

myTune: Web Visualization Technologies for Irish Traditional Music Archives

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ABSTRACT

Online digital music libraries have become important repositories for music for all enthusiasts of Irish traditional music. These libraries have certainly facilitated the discovery of new material and enabled extensive exploration of musical variations on well-known favorites. Current web interfaces to these repositories, offer a combination of text and notation-based information as well as providing audio and midi listening formats. However, these interfaces could take advantage of more recently available technologies offering graph-based, interactive, visual displays and more useful data analytic content. Drawing on the state-of-the-art data visualization web libraries, the objective of this work is to present a prototype of a new digital library for Irish traditional music. The design and architecture is detailed using standard Unified Modelling Language (UML) notation. Evaluation is carried out by a usability survey to determine the effectiveness of the enhancements.

CCS CONCEPTS

• **Information Systems** → **Information systems applications** → Digital archives; **Human-centered Computing** → **Interaction design** → User centered design

KEYWORDS

Digital Music Library, Music Visualization, Musicology Analysis

ACM Reference format:

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1 INTRODUCTION

There are a number of online digital music libraries dedicated to Irish traditional music. They have been around for a number of years. Some are the portals of official organization such as the Irish Traditional Music Archive [1] and Comhaltas [2]. Others websites have been created by enthusiasts of the genre, and include thesession.org [3] irishtuneinfo [4], the abc notation site [5], Ceolas USA [6], and Pete Braccio [7]. The Session¹ is one of the most popular sites. The web address was registered in 2001 [8]. It has traffic from across the western world. It has about 6000 visitors/day [9] and 17,500 pageviews/day [8]. Membership of the website is free. Information on the website consists of read-only text and music but some content is interactive. There are five main sections: Irish Traditional tunes, a reference list of relevant recordings, upcoming sessions, upcoming events, and user discussions that have been divided into categories of New and Active.

However, all the aforementioned traditional music libraries are not oriented towards the researcher and do not provide any musicological analysis on their pages. This is not to say that there is a lack of interest from the community and online analytical tools for Irish traditional music have already appeared. They are manifested in the specific outputs of a mobile application and audio corpora. One group of authors focused on developing the application: TunePal, written using J2EE, for identifying traditional tunes [10], [11], and [12]. Members of the same group have recently created an annotated audio corpus [13] of traditional music. A different team produced [14], which outlined the creation of a digital library of audio and metadata for studies in stylistic interpretations of traditional flute music.

A detailed discussion on analysis and visualization tools for digital libraries in general is given in [15]. This is in the context of

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¹ We will use the title "The Session" mostly in the remainder of the paper to refer to the website thesession.org

the requirements generation for a Digital Music Lab software system for musicologists. User interface and data analysis are part of the high priority requirements. This large-scale software development reflects what many researchers in Music Information Retrieval (MIR) are seeking to achieve. Other examples include [16], which examines development tools for MIR researchers to interact with digital archives, as does [17] and [18]. The Greenstone package of [18] is interesting as the idea is to develop a new class of digital library architecture where support for musicological study is paramount. The motivation given is that current digital libraries are hampered by a text-only, read-only mindset. This more or less reflects that the growing trend thus is to get away from this read-only perspective and to combine information analysis with digital libraries to build more useful systems.

How to build those systems is another question and a web-based interface is the most popular choice. An overview of systems developed for presenting music collections, particularly of ethnomusicological recordings, on the web is given in [19]. These systems are more focused towards searching and viewing audio recordings individually rather than making any analysis however. Enhanced web environments are described in [20] integrated with YouTube to facilitate extra material to be added to videos. Vmus.net that provides visualizations of outputs from Musical Performance analysis algorithms [17], and [21] which allows researchers to interact with audio analysis algorithms running on different machines without needing to understand distributed processing. Finally, the latest system introduced in [19] also propose a web-based interface.

