| Problem Chosen | 2025 | Team Control Number |
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| **B** | **MCM/ICM** **Summary Sheet** | **2510625** |

# An MCM Paper Made by Team 2510625

**Summary**

Here is the abstract of our paper.

**For Problem1**, 通过数据分析，我们发现游客人数、税率和基建投入占比对收入有影响。为此，我们构建了一个综合收入、社会满意度和环境质量的目标函数，并采用多起点优化算法寻找最优解。基于朱诺市的历史数据，我们对社会满意度和游客人数进行了非线性拟合，拟合可靠度为 0.7423。通过去量纲处理，我们量化了社会满意度和环境质量对目标函数的影响。模型结果显示，当游客人数为 1,431,579 人，游客税率为 8%，废物管理投入占比为 0.179，水资源管理投入占比为 0.113，环境保护投入占比为 0.108 时，总收入达到 272 亿美元，$CO_2$ 排放量为 1,331,368.42 吨，居民满意度为 67.18（满分 100），环境指数为 0.4876（满分 1，越小越好）。在敏感性分析中，我们评估了变量的局部和全局敏感性，发现游客人数是关键变量。最后，我们使用帕累托最优解算法对模型进行了验证，发现其最优解与之前的结果相似，证明了模型的可靠性。

**For Problem2**, 为了去适应另一个景点，我们需要结合该景点的实际情况，如游客人数，游客人均消费，当地的水资源和废物处理承载能力等因素来修改可持续旅游发展模型中的关键参数。在我们的文章中，我们以位于中国四川省的九寨沟景区为例展示了修改模型的过程以及得到的相应结果并发现结果基本符合当地的客观情况。

**For Problem3**,

**For the Memorandum**, 基于上述的模型的结果的分析，我们预测了之后游客数量可能会发生的变化并考虑了季节性因素，分析了措施带来的影响，最后提出了三点优化的建议。

# 目录

# 1    Introduction

## 1.1    Problem Background

Here is the problem background.  Three major problems are discussed in this paper, which are:

- **Geographical Location:** Juneau is the capital of Alaska, located in the southeastern part of the state, with a population of approximately 30,000 residents.

- **Current Tourism Situation:**  In 2023, Juneau set a record for hosting 1.6 million cruise passengers, with up to 7 large cruise ships and 20,000 passengers received in a single day.[1] These tourists brought considerable economic benefits to the city, amounting to approximately $375 million.[2] However, this rapidly developing tourism industry has also brought a series of problems, especially challenges related to over-tourism.

- **Environmental Impact:**  Mendenhall Glacier in Juneau is one of the city's main tourist attractions, but in recent years, due to rising temperatures, the glacier has been retreating rapidly. Since 2007, the glacier has retreated a distance equivalent to eight football fields. This environmental change has not only caused damage to the natural landscape but also raised concerns among local residents about the sustainability of tourism.[3]



Figure 1: Volume Change of Mendenhall Glacier from August 17, 1984 to July 28, 2023

## 1.2 Problem Restatement and Analysis

- **Problem1:** Develop a model for a sustainable tourism industry that should meet the maximization of revenue, the maximization of environmental quality, and the maximization of social satisfaction, and conduct a sensitivity analysis on it.

- **Problem2:** Demonstrate how the model can be adapted to another tourist destination affected by overtourism, by obtaining relevant information from another city and analyzing it with the model.

- **Problem3:** Develop a model to address the issue of visitor diversion, which is also a measure to increase revenue and reduce regional pressure.

- **An article:** Write a memo to the Juneau Convention and Visitors Bureau, outlining the forecast of the results, the impact of various measures, and suggestions on how to optimize the results.

## 1.3 Our work

To avoid complicated description , intuitively reflect our work process, the flow chart is show as the following figure:
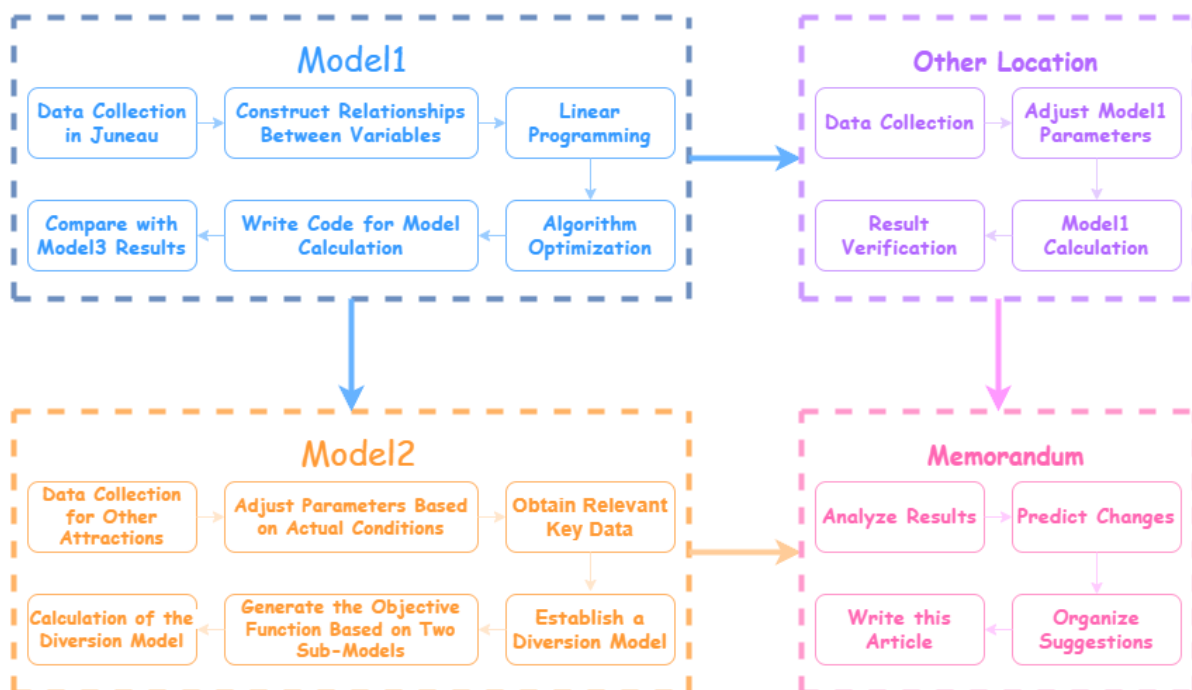


