Activity-Based Model (ABM) Development

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The ABM naming contest

Our journey in ABM Development

- **Needs Assessment**
- **Alternative Evaluations**
- **Model Development**
  - **Phase 0 Development**: Test version with real data
  - **Phase 1 Development:** Lite model estimation and calibration
  - **Phase 2 Development**: Fully calibrated and re estimated

Needs Assessment

- New or complex behaviors
  - Work arrangement (telecommuting & work from home)
  - Gig workers (ride hailing, ecommerce delivery, etc)
  - Emerging modes (CAVs, e-bikes, e-scooters)
  - Intra-household behaviors (HOVs, school escorting, joint trips)

- Equity and affordability impacts on ESGs
  - Gender-based analysis plus (GBA+)
  - Distribution of effects on sub population groups
  - Off-peak travel behaviors on a diverse set of trip purposes

- Complex pricing policies
  - Temporal effects due to peak spreading
  - Caps, rebates, exemptions and discounts (CRED)

Alternative Evaluations

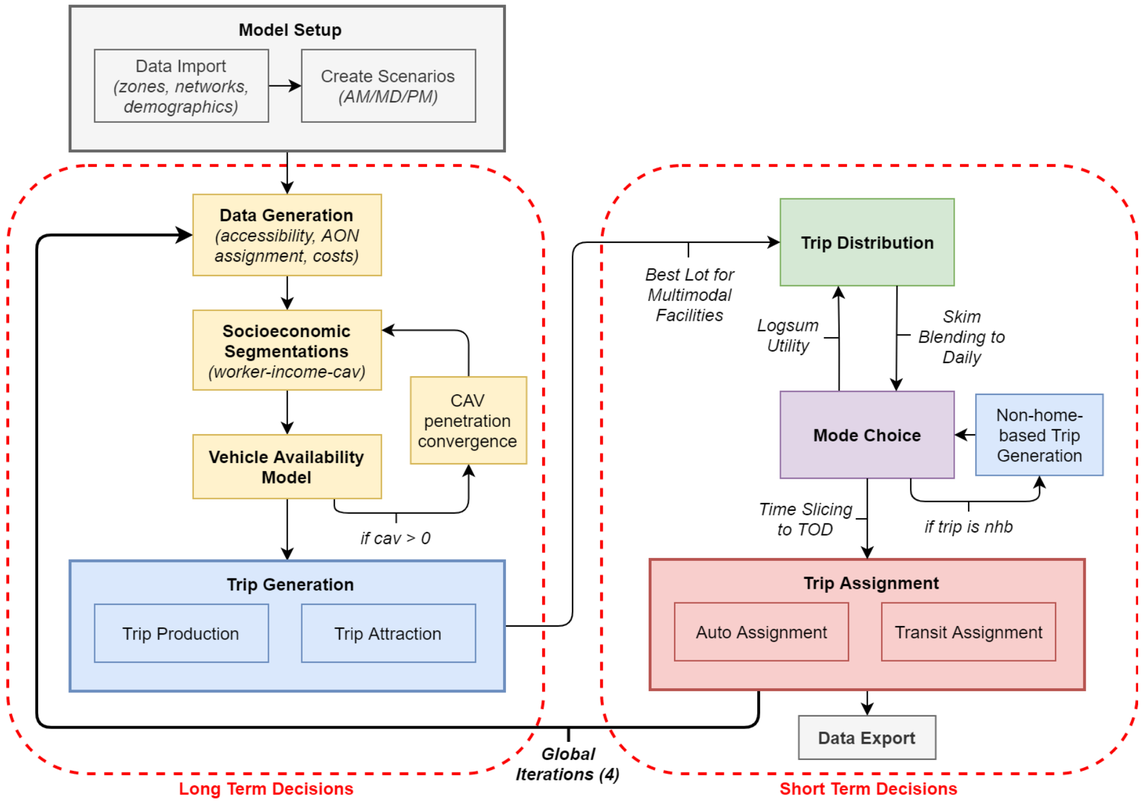
- Trip based models
- Hybrid models
  - HBD1 – Synthetic population with disaggregate long-term decisions and aggregate short-term decisions
  - HBD2 – HBD1 + disaggregate postprocessing
- Activity-based models

