

FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

AlumniEI World Map: A Platform for Lifelong Connections

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Abstract

Alumni networks are organized groups or associations that connect alumni (former students) of an educational institution. These networks are designed to encourage relationships between alumni and their alma mater, as well as among alumni themselves. They often serve as a platform for professional networking, mentorship, social interactions, and maintaining a sense of community.

This report explores the features and limitations of an already-existing alumni platform. The application displays clusters of FEUP alumni on a world map and allows users to filter the former students by their graduation year and degree.

The project aims to introduce solutions to current limitations, such as displaying additional available data, a temporal visualization system, and authenticated user features. Each user is now displayed with their job title and respective company. A timeline was implemented, allowing users to visualize the alumni locations and job titles on the map across different years, and a review system was created, allowing authenticated users to share their thoughts and experiences regarding a company or location they have worked at.

Additionally, the implementations are further supported by the analyzed existing literature and analogous platforms, as well as the conducted validations. Finally, the findings emphasize alumni platforms' role in facilitating engagement, promoting connections with institutions, contributing to professional opportunities, and helping broader regional development.

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Listings

Abbreviations and Symbols

API	Application Programming Interface
CSS	Cascading Style Sheets
DEI	Departamento de Engenharia Informática
FEUP	Faculdade de Engenharia da Universidade do Porto
ORM	Object-Relational Mapping
SDGs	Sustainable Development Goals
SUS	System Usability Scale

Chapter 1

Introduction

1.1 Context

To commemorate the 30th anniversary of FEUP's [10] first program in Informatics Engineering, known as the Bachelor of Informatics and Computing Engineering, released in 1994, a gathering was organized where former students could reunite and share experiences since completing their degrees.

Universities tend to have difficulty in tracking and maintaining contact with alumni, in addition to that, the alumni themselves often struggle to stay in touch with each other. As a result, a motivation to understand where alumni are in the present and the career paths they had taken arose, leading to the creation of a website called **AlumniEI World**¹, a project developed from January 1st to June 31st of 2024. AlumniEI World is aimed at visually representing the worldwide distribution of alumni from several bachelor's and master's programs, under the responsibility of the Department of Informatics Engineering, the desired result being achieved by pulling data from LinkedIn [25] and then further cross-referencing it with Sigarra [10].

The initial project was developed with the intent of being an introductory solution to the problem, functioning primarily as a prototype. Due to its limited development time, the initial solution has a set of limitations, which are detailed in a later section. These limitations have motivated the current project, aiming to advance the platform's development and address its shortcomings.

¹<https://eic30anos.fe.up.pt/alumnieiworld>

1.2 The Initial AlumniEI World Platform

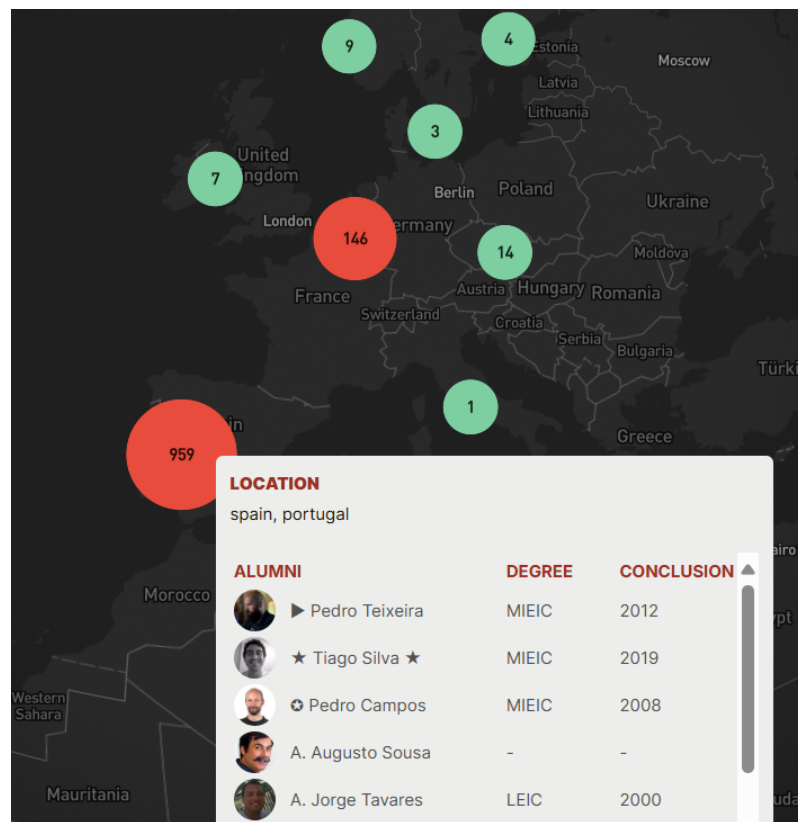


Figure 1.1: Original AlumniEI World Platform

As mentioned earlier, the original solution functions primarily as a prototype and is limited by a lack of extended development time, resulting in a set of shortcomings. The first notable limitation is the unorthodox joining method, which requires users to fill out a Google Forms [18] document with details such as their name, student number, year of conclusion, degree obtained, and LinkedIn profile. This data must then be manually processed and cross-referenced with the university's website to ensure validity.

Following that, the application has a limited set of information available. Currently, the only data that can be obtained from the website is the alumni's current location, making it impossible to track any past movements, along with their name, degree, conclusion year and LinkedIn page. Due to the limited amount of stored information, the filtering capabilities are also constrained to this specific set, allowing only for searches by name, course, and conclusion year. Additionally, each filtering option is of unique selection, preventing more complex queries from being made.

Moreover, LinkedIn profiles do not require every field to be normalized or filled in, creating gaps and discrepancies in the data that need workarounds to address.

Lastly, information displayed on the platform must be updated manually. While most of the displayed data is of a static nature and unlikely to change, a refresh of the data still has to be manually triggered.

1.3 High Level Objectives and Expected Results

- The project aims to introduce a temporal dimension to the platform, enabling searches around the globe not only based on the latest locations and information but also showcasing data from past positions in an intuitive manner (i.e., time sliders).
- A key objective is improving authentication to facilitate a more automated sign-up process, addressing one of the platform's current limitations. An updated authentication system would also enable personalized user experiences, such as the visualization and sharing of tailored opportunities, events, and user reviews.
- Beyond addressing existing limitations, the project plans to expand the platform's capabilities by integrating other courses from the Department of Informatics Engineering and incorporating additional categorical information. This enhancement would improve filtering features (for example, allowing users to filter by job title or company) and support the display of statistical information.
- Finally, the project aims to implement natural language filtering. This feature would convert natural language queries into filtering parameters, simplifying the process of searching for alumni.

1.4 Classification Component

Currently, another master's thesis, labeled as the **Classification Component**, is being developed in parallel, aiming to categorize LinkedIn data automatically. This initiative addresses the issue of data standardization, such as discrepancies between job titles for similar positions. The new system seeks to maintain an updated database of present and past user information, mainly locations and job positions, enabling goals such as the temporal dimension, incorporation of additional categorical information, and improved filtering features.

1.5 Structure

This report's structure begins with a **Background** section, providing context and explaining the original platform, its feature set, and limitations. Following this, the **State of the Art** section examines similar platforms and solutions, identifying relevant details that constitute these platforms and could be of relevance to improve the old system, and existing frameworks to aid the implementation of visualization techniques. The literature Review builds on this by analyzing relevant academic research to support the project's objectives. The report then transitions to the **System design and architecture** section, which outlines the project's goals, objectives, proposed approach, and design. The following is the **System Functionality and User Interaction** section, introducing the existing system and outlining the new functionalities and improvements. Additionally, a **Tests and validation** section details how the solution was evaluated to ensure its effectiveness and

relevance. Finally, a **Conclusions and future work** section reflects on the project's objectives and their fulfillment levels and discusses future work and potential improvements to the platform.

Chapter 2

State of The Art

The State of the Art section explores existing platforms and relevant research. Alumni network-related research can help understand proposed questions, such as what are the main challenges that universities face when trying to maintain long-term contact with alumni? What are the most effective methods to obtain alumni engagement? What can motivate alumni to keep participating in the network? How can alumni networks help their members grow professionally? What features are the most relevant to alumni?

Employed strategies involve examining academic research to highlight relevant theories and methodologies, as well as identifying successful strategies, common challenges, and effective solutions to those challenges, and helping to answer proposed research questions. Additionally, identifying similar platforms, their features, and limitations, since analyzing design patterns of existing and working systems is a key point of interest. Finally, to help fulfill the goals of dynamic data visualization, some visualization frameworks are analyzed.

2.1 Alumni Networks

George Ashline [3] highlights that alumni networks can inspire and guide students through tangible success stories, offering real-world examples of career trajectories and a better perception of industries and roles aligned with their education. Moreover, alumni networks help foster lifelong engagement with the institution. It is suggested to use exit surveys during graduation to collect contact information and gauge interest in network participation. Outreach efforts with the intent of reconnecting with alumni should ideally focus on recent graduates or those celebrating major graduation anniversaries, such as 5, 10, or 20 years since graduation, or in significant times in the academic calendar, such as holidays or graduation periods. Additionally, alumni interest can be sustained by sharing departmental updates via newsletters featuring faculty achievements, highlights, and lists of recent student graduates and honors.

When analyzing the goals, structure, and function of alumni networks, David and Coenen [9] note that these networks are often under-resourced, with limited professional staff and funding.

Activities like newsletters, homecoming events, and student-teacher exchanges on social networking platforms are common but are often insufficient for retention or (re)-attraction. However, these initiatives can serve as a foundation for developing more impactful strategies for (re)-attraction. Furthermore, many networks prioritize university-related activities, with minimal collaboration with regional stakeholders or a focus on regional promotion. To contribute meaningfully to regional development, alumni networks should diversify their communication channels to include regional opportunities, such as local job markets, in addition to university goals.

Rubens et al. [12] utilized web crawlers to collect data and assemble a dataset of alumni holding executive, investor, and board-level positions in technology-based industries and their corresponding service sectors. This dataset was analyzed using network science methodologies, offering a dynamic perspective compared to traditional tabular data analysis methods, such as examining average salaries or employment rates. The study examined alumni relationships with their universities, companies, and business clusters. The findings suggest that educational institutions can gain significant advantages from better understanding the connections of their alumni. Insights from this understanding can be utilized to better design curricula and enrichment programs, which constitute the educational experience. The authors emphasize the potential of integrating network analysis with predictive methods, such as machine learning, and leveraging visualization tools to align faculty, administrators, and donors around resource allocation and educational strategies.

2.2 Alumni and Alumni-related Platforms

The most notable examples of analogous platforms include other universities' alumni sites, generic alumni solutions, networking social media platforms, as well as other applications that track their members globally. The table (2.1) below showcases a general overview of the platforms that were chosen to be represented. Platforms were chosen based on how similar they were to the desired system or how well they integrate a particular feature of interest to the development of the application.

Table 2.1: General Overview

System	Graduway	Harvard	LinkedIn	GPS
Type	Generic Alumni Solution	University Alumni Portal	Social Media	Networking Platform
Temporal	User Profile History	User Profile History	User Profile History	Location Data per year
Type of Community	Alumni, Mentor/Mentee	Alumni, Mentor/Mentee	LinkedIn Users	Portuguese Scientists
Data Source	Provided by User	University Data	Provided by User	Provided by User
Standout Features	Gamification, Surveys, Newsletters	Alumni Directory, Mentoring	Advanced Filters	World Map, Temporal Location Data

2.2.0.1 Graduway/Harvard

Graduway [19]. and the **Harvard Alumni Entrepreneurs Association** [2] website have been grouped together as they provide similar experiences. Graduway offers a service in the form of an alumni platform, while the Harvard Alumni Association website exemplifies a university alumni platform in practice. Most other alternatives found are similar in design, and as such, these two were selected to represent alumni websites due to being better documented.

The **Alumni Directory** page indexes the alumni on the platform, presenting their information in the form of individual profiles. It also offers filtering options to facilitate the search for specific alumni. Examples can be seen in Annex [Alumni Directory Pages](#).

Both platforms provide a **Mentoring** feature. Mentors on an alumni platform play a role in providing guidance and support to help foster growth, build connections, and create a supportive environment for other alumni or students. Examples can be seen in Annex [Alumni Mentoring Pages](#).

The **Groups** feature on an alumni platform facilitates focused and meaningful interactions. Allowing for more specialized networking to help connect with like-minded users who share the same views or area of study. Examples can be seen in Annex [Alumni Groups Pages](#).

The **Events** page serves as a hub for alumni to stay informed about upcoming activities, gatherings, and opportunities to connect with the community. Examples can be seen in Annex [Alumni Event Pages](#).

2.2.0.2 LinkedIn

LinkedIn is a social media network centered around businesses, careers, and job opportunities. While it is not inherently an alumni platform, it is common for alumni groups to be formed on the website. The main standout feature is the robust set of filtering options provided, which helps

users find specific members more efficiently. The image (Figure 2.1) below, taken, as an example, from the FEUP alumni group, demonstrates this functionality by making available a complex array of filtering options.

The image shows a complex filtering interface for LinkedIn. It is organized into several sections:

- Filter only**: A dropdown menu set to 'People' with a 'by' label. Below it are tabs for '1st' and '2nd' connections.
- Connections of**: A section with a '+ Add a connection' button.
- Followers of**: A section with a '+ Add a creator' button.
- Locations**: A section with checkboxes for 'Portugal', 'Porto, Portugal', 'Porto Metropolitan Area', 'Porto', and 'Brazil'. It includes a '+ Add a location' button.
- School**: A section with checkboxes for 'Faculdade de Engenharia da Universidade do Porto', 'UFSCar - Alumni', 'Universidade do Porto', 'Porto Business School', and 'FEP U. Porto - Economics and Management'. It includes a '+ Add a school' button.
- Industry**: A section with checkboxes for 'Professional Services', 'Technology, Information and Internet', 'Technology, Information and Media', 'Manufacturing', and 'Education'. It includes a '+ Add an industry' button.
- Past company**: A section with checkboxes for 'Faculdade de Engenharia da Universidade do Porto', 'INESC TEC', 'Universidade do Porto', 'BEST Porto', and 'FAPESP'. It includes a '+ Add a company' button.
- Current company**: A section with checkboxes for 'Faculdade de Engenharia da Universidade do Porto', 'INESC TEC', 'Universidade do Porto', 'MIGSO-PCUBED', and 'European Commission'. It includes a '+ Add a company' button.
- Keywords**: A section with input fields for 'First name', 'Last name', 'Title', 'Company', and 'School'.

Figure 2.1: LinkedIn Filters

2.2.0.3 GPS

GPS [11] stands for Global Portuguese Scientists. It is an application designed to track its members worldwide, to understand where they are and what journeys they have taken. The platform aims to ease collaboration amongst Portuguese scientists, enhancing their visibility and recognition on a global scale. Their website serves as an excellent example of an application that visually represents their members' locations on a map. Additionally, it features a temporal timeline, allowing users to view where members were at specific points in time, organized by year.



Figure 2.2: Gps World Map

2.3 Information Visualization

In *The Eyes Have It*, Ben Shneiderman [31] introduces the visual information-seeking mantra: “Overview first, zoom and filter, then details-on-demand,” which summarizes the basic principle of visual design. He identifies seven data types, with two-dimensional data (planar or map data), temporal data, and network data (relationships between items) being particularly relevant. These data types are analyzed through seven key tasks that form the foundation of effective visualization. The first task, overview, involves providing a broad, zoomed-out perspective of the dataset, offering users a comprehensive understanding of the information at a glance. Following this, zoom enables users to focus on specific subsets of the data that interest them, while filtering allows the exclusion of irrelevant items, enabling users to control the content displayed and focus their interest. Once the relevant data is isolated, the details-on-demand task provides access to in-depth information about particular items or groups within the dataset. The relate task further enhances understanding by illustrating the relationships between different items, while the history task supports user interaction by maintaining a record of actions, enabling undo functionality. Finally, the extract task allows users to extract sub-collections or specific query parameters for future analysis. In *A Tour through the Visualization Zoo* [20], several notable techniques for visualizing and interacting with diverse datasets are explored, with three approaches standing out as particularly relevant. Flow maps use stroked lines overlaid on a geographic map to represent the movement of an entity across space and, implicitly, over time, making them useful for representing spatial and temporal changes. Choropleth maps, another technique, apply color encoding to geographic areas to communicate data, with one recommendation being to encode normalized values as opposed to raw data. An alternative approach is to use graduated symbol maps, which place symbols over an underlying map, allowing for the visualization of multiple dimensions simultaneously.

