Interest Tourism Route Plan Algorithm Based on Improved Minimum Spanning Tree

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Abstract. Currently, tourism route plan lacks of individuality, which can hardly meet the needs of tourists’ motive benefits. Aim at the problem, this paper brings forward interest tourism route plan algorithm based on improved minimum spanning tree. Firstly, tourism interest feature model is set up. Based on each influence factor, iteration values on minimum spanning trees of different start sight spots are obtained. Select the spanning tree and route with maximum value as the optimal spanning tree and route. This algorithm can get the optimal tourism route to meet the best motive benefits for tourists, which is feasible and practical.

Introduction

Before tourists visiting an unfamiliar tourism city, they will firstly select sight spots and get a feasible route to meet the best motive benefits. Tour route’s nodes are composed of several sight spots. Currently, sight spots information is usually obtained from tourism books or websites, which is abundant, from which extracting needed individual information is complex and difficult. Though tourists can extract information, they can hardly get the optimal route to meet the best motive benefits. Aim at the problems, based on individual interests and needs, this paper brings forward interest tourism route plan algorithm based on improved minimum spanning tree. This algorithm considers tourists’ interests and needs, and finally meets their best motive benefits.

Foundation of Tourism Interest Feature Model

Sight Spot Classification Coding Model

City sight spots can be classified into four groups in level I according to features and tourists’ interests. Define each group as $V_i$, $i \in (0,4) \in Z^*$, including Park and Greenland $V_1$, Venue $V_2$, Shopping $V_3$ and Entertainment $V_4$. Level II is contained in level I, defined as $V_jU_i$, $j \in (0,\max e_j) \in Z^*$. Parameter $\max e_j$ is the maximum value of group $V_i$. Sight spot classification code vector $\vec{P}_i$ is set up, $\vec{P}_i = \{V_jU_i\}$, $i \in (0,4) \in Z^*$, $j \in (0,\max e_j) \in Z^*$. Take Zhengzhou city for example to set up finite field classification code model composed of typical sight spots.

$P_1 = \{V_1U_1$ - Renmin Park, $V_1U_2$ - Zijingshan Park, $V_1U_3$ - Lvcheng Square, $V_1U_4$ - Bishagang Park, $V_1U_5$ - Forest Park, $V_1U_6$ - Zoo, $V_1U_7$ - Xiliuhu Park $\}.$

$P_2 = \{V_2U_1$ - Henan Museum, Zhengzhou Museum, $V_2U_3$ - Erqi Memorial, $V_2U_4$ - Science Museum, $V_2U_5$ - Aquarium $\}.$

$P_3 = \{V_3U_1$ - Wangfujing Mall, $V_3U_2$ - Erqi Uanda, $V_3U_3$ - Zhongyuan Uanda, $V_3U_4$ - CC Mall, $V_3U_5$ - Dehua Street, $V_3U_6$ - Dashanghai Mall $\}.$

$P_4 = \{V_4U_1$ - Fount Park, $V_4U_2$ - Water Park, $V_4U_3$ - Century Park $\}.$
Tourism Interest Feature Model

Tourists have different and individual interests and needs. Within limited time, tourists choose appropriate amount of sight spots. Relying on their own interest, they can directly choose amount of sight spots $v_i$. If they are unfamiliar with these sight spots, they can provide the amount of sight spots $v_i$, $i \in (0,4) \in Z^+$, as well as needs such as star level, popularity index, etc. Then the amount of $n_i$ sight spots will be intelligently selected by the system. The amount of selected sight spots $k$ is shown as formula 1.

$$ k = \sum_{i=1}^{\max C_{v_i}^n} $$ (1)

Set up interest sight spot vector $\overline{Q_r}$ on the selected sight spots, as formula 2 shows. Element $Q_r$ relates to the selected sight spots, $r \in (0,k) \in Z^+$.

$$ \overline{Q_r} = [Q_1, Q_2, ..., Q_k] $$ (2)

Tourism Route Plan Algorithm Based on Interests

Confirmation of Influence Factors

After selecting sight spot group and elements, system plans tourism route on the sight spots. The tour sequences are multiple. Not all the tour sequences can meet the best motive benefits. In the course of tour, there are several influence factors impacting motive benefits, for example, interval distance $s(v_i, v_j)$ between sight spots $v_i$ and $v_j$, bus and subway number $t$, taxi fee $c$ and traffic light number $l$. Each factor’s influence index $H_u$, $u \in (0,4) \in Z^+$ is shown in Table 1. When tourists take tour in certain sequence, influence factors impact motive benefits. Different sequences have different iteration values, which determine the priority of certain route under its sequence. The higher the iteration value is, the more motive benefits the route can provide for tourists.

<table>
<thead>
<tr>
<th>Influence Factors</th>
<th>$H_1$</th>
<th>$H_2$</th>
<th>$H_3$</th>
<th>$H_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval distance</td>
<td>$s(v_i, v_j)$</td>
<td>$0.1t$</td>
<td>$c^{-1}$</td>
<td>$l^{-1}$</td>
</tr>
</tbody>
</table>

Minimum Spanning Tree Algorithm Based on Influence Factors

The $A_1^t$ types of tour sequences are composed of interest sight spot vector $\overline{Q_r}$ elements. Along the sequence, tourists will take a one-way tour. The optimal route has the highest iteration value. Take one kind of route with a certain starting sight spot for example to set up minimum spanning tree algorithm based on influence factors.

Step 1. Ensure Sight Spots Shortest Path Network. Set the $k$ sight spots as vertexes to found the shortest path network, as Figure 1 shows. The link side parameter $\text{dis}(v_i, v_j)$ between two vertexes relates to the shortest distance.