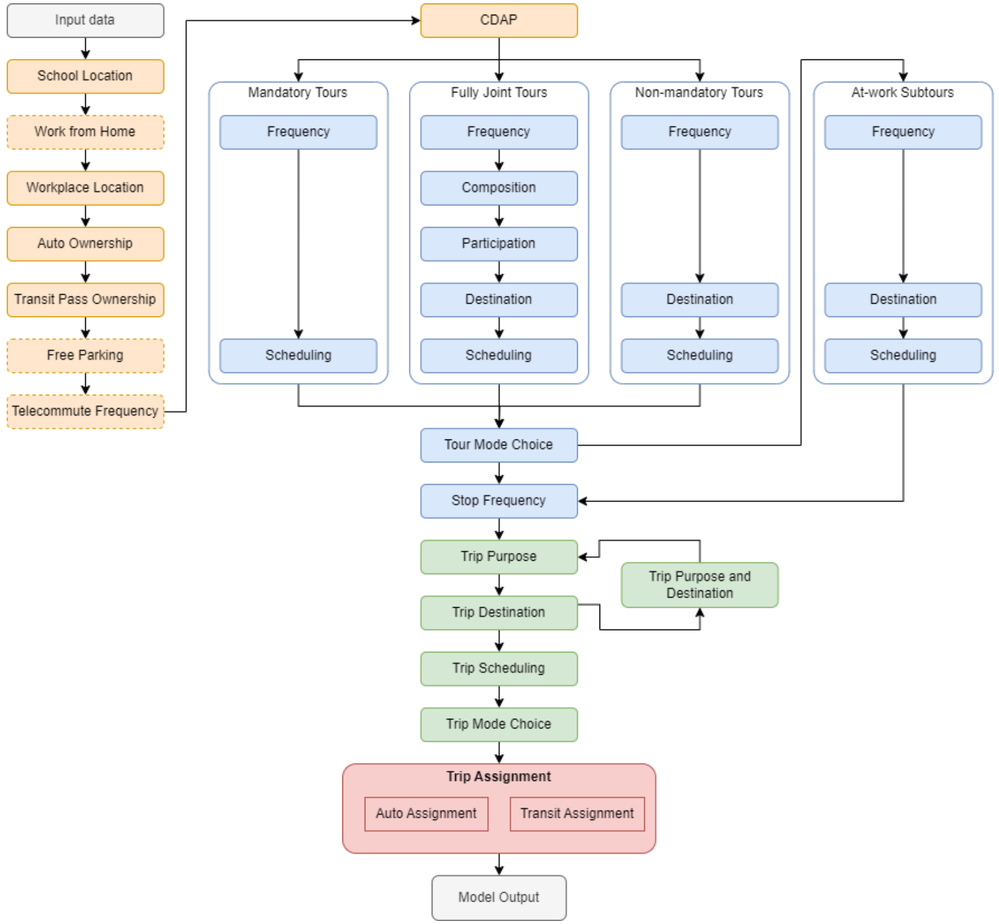
Alternative Evaluations

- Trip-based model performs poorly with increasing segmentations
- Trip-based model is becoming hard to maintain and enhance
- ABM can produce conventional metrics and answer complex questions
- ABM is less abstract and more interpretable
- Development cost for hybrid model is less predictable (less industry experiences)
- ABM is becoming industry standard
- ActivitySim was most suitable ABM platform for our development

Objectives	Sub-objectives	Trip Base	HBD1	HBD2	ABM
Capability to answer important questions	Objective Summary	-	✓	✓✓	✓✓✓
	Conventional metrics	-	✓	✓	✓✓
	Equity and Affordability	-	-	✓✓	✓✓✓
	Temporal responsiveness	-	✓	✓	✓✓
	Tour and resource constraints	-	✓	✓✓	✓✓✓
	New Mobility	-	✓	✓✓	✓✓✓
	New Behaviors (e.g. telecommuting)	-	✓✓	✓✓	✓✓✓
Resource requirements	Objective Summary[2]	-	✕	✕✕(✕)	✕✕
	Data needs	-	-	-	✕
	Development and maintenance cost	-	✕	✕✕(✕)	✕✕
	Development time	-	✕	✕✕(✕)	✕✕
	Model run times	-	-	-	✕(✕)
Risks	Objective Summary	-	-	✕	✕✕
	Global experience with these models	-	✕	✕✕✕	✕
	Communication with stakeholders	-	-	✕	✕
	Availability of local resources	-	✕	✕✕	✕✕✕
	Conformity with funding requirements	-	-	✓✓	✓✓✓