2.4 Visualization Frameworks

Visualization frameworks are software tools or libraries designed to transform raw data into visual representations such as charts, graphs, maps, and interactive dashboards. These frameworks enable developers to display datasets, providing an easier-to-use visual way for users to analyze and find relevant patterns and trends.

2.4.1 vis.gl

vis.gl [16] is an open-source suite of interoperable open-source visualization frameworks developed originally by Uber. It's designed to support large-scale geospatial data visualization

2.4.1.1 deck.gl

deck.gl [15] is the cornerstone library of the vis.gl Catalog. The framework is a GPU-powered tool for visual exploratory data analysis of large datasets. The design is around the use of Vanilla JavaScript or the React interface and integrates with base map libraries such as Google Maps or Mapbox [24]. The framework allows complex visualizations to be constructed by composing existing layers. The layer catalog is composed of 13 core layers, of which the icon layer, used to render custom icons or symbols at specific geographic locations. It was explored as a relevant way of quickly displaying increases or decreases of alumni concentrations in a cluster.

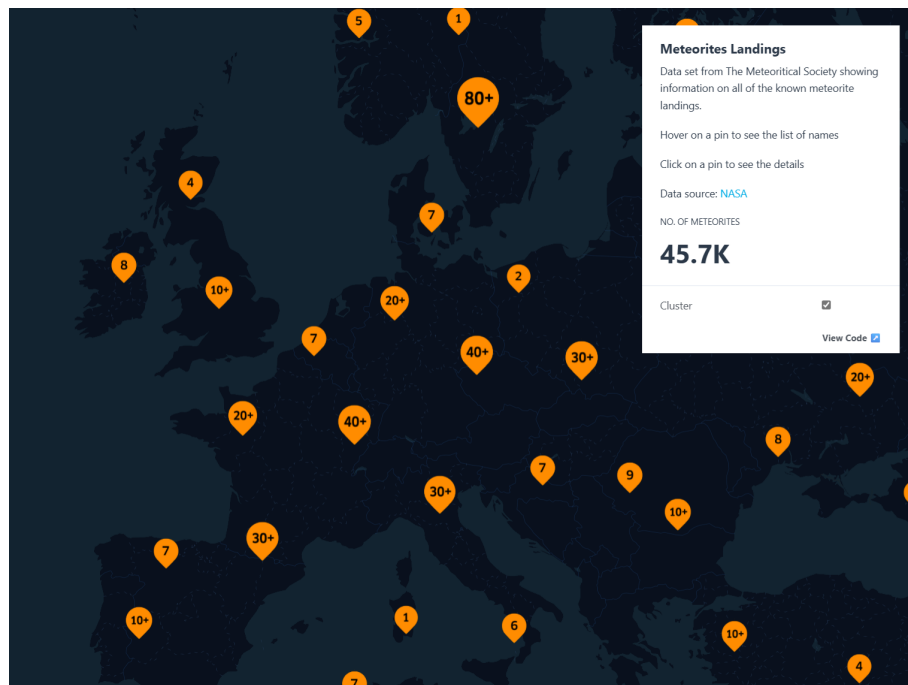


Figure 2.3: deck.gl Icon Layer example [13]

Furthermore, the arc layer is designed to draw curved arcs between pairs of geographic coordinates. These arcs are rendered in 3D space and can be used to visualize connections or flows

between locations. This technology was also explored as a potential means of animating the map and displaying alumni migration flows.

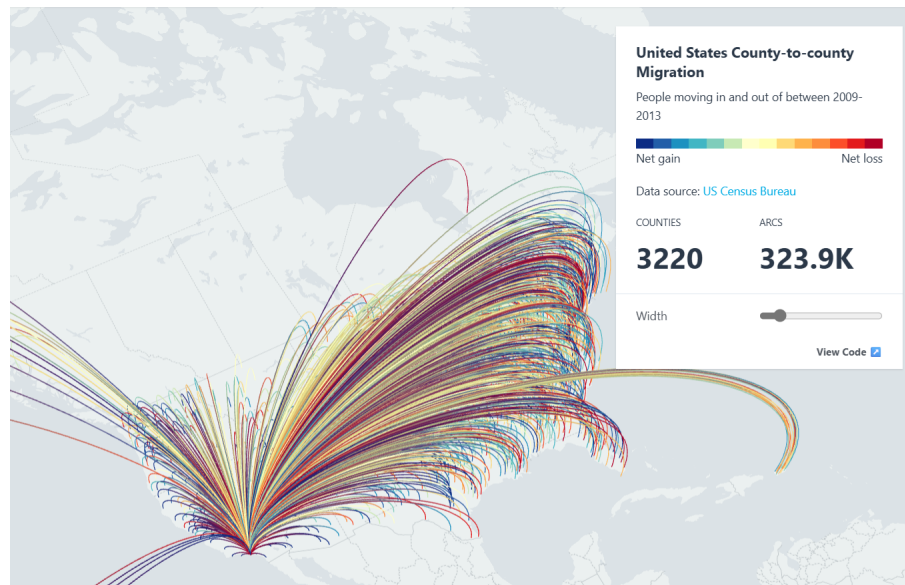


Figure 2.4: deck.gl Arch Layer example [14]

2.4.1.2 FlowmapBlue

FlowmapBlue [4] is an open-source tool built on top of deck.gl that makes use of Mapbox and specializes in visualizing flow data by displaying aggregated numbers of movements between geographic locations. As a standalone tool, FlowmapBlue is a low-code application used to create customizable flow maps that can represent a number of topics, such as urban mobility, commuting behavior, bus, subway, and air travel. However, a potential integration of the tool's open-source code into the AlumniEI platform was investigated. It was discovered that the application hasn't been updated in over 2 years, resulting in outdated or deprecated packages, versioning conflicts, and difficulty integrating with newer, up-to-date versions of React.

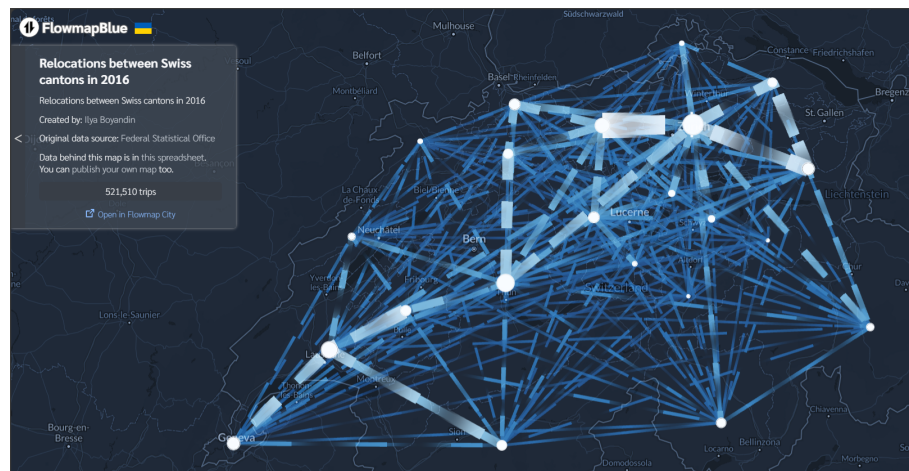


Figure 2.5: FlowmapBlue [5]

2.4.2 Mapbox GL

Developed by Mapbox, **Mapbox GL** [23] is a suite of open-source libraries designed to embed customizable and responsive client-side maps in web-based applications. One of the tools of Mapbox GL is the Mapbox GL JS library. A JavaScript specific library for rendering interactive maps using WebGL [7]. Much like deck.gl, Mapbox GL JS renders its contents using multiple layers. The circle layer is used on the AlumniEI website to display the alumni cluster circles, and the symbol layer is used to display alumni cluster counts.

2.5 Natural Language Queying

Lowe et al. [22] conducted a study to compare the retrieval effectiveness of Boolean searching with Google-style natural language searching for simple research questions commonly encountered in introductory undergraduate course projects. The study found that the effectiveness of retrieving information using natural language search was comparable to that of Boolean searching. However, Boolean logic introduces a learning curve, making natural language search a more user-friendly alternative. The researchers concluded that natural language search can enhance the usability and accessibility of information, making it a viable choice in environments where ease of use and user satisfaction are priorities. The main drawback of natural language search is its reliance on natural language processing algorithms to accurately parse and interpret user inputs.

2.6 Conclusions

The overall research shows that alumni networks are essential for creating value for universities and their alumni. They enhance opportunities for mentorship, professional guidance, and job placements for both graduates and current students. It is advised to focus on building the social aspect of the network and keep alumni interest through methods such as groups and events. Provide

and promote opportunities not only within the university but also to engage with the region. Additionally, trying to understand how the network is connected could provide important information to help create meaningful opportunities. Furthermore, relevant tactics for information visualization were mentioned, even though a portion of the techniques are already implemented, adding newer ones, such as an activity history with undo capabilities or the possibility to export subsets of data, could become significant. Lastly, natural language search has the potential to improve the overall usability of the application while making it more user-friendly. However, not much is yet known about specific details regarding proceeding with a natural language search implementation.

Chapter 3

System Design and Architecture

3.1 Requirements

The first objective is to integrate a temporal dimension, enabling users not only to view an alumnus's current location but also to track their past locations. Achieving this would require creating and displaying snapshots of information for each specific filter selected by the user. For example, yearly data snapshots could be implemented, allowing users to select and visualize information from a particular year, through an intuitive manner (i.e., time sliders), similar to GPS timelines. A foreseeable challenge in this process is correlating temporal information with location data, since the best method to generate snapshots without introducing significant gaps in an individual's history is still unknown. Additionally, current plans are to implement a similar visualization tactic for year of conclusion, allowing users to easily slide by the year of graduation of alumni.

The second objective involves improving authentication to streamline the sign-up process and allow platform customization for each user. This could include features such as personalized opportunities, event recommendations, and user reviews, along with facilitating the addition of new courses under the Department of Informatics Engineering. The current plan includes implementing traditional email and password logins alongside LinkedIn OAuth [1] authentication. While integrating a Sigarra login was considered, it is not feasible due to the lack of a readily available integration method and the fact that many users no longer have access to their old Sigarra accounts. Without Sigarra authentication, automatic user verification becomes impossible, necessitating some form of manual verification. The proposed solution is a verified user structure, where new users can join the platform with limited functionality as unverified users. Once their information is cross-referenced and approved by an administrator, they will become verified, unlocking full access to the platform.

The next goal would be to enable the display of new categorical data directly on the platform, such as job titles, companies, or seniority levels. The added data from the classification component can allow users to access basic information without having to open LinkedIn, and enables the implementation of more advanced filtering features.

A lower-priority objective is the implementation of natural language filtering. This feature

aims to convert natural language queries into filtering parameters, making it easier and more intuitive for users to search for alumni on the platform.

3.1.1 Functional and Non-functional Requirements

This section lists the main requirements for the development of the system. Functional requirements describe specific features and functions the system must perform to meet user and business needs, and Non-functional requirements define the quality attributes, performance standards, and constraints the system must adhere to, such as usability, reliability, and scalability.

As functional requirements:

- **FR1** — Allow the user to view data/events for a selected year;
- **FR2** — Allow users to select a range of years on the timeline;
- **FR3** — Automatically update the timeline to reflect data across the selected year or year range
- **FR5** — Display location-based reviews on a map to authenticated users.
- **FR6** — Allow authenticated users to hover on a map location and read associated reviews.
- **FR7** — Allow authenticated users to submit a review linked to a company;
- **FR8** — Allow authenticated users to submit a review linked to a location;
- **FR9** — Allow authenticated users to filter a review by type, rating, date, and relevance;

As non-functional requirements:

Performance requirements:

- **NFR1** — The map interfaces should load within a reasonable amount of time.

Security requirements:

- **NFR3** — Review features should be limited to authenticated users;
- **NFR4** — Users should be limited to submitting reviews for companies or locations where they have worked.

3.2 Use Cases

The diagram (Figure 3.1) demonstrates the use cases for the application. Use cases labeled with a letter (i.e., UCA, UCB) are representative of use cases that already existed from the original application, while use cases represented with a number (i.e., UC1, UC2) emerged from the requirements listed above.

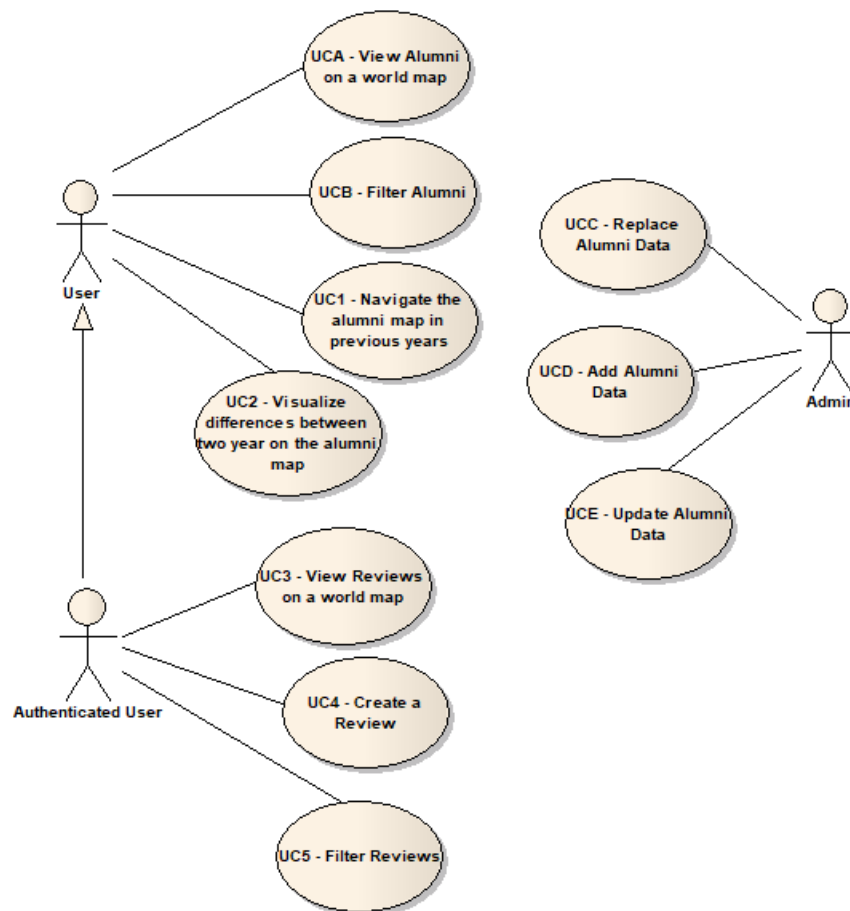


Figure 3.1: Use Case Diagram

3.2.1 Actors

The **User** has the main functionalities of the app, the lookup of alumni, and the search/filtering features. An **Admin** is required by the application for management-related functions. They have secure login access to the platform, which provides them with exclusive privileges to manage information. The capabilities consist of adding, replacing, or updating alumni data. The **Authenticated User** has access to additional functionalities, at the moment, limited to reading user reviews and creating a subsequent review.

3.2.2 Use Case Specification

3.2.2.1 UC1 - Navigate the alumni map in previous years

Description: As a user, I want to view past alumni locations and roles.

Flow of events:

- 1 - The user opens the filters tab and selects the timeline filtering checkbox.

- 2 - The system displays a timeline.
- 3 - The user drags to select a year between 1994 and the present year and lets go of the slider.
- 4 - The system updates the map to reflect the user positions and roles from the selected year.

3.2.2.2 UC2 - Visualize differences between two years on the alumni map

Description: As a user, I want to infer differences in alumni presence between a selected range of years.

Flow of events:

- 1 - The user opens the filters tab and selects the timeline filtering checkbox, followed by the "range selection" toggle.
- 2 - The system displays a timeline with two sliders.
- 3 - The user drags each slider to select a year between 1994 and the present year and lets go.
- 4 - The system updates the map to reflect the difference in alumni aggregation for each location that has or had alumni.

3.2.2.3 UC3 - View Reviews on a world map

Description: As an authenticated user, I want to view alumni reviews of locations and companies.

Preconditions : The user must be authenticated.

Flow of events:

- 1 - The user opens the side menu and selects the Reviews button.
- 2 - The system displays the world map with clusters of reviews.
- 3 - The user hovers over a cluster.
- 4 - The system displays a list of reviews for the hovered location.

Alternate scenario

- 5 - The user selects to up-vote or down-vote a review.
- 6 - The system marks and displays the review with the new vote.

3.2.2.4 UC4 - Create a Review

Description: As an authenticated user, I want to create a review of a location or company.

Preconditions :

The user must be authenticated.

The user must be on the reviews world map page.

