Improved Visualization and Exploration of Web2.0 Music Network Data

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Master in Informatics and Computing Engineering

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Abstract

Today, World Wide Web integrates a significant part of many people’s life, from business to pleasure, you can find a wide range of services available online.

A portion of these services relates to the art of music, anyone can listen to music virtually anywhere, accessing information from artists around the world and share music content created online.

The music invasion in the universe of Web enabled an easy and widespread access to content that would otherwise be inaccessible. Thus music services, such as radios and data aggregators to classify artists emerged, allowing users to listen to the music they want when they want, how they want. Later some services beyond music storage began to devote their space to store musical data of users and by analyzing it, started to arrange music suggestions tailored to a specific musical profile.

With this advance in musical suggestions, applications oriented to musical discovery began to be created to more than recommend music to someone, create an enjoyable experience during the process through the use of graphic constructions, generation of playlists oriented to a music profile or through the sharing of musical works.

This thesis proposed work aims to join the diverse concepts of musical discovery on a single site, in order to provide an enjoyable and effective exploration of musical data, regarding the artists information or a music profile.

A working prototype was developed as a web application based on Java and JavaScript, gathering graphical productions, music playback, content sharing and personalization, allowing users to experience this set of methods. Subsequently it was performed a critical evaluation of the application in order to obtain the conclusions about the efficiency of the prototype.

The evaluation concluded that the meeting of the various concepts has proved effective for the process of musical discovery and its use provides an enjoyable experience for its users.
Atualmente, a World Wide Web integra uma parte significativa da vida de muitas pessoas, de negócios a lazer, é possível encontrar uma vasta gama de serviços que estão disponíveis online.

Uma parte destes serviços refere-se à arte da música, é possível ouvir música virtualmente em qualquer lugar, aceder a informação de artistas de todo o mundo, criar e até partilhar conteúdo musical.

A invasão da música no universo da Web permitiu um acesso fácil e generalizado a conteúdos que de outra forma seriam inacessíveis. Desta forma serviços musicais como rádios e agregadores de dados de classificação de artistas emergiram, permitindo aos utilizadores ouvir a música que querem, quando querem, como querem. Posteriormente alguns serviços para além de um repositório musical, passaram a dedicar o seu espaço para guardar os dados musicais dos utilizadores e com uma análise a estes, passaram a providenciar sugestões musicais adaptadas a um perfil musical específico.

Com este avanço em sugestão musical, aplicações orientadas à descoberta musical começaram a ser criadas por forma a mais do que recomendar música a um utilizador, permitir uma agradável experiência enquanto o fazem, quer por intermédio de construções gráficas, geração de listas de músicas apropriadas a um perfil musical ou através da partilha de trabalhos musicais.

Nesta tese o trabalho proposto pretende o encontro de diversos conceitos de descoberta musical num único sítio, por forma a proporcionar uma agradável e eficaz exploração de dados musicais, quer referentes à informação de artistas ou a um perfil musical.

Foi desenvolvido um protótipo funcional de uma aplicação web baseada em Java e JavaScript que reuniu produções gráficas, reprodução musical, partilha de conteúdos e personalização, permitindo os utilizadores experienciarem este conjunto de métodos e posteriormente realizaram uma avaliação crítica da aplicação por forma a obtermos conclusões à cerca da eficiência do protótipo.

A avaliação realizada permitiu concluir que a reunião dos diversos conceitos revelou-se eficaz para o processo de descoberta musical e que o seu uso providencia uma agradável experiência aos seus utilizadores.
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Nuno Cruz
“The greatest value of a picture is when it forces us to notice what we never expected to see.”

John Tukey
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<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEUP</td>
<td>Faculdade de Engenharia da Universidade do Porto</td>
</tr>
<tr>
<td>LIACC</td>
<td>Laboratório de Inteligência Artificial e Ciência de Computadores</td>
</tr>
<tr>
<td>INESC Porto</td>
<td>Instituto de Engenharia de Sistemas e Computadores do Porto</td>
</tr>
<tr>
<td>MIT</td>
<td>Massachusetts Institute of Technology</td>
</tr>
<tr>
<td>MIR</td>
<td>Music Information Retrieval</td>
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<tr>
<td>UCP</td>
<td>Universidade Católica Portuguesa</td>
</tr>
<tr>
<td>MPEG</td>
<td>Moving Picture Experts Group</td>
</tr>
<tr>
<td>MP3</td>
<td>MPEG-1/2 Audio Layer 3</td>
</tr>
<tr>
<td>RAMA</td>
<td>Realtional Artist Maps</td>
</tr>
<tr>
<td>ISMIR</td>
<td>International Scociety for Music information Retrieval</td>
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<tr>
<td>DJ</td>
<td>Disc jockey</td>
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<td>TV</td>
<td>Television</td>
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<td>2d</td>
<td>Two dimensions</td>
</tr>
<tr>
<td>3d</td>
<td>Three dimensions</td>
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<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PHP</td>
<td>PHP Hypertext Preprocessor</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web</td>
</tr>
<tr>
<td>HTML</td>
<td>HyperText Markup Language</td>
</tr>
<tr>
<td>JVM</td>
<td>Java Virtual Machine</td>
</tr>
<tr>
<td>XML</td>
<td>eXtensible Markup Language</td>
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Chapter 1

Introduction

This section presents the context for the thesis Improved Visualization and Exploration of web2.0 Music Network Data, it also contains its motivation and objectives.

1.1 Context

With around two hundred and fifty five million pages~[net10] and with almost two billion users~[int09], the Internet proved itself to be a giant system with a great potential. It started just as a little network to exchange messages and today we find in it many types of use and applications, from work to pleasure~[PG09]. With so much content and usage, on a computer or a mobile phone, the internet has clearly a great impact on peoples life changing what we do and how we do it.

With the arrival of web2.0~[Lew06] the interaction between user and site became much more closer, people are now capable of changing or add information on a site to their own will, taste or usefulness, not requiring them to have any knowledge of any web technologies or programming languages, like blogging, tagging and collaborative edition of information. Another factor to consider is the ease to store large amounts of data, which allows great analysis and results, providing users with a vast amount of valuable information based on their actions or preferences, a specific implementation of this are suggestions on online shops like Ebay or Amazon or web radios based on listening tendencies. Nowadays there are many radios available and users spend much time on them, customizing or listening to them, this lets you save a great amount of musical tastes and then make suggestions~[Lew06, SO09].

With all this capabilities Diogo Costa and Fabien Gouyon from INESC Porto, Bruno Gustavo Costa from UCP and Luís Sarmento from LIACC / FEUP, developed at INESC Porto an interactive artist network visualization tool called RAMA~[RAM]. It is
Introduction

a web based application for visualizing and interacting with networks of music artists, which uses data gathered and analyzed by a crawler developed by João Norberto Fernandes da Costa Lima in his dissertation, supervised by Rui Camacho in FEUP and Fabien Gouyon in INESC Porto [RAM, Lim09]. The data gathered by the crawler comes from the Last.fm site through its API [lasa].

Last.fm is a musical community site that gathers musical information from its users, on it one can listen to music, find information about artists or discover new bands. Following Web2.0 concepts, users can also set up their own profile, facilitating targeted automatic music recommendations. Among other things they can also get information about users with similar tastes, gigs in their local area, videos of their bands and a lot more.

Always interlaced with this project is INESC Porto, a nonprofit association which develops activities of research and development, consultancy, advanced training and technology transfer in the areas of Telecommunications and Multimedia, Power Systems, Production Systems, Information Systems and Communication and Optoelectronics. It aims to build an interface between the academic and enterprise world and its actions generally involve innovation, internationalization and economic and social impact [ine10].

1.2 Motivation and Objectives

Over the Internet there are many services that allow users listen to music with just a few clicks and they spend a lot of time using them, especially if they are customizable, by doing so, users began to store their musical data online in order to get better results in the applications they use, this brings ease of access to a great amount of music personal data and music social networks arise with their own repository and suddenly new interactions between music lovers were born, this changed the way as people listen to music and share their tastes about it.

Uniting this music revolution to the graphic capabilities achievable through a technology called Processing [proa], RAMA was born as a prototype to explore new ways towards music data visualization and music discovery, but times keep changing and as such RAMA demands more, so together with some users of RAMA an inquiry was made in order to capture better what is missing in this kind of music exploration applications. Like so, this thesis aims to explore more deeply what relations can be made using Last.fm musical data combined with the web2.0 concepts and how music listening and shareable media content can enhance the user experience with music discovery [SO09].

After all the research, the aim is to implement the features on RAMA, adding personalization functionalities through the user component of Last.fm, allowing people to create their own relational maps, implement a free music listening player, allowing users to play their own relational and also the ability to build and share playlists. Also some interface
changes must be done, either to improve the already made graph or due to the new features inclusion.

1.3 Report Overview

Besides introduction, this report contains:

Chapter 2: State of the art for music visualization and discovery - A chapter in which the concepts to be used in this thesis are studied and a little evaluation is done to some applications of musical visualization, music discovery and web radios.

Chapter 3: Problem description - Description of the concepts described in the previous chapter applied to the aim of this thesis and the RAMA application.

Chapter 4: Problem approach - In this chapter it is presented the application architecture and how the development during the thesis was made.

Chapter 5: Results - Analysis and review of the results obtained from criticism from users regarding the application produced during the thesis.

Chapter 6: Conclusion - Reviews the project and the success between the thesis objectives and the results obtained.

Appendix A - RAMA interface studies.

Appendix B - RAMA new interface screen shots

Appendix C - First survey, questions and results.

Appendix D - Second survey, questions and results.
Introduction
Chapter 2

State of the Art

In this section it is described the state of the art for music visualization and some works in the field will be presented. It will also cover the main problems and solutions for music relational data and the ways to display it, a quick view and appreciation of many web radios, then the study of playlists and their role in music discovery and finally an overview on music discovery.

2.1 Music Data Visualization

Nowadays the world flourishes with data and consequently analysis and visualizations are born to give meaning and a better understanding to it. Musical data is no different, so a vast collection of music listening habits and similarities between artists exists freely available over the internet in services like Last.fm. Music enthusiasts or even a common listener are always egger to find new music that is similar to their own taste, so this generated a great use for this data. As always people love to have fun while doing anything, more than just a simple list of artists was demanded, this pushed people to develop visualizations of musical relational data, which allowed anyone to discover new music accordingly to their taste with amusement~[THA04, LE07].

When talking about visualizations, there are many types of data and representations possible, so in this dissertation the first obvious question would be: "What is the best way to represent music relational data?" Quoting Ben Fry in his book Visualizing Data: “Every problem is unique, so capitalize on that uniqueness to solve the problem.” With this affirmation it is safe to assume that there is a delicate correlation between visualizations and the data behind it. First of all the data must be acquired, parsed, filtered and mined and second, its representation must be appropriate to answer some questions: "Why was the data collected, what is interesting about it, and what stories can it tell?"~[Fry08]
Other important issue in relation to visualization is how much information we should display, often there is the temptation to show all that we have acquired in order to impress, take for example a TV remote control, in general most of the people think: "more buttons, more functions so it’s better", but in data visualization the story is not the same, with more information on the screen, it will be harder for the user to find what he wants or he will hardly see what we want to show him. Less information on screen is easier to organize and easier to understand. The simplest way to achieve simplicity is through thoughtful reduction~[Mae06].

