bhogan_tour_of_R_data_techniques

September 9, 2020

[ ]:
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################################################################################
#=> Author: Brian Hogan, bphogan@syr.edu, Syracuse
#=> https://github.com/bbe2/

#=> Purpose: Overview of analysis techniques when learning new data landscape
#=> My second phase is preparing/labeling data for in-depth machine learning␣
 ↪work

# Does not illustrate data cleaning. See "bbe_data_cleaning.ipynb"

# Data Assembly    => sqldf manipulation for grouping data by:
#                     state, cartype, car-color, street
# Data inspection  => outliers, heteroscedasticity
# Inference        => correlations, linear modeling, Bayesian assessment
# Machine Learning => randomForest (may add other unsupervised)
# Output           => ggplot(s), heatmaps, linear models
# data <zipped sorry>
#      https://github.com/bbe2/Data/streetsweeping-citations-2018-clean.csv
################################################################################
```

[22]:
```
################################################################################
#=> Libraries
################################################################################
library(maps,warn.conflicts = FALSE, quietly = TRUE);library(randomForest,warn.
 ↪conflicts = FALSE, quietly = TRUE);
library(ellipse, warn.conflicts = FALSE, quietly = TRUE); library(ggmap, warn.
 ↪conflicts = FALSE, quietly = TRUE)
library(RColorBrewer,warn.conflicts = FALSE, quietly = TRUE);library(sqldf,␣
 ↪warn.conflicts = FALSE, quietly = TRUE)
library(ggplot2, warn.conflicts = FALSE, quietly = TRUE);library(reshape2, warn.
 ↪conflicts = FALSE, quietly = TRUE)
library(ggmap, warn.conflicts = FALSE, quietly = TRUE);library(tidyr, warn.
 ↪conflicts = FALSE, quietly = TRUE)
library(coop,warn.conflicts = FALSE, quietly = TRUE);library(tidyverse,warn.
 ↪conflicts = FALSE, quietly = TRUE)
library(factoextra,warn.conflicts = FALSE, quietly = TRUE);library(cluster,warn.
 ↪conflicts = FALSE, quietly = TRUE)
```

```
library(mapproj,warn.conflicts = FALSE, quietly = TRUE)
```

```
Warning message:
"package 'randomForest' was built under R version 3.6.3"randomForest 4.6-14
Type rfNews() to see new features/changes/bug fixes.
```

[8]:
```
################################################################################
#=> Data Import & Inspection
################################################################################
df0 <- read.csv("C:/Users/17574/Desktop/Data/
 ↪streetsweeping-citations-2018-clean.csv")
anyNAs <- apply(apply(df0,2,is.na),2,sum)  #confirm no NAs...
print("If following zero there are no NAs or other cleaning issues")
sum(anyNAs)
```

```
[1] "If following zero there are no NAs or other cleaning issues"
```

```
0
```

[9]:
```
################################################################################
#=> Data Landscape
################################################################################
str(df0)    #colnames(df0)  head(df0,1)
df1 <- data.frame(df0) ##594546 obs. of  27 variables:
```

```
'data.frame':   594546 obs. of  27 variables:
 $ X                   : int  1 2 3 4 5 6 7 8 9 10 …
 $ ticket.number       : num  4.32e+09 4.32e+09 4.32e+09 4.32e+09 4.32e+09 …
 $ issue.date          : Factor w/ 320 levels "2018-01-02T00:00:00",..: 11 11 11
11 11 11 11 11 11 11 11 …
 $ issue.year          : int  2018 2018 2018 2018 2018 2018 2018 2018 2018 2018
…
 $ issue.month         : int  1 1 1 1 1 1 1 1 1 1 …
 $ issue.day           : int  12 12 12 12 12 12 12 12 12 12 …
 $ issue.weekday       : int  6 6 6 6 6 6 6 6 6 6 …
 $ issue.time          : Factor w/ 848 levels "0:00:00","0:31:00",..: 12 15 17
19 20 21 25 28 31 32 …
 $ issue.time.bin      : int  1 1 1 1 1 1 1 1 1 1 …
 $ agency.id           : int  56 56 56 56 56 56 56 56 56 56 …
 $ meter.id            : Factor w/ 136 levels "0","48","CP170",..: 1 1 1 1 1 1 1
1 1 1 …
 $ route.id            : Factor w/ 544 levels "0","1","1.80E+14",..: 432 432 432
432 432 432 432 432 432 432 …
 $ issue.address       : Factor w/ 262194 levels "! % CULVER BLVD",..: 174986
157490 157490 157490 157490 157490 183541 236912 201392 201392 …
 $ issue.address.lat   : num  -118 -118 -118 -118 -118 …
 $ issue.address.lon   : num  34.1 34 34 34 34 …
 $ violation.id        : Factor w/ 1 level "80.69BS": 1 1 1 1 1 1 1 1 1 1 …
```