Figure 2: Flowchart of Work

# 2 Preparation of the Models

## 2.1 Assumptions

对于模型一：

- 假设游客消费带来的正面影响会带动就业岗位等间接影响，总体可由游客消费统一衡量。为简化模型，只考虑对旅游业经济影响最重要的因素，即游客消费，不考虑旅游业发展带来的就业岗位等间接经济影响。

- 假设税收在一定合理范围内变动时不会对游客消费和游客人数产生剧烈影响。因为提高税收并没有对游客人数增长造成显著的影响，同时考虑到税收增长带来的消费意愿降低和游客消费提高的综合效应。

- 为简化模型，假设游客人均消费为常数。由近几年的数据分析，游客人均消费并没有明显波动，对游客人数并没有明显的抑制作用，可认为在对一年内或近几年的较短周期的分析优化时是常量。

- 考虑基建压力与其所带来的隐性成本与环境污染，根据居民调查报告与实际情况，选择居民认为压力最大的废物处理系统，与容易出现压力的水供应系统作为隐性成本的代表进行衡量。假设其他如交通压力与能源供应等所受的压力情况与趋势与这两者相似，并由这两者的承载量衡量，在模型中忽略其具体的数学关系。

- 假设支出能够直接反馈到承载量与最大碳排放量里面，并且使得其获得线性的增长。为简化模型与评测，综合考虑时间滞后效应下投入对当年的基建等的影响，将其简化为线性函数，并通过调节其前的系数调整支出的即时收益。

对于模型二：

- 假设宣传的成本消耗与所能分流的人数为线性关系，以便于量化计算宣传成本。

## 2.2 数据准备

朱诺市近年的年游客数量 朱诺市近年的月游客数量 朱诺市税收分配情况
朱诺市近年的各项税率    朱诺市近年的游客人均消费朱诺市近年的游客调查报告
朱诺市近年的居民调查报朱诺市近年的饮用水年供应朱诺市近年的日废物处理量
美国居民日均用水量     美国居民日均废物产生量 九寨沟近年的年游客数量
九寨沟近年的财政支出    九寨沟近年的游客人均消费朱诺市观鲸项目项目报告
朱诺市观鲸项目游客平均消费朱诺市观景项目近年年游客数量

## 2.3   Notations

The primary notations used in this paper are listed in Table 1.

Table 1: Notations

| Symbol | Definition |
| --- | --- |
| $R$ | 经济发展指数 |
| $R_e$ | Total tourism income |
| $N_t$ | Number of tourists |
| $N_{tmax}$ | Maximum number of tourists allowed per year |
| $\tau_t$ | Tax rate |
| $P_t$ | Average spending per tourist |
| $E$ | 环境污染指数 |
| $CO_{2max}$ | 所允许的最大年 $CO_2$ 排放量 |
| $CO_{2p}$ | Carbon emissions per person |
| $C_{waste}$ | 城市的废物处理系统能够承载的年游客人数 |
| $C_{water}$ | 城市的饮用水供应系统与水污染处理系统能够承载的年游客人数 |
| $S_{residents}$ | Residential satisfaction |
| $S$ | Social satisfaction |
| $P_{waste}$ | Cities' investment in waste management |
| $P_{water}$ | Cities' investment in water management |
| $P_e$ | Cities' investment in environment management |
| $Z$ | Representation of target equation |

# 3   Solution to Problem1

## 3.1   Establish a Sustainable Tourism Development Model

### 3.1.1   Identifying Relationships Between State Variables

Considering the needs of sustainable tourism development, we evaluate the comprehensive benefits of Juneau's tourism industry from three perspectives: environment, economy, and society. Environmental pollution index $E$, economic index $R$, and social

satisfaction index $S$ are set for the evaluation.

