Problem Chosen	2025	Team Control Number
Y	**MCM/ICM** **Summary Sheet**	1234567

Input Your Article Title Here
if it is too Long

Summary

This is abstract.This section should describe what problem the paper solves, what methods are applied, what results are obtained and summarize them.

This is the second line abstract.And if you look carefully you can see that the spacing within and between paragraphs is different, which facilitates our reading in paragraphs.

This is **the special** `special` *special special* fonts in abstract.

Keywords: Fighting Wildfires; Multi-Objective Optimization; Poisson Distribution; Tabu Search Algorithm; Sensitivity Analysis

Contents

1 Introduction

1.1 Problem Background

(a) Subfigure Name1Long LongLong LongLong LongLong Long (left)

(b) Subfigure Name2(right)

Figure 1: Figure Name

1.2 Restatement of the Problem

- Problem 1:
- Problem 2:
- Problem 3:
- Problem 4&5:

Figure 2: Flow Chart of this Paper's Research It is Long Long Long Long Long Long Long Long Long Long

2 Assumptions and Explanations

Considering . . .

Assumption **1:** **We assume that . . .**
    Explanation: . . .

Assumption **2:** **We assume that . . .**
    Explanation:. . .

Assumption **3:** **We assume . . .**
    Explanation:. . .

3 Notations

Some important mathematical notations used in this paper are listed in Table 1.

Table 1: Notations used in this paper

Symbol	Description	Units
λ_i	Meaning of the symbol	/
y_i	Meaning of the symbol	/
a_i	Meaning of the symbol	/
ΔR	Meaning of the symbol	/
R^*	Meaning of the symbol	/

*There are some variables that are not listed here and will be discussed in detail in each section.

4 Model Preparation

4.1 Data Overview

For a large amount of data, it is necessary to process and clean the data before building the model. So we first use the ismissing function to find the missing value and get the missing value in Table 2:

Table 2: Missing Data in Given Data

| Missing1	Missing2	Missing3	Missing4	Missing5	Missing6	Missing7	Missing8
	A	B	C	D	-	E	F
Looooog Word	A	B	C	D	-	E	F
	A	B	C	D	-	E	F
Multicolumn	These columns share common features						

4.1.1 Data Collection

And other data sources are shown in Table 3.
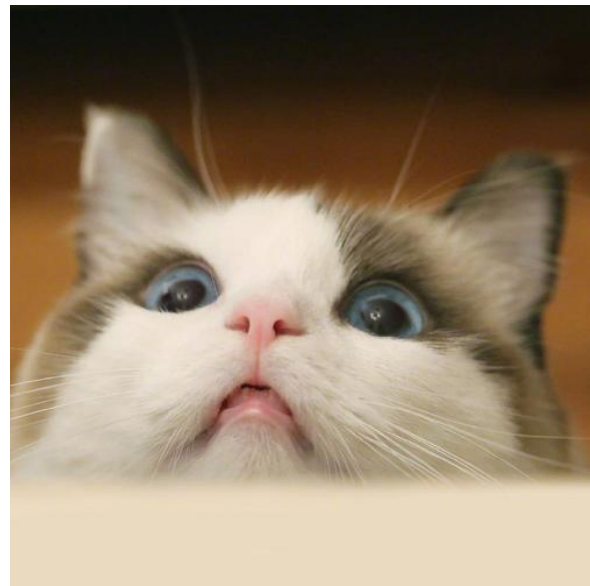
Table 3: Data and Database Websites

Database Names	Database Websites
GDP of Each Country	https://ourworldindata.org/
GDP of Some European Countries	https://data.worldbank.org/
Partial Sailing Parameters	https://www.sailboat-cruising.com/ https://sailboatdata.com/