Returning to Irish traditional music we could ask if there is any possibility of making tools for Irish musicologists that could work with current libraries? Fortunately, The Session leads other Irish traditional music archives as it offers API access with data returned in JSON, XML or RSS format. This easily facilitates outside developers who wish to customize access to such content and to provide interested users with a new bespoke presentation of the data available. With the latest client-side web technologies that use powerful PHP and Javascript libraries, there are now more advanced tools available for data visualization than a decade ago. Therefore an extension to The Session for visual analysis could quickly be achieved with the correct toolset.

The aim of this paper is to demonstrate by example how these libraries facilitate the design of a new web platform for Irish traditional music. This platform will allow for the graphical display and analysis of the music information contained in the digital library. The intention is to have both accessible and concise presentation, and a more pleasing user experience. The example of The Session is used throughout the paper but the ideas herein should be applicable to any similar archive with an API.

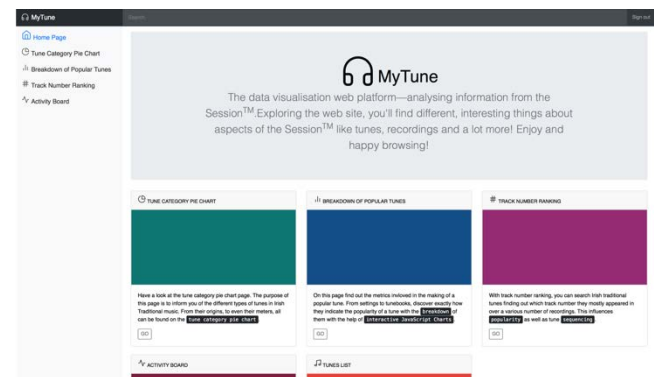
The layout of the paper is as follows: Section 2 explains the design of the new software system called myTune. UML [22] representations of the relevant structures are presented. Section 3 discusses the new visualizations available and illustrates them with examples. Section 4 describes the technical evaluation procedure to ensure it operates correctly, and then the assessment

by a user group to illustrate their satisfaction with its features. The final section offers conclusions and mentions some possible directions for future work.

2 TECHNICAL DESIGN

Data from The Session can be accessed through calls to The Session API. This is implemented using the PHP libcurl library [23]. The myTune application is launched in any web browser. The Browser interface is shown in Fig. 1. In the figure, the large colored boxes serve as links to relevant chart display pages and also are linked to the menu items on the left panel. There is a search bar that is placed at the top of the page above the myTune logo.

The UML use-case diagrams in Fig. 2(a) and Fig. 2(b) illustrate the main navigation tasks of myTune. These include: browsing



(a)

Have a look at the tune category pie chart page. The purpose of this page is to inform you of the different types of tunes in Irish Traditional music. From their origins, to even their meters, all can be found on the **tune category pie chart**.

(b)

Figure 1: The myTune application home page showing the menu for user interaction. The text in (b) is an enlarged version of that below the first colored rectangle.

tune types, tune data, member activity, tune rankings, and requesting data. Various sub-options are also available, for example, the particular events in which a member may be participating.

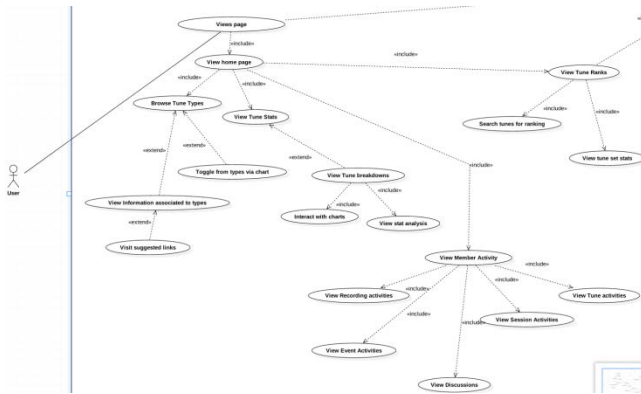


Figure 2(a): Use case diagram where the nodes describe the relationships between the levels in the web application.

Fig. 2(b) shows the connectivity between the nodes and the requests made to The Session API from either the application home page given in Fig. 2(a), or from the tune ranks page to display information is shown.

