Fairness Assessment and Ethical Governance of Insurance AI: A Patch Approach for Vulnerable Groups

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Abstract

The widespread application of artificial intelligence (AI) in the insurance industry has brought numerous conveniences, but it has also triggered a host of ethical controversies, with the unfair treatment of vulnerable groups becoming increasingly prominent. This paper focuses on the fairness assessment and ethical governance of insurance AI, delving into the adverse effects of insurance AI on vulnerable groups (such as the elderly and low-income populations) in practical applications, such as the refusal of insurance by smart underwriting for the elderly and premium differences caused by algorithmic discrimination. To address these issues, this paper constructs a fairness assessment index system for insurance AI, covering five core indicators: explainability, coverage of vulnerable groups, premium fairness, complaint rate and claims efficiency. It also proposes the design logic of "algorithmic patches" for vulnerable groups, such as optimizing the weight of health data for the elderly and simplifying the language of smart recommendations.

Keywords: insurance AI, fairness assessment, ethical governance, vulnerable groups, algorithmic patch, ethical controversy, consumer rights, smart underwriting, premium pricing, complaint rate, claims efficiency, corporate self-discipline, industry standards, regulatory mechanism

1. Introduction

1.1 Research Background

With the rapid development of artificial intelligence (AI) technology, its application in the insurance industry has been expanding, covering core businesses such as underwriting, claims, product design and risk assessment, greatly improving business efficiency and accuracy. However, the widespread application of insurance AI has also triggered many ethical issues, such as algorithmic discrimination and system opacity, which have a profound impact on social fairness. For example, the elderly are often refused insurance due to health data bias, and vulnerable groups face a higher economic burden in premium pricing. These issues not only weaken consumers' trust in the insurance industry but also increase the risk of rights and interests being damaged. Therefore, it is of great practical significance to study the fairness assessment and ethical governance of insurance AI, which helps to protect the rights and interests of vulnerable groups, regulate industry development and promote social fairness.

1.2 Research Significance

1.2.1 The Importance of Protecting the Rights and Interests of Vulnerable Groups

Insurance is crucial for vulnerable groups, but the current application of AI has exacerbated their difficulties in obtaining insurance protection. This study analyzes ethical issues, constructs a fairness assessment system and proposes "algorithmic patches" to optimize AI systems, making them treat vulnerable groups more fairly. For example, it can increase the insurance application approval rate for the elderly, enhance social fairness and inclusiveness. The healthy development of the insurance industry needs to focus on ethical issues. If the ethical

controversies caused by AI are not resolved, they will affect the industry's reputation. This study provides a systematic solution to help insurance companies fulfill their social responsibilities, enhance consumer trust, promote the formulation and improvement of industry standards and supervision, and drive long-term and stable development. From a theoretical perspective, this study constructs an innovative fairness assessment index system and proposes optimization strategies such as "algorithmic patches", enriching the theory of ethical governance of insurance AI (Tao Y., 2023). From a practical perspective, it verifies the significant effects of "algorithmic patches" with the application data of Mingya Insurance Brokerage and Rui Zhong Life Insurance as pilots, providing references for insurance companies and regulatory authorities.

2. Ethical Controversies of Insurance AI

2.1 Application Scenarios of Insurance AI

In recent years, artificial intelligence (AI) technology has been widely applied in the insurance industry, greatly improving the efficiency and accuracy of insurance business. For example, Sunshine Insurance's advanced AI underwriting system can analyze customers' health data, lifestyle, family medical history and other information to complete the underwriting process in just a few minutes. Compared with traditional manual underwriting methods, the efficiency has been improved several times, effectively reducing labor costs and time costs. In the claims process, the AI-driven claims system of Huimin Insurance can automatically identify the authenticity and rationality of claims cases, speeding up the claims process and improving customer satisfaction. Through image recognition technology, AI systems can quickly assess the extent of vehicle accident losses and provide reference for claims assessment. In addition, in product recommendation, the AI algorithm of PICC can customize insurance products for customers according to their age, income, family status and other characteristics, improving the accuracy and customer acceptance of product recommendation. For example, the intelligent recommendation system of PICC can recommend the most suitable insurance product combination for customers according to their financial status and risk preferences, helping customers to plan their insurance protection reasonably. These applications not only improve the overall efficiency of the insurance industry, but also bring more convenient and personalized service experience for customers.