The RTM vs The ABM

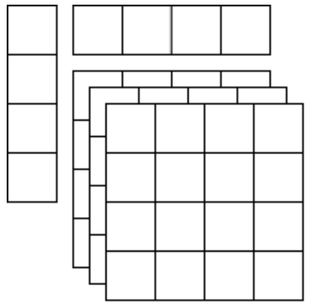




Different data structure for modeling

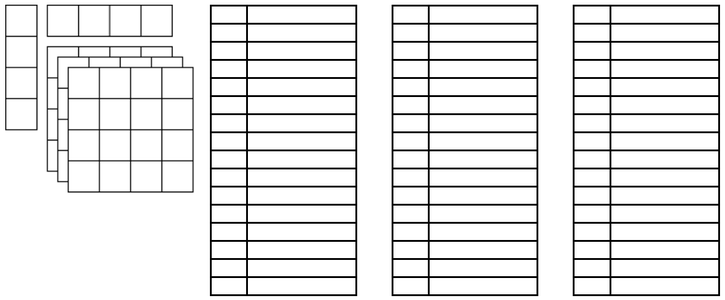
RTM

- All trip demand data are zones based
  - *Origin* (mo)
  - *Destination* (md)
  - *Origin to Destination* (mf)
- Aggregate choices for trips only



ABM

- All demand are row based
  - *Household* (household id, income, vehicles, etc)
  - *Person* (person id, age, gender, etc…)
  - *Tours* (tour id, start, end, tour mode, etc)
  - *Trips* (trip id, depart, mode, etc…)
- Disaggregate choices at different levels



Phase 0: Test version with real data

- Input data preparations
  - Synthetic households
  - Network skims
  - Land use
- Basic model set up
  - Sequencing of sub models
  - Recoding mode choice models
  - Code testing procedures
  - Basic integration with assignment

Phase 1: Lite model estimation and calibration

- Model estimation
  - Data processing of the 2017 Trip Diary into training data – tour formation, non-modeled behaviors, variable recoding.
  - Building model configurations
  - Debugging model issues due to inconsistency between observed and modeled behaviors
- Model calibration & validation
  - Preparations of targets for sub models calibration and for model validation
  - Creating scripts to systematically calibrate sub models individually.
- Sensitivity testing
  - Designing scenarios to test model responsiveness
  - Review and revise model parameters
  - Understand lessons learned and address data gaps for future development plans

	Estimation	Calibration
School Location	✔	✔
Workplace Location	✔	✔
WFH & TF	⊘	✔
Auto Ownership	✔	✔
Transit Pass Ownership	✔	✔
CDAP	✔	✔
Tour Frequency	⊘	In Progress
Tour Destination	⊘	In Progress
Tour Scheduling	✔	✔
Tour Mode Choice	✔	In Progress
Stop Frequency	⊘	Not Started
Trip Purpose	⊘	Not Started
Trip Destination	⊘	Not Started
Trip Scheduling	⊘	Not Started
Trip Mode Choice	In Progress	In Progress

