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Examining Sustainable Overseas Investment Information-Sharing Model for Automobile Enterprises: A Multi-Modal Weight Network Approach

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Abstract

In an era of globalization, automotive companies are increasingly looking to make overseas investments to expand their production capacity and explore foreign markets. However, the outcomes of such investments are often influenced by a myriad of factors, including policy changes, social dynamics, and market conditions. To address the need for a comprehensive overseas investment information-sharing model, this research proposes an innovative approach based on a multi-modal weight network. This model aims to provide users with a global perspective on overseas investment opportunities, encompassing policy insights, and market dynamics. It integrates data from various sources, offering multi-dimensional information on investment regions, scales, fields, motivations, and strategies. Real-time updates ensure the timeliness and accuracy of the information, enabling users to adapt to the rapidly changing international economic landscape. Challenges such as data collection, privacy concerns, investment diversity, advanced analytics, and real-time updates are carefully considered and addressed. The model incorporates sophisticated analytical methods to extract valuable insights from vast data, guiding sound decision-making for automotive enterprises. Experimental results demonstrate an impressive accuracy rate of 87.9% and an mAP value of 86.8%, highlighting the model's effectiveness in providing precise and reliable investment information. This innovative multi-modal weight network model empowers automotive companies to navigate the complexities of international investments, enabling them to make informed decisions and achieve success in the global market.

Keywords Overseas investment · Information-sharing model · Multi-mode weighting · Continuous bag of words · Sharing platform

Extended author information available on the last page of the article

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Introduction

Influenced by the globalization of trade, many automobile companies have made large-scale investments overseas, which can not only help automobile companies increase production capacity and expand foreign markets but also help enterprises better evaluate their long-term growth potential. However, due to the influence of policy, social, and other factors (Miglani, 2019; Ghauri et al., 2021), the outcome of many overseas investments is bleak. In order to help more automobile enterprises avoid failed overseas investments, it is urgent to build an excellent overseas investment information-sharing model.

The overseas investment information-sharing model of automobile enterprises needs to help users get comprehensive and multi-dimensional investment information about the destination, such as policy and market. Therefore, the model first needs to have a global perspective and provide the overseas investment situation of automobile enterprises on a global scale to help enterprises, governments, and researchers obtain more comprehensive industry insight. Secondly, the information shared should be multi-dimensional to integrate various information sources, including information on investment region, scale, field, motivation, and strategy, enabling users to conduct in-depth analysis (Liu et al., 2020). This model can then provide important support for automotive companies' investment decisions, market analysis, and competitor evaluation, helping them formulate more informed strategies. Finally, considering the rapidly changing international economic market, the model needs to update its data regularly or in real-time, ensuring the timeliness and accuracy of the information and helping users track changes in the industry.

The information-sharing model for overseas investment of automobile enterprises presents several critical challenges that demand careful consideration and robust solutions. As outlined in the existing literature (Gallagher & Qi, 2021; Corley, 2020), these challenges encompass data collection and integration, privacy concerns, diversity of investments, advanced analytics, and the need for real-time updates. To begin, the process of collecting and integrating massive overseas investment data is a formidable hurdle. This is further complicated by the diverse sources and formats from which this data originates. Ensuring data quality and accuracy is of paramount importance because any inaccuracies can severely undermine the subsequent analyses and decision-making processes. Robust data management and cleansing protocols are essential in addressing this issue. Privacy and data security emerge as the second significant challenge. Some information related to investment decisions and trade secrets may be highly sensitive. Therefore, the information-sharing model must be equipped with mechanisms to protect these sensitive data, ensuring full compliance with relevant laws and corporate policies. This not only involves data encryption and secure access control but also comprehensive audits to track any potential breaches. Overseas investments by automobile companies often span multiple countries, regions, markets, and sectors, leading to the need for a versatile model. It should be able to adapt to these diversities and cater to a range of scenarios.

Flexibility and adaptability are critical qualities that such a model should possess. The fourth challenge pertains to the analysis of overseas investment information. The model needs to incorporate sophisticated analytical methods and algorithms to extract valuable insights from this vast amount of data. This ensures that the information is not just shared but is also intelligently processed to guide sound decision-making. Furthermore, given the rapidly changing landscape of the automotive industry, the model must continuously update its data and analysis results. It is vital to establish an efficient update mechanism to maintain real-time information. Timely updates (Wang, 2020; Huang et al. 2019a) will provide decision-makers with the most current insights, enabling them to respond to market dynamics and changing conditions promptly.

Thanks to the Internet, big data platforms, and spatial information technology, the information-sharing model has been fully developed. Numerous researchers employ specialized software to construct information platforms, transform data into models, and present information in a more intuitive manner. In the work of Liu et al. (2021), the focus was on studying investment and security information sharing within enterprises using the evolutionary game method. They established an evolutionary game model involving a return matrix, conducted an analysis of the evolutionary strategy using dynamic equations, and provided valuable guidance for enhancing enterprise information sharing. Building upon this, Liu et al. (2022) delved into the relationship between enterprise incentive behavior and information-sharing practices. Through the construction of a game model among enterprises, they proposed an incentive mechanism designed to promote more effective enterprise information-sharing. Taking a systems and information perspective, Alzoubi and Yanamandra (2020) contributed to the analysis of the information-sharing process. They devised a measurement index system to assess internal information-sharing factors within enterprises. The results of their study underscored that information quality emerged as the most influential factor affecting the sharing of information. This collective body of research showcases the diverse methodologies and perspectives employed by scholars to explore and enhance information-sharing dynamics in the realm of enterprises. However, these methods can only implement end-to-end sharing and cannot realize the investment information sharing of too many enterprises. In addition, it is difficult to update the evolutionary model, which cannot realize the real-time sharing of overseas investment information of automobile enterprises.