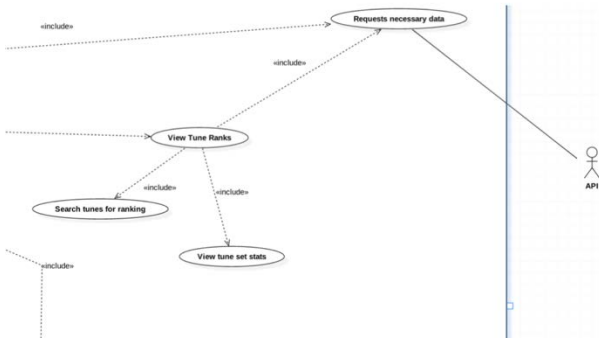


Figure 2(b): Use case diagram showing relationships between the levels in the web application, along with the connection to the external Session API.

2.1 Application architecture

Processing of user requests is through server-side PHP scripts using the PHP cURL library [23]. This library facilitates communication between different servers using various protocols. The protocols supported include HTTP, https, HTTP POST. For myTune, the PHP cURL library connects with The Session API and requests information in the JSON format. A PHP script decodes the returned JSON data to a multidimensional PHP array. This array format allows for easy manipulation later on using javascript libraries for the generation of charts (see Appendix A.3). The overall system architecture is shown in the UML component diagram of Fig. 3. This shows the relationship

between the three main components: myTune, The Session, and a database running on a Local Server.

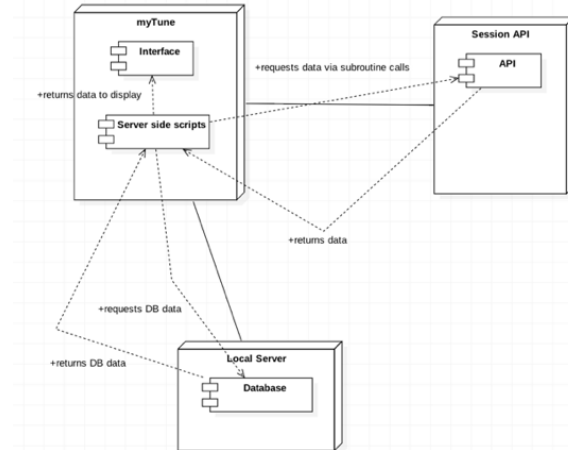


Figure 3: Component diagram showing the system architecture.

This relationship can be described as follows:

- (a) myTune makes requests to The Session API for data resulting from a user's inquiry (as in Fig 2(a) and (b)). The API then returns the data to the scripts for eventual display on the interface.
- (b) The data available through The Session API, is not stored locally. However, myTune uses a locally hosted database to store static tune type/genre descriptions (reel, jig, mazurka etc). This local database uses PDO drivers to transmit data to the interface [24].

The class diagram in Fig. 4 gives the methods and attributes details of the server PHP scripts which manage communications between the back-end and the interface. Here, the primary concern of the interface is in displaying the API data it receives on the loading pages or when the user requests it through interaction with the graphs or searches (via the homepage shown in Fig 1). In Fig. 4 the standard UML access modifiers specify the public (+) methods and private (-) attributes associated with requests to either the API or the local database. Included are methods such as `showTuneRank()` called from the user-interface, the attribute `$type`, and the private parameter, `$id`, required by the system. The track number ranking method computes the frequency of track position among others across all albums with recordings of that track.

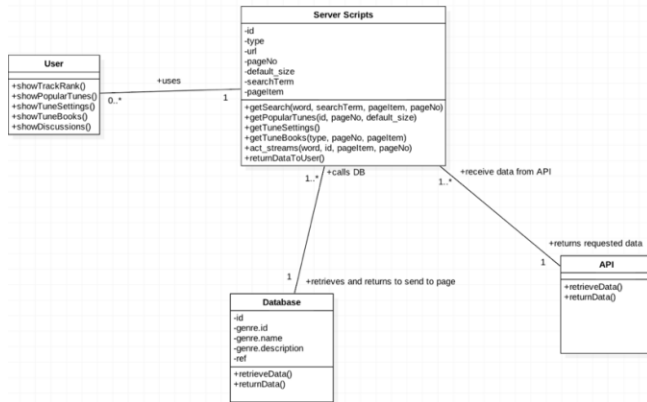


Figure 4: Class diagram of the system.

