

Evaluating Urban Traffic Congestion using **OpenStreetMap** and Sparse Public Transport Data

Andrei Bejan

(joint work with Richard Gibbens, David Evans, Alastair Beresford,
Jean Bacon, Ken Moody and Adrian Friday)



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The origins and main features of the data and tools used:

- bus locations recorded using GPS at the rate of 'once every 20–30 seconds' or more rare (+ 'silence' periods)
- source: archived and live bus location data stream (+ parsing and cleaning)
- road network
and features: OpenStreetMap data
- bus stops info: NaPTAN data (UK National Public Transport Access Node database) and OSM
- bus routes: timetables and/or OSM



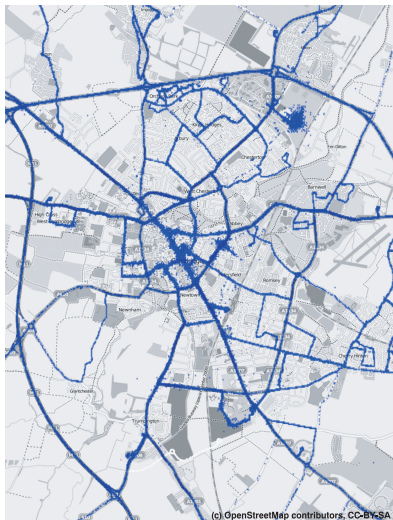
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- a GPS tracker



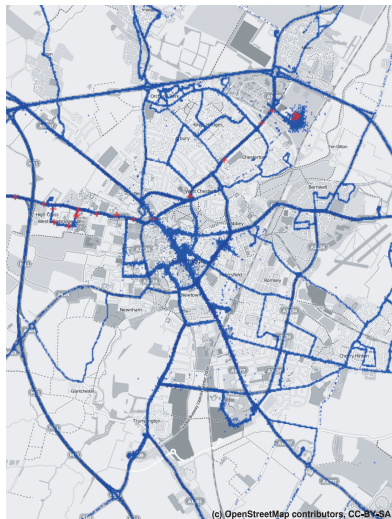
Road network coverage: each cell on the map corresponds to a 10×10 m square

Bus coverage of Cambridge (≈ 150 buses)



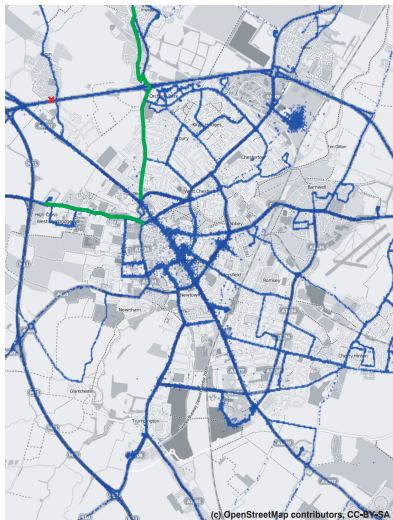
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An example of a bus trajectory

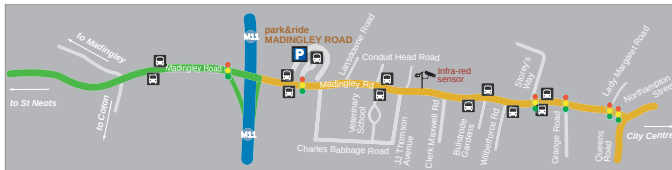
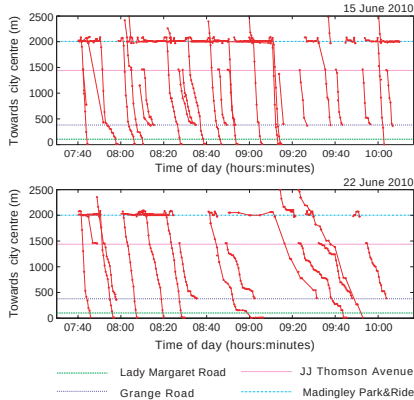


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Case studies: Madingley Rd, Histon Rd and A14 accident



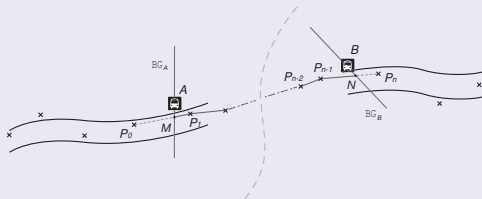
Bus 'trajectories' in time: Maddingley Road, Cambridge



Journey extraction

Methods:

- area-of-interest bounding rectangles (difficult to automate)
- bus stop gate technique: intersection of $\rho = P_0P_1 \dots P_n$ with bus stop gates defining a route $r_{AB} = A \rightsquigarrow B$

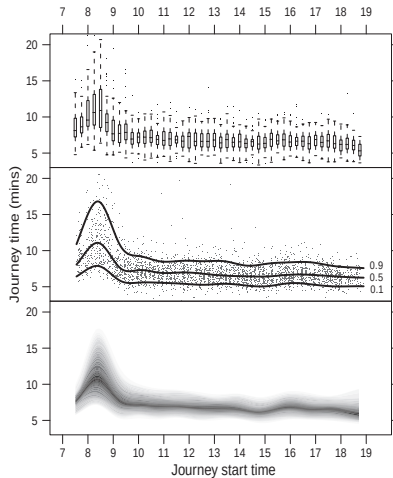
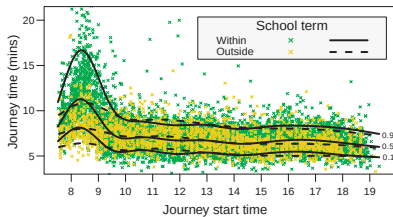
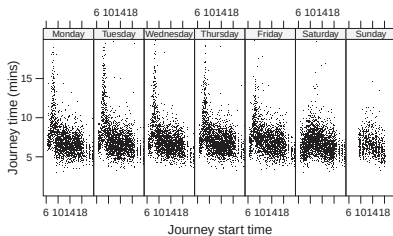


$$JT(\rho; r_{AB}) = t_n - t_0 - \left(\frac{P_0M}{P_0P_1}(t_1 - t_0) + \frac{NP_n}{P_{n-1}P_n}(t_n - t_{n-1}) \right).$$

