Information Visualisation Report

COMPSCI5099

Group 22

Group Member + GUID	Contribution
Abhishek Orwadkar - 2880475	Code for System A + Report
Sarvesh Dhapte - 2909662	Code for System A + Report
Rohit Jacob - 2936599	Code for System B + Report
Aquib Husain Iltija - 2898567	Code for System B + Report + Video
Apurv Appasaheb Bacchav - 2943937	Code for System C

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Appendix

Multiview Visualization of Film Industry Data

Dataset: **https://www.kaggle.com/datasets/ramjasmaurya/top-250s-in-imdb/data**

Demo Video Link: https://youtu.be/dVLM-YQre54?si=QDcyIE2J5jgq3yAq

A. Design & Implementation

1. The Data (0.1):

Overview:

The dataset encompasses an extensive collection of 1000 movies, meticulously compiled to represent a wide array of cinematic offerings. It spans various decades, genres, and styles, providing a panoramic view of the film industry's rich tapestry.

Dataset Attributes:

- **Film Rankings:** Placement within a curated list of top films, with "The Shawshank Redemption" often cited for its high rankings due to critical acclaim.
- **Titles:** Names of the films, from classics like "Casablanca" to modern epics such as "Avatar," showcasing the diversity in storytelling.
- **Release Years:** The distribution of film release years, reflecting industry evolution over time.
- **Certificate Ratings:** The spectrum of content suitability ratings from G to R, indicating the intended audience.
- **Run Time:** Duration trends, from the succinct 88-minute "Dr. Strangelove" to the expansive epics in cinema.
- **Genres:** The variety from dramas to science fiction, encapsulates the range of cinematic storytelling.
- **Ratings & Metascores:** Indicators of audience and critical reception, respectively, highlighting the film’s acceptance and acclaim.
- **Gross Earnings:** Financial success metrics, highlighted by record-breakers like "Avatar."

Qualitative Insights:

- Descriptions offering synopses of film plots.
- Directors and main actors, provide a glimpse into the creative forces behind the films.

Categorization:

This dataset is structured as tabular data, with rows representing movies and columns for their attributes, blending numerical and categorical data types.

- **Numerical Data Types:** Ranking, Year, Runtime, RATING, Metascore, Votes, GROSS COLLECTION.
- **Categorical Data Types:** Movie Name, Certificate, Genre, DETAIL ABOUT MOVIE, DIRECTOR, ACTOR 1, ACTOR 2, ACTOR 3, ACTOR 4.

Analysis Potential:

Data allows researchers to analyze dimensions from considering vertical analyses, such are commercial viability and critical reception. It also opens questions on cultural evolution, which can be reflected in context rating results.
This approach underpins the Multiview visualization systems that employ technologies such as filtering and linking to expose the interactive processes linking various fragments from the film industry.

Significance:

The collection of data also highlights the picture of the landscape of cinema so far and brings opportunities to examine the changes we have experienced in society and our preferences from a long-term historical point of view.
Using this data, our visualization systems can bring to light the untold stories and present the audiences with a well-rounded view of the hidden patterns that dictate the quality of the film.

2. The Tasks (0.1):

When exploring this dataset, users might want to perform the following actions:

1. **Data Exploration and Visualization:** Users may want to explore and visualize various aspects of the data to gain insights. This could involve generating summary statistics, plotting distributions of numerical features (e.g., runtime, rating, Metascore), or creating visualizations such as bar charts or scatter plots to identify patterns and relationships between variables.

2. **Data Cleaning and Preprocessing:** Users may need to clean and preprocess the data before analysis. This could include handling missing values, removing duplicates, converting data types (e.g., converting 'GROSS COLLECTION' to numerical format), or performing text preprocessing on the 'DETAIL ABOUT MOVIE' column (e.g., tokenization, stop-word removal).

