ON DEVELOPING THE RAAS

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Abstract

Choice is a pervasive feature of social life that profoundly affects us. Ranking results can be used as a reference to help people make a correct choice. But there are two problems. One problem is that fixed ranking results instead of the ranking methods are provided to people by service providers as a reference when making choice at most time. For example, TIMES World University Rankings can be used as a reference when choosing a college. However, in the numerous factors that affect objects ranking, people have their own understanding on the effect of each factor on objects ranking. Using mobile phone-selection as a practical case, some people think performance of a mobile phone is more important, while others hold the view that appearance of a mobile phone is more attractive. What’s more, there are many ranking methods proposed, such as The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and expert marking. Using only one kind of ranking methods for object ranking may lead to over objective or subjective ranking results. Although various ranking algorithms are studied, very little is known about the detailed development and deployment of the ranking services.

This paper proposes a comprehensive solution of Ranking as a Service (RaaS), with the manifold contributions: Firstly, we use combination weighting method in RaaS and it can overcome the defects of subjective and objective weighting methods. Secondly, we develop ranking service APIs that bring convenience to people when making choices. Thirdly, ranking service provides ranking results for people according to their own understanding on the effect of each factor on objects ranking. Fourthly, this paper is arguably the first one that proposes using Ranking as a Service. Finally, we evaluate and analyze the proposed strategies and technologies in accordance to the experimental results.

Keywords: Ranking as a Service; Combination Weighting Method; TOPSIS; Comprehensive Evaluation Method

1. INTRODUCTION

Life is always full of choices. For example, customers are faced with the choice of buying goods, companies are faced with the choice of recruiting and selecting new staff and parents are faced with the choice of choosing a school for their children. Different ranking results of various comprehensive evaluation algorithms are provided to people as a reference and help them make a correct choice, for example, ranking results of the top 100 app provided by App Store will always be used as a reference when people want to try new integrated applications, but few comprehensive evaluation algorithm was presented to the user as a service. Comprehensive evaluation methods such as fuzzy comprehensive evaluation method, artificial neural network evaluation method, Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) [1], grey relational analysis [2] and expert scoring evaluation method [3] are widely used. TOPSIS has been successfully applied to the areas of human resources management [11], transportation [12], product design [13], manufacturing [14], water management [15], quality control [16], and location analysis [17]. There are also many areas that grey comprehensive evaluation method and expert scoring evaluation method are used in, such as helping manufacturing
companies deal with the problem of assessment and selection of suppliers [19], evaluating land suitability [20], evaluating and selecting complex hardware and software systems [21], forecasting project risk [22] and evaluating water quality [24].

The most important step of evaluating objects with multiple indicators is to determine the weight of each indicator. At present, the method to determine indicators weight can be mainly divided into two categories: subjective weighting methods and objective weighting methods. The subjective weighting methods include Analytical Hierarchy Process (AHP) [4], precedence diagram method [5], Delphi method [6] and TACTIC method [7] and so on. The objective weighting methods include Principal Component Analysis (PCA) [8], entropy weight method [9], variation coefficient method [10] and so on.

The goal of this paper is threefold. Firstly, we would like to introduce some subjective and objective weighting methods to help users understand the advantages of combination weighting method. Secondly, we propose a formalized ranking model based on combination weighting method. Finally, we go through a complete case of ranking service to help users deeply understand the internals of APIs and their concrete usages.

This paper is organized as follows: Section II introduces several typical weighting methods and discusses the advantages and disadvantages of subjective and objective weighting methods. Section III combines subjective weighting methods with objective weighting methods to get combination weighting method and proposes new comprehensive evaluation method based on combination weighting method. Section IV presents the results of new comprehensive evaluation methods under several scenarios and analyzes their realtime in a different scenario. Section V concludes the paper and points out some potential future.

2. BACKGROUND

In this chapter, we will focus on the subjective and objective weight method. Typical subjective and objective weighting methods will be introduced and the advantages and disadvantages of subjective and objective weighting methods will be discussed.

2.1 SUBJECTIVE WEIGHTING METHODS

The subjective weighting methods discuss how to ascertain the weight allocation by applying the attribute importance based on the decision maker (experts). The original data is obtained by experts according to their experience and subjective judgment. There are several commonly used subjective weighting methods: AHP, precedence diagram method, Delphi method and TACTIC method and so on. AHP and precedence diagram method will be then briefly introduced.

