

**MUSCAMAGS**  
**Multi-Scale Geo-Simulation**  
**based on Software Agents**

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**Objective: To develop a methodology and a software platform to create multi-scale multi-agent geo-simulations to support operational decision support systems for Multi-Actor Dynamic Spatial Situations (MADSS)**

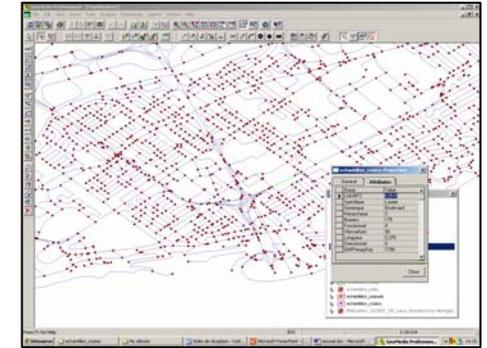
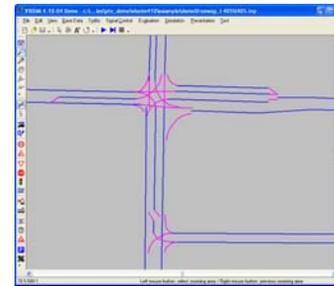
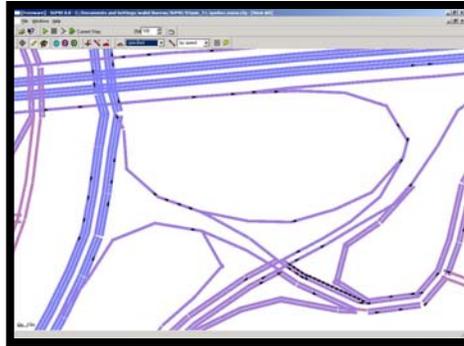
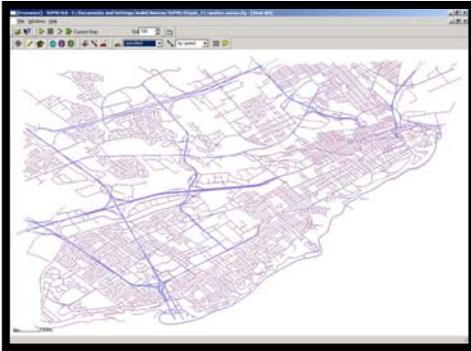
**MADSSs** involve a large number of actors of different types (human, animal, etc.) acting in geographic spaces of various extents

MADSSs need to be monitored to insure :

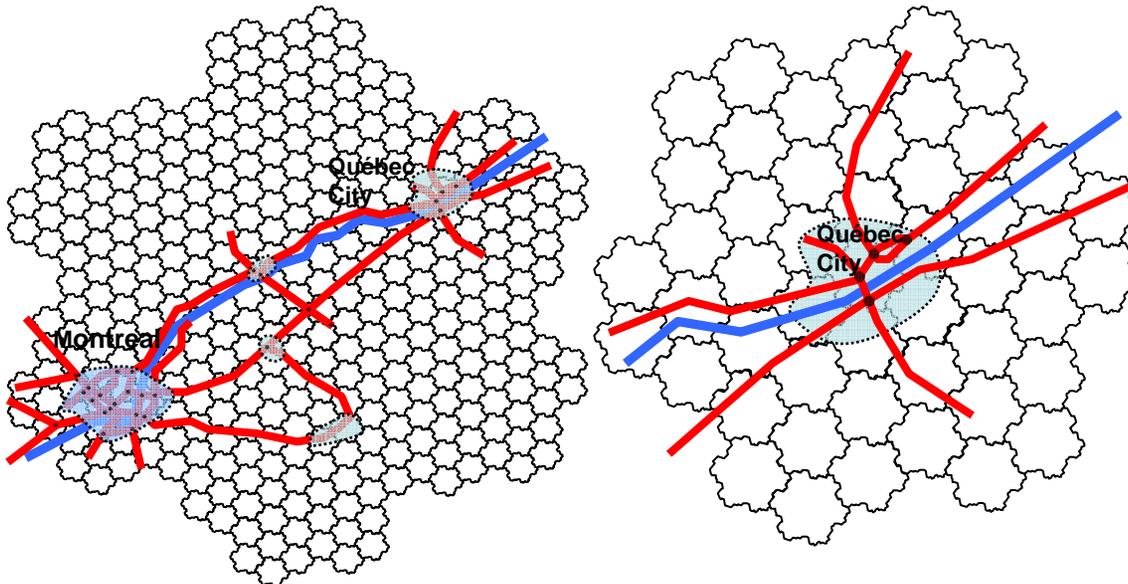
- *human security and equipment preservation* (flood, wildfire, oil slicks),
  - *the respect of public order* (population evacuation, crowd monitoring and control, peace-keeping, etc.)
  - *the adequate use of infrastructures* (monitoring of people and households transportation and shopping habits in a urban area to better plan transportation infrastructures, location of services' and retailers, etc.)
  - *Impact of emergency response plans*
- 
- Certain MADSSs occur on a regular basis (ex. daily traffic patterns in a urban area) whereas other MADSSs can evolve rapidly as a consequence of the occurrence of particular events and/or changes in individual behaviors (often in crisis situations)
  - Certain MADSSs occur within the context of another MADSS of larger extent
  - Decision makers need an overall understanding of the situation to monitor its evolution, to develop strategies to adequately intervene, to develop and compare alternative intervention scenarios and to anticipate the consequences of these interventions.
  - We intend to use a multi-agent geo-simulation approach to simulate at different (spatio-temporal) scales different interacting MADSSs in order to support the decision making process

