That's AWESOME: Awareness While Experiencing and Surfing On Movies through Emotions

Teresa Chambel[1], Patrícia Arriaga[2], Manuel J. Fonseca[1], Thibault Langlois[1], Octavian Postolache[2], Cláudia Ribeiro[1], Nuno Piçarra[2], Soraia M. Alarcão[1] and Ana Jorge[1]

[1] LASIGE, Faculdade de Ciências, Universidade de Lisboa, Portugal
[2,3] ISCTE-IUL, Instituto Universitário de Lisboa, {[2]CIS-ISCTE, [3]IT-IUL}, Portugal

Abstract

This paper presents the AWESOME Research Project: Awareness While Experiencing and Surfing On Movies through Emotions, with its motivation, main goals, tasks and contributions, highlighting directions for future work.

CCS Concepts

• ***Human-centered computing*** → Human computer interaction (HCI); Visualization→Visualization application domains→Information visualization; • ***Information systems***→Information retrieval→Users and interactive retrieval→Search interfaces; • ***Information systems***→Information retrieval→ Retrieval tasks and goals→Sentiment analysis; • ***Hardware*** → Sensors and actuators; PCB design and layout.

1. Introduction

Movies and videos are becoming pervasive in our lives, through technological advances and the trends for media convergence that are enabling the access to videos over the Internet, in social media, and through video on demand services on iTV. Although one of the greatest strengths of video and movies is their power to engage viewers cognitively and emotionally, the emotional dimension has not been adequatly supported. And several studies show that emotions influence the way we think and act, our health, our happiness and sense of wellbeing, having a central role in our lives.

The objective of the AWESOME research project has been to investigate and bring this emotional dimension to movies, by providing some evidence and new ideas to support the classification, access, navigation and visualization of movie collections, not only by genre, rating, etc. but based on the emotions expressed in their content and felt by the viewers, while and after watching movies. This holds the potential to increase emotional awareness and empower users regulating emotions when accessing and watching movies and videos. To accomplish these objectives, we addressed the following challenges:

- To identify and select the most relevant dimensions and labels in emotional impact and the predictors of enjoyment and gratifications from movies, understand viewers preferences, and the importance perceived in receiving emotional information. This would allow to identify the most relevant emotional responses to use for the emotional impact, to inform a better support in emotional elicitation, movie classification and access;

- To capture the emotional impact of movies, as felt and perceived by the viewers, for classification and indexing. This would help users to gain more awareness about the emotional impact of watching movies and allow to access movies based on these emotions;

- To analyze and classify movie content based on the processing of three information streams: subtitles, audio, and visual video content, with a special focus on emotional information;

- To conceive and create effective interactive access, navigation and visualization of the movies based on their content and their emotional impact on viewers, with the potential to provide insights based on the information visualized, and the users' emotional profiles, choices, and states.

Exploring movies by their emotional dimensions can be used for entertainment, but also education or health purposes. So, these results could be relevant to a wide audience.

Fig. 1 presents the seven project's tasks. The firt one delt with coordination with funding agency and research lab and within research teams; as well as project dissemination. Project's contributions have been presented and published in conferences and journals; and we organized 2 AWESOME Workshops, with project researchers and international invited speakers, to promote interaction, debates & exchange of experiences among the scientific community, industry players and general public. Tasks 2-7 will be addressed in the next sections, followed by conclusions and perspectives.

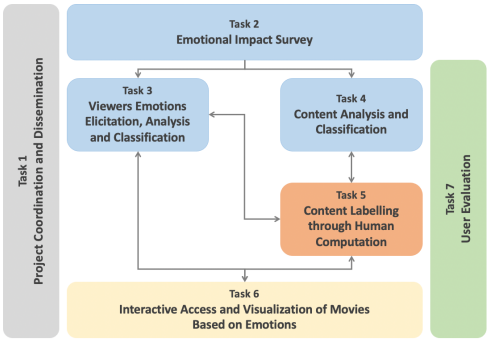

Figure 1: *AWESOME Project tasks*

2. Emotional Impact

This task focused on surveying and understanding movies' emotional impact on viewers, with the following goals: 1) Select the most relevant emotional models and terms to consider when analyzing and classifying the emotional impact of movies on viewers; 2) Understand the role of viewers' individual differences, like genre preferences and emotional movie gratifications, in predicting viewer's movie choices; and 3) Assess the viewer's perceived importance about the emotions shared by others, and its relevance alongside the movie ratings and descriptions.

To address goal 1, we reviewed several studies to learn about the state of the art, and eventualy conducted a scoping review [PRCA22] for a more thorough analysis, mainly to understand: a) how digital systems use emotional information to allow users to access, navigate, and recommend movies; and b) which emotional theories and conceptual frameworks have been applied in the development of these digital systems. Results indicated that some systems use emotions for searching and recommending, identifying emotions in movie content and in viewers. Sentiment analysis seems to be the preferred method to analyze movie content (e.g., subtitles) and viewers' comments and reviews, with a dimensional model of polarity or valence and arousal. As categorical approach of emotion, the most common emotional terms they use and analyze are sadness, anger, fear, surprise, happiness, disgust, and joy (from Ekman). Thus not incorporating many other emotional terms and gradients that previous research had also considered relevant, such as positive emotions (only one in Ekman's) and eudaimonic labels, e.g., feeling moved, awe, compassion, hope, motivation, enthusiasm and inspiration [COM11,BFC16,CK17]; reinforced by our other recent studies for this task of the project, as presented next.

