Which movie should I watch tonight?

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ABSTRACT

Data visualization is presenting data in the pictorial or graphical format to enable decision making, analysis of the data, grasp difficult concepts or identify new patterns. Making them interactive enables a drill down into charts and graphs for more details. How visualization techniques can be implemented to achieve all of this, was the question that intrigued us to pick up evaluation study of an existing visualization project theme. Different usability evaluation methods include Heuristic evaluation, Affinity Diagramming, Persona, User tasks, Think Aloud, survey. We learnt about how a visualization should be made better so as to be interactive and more intuitive, what users expect them to be. Do users really care about them being fancier over more usable? The database was not part of the study, however, to make it interesting to the users we picked up a theme based on a common man's interest and it was about Hollywood movies

KEYWORDS

Visualization, semantic depth, marks, channels, color blind safe, heuristics, user tasks, think aloud, affinity diagramming

INTRODUCTION

The time we decided to pick up the evaluation study, we wanted to pick a theme that interests a common man. One other requirement to choose the evaluation was to compare two visualizations on the same theme/topic. When we browsed through different available visualizations a few topics that interested the team members as users were Music, Movies, weather maps etc. More important factor was, we being able to comprehend them when we casually explore them. The team zeroed down on movies theme as we found a "Hollywood Visualization Challenge". In January 2012, The Information is Beautiful Awards launched a data visualization challenge for Hollywood films from 2007–2011, providing an "ultra-comprehensive dataset that lifts the lid on opening weekends, worldwide gross, budgets, storylines, review scores – everything – for every Hollywood film released in the last five years." [1] From the multiple entries we picked up two that looked pretty as well as useful.

PROBLEM SPACE

We explored both the shortlisted visualizations. We realized that we ourselves so many time are in the situation where we are not able to decide which movie to watch. One of the visualizations title caught our attention as it was the same burning question all of us have when we are in a fix to select a movie to watch. Most of the times we end up being disappointed with a wrong selection of the movie. Also, we searched and found that there are not many useful and effective movie search websites are available which gives information about the movies based on their popularity, ratings, star cast, story etc. from different genres and era. So our main problem space was identified clearly. We decided to base our study with this title "Which movie should I watch tonight?"

The two visualizations we shortlisted revolve around the same theme, one being more rating based, providing somewhat financial information and financial trend whereas other focussing more on rating, story, genre and popularity of the movie. Let's see what they offer to their offer

VISUALIZATION 1: PRETTY CIRCLES

Figure 1: Overall Pretty Circle view

Pretty circle Visualization looks pretty because of the color scheme and the opacity of the colors used. This is the overall view of the visualization. Visualization and filters occupy half of the view and user has to scroll down to read the description of the visualization. The black line navigates the user to different movie circles, represented by two circles for each movie, purple for critic rating and pink for audience rating. User can search the movie, or filter using the rating filter depicted my emoticons, or with audience and critic agreement filter. The movie circles are laid out from left to right with high critic rating on left to low on right and low audience rating on left to high audience rating to right. Y axis ratings go on increasing.

The area chart denotes the agreement of audience and critic rating.

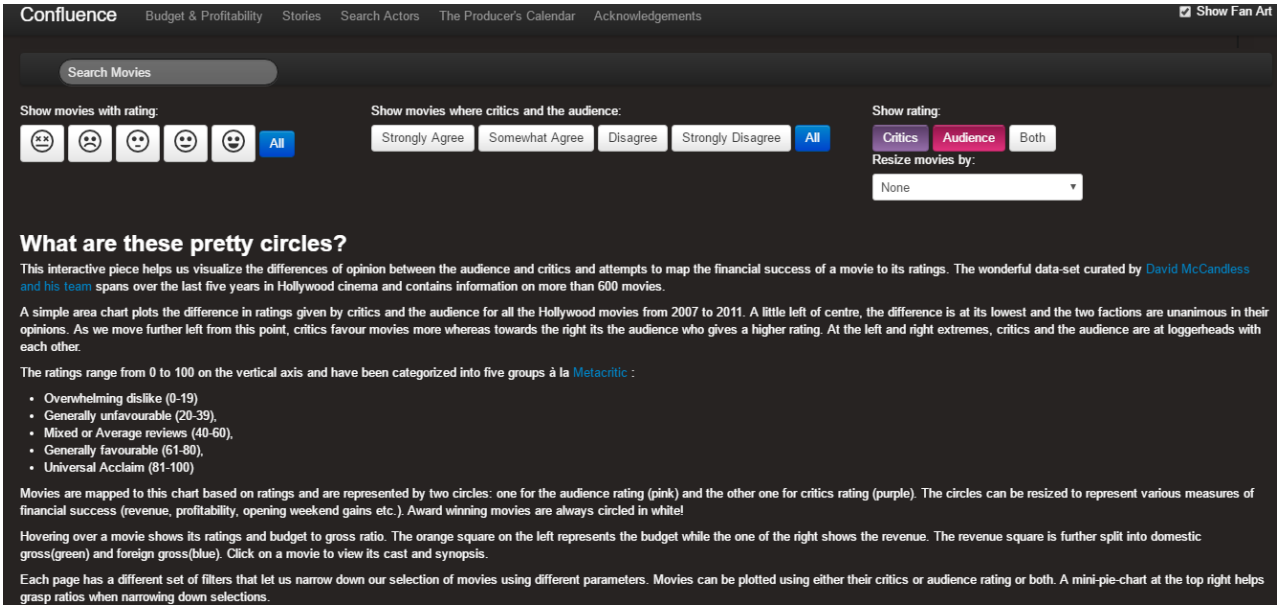

Figure 2: Ignored and textual description

Figure 3: Budget and Profitability Tab with filters

The user is on the second tab “Budget and Profitability”, however, the user never gets to know about it as the tab is not highlighted. Filters are used quite effectively

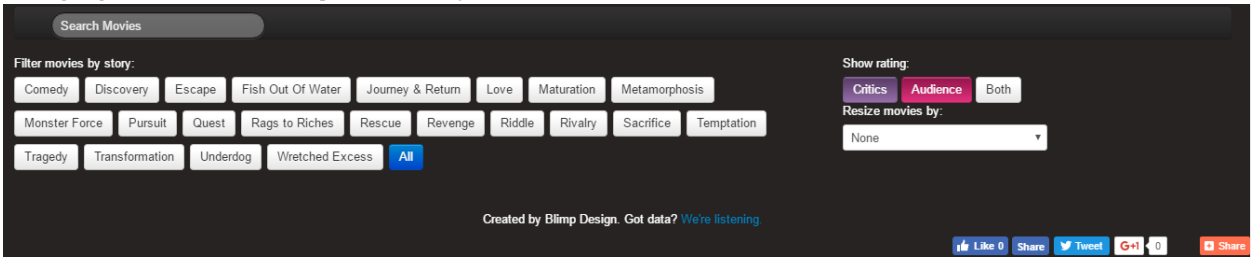

Figure 4: Story Filters on Stories tab

Figure 5: Search by actors tab, the main filter tab was moved to upper right corner which was highly unlikely noticeable

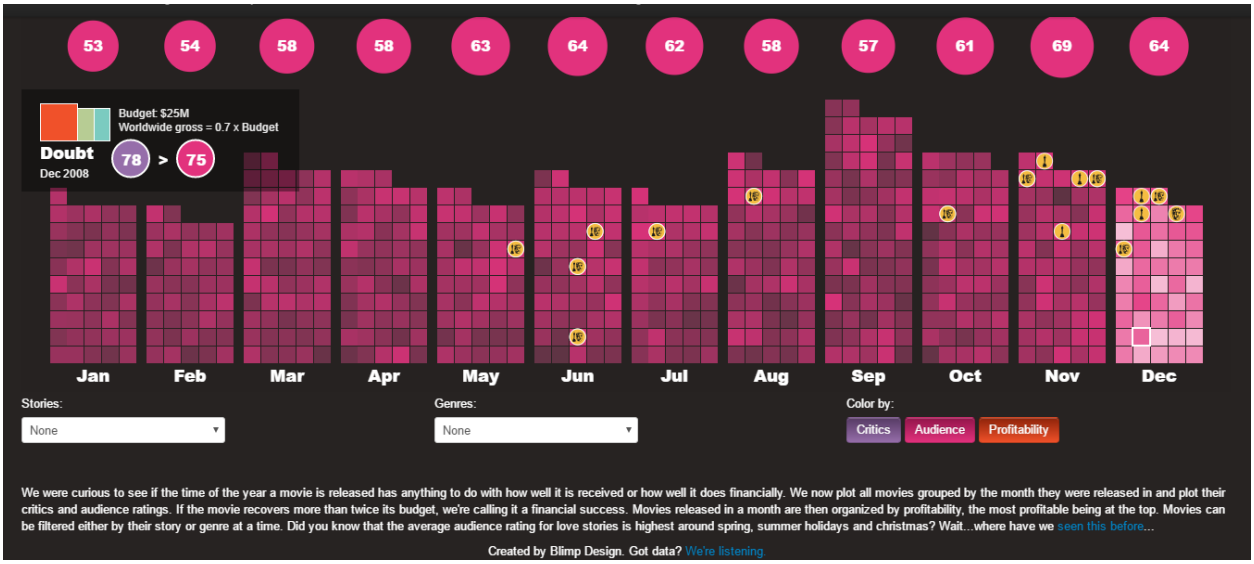

Figure 6: Producer's calendar tab showing the movie trend as per profit and month

In Producer's Calendar tab, until we read the description below we were not able to comprehend the functionality and how to read the information and find trend. Even after we got the gist of it, some questions were unanswered like how the color saturation impacts the profitability and how much is it, how many movies are laid out in the month

VISUALIZATION 2: WHAT MOVIE SHOULD WE WATCH TONIGHT?