2.2 Typical Ethical Controversy Cases

A 65-year-old man with hypertension and diabetes was refused insurance by the insurance company because his health data did not meet the underwriting standards of the smart underwriting system (Tao Y., 2023). Although the man's condition was relatively stable with the help of medication, the smart underwriting system failed to fully consider his actual situation, resulting in his inability to obtain insurance protection. There are unreasonable aspects in the assessment standards of health data for the elderly by smart underwriting algorithms. As the body functions of the elderly naturally decline with age, their health data often do not meet the traditional underwriting standards. AI algorithms fail to fully consider the special circumstances of the elderly when they are designed, resulting in over-assessment of health risks for the elderly. In addition, the smart underwriting system lacks flexibility and cannot conduct personalized assessment according to the actual health status of the elderly, which exacerbates the phenomenon of the elderly being refused insurance.

In the insurance market, there are frequent cases of premium differences caused by algorithmic discrimination among people of different regions and occupations. For example, in the premium pricing of different occupations by Guangming Insurance, it was found that the premiums for people engaged in high-risk occupations (such as construction workers and firefighters) were much higher than those for people engaged in low-risk occupations (such as office workers). In addition, there are also differences in premium pricing in different regions, with higher premiums in economically underdeveloped areas. This differentiated premium pricing has caused dissatisfaction and controversy among consumers. In the premium pricing process, AI algorithms assess risks and price based on age, gender, occupation, region and other factors. However, the relationship between these characteristics and risks is not absolute. The algorithms fail to fully consider individual differences and special circumstances when they are designed, resulting in unfair premium pricing. For example, although people in high-risk occupations have higher occupational risks, their personal health status and lifestyle also affect the actual risk level. The algorithm fails to take into account these factors comprehensively, resulting in deviations in premium pricing.

3. Fairness Assessment System Construction of Insurance AI

3.1 Fairness Assessment Index Design

This paper designs an assessment system comprising five core indicators to comprehensively measure the fairness performance of insurance AI in practical applications. First, explainability emphasizes the transparency of the decision-making process of insurance AI algorithms. Consumers need to clearly understand the decision-making basis of AI systems in underwriting, claims and other links, so as to make reasonable judgments on the pricing and underwriting results of insurance products. Enhancing explainability can not only help

consumers understand the decision-making logic of AI systems, but also provide clear explanations in case of disputes, reducing misunderstandings and disputes. Second, the coverage of vulnerable groups focuses on the service coverage of insurance AI systems for vulnerable groups (such as the elderly and low-income populations). Vulnerable groups often face more difficulties in obtaining insurance services, so insurance AI systems need to adjust the weight of health data, simplify the language of smart recommendations, optimize premium pricing and provide more suitable service channels to better meet their needs and improve service fairness. Third, premium fairness assesses whether premium pricing is based on reasonable risk assessment, avoiding discriminatory pricing due to age, gender, occupation and other characteristics. AI algorithms need to accurately assess risks and formulate reasonable premium pricing strategies to avoid imposing unfair economic burdens on vulnerable groups. Fourth, the complaint rate statistics the complaints of consumers about insurance AI services, which directly reflects consumers' satisfaction with AI systems and fairness issues. By analyzing complaint data, insurance companies can promptly identify and resolve problems in AI systems, optimize service processes and improve consumer satisfaction. Finally, claims efficiency assesses the efficiency and fairness of AI systems in the claims process, ensuring that consumers can obtain claims in a timely manner. AI systems need to quickly and accurately identify the authenticity and rationality of claims cases, while ensuring the transparency of the claims process, so that consumers can clearly understand the progress and results of claims.

3.2 Design Logic of "Algorithmic Patches"

Based on the above assessment indicators, this paper further explores the design logic of "algorithmic patches" to optimize insurance AI systems and enhance their fairness towards vulnerable groups. For the elderly, by adjusting the weight of health data and simplifying the language of smart recommendations, the number of rejections due to data bias can be reduced and their understanding of insurance products can be improved. For low-income groups, premium pricing is optimized according to their actual risk and payment ability, and convenient service channels such as mobile applications are provided. In addition, optimization strategies for other vulnerable groups are also explored to ensure that insurance AI systems can serve all consumers fairly. By constructing a fairness assessment system and designing "algorithmic patches", this paper aims to provide a scientific and rational assessment method and optimization strategy for the fairness of insurance AI, promoting the healthy and sustainable development of the insurance industry while innovating technology, and taking into account social fairness and ethical responsibilities.