Flow of events:

- 1 - The user clicks the Write a Review button in the bottom right corner of the map.
- 2 - The system displays the option to pick between a company review or a location review.
- 3 - The user selects to review a company.
- 4 - The system displays the create a company review form.
- 5 - The user selects a company associated with their profile, chooses a rating from 1 to 5 stars, writes a review that is between 10 and 500 characters long, and chooses the review anonymity.
- 6 - The system saves the review and displays it in the world map.

Alternate scenario

- 3a - The user selects to review a location.
- 3a1 - The system displays the create a location review form.
- 3a2 - The user selects a location associated with their profile, chooses a rating from 1 to 5 stars, writes a review that is between 10 and 500 characters long, and chooses the review anonymity.

Proceed with step 6.

3.2.2.5 UC5 - Filter Reviews

Description: As an authenticated user, I want to filter the review map to better identify relevant reviews.

Preconditions :

The user must be authenticated.

The user must be on the reviews world map page.

Flow of events:

- 1 - The user opens the filters tab.
- 2 - The system displays the filtering options.
- 3 - The user selects to filter by country or city, by review type, by rating, by date range, and/or by votes.
- 4 - The system automatically updates the world map using the filtering parameters.

3.3 Domain Model

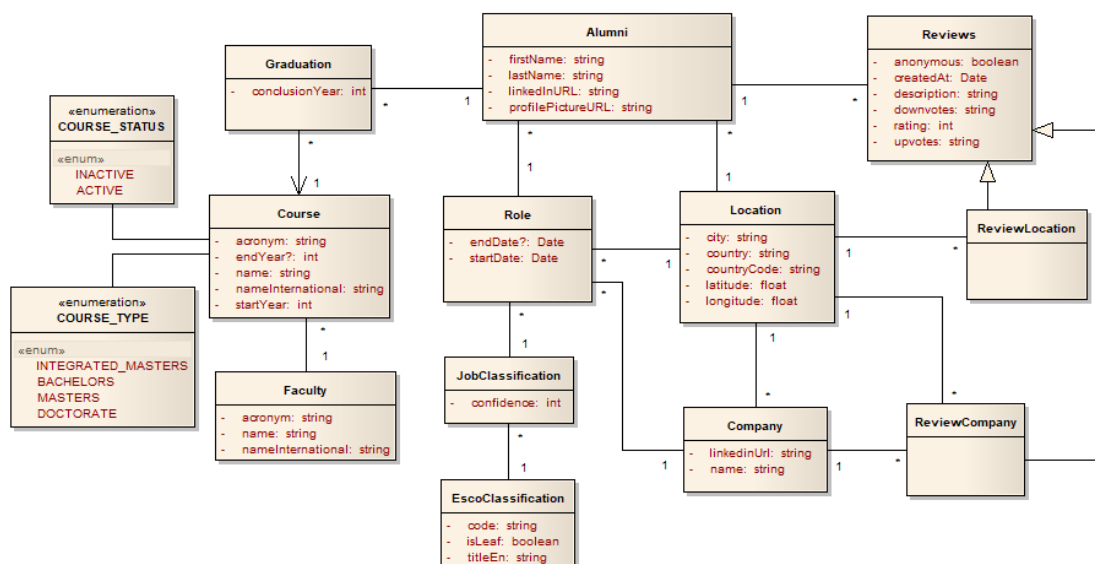


Figure 3.2: Domain Model

The domain of the application had to be adjusted to fit the new requirements. The *Graduation* and *Faculty* entities help evolve the concept of *Course*. This facilitates the expansion of the platform to new DEI courses while future-proofing the system for the eventuality of adding courses from other departments or other faculties. A new *Role* entity was added, each role represents a job position that an alumnus holds or used to hold, each *Role* is associated with a *Location* and a *Company*, and has a *Job Classification* that is automatically assigned based on an *ESCO Classification* [32] (the European multilingual classification of Skills, Competences and Occupations). Lastly, alumni can have *Reviews* associated with them, each review can be of type *ReviewLocation* or *ReviewCompany*.

3.4 Architecture and Technologies

The old system was composed of a back-end application written in Java and made use of JavaScript and React to compose the front-end application. Externally, it was connected to a proxy service called **ProxyCurl** [26] that helps retrieve LinkedIn Data. Additionally, it made calls to the **GeoNames API** [17] to obtain information regarding the geographical coordinates of alumni locations. Finally, Sigarra was used as a source of alumni information, however, it is not directly connected to the system, and associations have to be made manually.

The old architecture of the application incorporates a solution for joining the program, which involves completing a questionnaire through **Google Forms**. The information is then manually cross-referenced between the application form, data from the **LinkedIn API**, and the Sigarra platform. Once verified, the information is added to the database and displayed on the website.

Some time into the development phase, the entire code base was migrated. The front-end application was moved to **Next.js**, a React framework, integrated using TypeScript and Tailwind CSS, and the back-end portion is now in **Nest.js**, a Node.js framework also written in TypeScript. The changes that were performed resulted in the following architecture (Figure 3.3)

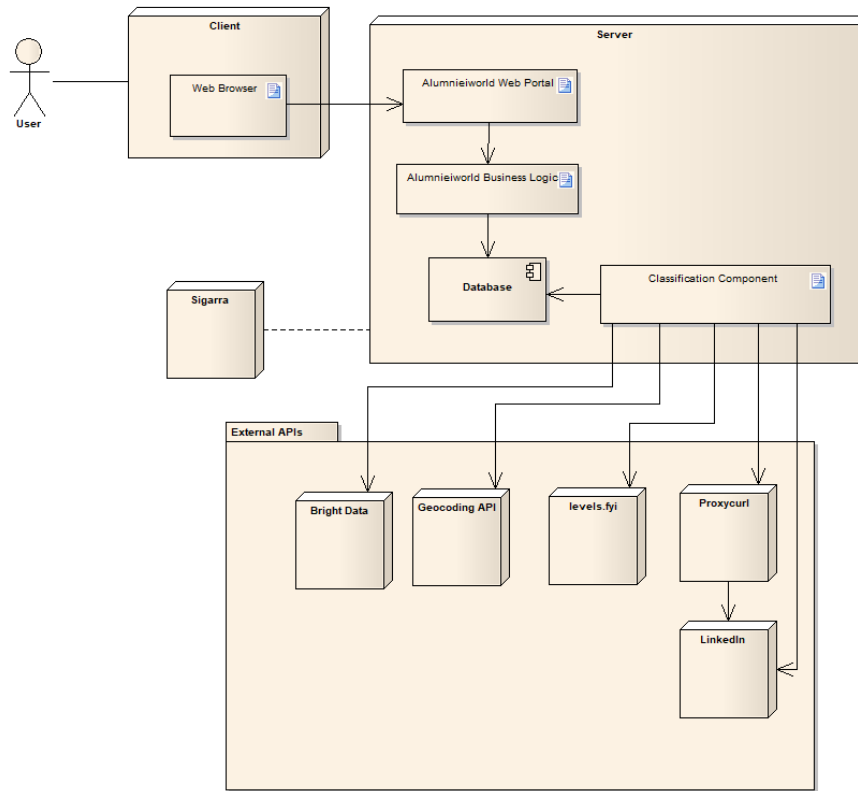


Figure 3.3: New Architecture

The updated architecture seeks to replace the previously required Google Forms in favor of a login option directly on the webpage. Additionally, it introduces the **Classification Component**, designed to update the database with user and company information based on LinkedIn profiles, which will then be utilized by other components within the system. Additionally, the new system keeps the **PostgreSQL** SQL database but adds **Prisma** [28] as a TypeScript ORM tool to facilitate database management and **Redis** [29], an in-memory database, to handle the caching behavior of the application. Externally, the application keeps the usage of Proxycurl to obtain LinkedIn data, while adding new connections to LinkedIn to handle authentication, **BrightData** [8] to handle company data, the **Geocoding API** [27] is used to extract user coordinates, instead of the previously used GeoNames API, and lastly, it also makes use of the **levels.fyi** [21] platform to obtain salary data for select companies.

3.5 Detailed Design

This section provides a global specification of the system functionalities, represented by class diagrams.

3.5.1 Alumni Functionalities

The diagram 3.4 refers to the alumni world map functionalities, mainly the timeline-related use cases.

3.5.2 Review Functionalities

The diagram 3.5 refers to the review world map functionalities.

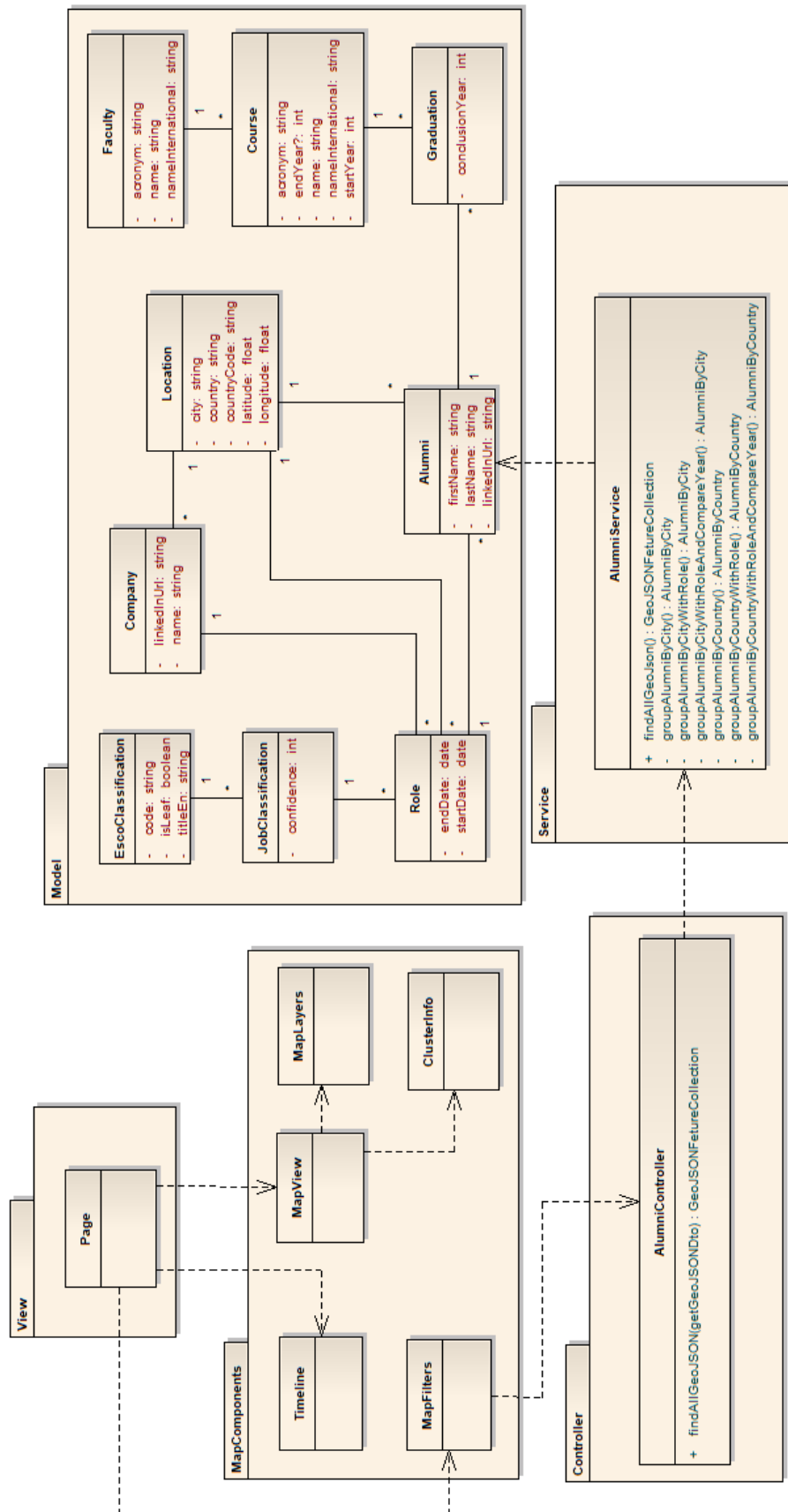


Figure 3.4: Alumni Map Class Diagram

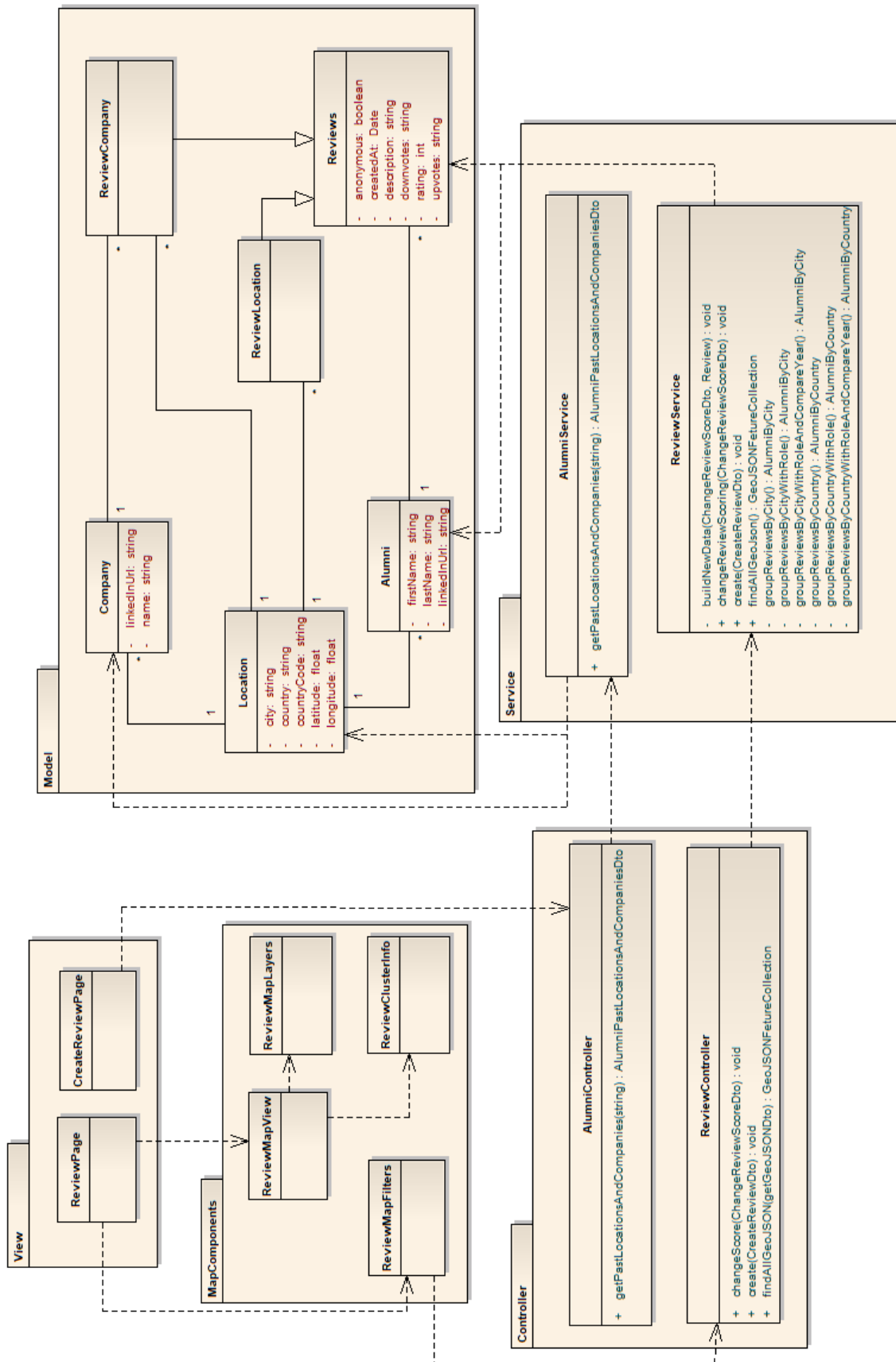


Figure 3.5: Review Map Class Diagram

3.5.3 Use Case Realization

The diagram **B.1** represents the sequence diagram for the first use case, **Navigate the alumni map in previous years**. Assuming the user is already on the alumni map page with the filters tab open, the user selects the timeline checkbox, which then renders the timeline below. After dragging to select a year, that year is set in the *MapFilters*, and a call is made to the *AlumniController* of the back-end application. The controller then calls the `findAllGeoJSON()` function from the *AlumniService*, which in turn makes a call to the database to obtain the relevant alumni based on the filters used. The alumni are then grouped by either country or city, and returned to the front-end side. Afterwards, the *MapView* component will use the returned information to render the map with the added map layers and the cluster information, and display it to the user.

