Characterizing Level 2 Automation in a Naturalistic Driving Fleet
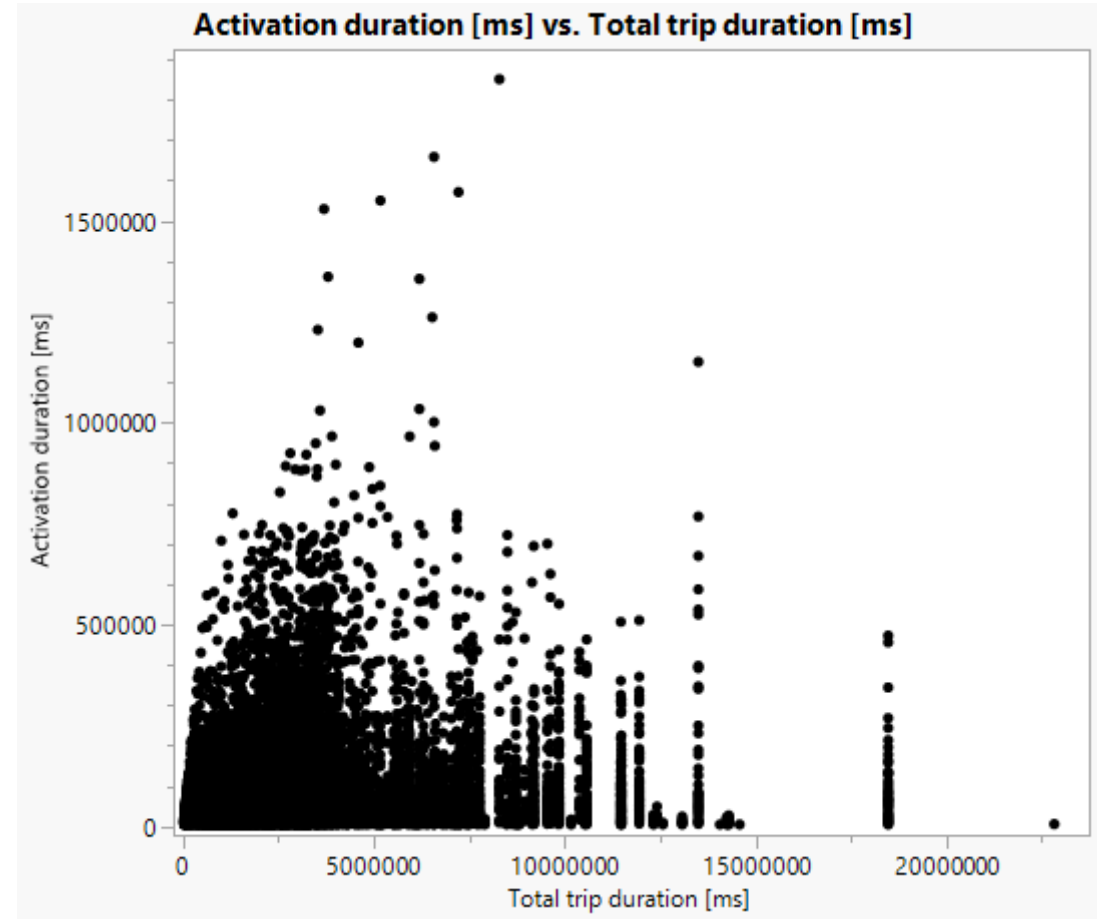
Data exercises solutions

(using JMP Pro 16)

Approach 1: Regression

Activation duration [ms] vs. Total trip duration [ms]

Code to generate plot

```
Graph Builder(
        Size( 534, 456 ),
        Show Control Panel( 0 ),
        Show Legend( 0 ),
        Variables(
                X( :"Total trip duration [ms]"n ),
                Y( :"Activation duration [ms]"n )
        ),
        Elements( Points( X, Y, Legend( 3 ) ) )
)
```

Note: Remove "no activation" entries on the table before the analysis

Approach 1: Regression

- Linear model can be run but has limited applicability
  - There is substantial additional variability that is not explainable by a linear model
- Total trip duration [ms] = 3142104.8 + 1.8417887*Activation duration [ms]
- R-square: 0.00441, significant, p<0.0001

Code to generate analysis

```
Bivariate(
        Y( :"Total trip duration [ms]"n ),
        X( :"Activation duration [ms]"n ),
        Fit Line( {Line Color( {212, 73, 88} )} )
)
```

