Project 1

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```
#Data sets
library(tidyverse)
```

```
## -- Attaching packages ---------------------------------------------------------------------------
## v ggplot2 3.2.1          v purrr   0.3.3
## v tibble  2.1.3          v dplyr   0.8.3
## v tidyr   1.0.0.9000     v stringr 1.4.0
## v readr   1.3.1          v forcats 0.4.0
## -- Conflicts ------------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library("readxl")
cars <- read.csv("~/cars.csv")
sdata <- read.csv("~/sdatareal.csv")

library(ggplot2)
head(cars)
```

```
##   X speed dist
## 1 1     4    2
## 2 2     4   10
## 3 3     7    4
## 4 4     7   22
## 5 5     8   16
## 6 6     9   10
```

```
glimpse(cars)
```

```
## Observations: 50
## Variables: 3
## $ X     <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18...
## $ speed <int> 4, 4, 7, 7, 8, 9, 10, 10, 10, 11, 11, 12, 12, 12, 12, 13, 13,...
## $ dist  <int> 2, 10, 4, 22, 16, 10, 18, 26, 34, 17, 28, 14, 20, 24, 28, 26,...
```

```
cars <- as.data.frame(cars)
head(sdata)
```

```
##   X speed period warning pair ticket
## 1 1    26      1       1    1    yes
## 2 2    26      1       1    1    yes
## 3 3    26      1       1    1    yes
## 4 4    26      1       1    1    yes
## 5 5    27      1       1    1    yes
```

```
## 6 6    28      1       1    1    yes
```

```
sdata <- as.data.frame(sdata)
glimpse(sdata)
```

```
## Observations: 8,437
## Variables: 6
## $ X       <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, ...
## $ speed   <int> 26, 26, 26, 26, 27, 28, 28, 28, 28, 29, 29, 29, 29, 29, 29,...
## $ period  <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,...
## $ warning <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,...
## $ pair    <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,...
## $ ticket  <fct> yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes,...
```

Introduction: The two data sets I chose were chosen from https://vincentarelbundock.github.io/Rdatasets/datasets.html and are having to due with cars that had been pulled over and whether or not they received a ticket. While this data may seem mundane, I chose it because I believe I may find a strong correlation between an unthought of variable and whether or not a car receieves a ticket. The data I am analyzing contains the variables speed(how fast the vehicle was going when pulled over), distance(how far the car travel before stopping), period(the time of day the car was pulled over, distinguished by 3, 8 hour periods), warning(whether or not the vechicle received a warning, pair(how many people were in the given vehicle), and ticket (whether or not the vehicle recieved a ticket). Initially, the strongest association I may expect to see is between time period and people in the car, as certain times of day may increase the amount of people traveling together. For example more people may travel together at night due to dinner plans or an evening event. Intutively, the other variables would not seem to have a strong assocation, however I am interested to see if there is an unexpected assocation.

```
midprojectpart1 <- sdata

midprojectpart1 <- sdata %>%
  pivot_wider(names_from = "warning", values_from = "period") %>%
  glimpse()
```

```
## Observations: 8,437
## Variables: 6
## $ X      <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 1...
## $ speed  <int> 26, 26, 26, 26, 27, 28, 28, 28, 28, 29, 29, 29, 29, 29, 29, ...
## $ pair   <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ ticket <fct> yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, ...
## $ `1`    <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ...
## $ `2`    <int> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, ...
```

```
midprojectpart1 <- midprojectpart1 %>%
  pivot_longer(c("1","2"),names_to = "warning",values_to = "period", values_drop_na=T ) %>%
  glimpse()
```

```
## Observations: 8,437
## Variables: 6
## $ X       <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, ...
## $ speed   <int> 26, 26, 26, 26, 27, 28, 28, 28, 28, 29, 29, 29, 29, 29, 29,...
## $ pair    <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,...
## $ ticket  <fct> yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes,...
## $ warning <chr> "1", "1", "1", "1", "1", "1", "1", "1", "1", "1", "1", "1",...
## $ period  <int> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,...
```

Because my data was already tidy, I pivoted wider by making a yes and no columns with the warning status of each car pulled over and then proceeded to pivot longer to condense the yes and no columns into one column

called "warning". This made the data easier to read. values_drop_na=T was used to omit the NAs.

```
#Joining
carspeedfulljoin<-inner_join(cars, sdata, by= c("speed", "speed"), suffix=c("cars", "sdata"))
glimpse(carspeedfulljoin)
```

```
## Observations: 258
## Variables: 8
## $ Xcars   <int> 36, 37, 38, 39, 39, 39, 39, 40, 40, 40, 40, 41, 41, 41, 41,...
## $ speed   <int> 19, 19, 19, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20,...
## $ dist    <int> 36, 46, 68, 32, 32, 32, 32, 48, 48, 48, 48, 52, 52, 52, 52,...
## $ Xsdata  <int> 2101, 2101, 2101, 2102, 3301, 3401, 6824, 2102, 3301, 3401,...
## $ period  <int> 2, 2, 2, 2, 2, 1, 3, 2, 2, 1, 3, 2, 2, 1, 3, 2, 2, 1, 3, 2,...
## $ warning <int> 1, 1, 1, 1, 1, 2, 1, 1, 1, 2, 1, 1, 1, 2, 1, 1, 1, 2, 1, 1,...
## $ pair    <int> 7, 7, 7, 7, 10, 10, 7, 7, 10, 10, 7, 7, 10, 10, 7, 7, 10, 1...
## $ ticket  <fct> yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes, yes,...
```

For joining, both datasets "cars" and "sdata" were joined using a fulljoin by the common variable, speed, while retaining all of the other variables unique to each data set. This join made the data clear and cohesive to read. The joined data was named "carspeedfulljoin".

```
#Wrangling
install.packages("kableExtra")
```

```
## Installing package into '/stor/home/gs27275/R/x86_64-pc-linux-gnu-library/3.4'
## (as 'lib' is unspecified)
```

```
library(knitr)
library(kableExtra)
```

```
##
## Attaching package: 'kableExtra'
```

```
## The following object is masked from 'package:dplyr':
##
##     group_rows
```

```
joindatomit<- carspeedfulljoin %>% filter(complete.cases(carspeedfulljoin))
carspeedfulljoin %>% select(period, speed)
```

```
##     period speed
## 1        2    19
## 2        2    19
## 3        2    19
## 4        2    20
## 5        2    20
## 6        1    20
## 7        3    20
## 8        2    20
## 9        2    20
## 10       1    20
## 11       3    20
## 12       2    20
## 13       2    20
## 14       1    20
## 15       3    20
## 16       2    20
## 17       2    20
```

```
## 18       1    20
## 19       3    20
## 20       2    20
## 21       2    20
## 22       1    20
## 23       3    20
## 24       1    22
## 25       1    22
## 26       1    22
## 27       2    22
## 28       1    22
## 29       1    22
## 30       1    22
## 31       2    22
## 32       2    22
## 33       2    22
## 34       1    22
## 35       1    22
## 36       1    22
## 37       2    22
## 38       3    22
## 39       3    22
## 40       3    22
## 41       3    22
## 42       1    23
## 43       2    23
## 44       2    23
## 45       2    23
## 46       2    23
## 47       2    23
## 48       2    23
## 49       1    23
## 50       1    23
## 51       2    23
## 52       1    23
## 53       3    23
## 54       3    23
## 55       3    23
## 56       1    24
## 57       1    24
## 58       1    24
## 59       1    24
## 60       1    24
## 61       1    24
## 62       2    24
## 63       1    24
## 64       1    24
## 65       1    24
## 66       1    24
## 67       1    24
## 68       1    24
## 69       2    24
## 70       2    24
## 71       2    24
```

```
## 72       2    24
## 73       2    24
## 74       2    24
## 75       2    24
## 76       2    24
## 77       2    24
## 78       2    24
## 79       2    24
## 80       2    24
## 81       1    24
## 82       1    24
## 83       1    24
## 84       1    24
## 85       3    24
## 86       3    24
## 87       3    24
## 88       3    24
## 89       3    24
## 90       3    24
## 91       3    24
## 92       3    24
## 93       3    24
## 94       3    24
## 95       1    24
## 96       1    24
## 97       1    24
## 98       1    24
## 99       1    24
## 100      1    24
## 101      2    24
## 102      1    24
## 103      1    24
## 104      1    24
## 105      1    24
## 106      1    24
## 107      1    24
## 108      2    24
## 109      2    24
## 110      2    24
## 111      2    24
## 112      2    24
## 113      2    24
## 114      2    24
## 115      2    24
## 116      2    24
## 117      2    24
## 118      2    24
## 119      2    24
## 120      1    24
## 121      1    24
## 122      1    24
## 123      1    24
## 124      3    24
## 125      3    24
```

