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The Role of Driver Attributes in Understanding Driver Behavior

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Outline

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  - Methods
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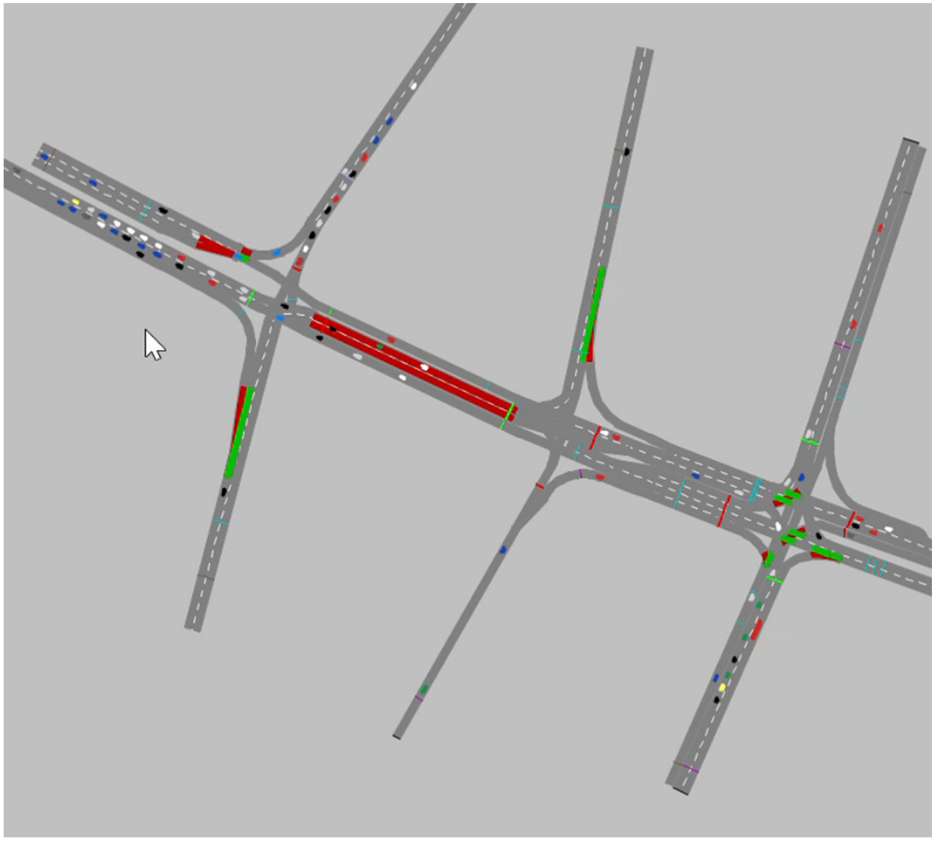
This research focuses on the application of the SHRP2 NDS **dataset to improve transportation operations decision support systems.**

