

Problem Statement for Main Round (2014-04-05)

Street View Routing



1. Introduction

The Street View imagery available in Google Maps is captured using specialized vehicles called "[Street View cars](#)". These cars carry multiple cameras capturing pictures as the car moves around a city.

Capturing the imagery of a city poses an optimization problem - the fleet of cars is available for a limited amount of time and we want to cover as much of the city streets as possible.

2. Task

Given a description of city streets and a number of Street View cars available for a period of time, your task is to schedule the movement of the cars to maximize the total length of city streets that were traversed at least once.

3. Problem description

3.1. City

The city is represented by a graph, the nodes of which represent city **junctions** and are connected with edges representing the **streets**. The graph is a realistic but idealized representation of a certain city - the junctions are associated with concrete geographic locations.

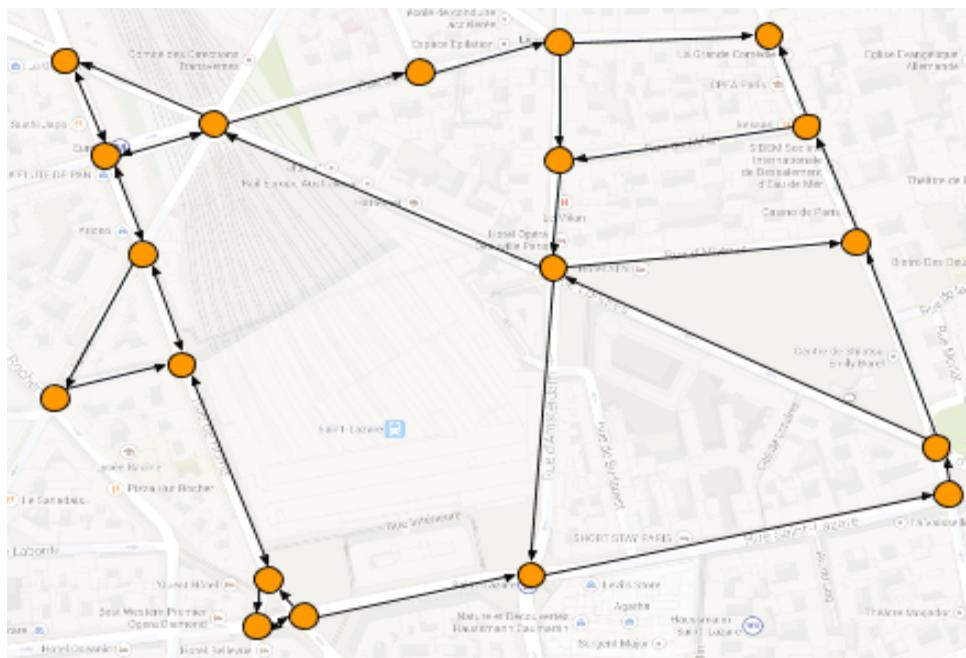


Figure 1: Part of the city

Streets are modelled as straight segments connecting two junctions. Each street has three properties:

- **direction** - each street can be either one, or bi-directional.
- **length** - the distance in meters that a StreetView car covers while moving through the street. This distance contributes to teams score, it corresponds to the real length of the (possibly curvy) street.
- **cost (time)** - the amount of time in seconds that a StreetView car takes to traverse the street.

Each pair of junctions is connected by at most one street. Each street connects two different junctions. The graph is not necessarily be planar (due to bridges and tunnels).

Both junctions and streets are referred to using their 0-based indices corresponding to the order in which they appear in the input file (see below).

3.2. Moving the cars

Your team manages a fleet of **N** cars, all located at the junction **S** at the beginning of the game.

The teams should schedule the cars movement for **T** seconds - this is the virtual time for the car movement on the map, it is independent from the duration of the competition. The teams have the full duration of the competition to provide an itinerary that covers the movement of the cars for **T** virtual seconds.

All car movement scheduled in the itinerary has to complete in **T** seconds (or less) - a car cannot be in transit when the time runs out.

The score of the team is the total length of all streets that were traversed by at least one car of their fleet at least once. Traversing a street that was already traversed multiple times (including traversing a bi-directional street in the opposite direction) does not increase the score.

