

# Virtual Wave: Unveiling the Gaming World

## A Introduction to Data Visualization Project Report

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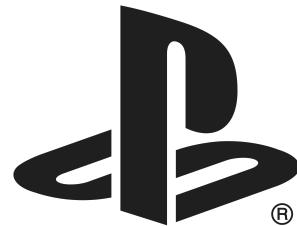
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# I. Introduction

According to the latest market research, although the global economy has been affected by the impact of the COVID-19 epidemic and unstable factors such as geopolitical tensions in various regions in recent years, the overall economic situation has shown a complex and volatile trend. At the same time, however, the video game market has shown strong growth. According to Grand View Research, the global video game market was valued at USD 217.06 billion in 2022 and is expected to grow at a CAGR of 13.4% from 2023 to 2030. Moreover, Newzoo data shows that the number of video game players globally was 3.22 billion in 2023 and is expected to increase to 3.32 billion by 2024. These figures indicate that the video game market continues to grow strongly despite the challenges of the global economy. As active gamers and data scientists, we hope to be able to explore the true dynamics of the current gaming market through in-depth analyses of real gaming data.

The data on the Steam platform and console platforms will gain a deeper understanding of the comprehensive features and trends of the gaming market. Steam, as one of the world's largest digital distribution platforms, and console platforms such as Xbox, PlayStation, and Nintendo represent key components of the gaming industry. The game libraries of these platforms are not only large but also diverse, providing a rich data resource for our study.



The core of this project lies in the use of data visualisation techniques to convert this complex data into intuitive, easy-to-understand visual information. We will use charts and graphs to show the dynamic changes and characteristics of the game market on different platforms. Such analyses will not only help to gain an in-depth understanding of the game market on Steam and console platforms, but also reveal the interrelationships and uniqueness between different platforms. This project also aims to explore how to improve user experience and data presentation through data visualisation. We hope to provide game developers, market analysts, and gamers with a comprehensive and in-depth perspective to better understand and evaluate changes in the digital gaming landscape.

## II. Data Overview

### 1. Data Description

We get this dataset from the search page on the Steam platform, Microsoft Xbox, Nintendo and Sony PlayStation Games' page, and includes a series of detailed information about video games. The data set covers countless records about various games, including the **Game Name**: The title of each game. **Original Price**: The original selling price of the game on Steam. **Discounted Price**: The discounted selling price of the game at the time of crawling. **Release Date/year**: When the game was released on Steam. **Link**: A link to the game's page in the Steam store. **Game Description**: A brief description of the game content. **Recent Review Summary**: An overview of recent user reviews of the game. **Summary of all reviews**: An overview of all user reviews about the game. **Number of recent reviews**: The number of recent user reviews. **Number of all reviews**: The number of all user reviews. **Developer**: The developer information of the game. **Publisher**: The publisher information of the game. **Supported languages**: List of languages supported by the game. **Popular tags**: Keywords or tags of games, such as "RPG", "Multiplayer", etc. **Game Features**: Features and functions of the game, such as "Single Player", "Online Multiplayer", etc. **Minimum System Requirements**: The minimum system configuration required to run the game. **Average Players by month/year**: the trend of each games' number of players by month/year. **Sales Data**: Including the North America, Japan, etc. **Recommendation Data**: the recommendation count of each games in total.

This data uses several dimensions to summarize and encompass everything.

a. **Economic dimension**: from pricing to discounted prices. We can observe the economic trends in the game market, understand the pricing strategies of different types of games, and how discount promotions affect the pricing decisions of game manufacturers.

- b. Time dimension:** Through the time of game release, we can trace the development trajectory of the game and understand how the market evolves over time.
- c. Community interaction:** Through game descriptions and player review summaries, this dataset not only demonstrates the characteristics of the game itself, but also reveals the feedback and interaction patterns of the player community.
- d. Diversity:** There is a wide variety of games in the dataset, from action-adventure to strategy simulation, each with its own unique appeal and audience. This reflects Steam's broad reach as a global digital gaming platform.

## 2. Data Preprocessing

In the data cleaning section, we remove all null values and then select and delete the data that is not needed.

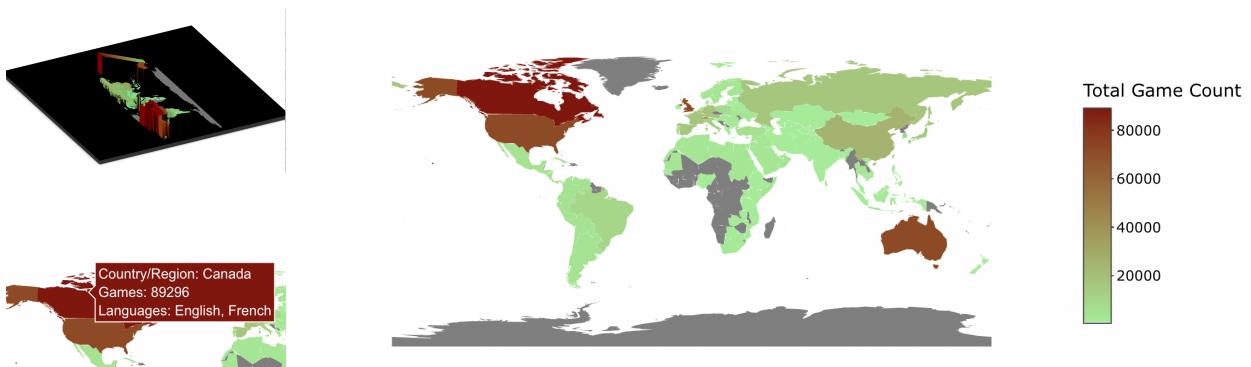
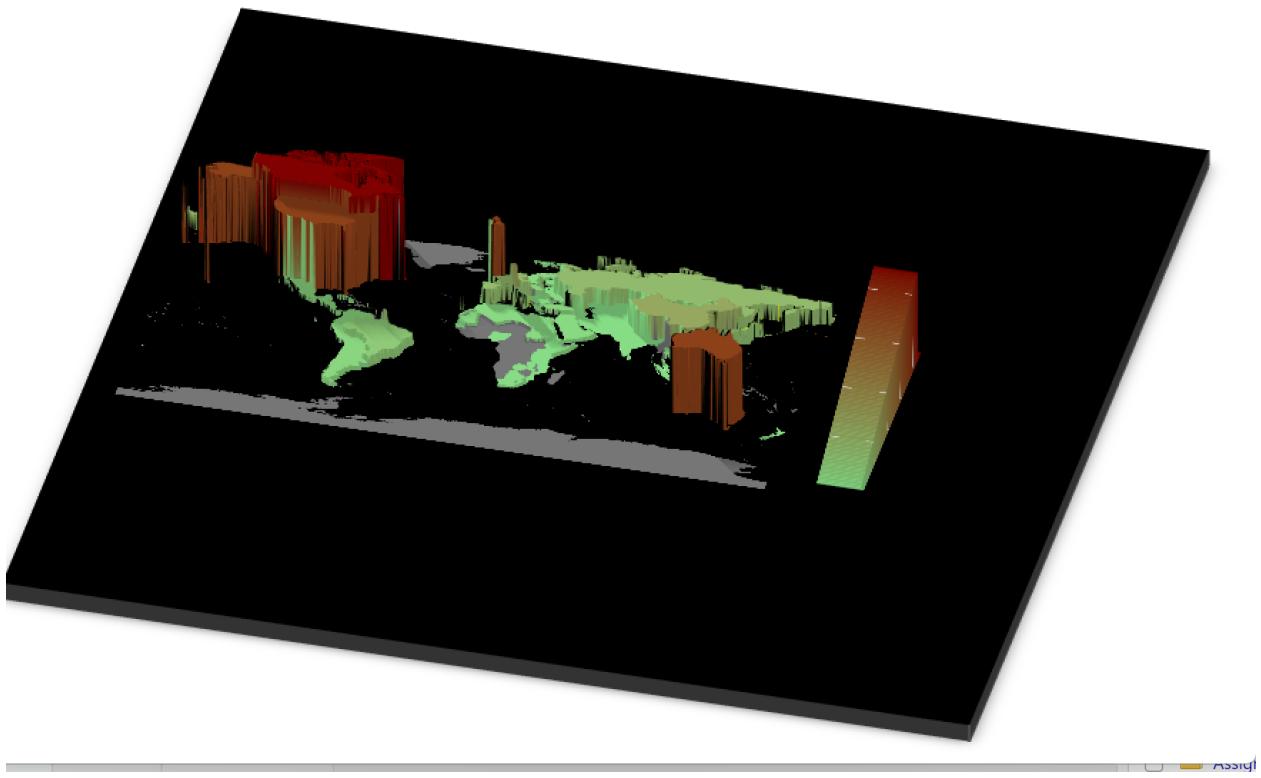
In feature engineering part, we focused on refining the dataset for more efficient and accurate analysis. A key step in this process was the extraction of the year from the 'Release.Year' field. Originally containing complete date information, we isolated the year component, discarding the day and month to streamline the temporal data for our year-based trend analysis.

Additionally, we addressed the 'Features' and 'Tags' fields, which were presented as arrays containing multiple categorical data entries. We extracted each category from the arrays, transforming them into individual, quantifiable units. This flattening of the data structure allowed for more straightforward manipulation and analysis, enabling us to assess the impact and prevalence of each feature and tag within the dataset.

Furthermore, the 'Review' field presented textual data with varying degrees of positivity, such as 'Positive' and 'Mostly Positive'. To convert this qualitative data into a machine-readable format, we applied label encoding, assigning a unique integer to each level of review positivity. This numerical transformation is crucial for subsequent algorithmic processing and pattern recognition within the review data, allowing us to quantitatively assess the general sentiment associated with the games in our dataset.

## III. Integrated Approach

### 1. Supported Language - Country Mapping: from 2D to 3D



To understand the level of multilingual support in different national game markets. In the globalised gaming industry, the number of languages supported by a game is an important measure of game accessibility and market reach. For example: Multi-language support indicates how much attention game developers are paying to each country or regional market. This helps to analyse in which countries or regions the game may have a wider audience. Also, Providing users with games in localised languages can greatly enhance the user experience and increase the appeal and accessibility of the game.

## A. Methodology

**Count Each Support Languages:** We use `tidyverse` package to preprocess and analyze game data from the dataset, paying special attention to the languages supported by the game. First, the data is read from the CSV file and its structure is examined to determine which columns contain supported language information. Then, extract and process the Supported Languages column to separate the language names in it from comma-separated strings and clean up any extraneous spaces or special characters. Next, the extracted language data are counted and sorted in descending order of frequency of occurrence.

**Establish the Supported Language - Country Mapping:** We first load the `ggplot2`, `rnatualearth` and `dplyr` packages for incoming map visualization and data processing. Next, a mapping relationship between languages and countries is defined (for main countries with main languages in those countries). The world map data was obtained using the `rnatualearth` package and a new data frame was created to store the number of languages supported by each country. Then, the language count for each country in this data frame is updated based on the language-country mapping relationship. Finally, the language count data is merged with the world map data.

**2D Interacted Map:** We iterate over the previously defined language-country mapping relationship, calculate the number of games in each country, and update the data frame. Then, the world map data was obtained using the `rnatualearth` package. Afterwards, the game count data is merged with the world map data through the `left_join` function. Finally, a choropleth map was created using the `ggplot2` package, in which the color depth of each country represents the number of games it supports, and converted into an interactive map using the `plotly` package to provide a richer user experience.

**2D to 3D Supported Language - Country Mapping:** We use the `plot_gg` function of the `rayshader` package to convert the `ggplot2` object into a `rayshader` graphics object. The object is then further processed to enhance its 3D effect, which includes setting the height scale (`zscale`), field of view (`fov`), viewing angle (`theta` and `phi`) and zoom (`zoom`). Finally, using the `rglwidget` function provided by the `rgl` package, an interactive 3D display is implemented, allowing users to view and explore the map from different angles in an interactive environment.

## B. Analysis and Principles for Visualization

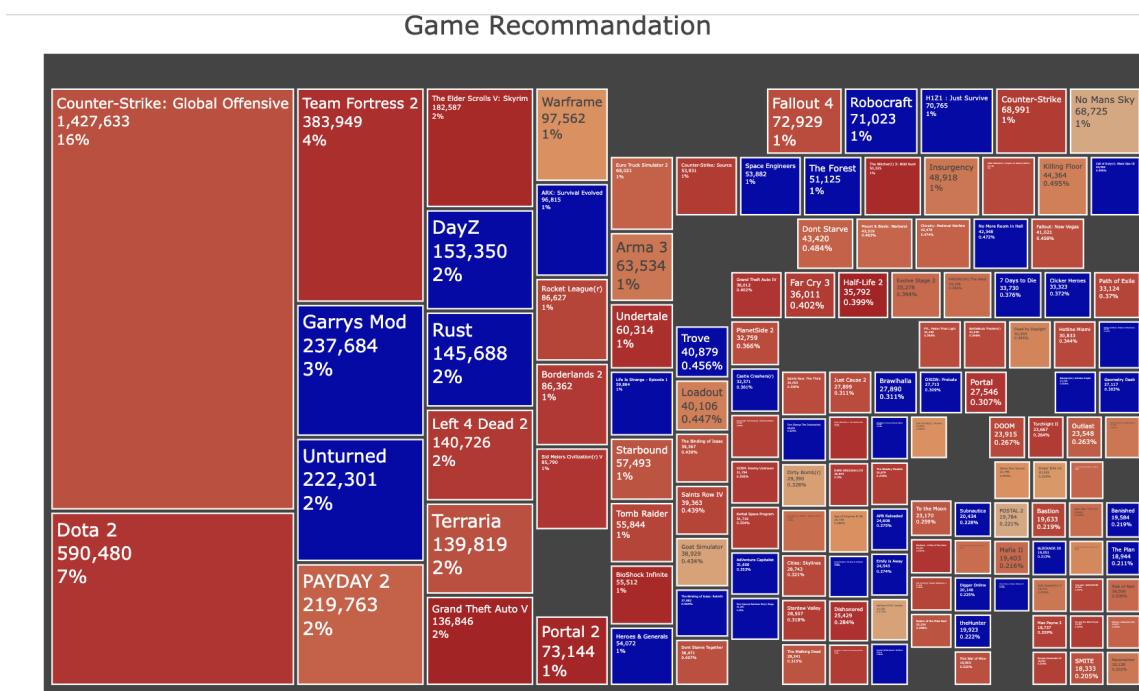
We can find that English and English-speaking counties, of course, occupied the first place in the world. Some small kinds of languages have few game languages support.

### Principles:

**3D Perspective:** It provides a visually striking representation of data, which can be engaging and informative when it comes to showing volumes.

**Distinctive Heights:** Different heights are immediately noticeable, which effectively indicates the variation in the number of supported languages across countries.

