An Automated Activity Identification Method for Passively Collected GPS Data

Vetri Venthan Elango

Randall Guensler

School of Civil and Environmental Engineering

Georgia Institute of Technology

Atlanta, GA

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Overview

- Introduction
- Problem statement and study scope
- Background
- Methodology
- Case study
- Conclusions and future research

Introduction

- Traditional two-day travel diaries have limitations in representativeness, completeness, and accuracy
  - Household travel variability
  - 25% of trips are missed
  - Various reporting accuracy issues
- Cross-sectional travel data have limited usefulness in disaggregate travel behavior analysis
- Longitudinal travel data are necessary for studying variations in travel behavior over time
- GPS devices that collect travel data passively can be excellent instruments for longitudinal surveys

Limitations of GPS Data

- **Limitations of passively collected GPS data include the failure to directly capture:**
  - **Trip purpose**
  - **Travel mode**
  - **Driver identification**
  - **Number of people involved in the activity**

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Problem Statement and Scope

- **Develop a methodology to identify trip end activity with passively-collected GPS data**
- **Use only the household data that would normally be collected during participant recruitment**
- **Use a commercially-available mapping software that is location independent of the GIS data**
- **Assume that data cleaning, and processing of the passively collected GPS data has been completed and individual trips have been identified**

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Longitudinal travel surveys

- Panels of traditional travel diary surveys
- GPS passive data collection
- Examples
  - Puget Sound Panel Study
  - Commute Atlanta Study

Travel Survey Methods using GPS

- **Handheld devices designed to replicate traditional cross-sectional travel diaries**
- **Longitudinal studies with vehicle-based GPS devices installed in participants' vehicles**
- **A hybrid of longitudinal passive GPS data collection coupled with intermittent online travel diary surveys**

Identifying Activity type from GPS data

- **Wolf, et al., 2001**
  - **Elimination of the Travel Diary: Experiment to Derive Trip Purpose from Global Positioning System Travel Data**
- **Schönfelder, et al., 2002**
  - **Exploring the Potentials of Automatically Collected GPS Data for Travel Behaviour Analysis**

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Assumptions

- **Assumptions, based upon passively collected data from instrumented vehicles:**
  - **The radius within which people tend to park their vehicles and walk to a destination is 0.2 miles**
  - **The points of interest that are closest to the trip end are the most likely locations visited by the individual**
  - **The search radius for the home location is 500 feet from the trip end**
  - **The search radius for work and school locations is 1000 feet from the trip end**
  - **If no points of interest within 0.2 mile of the trip end, the trip purpose is classified as 'Unknown'**

