

This Music Reminds Me of a Movie, or Is It an Old Song? An Interactive Audiovisual Journey to Find out, Explore and Play

Acácio Moreira and Teresa Chambel
LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal

Keywords: Music, Movies, Versions, Covers and Standards, Time; Genres, Emotions, Mood, Popularity, Hyperlinking, Video, Visualization, Graphics, Interactive Environments, Media Access, Synchronicity, Serendipity.

Abstract: Music and movies are major forms of entertainment with a very significant impact in our lives, and they have been playing together since the early days of the moving image. Music history on its own goes back till much earlier, and has been present in every known culture. It has also been common for artists to perform and record music originally written and performed by other musicians, since ancient times. In this paper, we present and evaluate *As Music Goes By*, an interactive web environment that allows users to search, visualize and explore music and movies from complementary perspectives, along time. User evaluation results were very encouraging in terms of perceived usefulness, usability and user experience. Future work will lead us further in the aim for increased richness and flexibility, the chance to find unexpected meaningful information, and the support to discover and experience music and movies that keep entertaining, connecting and touching us.

1 INTRODUCTION

The importance and impact of entertainment has been widely recognised (Zillmann and Vorderer, 2000), and media has played an important role in providing means and support for it. Music and movies, in particular, are major forms of entertainment, and they have been playing together since the early days of the moving image, amusing, relaxing, provoking and inspiring us.

Music has been present in every known culture, and it is a ubiquitous companion to people's everyday lives. People listen to music to regulate arousal and mood, to achieve self-awareness, and as an expression of social relatedness (Reflectd, 2014; Schäfer et al., 2013; Zillmann and Vorderer, 2000). Music is also said (Buchanan, 2016) to provide the backdrop to our lives, as we associate different tunes and sounds with various events and landmarks. It is no wonder that we treasure music so much and that it has been created, performed, and recorded since technology has allowed.

It has also been common for artists to perform and record music originally written and performed by other musicians, since ancient times (Maehner, 2015). New artists and bands often start versioning, or covering, their favorite songs, making them their

own, on the journey to find their own musical identity. It is also common for artists to imprint their individual style to favorite songs, to revive songs' popularity long after the original version, or even as tributes. There are covers that are career-making or career-breaking, one-hit wonders, and those that become more popular than the original.

Music has always played a significant role in movies, also seen as important sources of entertainment, learning and inspiration, with significant emotional impact (Chambel et al., 2011). Music was originally used to enhance mood and aid narrative and meaning, becoming an essential part of the movie itself (Inskip et al., 2008). Music was written especially for the movies, or consisted of well-known favourites from classical and popular repertoires, gradually leading to a creative industry and theories on how music works with film.

In this paper, we present and evaluate *As Music Goes By*, a web application we are designing and developing to provide users with an interactive environment to search, visualize and explore music and movies from complementary perspectives, along time. It contemplates the music in its different versions, the artists, and the movie soundtracks they belong to, highlighting properties like popularity, genre and emotional impact. We aim at increased richness and

flexibility in media access, and base our contribution on a reflection about the relevance and the support that has been given to accessing music in versions and movies along time. Section 2 makes a review of related and previous work. As Music Goes By and its underlying design rationale are described in sections 3 and 4, while section 5 presents the user evaluation that was recently carried out. Section 6 draws conclusions and identifies perspectives for future work.

2 STATE OF THE ART

This section presents most relevant concepts and developments in related and previous work in the relevant areas of Music Information Retrieval & Visualization, Music Versions, Music in Films, and the Emotional Impact of Movies and Films.

Music Information Retrieval & Visualization became a very relevant area when music digital collections were becoming large. Langer's survey (Langer, 2010) identified motivations, common ideas and techniques to solve main problems, and presented examples. In spite of the lack of "the" best-working method, visualization usually relied on music similarity, hierarchical structures, and tracks often based on time-bars along the music; with search methods aiming at Query-By-Example, Query-By-Humming, Query-By-Rhythm, and Query User Interfaces based on parameters or symbolic representations. Musicmap(.info) aims to provide the ultimate genealogy of popular music genres, based on an interactive visualization along time, genre relations, and textual descriptions, aiming at a balance between comprehensibility, accuracy and accessibility. The focus are the genres, in depth, not particular songs or movies. Music Timeline (music-timeline.appspot.com) is an interactive visualization tool of artists and genres over the decades, centered around an area chart. It uses aggregated data from Google Play Music to show how artists and genres have gained and dropped popularity. Users can highlight key artists in each genre, read their stories, and listen to the music on Google Play.

SecondHandSongs(.com) claims to be the largest and most accurate database (DB) of cover songs (refer to Tab.1 for a definition of these concepts), It includes information about who performed the originals and cover or sample versions, songwriters, releases, popularity, videos and web covers. Data is crossreferenced with other DBs, like Discogs, RateYourMusic, Echonest, Spotify, and iTunes. The web interface allows to search by song and by artist. Results are presented in lists that can be explored to watch and

listen to the songs. Users can also participate in discussions, contribute to the DB, play quizzes, and compare in a random selection a pair of original and cover song, introducing a touch of surprise to the experience. It involves users in the DB updating, in spite of the work in the area of audio processing for version identification, like (Salamon et al., 2012) that compares the use of different musical representations to demonstrate that: harmony remains the most reliable for version identification, but in some cases melody and bass line descriptions can improve performance. In another perspective, Smule (.com) is about creating social music experiences. It supports creating, sharing, discovering, participating, and connecting with people, around the world, making music and often singing covers in duets. It then allows to search and access all the covers of the same music.

Table 1: Key concepts for Music Versions.

Cover versions, cover songs, or simply covers, have been a quite relevant part of music history (Maehner, 2015). Although technically sonatas and piano concerts, originally from other artists, would also be covers, they do not usually go by that name. The same happening with Jazz **standards**: widely known by listeners and musicians, as an important part of their musical repertoire. It is in pop music and even in traditional folk music that the term cover is used more often.

For the sake of consistency, we will adopt the terms **cover** and **original versions**, independent of musical genre. Note that the term version may refer to both original and cover, but if a song is a version of another one, it is not the original.

Sampled versions, also a relevant concept in this context, refers to songs or pieces of music that take in a portions or sample of another pre-existing music or sound recording, but they are usually considered distinct from the original source(s), unlike cover versions.

Inskip et al., (2010) examined and discussed the classification of commercial popular music for use in films. They analyzed the metadata used by systems, choices for user queries, and music facets derived from musicological literature on semiotic analysis of popular music, finding that genre, subject and mood are used widely, along some musical facets, in some systems. Previously (Inskip et al., 2008), they had discussed the use and matching of music in films, advertising and TV programs, focusing on communication and meaning of the music, with the aim to inform and improve decision making. Although final decision is partly intuitive and determined by creative professionals, search by

content and context was found important. The IMDb (.com): Internet Movie Database, is probably the most popular and complete online database of information related to films, TV as a platform for audiovisual content. It allows users to search for: cast, production, characters, biographies, arguments, etc. It includes movies soundtracks as lists, but not to index the soundtracks in the movies, and trailers can also be watched, not the entire movies. The emotional dimension is also not contemplated. Registered users can make contributions such as comments, photos or content evaluations, where they can express their opinions. Whatsong (what song.com), since 2008, provides the official soundtrack and list of songs, from movies and TV shows, with scene descriptions. Can be searched by artists, movies and shows, not songs. Content is generated from admins and users, videos are from YouTube, and audio samples from Spotify and iTunes. More recently, Tunefind(.com) (TF) and Sweet Soundtrack(.com) (SS) also find music in TV shows and movies, by author or by shows and movies, not by song. Results are presented in lists, and for each movie or show, song can be accessed from iTunes or Amazon. In addition, SS lists all the songs in each movie, all the movies for each song, and all the songs for each artist, allowing to browse across movies that share the same songs or artists. In TF, the information comes from professionals (Music Supervisors), or may be submitted by users, Tunefind community voting on accuracy. All of them allow to search, sometimes play, but they barely present visualizations for overviews and comparison, and do not support music versions or scene indexing in the movies. With video timelines like those found in video players. On the other side of the spectrum, richer approaches like Story Curves (Kim et al., 2018) visualize nonlinear narratives of movies by showing the order in which events are told comparing them to their actual chronological order.

