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T1 ________________	**9088**	F1 ________________
T2 ________________		F2 ________________
T3 ________________	Problem Chosen	F3 ________________
T4 ________________	**A**	F4 ________________

2018
HiMCM
Summary Sheet

(Your team's summary should be included as the first page of your electronic submission.) Type a summary of your results on this page. Do not include the name of your school, advisor, or team members on this page.

Roller coaster is always a must when people decide to visit the amusement park. Many websites have provided the potential tourists with roller coaster rankings, but the rankings still have some drawbacks.

Therefore, we establish a revised evaluating system and design a concept for an interactive and user-friendly app. First, we develop three models that are used to evaluate the roller coasters from different aspects and to look for roller coasters that cater to people's preferences based on *the Analytic Hierarchy Process (AHP).* Besides, we adopt *the Vector Space Model (VSM)* and use the cosine similarity to compare online rankings with the public preferences and our own elevating system with these.

In general, we assume that people always sit in the middle of the roller coaster, as it's fairer for the comparison between roller coasters. Also, we do not consider the waiting time of people because of difficulty in both collecting relative data and quantifying its psychological influence on people's decision-making.

In the first model, we assume that the standard of ranking the roller coasters depends on public preferences and we make a questionnaire which has collected 517 questionnaires to collect the statistics. Model I is mainly based on the Analytic Hierarchy Process (AHP). For task 1, we first prepare to analyze the subset data given and only focus on four objective factors: the height, the drop, the length of orbit and the maximum speed. and we can figure out the score of every roller coaster. And from our results, we can draw the top ten roller coasters that fit the public needs. The results have all passed the RI test, which attests the credibility of this model.

In the second model, we first establish two vectors: vector of a ranking system and vector of public preferences. Then we calculate the dot product and obtain the cosine value of these two vectors. After that, we take advantage of the concept of cosine similarity to measure the similarity between these two vectors. By comparing the cosine similarity of different ranking systems, we can confirm which one, the online ranking or our own evaluating system, matches more to the preferences of the public. According to our calculations, we successfully prove that our ranking system is of higher cosine similarity and therefore we can draw the conclusion that our system is prior to the existing online rankings.

To conclude, we utilize AHP to eliminate top-10 steel and wooden roller coasters by evaluating four most essential factors. For task 2, we employ the second model to form a comprehensive comparison with two sets of top-10 roller coasters. For task 3, we add an extra factor-distance by employing longitude-latitude distance measure equation. We then apply both models-AHP for rough handling and VSM for the final ranking, which would bring the users of our app with precise accommodation.

News Release

Annoyed with checking those roller coasters ranking that **lack detailed information**?
Annoyed with find a suitable roller coaster while finding the **scariest one**?

Annoyed with being recommended with roller coasters that's **on the other side of the earth**?

We know that most people are fond of riding roller coasters regardless of their age and nationality mainly to seek stimulation and excitement. There are so many roaster coasters in the world with different styles and strengths, but the existing roller coaster rankings are mainly based only on the size or popularity. A family may have a different preference as the teenagers. It's important to take various factors such as the speed and drop as well as the geological location and the waiting time into consideration.

Roller coaster is a popular means of relaxation and has a large market. Since its recommendation system nowadays is not mature, compared with the various and intelligent food and accommodation rankings, it's urgent for us to create a better one to benefit the public as soon as possible.

Good news —now we made one! Based on the big data collected, we analyze the public's preference and came to the Top 10 ranking list of the steel as well as wooden roller coasters all over the world, as the following presents:

Furthermore, we create an app to provide a personal recommendation for each user. Due to their geological positions collected by the GPS, the importance of different factors in their mind, and specific options they select such as with or without kids, we will be able to provide individualized recommendation and accurate information about that roller coaster, including the ticket price, traffic route, current local weather and so on.

We will continuously analyze the data we collected. As the number of users of our App grows, we can have a more accurate prediction of the public's preference, and thus make a better recommendation.

In addition, we have a specific section of the Top roller coasters in different aspects on earth, serving for those who pursue the ultimate.

What a perfect app for no matter roller coaster lovers or novices! However, that's not the end:

We will add more elements to our app later and make it the unification of amusement activities. We will release it on various platforms including Android and IOS and build a website. Moreover, we will cooperate with other APPs such as the Trip Advisor and Yelp and devote ourselves to the promotion of global leisure activities.

So, what are you waiting for? Come and download it in app store!

Roller Coaster

#TEAM 9088

Contents

1.Introduction

1.1 Restatement of the Problem

The roller coaster has become so popular in the world that it. Every day, hundreds and thousands of people take a ride on roller coasters in all these well-known theme parks like Disneyland. Many online rankings offer an advice to the potential tourists, but still what they take into consideration is way too less. In order to develop a more precise rating system, we have to ensure that: (1)this system takes both objective and subjective factors into consideration; (2)this system is of reference value as it only considers roller coasters in operation now; (3)this system is prior to the existing systems;(4) this system is of practical use as it can be adopted for use and be developed subsequently in a user-friendly app.

1.2 Model Overview

We mainly use three models to establish our rating system.

1.2.1 Model I

In Model I, we assume that the standard of ranking the roller coasters depends on public preferences which are recognized based on the data from our online questionnaire. Model I is mainly based on the Analytic Hierarchy Process (AHP). AHP, the method we adopted here, is the mostly widely used method in the evaluation of the weight, though its objectivity is very poor. Nevertheless, the weight defined by objective method cannot match its importance in practice completely. As to the subjective method, it can reflect the difference of relative importance among the four indexes despite the subject process to define the indexes' weight, so we utilize the more subjective AHP method rather than other more objective model to gain the weight. We first prepare to analyze the subset data given and only focus on four objective factors: the height, the drop, the length of orbit and the maximum speed. While there are too many roller coasters' characters that are obviously different from our standard, we roughly filter certain roller coasters. By setting up five matrixes of the public preferences, the height, the length, the drop and the speed of the roller coaster and comparing the synthetic level value to order in whole system, we can figure out the score of each roller coaster. From our results, we can draw the top ten roller coasters that fit the public needs. The results have all passed the RI test, which attests the credibility of this model.

1.2.2 Model II

In Model II, we use the same assumptions as Model I, as it's based on the results of Model I. We adopt the Vector Space Model (VSM) in Model II to compare online rankings with the public preferences and our own evaluating system with these. We first calculate the dot product of two vectors: vector of a ranking system and vector of public preferences. After that, we obtain the cosine value of the angle between these two vectors with the help of the dot product and the product of vector films. Then we bring in the concept of cosine similarity, a measure that judge the orientation and be a way to decide how similar these two standards are likely to be in terms of their subject matter. By comparing the cosine similarity of different ranking systems, we can confirm which one, the online ranking or our own evaluating system, matches more to the preferences of the public. The results approximately show a higher cosine similarity of our system, which proves that our evaluating system is more precise than the existing ones.

1.2.3 Model III

In Model III, we still adopt AHP as our basic solution but meanwhile also make some improvements. We take the distance between visitors and roller coasters into consideration with the help of a distance formula and change the weight function according to the visitor's personal preferences in order to make a personalized plan for the visitor. For example, if the visitor wants a more thrilling experience, then we transform it as a higher weight function for the maximum speed and drop. Therefore, we use a series of random data to testify our system and successfully prove its feasibility.

2.Assumptions

1. We assume that when experiencing different roller coasters, people choose to sit in the same seat of the roller coaster.

