

The logo for RADemics, featuring the text "RADemics" in white on a blue arrow-shaped background pointing to the right. The arrow is part of a larger blue horizontal bar that is positioned over a dark blue vertical bar on the left side of the slide.

RADemics

Financial Data Science with Machine Learning: From Fraud Prevention to Stock Forecasting

A decorative graphic consisting of several thin, curved lines in shades of blue and grey, originating from the bottom left and extending upwards and to the right, resembling stylized grass or reeds.

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Financial Data Science with Machine Learning: From Fraud Prevention to Stock Forecasting

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Abstract

Financial systems are increasingly driven by high-volume, high-velocity, and heterogeneous data streams, presenting both opportunities and challenges for advanced analytical methods. Machine learning has emerged as a transformative tool for enhancing financial decision-making across multiple domains, including fraud detection, credit risk assessment, stock price forecasting, and algorithmic trading. This chapter provides a comprehensive exploration of machine learning frameworks applied to financial data, emphasizing adaptive, real-time, and explainable modeling techniques. Advanced methods for volatility estimation, risk-adjusted performance evaluation, and reinforcement learning-based trading are examined, alongside scalable big data infrastructures and secure, privacy-preserving analytics platforms. Practical considerations, such as regulatory compliance, model validation, and ethical AI deployment, are integrated to ensure robust and responsible financial intelligence. The chapter concludes with emerging research directions, highlighting multimodal data fusion, federated learning, and AI-driven autonomous financial systems. This work establishes a unified perspective on leveraging machine learning to optimize financial analytics while addressing operational, regulatory, and ethical constraints.

Keywords: Financial Data Science, Machine Learning, Fraud Detection, Stock Forecasting, Credit Risk Modeling, Algorithmic Trading.

Introduction

Financial systems have undergone a profound transformation over the past decade due to rapid digitalization, the proliferation of online banking platforms, high-frequency trading infrastructures, and the emergence of fintech and decentralized finance ecosystems [1]. These developments have generated massive volumes of transactional, market, and alternative datasets characterized by high velocity, heterogeneity, and dimensionality [2]. Traditional econometric and statistical models, which rely on assumptions of linearity, stationarity, and Gaussian distributions, struggle to capture the complex dependencies and dynamic structures present in modern financial data. Machine learning techniques, leveraging adaptive algorithms and data-driven insights, have therefore become central to financial analytics [3]. They enable automated detection of patterns, prediction of risk exposures, and optimization of decision-making processes, transforming the way financial institutions manage operational, market, and credit risks [4]. The increasing availability of real-time and high-frequency data has shifted analytical paradigms from retrospective analysis

to predictive and prescriptive frameworks capable of supporting instantaneous financial decisions [5].

Fraud detection has emerged as a critical area in financial systems due to the exponential growth of digital transactions and the increasing sophistication of fraudulent schemes [6]. Credit card fraud, identity theft, money laundering, and insurance fraud exploit minimal temporal gaps between transaction initiation and completion, demanding rapid and accurate detection mechanisms [7]. Machine learning algorithms provide the computational capacity to identify anomalous patterns in vast, streaming datasets while adapting to evolving fraudulent behaviors [8]. Real-time fraud detection systems utilize feature extraction, anomaly scoring, and graph-based modeling to uncover collusive networks and hidden threats [9]. These approaches reduce financial losses, preserve institutional credibility, and reinforce customer trust. Adaptive models that incorporate concept drift and online learning mechanisms ensure sustained detection performance under shifting market and behavioral conditions, creating robust financial crime analytics frameworks [10].