Music and movies are among the most used media to improve emotional states. In (Chambel et al., 2013) we present work related with accessing music based on mood, as consumers, like www.rockola.fm. Rothera et al. explored the creator's perspective in Flutter, an app using music to help those dealing with loss of loved ones, by expressing themselves in a safe, positive environment, as described in (Stinson, 2015). In (Oliveira et al., 2013) and (Bernardino et al., 2016) we made a literature review of models of emotions, emotional classification of movie content and their impact on viewers, video access and visualization, and eliciting and visualizing emotions. In summary, some related work exists, but not so much allowing to

access movies based on emotions. In our own work in iFelt, we addressed movie classification and access based on the emotions felt by the user. Movie Clouds (Chambel et al., 2013) allows to access, explore and watch movies based on their content, mainly in audio, and subtitles, and with a focus on emotions expressed in the subtitles, in the mood of the music, and felt by the users. As a follow-up (Jorge et al., 2017) we enriched the design of interactive spatiotemporal visualizations to enhance movie browsing, and in Media4Wellbeing (Bernardino et al., 2016) we are taking a step further to include other media (also music) and the sense of wellbeing.

3 AS MUSIC G.B - CONCEPTS AND DESIGN RATIONALE

As Music Goes By is being designed and developed as an interactive web application to allow users to search, visualize and explore music and movies from complementary perspectives that highlight music in different versions, the artists, and the movie soundtracks they belong to. Relevant properties are highlighted, including popularity, genre and emotional impact. It is possible to compare versions of same song, see which songs or artists have more versions, find the original versions, performers and authors, see the mood of the songs, and the movies and scenes they appear in. At all times, the user can listen to and watch the music clips, and access and watch the movie scenes where they play. This section presents an overview of main concepts, models and foundations in the design rationale of As Music Goes By. Next section will present more detailed options about its main views or perspectives, allowing for the interactive access to music, versions and movies along time.

3.1 Design Rationale

The quantity and complexity of the information produced in the most varied areas are increasing in recent years at an astonishing rate. Visualization not only contributes to the visual interpretation of data, as it helps to improve understanding, communication and decision-making, becoming a very useful tool to handle the complexity inherent to huge information systems. Edward Tufte, considered one of the founders of information visualization, declared that graphical excellence consists of complex ideas communicated with clarity, precision, and efficiency (Tufte, 2001). Ware (2012) states that the visualization can be considered a mapping process from information to images, the

data is processed and its value is expressed in visual representations. According to Shneiderman (1996), there is a mantra for effective visualizations, which can be defined in the following principle: “first overview, zoom and filter, and details on request”.

This principle is usually followed as a guideline when building information visualization systems, and was also followed in our approach. In particular, we combine Search Browsing, where users seek for well-defined targets, with Exploratory Browsing, where users query to discover a local neighborhood of interest and browse to explore this area in detail, looking for results they cannot fully specify but will recognize (general-purpose browsing) or engage in discoveries by accident exploration (serendipity browsing) (Chen, 2010).

3.2 Music Genres and Colors

We defined 17 genres to aggregate from the Spotify API subgenres: Classical, R&B and Soul, Electronic, Blues, Adult Standards, Jazz, Easy Listening, World Music, Folk, Country, Religious, Comedy, Movie Scores & Musicals, Latin, Rock, Hip Hop, and Pop. We used the list in (MGR-ref), and aggregated the Ethnic and Regional music in World Music. Three new genres were added: Adult Standards, because several songs are associated with this genre even though it does not belong to (MGR-ref), as well as the Religious and Movie Scores & Musicals, quite relevant in our context. In a UC Berkeley study (Palmer et al., 2013), participants consistently picked bright, vivid, warm colors to go with upbeat music, and dark, dull, cool colors to match the more somber pieces. According to Holm and Siirtola (2012) color-genre mapping is not totally consistent, probably due to cultural bias. We do not aim at providing a definite or reference mapping, but to adopt a consistent one that is aligned with previous work and what is commonly accepted or familiar. The genres in *As Music Goes By* were colored according to the UC Berkeley study (Palmer et al., 2013) and partially to (Holm and Siirtola, 2012), resulting in a palette that goes from brown for Classical, around the hue color to fuschia for Pop. Two shades of each color are used for different highlight levels, e.g. active / not active or selected / not selected. Text labels are also used to help genre identification, as illustrated in the Figures.

3.3 Model & Visualization of Emotions

We adopt Russell’s (1980) circumplex, or emotional wheel, based on the valence (x-axis) and arousal (y-

axis) bidimensional model for emotions. For a reference, we present the user with 12 categorical emotions around the circle, 3 in each quadrant (Fig.3b). These emotions are based in (Russell, 1980), but slightly adapted for a better match with the emotions and moods more commonly found associated with music (e.g. melancholic and calm at the bottom – both with low energy, the former tending to negative, and the latter to positive).

The position of each song is determined by the audio features of Valence (for valence) and Energy (for arousal) defined and provided by the Spotify API, and described as: Valence (0-1), the musical positiveness conveyed: high valence sounds more positive (happy, cheerful or euphoric) and low valence sounds more negative (sad, depressed or angry); and Energy (0-1), a perceptual measure of intensity and activity: typically, energetic songs feel fast, loud, and noisy. Perceptual features contributing to this attribute include dynamic range, perceived loudness, timbre, onset rate, and general entropy.

4 AS MUSIC G.B - INTERACTIVE VIEWS AND NAVIGATION

This section presents the main features of *As Music Goes By*, highlighting aspects of interactive visualization and navigation in the different views that are described in the subsections and illustrated in the figures.

4.1 Homepage View

In the homepage (Fig.1) the users can view a brief presentation of the motivation and goals of the application, in 3 images shown in carousel, and a view with a random video of an original and a version that the user can watch to compare, and then change to another random pair: original-version or sameOriginal-anotherVersion. The objective of this feature is to introduce the users to versions that they may not know, as a flavour of surprise and serendipity. It adds the flexibility to just change the cover, compared to what *SeconHand Songs* offers, to change both original-cover altogether.

In Fig.1 the user was presented with the original (from John Lennon in 1971) and a cover version (from Orleya in 2007) of *Jealous Guy*. As an interesting coincidence, the most popular version ever of this song is a cover by Bryan Ferry from 1981 (an artist highlighted in a couple of examples ahead), as a tribute to John Lennon (one of the most popular musicians ever). When the users click on the

Change Original or Change Cover, they're up for new discoveries. The menu at the top is always present and allows users to navigate to the three main views: Songs, Artists and Movies.

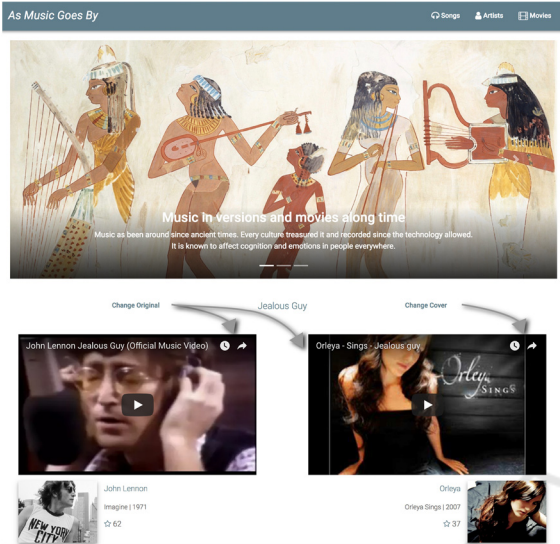


Figure 1: Homepage view. On Change Original, it changes original and cover versions; on Change Cover, only cover version is changed, same original. Always at random.