```
 $ violation.desc      : Factor w/ 1 level "NO PARK/STREET CLEAN": 1 1 1 1 1 1 1
1 1 1 …
 $ violation.fine.amt  : int  73 73 73 73 73 73 73 73 73 73 …
 $ plate.expire.date   : int  201801 201803 201801 201804 201803 201803 201801
201708 201810 201801 …
 $ plate.expire.year   : int  2018 2018 2018 2018 2018 2018 2018 2017 2018 2018
…
 $ plate.expire.month  : int  1 3 1 4 3 3 1 8 10 1 …
 $ plate.expire.flag   : int  0 0 0 0 0 0 0 0 1 0 …
 $ plate.state         : Factor w/ 73 levels "AB","AK","AL",..: 7 7 7 7 7 7 7 7
7 7 …
 $ car.make            : Factor w/ 62 levels "ACUR","ALFA",..: 43 52 41 28 37 56
39 7 1 21 …
 $ car.make.import.flag: int  0 0 1 0 0 0 1 1 1 1 …
 $ car.bodystyle       : Factor w/ 12 levels "BU","CM","MC",..: 7 7 7 7 7 7 7 7
7 7 …
 $ car.color           : Factor w/ 16 levels "BG","BK","BN",..: 9 13 2 13 12 13
13 15 13 9 …
```

[10]:
```
##############################################################################
#=> DATA ASSEMBLY - Get unique ids by category for table joins and graphs
##############################################################################
#Columns reordered when dataframes merged
#DATA TRANSFORMATION Process - get numeric codes for scatter+melt & correlations
    # f.make.numeric.id <-function(v.name)  ##FIX - v.name
    #     # { df.unique.temp <- data.frame(unique(df1$v.name))
          # fill in blanks to add a group size variable
    #     # level.rows <- c(1:nrow(df.unique.temp))
    #     # df.unique.temp <-cbind(df.unique.temp ,level.rows)
    #     # colnames(df.unique.temp) <- c("v.name",paste("v.name",".2"))
    #     # df2 <- merge(x=df1, y=df.unique.temp, by ="v.name", all.x=TRUE)
    #     # remove(df.unique.temp)  }

#NUMBERIC IDs FOR correlation & scatterplots--
c.names <- colnames(df1)
c.names.2 <- gsub("\\.","",c.names)  #remove dots for sqldf
c.names.2
colnames(df1)<-c.names.2
remove(c.names.2)
#route.ID  ==>levels=674
df.temp <- data.frame(unique(df1$routeid))
level.rows <- c(1:nrow(df.temp))  #fill in blanks
df.temp <-cbind(df.temp ,level.rows) #lookup table
colnames(df.temp) <- c("routeid",paste("routeid2"))
df1 <- merge(x=df1, y=df.temp, by ="routeid", all.x=FALSE)
#plate.state  ==> 7levels=73
df.temp <- data.frame(unique(df1$platestate))
```

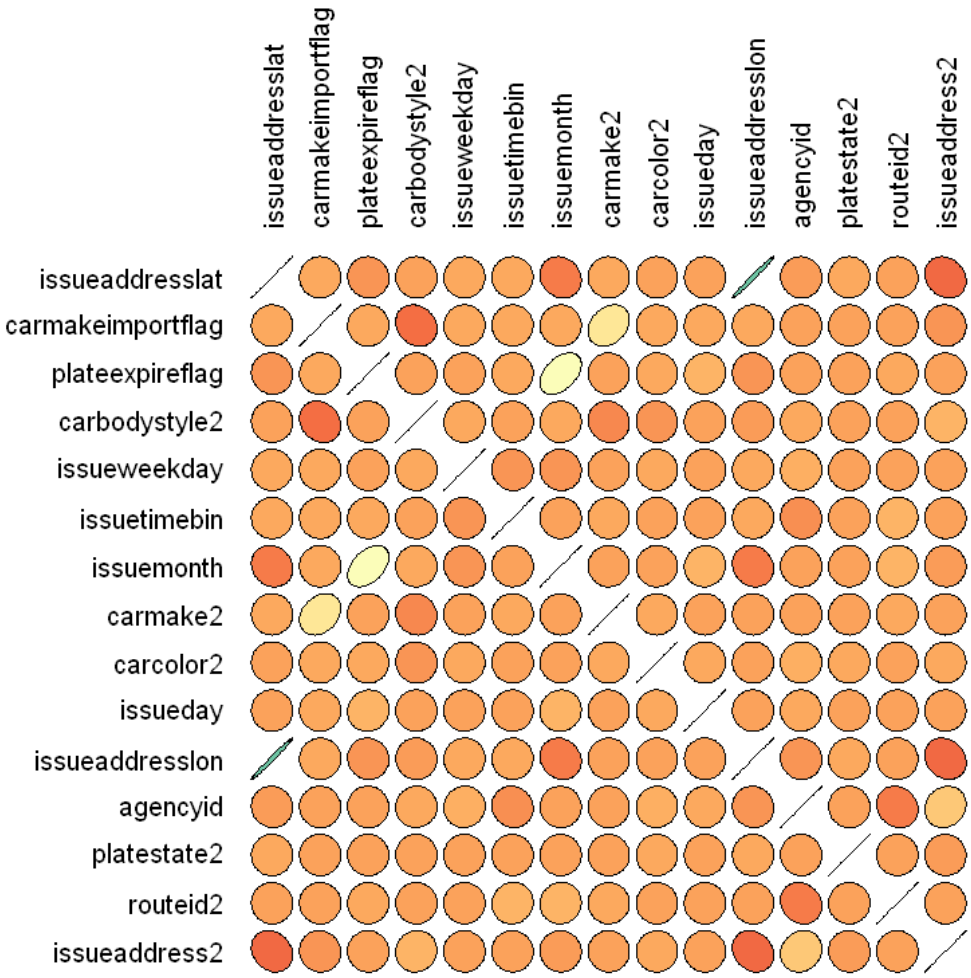
```
level.rows <- c(1:nrow(df.temp))  #fill in blanks
df.temp <-cbind(df.temp ,level.rows) #lookup table
colnames(df.temp) <- c("platestate",paste("platestate2"))
df1 <- merge(x=df1, y=df.temp, by ="platestate", all.x=FALSE)
#car.make ==> levels=62
df.temp <- data.frame(unique(df1$carmake))
level.rows <- c(1:nrow(df.temp))  #fill in blanks
df.temp <-cbind(df.temp ,level.rows) #lookup table
colnames(df.temp) <- c("carmake",paste("carmake2"))
df.carid.master <-df.temp
df1 <- merge(x=df1, y=df.temp, by ="carmake", all.x=FALSE)
write.csv(df.carid.master, "df.carid.master.csv") #spped up normalization
#car.bodystyle  ==> levels=12
df.temp <- data.frame(unique(df1$carbodystyle))
level.rows <- c(1:nrow(df.temp))  #fill in blanks
df.temp <-cbind(df.temp ,level.rows) #lookup table
colnames(df.temp) <- c("carbodystyle",paste("carbodystyle2"))
df1 <- merge(x=df1, y=df.temp, by ="carbodystyle", all.x=TRUE)
#car.color  ==>levels=16
df.temp <- data.frame(unique(df1$carcolor))
level.rows <- c(1:nrow(df.temp))  #fill in blanks
df.temp <-cbind(df.temp ,level.rows) #lookup table
colnames(df.temp) <- c("carcolor",paste("carcolor2"))
df1 <- merge(x=df1, y=df.temp, by ="carcolor", all.x=TRUE)
#issue.address ==>levels=292164
df.temp <- data.frame(unique(df1$issueaddress))
level.rows <- c(1:nrow(df.temp))  #fill in blanks
df.temp <-cbind(df.temp ,level.rows) #lookup table
colnames(df.temp) <- c("issueaddress",paste("issueaddress2"))
df1 <- merge(x=df1, y=df.temp, by ="issueaddress", all.x=TRUE)
head(df1,1)
```

1. 'X' 2. 'ticketnumber' 3. 'issuedate' 4. 'issueyear' 5. 'issuemonth' 6. 'issueday' 7. 'issueweekday' 8. 'issuetime' 9. 'issuetimebin' 10. 'agencyid' 11. 'meterid' 12. 'routeid' 13. 'issueaddress' 14. 'issueaddresslat' 15. 'issueaddresslon' 16. 'violationid' 17. 'violationdesc' 18. 'violationfineamt' 19. 'plateexpiredate' 20. 'plateexpireyear' 21. 'plateexpiremonth' 22. 'plateexpireflag' 23. 'platestate' 24. 'carmake' 25. 'carmakeimportflag' 26. 'carbodystyle' 27. 'carcolor'

	issueaddress	carcolor	carbodystyle	carmake	platestate	routeid	X	ticketnumber	issuec
!	% CULVER BLVD	BN	PA	JEEP	VT	136	245625	4332818545	2018-

[9]:
```
################################################################################
#=> CORRELATION----ELLIPSIS; ovals = relationship, circles = no correlation
################################################################################
library(ellipse, warn.conflicts = FALSE, quietly = TRUE)
library(RColorBrewer,warn.conflicts = FALSE, quietly = TRUE)
my_colors <- brewer.pal(11, "Spectral")  #build color panel
my_colors = colorRampPalette(my_colors)(100)
```

