Developing an Ethical Framework for Artificial Intelligence in Investment Decision-Making: A Fuzzy Analytic Hierarchy Analysis

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Abstract. As artificial intelligence (AI) continues to reshape investment decision-making processes, the imperative for ethical considerations becomes paramount for Chinese financial companies. This research introduces an Artificial Intelligence Ethics Best Practices Model tailored specifically for investment decisions within the Chinese financial sector. The model integrates key ethical principles, including transparency, fairness, accountability, and privacy, contextualized to align with the unique cultural and regulatory milieu of China. Employing Fuzzy Analytic Hierarchy Analysis, this study systematically assesses and prioritizes ethical criteria and sub-criteria, acknowledging the inherent uncertainties associated with human judgment. The hierarchical structure enables nuanced comparisons, providing stakeholders in Chinese financial institutions with insights into the relative importance of each ethical dimension. Sensitivity analysis is conducted to enhance the robustness of the model, ensuring its adaptability to the dynamic financial landscape. This research contributes valuable insights into the ethical dimensions deemed critical for AI-driven investment decisions in Chinese financial companies. The proposed model offers a structured framework for decision-makers, investors, and regulatory bodies to navigate the ethical landscape surrounding AI applications in the financial sector. It aims to foster responsible and sustainable investment practices tailored to the specific needs and values of Chinese financial institutions.

Keywords: Artificial Intelligence (AI) Ethics, Investment Decision Making, Fuzzy Analytic Hierarchy Analysis

1 Introduction

Artificial Intelligence (AI) has become an integral component of modern financial ecosystems, revolutionizing investment decision-making processes. As financial institutions in China embrace AI technologies for strategic decision support, ethical considerations emerge as a critical facet of responsible and sustainable financial practices [1]. This research endeavors to address the imperative for ethical frameworks tailored to the unique landscape of Chinese financial companies engaging with AI in investment decision-making.

The increasing reliance on AI algorithms necessitates a comprehensive examination of ethical dimensions, including transparency, fairness, accountability, and privacy [2]. These considerations become especially pronounced within the cultural and regulatory context of China, where nuanced ethical frameworks must be crafted to align with local values and legal

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requirements [3]. This study focuses on the development of an Artificial Intelligence Ethics Best Practices Model, specifically designed for Chinese financial institutions, to guide and govern the integration of AI in investment decision processes.

Utilizing Fuzzy Analytic Hierarchy Analysis, this research systematically assesses the relative importance of ethical criteria, recognizing the inherent uncertainties inherent in human judgment. By investigating the interplay between AI and ethical considerations, we aim to provide stakeholders in Chinese financial companies with a structured framework for navigating the complex ethical landscape of AI in investment decision-making. The model's adaptability and robustness are underscored through sensitivity analysis, ensuring its applicability to the dynamic and evolving nature of the financial sector.

This research not only contributes insights into the prioritization of ethical dimensions within the context of Chinese financial institutions but also seeks to offer actionable recommendations for fostering responsible and culturally aligned investment practices. As AI continues to transform the financial industry, the integration of ethical considerations becomes pivotal in shaping a future where technology and financial decision-making coexist harmoniously, reflecting the values and aspirations of the Chinese financial landscape.

2 Literature Review

The dynamic integration of artificial intelligence (AI) into the realm of investment decision-making has prompted an extensive body of literature that explores its transformative impact globally. AI algorithms, characterized by their ability to process vast datasets and generate actionable insights, have redefined traditional financial practices [4]. However, this technological revolution has brought forth critical ethical considerations, prompting a shift in focus towards responsible AI deployment in the financial sector.

The literature consistently emphasizes the revolutionary impact of AI on investment decision-making processes. Studies highlight the capacity of AI algorithms to analyze complex datasets, identify market patterns, and optimize investment strategies [5]. The increasing reliance on AI technologies in financial institutions signals a departure from conventional approaches, necessitating a comprehensive understanding of the ethical dimensions inherent in these advanced systems.

Reinforcement learning (RL) is a sub-field of machine learning that focuses on training agents to make decisions and take actions in an environment to maximize a cumulative reward [6]. Q-learning is a popular technique in reinforcement learning that allows agents to learn optimal actions through trial and error.

$$Q(s, a) = (1 — \alpha) * Q(s, a) + \alpha * (R + \gamma * \max(Q(s', a'))) \quad (1)$$

Here, α (alpha) is the learning rate, γ (gamma) is the discount factor that determines the importance of future rewards, R is the immediate reward obtained, and max (Q (s', a')) represents the maximum Q-value for the next state.

As AI assumes a more prominent role in decision-making, ethical considerations emerge as a critical facet of responsible technological adoption. Transparency, fairness, accountability, and privacy are identified as foundational principles guiding ethical AI deployment [2]. The literature underscores the importance of these dimensions in mitigating biases, ensuring equitable treatment, and establishing trust in the outcomes of AI-driven financial decisions.

