Class 9: Candy Analysis Mini Project

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Import Data

```
candy_file <- "https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-r
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
```

Data Exploration

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

There are 85 in the data set.

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

There are 38 fruity candy types in this dataset.

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

I love peanut butter M&Ms :) It's winpercent value is 71.46505

```r
candy["Peanut butter M&M's",]$winpercent
```

```
[1] 71.46505
```

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

The winpercent value for "Kit Kat" is 76.7686

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

The winpercent value for "Tootsie Roll Snack Bars" is 49.653503

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

Winpercent is on a different scale compared to the other columns in the dataset - will need to scale it when doing PCA.

```r
library(skimr)
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	

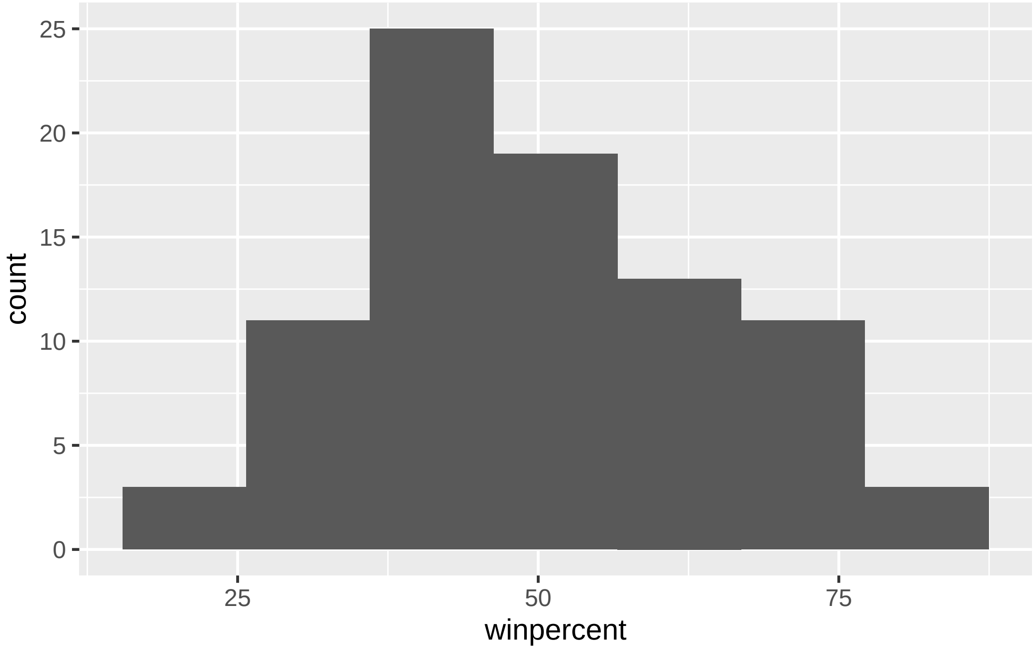
skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
nougat	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
crispedricewafer	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
hard	0	1	0.18	0.38	0.00	0.00	0.00	0.00	1.00	
bar	0	1	0.25	0.43	0.00	0.00	0.00	0.00	1.00	
pluribus	0	1	0.52	0.50	0.00	0.00	1.00	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	

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

0 means that the candy doesn't contain chocolate, a 1 represents that the candy has chocolate.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)
ggplot(candy, aes(winpercent)) + geom_histogram(bins = 7)
```



Q9. Is the distribution of winpercent values symmetrical?

No, it appears to be skewed where most of the values are lower than 50%.

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

It is below 50%.

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

```
chocolate_avg <- mean(candy$winpercent[as.logical(candy$chocolate)])

fruit_avg <- mean(candy$winpercent[as.logical(candy$fruity)])
```

The average winpercents for chocolate and fruit are 60.9215294 and 44.1197414, respectively. Chocolate candy, on average, is ranked higher than fruit candy.

Q12. Is this difference statistically significant?

```
t.test(candy$winpercent[as.logical(candy$chocolate)],candy$winpercent[as.logical(candy$fru
```

```

	Welch Two Sample t-test

data:  candy$winpercent[as.logical(candy$chocolate)] and candy$winpercent[as.logical(candy$f
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 
```

The p-value is <0.05. Therefore, the difference is statistically significant. super slay

Overall Candy Rankings

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

```
library(dplyr)
```

```

Attaching package: 'dplyr'
```

```
The following objects are masked from 'package:stats':

    filter, lag


The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```r
candy %>% arrange(winpercent) %>% head(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
```

Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters are the least liked candy types in this set.

