Development of a MultiModal Travel Demand Module for the Regional Strategic Planning Model tool

Experience of contributing to the VisionEval project

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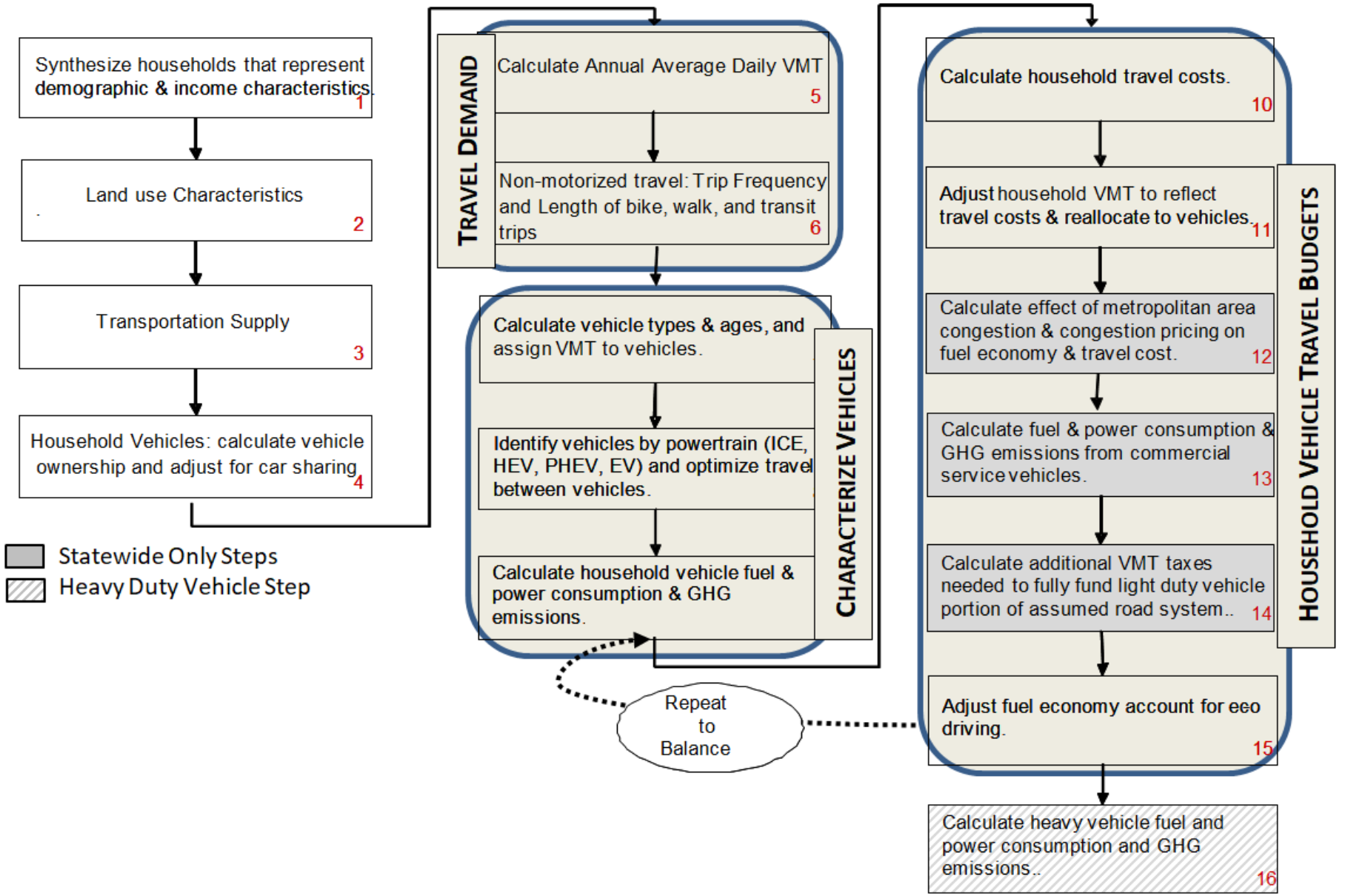
Outline

- The VETravelDemandMM module
- Innovations
- The process of contributing to VisionEval
- Reflections

The VETravelDemandMM module

- Started in 2015 as an Oregon DOT SPR project to better capture mode shifting for the Regional Strategic Planning Model (RSPM) tool to
  - Incorporate non-auto modes into a mode choice module for the RSPM tool;
  - Explore and utilize the best data sources available for model estimation;
  - Leverage this effort for additional research and expand the scope to include emerging modes (bike sharing, car sharing, shared automated vehicles).


