Class 9 Halloween Candy

In today's class we will examine some data about candy from the 538 website

Import Data

Data exploration

> Q1 How many different candy types are in the dataset

```
candy_file <- url("https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-ranking/c

candy = read.csv(candy_file, row.names=1)
head(candy)
```

```
             chocolate fruity caramel peanutyalmondy nougat crispedricewafer
100 Grand            1      0       1              0      0                1
3 Musketeers         1      0       0              0      1                0
One dime             0      0       0              0      0                0
One quarter          0      0       0              0      0                0
Air Heads            0      1       0              0      0                0
Almond Joy           1      0       0              1      0                0
             hard bar pluribus sugarpercent pricepercent winpercent
100 Grand       0   1        0        0.732        0.860   66.97173
3 Musketeers    0   1        0        0.604        0.511   67.60294
One dime        0   0        0        0.011        0.116   32.26109
One quarter     0   0        0        0.011        0.511   46.11650
Air Heads       0   0        0        0.906        0.511   52.34146
Almond Joy      0   1        0        0.465        0.767   50.34755
```

```
nrow(candy)
```

```
[1] 85
```

There are 85 different types of candy in this dataset

> Q2 How many fruity candy types are in the dataset

```
sum(candy$fruity)
```

```
[1] 38
```

```
candy["Snickers",]$winpercent
```

```
[1] 76.67378
```

```
candy["Warheads",]$winpercent
```

```
[1] 39.0119
```

> Q3. What is your favorite candy in the dataset and what is it's winpercent value?

```
candy["Milky Way",]$winpercent
```

```
[1] 73.09956
```

> Q4. What is the winpercent value for "Kit Kat"?

```
candy["Kit Kat",]$winpercent
```

```
[1] 76.7686
```

> Q5. What is the winpercent value for "Tootsie Roll Snack Bars"?

```
candy["Tootsie Roll Snack Bars",]$winpercent
```

```
[1] 49.6535
```

> Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset?

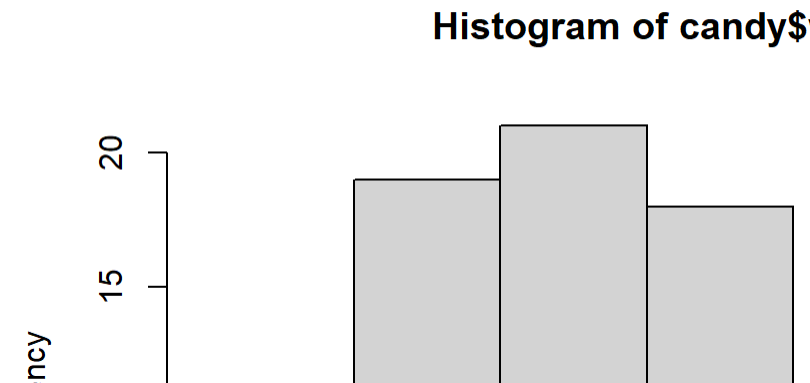
The sugar percent, price percent, and winpercent are not just 0's and one's because they are not either true or false values, they are measurable. The mean, sd, and histogram columns are also different for the same reason, they are all measurable values

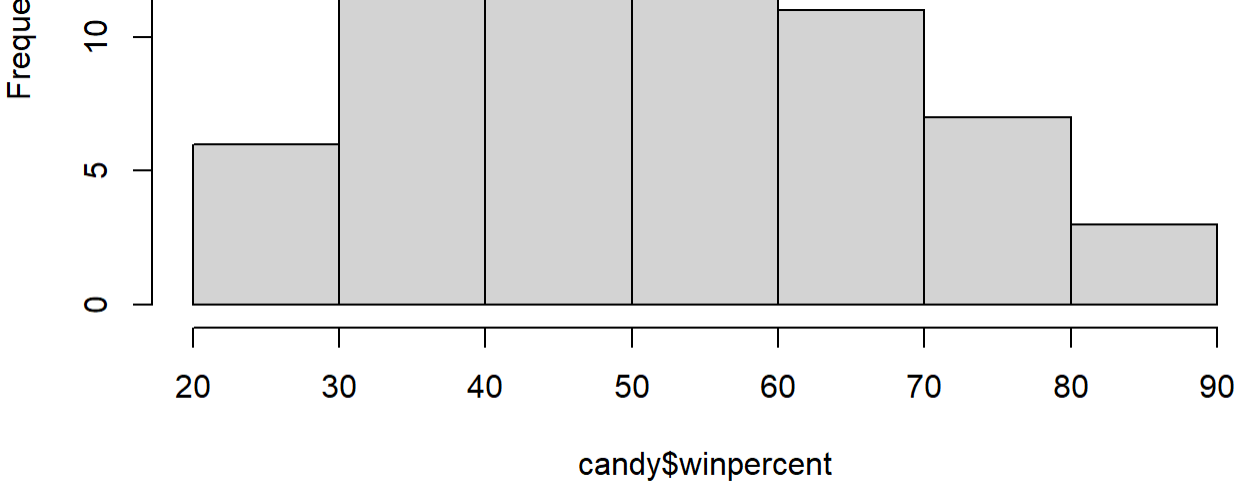
> Q7. What do you think a zero and one represent for the candy$chocolate column?

Zero means chocolate isnt contained in the candy while 1 means that it is

> Q8. Plot a histogram of win_percent values

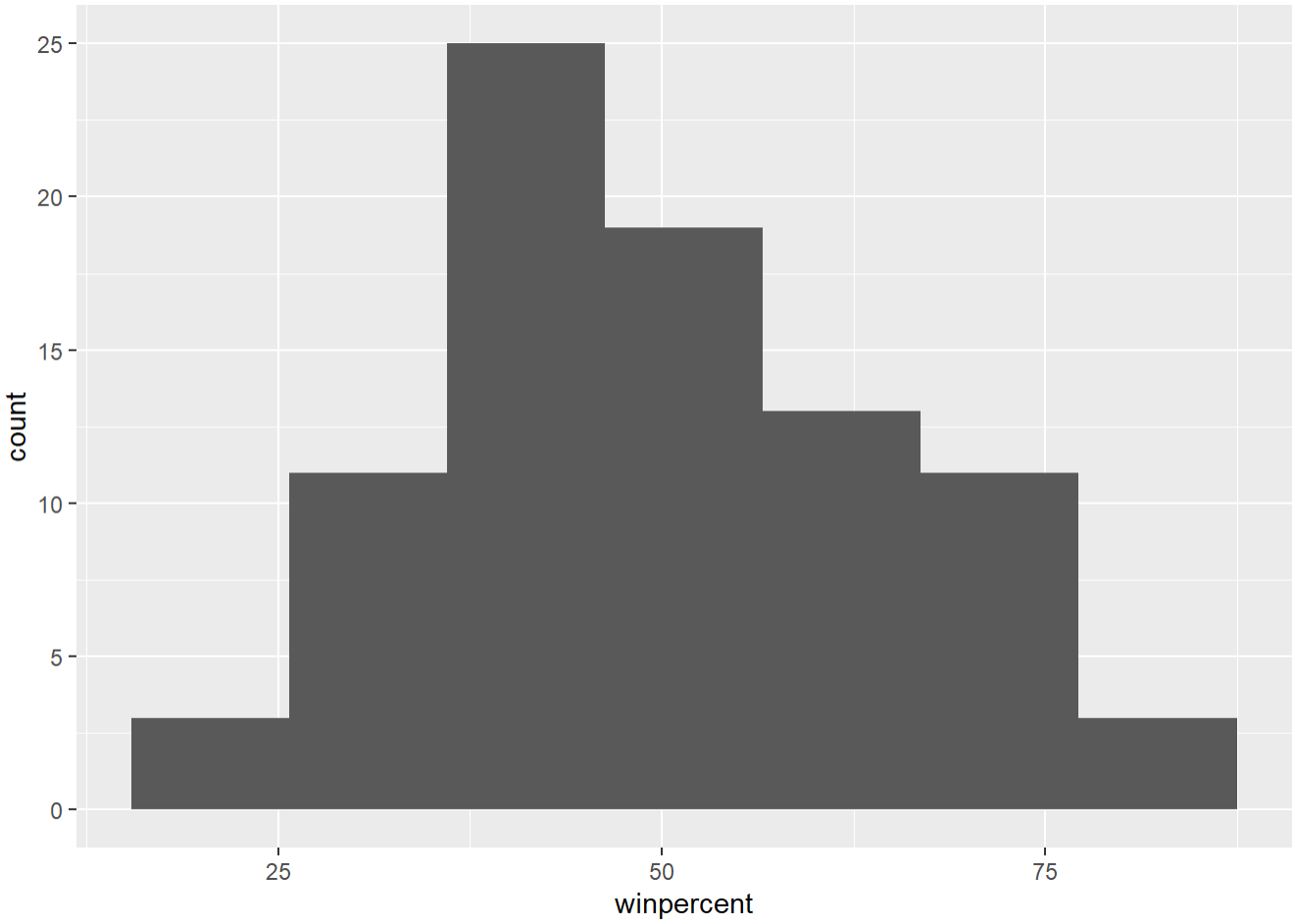
```
hist(candy$winpercent)
```






```
library(ggplot2)
```

```
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=7)
```



> Q9. Is the distribution of winpercent values symmetrical?

```
mean(candy$winpercent)
```

```
[1] 50.31676
```

The distribution is skewed slightly to the right, shown by both the histogram and the fact that the mean is slightly above 50% which should theoretically be the middle

> Q10. Is the center of the distribution above or below 50%?

```
summary(candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.14   47.83   50.32   59.86   84.18 
```

The center is above 50, but if you look at the median (outlier influence decreased) then it is below 50.