3. **Feature Engineering:** Users might want to create new features or transform existing ones to better represent the data or capture specific aspects of interest. For example, they could extract the release decade from the 'Year' column or create a binary feature indicating whether a movie is a sequel or not based on the movie title.

4. **Subset Selection:** Users may want to select a subset of the data based on specific criteria or conditions. For instance, they could filter the data to include only movies released after a certain year, movies with a particular genre, or movies directed by a specific director. This action is a prerequisite for many analysis tasks, as it allows users to focus on a specific subset of the data that is relevant to their goals.

5. **Predictive Modeling:** Users could build predictive models using this dataset, such as predicting a movie's rating or box office performance based on various features like genre, runtime, director, or cast. This may involve splitting the data into training and testing sets, selecting appropriate models (e.g., regression, classification), and evaluating model performance.

6. **Correlation and Association Analysis:** Users might be interested in identifying correlations or associations between different variables. For example, they could investigate the relationship

between a movie's rating and its metascore, or analyze the association between a movie's genre and its gross collection.

These actions cover a range of tasks, from exploratory data analysis and data preprocessing to predictive modeling and pattern discovery, enabling users to extract insights and knowledge from this movie dataset effectively.

3. The Core Systems (0.2)

In compliance with the coursework instructions, we have developed three distinct visualization systems, named System A, System B, and System C. Each system is designed as a multi-view composition that integrates multiple visual representations. These systems allow users to engage with the data through brushing and linking, enabling interactive data exploration as defined in our tasks section.

System A

Composition and Interaction:

- **Donut Chart:** Depicts average gross earnings by genre, allowing users to see the proportional distribution at a glance. Brushing over a genre highlights the corresponding segments in other views.
- **Line Chart:** Shows the average metascore by genre over time, enabling trend analysis across decades. It responds interactively to selections made in the donut chart.
- **Bar Chart:** Represents gross earnings based on movie certificates, providing a clear breakdown by category.

Brushing and Linking:

- Selecting a genre or certificate in one view highlights related data in the other views, enabling users to discern patterns and outliers quickly.

System B

Composition and Interaction:

- **Bar Chart:** Visualizes average gross earnings by genre, with interactive brushing that affects other components.
- **Heatmap:** Offers a visual exploration of average metascore by genre over time, with color density representing scores.
- **Stacked Bar Chart:** Shows gross earnings by movie certificate, with the ability to interactively select and view detailed information.

Brushing and Linking:

- An interval selection (brushing) over the bar chart influences the heatmap and the stacked bar chart, promoting comparative analysis.

System C

Composition and Interaction:

- **Combined Bar and Line Chart:** Provides a dual representation of total and average gross earnings by genre. It merges categorical and quantitative analysis in a single view.
- **Bubble Chart:** Displays gross earnings by movie certificate, allowing for outlier detection and distribution analysis.
- **Area Chart:** Illustrates average Metascore by genre over time, showing evolution and trends.

Color Accessibility:

In crafting the visual elements of System C, we prioritized color accessibility to ensure usability for individuals with color vision deficiencies. A color palette is supportive of color blindness was chosen, with distinct hues and saturation levels that are easily distinguishable.

Brushing and Linking:

- A selection within any chart leads to an update in the visualization across the entire system, demonstrating the interconnectedness of data points.

Each system is encapsulated in its respective zipped folder labeled System A, System B, and System C. The folders contain all the program code required to run these systems independently. Users can perform a comprehensive set of data exploration tasks using the interactivity features embedded in these visualizations. The systems have been tested to ensure that they are user-friendly and facilitate a seamless data discovery process.

4. Generalized Selection (0.2):

To enhance the user's interactive experience, we have developed a semantic structure for our movie dataset that allows for multi-level exploration and a traversal policy to navigate across these levels.

Semantic Structure: Our data is organized hierarchically, starting with the broadest category of 'Genre'. Under each genre, movies are further categorized by 'Decade of Release' and 'Movie Certificate', leading to the most granular level, which includes specific data points like 'Metascores' and 'Gross Earnings'. This semantic hierarchy enables users to perform generalized selections, facilitating broad and fine-grained analysis.

