Application for Machine Learning Methods in Financial Risk Management

Runqing Liu*

York University, Toronto, Canada

*Corresponding author: 2016121569@jou.edu.cn

Abstract. Financial risk management has significant importance and implications for individuals, businesses, investors, and even the whole nation. As the financial markets and institutes grow complex so does the risk associated with financial management. The spectrum of financial risks includes market risk, liquidity risk, credit risk, and a range of others. With a multitude of portfolios and sophisticated products, financial firms require apt tools that can accurately measure the risk, returns, and exposure. The growing complexity has also made statistical and simulation tools ineffective and there is a growing emergence of machine learning. Machine learning is a sub-category of artificial intelligence that uses algorithms. These algorithms analyze data and then learn from it so that a decision based on a certain experience or criteria can be made. Machine language tools provide data protection as the information is only accessible to the key decision-makers. Deep learning is modeled like a human brain and therefore it operates using multiple layers of artificial networks and can process and use a very vast amount of data.

Keywords: Financial risk, Machine learning, risk management.

1. Introduction

In the financial field, financial risk management holds significant importance due to its potential impact on enterprises, investors, and the overall financial system. Risk Management role in ensuring financial stability cannot be understated, as it aids in risk mitigation and the prevention of severe disruptions within the financial market. The historical occurrence of financial crises has underscored the necessity of risk avoidance and highlighted the detrimental consequences of disregarding potential risks. Financial risk management plays a crucial role in assisting investors in safeguarding their investments and maintaining their financial well-being. Furthermore, for large businesses, effective financial risk management offers substantial support for their growth endeavors. This support may manifest through avenues such as financial backing.

Consequently, financial risk management assumes immense significance for individuals, businesses, and even entire nations. Nonetheless, it is essential to acknowledge that financial risk management presents numerous challenges. The spectrum of financial risks it addresses includes market risk, liquidity risk, credit risk, and a range of others. Addressing these diverse risks necessitates distinct identification and management strategies. For instance, the utilization of machine learning has the potential to enhance risk identification processes. The financial market's inherent volatility, stemming from the evolution of financial products and trading methodologies, underscores the need for adaptive risk management strategies. Notable examples of such evolution include the emergence of technologies like Apple Pay and WeChat Payment.

Given this rapidly evolving landscape, machine learning can provide a means of swift adaptation to change. Machine learning's growing maturity and its successful integration across various domains, such as healthcare, exemplify its capabilities. In the medical field, machine learning aids in the analysis of medical images through deep learning, improving cancer detection rates and enabling earlier diagnoses. Similarly, machine learning enhances sales efficiency by swiftly and accurately analyzing consumer needs. It also finds application in natural language processing, powering real-time translation and AI-driven dialogues. Moreover, in manufacturing, machine learning facilitates quality control and predictive maintenance, ultimately boosting production efficiency.

This essay will consider the achievements that underline machine learning's efficacy in addressing complex and large-scale data challenges. It will also elaborate on how financial risk management and machine learning present a promising avenue for more accurate and effective risk mitigation strategies.

2. Application of Machine Learning in Financial Risk Management

The field of financial risk management is essential in quantifying and managing risk. The role of financial risk management has grown with the increasing complexity of financial organizations. With a multitude of portfolios and sophisticated products, financial firms require apt tools that can accurately measure the risk, returns, and exposure. The growing complexity has also made statistical and simulation tools ineffective and there is a growing emergence of machine learning. Machine learning has found its application in many fields such as robotics, natural language processing, computer vision, and financial risk management. Machine learning is an interdisciplinary domain that integrates the knowledge of multiple domains including probability theory and algorithm complexity theory. The core of machine learning is artificial intelligence [1].

Events such as loan defaults, untimely and unexpected insurance claims, fraud, loss of business or customer, and negative market trends can all impact the financial performance of a company. Based on these issues financial risks can be classified into four major categories including “market risk, credit risk, insurance and demographic risk, and lastly operating risks.” To mitigate these risks two broad strategies of risk decomposition and risk aggregation are used for risk management. Propose advanced machine learning methods and novel strategies to reduce economic risk [2].