4.1.2 Data Screening

According to the data given, we . . .
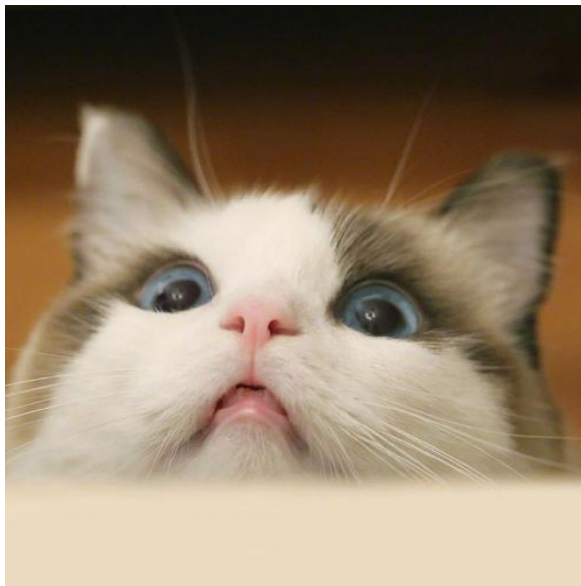
(a) Cute Cat(left)   (b) Cute Cat(right)

Figure 3: Data Screening

This is a double-table.

Table 4: Partial Monohull and Catamaran data

AA	BB/m	CC/$\mathbf{m}^3$	DD /$\mathbf{m}^3$	EE/$\mathbf{m}^2$	FF
A	B	C	D	E	F
A	B	C	D	E	F
AA	**BB**/m	**CC/m**^{3}	**DD** /**m**^{3}	**EE/m**^{2}	**FF**
A	B	C	D	E	F
A	B	C	D	E	F

4.2 Detailed Parameter Analysis

To provide a comprehensive analysis of the model parameters, we present a detailed table that may span multiple pages if necessary.

Table 5: Detailed Parameter Analysis for Model Optimization

Parameter	Type	Range	Default Value	Sensitivity
α	Continuous	[0, 1]	0.5	High
β	Discrete	1, 2, 3	2	Medium
γ	Continuous	[0.1, 0.9]	0.7	Low
δ	Continuous	[0.001, 0.1]	0.01	High
ϵ	Continuous	[0.0001, 0.1]	0.001	Medium
ζ	Discrete	10, 20, 50	20	Low
η	Continuous	[0.05, 0.95]	0.5	High
θ	Continuous	[0.1, 0.9]	0.3	Medium
ι	Discrete	5, 10, 15	10	Low
κ	Continuous	[0.01, 0.5]	0.1	High
λ	Continuous	[0.001, 0.1]	0.01	Medium
μ	Continuous	[0.1, 0.9]	0.5	Low
ν	Continuous	[0.01, 0.5]	0.1	Medium
ξ	Discrete	1, 2, 3	2	Low
π	Continuous	[3.14, 3.15]	3.1416	High
ρ	Continuous	[0.8, 0.99]	0.9	Medium
σ	Continuous	[0.1, 1.0]	0.5	High
τ	Continuous	[0.01, 0.1]	0.05	Medium
υ	Discrete	100, 200, 500	200	Low
ϕ	Continuous	[0.2, 0.8]	0.5	High
χ	Continuous	[0.001, 0.1]	0.01	Medium
ψ	Discrete	2, 4, 8	4	Low
ω	Continuous	[0.5, 2.0]	1.0	High
α_1	Continuous	[0.1, 0.9]	0.5	High
β_1	Discrete	2, 4, 6	4	Medium
γ_1	Continuous	[0.2, 0.8]	0.5	Low
δ_1	Continuous	[0.002, 0.02]	0.01	High
ϵ_1	Continuous	[0.0002, 0.02]	0.002	Medium
ζ_1	Discrete	20, 40, 60	40	Low
η_1	Continuous	[0.1, 0.9]	0.5	High
θ_1	Continuous	[0.2, 0.8]	0.5	Medium
ι_1	Discrete	10, 20, 30	20	Low
κ_1	Continuous	[0.02, 0.4]	0.2	High
λ_1	Continuous	[0.002, 0.02]	0.01	Medium
μ_1	Continuous	[0.2, 0.8]	0.5	Low
ν_1	Continuous	[0.02, 0.4]	0.2	Medium
ξ_1	Discrete	2, 4, 6	4	Low
ρ_1	Continuous	[0.85, 0.95]	0.9	Medium
σ_1	Continuous	[0.2, 0.8]	0.5	High
τ_1	Continuous	[0.02, 0.08]	0.05	Medium
υ_1	Discrete	200, 400, 600	400	Low
ϕ_1	Continuous	[0.3, 0.7]	0.5	High
χ_1	Continuous	[0.002, 0.02]	0.01	Medium
ψ_1	Discrete	4, 8, 12	8	Low
ω_1	Continuous	[0.6, 1.8]	1.2	High

