Problem Chosen	2024	Team Control Number
E	MCM/ICM Summary Sheet	2423957

An Analysis of Sustainable Strategies for Property Insurance

Summary

In recent years, homeowners and insurance companies have faced significant crises, necessitating the development of comprehensive solutions to meet the needs of all stakeholders involved in the insurance industry. This paper presents an innovative approach to property insurance by introducing an insurance company's property allocation model based on **deep learning** and **LSTM** and a market investment model utilizing **regression analysis**, as well as a community conservation building model employing **grey correlation analysis**. These models provide valuable insights and correlation analyses for the property-casualty insurance sector, promoting a more sustainable industry.

Task 1: We conducted a comprehensive time series analysis of natural disasters and related data over the past 30 years in Florida and California. Subsequently, we developed an **LSTM** model to forecast future natural disasters. We then utilized neural network, linear regression, and **deep learning** models to assess the relationship between natural disasters and property damage, ultimately selecting the most effective **deep learning** model as the prediction model. Our next step involved predicting future disasters in California and Florida using the **LSTM** model, and leveraging the outcomes to further anticipate potential property damage through the deep learning model. Finally, by integrating the prediction results with the **time value** calculation of insurance theory, we formulated a suitable index system to aid insurance companies in determining underwriting decisions.

Task 2: This task focuses on establishing a real estate investment model to support decision-making in construction and development. Through comprehensive **regression analysis**, including **linear regression**, **ridge regression**, and **Lasso regression**, we considered factors such as population density, income levels, employment opportunities, and willingness to purchase data to calculate housing market demand. Additionally, we predicted the impact of extreme weather events and property losses. By integrating income, willingness to purchase, and disaster-related losses, we accurately calculated the minimum investment cost. The model was successfully applied in Nanjing, China, providing accurate predictions and informing investment decisions.

Task 3: To empower community leaders in addressing insurance-related challenges, we designed a **grey correlation analysis model**. This model assisted in evaluating cultural, historical, economic, and other factors. By analyzing the problem's context, delineating data characteristics, and outlining the implementation environment, we applied the **grey correlation analysis model**, which yielded precise results.

Task 4: We scrutinized the models established in Task 2 and 3 across five sites in Nanjing, incorporating indicators such as resident population and GDP per capita. Through this analysis, we determined conservation priorities. Based on the outcomes of the model, we submitted an explanatory report to the community, detailing conservation priorities and strategies.

Keywords: Deep Learning LSTM Linear Regression Grey Correlation Analysis Time Value

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1 Introduction

1.1 Problem Background

In recent years, extreme weather is fast becoming an existential crisis for homeowners and their insurers. More than 1,000 recent extreme weather events have caused more than $1 trillion in global losses. According to BCG research[1], in 2022, the global insurance industry's natural catastrophe claims have soared 54 percent from the average of the last 10 years and 115 percent from the average of the last 30 years. As the frequency of disasters across all regions makes it increasingly difficult for insured people to stay insured, the need for insurers to be more rigorous in selecting the right coverage for each situation is becoming more urgent. In order to solve this multi-stakeholder dilemma, we need to provide a more effective analytical model based on the new climatic and social environment[2].

1.2 Restatement of the Problem

Considering the background information and restricted conditions identified in the problem statement, we need to solve the following problems:

(1) **Model 1:** Build a model for insurers to use to determine under what circumstances they should underwrite a policy. And analyze how property owners should approach this model.

(2) **Model 2**: Based on the model 1, get a model to to evaluate where to build, how to build, and whether to build in a given location when predicting future neighborhood and real estate development.

(3) **Model 3**: Develop a preservation model for community leaders to determine what steps they should take to preserve buildings in their neighborhoods.

(4) Use established insurance and preservation models to analyze the value of one selected historic landmark and write a letter to recommend a plan.

2 Assumptions and Notations

2.1 Assumption

- The insurance company's compensation model calculates insurance payouts by multiplying the damage to the insured property by the claim expense ratio, and the premium to be paid is determined as the annual premium for the insured sum multiplied by the value of the insured property.
- Assume that the insurance company's compensation model involves making a single lump-sum compensation payment while receiving regular annual premiums within each insurance contract.
- This article assumes that significant changes in policy factors and development demands do not have a major impact on investment decision-making when constructing an investment decision model. By overlooking these factors, we aim to explore a relatively simple investment model and evaluate its effectiveness and feasibility. However, we acknowledge that changes in policy

factors and the macroeconomic environment may influence the model's outcomes to some extent. Therefore, a more comprehensive consideration is required in actual investment decisions.

2.2 Notation

Table 1: **Notations**

Symbol or Notation	**Specification**
β_{True}, $\beta_{Expected}$	The true, desired percentage of an insurer's risk property
R_i	Insurance rate(Commission costs/Total insured property)
P_i	The amount of property owner i's insured property
D_i	The amount of property owner i's damaged property
Y_i	Property owner i insured period
α_i	The percentage of property owner i's compensation package
C_i	Insurance premium
$X_{1,2,3,4,5}$	Historic significance, Population density, Economic benefit, Protection difficulty, Disaster risk

3 Mode 1: Regional policy decision model based on deep learning and time series modeling

3.1 Data Preparation and Pre-processing

To model the associated risk predictions, it is necessary to analyze data from two regions with a high incidence of natural hazards, each in different geographic areas.

- Miami, Florida: the Miami area is often exposed to extreme weather events such as hurricanes and wave erosion. Not only is the area densely populated, but there is a large amount of real estate and property that requires insurance coverage. By analyzing data from the Miami area, it is possible to assess the risks and rewards of insurers writing coverage in this region.
- San Diego, California: The San Diego area is regularly exposed to natural disasters such as mountain fires, droughts and earthquakes. These disasters pose potential risks to local residents and properties. By examining data from the San Diego area, it is possible to assess the feasibility and risk distribution of insurance companies writing coverage in this area.

We conducted a Pearson correlation analysis of the disaster-related indicators and selected natural disasters with a correlation greater than 0.3 with property damage-related indicators as the disaster indicators for future training.

$$r=\frac{\sum_{i=1}^{n}\left(X_i-\bar{X}\right)\left(Y_i-\bar{Y}\right)}{\sqrt{\sum_{i=1}^{n}\left(X_i-\bar{X}\right)^2}\sqrt{\sum_{i=1}^{n}\left(Y_i-\bar{Y}\right)^2}} \tag{1}$$

In the end, we obtained the following natural disaster indicators:

