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Applications of Artificial Intelligence Generative Adversarial Techniques in the Financial Sector

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Abstract: This paper explores the application of artificial intelligence (AI) techniques in the financial sector, with a particular focus on the role of generative Adversarial networks (GANs) in defending against automated attacks in the financial sector. AI technology is regarded as the fundamental technology of the fourth Industrial revolution, and its applications cover robotics, speech recognition, image recognition, natural language processing and other fields. In the financial sector, AI technology has improved business efficiency and accuracy by developing terminal programs with business operation skills that partially or completely replace manual labor. A generative adversarial network is a system of generators and discriminators that generate realistic fake data to help financial institutions identify fraud. Therefore, it is suggested that websites should not only abandon the traditional verification code, but also find other more secure verification methods, and consider introducing a verification system with the ability to generate counter-network to improve the accuracy and security of authentication.

Keywords: Artificial Intelligence, The Financial Sector, Generate Adversarial Network, Identity Authentication.

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1 Introduction

Artificial Intelligence (AI), often abbreviated as AI, is regarded as the foundational technology of the Fourth Industrial Revolution. Some scholars even consider it a groundbreaking technology that fundamentally alters human production, lifestyle, and the course of civilization. In the academic domain, AI is defined as an emerging technical science that researches, develops, and applies theoretical, methodological, and technological systems to simulate, extend, and expand human intelligence. [1] The current scope of AI research encompasses areas such as robotics, speech recognition, image recognition, natural language processing, and expert systems.

AI technology is a product of highly developed information technology, and its application in the financial sector primarily involves the development of terminal programs that possess business operation skills. These programs partially or fully replace manual labor and gradually evolve to perform high-level computational tasks that surpass human cognitive capabilities. [2-3] Since the beginning of the 21st century, with the vigorous development of information and communication technology and automated production, AI technology has been widely applied in various domains of production and life. A landmark event was the victory of the intelligent robot AlphaGo over the world's top Go players in 2016, sparking a new wave of enthusiasm for AI technology.

Currently, major global economies consider AI technology a top priority in their technological innovation strategies. They expand investment in relevant basic research and talent cultivation through national fiscal allocations and other means. [4] Globally renowned technology companies, especially Silicon Valley giants, spare no effort to recruit top scientists and designate AI technology research and development applications as a breakthrough point to enhance their core competitiveness. Although China's technology companies started AI technology research and development relatively late, they have caught up with their strong industrial base and advantages in talent dividends. Currently, Chinese enterprises rank second globally in the number of AI technology patents, far ahead of other economies outside the United States. Continuous breakthroughs in AI technology innovation and research and development provide robust technical support for its application in other industries.

Regarding the application prerequisites of AI technology, unlike natural biological intelligence, its operation and evolution rely entirely on information technology devices and the internet. As the saying goes, "To do a good job, an artisan needs the best tools." [5-6] The scale and sophistication of IT facilities fundamentally

determine the energy rate of the AI technology system. In China, apart from telecommunications operators and leading internet companies, financial institutions, especially large state-owned commercial banks, are the largest buyers of IT hardware and software equipment. In recent years, the average annual investment in IT has been over a trillion yuan, accounting for about one-fifth of the total [7] IT investment in society. The massive IT infrastructure software and hardware resources accumulated by the financial sector's continuous years of informatization construction provide an ample material foundation for the implementation of AI technology applications.

2 Related Work

2.1 Artificial intelligence feature

From the perspective of AI technology application characteristics, the three elements of AI are data, computing power and algorithms. Among them, data is the foundation and value of all AI technology research and development results, and it is the most critical strategic resource. [8] From the perspective of the practice in the financial field, non-financial institutions that can timely and continuously provide massive basic data information, and have hundreds of thousands of business terminal outlets and tens of millions of employees are no other. Computing power mainly relies on large-scale computer networks and cloud storage equipment, which requires continuous investment in fixed asset facilities, in addition to a few strong Internet giants, most of the scientific and technological enterprises focusing on AI technology research and development are unable to cope, and financial institutions have the ability to bear high hardware and software investment. Starting from the technical principles of artificial intelligence, the financial AI operating system is actually the product of simulated human thinking by relying on a certain algorithm model and constantly "feeding" basic data materials [9]. Therefore, the performance parameters and reliability of AI systems completely depend on the quality, structure and integrity of the underlying data "fed". Not only do financial institutions have unparalleled advantages in the collection of underlying data, but end users can also provide real-time feedback on the application of AI technology systems and potential problems, thus enabling R&D institutions to better modify the system to better meet the development needs of financial businesses.