The diagram **B.2** represents the sequence diagram for the second use case, **Visualize differences between two years on the alumni map**. Assuming the user is already on the alumni map page with the filters tab open, the user selects the timeline checkbox and the year range toggle, which then renders the timeline below. After dragging to select both years, they are set in the *MapFilters*, and a call is made to the *AlumniController* of the back-end application. The controller then calls the `findAllGeoJSON()` function from the *AlumniService*, which in turn makes a call to the database to obtain the relevant alumni based on the filters used. The alumni are then grouped by either country or city, and returned to the front-end side. Afterwards, the *MapView* component will use the returned information to render the map with the added map layers, render the cluster information in year comparison mode, and display it to the user.

The diagram **B.3** represents the sequence diagram for the third use case, **View Reviews on a world map**. Assuming the user is already logged in, they navigate to the review map page, and a call is made to the *ReviewsController* of the back-end application. The controller then calls the `findAllGeoJSON()` function from the *ReviewsService*, which in turn makes a call to the database to obtain the relevant alumni and reviews based on the filters used. The reviews are then grouped by country and returned to the front-end side. Afterwards, the *MapView* component will use the returned information to render the map with the added map layers and the cluster information, and display it to the user. When hovering over a cluster, the user is given the option to up-vote or down-vote the review. Assuming the user casts a vote, the *ReviewsController* is called with the `changeReviewScore()` method. After obtaining the review from the database, the review is then adjusted based on the vote and updated, the changes are then displayed to the user.

The diagram **B.4** represents the sequence diagram for the fourth use case, **Create a Review**. Assuming the user is on the review map page, the user clicks to create a review, and a call is made to the *AlumniController* of the back-end application to obtain the alumnus's past and current location and companies. If the user selects to create a **Company** review, the system displays a form with the user's associated companies and asks to pick one, to pick a rating, write the review itself, and choose if the review is meant to be sent anonymously. A call to the back-end

ReviewsController is made carrying the provided information, and a new instance of review is created and added to the database. The system then redirects the user back to the map. In case the user selects **Location**, a similar process happens, however, the user picks a location instead of a company, and a **Location** review is created instead.

The diagram B.5 represents the sequence diagram for the fifth use case, **Filter Reviews**. Assuming the user is on the review map page, the user selects the desired filters between **groupBy**, type filter (Company or Location), rating, date, or date range, and **sortBy** (most or least voted). After setting the desired filters, a call is made to the *ReviewsController* of the back-end application, calling the *ReviewsService*, which will refresh the data based on the type, date, and rating filters. The new filtered information is then grouped by the chosen **groupBy** option and returned to the front-end application. Afterwards, the *MapView* component will use the returned information to render the map with the added map layers and the cluster information. If **sortBy** is selected, the cluster information will be sorted before being displayed to the user.

3.6 API Methods and Results

Table 3.1: API endpoints

Method	End Point	Function
GET	/alumni/geoJSON	Get the alumni GeoJSON
GET	/alumni/past-locations-companies/id	Get companies and locations from a user
GET	/reviews/geoJSON	Get the Reviews GeoJSON
POST	/reviews	Create a review
POST	/reviews/changeScore	updates a reviews feedback

3.7 Authentication and Joining Mechanisms

Two of the original goals of the project were to add LinkedIn authentication and to remove the Google Forms joining method in favor of an in-application solution. Both of these goals were moved to be implemented as part of the classification component project, since that project took on the responsibility of managing alumni and company data, as well as the process of obtaining said data from LinkedIn. The platform joining method still has to be done manually and later cross-referenced with Sigarra by an application admin, however, this process can now be accomplished via a form accessible inside the application. The LinkedIn OAuth authentication was successful, unfortunately, a problem was discovered where the sign-in API does not return the user's LinkedIn URL, a piece of information necessary to match the user to the database information, as such, when logging in, the user must input their LinkedIn profile URL to enable the matching process. A brief explanation of the authentication process required to utilize the review functionalities is given during the solution implementation section.

Chapter 4

System Functionality and User Interaction

This section describes the developed solution from a user's perspective.

4.1 Visualizing Alumni on the World Map

The following image (Figure 4.1) displays a screenshot of the application's map, where it is possible to see the number of alumni grouped by country.

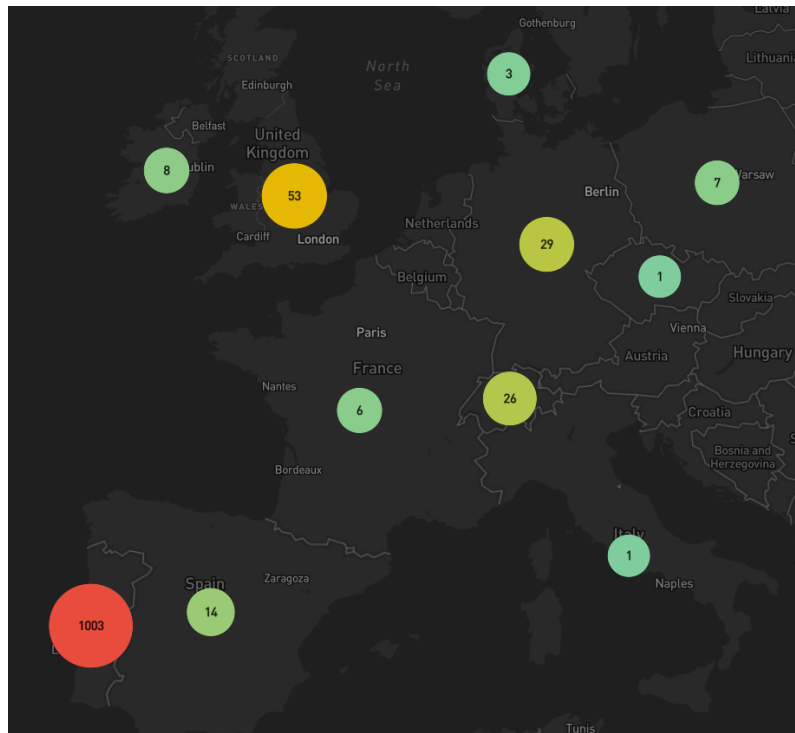


Figure 4.1: World Map By Country View

After zooming in (Figure 4.2), it is possible to inspect a specific country, revealing a list of alumni with their corresponding degree, year of conclusion, name, and profile picture. Clicking on any profile will redirect the user to that alumnus's LinkedIn page. The alumnus's current day role and company were added to the information found when inspecting a cluster.

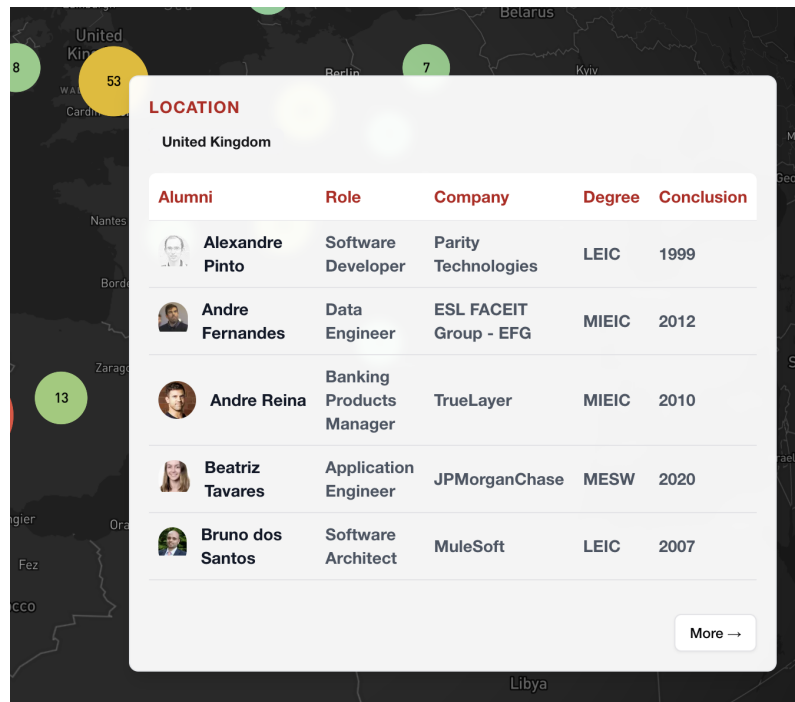


Figure 4.2: Alumni Cluster with added information

Filters (Figure 4.3) are available that allow users to filter by name, degree, and year of conclusion, as well as toggle between country and city views.

The image shows a 'Map Filters' sidebar. At the top is a header 'Map Filters' with a red downward arrow. Below it is a 'Group By' section with two buttons: 'Countries' (highlighted in dark red) and 'Cities' (light gray). Underneath is a 'Search' section with a text input field containing the placeholder 'By alumni name'. A horizontal line separates this from the 'Filter' section. The 'Filter' section contains two dropdown menus: 'Select degree' and 'Select conclusion year', both with downward arrows. Below these is a checkbox labeled 'Time Line'. At the bottom of the filter section is a gray 'Clear' button. Below the filter section is a light gray box containing the text 'Total number of alumni: 1329' and a smaller line of text '*Data from LinkedIn profiles and SIGARRA'.

Figure 4.3: Filters

When typing in the name search box, the user is given the alumni names that best match the search. After selecting the desired alumnus, the map automatically zooms in on their location.

Additionally, the application now allows for multiple degrees and conclusion years to be selected at once (Figure 4.4).

Filter

MESW (x)

LEIC (x)

×

▼

2021 (x)

2018 (x)

×

▼

☐ Time Line

Figure 4.4: Filter by course and conclusion year

Selecting one or more degrees will exclude the alumni who do not belong to the highlighted selections. In a similar fashion, selecting one or more conclusion years removes alumni who concluded their degrees in different years.

The country/city option is a group-by feature that allows the user to switch from the default group-by-country option to grouping alumni by city (Figure 4.5).

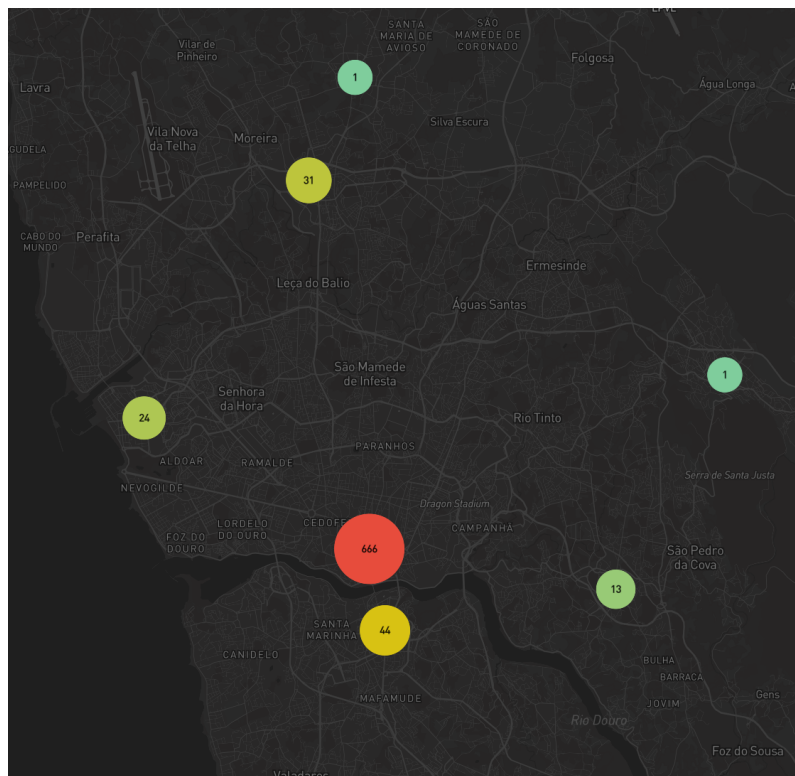


Figure 4.5: Country Map By City View

An additional checkbox option, with the **Time Line** label, was added to the filters section (Figure 4.6).

Filter

Select course



Select conclusion year



☒ Time Line

☐ Single Year

Clear

Figure 4.6: Time Line checkbox

When enabling the **Time Line** filter, a slider that allows the user to drag select a specific year is present by default. After dragging to the desired year, the map automatically updates to display alumni positions and job titles representative of what they were in the selected year (Figure 4.7).

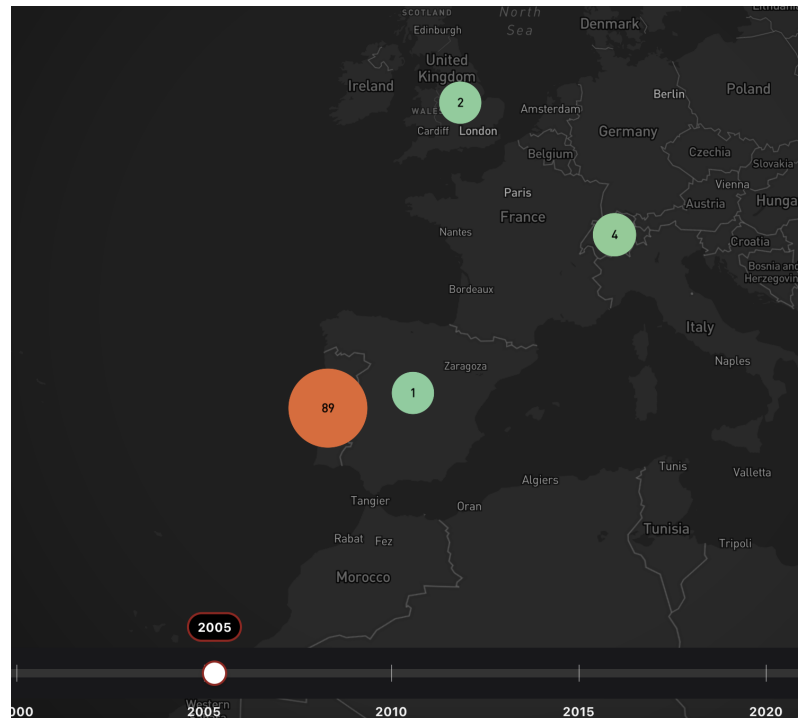


Figure 4.7: Alumni World Map 2005

Enabling the **Single Year** toggle turns the timeline to **Range Selection** mode, making the slider a selectable range between two years.

The range selection changes the alumni list to a card showing the difference in alumni between the older and the newer year for a given cluster (Figure 4.8). The mode also shifts the traditional look from the alumni count to a green arrow icon for situations where the alumni count goes up, a red downward arrow if it goes down, or a yellow equals sign when no changes happen.

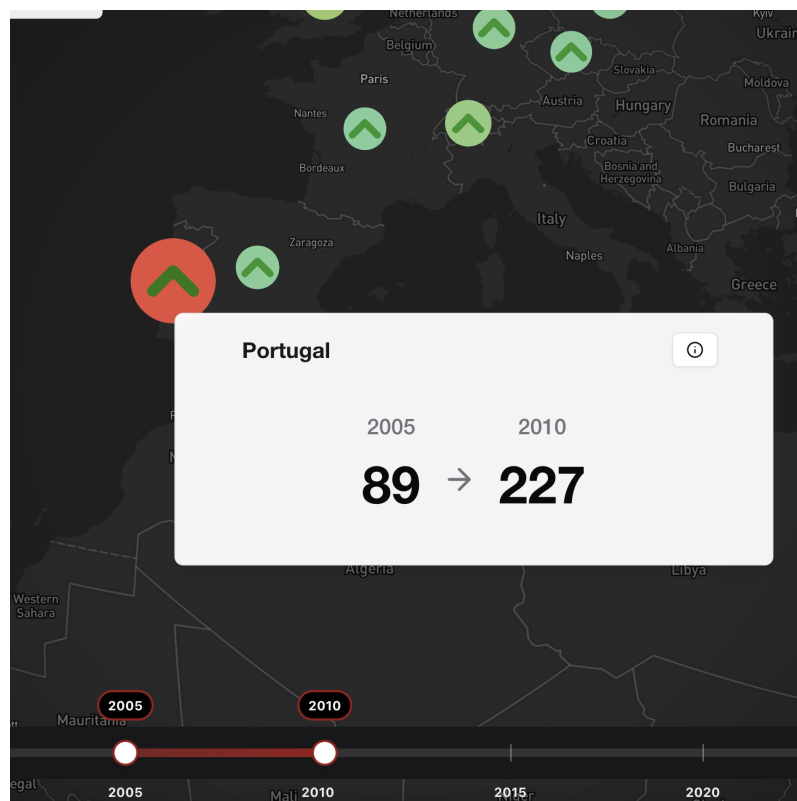


Figure 4.8: Alumni World Map 2005 to 2010

Pressing the icon in the top left allows the user to switch to the **additional info view**. The updated view displays additional stats regarding the number of alumni in the cluster and the total number of alumni, providing the percentage of alumni who were concentrated in that given country or city.