We do not consider the choice of the seat on a roller coaster, as it's fairer to the comparison between roller coasters. In general, people get more excited if they sit at the back and have a better view if they sit in the front when they take a ride on the roller coaster because of the difference in g-force. However, it's hard to judge the whole situation because each roller coaster varies from another. We cannot compare the function of a roller coaster without a regulated standard.

2. We assume that the time for waiting do not have impact on people's decision for a certain roller coaster.

Because of the difficulty in collecting related information, we do not take the waiting time into consideration. We assume that all potential visitors are ideal visitors. It means that visitors are patient enough to wait for their rides and the expectations of the ride will not be influenced. What's more, the psychological impact of the length of waiting time differs from one individual to another. Therefore, it's impossible to set up a general standard to judge the impact of waiting time.

3. We assume that the conditions of roller coasters do not change in a short period.

We assume that all roller coasters set out in the database will always be in operation in a considerable time period. And, we do not take into account the fluctuation of the ticket prices because the economic condition is a worldwide trend and will affect the prices in a unifying tendency.

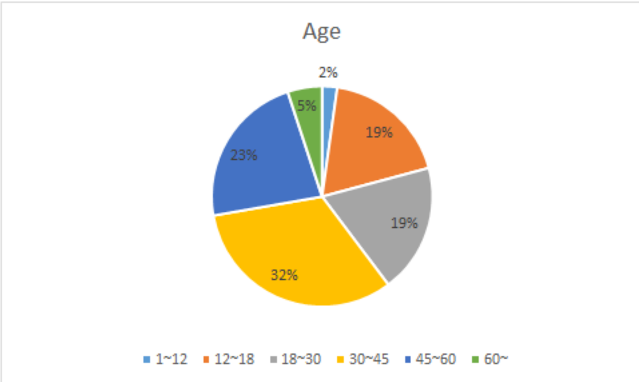
3. Modelling

3.1 Model I

3.1.1 Additional Assumption

1.The preferences of the general public base on our online questionnaire.

Because of the difficulty in collecting existing data on public preferences, we decide to collect information on our own. In advance, we use an online questionnaire to collect information about people's preference for roller coaster rides. We send this questionnaire on several social platforms and collect random samples instead of selecting a group of people as our target audience. Due to the data collected, over 1000 survey respondents cover different cities and age groups as the following graph presents:



This also coincides with the actual age group of roller coaster riders. Therefore, we believe that the results received can represent the preference of the general public and the conclusion can be generalized to the entire population.

2. We only consider objective factors in this model.

As the most basic model and the foundation of the later models, Model I is used to provide solution for the simplest situation, in which only objective factors count.

3. We divide the roller coasters according to their materials.

We cannot compare the experience of taking wooden roller coasters with that of steel-made ones together because of the massive calculation required and different riding experience. Therefore, we rank wooden and steel-made roller coasters separately.

3.1.2 Notations

Table 3-1-1: Notations and Descriptions

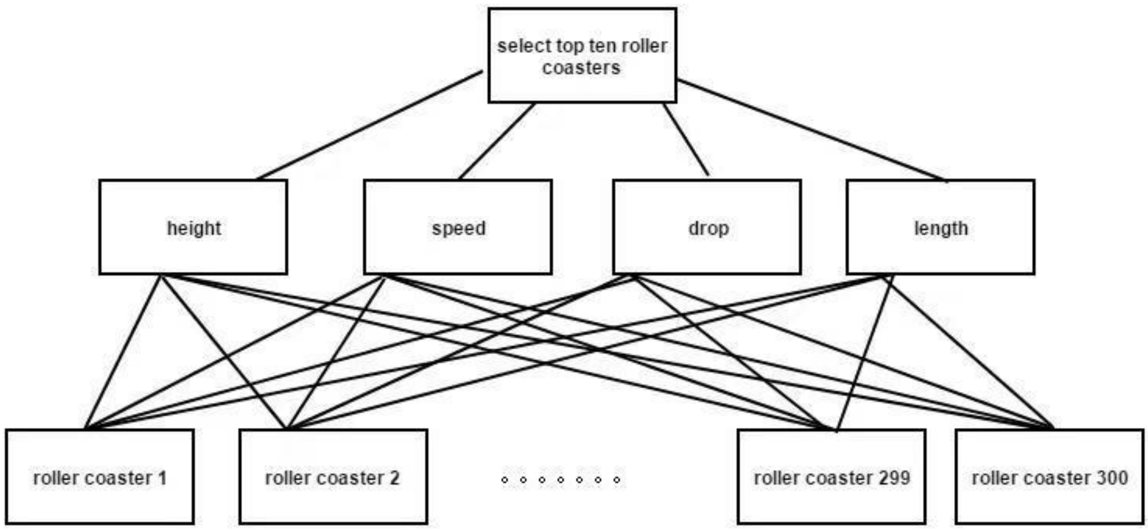
$\vec{a}$	Vector of public preferences
$Height_n$	Maximum height of a roller coaster
$Drop_n$	Maximum drop of a roller coaster

$Length_n$	Length of a roller coaster
$Speed_n$	Maximum speed of a roller coaster

3.1.3 Analytic Hierarchy Process (AHP)

We use a flow diagram to streamline our modeling process.

Chart 3-1-2: Initial Plan



We aim to figure out the top ten roller coasters and we set out an initial plan. The plan is to compare the public's preference with each roller coaster's data, as we are sympathetic to the fact that a roller coaster that meets public preferences is the best roller coaster.

It is made up of three parts: 1) the integration of the data; 2) filter certain roller coasters and 3) making several matrixes to deal with the data.