About the application status of artificial intelligence technology. At the present stage, the main breakthrough direction of artificial intelligence technology is computational intelligence, perceptual intelligence and cognitive intelligence, and the corresponding specific business functions are financial data processing and generation, human biological information recognition and computer-aided decision-making. AI applications in finance range from customer-facing front-office operations to the bottom-up aspects of an organization's strategic decisions [10]. At present, the most common application of financial institutions is AI biological information recognition technology, including face recognition, signature seal and other security and anti-counterfeiting functions, such technology serves high-frequency offline business scenarios, theoretically cannot rely on manual work and must rely on information technology tools. Especially since the outbreak of the new coronavirus epidemic in 2020, financial institutions have innovated remote contactless business, making AI-related applications play a big role and becoming an indispensable technical means for financial business.

2.2 Artificial intelligence and finance

At this stage, the most widespread application of AI technology is the field of offline customer service in the financial front desk. The financial needs in this field have inherent logic, replicability and portability with other key areas of AI, such as e-commerce and [11] O2O life services (take-out, ticketing, etc.), so financial institutions learn from Internet enterprises to introduce AI customer service systems and make corresponding improvements. The most outstanding advantage of artificial intelligence technology lies in its impersonal characteristics, that is, as a non-biological robot, in the process of communicating with natural person customers, there will be no emotional fluctuations and negative emotion transmission accompanied by the communication between real people, and it will not leave customers with bad attitudes, impatience and other bad impressions. It minimizes the user experience while reducing the labor intensity of front-line operators. [12]AI application practice shows that the application of AI customer service by financial institutions, especially banking institutions, can greatly reduce the user complaint rate and improve user satisfaction. In addition, AI also has functions such as real-time dynamic collection, labeling, sorting and classification of massive terminal data that cannot be humanly obtained, which can provide underlying technical support for financial institutions to improve their own services and research and develop innovative products.

How to dig the internal logical relationship between data deeply and provide necessary technical support for financial institutions to better carry out business and service customers needs more powerful and efficient system tools. With the development of the mobile Internet [13], banks and other financial institutions have vigorously developed online businesses and small and micro customers, and various natural person customers have continuously generated thousands of complicated behavioral data, which is no longer limited to the economic and financial field, but also includes equipment data, social data, employment data and other non-financial weakly related data. Data is more discrete and unstructured at the physical level. [14-16]The AI application program records the user's operation behavior in a timely manner to collect relevant information at the operation terminal, and uses the marketing brain big data analysis technology to trace the collected data, extract the

value model according to the customer attributes, and export it to build the analysis framework of customer characteristic information in different stages and forms to support the research and development of innovative financial products and services. It can help financial business departments to implement classified policies and carry out differentiated services for different customers, so as to achieve higher quality financial business growth under the big data-driven model.

2.3 Digital transformation of AI finance

In order to meet the requirements of financial digital transformation, the regulatory authorities need to increase the efforts of regulatory technology research and development innovation. Compared with normal financial transactions, financial illegal and criminal activities have significant randomness, disorder and irregularity, so it is more necessary to accumulate experience information to discriminate and dispose of them. [17]Incomplete inspection methods such as random random checks used by financial institutions to assist regulators in carrying out anti-money laundering and other activities will inevitably miss useful clues. [18]The use of AI data search system through the powerful computer processing function, can continue to output the equivalent of millions of people in a short period of time, so as to complete the programmatic verification of the transaction behavior between financial institution customers. [19]The AI dynamic monitoring system uses pre-set baselines, thresholds, and alarm suppression measures to reduce the proportion of false positives and false positives to maximize the alarm accuracy, detect anomalies when macro-monitoring indicators do not change, and quickly handle possible anomalies. [20]After AI technology eliminates most of the normal trading activities, the remaining abnormal trading behaviors and hidden money laundering fraud and other illegal behaviors will surface, thus helping law enforcement departments to efficiently and accurately locate and detect illegal activities.

