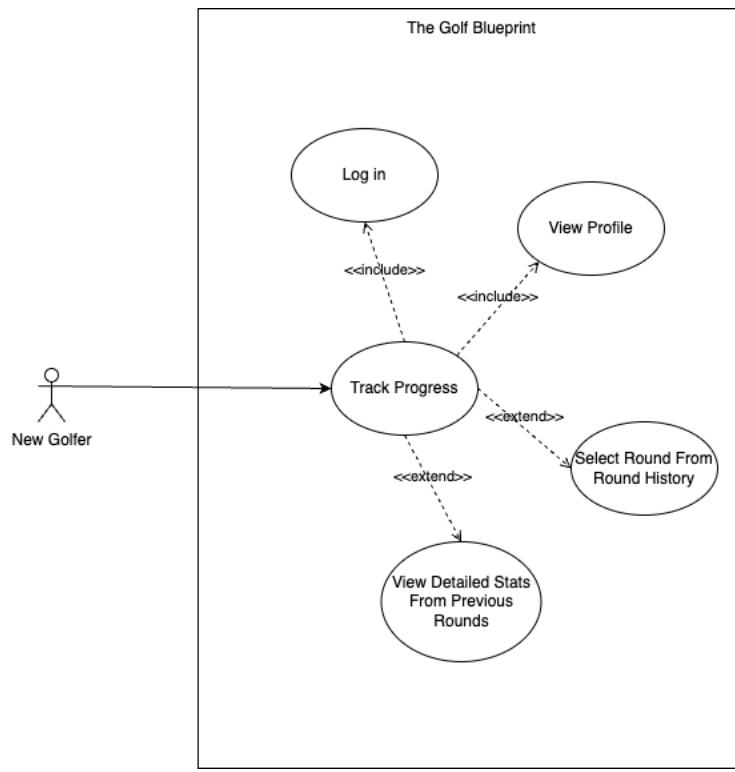
#### 4.2.5 Course Maintenance Analysis



*Figure 4.5: The Maintenance Analysis Use Case Diagram*

This diagram illustrates how maintenance staff would use the resource to analyse how the course is playing at the moment, with the ability to view heatmaps for each hole, and view detailed statistics for every zone throughout the course, allowing them to create their own maintenance reports to potentially alter the course if required.

#### 4.2.6 Progress Tracking



*Figure 4.6: The Progress Tracking Use Case Diagram*

This diagram shows how a new golfer who is less interested in course management would be able to use the resource in order to track their broader progress as they play more rounds of golf.

## 4.3 Functional Requirements

This section outlines the functional requirements for The Golf Blueprint, derived from research findings and user stories. These requirements represent specific capabilities the system must provide to deliver user value. Requirements are prioritised using the MoSCoW method: 'must have', 'should have', 'could have', and 'will not have' (Brush, 2023).

**Must have:** Critical requirements for project success - these deliver the minimum viable product and address core user needs. Without these, The Golf Blueprint would fail to deliver its fundamental value proposition of improving course management through data visualisation.

**Should have:** Important requirements that significantly enhance the system but are not absolutely critical. These features provide substantial value and should be included unless they would jeopardise delivery of the "must have" requirements.

**Could have:** Desirable features providing additional value but could be deferred if necessary. These enhancements would improve user experience but are not essential to achieve the project's primary objectives.

**Won't have:** Features considered but explicitly excluded from the current version. These have been documented to set clear expectations and provide a roadmap for future development.

User Account Management		
ID	PRIORITY	Requirement
FR1	Must have	The system must allow users to create a secure account providing name, email address, and password
FR2	Must have	The system must authenticate users through email and password login
FR3	Must have	The system must store user profiles including username, email and password
FR4	Should have	The system should support password reset functionality
FR5	Should have	The system should support editing account details
FR6	Could have	The system could store more detailed user information such as handicap, playing frequency, and preferred tees

Figure 4.7: Table showcasing the User Account Management Functional Requirements

Data Collection and Input		
ID	PRIORITY	Requirement
FR7	Must have	The system must provide interactive hole visualisations for all 18 holes at The Kendleshire Golf Club
FR8	Must have	The system must allow users to mark precise shot locations on each hole visualisation
FR9	Must have	The system must record the date for each round.
FR10	Must have	The system must allow for the user to enter number of putts and penalty shots.
FR11	Must have	The system must store the shot data in a secure database.
FR12	Must have	The system must validate input data to prevent unrealistic or incorrect entries
FR13	Should have	The system should limit users to entering a maximum of two rounds per calendar day
FR14	Should have	The system should allow users to review and edit their shot data before final submission
FR15	Could have	The system could support bulk data entry for multiple rounds in a single session

Figure 4.8: Table showcasing the Data Collection and Input Functional Requirements

Visualisation and Analytics		
ID	PRIORITY	Requirement
FR16	Must have	The system must generate color-coded heatmaps showing shot distribution patterns for each hole
FR17	Must have	The system must visualize different areas of each hole as optimal, suboptimal, or hazardous
FR18	Must have	The system must provide statistical analysis of scoring outcomes based on shot locations
FR19	Should have	The system should calculate and display average scores for specific areas of each hole
FR20	Could have	The system could generate comparative visualizations between user-specific data and aggregated data

Figure 4.9: Table showcasing the Visualisation and Analytics Functional Requirements

Round History		
ID	PRIORITY	Requirement
FR21	Must have	The system must store and display individual scoring history
FR22	Must have	The system must allow users to view each round specifically
FR23	Must have	The system must allow users to view detailed statistics about each historic round
FR24	Should have	The system should compare user performance against course averages
FR25	Could have	The system could generate achievement badges for round milestones

Figure 4.10: Table showcasing the Round History Functional Requirements

Administration		
ID	PRIORITY	Requirement
FR26	Must have	The system must secure all user data according to GDPR requirements
FR27	Must have	The system should allow administrators to update course visualisations if the course layout changes
FR28	Could have	The system could generate usage statistics to track system adoption

Figure 4.10: Table showcasing the Administration Functional Requirements

Won't Have		
ID	PRIORITY	Requirement
FR29	Won't have	The system won't provide live GPS tracking of users on the course
FR30	Won't have	The system won't integrate with existing golf handicap systems in this version
FR31	Won't have	The system won't include a social networking component for users to connect
FR32	Won't have	The system won't include a mobile app version in the initial release (web responsive only)

Figure 4.11: Table showcasing the Won't Have Functional Requirements

The requirements for The Golf Blueprint were systematically derived through a structured approach that ensured coverage of all users' needs while maintaining traceability to research findings.

Requirements were elicited through multiple complementary techniques:

- **Survey Analysis:** The survey of 86 members at The Kendleshire Golf Club provided quantitative data on user needs, specifically highlighting the desire for improved course management capabilities and ease of use.
- **User Story Development:** Eight detailed user stories were created to capture the diverse perspectives of different user groups, from high-handicap golfers to maintenance staff.
- **Use Case Modelling:** Six detailed use case diagrams were developed to visualize system interactions, helping identify functional boundaries.

## 4.4 Non-Functional Requirements

Non-functional requirements define the quality attributes of The Golf Blueprint. These requirements are organised according to the ISO/IEC 9126 Software Engineering Product Quality standard (ISO, 2024), ensuring comprehensive coverage of all quality aspects. Like the functional requirements, these are also prioritised using the MoSCoW method.

Usability		
ID	PRIORITY	Requirement
NFR1	Must have	The system must allow new users to complete the shot data entry process for a single hole within 2 minutes after minimal instruction
NFR2	Must have	The system user interface must be accessible and usable by golfers of ages 18+
NFR3	Should have	The system should present information in a clearly visible format suitable for outdoor use in daylight conditions
NFR4	Should have	The system must provide clear visual feedback when marking shot locations
NFR5	Should have	The system should use consistent golf terminology and iconography throughout the interface

Figure 4.12: Table showcasing the Usability Non-Functional Requirements

Functionality		
ID	PRIORITY	Requirement
NFR6	Must have	The system must accurately represent all 18 holes at The Kendleshire Golf Club with correct scaling and landmark placement
NFR7	Must have	The system must generate heatmap visualisations that accurately reflect underlying data patterns
NFR8	Should have	The system should support concurrent use by at least 50 users without performance degradation
NFR9	Should have	The system should function in multiple different window sizes

Figure 4.13: Table showcasing the Functionality Non-Functional Requirements

Reliability and Performance		
ID	PRIORITY	Requirement
NFR10	Must have	The system must handle temporary loss of internet connectivity by storing data locally until reconnection
NFR11	Must have	The system must process shot data input within 1 second of submission
NFR12	Should have	The system should generate heatmap visualisations within 5 seconds of request
NFR13	Should have	The system should load hole visualisations within 3 seconds on standard 4G connections
NFR14	Could have	The system could support database queries for up to 10,000 rounds of golf without performance degradation

Figure 4.14: Table showcasing the Reliability and Performance Non-Functional Requirements

Maintainability		
ID	PRIORITY	Requirement
NFR15	Must have	The system must log all system errors with contextual information for troubleshooting
NFR16	Must have	The system must be built using widely supported web technologies to ensure long-term maintainability
NFR17	Should have	The system should support course visualisation updates without requiring significant code changes
NFR18	Should have	The system should include comprehensive documentation for all data structures and code

Figure 4.15: Table showcasing the Maintainability Non-Functional Requirements

Security		
ID	PRIORITY	Requirement
NFR19	Must have	The system must implement GDPR-compliant data protection measures
NFR20	Must have	The system must require secure authentication for accessing user data
NFR21	Must have	The system must provide users with the ability to download or delete their personal data

Figure 4.16: Table showcasing the Security Non-Functional Requirements

## 5 Software Design

### 5.1 Software Architecture

#### 5.1.1 Software Architectural Pattern

The Golf Blueprint implements a client-server architecture following the Model-View-Controller (MVC) pattern to ensure separation of concerns and maintainability. This architecture consists of three primary components:

1. **Client-Side Application (View and Controller)** – A responsive HTML/CSS/JavaScript web application that provides the user interface and handles user interactions
2. **Server-Side API (Controller)** – A Node.js Express server that processes requests and mediates between the client and database
3. **Database (Model)** – A MySQL database that stores all persistent data

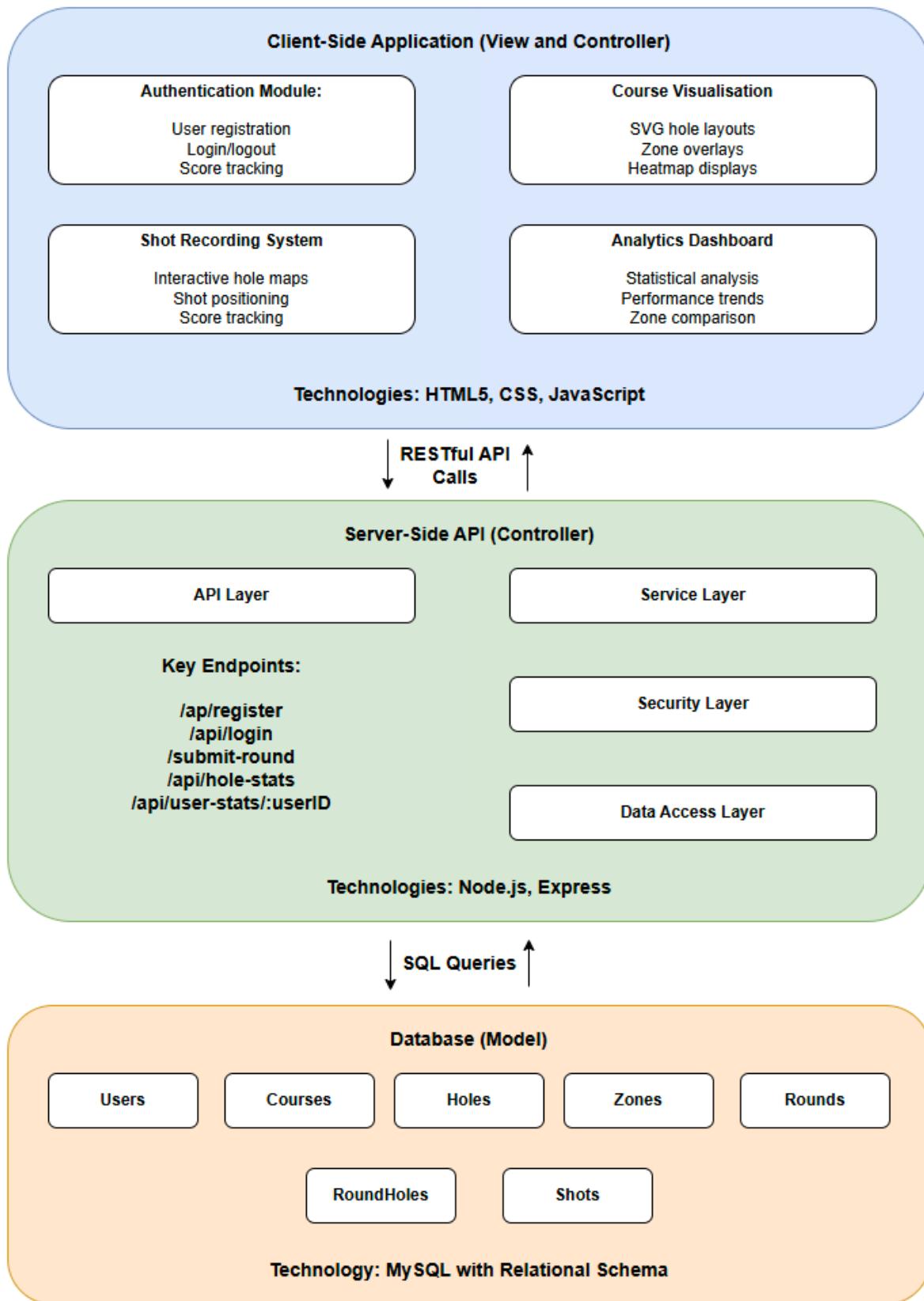


Figure 5.1: This image showcases the software architecture diagram for The Golf Blueprint

### 5.1.2 Client-Side Architecture

The client-side application follows a component-based design pattern with the following components:

1. Authentication – Manages user login, registration, and session maintenance using localStorage for client-side management
2. Hole Visualisation – Renders hole layouts using SVG images, with SVG zones overlayed to allow users to interact with each hole and its unique features independently
3. Shot Recording System – Allows for users to enter in the exact location of their golf shots
4. Analytics Dashboard – Processes and displays statistical data from the database in the form of heatmaps

The client-side technology stack includes the following:

- HTML5 for website structure
- CSS for responsive styling
- JavaScript for user interactivity

### 5.1.3 Server-Side Architecture

The server-side implementation uses Node.js with Express to provide RESTful API endpoints. The server architecture includes the following:

1. API Layer – Express routes that handle the HTTP requests and responses
2. Service Layer – Business logic for processing data and implementing rules
3. Data Access Layer – Database connection management and query execution
4. Security Layer – Authentication, authorisation and data protection

The client and server architecture were specifically designed to support the functional requirements FR8 and FR11, surrounding entering golf shot data into the database successfully.

### 5.1.4 Communication Protocol

The client and server communicate using a RESTful API pattern over HTTP:

Endpoint	Method	Purpose
/api/register	POST	Create new user accounts
/api/login	POST	Authenticate users
/api/submit-round	POST	Save completed round data
/api/hole-stats	GET	Retrieve statistical data for analysis
/api/round-count	GET	Get count of rounds for a specific hole
/api/user-stats/:userId	GET	Retrieve user performance statistics
/api/user-rounds/:userId	GET	List rounds completed by a user
/api/round-scorecard/:roundId	GET	Get detailed scorecard for a specific round

Figure 5.2: Table showcasing the communication protocol

## 5.2 Database Design

### 5.2.1 Database Schema

The Golf Blueprint utilises a relational MySQL database with a normalised schema to help support the data storage and interpretation requirements, while maintaining data integrity.