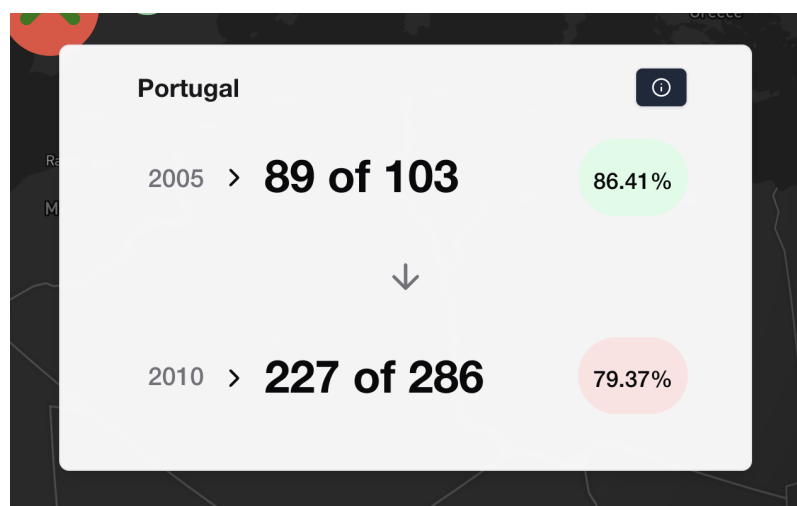


Figure 4.9: Additional info Portugal 2005 to 2010

Finally, filters can be stacked with one another to allow for search combinations. As an example, the figure 4.10 represents the 2018 locations of MIEIC alumni who graduated in 2013.

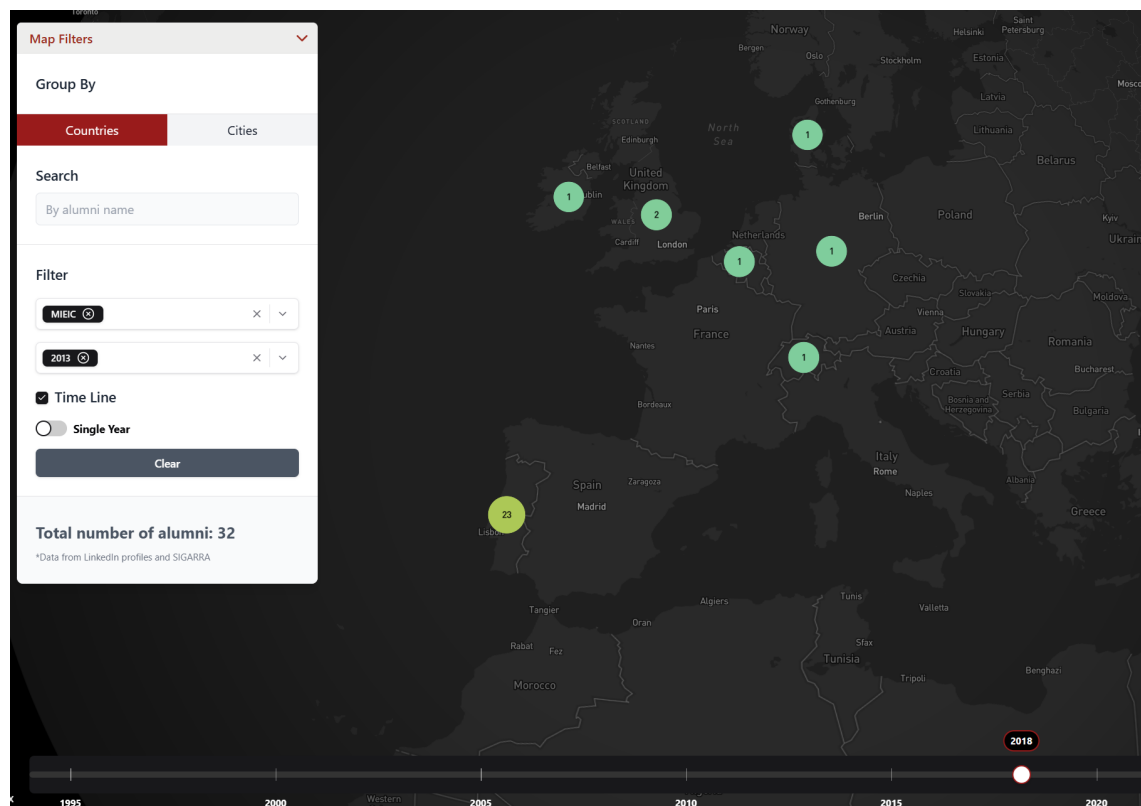


Figure 4.10: 2018 situation of MIEIC students who graduated in 2013

4.2 Authentication

By selecting the **Join Us** button found towards the bottom of the menu bar, the user is prompted with a log-in screen (Figure 4.11) consisting of a **Join the Network** button and an **Unlock extra features with LinkedIn** option.

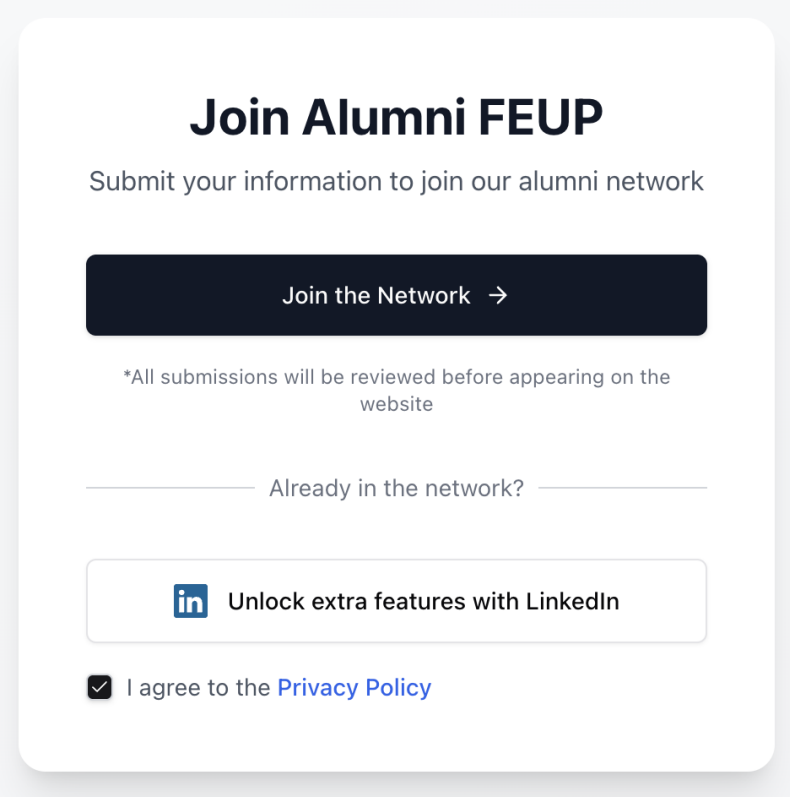
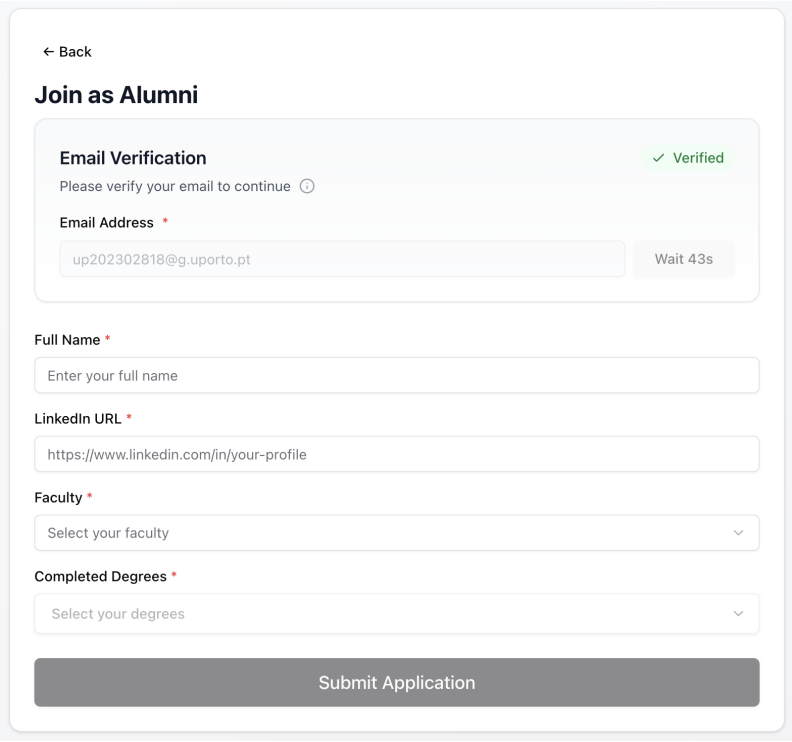
The image shows a login screen for the 'Join Alumni FEUP' network. It features a dark blue header with the title 'Join Alumni FEUP' and a subtitle 'Submit your information to join our alumni network'. Below this is a large dark blue button with the text 'Join the Network →'. A disclaimer states '*All submissions will be reviewed before appearing on the website'. A link 'Already in the network?' is present. A section for LinkedIn integration includes the LinkedIn logo and the text 'Unlock extra features with LinkedIn'. At the bottom, there is a checked checkbox and the text 'I agree to the Privacy Policy'.

Figure 4.11: Alumni FEUP Login Screen

If an alumnus is already registered on the platform, they can sign in with LinkedIn. The user will be redirected to LinkedIn's OAuth platform, and after inputting their credentials, they will be redirected back to the website where they will be asked to fill in their LinkedIn URL. When successful, the user is authenticated.

For alumni who are not yet registered on the platform, they have the option to join by filling in the manual submission form (Figure 4.12) that can later be reviewed by an admin and cross-referenced with Sigarra.



The image shows a web form titled "Join as Alumni". At the top left is a "← Back" link. The form is divided into several sections. The first section is "Email Verification", which includes a green checkmark and the word "Verified". Below this is a prompt "Please verify your email to continue" with a help icon. The "Email Address" field contains "up202302818@g.uporto.pt" and a "Wait 43s" button. The next section is "Full Name" with a text input field containing the placeholder "Enter your full name". This is followed by "LinkedIn URL" with a text input field containing "https://www.linkedin.com/in/your-profile". Then is the "Faculty" section with a dropdown menu showing "Select your faculty". Below that is the "Completed Degrees" section with a dropdown menu showing "Select your degrees". At the bottom of the form is a large grey button labeled "Submit Application".

Figure 4.12: Manual Submission form

4.3 Review System

One of the original goals was to introduce private content to the platform, content that is only accessible to logged-in users. This section explores the features that were made available after the user has authenticated themselves.

After authentication, the user receives an additional menu option called **Review**. The option brings them to a world map similar to the alumni world map, but displays reviews associated with specific locations.

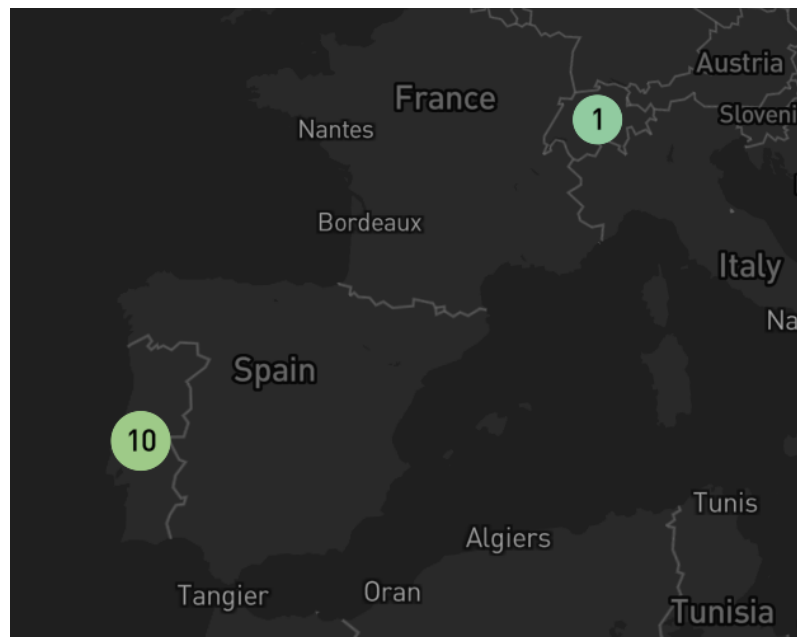


Figure 4.13: Reviews Map

Navigating to a cluster reveals a list of reviews for that location. Reviews have two distinct types **Review Company** or **Review Location**. Reviews of type company are for users wanting to refer to a specific institution they've worked at, while reviews of type location reflect discussions purely about the country or city in question. Users can only submit reviews referencing past or current workplaces or locations.

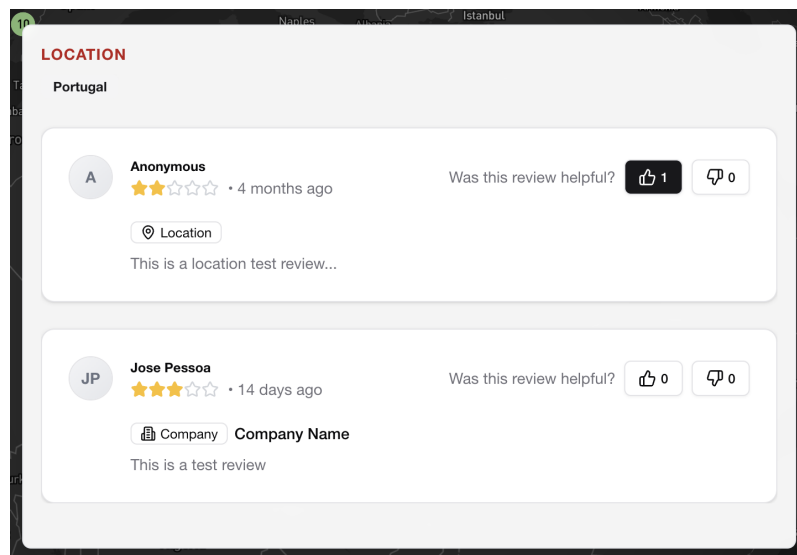


Figure 4.14: Review Cluster

A review consists of the user who made the submission or an Anonymous identity, for cases where the user chooses to submit in anonymous mode (explained in a later section). Additionally, a rating from 1 to 5 stars is visible, followed by how long ago the review was posted. The main

body is composed of the review text itself, with the review type (Company or Location) located above. Company-type reviews additionally display the name of the company being referenced. Finally, the user can see and interact with the feedback system, showing how many users reacted positively and how many reacted negatively to the review.

4.3.0.1 Create Review

The bottom right corner of the map displays a button labeled **Write a Review**. Pressing said button will redirect the user to the review creation page, where the user will be presented with a choice of company or location review. Selecting an option will expand the form, allowing the user to fill in the remaining necessary information. When selecting **Company**, the user is given a drop-down menu with all the companies related to their profile and must select one to associate with the review. Additionally, the user must pick a rating from 1 to 5 stars, type the respective review with a write-up between 10 and 500 characters, and select if they would like the review to be submitted anonymously.

The screenshot shows a 'Write a Review' form with the following elements:

- Title:** 'Write a Review' with a red asterisk and 'Required fields' text.
- Subtitle:** 'Share your experience about a company or location'.
- Question:** 'What are you reviewing?'.
- Options:** Two radio buttons: 'Company' (selected) and 'Location'.
- Field:** 'Company Name' with a red asterisk, featuring a dropdown menu showing 'The companies you have worked at'.
- Text:** 'Select the company you're reviewing'.
- Field:** 'Rating' with a red asterisk, showing five empty star icons.
- Text:** 'How would you rate your experience?'.
- Field:** 'Your Review' with a red asterisk, featuring a large text area with the placeholder 'Share details about your experience...'.
- Text:** 'Provide an honest and detailed review' and a character count '0/500'.
- Option:** A checkbox labeled 'Submit this review anonymously'.
- Button:** A black 'Submit Review' button.

Figure 4.15: Create Company Review

Alternatively, the user can select to post a **Location** review. The process is identical to the one described for a company review, but the user must select a location associated with their profile from the drop-down instead.

Write a Review

* Required fields

Share your experience about a company or location

What are you reviewing?

☐ Company ☒ Location

Location Name *

The locations where you have worked

Select the location you're reviewing

Rating *

How would you rate your experience?

Your Review *

Share details about your experience...