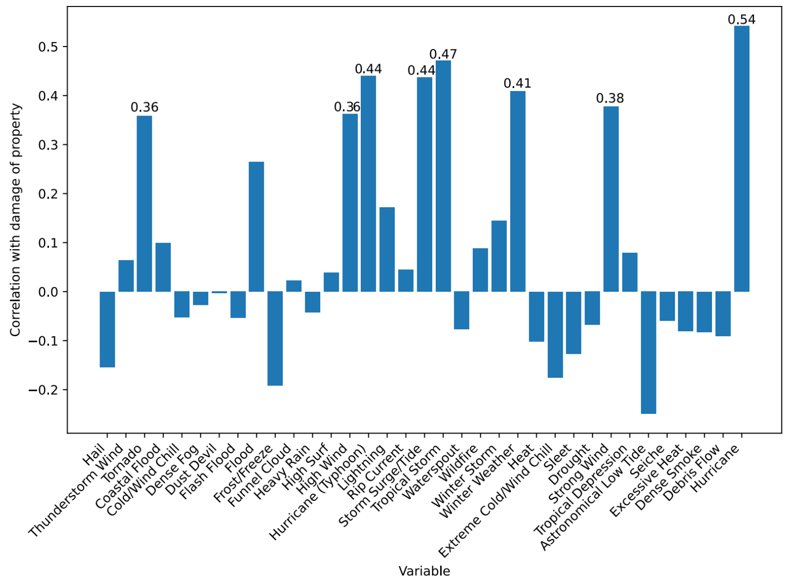


Figure 1: Selection of relevant climate indicators–Florida

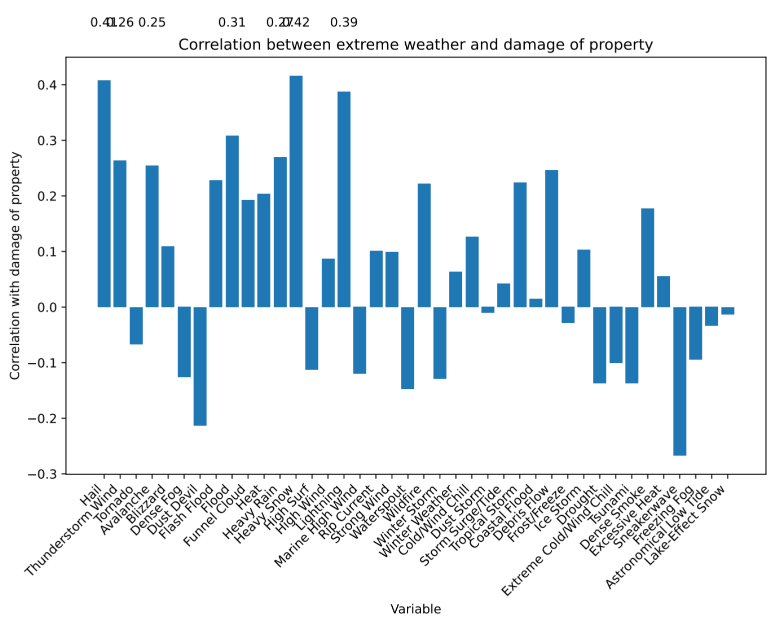


Figure 2: Selection of relevant climate indicators–California

For the data that have been obtained, we performed Z-Score Normalization ($x_{new} = \frac{x-\mu}{\sigma}$) on them to prepare for the next computation. The indicators marked with positive correlation coefficients at the top of the bar graph were selected, while the negative residual correlations indicate that these factors have little or no effect on property damage.

3.2 Training of predictive models

To achieve the best prediction results, we will employ three training models: Random Forest, Linear Regression, and Deep Learning. Ultimately, we will select the model with the best training results as the final prediction model.

The dataset was sliced on a 0.2 scale and the root mean squared error was ultimately used as an indicator of model effect.

3.2.1 Random Forest

Random Forests is a versatile machine learning algorithm utilized for both classification and regression tasks. It functions by creating numerous decision trees during training and produces the mode of the classes (for classification) or the average prediction (for regression) of the individual trees. Finally, we

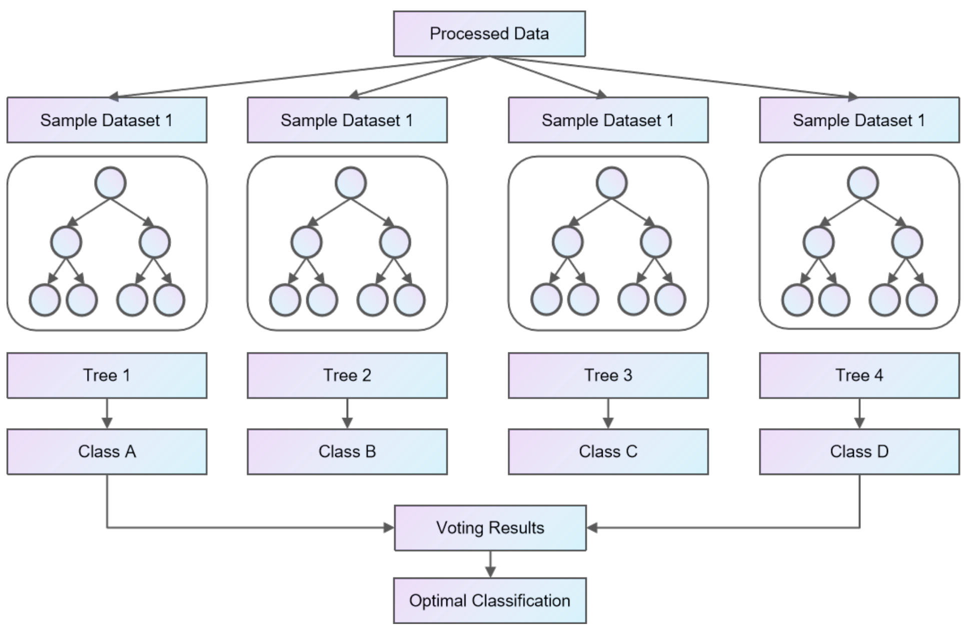


Figure 3: Random Forest Model

plot the loss and MSE results for both Training and validation results:
where we characterize the individual hazards in the random forest model through the Gini coefficient:

$$\operatorname{Gini}(D; A) = \sum_{i=1}^{m} \frac{|D_i|}{|D|} \operatorname{Gini}(D_i) \tag{2}$$