The schema consists of the following:

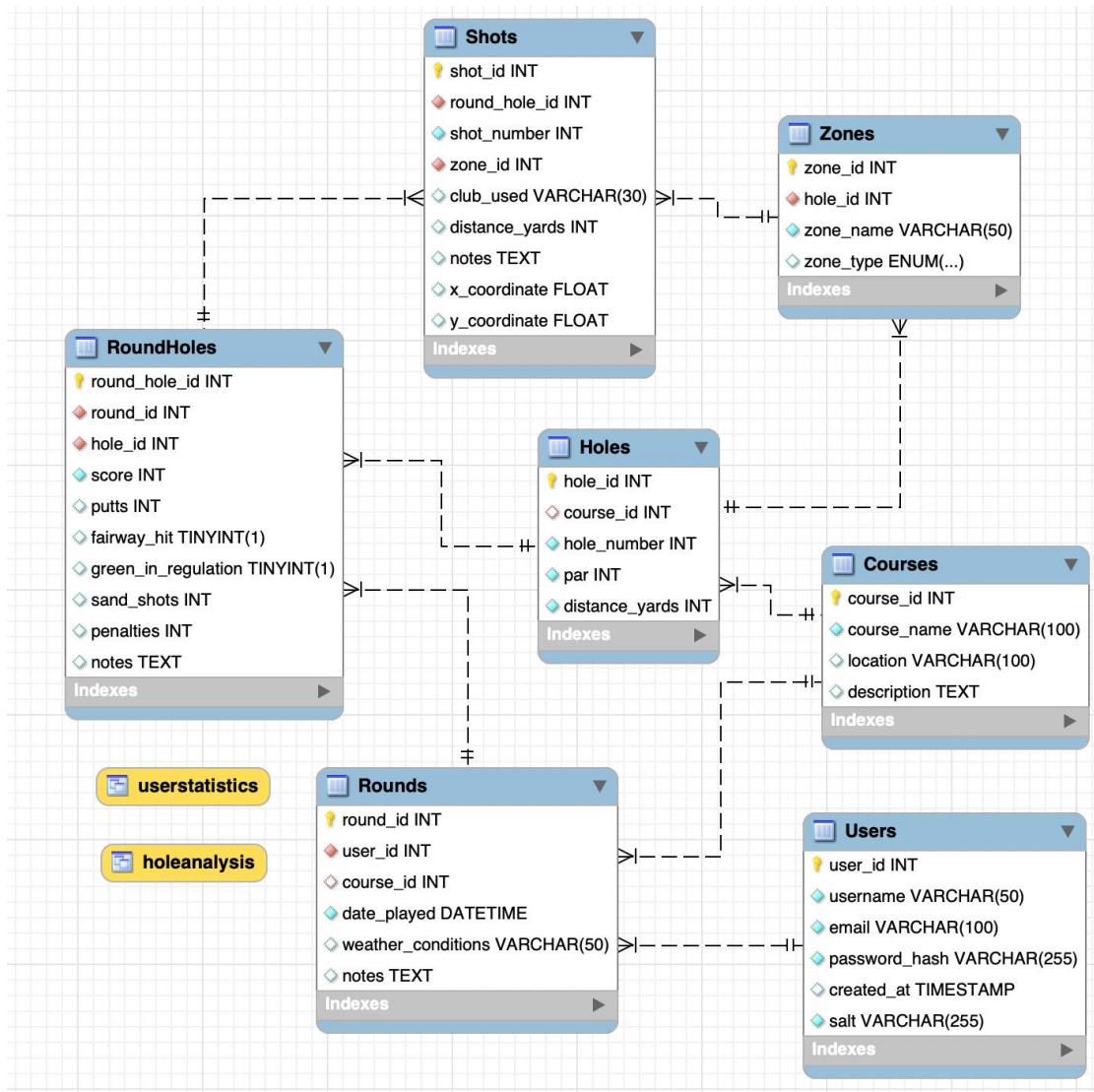


Figure 5.3: Entity Relationship diagram for the database

The database for the system was designed to specifically meet the functional requirements FR8, FR9, FR10, FR11, FR16 and FR18.

## 5.3 User Interface Design

### 5.3.1 Design Principles

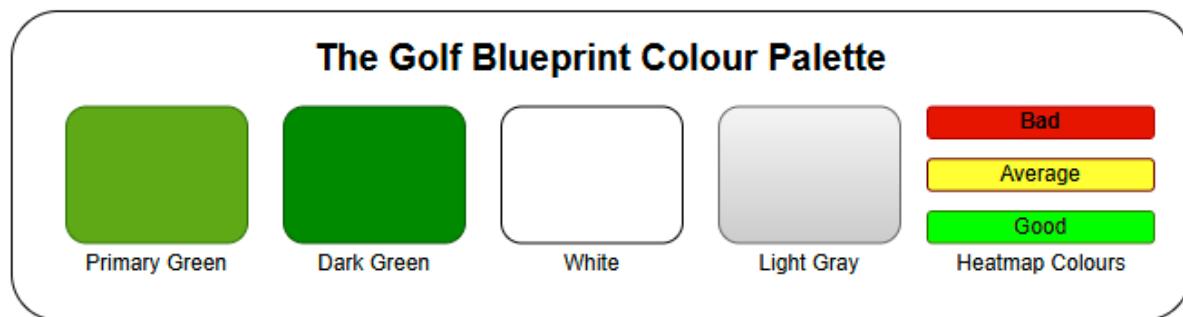
The user interface must allow users of all technological abilities to quickly input round data accurately while effectively displaying database information via heatmaps. I will adhere to these principles:

1. **Simplicity** – Clean, uncluttered layout that focus on the task at hand
2. **Consistency** – Uniform elements and patterns across all pages
3. **Feedback** – Clear visual cues for actions and state changes
4. **Accessibility** – Readable text, sufficient contrast and intuitive controls

These principles directly align with findings from primary and secondary research, plus functional and non-functional requirements.

### 5.3.2 Colour Palette

I will be using a colour palette that will give the resource a balance between professional aesthetics and a golf-themed visual identity.



*Figure 5.4: Image showcasing the colour palette for the design*

The primary green is bold yet not overly striking, familiar to golfers and connecting design to purpose. This is complemented by darker green for navigation elements and buttons, providing sufficient contrast for accessibility. White and light grey backgrounds ensure optimal information readability.

Red, yellow and green combinations will display heatmap data, making the resource intuitive with familiar colours representing 'Good', 'Average' and 'Bad' zones.

### 5.3.3 Wireframes

#### Homepage

The homepage features a clean design with concise proposition statement and a single button for round recording navigation. A consistent navigation bar appears across all pages for intuitive transitions between sections.

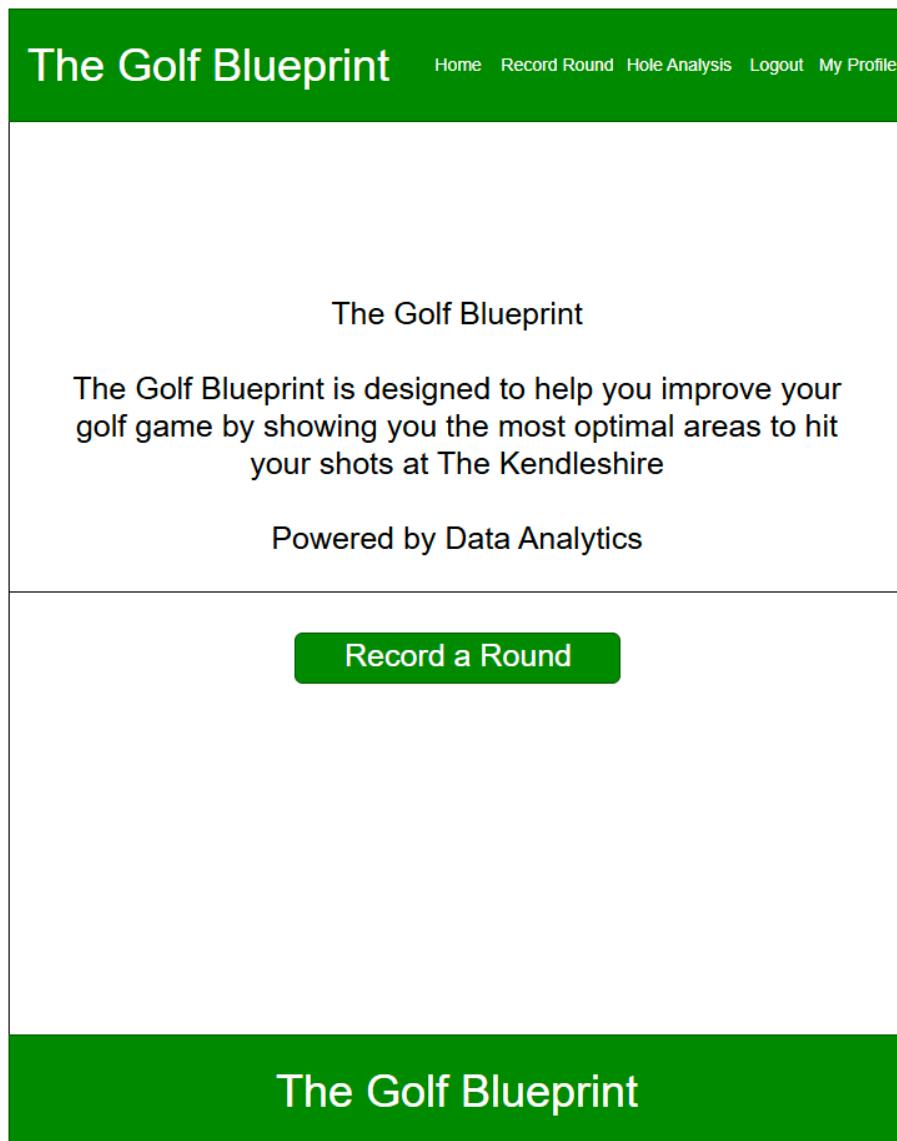


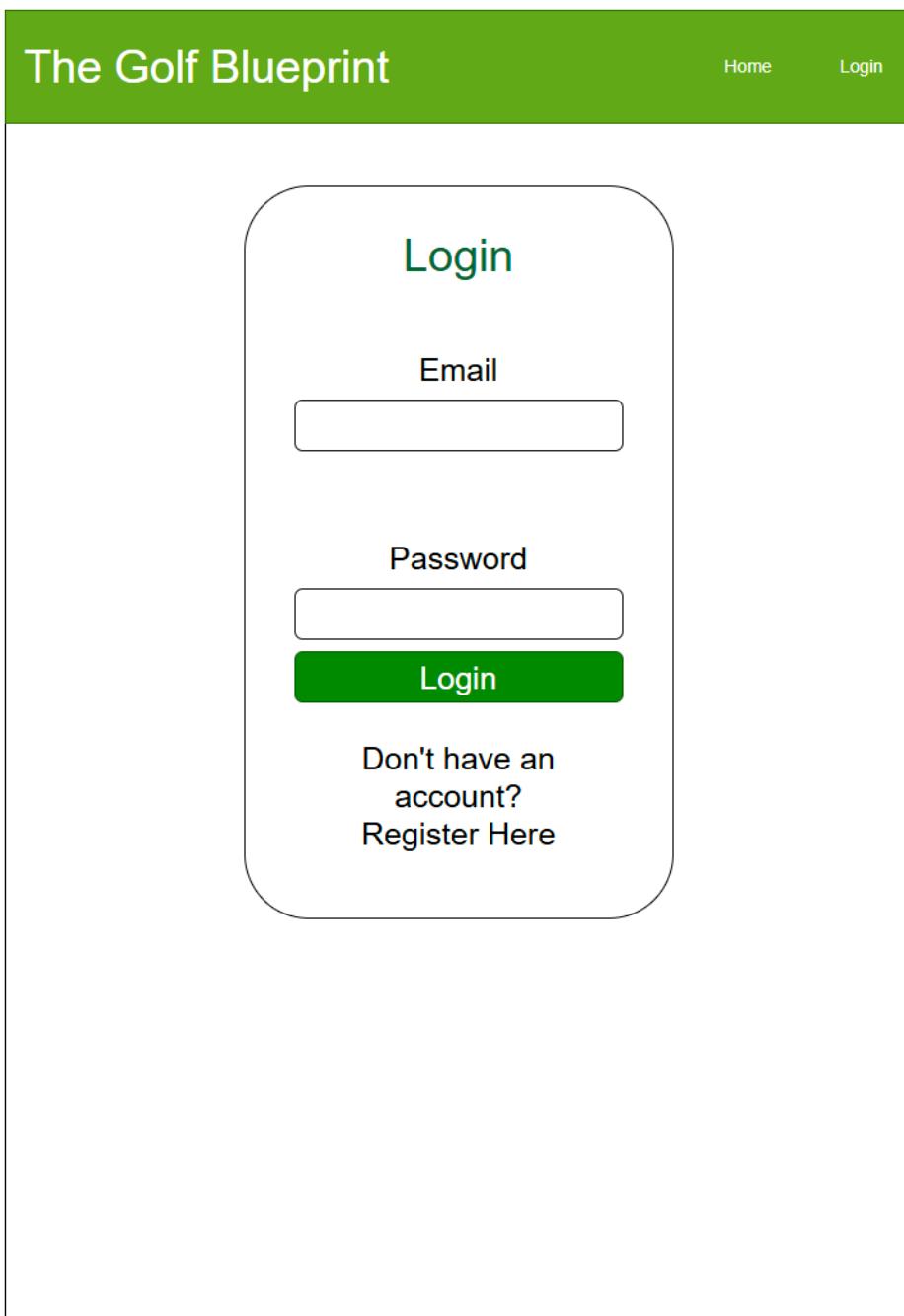
Figure 5.5: Wireframe showcasing the Homepage of The Golf Blueprint

### Login and Register Page

Login and Register pages employ clean design with straightforward, recognisable forms containing only essential fields and clear labelling. This enables quick system access with minimal interaction, addressing user-adoption risks.

The wireframe illustrates the 'Register' page of a web application. At the top, a green header bar displays the title 'The Golf Blueprint'. To the right of the title are two links: 'Home' and 'Login'. Below the header, the main content area features a large, rounded rectangular form. Inside this form, the word 'Register' is prominently displayed at the top in a green font. Below it, there are four input fields, each with a label above it: 'Username', 'Email', 'Password', and 'Confirm Password'. Each input field is represented by a white rectangle with a thin black border. After the input fields, a large green button with the word 'Register' in white is centered. At the bottom of the form, there is a link in black text that reads 'Already have an account? Login here'.

*Figure 5.6: Wireframe showcasing the Register page*



*Figure 5.7: Wireframe showcasing the Login page*

### Round Details Page

The Round Details page maintains minimal design, showing course name and round date. A calendar window facilitates date selection, minimising data entry errors. A prominent 'Begin Scoring' button allows users to proceed quickly to data entry.