Journey time: Impington/Histon → Histon Road → Victoria Road

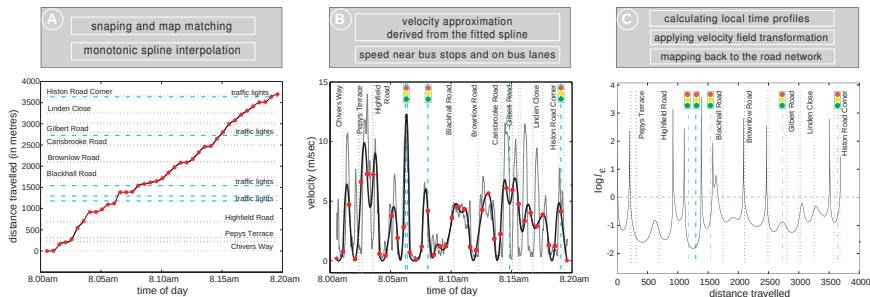


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ABC of velocity fields

Restoring behaviour of buses via spline interpolation



Time spent by a vehicle in ε -neighbourhood of a point s :

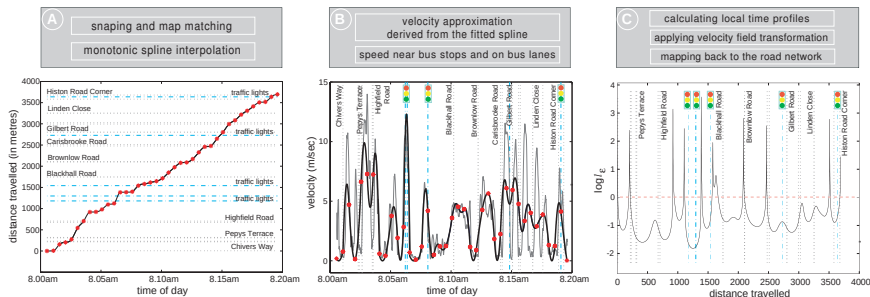
$$\ell_{\varepsilon}(s) = d^{-1}(s + \varepsilon/2) - d^{-1}(s - \varepsilon/2),$$

where d^{-1} is a generalised inverse function, defined as follows:

$$d^{-1}(s) := \sup \{t : d(t) < s\}.$$

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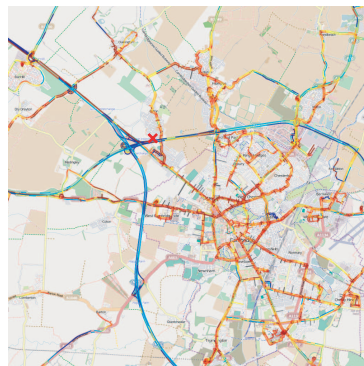
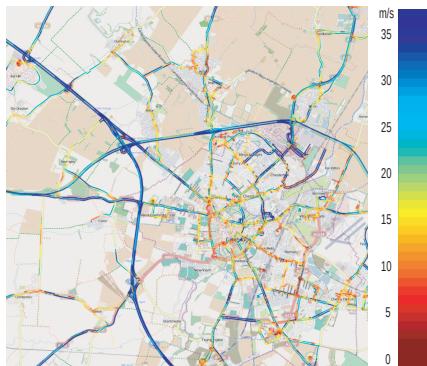
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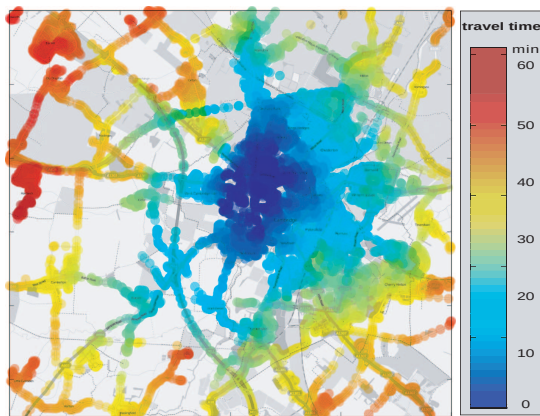
Snapshot visualisations of the velocity fields

15 June and 22 June 2010 (A14 accident)



Commuting time maps

22 June 2010 (A14 accident)



Summary

We have presented effective techniques of using sparse bus data in studying travel times (of buses and general vehicles), road traffic dynamics and congestion. These techniques can be used by in RTI applications, to more optimally manage public transport fleets, and for better informativeness of the road users.

OpenStreetMap data were used in our analysis for the following purposes:

- 1 **Road network:** linear segment representation of the road network (for snapping and map-matching purposes).
- 2 **Bus stops:** locations and bearings of bus stops for journey extraction (bus stop gate technique).
- 3 **Bus routes:** description of bus routes permits to identify a subgraph of the road network giving a set of roads which are most likely to be used by buses; this subgraph helps to reduce uncertainty in snapping and map-matching process.
- 4 **Bus lanes, barriers and bollards:** parts of the road may be used by buses in an exclusive way.
- 5 **Maps:** these were used for illustration purposes.

Pitfalls: (in)consistency in tagging bus stops, slow or no reflection on temporary changes in bus routes, etc.

These techniques make use of OSM and therefore do depend on the

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References



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