Therefore, we propose an overseas investment information-sharing model of automobile enterprises based on a multi-model weight network to ensure the accuracy of overseas investment information, predict the policy and social conditions of overseas investment, and improve the efficiency of overseas investment of automobile enterprises. Firstly, this paper proposes a method for selecting overseas investment information for automotive companies. This involves extracting relevant news articles, official announcements, investment reports, investment data, business dynamics, regional analyses of the automotive industry, and social media related to the automotive sector. The aim is to achieve a comprehensive understanding of overseas automotive investment scenarios. Subsequently, a classification model for investment information based on a multi-modal weight network is introduced to achieve a deep understanding of investment information. Finally, utilizing the proposed method, a platform for sharing overseas investment information for automotive companies is designed to assist in the decision-making process for overseas investments.

The main contributions of this paper are as follows:

1. We present a methodology to effectively curate international investment data tailored for automotive companies. This approach facilitates a comprehensive analysis of the automotive investment landscape by employing feature representation, thereby establishing a robust research groundwork for information sharing.
2. Our innovation involves the development of an investment information classification model, leveraging a multi-modal weight network. This model contributes to the establishment of the foundational framework for a collaborative platform, employing intelligent processing techniques for investment information.
3. In comparative evaluations against other state-of-the-art methodologies, our approach achieves 0.868 mAP value and outperforms, demonstrating superior performance in the dataset.

Related Works

Nowadays, the information-sharing model has been applied in various fields, such as social media and network analysis, health care, finance, supply chain and logistics, urban planning, traffic management, and energy management. The research on the information-sharing model continues to evolve in various fields (Tang et al., 2019). These models may involve techniques to better understand, predict, and respond to real-world problems. For the development of automobile enterprises, the establishment of an information-sharing mode can improve the problem of safety information asymmetry, promote the effective dissemination of enterprise information, and then improve the investment efficiency of enterprises. Second, it helps all enterprise departments to form safety management forces vertically and horizontally, thereby improving the decision-making ability and problem-solving efficiency of the enterprise, thus improving the safety production level (Helo & Hao, 2019). Information sharing among automobile enterprises can be effectively promoted through the establishment of an information-sharing mode.

In the context of the automotive industry, the implementation of an information-sharing model carries significant benefits. It is a powerful tool for mitigating the problem of safety information asymmetry, which has far-reaching implications for enhancing investment efficiency. This model enables automobile enterprises to make more informed and safer investment decisions by facilitating the exchange of pertinent safety-related information. Timely access to safety data, industry trends, and emerging risks equips these enterprises with the knowledge to optimize their strategies. Furthermore, the adoption of an information-sharing model within automobile enterprises fosters a culture of safety management. This culture permeates both vertically and horizontally across various departments, resulting in an organizational environment where safety is a collective responsibility. The model serves as a catalyst for the development of safety management forces throughout the enterprise. This, in turn, bolsters the decision-making capabilities and problem-solving efficiency of the organization. A more safety-conscious culture not only reduces the likelihood of accidents but also improves the overall efficiency of production processes. One of the central advantages of information-sharing models is the promotion of effective information exchange among automobile enterprises. In an increasingly interconnected and competitive industry, this sharing is essential for fostering innovation, efficiency, and safety. Collaboration among companies can lead to shared best practices, the identification of emerging safety issues, and the joint development of solutions. This collective approach to information sharing not only benefits individual enterprises but also contributes to the overall advancement of the automotive industry.

Luo et al. (2008) propose an information collection platform based on a new type of automation system based on domestic and foreign coal mine supervision systems, which can improve information sharing. Considering that automation platforms are often challenging to integrate as a whole into the infrastructure and can be difficult to maintain, Yu et al. (2009) developed a safety information system for a southwest county based on MapGIS and VisualC + +6.0 and Visual InterDev 6.0 and adopted a mixed C/S and B/S architecture to construct the information-sharing model and reduce the cost. Jeong and Leon (2012) put forward the optimal method of supply chain coordination via full and partial information sharing and concluded that employees can translate the solution to other employees under partial information sharing. In order to manage production safety information, Yang and Zhang (2016) proposed a new information platform through the design of a code designer, system universal service, system interface, etc., to ensure the safety of enterprises in production, and the platform met the needs of enterprise information sharing and safety supervision. The platform can provide stability and performance for the application scenario of safe production. However, there are numerous factors that automotive enterprises need to consider when investing in sharing. It is difficult to directly adopt its technology for information sharing. Jian et al. (2019) describe the function of a network and analyze the information sharing. Aiming at various limitations, an evolution model is established, and the dynamic evolution of information sharing in network organizations is analyzed through inference and evolution. Based on the simulation results of an agent, Tan et al. (2019) apply the evolution to analyze the evolution process of sharing among enterprises. Evolutionary game algorithms are a game theory model that evolves dynamically through natural selection and adaptability, capturing the adaptability and evolutionary processes within a system. By simulating natural selection, this model can explain why certain strategies or features become more prevalent in a population. Gu (2020) analyzes the information game relationship using the evolutionary game and constructs an information-sharing model using Vsesim, which can indicate that enterprise information is positively correlated with the evolutionary game results of the government incentive level. Li (2021) analyzed the information sharing among enterprises and the factors affecting the evolution of sharing, used evolutionary game theory, and put forward suggestions for the information sharing platform.

Wang et al. (2021) explore the law of information-sharing behavior, analyze the dynamic evolution process, and discuss the influencing factors before putting forward four characteristics of information-sharing management. Li et al. (2022) and other scholars studied the enthusiasm of information sharing, built a tripartite evolution model on the assumption of bounded rationality, and used Vensim to conduct dynamic simulation and analysis of the evolution process to explore the impact of changes in sharing. However, evolutionary games often involve significant computational complexity, especially when simulating dynamic evolution across multiple generations. This complexity makes handling large-scale problems challenging and computationally intensive. With the development of deep learning, the evolution of information-sharing models is gradually shifting towards intelligent platforms based on convolutional neural networks or recurrent neural networks.