We developed two empirical studies [AAP*20, PSCA21], in which we a) collected information addressing participant's favorite movies, film genres, and emotions evoked (with categorical and dimensional conceptualizations of emotions) (goal 1); and b) examined the role of individual differences such as need for cognition, need for affect, and personality traits in predicting individuals' interest in movies, including rewatching a movie they liked and remembered and making recommendations to friends (goals 2 and 3). These studies indicated that the emotions elicited by movies were deemed as one of the key factors that contributed to viewers' interest in watching them. Among the extensive list of emotions provided (based on prior studies e.g., CK17, BFC16), labels such as feeling inspired, love, kindness, generosity, moved, suspense, sadness, hope, fear, and awe were reported as the most appreciated emotions in movies. In [AAP*20] we also found that the need to watch movies for social sharing, thrill gratifications from movies, extraversion trait, and age contributed most to explain viewer's interest in rewatching a movie, whereas emotional contemplative preferences in movies, social sharing, need for affect, and age predicted movie recommendation.

In the subsequent study [PSCA21], besides continuing collecting data on specific emotions that are relevant to participants in movies (goal 1), we experimentally investigated how participants respond to a hypothetical online movie rating system to understand the role of quantitative ratings, reviewer's qualitative emotional comments (hedonic vs. eudaimonic), and participants' emotional gratification preferences on their interest in watching the movie (goals 2 and 3). Results indicated that participants were affected by the reviewer's ratings, reporting more interest for the movie with a higher number of "likes", but most importantly, it offered new evidence for the assumption that movies encompass both hedonic (e.g., fun) and eudaimonic (e.g., contemplation) emotions that individuals consider in their choices. Based on reviewer's comments, participants with hedonic preferences expressed greater interest in the movie with hedonic comments, while those with eudaimonic preferences showed more interest for a movie with the eudaimonic comments.

These findings suggest that providing additional nuanced information about the emotional content and elicited feelings of a movie may enable viewers to make better informed choices based on their current gratification preferences during the selection process.

3. Viewers Emotions Elicitation, Analysis and Classification

In addition to investigating the emotional preferences and evoked feelings, our project had the aim of identify the physiological responses elicit by movies with distinct content and sensors; and to support the continuous capture, analyses and classification of viewers' emotions through these physiological signals.

In one experimental study [ZAS*20], we examined how participants responded to short movies inducing distinct specific emotions, by contrasting sadness with positive emotions of awe and moving (this latter also named kama muta, and considered as a positive eudaimoic emotion). We measured both self-report and several physiological responses from the autonomic nervous system (cardiovascular, skin conductance, facial electromyography, skin temperature, respiration, piloerection, and lachrymation). Overall, we found some distinguishable physiological and self-report patterns for these negative and positive emotions, suggesting that in addition to the feelings, appraisals and motivations, we should consider other components of emotions through physiological responses.

Skin conductance, PPG, ECG and EEG sensing channels were tested to extract the relation between the physiological parameters and a set of emotions: happy, sad, angry, surprise and scared, in a multimodal emotion recognition system that was designed and implemented for simulated flight experiments, where emotions are often significant [RPGP19, RP19]. As a reference system for emotion recognition, Face Reader was considered; and different classification algorithms including deep and shallow neural networks were employed. Prototypes were also developed on: the influence of

music stimulation, in different genres, on heart rate variability (HRV) [RPC22]; multimodal physiological monitoring of signals like heart and respiratory rates (HR and RR), related with human stress [RPM22]; and sustained attention detection with HRV, ECG and PPG [CPA20], measured in different scenarios and media types, including video.

We also developed algorithms for estimation of Valence and Arousal (VA, dimensional model), using: skin conductance (SC), from autonomic nervous system, and electroencephalography (EEG), thus adding measures from central nervous system. For SC, we used time-based statistical features (e.g., maximum, minimum, standard deviation, skewness, kurtosis, etc.) and a Decision Tree estimator [Oli19]. For EEG, we used features like Hjorth parameters, spectral entropy, wavelet energy and entropy and IMF energy and entropy; as regression methods, tested Random Forest and K-Nearest Neighbours (KNN) [GAF21].

With these algorithms, we developed EmoStatus (and implemented web services to integrate it with our on-going platform in tasks 5 and 6), a software framework optimized for real-time running and parallel processing, allowing to perform a continuous assessment of participants' emotional status. On top of this, we developed metaFERA, a meta-framework for creating specific software frameworks for each type of physiological signal(s) [OACF23]. Additionally, we developed new libraries to allow devices like BITalino, mi band, and Muse2 to connect via web pages, to integrate with our EmoStatus platform.