## 2. Tree Map of Recommendation Counts



We want to know which games have the highest number of recommendations. This plot is a tree map that showing the number of players of different video games and their relative proportions. Each game's block size represents the size of its player base, which can be perceived by the area of the block.

### A. Methodology

`plot_ly` provides an interface to create many types of interactive charts, which makes the visual representation of data more intuitive and user-friendly. In this particular example, the `plot_ly` function is the core, allowing you to specify the chart type, define the label for each block (game name), set the value of the dendrogram (recommended number of games), and the information displayed on the label (including labels, values, and percentages). Through the `marker` attribute, we map the color to the Metacritic score of each game, using color gradients to represent the

level of the score. In addition, the layout function is used to fine-tune the visual layout of the chart, including the title, background color, and margins.

## **B. Analysis and Principles for Visualization**

We can see that the CS:GO or Counter Strike: Global Offensive has the most recommendation count, followed by Dota 2 and Team Fortress 2.

Hierarchy Representation: Treemaps are good at displaying hierarchical data and this chart does so by showing which games are most prominent within the dataset.

Color Coding: Different colors are used to represent different games, which helps in distinguishing them from one another.

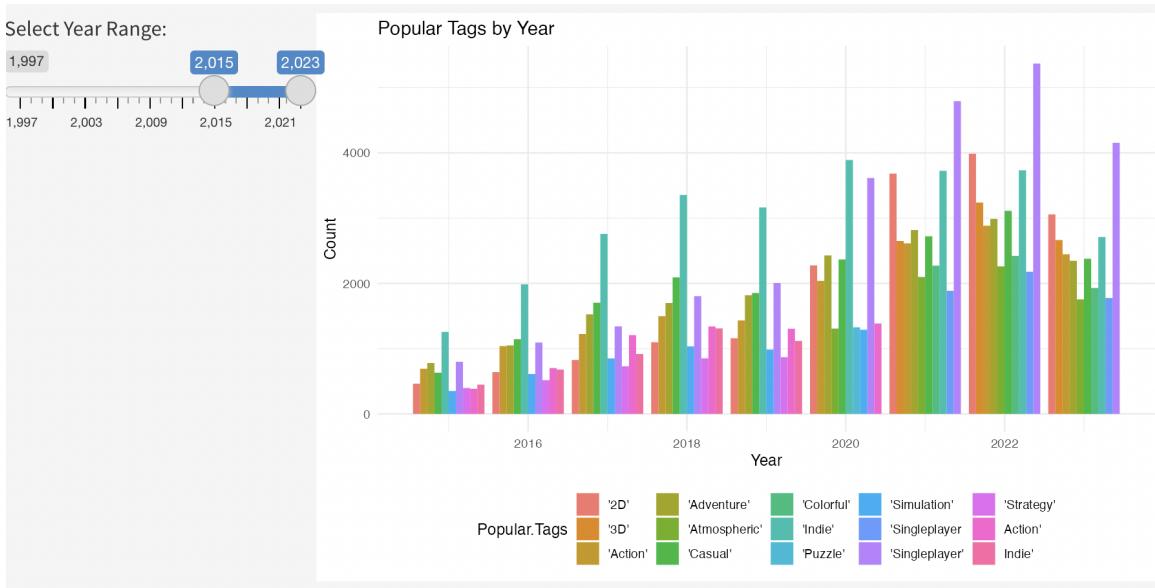
Data Labels: Each game block includes the game's name, a numeric value, and a percentage, which provides clear information about each game's standing.

## **3. Changing of Features by Controllable Time Series by Shiny**

### **a. Popular Tags by Year**

How do trends in game labelling over time impact on game development and marketing strategies?

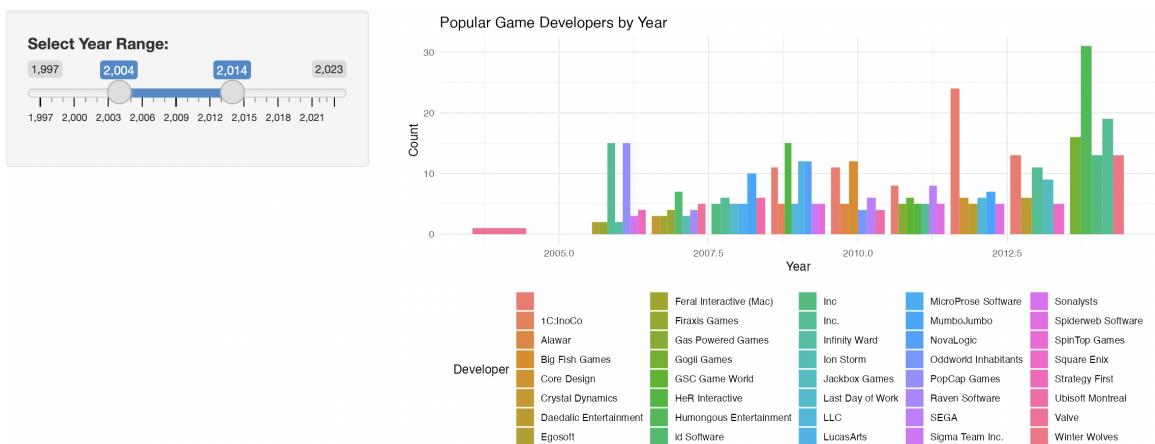
It aims to explore the popularity of different game labels over the calendar year and analyse how these trends can guide game developers and marketers to make more informed decisions in their future content creation and promotion strategies. By identifying upward and downward trends, relevant stakeholders can anticipate market demand and adjust their products and services accordingly to meet consumer expectations.



## b. Popular Developers by Year

Which game developers' titles have been the most popular over the past few years, and how do these trends reflect the changing competitive landscape within the industry?

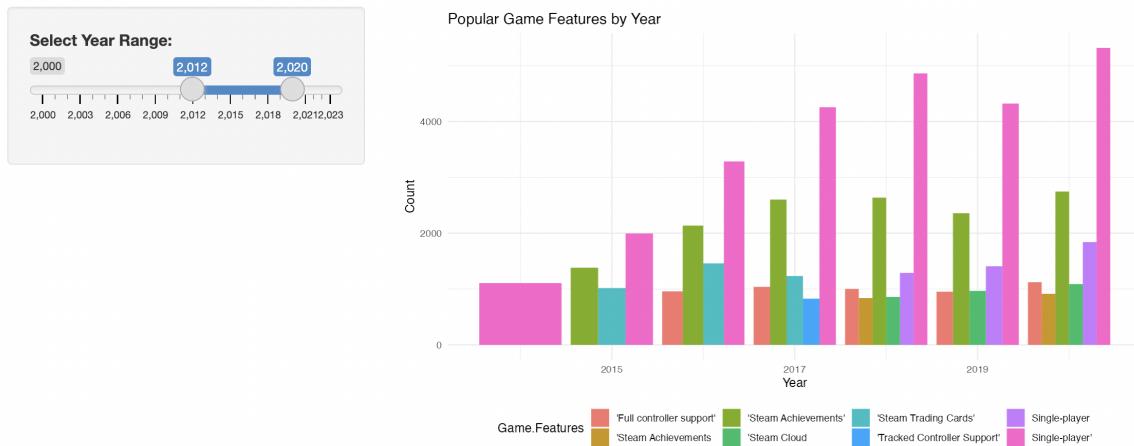
This question aims to explore how the popularity of game developers has changed over time, which may reflect market dynamics, shifts in consumer preferences, and the evolution of the industry's competitive landscape. Such an analysis can help investors, game developers, and market analysts understand industry trends and guide their business decisions and strategic planning. By understanding which developers have excelled at a given time, stakeholders can better identify successful market strategies and potential investment opportunities.



## c. Popular Game Features by Year

Which gaming features have grown in popularity in recent years and how does this reflect trends in player preferences and technological developments?

This question explores popular trends in game features that have changed over time and attempts to understand the player behaviour and technological advances behind these trends. This kind of analysis is vital for game developers as it can reveal changes in player preferences, help them prioritise which features to include in new projects and make appropriate updates or improvements to existing games. For market researchers and game publishers, this information is equally valuable, as it can help predict industry trends and adjust marketing strategies.



## A. Methodology

These figure are bar charts showing the distribution of the number of various popular tags/developers/Features in different years. It includes a time range selector that allows users to select a specific time range in order to view counts for individual tags/developers/features during that time period. The X-axis of the chart represents the year, and the Y-axis represents the count, which is the number of games with a certain label in a specific year. Pillars of different colors correspond to different game tags/developers/Features, etc., and the height of each color represents the count of the corresponding tag. Through this graph, we can observe which game tags/developers/features become more or less popular over time.

In our analysis, we utilized the `ggplot2` package to generate histograms, a powerful tool for data visualization in R. It allows us to visually display changes in the number of most popular game developers from year to year, making complex data easily understandable.

To increase user engagement and exploration, we used the `shiny` package to build an interactive web application. Inputted via a slider, this app enables users to select the year range they are interested in and instantly view data visualizations for that time period. This interactive approach improves the user experience and allows for personalized data exploration.

## B. Principles for Visualization

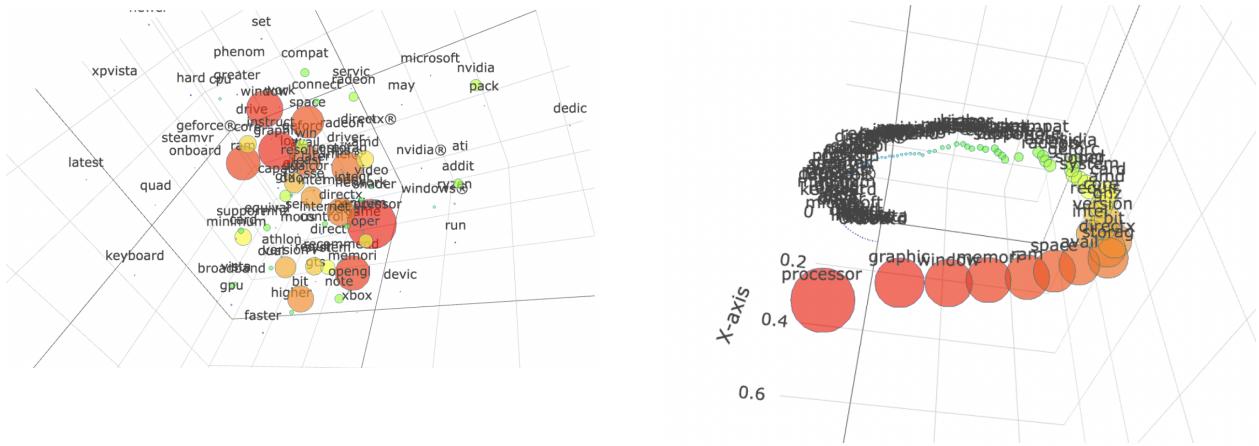
### Principles:

- Color Coding: The use of distinct colors for each category (tag) makes it easy to differentiate between them.
- Interactive Range Selector: The slider at the top suggests interactivity, allowing users to select the year range they are interested in, which can make the data exploration user-driven.
- Labeling: The x-axis and y-axis are clearly labeled with "Year" and "Count", respectively, which is good for understanding what the axes represent.
- Title: The chart has a descriptive title, "Popular Tags by Year," which helps users immediately understand the chart's purpose.

## 4. Word-Cloud & Word-Galaxy

### a. WordCloud & WordGalaxy of Game Description





## A. Methodology

**WordCloud:** First, the data is preprocessed through the `tm` package, including converting text to lowercase, removing punctuation and numbers, and eliminating common English stop words. Next, a text corpus was created using the `Corpus` function. Finally, the `wordcloud` package was used to generate a word cloud, which not only showed the most common words in the text data, but also reflected their frequency in the game description through words of different sizes and colors, thus visually revealing the game characteristics and themes.

**WordGalaxy:** Also, the data preprocessed step is similar to the 2D Word Cloud part: e.g., lowercase conversion, punctuation and number removal, stop word removal. Next, the `tm` package was used to create a corpus of text and generate a word frequency matrix. Finally, with the help of the `plotly` package, we converted these data into an interactive 3D word cloud, the color and big/small of the plot means the word frequency, which effectively showing the frequency and distribution of different words in game descriptions.

## B. Analysis and Principles for Visualization

### Principles for Word Galaxy:

**Visual Appeal:** The 3D effect can be visually striking and engaging, adding a layer of depth to the visualization.

**Word Emphasis:** The size variation of the words effectively conveys the frequency or importance of the terms within the dataset.

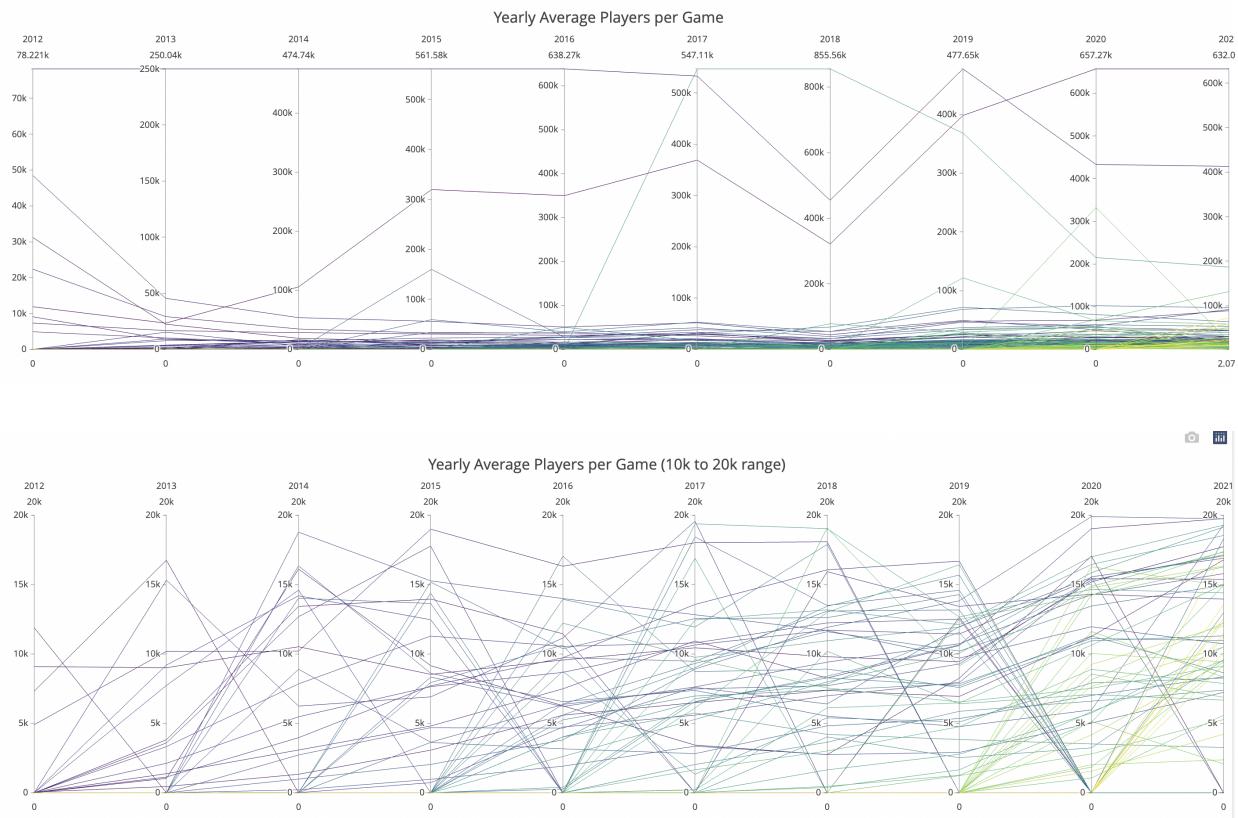
### Principles for 2D Word Cloud:

**Clarity:** It is easier to spot high-frequency words as the 2D format prevents overlap and occlusion

issues present in 3D.

