

# Analysis and Modeling of Trip Chaining and Mode Choice in a Transit-Rich region

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# Tour Formation and Mode Choice are the most fundamental components in Travel Demand Models...

## □ Tour Formation

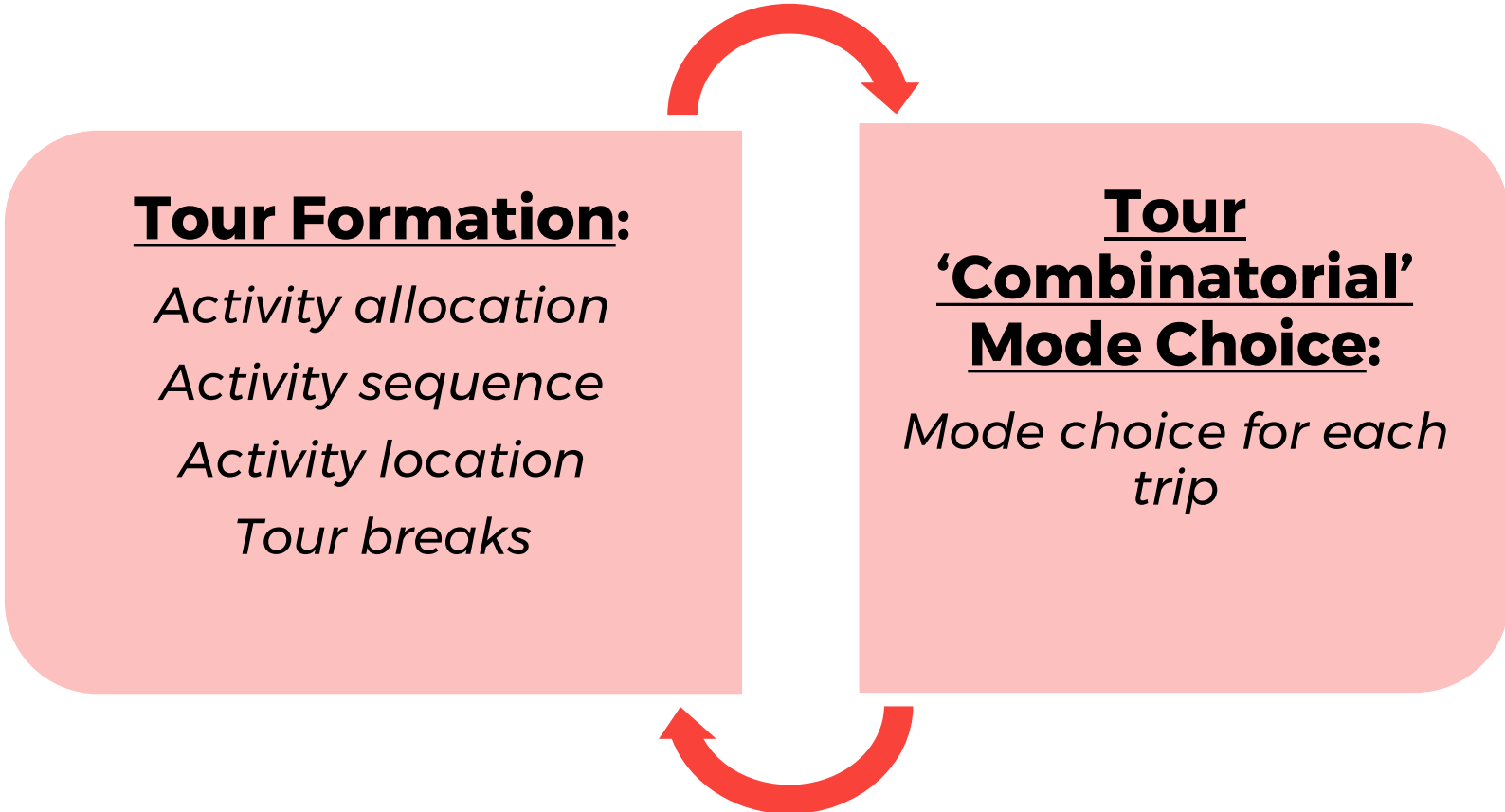
- *Combination of a sequence of steps involved in creating tours*
- *Tour characteristics can be:*
  - *Daily activity pattern*
  - *Number of tours*
  - *Stop frequency*
  - *Stop sequence, stop location, etc.*

## □ Tour Mode

- *Summary of mode choice of each trip on the tour: 'combinatorial'*

Trip Modes Examples	Combinatorial Tour Mode
Drive Alone - DA - DA	Driver
Transit - Transit	Transit
Driver - Transit - Transit - Driver	PNR

# In reality, people make the two decisions jointly...



# There are two types of ABMs in practice. However, both fall short in certain cases...

Existing Models	Description	Limitations
Most ABMs (e.g. CT-RAMP)	Tour mode choice first based on origin and primary destination, followed by inserting stops onto tours	Cannot explain cases where important stops affect mode choice (e.g. school escorting stops), see <b>1</b>
More advanced ABMs (e.g. CT-RAMP2)	A chain of trip destinations first, followed by mode choice for each trip	Suppresses transit tours with multiple stops, see <b>2</b>



