Time Geography for Activity Modeling with GPS Tracking Data

GPS Tracking and Time-Geography Applications for Activity Modeling and Microsimulation – FHWA-sponsored Peer Exchange and CSISS Specialist Meeting
Santa Barbara, CA October 10-11, 2005

Shih-Lung Shaw
Professor, Department of Geography
University of Tennessee
Knoxville, TN, USA
Email: sshaw@utk.edu

Acknowledgment: Hongbo Yu, Geography, Oklahoma State University
Activity Modeling and GPS Tracking Data:

- GPS tracking data provide useful information of *where* and *when* people or vehicles are located.

- GPS data *per se* do not indicate *who*, *what* and *why* people and vehicles are at particular locations at certain times.

- In other words, GPS helps collect data of *movements* rather than *activities*. 
For activity modeling, it is also important to collect and/or derive additional information such as:
- individual/household characteristics
- activities and opportunities
- constraints/interdependency of scheduling/performing activities, among others

Furthermore, information and communications technologies (ICT) have permitted people to expand their activities from physical space (e.g., shopping trips) to virtual space (e-shopping).
- Research has speculated that ICT could lead to important changes in human activity/travel patterns.
Therefore, it is important to ask questions such as:

- What GPS data can and cannot tell us?
- What kinds of information can we derive from the raw GPS tracking data using other technologies such as geographic information systems (GIS)?
Time geography is suggested as one of the origins of activity-based approaches (McNally 2000, Jones 2003).

With dense GPS tracking data, time-geographic concepts such as space-time path and space-time prism can be examined at finer spatial and temporal resolution levels.
Although time geography offers an elegant conceptual framework for studying individual activities under different constraints in a space-time context, performing *measurements* and *analyses* under the time-geographic framework can be challenging. For example,

- how can we analyze interactions among numerous space-time paths derived from GPS tracking data?
- How can we measure and identify spatiotemporal clusters among the space-time paths?
Representation of Individual Activities in GIS:

- Create 3D spatio-temporal features \((x, y, t)\)
- Represent individual activities on a space-time path using *spatio-temporal dynamic segmentation*

**Physical activities:**
1. Drive to work
2. Grocery shopping
3. Have lunch
4. Drive back home
5. Receive a cell phone call from spouse to do grocery shopping
6. Grocery shopping
7. Return home

**Virtual activities:**
2. Instant messaging with colleagues
Exploratory Analysis of ST Relationships:

- Locate time for point A on the ST path.
- Find locations of ST paths at time T.
- Find ST paths visiting location L.
- Find ST paths interacting with person P.
This form shows the result of spatio-temporal query. Select one major query person from the dropdown list and select a related person from the other list which comprises of every person who has co-existence relationship with the query person. Temporal information of this person with the query person is listed in the box below.

Primary Query Person List:

- G5 A1

Related Person List:

- G5 A2

Co-existence of G5 A1 with G5 A2:

- G5 A1 met G5 A2 at 15:20:30
- G5 A1 has stationary bundle relationship with G5 A2 from 16:00:00 to 17:45:00 for 54 min(s)

Click on one of the records in the list to find out what was going on for G5 A1 at the moment.

- playing tennis

Save the results to a DBF file:

C:\\\\Show\\New-UT\\Courses\\Thesis\\Hongbo\Yu\\Defense\\Demo\\Output_table.dbf
This form shows the result of spatio-temporal query. Select one location from the location dropdown list and select a person from the person list which comprises every person who has either stayed at or passed the location. Temporal information of the person at the location is listed in the box below.

### Location List:
- Geography

### Person List:
- Show all results

### All person(s) at Location: Geography
- GS A stayed at Geography from 09:00:00 to 14:20:00 for 5 hours
- GS A3 stayed at Geography from 07:00:00 to 09:00:00 for 2 hours
- GS B stayed at Geography from 16:50:00 to 17:00:00 for 10 minutes
- GS B stayed at Geography from 09:02:00 to 08:03:00 for 1 minute
- ST F stayed at Geography from 16:00:00 to 12:03:00 for 65 minutes

Total 9 entries
Co-existence

Co-location in space

Co-location in time

No co-location in either space or time
Network-based space-time prism

forward cone

backward cone

Space-time prism

origin

destination

Network-based space-time prism
Thank You!

Comments & Questions ...