Information-Sharing Model of Overseas Investment of Automobile Enterprises Based on Multi-mode Weighting Network

An information-sharing model serves as a conceptual framework for the design of organizational and systemic structures, intending to facilitate the seamless flow and exchange of information both within and beyond an organization. Typically employed to enhance communication, collaboration, and decision-making processes, these models fundamentally view information as a vital resource. The central premise revolves around ensuring the ubiquity and accessibility of information across the organization through the implementation of suitable technologies, processes, and a supportive cultural environment. By treating information as a critical asset, these models aim to optimize its availability, fostering a more interconnected and informed organizational landscape.

Selection of Overseas Investment Information for Automobile Enterprises

In order to build an information-sharing model, we first need to collect multi-dimensional and multi-faceted information on the destinations of overseas investment of automobile enterprises to build a sharing model.

First of all, the news media of the investment destination contains news information f_N about the automobile industry, especially about the local market and the expansion of enterprises. Large financial news websites, media specialized in the auto industry, and financial magazines are the way to get this information. Second, the official announcements of the local automobile companies in the destination also contain a lot of valuable information f_P. Check the official websites of their auto businesses regularly, especially in the investor relations or news section, to learn about their production and investment plans, partnerships, and other business activities. Third, local government agencies or trade organizations may issue investment reports on foreign auto companies f_I. These reports may contain investment data on the automobile industry, including detailed information on the amount of investment, investment projects, etc. Fourthly, some well-known commercial databases and financial data providers will provide investment data and business dynamics f_B of local auto companies. Meanwhile, local market research institutions or consulting companies will release analysis reports f_A of the auto industry, which may include data and insights on overseas investment and global trade. Finally, local social media will contain a lot of information f_M about automobiles, such as purchase preference, available payment amount, and car demand.

The information conducive to investment contained in the overseas investment sharing model of automobile enterprises can be expressed as $F_N=\{f_P, f_I, f_B, f_A, f_M\}$. Since this information is all text, we need to convert them into acceptable quantitative features of the model before building the sharing model. Therefore, we encode it using the continuous bag of words model (CBOW) and the jump-word model.

The input layer of CBOW is encoded by one-hot context $\{x_1, x_2, \ldots, x_c\}$, and the vocabulary size is V. The CBOW can be presented in Fig. 1. First, we connect the input vector through a $V\times N$ dimensional weight matrix W to the hidden layer. Then, the hidden layer is connected to the output layer through an $N\times V$ dimensional weight matrix. Finally, we utilize one-hot encoding for the output word y. Calculate the hidden layer h as the average weightings of the input vectors

$$h = \frac{1}{c} W \bullet \left(\sum_{i=1}^{C} x_i \right) \tag{1}$$

where W refers to the learnable matrix and h means the hidden layer.

Then, the input of each layer is:

$$u_j = v_{wj} \bullet h \tag{2}$$

where v means the encoded x.

Therefore, we can calculate that the output yi can be expressed as:

$$y_{c,j} = \frac{exp\left(u_j\right)}{\sum_{j=1}^{V} exp(u\prime j)} \tag{3}$$

where W is the original input matrix, v_{wj} is the j-th column of W, and u represents the original result of the output layer.

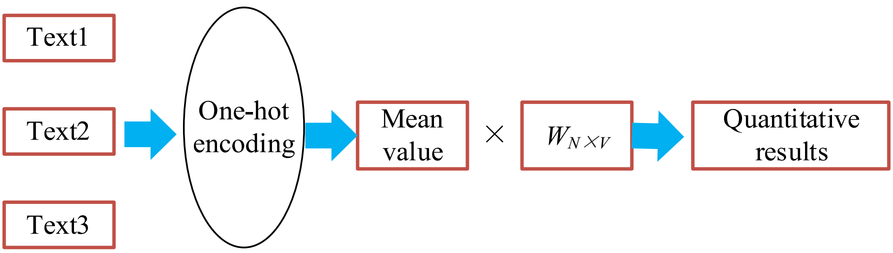

Fig. 1 CBOW model

Investment Information Classification Model Based on Multi-pattern Weight Network

However, through the above methods, our model can encode the information on overseas investment of automobile enterprises. However, the large amount of data in the sharing model makes it difficult to search the corresponding investment location through coding alone. We must first use investment information from different locations to find the destination. Therefore, we propose a classification model of investment information based on a multi-modal weight network.

The purpose of the multi-modal weighted network classification model (MWCM) is to analyze the investment environment of the destination automobile enterprise by using the above features, comprehensively consider a variety of features, and automatically evaluate the importance of a single feature by using the network to get a more accurate investment destination classification result. In this paper, the proposed multi-modal weight network can be adopted for automotive company information from different investment locations. The goal of this network is to integrate different information modalities to intelligently process investment information and lay the foundation for the basic logic of the sharing platform. In multi-modal weight networks, the role of Transformers may involve processing information from different modalities (such as text, images, sound), as well as achieving effective interaction and fusion between modalities. Through its powerful sequence modeling and feature extraction capabilities, as well as flexible attention mechanisms, the network can better process and understand information from different modalities. The specific model is shown in Fig. 2.