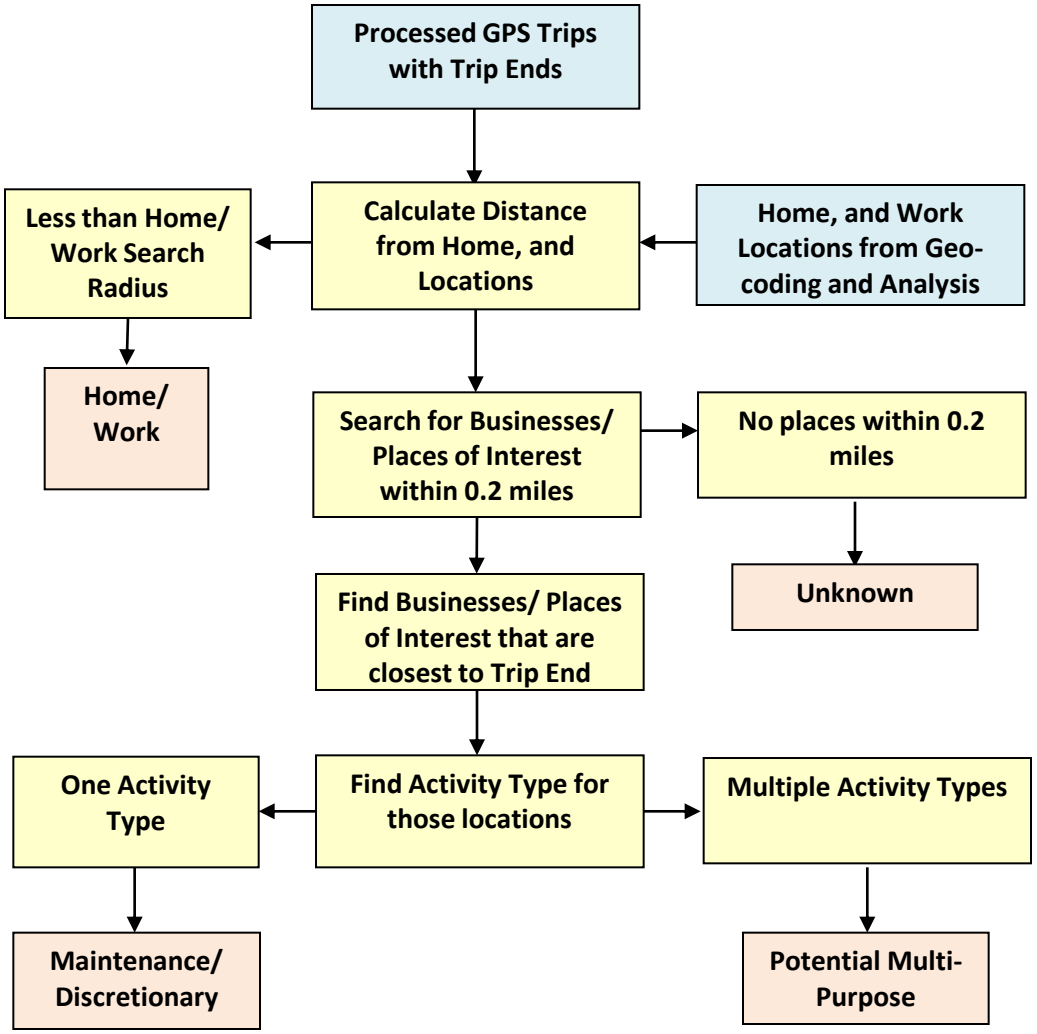
Activity Types

- Home
- Work
- Maintenance (shopping, services, school and dining)
- Discretionary (sports, recreation, social visit, landmarks etc.)
- Multi-purpose (potential)

Coded Points of Interest

- Home
- Work
- School and preschool
- Dining locations
- Shopping and service locations
- Discretionary activity locations
- Locations identified by the household during the recruitment process