Approach 2: ANOVA

Hands-off-wheel time [sec] vs. Lateral warning provided [5 sec]
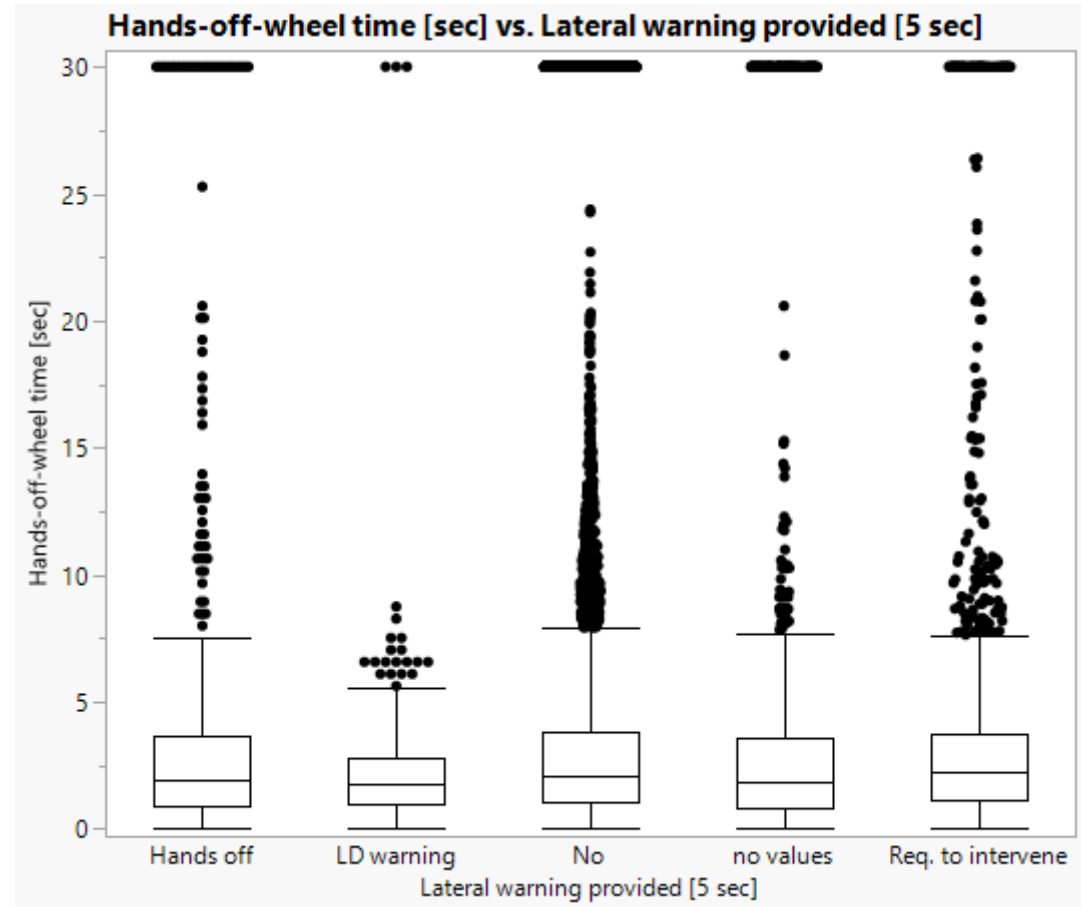
Code to generate plot

```
Graph Builder(
        Size( 528, 450 ),
        Show Control Panel( 0 ),
        Show Legend( 0 ),
        Variables(
                X( :"Lateral warning provided [5 sec]"n ),
                Y( :"Hands-off-wheel time [sec]"n )
        ),
        Elements( Box Plot( X, Y, Legend( 5 ) ) )
);
```

Note: Change "Always contact" values in the "Hands-off-wheel time [sec]" variable to either be missing, or 30 sec. The latter was done for this analysis

Approach 2: ANOVA

- "Lateral warning provided [5 sec]" is a significant factor for the "Hands-off-wheel time [sec]" dependent variable
  - F-Ratio: 10.1692, $p < 0.0001$
- Tukey HSD test

Level				Least Sq Mean
No	A			4.3880382
no values	A	B		4.3320181
Hands off	A	B		4.0460017
Req. to intervene		B		3.8415979
LD warning			C	2.3207674

