lab09

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Background

In this mini-project, you will explore FiveThirtyEight's Halloween Candy dataset. FiveThirtyEight, sometimes rendered as just 538, is an American website that focuses mostly on opinion poll analysis, politics, economics, and sports blogging. They recently ran a rather large poll to determine which candy their readers like best. From their website: "While we don't know who exactly voted, we do know this: 8,371 different IP addresses voted on about 269,000 randomly generated candy matchups".

So what is the top ranked snack-sized Halloween candy? What made some candies more desirable than others? Was it price? Maybe it was just sugar content? Were they chocolate? Did they contain peanuts or almonds? How about crisped rice or other biscuit-esque component, like a Kit Kat or malted milk ball? Was it fruit flavored? Was it made of hard candy, like a lollipop or a strawberry bon bon? Was there nougat? What even is nougat? I know I like nougat, but I still have no real clue what the damn thing is.

Today we will take a wee step back to some data we can taste and explore the correlation structure and principal components of some halloween candy.

Importing Candy Data

```r
candy_file <- "candy-data.txt"

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
```

Q1. How many different candy types are in this dataset?

```r
#dimensions
dim(candy)
```

```
[1] 85 12
```

```r
#How many different type of candy
nrow(candy)
```

```
[1] 85
```

Q2. How many fruity candy types are in the dataset?

```r
table(sum(candy$fruity == 1))
```

```
38
 1
```

> Q3. What is your favorite candy?

```r
candy["Hershey's Milk Chocolate", ]$winpercent
```

```
[1] 56.4905
```

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

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

```
[1] 76.7686
```

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

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

```
[1] 49.6535
```

Exploratory Analysis

We can use the **skimr** package to get a quick overview of a given data set. This can be useful for the first time you encounter a new data set.

```r
#can also use skimr::skim()
library("skimr")

skim(candy)
```

Table 1: Data summary

Name	candy
Number of rows	85
Number of columns	12

Column type frequency:

numeric	12
Group variables	None

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
chocolate	0	1	0.44	0.50	0.00	0.00	0.00	1.00	1.00	
fruity	0	1	0.45	0.50	0.00	0.00	0.00	1.00	1.00	
caramel	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
peanutyalmondy	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
nougat	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
crispedricewafer	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
hard	0	1	0.18	0.38	0.00	0.00	0.00	0.00	1.00	
bar	0	1	0.25	0.43	0.00	0.00	0.00	0.00	1.00	
pluribus	0	1	0.52	0.50	0.00	0.00	1.00	1.00	1.00	
sugarpercent	0	1	0.48	0.28	0.01	0.22	0.47	0.73	0.99	
pricepercent	0	1	0.47	0.29	0.01	0.26	0.47	0.65	0.98	
winpercent	0	1	50.32	14.71	22.45	39.14	47.83	59.86	84.18	

> 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 last column **winpercent** appears to be on a different scale to the majority of the other columns in the dataset.

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

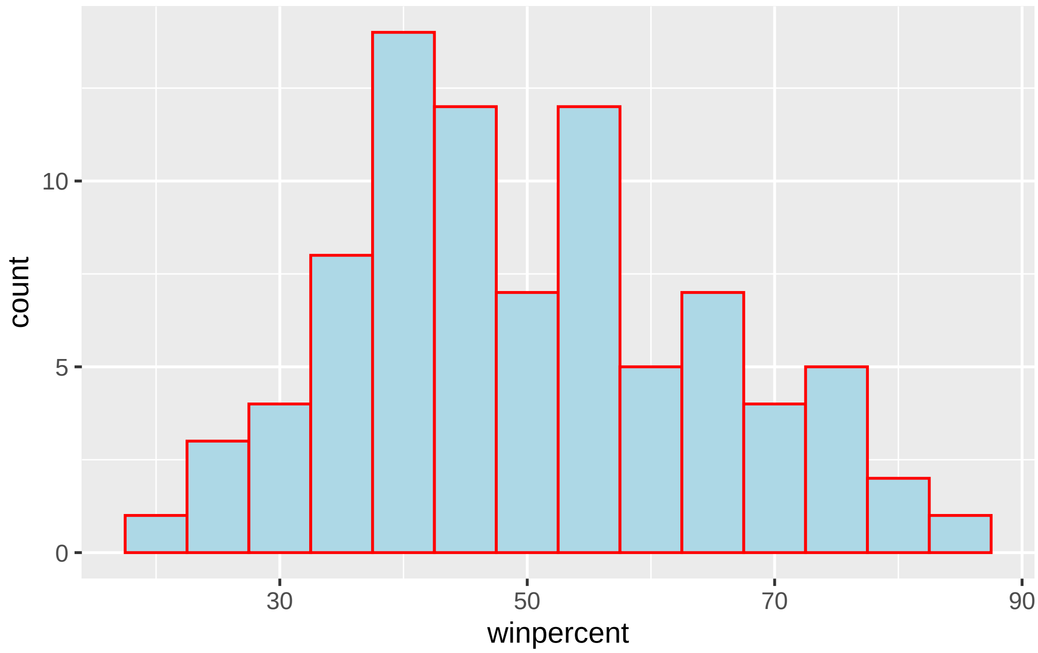
I believe the zero and one represents yes or no answers. The binomials 0 for "No" and 1 for "Yes". Within the candy$chocolate column it is assessing if each candy (rows) is either a choclate or not. If it is a chocolate a 1 is inserted into the chocolate column otherwise a 0 is entered.