While choosing the amount of data to display, one must also choose how to, in musical data representation it is common to encounter the following three ways of representation:

- **Graph**: highlighting the relations between data
  
  ![Figure 2.1: Graph from audiomap.tuneglu.net](image)

- **Map**: using bigger amounts of data to find patterns
  
  ![Figure 2.2: Map from swcp.com/~atomboy/lastfmgraph](image)

- **Time Series**: history of music playback
  
  In a graph (fig. 2.1) the common metaphor is that each related node shares some meta-data and it helps a person in discovering new artists or bands. As graphs have to show some consistency and ease of reading, they often show a controlled and carefully selected amount of data, but this does not mean that there are not some huge graphs,
which are a mixture between a graph and a map, their aim is to show not just the relations but also the popularity of its elements. On a map (fig. 2.2) large amounts of data generate noticeable patterns and like that, it is easy to infer some conclusions, for example if the data represented is about listening habits, a dense zone would reveal a person musical taste. Finally using a time series (fig. 2.3), besides consulting ones music history, it also helps to notice some patterns about musical taste or receptivity to a style depending on the time of the day, seasons or even weather.

2.1.1 Music Visualization applications

Visualization of musical data relations, not to be confused with music visualization, which is the visual interpretation of the sound waves itself, is a recent field, having only on the second half of the last decade made its major leap towards concretization. Most of the things developed were just mere prototypes or concept images and many of these projects have just died or fallen into oblivion, despite that, much can be learned from analyzing this applications, relating to the best ways to represent music relational data and other use cases that this applications might cover–[vc, DL].

In this section we will analyze and discuss some of the still working applications of music data visualization and some concepts images created.

Liveplasma

*Liveplasma*–[liv] maps and displays artists and movies using Amazon.com’s API. After the search term is submitted, a graph is created and the original node is immediately surrounded by other artists, the closer they are, more similar is their color, this brings a good visual information to the user because besides the line connection information the user can also distinguish the similarities by color proximity and also he does not get confused following the lines. A user can search, map, discover new movies or artists then save or share them.
State of the Art

Figure 2.4: Liveplasma example 1

Figure 2.5: Liveplasma example 2

TuneGlue

Figure 2.6: TuneGlue example

TuneGlue~[tun] (fig. 2.6) is a simple and clean graph generator, exploring relationships between artists based on the Last.fm database and Amazon. Starting just with an artist name, you can then build your network from there by expanding each individual node and dragging them around the screen. It is also possible to explore all albums from each artist on the spot and link out to Amazon.com to buy any of them.

Last.fm Artist Map

Last.fm user “shoxrocks” created a series of images using data from Last.fm API~[lam]. Of the several possible outputs, at the home page you can build an image like figure 2.7 and also compare two different users. By inputting your last.fm username in an appropriate field, you will get more five options to generate some images based on your Last.fm data, revealing some information harder to see using just the site tables.
State of the Art

Despite being a desktop application, Last.fm Spring Graph~\cite{lsg} (figs. 2.8, 2.9) it is worth mentioning because it has a good concept behind and also a web demonstration. Basically you just need to input your user name from Last.fm and some more if you want to and it loads the top fifty artists for each inputed name, then it connects them using artist similarity data. Afterwards it runs through every available week for each user musical history and adds the artists week by week, giving a good perspective of one’s listening history over time. The interface is a bit fuzzy with one user and becomes almost unreadable with just two users.
World of Music

![World of Music Map](image)

The World of Music—[wom], by researchers at Stanford, MIT and Yahoo!, intends to render the music space in an unprecedented way. Figure 2.10 left half is from visualization with nine thousand two hundred and seventy six artists and how they are related to each other. The artist relation data is mined from user ratings of artists in the Yahoo! music service. The researchers used a technique called semi definite programming to layout and cluster the data—[GZL05].

Genealogy of Pop/Rock Music

![Genealogy of Pop/Rock Music](image)

This figures 2.11 and 2.12 are a reproduction of Reebee Garofalo’s Genealogy of Pop/Rock Music—[gen]covering the time period from 1955 to 1978, more than seven hundred artists and thirty styles of music are mapped. For each performer, the length of time that he or she remained a major hit maker is provided, the overlapping streams allow you to compare the longevity and influence of multiple artists for the
same time period. The birth and genealogy of each stylistic category is presented, along with an estimation of its share of total record sales.

**Last.fm Listening History**

![Figure 2.13: Stacked graph example](image)

At Last.fm Listening History one can generate a stacked graph (fig. 2.13) about our music history in Last.fm in a time interval of our choice. This project allows us to see for example when we discover new musicians, and their resulting obsession and fade, also interesting was when musicians made a later resurgence but the best of all is to see what we listen to at given times. People often remarked at the ability to see critical life events reflected in their music listening habits.

### 2.1.2 Analysis and Remarks

After analyzing around twenty applications, seven have been chosen to be presented in this section because they cover all the details currently used in music data visualization and make a lot of good and bad examples to take notice. In the big picture we have all the visualization covered, graphs, maps and time series, each one implemented in different and unique ways, in order to show whatever the authors wanted them to unveil to their final users.

Starting with the graphs, the most common approach in this kind of applications for three main reasons, easy customization, fast creation and easily understood. On this type of visualization little tweaks can definitely improve how and what we perceive from it. In Liveplasma a brilliant use the colors spectrum to relate artists that are “next” to each other, on TuneGlue a useful options menu pops up when we press a node, allowing a user to configure the graph to his own will, Last.fm Spring Graph has a good goal, but fails to achieve it, due to its confusing interface and the lack of user control during the history play, this can be annoying because the play is very slow, a good idea is the representation of different sized nodes, explicitly saying the number of reproductions from the artist it
represents, although you cannot understand if it is from the displayed week or overall, finally Lastfm.dontdrinckandroot.net brings us some posters using Last.fm data, but here the lack of control in the images generations can create pretty messy graphs, even unreadable ones.

Now about maps and timelines, aiming to be a giant graph, the World of Music can be identified as a map on a zoomed out version, this happens because some density spots will be noticeable, telling us that musicians in that place are similar to each other, in this case the amount of data gathered creates a fantastic visual graph. Another map, timeline and also a tree worth mentioning is just a poster, the Genealogy of Pop/Rock Music, it starts from the root and then grows in waves until the end, this waving behavior allows us to identify the years when bands are created or end, finally the Last.fm Listening History a tool to build a stacked graph which mixes a time line with a map, it generates beautiful results and allows a careful study of one’s music history, trends and events that influence strongly our mood and therefore our listening tendencies.

In summary graphs are an easy and efficient way to represent relational data, they provide an excellent metaphor for relations between data and with a good research on visualizations and user interaction one can tweak them to a great result. As for the maps and timelines, despite not being the aim for this project their study gave a good comprehension of the power that analyzing data can provide.

### 2.2 Free music listening

In this section we will analyze and discuss some free music listening web radios studied for implementing free music reproduction.

#### 2.2.1 Web radios

**Deezer** is a web radio claiming to have around seven million songs for free reproduction, it has an API, which makes it attractive, but they have very uncompleted information on artists and do not respond to API key requests~[dee].

**Myway** claiming to have one million songs for free and the ability to hear music channels through pre-defined built playlists, users can sort and share music, listen to radio stations for artists and read information about them. It also does a great work in gathering specific information about Portuguese bands. It contains no API and uses Silverlight on the web player, which makes it less portable, although one can use it as an widget if it is already playing any genre or artist~[myw].

**The Hype Machine** keeps track of a variety of music blogs, whenever a post contains MP3 links, it adds those links to its database and displays them on the front page,
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while making it excellent for news, unfortunately we will never get a good database because a lot of remixes and other songs with less quality may appear on the site. Again no API or embed playing ~[thm].

**Mufin** as changed a lot lately and now it is a music discovery engine and also a personal online player, it analyses users added songs and listening habits to suggest new ones. With an internet connection one can listen to its music virtually anywhere, unfortunately it only works when you have an account and there is no API available~[muf].

**One LLama** is a powerful music site that works more based on a recommendation approach. It searches and plays music from web radios sites, it is not always accurate, the results often aim more for a song similar to the research, that for the search itself. Despite that, it is a pretty good application with geographic localization so that you can find even a local radio~[one].

**Grooveshark** is a very popular web radio with a great song database, but unfortunately with no API and being implemented only in Adobe Flash makes it almost unusable outside of its domain. To a more extensive use of it, one also needs to register~[gro].

**Qtrax** is a fully integrated music search engine and social networking site with full editorial content on all artists as well as complete discographies, pictures, biographies, album ratings and more. It claims to be the first and only free and legal music download service licensed by all four major record companies, but as always this is a delicate situation and the service is not available in all countries and also it does not provide and API~[Qtr].

**Bloson** combines music and charity in the same place. In it people come together to explore, discover, and share content, all the while earning points that will be converted into a real donation to a social cause of the user choosing. It has a great song collection, you can build your own playlists and while reproducing them, besides listening to the songs, you can also see the music video. Again like many services you need to register and you can encounter some countries limitations~[mb].

**Soundcloud** is an online audio platform that lets music professionals receive, share and distribute their music. It is a simple way for music professionals to exchange music that they are working on, allowing for easy collaboration and communication prior to a public release. One can play every track on it, but as it aims for musicians on a private scope, there are a lot of people sharing some personal mix or even big DJ sets in order to get feedback. It does not have an API but it allows embed playing~[sou].

**8tracks** is a simple way for people to share and discover music through an online mix, this mix has to meet a minimum of 8 tracks, hence the name of the site, an author
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assigns to his mixes no more than 5 tags and then shares it. It is a great playlist sharing site, where you never know what music is coming next on the playlist. The only downgrade, not in the terms of the site, but the goal of implementing a web radio using its API, is that one can only search for mixes. It is a great and addictive site which is growing and one must see a lot of new things from it soon—[8tr].

*Youtube Disco* allows a user to create playlists, it uses artists similarities, although it just shows around four or five similar artists, so it is not the best tool or artist similarities, but for an intended artist will definitely result—[ytd].

*YouTube* compared to *YouTube Disco*, let’s say that it just looses a little of the suggested artists, because it always suggest videos related to the one that is being watchied, but the similarities do not relate to the artist similarity but to the video metadata. There are some videos that cannot be embed and also some countries restrictions, but it has an API with a lot of options to counter this limitations and therefore the list of videos always come with just the results you want. Like no other site *YouTube* also has an API for controlling the video player—[yt].

*Last.fm* has a lot of radios available based on a user library, on one or more tags, on neighbors, on one or more artists and even from its recommendations. This feature makes it very complete unfortunately you need to pay to have full access to these radios and you ca not use them on another site—[lasa].

### 2.2.2 Analysis and Remarks

When analyzing a web radio service in order to implement a free music reproduction player, an API adds great value to the service, but this is not a key element to consider. For start most of sites only allow a good use or any at all only if you are registered on them, then we have to consider how complete their collections are, as for their music reproduction methods, they have to allow embed playing and control of the player, this is very hard to find, because often musical sites aim to be used just on their context and not outside, so it is just impossible to use their players. Only sites with an API or an embed player could be used, like *YouTube*, *Last.fm* or *Deezer*.

