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An Automated Insight Generation and Multi-Dataset Comparative Analysis System for Business Intelligence Dashboards

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***Abstract*—** Business Intelligence (BI) dashboards are widely adopted for performance monitoring across organizations; however, they rely heavily on manual interpretation of visualized data. As data volumes increase, identifying hidden patterns, inefficiencies, and anomalies becomes complex and time-consuming. This paper presents an automated insight generation and multi-dataset comparative analysis system for BI dashboards using digital marketing campaign data. The proposed system performs multi-dimensional analysis across channels, campaigns, demographics, and behavioral metrics to automatically generate explainable business insights. An anomaly detection mechanism using Isolation Forest identifies abnormal trends in key performance indicators. Insights are ranked based on business impact, and a recommendation engine provides actionable decision support. Additionally, the system supports comparative analysis across multiple datasets to assess robustness and sensitivity of generated insights. The framework aims to reduce manual analytical effort and enhance data-driven decision-making in enterprise environments.

Keywords— Automated Insights, Business Intelligence, Augmented Analytics, Anomaly Detection, Data Analytics, Decision Support Systems

I. Introduction

Business Intelligence dashboards play a critical role in monitoring organizational performance by presenting structured data through visualizations. Despite their widespread use, most BI tools rely on analysts to manually interpret charts and tables to extract insights. With the increasing scale and complexity of digital marketing and business datasets, this manual approach becomes inefficient and prone to subjective bias.

Recent developments in augmented analytics emphasize automating data preparation, pattern detection, and insight discovery using artificial intelligence techniques. Automated insight generation systems aim to bridge the gap between raw data visualization and actionable intelligence by detecting trends, inefficiencies, and anomalies without continuous human intervention.

This research proposes an automated insight generation framework integrated into an interactive BI dashboard. The system performs multi-dimensional analysis, anomaly detection, insight ranking, and recommendation generation while supporting comparative evaluation across multiple datasets.

II. Problem Statement

Traditional BI dashboards primarily provide descriptive analytics through static or interactive visualizations. However, they lack automated interpretation mechanisms that can highlight critical business issues such as high expenditure with low return, weak campaign performance, or abnormal behavioral trends.

Analysts must manually explore multiple dimensions of data to identify patterns, making the process time-consuming and difficult to scale across large datasets. Moreover, existing BI systems do not support systematic comparison of insights across multiple datasets to evaluate consistency and robustness.

Hence, there is a need for an intelligent BI framework capable of automatically generating, prioritizing, recommending, and comparing business insights.

III. Objectives

The key objectives of the proposed system are:

- To design an automated framework for generating business insights from digital marketing datasets
- To perform multi-dimensional analysis across channels, campaigns, demographics, and behavioral metrics
- To develop an insight ranking mechanism based on business impact
- To generate actionable recommendations for decision support
- To detect anomalous patterns in key performance indicators
- To support single-dataset analysis and multi-dataset comparative evaluation

IV. Literature Review

Augmented analytics has emerged as the next evolution of Business Intelligence, emphasizing automation of insight discovery and analytical reasoning. Prior research demonstrates the effectiveness of automated pattern extraction and natural language explanation systems in improving user understanding of data.

Recent AI-driven BI frameworks focus on large-scale automated insight generation but highlight challenges in prioritization and information overload. Other studies integrate anomaly detection into enterprise dashboards but lack formal ranking mechanisms and cross-dataset robustness evaluation.

These limitations motivate the development of an integrated automated insight system combining anomaly detection, impact-based ranking, actionable recommendations, and comparative dataset analysis within a unified BI environment.

V. Methodology

The proposed system follows a modular analytical pipeline as shown below:

A. Data Ingestion and Preprocessing

Structured digital marketing datasets are imported and cleaned through normalization, missing value handling, and feature standardization.

B. Multi-Dimensional Analysis

Performance metrics are analyzed across:

- Channel-wise performance
- Campaign-wise effectiveness
- Demographic segmentation
- Behavioral engagement trends

C. Anomaly Detection

An Isolation Forest algorithm is applied to detect abnormal fluctuations in KPIs such as spend, conversion rate, impressions, and ROI.

D. Automated Insight Generation

Statistical patterns, deviations, trends, and inefficiencies are converted into structured business insights.

E. Insight Ranking

Each generated insight is scored based on business impact considering magnitude of change, financial relevance, and operational importance.

F. Recommendation Engine

Rule-based logic generates actionable business recommendations such as budget reallocation, campaign optimization, or targeting adjustments.

G. Visualization Dashboard

An interactive frontend developed using Streamlit displays insights, anomalies, rankings, and comparative analysis results.

VI. Expected Results and Discussion

The system is expected to:

- Automatically detect hidden trends and inefficiencies in business datasets
- Identify abnormal campaign behavior using anomaly detection
- Provide ranked insights prioritized by business impact
- Deliver actionable recommendations for strategic decisions
- Enable robustness analysis across multiple datasets The automated framework significantly reduces manual analytical workload while improving consistency and decision speed.

VII. Conclusion

This paper presents an automated insight generation and multi-dataset comparative analysis framework for Business Intelligence dashboards. By integrating multi-dimensional analytics, anomaly detection, insight ranking, and recommendation generation, the proposed system transforms traditional BI dashboards into intelligent decision-support platforms.

The inclusion of comparative dataset analysis enhances robustness and reliability of automated insights. Future work may explore advanced machine learning models for predictive insight generation and natural language explanation modules for enhanced interpretability.

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