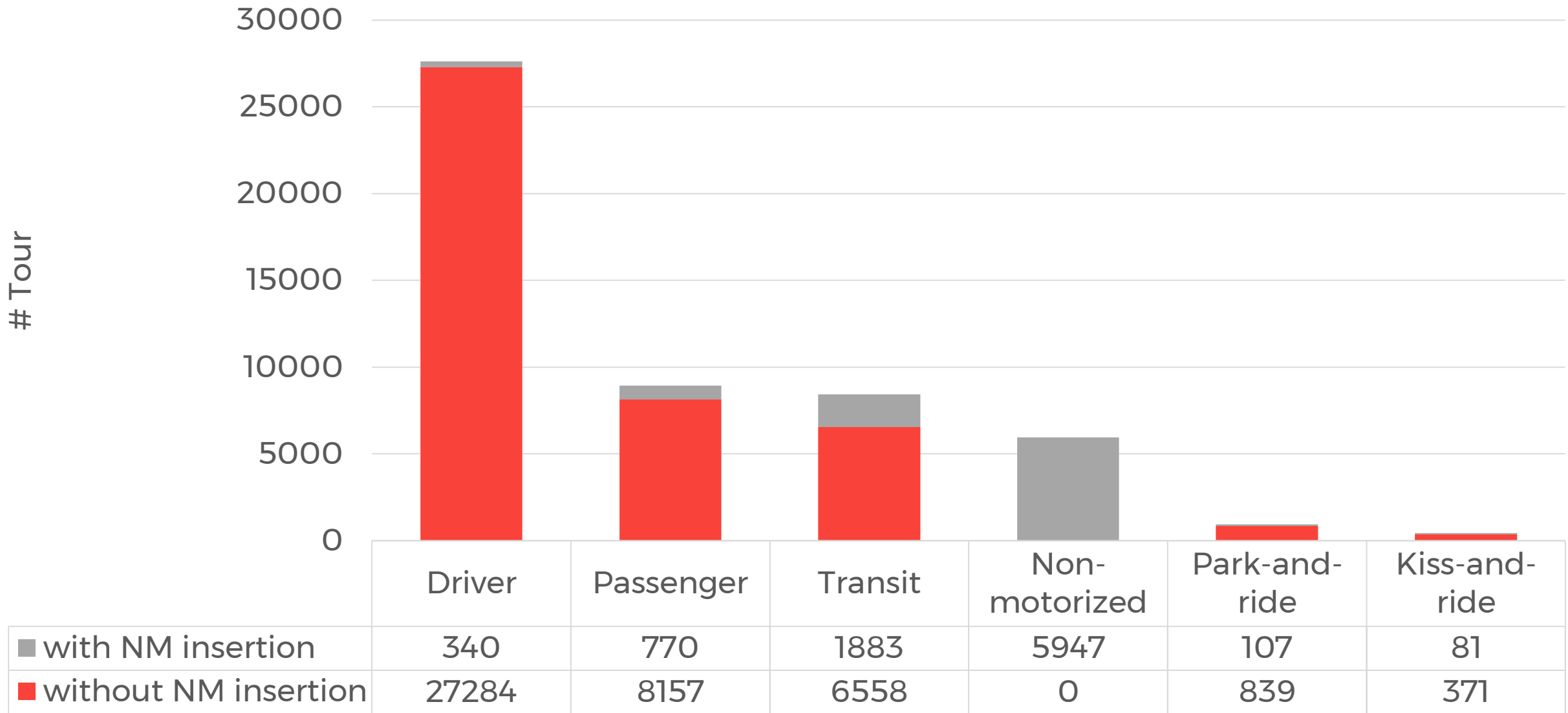
**This research used the 2010 NY Regional Household Travel Survey. Tour characteristics were defined as...**

Features in this research	Description
Anchor activity	Main travel purpose
Tour type	Joint travel structure of the tour
Number of stops by activity type (e.g. school escorting)	Tour skeleton and complexity
Tour length	Sum of all trips
Tour route deviation	Difference between tour length and direct roundtrip distance
Daily pattern	Placement of a tour in the individual's daily travel pattern
CBD	Location of tour origin and primary destination
Has non-motorized trip insertion	More detailed tour mode choice type

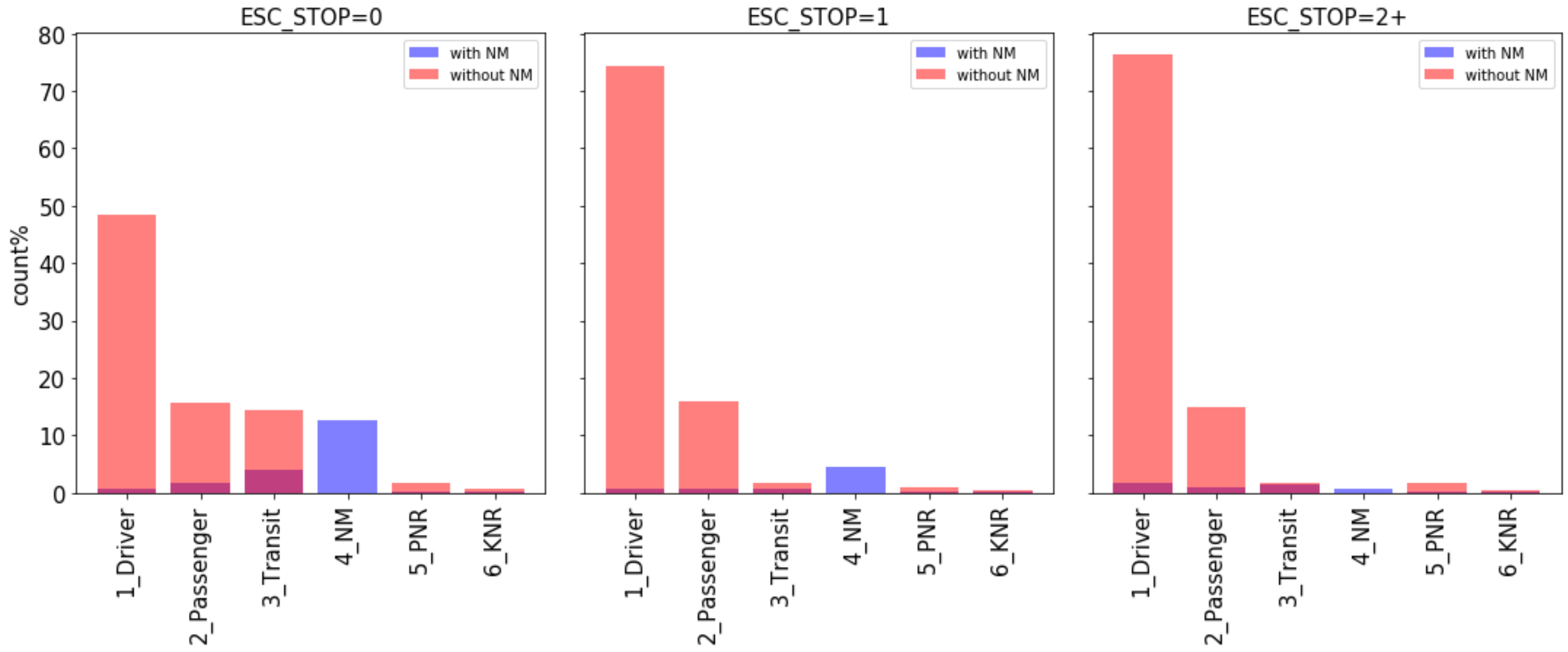
**Tour Mode Combination is defined as...**