Hint: look at the "Variable type" print out from the skim() function. Most varables (i.e. columns) are on the zero to one scale but not all. Some columns such as chocolate are exclusively either zero or one values.

> Q8. Plot a histogram of winpercent values

```r
library(ggplot2)

ggplot(candy) +
  aes (winpercent) +
  geom_histogram(binwidth = 5, color = "red", fill = "lightblue")
```



Q9. Is the distribution of winpercent values symmetrical?

No, based on the histogram the distribution is not symmetrical

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

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

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

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

Based on the mean only **chocolate candy is preferred** as the mean is 60.92153 vs fruity candy is 44.11974.

```r
choc.inds <- candy$chocolate == 1

choc.candy <- candy[choc.inds,]

choc.win <- choc.candy$winpercent

mean(choc.win)
```

```
[1] 60.92153
```

```r
#Alternative: fruit.win <- candy[as.logical ( candy$fruity),]$winpercent

fruity.inds <- candy$fruity == 1

fruity.candy <- candy[fruity.inds,]

fruity.win <- fruity.candy$winpercent

mean(fruity.win)
```

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

Yes, there is a significant statistical difference, chocolate is much preferred over fruity candy with a P-value of `r.ans$p.value`.

```r
ans <- t.test(fruity.win, choc.win)
ans
```

```

	Welch Two Sample t-test

data:  fruity.win and choc.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:
 -22.15795 -11.44563
sample estimates:
mean of x mean of y 
 44.11974  60.92153 
```

Overall Candy Rankings

There are two related functions that can help here, one is the classic `sort()` and `order()`

```
x <- c(5,10,1,4)
sort(x, decreasing = T)
```

```
[1] 10  5  4  1
```

```
order(x)
```

```
[1] 3 4 1 2
```

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

```
inds <- order(candy$winpercent)

head(candy[inds,], 5)
```

```
                   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
                   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
                   winpercent
Nik L Nip            22.44534
Boston Baked Beans   23.41782
Chiclets             24.52499
Super Bubble         27.30386
Jawbusters           28.12744
```

> Q14. What are the top 5 all time favorite candy types out of this set?

```r
inds <- order(candy$winpercent, decreasing = T)

head(candy[inds,], 5)
```

```
                          chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat                           1      0       0              0      0
Snickers                          1      0       1              1      1
                          crispedricewafer hard bar pluribus sugarpercent
Reese's Peanut Butter cup                0    0   0        0        0.720
Reese's Miniatures                       0    0   0        0        0.034
Twix                                     1    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Snickers                                 0    0   1        0        0.546
                          pricepercent winpercent
Reese's Peanut Butter cup        0.651   84.18029
Reese's Miniatures               0.279   81.86626
Twix                             0.906   81.64291
Kit Kat                          0.511   76.76860
Snickers                         0.651   76.67378
```