Traversal Policy: Users have the flexibility to initiate their exploration from any hierarchical level. They can either drill down from genre to specific movies or start with a more granular focus, such as a particular decade, and expand their view to include additional genres or certificates. This non-linear traversal policy is designed to accommodate diverse analytical approaches and encourage exploratory data analysis.

Implementation in Systems A, B, and C:

- **System A:** This system incorporates dropdown menus, allowing users to select genres, decades, or certificates, with each choice dynamically updating linked visualizations. The goal is to enable a seamless drill-down capability within a structured path.
- **System B:** With a real-time search bar, this system provides an intuitive entry point into the data. The search feature is complemented by auto-suggest, which proposes potential paths

through the data as the user types, facilitating immediate visual feedback across linked views.

- **System C:** Interactivity is provided through a series of widgets, including sliders for timeframes, checkboxes for certificates, and a clickable genre palette. Each interactive element is interconnected, ensuring that a selection in one widget automatically refines all related visualizations.

To implement the concept of 'brushing and linking' as discussed in the Visualisation Pipeline lecture, we have ensured that interactions in one view resonate across all others. Selecting a data point or category in one visualization will highlight and filter the related data across all visualizations, allowing for a comprehensive, cross-sectional analysis of the dataset. This approach not only increases the utility of each individual view but also enhances the overall coherence of the multi-view system.

The implementation code for the extended functionalities aligns with best practices in software engineering, focusing on modular design for scalability. All systems have been updated accordingly in their respective folders to replace the initial codebase while maintaining the same operational structure.

5. Demo Videos:

Please find the demonstration videos for Systems A, B, and C at https://youtu.be/dVLM-YQre54?si=QDcyIE2J5jgq3yAq

6. Design Comparison (0.4):

Design Decision 1: Colour Scheme for Genre Representation

- **Decision:** Choice of color scheme to represent different movie genres in the visualizations.
- **Choices:**
  - **System A**: Applied a monochromatic scheme with varying intensities of blue, with darker shades representing genres with higher gross earnings.
  - **System B:** Utilized an analogous color scheme, grouping related genres like action and adventure in warm colors and contrasting with cool colors for distinct genres like documentary and horror.
  - **System C:** Implemented a '**paired**' color scheme, with each genre represented by colors directly opposite on the color wheel to maximize contrast and distinction. This paired color scheme in **Fig 6.1** is color-blind friendly.
- **Alternatives:** A palette of entirely different colors for each genre or a grayscale palette could have been used, though they may not have provided the same level of distinction or visual appeal.
- **Best Choice & Justification:** The complementary color scheme of System C is the superior choice. It ensures that each genre is immediately distinguishable, facilitating faster recognition and comparison, which is supported by color theory regarding visual differentiation.
- **Support:** The report will include screenshots of the color palettes used in each system, with genres labeled accordingly, showing how the color choices map to each genre.

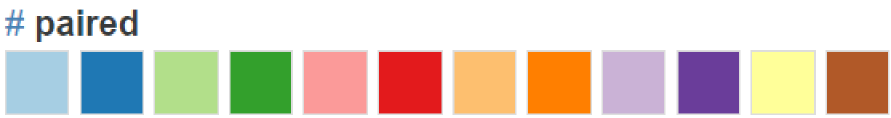

Fig 6.1 Paired Colour Scheme utilized in System C

Design Decision 2: Chart Type for Gross Earnings Display

- **Decision:** Selection of chart type to display movies' gross earnings by genre.
- **Choices:**
  - **System A:** Choose a pie chart to present a clear division of market share by genre.
  - **System B:** Implemented a stacked bar chart, offering insight into individual genre performance and cumulative earnings over time.
  - **System C:** Used a line chart to show the trend of gross earnings across time for each genre.
- **Alternatives:** Alternatives like heatmaps for density or separate bar charts for each genre were considered.
- **Best Choice & Justification:** The stacked bar chart in System B in **Fig 6.2** stands out as it allows comparison of both individual and total earnings, giving a comprehensive view of the market landscape, aligning with principles of multi-attribute representation.
- **Support:** A comparative visualization will be included showing the pie, stacked bar, and line charts, each with descriptive legends and annotations to indicate what the visual encodings represent.

