VariableSelection_Snedden

Madeline Snedden

The Dataset

This comes from the New York State Department of Environmental Conservation (NYSDEC), which from 2022-2024 collected data on the location and usage of medium- and heavy-duty vehicles operated by private and government entities throughout the state of New York. The goal of this project was to inform zero-emission vehicle infrastructure planning decisions.

```
nycars <- read.csv("nycars_clean.csv")
nycars$OrgID <- as.factor(nycars$OrgID)
nycars$ParentBodyID <- as.factor(nycars$ParentBodyID)
nycars$NAICSCode <- as.factor(nycars$NAICSCode)
nycars$NAICS_2 <- as.factor(nycars$NAICS_2)
nycars$FacilityID <- as.factor(nycars$FacilityID)
nycars$FacilityZIP <- as.factor(nycars$FacilityZIP)
nycars$DieselInfrastructure <- as.factor(nycars$DieselInfrastructure)
nycars$GasolineInfrastructure <- as.factor(nycars$GasolineInfrastructure)
nycars$NGInfrastructure <- as.factor(nycars$NGInfrastructure)
nycars$ChargingInfrastructure <- as.factor(nycars$ChargingInfrastructure)
nycars$HydrogenInfrastructure <- as.factor(nycars$HydrogenInfrastructure)
nycars$OtherInfrastructure <- as.factor(nycars$OtherInfrastructure)
nycars$WeightClassBinCode <- as.factor(nycars$WeightClassBinCode)
nycars$FF_Infrastructure <- as.factor(nycars$FF_Infrastructure)
nycars$Alt_Infrastructure <- as.factor(nycars$Alt_Infrastructure)
```

Data Collection Methodology

Medium- and heavy-duty vehicles are defined as vehicles with a gross-vehicle weight rating of 8,500 pounds or more. Entities who operated these vehicles completed a reporting form at https://dec.ny.gov/environmental-protection/air-quality/controlling-motor-vehicle-

[pollution/heavy-duty-vehicles#ACT.](pollution/heavy-duty-vehicles#ACT) A guidance document is also available at this website, but because this data is all self-reported, some errors may exist.

There are several fields in the reporting form where entities could enter free text to explain their answers; NYSDEC staff used these comments to update some data fields and annotated the entry to mark those fields as changed.

The reporting form also has fields for personal information (such as names, phone numbers, email addresses), which have been redacted in the public dataset. Confidential business information that was submitted with the reporting form has also been redacted upon request.

Results

The final dataset consists of 13,213 entries for 70 variables, including:

- Identifiers (IDs, names, parent companies) (not using)

- Organization characteristics (industry, ownership, jurisdiction)

```
nycars$Revenue2021 <- factor(nycars$Revenue2021, levels=c("N/A", "Less than $10M", "$10-

industries <- data.frame(
  code = c('11', '21', '22', '23', '31',
           '42', '44', '48', '51', '52',
           '53', '54', '55', '56', '61',
           '62', '71', '72', '81', '92','99'),
  def = c('Agriculture', 'Mining', 'Utilities', 'Construction', 'Manufacturing',
          'Wholesale', 'Retail','Transportation','Information','Finance',
          'RealEstate','Science','Management','WasteManagement','EducationalServices',
          'HealthCare','ArtsEntertainment','Accommodation','Other','PublicAdministration

library(vtable)
```

```
Loading required package: kableExtra
```

```
sumtable(nycars, vars=c("OrgType", "Revenue2021"), group="LEM")
```

```
sumtable(nycars, vars="NAICS_2", group="LEM", labels=industries)
```

- How many entities they deliver to, how many subhaulers are contracted, and the number of vehicles operated by those subhaulers

```
nycars$ContractedEntities <- factor(nycars$ContractedEntities, levels=c("N/A", "1 to 10'

nycars$SubhaulersContracted <- factor(nycars$SubhaulersContracted, levels=c("N/A", "1 to
```

Table 1: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
OrgType	2116		39		8082	
... GovernmentAgency	889	42%	10	26%	4442	55%
... PrivateCompany	857	41%	29	74%	3410	42%
... PublicBenefitCorporation	370	17%	0	0%	230	3%
Revenue2021	1906		39		7478	
... N/A	1304	68%	10	26%	4625	62%
... Less than $10M	0	0%	0	0%	58	1%
... $10-$49M	35	2%	0	0%	321	4%
... $50-$99M	12	1%	0	0%	242	3%
... $100-$499M	336	18%	15	38%	610	8%
... $500-999M	0	0%	0	0%	0	0%
... More than $1000M	219	11%	14	36%	1622	22%

```
nycars$SubhaulerVehicleCount <- factor(nycars$SubhaulerVehicleCount, levels=c("N/A", "0"

sumtable(nycars,vars=c("ContractedEntities","SubhaulersContracted","SubhaulerVehicleCoun
```

- Whether they have a sustainability plan, and whether that plan addresses options to reduce transportation emissions specifically

```
sumtable(nycars,vars=c("SustainabilityPlan","SustainabilityPlanTransportationEmissions")
```

- Facility location information and geospatial data (not using)

- Utility provider

```
nycars$FacilityType <- factor(nycars$FacilityType)
nycars$UtilityProvider <- factor(nycars$UtilityProvider)

sumtable(nycars,vars=c("FacilityType","OwnedLeased","UtilityProvider"),group="LEM")
```

- **Whether the facility has diesel, gasoline, natural gas, electric vehicle charging, hydrogen fueling, or any other type of fueling infrastructure (I'm interested in these as a main outcome)**

```
hist(c(nycars$FF_Sum), main="Histogram of number of fossil fuel infrastructure types at
```

Table 2: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
NAICS_2	1724		32		7490	
... 11	1	0%	0	0%	34	0%
... 21	0	0%	0	0%	54	1%
... 22	87	5%	0	0%	124	2%
... 23	528	31%	15	47%	732	10%
... 31	0	0%	0	0%	15	0%
... 32	0	0%	0	0%	94	1%
... 33	17	1%	0	0%	21	0%
... 42	2	0%	0	0%	363	5%
... 44	13	1%	0	0%	382	5%
... 45	6	0%	7	22%	59	1%
... 48	77	4%	0	0%	741	10%
... 49	15	1%	0	0%	863	12%
... 51	15	1%	0	0%	366	5%
... 52	2	0%	0	0%	26	0%
... 53	0	0%	0	0%	71	1%
... 54	0	0%	0	0%	14	0%
... 56	9	1%	0	0%	287	4%
... 61	193	11%	0	0%	144	2%
... 62	0	0%	0	0%	11	0%
... 71	120	7%	0	0%	252	3%
... 72	1	0%	0	0%	1	0%
... 81	52	3%	0	0%	150	2%
... 92	586	34%	10	31%	2684	36%
... 99	0	0%	0	0%	2	0%

Table 3: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
ContractedEntities	429		22		2111	
... N/A	0	0%	0	0%	0	0%
... 1 to 10	216	50%	0	0%	445	21%
... 11 to 20	39	9%	0	0%	83	4%
... 20 to 50	47	11%	15	68%	82	4%
... More than 50	127	30%	7	32%	1501	71%
SubhaulersContracted	213		7		1577	
... N/A	0	0%	0	0%	0	0%
... 1 to 10	173	81%	0	0%	575	36%
... 11 to 20	12	6%	0	0%	53	3%
... 20 to 50	11	5%	0	0%	22	1%
... More than 50	17	8%	7	100%	927	59%
SubhaulerVehicleCount	294		7		1688	
... N/A	0	0%	0	0%	0	0%
... 0	62	21%	0	0%	101	6%
... 1 to 10	153	52%	0	0%	346	20%
... 11 to 20	13	4%	0	0%	118	7%
... 20 to 99	38	13%	0	0%	219	13%
... 100 to 500	11	4%	0	0%	37	2%
... More than 500	17	6%	7	100%	867	51%

Table 4: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
SustainabilityPlan	2116		39		8082	
...	0	0%	0	0%	58	1%
... N/A	47	2%	0	0%	839	10%
... No	412	19%	15	38%	1978	24%
... Yes	1657	78%	24	62%	5207	64%
SustainabilityPlanTransportationEmissions	2116		39		8082	
...	0	0%	0	0%	61	1%
... N/A	364	17%	15	38%	2545	31%
... No	95	4%	7	18%	357	4%
... Yes	1657	78%	17	44%	5119	63%

Table 5: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
FacilityType	2116		39		8082	
... Administrative	187	9%	7	18%	980	12%
... Factory	38	2%	0	0%	301	4%
... Multi-building campus/base	507	24%	10	26%	543	7%
... Other	313	15%	0	0%	1756	22%
... ServiceCenter	369	17%	0	0%	548	7%
... Store	8	0%	0	0%	288	4%
... TruckYard	655	31%	15	38%	2673	33%
... Warehouse	39	2%	7	18%	993	12%
OwnedLeased	2116		39		8082	
...	51	2%	0	0%	10	0%
... Leased	131	6%	36	92%	1908	24%
... Owned	1934	91%	3	8%	6164	76%
UtilityProvider	2116		39		8082	
...	16	1%	0	0%	397	5%
... Central Hudson Gas and Electric	123	6%	0	0%	469	6%
... Consolidated Edison	636	30%	22	56%	1149	14%
... Long Island Power Authority	169	8%	0	0%	924	11%
... Municipal Utility	49	2%	0	0%	265	3%
... National Grid	549	26%	17	44%	2536	31%
... NYS Electric and Gas	346	16%	0	0%	1641	20%
... Orange and Rockland Utilities	41	2%	0	0%	267	3%
... Rochester Gas and Electric	187	9%	0	0%	434	5%

listogram of number of fossil fuel infrastructure types at a fa
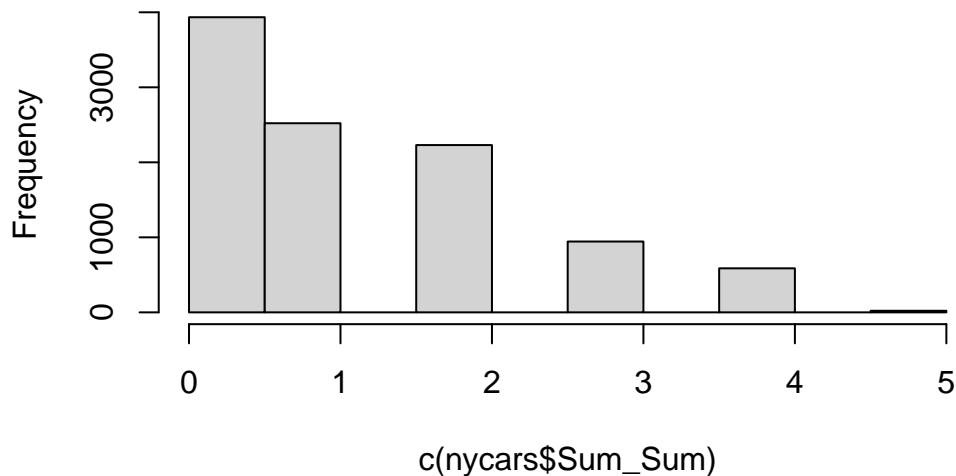

c(nycars$FF_Sum)
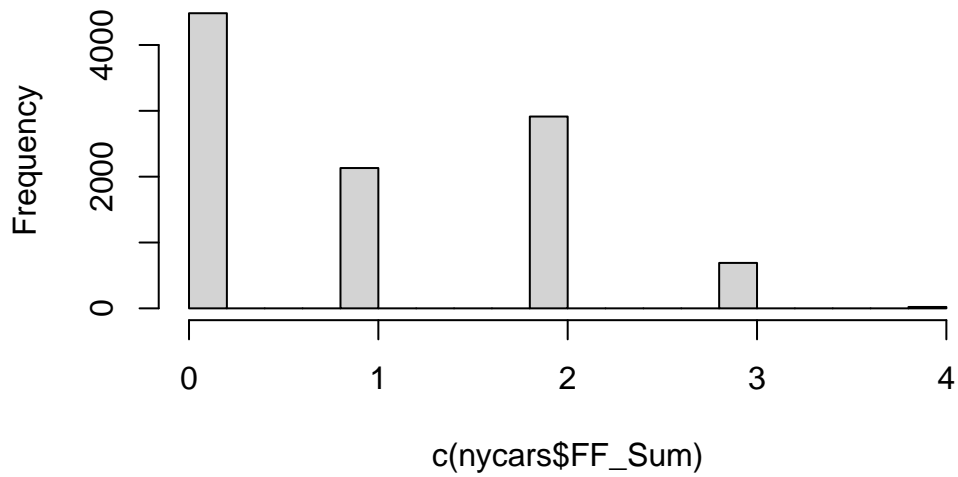
```
hist(c(nycars$Alt_Sum), main = "Histogram of number of low emissions fuel infrastructure
```

gram of number of low emissions fuel infrastructure types a

c(nycars$Alt_Sum)
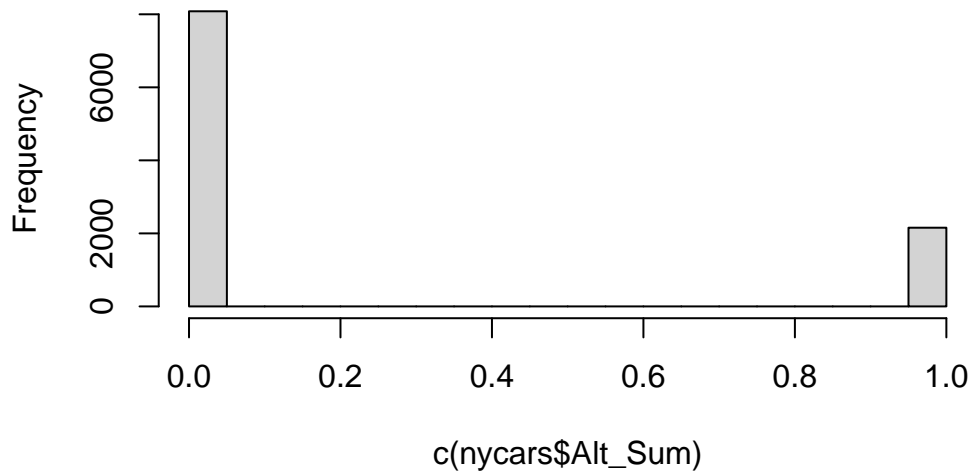
```
hist(c(nycars$Sum_Sum), main = "Histogram of number of any fuel infrastructure types at
```

7

Histogram of number of any fuel infrastructure types at a fac


```
#sumtable(nycars_mult,vars=c("GasolineInfrastructure","DieselInfrastructure","NGInfrastr
```

- Whether the facility hosts any of the following types of trailers: tractor, van-dry, van-reefer, tanker, flatbed, shipping container, low-bed, curtain

```
sumtable(nycars,vars=c("TractorTrailers","VanDryTrailers","VanReeferTrailers", "TankerTr
```

- Vehicle characteristics (primary fuel type, weight class, body type, equipped with GPS or all wheel drive, are model year 2010 or older, are retrofitted or repowered, whether they are owned or brokered, years kept, whether it is designated as a backup vehicle)

```
nycars$BodyType <- factor(nycars$BodyType)
nycars$FuelType <- factor(nycars$FuelType)
nycars$WeightClassBin <- factor(nycars$WeightClassBin)

sumtable(nycars,vars=c("WeightClassBin","FuelType","OwnerBroker"),group="LEM")

sumtable(nycars,vars=c("GPSMileageTracking", "AllWheelDrive","MY2010Older","RetrofittedF

library(tidyverse)

-- Attaching core tidyverse packages ----------------------- tidyverse 2.0.0 --
v dplyr     1.1.4      v readr     2.1.5
v forcats   1.0.0      v stringr   1.5.1
v ggplot2   3.5.1      v tibble    3.2.1
v lubridate 1.9.4      v tidyr     1.3.1
v purrr     1.0.4
-- Conflicts ------------------------------------- tidyverse_conflicts() --
```

Table 6: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
TractorTrailers	2116		39		8082	
...	0	0%	0	0%	7	0%
... N	0	0%	0	0%	1	0%
... No	1261	60%	22	56%	5660	70%
... Yes	855	40%	17	44%	2414	30%
VanDryTrailers	2116		39		8082	
...	0	0%	0	0%	85	1%
... No	1782	84%	25	64%	6965	86%
... Yes	334	16%	14	36%	1032	13%
VanReeferTrailers	2116		39		8082	
...	0	0%	0	0%	82	1%
... No	2054	97%	32	82%	7714	95%
... Yes	62	3%	7	18%	286	4%
TankerTrailers	2116		39		8082	
...	0	0%	0	0%	79	1%
... No	1845	87%	39	100%	7484	93%
... Yes	271	13%	0	0%	519	6%
FlatbedTrailers	2116		39		8082	
...	0	0%	0	0%	82	1%
... No	1595	75%	29	74%	7066	87%
... Yes	521	25%	10	26%	934	12%
ShippingContainerTrailers	2116		39		8082	
...	0	0%	0	0%	82	1%
... No	2057	97%	39	100%	7740	96%
... Yes	59	3%	0	0%	260	3%
LowBedTrailers	2116		39		8082	
...	0	0%	0	0%	85	1%
... No	1363	64%	29	74%	6913	86%
... Yes	753	36%	10	26%	1084	13%
CurtainTrailers	2116		39		8082	
...	0	0%	0	0%	89	1%
... No	2107	100%	39	100%	7803	97%
... Yes	9	0%	0	0%	190	2%

Table 7: Summary Statistics

LEM	Electric		Hydrogen		None	
Variable	N	Percent	N	Percent	N	Percent
WeightClassBin	2116		39		8082	
...	0	0%	1	3%	40	0%
... Class 2b-3	879	42%	16	41%	3555	44%
... Class 4-6	587	28%	11	28%	1915	24%
... Class 7-8	650	31%	11	28%	2572	32%
FuelType	2116		39		8082	
...	0	0%	0	0%	4	0%
... Diesel	1015	48%	24	62%	4476	55%
... Electricity	34	2%	0	0%	11	0%
... Gasoline	901	43%	15	38%	3377	42%
... Natural Gas	20	1%	0	0%	21	0%
... Other	146	7%	0	0%	193	2%
OwnerBroker	2116		39		8082	
...	4	0%	0	0%	200	2%
... Dispatched	10	0%	0	0%	65	1%
... Owner	2102	99%	39	100%	7817	97%