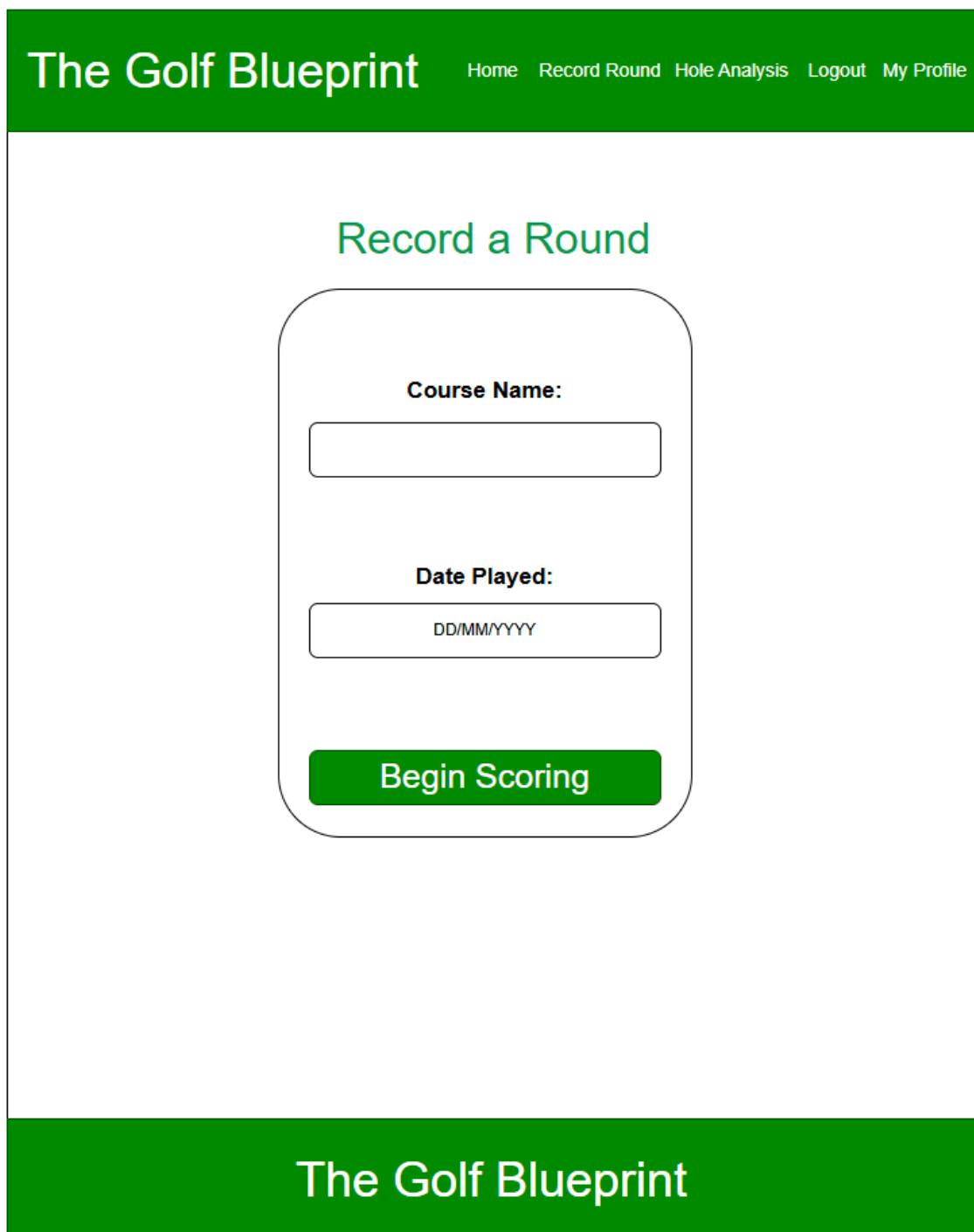


Figure 5.8: Wireframe showcasing the Round Details page

## Shot Input Page

This critical page enables users to record their golf shots. Well-designed for accuracy, it displays current hole details and provides concise instructions for proper usage.

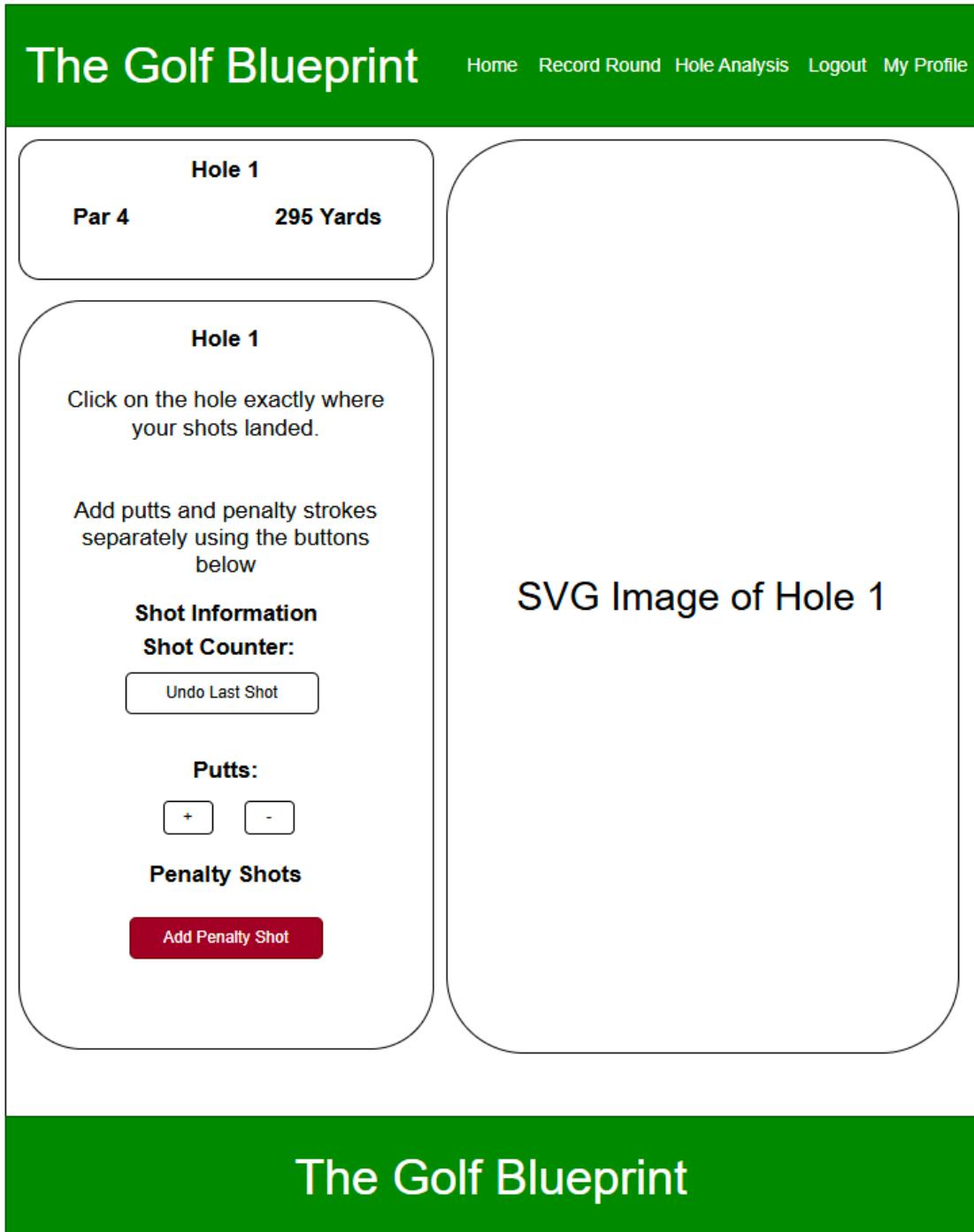


Figure 5.9: Wireframe showcasing the Shot Input page

## Round Summary Page

The round summary page presents a quick-glance overview using a simple grid layout of hole-by-hole scores. The page displays final total score, allowing accuracy verification before round submission.

The wireframe illustrates the layout of the Round Summary page. At the top, a green header bar features the logo 'The Golf Blueprint' on the left and navigation links 'Home', 'Record Round', 'Hole Analysis', 'Logout', and 'My Profile' on the right. Below the header is a large central section titled 'Round Summary' in a green box. This section contains a 4x4 grid of boxes, each labeled with a hole number (1 through 18) and a 'Score:' placeholder. A final green box at the bottom of the grid displays the 'Total Score:'. A 'Submit Round' button is positioned below the score box. The entire page is framed by a thick green border at the bottom, which also contains the 'The Golf Blueprint' logo.

Figure 5.10: Wireframe showcasing the Round Summary page

## Hole Analysis Page

As the system's most important page, Hole Analysis delivers the project's primary aim by displaying collected data insights. The well-designed two-column layout features interactive hole visualisation heatmap (left) and statistical breakdown (right), using colour-coded zones to identify optimal or sub-optimal landing areas.

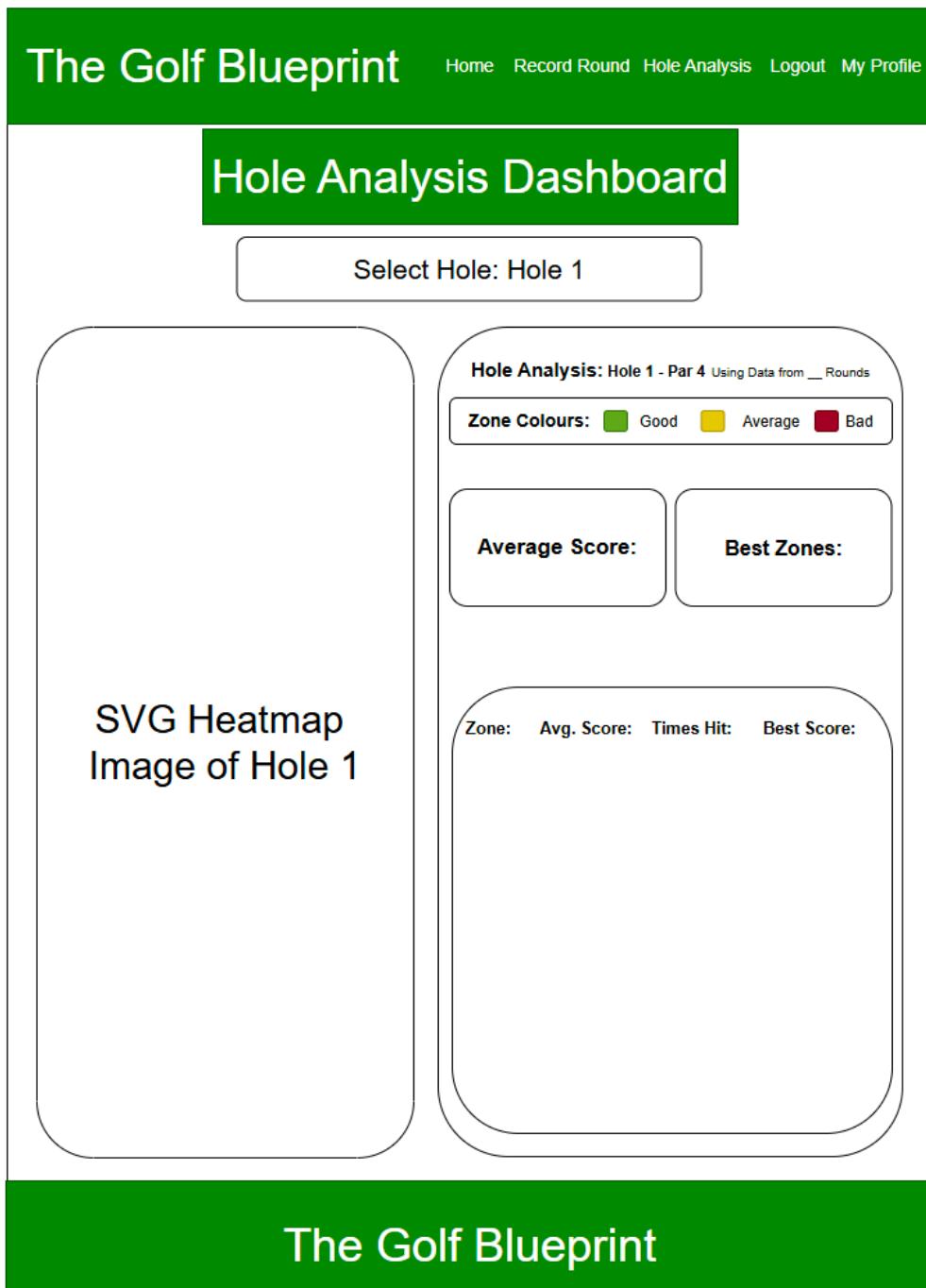


Figure 5.11: Wireframe showcasing the Hole Analysis page

## Profile Page

The profile page employs minimalist design focused on key metrics (rounds played, best score) followed by recent round history. Each round features a prominent 'view' button for easy scorecard access.

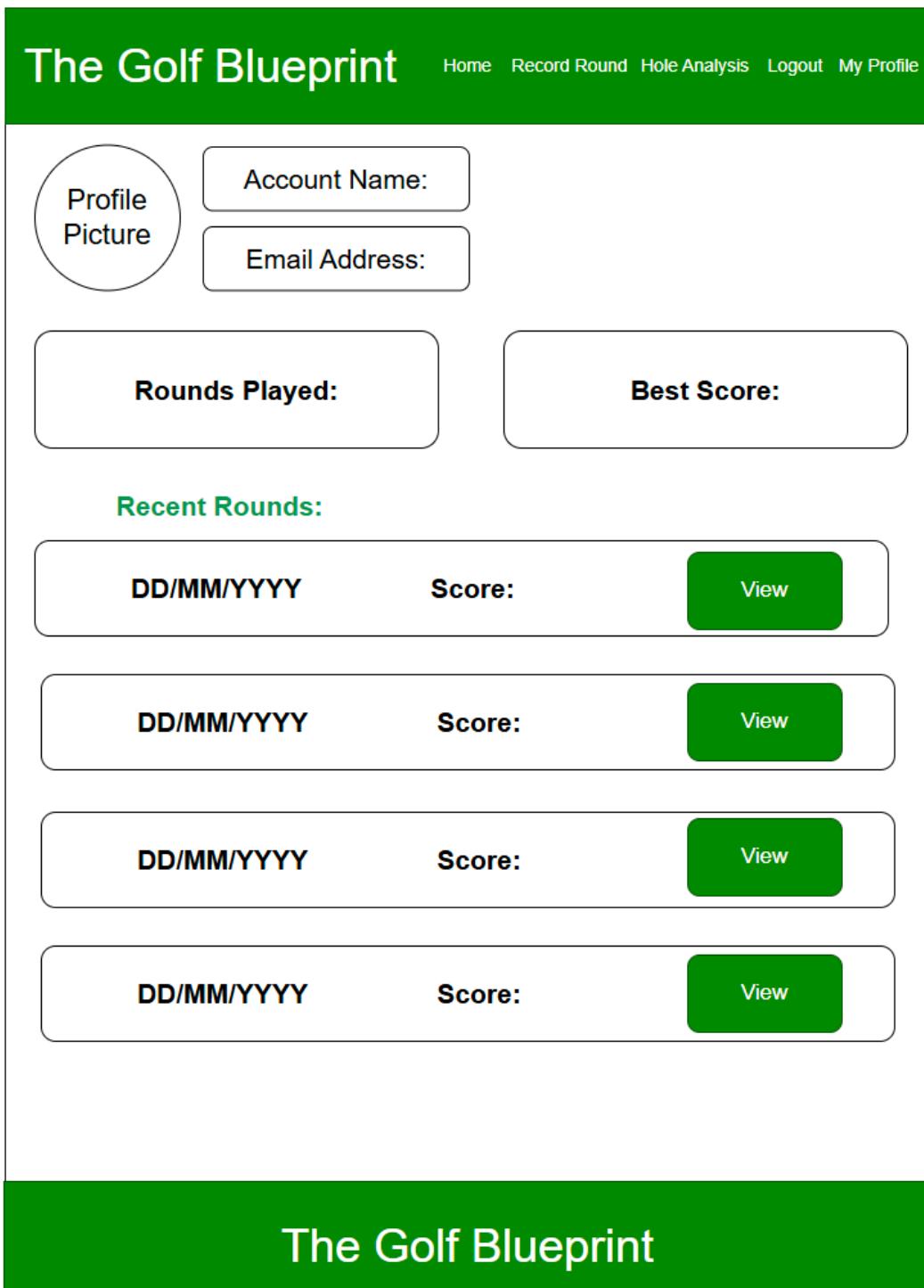


Figure 5.12: Wireframe showcasing the Profile page

## Scorecard Page

The scorecard page utilises a traditional golf scorecard layout familiar to all golfers, with hole-by-hole scores displayed alongside more detailed statistics such as number of pars and birdies. The design is simple and easy to read, allowing users to quickly analyse their previous rounds.

