Utrecht University

Department of Information and Computing Sciences

Game and Media Technology - Master Thesis

Active Exploration of Online Movie Databases by Visual Navigation

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ICA-3986799

June 23, 2017

Abstract

Typical interfaces of state-of-the-art online movie streaming services are designed to give users a pleasant and visually appealing browsing experience. However, they lack user engagement and encouragement of active exploration because little movie information is presented. In contrast, common movie information archive interfaces provide a lot of information that can be used to actively explore the database's content. Yet, they are not visually appealing or easy to use due to their text-based design. In this paper, we introduce the concept of visual navigation, which combines the advantages of both of these interfaces, that is, ease of browsing and information richness. Our solution presents movie information visually and in this way encourages users to navigate the database by selecting the information that they find most interesting. In this research, we implemented the visual navigation concept and compared it to a state-of-the-art alternative. Using a qualitative approach, we showed that participants experienced more intrinsic motivation to use the visual navigation implementation than the state-of-the-art alternative and find it more useful as well. By analyzing their usage logs, we discovered that participants more often used movie information to navigate the database and in this way explored the archive more actively. These results demonstrate the effectiveness of our visual navigation concept and indicate that active exploration of movie databases contributes to a more fulfilling browsing experience.

Acknowledgements

I would like to thank my supervisor dr. Wolfgang Hürst for his excellent guidance. He put more time in counseling me than I could dare hope for and he was always there to give feedback, encouragement and focus. I also want to thank Marij Nefkens for the feedback and support that she provided during our meetings. Furthermore, I would like to thank all the participants that partook in my experiments, both offline and online. Finally, I would like to thank my friends, family and fiancée that have supported me throughout this period and have distracted and encouraged me, both equally necessary. A special mention goes out to Unity for providing a free game development engine and to the community of TheMovieDB.org that carefully curates the movie data that I used for my experiments.

Contents

Preface

This thesis was written as part of a graduation project for the master's program of Game and Media Technology at Utrecht University. The title of the thesis is *Active Exploration of Online Movie Databases by Visual Navigation* and with it we introduce the concept of visual navigation. The thesis consists of the following parts:

- A scientific paper that presents the concept of visual navigation and an evaluation of its effectiveness.
- An annotated appendix that contains the information relevant to this research project that was not covered in the scientific paper:
  - A literature study that explores the research domains related to this project.
  - Extended information on the performed experiments which includes: motivation for the experiments, implementation details, experienced issues and gathered data.
  - A demonstration of the visual navigation concept.
  - A database comparison that justifies the choice for the used movie database.
  - A paper written about the pilot study and published in the adjunct publication of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video (TVX '17 Adjunct).
  - Concluding remarks and suggestions for future work.

Other deliverables that are not included in this written thesis are:

- Source code and executables that were used for this research project, including a written description of their major components.
- The complete set of data and log files that were gathered during the experiments.
- A website aimed at a broad audience that presents the visual navigation concept and shows the major results of our experiments. It can be found at the following location: `http://www.students.science.uu.nl/~3986799/`.

Chapter 1

Scientific Paper

In this section, the scientific paper that was written for this research project is presented. It introduces the concept of visual navigation and an evaluation of its effectiveness regarding user experience and active exploration.

Active Exploration of Online Movie Databases by Visual Navigation

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June 23, 2017

Abstract

The interfaces of state-of-the-art movie streaming services are often designed to give users a pleasant, simple browsing experience at the cost of having less information available. Online movie information archives give the user as much information as possible at the cost of a simple and intuitive browsing experience. We present the concept of visual navigation that combines the ease of browsing and information richness of both interfaces by presenting movie information visually and in this way encouraging users to navigate the database by selecting movie information that they find interesting. A controlled lab study and an online study showed that users prefer the visual navigation interface over a state-of-the-art alternative and that they are more actively exploring the database with the visual navigation interface.

1 Introduction

Movie streaming services like Netflix are designed to give users an easy and intuitive way to browse a movie database. They generally show a lot of images and use appealing visuals to give users a pleasant browsing experience. The cost of this approach is that there is not much information per movie available and the information is not prominently featured. This type of browsing will be referred to as *visual browsing* because users browse the database by looking at movie images and posters (see figure 1).

On the other end of the spectrum, movie information archives like The Internet Movie Database offer a lot of information per movie but lack an easy and intuitive way to browse the archive. Movie information is mostly presented as text in a traditional list-like fashion. They are visually less appealing and are more functional than fun. Users browse by searching for specific keywords or by clicking on textual hyper-links. Because users browse the database by entering or clicking on text, this type of browsing will be referred to as *text-based browsing*.

In this paper, the concept of *visual navigation* is presented. Visual navigation combines the ease of visual browsing with the information-richness of text-based browsing. By presenting the movie information visually, users are encouraged to use movie information to browse through the video database while still retaining the ease of browsing and the visual appeal of visual browsing. An initial pilot study [1] with a group of early adopters and tech-savvy subjects confirmed that they indeed experience state-of-the-art movie databases in the way that we discussed. A test with a prototype of the new concept showed that they find it intuitive and are able to handle it well. The general feedback was overwhelmingly positive and also yielded a few ways to improve the prototype.

For this paper, two experiments were conducted to test the concept in a realistic setting. A prototype with two interfaces was designed, one that is similar to visual browsing interfaces and another that uses visual navigation to navigate between movies. The prototype was tested in a controlled lab study and an online study to see if people still

use and prefer the visual navigation concept when offered a state-of-the-art alternative.

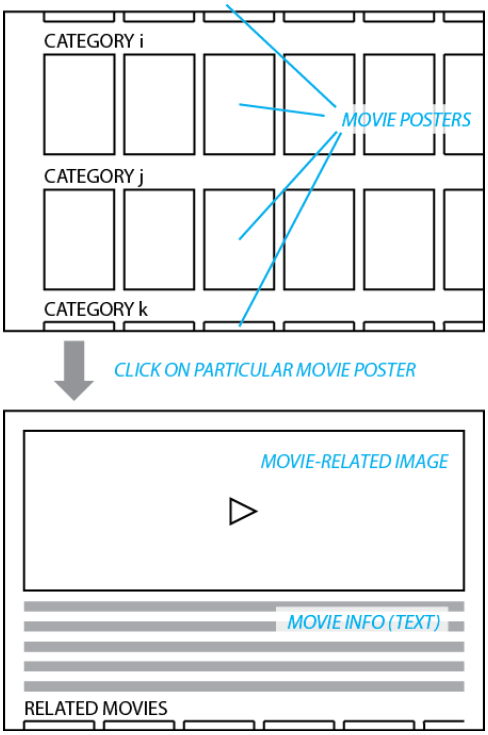

Figure 1: A common visual browsing interface of movie streaming services. Illustration taken from [1].

2 Background and Related Work

In recent years, a lot of research has been done on video browsing and video interaction. A survey by Schoeffmann et al. [2] provides an overview of the work done on video interaction tools up until 2015 and shows that most of the work on video browsing is focused on browsing within videos and not between videos. Furthermore, most of the work is performance-focused and not about user engagement and experience. The absence of these research topics is notable and shows the need for research on these subjects. The concept of visual navigation was designed as a high-level movie browsing system that engages users and offers a satisfying user experience.

A common way of browsing videos is by exploring related videos that are presented by the video database. There are several tools that use video metadata to create relations between videos. Waitelonis and Sack presented an exploratory search tool using Linked Open Data (LOD) for yovisto.com, an academic video database [3]. They created relations between videos by linking their known metadata. Craggs et al. presented the ThumbReels tool [4] which is aimed at creating new video metadata by using crowd-sourcing to tag videos with keywords. These tags can then be used to show related videos. While these tools are useful for videos with little known metadata, they are not as useful for movie browsing. Movies generally have much metadata readily available and the real challenge is to design an interface that encourages users to actually use the movie metadata to find related movies. A key aspect of visual navigation is that it encourages users to use movie metadata to navigate between movies and find movies that they otherwise would not have found.

Recently, Low et al. presented the Visual Berrypicking tool [5] which lets users actively explore a movie database by presenting the user with a 2-dimensional map of related movies. These relations are based on several types of metadata and similar movies are clustered. Users can select a movie that they are interested in and new related movies are shown for that movie. Their approach is similar to the visual navigation approach, but one of the key differences is that it does not show the user what the relations are based on. We claim that it is better, if not necessary, for users to make a conscious choice about the type of related movies that they browse so that they are actively engaged and can find what they are looking for. Visual navigation lets users choose what a movie relation should be based on and this allows them to explore movies that they are interested in.

A feature that many video databases offer is a recommendation system. When users do not know exactly what they are looking for, they could benefit from receiving recommendations. Most recommender systems for video browsing make usage-derived recommendations and are based on Collaborative Filtering [6]. These systems make recommendations based on what a user has watched before and thus rely heavily on known user profiles. Bollen et al. presented a method that does not rely

on user profiles by using temporal statistics to determine whether consecutive requests are made by the same user. More recent work on recommendation systems is focused on a multi-modal approach. Arapakis et al. showed a method [7] that films the reactions of users to determine what they like and don't like. Yang et al. presented a method [8] that combines metadata, visual and aural relevance in one function to improve their recommendations. While recommendations are useful for users that do not know what they are looking for, they are not always accurate because they do not take into account what users are currently in the mood for. There is also the dependency of knowing a user's browsing history to make accurate recommendations, which is not always possible. Visual navigation lets users make their own recommendations by encouraging them to actively explore the database and think about what they are looking for without a need for their browsing history.

3 Visual Navigation

State-of-the-art video database interfaces are either focused on an easy and visually appealing browsing experience (visual browsing) or on giving a user as much information as possible in a textual, list-style fashion (text-based browsing). Visual browsing allows for an easy and passive way of browsing, where users can scroll through categories until they find something they like. This approach is effortless for users but offers little movie metadata per movie and browsing options beyond just scrolling through categories. Text-based browsing relies on users entering search queries or clicking on certain textual information to find the movies and metadata they are looking for. Users can find all the information they need and are actively exploring but the ease of browsing and visual appeal is lost.

Visual navigation is a high-level movie browsing approach that aims at combining the best of both worlds by visualizing movie metadata in an esthetically pleasing way and allowing users to navigate a movie database by selecting visualized metadata (see figure 2). Selecting metadata shows related movies containing the same metadata. After selecting one of these movies, users can keep navigating from movie to movie by selecting metadata that they are interested in.

A key aspect of visual navigation is the facilitation of *active* exploration. When users do not know what movie they are in the mood for, they have to actively explore the movie database to figure that out. Active exploration engages users and helps them to think about what kinds of movies they are interested in. We claim that when exploring a movie database, users need to make a conscious choice about which kinds of movies they browse in order to discover what they are looking for. Visual navigation encourages users to make such conscious choices by having them choose metadata that they are interested in to navigate the database and advance their search.

Besides facilitating active exploration, it is also stimulated by presenting metadata visually instead of presenting it as text. Metadata is positioned in a circle around the movie poster and each piece of metadata is styled like a clickable button (in contrast to figure 1). Metadata that has photos associated with it (e.g. actors, directors and other filming crew) are presented with photos to encourage people to click on it and an icon depicting their role in the movie. In the pilot study a number of participants stated that they often recognized an actor's face but did not know their name. By showing photos with metadata, users will recognize the metadata and be more inclined to use and navigate by it. Another advantage of visualizing metadata, is the potential to highlight more uncommon navigable metadata, such as: production company, music composer and language. Participants of the pilot study stated that they would never have thought of navigating by certain metadata if it was not so prominently featured but they actually found it interesting when they did.

4 Evaluation

As said before, a pilot study that was performed with an early prototype of visual navigation showed that people can handle the concept and find it intuitive [1]. The feedback was overwhelmingly positive and many participants indicated that they would use the prototype instead of state-of-the-art alternatives if it was brought to the market. To put this statement to the test, a prototype featuring both the visual navigation in-

(a) Movie details view

(b) Category view

Figure 2: Screenshots of the visual navigation concept as used in the pilot study. All images have been replaced with copyright-free images from Wikimedia Commons.

terface and a typical state-of-the-art visual browsing interface has been developed. With this prototype, a controlled lab study and an online study have been performed to find out if people indeed preferred the visual navigation interface over the state-of-the-art interface. The second goal of the studies was to find out whether the participants explored the database more actively by using the visual navigation interface than by using the state-of-the-art interface.

4.1 Implementation

The same prototype implementation was used for both studies and was designed as an Android application for touch screen devices. Other devices, such as TV's or desktop computers will be addressed in future research. The application was forced to run in landscape mode to eliminate variance due to the usage of different screen orientations. All data, movie posters and other visuals were downloaded at runtime from *The Movie Database* (TMDb) which is a free and open movie database that is community-maintained.

The application starts in what we refer to as the *home view* (see figure 3, top). From the home view, users can select one of two interfaces to use by tapping the left or right side of the screen. The order of the interface buttons is randomized at each application launch to avoid any bias due to the order of the interfaces. After selecting either of the interfaces, the *genre view* is shown, where movies are categorized by genre for a total of 19 different movie genres. Twenty movie posters are shown per genre and users can request more movies for that genre by using the arrow buttons. The movies are sorted descending by popularity. From this view, a user can also enter a search query, which will lead the user to the category view that is explained below, showing movies matching with the search query. The genre view is identical for both interfaces to make the interfaces comparable.

When a user selects a movie, the *details view* is opened. This view shows the details for a movie and a button that directs the user to *YouTube* for a movie trailer. In the state-of-the-art interface, the movie metadata is presented as underlined clickable text and in the visual navigation interface, movie metadata is presented as circular-shaped visualizations. Photos are shown for actors and crew when available and icons depicting their job are shown as well. The following selectable metadata is presented for each movie when available: genres, three main actors, director, writer, main music composer, production company, language and year. Aside from the selectable metadata, a short plot, rating and the movie runtime is shown in the center of the circle.

When metadata is selected in either interface, the *category view* opens and shows movies containing the same metadata. Up to 20 of the most popular movies are shown for that metadata but more can be requested by using the arrow buttons on the side if available. The category view is identical for

both interfaces, except that the heading of the category view is either presented as text or visualized for the state-of-the-art and visual navigation interfaces respectively. From the category view, users can click on a movie to open the details view for that movie. From any view, users can press a back button to return to the previous view or a home button to return to the genre view.

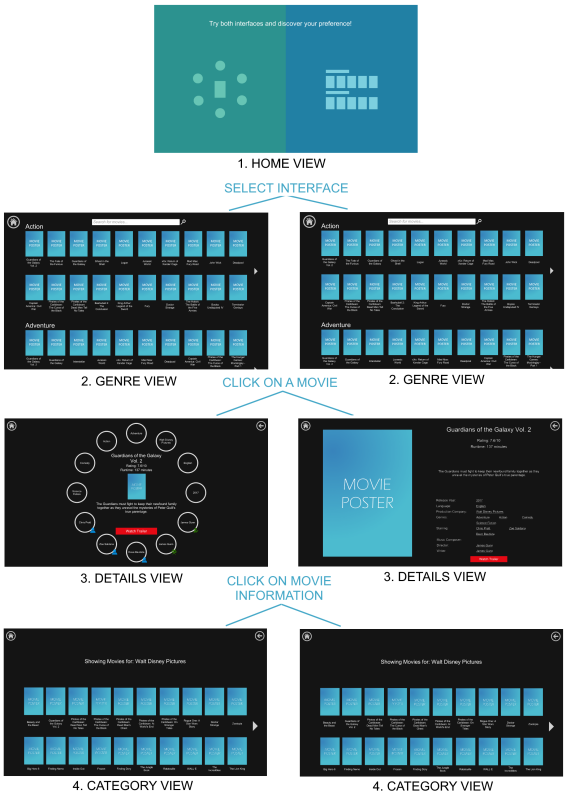

Figure 3: Screenshots of the implementation, movie images replaced with placeholders. Left: visual navigation interface, Right: state-of-the-art interface.

4.2 Lab Study

In this section we outline the objectives of the lab study (4.2.1), explain the methodology used (4.2.2), describe the participants (4.2.3) and present and discuss the results of the study (4.2.4, 4.2.5).

4.2.1 Objectives

The main objectives of the lab study were to find out whether people preferred the visual navigation interface over the visual browsing interface and if they explored the database more actively with the visual navigation interface. We measured preference for an interface with three subscales of the Intrinsic Motivation Inventory (IMI) [9]: interest/enjoyment, perceived competence and value/usefulness. These subscales indicate intrinsic motivation, competence and satisfaction respectively. We measured active exploration by looking at the amount of times that metadata was clicked per minute and how many different types of metadata were clicked. With these objectives, the following research questions were phrased:

1. Is the intrinsic motivation of users to use the visual navigation interface higher than it is for the visual browsing interface?
2. Are users more satisfied after using the visual navigation interface than after using the visual browsing interface?
3. Do users feel more competent when using the visual navigation interface than when using the visual browsing interface?
4. Do users click on more metadata per minute using the visual navigation interface than with the visual browsing interface?
5. Do users click on more different types of metadata using the visual navigation interface than with the visual browsing interface?

The first three research questions were phrased to find out which interface participants prefer to use and the last two research questions were phrased to find out with which interface people explore the database more actively.

4.2.2 Method and procedure

For the experiments, a 7 inch Android-based tablet (Asus Nexus 7) with a screen resolution of 1920x1200 was used. The experiments took place in a neutral room and subjects were not reimbursed for their participation in the experiment, it was entirely voluntarily. Before starting the experiments,

participants signed a consent form and were asked to fill out a small questionnaire regarding their personal information and experience with movies, movie streaming services and movie information archives.

At the start of the experiment, the observer selected the interface that the participant started with. The order of the interfaces was counterbalanced over the participants. The following tasks were performed for each interface. First, participants were asked to take a minute to try it out and discover how it worked. They were then explained the following use case and task:

"Imagine the following: You are boarding a long flight in a few hours and before you get on you would like to download a few movies that you will watch on the plane. Please take 5 minutes to find 5 movies that you are currently in the mood for. When you find a movie, notify the observer and he will write it down. Don't worry, you can change your picks."

Selecting five movies ensured that users had enough time with each interface and asking them to find movies that they are in the mood for encouraged them to carefully think about what they were looking for. After performing the task, they were asked to fill in a questionnaire about the used interface that featured 7-point Likert scale statements to measure the enjoyment/interest, perceived competence and usefulness/value subscales of the Intrinsic Motivation Inventory.

After completing the tasks for both interfaces, an interview was conducted with open questions about the visual navigation interface including questions about what they liked and disliked about it and whether they would use it if this would be integrated in movie streaming services like Netflix. Participants were also asked if they preferred the metadata as text or visualized and if they used the metadata to navigate between movies. Finally they were asked if they felt inclined to click on metadata and if they had any suggestions to improve the design.

All actions that participants made in the application were logged along with timestamps. An action was logged each time a user tapped on something that led to another view being opened. Detailed information about the type of action was logged as well.

4.2.3 Participants

A total of 21 participants took part in the experiment, of which 7 were female and 14 were male. The average age of the participants was 23.7 years. All 21 participants watch movies and 19 participants stated that they watch movies once a month or more. There were 18 participants who stated that they use movie streaming services such as Netflix to watch movies and 14 of those use them once a month or more. 19 participants stated that they use movie information archives such as IMDb to search for information on movies and 17 of those use them once a month or more.

