Capturing Pedestrian Tours and Activities through Smartphone Data: Lessons Learned

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iCity Webinar Series
#4 of 5
Elements of the Street and Its Users

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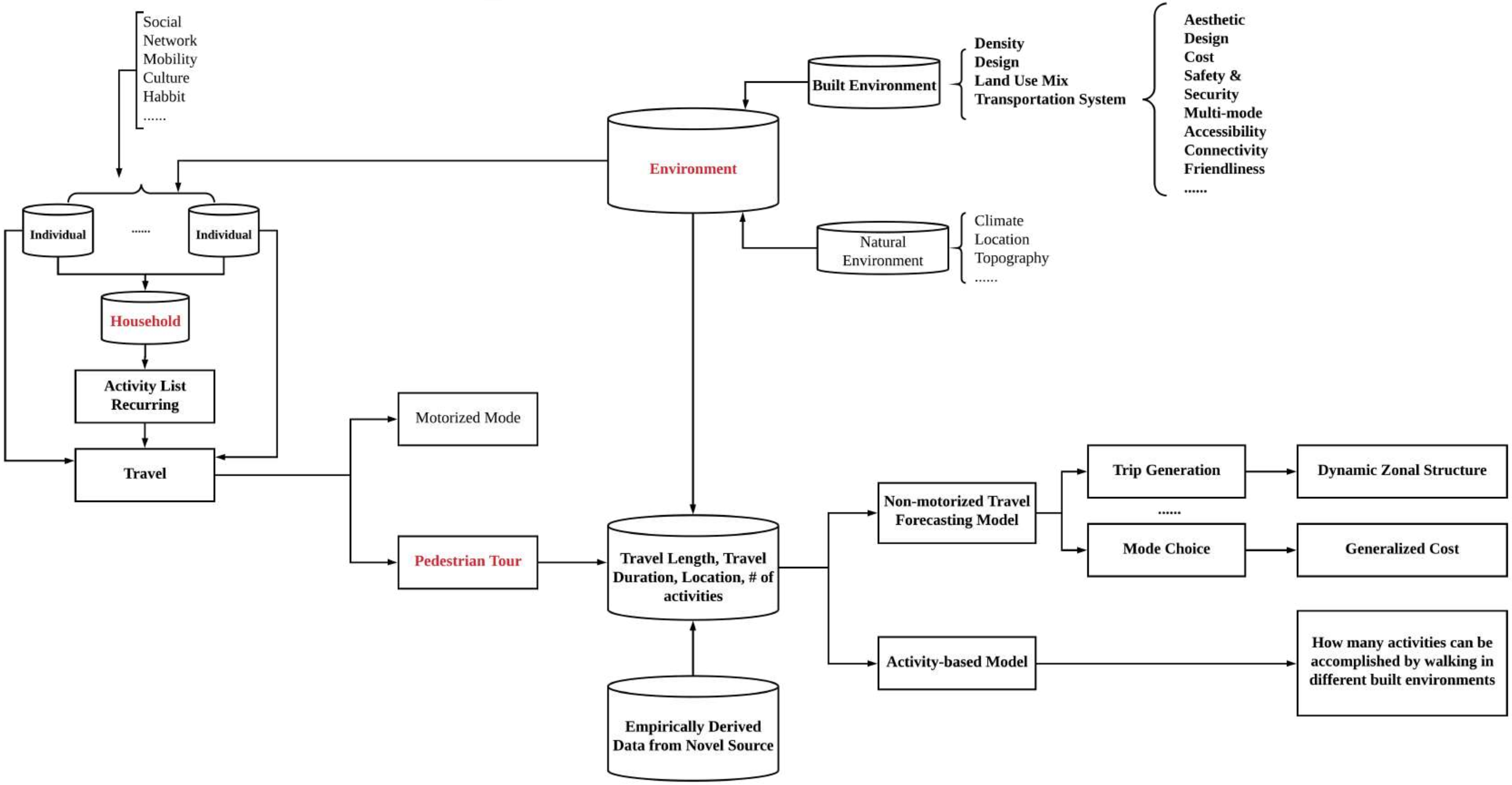
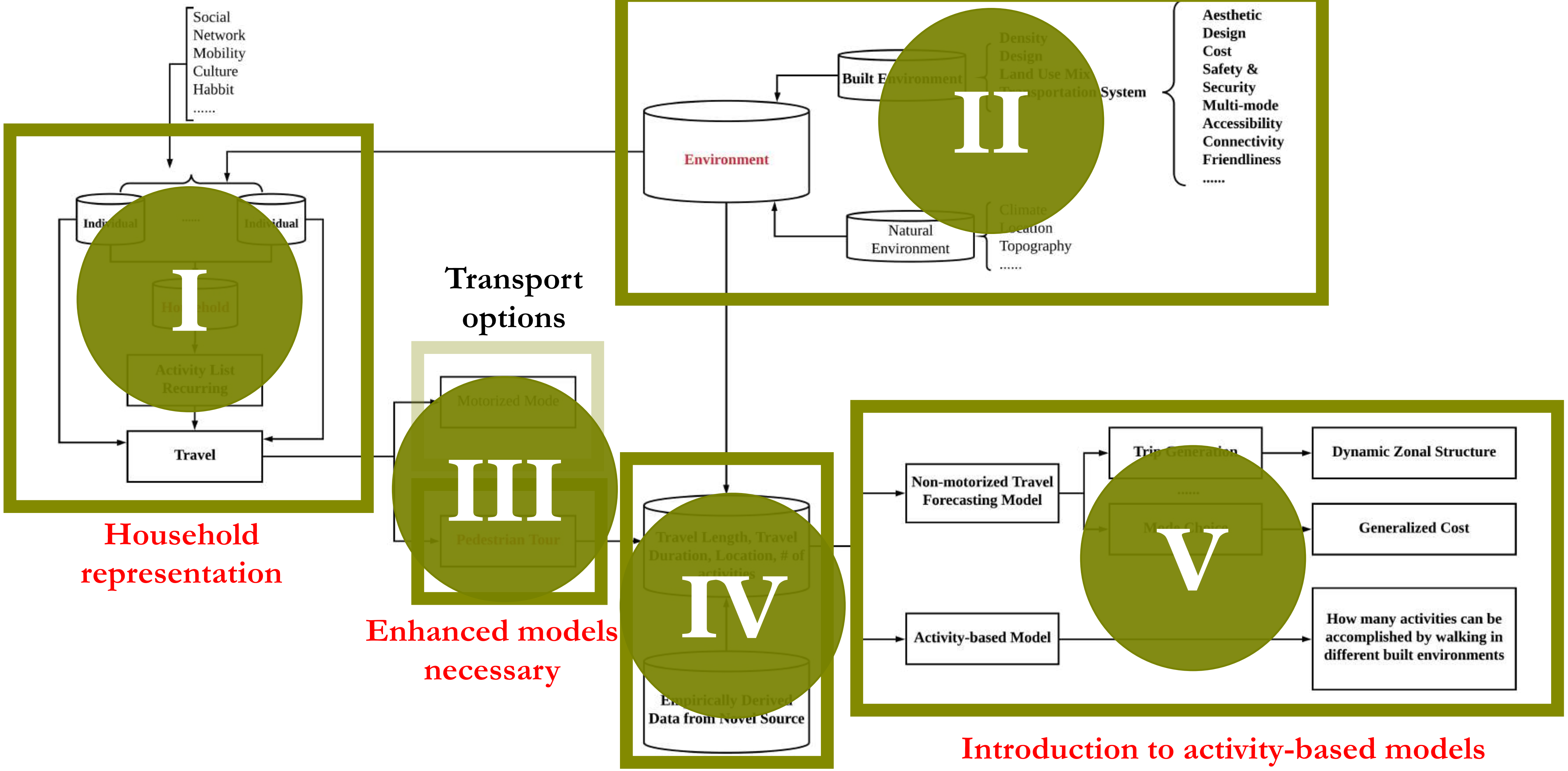
Structure of Concepts