> Q11. On average is chocolate candy higher ot lower ranked than fruit candy?

- first find all chocolate candy
- find their winpercent values
- calculate the mean of these values

-then do the same for the fruity candy and compare with the mean for chocolate candy

For chocolate

```
chocolate.inds <- candy$chocolate == 1
chocolate.win <- candy[chocolate.inds,]$winpercent
mean(chocolate.win)
```

```
[1] 60.92153
```

For fruity

```
fruity.inds <- candy$fruity == 1
fruity.win <- candy[fruity.inds,]$winpercent
mean(fruity.win)
```

```
[1] 44.11974
```

Chocolate is generally ranked higher than fruity candy

> Q12.

```
t.test(chocolate.win, fruity.win)
```

```
    Welch Two Sample t-test

data:  chocolate.win and fruity.win
t = 6.2582, df = 68.882, p-value = 2.871e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 11.44563 22.15795
```

```
sample estimates:
mean of x mean of y
 60.92153  44.11974
```

> Q13. What are the five least liked candy types in this set?

```
x <- c(5,6,4)
sort(x)
```

```
[1] 4 5 6
```

```
x[order(x)]
```

```
[1] 4 5 6
```

The order function returns the indices that make the input sorted.

```
inds <- order(candy$winpercent)
head(candy[inds,])
```

```
                  chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                 0      1       0              0      0
Boston Baked Beans        0      0       0              1      0
Chiclets                  0      1       0              0      0
Super Bubble              0      1       0              0      0
Jawbusters                0      1       0              0      0
Root Beer Barrels         0      0       0              0      0
                  crispedricewafer hard bar pluribus sugarpercent pricepercent
Nik L Nip                        0    0   0        1        0.197        0.976
Boston Baked Beans               0    0   0        1        0.313        0.511
Chiclets                         0    0   0        1        0.046        0.325
Super Bubble                     0    0   0        0        0.162        0.116
Jawbusters                       0    1   0        1        0.093        0.511
Root Beer Barrels                0    1   0        1        0.732        0.069
                  winpercent
Nik L Nip           22.44534
Boston Baked Beans  23.41782
Chiclets            24.52499
Super Bubble        27.30386
Jawbusters          28.12744
Root Beer Barrels   29.70369
```

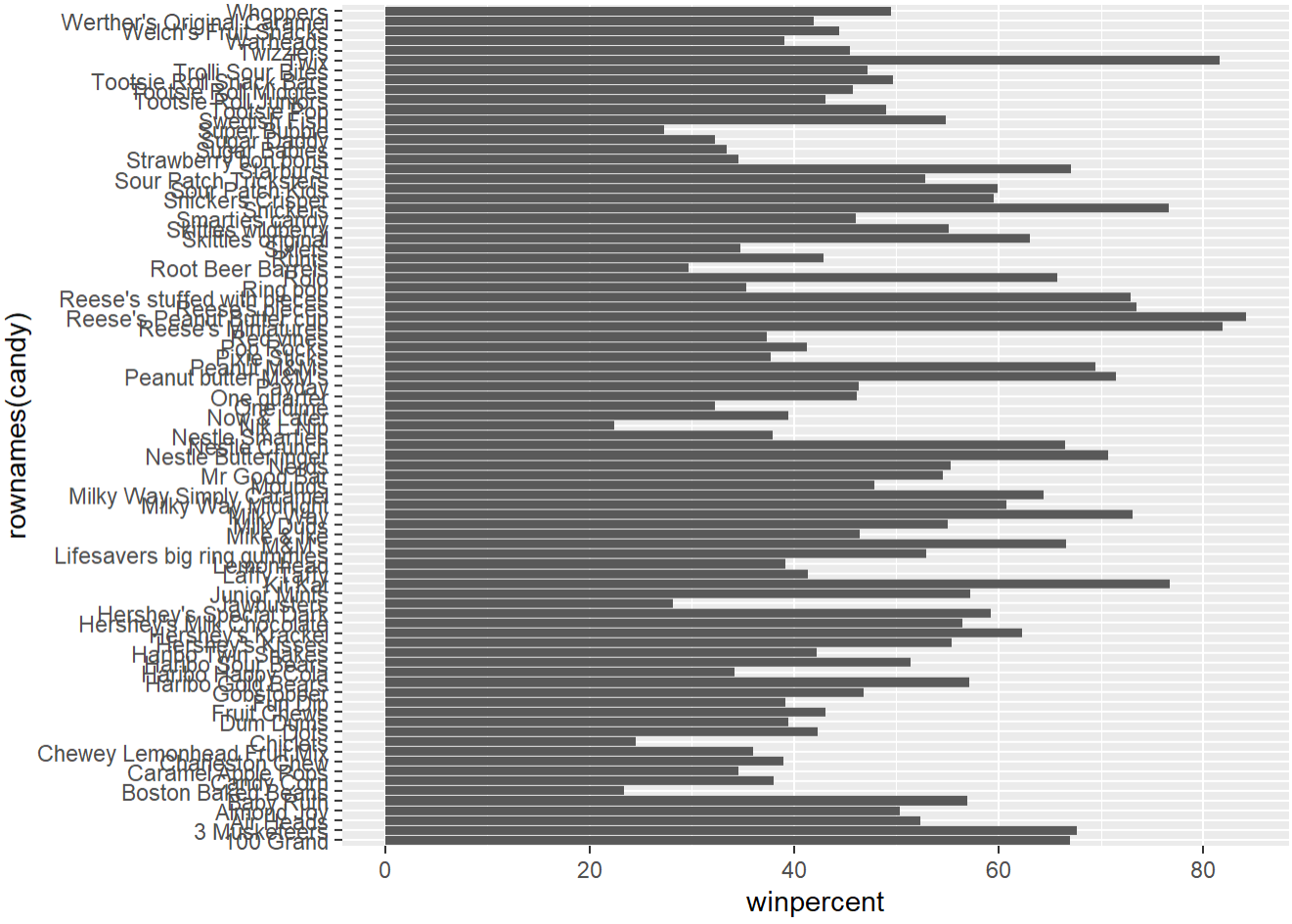
```
tail(candy[inds,])
```

```
                        chocolate fruity caramel peanutyalmondy nougat
Reese's pieces                  1      0       0              1      0
Snickers                        1      0       1              1      1
Kit Kat                         1      0       0              0      0
Twix                            1      0       1              0      0
Reese's Miniatures              1      0       0              1      0
Reese's Peanut Butter cup       1      0       0              1      0
                        crispedricewafer hard bar pluribus sugarpercent
```

```
Reese's pieces                     0    0   0        1        0.406
Snickers                           0    0   1        0        0.546
Kit Kat                            1    0   1        0        0.313
Twix                               1    0   1        0        0.546
Reese's Miniatures                 0    0   0        0        0.034
Reese's Peanut Butter cup          0    0   0        0        0.720
                           pricepercent winpercent
Reese's pieces                    0.651   73.43499
Snickers                          0.651   76.67378
Kit Kat                           0.511   76.76860
Twix                              0.906   81.64291
Reese's Miniatures                0.279   81.86626
Reese's Peanut Butter cup         0.651   84.18029
```

