SeaTac Airport Model

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Agenda

- Model background
- Description and derivation of input data
- Model design and structure
- Comparison of model outputs to observed data

Airport Model Background

Travel patterns to/from the airport are generally different than people's everyday travel represented in the resident DaySim model

- Departure times are dependent on airport schedules
- Mode distribution is much different
- Vehicle occupancy is different
- There is only one major airport in the region people need to travel to – trip lengths are different

Airport model provides an opportunity to test policies associated directly with airport travel

- How might increases in rental cars prices affect mode distribution?
- How might increases in parking costs around the airport affect where people choose to park their car?
- Would increases in transit service have a significant affect on auto congestion to the airport?
- …and many more!

Airport Model uses ActivitySim

ActivitySim is…

- Written in Python
- A very flexible platform with many modeling options and structures exposed to users
- Open source
- Used by many agencies around the US and internationally
- Maintained by a consortium of 14 MPOs and other agencies supported by 3 consulting firms (including RSG)

Why ActivitySim? (besides the above reasons)

- Easy for users to update parameters to test scenarios
- An airport model with very similar design was already implemented in ActivitySim for SANDAG region allowing for us a great jumping-off point
- PSRC is developing an ActivitySim model to replace their current DaySim resident demand model.

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Airport Model Overview

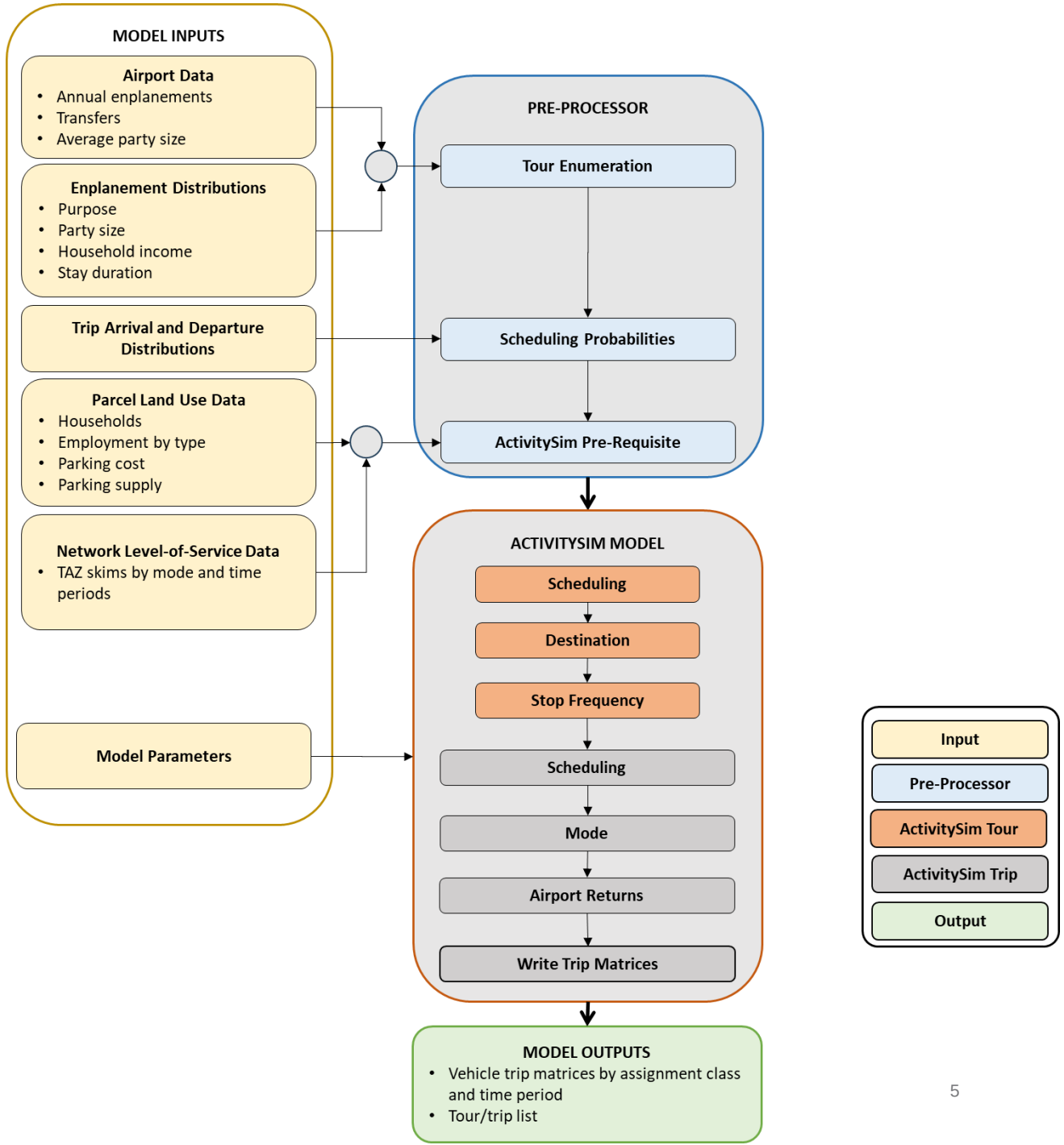
Model integrated in the SeaCast Activity-based model of the PSRC region.

SeaCast is a DaySim model that uses Emme for skimming and assignment.

Airport model demand is included with the resident model demand as part of the global feedback implemented in SeaCast

You can find more SeaCast info on Github:

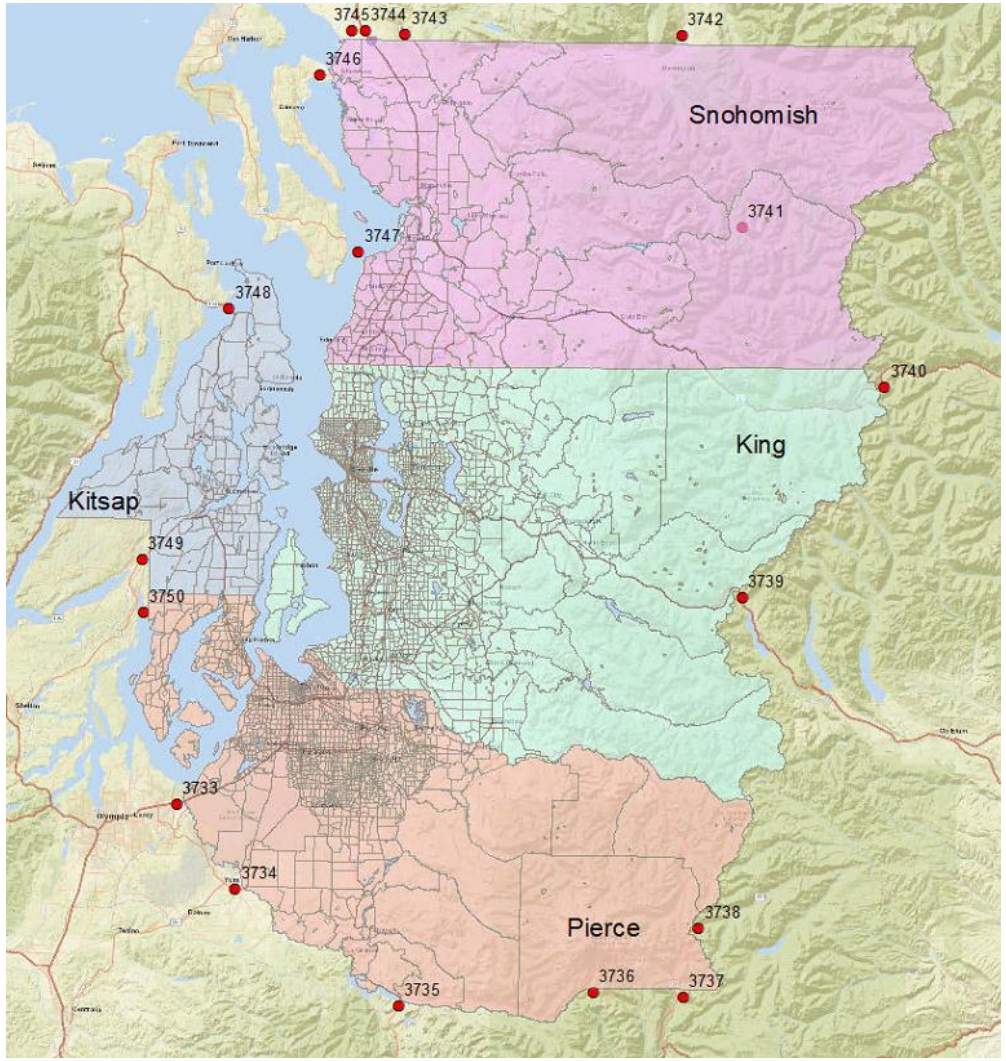
https://github.com/RSGInc/SeaCast



SeaCast AB Model System

- Base Year – **2018**
- Zone System

COUNTY	# ZONES
Internal	2970
City of SeaTac	*210*
King	*1727*
Snohomish	*135*
Pierce	*797*
Kitsap	*101*
External	18
Total	**2988**