4.2.4 Results

For the figures and tables in this section, the visual browsing interface will be denoted as *VB* and the visual navigation interface as *VN*. After testing each interface, participants filled in the Intrinsic Motivation Inventory questionnaire, which yielded enjoyment/interest, perceived competence and usefulness/value scores for that interface. Each of these scores range from 1 to 7 where 1 is the most negative score and 7 the most positive score. Figure 4 shows the mean scores for both interfaces. A Kolmogorov-Smirnov normality test showed that the scores were approximately normally distributed with a value of $p > 0.05$ for each set of scores. These values can be found in table 1. Because of this distribution, a one-tailed paired t-test was performed to find out if the difference in mean scores was significant. The results of this t-test can be found in table 2 and show that the enjoyment/interest and usefulness/value scores were significantly higher for the visual navigation interface than for the state-of-the-art interface with $p = 0.003$ and $p = 0.013$ respectively. A significant difference between perceived competence scores could not be identified.

From the log data, the amount of times that metadata was clicked per minute and the number of different types of metadata that was clicked on were extracted. The means and standard deviations of this data can be found in table 3. The data for the amount of times that metadata was clicked per minute was approximately normally

	D(21)	p
Enjoyment/Interest VB	0.161	0.165
Enjoyment/Interest VN	0.078	0.200
Perceived Competence VB	0.139	0.200
Perceived Competence VN	0.102	0.200
Usefulness/Value VB	0.133	0.200
Usefulness/Value VN	0.181	0.071

Table 1: Kolmogorov-Smirnov normality test for the IMI scores.

	t(21)	p
Enjoyment/Interest	-3.134	0.003
Perceived Competence	0.702	0.245
Usefulness/Value	-2.400	0.013

Table 2: One-tailed paired t-test for the IMI scores.

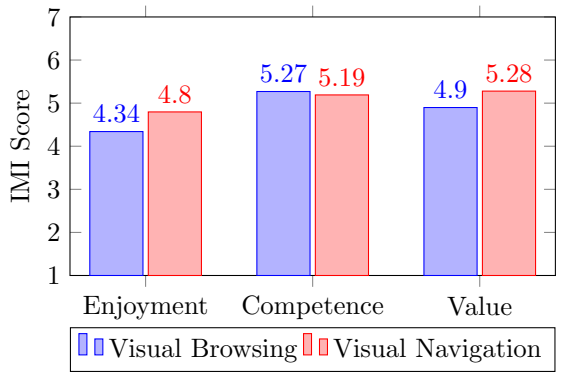

Figure 4: Mean IMI scores for the visual navigation and visual browsing interfaces.

	Mean	St. Dev.
Metadata Clicked VB	0.718	0.580
Metadata Clicked VN	1.236	0.894
Different Metadata VB	1.476	1.030
Different Metadata VN	2.571	1.248

Table 3: Mean values and standard deviations for the amount of times that metadata was clicked per minute and the amount of different types of metadata that was clicked for each interface.

	D(21)	p
Metadata Clicked VB	0.176	0.089
Metadata Clicked VN	0.174	0.096
Different Metadata VB	0.266	0.000
Different Metadata VN	0.206	0.021

Table 4: Kolmogorov-Smirnov normality test for the amount of times that metadata was clicked and the amount of different types of metadata that was clicked for each interface.

distributed so a one-tailed paired t-test was performed. The t-test showed with $t(21) = 2.269$ and $p = 0.017$ that metadata was clicked significantly more times per minute with the visual navigation interface than with the visual browsing interface. Because the data for the amount of uniquely clicked metadata was significantly not normally distributed (table 4), a Wilcoxon signed rank test was performed to find out if there was a significant difference between the interfaces. With $T = 10$ and $p < 0.001$, it shows that there were significantly more different types of metadata clicked for the visual navigation interface than for the visual browsing interface.

The post-experiment interviews showed that the majority of participants preferred the visualized metadata over the textual metadata (15 participants). Most participants stated that they felt inclined to click on the visualized metadata (17) and that they used the movie metadata to navigate between movies (15). Almost all of the participants stated that they believe visualized metadata can be integrated in movie streaming services like Netflix (19) and most of them stated that they would like to use it if it would be integrated (18).

4.2.5 Discussion

In this study, the visual navigation interface was compared to a state-of-the-art visual browsing alternative. The Intrinsic Motivation Inventory scores give a good view of the user experience that participants had when using both interfaces. From the results, it is evident that participants enjoyed using the visual navigation interface more than the visual browsing interface with a mean enjoyment/interest score of 4.80 out of 7 as opposed to 4.34. While it is clear that participants enjoyed the visual navigation interface more, this could be because it is an interface that they had never seen before and just liked the novelty of it. However, the usefulness/value score was also significantly higher for the visual navigation interface with 5.28 as opposed to 4.90. This seems to indicate that it was not just the novelty of the interface that participants like, but they also found it more useful than the alternative. The perceived competence score did not show a significant difference between the interfaces and this indicates that participants felt equally competent using both interfaces. In conclusion, participants experienced the visual navigation interface to be more enjoyable and useful than the visual browsing interface while not being more difficult to use.

The first three research questions are answered with these scores: participants did not feel more competent with any of the two interfaces, felt more satisfied after using the visual navigation interface, and had more intrinsic motivation to use the visual navigation interface.

Where visual browsing interfaces often have users scrolling through categories of movies, which is quite passive, visual navigation was designed to let users make conscious choices about what they like and dislike about movies to navigate the database. This was done by encouraging users to use movie metadata to navigate the database more actively. To measure how actively participants explored the movie database, we looked at how often participants clicked on movie metadata and how many different types of metadata they clicked on. The logs showed that participants clicked on significantly more metadata per minute with the visual navigation interface than with the visual browsing interface: 1.236 as opposed to 0.718 on average. This is quite a large difference and it supports our claim that the visual navigation interface encourages users to browse more actively. Also, there were significantly more different types of metadata clicked for the visual navigation interface: 2.571 opposed to 1.476 on average. While this data is likely correlated to the amount of metadata clicked, it still supports our claim. In conclusion, the results indicate that users explored the database in a more active way using the visual navigation interface than when using the visual browsing interface.

Research questions 4 and 5 are answered by these results: participants clicked more metadata in the visual navigation interface and also clicked on more different types of metadata using the visual navigation interface.

Participants' remarks during the interview support the results. Many participants indeed stated that they preferred the visual navigation interface over the visual browsing interface. Most participants also stated that they felt inclined to use the movie metadata and that they used it to navigate between movies. This indicates that the goal to have users explore the database in an active manner was successfully achieved with the visual navigation interface.

4.3 Online Study

In parallel to the lab study, an online study was performed over the course of 4 weeks. In this section we outline the objectives of the lab study (4.3.1), explain the methodology used (4.3.2), describe the participants (4.3.3) and present and discuss the results of the study (4.3.4, 4.3.5).

4.3.1 Objectives

The lab study was conducted in a neutral setting with a specific task to perform, which gives internal validity to the results but does not take into account possible external influences. Because we also want to present results with external validity, the main objective of the online study was to find out if the lab study results also hold in a real-life setting where participants can use whichever interface they like and experience external influences while using it. Similar to the lab study, the goals were to find out if participants would still prefer the visual navigation interface when offered

a state-of-the-art visual browsing alternative and if they explored the database more actively with the visual navigation interface. To compare the two studies, the same research questions as in the lab study were used (section 4.2.1).

4.3.2 Method and procedure

For the online study, the prototype implementation was published on *Google Play* under the name *MetaNav Movie Trailers*, with the following description:

"*Having trouble finding movies that you like? MetaNav Movie Trailers was designed to help you do just that. You can browse movies, movie information and trailers. This app was designed as part of a research project to improve the movie browsing experience. You can choose from two different interfaces and use the one you like the most.*"

The app was promoted on various Android- and movie-related websites as an application to browse movies, movie information and movie trailers.

The participants were free to use the application in any way they liked and to use whichever interface they wanted. After 10 minutes of using the application and having viewed the details of at least one movie on both interfaces, users were prompted to voluntarily fill in an online questionnaire. This questionnaire featured 7-point Likert scale statements to measure the enjoyment/interest, perceived competence and usefulness/value subscales of the Intrinsic Motivation Inventory for each interface. The questions were accompanied with a screenshot of the interface in question.

All actions that participants made in the application were logged along with timestamps. An action was logged each time a user tapped on something that led to an other view being opened. Detailed information about the type of action was logged as well.

4.3.3 Participants

The application has been installed by a total of 81 participants of which 31 participants still have the application installed at the time of writing this paper. A total of 49 usage logs were gathered, of which 29 indicate that the participants have used both interfaces. The questionnaire has been filled in by 12 participants.

	D(21)	***p***
Enjoyment/Interest VB	0.195	0.200
Enjoyment/Interest VN	0.208	0.159
Perceived Competence VB	0.112	0.200
Perceived Competence VN	0.125	0.200
Usefulness/Value VB	0.130	0.200
Usefulness/Value VN	0.269	0.017

Table 5: Kolmogorov-Smirnov normality test for the IMI scores.

4.3.4 Results

There were 12 participants that used the application for more than 10 minutes and filled out the IMI questionnaire. The mean scores can be found in figure 5. A normality test for the IMI scores is shown in table 5. The data for enjoyment/interest and perceived competence scores were approximately normally distributed so a one-tailed paired t-test was performed for those scores. The t-test showed with $t(12) = -2.241$ and $p = 0.023$ that the mean enjoyment/interest score significantly higher for the visual navigation interface than for the visual browsing interface. There was no significant difference in perceived competence scores for both interfaces with $t(12) = 0.815$ and $p = 0.216$. For the non-normally distributed usefulness/value scores, a Wilcoxon signed rank test showed with $T = 44.5$ and $p = 0.153$ that there was no significant difference between the usefulness/value scores for these interfaces.

The log files were grouped for each participant and only logs that showed the participant having used both interfaces were used for these results. This selection results to 29 useful participant log files and the amounts for metadata clicked and different types of metadata clicked can be found in table 6. With 29 samples, a normal distribution is approached so t-tests were used to compare the logs. The visual navigation interface was used for an average of 94 seconds and the visual browsing interface an average of 112 seconds. A paired-samples t-test showed with $t(29) = -1.112$

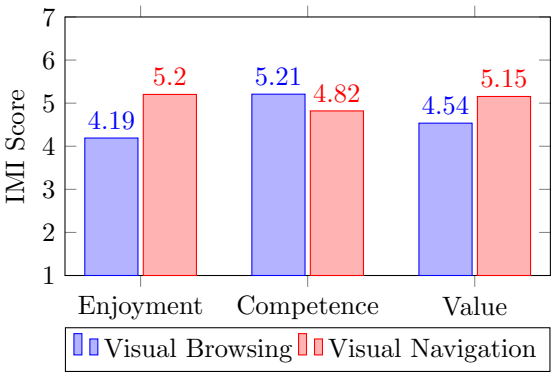

Figure 5: Mean IMI scores for the visual navigation and visual browsing interfaces.

	Mean	St. Dev.
Metadata Clicked VB	0.469	0.765
Metadata Clicked VN	1.009	1.106
Different Metadata VB	0.655	0.101
Different Metadata VN	0.965	0.981

Table 6: Mean values and standard deviations for the amount of times that metadata was clicked per minute and the amount of different types of metadata that was clicked for each interface.

and $p = 0.275$ that the amount of time spent in each interface was not significantly different. A one-tailed paired t-test showed that there was significantly more metadata clicked per minute for the visual navigation interface with $t(29) = 2.611$ and $p = 0.007$. There was no significant difference between the amount of different types of metadata that was clicked for each interface with $t(21) = 1.665$ and $p = 0.054$.

One-tailed paired t-tests for other log statistics showed that there was no significant difference for the total amount of movies clicked per minute ($t(29) = 0.344$ and $p = 0.366$) and no significant difference for the amount of movies clicked per minute from the category view ($t(29) = 1.543$ and $p = 0.066$). There was also no significant difference for the amount of time spent in each interface ($t(29) = -1.112$ and $p = 0.137$).

4.3.5 Discussion

The objectives of the online study were similar to the lab study but the conditions in which the participants used the interfaces were very different. While the lab study took place in a controlled setting with a specific task for participants to perform, the online study was anonymous and external influences varied. Also, users could use the application in any way they wanted to. To be sure that users had enough experience with both interfaces before filling in the questionnaire, they were only prompted to fill it in after 10 minutes of using the application. Following this restriction, there were 12 participants that filled in the IMI questionnaire for this study. The results showed a significant difference in enjoyment/interest scores for the interfaces: the visual navigation interface had an average score of 5.2 whereas the visual browsing interface had an average score of 4.19, which is quite a large difference. There were no significant differences for the perceived competence and usefulness/value scores, which indicates that participants did not find one of the interfaces more difficult or more useful.

The first three research questions are answered with these scores: participants did not feel more competent with any of the two interfaces, did not feel more satisfied after using any of the interfaces and had more intrinsic motivation to use the visual navigation interface.

There were more log files for the online study than for the lab study but there was a higher variance in the amount of time that people used the application. This is an advantage in the way that they truly show how people would use the app without any restrictions from participating in an experiment. Many of the metrics that were used in the logs did not show significant differences between the interfaces. The only difference that was significant was the amount of metadata clicked per minute. With 1.009 average metadata clicks per minute, the visual navigation interface encouraged users much more to click on the metadata in comparison to the visual browsing interface, which had less than half of the clicks on average: 0.469. The difference is relatively large and this shows that users were more actively exploring the database by clicking on metadata using the visual navigation interface. There was no significant difference found

in the amount of different types of metadata that were clicked, which indicates that people find the same types of metadata important, regarding of how it is visualized. There were no significant differences in the amount of movies clicked, which indicates that participants found interesting movies in both interfaces. The amount of time spent in each interface was also not significantly different, which is likely because users were encouraged to try both interfaces in the home screen.

Research questions 4 and 5 are answered with these results: participants clicked more metadata in the visual navigation interface and did not click on significantly more different types of metadata for any of the two interfaces.

5 Conclusion & Future Work

The concept of visual navigation was presented as a combination of visual browsing and text-based browsing. By visualizing movie metadata and encouraging users to navigate by selecting metadata that they like, users are exploring movie databases more actively while still having a smooth and easy-going browsing experience. Two experiments were performed: a controlled lab study and an online study. These studies were setup to see if users preferred the visual navigation interface over a state-of-the-art visual browsing alternative and if they explored movie databases more actively with it. Both studies showed that users had more intrinsic motivation to use the visual navigation interface and the lab study also showed that users were more satisfied after using the visual navigation interface. There was no significant difference in perceived competence for both interfaces which indicates that participants did not find it more difficult to use the visual navigation interface than the visual browsing interface. Both experiments showed that users explored the database more actively with the visual navigation interface by using movie metadata to navigate it. The fact that the two experiments were performed under very different circumstances but showed similar outcomes, adds to the strength of the results.

The concept of visual navigation shows promise, as was shown from the experiment results. A difference in results came up for the amount of unique types of metadata that participants clicked on. It would be interesting to research what types of metadata should be shown to engage users the most and to motivate them to use many different kinds of metadata to navigate the database. Also worth exploring are other types of visualizations, which might encourage users even more to click on (different) metadata. Finally, this research project only covered touch screen devices and it would be interesting to see how it can be implemented for other devices, such as: TV's and PC's. These interfaces are generally different and the way that people use movie metadata might be very different on these interfaces.

References

[1] Wolfgang Hürst and Bruno dos Santos Carvalhal. Exploring online video databases by visual navigation. In *Adjunct Publication of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video (TVX '17 Adjunct)*. ACM, 2017.

[2] Klaus Schoeffmann, Marco A Hudelist, and Jochen Huber. Video interaction tools: a survey of recent work. *ACM Computing Surveys (CSUR)*, 48(1):14, 2015.

[3] Jörg Waitelonis and Harald Sack. Towards exploratory video search using linked data. *Multimedia Tools and Applications*, 59(2):645–672, 2012.

[4] Barnaby Craggs, Myles Kilgallon Scott, and Jason Alexander. Thumbreels: query sensitive web video previews based on temporal, crowd-sourced, semantic tagging. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*, pages 1217–1220. ACM, 2014.

[5] Thomas Low, Christian Hentschel, Sebastian Stober, Harald Sack, and Andreas Nürnberger. Exploring large movie collections: Comparing visual berrypicking and traditional browsing. In *International Conference on Multimedia Modeling*, pages 198–208. Springer, 2017.

[6] Upendra Shardanand and Pattie Maes. Social information filtering: algorithms for automating word of mouth. In *Proceedings*

of the SIGCHI conference on Human factors in computing systems, pages 210–217. ACM Press/Addison-Wesley Publishing Co., 1995.

[7] Ioannis Arapakis, Yashar Moshfeghi, Hideo Joho, Reede Ren, David Hannah, and Joemon M Jose. Enriching user profiling with affective features for the improvement of a multimodal recommender system. In *Proceedings of the ACM International Conference on Image and Video Retrieval*, page 29. ACM, 2009.

[8] Bo Yang, Tao Mei, Xian-Sheng Hua, Linjun Yang, Shi-Qiang Yang, and Mingjing Li. Online video recommendation based on multimodal fusion and relevance feedback. In *Proceedings of the 6th ACM international conference on Image and video retrieval*, pages 73–80. ACM, 2007.

[9] Robert W Plant and Richard M Ryan. Intrinsic motivation and the effects of self-consciousness, self-awareness, and ego-involvement: An investigation of internally controlling styles. *Journal of Personality*, 53(3):435–449, 1985.

Chapter 2

Annotated Appendix

1 Introduction

There is a lot of video content available on the internet. The amount is ever-increasing and it is estimated that by the year 2020, 80 percent of the internet traffic will consist of video streaming [1]. This rise is partly due to the popularity of movie-streaming services like Netflix, which offer access to large online movie collections. With the amount of movies these services offer, it is not always trivial to pick one to watch. In fact, it can be so difficult that the search for a movie is abandoned altogether. When searching for a specific movie, it can easily be found by using the movie's title as search keywords. However, when users are not looking for a specific movie, but for any movie that matches their mood at that moment, they have to actively browse the movie library and rely on the library interface to guide them in their search effort. This kind of undirected search is called exploratory search [2], the process of browsing information in an exploratory way where a user's wishes evolve and get more clear as he progresses.

Movie streaming services like Netflix are designed to give users an easy and intuitive way to browse a movie database. They generally show a lot of images and use appealing visuals to give users a pleasant browsing experience. The cost of this approach is that there is not much information per movie available and the information is not prominently featured. On the other end of the spectrum, movie information archives like The Internet Movie Database offer a lot of information per movie but lack an easy and intuitive way to browse the archive. Movie information is mostly presented as text in a traditional list-like fashion. They are visually less appealing and are more functional than fun. Users browse by searching for specific keywords or by clicking on textual hyper-links.

The aim of this thesis project was to combine the ease of browsing from movie streaming services with the information richness of movie information archives. By stimulating users to actively explore a database we wanted to improve their browsing experience. With this goal in mind we came up with the concept of visual navigation that stimulates active exploration by presenting movie metadata visually.