2.2 Application details

The Session is a read-only API, and specially written PHP template functions operate by sending a GET request to The Session Server. These PHP functions pass search parameters via the URL of the GET request to configure specific queries (see Appendix A.3). These search parameters include:

`$id`. This parameter is concatenated to the URL to specify a search for a particular tune or recording. The `curl_init()` function is then called to initialize a cURL session for connection to the specified URL

`$pageNo`. This parameter is concatenated to the URL to indicate the specific page to GET when retrieving information on tunes or recordings

`$default_size`. This parameter concatenated to the URL configures how many items will be returned from the GET request of either tunes or recordings. The number of items is calculated using the `count()` function on the tune/recordings array from the JSON decoded data [25].

For all the functions that communicate with the server, the libcurl method `curl_setopt()` is called with the following parameters to set the options for the cURL session and data transfer:

1. RETURNTRANSFER: Permits transferring of data as a string to the server.
2. CUSTOMREQUEST: Configures the method on which to make the HTTP Request (GET, POST, HEAD).
3. HTTPHEADER: Configures headers for both servers and the proxies when making the HTTP Requests. There can also be a configuration of the content-type returned on an HTTP Call.

4. SSL_VERIFYPEER: Determines that the authenticity of the peer's certificate is set to 0 so it is not checked.

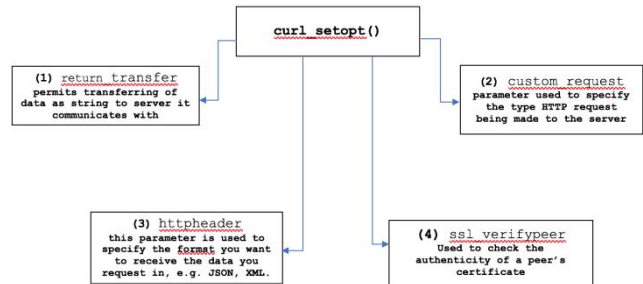


Figure 5: Block diagram of the components of `curl_setopt()` that communicate with The Session API. The text reflects that in points 1-5 above.

These operations of `curl_setopt()` are summarized in Fig. 5. It connects with The Session API, and after the request has been made by the `curl_exec()` function, it returns the information in JSON format. Appendix A.3 shows an example `curl_setopt()` call.

3 VISUALIZATIONS

Implementation of the data visualizations for the web application used the following tools:

Chart.js – this is an open-source, high-performance JavaScript library. It provides an array of interactive charts for designers and developers. Charts are rendered on `<canvas>` nodes on an HTML page accompanied with the JavaScript to create these charts [26].

ZingChart – This is a pure JavaScript and free dependency library that generates and renders charts on `<div>` nodes. The library offers more than 35 chart types. Its modules are capable of high-speed performance as well as facilitating customization of charts [27].

AMCharts – This is a highly-customizable, functional, adaptable JavaScript library [28].

VivusJS – This is a lightweight, dependency-free, JavaScript class for animation of SVGs. It offers a variety of animation styles as well as the option to create a custom script to draw SVGs [29].

The majority of the charts the platform utilizes are from Chart.js. The data retrieved from the API is delivered via the PHP scripts to become a chart object. Additionally, all charts have explanatory jumbotrons(description box) associated with them [30].

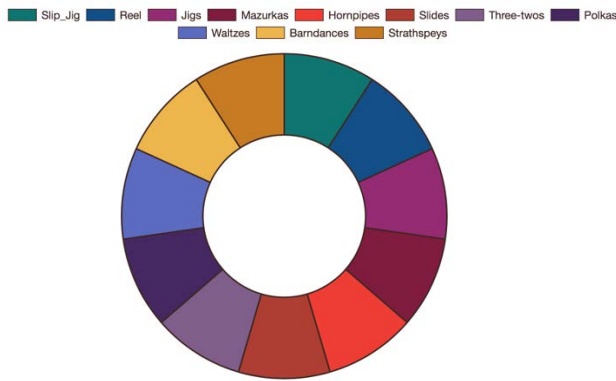


Figure 6: An example of an interactive pie chart presented by myTune for tune type descriptions.