Inputs

Landuse

Inputs

Landuse

Inputs: Landuse

Landuse data is derived from the resident model data by

- Aggregating parcel data into TAZs
- Include the number of households by each of our income bins because we segment destination choice size terms by income

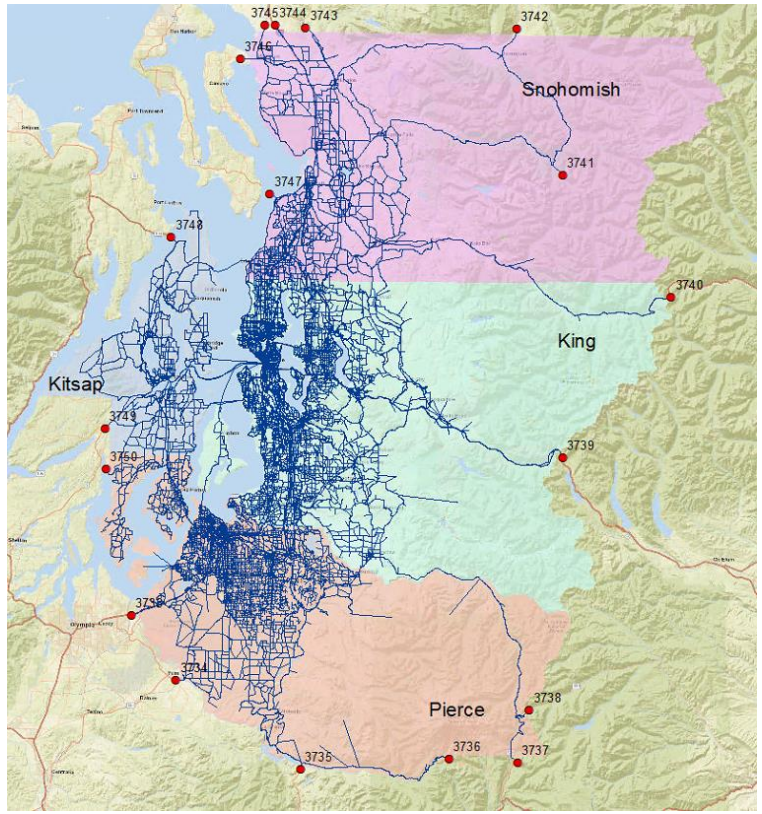
TAZ	APARKS	EMPTOT_P	HH_P	LUTYPE_P	MFUNITS	NPARKS	PARKDY_P	PARKHR_P	SFUNITS	SQFT_P	a1	a2	a3	a4	a5	a6	a7	a8
1	0	8134	1	140	0	0	0	0	1	76758755	1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	293	1	32	0	0	0	0	1	833535	1	0	0	0	0	0	0	0
8	0	327	0	121	0	0	0	0	0	424843	0	0	0	0	0	0	0	0
9	0	0	0	254	0	0	0	0	0	137396	0	0	0	0	0	0	0	0
10	1021470	24	198	5357	0	8	0	0	190	4883671	1	44	45	57	34	8	3	6
11	0	26	204	5311	0	0	0	0	200	2885586	0	59	46	47	32	8	2	10
12	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	24	169	4185	0	0	0	0	163	2402758	2	46	39	42	22	7	6	5
14	0	80	88	1806	0	0	0	0	74	923474	5	21	29	14	9	0	6	4
15	0	22	0	108	0	0	0	0	0	1065847	0	0	0	0	0	0	0	0

Network

Inputs

Skims

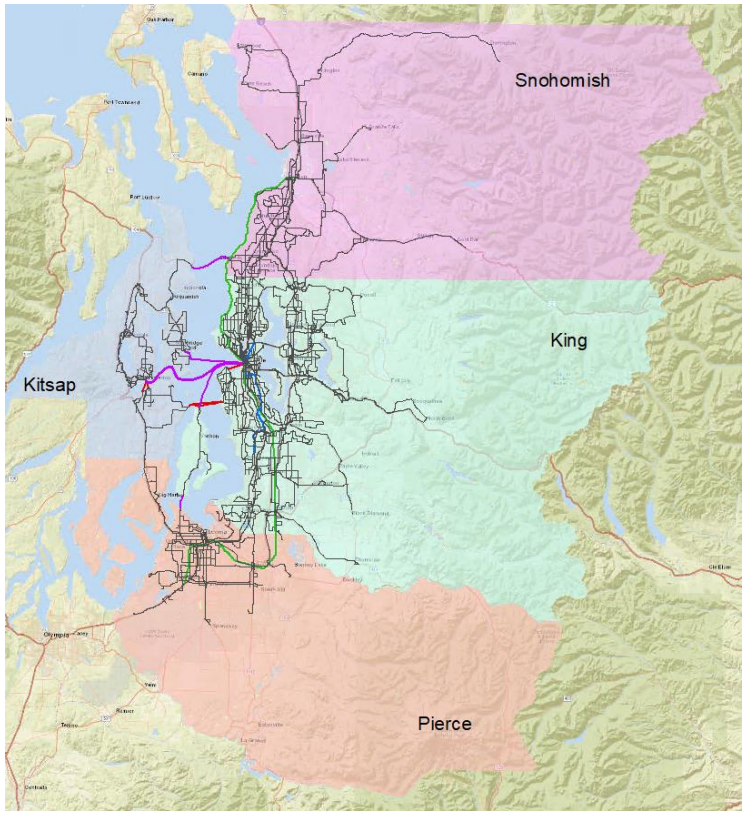
Highway Network



Period

- AM
- MD
- PM
- EV
- NI

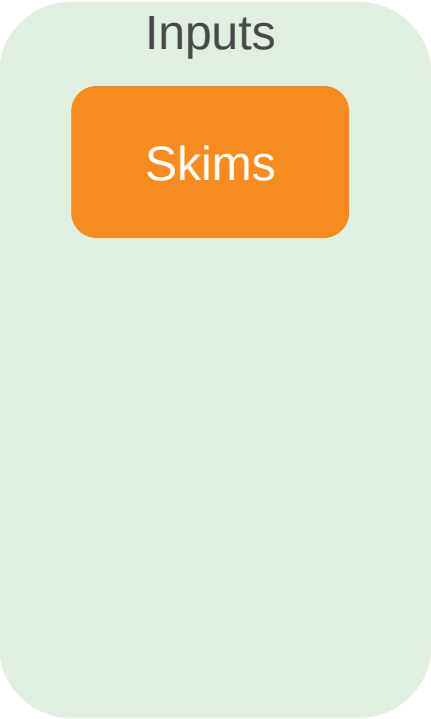
Transit Network



Period

- AM
- MD
- PM
- EV

Inputs: Skims



Highway Assignment and Skimming modes

- SOV
- HOV2
- HOV3+
- TNC

- Value of time class 1
- Value of time class 2
- Value of time class 3

Transit Assignment and Skimming modes

- Bus
- Light Rail
- Ferry
- Passenger Ferry
- Commuter Rail

We use the skims from the SeaCast model, but perform some additional processing:

- Convert from hdf5 to omx filetype
- Divide the skim values by 100 (SeaCast skims are output as 100's, so 2 miles would show up as 200)
- Append the time of day to the skim names: e.g. sov_inc2d__MD

Skims are now ready for use by ActivitySim!

Inputs: Airport Travelers

Synthetic airport travelers are distributed into **households**, **persons**, and **tours** files

Households and **persons** are created because ActivitySim requires them, but here they just represent the party going to the airport

- One household and one person record for each party going to the airport

Tours – Each tour represents a trip to / from the airport:

- Number of tours determined by the airport enplanements and connections

$$airport\ trips = \frac{(Enplanements - \ Connections)}{annualizationFactor * AveragePartySize} * 2$$