```
#x <- data.frame(colnames(df1))   #use colnames to get IDs
df.cor <-data.frame(df1[,c(11,12,13,15,16,18,19,26:33)])
cor.df1 <- cor(df.cor)   #build corrleation of data
ord <- order(df.cor[1,])  # Order the correlation matrix
data_ord = cor.df1[ord, ord]
plotcorr(data_ord , col = my_colors[data_ord * 50 + 30] , mar = c(1, 1, 1, 1))
#write.csv(round(cor.df1,2), "project.csv"): debug any coordinate issues
```



[15]:
```
str(df1)
```

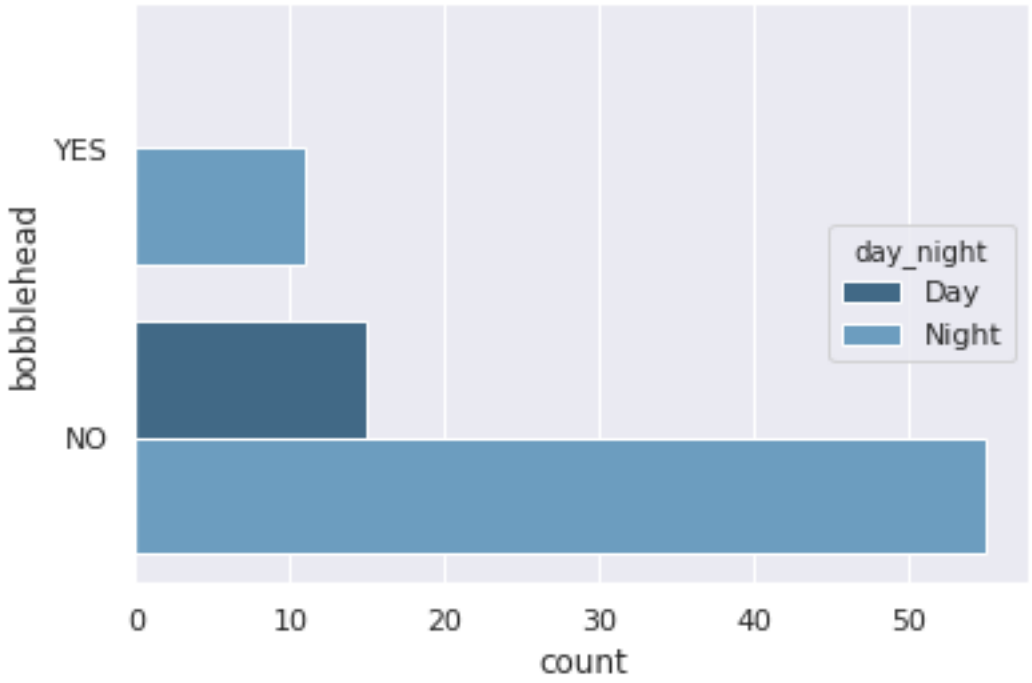
```
'data.frame':   594546 obs. of  33 variables:
 $ issueaddress     : Factor w/ 262194 levels "! % CULVER BLVD",..: 1 2 3 3 3 3
4 5 6 7 …
```