The regulatory authorities can also work with financial institutions and technology enterprises to use the digital twin and simulation function in the AI technology system to simulate the sandtable deduction similar to the behavior of the real world financial criminal entities through computer programs, so as to continuously improve the intelligence degree and power energy efficiency of the regulatory force. In addition to improving the level of financial supervision and technology, AI technology systems can also do a lot in more areas such as financial consumer education, financial literacy, and the automation of financial practitioner training. As the most valuable application scenario of AI technology, the financial sector can also reverse drive the entire artificial intelligence technology to evolve and upgrade the system.

2.4 Application of generative countermeasure technology（GANs)

Generative adversarial network (GAN)[21-22], as one of the core algorithms in the field of artificial intelligence, is increasingly applied in various fields of materials science. In this paper, the application of GAN in materials science is systematically summarized. First, the basic working principle of GAN and its variants are introduced. Then, the application of GAN in different scenarios such as material composition design, process optimization, crystal structure search, microstructure characterization and defect detection are analyzed and reviewed. Finally, the challenges in this field are prospected and possible solutions are suggested.

Compared with classical algorithms such as regression and classification, generative artificial intelligence algorithms such as generative adversarial networks have recently achieved good results in materials, chemistry, biology and other fields because of their excellent characterization and generative ability[23]. For example, in material design, generative algorithms are expected to directly generate required processes and components based on target properties, thereby replacing classical large-scale prediction/search methods based on candidate material pools and improving design efficiency while saving computational resources; In terms of microstructure, compared with generative algorithms such as variational autoencoder, [24]GAN can generate more realistic high-resolution microstructure images. In addition, the flexibility of the GAN architecture allows researchers to adapt the model structure to specific needs, making it also suitable for crystal structure generation and defect detection in engineering. This review introduces the application of GAN in all the above aspects, and summarizes the commonalities and characteristics applied to different scenarios through classic cases. Finally, based on the author's experience in the research and development of AI-assisted materials, the problems existing in this emerging interdisciplinary field are put forward and the research directions worthy of attention are forecasted.

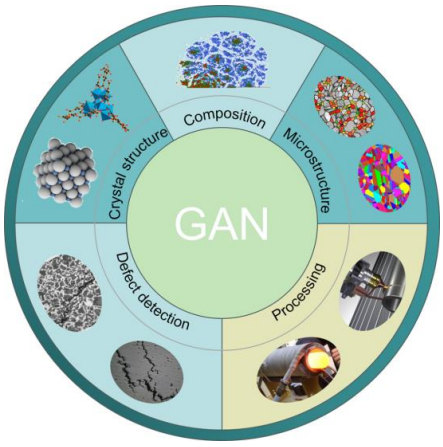

Figure 1. Generate adversarial network application scope

In addition, the applications of generative Adversarial networks (GANs) in the financial sector include, but are not limited to, fraud detection, risk management, market forecasting, and intelligent portfolio management. By training generator and discriminator models, GANs can generate realistic fake data to help financial institutions identify fraud. At the same time, GANs can also be used to generate large amounts of market data to help financial institutions conduct risk analysis and forecasting, as well as optimize the decision-making process of investment portfolios.

3 Methodology

3.1 Generate adversarial network (GAN) model

GAN includes generative model and discriminant model. The task of the generative model is to generate instances that look natural and realistic, similar to the original data. The task of the discriminant model is to determine whether a given instance is naturally real or artificially falsified. In fact, the principle of the generative adversarial network can be graphically likened to: the generative model is a counterfeit gang trying to produce and use counterfeit money, and the discriminant model is the police who detect counterfeit money. The generator tries to fool the discriminator, and the discriminator tries not to be fooled by the generator. It is said that the devil is high, and the road is high. The model has been alternately optimized for many times, and the performance of both models has been improved, but what we need is to improve the effect to a very high and good generative model (fraud gang), and the products generated by this generative model [25-27](fraud gang) can reach the point where it is difficult to distinguish between true and false. The overall framework of GAN is shown in the figure below.