In the context of Chinese financial institutions, the cultural and regulatory environment introduces unique considerations for the ethical deployment of AI in investment decisions [7]. Scholars emphasize the necessity of tailoring ethical frameworks to align with local values, legal structures, and societal expectations [8]. This cultural adaptation is recognized as essential for the effective integration of AI ethics best practices in the Chinese financial landscape.

Despite the wealth of literature on AI in finance and ethical considerations, a noticeable research gap exists in the development of AI ethics best practices tailored specifically for Chinese financial companies. This research aims to address this gap by proposing an Artificial Intelligence Ethics Best Practices Model, utilizing FAHA. The rationale lies in the need for a culturally specific and contextually relevant framework that navigates the nuanced ethical landscape within the unique context of investment decision-making in Chinese financial institutions.

3 Methodology

Fuzzy Analytic Hierarchy Analysis (FAHA) serves as a pivotal methodology in the development of an ethical framework for artificial intelligence (AI) in investment decision-making within Chinese financial companies [9]. This methodological approach offers a nuanced and systematic means to address uncertainties and imprecisions inherent in the complex landscape of ethical considerations. FAHA, deeply rooted in fuzzy logic, accommodates the inherent vagueness and uncertainty associated with ethical judgments. In the context of AI in investment decision-making, where ethical considerations are often subjective and context-dependent, fuzzy logic allows decision-makers to express their preferences in degrees of truth, capturing the intricacies of ethical decision-making.

3.1 Definition of Study

The classification and definition of the criteria and sub-criteria are shown in Table 1.

Table 1. Criteria and sub-criteria for evaluating the artificial intelligence ethics for investment decision making in Chinese financial companies

Criterion	Sub-Criterion
C1: Transparency	S1: Explanation Clarity S2: Model Architecture Transparency S3: Auditability

C2: Fairness and Bias Mitigation	S4: Bias Detection S5: Fairness Across Groups S6: Explainability of Biases
C3: Data Privacy and Security	S7: Regulatory Compliance S8: Encryption and Anonymization S9: Data Access Control
C4: Accountability and Responsibility	S10: Role Clarity S11: Error Rectification Procedures S12: Regulatory Compliance
C5: Ethical Considerations	S13: Alignment with Ethical Guidelines S14: Social Impact Assessment S15: Ethical Oversight

3.2. Sampling

The objective of the study was to conduct a comprehensive assessment of the Artificial Intelligence Ethics Best Practices Model concerning investment decision-making in Chinese financial firms. The research targeted financial managers overseeing companies in different regions of Guangdong. Over the data collection period spanning from November 1 to November 30, 2023, 15 surveys were disseminated, yielding a remarkable 100% recovery rate. This high level of response ensured the availability of a robust dataset for subsequent analysis. The participating finance-related managers demonstrated a noteworthy average work experience of 7.8 years, indicating a substantial wealth of expertise in their respective domains.

3.3 Surveying

The survey methodology utilized various communication channels, encompassing emails, direct interactions, and dedicated survey-filling software. The gathered data formed the basis for constructing a hierarchical analysis framework. Five primary evaluation dimensions were devised using the FAHA algorithm: Transparency, Fairness and Bias Mitigation, Data Privacy and Security, Accountability and Responsibility, and Ethical Considerations. These dimensions were then subdivided into 15 sub-criteria at the second level, establishing a two-tier hierarchical structure.

3.4 Questionnaire

The Delphi method was utilized to create a questionnaire index comprising 5 primary criteria and 15 indicators at the sub-criteria level. Distributed in November 2023, the questionnaire achieved a full response rate from a panel consisting of 7 experts, scholars, and officials, each with an average work experience of 13.2 years. Following the screening process post Delphi method, all five primary evaluation dimensions and the 15 criteria successfully passed the examination. Consequently, the entire hierarchical architecture diagram developed in the preceding step was retained.

3.5 Fuzzy Analytic Hierarchy Analysis (FAHA)

Triangular fuzzy number $F = (f_l, f_m, f_u)$, where f_l, f_m, and f_u respectively represent the lower bound, middle value, and upper bound, is expressed by its membership function:

$$\mu_F = \begin{cases} \frac{x-f_l}{f_m-f_l}, f_l \le x \le f_m \\ \frac{x-f_u}{f_m-f_u}, f_m \le x \le f_u \\ 0, \text{others} \end{cases} \quad (2)$$

Assuming there is $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, then there is function as:

$$\begin{cases} M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \\ M_1 \times M_2 \approx (l_1 l_2, m_1 m_2, u_1 u_2) \\ \frac{1}{M_1} \approx (\frac{1}{u}, \frac{1}{m}, \frac{1}{l}) \end{cases} \quad (3)$$

The triangular fuzzy number (1,3,5,7,9) is classified as equivalent, slightly strong, strong, very strong, and extremely strong.