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

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

```r
candy %>% arrange(desc(winpercent)) %>% head(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
```

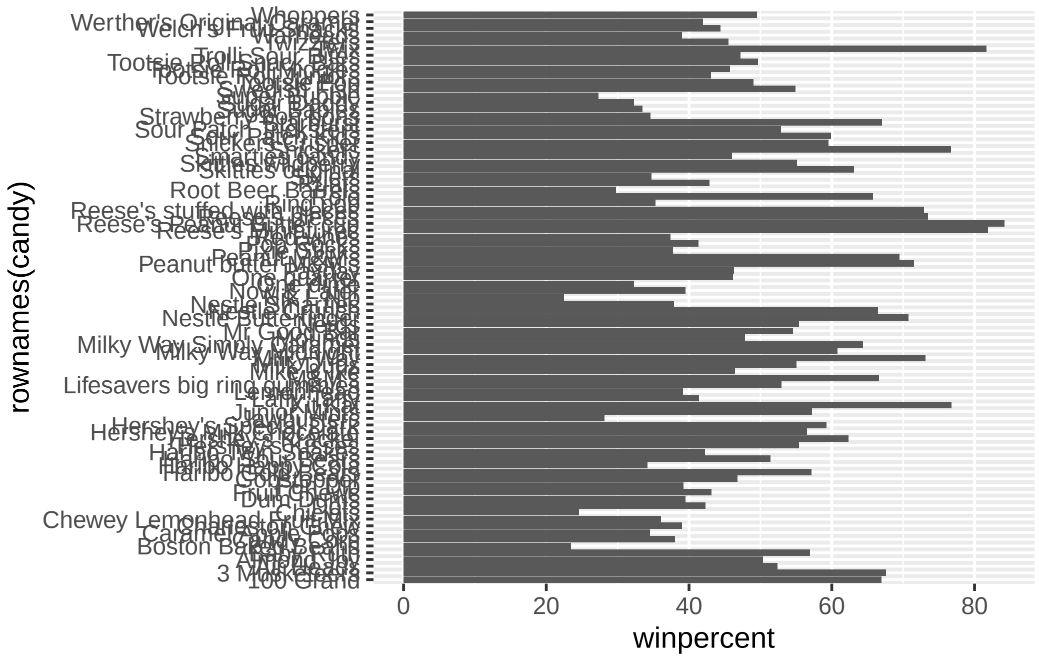
```
#OR

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
```

Reese’s Peanut Butter cup, Reese’s Miniatures, Twix, Kit Kat, and Snickers are the top 5 all time favorite candy types.

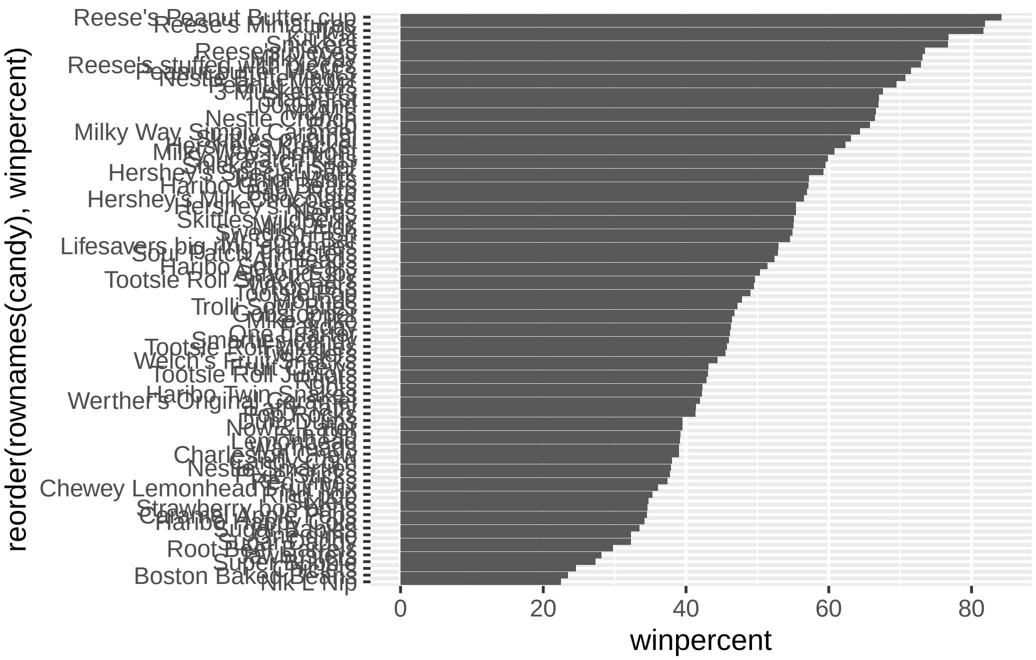
> Q15. Make a first barplot of candy ranking based on winpercent values.

```
ggplot(candy) + aes(x = winpercent, y= rownames(candy)) + geom_col()
```



> Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```
# use | to set parameters for figure

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

ggplot(candy) + aes(x = winpercent, y= reorder(rownames(candy),winpercent)) + geom_col()
```

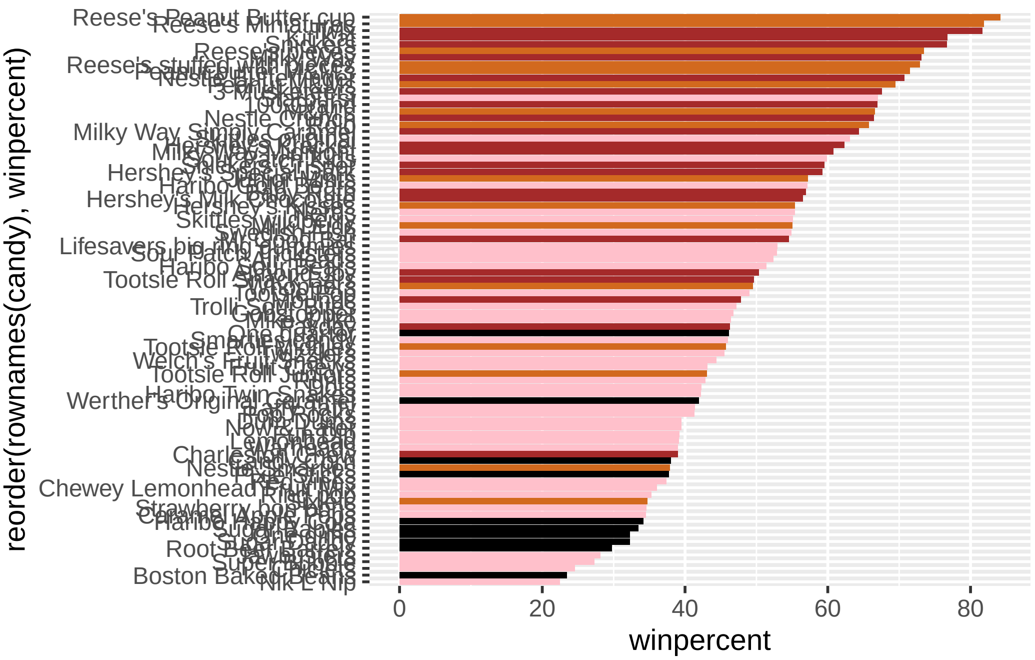


```r
ggsave("myplot.png", height = 10)
```

```
Saving 5.5 x 10 in image
```

Make Color Plot :)))

```r
# Create color vector - start out with black for each color
my_cols=rep("black", nrow(candy))
# overwrite colors per type of candy
my_cols[candy$chocolate == 1] = "chocolate"
my_cols[candy$bar == 1] = "brown"
my_cols[candy$fruit == 1] = "pink"

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



Q17. What is the worst ranked chocolate candy?

Sixlets

Q18. What is the best ranked fruity candy?