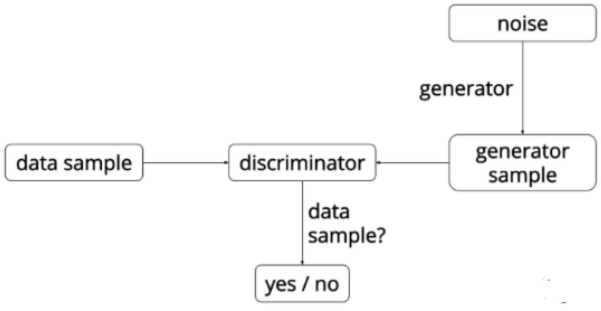

Figure 2. Overall framework model of GAN

In fact, the generation network G receives a random noise z, and generates a picture G(z) through this noise, while the discriminator D needs to judge whether the input picture x is real or not, and the discriminator will output the probability D(x) of judging the picture, D(x)=1 if judged to be a real picture, D(x)=0 if judged to be an untrue picture. In the process of iterative training, the generator model tries its best to generate real pictures to deceive the discriminator, and the discriminator tries its best to distinguish the generator from the real pictures, thus forming a dynamic game process. In the best case, the generator G is enough to be true, and it is difficult for the discriminator to judge the true and false images generated by the generator G.

3.2 Experimental design

Graph-driven fraud detection is a common problem in generating adversarial technologies in areas such as e-commerce, banking, insurance, and social networking, where data can naturally be represented as a graph structure. Especially in the field of e-commerce, fraud detection has become an important and serious issue due to its massive scale and the real-time transaction volume of millions of goods. There are three main challenges: sparse fraud samples, complex features in online transactions, and the sheer size of e-commerce data.

There are several major challenges when implementing graph-based fraud detection, which can be summarized as follows:

Although financial frauds in e-commerce are common among individuals or organizations, they are somewhat sparse and scattered on very large scales. In most cases, they are discovered through user reports or complaints, making it time-consuming and laborious to mine enough fraudulent entities for model training. Therefore, it is challenging but necessary to accurately and efficiently identify a wider range of fraudulent entities in large-scale graphs on top of existing sparse fraud seeds.

Financial risk transactions in e-commerce have complex features in different views. For example, there are configuration characteristics, behavior patterns, and spatio-temporal information. A single view cannot be fully described, so a multi-view model is needed to recover the entire scene and achieve high detection accuracy.

The explosive growth in the size of e-commerce transaction graphs dramatically increases computational complexity and makes efficient model training very challenging. At the same time, fraud detection in e-commerce platforms can be time-sensitive and requires high scalability. Therefore, a large-scale fraud detection system based on a graph computing engine is needed to effectively implement the algorithm.

3.3 Experimental content

The early text-based captCHA is the first iteration of this technology, and it is no longer suitable for the development of The Times in terms of network security. The captCHA involves using a mixture of letters and numbers, as well as other features such as occlusion lines, to distinguish computers from humans. Ultimately, the basic idea behind text-based capt[28]CHA is that humans can

easily identify letters and numbers, while computers can't.

The novelty of this latest effort is that it uses generative adversarial network (GAN) technology to create training data. The technique involves teaching a captCHA generator to create a large number of training captCHA indistinguishable from the original captcha. This data can then be used to quickly train the solver and test it against the real capTcha. In this way, automated captcha techniques using machine learning can reduce the time and effort involved in identifying and manually labeling captCHA to train software.

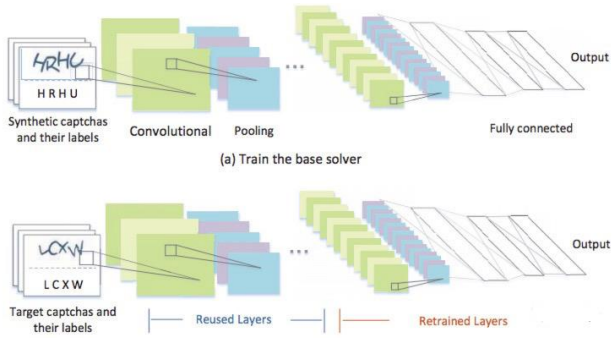

Figure 3. Building a solver based on a generative adversarial network (GAN) approach

Although deep neural networks show amazing performance in image recognition. However, building successful models often requires millions of manually labeled images for smooth learning. Instead of collecting and labeling millions of capTCHA text data, the system only needs 500 sets of data to successfully learn. And because the new solver requires minimal human involvement, it's easy to rebuild it to fit a new or modified captCHA scheme. The system has been successfully tested on 33 different captCHA systems, including 11 from some of the most popular websites in the world, including eBay and Wikipedia[29].