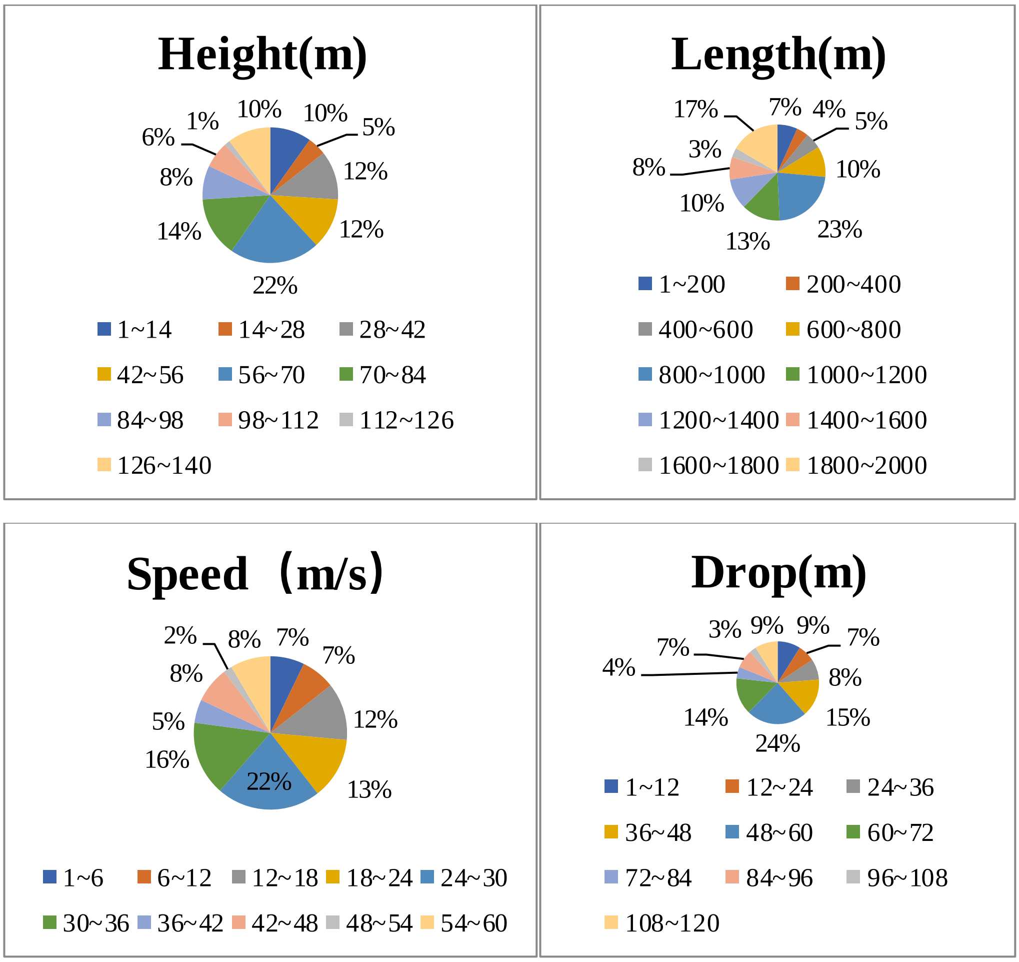
1. Preparation

a) Collecting the Data

Because of the lost statistics in the chart given, we must find a reference other than the database offered. In order to achieve related information and to get as objective assessment as we can, we designed an online questionnaire to collect information about people’s preference for roller coaster rides and spread it by the social media.

The questionnaire consists of questions about most aspects of a roller coaster’s character and the number of participants is quite considerable thus we will get a relatively objective indication of the preference for roller coaster rides.

Chart 3-1-3: Results of public preferences for roller coaster rides



Concluded from the chart above, the average choice of the height is 228.5 meters while the speed is 30.7 meters per second, the drop is 61.6 meters and the length is 1184.0 meters.

From the questionnaire, we get information of the numerical and descriptive specification data which most people ranging from all the age groups prefer.

b) The Filtration

Evaluating more than 30 roller coasters simultaneously would be impossible since this requires massive amount of calculation. So, we decided to divide roller coasters into two types due to their materials and consider them separately: the wooden and the iron. However, it still requires elimination.

Based on the public preference we collected from the survey, we can roughly eliminate the best roller coaster candidate at first and apply AHP for final ranking.

For instance, the public preference for the height of the roller coasters is "237.927ft", and we chose the roller coasters that have the similar value of height-in the range of $\pm 10\%$. As a result, we chose the roller coasters whose height is from "214ft" to "261ft".

After using an aforementioned method to compare the given data with the collected preference and filter by 10% difference allowance, we reach the final result. We successfully eliminate the number of steel-made roller coasters from originally 250 to 13 and that of wooden-made roller coasters from originally 50 to 13.

And the result is shown below:

Table 3-1-4: ranking of wood-made roller coasters

Name	Construction	Height (feet)	Speed (mph)	Length (feet)	Drop (feet)
Anaconda	Wood	118.1	55.9	3937.0	40.0
Balder	Wood	118.1	55.9	3510.5	62.9
Boardwalk Bullet	Wood	96.0	51.0	3236.0	92.0
Grizzly	Wood	91.0	55.0	3250.0	48.5
Jungle Trailblazer	Wood	111.6	54.1	3989.5	91.8
Legend	Wood	99.0	59.0	4042.0	52.7
Montana Rusa	Wood	110.0	52.8	4000.0	58.6
Mystic Timbers	Wood	109.2	53.0	3265.0	98.0
Racer	Wood	88.0	53.0	3415.0	53.3
Timber Wolf	Wood	100.0	53.0	4230.0	95.0
Tonnerre de Zeus	Wood	98.0	52.0	4044.0	52.2
Wild One	Wood	98.0	53.0	4000.0	88.0
Wildfire	Wood	183.8	71.5	4150.3	160.8

Table 3-1-5: ranking of steel-made roller coasters

Name	Construction	Height (feet)	Speed (mph)	Length (feet)	Drop (feet)
Big Apple Coaster	Steel	203.0	67.0	4777.0	144.0
Big Thunder Mountain	Steel	72.2	40.4	4921.3	39.3
Cannibal	Steel	208.0	70.0	2735.0	110.8
Flash	Steel	200.2	71.5	4176.5	190.3
Flying Aces	Steel	206.7	74.6	4921.3	110.1
Goliath	Steel	200.0	70.0	4480.0	175.0
Griffon	Steel	205.0	71.0	3108.0	109.2
Hyper Coaster	Steel	200.2	71.5	4176.5	190.3
Magnum XL-200	Steel	205.0	72.0	5106.0	194.7
Mako	Steel	200.0	73.0	4760.0	200.0
Raging Bull	Steel	202.0	73.0	5057.0	208.0
Shock Wave	Steel	116.0	60.0	3600.0	104.5
Skyrush	Steel	200.0	75.0	3600.0	191.0

2. Analytic Hierarchy Process (AHP)

We use the Analytic Hierarchy Process (AHP) to rank the remaining roller coasters and come to the TOP 10 roller coaster ranking.

a) The significance (the weight function)

Before we start to focus on the comparison of different roller coasters, we need to analyze the significance of the public preference. Basically, there are four variables which can affect the public preference: the height of a roller coaster, the speed of a roller coaster, the length of a roller coaster and the drop of a roller coaster. We compare them pair wise to get the initial ratio of significance with the 4-point important scale at first.

Table3-1-6: the significance of four factors

	H	S	D	L
H	1	5	3	3
S	$\frac{1}{5}$	1	$\frac{1}{2}$	$\frac{1}{3}$
D	$\frac{1}{3}$	2	1	2
L	$\frac{1}{3}$	3	$\frac{1}{2}$	1

In fact, the elements are given by the ratio of the highest value of the whole and comparing with each other.

From the table above, we build a comparison matrix for the four elements.

$$A=\begin{pmatrix} 1 & 5 & 3 & 3 \\ \frac{1}{5} & 1 & \frac{1}{2} & \frac{1}{3} \\ \frac{1}{3} & 2 & 1 & 2 \\ \frac{1}{3} & 3 & \frac{1}{2} & 1 \end{pmatrix}$$

It is obvious that A is not a conformity matrix. We will perform several tests to see if the inconformity is small enough to be allowed. First, we will figure out the maximum eigenvalue and the feature vector of A by the following steps:

$$A=\begin{pmatrix} 1 & 5 & 3 & 3 \\ \frac{1}{5} & 1 & \frac{1}{2} & \frac{1}{3} \\ \frac{1}{3} & 2 & 1 & 2 \\ \frac{1}{3} & 3 & \frac{1}{2} & 1 \end{pmatrix}$$

$$\Big\downarrow \quad \boxed{\text{Normalization along the column}}$$

$$A_1=\begin{pmatrix}\frac{15}{28} & \frac{5}{11} & \frac{3}{5} & \frac{9}{19}\\ \frac{3}{28} & \frac{1}{11} & \frac{1}{10} & \frac{1}{19}\\ \frac{5}{28} & \frac{2}{11} & \frac{1}{5} & \frac{6}{19}\\ \frac{5}{28} & \frac{3}{11} & \frac{1}{10} & \frac{3}{19}\end{pmatrix}$$

$$\Big\downarrow \ \boxed{\text{Addition along the row}}$$

$$A_2=\begin{pmatrix}2.06394\\0.35068\\0.87618\\0.70919\end{pmatrix}$$

$$\Big\downarrow \ \boxed{\text{normalization}}$$

$$w=\begin{pmatrix}0.5159\\0.0876\\0.2190\\0.1772\end{pmatrix},$$

which is the feature vector of A about the maximum eigenvalue

$$\Big\downarrow \ \boxed{\text{Multiply A by w}}$$

$$A\times w=\begin{pmatrix}2.1425\\0.3593\\0.9205\\0.7214\end{pmatrix}$$

And the maximum eigenvalue of A is:

$$\lambda=4.1322$$

The vector w can be considered as the weight value which can demonstrate the values of significance of the public preference to the height, speed, length and drop of the roller coasters. However, we need to test its conformity.