### 2.3 Playlisting

In the early nineteen’s, radio broadcast started and certain genres start to emerge on an unordered set of songs, this was the beginning of playlists. After that DJ’s started to use two turn tables at discos and the idea of continuous mixing lead them to try to make the transitions unnoticeable to the crowd, then came the cassettes and with portable audio players the so called mix tapes were born, some persons even started to trade them and
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distribute their owns, providing recommendation and discovery. Then the internet arrived and the “playlist mania” increased with the MP3 generation, now you can find them everywhere~[FL10].

There are certainly a lot of objectives behind a playlist, whether its choice is at a personal level or for a social event, like a party or a radio program, etc. On a personal scope we might relate it to the authors mood, current activity or location, but on a social level it represents a certain identity and also it is able to connect groups that share similar musical taste even for just a bit of that playlist. This social part brings calls to the social sharing concept, now not only you will listen to a certain set on a disco, but you will also find it on Soundcloud or 8track (section 2.2.1), where people comment on it and talk directly to its author. So the construction of a playlist besides the personal scope, thanks to the internet, has now gained a strong social mean and one’s personal musical choices can travel the world and amuse everybody~[LR08].

2.4 Music Discovery

In the early years the problem in music discovery was how to find bands that were not main stream, because their records were not distributed by major disco record companies, they could not get any air time on famous radio stations or an interview in a magazine, only through the work of the little fan communities, were the bands able reveal their work, so finding out new music in the past boils down to knowing the fans from the local area of a band.

Now it is a lot different and again the internet plays a central role in the new music discovery paradigm. On the first place the means to arrive to any part of the world have been reduced almost to zero, both for the band or the fans, one just needs an internet connection and from Australia one can send a video or an article, etc, to anyone in Canada. One of the things that we see a lot nowadays are music blogs interviewing artists from far away even inviting them, other example is the possibly to buy a record virtually from anywhere.

After this initial revolution of information distribution, discovering new music was not the problem because new web sites, blogs, and fans groups were and still are being launched almost daily. The problem that arose with this the abundance of information was its classification, there is simply too much information to be classified by information professionals alone. When the concept of web2.0 came, the users power to classify information and generate metadata helped a lot this problem of abundance, like so Last.fm and other similar social networks were born and not only the information became organized, but also centralized and personal, such services are believed to provide better results for fans because the descriptors used to classify nearly everything, speak the same language
as the fans and the data corresponds exactly to a specific user. This great amount of in-
formation made possible the new age of music discovery, were a user no long needs to
look for non main stream bands with friends of friends, now they can easily find any band
based on a folksonomy that was created by the user itself or other fans~[Gaf08].

After this organization of information, the access to information of similarities be-
tween bands made possible the internet radios that now flourish through the web. Usually
the principle is, launch the radio with a certain artist or musical tag, then the user will
have control over it and it is expected that he provides information for the songs being
played, if in his opinion they are similar or not to the original artist or tag. Web radios,
usually are associated to some music discovery engine and it is this engine that creates
the playlists and the artists similarities~[OKT10].
Chapter 3

Problem description

In this chapter it will be presented in more detail the problems associated with music relational data visualization, reproduction and the creation of playlists and the creation and subsequently sharing of playlists, why were they selected to be included in the RAMA application and their impact in the overall process of music discovery.

3.1 Introduction

RAMA emerged as visualization tool that allows users to navigate inside a map of relations for a given artist, the map is created based on information about artists similarity and their tags provided by Last.fm. Initially browsing the net of an artist was good enough for showing results and users were satisfied with this prototype, but after a while the music concepts on the Web continued to evolve, new radio services arose, big communities for sharing playlists and like so RAMA users demanded more.

3.1.1 Users inquiry

In order to find what was this “more” that users needed in order to enhance their experience with music discovery on RAMA, an inquiry was created to attend this questions. This inquiry motivation and questions originated from an earlier feedback given by some specialists, after seeing the first version of the application presented in ISMIR 2009 conference~[ism, ram09], good reviews have been made and a new list of requirements was created. With this features list and opinions from some persons behind the project, the questionnaire (see Appendix C) was created, being the target population all the current students from FEUP, so an email was sent to near eight thousand people and 145 were kind enough to respond.
Problem description

3.1.2 Analysis of the survey results

In Appendix C are present the findings of this survey data which allowed us to conclude what would the new RAMA become.

Analyzing group 2 answers which asks the users to evaluate the interface, about 50% of them are satisfied with it, 30% to 40% are not satisfied and the rest are satisfied with it, this minority in very satisfied people prompted the team to ask the professor Joana Fernandes Gomes from Universidade Católica Portuguesa to help with some studies to create a new interface (see Appendix A). In this group it was also asked from users their opinion about their discovery experience, this revealed that 81% of users were satisfied or very satisfied with the experience, which reveals that this kind of approach to music discovery is very effective.

Next on group 3, users were asked to give their opinion. On the first question they had to choose five new features to include in RAMA, The five most voted in descending order are the following: music reproduction 81%, music recommendations based on an user profile 66%, playlists 63%, musical events suggestions 57%, artists information 50%. They were not all chosen to implement, artists information was discarded because when using Last.fm’s API one must always link back to the site, so each artist would have the option to link back to its corresponding Last.fm page, were the users can find information about the artist. As the interface needed a lot of changes, the next feature less voted which was the musical events suggestions was discarded. Next the users were asked about their views regarding the use of graphs for discovering new artists and interpret relationships between artists and most proved to be satisfied with the concept.

Finally a section about Last.fm and the benefits that might emerge from using its data on the application led most of users to respond that they would be interested in using this service if they were not already doing it, meaning more users to the service and more data for it to use.

3.2 Musical relational data visualization

Sometimes users look up to efficiency, other times for amusement. Let’s consider Google Search (http://www.google.com) for example, here the case is clearly efficiency, users want to find the item or items of their interest as quickly as possible, so visualizing the results in a dynamic less organized manner would cause great inconvenience, so the solution here follows a “keep it simple and short” philosophy, an organized list displaying the results, so it is easy for the user to analyze all the results and do not leave anything behind. On other activities the users want to amuse their selves in the process of finding information, locate the objective in simple games or stumble across things in a labyrinth of information, this is the case for music discovery. People often use music to a lot of
different objectives and amusement is clearly one of them in many situations, so while having fun with it, the users also have fun discovering it, either by following the paths constructed to connect artists or by looking up the most related artists concentrated in an area of the visualization. This justifies the inclusion of relational data visualization to enhance the music discovery experience.

When talking about musical relational data visualizations one must first define the objective of it, in this case the visualization main goal is to understand what artists are related to each other and what folksonomies they share, secondary is music discovery. The users exploration of the 2d or 3d space allows him to understand by the use of this spatial metaphor the meaning of the data, like distance meaning how similar artists are.

### 3.3 On-line music reproduction

During the process of discovering new music, it is important to let users listen to what they are discovering, at first one must think that if someone is discovering music, he or she must be listening to it, but this is not the case, because in the first instance the user gets an artist map and not a playlist, so in order to increase the experience of discovery to the user, he will be able not only to explore a visual map, but also listen to it.

Services that provide online music reproduction vary in the way as they do in objective. On some sites, music reproduction is the only service that is provided, they behave as radio stations randomly playing a song, after the user inputs the search term, a playlist is generated with songs or even web radio stations similar to the search term, that can be a tag, an artist or even a state of mind, in other cases the results might be user generated playlists like in 8track or some results from YouTube. YouTube and Grooveshark are not like this because their results are more reliable and close to the search term, so they work almost as a player with your music collection. Most of this services work with this random playlist generation method because having a vast music collection to freely make available all over the world has great constraints and a heavy cost. On other sites music reproductions poses itself as an alternative or complementary service to their objective, like in Last.fm, one can find bands that are similar by browsing the artists page or by listening to a radio created based on that same artist.

### 3.4 Playlists

Playlists are the most common method to organize a set of songs, there can be a lot of different objectives in their construction, a lot of parameters by which they can be organized. In music discovery sharing a playlist between one or more individuals is an usual and effective method, to listen to a certain set created by someone that shares some musical taste or even if the playlist is classified with some metadata that is of one’s interest.
Problem description

So it is important not only to listen to what we are discovering, but also build a set of this discovery in order to share it.

3.5 Users library data

Often in music services whenever is needed some user input, it is going to be something that pops right on one’s mind, mainly because it is a personal favorite or because the user has been listening to it recently, ultimately because someone told him about it and he is checking it up.

A great meaning in web2.0 applications is the user component embedded in its context, this brings the user closer to the application and compels him to use it, because without a great effort one can see personalized results in an instant.

3.6 Music discovery

Using Last.fm powerful data, music discovery is much easier to develop, there are a lot of different concepts used in this area, visual constructions of relational data, random reproductions of music playlists generated on real time or even by sharing media. All this disciplines have proved to work separately, so the reunion of them might result on a pleasant experience to the user.

Here the features chosen to enhance the process of discovering new music were:

Visualizations (3.2) in order to add an amusement component to it and also provide some metaphors easy to understand;

Music Reproduction (3.3) to allow the users to listen what they are discovering;

Playlists (3.4) construction capability to allow the user to listen again any tracks that emerged during his listening session and have pleased him or to share his own set;

User data (3.5) to create a contextual view of the users preferences.

3.7 Problem Statement

All of this separated concepts attended in this chapter, relate somehow to music discovery, the main problem is how to combine all of them to successfully create an application that while generates a visual space for the user to explore musical relational data, allows him to listen what he is exploring and immediately grants the user the capability to share this new content of his and find information about his new discoveries, all in a pleasant way and with and easy extraction of the data meaning~[LE07].
3.8 The solution

Deployed near his prior version, in the link [http://rama.inescporto.pt/ncruzapp](http://rama.inescporto.pt/ncruzapp), the new RAMA would be developed following an evolutionary prototyping methodology. As the modules are implemented, tests will be applied to each one and after those, correct possible errors and only after that the next module should be implemented.

![Evolutionary prototyping](image)

Figure 3.1: Evolutionary prototyping

The tests should be made based on direct observation on no more than 5 users during the development phase, just on the last questionnaire, has in the first one presented in section 3.1.1, the scope will not be limited.

The first module to be implemented would be music reproduction, the objective is to use it as a complementary tool to music discovery. As people navigate through the network of artists they can launch the player with a specific artist, this compels the user to explore and use more the visualization component of the application to go deeper and further into the network he originally created to build an artist map.

The second module was the interface design and the graph display algorithm. The visualization of relations between any given number of elements is best defined by representing the elements themselves and a connection between them, the structure that originates from this kind of implementation is a graph, which is clearly the best way to achieve the goal of representing one or more relations between artists, RAMA the users also think so (see figure C.11) and from the state of art it is the most common approach. Having the structure decided, the remaining step was to select how to display it and organize the information, this matters will be attended on chapter 4.

The third module was the playlist creation, here the target was to, along with web2.0 and music discovery by sharing content, give the user the power to create a playlist that
Problem description

is able to be shared with others and with a structure easy to understand so that it can be easily edited.

Finally the use of personal music data, a field that stands very complex, because it depends on many variables like the social environment in which the user is inserted, he might have friends with big music knowledge that easily recommend what he likes, might not and one can find a lot of other “might’s” for this situation, so in this matter what has been selected to do is, access the recent artists from a Last.fm user profile and build graphs based on them. Clearly for some reason the user chooses, from his available services that scrooble\textsuperscript{1} to Last.fm, some collection of artists that week, so not to get away from the user recent tastes, that is the data that will be used from his profile.