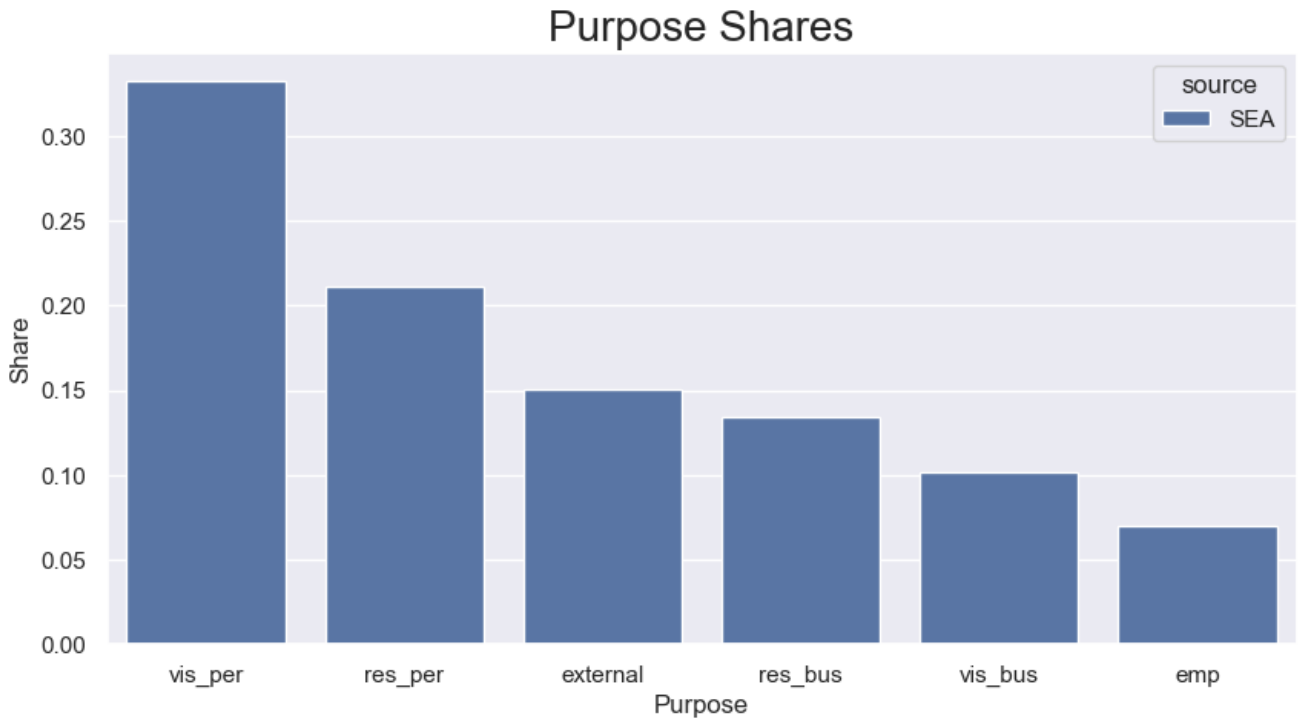
- Each tour is assigned to a representative household/person
- Even split between outbound and inbound trips (the airport is the “home” end)

Airport Data

Input Tour Attributes: Purpose

Purposes are segmented into the following categories:

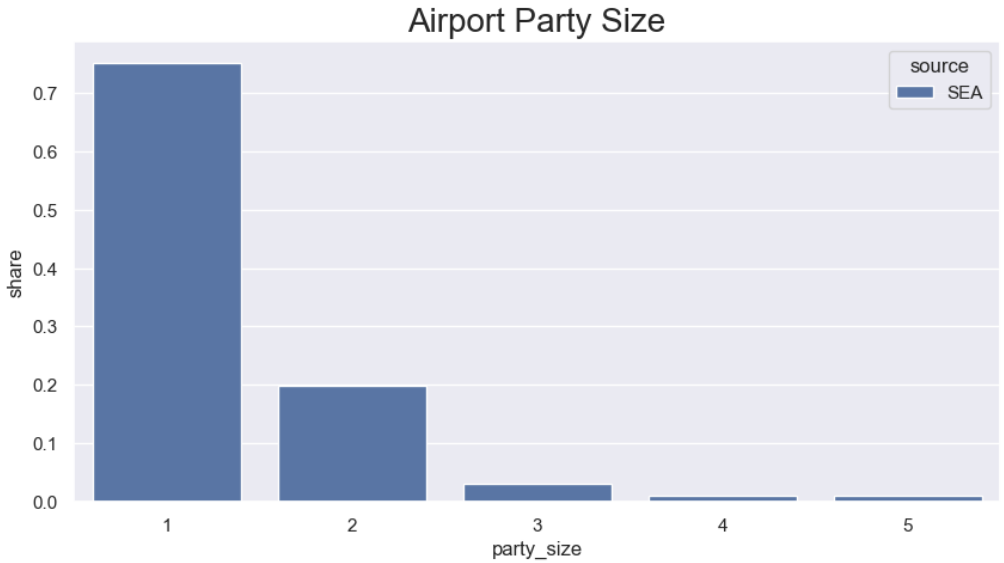
1. Resident on personal travel
2. Resident on business travel
3. Visitor on personal travel
4. Visitor on business travel
5. People who live external to the region but consider SeaTac as their home airport
6. Employees who work at the airport

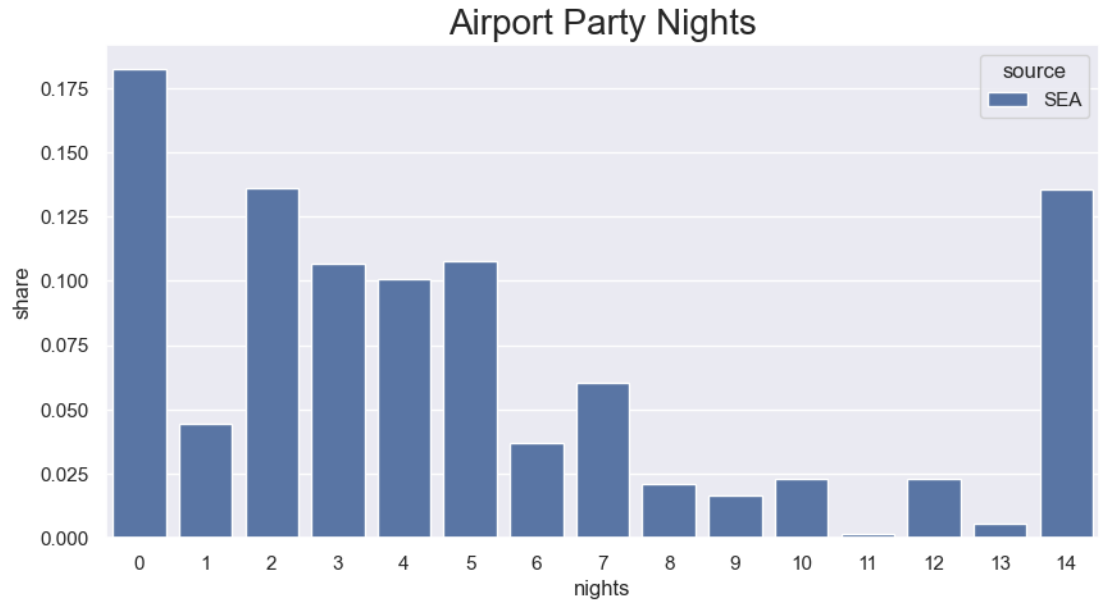


The purpose distribution is important because residents and visitors have different travel behavior

Derived from the airport passenger survey data

Input Tour Attributes: Traveler Info





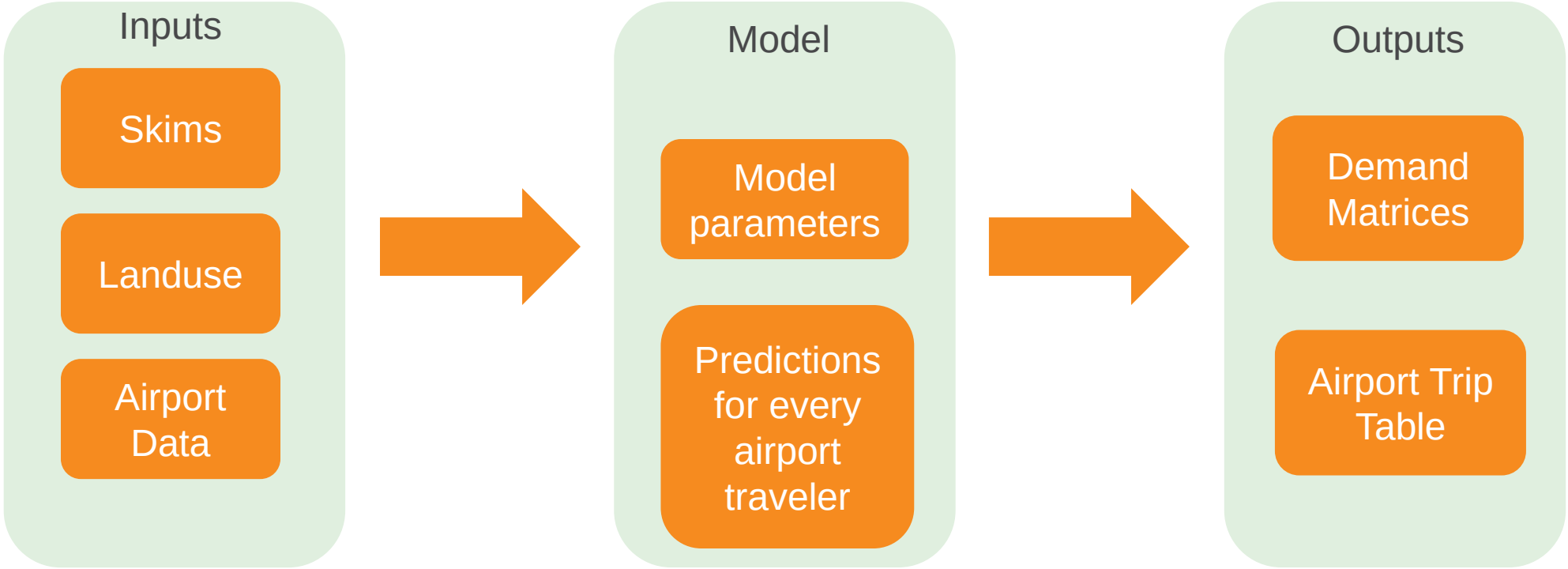
All of these variables can influence travel behavior – there are model coefficients that interact with these terms