b)Consistency index (CI) and Random conformity index (RI)

We define a **consistency index (CI)** as:

$$C.I.=\frac{\lambda_{max}-n}{n-1}$$

A consistency index (CI) and the **random conformity index (RI)** determine whether the inconformity of A is allowed. The random index of a n×n matrix is shown in Table 3-1-5

Table 3-1-7:

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

The random index of A, a 4×4 matrix, could be simply decided as 0.90; the CI of A is 0.00158283. The ratio of CI to RI is

$$\frac{\mathrm{CI}}{\mathrm{RI}}=\frac{0.04407}{0.90}=0.0490<0.1$$

The theory, AHP, purposes that the inconformity of A can be neglected if $\frac{\mathrm{CI}}{\mathrm{RI}}<0.1$ so that the inconformity of A can be overlooked and the feature vector of A, can serve as the weight vector.

To find the roller coasters which are the top ten to conform to the public preference, we will calculate the weight vectors of the roller coasters filtered in Table 3-1-6 and Table 3-1-7 in height, speed, length and drop.

$$\omega_1=\begin{pmatrix}0.0642\\0.1805\\0.0626\\0.0651\\0.0630\\0.0652\\0.0636\\0.0651\\0.0636\\0.0652\\0.0645\\0.1123\\0.0652\end{pmatrix}\quad \omega_2=\begin{pmatrix}0.0765\\0.1269\\0.0733\\0.0717\\0.0687\\0.0733\\0.0722\\0.0717\\0.0712\\0.0703\\0.0703\\0.0855\\0.0684\end{pmatrix}\quad \omega_3=\begin{pmatrix}0.0062\\0.0642\\0.1155\\0.0757\\0.0642\\0.0705\\0.1017\\0.0757\\0.0619\\0.0664\\0.0625\\0.0878\\0.0878\end{pmatrix}\quad \omega_4=\begin{pmatrix}0.0765\\0.1269\\0.0733\\0.0717\\0.0687\\0.0733\\0.0722\\0.0717\\0.0712\\0.0703\\0.0703\\0.0855\\0.0684\end{pmatrix}$$

Using the same way as the matrix A, inconformity of four matrixes all passes the test thus we conclude the weight vectors, which are shown above, of the matrixes in comparison with the height, the speed, the length and the drop.

We build a weight matrix corresponding to four weight vectors.

$$B=\begin{pmatrix}0.0642 & 0.0765 & 0.0062 & 0.0765\\ 0.1805 & 0.1269 & 0.0642 & 0.1269\\ 0.0626 & 0.0733 & 0.1155 & 0.0733\\ 0.0651 & 0.0717 & 0.0757 & 0.0717\\ 0.0630 & 0.0687 & 0.0642 & 0.0687\\ 0.0652 & 0.0733 & 0.0705 & 0.0733\\ 0.0636 & 0.0722 & 0.1017 & 0.0722\\ 0.0651 & 0.0717 & 0.0757 & 0.0717\\ 0.0636 & 0.0712 & 0.0619 & 0.0712\\ 0.0652 & 0.0703 & 0.0664 & 0.0703\\ 0.0645 & 0.0703 & 0.0625 & 0.0703\\ 0.1123 & 0.0855 & 0.0878 & 0.0855\\ 0.0652 & 0.0684 & 0.0878 & 0.0684\end{pmatrix}$$

The row represents the thirteen roller coasters we filter from the whole and the column represents the weight of the height, the speed, the length and the drop separately.

Calculating the synthetic level value to order in whole system, we get that

$$B'=B\times w=\begin{pmatrix}0.0642 & 0.0765 & 0.0062 & 0.0765\\ 0.1805 & 0.1269 & 0.0642 & 0.1269\\ 0.0626 & 0.0733 & 0.1155 & 0.0733\\ 0.0651 & 0.0717 & 0.0757 & 0.0717\\ 0.0630 & 0.0687 & 0.0642 & 0.0687\\ 0.0652 & 0.0733 & 0.0705 & 0.0733\\ 0.0636 & 0.0722 & 0.1017 & 0.0722\\ 0.0651 & 0.0717 & 0.0757 & 0.0717\\ 0.0636 & 0.0712 & 0.0619 & 0.0712\\ 0.0652 & 0.0703 & 0.0664 & 0.0703\\ 0.0645 & 0.0703 & 0.0625 & 0.0703\\ 0.1123 & 0.0855 & 0.0878 & 0.0855\\ 0.0652 & 0.0684 & 0.0878 & 0.0684\end{pmatrix}\times\begin{pmatrix}0.5159\\ 0.0877\\ 0.2190\\ 0.1773\end{pmatrix}=\begin{pmatrix}0.041322\\ 0.107953\\ 0.042533\\ 0.042802\\ 0.041151\\ 0.042882\\ 0.042651\\ 0.042802\\ 0.041673\\ 0.042503\\ 0.042056\\ 0.068873\\ 0.042771\end{pmatrix}$$

By putting the elements in numerical order, we finally get the top ten of the steel roller coaster:

$$B_{steel}=\begin{pmatrix}0.041322\\ 0.107953\\ 0.042533\\ 0.042802\\ 0.041151\\ 0.042882\\ 0.042651\\ 0.042802\\ 0.041673\\ 0.042503\\ 0.042056\\ 0.068873\\ 0.042771\end{pmatrix}\xrightarrow{\text{represents}}$$

1 Big thunder
2 Shock Wave
3 Cannibal
4 Griffon
5 Big Apple Coaster
6 Flying Aces
7 Goliath
8 Flash
9 Hyper Coaster
10 Magnum xl 200
11 Mako
12 Skyrush
13 Raging Bull

3.2 Model II

3.2.1 Additional Assumption

1.The preferences of the general public base on our online questionnaire.

Because of the same reason mentioned in 3.1.1, we collect people's preferences on the basic of our online questionnaire.

2. Based on Model I, we only consider four objective factors in this model.

In Model I, we only take four objective factors into consideration. Since we establish our Model II based on the results of Model I, we compare our evaluating system with the online ranking systems in the same four aspects: height, speed, drop and length.