```
 $ carcolor         : Factor w/ 16 levels "BG","BK","BN",..: 3 2 2 10 4 13 2 13
2 2 …
 $ carbodystyle     : Factor w/ 12 levels "BU","CM","MC",..: 7 7 7 7 7 7 7 3 7 7
…
 $ carmake          : Factor w/ 62 levels "ACUR","ALFA",..: 28 40 43 59 43 17 34
29 56 7 …
 $ platestate       : Factor w/ 73 levels "AB","AK","AL",..: 68 7 7 7 7 7 7 7 7
7 …
 $ routeid          : Factor w/ 544 levels "0","1","1.80E+14",..: 50 50 121 121
121 121 121 52 121 85 …
 $ X                : int  245625 591550 390212 390211 390210 390209 276040
80070 564300 480768 …
 $ ticketnumber     : num  4.33e+09 4.34e+09 4.34e+09 4.34e+09 4.34e+09 …
 $ issuedate        : Factor w/ 320 levels "2018-01-02T00:00:00",..: 134 320 210
210 210 210 150 34 308 264 …
 $ issueyear        : int  2018 2018 2018 2018 2018 2018 2018 2018 2018 2018 …
 $ issuemonth       : int  5 12 8 8 8 8 6 2 12 10 …
 $ issueday         : int  23 31 17 17 17 17 11 5 14 19 …
 $ issueweekday     : int  4 2 6 6 6 6 2 2 6 6 …
 $ issuetime        : Factor w/ 848 levels "0:00:00","0:31:00",..: 210 97 212
210 209 205 294 73 322 300 …
 $ issuetimebin     : int  4 3 4 4 4 4 4 3 4 4 …
 $ agencyid         : int  51 51 51 51 51 51 51 51 51 51 …
 $ meterid          : Factor w/ 136 levels "0","48","CP170",..: 1 1 1 1 1 1 1 1
1 1 …
 $ issueaddresslat  : num  -138 -138 -138 -138 -138 …
 $ issueaddresslon  : num  27.5 27.5 27.5 27.5 27.5 …
 $ violationid      : Factor w/ 1 level "80.69BS": 1 1 1 1 1 1 1 1 1 1 …
 $ violationdesc    : Factor w/ 1 level "NO PARK/STREET CLEAN": 1 1 1 1 1 1 1 1
1 1 …
 $ violationfineamt : int  73 73 73 73 73 73 73 73 73 73 …
 $ plateexpiredate  : int  201909 201905 201809 201901 201809 201808 0 0 0
201906 …
 $ plateexpireyear  : int  2019 2019 2018 2019 2018 2018 0 0 0 2019 …
 $ plateexpiremonth : int  9 5 9 1 9 8 0 0 0 6 …
 $ plateexpireflag  : int  1 1 0 1 0 0 0 0 0 1 …
 $ carmakeimportflag: int  0 1 0 0 0 0 1 0 0 1 …
 $ routeid2         : int  117 117 97 97 97 97 97 143 97 20 …
 $ platestate2      : int  59 1 1 1 1 1 1 1 1 1 …
 $ carmake2         : int  5 28 6 1 6 2 11 42 9 13 …
 $ carbodystyle2    : int  1 1 1 1 1 1 1 7 1 1 …
 $ carcolor2        : int  6 4 4 12 11 8 4 8 4 4 …
 $ issueaddress2    : int  117066 113771 112613 112613 112613 112613 26168
212701 79939 23217 …
```

[72]:
```
#############################################################################
#=> MELT HISTROGRAM to Further Assess Potential Relationships
```

```
# Assessing any relationships such as influence time of day or address
# hard to make conclusions with this data so using RandomForest GINI
# to see relationships
#############################################################################
#libraries: sqldf, ggplot2, reshape2, ggmap
suppressWarnings(require(RColorBrewer)) #install.packages("RColorBrewer")
 ↪#16,18,19
ggplot(data = melt(df1[,c(11,12,13,15,22,27:33)]), mapping = aes(x = value)) +
  geom_histogram(bins=12)+ facet_wrap(~variable, scales = "free")
```

```
No id variables; using all as measure variables
```

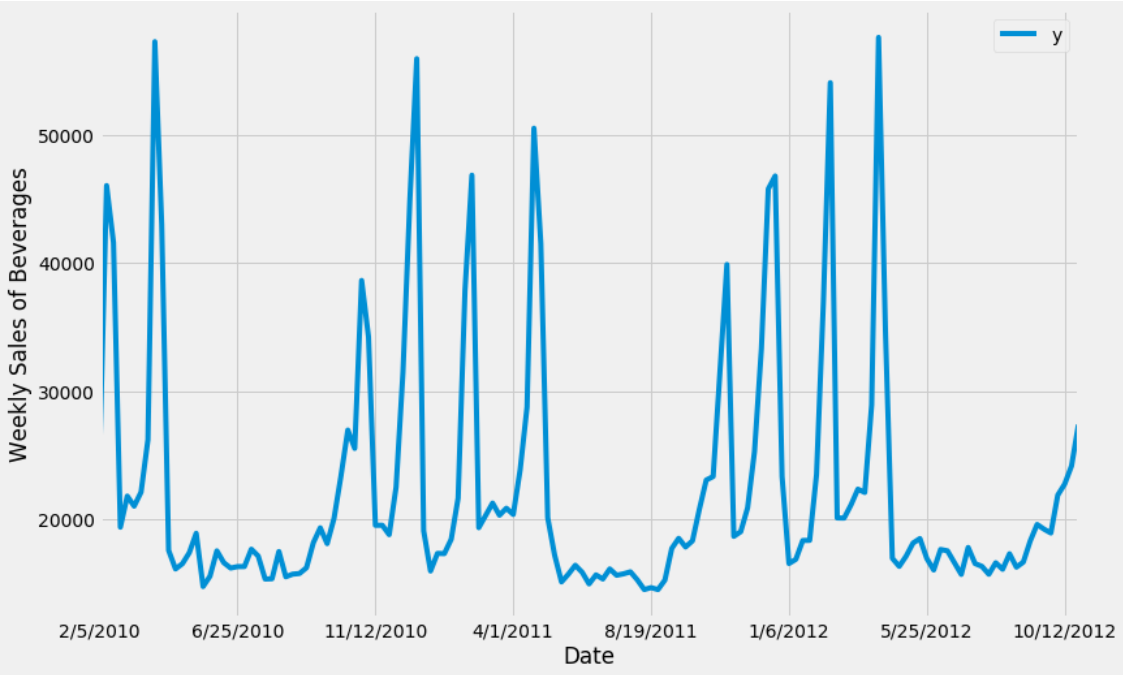


[40]:
```
#############################################################################
# RANDOM FOREST - using to for GINI assessment on variable importance
#==> can't run without additional data cleaning
"""standard to generate 'importance' scale to help assess variable
 ↪relationships"""