Structure of Concepts

Walking Travel Need: Exogenous variables known to influence walking



Household representation

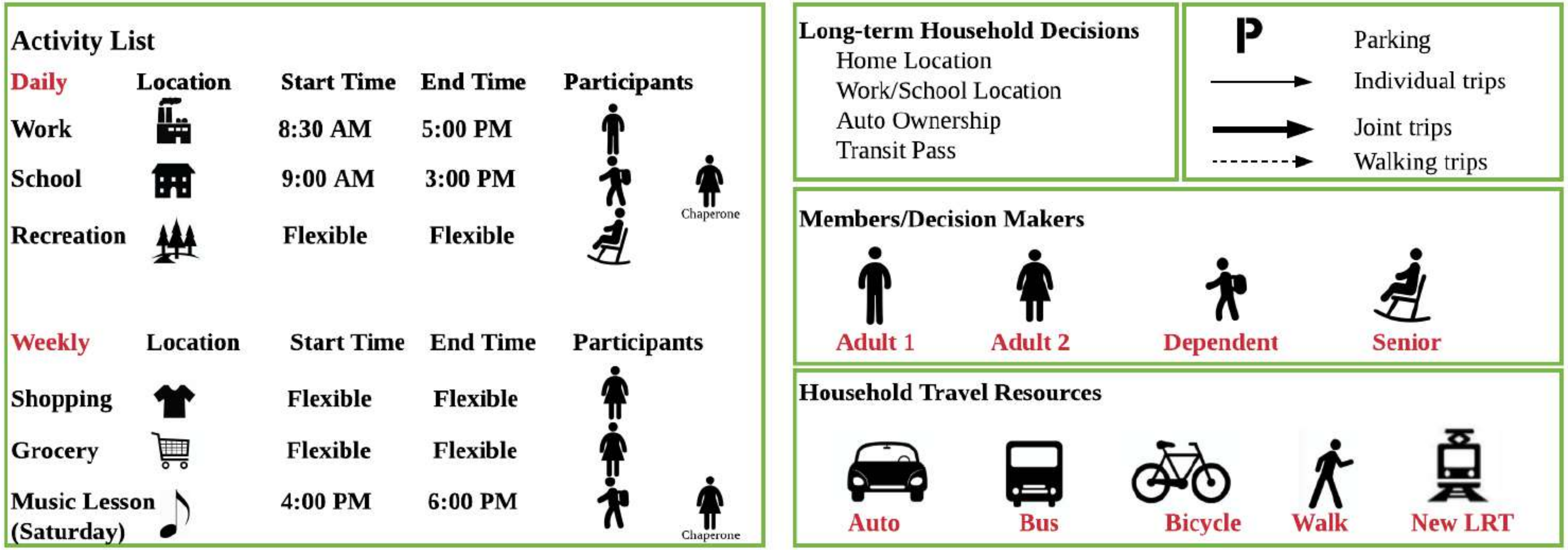
Enhanced models necessary

Data gathering

Introduction to activity-based models

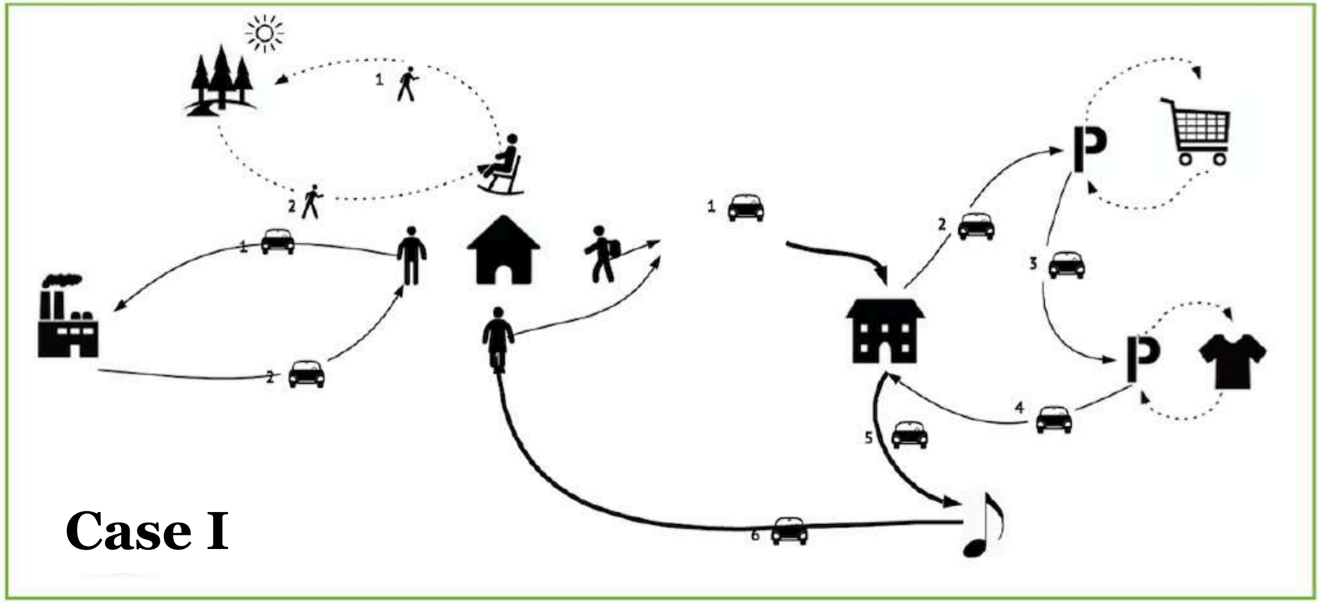
Household Representation: Household Utility

- Decision-making: long-term; mid-term; short-term
- Generate different types of activities
- Share resources and experiences
- Budget: Money/Time/Resources/Chauffer



I

Walking Travel Need: Locational Attributes



Region of Waterloo Suburban

II

Walking Travel Need: Locational Attributes

Case II

Region of Waterloo Downtown

Pedestrian tour: trip-chaining as a pedestrian, varies as a function of household status and land use patterns; provide improved representation of walking travel behavior.

II

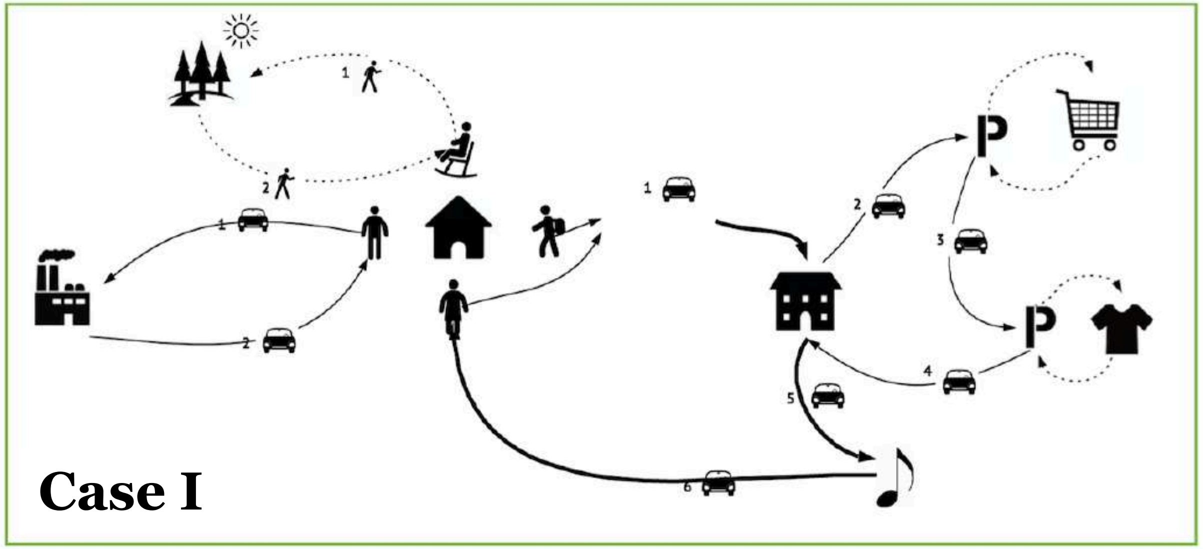
Walking Travel Need: Locational Attributes

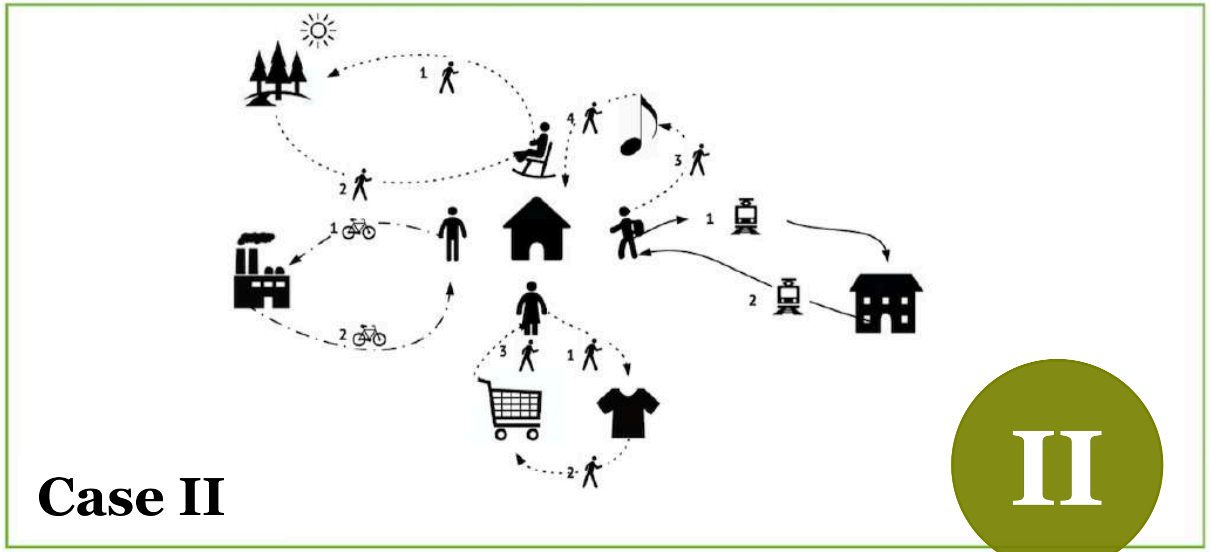
Residential and work area attributes:

- High utility destination area (support multi-purpose at single destination), but different desirable functions
- Within energy expenditure
- Accessibility to destinations
- Diversity and density of land uses
- Safe neighborhood
- Within time budget
- Comfort and pleasure design

Other destination areas:

- Distribution of destinations/land uses
- Density and diversity of land uses
- Proximity to trip ends/easy to transfer