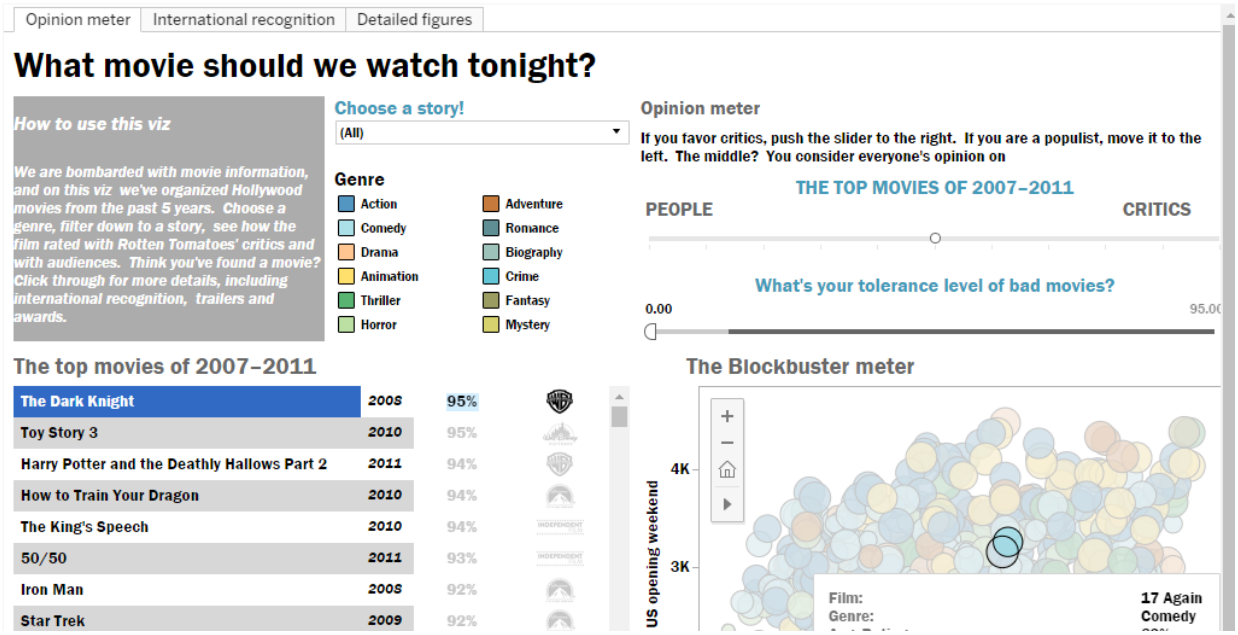

Figure 7: Overall view of the visualization, displays description, movie critic and popularity bar

Visualization 2 is more specific about selecting a movie. The main attraction is somewhat ignored due to its location. The catchy part of the visualization is the title. Description is very brief and very easy to understand. Then the story and its dependent genre filter come into picture. The opinion meter provided with audience and people rating and how strongly they agree and disagree. However, it is not well explained so we were not able to use it very effectively. Then comes the Top movies list, it changes as per the filter selection giving release year and average rating of the movie. Now comes the main visualization. Scatter plot with 4 different variables, rating on X-Axis, number of the theatres in US opening week, color of the circle depicting the genre of the movie and size was based on the number of countries the movie was scanned. On hovering over a movie circle, tooltip displays the information about the movie. Pan and zoom selection is provided to again select movies in a particular region

Tab 2 is about how well the movie did internationally in terms of budget, gross income etc. using a world map with pan and zoom functionality

Tab 3 mostly gives detailed information about the selected movie

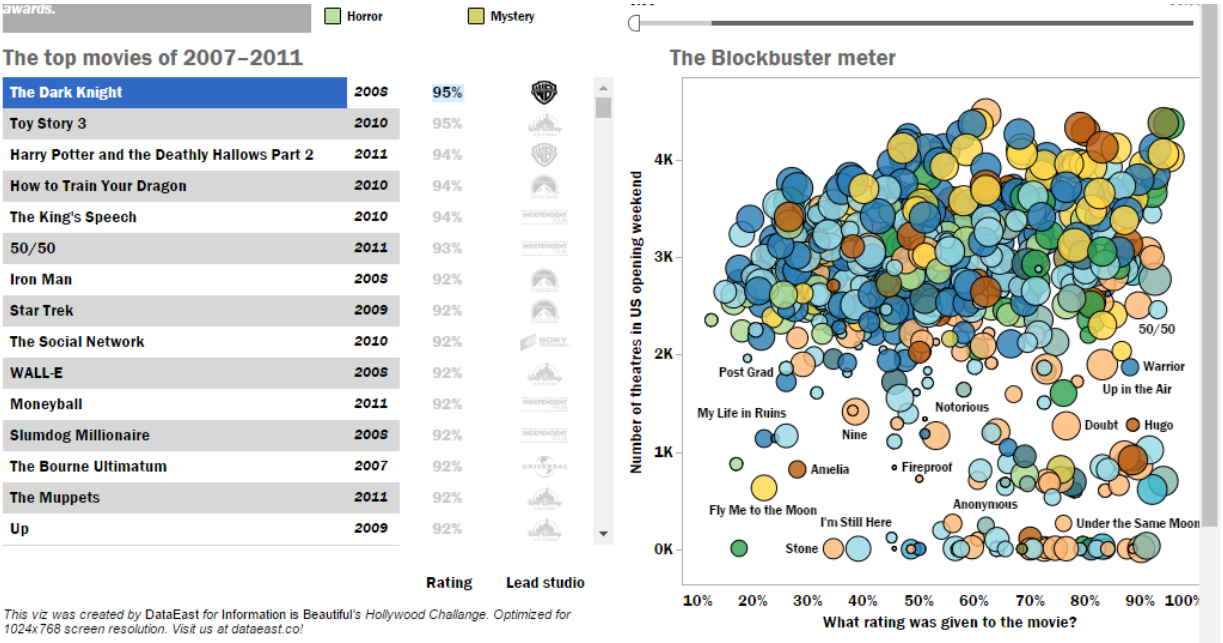

Figure 8: Main visualization, somewhat remains unnoticeable because of the list of top movies and the placement of visualization

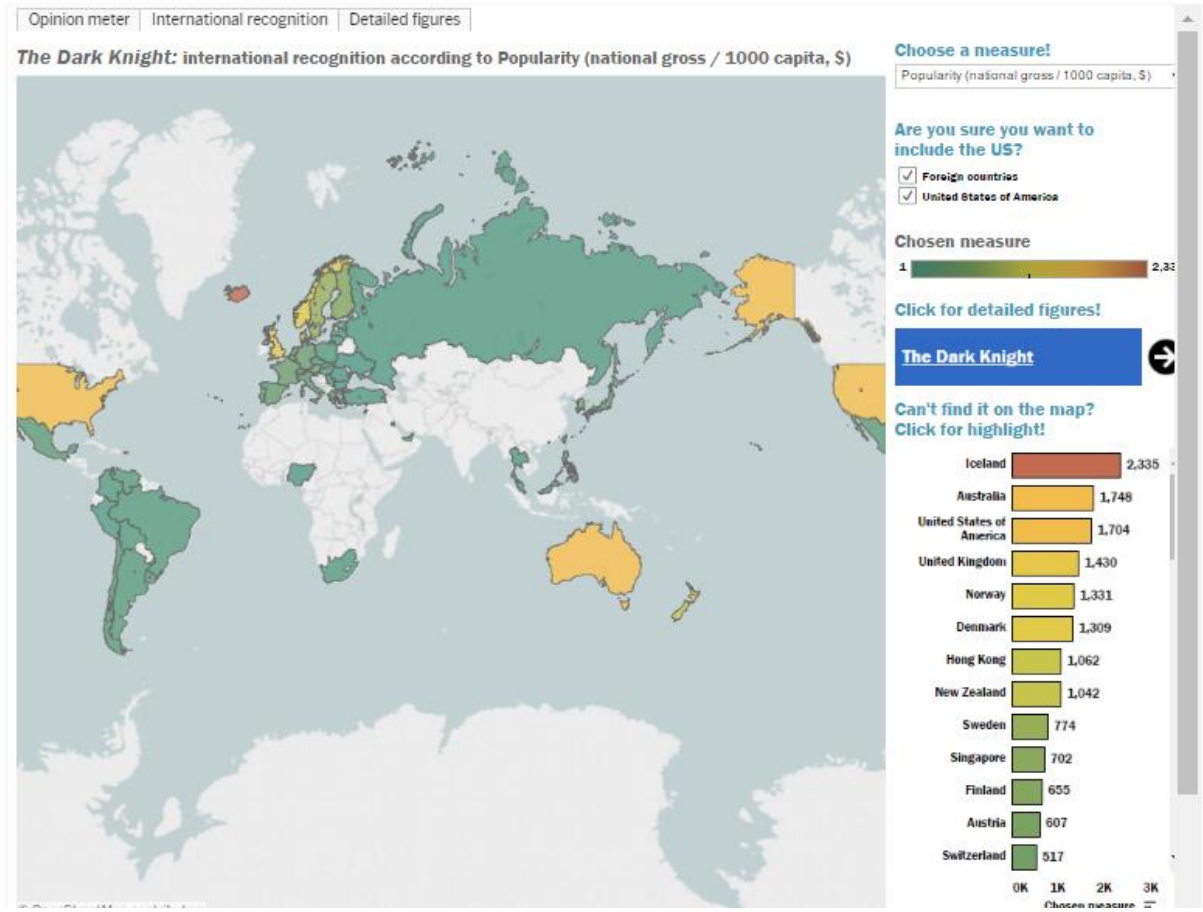

Figure 9: Tab 2 'International Recognition", giving very useful information about how much a movie was popular and financial successful in other countries