Code to generate analysis

```
Fit Model(
        Y( :"Hands-off-wheel time [sec]"n ),
        Effects( :"Lateral warning provided [5 sec]"n ),
        Personality( "Standard Least Squares" ),
        Emphasis( "Effect Leverage" ),
        Run(
                :"Hands-off-wheel time [sec]"n << {Summary of Fit( 1 ),
                Analysis of Variance( 1 ), Parameter Estimates( 1 ), Lack of Fit( 0 ),
                Scaled Estimates( 0 ), Plot Actual by Predicted( 1 ), Plot Regression( 0 ),
                Plot Residual by Predicted( 1 ), Plot Studentized Residuals( 0 ),
                Plot Effect Leverage( 1 ), Plot Residual by Normal Quantiles( 0 ),
                Box Cox Y Transformation( 0 ), {:"Lateral warning provided [5 sec]"n <<
                {LSMeans Tukey HSD( 0.05 )}}}
        )
);
```

Approach 3: Frequency analysis

- Yes, the chi square test for the relationship is significant (p<0.0001)
  - Requests to intervene seem to be more common in cases where a curve is present
  - Similar trend for Hands off warnings
  - No lateral warnings seem to be more likely to be provided in cases when there is not a curve present

Contingency Analysis of Lateral warning provided [5 sec] By Curve presence

Mosaic Plot
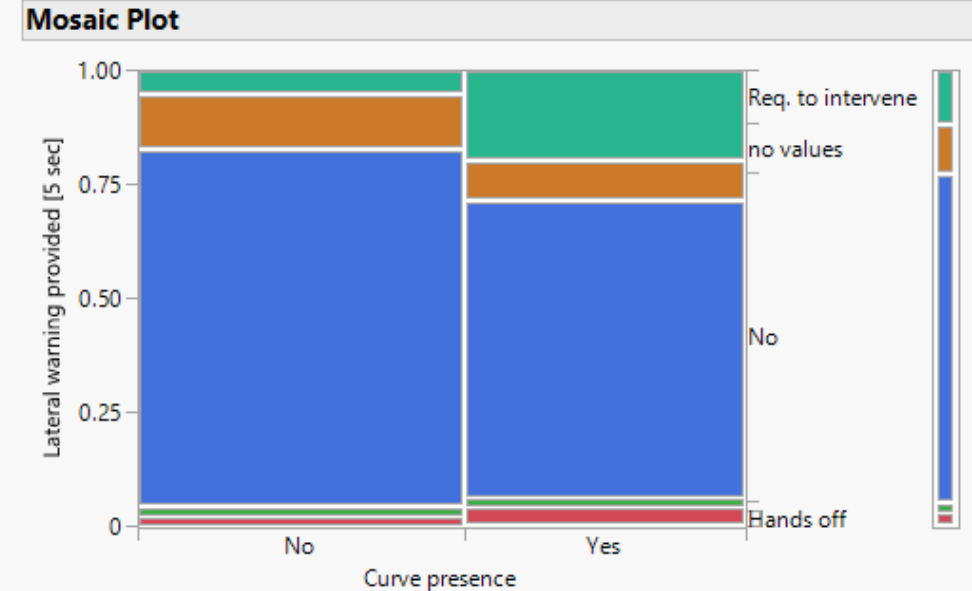
Contingency Table

Lateral warning provided [5 sec]

Count Total % Col % Row %	Hands off	LD warning	No	no values	Req. to intervene	Total
No	210	234	7801	1222	504	9971
	1.14	1.26	42.17	6.61	2.72	53.90
	35.00	62.57	58.41	61.56	23.06	
	2.11	2.35	78.24	12.26	5.05	
Yes	390	140	5554	763	1682	8529
	2.11	0.76	30.02	4.12	9.09	46.10
	65.00	37.43	41.59	38.44	76.94	
	4.57	1.64	65.12	8.95	19.72	
Total	600	374	13355	1985	2186	18500
	3.24	2.02	72.19	10.73	11.82	

Tests

N	DF	-LogLike	RSquare (U)
18500	4	561.47853	0.0331

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1122.957	<.0001*
Pearson	1090.858	<.0001*

Code to generate analysis

```
Contingency(
        Y( :"Lateral warning provided [5 sec]"n ),
        X( :Curve presence ),
        Contingency Table
);
```