Pie charts are good for presenting proportions. By clicking on the various genre name boxes above the pie chart (see Fig 6.), the user can choose the number of tune types(jig, reel, etc) to display within the pie chart. This will determine the size of the segments displayed. Subsequently, clicking on any sector of the pie chart triggers an AJAX request [31] to the local database with the chart label as parameter (specifying the tune type) and returns the tune information rendered in a type description box (jumbotron - not shown in Fig. 6) below the pie chart.

The myTune application has a Popular Tunes Breakdown page that offers various data visualization models that represent the factors that reflect a tune’s popularity on The Session website. These include the number of settings (variations) of a tune, the number of appearances users tune-books (personal music libraries). This information can be analyzed using bar charts, polar charts, and radar charts. The displayed results are proportional to the user data available on The Session website at any particular time.

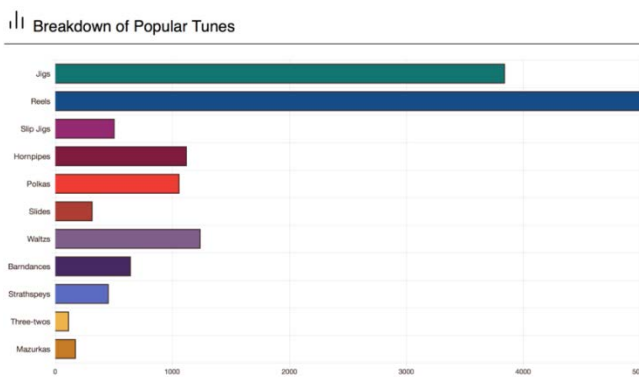


Figure 7: The bar chart presented by myTune on the popular tunes page indicates the number of tunes for each tune type.

Here data retrieval is implemented using the sequence of method calls triggered by the `getPopularTunes()` script shown in the class diagram of Fig 3. The returned data is decoded

using the `json_decode()` method [32]. The result is processed by the JavaScript libraries and rendered using the selected chart type. In Fig. 7 the bar chart shows the number of popular tunes available for each tune type.

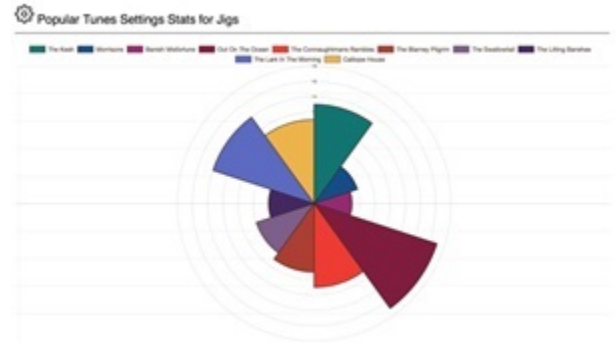


Figure 8: Example of a polar chart rendered by the web application showing the number of settings for each of the top ten jigs from The Session.

The polar chart and radar chart also present analytics. Fig. 8 gives an example of a polar chart. This displays the number of settings of each of the top ten jigs (determined by the most occurrences of jigs in tune books) from The Session. The number is reflected in the size of each segment. Fig. 9 shows a radar chart illustrating the number of appearances of the top ten jigs in users’ tune-books.

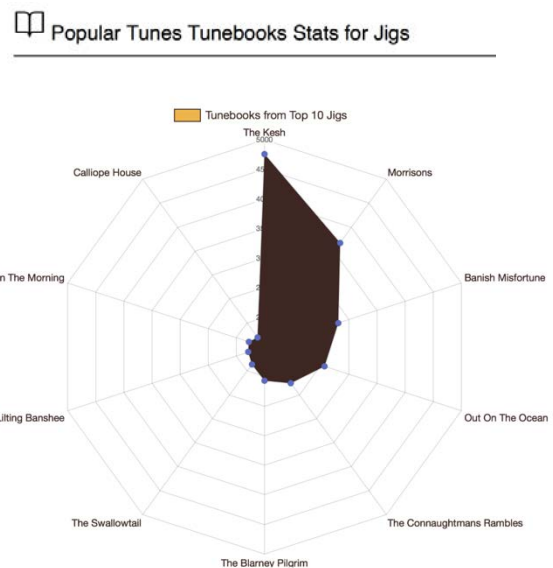


Figure 9: Example of a radar chart rendered by the web application showing the number of appearances in tune-books of the top ten jigs from The Session.