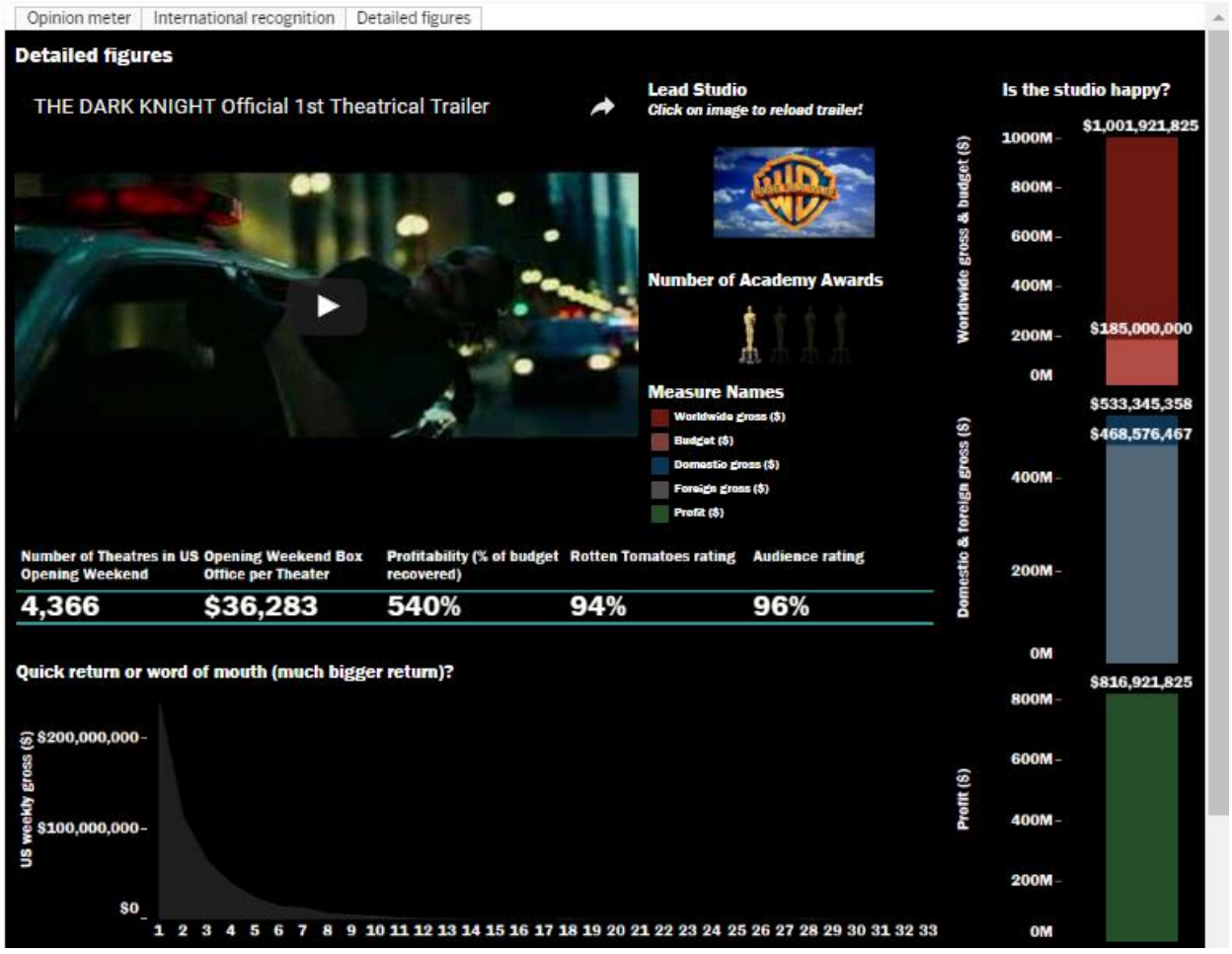

Figure 10: Detailed figure tab with more detail information about the movie selected on the first tab

STUDY DESIGN

The whole process of visualization evaluation can be divided into 2 phases.

Phase 1:

The heuristic Evaluation. The goal of this evaluation was to figure out the major usability strengths and flaws with the two selected visualizations in reference to Jakob Nielsen's ten usability heuristics, Visualization heuristics from the literature and the principles from the class. In order to ensure quality and unbiased evaluations from each evaluator, we sat together to came up with our observations regarding the application's interface and then compared it with the pre-defined list of the heuristics. We tried to focus on the core functionality of both the visualizations.

We then gathered as a group and did an affinity diagram to gather our thoughts and combine elements with the same heuristics problems. The problems were written on post-it notes in an online collaborative application called "Realtimeboard" for data aggregation and analysis. Since the observations were diverse and/or overlapping, we conducted affinity diagrams in several steps till we got all the data aggregated in some meaningful clusters. The final step of the affinity diagramming involved clustering the observations based on interface and interactions elements and then dividing the data inside these into the pain points and the good elements. The final clusters were organised in a flow as shown below:

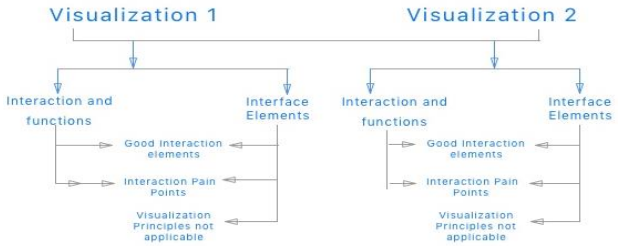

Figure 11: Final data cluster in affinity Diagramming process

Phase 2:

The second phase for the evaluation was the Usability testing. This proved out to be a very efficient technique to evaluate both the visualizations by testing it on users. This method gave us direct input on how real users use the system. To proceed with this study, we went through the following steps:

Persona Creation:

We build a persona to facilitate us finding the target user for the visualization. The personas also had the scenario which stated a situation where the user will be using the visualization. Since the visualization could also show movie trends, we decided to go with 2 types of personas. The first being a normal user who would be looking for a movie suggestion and another who would be interested in seeing the different trend in the film industry.

User tasks:

We came up with 5 different tasks for the user based upon the pain points we had figured out in the heuristic study. The tasks was framed such that the results would help us gauge the performance and effectiveness of both the visualizations. The tasks were both exploratory and specific in nature.

Pilot Study:

The decided tasks were performed by one of us to ensure our process was foolproof and that the metrics we had chosen would provide us with valid results.

Think Aloud Session:

This was the part, the participants were subjected to an experimental study where the users were given a scenario and asked to execute five tasks in both of the visualizations and think aloud their thoughts while doing so. The time on task, error count and task success for all the tasks was measured to understand the correlation between the two visualization usages in terms of convenience. After the experiment, the users were asked several open-ended questions to understand their overall experience interacting with both the visualization, followed by a survey. Participants were asked open-ended questions in order to grasp an understanding about the general view the participants hold about the factors that might impact their usage of these visualizations. The data collected here was all in the form of field notes and Qualitative in nature.

User Survey:

After the think aloud session, the participants were asked to fill out a survey. The survey was to collect the basic demographic information of the participants such as age, and few open-ended questions. The open-ended questions helped in making design decisions for the experimental setup like which elements and filters could be used for an efficient working of the Visualization. This was also a source to collect information about user's choice of filters when searching for a movie.

Data Analysis:

This was the part where the data was aggregated and then analysed to come up with design recommendations. The qualitative data was used to find opinions and the Quantitative data was used to find the reasons for the opinions and preferences. Together it gave us an insight on components users had trouble with, the components they liked or disliked.

User Tasks

Following are the user tasks that we came up with:

1. Exploration - Go through the whole visualization and speak out whatever you learn from it.
2. List a movie which belongs to the genre "Action" and story "Comedy".
3. List a movie which has excellent critic as well as audience rating.
4. List a movie which has Gross income at least 5 times the budget.
5. Hit any movie, Give us the following details about it
    a. Audience rating
    b. Budget of the movie
    c. Is it an award winning movie? Yes/ No?
    d. How much profit did it make?
    e. When was it released?
    f. Genre
    g. Story
    h. Actors

Usability Study Methodology

We used within-subjects design. In this within-subjects study, all participants worked through both the visualizations. We conducted 9 individual 45-minute usability study sessions. Each participant performed all of

the five tasks provided to them in both the visualizations. Three minutes at the beginning of each session was used to explain the session to the participant, and review basic background information with the participant. We also conducted a post-task five minute survey.

Participants:
Our target audience for the survey were adult people between 23-30 years who are interested in watching movies. The mode of recruiting participants was through emails, instant messages, approaching participants one-on-one and requesting on social network websites. Participants were grad students, IT professional. We conducted the testing with 9 participants and all of the 9 also took the survey. The interaction of different age group users added richness to our dataset and helped to analyse the factors that are impacted by the age of the participants. The variation in the participants allowed for a better understanding of the different levels of perception about the different elements of both the visualizations.

Pre-Test Introduction (5 minutes):
It was a five minute conversation with Participants to give them introduction about the session and ask general questions to make them feel comfortable (name, age, how they usually find movies). We explained them what we were trying to achieve through our study.