Scheme	Captcha Image	Ground Truth	Solver Output
Sohu		d4sk	d4sh
eBay		934912	994912
JD		BHER	BFER
Wikipedia		mewsboxes	mewsbores
Microsoft		XK6NK	XK6VK
Alipay		B7JK	B7YK
Qihu360		s34Ea	s3VFa
Sina		nG3uu	nG3uv
Weibo		4TXB	4TX8
Baidu		WFIH	WFEH
Google		irgandoca	igiruloca

Figure. 4. Comparison of the recognition accuracy rate of the system and the current recognizer for each website verification code

Based on the experimental results of the study, Mr. Guixin, the lead student author, noted that traditional text captcha schemes have limitations in preventing automated attacks, and the experimental approach has achieved a high recognition success rate. This situation may be affected by advanced technologies such as generative adversarial networks (GANs), which can effectively crack traditional capTCHA systems.

Generative adversarial network is a system consisting of two competing neural networks, the generator and the discriminator. The generator is responsible for generating fake data samples, while the discriminator tries to distinguish between real data and fake data. Through repeated training, the generator can generate increasingly realistic fake data that is difficult to distinguish by the discriminator.

Therefore, the researchers suggest that websites should not only ditch traditional capt[30-33]CHA, but also look for other, more secure methods of verification. Given the widespread use of generative adversarial network technology, websites can consider adopting verification methods with generative adversarial network capabilities in response to possible automated attacks. For example, websites can introduce a verification system based on multi-modal data, combining the user's usage pattern, device location, biometric information and other factors for verification, thereby improving the accuracy and security of authentication.

In summary, the progress of generative adversarial network technology challenges the traditional capTCHA system. To address this challenge, websites need to adopt a more advanced and multi-layered approach to authentication to ensure the security of user accounts and information.

4 Conclusion

There are many advantages to data-driven marketing decisions, among which:

More accurate target market determination: Through data-driven user profiling, marketing teams are able to more accurately understand the target market, including user characteristics, preferences and behaviors, to identify the most attractive market segments and provide guidance for targeted marketing campaigns.

Product positioning and differentiation: [27-30] Through the analysis of user profiles, marketing teams can determine product positioning and differentiation strategies. Understanding users' needs and preferences can help them determine a product's unique selling point in the market and differentiate it from competitors.

Marketing and communication strategies: Data-driven user profiles can also guide marketing and communication strategies. By understanding users' channel preferences and spending behaviors, marketing teams can choose the most effective promotion channels and communication methods

to maximize the appeal to their target user groups.

Personalized Marketing and Customer Relationship Management: User portraits can help marketing teams implement personalized marketing and customer relationship management strategies. With a deep understanding of their users, they can provide personalized product recommendations, customized marketing messages, and personalized service experiences that increase user loyalty and satisfaction.

Therefore, with the continuous development of data science and artificial intelligence technology, the role of data-driven marketing decisions in enterprises will be further enhanced. In the future, we can expect the following developments:

Smarter data analytics tools: As technology advances, data analytics tools will become smarter, able to analyze massive amounts of data more quickly and accurately, and provide deeper insights to support marketing decisions.

More personalized marketing strategies: With data-driven user profiles, businesses will be able to implement more personalized marketing strategies and provide customized products and services to different users, thereby increasing user satisfaction and loyalty.

Cross-platform integrated marketing: In the future, enterprises will pay more attention to cross-platform integrated marketing, through the integration of data and information from different channels, to achieve seamless marketing activities, improve marketing effectiveness and ROI.

Real-time decision support: With the advancement of data analysis technology, enterprises will be able to achieve more real-time marketing decision support, timely adjustment of marketing strategies, seize market opportunities, and respond to market challenges.

In general, the advantages and prospects of data-driven marketing decisions for enterprises are multifaceted, and by making full use of data science and artificial intelligence technology, enterprises can achieve more accurate, personalized and intelligent marketing, thereby enhancing market competitiveness and achieving business growth and profitability goals.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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