Provide an honest and detailed review

0/500

☒ Submit this review anonymously

Submit Review

Anonymous Review: Your review will be displayed without a name or any identifying information.

Figure 4.16: Create Location Review

4.3.0.2 Filter Review

While browsing the review map, the user has access to a filters tab. Users can filter reviews by type, choosing between company or location reviews. They are also able to filter by rating, selecting reviews from 1 to 5 stars. Additionally, the users can choose to look for reviews on a given date or in a date range. Finally, users can filter by votes, reordering the reviews by most or least voted. The Countries/Cities filter is also present, distributing the available reviews across the designated countries or the respective cities. Selecting a filter will automatically update the map to reflect the changes.

Review Filters

Group By

Countries

Cities

Review Type

Rating

Date Range

Sort by Votes

Clear

Figure 4.17: Review Filters

Chapter 5

Testing and Validation

5.1 System Tests

The tables below demonstrate some system tests that were executed. The layout displays the tests and observed results with an associated use case.

Table 5.1: Alumni Map Tests

UC	Test	Result
UCA	Navigate the world map	The globe moves as expected
UCA	Zooming in and out on the map	When zooming out, the alumni circles
UCA		fail to cluster properly
UCA	Hovering a cluster	Alumni list is displayed
UCA	Navigate Alumni Cluster	When scrolling, there is a problem with the alumni
UCA		information clipping slightly above the label

Table 5.2: Alumni Map Filters Tests

UC	Test	Result
UCB	Filter by country	Alumni are grouped by country
UCB	Filter by city	Alumni are grouped by city
UCB	Filter by alumni name	The map zooms-in on the selected alumni
UCB	Filter by degree	Only alumni with the selected degree are returned
UCB	Filter by conclusion year	Only alumni with the selected conclusion
UCB		year are returned
UCB	Apply multiple filters at once	Displayed alumni match multiple filters

Table 5.3: Alumni Map Timeline Filter Tests

UC	Test	Result
UC1	Filter by single year	Map is automatically updated to the selected year
UC2	Filter by year range	The map is automatically updated, arrow/equals icons are displayed
UC1	Hover cluster (single year)	Displays alumni list
UC2	Hover cluster (range selection)	Displays old and new alumni count
UC2	Show additional info	Displays the total number of alumni and the corresponding percentages

Table 5.4: Reviews Map Tests

UC	Test	Result
UC3	Navigate the world map	The globe moves around as expected
UC3	Zooming in and out on the map	When zooming out, the review circles fail to cluster properly
UC3	Hover cluster	The Review list is displayed
UC3	Navigate the Review Cluster	The reviews are displayed as expected
UC4	Give review feedback	When clicking, adds positive or negative feedback, clicking the other option moves the vote, clicking again removes the vote

Table 5.5: Reviews Map Filters Tests

UC	Test	Result
UC5	Filter by country	Reviews are grouped by country
UC5	Filter by city	Reviews are grouped by city
UC5	Filter by review type	Only reviews of the selected type are returned
UC5	Filter by rating	Only reviews of the selected rating are returned
UC5	Filter by single date	Only reviews on the selected date are returned
UC5	Filter by single date range	Only reviews within the selected dates are returned
UC5	Filter by voted	Reviews are returned in the selected order
UC5	Apply multiple filters at once	Displayed reviews match multiple filters

5.2 Validation

5.2.1 Demonstrations and Focus Groups

On the 4th of June, a demonstration of the AlumniEI platform was given in a meeting composed of DEI teachers. The platform received positive feedback, with some directors showing interest

in integrating courses they oversee into the platform. A week later, on the 12th of June, a focus group was held, giving us the bulk of our feedback. The session, consisting of around 10 members of the AlumniEI board, began with a demonstration of the platform, and then the session members were encouraged to experiment with the platform themselves. From this reunion, some notable suggestions were obtained. Questions were raised regarding the review's anonymity and whether the platform should allow them to be displayed with no associated alumni. Next, the possibility of viewing the map in a flat projection instead of a globe was requested. It was also recommended that we remove, or create a new way of displaying, the cluster of alumni with missing location information, situated at 0°N 0°E on the map.

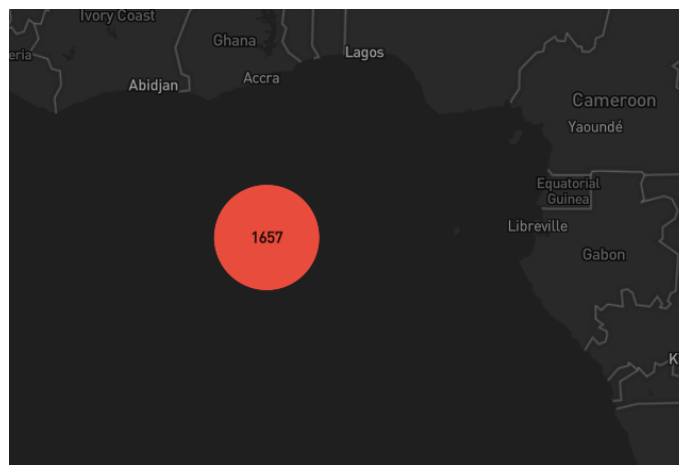


Figure 5.1: 0°N 0°E Alumni cluster

Furthermore, some bugs were reported, mainly the bug related to the alumni list clipping above the header. Finally, some suggestions of features that were already being planned or pondered were made, the possibility to edit or remove reviews, a way to query the platform using a natural language mechanism, a visual representation of alumni migrations, and a way of playing an animation that would automatically evolve the alumni map timeline to display the distribution of alumni over the years in a continuous motion. These suggestions were a helpful way of reinforcing the validity of potential features.

5.2.2 Questionnaire

Another method of validation employed was the distribution of a Google Forms questionnaire relating to the application. By sending emails and creating forum posts (LinkedIn, Slack [30]) containing the questionnaire, an opportunity was given to members of the alumni community to test the application and provide feedback through the related form. The form begins by having the user fill out the **System Usability Scale (SUS)** [6], a common methodology used to measure the perceived usability of a system, composed of 10 items rated on the Likert Scale from 1 to 5, ranging from **strongly disagree** to **strongly agree**. Additionally, some questions are presented

regarding the world map, and another similar set of questions is presented inquiring about the review map. In the end, 21 answers were obtained, resulting in some relevant feedback.

The chart 5.2 displays the results of the System Usability Scale, plotting the average score obtained for each question. When calculating the SUS total, a score of 72 (on a scale from 0 to 100) is obtained, placing the application at a good usability rating, comparatively speaking.

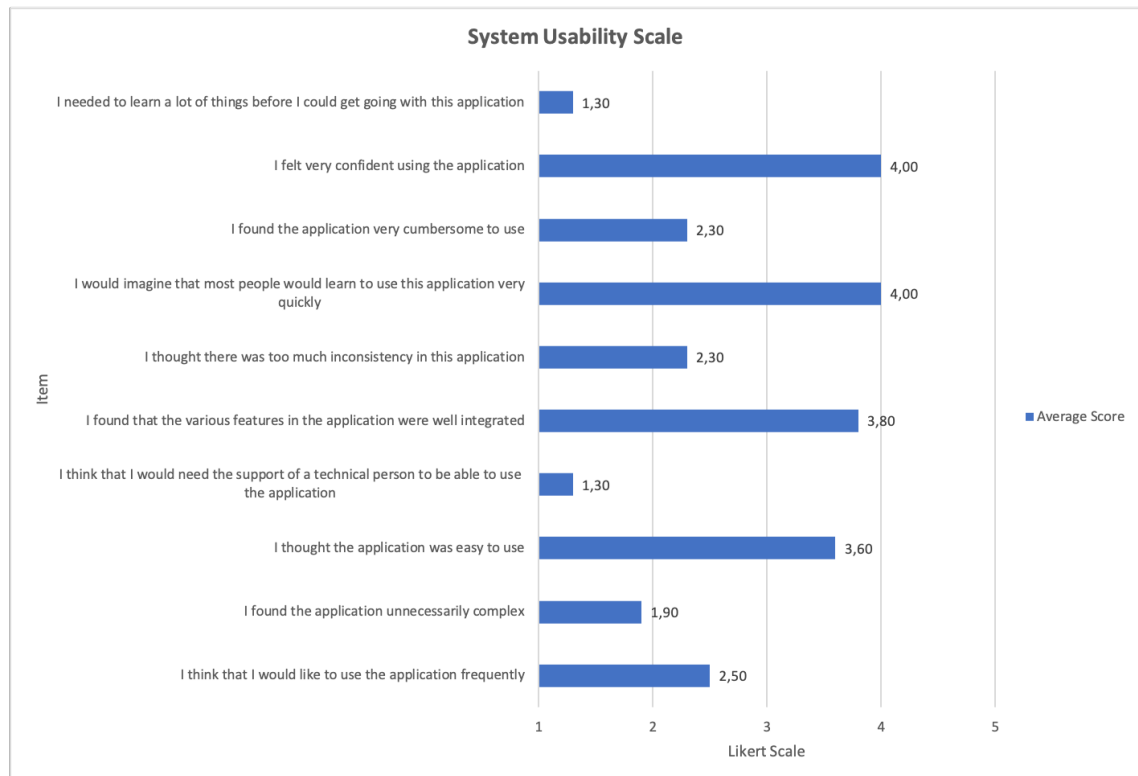


Figure 5.2: System Usability Scale results

In the **world map** questions section, a question regarding how easy the overall visualization experience of alumni on a world map was asked, also using a scale from 1 to 5, representing **Complicated to understand** to **Straightforward**. Additionally, two questions were asked regarding how useful the user found the visualization of alumni on a map, and how useful they found the filters to be. The questions were represented again on a scale from 1 to 5, this time ranging from **Did not use** to **Extremely useful**. The questions all weighed towards a 4, meaning the overall user base found the visualization of alumni to be of easy usage and relevant.

Furthermore, an additional multiple-choice question was present, inquiring about which filters the users found relevant. The most common filters were the country/city view filter and the conclusion year filter, followed by the name and course filters, and finally the timeline filters. A couple of users also reported not finding any filters useful.

The **review map** questions section was displayed only to users who answered yes when asked if they had logged into the platform. Out of the 21 users who took part in the test, only 8 au-

thenticated themselves. As a result, the review map section saw less interaction, obtaining only 7 answers.

This section asked users how easy the experience of visualizing and writing a review was, and while the results lean towards a clear user experience, one user reported both as complicated to understand. The questionnaire then requested two separate questions on how interested the users are in reading reviews regarding locations and how interested they are in reading reviews regarding companies, as well as how likely they are to leave a review of their own. The results show that users are interested in both reading and leaving reviews of both types, with a slight preference towards company reviews.

Moreover, free-text questions were provided for users to leave some optional feedback. The most requested feature was the ability to filter by enrollment year, with one user explaining that most alumni they know identify more with their enrollment year rather than their graduation year. Also, some users requested the ability to filter by job position, by wage band, and by remote/on-site positions. Regarding reviews, feedback was given requesting an alternate view to reviews that would group them by company, as opposed to location.

In conclusion, the System Usability Scale reveals that the application is mostly user-friendly, with the worst scoring parameter being the item relating to how frequently the user would like to use the application. Given the nature of the application, it was mostly expected that users would mainly want to use it periodically instead of regularly. Furthermore, the world map section questions mostly confirmed the system's usability, and the filtering questions revealed that the most common use case was users wanting to identify the specific whereabouts of former university colleagues. Additionally, the review questions section also indicates a simple user experience, for the most part, and demonstrates the fact that users showed interest in having a review system. Finally, the free text questions reinforced user requests for features that were already under consideration, but also revealed requests for features that had not yet been considered, such as filtering by enrollment year or remote/on-site positions.

Chapter 6

Conclusions and Future Work

This section begins by reasoning about the level of fulfillment of the project’s original goals and proceeds by discussing methods and recommendations for future work. The **Fulfillment of Objectives** section evaluates the project’s outcome in comparison to its starting objectives, mentioning the features that were accomplished and explaining the observed limitations. The **Sustainable Development Goals** section reflects on how the work contributes to the United Nations Sustainable Development Goals. The **Future Work** section presents recommendations for platform improvements and suggestions on relevant features for future iterations.

6.1 Fulfillment of Objectives

Overall, the project managed to achieve the primary objectives of displaying temporal data and introducing privileged content to the platform in the form of reviews. Unfortunately, not all goals originally desired were achievable due to unforeseen challenges and time constraints. Initially, a part of the available time was used investigating visualization techniques that proved complicated to implement due to the need to integrate certain technologies within the existing code base, as well as other issues such as package versioning mismatches and complications creating animations on a globe projection. Additionally, some features, such as user LinkedIn roles, required to implement the beginning steps of the work plan (temporal dimension), were being developed concurrently, causing uncertainty during the development period, together with factors such as the database scheme and domain model still being discussed and improved. Finally, the code base migration affected progress by introducing a slight setback and creating some problems related to bugs identified in the previous chapter. As for natural language querying, it was foreseeable early on that the limited amount of time would make this objective close to impossible to achieve.

6.2 Sustainable Development Goals

The United Nations Sustainable Development Goals (SDGs) are a collection of 17 global goals set by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development. This sec-

tion reflects on how the development aligns with the SDGs, which provide an established framework for addressing the most pressing challenges facing our society.

Table 6.1: Sustainable Development Goals

SDG	Goal	Contribution	Performance Indicators and Metrics
4	Quality Education	The application incentivizes connections between alumni and provides valuable data to the university to tailor education topics and methodologies.	Monitoring alumni network activity, comparing academic results between years, and tracking alumni career-related metrics.
8	Decent Work and Economic Growth	An alumni network can help provide opportunities and career growth to its members.	Correlate provided opportunities, events, and resources with alumni career growth.
10	Reduced Inequalities	Alumni networks connect people from diverse backgrounds and geographic locations. The application can broaden the reach of relevant opportunities.	Analyze regional growth from underrepresented regions, and compare levels of engagement for specific events with alumni network activity.
11	Sustainable Cities and Communities	Alumni network activity tends to correlate with positive growth in the regions.	Correlate regional growth with alumni network activity levels.

6.3 Future Work

Future development of the platform is recommended to begin with steps towards refactoring the existing code to resolve current issues and improve the application's scalability. As for the alumni world map, the implementation of additional filtering features (i.e., Role or company) is highly valued. Regarding the reviews feature, the implementation of the remaining CRUD operations (i.e., edit, delete) would help towards a more complete solution. Additionally, the content available to authenticated users could be expanded to the sharing of career opportunities and upcoming events. Moreover, further investigation into effective ways to implement visualization techniques is needed to help represent alumni migration and alumni distribution, and for features such as automatically evolving the alumni map through calendar years or years of graduation. Finally,

analyzing the implementation possibilities of natural language querying, as the platform's functionalities continue to grow, its addition could be a great way to ensure the application remains as user-friendly as possible.