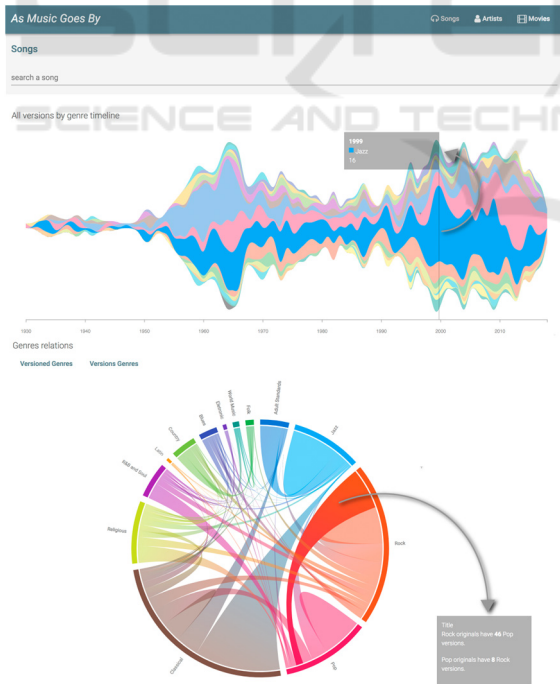


Figure 2: Songs view. On entry, it displays overview visualizations. Version Genres Timeline as a streamgraph (top); switch between Versioned or Versions genres chord diagrams (bottom). More detailed information on over (e.g. Rock originals have 46 Pop versions, at the bottom).

4.2 Songs View

In the Songs View, we are presented with overview visualizations for a high level perception of the evolution of the number of versions along time, and the relations between genres and versions.

In Fig.2, a streamgraph view is shown where we can see how the various genres have evolved along time, in terms of the number of versions. For example the Adult Standards genre had a large number of versions between 1950 and 1970 and thereafter has a reduced expression. When hovering the cursor, information about the number of versions of the genre is displayed in that year. Also on this view, users can see the relations between genres, in terms of number of versions. To this purpose, we used an interactive chord diagram, allowing the users to see the relation from two perspectives: Versioned Genres (originals) and Versions Genres (covers), which the user can choose using a button. In Fig.2 (bottom) we can see that the most versioned genre is Classical. On over, it is possible to see more detailed information about that relation.

When users Search a song in the search field or click a song name elsewhere in the application, Smoke Gets in Your Eyes in this case, they navigate to the Song view (Fig.3). This view has information about the original version, always present, and tabs for different perspectives and features of this section, Timeline, Emotions, Movies and Compare. The Timeline view (Fig.3a) represents all the versions of that song by circles, having the size for the popularity and the color for the genre.

Once the user clicks on a genre in the caption, the versions in that genre are displayed in a list below, with title and background in the genre color (e.g. Adult Standards, with 24 versions, in blue). When the user clicks on one song (e.g. cover by The Platters), it opens a Player View with more details about the song (title, artist, release date, genre, popularity and emotion) and a video that can be played (Fig.3c). We chose to use non-overlapping circles (bubbles, in bubble charts) to represent the popularity and genre dimensions, because they can represent songs as individuals points of data and, at the same time, and it is possible to clearly perceive both the amount and popularity of versions along time, as well as their genres.

In the Emotions tab (Fig.3b), circles represent each version in the emotional circumplex, their position is based on valence and energy. We think that this kind of visualization allows for a good perception of the songs emotions, while keeping the song's circle representation. This also allows for a

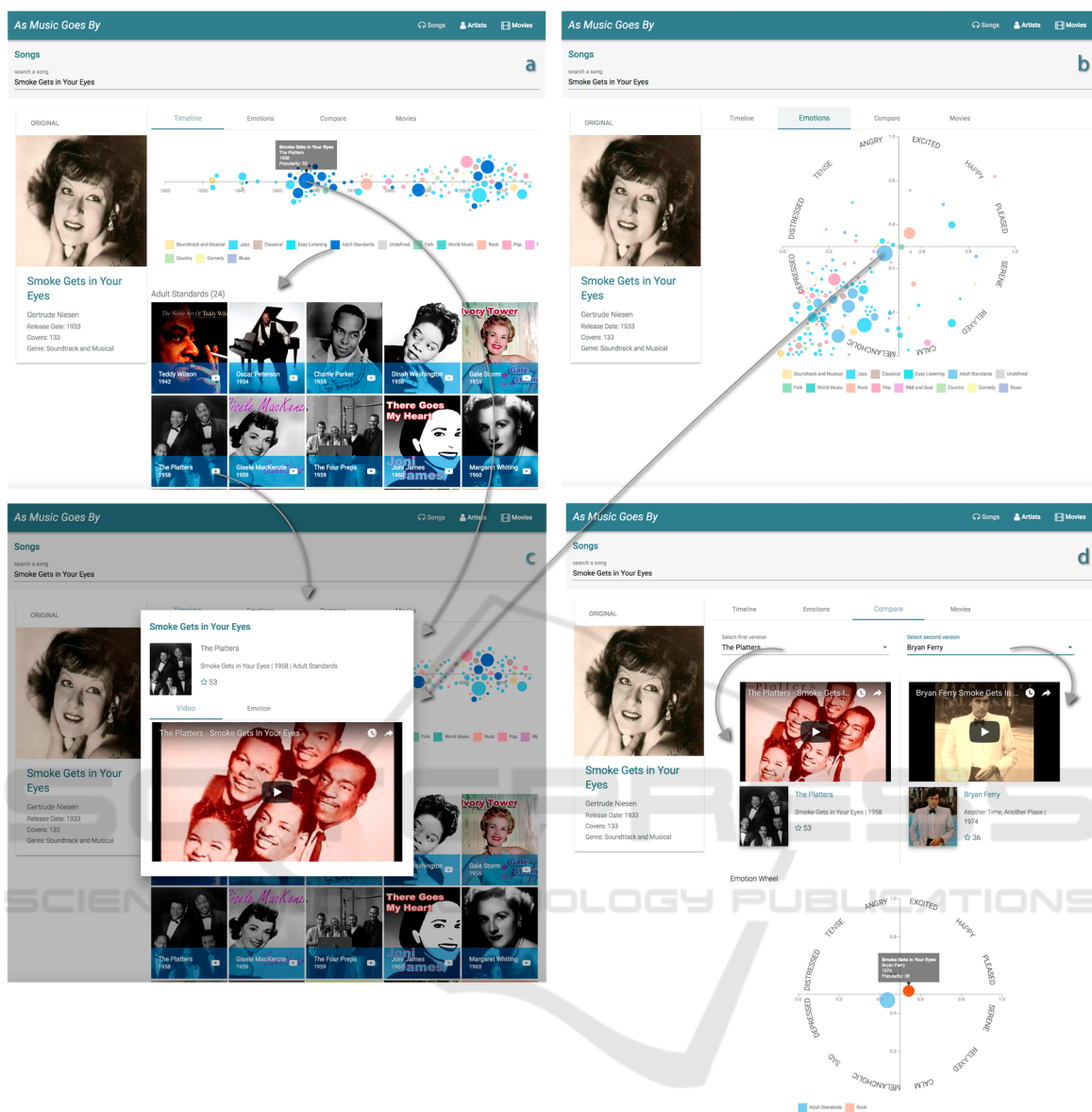


Figure 3: Song View. a) Versions Timeline: each version represented by a color circle along a timeline. Information on over, access to video on click. Uses caption to filter by genre; b) Emotional perspective: versions distributed in emotion wheel; c) Song Player view, appears in a dialog window, can be access through circle click or button click on YouTube icon in list item (a); d) Compare versions: select 2 versions from dropdown lists to view video, info and emotions. Smoke Gets in Your Eyes by Gertrude Niesen, The Platters and Bryan Ferry exemplified.

quick browsing and access (by clicking the circles) to the songs from an emotional perspective. Again, circle size used for popularity and color for genre.