Local investment information YF = $\{y1, y2, \ldots, yj\}$ is input to the overall model. First, destination policy, market, and industry characteristics in YF are obtained by a preference LSTM for the classified probability distribution of environmental quality of automobile enterprises Ps = $\{s1, s2, \ldots, sj\}$. Then, text information related to automotive media, news, etc. in YF passes through an independent CNN to get a probability distribution of the quality of the local automotive audience Pt = $\{t1, t2, \ldots, tj\}$. The result of each single forecast is the embodiment of a single feature in the classification. It dynamically assigns different weights to the forecast results of different models, which means dynamically changing the impact of a single feature

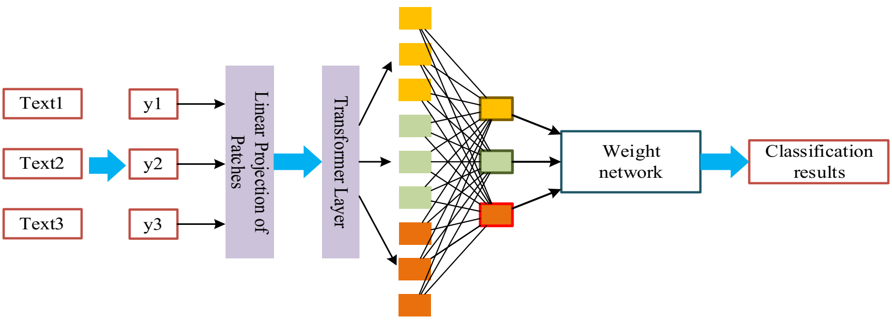

Fig. 2 MWCM model

in the overall classification and further improving the classification accuracy of destination investment information. Within the weighted network, the components of the probability distribution of each single model are used to linearly regression the corresponding components of the final classification probability through the following formula:

$$\theta_n = \omega_s s_n + \omega_t t_n + g \tag{4}$$

where n indicates the classification of investment information. The categories in this article depend entirely on the target location for automotive investment in the sharing model. g is the coefficient that balances the two and is a learnable weight and bias term. θ_n represents the probability that the weighted network will automatically assign weight to the class after regression. The application of Softmax normalization in the context of investment information classification provides a crucial step in obtaining the probability distribution for different investment categories. This distribution reflects the likelihood of investment information belonging to each category, allowing for effective classification and decision-making.

Furthermore, the integration of multi-modal features using the Transformer model adds another layer of sophistication to the process. This choice is driven by the need to capture subtle variations in investment patterns across different regions. Transformer's attention mechanism, a key component of the model, allows for the selective highlighting of regional automotive investment characteristics. It accomplishes this by dynamically weighting the importance of different features, providing a more nuanced understanding of the investment landscape. As a result of this Transformer processing, the features extracted are not only regionally sensitive but also more amenable to subsequent weight model processing. This means that the processed data is optimized for further analysis and modeling, making it easier to discern patterns, correlations, and relevant insights. The combination of Softmax normalization and the Transformer model enhances the effectiveness of information classification and contributes to a more in-depth understanding of regional investment conditions in the automotive sector.

According to the MWCM model in Fig. 2, we can intelligently classify the automobile investment environment of each region in the sharing model. The investment environment of automobile enterprises in each region is shown in Fig. 3.

Design of Information Sharing Platform for Overseas Investment of Automotive Companies

In the information-sharing model, we have finished sorting and summarizing the existing information and built the storage structure related to the investment information of automobile enterprises for different locations (Fig. 3). In order to give full play to the advantages of our information-sharing model, we design an information sharing platform for the overseas investment of automobile enterprises to realize real-time information search, as shown in Fig. 4.

The platform construction is divided into HTML front-end design and MySQL database creation, and its application and functional advantages in an overseas

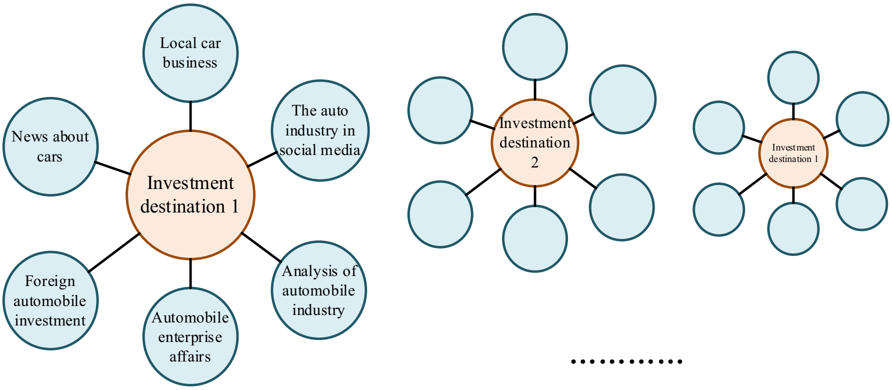

Fig. 3 Information on the investment environment of automotive companies by region

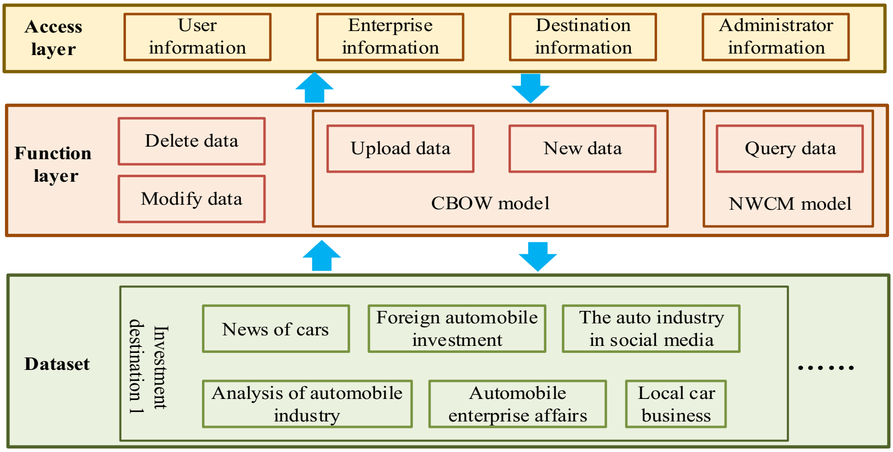

Fig. 4 Information sharing platform for overseas investment of automobile enterprises

investment of automobile enterprises are analyzed to prove the feasibility of the platform. The front-end design of HTML mainly involves HTML, CSS, and JavaScript. Among them, HTML is the hypertext markup language, which can be used to structure headings, paragraphs, lists, and other information and can also be used to describe the web interface. CSS is a cascading style sheet that can be used to describe the style of HTML documents and can be used with various scripting languages to achieve dynamic web page decoration. JavaScript(JS) language has the characteristics of being lightweight and interpretive; not only can it create objects, but it also can use existing objects and can be interpreted while the program is running. MySQL is a relational database management system; this system uses MySQL to create a database for each region to establish a variety of information storage of automobile overseas investment conditions.