myTune also has a track number ranking page. This page uses the JavaScript chart plugin, AMCharts [28], to create a bar chart. This chart displays the frequency of the track position for a particular tune. Rendering for data for AMCharts is slightly different from that of the other charts. An extra step in processing the PHP array data for AMCharts is that the result is restructured in the form of key-value pairs, the key being the tune name and the value being the frequency of the tune. This data is then rendered using JavaScript by AMCharts.

Fig. 10 shows that the popular ‘the Kesh’ jig has appeared as the first tune on a recording over 60 times. The graph also indicates that it has appeared in the first position 6 times more often than in the second position, and at least 30 times more often than the 7th position.

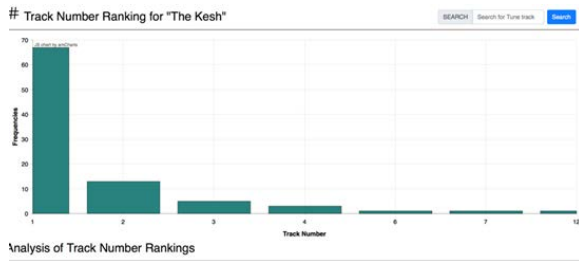


Figure 10: A bar chart showing the track position of a particular tune across the recording archives.

Figure 11 shows a half-donut chart and its jumbotron underneath. The intention of this chart is to highlight the number of appearances of a particular tune within users’ tune sets, and thus

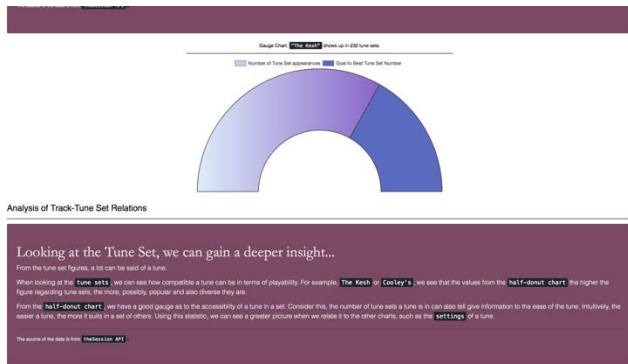


Figure 11: Half-donut chart illustrating appearances of a tune within a user’s sets of tunes.

provide a measure of popularity of that tune. The more often a tune appears the darker the gradient across the chart

4 SYSTEM EVALUATION

Evaluation was carried out by a verification followed by a validation. It was first verified with tests to show that the software worked correctly. Then it was validated with user questionnaires

to determine that it added worthwhile functionality that is not currently available in The Session website.

4.1 Verifying the software system

The correct operation of myTune was verified using black-box testing [33]. Each test case involved getting data from one of the five main sections of The Session API: tunes, recordings, sessions, and events.

Table 1: Test cases

| Method under Test | Input | Expected Output |
|-------------------|---------------|--------------------------------|
| recRelate() | Tune id | Recordings tune id |
| getPSpec() | Tune type | Top 10 tunes of specified type |
| act_streams() | "sessions" | All user activity on sessions |
| act_streams() | "events" | All user activity on sessions |
| act_streams() | "discussions" | All user activity on sessions |

Table 1 shows the black-box tests for the functionality of myTune. Passing all tests is necessary for the correct operation of the software. For example, in the first test that tests the recRelate() method. Here the ID of a tune is provided, and it is then verified that data on all albums that contain a recording of that tune is retrieved.

The methods of myTune that make GET requests, get_popular() and get_search() were also tested to verify that they were working correctly.