Synthesize households that represent demographic & income characteristics. 1
Land use Characteristics 2
Transportation Supply 3
Household Vehicles: calculate vehicle ownership and adjust for car sharing 4
Statewide Only Steps
Heavy Duty Vehicle Step
TRAVEL DEMAND
Calculate Annual Average Daily VMT 5
Non-motorized travel: Trip Frequency and Length of bike, walk, and transit trips 6
CHARACTERIZE VEHICLES
Calculate vehicle types & ages, and assign VMT to vehicles.
Identify vehicles by powertrain (ICE, HEV, PHEV, EV) and optimize travel between vehicles.
Calculate household vehicle fuel & power consumption & GHG emissions.
Repeat to Balance
HOUSEHOLD VEHICLE TRAVEL BUDGETS
Calculate household travel costs. 10
Adjust household VMT to reflect travel costs & reallocate to vehicles. 11
Calculate effect of metropolitan area congestion & congestion pricing on fuel economy & travel cost. 12
Calculate fuel & power consumption & GHG emissions from commercial service vehicles. 13
Calculate additional VMT taxes needed to fully fund light duty vehicle portion of assumed road system.. 14
Adjust fuel economy account for eco driving. 15
Calculate heavy vehicle fuel and power consumption and GHG emissions.. 16

Progress

- Scope includes review of literature & data, model design and testing, and finally implementation
- The implementation was orginally planned for RSPM/GreenSTEP (ver 3.5)
- Modes/models included:
  - Annual Average Daily Vehicle Models Travelled (VMT) model
  - Transit trips (frequency and length) and Person Miles Travelled (PMT)
  - Biking trips and PMT
  - Walking trips and PMT
- Products (so far):
  - Project working papers and report deliverables
  - A poster presentation at the 2018 TRB annual meeting
  - A manuscript under review for publication at the Journal of Transport and Land Use
  - TRB ITM 2018

SPR Funded
Research Project Work Plan
for

Incorporate Travel Mode Choices in the Regional Strategic Planning Model (RSPM) Tool