Through an in-depth analysis of distinct regional features, our primary emphasis centers on the practical application of an information-sharing platform in the context of overseas investments made by automobile enterprises. This platform leverages a meticulously curated dataset comprising comprehensive data on the investment climate in various regions. Moreover, it incorporates a robust classification model that ensures expedited and precise query responses. This dynamic functionality significantly streamlines the process for automobile companies searching for investment destinations. The platform's design allows for an intuitive, user-friendly experience, enabling businesses to effortlessly access essential investment information or pinpoint ideal investment opportunities based on specific criteria. This feature is of paramount importance, as it empowers automobile enterprises to make well-informed decisions and select locations that align perfectly with their strategic goals. Key functions of the platform encompass publishing, categorizing, tracking, verifying, and continually updating data. The frequency of database updates can be tailored to specific business needs, ranging from daily and weekly to other intervals. For enterprises dealing with real-time data, opting for shorter update cycles becomes viable, with the possibility of employing real-time monitoring mechanisms and immediate triggers for updates. Simultaneously, implementing an automated monitoring system capable of detecting changes in source data, encompassing additions, modifications, or deletions of records. The establishment of an alarm and notification mechanism ensures that the system promptly notifies relevant teams upon detecting data changes, facilitating swift responses. Ensuring data timeliness not only provides real-time decision support but also empowers decision-makers to make more informed choices based on the latest information, especially in areas like market trends and investment opportunities. Real-time updates grant businesses the flexibility to adapt swiftly to changes, enhancing overall business agility. This adaptability is particularly crucial in dynamic markets and competitive environments that undergo rapid transformations. By leveraging real-time data, organizations can advance towards data-driven decision-making, ensuring that strategic planning and execution align with accurate and current information. These functions are pivotal in facilitating the needs of diverse enterprises, ensuring that they can access and filter information according to their unique requirements. This flexibility is integral to supporting businesses with varying investment preferences, enabling them to tailor their searches to find the most suitable investment destinations. The information-sharing platform is a versatile and indispensable tool for automobile enterprises embarking on overseas investments. Its capacity to swiftly deliver accurate and relevant data, coupled with its adaptability to cater to the specific needs of individual businesses, positions it as a valuable resource in the realm of global investment.

Ensuring transparency and confidentiality in data processing is of utmost importance. Firstly, it is imperative to establish and communicate clear privacy policies to all stakeholders, including employees, customers, and users engaging with the data. These policies offer a comprehensive description of the data types collected, the purpose of data processing, and the security measures in place. To enhance data security, sensitive information, both during transmission and in static storage, is encrypted. This robust encryption ensures that, even in the event of unauthorized access, the data remains indecipherable and secure. Secondly, to protect individual privacy, personal identifiers are either removed or encrypted, achieving data anonymization and mitigating the risk of re-identification. The use of disguise replaces sensitive information, allowing for data analysis while preserving privacy. In addition, regular internal privacy audits are conducted to evaluate compliance with privacy policies, scrutinize data processing practices, and pinpoint areas for improvement. This ongoing assessment ensures that the organization remains aligned with evolving privacy standards and continuously enhances its privacy practices.

In navigating the intricacies of today's global market dynamics, automotive companies stand to benefit significantly from the application of multi-modal weight network methods. The process unfolds through a series of strategic steps. Initially, a diverse array of data is collected, encompassing multiple modalities such as text, images, videos, and numerical values. This rich dataset encapsulates information on various aspects of the global market, ranging from company reports and social media content to market trend charts. Subsequently, tailored feature extraction techniques are applied to each modality, utilizing natural language processing, computer vision technology, and statistical analysis methods. The crux of the approach lies in the utilization of a multi-modal weight network designed for purposes. This network learns the weights associated with different modal data, determining their respective contributions to the final result. Through the intricate interplay of these weights, features extracted from individual modalities are fused, giving rise to a comprehensive representation that offers a global perspective. This fusion representation facilitates simultaneous consideration of diverse information sources, enabling a nuanced and thorough understanding of the global market scenario. The true value of this approach comes to fruition in decision-making processes. Decision-makers can draw on the insights extracted from multi-modal weight networks to make judicious choices. Informed by a well-rounded and balanced understanding of the intricacies of the global market, this method enhances the adaptability and decision-making capabilities of automotive industry leaders. Overall, it enables a more comprehensive utilization of multi-source and multi-modal information, providing robust and reliable support for decision-makers navigating the complexities of the global automotive market.