#############################################################################
#df1.carimportflag.rf <- randomForest(df1[,c(-1:-10,-13:-27,-30:-33)],
 ↪df1[,30], prox=TRUE)
#importance(df1.carimportflag.rf)
#------------
#Error: cannot allocate vector of size 2633.7 Gb
```

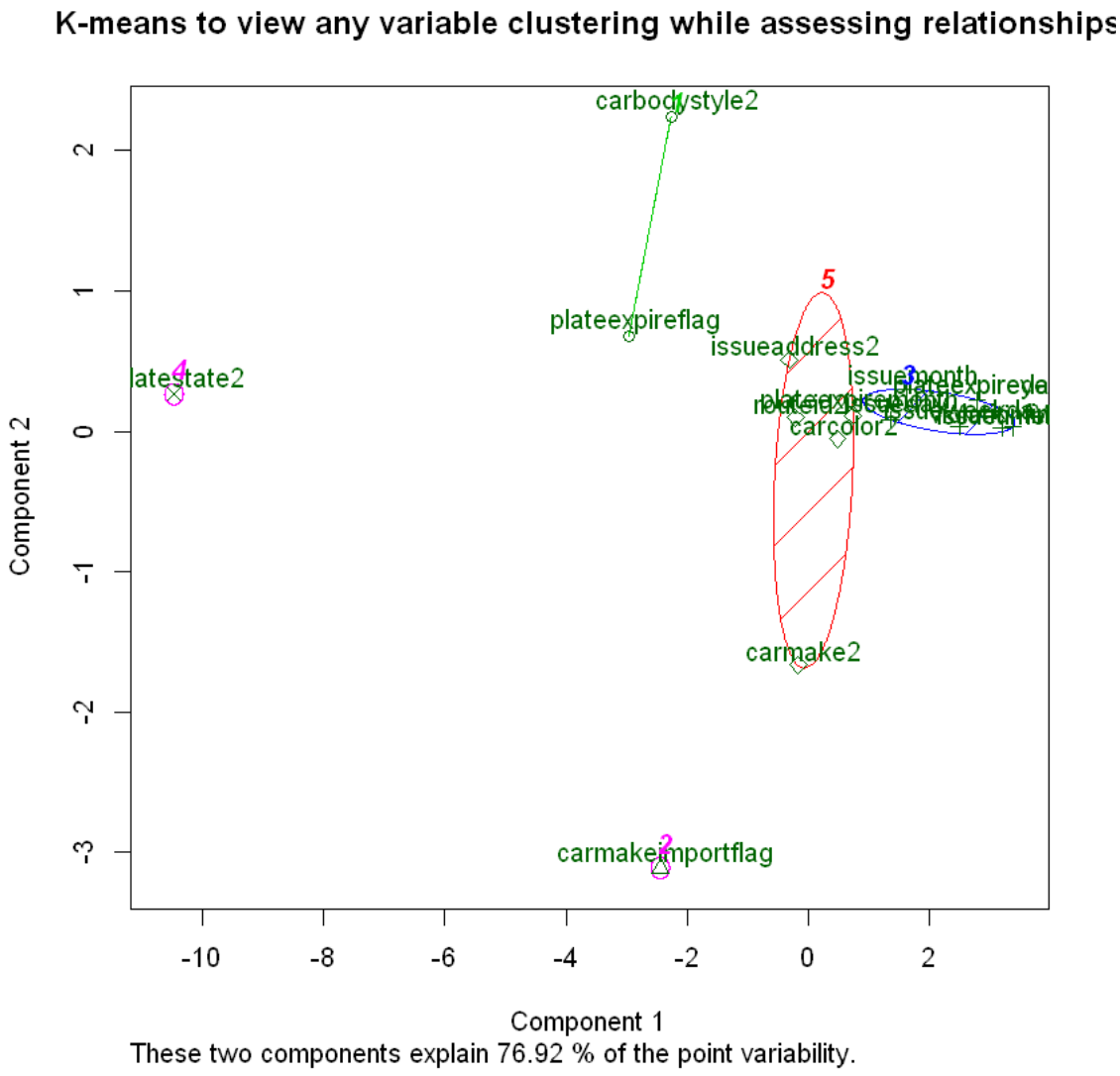
[73]:
```
##############################################################################
# OUTLIERS - ASSESSING VARIABLE IMPACT ON PREDICTION GROUPING
##############################################################################
#library(coop,tidyverse
df1_cosine <- data.frame(cosine(df1[,c(-1:-10,-14,-16:-21)]))  #cosine data␣
 ↪frame
df2_no_outliers_cosine <- data.frame(cosine(df1_cosine))