Also derived from the airport passenger survey data

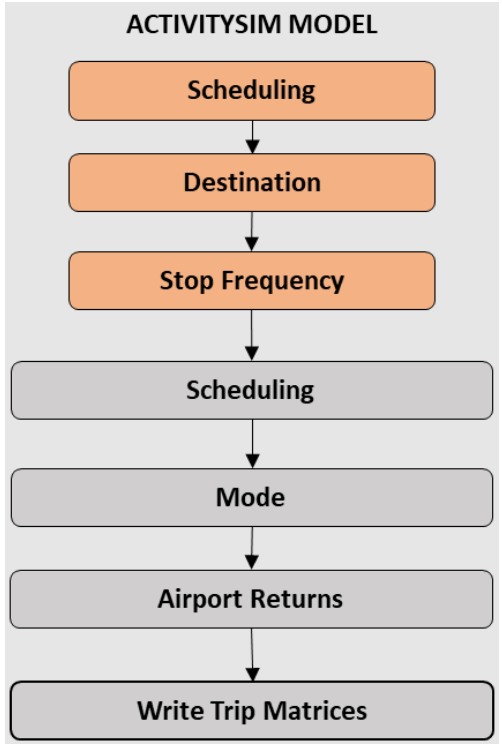
Airport Model Overview

Now we have our input skims, landuse information, and some distributions about who is coming to the airport.

Need our model to tell us **where** they are coming from, **how** they are getting to the airport, and **when**



Model Structure



Samples time-of-day from a probability distribution

"Dummy" model which just assigns the time-of-day from the tours to the trips

ActivitySim Tour

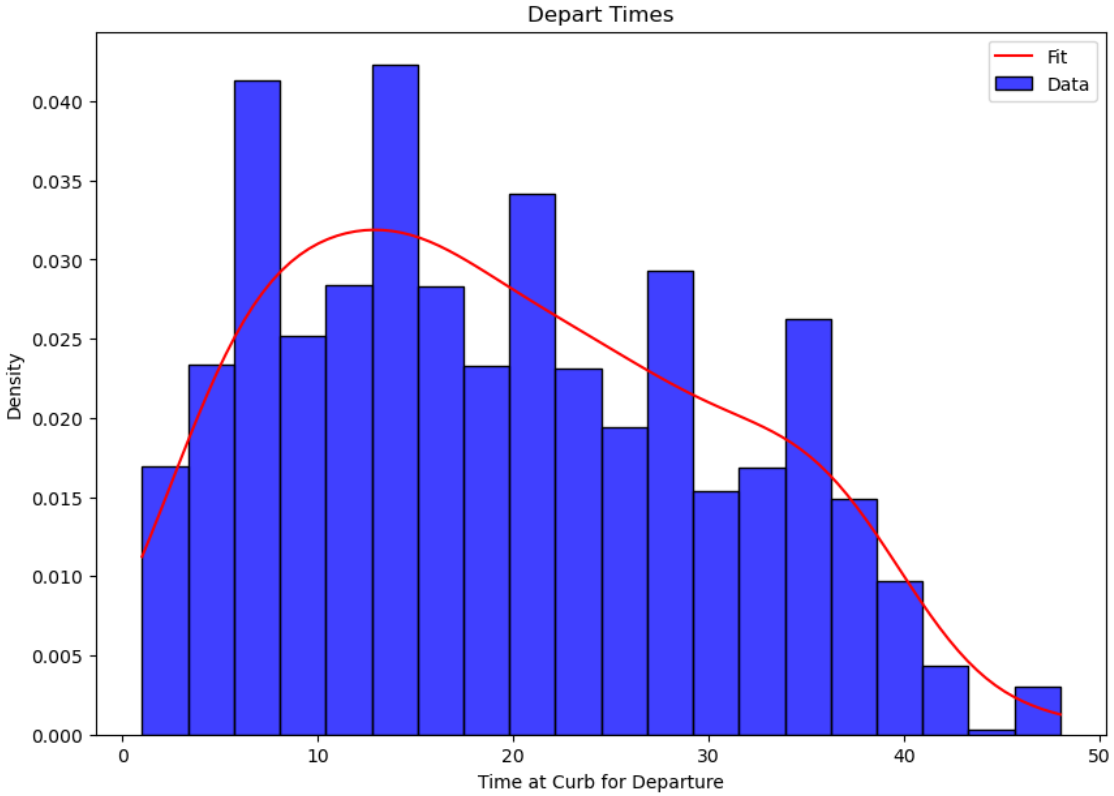
ActivitySim Trip

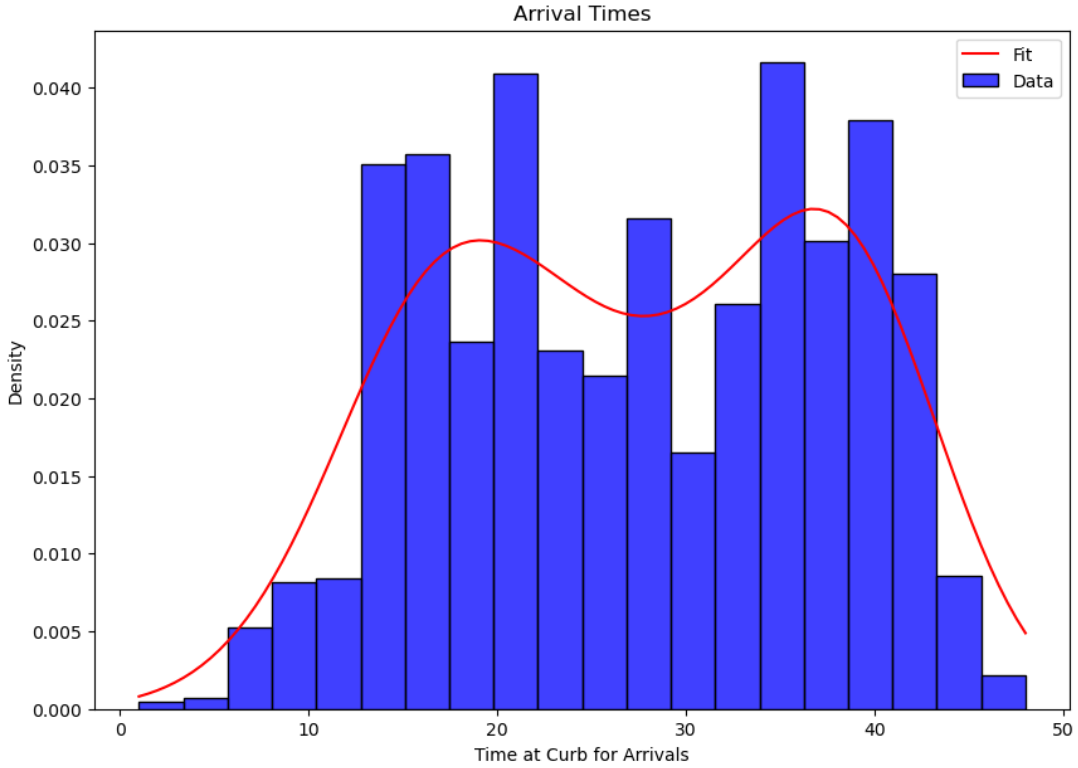
Scheduling Distribution

Tour time of day determined from the curb arrival and departure times from the airport.

