

BI Analytics: A Domain-Aware Business Intelligence Platform for Self-Service Data Visualization

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Abstract: Business Intelligence (BI) platforms play a critical role in transforming raw organizational data into meaningful insights. However, many existing solutions require technical expertise for dataset preparation, modeling, and visualization. This paper presents BI Analytics, a domain-aware analytics platform designed to simplify data processing and visualization for non-technical users. The system automates dataset analysis, classifies data into domain-specific workspaces, and enables dynamic dashboard generation. The proposed solution improves usability, reduces manual effort, and enhances decision-making efficiency. The system is implemented using a React-based frontend, Flask backend, and MongoDB database.

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I. INTRODUCTION

The rapid expansion of data across modern enterprises has created a pressing need for systems that can efficiently transform raw information into actionable insights [1]. While Business Intelligence (BI) tools are widely adopted for this purpose, many existing solutions require significant technical expertise to configure datasets, define models, and generate visualizations. This complexity limits accessibility, particularly for non-technical users, and slows down the decision-making process.

In addition to usability challenges, traditional BI platforms often lack effective mechanisms for organizing data in a meaningful way. Users frequently struggle with understanding dataset structures, identifying relevant attributes, and managing large volumes of unstructured or semi-structured data. The absence of domain-oriented organization further complicates analysis, leading to inefficient workflows and increased setup time before meaningful insights can be generated.

To overcome these limitations, this paper introduces BI Analytics, a domain-aware business intelligence platform designed to simplify and automate the analytics process. The proposed system integrates automated dataset processing, intelligent domain classification, and interactive visualization capabilities into a unified framework. By providing a scalable, secure, and user-friendly environment, the platform

enables users to perform self-service analytics with minimal technical expertise.

II. SYSTEM OVERVIEW

The BI Analytics platform is designed to provide an end-to-end solution for data analysis by simplifying the complete workflow, starting from dataset ingestion to dashboard generation. Users can upload datasets in multiple formats such as CSV, Excel, and JSON through a user-friendly interface. Once the data is uploaded, the system automatically performs schema validation, analyzes the dataset structure, and identifies key attributes required for further processing. Based on these characteristics, the platform intelligently classifies the dataset into an appropriate business domain such as retail, finance, or healthcare. Each dataset is then stored within a dedicated domain-specific workspace, ensuring organized data management and easy accessibility.

In addition to data organization, the platform includes an interactive visualization engine that enables users to generate various types of charts, including bar charts, line charts, pie charts, and scatter plots. These visualizations can be dynamically customized and combined to form comprehensive dashboards, allowing users to explore patterns, trends, and insights effectively. By integrating automated processing with intuitive visualization capabilities, the BI Analytics platform significantly reduces manual effort

and enhances the overall efficiency of the analytics workflow [2].

III. SYSTEM ARCHITECTURE

The BI Analytics platform is built using a layered architecture that ensures scalability, modularity, and efficient data processing. The system begins with the data source layer, where users upload datasets in formats such as CSV, Excel, or JSON through the application interface. These datasets are then stored in the data storage layer using a NoSQL database (MongoDB), which manages dataset records, user information, and workspace metadata in a flexible and scalable manner.

The data processing layer is responsible for handling core operations such as data ingestion, validation, cleaning, and transformation to prepare the dataset for analysis. Following this, the domain classification module analyzes dataset attributes and assigns the data to an appropriate business domain, enabling structured organization within the system. The visualization engine then generates graphical representations of the processed data, supporting multiple chart types and dashboard creation. Finally, the presentation layer provides an interactive user interface where users can upload datasets, create visualizations, and manage dashboards seamlessly. This architecture ensures secure data handling, efficient processing, and a responsive analytics experience [4].