dftidy1 <- df2_no_outliers_cosine %>%
  rownames_to_column() %>%   #outliers made no difference in v
  gather(colname, value, -rowname)
ggplot(dftidy1, aes(x=rowname, y=colname, fill=value))+
  geom_tile()+
ggtitle("Cosine Distance: No Outliers.Abundance View.Suggests
          'out of state' plays factor into ticketing")
```



[56]:
```
##############################################################################
# K-Means CLUSTERING - use unsupervised to inspect anomaly groupings
##############################################################################

km_w_outliers <-kmeans(df1_cosine, centers=5, nstart=20,
                iter.max = 300, algorithm="Hartigan-Wong")
clusplot(df1_cosine, km_w_outliers$cluster,color=TRUE, shade=TRUE,
         labels=2, lines=0,
main="K-means to view any variable clustering while assessing relationships")
```

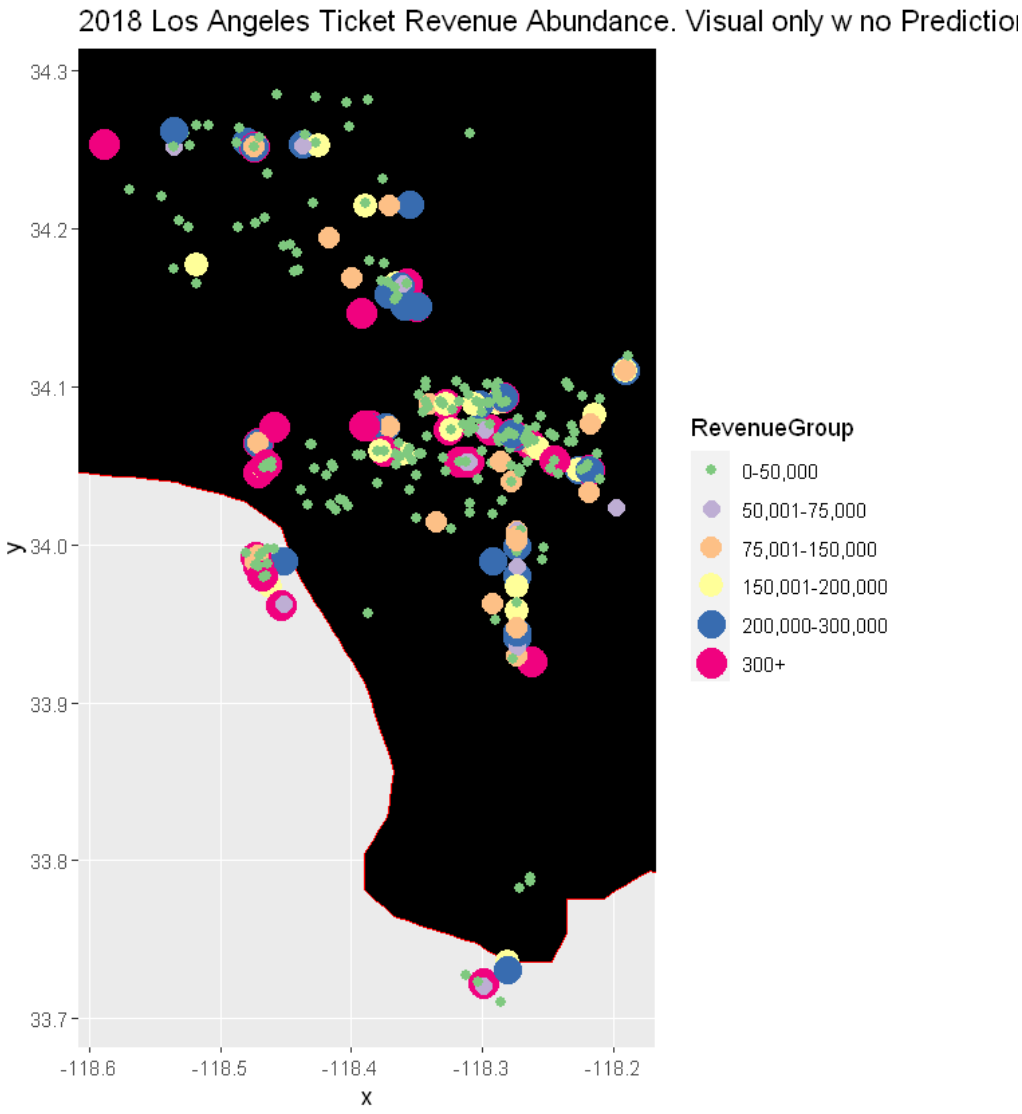


[61]:
```
##############################################################################
# GGplot- inspecting Revenue Grouping vai data query
##############################################################################
us <-map_data("state")
state <-map_data("state")
route.df1 <- sqldf('select routeid2, issueaddresslat as long,issueaddresslon as␣
 ↪lat,
                   SUM(violationfineamt) as fine from df1 group by routeid2')
RevenueGroup <- c(1:nrow(route.df1))  #fill in blanks to add a group size␣
 ↪variable
state <- c(1:nrow(route.df1))     #write.csv(route.df1, "Route_Fine.csv")
longnew <-c(1:nrow(route.df1))
latnew <-c(1:nrow(route.df1))
```