Data was fit to smooth the distribution, and probabilities were drawn from the fitted function

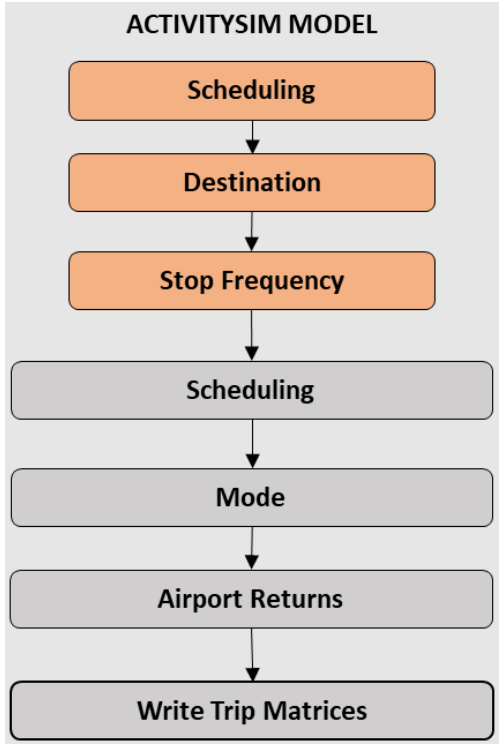
Converted into an ActivitySim configuration file





Time in ActivitySim bins: half-hour increments starting at 3:AM

Model Structure



ActivitySim Tour

ActivitySim Trip

Destination choice model:

- Chooses the home location for residents and destination for visitors

Destination Choice Specification

$$\Pr(i) = \frac{\exp(V_i)}{\sum_{j=1}^{J} \exp(V_j)}$$

where $\Pr(i)$ is the probability of the decision-maker choosing alternative i

V_j is the systematic component of the utility of alternative j.

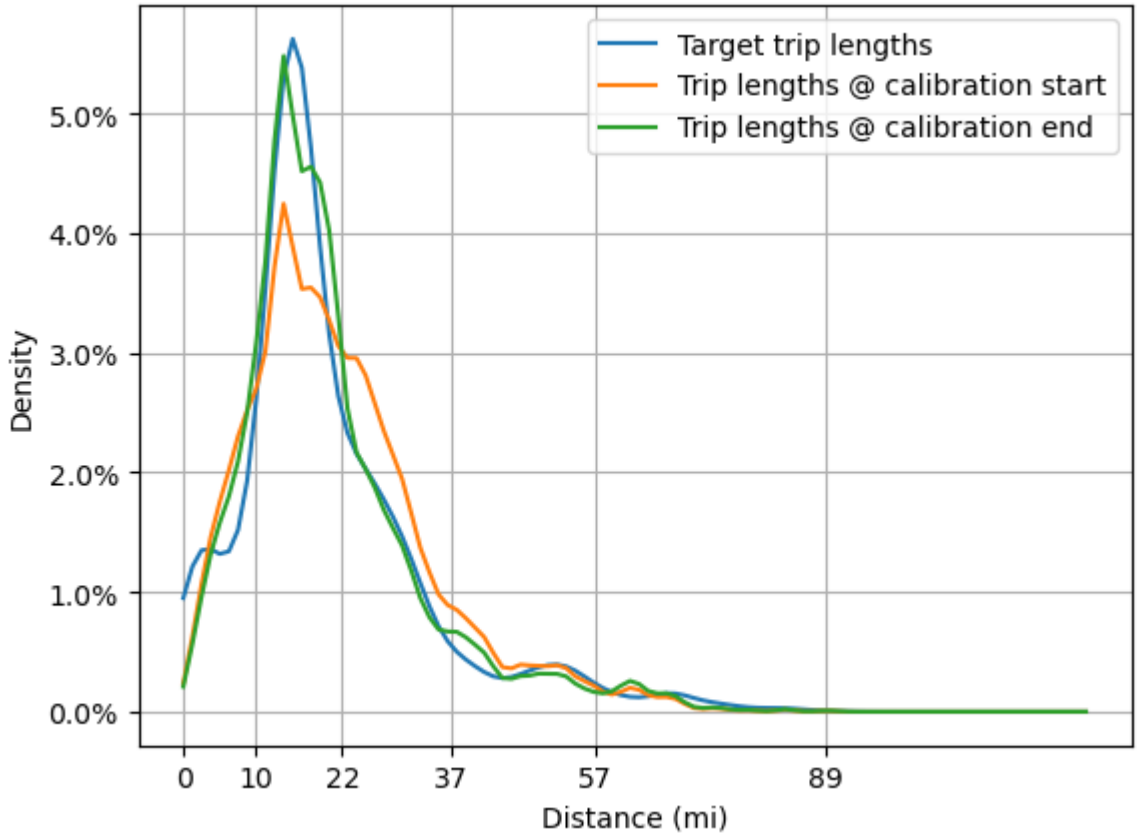
- Utility given by the expressions
- Coefficients are segmented by household income and purpose
- Size terms are segmented by income – low-income households are mode likely to go to TAZs with more low-income households

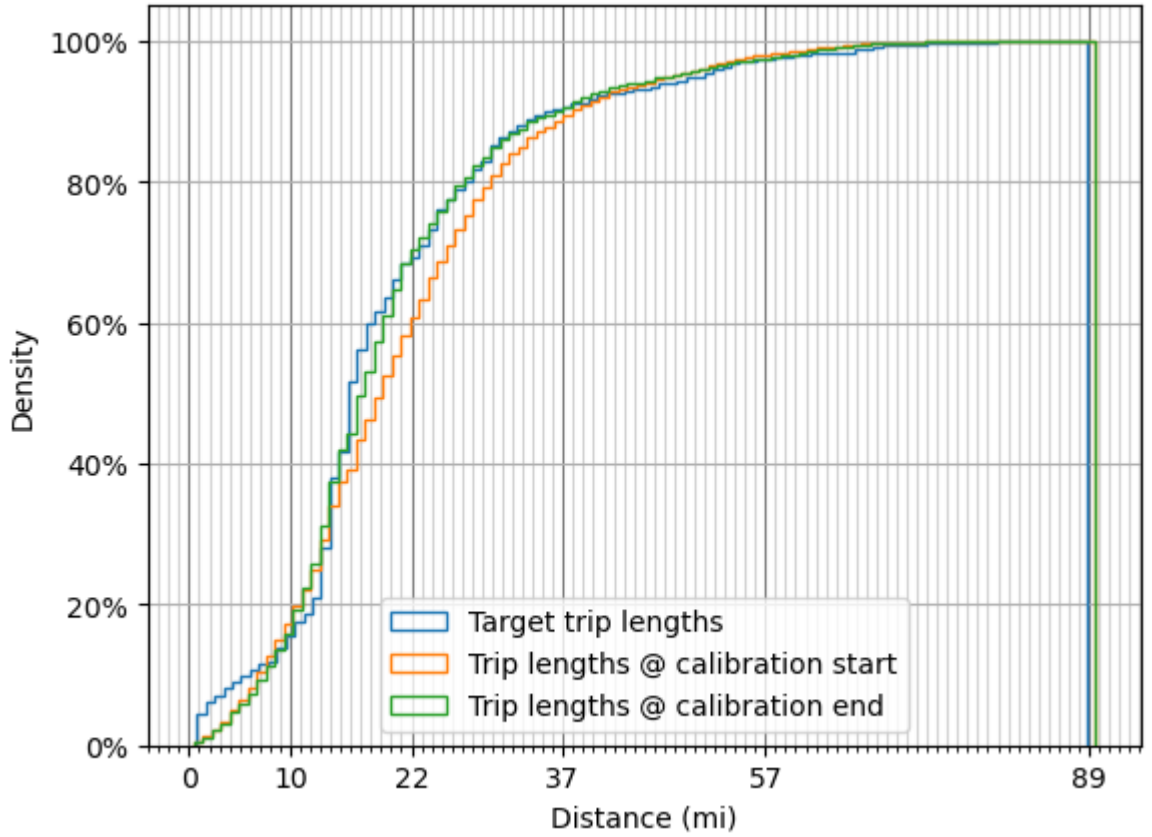
Description	Expression
	_DIST@skims['DIST']
Size variable	@np.log1p(df.size_term)
Sample of alternatives correction factor	@np.minimum(np.log(df.pick_count/df.prob), 60)
No attractions	@df.size_term==0
intercept	@df['intercept']
distance >= 0	@((_DIST >= 0) * np.minimum((_DIST - 0), (0.5 - 0)))
distance >= 0.5	@((_DIST >= 0.5)*np.minimum((_DIST - 0.5), (1 - 0.5)))
distance >= 1.0	@((_DIST >= 1)*np.minimum((_DIST - 1), (2 - 1)))
distance >= 2.0	@((_DIST >= 2)*np.minimum((_DIST - 2), (3 - 2)))
distance >= 3.0	@((_DIST >= 3)*np.minimum((_DIST - 3), (5 - 3)))
distance >= 5.0	@((_DIST >= 5)*np.minimum((_DIST - 5), (10 - 5)))
distance >= 10.0	@((_DIST >= 10)*np.minimum((_DIST - 10), (20 - 10)))
distance >= 20.0	@((_DIST >= 20)*np.minimum((_DIST - 20), (30 - 20)))
distance >= 30.0	@((_DIST >= 30)*np.minimum((_DIST - 30), (50 - 30)))
distance >= 50.0	@((_DIST >= 50)*np.minimum((_DIST - 50), (5000 - 50)))
#Sea calibration	
distance <= 10 miles	@(_DIST <= 10)
distance 10 to 22 miles	@(_DIST > 10) & (_DIST <= 22)
distance 22 to 37 miles	@(_DIST > 22) & (_DIST <= 37)
distance 37 to 57 miles	@(_DIST > 37) & (_DIST <= 57)
distance > 57 miles	@(_DIST > 57)