“Machine Learning is a computational method that uses past information to improve performance in a specific task or make accurate predictions” [3]. Four types of machine learning have multiple applications in the field of financial risk management.

Learning method	Learning task	FRM application
Supervised learning	Classification	Fraud Detection[19]
		Portfolio optimization[20}
		Credit Scoring& Bankruptcy prediction[21]
	Regression	Volatility forecasting[2]
		Sensitivity analysis[22]
		Claims modelling[23]
		Loss reserving[24]
		Mortality modelling[25]
Unsupervised learning	Clustering	Insurance pricing[23]
		Sensitivity analysis [26]
		Credit scoring&Bankruptcy prediction[27]
	Anomaly detection	Fraud detection[28]
	Dimensionality reduction	Insurance underwriting[29]
		Mortality modelling[30]
Reinforcement Learning		Portfolio optimization[31]
Semi-supervised learning		Sensitivity analysis[32]

Fig. 1 Machine learning and its implementation in financial risk management [2]

Figure 1 shows a list of measures that use machine language to mitigate financial risks. Machine language has the following applications in the field of financial risk management.

2.1. Market risk

Markets are generally considered volatile and associated with bringing deviation in the value of return on assets. This risk is managed by using financial derivates such as leverage and insurance. Hedging is another common strategy for portfolio risk management that reduces risk exposure. The market sensitivity of the assets in the portfolio guides the hedging strategies that can be used. Lastly, portfolio optimization is also used to reduce risk and increase return [2]. “Volatility is a statistical measure to describe the dispersion of return of a financial asset or portfolio.” Higher volatility means

that the market risk is high which creates market uncertainty regarding the prices of the assets. The future impact of market volatility cannot be estimated or measured and is therefore one of the major financial risks [2].

2.2. Credit Risk

Credit risk refers to the ability (of someone who has borrowed or loaned money) to fulfill financial obligations. Credit risk for individuals means defaulting on and loan whereas business firms usually declare themselves bankrupt. Today's AI-backed solutions have provided banks with the information that can help them make informed decisions about lending or refusing a loan. These AI-driven systems can generate a warning for the banking staff about the risk of fraud [4].

2.3. Insurance Risk

Many financial institutes offer insurance as an additional service but with an additional risk for the institute as well. As financial risk can arise from any number of reasons, financial companies need to correctly estimate the impact of each of the factors of risk. If the prediction of the insurance product is incorrect then it leads to loss for the insurer due to its underpricing. Demographic information is also necessary to estimate the lifespan of life insurance products [2].

2.4. Operational Risk

Fraudulent activities are a major cause of operational risks. These activities include money laundering, false insurance claims, banking fraud, corporate fraud, and securities fraud. These frauds are considered financial frauds and they are considered to have a harmful impact on the financial stability and growth of an organization. Financial fraud detection systems may use supervised or unsupervised machine learning algorithms. These algorithms can identify fraudulent activities even from large data [5].

In supervised machine learning the data input is used to test an output. This is similar to how a statistical model uses independent and dependent variables to test and establish the relationship. In the unsupervised machine language, there is only input data and the machine language helps the user understand the structure of the data [4].

3. Development Strategy

R Machine learning and AI have transformed the field of financial risk management. It has improved the control and mitigation of risk. The application of machine learning can help a banker decide how much loan should they sanction, detect fraud, and improve compliance. Machine learning is a sub-category of artificial intelligence that uses algorithms. These algorithms analyze data and then learn from it so that a decision based on a certain experience or criteria can be made. Deep learning is a sub-category of machine learning. Deep learning is modeled like a human brain and therefore it operates using multiple layers of artificial networks and can process and use a very vast amount of data [6]. Deep learning can use both supervised and unsupervised machine language depending on the purpose for which it is being used. Deep learning uses hidden layers to generate combinations and factors. Machine language tools provide data protection as the information is only accessible to the key decision-makers. Furthermore, the complex layering of data such as that in deep learning makes it challenging to understand it and use it for decision-making and reports. It also requires reasonable interpretation of any data so that reports can be generated and understood [4].