Algorithm



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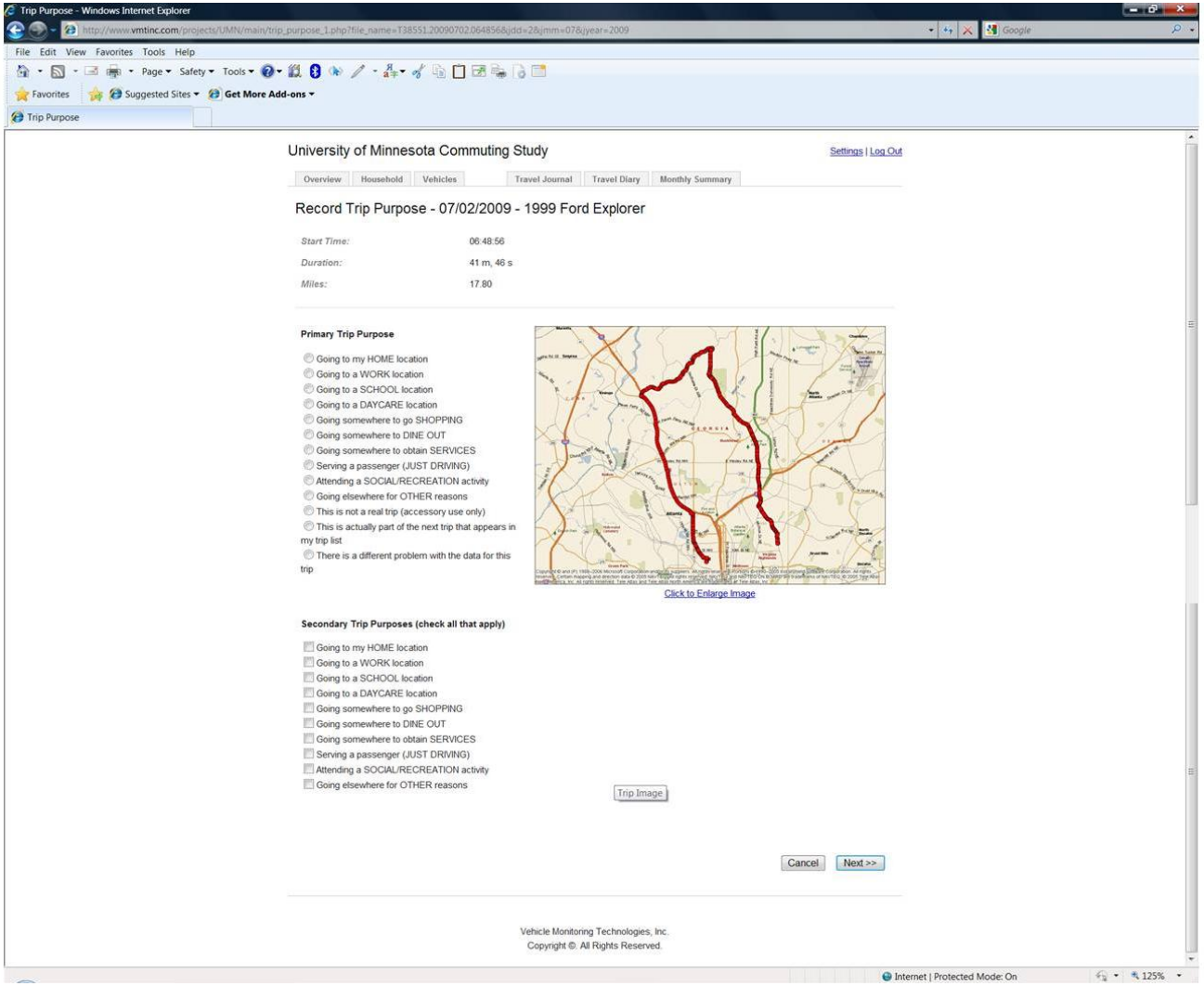
Data

- The University of Minnesota conducted a travel behavior study on the use of the I-35W Bridge
- 46 participants I-35 Bridge commuters
- Participant's commute vehicle instrumented with GPS device September - December 2008
- GPS device transmitted second-by-second data to the server using GPRS/GSM
- Entire household demographics not collected, only participant's information

Data Collection Method

- Hybrid travel survey with passive GPS data and interim online travel diaries
- Each participant was asked to complete 6 to 14 days of travel diary during the study
- The participants completed 94% of received travel diary requests
- Participants voluntarily completed extra travel diary days that were not requested
  - Participants reported trip purpose details for twice as many trips as they were asked to provide data
  - 200% reporting rate