4. Content Analysis and Classification

Besides the emotional impact on viewers, we also take into account emotions through content analysis. These are emotions intended by the writer or filmmaker. Three vectors of emotions are identified: text through movie reviews and subtitles analysis, audio tracks with sound detection and visual contents through the analysis of video frames and frame sequences.

4.1 Text in Subtitles and Reviews

Subtitles indexing was studied in the context of our previous VIRUS project [LCO*10]. Techniques based on stemming, Wordnet relations and tf*idf filtering have been implemented and evaluated. We also developed methods for finding emotional and sentimental information captured in the subtitles, by searching emotions from most known categorical and appraisal emotional models, complemented with words following "feel" and "feeling". Then, we supported search, overview and browsing of movies based on the information conveyed in the different tracks or perspectives of its content, especially audio and subtitles, where most of the semantics is expressed (by every word, or with a special focus on emotions) [GSD*12].

We have now integrated a sentiment analysis system in our on-going platform, supporting: searching a movie by name; visualizing movie details (cover, release date, rating and reviews); identifying within a specific review, which terms have a polarity score (-5 to 5); and visualizing, for each review, a list of terms and corresponding score. Also, a web-based application was developed where the sentiment analysis engine exists, and a GUI was integrated to easily choose different labelled databases and language, as well as updating current database with new words and scores.

4.2 Audio Classification

The audio track is an important part of a movie. It contributes significantly to the emotions felt by the viewer. In this section, we focus our attention in the emotional content of the audio. To this end, emotional sound detection models have been developed. After some less successful attempts to predict valence and arousal (VA) from audio signals, we turned to audio detection by considering sounds that are universally understood as proxies to moods such as "sad music" or sound events (e.g., crying or laughter). We are not aware of previous use of this technique for the detection of emotional content in movies. These models receive the audio signal (more precisely an image that corresponds to the FFT of an audio exerpt) and produce a prediction regarding the presence or absence of a category of sound event. In order to train the models, audio excerpts are collected from Youtube (google audio set https://research.google.com/audioset/).

We used data-augmentation techniques (time shifting and noise addition) on our datasets to obtain better performance. The resulting models based on CNNs are able to detect screaming, laughter, crying, dog barks from audio tracks. Each CNN implements a binary classifier for a given sound event. These models have been tested on movies (10 most ranked movies on IMDB plus 2 movies for testing specific sound events). Since movie audio tracks are not labeled, we developed a tool for manually evaluating the results on a larger scale. Regarding audio detection, future work will consist in automating the process for building new models (and refining old ones) based on on-going data collection.

4.3 Visuals in Images and Video

Classification of videos using visual content was done using two types of information: visual information in frames; and cinematographic information in shots (sets of frames).

For individual frames, we developed an approach for estimating VA using low-level and high-level (semantic) features, combining visual (e.g., color, shape, texture) with semantic features (tags), and a stacking ensemble method using an SVM with RBF kernel for regression. This approach showed a low estimation error, a strong relationship between the estimated and expected VA values, and achieved state of the art values [AF18]. We also analyzed the impact of using handcrafted features in CNNs to estimate VA conveyed by images. We conducted experiments using traditional regression methods and deep learning CNN architectures, and features selected considering visual and semantic characteristics and emotional information based on aesthetics, psychology, and photography theories. These revealed that using color and semantic information with the ResNet50 yielded promising results.

A second path we explored for identifying emotions in videos was the use of cinematographic features (namely shot

length, key lightning, shot type, and motion), to describe shots. These were used to train machine learning models to predict emotions at different granularities, by VA, High/Low VA, or VA quadrants. Achieved results were similar to the state of the art, which uses more complex approaches (e.g., deep learning) and multiple modalities (e.g., audio, visual, motion) [Gra22].

5. Content Labelling through Human Computation

The emotional annotation of movies was designed and developed for our AWESOME platform, using a flexible approach to support different emotional representations (in dimensional or categorical models) in instants and segments like scenes; and gamification elements to further engage users in this task, beyond their intrinsic motivation.

These annotations can help enriching emotional classification of movies and their impact on users (tasks 3,4) with machine learning approaches, later helping to find movies based on this impact; and they can also be collected as personal notes like on a journal where users collect the movies they treasure the most, and that they can review and even compare along their journey [NRC22]. Fig. 2 provides an overview as illustration.

We are adopting Russel's VA circumplex, or wheel, as the central model for emotions (aligned with VA classification in tasks 3 and 4), where we color the wheel and also place categorical emotions (in words or emojis) to help convey more meaning. Users can annotate in categorical emotions, Self-Assessment Manikin (SAM) and emotional wheel based on VA (task 5); when using sensors like EEG, ECG or EDA to identify emotions, these are often classified in VA; when using the webcam, emotions are most naturally expressed by emojis (task 6).

As long as categorical emotions are associated with a VA, and a color map is defined for the wheel, representations can be converted among each other. We provide some default mappings (e.g., Plutchik or Geneva) to choose from; and, for flexibility and personalization (task 2), are including an interface for customizable wheels, defining: the categorical emotions, their VA, colors and emojis. More details in the recent papers.