The wireframe shows the 'Round Scorecard' page. At the top right, there is a green button labeled 'Score:'. Below it, there are fields for 'Date: DD/MM/YYYY' and 'Course: The Kendleshire'. A large rectangular area contains a table for tracking golf scores across 18 holes. The table has columns for 'Hole', 'Par', 'Score', and 'Total'. The first column is numbered 1 through 18. At the bottom of this section is a green button labeled 'Back to Profile'.

Hole	Par	Score	Total
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

**Back to Profile**

*Figure 5.13: Wireframe showcasing the Round Scorecard page*

The wireframes for the design of the system were specifically designed in order to meet the functional requirements FR1, FR2, FR3, FR7, FR21, FR22, FR23 and the non-functional requirements NFR2 and NFR3.

## 5.4 Key Algorithms and Technical Components

### 5.4.1 Shot Tracking Algorithm

The shot-tracking system uses the following code to accurately record the users' shots:

1. Capture click coordinates relative to the hole container with the SVG image inside it
2. Determine the specific zone that was clicked on
3. Create a shot object with position and zone information
4. Add the shot marker to the visualisation for the user to check it was the correct location
5. Update the shot counter and score totals
6. Store the shot data in the client's local storage

This algorithm allows for the users to accurately and easily record where their shots finished in a systematic way, allowing for easy data analysis, directly supporting the core objective of the project. It was developed to directly align with the functional requirements FR8, FR10 and FR11.

```

/**
 * Shot Tracking System for The Golf Blueprint
 * Core implementation of the interactive shot data collection
 */

// Track shot data and user interactions
let shotCount = 0;
let puttCount = 0;
let penaltyCount = 0;
let shots = [];
let actionHistory = [];

/**
 * Records a shot when user clicks on the hole visualisation
 */
function recordShot(event) {
    // Calculate exact coordinates where user clicked
    const container = document.getElementById('fullHoleView');
    const rect = container.getBoundingClientRect();
    const x = event.clientX - rect.left;
    const y = event.clientY - rect.top;

    // Identify which course zone was clicked (fairway, rough, etc.)
    const zone = getZoneAtPosition(event.target);

    // Create shot data object with complete information
    const shot = {
        number: ++shotCount,
        x: x,
        y: y,
        zone: zone,
        xPercent: (x / rect.width) * 100, // For responsive scaling
        yPercent: (y / rect.height) * 100,
        type: 'shot'
    };

    // Store shot data and update history
    shots.push(shot);
    actionHistory.push({ type: 'shot', shotIndex: shots.length - 1 });

    // Create visual marker on the hole visualisation
    addShotMarker(shot);

    // Update UI and save data
    updateDisplay();
    saveHoleData();
}

```

*Figure 5.14: First code snippet showcasing the shot tracking system*

```

    /**
     * Creates visual indication of shot location
     */
    function addShotMarker(shot) {
        const container = document.getElementById('fullHoleView');

        // Create numbered marker element
        const marker = document.createElement('div');
        marker.className = 'shot-marker';
        marker.textContent = shot.number;

        // Position precisely where user clicked
        marker.style.left = shot.x + 'px';
        marker.style.top = shot.y + 'px';

        container.appendChild(marker);
    }

    /**
     * Saves shot data to persistent storage
     */
    function saveHoleData() {
        const holeNumber = getHoleNumber();

        // Prepare complete hole data
        const holeData = {
            holeNumber: holeNumber,
            shotCount: shotCount,
            puttCount: puttCount,
            penaltyCount: penaltyCount,
            holeScore: shotCount + puttCount + penaltyCount,
            shots: shots,
            actionHistory: actionHistory
        };

        // Save to browser's localStorage
        let roundData = JSON.parse(localStorage.getItem('currentRound') || '{}');
        roundData[`hole${holeNumber}`] = holeData;
        localStorage.setItem('currentRound', JSON.stringify(roundData));
    }

    // Initialise tracking system when page loads
    document.addEventListener('DOMContentLoaded', function() {
        // Load existing data if available
        loadHoleData();

        // Set up click handler for the hole visualisation
        const holeView = document.getElementById('fullHoleView');
        if (holeView) {
            holeView.addEventListener('click', recordShot);
        }

        updateDisplay();
    });
}

```

*Figure 5.14: Second code snippet showcasing the shot tracking system*

### 5.4.2 Data Visualisation Algorithm

The heatmap visualisation which is used for shot analytics uses the following process:

1. Fetches zone performance data from the API
2. Calculates performance metrics for each zone (relative to median)
3. Apply appropriate colour coding based on performance
4. Adjust colour opacity depending on magnitude of difference
5. Apply styles to the zone elements in the SVG visualisation

This algorithm was specifically developed to incorporate the functional requirements FR16, FR17, FR18, FR19.

```

/**
 * Analytics Heatmap System for The Golf Blueprint
 */

// Statistical visualisation algorithm for golf course zones
function updateZonePerformanceVisualization(zoneData, holeNumber) {
    const container = document.getElementById('hole-visualization');

    // Reset previous visualisation state
    container.querySelectorAll('.zone').forEach(zone => {
        zone.style.backgroundColor = '';
        zone.style.opacity = '0';
        zone.style.display = 'none';
    });

    if (!zoneData || zoneData.length === 0) return;

    // Calculate statistical reference points
    const scores = zoneData.map(zone => zone.avgScore);
    const minScore = Math.min(...scores);
    const maxScore = Math.max(...scores);

    // Use median as performance baseline
    scores.sort((a, b) => a - b);
    const medianScore = scores.length % 2 === 0
        ? (scores[scores.length/2 - 1] + scores[scores.length/2]) / 2
        : scores[Math.floor(scores.length/2)];

    // Apply performance-based color coding to each zone
    zoneData.forEach(zone => {
        // Handle different zone naming conventions between front/back nine
        const zoneId = parseInt(holeNumber) < 10
            ? zone.zone.toLowerCase().replace(/\B/, '-') // Front nine uses hyphens
            : zone.zone.toLowerCase().replace(/\B/g, ''); // Back nine has no hyphens

        const zoneElement = document.getElementById(zoneId);

        if (zoneElement) {
            // Color based on performance relative to median (threshold = 15% of range)
            const scoreDiff = zone.avgScore - medianScore;
            const threshold = (maxScore - minScore) * 0.15;

            // Apply color coding based on statistical performance
            if (zone.avgScore < medianScore - threshold) {
                // Better than average - green with opacity based on how much better
                const opacity = 0.5 + Math.min(0.4, Math.abs(scoreDiff / threshold)) * 0.4;
                zoneElement.style.backgroundColor = `rgba(59, 243, 46, ${opacity})`;
            } else if (zone.avgScore > medianScore + threshold) {
                // Worse than average - red with opacity based on how much worse
                const opacity = 0.6 + Math.min(0.3, Math.abs(scoreDiff / threshold)) * 0.4;
                zoneElement.style.backgroundColor = `rgba(255, 102, 102, ${opacity})`;
            } else {
                // Average performance - orange
                zoneElement.style.backgroundColor = `rgba(255, 152, 0, 0.5)`;
            }

            // Make zone visible and add tooltip with statistics
            zoneElement.style.display = '';
            zoneElement.style.opacity = '1';
            zoneElement.title = `${zone.zone}: Avg. Score ${zone.avgScore.toFixed(1)} (${zone.count} shots)`;

            // Add interactivity for user exploration
            zoneElement.addEventListener('click', () => highlightTableRow(zone.zone));
        }
    });
}

// API interaction to fetch performance data
function fetchHoleData(holeNumber) {
    // Fetch statistical data for the selected hole
    fetch('/api/hole-stats?hole=${holeNumber}&shot=all&datePeriod=all-time')
        .then(response => response.json())
        .then(data => {
            if (data?.zones?.length > 0) {
                // Process data into visualisations
                updateZonePerformanceVisualization(data.zones, holeNumber);
                updateZoneStatsTable(data.zones, holeNumber);
                updateScoreChart(data.zones, holeData[holeNumber].par);
            } else {
                // Handle no data case
                document.getElementById('score-chart').innerHTML =
                    '<div class="loading-placeholder"><p>No data available for this hole</p></div>';
            }
        })
        .catch(error => {
            console.error('Error fetching data:', error);
        });
}

// Initialise dashboard with event listeners
document.addEventListener('DOMContentLoaded', function() {
    document.getElementById('hole-select').addEventListener('change', updateDashboard);
    updateDashboard(); // Load initial hole data
});
}

```

Figure 5.15: Code snippet showcasing the heatmap data visualisation

### 5.4.3 Security Implementation

Security is implemented into the system through multiple layers:

1. **Protected Route Enforcement** – the ‘checkPageAccess()’ function validates whether a user is authorised to access certain pages:
  - Identifies protected pages (round details, shot analysis, hole pages)
  - Verifies authentication status before allowing access
  - Redirects unauthorised users to the login page

```
/** 
 * Client-side security implementation for The Golf Blueprint
 * This module handles authentication verification and protected route access
 */

/**
 * Check if current page requires authentication and enforce access control
 */
function checkPageAccess() {
  // Determine current page path
  const currentPath = window.location.pathname;

  // Define protected pages that require authentication
  const isRoundDetails = currentPath.includes('round-details.html');
  const isShotAnalysis = currentPath.includes('shot-analysis.html');
  const isHolePage = currentPath.includes('/holes/hole');

  // These pages require authentication
  const requiresAuth = isRoundDetails || isShotAnalysis || isHolePage;

  if (requiresAuth) {
    // Check if user is logged in by verifying user data exists
    const userData = localStorage.getItem('user');

    if (!userData) {
      // Security measure: User is not authenticated but trying to access protected page
      // Display error and prevent access to protected content
      displayAuthError();
      return false;
    }
  }

  return true;
}
```

*Figure 5.16: Code snippet showcasing the ‘checkPageAccess()’ function*

## 2. Authentication State Management - The ‘updateAuthNavigation()’ function:

- Checks for valid session data in localStorage
- Includes error handling to prevent security issues with malformed data
- Updates UI elements based on authentication status

```
/** 
 * Updates UI elements based on authentication status
 */
function updateAuthNavigation() {
    const authLinkElement = document.getElementById('auth-link');
    const profileLinkElement = document.getElementById('profile-link');

    // Get protected feature navigation elements
    const recordRoundLinks = document.querySelectorAll('.nav-links a[href="round-details.html"], .nav-links a[href="../../round-details.html"]');
    const shotAnalysisLinks = document.querySelectorAll('.nav-links a[href="shot-analysis.html"], .nav-links a[href="../../shot-analysis.html"]');

    // Check authentication status
    const userData = localStorage.getItem('user');

    if (userData) {
        try {
            // Parse user data to verify it's valid
            const user = JSON.parse(userData);

            // Update UI for authenticated user
            if (authLinkElement) {
                authLinkElement.innerHTML = '<a href="#" class="nav-link" onclick="logout()">Logout</a>';
            }

            // Show protected navigation links for authenticated users only
            profileLinkElement.style.display = 'block';
            recordRoundLinks.forEach(link => {
                if (link.parentElement) link.parentElement.style.display = 'block';
            });

            shotAnalysisLinks.forEach(link => {
                if (link.parentElement) link.parentElement.style.display = 'block';
            });
        } catch (error) {
            // Security measure: Invalid user data format in localStorage
            // Treat as unauthenticated to prevent security issues
            handleLoggedOutState(authLinkElement, profileLinkElement, recordRoundLinks, shotAnalysisLinks);
        }
    } else {
        // User is not authenticated - restrict access to protected features
        handleLoggedOutState(authLinkElement, profileLinkElement, recordRoundLinks, shotAnalysisLinks);
    }
}
```

*Figure 5.17: Code snippet showcasing the ‘updateAuthNavigation()’ function*

### 3. Secure Logout Process - The ‘logout()’ function:

- Removes authentication data from browser storage
- Updates UI to reflect logged-out state
- Redirects to public area after logout

```
/*
 * Secure logout implementation
 */
function logout() {
    // Remove authentication data from browser storage
    localStorage.removeItem('user');

    // Update UI to reflect unauthenticated state
    updateAuthNavigation();

    // Provide user feedback
    alert('You have been logged out successfully.');

    // Security measure: Redirect to public area after logout
    let redirectPath = 'index.html';
    if (window.location.pathname.includes('/holes/')) {
        redirectPath = '../index.html';
    }

    window.location.href = redirectPath;
    return false;
}

// Initialise security checks when page loads
document.addEventListener('DOMContentLoaded', function() {
    // Apply authentication-based UI updates
    updateAuthNavigation();

    // Enforce access control for protected pages
    checkPageAccess();
});
```

*Figure 5.18: Code snippet showcasing the ‘logout ()’ function*

The code prevents unauthorised users from seeing protected features by:

- Hiding navigation links to protected features
- Displaying appropriate login/logout options

These security related implementations incorporate the functional requirements FR1, FR2 and FR3

## 6. Results

### 6.1 Implementation

The Golf Blueprint was successfully implemented as a fully working web application with all core functionality specified in the requirements. This section presents key implementation outcomes, demonstrating how the produced software met objectives and requirements.

#### 6.1.1 SVG Image Creation

An important first step for system implementation was recreating all 18 individual holes at The Kendleshire as SVG files. This allows users to interact with specific holes by breaking each down into hole-specific zones/areas. User interaction with these zones enables collecting, storing and reproducing accurate golf shot data to generate meaningful heatmap visualisations and course management recommendations, as specified in the requirements.

To recreate each hole accurately, I gathered satellite imagery using Google Earth and traced each hole by drawing shapes matching features such as fairways, greens and lakes.