Tasks (40 minutes):
Participants were asked to complete all the five tasks in both the visualizations. The first five participants were asked to complete all the tasks on visualization 1 first and then take up the second one. We changed the order of visualization to be evaluated for the next set of participants. This was done to take care that there would be no biased decisions made by the users for the second visualization they would be evaluating.

Post-test Survey (5 minutes):
Open ended questions to figure out the reasons for their preferences.

Follow up on any interesting data or any particular problem that came up for the participant.

Types of data collected:
We collected both qualitative and quantitative data from the user task study and quantitative data from the post task survey. Overall, the data collected was:
Quantitative Data:

1. Time on task
2. Task success

Qualitative data:

1. Field notes
2. Quotes from participants

Observation data:
Notes taken during the think aloud session.

RESULTS

Heuristics Evaluation Result:
We evaluated both the interaction and interface heuristics of the visualizations separately. For interaction design evaluation, we used Neilson & Norman Group Heuristic Principles as guidelines. For the interface evaluation, we collected all the principles for visualizations from our class and a couple of papers. Then evaluated the visualizations based on all these principles.
Appendix A&B are the results of interaction evaluation.

After completing the Heuristic evaluation for both the visualizations we felt that we have understood the functions of both the visualizations and the information which they provide. Also, it gave us a fair idea about the target users of the visualizations.

Personas:
This evolved into two personas – two types of users of the visualizations. One is a student who is a movie fan, another one is a filmmaker who needs to know the box office trends of the past released movies.

PERSONA: STUDENT

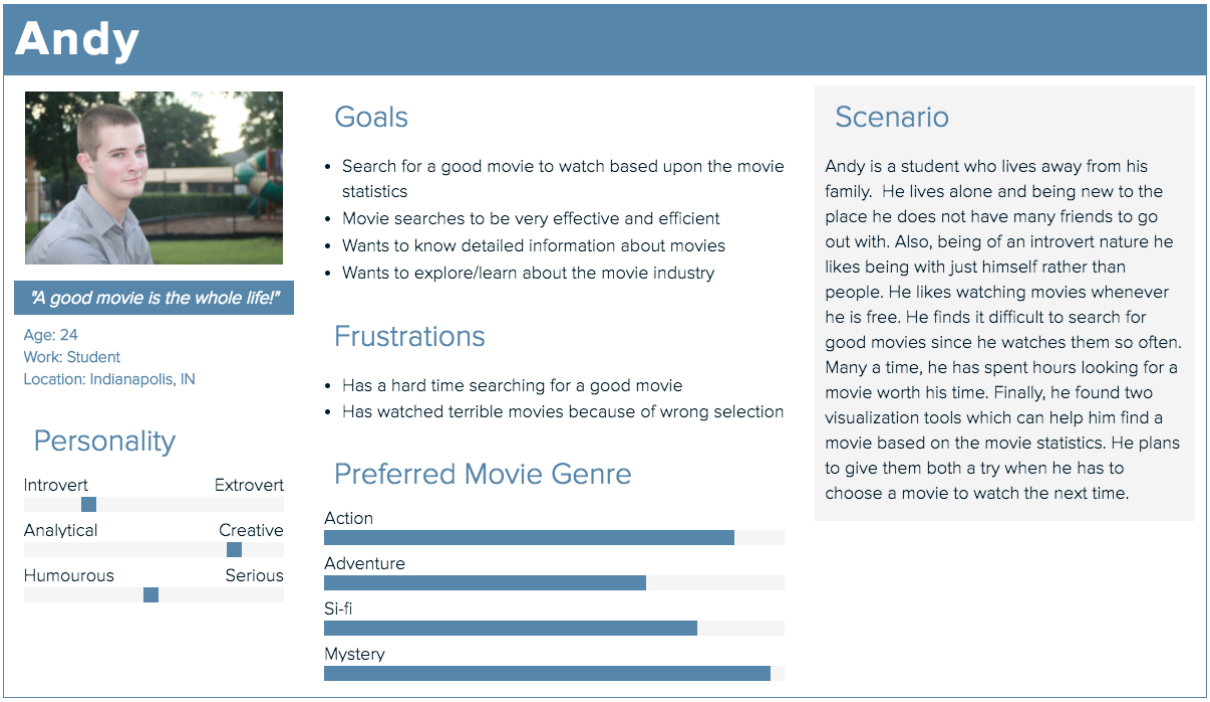

Figure 11: Student Persona who is a movie and always struggles to find a good movie to watch

PERSONA: FILM MAKER

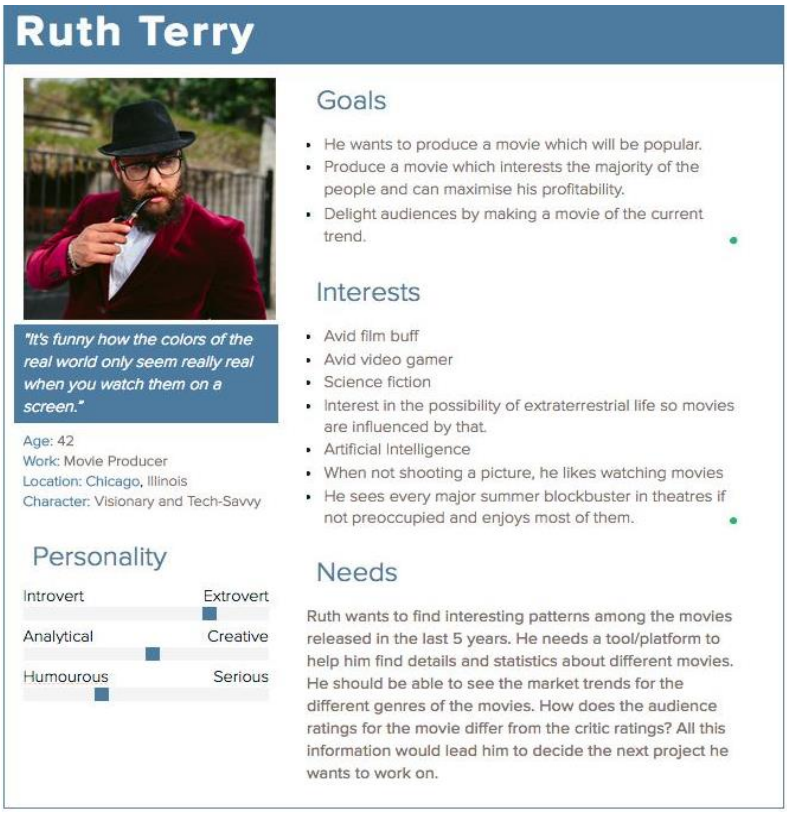

Figure 12: Film Maker Persona who is a movie buff and would like to make a popular and successful movie

Affinity Diagramming:

In order to make sense of the data collected from Heuristic evaluation we did affinity diagram (Figure 2~5). With the affinity diagramming, we summarized the main issues of the visualizations and good aspects as well.