Gamification was adopted to engage, motivate and reward users in their annotation tasks, and for that, elements like points, level, challenges, achievements and leaderboards were used. Leaderboards support the needs for esteem and belonging; while the progression with points and levels support Pink's intrinsic motivation of mastery, even recognised at the level of specific movies and their fans; and the challenges can account for the motivation of purpose; all these related with the self-actualization need of Maslow [NRC22].

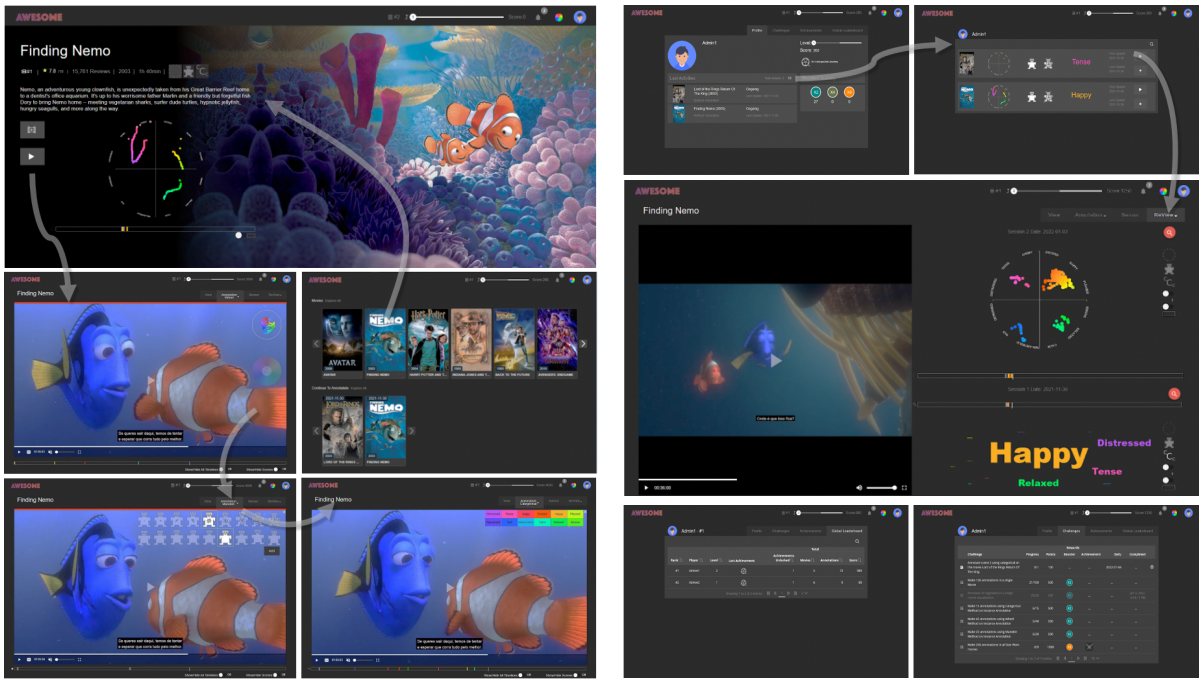

Figure 2: *Emotional and Engaging Movie Annotation with Gamification in AWESOME: (left) Selecting movie at Gallery View, accessing that Movie Detail with emotional information, and watching movie at Annotation View with emotion wheel, SAM (Self-Assessment Manikin) or categorical emotions (all with synchronized annotations in the timeline); (right top) Emotional Journal & Review with Profile view and Emotional Journal Views (at the top), then ReViewing an annotation session (middle); and (right bottom) Gamification System with Leaderboard & Challenges [NRC22].*

6. Interactive Access and Visualization of Movies Based on Emotions

As our first interactive web application in the project, As Music Goes By was designed and developed to allow users to search, visualize and explore music and movies from complementary perspectives that navigate music in different versions, artists, and movie soundtracks they belong to; with relevant properties like popularity, genre and emotional impact; from overviews to the actual music or movie viewing [MC19]. It was developed further to support quotes, also with an emotional flavour [SC20] (Fig.3).