This annotated appendix serves the goal of presenting the relevant information that was not covered in the scientific paper. Section 2 presents a literature study that was performed to explore the research domains related to this project. In section 3, we describe the performed experiments in more detail. A demonstration of the concept is given in section 4 and a comparison of the databases that were considered for this project is presented in section 5. Section 6 shows the paper that was written about the pilot study for the 2017 ACM International Conference on Interactive Experiences for TV and Online Video (TVX '17 Adjunct). Finally, concluding remarks and suggestions for future work are discussed in section 7.

2 Making Online Movie Browsing Fun Again - Literature Study

During the preparation phase of this thesis project, this literature study served the goal of exploring the research domains related to this thesis project to design the visual navigation concept and its implementation.

First, to understand the limitations of current movie library interfaces, the most common interfaces of commercial systems will be discussed in section 2.1. The various ways in which these interfaces facilitate exploratory and/or undirected search approaches will be covered. Next, to learn about popular video browsing approaches, several state-of-the-art systems to browse video databases are discussed with regard to their suitability for undirected search approaches and the mobile application in section 2.2. To create an effective and pleasant mobile interface, section 2.3 discusses research about mobile interface design, split into design guidelines and touch interaction. Finally, to learn more on how to test the interface, user experience evaluation methods are compared in section 2.4. This literature research concludes with a summary of the relevant outcomes for the interface.

2.1 Commercial Movie Library Interfaces

Most online movie libraries can be categorized in one of the following two categories: movie streaming services and movie information services. Movie streaming services are designed to let users navigate between movies and stream the movies to their device when they've picked one. Movie information services are designed to give users as much information on movies as possible and don't facilitate the watching of those movies. For this section, the interfaces of both types of services were examined and will be discussed with regards to their suitability for exploratory searching.

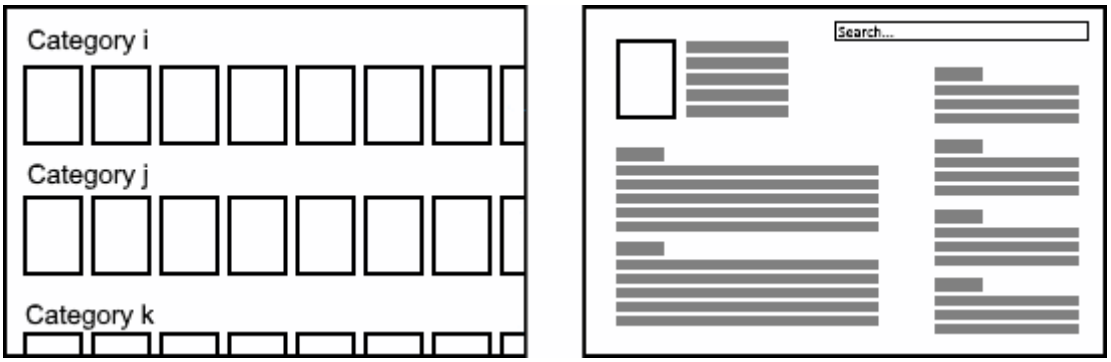

Figure 2.1: Left: Common movie streaming interfaces, Right: common movie information interfaces.

Movie Streaming Services

Online movie streaming services have gained a lot of popularity over the last few years, with Netflix being the largest provider worldwide. Other popular services include: Amazon Prime, Hulu and HBO Go. These services have many subscribers that pay a monthly fee to watch movies, TV series, documentaries and other video entertainment. The interfaces of these services are very similar and they all offer the following navigational features: movie categories, movie recommendations and search functionality. The first common feature is that the content of these services is structured in categories. Users can navigate through rows or a grid of categories, containing movies belonging to that category (figure 2.1, left). There are many types of categories offered, such as: genres, themes, recommendations and lists of user-selected movies. The movies are presented in a visually appealing way, with a large thumbnail image for each of them. When users are unsure of what to watch, scrolling through these categories is one of the ways to find a movie. Another way of finding a movie to watch is by following movie recommendations. Movie recommendations are mostly based on what a user has watched before and what other users with similar interests liked. Since most movie streaming services are paid, users have individual accounts. This means that individual movie watching statistics can be kept and used for the making of accurate movie recommendations. The third feature that all movie streaming services have in common is search functionality. A user can search for specific movies or other video content by entering a search query in the interface. This is useful when users already know what they want to watch beforehand.

Movie Information Services

Movie information services have been around for a longer time than movie streaming services. These information databases offer all kinds of metadata and other information about movies. The most popular movie database is IMDb (Internet Movie Database). Other movie databases include but are not limited to: TMDb (The Movie Database), AllMovie and Wikipedia (not solely for movies). What the interfaces of these services have in common, is that they offer a nearly complete set of information about any movie, offer search functionality and allow navigation between pages. The goal of these services is to provide users with as much information as possible, condensed on a page which is as small as the amount of information allows (figure 2.1, right). To achieve this, information is presented in a list-style textual manner. A downside of this is that it can make a page feel cluttered and this makes navigating it harder. To find specific information, users can perform a search with a search query that matches their information need. This will lead them to pages related to their query. Apart from using a search functionality, users can navigate the interface by clicking on certain pieces of information, which will lead them to the dedicated page for that information.

Discussion

Both movie streaming services and movie information services have in common that they allow users to browse and find movies. However, the way they go about it is very different. Movie streaming services are focused on giving the user an easy way to navigate between movies and categories. Movies are presented in a visually pleasing way and not too much information per movie is offered. For a user that is not too picky, this might be a good way of movie browsing. But for a user that has a more specific kind of movie in mind, there might not be enough information available per movie. When performing an exploratory search, users should be able build upon their previous actions and get closer to a movie they like with each step they take. Movie streaming services generally do not support such an approach. Users have to scroll through categories and they do not progress their search in this manner, they have to hope that they scroll past a movie that they are in the mood for. On the other hand, the ease of navigation is beneficial for exploratory searching. Users can freely browse through a lot of content.

Movie information services are designed to give users as much information on movies as possible. For each movie, there is a page with a near complete set of information about that movie. To find information on a movie, users either have to search for content using search keywords or click on specific information on a page. This manner of navigating is harder and less user friendly than that of movie streaming services but users are able to navigate based on information that they find interesting. This functionality is useful when a user performs an exploratory search because in this way, users can progress their search. A downside of this style of navigation is that users are not able to browse multiple movies at a time, which is very time-consuming. Movie information services are often not designed for intuitive navigation either. While both types of services are not designed for exploratory searching, a combination of the two might just be what a user needs.

2.2 Video Browsing

To learn more about browsing videos, state-of-the-art applications and techniques of video browsing are reviewed. Unfortunately there hasn't been much research on movie libraries specifically but there is research about generic video browsing tools. As a basis for this section, a survey on video interaction tools by Schoeffmann et al. was used [3]. This survey features many kinds of video interaction tools, including tools to browse within and between videos. For this research, only tools that can be used to browse between videos are relevant so these will be discussed. First, in section 2.2, content-based video browsing systems will be discussed. Next, section 2.2 discusses video browsing systems that are based on metadata instead of video content. This category of tools is not part of the survey but is deemed relevant to this research because of the exploratory aspect. Finally, section 2.2 discusses video recommendation systems, which are prevalent in most commercial video libraries.

Content-based Video Browsing Systems

To encourage novel methods of video searching and browsing, the Video Browser Showdown (VBS) contest is held each year [4]. The competition features two variations of a Known Item Search

(KIS): a visual KIS and a textual KIS. For the visual KIS, participants are shown a video clip of approximately 20 seconds and have to find it within the full 100- to 200-hour video library. For the textual variant, only a description of the video is given. This section discusses video browsing methods that are based on the content of the videos. The VBS is designed for directed search approaches, but some participants show that their method could also be used for undirected searches. In this section, two of these methods will be discussed.

For the 2016 edition of the VBS, Zhang et al. showcased a method that facilitates faceted navigation through a video collection [5]. They used pre-trained Deep Convolutional Networks to classify the frames of the video's and recognize objects within them. They then created a faceted navigation interface for the search results, through which users can find related search results that contain similar objects. In this way new videos can be discovered that were not part of the original set of search results.

The winners of the 2016 edition of the VBS were Barthel et al. with their graph-based method of browsing large video collections [6]. The method builds upon their previous work on ImageMap [7], which creates a 2D map of images where similar images are placed close to each other. To give the map more semantic meaning, the authors use convolutional networks to recognize objects in the images. With this information, they create a connected graph and display this graph in 2D to the user. The user can then quickly find semantically and visually related video frames.

Metadata-based Video Browsing Systems

The second category of video browsing system that will be discussed are metadata-based. These systems don't rely on video content but rather the metadata of the videos to browse them.

Waitelonis and Sack presented an exploratory search tool using Linked Open Data (LOD) for yovisto.com, an academic video database [8]. Exploratory search tools differ from faceted search tools in the way that faceted search tools offer search result refinement in the form of categories and filtering, whereas exploratory approaches would allow for the finding of new, related results that were not part of the original set of results as well. Through the linking of metadata, users can find results that they would not have searched for by serendipity, which is one of the goals of exploratory search approaches. The LOD project aims to create a Semantic Web by unifying and linking data across the web. In this way, relations between data can be understood by computers and used in applications. In their tool, Waitelonis and Sack extracted data from the DBpedia data set, which was designed as a linked version of Wikipedia. They then presented related search results by using heuristics to find and rank relations. By presenting related results and allowing the users to stumble upon unexpected videos, Waitelonis and Sack have created an exploratory search tool for a large video collection. Another implementation which was presented by Nguyen et al. uses the Linked Movie Database to create an exploratory search engine for movies [9]. In a similar way to Waitelonis and Sack's method, they designed suggestions based on relations between movies. The implementation is not accessible anymore, but their results indicate that about 70 percent of the users assessed the implementation as "good". It is not clear what this means exactly, so a follow-up study would be needed to complement their results.

When a video collection is used by a large enough crowd, crowd-sourcing can be used to create new metadata for videos. An example of this is ThumbReels, by Craggs, Scott and Alexander [10]. They found that the thumbnails of YouTube videos often did not represent the actual content of the video well. They developed a system where watchers of the videos could attach tags to the videos at different times. The thumbnails of search results can then be matched to the tags of a video. For example, when a user searches for "Apple Juice", a thumbnail can be shown from the part of the video where apples are visible, on the condition that there is an "Apple" tag at that location. Also, the database can be explored by searching on the crowd-sourced metadata.

A very recent publication by Low et al. showed Visual Berrypicking [11] as an exploratory interface for browsing a movie library. It uses Multidimensional Scaling (MDS) and Procrustes analysis [12] to find locally related movies based on their metadata. The related movies are projected as a map and users can click on a movie to get a new set of related movies. The relations are based on several metadata, including actors, plot and genre. Visual Berrypicking aims to be an exploratory search engine and users are able to evolve their search query while browsing. However, users do not choose the relations between movies and are thus not consciously picking movie metadata that they find interesting. The authors performed a study where they compared their interface to that of theMovieDatabase (tMDB) and found that there was not a clear winner. However, the study did show that users found more interesting results using the Visual Berrypicking

method and that there was a clear correlation between screen size and the perceived complexity of the interface (smaller screens being more complex).

Video Recommendation Systems

When users do not know exactly what they are looking for, they could benefit from receiving recommendations. The most commonly used recommendation system is usage-derived recommendations, which is used by many websites. The origin of usage-derived recommendations is Collaborative Filtering (CF) [13]. This method was created to simulate word-of-mouth advertising and gives recommendations based on a user profile, which can consist of ratings and past purchases among other things. For the recommendations, the algorithm looks at user profiles that are similar to that of the current user and recommends things based on what the users of these profiles have bought. In the case of a movie collection, it would look at what movies other users with similar interests liked. A more advanced variation on usage-derived recommendation is that of J.Bollen et al. [14]. They state that one of the major problems with CF is that it relies on user profiles. The problem with this, is that different users use the same computer or account, or users don't bother to log-in to their account at all. This can cause inaccurate recommendations. J. Bollen et al. use temporal statistics to determine whether consecutive downloads are made by the same user. Using this kind of data they created a relation network for the Open Video Project database. They compared their recommendations to those of an item-based CF and found that their algorithm performed with better precision and recall.

Newer recommender systems are based on multimodal approaches. These approaches take more into account than just usage statistics. Arapakis et al. introduced a method where users are filmed during the browsing of a video database [15]. Their emotions while browsing and watching videos are recognized and used to enrich their user profile. To find relevant videos, the authors trained an SVM model to distinguish between relevant and irrelevant videos based on user emotions. Another multimodal approach is that of Yang et al. [16]. Instead of only looking at metadata relevance or visual relevance, they also look at aural relevance and combine these three using a single function: the Attention Fusion Function (AFF)[17]. This function simulates human attention characteristics. By using a user's click-through data and AFF, they combine three modalities in a semantically sound way and can present the user with relevant videos.

Discussion

This discussion will feature an assessment of the suitability of the mentioned methods and techniques for browsing an online movie library. When browsing online movie libraries, users are often performing an undirected search: searching without knowing exactly what they are searching for. Suitability for undirected searching is also assessed in this discussion.

Most content-based video browsers are not designed for undirected searching within movie collections, but there are some that could work with a few adjustments. Zhang et al. show a method to browse a video collection in a semantic way by recognizing objects within videos and using a faceted navigation interface to browse through the videos. An interface like this would be suitable for movie-streaming services when using movie metadata instead of image recognition data. In this way, users can still enjoy the benefits of faceted browsing, but in a way that is semantically more beneficial for movies. A faceted navigation method works very well for undirected searches because it allows users to explore the database and discover what they are looking for. Barthel et al. show a 2D map-like interface design with which users can quickly navigate through a collection of videos. As the winners of the 2016 VBS contest, they show that this interface is state-of-the-art for use as a video search tool. This shows promise for use in movie-streaming services as well, especially when you replace the image recognition data with movie metadata. In this way, users can browse the entire movie collection in a fast way and find related movies close to each other. In this way, it will be very similar to the Visual Berrypicking method which was discussed in section 2.2.

Metadata-based video browsers are well suited for movie-streaming services because metadata is very relevant for movie libraries. When picking a movie, users look at metadata or movie trailers. The actual content of movies would be too large and non-trivial to use as a data source. Waitelonis and Sack present a tool that facilitates exploratory searching through a video database using Linked Open Data. In their tool, they use the DBpedia data set, which is based on Wikipedia and useful for the academic video website that is their target. There are other linked data sets available (if not

creatable) that are aimed at movies, for example the Linked Movie Database [18]. With the use of a data set specific to movies, linked data is an excellent way of giving users a way to explore related movies. The ThumbReels tool, presented by Craggs et al. shows that crowd-sourcing is another option of generating unique metadata for a search engine. If one can crowd-source the tagging of movies within a movie collection, it would be possible to cross-reference tags to find related movies and facilitate exploratory searching. In this way it is possible to create new relations within a movie database and help users in their undirected searches. Visual Berrypicking was designed to provide an exploratory way of browsing movie libraries and help users find movies more quickly. While it did not show that it won out over a traditional movie database website, it remains a very promising method because users noted that they did in fact find more interesting results than with the traditional database website. One of the reasons why it did not win over traditional movie databases, could be the that it was not clear to users what relations between movies were based on. If a user could explicitly choose the types of relationships, better results might be achieved. While the functionality of the method was good, the layout should be improved for usage with small screens (e.g. for mobile devices). This would likely improve the effectiveness of the method as well.

Various types of recommendation systems have been discussed. In general, recommendation systems are suitable for undirected search approaches, because they advise the user with a search result. However, there is no autonomy for the user to search and browse the movie collection. When a recommendation system fails to give a good recommendation, it becomes clear that a recommendation system is best used as an addition to another browsing or search method. Also, it is hard to know what a user is in the mood for and most recommendation systems do not take this into account. The most common recommendation system, usage-derived recommendations, is already being used by movie-streaming services [19]. It is very well suited for these kinds of applications because users are always logged in and, in the case of Netflix, have a separate user profile per user. Both multimodal approaches that have been discussed, would be less suitable for movie-streaming services. For legal and privacy reasons it would be difficult to use the method of Arapakis et al. to record a user while browsing and watching movies. It would also be a lot more intensive, computationally, because movies are typically much longer than online videos. The multimodal relevance method of Yang et al. could be used for movies as well, but it seems to be more suited for collections of short online videos, such as YouTube. The reason for this is that when picking a movie, a user is looking for a certain genre or story that matches his mood, the visual or auditory relatedness of movies may not be important. For short online videos, these modalities are more important because a user is often looking for videos on very specific subjects.

2.3 Mobile Interface Design

The aim of this section is to learn which rules should be followed in order to design an effective and user-friendly mobile interface. The application that will be designed for the upcoming research project will be a mobile application and used on tablets. Therefore, the following subsections will address various aspects of mobile interface design.

Design Guidelines

In 2004, Gong and Tarasewich published a set of guidelines [20] for mobile interface design which build upon Schneiderman's "Golden rules for interface design" [21]. Some of these guidelines are the same as Schneiderman's guidelines and others are adjusted or added to fit mobile devices in particular. For the full list of guidelines by Gong and Tarasewich, the reader is referred to their publication. Below, some more notable guidelines are listed.

- Support internal locus of control: Users want to feel in control and should initiate actions rather than respond to them.
- Reversal of actions: Especially on mobile devices it is easier to tap the wrong things by accident. Therefore, actions should be easily reversible.
- Reduce short-term memory load: It should be clear at any moment what a user can do, without requiring much knowledge about previous activities.
- Design for small devices: Mobile devices are often a lot smaller than desktop devices.

- Design for speed and recovery: Mobile applications should be fast and recovery should be possible because mobile users often switch between application while in the middle of tasks.
- Design for "top-down" interaction: Instead of having users scroll to many pages of information, allow for a hierarchical design to let users choose what they are interested in.
- Design for enjoyment: It should be fun for users to use the application. Color use and animations are important considerations for mobile applications.

In 2002, Kärkkäinen and Laarni aimed to systematically analyze the characteristics of small-screen devices to research their implications on interface design [22]. They found that because of the smaller screen size and lower resolutions, organization of the content is one of the key usability issues. Several examples of increasing the amount of information that can be shown on a small screen are discussed: transparent widgets and rapid serial presentation of text (RSVP).

While small text is difficult to read, humans are actually capable of understanding surprisingly small images, as was showed by Hürst et al. [23]. They used various designs for a mobile video retrieval interface to find frames within a video. The results showed that a thumbnail size of only 110 pixels proved sufficient for accurate human verification.

Touch Interaction

One key aspect of mobile applications is that they are navigated by touch. To learn about touch interface interaction, and know how to design them effectively, research regarding touch gestures and touch interaction techniques is discussed in this section.

Touch gestures can have different meanings per application or culture. To avoid confusion and misinterpretation of touch gestures, Lao et al. constructed a unified definition and description of all possible touch gestures [24]. They structured touch into three levels: The action level, motivation level and computing level. The action and motivation levels are platform independent and specify what a user can do and wants to do respectively. The computing level specifies the software and hardware of the computer. They defined a simple gesture as a single hand action which does not contain repeated actions or other simple gestures. They split contact into continuous contact and discrete contact and defined the basic movements as: pressing, tapping and dragging. With these definitions, all simple touch gestures can be defined.

