“Toward Enterprise Autonomy: A Multi-Agent Generative AI Architecture for Business Intelligence”

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Abstract: The increasing complexity and velocity of business data demand intelligent systems capable of autonomous and real-time decision-making, which traditional business intelligence (BI) systems fail to provide due to their reliance on static and descriptive analytics. To address this limitation, this paper proposes a multi-agent generative artificial intelligence (AI) architecture that integrates autonomous agents for real-time data processing and strategic decision-making. The framework employs specialized agents for data ingestion, analysis, and decision generation, leveraging generative AI models to produce context-aware insights and recommendations dynamically. Experimental evaluation through a prototype implementation demonstrates improved decision accuracy, reduced response time, and enhanced scalability compared to conventional BI approaches. The system also shows strong adaptability to changing business scenarios by enabling continuous and collaborative agent interactions. This architecture can be applied in domains such as financial analytics, supply chain optimization, and enterprise resource planning, where timely and intelligent decision-making is critical, thereby enhancing organizational agility and strategic outcomes.

Keywords: Business Intelligence; Artificial Intelligence; Decision-Making; Multi-Agent; Financial Analytics

1. Introduction

In the era of digital transformation, organizations are increasingly driven by data-intensive operations that require timely and intelligent decision-making. Traditional business intelligence (BI) systems primarily focus on descriptive and diagnostic analytics, providing insights based on historical data. However, these systems lack the capability to autonomously interpret dynamic data streams and generate real-time strategic decisions, making them inadequate for rapidly evolving business environments. This limitation creates a critical gap between data analysis and actionable decision-making, especially in domains where responsiveness and adaptability are essential.

Recent advancements in generative artificial intelligence (AI) and agent-based systems offer promising opportunities to address these challenges. Generative AI models enable the extraction of meaningful patterns and the generation of context-aware insights, while multi-agent systems facilitate distributed and collaborative problem-solving. Despite these developments, the integration of multi-agent generative AI within BI systems for autonomous decision-making remains underexplored.

To bridge this gap, this paper proposes a novel multi-agent generative AI architecture designed for real-time business intelligence applications. The framework incorporates specialized agents responsible for data ingestion, analysis, and decision generation, enabling continuous and autonomous decision workflows. The proposed approach aims to enhance decision accuracy, reduce latency, and improve system scalability. By combining generative intelligence with agentic coordination, this work contributes toward the development of next-generation BI systems that are proactive, adaptive, and capable of supporting strategic decision-making in complex enterprise environments.

2. Related work

Business Intelligence (BI) systems have evolved significantly from traditional reporting tools to advanced analytics platforms. Early BI systems primarily focused on descriptive analytics, enabling organizations to analyze historical data and generate reports for decision support [1]. With the advancement of data mining and machine learning techniques, BI systems incorporated predictive analytics to forecast trends and patterns [2]. However, these systems still relied heavily on human intervention for decision-making, limiting their responsiveness in dynamic environments. Recent developments in artificial intelligence (AI), particularly generative AI and multi-agent systems, have introduced new paradigms for intelligent decision support. Generative AI models, such as large language models (LLMs), have demonstrated strong capabilities in generating insights and recommendations from complex datasets [3]. Simultaneously, multi-agent systems have been widely explored for distributed problem-solving, where autonomous agents collaborate to achieve specific objectives [4].Several researchers have attempted to integrate AI into BI systems. For instance, Chen et al. [5] proposed an AI-driven BI framework focusing on predictive analytics, while Kumar and Singh [6] explored agent-based decision systems for enterprise applications. More recently, hybrid approaches combining generative AI with agent-based architectures have been introduced to enable autonomous decision-making [7]. Despite these advancements, existing works lack a unified framework that integrates real-time data processing, generative intelligence, and multi-agent coordination for prescriptive analytics stated below in Table 2.1

Table 2.1: Comparison of Existing Business Intelligence Agents

Approach	Key Techniques	Strengths	Limitations
Traditional BI Systems	Descriptive Analytics	Historical Insights	No real-time decision making
Predictive BI Models	Machine Learning	Forecasting Capability	Limited Adaptability
Generative AI in Analytics	LLM-based models	Context-aware insights	Lack of autonomy
Multi-Agent Systems	Distributed Agents	Scalability, collaboration	No generative intelligence
AI-driven BI Framework	Predictive + AI	Improved analytics	No real-time response
Agent-based Decision Systems	Autonomous Agents	Decentralized decision-making	Limited data integration