```
## 126      3    24
## 127      3    24
## 128      3    24
## 129      3    24
## 130      3    24
## 131      3    24
## 132      3    24
## 133      3    24
## 134      1    24
## 135      1    24
## 136      1    24
## 137      1    24
## 138      1    24
## 139      1    24
## 140      2    24
## 141      1    24
## 142      1    24
## 143      1    24
## 144      1    24
## 145      1    24
## 146      1    24
## 147      2    24
## 148      2    24
## 149      2    24
## 150      2    24
## 151      2    24
## 152      2    24
## 153      2    24
## 154      2    24
## 155      2    24
## 156      2    24
## 157      2    24
## 158      2    24
## 159      1    24
## 160      1    24
## 161      1    24
## 162      1    24
## 163      3    24
## 164      3    24
## 165      3    24
## 166      3    24
## 167      3    24
## 168      3    24
## 169      3    24
## 170      3    24
## 171      3    24
## 172      3    24
## 173      1    24
## 174      1    24
## 175      1    24
## 176      1    24
## 177      1    24
## 178      1    24
## 179      2    24
```

```
## 180      1    24
## 181      1    24
## 182      1    24
## 183      1    24
## 184      1    24
## 185      1    24
## 186      2    24
## 187      2    24
## 188      2    24
## 189      2    24
## 190      2    24
## 191      2    24
## 192      2    24
## 193      2    24
## 194      2    24
## 195      2    24
## 196      2    24
## 197      2    24
## 198      1    24
## 199      1    24
## 200      1    24
## 201      1    24
## 202      3    24
## 203      3    24
## 204      3    24
## 205      3    24
## 206      3    24
## 207      3    24
## 208      3    24
## 209      3    24
## 210      3    24
## 211      3    24
## 212      1    25
## 213      1    25
## 214      1    25
## 215      1    25
## 216      1    25
## 217      1    25
## 218      1    25
## 219      2    25
## 220      1    25
## 221      1    25
## 222      1    25
## 223      2    25
## 224      2    25
## 225      1    25
## 226      1    25
## 227      1    25
## 228      2    25
## 229      2    25
## 230      2    25
## 231      2    25
## 232      2    25
## 233      2    25
```

```
## 234      2    25
## 235      2    25
## 236      1    25
## 237      2    25
## 238      2    25
## 239      2    25
## 240      2    25
## 241      2    25
## 242      1    25
## 243      2    25
## 244      2    25
## 245      3    25
## 246      3    25
## 247      3    25
## 248      3    25
## 249      3    25
## 250      3    25
## 251      3    25
## 252      3    25
## 253      3    25
## 254      3    25
## 255      3    25
## 256      3    25
## 257      3    25
## 258      3    25
```

```
carspeedfulljoin %>% arrange(desc(period))
```

```
##     Xcars speed dist Xsdata period warning pair ticket
## 1      39    20   32   6824      3       1    7    yes
## 2      40    20   48   6824      3       1    7    yes
## 3      41    20   52   6824      3       1    7    yes
## 4      42    20   56   6824      3       1    7    yes
## 5      43    20   64   6824      3       1    7    yes
## 6      44    22   66   5685      3       1    1    yes
## 7      44    22   66   5810      3       1    2    yes
## 8      44    22   66   6152      3       1    3    yes
## 9      44    22   66   7747      3       2   11     no
## 10     45    23   54   6156      3       1    3    yes
## 11     45    23   54   6157      3       1    3    yes
## 12     45    23   54   6397      3       1    5    yes
## 13     46    24   70   5795      3       2    1    yes
## 14     46    24   70   6083      3       1    3    yes
## 15     46    24   70   6087      3       1    3    yes
## 16     46    24   70   6828      3       1    7    yes
## 17     46    24   70   6832      3       1    7    yes
## 18     46    24   70   6845      3       1    7    yes
## 19     46    24   70   7418      3       1   10     no
## 20     46    24   70   7482      3       2   10     no
## 21     46    24   70   7610      3       1   11     no
## 22     46    24   70   7645      3       2   11     no
## 23     47    24   92   5795      3       2    1    yes
## 24     47    24   92   6083      3       1    3    yes
## 25     47    24   92   6087      3       1    3    yes
## 26     47    24   92   6828      3       1    7    yes
```

```
## 27     47    24   92   6832       3        1    7    yes
## 28     47    24   92   6845       3        1    7    yes
## 29     47    24   92   7418       3        1   10     no
## 30     47    24   92   7482       3        2   10     no
## 31     47    24   92   7610       3        1   11     no
## 32     47    24   92   7645       3        2   11     no
## 33     48    24   93   5795       3        2    1    yes
## 34     48    24   93   6083       3        1    3    yes
## 35     48    24   93   6087       3        1    3    yes
## 36     48    24   93   6828       3        1    7    yes
## 37     48    24   93   6832       3        1    7    yes
## 38     48    24   93   6845       3        1    7    yes
## 39     48    24   93   7418       3        1   10     no
## 40     48    24   93   7482       3        2   10     no
## 41     48    24   93   7610       3        1   11     no
## 42     48    24   93   7645       3        2   11     no
## 43     49    24  120   5795       3        2    1    yes
## 44     49    24  120   6083       3        1    3    yes
## 45     49    24  120   6087       3        1    3    yes
## 46     49    24  120   6828       3        1    7    yes
## 47     49    24  120   6832       3        1    7    yes
## 48     49    24  120   6845       3        1    7    yes
## 49     49    24  120   7418       3        1   10     no
## 50     49    24  120   7482       3        2   10     no
## 51     49    24  120   7610       3        1   11     no
## 52     49    24  120   7645       3        2   11     no
## 53     50    25   85   5666       3        1    1    yes
## 54     50    25   85   5700       3        1    1    yes
## 55     50    25   85   5920       3        2    2    yes
## 56     50    25   85   6154       3        1    3    yes
## 57     50    25   85   6174       3        1    3    yes
## 58     50    25   85   6411       3        1    5    yes
## 59     50    25   85   6777       3        1    7    yes
## 60     50    25   85   6780       3        1    7    yes
## 61     50    25   85   6793       3        1    7    yes
## 62     50    25   85   6826       3        1    7    yes
## 63     50    25   85   6846       3        1    7    yes
## 64     50    25   85   7525       3        2   10     no
## 65     50    25   85   7571       3        1   11     no
## 66     50    25   85   7693       3        2   11     no
## 67     36    19   36   2101       2        1    7    yes
## 68     37    19   46   2101       2        1    7    yes
## 69     38    19   68   2101       2        1    7    yes
## 70     39    20   32   2102       2        1    7    yes
## 71     39    20   32   3301       2        1   10    yes
## 72     40    20   48   2102       2        1    7    yes
## 73     40    20   48   3301       2        1   10    yes
## 74     41    20   52   2102       2        1    7    yes
## 75     41    20   52   3301       2        1   10    yes
## 76     42    20   56   2102       2        1    7    yes
## 77     42    20   56   3301       2        1   10    yes
## 78     43    20   64   2102       2        1    7    yes
## 79     43    20   64   3301       2        1   10    yes
## 80     44    22   66   1301       2        2    4    yes
```

```
## 81     44    22    66   2105       2        1     7    yes
## 82     44    22    66   2106       2        1     7    yes
## 83     44    22    66   2107       2        1     7    yes
## 84     44    22    66   5301       2        2     3    yes
## 85     45    23    54   2108       2        1     7    yes
## 86     45    23    54   2109       2        1     7    yes
## 87     45    23    54   2110       2        1     7    yes
## 88     45    23    54   2111       2        1     7    yes
## 89     45    23    54   2112       2        1     7    yes
## 90     45    23    54   2501       2        1     8    yes
## 91     45    23    54   3302       2        1    10    yes
## 92     46    24    70   1501       2        1     5    yes
## 93     46    24    70   2113       2        1     7    yes
## 94     46    24    70   2114       2        1     7    yes
## 95     46    24    70   2115       2        1     7    yes
## 96     46    24    70   2116       2        1     7    yes
## 97     46    24    70   2117       2        1     7    yes
## 98     46    24    70   2118       2        1     7    yes
## 99     46    24    70   2119       2        1     7    yes
## 100    46    24    70   2120       2        1     7    yes
## 101    46    24    70   2121       2        1     7    yes
## 102    46    24    70   2122       2        1     7    yes
## 103    46    24    70   2901       2        1     9    yes
## 104    46    24    70   3303       2        1    10    yes
## 105    47    24    92   1501       2        1     5    yes
## 106    47    24    92   2113       2        1     7    yes
## 107    47    24    92   2114       2        1     7    yes
## 108    47    24    92   2115       2        1     7    yes
## 109    47    24    92   2116       2        1     7    yes
## 110    47    24    92   2117       2        1     7    yes
## 111    47    24    92   2118       2        1     7    yes
## 112    47    24    92   2119       2        1     7    yes
## 113    47    24    92   2120       2        1     7    yes
## 114    47    24    92   2121       2        1     7    yes
## 115    47    24    92   2122       2        1     7    yes
## 116    47    24    92   2901       2        1     9    yes
## 117    47    24    92   3303       2        1    10    yes
## 118    48    24    93   1501       2        1     5    yes
## 119    48    24    93   2113       2        1     7    yes
## 120    48    24    93   2114       2        1     7    yes
## 121    48    24    93   2115       2        1     7    yes
## 122    48    24    93   2116       2        1     7    yes
## 123    48    24    93   2117       2        1     7    yes
## 124    48    24    93   2118       2        1     7    yes
## 125    48    24    93   2119       2        1     7    yes
## 126    48    24    93   2120       2        1     7    yes
## 127    48    24    93   2121       2        1     7    yes
## 128    48    24    93   2122       2        1     7    yes
## 129    48    24    93   2901       2        1     9    yes
## 130    48    24    93   3303       2        1    10    yes
## 131    49    24   120   1501       2        1     5    yes
## 132    49    24   120   2113       2        1     7    yes
## 133    49    24   120   2114       2        1     7    yes
## 134    49    24   120   2115       2        1     7    yes
```