SPR 788

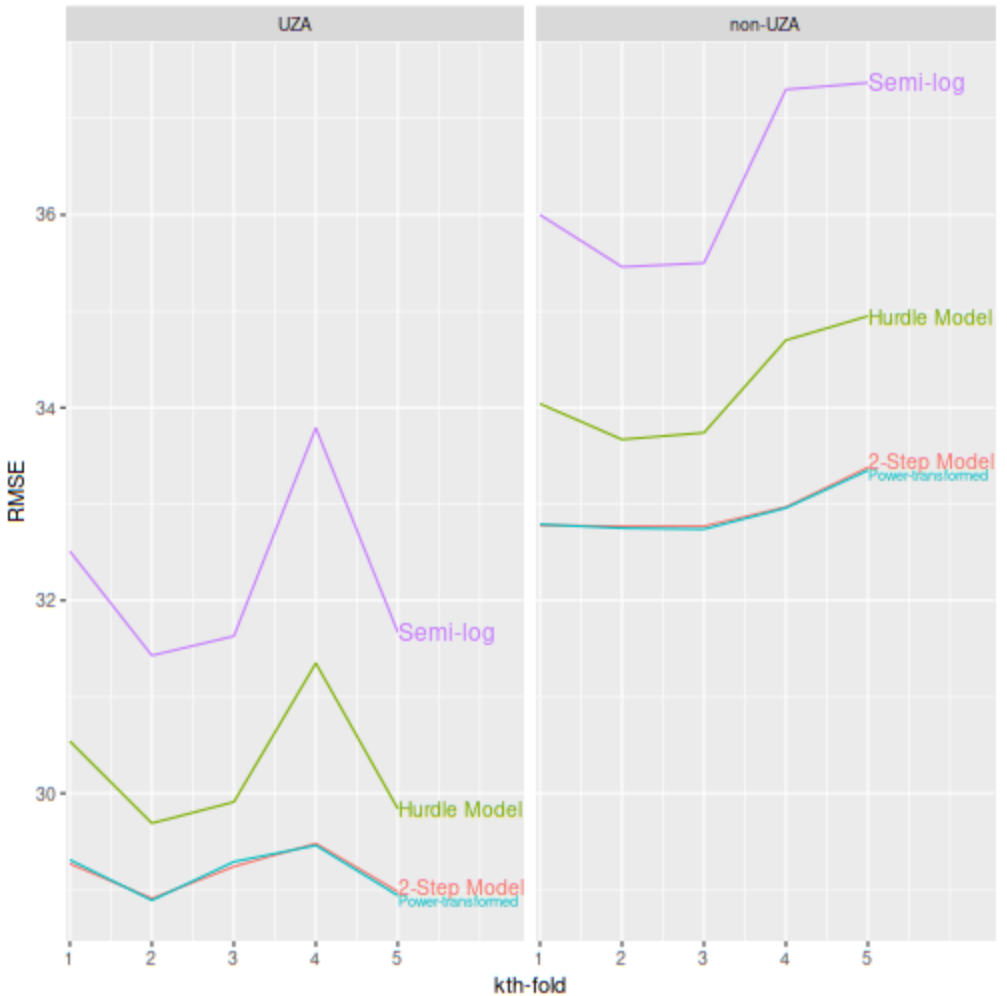
Project Tasks	FY16				FY17				FY18	
	Qtr 1 July - Sep	Qtr 2 Oct - Dec	Qtr 3 Jan - Mar	Qtr 4 Apr - Jun	Qtr 1 July - Sep	Qtr 2 Oct - Dec	Qtr 3 Jan - Mar	Qtr 4 Apr - Jun	Qtr 1 July - Sep	Qtr 2 Oct - Dec
Task 1: Literature review and data exploration		* T			*					
Task 2: Model design and estimation						*				
Task 3: Model Implementation						T	*			
Task 4: Mode testing								* T		
Task 5: Brian Gregor training, consultation and support for Tasks 2-4										
Task 6: Final Report								* T		
Task 7: Code Implementation										