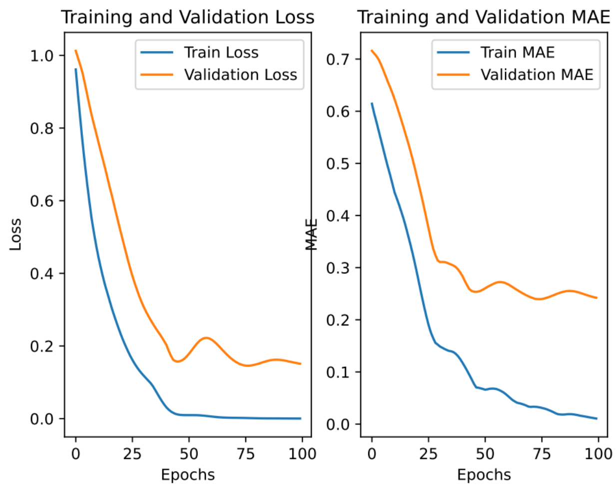


Figure 4: Loss and MSE Result for Random Forest Model–Florida

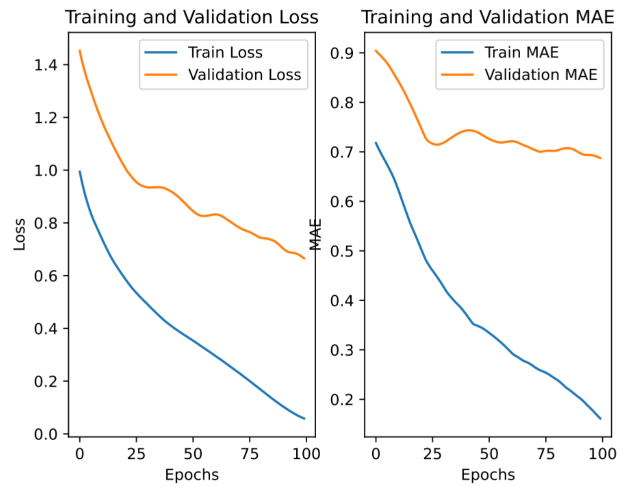


Figure 5: Loss and MSE Result for Random Forest Model–California

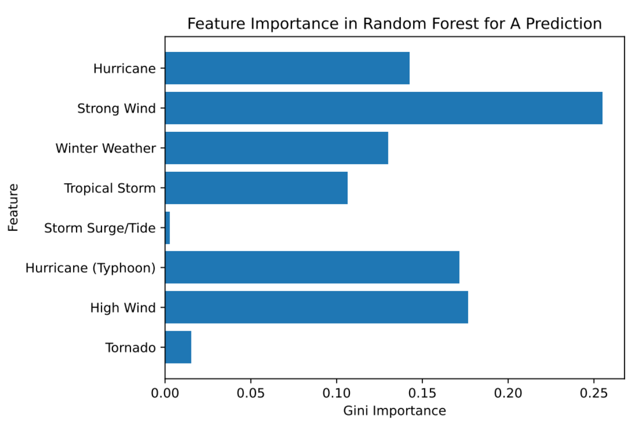


Figure 6: Random Forest Gini Coefficient–Florida

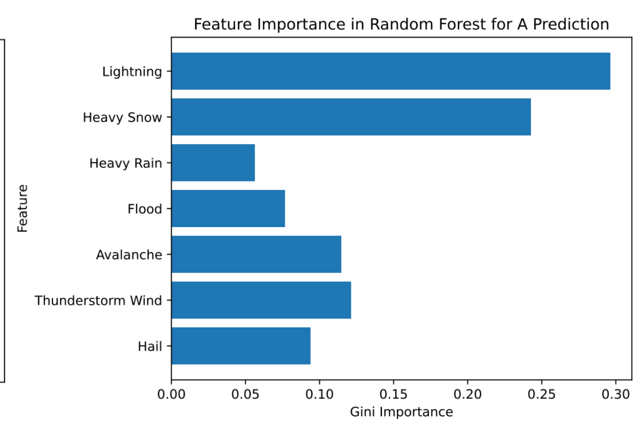


Figure 7: Random Forest Gini Coefficient–California

3.2.2 Linear Regression

The linear prediction equation was finally obtained:

$$\begin{aligned} y = & 67.18 \times Tornado + 5.50 \times Hurricane(Typhoon) + 19.75 \times Hurricane(Typhoon) \\ & + 10.77 \times StormSurge/Tide + 43.81 \times TropicalStorm + 4.46 \times WinterWeather \\ & + 4.89 \times StrongWind + 4.02 \times Hurricane \end{aligned} \quad (3)$$

3.2.3 Deep Learning

In the deep learning method, after several attempts, we choose Rectified Linear Unit as the activation function:

$$\text{Output } = \max\left(0, W^T X + B\right). \quad (4)$$

Deep learning is computed using fully connected models

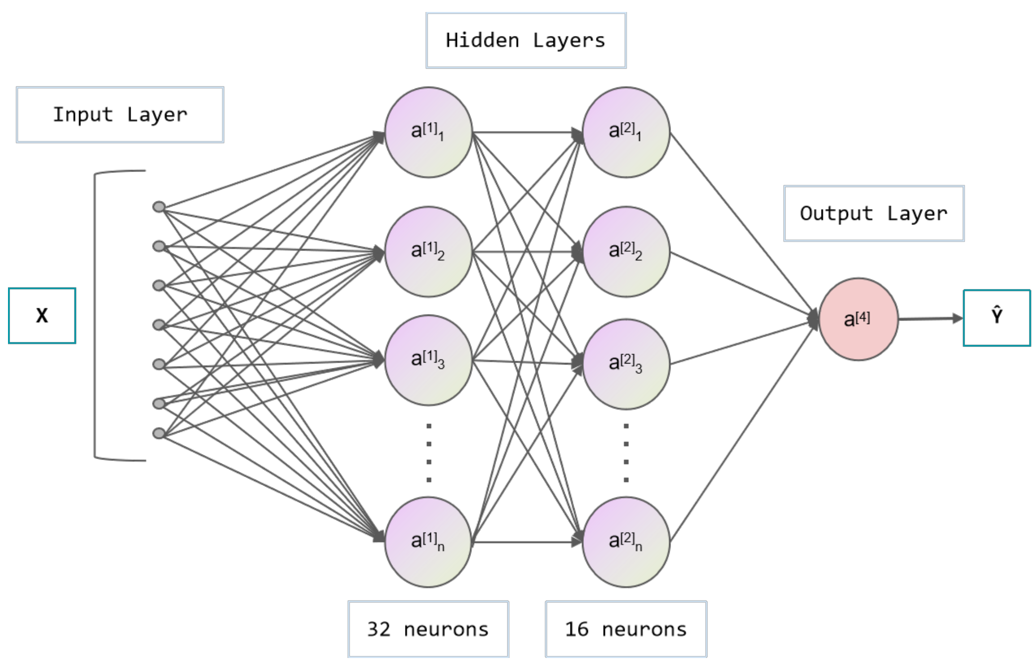


Figure 8: Neural Network Model

In the optimization segment, we employ the Adam Optimizer. This optimizer uniquely assigns adaptive learning rates for each parameter through the computation of both first-order and second-order moment estimates of the gradients. This sophisticated approach culminates in achieving outstanding outcomes: We observed that the model began to overfit beyond the 50th iteration, leading us to settle on training for 50 generations as our optimal parameter choice.

Ultimately, the deep learning model achieved an RMSE (Root Mean Square Error) value of 0.4395, marking it as the superior performer among the three models developed. Hence, we select this model for predicting property losses.

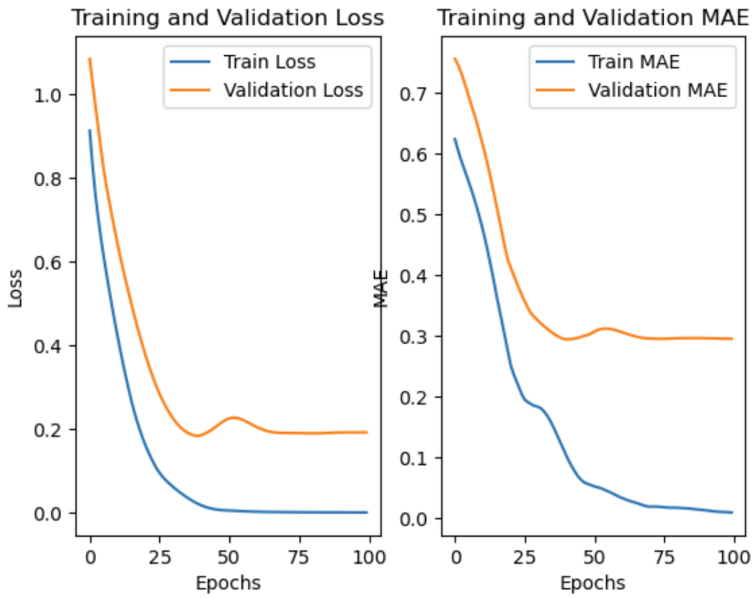


Figure 9: Loss and MSE Result ofNeural Network Model

3.3 Training of LSTM Model

Considering the predictable patterns of climate and natural disasters in a specific region, we choose to simulate predictions of these events using a time series methodology, employing the Long Short-Term Memory (LSTM) model. As a specialized form of recurrent neural networks, LSTM excels in handling sequential data, making it particularly well-suited for analyzing time series. This feature significantly improves the precision and efficiency of time series analysis over conventional feed-forward neural networks.