```
## 135    49    24  120   2116       2        1    7    yes
## 136    49    24  120   2117       2        1    7    yes
## 137    49    24  120   2118       2        1    7    yes
## 138    49    24  120   2119       2        1    7    yes
## 139    49    24  120   2120       2        1    7    yes
## 140    49    24  120   2121       2        1    7    yes
## 141    49    24  120   2122       2        1    7    yes
## 142    49    24  120   2901       2        1    9    yes
## 143    49    24  120   3303       2        1   10    yes
## 144    50    25   85    701       2        2    2    yes
## 145    50    25   85    902       2        1    3    yes
## 146    50    25   85   1302       2        2    4    yes
## 147    50    25   85   2123       2        1    7    yes
## 148    50    25   85   2124       2        1    7    yes
## 149    50    25   85   2125       2        1    7    yes
## 150    50    25   85   2126       2        1    7    yes
## 151    50    25   85   2127       2        1    7    yes
## 152    50    25   85   2128       2        1    7    yes
## 153    50    25   85   3304       2        1   10    yes
## 154    50    25   85   3305       2        1   10    yes
## 155    50    25   85   3501       2        2   10    yes
## 156    50    25   85   3502       2        2   10    yes
## 157    50    25   85   3701       2        1   11    yes
## 158    50    25   85   3702       2        1   11    yes
## 159    50    25   85   3901       2        2   11    yes
## 160    50    25   85   4101       2        1   12    yes
## 161    50    25   85   5302       2        2    3    yes
## 162    39    20   32   3401       1        2   10    yes
## 163    40    20   48   3401       1        2   10    yes
## 164    41    20   52   3401       1        2   10    yes
## 165    42    20   56   3401       1        2   10    yes
## 166    43    20   64   3401       1        2   10    yes
## 167    44    22   66    601       1        2    2    yes
## 168    44    22   66    602       1        2    2    yes
## 169    44    22   66    801       1        1    3    yes
## 170    44    22   66   2001       1        1    7    yes
## 171    44    22   66   2002       1        1    7    yes
## 172    44    22   66   2003       1        1    7    yes
## 173    44    22   66   3201       1        1   10    yes
## 174    44    22   66   3402       1        2   10    yes
## 175    44    22   66   3801       1        2   11    yes
## 176    45    23   54    603       1        2    2    yes
## 177    45    23   54   3202       1        1   10    yes
## 178    45    23   54   3203       1        1   10    yes
## 179    45    23   54   3802       1        2   11    yes
## 180    46    24   70    604       1        2    2    yes
## 181    46    24   70    605       1        2    2    yes
## 182    46    24   70    802       1        1    3    yes
## 183    46    24   70    803       1        1    3    yes
## 184    46    24   70   1001       1        1    4    yes
## 185    46    24   70   1002       1        1    4    yes
## 186    46    24   70   2004       1        1    7    yes
## 187    46    24   70   2005       1        1    7    yes
## 188    46    24   70   2006       1        1    7    yes
```

```
## 189    46    24    70    2007       1        1     7     yes
## 190    46    24    70    2008       1        1     7     yes
## 191    46    24    70    2009       1        1     7     yes
## 192    46    24    70    3403       1        2    10     yes
## 193    46    24    70    3404       1        2    10     yes
## 194    46    24    70    3405       1        2    10     yes
## 195    46    24    70    3601       1        1    11     yes
## 196    47    24    92     604       1        2     2     yes
## 197    47    24    92     605       1        2     2     yes
## 198    47    24    92     802       1        1     3     yes
## 199    47    24    92     803       1        1     3     yes
## 200    47    24    92    1001       1        1     4     yes
## 201    47    24    92    1002       1        1     4     yes
## 202    47    24    92    2004       1        1     7     yes
## 203    47    24    92    2005       1        1     7     yes
## 204    47    24    92    2006       1        1     7     yes
## 205    47    24    92    2007       1        1     7     yes
## 206    47    24    92    2008       1        1     7     yes
## 207    47    24    92    2009       1        1     7     yes
## 208    47    24    92    3403       1        2    10     yes
## 209    47    24    92    3404       1        2    10     yes
## 210    47    24    92    3405       1        2    10     yes
## 211    47    24    92    3601       1        1    11     yes
## 212    48    24    93     604       1        2     2     yes
## 213    48    24    93     605       1        2     2     yes
## 214    48    24    93     802       1        1     3     yes
## 215    48    24    93     803       1        1     3     yes
## 216    48    24    93    1001       1        1     4     yes
## 217    48    24    93    1002       1        1     4     yes
## 218    48    24    93    2004       1        1     7     yes
## 219    48    24    93    2005       1        1     7     yes
## 220    48    24    93    2006       1        1     7     yes
## 221    48    24    93    2007       1        1     7     yes
## 222    48    24    93    2008       1        1     7     yes
## 223    48    24    93    2009       1        1     7     yes
## 224    48    24    93    3403       1        2    10     yes
## 225    48    24    93    3404       1        2    10     yes
## 226    48    24    93    3405       1        2    10     yes
## 227    48    24    93    3601       1        1    11     yes
## 228    49    24   120     604       1        2     2     yes
## 229    49    24   120     605       1        2     2     yes
## 230    49    24   120     802       1        1     3     yes
## 231    49    24   120     803       1        1     3     yes
## 232    49    24   120    1001       1        1     4     yes
## 233    49    24   120    1002       1        1     4     yes
## 234    49    24   120    2004       1        1     7     yes
## 235    49    24   120    2005       1        1     7     yes
## 236    49    24   120    2006       1        1     7     yes
## 237    49    24   120    2007       1        1     7     yes
## 238    49    24   120    2008       1        1     7     yes
## 239    49    24   120    2009       1        1     7     yes
## 240    49    24   120    3403       1        2    10     yes
## 241    49    24   120    3404       1        2    10     yes
## 242    49    24   120    3405       1        2    10     yes
```

```
## 243    49    24  120   3601      1       1   11    yes
## 244    50    25   85    202      1       2    1    yes
## 245    50    25   85    203      1       2    1    yes
## 246    50    25   85    401      1       1    2    yes
## 247    50    25   85    606      1       2    2    yes
## 248    50    25   85    607      1       2    2    yes
## 249    50    25   85    608      1       2    2    yes
## 250    50    25   85    609      1       2    2    yes
## 251    50    25   85    804      1       1    3    yes
## 252    50    25   85    805      1       1    3    yes
## 253    50    25   85    806      1       1    3    yes
## 254    50    25   85   2010      1       1    7    yes
## 255    50    25   85   2011      1       1    7    yes
## 256    50    25   85   2012      1       1    7    yes
## 257    50    25   85   3406      1       2   10    yes
## 258    50    25   85   4001      1       1   12    yes
```

```
carspeedfulljoin %>% group_by(period, speed) %>% summarize(mean_speed=mean(speed, na.rm=T))
```

```
## # A tibble: 16 x 3
## # Groups:   period [3]
##    period speed mean_speed
##     <int> <int>      <dbl>
##  1      1    20         20
##  2      1    22         22
##  3      1    23         23
##  4      1    24         24
##  5      1    25         25
##  6      2    19         19
##  7      2    20         20
##  8      2    22         22
##  9      2    23         23
## 10      2    24         24
## 11      2    25         25
## 12      3    20         20
## 13      3    22         22
## 14      3    23         23
## 15      3    24         24
## 16      3    25         25
```