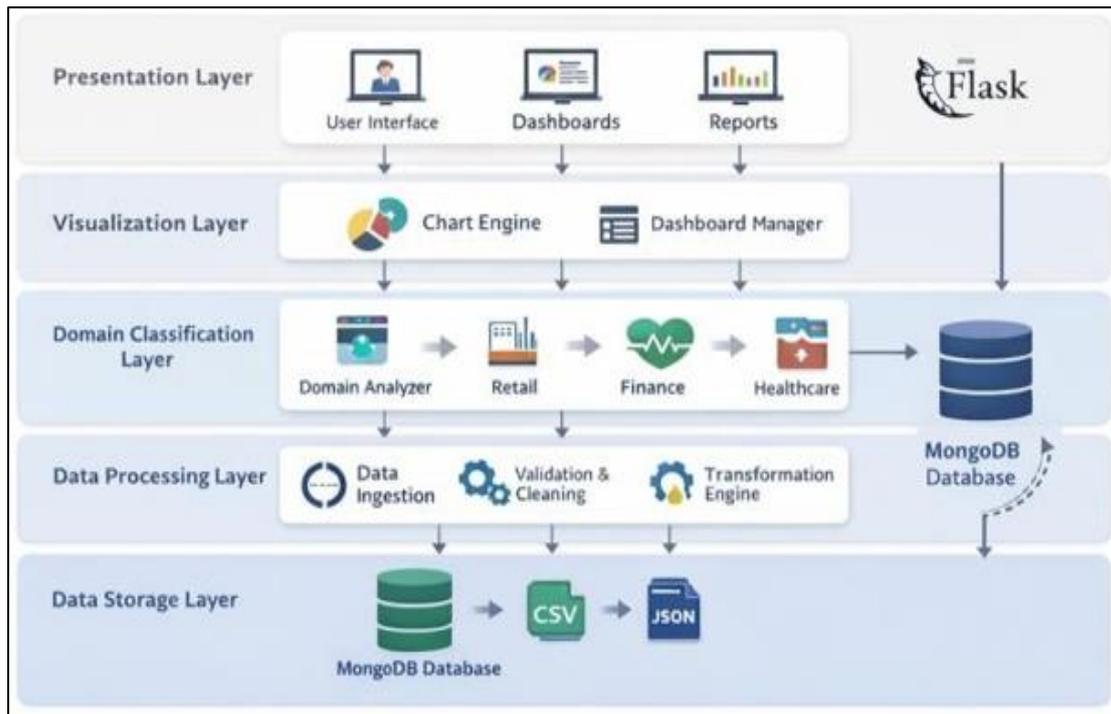


Fig. 1. BI Analytics System Architecture

IV. DATA PROCESSING PIPELINE

The BI Analytics platform follows a structured data processing pipeline to ensure accurate and efficient analysis of uploaded datasets. The process begins with the dataset upload stage, where users submit data files through the system interface. Once uploaded, the system performs validation to verify file format compatibility, schema consistency, and overall data integrity, ensuring that only clean and usable data proceeds to subsequent stages.

Following validation, the system performs domain classification by analyzing column names, data types, and attribute patterns to determine the most appropriate business domain for the dataset. The next stage involves data transformation, where preprocessing operations such as handling missing values, data aggregation, and feature extraction are applied to improve data quality and usability. Finally, the processed data is forwarded to the visualization layer, where charts and dashboards are generated to present meaningful insights. This pipeline minimizes manual intervention, enhances processing efficiency, and enables users to derive insights effectively from raw data. The overall workflow of this process is illustrated in Fig. 2.