Motivation

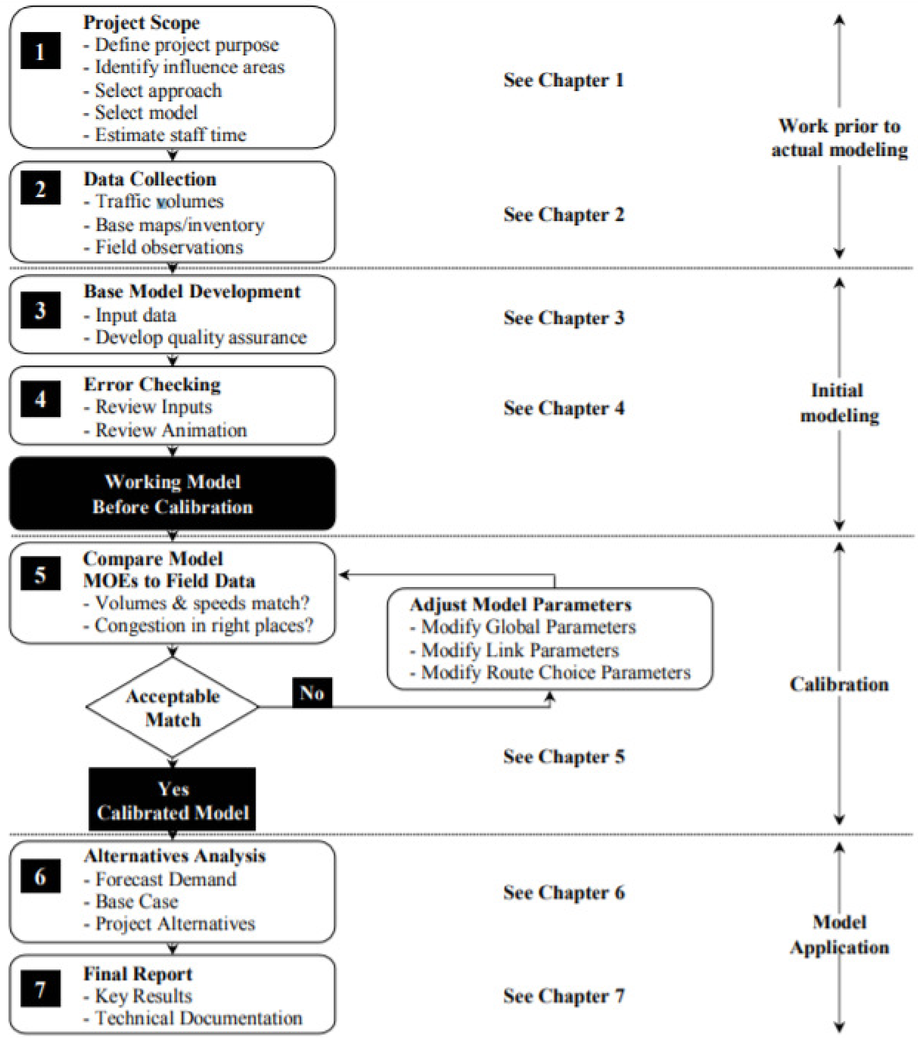
- Decision making tool
- Comprised of sub-models
- Car-following models: sub-second level acceleration behavior
- Traditional application: benefits estimation



