

EMDIF: An Explainable Multi-Agent Intelligence Framework for Cross-Domain Analytics

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Abstract: To address the challenges of limited decision transparency, insufficient reasoning interpretability, and weak cross-domain collaboration in AI-driven simulation and analytics systems, this paper proposes an Explainable Multi-Agent Intelligence Framework (EMAIF) for intelligent simulation-driven decision support across retail, finance, and networking domains. The proposed framework integrates specialized AI agents with a centralized orchestration layer to coordinate supply chain simulation, financial risk modeling, and network infrastructure simulation through collaborative multi-agent interactions. Furthermore, an explainable reasoning mechanism combining SHAP, LIME, and Retrieval-Augmented Generation (RAG) is incorporated to provide transparent, interpretable, and traceable explanations for predictive analytics and agent decision-making, thereby enhancing user trust and model accountability. To support proactive decision-making, the framework adopts a digital-twin-inspired simulation environment that enables scenario-based analysis, runtime feedback, and cross-agent knowledge sharing for adaptive resource optimization, risk identification, and operational forecasting. Experimental evaluation demonstrates that EMAIF effectively delivers accurate, reliable, and explainable intelligent analytics in complex cross-domain environments while exhibiting superior scalability, interpretability, and adaptability. The proposed framework provides a practical foundation for the development and deployment of trustworthy explainable multi-agent simulation systems in next-generation intelligent enterprises.

Keywords: Explainable Artificial Intelligence (XAI); Multi-Agent Systems; Simulation Analytics; Digital Twin; Supply Chain Optimization; Risk Forecasting; Network Performance Optimization