Bragdon et al. performed experiments to analyze the effectiveness of touch-screen gestures in non-ideal mobile environments [25]. A user is likely to be distracted while operating a mobile device, which causes soft buttons to be impractical: They are often too small and thus they need to be looked at to press. Touch gestures can be done anywhere on the screen space, can be committed to muscle memory and it is possible to make gestures with one hand. Bragdon et al. evaluated touch gestures in various conditions of user impairment. Different gestures (free-form paths and mark-based gestures) were combined with various moding techniques (starting gestures from edge of the screen (bezel) or with a hardware button). They found that mark-based bezel-initiated gestures were preferred and outperformed other gestures/buttons in distracting environments. When directly looking at the screen, traditional soft buttons were preferred by a majority of the test subjects. The users did comment unanimously that gestures would be useful when not devoting their full attention to the phone.

In 2010, Schmidt et al. presented a set of multi-touch graph interaction techniques [26], which can be implemented to improve interaction with node-link graph exploration interfaces. They called the techniques: TouchPlucking, TouchPinning, TouchStrumming, TouchBundling and PushLens. The motivation for creating these interaction techniques was the fact that graphs of real-world data tend to be quite dense and can lose their clarity when there are many nodes and edges. On small screen devices, this is definitely the case. The various techniques are interactions that enable users to understand the graph better. For their exact operation, the reader is referred to the 2010 paper of Schmidt et al. The techniques are applicable to any graph interface, so also to movie graph interfaces.

Discussion

The goal of this section was to find guidelines on how to design the mobile application for the movie database browser. A few of the guidelines are more important than others, for example: Reversal of actions is important in a database browser to get back to previously found results,

while designing for small screens is less important because the application is designed for tablets and not mobiles. Designing for enjoyment is also very important to give the users a pleasant experience when browsing the database. Organizing the content clearly is also a challenge that must be undertaken in order to not confuse users. It was also shown that a very small image size is still perceivable by users. This fact can be used when showing movie posters in the application.

Section 2.3 discussed how to define touch gestures in a cross-cultural and goal-independent manner. Bragdon et al. also showed that in non-ideal environments, touch gestures are very beneficial. A typical use-case scenario of the application is a user sitting on the couch, looking for a movie to watch. In this scenario, there is not much distraction, so touch gestures might not be needed. However, a level of distraction will always be present, so touch gestures will be useful as an add-on to other interactions. The set of graph interactions that Schmidt et al. presented, can also be quite useful for a database browser. When deviating from the more standard grid- or list-style interfaces, a graph-interface quickly comes to mind. This kind of interface can be well suited for a movie database and these touch interactions should then be used to help users navigate it.

2.4 User Experience Evaluation

User experience (UX) is defined as: "A person's perception and responses that result from the use and/or anticipated use of a product, system or service." [27]. Even though UX is often grouped together with usability, they are fundamentally different. Usability focuses on objective task performance, while UX focuses on the subjective experience of a user while performing the task.

In order to perform meaningful experiments to evaluate the user experience of the application, the domain of UX evaluation methods is explored. There are two methods needed to perform experiments with the mobile application: One for use in lab or field studies with selected participants (hereafter referred to as the "offline method") and one method that can be used online to study the larger group of users that downloaded the application through an app store and used it individually (hereafter referred to as the "online method"). This section discusses possible evaluation methods for both purposes.

Methods

In 2010, Vermeeren et al. published a survey of the current state of user experience evaluation methods [28]. For this survey, they collected 96 methods from various origins and analyzed them. The analyzed methods and some newer methods since, are kept up-to-date on their website [29]. These methods were used as a basis for this analysis. First, an initial filtering was applied on several suitability criteria, which can be found in table 2.1. After this filtering, only 19 and 14 methods were left for the offline and online method respectively. After removing 3 more methods, 1 specifically aimed at children, one requiring multiple products and one duplicate, 16 methods for the offline studies and 12 for the online studies remained. All 12 online methods are also present in the set of offline methods.

	Offline methods	**Online methods**
Type of study	Lab/Field study	Online studies
Development phase	Functional prototypes	Functional prototypes / Products on the market
Studied period of experience	An episode	An episode / Long-term UX
Info provider	One user at a time	One user at a time
Applications	Mobile software	Mobile software
Special requirements	No trained researcher/special equipment needed	No trained researcher/special equipment needed
Total methods after filtering	**19**	**14**

Table 2.1: Used filters for initial filtering of the user experience evaluation methods.

Analysis Criteria

Because the set of online methods is subsumed by the set of offline methods, the two sets are treated as one set with an extra criterion for online use. The methods were analyzed based on the

following criteria:

- Measurements: What does the method measure?
- Time per user: How long does it take to perform the method for one user?
- Online use: Can the method be used online?
- Reliability: Is the method considered reliable and/or validated?
- General Strengths: What are the strengths of this method not covered by other criteria?
- General Weaknesses: What are the weaknesses of this method not covered by other criteria?

In the next few subsections, the methods that were considered most applicable to the goal of the research are discussed. These 4 methods were selected because they were all considered reliable, were applicable for online use, see wide-spread usage and measure useful data. An overview of all the analyzed methods can be found in table 2.2.

Positive And Negative Affect Scale (PANAS)

The Positive And Negative Affect Scale [30] measures the positive and negative affect constructs as both states and traits. It features two 10-item mood scales and is one of the most used scales for measuring emotional states of users worldwide. It is translated into many languages including Dutch, the language of the country that the research project is based in. It is a validated method and very reliable. PANAS is a very general method to measure the positive and negative affects on the emotional state of the subjects. This might be too general for the purposes of the research. It is not possible to adjust the method to fit specific parts of the research prototype but is only applicable to the complete experience. Also, there are several items in the PANAS test that are not useful for the research topic (e.g. Hostile or Scared).

Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT [31] is a method to measure the acceptance of a new technology. It is a unification of eight different existing acceptance models, including the Technology Acceptance Model (TAM) [32]. It measures the following four constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. Because of its focus on technology, UTAUT would be well-suited for testing the new interface. It measures various different characteristics that are all helpful for improving the interface. It is not as easy to set up as other methods, because it needs to be adjusted to the specific piece of technology. It can also be chaotic due to the large amount of variables so the results take more time to draw conclusions from.

Intrinsic Motivation Inventory (IMI)

The Intrinsic Motivation Inventory [33] is a multidimensional measuring device to record a user's subjective experience related to an activity. The device consists of the following six sub-scales: interest/enjoyment, perceived competence, effort, value/usefulness, felt pressure and tension, and perceived choice while performing an activity. While the device is called Intrinsic Motivation Inventory, only the interest/enjoyment sub-scale measures intrinsic motivation, which causes it to have more items than the other sub-scales. The amount of items on each sub-scale vary. IMI is a device that can be adjusted to any given activity, but it should be done with caution as wrong wording can negatively influence the results. The various sub-scales seem very suitable to test a mobile interface, they all measure a construct that can impact the browsing experience of the interface. The results of this method are also easily comparable and makes for clear experiment outcomes.

Self Assessment Manikin (SAM)

The Self Assessment Manikin [34] is a method that uses pictures to let users self assess their emotional responses to a wide variety of stimuli. In particular, it measures the pleasure, arousal and dominance associated with their affective reactions. It uses picture scales instead of text, which makes is usable cross-culturally, according to the authors. Another advantage is that it is

usable by illiterate test subjects. The meaning of the avatars on the SAM pictures are not that clear at times which can be confusing to test subjects. Since the mobile interface will feature text, there is no need for a method for illiterate subjects. While this method offers a possibly intuitive way of assessing your own emotions, it might be too subjective.

Discussion

Of the four discussed methods, IMI and UTAUT seem particularly suitable for testing a mobile interface. In contrary to PANAS, they are not too general and contain many useful scales. They are more clear than SAM in the way that the possible answers are much less likely to be misinterpreted. IMI and UTAUT would be equally suitable for both lab studies and online studies. However, UTAUT is validated cross-culturally which makes it more suitable for the online studies than IMI. On the other hand, the IMI questionnaire is easily found on the internet, while UTAUT proves considerably more difficult to find. Also UTAUT is critiqued to be chaotic because of the large amount of variables, whereas IMI is not. It is recommended that either IMI or UTAUT is used to test the user experience of the mobile interface.

2.5 Conclusion

This literature research was conducted to explore the related research domains to browsing a movie database for performing an exploratory search. Section refcommercial discussed the two main commercial interfaces for browsing online movie libraries. It was clear that they both were suboptimal for exploratory searching. A combination of the two might be what users need to find movies in an exploratory way.

Section 2.2 discussed various systems that can be used for movie database browsing. Metadata-based video browsers seem the most suitable for a movie database browser because there is a lot of metadata available for movies and not much content-based data. In particular, the Visual Berrypicking method is a good functional implementation of an exploratory movie browser. They seem to yield good results but it appears that their interface design is sub optimal and this impacts the results negatively. A similar (functional) approach could be taken for the upcoming research project, but the interface design should be different and relations between movies should be made by the user.

For the interface design of the application, various guidelines and touch interactions were discussed in section 2.3. Many of these guidelines are good to keep in mind while designing the interface. The use of touch gestures is not needed for the application but can definitely be used as an add-on to other interaction techniques.

In section 2.4, various methods to evaluate user experience were compared and assessed with regards to their suitability for this project. Four methods were given a more detailed assessments and of these for methods, the Intrinsic Motivation Inventory and the Unified Theory of Acceptance and Use of Technology seem the most suitable for our goal. While IMI and UTAUT would both be suitable for both online use and lab studies, IMI is easier to acquire and analyze and is therefore the recommended method to use.

With the related research domains explored, the next step is to start designing the application using the learned information and guidelines.

Method	Measures	Time per user (minutes)	Suitable for online use	Reliability	Strengths	Weaknesses
AttrakDiff [35]	Hedonic and pragmatic qualities	1-5	Yes	Unknown	Produces quantative data. Easy to set up and use.	No information on experience, just on reflection of experiences.
Audio narrative [29]	Anything you can extract from a user testimony	Variable	No	N/A	User gives most felt experiences.	Results differ per user. User might not be talkative. Transcription needed.
Differential Emotions Scale (DES) [36]	Emotions	1-5	No	Validated [37]	Very general method, applicable on a lot of experiments.	Limited set of emotions.
Emocards [38]	Emotions	Variable	Yes	Unknown	Easy and intuitive.	Not always covering all experienced emotions.
Exploration test [29]	General perception of product	Variable	No	N/A	You get a person's real perception of a product.	Subjective scale. Not easily comparable with other results.
Geneva Appraisal Questionnaire [39]	Affective appraisal and emotions	5-10	Yes	Unknown but widely used	Developed by well renowned team.	Not usable for many applications due to its specific nature.
Geneva Emotion Wheel [40]	Emotions	1-5	Yes	Positive rating study [40]	Easy and intuitive. Developed by well renowned team.	Can be subjective.
Hedonic Utility scale (HED/UT) [41]	Hedonic and utalitarian values	5-10	Yes	Considered unreliable by one study [42]	Measures both hedonic and utilitarian values.	Sensitivity can be a problem.
Intrinsic motivation inventory (IMI) [33]	enjoyment, perceived competence, effort, usefulness, felt pressure, tension, intrinsic motivation	5-10	Yes	Considered reliable [43]	Used in different fields (e.g. sports).	Sensitivity can be a problem.
MAX – Method of Assessment of eXperience [44]	Emotions, usability, intention	5-10	No	Unknown	Good for shy people.	Limited to what's on the cards.
Mental effort [45]	Mental effort	1-5	Yes	Unknown	Easy and simple scale.	No explanation for why there was mental effort.
PAD [46]	Pleasure, arousal and dominance.	5-10	Yes	Unknown	Multi-functional for single stimuli or complete experiences.	Dominance scale is not always easy to understand for users.
Positive and Negative Affect Scale (PANAS) [30]	Positive and negative affect	1-5	Yes	Validated in many languages [47]	Widely used and well researched Clear results.	Designed for clinical setting originally.
Reaction checklists [29]	Agreement on statements about the product	Variable	Yes	N/A	Gives clear initial responses to a product.	No unexpected responses.
Self Assessment Manikin (SAM) [34]	Pleasure, arousal and dominance.	5-10	Yes	Claimed to be validated by authors	Language independent.	Not understood the same by everyone.
Unified Theory of Acceptance and Use of Technology (UTAUT) [31]	Intentions and acceptance of technology	10-20	Yes	Validated cross-culturally [48]	Measures many different values.	A lot of variables. Critiqued to be chaotic.

Table 2.2: Overview of the analyzed user experience evaluation methods

3 Experiments

3.1 Pilot Study

Motivation

Before starting the experiments, we had some assumptions about what problems people experience with state-of-the-art video database interfaces. These assumptions include the assumption that visual browsing interfaces (like Netflix) are visually appealing but simplistic and not very detailed in the amount of information. We also assumed that text-based browsing interfaces (like IMDb) can be overwhelming and generally not pleasant to use because it is so text-reliant. One of the goals of the pilot study was to verify that people indeed experience these issues and thus validate our assumptions. A second goal was to test the concept of visual navigation and see if people were able to handle it and liked it. Lastly, feedback was gathered to improve the design for the following experiments.

Implementation

For the pilot study, the visual navigation concept was implemented as an Android application for tablets. The experiments were conducted on an Android-based tablet (HTC Nexus 9) with an 8.9-inch screen (2048x1536 pixels resolution, 4:3 aspect ratio). For the underlying database, *TheMovieDB.org* was used. The choice for this database was based on the comparison in section 5.

The application was written in Unity, which is a framework to design 2D and 3D games. For this implementation, we solely used the 2D functionality of unity to create a flat user interface design. In Unity, elements of the application that you see on the screen are called *GameObjects*. Each GameObject has a C# script attached to it that tells it how to behave. Aside from static elements, the application has 2 main GameObjects that are generated at runtime: movies and metadata bubbles. Movies are generated when a movie is retrieved from the database and shown in the interface, metadata bubbles are spawned when a user taps on a movie. A simplified UML diagram of the code can be found in figure 2.2. In the diagram is shown that *GameController* is the main controller that manages the state of the application. It controls the *MovieResultController* and the *BubbleController* which in turn control the shown movies and metadata bubbles respectively. API requests to the database are requested by the GameController and performed by the *ApiController*.

Issues

One issue that was encountered while performing the experiments was that some participants find movies much faster than others. For the experiment they were asked to find 3-5 movies in about 5 minutes, but some participants were done much sooner than that. To ensure that all participants had similar experience with the interface, the participants that finished early were asked to keep browsing until they had browsed for at least 3 minutes.

Data

The data and results of the pilot study are discussed in the paper that can be found in section 6. This section shows tables of the questionnaire statements (table 2.3) and interview answers (tables 2.4 and 2.5) that were gathered from the pilot study.

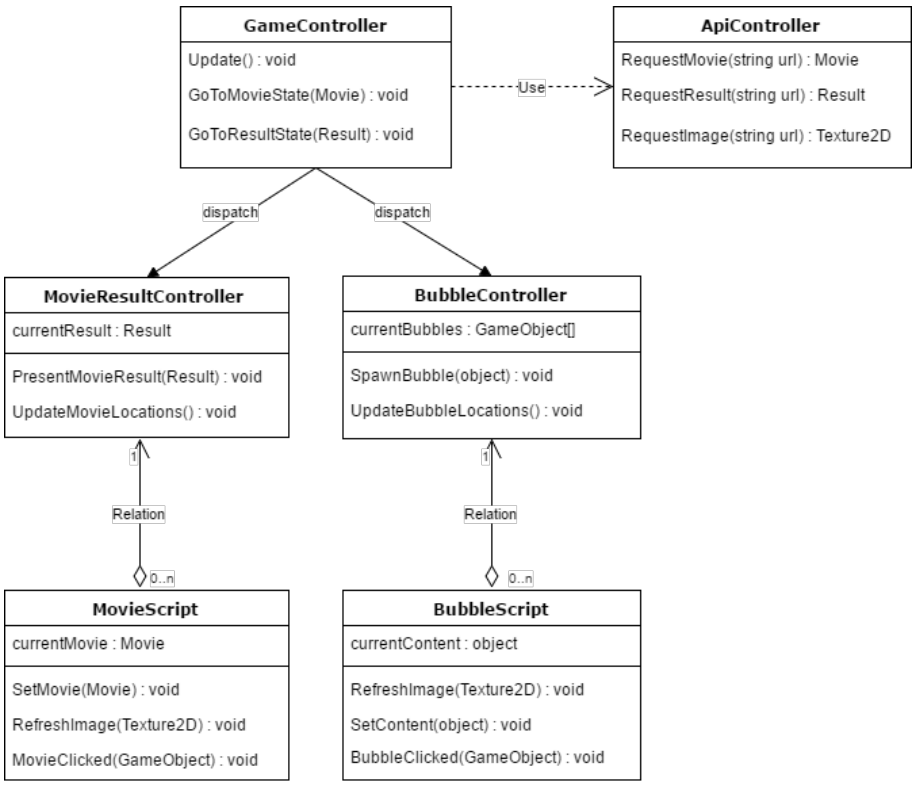

Figure 2.2: A simplified UML diagram of the Unity code for the pilot study application.

Participant	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
I understood the purpose of this application.	4	4	4	5	5	4	5	5	5	5
The application worked intuitively.	4	4	5	4	4	5	5	5	4	5
Navigating between movies was easy and straightforward.	5	5	4	5	5	4	4	4	4	5
I felt in control of the application.	3	4	4	4	4	5	5	4	4	4
I felt like all information that I needed was there	3	2	3	2	5	4	4	5	4	4
It was easy to find movies that I wanted to watch	5	4	4	3	4	4	4	4	5	4
It was easy to navigate between movies.	4	5	4	4	4	5	4	4	3	3
There was enough information for each movie.	2	3	3	2	4	4	3	3	4	3
I would use this application instead of Netflix for finding movies to watch	3	4	5	3	4	5	4	4	3	5
I would use this application as a complement to Netflix for finding movies to watch	4	4	4	4	5	5	5	4	4	4
I would use this application instead of IMDb for finding movies to watch	3	4	2	3	3	5	3	5	4	5
I would use this application as a complement to IMDb for finding movies to watch	3	2	4	4	4	1	3	4	5	5

Table 2.3: Questionnaire statements (left) that the participants (top) rated using a Likert scale of 1 to 5 with the following labels: 1 - Strongly Disagree, 2 - Disagree, 3 - Neutral, 4 - Agree, 5 - Strongly Agree.