Motivation

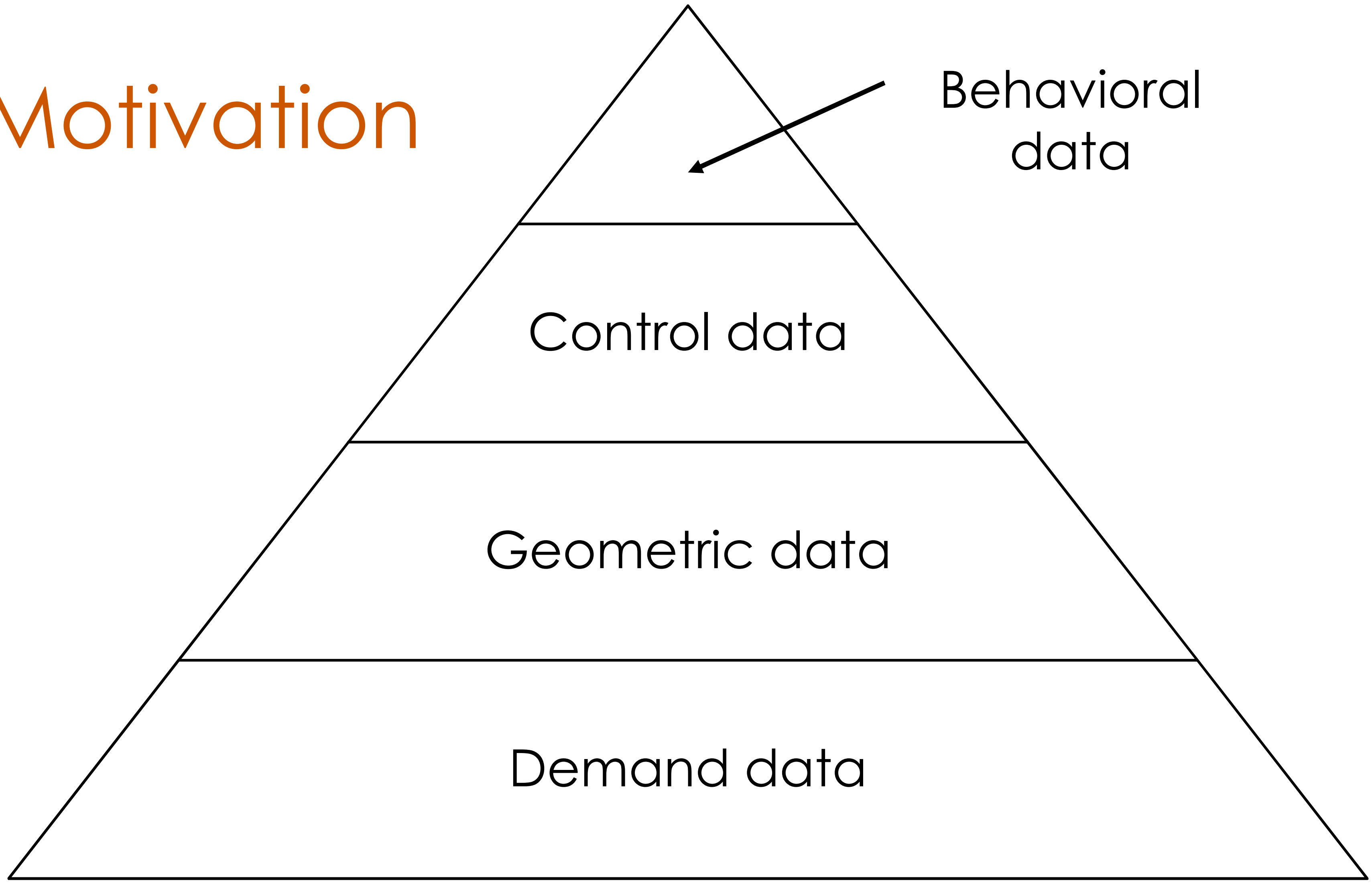
Required data:

- Demand
- Geometric
- Control
- Driver behavior



Developed by the FHWA Traffic Analysis Tools Team and later adapted from *Advanced Corsim Training Manual*, Short, Elliott, Hendrickson, Inc., Minnesota Department of Transportation, September 2003.

Motivation



Motivation

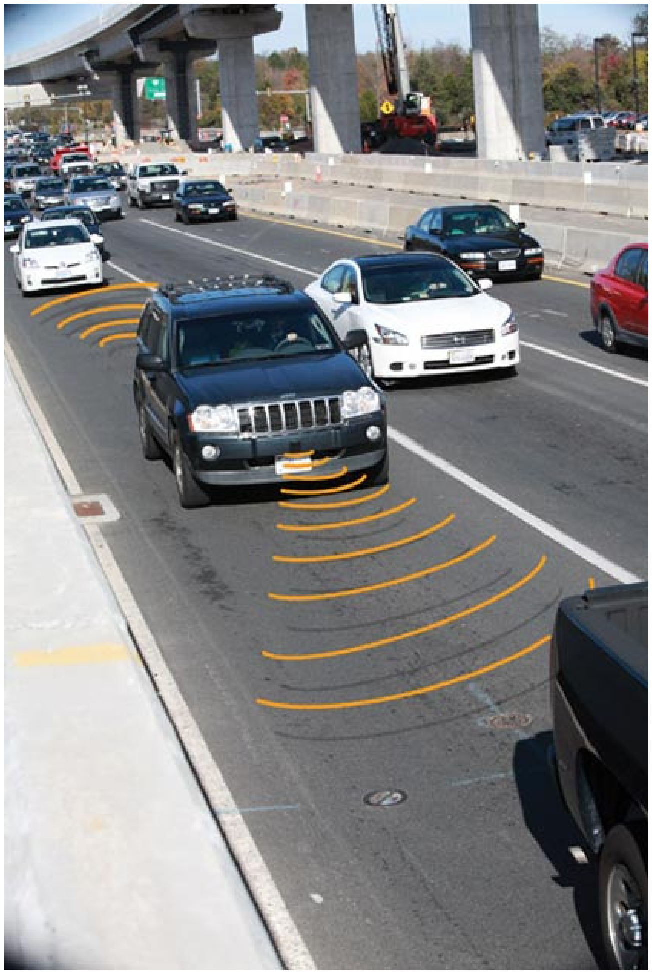
- Emerging applications of microsimulation results:
  - Modeling mixed-fleet vehicle interactions
  - Emissions modeling (MOVES)
  - Risk-based crash modeling (SSAM)