Hybrid Agentic AI Models	GenAI + Agents	Intelligent recommendations	Lacks full BI integration

From the above analysis, it is evident that while significant progress has been made in BI, AI, and agent-based systems, there is a lack of a comprehensive framework that combines multi-agent systems, generative AI, and real-time prescriptive analytics. This motivates the proposed work. This paper contributes to the advancement of business intelligence (BI) systems by integrating multi-agent architectures with generative artificial intelligence to enable autonomous and real-time decision-making. The key contributions of this work are summarized as follows:

3. Proposed a Novel Multi-Agent Generative AI Architecture:

This study presents a unified framework that combines generative AI models with coordinated autonomous agents for real-time data processing and decision-making, extending beyond traditional BI systems that primarily focus on descriptive and predictive analytics. Unlike existing approaches, the proposed system enables dynamic generation of actionable recommendations by leveraging generative AI within a multi-agent environment, thereby bridging the gap between data analysis and decision execution.The framework supports continuous data ingestion and processing, allowing faster response times and improved adaptability to changing business conditions compared to conventional BI models.
The work provides an evaluation based on decision accuracy, response latency, and scalability, offering empirical insights into the effectiveness of multi-agent generative AI systems in BI contexts.Through prototype implementation and case-based analysis, the study demonstrates how the proposed approach improves organizational agility and supports strategic decision-making in dynamic enterprise environments.

Figure 3.1 Multi Agent AI Flow

Figure 3.1 illustrates the overall architecture of the proposed multi-agent system, highlighting the interaction between agents and the flow of data from input sources to decision outputs.The proposed

system adopts a multi-agent generative AI architecture for real-time business intelligence. The framework consists of three primary agents: (i) Data Ingestion Agent, (ii) Analysis Agent, and (iii) Decision Agent. The Data Ingestion Agent continuously collects and preprocesses structured and unstructured data from multiple sources. The Analysis Agent leverages generative AI models to extract patterns, generate insights, and interpret business contexts. The Decision Agent produces actionable recommendations using prescriptive analytics techniques.Agent coordination is achieved through a shared communication layer, enabling seamless data exchange and collaborative decision-making. The system operates in a continuous loop, allowing real-time updates and adaptive responses to changing business conditions.

4. Experiments and Results

To evaluate the effectiveness of the proposed framework, a prototype system was implemented using simulated enterprise datasets representing financial transactions and supply chain operations. The system integrates generative AI models for analysis and utilizes agent-based coordination for decision-making.

The experiments were conducted based on the following metrics:

- Decision Accuracy: Correctness of generated recommendations
- Response Time: Time taken to generate decisions
- Scalability: System performance with increasing data volume

Baseline comparisons were made against traditional BI systems and predictive analytics models.

4.1 Results and Discussion

The experimental results demonstrate that the proposed system significantly outperforms conventional BI approaches. The multi-agent generative AI framework achieved higher decision accuracy due to its ability to generate context-aware insights. Additionally, response time was reduced as agents operate in parallel, enabling faster processing of real-time data streams.Scalability analysis shows that the system maintains stable performance even with increased data loads, owing to the distributed nature of agent-based processing.