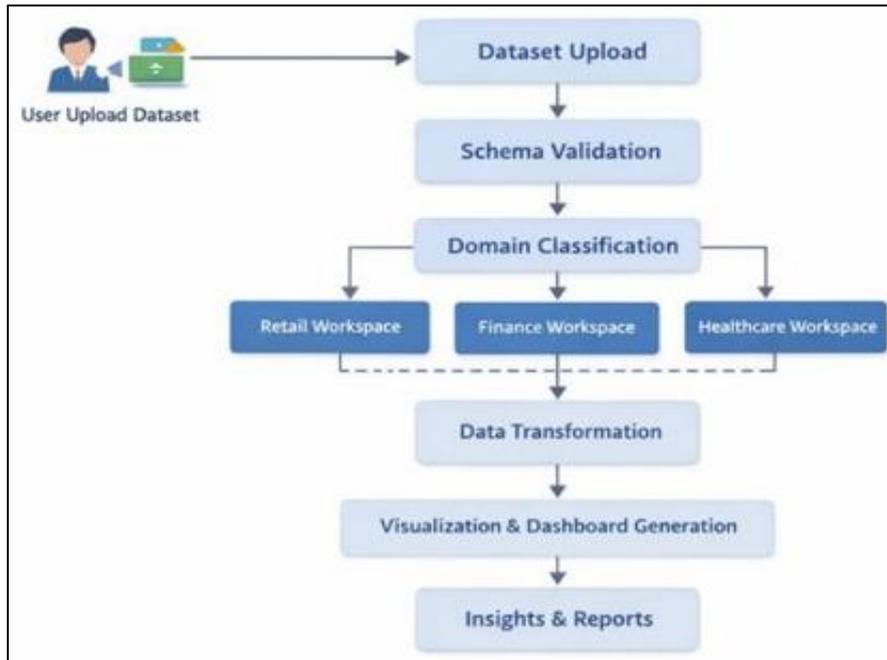


Fig. 2. BI Analytics Data Flow Diagram

V. IMPLEMENTATION

The BI Analytics platform is developed using a modern full-stack architecture to ensure high performance, scalability, and maintainability. The frontend is implemented using React, following a component-based design approach that enables modular and reusable UI elements. The visualization layer is structured using specialized chart engines, including Cartesian, Pie, and Hierarchical modules, allowing the system to dynamically render different types of visualizations based on dataset characteristics. State management and data flow are handled efficiently to support real-time updates, enabling users to interact with datasets, configure visualizations, and build dashboards through a responsive and intuitive interface.

The backend is implemented using the Flask framework, which is responsible for managing core functionalities such as dataset upload, schema validation, domain classification, and visualization data preparation. The system processes incoming datasets by performing validation checks, parsing data structures, and transforming them into a standardized format suitable for analysis. MongoDB is used as the primary database due to its flexibility in handling semi-structured and unstructured data. It stores datasets, user credentials, and workspace metadata, enabling efficient querying and retrieval of information required for analytics operations.

To ensure security and controlled access, the platform integrates multiple authentication and authorization mechanisms. JSON Web Tokens (JWT) are used for secure session management, allowing stateless authentication across client-server interactions. Additionally, One-Time Password (OTP) verification is implemented during user registration and login to enhance account security. Role-based access

control (RBAC) is enforced to restrict access to datasets and dashboards based on user roles, ensuring data privacy and integrity. Together, these implementation strategies enable the system to provide a secure, scalable, and user-friendly environment for managing datasets, generating visualizations, and performing self-service analytics efficiently.

VI. RESULTS AND DISCUSSION

The BI Analytics platform was evaluated using multiple sample datasets, including retail sales data and financial transaction records, to assess its performance, scalability, and usability. The experimental results demonstrate that the system is capable of efficiently handling large datasets while maintaining low processing latency and fast visualization rendering. The automated data processing pipeline significantly reduces the need for manual configuration, enabling users to quickly transition from dataset upload to actionable insights.

Users were able to upload datasets in various formats, after which the system automatically analyzed schema structures, identified relevant attributes, and classified the data into domain-specific workspaces. The visualization engine enabled users to generate interactive dashboards with minimal effort, providing clear insights into trends and patterns. Compared to traditional BI tools, the platform offers a more streamlined and user-friendly experience.

In addition, the system demonstrated strong scalability and responsiveness when handling larger datasets. The modular architecture and efficient API communication ensured smooth performance. These results indicate that the BI Analytics platform provides an effective and scalable solution for real-world analytics applications [8].

VII. CONCLUSION

This paper presented BI Analytics, a domain-aware business intelligence platform designed to simplify data analysis and visualization through automation and intelligent organization. The system integrates dataset processing, domain classification, and visualization into a unified workflow. By reducing complexity, it enables non-technical users to perform self-service analytics effectively, improving productivity and decision-making capabilities.

Future enhancements will include machine learning-based dataset classification, predictive analytics, natural language query support, and real-time data processing. These improvements will further strengthen the system's ability to support modern data-driven organizations.

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