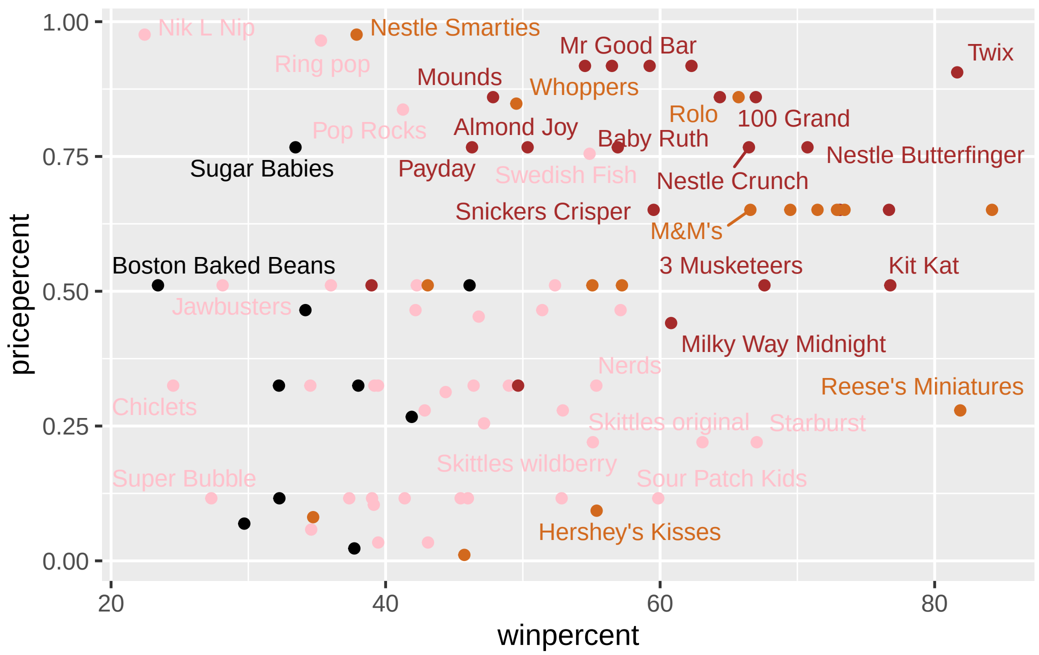
Starbursts

Price vs Percent Plot

Since there are so many labels, we will use ggrepel

```r
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, max.overlaps = 8)
```

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



Exploring the Correlation Structure

```
library(corrplot)
```

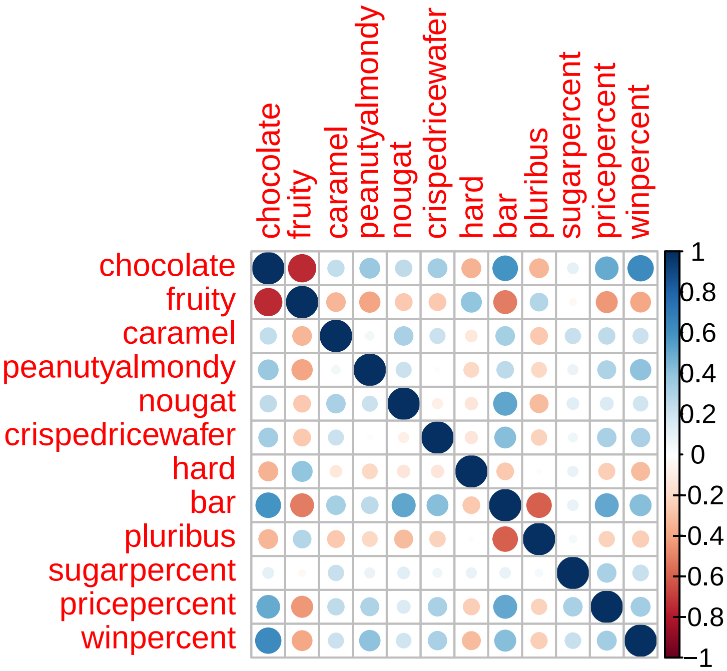
```
corrplot 0.92 loaded
```

```
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)?

Fruity and chocolate are anti-correlated.

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

Chocolate and win percentage/bar are most positively correlated.

Principal Component Analysis

We will perform a PCA of the candy. Key-question: do we need to scale the data before PCA? (do they all lie at the same range)

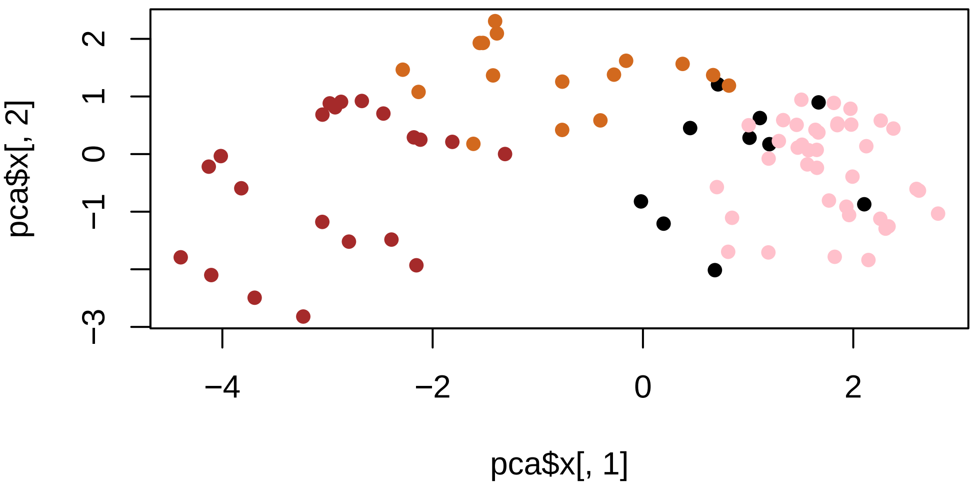
We need to scale it because one of the values is on a different order of magnitude.