Question	Answer	Amount
How often do you watch movies or TV series on average?	Very Often (e.g. almost daily)	5
	Often (e.g. a couple of times per week)	3
	Sometimes (e.g. a couple of times per month)	2
How often do you use Netflix or similar services on average?	Never	3
	Often (e.g. a couple of times per week)	3
	Very Often (e.g. almost daily)	3
	Barely (e.g. a couple of times per year)	1
On which devices do you use Netflix or similar services?	Laptop / PC	6
	Smartphone	5
	TV	5
How do you go about finding a movie or TV series using Netflix or similar services?	Look at categories and scroll until you find a movie.	7
	Suggestions from friends	2
	Search outside of Netflix	1
What do you like about the interface of Netflix or similar services?	Movie thumbnails (visually pleasing) / Goodlooking interface	6
	Movie suggestions	2
	Netflix keeps track of what you watch	2
What do you dislike about the interface of Netflix or similar services?	Category order seems arbitrary/hard to find.	4
	Searching takes a long time when you don't know what to watch	3
	Amount of content is not enough.	2
	You see the same movies often	2
	No categorized search function	1
	No trailers	1
	Too much movies to choose	1
	Netflix does not offer enough options to match results to your mood or what you feel like.	1
How often do you use IMDb or similar services on average?	Barely (e.g. a couple of times per year)	4
	Often (e.g. a couple of times per week)	3
	Sometimes (e.g. a couple of times per month)	2
	Never	1
On which devices do you use IMDb or similar services?	Smartphone	6
	Laptop / PC	6
	Tablet	1
In which situations do you use IMDb or similar services?	Lookup actors	7
	Lookup reviews / ratings	3
	Lookup episode lists	1
	Lookup movie producer/director	1
	To find out something about a movie (General)	1
	To find inspiration on what to watch and find out which movies are good.	1
What do you like about the interface of IMDb or similar services?	Movie suggestions	2
	Easy to navigate from one page to another	2
	A lot of information available on one page	2
	Page structure	1
	Reliable ratings	1
	Quick overview of actors and how they are sorted.	1
	Search functionality	1
What do you dislike about the interface of IMDb or similar services?	Chaotic interface	4
	Nothing	2
	Various information is hard to find	2
	Design is not so nice (old-fashioned)	1
	Much of the information is useless	1
Do you think IMDB-like services could complement the interface of Netflix or similar services and why? What would be the disadvantages?	Yes, so there is more information on movies	5
	Yes, so there is no need for 2 applications	1
	Yes, but if there is not too much information, like on IMDb	1

Table 2.4: Answers for the first interview of the pilot study, grouped and counted.

Question	Answer	Amount
What did you like about the application?	Application feels natural / Well-designed interface / Easy to use	6
	Build upons your previous search queries and don't have to keep starting over.	5
	Easy to click on things that appeal to you and get good suggestions	3
	A lot of information present	2
	A limited amount of movies presented makes it easier to choose	1
What did you dislike about the application?	No (categorized) search functionality	8
	Not enough information per movie (runtime, more actors)	4
	Missing reviews / ratings	3
	Missing Home button	3
	Missing trailers	1
	Not detailed enough categories	1
	Missed overview of categories	1
	UI not clear enough	1
How can the things you disliked be improved?	Add Search functionality	8
	Add a list of categories you can choose from	3
	Add missing info	3
	Add Home Button	3
	Make a glowing edge for the main movie to indicate that you can tap on it	1
	Add an extra bubble to click on for more actors	1
If these things are improved, would you use this application instead of other popular movie browsers?	Yes	5
	Yes, Instead of IMDb	2
	Maybe	1
	Yes, to find movies quickly	1
	Yes, as a complement. Because it is more fun to pick a movie	1
	Yes, the visual representation makes it easier to navigate.	1
Are there any things that you missed and would like to have in this application? Or do you have any other ideas on how to improve it?	More actors	1
	A visual history of your steps (like a web)	1
	A filtering to specify what you like	1
	More movies to scroll	1
	Make it more clear where to find movie plot	1
	Integrate it into netflix instead of a seperate app	1

Table 2.5: Answers for the second interview of the pilot study, grouped and counted.

3.2 Online Study

Motivation

After performing the pilot study and making some improvements to the design, our goal was to test the concept in a real-life setting. Would people still use it when offered a state-of-the-art alternative? To test this, we developed a version of the app that contains two interfaces: the visual navigation interface and one that is similar to state-of-the-art interfaces. To get a wide range of participants to participate in the experiment, we published the application on *Google Play* and advertised it as an application to browse movies, movie information and trailers. We notified the participants that they would be partaking in a scientific experiment and encouraged them to try both interfaces.

Implementation

For the online study, an application featuring two interfaces was created. Like the pilot study implementation, it was developed in Unity. Starting in a main screen, users could choose to use either of the interfaces and a header encouraged them to try both interfaces. Selecting an interface loads a new Unity *scene* with the selected interface. A scene in Unity is a separate environment with its own GameObjects and classes. The two interfaces are implemented in a similar way to the implementation of the pilot study so the reader is referred to that UML diagram (figure 2.2) for the inner workings of the scenes. The UML diagram in figure 2.3 shows an overview of the scene selection functionality. The data was logged as a comma-separated values (csv) file in the following format:

"<Timestamp>;<Current Scene>;<Current View>;<Action>;<Action Details>"

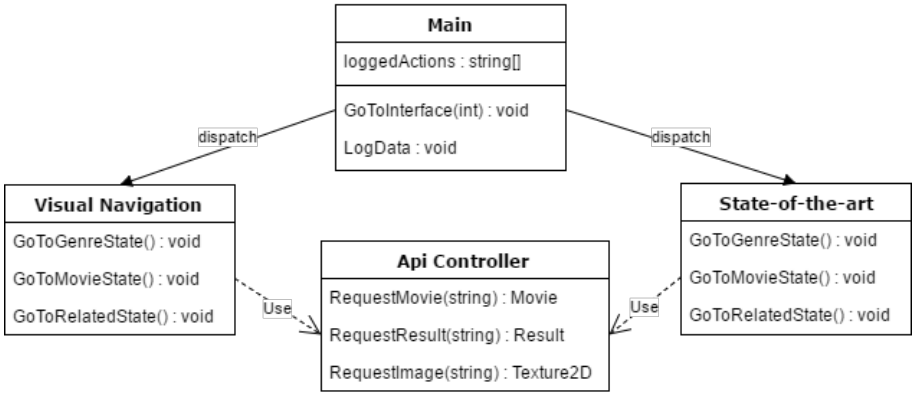

Figure 2.3: A simplified UML diagram of the Unity code for the interface-selection functionality of the online study implementation.

Promotion

We promoted the application on various websites, Facebook groups and among fellow students. The exact locations can be found in table 2.6. We used the following texts for promotion:

Programming/Unity related locations
For my Master thesis Game and Media Technology I made something a little different than most of the content here. Have you ever had difficulties finding a movie to watch? Find yourself browsing endlessly on Netflix? This is the problem that I tried to tackle with my thesis. I made an app to browse movies and watch trailers so you can find the movie that you feel like watching. Because of my game background, I developed the app in Unity. I did everything in Unity UI on the canvas and for this purpose, I think it worked out great. There are two different interfaces that I'm comparing and you can choose the one you like most in the app. But now I need your help! To get some results worth writing about, I need quite a lot of people that download and use the app. Would you help

me? After 10 minutes of using the app, you will be asked to fill out a short survey (5 minutes) but apart from that you won't be bothered. The app is completely non-commercial and ad-free. Anyone with a tablet can download it here: https://play.google.com/store/apps/details?id=com.Bruno.Flix.

Other locations
Have you ever had difficulties finding a movie to watch? Find yourself browsing endlessly on Netflix? This is the problem that I tried to tackle for my master thesis. I made an app to browse movies and watch trailers so you can find the movie that you feel like watching. The app I created is an Android application that allows you to browse and watch movie trailers. I am comparing two different interfaces that you can choose from. It is completely non-commercial and ad-free. But now I need your help! To get some results worth writing about, I need quite a lot of people that download and use the app. Would you help me? After 10 minutes of using the app, you will be asked to fill out a short survey (takes about 5 minutes) but apart from that you won't be bothered. Anyone with a tablet can download it here: https://play.google.com/store/apps/details?id=com.Bruno.Flix.

Date	**Location**
18-05-2017	https://www.reddit.com/r/unity3d/
18-05-2017	https://www.reddit.com/r/unity2d/
18-05-2017	https://www.reddit.com/r/movies/
18-05-2017	https://www.reddit.com/r/androidapps/
22-5-2017	GMT Students (WhatsApp)
22-5-2017	A-Eskwadraat Study Association (Facebook)
22-5-2017	Dutch Game Industry (Facebook)

Table 2.6: Promotion locations for the first week. The promotion on these locations was repeated one week after the mentioned dates.

Issues

Initially, the application could only be installed on Android-based *tablets* because that was what it was designed for. When promoting the application and research project, many people said that they would install the application if it was available for mobile phones as well. After making sure that the application works well and in the same way on mobile phones, we decided to release an update of the application that allowed mobile phones to install it as well. The number of installations increased much faster after that.

Data

The logged data was processed using a command-line program in C#, developed using Visual Studio 2015. The statistical analyses were done using Microsoft Excel and SPSS Statistics 24. In this section, the scores for the intrinsic motivation inventory questionnaire are summarized in table 2.7 and the log data for the amount of (different) metadata that participants clicked is listed in table 2.8.

Part.	Enjoyment VB	Enjoyment VN	Competence VB	Competence VN	Usefulness VB	Usefulness VN
1	3,714	6,142	5,833	6,167	2,857	5,857
2	4	4,857	4,333	4,5	3,714	3,714
3	4	5,428	5,333	4,667	4,428	4,142
4	4,857	6,714	4,667	6,5	4,857	6,571
5	4,857	6	5	3,333	5,571	6,285
6	3,857	4,428	6	5,333	4,714	4,428
7	3,571	5,857	3,5	5,167	3,285	6,142
8	4,285	3,285	4,833	4,167	6,571	5,857
9	4,571	3,571	7	2,833	5	2,142
10	3,142	6	5,167	5,333	4,571	6
11	3,857	6,428	4,833	5,667	3	6,857
12	5,571	3,714	6	4,167	5,857	3,857

Table 2.7: Online Study: Scores for the Enjoyment/Interest, Perceived Competence and Usefulness/Value subscores of the Intrinsic Motivation Inventory for the participants. The state-of-the-art visual browsing interface is indicated by *VB* and the visual navigation interface by *VN*.

Participant	Metadata Clicked VB	Metadata Clicked VN	Different Metadata Clicked VB	Different Metadata Clicked VN
1	0	0	0	0
2	0	0	0	0
3	1,109	2,398	2	2
4	0	0	0	0
5	0,552	0,970	3	2
6	0	0	0	0
7	0	0	0	0
8	0,499	1,567	1	2
9	0	0	0	0
10	2,451	0	1	0
11	0	1,553	0	2
12	2,259	1,518	2	1
13	0	0	0	0
14	0,493	0,260	2	1
15	0	0	0	0
16	0	2,615	0	1
17	0	0	0	0
18	0,833	1,140	3	2
19	0	1,269	0	3
20	0	1,343	0	1
21	0	0	0	0
22	0	3,353	0	1
23	0	2,610	0	2
24	0	0	0	0
25	0,775	1,685	2	2
26	0,703	1,607	1	2
27	2,219	3,135	0	2
28	0	0	0	0
29	1,704	2,232	2	2

Table 2.8: Online Study Log data for the amount of metadata that participants clicked per minute and the amount of different types of metadata that they clicked on. The state-of-the-art visual browsing interface is indicated by *VB* and the visual navigation interface by *VN*.

3.3 Lab Study

Motivation

Concurrent to the online study, a lab study was performed to test the same application in a controlled environment with a set task for participants. The motivation for this study was to attain both external and internal validity of the results by also testing the interfaces in a controlled environment. The objectives of the study were the same as those of the online study and can be found in section 3.2.

Implementation

The implementation that was used for the lab study was the same as the one that was used for the online study and can be found in section 3.2. The application was used on the tablet of the observer (Asus Nexus 7, 1900x1200 resolution). The difference in usage of the application is that the observer selected the order of the interfaces that participants would be using and counterbalanced this for all participants.

Issues

An issue that came up with the lab study is the same issue that arose during the pilot study: some people find movies much faster than others. The same solution was used and participants were asked to keep browsing until they browsed for at least three minutes on each interface. This ensured a comparable usage time for the participants. Another issue was that one participant did not select any metadata to navigate the database because he did not know this was possible. The data for this participant was not excluded because it is a meaningful result.

Data

The logged data was processed using a command-line program in C#, developed using Visual Studio 2015. The statistical analyses were done using Microsoft Excel and SPSS Statistics 24. In this section, the scores for the intrinsic motivation inventory questionnaire are summarized in table 2.9 and the log data for the amount of (different) metadata that participants clicked is listed in table 2.10. The interview answers are shown in table 2.11.

Part.	Enjoyment VB	Enjoyment VN	Competence VB	Competence VN	Usefulness VB	Usefulness VN
1	3,285	4,857	4,333	4,333	4,285	4,714
3	4,857	5,857	5,333	6	5,142	6,285
5	4	2,857	5	5,667	5,285	5,285
7	4,571	5,142	5,667	5	2,857	4,857
9	4,142	3,428	3,833	3,333	4,428	4,571
11	4,285	4,142	4,667	4,5	4,142	4,714
13	4,571	5,571	6,167	5,333	4,857	5,714
15	5,857	6,714	6,833	7	6,428	6,857
17	4,857	6	5	5,667	5,571	6,714
19	4	4,285	5,833	5	5	4,285
21	4,857	5,857	7	7	5,714	5,714
2	3,857	4,571	5,333	5,667	5,714	5,857
4	4,571	4,285	4,833	5	4,857	5,857
6	4,857	4,857	6,667	6,333	6,571	5,857
8	3,428	4,142	4,167	5	5	4,571
10	4,285	5,428	5,833	5,833	4,571	6,142
12	4,428	4,714	5,333	5,333	4,428	4,428
14	3,571	3,857	5	4,5	4,428	4,571
16	4,857	5,285	4,833	4,667	4,571	5,285
18	4,714	5,571	3,833	3,5	4,857	4,285
20	3,285	3,285	5,167	4,333	4,142	4,285

Table 2.9: Lab Study: Scores for the Enjoyment/Interest, Perceived Competence and Usefulness/Value subscores of the Intrinsic Motivation Inventory for the participants. The state-of-the-art visual browsing interface is indicated by *VB* and the visual navigation interface by *VN*.

Participant	Metadata Clicked VB	Metadata Clicked VN	Different Metadata Clicked VB	Different Metadata Clicked VN
1	1,019	2,920	2	4
2	1,128	0,672	3	2
3	0	1,942	0	4
4	1,292	0,840	2	3
5	0	1,559	0	2
6	1,204	1,053	2	4
7	0,379	2,448	2	3
8	1,083	0,510	2	1
9	1,006	1,261	2	3
10	0,941	0,504	3	4
11	0,163	0,952	1	3
12	0	0	0	0
13	0,395	0,306	1	1
14	1,832	2,354	3	3
15	0,354	2,905	2	4
16	1,481	0,681	1	2
17	0	0,151	0	1
18	1,601	0,931	2	4
19	0,413	2,276	2	2
20	0,327	0,719	1	3
21	0,455	0,965	0	1

Table 2.10: Lab Study: Log data for the amount of metadata that participants clicked per minute and the amount of different types of metadata that they clicked on. The state-of-the-art visual browsing interface is indicated by *VB* and the visual navigation interface by *VN*.

Question	Answer	Amount
What did you like about this interface?	Visually appealing	9
	You can navigate from movie to movie	8
	Well-organized design	7
	Useful/fun that information is visualized	6
	Fun to use	3
	Smaller chance to miss information	2
	Clear that information was clickable	2
	A good amount of information	1
	Used more information than with the textual design	1
What did you dislike about this interface	Needed to search more to find information	3
	The plot was less noticable.	3
	Could use sorting options	2
	Interface was sometimes slow to respond.	1
	Felt like there was less information	1
	Missed movie screenshots	1
	Text is harder to read in bubbles	1
	Need to get used to design	1
	Bubbles did not seem clickable	1
	Actor heads were not always centered correctly	1
Did you feel inclined to click on the movie information? Why/Why not?	Yes, it looked clickable	9
	Yes, I wanted to see more movies related to what I liked	8
	Not more than the textual variant	2
	No, I did no know that I could	1
	No, I only watch movies that I know already	1
	No, I use IMDb for that	1
Did you use the movie information to navigate between movies? Why/Why not?	Yes, to find movies that had certain elements that I liked	13
	No I used the genre screen mostly	5
	Yes, I felt inclined to click on it	2
	No, I did not know that I could	1
Did you prefer the textual movie information or the visualized movie information? Why?	Visualized because it was easier to use	6
	Visualized because it looked better	6
	Textual, because it is familiar	4
	No preference	2
	Visualized because you can find movies that you don't know yet	1
	Textual, because is better organized	1
	Visualized, because it is harder to miss things	1
What could be improved about the way that the information is visualized?	Nothing	5
	A more contrasting/coloured background for the bubbles	5
	Better positioning of bubbles	3
	Make plot more noticable	3
	Add an indication that bubbles are clickable	2
	Center the actor heads better	1
	Make it more relevant to what you like	1
	You could adjust the size of bubbles for extra information	1
	Make it load faster	1
	Add a button to see more actors/genres	1
Do you think something like this could be integrated in movie streaming services like Netflix?	Yes	13
	Yes, it is easier	2
	Yes, if it is better organized	1
	Yes, it is different than what I see often	1
	Yes, if it would be better personalized	1
	Yes, for touch screen devices	1
	No, a separate app is better	1
	No, Netflix does it better	1
If so, would you use it? Why?	Yes, it is easier	6
	Yes	6
	Yes, it is useful to find what you like	4
	No	3
	Yes, it is more fun to use.	2

Table 2.11: Answers for the interview of the lab study, grouped and counted. The questions were all about the visual navigation interface.

4 Demonstration

In this section, a demonstration is given of the visual navigation concept and an implementation that shows of its strength. Feedback that participants have given during the various studies has been used to improve the implementation. Features that were not explicitly part of the visual navigation concept (such as search functionality and a genre overview) were left out of this implementation in order to better show off the concept. Note that the screenshots in this section contain some images (movie posters, movie stills and photos of people) that might be copyright protected. These images were downloaded from *TheMovieDB.org* and used under the fair-usage policy that applies to copyright protected images.

4.1 Application

The application starts with a screen that shows current popular movies (figure 2.4), as rated by TheMovieDB.org. Any type of starting screen can be used in combination with visual navigation, but it needs a starting point so that users can navigate to a movie that they are interested in. An overview of the most popular movies was chosen as a starting point.

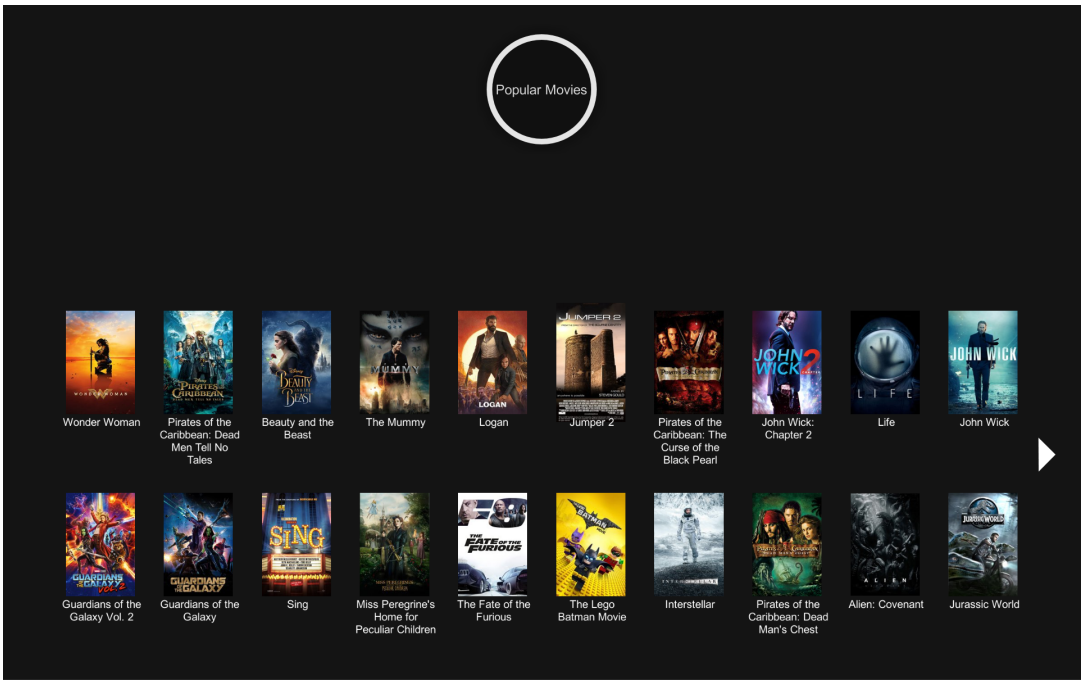

Figure 2.4: Starting point of the application, an overview of the most popular movies. Movie posters were downloaded at runtime from http://www.themoviedb.org and used under the fair-usage policy.