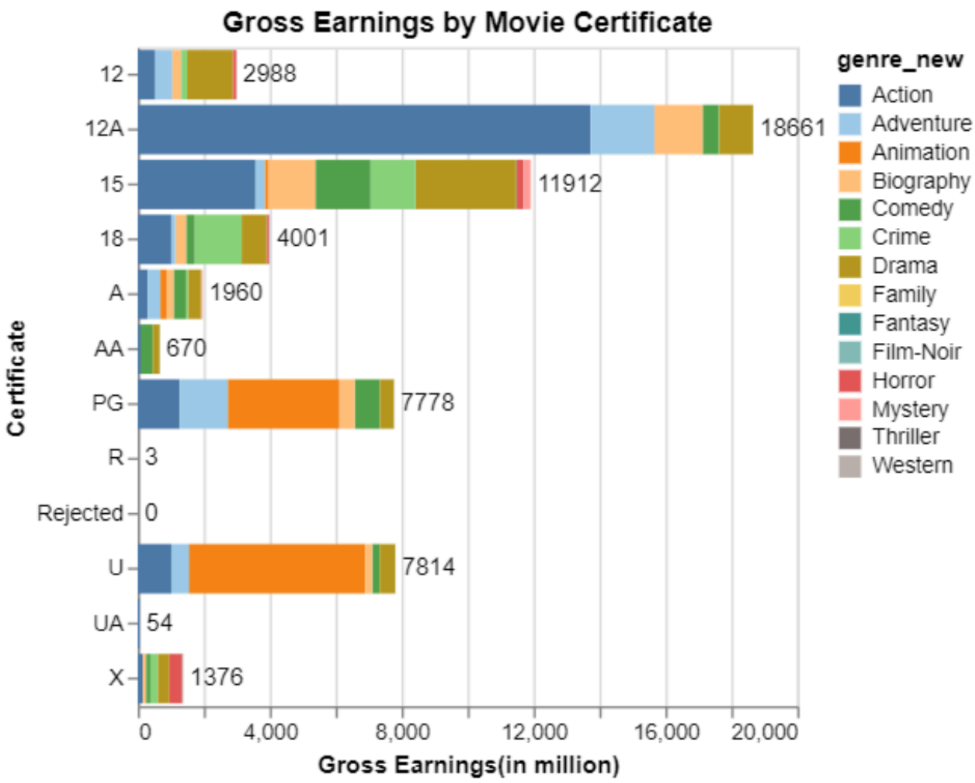

Fig 6.2 Stacked Bar chart in System B

Design Decision 3: Interaction Model for Data Exploration

- **Decision:** Implementation of user interaction models for data exploration.
- **Choices:**
  - **System A:** Incorporated hover-over tooltips that display detailed information for each data point.
  - **System B:** Designed clickable legends that, when selected, highlight corresponding data across all visual components.
  - **System C:** Added dynamic sliders that filter the data across different years, allowing the user to explore temporal changes.
- **Alternatives:** Other possible interactions included data brushing, zooming, and panning across visualizations.
- **Best Choice & Justification:** The dynamic sliders in System C offer the most engaging experience, allowing users to conduct a temporal analysis easily, which is essential for understanding trends in movie earnings and ratings over time.
- **Support:** Demonstrative GIFs or video clips will show these interactions in action, highlighting how each contributes to the data exploration process.

