Class 09: Halloween Candy Mini Project

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Today is Halloween! We will apply lots of the analysis methods and R graphics approaches to find out all about typical Halloween candy.

```
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
```

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

```
dim(candy)
```

```
[1] 85 12
```

There are 85 different candy types in this dataset.

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

```r
sum(candy["fruity"])
```

```
[1] 38
```

```r
# or, sum(candy$fruity)
```

There are 38 fruity candy types.

I can convert the 1 and 0 values to be TRUE or FALSE and use that to extract the tpe of candy I want. For example:

```r
candy[as.logical(candy$chocolate),]
```

```
                            chocolate fruity caramel peanutyalmondy nougat
100 Grand                           1      0       1              0      0
3 Musketeers                        1      0       0              0      1
Almond Joy                          1      0       0              1      0
Baby Ruth                           1      0       1              1      1
Charleston Chew                     1      0       0              0      1
Hershey's Kisses                    1      0       0              0      0
Hershey's Krackel                   1      0       0              0      0
Hershey's Milk Chocolate            1      0       0              0      0
Hershey's Special Dark              1      0       0              0      0
Junior Mints                        1      0       0              0      0
Kit Kat                             1      0       0              0      0
Peanut butter M&M's                 1      0       0              1      0
M&M's                               1      0       0              0      0
Milk Duds                           1      0       1              0      0
Milky Way                           1      0       1              0      1
Milky Way Midnight                  1      0       1              0      1
Milky Way Simply Caramel            1      0       1              0      0
Mounds                              1      0       0              0      0
Mr Good Bar                         1      0       0              1      0
Nestle Butterfinger                 1      0       0              1      0
Nestle Crunch                       1      0       0              0      0
Peanut M&Ms                         1      0       0              1      0
Reese's Miniatures                  1      0       0              1      0
```

```
Reese's Peanut Butter cup           1      0       0              1      0
Reese's pieces                      1      0       0              1      0
Reese's stuffed with pieces         1      0       0              1      0
Rolo                                1      0       1              0      0
Sixlets                             1      0       0              0      0
Nestle Smarties                     1      0       0              0      0
Snickers                            1      0       1              1      1
Snickers Crisper                    1      0       1              1      0
Tootsie Pop                         1      1       0              0      0
Tootsie Roll Juniors                1      0       0              0      0
Tootsie Roll Midgies                1      0       0              0      0
Tootsie Roll Snack Bars             1      0       0              0      0
Twix                                1      0       1              0      0
Whoppers                            1      0       0              0      0
                            crispedricewafer hard bar pluribus sugarpercent
100 Grand                                  1    0   1        0        0.732
3 Musketeers                               0    0   1        0        0.604
Almond Joy                                 0    0   1        0        0.465
Baby Ruth                                  0    0   1        0        0.604
Charleston Chew                            0    0   1        0        0.604
Hershey's Kisses                           0    0   0        1        0.127
Hershey's Krackel                          1    0   1        0        0.430
Hershey's Milk Chocolate                   0    0   1        0        0.430
Hershey's Special Dark                     0    0   1        0        0.430
Junior Mints                               0    0   0        1        0.197
Kit Kat                                    1    0   1        0        0.313
Peanut butter M&M's                        0    0   0        1        0.825
M&M's                                      0    0   0        1        0.825
Milk Duds                                  0    0   0        1        0.302
Milky Way                                  0    0   1        0        0.604
Milky Way Midnight                         0    0   1        0        0.732
Milky Way Simply Caramel                   0    0   1        0        0.965
Mounds                                     0    0   1        0        0.313
Mr Good Bar                                0    0   1        0        0.313
Nestle Butterfinger                        0    0   1        0        0.604
Nestle Crunch                              1    0   1        0        0.313
Peanut M&Ms                                0    0   0        1        0.593
Reese's Miniatures                         0    0   0        0        0.034
Reese's Peanut Butter cup                  0    0   0        0        0.720
Reese's pieces                             0    0   0        1        0.406
Reese's stuffed with pieces                0    0   0        0        0.988
Rolo                                       0    0   0        1        0.860
Sixlets                                    0    0   0        1        0.220
```

```
Nestle Smarties                            0    0   0        1        0.267
Snickers                                   0    0   1        0        0.546
Snickers Crisper                           1    0   1        0        0.604
Tootsie Pop                                0    1   0        0        0.604
Tootsie Roll Juniors                       0    0   0        0        0.313
Tootsie Roll Midgies                       0    0   0        1        0.174
Tootsie Roll Snack Bars                    0    0   1        0        0.465
Twix                                       1    0   1        0        0.546
Whoppers                                   1    0   0        1        0.872
                            pricepercent winpercent
100 Grand                          0.860   66.97173
3 Musketeers                       0.511   67.60294
Almond Joy                         0.767   50.34755
Baby Ruth                          0.767   56.91455
Charleston Chew                    0.511   38.97504
Hershey's Kisses                   0.093   55.37545
Hershey's Krackel                  0.918   62.28448
Hershey's Milk Chocolate           0.918   56.49050
Hershey's Special Dark             0.918   59.23612
Junior Mints                       0.511   57.21925
Kit Kat                            0.511   76.76860
Peanut butter M&M's                0.651   71.46505
M&M's                              0.651   66.57458
Milk Duds                          0.511   55.06407
Milky Way                          0.651   73.09956
Milky Way Midnight                 0.441   60.80070
Milky Way Simply Caramel           0.860   64.35334
Mounds                             0.860   47.82975
Mr Good Bar                        0.918   54.52645
Nestle Butterfinger                0.767   70.73564
Nestle Crunch                      0.767   66.47068
Peanut M&Ms                        0.651   69.48379
Reese's Miniatures                 0.279   81.86626
Reese's Peanut Butter cup          0.651   84.18029
Reese's pieces                     0.651   73.43499
Reese's stuffed with pieces        0.651   72.88790
Rolo                               0.860   65.71629
Sixlets                            0.081   34.72200
Nestle Smarties                    0.976   37.88719
Snickers                           0.651   76.67378
Snickers Crisper                   0.651   59.52925
Tootsie Pop                        0.325   48.98265
Tootsie Roll Juniors               0.511   43.06890
Tootsie Roll Midgies                0.011   45.73675
Tootsie Roll Snack Bars             0.325   49.65350
Twix                                0.906   81.64291
Whoppers                            0.848   49.52411
```