Accurately calibrated car-following models VERY important towards robust results of these analyses

Motivation

Two primary obstacles

- Complex optimization problem
- Availability of appropriate data
  - Loop detector
  - Aerial
  - IRV (SHRP 2)

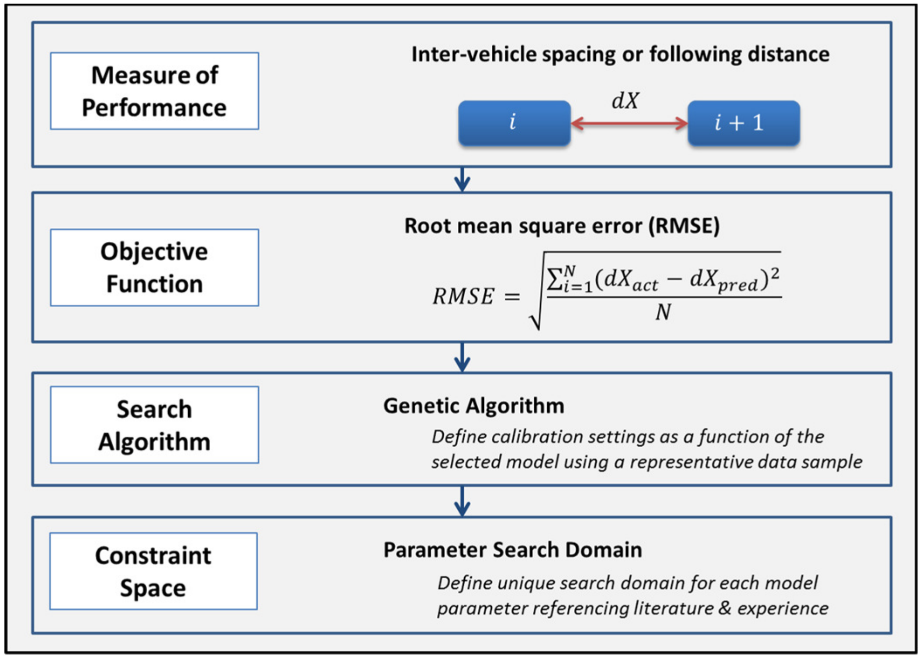


Data

- Wyoming Implementation Assistance Program
- Filter data: clear weather on freeways
- 691 trip sample
- 82 drivers

Data – Calibration Method

- Identify three CFMs
  - Safety distance CFM
  - Psychophysical CFM
  - Social force CFM
- Identify segments of CF
- Calibrate each trip
  - **Calibrated parameter sets used as surrogates for driver behavior**