Table 8: Summary Statistics

LEM	Electric				Hydrogen				None			
Variable	N	Mean	SD	Median	N	Mean	SD	Median	N	Mean	SD	Med
GPSMileageTracking	2116	4.6	12	1	39	8.2	18	2	8082	4.5	20	1
AllWheelDrive	2116	1.4	4.4	0	39	0.54	1.8	0	8082	1	6.6	0
MY2010Older	2116	0.73	2.1	0	39	2.5	3.2	1	8082	1	4.7	0
RetrofittedRepowered	2116	0.019	0.31	0	39	0.18	0.39	0	8082	0.079	1.2	0
YearsKept	2116	12	5.1	10	39	15	5.5	15	8082	12	4.8	10

```
x dplyr::filter()     masks stats::filter()
x dplyr::group_rows() masks kableExtra::group_rows()
x dplyr::lag()        masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to
```

```
ggplot(data=nycars, aes(x=log(GPSMileageTracking))) +
    geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

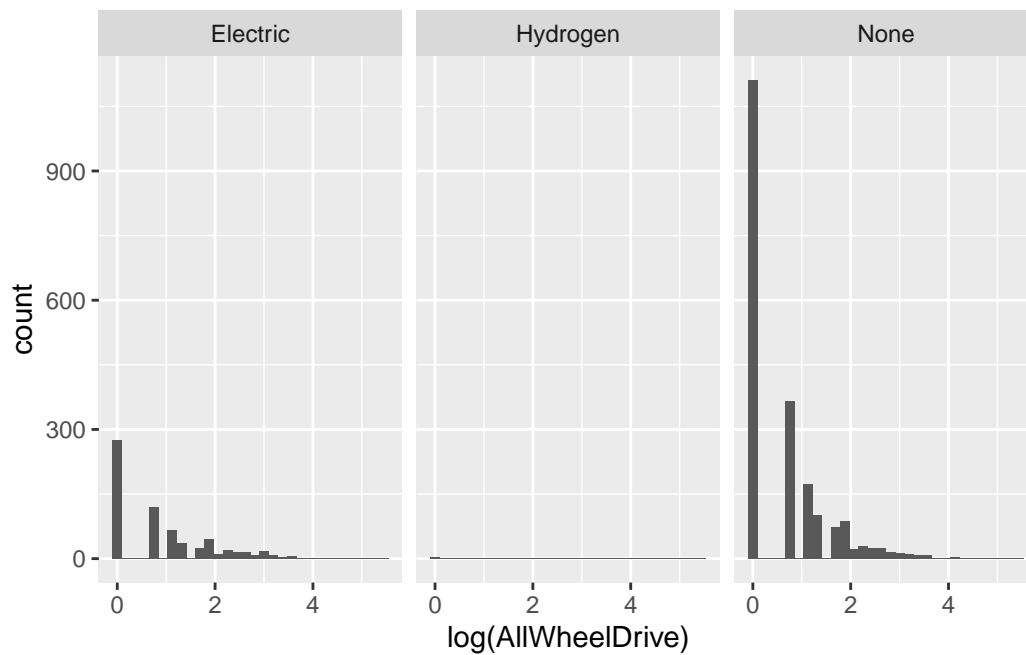`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 3821 rows containing non-finite outside the scale range
(`stat_bin()`).
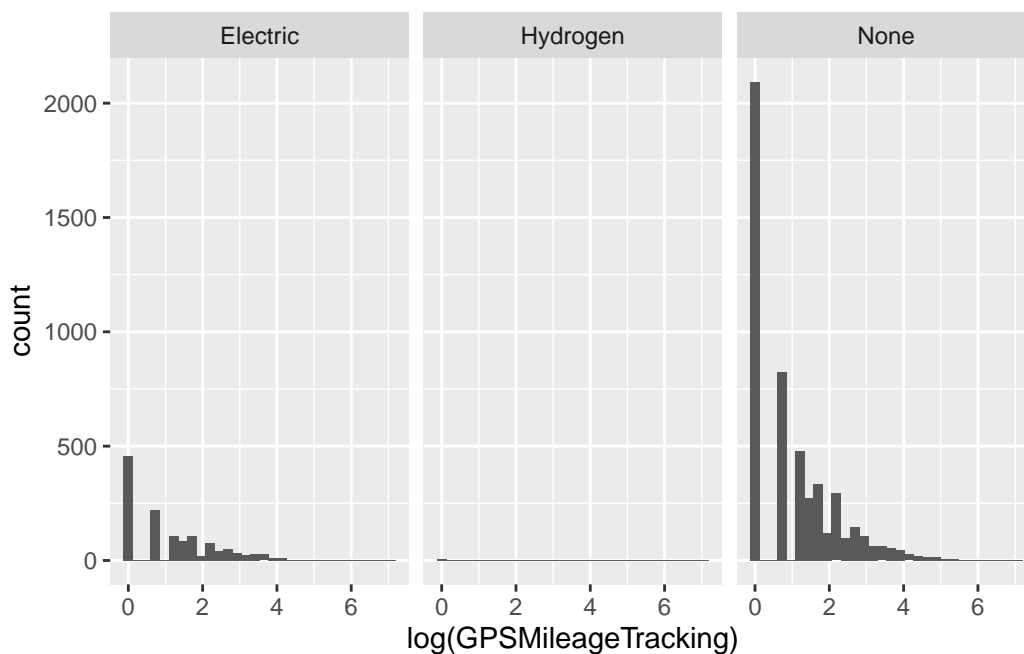

```
ggplot(data=nycars, aes(x=log(AllWheelDrive))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

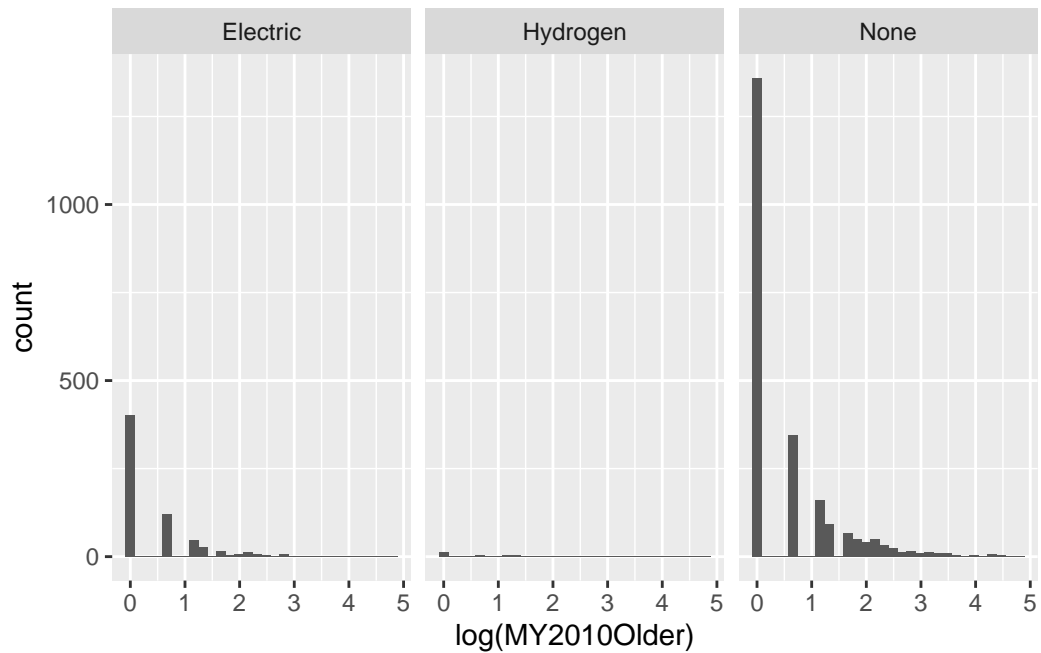`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 7477 rows containing non-finite outside the scale range
(`stat_bin()`).

```
ggplot(data=nycars, aes(x=log(MY2010Older))) +
  geom_histogram() +
facet_wrap(~nycars$LEM, nrow=1)
```

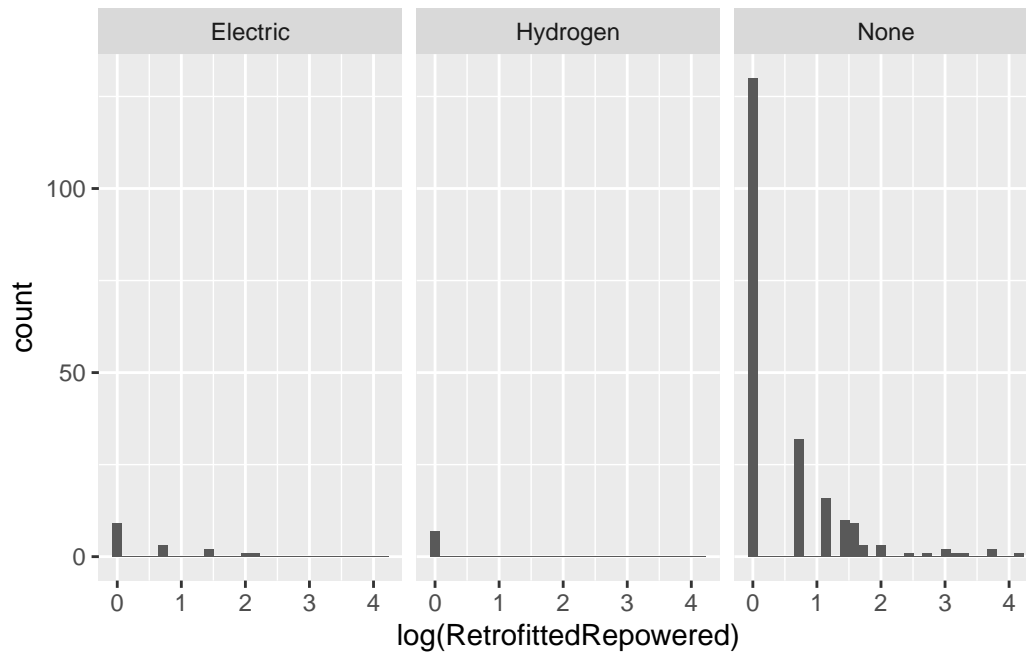`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 7225 rows containing non-finite outside the scale range
(`stat_bin()`).

```
    ggplot(data=nycars, aes(x=log(RetrofittedRepowered))) +
    geom_histogram() +
    facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
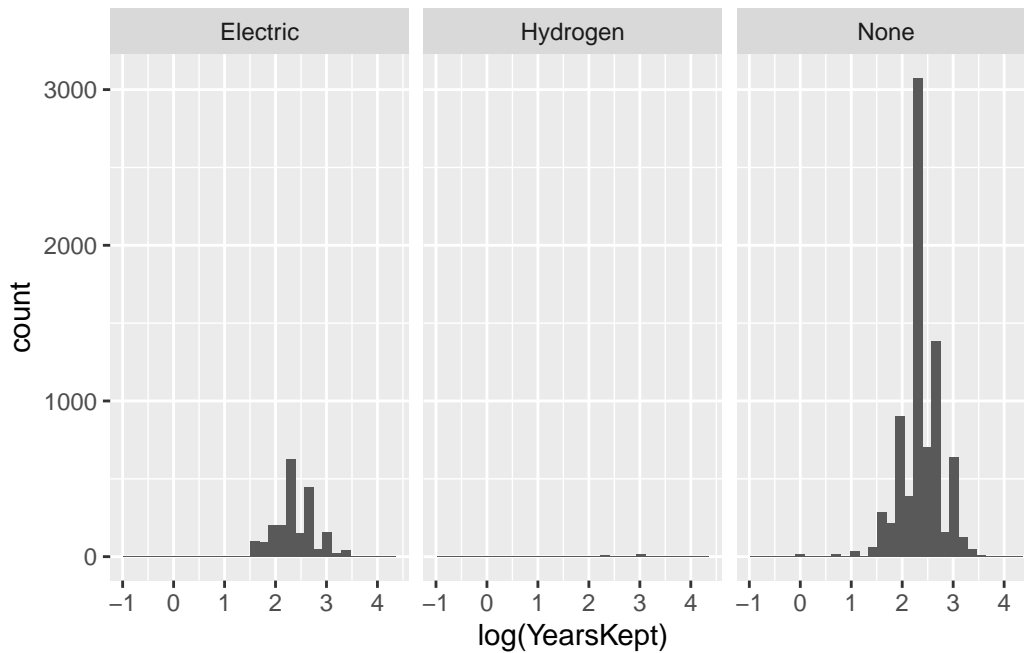
Warning: Removed 10002 rows containing non-finite outside the scale range
(`stat_bin()`).

```
    ggplot(data=nycars, aes(x=log(YearsKept))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```
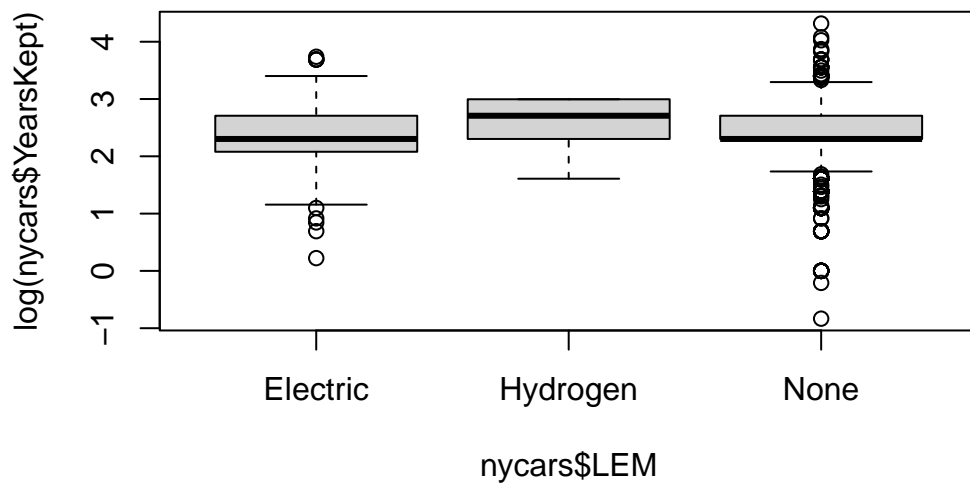
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 4 rows containing non-finite outside the scale range
(`stat_bin()`).

```
boxplot(log(nycars$YearsKept)~nycars$LEM)
```

```
Warning in bplt(at[i], wid = width[i], stats = z$stats[, i], out =
z$out[z$group == : Outlier (-Inf) in boxplot 3 is not drawn
```


- Daily and annual mileage, and what fraction of those occur in New York State

```
sumtable(nycars,vars=c("NumberOfVehicles", "NumberBelow100mi","NumberBetween100and150mi'
```

```
ggplot(data=nycars, aes(x=log(NumberOfVehicles))) +
  geom_histogram() +
```

Table 9: Summary Statistics

LEM	Electric				Hydrogen					
Variable	N	Mean	SD	Median	N	Mean	SD	Median	N	Mean
NumberOfVehicles	2116	5.9	12	2	39	8.9	18	3	8082	6.1
NumberBelow100mi	2089	4.8	10	2	39	4.8	6.4	2	8023	4.5
NumberBetween100and150mi	1983	0.4	3.7	0	39	0	0	0	7846	0.62
NumberBetween150and200mi	2017	0.43	2.4	0	39	0	0	0	7774	0.34
NumberBetween200and300mi	1966	0.15	1.4	0	39	4.1	18	0	7764	0.29
NumberMoreThan300mi	1977	0.15	1.8	0	39	0	0	0	7746	0.36
AverageAnnualMiles	2114	7762	12072	5000	39	12207	24792	5000	8024	12542

```
    facet_wrap(~nycars$LEM, nrow=1)
```

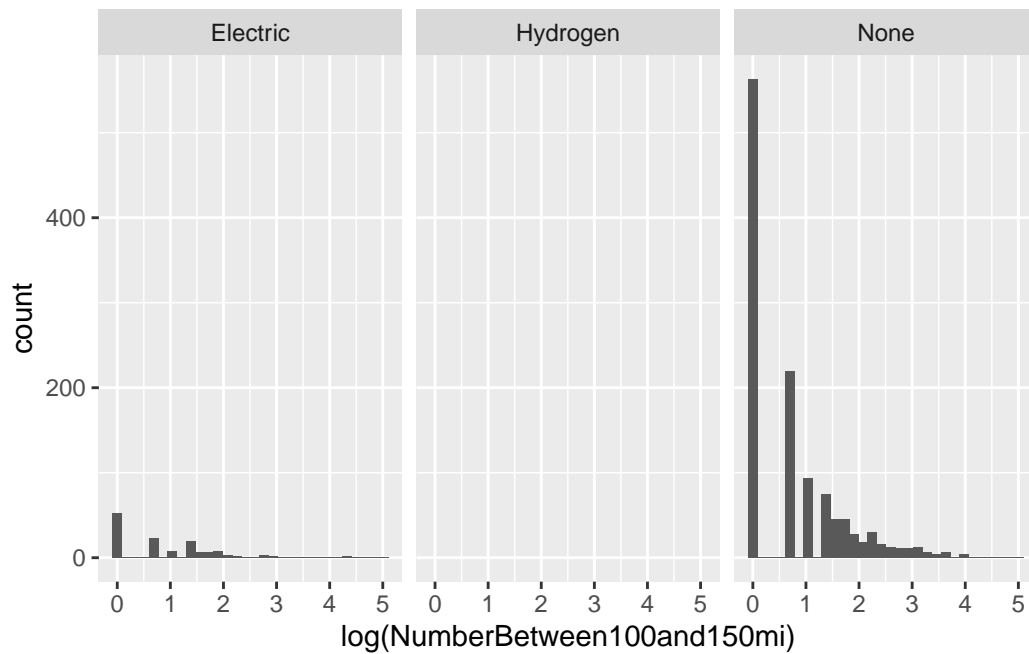`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 2 rows containing non-finite outside the scale range
(`stat_bin()`).
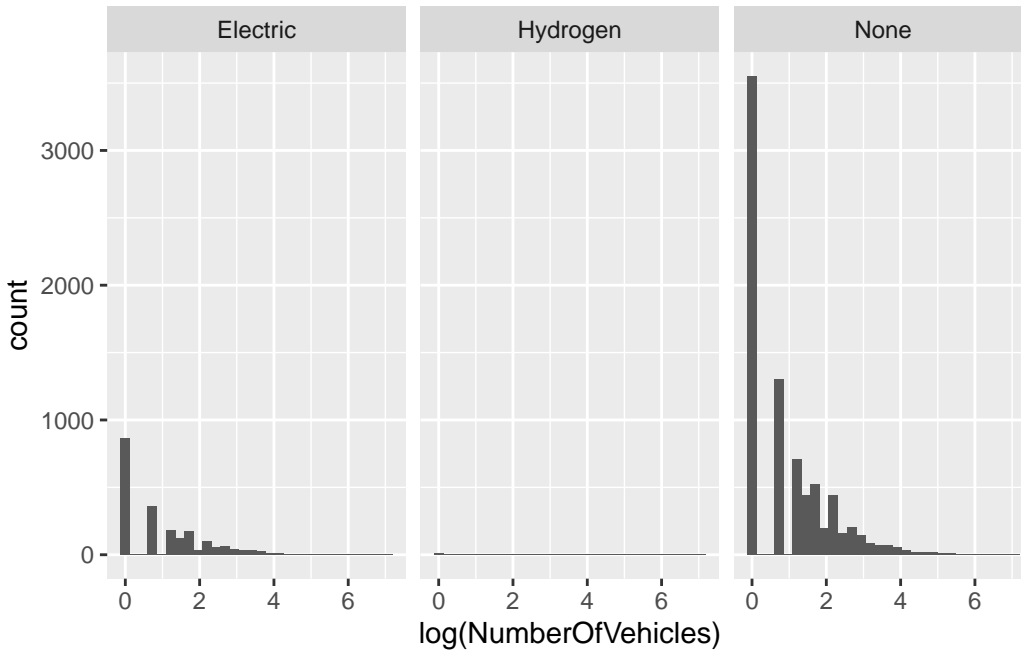

```
ggplot(data=nycars, aes(x=log(NumberBetween100and150mi))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 8892 rows containing non-finite outside the scale range
(`stat_bin()`).


```
ggplot(data=nycars, aes(x=log(NumberBetween150and200mi))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 9478 rows containing non-finite outside the scale range
(`stat_bin()`).

```r
ggplot(data=nycars, aes(x=log(NumberBetween200and300mi))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 9828 rows containing non-finite outside the scale range
(`stat_bin()`).

