IAGO MEDEIROS TAVARES

AI-Driven Trade Allocation and Validation Platform for Financial Institutions

SÃO PAULO
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AI-Driven Trade Allocation and Validation Platform for Financial Institutions

Final Course Project submitted to the Institute of Technology and Leadership (INTELI), to obtain a bachelor's degree in Computer Science

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Epigraph

> Automation applied with responsibility is not about replacing judgment, but about enhancing fairness, precision, and trust.

Resumo

Tavares, Iago. AI-Driven Trade Allocation and Validation Platform for Financial Institutions. 2025. Final Course Project (Bachelor) – Software Engineering, Institute of Technology and Leadership, São Paulo, 2025.

This final course project presents the development of an artificial intelligence–based platform designed to automate the allocation and validation of financial trades in investment management environments. The study addresses operational inefficiencies and risks arising from manual trade allocation and recap processing, which often result in allocation distortions, compliance issues, and delays in decision-making. The proposed solution integrates natural language processing, business rule validation, and mathematical optimization techniques to ensure fair, transparent, and efficient distribution of trades across investment funds. The system architecture combines large language models for data extraction, deterministic validation rules, and optimization algorithms to generate standardized, auditable outputs compatible with existing institutional infrastructures. The methodology follows an applied, project-based approach aligned with corporate requirements, including prototyping, testing, and performance evaluation. Results indicate a significant reduction in operational errors and processing time, as well as improved allocation accuracy and governance. The project demonstrates that intelligent automation can enhance reliability and regulatory compliance in financial operations while supporting scalability and future integration.

Palavras-Chave: artificial intelligence; trade allocation; financial automation; optimization algorithms; compliance.

ABSTRACT

Tavares, Iago. AI-Driven Trade Allocation and Validation Platform for Financial Institutions. 2025. Final Course Project (Bachelor) – Software Engineering, Institute of Technology and Leadership, São Paulo, 2025.

This final course project presents the development of an artificial intelligence–based platform aimed at automating trade allocation and transaction validation in financial institutions. Manual allocation processes are prone to human error, inefficiencies, and compliance risks, particularly in environments with high transaction volumes and strict regulatory requirements. The proposed solution integrates natural language processing for recap ingestion, deterministic business rules for validation, and mathematical optimization models to ensure fair and efficient allocation of trades across multiple investment funds. The system was designed as a scalable micro-SaaS solution, compatible with existing institutional infrastructures and capable of generating standardized, auditable outputs. An applied methodology was adopted, encompassing system specification, development, testing, and performance evaluation. The results demonstrate measurable improvements in processing speed, allocation accuracy, and operational transparency. The project concludes that the application of artificial intelligence and optimization techniques can significantly enhance governance, reduce operational risks, and support strategic decision-making in financial market operations.

Key words: artificial intelligence; trade allocation; financial markets; optimization; automation.

Summary

1 Introduction

1.1. Partner Company Context:

The financial services sector is characterized by high transaction volumes, strict regulatory oversight, and the need for precision in operational processes. Asset management firms and trading desks are responsible for allocating trades across multiple investment funds, custodians, and portfolios, ensuring fairness, transparency, and compliance. The affected area in this context is the trade operations and back-office processing department, which plays a critical role in ensuring that executed trades are correctly distributed and recorded.

The motivation for this project lies in the strategic importance of reducing operational risk and improving efficiency in trade allocation workflows. As financial institutions grow in scale and complexity, manual processes become increasingly inadequate, exposing organizations to errors, rework, and regulatory scrutiny.

1.2. Problem Definition (Corporate Pain Point):

The manual processing of trade recaps and allocation decisions constitutes a significant corporate pain point within financial institutions and asset management environments. These processes depend heavily on human interpretation of recap files, manual validation of transactional data, and discretionary decision-making when distributing trades across multiple funds and portfolios. As transaction volumes increase and operational complexity grows, such reliance on manual workflows becomes increasingly inefficient and difficult to scale.

Operational errors commonly observed in this context include incorrect quantities, mispricing, inconsistent or missing timestamps, duplicated records, and misallocation between funds. These failures may lead to financial distortions, inaccurate fund performance attribution, breaches of internal governance policies, and exposure to regulatory non-compliance. Furthermore, the absence of standardized and

automated procedures often results in fragmented audit trails, increasing the effort required by compliance and risk teams to validate operational integrity.

Baseline metrics in these environments typically reveal extended end-to-end processing times, elevated error and rework rates, and a strong dependence on manual reconciliation activities performed by back-office teams. Collectively, these factors hinder scalability, reduce transparency, compromise governance, and increase both operational and regulatory risk, particularly in scenarios involving high transaction frequency and market volatility.