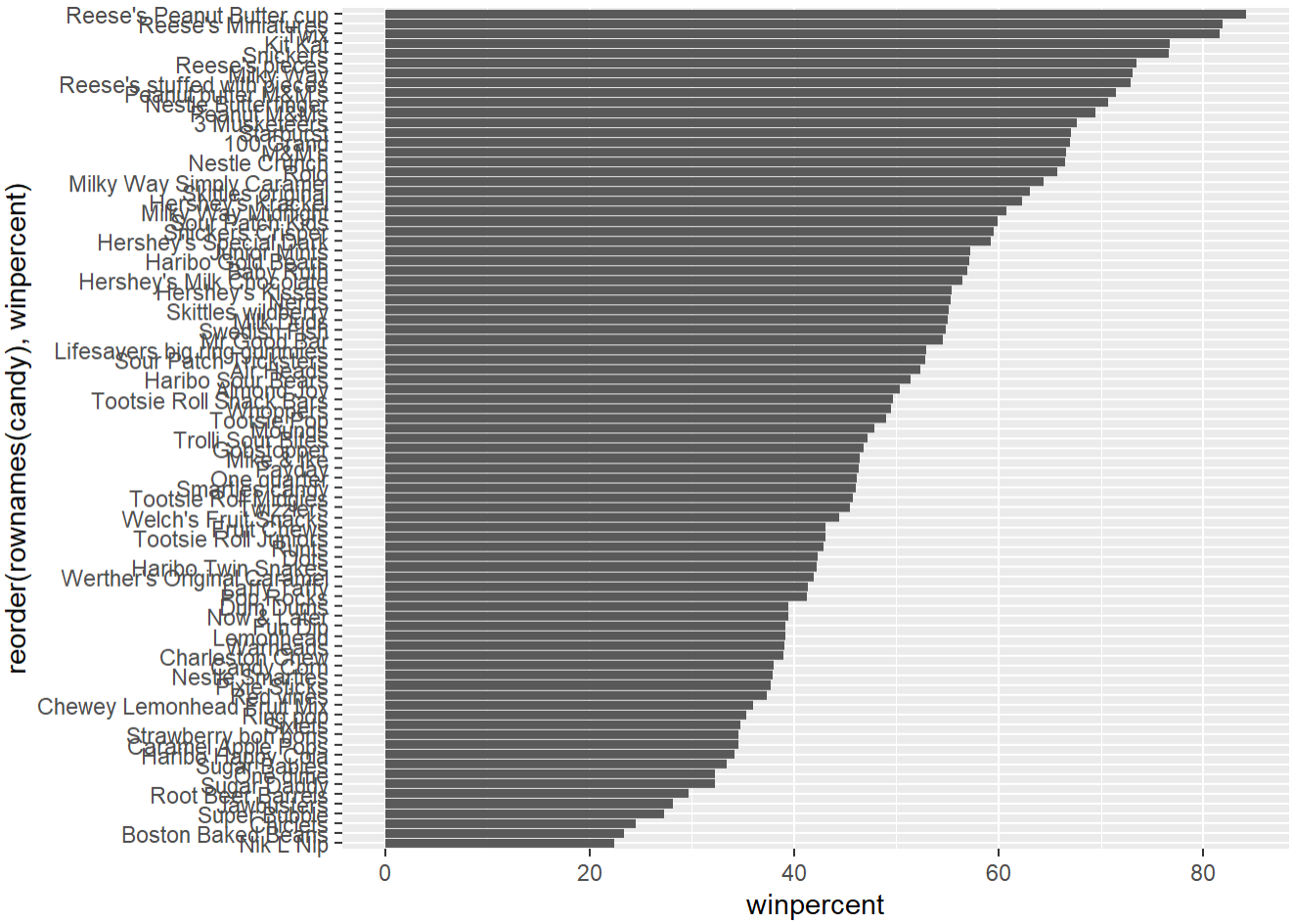
Nik L Nip, Boston Bakes Beans, Chiclets, Super Bubble, and Jawbusters are the 5 least liked (having the lowest winpercents)

```
ggplot(candy)+
  aes(winpercent, rownames(candy))+
  geom_col()
```



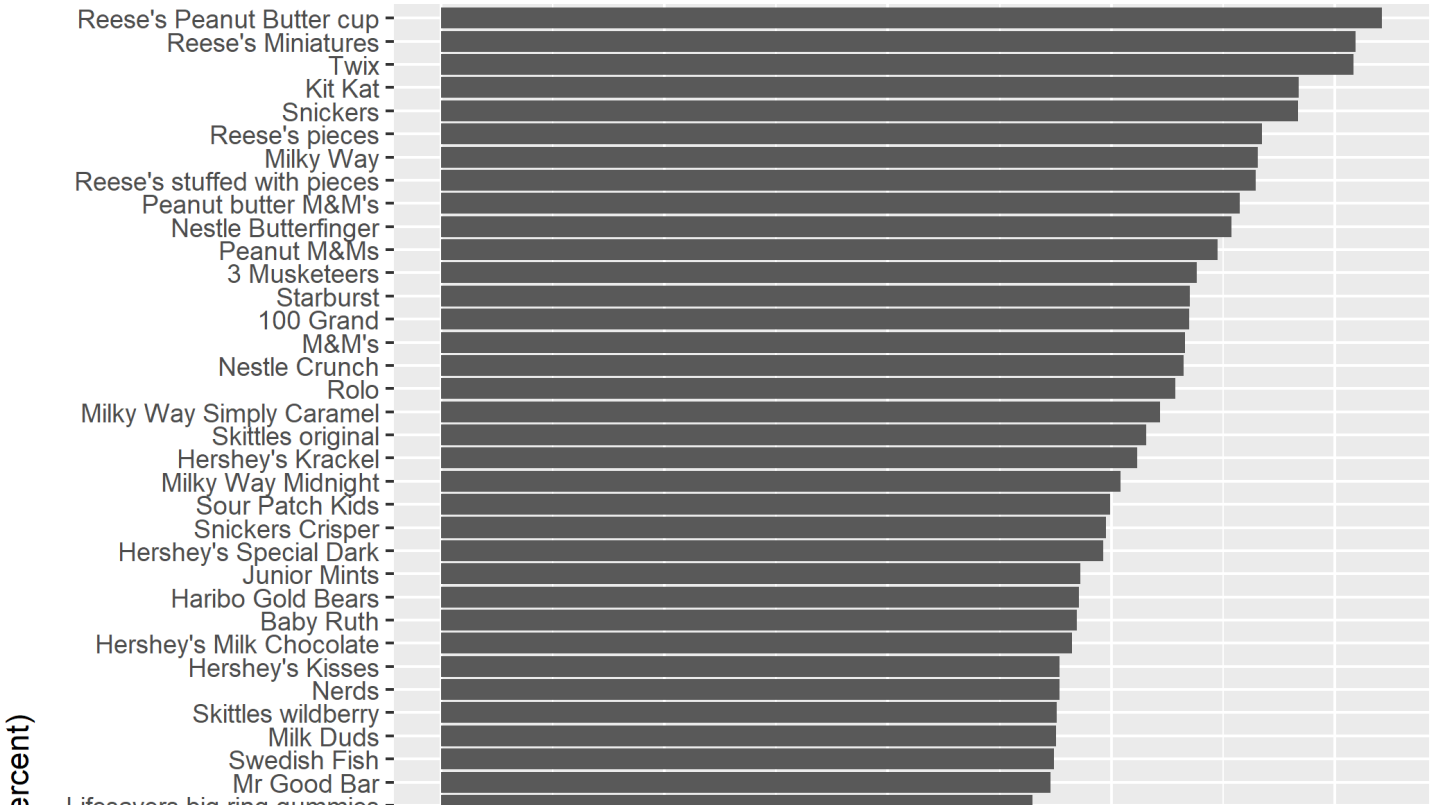

```
library(ggplot2)

#| fig-height: 10
#| fig-width: 7

ggplot(candy) +
```

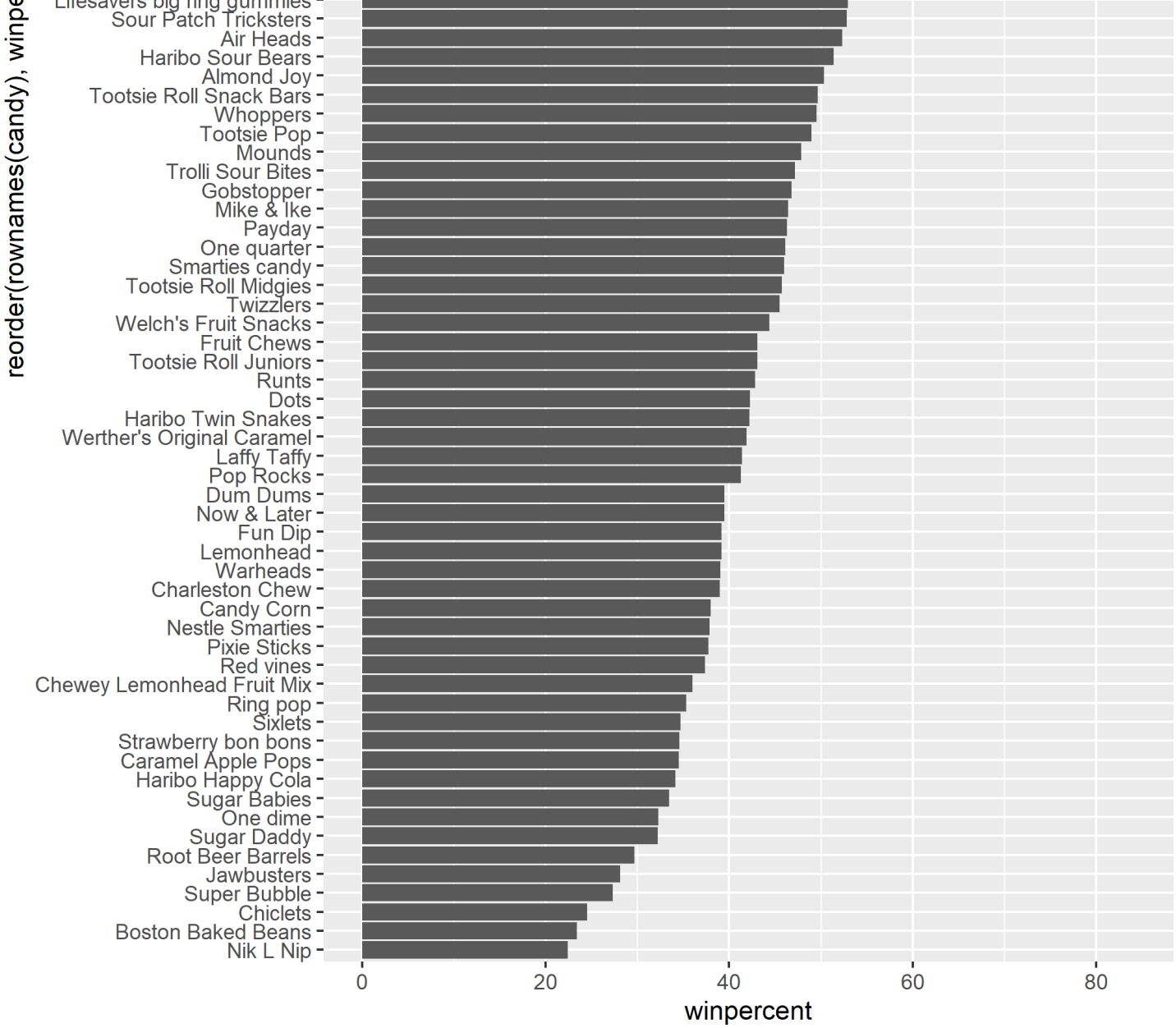
```
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col()
```




```
ggsave("mybarplot.png", height=10)
```

```
Saving 7 x 10 in image
```