```
ggplot(data=nycars, aes(x=log(NumberMoreThan300mi))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

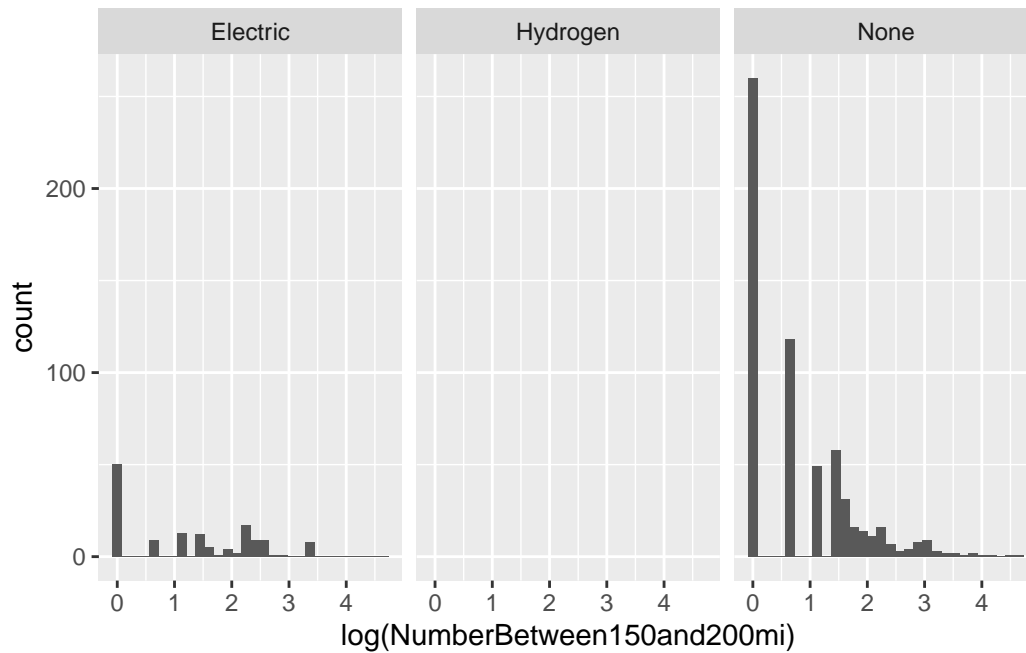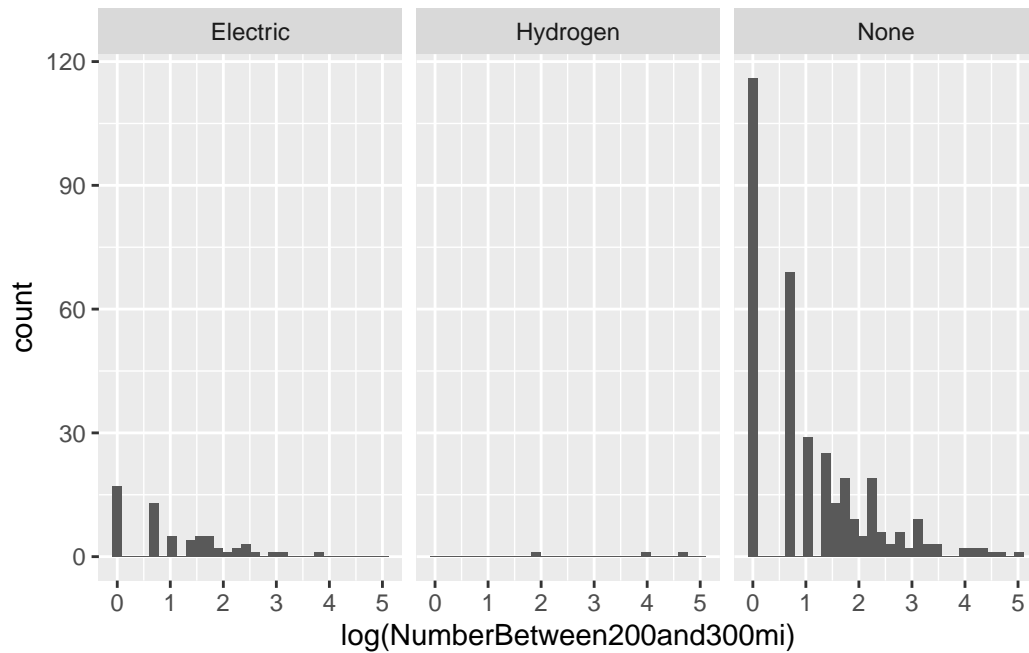Warning: Removed 9976 rows containing non-finite outside the scale range
(`stat_bin()`).
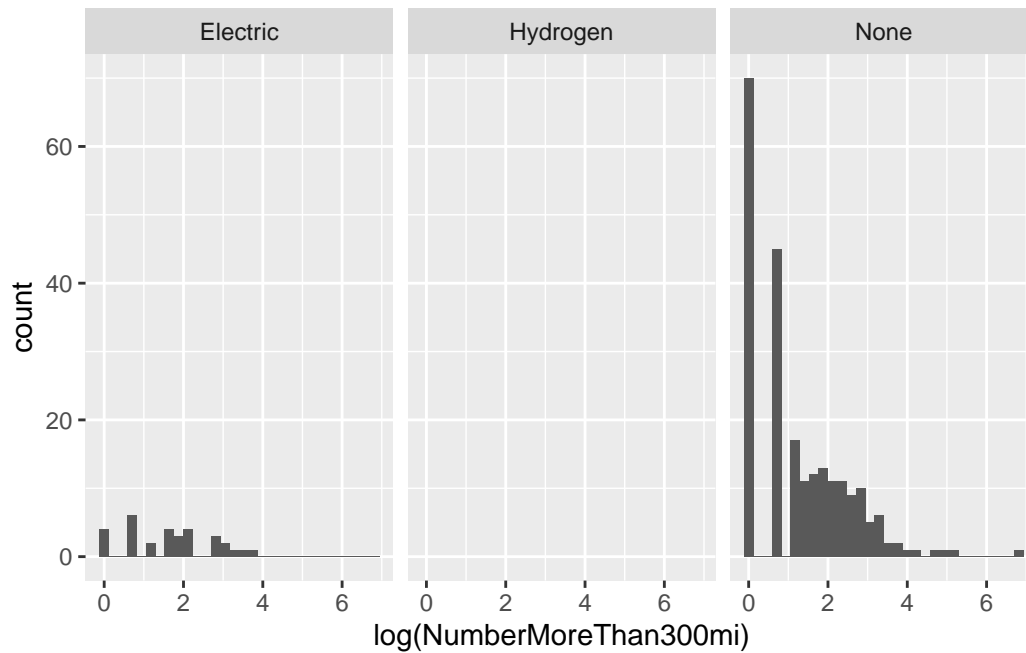
```r
boxplot(log(nycars$AverageAnnualMiles)~nycars$LEM)
```

```
Warning in bplt(at[i], wid = width[i], stats = z$stats[, i], out =
z$out[z$group == : Outlier (-Inf) in boxplot 1 is not drawn

Warning in bplt(at[i], wid = width[i], stats = z$stats[, i], out =
z$out[z$group == : Outlier (-Inf) in boxplot 2 is not drawn

Warning in bplt(at[i], wid = width[i], stats = z$stats[, i], out =
z$out[z$group == : Outlier (-Inf) in boxplot 3 is not drawn
```

```
ggplot(data=nycars, aes(x=log(PredictableUsagePattern))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 4325 rows containing non-finite outside the scale range
(`stat_bin()`).
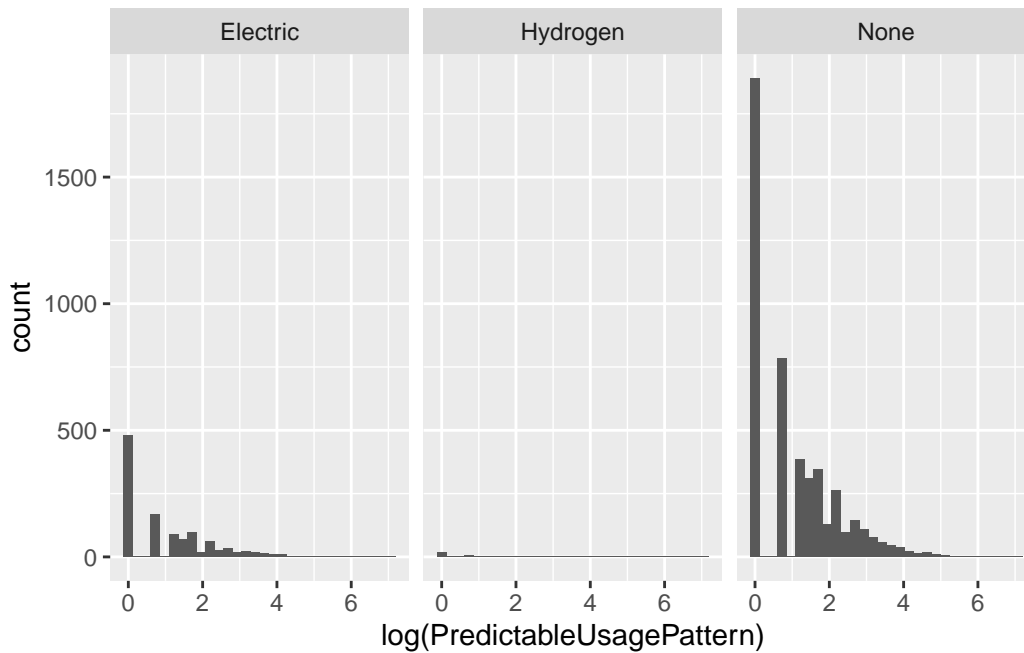
```
ggplot(data=nycars, aes(x=log(FuelAtHome))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 4802 rows containing non-finite outside the scale range
(`stat_bin()`).


```
ggplot(data=nycars, aes(x=log(ReturnToHome))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 426 rows containing non-finite outside the scale range
(`stat_bin()`).

```
ggplot(data=nycars, aes(x=log(Within50mi))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 1288 rows containing non-finite outside the scale range
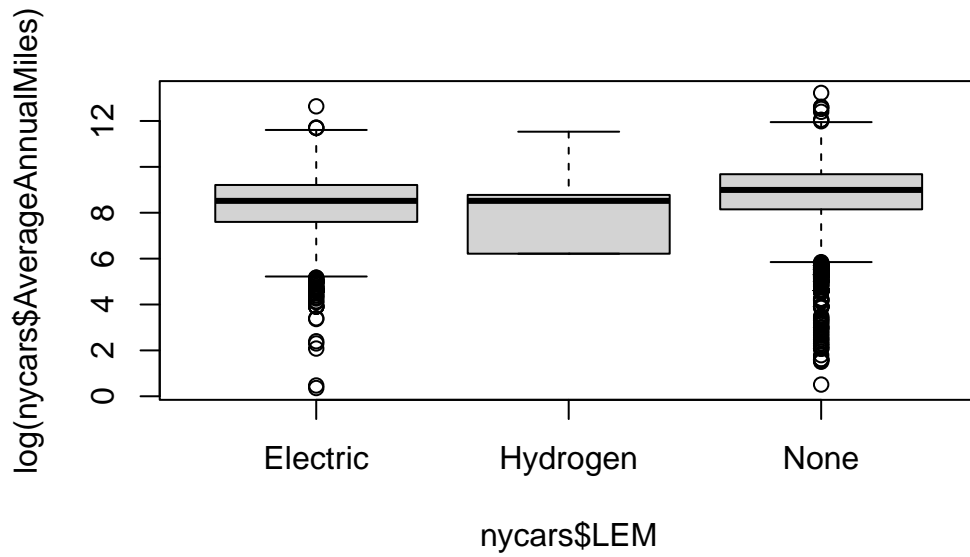(`stat_bin()`).

```
ggplot(data=nycars, aes(x=log(TowMoreThan100mi))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 9480 rows containing non-finite outside the scale range
(`stat_bin()`).
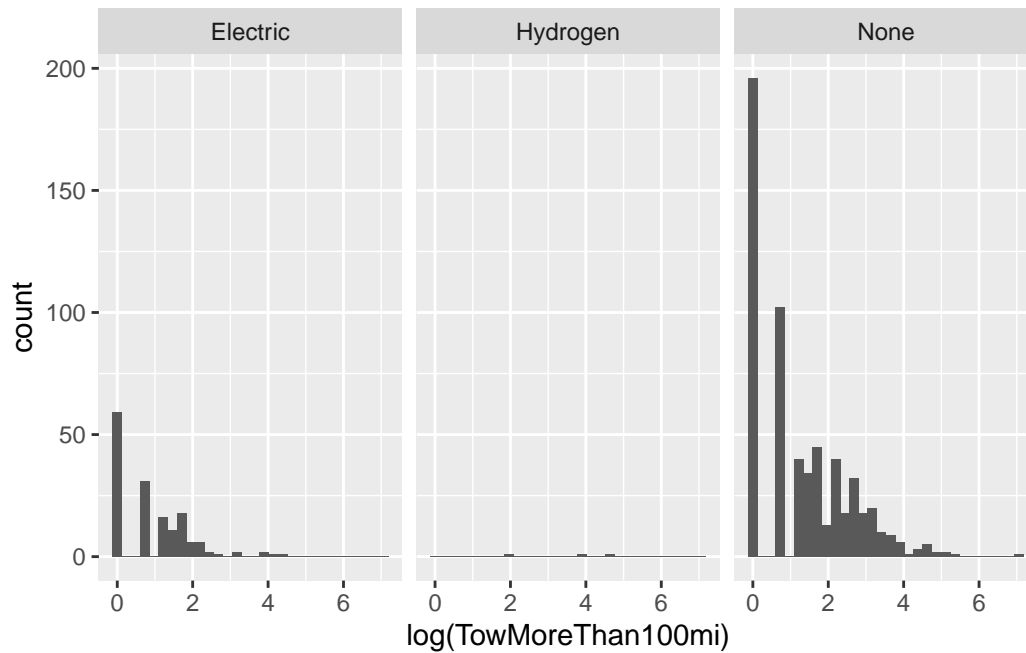
```
ggplot(data=nycars, aes(x=log(AtWeightLimit))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

Warning: Removed 5164 rows containing non-finite outside the scale range
(`stat_bin()`).
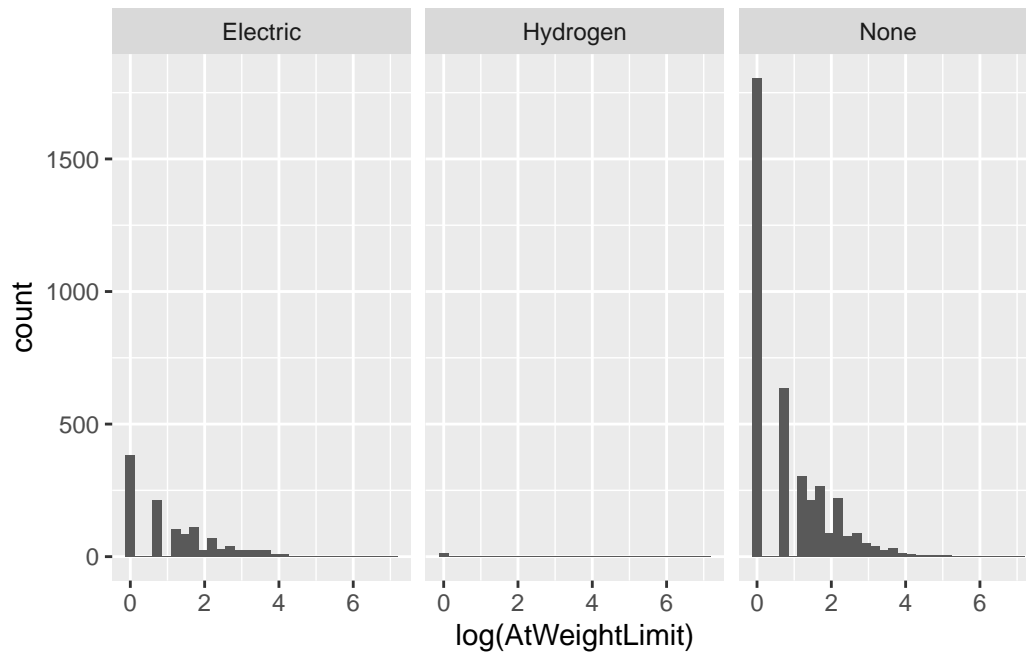
```
ggplot(data=nycars, aes(x=log(Parked8Hours))) +
  geom_histogram() +
  facet_wrap(~nycars$LEM, nrow=1)
```

`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.