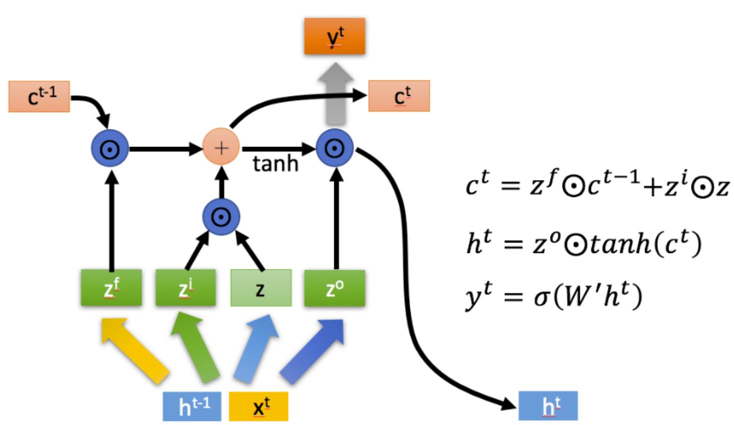


Figure 10: Neural Network Model

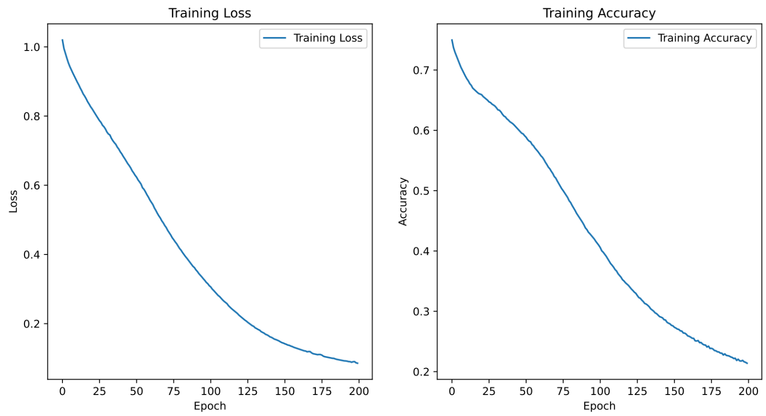


Figure 11: Training Loss and Accuracy–Florida

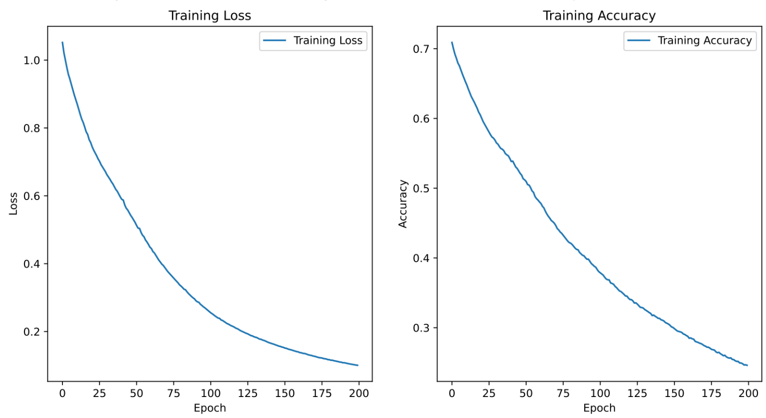


Figure 12: Training Loss and Accuracy–California

3.3.1 Data Preparation

We curate a dataset of extreme weather events structured as a time series, where each interval encapsulates a variety of attributes such as temperature and rainfall, alongside the associated property damage figures.
Subsequently, we partition the dataset into a training set and a test set following a chronological sequence. This approach guarantees that the model can effectively generalize and accurately forecast future outcomes.

3.3.2 Model Establishment

The outcomes from training the LSTM model clearly indicate convergence around the 150-iteration mark. Consequently, we select the model at this juncture as our predictive tool for natural disaster events.

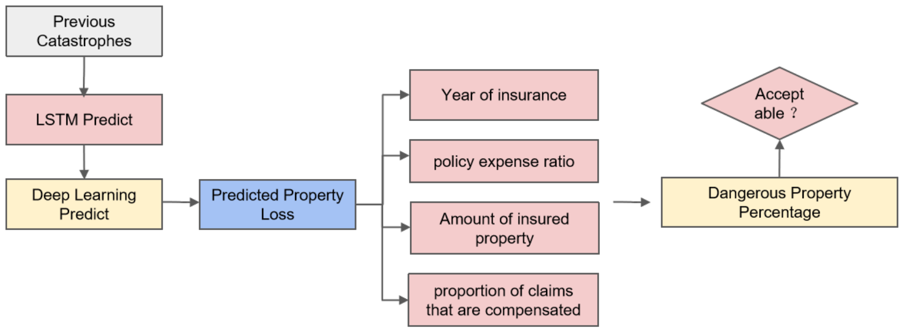


Figure 13: The Process of Whether Underwrite Policies

3.4 A Predictive Model on Property Losses

3.5 Underwriting decisions

The basic judgment of whether an insurance company is contracting or not is that the percentage β_{True} of the company's risk property selected as a percentage of its total property cannot exceed the company's risk property thresholds $\beta_{Expected}$.

The proportion of property at risk is calculated as the expected loss on the company's future insured properties, multiplied by their respective premium rates.

$$\beta = \frac{\sum_{i=1}^{k} D_i \times \alpha_i}{Total \ \ Assets} \tag{5}$$

$$\beta_{True} \leq \beta_{Expected} \tag{6}$$

where k is the number of total property owners. The company's premium income is the total number of properties P_i they write multiplied by the corresponding premium rate R_i:

$$C = \sum_{i=1}^{k} P_i \times R_i \tag{7}$$

The Time Value of Money (TVM) embodies the financial concept that possessing a specific sum of money now holds greater value than possessing the same sum at a future date. This concept stems from the premise that money owned presently can be invested to yield additional income, thereby enhancing its value over time. Consequently, when computing the total cost, future amounts must be discounted to reflect their present value accurately, providing a more precise evaluation of financial worth.

$$PresentValue = \sum_{k=1}^{Y_i} P_i \times R_i \times (1+k)^{-i} \tag{8}$$

Ultimately, the decision to accept the policy will be made by calculating the current costs to the insurance company, discounting future amounts to their present value, and assessing the percentage of the company's property that is at risk. This approach allows for a comprehensive evaluation of the financial implications and risk exposure associated with the policy. S

4 Model 2: Improvements to Model 1 in the Real Estate Prediction Method Based on Ridge Regression

As we look towards the future of communities and real estate development, it's crucial for the insurance industry to proactively make real estate decisions. This forward-thinking approach is essential to sustain the growth of our real estate business, enabling us to effectively cater to the evolving needs of our community's population and demographics.

4.1 Background Information of Market Revenue Forecast

To project future market revenues, we employ regression analysis to estimate the demand for homeownership, integrating data on population density, income levels, and employment opportunities. Our analysis leverages data from the Nanjing Statistical Yearbook, taking into account the following factors:

(1) **Population Density**: Areas with high population density typically have a higher demand in the housing market.

(2) **Income Levels**: Regions with a concentration of high-income individuals usually exhibit a more robust demand in the housing market.

(3) **Employment Opportunities**: Areas with high employment rates attract population influx, driving the demand in the housing market.

(4) **Educational Resources**: Regions with abundant educational resources attract families' housing needs.

(5) **Regional Development**: Prosperous areas (GDP) usually experience strong demand in the housing market.

4.1.1 Visualization and analysis

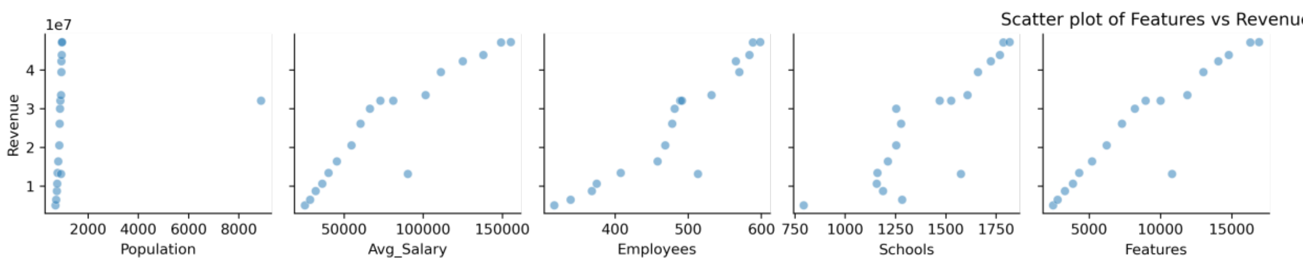


Figure 14: Visualization and analysis

4.2 Market Revenue Forecast

4.2.1 Preparation

Determining the Dependent and Independent Variables: Dependent Variable: Business Revenue (the variable to be predicted). Independent Variables: These are factors anticipated to impact housing market demand, including permanent population, per capita income, employed population, school facilities, and regional Gross Domestic Product (GDP).

Feature Engineering:Perform necessary preprocessing on the explanatory variables$X = \frac{X - X \cdot \text{mean}()}{X_{std}()}$.