## Preliminary ideas to create a multiscale environment

**Current Approaches:** Current multi-scale simulations are done for traffic simulations based on different spatial models at the macro, meso and micro level. Problems related to the detection of incoherencies between heterogeneous models



**Our Goal:** To develop a unique geographic environment that can be used at different scales, integrating different levels of detail for areas as well as for transportation networks.



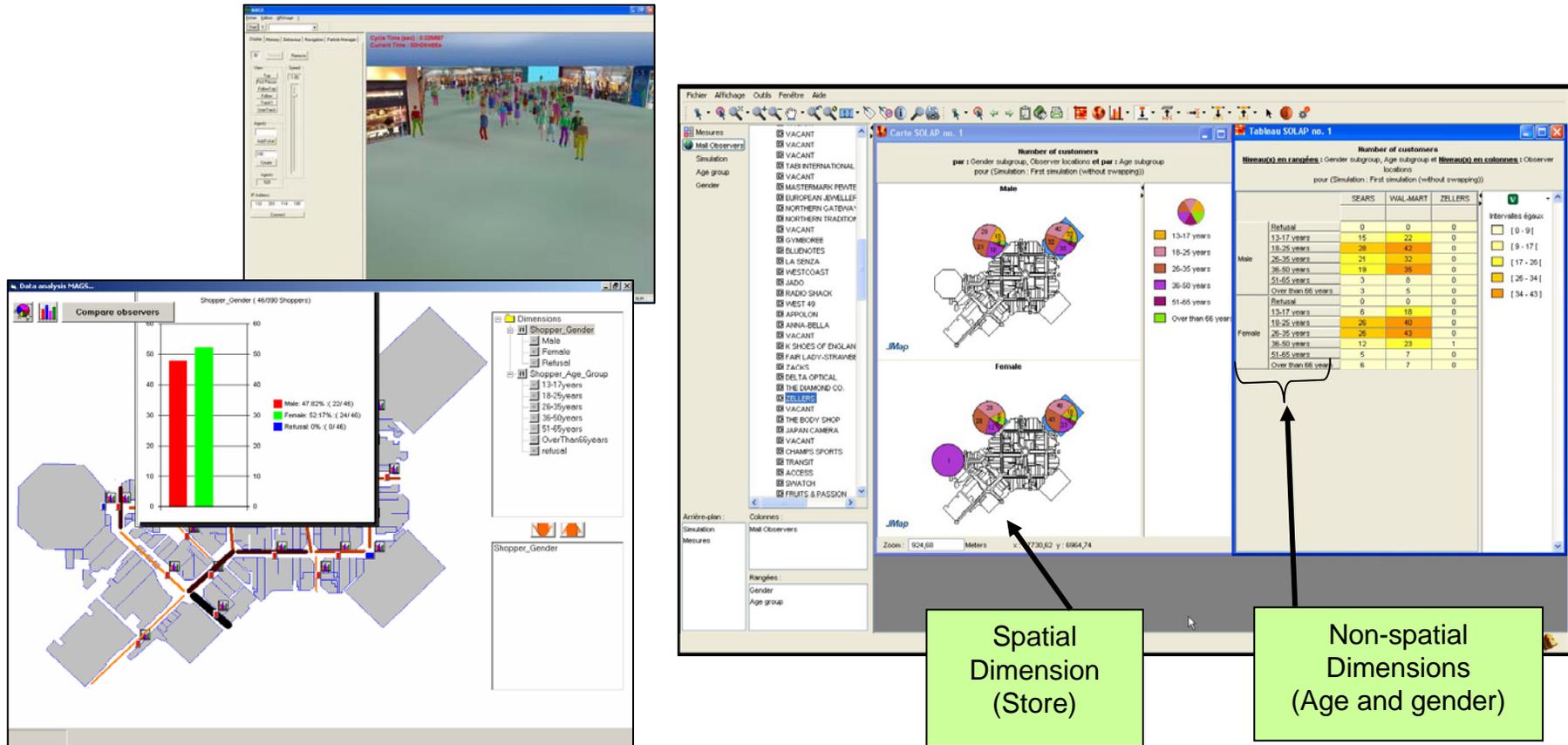
### **Current work:**

Find the most appropriate data structures to create our multi-scale virtual geographic environment