**Quick Insights:** This format provides a rapid understanding of key themes or topics present in the data.

## 5. Yearly Average Players



Use the parallel coordinates plot to plot Yearly Average Players Visualization to analyze the consistency of player engagement across various games over the years to identify potential patterns or anomalies in player behavior, such as spikes in popularity or sudden declines, and correlate these trends with external events or game releases.

## A. Methodology

- **plotly:** Used for creating interactive plots. Here, it generates a parallel coordinates plot allowing dynamic exploration of player data across years.
- **dplyr:** Facilitates data manipulation, such as grouping and summarizing average player counts, and filtering the dataset.

- **tidyverse**: Assists in reshaping data, particularly pivoting yearly data into a wide format suitable for the plotly visualization.
- **RColorBrewer**: Provides color palettes to enhance visual distinction among data lines in the plot.

## B. Analysis and Principles for Visualization

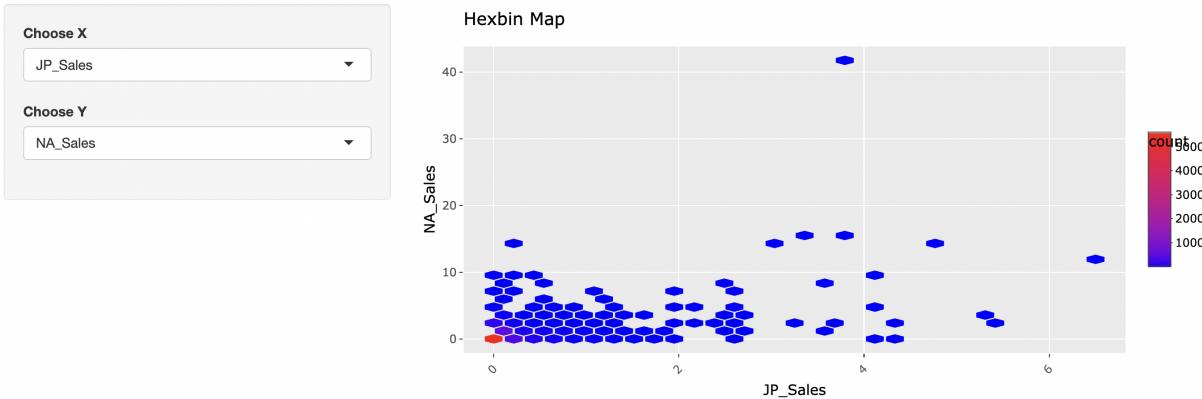
**Top Graph (Full Range):** This graph shows a wide range of values with the Y-axis ranging up to around 800k players, given an overview of the entire range of average players, highlighting games with exceptionally high average player counts. The lines represent individual games or aggregates of games, and the graph displays significant variation between them. There are some lines (games) that peak at different years indicating a high average player count in those years. But there is hard to distinguish the range of 0-20k.

**Bottom Graph (0k to 20k Range):** The second graph focuses on a narrower Y-axis scale, from 0 to 20k players, providing a more detailed view of games with average player counts in that range, offering a detailed look at the games with fewer average players, showing the volatility and dynamics within this segment. This zoomed-in view shows the fluctuation of player counts for games with smaller player bases, which would be less visible on the full range graph.

### Principles:

1. **Multivariate Analysis:** Parallel coordinates plots are excellent for displaying multivariate data, allowing each axis to represent a different variable (in this case, each year) and each line to represent a data point (game).
2. **Color Coding:** By employing a distinct color for each game (using RColorBrewer), the plot provides a clear visual distinction between games, which is vital for tracking individual game trends across multiple variables.
3. **Interactivity:** Utilizing `plotly`, the plot offers interactivity that can enhance user engagement. Users can interact with the data in real-time, such as highlighting specific lines (games) to see their performance over different years.

## 6. Hexagonal Binning Map of Sales Data by Shiny



Investigate the comparative distribution and density of video game sales in North America versus Japan, using the interactive capabilities of the Shiny application to adjust variables and identify any significant correlations, clusters, or discrepancies between the two markets.

## A. Methodology

- **shiny:** Provides tools for building interactive web applications directly from R. In this application, it is used to create the user interface and server logic for the hexbin plot visualization.
- **plotly:** Allows for the creation of interactive plots that can be embedded in web applications. Here, it is used to convert a ggplot object into an interactive Plotly object.
- **hexbin:** Utilized for creating hexagonal binning plots, which is a method of visualizing the structure of datasets with many points. The hexbin plot in the application visualizes the density of bivariate data.

## B. Analysis and Principles for Visualization

In this plot, users can adjust the variables plotted on the X and Y axes. In this case, the plot is showing the relationship between 'JP\_Sales' on the X-axis and 'NA\_Sales' on the Y-axis. Each hexagonal cell represents a concentration of data points, with the color intensity reflecting the number of data points within that cell – the darker or more intense the color, the higher the number of data points.

### Principles:

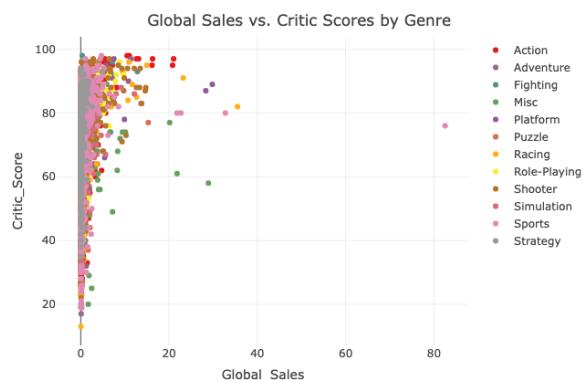
- **Interactivity:** Shiny enables user interaction, allowing for real-time data exploration.
- **Clarity:** Plotly and ggplot2 provide clear, interactive visualizations.

- **Data Integrity:** Readr and dplyr ensure accurate data handling.
- **Visual Encoding:** Hexbin and color gradients effectively represent data densities.

## IV. Marketing Strategy

### 1. Visualization Analysis

#### A. Global Sales & Critic Scores

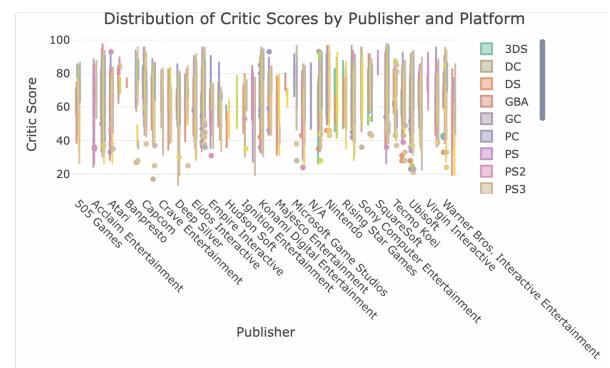


How does the relationship between market sales and critical ratings of game genres reveal the interplay between game reviews and commercial success?

There appears to be a positive correlation between global sales and critic scores within some genres, suggesting that higher-rated games tend to sell better. The distribution of points across genres suggests that this relationship varies by genre, with

#### B. Distribution of Critic Scores

Investigate the variation in critic scores for video games across different publishers and platforms to determine if there are any patterns or disparities in critical reception that could be linked to publisher reputation or platform capabilities.

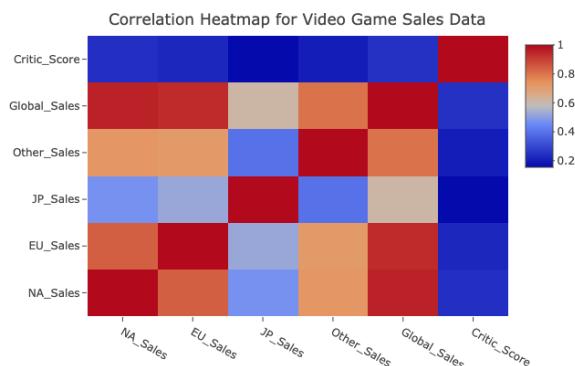


The plot indicates a wide range of critic scores across publishers and platforms, with some publishers showing a broad spectrum of scores, suggesting variability in game quality. Certain platforms seem to have higher median scores, which may imply

some genres potentially showing a stronger correlation than others.

### C. Correlation Heatmap

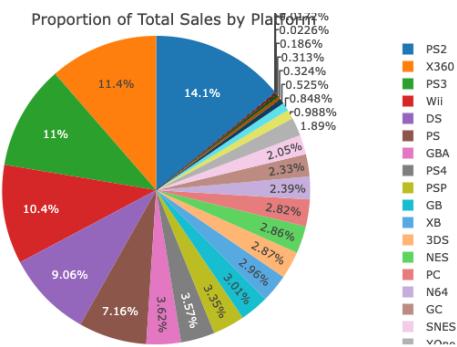
What correlation exists between sales figures in different regions and between these sales figures and critical ratings, and how does this affect the development of global market strategies?



**Sales Correlations:** North American (NA) sales show a strong positive correlation with European (EU) sales, and both are strongly correlated with global sales. This suggests that games that sell well in NA are likely to sell well in EU and vice versa, which significantly impacts global sales.  
**Japan (JP) Sales:** Sales in Japan show a moderate correlation with global sales but a weaker

platform-specific quality standards or audience expectations. No single publisher or platform consistently dominates the highest critic scores, highlighting the competitive nature of the gaming industry.

### D. Proportion of Total Sales by Platform



How is market share changing across gaming platforms and how does this impact on predicting platform lifecycles and determining platform strategies for developing new games?

Certain platforms have a significantly larger share of total sales, indicative of their popularity and success in the market.

correlation with sales in other regions, indicating unique regional preferences.

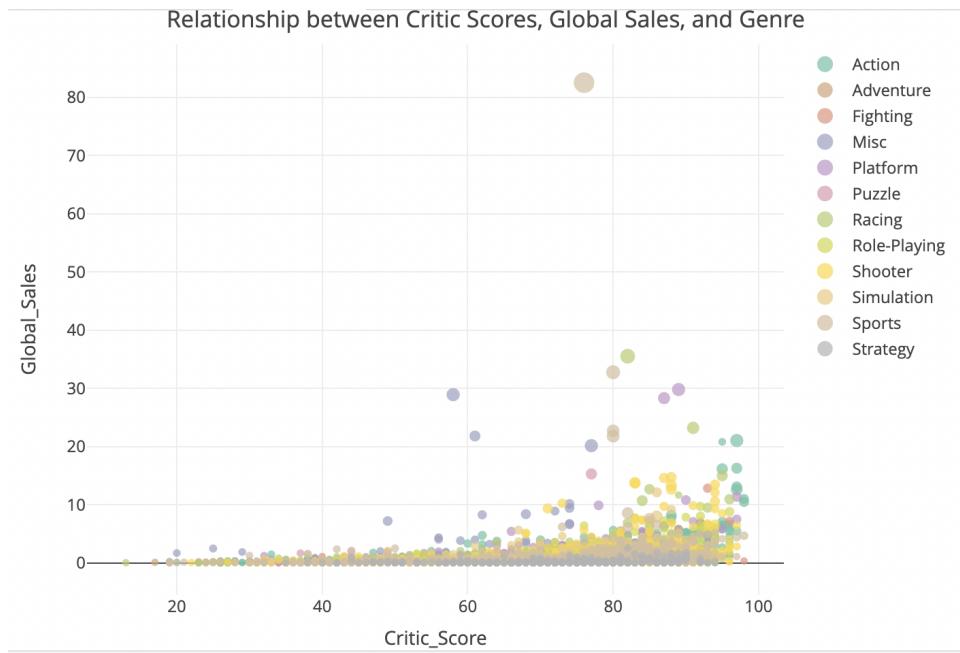
**Critic Score Correlation:** The critic score has a weak but positive correlation with sales in all regions, including global sales. This suggests that while higher critic scores can be associated with higher sales, many other factors contribute to sales performance.

The PlayStation 2 (PS2), Xbox 360 (X360), PlayStation 3 (PS3), and Wii are among the platforms with the largest market shares. There are also a considerable number of platforms with smaller shares, reflecting the competitive nature of the gaming hardware market and the diversity of options available to consumers.

## E. Relationship between Scores, Sales, Genre

Evaluate how critic scores correlate with global sales across various game genres to understand the extent to which critical acclaim influences commercial success in the video game industry.

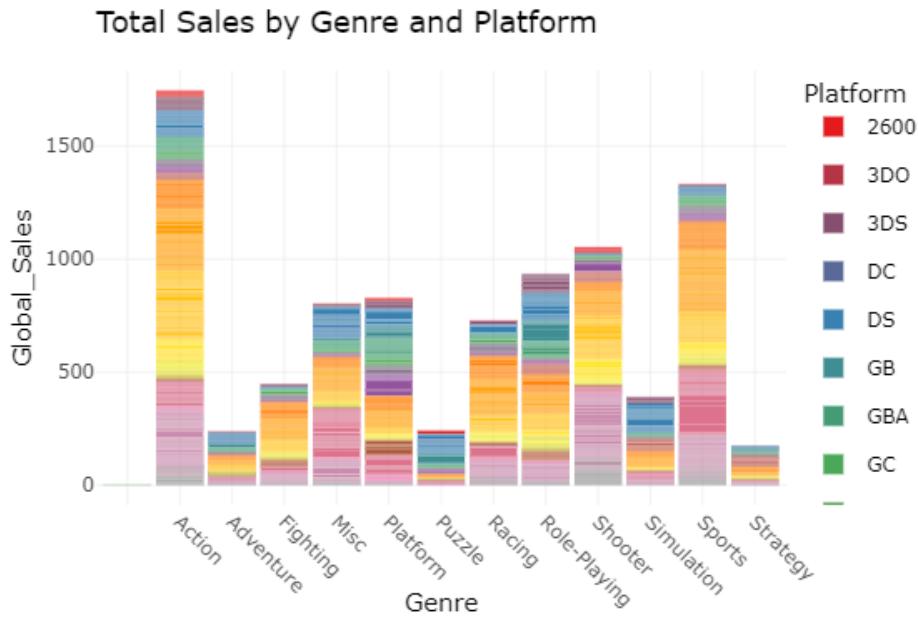
The scatter plot suggests a positive correlation between critic scores and global sales for video games, particularly noticeable in genres such as Action, Shooter, and Role-Playing, where higher scores often align with greater sales. However, this trend is less pronounced or non-existent in genres like Puzzle and Simulation, indicating that critical acclaim may not be as influential on sales in these categories. It appears that while good reviews can boost sales, the strength of this effect varies by genre.