4.2.2 Establishment of regression models

We developed three predictive models: a linear regression model, a ridge regression model, and a lasso regression model, with the following outcomes in terms of fitting accuracy: the mean square error (MSE) for the linear regression model stands at 51,167,783.10993379, for the ridge regression model at 51,147,212.37260074, and for the Lasso regression model, the MSE is yet to be determined.: 51634897.07994562.

Based on the comparison of output results, the ridge regression model demonstrates the lowest mean

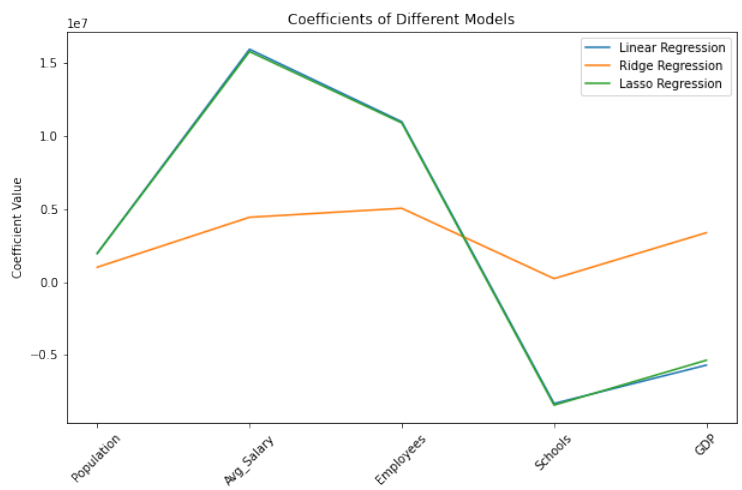


Figure 15: Coefficients of Different Models

square error (MSE), establishing it as the optimal choice among the regression models we tested. Consequently, we select the ridge regression model as the most effective for our analysis, characterized by the following expression:

$$\begin{aligned} Y = 4999003.22 + 48423.42 \times X_1 + 208775.14 \times X_2 + \\ 53143.68 \times X_3 + 68604.49 \times X_4 + 52683.62 \times X_5 \end{aligned} \tag{9}$$

Where X_1 denotes resident population, X_2 denotes per capita wages, X_3 denotes persons in employment, X_4 denotes number of schools, and X_5 denotes Gross Regional Product (GRP)

4.3 Model testing

By contrasting the actual values with the predicted ones across the time series, we've visualized the prediction outcomes through a graph. This visualization leads us to conclude that the model's forecasts are indeed satisfactory, evidencing a commendable match between the predicted and actual data points. This concordance underscores the model's proficiency in accurately capturing the dataset's inherent patterns and trends.

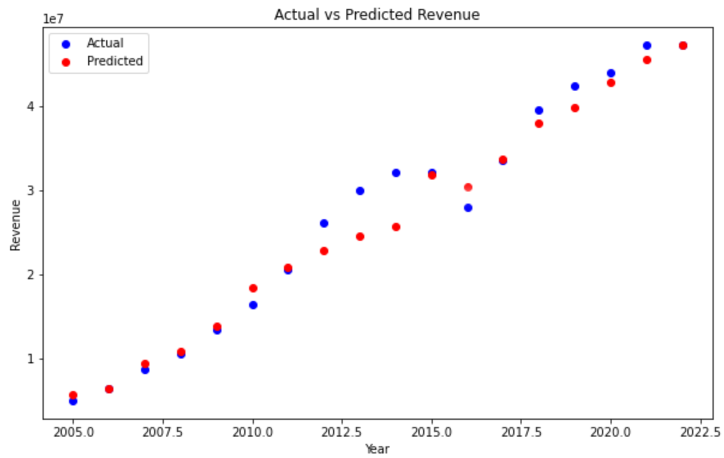


Figure 16: Actual vs. Predicted Revenue

The analysis of the error plots indicates that the distribution of prediction errors falls within acceptable bounds. This observation suggests that the model's predictive accuracy is consistent and the deviations from actual values are within a tolerable range, highlighting the reliability of the model's forecasts.

Based on the above distribution graph, it can be concluded that the final regression result through the constructed ridge regression is ideal.

4.4 Calculation of minimum investment costs

According to the questionnaire survey and the insurance decision model, the minimum purchase rate and catastrophic financial loss in 2022 are 50.71% and 70.463 billion dollars, respectively. Substituting the investment cost formula:

$$MinimumInvestmentCost = Revenue * MinimumPurchaseRate + DisasterLosses \quad (10)$$

It can be concluded that the minimum investment cost of real estate developers in 2022 is 310.97 billion dollars. If the real estate developers in Nanjing investment plan, 310.97 billion yuan of investment costs within their investment capacity, they can decide to build. If not, you can choose to borrow with the government, banks, relevant departments and enterprises to seek support policies to continue to invest.

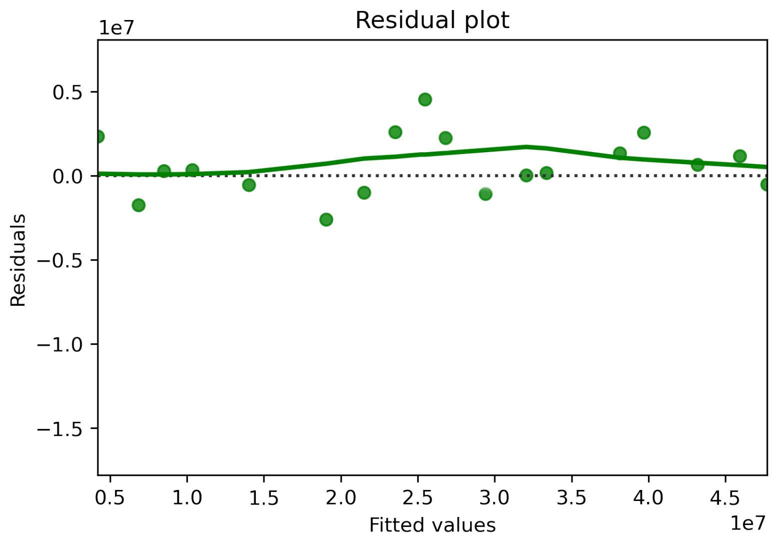


Figure 17: Residual Plot

5 Model 3:

5.1 Problem analysis

As community leaders, we need multiple levels of reality to make preservation determinations about buildings to better protect them. Therefore, we will construct a system of indicators by selecting factors related to buildings at the social display level, including historical significance, population density, economic benefits, preservation difficulty, and disaster risk:

(1) **Historical significance** X_1: The building's historical longevity, cultural heritage value, and connection to local historical events. Historical significance can be assessed by factors such as the age of the building and the degree of influence of historical events. The deeper the historical significance, the higher the conservation priority.

(2) **Population density** X_2: the number and density of people in the area where the building is located. Areas with high population densities are likely to have buildings with more community significance and influence, the higher the priority.

(3) **Economic benefits** X_3: The contribution and impact of the building on the local economy. For example, the promotion of tourism, cultural industries or commercial activities. The higher the economic benefit, the more the building deserves to be valued by the community.

(4) **Difficulty of conservation** X_4: Difficulty and cost of conservation of buildings. Consider factors such as the structural condition of the building, the degree of difficulty in repairing and maintaining it, and the resources and technology required for conservation. If building maintenance is too costly and time-consuming, community leaders may choose to abandon it.

(4) **Disaster risk** X_5: Potential risk of natural hazards in the area where the building is located, e.g., earthquakes, floods, typhoons. Assess the likelihood and extent of the building being

affected by disasters. Frequent disasters will result in frequent repairs and protection, and the economic pressure borne by the government may be greater, so it must be within the reach of the government.

