Exploring Key Factors Associated with Gaming Time

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1 Introduction

The rise of video games as a predominant form of leisure among young people has significant implications for their social behaviors, economic conditions, and educational outcomes. As gaming becomes increasingly integrated into daily life, it is crucial for stakeholders, including academic professionals and researchers, to understand the underlying factors that influence gaming habits. This understanding is pivotal not only for the development of educational strategies but also for the resolution of broader socioeconomic issues.

Our project introduces an innovative visualization system to analyze gaming patterns from a macro to a micro perspective. By integrating geospatial and economic data, the system provides interactive tools for stakeholders to explore national and local relationships, enhancing our understanding of how various factors influence gaming behavior.

The project faces several challenges from gaming behavior's intricate and dynamic nature. Collecting data that accurately captures variables such as job nature, family dynamics, cultural background, and social engagements is inherently challenging due to their diverse and subjective characteristics. Additionally, gaming patterns are subject to fluctuations influenced by external factors like new game releases, technological upgrades, and seasonal events, which can temporarily skew the observed behaviors. A critical challenge is designing visualizations that effectively communicate the multidimensional relationships among geographic disparities, temporal changes, and gaming habits. These visualizations must overcome spatial and temporal data complexities to ensure they are informative and easy to interpret, enabling stakeholders to make informed decisions based on clear, actionable insights.

Our contributions advance the field through: (1) a multi-scale visualization system linking national and neighborhood-level gaming patterns, (2) interactive data aggregation techniques maintaining visual clarity across scales, (3) coordinated views revealing relationships between location, income, and gaming preferences, and (4) link geospatial data selection to more informative visualizations. This approach enables stakeholders to uncover patterns and relationships previously difficult to identify through traditional methods. The remainder of the paper is organized as follows: Section 2 reviews related work in geographic visualization and gaming behavior analysis. Section 3 describes our data sources and preparation methods. Section 4 details our design process and implementation choices. Section 5 presents the demonstration scenarios, highlighting the contributions and insights gained. Finally, Section 6 summarizes the use of spatial data in our project to analyze gaming behavior, addressing challenges such as data limitations and performance issues, with plans for future improvements.

2 Related Work

Previous work has demonstrated effective approaches to gaming data visualization through hexagonal binning and visual glyphs. Wallner et al. [6] conducted a large-scale study evaluating how multivariate game metrics can be represented across game environments, providing insights about balancing visualization complexity with user comprehension. In parallel, Kejstova et al. [4] explored visualization literacy through gaming platforms, examining how interactivity enhances understanding of complex data relationships. In the field of large-scale geographic visualization, McDonald's Internet Map [5] and Steams' interactive map [2] demonstrates effective techniques for visualizing dense spatial data across the globe, providing provides relevant insights for large-scale geographic data visualization. This project uniquely integrates data on internet access and gaming behavior into a cohesive, interactive visualization framework. Unlike prior work that examines these elements in isolation, our visualization dashboard: (1) enables drill-down analysis from national to neighborhood levels, and (2) employs dynamic visual tools that allow users to explore between gaming, internet access, and socioeconomic factors interactively.

3 Data

This project incorporates available and synthetic datasets. We uses Internet Speeds and Prices [1] and US Household Income Statistics [3] from Kaggle. The first dataset provides detailed information about internet service, geographic location details, and crucial demographic factors. The second dataset provides detailed household income statistics, number of households, and precise geographic identifiers. We synthesize gaming data based on these two datasets and obtain a combination dataset covering various domain's information we desired.

4 Design and Implementation

4.1 Design Process

Our visualization app consists of 3 dashboards, one US level, one state level, and one city level. Each dashboard implements an interactive visualization system, utilizing Mapbox and Deck.gl. The visualization adopts a dark theme and features a three-panel layout, with a dominant map occupying two thirds of the viewport and two complementary charts positioned on the right. A time slider is added at the bottom of each map. So, our user can easily select the scope of spatial and time series data they want to investigate.