\footnote{Scrobbing is a way to send information about the music a user is listening to. A client is anything that plays music, such as desktop music players, mobile apps, websites, etc.}
Chapter 4

Problem Approach

RAMA had already an early version (fig. 4.1), available at http://rama.inescporto.pt/, consisting only in visualization tool, it was built using Processing and Java. This would pose itself as the building base to implement and test the new features, in order to save time by reusing some of its code and architecture.

Figure 4.1: First version of RAMA

4.1 Work methodology

As described in the section 3.8 of the previous chapter, the work methodology followed during this thesis was an evolutionary prototyping.

The first step was the elaboration of a heuristic analysis and an inquiry among users of RAMA, in order to ascertain which features were to be implemented in the new version of the application (see section 3.1). After having established what to do, the schedule for the implementation was created, having decided that the first module would be music reproduction, an important feature, after all music is what this application is all about and
it was the feature with more percentage of choice from the users (see figure C.10), this would allow one to immediately listen to what he or she searched, next came the interface changes, this demanded a little more time because it was needed to understand the code from the previous version and only after that, changes could be made, next the playlists and finally the use of user personal data from Last.fm. Between each of the modules implementations, tests and bug fixing were made.

After implementing and testing all this features another survey was made, in order to get the users feedback about the changes made compared to the old version and also to get feedback on the new features included.

4.2 Application architecture

This section presents the application architecture and a brief description of its class model.

The application works as an applet, a compiled Java application runnable on a browser. Once the user accesses RAMA page, the applet is downloaded to his machine and it runs from there, accessing the database stored on the same server from where it was downloaded. This server performs a monthly update of its database using the Last.fm API.

![Application architecture](image)

Figure 4.2: Application architecture

Now focusing more on the application, its core and applet launcher are contained in the class RAMA, the communication with the database on the server is done through the class API which has an event manager that uses the APIEvent class. The class that deals with the connections to the Last.fm user data, and parses the XML results from is Reader and finally in the matter of connections, the class Radio connects to the YouTube Data API in order to create the individual artists playlists, this class also connects to the applet’s page JavaScript, used to control the embedded YouTube player.

Now regarding the visual component, first the class Grafo, Portuguese word for graph, the base structure to compile all the elements (tags, nodes, edges) and calculate all of their positions, it is responsible for all of this and it also represents the relational map itself. Attached to it is the class GrafoViz, responsible for all the drawing in the application, this class was previously developed with the Processing syntax but now it is in pure Java, this change as also been applied to all the classes that used the Processing syntax. A graph
is formed by the edges and nodes, represented here by the classes Ramo and Vertice respectively, the content of the node is defined by the class No, part of the content is the Artist itself, the class for him is Artista which can have one or more tags, hence the class Tag. Finally there is the class Nuvem, Portuguese word for cloud, which is an abstraction to a group of tags, this clouds are of course contained in the graph and they circulate near the nodes, in other words, the artists which they belong to.

4.3 Developing the new RAMA

Looking for maximum capability between browsers and operating systems, the RAMA initial project developed in Java was recycled for this new version, relying on the JVM to do its job in regard to compatibility between operating systems and in JQuery~[jqu] for the browser issues.

4.3.1 Music player

After analyzing some web radios and YouTube itself for the state of art (see sub-section 2.2.1), the choice made to implement an online free player was YouTube. From the analyses done at the state of art it was concluded that to serve as player source, a service must have a great collection of songs, an API and must allow an embedded use of its player. Deezer excluded itself, because no answer was received regarding an API key request, next Last.fm, being the source of RAMA data, use it for the radio would be a great feature, the radio options are customizable on the link, but for control one can only use just the
Problem Approach

radio interface and it is not for free, so this option was also discarded, leaving just the YouTube left.

YouTube has many search options, customizable on the request link for its data API, this helps to overcome a lot of constraints in selecting videos that one can use due to country restrictions, embedded playing capability and category selection. By analyzing a request result which comes in XML, one can easily select a video and start reproducing it, controlling the player via the YouTube JavaScript Player API, this is a key feature and made the choice for YouTube obvious, also it has Java libraries which make possible to filter the results transparently so there is no need to implement parsers or data filters.

The major constraint in this phase was creating a bridge from the Java applet to the embed player on the web page. An older version of Java supported this type of communication, but now it does not, at least on first hand because the library used to do that in the past still exists in the Java installation, so it was just a matter of finding it and uses it accordingly to the feature needs.

On the applet side, after the user instruction to launch the player, the application consults the YouTube Data API, retrieves the results, scrambles them and orders the player to start with the first item on the list and passes the rest of it to a JavaScript array on the page for that purpose, after this launch part, the applet role in the radio is done and now all the controlling is done via JavaScript and the YouTube JavaScript Player API.

![Music player](image)

The player (fig. 4.4) is very simple, on the top it displays the title of the song being played and has a plus button whose function is to add the current song into the user playlist, as for the other controls it has three buttons, one to play and pause, another to go to the next song and finally one to mute or un-mute, the slider on the right controls the volume. Regarding the status of the playlist unseen by the user, the one which is generated and passed by the Java applet, when it reaches the end, the player will warn the user by means of a JavaScript alert message. As for the music discovery process in each session, if the player is playing songs from this playlist it will never repeat a song already played.

### 4.3.2 Interface changes

As RAMA gained new features, their implementation demanded direct interface changes, but due to the negative feedback regarding the controls, the input field and the elements in the artists graph, this step was included to create a more user friendly interface.
Problem Approach

Reshape of the elements

For this first task, the professor Joana Fernandes Gomes from Universidade Católica Portuguesa helped with studies to the new interface (see appendix A). On a first step a biological metaphor was asked, but this approach created some barriers to the customization of the map, so it was discarded, then two more concepts emerged, one following a radical approach, where random shapes and white spaces dictated the flow of the map and other approach more simple and clean. The choice followed was the simple one, due to the difficulty of implementation and interpretation for the more radical proposal and because the cleaner proposal would provide a more readable and understandable map for the users (see figure A.8). The final interface looks like figure 4.5, it can be seen live at http://rama.inescporto.pt/ncruzapp/rama_beta/ and more screen shots are available in the appendix B.

![Figure 4.5: New version of RAMA](image)

The elements of the graph give out information by color and size, when the mouse is hover a node, the edges that connect to his children start to randomly change color. Regarding sizes, for artists there are 5 different ones, the origin node has the biggest size of all, then there are then 4 other sizes that are assigned depending on the artist fame that goes from 1 to 100, the assignment of values is done at intervals of 25 values, starting with the larger size from 100 to 75, to the smaller size between 24 and 1. The tag size is related to the number of occurrences of the same tag in an artist, due to its attribution by several users and to how many artists in common it has on the current map. So for example, in the figure 4.5 the tag “belgian” is the most common to every artist in the graph and the one with the most counts on each artist, hence its bigger size. So size matters, the biggest the size of an element means that it is more important, it has greater meaning.

The tags float around the graph and if one changes the position of a node, the tags that are related to that node will also move, this happens because the tags relative position is the centroid between all the artists that share the same tag, but it tends more to the artists that have more count occurrences to it.
Graph draw algorithm

Not only the interface elements needed changing but also the graph drawing algorithm, there were just too many items overlapping each other in the first version, so after some study in force directed drawing algorithms—[Tam07], the approach used to draw the map was the spring system with electrical forces, but a little tweaking needed to be made.

\[ f_a(d) = \frac{d^2}{k} \]  \hspace{1cm} (4.1)

\[ f_r(d) = -\frac{k^2}{d} \]  \hspace{1cm} (4.2)

\[ k = C \sqrt{\frac{\text{area}}{\text{number of vertices}}} \]  \hspace{1cm} (4.3)

4.1 - Attractive force, 4.2 - Repulsive force, 4.3 - Optimal distance between vertices

---

Problem Approach

| area := W * L; \{W and L are the width and length of the frame\} |
| \( G := (V, E); \{\text{the vertices are assigned random initial positions}\} \) |
| \( k := \frac{\sqrt{\text{area}}}{|V|}; \) |
| function \( f_a(x) := \begin{cases} x^2/k & \text{if } x < 0 \\ 0 & \text{otherwise} \end{cases} \) |
| function \( f_r(x) := \begin{cases} x^2/k & \text{if } x < 0 \\ 0 & \text{otherwise} \end{cases} \) |
| for \( i := 1 \text{ to iterations do begin} \) |
| \( \{\text{calculate repulsive forces}\} \) |
| for \( v \in V \text{ do begin} \) |
| \( \{\text{each vertex has two vectors: } .pos \text{ and } .disp\} \) |
| \( v.disp := 0; \) |
| for \( u \in V \) do |
| \( \{\text{\( \delta \) is the difference vector between the positions of the two vertices }\} \) |
| \( \delta := v.pos - u.pos; \) |
| \( v.disp := v.disp + (\delta/|\delta|) \times f_r(|\delta|) \) |
| end |
| \( \{\text{caluculate attractive forces}\} \) |
| for \( e \in E \text{ do begin} \) |
| \( \{\text{each edge is an ordered pair of vertices } .v \text{ and } .u\} \) |
| \( \delta := e.v.pos - e.u.pos; \) |
| \( e.v.disp := e.v.disp - (\delta/|\delta|) \times f_a(|\delta|); \) |
| \( e.u.disp := e.u.disp + (\delta/|\delta|) \times f_a(|\delta|) \) |
| end |
| \( \{\text{limit max displacement to temperature } t \text{ and prevent from displacement outside frame}\} \) |
| for \( v \in V \text{ do begin} \) |
| \( \{\text{reduce the temperature as the layout approaches a better configuration}\} \) |
| \( t := \text{cool}(t) \) |
| end |

Figure 4.6: Spring system with electrical forces algorithm

The algorithm selected is based on a system which assumes that each node as an electric charge value, this value varies between each pair of nodes, but the signal of the charge is the same, this
means that every node repels every single other node, making them to evenly distribute through the screen obeying to a coefficient calculated in the formula 4.3. Also each node connected by an edge has a spring between them, this makes the nodes connected to each other come closer. Simply describing, the algorithm (fig. 4.6) works as follows:

- First the repulsive forces are calculated, each node electrical force (formula 4.2) is calculated for every other node in the graph, the lower the similarity between two artists, higher the value of the charge, making them to be more apart from each other, the greater the similarity, lower the charge, making them to be less apart. Each time that the charge value between two nodes is calculated, the current node position is recalculated. After all repulsive electrical forces calculations between every pair of nodes are terminated, the attractive force (formula 4.1) calculations kicks in.

- The spring force is calculated between every pair of connected nodes, again, the similarity will dictate the value of the spring force, more similar artists will have a stronger spring that less similar artists. After the force is calculated the positions are again updated. Finally after all the calculations of the new positions influenciated by the forces, the nodes are redrawn into their new positions and here enters the temperature calculation.

- This temperature metaphor assumes that at the beginning the graph is “warm” and for each draw iteration, it “cools down” a little, as iterations go by, the graph starts to reach its optimal configuration so the temperature is getting very low, until it completely freezes, after this no more changes are made to the node positions by the algorithm.