Design Decision 4: Layout and Composition of Multiple Views

- **Decision:** Determining the most effective layout for composing multiple views within the visualization interface.
- **Choices:**
  - **System A:** Implemented a grid layout, giving equal weight to each visualization, thus providing a democratic data overview.
  - **System B:** Adopted a master-detail layout, prioritizing one primary view with secondary views offering detailed data when selected.
  - **System C:** Utilized a sequential layout to lead users through a data narrative, starting with broader trends and moving toward specifics.
- **Alternatives:** Other layouts considered included a dashboard layout with widgets or a freeform layout with drag-and-drop customizability.
- **Best Choice & Justification:** The master-detail layout in System B is most effective as it creates a user-centric flow, drawing attention to key data insights while providing the ability to dive deeper on demand, aligning with the focus-plus-context strategy in information visualization.
- **Support:** The report will include layout diagrams for each system, showcasing how the visual arrangement facilitates user interaction with the data.

Design Decision 5: Encoding Method for Metascores

- **Decision:** How to visually encode meta scores for comparative and analytical effectiveness.
- **Choices:**
  - **System A:** Implemented color intensity encoding, using a gradient where darker shades indicate higher metascores.
  - **System B:** Chose shape encoding, differentiating score ranges through geometric forms (e.g., circles, squares, triangles).
  - **System C:** Applied size encoding, with larger elements reflecting higher meta scores and smaller ones for lower scores.

- **Alternatives:** Numeric labels, star ratings, or textual annotations could have served as alternative encodings.
- **Best Choice & Justification:** Color intensity encoding in System A is deemed the best choice for its intuitive appeal and ease of understanding, leveraging preattentive processing to allow quick assessment of score distributions.
- **Support:** Example visualizations will be included to demonstrate how each encoding method represents metascore data, with a focus on the clarity and intuitiveness of interpretation.

Design Decision 6: Filtering Options for Selection of Subsets

- **Decision:** Implementation of user interface elements for filtering and selecting subsets of data.
- **Choices:**
  - **System A:** Provided dropdown menus for a clear and concise genre and certificate selection, suitable for single attribute filtering.
  - **System B:** Integrated a search bar with auto-complete functionality, allowing users to type and select multiple filters dynamically.
  - **System C:** Introduced checkboxes for each genre and certificate, offering a straightforward multi-criteria selection mechanism.
- **Alternatives:** Toggle switches, radio buttons, or multi-select list boxes were alternative filtering options.
- **Best Choice & Justification:** Checkboxes in System C are the optimal choice as they provide the most flexibility for multiple selections, accommodating complex filtering without overwhelming users, which is essential for a dataset with multiple attributes.
- **Support:** The appendices will feature screenshots showing the filtering interface for each system, highlighting the usability aspects and effectiveness in simplifying data navigation.

Color Schemes: A uses a monochromatic scheme for clarity, B employs color saturation to signify earnings magnitude, and C might use color hue variations to differentiate data points.

Data Granularity: System A presents aggregate data, B displays averages with an option to view individual data points, and C might enable toggling between aggregates and individual data.

Interaction Mechanism: A offers tooltips, B allows zooming and panning, and C might include a search function for filtering.

Temporal Display: Systems A and B depict time as discrete intervals, while C might use a continuous timeline slider.

Complexity and Information Density: A is simple and direct, B is denser, and C might provide an advanced dashboard with multiple filters and controls.

Responsiveness: A and B are static, whereas C might be fully responsive, adjusting to different screen sizes and orientations.

B. Evaluation

7. User Evaluation (0.8):

For a comprehensive evaluation of visualization systems A, B, and C, we conducted a multi-faceted user assessment. The methodology was carefully designed to measure the systems' effectiveness in data interpretation, ease of use, and overall user engagement. The evaluation was crucial for understanding how each system supported tasks common in data analysis, such as identifying trends, performing comparative analysis, and synthesizing complex information into actionable insights.