<b>Combinatorial Tour Mode</b>	<b>Examples of Chains of Trip Modes</b>
1 = driver	Drive Alone - DA - DA Shared ride driver - DA
2 = driver with NM	DA - walk - walk - DA
3 = Passenger	Shared ride passenger - shared ride passenger
4 = Passenger with NM	Shared rider passenger - walk - shared rider passenger
5 = Transit	Transit - transit - transit
6 = Transit with NM	Transit - walk - walk - transit
7 = Non-motorized (NM)	Walk - walk - walk
8 = Park-and-ride	Driver - transit - transit - driver
9 = PNR with NM	Driver - transit - walk - walk - transit - driver
10 = Kiss and ride	Passenger - transit - transit
11 = KNR with NM	Passenger - transit - walk - transit

# Distribution of Tour Modes in Survey

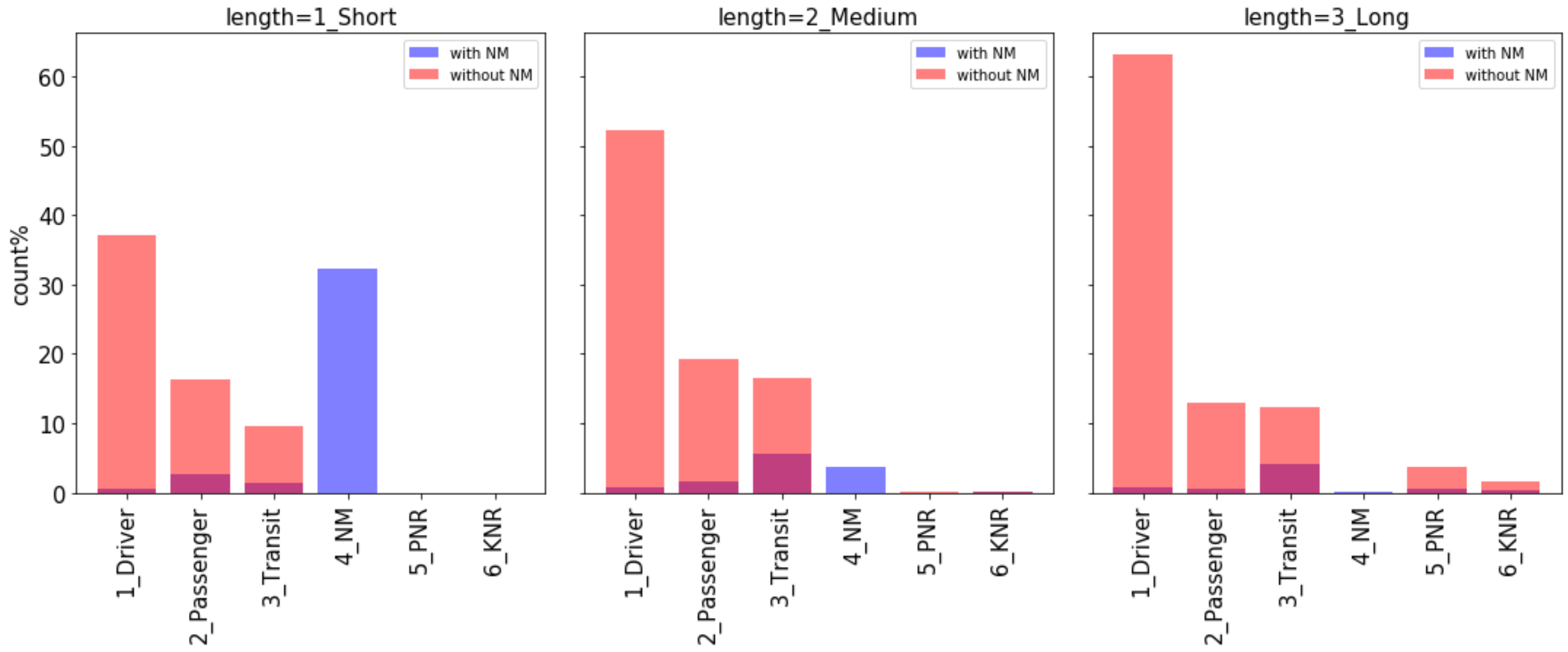


# Frequency distribution of combinations of Tour Characteristics and Tour Modes - Escorting Stop

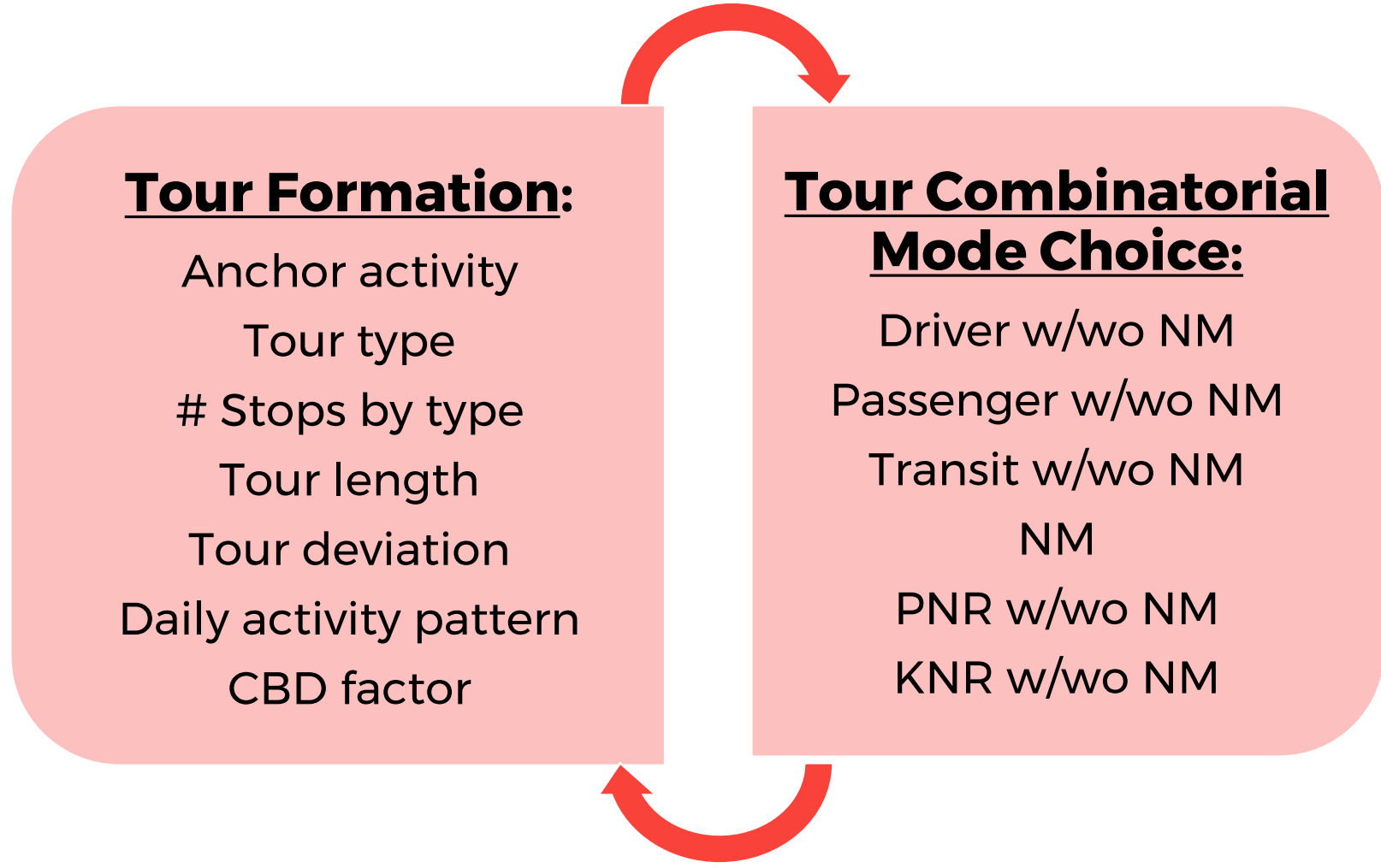