The users can also Compare two versions (Fig.3d) by selecting them in dropdown lists in the Compare view. In the e.g. the current version of Smoke Gets in Your Eyes is from The Platters, 1958, the most popular (60/100), in adult standards genre, and it is now compared to Bryan Ferry’s version, 1974, also very popular (45), in rock genre,

and a more positive emotion (higher valence). Both can be played. An emotion wheel is presented with the two compared versions, and there is a Movies tab where users can see in which movies the versions of this song have appeared.

4.3 Artists View

In the Artists View (Fig.4), overviews and search are available. On the left side, the artist personal data

This Music Reminds Me of a Movie, or Is It an Old Song? An Interactive Audiovisual Journey to Find out, Explore and Play

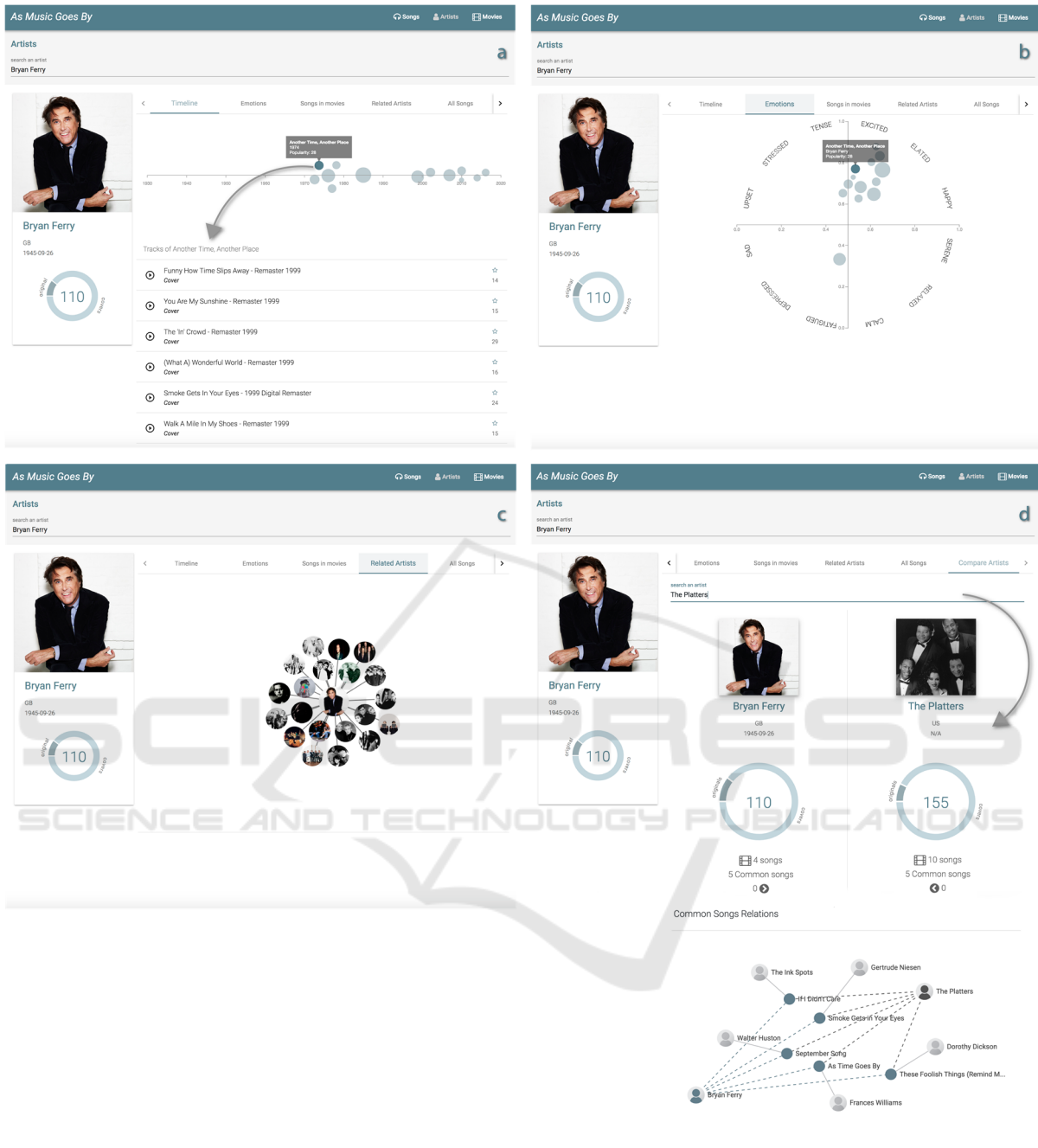


Figure 4: Artist View. a) Album Timeline, click on circle to show album tracks; b) Album Emotions; c) Related artists, on click navigates to that artist view.; d) Compare, search an artist in search field to view comparison, in this case Bryan Ferry vs The Platters. Displays info on both artists and Common Songs Relations graph, with cover versions made of each other, and original versions from others artists that they both covered.

(photo, name, country, birth), nb. of covers and originals, with more details on over, is always displayed.

In the Album tab (Fig.4a), a timeline is showing albums released by this artist along time, with

popularity represented by size of the circles, and below, a list of tracks for the selected/clicked album, highlighting if it is a cover or an original version. In Fig.4a) we can see the Another Time, Another Place (1974) album highlighted and its list of tracks.

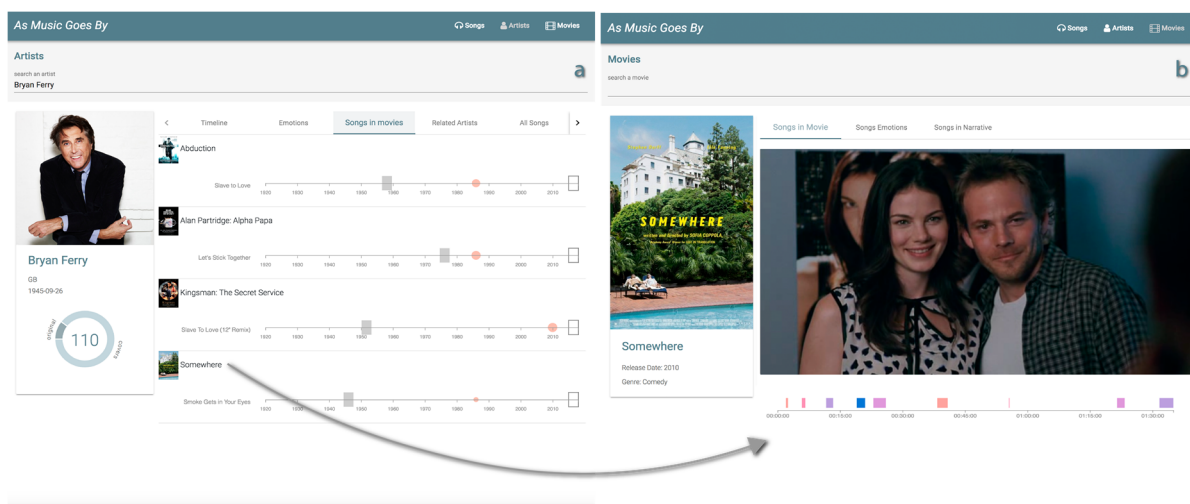


Figure 5: a) Artist Songs in Movies. Bryan Ferry songs that appeared in movies. Click in song name, navigates to song view, and click In movie name navigates to the Movie view (b).

Fig.4b) shows a distribution of the albums in the Emotion wheel. The emotion of each album is an average of its tracks. The Related tab (Fig.4c), displays a connected graph with images of the artists related to the selected artist, in this case Bryan Ferry. The related artists are fetched from the Spotify API.