Precedence diagram method is put forward by Muti. Its basic idea is that weight of indicators is decided by experts through pairwise comparison between indicators. AHP is proposed by Thomas L. Saaty in the 1970s. It is always used for solving a complicated multi-objective decision-making problem. The first and most important step when using AHP is to establish hierarchy structure on the basis of decision-making target, decision-making objects and multiple indicators affecting objects. Once the hierarchy has been constructed, the indicators that have a impact on the object are pairwise compared against the goal for importance by users.

2.2 OBJECTIVE WEIGHTING METHODS

The objective weighting method determines the weight mainly based on the relationships between the raw data. The commonly used objective weighting methods are as follows: PCA, entropy weight method, variation coefficient method, mean square error method and so on. PCA, entropy weight method and variation coefficient method will be then briefly introduced. PCA was invented in 1901 by Karl Pearson and it linearly compresses multidimensional data into lower dimensions with minimal loss of information. Variation coefficient method obtains weights of all indicators by taking advantage of all the information included in each indicator. Its basic idea is that the bigger the value of one indicators compared with values of other indicators, the more difficult the indicator is to achieve. This kind of indicator can better reflect the differences among the objects to be evaluated and should be endowed with a larger weight. The concept of entropy as a measure of information is introduced by Claude Shannon (C.E.Shannon) in 1948. Entropy weight method is an objective weighting method. According to variation degree among the evaluation indicators, information entropy is used to calculate the entropy weight of each indicator. Then the weights of the indicators are modified by entropy weight to obtain more objective indicator weight.

2.3 ADVANTAGES AND DISADVANTAGES OF SUBJECTIVE AND OBJECTIVE WEIGHTING METHODS
Advantages and disadvantages of subjective and objective weighting methods are summarized as Table I:

<table>
<thead>
<tr>
<th></th>
<th>Subjective weighting method</th>
<th>Objective weighting method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin</strong></td>
<td>Early</td>
<td>A bit late</td>
</tr>
<tr>
<td><strong>As a service</strong></td>
<td>Increases the burden to user</td>
<td>Not bring the burden to user</td>
</tr>
<tr>
<td><strong>Theoretical support</strong></td>
<td>Strict mathematical theory of support</td>
<td>Strict mathematical theory of support</td>
</tr>
<tr>
<td><strong>Complexity</strong></td>
<td>Less Complicated</td>
<td>Complicated</td>
</tr>
<tr>
<td><strong>Evaluation results</strong></td>
<td>Reflect importance of different attributes to the decision makers</td>
<td>Not reflect importance of different attributes to the decision makers.</td>
</tr>
<tr>
<td><strong>Applicability</strong></td>
<td>Limited</td>
<td>More general</td>
</tr>
</tbody>
</table>

Table 1. Comparison between Subjective and Objective Weighting Method
The core idea behind TOPSIS is to rank objects according to their geometric distance between the positive ideal solution and the negative ideal solution. The positive ideal solution consists of the best value of each indicator among objects and the negative ideal solution consists of the worst value of each indicator among objects. The closer an object to the positive ideal solution, the more likely the object's ranking is to be on top.

3.4 Establishment of Comprehensive Evaluation Model

The procedure for using new comprehensive evaluation method can be summarized as figure 1. AHP and three typical objective weighting methods mentioned in section II are combined using multiplicative synthesis to obtain three combination weighting methods. Then six new comprehensive evaluation methods can be obtained through the combination of TOPSIS, Gray Relational Analysis and three combination weighting methods. The process to evaluate objects using new comprehensive evaluation method is complicated and thus six new comprehensive evaluation methods won't be described in detail. One new comprehensive evaluation method combining TOPSIS and the combination weighting method using AHP and entropy weight method will be introduced in the following as an example.

1. Form the original data matrix

\[
X = \begin{bmatrix}
x_{11} & x_{12} & \cdots & x_{1n} \\
x_{21} & x_{22} & \cdots & x_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
x_{n1} & x_{n2} & \cdots & x_{nn}
\end{bmatrix}
\]

\(x_{mn}\) is the \(n^{th}\) indicator data of the \(m^{th}\) object

2. Use entropy weight method to determine the objective weight of each indicator \(w_{ij}\).

The step of using entropy weight method to calculate objective weight of each indicator \(w_{ij}\) is as follows:

Step 1: Carry out dimensionless parametrization for the original data matrix.