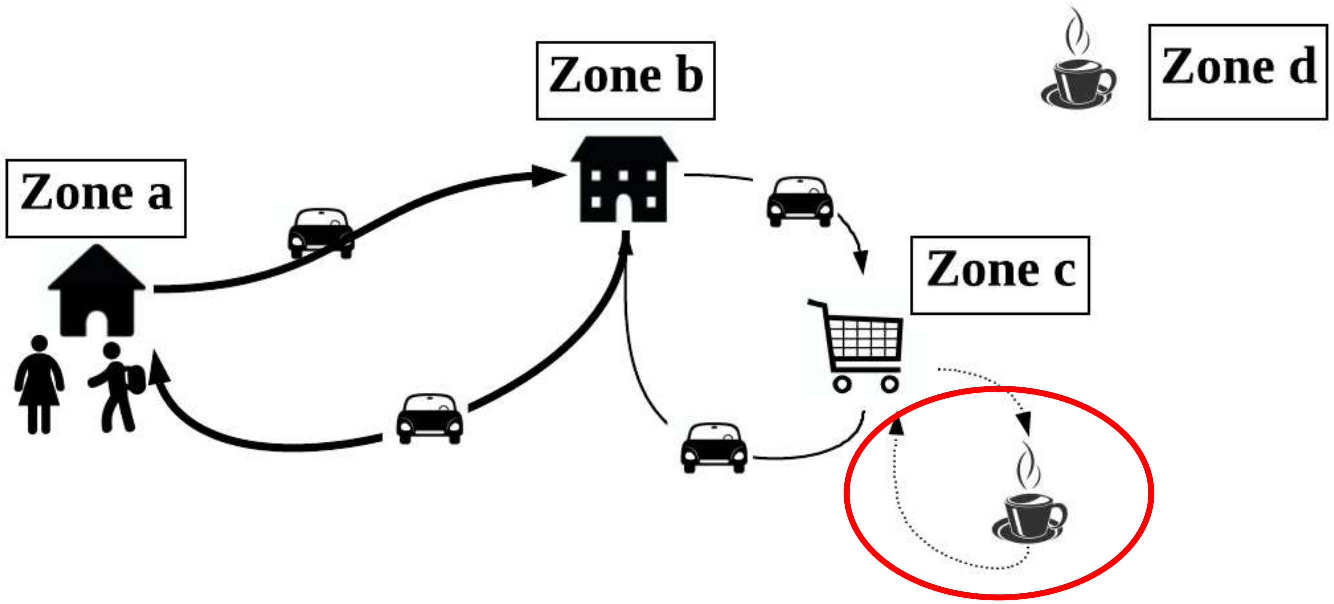




II

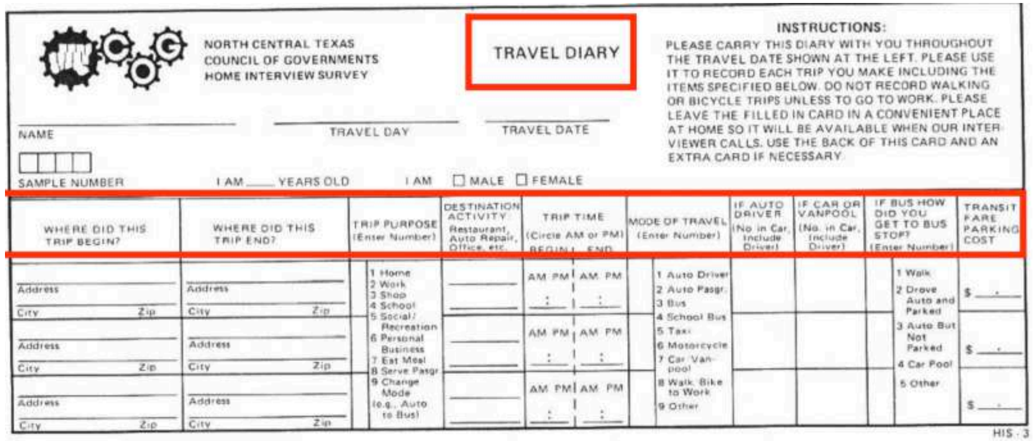
Enhanced Model Necessary

- Failure to consider pedestrian tours in satisfying activities
- A lack of empirical data (Singleton et al., 2018;)
- Inappropriate travel survey design/methods (Harding, et al., 2018)
- Inappropriate zonal structure (Iacono, 2010; Clifton, 2016)
- Failure to develop appropriate cost representation for pedestrians

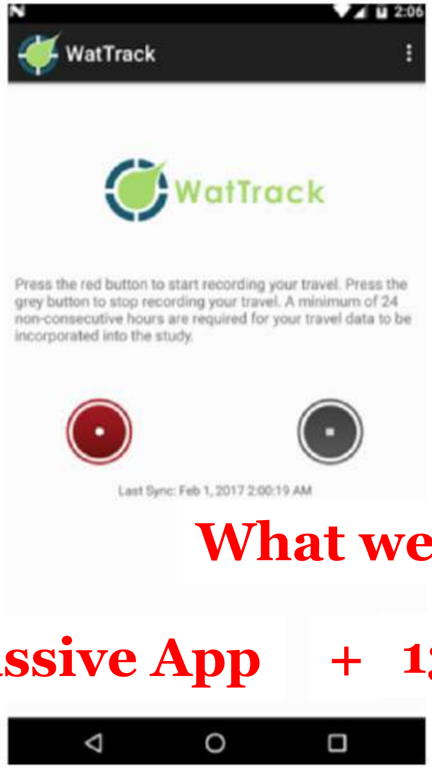


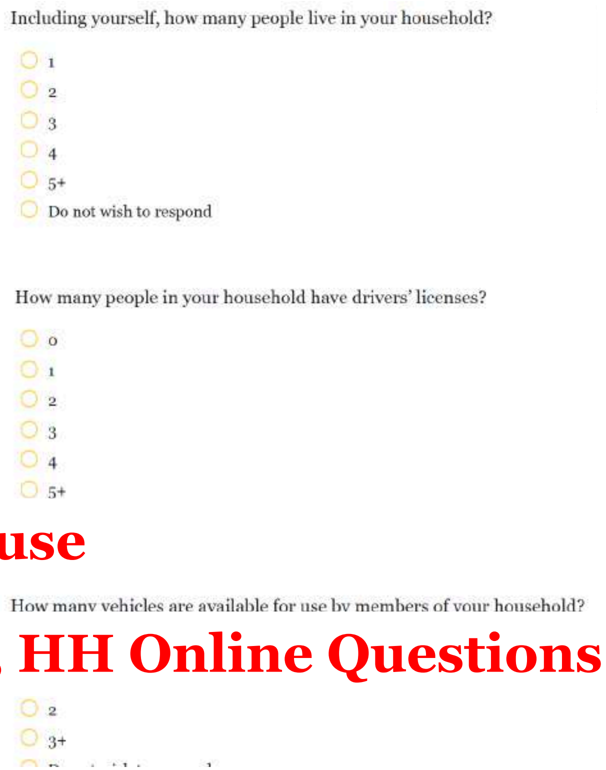
III

Data Gathering: Survey Methods



Conventional Travel Diary





What we use

Passive App + 13 HH Online Questions

Tour Segments/Trips	Mode	Time	Zone	Location	Activity
1	Transit	7:09	221	Home	
		7:13	312	Location 1	Activity 1
2	Transit	7:17	312	Location 1	
		7:35	342	Location 2	Activity 2
3	Walk	1:56	342	Location 2	
		1:59	432	Location 3	Activity 3
4	Walk	2:07	432	Location 3	
		2:10	342	Location 2	Activity
5	Transit	7:12	342	Location 2	
		7:33	221	Home	