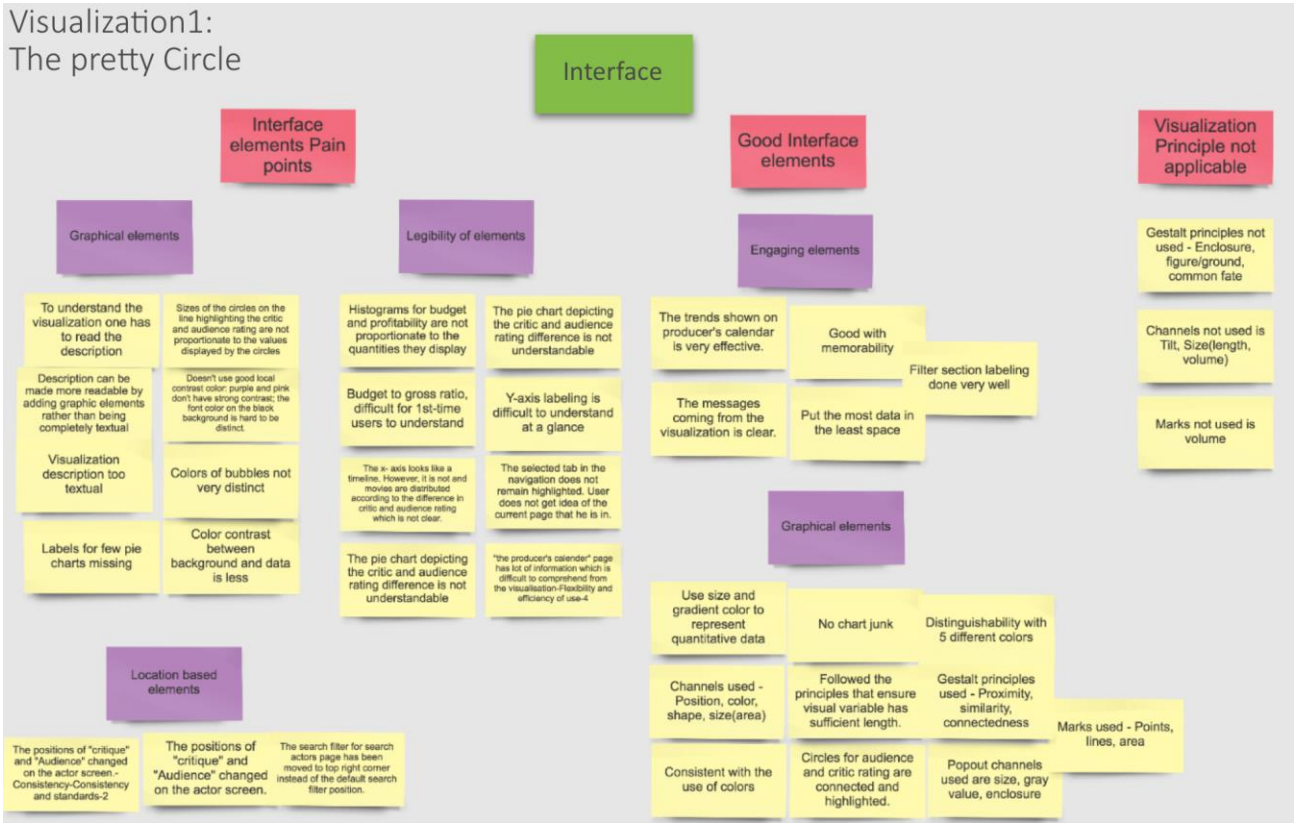

Figure 13: Affinity diagram for Visualization 1, Level1

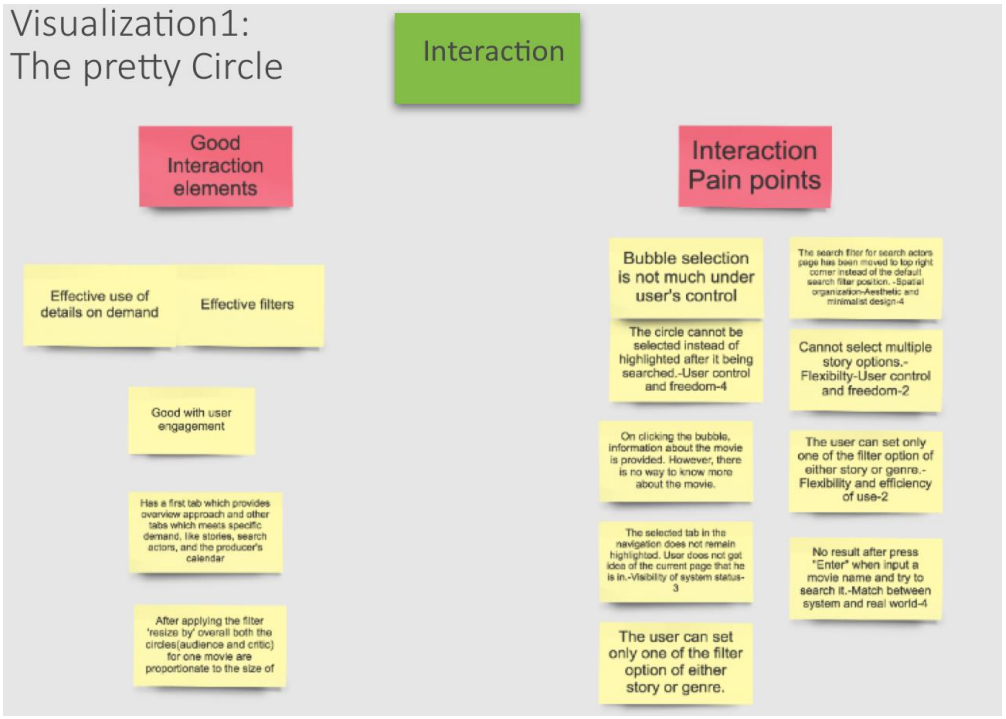

Figure 14: Affinity diagram for Visualization 1, Level2

Figure 15: Affinity diagram for Visualization 2, Level1

Figure 16 Affinity diagram for Visualization 2, Level2

There are many visualization principles involved in both the visualizations. However, it was tough to comment on the effectiveness of those principles in the design. So we decided to design the usability testing tasks based on the results of interface and interaction evaluations for the participants. Our sole purpose was to evaluate if the visualization elements were designed to follow the visualization principles effectively and efficiently and conveys the message to the user intuitively. This led us to understand what the users' opinion are, what they want to see, what they understand etc. We also got idea and motivation for the conceptual design of a new visualization based on the same theme.

Usability Testing:

As Appendix D shows, we designed 5 same tasks for the two visualizations, also we made hypothesis for each task performance based on the heuristic evaluation results. During the usability testing, we recorded both quantitative data and qualitative data. Time on tasks and Task success are recorded as the quantitative data. Think-aloud results and post survey results are the qualitative data. Following are the detailed results

1. Quantitative data
2. Time on Task

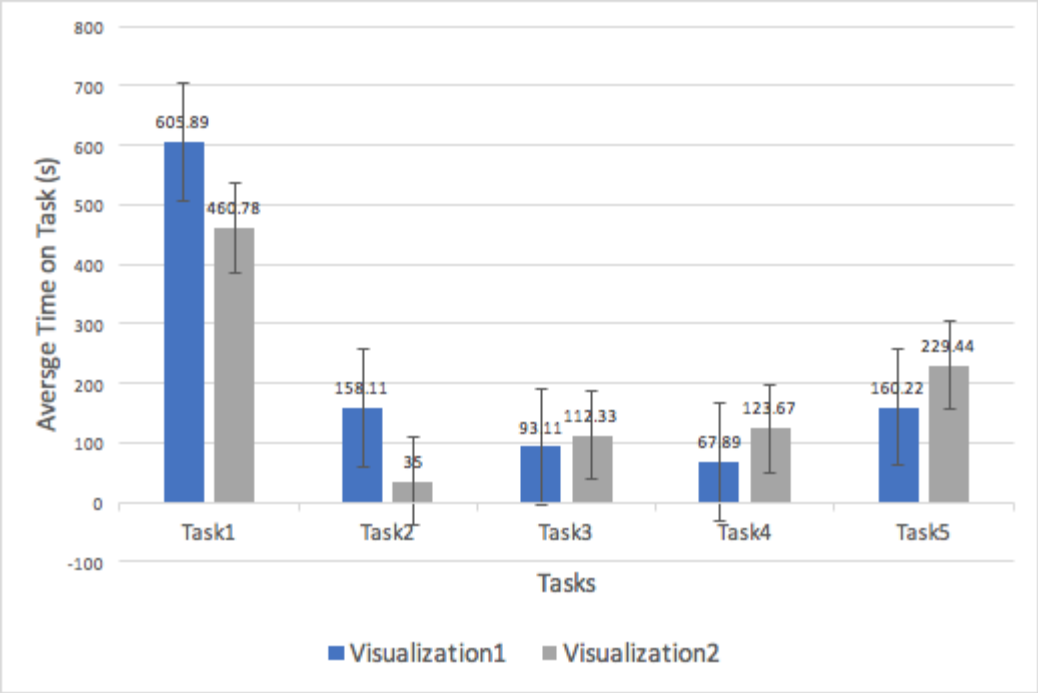

Figure 17: Bar chart depicting Time-on-task for both the visualizations and for all the five tasks

From the bar chart of Time on Tasks, we can see that the participants use more time on task 1 and task 2 in visualization than in visualization 2; they use less time on task 3, task 4, and task 5 in visualization 1 then in visualization 2.

	Visualization 1			Visualization 2		
	Success	**Partially Success**	**Failure**	**Success**	**Partially Success**	**Failure**
Task 2	33.3%	44.4%	22.2%	88.9%	11.1%	0
Task 3	66.7%	22.2%	11.1%	44.4%	44.4%	11.1%
Task 4	100%	0	0	11.1%	0	88.9%
Task 5	0	100%	0	0	100%	0

Table 1: Task Success table for Task 2 to 4, the highlighted cells show the success rate for that task

From the table above, we learned that most participants could achieve the task 2 in the visualization 2, while less participants can do it in visualization 1. More than half of the participants could achieve the task 3 in visualization 1. However, less participants could complete it in visualization 2 successfully. All the participants performed the task 4 in visualization 1, but most participants failed in visualization 2. All the participants partially performed the task 5 in both visualizations.

Fortunately, all the quantitative data support the five hypotheses. In order to explore the reason of the task performance results, we analysed the qualitative data as well.

Qualitative data:

This part is the tasks and hypothesis with user feedback. The qualitative data provide evidence for the hypothesis.

Task 1:

Exploration - Go through the whole visualization and speak out whatever you learn from it.

Hypothesis 1:

Visualization 1 is more difficult to understand than the visualization 2.

Heuristic reference:

- People won't read the description for visualization 1 as it is very elaborate failing in effective usage of the heuristic "*Visualisation Description*".
- Fails in the heuristics like "*Label Chart*". Missing titles in Visualization 1, labels on histogram on the tooltip, identifying and comprehending both Axes will take users more time to understand Visualization 1.
- There is no stability of Vertical black line when user will select the movie failing in proper implementation of the heuristic "*Link Selection and highlighting*".
- The information displayed in Producer's calendar tab is difficult to comprehend. "*Color Channel (Saturation)*" was problem in producer's calendar page for visualization 1.
- The font size of the navigation might not get noticed and user might explore the other features of the visualization
- Distinguishability was a problem in visualization 2- use of many colors thus increasing cognitive load for the user.