```
carspeedfulljoin %>% mutate_if(is.numeric, round)
```

```
##     Xcars speed dist Xsdata period warning pair ticket
## 1      36    19   36   2101      2       1    7    yes
## 2      37    19   46   2101      2       1    7    yes
## 3      38    19   68   2101      2       1    7    yes
## 4      39    20   32   2102      2       1    7    yes
## 5      39    20   32   3301      2       1   10    yes
## 6      39    20   32   3401      1       2   10    yes
## 7      39    20   32   6824      3       1    7    yes
## 8      40    20   48   2102      2       1    7    yes
## 9      40    20   48   3301      2       1   10    yes
## 10     40    20   48   3401      1       2   10    yes
## 11     40    20   48   6824      3       1    7    yes
## 12     41    20   52   2102      2       1    7    yes
```

```
## 13     41    20    52   3301       2        1   10     yes
## 14     41    20    52   3401       1        2   10     yes
## 15     41    20    52   6824       3        1    7     yes
## 16     42    20    56   2102       2        1    7     yes
## 17     42    20    56   3301       2        1   10     yes
## 18     42    20    56   3401       1        2   10     yes
## 19     42    20    56   6824       3        1    7     yes
## 20     43    20    64   2102       2        1    7     yes
## 21     43    20    64   3301       2        1   10     yes
## 22     43    20    64   3401       1        2   10     yes
## 23     43    20    64   6824       3        1    7     yes
## 24     44    22    66    601       1        2    2     yes
## 25     44    22    66    602       1        2    2     yes
## 26     44    22    66    801       1        1    3     yes
## 27     44    22    66   1301       2        2    4     yes
## 28     44    22    66   2001       1        1    7     yes
## 29     44    22    66   2002       1        1    7     yes
## 30     44    22    66   2003       1        1    7     yes
## 31     44    22    66   2105       2        1    7     yes
## 32     44    22    66   2106       2        1    7     yes
## 33     44    22    66   2107       2        1    7     yes
## 34     44    22    66   3201       1        1   10     yes
## 35     44    22    66   3402       1        2   10     yes
## 36     44    22    66   3801       1        2   11     yes
## 37     44    22    66   5301       2        2    3     yes
## 38     44    22    66   5685       3        1    1     yes
## 39     44    22    66   5810       3        1    2     yes
## 40     44    22    66   6152       3        1    3     yes
## 41     44    22    66   7747       3        2   11      no
## 42     45    23    54    603       1        2    2     yes
## 43     45    23    54   2108       2        1    7     yes
## 44     45    23    54   2109       2        1    7     yes
## 45     45    23    54   2110       2        1    7     yes
## 46     45    23    54   2111       2        1    7     yes
## 47     45    23    54   2112       2        1    7     yes
## 48     45    23    54   2501       2        1    8     yes
## 49     45    23    54   3202       1        1   10     yes
## 50     45    23    54   3203       1        1   10     yes
## 51     45    23    54   3302       2        1   10     yes
## 52     45    23    54   3802       1        2   11     yes
## 53     45    23    54   6156       3        1    3     yes
## 54     45    23    54   6157       3        1    3     yes
## 55     45    23    54   6397       3        1    5     yes
## 56     46    24    70    604       1        2    2     yes
## 57     46    24    70    605       1        2    2     yes
## 58     46    24    70    802       1        1    3     yes
## 59     46    24    70    803       1        1    3     yes
## 60     46    24    70   1001       1        1    4     yes
## 61     46    24    70   1002       1        1    4     yes
## 62     46    24    70   1501       2        1    5     yes
## 63     46    24    70   2004       1        1    7     yes
## 64     46    24    70   2005       1        1    7     yes
## 65     46    24    70   2006       1        1    7     yes
## 66     46    24    70   2007       1        1    7     yes
```

```
## 67     46    24    70    2008       1        1     7     yes
## 68     46    24    70    2009       1        1     7     yes
## 69     46    24    70    2113       2        1     7     yes
## 70     46    24    70    2114       2        1     7     yes
## 71     46    24    70    2115       2        1     7     yes
## 72     46    24    70    2116       2        1     7     yes
## 73     46    24    70    2117       2        1     7     yes
## 74     46    24    70    2118       2        1     7     yes
## 75     46    24    70    2119       2        1     7     yes
## 76     46    24    70    2120       2        1     7     yes
## 77     46    24    70    2121       2        1     7     yes
## 78     46    24    70    2122       2        1     7     yes
## 79     46    24    70    2901       2        1     9     yes
## 80     46    24    70    3303       2        1    10     yes
## 81     46    24    70    3403       1        2    10     yes
## 82     46    24    70    3404       1        2    10     yes
## 83     46    24    70    3405       1        2    10     yes
## 84     46    24    70    3601       1        1    11     yes
## 85     46    24    70    5795       3        2     1     yes
## 86     46    24    70    6083       3        1     3     yes
## 87     46    24    70    6087       3        1     3     yes
## 88     46    24    70    6828       3        1     7     yes
## 89     46    24    70    6832       3        1     7     yes
## 90     46    24    70    6845       3        1     7     yes
## 91     46    24    70    7418       3        1    10      no
## 92     46    24    70    7482       3        2    10      no
## 93     46    24    70    7610       3        1    11      no
## 94     46    24    70    7645       3        2    11      no
## 95     47    24    92     604       1        2     2     yes
## 96     47    24    92     605       1        2     2     yes
## 97     47    24    92     802       1        1     3     yes
## 98     47    24    92     803       1        1     3     yes
## 99     47    24    92    1001       1        1     4     yes
## 100    47    24    92    1002       1        1     4     yes
## 101    47    24    92    1501       2        1     5     yes
## 102    47    24    92    2004       1        1     7     yes
## 103    47    24    92    2005       1        1     7     yes
## 104    47    24    92    2006       1        1     7     yes
## 105    47    24    92    2007       1        1     7     yes
## 106    47    24    92    2008       1        1     7     yes
## 107    47    24    92    2009       1        1     7     yes
## 108    47    24    92    2113       2        1     7     yes
## 109    47    24    92    2114       2        1     7     yes
## 110    47    24    92    2115       2        1     7     yes
## 111    47    24    92    2116       2        1     7     yes
## 112    47    24    92    2117       2        1     7     yes
## 113    47    24    92    2118       2        1     7     yes
## 114    47    24    92    2119       2        1     7     yes
## 115    47    24    92    2120       2        1     7     yes
## 116    47    24    92    2121       2        1     7     yes
## 117    47    24    92    2122       2        1     7     yes
## 118    47    24    92    2901       2        1     9     yes
## 119    47    24    92    3303       2        1    10     yes
## 120    47    24    92    3403       1        2    10     yes
```

```
## 121    47    24    92   3404       1        2   10     yes
## 122    47    24    92   3405       1        2   10     yes
## 123    47    24    92   3601       1        1   11     yes
## 124    47    24    92   5795       3        2    1     yes
## 125    47    24    92   6083       3        1    3     yes
## 126    47    24    92   6087       3        1    3     yes
## 127    47    24    92   6828       3        1    7     yes
## 128    47    24    92   6832       3        1    7     yes
## 129    47    24    92   6845       3        1    7     yes
## 130    47    24    92   7418       3        1   10      no
## 131    47    24    92   7482       3        2   10      no
## 132    47    24    92   7610       3        1   11      no
## 133    47    24    92   7645       3        2   11      no
## 134    48    24    93    604       1        2    2     yes
## 135    48    24    93    605       1        2    2     yes
## 136    48    24    93    802       1        1    3     yes
## 137    48    24    93    803       1        1    3     yes
## 138    48    24    93   1001       1        1    4     yes
## 139    48    24    93   1002       1        1    4     yes
## 140    48    24    93   1501       2        1    5     yes
## 141    48    24    93   2004       1        1    7     yes
## 142    48    24    93   2005       1        1    7     yes
## 143    48    24    93   2006       1        1    7     yes
## 144    48    24    93   2007       1        1    7     yes
## 145    48    24    93   2008       1        1    7     yes
## 146    48    24    93   2009       1        1    7     yes
## 147    48    24    93   2113       2        1    7     yes
## 148    48    24    93   2114       2        1    7     yes
## 149    48    24    93   2115       2        1    7     yes
## 150    48    24    93   2116       2        1    7     yes
## 151    48    24    93   2117       2        1    7     yes
## 152    48    24    93   2118       2        1    7     yes
## 153    48    24    93   2119       2        1    7     yes
## 154    48    24    93   2120       2        1    7     yes
## 155    48    24    93   2121       2        1    7     yes
## 156    48    24    93   2122       2        1    7     yes
## 157    48    24    93   2901       2        1    9     yes
## 158    48    24    93   3303       2        1   10     yes
## 159    48    24    93   3403       1        2   10     yes
## 160    48    24    93   3404       1        2   10     yes
## 161    48    24    93   3405       1        2   10     yes
## 162    48    24    93   3601       1        1   11     yes
## 163    48    24    93   5795       3        2    1     yes
## 164    48    24    93   6083       3        1    3     yes
## 165    48    24    93   6087       3        1    3     yes
## 166    48    24    93   6828       3        1    7     yes
## 167    48    24    93   6832       3        1    7     yes
## 168    48    24    93   6845       3        1    7     yes
## 169    48    24    93   7418       3        1   10      no
## 170    48    24    93   7482       3        2   10      no
## 171    48    24    93   7610       3        1   11      no
## 172    48    24    93   7645       3        2   11      no
## 173    49    24   120    604       1        2    2     yes
## 174    49    24   120    605       1        2    2     yes
```