```
route.df1 <-cbind(route.df1,RevenueGroup)   #Gadd state full name back for␣
 ↪mapping please
route.df1 <-cbind(route.df1,state)
route.df1 <-cbind(route.df1,longnew)
route.df1 <-cbind(route.df1,latnew)
remove(RevenueGroup,state,latnew, longnew)  #----ADD FIXING OF LAT/LON␣
 ↪CONVERSION HERE
#str(route.df1)
# there are both bad and blank coordinates; I am just grouping for revenue␣
 ↪diagram
#old values = -137.9131, 27.51751
#new values = -118.24532, 34.05349
n <-1
while (n <= nrow(route.df1))
  {  route.df1[n,7]= round(route.df1[n,2],4)
     route.df1[n,8]= round(route.df1[n,3],5)
     #route.df1[n,2]= 0
     #route.df1[n,3]= 0
     n <- n+1                  #fixing some bad lat long positions - moving over␣
 ↪from ocean
  }                                #REVENUE DOT PLOT FIXING LAT/LONG
n <- 1
while (n <= nrow(route.df1))
  { #if (route.df1[n,7]== -137.9131) { baddates <- baddates+1 }
    if (route.df1[n,7]== -137.9131)  {route.df1[n,2]= -118.24532  }
    if (route.df1[n,8]== 27.51751)   {route.df1[n,3]= 34.05349  }
    if (route.df1[n,7]== 0)         {route.df1[n,2]= -118.24532  }
    if (route.df1[n,8]== 0)       {route.df1[n,3]= 34.05349  }
    n <- n+1  }
    #colnames(route.df1) <-␣
 ↪c("routeid2","long","lat","fine","grpsize","state","fix")
#head(route.df1)
route.df1$state <- "california"   #expand to get whole view on R windows
route.df1$RevenueGroup <- cut(route.df1$fine,           #make buckets for␣
 ↪mapping
                    breaks = c(-Inf, 50000, 75000, 150000, 200000, 300000, Inf),
  labels =␣
 ↪c("0-50,000","50,001-75,000","75,001-150,000","150,001-200,000","200,000-300,000","300+"),
                         right = FALSE)
mycolors <- brewer.pal(6, "Accent")   #head(df4,1)
names(mycolors) <-levels(route.df1$grpsize)  #getting the color names
ggplot(route.df1, aes(map_id=state)) +
  expand_limits(x=route.df1$long, y=route.df1$lat) + coord_map()+
  geom_map(map = us, fill="black", color="red" ) + geom_point(data=route.df1,
                    aes(x=long,y=lat, color=RevenueGroup, size=RevenueGroup ))+
  #stat_density2d(data=route.df1,aes(x=long,y=lat), geom="density_2d")+
```

```
  scale_colour_manual( values=mycolors) +  #name="Color",
  ggtitle("2018 Los Angeles Ticket Revenue Abundance. Visual only w no␣
↪Prediction")
```

```
Warning message:
"Using size for a discrete variable is not advised."
```



[71]:
```
##############################################################################
# GGplot- HEATMAP
##############################################################################
#-------------->>>>> HEATMAP PROCESS WORK  <<<<=========================
#GET A GRID OF THE CARS AS NEED TO MAKE NUMERIC THEN NORMALIZE 0-1
#
```

```
#       head(df1$carmake)
#       hist(df1$carmake2)
#       nrow(table(df1$violation.fine.amt))
#       hist(df1$violation.fine.amt)
#       df.temp <- data.frame(tapply(df1$carmake2, df1$carmake,min))
#       unique(df1$carmake)
#       tapply(df1$carmake2, df1$carmake,min)

car.df1 <- data.frame(sqldf('select carmake,SUM(carmake2) as CarQty
                            from df1 group by carmake') )
# note: I usually normalize in R but was running out of time so did Excel
car.df2 <- read.csv("C:/Users/17574/Desktop/Data/
 ↪streetsweeping-Car-Group-Normalize.csv")
df.temp <- data.frame(car.df2)
#head(df.temp)
              # carqty <- c(1:nrow(df1))
              # cargroupnormalize <- c(1:nrow(df1))
              # df2.heat <-cbind(df1 ,carqty,cargroup,cargroupnormalize)
              # df2.heat$carqty <- -199
              # df2.heat$cargroup <- -199
              # df2.heat$cargroupnormalize <- -199
#============================================================
#FINDING===> WAS USING 2 DIFFERENT TABLE IDS PULLED AT DIFFERETN TIME PIONTS!
#===> R resorts data on subsequent data merges
#============================================================
#fixed the merge - was using 2 different tables w differing assignment values..
df2.heat <-merge(x=df1, y=df.temp, by=c("carmake2","carmake"), all.x = TRUE)
#head(df2.heat,10)
remove(car.df1,car.df2)
cargroupname <- c("Dom.EconY","Dom.EconN","Intl.EconY","Intl.
 ↪EconN","Fancy","Trucks")
cargroup<- c(1,2,3,4,5,6)
df.car.group <- data.frame(cargroup, cargroupname)
df.car.group
df2.heat <-merge(x=df2.heat, y=df.car.group, by="cargroup", all.x = TRUE)
#head(df2.heat)
#=================>>>>>remove(df.car.group)
#Heatmap
#car type grouping - 0-1 scaling was done in Excel to spped up as had issue␣
 ↪mergeing
#issue wasn't mergeing but was 2 different data tables pulled at different time␣
 ↪points
#colnames(df2.heat)
# table(df2.heat$issuetimebin)
# hist(df2.heat$cargroupnormalize)
```

```
#Step 4 Heatmap---using normalization approach between 0-1 as didnt' want␣
 ↪negative scale
#head(df2.heat)
df3.heat <- data.frame(df2.heat[,c(9,12,13,15,17,1,37,36)])
#head(df3.heat,10)
max(df3.heat$issuetimebin)
range(df3.heat$issuetimebin)
df3.heat$timebin.z <- (df3.heat[,5]-min(df3.heat$issuetimebin))/
  (max(df3.heat$issuetimebin)-min(df3.heat$issuetimebin))
df3.heat$cargrp.z <- (df3.heat[,6]-min(df3.heat$cargroup))/
  (max(df3.heat$cargroup)-min(df3.heat$cargroup))
# head(df3.heat,1)
# length(df3.heat)

dftemp<-data.frame(df3.heat) #    <----switch to dataframe w no dots in it
#str(dftemp)
#============================================================
#hwat I really want is by car groups........
cargrp <- sqldf('select issuemonth as month, issueweekday as day,
        cargroupname , cargroupnormalize as zscore from dftemp ')

