Stock Data Analysis and Empirical Research Based on Python Data Visualization

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Abstract: With the continuous improvement of financial market informatization, stock data continues to grow in terms of scale, dimension, and complexity, and traditional numerical analysis methods are gradually showing limitations in terms of intuitiveness and interpretation. Therefore, this paper takes stock data as the research object. Based on the data visualization technology of the Python platform, the stock price, trading volume, and technical indicators are visualized and presented, and empirical analysis is carried out in combination with the simple trading model. The research results show that reasonable data visualization can effectively reveal the dynamic characteristics and market structure information of stock prices, while significantly improving the interpretability of model analysis and strategy evaluation. The research in this article provides practical reference for the application of Python data visualization in stock analysis, which has certain theoretical significance and application value in improving the efficiency and research quality of financial data analysis.

Keywords: Data Analysis, Finance, Big Data, Data Visualization

1 Introduction

With the deep integration of information technology and the financial market, the stock market has shown a significant growth trend in terms of transaction frequency, data size, and data complexity. Visual analysis of stock data helps researchers and market participants to visually identify the characteristics and potential trends of price fluctuations, thus providing more effective support for investment decision-making and risk management [1]. However, stock prices, trading volume, technical indicators, and related macroeconomic data have typical high-dimensional, strong timing, and high noise characteristics [2]. It is difficult to reveal their inherent laws intuitively and comprehensively by relying on traditional numerical statistical methods alone. Against this background, data visualization, as an important bridge between data analysis and decision-making understanding, has gradually become a key technical means in financial data analysis. Python is a scripting language that combines interpretation, compilation, interactivity, and object-oriented programming. It has a rich toolkit and an active open-source community, which can carry out effective exploratory analysis of data; its super visualization function can display unstructured data in a visual effect, providing empirical

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support for the realization of the use of big data in practice [3]. By transforming abstract data into intuitive graphic forms, researchers and investors can more efficiently identify trend changes, fluctuation characteristics, and potential risks, thus assisting investment decision-making and risk management [1,4].

As one of the most widely used programming languages in the field of data analysis and scientific computing, Python occupies an important position in the field of data visualization with its advantages of simple syntax, perfect ecology, and strong cross-platform ability. Data analysis and visualization libraries around Python, such as NumPy, Pandas, Matplotlib, Seaborn, etc., provide a complete and efficient technical system for the acquisition, processing, analysis, and display of stock data.

This article takes stock data as the research object, focuses on the application value of Python in the field of data visualization, shows the visualization process of stock information through specific examples, and explains the practical significance of visualization technology in stock analysis in combination with empirical analysis [5].

2 Data Visualization

2.1 Application of Python in the field of data visualization

Against the background of the rapid development of big data and financial technology, Python has gradually become one of the important technical platforms in the field of data visualization. From the perspective of the overall technical system, the application of Python in data visualization usually runs through multiple links such as data acquisition, data preprocessing, statistical analysis, and result presentation, forming a relatively complete data analysis link. For the stock market, data sources are wide, updated frequently, and data types are mainly time series and multi-dimensional structures. Python shows strong adaptability when processing such data.

Python shows strong adaptability when processing such data. Among them, NumPy mainly provides efficient support for numerical calculation and vectorized operation of stock data, which significantly reduces the computing cost of large-scale time series data; Pandas realizes index management, time alignment, and Missing value processing provides a structured data basis for subsequent visualization and model analysis. On top of this, Matplotlib, Seaborn, and other visualization libraries provide multi-level support from low-level drawing control to advanced statistical graphics construction, enabling researchers to flexibly design graphic expressions according to analytical goals. For example, in stock research, price trends, turnover changes, and technical indicators often need to be displayed comprehensively under a unified framework. Python's visualization tool can realize information integration through multi-chart linkage and coordinate sharing, thus enhancing the integrity and logic of the analysis results.

From the perspective of research methods, Python data visualization not only assumes the function of result display but also is an important part of exploratory data analysis. Researchers can find anomalies, structural changes, or potential patterns in the visualization process by constantly adjusting the graphic form and parameter configuration. This method of "visualization-driven analysis" is of great value in financial data research.

2.2 The necessity of data visualization and the advantages of Python visualization

The essence of data visualization lies in transforming complex data structures into visual expression forms that conform to the laws of human cognition. Stock data usually has the characteristics of high dimension, high noise, and strong time dependence. It is difficult to fully reveal the dynamic changes and intrinsic connections behind the data by simply relying on numerical statistics or text descriptions. Through visualization, researchers can grasp the overall trend, fluctuation interval, and stage characteristics of stock prices in a relatively short time, thus significantly improving the efficiency of analysis and the depth of understanding.

From the perspective of the necessity of analysis, data visualization can effectively make up for the lack of intuitiveness of traditional quantitative analysis. On the one hand, visualization helps to identify long-term trends and structural changes at the macro level; on the other hand, it can also reveal local anomalies and short-term fluctuations at the micro level, providing a basis for subsequent model construction and strategy verification. In stock research, issues such as trend judgment, risk identification, and strategy effect evaluation rely heavily on the support of visualization results.