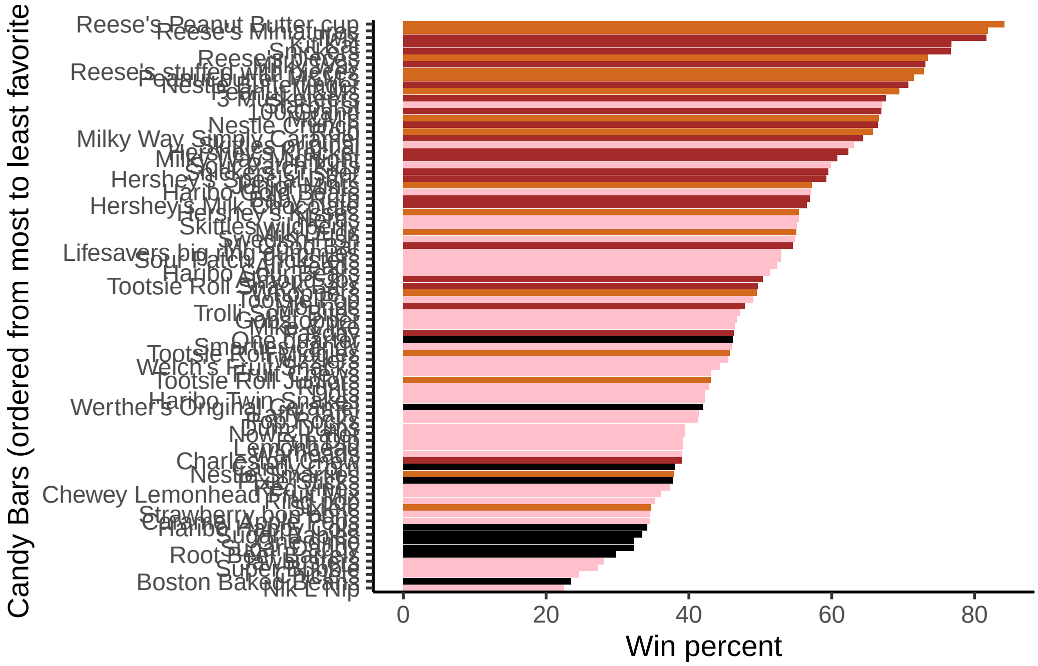
> Q15. Make a first barplot of candy ranking based on winpercent values.

Here we want a custom color vector to color eahc bar they way we want - with chocolate and fruity candy together with it wether it is a bar or not.

```r
#alternative: my_cols[2] <- "color"
my_cols=rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] = "chocolate"
my_cols[as.logical(candy$bar)] = "brown"
my_cols[as.logical(candy$fruity)] = "pink"
```

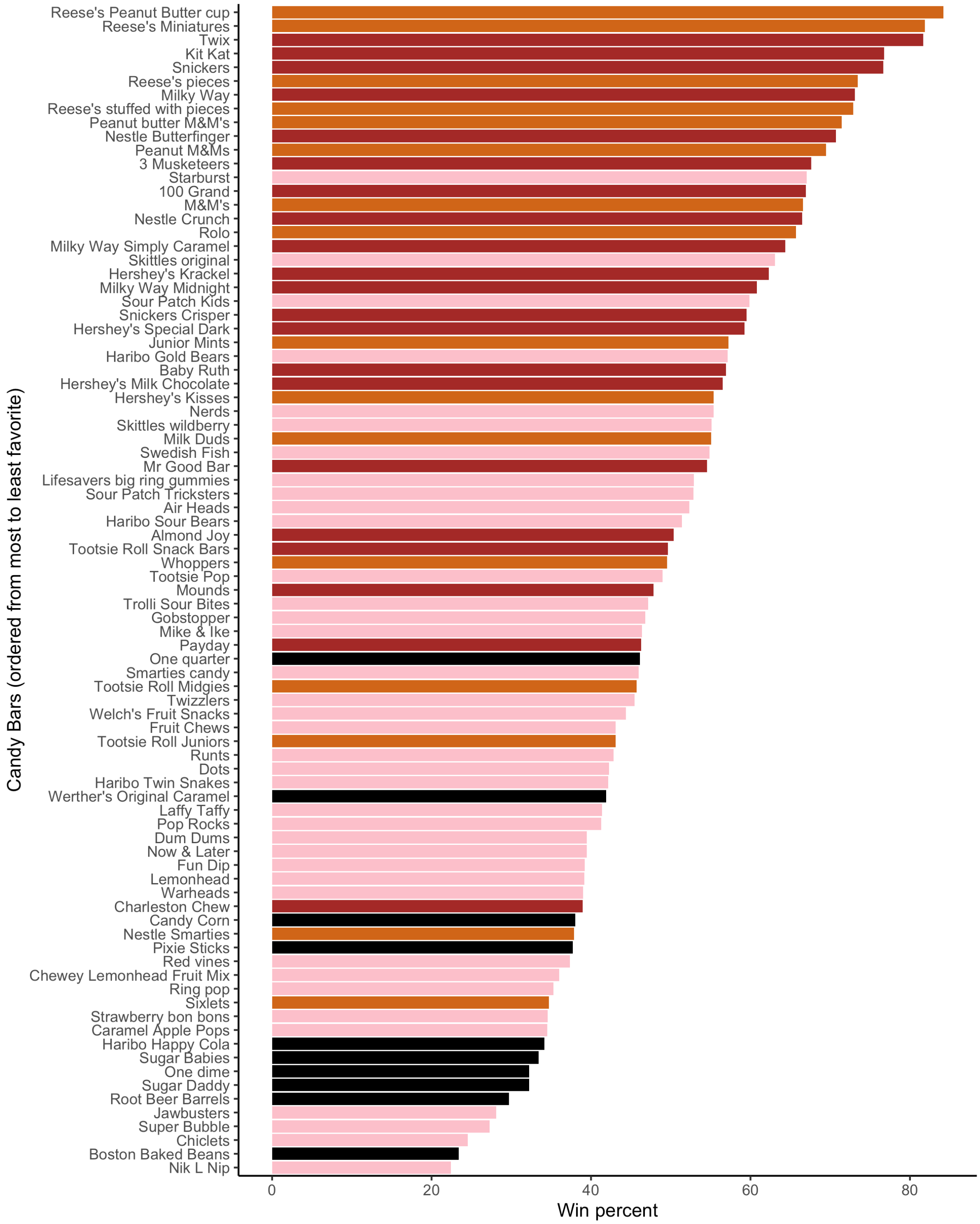
Make a bar plot and order it by winpercent values

```r
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col(fill = my_cols) +
  theme_classic() +
  labs(x = "Win percent", y = "Candy Bars (ordered from most to least favorite)")
```




```
ggsave("mybarplot.png", width = 8, height = 10)
```