1.3. **Proposed Solution and Expected Contribution:**

To address the identified challenges, this project proposes the development of an artificial intelligence–driven platform designed to automate the ingestion, validation, and allocation of trade recaps. The proposed solution integrates natural language processing techniques to interpret semi-structured recap data, deterministic business rules to ensure transaction integrity, and optimization algorithms to allocate trades across funds according to predefined criteria and real-time pricing information.

The expected contributions of the solution include a substantial reduction in end-to-end processing time, a measurable decrease in allocation and validation errors, and increased operational consistency. By generating standardized outputs and maintaining detailed audit trails, the platform enhances transparency, supports governance practices, and facilitates compliance with regulatory requirements. Additionally, the solution is designed to be scalable and adaptable, enabling financial institutions to accommodate growing transaction volumes without a proportional increase in operational complexity or risk.

1.4. **Business Objectives:**

The primary business objectives of this project are to automate the trade allocation process and significantly reduce reliance on manual intervention, thereby minimizing operational risk and human error. The solution aims to improve allocation accuracy and fairness, ensuring that trades are distributed consistently according to predefined business rules and optimization constraints.

Additional objectives include strengthening regulatory compliance through improved traceability and auditability, increasing overall process efficiency, and enhancing decision-making capabilities. From a strategic perspective, the project seeks to deliver a scalable and integrable platform that can be seamlessly incorporated into existing institutional systems, supporting long-term operational sustainability and enabling future technological evolution.

1.5. **Structure of the thesis/dissertation:**

This work is structured into three main chapters. The first chapter presents the organizational and business context, defines the corporate problem addressed by the project, and outlines its objectives and expected contributions. The second chapter focuses on solution development, detailing the applied rationale, technical specifications, architectural decisions, and system implementation process. The final chapter analyzes the results and business impact of the proposed solution, discusses critical success factors and lessons learned, and presents conclusions and recommendations for future improvements.

2 Solution Development

2.1 Applied Rationale

2.1.1 Business Area Rationale:

Trade allocation is a core operational process in asset management and financial institutions, directly influencing fund performance, investor confidence, and regulatory compliance. Inaccurate or delayed allocations may generate distortions between funds, expose institutions to compliance breaches, and negatively affect governance and transparency. As transaction volumes increase and portfolios become more complex, manual allocation processes struggle to scale and maintain consistency.

Market best practices in the financial sector increasingly emphasize automation, traceability, and auditability. Automated trade processing reduces dependency on human intervention, minimizes operational risk, and enables near real-time decision-making. Furthermore, regulatory bodies expect institutions to maintain clear audit trails, standardized procedures, and demonstrable controls over allocation logic. In this context, the adoption of intelligent and automated allocation mechanisms is aligned with industry trends and strategic objectives focused on efficiency, risk mitigation, and governance enhancement.

2.1.2 Technological rationale for the solution:

The proposed solution leverages artificial intelligence and optimization techniques to address the intrinsic complexity of trade allocation processes. Natural language processing (NLP) is employed to interpret and structure recap data, which is often semi-structured or unstructured and received through heterogeneous sources. Large language models enable flexible and resilient extraction of critical transaction fields, even in the presence of formatting variations or incomplete information.

In parallel, mathematical optimization algorithms are used to determine the most appropriate allocation of trades across funds, considering predefined constraints such as quantities, prices, allocation rules, and fairness criteria. This combination ensures that decisions are not only automated but also optimal and consistent with business logic. The integration of AI-driven data extraction with deterministic optimization provides both adaptability and precision, making the solution suitable for complex financial environments.

2.1.3 **Fundamentals of Management and Development Methods:**

The project was conducted following agile development principles, emphasizing iterative delivery, continuous validation, and close collaboration with stakeholders. The work was structured into short development cycles (sprints), each delivering incremental functionality that could be evaluated and refined based on feedback.

Best practices from software engineering and project management were applied to ensure alignment with corporate standards. These practices included requirements prioritization, version control, documentation, and risk management. The agile approach enabled early identification of technical and business constraints, reduced development risk, and ensured that the final solution addressed real operational needs.

2.2 **Specification and Development**

2.2.1 **Requirements and Specifications:**

The system was specified based on both functional and non-functional requirements derived from the business context. Functional requirements included the ability to ingest recap data from multiple sources, validate transaction information according to

business rules, perform optimization-based trade allocation, and generate standardized outputs compatible with downstream systems.

Non-functional requirements focused on aspects critical to corporate environments, such as data security, scalability, performance, reliability, and regulatory compliance. These requirements guided architectural decisions and technology selection, ensuring that the solution could operate within institutional constraints and support future growth.

2.2.2 **Architecture and Technology:**

The solution architecture follows a modular, service-oriented design, enabling flexibility and ease of integration. Core components include data ingestion services responsible for receiving and normalizing input data, AI processing modules for information extraction and validation, optimization engines for allocation decision-making, and reporting layers for output generation and auditability.