```
## 175    49    24  120    802       1        1    3    yes
## 176    49    24  120    803       1        1    3    yes
## 177    49    24  120   1001       1        1    4    yes
## 178    49    24  120   1002       1        1    4    yes
## 179    49    24  120   1501       2        1    5    yes
## 180    49    24  120   2004       1        1    7    yes
## 181    49    24  120   2005       1        1    7    yes
## 182    49    24  120   2006       1        1    7    yes
## 183    49    24  120   2007       1        1    7    yes
## 184    49    24  120   2008       1        1    7    yes
## 185    49    24  120   2009       1        1    7    yes
## 186    49    24  120   2113       2        1    7    yes
## 187    49    24  120   2114       2        1    7    yes
## 188    49    24  120   2115       2        1    7    yes
## 189    49    24  120   2116       2        1    7    yes
## 190    49    24  120   2117       2        1    7    yes
## 191    49    24  120   2118       2        1    7    yes
## 192    49    24  120   2119       2        1    7    yes
## 193    49    24  120   2120       2        1    7    yes
## 194    49    24  120   2121       2        1    7    yes
## 195    49    24  120   2122       2        1    7    yes
## 196    49    24  120   2901       2        1    9    yes
## 197    49    24  120   3303       2        1   10    yes
## 198    49    24  120   3403       1        2   10    yes
## 199    49    24  120   3404       1        2   10    yes
## 200    49    24  120   3405       1        2   10    yes
## 201    49    24  120   3601       1        1   11    yes
## 202    49    24  120   5795       3        2    1    yes
## 203    49    24  120   6083       3        1    3    yes
## 204    49    24  120   6087       3        1    3    yes
## 205    49    24  120   6828       3        1    7    yes
## 206    49    24  120   6832       3        1    7    yes
## 207    49    24  120   6845       3        1    7    yes
## 208    49    24  120   7418       3        1   10     no
## 209    49    24  120   7482       3        2   10     no
## 210    49    24  120   7610       3        1   11     no
## 211    49    24  120   7645       3        2   11     no
## 212    50    25   85    202       1        2    1    yes
## 213    50    25   85    203       1        2    1    yes
## 214    50    25   85    401       1        1    2    yes
## 215    50    25   85    606       1        2    2    yes
## 216    50    25   85    607       1        2    2    yes
## 217    50    25   85    608       1        2    2    yes
## 218    50    25   85    609       1        2    2    yes
## 219    50    25   85    701       2        2    2    yes
## 220    50    25   85    804       1        1    3    yes
## 221    50    25   85    805       1        1    3    yes
## 222    50    25   85    806       1        1    3    yes
## 223    50    25   85    902       2        1    3    yes
## 224    50    25   85   1302       2        2    4    yes
## 225    50    25   85   2010       1        1    7    yes
## 226    50    25   85   2011       1        1    7    yes
## 227    50    25   85   2012       1        1    7    yes
## 228    50    25   85   2123       2        1    7    yes
```

```
## 229    50    25   85   2124      2       1    7    yes
## 230    50    25   85   2125      2       1    7    yes
## 231    50    25   85   2126      2       1    7    yes
## 232    50    25   85   2127      2       1    7    yes
## 233    50    25   85   2128      2       1    7    yes
## 234    50    25   85   3304      2       1   10    yes
## 235    50    25   85   3305      2       1   10    yes
## 236    50    25   85   3406      1       2   10    yes
## 237    50    25   85   3501      2       2   10    yes
## 238    50    25   85   3502      2       2   10    yes
## 239    50    25   85   3701      2       1   11    yes
## 240    50    25   85   3702      2       1   11    yes
## 241    50    25   85   3901      2       2   11    yes
## 242    50    25   85   4001      1       1   12    yes
## 243    50    25   85   4101      2       1   12    yes
## 244    50    25   85   5302      2       2    3    yes
## 245    50    25   85   5666      3       1    1    yes
## 246    50    25   85   5700      3       1    1    yes
## 247    50    25   85   5920      3       2    2    yes
## 248    50    25   85   6154      3       1    3    yes
## 249    50    25   85   6174      3       1    3    yes
## 250    50    25   85   6411      3       1    5    yes
## 251    50    25   85   6777      3       1    7    yes
## 252    50    25   85   6780      3       1    7    yes
## 253    50    25   85   6793      3       1    7    yes
## 254    50    25   85   6826      3       1    7    yes
## 255    50    25   85   6846      3       1    7    yes
## 256    50    25   85   7525      3       2   10     no
## 257    50    25   85   7571      3       1   11     no
## 258    50    25   85   7693      3       2   11     no
```

```
carspeedfulljoin %>% summarize_all(n_distinct)
```

```
##   Xcars speed dist Xsdata period warning pair ticket
## 1    15     6   15    123      3       2   11      2
```

```
joindatomit %>% group_by(warning) %>% summarize(sd_speed=sd(speed), mean_speed=mean(speed), var_speed=va
```

```
## Warning in cor(warning, speed): the standard deviation is zero
```

```
## Warning in cor(warning, speed): the standard deviation is zero
```

```
## # A tibble: 2 x 12
##   warning sd_speed mean_speed var_speed max_speed min_speed quan_speed
##     <int>    <dbl>      <dbl>     <dbl>     <int>     <int>      <dbl>
## 1       1     1.38       23.6      1.90        25        19         25
## 2       2     1.40       23.7      1.96        25        20         25
## # ... with 5 more variables: n_dist_speed <int>, `n()` <int>, cor_speed <dbl>,
## #   median_speed <dbl>, mad_speed <dbl>
```

```
joindatomit %>% group_by(warning, period) %>% summarize(sd_speed=sd(speed), mean_speed=mean(speed), var
```

```
## Warning in cor(period, speed): the standard deviation is zero
```

```
## Warning in cor(period, speed): the standard deviation is zero
```

```
## Warning in cor(period, speed): the standard deviation is zero
```

```
## Warning in cor(period, speed): the standard deviation is zero

## Warning in cor(period, speed): the standard deviation is zero

## Warning in cor(period, speed): the standard deviation is zero
```

```
## # A tibble: 6 x 13
## # Groups:   warning [2]
##   warning period sd_speed mean_speed var_speed max_speed min_speed quan_speed
##     <int>  <int>    <dbl>      <dbl>     <dbl>     <int>     <int>      <dbl>
## 1       1      1    0.716       23.9     0.513        25        22       24
## 2       1      2    1.64        23.4     2.67         25        19       24
## 3       1      3    1.43        23.6     2.03         25        20       25
## 4       2      1    1.57        23.4     2.46         25        20       25
## 5       2      2    1.39        24.2     1.93         25        22       25
## 6       2      3    0.680       24.1     0.462        25        22       24.8
## # ... with 5 more variables: n_dist_speed <int>, `n()` <int>, cor_speed <dbl>,
## #   median_speed <dbl>, mad_speed <dbl>
```

```
joindatomit %>% group_by(warning) %>% summarize(sd_pair=sd(pair), mean_pair=mean(pair), var_pair=var(pa
```

```
## # A tibble: 2 x 12
##   warning sd_pair mean_pair var_pair max_pair min_pair quan_pair n_dist_pair
##     <int>   <dbl>     <dbl>    <dbl>    <int>    <int>     <dbl>       <int>
## 1       1    2.34      6.76     5.50       12        1        10          11
## 2       2    4.17      6.66    17.4        11        1        10           6
## # ... with 4 more variables: `n()` <int>, cor_pair <dbl>, median_pair <dbl>,
## #   mad_pair <dbl>
```

```
joindatomit %>% group_by(warning, period) %>% summarize(sd_pair=sd(pair), mean_pair=mean(pair), var_pai
```

```
## # A tibble: 6 x 13
## # Groups:   warning [2]
##   warning period sd_pair mean_pair var_pair max_pair min_pair quan_pair
##     <int>  <int>   <dbl>     <dbl>    <dbl>    <int>    <int>     <dbl>
## 1       1      1    2.52      6.20     6.34       12        2         7
## 2       1      2    1.49      7.53     2.21       12        3        10
## 3       1      3    2.93      6.06     8.59       11        1        10
## 4       2      1    4.15      6.42    17.2        11        1        10
## 5       2      2    3.76      5.88    14.1        11        2        10
## 6       2      3    4.5       7.62    20.2        11        1        11
## # ... with 5 more variables: n_dist_pair <int>, `n()` <int>, cor_pair <dbl>,
## #   median_pair <dbl>, mad_pair <dbl>
```