With the complexity of the financial markets and the increasing number of customers, financial institutions need to keep large amounts of data, also termed big data. Technology such as computers can obtain, store, manage and analyze data which means that efficiency with the data can be retrieved, processed, and utilized has also improved. With the application of machine language to the existing efficiencies of big data, financial firms are in a better position to estimate risk objectively and with higher precision [7].

Companies like Google and IBM are also developing tools that can help banks and financial institutions mitigate risk [8, 9]. For instance, IBM has developed a real-time voice conversation analysis that uses "a combination of IBM's Watson AI expertise and Promontory's domain-specific expertise" that helps to translate the voice into text [10]. This text is then classified into categories using a machine language process so that potential non-compliance can be identified. Another example is Zest Finance which was a partnership between China's dominant search engine Baidu and Google. Given the needs of the Chinese financial markets where less than 20% of people had a credit profile, Baidu wanted to improve and reduce the risk of financial decisions. Zest Finance used the search history and purchase history of people in Baidu to develop a credit profile that could be used to lend small loans [4].

4. Conclusion

Machine learning is perceived to give financial institutes the ability to intelligently control and reduce risk. Although the emergence of machine learning the the field of financial risk management has established its need. There is also an increased reliance on machine learning for making intelligent and well-informed decisions. However, there are still some challenges that need to be addressed to utilize the full potential of machine learning. The biggest challenge is the avialbility of data that is suitable for financial decision-making. If data is organized in a way that one department in a financial institute does not have access to it, it may lead to poor decision-making. Additionally, privacy policies under the internal and external compliance requirements may also create a challenge in data sharing. Furthermore, there is also the need for trained and skilled professionals who know how to use and interpret the reports generated by these technologies. Lastly, there would always be concerns about how accurate the machines can be. Even with deep learning that is expected to imitate the human brain the questions about its limitations would remain.

References

[1] Jia, D., and Wu, Z. Application of Machine Learning in Enterprise Risk Management. Security and Communication Networks, 2022, e4323150.

[2] Mashrur, A., Luo, W., Zaidi, N., and Robles-Kelly, A. Machine Learning for Financial Risk Management: A Survey. IEEE Access, 2020, 8, 203203-203223.

[3] Mohri, M., Rostamizadeh, A., and Talwalkar, A. Foundations of Machine Learning, Second Edition by Rostamizadeh, Talwalkar, Mohri (2nd ed.). MIT, 2018.

[4] Aziz, S., and Dowling, M. Machine Learning and AI for Risk Management. In T. Lynn, J. G. Mooney, P. Rosati, & M. Cummins (Eds.), Disrupting Finance: FinTech and Strategy in the 21st Century. Springer International Publishing, 2019, 33-50.

[5] Ngai, E. W. T., Hu, Y., Wong, Y. H., Chen, Y., and Sun, X. The application of data mining techniques in financial fraud detection: A classification framework and an academic review of literature. Decision Support Systems, 2011, 50, 559–569.

[6] Milojević, N., and Redzepagic, S. Prospects of Artificial Intelligence and Machine Learning Application in Banking Risk Management. Journal of Central Banking Theory and Practice, 2011, 10(3), 41–57.

[7] Murugan, M. S., and T, S. K. Large-scale data-driven financial risk management & analysis using machine learning strategies. Measurement: Sensors, 2023, 27, 100756.

[8] Aziz S, Dowling M. Machine learning and AI for risk management[J]. Disrupting finance: FinTech and strategy in the 21st century, 2019: 33-50.

[9] Battanta L, Giorgino M, Grassi L, et al. Regtech: Case studies of cooperation with banks in Italy. European Conference on Innovation and Entrepreneurship. Academic Conferences International Limited, 2020: 112-119.

[10] Aziz S, Dowling M. Machine learning and AI for risk management. Disrupting finance: FinTech and strategy in the 21st century, 2019: 33-50.