Inserting plot png



Q17. What is the worst ranked chocolate candy?

The worst ranked chocolate candy is **Sixlets**.

Q18. What is the best ranked fruity candy?

The best ranked fruity candy is **Starburst**.

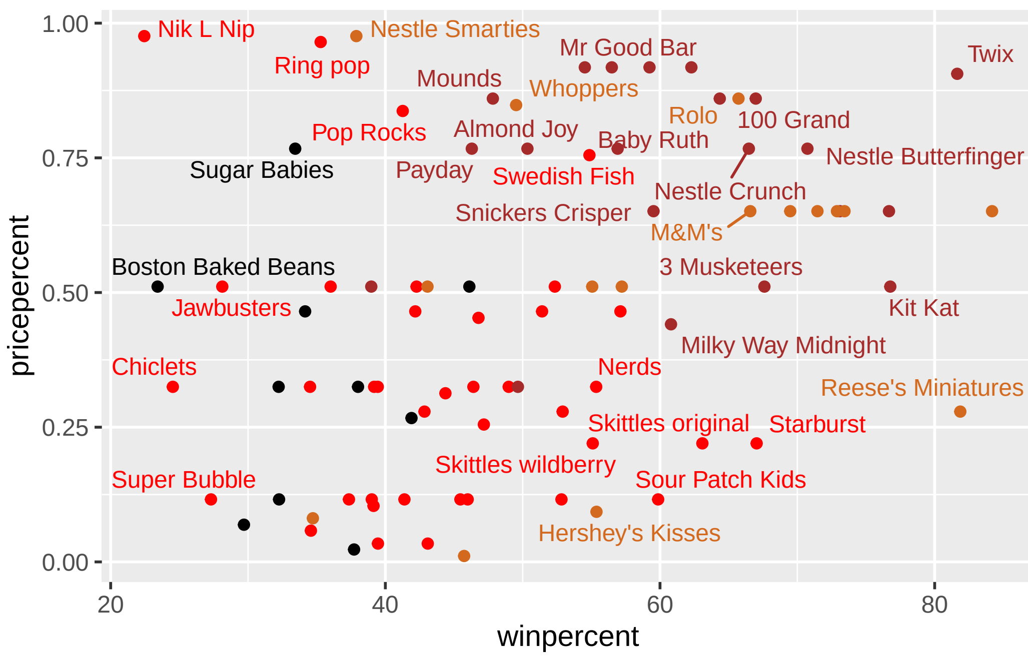
Winpercent vs Pricepercent

```
#pink is too light, lets change to red
my_cols=rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] = "chocolate"
my_cols[as.logical(candy$bar)] = "brown"
my_cols[as.logical(candy$fruity)] = "red"

library(ggrepel)

# How about a plot of price vs win
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=3.3, max.overlaps = 8)
```

```
Warning: ggrepel: 52 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Q19. Which candy type is the highest ranked in terms of winpercent for the least money - i.e. offers the most bang for your buck?