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Appendix A

Alumni Pages

Alumni Directory Pages

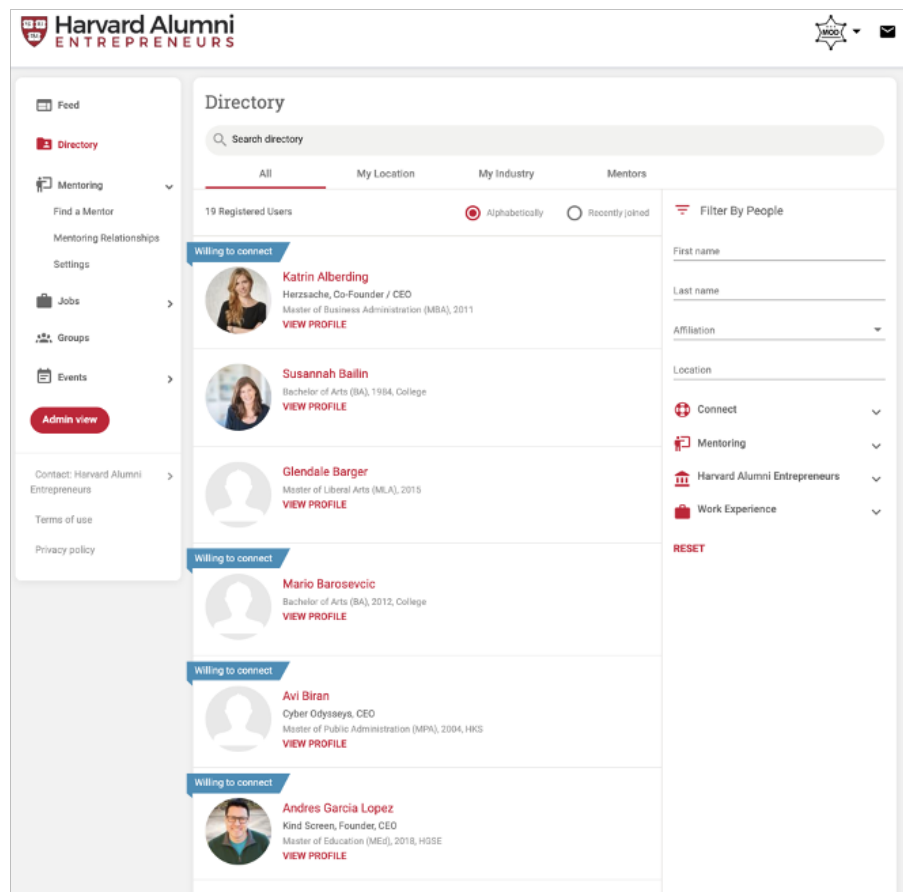


Figure A.1: Harvard Alumni Directory Page

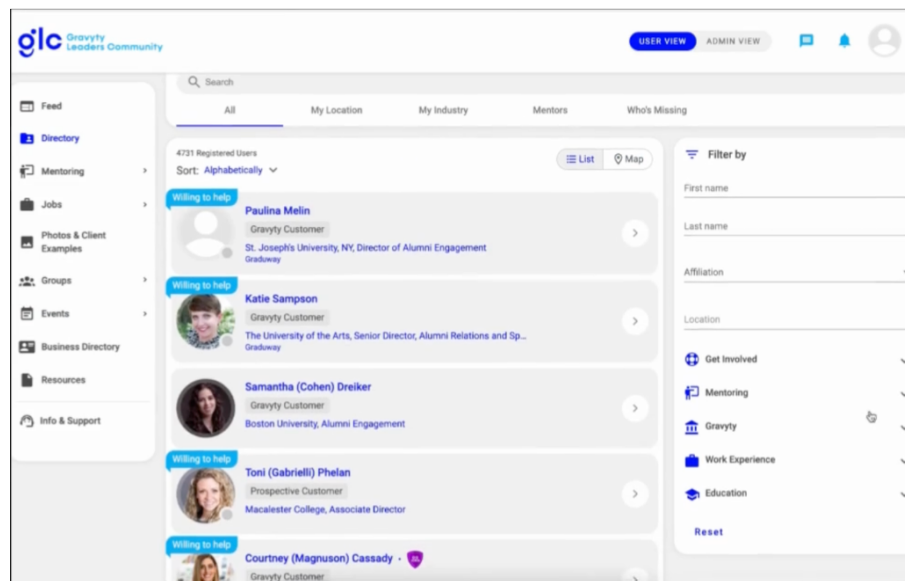


Figure A.2: Graduway Alumni Directory Page

Alumni Mentoring Pages

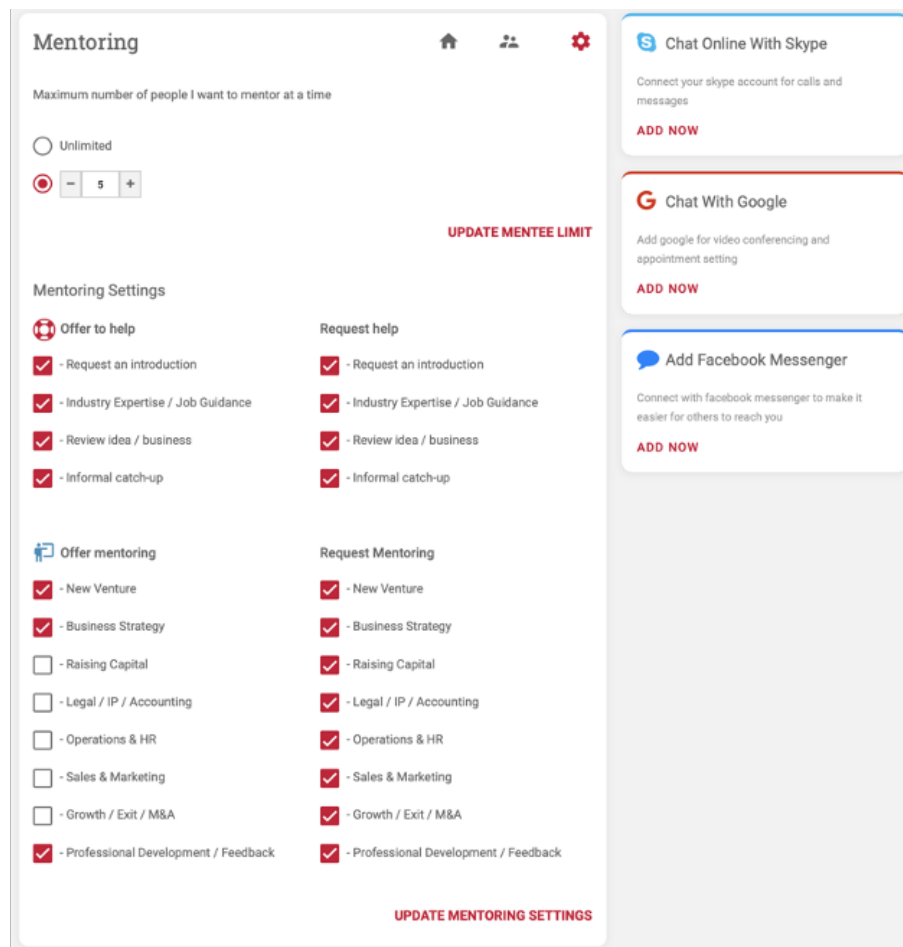


Figure A.3: Harvard Alumni Mentoring Page

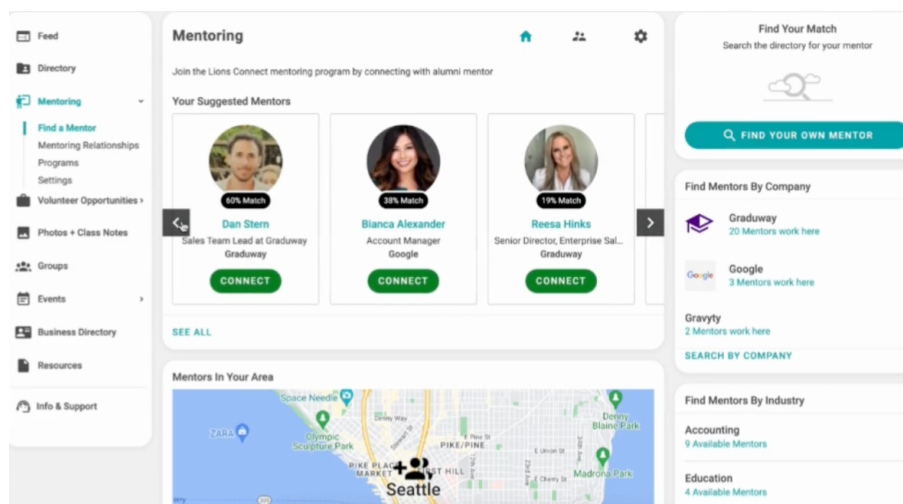


Figure A.4: Graduway Alumni Mentoring Page

Alumni Groups Pages

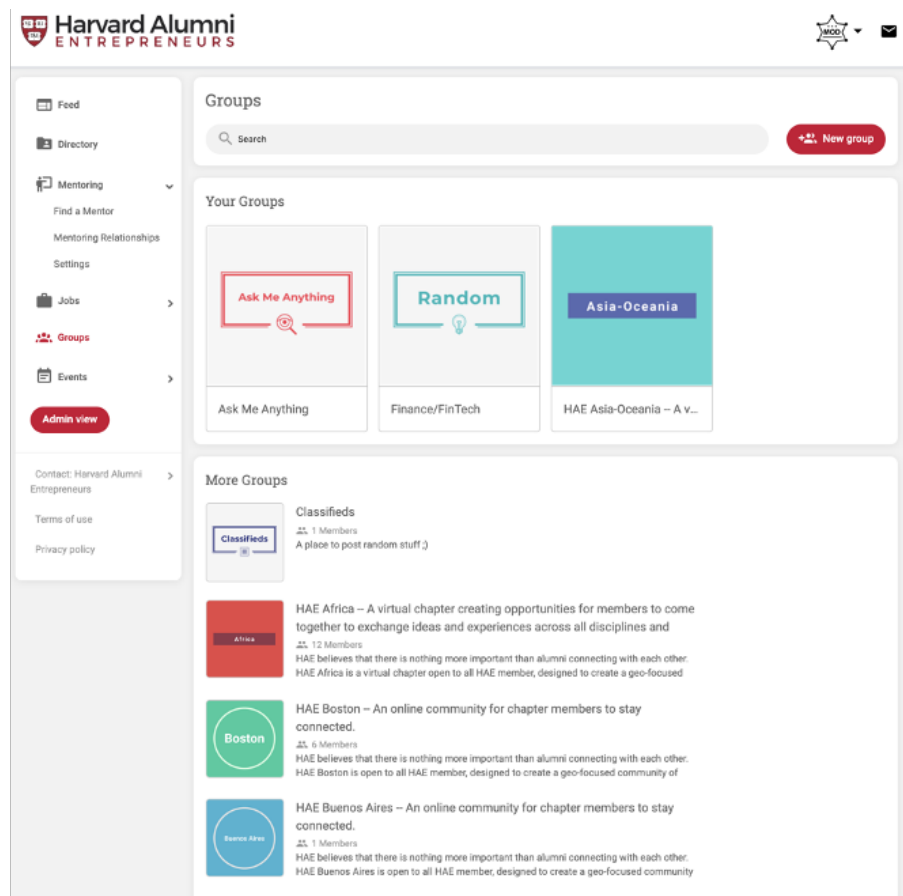


Figure A.5: Harvard Alumni Groups Page

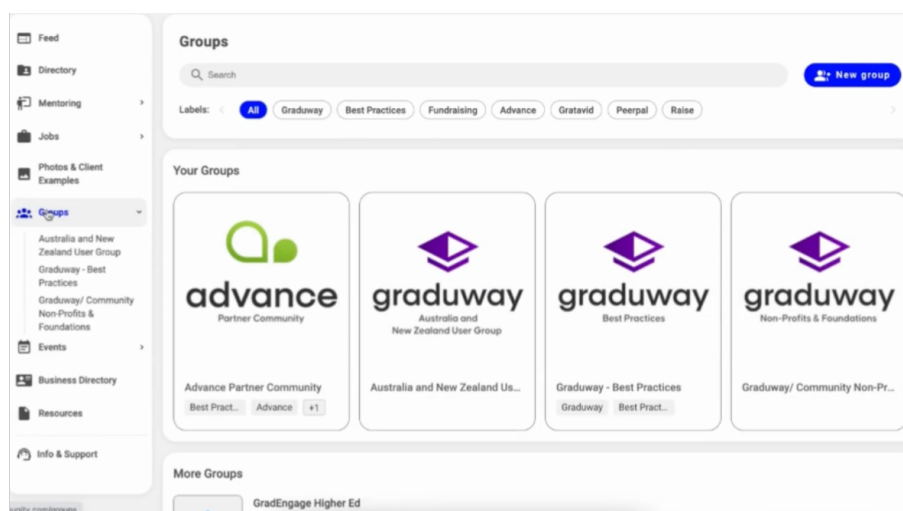


Figure A.6: Graduway Alumni Groups Page

Alumni Event Pages

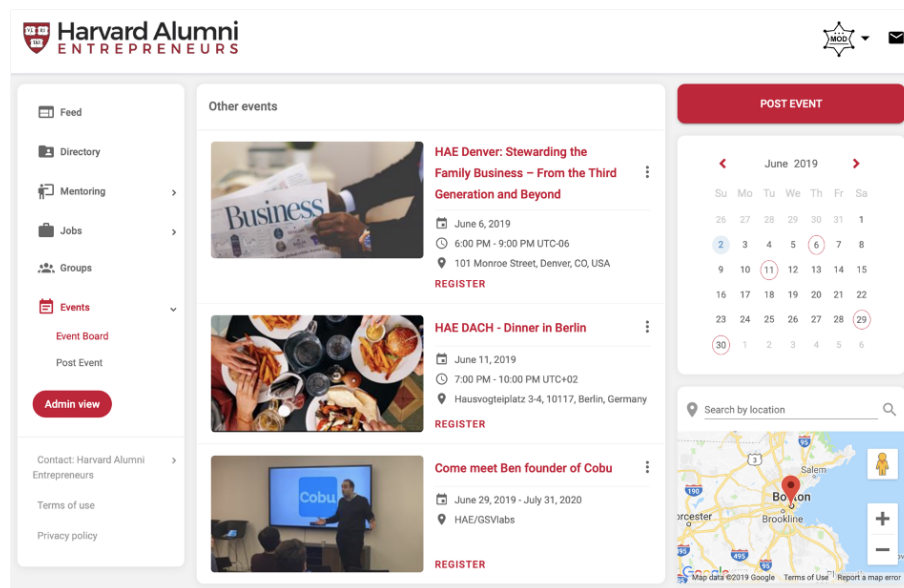


