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INFINITECH Real-Time Risk Assessment Solution

Combining Deep Learning and Sentiment Analysis for Real-Time Risk Assessment of Complex Financial Portfolios

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George Fatouros

INNOV-ACTS LTD

John Soldatos

INNOV-ACTS LTD

Petra Ristau

JRC Capital Management Gmbh

Ernesto Troiano

GFT Italia Srl

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1. Introduction

1.1 Introducing Portfolio Risk Assessment

The risk of loss in trading or investing in securities can be substantial. According to [Basel III/IV](#), financial institutions should report accurate risk estimations for their investments. This is the reason why traders, investors and asset managers must assess the risk of the portfolios that they manage. A portfolio's risk indicates the probability that the combination of assets comprised by investments fails to meet the target financial objectives. In most cases, higher portfolio risks are associated with higher potential returns. Therefore, managing a portfolio's risk becomes a key ingredient for successful investing, trading, and asset management.

Nowadays, traders and portfolio investors are provided with a rich set of tools and services for assessing risks of various portfolios. Legacy risk assessment tools focus on estimating the risks of individual securities. In recent years, there are also tools that use more sophisticated statistical models (e.g., [GARCH \(Generalized AutoRegressive Conditional Heteroskedasticity\)](#)), which capture the volatility clustering of various assets on a portfolio level. Furthermore, there are services which offer quantitative risk management approaches to the assessment and control of portfolio risks. Some state-of-the-art tools use Machine Learning (ML) to identify all major risks in every asset or sub-asset, develop scenarios of each event, and to analyse the expected impact on current portfolio. In many cases such machine learning tools incorporate insights from alternative data, such as market sentiment. Market sentiment for specific investment firms and/or securities can be nowadays extracted from the vast amounts of textual data that are produced in news sites and social media.

Overall, machine learning and artificial intelligence are giving a significant boost to the automation and intelligence of portfolio risk assessment tools. However, most of the existing ML-based risk assessment tools do not process information in real time and hence cannot offer real time risk analysis insights. Therefore, traders and portfolio managers lack access to accurate risk information in real-time. For instance, many portfolio risk assessment services (re)calculated risk once a day, in batch mode, which makes them unsuitable for trading in high frequency markets such as Forex (FX). Likewise, most state-of-the-art tools are not capable of sufficiently monitoring risk exposures due to intraday price fluctuations. This can lead to considerable trading inefficiencies. Moreover, in real-time trading scenarios, traders and asset managers are confronted with the challenge of balancing between speed and accuracy. This is an issue in cases where close risk monitoring is a regulatory requirement. As a prominent example, the bank for International Settlements (BIS) penalizes financial institutions that utilize poor risk models.

1.2 The Market of Portfolio Risk Assessment Services

Portfolio risk assessment metrics such as for example VaR (Value at Risk) are very widely used in the finance and insurance sectors. These metrics are usually integrated in trading, investment, and asset management tools of the wealth management sector. The latter integrate different VaR calculations based on statistical methods including the historical method, the Variance-Covariance method and the Monte Carlo Simulation method. Beyond

these classical methods, there are also ML-based methods that tend to be more accurate, while being appropriate for high frequency financial transactions (e.g., FOREX (FX) trading).

According to AlliedTelesis the global risk management market size was valued at \$7,39 billion in 2019, and is projected to reach \$28,87 billion by 2027. This forecast indicates a notable growth at a Compound Annual Growth Rate (CAGR) of 18.7% for the specified period. This growth considers the risk management market across various sectors, including manufacturing, retail, healthcare, energy & utilities, government, and public administration, as well as banking, finance, and insurance. The latter segment is expected to experience the highest growth, due to the increasing adoption of risk management software by banks and other financial institutions.

The scope of risk management tools for finance and insurance spans across multiple application areas, including credit risk, liquidity risk, money laundering risks, cybersecurity risks, compliance risks, as well as investment and trading risks. These tools address many different types of financial institutions, such as banks, regulators, fintechs, investment firms, asset managers and more. The latter include several firms that engage in high-frequency trading, using either their own trading platform or some third-party trading platform. It is estimated that the European market includes tens of high-frequency trading firms, which serve many hundreds of firms as their users/partners.