This temperature metaphor described in the last item works as follow: in each iteration when the redraw is happening, the length between the old node position and the new one is calculated, then the node replacement value is selected between the minimum temperature or the length of the node displacement. The temperature starts with a certain value, it is not clear what initial value should be assigned, only through experimentation one can see the values that generate better results and stick with them, this initial assigned value must be a high one, so that the minimum value at the initial steps will correspond to nodes displacements, as iterations go by and the displacements gets lower as also the temperature. When the temperature gets very low it becomes smaller than the displacement value, this means that the graph is reaching its optimal configuration and changes to the positions are almost useless at this point, so the temperature value is now used instead of the forces displacements. When the temperature reaches zero, the nodes are fixed into place and from now on they can only be moved by the user.

The first application did not have this temperature approach, which is really important, because the nodes which are placed in the screen space, respect its dimensions which are defined by two integer values, the width and the height. The forces calculated during the nodes placement are not integer values, because this would provoke some nodes to “teleport” on the screen and not have a smooth movement, so in the end of all calculations the coordinate values of nodes need to be rounded up to an integer value and this round up causes the forces never to stabilize and because
Problem Approach

of this they become infinite. This temperature approach puts an end to a great effort made by the processor in each iteration, making the application more fluid and responsive.

About the two little tweaks made to the algorithm: the first tweak was done in the repulsive force formula (formula 4.2), the minus on the force would not make sense on the proposed algorithm in the same book, because what is used to calculate is the absolute value of the force. The second tweak was done in the algorithm itself (fig. 4.6), because a graph node is supposed to be just a point, but in this case it is not, here a node is represented by the name of the artist wrapped on a box, so the space rules defined for dots can no longer be applied here and in order to improve the node distribution a little increase was given in the calculations of the repulsive forces. Depending on the graph complexity level, which are 3, the increase is going to be greater or smaller. On the first level less help “force” is given because there are few elements on the window, which makes the distribution easier, but as the complexity levels increase to 2 or 3, more elements appear and to get the best spatial distribution of the artists the increase needs to be bigger.

User map interactions

RAMA map interactions are quite a few, so the better way to let the users know what they can do was through an instruction manual. The picture 4.13 corresponds to the manual, it also includes were the application works with no problems, that was included because this image is presented on the application page, this is the first thing that a user will see, only then he enters the application itself.

Describing the user’s available interactions:

Mouse hover: hover an artist, its corresponding tags are highlighted, the artist text color becomes pure blue and also its tags (fig. 4.7);

Mouse hover: hover a tag, its corresponding artists are highlighted, the tag color becomes pure red and also its artists (fig. 4.8, 4.9).

Mouse left button: hover nothing, click and drag to zoom in on the graph (fig. 4.10, 4.11);

Mouse left button: click hover an artist, makes the user able to drag it anywhere.
Problem Approach

Figure 4.9: Hover a tag that does not belong to Nick Oliveri

Figure 4.10: Zoom selection

Figure 4.11: Zoom result

Mouse right button: hover nothing, click and drag to move the graph;

Mouse right button: clicking hover an artist opens its menu.

Click on mouse wheel or press Space bar: resets the graph zoom.

Rotate mouse wheel: changes the map complexity between three levels.

The node menu (seen in figure 4.12), corresponds to the actions available from an artist, they are as follow:

Figure 4.12: Node menu
Problem Approach

**Open Radio** - Launches the player for the chosen artist;

**Expand Node** - A query is made to the database to search for related artists and if they are not already in the graph, they are inserted and then the connection between this new nodes and the one which the request came from is made;

**Create graph** - Creates a new graph using the selected artist;

**Last.fm page** - Opens a new tab in the browser to the artist *Last.fm* page;

**Remove artist** - Removes the select artist and its children nodes from the graph;

Browsers and Operating systems compatibility

![ compatibility logos ]

**USER INTERACTIONS AVAILABLE**

- **Mouse hover**
  1. Hover artist, highlights its corresponding tag(s).
  2. Hover tag, highlights its corresponding artist(s).

- **Mouse 1**
  1. Hover nothing, click and drag to zoom in.
  2. Click over artist to drag it.

- **Mouse 2**
  1. Hover nothing, click and drag to move the map.
  2. Click hover artist, open node menu.

- **Click on mouse wheel or Space bar**
  1. Reset graph zoom

- **Rotate mouse wheel**
  1. Change map complexity (3 levels available)

Figure 4.13: Welcome page for the new RAMA
4.3.3 Playlist

The playlist (fig. 4.14) implementation was pretty straightforward, with the help of the powerful jQuery library. The list created by the user corresponds to the HTML ordered list tag (<ol>), as it represents a list in which the order matters. It allows the user to add items by the use of the jQuery selectors, done either through the plus button on the player or by loading a playlist file, using the first button on the user playlist bar. Each list item is sortable and can be deleted, so the user has the freedom to change the playlist to its own taste.

After the users builds or loads its playlist into the page, they have three options besides editing the playlist. It is possible to save the playlist to a file through the second button, start to play the list by the third button or by clicking on an item and finally clear the current playlist using the last button. During the reproduction whenever an item is clicked the player loads that item and starts playing it, during the user playlist music reproduction the music being played is highlighted and the tracks can be played more than once.

The file exported by the application has the following structure at the top:

```
| rama playlist format: video id,video title |
| This playlist was generated by SESSION USER NAME at DATE TIME |
| To play any video from this playlist, just replace VIDEO_ID on this link: "http://www.youtube.com/watch?v=VIDEO_ID" |
| by the video id that you want to listen to and then copy and paste the link to any browser. |
| example: _grruxHpxLE,AIR - Electronic Performers |
| http://www.youtube.com/watch?v=_grruxHpxLE |
```

<table>
<thead>
<tr>
<th>Video ID</th>
<th>Video Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>iMMbvmRmMQI,Nicolas Jaar - Nico’s Feelin’ Good</td>
<td></td>
</tr>
<tr>
<td>SBuE6mu-hJs,Foals - Blue Blood (Prince Club Remix)</td>
<td></td>
</tr>
<tr>
<td>lpc2ZYqpE_8,Black Strobe - Me &amp; Madonna (The Twelves Remix)</td>
<td></td>
</tr>
<tr>
<td>PKz5I8IsDF4,Toro y Moi - Still Sound</td>
<td></td>
</tr>
</tbody>
</table>
Problem Approach

This structure explaining carefully the file architecture aims for the curious users that might open the file and find its content hard to understand, it is an objective that power users open the file and by understanding it, start to manually increase or build their own RAMA playlist files from scratch or just by adding new songs to the playlist, in this case, YouTube video id’s and the corresponding video title separated by a coma. If users are looking to use it on RAMA they have always to include the initial squared explanatory note or it will not work, this compels to always have this note in every file, not only it identifies the creator but also it makes it more understandable and user friendly to other future users.

The greatest constraints with this module were found in the browsers interpretation for CSS rules and it was not that big of a problem. The export and import features were made in a Java applet using the JFileChooser class, regarding security reasons the browsers do not allow JavaScript to write files on the users disk, so as there was already and applet in the page, Java was used to this feature also, but in order to use the JFileChooser on a browser, some special sandbox security settings are needed, settings which would mess with the RAMA applet causing it to not work, so this features had to be implemented in a separate applet.

4.3.4 User Data

Last.fm API grants many operations regarding user’s data, some require his authorization and others do not. By wanting immediate results just after the input of the user name, the operation chosen was the user.getWeeklyArtistChart, either because it does not require any special authorization from the user to access its data, hence the immediate results and because this operation allows to add a little context from the user recent listening habits to the application. The result of the chosen operation is a list of the artists listened by the user in the last seven days, so he will definitely remember listening recently to the artist which will originate a new map, this will make this map in the mood of users recent listening tendencies.

The request answers from Last.fm API come in XML, but unlike YouTube’s data API, there are no libraries to filter the results, so in order to successfully store and use the information contained in the requested operation, a XML parser adapted to the answer was created. After the request is stored on the application, an artist is randomly selected from the list, then it is used to create a map and finally removed from that same list, this allows each user to get always a different map in the same session and when there are no more artists a JavaScript alert message notifies the user of that fact.

4.3.5 Other related work

Old RAMA code surely caused some delay in the interface interactions, so some refactoring in the calculations was made, they were simplified to enhance performance which worked well, but despite this on Linux it runs clearly more slowly than Windows, the reason for this was not clearly assorted if was the JVM, the graphics driver or the browser itself.
Problem Approach

Another matter relates to the inclusion of the Google data API Java libraries. This action requested that from that moment forward the applet should be signed by a trusted certificated. A good certificate costs a lot and it is limited in time, so a free of charge self signed certificate was created in order for the applet to run, because of this, first time users will always be prompted by the browser to accept the certificate.

During the development the greatest problem that arose was that some features, in the same operating system worked on some browsers and did not on others, or in the same browser it worked in a specific operating system and did not on a different one. This led to conclude that the application does not depend only on the JVM, but also depends on what the browsers allow the content of the tag applet to do. As this was noticed in the middle the development, there was no turning back from Java because it would mean the rebuild of all the work done and nothing from the first application would be recycled. Further conclusions in this matter will be attended in the conclusion chapter (6.3).

4.3.6 Deployment and further tests

After the development of all the features was completed, the application was deployed on the link http://rama.inescporto.pt/ncruzapp/rama_beta/, but before, the page on http://rama.inescporto.pt/ncruzapp/, (as seen in figure 4.13) indicates where it works and explains how the user can interact with the map. After the deployment, the application was tested by some users and after confirming that all was alright and good to go, the final survey to get the users feedback about the changes made and the new features included.
Problem Approach
Chapter 5

Results

After all the development during the semester, the last weeks were reserved to test the application and launch it to the general population in its beta state. This made possible the realization of a final survey which would collect the users views from the features that were improved and from the new ones included in this version, the target population was again the FEUP’s community, the same eight thousand people of the first survey, only this time only 94 answered.

In this chapter the results of the second survey (appendix D) will be analyzed and when possible compared with the first one.

5.1 Survey results

The following tables 5.1 and 5.2 refer to the data results obtained in the first and the second questionnaire respectively. For the evaluation from 1 to 4 was calculated the average and the standard deviation, as for the yes or no question just a simple count was made.

5.2 Analysis

Beginning with the results that can be compared between questionnaires. As for the input text field the average increased from 2.52 to 3.05, the controls feedback got from 2.73 to 2.99, the text readability has also increased, but just a little from 2.71 to 2.89, meaning that more can be done in this field, the opinion about the elements overlapping was better, it got from 2.46 to 2.60, still a lot work to do here too, new music discoveries rose from 3.06 to 3.37 and the overall experience with the map rose from 2.75 to 3.12. It is easy to conclude that overall the old features were improved, despite that some have not improved that much in the general opinion. Regarding the standard deviation of the questions from the first survey, they all vary from 0.74 to almost 0.87, a lot of people gave a negative score to the interface and so this deviation refers more to that negative
## Results

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Average</th>
<th>Standard deviation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you know project RAMA - Relational Artists Maps based at INESC Porto? (C.1)</td>
<td>55</td>
<td>90</td>
<td></td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>User Interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the input text field. (C.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the parameters sliders. (C.3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion the controls feedback. (C.4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relational Map</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion on the text readability. (C.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the elements overlapping. (C.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about new music discoveries. (C.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the interactivity with the map functions. (C.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction of the experience with map. (C.9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a relationship map is the most appropriate structure for interpreting artists similarities? (C.11)</td>
<td>127</td>
<td>18</td>
<td></td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>Is a relationship map the most appropriate structure to find new bands? (C.12)</td>
<td>126</td>
<td>19</td>
<td></td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>Last.fm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior to this questionnaire, had you heard of the Last.fm service? (C.13)</td>
<td>92</td>
<td>53</td>
<td></td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>Do you use the Last.fm service? (C.14)</td>
<td>45</td>
<td>100</td>
<td></td>
<td></td>
<td>145</td>
</tr>
<tr>
<td>If the answer in the previous question, with the features stated in question 3.1, these features of personal data arising from a free account on last.fm, would you be interested in signing up for the service? (C.15)</td>
<td>60</td>
<td>43</td>
<td></td>
<td></td>
<td>103</td>
</tr>
</tbody>
</table>

Table 5.1: First questionnaire results

feedback, a situation that is no longer present in the second survey which helps to confirm the improvement done.