IV

Defining Key Elements from Data

Activities: Purpose of travel

- Location, duration, utilitarian actions

Trips: Travel that separates two activities

- OD, path, duration

Stops: Travel stops or activities

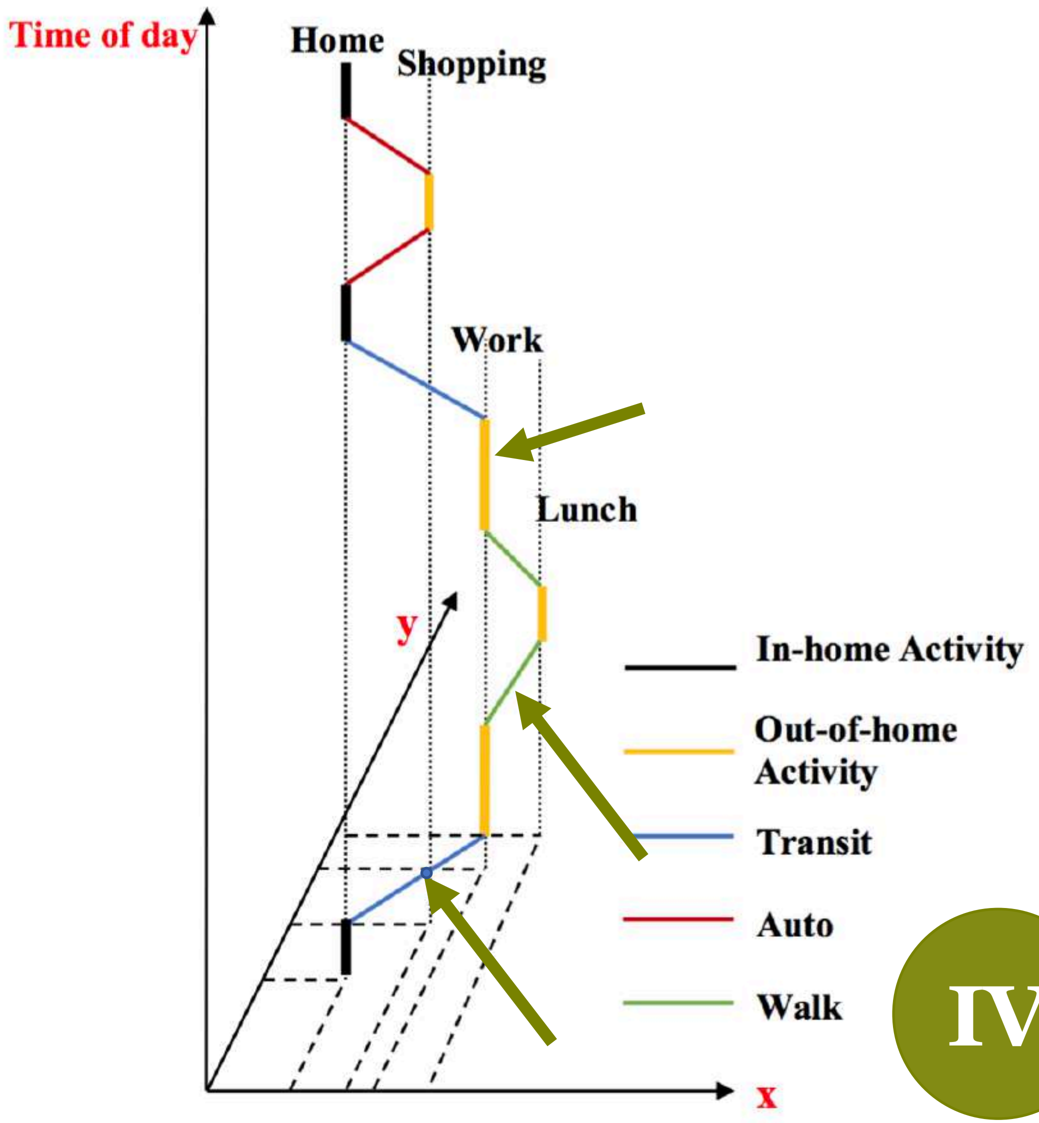
- Location, duration

Tours: a sequence of movements starting and ending at the same location

- Activities , related trips

To determine activities, trips, and stops

- Identify when an activity takes place
- Differentiate travel stops from activities

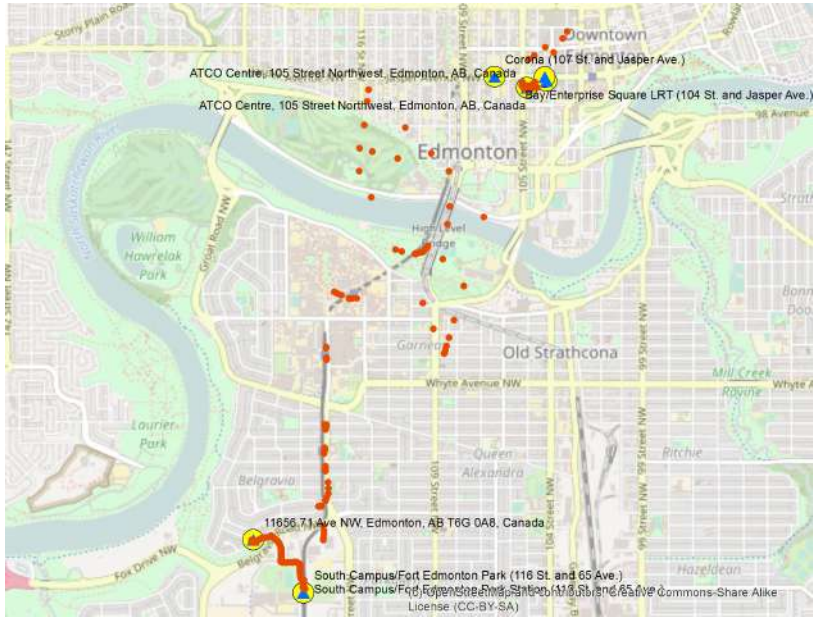


IV

Extracting Key Elements from Data: Assessment

Representative examples of errors

- Inattentive users and inconsistent GPS data;
  - Lost GPS signal or smartphone app crash; App turn-off ; Infrequent GPS reporting; GPS data duplicated; Waited long enough at transfer to record as extra stop; GPS emitting erroneous trips



Error example 1: Scattered path

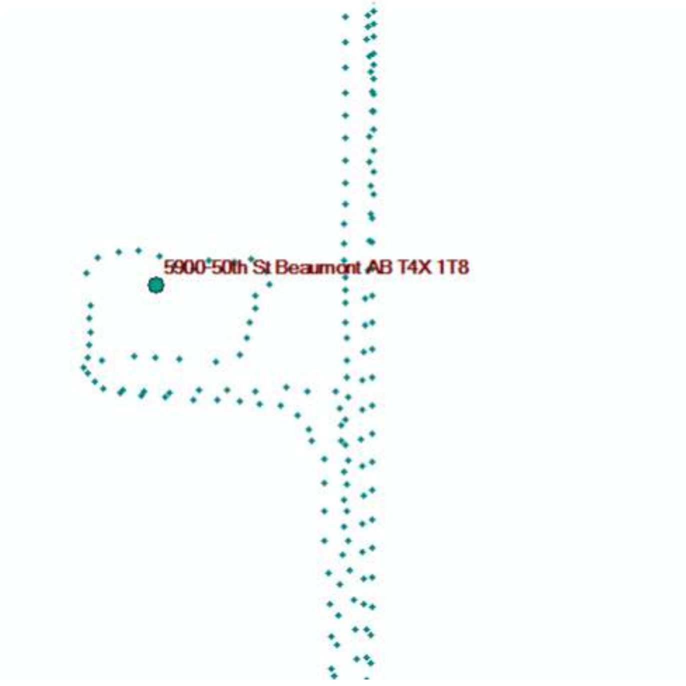
Error example 2: Lost GPS signal

IV

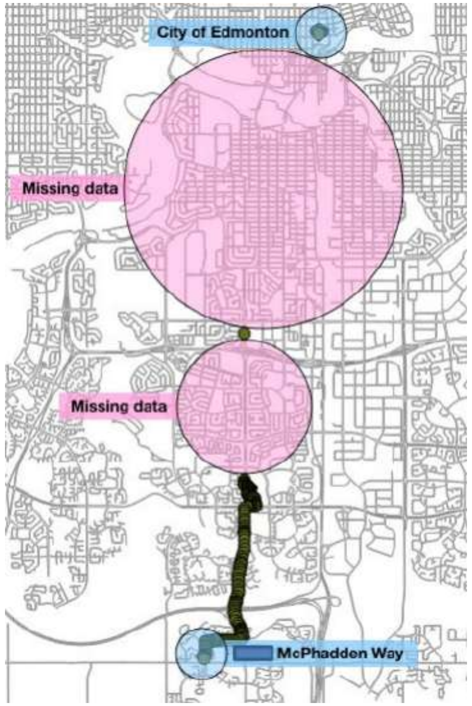
Extracting Key Elements from Data: Assessment

Representative examples of errors

- Entry to tunnels;
- Travel by LRT;
- When travel includes “drive-thrus”.



Error example 3: Drive-thrus



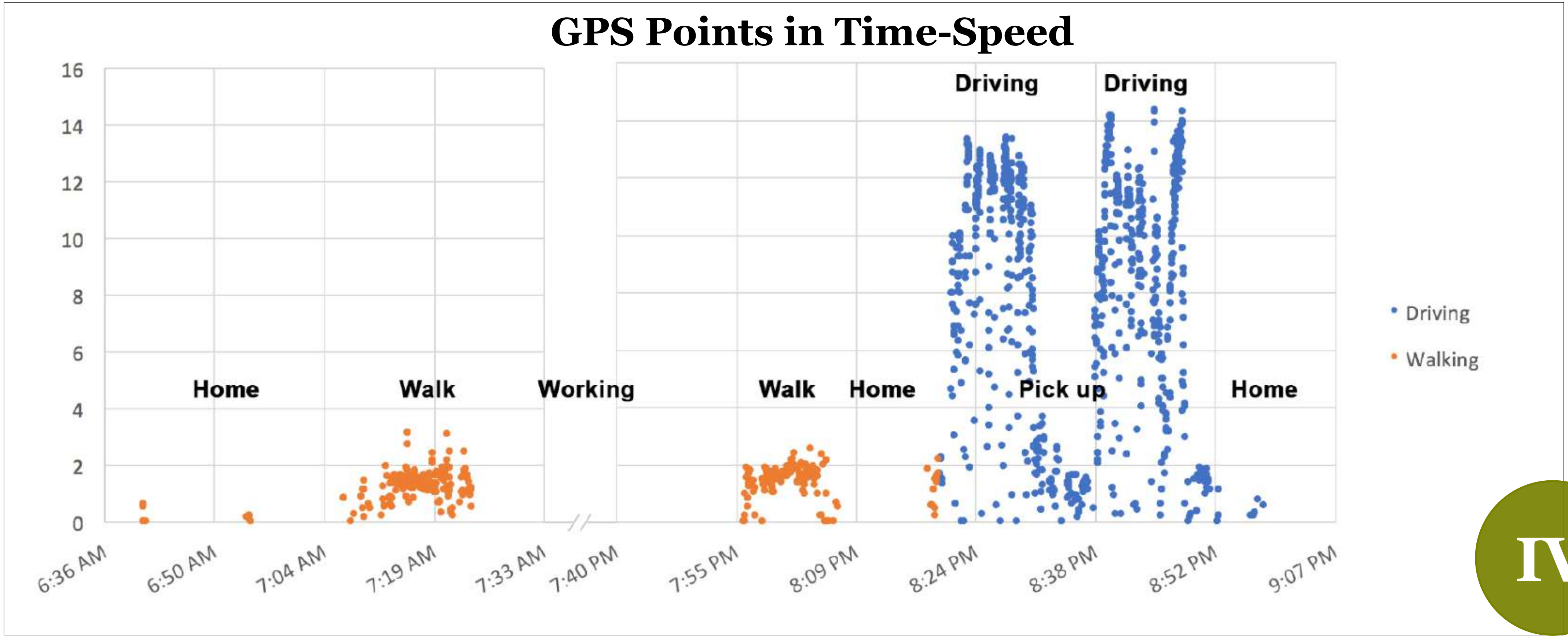
Error example 4: Travel by LRT

IV

Extracting Key Elements from Data

Criteria 1: Low speed + dwell-time threshold

- We consider a series of points below the speed threshold is a stop which potential to be an activity