2. The INFINITECH Real Time Risk Assessment

2.1 Overview

The INFINITECH project provides a novel service for real-time risk assessment and monitoring of financial portfolios. The service supports traders and asset managers in their portfolio risk assessment decisions. It implements and calculates popular portfolio risk metrics (e.g., VaR and Expected Shortfall (ES)) nearly in real-time and with very high accuracy. The latter features are empowered by novel deep learning model for VaR/ES which are conveniently called DeepVaR techniques.

From a functional perspective, the service provides traders with pre-trade analysis capabilities which enable the credible estimation of changes in risk measures before a new trading position is entered. Moreover, the service implements and integrate a market sentiment-based decision support indicator, which is derived from financial and economic news data. This enables traders to consider market sentiment information in their risk estimations.

Figure 1, provides an overview the risk analytics pipeline of the INFINITECH real time risk assessment service. The service operates in a data driven way, leveraging historical data about asset prices, as well as alternative data which empower the sentiment analysis functionalities. It combines information from the statistical properties of the portfolio, the market sentiment and various pre-trade analysis scenarios towards calculating risks using the DeepVaR approach. Trades that yield acceptable risk levels are executed and accordingly monitored at real-time. Real-time information is then used to reassess the risk and adapt the trading actions accordingly.

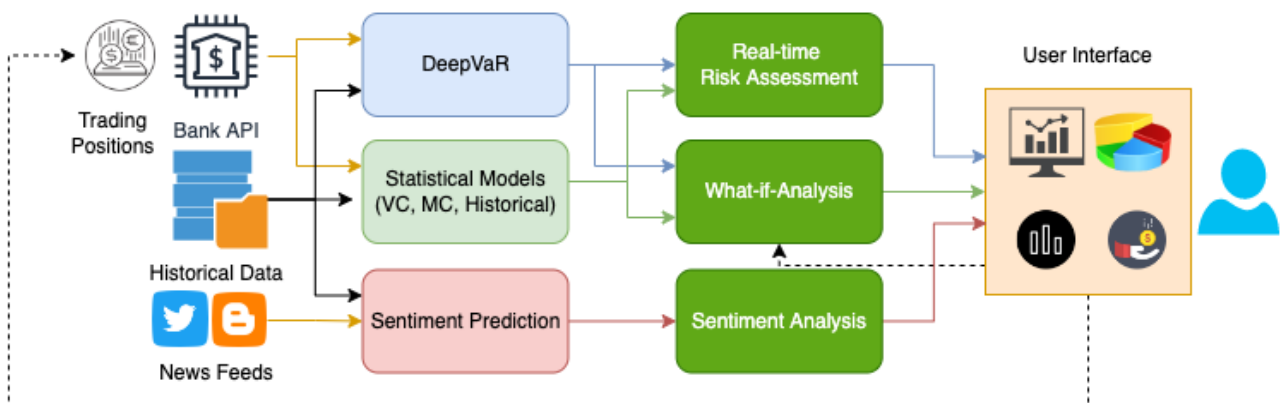


Figure 1: INFINITECH Real-Time Risk Assessment Pipeline

2.2 Solution Features and Value Proposition

The INFINITECH real-time portfolio risk assessment service offers the following novel and unique value propositions:

- **High Accuracy:** The service offers increased accuracy in the risk calculations. This is due to the use of a VaR model based on a deep neural architecture rather than conventional simple econometric models. The service provides valid risk estimations

with fewer VaR breaches, which can enable traders and asset managers to optimize the level of reserve capital.

- **Real-Time Operation:** Risk estimations are updated in real time as the service collects, handles, and process the most recent data available. Risk estimations are based on valid data and enable quicker reactions. This provides traders and asset managers with opportunities for dynamically adjusting the portfolio composition.
- **Market Sentiment Integration:** The service considers the ever-important market sentiment, based on analysis of financial news using novel transfer learning techniques. When the market sentiment feature is on, the service offers it as a extra risk indicator beyond quantitative risk metrics.