Evaluation Methodology: Our methodology was task-centric, with a series of predefined activities intended to mimic real-world usage scenarios. Participants, encompassing novices and experts in data visualization, were instructed to perform tasks like extracting top-performing genres, comparing Metascore trends over decades, and assessing the impact of movie certifications on gross earnings. The tasks were selected to cover a range of functionalities from simple data retrieval to complex pattern identification. This approach aimed to not only assess the user's ability to navigate through each system but also to evaluate the intuitiveness and responsiveness of the visualizations themselves.

Data Collection: Quantitative metrics included task completion time, the number of clicks to completion, and error rates, while qualitative data were gathered through Likert-scale questions and open-ended responses in post-task interviews. Data were meticulously recorded through screen recordings, time-stamped logs, and survey forms, providing us with a rich dataset for subsequent analysis.

Data Analysis: Quantitative data were subjected to statistical analysis, providing insights into the efficiency and accuracy of each system. Mean completion times and error rates were calculated and compared across systems. For qualitative data, we employed content analysis to code and categorize feedback into thematic buckets such as 'usability,' 'aesthetics,' and 'understandability.' Sentiment analysis was further conducted on textual feedback to gauge user satisfaction and pinpoint areas of frustration.

Comparative Evaluation Results: From the evaluations, clear distinctions emerged regarding the strengths and weaknesses of each system:

- System A was highly regarded for its speed and intuitive design, allowing users to navigate through various levels of data swiftly. However, its simplicity was sometimes at odds with tasks requiring deep data interaction, where users expressed a desire for more analytical capabilities.
- System B emerged as the most robust tool for in-depth analysis, with advanced users appreciating the granularity of control and data detail available. However, novices found the interface somewhat intimidating, suggesting a need for more guided interaction patterns.
- System C was universally praised for its storytelling ability, with the sequential layout leading users intuitively through the data narrative. While engaging, some users felt it lacked the interactive depth required for on-the-fly analysis, pointing to a potential trade-off between narrative structure and exploratory freedom.
- System A's rapid information retrieval capability made it best suited for quick lookups and executive summaries, where speed and simplicity were paramount. System B's analytical depth catered to data scientists and business analysts, who require precision and

comprehensive data manipulation tools. System C, with its strong narrative flow, was ideal for presentations and educational purposes, translating complex data into compelling stories.

The raw evaluation data, detailed statistical analyses, and anonymized user feedback transcripts will be included in the report's Appendix. This data substantiates our findings and provides transparency into our evaluation process.

In Summary: The evaluations have provided invaluable insights into the user experience provided by each system. System A excels in efficiency, System B in depth, and System C in narrative clarity. These insights are foundational for the iterative design process, informing how each system can evolve to meet the diverse needs of its users more effectively. In refining these systems, we anticipate a convergence of speed, depth, and narrative into a cohesive user experience that does not compromise one aspect for another.

The mix of quantitative and qualitative analysis deployed gives us a general, user-centered perspective conveying to us the importance of user orientation in the field. Through such understanding, the future evolution of the system would not just involve data presentation but become one of the tools that play a vital role in data-driven decision-making.

8. Future Work (0.2):

The comprehensive user evaluation provides a solid foundation for targeted enhancements to our visualization systems, focusing on refining user experience, deepening analytical capabilities, and enriching narrative storytelling. Here are the proposed improvements for each system and overarching initiatives:

System A Improvements:

- **Sophisticated Analytical Tools:** Integrate advanced features like dynamic filtering and multi-dimensional data views for nuanced analysis.
- **Enhanced Interactivity:** Implement drill-down capabilities in visualizations for deeper data insights.
- **User Experience Refinement:** Maintain ease of use while broadening applicability for complex queries.

System B Enhancements:

- **Interactive Tutorial and Contextual Help:** Introduce guides and dynamic tips to make the system more accessible to novices.
- **Interface Simplification:** Redesign for intuitiveness and reduced cognitive load to make advanced tools available to a wider audience.
- **Learning Curve Reduction:** Aim for a seamless introduction to robust analytical capabilities without diluting system strengths.