Our objective function should be influenced by income, social satisfaction and environmental quality. We aim to maximize economic effects and social satisfaction while minimizing environmental pollution. Therefore, the economic index $R$ and social satisfaction index $S$ have positive effects on the objective function, while the environmental pollution index has a negative inhibitory effect on the objective function. Finally, we obtain:

$$\text{Objective Function} : Z = R + S - E \tag{1}$$

We mainly measure tourism income through the total expenditure of tourists during their travels. Total tourism revenue is mainly affected by per capita consumption and the total number of tourists. To simplify the model, we assume that per capita consumption will not fluctuate significantly in the short term and is a constant value. Therefore, the total tourism revenue should have a simple linear relationship with the number of tourists, so we can easily obtain Function 2.

$$R_e(N_t, P_t) = P_t N_t \tag{2}$$

It should be noted that since most tourism taxes, such as hotel taxes and alcohol taxes, are hidden taxes that are directly reflected in consumption, we consider that the tax revenue obtained by the government from the tourism industry is included in the calculated revenue, which is obtained by converting from the revenue according to the proportion of total tax revenue.

Meanwhile, in order to perform mathematical operations with environmental and social indices in the objective function for benefit evaluation, we normalized the per capita income to eliminate dimensional differences to obtain the objective function.

$$R = R_e / R_{estandard} \tag{3}$$

Where $R_{estandard}$ is the theoretical maximum value set for income. We believe that due to the need for environmental protection and other factors, the economy will not grow too much in the short term. Therefore, we select a constant slightly higher than the highest annual income in the most recent year as the maximum income to perform normalization and obtain the economic index.

In terms of environmental quality, we mainly consider the impact of three factors: carbon dioxide emissions, water consumption, and waste generation, all of which are closely related to the number of tourists. For the carbon emission factor, we mainly consider the

glacier melting problem in Juneau caused by excessive tourism. According to NASA data, the Mendenhall Glacier melted approximately 1.6 kilometers between 1984-2023 over 40 years, with an average melting rate of 40 meters per year, and its melting speed needs to be controlled. We can use the degree-day factor method to estimate the glacier melting rate:

$$M = DDF \times DDT \tag{4}$$

Where DDF is the degree-day factor, which varies little and is close to constant, and DDT is the positive temperature sum, which is directly affected by temperature. To control the rate of glacier melting, the key is to control temperature rise, and carbon emissions are the main factor affecting temperature rise. According to the *Paris Agreement*, the average annual temperature rise between 1850-2100 should be controlled between 1.5-2.0 degrees, and we use 1.5 degrees as the maximum temperature rise to calculate the maximum carbon emissions.

$$\Delta T = \lambda \times \ln(CO_2/CO_{2pre-industrial}) \tag{5}$$

According to this formula, we calculate the global average increase in carbon dioxide concentration, multiply it by atmospheric mass to obtain the total global carbon dioxide emissions over 250 years, and estimate Juneau's average annual emissions through its population proportion. Tourism is Juneau's largest industry, accounting for 60 percent of total emissions. Meanwhile, we calculate the maximum carbon emissions by adding the forest wetland area and average carbon absorption of Juneau. As for tourists' per capita carbon footprint, we considered that tourists mainly travel by cruise ships, which have relatively high carbon emissions, and estimated per capita carbon emissions by combining the average carbon emissions of cruise travel and tourists' onshore activities. Through Juneau's processing capacity for the latter two factors and the per capita consumption/generation of tourists and residents, we can calculate the number of tourists that Juneau's water supply system and waste treatment system can accommodate annually, $C_{waste}$ and $C_{water}$. We normalize the actual number of people compared to the carrying capacity to measure the pressure on the infrastructure system. Finally, combining the importance factors of each factor, we obtained Function 3:

$$E = k_1 \frac{CO_{2p} N_t}{CO_{2max}} + k_2 \frac{N_t}{C_{waste}} + k_3 \frac{N_t}{C_{water}} \tag{6}$$

Specifically, we believe that Juneau currently faces a relatively serious glacier melting problem and needs to control carbon emissions. Additionally, its waste treatment system has a smaller capacity compared to its water supply system, and population growth puts greater pressure on it. Therefore, we consider $k_1 > k_2 > k_3$.