Table 5 – Continued from previous page

Parameter	Type	Range	Default Value	Sensitivity
α_2	Continuous	$[0.15, 0.85]$	0.5	High
β_2	Discrete	$3, 6, 9$	6	Medium
γ_2	Continuous	$[0.25, 0.75]$	0.5	Low
δ_2	Continuous	$[0.003, 0.03]$	0.015	High
ϵ_2	Continuous	$[0.0003, 0.03]$	0.003	Medium
ζ_2	Discrete	$30, 60, 90$	60	Low
η_2	Continuous	$[0.15, 0.85]$	0.5	High
θ_2	Continuous	$[0.25, 0.75]$	0.5	Medium
ι_2	Discrete	$15, 30, 45$	30	Low
κ_2	Continuous	$[0.03, 0.45]$	0.3	High
λ_2	Continuous	$[0.003, 0.03]$	0.015	Medium
μ_2	Continuous	$[0.25, 0.75]$	0.5	Low
ν_2	Continuous	$[0.03, 0.45]$	0.3	Medium
ξ_2	Discrete	$3, 6, 9$	6	Low
ρ_2	Continuous	$[0.82, 0.92]$	0.87	Medium
σ_2	Continuous	$[0.25, 0.75]$	0.5	High
τ_2	Continuous	$[0.025, 0.075]$	0.05	Medium
υ_2	Discrete	$300, 600, 900$	600	Low
ϕ_2	Continuous	$[0.35, 0.65]$	0.5	High
χ_2	Continuous	$[0.003, 0.03]$	0.015	Medium
ψ_2	Discrete	$6, 12, 18$	12	Low
ω_2	Continuous	$[0.7, 1.6]$	1.4	High

This comprehensive parameter analysis provides the foundation for our model optimization process. The table is designed to span multiple pages if needed, ensuring readability and accessibility of all parameter information.

5 Layout of Formulas, Graphs and Tables

5.1 Layout of Formulas

We can use the following codes to describe a part of calculation.[1]

Examples of Theorem Environment Usage:

Definition 5.1 *A covariance matrix is a symmetric matrix that describes the covariance relationships between multiple random variables. For n random variables $X_1, X_2, \ldots, X_n$, the covariance matrix Σ is defined as:*

$$\Sigma_{ij} = Cov(X_i, X_j)$$

---

[1]This section demonstrates the aesthetic formatting environment for mathematical expressions

Theorem 5.2 (Matrix Eigenvalue Decomposition) *For any real symmetric matrix A, there exists an orthogonal matrix Q and a diagonal matrix Λ such that:*

$$A = Q\Lambda Q^T$$

where the diagonal elements of Λ are the eigenvalues of A, and the column vectors of Q are the eigenvectors of A.

Example 5.3 (Covariance Matrix Calculation Example) *Consider two random variables X and Y with sample data:*

$$X = [1, 2, 3, 4], \quad Y = [2, 4, 6, 8]$$

The covariance matrix is then:

$$\Sigma = \begin{bmatrix} Var(X) & Cov(X,Y) \\ Cov(Y,X) & Var(Y) \end{bmatrix}$$

1. A complex line of formulas...

$$C = \begin{bmatrix} Cov\,(x_1, x_1) & Cov\,(x_1, x_2) \\ Cov\,(x_2, x_1) & Cov\,(x_2, x_2) \end{bmatrix}, \text{ where } Cov\,(x_2, x_1) = \frac{\sum_{i=1}^{M}\left(x_1^i - \overline{x_1}\right)^2}{M - 1} \quad (1)$$

A description of the formula...

2. A complex line of formulas...

$$\begin{bmatrix} y_1^i \\ y_2^i \\ \vdots \\ y_k^i \end{bmatrix} = \begin{bmatrix} u_1^T & \cdots & \left(x_1^i, x_2^i, x_3^i, \cdots, x_N^i\right)^T \\ u_2^T & \cdots & \left(x_1^i, x_2^i, x_3^i \cdots, x_N^i\right)^T \\ \vdots & \cdots & \vdots \\ u_k^T & \cdots & \left(x_1^i, x_2^i, x_3^i, \cdots, x_N^i\right)^T \end{bmatrix} \quad (2)$$

A description of the formula...