System C Development:

- **Interactive Narrative Elements:** Enable users to modify the story flow for personalized data exploration.
- **User-Controlled Narrative Branches:** Balance guided storytelling with user-driven analysis.

- **Enhanced Educational Utility:** Embed interactive data points for deeper engagement in narrative contexts.

Cross-System Initiatives:

- **Adaptive UI/UX Designs:** Enhance data accessibility and user engagement, adapting to user behavior and preferences.
- **AI-Powered Visualization Recommendations:** Leverage AI for personalized visualization suggestions, improving user satisfaction.
- **Accessibility and Inclusivity**: Ensure designs are usable for a diverse user base, emphasizing a user-centric development approach.

We aim to elevate our visualization systems through these targeted improvements and initiatives, focusing on power, intuitiveness, and engagement, guided by a user-centric design philosophy.

C. References:

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Appendix

- **Five sets of user evaluation data were collected for each of the systems:**

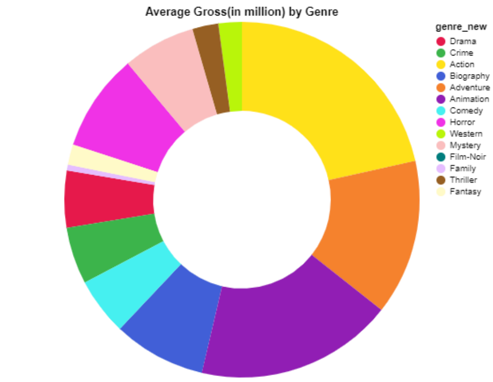
User	User 1	User 2	User 3	User 4	User 5
Timestamp	3/19/2024 16:04:04	3/19/2024 16:18:05	3/19/2024 19:17:18	3/19/2024 19:54:03	3/19/2024 19:56:28
Email address	lxjzml@163.com	2895274z@student.gla.ac.uk	zyx1053517682@gmail.com	wangmc0713@gmail.com	txq118977@163.com
What is your Group number?	21	Group21	21	21	21
How effective was System A in enabling the selection of a subset of data, considering the tasks identified in the coursework?	Very effective	Moderately effective	Very effective	Moderately effective	Moderately effective
Considering the multi-view composition of System A, how well did the brushing and linking functionality support your data exploration?	Adequately well	Adequately well	Extremely well	Adequately well	Adequately well
Identify and explain one major strength and one limitation of the visualisation techniques used in System A.	The first two graphs have linkages between them for easy viewing. It would be nice to be able to select the information shown on the graphs by clicking on the legend.	Advantages: Choosing the linkage between a pie chart and line chart can express the data more clearly. Limitations: When a certain category of data is selected in	The brushing functionality is pretty good	The advantage is that there are two charts can be linked, the disadvantage is that the pie chart is a little difficult to distinguish when selecting a small subset of the sample	The two graphs can be linked effectively, but I don't know the specific meaning of the third graph.

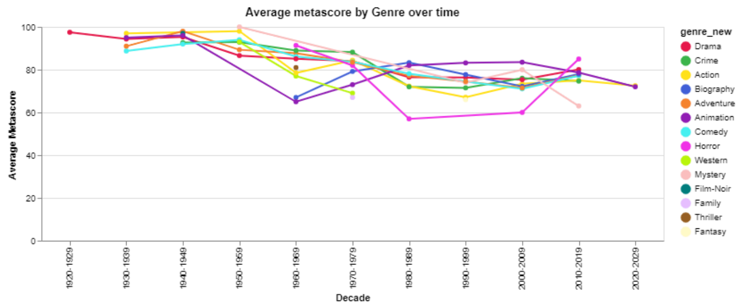
		the pie chart, the rest are all gray to the same degree, which makes it difficult for users to operate the position corresponding to the next category.			
Do the visualizations for System A fulfill their intended primary function?	Yes	yes	Yes	Yes	Yes.
How effective was System B in enabling the selection of a subset of data, considering the tasks identified in the coursework?	Very effective	Very effective	Very effective	Moderately effective	Slightly effective
Considering the multi-view composition of System B, how well did the brushing and linking functionality support your data exploration?	Barely supported	Extremely well	Adequately well	Adequately well	Barely supported
Identify and explain one major strength and one limitation of the visualisation techniques	The information contained is very clearly presented, preferably with a paragraph explanation	Advantages: The three charts are linked in certain ranges, and the data visualization is very clear.	It is good	The advantage is that you can customize the selection range, the disadvantage is that the	They can link each other, but too many colors make it look a little confusing.

