Enhancing Asset Purchase Compliance through AI-Driven Analysis

Authors: *Giovanna Duarte and Paulo Machado.*

Introduction

Regulatory compliance is a crucial pillar for the success and sustainability of investment funds. In Brazil, regulations imposed by the Securities and Exchange Commission (CVM), such as Resolution 175, set strict guidelines that must be followed to ensure that funds purchase only permitted assets. However, interpreting and applying these rules can be complex and prone to human error, particularly when dealing with a large volume of assets and funds.

With the advancement of Artificial Intelligence (AI) and the availability of sophisticated language models, there is an opportunity to automate and enhance the compliance verification process. This work presents an innovative solution to automate compliance analysis in the asset purchase process for investment funds, using AI to interpret regulations and fund prospectuses.

Project Overview

The primary goal of this project is to develop an automated system capable of determining whether a mutual fund can legally purchase a specific asset, in accordance with Brazilian financial regulations. This system leverages a range of AI models and tools to meticulously analyze regulatory documents, fund prospectuses, and asset data. By integrating these technologies, the system aims to provide a comprehensive and accurate compliance assessment, ensuring that investment decisions are made with full adherence to regulatory standards. The project combines state-of-the-art natural language processing models with specialized tools to handle complex legal and financial information, thus enhancing the efficiency and reliability of the compliance verification process.

Tests and Execution

Tests were conducted using a database of real assets and funds. For each combination of fund and asset, the system was executed in four distinct modes:

- **Simple Prompt:** Using the GPT-4 model to generate responses directly.
- **Agents Without Specific Tools:** Utilizing agents without additional research resources.
- **Agents with Specific Tools:** Integrating specific tools such as regulation search and PDF reading.
- **RAG:** Implementing the RAG method to enhance the model's responses by retrieving relevant regulatory information from external databases before generating the final output. This approach aimed to improve accuracy by providing contextually rich data to the model.

The results were stored in an Excel file, allowing for a comparative analysis of the performance of each approach.

Time Performance Evaluation

The time performance of each method was evaluated by measuring the average execution time over six consecutive days, with timing recorded using the *time.monotonic()* function.

	Avg Time						
	21/08/2024	22/08/2024	23/08/2024	24/08/2024	25/08/2024	26/08/2024	Average Model
Simple Prompt	1,671	1,976	2,190	1,983	2,533	1,948	**2,050**
Agent With No Tools	27,189	22,270	23,342	21,406	24,414	30,164	**24,798**
Agent With Tools	46,339	55,517	81,664	50,890	178,398	99,186	**85,332**
RAG	46,343	51,785	42,421	44,837	49,229	47,215	**46,972**

The findings clearly illustrate a trade-off between the simplicity and speed of the Simple Prompt method and the enhanced capabilities, albeit at the cost of longer execution times, of the more complex methods such as Agent With Tools and RAG. While Simple Prompt method is optimal for scenarios requiring rapid and straightforward responses, the other methods, despite their slower processing times, demonstrate a larger capacity in extracting and synthesizing information from a broader array of external sources.

Costs

The cost analysis highlights significant variations in the financial resources needed to run the models. The Simple Prompt method, at $0.03 per 20 executions, is the most cost-effective and the fastest. However, as the complexity of the methods increases, so does the cost. For example, the Agent No Tools method costs $1.38 per 20 executions, due to higher computational demands. The RAG models, which incorporate external information sources, range from $0.20 to $1.03, offering a balance between cost and the comprehensiveness of data captured.

Results and Observations

The accuracy of the models was evaluated on six different dates, and several key insights emerged:

- **Regulatory Capture Ability:** The models demonstrated a rather generalist approach in capturing Brazilian regulations and fund prospectuses, even when these sources were integrated as tools and research references.
- **Impact of the "Shelter" Name**: The name "Shelter" in the funds EQUITAS SHELTER and DRYS SHELTER PREV significantly impacted the results. In nearly all instances, none of the models tested were able to correctly identify the associated fund, even when the corresponding prospectus was included.
- **Hallucinations and Response Variations:** Numerous instances of hallucinations were observed across the tests, even within the same model. Responses exhibited considerable variations, as seen in the interpretation of terms like "stocks" versus "PETR4." Additionally, the system produced erroneous answers, such as the incorrect assertion that DRYS SHELTER PREV could not purchase "Compromissadas," falsely stating that the fund was restricted to investing in low-barrier shelters for cattle and Dry Deck Shelters (DDS) for US Navy submarines.

Below are the accuracy percentages of the models evaluated on different dates.

Simple Prompt							Average
Fund Name	21/08/2024	22/08/2024	23/08/2024	24/08/2024	25/08/2024	26/08/2024	
TREND DI	80%	100%	100%	100%	80%	100%	93%
SHELTER	40%	40%	20%	20%	40%	80%	40%
SHELTER PREV	40%	40%	40%	40%	60%	20%	40%
SELECTION	-	80%	100%	100%	80%	100%	92%

Agent with No Tools							
Fund Name	21/08/2024	22/08/2024	23/08/2024	24/08/2024	25/08/2024	26/08/2024	
TREND DI	80%	40%	40%	80%	100%	100%	73%
SHELTER	40%	60%	80%	60%	60%	60%	60%
SHELTER PREV	60%	40%	40%	60%	40%	40%	47%
SELECTION	-	80%	80%	80%	100%	60%	80%

Agents with Tools							
Fund Name	21/08/2024	22/08/2024	23/08/2024	24/08/2024	25/08/2024	26/08/2024	
TREND DI	80%	40%	40%	40%	100%	20%	53%
SHELTER	0%	60%	60%	40%	60%	20%	40%
SHELTER PREV	60%	20%	40%	60%	60%	60%	50%
SELECTION	-	80%	80%	80%	60%	100%	80%

RAG							
Fund Name	21/08/2024	22/08/2024	23/08/2024	24/08/2024	25/08/2024	26/08/2024	
TREND DI	80%	80%	60%	80%	60%	100%	77%
SHELTER	20%	60%	60%	60%	60%	20%	47%
SHELTER PREV	80%	20%	40%	60%	80%	80%	60%
SELECTION	-	60%	60%	40%	100%	60%	64%

We observed that the TREND DI, a fixed-income fund, and EQUITAS SELECTION, a well-known equity fund, produced the most consistent results across the evaluations.

During the evaluation period, we thoroughly examined the reasoning behind each response generated by the models. On average, the accuracy of the responses was below 50%, despite the provision of regulatory tools and specific investment fund regulations. This outcome reveals substantial difficulties that the models encounter in interpreting Brazilian investment fund regulations and understanding the characteristics of the tested assets relative to the American market.

This analysis highlights the complexities involved in applying AI to the Brazilian regulatory environment, where local legislation and market conditions present significant challenges that current models have yet to fully grasp.

Conclusion

The AI-driven compliance system represents a notable advancement in ensuring regulatory adherence for mutual fund asset purchases. By incorporating state-of-the-art tools and advanced AI models, the system enhances the precision of compliance assessments and streamlines the process, making it more efficient. This progress signifies a major step forward in automating complex regulatory evaluations, which previously demanded extensive manual effort.

Looking ahead, future developments will focus on refining the AI models and expanding the system's capabilities to address additional regulatory scenarios and incorporate more nuanced aspects of compliance. These improvements aim to ensure that the system remains at the forefront of regulatory technology, continuously enhancing its effectiveness in navigating the evolving landscape of financial regulations.