```
joindatomit %>% group_by(warning) %>% summarize(sd_period=sd(period), mean_period=mean(period), var_per
```

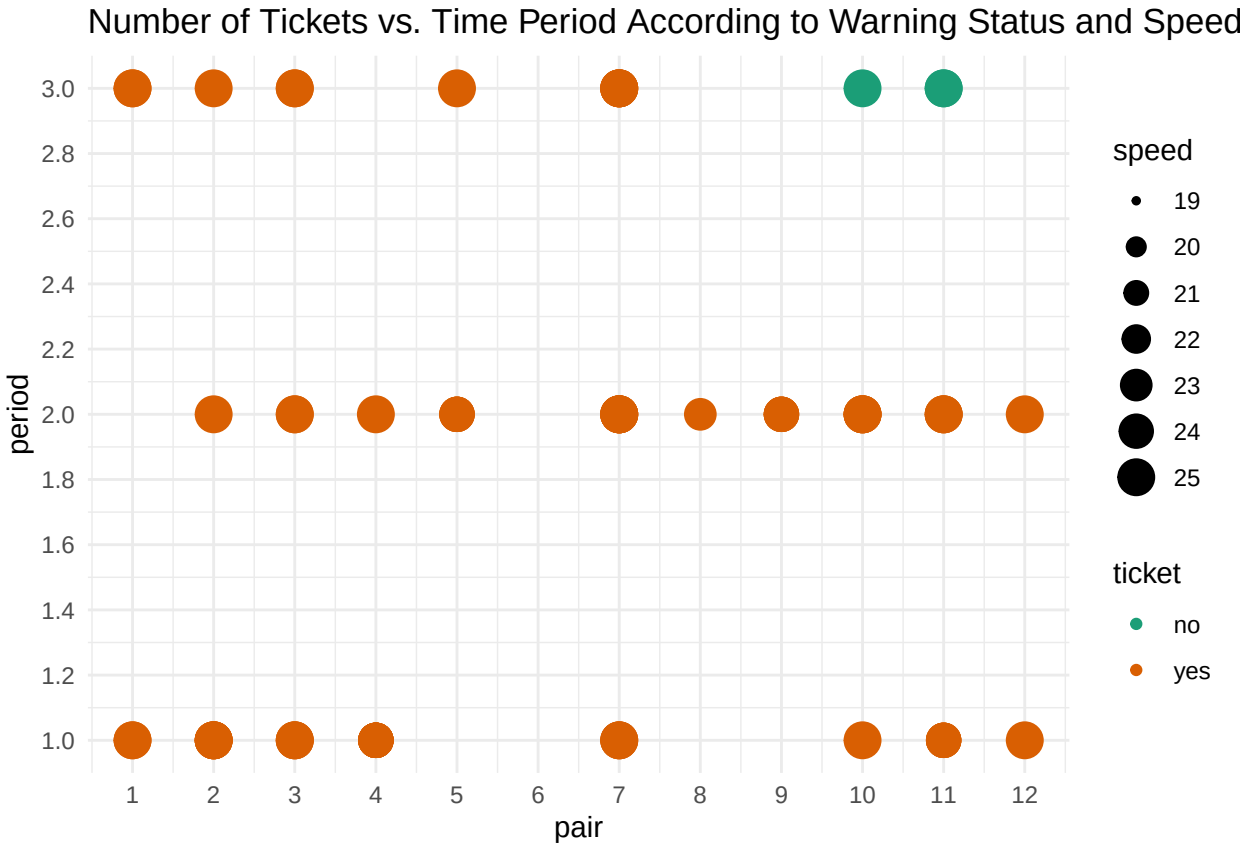
```
## # A tibble: 2 x 12
##   warning sd_period mean_period var_period max_period min_period quan_period
##     <int>     <dbl>       <dbl>      <dbl>      <int>      <int>       <dbl>
## 1       1     0.746        1.95      0.557          3          1           3
## 2       2     0.870        1.65      0.757          3          1           3
## # ... with 5 more variables: n_dist_period <int>, `n()` <int>,
## #   cor_period <dbl>, median_period <dbl>, mad_period <dbl>
```

```
joindatomit %>% group_by(warning, speed) %>% summarize(sd_period=sd(period), mean_period=mean(period),
```

```
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## Warning in cor(speed, period): the standard deviation is zero
## # A tibble: 11 x 13
## # Groups:   warning [2]
##    warning speed sd_period mean_period var_period max_period min_period
##      <int> <int>     <dbl>       <dbl>      <dbl>      <int>      <int>
##  1       1    19     0            2         0              2          2
##  2       1    20     0.488        2.33      0.238          3          2
##  3       1    22     0.874        1.82      0.764          3          1
##  4       1    23     0.669        2.08      0.447          3          1
##  5       1    24     0.754        1.87      0.569          3          1
##  6       1    25     0.790        2.10      0.624          3          1
##  7       2    20     0            1         0              1          1
##  8       2    22     0.787        1.57      0.619          3          1
##  9       2    23     0            1         0              1          1
## 10       2    24     0.984        1.75      0.968          3          1
## 11       2    25     0.775        1.75      0.6            3          1
## # ... with 6 more variables: quan_period <dbl>, n_dist_period <int>,
## #   `n()` <int>, cor_period <dbl>, median_period <dbl>, mad_period <dbl>
```

For Wrangling, the dplyr functions filter, select, arrange, group_by, mutate, and summarize were utilized. 10 different summary statistics were also computed which include sd, mean, var, max, min, quantile, n_distinct, cor, median, and mad. 4 variables, period, pair, speed, and warning were used for the summary statistics. The pair variable indicate how many people were in a given vechicle. These variables were grouped by the categorical variable,"warning", and then by "warning" and "period" together. I chose to generate these summary statistics for car speed, pair. It was interesting how the number people in the car related with the speed of the vehcile and whether or not the vehicle received a warning.

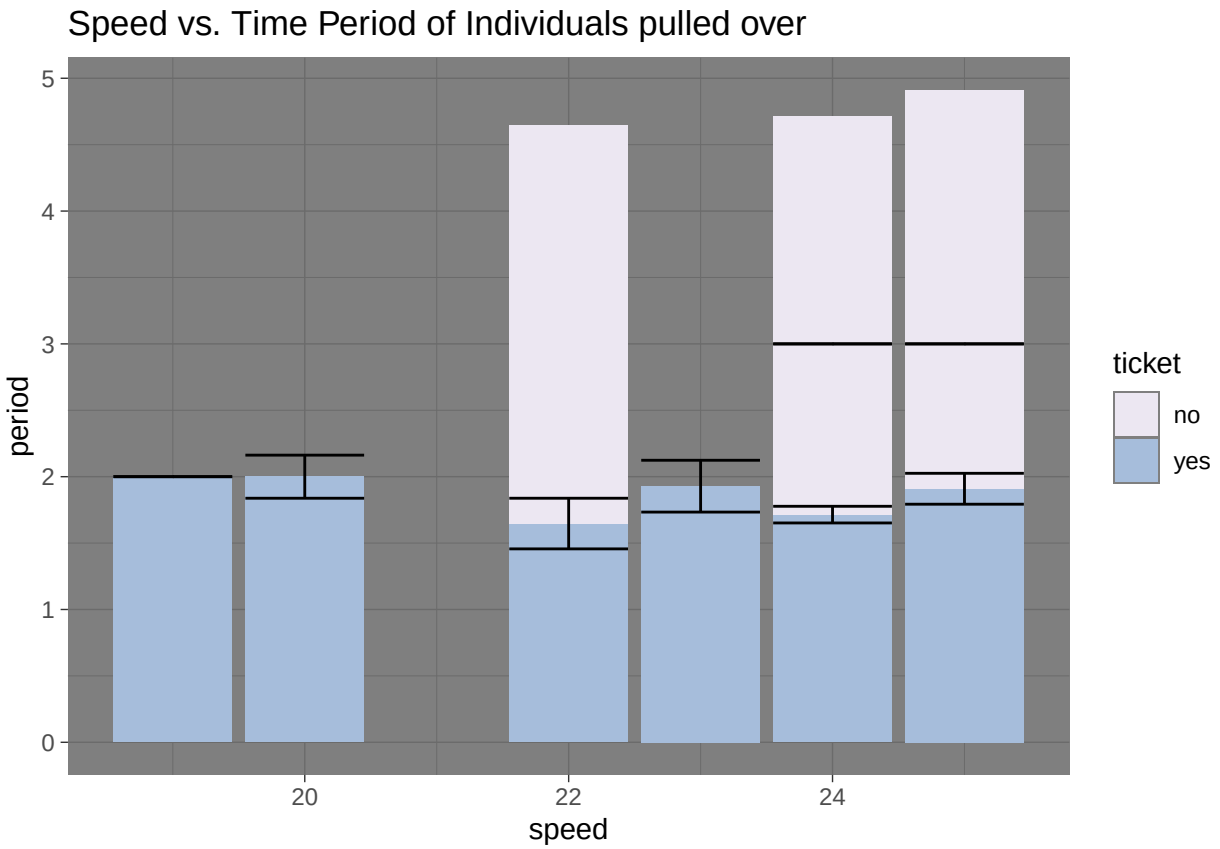
```
#Visualizing
library(ggplot2)