2. What's your favorite candy

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

```
candy["Reese's Peanut Butter cup", ]$winpercent
```

```
[1] 84.18029
```

My favorite candy has a win percent of 84.18%.

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

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

```
[1] 76.7686
```

Kit Kat has a winpercent value of 76.77%.

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

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

```
[1] 49.6535
```

Tootsie Roll Snack Bars have a winpercent value of 49.65%.

The "skimr" package has a function that helps to give a quick overview of a given dataset.

```
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	

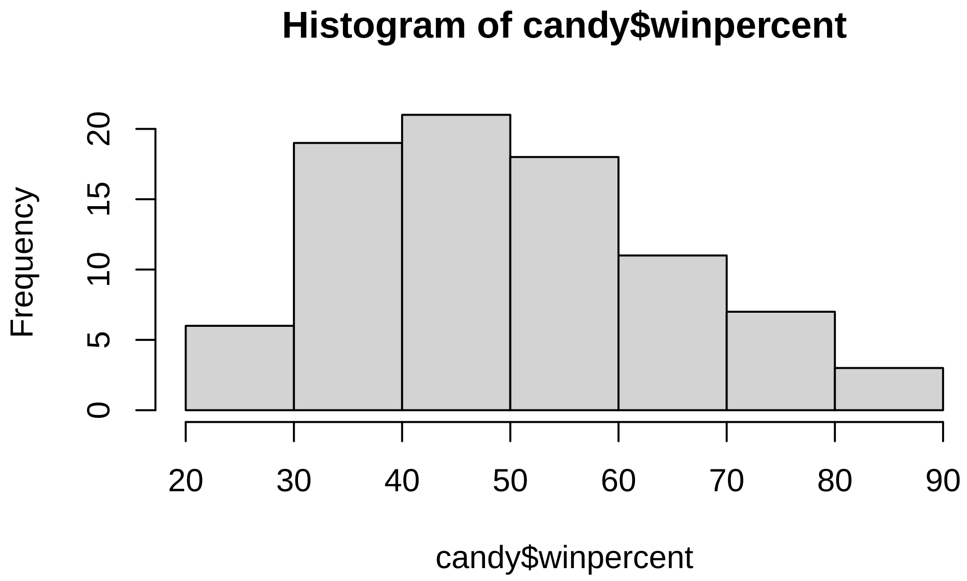
Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset? The winpercent variable looks to be on a different scale to the majority of the other columns.

Q7. What do you think a zero and one represent for the candy$chocolate column? A zero and one likely represents logicals for the candy types, determining whether it is TRUE or FALSE that the candy type is considered chocolate or not.

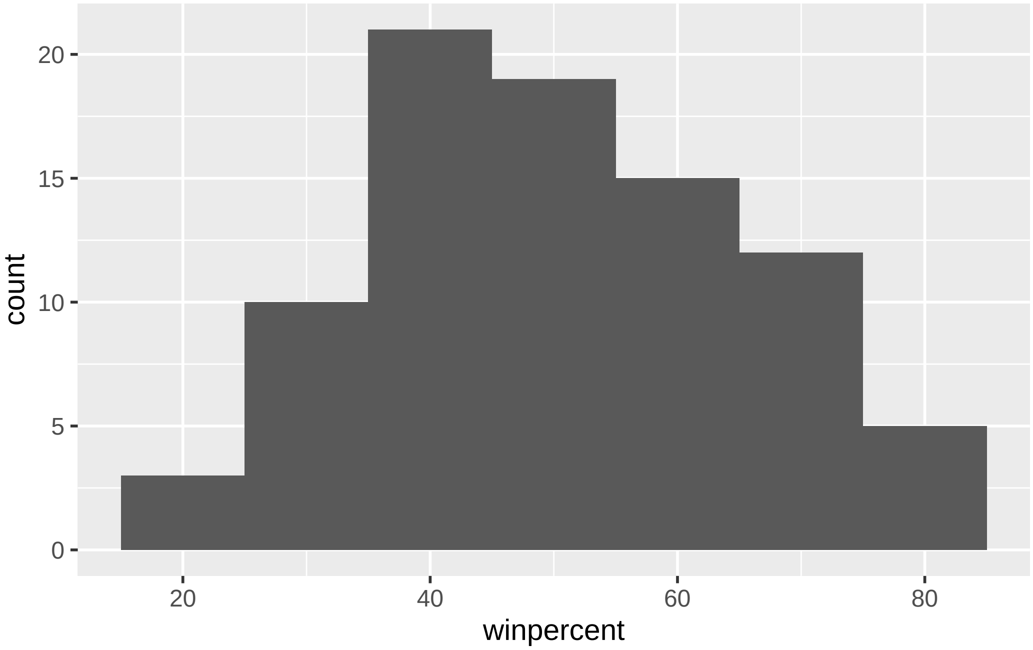
Q8. Plot a histogram of winpercent values

```
library(ggplot2)
```

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



```
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(binwidth=10)
```



Q9. Is the distribution of winpercent values symmetrical? No, they're not symmetrical.

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

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

```
choco.win <- candy$winpercent[as.logical(candy$chocolate)]
fruit.win <- candy$winpercent[as.logical(candy$fruity)]

mean(choco.win)
```

```
[1] 60.92153
```

```
mean(fruit.win)
```

```
[1] 44.11974
```

Another way to do this is:

```r
choc.inds <- as.logical(candy$chocolate)
choc.win <- candy[choc.inds, "winpercent"]
choc.win
```

```
 [1] 66.97173 67.60294 50.34755 56.91455 38.97504 55.37545 62.28448 56.49050
 [9] 59.23612 57.21925 76.76860 71.46505 66.57458 55.06407 73.09956 60.80070
[17] 64.35334 47.82975 54.52645 70.73564 66.47068 69.48379 81.86626 84.18029
[25] 73.43499 72.88790 65.71629 34.72200 37.88719 76.67378 59.52925 48.98265
[33] 43.06890 45.73675 49.65350 81.64291 49.52411
```

On average, chocolate candy is ranked higher than fruit candy.

Q12. Is this difference statistically significant?

```r
t.test(choco.win, fruit.win)
```

```


	Welch Two Sample t-test

data:  choco.win and fruit.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 
```

This difference is statistically significant as the two-sample t-test yielded a low p-value of 2.871e-08.

3. Overall Candy Rankings

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

```r
head(candy[order(candy$winpercent),], n=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
```