## F. Total Sales by Genre and Platform

Determine the impact of platform diversity on the global sales performance of various video game genres.

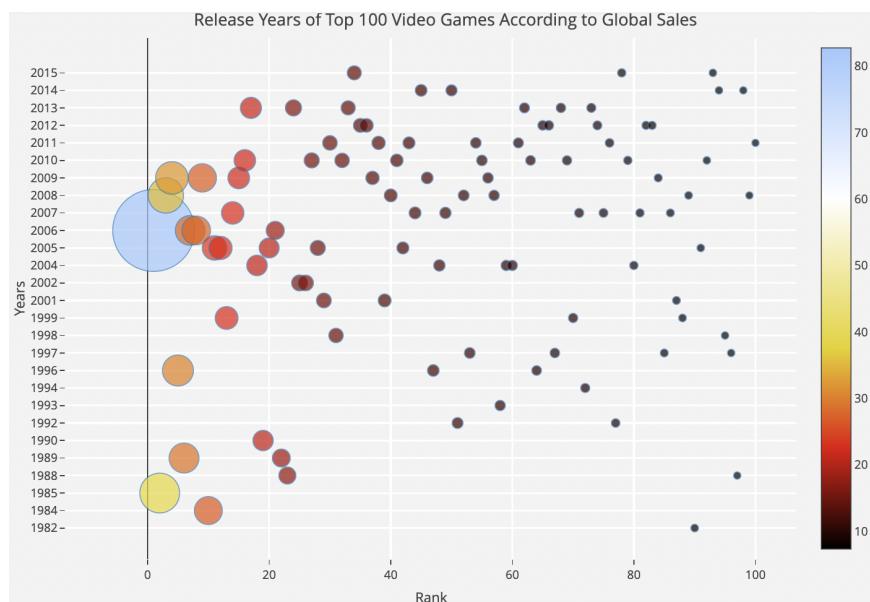
The chart indicates that action games lead in global sales across various platforms, while puzzle and simulation genres show the lowest sales. Sales in genres like shooter and sports are also strong and less dependent on specific platforms.



## G. Total Sales by Genre and Platform

Look at the global sales of the top 100 video games to see which years had the best-selling games.

The chart shows that best-sellers come from various years, with many successful games released in the mid-2000s to early 2010s. Not all the best-sellers are recent, with some older games also having high sales.



## 2. Methodology

we mainly used the `ggplot2` package, which is based on a graphical syntax and provides powerful graphical plotting capabilities. In particular, scatterplots to show the relationship between global sales and critical ratings, we used ggplot2's `geom_point` function and faceted by game type via `facet_wrap`. To show the distribution of ratings across publishers and platforms, the `geom_boxplot` function helped us create box-and-line plots to visualise the distribution of the data and outliers.

In exploring the correlation between regional sales data, we utilised the `corrplot` package, which provides a concise way to create correlation heatmaps based on the correlation matrix computed by the `cor` function. Finally, we plotted pie charts to visualise the distribution of total sales shares across different platforms through the `geom_pie` function of ggplot2.

Throughout the analysis, the `lubridate` package provided assistance in handling date and time, while the `scales` package was used to improve the axis labels and colour gradients. In addition, the `RColorBrewer` and `viridis` packages provided us with additional colour options to enhance the visual appearance and readability of the charts.

## 3. Summary of Marketing Analysis

### 1. Relationship between Global Sales and Critical Ratings

Game genres have an impact on the relationship between their market sales and critical ratings. Highly rated games tend to have better sales performance, but this trend varies between genres.

### 2. Distribution of ratings across publishers and platforms.

The distribution of critical ratings across platforms for games released by different publishers suggests that publisher and platform choice have a significant impact on game ratings. Some publishers are able to maintain consistently high ratings on specific platforms, while game ratings from other publishers show more volatility.

### 3. Correlation Heatmap of Video Game Sales Data.

Correlation analysis between regional sales shows that sales in North America and Europe have a strong positive correlation with global sales, while the Japanese market exhibits unique market trends. In addition, the weak correlation between critical ratings and sales by region suggests that ratings are only one of many factors influencing sales.

### 4. Total sales share across different platforms :

The distribution of sales share reveals the market share of different platforms, with PS2, X360, PS3 and Wii dominating the market. This shows the diversity of options that exist in the market and provides insight into the life cycle of each platform.

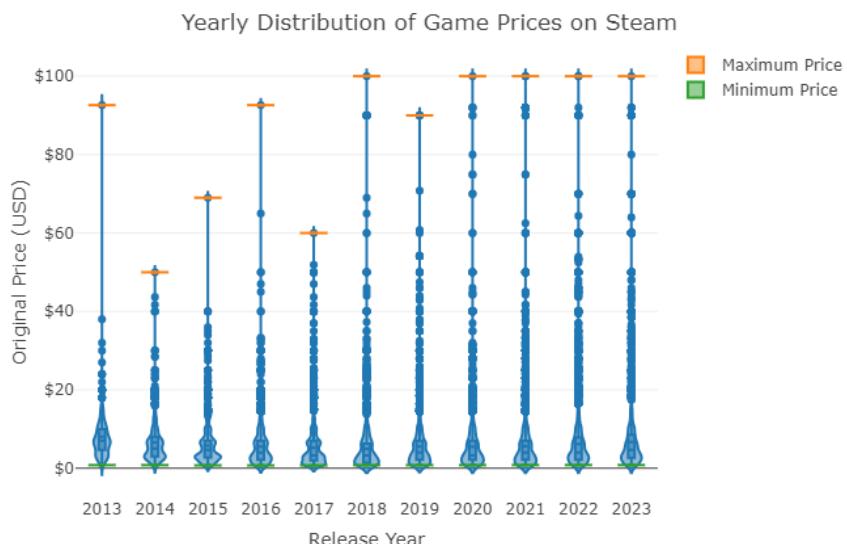
## 4. Principles for Visualization

1. **Interactivity:** Through plotly that allows people to move their mouse to the graph to find the detail information, it incorporates interactivity, enabling viewers to filter data.
2. **Color Coding:** It uses colors to differentiate between attributes, which aids in quick visual differentiation.
3. **Clear Labeling:** Both axes are clearly labeled, and a legend is provided, making the data easy to interpret, adhering to principles of clarity.

## IV. Pricing Analysis

### 1. Pricing distribution by year

**Question: What is the trend of price in recent years, and what is the distribution of the most expensive and cheapest prices?**



The graph is a violin plot titled "Yearly Distribution of Game Prices on Steam," displaying the distribution of game prices from 2013 to 2023. The y-axis represents the original price in USD, ranging from \$0 to \$100. The x-axis lists years from 2013 to 2023. Each year has a violin plot

shape that indicates the distribution of game prices for that year, with wider sections of the violin indicating a higher density of games at that price point.

There are also markers indicating the maximum and minimum prices for each year, with the maximum price represented by an orange square and the minimum price represented by a green triangle. The distribution suggests variability in game pricing, with the bulk of game prices falling in the lower price range, but with a long tail of more expensive games.

### **A. Visualization Design & Corresponding Theories/Principles:**

The visualization uses a violin plot, which is effective for showing the distribution of data and is especially useful for comparing distributions across different categories—in this case, years. According to the principle of graphical excellence by Edward Tufte, this visualization presents many numbers in a small space, making large data sets coherent and revealing the data at several levels of detail.

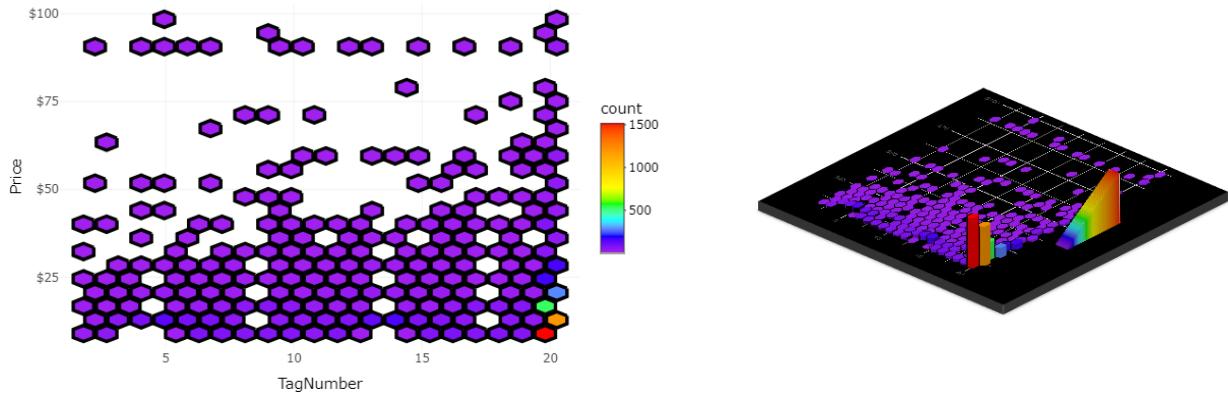
The use of distinct colors and shapes for maximum and minimum prices allows for immediate visual differentiation, in line with the pre-attentive processing theory where certain visual properties (color, shape) are detected more quickly and accurately.

### **B. Visualization Results:**

The violin plots suggest that while the median price of games on Steam does not show significant variation over the years, the range and distribution of prices do vary. In most years, the distribution is skewed towards the lower end of the price spectrum, indicating that most games are priced lower, with fewer games reaching the higher price points.

## **2. Price with Tag Counts**

**Question: What is the relationship between the price of a game and the number of tags in a game, and does a more expensive game have more tags, or vice versa?**



The graph is a hexbin plot showing the relationship between "TagNumber" and "Price," with a color-coded legend indicating the count of data points within each hexagonal bin. The x-axis, labeled "TagNumber," ranges from approximately 0 to 20. The y-axis, labeled "Price," ranges from \$0 to \$100. Each hexagon's color corresponds to the number of occurrences within that bin, with a gradient ranging from purple (lower counts) to green, then yellow, and finally red (higher counts), as indicated by the color bar legend on the right side.

## A. Visualization Design & Corresponding Theories/Principles:

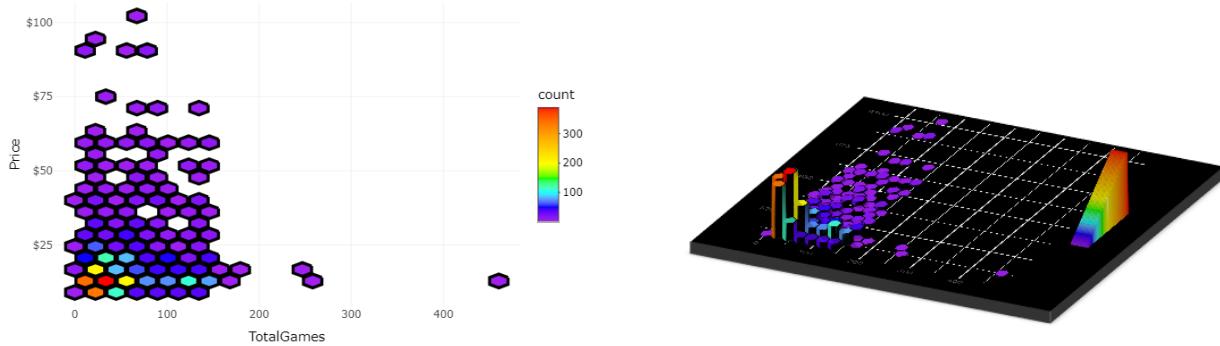
This hexbin plot is a bivariate density representation, suitable for large datasets to show the distribution of data points across two dimensions. The choice of hexagonal bins is based on the principle that the human eye is good at interpreting hexagonal shapes as they tessellate without gaps, which square bins would create. The color-coding is an application of Bertin's visual variables, which uses color as a variable to represent the quantity.

## B. Visualization Results:

The plot demonstrates a high concentration of games priced between approximately \$20 and \$30, especially around the range of 10 to 15 tags. There are fewer games with a higher price, and these are more spread out across the tag numbers. The highest count of games (indicated by the red bins) is found in the middle range of tag numbers and lower price ranges.

## 3. Price with Total Number of the Games Release by the Publisher

**Question: What is the relationship between the price of a game and the total number of games publisher have released, does the more games the publisher releases, the higher the price of the game they release, or vice versa?**



The graph is a hexbin plot that displays the relationship between the "TotalGames" produced by a publisher and the "Price" of those games. The x-axis, labeled "TotalGames," spans from 0 to over 400. The y-axis, labeled "Price," ranges from \$0 to over \$100. The color of each hexagon represents the count of data points within that bin, with the color scale ranging from purple (lower counts) to red (higher counts), as depicted by the color bar legend on the right side indicating counts from under 100 to over 300.

## A. Visualization Design & Corresponding Theories/Principles:

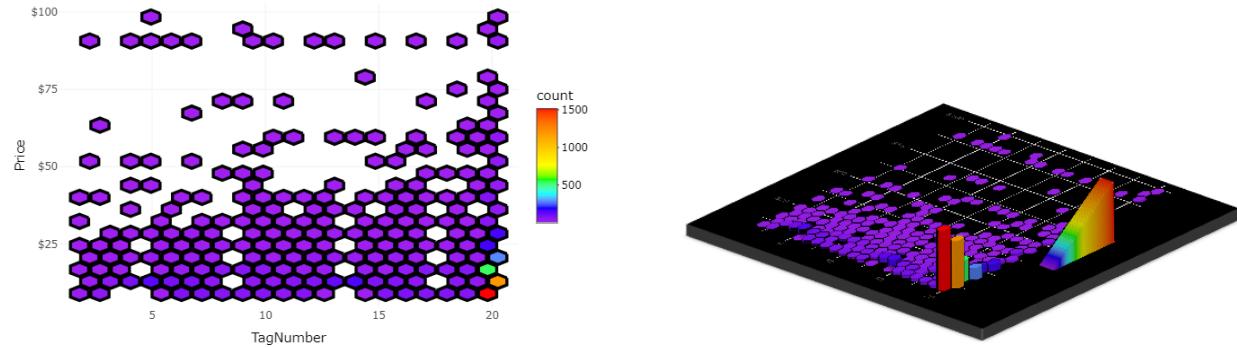
The hexbin plot is chosen for its efficiency in representing the density of points within two-dimensional space, which is helpful when dealing with large data sets where individual points would overlap. The color gradient serves as a quantitative visual encoding, applying the principle of using color to represent numerical data — a concept rooted in Jacques Bertin's semiology of graphics.