# Frequency distribution of combinations of Tour Characteristics and Tour Modes - Tour Length

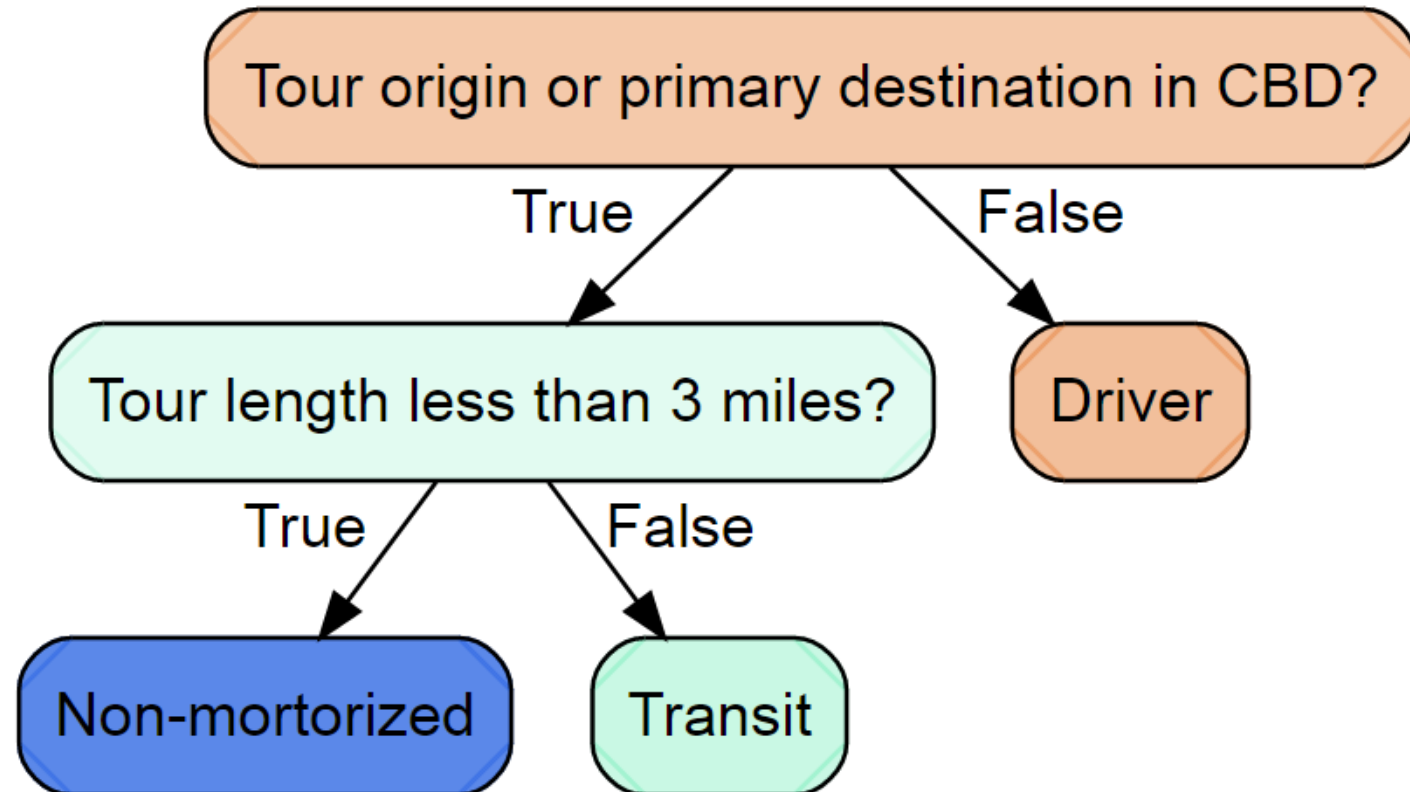


# Explore two-way causality using Machine Learning (tree-based) methods

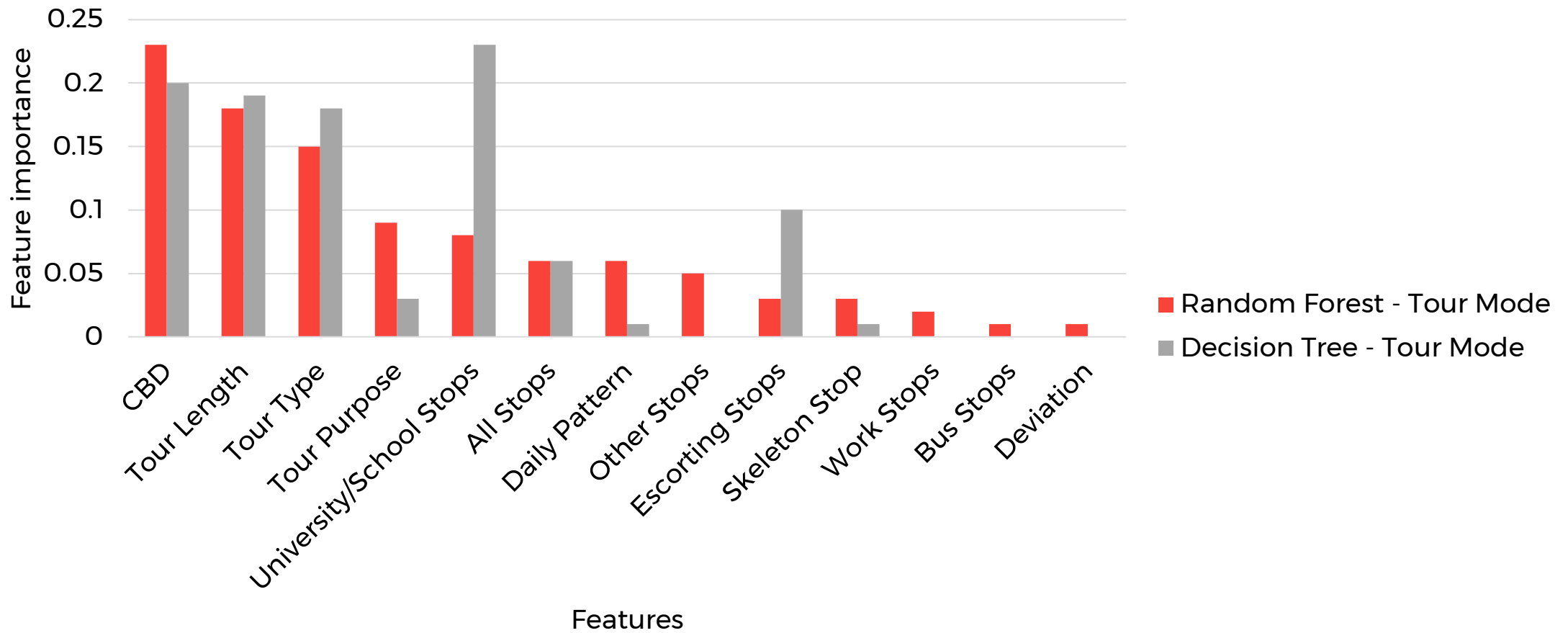


# Direction 1: Tour formation $\longrightarrow$ Tour Mode

## Example of decision tree branches for predicting Tour Mode

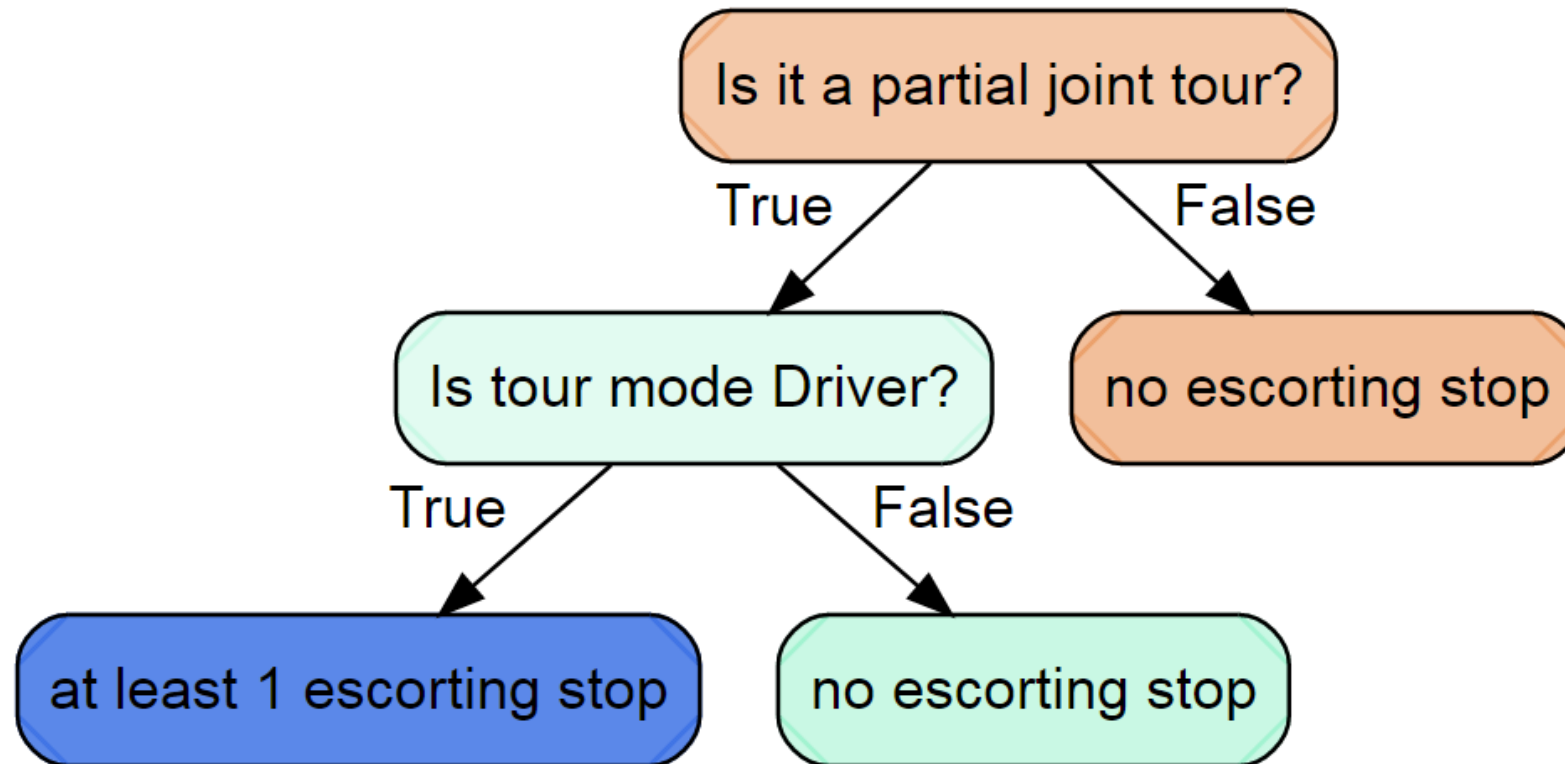


# Feature importance report for predicting Tour Mode based on tour characteristics

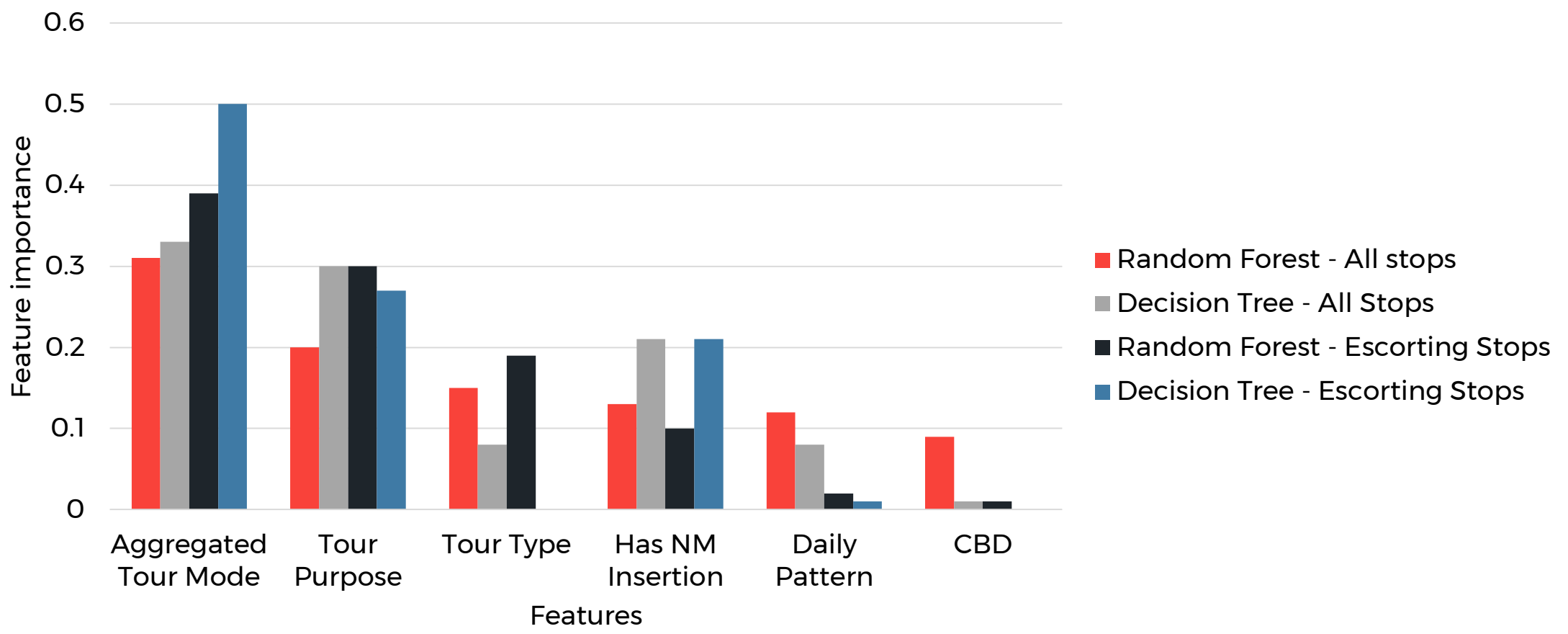