2.3 INFINITECH Technology

The value-added features of the service are empowered by the following technological innovations of the INFINITECH project.

2.3.1 The DeepVaR Algorithm

The DeepVaR algorithm utilizes RNNs (Recurrent Neural Networks) to produce probabilistic forecasts in the form of Monte Carlo samples. Therefore, it computes consistent quantile estimates in a certain prediction horizon. The algorithm is fed simultaneously with several similar time series, which enables cross-learning between them. This facilitates the consideration of the correlations between different assets of a portfolio.

DeepVaR can be trained very fast, which ensures its applicability in intra-day VaR estimation scenarios. Moreover, the DeepVaR implementation leverages a continuous learning approach, which makes provisions for the dynamic nature of financial data. In this way the service avoids bias and drift, while capturing serial correlations between VaR estimations and clustered VaR violations. Extensive back-testing proves that DeepVaR outperforms other well-established risk models with the benefits being more evident during turbulent periods in the financial markets. For instance, Figure 2 illustrates DeepVaR performance against VaR calculations based on the popular GARCH statistical model, when tested over 1000 different FX portfolios during Covid-19 expansion (March 2020).

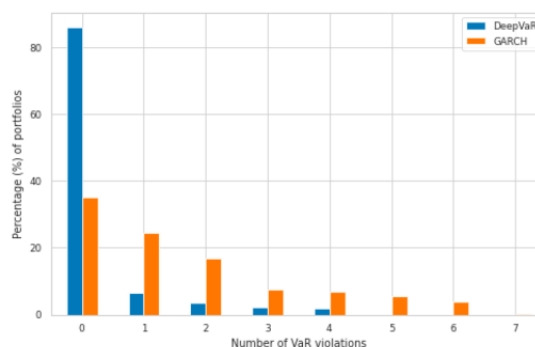


Figure 2: INFINITECH DeepVaR Outperforms the GARCH Method during high volatility in financial markets

2.3.2 Financial Sentiment Analysis

The Sentiment analysis functionalities of the solution are based on transfer learning and take advantage of the [FinBERT model](#). FinBERT is a pre-trained NLP (Natural Language

Processing) model that analyses sentiment of financial texts. It is built by further training the BERT language model in the finance domain, using a large financial corpus. In this way, the BERT model is fine-tuned for financial sentiment classification.

2.3.3 Real-Time Data Management

The INFINITECH real time risk assessment solutions leverage the INFINISTORE big data database backed by [LeanXcale](#). It enables real-time analytical processing over operational data. INFINITECH store provides a novel data management layer, which offers online data aggregation and integrated query processing for data in-flight and at-rest. This layer offers also automated storage of high frequency data streams leveraging an [Apache Kafka queue](#) infrastructure as illustrated in Figure 3.