SeaCast / scripts / airport / configs_airport / **non_mandatory_tour_destination.csv**

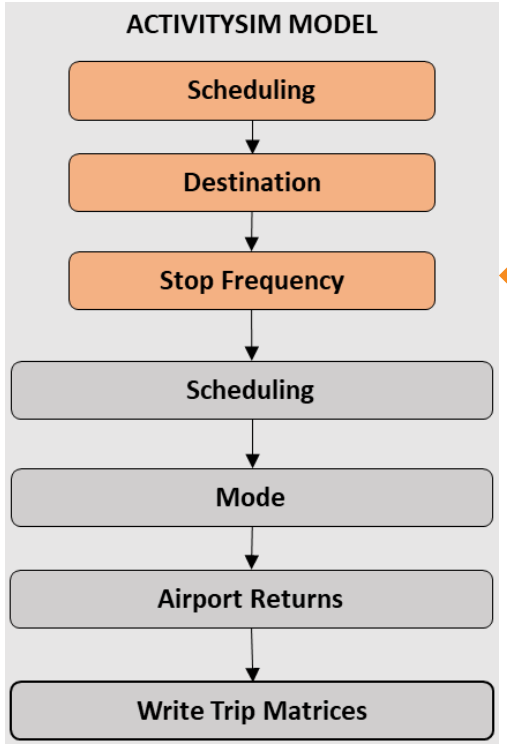
Calibrated Destination Choice

Target distribution derived from the EPS passenger survey data





Model Structure



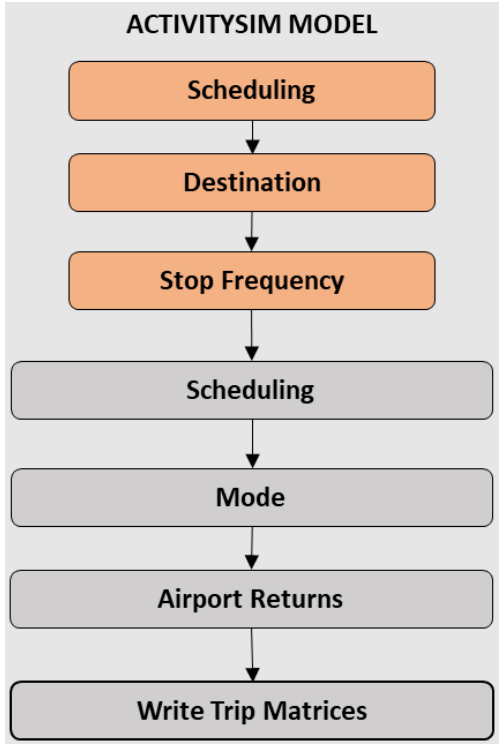
ActivitySim Tour

ActivitySim Trip

"Dummy" model – no additional stops are allowed to/from the airport

- Turns airport "tours" into "trips"

Model Structure



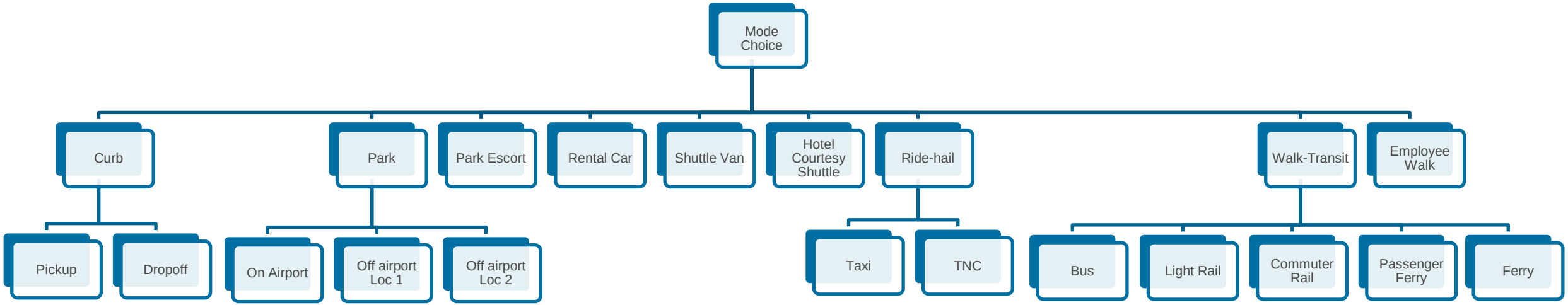
Determines the mode people take to the airport