## Direction 2: Tour Mode $\longrightarrow$ Tour Formation

### Example of decision tree branches for predicting # Escorting Stops

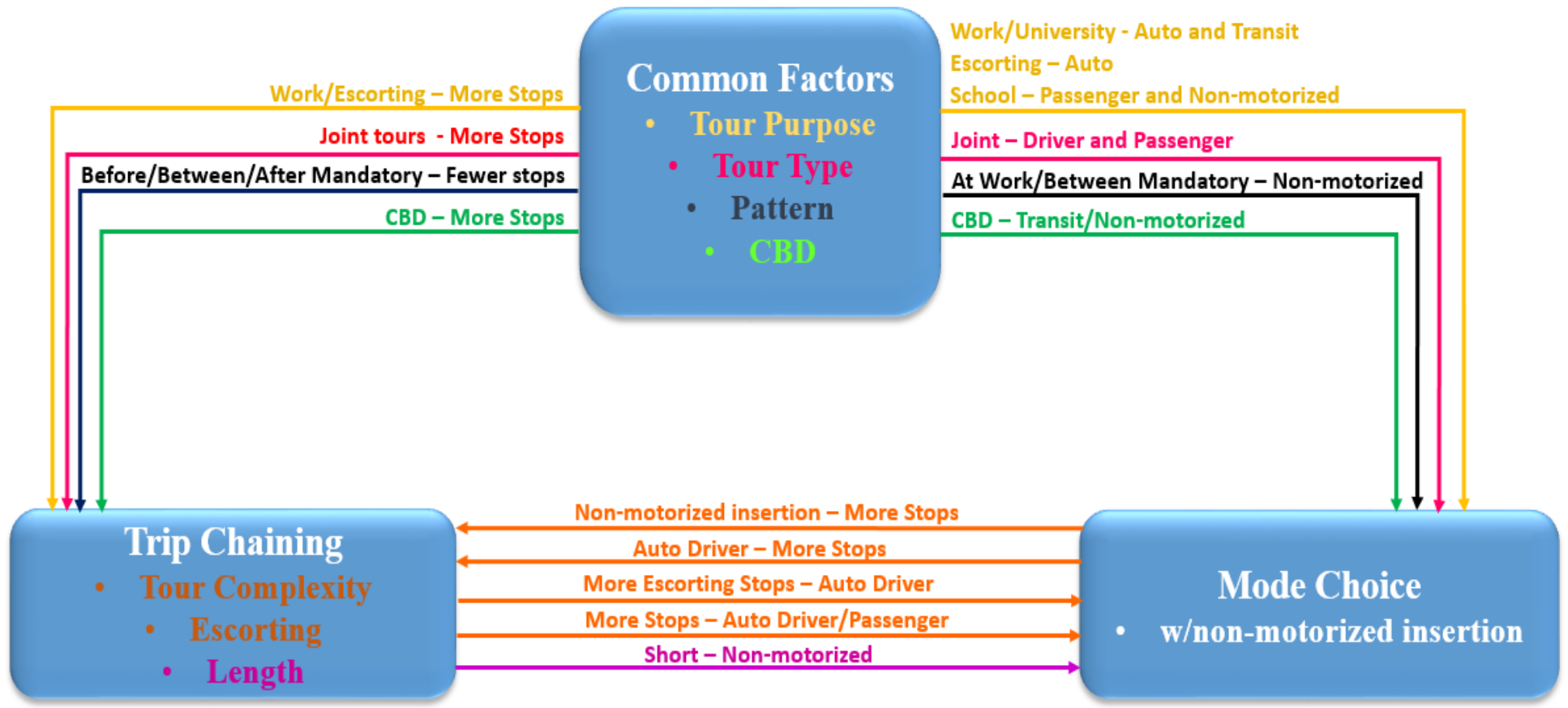


# Feature importance report for predicting number of all stops, and number of escorting stops



# Example of two-way interlinkage

- Common factors such as tour purpose can be used as external explanatory variables in both directions.