In the Compare tab (Fig.4d), the user can compare information about the current artist with another one, and see how their work is related through a connected graph highlighting cover versions they have made of each other, and original versions from others artists that they both covered.

Finally, in the Movies tab, a list of songs in movies is available (Fig.5a). We are designing a proof of concept view for each movie of the list, where a timeline is representing the movie release date (wireframe rectangle on the right), grey rectangles represent times in the narrative of the movie, and a colored circle represents the song positioned in the timeline by release date. The user can click both movie or song to access the views related to each one (Fig.5b). In this case, movie Somewhere was selected, featuring Bryan Ferry’s cover of Smoke Gets in Your Eyes.

4.4 Movies View

This view allows users to present more detailed information about a movie and its soundtrack, and view the complete movie, from the start or indexed by the songs on the soundtrack. In the Timeline tab, the user can see the movie, its songs and a timeline to access the movie at the time the song is playing. Fig.6a) shows the movie Always, in the scene where the selected song: Smoke Gets in Your Eyes from

The Platters is playing. The soundtrack features a list of song titles, artists, popularity, and genre. It shows the current music, with a different background color, and this is synchronized with the timeline of the movie (below the movie) and with the movie itself when viewed (above). We assume the use within a context in which the user has access to the movies. For cases where this does not happen, one could think of access to isolated scenes available in a generalized way, for example in videos on YouTube.

The Movie view also has an Emotions tab (Fig.6b) with the emotion wheel of the movie songs. As with the song versions emotion wheel, the songs are colored by genre and sized by popularity and can be clicked to access the song video.

In the Narrative timeline it is shown how the release date of the songs relate to the movie release date and the narrative date (in the y-axis) along the whole movie (in the x-axis). In Fig.6c) we have an example of this visualization for the movie Back to the Future. It is perceivable that the songs generally match the date of the narrative of the movie both in 1985 and 1955, with some exception of recent musics in 1985 being some times played in the 1955 part of the story being told.

When accessing the Movies view, overview visualizations about movies are presented. In Fig.6d) one relating movie to song genres. Rock is displayed as the most used genre in movies, for Comedy, although Pop music is also very popular in this movie genre. Colors are adopted for music genre, movie genres are depicted in grey. This alignments with the color design options in the application, highlighting music genres, and contributing to an elegant representation.

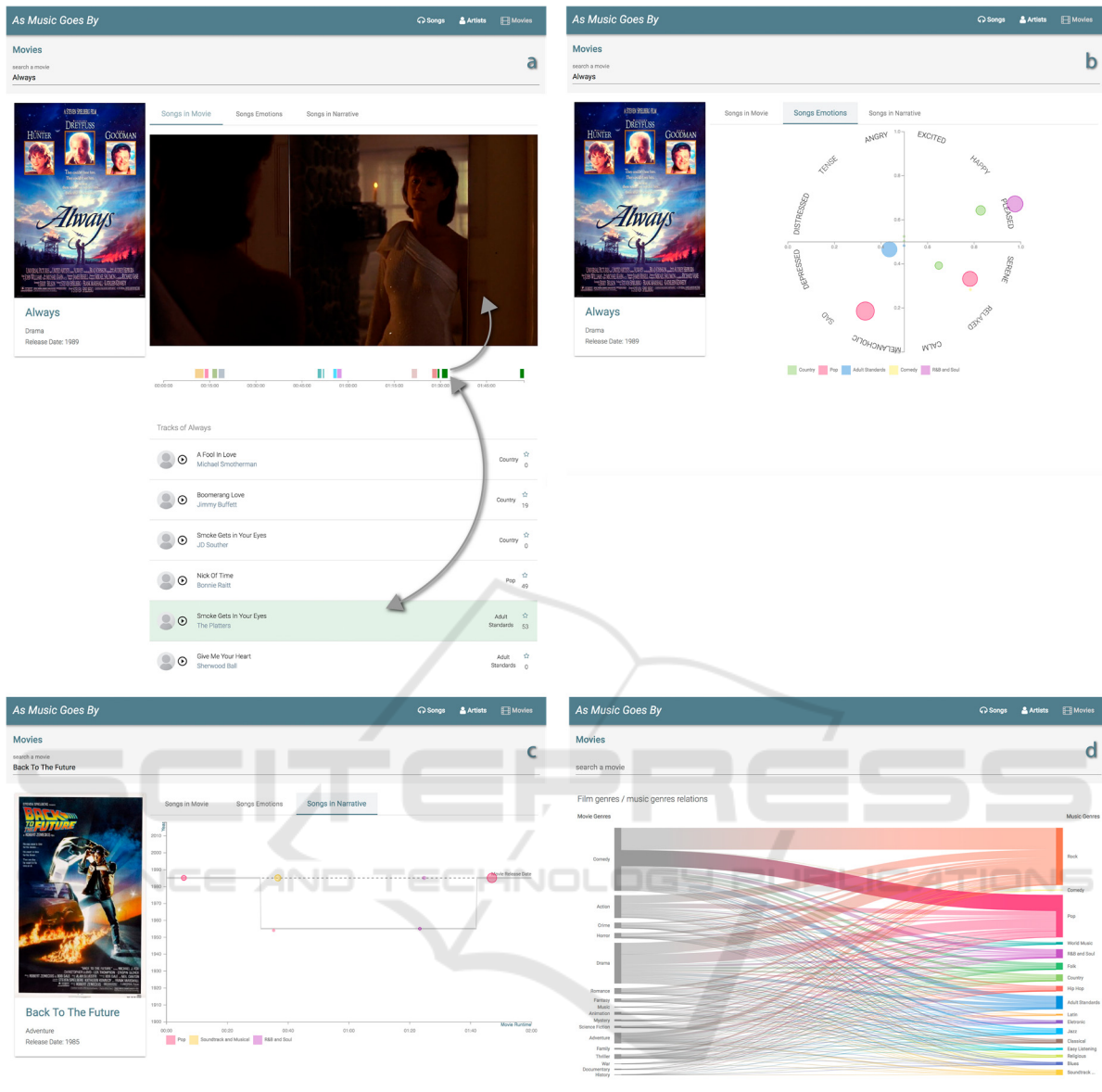


Figure 6: Movies view. a) Movie view. users watch the movie, songs along timeline, indexed to scenes in the movie; b) Emotions tab; c) Narrative timeline: movie and song release compared with narrative dates; d) Movies view: Visualization relating Movies genres to Music Genres.

4.5 Architecture and Technologies

A three tier architecture is used, with Data Layer (Mongo DB, external APIs), Business Logic Layer (NodeJS, Express) and Presentation Layer (AngularJS, D3). It uses external REST APIs to collect data, at this point from Spotify (tracks, artists, albums, images, popularity and audio features), Second-HandSongs (original and cover versions, and YouTube links for the songs), and WhatSong (song information in the movies).

5 USER EVALUATION

A user evaluation was conducted to assess perceived usefulness, usability and user experience in As Music Goes By. We wanted to know how users would use the it and their opinion on the user interface and functionalities, how interesting, effective and usable the interactive visualizations, the search and navigation across and within music, artists and movies.

5.1 Methodology

We conducted a task-oriented evaluation with semi-structured Interviews and Observation while the users performed the tasks with the different features and visualizations. After explaining the purpose of the evaluation, asking some demographic questions and briefing the subjects about the application, the users performed a set of tasks. For each task, we observed and annotated success and speed of completion, errors, hesitations, and their qualitative feedback through comments and suggestions. There was also an evaluation based on USE (Lund, 2001) for each task, where they rated perceived Utility, Satisfaction in user experience and Ease of use on a 5-point scale.