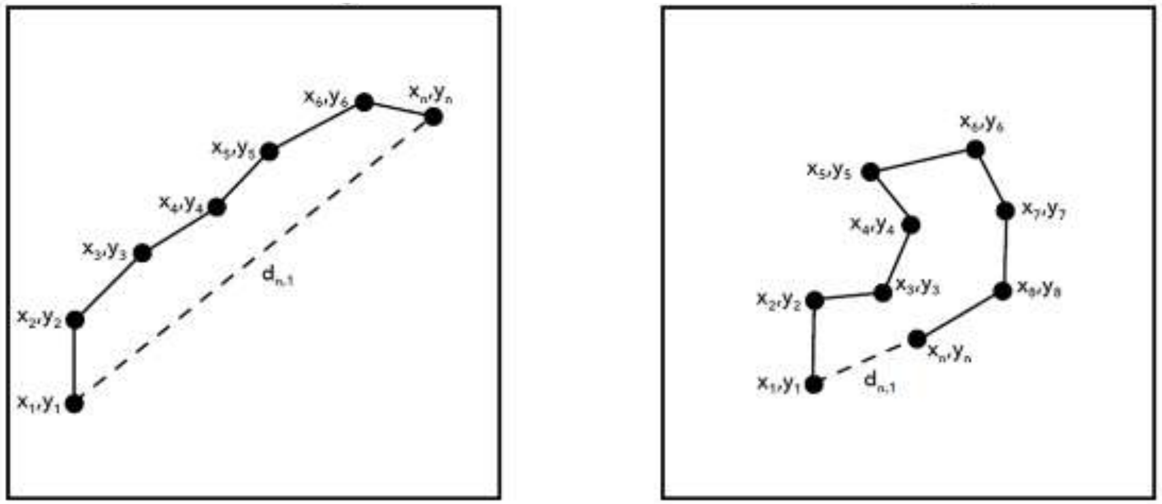
IV

Extracting Key Elements from Data

Criteria 2: Circuitous trajectories

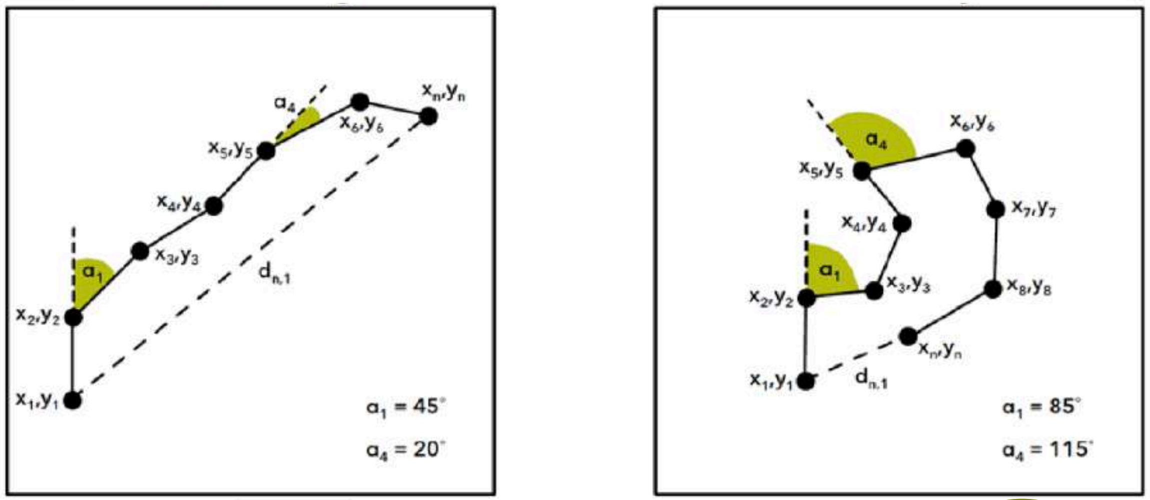
- Ratio of cumulative travel distance to Euclidean distance between start point and end point
- Cumulative deviation in bearing