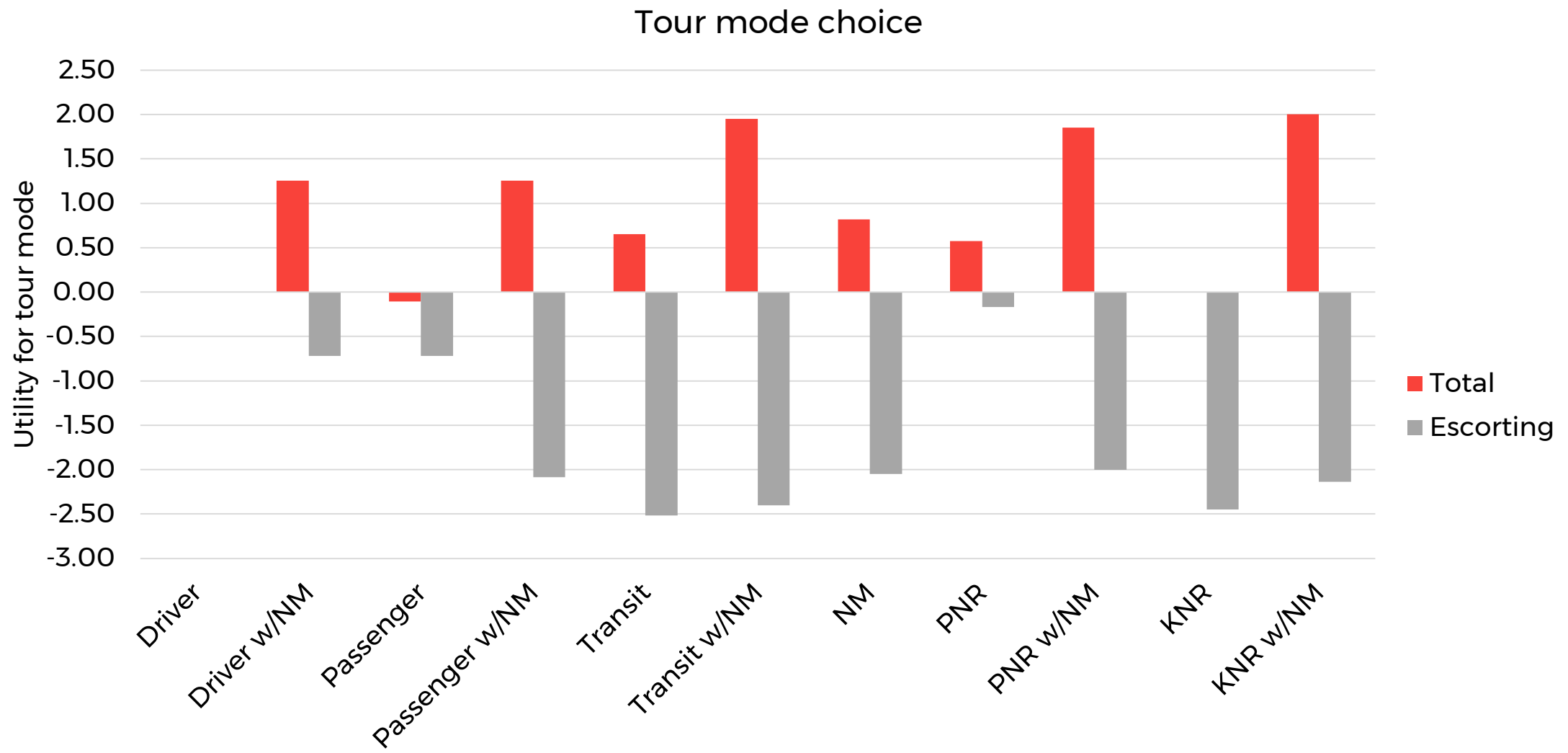


# Testing variables identified by ML in econometric model

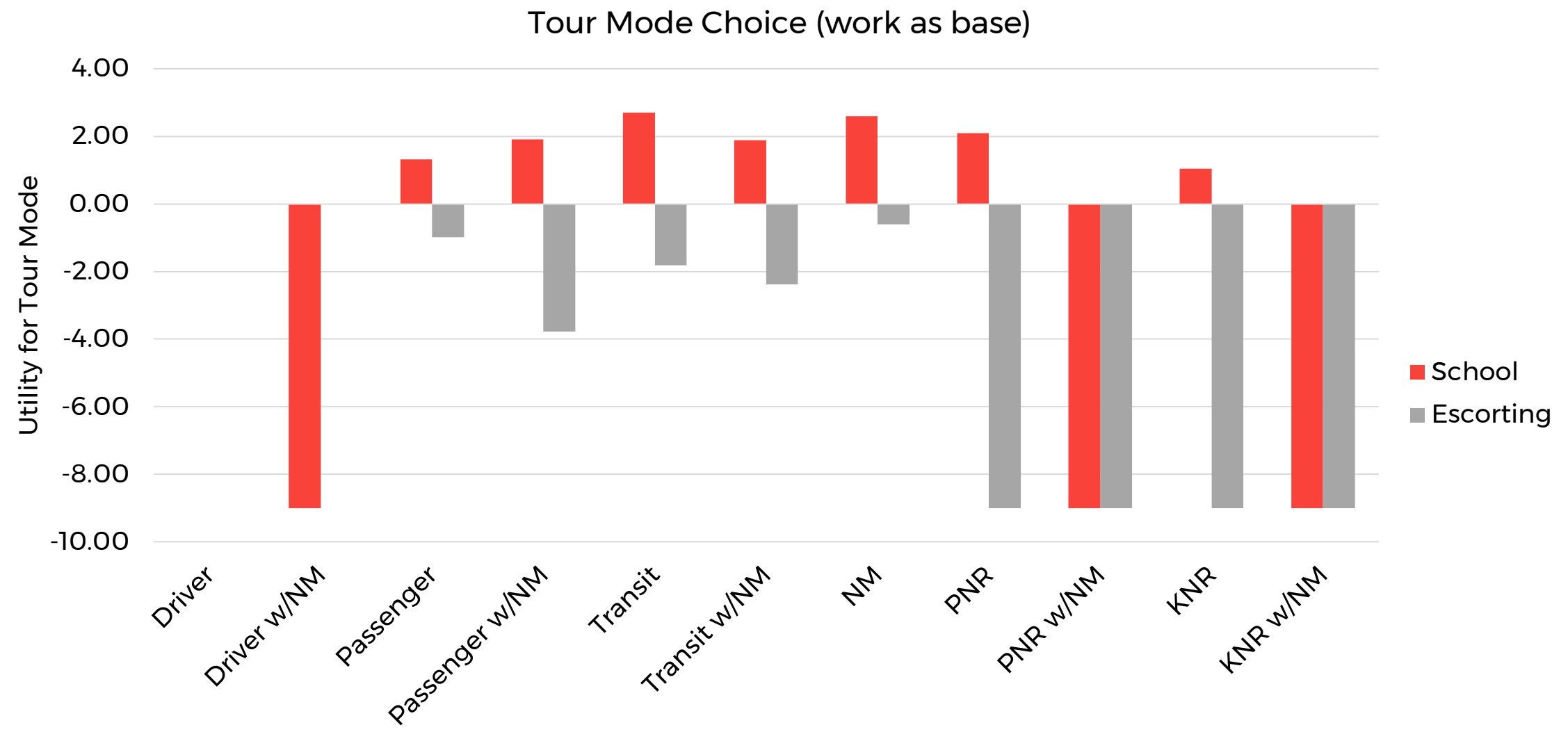
- ❑ Goal: get meaningful coefficients for planning application
- ❑ Independent variables:
  - *Tour characteristics:*
    - Anchor activity, daily activity pattern, tour joint type, CBD factor, tour length, # stops by types, tour deviation
  - *Level of service:*
    - In-vehicle travel time, out-of-vehicle travel time, cost, drive access time for transit
  - *Demographics:*
    - Household car sufficiency, household income, age