ggplot(joindatomit, aes(pair, period)) + geom_point(aes(color=ticket, size=speed)) +ggtitle("Number of
```



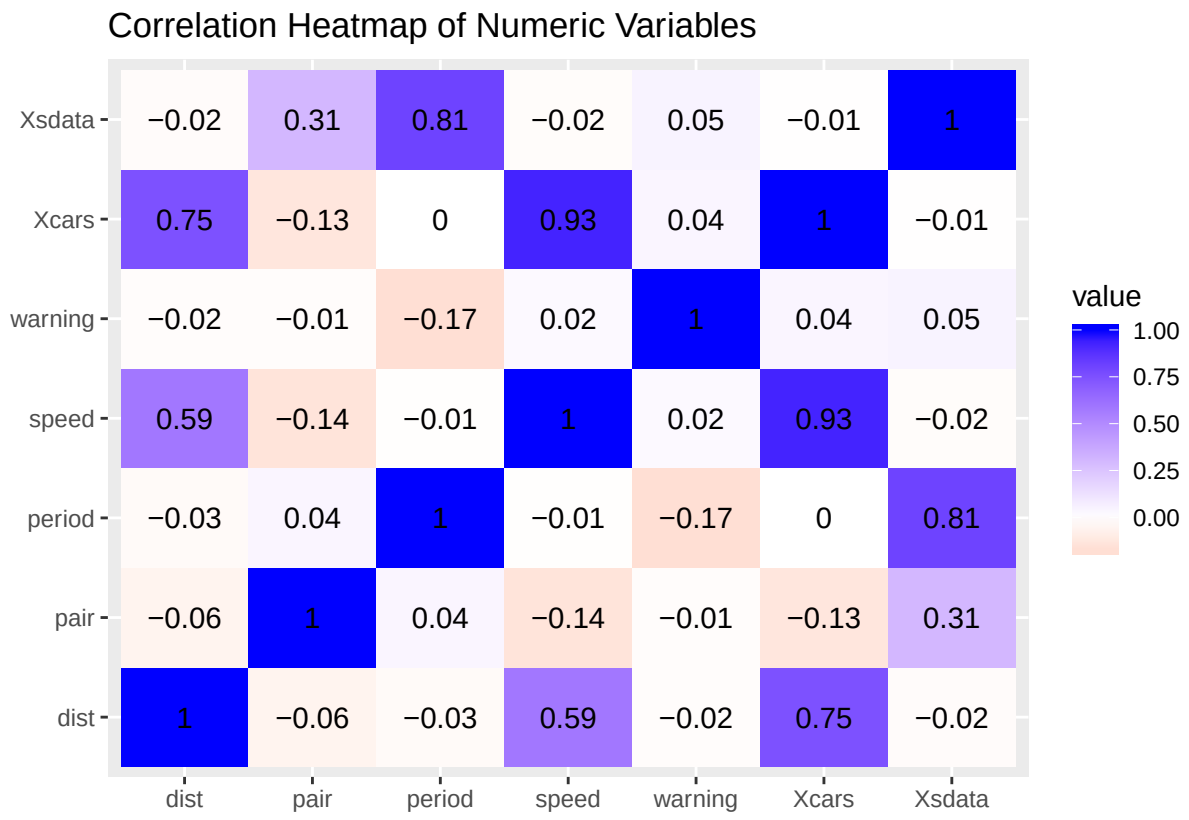

```
ggplot(joindatomit, aes(x=speed, y=period, fill=ticket)) +geom_bar(stat="summary", fun.y="mean")+geom_e
```

```
## No summary function supplied, defaulting to `mean_se()
```

```
## Warning: Removed 1 rows containing missing values (geom_errorbar).
```




```
joindatomit %>% select_if(is.numeric) %>% cor %>% as.data.frame %>% rownames_to_column %>% pivot_longer
```



For the first visualization, a scatter plot shows the linear relationship between the number of people in a vehcile vs. the the time period of the day, according to the speed and ticket status. According to this graph, there doesnt really appear to be a distinct relationship between the variables. The time of the day, the amount of indiviudals in the vehicle, and the speed of the car don't seem to have a significant relationship as almsot every vehicle received a ticket.

The second visualization is a bar plot called "Speed vs. Time Period of Individuals pulled over." According to this chart, vehicles that were pulled over at an earlier time in the day tend to receieve a much higher amount of tickets as opposed to vehicles pulled over later in the day.

The third vizualization displays a correlation heatmap of the numeric variables. The correlations that this visualization displays are not very high at all, indicating no relationship or assocation amongst the variables. The strongest correlation was found to be speed and distance at .59, which is a roughly moderate correlation. Similarly to the first graph, I was surprised to see that correlations amongst the numeric variables was very weak.

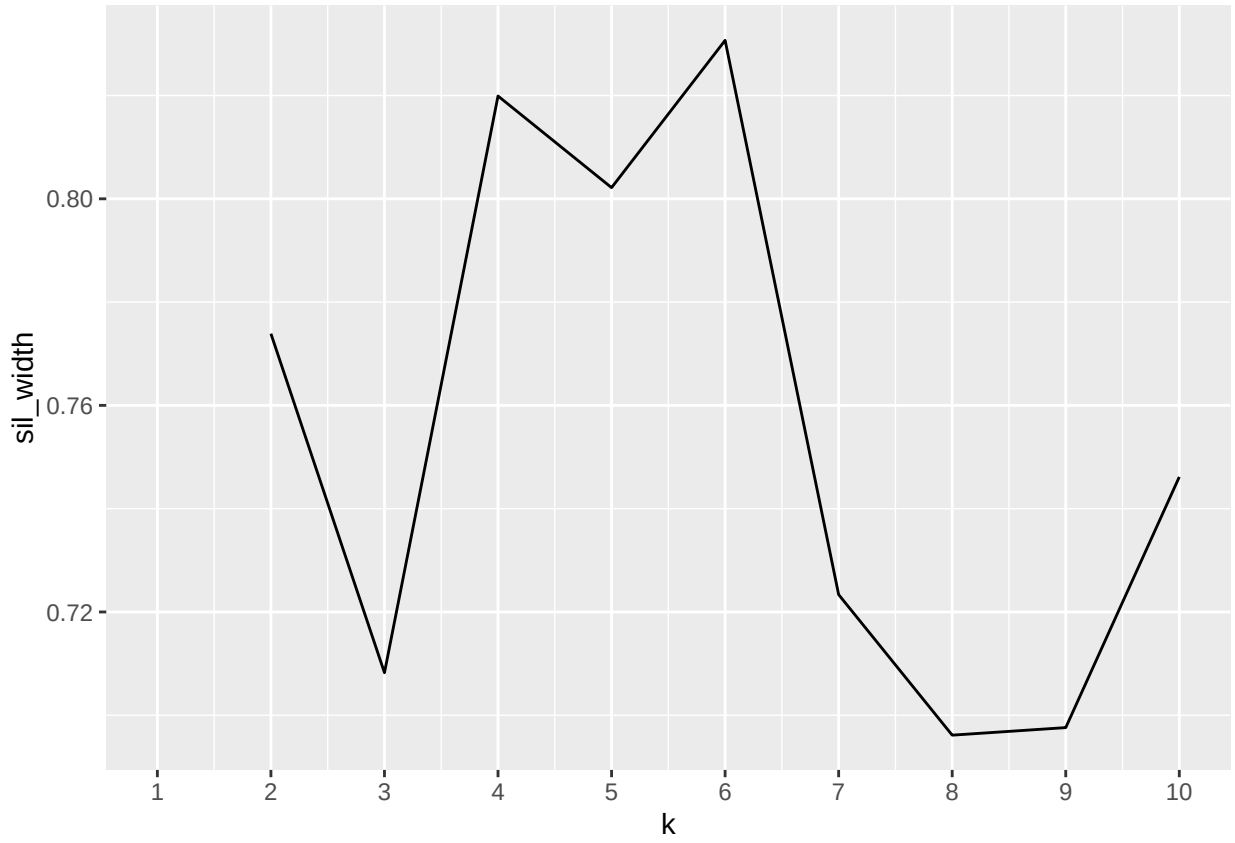
```
#Dimentionality Reduction
install.packages('cluster')
```

```
## Installing package into '/stor/home/gs27275/R/x86_64-pc-linux-gnu-library/3.4'
## (as 'lib' is unspecified)
```