Legend

Completed	✔
In Progress	In Progress
Not Started	Not Started
Deferred	⊘

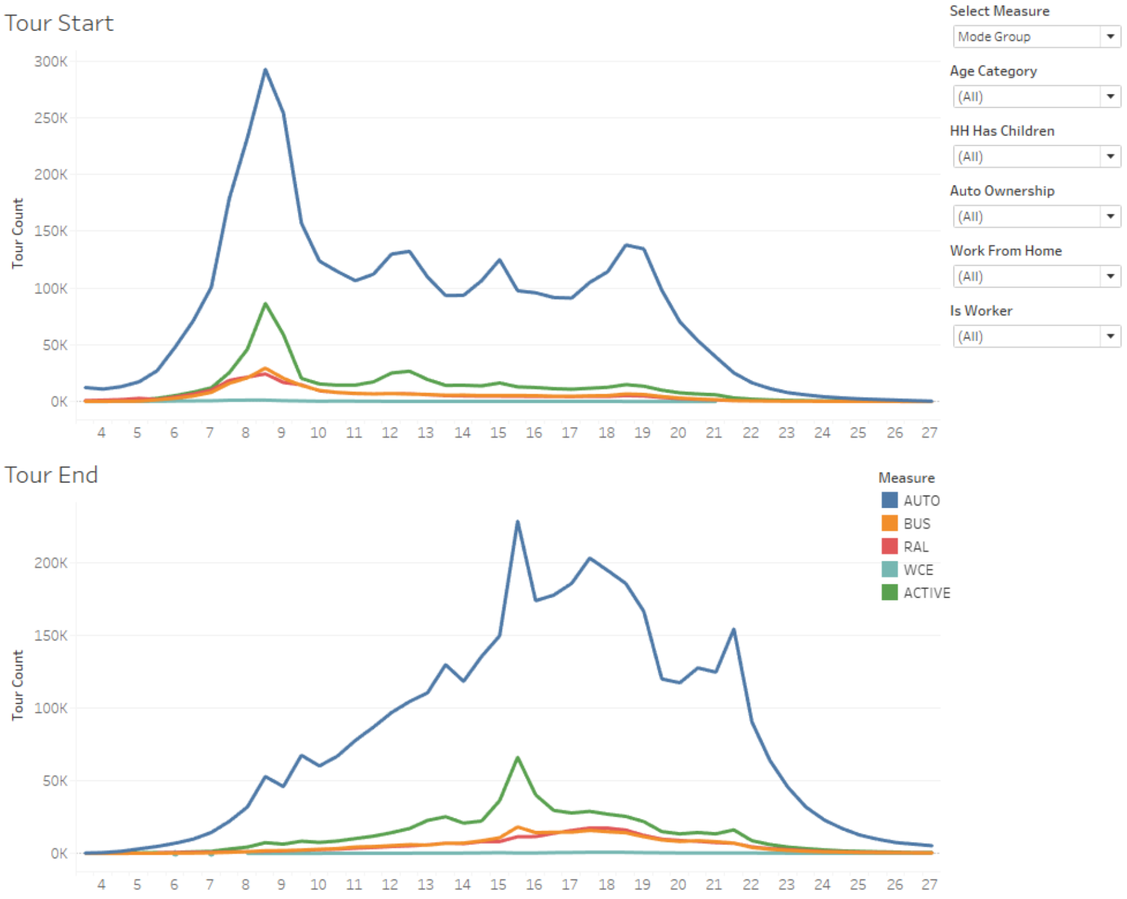
Looking forward to Phase 2

- Estimation of models with post pandemic behaviors using the 2023 Trip Diary data
- Calibration of all sub models
- Scenario testing with example studies & past events
- More testing, testing, testing…

Potential use cases

Peak spreading

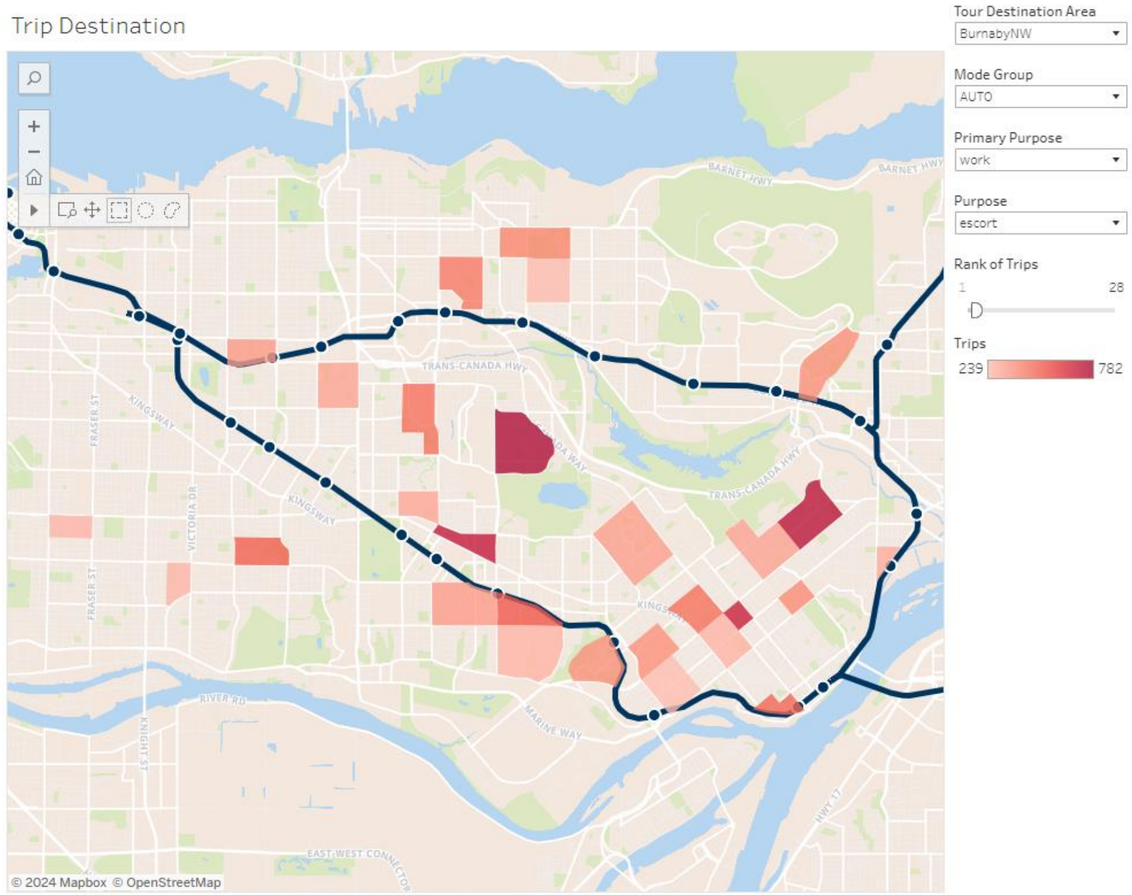
- Time of day dynamics for tours and trips
- Congestion impacts during different time periods
- Different behavioral responses by different demographics (income, age etc…)