- ❑ Dependent variable:
  - *11 tour modes*



# Impact of # Stops on Tour Mode Choice

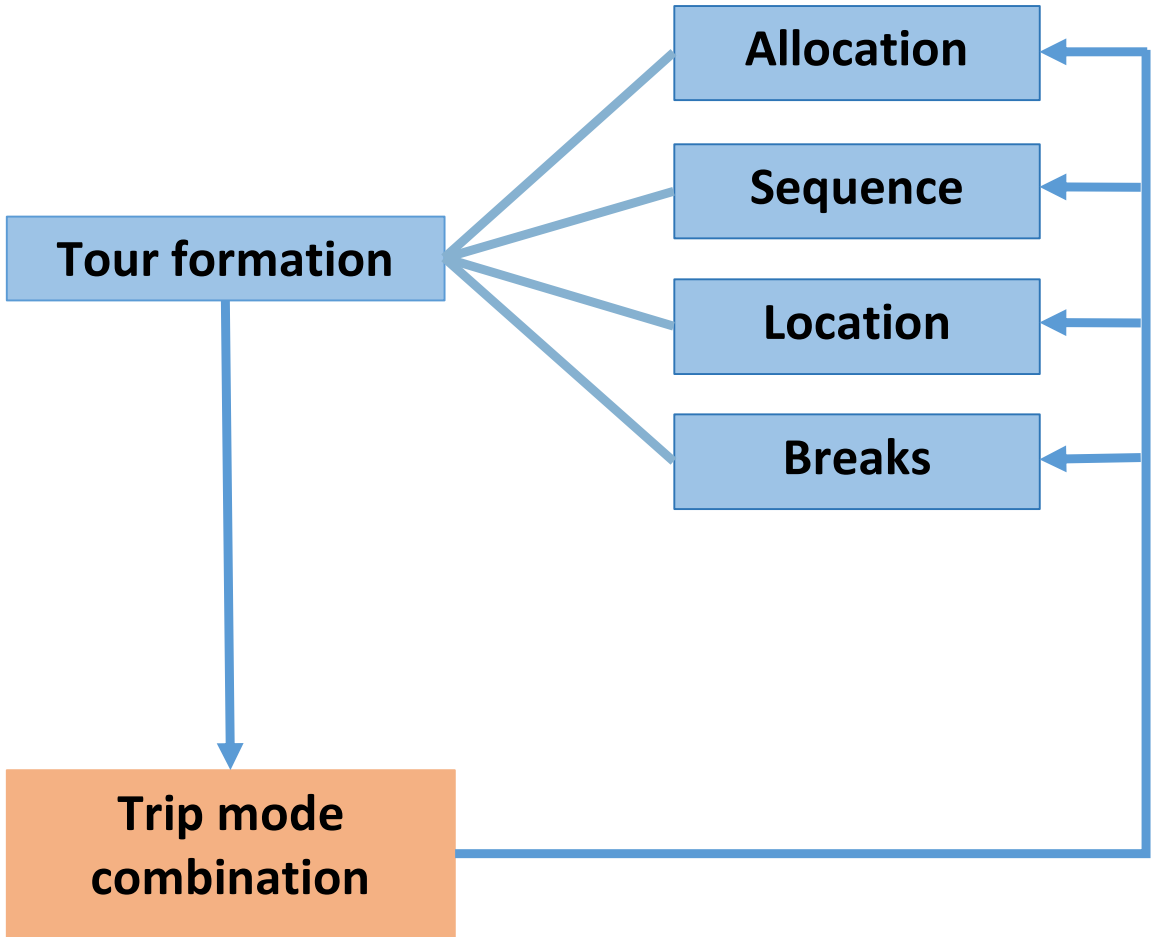


# Impact of Anchor Activity Type on Tour Mode Choice



# Possible Feedback Model Framework

Iterate until a tour's structure and mode become stable:



## Conclusion and future directions

- ❑ Tour formation and mode choice under trip chaining context
- ❑ Two-way causality between tour formation and mode choice
- ❑ Possibility to model the two-way causality
- ❑ More ABM details

Thank you! Questions?  
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