Probe Data Analysis for Road Slope

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Introduction

- What is Probe Data ?
  - It is data which is generated by monitoring the position of moving objects over space and time. These moving objects can be dedicated vehicles used to collect information.
  - The individual probe points consist of ProbeID, dateTime, sourceCode, latitude, longitude, altitude, speed, heading etc.,
- When receiving probe data from cars, especially in urban areas the GPS data is off the road path due to satellite signal deflection by tall buildings.
- To increase the accuracy of the current road network, the incoming probe data must be matched to the right “link” in the road network.

What is Link Data?

- Link is usually a set of GPS coordinates which can be used to either constitute a road curve or indicate a road segment.
- Whereas, Link data is termed as a information of road segments (links).
- Link data consist of data for the links that probe points can be map-matched to.
- It consist of linkPVID, direction of Travel etc

Problem Statement

Input: Probe data map

1. The raw probe points collected over several months
2. The link data for the links that probe points can be map-matched to following output tasks.

Output:

1. Map match probe points to road links
2. Derive road slope for each road link
3. Evaluate the derived road slope with the surveyed road slope in the link data file.

TASK - Part One: Map Matching

- Latitude and Longitude are given in both Probe Data and Link Data.
- To Map- Match we use these Latitude and Longitude information of both these files and compare them with every other to find the one-pair with minimum distance between them.
- This pair is resultant Map-Matched Probe data points to corresponding Link.

TASK - Part Two: Slope Derivation

1. To calculate the slope between two points here we use the matched points from previous step to calculate the slope of two consecutive points.

   The slope between two consecutive points (P1, P2) is = $RISE/RUN$ $i.e.$ $(Y2-Y1)/(X2-X1)$, where p1(x1,y1) p2(x2,y2) are two points.

2. Calculate for all the matched points.

TASK - Part Three: Compare

1. Evaluating derived road slope with surveyed road slope
    a. Average of slope is calculated for each Link data.
    b. This slope is then compared with the slope we calculated in previous step.

Obtained Results

- **MatchedPoints.csv:**

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	sampleID	dateTime	sourceCode	latitude	longitude	altitude	speed	heading	linkPVID	direction	distFromRef	distFromLink	slope
2	3496	########	13	51.49687	9.386022	200	23	339	62007637	U	36.62946185	0.066171365	U
3	3496	########	13	51.49668	9.386157	200	10	129	62007637	T	12.94627719	0.022547044	0
4	3496	########	13	51.4967	9.386422	201	21	60	5.67E+08	U	79.34459644	0.078774386	U
5	3496	########	13	51.49675	9.38684	201	0	360	5.67E+08	T	43.97214741	0.035344669	0
6	3496	########	13	51.49686	9.387294	199	0	360	5.67E+08	U	43.97214741	0.067523659	-0.02742
7	3496	########	13	51.49693	9.387716	198	5	89	5.67E+08	F	66.00914875	0.01413641	-0.02742
8	3496	########	13	51.49696	9.387794	198	1	288	5.67E+08	F	72.05660059	0.018484941	0
9	3496	########	13	51.49695	9.387805	197	0	310	5.67E+08	F	72.74967862	0.010143271	-0.02742
10	3496	########	13	51.49695	9.387818	196	0	274	5.67E+08	F	73.59559804	0.003551743	-0.02742
11	3496	########	13	51.49694	9.38784	196	0	226	5.67E+08	F	75.0526369	0.007126802	0
12	3496	########	13	51.49694	9.387852	197	0	201	5.67E+08	F	75.80232272	0.013423288	0.027416
13	3496	########	13	51.49694	9.387855	197	0	182	5.67E+08	F	76.00881858	0.016950392	0
14	3496	########	13	51.49694	9.387857	197	0	232	5.67E+08	F	76.07502523	0.018348494	0
15	3496	########	13	51.49694	9.387859	197	0	202	5.67E+08	F	76.24583348	0.02024951	0
16	3496	########	13	51.49694	9.38786	197	0	199	5.67E+08	F	76.29456552	0.020967001	0
17	3496	########	13	51.49693	9.387863	197	0	179	5.67E+08	F	76.47546474	0.022995421	0
18	3496	########	13	51.49693	9.387865	197	0	184	5.67E+08	F	76.61107763	0.024145418	0
19	3496	########	13	51.49693	9.387867	197	0	199	5.67E+08	F	76.72773917	0.026180544	0
20	3496	########	13	51.49693	9.387869	197	0	178	5.67E+08	F	76.81609675	0.027142787	0
21	3496	########	13	51.49693	9.38787	197	0	183	5.67E+08	F	76.84612356	0.028135204	0
22	3496	########	13	51.49693	9.38787	197	0	194	5.67E+08	F	76.87295079	0.028678351	0
23	3496	########	13	51.49693	9.387871	197	0	176	5.67E+08	F	76.9386652	0.029201382	0
24	3496	########	13	51.49693	9.387872	197	0	172	5.67E+08	F	77.04597412	0.029278496	0
25	3496	########	13	51.49693	9.387873	197	0	177	5.67E+08	F	77.11439587	0.029375726	0
26	3496	########	13	51.49693	9.387874	197	0	195	5.67E+08	F	77.16263566	0.029218146	0
27	3496	########	13	51.49693	9.387875	197	0	185	5.67E+08	F	77.23204189	0.028970042	0

Partition6467MatchedPoints

- **EvaluatedRoadSlope.csv:**

	linkPVID	calculatedMeanSlope	givenMeanSlope
2	51881672	0	-0.014
3	51881767	-1.23E-07	0.104333333
4	51881768	-0.010965763	-0.0165
5	51881825	0.020561311	-0.117
6	51881938	0	0.123333333
7	811768915	0	0.175333333
8	51883233	0	1.491666667
9	67948960	-0.027414617	0.83725
10	67948524	1.28E-08	0.424333333
11	51883237	0	0.978
12	51883238	-4.48E-08	0.10875
13	572204412	0	-0.8665
14	51883362	-0.027414991	1.15375
15	67948946	0	1.17875
16	67948945	0	0.09575
17	67948530	0	-0.6805
18	51883890	1.36E-08	-0.35825
19	554728228	0.013707216	0.942142857
20	554728229	0	0.2355
21	51867645	-0.018276381	-0.102
22	762732456	0	-0.0185
23	51866678	-0.027415431	-0.021
24	51866677	0	-0.002
25	799517966	0.005483125	-0.055666667
26	799517967	0.013707664	-1.45E-18
27	51865408	-5.01E-09	-0.024

SlopeEvaluation

References

- “Online map-matching based on Hidden Markov model for real-time traffic sensing applications” by C.Y. Goh, J. Dauwels, N. Mitrovic, M. T. Asif, A. Oran, P. Jaillet (2012 ITSC).
- “Map-Matching for Low-Sampling-Rate GPS Trajectories” Yu Zheng, MS Research.