![Figure 1. Sight spots shortest path network.](image-url)
Set up Path Generation Set and Node Consuming Set. Set up path generation set $U$ and node consuming set $V$. Path generation set is composed of the sight spots in tour sequence, whose elements form the minimum spanning tree. Node consuming set is the transition set from interest sight spot set $Q_k$ to path generation set. Path generation set and node consuming set form minimum spanning tree node table, as Table 2 shows.

**Table 2. Minimum spanning tree node table.**

<table>
<thead>
<tr>
<th>$U$</th>
<th>$V$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$[Q_1]$</td>
<td>$[Q_1, Q_2, \ldots, Q_{k-1}, Q_k]$</td>
</tr>
<tr>
<td>$[Q_1, Q_2]$</td>
<td>$[Q_1, Q_{n-1}, Q_n]$</td>
</tr>
<tr>
<td>$\ldots$</td>
<td>$\ldots$</td>
</tr>
<tr>
<td>$[Q_1, Q_{n-1}, Q_n]$</td>
<td>$\emptyset$</td>
</tr>
</tbody>
</table>

Set up Route Motive Value Iteration Model. Start from sight spot $Q_1$. Take initial value $W_0$ to calculate the motive iteration value of the sight spot to the follow-up ones, as formula 3 shows, in which $1$ and $v$ is the interval between sight spot $Q_i$ and $Q_v$, $v \in (0, k] \in Z^+$. Select the follow-up sight spot $Q_r$ with the highest value $\max W_{(i,v)}$ and add it to set $U$.

$$W(1,v) = \sum_{u=1}^{4} W_0 H_{u(1,v)}$$  \hspace{1cm} (3)

Continue to search the next sight spot and calculate iteration value, and then select the follow-up sight spot $Q_r$ with the highest value $\max W_{(i,v)}$ and add it to set $U$, till all sight spots being added into set $U$. And then the minimum spanning tree based on influence factors and the optimal tourism route $Path(1)$ are obtained.

If tourists decide to start the tour from a certain sight spot, the optimal tourism route $Path(1)$ is the final route and the algorithm ends. If tourists have no idea which sight spot to start from, Step 4 continues to work.

Set up Minimum Spanning Tree Vector. Change the start sight spot and form the No. $p$ type of minimum spanning tree Algorithm returns back to step 1. Confirm route $Path(p)$ with the highest iteration value, $p \in (0, k] \in Z^+$. Take the same way to form $k$ types of trees with iteration values, through which minimum spanning tree vector $TreePath$ is set up, as formula 4 shows. Elements are arranged descending order, $p \in (0, k] \in Z^+$. And then its first element relates to the optimal route, which has the highest iteration value. Tourists can get the best motive benefits by taking this route to travel.

$$TreePath = [\max Path, \ldots, Path(p), \ldots, \min Path]$$  \hspace{1cm} (4)

Algorithm Example Experiment

A tourist brings forward tourism needs. He chooses sight spots, one from Park and Greenland type, one from venue, and one from shopping. System randomly chooses $V_1U_1$ Bishagang Park, $V_2U_2$ Erqi Memorial and $V_3U_3$ Erqi Uanda. Then vector $\mathbf{Q}_1 = [Q_1, Q_2, Q_3]$ is obtained. Tourist has no request on the start sight spot. System sets up the shortest path network, path generation set and node consuming set. Starting from sight spot $Q_1$, two minimum spanning trees are formed, as Table 3 shows. Take the highest iteration value for example to get the optimal spanning tree and tourism route, as Figure 2 and Figure 3 shows.
Table 3. Tourism route spanning tree and related data.

<table>
<thead>
<tr>
<th>Interval</th>
<th>( H_1 )</th>
<th>( H_2 )</th>
<th>( H_3 )</th>
<th>( H_4 )</th>
<th>( W )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_1 U_4 \leftrightarrow V_1 U_5 \leftrightarrow V_1 U_2 )</td>
<td>0.280/0.182</td>
<td>0.500/0.500</td>
<td>0.091/0.083</td>
<td>0.333/0.111</td>
<td>2.080</td>
</tr>
<tr>
<td>( V_1 U_4 \leftrightarrow V_1 U_5 \leftrightarrow V_1 U_3 )</td>
<td>0.169/0.182</td>
<td>0.400/0.500</td>
<td>0.071/0.083</td>
<td>0.077/0.111</td>
<td>1.593</td>
</tr>
<tr>
<td>( V_1 U_3 \leftrightarrow V_1 U_5 \leftrightarrow V_1 U_2 )</td>
<td>0.280/0.169</td>
<td>0.500/0.400</td>
<td>0.091/0.071</td>
<td>0.333/0.077</td>
<td>1.921</td>
</tr>
<tr>
<td>( V_1 U_3 \leftrightarrow V_1 U_5 \leftrightarrow V_1 U_4 )</td>
<td>0.182/0.169</td>
<td>0.500/0.400</td>
<td>0.083/0.071</td>
<td>0.111/0.077</td>
<td>1.593</td>
</tr>
<tr>
<td>( V_1 U_2 \leftrightarrow V_1 U_5 \leftrightarrow V_1 U_4 )</td>
<td>0.169/0.280</td>
<td>0.400/0.500</td>
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</table>

Conclusion

Based on current problems on planning tourism route, this paper brings forward interest tourism route plan algorithm based on improved minimum spanning tree, which considers individuality most. Take sight spots chosen from tourists as nodes to calculate iteration value with influence factors, and get minimum spanning trees and related tourism routes under different start sight spots, finally choose the optimal one. This algorithm can get the optimal tourism route to meet the best motive benefits for tourists, which is feasible and practical.

References