19011230



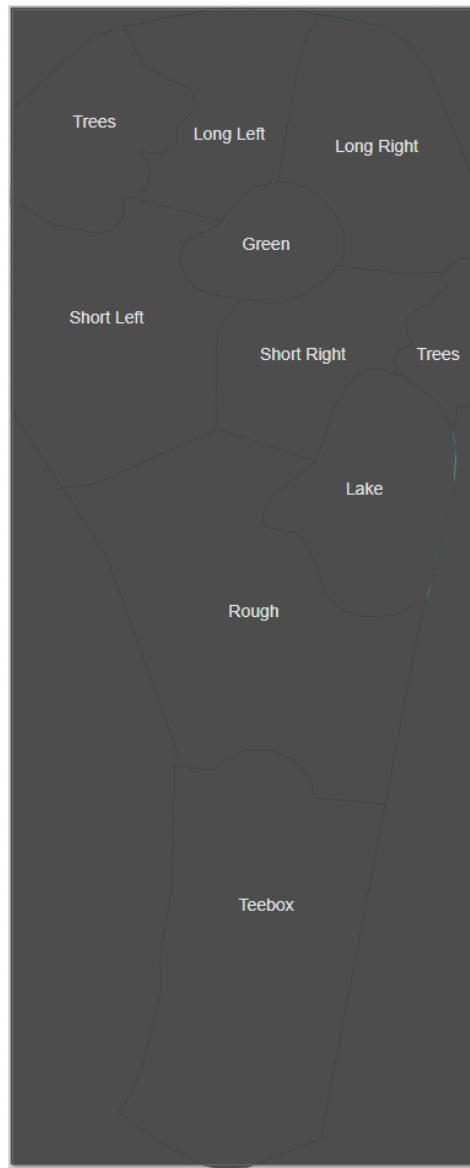
*Figure 6.1: Screenshot of the satellite image of Hole 2*

19011230



*Figure 6.2: Screenshot showing the SVG recreation of Hole 2*

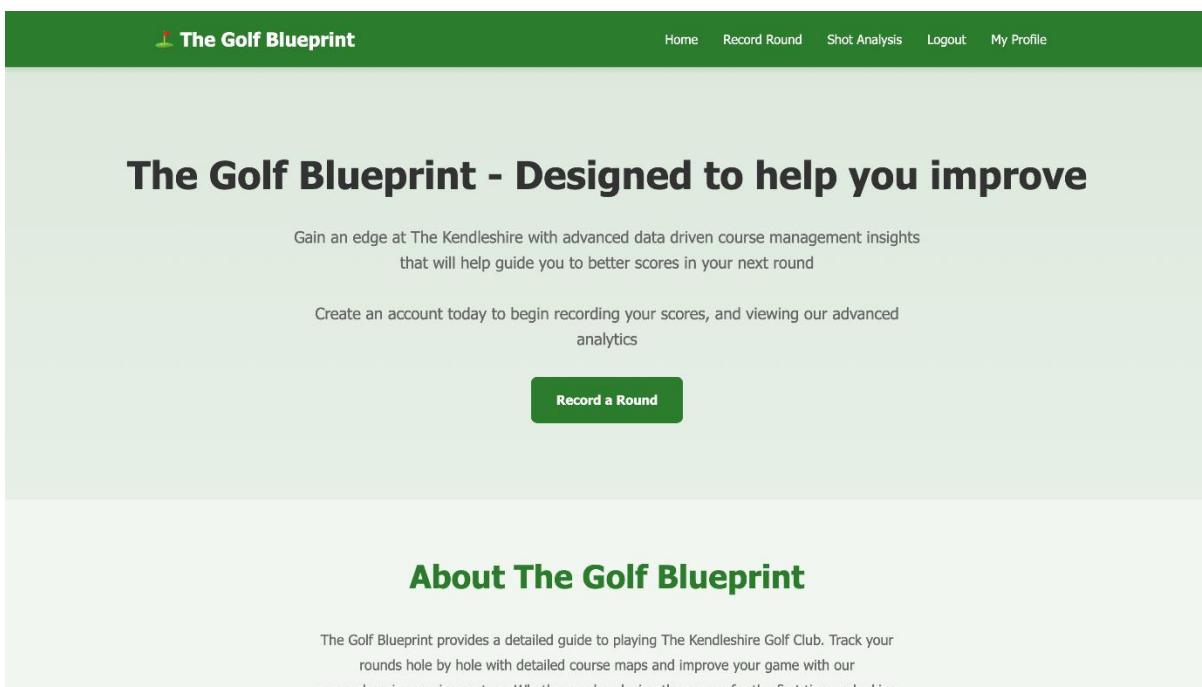
After recreating each hole as SVG files, I began drawing hole-specific zones. To ensure maximum accuracy, I hand-drew each zone individually for every hole. Whilst time-consuming, this approach was necessary for precise data collection, as different holes feature unique characteristics that would make a standardised zoning approach unsuitable for effective data collection and analysis.



*Figure 6.3: Screenshot showing the SVG image for Hole 2, with the hole specific zones drawn on top. This image has text containing the correlated zone for explanatory purpose*

## 6.1.2 User Interface Implementation

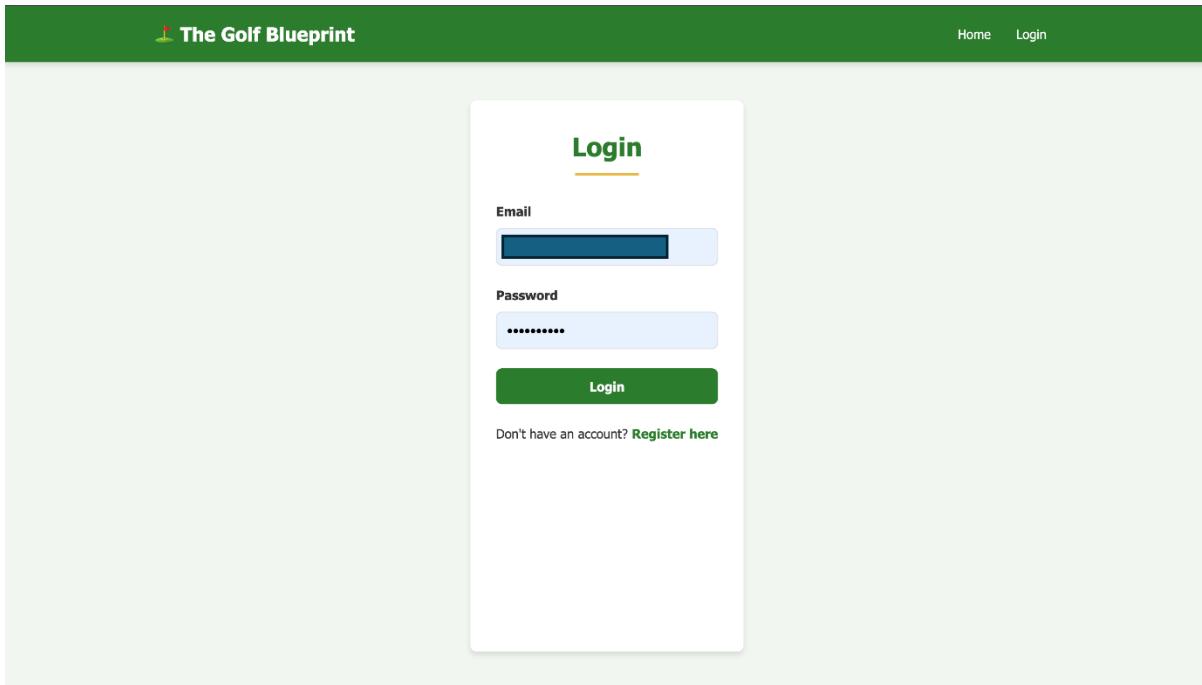
The user interface was implemented following wireframe designs documented in the design section. Figure 6.4 shows The Golf Blueprint homepage, providing users with a clear introduction to the system. The minimalistic design adheres to the outlined colour palette, creating a professional appearance throughout the entire system. An intuitive navigation bar spans the top of each page, enabling quick application navigation across all system pages.



*Figure 6.4: Homepage implementation showing the welcome message, call-to-action button for recording a round and navigation bar*

### 6.1.3 User Login Page

The user login page was an extremely important feature of the system, for allowing users to keep track of their individual progress. A secure way of logging in and out of The Golf Blueprint was implemented using a simple page, which can be seen in Figure 6.5.



*Figure 6.5: Screenshot showcasing the login page for The Golf Blueprint*

As well as implementing this simple login page, it was just as important to incorporate a registration page to allow new users to sign up. It was important to incorporate password masking into this design, so that when the password boxes are typed into, no text is visible.

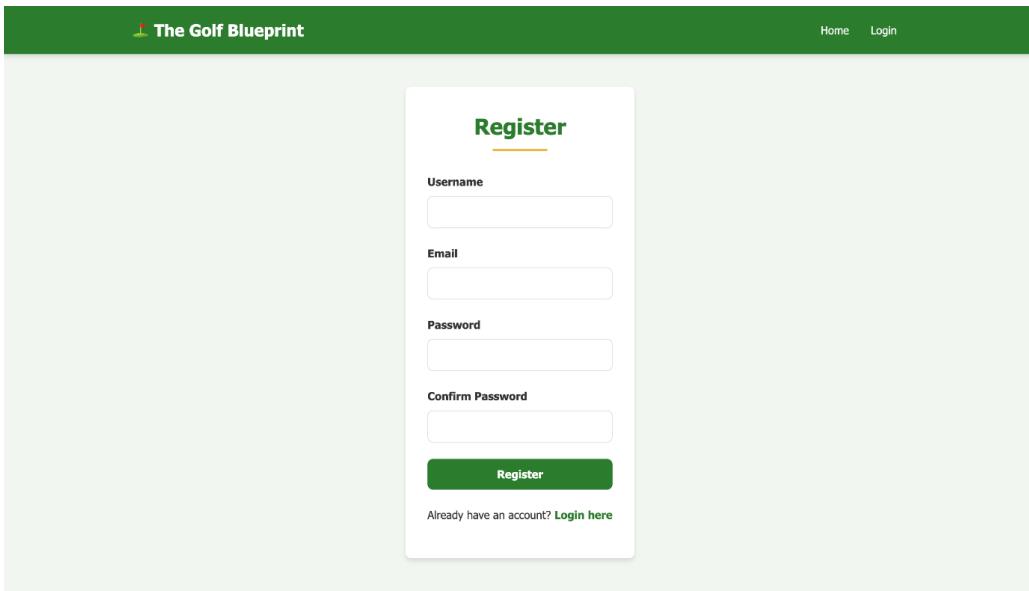


Figure 6.6: Screenshot showcasing the registration page of The Golf Blueprint

To comply with system design requirements, I implemented error handling ensuring users must be logged in to access features like round recording. The error message design balances system consistency with sufficient boldness to alert users of errors. Importantly, the message includes a 'Go to Login' button, allowing users to easily navigate to the login page directly from the error notification.

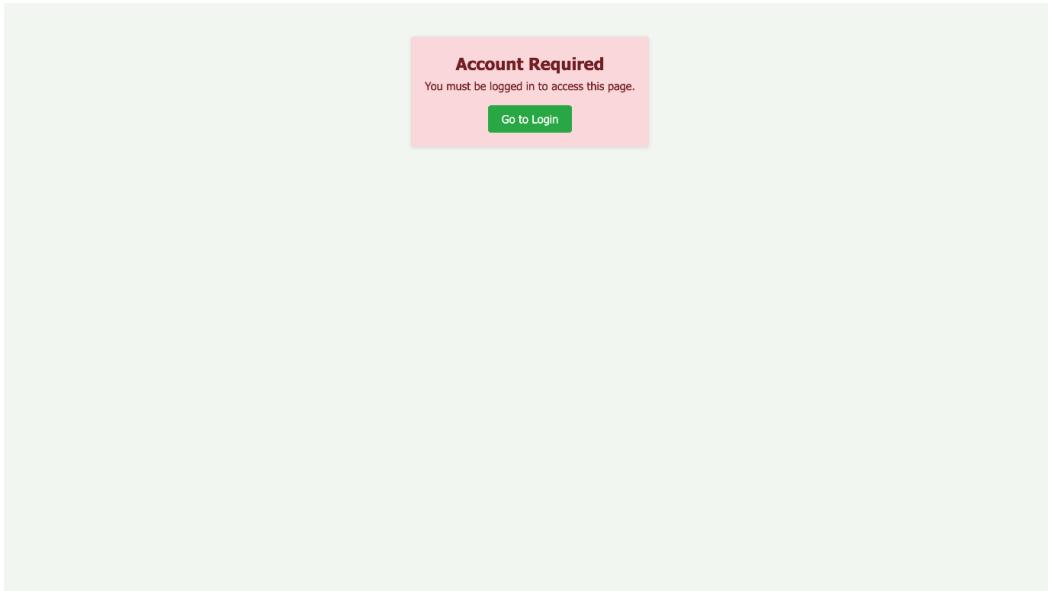


Figure 6.7: Screenshot showcasing the error generated by a user attempting to record a round, without having logged in

### 6.1.4 User Profile Pages

A key application feature was implementing user profile pages, allowing users to view their account information including detailed account data, statistics on rounds played, best round score, and complete round history. This fulfils the requirement to provide users with a means of tracking their golfing progress over time.

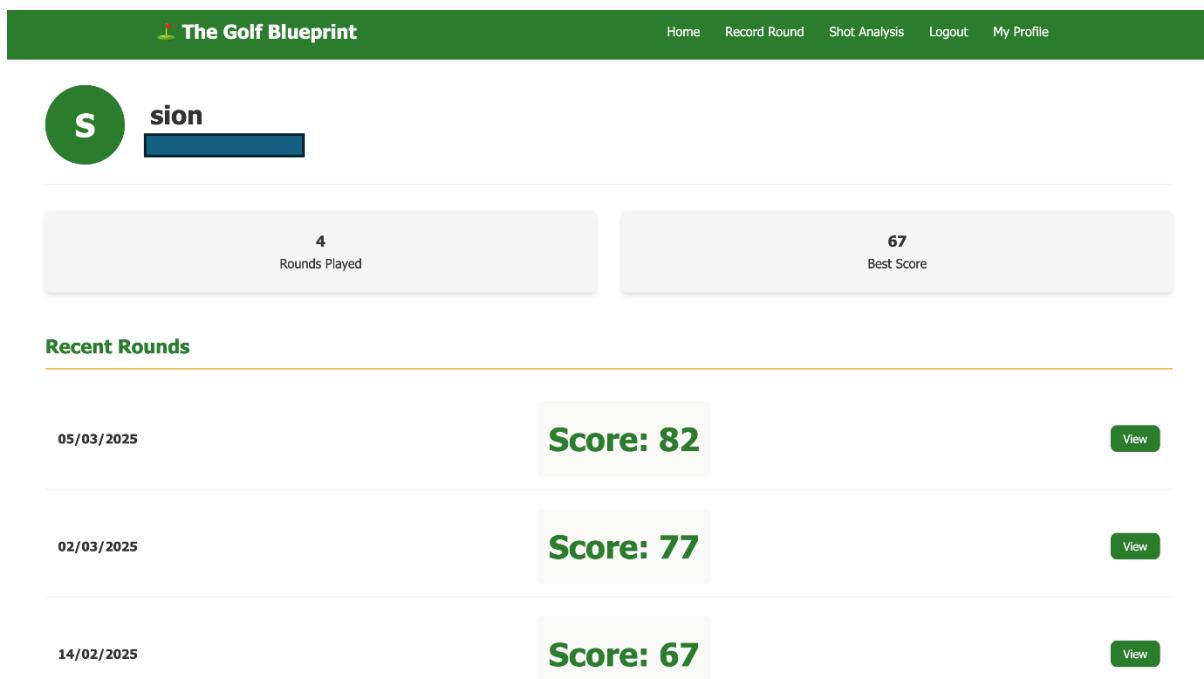


Figure 6.8: Screenshot showcasing the implementation of the user profile page

The user profile page enables viewing overall round history, while the successfully implemented detailed round view functionality allows users to track individual rounds entered in the database. This simple, familiar golf scorecard layout permits revisiting previous rounds in greater detail, displaying statistics such as number of pars, birdies, bogeys and double+ bogeys.