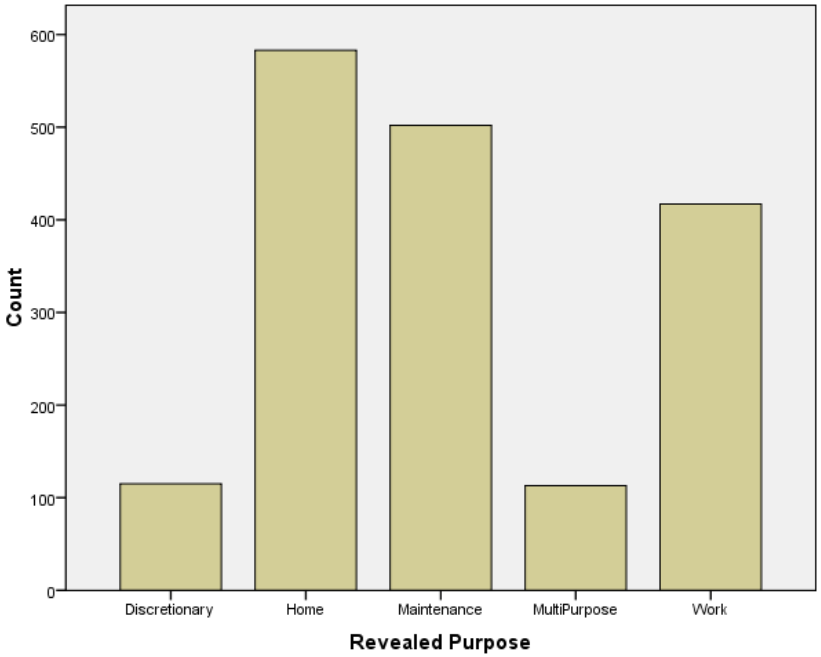
Online Survey

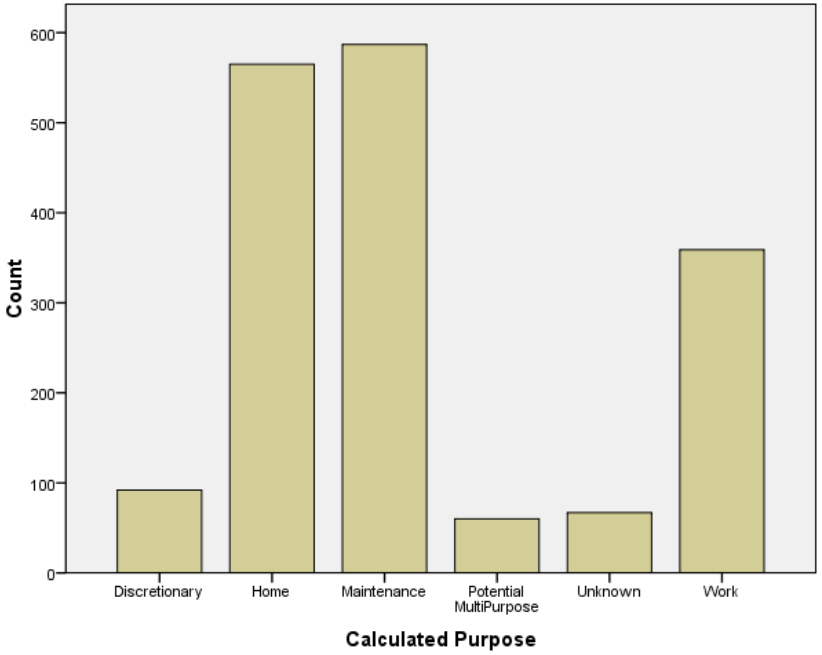


Data QA/QC

- Participants completed diaries for 4300 trips
- The initial data set included the 2185 trips for which travel diary were requested
- Some data were eliminated:
  - 150 trips with GPS data issues
  - 250 trips with trip purpose coded as "Other"
  - One household that reported using their vehicle for commercial purposes
  - One household that clearly reported frivolous data
- Retained 1730 trips in the analytical data set