Based on the analysis of the above dimensions, we can know that when we consider multiple dimensions of society to construct the indicator system, it will have the following characteristics:

- The mechanisms by which the indicators interact with each other are unclear or too complex.
- The dataset currently available is not large enough to allow for training with large samples
- For community leaders, there is a need for a more efficient way to build metrics, which is not possible with traditional methods such as machine learning, neural networks, etc.
- Indicators are more difficult to quantify, but are generalizable by way of ranking
- It is clear to us that a building is most deserving of preservation when it is of great historical value, in a high-density population situation, can bring great economic benefits, is moderately difficult to preserve, and has a moderate risk of disaster.

Grey Relational Analysis (GRA) is a significant analytical method of Grey System Theory, primarily employed for dealing with the analysis of systems characterized by incomplete or uncertain information. Grey System Theory was introduced by the Chinese scholar Deng Julong in 1982 and serves as an effective tool for the analysis and decision-making in systems with limited data and incomplete information. Grey Relational Analysis identifies and evaluates the degree of influence and the closeness of relationships among system factors by analyzing their relational degrees.
The fundamental idea of Grey Relational Analysis is that, in system analysis, factors often present a ”grey” state due to incomplete information, that is, a state of being partially known and partially unknown. By analyzing the known information, one can infer the general trend of the unknown information, thereby facilitating effective analysis and decision-making for the system.
Based on the above analysis, it can be found that the characteristics of the method are in line with our expected model.

5.2 Model Construction

Let n data sequences form the following matrix:

$$(X_1', X_2' \cdots, X_n') = \begin{pmatrix} x_1'(1) & x_2'(1) & \cdots & x_n'(1) \\ x_1'(2) & x_2'(2) & \cdots & x_n'(2) \\ \vdots & \vdots & \vdots & \vdots \\ x_1'(m) & x_2'(m) & \cdots & x_n'(m) \end{pmatrix} \tag{11}$$

where m is the number of indicators, the number of indicators in this paper is 5:

$$X_i' = (x_i'(1), x_i'(2), \cdots, x_i'(m))^T, \quad i = 1, 2, \cdots, n \tag{12}$$

5.2.1 Determine the reference series

The reference data column should be an ideal standard of comparison and can be constructed from the best (or worst) values of the indicators, or from other reference values depending on the purpose of the evaluation. The reference data column should be an ideal standard of comparison:

$$X_0' = (x_0'(1), x_0'(2), \cdots, x_0'(m))^\top \tag{13}$$

From the analysis of the significance of the above indicators, historical significance X_1, population density X_2, economic benefits X_3 are very large data indicators; protection difficulty X_4, disaster risk X_5 are intermediate data indicators, so the reference data column in this paper is recorded as:

$$X_0' = (9, 9, 9, 5, 5)^T \tag{14}$$

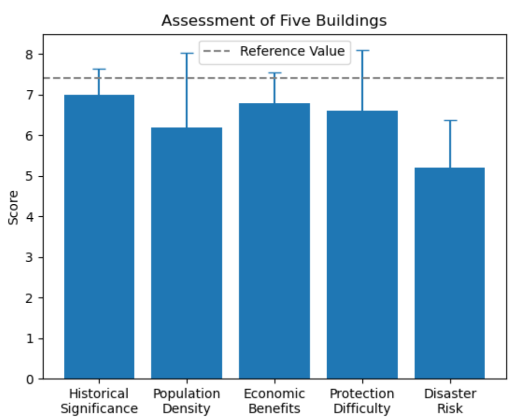


Figure 18: Assessment of Five Buildings–Box Graph

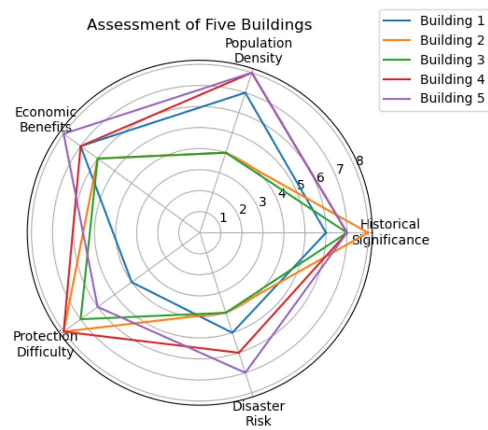


Figure 19: Assessment of Five Buildings–Radar Graph

5.2.2 Dimensionless treatment of indicator data

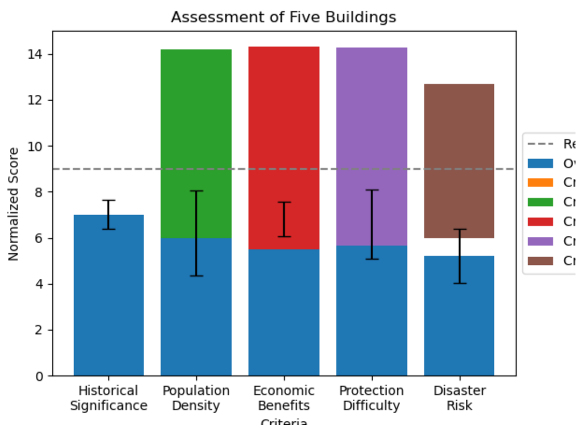
The dimensionless data series form the following matrix:

$$(X_0, X_1, \cdots, X_n) = \begin{pmatrix} x_0(1) & x_1(1) & \cdots & x_n(1) \\ x_0(2) & x_1(2) & \cdots & x_n(2) \\ \vdots & \vdots & \vdots & \vdots \\ x_0(m) & x_1(m) & \cdots & x_n(m) \end{pmatrix} \tag{15}$$

The dimensionless method of this paper is homogenization method.

5.2.3 Computation

The absolute difference between each indicator of each evaluated objects and the indicator of the reference series is calculated one by one–$|x_0(k) - x_i(k)|$ $(k = 1, \cdots, m \quad i = 1, \cdots, n)$, where n is



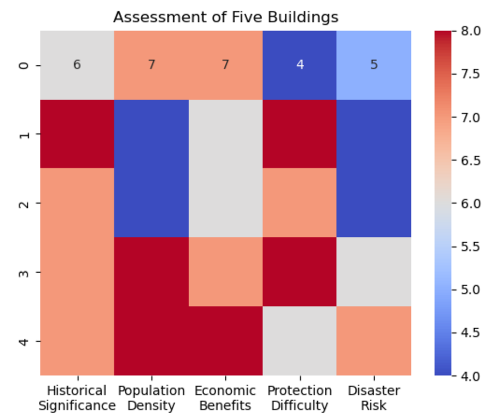


Figure 20: Loss and MSE Result for Random Forest Model

Figure 21: Loss and MSE Result for Random Forest Model

the number of evaluated objects.

$$\begin{gathered} \min_{i=1}^{n} \min_{k=1}^{m} |x_0(k) - x_i(k)| \\ \max_{i=1}^{n} \max_{k=1}^{m} |x_0(k) - x_i(k)| \end{gathered} \tag{16}$$

5.2.4 Calculation of correlation coefficient

The correlation coefficients were calculated based on each comparison sequence separately from the reference sequence by means of correlation coefficient:

$$\zeta_i(k) = \frac{\min_i \min_k |x_0(k)-x_i(k)| + \rho \cdot \max_i \max_k |x_0(k)-x_i(k)|}{|x_0(k)-x_i(k)| + \rho \cdot \max_i \max_k |x_0(k)-x_i(k)|} \qquad k = 1, \cdots, m \tag{17}$$

where ρ is the resolution factor, ranging from 0 to 1. If ρ is smaller, the greater the difference between the correlation coefficients, the stronger the differentiation ability, usually ρ takes 0.5. If $\{x_0(k)\}$ is the optimal value data column, the larger $\zeta_{\mathrm{i}}(k)$ is better; if $\{x_0(k)\}$ is the most column data column, the smaller $\zeta_{\mathrm{i}}(k)$ is better.

The reference data column in this model is the optimal value data column.