Traveling Activity



1: Distance

Traveling Activity



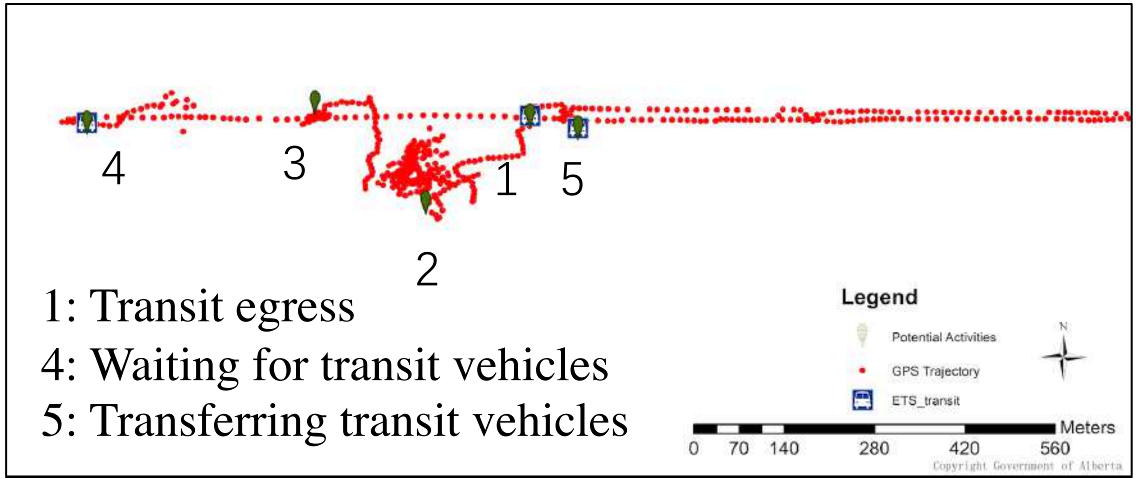
2: Bearing

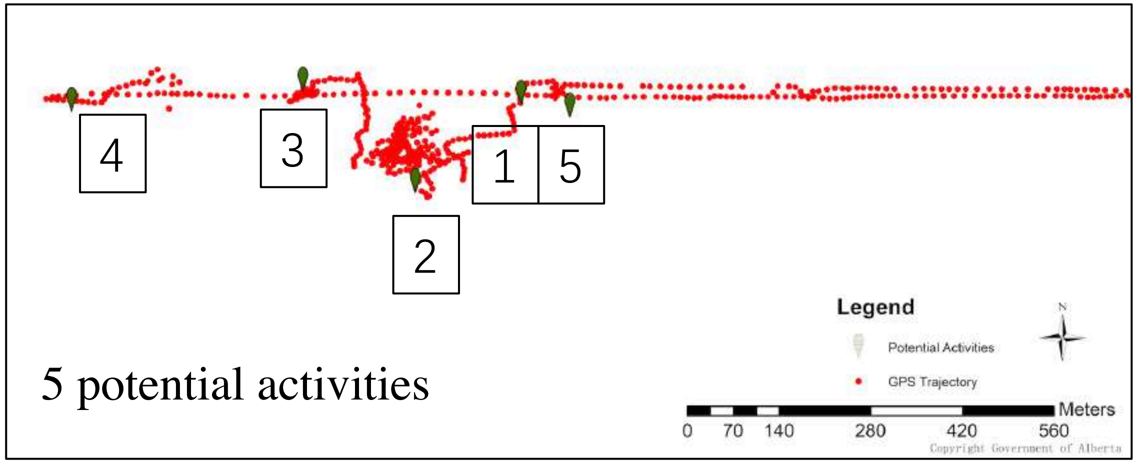
IV

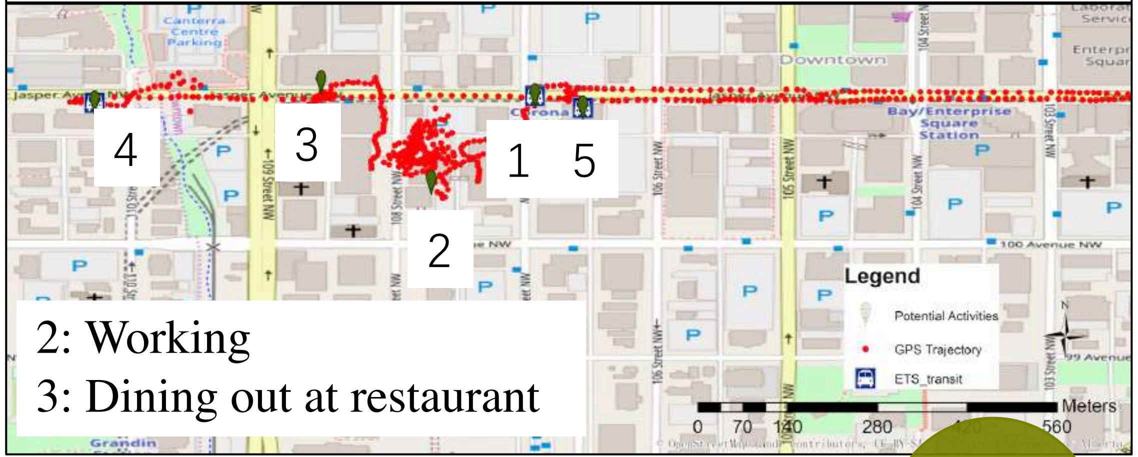
Extracting Key Elements from Data

Criteria 3: Spatial indication of activities

- Distance from the roadway network
- Land use map matching



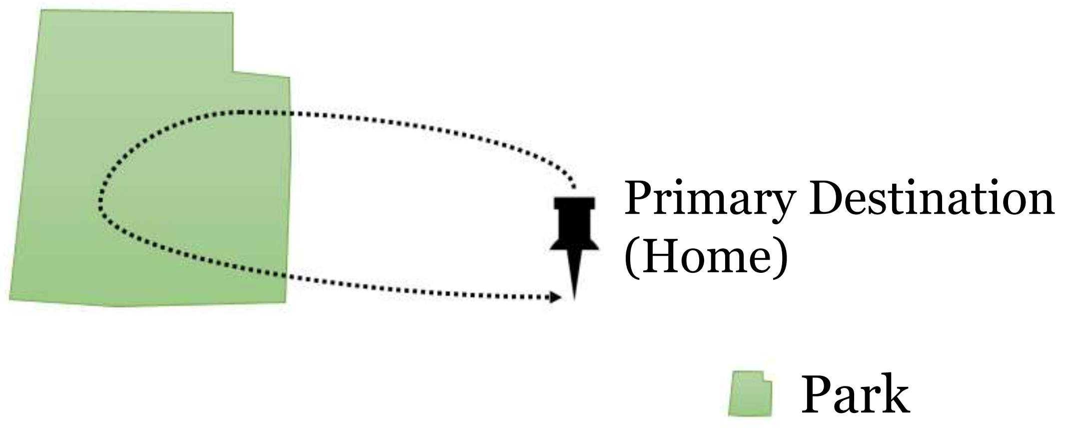




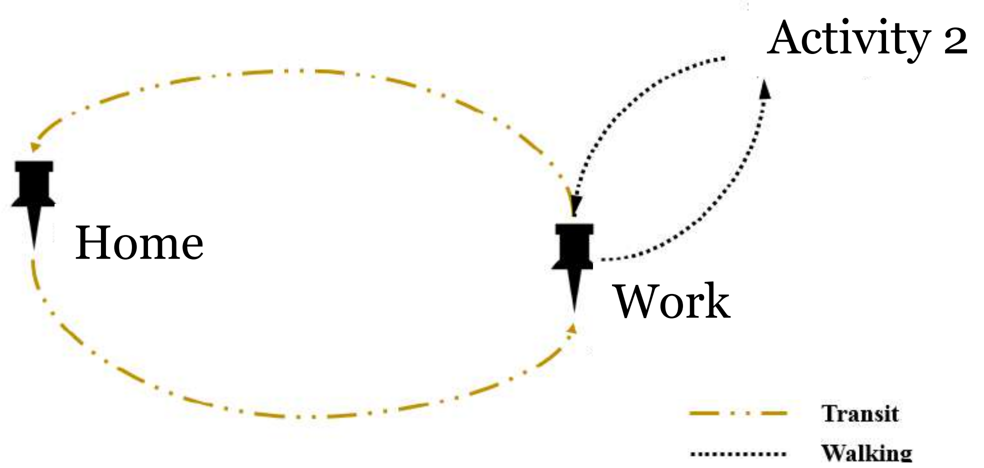
IV

Pedestrian Tour: Typology and Complexity

- **Typology (Purpose & Access Mode)**
  - Recreational and Utilitarian
  - Unimodal and Multimodal (access modes)



Recreational Pedestrian Tour-Unimodal



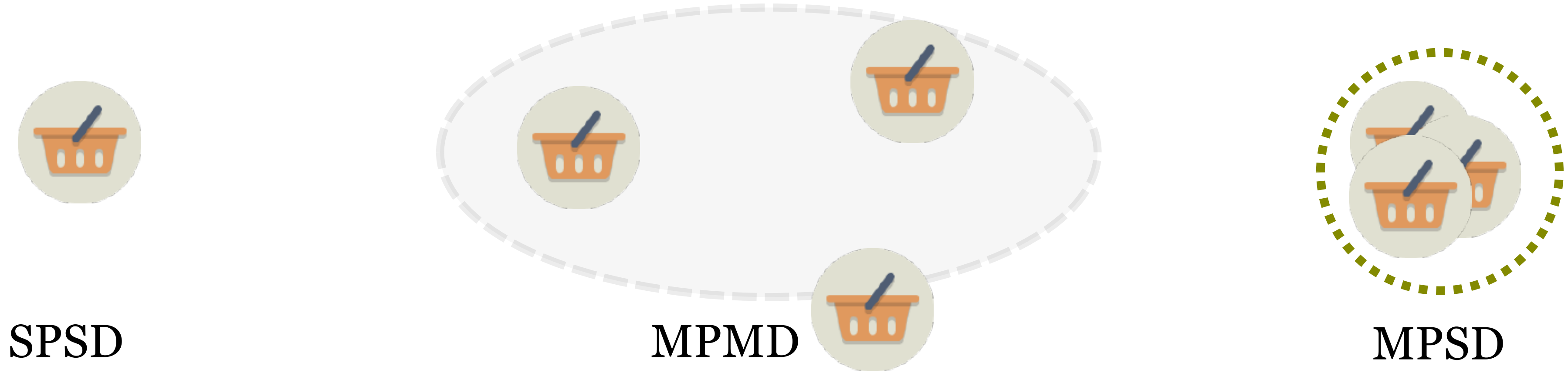
Utilitarian Pedestrian Tour-Multimodal

Pedestrian Tour: Typology and Complexity

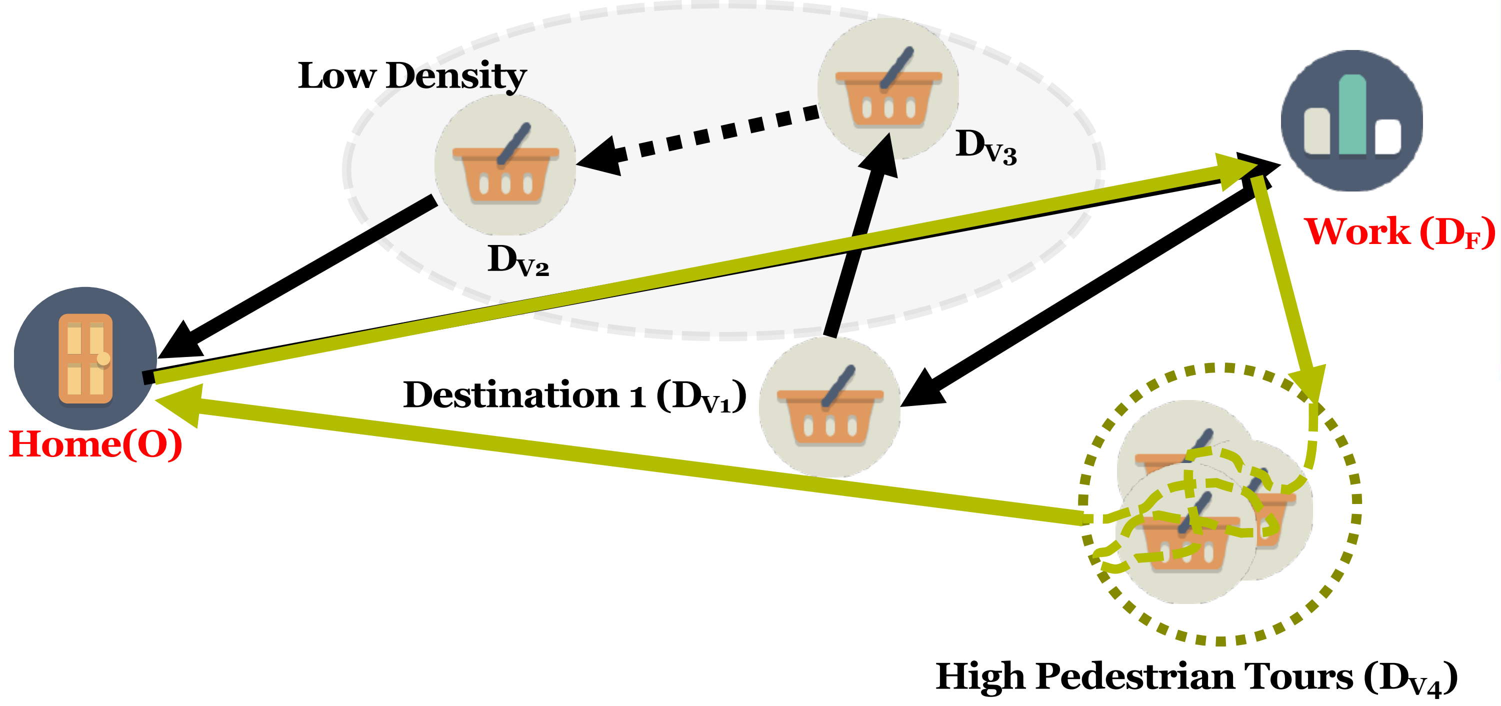
- **Complexity (Distribution of destinations, # of activities)**