3.2.2 Notations

Table 3-2-1: Notations and Descriptions

$\vec{a}$	Vector of public preferences
$\vec{b}$	Vector of online ranking system 1
$\vec{c}$	Vector of online ranking system 2
$\vec{d}$	Vector of our own evaluating system
n	The rank of a roller coaster in one ranking system
β_n	Roller coaster in online ranking system 1
χ_n	Roller coaster in online ranking system 2
δ_n	Roller coaster in our own evaluating system
$\angle B_n$	Angle between vector $\vec{a}$ and vector $\overrightarrow{\beta n}$
$\angle C_n$	Angle between vector $\vec{a}$ and vector $\overrightarrow{\chi n}$
$\angle D_n$	Angle between vector $\vec{a}$ and vector $\overrightarrow{\delta n}$

3.2.3 Vector Space Model

1. Evaluation

Model II is based on the Vector Space Model (VSM). We adopt VSM to compare online rankings with the public preferences and our own evaluating system with these.

Take the vector of public preferences $\vec{a}$ and the vector of online ranking system 1 $\vec{b}$ as example.

In each ranking system, we have 10 best roller coasters. So, we define each roller coaster which ranks **n** in the ranking system 1 as $\boldsymbol{\beta_n}$, in which **n** range from **1 to 10**.

We use the same way to define other roller coasters. Roller coasters in online ranking system 2 are defined as $\boldsymbol{\chi_n}$. And roller coasters in our own evaluating system are defined as $\boldsymbol{\delta_n}$.

As we only consider four factors, which are the height, the drop, the length of orbit and the maximum speed, therefore we define $\overrightarrow{\boldsymbol{\beta n}}$ as

$$\overrightarrow{\boldsymbol{\beta n}} = [\boldsymbol{\beta_{n1}}, \boldsymbol{\beta_{n2}}, \boldsymbol{\beta_{n3}}, \boldsymbol{\beta_{n4}}],$$

in which $\boldsymbol{\beta_{n1}}$ stands for the height, $\boldsymbol{\beta_{n2}}$ stands for the drop, $\boldsymbol{\beta_{n3}}$ stands for the length of orbit, $\boldsymbol{\beta_{n4}}$ stands for the maximum speed of this roller coaster.

And by the same logic, we define $\vec{\boldsymbol{a}}$ as

$$\vec{\boldsymbol{a}} = [\boldsymbol{\alpha_1}, \boldsymbol{\alpha_2}, \boldsymbol{\alpha_3}, \boldsymbol{\alpha_4}],$$

in which $\boldsymbol{\alpha_1}$ stands for the average height that people favor, $\boldsymbol{\alpha_2}$ stands for the average drop that people favor, $\boldsymbol{\alpha_3}$ stands for the average length of orbit that people favor, $\boldsymbol{\alpha_4}$ stands for the average maximum speed that people favor.

First, we calculate the dot product of $\vec{\boldsymbol{a}}$ and $\overrightarrow{\boldsymbol{\beta n}}$. We define the dot product of $\vec{\boldsymbol{a}}$ and $\overrightarrow{\boldsymbol{\beta n}}$ as $\vec{\boldsymbol{a}}\cdot\overrightarrow{\boldsymbol{\beta n}}$,

$$\text{While } \vec{\boldsymbol{a}}\cdot\overrightarrow{\boldsymbol{\beta n}} = \sum_{i=1}^{4} \boldsymbol{ai\beta_{ni}} = \mathbf{a_1\beta_{n1}+a_2\beta_{n2}+a_3\beta_{n3}+a_4\beta_{n4}}$$

Then, we calculate the product of vector films of $\vec{\boldsymbol{a}}$ and $\overrightarrow{\boldsymbol{\beta n}}$. We define the vector film of $\vec{\boldsymbol{a}}$ as $|\vec{\boldsymbol{a}}|$,

$$\text{While } |\vec{\boldsymbol{a}}| = \sqrt{(\boldsymbol{\alpha 1})^2 + (\boldsymbol{\alpha 2})^2 + (\boldsymbol{\alpha 3})^2 + (\boldsymbol{\alpha 4})^2}$$

And by the same logic, we define the vector film of $\overrightarrow{\boldsymbol{\beta n}}$ as $|\overrightarrow{\boldsymbol{\beta n}}|$,

$$\text{While } |\overrightarrow{\boldsymbol{\beta n}}| = \sqrt{(\boldsymbol{\beta n1})^2 + (\boldsymbol{\beta n2})^2 + (\boldsymbol{\beta n3})^2 + (\boldsymbol{\beta n4})^2}$$

We define the product of $|\vec{\boldsymbol{a}}|$ and $|\overrightarrow{\boldsymbol{\beta n}}|$ as $|\vec{\boldsymbol{a}}|\cdot|\overrightarrow{\boldsymbol{\beta n}}|$,

While

$$|\vec{\boldsymbol{a}}|\cdot|\overrightarrow{\boldsymbol{\beta n}}| = \sqrt{(\boldsymbol{\alpha 1})^2 + (\boldsymbol{\alpha 2})^2 + (\boldsymbol{\alpha 3})^2 + (\boldsymbol{\alpha 4})^2} \cdot \sqrt{(\boldsymbol{\beta n1})^2 + (\boldsymbol{\beta n2})^2 + (\boldsymbol{\beta n3})^2 + (\boldsymbol{\beta n4})^2}$$

After that, we obtain the cosine value of the angle between $\vec{\boldsymbol{a}}$ and $\overrightarrow{\boldsymbol{\beta n}}$ with the help of the $\vec{\boldsymbol{a}}\cdot\overrightarrow{\boldsymbol{\beta n}}$ and $|\vec{\boldsymbol{a}}|\cdot|\overrightarrow{\boldsymbol{\beta n}}|$. We define the angle between $\vec{\boldsymbol{a}}$ and $\overrightarrow{\boldsymbol{\beta n}}$ as $\angle\mathbf{B_n}$, the cosine value of $\angle\mathbf{B_n}$ as $\mathbf{cos}\angle\mathbf{B_n}$,

$$\text{While } \mathbf{cos}\angle\mathbf{B_n} = \vec{\boldsymbol{a}}\cdot\overrightarrow{\boldsymbol{\beta n}} \;/\; |\vec{\boldsymbol{a}}|\cdot|\overrightarrow{\boldsymbol{\beta n}}|$$

With the help of methods above, we can get the cosine values of the angle between the vector of each roller coaster in online ranking system 1 and the vector of public preferences.

Then we repeat this process to get the data from two other systems: online ranking system 2 and our own evaluating system.

Then we bring in the concept of **cosine similarity**, a measure that judge the orientation and decide how similar these two standards are likely to be in terms of their subject matter. If the cosine value is closer to 1, then it indicates that this result is more appropriate and is more likely to fit the public preferences.

By comparing the cosine similarity of different ranking system, we can confirm which one, the online rankings or our own evaluating system, matches more to the preferences of the public.

As we use a method that differs from the way online rankings use, there may be some differences between the original ranking and our results of online ranking systems. In this case, we make two comparisons to show the credibility of our evaluating system.

We first make a new ranking of the roller coasters the existing ranking systems and compare the original ranking with the new results. By putting the roller coasters in an order that ranges from a higher cosine similarity to a lower cosine similarity, we can get new results. If there are any differences in between, it suggests that the original ranking is not completely consistent to the public preferences.

And second, we compare the roller coaster that ranks in the same place in online rating systems and our own evaluating system with each other. If the one in our evaluating system has a higher cosine similarity, then we can infer that the data from our system is of higher reliability.

Therefore, we expect to present the reliability and the precision of our model in combination of the explanation for self-contradiction of online systems and greater association to public preferences of our system.

2. Solution

We collect data about two rankings from Google and use the method above to compare all three ranking systems. Data from online ranking system 1 is retrieved from Coaster Buzz and data from online ranking system 2 is retrieved from the Ranker Community.