For the bigger the better indicators:

\[
v_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}
\]

For the smaller the better indicators:

\[
v_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})}
\]

Step 2: Calculate the characteristic proportion of the \(j^{th}\) indicator of the \(i^{th}\) evaluated object.

The characteristic proportion of the \(j^{th}\) indicator of the \(i^{th}\) evaluated object is recorded as \(p_{ij}\), then

\[
p_{ij} = v_{ij} / \sum_{i=1}^{m} v_{ij}
\]

Step 3: Calculate the entropy of the indicator \(e_j\)

\[
e_j = -1 / \ln(m) \sum_{i=1}^{m} p_{ij} \cdot \ln p_{ij}
\]
Step 4: Calculate the difference coefficient of the $j$th indicator $d_j$

$$d_j = 1 - e_j$$

Step 5: Determine the entropy weight of each indicator

$$w_{ij} = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

The entropy weight of each indicator $w_{ij}$ is also objective weight of each indicator.

3. Use AHP to determine the subjective weight of each indicator $w_{ij}^s$.

The process to use AHP to obtain the subjective weight of each indicator $w_{ij}^s$ is shown in Figure II.

4. Adopt multiplicative synthesis to assemble the subjective and objective weights of each indicator and get the combination weight of each indicator $w_{ij}$.

5. Give the evaluation results through TOPSIS based on combination weight $w_{ij}$.

The TOPSIS process to obtain the evaluation results is carried out as follows:

Step 1: Obtain normalized matrix $S = (s_{ij})_{mxn}$ using the normalisation method,

$$s_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n} x_{ij}^2}}, i = 1, 2, \cdots, m, j = 1, 2, \cdots, n.$$

Step 2: Calculate the weighted normalized decision matrix $U = (u_{ij})_{mxn}$ on the basis of combination weight,

$$U = (u_{ij})_{mxn} = (w_j r_{ij})_{mxn}, i = 1, 2, \cdots, m$$

Where $\sum_{j=1}^{n} w_j = 1$.

Step 3: Determine the worst object $A_w$ and the best object $A_b$:

$$A_w = \{ \max(u_{ij} | i = 1, 2, \cdots, m) | j \in O_+ \}$$

$$A_b = \{ \min(u_{ij} | i = 1, 2, \cdots, m) | j \in O_- \}$$

Where,$$

$$O_+ = \{ j = 1, 2, \cdots, n | j \text{ associated with the indicator having a positive impact on the object} \}$$

$$O_- = \{ j = 1, 2, \cdots, n | j \text{ associated with the indicator having a negative impact on the object} \}$$

Step 4: Calculate the distance $d_{iw}$ between the $i$th object and the worst object $A_w$:

$$d_{iw} = \sqrt{\sum_{j=1}^{n} (u_{ij} - u_{ij}^w)^2}$$
and the distance between the \( i \)th object and the best object \( A_i \): 
\[
d_{ib} = \sqrt{\sum_{j=1}^{n}(u_{ij} - u_{ib})^2}
\]

Step 5: Calculate the proximity \( c_{iw} \) between each object and the best object:
\[
c_{iw} = \frac{d_{iw}}{d_{iw} + d_{ib}}, \quad 0 \leq c_{iw} \leq 1, \ i = 1, 2, \cdots, m
\]
\( c_{iw} = 1 \) when the object is the same as the best object and \( c_{iw} = 0 \) when the object is closest to the worst object.

Step 6: Rank the objects according to \( c_{iw} (i = 1, 2, \cdots, m) \).

Another example is about a new comprehensive evaluation method combining Gray Relational Analysis and the combination weighting method using AHP and variation coefficient method.

1. Form the original data matrix.
\[
X = \begin{bmatrix}
  x_{11} & x_{12} & \cdots & x_{1n} \\
  x_{21} & x_{22} & \cdots & x_{2n} \\
  \vdots & \vdots & \ddots & \vdots \\
  x_{m1} & x_{m2} & \cdots & x_{mn}
\end{bmatrix}
\]

\( x_{mn} \) is the \( n \)th indicator data of the \( m \)th object.

2. Use variation coefficient method to determine the objective weight of each indicator \( w_{ij} \).

   The step of using variation coefficient method to calculate the objective weight of each indicator \( w_{ij} \) is as follows:

   Step 1: Calculate the mean and standard deviation of each column i.e each indicator in the matrix. The mean and standard deviation of the \( j \)th indicator is recorded as \( \delta_j \) and \( \bar{x}_j \).