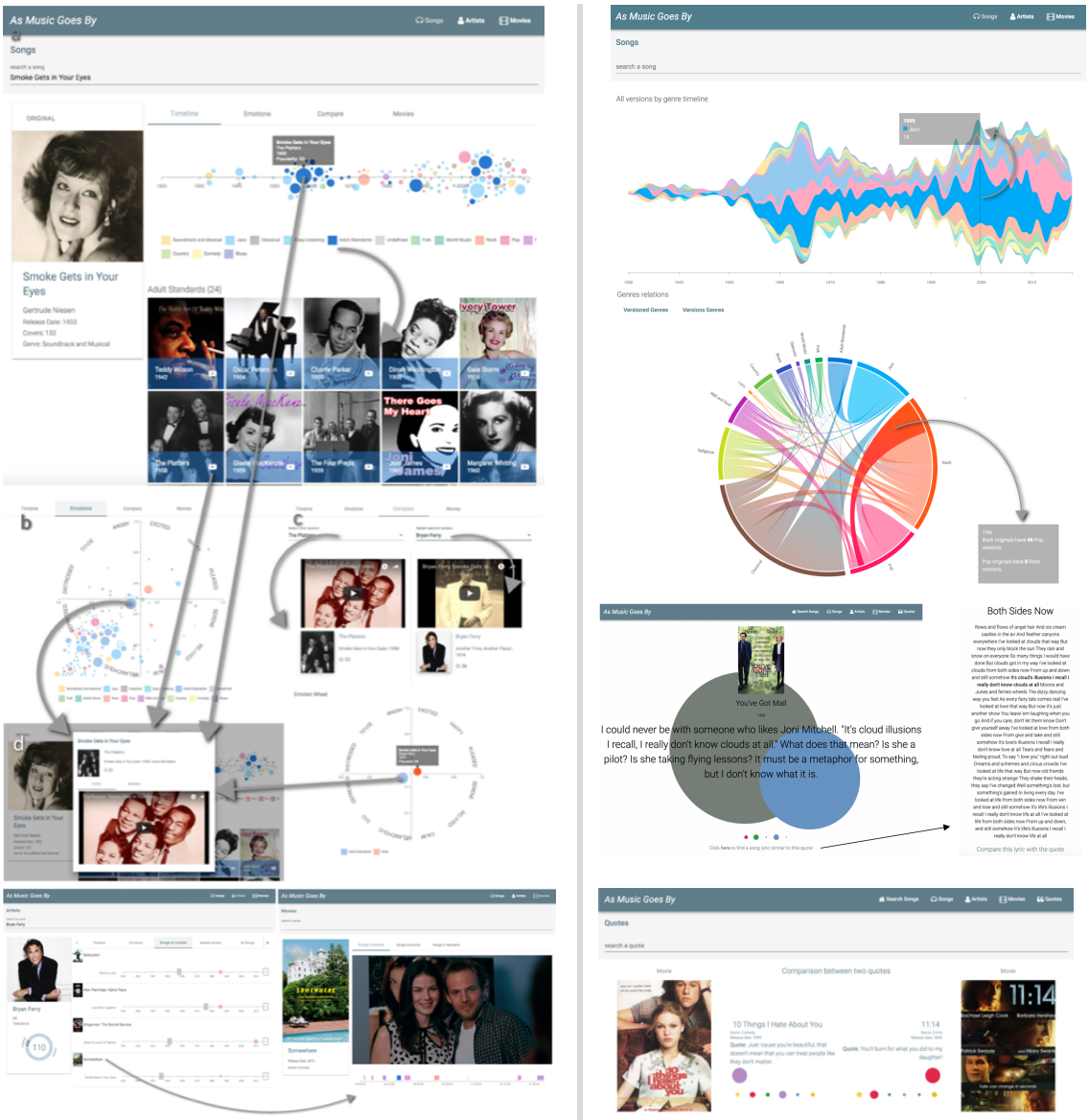

Figure 3: As Music Goes By: (left top) Searching and navigating Music and their versions, with a) timeline representing versions of selected song (Smoke Gets in Your Eyes) as circles along time with popularity (circle size) and genre (circle color), and mosaic of songs in selected genre (Adult Standards, in blue); (in another tab) b) emotional impact in VA wheel (instead of timeline); then access to song clips that can be compared in pairs; (left bottom) accessing a Movie View from a song (belonging to its movie soundtrack) listed in the Songs in Movies tab at an Artists' View. There, the user can watch the movie, indexed and synchonized with its soundtrack. (right top) Music Overview with genres along time (in a streamgraph), and beneath anternative views, comparing (in chords) genres in original songs and versions; (right middle) Comparing movie quote with song lyrics (large circle with average color of emotions in quote, blue medium sized circle with dominant emotion in size reflecting % of dominance, beneath all the emotions detected in the quote, represented in small circles with respective color,and size reflecting their %); (right bottom) Comparing quotes in different movies, highlighting in larger circles the dominant emotion, and beneath all the emotions, as in the previous (above) situation. Other views and features in the papers[MC19,SC20].