5.2.5 Calculating correlation

The mean value of the correlation coefficients between several indicators and the corresponding elements of the reference sequence is calculated separately for each evaluation object (comparison sequence) to reflect the correlation relationship between each evaluation object and the reference sequence and is called the degree of correlation, denoted as:

$$r_{0i} = \frac{1}{m} \sum_{k=1}^{m} \zeta_i(k) \tag{18}$$

If the indicators play different roles in the overall evaluation, the correlation coefficients can be weighted for a mean value:

$$r'_{0i} = \frac{1}{m}\sum_{k=1}^{m} W_k \cdot \zeta_i(k) \quad (\mathrm{k} = 1, \cdots, m) \tag{19}$$

where W_k is the weight of each indicator.

5.2.6 Result

Based on the relevance of each observation, it is ranked to produce a comprehensive evaluation result. Determine whether to protect: Based on the grey relational values and other relevant information, identify which communities need more protection and resource allocation, and develop corresponding protection strategies and action plans. For the demand of protective measures for buildings within the community, a preservation model can be designed based on the results obtained from the grey relational degree model, for community leaders to reference. Below is a simple design of a preservation model:

- **High priority buildings**: For buildings with higher grey relational values, it is recommended to take maximum protective measures, including but not limited to: Developing detailed protection plans and action schemes, specifying protection goals, measures, and responsible persons; Strengthening the inspection and monitoring of buildings to promptly identify and address potential damages and risks; Conducting necessary repairs, rectification, and reinforcement of the buildings to ensure their safety and stability; Enhancing the protection and promotion of cultural relics to raise public awareness and attention to the buildings.

- **Medium priority buildings**: For buildings with moderate grey relational values, it is recommended to take certain protective measures, including but not limited to: Developing brief protection plans and action schemes, specifying protection goals and measures; Regularly inspecting and repairing buildings to discover and correct problems early; Strengthening the protection and promotion of cultural relics to raise public awareness and attention to the buildings.

- **Low priority buildings**: For buildings with lower grey relational values, conventional protective measures can be taken, including but not limited to: Developing basic protection plans and measures, specifying protection goals and responsible persons; Regularly checking and maintaining the buildings to ensure their basic stability and safety; Carrying out the protection and promotion of cultural relics to raise public awareness and attention to the buildings. It should be noted that the actual situation and needs of different communities may vary, and the preservation model should be adjusted and refined according to specific circumstances. At the same time, community leaders, in formulating and implementing protective measures, should also consider relevant laws, regulations, and professional knowledge and skills in cultural relic protection.

5.2.7 Summary of Thoughts

(1) Consider the cultural, historical, economic or community significance of buildings in the community, as well as current and potential future risks and threats.

(2) Evaluate and prioritize the importance and conservation needs of buildings using methods such as grey correlation models.

(3) According to the priority of the buildings, develop corresponding protection measures and action programs, including but not limited to strengthening inspection and monitoring, repair and remediation work, heritage protection and publicity work.

(4) Consider relevant laws and regulations as well as professional knowledge and skills in heritage protection when formulating protection measures, so as to avoid illegal behavior or causing more damage to the heritage.

(5) For some important buildings, community leaders may also consider taking some special measures, such as establishing a special heritage conservation organization or foundation to attract the participation and donations of the public and enterprises.

(5) Finally, community leaders should periodically evaluate and refine the preservation model to ensure that it is adapted to current and future community needs and development.

5.3 Background Information

In the fourth question, we choose five famous scenic spots in Nanjing to analyze, through the historical significance Population density Economic benefits Protection difficulty Disaster risk aspects, we can get the basic information as follows:

5.3.1 Xuanwu Lake

- **Historical significance**: as one of the iconic attractions of Nanjing, Xuanwu Lake carries rich historical and cultural connotations and represents an important historical stage of Nanjing's urban development.
- **Population density**: the area around Xuanwu Lake has a relatively high population density, which makes it an important place for residents to go for leisure and entertainment.
- **Economic benefits**: Xuanwu Lake, as a tourist attraction, attracts a large number of tourists and has positive economic benefits for the tourism industry and related industries in Nanjing.
- **Protection Difficulty**: Since Xuanwu Lake is an artificial lake, the protection difficulty is relatively low, but regular water quality and ecological environment monitoring and management is required.
- **Disaster risk**: The area around Xuanwu Lake may be at risk of flooding, and appropriate flood prevention measures need to be taken.

5.4 Ming Xiaoling Mausoleum

- **Historical significance**: Ming Xiaoling Mausoleum is the mausoleum of the first emperor of the Ming Dynasty, which is of great historical significance and represents the architectural style and scale of ancient Chinese royal tombs.

- **Population density**: The population density of the surrounding area is relatively low, and the area where the Xiaoling Mausoleum is located is mainly dominated by scenic spots and cultural heritage.
- **Economic benefits**: As a tourist attraction, the Ming Xiaoling Mausoleum attracts a large number of tourists and has a positive economic impact on the local tourism industry and related industries.
- **Conservation Difficulty**: Due to its long history and large scale, the Ming Xiaoling Mausoleum is difficult to conserve, requiring regular maintenance and repairs, as well as ensuring that the impact of tourist behavior on the mausoleum is minimized.
- **Disaster risk**: The area where the Xiaoling Mausoleum is located may be at risk of natural disasters, such as floods and earthquakes, and appropriate disaster prevention measures need to be established.

5.5 Zhongshan Mausoleum

- **Historical significance**: The Zhongshan Mausoleum is the mausoleum of Mr. Sun Yat-sen, the father of China's modern nation, and is of great historical commemorative significance, representing the development and change of China's modern history.
- **Population density**: The area around the Sun Yat-sen Mausoleum has a relatively low population density and is mainly characterized by scenic spots and cultural heritage.
- **Economic benefits**: As an important tourist attraction, the Sun Yat-sen Mausoleum has a positive economic effect on the local tourism industry and related industries, attracting a large number of tourists.
- **Conservation Difficulty**: With its grand planning and unique architectural style, the Sun Yat-sen Mausoleum is difficult to protect and requires regular maintenance and repairs, as well as enhanced visitor management measures.
- **Disaster risk**: The area where the Sun Yat-sen Mausoleum is located may be at risk of natural disasters, such as floods and earthquakes, and corresponding disaster prevention measures need to be established.

5.6 Nanjing City Wall

- **Historical significance**: The Nanjing City Wall is one of the longest existing ancient city walls in China, and is of great historical significance, representing Nanjing's historical status as an ancient capital.
- **Population Density**: The population density of the area around the Nanjing City Wall is relatively high, and the area along the wall is one of the prosperous areas of Nanjing.

- **Economic benefits**: The protection and development of the Nanjing City Wall can promote the development of cultural tourism, drive the surrounding commercial activities, and have a positive impact on the local economy.
- **Protection Difficulty**: The protection of the Nanjing City Wall needs to take into account the structural condition of the wall and the difficulty of repairing it. Regular maintenance and repairs are necessary, as well as strengthening the management of the surrounding environment of the wall.
- **Disaster risk**: The area where the Nanjing City Wall is located may be at risk of natural disasters, such as floods and earthquakes, and corresponding disaster prevention measures need to be established.

5.7 Fuzimiao

- **Historical significance**: Fuzimiao is a representative of the traditional culture of ancient Chinese feudal society, and is of great historical significance as one of the historical and cultural districts of Nanjing.
- **Population Density**: The area around Fuzimiao has a relatively high population density and is a commercial and tourist area with a large flow of people.
- **Economic benefits**: As a tourist attraction and cultural neighborhood, Fuzimiao attracts a large number of tourists and businesses, which has a positive economic impact on local tourism and commercial activities.
- **Conservation Difficulty**: The protection of Fuzhimiao requires consideration of the repair and management of historical buildings, strengthening the regulation and control of commercial development, and maintaining the unique charm of its historical and cultural neighborhood.
- **Disaster risk**: Fire and other safety risks may exist in the area where the Fuzimiao is located, and fire safety and related safety management measures need to be strengthened.