```r
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
```

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

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

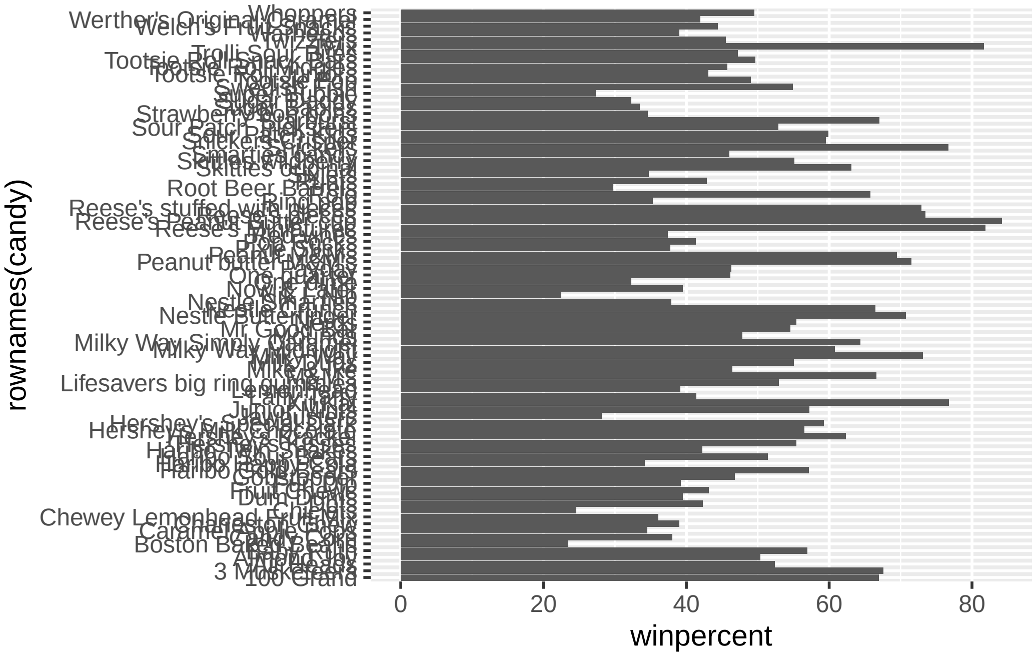
```
head(candy[order(candy$winpercent, decreasing=TRUE),], n=5)
```

```
                          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
```

The top 5 all time favorite candy types out of this set are Reese's Peanut Butter cup, Reese's Miniatures, Twix, Kit Kat, and Snickers.

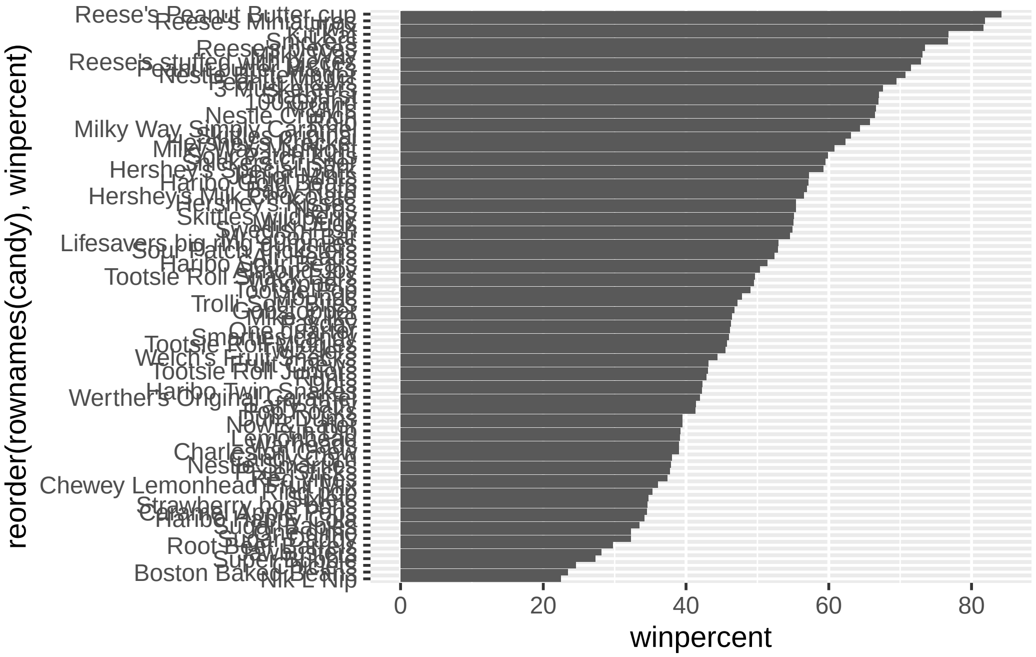
Q15. Make a first barplot of candy ranking based on winpercent values.

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



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

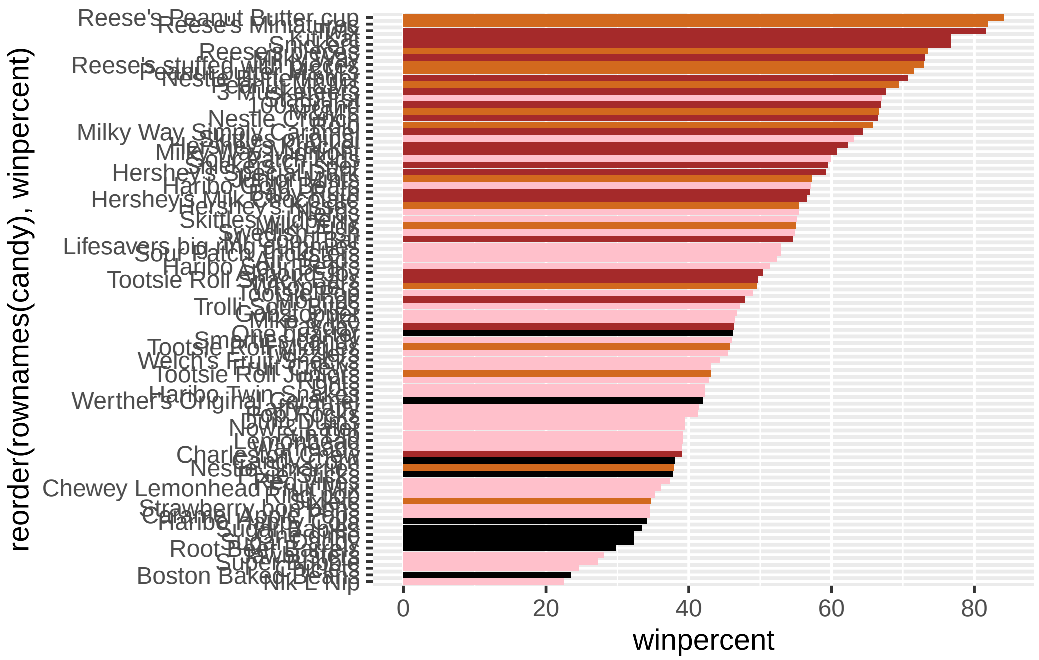
```r
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col()
```



Let's add a color vector to our plot.