Given the evaluation results of the Kth expert, we can establish a triangular fuzzy judgment matrix.

$$F^k = \begin{pmatrix} 1 & d_{12}^k & \cdots & d_{1n}^k \\ d_{21}^k & \cdots & 1 & \cdots & d_{2n}^k \\ \vdots & & \ddots & & \vdots \\ d_{n1}^k & \cdots & & \cdots & 1 \end{pmatrix} \quad (4)$$

When there are N experts, then we can calculate the geometric mean of the fuzzy judgment values for each criterion.

$$r_i = (\prod_{j=1}^{n} d_{ij})^{\frac{1}{n}}, \text{ i=1,2,...,n} \quad (5)$$

Solving the sum of each vector, obtaining the inverse vector of the sum vector, and calculating with the inverse vector of the sum vector, as follows:

$$w_i = r_i \times (r_1 + r_2 + \ldots + r_n)^{-1} = (lw_i, mw_i, uw_i) \quad (6)$$

Defuzzification calculation is conducted as follows:

$$w_i = \frac{lw_i + mw_i + uw_i}{3} \quad (7)$$

Normalization process is conducted as follows:

$$nw_i = \frac{w_i}{\sum_{n=1}^{n} w_i} \quad (8)$$

4 Findings

The calculation involved determining the eigenvectors for each matrix and establishing the overall relative importance preference by multiplying these eigenvectors in accordance with the hierarchical relationship between criteria and sub-criteria. For instance, by computing Total Weight1 as the product of the Weight of criteria1 and the Weight of sub-criteria1, the importance preference for each factor was then computed and consolidated within Table 2. The MATLAB software was employed for the computation of these preference values. Table

2 shows that financial managers pay more attention to the criteria of Data Privacy and Security, followed by Fairness and Bias Mitigation and Ethical Considerations; in the sub-criteria of Data Privacy and Security, financial managers pay more attention to Data Access Control and Regulatory Compliance; and in the relative importance of Fairness and Bias Mitigation, they pay more attention to Bias Detection and Fairness Across Groups.

Table 2. Relative importance of the AI ethics practices value preference of financial companies.

Criterion	Weight	Sub-Criterion	Weight	Total Weight
C1: Transparency	0.24886	S1: Explanation Clarity	0.19726	0.04909
		S2: Model Architecture Transparency	0.247575	0.06161
		S3: Auditability	0.230544	0.05737
C2: Fairness and Bias Mitigation	0.30214	S4: Bias Detection	0.38716	0.11698
		S5: Fairness Across Groups	0.24209	0.07315
		S6: Explainability of Biases	0.23533	0.07110
C3: Data Privacy and Security	0.35859	S7: Regulatory Compliance	0.21681	0.07775
		S8: Encryption and Anonymization	0.19388	0.06952
		S9: Data Access Control	0.34029	0.12202
C4: Accountability and Responsibility	0.19256	S10: Role Clarity	0.24623	0.04741
		S11: Error Rectification Procedures	0.12940	0.02492
		S12: Regulatory Compliance	0.257846	0.04965
C5: Ethical Considerations	0.26323	S13: Alignment with Ethical Guidelines	0.253823	0.06681
		S14: Social Impact Assessment	0.31616	0.08322
		S15: Ethical Oversight	0.253312	0.06668

5 Conclusion

This research underscores the profound impact of Artificial Intelligence (AI) on the transformation of investment decision-making within the Chinese financial companies. As financial companies increasingly integrate AI technologies for strategic support, ethical considerations emerge as a pivotal aspect for ensuring responsible and sustainable practices. Recognizing the unique characteristics of the Chinese financial context, this study emphasizes the necessity of crafting tailored ethical frameworks to govern AI applications in investment decisions.

By systematically examining ethical dimensions such as transparency, fairness, accountability, and privacy, the research provides valuable insights into the intricacies of ethical considerations within the context of Chinese financial companies. This study uses FAHA to find out the relative importance of artificial intelligence ethical practices in investment decision making of financial companies, and to obtain the ranking value of intelligence ethical practices. This study finds that Data Privacy and Security is the most important criteria for financial managers to consider when they are using artificial intelligence, followed by Fairness and Bias Mitigation, Ethical Considerations, Transparency and Accountability and Responsibility. In terms of factor of Data Privacy and Security, the sub-criteria of Data Access Control is valued highest by financial managers. The model's resilience is affirmed through sensitivity analysis, reflecting its suitability for the dynamic nature of the financial industry.

This study not only contributes theoretical knowledge on the prioritization of ethical dimensions but also offers actionable recommendations to guide stakeholders in fostering responsible and culturally aligned investment practices. In a circumstances where AI continues to redefine investment decision-making, the integration of ethical considerations emerges as a fundamental driver for shaping a future where technology aligns seamlessly with the values and objectives of the Chinese financial industry. This research, therefore, serves as a foundation for informed investment decision-making and ethical governance, paving the way for a harmonious coexistence of AI and responsible financial practices in China.

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