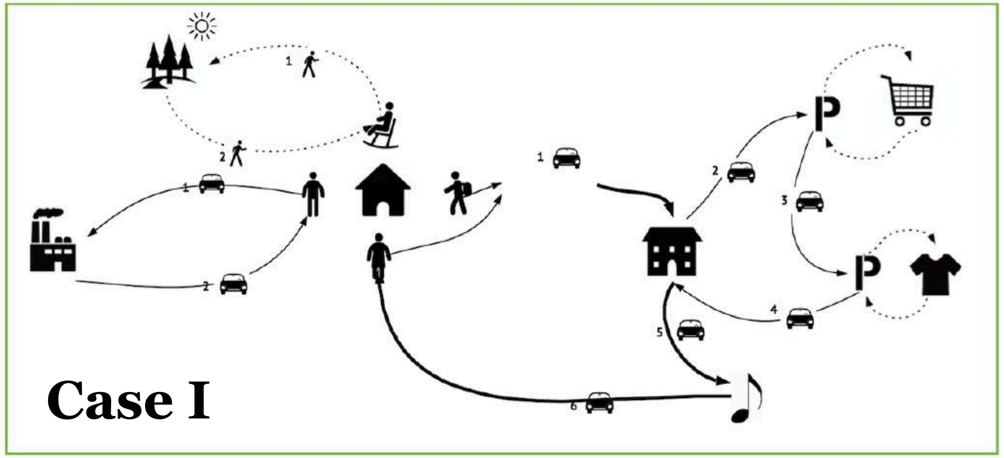
	Single Purpose	Multiple Purposes
Single Destination	✓	✓
Multiple Destinations	**NA**	✓

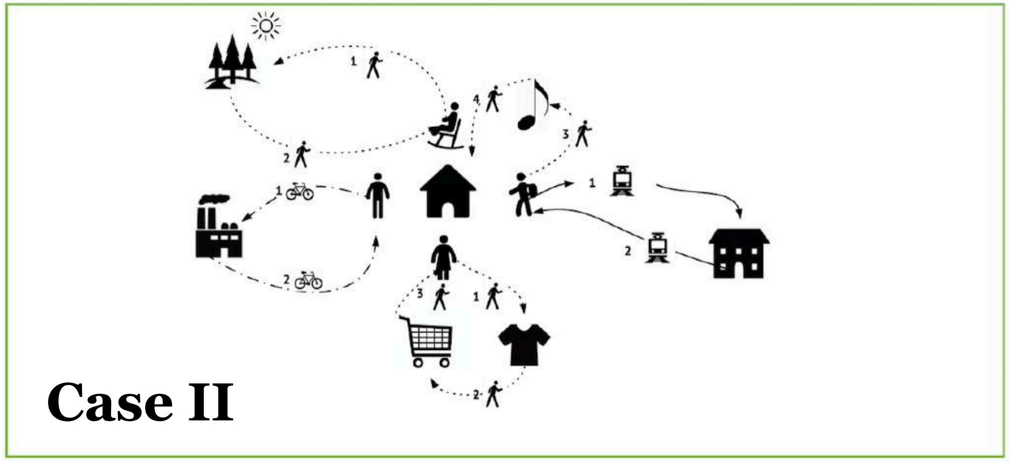
(Ho & Mulley, 2013)



Pedestrian Tour: Travel Cost







Case 1 —— (black line)
Case 2 —— (green line)

Case 1 Total Cost = $\sum TT + \sum AT = OD_F + D_F D_{V1} + AT_1 + D_{V1} D_{V3} + \ldots$

Case 2 Total Cost = $\sum TT + \sum AT = OD_F + D_F D_{V4} + AT_4 + D_{V4} O$

$$\text{Maximize HUF} = H(u_1, u_2)$$

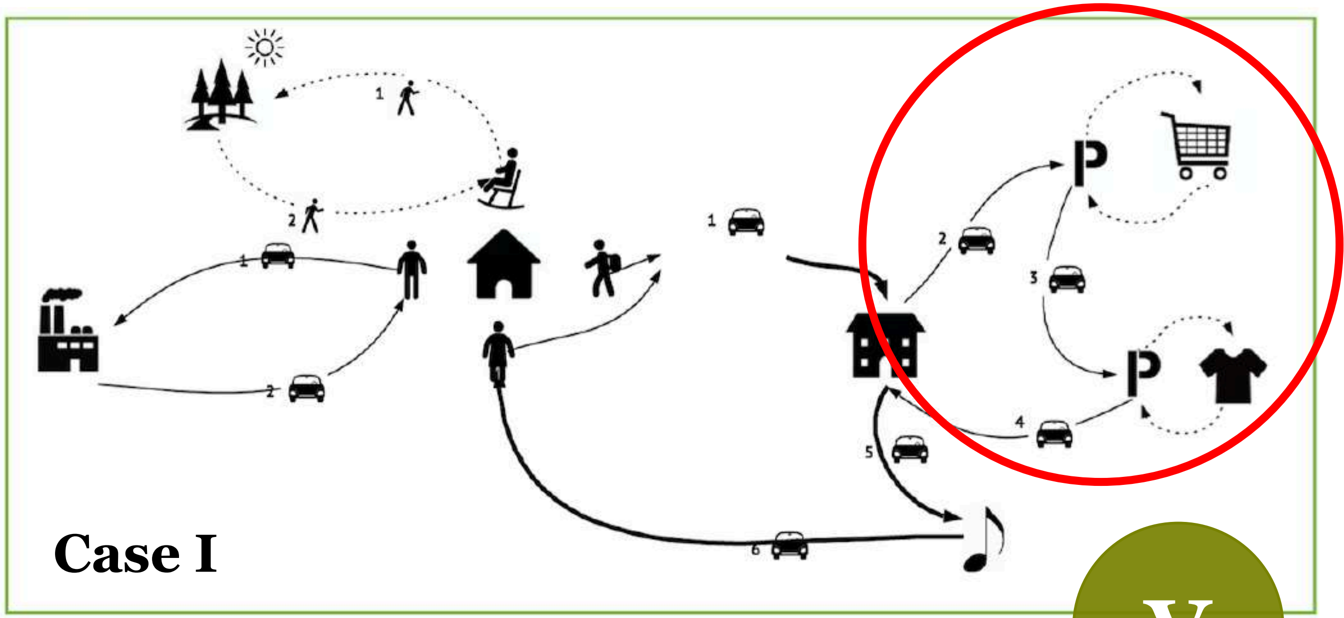
Choose **pedestrian tour's utility > auto tour's utility**

V

Pedestrian Tour: Common Observation

1. Auto → Short Pedestrian Tour → Auto → Short Pedestrian Tour → Auto

Multiple errands run with long auto trips followed by short pedestrian tours – parking lot to the store, back to the vehicle. Common in suburban areas.