At the end, the users were asked to provide a global appreciation of the application, through a USE rating, to mention the features or characteristics that stood out on the positive or negative sides, and suggestions regarding what they would like to see improved or added in the future. Users were also asked to characterize the application with most relevant perceived ergonomic, hedonic and appeal quality aspects, by selecting pre-defined terms (Hassenzahl et al., 2000) that reflect aspects of fun and pleasure, user satisfaction and preferences.

5.2 Participants

This study had 12 participants, 7 male, 5 female, 31-51 years old (Mean 38.4, StdDev 6.6), most having college education (2 MSc, 7 BSc, 3 high school), coming from diverse backgrounds (3 designers, 3 managers, 1 IT, engineer, psychologist, journalist, salesman, and postman), all having moderate to high acquaintance with computer applications and having their first contact with this application, allowing to discover most usability problems and perceive a tendency in user satisfaction.

Most participants listen to music every day(10), week(1) or month(1), using mostly YouTube(11), but also Spotify(3), SoundCloud(3) and iTunes(2); whereas they watch movies mostly every week(8) - day(2), month(1) or occasionally(1) - using mostly YouTube(7), but also Netflix(4), Vimeo(3) and Daily-Motion(2). Most of them search for information about music or movies every day(5) or weekly(3) - monthly(1), occasionally(2), never(1) - using mostly IMDb(9) or RottenTomatos(4), less often AllMusicGuide(2) and Wikipedia(2) and even less(1) often applications like Last.FM, MusicBrainz, AllMusicGuide, Discogs, and MetalArchivez. As positive aspects about these platforms and services, YouTube was clearly the preferred one to access music and movies, and users

pointed out as key qualities the diversity of content, playlists, being free and the music suggestions. As negative aspects, they mainly criticized the ads. For media information search users preferred IMDb, praising the amount of information and comments.

In terms of music in versions and movies, the main focus of the application, half the participants rated their interest in song versions as medium(6) – very high(2), high(1), low(2), none(1) - whereas half rated their interest in songs in movies as very high(6) - medium(5), low(1). Users were not aware of any application for this purpose, like SecondHand-Song and WhatSong. In sum, most participants have at least some interest in the main focus of the application, with an a priori greater interest in songs in movies, although they do not know any applications providing that support.

5.3 Results

The users finished almost all the tasks quickly and without many hesitations, and generally enjoyed the experience with the application. The results are presented in tables 2 and 3, and explained in the text along with the comments made by the users.

Homepage. On the homepage we tested the interactive feature of watching and comparing music videos of random original-version pairs. To evaluate this functionality, we asked the subjects *'to pick a random song and watch the videos of the original and random versions presented'*. We had quite positive results for USE (U:4.1; S:4.2; E:4.8), as can be seen on table 2. Users found the feature “very easy to use”, “interesting” and “appealing”. They liked to “see the covers of each original” and noted that It “allows to know new songs”. In a dissenting opinion, a user said that it could be made visually more appealing. Another user suggested that it could have more information about the songs and artists, which they would in fact access if they navigated to those song’s and artist’s view.

Songs View. For this view of the application we created 8 tasks to test the information overview visualizations in the initial screen, the search and the song’s detail interface and functionalities.

In T 2.1, the users were asked *'to identify the year with the most versions and the genre with the most versions in that year'* in the overview visualizations of the Songs View. Although all subjects completed the task reasonably quick, some hesitated a bit in the second part, not realizing immediately that they could interact with the visualization. It was noted that “there could be a caption to identify the genres” (something already present in other similar

visualizations in the application) and that some were “not familiar with this kind of graphic representation”. Despite this, the general opinion was quite positive (U:3.8; S:4.3; E:4.2), with some highlighting the “visual appeal” of the visualization.

In T 2.2, the user is asked ‘to identify what is the genre whose originals are more versioned, and what genre has more versions’. Overall opinion was quite positive (U:3.9; S:4.0; E:4.1), with some users considering that the visualization is visually appealing and that the gender relations are easy to perceive. Others, on the contrary, have said that it could be more intuitive. Regarding these visualizations, the mixed opinions could be a result of different levels of familiarity with this type of visualization.

Table 2: USE evaluation of As Music Goes By. (Scale:1-5: lowest-highest); M=Mean; SD=Std. Deviation).

| Task | U | | S | | E | |
|----------------------------------|------------|-----|------------|-----|------------|-----|
| T# Feature | M | SD | M | SD | M | SD |
| 1 Home: Random versions | 4.1 | 0.9 | 4.2 | 0.7 | 4.8 | 0.6 |
| Songs View: (mean) | 4.3 | 0.6 | 4.3 | 0.6 | 4.5 | 0.6 |
| 2.1 Vis: overview (streamgrap) | 3.8 | 0.7 | 4.3 | 0.5 | 4.2 | 0.7 |
| 2.2 Vis: Genre relations (chord) | 3.9 | 0.7 | 4.0 | 0.4 | 4.1 | 0.8 |
| 2.3 Search music & versions | 4.8 | 0.5 | 4.8 | 0.5 | 4.9 | 0.3 |
| 2.4 Vis: Timeline (scatterplot) | 4.4 | 0.5 | 4.3 | 0.5 | 4.8 | 0.5 |
| 2.5 Vis: Emotions (scatterplot) | 4.3 | 0.6 | 4.5 | 0.7 | 4.5 | 0.7 |
| 2.6 Vis: List byGenre (imgs) | 4.6 | 0.5 | 4.5 | 0.5 | 4.6 | 0.5 |
| 2.7 Music video play | 4.7 | 0.5 | 4.3 | 0.9 | 4.8 | 0.5 |
| 2.8 version comparison | 4.0 | 0.6 | 4.1 | 0.7 | 4.4 | 0.7 |
| Artists View: (mean) | 4.4 | 0.6 | 4.2 | 0.7 | 4.3 | 0.8 |
| 3.1 Artist info | 4.6 | 0.7 | 4.3 | 0.6 | 4.4 | 0.7 |
| 3.2 Vis: Album + tracks | 4.4 | 0.7 | 4.3 | 0.6 | 4.3 | 0.9 |
| 3.3 Vis: Related Artists | 4.3 | 0.5 | 4.1 | 0.7 | 4.8 | 0.5 |
| 3.4 Vis: Artists comparison | 4.2 | 0.7 | 4.2 | 1.0 | 3.8 | 1.1 |
| 3.5 Vis: Artists movies (music) | 4.6 | 0.5 | 4.2 | 0.4 | 4.3 | 0.7 |
| Movies View: (mean) | 4.3 | 0.7 | 4.4 | 0.6 | 4.6 | 0.6 |
| 4.1 Movie info | 4.7 | 0.7 | 4.8 | 0.6 | 4.8 | 0.4 |
| 4.2 Vis: Music timeline | 4.7 | 0.7 | 4.6 | 0.7 | 4.4 | 1.0 |
| 4.3 Vis: Music emotion wheel | 4.0 | 0.7 | 4.2 | 0.7 | 4.5 | 0.7 |
| 4.4 Vis: Music vs narrative | 3.8 | 0.7 | 3.9 | 0.7 | 4.3 | 0.6 |
| 4.5 Vis: Overview genres | 4.3 | 0.8 | 4.5 | 0.5 | 4.8 | 0.5 |
| Global Evaluation | 4.6 | 0.5 | 4.7 | 0.5 | 4.3 | 0.8 |
| Total per Task (mean) | 4.3 | 0.6 | 4.3 | 0.6 | 4.5 | 0.6 |

The search functionality was tested in T 2.3, where we asked the subjects ‘to search for the song *Smoke Gets in Your Eyes*’. All the users performed the task quickly and without any hesitation, it was highly appreciated (U:4.8; S:4.8; E:4.9) and considered “user friendly”.

To test the initial view of the song – a version timeline view - we asked the subjects ‘to identify the

original version of this song, its genre, popularity and number of versions’ (T 2.4). Once more, the users had no problems performing the task, and appreciated it (U:4.4; S:4.3; E:4.8). The visual aspect and the intuitiveness were praised, although a user said it could be more appealing. It was suggested that it could have a link to Wikipedia to allow access to more information.