Potential use cases

Intra-household escorting & carpooling

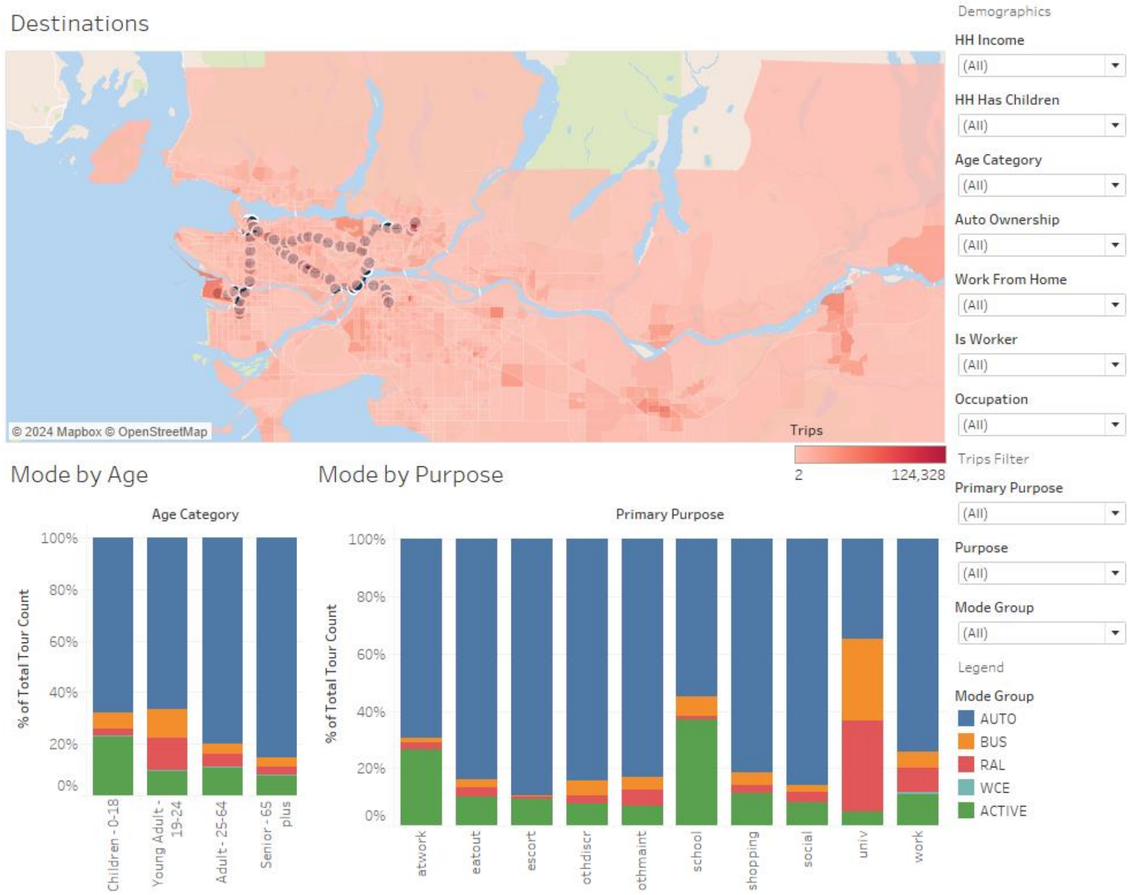
- Explicit representation of escorting and carpooling behavior
- Specific destination choices for drop off points or intermediate stops
- VKT and emissions reductions tied to changes in personal travel behaviors



Potential use cases

Individual / Household Analysis

- Impact of complex TDM policies on affordability and accessibility of transportation options
- Equity analysis with intersectionality of different demographic attributes
  - Low Income, Senior, Child, worker status, gender, etc…



Learning resources

- TF Resources on Activity-based Models (TRB AEP50)
  - https://tfresource.org/topics/Activity_based_models.html

- Activity-Based Travel Demand Models: A Primer (SHRP2)
  - https://nap.nationalacademies.org/catalog/22357/activity-based-travel-demand-models-a-primer

- ActivitySim Documentation
  - https://activitysim.github.io/activitysim/v1.2.0/