Now moving on to the new features of RAMA, the graph new complexity control received a good feedback with an average of 3.06 and a standard deviation of 0.73, seeing its corresponding graphic (fig. D.2) one must conclude that this deviation is definitely more influenced by the users very pleased with it, which is fortunate.

Regarding music reproduction, there was an odd start with a low average for the opinion about the perception of the controls functions, only 2.91 but it had the biggest standard deviation of 1.00, influenced by the 70% that were pleased or very pleased as seen in figure D.8. This was classified as odd because the player has all the usual buttons symbols of a music player in it, no one tried to reinvent the wheel here, so people should not have had a hard time using the controls. Next there is the opinion about the interaction with the controls and a similar behavior in this question is found as before, an average of 2.98 and a big standard deviation of 0.92, again influenced by the very pleased users. Finally regarding music reproductions there is the opinion about the playlists automatically generated which had an average of 2.97 and the second highest standard deviation of 0.99, again this deviation is derived from the 33% that were very pleased with the list, this poses as a great feedback and also a big thanks to YouTube, clearly its search results, after a little treatment of course, meet the users expectations or revealed great new songs.

Passing of to playlists, the first question made was if the users, without help, have been able
Results

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Average</th>
<th>Standard deviation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you answered to the previous inquiry? (D.20)</td>
<td>37</td>
<td>57</td>
<td></td>
<td></td>
<td>26</td>
</tr>
<tr>
<td><strong>User Interface</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the input text fields. (D.1)</td>
<td></td>
<td></td>
<td>3.05</td>
<td>0.77</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about the control to change the map complexity. (D.2)</td>
<td></td>
<td></td>
<td>3.06</td>
<td>0.73</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about the controls feedback. (D.3)</td>
<td></td>
<td></td>
<td>2.99</td>
<td>0.82</td>
<td>1 to 4</td>
</tr>
<tr>
<td><strong>Relational Map</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the text readability. (D.4)</td>
<td></td>
<td></td>
<td>2.89</td>
<td>0.75</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about the elements overlapping. (D.5)</td>
<td></td>
<td></td>
<td>2.60</td>
<td>0.86</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about new music discoveries. (D.6)</td>
<td></td>
<td></td>
<td>3.37</td>
<td>0.82</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Satisfaction of the experience with map. (D.7)</td>
<td></td>
<td></td>
<td>3.12</td>
<td>0.73</td>
<td>1 to 4</td>
</tr>
<tr>
<td><strong>Music Reproduction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opinion about the perception of the controls functions. (D.8)</td>
<td></td>
<td></td>
<td>2.91</td>
<td>1.00</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about the interaction with the controls. (D.9)</td>
<td></td>
<td></td>
<td>2.98</td>
<td>0.92</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about the playlists automatically generated. (D.10)</td>
<td></td>
<td></td>
<td>3.97</td>
<td>0.99</td>
<td>1 to 4</td>
</tr>
<tr>
<td><strong>User Playlists</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Could generate a list intuitively? (D.11)</td>
<td>60</td>
<td>34</td>
<td></td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>Opinion about the perception of the controls functions. (D.12)</td>
<td></td>
<td></td>
<td>3.05</td>
<td>0.81</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Opinion about interaction with the controls. (D.13)</td>
<td></td>
<td></td>
<td>3.16</td>
<td>0.86</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Capability to import and export the list. (D.14)</td>
<td></td>
<td></td>
<td>3.22</td>
<td>0.86</td>
<td>1 to 4</td>
</tr>
<tr>
<td><strong>Opinion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you consider the application effective to discover new bands? (D.17)</td>
<td>86</td>
<td>8</td>
<td></td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>With the possibility of building personal music lists, do you consider to share them with your friends? (D.18)</td>
<td>88</td>
<td>6</td>
<td></td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>If you answered yes in the previous question, do you believe that such social sharing can enrich the application component of discovering new bands or songs? (D.19)</td>
<td>86</td>
<td>2</td>
<td></td>
<td></td>
<td>88</td>
</tr>
<tr>
<td><strong>Last.fm</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have and account at Last.fm’s site? (D.15)</td>
<td>26</td>
<td>68</td>
<td></td>
<td></td>
<td>94</td>
</tr>
<tr>
<td>Are you satisfied with the result of entering your username from Last.fm? (D.16)</td>
<td>20</td>
<td>6</td>
<td></td>
<td></td>
<td>26</td>
</tr>
</tbody>
</table>

Table 5.2: Second questionnaire results

to generate a list intuitively, 65% have made it and 35% have not. Again the users were asked about the perception of the buttons functions and this time a greater average was found, 3.05 and a standard deviation of 0.81, favoring the 30% very pleased users, this is again a bit odd because the same approach was used here, the icons belong to the same pack from the ones present in the player and yet better results were obtained. Users were also asked about the interaction with the controls and again a better feedback was given here, an average of 3.16 and a standard deviation of 0.86, here 40% of the users where pleased and another 40% were very pleased. At this point this interaction feedback on the buttons made clear that greater actions on the screen, like opening a big new window or clearing a big list from the screen are actions are more visible to the user, hence the better results for this controls, the lower results are not from a worse implementation but due to an action less visible like changing the name of the track on the player. Finishing the analysis in this matter, the users were lastly asked to give their opinion about the capability to import and export the list, this feature had the highest average of 3.22 and a standard deviation of
Results

0.86, this was an expected result because users are always eager to share their findings or to save them to another time and this feature allows them just to do that.

The next little group covered the Last.fm service. Back in the first survey a question was made to the users about the creation of an account on the site, motivated by RAMA features and 60 respondents out of 100 said that yes, they would create an account if that meant more user experience from the application. So again the users were asked about the possession of an account on the site and then if they were pleased with the results, only 26 out of 94 had an account but out of this 26 users, 20 liked the results presented by the application. When asked for what more could be used from the Last.fm data, there was no consensus, due to the short number of answers which were all different, so no conclusions could be retrieved.

Getting to the end, users were asked if they consider the application effective to discover new bands and 86 from 94 said yes, then respondents were asked about the possibility to share their playlist built on the application and confirming the great feedback received on the import/export question, 88 users said yes, finally the users who responded yes in this last question were asked if they agree that such social sharing can enrich the application component of discovering new bands or songs and again a big yes, with 86 out of 88 users, was given.

In the end users were asked if they responded to the first questionnaire and only 40% had. This was some of a big surprise, meaning that most of feedback received came not from a comparison with a poor application, but from a pleasant experience.

5.3 Conclusion

There is still work to be done in the interface due to the low feedback received about the elements overlapping each other, some bugs might also have influenced this low opinion, in a stable version this would probably not be the case. Also, more research and feedback are needed regarding the use of Last.fm user data, despite the good feedback obtained, it was clearly poor with only 26 users giving their opinion.

Despite the big failure on operating systems compatibility, the new RAMA beta was able to be tested and despite some minor bugs, a very positive feedback was received from users. The combination of more than one process of music discovery definitely increases the user amusement during the process and surely delivers more results.
Chapter 6

Conclusion

The developed work explored some mechanisms of music discovery considered to be among the most efficiently ones used in some prototypes or in web services. The development consisted in a implementation of all this studied concepts in only one application, allowing to greatly enhance the process of discovering new artists or bands.

6.1 Work Objectives

The project objectives were all achieved, the initial RAMA application has now music reproduction capability, it can use a Last.fm user name to generate visual data, the system is now able to create and distribute user generated playlists and the interface has been improved. Overall regarding all this new features, the user music recommendation experience has been improved. The new RAMA allows the user not only to explore a relational map, but also, to listen to what he is discovering in real time, using YouTube, a search with an artist name is made and after sorting out the results, the music player begins to play the created playlist, hidden from the user, this means that the user never knows what song might come next, potentiating his curiosity.

The construction of playlists, using the YouTube video id’s of the videos used on the player, allow the user on the first hand to listen again to a music that as pleased him during his exploration and on second hand, when a list is built and imported to file, the user can share it with others and by exploring the file one can find exactly which video was playing.

When one does not want to think of an artist and wants the application to use the data stored at Last.fm user account, just the input of a user name is enough to create a map based in any artist from the most recent artists chart from the users profile. The use of the most recent concrete data gives the user a map consistent with his current listening habits.

An improved visualization, allows a more clear view and readability of the relational map, more understandable interactions and options, making use on Nielson sixth heuristic, “recognize rather than recall”, are now available to the user and a greater control is attributed to the user, so that he or she can arrange the map accordingly to their needs or taste.
Conclusion

The implemented work resulted in a prototype that suited the solution proposed for this thesis, functioning as a proof of concept for the reunion of many concepts related to music discovery.

6.2 Future work

It is safe to assume that Java must be removed from the project, the first RAMA prototype was built using it and at the beginning it posed as a great help to build the new application, but from the middle to the end it became a big headache. First there was the need of a certificate, then came the browser incompatibility and finally also the operating systems incompatibility. Different browsers interpret the applet in different ways, the JVM over the operation systems are in different versions and become incompatible with some of the libraries used in the application, so if RAMA is to continue as a browser application it needs a migration to JavaScript and HTML5 using libraries like the JavaScript InfoVis Toolkit~[jit], arbor.js~[arb] or even processing.js~[prob].

A more careful approach on the subjects to collect feedback is needed in order to attend specific problems and obtain more reliable feedback. This is the case at least for the Last.fm users feedback.

Another improvement needed is to give some feedback to the users when the application cannot generate a map from a given artist, this does not happens now and some times the users just does not perceive why nothing happened.

6.3 Final remarks

The work made during these thesis resulted in a pleasant application for music discovery, gathering in one place and effectively the common concepts of this area. With this new concept people are able to amuse a lot more and discover more and more music.
References

REFERENCES


REFERENCES


Appendix A

RAMA interface studies

Figure A.1: First study presented - page 1

Figure A.2: First study presented - page 2

Figure A.3: First study presented - page 3
RAMA interface studies

Figure A.4: First study presented - page 4

48
Tags comuns ao artistas aparecem ao lado do gráfico
Ao passar o rato sobre palavra descobrimos quais artistas tem aquela tag

O zoom pode definir o grau de complexidade
do gráfico ao invés de apresentarmos uma barra
para evitar ser uma coisa muito estática
deve haver uma pequena simulação como rajadas de vento que movimentam galhos e flores

Tags que só dizem diferentes dos demais artistas

Quando o rato estiver sobre o artista surge o menu
Figure A.6: First study presented - page 6
RAMA interface studies

Figure A.7: Second study presented - Graph example
Figure A.8: Third study presented - Graph example
Appendix B

RAMA new interface screens
Figure B.1: Application aspect after launch. 1 - player, 2 - User playlist control bar, 3 - input field for artist, 4 - input field for Last.fm user name, 5 - map zone, 6 - links to YouTube and Last.fm
Figure B.2: Example of a map, complexity level 1
Figure B.3: Example of a map, complexity level 2
RAMA new interface screens

Figure B.4: Example of a map, complexity level 3
RAMA new interface screens

Figure B.5: Example of a map, complexity level 1
Figure B.6: Example of a map, complexity level 2
RAMA new interface screens

Figure B.7: Example of a map, complexity level 3

60
Figure B.8: Example of application aspect after the user changes some nodes positions and creates playlist, complexity level 1
Figure B.9: Application aspect on the highest complexity level after the user changes some nodes positions and creates playlist.
Appendix C

RAMA users questionnaire

The questionnaire is in Portuguese because it was the natural language of the target population, but before you have an introductory note explaining what is intended in each group of questions.