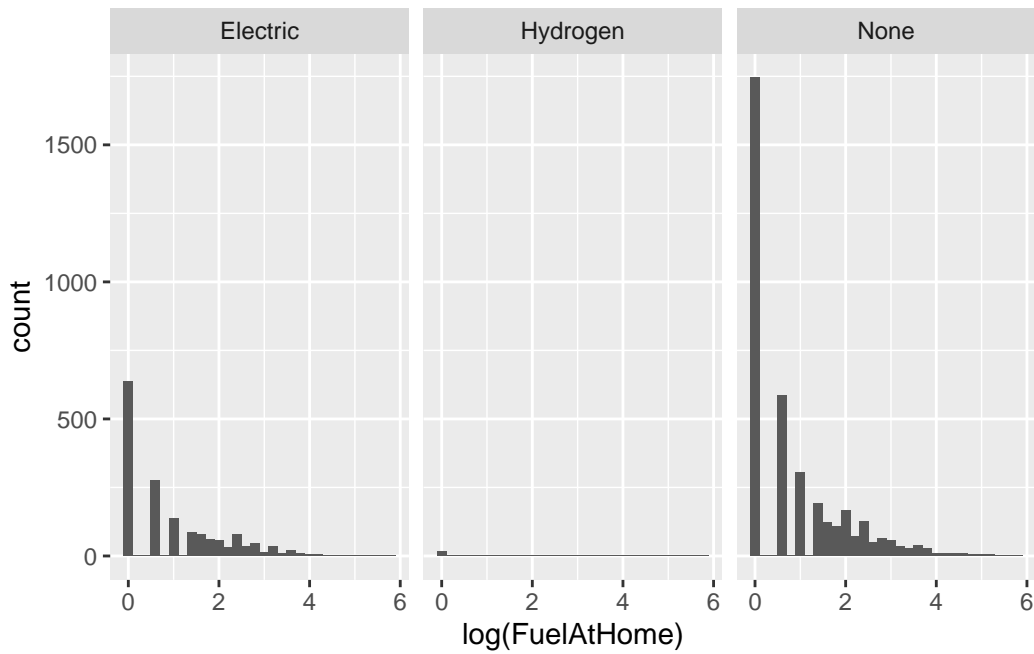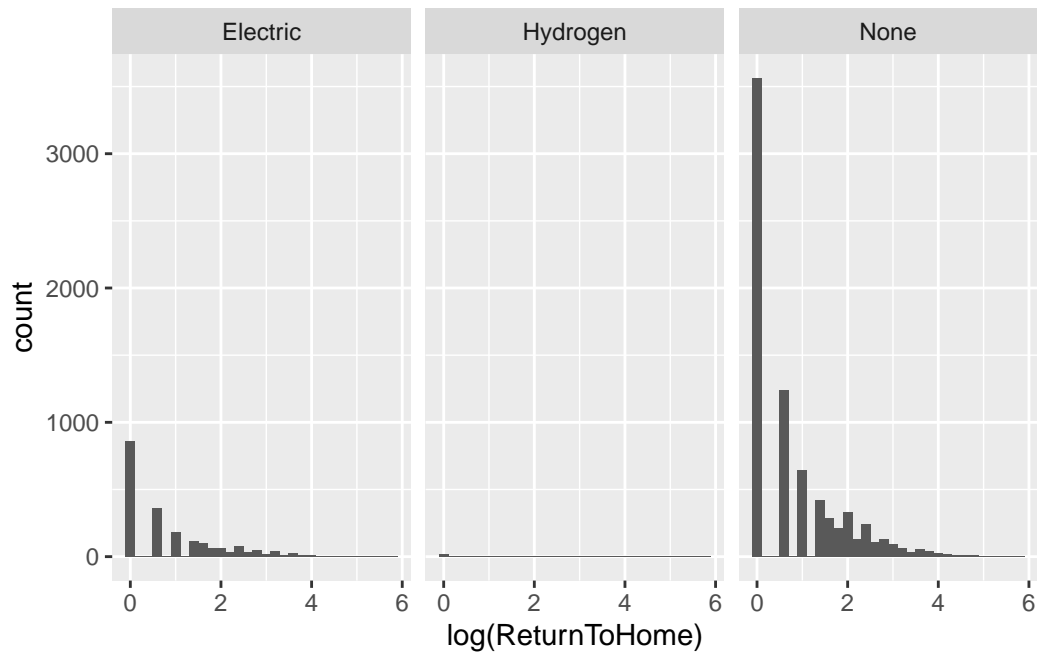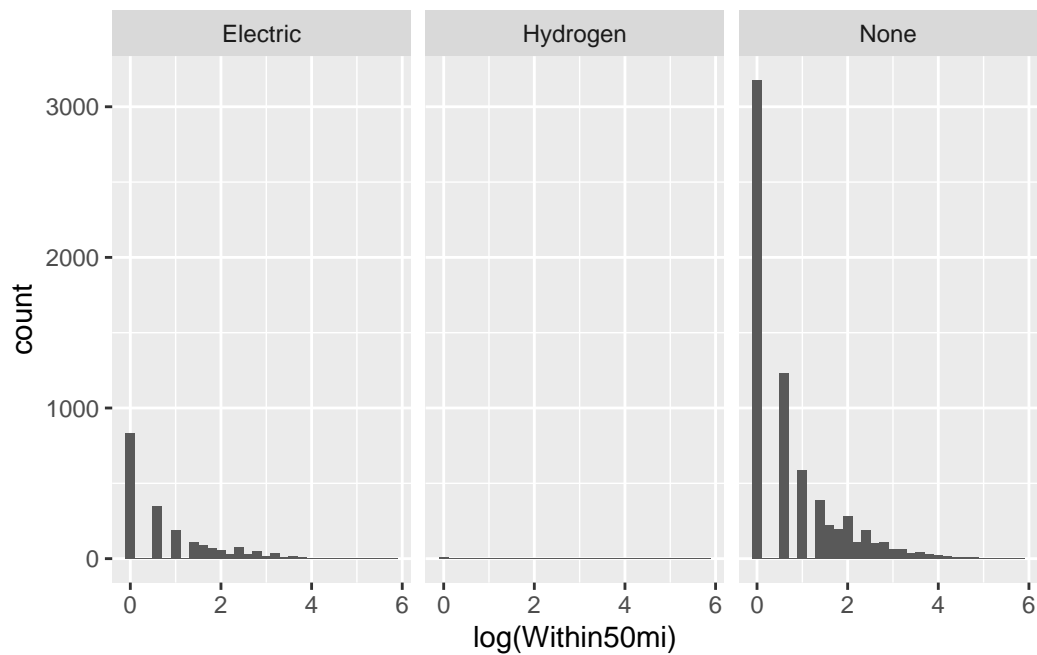Warning: Removed 1103 rows containing non-finite outside the scale range
(`stat_bin()`).
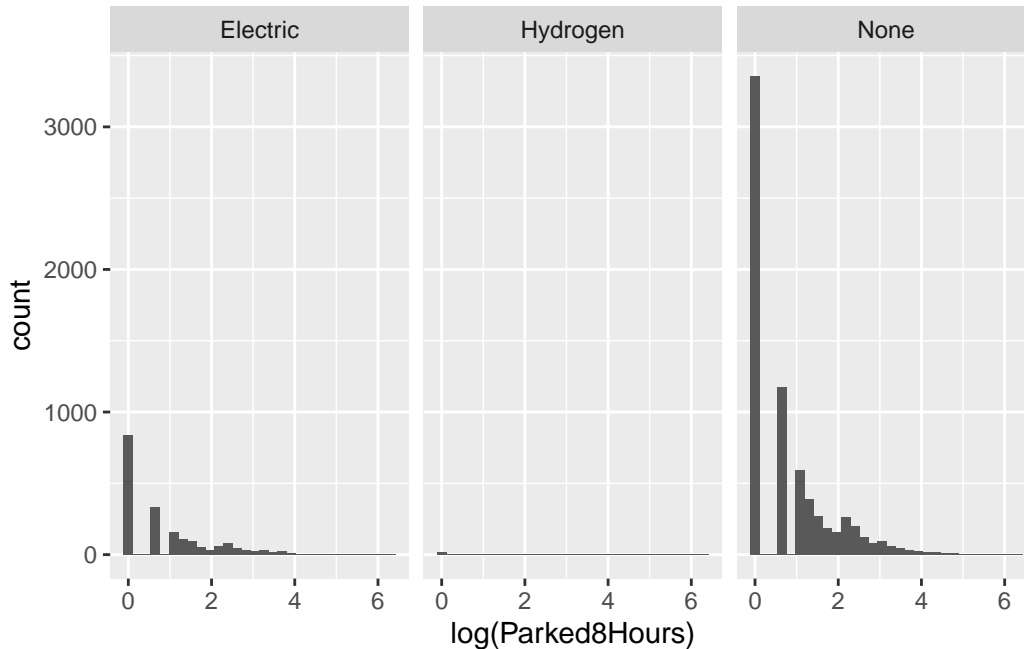
- Daily use patterns (whether they have predictable use patterns, fuel at the facility, return to the facility at the end of the day, park at least 8 hours at the facility, operate at their weight limit, how far from the facility they travel)

With the exception of the geospatial data, number of vehicles operated, and the number of years the vehicle has been kept, the rest of the data are all categorical variables - some are binary (whether the facility has natural gas infrastructure); others are ordinal (average daily mileage has been binned into 4 levels); some are non-ordinal, non-binary categorical (is the organization a government agency, private company, or public benefit corporation).

Proposed Analysis

The proposed primary outcomes are whether the facility has low-emissions fueling infrastructure, and which type of low-emissions fuel (hydrogen, electric).

Because these data were entered by hand, I anticipate some data cleaning will be necessary (for instance, the variable 'Owner or Broker' has entries for both 'owner' and 'owned').

- Done in Excel.

Some variables have so many levels that it would be prudent to condense them into broader categories. This includes 'NAICS Code', with 154 levels. I will create a new variable that uses the first two digits of the 'NAICS Code' variable to sort them into the 20 sectors used by the North American Industry Classification System - still unwieldy, but more manageable than

27

before. I do not plan to use location information (addresses, zip codes, geospatial coordinates) or parent organization identifiers (463 levels).

- Done in Excel.

I would first run some descriptive statistics (mean, SD, median) and summary tables to see the frequency of each response for the remaining variables. Entries that skipped the questions on fueling infrastructure will be excluded from the final regression, but will be included in this exploratory analysis to see if there are any differences in other predictors compared to organizations who *did* report fueling infrastructure data.

I will examine the correlation between the predictors and four response variables: whether they have (1) electric vehicle charging infrastructure, (2) hydrogen fueling infrastructure, or (3) any of those 2 low-emissions fueling infrastructures. I will also look for correlations between different predictors to identify potential interaction terms. For continuous data, I will examine their distributions with regard to the response variables to determine whether polynomial terms should be added.

The results of the planned exploratory analyses will inform how I build (1) a logistic regression to predict whether a facility has low-emissions fueling/charging infrastructure, and (2) a multinomial logistic regression to predict which type of infrastructure is used. Because I don't have any background in this field, I plan to use stepwise variable selection with AIC criterion on a maximum model, which will help prevent bias by me accidentally leaving out significant predictors otherwise. I will evaluate the fit of my models by examining residuals (and checking for overdispersion, which could prompt using beta-binomial regression instead), accuracy, and ROC.

Multinomial Regression

```
# remove all vars not needed in any model
nycars <- nycars %>% select(-c(OrgID, OrgName, ParentBodyID, ParentBodyName, NAICSCode, NAICS

# remove fueling vars not needed for THIS model
nycars_mult <- nycars %>% select(-c(Sum_Infrastructure, Alt_Sum, Sum_Sum, Alt_Infrastructure

# set "none" as baseline
nycars_mult$LEM <- relevel(factor(nycars_mult$LEM), ref="None")

nycars_mult <- na.omit(nycars_mult)

library(caret)
```

Loading required package: lattice

Attaching package: 'caret'

The following object is masked from 'package:purrr':

    lift

```r
set.seed(923)
trainIndex <- createDataPartition(nycars_mult$LEM, p =0.5,
                                        list = FALSE,
                                        times =1)
nycars_mult_train <- nycars_mult[trainIndex,]
nycars_mult_test <- nycars_mult[-trainIndex,]

# creating 4 different sets of explanatory variables + outcome to test which vars are signif
ny_1m <- nycars_mult_train %>% select(OrgType, GovJurisdiction, Revenue2021, NAICS_Name, Sus
# Removed due to preventing model convergence: ContractedEntities, SubhaulersContracted, Subl
## Not significant: OrgType, SustainabilityPlanTransportationEmissions, GovernmentJurisdictio
## Significant: Revenue2021, NAICS_Name, SustainabilityPlan, SustainabilityPlan, FacilityType

ny_2m <- nycars_mult_train %>% select(DieselInfrastructure, GasolineInfrastructure, NGInfrast
## Not significant: TractorTrailers, VanDryTrailers, VanReeferTrailers, TankerTrailers, Flati
## Significant: Everything else

ny_3m <- nycars_mult_train %>% select(BodyType, FuelType, WeightClassBin, NumberOfVehicles, 
## Not significant: BodyType, WeightClassBin
## Significant: Everything else


ny_4m <- nycars_mult_train %>% select(PredictableUsagePattern, FuelAtHome, ReturnToHome, Witl

library(nnet)

mod_1m_max <- multinom(LEM ~ .,
            ny_1m,
            family = binomial())
```


```
# weights:  87 (56 variable)
initial  value 710.802151
```

```
iter  10 value 115.019179
iter  20 value 93.059408
iter  30 value 91.867039
iter  40 value 91.780780
iter  50 value 91.738003
iter  60 value 91.737387
final   value 91.737385
converged
```

summary(mod_1m_max)

Warning in sqrt(diag(vc)): NaNs produced

```
Call:
multinom(formula = LEM ~ ., data = ny_1m, family = binomial())

Coefficients:
         (Intercept) OrgTypePrivateCompany GovJurisdictionCityTownVillage
Electric  -437.82809           -172.71740                     -307.436745
Hydrogen   -67.07371            -90.15196                       -5.166888
         GovJurisdictionCounty GovJurisdictionFederal GovJurisdictionOther
Electric              12.46160               34.40061            -4.536146
Hydrogen             -57.56419               80.80000             5.009310
         Revenue2021Less than $10M Revenue2021$10-$49M Revenue2021$50-$99M
Electric                -71.192313           207.61991          -217.92959
Hydrogen                  7.579171           -50.07813           -96.08245
         Revenue2021$100-$499M Revenue2021$500-999M Revenue2021More than $1000M
Electric             206.35097                    0                  208.79190
Hydrogen             -42.27179                    0                   69.00705
         NAICS_NameConstruction NAICS_NameOther NAICS_NamePublicAdministration
Electric              -5.787814       -15.50373                       12.46160
Hydrogen              61.704852      -107.00108                      -57.56419
         NAICS_NameTransportationWarehousing SustainabilityPlanNo
Electric                           -13.37827             407.31334
Hydrogen                          -239.58424             -55.49626
         SustainabilityPlanYes SustainabilityPlanTransportationEmissionsNo
Electric             163.53834                                   -9.219276
Hydrogen             -58.68028                                   52.512962
         SustainabilityPlanTransportationEmissionsYes FacilityTypeFactory
Electric                                     246.3704          -0.7460905
Hydrogen                                     174.9673         -28.0961707
         FacilityTypeMulti-building campus/base FacilityTypeOther
```

```
Electric                                        -147.848043        -123.13499
Hydrogen                                          -9.391026         -34.60143
        FacilityTypeServiceCenter FacilityTypeStore FacilityTypeTruckYard
Electric                  2.09477          532.0528              2.834306
Hydrogen                 12.58471          -42.8152             31.075919
        FacilityTypeWarehouse OwnedLeasedOwned
Electric             4.808683         2.937203
Hydrogen            80.107106        -2.054673
```

Std. Errors:
```
        (Intercept) OrgTypePrivateCompany GovJurisdictionCityTownVillage
Electric   0.8344520            0.6031973                   1.729094e-14
Hydrogen   0.1655146            0.1655146                   1.211567e-42
        GovJurisdictionCounty GovJurisdictionFederal GovJurisdictionOther
Electric          4.254255e-01           1.262735e+00         5.603487e-15
Hydrogen          4.420029e-44           5.797611e-34        2.673331e-102
        Revenue2021Less than $10M Revenue2021$10-$49M Revenue2021$50-$99M
Electric              2.627512e-15        1.313198e+00                 NaN
Hydrogen              3.365236e-63        6.322169e-73        2.975157e-73
        Revenue2021$100-$499M Revenue2021$500-999M Revenue2021More than $1000M
Electric          8.640461e-01                 NaN                  0.8165023
Hydrogen          2.214904e-46                   0                  0.1655146
        NAICS_NameConstruction NAICS_NameOther NAICS_NamePublicAdministration
Electric           1.262060e+00       1.3035536                   4.254255e-01
Hydrogen           2.420751e-46       0.1655146                   4.420029e-44
        NAICS_NameTransportationWarehousing SustainabilityPlanNo
Electric                        1.169213e+00         8.416561e-01
Hydrogen                        5.797611e-34         1.211567e-42
        SustainabilityPlanYes SustainabilityPlanTransportationEmissionsNo
Electric             0.5212717                                1.064088e+00
Hydrogen             0.1655146                                9.199405e-55
        SustainabilityPlanTransportationEmissionsYes FacilityTypeFactory
Electric                                    0.5212717        2.052260e+00
Hydrogen                                    0.1655146        5.412346e-60
        FacilityTypeMulti-building campus/base FacilityTypeOther
Electric                          8.648067e-65      2.519331e-52
Hydrogen                          8.623689e-52      4.420033e-44
        FacilityTypeServiceCenter FacilityTypeStore FacilityTypeTruckYard
Electric              1.318169e+00                 0          1.254131e+00
Hydrogen              6.934680e-98                 0          5.797611e-34
        FacilityTypeWarehouse OwnedLeasedOwned
Electric             1.6644735         1.083304
Hydrogen             0.1655146         1.639842
```

```
Residual Deviance: 183.4748
AIC: 283.4748
```

```r
mod_1m_best <- suppressWarnings(step(mod_1m_max, direction="both",trace=0))
```

```
trying - OrgType
trying - GovJurisdiction
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - SustainabilityPlanTransportationEmissions
trying - FacilityType
trying - OwnedLeased
# weights:  75 (48 variable)
initial  value 710.802151
iter  10 value 119.512490
iter  20 value 93.945224
iter  30 value 92.389435
iter  40 value 92.009181
iter  50 value 91.992538
iter  60 value 91.992142
final  value 91.992140
converged
trying - OrgType
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - SustainabilityPlanTransportationEmissions
trying - FacilityType
trying - OwnedLeased
trying + GovJurisdiction
# weights:  69 (44 variable)
initial  value 710.802151
iter  10 value 113.406472
iter  20 value 95.848189
iter  30 value 94.155222
iter  40 value 94.125434
iter  50 value 94.124900
final  value 94.124893
converged
trying - OrgType
```

```
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying + GovJurisdiction
trying + SustainabilityPlanTransportationEmissions
# weights:  66 (42 variable)
initial  value 710.802151
iter  10 value 114.530621
iter  20 value 96.964088
iter  30 value 95.205509
iter  40 value 95.122996
iter  50 value 95.121853
final  value 95.121849
converged
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying + OrgType
trying + GovJurisdiction
trying + SustainabilityPlanTransportationEmissions
```

