HiVis: A Web-Based Library for Financial Data Visualizations

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ABSTRACT

This paper introduces a declarative web-based library HiVis, designed for financial data visualizations. With the increasing complexity of financial data and the growing demand for intuitive authoring tools, there is a need for rapid development and high user usability financial data visualization solutions. HiVis offers a range of visual designs, dynamic charts, interactions, and customizable visualizations tailored to financial data, enabling users to explore and analyze complex finance datasets with ease. Moreover, the library provides a series of well-designed strategies for financial features and scenarios, including financial characteristics visualization, data compression, and data aggregation. HiVis aims to empower developers to effectively construct financial data visualizations that provide financial analysts, researchers, and professionals with powerful visualizations for data-driven decision-making.

Index Terms: Finance visualization, web-based library, finance data.

1 INTRODUCTION

Financial data visualization and analysis are crucial in finance, covering diverse data types (e.g., stock prices, trading volumes, interest rates) and dimensions (e.g., time series, geography). Visualization aids in understanding data, detecting anomalies, and making decisions [1, 3, 6]. However, existing tools struggle with complex financial data [2, 4, 5], cross-device development, and real-time performance for large-scale data. We identified key requirements for a financial visualization tool: supporting temporal data, adapting to financial scenarios, enhancing development efficiency, enabling cross-device compatibility, optimizing large-scale data handling, and ensuring user-friendliness. Collaborating with developers and users, we developed HiVis, a web-based declarative visualization library Figure 1,. It offers customizable components, dynamic charts, and cross-device support, with strategies for data compression and aggregation. User feedback and experiments demonstrate its usability, richness, and performance benefits for large-scale data.

2 HIVIS

We use JavaScript to construct HiVis, which can have lower maintenance costs and extremely high scalability and compatibility to deal with multi-end synchronization and development efficiency issues. Therefore, HiVis is a web-based library and provides a Uni-

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Figure 1: Examples and applications of financial data visualization created by HiVis, more visualization solutions can be found at https://datav.iwencai.com/.
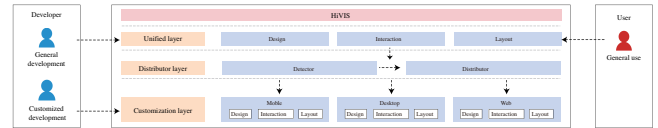

Figure 2: Developers can create visualizations via a unified layer or customize schemes for different devices. HiVis will automatically detect environment variables and distribute to specific modules when used.

fied layer to support developers' unified construction, distributes to component chains designed for cross-device adaptation through the distributor layer, and supports developers to directly customize and modify visualization solutions for different devices in the customization layer Figure 2. For large-scale data scenarios, HiVis provides data compression strategies and data aggregation strategies to reduce transmission and execution time. We propose a series of improvement solutions for traditional visualizations and contribute suitable visualizations for financial scenarios.

Theme Configurations: To adapt to the visualization needs of multiple markets, HiVis introduces a theme mechanism. This mechanism designs the differentiated functions of different markets as atomic token variables. By combining different token sets, HiVis can more easily adapt to the styles of different markets. This flexible theme mechanism allows our visualization tools to easily adapt to users' preferences and habits in various international markets, provide a more personalized data visualization method, and enhance user experience and work efficiency.

Customizable Sankey Diagram: Traditional Sankey diagrams effectively show data composition relationships but have limitations in financial contexts, especially with negative indicators. They typically require positive and equal node data, which is unsuitable for financial scenarios like partial losses in operating income. To address this, HiVis introduces an improved Sankey diagram method

that supports both positive and negative node data while maintaining overall balance.
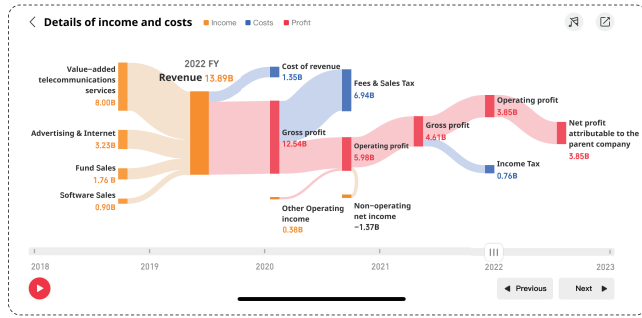

Figure 3: Sankey diagram supporting negative data, more intuitively showing income, expenditure, etc. in financial data.