Experiment and Analysis

Dataset and Implement Details

We use the automobile enterprise investment dataset (https://zenodo.org/record/8238450, https://doi.org/10.5281/zenodo.8238450) to test an automobile enterprise overseas investment information-sharing model based on a multi-modal weight network. In our experimental approach, we meticulously selected data sources directly relevant to automotive enterprise investment. These sources encompassed information from automotive industry reports, financial statements, market trend analyses, and more. We placed a high priority on opting for data from trustworthy automotive industry databases and statistical data released by authoritative institutions. This strategic selection ensured the inclusion of comprehensive investment information, spanning various enterprises, regions, and time periods, thereby catering to the demands of thorough and inclusive research. Furthermore, our data processing pipeline involved a thorough cleaning, transformation, and standardization process to guarantee format consistency and overall data quality. Employing unique similarity algorithms, we facilitated the matching of corresponding information across diverse data sources. This matching process was followed by data merging, culminating in the creation of a holistic dataset specifically tailored for automotive enterprise investment. This dataset retained all pivotal information derived from the various sources. As a crucial step, we eliminated duplicate entries during the merging process to uphold the dataset's uniqueness. Throughout the merging and processing stages, we implemented a diligent conflict resolution strategy. By comparing information from disparate data sources, we identified potential conflicts, such as disparities in investment amounts and timings. Our proactive approach involved developing effective conflict resolution strategies, such as favoring information from more reliable data sources for average processing. In some cases, we employed weighted averaging methods to make nuanced adjustments based on actual circumstances. This comprehensive and meticulous methodology ensured the reliability, accuracy, and cohesion of our automotive enterprise investment dataset. The experimental parameters are shown in Table 1. We utilize an R7-7950 CPU and an RTX 4070Ti GPU. All our experiments are conducted using the TensorFlow framework. The training is configured with 45 epochs, a batch size of 16, an initial learning rate of 0.01, and Momentum is set to 0.87. Besides, we set the decay of the learning rate to 0.003 and adopted Adam.

Considering that the generalization of information in the shared model is a classification problem, we adopted accuracy as the evaluation criterion for the models. The formula for calculating the positive and negative samples of the classification is as follows:

$$Accuary = \frac{V(pr)}{V(gt)} \tag{5}$$

where *pr* denotes the result predicted and *gt* refers to the true value of the dataset. In addition, mean average precision (mAP) is also chosen to evaluate our method. The formula is as follows:

Table 1 Implementation parameters

Types	Parameters
Computer CPU	R7-7950
Computer GPU	Rtx 4070Ti
Framework	Tensorflow
Epoch	40
Batch size	16
Initial learning rate	0.01
Momentum	0.87

$$\mathrm{mAP}=\frac{1}{n}\sum_{i=1}^{r}\left|\frac{gt-pr}{gt}\right| \tag{6}$$

where n refers to the number of samples. The smaller the mAP value is, the higher the prediction accuracy is, indicating the better the prediction effect of the model.

Comparison of our Method and Other Methods

We conduct performance experiments of our methods on datasets. We select 8 excellent classification models; they are SVM (Mohammadi et al., 2021), Binary tree (Huang et al. 2019b), CNN (Kattenborn et al., 2021), LSTM (Yu et al., 2019), Transformer (Bagal et al., 2021), Bert (Deepa, 2021), Vit (Khan et al., 2022), and TypeFormer (Stragapede et al., 2022). For performance comparison, as shown in Fig. 5, it can be found that compared with other investment information classification models, our method can obtain the highest accuracy and mAP values, 0.879 and 0.868, respectively. Compared with SVM and Binary tree methods, the accuracy and mAP value of our model can be improved by more than 8%. The main reason for the improvement is that SVM and Binary tree do not contain deep structures and cannot give full play to the characteristics of overseas automobile investment extracted by us. Compared with LSTM and CNN, our method improves accuracy and mAP values by more than 5%, which means that our method can deal with multi-modal features better. Compared to Transformer and Bert, our model can achieve better results, with a 2% performance improvement. Finally, our approach still achieves the best performance compared to Vit and TypeFormer, with a metric improvement of over 1%. Our method is similar to

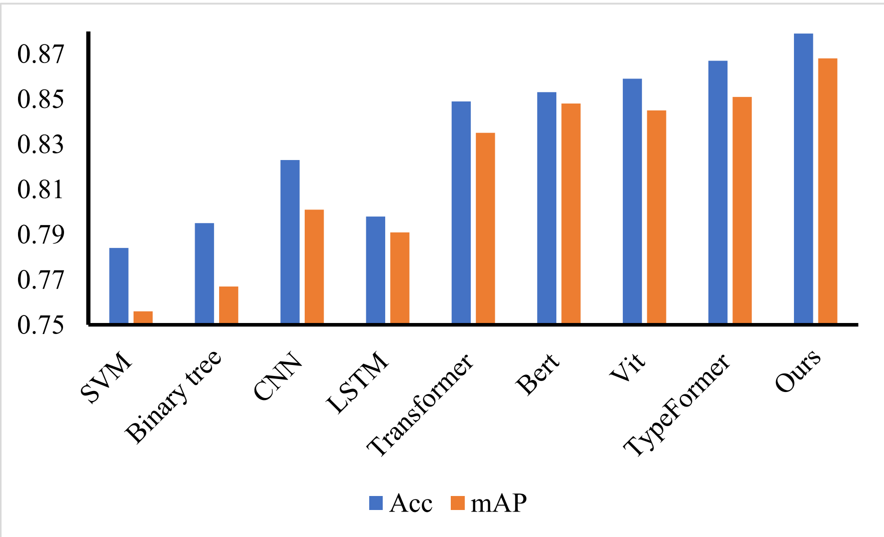

Fig. 5 Comparison with other methods

the basic units of Transformer, Bert, TypeFormer, and Vit. However, by designing trainable weights, our method can better predict investments in automotive companies. Therefore, our method achieved higher accuracy. Our method further boosts the model by integrating the news information f_N of the investment destination, the official announcement information f_P of the local automobile company, the investment report f_I of the foreign automobile company, the investment data and business dynamics f_B of the local automobile company, the analysis report f_A of the local automobile industry, and the information f_M about automobiles in the local social media. In addition, the weighted network used in our model can classify information more effectively, so it is better than SVM, LSTM, CNN, and TypeFormer.

We perform performance experiments of our method on datasets. First, we trained our method according to the model structure in Fig. 2. Model input $F=\{f_N, f_P, f_I, f_B, f_A, f_M\}$ six different features, the model loss function curve is shown in Fig. 6. Furthermore, to illustrate the model's performance, we have conducted an in-depth analysis of its key milestones during the training process, which spanned 40 epochs. These significant checkpoints were used to evaluate the model's results with verification sets, and the outcomes are visually depicted in Fig. 7.

