road network that cause an increase in the computational time of Dijkstra's algorithm. This means that there exists a significant efficiency benefit to a user if the algorithm would only use the part of the network that is most likely to be matched to the GPS trajectory or if the user trimmed the network to include only parts that would most likely be used before applying the algorithm. Figure 4.21 is an illustration of just how little of the entire road network the trajectory in Figure 4.19 used.

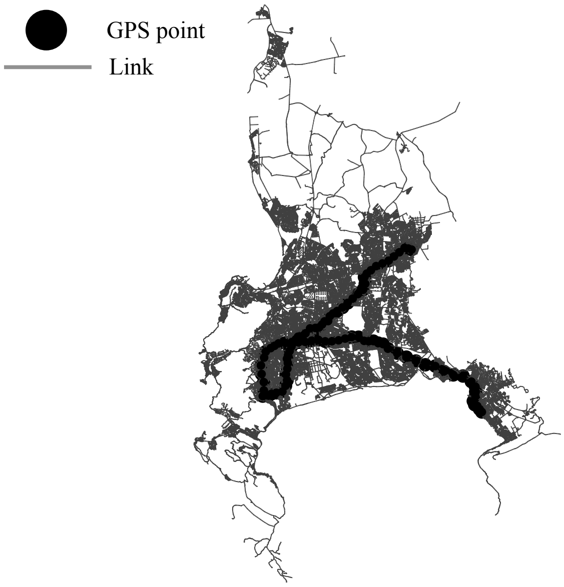

Figure 4.21: Overview of GPS trajectory on entire real-world road network

4.6.2 Accuracy

The accuracy of the algorithm shows a considerable increase as compared to results obtained with the simple grid network. As expected, the nature of the simple grid does not lend itself to providing options with a high variability in the probabilities as segments are all the same length and speed. Figure 4.22 illustrates that al GPS periods yielded a similar level of accuracy except the GPS periods close to 1, that caused a slightly higher IARR because the higher density of GPS points caused possible U-turns to occur in the matched routes.

Figure 4.23 shows portion of the map seen in Figure 4.19, and is an example of an erroneous match the algorithm performed. Both points i and $i+1$ were recorded so close to the off- and on-ramp, respectively, that the observation- and spatial probabilities trumped the temporal probability. It should also be noted that the free speed on the highway as well as on the ramps are 90 km/h and the free speed on the side road is 60 km/h for ±250 m, leading to a smaller effect of the temporal probability. Furthermore, due to the GPS error, if both these points where generated with an offset in the direction of each other then the inferred speed could actually be lower than the highway speed and further diminish the effect of the temporal probability on the overall outcome.

4.6.3 Speed analysis

In Figure 4.24 the speed analysis on real-world network shows that the probability of choosing realistic road segments increases for trajectories when the GPS period is 5 s and

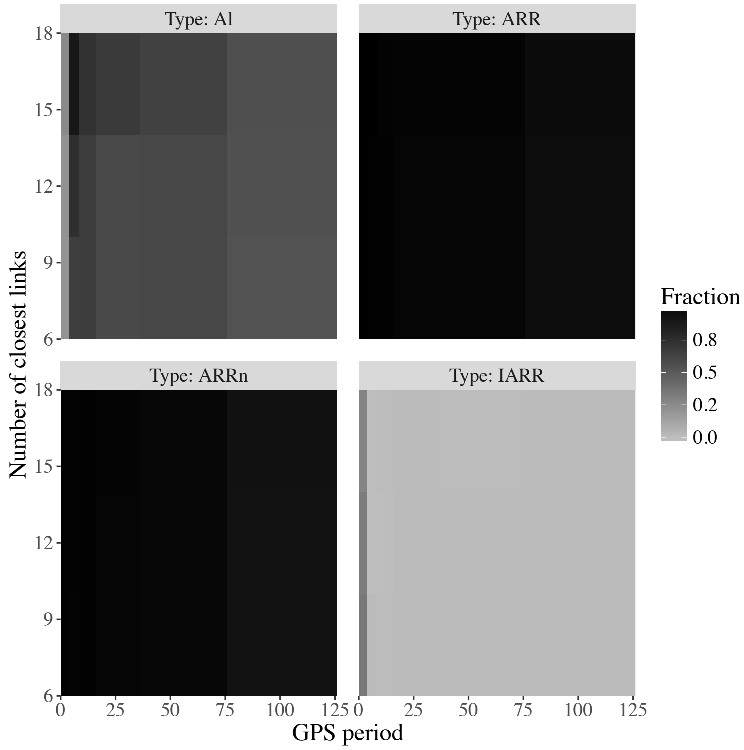

Figure 4.22: Accuracy versus number of closest links

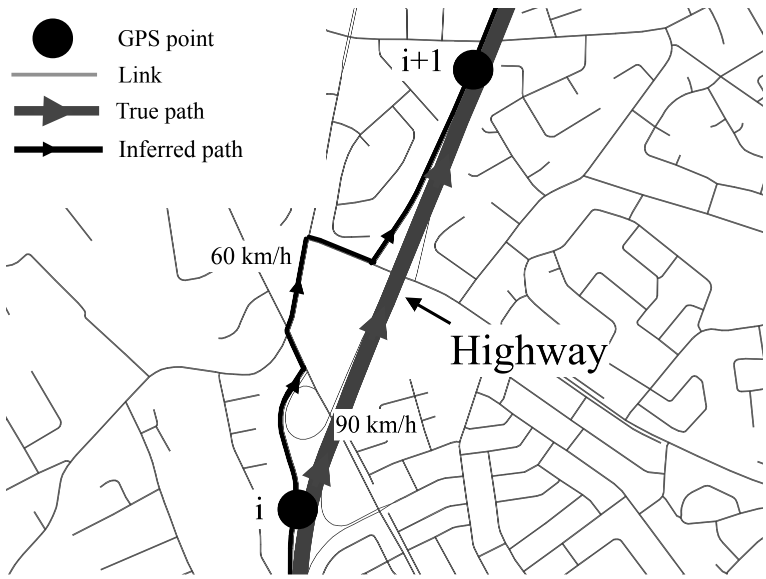

Figure 4.23: Erroneous road segments identified

starts to decrease significantly when GPS period are 50 s. When compared to the simple grid network results, where the analysis was only done on a GPS period of 5 s, the real-world network shows a decrease in deviation from free speed if one increases the number of links to assess from 8 to 12. However, when increasing the number of links for all the other GPS periods, it does not seem to make a significant difference