Regarding social satisfaction, since tourist satisfaction has shown no significant changes in statistical data over a long time span, with overall satisfaction remaining around 99%, we believe that tourist satisfaction will not change significantly when factors like taxation are reasonable. Therefore, we mainly consider resident satisfaction. We primarily collected social satisfaction survey results from Juneau for five years: 1998, 2002, 2006, 2022, and 2023[4]. After excluding invalid evaluations marked as "no impact" and "don't know," the remaining evaluations were categorized into five levels according to the Likert scale. We converted the data scoring to a 100-point scale. Additionally, we looked up the tourist numbers for these five years[?] and performed data fitting with social satisfaction, obtaining the following results:
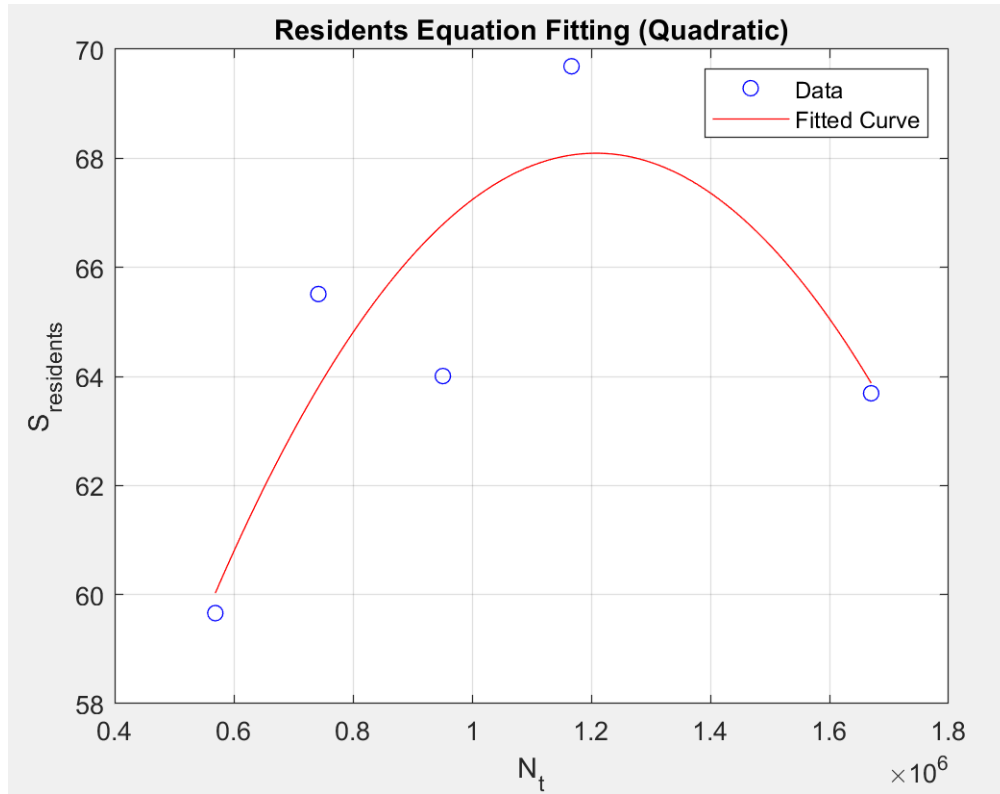


Figure 3: Nonlinear Fitting between $N_t$ and $S_{residents}$

Where $a_1 = -1.9753\text{e}{-}11$, $a_2 = 4.772\text{e}{-}5$, $b = 39.2660$, $R^2 = 0.7423$. Finally, to eliminate the impact of dimensionality, we divided the satisfaction score by the maximum satisfaction value of 100 points. The resulting Function 4 is as follows:

$$\begin{cases} S_{residents} = a_1 N_t^2 + a_2 N_t + b_1 \\ S = S_{residents}/100 \end{cases} \tag{7}$$

In terms of additional investment, we considered the feedback effect of the govern-

ment's tax allocation plan on the system. The government can invest in water supply systems, waste treatment systems, and environmental protection, such as infrastructure construction or increasing afforestation efforts, to improve the maximum carrying capacity of infrastructure and maximum carbon emissions, thereby obtaining higher returns. We believe that the government can adjust the proportion of investment in actual government allocation to maximize returns. The resulting Function 5 is as follows:

$$
\begin{cases}
P_{waste} = k_5 \tau_t R_e \\
P_{water} = k_6 \tau_t R_e \\
P_e = k_7 \tau_t R_e \\
k_5 + k_6 + k_7 \leqslant 0.4
\end{cases}
\tag{8}
$$

To simplify the model, we assume that investment can directly generate returns, and expenditures directly increase infrastructure carrying capacity or maximum carbon emissions at a certain ratio, in order to facilitate model decision-making.

$$
\begin{cases}
C_{waste}+ = \alpha_1 P_{waste} \\
C_{water}+ = \alpha_2 P_{water} \\
CO_{2max}+ = \alpha_3 P_e
\end{cases}
\tag{9}
$$

### 3.1.2 Find the constraints

In terms of economics, to limit the tax rate value and ensure the accuracy of assumptions, we set a restriction that the overall tax rate should be less than or equal to 8%. Therefore, we have Formula 7:

$$
\text{Financial} : \tau_t \leqslant 8\% \tag{10}
$$

Regarding tourist numbers, based on Juneau's policy[?], we derived the daily tourist number limit. Function 8 is as follows:

$$
\text{Touristic} : 0 \leqslant N_t \leqslant N_{tmax} \tag{11}
$$

Regarding environmental aspects, first, we set a limit on the maximum carbon dioxide emissions. For the maximum carrying capacity of water resources and waste treatment, we considered that seasonal fluctuations in tourist numbers would lead to increased infrastructure pressure during peak seasons. Based on the data, we obtained the ratio of maximum daily tourist numbers during peak season to total annual tourist numbers. Taking into account the elasticity of infrastructure capacity within a year, we set 1.2 times the

daily average carrying capacity as an upper limit to restrict the maximum daily number of tourists. Function 9 is as follows:

$$\text{Environmental}: \begin{cases} N_t \cdot CO_{2p} \leqslant CO_{2max} \\ 0.012N_t \leqslant \frac{1.2}{365}C_{waste} \\ 0.012N_t \leqslant \frac{1.2}{365}C_{water} \end{cases} \tag{12}$$