```
pca <-prcomp(candy, scale = TRUE)
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
```

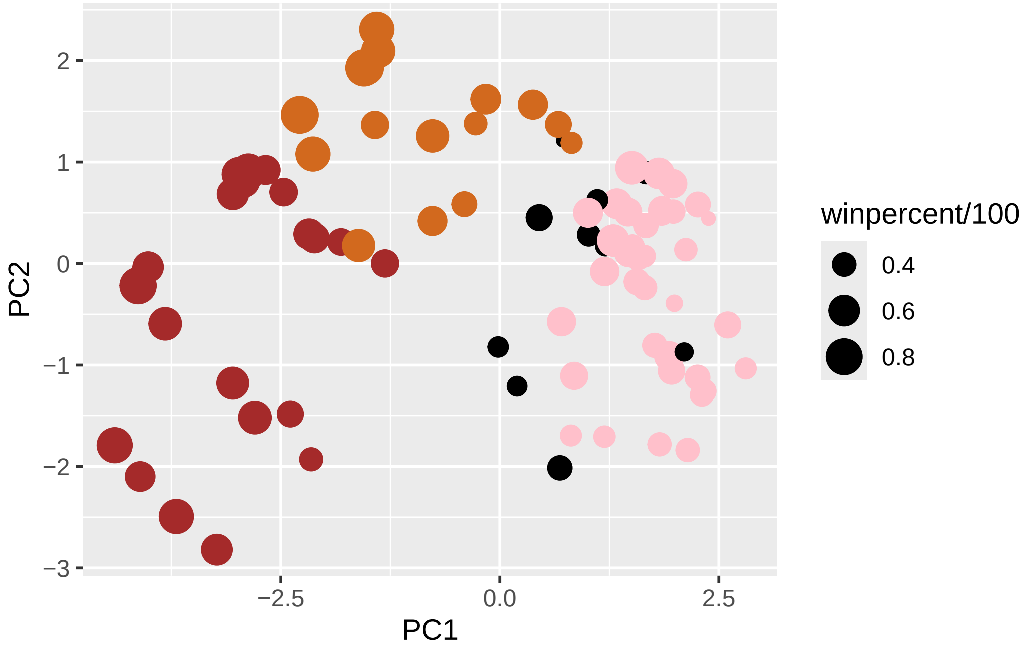
```
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 0.7424 0.79830 0.85369
                           PC8     PC9    PC10    PC11    PC12
Standard deviation     0.74530 0.67824 0.62349 0.43974 0.39760
Proportion of Variance 0.04629 0.03833 0.03239 0.01611 0.01317
Cumulative Proportion  0.89998 0.93832 0.97071 0.98683 1.00000
```

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



Making a ggplot:

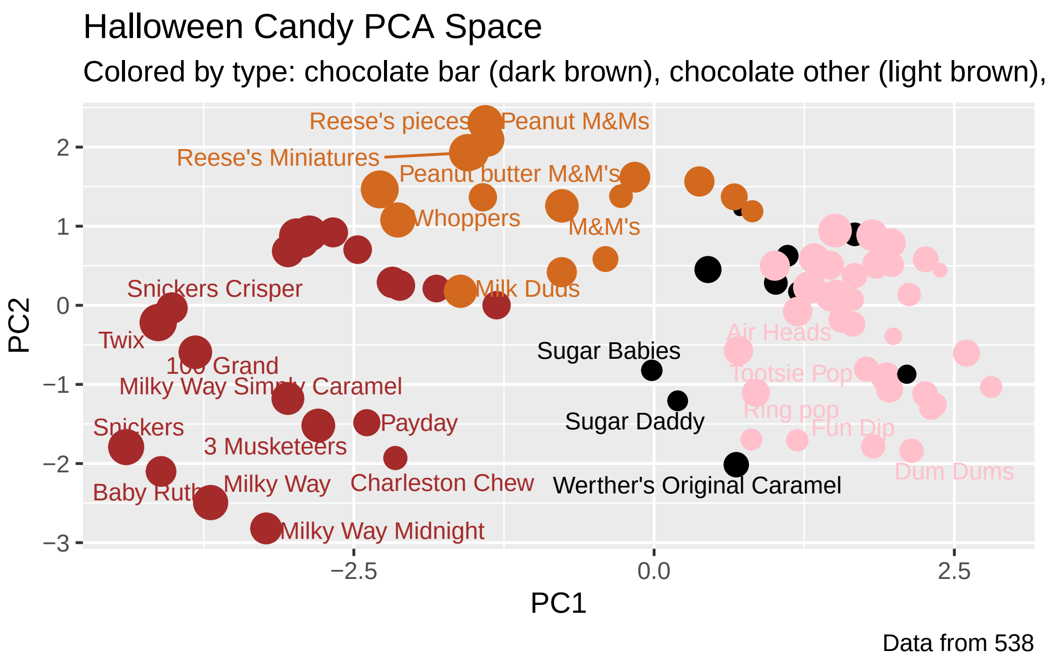
```
# Make a new data-frame with our PCA results and candy datea
my_data <- cbind(candy, pca$x[,1:3])