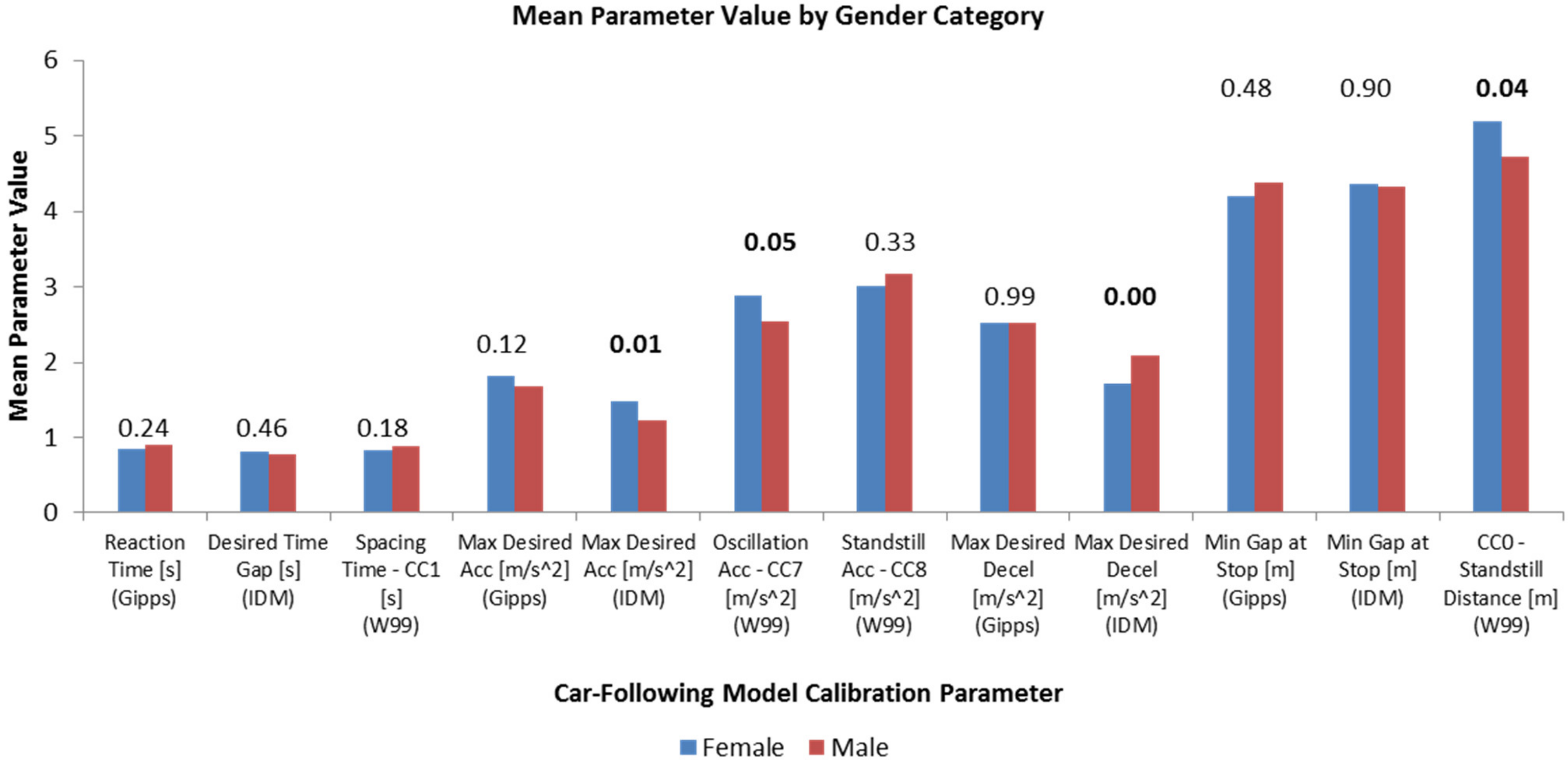
Research Questions

- Q1: Do different hypothesized groups of drivers exhibit statistically significant differences in driving behavior?
- Q2: Do different subgroups of drivers behave sufficiently similarly to be considered one homogenous group of drivers?