# head(cargrp)
# str(cargrp)
# table(cargrp$cargroupname)

#Comparison to learn if need to transform data to interpret better in heatmap
#ggplot(data = melt(df3.heat[,c(8:10)]), mapping = aes(x = value)) +␣
 ↪geom_histogram(bins=20)+
#  facet_wrap(~variable, scales = "free") +
#  ggtitle("Checking out for heat map")
#str(df3.heat)

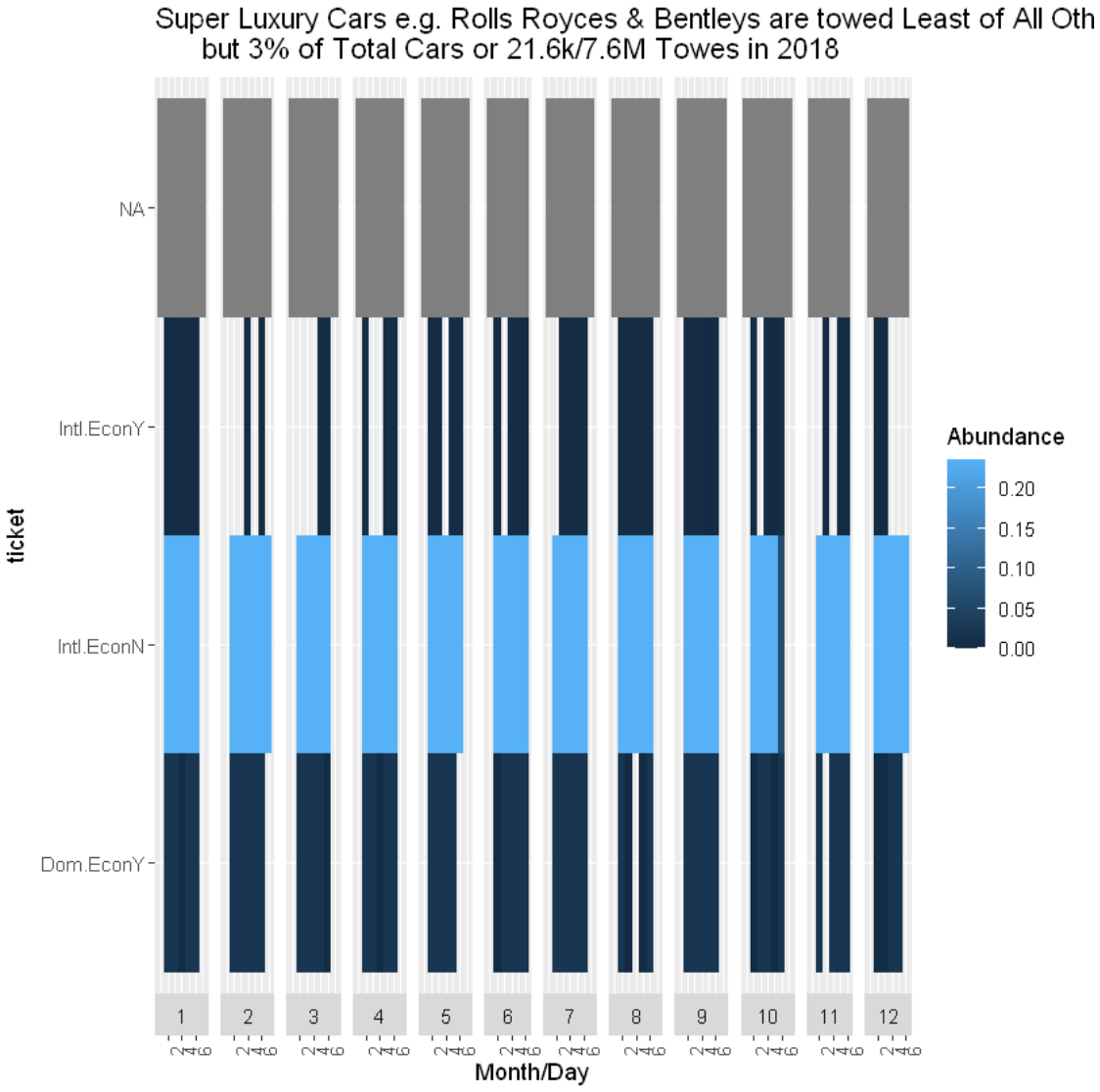
#library(tidyr)
#Abundance = grouping of all air quality factor values 0-1
#Felt Square Root Transformation did help with graph read but could vary by␣
 ↪person
df4.heat <- gather(data = cargrp, key = Class, value= Abundance,-c(1:3))
df4.heat$Sqrt.Abundance <- sqrt(df4.heat$Abundance)
#head(df4.heat,4)
#str(df4.heat)
                                                    #y=Class
heat.reg <-ggplot(data=df4.heat, mapping=␣
 ↪aes(x=day,y=cargroupname,fill=Abundance))+
  geom_tile() + xlab(label="Month/Day") + ylab(label="ticket") +
  ggtitle("Super Luxury Cars e.g. Rolls Royces & Bentleys are towed Least of␣
 ↪All Others
      but 3% of Total Cars or 21.6k/7.6M Towes in 2018") +
```

```
  theme(axis.text.x = element_text(size=8,angle = 90, hjust = 1)) +
  facet_grid(~ month, switch = "x", scales="free_x", space="free_x")
heat.reg #non transformed data
```

cargroup	cargroupname
1	Dom.EconY
2	Dom.EconN
3	Intl.EconY
4	Intl.EconN
5	Fancy
6	Trucks

6

1. 0 2. 6



[ ]:
```
#############################################################################
# HOUSE KEEPING - standard practices for managing memory by removing dataframes
#############################################################################
remove(df0, df1,df.temp, cor.df1, route.income.df1, df.carid.master)
```