ActivitySim Tour

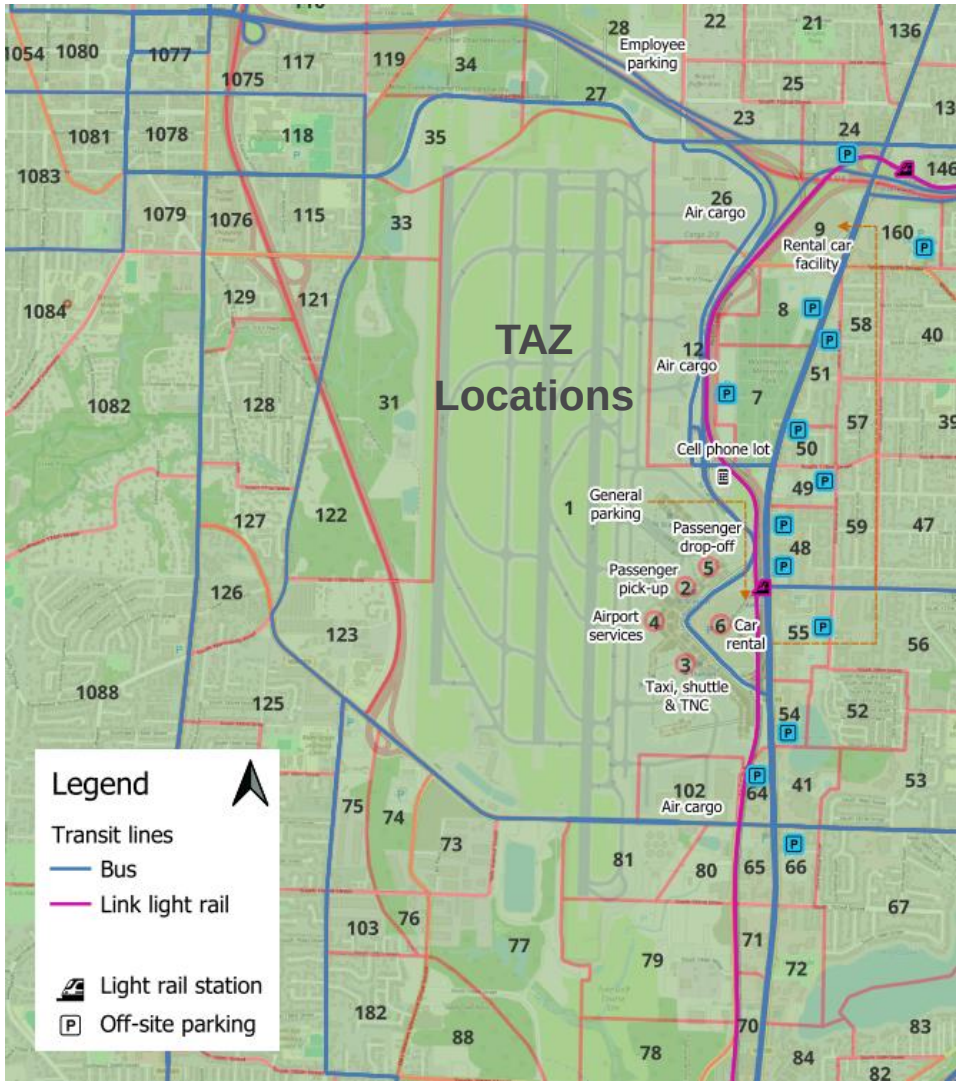
ActivitySim Trip

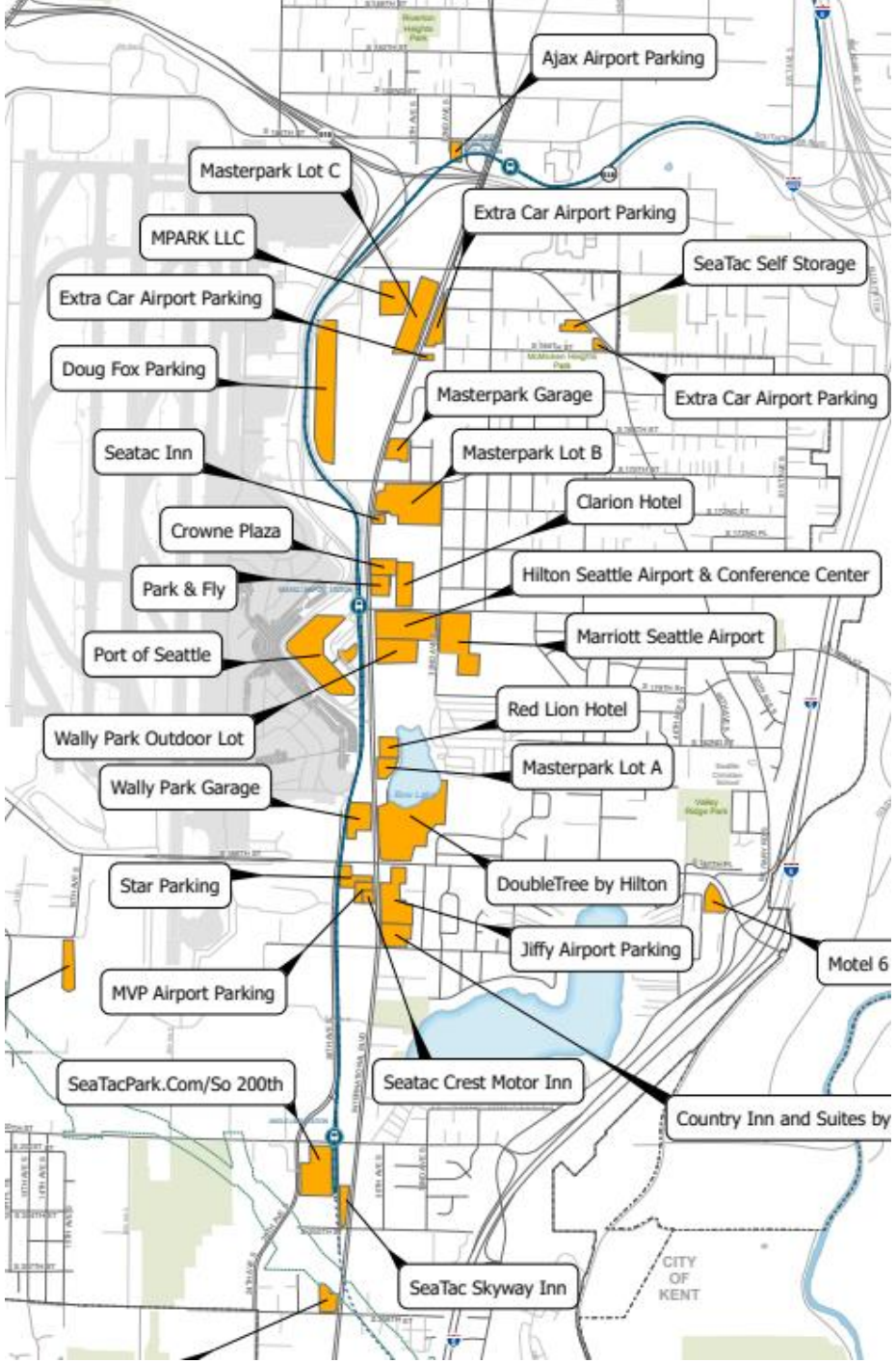
Trip Mode Choice

Trip mode choice is a nested logit model



Trip Mode Choice





Aggregated Parking locations into four representative TAZs

1. Terminal parking
2. North of the airport
3. South of the airport
4. Just East of the airport

Airport Model Development: Utility Equations

- Curb drop off / pickup
  - In-vehicle time + in-vehicle cost + walk time to terminal
- Park / Park-escort
  - In-vehicle time + in-vehicle cost + parking cost + wait for parking shuttle + in-vehicle time from lot to terminal + walk time to terminal
- Rental Car
  - In-vehicle time + in-vehicle cost + rental cost + wait for parking shuttle + in-vehicle time from rental lot to terminal + walk time to terminal
- Shuttle / Hotel Courtesy
  - In-vehicle time + wait for shuttle + walk time to terminal
- Taxi / TNC
  - In-vehicle time + taxi / tnc cost + wait for taxi / tnc + walk time to terminal
- Transit
  - In-vehicle time + auxiliary walk time + wait time + transfer wait time + transfer penalty
- Cost coefficients taken from SANDAG
- Applied Several coefficients from previous NREL model:
  - income, single party size, travel time coefficients for residents and visitors, ASCs

Airport Model Development: Utility Parameters

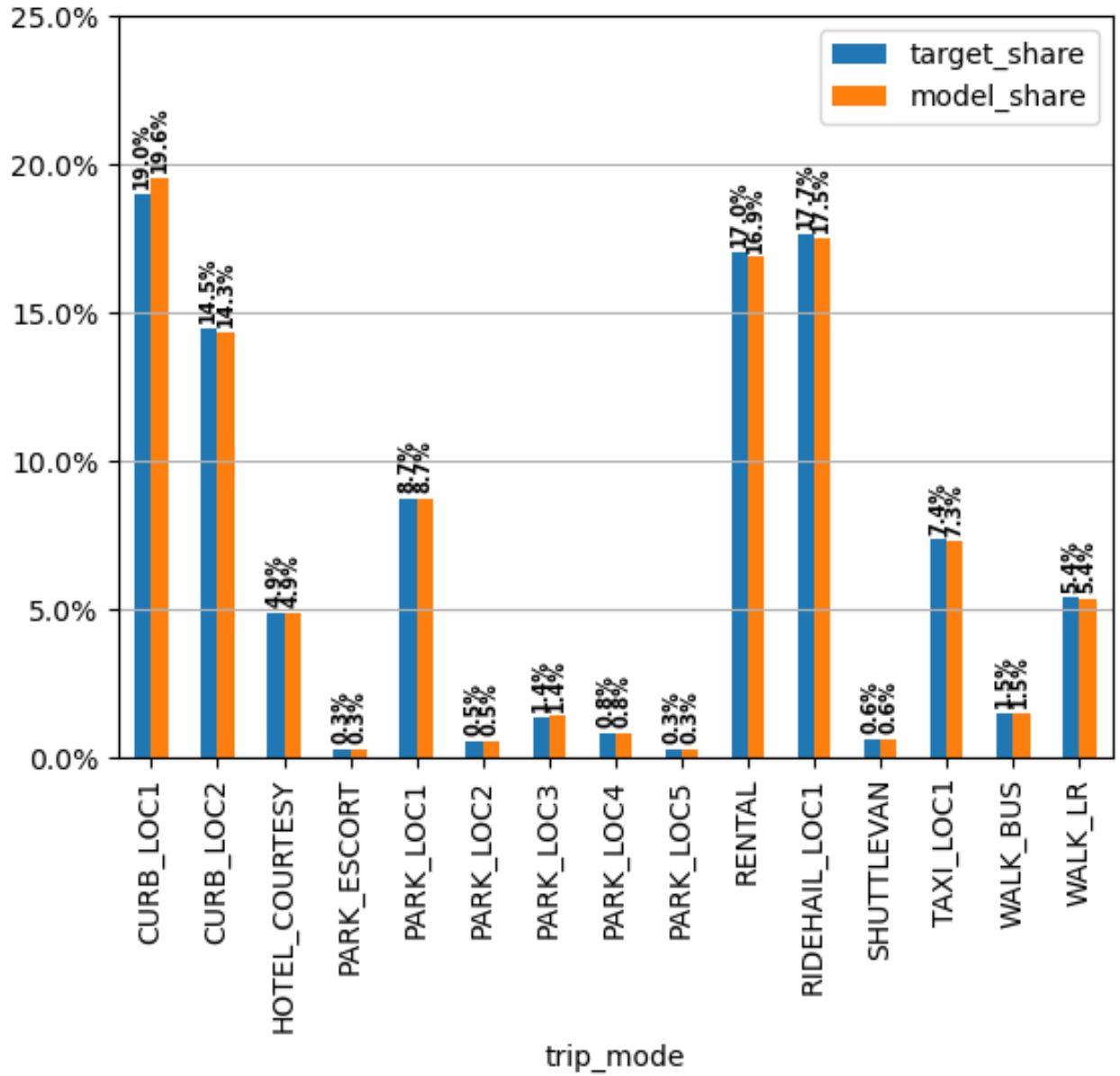
```
CONSTANTS:
  parkLocation1TAZ: 1  # terminal, park on airport, need to adjust ASCs if changing with other parkLocationTAZs
  parkLocation2TAZ: 55  # wallypark outdoor, park & fly
  parkLocation3TAZ: 8  # Master Park, Extra Car, Doug Fog, represents all parking north of airport
  parkLocation4TAZ: 64  # wallypark garage, Star Parking, Jiffy Airport Parking
  parkLocation5TAZ: 93  # SeaTacPark, etc.
  parkEscortLocationTAZ: 6
  rentalLocationTAZ: 9
  terminalTAZ: 1
  centralMobilityHubTAZ: -999
  ridehailLocation1TAZ: 3
  ridehailLocation2TAZ: -999
  transitTAZ: 1
  curbLocation1TAZ: 5  # drop off, if changing need to update availability condition on direction
  curbLocation2TAZ: 2  # pick up, if changing need to update availability condition on direction
  curbLocation3TAZ: -999
  curbLocation4TAZ: -999
  curbLocation5TAZ: -999
  shuttleVanTAZ: 3
  hotelCourtesyTAZ: 3
  parkLocation1AccessCost: 0.00
  parkLocation1CostDay: 39.04
  parkLocation1InVehicleTime: 0.00
  parkLocation1WalkTime: 5.00
  parkLocation1WaitTime: 0.00
  parkLocation2AccessCost: 0.00
  parkLocation2CostDay: 25.62
```