Regarding social satisfaction, after appropriate quantification, we set 60 as the passing threshold. Therefore, Function 10 is as follows:

$$\text{Social}: \ S_{residents} \geqslant 60 \tag{13}$$

### 3.1.3 Multi-start Optimization Algorithm

Since our model has five decision variables, namely $N_t$, $\tau_t$, $k_5$, $k_6$ and $k_7$, which interact with each other and have varying degree of influence on the objective function. In order to achieve relatively optimal conditions for each decision variable locally and at the same time strive for the global objective to be optimal, such as maximizing tourism revenue, minimizing environmental impact, and maximizing resident satisfaction, etc., we use a multi-start optimization strategy to optimize the various influencing factors of the objective function. The pseudocode is as follows:

**The solution and output of the model:** The model maximizes economic, environmental, and social benefits through multi-start optimization of five decision variables. In the initialization phase, the algorithm first sets up an empty optimal solution container and an infinite initial optimal objective value as the benchmark. Then, the algorithm generates multiple sets of different starting points within reasonable value ranges to ensure that the algorithm can explore a larger solution space. During the optimization loop phase, the algorithm performs a complete optimization attempt for each set of starting points. Each attempt uses the **Sequential Least Squares Quadratic Programming** (SLSQP) method to find the solution that optimizes the objective function, considering all constraints, such as visitor number limits, tax rate range, investment ratio restrictions, etc.). If an optimization attempt is successful and the resulting objective function value is better than the currently recorded optimal value, the optimal solution and objective value are updated. This process repeats until all starting points have been tested, and the globally optimal result is retained.

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**Algorithm 1** Multi-start Optimization Algorithm

---

1: **Input:** $n\_starts$, $Nmax$

2: **Output:** $best\_result$

3: /* Initialize variables */

4: $best\_result \leftarrow null$

5: $best\_objective \leftarrow \infty$

6: /* Generate starting points for each parameter */

7: $Nt\_starts \leftarrow linspace(100000, 0.8 \times Nmax, n\_starts)$

8: $\tau\_starts \leftarrow linspace(0.02, 0.07, n\_starts)$

9: $k\_starts \leftarrow linspace(0.05, 0.15, n\_starts)$

10: **Define optimization bounds**

11: /* Perform optimization from multiple starting points */

12: **for** $i \leftarrow 0$ **to** $n\_starts - 1$ **do**

13:     /* Construct initial point */

14:     $x0 \leftarrow [Nt\_starts[i], \tau\_starts[i], k\_starts[i], k\_starts[i]]$

15:     /* Minimize objective function */

16:     $result \leftarrow$ **minimize_function**

17:     /* Update best result if better solution found */

18:     **if** $result.success$ **and** $result.objective < best\_objective$ **then**

19:         $best\_objective \leftarrow result.objective$

20:         $best\_result \leftarrow deepcopy(result)$

21:     **end if**

22: **end for**

23: **return** $best\_result$

---

### 3.1.4   Calculation Results

Regarding total tourism revenue, based on historical data, we assign the value x to the average tourist expenditure. Through our calculations, we can determine that the annual number of tourists should be 1,431,579 people, with $P_e$ being \$4272,000,000,000. Looking at historical data, this figure appears relatively reasonable.

Regarding resident satisfaction, after inputting the number of tourists into the fitting equation, we obtain a resident satisfaction score of 67.18, which falls within our expected range.

Regarding environmental quality, through calculations, we obtained $k_5 = 0.179$, $k_6 = 0.113$, $k_7 = 0.108$. After substituting the number of tourists, $CO_{2max}$, $C_{waste}$, $C_{water}$, and $N_t$ into the equation, we got a result of 0.4876, which falls within our expected range.

## 3.2   Sensitivity Analysis

Since we have used a multi-start optimization strategy, we use **Sobol Analysis** to simultaneously analyze the local sensitivity and global sensitivity of the input variables $N_t$, $\tau_t$, $k_5$, $k_6$ and $k_7$. The pseudocode is as follows:

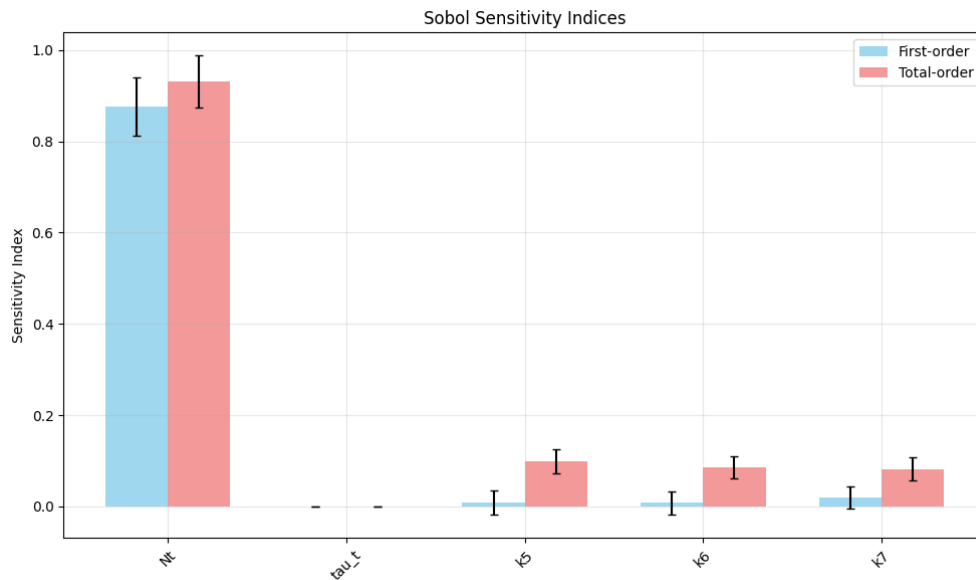The results are shown in the figure below:



Figure 4: Sensitivity Analysis

From the figure, it is clear that the number of tourists is the most critical variable, with

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**Algorithm 2** Sensitivity Analysis

---

1: **Input:** $n\_samples$

2: **Output:** $Si$ (result of Sobol Analysis)

3: /* Define problem structure */

4: **Initialize problem dictionary:**

5:      number of variables, variable names, variable bounds

6: /* Generate samples */

7: $param\_values = saltelli.sample(problem, n\_samples)$

8: /* Evaluate model for all samples */

9: Initialize empty array $Y$

10: **for** each parameter set $X$ in $param\_values$ **do**

11:      Calculate objective function value for $X$

12:      Add result to array $Y$

13: **end for**

14: /* Normalize results */

15: $Y = (Y - minimum\ of\ Y)/(maximum\ of\ Y - minimum\ of\ Y)$

16: /* Perform Sobol Analysis */

17: $Si = sobol.analyze(problem, Y)$

18: **Print results**

19: **Visualize results**

20: **return** $Si$

---

its local and global sensitivities reaching 0.877 and 0.932, respectively, far greater than the other input variables. This also aligns with the objective fact that, as a tourist city, Juneau's income is heavily influenced by the number of tourists.

## 3.3   Model Validation

In Section 3.1, we used a multi-starting point hybrid optimization strategy to calculate our established sustainable tourism development model, and conducted sensitivity analysis in Section 3.2. Although our calculation results were relatively consistent with reality, we still raised some doubts about their accuracy. Therefore, we employed a multi-objective optimization strategy to recalculate the optimal conditions for the above model to verify the correctness of the multi-starting point hybrid optimization strategy in Section 3.1. Our optimization objectives remained maximizing income, minimizing environmental impact, and maximizing social satisfaction. In the new multi-objective optimization strategy, we used the DEAP (Distributed Evolutionary Algorithms in Python) framework to implement NSGA-II (Non-dominated Sorting Genetic Algorithm II). We then used Pareto optimization to obtain a series of optimal conditions under this model, and based on requirements and actual situations, selected the final result range between 1,300,000 and 1,450,000. This result both met our expectations and corroborated the results from the multi-starting point hybrid optimization strategy in Section 3.1. Additionally, we also performed Sobol sensitivity analysis on the multi-objective optimization strategy algorithm, obtaining results that were very similar to those in Section 3.2, which further proved the correctness of both the multi-objective optimization strategy algorithm in Section 3.3 and the multi-starting point hybrid optimization strategy algorithm in Section 3.1. The figure shows the execution results of the multi-objective optimization strategy algorithm.
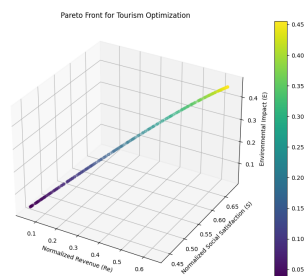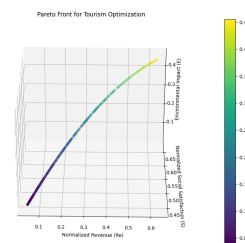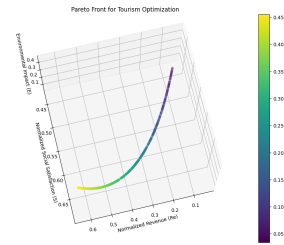


(a) Pareto Front 1                              (b) Pareto Front 2
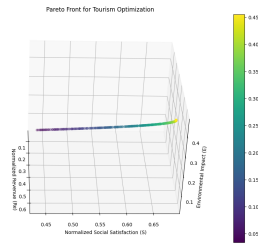
(a) Pareto Front 3                                      (b) Pareto Front 4