   Step 2: Calculate the variation coefficient according to the mean and standard deviation of each indicator. The characteristic proportion of the \( j \)th indicator is recorded as \( v_j \):
   \[
v_j = \frac{\delta_j}{\bar{x}_j}
\]

   Step 3: Add up the variation coefficient of each indicator and thus the variation coefficient weight of each indicator \( w_{ij} \) is determined:
   \[
w_{ij} = \frac{v_j}{\sum_{j=1}^{m} v_j}
\]

   The variation coefficient weight of each indicator \( w_{ij} \) is also objective weight of each indicator.

3. Use AHP to determine the subjective weight of each indicator \( w_{2j} \).

   The process to use AHP to obtain the subjective weight of each indicator \( w_{2j} \) is shown in Figure II.

4. Adopt multiplicative synthesis to assemble the subjective and objective weights of each indicator and get the combination weight of each indicator \( w_j \).

5. Give the evaluation results through Gray Relational Analysis based on combination weight \( w_j \).

   The Gray Relational Analysis process to obtain the evaluation results is carried out as follows:

   Step 1: Calculate the mean of each column in the matrix to form a reference sequence and the reference sequence is recorded as \( Y \), i.e.
   \[
   Y_j = \frac{\sum_{i=1}^{n} x_{ij}}{n}
   \]

   Step 2: Dimensionless all rows in the matrix according to the reference sequence and we denote the \( ith \) normalized row as \( X_i \):
   \[
   \left( X_i - Y_i \right) = \left( \frac{x_{ij}}{Y_j} \right)
   \]

   Step 3: Calculate the correlation coefficient between \( X_i(j) \) and \( Y_j \) and it is recorded as \( \xi(j) \), a new variable \( \Delta_i \) is introduced for the convenience of describing \( \xi(j) \) and \( \Delta_i = X_i(j) - Y_j \) thus
   \[
   \xi(j) = \frac{\min \Delta_i + \rho \max \Delta_i}{\left| X_i(j) - Y_j \right| + \rho \max \Delta_i}
   \]

   Where \( \rho \) is a nonnegative distinguishing coefficient and its value is normally between 0 and 1. The smaller the distinguishing coefficient, the better the resolving power. When \( \rho \leq 0.5463 \), the resolving power is the best. In this paper, \( \rho = 0.5 \).

   Step 4: Calculate the degree of correlation between \( X_i \) and \( Y_j \) based on combination weight of each indicator and we denote it as \( r_i \):
   \[
r_i = \sum_{j=1}^{m} w_j \xi(j)
   \]

   Step 5: Rank the objects according to \( r_i (i = 1, 2, \cdots, m) \).
3.5 INNOVATIONS ON RaaS

RaaS provided by us is innovative in threefold. Firstly, it can deal with objects with missing data. Moreover, it can provide more evaluation results for people as a reference compared with fixed evaluating results provided by other service provider as a reference to make a choice. Thirdly, ranking service provided by us is more people-oriented. It provides ranking results for users according to the importance choice of factors affecting the ranking object made by users. It is reasonable because most of users consider one factor more important than other factors in affecting objects when making a choice.

3.6 IMPLEMENTATION DETAILS

The structure of ranking service is shown in Figure III. The process of data processing in ranking service is implemented through the R language and structure of ranking service is established on the basis of SpringMVC structure.

![Figure III. Architecture of RaaS](image)

4. CASE STUDY

In this section, the evaluation results of new comprehensive evaluation methods based on combination weighting method under several scenarios will be analyzed. What’s more, real-time performance of new comprehensive evaluation methods based on combination weighting method are compared under a different scenario.

As shown in Table II, new comprehensive evaluation methods based on combination weighting methods are recorded as Method I to Method VI.