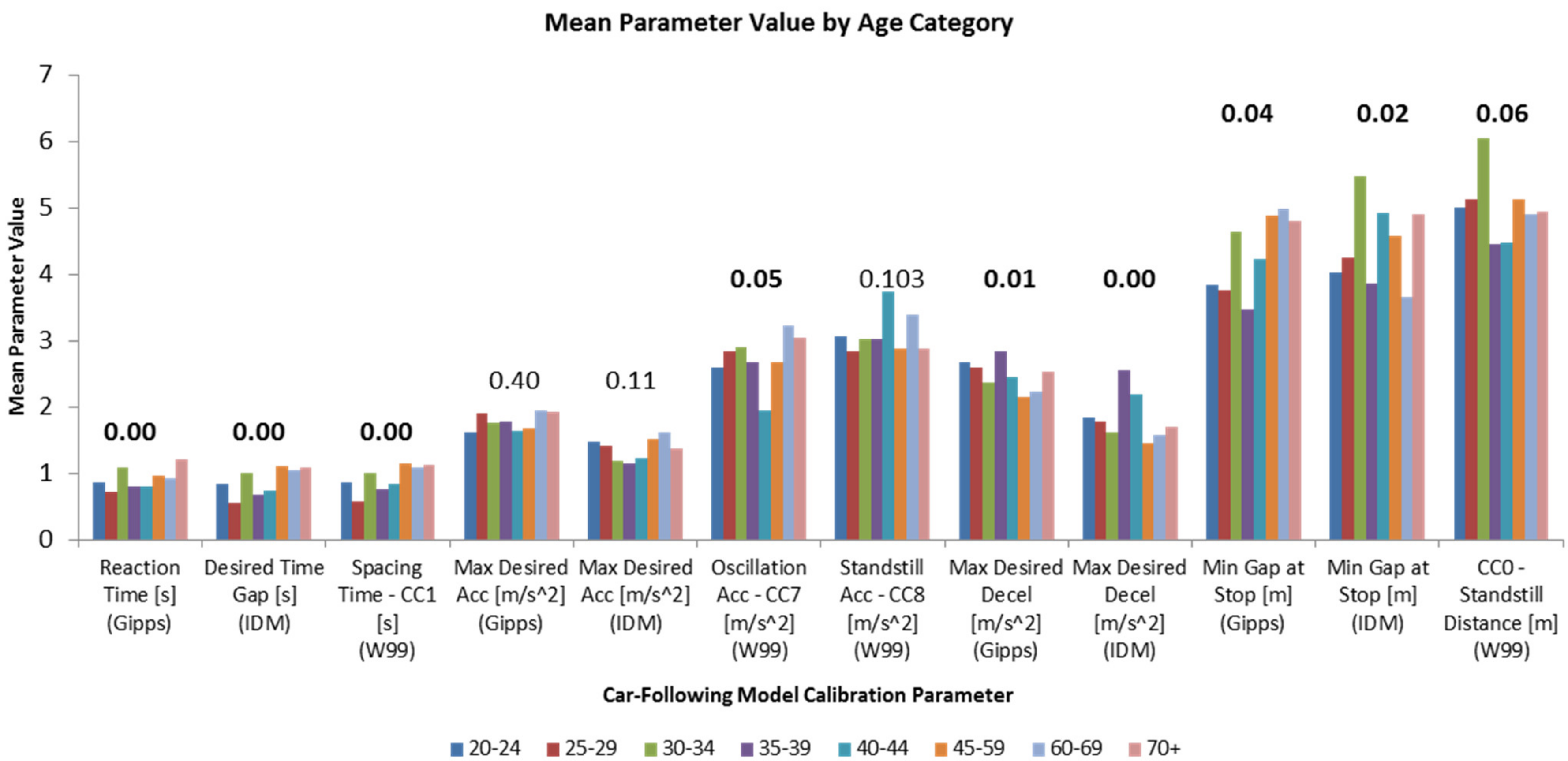
Q1 – Methods

- Identify set of critical driver attributes:
  - Gender
  - Age
  - Income
  - Miles driven last year
- Divide each attribute into subgroups
- ANOVA test