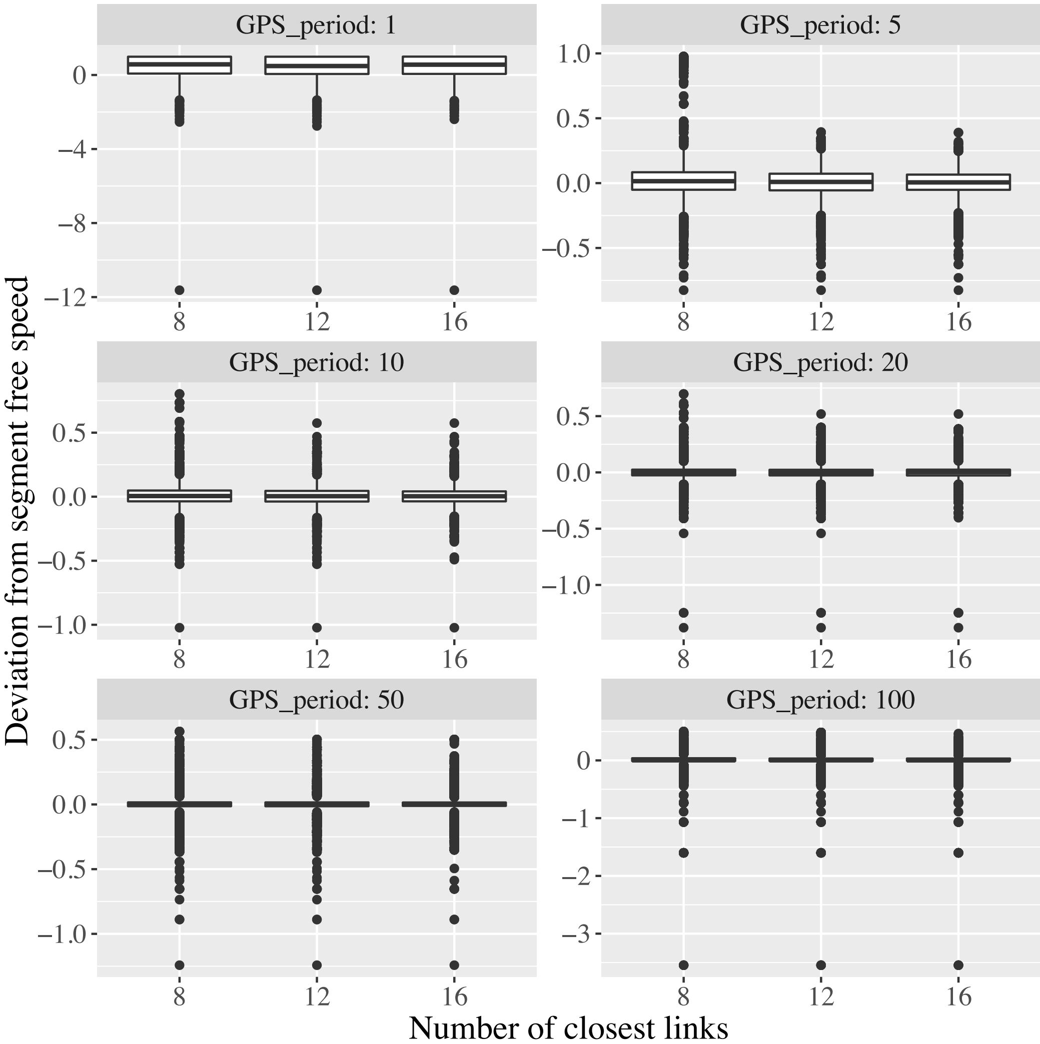

Figure 4.24: Speed analysis versus number of closest links

4.7 Conclusion and future work

The map-matching algorithm appears very robust in handling different GPS sampling rates but generates anomalous results if sampling rates increase above 50 s. The algorithm is also not apt at using sampling rates of less than 5 s and will start to output U-turns and loops in the IP if the sampling rate drops to 1 s.

Increasing the number of closest links to assess in the analysis increases the execution time considerably but his can be mitigated by reducing the road network to include only the part of the network that will most likely be used in the analysis.

Only at the low GPS sampling rates, less than 5 s, was there a beneficial influence of using more links in the matching algorithm. Using 8 or even 12 links appears to give sufficient results with accuracies in the high 80% for both ARR and accuracy ratio of route by number of links (ARRn), and with very low IARR scores. Lower accuracies were observed when the sampling rate was above 50 s and increasing the number of links to assess did not yield an improvement.

These results conclude the synthesised experiments done on simple grid and real-world networks. These tests excluded dynamically changing GPS sampling rates. Future work could include developing more realistic grid networks and more variable trajectories in terms of the speed of the object travelling on the network as well as the sampling rate of the GPS generation.

The next section will focus on a sample set of the real-world data available to this study and assess, based on observation, how well the algorithm manages to match the trajectory to a route. It also includes some detail on the use of the inferred versus free speed comparison as a means to gain insight into the accuracy of the match.