We first analyze the data according to the results achieved in Model I. By calculating the average, we obtain numbers about public preferences in height, speed, drop and length.

Table 3-2-2: The average numbers that represent people's preferences

H	237.927
S	57.120
D	201.969
L	3884.514

In Table 2, H stands for the height, S stands for the maximum speed, D stands for the drop, L stands for the length of orbit.

In this case, $\vec{a}$ **= [237.927, 201.969, 3884.514, 57.12]**

After this, we analyze the data from Google and get the results of three ranking systems. The data are presented as follows.

Table 3-2-3: The data about $\overrightarrow{\beta n}$, $\overrightarrow{\chi n}$ and $\overrightarrow{\delta n}$

$\overrightarrow{\beta 1}$	Steel Ven	(203.412,73.943,5741.470,200.131)
$\overrightarrow{\beta 2}$	Fury 325	(324.803,95.070,6601.050 ,321.522)
$\overrightarrow{\beta 3}$	El Toro	(180.446 , 68.351, 4265.092,177.165)
$\overrightarrow{\beta 4}$	Lightning Rod	(400.262,72.700,3937.008,164.042)
$\overrightarrow{\beta 5}$	Twisted Timbers	(111.549, 54.059,3349.738,108.268)
$\overrightarrow{\beta 6}$	Millennium Force	(308.399,93.206,6594.488,298.556)
$\overrightarrow{\beta 7}$	Twisted Colossus	(121.391,57.166,4986.877,127.953)
$\overrightarrow{\beta 8}$	Boulder Dash	(111.549,60.273,4724.409,114.829)
$\overrightarrow{\beta 9}$	Wicked Cyclone	(108.268,55.302,3313.648 , 59.055)
$\overrightarrow{\beta 10}$	Voyage	(164.042,67.419,6443.570, 154.199)

$\overrightarrow{\chi 1}$	Millennium Force	(302,93,292,6449)
$\overrightarrow{\chi 2}$	Steel Ven	(199,74, 196 ,5615)
$\overrightarrow{\chi 3}$	Top Thrill Dragster	(417,118,2727,385)
$\overrightarrow{\chi 4}$	Maverick	(103,68,4363,96)
$\overrightarrow{\chi 5}$	El Toro	(176,68,4171 ,173)
$\overrightarrow{\chi 6}$	Fury 325	(318,95,6455,314)
$\overrightarrow{\chi 7}$	Intimidator305	(298 ,87 ,5133 ,392)
$\overrightarrow{\chi 8}$	Kingda Ka	(446,128,3048,407)

$\overrightarrow{\chi 9}$	Voyage	(160,67 ,6301 ,151)
$\overrightarrow{\chi 10}$	Apollo's Chariot	(167,73,4774,205)

Our ranking of steel-made roller coasters

$\overrightarrow{\chi 1}$	Big Thunder Mountain	(72.2,40.4,4921.3, 39.3)
$\overrightarrow{\chi 2}$	Shock Wave	(116.0,60.0,3600.0, 104.5)
$\overrightarrow{\chi 3}$	Cannibal	(208.0,70.0,2735.0, 110.8)
$\overrightarrow{\chi 4}$	Friffon	(205.0,71.0,3108.0, 109.2)
$\overrightarrow{\chi 5}$	Big Aapple Coaster	(203.0,67.0, 4777.0, 144.0)
$\overrightarrow{\chi 6}$	Flying Aces	(206.7,74.6,4921.3, 110.1)
$\overrightarrow{\chi 7}$	Goliath	(235.0,85.0,4500.0, 255.0)
$\overrightarrow{\chi 8}$	Flash	(200.2，71.5， 4176.5， 190.3)
$\overrightarrow{\chi 9}$	Hyper Coaster	(200.2，71.5， 4176.5， 190.3)
$\overrightarrow{\chi 10}$	Magnum xl 200	(205.0，72.0， 5106.0, 194.7)

Then we use the product of vector films and the dot product to calculate the cosine value of $\angle$ **B**$_n$, $\angle$**C**$_n$, $\angle$**D**$_n$. And as all fundamental data needed are known, we begin to compare the reliability of three ranking systems.

First, we check if the two online systems contradict themselves. According to our calculations, …

Table 3-2-4: The original and present online ranking system 1

Original Online Ranking 1	**Revised Online Ranking 1**
Steel Ven	Fury 325
Fury 325	Millennium force
El Toro	El Toro
Lightning Rod	Steel vVen

Twisted Timbers	Twisted Timbers
Millennium Force	Lightning Rod
Twisted Colossus	Wicked Cyclone
Boulder Dash	Twisted Colossus
Wicked Cyclone	Voyage
Voyage	Boulder Dash

Table 3-2-5: The original and present online ranking system 2

Original Online Ranking 2	**Revised Online Ranking 2**
Millennium Force	Intimidator305
Steel Ven	Fury 325
Top Thrill Dragster	Millennium force
Maverick	El Toro
El Toro	Apollo's Chariot
Fury 325	Steel Ven
Intimidator305	Voyage
Kingda Ka	Maverick
Voyage	Kingda Ka
Apollo's Chariot	Top Thrill Dragster

Then we use data collected to compare the cosine similarity of different ranking systems.

Table 3-2-6: The comparison between three ranking systems and public preferences

Comparison 1	**Roller Coaster**	**Comparison 2**	**Roller Coaster**
0.99992280838317	Fury 325	0.999988647335612	Intimidator305
0.999873689222673	Millennium force	0.99992280838317	Fury 325

0.999767326390241	El toro	0.999873689222673	Millennium force
0.999522378987197	Steel ven	0.999767326390241	El toro
0.999419779524472	Twisted timbers	0.999597102909464	Apollo's Chariot
0.999375958155559	Racer	0.999502138805452	Steel Ven
0.999229164774112	Boardwalk Bullet	0.999229164774112	Boardwalk Bullet
0.999135188655037	Lightning rod	0.999229164774112	Timber Wolf
0.999044581859454	Balder	0.999044581859454	Tonnerre de Zeus
0.999032949800891	Legend	0.999032949800891	Montana Rusa
0.999013094096679	Wicked cyclone	0.99896756653041	Voyage
0.998974475523367	Twisted colossus	0.998874817534783	Maverick
0.998964410315194	Voyage	0.998862431539364	Anaconda
0.99891435541932	Boulder dash	0.998765726468396	Racer
0.998881930092718	Wild One	0.998765726468396	Grizzly
0.998862431539364	Tonnerre de Zeus	0.998716774084454	Balder
0.998765726468396	Grizzly	0.99864554165159	Wild One
0.998740603641922	Montana Rusa	0.998575377033444	Legend
0.998716774084454	Timber Wolf	0.993013798549962	Kingda Ka
0.99864554165159	Anaconda	0.99177062302894	Top Thrill Dragster

3.3 Model III

3.3.1 Additional Assumptions

1. We assume that we can have access to all information.

We assume that we can have access to the databases of other departments to get the geological positions of the visitors, information about the current traffic condition of their destinations, the local weather, discount information and ticket prices under any circumstances. In this case, we can develop a dynamic evaluating system on the basic of flexible and information that is not pre-set.

2. We assume that all information visitors provide is real.

We make a personalized traveling plan that highly depends on the information offered by a potential visitor. So, we suggest that all information he or she provides about personal preferences is reliable and can be regarded as our reference.