An intriguing observation emerges from this analysis: at the 25th epoch, the model essentially attains an optimal fit. This pivotal turning point is evident in Fig. 7, where it is illustrated that the model achieves its peak performance concerning the verification set precisely at epoch 25. This observation underscores the fact that the training process of our model yielded the most favorable model parameters at this specific epoch. The convergence of the model's performance at the 25th epoch highlights the effectiveness of our training methodology, which successfully guided the model towards its peak capabilities. This insight is instrumental in fine-tuning the model and ensuring it delivers the best possible results for its intended application.

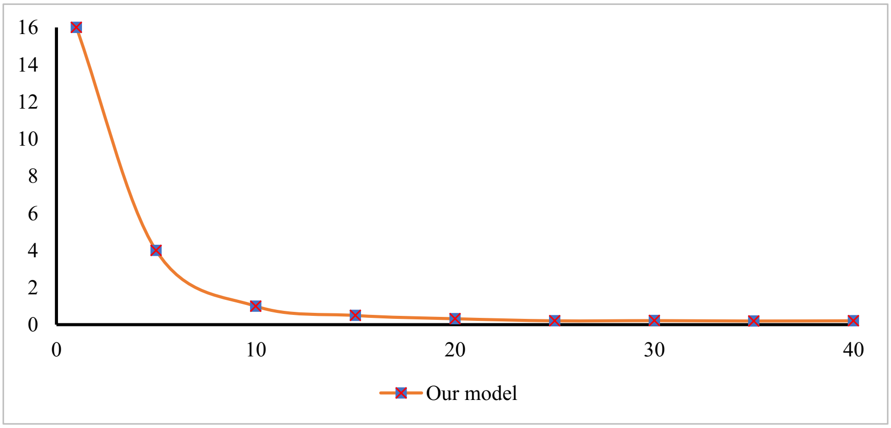

Fig. 6 The loss of our model

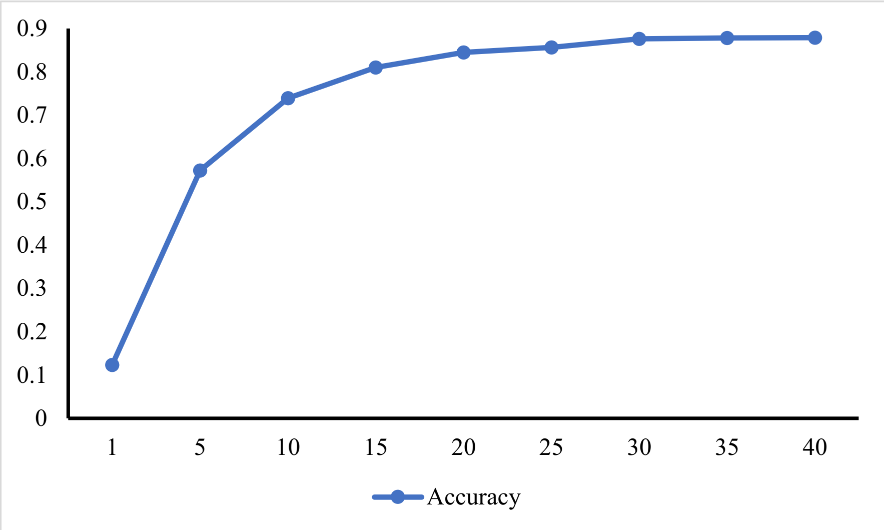

Fig. 7 The validation of our model during training

Ablation Experiments of Our Features

We used the investment information F = {f_N, f_P, f_I, f_B, f_A, f_M} these six different characteristics and perform feature fusion. In order to highlight the validity of the features we adopted, we will conduct an ablation experiment on the six features f_N, f_P, f_I, f_B, f_A, and f_M that affect the investment of automobile companies.

Considering that we used a multi-modal weight network in the experiment, only each group was tested in the ablation experiment. First, we fix the environmental quality {f_I, f_B, f_A} of automotive enterprises in the region and conduct ablation experiments on auto-related media, news, and other text information {f_N, f_P, f_M}, as shown in Table 2. The table shows that text information related to automobile media, news, and other text information {f_N, f_P, f_M} has good expression, and our multi-mode weight network has strong stability. As an increasing number of features are added to the model, the performance of the model gradually increases. The above ablation experiments directly demonstrated the effectiveness of textual information related to automobiles in media, news, and other contexts. At the same time, it indicated the powerful performance of the proposed CBOW model and the investment information classification model based on a multi-modal weight network. Both models are capable of comprehensively understanding the semantic and contextual information embedded in features, integrating the true meanings of various features, and making corresponding interpretative judgments.

Meanwhile, we keep auto-related media, news, and other text information {f_N, f_P, f_M} unchanged and conduct an ablation experiment on the environmental quality {f_I, f_B, f_A} of automobile enterprises in the region, as shown in Table 3. The experimental results show that no matter whether there is {f_N, f_P, f_M} feature; f_I, f_B, and f_A all present a positive correlation with the model performance. The

Table 2 Ablation of different $\{f_N, f_P, f_M\}$

	Precision	mAP
$\{f_N\}$	0.765	0.749
$\{f_P\}$	0.762	0.742
$\{f_M\}$	0.759	0.745
$\{f_N, f_P\}$	0.772	0.768
$\{f_P, f_M\}$	0.769	0.761
$\{f_N, f_M\}$	0.775	0.764
$\{f_N, f_P, f_M\}$	0.794	0.786
$\{f_N\}\{f_I, f_B, f_A\}$	0.812	0.801
$\{f_P\}\{f_I, f_B, f_A\}$	0.823	0.814
$\{f_M\}\{f_I, f_B, f_A\}$	0.821	0.819
$\{f_N, f_P\}\{f_I, f_B, f_A\}$	0.853	0.848
$\{f_P, f_M\}\{f_I, f_B, f_A\}$	0.849	0.845
$\{f_N, f_M\}\{f_I, f_B, f_A\}$	0.856	0.851
$\{f_N, f_P, f_M\}\{f_I, f_B, f_A\}$	0.879	0.868