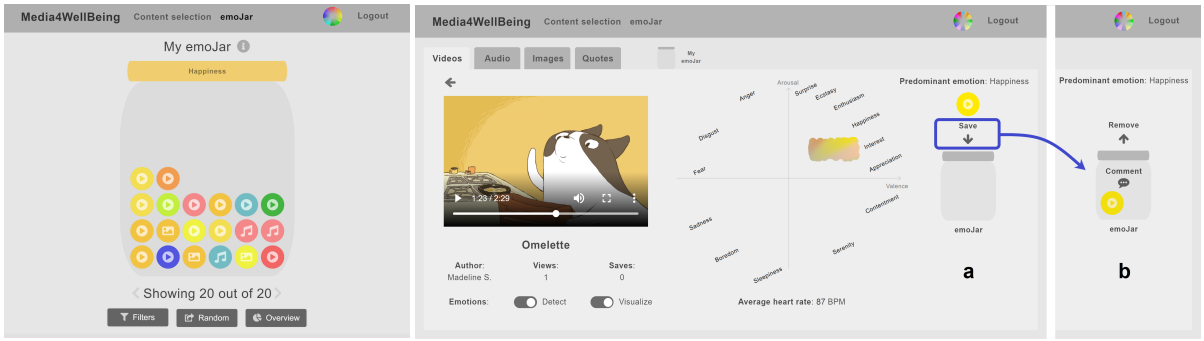

Figure 4: *EmoJar: (left) the Jar with saved content, that users can access to revisit, jar lid has color of most frequent dominant emotion in the content (represented by colored circle); (right) Content Reproduction page: with video, emotion recognition results in "emoPaint" wheel, user's average heart rate, and the colored circle representing this content with its dominant felt emotion, being saved in the emoJar (on the right) after which users can add comments on felt emotions. Other views and features in the papers [CC19,CC20].*

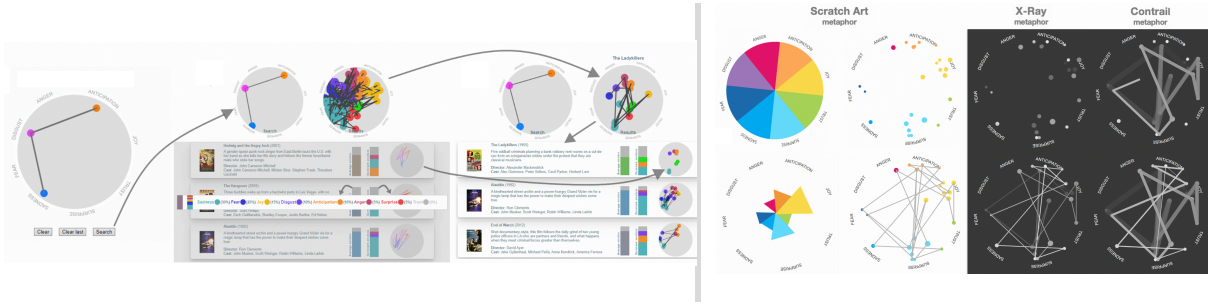

Figure 5: *Multimodal Search and Visualization of Movies Based on Emotions in As Movies Go By (when the focus in on the movies): (left) movie search by emotional trajectory along the movie, with discrete points, each movie in the results giving access to watching the movie (with emotional information); (right) Visualization of Emotional Wheel: (top left-white background) the 8 central emotions in the Plutchik Model; and emotion wheel with circles (created with Scratch Art metaphor); (bottom) cumulative dominant emotions, and wheel with trajectories; (top right-dark background) X-Ray view: circles and lines; Contrail view: in progress and final state. More information, other views and features in the papers [CLSC22, CLC23].*

Another application, EmoJar, extended previoud work [BFC16] with a focus on wellbeing, based on the Happiness Jar concept, to collect and remind users of the good things they experience in life, enriched with emotionally impactful and memorable media, like video, helping them to perceive and regulate their emotions [CC19,CC20] (Fig.4).

The AWESOME platform prototype, with same approach of As Music Goes By, focused on the manual (task 5) and automatic annotation of movies with emotions captured by sensors (task 6) while watching movies (via EmoStatus, task 3), and movie access with interactive and immersive means for emotional impact awareness (Fig.2). After the annotation, the follow-up work has been the interactive means to visualize and search for movies based on their dominant and actual emotional impact along the movie (addressing the challenges of representing emotions along time), with different models and modalities (e.g., emotional highlights and trajectories, the user's emotional state, or a music being played) [JCC21,CLSC22,CLC23] (Fig.5).

7. User Evaluation

Perceived Usefulness, Satisfaction and Ease of use (USE) of prototypes, and main set of new features at each stage, have been assessed for each feature and overall, based on task analysis, interviews and observation. Users have also often been asked to classify the applications with ergonomic, hedonic and appeal quality aspects. These evaluations have helped to assess usability and research questions, mainly for tasks 5 and 6 (see papers referenced in these sections).

The interactive mechanisms that have been designed and built have addressed challenges and open issues in promising ways, and often extended previous features, in each new phase and students' thesis.

In general, users found the interactive applications and their features useful, easy, and quite satisfactory to use; and most users described them as quite interesting, comprehensible, pleasant, and also clear, trustworthy, innovative and original.

Approaches developed in task 3 and 4 have also involved evaluations with users, or datasets previously obtained with users, like in [GAF21], to assess the different methods to detect and estimate user emotional and physiological states, in different conditions. The studies carried out in task 2, on the other hand, were often informative and aligned with the goal to assess the effects of showing emotional descriptions of films to viewers.

8. Conclusions and Perspectives

In this paper we presented an overview of the AWESOME Research Project, highligthing its main tasks and components and how they are interrelated. This work is the result of a collaboration within a multidisciplinary team. Inputs from Psychology, Machine Learning, Multimedia and Human-Computer Interaction and Design were essential to the success of this project.