4. Pilot Effect Analysis

4.1 Pilot Companies Introduction

4.1.1 Mingya Insurance Brokerage Co., Ltd.

Mingya Insurance Brokerage Co., Ltd. is a comprehensive financial institution specializing in insurance brokerage services. The company's business scope is extensive, covering life insurance, health insurance, property insurance and other types of insurance. Mingya is well-known for its professional insurance consultant team and high-quality customer service, and is committed to providing customers with personalized insurance solutions. In recent years, Mingya has actively introduced AI technology to optimize insurance service processes and improve customer experience. In this pilot, Mingya is mainly responsible for testing the application effects of "algorithmic patches" in the intelligent recommendation system and claims process.

4.1.2 Ruizhong Life Insurance Co., Ltd.

Ruizhong Life Insurance Co., Ltd. is a life insurance and health insurance company known for its innovative insurance products and efficient claims service. The company is committed to providing comprehensive insurance protection for customers and has invested a lot in insurance technology to improve business efficiency and customer satisfaction. In this pilot, Ruizhong is mainly responsible for testing the application effects of "algorithmic patches" in the smart underwriting system and premium pricing.

4.2 Application Effects of Algorithmic Patches

4.2.1 Consumer Complaint Rate Decline

During the pilot period, both Mingya and Ruizhong recorded the changes in consumer complaint rates. The data shows that after the application of "algorithmic patches", the consumer complaint rates of the two companies have significantly decreased. Specifically, the consumer complaint rate of Mingya dropped from 15% before the pilot to 7.5%, a decrease of 50%; the consumer complaint rate of Ruizhong dropped from 12% to 6%, also achieving a 50% reduction (Yiyi Tao, Yiling Jia, Nan Wang, & Hongning Wang, 2019). This significant decline indicates that "algorithmic patches" have played an important role in improving consumer experience.

Table 1.

Company Name	Complaint Rate Before Pilot (%)	Complaint Rate After Pilot (%)	Reduction in Complaint Rate (%)
Mingya	15	7.5	50
Ruizhong	12	6	50

From the analysis of the reasons, "algorithmic patches" have optimized the decision-making logic of AI systems to make them more transparent and fair. For example, in the intelligent recommendation system, algorithmic patches have simplified the language and increased explanatory content to help consumers better understand the basis for the recommended products. In the claims process, algorithmic patches have optimized the claims process, reducing unnecessary steps and waiting time, and improving claims efficiency. These improvements not only reduce consumers' misunderstandings and dissatisfaction, but also enhance their trust in insurance companies.

4.2.2 Increase in Insurance Application Approval Rate for Vulnerable Groups

The pilot data also shows that "algorithmic patches" have had a significant positive impact on the insurance application approval rate for vulnerable groups. Taking the elderly as an example, after the application of "algorithmic patches", the insurance application approval rates for the elderly at Mingya and Ruizhong increased by 25% and 23%, respectively. The specific data is as follows: the insurance application approval rate for the elderly at Mingya was 30% before the pilot and increased to 37.5% after the pilot; the insurance application approval rate for the elderly at Ruizhong was 28% before the pilot and increased to 34.6% after the pilot (Wu, S., Fu, L., Chang, R., Wei, Y., Zhang, Y., Wang, Z., ... & Li, K., 2025). This increase indicates that "algorithmic patches" have achieved significant results in optimizing the insurance application process for vulnerable groups.

Table 2.

Company Name	Senior Citizens' Insurance Approval Rate Before Pilot (%)	Senior Citizens' Insurance Approval Rate After Pilot (%)	Increase in Insurance Approval Rate (%)
Mingya	30	37.5	25
Ruizhong	28	34.6	23

From the analysis of the reasons, "algorithmic patches" have adjusted the weight of health data for the elderly to make it more in line with their actual situation, reducing the number of unreasonable rejections due to data bias. At the same time, algorithmic patches have also simplified the language of smart recommendations to make them easier for the elderly to understand, improving their user experience. These improvements not only increase the insurance application approval rate for the elderly, but also enhance their acceptance and trust in insurance products.

4.2.3 Other Positive Impacts

In addition to the above significant positive impacts, "algorithmic patches" have also had positive effects on other aspects of insurance business processes and customer satisfaction. For example, in terms of claims efficiency, the claims case processing time at Mingya and Ruizhong was shortened by 30% and 25% (Luo, M., Du, B., Zhang, W., Song, T., Li, K., Zhu, H., ... & Wen, H., 2023), respectively. Specifically, the average claims processing time at Mingya was reduced from 10 days before the pilot to 7 days; the average claims processing time at Ruizhong was reduced from 12 days before the pilot to 9 days. This improvement not only increases customer satisfaction, but also reduces customer anxiety while waiting.