When a movie is selected, the *movie details view* is loaded and the visual navigation interface is shown. Figure 2.5 shows details for the movie *Wonder Woman*. Surrounding the movie posters are bubbles containing the following movie metadata that can be used to navigate by: genres, three main actors, director, writer, main music composer, production company, language and year of release. Note that these bubbles are only shown when available in the database of TheMovieDB.org. The following features have been implemented in order to visualize the metadata and encourage users to navigate by it:

- Photos are shown for people that worked on the movie (actors, director, writer, main music composer).
- Icons are shown depicting the type of job that people had when working on the movie (actors, director, writer, main music composer).
- Metadata items are styled like clickable buttons.

- Metadata items are positioned in a circle to draw the attention of users.
- Metadata items are colored based on their type, to make it easier to distinguish the type of information shown.
- Non-navigable information is only shown when the movie poster is pressed (as indicated by the *info* icon).

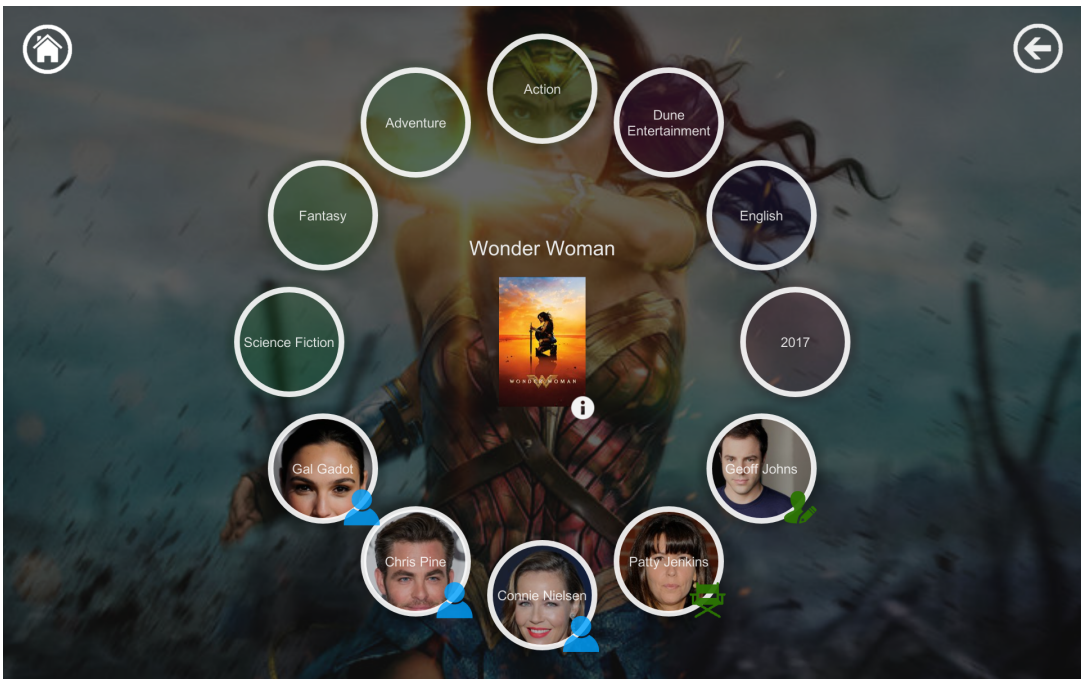

Figure 2.5: Movie details view for the movie Wonder Woman, showing the visual navigation concept. The used photos and images were downloaded at runtime from http://www.themoviedb.org and used under the fair-usage policy.

When one of the metadata bubbles is tapped, the *category view* is loaded and shows movies containing the same metadata that was tapped. Figure 2.6 shows movie that contain Chris Pine as an actor. When one of the movies is tapped, the movie details view is loaded for that movie. Alternatively, a user can press the back button to return to the previous movie details view. The home button can be tapped at any time to return to the starting point.

Because the amount of information that is offered for each movie varies, the layout of the movie details varies as well. Figure 2.7 shows the movie details view for the movie Sing. As you can see, there are more genres presented and a music composer as well. Also note that Garth Jennings is both director and writer for this movie. When the writer bubble containing Garth Jennings is tapped, only movies that contain Garth Jennings as a writer are shown (See figure 2.8).

4.2 Limitations

There are certain limitations imposed by the database that was used. Preferrably, there should be more types of metadata that can be used to navigate by (e.g. filming location). The types that were used in this demonstration are the types that TheMovieDB allows searching by. Also, images could be used for non-person metadata as well, such as: company logo's for production companies, genre icons for genres and country flags for languages. For this implementation, we had no access to those images but for a commercialization of the concept it should be feasible.

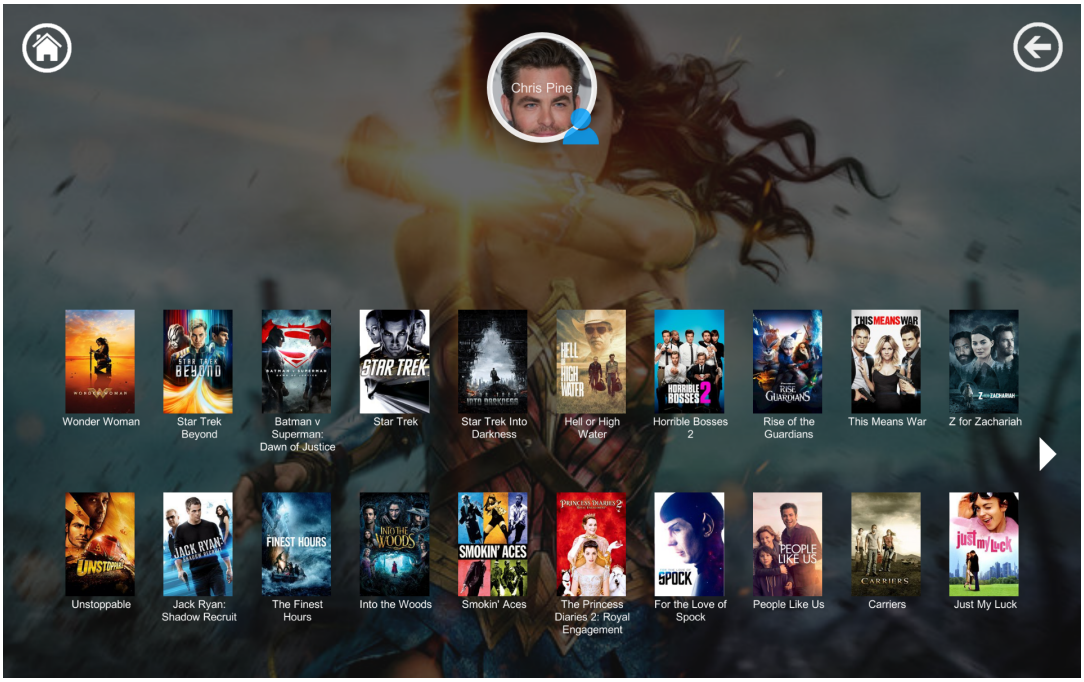

Figure 2.6: Category view for the actor Chris Pine. The used photos and images were downloaded at runtime from http://www.themoviedb.org and used under the fair-usage policy.

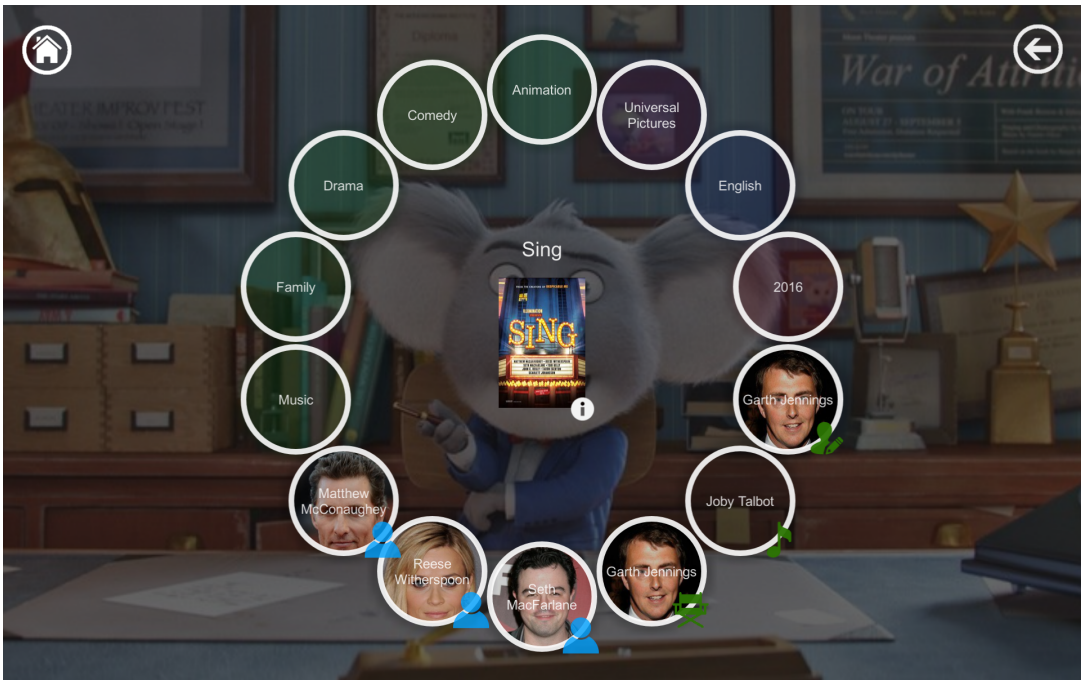

Figure 2.7: Movie details view for the movie Sing, showing a larger amount of metadata items. The used photos and images were downloaded at runtime from http://www.themoviedb.org and used under the fair-usage policy.

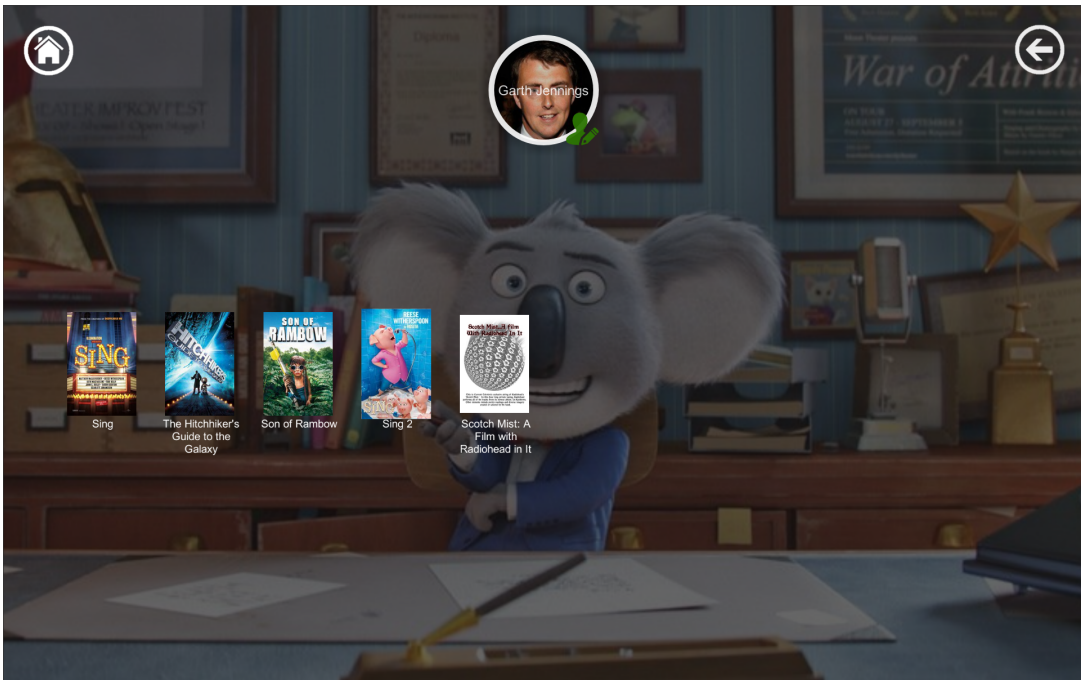

Figure 2.8: Category view for the writer Garth Jennings. The used photos and images were downloaded at runtime from http://www.themoviedb.org and used under the fair-usage policy.

5 Database Comparison

For this research project on navigating online movie collections, an online movie database was used. To choose a suitable database, various online movie databases were compared on the basis of the following criteria:

- Content - How complete is the database and how much information is there for each entry?
- Access - How is the database accessible and is it easy to use? Is there a limit to the amount of requests that can be made to the database?
- Legal - Can the database be used for non-commercial research purposes? Can the database be downloaded for offline use?

The results of the comparison are summarized in table 2.12 and discussed in the following sections.

5.1 Internet Movie Database (IMDb)

The Internet Movie Database is one of the oldest and most-used movie databases online. Its movie ratings are used as a reference on many other websites and are generally viewed as a good indication of the quality of a movie.

Content

Content-wise, IMDb is very complete. It has nearly every movie ever published with 85,070 TV movies on record [49], this number does not include over 150,000 documentaries and more than 400,000 shorts. Each movie has a wide range of metadata available; more detailed information on the available metadata can be found in the results section.

Access

IMDb is freely accessible for human users through the searchable website, but it offers no public API and is not designed to be used by computer programs. Technically (but not legally), it would be possible to create a website crawling program to retrieve data from the website.

Legal

According to the IMDb Conditions of Use, data mining, robots, screen scraping or similar data gathering and extraction tools are not allowed on IMDb without express written consent. This limits the use of IMDb to human users. For data mining permissions, it is possible to contact their licensing department. Licensing fees are not stated.

5.2 Open Movie Database (OMDb)

The Open Movie Database was designed as an API only service and an alternative to IMDb. Through the years, the database was built up through community collaboration. It has a lot of users because of its simplicity. Because of the non-corporate nature of the database, there is not a lot of information to be found about the database and the website is quite limited.

Content

OMDb offers no statistics on the size of the database. A search for the movie title keyword "batman" gives 266 results, whereas IMDb only gives 121 results. All of the results from IMDb are also among the OMDb results. This leads us to believe that the OMDb database is quite complete, but this has to be verified by using it. OMDb offers simple movie metadata only, no extensive data such as reviews, related movies or filming locations.

Access

OMDb offers a simple API of which the options are easy but limited. It is possible to search for specific movies or keywords, but you can't search on actors or directors for example. It is also not possible to request all movies or all movies for a certain metadata criterium. There does not seem to be a restriction on the amount of requests one can make with this API. It is only limited to 20 concurrent connections, according to the change log [50].

Legal

The database is freely accessible for non-commercial purposes under the Creative Commons BY-NC 4.0 License. Registration is required as per the Terms of Use and can be done by sending an e-mail to registration@omdbapi.com. It is allowed (but not explicitly facilitated) to download the content for offline use when retaining the original trademark, copyright and other proprietary notices.

5.3 The Movie Database (TMDb)

The Movie Database was started as a platform to share high-resolution movie posters. In 2009, it became a full movie database thanks to a starting dataset extracted from OMDb. Now, it is a well-known movie database and has one of the few free movie data API's. It offers a service where users can keep track of the movies they have watched and compare that with other users. It is also used to discover new movies through trailers and related movies.

Content

On the frequently asked questions page of TMDb, it is stated that the database contains 311,490 movies at the time of writing [51], which indicates that it is very complete. It contains a lot of metadata, similar to IMDb and it is all available through the API. For more details on the metadata, see the results section.

Access

TMDb offers an API to access the database, which returns data in JSON format. It has extensive documentation and it is easy to use. A maximum of 40 requests per 10 seconds per IP address is allowed. Notable is that the API features "discover" functionality where one can find movies that match a certain predicate. This is particularly useful when you are not looking for one specific movie.

Legal

The API can be used freely for any non-commercial project. A credit to TMDb in the application is the only thing required. It is allowed (but not explicitly facilitated) to download the content for offline use when retaining the original trademark, copyright and other proprietary notices.

5.4 Linked Movie Database (LinkedMDB)

The Linked Movie Database is a dataset based on Linked Open Data (LOD) created by Hassanzadeh et al. [52]. The LOD project aims to create a Semantic Web by unifying and linking data across the web. In this way, relations between data can be understood by computers and used in applications. LinkedMdb creates interlinks between various online movie data resources.

Content

The LinkedMDb website [53] is not working for the most part at the time of writing. In particular, the statistics and licensing page are missing. Luckily, the Wayback Machine [54] offers a snapshot of the statistics page for March 2016. There it is claimed that the database contains 85,620 movies. There is a large amount of potential metadata that the database offers. However, these are only present for certain movies. When taking a small sample from the database, it became clear that for most movies there is a limited subset of metadata. Also, multimedia metadata like movie posters and trailers is not available.

Access

The database is accessible using a semantic browser or by using a SPARQL client. The querying of the database is done using SPARQL, which is a query language for RDF (Linked) data. The latest work on SPARQL is a recommendation by the World Wide Web Consortium (W3C) in 2008 [55]. The query language is similar to the better-known SQL language. It is not trivial to use and requires significant programming efforts to incorporate in an application.

Legal

The licensing page of the LinkedMDb website is not online anymore, so definitive conclusions on this part cannot be drawn without contacting the authors. However, the Wayback Machine reveals that it used to be licensed under the Creative Commons BY 3.0 License, which allows for unlimited usage of the data if the authors are credited. It is likely that this license still applies. There is no explicit statement about downloading the data for offline use.

5.5 Results

This section contains the results of the comparison. Table 2.12 shows a simplified comparison using a scale with the following set of possible values: {--, -, +/-, +, ++}, where -- is the least favorable option and ++ the most favorable option. Table 2.13 shows an in-depth comparison of the available movie metadata for each database.

	IMDb	OMDb	TMDb	LinkedMDb
Database completeness	++	+	++	+/-
Metadata amount	++	-	++	+/-
Accessibility	n/a	++	++	+
Ease of use	n/a	++	++	-
Request Limit	n/a	++	+	++
Offline use	--	+	+	+/-
Non-commercial licensing	--	++	++	+

Table 2.12: Database comparison overview

	IMDb	OMDb	TMDb	LinkedMDb
Film Title				
Cast		[1]		
Director(s)				
Writer(s)				
Crew				[3]
Reviews				
Movie Poster				
Movie Runtime				
Age Rating				
Genre(s)				[3]
Release Date				
Trailer				
Related Movies				
Short Plot				
Full Plot				
Box Office				[3]
Rating				[3]
Awards				
Language				[3]
Country				[3]
Filming Locations			[2]	

[1] Only lead characters.
[2] Only countries.
[3] Only for certain movies.