# 4    Solution to Problem2

为了展示模型是如何适应另一个受过度旅游影响的，我们经过数据的查找和收集决定选择位于中国四川省的九寨沟风景区来进行分析。

## 4.1    数据收集

因为每个地方的基础设施压力，人均消费等都大不相同，我们需要经过数据调研修改相应的参数后才能使用当前的模型进行预测。

通过对官网数据的收集 [6]，我们可以得出九寨沟县每年的收入和九寨沟风景区之间的关系。但是由于官方网站缺乏相应的满意度调查等信息，我们根据社会上的普遍评价对这些值进行了简单的估计，通过修改相应的限制条件，如水资源的人均消耗量，废物的人均产生量，水资源和废物处理的承载能力，游客人均消费水平，我们可以将模型适用于九寨沟的情况。
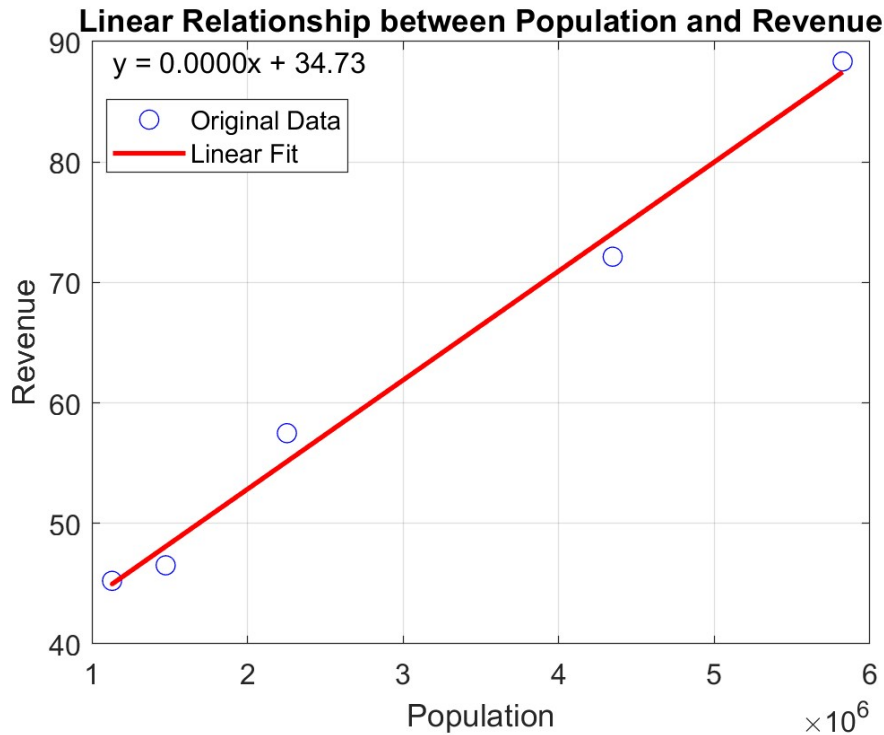
Figure 7: The Relationship between Tourism Revenue and Number of Visitors in Jiuzhaigou Scenic Area

## 4.2 结果展示

根据我们模型跑出来的最佳结果显示，$N_t$ 为 3747368，$P_e$ 为 2248421052.70 元，$S_{residents}$ 为 65.10，$k5$ 为 0.169，$k6$ 为 0.123，$k7$ 为 0.108。这些结果与往年数据相比较具有合理性。

# 5 Solution to Problem3

## 5.1 生成不同景点的目标函数

为了进行不同景点之间分流，我们需要获取各个景点的目标函数以来衡量各景点人流量变化后的收益变化。因此，我们需要获得具体每个景点的相关数据。因为不同景点的游客人数，人均消费不同，随之而导致的基建压力和社会满意度也大不相同，所以我们需要修改模型一的参数以来适应不同景点的实际情况。

阐述一下不同景点修改的实际数据

## 5.2  建立分流模型

在对景点进行了目标函数的构建之后，我们通过各景点的经过修改后的模型一计算得出具体的最优游客人数和各景点的支出分配政策。

在此基础上，我们考虑分流问题。假设模型中有 $n$ 个子模型，代表了具体的 $n$ 个景点。则总收益函数为:

$$Z = \sum_{i=1}^{n} Z_i \tag{14}$$

每个模型中的实际人数为 $N_{ti}$,，最优人数为 $N_{ei}$。对于实际人数大于最优人数的景点 $n_i$，我们希望将超出最有人数的部分分流去 $n_j$，则 $C_{i-j} = C_{pi-j} * \Delta N_{i-j}$(总成本，等于将一个人分流走的宣传成本乘以分流走的人数)，则宣传需要 $C = \sum_{i,j} C_{i-j}$，故决策变量为:

$$\Delta N_{i,j}(1 \le i, j \le n) \tag{15}$$

目标函数为:

$$Z = \sum_{i=1}^{n} Z_i(N_{ti}) - \frac{C}{C_{std}} \tag{16}$$

## 5.3  结果展示

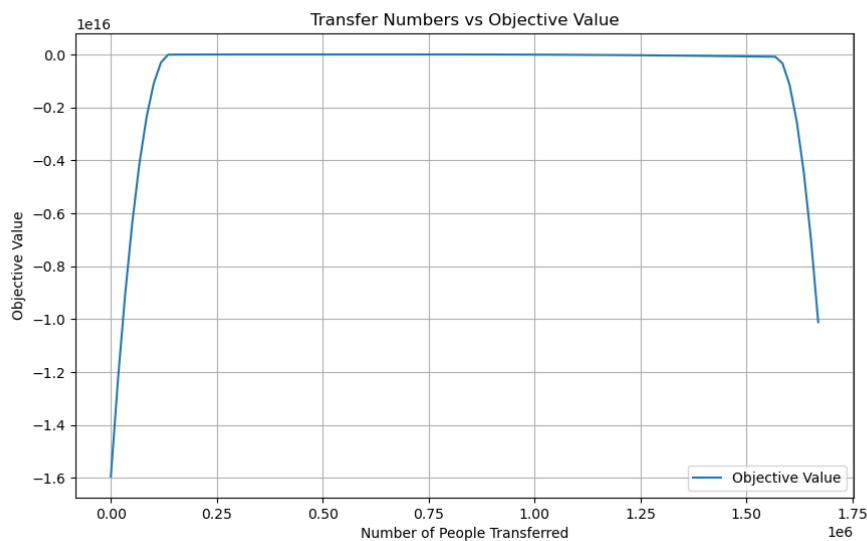这里以朱诺市两个景点门登霍尔冰川和赏鲸雨林为例来具体展示分流模型的结果。



Figure 8: model2

解释一下这个图，我看不太懂 QAQ

# Memorandum

**To:** 朱诺市政府
**From:** Team 2510625
**Date:** January 27th, 2025
**Subject:** 关于政府在旅游业上的一些建议

随着旅游市场的不断发展，朱诺市作为阿拉斯加的首府，拥有丰富的自然景观和独特的文化魅力，吸引了大量游客前来观光旅游。为了更好地了解旅游市场的发展趋势，评估各种措施对旅游市场的影响，并提出优化建议，我们进行了深入的市场调研和数据分析。

首先是关于旅游市场的预测，根据我们的市场调研和数据分析，预计未来几年朱诺市的旅游市场将呈现以下趋势：**游客数量增长：** 随着全球经济的复苏和人们生活水平的提高，预计未来几年朱诺市的游客数量将呈现稳步增长的趋势。特别是来自亚洲和欧洲的游客数量将有较大幅度的增加。**旅游季节变化：** 虽然夏季仍然是朱诺市的旅游旺季，但随着冬季旅游项目的不断丰富，如狗拉雪橇、冰钓等，冬季旅游市场也将逐渐升温。

二是各种措施的影响，为了促进朱诺市旅游市场的发展，我们分析了一系列措施，这些措施对旅游市场产生了以下影响：**适量提高税率：** 适量提高税率短时间不会对旅游人数产生较大的影响，而税率的提高可以增加旅游业带来的收入，额外收入增加后可以对基建投入更多的金钱以来提高水资源和废物处理承载能力。**限制每日的游客人数：** 限制每日的人数有助于缓解基础设施压力，提高居民满意度，同时如果限制的人数控制在一个比奥较好的值也能确保每日的收入保持在一个比较高的水平。

最后是一些优化的建议：**加强旅游基础设施建设：** 继续加大对旅游基础设施的投入，进一步改善住宿、餐饮、交通等方面的条件。特别是要加大对偏远地区的旅游基础设施建设，提高旅游的可达性和便利性。有利于游客参观更多的景点，分散个别热门景点的压力。**提升旅游服务质量：** 加强对旅游从业人员的培训，提高旅游服务的质量和水平。特别是要加强对导游、酒店服务人员等的培训，提高他们的专业素质和服务意识。这样可以提升朱诺市的旅游风评，增加游客前来的意愿。**加强市场营销推广：** 继续在国内外主要旅游市场进行市场营销推广，提高朱诺市的知名度和美誉度。可以通过举办旅游推介会、参加旅游展会等方式，向更多的游客宣传朱诺市的旅游资源和旅游产品以来吸引更多游客和刺激游客消费，提高游客平均消费水平。

# 参考文献

[1]   `https://abc7.com/post/juneau-alaska-cruise-ship-limits-overtourism/15048713/`

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[3]   `https://alaskapublic.org/2023/08/07/crammed-with-tourists-juneau-wonders-what-will-happen-as-mendenhall-glacier-recedes/`

[4]   *A simple, easy LATEX template for MCM/ICM: EasyMCM.* (2018). Retrieved December 1, 2019, from `https://www.cnblogs.com/xjtu-blacksmith/p/easymcm.html`

[5]   `https://earthobservatory.nasa.gov/images/151682/alaskas-mendenhall-glacier`

[6]   `https://www.jiuzhai.com/news/number-of-tourists/`

# Appendix A: 关于 AI 工具的使用说明

To clarify the importance of using LaTeX in MCM or ICM, several points need to be covered, which are . . .

To be more specific, . . .

All in all, . . .

Anyway, nobody **really** needs such appendix . . .