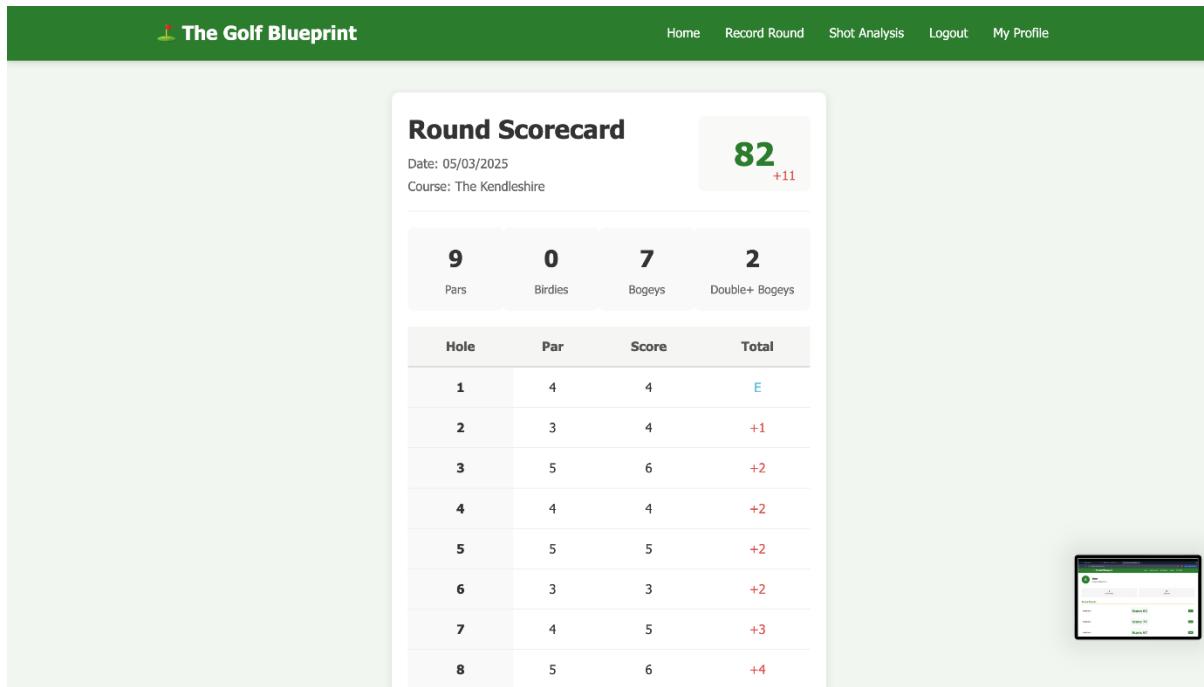


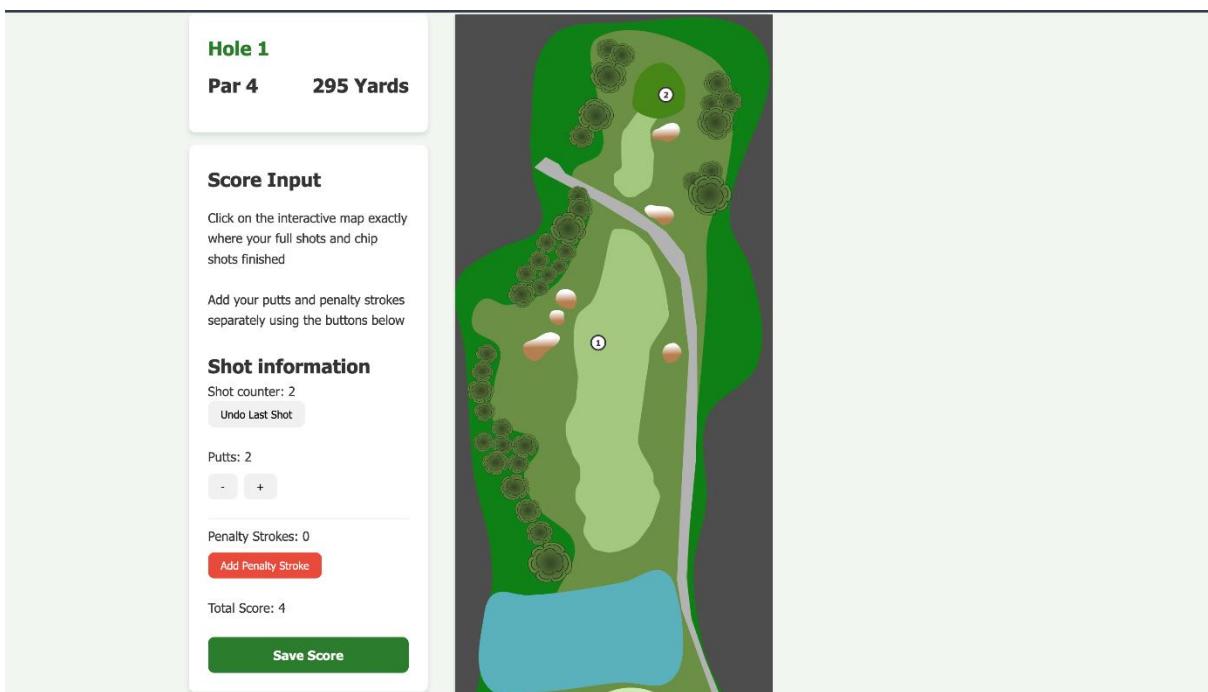
Figure 6.9: Screenshot showcasing the individual round scorecard page of the system

### 6.1.5 Shot Data Collection System

Users first select round date for database attachment before entering shot data.

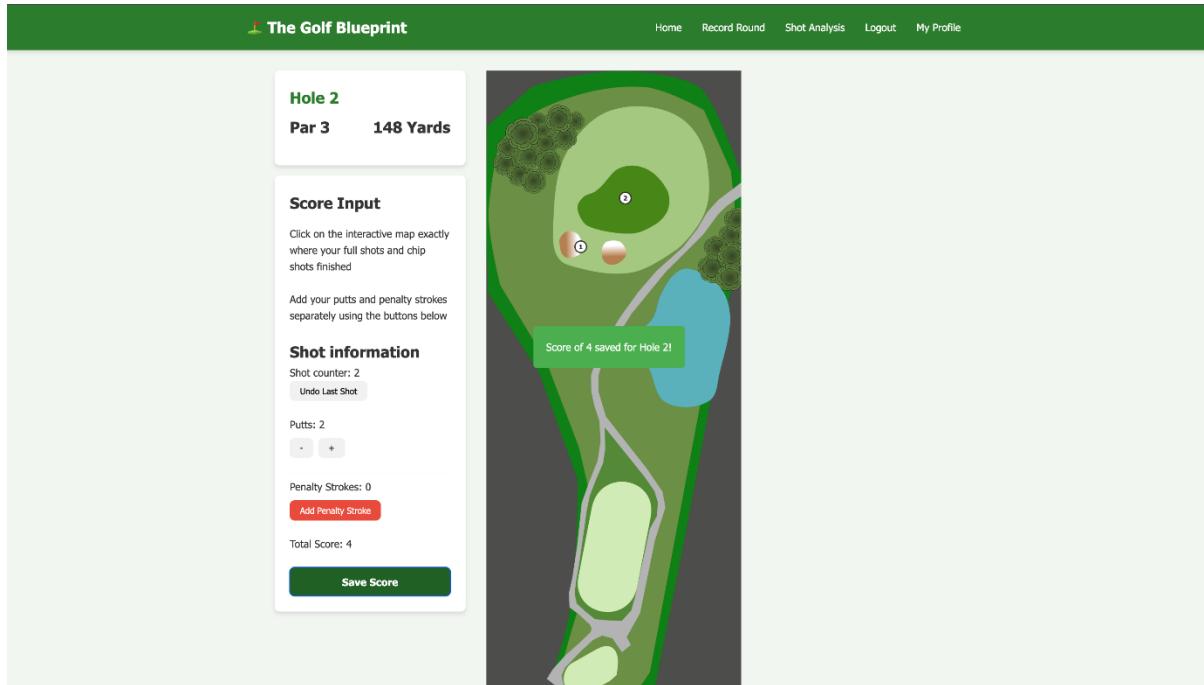
The system uses interactive SVG graphics for accurate shot location marking. With the image divided into detailed zones, users click where shots landed, storing this information. Intuitive instructions guide accurate recording, while hovering highlights specific zones, providing insight into data storage methodology.

The page also allows entry of additional hole details including putt count and penalty strokes.



*Figure 6.10: Screenshot showcasing the shot placement screen*

After clicking on the map with necessary shot locations and entering correct putt counts or penalty strokes, users can view their shots in sequence through white numbered circles on the image. Once satisfied with data accuracy, users click the save score button, receiving a confirmation message before transitioning to the next hole's data entry after a brief delay.



*Figure 6.11: Screenshot showcasing the confirmation of score entry once a user has clicked on 'Save Score'*

## 6.1.6 Data Heatmap Visualisation and Analytics

The heatmap visualisation system has been successfully implemented, analysing SQL database data to create hole-specific heatmaps providing detailed course management insights that satisfy system requirements.

The implementation uses intuitive colour coding (green for lower scores, yellow for neutral, red for higher) to represent average score per zone. This design enables users to quickly identify areas to utilise or avoid on each hole to improve their golf scoring.

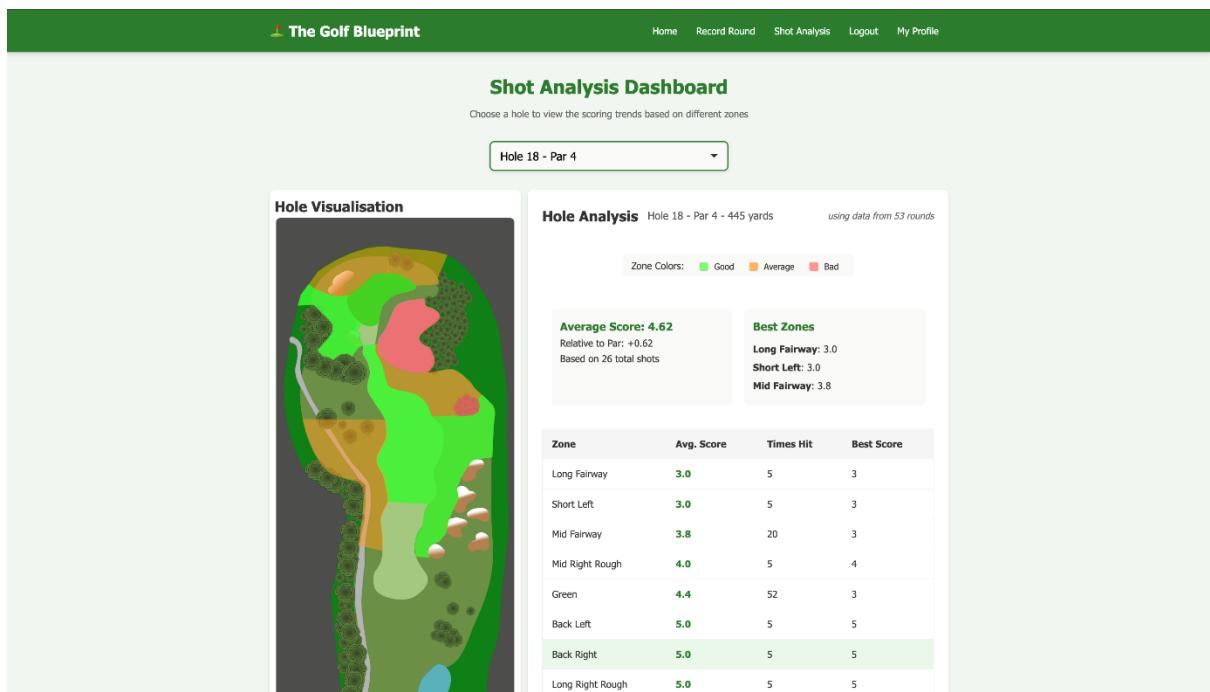


Figure 6.12: Screenshot showcasing the hole/shot visualisation page for the 18<sup>th</sup> hole

## 6.2 System Testing

### 6.2.1 Test Approach

Testing followed a comprehensive approach ensuring the application met specified requirements and delivered high-quality user experience.

31 test cases were developed across 4 components: User Authentication (9 tests), Profile Access (5 tests), Hole/Shot Analysis (4 tests) and Round Recording (13 tests). These represent key system functionality and ensure alignment with project objectives.

## 6.2.2 User Authentication

The User Authentication was tested covering the essential functionality of user registration, login, logout and validation:

Test ID	Component	Test Description	Test Steps	Expected Result	Actual Result	PASS/FAIL
1	User Authentication	Test User Setup	1. Click login 2. Click 'Register' 3. Enter user details 4. Click 'Register' 5. Verify user creation in database	User details are created and stored in SQL database	As Expected	PASS
2	User Authentication	Test User Login	1. Click 'Login' 2. Enter user details 3. Click 'Login' 4. Verify login in console	User is logged in - confirmed by console	As Expected	PASS
3	User Authentication	Test User Logout	1. Ensure user is logged in 2. Click 'Logout' 3. Check user is logged out with the system message	System provides message that user has logged out. 'Logout' changes to 'Log in'	As Expected	PASS
4	User Authentication	Test Invalid Credentials	1. Click 'Login' 2. Enter invalid credentials 3. Click 'Login' 4. Check error message is shown	System provided error message that email or password is invalid	As Expected	PASS
5	User Authentication	Test Invalid Email	1. Click 'Register' 2. Enter an email that doesn't include an '@' 3 Click 'Register'	System provides error message for the email box requiring an '@'	As Expected	PASS
6	User Authentication	Test Single Use Email Addresses	1. Click 'Register' 2. Enter an email address that is already in use 3 Click 'Register'	System provides an error stating the email is already in use	As Expected	PASS
7	User Authentication	Test Password Matching	1. Click 'Register' 2. Enter valid email address 3. Enter password 4. Enter different password in 'Confirm Password' box 5. Click 'Register'	System provides an error saying that the passwords do not match	As Expected	PASS
8	User Authentication	Test Login Requirement to Record Round	1. Ensure user is logged out 2. Click 'Record a Round'	System provides an error saying that the user must be logged in to record a round	As Expected	PASS
9	User Authentication	Test Logging Out Takes User to Homepage	1. Click 'Logout' 2. Ensure user is taken to homepage	When clicking logout, no matter what page the user is on, they are taken to the homepage	As Expected	PASS

Figure 6.13: Table showcasing the user authentication test cases

These tests verified the authentication system provided secure application access while offering appropriate user feedback for invalid operations. Results confirm users can successfully register, login, and logout, with the system appropriately handling error cases.

### 6.2.3 Profile Access

The Profile Access component was tested with 5 test cases to ensure user profiles displayed accurate information and provided access to historical data:

Test ID	Component	Test Description	Test Steps	Expected Result	Actual Result	PASS/FAIL
1	Profile Access	Test Loading User Profile	1. Ensure Status is Logged In 2. Click 'Profile'	The system should load the correct profile for the logged in user	As Expected	PASS
2	Profile Access	Test Data Accuracy	1. Click 'Profile' 2. Ensure Username and Email Address are Correct	The system should automatically load the signed in user's username and email address	As Expected	PASS
3	Profile Access	Test Statistic Accuracy	1. Click 'Profile' 2. Ensure Rounds Played and Best Score Statistics are Correct	The system should automatically load the rounds played and best score statistics, accurately	As Expected	PASS
4	Profile Access	Test Viewing a Historic Round	1. Click 'Profile' 2. Click 'View' on an Old Round	When clicking view, the system should load up the scorecard for the historic round	As Expected	PASS
5	Profile Access	Test Historic Round Details are Correct	1. Click 'View' on an Old Round	When viewing an old round, the data that is displayed, such as round location, round date and scoring details should all match that of the original round	As Expected	PASS

*Figure 6.14: Table showcasing the profile access test cases*

These tests verified user profiles correctly displayed personalised information and allowed historical round data access. Results confirm users can track progress over time, addressing the progress tracking requirement objective.