Table 2.13: Metadata Comparison

5.6 Conclusion

Four online movie databases have been compared based on their content, accessibility and legal restrictions. IMDb is the most extensive database with the most metadata per movie but it is only usable by humans and does not offer access through an API. OMDb offers less metadata but is very accessible via a basic API and has no request limit. TMDb is almost as complete as IMDb in their content and offers a very extensive API but imposes a request limit of 40 requests per second per IP address. LinkedMDb has a decent amount of movies but not all movies have the same amount of metadata. It is not easily accessible because of it uses a SPARQL endpoint and there is not an API.

If we take these tings into account, The Movie Database (TMDb) comes forward as the winner because it has a very good amount of content and metadata. Also, the API offers the most options, including a very useful 'discover' option. The only downside is that it allows only 40 requests per ten seconds, but for research purposes this should not be a problem.

6 Pilot Study - Work-In-Progress Paper

After we performed the pilot study, dr. Wolfgang Hürst wrote a work-in-progress paper [56] about the study and submitted this to the ACM International Conference on Interactive Experiences for Television and Online Video (TVX) listing me as co-author. The paper was accepted in April and will be published in the proceedings. In the paper, details of the pilot study that was performed and the general concept of visual navigation are presented. This section of the annotated appendix shows the paper as it was submitted.

Exploring Online Video Databases by Visual Navigation

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ABSTRACT
We present an interface design for interactive exploration of large movie databases based on a concept we entitle *visual navigation*. Our approach aims at combining the major advantages of existing systems, which are commonly either simple but limited in functionality or powerful but complex and less engaging. To verify the potential of our idea, we performed a pilot study, which indicates the validity of our approach, highlights advantages, and pinpoints areas for improvement and future work.

Author Keywords
Video database browsing, video archive access, movie database interfaces, interaction design, user experience.

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation (e.g. HCI)]: User Interfaces – Graphical user interfaces (GUI), input devices and strategies, interaction styles, screen design

INTRODUCTION & VISUAL NAVIGATION CONCEPT
Online databases such as *Netflix* (http://www.netflix.com) provide users with instant access to a tremendous number of movies and TV shows. Yet, the amount of available data results in challenges for the interface design. Common interfaces rely on a rather simplistic representation – likely to not overwhelm users and keep the interaction simple. They generally offer a somehow categorized overview of movie posters, which is complemented by a detailed view of a movie once it is selected from the overview; cf. Fig. 1. We refer to this type of video database browsing as *visual browsing*, because it enables users to browse and access movies based on visual information; a movie's poster.

This works well in situations where the recommendations provided by the interface fit a user's current needs. Yet, these needs can also change frequently based on status, mood, or context. Two common issues in such situations include that the interface only shows a rather small part of the database and does not provide much additional information on the displayed movies. Movie information archives such as the *Internet Movie Database* (IMDb, http://www.imdb.com) cope with the latter issue by providing a structured, mostly textual overview of various details about a movie, not only including synopsis, runtime and actor information, but also information on writers, directors, filming location, and much more. Because this data is mostly displayed as text, we refer to this type of video database browsing as *text-based browsing*. While the presented information could potentially be very useful when searching for a movie to watch, the interface appears to be too overwhelming and, due to its heavy reliance on textual descriptions, less attractive and appealing.

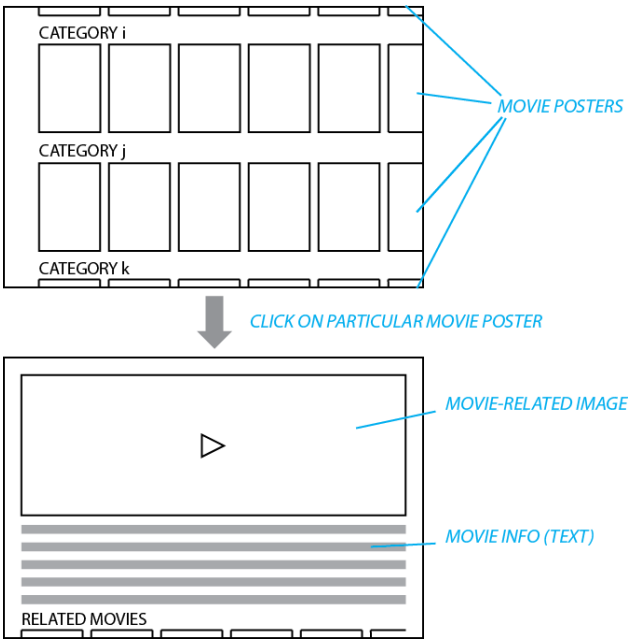

Figure 1. Illustration of common online movie database interfaces with a categorized overview of movie posters (top) and a detailed movie view (bottom). Categories can include, for example, new releases, personal recommendations, and genres, which are generally based on the user's and other's viewing behavior in the past. Movie details include some visuals representing it, accompanied by some text (short synopsis, runtime, etc.) and posters of a few related movies.

In this paper, we therefore introduce a new video database browsing concept called *visual navigation*, which aims at combining the best of both approaches; an interface that is as simple, intuitive, and appealing as visual browsing, yet also almost as powerful as text-based browsing. The key

TVX '17 Adjunct, June 14-16, 2017, Hilversum, Netherlands

ACM ISBN 978-1-4503-5023-5/17/06…$15.00

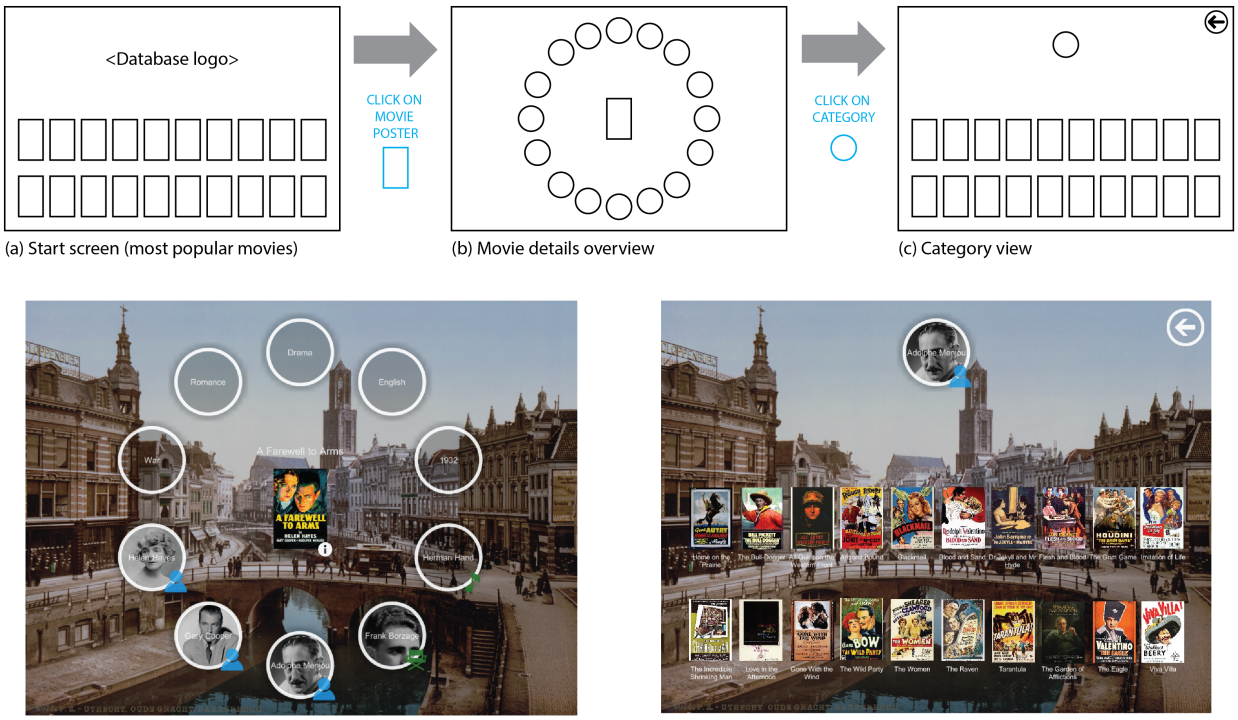

Figure 2. Illustration of the concept of *visual navigation* and screenshots of implementation used in the user study. Notice that visuals used in the test have been replaced here with copyright free material from Wikimedia.

idea is to visualize some of the information enlisted in text-based browsing approaches in an intuitive way, thus offering users the opportunity to easily explore related contexts; cf. Fig. 2.

While this idea of visual navigation seems simple, it is in no way obvious if such an interface would achieve the benefits we expect. Does it really provide a simplicity that is comparable to visual browsing interfaces? Can users understand and handle it? And does it really give you better access to the information displayed in text-based browsing approaches? Is that information helpful in finding better movies to watch? To get an initial understanding of the power of this concept of visual navigation, we present an informal pilot study addressing users' reaction to the idea, verifying if they can understand and handle the concept, and identifying possible advantages, issues, and pitfalls.

RELATED WORK

Common video database systems offer at least a simple search field enabling users to search for movie titles, actors, but also other things, such as directors and writers. Yet, in practice, most users generally restrict their search to the first two (titles and actors). Advanced searches on other movie characteristics, such as directors, filming locations, etc., could be very helpful in finding a movie, but are often not done, either because they are too complex to phrase or not supported by the system. Thus, providing an interface that enables *intuitive* search based on such advanced movie characteristics is one of the key goals for our approach.

Video browsing is a topic that gained increasing attention in the video search and retrieval community in recent years. Good overviews of basic concepts and latest developments are provided by Schoeffmann et al. [5, 6]. Yet, most of this work addresses content-related search within video files, but lacks in supporting higher level characteristics, which we consider essential to create a more sophisticated video browsing experience. Thus, providing an interface that enables *powerful* higher-level concept browsing is another key goal for our approach.

In contrast to this work on content-based search within single videos, research related to exploring whole databases is often focused on recommendation systems, which are, for example, based on user profiles [7] or usage-driven [2]. Newer work also tries to accommodate for the fact that preferences can change and thus consider more context and user related issues (see [1, 2, 8], for example). While such systems work well if and only if the recommendation fits to a user's current need, this need cannot always be classified correctly (e.g., users themselves might not be sure or aware of it), it can vary, or it can have contradictory sub-aspects. In such situations, it is beneficial to complement such recommendation-based search with exploratory search.

Thus, providing the option to *actively explore* the video database is another key goal for us.

Active exploration is supported by Low et al.'s approach [4] where movies are represented and thus navigated using a metadata based clustering approach. Although quite related to our idea, the approach differs insofar as the reasons for these clusters (e.g., metadata such as genre, actors, director) are not visualized to the user. We claim that explicitly providing this information to a user can have a benefit not only in search performance, but can also make the search process more interesting and engaging. Particularly, we believe that the search for a movie to watch could and should itself be an engaging, entertaining, and fun experience. Thus, providing an *engaging* browsing experience is another key goal we are aiming for.

PROTOTYPE IMPLEMENTATION & STUDY SETUP

Based on the questions stated at the end of the first section and the criteria specified in the preceding one, we performed a pilot study to verify the potential of our idea for visual navigation. Particularly, we were interested in the following three issues:

1. Is our intuition about the lack of existing systems and the resulting specification of goals for our approach correct?
2. Is our approach as simple and intuitive as we assume? That is, can people understand and handle it easily?
3. Is this concept a valid alternative to visual and text-based browsing? What are advantages and disadvantages?

Prototype implementation

In this first step, we are interested in the applicability of our ideas for touchscreen operated tablets. Other devices, such as smartphones, TVs, or PCs will be addressed in our future research. The prototype used in the pilot study and depicted in Fig. 2 was implemented on an Android-based tablet (HTC Nexus 9) with an 8.9-inch screen (2048x1536 pixels resolution, 4:3 aspect ratio). Posters, other visuals, movie information and meta data were taken from *The Movie Database* (TMDb, https://www.themoviedb.org), a collaborative database for movies comparable to the commercial IMDb. We excluded movies of 2017 to avoid having movies in the test that have not been released yet.

The interface starts with a title page showing the twenty most popular movies in the database according to the provided popularity ranks (Fig. 2a). Selecting a movie by tapping its poster evokes the representation of this movie's *detail overview* (Fig. 2b). Here, the movie's poster is centrally shown in front of a movie-related background image. Movie-related meta data is represented around the poster in circular-shaped visualizations. Meta data includes genre, the three main actors, director, writer, main music composer, production company, language, and year. Notice that not all this data is available for each movie. Selecting a category by tapping it evokes what we call the *category view* (Fig. 2c). Here, the 20 most popular movies from that category are shown. Notice that for some specific categories or some actors there might be fewer than 20 movies in the database. Users can then select one of the proposed movies or go back to the previous one using a back button at the top right of the screen.

Participants, study design, and procedure

We invited ten volunteers (8 males, 2 females, 18-23 years, average age 20.5 years) to participate in the pilot study. We focused on younger participants due to the intended target user groups, that is, frequent online media consumers and early adopters. Users were asked about their viewing behavior, with five indicating that they watch TV/movies "very often", three "often", and two "sometimes". Three mentioned to use Netflix or a comparable service "very often", three "often", one "barely", and three "never". Three said to use IMDb or a comparable service "often", two "sometimes", four "barely", and one "never". There was no correlation between these characteristics and the gathered data. Studies took place in a neutral room with participants seated comfortably at a table (cf. Fig. 3).

Figure 3. Illustration of the study conditions.

Despite its informal character, interviews with the subjects were scripted to avoid influencing their answers and achieve comparable feedback across participants. One subject was interviewed at a time. Duration was about 30 minutes per subject. Studies were split in three parts.

Part 1. To gain more insight into problems with standard interfaces (cf. first issue specified above), we started with an informal interview about users' viewing behavior and opinions on related interfaces. At the beginning, users were informed that:

"This is a study about a new alternative interface to access and browse online movie libraries."

After signing a consent form also informing subjects about the anonymous processing of their data, they provided demographic information and viewing behavior (cf. above), and were asked to explain what they liked and disliked about the interfaces of Netflix or similar services and IMDb or similar services. For the latter, subjects were also asked if they would consider it a useful complement to the first one if integrated into it. Screenshots of the interfaces were provided for subjects rather unfamiliar with these services. The interviewer wrote down all the subjects' answers.

Part 2. To verify if people can understand and handle our visual navigation concept (cf. second issue specified above)

we then let people explore the interface without further introduction. The interviewer only stated that:

"This is now a new, alternative interface for accessing and browsing online movie libraries. First, I want to see if you can figure out how it works on your own. Can you try to use it for, let's say 2 minutes? Note that it's not connected to the actual movie database yet, since this test is just about the new interface."

After using the interface for two minutes without any interference of the interviewer, subjects had to rate five statements on a 5-point Likert scale from "strongly disagree" to "disagree" to "neutral" to "agree" to "strongly agree" (see results below for the concrete statements). Afterward, features not used or wrongly handled by the subjects were explained to them.

Part 3. To identify advantages, potential disadvantages, and possibly useful extensions (cf. third issue specified above), subjects then had to solve a concrete task, which was introduced by stating that:

"Now we want to test the interface for 5 minutes with a concrete task. Assume you are about to board a long flight, so you will be offline for a couple of hours. Hence, you want to download a couple of movies to watch when you are in the air. Now use the interface to search for, let's say 3-5 movies that you would probably download. Once you found a candidate, just tell me and I write it down, since we haven't implemented any bookmarking yet."

After performing this task for five minutes without any interference of the interviewer other than writing down the subjects' movie suggestions, they had to rate seven statements related to the interface using the same 5-point Likert scale as above. Following this, the session closed with an informal interview, where subjects were asked what they liked and disliked about the interface, how things they disliked could be improved, if the approach could be used as a replacement or complement to existing interfaces, and if they had any other comments or ideas for possible improvements. Finally, the interviewer discussed their provided ratings and other observations made during the tests with the subjects.

RESULTS & DISCUSSION

In the following, we summarize and discuss the results of the study. While we used the phrasings "Netflix / IMDb or similar services" during the interviews, we will subsequently use the terms "visual browsing" and "text-based browsing" describing the basic underlying concepts. Likewise, we will use "visual navigation" instead of "new interface". Terms in brackets after a statement given below indicate how many subjects made this or a related comment.

Part 1 results (problems with standard approaches)

When asked about the positive aspects of visual browsing-style interfaces, subjects characterized them as visually pleasing and "good looking" (6 subjects), and commented positively on the recommendations (2) and that the interface keeps track of what you watched (2). Most commonly stated negative aspects were that the category order seemed arbitrary and/or hard to find (4) and that searching takes long when one does not know what to watch (3). Other comments include that the amount of content is not enough (2) and that one sees the same movies often (2). These and additional individual statements seem to confirm our intuitive assumption about these types of interfaces stated in the first section.

While some subjects praised the additional functionality offered by text-based browsing interfaces and the provided structure, others described them as chaotic (4), stated that information is hard to find (2). While one subject said that "much of the information is useless", half of them would see text-based browsing as a good complement when integrated into a visual browsing application (5). Thus, again, the subjects' statements confirm our initial assumption that this data could potentially be very useful for video search if and only if it is represented in a way that is simple, structured, and easy to handle and understand.

Part 2 results (understanding and handling)

Table 1 illustrates the answers to the statements rated by the subjects. We see that people give high ratings for the intuitiveness and ease of use of visual navigation. Observations of the interviewer also suggest only minor issues with it that are mostly due to lack of experience; three subjects initially tried to swipe instead of clicking on categories or poster thumbnails, one started clicking on things too fast. (The transitions between the two views were animated.)

	Strongly disagree	Dis-agree	Neutral	Agree	Strongly agree
S1	**0**	**0**	**0**	**4**	**6**
S2	**0**	**0**	**0**	**5**	**5**
S3	**0**	**0**	**0**	**5**	**5**
S4	**0**	**0**	**1**	**7**	**2**
S5	**0**	**2**	**2**	**4**	**2**

S1: I understood the purpose of this application.
S2: The application worked intuitively.
S3: Navigating between movies was easy and straightforward.
S4: I felt in control of the application.
S5: I felt like all information that I needed was there.

Table 1. Number of subjects providing the related rating (column) for the given statement (row).

Despite the additionally displayed information compared to standard visual browsing-based interfaces, we can observe that subjects still felt that providing additional data would be good. When asked, most of them mentioned the information that is shown in the textual descriptions on the

details page for visual browsing (cf. Fig. 1, bottom), for example, run time and short synopsis. Such info could easily be integrated into our design using the empty spaces next to the visuals (cf. screenshots in Fig. 2). Yet, finding the right balance between how much and what kind of information should be displayed at all and in what way (textual or visual) is no trivial task and needs to be addressed in future research.

Part 3 results (advantages, disadvantages, ideas)

Statements in the questionnaire, illustrated in Table 2, cover different aspects. Subjects gave high ratings for ease of use (S1/S2), which is in line with the comments, ratings, and observations of part 2. Considering availability of information (S3), ratings are more neutral, which is again in line with part 2. It can be seen though that the tendency towards a lower rating is even stronger when faced with a concrete task. Again, this supports our claim that users appreciate or even demand more information when exploring movie databases. Keeping in mind that our approach provides much more context information about a movie than standard visual browsing interfaces, it is no surprise then, that most participants see visual navigation as a good complement (S5) or even replacement (S4) to those. A similarly strong trend cannot be observed for text-based browsing however (S6/S7). It is unclear though if this really suggests that our approach is considered to lack in power, or if subjects consider the lacking parts to be of lesser need when searching for videos.