```
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"
```

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



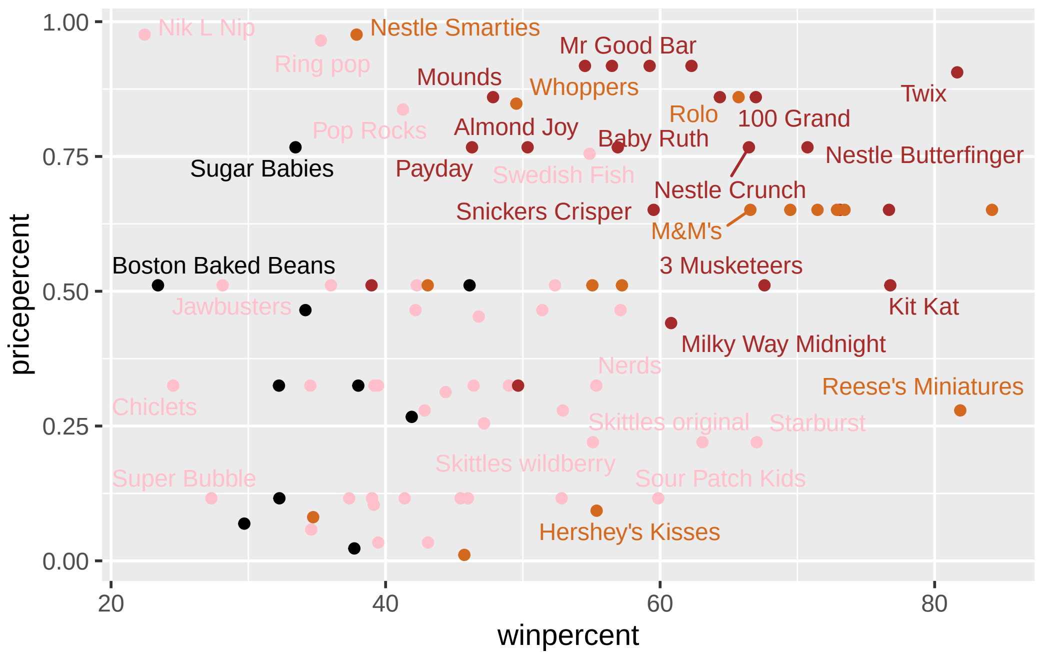
Q17. What is the worst ranked chocolate candy? The worst ranked chocolate candy is Sixlets.

Q18. What is the best ranked fruity candy? The best ranked fruity candy is Starburst.

4. Taking a look at pricepercent