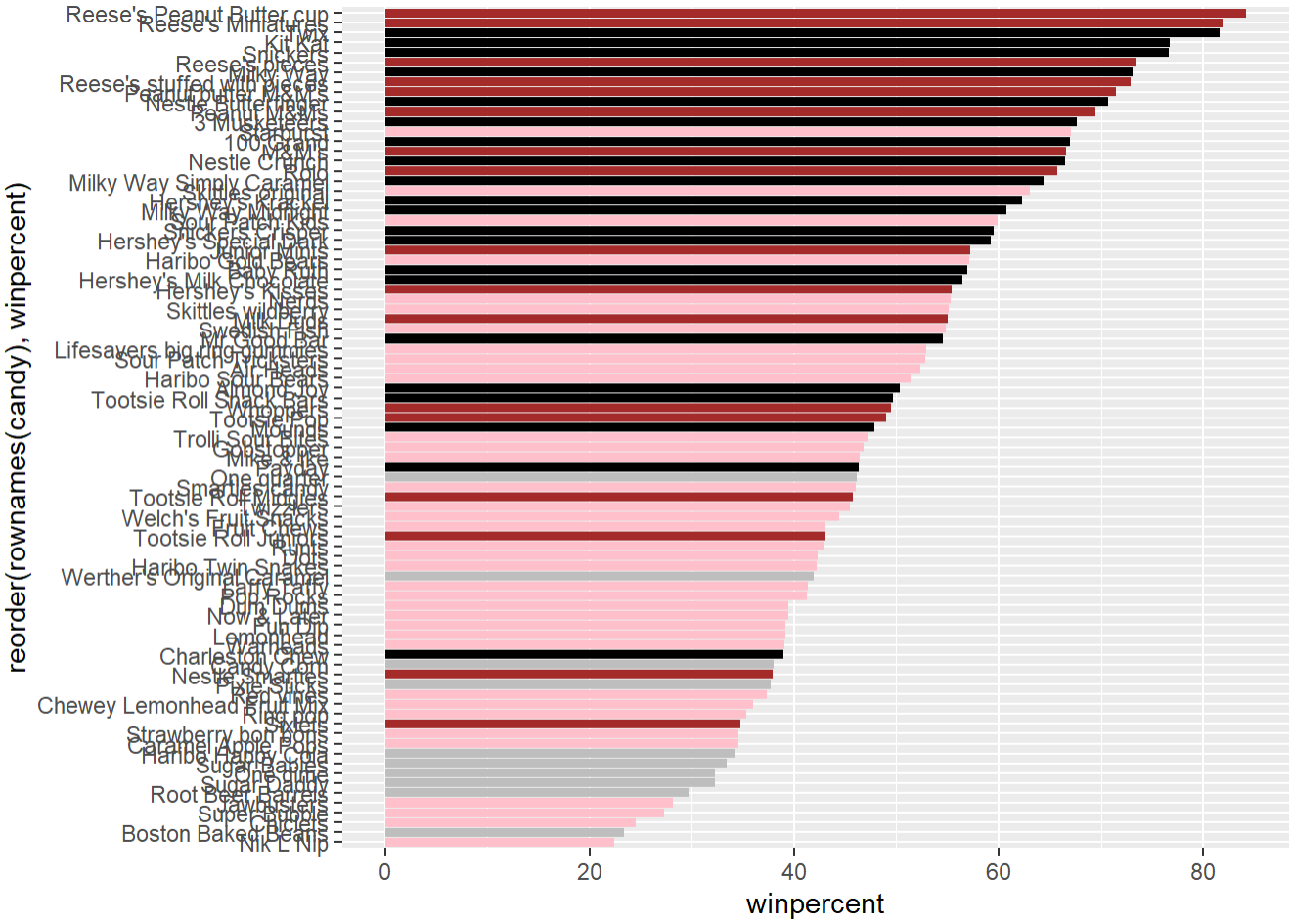
Exported image that is a bit bigger so I can read it

Add my custom colors to my barplot

```
my_cols=rep("gray", nrow(candy))
my_cols[candy$fruity == 1] <- "pink"
my_cols[candy$chocolate == 1] <- "brown"
my_cols[candy$bar == 1] <- "black"
my_cols
```

```
 [1] "black" "black" "gray"  "gray"  "pink"  "black" "black" "gray"  "gray" 
[10] "pink"  "black" "pink"  "pink"  "pink"  "pink"  "pink"  "pink"  "pink" 
[19] "pink"  "gray"  "pink"  "pink"  "brown" "black" "black" "black" "pink" 
[28] "brown" "black" "pink"  "pink"  "pink"  "brown" "brown" "pink"  "brown"
[37] "black" "black" "black" "black" "black" "pink"  "black" "black" "pink" 
[46] "pink"  "black" "brown" "gray"  "pink"  "pink"  "brown" "brown" "brown"
[55] "brown" "pink"  "brown" "gray"  "pink"  "brown" "pink"  "pink"  "brown"
[64] "pink"  "black" "black" "pink"  "pink"  "pink"  "pink"  "gray"  "gray" 
[73] "pink"  "pink"  "brown" "brown" "brown" "black" "pink"  "black" "pink" 
[82] "pink"  "pink"  "gray"  "brown"
```

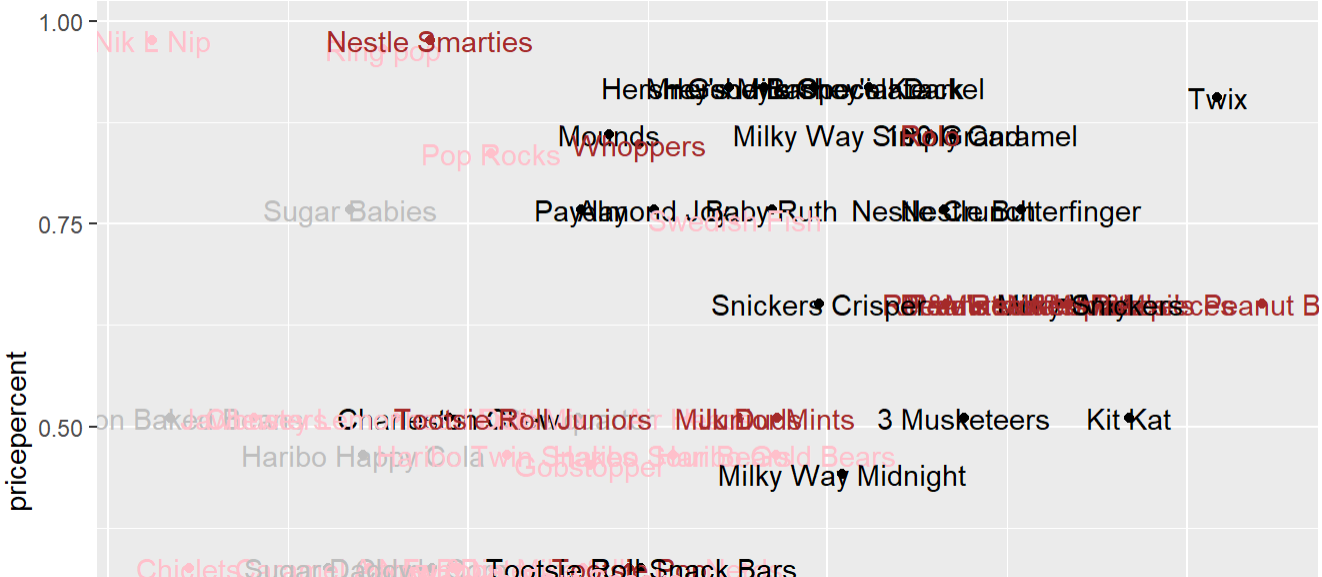
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col(fill=my_cols)
```

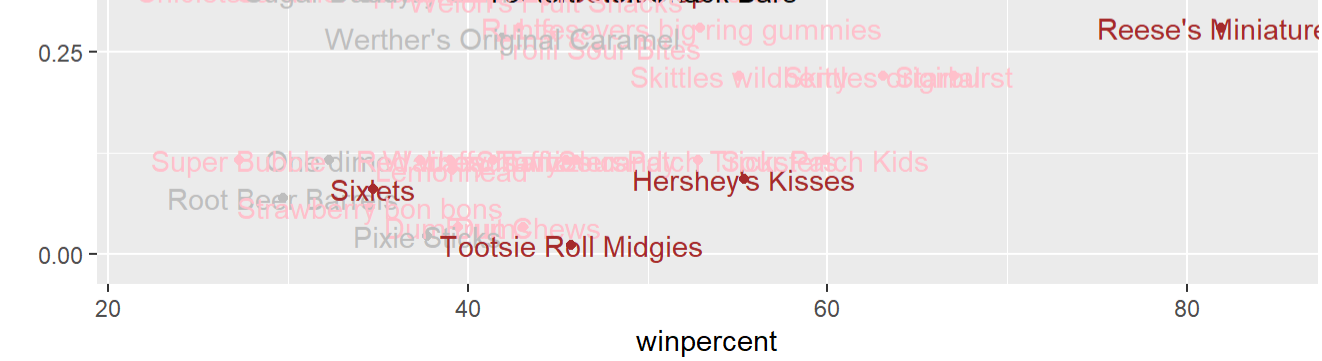


Q17. What is the worst ranked chocolate candy? - Q18. What is the best ranked fruity candy?

Plot of winpercent vs pricepercent