	Strongly disagree	Dis-agree	Neutral	Agree	Strongly agree
S1	**0**	**0**	**1**	**7**	**2**
S2	**0**	**0**	**2**	**6**	**2**
S3	**0**	**2**	**5**	**3**	**0**
S4	**0**	**0**	**3**	**4**	**3**
S5	**0**	**0**	**0**	**7**	**3**
S6	**0**	**1**	**4**	**2**	**3**
S7	**1**	**1**	**2**	**4**	**2**

S1: It was easy to find movies that I wanted to watch.
S2: It was easy to navigate between the movies.
S3: There was enough information for each movie.
S4: I would use this application instead of Netflix for finding movies to watch.
S5: I would use this application as a complement to Netflix for finding movies to watch.
S6: I would use this application instead of IMDb for finding movies to watch.
S7: I would use this application as a complement to IMDb for finding movies to watch.

Table 2. Number of subjects providing the related rating (column) for the given statement (row).

The subjects' comments during the subsequent interview support these observations. Most described the interface as visually appealing and easy to use. Related phrases included "feels natural", "well-designed", "easy to use" (6 subjects). Some also appreciated that one can "build on previous search queries and don't has to keep starting over" (5). Some mentioned that you get "good suggestions" (3) and that "lot of information (is) present" (2). On the negative side, only one subject stated that the "UI (is) not clear enough." All other negative comments expressed the desire for additional functionality: a (categorized) search functionality (8), more information per movie, e.g., runtime, more actors (4), ratings / reviews (3), a home button (3), trailers (1), an overview of categories (1), and more detailed ones (1).

This, again, supports our claim that users prefer access to more information when searching for movies than usually provided by standard systems. Two subjects made comments during the test that are particularly interesting in this context: One said that "I never would've thought to search on production company, this is nice!" After clicking on the icon of an actress, another one asked: "Does she really play in all those movies?" These statements suggest that our approach does not only provide additional information to users that they are otherwise missing, but that it can also encourage them to search differently and help them to find movies that they would otherwise miss or ignore.

While one subject stated that "there is a good balance between the amount of information and easy browsing," we do consider it a non-trivial and maybe the most important question for future research to find this perfect balance. Two subjects highlighted that it could happen that one "enters a loop of the same movies". We often hear similar statements when people click on the "related movies" suggestions in visual browsing interfaces and the same movies are recommended repeatedly. Yet, it is certainly a risk in our approach as well. One might be able to resolve this issue though by finding the best information-versus-complexity balance as more navigation options will make this less likely.

CONCLUSION & FUTURE WORK

The design of better interfaces for online video archives is a problem of high relevance due to the increasing amount of data. Part 1 of our pilot study confirmed our initial, intuitive assumptions about common problems with existing interfaces, which mostly rely on the concept of visual browsing. Parts 2 and 3 confirmed that our alternative idea, entitled visual navigation, could provide a solution to deal with these problems: the subjects' answers and comments suggest a need for providing more information and that visualization could be a good and intuitive way to do this. Yet, it also became clear that what to visualize and how is a critical and non-trivial question.

General feedback for the prototype implementation was overwhelmingly positive. One user even said this is "exactly what I want for Netflix." The more critical comments suggest that this positive impression is not just due to the commonly observed "newness factor", but based on educated reasoning. Also, we restricted the subjects to a group of early adopters and tech-savvy users. While this makes the statements more reliable, it does not allow us to generalize observations about intuitiveness and ease of use to the general population. This is in fact one of the most important and hardest challenges we are facing when designing interfaces for online movie databases: that they must be so intuitive and easy to handle that even totally inexperienced users can work with them (and enjoy doing this), while at the same time providing all the necessary power and functionality more experienced users are demanding for.

The positive results of our pilot study are based on feedback from the latter group, i.e., experienced users. Their encouraging comments and positive recommendations suggest several improvements, which we will address as a next step before testing a revised and enhanced design with broader and more heterogeneous user communities. Important questions to answer in this context include: What textual information should be added? What categories should be used and how should they be visualized? And, most importantly, what is the optimum tradeoff between providing additional information and not overwhelming the user or complicating the interaction? Likewise, we need to investigate what other functions (e.g., standard search, history and "go back" options) should be added and how they can best be integrated.

REFERENCES

1. Arapakis, I., Moshfeghi, Y., Joho, H., Ren, R., Hannah, D. and Jose, J.M., 2009, July. Enriching user profiling with affective features for the improvement of a multimodal recommender system. In *Proceedings of the ACM International Conference on Image and Video Retrieval* (p. 29). ACM.
2. Bollen, J., Nelson, M.L., Geisler, G. and Araujo, R., 2007. Usage derived recommendations for a video digital library. *Journal of network and computer applications*, *30*(3), pp.1059-1083.
3. Hua, X.S. and Zhang, H.J., 2004, November. An attention-based decision fusion scheme for multimedia information retrieval. In *Pacific-Rim Conference on Multimedia* (pp. 1001-1010). Springer Berlin Heidelberg.
4. Low, T., Hentschel, C., Stober, S., Sack, H. and Nürnberger, A., 2017, January. Exploring Large Movie Collections: Comparing Visual Berrypicking and Traditional Browsing. In *International Conference on Multimedia Modeling* (pp. 198-208). Springer, Cham.
5. Schoeffmann, K., Hopfgartner, F., Marques, O., Boeszoermenyi, L. and Jose, J.M., 2010. Video browsing interfaces and applications: a review. *Journal of Photonics for Energy*, pp.018004-018004.
6. Schoeffmann, K., Hudelist, M.A. and Huber, J., 2015. Video interaction tools: a survey of recent work. *ACM Computing Surveys (CSUR)*, *48*(1), p.14.
7. Shardanand, U. and Maes, P., 1995, May. Social information filtering: algorithms for automating "word of mouth". In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 210-217). ACM Press/Addison-Wesley Publishing Co.
8. Yang, B., Mei, T., Hua, X.S., Yang, L., Yang, S.Q. and Li, M., 2007, July. Online video recommendation based on multimodal fusion and relevance feedback. In *Proceedings of the 6th ACM international conference on Image and video retrieval* (pp. 73-80). ACM.

7 Conclusion and Future Work

The goal of this thesis was to combine the ease of browsing from visual browsing interfaces with the information richness of text-based browsing interfaces and in this way stimulate active exploration of online movie databases. Towards this goal, we presented the concept of visual navigation. With visual navigation, movie information is presented visually and it allows users to browse related movies by selecting movie information that they are most interested in. After a successful pilot study that showed the potential of the concept, we performed two experiments to compare visual navigation to a state-of-the-art alternative. A controlled lab study and an online study were performed and both studies showed that participants experienced more intrinsic motivation to use the visual navigation concept. Participants of the lab study also found the visual navigation interface to be more useful. The studies also showed that participants used movie metadata significantly more often while browsing with the visual navigation interface. This observation indicates that participants were exploring the movie database more actively using the visual navigation interface. The fact that the two studies were performed under very different circumstances but showed similar outcomes, adds to the strength of the results.

In the annotated appendix, we explored related research domains and discussed how they can benefit this project. Next, we presented details of the performed experiments that were not covered by the scientific paper, including a published paper that discusses the pilot study. To showcase the concept, we demonstrated an implementation of visual navigation where feedback from the experiments was taken into account. Finally we justified our choice of movie database with a comparative analysis of four major movie databases.

With this thesis, we presented the visual navigation concept and showed its promise by presenting the results of two experiments. One of the areas where the experiment results differed was the amount of different types of metadata that users clicked on. For future research it would be interesting to investigate what types of metadata users are interested in and which metadata should be presented to engage users the most. We presented movie metadata in a circle around the movie poster. When one wishes to present more metadata than we do right now, this design is not feasible. Therefore it is worth exploring other designs to present the movie metadata and visualize it. Finally, this research project only covered touch screen devices and it would be interesting to see how it can be implemented for other devices, such as: TV's and PC's. These interfaces are generally different and the way that people use movie metadata might be very different on these interfaces.

References

[1] Cisco Visual Networking Index. Cisco visual networking index: Global mobile data traffic forecast update, 2015-2020 white paper. *Accessed date: 16-01-2017*.

[2] Gary Marchionini. Exploratory search: from finding to understanding. *Communications of the ACM*, 49(4):41–46, 2006.

[3] Klaus Schoeffmann, Marco A Hudelist, and Jochen Huber. Video interaction tools: a survey of recent work. *ACM Computing Surveys (CSUR)*, 48(1):14, 2015.

[4] Klaus Schoeffmann. A user-centric media retrieval competition: The video browser showdown 2012-2014. *IEEE MultiMedia*, 21(4):8–13, 2014.

[5] Zhenxing Zhang, Wei Li, Cathal Gurrin, and Alan F Smeaton. Faceted navigation for browsing large video collection. In *International Conference on Multimedia Modeling*, pages 412–417. Springer, 2016.

[6] Kai Uwe Barthel, Nico Hezel, and Radek Mackowiak. Graph-based browsing for large video collections. In *International Conference on Multimedia Modeling*, pages 237–242. Springer, 2015.

[7] Kai Uwe Barthel, Nico Hezel, and Radek Mackowiak. Imagemap-visually browsing millions of images. In *International Conference on Multimedia Modeling*, pages 287–290. Springer, 2015.

[8] Jörg Waitelonis and Harald Sack. Towards exploratory video search using linked data. *Multimedia Tools and Applications*, 59(2):645–672, 2012.

[9] Thi-Nhu Nguyen, Duy-Thanh Dinh, and Tuan-Dung Cao. Empowering exploratory search on linked movie open data with semantic technologies. In *Proceedings of the Sixth International Symposium on Information and Communication Technology*, pages 296–303. ACM, 2015.

[10] Barnaby Craggs, Myles Kilgallon Scott, and Jason Alexander. Thumbreels: query sensitive web video previews based on temporal, crowdsourced, semantic tagging. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems*, pages 1217–1220. ACM, 2014.

[11] Thomas Low, Christian Hentschel, Sebastian Stober, Harald Sack, and Andreas Nürnberger. Exploring large movie collections: Comparing visual berrypicking and traditional browsing. In *International Conference on Multimedia Modeling*, pages 198–208. Springer, 2017.

[12] John C Gower. Generalized procrustes analysis. *Psychometrika*, 40(1):33–51, 1975.

[13] Upendra Shardanand and Pattie Maes. Social information filtering: algorithms for automating "word of mouth". In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 210–217. ACM Press/Addison-Wesley Publishing Co., 1995.

[14] Johan Bollen, Michael L Nelson, Gary Geisler, and Raquel Araujo. Usage derived recommendations for a video digital library. *Journal of network and computer applications*, 30(3):1059–1083, 2007.

[15] Ioannis Arapakis, Yashar Moshfeghi, Hideo Joho, Reede Ren, David Hannah, and Joemon M Jose. Enriching user profiling with affective features for the improvement of a multimodal recommender system. In *Proceedings of the ACM International Conference on Image and Video Retrieval*, page 29. ACM, 2009.

[16] Bo Yang, Tao Mei, Xian-Sheng Hua, Linjun Yang, Shi-Qiang Yang, and Mingjing Li. Online video recommendation based on multimodal fusion and relevance feedback. In *Proceedings of the 6th ACM international conference on Image and video retrieval*, pages 73–80. ACM, 2007.

[17] Xian-Sheng Hua and Hong-Jiang Zhang. An attention-based decision fusion scheme for multimedia information retrieval. In *Pacific-Rim Conference on Multimedia*, pages 1001–1010. Springer, 2004.

[18] Oktie Hassanzadeh and Mariano P Consens. Linked movie data base. In *LDOW*, 2009.

[19] Xavier Amatriain and Justin Basilico. Netflix recommendations: beyond the 5 stars (part 1). *Netflix Tech Blog*, 6, 2012.

[20] Jun Gong and Peter Tarasewich. Guidelines for handheld mobile device interface design. In *Proceedings of DSI 2004 Annual Meeting*, pages 3751–3756, 2004.

[21] Ben Shneiderman. *Designing the user interface: strategies for effective human-computer interaction.* Pearson Education India, 2010.

[22] Lari Kärkkäinen and Jari Laarni. Designing for small display screens. In *Proceedings of the Second Nordic Conference on Human-computer Interaction*, NordiCHI '02, pages 227–230, New York, NY, USA, 2002. ACM.

[23] Wolfgang Hürst, Cees GM Snoek, Willem-Jan Spoel, and Mate Tomin. Size matters! how thumbnail number, size, and motion influence mobile video retrieval. In *International Conference on Multimedia Modeling*, pages 230–240. Springer, 2011.

[24] Songyang Lao, Xiangan Heng, Guohua Zhang, Yunxiang Ling, and Peng Wang. A gestural interaction design model for multi-touch displays. In *Proceedings of the 23rd British HCI Group annual conference on people and computers: Celebrating people and technology*, pages 440–446. British Computer Society, 2009.

[25] Andrew Bragdon, Eugene Nelson, Yang Li, and Ken Hinckley. Experimental analysis of touch-screen gesture designs in mobile environments. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 403–412. ACM, 2011.

[26] Sebastian Schmidt, Miguel A. Nacenta, Raimund Dachselt, and Sheelagh Carpendale. A set of multi-touch graph interaction techniques. In *ACM International Conference on Interactive Tabletops and Surfaces*, ITS '10, pages 113–116, New York, NY, USA, 2010. ACM.

[27] ISO DIS. 9241-210: 2010. ergonomics of human system interaction-part 210: Human-centred design for interactive systems. *International Standardization Organization (ISO). Switzerland*, 2009.

[28] Arnold POS Vermeeren, Effie Lai-Chong Law, Virpi Roto, Marianna Obrist, Jettie Hoonhout, and Kaisa Väänänen-Vainio-Mattila. User experience evaluation methods: current state and development needs. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries*, pages 521–530. ACM, 2010.

[29] V Roto, E Law, A Vermeeren, and J Hoonhout. All about ux. `http://www.allaboutux.org`. Accessed: 14-01-2017.

[30] David Watson, Lee A Clark, and Auke Tellegen. Development and validation of brief measures of positive and negative affect: the panas scales. *Journal of personality and social psychology*, 54(6):1063, 1988.

[31] Viswanath Venkatesh, Michael G Morris, Gordon B Davis, and Fred D Davis. User acceptance of information technology: Toward a unified view. *MIS quarterly*, pages 425–478, 2003.

[32] Fred D Davis Jr. *A technology acceptance model for empirically testing new end-user information systems: Theory and results.* PhD thesis, Massachusetts Institute of Technology, 1986.

[33] Robert W Plant and Richard M Ryan. Intrinsic motivation and the effects of self-consciousness, self-awareness, and ego-involvement: An investigation of internally controlling styles. *Journal of Personality*, 53(3):435–449, 1985.

[34] Margaret M Bradley and Peter J Lang. Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of behavior therapy and experimental psychiatry*, 25(1):49–59, 1994.

[35] Marc Hassenzahl, Michael Burmester, and Franz Koller. Attrakdiff: Ein fragebogen zur messung wahrgenommener hedonischer und pragmatischer qualität. In *Mensch & Computer 2003*, pages 187–196. Springer, 2003.

[36] Carroll E Izard. *The Differential Emotions Scale: DES IV-A;[a Method of Measuring the Meaning of Subjective Experience of Discrete Emotions]*. University of Delaware, 1993.

[37] Gregory J Boyle. Reliability and validity of izard's differential emotions scale. *Personality and Individual Differences*, 5(6):747–750, 1984.

[38] Raphael Zenk, Matthias Franz, and Heiner Bubb. Emocard–an approach to bring more emotion in the comfort concept. *SAE International Journal of Passenger Cars-Mechanical Systems*, 1(2008-01-0890):775–782, 2008.

[39] Geneva Emotion Research Group et al. Geneva appraisal questionnaire (gaq): Format, development, and utilization. *Staženo*, 16(1):2015, 2002.

[40] Tanja Bänziger, Véronique Tran, and Klaus R Scherer. The geneva emotion wheel: A tool for the verbal report of emotional reactions. *Poster presented at ISRE*, 149:271–294, 2005.

[41] Kevin E Voss, Eric R Spangenberg, and Bianca Grohmann. Measuring the hedonic and utilitarian dimensions of consumer attitude. *Journal of marketing research*, 40(3):310–320, 2003.

[42] Hans Van der Heijden and Lotte Sangstad Sørensen. Measuring attitudes towards mobile information services: an empirical validation of the hed/ut scale. In *ECIS*, pages 765–777, 2003.

[43] Edward McAuley, Terry Duncan, and Vance V Tammen. Psychometric properties of the intrinsic motivation inventory in a competitive sport setting: A confirmatory factor analysis. *Research quarterly for exercise and sport*, 60(1):48–58, 1989.

[44] Emanuelle Cavalcante, Luis Rivero, and Tayana Conte. Max: A method for evaluating the post-use user experience through cards and a board. In *SEKE*, pages 495–500, 2015.

[45] Ferdinand Rudolf Hendrikus Zijlstra. *Efficiency in work behaviour: A design approach for modern tools*. TU Delft, Delft University of Technology, 1993.

[46] Albert Mehrabian. Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in temperament. *Current Psychology*, 14(4):261–292, 1996.

[47] Ute Engelen, Steven De Peuter, An Victoir, Ilse Van Diest, and Omer Van den Bergh. Verdere validering van de positive and negative affect schedule (panas) en vergelijking van twee nederlandstalige versies. *gedrag en gezondheid*, 34(2):61–70, 2006.

[48] Lidia Oshlyansky, Paul Cairns, and Harold Thimbleby. Validating the unified theory of acceptance and use of technology (utaut) tool cross-culturally. In *Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI...But Not As We Know It - Volume 2*, BCS-HCI '07, pages 83–86, Swindon, UK, 2007. BCS Learning & Development Ltd.

[49] Inc. IMDb.com. Imdb database statistics. http://www.imdb.com/stats. Accessed: 2016-12-05.

[50] Brian Fritz. Open movie database change log. https://www.omdbapi.com/#changeLog. Accessed: 2016-12-05.

[51] The Movie Database. General faq. https://www.themoviedb.org/faq/general. Accessed: 2016-12-06.

[52] O. Hassanzadeh and M. Consens. Linked movie data base. *Proceedings of LDOW2009, World Wide Web Conference*, 2009.

[53] Mariano P. Consens, Oktie Hassanzadeh, and Adrian M. Teisanu. Linked movie database. http://www.linkedmdb.org/. Accessed: 2016-12-06.

[54] Internet Archive. The wayback machine. https://archive.org/web/. Accessed: 2016-12-06.

[55] World Wide Web Consortium. Sparql query language for rdf, w3c recommendation 15 january 2008. *https://www.w3.org/TR/2008/REC-rdf-sparql-query-20080115/*.

[56] Wolfgang Hürst and Bruno dos Santos Carvalhal. Exploring online video databases by visual navigation. In *Adjunct Publication of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video*, TVX '17 Adjunct, pages 39–44, New York, NY, USA, 2017. ACM.