```
library(ggrepel)

# Plot of price vs. winpercent
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
```



`geom_text_repel()` moves around the labels so that the text becomes more legible on the plot.

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? Reese's Miniatures is the candy type that is ranked the highest in terms of winpercent for the least money.

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

```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                         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
```

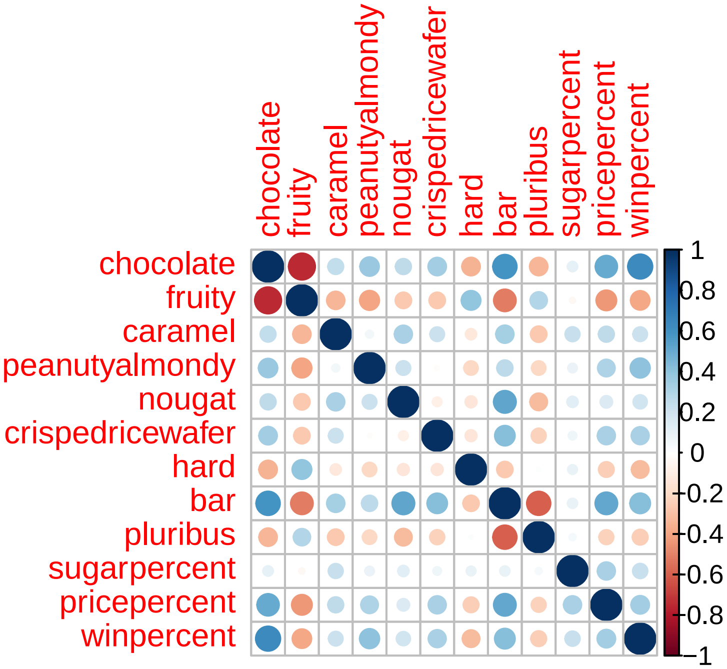
The top 5 most expensive candy types in the data set are Nik L Nip, Ring pop, Nestle Smarties, Hershey's Krackel, and Hershey's Milk Chocolare. Of these, Nik L Nip is the least popular.

5. Exploring Correlation Structure