Q1 – Results


Mean Parameter Value by Gender Category
Mean Parameter Value
6
5
4
3
2
1
0
0.24
0.46
0.18
0.12
0.01
0.05
0.33
0.99
0.00
0.48
0.90
0.04
Reaction Time [s] (Gipps)
Desired Time Gap [s] (IDM)
Spacing Time - CC1 [s] (W99)
Max Desired Acc [m/s^2] (Gipps)
Max Desired Acc [m/s^2] (IDM)
Oscillation Acc - CC7 [m/s^2] (W99)
Standstill Acc - CC8 [m/s^2] (W99)
Max Desired Decel [m/s^2] (Gipps)
Max Desired Decel [m/s^2] (IDM)
Min Gap at Stop [m] (Gipps)
Min Gap at Stop [m] (IDM)
CC0 - Standstill Distance [m] (W99)
Car-Following Model Calibration Parameter
Female
Male

Q1 – Results


Mean Parameter Value by Age Category
Mean Parameter Value
0
1
2
3
4
5
6
7
0.00
0.00
0.00
0.40
0.11
0.05
0.103
0.01
0.00
0.04
0.02
0.06
Reaction Time [s] (Gipps)
Desired Time Gap [s] (IDM)
Spacing Time - CC1 [s] (W99)
Max Desired Acc [m/s^2] (Gipps)
Max Desired Acc [m/s^2] (IDM)
Oscillation Acc - CC7 [m/s^2] (W99)
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Max Desired Decel [m/s^2] (IDM)
Min Gap at Stop [m] (Gipps)
Min Gap at Stop [m] (IDM)
CC0 - Standstill Distance [m] (W99)
Car-Following Model Calibration Parameter
20-24
25-29
30-34
35-39
40-44
45-59
60-69
70+

Q1 – Summary

- Significant differences in driver behavior between hypothesized subgroups:
  - Miles driven last year
  - Age
  - Income
- Differences in behavior attributable to gender not statistically significant

Research Questions

- Q1: Do different hypothesized groups of drivers exhibit statistically significant differences in driving behavior?
- Q2: Do different subgroups of drivers behave sufficiently similarly to be considered one homogenous group of drivers?