3. We assume that the geographic location of each roller coaster is the location of the city it's in.

In the real world, it's impossible to find all the detailed location of a certain roller coaster. By detailed location we mean the detailed address of a certain roller coaster which is inclusive of the house number, the street name and so on. Therefore, we only matter the city each roller coaster is in when we consider the geographic location.

3.3.2 Notations

Table 3-3-1: Notations and Descriptions

Arriving	the central city
Departure	the visitor's current location
$Distance_n$	Distance between the central city and the visitor's current location

3.3.3 A distance Formula and Analytic Hierarchy Process (AHP)

1. Evaluation

a) A Distance Formula

We use a distance formula to figure out the added factor distance. As the distance formula determines the great-circle distance between two points on a sphere given their longitudes and latitudes, data about the longitude and latitude of the destination and the current position of a visitor is required. And this formula functions as follows:

$$C = \sin(MLatA)*\sin(MLatB)*\cos(MLonA-MLonB) + \cos(MLatA)*\cos(MLatB)$$

In which **Lat** stands for latitude and **Lon** stands for longitude.

Take the USA for example. Based on the database given, we draw a map of roller coasters in the USA.

Diagram 3-3-2: The map of roller coasters in the USA based on the given database

From this map, we can clearly see that the roller coasters assemble in five main parts: The Northeast, the Southeast, the North, the South, and the West.

In order to simplify our model, we set a center in each part: in the northeast New York City, in the southeast Miami, in the north Chicago, in the south Houston, and in the west Los Angeles. Five circles are centered on the five central cities in the radium of 500 kilometers.

Table 3-3-3: The geographic location of the five US central cities

Since we are now authorized to collect or use information from other database, we can simply use GPS to get the visitor's current location. We define longitude of the visitor's current location as **departure longitude**, and latitude of visitor's current location as **departure latitude**.

When calculating the distance, we use only the latitude and longitude of the central cities. We define longitude of the city as **arriving longitude**, latitude of the city as **arriving latitude**, the distance between the central city and the visitor's current location as $\mathbf{Distance_n}$.

And according to the A distance formula, we define $\mathbf{Distance_n}$ as

$$Distance_n = \mathbf{R} \cdot \mathbf{arccos}\Big(\mathbf{sin}(\mathbf{Departure_{latitude}}) \cdot \mathbf{sin}(\mathbf{Arriving_{latitude}}) + \mathbf{cos}(\mathbf{Departure_{latitude}})\,\mathbf{cos}(\mathbf{Arriving_{latitude}})\,\mathbf{cos}\big(\mathbf{Departure_{longitude}} - \mathbf{Arriving_{longitude}}\big)\Big)$$

In this way, we can calculate the distance between the central city and the visitor's current location and deduce the distance between the destination and the visitor's current location.

By the same logic, we popularize this technique of distance calculation to other countries and continents. All the related information, including the geographic location of the visitor's current location and the geographic location of the destination, are captured by programming. After this, the automatic comparison of the distances between central cities and visitor's location is also realized by programming.

b) Analytic Hierarchy Process (AHP)

The AHP strategy applied in model III is similar to that in model I. In addition, we added an extra factor which is "distance". In this step, we select the five factors of all the 300 roller coasters and list them in one 5×300 matrix. Also, the quantified preference for each user is calculated by applying classification algorithm, which is a 1×5 matrix. As a result, we multiply the two matrixes to get a 1×300 matrix that represent the rough ranking from roller coaster_1 to roller coaster_300. Then, we would pick out the 15 top-ranked roller coasters and apply AHP to specifically rank the top-15 roller coasters. After all, what shown in front of the users are the most suitable roller coasters for them.

2. Solution

To help better understand the overall solution, we decide to employ flow diagram:

$$\omega_1 = \begin{pmatrix} Height_1 & Speed_1 & Drop_1 & Length_1 & Distance_1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ Height_n & Speed_n & Drop_n & Length_n & Distance_n \end{pmatrix}, \omega_2 = \begin{pmatrix} Height_{prefer} \\ Speed_{prefere} \\ Drop_{prefer} \\ Length_{prefer} \\ Distsance_{prefer} \end{pmatrix}$$

$$\text{Ranking} = \frac{\omega_1 \omega_2}{\sqrt{H1^2 + S1^2 + D1^2 + L1^2 + Dis^2} \cdot \sqrt{Hp^2 + Sp^2 + Dp^2 + Lp^2 + Dis\_p^2}}$$
$$= \begin{pmatrix} Ranking_{rolller\_coaster\_1} \\ \vdots \\ Ranking_{rolller\_coaster\_n} \end{pmatrix}$$

$$\Big\downarrow \text{AHP}$$

$$\text{Recommended roller coaster} = \begin{pmatrix} ranked\ first \\ \vdots \\ ranked\ fifteenth \end{pmatrix}$$

Since it is not a fixed model, we use some specified information to attest this model:

Supposing that a user of our app that live in Shanghai with a $\text{preference matrix} = \begin{pmatrix} 3 \\ 3 \\ 5 \\ 9 \\ 7 \end{pmatrix}$

$$\text{Ranking} = \begin{pmatrix} 0.9288 \\ \vdots \\ 0.9085 \end{pmatrix}$$

After all, we can easily get the ranking b sorting the result.

4.Conclusions

1. AHP requires the support of data. As a result, the more data we access, the more precise outcome it would calculate.

2.Quantify or evaluate a certain kind of complex device requires the multi-dimensional data to make the evaluation possible.

5. Strength and Limitations

5.1 Strength

1. Double examination

In model I, we first filter out the roller coasters of too big differences with the preference of the public and then use the AHP to analyze the remaining ones. In the second model, we use a totally different method, the VSL model to examine, and successfully proof that our model best coincides with the expectation of the public and any other existing ranking systems.

2. Two styles

Most ranking systems only provide the overall data of the roller coasters. But according to our knowledge, the wooden roller coasters spread widely all over the world and gain large popularity quickly, but they offer a totally different experience as the steel ones. It is perhaps the first time that there is a separate ranking for the wooden roller coasters.

3. The innovative way of distance calculation

Most roller coaster fans are travelers from distant origins. That's because the locals will surely know which roller coaster to ride, since there are not so many roller coasters in a city. Thus, it's reasonable to plan a route for them. We look into the global geological information and precisely select the biggest cities with the busiest airport in each region as their destinations, in which we can both calculate the distance to get there but also provide them with the private travelling routes.

5.2 Limitations

1. Single database on public preferences

In first two models, we are highly dependent on the data and results from our online questionnaire when we try to find reference for public preferences for roller coasters due to the difficulty in collecting and quantifying data. Although these data are of high reliability and is representational of the whole pubic preference, we find it one-sided to rely on a single database.

2. Single database on roller coasters

We only provide the information of the already existing roller coasters without the consideration of the newly being built ones and the situations in which the roller coasters are shut off due to mechanical breakdowns or damaging weathers. Later we will use crawlers to follow the associated updates.

3. Limited assumption

Our solution is based on the principle that the dominance of the public's preference means the higher ranking, but we must consider the fact that different age groups of people with different personality have different favor of roller coasters. We should provide different scoring models to fit the demand of different people.

4. Limited factors

In the third model, we only put one additional factor into consideration---- the geological position. But we haven't analyzed the subjective factors such as the popularity and the scenery, which also have large influence on the personal experience.