```
inds <- order(candy$winpercent/candy$pricepercent)

head(candy[inds,], 5)
```

```
                   chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                  0      1       0              0      0
Ring pop                   0      1       0              0      0
Nestle Smarties            1      0       0              0      0
Sugar Babies               0      0       1              0      0
Boston Baked Beans         0      0       0              1      0
                   crispedricewafer hard bar pluribus sugarpercent pricepercent
Nik L Nip                         0    0   0        1        0.197        0.976
Ring pop                          0    1   0        0        0.732        0.965
Nestle Smarties                   0    0   0        1        0.267        0.976
Sugar Babies                      0    0   0        1        0.965        0.767
Boston Baked Beans                0    0   0        1        0.313        0.511
                   winpercent
Nik L Nip            22.44534
Ring pop             35.29076
```

```
Nestle Smarties       37.88719
Sugar Babies          33.43755
Boston Baked Beans    23.41782
```

> Q20. What are the top 5 most expensive candy types in the dataset and of these which is the least popular?

Top 5 most expensive candies are **Nik L Nip**, **Nestle Smarties**, **Ring Pop**, **Hershey's Krackel** and **Hershey's Milk Chocolate**. Of these five, **Nik L Nip** is also the least popular.

```r
inds <- order(candy$pricepercent, decreasing = T)

head(candy[inds,], 5)
```

```
                         chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                        0      1       0              0      0
Nestle Smarties                  1      0       0              0      0
Ring pop                         0      1       0              0      0
Hershey's Krackel                1      0       0              0      0
Hershey's Milk Chocolate         1      0       0              0      0
                         crispedricewafer hard bar pluribus sugarpercent
Nik L Nip                               0    0   0        1        0.197
Nestle Smarties                         0    0   0        1        0.267
Ring pop                                0    1   0        0        0.732
Hershey's Krackel                       1    0   1        0        0.430
Hershey's Milk Chocolate                0    0   1        0        0.430
                         pricepercent winpercent
Nik L Nip                       0.976   22.44534
Nestle Smarties                 0.976   37.88719
Ring pop                        0.965   35.29076
Hershey's Krackel               0.918   62.28448
Hershey's Milk Chocolate        0.918   56.49050
```

Exploring the Correlation Structure

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

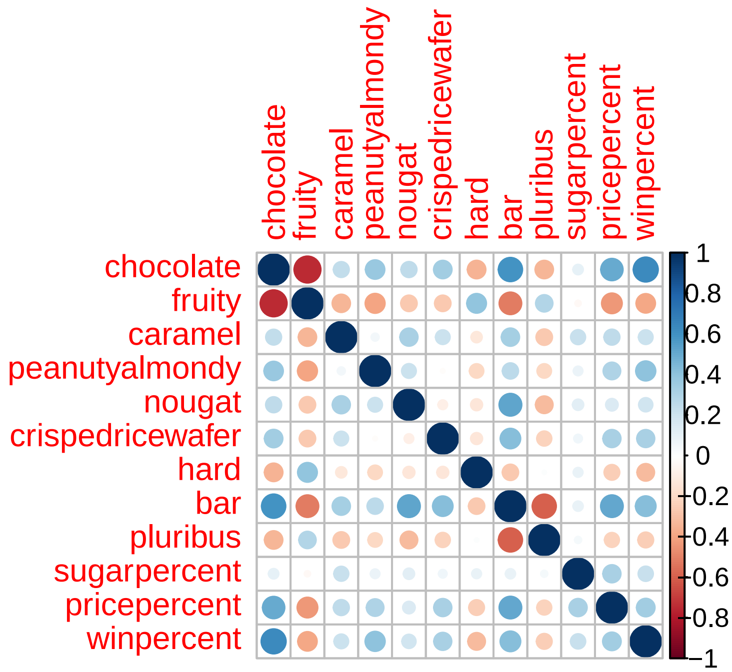
```
                  chocolate      fruity     caramel peanutyalmondy      nougat
```

```
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
```

```r
library(corrplot)
```

```
corrplot 0.95 loaded
```

```r
corrplot(cij)
```



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

Chocolate and Fruity have the strongest anti correlation(negatively correlated) with a correlation of -0.74.