## B. Visualization Results:

The plot reveals a dense clustering of games in the price range of roughly \$20 to \$30, particularly among publishers with fewer than 100 total games. There are also a few higher-priced games from publishers with a similar number of total games. The frequency of games (indicated by the color intensity) decreases significantly as the number of total games increases, with sparse data points at both high and low price ranges for publishers with the most games.

## 4. Price with Year

**Question:** What is the relationship between the price of a game and the release year, does the price will be more expensive, or vice versa?



The graph is a hexbin plot that maps the relationship between the number of tags associated with games (TagNumber) and their price. The x-axis represents the 'TagNumber' and ranges from approximately 0 to 20. The y-axis represents the 'Price' in USD, ranging from \$0 to \$100. Each hexagonal cell's color indicates the count of games that fall within that cell, with a color scale going from purple (lower counts) to red (higher counts), as shown by the legend on the right.

### A. Visualization Design & Corresponding Theories/Principles:

The hexbin plot is an appropriate choice for this type of data, which likely has many overlapping points; hexagons are more effective than squares for visualizing bivariate distributions as they have no gaps or overlaps when tiling the plane. The use of color to represent count is based on the theory of preattentive visual properties, which states that color differences can be quickly and accurately perceived by the visual system.

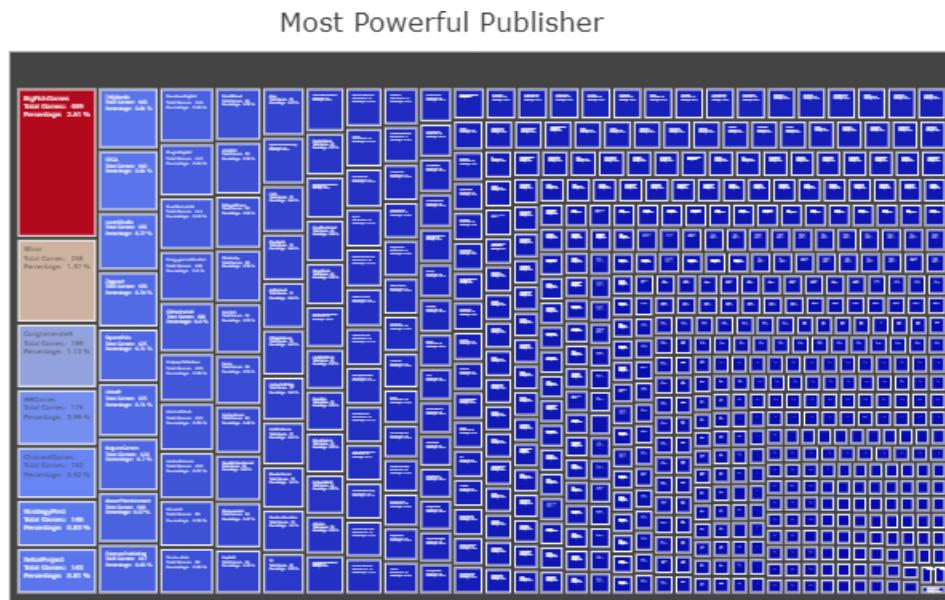
### B. Visualization Results:

The plot indicates that games with approximately 10 to 15 tags are the most common, predominantly priced between \$20 and \$30. There are fewer games with a price above \$50, and these are spread across a range of tag numbers. The highest concentration of games (indicated by the red and orange colors) is in the \$20 to \$30 price range.

## V. Publisher Analysis

## 1. Publisher distribution

**Question: What is the distribution of publisher in our dataset?**



The graph provided appears to be a treemap visualization, which is used to represent hierarchical data through nested rectangles. The title of the graph is "Most Powerful Publisher," which suggests that the rectangles may represent different game publishers categorized by their market influence, likely determined by metrics such as the number of games published, revenue, or other business metrics.

### **A. Visualization Design & Corresponding Theories/Principles:**

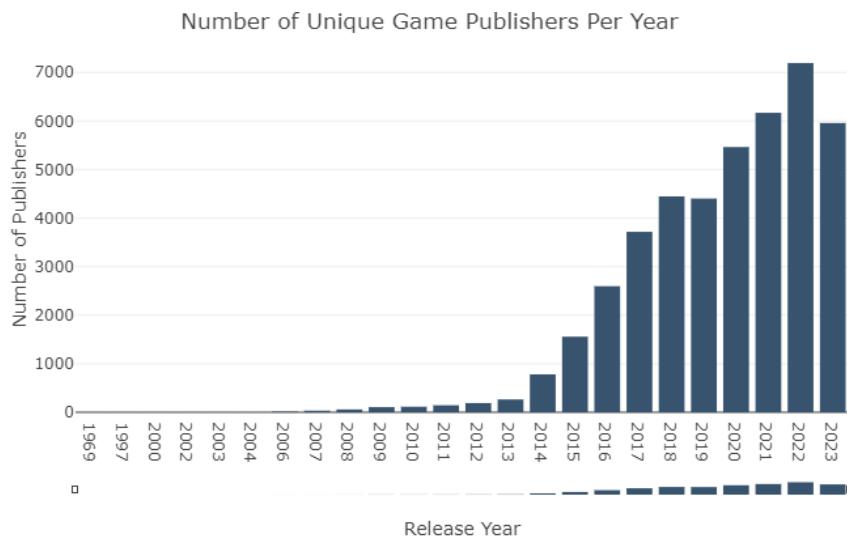
Treemaps display hierarchical data via nested rectangles, with the size of each rectangle corresponding to a data value. This visualization technique aligns with the Gestalt principles of perceptual organization, particularly the principle of enclosure, which facilitates the understanding of hierarchy. The principle of proximity is also at play; rectangles closer to each other are perceived as related.

## B. Visualization Results:

The treemap shows one large, dominant rectangle, which represents the most powerful publisher, followed by progressively smaller rectangles, likely representing publishers with decreasing influence or number of games published. The largest rectangle's prominence is enhanced by a contrasting color, drawing attention to the market leader.

## 2. Publisher with Year

**Question: What is the trend of publishers in recent years, does the number of publishers are increasing, or vice versa?**



The graph is a bar chart titled "Number of Unique Game Publishers Per Year," showing the count of game publishers that released games in each specified year. The x-axis indicates the "Release Year," presented as two-digit abbreviations of years from an unclear starting point (presumably '96' refers to 1996) to '23' (which presumably refers to 2023). The y-axis represents the "Number of Publishers," with counts ranging from 0 to over 6000.

### A. Visualization Design & Corresponding Theories/Principles:

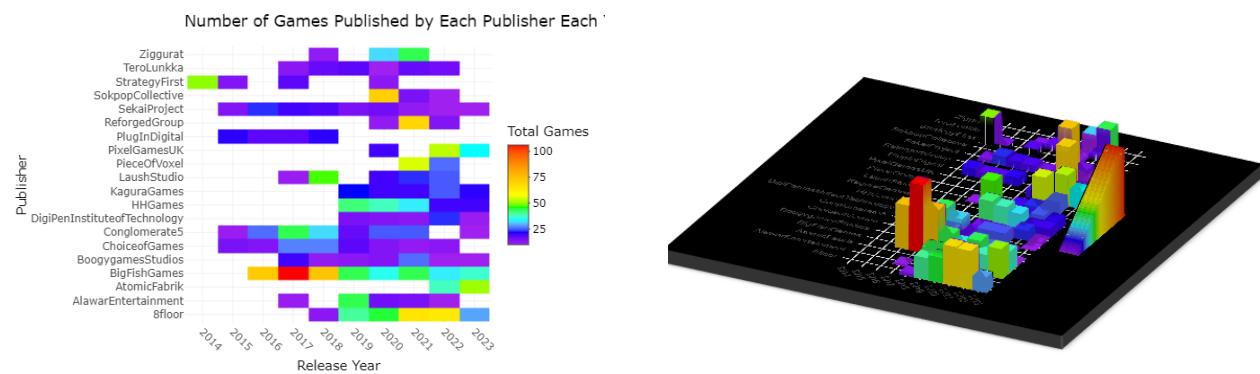
The bar chart is a fundamental visualization tool used to represent categorical data with rectangular bars. The lengths of the bars are proportional to the values they represent, making it easy to compare different categories. This design adheres to the principle of proportional ink, where the size of a graphical element should be directly proportional to the data value it represents. It is also in line with Tufte's theory of the data-ink ratio, as the chart is simple, with minimal non-data ink, maximizing the data presented.

## B. Visualization Results:

The bar chart shows a clear upward trend in the number of unique game publishers each year. The growth appears to be somewhat exponential, with a significant increase in recent years, especially from the year corresponding to '18' onwards.

## 3. Total Number of Released Games by TOP 20 Publishers with Year

**Question: What is the relationship between the total number of released games by TOP 20 publishers and year, does the more games the publisher releases, the higher the price of the game they release, or vice versa?**



The graph is a stacked bar chart titled "Number of Games Published by Each Publisher Each Year." It displays multiple publishers on the y-axis, each with a stack of colored bars corresponding to different years on the x-axis, ranging from 2014 to 2023. The color of each bar segment represents the total number of games published in that year by the publisher, with a color gradient scale provided that ranges from light green (for fewer games) to purple (for more games), with the highest count being indicated by orange.

## A. Visualization Design & Corresponding Theories/Principles:

The stacked bar chart is an effective way to compare the part-to-whole relationships among categories over time, which in this case are the publishers and the number of games they released each year. The color-coding aids in distinguishing between the years, and the gradient effectively shows the volume of games published. This visualization follows the principle of direct proportionality, where the length of the bar represents the quantity of games published.

## B. Visualization Results:

The chart depicts varying publication volumes for different publishers, with some showing consistent publication patterns and others displaying fluctuations. Certain publishers have a year or years with particularly high publication counts, indicated by the orange segments.

# VI. Tags Analysis

## 1. Tags distribution

**Question: What is the distribution of tags counts in our dataset?**



The graph appears to be a treemap visualization titled "Most Popular Tag," which shows different game tags categorized by their popularity, likely determined by the number of games associated with each tag.

## A. Visualization Design & Corresponding Theories/Principles:

Treemaps are effective for displaying hierarchical (tree-structured) data by using nested rectangles, where each branch of the tree is given a rectangle, which is then tiled with smaller rectangles representing sub-branches. The size of each rectangle is proportional to a specific dimension of the data, in this case, the number of games associated with each tag. This visualization design adheres to the principle of area equivalence, where the perceived size of

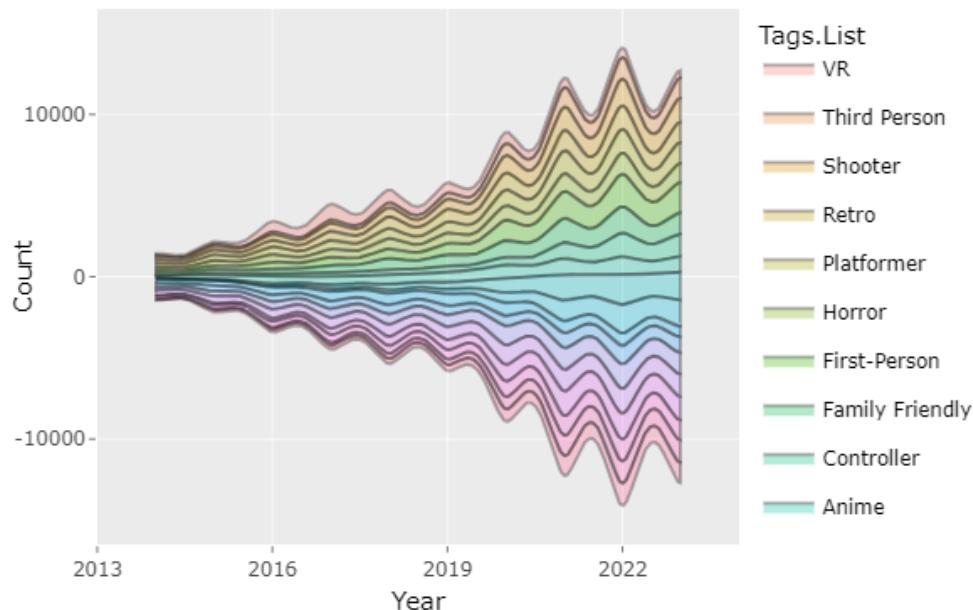
each rectangle corresponds to the data quantity it represents, making it easy to compare at a glance.

## B. Visualization Results:

The treemap shows that the "Indie" and "Singleplayer" tags have the largest number of associated games, with "Action" and "Adventure" following. The rectangles are sized and colored differently, with "Indie" being the largest and most distinct, indicating its prevalence in the gaming industry.

## 2. Tags with Year

**Question: What is the trend of the tags by year, does every number of games of each tag are increasing, or vice versa, or whether there is a certain tag will suddenly increase or decrease dramatically?**



The graph is a stream graph (also known as a theme river), which displays the change over time in the frequency of various game tags listed in the "Tags.List" legend. Each tag is represented by a different color, and the thickness of each stream represents the count of that tag's occurrence per year from 2013 to 2022. The tags included are VR, Third Person, Shooter, Retro, Platformer, Horror, First-Person, Family Friendly, Controller, and Anime.

## A. Visualization Design & Corresponding Theories/Principles:

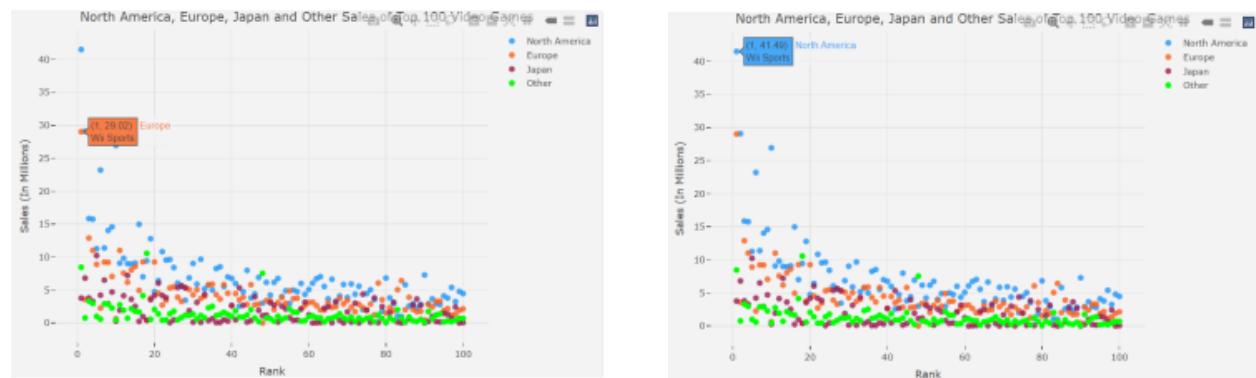
A stream graph is a type of stacked area graph that is centered around a common baseline, which allows for the visual comparison of multiple time-series data. It illustrates how the data values evolve over time, with the area under the curve corresponding to the value magnitude. This design applies the principle of continuity from Gestalt psychology, which suggests that elements arranged on a line or curve are perceived to be more related than elements not on the line or curve. It also uses color to help differentiate between categories, making the data more accessible.