6. References

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7. Appendix

Question 1:

Python part:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import datetime
import os
import xlrd

from datetime import date,datetime

df=pd.read_csv('/home/16713-zyzx/COMAP_RollerCoasterData_2018.csv')

df.head()

all_data_na = (df.isnull().sum() / len(df)) * 100
all_data_na = all_data_na.drop(all_data_na[all_data_na ==
0].index).sort_values(ascending=False)[:30]
missing_data = pd.DataFrame({'Missing Ratio' :all_data_na})
missing_data.head(20)

('Height (feet)'):
    df['Height (feet)']=df['Height (feet)'].fillna(value=83.4)

for col in df['Drop (feet)']:
    df['Drop (feet)']=df['Drop (feet)'].fillna(df['Drop (feet)'].median()[0])

for col in df['Speed (mph)']:
    df['Speed(mph)']=df[' Speed(mph)'].fillna(df[' Speed(mph)'].mode()[0]

for col in df['Length (feet)']:
    df['Length(feet)']=df['Length (feet)'].fillna(df['Length (feet)'].median()[0])
```

df.to_csv('C:\Users\zhuyue\Desktop\HIMCM\excel\df')

matlab part:

```
clc;
clear;
for k =1:5
    A=xlsread('C:\Users\zhuyue\Desktop\HIMCM\excel\assistor_k')

    [m,n]=size(A);
    RI=[0 0 0.58 0.90 1.12 1.24 1.32 1.41 1.45 1.49 1.51 1.54 1.56];
    R=rank(A);
    [V,D]=eig(A);
    tz=max(D);
    B=max(tz);
    [row, col]=find(D==B);
    C=V(:,col);
    CI=(B-n)/(n-1);
    CR=CI/RI(1,n);
    if CR<0.10 & CR>0
        disp('CI=');disp(CI);
        disp('CR=');disp(CR);
        disp('The weight vector is:');
        Q_k=zeros(n,1);
        for i=1:n
            Q_k(i,1)=C(i,1)/sum(C(:,1));
        end
        Q_k
    else
        disp('cannot calculate the weight vector, adjustment required');
    end
end
```

excel part:

After employing AHP(matlab part) to the four factors of 13 roller coaster, we collected a 4×13 matrix:

$$\omega_1 = \begin{pmatrix} Height_1 & Speed_1 & Drop_1 & Length_1 \\ Height_2 & Speed_2 & Drop_2 & Length_2 \\ Height_3 & Speed_3 & Drop_3 & Length_3 \\ Height_4 & Speed_4 & Drop_4 & Length_4 \\ Height_5 & Speed_5 & Drop_5 & Length_5 \\ Height_6 & Speed_6 & Drop_6 & Length_6 \\ Height_7 & Speed_7 & Drop_7 & Length_7 \\ Height_8 & Speed_8 & Drop_8 & Length_8 \\ Height_9 & Speed_9 & Drop_9 & Length_9 \\ Height_{10} & Speed_{10} & Drop_{10} & Length_{10} \\ Height_{11} & Speed_{11} & Drop_{11} & Length_{11} \\ Height_{12} & Speed_{12} & Drop_{12} & Length_{12} \\ Height_{13} & Speed_{13} & Drop_{13} & Length_{13} \end{pmatrix}, \omega_2 = \begin{pmatrix} Height_{public} \\ Speed_{public} \\ Drop_{public} \\ Length_{public} \end{pmatrix}$$

$$rank_{roller\_coaster1} = Height_1 \cdot Height_{public} + Speed_1 \cdot Speed_{public} + Drop_1 \cdot Drop_{public} + Length_1 \cdot Length_{public}$$

#apply this equation to 13 selected roller coaster by using excel algorithm: #

$$\omega_{rank} = \omega_1 \cdot \omega_2 = \begin{pmatrix} rank_{roller\_coaster1} \\ rank_{roller\_coaster2} \\ rank_{roller\_coaster3} \\ rank_{roller\_coaster4} \\ rank_{roller\_coaster5} \\ rank_{roller\_coaster6} \\ rank_{roller\_coaster7} \\ rank_{roller\_coaster8} \\ rank_{roller\_coaster9} \\ rank_{roller\_coaster10} \\ rank_{roller\_coaster11} \\ rank_{roller\_coaster12} \\ rank_{roller\_coaster13} \end{pmatrix}$$

ranking result = Sort($rank_{roller\_coaster1}$: $rank_{roller\_coaster13}$)

Question2:

```
M_Steel=xlsread('C:\Users\zhuyue\Desktop\HIMCM\assistor_1');
N=_steel=xlsread('C:\Users\zhuyue\Desktop\HIMCM\assistor_2');
Compare_Steel=(M*N)/(SQR(H1^2+S1^2+D1^2+L1^2)*SQR(H_P^2+S_P^2+
D_P^2+L_P^2));
M_Steel_website1=xlsread('C:\Users\zhuyue\Desktop\HIMCM\assist
or_3');
```

```
N_steel_website1=xlsread('C:\Users\zhuyue\Desktop\HIMCM\assist
or_4');
Compare_w1=M_Steel_website1*N_steel_website1/(SQR(H_W1^2+S_W1^
2+D_W1^2+L_W1^2)*SQR(H_P^2+S_P^2+D_P^2+L_P^2))

#Utilize excel to rank them from the highest to the lowest #
```

Question 3:

```
H_p=input('What do you think of the maximum height of roller coasters?
Insignificant-1/ not very significant-2/normal-3/significant-4/extremly
significant-5');
S_p=input('What do you think of the maximum speed of roller coasters?
Insignificant-1/ not very significant-2/normal-3/significant-4/extremly
significant-5');
D_p=input('What do you think of the maximum of roller coasters?
Insignificant-1/ not very significant-2/normal-3/significant-4/extremly
significant-5');
L_p=input('What do you think of the length of roller coasters?
Insignificant-1/ not very significant-2/normal-3/significant-4/extremly
significant-5');
Location=('Which city do you live in?')
C=intersect(Location,City)
if C=[]
    Location=input('city does not exist, please reenter your living
location')
end
[Longitude_Departure,Latitude_Departure]=find(City==Location)
if H_p==1
    H_p=1
elseif H_p==2
    H_p=3
elseif H_p==3
    H_p=5
elseif H_p==4
    H_p=7
elseif H_p==5
    H_p=9
end
```

```
if S_p==1
    S_p=1
elseif S_p==2
    S_p=3
elseif S_p==3
    S_p=5
elseif S_p==4
    S_p=7
elseif S_p==5
    S_p=9
end
if D_p==1
    D_p=1
elseif D_p==2
    D_p=3
elseif D_p==3
    D_p=5
elseif D_p==4
    D_p=7
elseif D_p==5
    D_p=9
end
if L_p==1
    L_p=1
elseif L_p==2
    L_p=3
elseif L_p==3
    L_p=5
elseif L_p==4
    L_p=7
elseif L_p==5
    L_p=9
end
R=6370
for i=1:300
```

```
    Distance_i=R*
arccos(sind(Latitude_i)sind(Latitude_Daparture)+cosd(Latitude_i)cosd(Latitu
de_Daparture)cosd(Longitude_i-Latitude_Departure) )
end
```

Excel Part:

$$\boldsymbol{\omega_{final}} = \begin{pmatrix} Height_1 & Speed_1 & Drop_1 & Length_1 & Distance_1 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ Height_n & Speed_n & Drop_n & Length_n & Distance_n \end{pmatrix}$$

Then apply the same method mentioned in problem 1。