5.8 Calculation of indicators

Table 2: **function parameter**

Buildings	Historical significance	Population density	Economic benefits	Protection difficulty	Disaster risk
Xuanwu Lake	6	7	7	4	5
Ming Xiaoling Mausoleum	8	4	6	8	4
Zhongshan Mausoleum	7	4	6	7	4
Nanjing City Wall	7	8	7	8	6
Fuzimiao	7	8	8	6	7

After the gray correlation analysis model calculation, the final output of each variable is $[5, 1, 2, 4, 3]$, i.e., the final importance of the sequential ranking results for the Ming Xiaoling Mausoleum $>$ Zhongshan Mausoleum $>$ Fuzimiao $>$ Nanjing City Wall $>$ Xuanwu Lake.I

6 Strength and Weakness

6.1 Strength

(1) **Comprehensive model construction process**: The paper covers multiple aspects such as market demand analysis, willingness-to-purchase rate calculation, risk assessment, and investment cost calculation, constructing a relatively complete real estate developer market investment model.

(2) **Data analysis and model selection**: By conducting data preprocessing, visualization analysis, and building various regression models, the ridge regression model was ultimately selected as the best model, improving the prediction accuracy and reliability.

(3) **Practical case application**: By using Nanjing city as an example to demonstrate the application of the model, the study enhances its practicality and operability, providing reference for actual decision-making.

6.2 Weakness

(1) **Limitations in data sources**: There may be limitations in the data sources, affecting the model's universality and generalizability. It is essential to validate the model's reliability by incorporating data from diverse sources.

(2) **Fine-tuning decision recommendations**: In the decision-making section, it could be beneficial to further refine the recommendations, including specific ways of cooperation with the government and banks for loans, as well as seeking specific pathways for supportive policies. This would make the recommendations more actionable and targeted.

7 Recommendation Letter

Dear Community Members:

I am pleased to be able to advise you on future plans, timelines, and cost recommendations for the preservation of five historic landmarks in Nanjing. Based on my insurance and preservation modeling analyses, here is the order of my preservation recommendations for these landmarks: Ming Xiaoling Mausoleum > Zhongshan Mausoleum > Fuzimiao > Nanjing City Wall> Xuanwu Lake.

Ming Xiaoling Mausoleum: Ming Xiaoling Mausoleum, as the mausoleum of the Ming Emperor Zhu Di and his empress, is of great historical significance and cultural value. In order to protect the Ming Xiaoling Mausoleum, I suggest that the community develop a detailed conservation plan. This plan should include regular inspection, restoration and maintenance work to ensure the integrity and safety of the Ming Xiaoling Mausoleum. In addition, the community should strengthen visitor management and education to raise public awareness of the Ming Xiaoling Mausoleum and its protection.

Zhongshan Mausoleum: The Zhongshan Mausoleum is the mausoleum of Mr. Sun Yat-sen, the great founding father of China in modern times, and is of great commemorative significance and cultural heritage value. To protect the Zhongshan Mausoleum, I suggest that the community formulate a long-term conservation plan, including regular inspections, restoration of cultural relics such as stone monuments and sculptures, and improvement of visitor service facilities. The community can also organize relevant cultural activities and educational programs to enhance the popularity and attractiveness of the Sun Yat-sen Mausoleum.

Fuzimiao: Fuzimiao is one of the oldest cultural scenic spots in Nanjing, representing a traditional cultural and academic atmosphere. In order to preserve the unique charm of Fuzimiao, I recommend that the community enhance the maintenance and restoration of the ancient buildings, courtyards and cultural relics, as well as improve visitor circulation and facilities. In addition, the community can actively promote cultural activities and educational programs to enhance the visibility and attractiveness of Fuzimiao

Nanjing City Wall: The Nanjing City Wall is one of the longest and most complete ancient city walls existing in China, and is of great historical and cultural value. In order to protect the Nanjing City Wall, I suggest that the community carry out restoration work on the wall, including cleaning and repairing the bricks of the wall and updating the protective facilities of the wall. At the same time, the community can organize cultural festivals of the city wall and hiking activities on the wall to increase the public's awareness of the Nanjing city wall and its protection.

Xuanwu Lake: Xuanwu Lake is the largest lake in Nanjing and is an important part of the city's ecological environment. In order to protect Xuanwu Lake, I suggest that the community develop a comprehensive protection plan, including pollution control of the lake and its shores, protection and restoration of the lake's ecosystem, and enhanced protection of the natural landscape around the lake. The community can also carry out lakeside park construction and environmental education activities to raise public awareness of environmental protection.

In formulating the above conservation plans, the community needs to consider the timetable and cost factors. I suggest that the community work with relevant professional organizations to conduct detailed feasibility studies and budget assessments. At the same time, the community can seek government support, attract private funding, and conduct public service fund-raising to raise funds. Encourage the public to participate in the conservation work and strengthen the cooperation between the community and the relevant stakeholders to work together for the conservation and development of the landmark.

Through the above measures, we will be able to ensure that these precious historical landmarks will be properly preserved and handed down, leaving behind valuable historical and cultural treasures for future generations.
Thank you for your interest in and support for the preservation of landmarks!
Best wishes.

References

[1] Boston Consulting Group. (2023, December 4). An Insurance Risk Framework for Climate Adaptation. Retrieved at: https://www.bcg.com/publications/2023/an-insurance-risk-framework-for- climate-adaptation

[2] Munich RE. (2022, January 10). Hurricanes, cold waves, tornadoes: Weather disasters in USA dominate natural disaster losses in 2021.

8 AI Report

1.OpenAI ChatGPT (November 5,2023, ChatGPT-4)
Query 1: Now the questions are as follows. Please provide us with the competition question ideas and modeling suggestions. As climate change increases the likelihood of more severe weather and natural disasters, ICM wants to determine how best to configure property insurance to make the insurance system resilient to pay unpaid To claim costs while ensuring the long-term health of insurance companies. If insurers are reluctant to cover policies in many cases, they fail because they have too few customers. Conversely, if the policy they cover is too risky, they may pay too much for claims.in which case Should insurance companies cover insurance policies? When should they choose to take the risk? What owners can do to influence this decision? Create a model for insurance companies to determine whether they should cover policies in areas with increasing extreme weather events. Demonstrate your model using two areas on different continents that experience extreme weather events. As we look into the future, communities and property developers need to ask themselves, how and where to build and develop. With the insurance industry pattern Future real estate decisions must be made to ensure that real estate is more resilient and carefully built, including for the growing communities and population Feasibility of providing appropriate services. How do you adjust your insurance model to assess where, how, and whether it is built in certain locations? In certain communities, your insurance model may recommend not underwriting current or future property insurance policies. This may lead to community leaders Facing difficult decisions about property of cultural or community significance. For example, the Cape Hatteras Lighthouse (Cape Hatteras Lighthouse) Was moved to the Bund in North Carolina (Outer Banks of North Caroli a community that should be protected and protected because of its cultural, historical, economic, or community significance? Develop a preservation model for use by community leaders, To determine the extent of what work they should do to preserve the buildings in the community. Choosing a historic landmark —— instead of the Cape Hatteras Lighthouse —— that is a place experiencing extreme weather events. Use your insurance with and Protection model to evaluate the value of this landmark. Given the insight you gain from the results of your insurance and preservation model, write one to the community A one-page letter advising their valuable landmarks for future plans, schedules and cost proposals. And na) to protect the historic lighthouse in and around Its local tourism industry.[3] As a community leader, how do you work in a
Output 1: To address this complex problem, we need to develop two main models: the insurance decision model to help insurance companies decide whether to cover regional policies in the face of climate change and increased risk of extreme weather events, and the community protection model to assess and recommend how to protect landmarks of significant cultural, historical or social value. Here are the modeling ideas and suggestions for these two models: