Machine Learning in Finance: A Brief Review

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Abstract. In the era of AI, machine learning theory has developed rapidly, and its application in the financial field has become a hot topic. Machine learning methods can effectively reduce operating costs, monitor risks and expand services. This paper summarizes the application of machine learning in the field of fintech based on the theory of machine learning and its application literature in finance. The basic contents, advantages and disadvantages of deep learning, knowledge graph, decision tree model and natural language processing are summarized. The innovative applications of machine learning methods in market prediction, portfolio optimization and text analysis are introduced and analyzed. In addition, the paper also analyzes its limitations, and then provides some suggestions on the choice of methods in financial applications.

Keywords: Fintech · Machine Learning · Deep Learning · Financial Application

1 Introduction

With the rapid development of artificial intelligence, machine learning and deep learning are increasingly used in innovative applications in the financial field, especially in the field of financial technology. Machine learning studies and constructs algorithms for learning and prediction from data. According to the sample input, this algorithm builds a model and makes predictions or decisions driven by data, which overcomes the disadvantage of strictly following the static program instructions [17, 19]. Machine learning includes four methods: supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning. Most machine learning adopts the method of supervised learning. As a subset of machine learning, deep learning uses multiple layers to gradually extract higher-level features from the original input [1]. Deep learning can also be defined as neural networks with many parameters and layers in the following four basic network frameworks: unsupervised pre-training network, convolutional neural network, cyclic neural network and recursive neural network. Compared with traditional machine learning, deep learning relies on a larger data scale, higher-end machines and longer training time. What surpasses traditional machine learning is that its algorithm can learn advanced features from data, requiring less time to test [22].

The rest of this paper is organized as follows: Sect. 2 introduces the concepts, functions, advantages and disadvantages of deep learning, knowledge map, decision tree model and natural language processing. In Sect. 3, the latest application of machine

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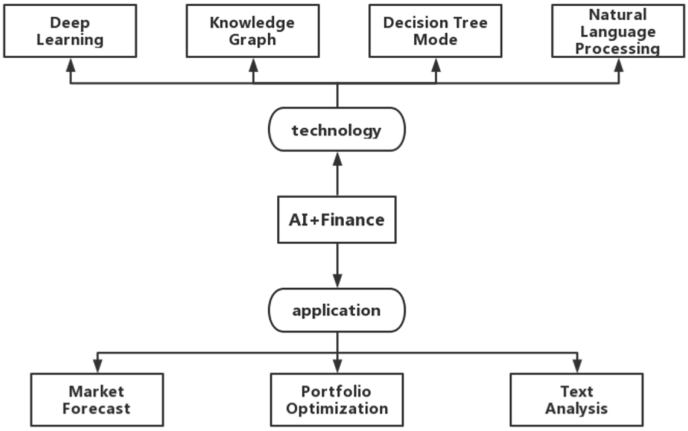

Fig. 1. Article layout. This figure was drawn by myself

learning in the financial field from market prediction, portfolio optimization and text analysis. Section 4 examines machine learning methods from different perspectives and analyzes their limitations. Conclusions are drawn in Sect. 5. The layout of the whole article can be seen in Fig. 1.

2 Methods

2.1 Deep Learning

Machine learning is a methodology to realize AI. Deep learning is a new technology under this methodology. It has an excellent effect on image recognition, semantic understanding and speech recognition. Deep learning is one of the most famous scientific research trends and its model is often better than the traditional machine learning model. The procedure of Deep Learning for processing big data is shown in Fig. 2. Artificial neural network (ANN) is the most used form of deep learning [18, 23]. Support vector machines (SVM) has been applied in pattern recognition such as portrait recognition, text classification, handwritten character recognition and bioinformatics [2, 4]. After that, other neural networks were developed. At present, the most widely used are convolutional neural network (CNN), recursive neural network (RNN), denoising automatic encoder (DAE), deep belief network (DBN) and long-term and short-term memory (LSTM) [15].

2.2 Knowledge Map

Knowledge map is a network knowledge base linking information through relationships, and it can directly and efficiently represent relationships, with its essence being a semantic network. It is a research hotspot in the field of artificial intelligence. Moreover, it can solve text classification, text mining, entity association, and other tasks in machine learning, helping to build interpretable machine learning [6]. However, there

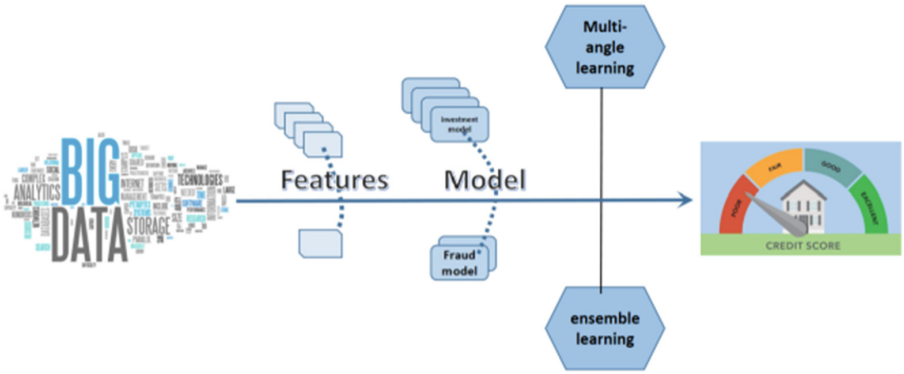

Fig. 2. Big data processing. This figure was drawn by myself

are still challenges in each link of knowledge map construction: First, there are typical problems in information extraction, such as low algorithm accuracy and recall rate, various restrictions and poor scalability [3]. Second, in the link of knowledge fusion, realizing accurate entity links is the main challenge [12]. Third, the main research problems of knowledge processing include: automatic construction of ontology, knowledge reasoning technology, means of knowledge quality evaluation and application of reasoning technology [9]. Lastly, in the process of knowledge updating, incremental updating technology is the development direction. It is a significant challenge in the effectiveness of automatic updating [24].