Observed User Behaviour:

- 5/9 participants took more time to complete the task in visualization 1.
- Participants hardly noticed the navigation on the top of both visualizations. This is what one user commented about the visualization 1: "Didn't notice the tabs, thought they are advertisements"
- The participants felt they were comfortable using the visualization 1 within the time they took to explore the visualization.
- However, it was observed that the participant's performance was not very effective and efficient in the subsequent tasks. This depicts that the visualization 1 was less successful in clarity to the participants even when they said it was.
- Visualization 1 was difficult to understand at a glance than visualization 2 because of the following observed reasons:
- The description being too long and very textual, most of the participants didn't scroll all the way down to read. Few of them skimmed it, and few just read the bulleted points thinking that would be enough. Also, the description not available to the user's view at first sight, the visualisation looked overwhelming to few users. "I don't want to read this big text."
- The couple of circles for each movie looked confusing to the users. They took time to comprehend what the visualization was about. The missing title made them ask "What is it about, it looks scary to me!" However, the user's response for visualization 2 was "oh, this is cool" because reading the title at an instant gave them an idea what information they can get from it.
- The visualization 2 even though was clear to understand by the users but was not the first thing to be seen by the users. They concentrated on the filters more.

Producer Persona Observations:

- In visualization 1, the histograms about movie finance status was not understandable - Chart labels missing
- She found the description sentences confusing and complicated. Participant felt everything is textual in the description and it is difficult to remember all the information throughout the visualization – "*Cognitive load, Recognition rather than recall"*

Recommendations:

- The Visualisation should have a clear bold title and description
- The title and description of the visualization should be the 1st thing user's focus should be attracted to. This would make them comfortable seeing the screen for the 1st time. Care should be taken to keep this text as precise as possible. Use of visual elements will enhance the reception of the information by the users.
- Better utilization of space
- Visualisation should be the main focus of the page if all the other filters and information on the page are revolving around it.
- Effective navigation
- The navigation should be helpful with legible color and fonts and meaningful wording.

Task 2:

List a movie which belongs to the genre "Action" and story "Comedy".

Hypothesis 2:

Completing this task is easier in visualization 2 then in visualization 1.

Success Criteria:

Though the filters to choose both are present in the visualisation, they are mutually exclusive. If the users figure out that this task is not possible, we mark the task as success.

Heuristic reference:

- Flexibility and efficiency of use, User control and freedom are the two heuristic that have been violated.
- In visualization 1, the user does not have the flexibility to choose both the filters as they are mutually exclusive in selection. If one is selected the other one gets deselected. Hence we predict that the task would be successful as per the success criteria.
- In Visualization 2, upon selecting the story, only the genres which are related to the story are highlighted. User can make a choice of Genre and Story both with restricted control violating User Control and Freedom. In this case, we predict that the task would be partially successful
- The other difficulty in performing the task in the visualization 1 is giving the user all the functions/filters on the first tab of the visualization which violates the heuristic Embedding view in the same space. As oppose to visualization 1, visualization 2 has given these filters in the same space with ease of use for selection.
- Along with the issue mentioned in #1 of this section, visualization 1 also violates heuristic "Use detailed and clear labelling to defeat graphical distortions". If they would have labelled "OR" text between the filters, it would have been obvious to the user that only one filter selection is possible at a time

Observed User Behaviour:

- In visualization 1, participant targeted the "Stories" tab quickly and they expect a similar "Genre" tab on the navigation menu as well.
- In visualization 1, participants tried to find the filters on the main page whereas the filters were present in the Producer's calendar tab. This is because the tabs on the top are invisible and the wording of the tabs is pointless.
- Participants targeted the "story" and "genre" filter fast in visualization 2.

Recommendations:

- Obvious filter
- Locate the story and genre filters on the main page which can be noticed easily.
- Group the two filters
- Put the story filter and genre filter together since they are the similar functions which are complementary to each other.

Task 3:

List a movie which has excellent critic as well as audience rating.

Hypothesis 3:

Completing this task is easier in visualization 1 than in visualization 2

Success Criteria:

We will rate this task a success if they figure out these ratings in the "detailed figures" tab for visualization 2. In visualization 1, there are multiple and easy ways to find both the ratings, so if user finds it by any mean would be considered as success. However, we will consider the most efficient way of finding the ratings in our design recommendation.

Heuristic reference:

- The people's bar, in visualization 2, does not make it clear to the users what exactly will happen when they move it. There is no clear label that explains the behaviour of the slider.
- Heuristics violated: "*Information coding*", "*Label each chart*", "*Prompting"*
- The visualisation 1 makes use of marks and channels efficiently. It makes use of the position and the color channels to encode information which is quite effective which gives user multiple ways of finding rating.

Observed behaviour:

- In Visualization 1, 2/10 participants understood how critic and audience rating is distributed over the Pretty circles graph. Rest of them randomly moved over the circles, glancing over the displayed ratings, and randomly picked any movie which had higher critic and audience rating.
- In visualization 1, 3/10 participants used the emoji filters and the filters which says critic and audience strongly agree to find a movie.
- In visualization 2, many participants found one way to perform this task is with the people's bar. It was very easy to figure it out because of the

placement. However, they were unable to understand the behaviour of the bar.

- In visualization 2, participants did not find the results as anticipated by moving the bar control to either critic's rating side or people's rating side. They expected to see a change in the list of popular movies and very few could identify a change in the actual visualization.
- Most of the participants were always pointing to the average rating displayed on the visualization 2 for a movie or in the popular movies list.
- Just 3 participants reached to the details figure tab to find the Audience rating, and only 1 found Rotten Tomatoes rating on Details figure tab. Overall in visualization 2, users could not find critics rating.

Recommendations:

- Clearly expressed rating
- Use a clear and easy way to express the rating and its filter function.
- More interactive visualization
- Provide obvious feedback on the visualization when filter the rating. In doing so, the whole visualization could be perceived as an entity then elements in the visualization can be related easier which is good for interacting with the visualization.

Task 4:

List a movie which has Gross income at least 5 times the budget.

Hypothesis 4:

Visualization 1 takes less time to complete this task with success than visualisation 2.

Success Criteria:

There are multiple ways to achieve results for this task in Visualization 1. We will consider all of them to be a success. However, at the end the way which will take the user the least amount of time, we will consider that to be the most efficient way.

Heuristic reference:

- Visualization 1 will take less time because of the effective usage of the heuristics "Spatial Organization", "Embedding view in the same space". In visualization 1, most of the information about the movie is displayed in a box and always displayed at a consistent place
- For visualization 2, user is expected to spend more time because the budget of the movie is not visible in the tab that shows movie overview. This information is only available when the user will click on the movie and go to detailed figures. The heuristics "*Overview first*" is not effective since it doesn't give an overview of the movie budget and profit. However, we will have usability study to find out if users consider budget and profit to be an important information about the movie.

Observed behaviour:

- One interesting fact about the task is, the participants who did visualization 1 first, they got familiar with the profitability being displayed in multiples of budget (n x budget). They expected to see the profitability in the same way on visualization 2. However, visualization 2 displays profitability in terms of percentage and on the sidebar as actual figure.
- Most of the participants wanted to see all the related information about the movie on the first page like visualization 1.

Recommendations:

- Less steps to access to the information
- In the visualization 2, participants have to go to the "detailed figures" page to find the information about budget and profit of one specific movie. They have to go back to the first page to choose another movie if they want to check the budget information of it. This process is complex and time consuming. It would be better to move the budget information into the page where the participants can select movies they are interested in.

Task 5:

Hit any movie, Give us the following details about it:

- Audience rating
- Budget of the movie
- Is it an award winning movie? Yes/ No?
- How much profit did it make?
- When was it released?
- Genre
- Story
- Actors

Hypothesis 5:

Audience rating, budget, award winner, profit, release date, actors are easier to find in visualization 1; Genre and Story are easier to find in visualization 2.

Heuristic reference:

- In Visualization 2 most of the useful information is displayed in different tabs when compared to visualization 1. Visualization 1, displays most of the required information for the task in a box displayed at consistent place maintaining "*Spatial organisation*" Heuristic and embedding views in the same space
- Due to the violation of "*Navigation*" heuristic in visualization 2, users will find it difficult to successfully complete the task
- Both the visualizations have done well in use of "*channels like colors, size, position, marks as area, distinguishability* "
- Visualization 1 takes care of the consistency heuristic which can make looking for information easy. However, it has problems with "*Link Selection*"

Observed behaviour:

- Only 1/9 participants took less time to complete the task on visualization 1. However, remaining all the participants took almost 2-5 minutes to complete the task.
- Most of the participants found rating, budget, profitability, Actors, release time award winning or not in visualization 1 very easily.
- The participants tried to search for Genre and story on tab1 of visualization 1. When they could not, some participants, tried to go to other tabs and search for it. But there was no information associated to the movie about genre or story. They tried to perform the task other way round. By guessing and searching for the genre or story on different tabs. At the end they gave up on this and declared the task is complete.
- The participants were trying to search for their favourite movie for the task, the black line highlights the movie. However, when the participants tried to move the mouse cursor to the visualization to click and see the actors on details pop-up, the black line would move to where the cursor would point on the visualization.
- In visualization 2, some participants chose the story and genre to filter movie. They clicked on one circle which was highlighted and went to the other two tabs to check detailed information.
- In visualization 2, some participants tried to find the profit and budget on "International Recognition" tab in choose a measure filter. When they realized that is not the way to find it, they moved to details figure tab to find the information. Still they could not find the actors information on any of the tabs

Recommendations:

- A Reasonable Layout
- Put relative information on the same page or in one area; the route of finding information should follow human logic and behaviour habits; Cut the steps as less as possible.
- Effective Interaction
- Provide connection between two relative elements. For example, highlighting a bar of budget when click on the "budget" button aside. In doing so, the users can receive effective and immediate feedback for their actions. Therefore, the users would feel more engagement and the visualization would be more memorable as well.