We highlight the importance of having platforms to support emotion recognition in real-time, allowing to perform a continuous assessment of participants' emotional status; meta-frameworks to accommodate different types of physiological signals; and having both automatic as well as user classification and annotation. VA provides a good balance for simplicity, flexibility, personalization, and interoperability with different sensors; and it can be mapped to richer models that align with different modalities, and even to more eudaimonic emotions that users value so much in the context of movies, deserving a more thorough investigation, along with other gratification preferences.

Future work also includes refinements based on user evaluations and strengthening the convergence, integration and upgrading of the techniques and features developed in the context of the project. In particular, to optimize emotion classification and explore other unintrusive sensors; further extending the interactive visualization and search features, providing useful and interesting ways to perceive and find movies that we value and can enrich our experience, increase our emotional awareness, and possibly the ability to help regulate our emotional states, taking into account our personalities or preferences. Recommendation techniques based on affective states and impact, as well as access patterns, can help in this direction. Scale is also an important aspect to keep in mind, either in the amount of movies, and the amount of emotions detected or annotated in each movie; already accounted for to some extent with some filtering approaches. Other media and modalities can also be explored for accessibility and to increase awareness even when not relying on the visual dimension (e.g., when listening to a talk or a song, or just focusing the visual attention on the movie), for a more immersive experience.

From a user-centric perspective, it is also important to study the impact of such tools in a longer term use, and account for privacy issues. How would the users welcome these approaches to detect or annotate their emotional impact, or have recommendations based on these analysis? Would they have such a positive feedback if to use in the long run in their media access, or would they find some features intrusive?

Overall, we believe that these approaches could provide a service valuable for everyone: the general public, interested in movies, and music, for entertainment, curiosity and inspiration, getting into movies in serendipitous ways; as well as to professionals and content creators, e.g., to raise awareness about the way these media have evolved and impacted people, and as a support to help them choose or create movies and music that keep entertaining, connecting & touching us.

Acknowledgments

This research was partially supported by Fundação para a Ciência e a Tecnologia (FCT) through the AWESOME project PTDC/CCI-INF/29234/2017; the LASIGE Research Unit, ref.\ UIDB/00408/2020 and ref.\ UIDP/00408/2020; and by Project UID/EEA/50008/2019, Instituto Universitário de Lisboa (ISCTE-IUL) and Instituto de Telecomunicações (IT-IUL), from Lisbon, Portugal. We also thank all our MSc and PhD students who contributed to this project.

References

[AF18] ALARCÃO, S. M., FONSECA, M. J.: Identifying emotions in images from valence and arousal ratings. *Multimedia Tools and Applications*, Springer, 77(13) (2018). 17413-35.

[AAP*20] ARRIAGA, P., ALEXANDRE, J., POSTOLACHE, O., FONSECA, M. J., LANGLOIS, T., CHAMBEL, T.: Why do we watch? The role of emotion gratifications and individual differences in predicting rewatchability and movie recommendation. *Behavioral Sciences*, 10 (8), (2020), 1-11.

[BFC16] BERNARDINO, C., FERREIRA, H. A., CHAMBEL, T.: Towards Media for Wellbeing. In Proc. of ACM TVX (2016), pp.171-177.

[CLSC22] CALDEIRA, F., LOURENÇO, J., SILVA, N. T., CHAMBEL, T.: Towards Multimodal Search and Visualization of Movies Based on Emotions. *ACM IMX* (2022), pp. 349-356.

[CLC23] CALDEIRA, F., LOURENÇO, J., CHAMBEL, T.: Happy or Sad, Smiling or Drawing: Multimodal Search and Visualisation of Movies Based on Emotions Along Time. *VISIGRAPP/HUCAPP* (2023), pp. 85-97. Best Paper Award.

[CC19] CARVALHO, P. CHAMBEL, T.: EmoJar: Collecting and Reliving Happy and Memorable Media Moments. *ACM TVX* (2019), pp.262-272.

[COM11] CHAMBEL, T., OLIVEIRA, E., MARTINS, P.: Being Happy, Healthy and Whole Watching Movies that Affect our Emotions. *Proc. of ACII* (2011), Springer: Berlin Heidelberg. pp. 35-45.

[CC20] CHAMBEL, T., CARVALHO, P.. Memorable and Emotional Media Moments: reminding

yourself of the good things!, *VISIGRAPP/ HUCAPP* (2020), pp.86-98. Best Paper Award.

[CAF*21] CHAMBEL, T., ARRIAGA, P. FONSECA, M.J., LANGLOIS, T., POSTOLACHE, O., RIBEIRO, C., PIÇARRA, N., ALARCÃO, S. M., OLIVEIRA, J.: AWESOME: Awareness While Experiencing and Surfing On Movies through Emotions. In *Encontro com a Ciência e a Tecnologia em Portugal*, 28-30 Jun, (2021).

[CPA20] COSTA, B. N. d., POSTOLACHE, O. and ARAUJO, J.: Sustained Attention Detection System in Learning Environments. *EPE* (2020), Iasi, Romania, pp. 609-615.