```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text(col=my_cols)
```

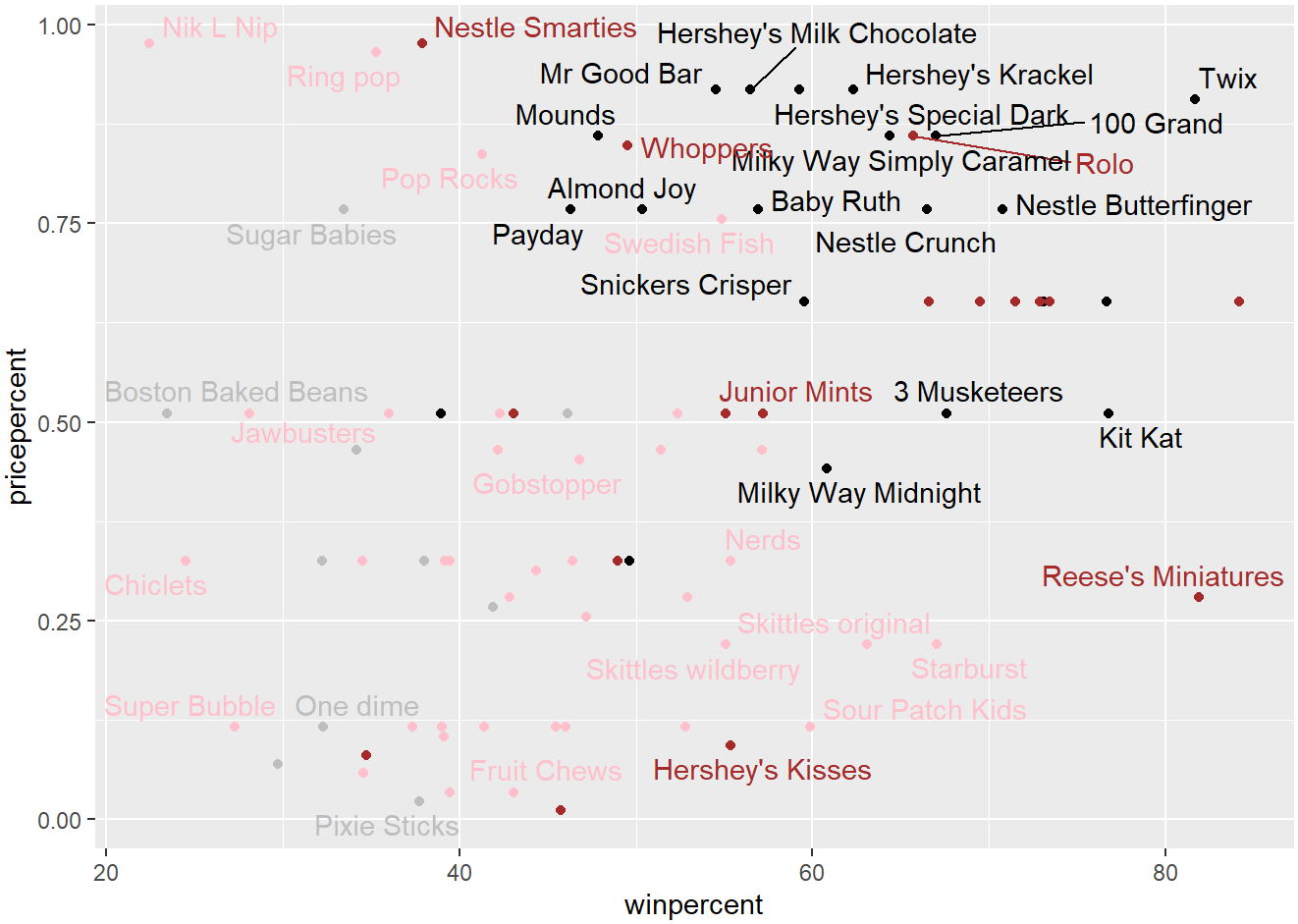




There are just too many labels in this above plot to be readable. We can use the `ggrepel` package to do a better job of placing labels so they minimize text overlap

```
library(ggrepel)

ggplot(candy) +
  aes(winpercent, pricepercent, label = rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, max.overlaps = 7)
```

```
Warning: ggrepel: 44 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Exploring the correlation structure

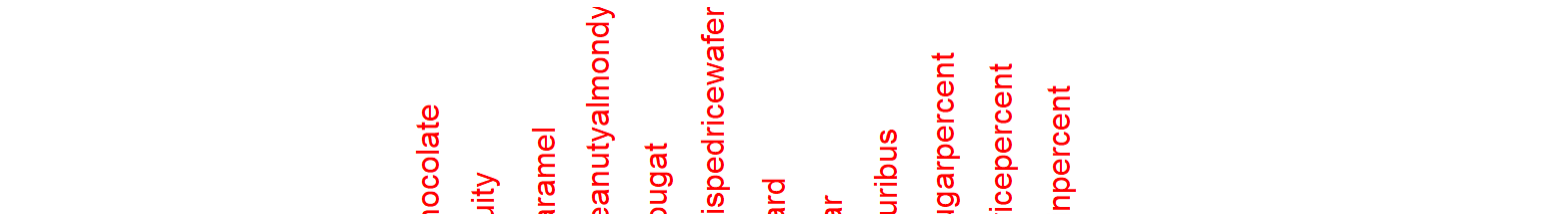
```
library(corrplot)
```

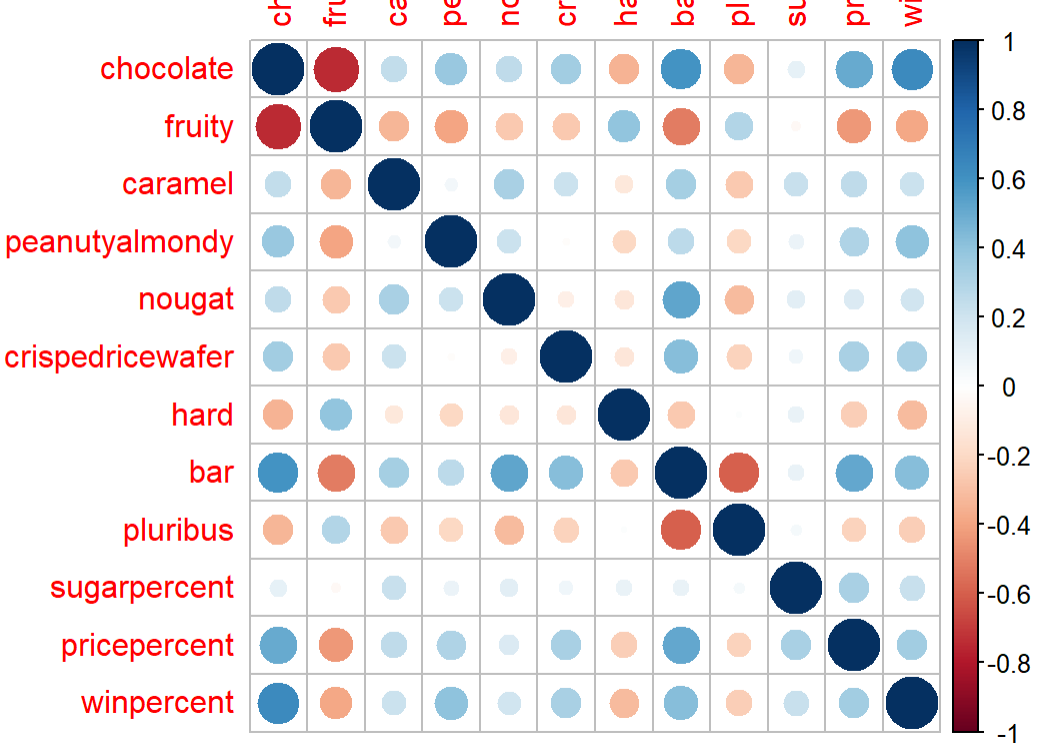
```
corrplot 0.92 loaded
```

```
cij <- cor(candy)
cij
```

```
                  chocolate      fruity     caramel peanutyalmondy      nougat
chocolate         1.0000000 -0.74172106  0.24987535     0.37782357  0.25489183
fruity           -0.7417211  1.00000000 -0.33548538    -0.39928014 -0.26936712
caramel           0.2498753 -0.33548538  1.00000000     0.05935614  0.32849280
peanutyalmondy    0.3778236 -0.39928014  0.05935614     1.00000000  0.21311310
nougat            0.2548918 -0.26936712  0.32849280     0.21311310  1.00000000
crispedricewafer  0.3412098 -0.26936712  0.21311310    -0.01764631 -0.08974359
hard             -0.3441769  0.39067750 -0.12235513    -0.20555661 -0.13867505
bar               0.5974211 -0.51506558  0.33396002     0.26041960  0.52297636
pluribus         -0.3396752  0.29972522 -0.26958501    -0.20610932 -0.31033884
sugarpercent      0.1041691 -0.03439296  0.22193335     0.08788927  0.12308135
pricepercent      0.5046754 -0.43096853  0.25432709     0.30915323  0.15319643
winpercent        0.6365167 -0.38093814  0.21341630     0.40619220  0.19937530
                crispedricewafer        hard         bar    pluribus
chocolate             0.34120978 -0.34417691  0.59742114 -0.33967519
fruity               -0.26936712  0.39067750 -0.51506558  0.29972522
caramel               0.21311310 -0.12235513  0.33396002 -0.26958501
peanutyalmondy       -0.01764631 -0.20555661  0.26041960 -0.20610932
nougat               -0.08974359 -0.13867505  0.52297636 -0.31033884
crispedricewafer      1.00000000 -0.13867505  0.42375093 -0.22469338
hard                 -0.13867505  1.00000000 -0.26516504  0.01453172
bar                   0.42375093 -0.26516504  1.00000000 -0.59340892
pluribus             -0.22469338  0.01453172 -0.59340892  1.00000000
sugarpercent          0.06994969  0.09180975  0.09998516  0.04552282
pricepercent          0.32826539 -0.24436534  0.51840654 -0.22079363
winpercent            0.32467965 -0.31038158  0.42992933 -0.24744787
                sugarpercent pricepercent winpercent
chocolate         0.10416906    0.5046754  0.6365167
fruity           -0.03439296   -0.4309685 -0.3809381
caramel           0.22193335    0.2543271  0.2134163
peanutyalmondy    0.08788927    0.3091532  0.4061922
nougat            0.12308135    0.1531964  0.1993753
crispedricewafer  0.06994969    0.3282654  0.3246797
hard              0.09180975   -0.2443653 -0.3103816
bar               0.09998516    0.5184065  0.4299293
pluribus          0.04552282   -0.2207936 -0.2474479
sugarpercent      1.00000000    0.3297064  0.2291507
pricepercent      0.32970639    1.0000000  0.3453254
winpercent        0.22915066    0.3453254  1.0000000
```

```
corrplot(cij)
```





> Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)?

chocolate and fruity b/c red dot

> Q23. Similarly, what two variables are most positively correlated?

chocolate ad bar b/c blue dot

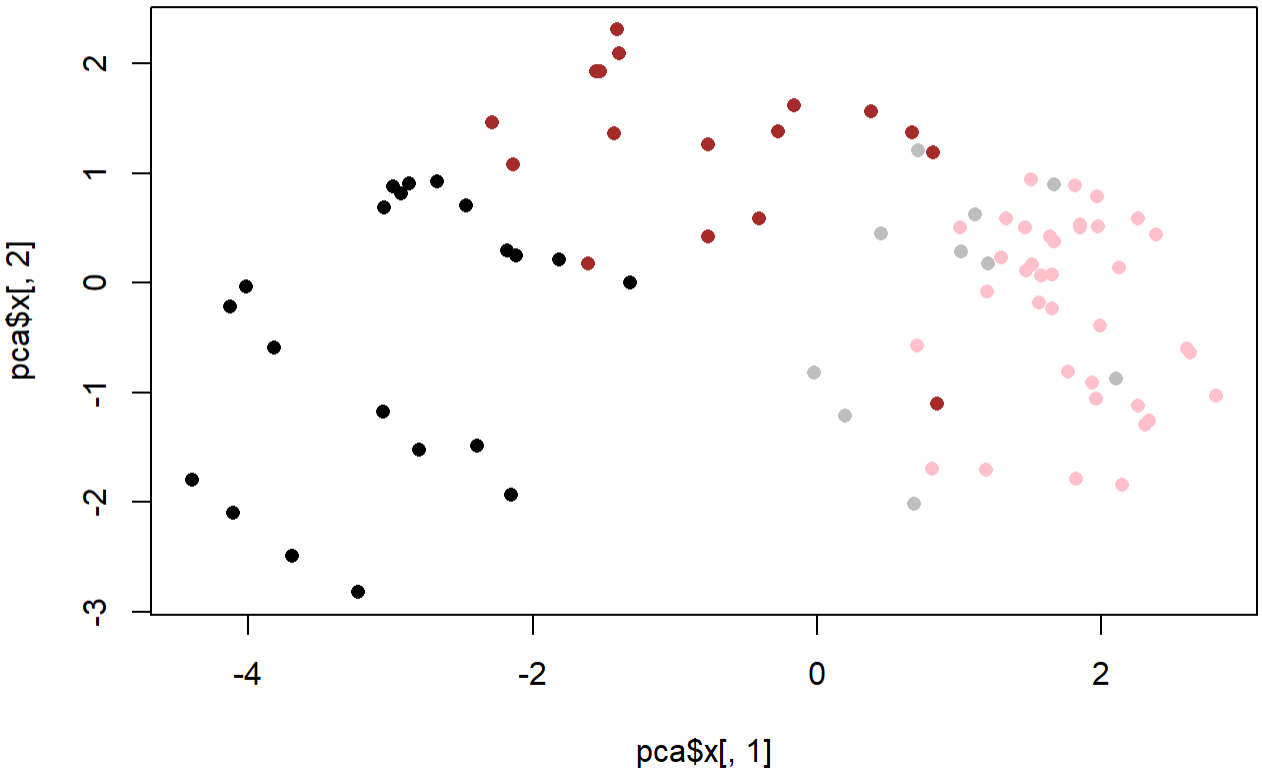
6. Principal Coponent Analysis

We will perform a PCA of the candy. Key-question: do ween need to scale the data before PCA?

```
pca <- prcomp(candy, scale=T)
summary(pca)
```

```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 0.7424 0.79830 0.85369
                           PC8     PC9    PC10    PC11    PC12
Standard deviation     0.74530 0.67824 0.62349 0.43974 0.39760
Proportion of Variance 0.04629 0.03833 0.03239 0.01611 0.01317
Cumulative Proportion  0.89998 0.93832 0.97071 0.98683 1.00000
```

```
plot(pca$x[,1], pca$x[,2], col=my_cols, pch=16)
```



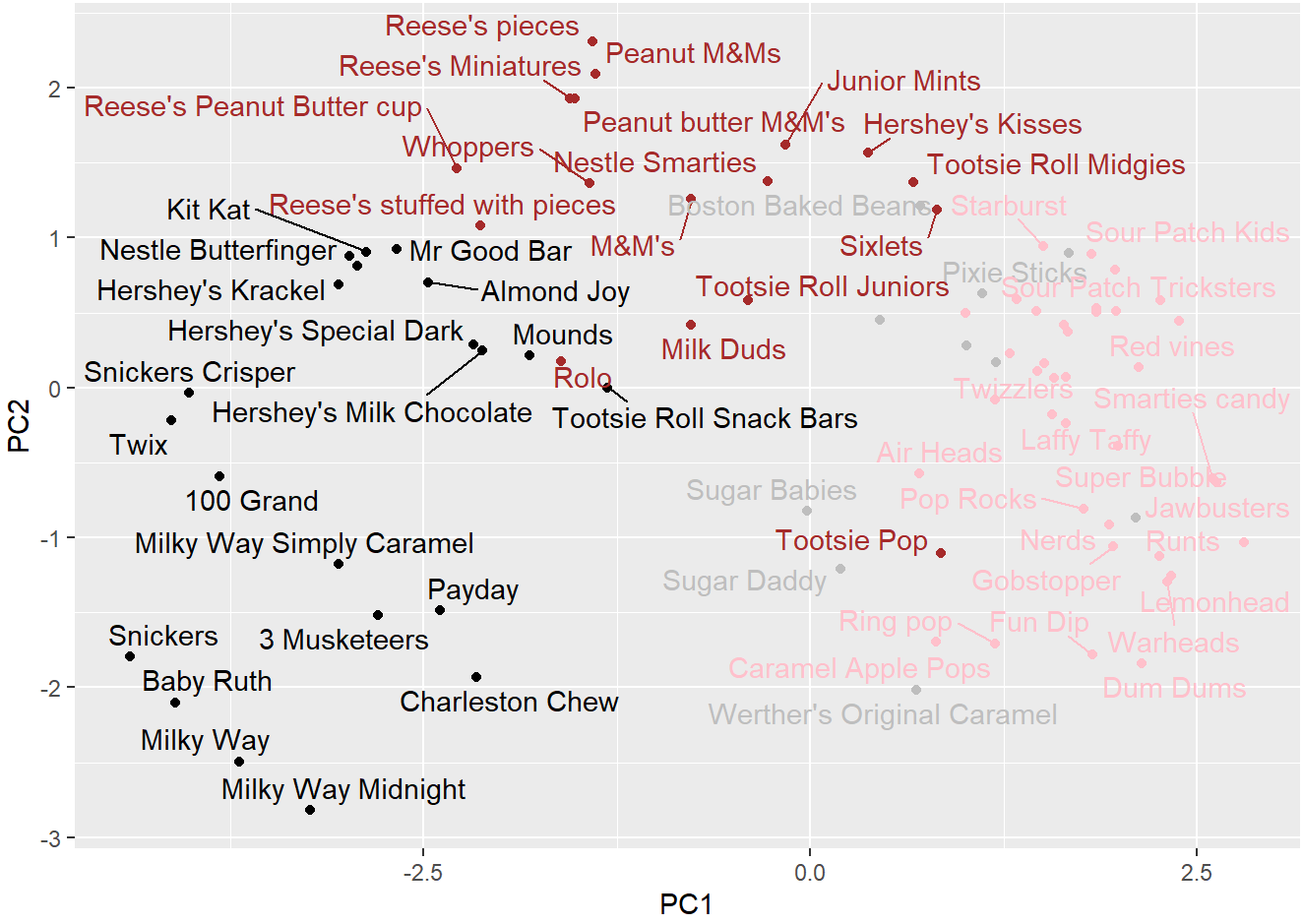
make a ggplot version of this figure:

```
# make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
head(my_data)
```

```
             chocolate fruity caramel peanutyalmondy nougat crispedricewafer
100 Grand            1      0       1              0      0                 1
3 Musketeers         1      0       0              0      1                 0
One dime             0      0       0              0      0                 0
One quarter          0      0       0              0      0                 0
Air Heads            0      1       0              0      0                 0
Almond Joy           1      0       0              1      0                 0
             hard bar pluribus sugarpercent pricepercent winpercent        PC1
100 Grand       0   1        0        0.732        0.860   66.97173 -3.8198617
3 Musketeers    0   1        0        0.604        0.511   67.60294 -2.7960236
One dime        0   0        0        0.011        0.116   32.26109  1.2025836
One quarter     0   0        0        0.011        0.511   46.11650  0.4486538
Air Heads       0   0        0        0.906        0.511   52.34146  0.7028992
Almond Joy      0   1        0        0.465        0.767   50.34755 -2.4683383
                     PC2        PC3
100 Grand    -0.5935788 -2.1863087
3 Musketeers -1.5196062  1.4121986
One dime      0.1718121  2.0607712
One quarter   0.4519736  1.4764928
Air Heads    -0.5731343 -0.9293893
Almond Joy    0.7035501  0.8581089
```