## Methods to analyse input and output data

**Current work:** Exploration of different approaches to analyse data (Multi-nomial regression for the OD survey, spatial OLAP approaches to explore the outputs of the simulations, spatial traces). Further investigations are needed to identify the more appropriate analysis techniques, depending on the types of data to analyse. Given the huge amount of data that may be obtained from simulations, we are also considering using spatial data mining techniques

**Observer agents:** Observer agents are created in the simulation environment to gather the appropriate data from the agents and the virtual environment for analysis purposes

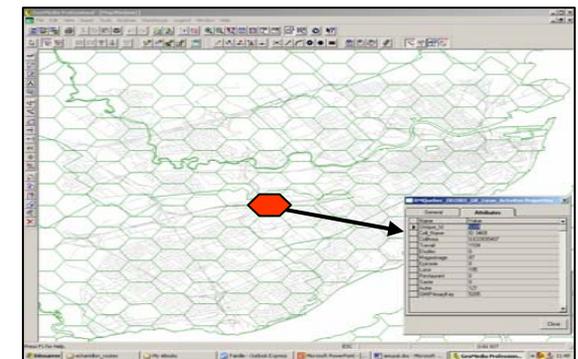
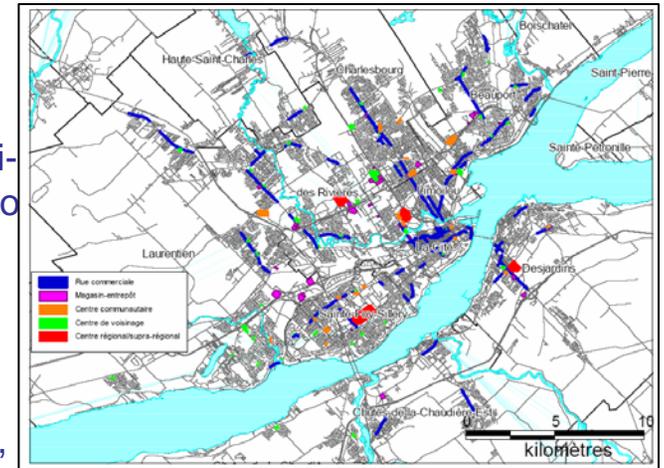