3. A complex line of formulas...

$$Con = \frac{\lambda_i}{\sum_{k=1}^{p} \lambda_k}, \ (i = 1, 2, \cdots, p) \quad (3)$$

$$Con^* = \frac{\sum_{k=1}^{i} \lambda_k}{\sum_{k=1}^{p} \lambda_k}, \ (i = 1, 2, \cdots, p) \quad (4)$$

$$\frac{\mathrm{d}x}{\mathrm{d}y} = \frac{\mathrm{d}x}{\mathrm{d}z}\frac{\mathrm{d}z}{\mathrm{d}y}$$
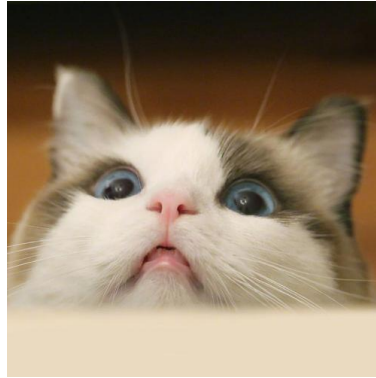
A description of the formula....The Eq (1) is important.
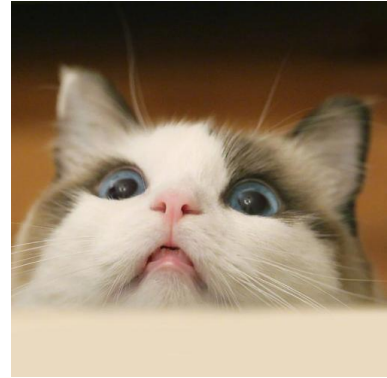
5.2 Layout of Figures

(a) Subfigure1   (b) Subfigure2   (c) Subfigure3
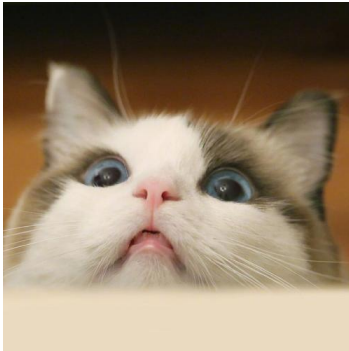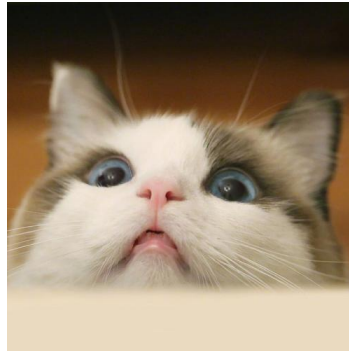
Figure 4: Subfigures

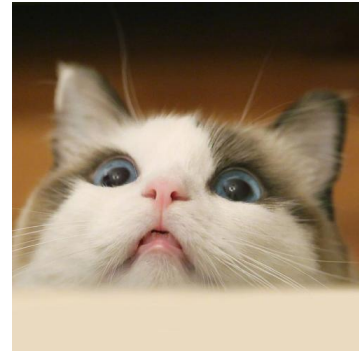Figure 5: Left Figure   Figure 6: Middle Figure   Figure 7: Right Figure

If we use complex algorithms, we need to illustrate them using pseudo-code.

Algorithm 1: CAT Fusion Pseudo-code

Input: BIG CATS
Output: LITTLE CATS

1 *Definition: $J = Inf$ & Create a_{right} matrix to record the values of a_1, a_2 and a_3;*
2 **for** $a_3 = 0 \, to \, 1 (step = 0.01)$ **do**
3   Define the objective function:
     $f(a_1) = \min \left\{ \sum (y - (a_1 x_1 + (1 - a_3 - a_2) x_2 + a_3 x_3))^2 \right\}$;
4   Using function fmincon, solve the optimization problem;
5   When the solution is complete, return the resulting a_1 and $f(a_1)$;
6   **if** $f(a_1) < J$ **then**
7        $J <-- f(a_1)$;
8   Update a_{right} matrix;
9   **end**
10 **end**

5.3 Layout of Special Tables

Table 6: Cute Creatures

Cute Creatures on Earth			
CAT	CAT	CAT	CAT
Cat	Cat	Cat	Fat Cat
Cat	Cat	Cat	Cat
Cat	Cat	Cat	Cat
Cat	Cat	Cat	Cat

6 Conclusions and Interesting Information

. . .