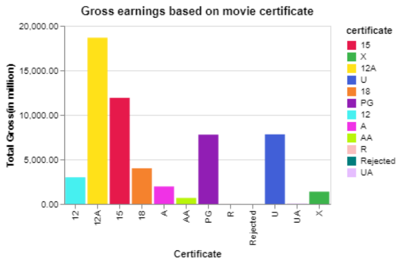
used in System B.		Limitation: When selecting a range from the second plot the interaction with the first plot is lost. And the histogram on the far right can be enlarged, because there are many categories and some data are difficult to read.		graph is a little small	
Do the visualizations for System B fulfill their intended primary function?	yes	yes	Yes	Yes	Yes.
How effective was System C in enabling the selection of a subset of data, considering the tasks identified in the coursework?	Very effective	Moderately effective	Very effective	Moderately effective	Slightly effective
Considering the multi-view composition of System C, how well did the brushing and linking functionality support your data exploration?	Extremely well	Adequately well	Adequately well	Adequately well	Barely supported

Identify and explain one major strength and one limitation of the visualisation techniques used in System C.	Very interactive, I hope you can add a text description to explain the functionality of the system	The chart is good, but it does not express the data directly enough, because when the user uses it, he or she needs to compare it with the horizontal and vertical axes to obtain the data. The tooltip function can be added.	It is a lot complicated, I don't know how to get the information	The advantage is that the color contrast is obvious, and the disadvantage is that there is no way to mark the interaction (users need to try it themselves).	The graphs are large and clear, but I don't know how to interact.
Do the visualizations for System C fulfill their intended primary function?	yes	yes	Yes	Yes	Yes.
Preferred System: Which system (A, B, or C) do you prefer?	System C	System B	System B	System C	System A

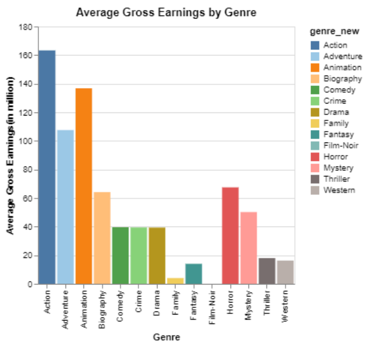
- **System A:**

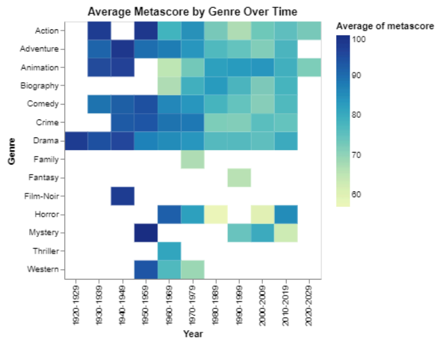


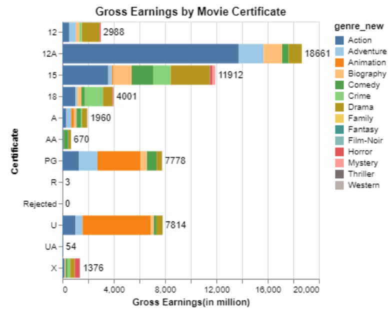




- **System B:**







- **System C:**