Among many visualization tools, Python has obvious advantages in stock data visualization. First of all, Python has good openness and extensibility, can be seamlessly combined with a variety of data interfaces and analytical models, and is suitable for systematic and repeatable academic research. Secondly, the Python visualization library achieves a good balance between expression ability and flexibility, which can not only meet the requirements of graphic standardization and rigor in academic papers, but also support multivariate display in complex financial scenarios. In addition, the visualization process of Python has a high degree of reproducibility. Researchers can completely record the analysis process through code, which helps to ensure the transparency and reliability of research results.

In summary, the introduction of Python data visualization in stock data research is not only a technical choice at the result presentation level, but also an important methodological tool to improve the depth of analysis and the quality of research.

3 Empirical analysis: visual expression of data, algorithms, and models

Taking the historical trading data of a listed company's shares as an example, Python can obtain information such as its daily closing price, opening price, highest price, lowest price, and trading volume. Hilpisch and McKinney point out that Python, combined with Pandas, can efficiently acquire and structure historical stock trading data, including daily closing prices, opening prices, highest prices, lowest prices, and trading volume [6,7].

After completing the data cleaning, first draw a time series line chart of the closing price of the stock. The chart can intuitively reflect the overall trend and fluctuation of stock prices in different periods of time, which helps to identify long-term trends and stage inflection points.

On this basis, the trading volume data is superimposed under the price chart in the form of a bar chart, which can be further analyzed to determine the relationship between price changes and the activity of market transactions. Hilpisch and Lewinson emphasize that overlaying

trading volume data as a bar chart below the price line chart helps visually analyze the relationship between price changes and market trading activity [6,8].

When the stock price rises with the expansion of trading volume, it usually indicates that the market participation is relatively high; on the contrary, it may imply that the upward momentum is insufficient. Through this visualization of multi-picture linkage, the intrinsic connection of stock information can be presented more clearly.

In the empirical analysis, the historical data of stocks within a certain period of time is selected as the research sample. The data is first structured through Pandas, and the commonly used technical indicators, such as the moving average, are calculated. Then, a simple trading model is built based on the moving average strategy to generate buying and selling signals by comparing the intersection of short-term moving averages and long-term moving averages. Monteiro et al. and Hilpisch indicate that comparing the intersection of short-term and long-term moving averages can effectively generate buy and sell signals and visually demonstrate the signal generation process [6,9].

In order to enhance the intuitiveness of the analysis, the moving averages of different periods and the original price curves can be drawn in the same coordinate system. When the short-term moving average breaks through the long-term moving average, an obvious intersection will be formed graphically, which visually shows the generation process of trading signals from a visual perspective. Hilpisch and Lewinson point out that plotting moving averages of different periods together with the original price curve in the same coordinate system creates clear intersection points when the short-term moving average crosses the long-term moving average [6,8].

In addition, the rate of return generated by the model can also be visualized, such as drawing the cumulative return curve of the strategy to compare the difference between the return of the strategy and the benchmark return. Through the above visualization results, the effectiveness of the model and its risk characteristics can be visually evaluated, so as to verify the application value of Python data visualization in stock empirical analysis. Hilpisch, Lewinson**,** and Monteiro et al. recommend drawing the cumulative return curve of the strategy to compare its performance with the benchmark return; Park and Irwin further point out that such visualizations help evaluate the effectiveness and risk characteristics of the model [9,10].

4 Outlook

With the continuous expansion of the scale of financial market data and the continuous evolution of analysis methods, the application of Python data visualization in stock research still has a wide range of room for development. Future research can introduce machine learning and deep learning models on the basis of the existing visual analysis framework, and present the predictive results, characteristic importance, and model uncertainty in a visual way, so as to improve the interpretability of complex models in financial scenarios. In addition, the development of interactive visualization technology has also provided a new research direction for stock analysis. Through dynamic charts and multi-dimensional linkage views, researchers can explore high-dimensional financial data more flexibly.

At the same time, Python data visualization still faces certain challenges in practical

applications. On the one hand, stock data has the characteristics of real-time and high frequency. How to handle large-scale data flow while ensuring visualization efficiency is an urgent problem to be solved; on the other hand, overly complex graphic design may increase the cognitive burden and even lead to information misreading. Therefore, future research needs to strike a balance between information integrity and visual conciseness and further standardize the design principles of financial data visualization at the methodological level.

5 Conclusion

From the perspective of data visualization, based on the Python technology system, this article conducts a systematic study on the visual analysis method and empirical application of stock data, focusing on the role mechanism and application value of visualization technology in stock analysis.

The study found that Python data visualization can effectively improve the intuitiveness and interpretability of stock data analysis. First of all, through the visual expression of price and trading volume, the relationship between stock price trend and market trading activity can be clearly revealed, providing an intuitive basis for trend judgment. Secondly, the visual analysis based on technical indicators helps to reduce the noise interference in the financial time series and makes the potential trend more obvious. Thirdly, the visual display of the transaction model and the income results is conducive to the intuitive assessment of the effectiveness and risk characteristics of the model, and to improve the transparency and credibility of empirical analysis. On the whole, data visualization is not only a tool for presenting analysis results, but also an important analysis tool to support model construction and strategy verification.

With the continuous development of data scale and analysis technology, the further combination of Python data visualization with intelligent algorithms and big data analysis frameworks is expected to provide more efficient and reliable technical support for stock market research and investment decision-making.

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