GPS and Travel Monitoring

Val Noronha (noronha@dgrc.ca)
University of California, Santa Barbara
September 2005

Several areas of DTD[1] in transportation are of interest to me, from the challenges of instrumentation to real-time and post-analysis of tracks, data uncertainty, map interoperability and automated update.

In the area of personal travel monitoring, five problems stand out.

Exploring microscopic driving behaviors in space-time

DTD opens up possibilities for monitoring not just origins, destinations and routes, but also microscopic behavior en route. Where do drivers slow down and accelerate? What does that reveal about congestion, road conditions and visibility, permanent or temporary traffic restrictions, the individual's familiarity with the area, or land use? There are obvious and compelling uses of such data in incident management and infrastructure analysis—for example, in preliminary tests we were able to determine whether intersections had traffic lights or stop signs, or were unregulated. One area of potential application in travel studies is to automate the detection of the least intelligible trip ends: passenger drop-offs and pick-ups. Another is perhaps to capture driver attitude as an explanatory variable in route choice.

Microsimulation

Real data on route choice, and variability in route choice, enrich traffic assignment and microsimulation algorithms. There are potential applications in other areas—reflexive response to horizontal curves and vertical gradients, given visibility and other conditions—but GPS resolution is currently insufficient and driving simulators provide superior data. In the future, when GPS is available for larger samples, and data are delivered simultaneously from other vehicle based sensors (e.g. headway distance and video), we can anticipate additional inputs to microsimulation.

Shopping choices: DTD fills in the blanks

DTD provides valuable insights on shopping choices. Due to historic structures of census data, retail location models commonly assume store choice to depend on distance to one's home. We know from introspection that the thought process is more complex. Up to now, financial firms have had some ability to track the time and location of transactions, creating a coarse breadcrumb of an individual's activities and spending habits. DTD fills in the gaps, potentially shedding light on the decision process, with plentiful data for model specification and calibration.

Improving the user interface for electronic diaries

Travel survey by trip diaries is expensive and error-prone, because of the substantial human input component. Entirely passive data gathering is technically much easier and relatively free of error, but the data do not reveal trip purpose, reasons for detours, the number of passengers traveling together, etc—these require input from the subject. To a large degree, intelligent processing can infer trip ends and purposes. The task of the user interface can therefore be reduced to prompting the user for input at points of uncertainty, and confirming inferences. Voice synthesis and recording

---

[1] We use the term "Dense Tracking Data" (DTD) to refer to space-time couplings (x,y,z,t) at resolutions of roughly 1~10 m in space and 0.1~10 seconds in time.

(both of which are easily implemented on common current hardware) can further simplify the user interface, decreasing the burden for the subject.

Protecting, spoofing and uncovering the truth

DTD are inherently information-rich, so the more ambitious the plans for DTD mining, the deeper the conflict with personal privacy. There are legal and institutional workarounds and avenues towards compromise, such as total informed consent. What about at the technical level? One technical compromise is to coarsen the spatial and/or temporal resolution of the data. This raises research questions: What is an appropriate resolution in space and time at which data are sufficiently anonymous, yet sufficiently useful? Because of the rich content of DTD, the block group is too small as a basic data unit, to protect the identity of individuals when the entire population is tracked; to protect privacy is smaller samples, aggregation units to be larger. What are the types of packages in which useful data can be presented to researchers so that individuals are no longer identifiable? What are the methods by which data can be spoofed, for example by swapping trajectories of residents of the same spatial aggregation unit? Can a determined sleuth reconstitute the tracks? What types of data (e.g. the GSV satellite configuration sentence in NMEA) must be suppressed? At what cost—what is the residual fitness for use of the corrupted, aggregated data?

The consequences of information in the wrong hands must be balanced against the value of information in the right hands. Perhaps as often as not, it is in an individual's interest to be tracked.

Dr. Val Noronha is Director of the Vehicle Intelligence and Transportation Analysis Laboratory at the University of California, Santa Barbara; Project Director of the National Consortium on Remote Sensing in Transportation–Infrastructure; and President of Digital Geographic Research Corporation. He has worked in GIS for more than 20 years, in Australia, Canada and the U.S., in academia and as a consultant to governments and the private sector. In transportation he has worked on location expression and interoperability standards testing, centerline mapping error, remote sensing applications, GPS, data modeling, transit and accessibility.