In T 2.5, we asked the subjects ‘to identify the emotion associated with the original version of the song’. Some users found the emotion wheel visualization very interesting (U:4.3; S:4.5; E:4.5), saying that it was “useful to be able to access the songs according to their mood”. The suggestions included “highlighting more the original and the names of the emotions” although the original already has a frame around it, and the names are presented around the emotion wheel, as a reference for the positions in the wheel, where the songs are positioned. This was not obvious to everyone on the first contact.

In T 2.6, to test the song list by genre, the users had ‘to select the songs of the genre of the most popular song’. The objective was to test the interaction and the perception of information in this view. All users performed the task with no hesitations and appreciated it (U:4.6; S:4.5; E:4.6). Some highlighted the “visual appeal” and that “it was good to be able to select songs from a preferred genre”.

The ‘song video play interface’ was tested in T 2.7. In the results we can notice that the subjects found it easier to use (4.8) than satisfactory (4.3), but still useful (4.7). This reflects the familiarity of this feature: “there are already other applications that allow you to watch videos”, so they were not impressed, though satisfied. One user said that he would prefer the video to open in the same screen.

The version compare feature was tested in T 2.8, where subjects were asked ‘to compare the *Smoke Gets in Your Eyes* version from *The Platters* with the one from *Bryan Ferry*’. This option was appreciated (U:4.0; S:4.1; E:4.4), as had already happened with T1, though now the versions were not picked at random, with a subject highlighting its “ease of use”.

Artists View. In T 3.1, it was asked that the subjects ‘identified how many songs the artist (*Bryan Ferry*) had and how many of these were covers and originals’. The subjects had no problems performing this task, all of them completed the task quickly without errors or hesitations. It was appreciated (U:4.6; S:4.3; E:4.4), and one user mentioned that the requested information was “easy to find”.

In T 3.2, subjects were asked ‘to indicate he’s most popular album, its date and the most popular

song of that album'. In this task, 3 users took a while to realize that they had to click the circle to show the songs, but most of them had no hesitations. The global evaluation was positive (U: 4.4, S: 4.3, E:4.3), and users found it "easy to use", "one of the most interesting" features and "useful to be able to access the albums and tracks to know new songs". One user suggested that it could also "show the original artist of the cover versions in the list".

The T 3.3 task consisted of '*identifying the artists related to the selected artist*'. All users completed it without any issues, appreciated it (U:4.3; S:4.1; E:4.8), and said it was easy to understand. According to a user the "images are too small".

In the compare artist view, the users were asked '*to compare The Platters with Bryan Ferry, say how many songs they had in common and identify who is the original author of the September Song*' (T 3.4). Subjects had some hesitations in the second part of the task, taking longer than expected to complete it, and that was reflected in the slightly lower score for E (U:4.2; S:4.2; E:3.8). They had to use a connected graph, that some users could not understand well at first sight. It was mentioned by some of them that the representation is "not very intuitive" and that "it takes a while to understand the graph". On the other hand, a user especially "liked the interactivity".

To evaluate the 'artist's songs in movies' view we asked users '*to identify in which movies the song Smoke Gets in Your Eyes appears*' (T 3.5). The users generally liked this feature (U:4.6; S:4.2; E:4.3), with one mentioning the "font was too small".

Movies View. In T 4.1, subjects were asked '*to go to the Always movie, and indicate how many songs there are in this movie*'. Users liked it a lot (U:4.7; S:4.8; E:4.8). Most users found the task very easy to perform, with one taking a little longer due to hesitations. Users found it "useful and good to be able to watch the movie and access the soundtrack". One user commented that "it could be useful for people choosing soundtracks for movies". One of our goals, actually.

Still on this view, we asked the users '*to indicate the moment of the movie in which the song Smoke Gets in your Eyes from The Platters appears, and to visualize the moment in the movie in which the song appears*'. Some users did not understand right away how they could do the task, with one user noting that "it wasn't easy to find the song", but once they did, they found it easy to use. These hesitations did not heavily affect the evaluation of the functionality after all (U:4.7; S:4.6; E:4.4). Some users referred to it as "aesthetically pleasing" and "useful".

In T 4.3, it was asked the subjects '*to identify the mood of the songs in the movie*'. As with the other emotional view we tested in T 2.5, there were mixed opinions about the usefulness, with a slightly lower score in average (U:4.0) reflecting that some find it very interesting while others not so much, not being used to this emotional perspective. Still, a user mentioned that "it could help to understand the mood of the movie" and they liked the experience and found it easy (S:4.2; E:4.5).

In T 4.4, the task was '*to check if the release date of the songs matched the date of the narrative of the Back to the Future movie*'. This visualization got some of the lowest scores in Usefulness and Satisfaction (U:3.8; S:3.9; E:4.3), showing that some of the users did not have much interest in this information, or did not fully understand its relevance, though they found it easy. One user mentioned that "it didn't seem useful". These were the same subjects who did not appreciate the overview visualizations (T 2.1, 2.2 and 4.5) so much.

The movie genres - music genres relations visualization was evaluated in T 4.5, where we asked users '*to identify which is the predominant musical genre in comedy films*'. The users found this visualization "aesthetically pleasing", "original" and "interesting". They were quite satisfied and particularly appreciated its ease of use (U: 4.3; S: 4.5; E: 4.8), noting that the information was "easy to perceive".

Global Evaluation. Overall, users thought the application was interesting, innovative and visually appealing. Although there were some difficulties in the first interactions with some of the most unusual visualizations for the participants less familiar with this kind of representations, the ease of use was also referred. Interesting to notice that the global USE classification users assigned to the application (U: 4.6; S: 4.7; E: 4.3) indicates that at the end they found it even more useful and satisfactory that along their appreciation for the individual features, in average: (U: 4.3; S: 4.3; E: 4.5). Ease of use as the most highlighted along the way, gave way to usefulness and especially to satisfaction as main take aways from the experience.

When explicitly asked to refer to the features and functionalities that they appreciated the most, they mentioned: the "visually appealing visualizations", "ability to view various versions and information of songs and artists", "ability to access songs in the movie", "the emotional perspective", "Ease of use", "appealing design", "comparing songs" and the "timeline view of the versions". Some of the less appreciated aspects were "the connected graph [from the artist compare screen] is not easy to perceive",

“some parts could be more intuitive”, “the video play view”, and the “all versions timeline streamgraph”.

The users made some suggestions that they think would benefit the application like “using analysis of the song lyrics for the emotions”, “links to IMDb, and the artist’s website” or “gamification of some parts of the application”.

To summarize this appreciation, users classified the application with most relevant (as many as they found appropriate) perceived ergonomic (8 positive + 8 negative (opposite)), hedonic (7+7) and appeal (8+8) quality aspects in (Hassenzahl et al., 2000).

Table 3: Quality terms users chose for As Music Goes By. H:Hedonic; E: Ergonomic; A: Appeal; Simple (+) vs Complex (-); Exclusive (+) vs Standard (-).

| l | | Terms | type | # |
|-----------------------|---|-------|-----------------|------------|
| Comprehensible | E | 10 | Attractive | A 3 |
| Interesting | H | 8 | Exclusive | H 2 |
| Aesthetic | A | 8 | Desirable | A 2 |
| Clear | E | 7 | Predictable | E 1 |
| Original | H | 7 | Trustworthy | E 1 |
| Innovative | H | 7 | Controllable | E 1 |
| Simple | E | 5 | Familiar | E 1 |
| Supporting | E | 4 | Exciting | H 1 |
| Motivating | A | 4 | Sympathetic | A 1 |
| Pleasant | A | 3 | <i>Complex</i> | <i>E 1</i> |
| Inviting | A | 3 | <i>Standard</i> | <i>H 1</i> |

Comprehensible was the most chosen term. Interesting, Aesthetic, Clear, Original and Innovative were also chosen by more than half of the subjects. Just two negative terms were chosen: Complex and Standard, only once, and less often than the opposite positive terms. The chosen terms are well distributed among the hedonic, ergonomic and appeal qualities. These results confirm and complement the feedback from the other evaluation aspects and user comments.