Q2 - Methods

Clustering

- Expectation Maximization algorithm

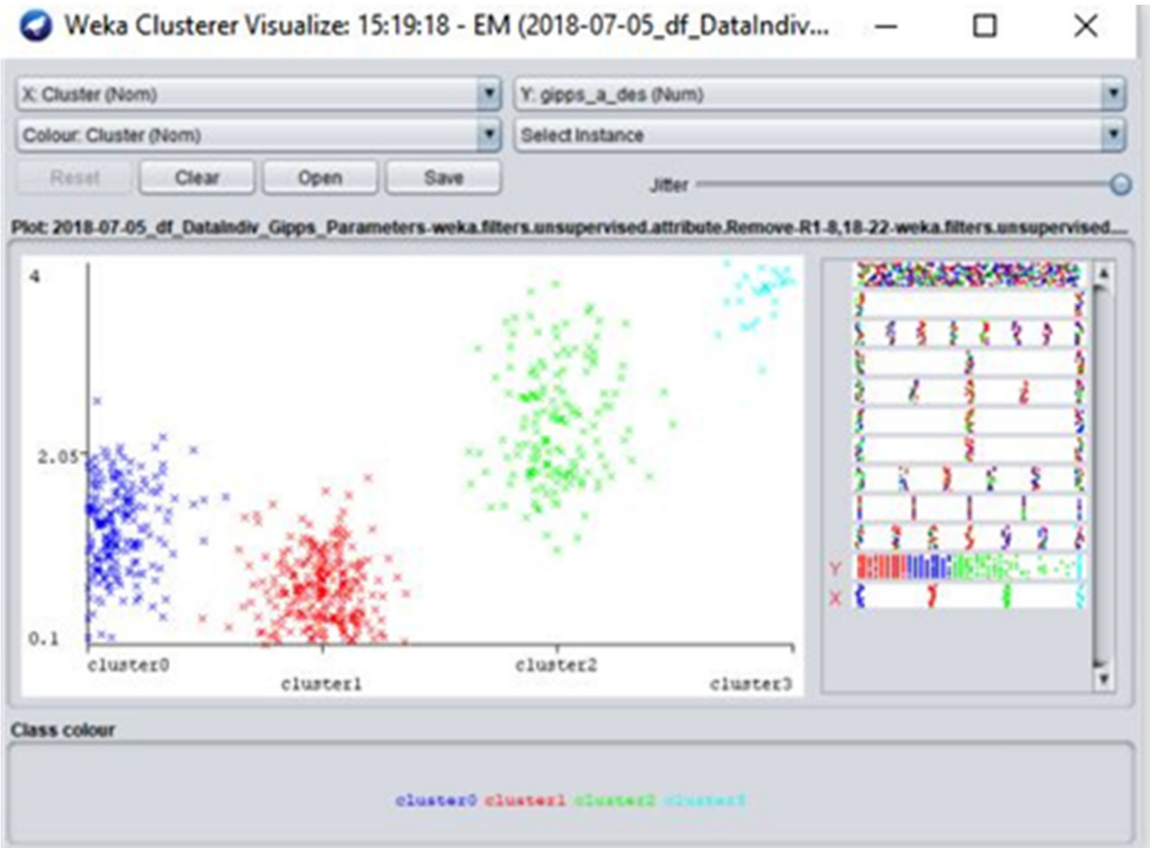
Attribute Selection

- CfsSubsetEval algorithm

Classification

- ZeroR algorithm
- OneR algorithm
- PART Decision Rules algorithm
- J48 Decision Tree algorithm

Q2 - Methods



Assign each trip to a cluster using calibrated parameters

Classify each trip into a cluster ID using driver attributes

Q2 - Results

- Most commonly selected attributes
  - Age
  - Income
  - Marital status

- Least commonly selected attributes
  - Gender
  - Work status
  - Living status

Q2 – Desired Velocity Results

Model Calibration Parameter	Optimal Clusters	Baseline Accuracy Rate	Best Model Accuracy Rate	% Difference (from baseline)	Best Model
Gipps	5	229	360	57%	J48
IDM	5	194	332	71%	J48
W99	4	288	412	43%	PART

Q2 – Standstill Distance Results

Model Calibration Parameter	**Optimal Clusters**	**Baseline Accuracy Rate**	**Best Model Accuracy Rate**	**% Difference (from baseline)**	**Best Model**
Gipps	6	172	182	6%	PART
IDM	4	316	311	-2%	PART
W99	6	163	201	23%	OneR

Q2 – Summary

- Evidence that some drivers behave sufficiently similar to one another—and sufficiently different from drivers belonging to a different group—to be considered a homogenous group of drivers

- Driver specific attributes can be carefully utilized to classify drivers into homogenous driver groups

Conclusions

- A modeler may not need to model every single driver differently to properly calibrate the driving behavior component of microsimulation.
- Modelers may be able to improve the realism of their models, by accounting for heterogeneity, without significantly increasing the complexity of their effort.

Future Work

- Census-level demographics data can be used to divide the driving population into homogenous groups of driving behavior.
- Future work:
  - Calibrate each homogenous group of drivers.
  - Develop new framework for the calibration of a microsimulation network using the proportion of expected drivers belonging to a homogenous driver group.

Thank you! Any Questions?

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