## B. Visualization Results:

The graph reveals fluctuations in the popularity of different game tags over the years. Some tags show a general increase, some decrease, and others fluctuate more unpredictably. For example, certain streams such as VR show growth in more recent years, while others may show a decline or remain relatively stable.

# VII. Segmented Approach

## 1. The sales of the top 100 games by regions



The purpose of creating these plots is to visualize and compare the sales performance of the top 100 video games across different global markets. This allows stakeholders, such as game developers, publishers, marketers, and industry analysts.

## A. Methodology

1. `plotly`: An R package that allows for interactive, complex plots to be created. It is used here to generate both the boxplots and scatterplots.
2. `readr`: Used for reading in CSV files efficiently.
3. `dplyr`: A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

## B. Analysis and Principles for Visualization

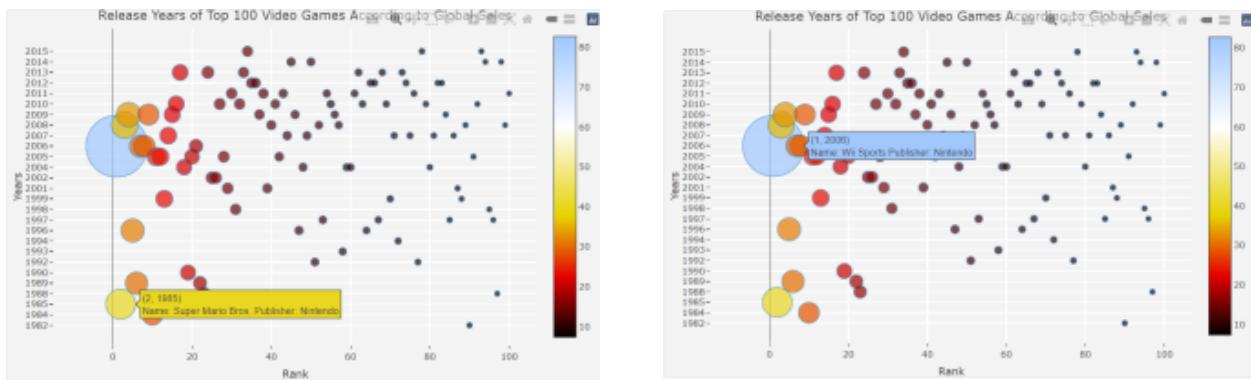
The table below shows the sales of the top 100 games according to different regions. Different regions are represented by different colors. Each dot displays the name of the game represented by that dot, its region, and its sales volume.

As we can see from the chart, the game sales in North America are generally higher in blue, and the number one game sales in North America and Europe is Wii Sports. Other games rank as follows: Wikipedia,3- Mario Kart Wii, 4- Wii Sports Resort, 5- Pokemon Red / Pokemon Blue, 6- Tetris, 7- New Super Mario Bros, 8- Wii Play, 9- New Super Mario Bros Wii ,10-Duck Hunt, and so on.

### Principles:

- **Pre-attentive Processing:** It uses color coding to distinguish sales in different regions, allowing quick and effortless visual differentiation.
- **Gestalt Principles:** The proximity of dots suggests a relationship, such as games with similar sales figures being close to each other.
- **Data-Ink Ratio:** The chart maintains a high data-ink ratio, emphasizing data points over decorative elements.

## 2. Release Years of Top 100 Video Games According to Global Sale



We want to analysis How the sales volumes of the top 100 video games are distributed over different years. Which particular years had the most commercially successful games. The rank of the game correlated to its sales volume, with some games labeled to highlight specific high-performing titles.

## A. Methodology

1. `plotly` : An R package that allows for interactive, complex plots to be created. It is used here to generate both the boxplots and scatterplots.
2. `readr` : Used for reading in CSV files efficiently.
3. `dplyr` : A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

## B. Analysis and Principles for Visualization

The bubble graph above is based on the release years and rankings of the games. The size and color of the bubbles are based on the global sales of the games. The names of the games are also provided with the publishers.

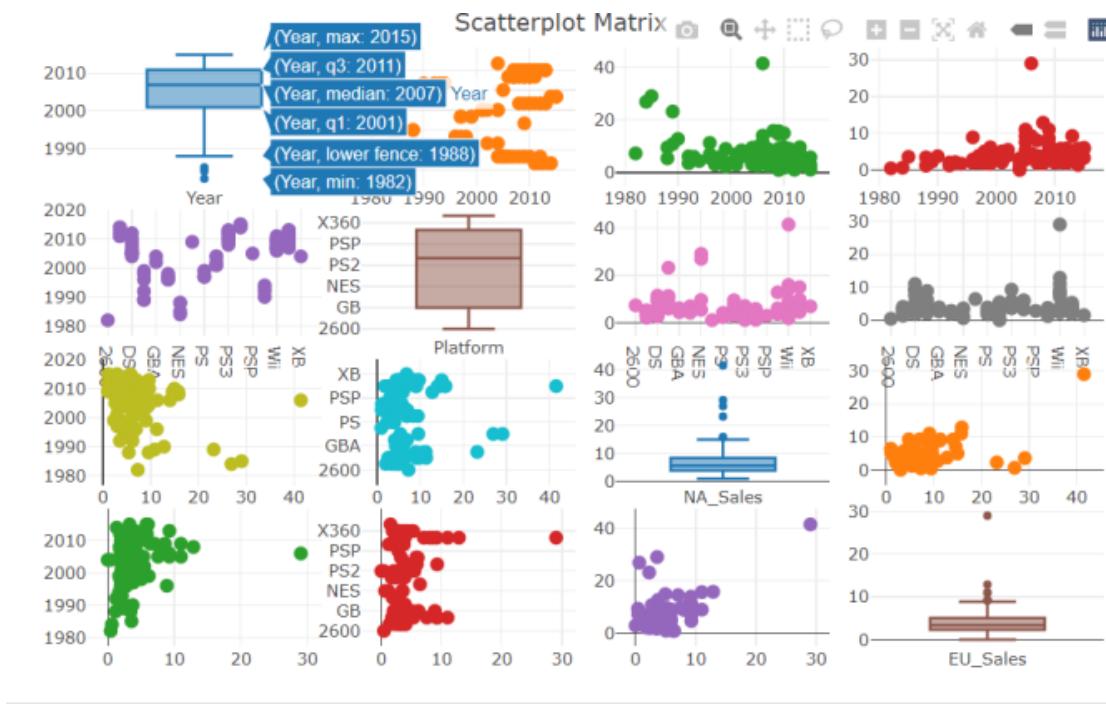
The game, called Wii sports and published by publisher Nintando, became the best-selling game in 2006. The game, called Super Mario Bros and Publisher Nintando, reached number two in sales in 1985. We can see from the figure that the sales volume was relatively high during the period from 2005 to 2009.

### Principles:

- **Encapsulation:** Combines multiple types of data into a single graphical construct (bubble) for easier comparison.

- **Visual Hierarchy:** Larger bubbles naturally draw more attention, effectively indicating higher sales volumes.

### 3. Scatter Plot Matrix of Marketing



We want to understand the distribution and relationship of video game sales across different regions (North America and Europe) and years. Compare the performance of different gaming platforms over time. Identify any patterns, trends, or anomalies in video game sales with respect to years and platforms.

### A. Methodology

1. **plotly:** An R package that allows for interactive, complex plots to be created. It is used here to generate both the box plots and scatter plots.
2. **readr:** Used for reading in CSV files efficiently.
3. **dplyr:** A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

### B. Analysis and Principles for Visualization

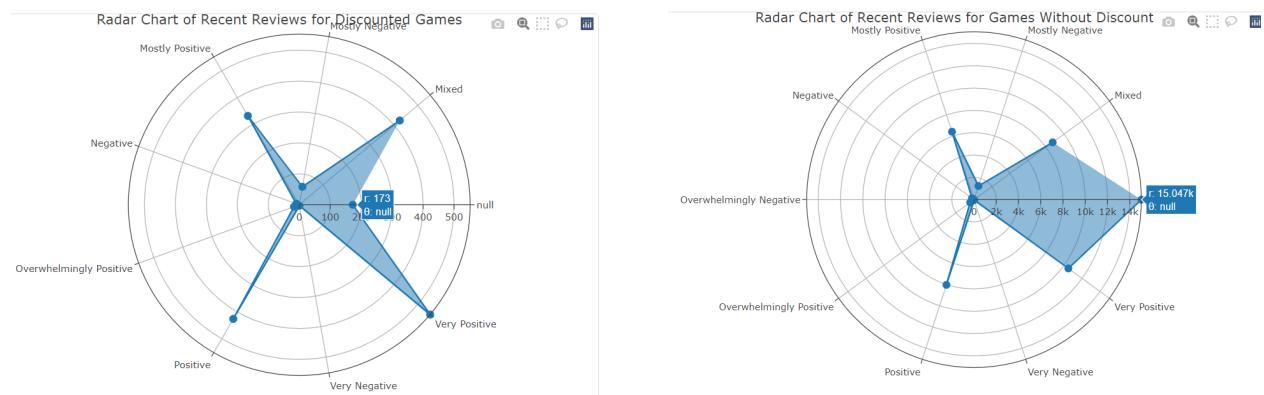
The scatter plot matrix you've generated is already included in the code you've provided. To explain briefly:

It represents a comparative analysis of video game sales data across North American and European markets, segmented by platform and year. The diagonal plots are box plots showing the distribution of a single variable, such as 'Year', while the off-diagonal plots are scatter plots showing relationships between two different variables, like 'NA\_Sales' vs 'Year'. There appears to be a concentration of data points in certain areas, such as the dense clusters on the 'NA\_Sales' vs 'Platform' plot, which could indicate periods of peak sales for certain platforms. Sales trends could be inferred from the 'Year' vs 'NA\_Sales' and 'Year' vs 'EU\_Sales' plots, if there's an upward trend, it might suggest increasing sales over time. Any anomalies, such as a year with significantly different sales from others, would be worth investigating further to understand the underlying causes.

#### Principles:

- **Multivariate Analysis:** It allows for simultaneous observation of relationships and patterns across multiple variables.
- **Visual Economy:** The matrix format efficiently uses space to show multiple plots together.

## 4. Radar Chart of Recent Reviews for Discounted Games



"How do the distributions of customer review sentiments for discounted and non-discounted games compare in recent evaluations?"

## A. Methodology

1. `plotly`: An R package that allows for interactive, complex plots to be created. It is used here to generate both the box plots and scatter plots.
2. `readr`: Used for reading in CSV files efficiently.
3. `dplyr`: A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

## B. Analysis and Principles for Visualization

The two columns of Discounted Price and Original Price are used to calculate whether the game is discounted, and then the number of different reviews for discounted games and the number of different reviews for games without discounted games are drawn respectively.

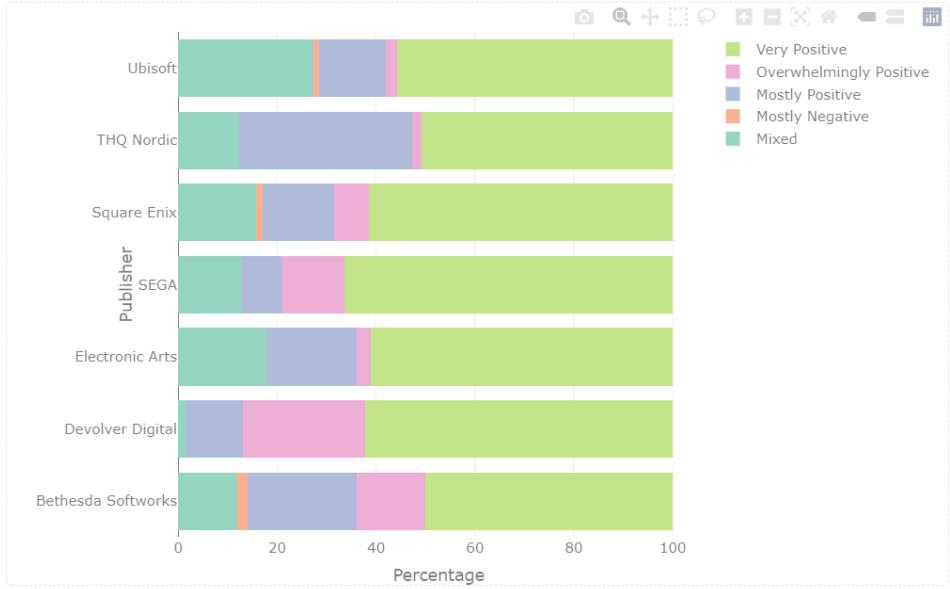
Analyzing these two graphs, we can draw the conclusion that the number of NA in the discounted game is significantly reduced, indicating that more people play the game after the discount, and more comments. It can be seen that when fewer people play the game, the company can choose to discount the way to promote more people to play.

### **Principles:**

- **Comparative Metrics:** Radar charts are useful for comparing different items or groups across various features.
- **Visual Clarity:** By having multiple axes radiating out from the center, it provides a clear view of which variables score higher or lower for a particular dataset.

## 5. Distribution of All Reviews Summary

We wanted to analyze the distribution of different reviews of games from different publishers to analyze which publisher's game was better.