6 IN CONCLUSION

This paper presented As Music Goes By, a web application being designed and developed with the aim to propose a richer way to access and relate music and movies along time. There is also a focus on genres, emotions and popularity, reflecting the impact that these media have on us, and following on our previous work on movies, media and wellbeing (Bernardino et al., 2016). The way we see it differing from and contributing to the scenario of existing applications is through flexibility and richness, and the user evaluation provided a good indication that it is achieving its goals.

Users appreciated the concept of As Music Goes By, and the new possibilities and perspectives provided to search, overview, listen, watch and

browse music versions, artists and movies. Overall, the results were very encouraging, and we got some insights to inform our future developments. Scores for Usefulness, Satisfaction and Ease of use were quite high, and users particularly liked the visually appealing visualizations, the ability to view various versions and information of songs and artists, to compare songs, to access songs in the movies, the timeline view of the versions and the emotional perspective. Ease of use and appealing design were also mentioned often. The less appreciated aspects, especially by those less familiar with graphical representations and visualizations were the connect and stream graphs, although they came to like them better as soon as they understood them. Interesting, Aesthetic, Clear, Original and Innovative were the most perceived qualities, followed by Simple, Supporting and Motivating.

For the future, we plan to refine the As Music Goes By, based on this recent user evaluation and extend its interactive features. To develop visualizations further, with more integrated overviews, and enriching relations among music, artists and movies, making it easy to go through, relate and find them based on common features (e.g. songs that appear in similar movies), increasing the chances and opportunities to find unexpected meaningful information, by chance, synchronicity or serendipity (Chambel, 2011). This could be enhanced by richer content processing (e.g. subtitles, lyrics, quotes, and audio (Chambel et al., 2013), possibly with human aid (Gomes et al., 2013)), and emotional impact (Bernardino et al., 2016); and the flexibility of access from diverse media, modalities and contexts, e.g. while listening to a music (identifying the version, like in Shazan, through query by example, or by humming); or when feeling blue; or while watching a movie or music clip, to reach at related or recommended information.

We believe that this could be a service valuable for everyone, the general public, interested in music and movies, for entertainment, curiosity and inspiration, as well as to professionals and content creators, e.g. to raise awareness about the way music has evolved and has been used in movies, and as a support to help them choose or create music and movies that keep entertaining, connecting and touching us.

ACKNOWLEDGEMENTS

This work was partially supported by FCT through funding of the AWESOME project, ref. PTDC/CCI/29234/2017, and LASIGE Research Unit, ref. UID/CEC/00408/2019.

REFERENCES

- Bernardino, C., Ferreira, H.A., and Chambel, T. 2016. Towards Media for Wellbeing. In *Proc. of ACM TVX'2016*, ACM, 171-177.
- Buchanan, B. 2016. The importance of music in entertainment. Alternative Nation. <http://www.alternativenation.net/the-importance-of-music-in-entertainment/>
- Chambel, T. 2011. Towards Serendipity and Insights in Movies and Multimedia. In *Proc. of International Workshop on Encouraging Serendipity in Interactive Systems*. Interact'2011, 12-16.
- Chambel, T., Langlois, T., Martins, P., Gil, N., Silva, N., and Duarte, E., 2013. Content-Based Search Overviews and Exploratory Browsing of Movies with MovieClouds. *IJAMC*, InderScience, 5(1): 58-79.
- Chambel, T., Oliveira, E., and Martins, P. 2011. Being Happy, Healthy and Whole Watching Movies that Affect our Emotions. *Proc. of ACII 2011*, 35-45.
- Chen, Y. 2010. Exploratory Browsing: Enhancing the Browsing Experience with Media Collections, PhD thesis, Ludwig-Maximilians-Universität München.
- Gomes, J.M.A., Chambel, T., and Langlois, T. 2013. SoundsLike: Movies Soundtrack Browsing and Labeling Based on Relevance Feedback and Gamification", In *Proc. of EuroITV'2013*, ACM, 59-62.
- Hassenzahl, M., Platz, A., Burmester, M, Lehner, K. 2000. Hedonic and Ergonomic Quality Aspects Determine a Software's Appeal. *ACM CHI 2000*. The Hague, Amsterdam, pp.201-208.
- Holm, J., Siirtola, H. 2012. A Comparison of Methods for Visualizing Musical Genres. *Proc. of 16th International Conf. on Information Visualisation*, 636-645.
- Inskip, C., MacFarlane, A., Rafferty, P. 2008. Music, movies and meaning: communication in film-markers' search for pre-existing music, and the implications for music information retrieval. *Proceedings of ISMIR'2008*, pp. 477-482.
- Inskip, C., MacFarlane, A., Rafferty, P. 2010. Organising music for movies. *Aslib Proc.*, 62(4/5), pp. 489-501.
- Jorge, A., Correia, N., and Chambel, T. 2017. Designing Interactive Spatiotemporal Visualizations to Enhance Movie Browsing. *Proc. of Interact.* 352-5.
- Kim, N.,W., Bach, B., Im, H., Schriber, S., Gross, M., Pfiste, H. 2018. Visualizing Nonlinear Narratives with Story Curves. *IEEE Transactions on Visualization and Computer Graphics*, 24(1):595-604.
- Langer, T. 2010. Music information retrieval & visualization. *Trends in Information Visualization*.
- Lund, A. M. 2001. Measuring usability with the USE questionnaire. *Usability and User Experience*, 8(2).
- Maehner, J. 2015. Under The Covers: Second Hand Songs That Matter, Cuepoint. <https://medium.com/cuepoint/under-the-covers-5ffe85ac96d0>
- MGL-ref: Music Genres List https://en.wikipedia.org/wiki/List_of_popular_music_genres
- Oliveira, E., Martins, P., and Chambel, T. 2013. Accessing Movies Based on Emotional Impact. *ACM/Springer Multimedia Systems Journal*, ISSN: 0942-4962, 19(6), Nov. 559-576.
- Palmer, S. E., Schloss, K.B., Xu, Z., Prado-León, L. R. 2013. Music-color associations are mediated by emotion. *Proc. of the National Academy of Sciences*.
- Reflectd. 2014. The Psychology of Music: Why We Listen to Music and How It Affects The Mind. <http://reflectd.co/2014/06/17/the-psychology-of-music>
- Russell J. 1980. A circumplex model of affect. *Journal of Personality and Social Psychology*, 39:1161-1178.
- Salamon, J., Serrà, J., Gómez, E. 2012. Melody, Bass Line, and Harmony Representations for Music Version Identification. In *AdMIRE'12 Workshop: "The Web of Music"*. *Proc. of WWW 2012 Companion*, ACM, 887-894.
- Schäfer, T., Sedlmeier, P., Städtler, C., Huron, D. 2013. The psychological functions of music listening. *Front. Psychology*, 4:511.
- Shneiderman B. 1996. The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. *Proceedings IEEE Symposium on Visual Languages*.
- Stinson, E. 2015. A Music-Making APP Designed to Help Teens Deal with Death, WIRED, *Design 1*(15).
- Tufte E. 2001. The Visual Display of Quantitative Information. *Graphics Press*, 2nd ed.
- Ware C. 2012. Information Visualization: Perception for Design. *Morgan Kaufmann*, 3rd ed.
- Zillmann, Dolf; Vorderer, Peter. 2000. Media Entertainment – the psychology of its appeal. Mahwah, NJ: Lawrence Erlbaum Associates, Inc. Taylor & Francis e-library 2009. pp. vii. ISBN 0-8058-3324-2.