summary(mod_1m_best)

```
Warning in sqrt(diag(vc)): NaNs produced

Call:
multinom(formula = LEM ~ Revenue2021 + NAICS_Name + SustainabilityPlan +
    FacilityType + OwnedLeased, data = ny_1m, family = binomial())

Coefficients:
         (Intercept) Revenue2021Less than $10M Revenue2021$10-$49M
Electric   -94.625073               -24.104298           1.417898
Hydrogen    -6.498607                -2.071278         -16.294702
         Revenue2021$50-$99M Revenue2021$100-$499M Revenue2021$500-999M
Electric            -55.17608             1.279979                    0
Hydrogen            -18.97683           -30.343001                    0
         Revenue2021More than $1000M NAICS_NameConstruction NAICS_NameOther
Electric                    2.575406              3.7334566       -4.686513
```

```
Hydrogen                              -7.418601               -0.8792968              -4.340195
        NAICS_NamePublicAdministration NAICS_NameTransportationWarehousing
Electric                     2.023874                                    -2.210552
Hydrogen                   -20.971383                                   -28.306110
        SustainabilityPlanNo SustainabilityPlanYes FacilityTypeFactory
Electric            86.26709              88.82763        -0.09848553
Hydrogen           -12.60831              11.29238         1.01966116
        FacilityTypeMulti-building campus/base FacilityTypeOther
Electric                              -15.848431         -25.495058
Hydrogen                                3.175517          -6.186074
        FacilityTypeServiceCenter FacilityTypeStore FacilityTypeTruckYard
Electric                 2.052091        70.350385             3.1728215
Hydrogen                 5.856981        -6.651694            -0.2640198
        FacilityTypeWarehouse OwnedLeasedOwned
Electric              4.124652         3.506679
Hydrogen              8.086224        -2.348940

Std. Errors:
        (Intercept) Revenue2021Less than $10M Revenue2021$10-$49M
Electric   1.475243              6.182482e-09            1.701774
Hydrogen 239.678653              9.542837e-02           26.371447
        Revenue2021$50-$99M Revenue2021$100-$499M Revenue2021$500-999M
Electric            NaN              0.9718706                  NaN
Hydrogen        359.985              0.3360433         7.285992e-24
        Revenue2021More than $1000M NAICS_NameConstruction NAICS_NameOther
Electric                  1.068593               1.293542        1.577323
Hydrogen                148.797131             360.079935      122.082001
        NAICS_NamePublicAdministration NAICS_NameTransportationWarehousing
Electric                     1.13829669                            1.533936
Hydrogen                     0.02396409                            1.375061
        SustainabilityPlanNo SustainabilityPlanYes FacilityTypeFactory
Electric           0.9110773              1.061977            1.768541
Hydrogen           0.3064368            239.372216          376.668313
        FacilityTypeMulti-building campus/base FacilityTypeOther
Electric                              3.217840e-07       4.174341e-08
Hydrogen                              3.458984e-01       5.973784e+01
        FacilityTypeServiceCenter FacilityTypeStore FacilityTypeTruckYard
Electric              1.2471299097      2.070726e-28             1.189579
Hydrogen              0.0001320032      3.329559e-28            11.002799
        FacilityTypeWarehouse OwnedLeasedOwned
Electric              1.525115         1.235222
Hydrogen            208.171513         1.610706
```

```
Residual Deviance: 190.2437
AIC: 270.2437
```

```
## include:
## Revenue2021, NAICS_Name, SustainabilityPlan, SustainabilityPlan, FacilityType, OwnedLease
## remove:
## OrgType, SustainabilityPlanTransportationEmissions, GovernmentJurisdiction

mod_2m_max <- multinom(LEM ~ .,
          ny_2m,
          family = binomial())
```

```
# weights:  18 (10 variable)
initial  value 710.802151
iter  10 value 85.294227
iter  20 value 84.297398
iter  30 value 84.285335
iter  40 value 84.274765
final  value 84.274731
converged
```

```
mod_2m_best <- suppressWarnings(step(mod_2m_max, direction="both",trace=0))
```

```
trying - DieselInfrastructure
trying - GasolineInfrastructure
trying - NGInfrastructure
trying - OtherInfrastructure
```

```
summary(mod_2m_best)
```

```
Call:
multinom(formula = LEM ~ DieselInfrastructure + GasolineInfrastructure +
    NGInfrastructure + OtherInfrastructure, data = ny_2m, family = binomial())

Coefficients:
        (Intercept) DieselInfrastructure1 GasolineInfrastructure1
Electric   -5.109841             1.507807               2.247743
Hydrogen  -20.388801            17.850688             -29.242121
        NGInfrastructure1 OtherInfrastructure1
Electric        5.227105                     0
```

```
Hydrogen              -7.822097                          0

Std. Errors:
         (Intercept) DieselInfrastructure1 GasolineInfrastructure1
Electric   0.5827086             0.9304578             8.090439e-01
Hydrogen   0.2596509             0.2596509             3.332471e-10
         NGInfrastructure1 OtherInfrastructure1
Electric          1.056719         1.582637e-14
Hydrogen        438.129836         0.000000e+00

Residual Deviance: 168.5495
AIC: 184.5495
```

```
## include:
## DieselInfrastructure, GasolineInfrastructure, NGInfrastructure, OtherInfrastructure
## Remove:
## TractorTrailers, VanDryTrailers, VanReeferTrailers, TankerTrailers, FlatbedTrailers, Shipp

mod_3m_max <- multinom(LEM ~ .,
         ny_3m,
         family = binomial())
```

```
# weights:  87 (56 variable)
initial  value 710.802151
iter  10 value 251.764898
iter  20 value 163.133458
iter  30 value 157.269050
iter  40 value 155.721472
iter  50 value 155.190220
iter  60 value 154.670810
iter  70 value 154.453092
iter  80 value 154.384238
iter  90 value 154.382495
final  value 154.382473
converged
```

```
mod_3m_best <- suppressWarnings(step(mod_3m_max, direction="both",trace=0))
```

```
trying - BodyType
trying - FuelType
trying - WeightClassBin
```

```
trying - NumberOfVehicles
trying - NumberBelow100mi
trying - NumberBetween100and150mi
trying - NumberBetween150and200mi
trying - NumberBetween200and300mi
trying - NumberMoreThan300mi
trying - AverageAnnualMiles
# weights:  78 (50 variable)
initial  value 710.802151
iter  10 value 236.205197
iter  20 value 162.979936
iter  30 value 157.362103
iter  40 value 156.371407
iter  50 value 155.911787
iter  60 value 155.176043
iter  70 value 154.955123
iter  80 value 154.953202
final  value 154.953198
converged
trying - BodyType
trying - FuelType
trying - NumberOfVehicles
trying - NumberBelow100mi
trying - NumberBetween100and150mi
trying - NumberBetween150and200mi
trying - NumberBetween200and300mi
trying - NumberMoreThan300mi
trying - AverageAnnualMiles
trying + WeightClassBin
# weights:  42 (26 variable)
initial  value 710.802151
iter  10 value 243.559518
iter  20 value 181.616063
iter  30 value 178.797654
iter  40 value 178.265522
iter  50 value 178.185180
iter  60 value 178.175319
iter  70 value 178.119633
iter  80 value 178.086655
iter  90 value 178.048374
iter 100 value 178.046503
final  value 178.046503
stopped after 100 iterations
```

```
trying - FuelType
trying - NumberOfVehicles
trying - NumberBelow100mi
trying - NumberBetween100and150mi
trying - NumberBetween150and200mi
trying - NumberBetween200and300mi
trying - NumberMoreThan300mi
trying - AverageAnnualMiles
trying + BodyType
trying + WeightClassBin
```

summary(mod_3m_best)

```
Call:
multinom(formula = LEM ~ FuelType + NumberOfVehicles + NumberBelow100mi +
    NumberBetween100and150mi + NumberBetween150and200mi + NumberBetween200and300mi +
    NumberMoreThan300mi + AverageAnnualMiles, data = ny_3m, family = binomial())

Coefficients:
         (Intercept) FuelTypeDiesel FuelTypeElectricity FuelTypeGasoline
Electric    87.55643     -88.606725         -88.180374        -90.36909
Hydrogen   -12.24670       7.159863          -9.820069          6.60101
         FuelTypeNatural Gas FuelTypeOther NumberOfVehicles NumberBelow100mi
Electric        446.47511515     -91.76250         1.560424        -1.563452
Hydrogen          0.01827145     -16.20577     -3030.718365      3030.724460
         NumberBetween100and150mi NumberBetween150and200mi
Electric                -1.907290                -1.379134
Hydrogen                -8.298151             -4773.075291
         NumberBetween200and300mi NumberMoreThan300mi AverageAnnualMiles
Electric                -1.613315           -13.50319      -4.627867e-05
Hydrogen              3030.818158         -3755.90991       1.065876e-05

Std. Errors:
          (Intercept) FuelTypeDiesel FuelTypeElectricity FuelTypeGasoline
Electric 0.0004812805   0.0007459727        5.899352e-05     0.0004000011
Hydrogen 0.0004476200   0.0002037316        1.213363e-13     0.0002439283
         FuelTypeNatural Gas FuelTypeOther NumberOfVehicles NumberBelow100mi
Electric        8.158392e-11  2.166339e-05       0.01624454       0.01700761
Hydrogen        0.000000e+00  5.563741e-15       0.02306333       0.02296105
         NumberBetween100and150mi NumberBetween150and200mi
Electric               0.0001740715               0.03043877
Hydrogen               0.0000000000               0.00000000
```

```
        NumberBetween200and300mi NumberMoreThan300mi AverageAnnualMiles
Electric          8.650706e-05        3.543408e-09        1.094492e-05
Hydrogen          1.333374e-04        0.000000e+00        2.018899e-05


Residual Deviance: 356.093
AIC: 404.093
```

```
## include: FuelType, NumberOfVehicles, NumberBelow100mi, NumberBetween100and150mi, NumberBe
##
## remove:
##  BodyType, WeightClassBin,


mod_4m_max <- multinom(LEM ~ .,
          ny_4m,
          family = binomial())
```

```
# weights:  51 (32 variable)
initial  value 710.802151
iter  10 value 205.692112
iter  20 value 185.710302
iter  30 value 142.959102
iter  40 value 121.109764
iter  50 value 119.947272
iter  60 value 119.367960
iter  70 value 118.955856
iter  80 value 118.485123
iter  90 value 117.483797
iter 100 value 115.996212
final   value 115.996212
stopped after 100 iterations
```

```
mod_4m_best <- suppressWarnings(step(mod_4m_max, direction="both",trace=0))
```

```
trying - PredictableUsagePattern
trying - FuelAtHome
trying - ReturnToHome
trying - Within50mi
trying - TowMoreThan100mi
trying - AtWeightLimit
trying - Parked8Hours
```

```
trying - GPSMileageTracking
trying - AllWheelDrive
trying - Backup
trying - MY2010Older
trying - RetrofittedRepowered
trying - YearsKept
trying - OwnerBroker
# weights:  45 (28 variable)
initial  value 710.802151
iter  10 value 207.106899
iter  20 value 184.287543
iter  30 value 139.448331
iter  40 value 121.957515
iter  50 value 120.893141
iter  60 value 120.265963
iter  70 value 119.897577
iter  80 value 118.068877
iter  90 value 116.887743
iter 100 value 116.158713
final  value 116.158713
stopped after 100 iterations
trying - PredictableUsagePattern
trying - FuelAtHome
trying - ReturnToHome
trying - Within50mi
trying - TowMoreThan100mi
trying - AtWeightLimit
trying - Parked8Hours
trying - GPSMileageTracking
trying - AllWheelDrive
trying - Backup
trying - MY2010Older
trying - RetrofittedRepowered
trying - YearsKept
trying + OwnerBroker
# weights:  42 (26 variable)
initial  value 710.802151
iter  10 value 207.107020
iter  20 value 184.286160
iter  30 value 138.487390
iter  40 value 121.853913
iter  50 value 121.001828
iter  60 value 120.632382
```

```
iter  70 value 119.411567
iter  80 value 117.668990
iter  90 value 116.584913
iter 100 value 116.219966
final   value 116.219966
stopped after 100 iterations
trying - PredictableUsagePattern
trying - FuelAtHome
trying - ReturnToHome
trying - Within50mi
trying - TowMoreThan100mi
trying - AtWeightLimit
trying - Parked8Hours
trying - GPSMileageTracking
trying - AllWheelDrive
trying - Backup
trying - MY2010Older
trying - YearsKept
trying + RetrofittedRepowered
trying + OwnerBroker
# weights:  39 (24 variable)
initial   value 710.802151
iter  10 value 155.715547
iter  20 value 127.802022
iter  30 value 121.418763
iter  40 value 120.687103
iter  50 value 118.807852
iter  60 value 118.574718
iter  70 value 118.128959
iter  80 value 117.685446
iter  90 value 117.666943
final   value 117.660317
converged
trying - PredictableUsagePattern
trying - FuelAtHome
trying - ReturnToHome
trying - Within50mi
trying - TowMoreThan100mi
trying - AtWeightLimit
trying - Parked8Hours
trying - GPSMileageTracking
trying - AllWheelDrive
trying - Backup
```

```
trying - MY2010Older
trying + RetrofittedRepowered
trying + YearsKept
trying + OwnerBroker
# weights:  36 (22 variable)
initial  value 710.802151
iter  10 value 154.719248
iter  20 value 127.385363
iter  30 value 121.457372
iter  40 value 120.628870
iter  50 value 119.637794
iter  60 value 119.398403
iter  70 value 118.992369
final  value 118.985145
converged
trying - PredictableUsagePattern
trying - FuelAtHome
trying - ReturnToHome
trying - Within50mi
trying - TowMoreThan100mi
trying - AtWeightLimit
trying - Parked8Hours
trying - GPSMileageTracking
trying - AllWheelDrive
trying - Backup
trying + MY2010Older
trying + RetrofittedRepowered
trying + YearsKept
trying + OwnerBroker
# weights:  33 (20 variable)
initial  value 710.802151
iter  10 value 166.173447
iter  20 value 127.024796
iter  30 value 122.468073
iter  40 value 121.440517
iter  50 value 120.899648
iter  60 value 120.606856
final  value 120.539332
converged
trying - PredictableUsagePattern
trying - FuelAtHome
trying - ReturnToHome
trying - Within50mi
```

```
trying - AtWeightLimit
trying - Parked8Hours
trying - GPSMileageTracking
trying - AllWheelDrive
trying - Backup
trying + TowMoreThan100mi
trying + MY2010Older
trying + RetrofittedRepowered
trying + YearsKept
trying + OwnerBroker
```

```
summary(mod_4m_best)
```

```
Call:
multinom(formula = LEM ~ PredictableUsagePattern + FuelAtHome +
    ReturnToHome + Within50mi + AtWeightLimit + Parked8Hours +
    GPSMileageTracking + AllWheelDrive + Backup, data = ny_4m,
    family = binomial())

Coefficients:
         (Intercept) PredictableUsagePattern FuelAtHome ReturnToHome Within50mi
Electric   -1.668544              -0.2975097   1.077737   -0.5958564   0.303221
Hydrogen   -4.236327               0.2880432   4.050171   -3.5431510  -2.158096
         AtWeightLimit Parked8Hours GPSMileageTracking AllWheelDrive     Backup
Electric    -0.1613222   -0.5871378         -0.2075801   -0.263975170  1.1711172
Hydrogen    -4.0189601    1.4241569          0.2288983    0.001514598 -0.3971031

Std. Errors:
         (Intercept) PredictableUsagePattern FuelAtHome ReturnToHome Within50mi
Electric   0.2129741               0.1115913  0.1723376    0.1646288  0.1142284
Hydrogen   1.2574868               0.8028740  2.4136758    1.8777823  1.5295819
         AtWeightLimit Parked8Hours GPSMileageTracking AllWheelDrive     Backup
Electric     0.1140584    0.1844618         0.08461308     0.1107738  0.1878089
Hydrogen     2.3037521    1.2364347         0.14942761     0.9514744  1.1973024

Residual Deviance: 241.0787
AIC: 281.0787
```

```
## include:
## PredictableUsagePattern, FuelAtHome, ReturnToHome, Within50mi, Parked8Hours, AtWeightLimi
## remove:
## TowMoreThan100mi, MY2010Older, RetrofittedRepowered, YearsKept, OwnerBroker
```

```
ny_short <- nycars_mult_train %>% select(Revenue2021, NAICS_Name, SustainabilityPlan, Facilit

# Can't go all in on all interactions - multinom() refuses to run (too many weights)
# Check for interactions manually
library(plotly)
```

Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':

    last_plot

The following object is masked from 'package:stats':

    filter

The following object is masked from 'package:graphics':