```r
round(cij["chocolate", "fruity"],2)
```

```
[1] -0.74
```

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

Chocolate and bar are the two variables most positively correlated with a correlation value of 0.6.

```r
round(cij["chocolate", "bar"], 2)
```

```
[1] 0.6
```

Principal Component Analysis (PCA)

We need to be sure to scale our input `candy` data before PCA as we have the `winpercent` column on a different scale to all others in the data.

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

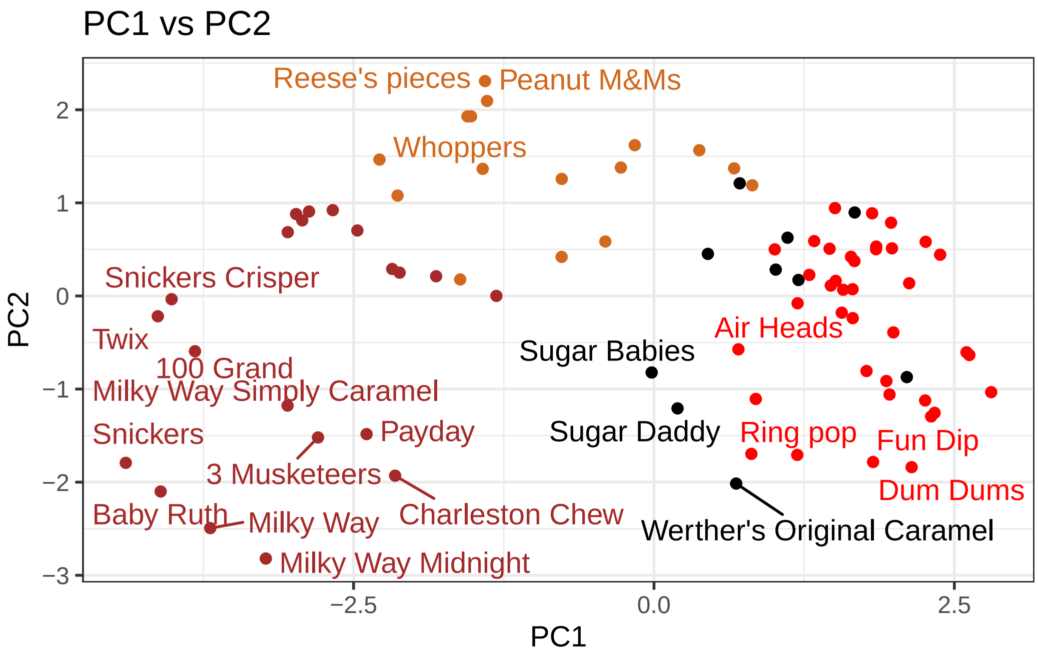
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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
```