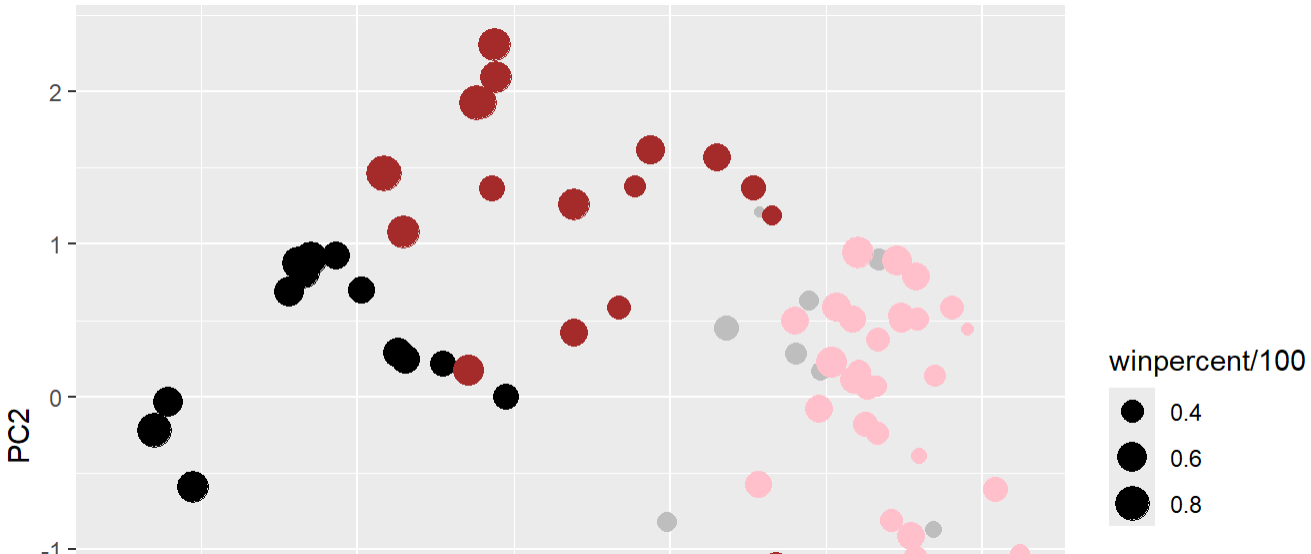
```
ggplot(my_data) +
  aes(PC1, PC2, label=rownames(my_data)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols)
```

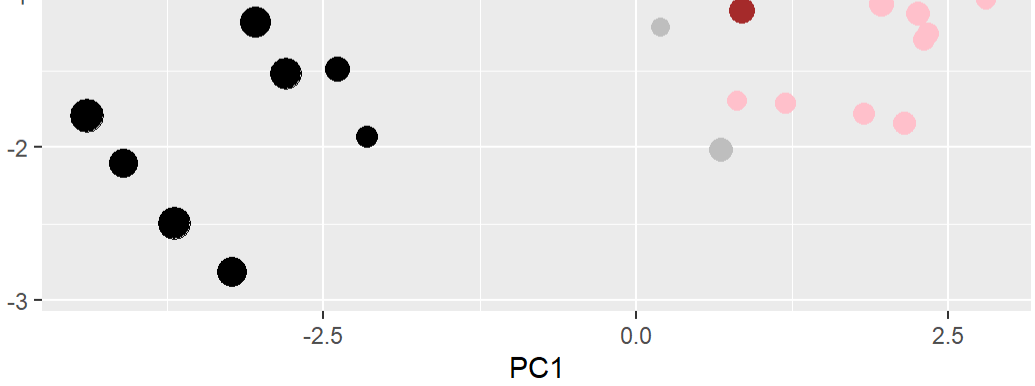
```
Warning: ggrepel: 23 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Make this a bit nicer

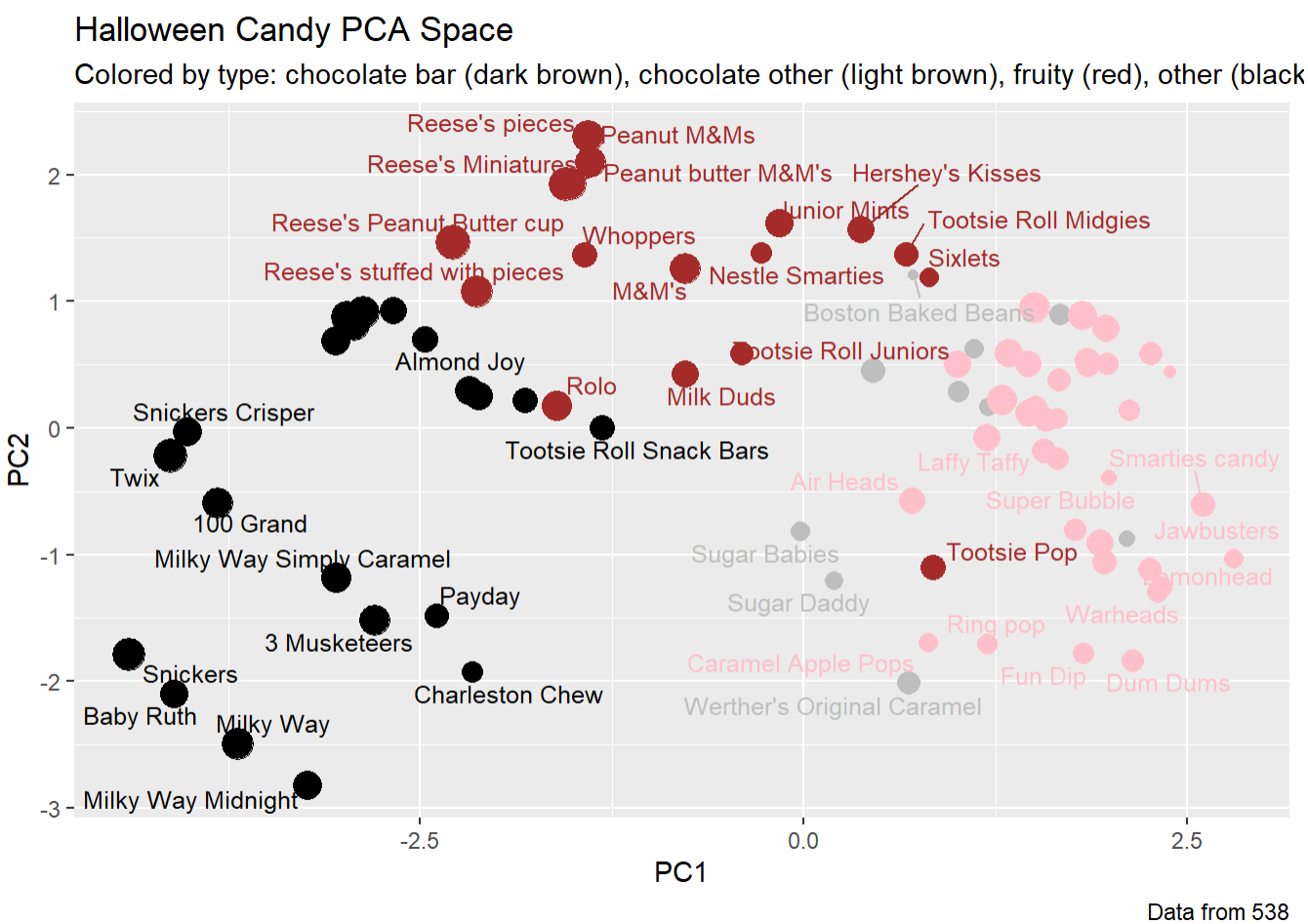
```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)
p
```