* Deliverables (*) Initial deliverables T – TAC Meeting

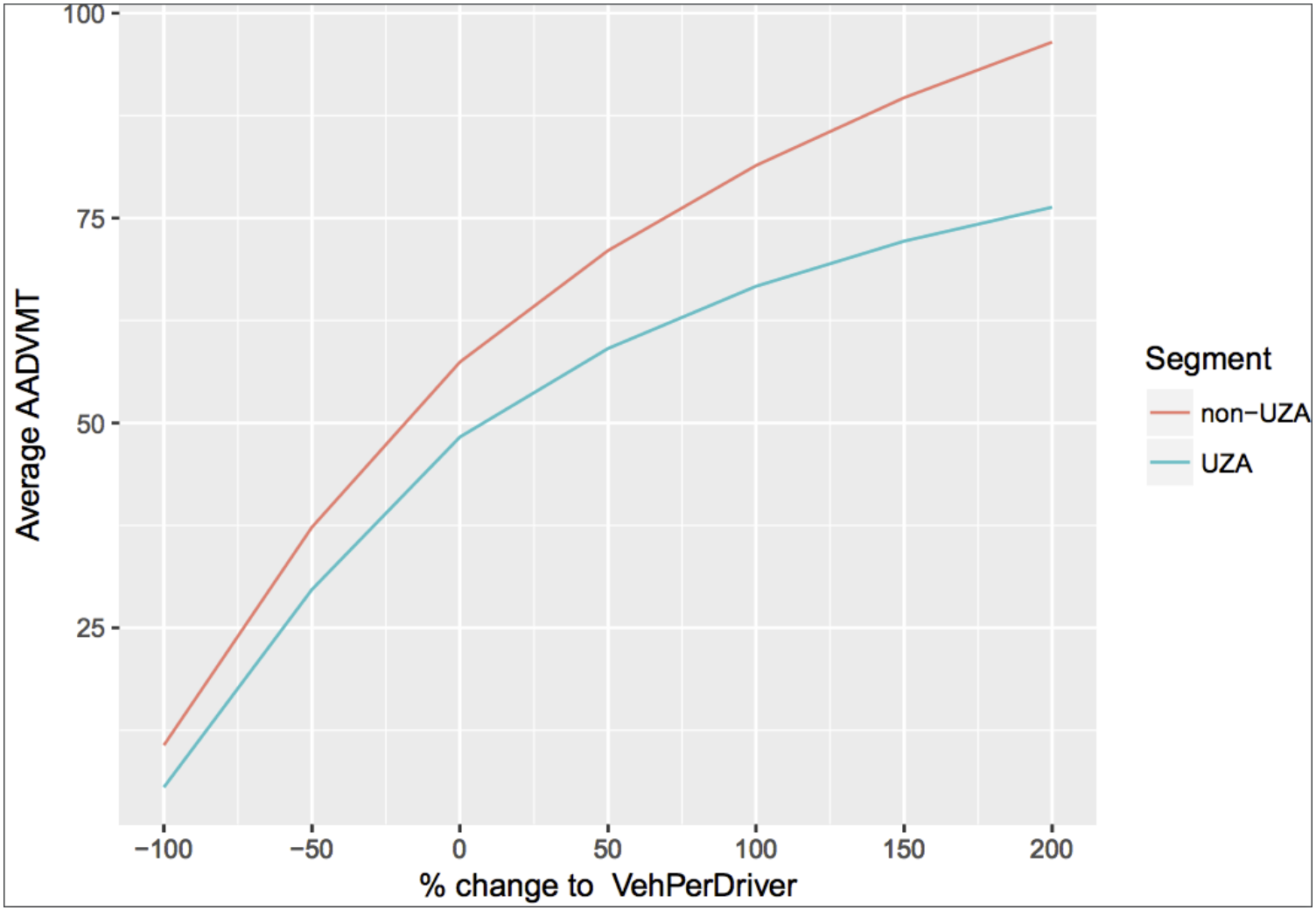
Innovations

- Utilizing **a novel nationwide dataset** of highly detailed information of households (2009 NHTS) and built environment (EPA Smart Location Database) with a complete US coverage;
- Modeling **annual average daily Vehicle Miles Traveled (AADVMT)**, instead of the VMT during the day of the survey commonly used in similar models;
- Use of **cross validation** in model development to avoid overfitting;
- Conducting **model selection**, in addition to variable selection, in the model development process to select the best model structure among a handful of options;
- **Implemented as a self-contained R package for VisionEval**, which contains documents and functions for model (re-)estimation and prediction;
- The model development process, from data processing, model estimation, validation and testing, to report and document compiling, **follows the best practice of reproducible research**; results and products derived from our work, including this ITM paper/presentation, is fully reproducible by others (sans confidential data).

Model Selection



Elasticities



Validation: VETravelDemandMM Predictions

			Trips			PMT		
Category	**n**	**AADVMT**	**BikeTrips**	**WalkTrips**	**TransitTrips**	**BikePMT**	**WalkPMT**	**TransitPMT**
Overall								
RVMPO	74045	41.800	0.146	0.891	0.144	0.290	0.578	0.751
DevelopmentType								
Rural	6476	49.200	0.158	0.754	0.134	0.294	0.513	0.816
Urban	67569	41.100	0.145	0.905	0.145	0.290	0.584	0.745
Income								
<$40k	31432	25.100	0.124	0.762	0.180	0.167	0.482	0.676
$40k-$80k	18071	43.800	0.149	0.907	0.125	0.288	0.586	0.754
>$80k	24542	61.800	0.172	1.045	0.111	0.449	0.694	0.844
Popuplation per Square Mile								
<1k	19126	42.300	0.143	0.710	0.133	0.249	0.476	0.739
1k-5k	35477	42.300	0.144	0.898	0.141	0.294	0.579	0.753
5k-10k	18211	40.700	0.151	1.071	0.157	0.327	0.682	0.757
>10k	1231	36.900	0.157	0.876	0.202	0.258	0.575	0.792