4.2 Validation by User Assessment

myTune was validated with User testing. An assessment by comparative survey was made based on ISO-9001:2015 [34]. The emphasis was on measuring the usability and the learnability of myTune, two the key goals of user-centered design [35]. Thus, the questions in the survey were aimed at assessing its appearance and operation.

The assessment procedure required the user to work with both myTune and The Session website. The set of tasks are given in appendices A.1 and A.2. Both have the same number of tasks and level of difficulty. Essentially, the tasks involve a user navigating through different stages of the websites and accomplishing a variety of actions.

There were a total of 18 participants in the survey, of which 50% of them are non-Computer Science students. This was to overcome any potential bias in that regard.

After surveys were completed, the responses were analyzed. The first aspect measured was the visual aspect of myTune. Fig. 12 shows these results in a bar chart. Out of the 18 users who partook in the survey, 4 of them found that the visual component of myTune was not engaging. Another 4 answered that the pages were very engaging, while 10 believed it was fairly engaging.

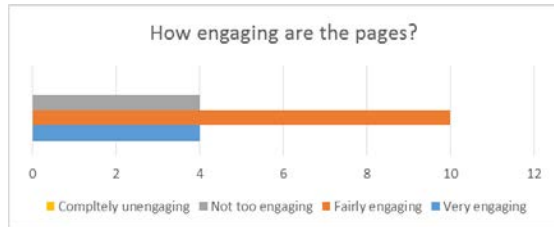


Figure 12: Assessing the visual engagement of myTune.

In terms of interactivity, Fig. 13 shows that 10 of the users found myTune’s charts to be very interactive. Additionally, 6 found the charts quite interactive while 2 thought they were fairly interactive.

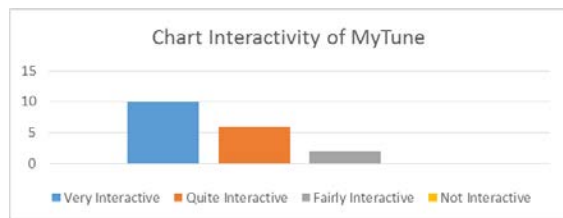


Figure 13: Responses from users regarding the chart interactivity of myTune.

Responses for navigation through myTune were also positive. They are illustrated by the pie chart in Fig. 14. Of the participants, 14 found the navigation between pages better than for The Session and 4 believed it to be fairly easy. Nobody found it to be difficult.



Figure 14: User responses assessing the ease of navigation for myTune.

5 CONCLUSIONS

The myTune web application has been designed to work with the data from an existing digital library, The Session, and extend its usefulness with the latest data visualisation tools. The results of a survey suggested that myTune has good navigation and interactive components. This illustrates the principle, that by using modern visualisation tools, new information about traditional Irish music can be extracted and presented from an older source once an API is available.

It is important to note that myTune is a prototype. Short-term future work could consist of making improvements to the site based on user feedback. For example, font sizes, loading times and the layout could be improved. A larger sample of test users including those familiar with The Session website would be beneficial. A search feature based on tune name is envisaged. Furthermore, the addition of graphs providing more statistics of Irish Traditional music can be included, for example, to take into the same tune identified by different names. Over a longer period of time, myTune could integrate information from other traditional music repositories. These other libraries contain information that is not available from The Session, e.g. rhythm distribution, most popular albums, background history of tunes. This could be used to extend the functionality of myTune and its service to users.

Employing machine-learning algorithms to build analytical models of tunes could also be implemented as future work. For example, K-Means Clustering [36] could provide interesting analyses on traditional Music and might offer another insight into the underlying musical structure. Releasing a cross-platform mobile version of myTune would be further work to consider, creating accessibility for those who have an interest in Irish Traditional Music and would like to access it on-the-go.

A APPENDIX

A.1 User Tasks for myTune

A.1.1 Tune Type Pie Chart:

- (a) From the home page, click on either the ‘GO’ button under the ‘TUNE TYPE PIE CHART’ or from the sidebar menu to the left of the homepage.
- (b) Pay close attention to the **jumbotrons (purple box)** and the contents of the **jumbotrons**.
- (c) To change the content in the description box, click on one of the coloured sectors of the pie chart. Try this for Barndances, Jigs, and Polkas.
- (d) After completing these steps, navigate to the **Breakdown of Popular Tunes** page from the sidebar menu.