# Creation of a synthetic population

**Current work:** Compilation of Quebec city's 2001 *Origin Destination survey* to identify the characteristics of the sample population (MNL: multinomial logitics). Households and individuals are created and assigned to residence places in the hexagonal grid . We are able to demonstrate the representativity of the synthetic population with respect to the OD survey sample

**Work in progress:** We assign to each grid cell the percentages of the different types of activities that may be done in it (work, leisure, shopping, health care activities) based on the real locations of the different organizations obtained from various data sources. We also use the MNL approach to identify for each individual (according to its characteristics: gender, profession, etc.) its workplace, its preferred shopping places (malls, shops, etc.), its preferred leisure places, health care places. We will also determine for each individual the preferred routes to go to its preferred places, using TransCad route determination facilities.

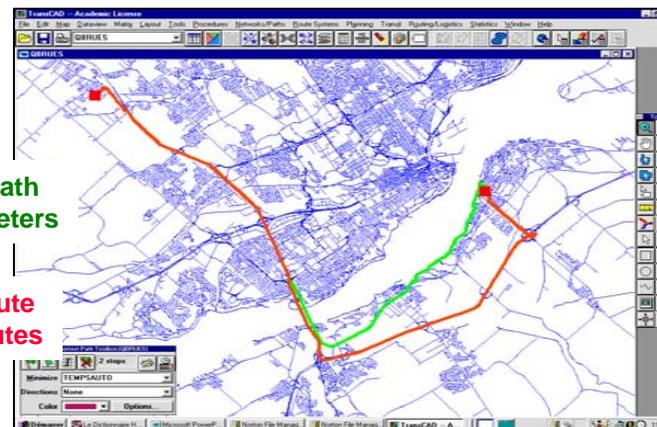
**Future works:** After the creation of the synthetic population, we will be able to start the first simulations of people displacements in the Greater Quebec urban area (Week-day car traffic MADDs)



MENAGE	Coast %	NOMBRE TOTAL D'ENFANTS								TOTAL			
		0	1	2	3	4	5	6	7		8		
1	6441	100,0											6441
2	1869	100,0											1869
3	1910	100,0	1	506	707	228	40	20	7				1910
4	3240	100,0	0,1	33,5	46,8	13,1	2,6	1,3	0,5			0,1	3240
5	4906	100,0	17,97	24,22	6,34	10,2	10			1			4906
6	3075	100,0	35,4	49,4	12,9	2,1	0,2			0,0			3075
7	123	100,0		67	44	9	3						123
8	1194	100,0		54,5	35,8	7,3	2,4						1194
9	502	100,0		59,1	32,3	6,8	1,6	0,1					502
10	182	100,0		51	43	5	3						182
11	1085	100,0		50,0	42,2	4,9	2,9						1085
12	230	100,0		161	55	10	2	1			1		230
13	2573	100,0		70,0	23,9	4,3	0,9	0,4		0,4			2573
14	979	100,0		257,3	70,0	21,3	4,8	1,3	3	1		1	979
TOTAL	27839	100,0	18806	3922	3867	1015	182	35	8	2	2	0,1	27839
			67,6	14,1	13,9	3,6	0,7	0,1	0,0	0,0	0,0	0,0	