```
library(corrplot)
```

```
corrplot 0.92 loaded
```

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



Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)? Chocolate and fruity candy types are anti-correlated. (They are negatively associated with each other.) This makes sense since you don't often see chocolatey fruity candies.

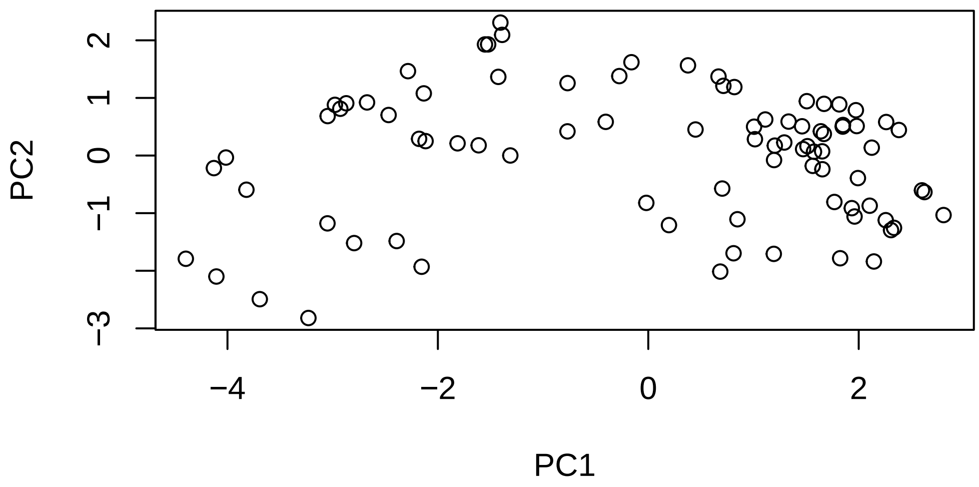
Q23. Similarly, what two variables are most positively correlated? Chocolate and bar candy types are the most positively correlated. This makes sense since chocolate candies come in a bar form.