p <- ggplot(my_data) + aes(PC1, PC2, label = rownames(my_data), size = winpercent/100) + g

p
```



Making the plot nicer :)

```
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
       caption="Data from 538")
```

```
Warning: ggrepel: 59 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Halloween Candy PCA Space

Colored by type: chocolate bar (dark brown), chocolate other (light brown),

Data from 538

```r
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
```

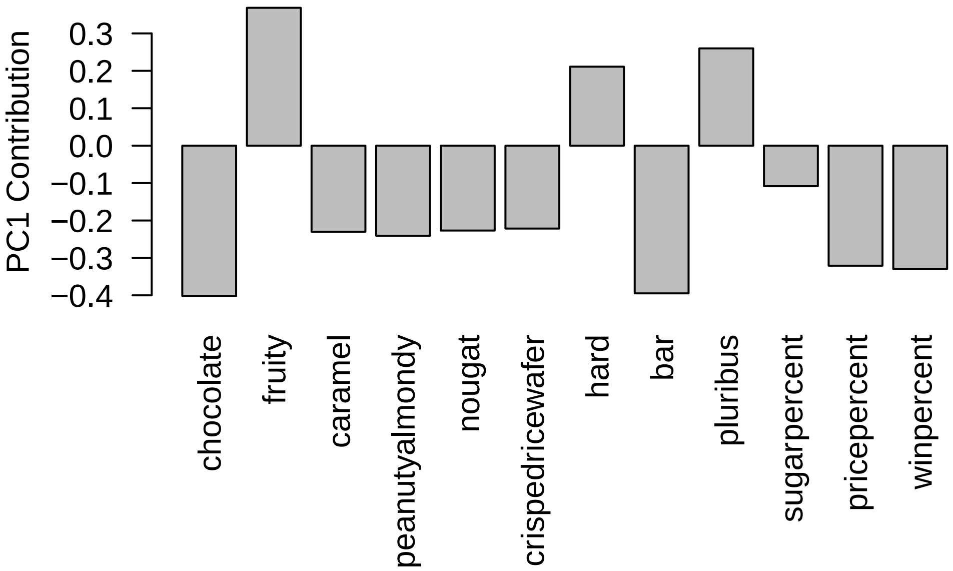
```r
# ggplotly(p)
```

How do the original variables contribute to our PCs? For this we will look at the loadings component of our results object, i.e. the `pca$rotation` object and look at PC1.

```r
head(pca$rotation)
```