Shortest path  
43.1 kilometers

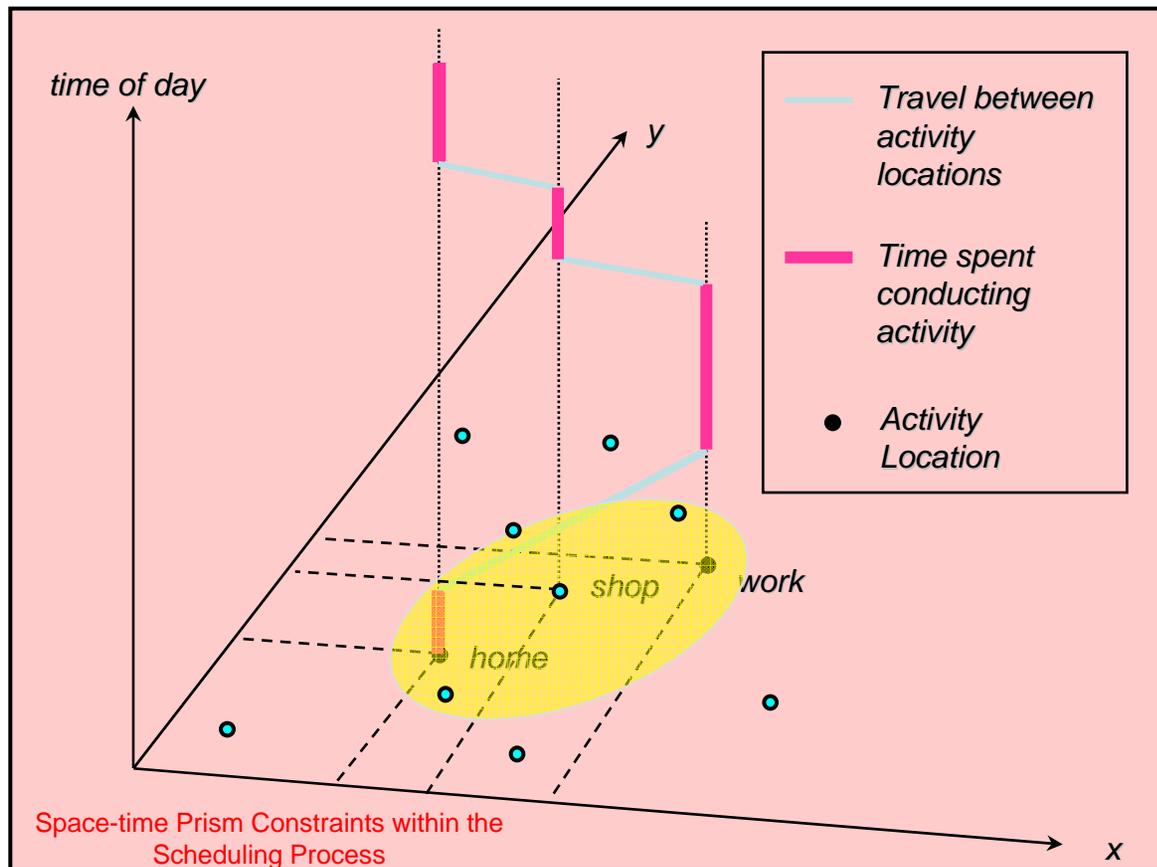
Fastest route  
34.25 minutes



# Towards more sophisticated behavioral models for synthetic populations

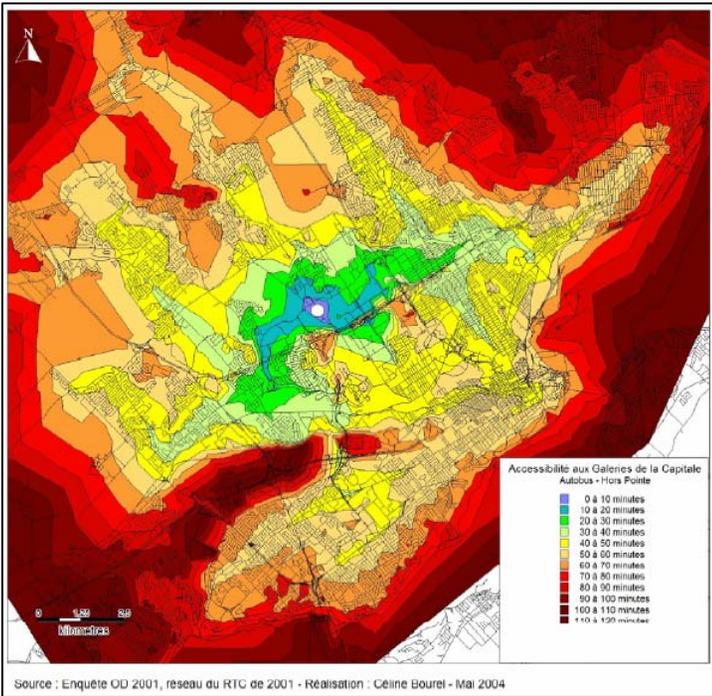
**Motivation:** The OD survey has limitations (the interviews are done with one individual per household for the activities of all members during one week day, we do not know what was intended, information about displacements are limited, etc.). Hence, the models that we will get will lack details about the decision making process and activity scheduling done by individuals. Such information can be obtained from more detailed panel surveys which were done by the PROCESSUS Network in 2002-04