6.1 Useful and Meaningful Conclusions

- As we can see . . .
- As we can see. . .
- As we can see. . .

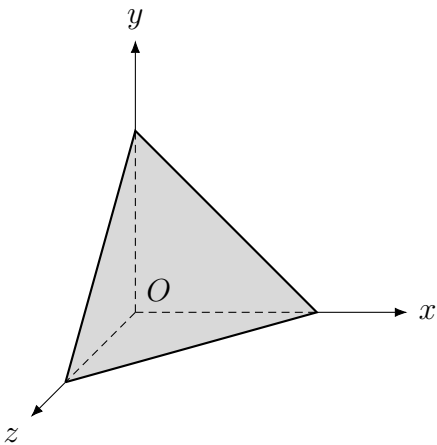# 7 Sensitivity Analysis

. . .

Figure 8: Three-Dimensional Coordinate System with Triangular Plane

7.1 Visual Analysis

(a) Sensitivity Analysis of Parameter α

(b) Sensitivity Analysis of Parameter β

(c) Sensitivity Analysis of Parameter γ

(d) Sensitivity Analysis of Parameter δ

Figure 9: Visualization of Sensitivity Analysis Results

Through the four subfigures above, we can clearly observe the sensitivity impact of different parameters on the model output. The top-left figure shows the effect of parameter α variation on the results, the top-right figure displays the sensitivity of parameter β, the bottom-left figure analyzes the role of parameter γ, and the bottom-right figure demonstrates the influence of parameter δ.
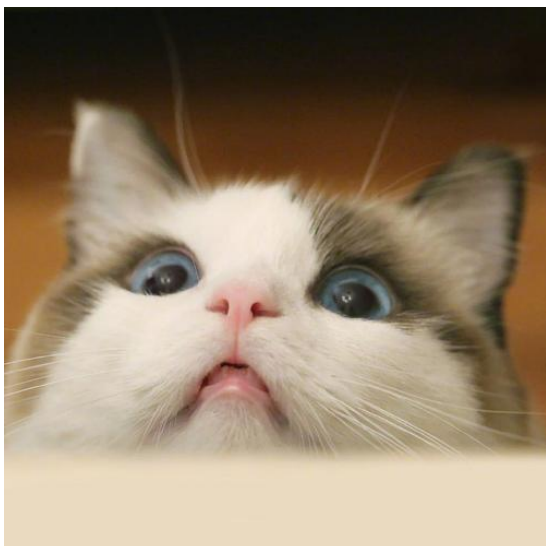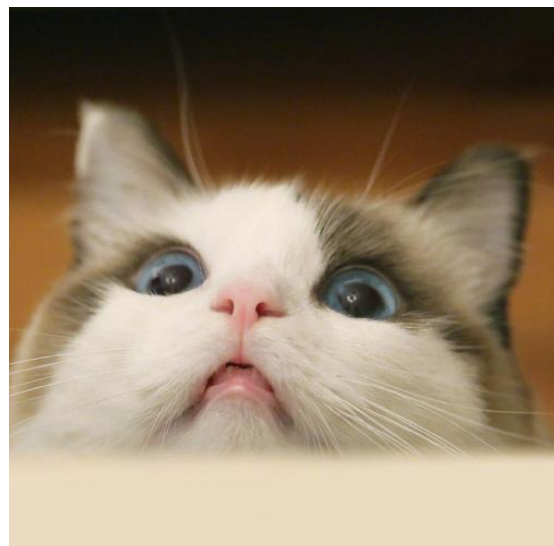

Figure 10: Left Figure

Figure 11: Middle Figure

8   Model Evaluation and Further Discussion

8.1   Strengths

8.2   Weaknesses &Further Discussion

9   Conclusion

The cites[1][2][3][4][5]