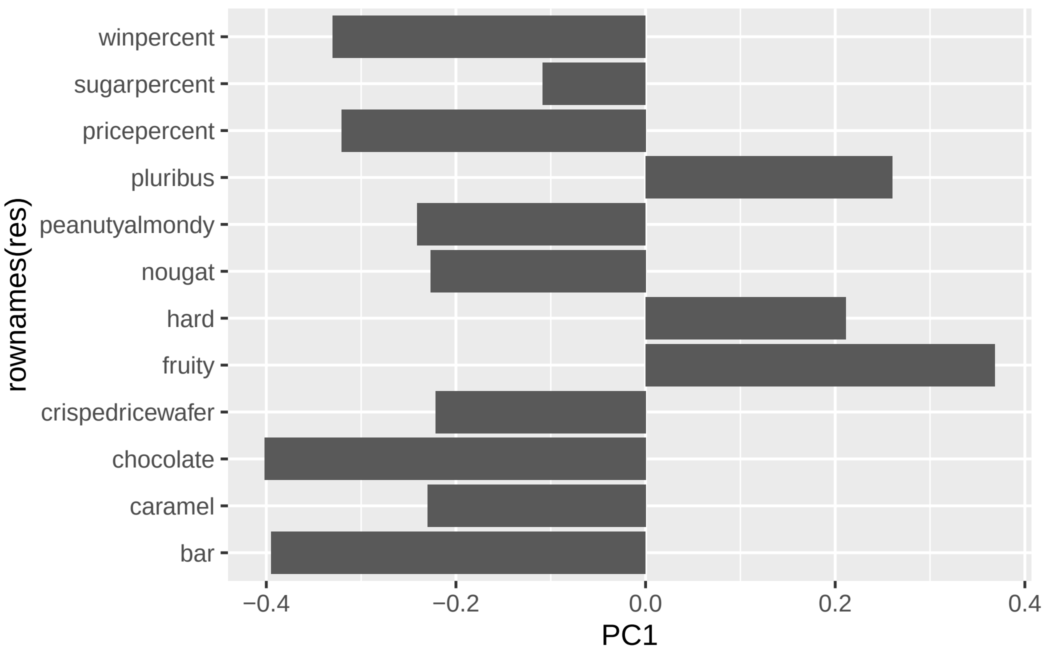
```
                        PC1         PC2         PC3          PC4         PC5
chocolate        -0.4019466  0.21404160  0.01601358 -0.016673032  0.06603585
fruity            0.3683883 -0.18304666 -0.13765612 -0.004479829  0.14353533
caramel          -0.2299709 -0.40349894 -0.13294166 -0.024889542 -0.50730150
peanutyalmondy   -0.2407155  0.22446919  0.18272802  0.466784287  0.39993025
nougat           -0.2268102 -0.47016599  0.33970244  0.299581403 -0.18885242
crispedricewafer -0.2215182  0.09719527 -0.36485542 -0.605594730  0.03465232
                         PC6         PC7        PC8          PC9        PC10
chocolate        -0.09018950 -0.08360642 -0.4908486 -0.151651568  0.10766136
fruity           -0.04266105  0.46147889  0.3980580 -0.001248306  0.36206250
caramel          -0.40346502 -0.44274741  0.2696345  0.019186442  0.22979901
peanutyalmondy   -0.09416259 -0.25710489  0.4577145  0.381068550 -0.14591236
nougat            0.09012643  0.36663902 -0.1879396  0.385278987  0.01132345
crispedricewafer -0.09007640  0.13077042  0.1356774  0.511634999 -0.26481014
                       PC11       PC12
chocolate         0.1004528 0.69784924
fruity            0.1749490 0.50624242
caramel           0.1351582 0.07548984
peanutyalmondy    0.1124428 0.12972756
nougat           -0.3895447 0.09223698
crispedricewafer -0.2261562 0.11727369
```

```r
par(mar=c(8,4,2,2))
barplot(pca$rotation[,1], las=2, ylab="PC1 Contribution")
```



Let's make a barplot with ggplot and order the bars by their value. We will need to create a data.frame as input for ggplot.

```
res <- pca$rotation
ggplot(res) +
  aes(y = rownames(res),x= PC1) + geom_col()
```



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

Fruity candies, pluribus, and hard are picked up strongly by PC1 in the positive direction and these make sense based on the correlation structure in the data set. If you are a fruity candy, you will tend to be hard and come in a pack with multiple candies in it.