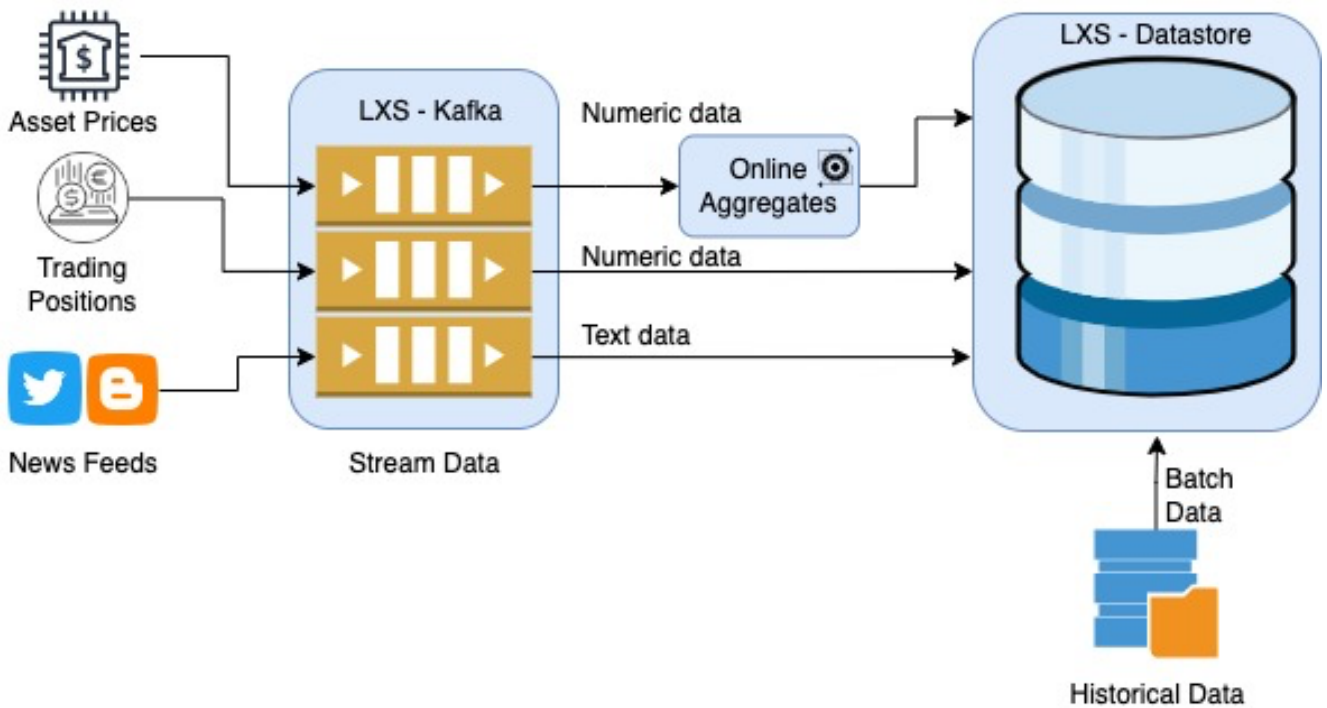


Figure 3: LeanXcale's Big Data services Empower Real-Time Data Management

3. Accessing the INFINITECH Risk Assessment Solution

3.1 Service Models

We offer the portfolio risk management solution based on two models:

- **Licensed Model:** This model enables third parties to license our risk assessment solution. The licensed solution comes with a range of complementary business services including training and integration support. It is an ideal model for digital finance solution integrators who wish to integrate an accurate and real-time portfolio risk assessment solution within their own products and services.
- **Pay-Per-Use Model:** This model enables asset managers, digital finance solution developers and other stakeholders to access our solution as a service. It comes with a flexible pay-per-use models that involves a minimal upfront fee and a pay-per-use fee. The latter scales according to the usage of the service i.e., the risk assessment requests fulfilled, and the data points produced.

This dual access model provides flexibility to potential users and helps them adapt the risk assessment functionalities to their deployment needs.

For more information on licensing, pricing and use issues, please contact us at: innov@infinitech-h2020.eu

3.2 Free Version of the Risk Assessment Solution

A free open-source version of the solution is available through the INFINITECH marketplace. To access this version please follow the steps below:

- Register to the marketplace at: <https://marketplace.infinitech-h2020.eu/login>
- Browse through assets at: <https://marketplace.infinitech-h2020.eu/assets> and locate assets associated with the risk assessment solution:
 - The “[DeepVaR: Value-at-Risk prediction leveraging Deep Learning](#)” component, which is an implementation of the DeepVaR algorithm that is available as a Data Science notebook.
 - The “[Sentiment Analysis in Financial News](#)” component, which is available as a Docker container.

You can also:

- Access INFINITECH trainings, how-to-videos and other training resources through the training catalogue at: <https://marketplace.infinitech-h2020.eu/vdih/training/courses>

4. Complementary Resources & More Information

Stay up to date about the INFINITECH solutions, assets and services through:

- Visiting the INFINITECH project web site: <https://www.infinitech-h2020.eu/>
- Subscribing to the INFINITECH YouTube Channel: <https://www.youtube.com/channel/UCIVeOyQyljdCpL51GSPa7Zg>
- Subscribe to the INFINITECH Newsletter at: <https://www.infinitech-h2020.eu/contact-us>
- Registering to INFINITECH Marketplace: <https://marketplace.infinitech-h2020.eu/>
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