In additional, the answer of the post survey give us motivation and ideas of our conceptual design. We used word cloud generation tool and picked the main elements which the users need mostly in a movie based visualization. The main elements are Rating, Actors, Genre, Story, Awards, and Director.

Figure 18: Word cloud generated by using Survey question #8

DISCUSSION AND INTERPRETATION OF THE RESULTS

With all the quantitative and qualitative data analysis the result interpretation was one more important task. *Making sense of the results after making sense of Data*!

Time on Task data analysis:

We observed different time on tasks. After analysing the data we realized that it was not dependent on the task difficulty level for all the tasks. The reason sometimes was that some users had quite casual approach in understanding or reading the information on visualization while others were very thorough. A few users took less time for exploration and others took more time. Less time in exploration showed they were casual about it and then while performing the remaining tasks they were stuck/confused and could not find out ways to perform task.

The users who took more time for each task were thorough with their approach and wanted to genuinely find the information. So they remained on the page to find out different ways to complete the task or visited different tabs to search.

This was also dependent on the intuitiveness of the components and most of the visualization techniques would have helped here.

Qualitative Data Analysis:

This data gave us a fair idea of what information is important to the users for the theme/topic we selected from both as a common man and as a film maker. Even though we did not get many film makers as our users, the analysis is based on just one participant we found which fit into the Filmmaker persona which we had not anticipated.

The views of common man, one film maker, task results and our heuristic hypothesis results gave us a few pointers to the conceptual design we can come up with.

Considerations for conceptual design:

- Description of the visualization overall
- Color contrast
- Circle sizing based on rating
- Proper Labelling - Histograms/ pie charts/ axis
- Keep elements position consistent
- More control over movie selection
- Drill down approach
- Effective use of area
- Aesthetics
- Improved Content (labels conveying the meaning)
- Should make use of marks and channels effectively
- Should keep the user engaged

CONCEPTUAL DESIGN

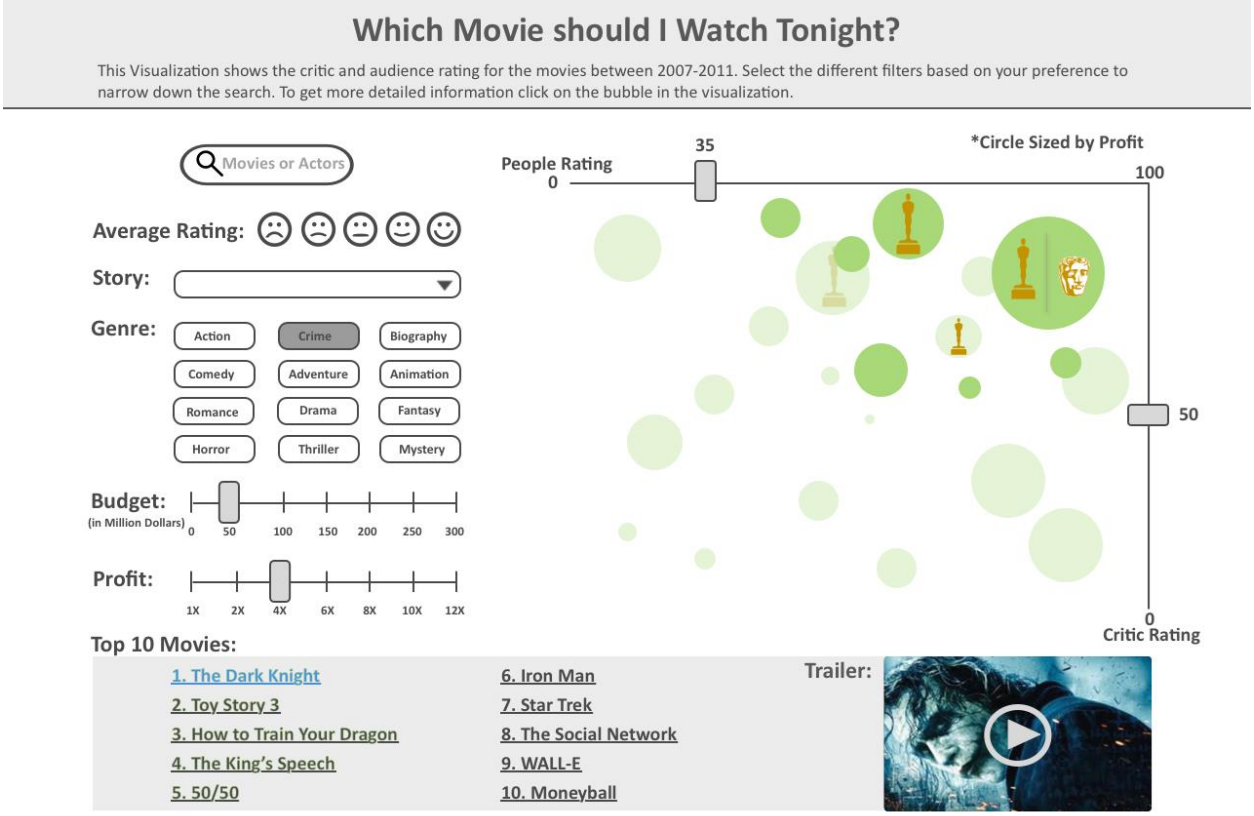

Figure 19: Main page of the concept

We included:

- A catchy title - to grab the attention and intuitive enough to let user know what the visualization is about
- Description - good enough to understand the visualization concept
- Filters
  - Search – to search either based on movies/actors
  - Average rating, story, genre, and budget and profit filter design – we picked the effective designs from either of the visualizations
  - Top 10 movies – the list grabbed user's attention and gave us a good platform to showcase the trailer, this list will keep updating as per user's filter preferences
- Main visualization –
  - Scatter plot of different movie circles, plotting different variables – critic rating, audience rating, sized by profit,
  - Pop-out channel like displaying award trophies inside the movie circle
  - Giving more user control and freedom by giving the ability to the user to slide the rating axis and filter the rating
  - Using colors that are color blind safe
  - Use of semantic depth when filters are applied
  - On demand detailed information about the movie

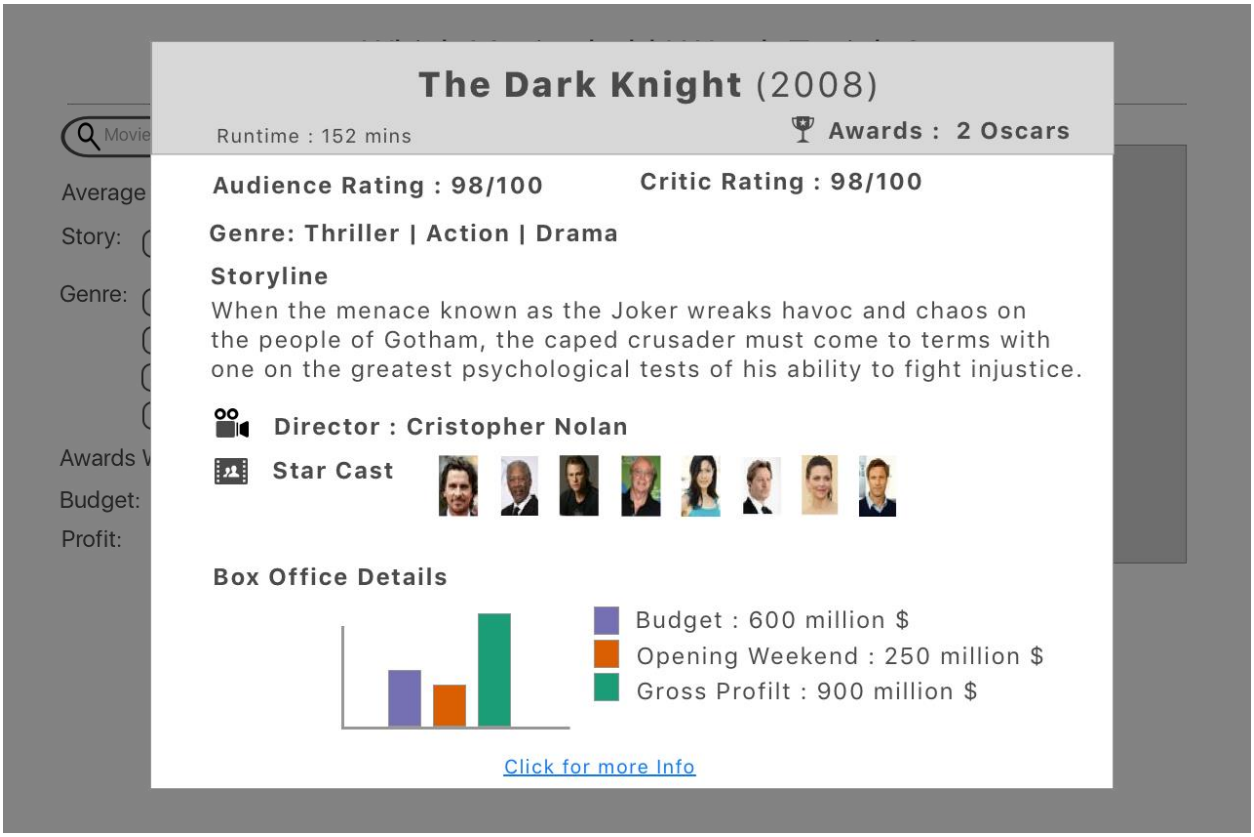

Figure 20: On demand detailed information about the movie

Detailed screen was designed as per user's preferences from the word cloud. We maintained the information and displayed the box office details using the graphs that use color blind safe colors. A link is provided which navigates the user to other search engines to get more information about the movie that they might be looking for.