<table>
<thead>
<tr>
<th>Function</th>
<th>New comprehensive evaluation methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method I</td>
<td>TOPSIS, AHP and PCA</td>
</tr>
<tr>
<td>Method II</td>
<td>TOPSIS, AHP and entropy weight method</td>
</tr>
<tr>
<td>Method III</td>
<td>TOPSIS, AHP and variation coefficient method</td>
</tr>
<tr>
<td>Method IV</td>
<td>grey-relational analysis, AHP and PCA</td>
</tr>
<tr>
<td>Method V</td>
<td>grey-relational analysis, AHP and entropy weight method</td>
</tr>
<tr>
<td>Method VI</td>
<td>grey-relational analysis, AHP and variation coefficient method</td>
</tr>
</tbody>
</table>

Table II. Function of New Comprehensive Evaluation Methods

4.1 EVALUATION RESULTS OF UNIVERSITIES

1. Part of the world university ranking results by TIMES are shown in Table III:

   It can be seen from the Table III there are 5 factors that influence university rankings. In the process of ranking the universities, Teaching, Research and Citations are considered equally important and they are far more important than the other two factors. Part of the world university ranking results by new comprehensive evaluation methods based on combination weighting method are shown in Table IV:

   To better analyze ranking results of Method I to Method VI, mean square error between ranking results of TIMES and ranking results of Method I to Method VI are calculated. As shown in Table V, university ranking results of combination method of TOPSIS, AHP and PCA is closest to college ranking results of TIMES.

   Through comparison between Table III and Table IV, Table IV is the specific indicator parameters of each university and we can't get the intuitive understanding of the university. On the contrary, Table IV shows university ranking results provided by RaaS based on people’s understanding of the factors influencing the university rankings and it can make people have a whole understanding of the university.
<table>
<thead>
<tr>
<th>Rank</th>
<th>University Name</th>
<th>Teaching</th>
<th>International Outlook</th>
<th>Research</th>
<th>Research Citations</th>
<th>Industry Income</th>
<th>Overall Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>California Institute of Technology</td>
<td>95.6</td>
<td>64</td>
<td>97.6</td>
<td>99.8</td>
<td>97.8</td>
<td>95.2</td>
</tr>
<tr>
<td>2</td>
<td>University of Oxford</td>
<td>86.5</td>
<td>94.4</td>
<td>98.9</td>
<td>98.8</td>
<td>97.1</td>
<td>94.2</td>
</tr>
<tr>
<td>3</td>
<td>Stanford University</td>
<td>92.5</td>
<td>76.3</td>
<td>96.2</td>
<td>99.9</td>
<td>63.3</td>
<td>93.9</td>
</tr>
<tr>
<td>4</td>
<td>University of Cambridge</td>
<td>88.2</td>
<td>91.5</td>
<td>96.7</td>
<td>97</td>
<td>55</td>
<td>92.8</td>
</tr>
<tr>
<td>5</td>
<td>Massachusetts Institute of Technology</td>
<td>89.4</td>
<td>84</td>
<td>88.6</td>
<td>99.7</td>
<td>95.4</td>
<td>92</td>
</tr>
<tr>
<td>6</td>
<td>Harvard University</td>
<td>83.6</td>
<td>77.2</td>
<td>99</td>
<td>99.8</td>
<td>45.2</td>
<td>91.6</td>
</tr>
<tr>
<td>7</td>
<td>Princeton University</td>
<td>85.1</td>
<td>78.5</td>
<td>91.9</td>
<td>99.3</td>
<td>52.1</td>
<td>90.1</td>
</tr>
<tr>
<td>8</td>
<td>Imperial College London</td>
<td>83.3</td>
<td>96</td>
<td>88.5</td>
<td>96.7</td>
<td>53.7</td>
<td>89.1</td>
</tr>
<tr>
<td>9</td>
<td>Swiss Federal Institute of Technology</td>
<td>77</td>
<td>97.9</td>
<td>95</td>
<td>91.1</td>
<td>80</td>
<td>88.3</td>
</tr>
<tr>
<td>10</td>
<td>University of Chicago</td>
<td>85.7</td>
<td>65</td>
<td>88.9</td>
<td>99.2</td>
<td>36.6</td>
<td>87.9</td>
</tr>
</tbody>
</table>

**Table III. Ranking Results of Universities by TIMES**

<table>
<thead>
<tr>
<th>University Name</th>
<th>TIMES</th>
<th>Method I</th>
<th>Method II</th>
<th>Method III</th>
<th>Method IV</th>
<th>Method V</th>
<th>Method VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>California Institute of Technology</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>University of Oxford</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Stanford University</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>University of Cambridge</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Harvard University</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Princeton University</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Imperial College London</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Swiss Federal Institute of Technology</td>
<td>9</td>
<td>10</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>University of Chicago</td>
<td>10</td>
<td>11</td>
<td>15</td>
<td>13</td>
<td>9</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