SeaCast / scripts / airport / configs_airport / **trip_mode_choice.yaml**

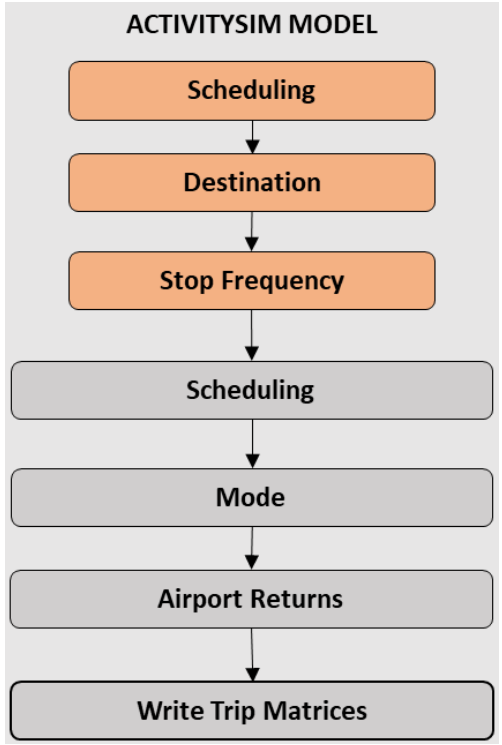
Calibrated Trip Mode Choice

Trip mode choice targets were derived from a number of sources:

- Airport counts of curb pickup and dropoff
- Airport counts and assumed occupancy rates for hotel courtesy shuttles and vans
- Parking counts at the airport
- Parking shuttle counts coming to the airport with a distribution assumed by the number of spaces around the off-airport locations
- Rental car purchases
- TNC / Taxi count data
- Transit boardings at the airport



Model Structure

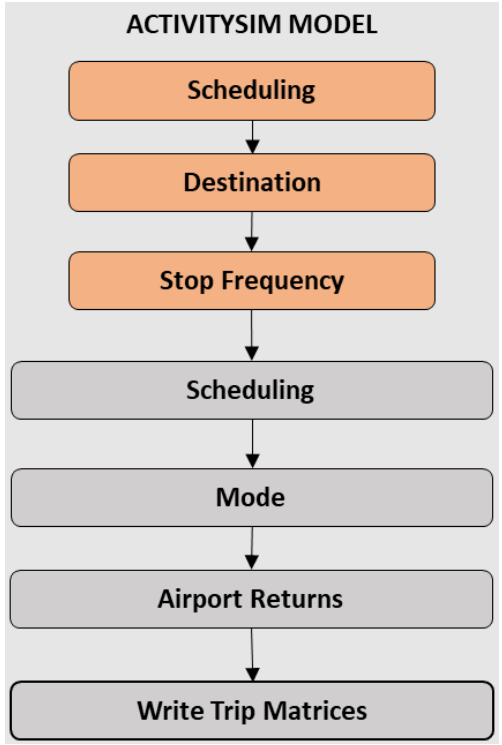


Simple model that adds a trip back home for people that chose the curb-dropoff mode

ActivitySim Tour

ActivitySim Trip

Model Structure



ActivitySim Tour

ActivitySim Trip

Writes output OMX trip matrices based on trip attributes

- Aggregate into assignment time periods

SeaCast / scripts / airport / configs_airport / **write_trip_matrices.yaml**

```
MATRICES:
  # 5to6
  - file_name: airport_demand_5to6.omx
    tables:
      - name: sov_inc1
        data_field: DRIVEALONE_5to6_LOW
      - name: sov_inc2
        data_field: DRIVEALONE_5to6_MED
      - name: sov_inc3
        data_field: DRIVEALONE_5to6_HIGH
      - name: hov2_inc1
        data_field: SHARED2_5to6_LOW
      - name: hov2_inc2
        data_field: SHARED2_5to6_MED
      - name: hov2_inc3
        data_field: SHARED2_5to6_HIGH
      - name: hov3_inc1
        data_field: SHARED3_5to6_LOW
      - name: hov3_inc2
        data_field: SHARED3_5to6_MED
      - name: hov3_inc3
        data_field: SHARED3_5to6_HIGH
      - name: walk
        data_field: WALK_5to6
      - name: walk_bus
        data_field: WALK_BUS_5to6
      - name: walk_lr
        data_field: WALK_LR_5to6
      - name: walk_cr
        data_field: WALK_CR_5to6
      - name: walk_fr
        data_field: WALK_FR_5to6
      - name: walk_fp
        data_field: WALK_FP_5to6
  # 6to7
  - file_name: airport_demand_6to7.omx
```

Disaggregate Outputs

Model output includes disaggregate information for each party traveling to the airport

- Demographic info: household income, party size, resident vs visitor, personal vs business travel
- Travel info: Mode, time of day, destination to/from the airport

Ready for detailed scenario analysis

- Sensitivities to congestion, transit service, landuse changes in the region, rental car prices, and many more!

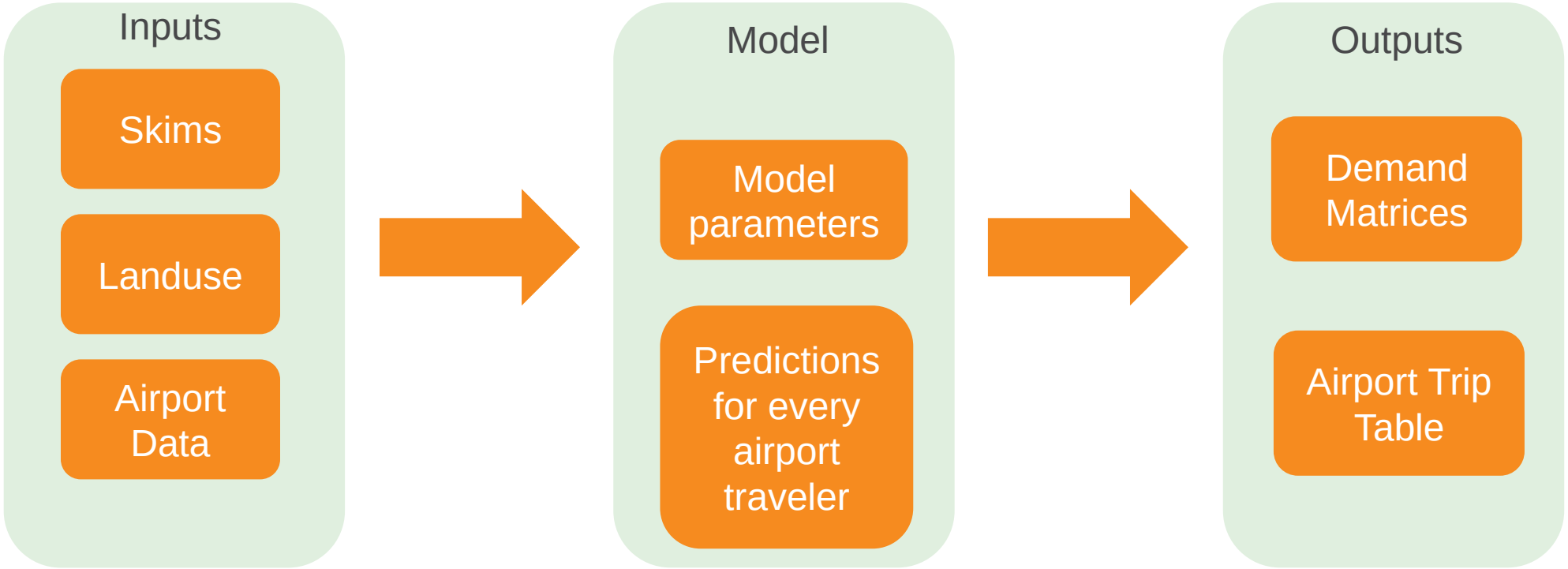
Summary

Derived input distributions from observed airport data

Modeled how people got to the airport and where they came from

Have output fed back into the SeaCast modeling and assignment

All the code and model parameters live in SeaCast / scripts / airport /



Q & A

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