A.1.2 Breakdown of Popular Tunes

- (a) After browsing the **pie chart** page, have a look at the charts on the **Breakdown of popular tunes** page.

Interact with the chart legends by clicking on it and pay close attention to the **jumbotrons** associated with the charts.

- (b) After completing the task on the **Breakdown of Popular Tunes** page, navigate to the track number ranking page, the **4th link on the sidebar** to the left of the page.

A.1.3 Track Number Ranking

- (a) On this page, hover over the histogram, down to the **half-donut** chart, also reading the **jumbotrons** associated with them. See Figure xx.
- (b) There is a search bar to the right of the page, enter in the following tune names: **The Swallow Tail**, **Drowsy Maggie**, and **Out on the ocean**. Observe the page see if there are any changes in the **Bar chart** specifically.
- (c) After having visited all of the pages, navigate to the **Activity Board** page, the last link on the left **sidebar** of the page.

A.1.4 Activity Board

- (a) Firstly, browse through all the slides presented on the carousel and choose of the activities to visit: **Tunes**, **Recordings**, **Events**, **Discussions**, and **Sessions**.
- (b) Follow the direction to the activity page dependent on what you had chosen in part (a). Navigate to the **Activities** list, browsing the list and the **Suggestions** section.
- (c) After navigating the page, have a look at the other options available at the navigation bar below the main black navigation bar.

A.2 User Tasks for The Session website

A.2.1 Tune Page

- (a) From the home page provided on the browser, click on the **Tunes** tab on the top of the page, (the burgundy navigation bar).
- (b) On the tunes, page navigates down to the **Popular tunes** section and look for the link underneath it.
- (c) When found, click on the link to navigate to the **Popular Tunes** page. Browse the page, by clicking on the pagination **arrows** to look at more tunes, and even look at different **tune types (jigs, slip jigs, etc.)** to find which tunes are popular in each type.
- (d) After you have finished visiting the page, click on the **Recordings** tab within the burgundy navigation bar.

A.2.2 Recordings

- (a) On the recordings page, there is a search bar section. Type in and search the following recordings: **Down the River**, **A Winter Solstice**, and **Sandwood**. For each of these, observe the pages returned with the list of tunes and information regarding **artists and tunes recorded**.
- (b) After having visited the page, navigate to the **Sessions** and **Events** pages respectively.

A.2.3 Sessions and Events

- (a) For both the Session's page and the **Tunes** page use their respective search bars and type in: **Dublin**. In both cases, these will bring you to their results page.
- (b) Click on the first **3 search results**. This will bring you to the specific results where you can navigate the page with information such as **location, schedules, phone number, and comments**.
- (c) After having completed both the tasks, navigate to the final page of the test, the **Discussions** page.

A.2.4 Discussions

- (a) Browse the page, taking a detailed look at the sections such as **Newest Discussions** and **Newest Comments**. After browsing through the sections, also look at the **Active Discussions**.
- (b) Observe the **Active discussions** and view the **comments** accompanying these discussions. Pay close attention to the format and the structure of the information as it is presented.

A.3 Code example using curl_setopt()

```
$url = "https://thesession.org/tunes/popular/" . $type . "?format=json
&page=" . $pageNo . "&perpage=" . $perPage;
```

```
$ch = curl_init($url);
```

```
// return an array of the data
curl_setopt($ch, CURLOPT_RETURNTRANSFER, true);
curl_setopt($ch, CURLOPT_CUSTOMREQUEST, "GET");
curl_setopt($ch, CURLOPT_HTTPHEADER, array('Accept:
application/json;', 'Content-Type: application/json'));
curl_setopt($ch, CURLOPT_SSL_VERIFYPEER, 0);
```

```
// save response to variable
$response = curl_exec($ch);
```

ACKNOWLEDGMENTS

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