4. Input data

The input data is provided as a plain text file containing exclusively ASCII characters with lines terminated with UNIX-style line endings (single '\n' character ending each line).

The file consists of:

- one line containing the following natural numbers separated by single spaces:
 - **N** denotes the number of junctions in the city
 - **M** denotes the number of streets in the city
 - **T** denotes the virtual time in seconds allowed for the car itineraries
 - **C** denotes the number of cars in the fleet
 - **S** denotes the junction at which all the cars are located initially
- **N** subsequent lines describing individual junctions. The i -th ($0 \leq i < N$) such line contains the following decimal numbers separated by a single space and describing the i -th junction of the city:
 - **lat_i** and **long_i** ($-90 \leq \text{lat}_i \leq 90$, $-180 \leq \text{long}_i \leq 180$) denote the geographical coordinates of the junction in [decimal degrees](#)
- **M** subsequent lines describing individual streets. The j -th ($0 \leq j < M$) such line contains the following natural numbers separated by single spaces and describing the j -th street of the city:
 - **A_j** and **B_j** ($0 \leq A_j, B_j < N$) ($A_j \neq B_j$) denote the indices (0-based) of two junctions connected by the street.
 - **D_j** is either 1 or 2. If **D_j** equals 1, the j -th street is one-directional and can be traversed only from the junction **A_j** towards the junction **B_j**. Otherwise (for **D_j** equal to 2) the street can be traversed in both directions.
 - **C_j** denotes the time cost of traversing the street: the time, in virtual seconds, a car needs to traverse the street
 - **L_j** denotes the length, in meters, of the street. This is the score that is awarded for traversing the street for the first time.

Example of input file

```
3 2 3000 2 0    // 3 junctions, 2 streets, 3000 seconds, 2 cars, starting at 0.  
48.8582 2.2945 // Coordinates of the first junction.  
50.0 3.09       // Coordinates of the second junction.  
51.424242 3.02 // Coordinates of the third junction.  
0 1 1 30 250   // Street from first junction to second junction.  
1 2 2 45 200   // Street from second junction to third junction.
```

5. Submissions

5.1. File format

Team submission needs to be described in a plain-text ASCII file with either Unix-style or Windows-style line endings.

The file needs to start with one line containing a single natural number **C** representing the number of cars in the teams fleet. Then itineraries for each car of the fleet should be described in the format indicated below.

The itinerary for the i -th car ($0 \leq i < C$) should start with one line containing a single natural number **V_i** ($1 \leq V_i \leq 10^6$) denoting the number of junctions visited by the car. This should include the initial junction **S** as the first junction. Subsequently, the itinerary needs to contain **V_i** lines describing the junctions visited by the car in the order that they were visited. Each line should contain a single natural number denoting the index (0-based) of the junction.

Example of submission file

```
2 // Two cars in the fleet.  
1 // First car stays at the initial junction:  
0 // - the initial junction  
3 // Second car visits 3 junctions:  
0 // - the initial junction  
1 // - the car moves from junction 0 to junction 1  
2 // - the car moves from junction 1 to junction 2
```

5.2. Validation

For the solution to be accepted, it has to meet the following criteria:

- the format of the file has to match the description above,
- the number of cars in the fleet **C** has to match the number of cars indicated in the problem input,
- the first junction on each itinerary has to be the starting junction **S** indicated in the input file,
- for each consecutive pair of junctions on the itinerary, a street connecting these junctions has to exist in the input file,
 - if the street is one-directional, it has to be traversed in the correct direction,
- total time for each itinerary has to be lower or equal to **T**,

5.3. Scoring

The score of a solution is the total length of the streets which have been visited at least once by a car in the fleet.

Each valid submission will be immediately scored and the score will be revealed to the team. The teams are allowed to submit multiple solutions - the highest scoring valid solution from each team will be used for team ranking.

Teams will be ranked according to their best submission score. In an event of a tie (two teams having the same best submission score), the team that reached that score for the first time earlier will be ranked higher. Resubmitting the same best solution again does not hurt the teams ranking.

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