    layout

```
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~NumberBelow100mi, z=~LEM) # add intera
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~NumberBetween100and150mi, z=~LEM) # ad
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~NumberBetween150and200mi, z=~LEM) # ad
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~NumberBetween200and300mi, z=~LEM) # ad
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~NumberMoreThan300mi, z=~LEM) # add int
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~AverageAnnualMiles, z=~LEM) # add inte
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~PredictableUsagePattern, z=~LEM) # add
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~FuelAtHome, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~ReturnToHome, z=~LEM) # add interactio
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~Within50mi, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~Parked8Hours, z=~LEM) # add interactio
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~AtWeightLimit, z=~LEM) # add interacti
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~GPSMileageTracking, z=~LEM) # add inte
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~AllWheelDrive, z=~LEM) # add interacti
# plot_ly(nycars_mult_train, x= ~NumberOfVehicles, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~NumberBetween100and150mi, z=~LEM) # ad
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~NumberBetween150and200mi, z=~LEM) # ad
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~NumberBetween200and300mi, z=~LEM) # no
```

```
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~NumberMoreThan300mi, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~AverageAnnualMiles, z=~LEM) # add inte
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~PredictableUsagePattern, z=~LEM) # ad
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~FuelAtHome, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~ReturnToHome, z=~LEM) # add interactio
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~Within50mi, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~Parked8Hours, z=~LEM) # add interactio
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~AtWeightLimit, z=~LEM) # add interacti
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~GPSMileageTracking, z=~LEM) # add inte
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~AllWheelDrive, z=~LEM) # add interacti
# plot_ly(nycars_mult_train, x= ~NumberBelow100mi, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~NumberBetween150and200mi, z=~
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~NumberBetween200and300mi, z=~
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~NumberMoreThan300mi, z=~LEM)
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~AverageAnnualMiles, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~PredictableUsagePattern, z=~L
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~FuelAtHome, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~ReturnToHome, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~Within50mi, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~Parked8Hours, z=~LEM) # add i
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~AtWeightLimit, z=~LEM) # add
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~GPSMileageTracking, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~AllWheelDrive, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween100and150mi, y= ~Backup, z=~LEM) # add interact

# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~NumberBetween200and300mi, z=~
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~NumberMoreThan300mi, z=~LEM)
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~AverageAnnualMiles, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~PredictableUsagePattern, z=~L
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~FuelAtHome, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~ReturnToHome, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~Within50mi, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~Parked8Hours, z=~LEM) # add i
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~AtWeightLimit, z=~LEM) # add
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~GPSMileageTracking, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~AllWheelDrive, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween150and200mi, y= ~Backup, z=~LEM) # add interact

# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~NumberMoreThan300mi, z=~LEM)
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~AverageAnnualMiles, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~PredictableUsagePattern, z=~L
```

```
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~FuelAtHome, z=~LEM) # add inte
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~ReturnToHome, z=~LEM) # add i
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~Within50mi, z=~LEM) # add inte
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~Parked8Hours, z=~LEM) # add i
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~AtWeightLimit, z=~LEM) # add
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~GPSMileageTracking, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~AllWheelDrive, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberBetween200and300mi, y= ~Backup, z=~LEM) # add interact

# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~AverageAnnualMiles, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~PredictableUsagePattern, z=~LEM) #
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~FuelAtHome, z=~LEM) # add interacti
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~ReturnToHome, z=~LEM) # add interac
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~Within50mi, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~Parked8Hours, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~AtWeightLimit, z=~LEM) # add intera
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~GPSMileageTracking, z=~LEM) # add
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~AllWheelDrive, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~NumberMoreThan300mi, y= ~Backup, z=~LEM) # no

# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~PredictableUsagePattern, z=~LEM) # n
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~FuelAtHome, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~ReturnToHome, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~Within50mi, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~Parked8Hours, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~AtWeightLimit, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~GPSMileageTracking, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~AllWheelDrive, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~AverageAnnualMiles, y= ~Backup, z=~LEM) # no

# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~FuelAtHome, z=~LEM) # add inter
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~ReturnToHome, z=~LEM) # add int
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~Within50mi, z=~LEM) # add inter
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~Parked8Hours, z=~LEM) # add int
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~AtWeightLimit, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~GPSMileageTracking, z=~LEM) # a
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~AllWheelDrive, z=~LEM) # no
# plot_ly(nycars_mult_train, x= ~PredictableUsagePattern, y= ~Backup, z=~LEM) # add interacti

# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~ReturnToHome, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~Within50mi, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~Parked8Hours, z=~LEM) # add interaction
```

```r
# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~AtWeightLimit, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~GPSMileageTracking, z=~LEM) # add interactio
# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~AllWheelDrive, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~FuelAtHome, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~ReturnToHome, y= ~Within50mi, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~ReturnToHome, y= ~Parked8Hours, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~ReturnToHome, y= ~AtWeightLimit, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~ReturnToHome, y= ~GPSMileageTracking, z=~LEM) # add interac
# plot_ly(nycars_mult_train, x= ~ReturnToHome, y= ~AllWheelDrive, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~ReturnToHome, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~Within50mi, y= ~Parked8Hours, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~Within50mi, y= ~AtWeightLimit, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~Within50mi, y= ~GPSMileageTracking, z=~LEM) # add interactio
# plot_ly(nycars_mult_train, x= ~Within50mi, y= ~AllWheelDrive, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~Within50mi, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~Parked8Hours, y= ~AtWeightLimit, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~Parked8Hours, y= ~GPSMileageTracking, z=~LEM) # add interact
# plot_ly(nycars_mult_train, x= ~Parked8Hours, y= ~AllWheelDrive, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~Parked8Hours, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~AtWeightLimit, y= ~GPSMileageTracking, z=~LEM) # add interac
# plot_ly(nycars_mult_train, x= ~AtWeightLimit, y= ~AllWheelDrive, z=~LEM) # add interaction
# plot_ly(nycars_mult_train, x= ~AtWeightLimit, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~GPSMileageTracking, y= ~AllWheelDrive, z=~LEM) # add interac
# plot_ly(nycars_mult_train, x= ~GPSMileageTracking, y= ~Backup, z=~LEM) # add interaction

# plot_ly(nycars_mult_train, x= ~AllWheelDrive, y= ~Backup, z=~LEM) # no


mod_short <- multinom(LEM ~ . + NumberOfVehicles:NumberBelow100mi + NumberOfVehicles:NumberB
          ny_short,
          family = binomial())
```

```
# weights:  393 (260 variable)
initial  value 710.802151
iter  10 value 494.112153
iter  20 value 453.823940
iter  30 value 406.267677
```

```
iter  40 value 374.916841
iter  50 value 327.478667
iter  60 value 253.034036
iter  70 value 217.134964
iter  80 value 175.919338
iter  90 value 138.119806
iter 100 value 90.053413
final  value 90.053413
stopped after 100 iterations
```

```
mod_short_best <- suppressWarnings(step(mod_short, direction="both",trace=0))
```

```
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying - DieselInfrastructure
trying - GasolineInfrastructure
trying - NGInfrastructure
trying - OtherInfrastructure
trying - FuelType
trying - NumberOfVehicles:NumberBelow100mi
trying - NumberOfVehicles:NumberBetween100and150mi
trying - NumberOfVehicles:NumberBetween150and200mi
trying - NumberOfVehicles:NumberBetween200and300mi
trying - NumberOfVehicles:NumberMoreThan300mi
trying - NumberOfVehicles:AverageAnnualMiles
trying - NumberOfVehicles:PredictableUsagePattern
trying - NumberOfVehicles:FuelAtHome
trying - NumberOfVehicles:ReturnToHome
trying - NumberOfVehicles:Within50mi
trying - NumberOfVehicles:Parked8Hours
trying - NumberOfVehicles:AtWeightLimit
trying - NumberOfVehicles:GPSMileageTracking
trying - NumberOfVehicles:AllWheelDrive
trying - NumberOfVehicles:Backup
trying - NumberBelow100mi:NumberBetween100and150mi
trying - NumberBelow100mi:NumberBetween150and200mi
trying - NumberBelow100mi:AverageAnnualMiles
trying - NumberBelow100mi:PredictableUsagePattern
trying - NumberBelow100mi:FuelAtHome
```

```
trying - NumberBelow100mi:ReturnToHome
trying - NumberBelow100mi:Within50mi
trying - NumberBelow100mi:Parked8Hours
trying - NumberBelow100mi:AtWeightLimit
trying - NumberBelow100mi:GPSMileageTracking
trying - NumberBelow100mi:AllWheelDrive
trying - NumberBelow100mi:Backup
trying - NumberBetween100and150mi:NumberBetween150and200mi
trying - NumberBetween100and150mi:AverageAnnualMiles
trying - NumberBetween100and150mi:Parked8Hours
trying - NumberBetween100and150mi:AtWeightLimit
trying - NumberBetween100and150mi:Backup
trying - NumberBetween150and200mi:NumberMoreThan300mi
trying - NumberBetween150and200mi:Parked8Hours
trying - NumberBetween150and200mi:AtWeightLimit
trying - NumberBetween150and200mi:GPSMileageTracking
trying - NumberBetween150and200mi:Backup
trying - NumberBetween200and300mi:AtWeightLimit
trying - NumberBetween200and300mi:Backup
trying - NumberBetween200and300mi:NumberMoreThan300mi
trying - NumberBetween200and300mi:AverageAnnualMiles
trying - NumberBetween200and300mi:PredictableUsagePattern
trying - NumberBetween200and300mi:FuelAtHome
trying - NumberBetween200and300mi:ReturnToHome
trying - NumberBetween200and300mi:Within50mi
trying - NumberBetween200and300mi:Parked8Hours
trying - NumberMoreThan300mi:PredictableUsagePattern
trying - NumberMoreThan300mi:FuelAtHome
trying - NumberMoreThan300mi:ReturnToHome
trying - NumberMoreThan300mi:AtWeightLimit
trying - NumberMoreThan300mi:GPSMileageTracking
trying - PredictableUsagePattern:FuelAtHome
trying - PredictableUsagePattern:ReturnToHome
trying - PredictableUsagePattern:Within50mi
trying - PredictableUsagePattern:Parked8Hours
trying - PredictableUsagePattern:GPSMileageTracking
trying - PredictableUsagePattern:Backup
trying - FuelAtHome:ReturnToHome
trying - FuelAtHome:Within50mi
trying - FuelAtHome:Parked8Hours
trying - FuelAtHome:AtWeightLimit
trying - FuelAtHome:GPSMileageTracking
trying - FuelAtHome:AllWheelDrive
```

```
trying - FuelAtHome:Backup
trying - ReturnToHome:Parked8Hours
trying - ReturnToHome:AtWeightLimit
trying - ReturnToHome:GPSMileageTracking
trying - ReturnToHome:AllWheelDrive
trying - ReturnToHome:Backup
trying - ReturnToHome:Within50mi
trying - Within50mi:Parked8Hours
trying - Within50mi:AtWeightLimit
trying - Within50mi:GPSMileageTracking
trying - Within50mi:AllWheelDrive
trying - Within50mi:Backup
trying - Parked8Hours:AtWeightLimit
trying - Parked8Hours:GPSMileageTracking
trying - Parked8Hours:AllWheelDrive
trying - Parked8Hours:Backup
trying - AtWeightLimit:GPSMileageTracking
trying - AtWeightLimit:AllWheelDrive
trying - AtWeightLimit:Backup
trying - GPSMileageTracking:AllWheelDrive
trying - GPSMileageTracking:Backup
# weights:  390 (258 variable)
initial  value 710.802151
iter  10 value 494.115383
iter  20 value 453.944887
iter  30 value 394.065424
iter  40 value 377.775799
iter  50 value 307.168468
iter  60 value 219.316611
iter  70 value 182.154851
iter  80 value 153.259765
iter  90 value 107.838707
iter 100 value 66.029324
final   value 66.029324
stopped after 100 iterations
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying - DieselInfrastructure
trying - GasolineInfrastructure
trying - NGInfrastructure
```

```
trying - OtherInfrastructure
trying - FuelType
trying - NumberOfVehicles:NumberBelow100mi
trying - NumberOfVehicles:NumberBetween100and150mi
trying - NumberOfVehicles:NumberBetween150and200mi
trying - NumberOfVehicles:NumberBetween200and300mi
trying - NumberOfVehicles:NumberMoreThan300mi
trying - NumberOfVehicles:AverageAnnualMiles
trying - NumberOfVehicles:PredictableUsagePattern
trying - NumberOfVehicles:FuelAtHome
trying - NumberOfVehicles:ReturnToHome
trying - NumberOfVehicles:Within50mi
trying - NumberOfVehicles:Parked8Hours
trying - NumberOfVehicles:AtWeightLimit
trying - NumberOfVehicles:GPSMileageTracking
trying - NumberOfVehicles:AllWheelDrive
trying - NumberOfVehicles:Backup
trying - NumberBelow100mi:NumberBetween100and150mi
trying - NumberBelow100mi:NumberBetween150and200mi
trying - NumberBelow100mi:AverageAnnualMiles
trying - NumberBelow100mi:PredictableUsagePattern
trying - NumberBelow100mi:FuelAtHome
trying - NumberBelow100mi:ReturnToHome
trying - NumberBelow100mi:Within50mi
trying - NumberBelow100mi:Parked8Hours
trying - NumberBelow100mi:GPSMileageTracking
trying - NumberBelow100mi:AllWheelDrive
trying - NumberBelow100mi:Backup
trying - NumberBetween100and150mi:NumberBetween150and200mi
trying - NumberBetween100and150mi:AverageAnnualMiles
trying - NumberBetween100and150mi:Parked8Hours
trying - NumberBetween100and150mi:AtWeightLimit
trying - NumberBetween100and150mi:Backup
trying - NumberBetween150and200mi:NumberMoreThan300mi
trying - NumberBetween150and200mi:Parked8Hours
trying - NumberBetween150and200mi:AtWeightLimit
trying - NumberBetween150and200mi:GPSMileageTracking
trying - NumberBetween150and200mi:Backup
trying - NumberBetween200and300mi:AtWeightLimit
trying - NumberBetween200and300mi:Backup
trying - NumberBetween200and300mi:NumberMoreThan300mi
trying - NumberBetween200and300mi:AverageAnnualMiles
trying - NumberBetween200and300mi:PredictableUsagePattern
```

```
trying - NumberBetween200and300mi:FuelAtHome
trying - NumberBetween200and300mi:ReturnToHome
trying - NumberBetween200and300mi:Within50mi
trying - NumberBetween200and300mi:Parked8Hours
trying - NumberMoreThan300mi:PredictableUsagePattern
trying - NumberMoreThan300mi:FuelAtHome
trying - NumberMoreThan300mi:ReturnToHome
trying - NumberMoreThan300mi:AtWeightLimit
trying - NumberMoreThan300mi:GPSMileageTracking
trying - PredictableUsagePattern:FuelAtHome
trying - PredictableUsagePattern:ReturnToHome
trying - PredictableUsagePattern:Within50mi
trying - PredictableUsagePattern:Parked8Hours
trying - PredictableUsagePattern:GPSMileageTracking
trying - PredictableUsagePattern:Backup
trying - FuelAtHome:ReturnToHome
trying - FuelAtHome:Within50mi