Figure A.7: Harvard Alumni Events Page

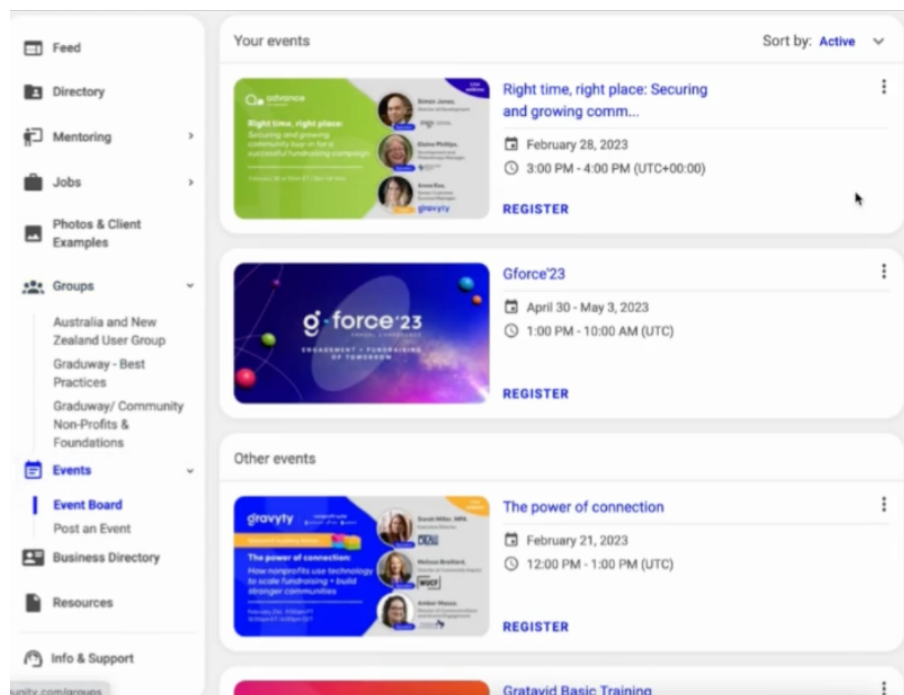


Figure A.8: Graduway Alumni Events Page

Appendix B

Diagram specifications

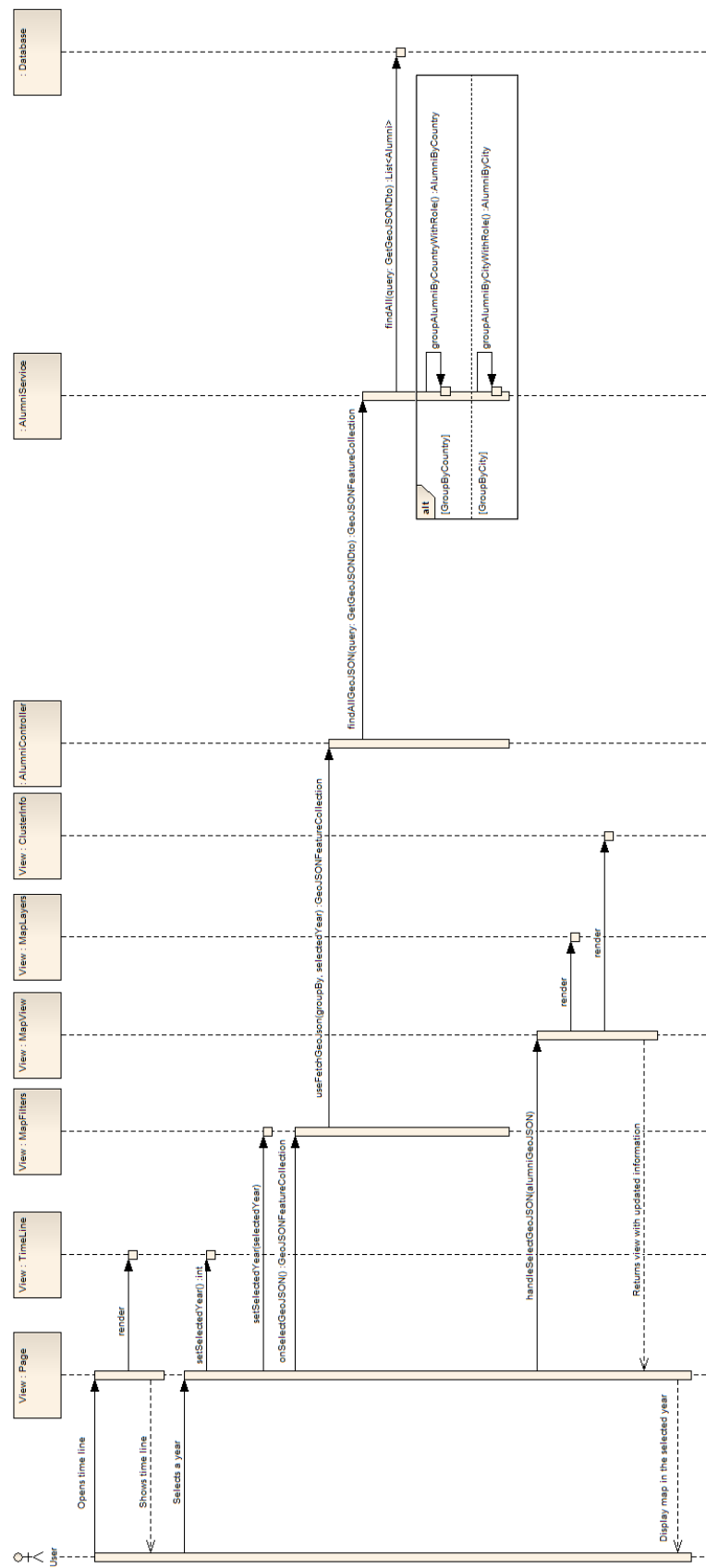


Figure B.1: Sequence Diagram - Navigate the alumni map in previous years

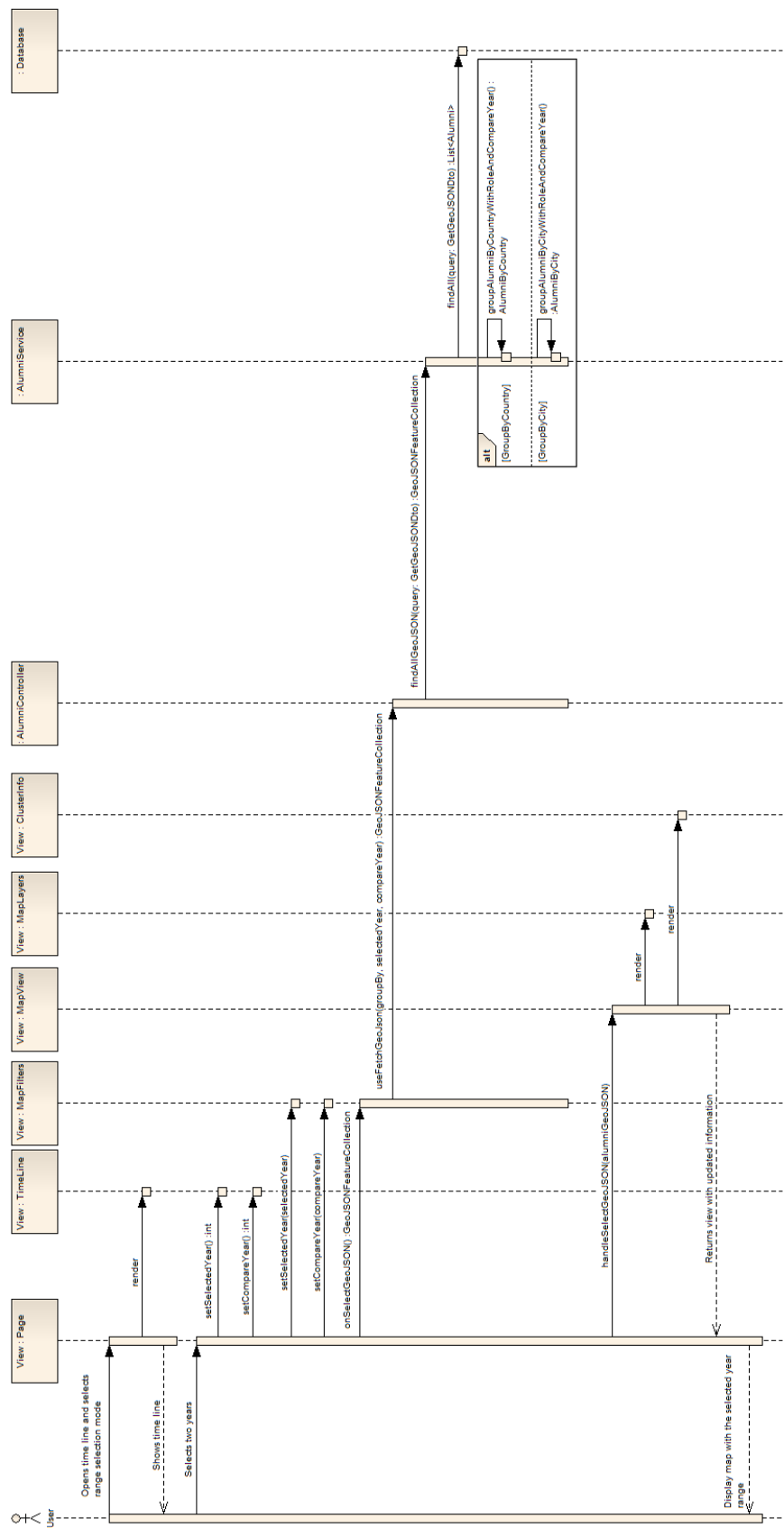


Figure B.2: Sequence Diagram - Visualize differences between two years on the alumni map

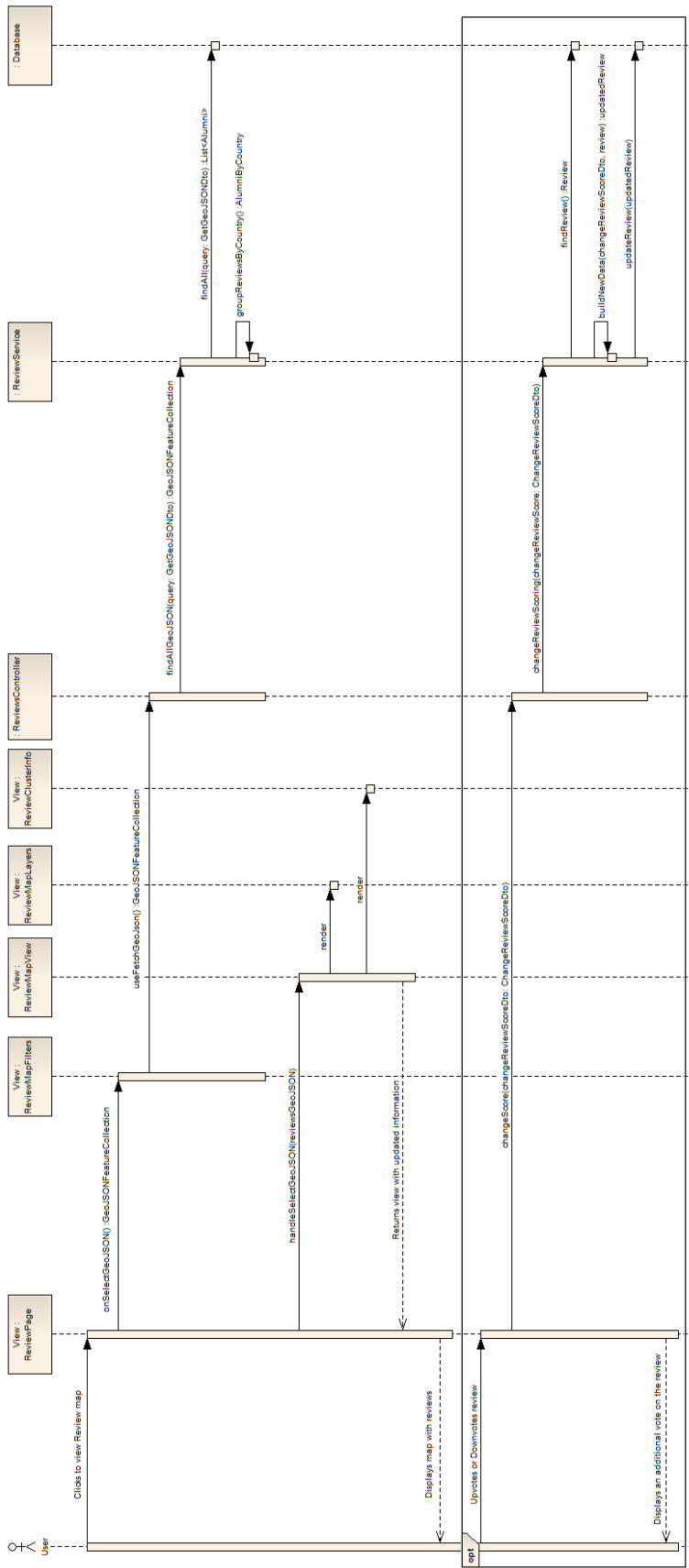


Figure B.3: Sequence Diagram - View Reviews on a world map

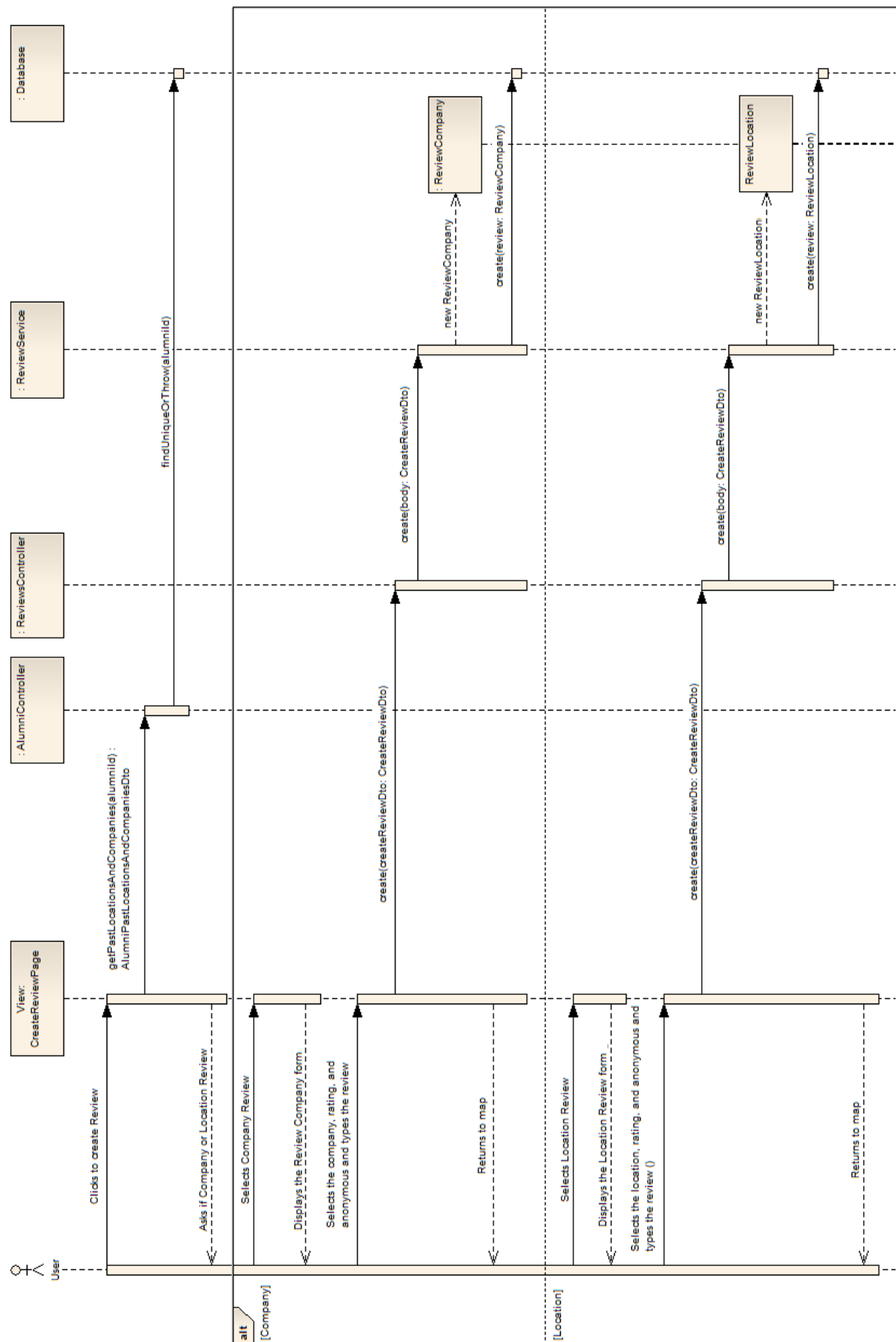


Figure B.4: Sequence Diagram - Create a Review

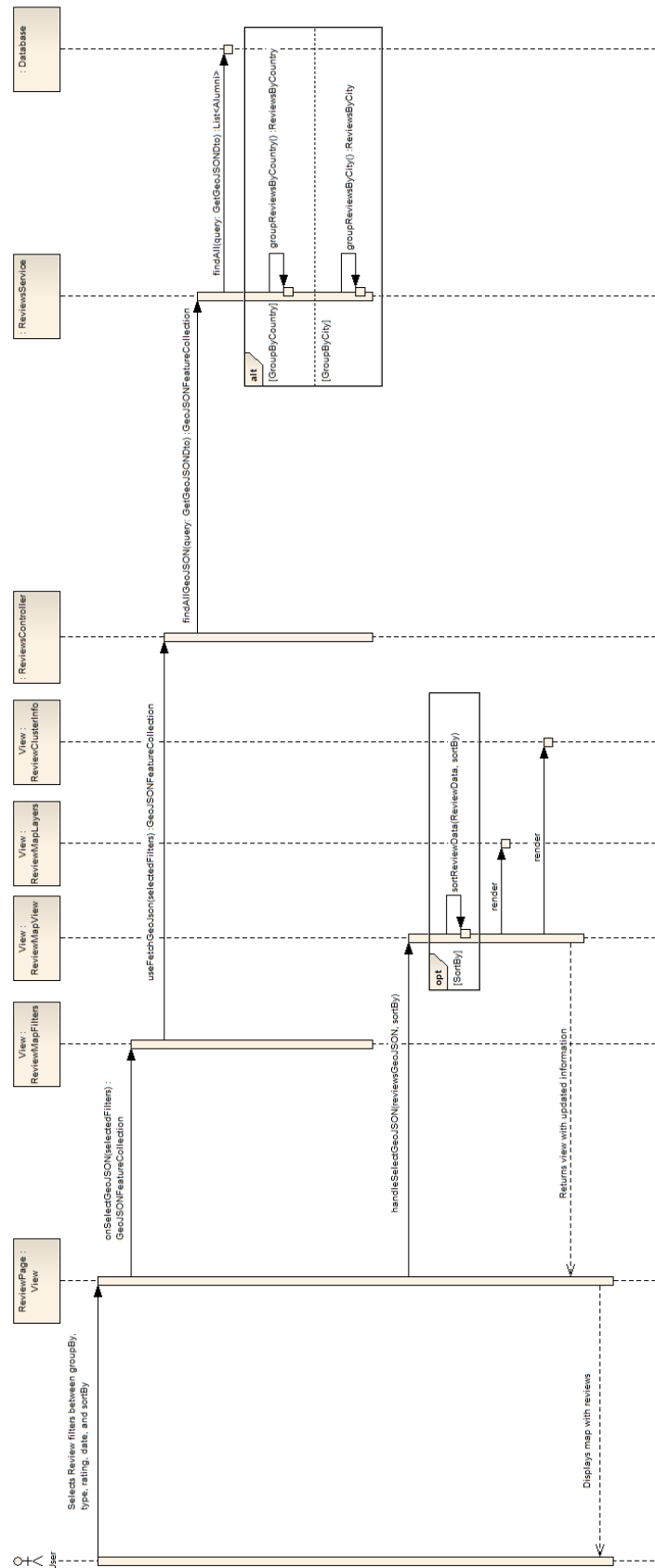


Figure B.5: Sequence Diagram - Filter Reviews