C.1 Questionnaire

C.1.1 Explanatory summary

After a little introductory note, the respondent is asked if he knows the application and if not, he is asked to try it for a little bit. Then, after trying it, now or prior to this inquiry, we follow to the main inquiry about RAMA itself, covering interface, music discovery and the metaphors used to achieve it, satisfaction with their experience of RAMA and free suggestions.

On group 2, people are asked to respect following scale, from 1 to 4, meaning:

- 1 - Not at all satisfied;
- 2 - Not satisfied;
- 3 - Satisfied;
- 4 - Very pleased.

On group 3 users are asked to give their opinion about new features for RAMA, music discovery and the metaphors used to achieve it, satisfaction with their experience using RAMA.

On group 4, the inquiry deviates a little bit from RAMA and focus on the (Last.fm), a very important service for RAMA to work. A little description is made for the ones who do not know the service and a link is provided for the more curious users.

Finally a general opinion and suggestions about the application are asked.

C.1.2 Questionnaire

A aplicação RAMA é um protótipo web desenvolvido em JAVA, pelo que precisa deste instalado para correr, que permite visualizar e interagir com redes de artistas de música. Actualmente são usados dados de cerca de 200 mil artistas e 3 milhões de etiquetas musicais. Os dados incluem artistas, semelhanças, etiquetas musicais associadas e popularidade.

De momento o RAMA oferece duas camadas simultâneas de informação:

- mapa de relações entre artistas construído a partir de dados de similaridade entre estes.
RAMA users questionnaire

- as etiquetas musicais mais comuns entre as bandas.

Este inquérito pretende averiguar o grau de satisfação com a aplicação e descobrir quais as melhorias que os seus utilizadores pretendem.

* Questão de resposta obrigatória

   - Sim
   - Não

2. CLASSIFICAÇÃO DA APLICAÇÃO RELATIVAMENTE A:

2.1. Menu do utilizador
2.1.1. Campo de inserção de texto *
2.1.2. Sliders dos parâmetros do mapa *
2.1.3. Resposta de utilização que estes controlos fornecem *

2.2 MAPA DE RELAÇÕES
2.2.1. Leitura do texto *
2.2.2. Sobreposição dos elementos *
2.2.3. Descoberta de novas bandas/artistas *
2.2.4. Interactividade com as funções do mapa *
2.2.5. Satisfação da experiência com o mapa *

3. OPINIÃO

3.1. Para além de criar visualizações entre bandas, das seguintes funções indique 5 das quais gostaria ou, acha que mais se adequariam para a aplicação? *

- Reprodução de música
- Utilização de dados pessoais relativos a gostos musicais
- Listas de músicas para reprodução
- Nova interface com utilizador
- Recomendações musicais com base num perfil pessoal
- Sugestão de eventos musicais
- Mapa de relação entre amigos
- Informações sobre artistas
- Outra:

3.2. Considera que um mapa de relações é a estrutura mais adequada para interpretar as ligações entre artistas? *
RAMA users questionnaire

• Sim
• Não

3.2.1. Caso tenha respondido negativamente na questão anterior que outros tipos de visualizações considera eficazes para interpretar relações entre artistas?

3.3. Considera que um mapa de relações é a estrutura mais adequada para descobrir novas bandas?

• Sim
• Não

3.3.1. Caso tenha respondido negativamente na questão anterior, que outros tipos de visualizações considera eficazes para descobrir novas bandas?

4. SERVIÇO LAST.FM
"O Last.fm é um serviço de recomendações musicais. Para usar a Last.fm, é preciso inscrever-se e fazer o download do Scrobbler, que o ajudará a descobrir novas músicas com base nas músicas que você ouve." http://www.last.fm/about

4.1. Antes deste questionário, já tinha ouvido falar do serviço last.fm? *

• Sim
• Não

4.2. Utiliza o serviço? *

• Sim
• Não

4.3. Caso tenha respondido negativamente na pergunta anterior, com as funcionalidades que assinalou na questão 3.1, funcionalidades essas que advém dos dados pessoais presentes numa conta gratuita do last.fm, estaria interessado em inscrever-se no serviço?

• Sim
• Não

5. Outras sugestões/opinião geral da aplicação

C.2 Results
RAMA users questionnaire

1. Conhece o projecto RAMA - Relational Artists MApS sediado no INESC Porto?

<table>
<thead>
<tr>
<th>Sim</th>
<th>55</th>
<th>38%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Não</td>
<td>90</td>
<td>62%</td>
</tr>
</tbody>
</table>

Figure C.1: Question 1. Do you know project RAMA - Relational Artists Maps based at INESC Porto? Yes - 55, No - 90

2.1.1. Campo de inserção de texto

| 1 - Nada satisfeito | 16  | 11% |
| 2                  | 44  | 30% |
| 3                  | 79  | 54% |
| 4 - Muito satisfeito | 6   | 4% |

Figure C.2: Question 2.1.1 Opinion about the input text field. Average - 2,52; Standard Deviation - 0,75

2.1.2. Sliders dos parâmetros do mapa

| 1 - Nada satisfeito | 11  | 8% |
| 2                  | 44  | 30% |
| 3                  | 79  | 54% |
| 4 - Muito satisfeito | 11  | 8% |

Figure C.3: Question 2.1.2 Opinion about the parameters sliders. Average - 2,62; Standard Deviation - 0,75
RAMA users questionnaire

2.1.3. Resposta de utilização que estes controlos fornecem

![Bar Graph](image)

<table>
<thead>
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<th>Rating</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Nada satisfeito</td>
<td>14</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>21%</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>55%</td>
</tr>
<tr>
<td>4 - Muito satisfeito</td>
<td>20</td>
<td>14%</td>
</tr>
</tbody>
</table>

Figure C.4: Question 2.1.3 Opinion the controls feedback. Average - 2,73; Standard Deviation - 0,82

2.2.1. Leitura do texto

![Bar Graph](image)

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<thead>
<tr>
<th>Rating</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Nada satisfeito</td>
<td>15</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>34</td>
<td>23%</td>
</tr>
<tr>
<td>3</td>
<td>74</td>
<td>51%</td>
</tr>
<tr>
<td>4 - Muito satisfeito</td>
<td>22</td>
<td>15%</td>
</tr>
</tbody>
</table>

Figure C.5: Question 2.2.1 Opinion on the text readability. Average - 2,71; Standard Deviation - 0,85

2.2.2. Sobreposição dos elementos

![Bar Graph](image)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Nada satisfeito</td>
<td>19</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>51</td>
<td>35%</td>
</tr>
<tr>
<td>3</td>
<td>64</td>
<td>44%</td>
</tr>
<tr>
<td>4 - Muito satisfeito</td>
<td>11</td>
<td>8%</td>
</tr>
</tbody>
</table>

Figure C.6: Question 2.2.2 Opinion about the elements overlapping. Average - 2,46; Standard Deviation - 0,82
2.2.3. Descoberta de novas bandas/artistas

1 - Nada satisfeito 9 6%
2             19 13%
3             72 50%
4 - Muito satisfeito 45 31%

Figure C.7: Question 2.2.3 Opinion about new music discoveries. Average - 3,06; Standard Deviation - 0,83

2.2.4. Interatividade com as funções do mapa

1 - Nada satisfeito 12 8%
2             36 25%
3             73 50%
4 - Muito satisfeito 24 17%

Figure C.8: Question 2.2.4 Opinion about the interactivity with the map functions. Average - 2,75; Standard Deviation - 0,83

2.2.5. Satisfação da experiência com o mapa

1 - Nada satisfeito 15 10%
2             32 22%
3             72 50%
4 - Muito satisfeito 26 18%

Figure C.9: Question 2.2.5 Satisfaction of the experience with map. Average - 2,75; Standard Deviation - 0,87
3.1. Para além de criar visualizações entre bandas, das seguintes funções indique 5 das quais gostaria ou, acha que mais se adequariam para a aplicação?

- Reprodução de música (118, 81%)
- Utilização de dados pessoais relativos a gostos musicais (43, 30%)
- Listas de músicas para reprodução (91, 63%)
- Nova interface com utilizador (66, 46%)
- Recomendações musicais com base num perfil pessoal (95, 66%)
- Sugestão de eventos musicais (83, 57%)
- Mapa de relação entre amigos (39, 27%)
- Informações sobre artistas (73, 50%)
- Other (3, 2%)

People may select more than one checkbox, so percentages may add up to more than 100%.

**Figure C.10: Question 3.1**

3.2. Considera que um mapa de relações é a estrutura mais adequada para interpretar as ligações entre artistas?

- Sim [127] (88%)
- Não [18] (12%)

**Figure C.11: Question 3.2 Is a relationship map is the most appropriate structure for interpreting artists similarities? Yes - 127 No - 18**

3.3. Considera que um mapa de relações é a estrutura mais adequada para descobrir novas bandas?

- Sim [126] (87%)
- Não [19] (13%)

**Figure C.12: Question 3.3 Is a relationship map the most appropriate structure to find new bands? Yes - 92; No - 53**
4.1. Antes deste questionário, já tinha ouvido falar do serviço last.fm?

<table>
<thead>
<tr>
<th>Sim</th>
<th>Não</th>
</tr>
</thead>
<tbody>
<tr>
<td>92</td>
<td>53</td>
</tr>
<tr>
<td>63%</td>
<td>37%</td>
</tr>
</tbody>
</table>

Figure C.13: Question 4.1 Prior to this questionnaire, had you heard of the Last.fm service? Yes - 92; No - 53

4.2. Utiliza o serviço?

<table>
<thead>
<tr>
<th>Sim</th>
<th>Não</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>31%</td>
<td>69%</td>
</tr>
</tbody>
</table>

Figure C.14: Question 4.2 Do you use the Last.fm service? Yes - 45; No - 100

4.3. Caso tenha respondido negativamente na pergunta anterior, com as funcionalidades que assinalou na questão 3.1, funcionalidades essas que advêm dos dados pessoais presentes numa conta gratuita do last.fm, estaria interessado em inscrever-se no serviço?

<table>
<thead>
<tr>
<th>Sim</th>
<th>Não</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>43</td>
</tr>
<tr>
<td>41%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Figure C.15: Question 4.3 If the answer in the previous question, with the features stated in question 3.1, these features of personal data arising from a free account on Last.fm, would you be interested in signing up for the service? Yes - 60, No - 43
Appendix D

Second RAMA users questionnaire

The questionnaire is in Portuguese because it was the natural language of the target population, but before you have an introductory note explaining what is intended in each group of questions.

D.1 Questionnaire

D.1.1 Explanatory summary

The respondents received an email asking to use the application for some minutes and then respond to this questionnaire.

