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Toward Automated Compliance Checking of Fund Activities Using Runtime Verification Techniques

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ABSTRACT

Fund activities such as subscriptions or redemption of shares to issuers, fee management, and acquisition or sale of holdings may affect the fund's compliance to requirements of different sources (legal, regulatory but also self-imposed requirements) with potentially huge impact such as hefty fines. One pressing challenge for fund managers and regulators is to target live monitoring of such activities in order to evaluate compliance as soon as possible and in a continuous way. Setting the rules for automatic monitoring and checking the compliance of fund activities is difficult due to the complexity and heterogeneity of the applicable requirements and the observability of data. In this position paper, we introduce our vision toward runtime monitoring of fund activities. Specifically, we aim at extracting monitoring rules from legislation and fund documentation and at providing automated support for enabling the runtime verification of fund activities.

KEYWORDS

FinTech, fund monitoring, runtime verification, information extraction

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1 INTRODUCTION

Monitoring fund activities (e.g., the subscription of shares or portfolio composition) is essential to protect the rights of investors and fight financial crime (e.g., fraud and money laundering). This monitoring is done by overseeing and supervising financial transaction records in relation to two major sources of requirements: (a) financial regulations, i.e., legislative texts that provide the regulatory framework for the overall fund activities and (b) fund documents, written by fund managers in compliance with applicable law such as the European Prospectus regulation (2017/1129) [6], which specify additional restrictions and rules of conduct for the fund itself.

Evaluating the compliance of investment funds is one of the most costly activities and remains a manual activity achieved through audits and reporting. One pressing challenge is to enable continuous monitoring and compliance checking of fund activities. However, monitoring fund activities is challenging and error-prone, especially due to (i) the complexity of financial regulations and fund documents, (ii) the distinct characteristics of each individual fund, and (iii) the dynamic nature of regulatory documents that frequently change across time, demanding for tailored monitoring solutions.

To illustrate, consider the following simplified example describing the fund monitoring process against (a) the investment limits set out in the European UCITS Directive [5] and (b) investment constraints listed in the fund's investment policy from which the fund should not deviate. Regarding (a), according to Article 52 of the Directive, "A fund shall not invest more than 5% of its assets in 'transferable securities' or 'money market instruments' issued by the same 'issuer' ". To evaluate this rule, run-time monitoring involves verifying a data-aware assertion that checks whether the sum of all investments on assets from the same issuer does not surpass the threshold of 5%. Regarding (b), depending on the type of funds and their investment policies, assets that a fund can invest in can be restricted, e.g., "the main investment exposure is at least 67% of assets invested that are domiciled in the US". In such case, the monitoring would need to verify that the fund assets fulfill the conditions of domicile (a data-aware assertion) and minimal quantity (an aggregation-based assertion using a counting operator).

In this position paper, we introduce our vision of applying runtime verification techniques for monitoring fund activities. To address the above challenges, we define two main objectives: **(O1)** AI-based extraction of relevant information and intermediate semantic representation of monitoring rules from financial regulations and fund documents; **(O2)** automated monitoring and verification of financial transaction records against the requirements extracted from the regulations and documents. To achieve these objectives, we plan to leverage a combination of Natural Language Processing (NLP) [4], Machine Learning (ML) [1] and runtime verification (RV) [2] techniques. This work is part of a multi-disciplinary project where we contribute with our expertise in software engineering and join hands with experts from the financial and legal domains.

The main hypothesis of the project is that the fund activities can be seen as an abstract business process whose execution can be logged and monitored with respect to requirements derived from financial regulations and fund documents. The project will study this hypothesis by investigating the following research questions

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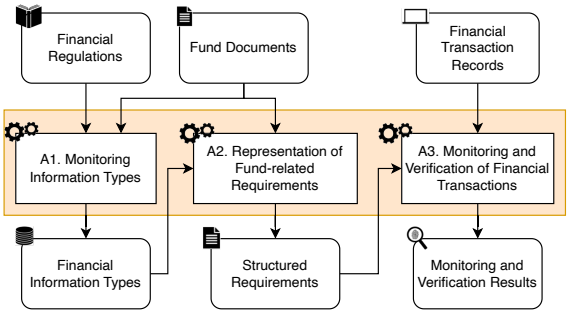

Figure 1: Our vision toward automated compliance checking of fund activities using runtime verification techniques

(**RQs**): **RQ1:** Which information types should be extracted from financial regulations and documents to enable the monitoring of fund activities? **RQ2:** How to capture and formally express monitoring requirements on fund activities? **RQ3:** How to verify requirements on fund activities by analyzing financial transaction records?

2 RESEARCH AGENDA

Methods and Approach. To achieve the objectives introduced earlier in the paper, we plan to conduct three key activities, whose relationships are depicted in Figure 1 and elaborated below.

(A1) Information extraction from financial regulations and fund documents. Financial regulations and documents such as prospectuses or Key Information Documents describe, in natural language, the requirements for executing fund activities [7]. We plan to develop an automated solution for extracting different information types from the fund-related requirements. Information types can be numeric (such as fees or ratios), temporal (e.g., initial subscription), sequence-based (e.g., the order in which transactions take place), and profiling-related (e.g., the nationality of the subscriber, industrial sectors, regional investments). In (A1), we will create a model that describes the elements pertinent to monitoring of fund activities and develop an automated solution using a combination of NLP and ML for extracting the relevant information.

(A2) Creating semantic representations of the fund-related requirements. This activity is concerned with transforming the natural language requirements into a formal representation (e.g., metric first-order temporal logic [3]). In (A2), we plan to devise AI-based techniques for extracting the textual requirements and specifying the monitoring rules needed for monitoring fund activities (e.g., computational instructions). Activities (A1) and (A2) will contribute to achieve our first objective.

(A3) Automated monitoring and verification of financial transaction records against requirements. This activity will contribute to achieve the monitoring and verification objectives of the project. First, we will assess the degree of observability of the input transaction records (e.g., reports made available to regulators, anonymous transaction records recorded by financial institutions, open financial information from data providers) by extracting the relevant information from the records using the information extraction approach developed in (A1) and log parsing approaches. For requirements that can be observed from the records, we will automatically generate monitors to efficiently verify if the given requirements are satisfied in the records using run-time verification techniques.

3 ONGOING AND FUTURE WORK

In the initial phase of the project, we chose to focus on requirements concerning the portfolio composition of UCITS funds since UCITS funds are arguably the most regulated type of funds and one of the most popular investment schemes in Europe. Our first task was to analyze and formalize the different types of holdings a fund can have within a conceptual model. To do so, we investigated the legislative landscape, in close collaboration with experts in finance, more particularly the UCITS (IV) Directive and its national transposing acts. In particular, we manually analyzed the provisions of Chapter VII of the directive, which describes the authorized investments of UCITS funds and extracted the terms we deemed relevant to represent information of the domain. More particularly, we focused on Article 50 of the directive, which describes the set of authorized investments and the conditions for a fund to be able to invest. From the elicited information and observations, we manually built the conceptual model. We then complemented the model with (1) information on holding types, retrieved from fund holdings data provided by some financial information provider, and (2) data from a qualitative study on 30 various funds' investment policies.

Future work includes devising (i) a logic-based representation for expressing the monitoring rules from the UCITS Directive and (ii) using NLP technologies to extract those requirements that are specific to each individual fund and expressed in its investment policies and transform them into the logic-based representation.

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