## 6.2.4 Hole/Shot Analysis

The Hole/Shot Analysis component was tested with 4 test cases to ensure the heatmap visualisation correctly displayed strategic insights:

Test ID	Component	Test Description	Test Steps	Expected Result	Actual Result	PASS/FAIL
1	Hole/Shot Analysis	Test Loading Shot Analysis Page	1. Click 'Shot Analysis'	The shot analysis page will load, and display the data for the first hole by default	As Expected	PASS
2	Hole/Shot Analysis	Test Changing Hole	1. Click the Hole Drop Down Menu 2. Select Hole to View	The system will change the hole view to whatever hole is clicked by the user	As Expected	PASS
3	Hole/Shot Analysis	Test Heatmaps Working	1. Click on a Hole to View the Heatmap 2. Check the Heatmap Colour Matches the Average Scores for That Zone	When viewing a hole's zone heatmaps, the higher score zones should be red, and lower score zones should be green	As Expected	PASS
4	Hole/Shot Analysis	Test Hovering Over Heatmap	1. Click on a Hole to View the Heatmap 2. Hover Over a Zone	When hovering over a zone, it should show the user the name of the zone, and the average score	As Expected	PASS

*Figure 6.15: Table showcasing the hole/shot analysis test cases*

These tests verified shot analysis functionality correctly displayed heatmap visualisation. Successful implementation of colour-coded zones (red for higher scores, green for lower) directly addresses the primary aim of improving course management through visual insights.

## 6.2.5 Round Recording

The Round Recording component was tested with 13 test cases to ensure accurate and reliable shot data collection:

Test ID	Component	Test Description	Test Steps	Expected Result	Actual Result	PASS/FAIL
1	Round Recording	Test Entering Round Details	1. Click 'Record a Round' 2. Enter Date for the round 3. Click 'Begin Scoring'	The chosen date will be reflected in the database	As Expected	PASS
2	Round Recording	Test Not Putting a Date	1. Click 'Record a Round' 2. Do not Enter a Date 3. Click 'Begin Scoring'	The system will prompt the user to enter a date	As Expected	PASS
3	Round Recording	Test Hole 1 Loading	1. Click 'Begin Scoring'	The first hole's page should load up automatically	As Expected	PASS
4	Round Recording	Test Placing Shots	1. Click on SVG Image of Hole Where Shots Landed	The SVG image should showcase a white circle where the shot was placed. Total score should	As Expected	PASS
5	Round Recording	Test Adding Putts	1. Click the Plus Button Under Putts	The number of putts and the total score should increase by 1	As Expected	PASS
6	Round Recording	Test Adding Penalty Stroke	1. Click 'Add Penalty Stroke'	The system should give a message saying 'Penalty Stroke Added'. Total score should increase by 1	As Expected	PASS
7	Round Recording	Test Removing a Shot	1. Click 'Undo Last Shot'	The last shot should be undone. Whether it is a putt or a full shot, or penalty shot	As Expected	PASS
8	Round Recording	Test Removing a Putt	1. Click the Minus Button Under Putts	The number of putts and the total score should decrease by 1	As Expected	PASS
9	Round Recording	Test Saving Score	1. Enter Scoring for Hole 2. Click 'Save Score'	System should show a message saying that the score was saved. The next hole should load up after a short delay	As Expected	PASS
10	Round Recording	Test Unrealistic Score	1. Try to Submit a Score of 0	System should show a message saying that a score of 0 is not possible	As Expected	PASS
11	Round Recording	Test Round Summary	1. Submit Score for 18th hole	The system should automatically load up the round summary	As Expected	PASS
12	Round Recording	Test Editing a Hole	1. Click 'Edit'	When clicking edit, the system should take the user back to the score input for that hole	As Expected	PASS
13	Round Recording	Test Round Submission	1. Enter Full Round 2. Submit Round	When clicking submit, the system should show a message confirming the submission. The round should appear in the database	As Expected	PASS

*Figure 6.16: Table showcasing the round recording test cases*

These tests verified users could accurately record round data, including shot locations, putts, and penalty strokes. Successful implementation ensures reliable data collection supporting heatmap visualisations and analytical features.

### 6.3 Requirements Traceability Matrix

The Requirements Traceability Matrix (RTM) provides structured mapping between functional requirements, implementation and testing. It demonstrates how each requirement was addressed, relevant software file, testing ID and pass/fail status.

Requirement ID	Priority	Software Module	Test Case ID	Status
FR1	Must	register.html	Authentication 1	Pass
FR2	Must	login.html	Authentication 2	Pass
FR3	Must	golf_blueprint.sql	Authentication 1	Pass
FR4	Should	-	Unimplemented	Fail
FR5	Should	-	Unimplemented	Fail
FR6	Could	-	Unimplemented	Fail

Figure 6.17: Table showcasing the RTM for the functional requirements 1-6

Requirement ID	Priority	Software Module	Test Case ID	Status
FR7	Must	hole1.html	Round Recording 3	Pass
FR8	Must	hole1.html	Round Recording 4	Pass
FR9	Must	round-details.html	Round Recording 1	Pass
FR10	Must	hole1.html	Round Recording 5	Pass
FR11	Must	round-summary.html	Round Recording 13	Pass
FR12	Must	hole1.html	Round Recording 10	Pass
FR13	Should	-	Unimplemented	Fail
FR14	Should	round-summary.html	Round Recording 12	Pass
FR15	Could	hole1.html	Round Recording 13	Pass

*Figure 6.17: Table showcasing the RTM for the functional requirements 7-15*

Requirement ID	Priority	Software Module	Test Case ID	Status
FR16	Must	shot-analysis.html	Hole/Shot 3	Pass
FR17	Must	shot-analysis.html	Hole/Shot 3	Pass
FR18	Must	shot-analysis.html	Hole/Shot 3	Pass
FR19	Should	shot-analysis.html	Hole/Shot 4	Pass
FR20	Could	-	Unimplemented	Fail

*Figure 6.17: Table showcasing the RTM for the functional requirements 16-20*

Requirement ID	Priority	Software Module	Test Case ID	Status
FR21	Must	profile.html	Profile Access 3	Pass
FR22	Must	scorecard.html	Profile Access 4	Pass
FR23	Must	scorecard.html	Profile Access 5	Pass
FR24	Should	-	Unimplemented	Fail
FR25	Could	-	Unimplemented	Fail

Figure 6.17: Table showcasing the RTM for the functional requirements 21-25

Requirement ID	Priority	Software Module	Test Case ID	Status
FR26	Must	golf_blueprint.sql	Authentication 1	Pass
FR27	Must	1.svg	Hole/Shot 1	Pass
FR28	Could	-	Unimplemented	Pass

Figure 6.17: Table showcasing the RTM for the functional requirements 26-28

The RTM demonstrates The Golf Blueprint successfully met its primary objective through complete implementation of 100% of "Must Have" requirements. Strategic prioritisation ensured core functionality for shot data collection, heatmap visualisation, and progress tracking was delivered successfully.

While some secondary features remain for future implementation, these don't impact the system's fundamental value proposition. The 74.1% overall implementation rate represents appropriate balance between feature completeness and development timeframe constraints.

## 7. Conclusion and Next Steps

### 7.1 Conclusion

The project was overall a great success, achieving 100% of the Must Have requirements set at the project's outset. To reflect upon the project in greater detail, I will use Gibbs' Reflective Cycle (Gibbs, 1988) (Appendix 1.1) to critically evaluate the project as a whole.

#### 7.1.1 Description

The Golf Blueprint project aimed to create a data-driven golf course management tool for The Kendleshire Golf Club, enabling players to make informed strategic decisions through visual heatmap analytics. Following Agile methodology, this project evolved from concept to fully functional web application, implementing 100% of "Must Have" requirements and achieving an overall implementation rate of 74.1% across all prioritised features.

Development encompassed detailed SVG recreations of all 18 holes, an interactive shot tracking system, comprehensive data visualisation, and user progress tracking capabilities.

#### 7.1.2 Feelings

The development journey evoked mixed enthusiasm and technical challenge. Initial excitement stemmed from identifying a genuine opportunity to improve course management for Kendleshire golfers, supported by strong primary research validation (85% interest level). This motivation proved essential during technically demanding phases, particularly creating accurate SVG hole representations and zone-specific analytics. Responsive testing feedback was particularly rewarding, confirming the system's potential value. However, inability to implement all "Should Have" and "Could Have" features within the timeframe generated some frustration, despite understanding academic project constraints.

### 7.1.3 Evaluation

The project's strengths lie in its focused approach to solving a specific problem with a tailored solution. Successful implementation of core functionality—user authentication, shot data collection, and heatmap visualisation—demonstrates concept viability. The strategic decision to prioritise development using MoSCoW methodology proved effective, ensuring essential features were delivered to high standards. Comprehensive testing (31 test cases across 4 components) validated system reliability and usability.

Limitations included inability to implement several enhancement features, including password reset functionality (FR4), user statistics comparison (FR24), and achievement badges (FR25). The project would have benefited from more extensive user testing throughout development rather than primarily at completion. Additionally, time invested in SVG creation, whilst necessary for accurate visualisation, consumed resources that could have supported implementing additional features.

### 7.1.4 Analysis

Primary research findings strongly correlated with project outcomes, confirming the need for a course-specific management tool. The 80% of respondents reporting "Average" or worse understanding of course management aligned with 85% expressing interest in The Golf Blueprint concept, reinforcing the market opportunity identified during inception.

Architectural decisions, particularly implementing interactive SVG graphics and zone-specific data collection, provided the technical foundation necessary for accurate heatmap visualisation. The comprehensive database schema successfully supported complex relationships between users, rounds, holes, and shots, enabling meaningful data analysis.

The Agile methodology choice proved appropriate given variable workload alongside other academic commitments, though more structured timeboxing could have improved feature completion. The Requirements Traceability Matrix demonstrates strong alignment between project objectives and implementation, with all "Must Have" requirements successfully delivered.

### 7.1.5 Conclusion

The Golf Blueprint successfully delivers on its core objective of providing data-driven course management insights specific to The Kendleshire Golf Club. The system's ability to collect, analyse, and visualise shot data fulfils a demonstrated need among the target audience. While enhancement features remain for future implementation, these do not diminish the fundamental value proposition of improved course management through visual analytics.

The project could have benefited from earlier user involvement in development, potentially through iterative prototyping. A more conservative scope definition might have allowed complete implementation of all planned features, though this would have risked limiting the system's comprehensive approach to course management visualisation.

## 7.2 Next Steps

### 7.2.1 Short-term Development Plans

1. **Complete "Should Have" Requirements:** Implement password reset functionality (FR4), ability to edit account details (FR5), and user performance comparison features (FR24).
2. **Enhance Data Validation:** Strengthen the shot data validation system to improve data accuracy, implementing limits on rounds per day (FR13) and supporting shot data review.
3. **Conduct Extended User Testing:** Engage with a broader group of members from The Kendleshire for extended testing across varying skill levels to identify usability improvements and validate the effectiveness of the provided course management recommendations.

### 7.2.2 Long-term Development Vision

1. **Mobile Application Development:** Create a native mobile application to enable shot data collection during rounds, potentially using GPS to improve shot location accuracy.
2. **Integration Capabilities:** Develop integration with existing golf handicap systems (FR30) to provide a more comprehensive golfing experience.
3. **Expanded Analytics:** Implement comparative visualizations between user-specific data and aggregated data (FR20) and achievement badges for round milestones (FR25).
4. **Multi-Course Expansion:** Adapt The Golf Blueprint framework for additional golf courses, creating a scalable platform for course-specific management insights

## 8 References

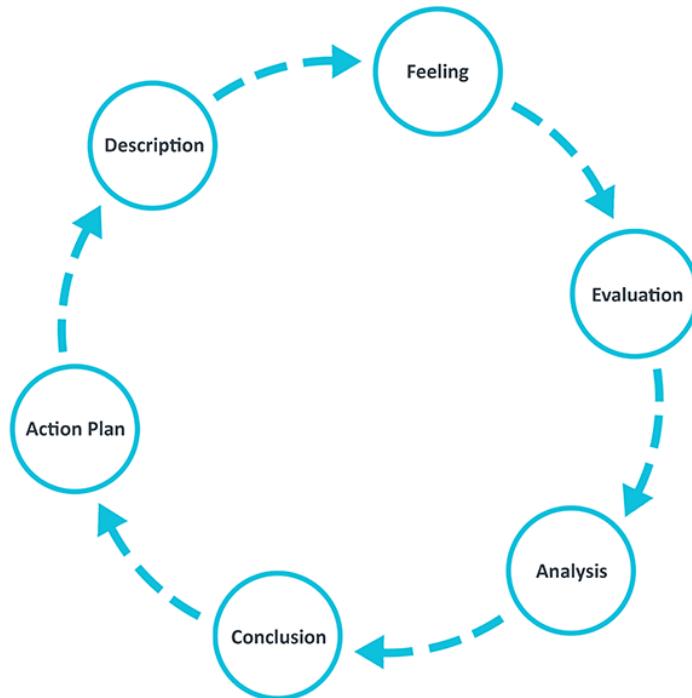
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## 9 Appendices

### Appendix 1.1:



*Appendix 1.1: Gibbs' reflective model*

**Appendix 1.2:**

## The Golf Blueprint Informed Consent Form

Addressing future reuse of research data

**Please tick the appropriate boxes**

**1. Taking part in the study**

**Yes      No**

I have read and understood the study information dated [09/12/2024], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions, and I can withdraw from the study at any time, without having to give a reason.

I understand that taking part in the study involves completing an anonymous Qualtrics questionnaire, completed by you the participant.

**2. Use of the information in the study**

I understand that information I provide will be used for helping to create 'The Golf Blueprint', a website that will collect data from golfers who play at the Kendleshire to hopefully show how better golf can be played.

I understand that personal information collected about me that can identify me, such as my name or where I live, will not be shared beyond the study team.

**3. Future use and reuse of the information by others**

I give permission for the questionnaire data that I provide to be deposited in an anonymous survey database within the Qualtrics system, and the information that I provide about my future rounds of golf at the Kendleshire will be stored in a secure, anonymous database, so it can be used for future research and learning, and improvement of The Golf Blueprint resource.

**4. Signatures**

---

Name of participant [IN CAPITALS]      Signature      Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

---

Name of researcher [IN CAPITALS]      Signature      Date

**5. Study contact details for further information**

Sion Hayward – Project Manager of The Golf Blueprint  
Email – sion2.hayward@live.uwe.ac.uk

*Appendix 1.2: Questionnaire Consent Form*

### Appendix 1.3:



### Participant Information Sheet: The Golf Blueprint

#### Participant Information Sheet: The Golf Blueprint

You are invited to participate in a research project that will help shape the development of "The Golf Blueprint" - a web-based system designed to help golfers improve their scoring at the Kendleshire Golf Club in Bristol. This research is being conducted as part of a final year software engineering project at UWE Bristol. The proposed system aims to provide golfers with data-driven insights about how to play each hole effectively, creating what could essentially become a strategic guide to playing better golf at the Kendleshire.