4.2 Implementation choices

US level dashboard and **State level dashboard** implement the Deck.gl hexagon layer in their dominant maps. The system enables dynamic state/county-level filtering that triggers coordinated updates across all components, including automatic adjustment of hexagon layer parameters and elevation scaling. When users select a specific region, the visualization seamlessly transitions to the selected area while updating the accompanying histogram of weekly gaming hours and scatter plots that examine the relationship between mean income, exercise time, and gaming time. Interactive features include hover tooltips on all components, providing detailed information on gaming habits, income levels, and demographic types, ensuring a comprehensive analytical experience. **City level dashboard** focuses on household video game play patterns in Los Angeles, leveraging Deck.gl's ScreenGridLayer to create a responsive visualization that dynamically adjusts cell resolution based on user interaction. When specific grid cells are selected, the system displays two complementary charts: a pie chart revealing the video game category distribution for the selected area, and a horizontal stacked bar chart that correlates income levels with gaming time, segmented by game category. This multi-dimensional approach enables users to explore both spatial patterns and detailed gaming preferences while maintaining visual clarity and analytical depth.

4.3 Usage of Gen AI

We utilized Generative AI (Gen AI) to support the design and development of our dashboard and visualizations. Gen AI played a crucial role in facilitating the implementation of functionality and aesthetics while reducing the need for extensive manual adjustments. By setting consistent design principles, Gen AI delivered a cohesive result in the formatting of visual elements. Its integration into our workflow also significantly reduced development time, enabling us to allocate more attention to interpreting insights and enhancing the overall clarity and effectiveness of the dashboard.

4.4 Challenges

Our visualization app faced several technical challenges during implementation. Managing smooth transitions between national and state-level views demanded sophisticated auto-pan and zoom mechanisms. Data synchronization between the selected state region and the corresponding histogram and scatter plot visualizations added to the overall complexity. One of the most significant challenges emerged from performance issues, particularly in handling large datasets in d3 scatter plots, which sometimes caused interface freezing and crashes of the maps during user interactions—a problem for which we have not yet found a perfect solution.

5 Demonstration Scenarios and Results

The dashboard spans three distinct visualizations, each serving unique analytical purposes. US level dashboard demonstrates seamless transitions between national and state-level explorations, contributing through its three-panel design, GPU-accelerated hexagonal binning, and synchronized filtering, while displaying a dark-themed interface with dynamic mapping, gaming distributions, and income correlations. State level dashboard focuses on California's county-level visualization, employing similar technical contributions of GPU-acceleration and synchronized updates, presenting exercise and gaming patterns through an integrated dark-themed display of maps and scatter plot. City level dashboard showcases Los Angeles gaming patterns across multiple scales, contributing through dynamic resolution adjustment and spatial-statistical integration, with its visual display incorporating an adaptive ScreenGridLayer, gaming preference pie charts, and income-gaming bar chart, all unified by a consistent dark theme.

6 Conclusion

Our project integrates spatial data into analysis of gaming behavior, addressing the lack of geographic context in previous studies. Using hexagonal binning and multivariate visualizations, we explore relationships such as gaming time with income and exercise, offering insight from national to neighborhood levels. This framework connects gaming patterns with social, economic, and lifestyle factors, providing insight into digital inequality. We encountered challenges in achieving smooth transitions between geographic scales, which required the development of advanced auto-pan and zoom functionalities. Additionally, performance issues appeared when handling large datasets in the scatter plot of US level dashboard, which occasionally caused interface freezes. Limited real-world data also meant relying on synthetic data, which could affect accuracy. Our current limitations include synthetic data reliance, unresolved performance issues, and a narrow focus on gaming time associated with income and exercise. Future improvements aim to enhance performance with better algorithms or GPU acceleration, incorporate more real-world data, and expand the analysis to explore additional variables and patterns.

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