Stacked Waterfall Plot: Traditional waterfall plots are commonly used in finance to visualize balance sheets, cash flow statements, and income statements. However, they fall short in detailed comparisons and compositions, such as breaking down assets and liabilities into liquidity and non-liquidity items. To address this, HiVis has enhanced the waterfall plot to support stacking, allowing vertical comparison of data indicators while maintaining data logic consistency.
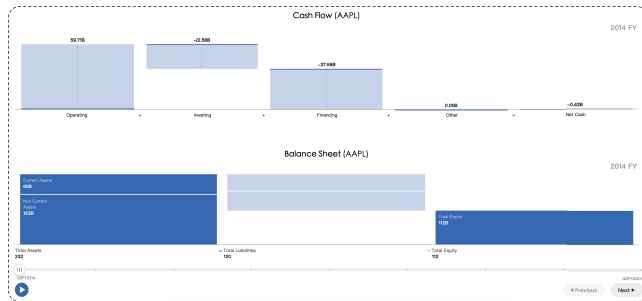

Figure 4: Stacked waterfall plot.

Temporal Data Visualizations: Due to the temporal nature of financial data, users often need to compare data from different periods to view historical trends. Common visualization methods include timelines and animations. However, for developers, creating timelines and binding data involves complex coding for animations and interactions, which is labor-intensive and poses challenges in efficiency and reusability. To address this, HiVis designs a declarative visualization component for timelines.

Figure 5: A: Dynamic line chart with event markers; B: Dynamic ranking line chart; C: Dynamic line chart; D: Dynamic ranking bar chart.

Petal Chart: In financial scenarios, combining multiple charts into a composite visualization significantly improves data clarity.

For example, integrating a line chart with a Gully enhances expressiveness. Thus, HiVis offers a Petal Chart for visualizing market trends and key events. Its declarative API design hides the underlying logic, reducing development difficulty and time.
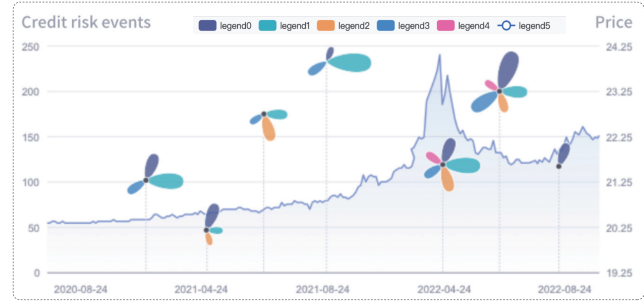

Figure 6: Different petals in the petal chart encode different types of events, and different attribute mappings are used for color and size according to the requirements.

Data Compression and Data Aggregation: In financial data visualization, the large size of multi-dimensional financial data, such as 200MB for 1-year stock market trends, poses challenges like slow rendering and interaction delays. Existing compression methods like HPack (for HTTP headers) and cJSON (for fixed-format data) are insufficient for complex financial data. We propose a Huffman-based key-map compression strategy for JSON data to enhance performance. We also design a data aggregation strategy that uses sampling algorithms for large datasets, full rendering for low-density data, and down-sampling for medium-to-high density data. We also modified the Largest Triangle Three Buckets (LTTB) algorithm to include extreme values and support abnormal data features, ensuring efficient rendering while retaining key information.

3 CONCLUSIONS

This paper presents HiVis, a web-based declarative financial data visualization library, aimed at addressing the challenges faced by financial visualization creators and providing high-quality interactive visualization solutions for financial application users. HiVis provides data compression, data aggregation, and a variety of visualization schemes to meet the needs and scenarios of large-scale, time-series, and multidimensional financial data visualization. It also provides cross-device adaptation, diversified themes, and financial customized visual analysis solutions.

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