Before you decide whether to take part, it is important for you to understand why this research is being conducted and what your participation will involve. Please read the following information carefully, and if you have any questions or would like more information, please contact Sion Hayward at [sion2.hayward@live.uwe.ac.uk].

#### What is the aim of this research?

Golf course management and shot selection are crucial elements in improving a player's performance, and for scoring well in a round of golf. Whether you are an aspiring professional, or simply a casual weekend player who is trying to beat their friends, course management is an incredibly powerful tool for improving. Currently, golfers around the world, such as those at the Kendleshire Golf Club rely primarily on personal experience, course guides or advice from friends or professionals to make strategic decisions during their rounds. While valuable, these methods don't capture the wealth of data that could be gathered from analysing thousands of shots from different players played across a golf course.

When watching a professional tournament on the PGA Tour or DP World Tour, fellow golfers can often be left amazed at how well professionals are able to play. However, a commonly overlooked factor is that the professionals spend hours before the tournament even starts, analysing the golf course and working out how to best play it. Even at the highest level, golf is a game of misses and knowing where and where not to miss your shots on certain holes plays a massive role in how well you are able to score during your round.

The aim of this research is to gather feedback from golfers at the Kendleshire about a proposed interactive web-based system that would allow players to record and analyse their rounds. I want to understand whether golfers would find value in a system that could show the most successful strategies for playing each hole through detailed heatmaps and data visualisation. This feedback will help ensure that if developed, the system would genuinely benefit golfers of all skill levels.

Through this questionnaire, I would like to understand:

- What features would be most valuable to you as a golfer
- How you would prefer to interact with such a system

## **Participant Information Sheet:**

### The Golf Blueprint

- What specific insights would help improve your course management
- Whether you would use this type of system during or after your rounds
- How this could complement your existing approach to course management

As a participant in the study, I will also be looking for you to submit data from your rounds of golf, once the website has enough functionality. By collecting this data over time, I can create detailed heatmaps showing the most successful strategies for playing each hole. This could help golfers make more informed decisions about club selection, shot placement, and overall course management.

The kind of data I will collect is:

- Shot locations for each hole (where your ball landed)
- Scores for each hole
- Number of shots taken
- Club Selection
- Final hole score
- Overall round score

I would like to discover if meaningful patterns emerge from collecting this shot data, and whether these patterns can help identify optimal playing strategies for different holes. By analysing data from multiple players over time, I hope to create visual representations that show the most successful approaches to each hole.

By collecting feedback from a diverse range of golfers, I hope to understand whether this type of system would be beneficial to the members of the Kendleshire. Your insights will help determine if and how this project should be developed to best serve both new members learning the course and experienced players looking to improve their course management. Data collected from your future rounds of golf would also be incredibly useful, as this would allow

Be assured that all data collected will be anonymised, ensuring that individual participants cannot be identified. The anonymised data will be stored securely and used solely for research purposes. The findings will help inform whether to proceed with development of this system and, if so, what features and capabilities would be most valuable to include.

**Why have I been invited to take part?**

## **Participant Information Sheet:**

### The Golf Blueprint

As a fellow golfer at the Kendleshire Golf Club, your views and experiences are valuable for understanding how this proposed system could benefit players of all skill levels who also play at the Kendleshire. I am interested in gathering feedback from golfers like yourself about whether a shot-tracking and analysis system would be useful, and if so, what features would be most helpful for improving course management.

Through this research, I'm seeking to understand your perspective as someone who plays the course regularly. Your insights about what information would be most valuable when making strategic decisions on each hole will be crucial in determining if this system should be developed and what capabilities it should include. Whether you're a low handicapper who regularly shoots under par or a beginner still learning the game, your input is equally valuable to this research.

The research will simply ask for your opinions and preferences - no personal identifying information will be collected beyond what is necessary for the research, and your responses will be completely anonymized.

#### **Do I have to take part?**

You do not have to take part in this research. It is entirely up to you to decide whether you want to be involved. If you do decide to take part, you will be given a copy of this information sheet to keep and will be asked to sign a consent form.

If you do decide to take part, you are able to withdraw from the research without giving a reason up until the point at which your data is anonymised and can therefore no longer be traced back to you. This anonymisation will take place 14 days from the date you signed your consent form. If you want to withdraw from the study within this period, please write to Sion Hayward at [sion2.hayward@live.uwe.ac.uk].

Deciding to not take part, either before or after data is provided will not affect you in any way, and the choice remains entirely your own.

#### **What will happen to me if I take part and what do I have to do?**

If you agree to take part in the research, you will be given a questionnaire to complete. The questionnaire will be a simple Qualtrics form, and will be easy to complete, and will not require any special device access. Secondly, once created The Blueprint will give you access to a web-based system that allows you to record your shots and rounds at the Kendleshire Golf Club. This will be accessible through any web browser on your mobile phone, tablet, or computer. The system is designed to be simple to use with minimal instruction and should not significantly impact your pace of play if you do opt to complete it during a round.

The questionnaire will ask about:

- Your thoughts on tracking golf shots and rounds digitally
- What features would be most valuable to you

## **Participant Information Sheet: The Golf Blueprint**

- How you would prefer to record your round data
- Whether you would use such a system during or after your rounds
- How this type of analysis might help improve your game

For The Blueprint website, either during or after your round, you will be required to:

- Sign in using your account details
- Start a new round on the website
- Click on an interactive map of each hole to show where your shots finished
- Select which club you used for each shot
- Enter your score for each hole

You can participate whenever you play a round at the Kendleshire, and there is no minimum number of rounds required. The process of recording your round should take approximately 5-10 minutes if done after your game or can be done hole-by-hole during play.

Your data will be stored securely within a database. For 14 days after you provide data to the website, it will remain traceable back to you. After this period, your data will be fully anonymised and analysed alongside data from other participants to create heatmaps and identify optimal playing strategies for each hole. I hope that as more and more rounds of golf are entered into the database, the data given to the users about the Kendleshire will become more and more accurate, and in turn useful.

In return for your participation, you will have access to the resulting heatmaps and analysis through the same web platform while the resource is being developed. Having access to this data may help you with your own golf game and will hopefully allow you to improve your scores.

### What are the benefits of taking part?

By participating in this research, you will play a valuable role in shaping a potential tool that could benefit many of the members at the Kendleshire, and potentially all golfers in the future. Your feedback will have a direct impact and influence on what features it includes

If the system is developed based on the research findings, participants of the research will:

- Have first access to the platform during its development
- Help create a comprehensive database of playing strategies for the course
- Gain insights into optimal ways to play each hole
- Contribute to a resource that could help both new and experienced golfers improve their course management
- Be part of creating something unique to the Kendleshire that could enhance the golfing experience for all members

Additionally, your participation helps support student research at UWE Bristol, providing valuable real-world feedback that helps bridge the gap between academic study and practical applications. This project represents an opportunity to combine modern technology with the traditional game of golf in ways that could benefit the whole golfing community at the Kendleshire.

### What are the possible risks of taking part?

I do not foresee any risks in you taking part in this study. The questionnaire simply asks for your opinions about the proposed golf analysis system, and you can skip any questions you don't wish to answer. If you later participate in recording your rounds, this would be done during your normal golf activities and would not require any changes to how you play.

All data collected will be handled securely and confidentially, with any personal information being removed after the 14-day withdrawal period. If at any point you feel uncomfortable or wish to stop participating, you can do so immediately without giving any reason.

If you have any concerns or questions during the research, you can contact me directly at [\[sion2.hayward@live.uwe.ac.uk\]](mailto:sion2.hayward@live.uwe.ac.uk), and I will aim to respond quickly and resolve any issues or address any concerns that you may have.

### What will happen to your information?

All information collected through this research project will be treated with strict confidentiality. The questionnaire responses and any future golf round data will be stored securely and handled according to data protection guidelines.

During the initial 14-day period after you provide data, your information will be stored with a unique identifier that allows you to withdraw if you wish. After this period, all personal identifying information will be removed, and your data will be fully anonymised. Only myself and my academic supervisors will have access to the non-anonymised data during this period.

The anonymised data will be used for:

- Analysing the potential value of a golf shot tracking system
- Understanding golfer preferences and requirements
- Informing the development of the proposed system
- Academic research purposes as part of my final year project

All findings will be presented in an anonymised format that cannot be traced back to individual participants. The results may be used in my project report and other academic publications, but no personal information will ever be shared.

### Where will the results of this research study be published?

A Report will be written containing our research findings. This Report will be available on the University of the West of England's open-access Research Repository. The project funder is the College of Arts, Technology and Environment. The report will be made available to all research participants who would like to see it, please just ask.

### Who has ethically approved this research?

The project has been reviewed and approved by the CATE Faculty Research Ethics Committee. Any comments, questions or complaints about the ethical conduct of this study can be addressed to the Research Ethics Committee at the University of the West of England ([researchethics@uwe.ac.uk](mailto:researchethics@uwe.ac.uk)).

## Privacy Notice for Research Participants – The Golf Blueprint

### Purpose of the Privacy Notice

This privacy notice explains how the University of the West of England, Bristol (UWE Bristol) collects, manages and uses your personal data before, during and after you participate in 'The Golf Blueprint' project. 'Personal data' means any information relating to an identified or identifiable natural person (the data subject).

This privacy notice adheres to the General Data Protection Regulation (GDPR) principle of transparency. This means it gives information about:

- How and why your data will be used for the research;
- What your rights are under GDPR; and
- How to contact UWE Bristol and the project lead in relation to questions, concerns or exercising your rights regarding the use of your personal data.

This Privacy Notice should be read in conjunction with the Participant Information Sheet and Ethical Consent Form provided to you before you agree to take part in the research.

### Why are we processing your personal data?

UWE Bristol undertakes research under its public function to provide research for the benefit of society. As a data controller we are committed to protecting the privacy and security of your personal data in accordance with the (EU) 2016/679 the General Data Protection Regulation (GDPR), the Data Protection Act 2018 (or any successor legislation) and any other legislation directly relating to privacy laws that apply (together "the Data Protection Legislation"). General information on Data Protection law is available from the Information Commissioner's Office (<https://ico.org.uk/>).

### How do we use your personal data?

We will only process your personal data when the law allows us to. In addition, we will always comply with UWE Bristol's policies and procedures in processing your personal data. Our lawful basis for using your personal data for research purposes is fulfilling tasks in the public interest, and for archiving purposes in the public interest, for scientific or historical research purposes.

We will always tell you about the information we wish to collect from you and how we will use it. We will not use your personal data for automated decision making about you or for profiling purposes.

Our research is governed by robust policies and procedures and, where human participants are involved, is subject to ethical approval from either UWE Bristol's Faculty or University Research Ethics Committees. This research has been approved by CATE Faculty Research Ethics Committee, ethics application **reference number FET-2122-131**. Any comments, questions or complaints about the ethical conduct of this study can be addressed to the Research Ethics Committee at the University of the West of England at: [Researchethics@uwe.ac.uk](mailto:Researchethics@uwe.ac.uk)

The research team adhere to the principles of the General Data Protection Regulation (GDPR). For more information about UWE Bristol's research ethics approval process please see our Research Ethics webpages ([www1.uwe.ac.uk/research/researchethics](http://www1.uwe.ac.uk/research/researchethics)).

### What data do we collect?

The data we collect will vary from project to project. Researchers will only collect data that is essential for their project. The specific categories of personal data processed are described in the Participant Information Sheet provided to you with this Privacy Notice. The only personal information we collect about you is your consent.

### Who do we share your data with?

We will only share your personal data in accordance with the attached Participant Information Sheet. Any data that can be linked to you personally will only be seen by the research team. Only once it has been anonymised will it be available more widely.

### How do we keep your data secure?

We take a robust approach to protecting your information with secure electronic and physical storage areas for research data with controlled access. Access to your personal data is strictly controlled on a need to know basis and data is stored and transmitted securely using methods such as encryption and access controls for physical records where appropriate.

Alongside these technical measures there are comprehensive and effective policies and processes in place to ensure that those who process your personal information (such as researchers, relevant University administrators and/or third-party processors) are aware of their obligations and responsibilities for the data they have access to.

By default, people are only granted access to the information they require to perform their duties. Mandatory data protection and information security training is provided to staff and expert advice available if needed.

### How long do we keep your data for?

Your personal data will only be retained for as long as is necessary to fulfil the cited purpose of the research. The length of time we keep your personal data will depend on several factors including the significance of the data, funder requirements, and the nature of the study. Specific details are provided in the attached Participant Information Sheet. Any information that could be used to identify you will be destroyed or deleted before the end of the project.

Anonymised data that falls outside the scope of data protection legislation as it contains no identifying or identifiable information may be stored in UWE Bristol's research data archive or another carefully selected appropriate data archive.

### Your Rights and how to exercise them

Under the Data Protection legislation, you have the following **qualified rights**:

- (1) The right to access your personal data held by or on behalf of the University;
- (2) The right to rectification if the information is inaccurate or incomplete;
- (3) The right to restrict processing and/or erasure of your personal data;
- (4) The right to data portability;
- (5) The right to object to processing;
- (6) The right to object to automated decision making and profiling;
- (7) The right to complain to the Information Commissioner's Office (ICO).

We will always respond to concerns or queries you may have. If you wish to exercise your rights or have any other general data protection queries, please contact UWE Bristol's Data Protection Officer ([dataprotection@uwe.ac.uk](mailto:dataprotection@uwe.ac.uk)).

If you have any complaints or queries relating to the research in which you are taking part please contact either the research project lead, whose details are in the attached Participant Information Sheet or UWE Bristol's research governance manager ([researchgovernance@uwe.ac.uk](mailto:researchgovernance@uwe.ac.uk)).

### *Appendix 1.3: Participant Information Sheet*



The Golf Blueprint is aiming to create a data-driven course management resource that will help the golfers who play at The Kendleshire to improve their scores.

Once operational, the resource will:

- Collect shot data from golfers at The Kendleshire
- Create heatmaps showing optimal and challenging areas for each hole
- Provide hole-specific strategic recommendations
- Help players make better decisions during their rounds

By participating in this study you will help to shape the development of this tool, and ensure that it meets the needs of the golfers at The Kendleshire.

This survey should take around 5 minutes to complete. Please be aware that your participation in this study is voluntary, and you have the right to withdraw from participating at any point. If you have any questions related to this survey or The Golf Blueprint, please contact the project leader Sion Hayward at [sion2.hayward@live.uwe.ac.uk].

By consenting to participation below, you acknowledge:

- Your participation in the study is voluntary
- You are 18 years of age or older
- You are aware that you can end your participation at any time

I consent

I do not consent



Would you feel motivated to submit data about your rounds to create a more accurate resource for you and other golfers?

Yes

No

What features would you want to see on this website/app?



How interested would you be in an app/website that shows you the most optimal areas to aim for on every hole at The Kendleshire for a better score?

Very Interested

Interested

Uninterested

Very Uninterested

Would you be willing to participate in the data collection for this project?

Yes

No



What features do you find the most useful on these apps?



How long have you been a member at the Kendleshire?

- 0-5 years
- 6-10 years
- 10 years+

What is your current handicap?

- 0 or better
- 1-5
- 6-10
- 11-20
- 20+

How often do you play at The Kendleshire?

- More than once per week
- Once per week
- Twice per month
- Once per month
- Less than once per month

How would you rate your understanding of course management?

Select One	<input type="radio"/> Very Good	<input type="radio"/> Good	<input type="radio"/> Average	<input type="radio"/> Bad	<input type="radio"/> Very Bad
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Do you currently use any golf apps or technology during your rounds?

- Yes
- No

#### *Appendix 1.4: Questionnaire Questions*