2.3 Decision Tree Model

The decision tree model is a predictive analysis model expressed in the form of the tree structure, which is composed of nodes (internal nodes and leaf nodes) and directed edges. Its structure includes the root node, non-leaf node, branch and leaf node [16]. The decision tree learning process includes feature selection, decision tree generation and decision tree pruning. The main advantage of the decision tree model is its fast speed and high accuracy. It can process classified data without any domain knowledge and parameter assumptions. On the other hand, its shortcomings are mainly reflected in the feature that the information gain is biased towards multiple values, easy to overfit, and ignores the correlation between attributes [11].

2.4 Natural Language Processing

Natural language processing (NLP) takes language as the object and uses computer technology to analyze, understand and process natural language. Meanwhile, it provides a language description that can be used by humans and computers together [5]. NLP includes natural language understanding (NLU) and natural language generation (NLG). Machine learning has great advantages in promoting natural language processing. Because deep learning can overcome the shortcomings of sparse and incomplete manual labeling of language features by effectively labeling, and significantly reduce the amount of calculation [10].

3 Applications

3.1 Market Forecast

A marketing strategy's effectiveness can be predicted by analyzing previous advertising, online activities and customers' mobile application utilization. For example, Dai Y and Wang T (2021) applied machine learning algorithms to the prediction of customer engagement behavior selection for marketing positions, providing enterprises with more effective prediction and helping them make marketing decisions [7]. We can use machine learning analysis to predict current market conditions, high-impact events, and critical information. It helps financial institutions manage upcoming risks and forecast the probability of a financial crisis. Machine learning is often used in supply chain risk management. Sang [20] used a genetic algorithm combined with a support vector machine and BP neural network to evaluate the credit risk of supply chain finance. Figure 3 shows Fintech applications and related technologies.

3.2 Portfolio Optimization

AI investment consultant is usually called robot consultant. It is an online platform based on AI or machine learning to provide investment consulting services for investors. Through a series of intelligent algorithms and portfolio theory, intelligent investment advisers obtain individual users' risk-taking level and income objectives and provide customized investment schemes for customers. The judgment of intelligent investment advisers is often more rational and long-term [25]. Compared with expensive manual investment advisers, the use of lower cost and faster intelligent investment advisers and portfolio management based on machine learning is becoming more and more popular today. The portfolio of stock price prediction based on LSTM in deep learning can provide higher returns than traditional methods. Although the intelligent investment advisor is efficient, it also has risks and challenges related to compliance with the law, and it is necessary to explore implementable regulatory solutions [8].

3.3 Text Analysis

Deep learning has revolutionized the way financial institutions work in law, which can translate and analyze many documents in just a few seconds, thus greatly reducing the workload of their lawyers [14]. The research results of Saurabh, S and Dey, K [21] show that the dimension of social emotion significantly affects the market return on the overall level, and the prediction accuracy of artificial neural networks is relatively high compared with models such as support vector machine, discriminant analysis and decision tree. Text emotion analysis based on the deep learning method is usually used in public opinion control, business decision-making, opinion search, information prediction, emotion management and other scenarios. Lully, V et al. [13] explored the synergy between knowledge graph technology and computer vision tools for image user analysis.

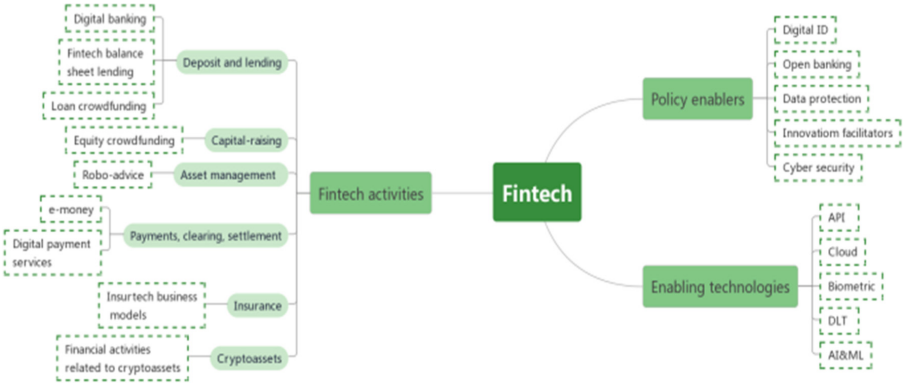

Fig. 3. Fintech tree. This figure was drawn by myself

4 Limitation and Perspective

Machine learning relies heavily on data and models and lacks universality and autonomy. In terms of market prediction, the performance of the deep learning model is not always better than that of traditional methods, and the time resources and computing resources required for deep learning are far higher than those of traditional methods. Therefore, it requires high investment but boasts great potential.

Now is the golden age of machine learning. New progress and challenges are faced in data (acquisition and generation), learning algorithms, and inference and prediction. In the future, the development of these aspects will be more mature. At the same time, it will promote the development of financial technology, significantly improve the efficiency of the financial industry, and make business activities more efficient and convenient.

5 Conclusions

Machine learning, especially the deep learning methods, provides more efficient technical support for the financial field in the AI era. Fintech drives innovation and development of applications with the help of knowledge graphs, decision tree models and natural language processing. Because risks and benefits coexist, while seeing the advantages, we should also pay attention to the limitations of machine learning. In specific financial practice, attention should be paid to the comprehensive consideration of machine learning models and traditional methods, and thus making use of the best ones.

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