CONCLUSION

After completion of the Concept design we understand that it needs to be evaluated by experts on the same set of heuristics and evaluated by our target audience too. So until we get a fair idea about the user's assessment we will iterate over the design, evaluate it and then develop the prototype.

This conceptual design was developed only for one persona – student.

There would be another design for the Film maker's persona which will have more box office details, movie trends monthly, yearly, genre wise etc. Also, the only user with Film-maker background was interested in award details, which movie won which award and in which categories it was nominated, the names of the actors or technicians who won the award. This will help the film-maker choose the cast for her movie, with her own quotes that said - "Yes I would like to put in my money on this award winning person may it be actor or cinematographer"

Overall, we were quite successful in our attempt to learn and understand the visualization techniques practically without even coding them and with User's perspective.

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APPENDIX A

Heuristic evaluation using Neilson and Norman Group – 10 Principles of Heuristics

Visualization 1: The Pretty Circle

Issue	Heuristic Principles	Neilsen Heuristic Principles	Rating
The colors of the bubbles are not very distinct from each other.	Information coding		1
It is difficult to choose one specific bubble. The user has to scroll to nearby area to have the bubble selected which is not under the user's control.	Orientation and help	Flexibility and efficiency of use	4
The colors of audience and critic remain consistent in three different contexts	Consistency	Consistency and standards	
The budget scrollbar is not required on the main screen.	Remove the extraneous	Aesthetic and minimalist design	0
Hovering over a movie shows its budget to gross ratio which is difficult for the first time users to understand. The user has to refer the documentation to read about it and only then he will be able to know what it is about.	Recognition rather than recall	Recognition rather than recall	2
"What are these pretty circles?" Some information under this section is too textual, usage of visuals will convey the information more efficiently.	Information coding	Aesthetic and minimalist design	3
The pie chart at the top right corner depicting the information of percentage between critic and audience rating difference, is not understandable. This is a kind of redundant data and not required.	Remove the extraneous	Aesthetic and minimalist design	4
The x- axis looks like a timeline. However, it is not and movies are distributed according to the difference in critic and audience rating which is not clear.	Information coding		4

On clicking the bubble, information about the movie is provided. However, there is no link to the Wikipedia page or IMDB page which can give user more information if desired.	Prompting.	Flexibility and efficiency of use	2
After inputting a movie name, as the user press enter, the page refreshes without any result. Only when the movie's name is selected, the user is able to see the information		Match between system and the real world	4
After selecting the movie from search menu, it highlights the bubble, but it does not select it.		User control and freedom	4
User cannot select multiple story options.	Flexibility	User control and freedom	2
The placement for the rating by user and critique changes on the actor screen	Consistency	Consistency and standards	2
The search filter for search actors' page has been moved to top right corner instead of the default search filter position. This makes it difficult for the user to spot it	Spatial organization	Aesthetic and minimalist design	4
The selected tab in the navigation does not remain highlighted. User does not get idea of the current page that he is in.		Visibility of system status	3
"the producer's calendar" page has lot of information which is difficult to comprehend from the visualisation		Flexibility and efficiency of use	4
"Producer's calendar" page takes more time to comprehend.	Flexibility and efficiency of use		2
The user can set only one of the filter option of either story or genre.	Flexibility and efficiency of use	E11: Flexibility.	2

APPENDIX B

Visualization 2: Which Movie Should We Watch Tonight?

Issue	Heuristic Principles	Neilsen Heuristic Principles	Rating
No option to choose multiple genres		User control and freedom	2
When you choose one genre of movie just that genres movies are displayed in a color. Now, if you go to the map to read about the movies, all genres movies become visible again.		User control and freedom	4
When I choose the story and genre, the circles of movies which are Not included in the selected story and genre become transparent, this is good. But when I hover on one of the remained circle and remove, then all the circles become transparent.	Minimal actions	User control and freedom	4

The top movies of 2007-2011 aside depends on the story only, but It appears to be dependent on both, story and genre.		Match between system and the real world	2
Don’t understand the people-critics bar	Information coding		4
function of "what is your tolerance level of bad movies" is good, but the text is misleading	Consistency	Consistency and standards	3
The blockbuster meter shows part of the movies' name	Consistency	Consistency and standards	1
The function to choose more than one movies to check the detail is hard to notice	Spatial organization		2
When choose bunch of movies , it will jump to the international recognition automatically, but the movies list is messy and unreadable	Spatial organization.		1
The map in "International Recognition" has duplicated when showing countries.	Information coding, Spatial organization	Match between system and the real world	1
In "International recognition" the chosen measure signs blow aside are not meaningful	Information coding	Consistency and standards	1
In "Detailed Figures" the order function in the chart is unnecessary	Remove the extraneous	Aesthetic and minimalist design, Chart Junk	3
In "Detailed Figure" the hover function of the aside bar is unnecessary	Remove the extraneous	Aesthetic and minimalist design, Chart Junk	1
Measure names in "Detailed Figures” look exactly similar to genres on home page. While genres are clickable, measure names are not.	Consistency	Consistency and standards	1
In "Detailed Figures" data updates according to the selected movie but the trailer and the title remains "The Dark knight"	Information coding.		4
Many icons in this visualisation are too tiny to be viewed clearly	Aesthetic and minimalist design		1
The statistics of the movie in the detailed figures tab can be selected. On select it highlights it but there is no contrast between the text color and the highlighted color.	Information coding		1
The background for the first 2 tabs is white while shifting to the 3rd screen changes the background to black color making it appear as if it is not a part of the same visualisation	Consistency	Consistency and standards	1
In “Detailed Figures” tab the heading "Quick return or word of mouth" does not convey the meaning clearly about the graph displayed.	Information coding.		1

APPENDIX C

Heuristics for Interface Design – Class slides, Paper [4], [6]

1. Use detailed and clear labelling to defeat graphical distortions
2. The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.
3. Avoid chart junk
4. Maximize Data ink ratio
5. Visual embellishment can in some cases improve memorability and engagement with the visualization
6. Single Popout channel at a time to draw attention
    a. Orientation
    b. Curved/Straight
    c. Shape
    d. Size
    e. Number
    f. Gray/Value
    g. Enclosure
    h. Convexity/Concavity
    i. Addition
    j. Juncture
    k. Parallelism
7. Semantic depth of field
8. Gestalt Principle
    a. Proximity – NA
    b. Similarity – Same genre movies are in the same color
    c. Connectedness – NA
    d. Enclosure
    e. Figure/ground
    f. Common fate – Na
9. Distinguishability – max 6 to 12 unique colors
10. Marks
    a. Points (0D) – NA
    b. Lines (1D) – NA
    c. Areas (2D) – NA
    d. Volumes (3D)
11. Channels
    a. Position – Identity (Where or what) and Magnitude (How much)
    b. Color - Identity (Where or what) and Magnitude (How much)
    c. Shape - Identity (Where or what)
    d. Tilt - Magnitude (How much)
    e. Size – Magnitude (How much)
11. Trend
12. Message
13. Memorability
14. Engagement
15. Persuasion
16. Interactions
    a. Selection (Details on Demand) –

    b. Brushing & Linking – not used
17. Navigation
    a. Pan & Zoom
    b. Rotate
    c. Overall + Detail
18. Visualization Description
19. Label each chart
20. Contrast between background and data
21. Linked selection and highlighting
22. Embedding views in the same space
23. Stacking
24. Color perception varies with size of colored item
25. Local contrast affects color & gray perception
26. Consider people with color blindness
27. Quantitative assessment requires position or size variation
28. Put the most data in the least space
29. Overview first
30. Zoom and filter
31. Minimal actions/ User control and freedom
32. Match between system and the real world
33. Information coding
34. Consistency and standards
35. Remove the extraneous/ Aesthetic and minimalist design, Chart Junk
36. User control and freedom
37. Aesthetic and minimalist design

Heuristic Report Links for both the visualizations:

Visualization 1:

https://docs.google.com/a/umail.iu.edu/document/d/1ELxm9aA7Bp_4glO4afRQP42WtAddIaouReV8eJG8yzI/edit?usp=sharing

Visualization 2:

https://docs.google.com/a/umail.iu.edu/document/d/1zWSBsSszItY_jHeLKx6jP_p2Cj6lG32obDYBCC02kYk/edit?usp=sharing

APPENDIX D
User Tasks and Hypotheses

Task No	Task	Hypothesis
1	Exploration - Go through the whole visualization and speak out whatever you learn from it.	Visualization 1 is more difficult to understand than the visualization 2.
2	List a movie which belongs to the genre “Action” and story “Comedy”.	Completing this task is easier in visualization 2 then in visualization 1.

3	List a movie which has excellent critic as well as audience rating.	Completing this task is easier in visualization 1 than in visualization 2
4	List a movie which has Gross income at least 5 times the budget.	Visualization 1 takes less time to complete this task with success than visualisation 2.
5	Hit any movie, Give us the following details about it : • Audience rating • Budget of the movie • Is it an award winning movie? Yes/ No? • How much profit did it make? • When was it released? • Genre • Story • Actors	Audience rating, budget, award winner, profit, release date, actors are easier to find in visualization 1; Genre and Story are easier to find in visualization 2.

APPENDIX E

Post Survey Questionnaire

1. Name _____

2. Gender

    ○ Female

    ○ Male

3. Age _____

4. Profession Mark only one

    ○ Student Work

    ○ Professional

    ○ Other _____

5. How do you feel about the 2 visualizations? _____

6. What do you remember about both Visualizations? _____