6. Principal Component Analysis

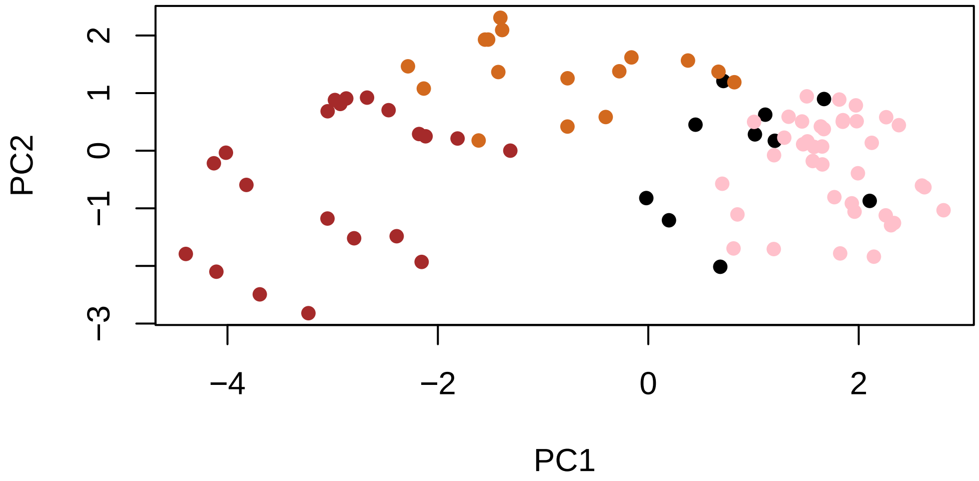
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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[,1:2])
```

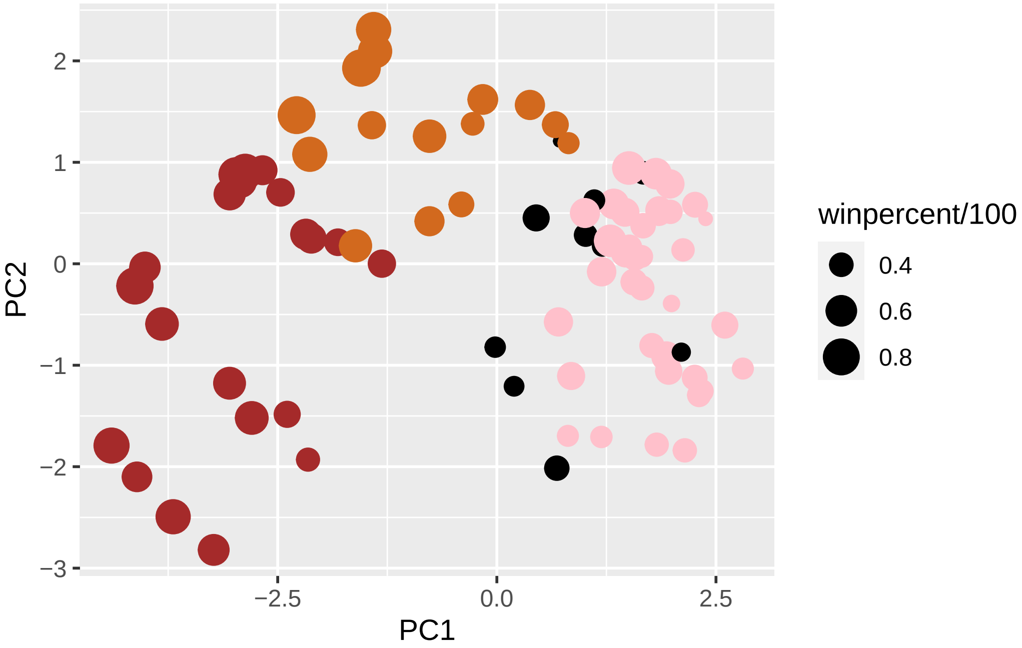


```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



Let's try to plot the same thing using ggplot2.

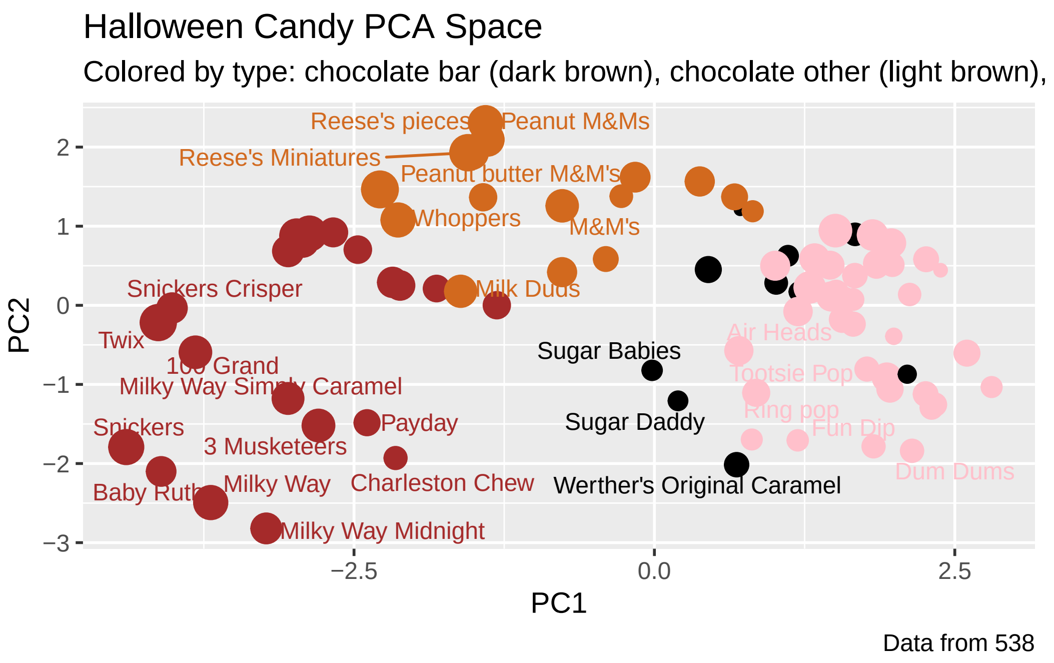
```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])