Validation: RSPM Predictions

Category	n	DVMT	Trips		
			BikeTrips	WalkTrips	TransitTrips
Overall					
RVMPO	74045	52.400	0.092	0.690	0.037
DevelopmentType					
Rural	6676	65.400	0.088	0.741	0.023
Urban	67369	51.200	0.092	0.685	0.038
Income					
<$40k	31791	34.700	0.090	0.604	0.053
$40k-$80k	17852	56.200	0.090	0.645	0.023
>$80k	24402	72.800	0.095	0.834	0.026
Popuplation per Square Mile					
<1k	19208	57.400	0.087	0.598	0.022
1k-5k	34215	54.300	0.093	0.704	0.035
5k-10k	19384	45.900	0.094	0.752	0.050
>10k	1238	29.200	0.103	0.751	0.108

Validation: "Observed" OHAS

Category	n	DVMT	Trips			PMT		
			BikeTrips	WalkTrips	TransitTrips	BikePMT	WalkPMT	TransitPMT
Overall								
RVMPO	931	36.700	0.232	0.870	0.094	0.395	0.276	0.538
DevelopmentType								
Rural	81	50.200	0.159	0.435	0.008	0.210	0.137	0.042
Urban	850	35.700	0.237	0.901	0.100	0.408	0.286	0.573
Income								
<$40k	367	27.200	0.138	0.798	0.144	0.164	0.222	0.762
$40k-$80k	329	39.100	0.455	0.777	0.014	0.763	0.313	0.050
>$80k	235	53.900	0.072	1.186	0.114	0.300	0.336	0.845
Popuplation per Square Mile								
<1k	226	40.800	0.079	0.510	0.037	0.270	0.135	0.013
1k-5k	460	37.100	0.361	0.891	0.084	0.595	0.304	0.495
5k-10k	232	32.800	0.167	1.036	0.145	0.222	0.310	0.979
>10k	13	43.500	0.000	1.408	0.076	0.000	0.528	0.055

VisionEval Framework

- When the project started, VisionEval (formerly RSPM Framework) was still on the drawing board;
- As VE development picked up steam and materialized, the project team and TAC decided that it made more sense to implement for VE instead;
- Started swtiching to implement as a VE module package in 12/2016;
- Amended the Scope of Work to include the contribution review in 02/2017

VETravelDemandMM Implementation

- GitHub Repository: https://github.com/cities-lab/VETravelDemandMM
- A standard R package with
  - inst/extdata - external datasets (HPMS, NTD, Place Types etc; 2009 NTHS and SLD are dependencies as separate packages)
  - data-raw/ - scripts for model estimation; can be adapted for re-estimating models with new data
  - data/ - estimated R model objects
  - R/ - implementation of the module
  - man/ - manuals for functions implemented in the package
  - vignettes/ - vignettes (documents) for the package, including an introduction document, contribution review and feedback
  - test/ - tests that are automatically with travis-ci 

Contribution Review Process

- Contribution Review Criteria Check List
- Responses to Contribution Review Criteria
- Pull Request
- Comments from the Review team

Reflections

- The modular VE framework, along with the design principle, sample modules, extensive documentation and coding style guide, is extremely helpful;
- Best practices we follow facilitate incorporating our code with the VE code base:
  - The git/GitHub workflow
  - Automated tests and continous integration
  - Code organization as R package
  - Reproducible research practice
- Working closely with VE core developers like Brian Gregor and review team members (Tara Weinder, Ben Stabler, et al) helped tremendously;
- Bridging the gap between transportation research and professional practice and leveraging SPR/UTC funding

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