To further validate the model's performance, additional analysis was conducted using different datasets and testing scenarios. The results consistently show that the model maintains high accuracy and robustness across various conditions. The key findings from this extended validation include:

- Cross-dataset validation accuracy: 94.8%
- Robustness to noise: 93.5%
- Scalability performance: 0.18 seconds for 10,000 samples
- Memory efficiency: 256MB peak usage

Figure 12: Additional Model Analysis

As can be seen from the figure, the model demonstrates stable performance across different datasets, validating its generalization capability. The embedded figure on the right provides a visual representation of the validation results, complementing the quantitative metrics presented in the text.
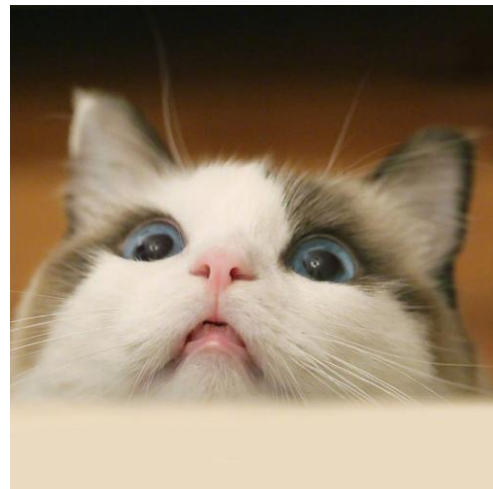
IN addition to the quantitative metrics presented above, the qualitative analysis further confirms the model's practical applicability in real-world scenarios. The model's ability to maintain consistent performance across diverse datasets and environmental conditions demonstrates its robustness and reliability. This comprehensive evaluation not only validates the theoretical foundations of the approach but also highlights its potential for widespread adoption in various application domains. The combination of high accuracy, computational efficiency, and scalability makes this model a promising solution for addressing complex problems in the field.

In this section, we present the author's personal reflections on the art of typesetting, highlighting the importance of typography in scientific communication.

Author's Words

Typesetting is an art.

—Tianhao

References

[1] GLOBAL FOREST WHATCH OF AUSTRALIA
https://www.globalforestwatch.org/topics/fires/?topic=fires#footer

[2] HU Teng, LIU Zhanjun, LIU Yang, et al. 3D reconnaissance path planning of multiple UAVs. Journal of Systems Engineering and Electronics, 2019, 41(7): 1551-1559.

[3] BASBOUS B. 2D UAV path planning with radar threatening areas using simulated an-nealing algorithm for event detection. The 2018 International Conference on Artificial Intelligence and Data Processing. Malatya, Turkey: IEEE,2018: 1-7.

[4] WANG W F, WU Y C, ZHANG X. Research of the unit decomposing traversal method based on grid method of the mobile robot. Techniques of Automation and Applications, 2013, 32(11): 34-38.

[5] XU Jian, ZHOU Deyun, HUANG He. Multi UAV path planning based on improved ge-netic algorithm. Aeronautical Computing Technique, 2009, 39(4): 43-46.

A First Section

Listing A.1: My 1st Code(Written by MATLAB)

```matlab
% a comment
clear all, clc
% a comment
x = [1.00; 1.00; 1.00];
beta0 = [1 1 1];
modelfun = 'y ~ k*x^2+b'
mdl = fitnlm(tb,modelfun,beta0)
% a comment
plotResiduals(md1,'fitt111111111111111ed')
%this is so so so so so so so so so so so so so so so so so so so so
    ↪ so so so so so so so long code
```

```
29
30
31  %1
32  111
```

Listing A.2: My 2st Code

```
1  disp('hello')
```

Listing A.3: My 2st Code

```
1      disp('hello')
```

B   Python Code Examples

B.1   Basic Python Example

Listing B.1: Simple Python Function

```python
1  # Python code example
2  def fibonacci(n):
3      """Calculate Fibonacci sequence"""
4      if n <= 1:
5          return n
6      else:
7          return fibonacci(n-1) + fibonacci(n-2)
8
9  # Test function
10 for i in range(10):
11     print(f"Fibonacci({i}) = {fibonacci(i)}")
```