## A. Methodology

1. `plotly`: An R package that allows for interactive, complex plots to be created. It is used here to generate both the box plots and scatter plots.
2. `readr`: Used for reading in CSV files efficiently.
3. `dplyr`: A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

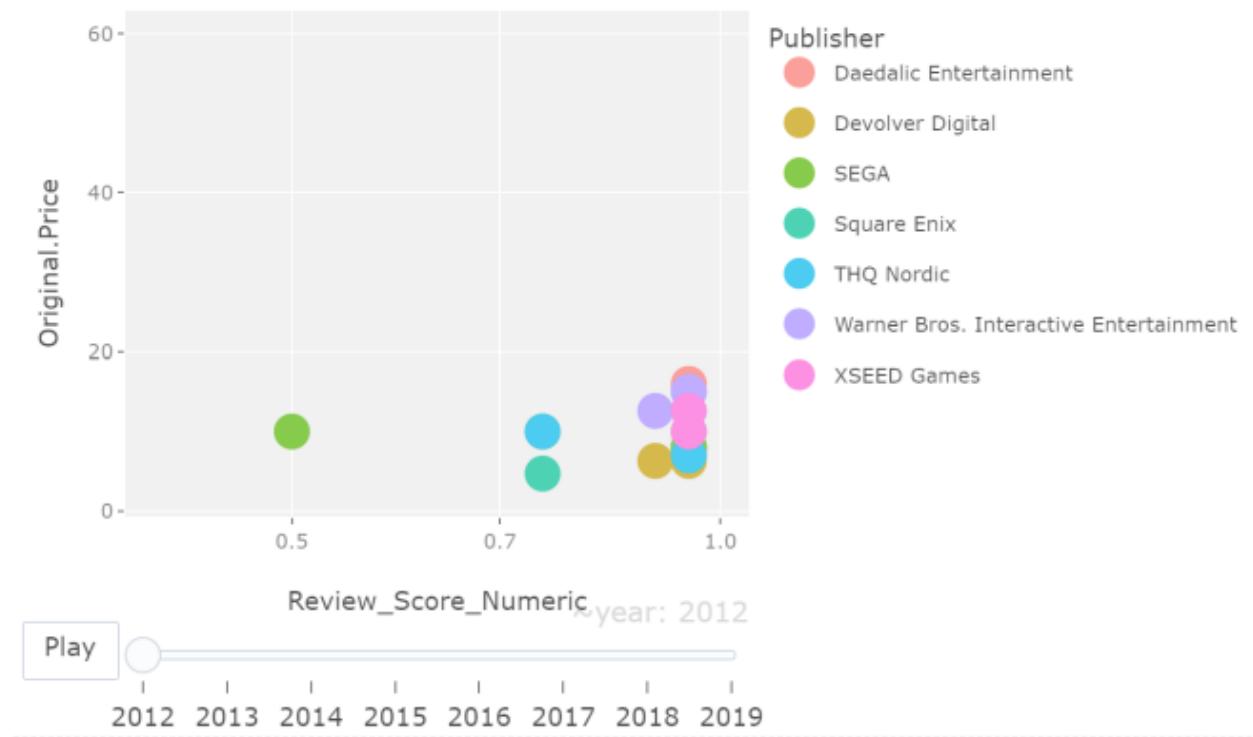
## B. Analysis and Principles for Visualization

We select the top 7 publishers with the highest total number of games released, exclude review categories that are rated by a specific number of users, and then calculate the distribution of different reviews for all games from each publisher. The different categories of comments are represented by different colors, and the longer the bars of each color, the greater the number of comments.

### Principles:

- **Part-to-whole relationships:** The chart shows how various review categories contribute to the whole for each publisher.
- **Color coding:** Different colors represent different sentiment categories, making it easier to see the proportion of each sentiment.

## 6. Price-Review Score Animation Scalar Plot



Whether the rating of the previous game affects the price of the next game?

X-axis (Review\_Score\_Numeric) : This shows the score of the game.

Y-axis (original.price) : This shows the Original Price of the game. This is a continuous variable and may reflect the pricing strategy of the game.

Color (Publisher): A color that distinguishes between game publishers.

Animation (frame = year) : Added an animation using the 'frame' argument, showing the evolution of ratings and prices according to the year.

This question concerns the impact of reviews on a game's brand and market position.

Manufacturers need to balance the quality of the game and the market demand to develop the most effective pricing strategy.

### A. Methodology

There are seven publishers who publish games every year between 2012 and 2019.

This code uses two major data visualization libraries: ggplot2 and plotly. The 'ggplot' section creates a scatter plot. 'scale\_x\_log10' log-transforms the X-axis, probably to better show subtle

differences in ratings between low and high scores. `ggplotly` converts a ‘`ggplot`’ object into a ‘`plotly`’ object, adding interactivity and enabling users to perform interactive operations such as zooming and zooming on the chart.

## B. Analysis and Principles for Visualization

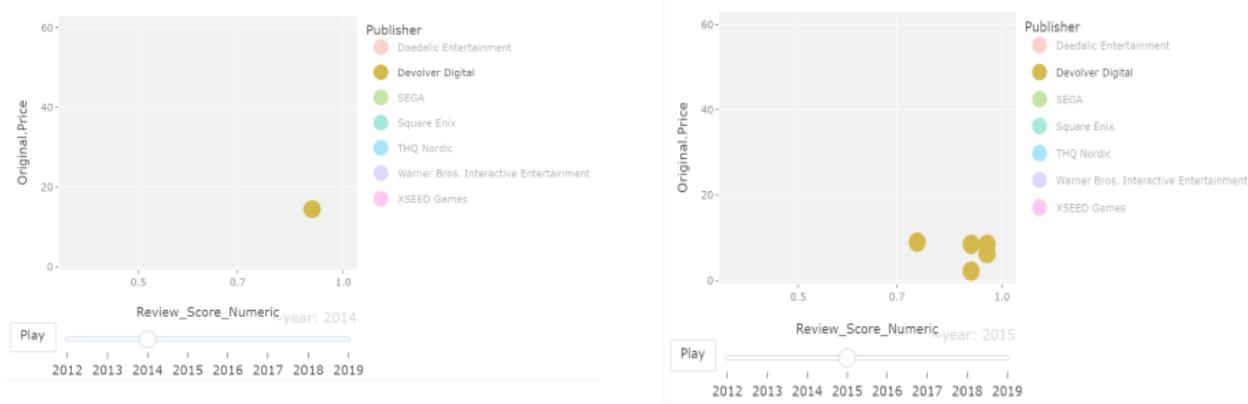
### 1. The ratings did not significantly change the price.

SEGA publisher seems unaffected by the performance of the previous game's reviews, with prices staying relatively high. This may indicate that SEGA has a high degree of confidence in its brand and market position, insisting on a high price level. (Take 2015 and 2017 as examples)



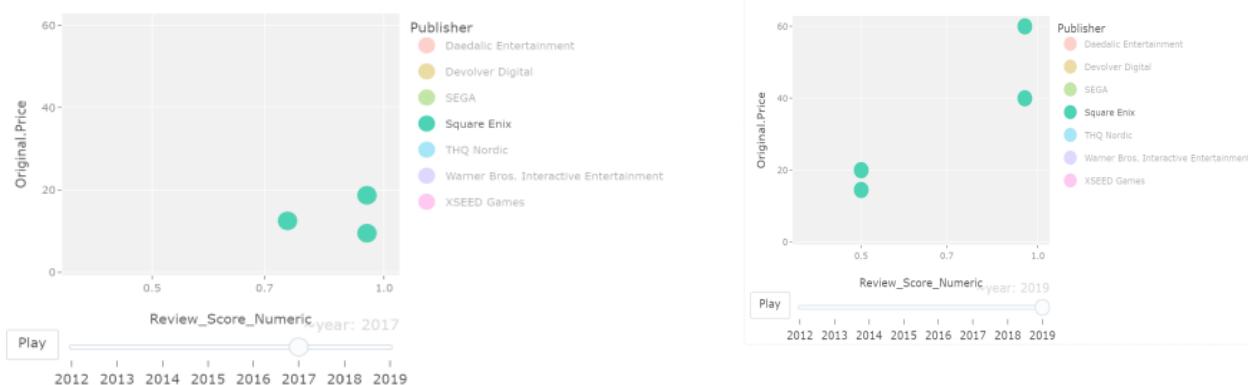
### 2. Higher rating but lower price.

Devolver Digital publisher's games are usually highly rated, but the price drops. This may reflect a marketing strategy to lower prices to attract more players, increase sales, and possibly gain an advantage in a competitive market. (Take 2014 and 2015 as examples)



### 3. Higher ratings increase prices.

When a Square Enix publisher's game has a high rating, the price of the next game tends to increase. This may indicate that Square Enix associates game quality with high value, arguing that excellent reviews may provide a reason to raise prices.

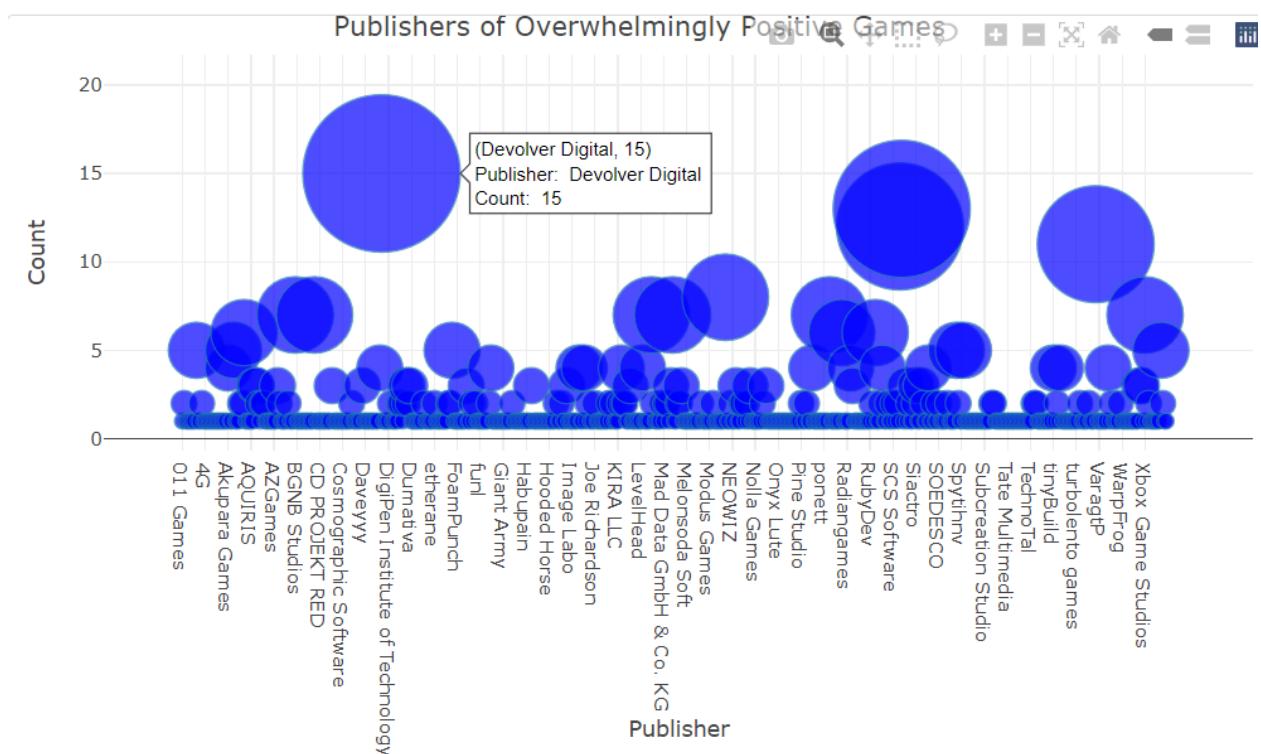


### Principles:

- **Color-coding:** Different publishers provides an intuitive way to differentiate and compare different categories of data.
- **Animated Scatter Plot:** The 'frame' parameter and the 'id' parameter are used to create a dynamic scatter plot that shows changes over time. This dynamic effect makes it more intuitive to observe the evolution of the data over time and captures the change of trends and patterns.

- **Logarithmic Scale:** A logarithmic scale is used for the horizontal axis, which is very helpful for dealing with data with a wide range of values. Here, the horizontal axis uses a logarithmic scale ( $\log_{10}$ ) to make the chart easier to understand and to highlight differences between smaller values.

## 7. Publishers of Overwhelmingly Positive Games



Which publishers have released games that have received "overwhelmingly positive reviews," and how many of those games have. This information is useful for analyzing which publishers in the gaming industry are most successful and which publishers are likely to have a track record of releasing high-quality games.

### A. Methodology

1. **plotly:** An R package that allows for interactive, complex plots to be created. It is used here to generate both the box plots and scatter plots.
2. **readr:** Used for reading in CSV files efficiently.

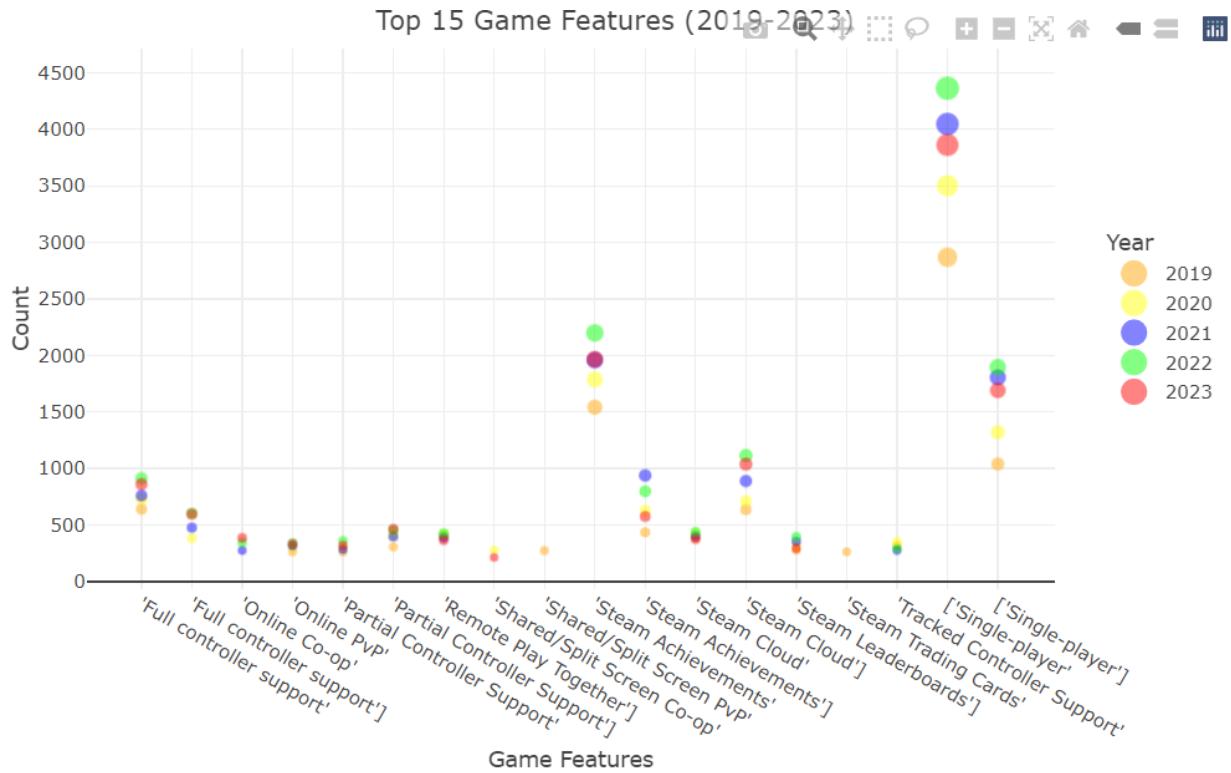
3. dplyr: A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

## B. Analysis and Discussion for Visualization

Overwhelmingly Positive is the highest level of Positive reviews. We first select games with Overwhelmingly Positive reviews, and then match each game with the corresponding publishing company. Then count the number of games with Overwhelmingly Positive reviews from each publishing company, and show it as a bubble chart. The bigger the bubble, the more critically acclaimed games the company has released. The bubble map adds an interactive format that displays information about which bubble you point to, including the company name and number of games.

From the graph, we can see that the number of best reviewed games of the four publishing companies Devolver Digital, Sekai project, SEGA and Valve is the top four, respectively 15, 13, 12, 11. This result shows that these four publishers have more professional game production capabilities, are more in line with contemporary game publishing trends, and are more trustworthy. Games from these publishers can be considered when choosing a new game in the future.

## 8. Top 15 Game Features



We want to know what are the most popular Game Features of this era.

## A. Methodology

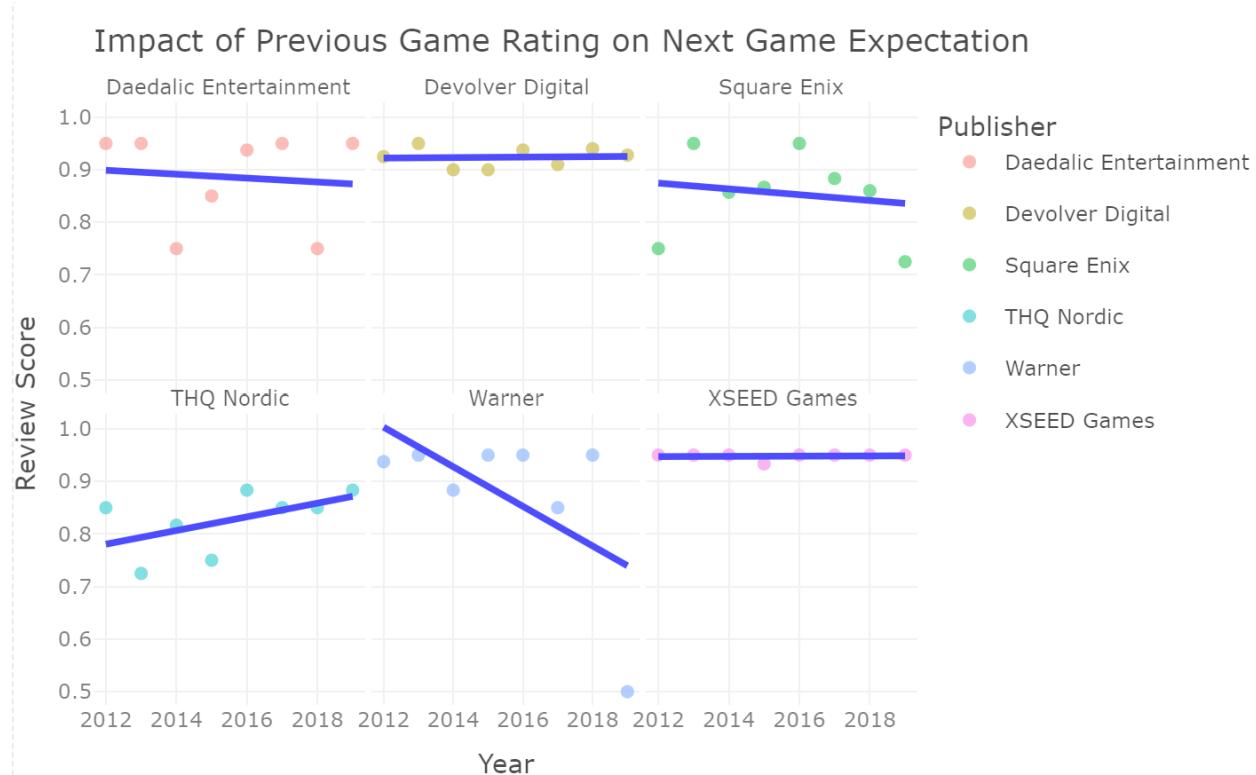
1. **plotly:** An R package that allows for interactive, complex plots to be created. It is used here to generate both the box plots and scatter plots.
2. **readr:** Used for reading in CSV files efficiently.
3. **dplyr:** A grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges.

## B. Analysis and Discussion for Visualization

Different colors of bubbles represent different years. The ordinate represents the number of each game feature. We chose to show the top 15 game features.

As can be seen from the figure, the number of games increased year by year from 2019-2022. The number of games characterized by Single-player is the highest, followed by steam Achievement. The quantities are 4363,2199 respectively.

## 9. Review Score Scatter Plot



Whether the rating of the previous game affected the expectations of the player for the next game?

X-axis (year) : The year the game was released.

Y-axis (original.price) : Numeric price value for the game.

Color (Publisher): The publisher of the game. There is a subgraph for each publisher.

For developers and publishers, understanding the relationship between the previous game's rating and the next game's sales and player feedback can help them make more informed decisions regarding product development and marketing.

## A. Methodology

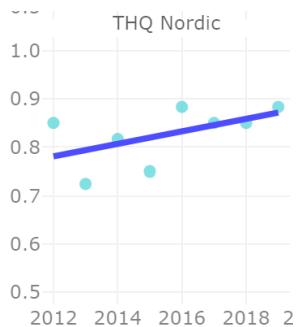
There are seven publishers who publish games every year between 2012 and 2019.

The use of the "ggplot2" creates a scatter diagram and a return line diagram, which is sorted by the "the", "the" publisher" line. After that, the "ggplotly" function of the "plotlybag" is converted into an interactive plotly diagram.

## B. Analysis and Discussion for Visualization

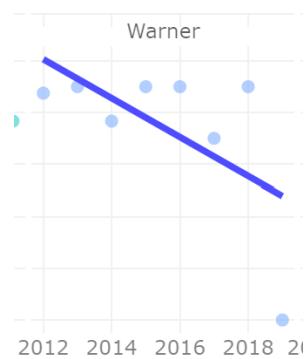
### 1. Positive correlation.

If the previous game has a high rating, players are likely to have higher expectations for the next game from the same publisher, expecting the same or better quality.



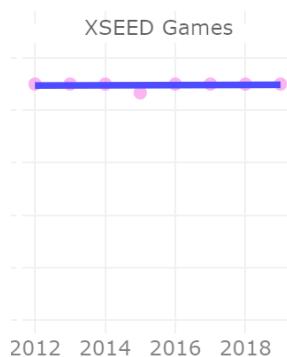
### 2. Negative correlation.

On the contrary, if the previous game has a low rating, players may have lower expectations for the next game and doubt whether the quality of the new game has improved.



### 3. Neutral case

When there is no clear correlation between the ratings of the previous game and expectations of the next game, there may be other factors influencing players' expectations, such as the promotion of the game, marketing, etc.

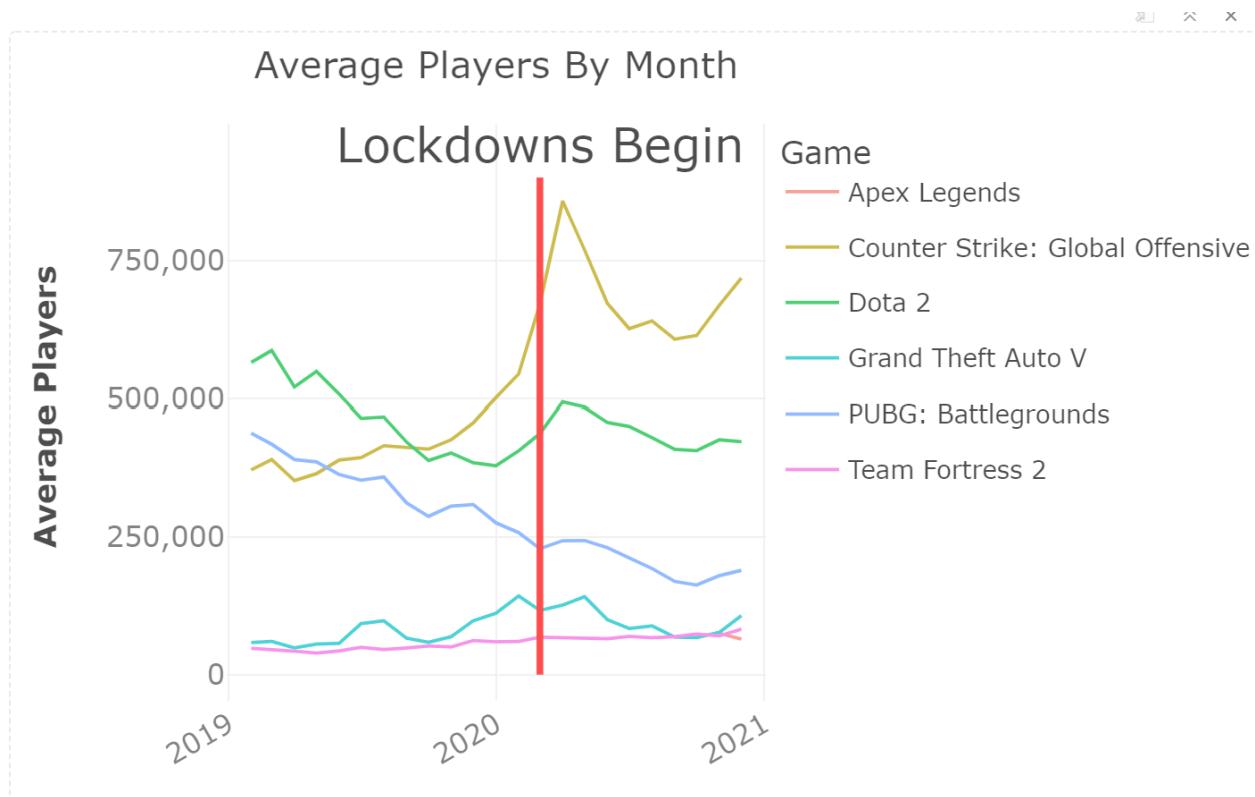


## Principles:

- **Color Encoding:** The data is encoded using color, where the color of each dot represents the Publisher of the game.

- **Trendline:** A linear regression model is fitted to the data by adding a trendline to show the overall trend in ratings over time. This helps observers identify if there are general rating trends, such as whether game ratings are rising or falling over time.
- **Faceting:** Use the 'facet\_wrap' function to split the graph into smaller images by publisher. This faceted presentation can make it easier for observers to compare rating trends across publishers, improving readability.

## 10. Covid-19's Impact On Number of Players



Whether the Covid-19 pandemic will affect the number of gamers ?

X-axis (Date) : The axis of time.

Y-axis (Avg\_players): Represents the average number of players for each game in the corresponding month.

Color (Game\_Name):The broken lines for different games are shown in different colors, allowing you to compare the average player count trends between them.

Red line (annotate(segment)): There is a red vertical line in the figure representing the time point

"2020-03-01". This is a line added via the 'annotate' function to mark the time when the global lockdown began. This line was probably added to emphasize events during lockdown.

This chart shows the trend of the average number of players for a given game between January 2019 and January 2021, with the start points of lockdown measures globally highlighted by red vertical lines and text labels. The colored lines allow you to compare player activity for different games over that time period.

## A. Methodology

1. scales library: The 'scales' package provides functions for scaling and transforming data, such as adding commas to the number line labels to make the numbers easier to read.
2. annotate: Adds annotations to add text and line segments to the graph. In this case, the date used to mark the start of the lockdown and a red vertical line.
3. ggplotly: Converts a ggplot2 graph object into an interactive plotly graph, allowing users to explore the graph interactively with the mouse.

## B. Analysis and Discussion for Visualization

During the period at the beginning of the pandemic, the game experienced a significant increase in the number of players. This is probably because many people are forced to adopt the remote working and distance learning model, which makes people have more free time. Games may be a way for them to relax and entertain themselves.

However, the novelty may have worn off over time, leading some people to reduce their playing time.

### Principles:

- **Color Coding:**

Comparing trends across multiple games in the same graph is more intuitive by using different colors to represent different games.

- **Interactivity:**

By converting the chart into an interactive chart using the 'plotly' library, users can interact with the chart by hovering, zooming, and dragging.

- **Time Axis Labels:**

The timeline labels use the year format and rotate the angle to make the labels easier to read. This helps to identify critical time points over a longer time span.

## **VIII. Conclusion & Future Work**

In this project, we attempted to analyse the global gaming market in order to come up with results on its trends and influencing factors. After a series of phases of research and data analysis over several months, we finally accomplished our goal. From the results of our analysis, we can see the trend of steady growth in the global gaming market and the number of players. For example:

- We have seen a trend towards lower and lower pricing for games, which can be explained by the lowering of the barriers to game production in recent years, improvements in gaming technology, and an increase in the number of new game makers.
- As for the relationship between price and the number of games released by manufacturers, we can see that game manufacturers do not increase pricing because of the number of games released, indicating that the current game market is more active, there is no monopoly, and there is still a huge space for development and prospects.
- In terms of marketing strategy, we can conclude that the sales of games in North America are linked to sales in Europe, with Action, Shooter, and Role-Playing games selling better with better ratings. So game makers can use this result as a reference for what type of game to make and which market to put it in.

Despite some limitations in our data and analysis methodology, these results still show the trend of the global game market. In the future, China's game industry is expected to integrate more actively into the pan-entertainment industry ecosystem, forming closer cooperation with film, television, music, literature and other fields to further expand the influence and value of the game industry.

These results all point to a steady upward trend in the development of the current gaming market. Although our data and analysis methods have some limitations, we cannot deny that our results are of some reference significance. And, it also confirms the game market development trend we mentioned before through real data.

However, under the current world situation (e.g. economic situation, natural environment, etc.), the development of the gaming market looks pretty good and is expected to continue to grow, which is certainly a positive news. Apart from that, based on the findings of our project, we can't help but have some questions, such as why has the gaming market been able to grow so rapidly? What is the significance of the growth of the gaming market to the global economy and to the

development of human society? These questions are very important and meaningful, but also fascinating enough.

Therefore, in the future, we hope to build on our project to further analyse these questions and find a reasonable and meaningful answer. We hope that our work on this project can help the relevant workers, and we also hope that we can make some small contributions to the great rejuvenation of the Chinese nation and the development of the Communist Party of China.

## XI. References

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