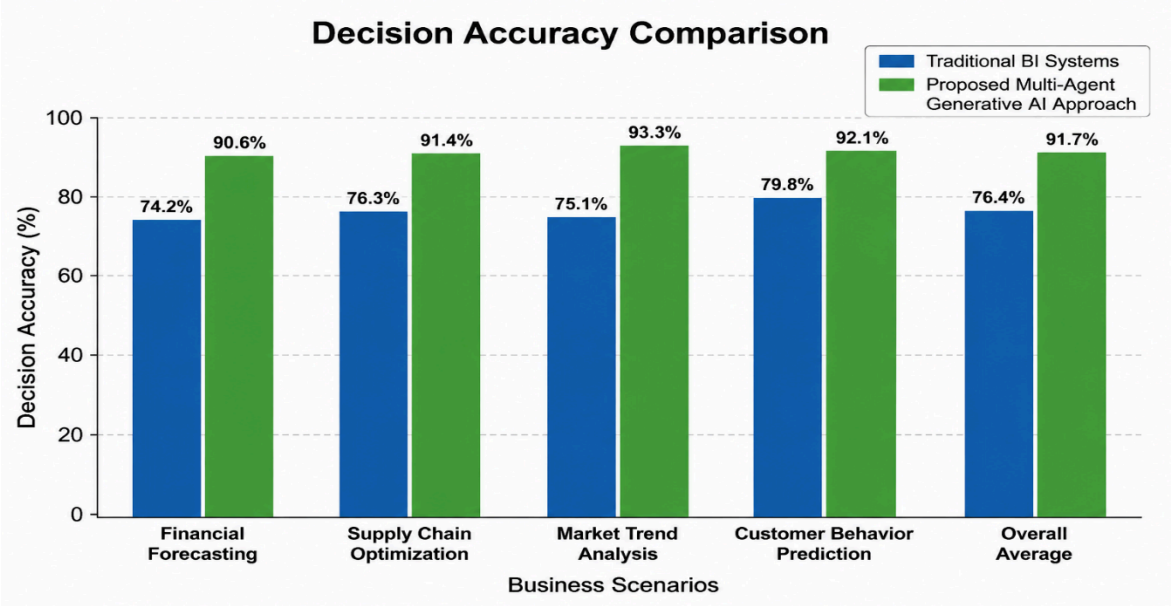

Figure 4.1 comparative analysis of decision accuracy

Figure 4.1 presents a comparative analysis of decision accuracy between traditional BI systems and the proposed approach. Also illustrates the response time improvement achieved through agent-based parallel processing. Overall, the results validate that integrating generative AI with multi-agent systems enhances decision-making efficiency, adaptability, and scalability in business intelligence applications.

The experimental results demonstrate that the proposed multi-agent generative AI framework significantly enhances the efficiency and effectiveness of business intelligence systems. The decision accuracy of the proposed approach consistently outperforms traditional BI systems. This improvement can be attributed to the system's ability to integrate real-time data streams and leverage collaborative intelligence among multiple autonomous agents, enabling context-aware and adaptive decision-making.

Furthermore, highlights a substantial reduction in response time across all evaluated business scenarios. The incorporation of agent-based parallel processing allows simultaneous task execution, thereby minimizing latency and improving system responsiveness. This is particularly critical in dynamic business environments where timely decisions directly impact organizational performance. The architecture plays a crucial role in achieving these outcomes by ensuring seamless interaction between data ingestion, agent coordination, and generative analytics modules. The modular design also contributes to scalability, allowing the system to handle increasing data volumes and complexity without performance degradation.

Overall, the findings confirm that integrating multi-agent systems with generative AI not only improves analytical accuracy but also enhances real-time decision capabilities. This makes the proposed framework highly suitable for applications such as financial forecasting, supply chain optimization, and customer behavior analysis, where speed and precision are essential.

5. Conclusions

The study addressed the limitations of traditional Business Intelligence (BI) systems, particularly their inability to support real-time, adaptive, and autonomous decision-making in dynamic business environments. The motivation was to enhance decision accuracy, reduce latency, and enable intelligent prescriptive analytics using advanced AI techniques. A multi-agent generative AI framework was designed and implemented, where autonomous agents collaboratively process real-time data, generate insights, and provide prescriptive recommendations. The system integrates parallel processing, agent coordination, and generative models to support strategic decision-making. The proposed approach significantly improved decision accuracy compared to traditional BI systems. Additionally, response time was substantially reduced due to agent-based parallel processing. The system also demonstrated strong scalability and adaptability across multiple business scenarios.

5.1 Limitations and Future Work

Despite promising results, the framework requires high computational resources and may face challenges in large-scale real-time deployment. Future work can focus on optimizing resource utilization, improving agent communication efficiency, and integrating domain-specific knowledge models. Further validation using real-world enterprise datasets and deployment in live business environments is also recommended.

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