PCA plot

First main result figure is my "PCA plot"

```
ggplot(pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col = my_cols) +
  geom_text_repel(max.overlaps = 7, col = my_cols) +
  theme_bw() +
  labs(title = "PC1 vs PC2")
```

```
Warning: ggrepel: 64 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

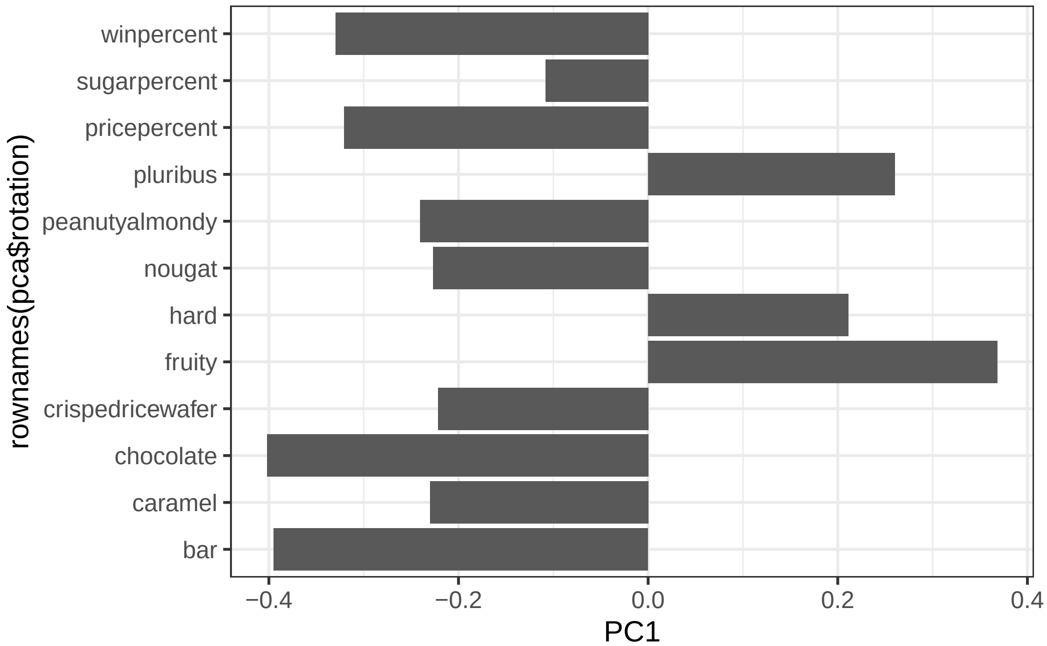


Loadings plot

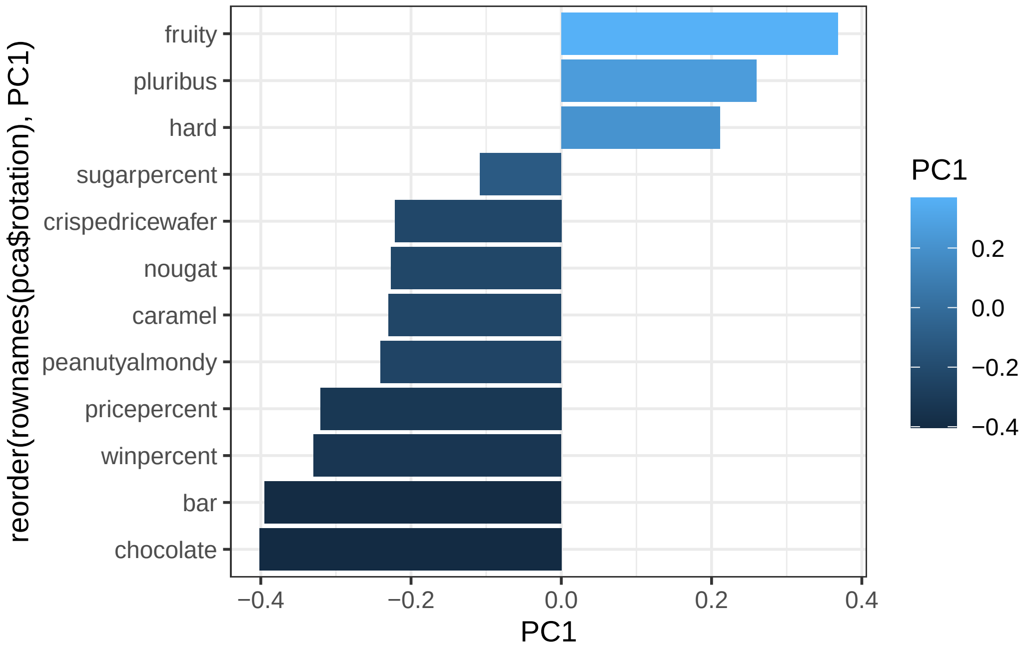
The second main PCA result is in the `pca$rotation` we can plot this to generate a so called "loadings" plot.

```
#pca$rotation

ggplot(pca$rotation) +
  aes(PC1, rownames(pca$rotation)) +
  geom_col() +
  theme_bw()
```




```
ggplot(pca$rotation) +
  aes(PC1, reorder(rownames(pca$rotation), PC1), fill = PC1) +
  geom_col() +
  theme_bw()
```



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

The original variables strongly picked up by PC1 in the positive direction are fruity, pluribus and hard, yes these variables make sense as they are contrasting the chocolate side which lines up with the other plots. The PC1 plot is separating the the fruity/hard candies from the chocolate ones, drawing a line down the middle.