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
```



Let's add labels to this plot:

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

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



The max.overlaps argument can be changed to allow more overlapping labels.

Or, plotly can be used to create a more interactive plot that will show the data labels when it is moused over. *Note: This only works in HTML format*

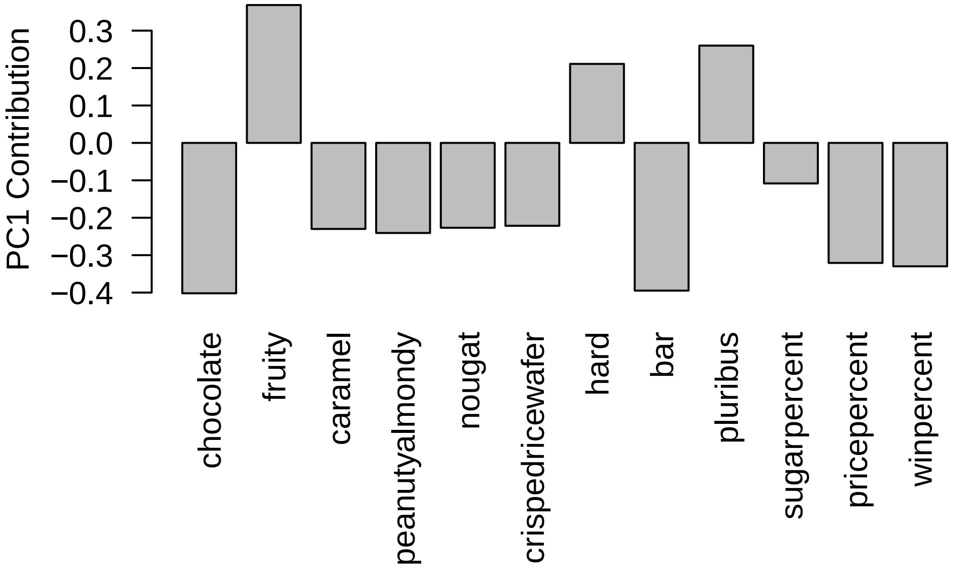
```
library(plotly)
```

```
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
```

The following interactive plot is commented out since it doesn't work in pdf format.

```
# ggplotly(p)
```

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



Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you? Fruity,hard, and pluribus candy types are picked up strongly by PC1 in the positive direction. This makes sense as they are commonly associated with each other. They are also anti-correlated with the other variables, like chocolate and bar.