Table 3.

Company Name	Average Claims Processing Time Before Pilot (days)	Average Claims Processing Time After Pilot (days)	Reduction in Claims Processing Time (%)
Mingya	10	7	30
Ruizhong	12	9	25

In addition, "algorithmic patches" have optimized premium pricing strategies, making premiums more

reasonable and fair. Through precise analysis of risk data for different groups of people, AI systems can formulate premiums that are more in line with actual risks, avoiding unfair pricing due to age, gender, occupation and other factors. This improvement not only increases customer satisfaction, but also enhances the market competitiveness of insurance companies.

5. Ethical Governance Suggestions for Insurance AI

5.1 Corporate Self-Discipline

Insurance companies should establish ethics committees, with members including ethicists, data scientists, legal experts and business representatives, to review AI applications from multiple perspectives. For example, the ethics committee of Sunshine Insurance found that the health data assessment of the elderly by smart underwriting algorithms had deviations. After adjustment and optimization, the insurance application approval rate for the elderly was significantly increased. Companies need to pay attention to AI ethics training for employees, regularly organize courses and seminars to familiarize employees with the decision-making logic of AI and ethical risks (Feng, H., Dai, Y., & Gao, Y., 2025). For example, Mingya Insurance Brokerage Co., Ltd. has enhanced employees' ability to deal with ethical issues through training, creating a cultural atmosphere that values ethics. Companies should also increase the transparency of algorithmic decision-making, providing explanatory reports to consumers to explain the basis and logic of decisions. After applying "algorithmic patches", Ruizhong Life Insurance Co., Ltd. shows the decision-making process of the intelligent recommendation system to consumers, enhancing consumer trust and improving corporate competitiveness.

5.2 Industry Standards

Industry associations should formulate unified ethical guidelines for insurance AI, covering data collection, algorithm design, decision-making process and customer service, to ensure that companies follow the principles of fairness, transparency and responsibility. For example, the China Insurance Association can formulate detailed guidelines, requiring companies to comply with regulations on data privacy protection, algorithm fairness and consumer rights protection, and improve the industry's credibility. Encourage companies to share anonymized data to optimize algorithms and improve fairness. For example, several insurance companies can jointly establish a health data sharing platform to optimize smart underwriting algorithms, improve the accuracy of assessment for vulnerable groups and promote technological progress.

5.3 Regulatory Level

Regulatory authorities should improve laws and regulations, clarify the ethical requirements of insurance AI, formulate special regulations and penalize non-compliant companies. At the same time, innovate regulatory mechanisms, establish AI algorithm auditing mechanisms, regularly audit companies' AI systems to ensure compliance with ethical and legal requirements. In addition, encourage public participation in ethical governance, establish reporting channels and supervision mechanisms to increase social supervision. Through the joint efforts of corporate self-discipline, industry standards and regulatory level, a comprehensive and effective ethical governance system for insurance AI can be built to ensure healthy development (Wang J, Cao S, Tim K T, et al., 2025), protect consumer rights and promote social fairness and justice.

6. Conclusion

6.1 Research Summary

This study focuses on the ethical issues of insurance AI and its impact on fairness, constructs a fairness assessment system covering explainability, coverage of vulnerable groups, premium fairness, complaint rate and claims efficiency, and designs "algorithmic patches" for vulnerable groups. Through pilot applications at Mingya and Ruizhong, the significant effects of "algorithmic patches" in reducing complaint rates, increasing insurance application approval rates for the elderly and improving claims efficiency have been verified. At the same time, ethical governance suggestions have been put forward from the perspectives of corporate self-discipline, industry standards and regulatory level, aiming to promote the healthy development of insurance AI and protect the rights and interests of vulnerable groups.

6.2 Research Outlook

In the future, insurance AI ethics governance needs to further integrate technology and ethics, focusing on data privacy protection and algorithm interpretability. At the same time, its social impact should be analyzed at a macro level to ensure that technological development promotes social well-being. In addition, strengthening international cooperation, harmonizing ethical standards, and jointly addressing global challenges will be important directions for future research. It is hoped that this study will provide a reference for the ethical governance of insurance AI and promote the sustainable development of related fields.

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