```
library(cluster)
library(tidyverse)

pam2<-joindatomit%>%select(-period, -speed, -pair, -ticket)%>%pam(3)

sil_width<-vector()
for(i in 2:10){
```

```
pam_fit <- joindatomit%>%select(-period, -speed, -pair, -ticket)%>%pam(i)
sil_width[i] <- pam_fit$silinfo$avg.width }
ggplot()+geom_line(aes(x=1:10,y=sil_width))+scale_x_continuous(name="k",breaks=1:10)
```

```
## Warning: Removed 1 rows containing missing values (geom_path).
```

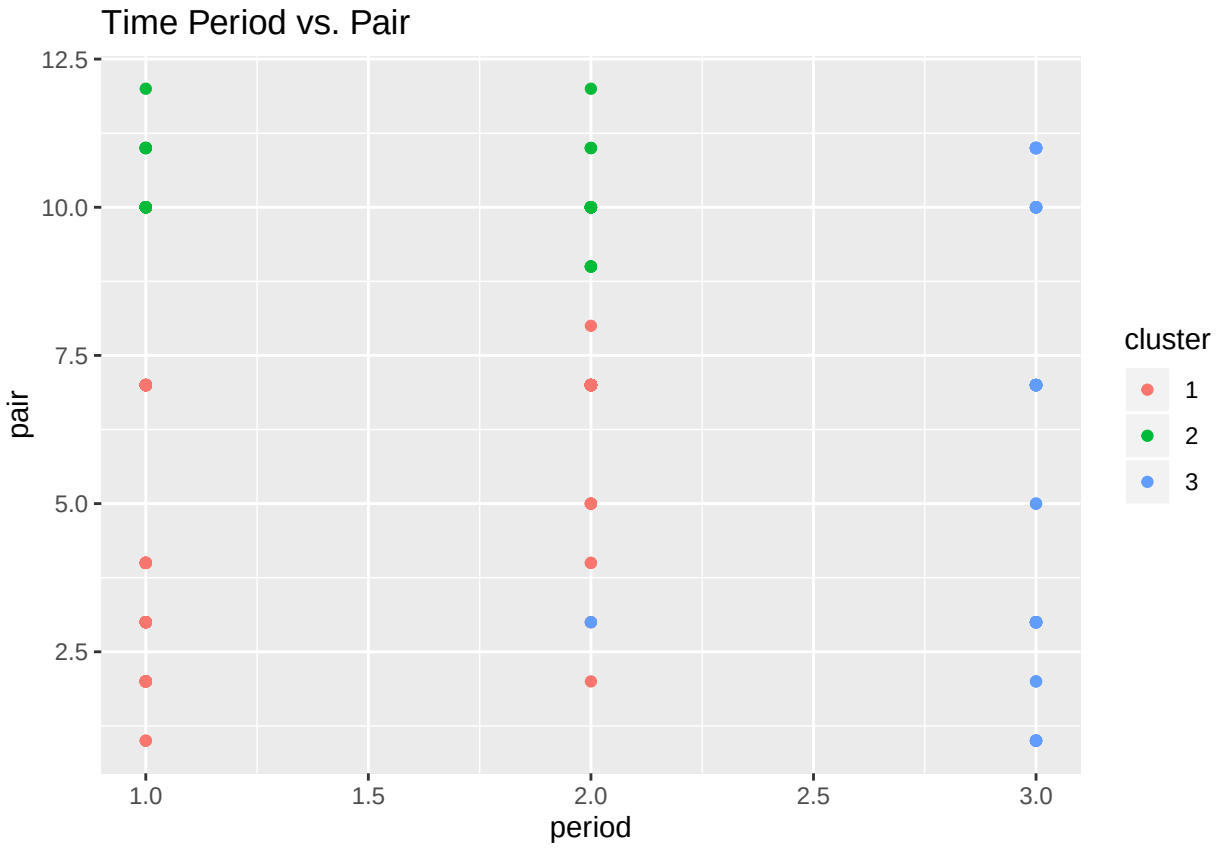



```
finallydone<-joindatomit%>%mutate(cluster=as.factor(pam2$clustering))

conmat<-finallydone%>%group_by(period, speed, pair, ticket)%>%count(cluster)%>%arrange(desc(n))%>%
pivot_wider(names_from="cluster",values_from="n",values_fill = list('n'=0))

conmat
```

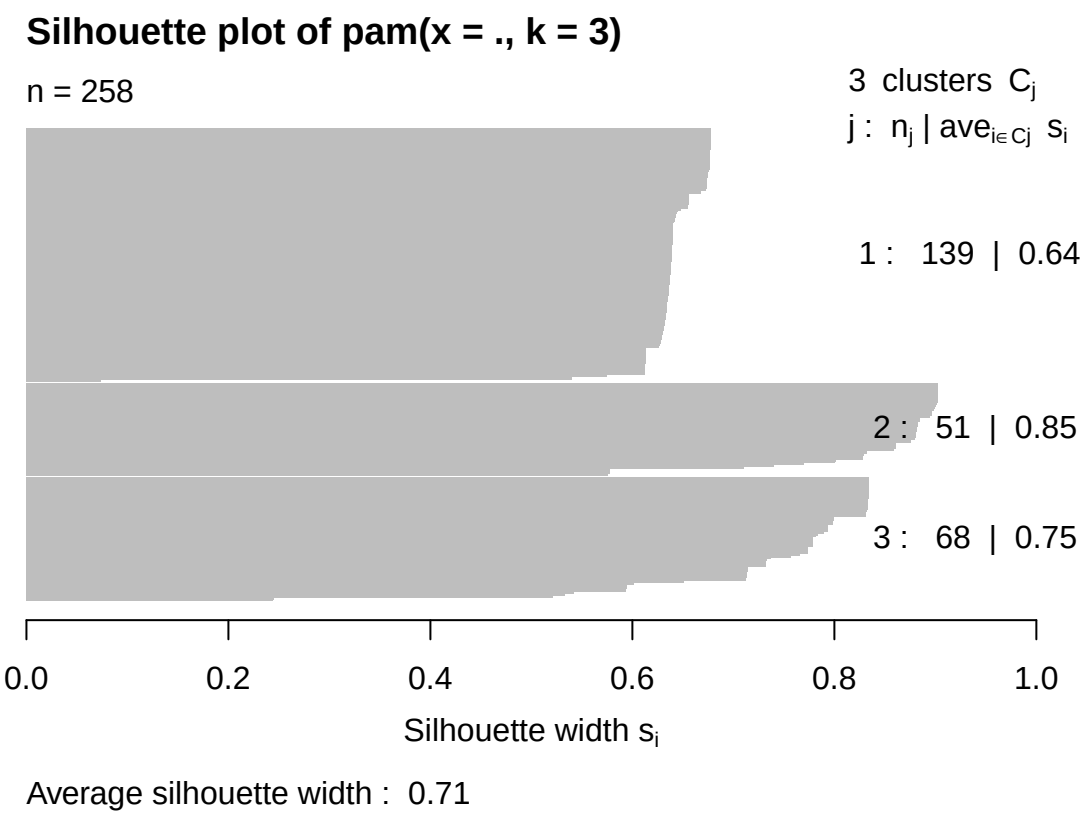
```
## # A tibble: 60 x 7
## # Groups:   period, speed, pair, ticket [120]
##    period speed  pair ticket   `1`   `2`   `3`
##     <int> <int> <int> <fct>  <int> <int> <int>
##  1      2    24     7 yes       40     0     0
##  2      1    24     7 yes       24     0     0
##  3      1    24    10 yes        0    12     0
##  4      3    24     7 yes        0     0    12
##  5      1    24     2 yes        8     0     0
##  6      1    24     3 yes        8     0     0
##  7      1    24     4 yes        8     0     0
##  8      3    24     3 yes        0     0     8
##  9      3    24    10 no         0     0     8
## 10      3    24    11 no         0     0     8
```

```
## # ... with 50 more rows
```

```
ggplot(finallydone, aes(x=period,y=pair, color=cluster))+ ggtitle("Time Period vs. Pair")+geom_point()
```




```
plot(pam2,which=2)
```




```
library(GGally)
```

```
##
## Attaching package: 'GGally'
```

```
## The following object is masked from 'package:dplyr':
##
##     nasa
```

```
ggpairs(finallydone, columns=5:9, aes(color=cluster))
```

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

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

For the final part of the project, I utilzied 3 clusters according to the sil_width graph. The average silhouette width value computed was .71 according to the silhouette plot. According to this value, "a strong structure has been found. I visualized all pairwise combinations of the numeric variables in the dataset. The correlation of people in a given vehicle and period of the day were found to be the highest. However despite this, this correlation was moderate. This kind of makes sense because there might be certain times of day were people would travel together like going to dinner or an evening event. The other variables had weak correlations which is to be expected as you shouldn't expect an increase in ticket frequency based on people in the car or time period of the day. Overall the data appears to make sense if you think about it, but it is interesting see weak correlations amongst variables that I personally would have thought to have been higher.