**Goals:** 1) Find an adequate model for constrained activity scheduling, 2) Find an adequate model for constrained destination choice, 3) Develop these models from appropriate data surveys (panel surveys done by the PROCESSUS Network), 4) Derive from these models the corresponding agent's behavior models



## Work in progress:

- 1) Work with an approach based on a Prism Constrained Scheduling Process;
- 2) Assess the available data from the Panel surveys,
- 3) Calibrate the activity pre-planning choice rules,
- 4) Refine the space-time prism algorithm (Constrained destination choice sets for more in-day and impulsive activities, Minimum assumed participation time)



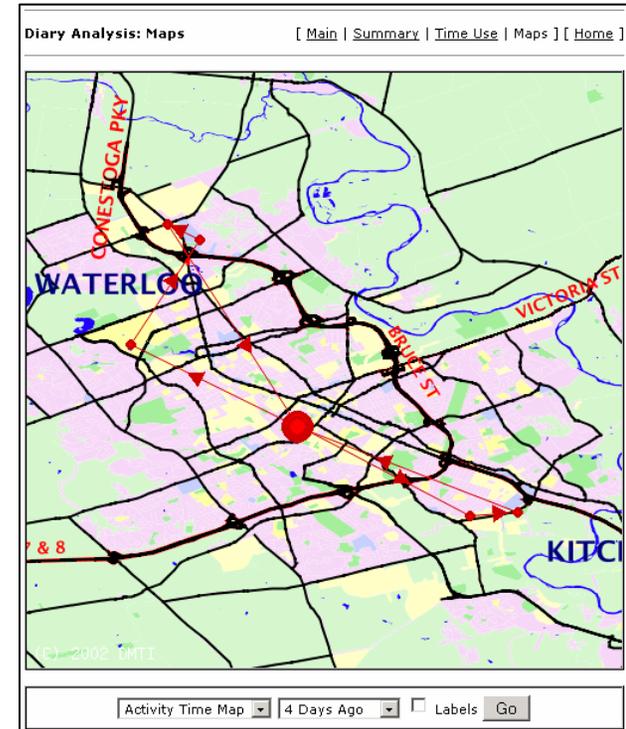
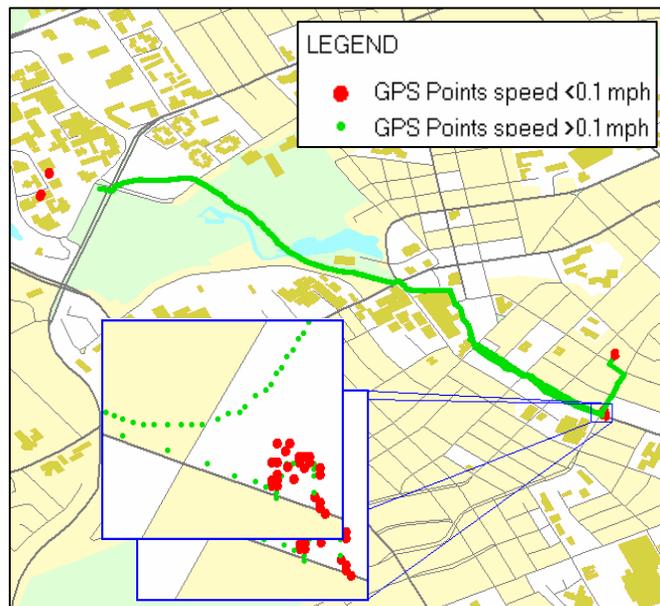
Accessibility maps using the transit bus system (case of Quebec Galleries de la capitale)

## Snapshots of some projects done with partners



BlackBerry with GPS Diary

Person-based Raw GPS Traces (home to work)



GPS Prompted Recall Diary (spatial summary)