Results





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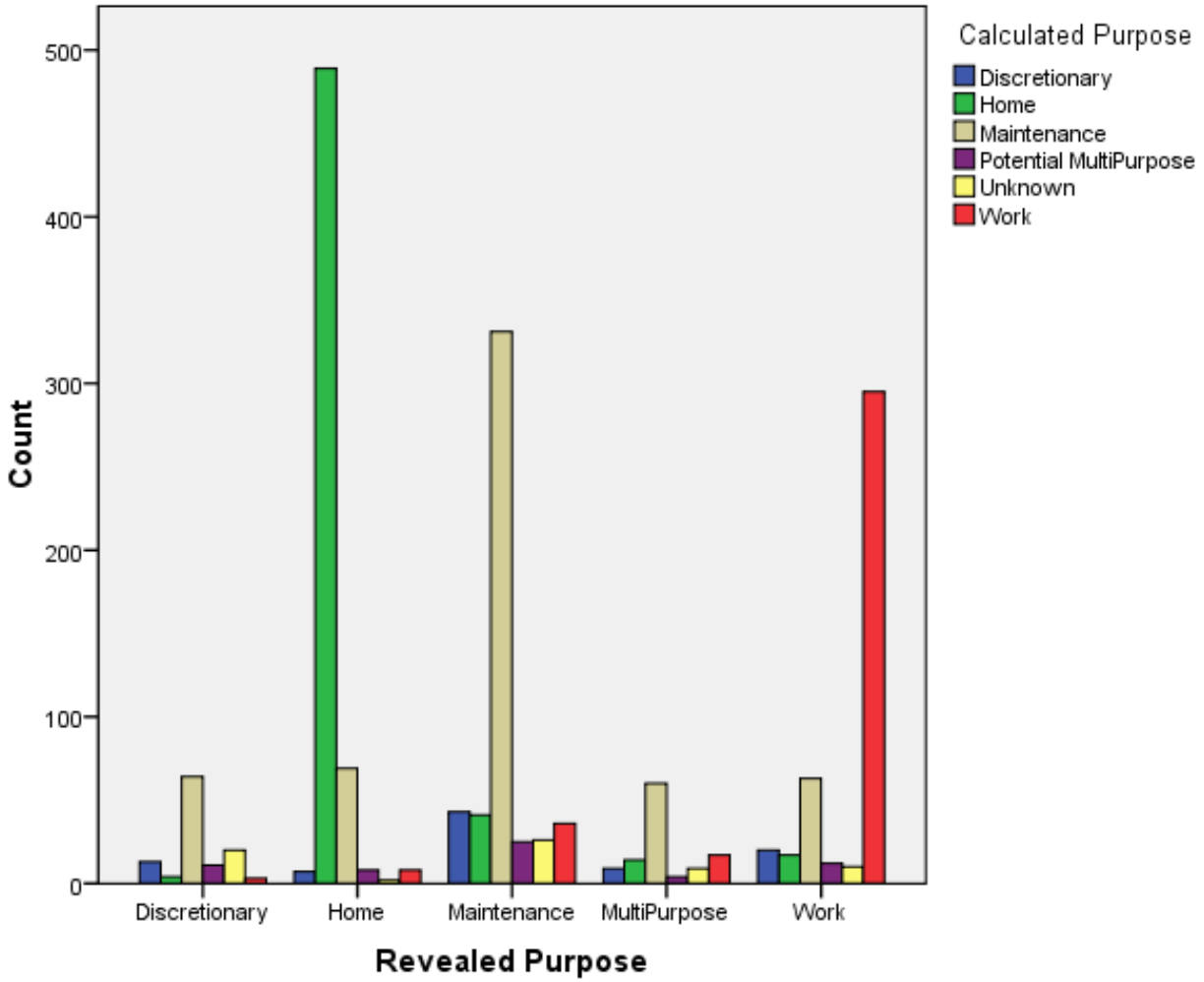
Results



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Results

- 67 trips (4%) fall under the 'Unknown' category
- 65.4% of the trips were identified correctly
- Home activity predicted with 84% accuracy
- Work activity identified with 71% accuracy
- Maintenance activity identified with 66% accuracy
- Discretionary and potential multi-purpose activities are predicted poorly

Discussion

- It is assumed that stated trip purpose is correct
  - This is not always true
  - One household reported 3 trips starting at 16:04, 16:18 and 16:50 as trips to home
- MapPoint 2006 was used in this analysis and it may not have latest information on points of interest
- Complete household information, such as other work locations, schools, friend's homes, etc., will further improve prediction accuracy

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Conclusions

- The proposed methodology does not require human interaction to identify the activity type
- With commercial mapping software, the methodology is applicable anywhere in the US
- Eliminates variability in land use data formats used by different organizations
- Assumptions should be re-evaluated with hand-held-GPS data
- The case study found the methodology to be 65% accurate
- Researchers noted that the stated purposes are not always 'ground truth'

Next Steps

- Incorporate activity duration, time-of-day, and day-of-week into the algorithms being used to identify trip activity
  - e.g., commercial activity occurs during business hours
- Incorporate learning algorithms that will use two-day travel diary data to automatically predict the activities that occur on other days

Cross-tabulation
Revealed Activity vs. Calculated Activity

Revealed Purpose	Calculated Purpose						
	Discretionary	Home	Maintenance	Potential Multi-Purpose	Unknown	Work	Total
Discretionary	13	4	64	11	20	3	115
Home	7	489	69	8	2	8	583
Maintenance	43	41	331	25	26	36	502
Multi-Purpose	9	14	60	4	9	17	113
Work	20	17	63	12	10	295	417
Total	92	565	587	60	67	359	1730

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