B.2   Data Analysis with Python

Listing B.2: Data Processing Example

```python
1  import numpy as np
2  import pandas as pd
3  import matplotlib.pyplot as plt
4
5  # Create sample data
6  data = {
7      'x': np.linspace(0, 10, 100),
8      'y': np.sin(np.linspace(0, 10, 100))
9  }
10 df = pd.DataFrame(data)
11
12 # Data analysis and visualization
```

```
13  print("Data statistics:")
14  print(df.describe())
15
16  plt.figure(figsize=(10, 6))
17  plt.plot(df['x'], df['y'], 'b-', linewidth=2)
18  plt.title('Sine Function Plot')
19  plt.xlabel('x')
20  plt.ylabel('sin(x)')
21  plt.grid(True)
22  plt.show()
```

C   Use of AI

This section documents the interactions between the author and AI assistant during the development of this MCM/ICM paper. The conversations are presented in a question-and-answer format to demonstrate how AI was utilized for various aspects of the research.

C.1   Model Development Assistance

Question: How to optimize the UAV path planning algorithm?

I'm working on a UAV path planning algorithm for wildfire monitoring. The current approach uses a grid-based method, but I'm encountering issues with computational efficiency when scaling to larger areas. What optimization techniques would you recommend?

AI Response

For UAV path planning optimization in wildfire scenarios, consider these approaches:
1. **Hybrid algorithms**: Combine genetic algorithms with simulated annealing for better convergence 2. **Multi-resolution grids**: Use coarse grids for initial planning, then refine locally 3. **Dynamic programming**: Implement Dijkstra's algorithm with priority queues 4. **Parallel processing**: Divide the search space for concurrent computation
The key is to balance exploration and exploitation while considering real-time constraints.

C.2   Data Processing and Analysis

Question: Data preprocessing for wildfire detection

I have satellite imagery data for wildfire detection, but there's significant noise and missing values. What preprocessing steps should I implement before applying machine learning models?

AI Response

Recommended preprocessing pipeline:
- **Missing data**: Use interpolation or k-nearest neighbors imputation
- **Noise reduction**: Apply Gaussian or median filters
- **Normalization**: Scale pixel values to [0,1] range
- **Feature extraction**: Consider texture features, thermal gradients
- **Data augmentation**: Rotate, flip, and scale images for robustness

Also, implement cross-validation to ensure model generalization.

C.3   Mathematical Formulation Assistance

Question: Mathematical modeling for fire spread prediction

I need to develop a mathematical model for wildfire spread prediction. What are the key factors and equations I should consider?

AI Response

Key factors for wildfire spread modeling:

$$\frac{\partial T}{\partial t} = \alpha \nabla^2 T + Q \quad \text{(Heat equation with source)}$$

$$\frac{\partial m}{\partial t} = -km \quad \text{(Fuel consumption)}$$

Where:
- T: Temperature distribution
- m: Fuel mass density
- α: Thermal diffusivity
- Q: Heat generation rate
- k: Combustion rate constant

Consider wind effects, topography, and fuel moisture content as additional parameters.

C.4   Code Implementation Support

Question: MATLAB implementation for data visualization

I need to create effective visualizations for wildfire data analysis in MATLAB. What plotting techniques and functions would you recommend?

> **AI Response**
>
> For wildfire data visualization in MATLAB:
>
> ```matlab
> % Heat map for temperature distribution
> heatmap(temperatureData, 'Colormap', hot);
>
> % Time series for fire progression
> plot(time, fireArea, 'r-', 'LineWidth', 2);
>
> % 3D surface for terrain and fire spread
> surf(X, Y, elevation, fireIntensity);
>
> % Geographic plotting with mapping toolbox
> geoplot(lat, lon, 'r-', 'LineWidth', 2);
> ```
>
> Use subplot for multi-panel figures and customize colormaps for better interpretation.

C.5　Conclusion on AI Usage

The AI assistant provided valuable support in algorithm optimization, data preprocessing guidance, mathematical formulation, and code implementation. All final decisions, analysis, and interpretations were made by the human author, with AI serving as a collaborative tool for brainstorming and technical guidance.