**Table IV. Ranking Results of Universities by New Ranking Methods**

<table>
<thead>
<tr>
<th>Mean square error</th>
<th>Method I</th>
<th>Method II</th>
<th>Method III</th>
<th>Method IV</th>
<th>Method V</th>
<th>Method VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIMES</td>
<td>9.74</td>
<td>19.75</td>
<td>18.2</td>
<td>18.92</td>
<td>17.44</td>
<td>15.7</td>
</tr>
</tbody>
</table>

**Table V. Analysis of College Ranking Results**
<table>
<thead>
<tr>
<th>City Name</th>
<th>Exhibition Number</th>
<th>Exhibition Area</th>
<th>Professional Exhibition Number</th>
<th>Professional Exhibition Indoor Area</th>
<th>Number of Exhibition Management Institutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shanghai</td>
<td>798</td>
<td>1200.8</td>
<td>13</td>
<td>44.4</td>
<td>3</td>
</tr>
<tr>
<td>Guangzhou</td>
<td>480</td>
<td>831</td>
<td>6</td>
<td>53.48</td>
<td>2</td>
</tr>
<tr>
<td>Beijing</td>
<td>418</td>
<td>552.1</td>
<td>9</td>
<td>44.79</td>
<td>1</td>
</tr>
<tr>
<td>Chongqing</td>
<td>581</td>
<td>500.4</td>
<td>5</td>
<td>35.6</td>
<td>2</td>
</tr>
<tr>
<td>Nanjing</td>
<td>347</td>
<td>370</td>
<td>4</td>
<td>19.5</td>
<td>3</td>
</tr>
<tr>
<td>Shenzhen</td>
<td>86</td>
<td>259.77</td>
<td>1</td>
<td>10.5</td>
<td>2</td>
</tr>
<tr>
<td>Chengdu</td>
<td>169</td>
<td>300.9</td>
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Table VI. Exhibition and Convention City Ranking Results of China

4.2 REAL-TIME ANALYSIS UNDER SEVERAL SCENARIOS

Part of the exhibition and convention city ranking results of China are shown in Table VI:

As seen in Table VI, there are 9 factors affecting the competitiveness of city meeting and exhibition industry in China. 100 cities are analyzed and real-time of new comprehensive evaluation methods are compared under this scenario. Run time of new comprehensive evaluation methods under this scenario are shown in Figure IV and Figure V.
It can be seen in Figure IV that run time of Method IV is much longer than Method V and Method VI. The result is reasonable as it is needed to analyze the eigenvalue and characteristic vector of data matrix when using PCA to calculate subjective weight.

As seen in Figure V, run time of Method I is much longer than Method II. The result is reasonable as the process of using grey correlation analysis to rank objects is more complicated than using TOPSIS.

4.3 INSTRUCTIONS ON MOBILE PHONE MARKETING SHARE RANKING

RaaS provides a reference for users when they make choices. APIs of RaaS require users to provide data and select the type of ranking algorithm then it returns ranking results to users. However, data provided by users are always with small number of data fields. In order to make ranking results more convincing, more comprehensive data would be supplemented. The supplemented data will be used for building more data fields. Data supplementing can be realized through the following two ways. One way is to supply data through the crawler and another is to supply data from big data pool, such as the Kingdee’s existing cloud-based bigdata analytics services [29]. Taking mobile phone marketing share ranking as an example, the type of mobile phone used by users visiting HTML5 [30] webpage can be viewed as a reference of market share and popularity of various mobile phones. Flashing HTML5 is a service provided by WeChat [31] light application product KAActivity [32]. Data of user’s mobile phone type is shown in Figure VI. In Figure VI, the total views of a single HTML5 page using various types of mobile phones in the recent 7 days is 313832, which is a large number for data supplementing.

5. CONCLUSION

This paper proposes Ranking as a Service (RaaS). This paper also proposes a comprehensive solution of RaaS, including its development, deployment and evaluation stages. Several typical weighting methods are firstly introduced and the advantages and disadvantages of subjective and objective weighting methods are discussed. Compared with subjective and objective weighting methods, combination weighting method is considered to be more reasonable. This paper divides RaaS into four steps based on combination weighting method and then uses one of new comprehensive evaluation methods as an example to explain usages of RaaS. Finally, for a better leverage of ranking service, this paper has explained a concrete college ranking example. Real-time performance of RaaS is also analysed under a different scenario.

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7. Reference


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