trying - FuelAtHome:Parked8Hours
trying - FuelAtHome:AtWeightLimit
trying - FuelAtHome:GPSMileageTracking
trying - FuelAtHome:AllWheelDrive
trying - FuelAtHome:Backup
trying - ReturnToHome:Parked8Hours
trying - ReturnToHome:AtWeightLimit
trying - ReturnToHome:GPSMileageTracking
trying - ReturnToHome:AllWheelDrive
trying - ReturnToHome:Backup
trying - ReturnToHome:Within50mi
trying - Within50mi:Parked8Hours
trying - Within50mi:AtWeightLimit
trying - Within50mi:GPSMileageTracking
trying - Within50mi:AllWheelDrive
trying - Within50mi:Backup
trying - Parked8Hours:AtWeightLimit
trying - Parked8Hours:GPSMileageTracking
trying - Parked8Hours:AllWheelDrive
trying - Parked8Hours:Backup
trying - AtWeightLimit:GPSMileageTracking
trying - AtWeightLimit:AllWheelDrive
trying - AtWeightLimit:Backup
trying - GPSMileageTracking:AllWheelDrive
trying - GPSMileageTracking:Backup
trying + NumberBelow100mi:AtWeightLimit
```

```
# weights:  387 (256 variable)
initial  value 710.802151
iter  10 value 494.124247
iter  20 value 457.823086
iter  30 value 396.419089
iter  40 value 371.955763
iter  50 value 312.261911
iter  60 value 230.507208
iter  70 value 182.311644
iter  80 value 146.537354
iter  90 value 99.071556
iter 100 value 59.435978
final  value 59.435978
stopped after 100 iterations
trying - Revenue2021
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying - DieselInfrastructure
trying - GasolineInfrastructure
trying - NGInfrastructure
trying - OtherInfrastructure
trying - FuelType
trying - NumberOfVehicles:NumberBelow100mi
trying - NumberOfVehicles:NumberBetween100and150mi
trying - NumberOfVehicles:NumberBetween150and200mi
trying - NumberOfVehicles:NumberBetween200and300mi
trying - NumberOfVehicles:NumberMoreThan300mi
trying - NumberOfVehicles:AverageAnnualMiles
trying - NumberOfVehicles:PredictableUsagePattern
trying - NumberOfVehicles:FuelAtHome
trying - NumberOfVehicles:ReturnToHome
trying - NumberOfVehicles:Within50mi
trying - NumberOfVehicles:Parked8Hours
trying - NumberOfVehicles:AtWeightLimit
trying - NumberOfVehicles:GPSMileageTracking
trying - NumberOfVehicles:AllWheelDrive
trying - NumberOfVehicles:Backup
trying - NumberBelow100mi:NumberBetween100and150mi
trying - NumberBelow100mi:NumberBetween150and200mi
trying - NumberBelow100mi:AverageAnnualMiles
trying - NumberBelow100mi:PredictableUsagePattern
```

```
trying - NumberBelow100mi:FuelAtHome
trying - NumberBelow100mi:ReturnToHome
trying - NumberBelow100mi:Within50mi
trying - NumberBelow100mi:Parked8Hours
trying - NumberBelow100mi:GPSMileageTracking
trying - NumberBelow100mi:AllWheelDrive
trying - NumberBelow100mi:Backup
trying - NumberBetween100and150mi:NumberBetween150and200mi
trying - NumberBetween100and150mi:AverageAnnualMiles
trying - NumberBetween100and150mi:Parked8Hours
trying - NumberBetween100and150mi:AtWeightLimit
trying - NumberBetween100and150mi:Backup
trying - NumberBetween150and200mi:NumberMoreThan300mi
trying - NumberBetween150and200mi:Parked8Hours
trying - NumberBetween150and200mi:AtWeightLimit
trying - NumberBetween150and200mi:GPSMileageTracking
trying - NumberBetween150and200mi:Backup
trying - NumberBetween200and300mi:AtWeightLimit
trying - NumberBetween200and300mi:Backup
trying - NumberBetween200and300mi:NumberMoreThan300mi
trying - NumberBetween200and300mi:AverageAnnualMiles
trying - NumberBetween200and300mi:PredictableUsagePattern
trying - NumberBetween200and300mi:FuelAtHome
trying - NumberBetween200and300mi:ReturnToHome
trying - NumberBetween200and300mi:Within50mi
trying - NumberBetween200and300mi:Parked8Hours
trying - NumberMoreThan300mi:PredictableUsagePattern
trying - NumberMoreThan300mi:FuelAtHome
trying - NumberMoreThan300mi:ReturnToHome
trying - NumberMoreThan300mi:AtWeightLimit
trying - NumberMoreThan300mi:GPSMileageTracking
trying - PredictableUsagePattern:FuelAtHome
trying - PredictableUsagePattern:ReturnToHome
trying - PredictableUsagePattern:Within50mi
trying - PredictableUsagePattern:Parked8Hours
trying - PredictableUsagePattern:GPSMileageTracking
trying - PredictableUsagePattern:Backup
trying - FuelAtHome:ReturnToHome
trying - FuelAtHome:Within50mi
trying - FuelAtHome:Parked8Hours
trying - FuelAtHome:GPSMileageTracking
trying - FuelAtHome:AllWheelDrive
trying - FuelAtHome:Backup
```

```
trying - ReturnToHome:Parked8Hours
trying - ReturnToHome:AtWeightLimit
trying - ReturnToHome:GPSMileageTracking
trying - ReturnToHome:AllWheelDrive
trying - ReturnToHome:Backup
trying - ReturnToHome:Within50mi
trying - Within50mi:Parked8Hours
trying - Within50mi:AtWeightLimit
trying - Within50mi:GPSMileageTracking
trying - Within50mi:AllWheelDrive
trying - Within50mi:Backup
trying - Parked8Hours:AtWeightLimit
trying - Parked8Hours:GPSMileageTracking
trying - Parked8Hours:AllWheelDrive
trying - Parked8Hours:Backup
trying - AtWeightLimit:GPSMileageTracking
trying - AtWeightLimit:AllWheelDrive
trying - AtWeightLimit:Backup
trying - GPSMileageTracking:AllWheelDrive
trying - GPSMileageTracking:Backup
trying + NumberBelow100mi:AtWeightLimit
trying + FuelAtHome:AtWeightLimit
# weights:  369 (244 variable)
initial  value 710.802151
iter  10 value 494.124247
iter  20 value 457.822598
iter  30 value 397.443563
iter  40 value 366.235088
iter  50 value 324.802501
iter  60 value 203.894814
iter  70 value 162.968873
iter  80 value 140.341001
iter  90 value 102.014242
iter 100 value 65.456455
final  value 65.456455
stopped after 100 iterations
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying - DieselInfrastructure
trying - GasolineInfrastructure
trying - NGInfrastructure
```

```
trying - OtherInfrastructure
trying - FuelType
trying - NumberOfVehicles:NumberBelow100mi
trying - NumberOfVehicles:NumberBetween100and150mi
trying - NumberOfVehicles:NumberBetween150and200mi
trying - NumberOfVehicles:NumberBetween200and300mi
trying - NumberOfVehicles:NumberMoreThan300mi
trying - NumberOfVehicles:AverageAnnualMiles
trying - NumberOfVehicles:PredictableUsagePattern
trying - NumberOfVehicles:FuelAtHome
trying - NumberOfVehicles:ReturnToHome
trying - NumberOfVehicles:Within50mi
trying - NumberOfVehicles:Parked8Hours
trying - NumberOfVehicles:AtWeightLimit
trying - NumberOfVehicles:GPSMileageTracking
trying - NumberOfVehicles:AllWheelDrive
trying - NumberOfVehicles:Backup
trying - NumberBelow100mi:NumberBetween100and150mi
trying - NumberBelow100mi:NumberBetween150and200mi
trying - NumberBelow100mi:AverageAnnualMiles
trying - NumberBelow100mi:PredictableUsagePattern
trying - NumberBelow100mi:FuelAtHome
trying - NumberBelow100mi:ReturnToHome
trying - NumberBelow100mi:Within50mi
trying - NumberBelow100mi:Parked8Hours
trying - NumberBelow100mi:GPSMileageTracking
trying - NumberBelow100mi:AllWheelDrive
trying - NumberBelow100mi:Backup
trying - NumberBetween100and150mi:NumberBetween150and200mi
trying - NumberBetween100and150mi:AverageAnnualMiles
trying - NumberBetween100and150mi:Parked8Hours
trying - NumberBetween100and150mi:AtWeightLimit
trying - NumberBetween100and150mi:Backup
trying - NumberBetween150and200mi:NumberMoreThan300mi
trying - NumberBetween150and200mi:Parked8Hours
trying - NumberBetween150and200mi:AtWeightLimit
trying - NumberBetween150and200mi:GPSMileageTracking
trying - NumberBetween150and200mi:Backup
trying - NumberBetween200and300mi:AtWeightLimit
trying - NumberBetween200and300mi:Backup
trying - NumberBetween200and300mi:NumberMoreThan300mi
trying - NumberBetween200and300mi:AverageAnnualMiles
trying - NumberBetween200and300mi:PredictableUsagePattern
```

```
trying - NumberBetween200and300mi:FuelAtHome
trying - NumberBetween200and300mi:ReturnToHome
trying - NumberBetween200and300mi:Within50mi
trying - NumberBetween200and300mi:Parked8Hours
trying - NumberMoreThan300mi:PredictableUsagePattern
trying - NumberMoreThan300mi:FuelAtHome
trying - NumberMoreThan300mi:ReturnToHome
trying - NumberMoreThan300mi:AtWeightLimit
trying - NumberMoreThan300mi:GPSMileageTracking
trying - PredictableUsagePattern:FuelAtHome
trying - PredictableUsagePattern:ReturnToHome
trying - PredictableUsagePattern:Within50mi
trying - PredictableUsagePattern:Parked8Hours
trying - PredictableUsagePattern:GPSMileageTracking
trying - PredictableUsagePattern:Backup
trying - FuelAtHome:ReturnToHome
trying - FuelAtHome:Within50mi
trying - FuelAtHome:Parked8Hours
trying - FuelAtHome:GPSMileageTracking
trying - FuelAtHome:AllWheelDrive
trying - FuelAtHome:Backup
trying - ReturnToHome:Parked8Hours
trying - ReturnToHome:AtWeightLimit
trying - ReturnToHome:GPSMileageTracking
trying - ReturnToHome:AllWheelDrive
trying - ReturnToHome:Backup
trying - ReturnToHome:Within50mi
trying - Within50mi:Parked8Hours
trying - Within50mi:AtWeightLimit
trying - Within50mi:GPSMileageTracking
trying - Within50mi:AllWheelDrive
trying - Within50mi:Backup
trying - Parked8Hours:AtWeightLimit
trying - Parked8Hours:GPSMileageTracking
trying - Parked8Hours:AllWheelDrive
trying - Parked8Hours:Backup
trying - AtWeightLimit:GPSMileageTracking
trying - AtWeightLimit:AllWheelDrive
trying - AtWeightLimit:Backup
trying - GPSMileageTracking:AllWheelDrive
trying - GPSMileageTracking:Backup
trying + Revenue2021
trying + NumberBelow100mi:AtWeightLimit
```

```
trying + FuelAtHome:AtWeightLimit
# weights:  366 (242 variable)
initial  value 710.802151
iter  10 value 494.131790
iter  20 value 458.621829
iter  30 value 400.670990
iter  40 value 374.229078
iter  50 value 308.514965
iter  60 value 242.161223
iter  70 value 194.692286
iter  80 value 149.065770
iter  90 value 104.749611
iter 100 value 55.238871
final  value 55.238871
stopped after 100 iterations
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying - DieselInfrastructure
trying - GasolineInfrastructure
trying - NGInfrastructure
trying - OtherInfrastructure
trying - FuelType
trying - NumberOfVehicles:NumberBelow100mi
trying - NumberOfVehicles:NumberBetween100and150mi
trying - NumberOfVehicles:NumberBetween150and200mi
trying - NumberOfVehicles:NumberBetween200and300mi
trying - NumberOfVehicles:NumberMoreThan300mi
trying - NumberOfVehicles:AverageAnnualMiles
trying - NumberOfVehicles:PredictableUsagePattern
trying - NumberOfVehicles:FuelAtHome
trying - NumberOfVehicles:ReturnToHome
trying - NumberOfVehicles:Within50mi
trying - NumberOfVehicles:Parked8Hours
trying - NumberOfVehicles:AtWeightLimit
trying - NumberOfVehicles:GPSMileageTracking
trying - NumberOfVehicles:AllWheelDrive
trying - NumberOfVehicles:Backup
trying - NumberBelow100mi:NumberBetween100and150mi
trying - NumberBelow100mi:NumberBetween150and200mi
trying - NumberBelow100mi:AverageAnnualMiles
trying - NumberBelow100mi:PredictableUsagePattern
```

```
trying - NumberBelow100mi:FuelAtHome
trying - NumberBelow100mi:ReturnToHome
trying - NumberBelow100mi:Within50mi
trying - NumberBelow100mi:Parked8Hours
trying - NumberBelow100mi:GPSMileageTracking
trying - NumberBelow100mi:AllWheelDrive
trying - NumberBelow100mi:Backup
trying - NumberBetween100and150mi:NumberBetween150and200mi
trying - NumberBetween100and150mi:AverageAnnualMiles
trying - NumberBetween100and150mi:Parked8Hours
trying - NumberBetween100and150mi:AtWeightLimit
trying - NumberBetween100and150mi:Backup
trying - NumberBetween150and200mi:NumberMoreThan300mi
trying - NumberBetween150and200mi:Parked8Hours
trying - NumberBetween150and200mi:AtWeightLimit
trying - NumberBetween150and200mi:GPSMileageTracking
trying - NumberBetween150and200mi:Backup
trying - NumberBetween200and300mi:AtWeightLimit
trying - NumberBetween200and300mi:Backup
trying - NumberBetween200and300mi:NumberMoreThan300mi
trying - NumberBetween200and300mi:AverageAnnualMiles
trying - NumberBetween200and300mi:PredictableUsagePattern
trying - NumberBetween200and300mi:FuelAtHome
trying - NumberBetween200and300mi:ReturnToHome
trying - NumberBetween200and300mi:Within50mi
trying - NumberBetween200and300mi:Parked8Hours
trying - NumberMoreThan300mi:PredictableUsagePattern
trying - NumberMoreThan300mi:FuelAtHome
trying - NumberMoreThan300mi:ReturnToHome
trying - NumberMoreThan300mi:AtWeightLimit
trying - NumberMoreThan300mi:GPSMileageTracking
trying - PredictableUsagePattern:FuelAtHome
trying - PredictableUsagePattern:ReturnToHome
trying - PredictableUsagePattern:Within50mi
trying - PredictableUsagePattern:Parked8Hours
trying - PredictableUsagePattern:GPSMileageTracking
trying - PredictableUsagePattern:Backup
trying - FuelAtHome:ReturnToHome
trying - FuelAtHome:Within50mi
trying - FuelAtHome:Parked8Hours
trying - FuelAtHome:GPSMileageTracking
trying - FuelAtHome:AllWheelDrive
trying - FuelAtHome:Backup
```

```
trying - ReturnToHome:Parked8Hours
trying - ReturnToHome:GPSMileageTracking
trying - ReturnToHome:AllWheelDrive
trying - ReturnToHome:Backup
trying - ReturnToHome:Within50mi
trying - Within50mi:Parked8Hours
trying - Within50mi:AtWeightLimit
trying - Within50mi:GPSMileageTracking
trying - Within50mi:AllWheelDrive
trying - Within50mi:Backup
trying - Parked8Hours:AtWeightLimit
trying - Parked8Hours:GPSMileageTracking
trying - Parked8Hours:AllWheelDrive
trying - Parked8Hours:Backup
trying - AtWeightLimit:GPSMileageTracking
trying - AtWeightLimit:AllWheelDrive
trying - AtWeightLimit:Backup
trying - GPSMileageTracking:AllWheelDrive
trying - GPSMileageTracking:Backup
trying + Revenue2021
trying + NumberBelow100mi:AtWeightLimit
trying + FuelAtHome:AtWeightLimit
trying + ReturnToHome:AtWeightLimit
# weights:  363 (240 variable)
initial  value 710.802151
iter  10 value 494.132002
iter  20 value 458.046466
iter  30 value 408.137996
iter  40 value 370.936554
iter  50 value 301.524090
iter  60 value 202.920305
iter  70 value 159.278964
iter  80 value 126.230621
iter  90 value 92.495152
iter 100 value 54.518470
final  value 54.518470
stopped after 100 iterations
trying - NAICS_Name
trying - SustainabilityPlan
trying - FacilityType
trying - OwnedLeased
trying - DieselInfrastructure
trying - GasolineInfrastructure
```

```
trying - NGInfrastructure
trying - OtherInfrastructure
trying - FuelType
trying - NumberOfVehicles:NumberBelow100mi
trying - NumberOfVehicles:NumberBetween100and150mi
trying - NumberOfVehicles:NumberBetween150and200mi
trying - NumberOfVehicles:NumberBetween200and300mi
trying - NumberOfVehicles:NumberMoreThan300mi
trying - NumberOfVehicles:AverageAnnualMiles
trying - NumberOfVehicles:PredictableUsagePattern
trying - NumberOfVehicles:FuelAtHome
trying - NumberOfVehicles:ReturnToHome
trying - NumberOfVehicles:Within50mi
trying - NumberOfVehicles:Parked8Hours
trying - NumberOfVehicles:AtWeightLimit
trying - NumberOfVehicles:GPSMileageTracking
trying - NumberOfVehicles:AllWheelDrive
trying - NumberOfVehicles:Backup
trying - NumberBelow100mi:NumberBetween100and150mi
trying - NumberBelow100mi:NumberBetween150and200mi
trying - NumberBelow100mi:AverageAnnualMiles
trying - NumberBelow100mi:PredictableUsagePattern
trying - NumberBelow100mi:FuelAtHome
trying - NumberBelow100mi:ReturnToHome
trying - NumberBelow100mi:Within50mi
trying - NumberBelow100mi:Parked8Hours
trying - NumberBelow100mi:GPSMileageTracking
trying - NumberBelow100mi:AllWheelDrive
trying - NumberBelow100mi:Backup
trying - NumberBetween100and150mi:NumberBetween150and200mi
trying - NumberBetween100and150mi:AverageAnnualMiles
trying - NumberBetween100and150mi:Parked8Hours
trying - NumberBetween100and150mi:AtWeightLimit
trying - NumberBetween100and150mi:Backup
trying - NumberBetween150and200mi:NumberMoreThan300mi
trying - NumberBetween150and200mi:Parked8Hours
trying - NumberBetween150and200mi:AtWeightLimit
trying - NumberBetween150and200mi:GPSMileageTracking
trying - NumberBetween150and200mi:Backup
trying - NumberBetween200and300mi:AtWeightLimit
trying - NumberBetween200and300mi:Backup
trying - NumberBetween200and300mi:NumberMoreThan300mi
trying - NumberBetween200and300mi:AverageAnnualMiles
```

```
trying - NumberBetween200and300mi:PredictableUsagePattern
trying - NumberBetween200and300mi:FuelAtHome
trying - NumberBetween200and300mi:ReturnToHome
trying - NumberBetween200and300mi:Within50mi
trying - NumberBetween200and300mi:Parked8Hours
trying - NumberMoreThan300mi:PredictableUsagePattern
trying - NumberMoreThan300mi:FuelAtHome
trying - NumberMoreThan300mi:ReturnToHome
trying - NumberMoreThan300mi:AtWeightLimit
trying - NumberMoreThan300mi:GPSMileageTracking
trying - PredictableUsagePattern:FuelAtHome
trying - PredictableUsagePattern:ReturnToHome
trying - PredictableUsagePattern:Within50mi
trying - PredictableUsagePattern:Parked8Hours
trying - PredictableUsagePattern:GPSMileageTracking
trying - FuelAtHome:ReturnToHome
trying - FuelAtHome:Within50mi
trying - FuelAtHome:Parked8Hours
trying - FuelAtHome:GPSMileageTracking
trying - FuelAtHome:AllWheelDrive
trying - FuelAtHome:Backup
trying - ReturnToHome:Parked8Hours
trying - ReturnToHome:GPSMileageTracking
trying - ReturnToHome:AllWheelDrive
trying - ReturnToHome:Backup
trying - ReturnToHome:Within50mi
trying - Within50mi:Parked8Hours
trying - Within50mi:AtWeightLimit
trying - Within50mi:GPSMileageTracking
trying - Within50mi:AllWheelDrive
trying - Within50mi:Backup
trying - Parked8Hours:AtWeightLimit
trying - Parked8Hours:GPSMileageTracking
trying - Parked8Hours:AllWheelDrive
trying - Parked8Hours:Backup
trying - AtWeightLimit:GPSMileageTracking
trying - AtWeightLimit:AllWheelDrive
trying - AtWeightLimit:Backup
trying - GPSMileageTracking:AllWheelDrive
trying - GPSMileageTracking:Backup
trying + Revenue2021
trying + NumberBelow100mi:AtWeightLimit
trying + PredictableUsagePattern:Backup
```

```
trying + FuelAtHome:AtWeightLimit
trying + ReturnToHome:AtWeightLimit
```