```
library(ggrepel)

p + geom_text_repel(size=3.3, col=my_cols, max.overlaps = 7)  +
  theme(legend.position = "none") +
  labs(title="Halloween Candy PCA Space",
       subtitle="Colored by type: chocolate bar (dark brown), chocolate other (light brown), fruity (r
       caption="Data from 538")
```

```
Warning: ggrepel: 40 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

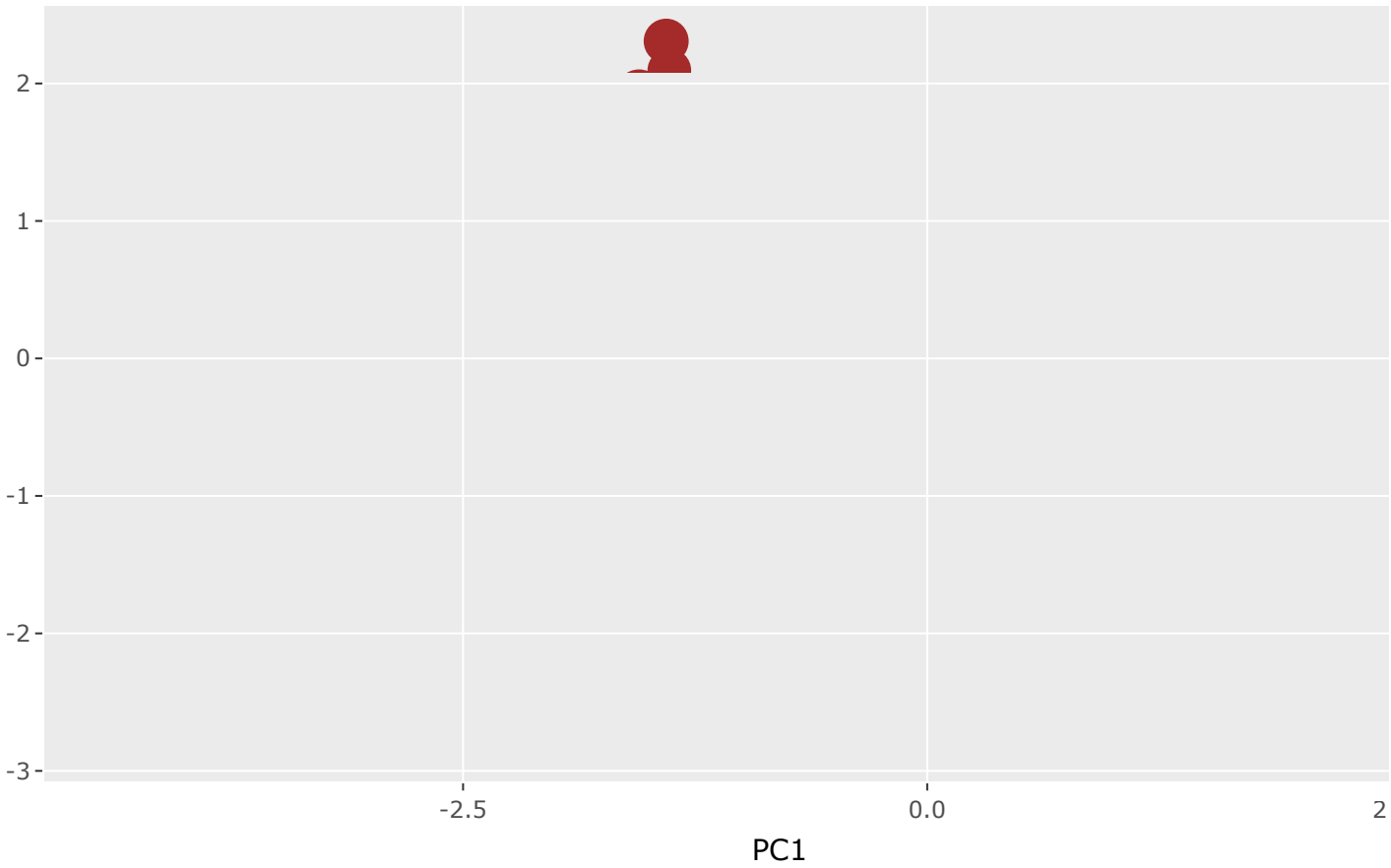



```
library(plotly)
```

```
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
```

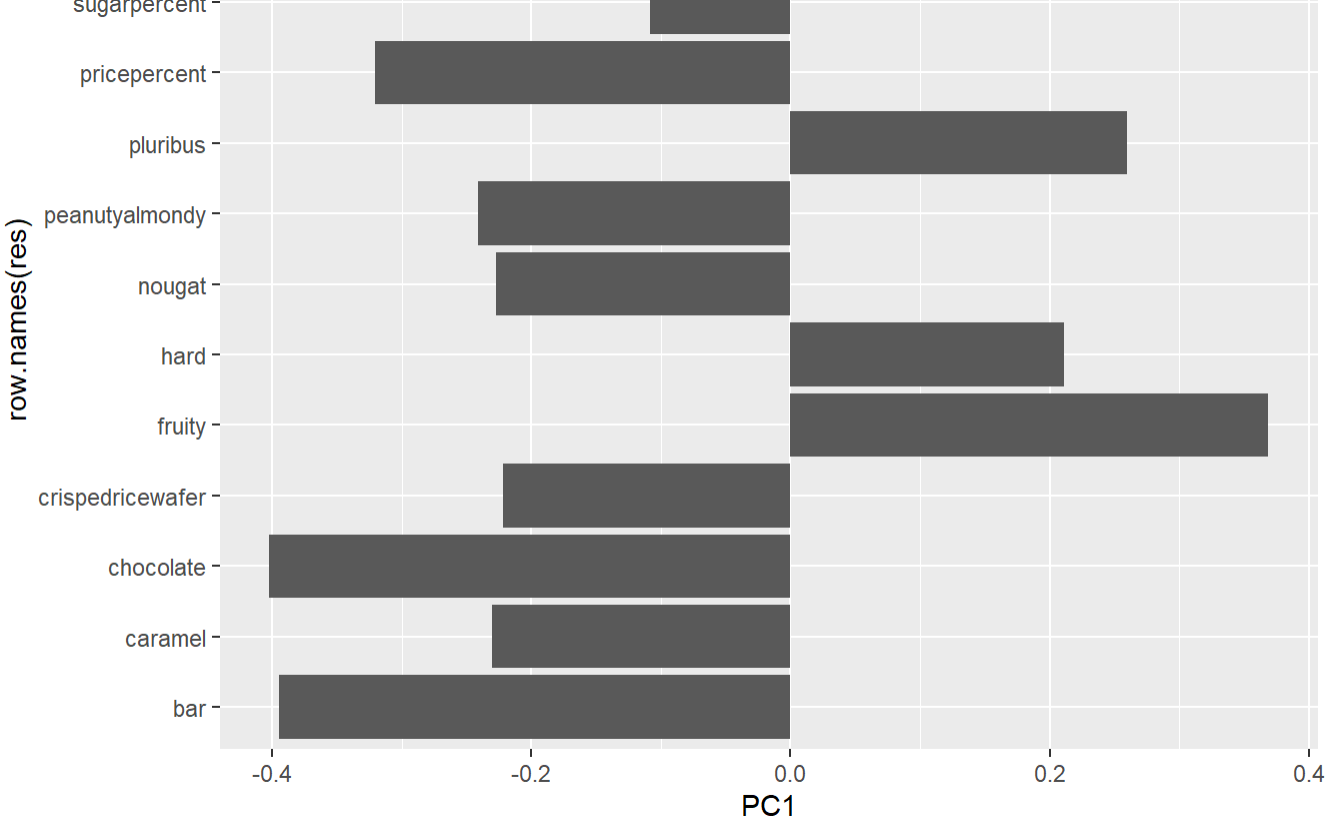
```
ggplotly(p)
```



How do the original variable contribute to our PCs> For this we look at the loadings component of our results object i.e the `pca$rotation` object?

Make a barplot with ggplot and order the bars by their value. Recall that you need a data.frame as input for ggplot

```
res <- as.data.frame(pca$rotation)

ggplot(res) +
  aes(x=PC1, row.names(res)) +
  geom_col()
```



> Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you?

Fruit, pluribus, and hard are all picked up in the +ve direction and these do make sense based on the correlation structure in the dataset.