V

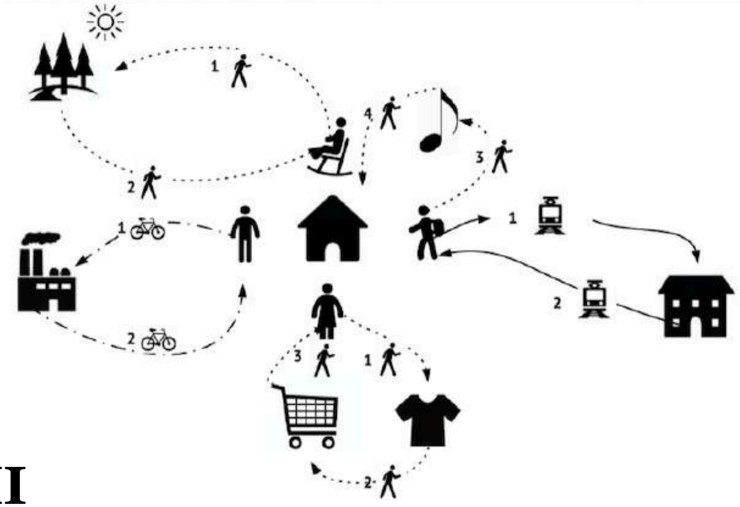
Pedestrian Tour: Common Observation

2. Transit → Long Pedestrian Tour → Transit

Transit access from suburban areas to downtown; long pedestrian tour

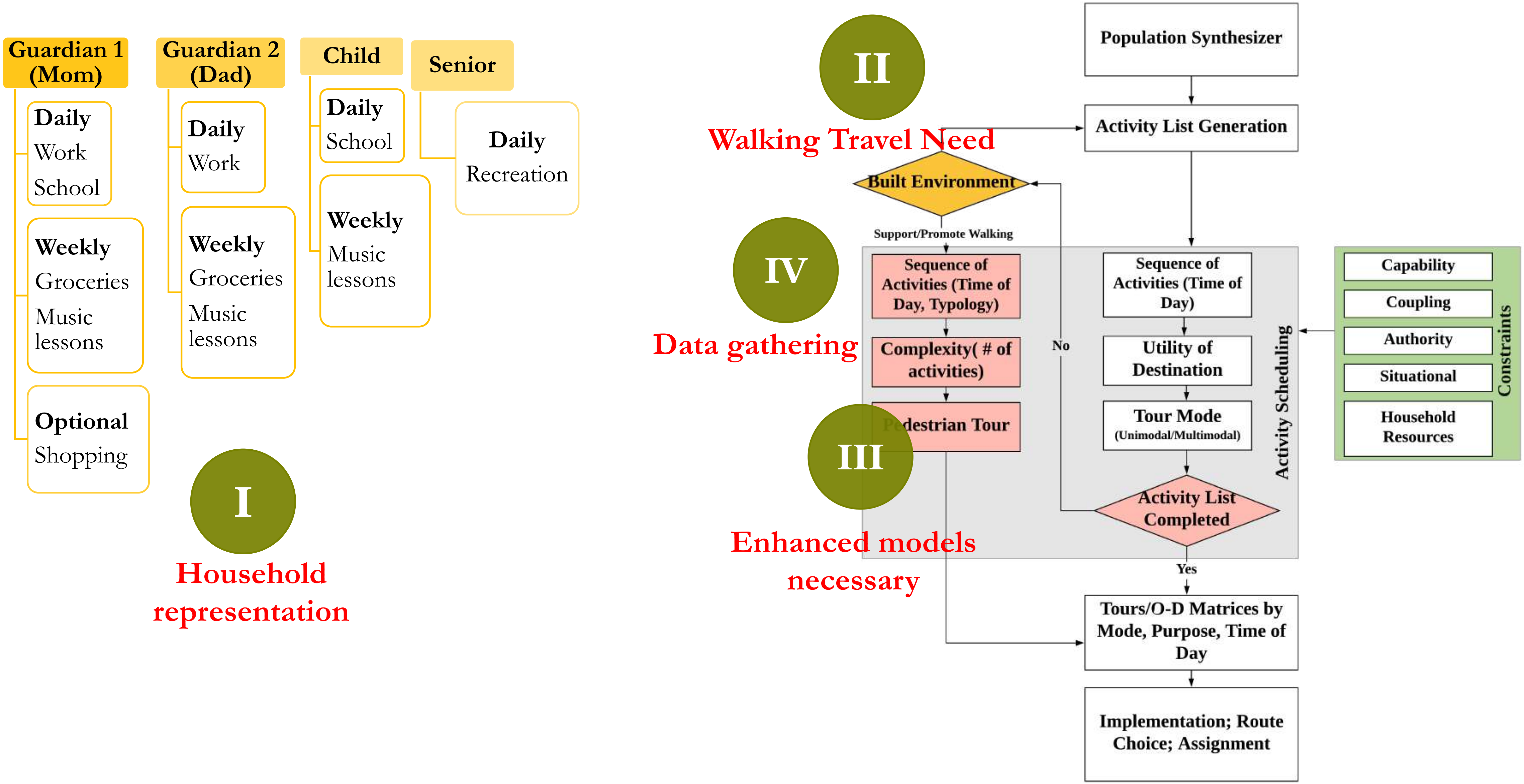
3. Auto → Long Pedestrian Tour → Auto

Auto access to parking – at destination in suburban areas, adjacent to core downtown area; long pedestrian tour accomplishing multiple activities.



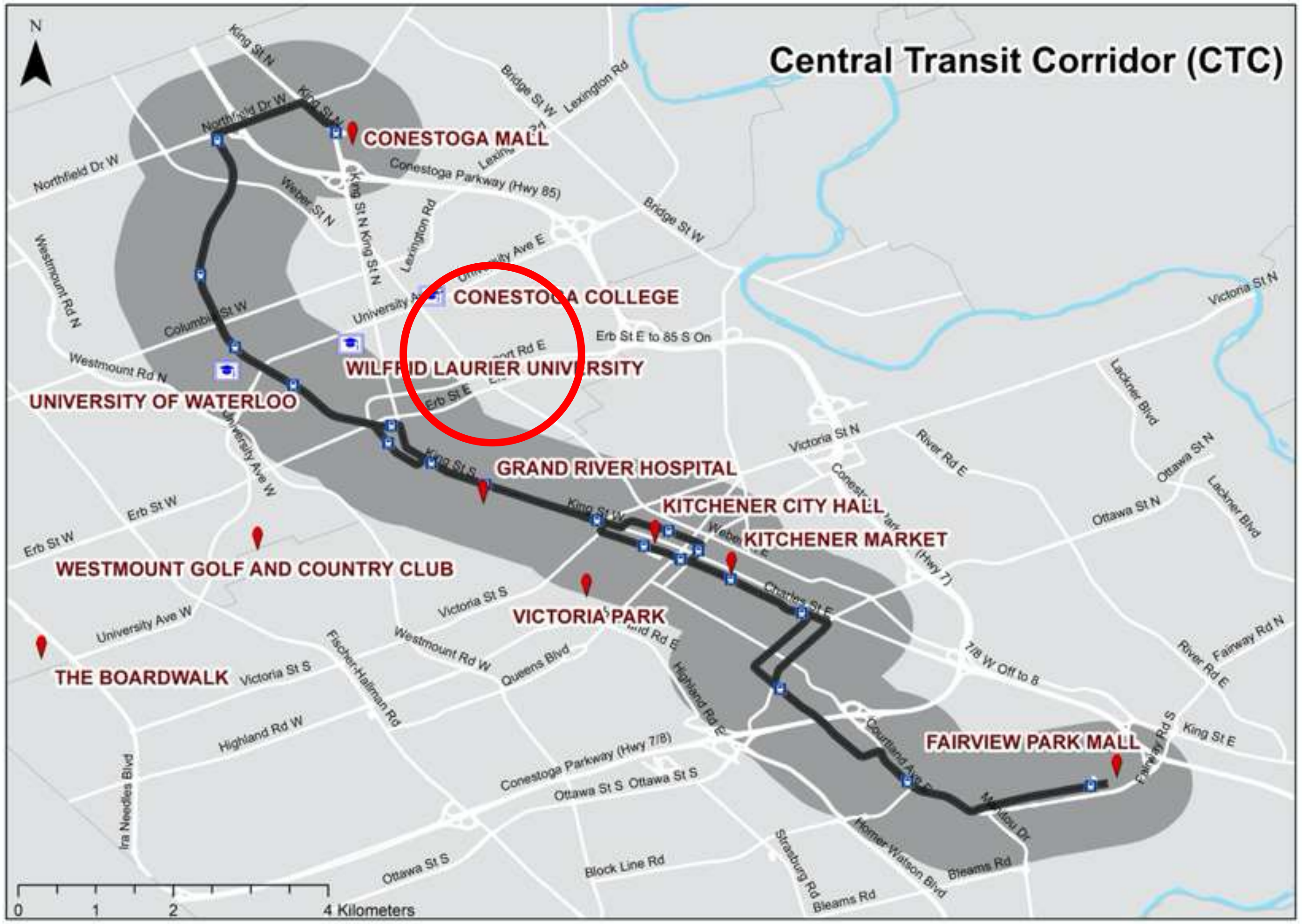
Case II

Pedestrian Tour: in Activity-based Model



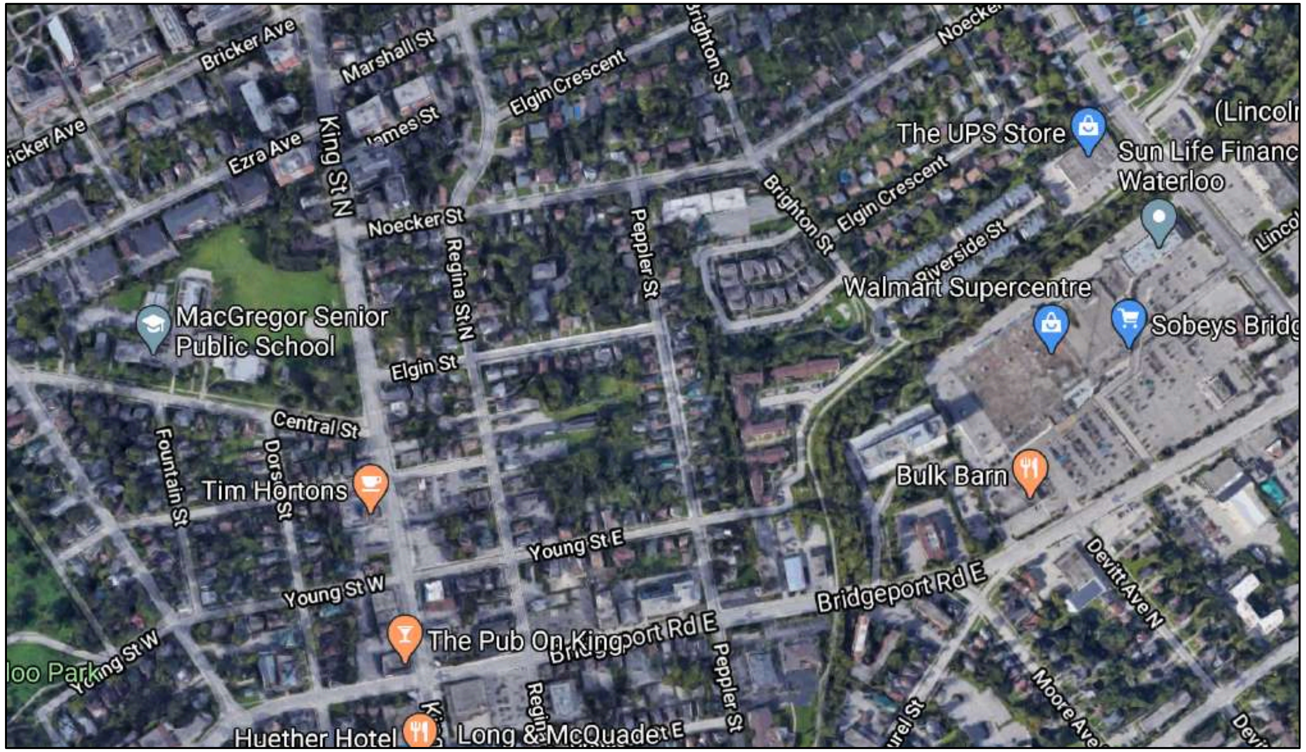
Future Study

- **Recruitment**
  - Neighborhood Associations
  - Local businesses (BIA)
  - Organizations (TravelWise)
- **Method**
  - Meetings
  - Flyers, posters
  - Face-to-face
  - Social media
- **Incentives**
  - Amazon Gift Card or EasyGO Card
  - Portable phone charger



Future Study

- **Dynamic Activity Zone**
  - Through a multi criteria approach, homogenous adjacent segments are merged and create an Activity-Cluster Zone. (Fard and Casello, 2019, Ongoing project)



Data provided by Municipal Property Assessment Corporation

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WPTI
https://uwaterloo.ca/waterloo-public-transportation-initiative/

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Thank you!

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