Table 3 Ablation of different $\{f_I, f_B, f_A\}$

	Precision	mAP
$\{f_I\}$	0.734	0.721
$\{f_B\}$	0.738	0.727
$\{f_A$	0.728	0.714
$\{f_I, f_B\}$	0.767	0.743
$\{f_I, f_A\}$	0.764	0.748
$\{f_B, f_A\}$	0.771	0.751
$\{f_I, f_B, f_A\}$	0.797	0.775
$\{f_N, f_P, f_M\}\{f_I\}$	0.794	0.788
$\{f_N, f_P, f_M\}\{f_B\}$	0.801	0.794
$\{f_N, f_P, f_M\}\{f_A\}$	0.799	0.782
$\{f_N, f_P, f_M\}\{f_I, f_B\}$	0.844	0.837
$\{f_N, f_P, f_M\}\{f_I, f_A\}$	0.851	0.845
$\{f_N, f_P, f_M\}\{f_B, f_A\}$	0.848	0.837
$\{f_N, f_P, f_M\}\{f_I, f_B, f_A\}$	0.879	0.868

efficiency of the information-sharing model on overseas investment of automobile enterprises is gradually improved by adding more features to the model. Similar to the previous experimental results, this ablation experiment demonstrates the importance and stability of environmental quality features of automotive enterprises in different regions. It can provide a stable data foundation for subsequent models. In summary, these six features have practical significance for the investment information classification model based on a multi-modal weight network and the overseas investment information-sharing platform for automotive enterprises. They serve as the data source and analytical research foundation for these two subsequent works, enhancing the performance of overseas investment information sharing for automotive enterprises.

Discussion

Through the experiments conducted in this study, our proposed model for sharing overseas investment information, based on a multi-modal weight network, has demonstrated superior performance. In comparison to other advanced methods, our model excels in accuracy, training processes, and fitting efficiency. Moreover, through ablation experiments involving comparative analyses, we have individually validated the effectiveness of the six distinct features for overseas automotive investment proposed in our approach. The combinations of these features consistently enhance the model's capabilities for sharing information, leading to improved execution accuracy.

Our approach assumes a pivotal role in facilitating cross-border investments within the automotive industry. By extracting multi-modal overseas investment information specific to automotive companies, businesses can achieve a more precise quantification of investment data, thereby providing decision-makers with enhanced data support. Leveraging the multi-modal weight network, the model integrates information from various sources, spanning financial, market, regulatory, and other dimensions, to present a more comprehensive perspective for information sharing. Consequently, businesses gain a holistic understanding of the investment environment from diverse angles, enhancing insight into potential markets.

In summary, the overseas investment information-sharing platform designed for automotive companies provides a concise and clear interface, making it easy for decision-makers to access and comprehend the investment environment. Through this platform, businesses can continuously monitor global market trends, obtain real-time market analyses and data updates, and promptly adjust their investment strategies.

Conclusions

In our pursuit of enhancing overseas investment for automotive companies, we propose an innovative overseas investment information-sharing model built upon a multi-mode weight network. Our approach involves a comprehensive analysis of the myriad factors influencing the investment decisions of automotive enterprises. We extract multi-modal characteristics encapsulating the investment environment and relevant quality considerations to these enterprises. These multi-modal characteristics serve as input data, forming the foundation for the design of an overseas investment information platform tailored specifically to automotive businesses. This platform incorporates a sophisticated investment information classification system based on the multi-modal weight network. The primary objective is to provide automotive companies access to high-quality investment opportunities that align with their strategic objectives. The approach we propose achieves a multi-dimensional and dynamic description of investment information in the automotive industry, effectively showcasing the process of information sharing through the utilization of multi-modal features. The experimental results are a testament to the effectiveness of our model. We have achieved an impressive accuracy rate of 87.9% and a mAP value of 86.8%. Compared to other methods, our approach offers a more comprehensive quantification of investment information, resulting in the highest accuracy and optimal execution efficiency. These results indicate the model's capability to consistently provide automotive enterprises precise and reliable investment information. The platform's ability to deliver such accuracy and stability empowers these businesses to make informed decisions, ultimately facilitating successful and advantageous overseas investments. Our innovative multi-modal weight network model represents a significant step forward in optimizing the overseas investment process for automotive companies. It equips them with a powerful tool to navigate the complex landscape of international investments, offering reliable data and insights that lead to sound investment decisions and, ultimately, success in the global market.

In the forthcoming period, our focus will be on enhancing and refining the existing dataset related to overseas investments in automotive companies. This effort will involve updating information on the latest market trends, regulatory developments, competitive landscapes, and other relevant factors. To achieve a more comprehensive understanding of investment decisions, we will diversify the dataset by incorporating additional modalities, such as images, text, and time series data. Simultaneously, we plan to refine the multi-modal weight network, integrating adaptive learning and transfer learning techniques. This refinement aims to boost the model's adaptability and generalization across diverse contexts. Furthermore, our strategy involves the development of a real-time decision support system. This system will empower the model to promptly react to shifts in the market and assimilate new information. We also intend to leverage online learning techniques within the machine learning framework, enabling the model to dynamically adjust to emerging data and iteratively optimize decision-making processes.

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Data Availability The dataset employed in this investigation is made readily available and accessible to interested parties.

Declarations

Ethical Approval This article does not contain any studies with human participants or animals performed by any of the authors.

Consent to Participate The author declare that all the authors have informed consent.

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