On group 1 people are asked to respect following scale, from 1 to 4, meaning:

- 1 - Not at all satisfied;
- 2 - Not satisfied;
- 3 - Satisfied;
- 4 - Very pleased.

In matters of classification of features, all the questions applicable from the previous inquiry were asked here and of course new ones related to the new features.

The last question from group on dictates the next questions of the questionnaire, if the users say Yes, they are forwarded to group 2, otherwise they go directly to group 3.

On group 2 users are asked about their satisfaction with the user of their last.fm users data used on the application.

On group 3 users are asked to give their opinion about music discovery, playlists and if they responded to the first questionnaire.

D.1.2 Questionnaire

Este inquérito pretende averiguar o grau de satisfação com os melhoramentos que foram feitos na aplicação bem como a satisfação com as novas funcionalidades incluídas na aplicação.

* Questão de resposta obrigatória

1. CLASSIFICAÇÃO DA APLICAÇÃO RELATIVAMENTE A:

1.1. Interface do utilizador
1.1.1. Campos de inserção de texto *
1.1.2. Alterar o grau de complexidade do grafo *
1.1.3. Resposta de utilização que estes controlos fornecem *
Second RAMA users questionnaire

1.2 Mapa de relações
1.2.1. Leitura do texto *
1.2.2. Sobreposição dos elementos *
1.2.3. Descoberta de novas bandas/artistas *
1.2.4. Satisfação da experiência com o mapa *

1.3 Reprodução de música
1.3.1. Percepção das funcionalidades dos controlos *
1.3.2. Interacção com os controlos *
1.3.3. Listas de músicas de um artista automaticamente geradas *
Refere-se às listas geradas quando selecionam a opção de um artista "open radio"

1.4 Lista de músicas do utilizador e respectivo ficheiro
Caso não tenham usado esta funcionalidade, pede encarecidamente que o fizessem. Para adicionar uma música à lista, basta clicar no sinal "+" que existe no reprodutor de música no canto superior esquerdo.

Após terem algumas músicas na vossa lista, podem apagar alguma indesejada usando o "x" do lado direito do item respectivo, podem também arrastar para trocar a ordem da música.

Para iniciar a reprodução da vossa lista existem 2 alternativas, usar o botão "play playlist " (3º do menu "User Playlist") ou clicar numa música.

Existe a possibilidade de importar/exportar a vossa lista, para isso têm o botão "save" (2º do menu "User Playlist") e escolher onde querem guardar o ficheiro. Este pode ser posteriormente partilhado e carregado para o programa usado o botão "open" (1º do menu "User Playlist"). Finalmente o último botão elimina a lista actual para poderem criar uma nova.

Estas funcionalidades só foram descritas nesta fase, pois era esperado que fossem descobertas durante a exploração da aplicação.

1.4.1. Conseguiu gerar uma lista intuitivamente? *
Isto é sem qualquer ajuda do texto introdutório a esta secção (2.4)

- Sim
- Não

1.4.2. Percepção das funcionalidades dos controlos *
Interacções com os itens (arrastar, reproduzir e apagar) inclusive.

1.4.3. Interacção com os controlos *
Interacções com os itens (arrastar, reproduzir e apagar) inclusive.

1.4.4. Possibilidade de importar e exportar lista para ficheiro *

1.5 Serviço Last.fm
1.5.1. Contem uma conta na rede social de música Lasf.fm? *
www.last.fm

- Sim
- Não

2. Last.fm
Caso não tenha inserido o seu nome de utilizador na aplicação por favor faça-o.

2.1. Está satisfeito com o resultado da acção de inserir o seu nome de utilizador do last.fm?
- Sim
- Não

2.2. Que outras opções com dados provenientes do Last.fm gostaria de ter ao seu dispos na aplicação?
3. Opinião

3.1. Considera a aplicação eficaz para a descoberta de novas bandas *

- Sim
- Não

3.2. Com a possibilidade de construção de listas de música pessoais, consideraria em partilhar uma construída por si com amigos/conhecidos? *

- Sim
- Não

3.2.1. Se respondeu afirmativamente na pergunta anterior, considera que tal partilha social pode enriquecer a componente de descoberta de novas bandas e até músicas?

- Sim
- Não

4. Respondeu ao primeiro questionário relativo à primeira versão desta aplicação? *

- Sim
- Não

D.2 Results
Second RAMA users questionnaire

1.1.1. Campos de inserção de texto

![Graph showing opinion on text insertion fields]

1 - Nada satisfeito  4  4%
2                                13  14%
3                                51  53%
4 - Muito satisfeito  26  27%

Figure D.1: Question 1.1.1. Opinion about the input text fields. Average - 3,05; Standard Deviation - 0,77

1.1.2 Alternar o grau de complexidade do grafo

![Graph showing opinion on map complexity]

1 - Nada satisfeito  3  3%
2                                13  14%
3                                53  55%
4 - Muito satisfeito  25  26%

Figure D.2: Question 1.1.2. Opinion about the control to change the map complexity. Average - 3,06; Standard Deviation - 0,73

1.1.3. Resposta de utilização que estes controlos fornecem

![Graph showing opinion on controls feedback]

1 - Nada satisfeito  5  5%
2                                17  18%
3                                46  48%
4 - Muito satisfeito  26  27%

Figure D.3: Question 1.1.3. Opinion about the controls feedback. Average - 2,99; Standard Deviation - 0,82

74
Second RAMA users questionnaire

Figure D.4: Question 1.2.1. Opinion about the text readability. Average - 2,89; Standard Deviation - 0,75

Figure D.5: Question 1.2.2. Opinion about the elements overlapping. Average - 2,60; Standard Deviation - 0,86

Figure D.6: Question 1.2.3. Opinion about new music discoveries. Average - 3,37; Standard Deviation - 0,82
Second RAMA users questionnaire

1.2.4. Satisfação da experiência com o mapa

<table>
<thead>
<tr>
<th>Nível de Satisfação</th>
<th>Cód.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Nada satisfeito</td>
<td>2</td>
<td>2%</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>15%</td>
</tr>
<tr>
<td>3</td>
<td>49</td>
<td>51%</td>
</tr>
<tr>
<td>4 - Muito satisfeito</td>
<td>29</td>
<td>30%</td>
</tr>
</tbody>
</table>

Figure D.7: Question 1.2.4. Satisfaction of the experience with map. Average - 3.12; Standard Deviation - 0.73

1.3.1. Percepção das funcionalidades dos controles

<table>
<thead>
<tr>
<th>Nível de Satisfação</th>
<th>Cód.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Nada satisfeito</td>
<td>12</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>16%</td>
</tr>
<tr>
<td>3</td>
<td>36</td>
<td>38%</td>
</tr>
<tr>
<td>4 - Muito satisfeito</td>
<td>31</td>
<td>32%</td>
</tr>
</tbody>
</table>

Figure D.8: Question 1.3.1. Opinion about the perception of the controls functions. Average - 2.91; Standard Deviation - 1.00

1.3.2. Interacção com os controles

<table>
<thead>
<tr>
<th>Nível de Satisfação</th>
<th>Cód.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Nada satisfeito</td>
<td>10</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>10%</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
<td>48%</td>
</tr>
<tr>
<td>4 - Muito satisfeito</td>
<td>28</td>
<td>29%</td>
</tr>
</tbody>
</table>

Figure D.9: Question 1.3.2. Opinion about the interaction with the controls. Average - 2.98; Standard Deviation - 0.92
Second RAMA users questionnaire

1.3.3. Listas de músicas de um artista automaticamente geradas

<table>
<thead>
<tr>
<th>Satisfação</th>
<th>Número</th>
<th>Porcentagem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nada satisfeito</td>
<td>12</td>
<td>13%</td>
</tr>
<tr>
<td>Satisfeito</td>
<td>11</td>
<td>11%</td>
</tr>
<tr>
<td>Muito satisfeito</td>
<td>32</td>
<td>33%</td>
</tr>
</tbody>
</table>

Figure D.10: Question 1.3.3. Opinion about the playlists automatically generated. Average - 2.97, Standard Deviation - 0.99

1.4.1. Consegui gerar uma lista intuitivamente?

<table>
<thead>
<tr>
<th>Resposta</th>
<th>Número</th>
<th>Porcentagem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sim</td>
<td>60</td>
<td>63%</td>
</tr>
<tr>
<td>Não</td>
<td>34</td>
<td>35%</td>
</tr>
</tbody>
</table>

Figure D.11: Question 1.4.1. Could generate a list intuitively? Yes - 60; No - 34

1.4.2. Percepção das funcionalidades dos controles

<table>
<thead>
<tr>
<th>Satisfação</th>
<th>Número</th>
<th>Porcentagem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nada satisfeito</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Satisfeito</td>
<td>13</td>
<td>14%</td>
</tr>
<tr>
<td>Muito satisfeito</td>
<td>48</td>
<td>50%</td>
</tr>
</tbody>
</table>

Figure D.12: Question 1.4.2. Opinion about the perception of the controls functions. Average - 3.05; Standard Deviation - 0.81
Figure D.13: Question 1.4.3. Opinion about interaction with the controls. Average - 3.16; Standard Deviation - 0.86

Figure D.14: Question 1.4.4. Capability to import and export the list. Average - 3.22; Standard Deviation - 0.86

Figure D.15: Question 1.5.1. Do you have an account at Last.fm’s site? Yes - 26; No - 68
Second RAMA users questionnaire

1. Está satisfeito com o resultado da acção de inserir o seu nome de utilizador do last.fm?

<table>
<thead>
<tr>
<th>Sim</th>
<th>Nao</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>6</td>
</tr>
</tbody>
</table>

21%  6%

Figure D.16: Question 2.1. Are you satisfied with the result of entering your username from Last.fm? Yes - 20; No - 6

2.1. Considere a aplicação eficaz para a descoberta de novas bandas

<table>
<thead>
<tr>
<th>Sim</th>
<th>Nao</th>
</tr>
</thead>
<tbody>
<tr>
<td>86</td>
<td>8</td>
</tr>
</tbody>
</table>

90%  8%

Figure D.17: Question 3.1. Do you consider the application effective to discover new bands? Yes - 86; No - 8

2.2. Com a possibilidade de construção de listas de música pessoais, consideraria em partilhar uma construída por si com amigos/conhecidos?

<table>
<thead>
<tr>
<th>Sim</th>
<th>Nao</th>
</tr>
</thead>
<tbody>
<tr>
<td>88</td>
<td>6</td>
</tr>
</tbody>
</table>

92%  6%

Figure D.18: Question 3.2. With the possibility of building personal music lists, do you consider to share them with your friends? Yes - 88; No - 6
2.2.1. Se respondeu afirmativamente na pergunta anterior, considera que tal partilha social pode enriquecer a componente de descoberta de novas bandas e até músicas?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sim</td>
<td>86</td>
<td>2</td>
</tr>
<tr>
<td>Não</td>
<td>90%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Figure D.19: Question 3.2.1. If you answered yes in the previous question, do you believe that such social sharing can enrich the application component of discovering new bands or music? Yes - 86; No - 2

3. Respondeu ao primeiro questionário relativo à primeira versão desta aplicação?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sim</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Não</td>
<td>57</td>
<td></td>
</tr>
</tbody>
</table>

Figure D.20: Question 4. Did you answered to the previous inquiry? Yes - 37; No - 57