[CK17] COWEN, A. S., KELTNER, D.: Self-report captures 27 distinct categories of emotion bridged by continuous gradients. *Proceedings of the national academy of sciences, 114(38)* (2017), E7900-E7909.

[GAF21] GALVÃO, F., ALARCÃO, S. M., FONSECA, M. J.: Predicting Exact Valence and Arousal Values from EEG. *MDPI Sensors*, May, 21(10): 3414, (2021).

[GSD*12] GIL, N., SILVA, N., DUARTE, E., MARTINS, P., LANGLOIS, T., CHAMBEL, T.: Going Through the Clouds: Search Overview and Browsing of Movies. *Academic MindTrek* (2012), Tampere, Finland, Oct 3-5, ACM, pp.158-165.

[Gra22] GRAÇA, S. M.: Emovideo : automatic prediction of emotional responses to videos using its cinematic features. *Master in Engenharia informática, FCUL*, Feb (2022). https://repositorio.ul.pt/handle/10451/53904

[JCC21] JORGE, A., CORREIA, N., CHAMBEL, T.: Design Guidance for Interactive Visualization of Movies and Videos in Time and Space. In: Martins, N., Brandão, D. (eds) *Advances in Design and Digital Communication. Digicom 2020.* Springer Series in Design and Innovation, vol 12. Cham, Switzerland: Springer, (2021), 102-113.

[LCO*10] LANGLOIS, T., CHAMBEL, T., OLIVEIRA, E., CARVALHO, P., MARQUES, G., FALCÃO, A.: VIRUS: Video Information Retrieval Using Subtitles. *Academic MindTrek* (2010), Tampere, Finland, Oct 6-8, ACM, pp.197-200.

[Men21] MENDONÇA, F.: AudioMood: Classificação de emoções em bandas sonoras de filmes usando Redes Neuronais. *Master in Informática, FCUL*, Jul (2021). https://repositorio.ul.pt/handle/10451/49347

[MC19] MOREIRA, A., CHAMBEL, T.: This Music Reminds Me of a Movie, or Is It an Old Song? An Interactive Audiovisual Journey to Find out, Explore and Play. *VISIGRAPP/GRAPP* (2019), pp.145-158.

[NRC22] NUNES, L.; RIBEIRO, C., CHAMBEL, T.: Emotional and Engaging Movie Annotation with Gamification. *VISIGRAPP/HUCAPP* (2022), pp. 262-272.

[Oli19] OLIVEIRA, J.: EmoStatus - Estimating the emotional state of people using electrodermal activity. *Master in Engenharia Informática, FCUL*, Nov (2019). https://repositorio.ul.pt/handle/10451/40576

[OACF23] OLIVEIRA, J., ALARCÃO, S. M., CHAMBEL, T., FONSECA, M. J.: metaFERA: A Meta-Framework for Real-Time Emotion Recognition from Physiological Signals. *Multimedia Tools and Applications*, Springer, accepted for publication, (2023).

[PSCA21] PIÇARRA, N., SILVA, N., CHAMBEL, T., ARRIAGA, P.: What movie will I watch today? The role of online review ratings, reviewers' comments, and user's gratification style. Projections, *the Journal for Movies and Mind*, 15 (3), (2021), 24-46.

[PRCA22] PIÇARRA, N.; REIS, E., CHAMBEL, T., ARRIAGA, P.: Searching, Navigating, and Recommending Movies through Emotions: A Scoping Review. *Human Behavior and Emerging Technologies*, vol. (2022), Article ID 7831013, 24 pages. Pre-registered at OSF: DOI: 10.17605/OSF.IO/83C75

[RPM22] RIBEIRO, G., POSTOLACHE, O., MARTÍN, F. F.: A Practical Approach to Health Status Monitoring Based on Heart Rate and Respiratory Rate Assessment. *IEEE MeMeA* (2022), Messina, Italy, Jun 22-24, pp. 1-6.

[RPC22] RODRIGUES, M. J., POSTOLACHE, O., CERCAS, F.: The Influence of Music Stimulation on Heart Rate Variability: Preliminary Results. *IEEE MeMeA* (2022), Messina, Italy, Jun 22-24, 2022, pp. 1-6.

[RPGP19] ROZA, V. C., POSTOLACHE, O., GROZA, V., PEREIRA, J. D.: Emotions Assessment on Simulated Flights. *IEEE MeMeA* (2019), Istanbul, Turkey, Jun 26-28, pp. 1-6.

[RP19] ROZA, V.C., POSTOLACHE, O. A.: Multimodal Approach for Emotion Recognition Based on Simulated Flight Experiments, *Sensors*, 19(24), 5516, (2019).

[SC20] SERRA, V., CHAMBEL, T.: Quote Surfing in Music and Movies with an Emotional Flavor. *VISIGRAPP/HUCAPP* (2020), pp.75-85.

[ZAS*20] ZICKFELD, J. H., ARRIAGA, P., SANTOS, S. V., SCHUBERT. T., SEIBT, B.: Tears of joy, aesthetic chills, and heartwarming feelings: Physiological correlates of Kama Muta. *Psychophysiology*, (2020).