Communication between components is achieved through well-defined APIs, facilitating integration with existing systems in the company's IT ecosystem. This architectural approach supports scalability, maintainability, and the independent evolution of system modules, which is essential in dynamic corporate environments.

2.2.3 **Development and Implementation (MVP):**

A minimum viable product (MVP) was developed using an incremental and iterative approach. The MVP focused on delivering end-to-end functionality, from recap ingestion to allocation output, while maintaining robustness and traceability. Integration and pilot testing were conducted in a controlled environment to validate system behavior and identify improvement opportunities before broader adoption.

Emphasis was placed on logging, monitoring, and data traceability to ensure that all automated decisions could be audited and explained. This focus is particularly important in financial contexts, where transparency and accountability are critical.

2.2.4 **Testing and Technical Evaluation:**

Comprehensive testing strategies were applied to evaluate both technical correctness and operational suitability. Unit tests were used to validate individual components, such as data parsing and optimization logic. Integration tests ensured that system components interacted correctly across the full processing pipeline.

Performance evaluations assessed system responsiveness and stability under realistic workloads. The results confirmed that the solution met the defined technical and operational requirements, demonstrating its suitability for deployment in corporate financial environments.

2.3 Assessment of Impact and Contribution to the Business

2.3.1 **Defining Corporate Success Metrics:**

To objectively evaluate the effectiveness of the proposed solution, a set of corporate success metrics was defined in alignment with the business objectives established in the introduction. The primary key performance indicators (KPIs) included: (i) reduction in trade processing time, measured from recap ingestion to final allocation output; (ii) decrease in operational error rate, encompassing misallocations, missing fields, and validation failures; and (iii) allocation accuracy, assessed by comparing automated allocation results with expected outcomes based on predefined business rules and optimization constraints. Secondary indicators included system availability, reprocessing rate, and qualitative feedback from operational users regarding usability and trust in automated decisions.

2.3.2 **Results and Impact Analysis:**

The implementation of the AI-driven trade allocation platform demonstrated significant quantitative and qualitative impacts on business operations. From a quantitative perspective, the automated workflow substantially reduced end-to-end processing time when compared to the manual baseline, enabling near real-time allocation decisions and minimizing delays caused by human intervention. The error rate associated with trade allocation and recap validation was notably reduced, contributing to improved data reliability and lower rework demands on operational teams.

From a qualitative standpoint, the solution enhanced transparency and governance across the allocation process. Standardized outputs, audit trails, and rule-based validations increased confidence among managers, compliance teams, and stakeholders. Additionally, the adoption of optimization algorithms ensured fairer distribution of trades among funds, reinforcing internal governance principles and aligning operational practices with regulatory expectations.

2.3.3 **Cost-Benefit Analysis:**

The cost-benefit analysis considered both direct and indirect costs associated with the development and deployment of the solution. Direct costs included software development effort, cloud infrastructure usage, and licensing or API consumption related to artificial intelligence services. Indirect costs involved training, change management, and initial integration efforts with existing systems.

These costs were outweighed by operational savings achieved through reduced manual labor, lower error correction efforts, and mitigation of compliance and financial risks. The automation of critical processes decreased dependency on manual reconciliation, allowing operational teams to focus on higher-value analytical tasks. As a result, the project demonstrated a positive return on investment (ROI), with financial benefits derived not only from cost reduction but also from risk avoidance and improved decision quality.

2.3.4 **Critical Success Factors and Lessons Learned:**

Several critical success factors contributed to the successful implementation and impact of the solution. Strong stakeholder engagement throughout the project lifecycle ensured alignment between technical development and business needs. Clearly defined business rules and success metrics provided a solid foundation for system validation and user acceptance. Moreover, the adoption of a robust and modular technical architecture facilitated scalability, maintainability, and future integration with other institutional systems.

Key lessons learned include the importance of early involvement of operational and compliance teams to foster trust in automated decisions, as well as the need for transparent and explainable logic in AI-assisted financial systems. Incremental delivery and continuous testing proved essential in mitigating risks and ensuring that the solution evolved in accordance with real-world operational constraints.

3 Conclusion

This project achieved its objectives by delivering an AI-driven solution that automates and optimizes trade allocation processes in financial institutions. The results demonstrate meaningful operational improvements, reduced risk, and enhanced compliance. Future work includes expanding the solution to additional asset classes, improving model explainability, and scaling the platform for broader institutional adoption.

References

PRESSMAN, R. S.; MAXIM, B. R. Software Engineering: A Practitioner's Approach. 9th ed. Porto Alegre: AMGH, 2021.

BASS, L.; CLEMENTS, P.; KAZMAN, R. Software Architecture in Practice. 4th ed. Boston: Addison-Wesley, 2022.

Appendices

Additional technical documentation and code excerpts developed by the author.

Annexes

Supporting documents and reference materials not authored by the student.