summary(mod_short_best)

```
Call:
multinom(formula = LEM ~ NAICS_Name + SustainabilityPlan + FacilityType +
    OwnedLeased + DieselInfrastructure + GasolineInfrastructure +
    NGInfrastructure + OtherInfrastructure + FuelType + NumberOfVehicles +
    NumberBelow100mi + NumberBetween100and150mi + NumberBetween150and200mi +
    NumberBetween200and300mi + NumberMoreThan300mi + AverageAnnualMiles +
    PredictableUsagePattern + FuelAtHome + ReturnToHome + Within50mi +
    Parked8Hours + AtWeightLimit + GPSMileageTracking + AllWheelDrive +
    Backup + NumberOfVehicles:NumberBelow100mi + NumberOfVehicles:NumberBetween100and150mi +
    NumberOfVehicles:NumberBetween150and200mi + NumberOfVehicles:NumberBetween200and300mi +
    NumberOfVehicles:NumberMoreThan300mi + NumberOfVehicles:AverageAnnualMiles +
    NumberOfVehicles:PredictableUsagePattern + NumberOfVehicles:FuelAtHome +
    NumberOfVehicles:ReturnToHome + NumberOfVehicles:Within50mi +
    NumberOfVehicles:Parked8Hours + NumberOfVehicles:AtWeightLimit +
    NumberOfVehicles:GPSMileageTracking + NumberOfVehicles:AllWheelDrive +
    NumberOfVehicles:Backup + NumberBelow100mi:NumberBetween100and150mi +
    NumberBelow100mi:NumberBetween150and200mi + NumberBelow100mi:AverageAnnualMiles +
    NumberBelow100mi:PredictableUsagePattern + NumberBelow100mi:FuelAtHome +
    NumberBelow100mi:ReturnToHome + NumberBelow100mi:Within50mi +
    NumberBelow100mi:Parked8Hours + NumberBelow100mi:GPSMileageTracking +
    NumberBelow100mi:AllWheelDrive + NumberBelow100mi:Backup +
    NumberBetween100and150mi:NumberBetween150and200mi + NumberBetween100and150mi:AverageAnnu
    NumberBetween100and150mi:Parked8Hours + NumberBetween100and150mi:AtWeightLimit +
    NumberBetween100and150mi:Backup + NumberBetween150and200mi:NumberMoreThan300mi +
    NumberBetween150and200mi:Parked8Hours + NumberBetween150and200mi:AtWeightLimit +
    NumberBetween150and200mi:GPSMileageTracking + NumberBetween150and200mi:Backup +
    NumberBetween200and300mi:AtWeightLimit + NumberBetween200and300mi:Backup +
    NumberBetween200and300mi:NumberMoreThan300mi + NumberBetween200and300mi:AverageAnnualMile
    NumberBetween200and300mi:PredictableUsagePattern + NumberBetween200and300mi:FuelAtHome +
    NumberBetween200and300mi:ReturnToHome + NumberBetween200and300mi:Within50mi +
    NumberBetween200and300mi:Parked8Hours + NumberMoreThan300mi:PredictableUsagePattern +
    NumberMoreThan300mi:FuelAtHome + NumberMoreThan300mi:ReturnToHome +
    NumberMoreThan300mi:AtWeightLimit + NumberMoreThan300mi:GPSMileageTracking +
    PredictableUsagePattern:FuelAtHome + PredictableUsagePattern:ReturnToHome +
    PredictableUsagePattern:Within50mi + PredictableUsagePattern:Parked8Hours +
    PredictableUsagePattern:GPSMileageTracking + FuelAtHome:ReturnToHome +
    FuelAtHome:Within50mi + FuelAtHome:Parked8Hours + FuelAtHome:GPSMileageTracking +
```

```
        FuelAtHome:AllWheelDrive + FuelAtHome:Backup + ReturnToHome:Parked8Hours +
        ReturnToHome:GPSMileageTracking + ReturnToHome:AllWheelDrive +
        ReturnToHome:Backup + ReturnToHome:Within50mi + Within50mi:Parked8Hours +
        Within50mi:AtWeightLimit + Within50mi:GPSMileageTracking +
        Within50mi:AllWheelDrive + Within50mi:Backup + Parked8Hours:AtWeightLimit +
        Parked8Hours:GPSMileageTracking + Parked8Hours:AllWheelDrive +
        Parked8Hours:Backup + AtWeightLimit:GPSMileageTracking +
        AtWeightLimit:AllWheelDrive + AtWeightLimit:Backup + GPSMileageTracking:AllWheelDrive +
        GPSMileageTracking:Backup, data = ny_short, family = binomial())


Coefficients:
        (Intercept) NAICS_NameConstruction NAICS_NameOther
Electric   -1.763521             -1.6928854      -0.1713455
Hydrogen   -1.876288             -0.3525883      -0.4187264
        NAICS_NamePublicAdministration NAICS_NameTransportationWarehousing
Electric                    -0.6711587                          -0.0996889
Hydrogen                    -1.4037703                          -0.7064338
        SustainabilityPlanNo SustainabilityPlanYes FacilityTypeFactory
Electric          -0.647544            -0.1903007          -0.5590573
Hydrogen          -1.520347            -0.4327909          -0.5726417
        FacilityTypeMulti-building campus/base FacilityTypeOther
Electric                             -1.4894051        -2.4084593
Hydrogen                             -0.3145281        -0.4968996
        FacilityTypeServiceCenter FacilityTypeStore FacilityTypeTruckYard
Electric                 1.209548        1.697573228           0.08564237
Hydrogen                -0.788412       -0.001312113          -0.21369698
        FacilityTypeWarehouse OwnedLeasedOwned DieselInfrastructure1
Electric          -0.3539821        0.7566122           -0.4650714
Hydrogen           0.9225696        0.1422483            0.9613836
        GasolineInfrastructure1 NGInfrastructure1 OtherInfrastructure1
Electric               2.3318147          4.259137                    0
Hydrogen               0.2400449          1.533805                    0
        FuelTypeDiesel FuelTypeElectricity FuelTypeGasoline
Electric     -1.099172           1.1612771       -0.7501947
Hydrogen     -0.536396          -0.5192973       -0.3094950
        FuelTypeNatural Gas FuelTypeOther NumberOfVehicles NumberBelow100mi
Electric       -8.533241e-05    -1.0753460       -0.1019811       0.40198035
Hydrogen        2.118000e-05    -0.5111204        0.2140285      -0.05409801
        NumberBetween100and150mi NumberBetween150and200mi
Electric                0.5114757                0.1130137
Hydrogen               -0.7346264                0.7295762
        NumberBetween200and300mi NumberMoreThan300mi AverageAnnualMiles
Electric                0.5138416          0.04807622       -1.151001e-05
```

```
Hydrogen                   -0.2939529         0.78735946       -3.007277e-05
          PredictableUsagePattern FuelAtHome ReturnToHome Within50mi
Electric                  -1.385154  0.2309341    0.6419812  0.1833241
Hydrogen                  -1.006882 -0.1114219   -0.5461888  0.8209928
          Parked8Hours AtWeightLimit GPSMileageTracking AllWheelDrive
Electric     0.2964121   -0.03721072        -0.3320710    -0.2921627
Hydrogen     0.5595025   -0.03300612        -0.2017258     0.0080458
             Backup NumberOfVehicles:NumberBelow100mi
Electric -0.04271078                        -0.13019018
Hydrogen  0.12093172                        -0.08092384
          NumberOfVehicles:NumberBetween100and150mi
Electric                                    0.6307055
Hydrogen                                    0.2060686
          NumberOfVehicles:NumberBetween150and200mi
Electric                                    0.2553991
Hydrogen                                    0.1497029
          NumberOfVehicles:NumberBetween200and300mi
Electric                                    0.55138325
Hydrogen                                    0.08392775
          NumberOfVehicles:NumberMoreThan300mi
Electric                                    0.39858588
Hydrogen                                   -0.03132453
          NumberOfVehicles:AverageAnnualMiles
Electric                                    1.596790e-05
Hydrogen                                    2.940625e-06
          NumberOfVehicles:PredictableUsagePattern NumberOfVehicles:FuelAtHome
Electric                                    0.2143097                0.05296903
Hydrogen                                    0.1715806               -0.14553901
          NumberOfVehicles:ReturnToHome NumberOfVehicles:Within50mi
Electric                    -1.40330980                 0.455678663
Hydrogen                    -0.07584609                -0.006692256
          NumberOfVehicles:Parked8Hours NumberOfVehicles:AtWeightLimit
Electric                     0.17174176                 0.3431767
Hydrogen                    -0.05696085                -0.4026162
          NumberOfVehicles:GPSMileageTracking NumberOfVehicles:AllWheelDrive
Electric                         -0.4237408                 0.17357069
Hydrogen                         -0.2289857                 0.03471901
          NumberOfVehicles:Backup NumberBelow100mi:NumberBetween100and150mi
Electric           -0.27461307                              0.4853953
Hydrogen           -0.06607831                              0.5596708
          NumberBelow100mi:NumberBetween150and200mi
Electric                                   -0.1086718
Hydrogen                                   -0.1332697
```

```
       NumberBelow100mi:AverageAnnualMiles
Electric                    -1.705172e-05
Hydrogen                    -4.181582e-06
       NumberBelow100mi:PredictableUsagePattern NumberBelow100mi:FuelAtHome
Electric                               -0.1113525                 0.14771598
Hydrogen                               -0.1253458                -0.05716652
       NumberBelow100mi:ReturnToHome NumberBelow100mi:Within50mi
Electric                 -0.07837022                  0.09718703
Hydrogen                 -0.20037500                  0.12162725
       NumberBelow100mi:Parked8Hours NumberBelow100mi:GPSMileageTracking
Electric                  -0.1960429                          0.6395927
Hydrogen                   0.5773871                          0.1793942
       NumberBelow100mi:AllWheelDrive NumberBelow100mi:Backup
Electric                   -0.1043779            -0.17404250
Hydrogen                    0.3817943            -0.01278371
       NumberBetween100and150mi:NumberBetween150and200mi
Electric                                        0.009365387
Hydrogen                                       -0.222206071
       NumberBetween100and150mi:AverageAnnualMiles
Electric                               -9.565438e-06
Hydrogen                                1.725441e-05
       NumberBetween100and150mi:Parked8Hours
Electric                  -0.47990702
Hydrogen                  -0.09835962
       NumberBetween100and150mi:AtWeightLimit NumberBetween100and150mi:Backup
Electric                              0.1580122                     -0.2672910
Hydrogen                             -0.3016824                      0.5042755
       NumberBetween150and200mi:NumberMoreThan300mi
Electric                                 -0.19628967
Hydrogen                                  0.05342987
       NumberBetween150and200mi:Parked8Hours
Electric                   0.29310005
Hydrogen                  -0.01317136
       NumberBetween150and200mi:AtWeightLimit
Electric                  -0.278512477
Hydrogen                   0.009471055
       NumberBetween150and200mi:GPSMileageTracking
Electric                                 -0.1171726
Hydrogen                                  0.3384923
       NumberBetween150and200mi:Backup NumberBetween200and300mi:AtWeightLimit
Electric                      0.14148044                              0.1830060
Hydrogen                     -0.04056359                             -0.2959271
       NumberBetween200and300mi:Backup
```

```
Electric                               -0.2819316
Hydrogen                                0.6661763
        NumberBetween200and300mi:NumberMoreThan300mi
Electric                                      -0.1925771
Hydrogen                                      -0.1919299
        NumberBetween200and300mi:AverageAnnualMiles
Electric                                      -8.843990e-06
Hydrogen                                       9.172393e-06
        NumberBetween200and300mi:PredictableUsagePattern
Electric                                           -0.1142841
Hydrogen                                            0.1581263
        NumberBetween200and300mi:FuelAtHome
Electric                               -0.1494385
Hydrogen                                0.3218258
        NumberBetween200and300mi:ReturnToHome
Electric                               -0.8039638
Hydrogen                                0.1999039
        NumberBetween200and300mi:Within50mi
Electric                                0.045560963
Hydrogen                               -0.001284153
        NumberBetween200and300mi:Parked8Hours
Electric                                0.5834857
Hydrogen                                0.1906045
        NumberMoreThan300mi:PredictableUsagePattern
Electric                                     -0.422721027
Hydrogen                                     -0.009260145
        NumberMoreThan300mi:FuelAtHome NumberMoreThan300mi:ReturnToHome
Electric                       -0.3993767                        0.2863837
Hydrogen                       -0.1747660                        0.1115384
        NumberMoreThan300mi:AtWeightLimit
Electric                               -0.2302848
Hydrogen                                0.2806326
        NumberMoreThan300mi:GPSMileageTracking
Electric                                0.39858588
Hydrogen                               -0.03132453
        PredictableUsagePattern:FuelAtHome
Electric                               -0.42981253
Hydrogen                                0.09197026
        PredictableUsagePattern:ReturnToHome
Electric                                0.3965456
Hydrogen                               -0.3192284
        PredictableUsagePattern:Within50mi
Electric                                0.45027389
```

```
Hydrogen                                  0.08969044
        PredictableUsagePattern:Parked8Hours
Electric                                  -0.2650606
Hydrogen                                   0.3300119
        PredictableUsagePattern:GPSMileageTracking FuelAtHome:ReturnToHome
Electric                                  -0.17578168                0.02308588
Hydrogen                                  -0.08367868                0.32953452
        FuelAtHome:Within50mi FuelAtHome:Parked8Hours
Electric          -0.19684386              0.3979179
Hydrogen           0.04964047             -0.2660094
        FuelAtHome:GPSMileageTracking FuelAtHome:AllWheelDrive
Electric                  0.068418897            -0.04691603
Hydrogen                 -0.004445755             0.04444805
        FuelAtHome:Backup ReturnToHome:Parked8Hours
Electric        -0.1966527              0.3208425
Hydrogen         0.1059971             -0.2338668
        ReturnToHome:GPSMileageTracking ReturnToHome:AllWheelDrive
Electric                    1.4114170                -0.42379464
Hydrogen                    0.1260461                -0.01393423
        ReturnToHome:Backup ReturnToHome:Within50mi Within50mi:Parked8Hours
Electric        -0.8131155             -0.173926527               0.2515721
Hydrogen         0.1340997              0.002327951              -0.1930317
        Within50mi:AtWeightLimit Within50mi:GPSMileageTracking
Electric              -0.16325939                  -0.8040981
Hydrogen              -0.07467723                  -0.1472751
        Within50mi:AllWheelDrive Within50mi:Backup Parked8Hours:AtWeightLimit
Electric              0.08669202         0.3467408              -0.08525634
Hydrogen              0.01916580         0.2023121               0.09556247
        Parked8Hours:GPSMileageTracking Parked8Hours:AllWheelDrive
Electric                    -0.7050122                  0.3394968
Hydrogen                     0.2293215                 -0.4599138
        Parked8Hours:Backup AtWeightLimit:GPSMileageTracking
Electric         0.9148618                      -0.1092647
Hydrogen        -0.2627501                       0.3431704
        AtWeightLimit:AllWheelDrive AtWeightLimit:Backup
Electric                  0.3334268            0.01843320
Hydrogen                 -0.1185647           -0.08167231
        GPSMileageTracking:AllWheelDrive GPSMileageTracking:Backup
Electric                    -0.3576755                  0.2367842
Hydrogen                     0.0378326                  0.1146302

Std. Errors:
        (Intercept) NAICS_NameConstruction NAICS_NameOther
```

```
Electric  2.231938e-06          7.067095e-07   1.207114e-06
Hydrogen 1.161207e-06          4.439765e-07   1.085432e-07
        NAICS_NamePublicAdministration NAICS_NameTransportationWarehousing
Electric                 3.007209e-07                        6.384894e-07
Hydrogen                 1.778395e-07                        2.183306e-07
        SustainabilityPlanNo SustainabilityPlanYes FacilityTypeFactory
Electric         2.179490e-06         4.390090e-07         3.518193e-07
Hydrogen         1.112932e-06         2.808893e-07         2.067469e-08
        FacilityTypeMulti-building campus/base FacilityTypeOther
Electric                           1.759871e-08     4.545222e-07
Hydrogen                           3.605400e-09     1.974087e-07
        FacilityTypeServiceCenter FacilityTypeStore FacilityTypeTruckYard
Electric              7.366191e-08     1.309611e-07          1.970901e-06
Hydrogen              4.734841e-07     1.717261e-09          1.339993e-06
        FacilityTypeWarehouse OwnedLeasedOwned DieselInfrastructure1
Electric         1.321167e-07     2.615190e-06          2.485529e-06
Hydrogen         2.919448e-07     1.187734e-06          1.174715e-06
        GasolineInfrastructure1 NGInfrastructure1 OtherInfrastructure1
Electric           2.244012e-06     1.657438e-06          1.490029e-15
Hydrogen           1.084296e-06     1.288228e-06          0.000000e+00
        FuelTypeDiesel FuelTypeElectricity FuelTypeGasoline
Electric   7.715842e-07        1.370470e-07     1.401675e-06
Hydrogen   5.676193e-07        7.606726e-09     1.047416e-06
        FuelTypeNatural Gas FuelTypeOther NumberOfVehicles NumberBelow100mi
Electric         1.310923e-08  2.721291e-08     2.910294e-05     1.474574e-05
Hydrogen         1.256455e-11  2.795308e-08     1.601283e-05     1.007004e-05
        NumberBetween100and150mi NumberBetween150and200mi
Electric             1.117463e-06             3.227766e-05
Hydrogen             9.919087e-07             1.220680e-05
        NumberBetween200and300mi NumberMoreThan300mi AverageAnnualMiles
Electric             1.041506e-06        8.845544e-06       1.749059e-05
Hydrogen             5.670649e-06        2.766455e-07       2.235403e-05
        PredictableUsagePattern   FuelAtHome ReturnToHome   Within50mi
Electric             2.476572e-05 2.164450e-05 2.442007e-05 3.030503e-05
Hydrogen             5.939544e-06 1.710676e-05 1.624576e-05 1.550007e-05
        Parked8Hours AtWeightLimit GPSMileageTracking AllWheelDrive
Electric 2.004126e-05  2.273714e-05       2.332473e-05  6.230973e-06
Hydrogen 1.692779e-05  1.493977e-05       1.826803e-05  2.663956e-06
          Backup NumberOfVehicles:NumberBelow100mi
Electric 1.479533e-05                   0.0006256876
Hydrogen 1.904924e-05                   0.0004196860
        NumberOfVehicles:NumberBetween100and150mi
Electric                               9.712120e-05
```

```
Hydrogen                                  6.814027e-05
        NumberOfVehicles:NumberBetween150and200mi
Electric                                  0.0006223392
Hydrogen                                  0.0001421546
        NumberOfVehicles:NumberBetween200and300mi
Electric                                  0.0002666662
Hydrogen                                  0.0002144229
        NumberOfVehicles:NumberMoreThan300mi
Electric                                  4.171684e-04
Hydrogen                                  1.835701e-05
        NumberOfVehicles:AverageAnnualMiles
Electric                                  2.768680e-06
Hydrogen                                  3.069456e-06
        NumberOfVehicles:PredictableUsagePattern NumberOfVehicles:FuelAtHome
Electric                                  0.0003068811                 0.0004350606
Hydrogen                                  0.0003847895                 0.0005518759
        NumberOfVehicles:ReturnToHome NumberOfVehicles:Within50mi
Electric                  0.0002409540                 0.0003732207
Hydrogen                  0.0002727806                 0.0004843580
        NumberOfVehicles:Parked8Hours NumberOfVehicles:AtWeightLimit
Electric                  0.0004695513                 0.0004017738
Hydrogen                  0.0002447477                 0.0003041212
        NumberOfVehicles:GPSMileageTracking NumberOfVehicles:AllWheelDrive
Electric                          0.0007091733                 2.308493e-04
Hydrogen                          0.0007368654                 7.833694e-05
        NumberOfVehicles:Backup NumberBelow100mi:NumberBetween100and150mi
Electric            0.0002123044                              7.682338e-05
Hydrogen            0.0002980183                              5.804834e-05
        NumberBelow100mi:NumberBetween150and200mi
Electric                                  5.264153e-05
Hydrogen                                  4.116165e-05
        NumberBelow100mi:AverageAnnualMiles
Electric                                  5.712384e-06
Hydrogen                                  4.570597e-06
        NumberBelow100mi:PredictableUsagePattern NumberBelow100mi:FuelAtHome
Electric                                  0.0002919773                 0.0007483641
Hydrogen                                  0.0001493656                 0.0003254845
        NumberBelow100mi:ReturnToHome NumberBelow100mi:Within50mi
Electric                  0.0004491211                 0.0003767841
Hydrogen                  0.0001870214                 0.0003755869
        NumberBelow100mi:Parked8Hours NumberBelow100mi:GPSMileageTracking
Electric                  0.0004093404                         0.0007295433
Hydrogen                  0.0001329432                         0.0006280826
```

```
        NumberBelow100mi:AllWheelDrive NumberBelow100mi:Backup
Electric                  2.294430e-04              0.0004715104
Hydrogen                  2.986614e-05              0.0001222952
        NumberBetween100and150mi:NumberBetween150and200mi
Electric                                  6.447835e-06
Hydrogen                                  4.189587e-06
        NumberBetween100and150mi:AverageAnnualMiles
Electric                                  8.593805e-06
Hydrogen                                  1.054630e-05
        NumberBetween100and150mi:Parked8Hours
Electric                                  1.495649e-05
Hydrogen                                  1.050101e-05
        NumberBetween100and150mi:AtWeightLimit NumberBetween100and150mi:Backup
Electric                                  1.559932e-05                    1.797098e-05
Hydrogen                                  1.095317e-05                    8.353379e-06
        NumberBetween150and200mi:NumberMoreThan300mi
Electric                                  2.349577e-05
Hydrogen                                  1.444893e-06
        NumberBetween150and200mi:Parked8Hours
Electric                                  0.0005158867
Hydrogen                                  0.0001478513
        NumberBetween150and200mi:AtWeightLimit
Electric                                  0.0005456422
Hydrogen                                  0.0001466307
        NumberBetween150and200mi:GPSMileageTracking
Electric                                  0.0006223908
Hydrogen                                  0.0001421527
        NumberBetween150and200mi:Backup NumberBetween200and300mi:AtWeightLimit
Electric                  0.0004914973                          0.0002785184
Hydrogen                  0.0001570198                          0.0002706508
        NumberBetween200and300mi:Backup
Electric                  4.737004e-06
Hydrogen                  4.189382e-05
        NumberBetween200and300mi:NumberMoreThan300mi
Electric                                  5.272339e-06
Hydrogen                                  3.812636e-06
        NumberBetween200and300mi:AverageAnnualMiles
Electric                                  4.614456e-06
Hydrogen                                  3.808269e-06
        NumberBetween200and300mi:PredictableUsagePattern
Electric                                  0.0002721200
Hydrogen                                  0.0003026414
        NumberBetween200and300mi:FuelAtHome
```

```
Electric                             0.0002913771
Hydrogen                             0.0003395816
        NumberBetween200and300mi:ReturnToHome
Electric                             2.551753e-05
Hydrogen                             1.870649e-04
        NumberBetween200and300mi:Within50mi
Electric                             1.502852e-05
Hydrogen                             1.841130e-04
        NumberBetween200and300mi:Parked8Hours
Electric                             2.321161e-05
Hydrogen                             2.127876e-04
        NumberMoreThan300mi:PredictableUsagePattern
Electric                                0.0003536152
Hydrogen                                0.0000100956
        NumberMoreThan300mi:FuelAtHome NumberMoreThan300mi:ReturnToHome
Electric                5.323760e-04                             4.652087e-04
Hydrogen                1.130607e-06                             5.449050e-06
        NumberMoreThan300mi:AtWeightLimit
Electric                4.426976e-04
Hydrogen                9.113887e-06
        NumberMoreThan300mi:GPSMileageTracking
Electric                             4.171684e-04
Hydrogen                             1.835701e-05
        PredictableUsagePattern:FuelAtHome
Electric                             0.0005149208
Hydrogen                             0.0004966420
        PredictableUsagePattern:ReturnToHome
Electric                             0.0001320875
Hydrogen                             0.0001995239
        PredictableUsagePattern:Within50mi
Electric                             0.0002919907
Hydrogen                             0.0002135398
        PredictableUsagePattern:Parked8Hours
Electric                             0.0003670667
Hydrogen                             0.0001710770
        PredictableUsagePattern:GPSMileageTracking FuelAtHome:ReturnToHome
Electric                                0.0003376489                0.0004617421
Hydrogen                                0.0004511043                0.0004745887
        FuelAtHome:Within50mi FuelAtHome:Parked8Hours
Electric          0.0006835100                0.0004675122
Hydrogen          0.0004430945                0.0004743923
        FuelAtHome:GPSMileageTracking FuelAtHome:AllWheelDrive
Electric                  0.0005763353                2.312996e-04
```

```
Hydrogen                  0.0003547957                 2.333573e-05
        FuelAtHome:Backup ReturnToHome:Parked8Hours
Electric     0.0001665776                0.0004612773
Hydrogen     0.0001562598                0.0003094367
        ReturnToHome:GPSMileageTracking ReturnToHome:AllWheelDrive
Electric                   0.0002951513                 2.310806e-04
Hydrogen                   0.0002750188                 4.313119e-05
        ReturnToHome:Backup ReturnToHome:Within50mi Within50mi:Parked8Hours
Electric       0.0002717536            0.0004166701             0.0002731500
Hydrogen       0.0002508739            0.0002654584             0.0002237781
        Within50mi:AtWeightLimit Within50mi:GPSMileageTracking
Electric             0.0002386928                  0.0003536197
Hydrogen             0.0002454716                  0.0007012781
        Within50mi:AllWheelDrive Within50mi:Backup Parked8Hours:AtWeightLimit
Electric             2.293245e-04     0.0002079527              0.0005046234
Hydrogen             2.149932e-05     0.0002207833              0.0003044706
        Parked8Hours:GPSMileageTracking Parked8Hours:AllWheelDrive
Electric                   0.0005567200                 2.310658e-04
Hydrogen                   0.0002978291                 4.306445e-05
        Parked8Hours:Backup AtWeightLimit:GPSMileageTracking
Electric       0.0002171024                 0.0004018883
Hydrogen       0.0002505630                 0.0003040733
        AtWeightLimit:AllWheelDrive AtWeightLimit:Backup
Electric               2.295651e-04         0.0001693082
Hydrogen               8.082495e-05         0.0002296341
        GPSMileageTracking:AllWheelDrive GPSMileageTracking:Backup
Electric                   2.295145e-04              0.0001677816
Hydrogen                   7.839713e-05              0.0002414959

Residual Deviance: 109.0369
AIC: 577.0369
```

```r
# include:
## NAICS_Name, SustainabilityPlan, FacilityType, OwnedLeased, DieselInfrastructure, Gasoline
# remove:
## Revenue2021, NumberBelow100mi, NumberBetween100and150mi, NumberBetween150and200mi, Number

#mod_best <- step(mod_max)

actual <- factor(nycars_mult_test$LEM)
pred <- factor(predict(mod_short_best, nycars_mult_test),c("Electric","Hydrogen","None"))
print(confusionMatrix(pred,actual))
```

```
Warning in confusionMatrix.default(pred, actual): Levels are not in the same
order for reference and data. Refactoring data to match.


Confusion Matrix and Statistics


          Reference
Prediction None Electric Hydrogen
  None      539        7        1
  Electric   27       54        0
  Hydrogen   15        1        2


Overall Statistics

               Accuracy : 0.9211
                 95% CI : (0.8975, 0.9407)
    No Information Rate : 0.8994
    P-Value [Acc > NIR] : 0.03537

                  Kappa : 0.6511

 Mcnemar's Test P-Value : 1.533e-05


Statistics by Class:

                     Class: None Class: Electric Class: Hydrogen
Sensitivity               0.9277         0.87097        0.666667
Specificity               0.8769         0.95377        0.975117
Pos Pred Value            0.9854         0.66667        0.111111
Neg Pred Value            0.5758         0.98584        0.998408
Prevalence                0.8994         0.09598        0.004644
Detection Rate            0.8344         0.08359        0.003096
Detection Prevalence      0.8467         0.12539        0.027864
Balanced Accuracy         0.9023         0.91237        0.820892
```

```
# Not helpful to plot residuals here
# plot(fitted(mod_short_best),residuals(mod_short_best))
# plot(residuals(mod_short_best))
# plot(residuals(mod_short_best,type="pearson"))

# checking for multicollinearity in this fashion was also pointless
#library(car)
#vif(mod_short_best)
```