Class 10: Halloween Project

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Importing Candy Data

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

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
```

```r
flextable::flextable(head(candy))
```

chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus
1	0	1	0	0	1	0	1	0
1	0	0	0	1	0	0	1	0

chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	s
0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	
0	1	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	0	

```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
```

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

There are 85 different candy types in this dataset.

```r
num_candy_types <- nrow(candy)
num_candy_types
```

```
[1] 85
```

> Q2. How many fruity candy types are in the dataset? The functions dim(), nrow(), table() and sum() may be useful for answering the first 2 questions.

There are 38 fruity candy types in this dataset.

```r
num_fruity_candies <- sum(candy$fruity)
num_fruity_candies
```

```
[1] 38
```

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

```
[1] 81.64291
```

What is your favorate candy?

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

The winpercent value for "Snickers" is 76.67%.

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

```
[1] 76.67378
```

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

The winpercent value for "Kit Kat" is 76.77%.

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

```
[1] 76.7686
```

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

The winpercent value for "Tootsie Roll Snack Bars" is 49.65%.

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

```
[1] 49.6535
```

```
library("skimr")
skim(candy)
```

Table 2: 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?

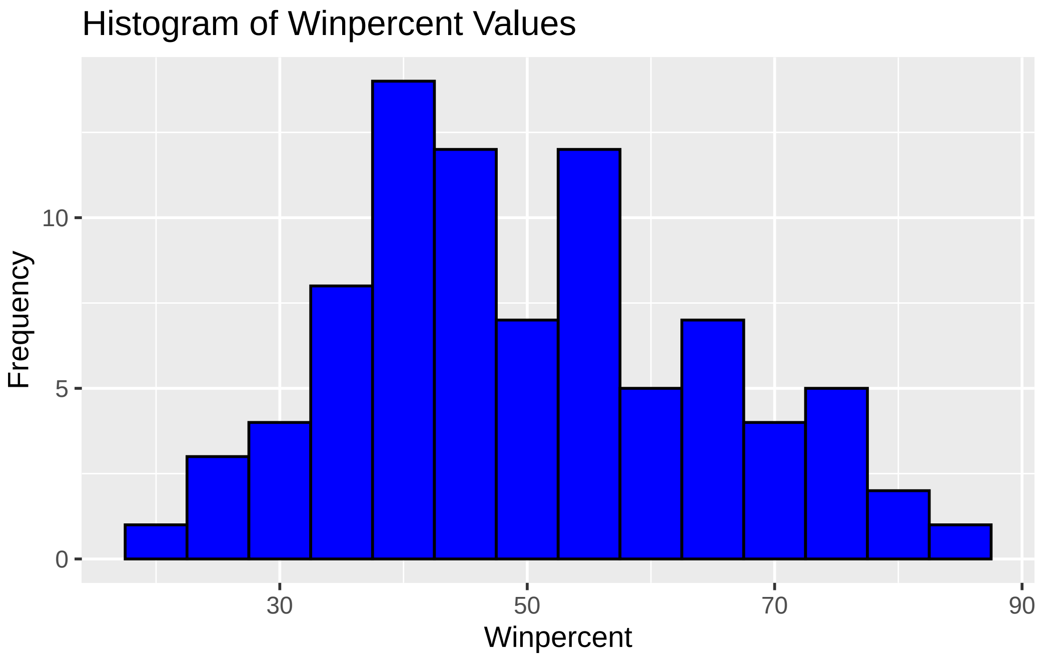
I think winpercent is different from other data becasue it is in percentage form while other columns are binary (0 or 1).

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

A zero represents that the candy does not contain chocolate, while a one indicates that the candy contains chocolate.

> Q8. Plot a histogram of winpercent values

```r
library(ggplot2)
ggplot(candy, aes(x = winpercent)) +
  geom_histogram(binwidth = 5, fill = "blue", color = "black") +
  labs(title = "Histogram of Winpercent Values", x = "Winpercent", y = "Frequency")
```



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent values is slightly right-skewed (> 0 → right-skewed), indicating that there are more candies with lower winpercent values compared to those with higher winpercent values.

```r
# install.packages("moments")  # run this once if not installed
library(moments)

# Calculate skewness
skewness_value <- skewness(candy$winpercent, na.rm = TRUE)
skewness_value
```

```
[1] 0.3264194
```

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

Median is actually 47.83%, but Mean is 50.32%. For a skewed graph, we use median, so the center of distribution is below 50%.

```r
mean_winpercent <- mean(candy$winpercent, na.rm = TRUE)
mean_winpercent
```

```
[1] 50.31676
```

```
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?

Chocolate candy has a higher average winpercent (60.92%) compared to fruity candy (44.12%).

```
avg_chocolate_winpercent <- mean(candy$winpercent[candy$chocolate == 1], na.rm = TRUE)
avg_fruity_winpercent <- mean(candy$winpercent[candy$fruity == 1], na.rm = TRUE)
avg_chocolate_winpercent
```

```
[1] 60.92153
```

```
avg_fruity_winpercent
```

```
[1] 44.11974
```

```
#Find all chocolate candy
choc.inds <- as.logical(candy$chocolate)
choc.candy <- candy[choc.inds,]
choc.candy
```

```
                            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
```

```
fruit.inds <- as.logical(candy$fruity)
fruit.candy <- candy[fruit.inds,]
fruit.candy
```

```
                            chocolate fruity caramel peanutyalmondy nougat
Air Heads                           0      1       0              0      0
Caramel Apple Pops                  0      1       1              0      0
Chewey Lemonhead Fruit Mix          0      1       0              0      0
Chiclets                            0      1       0              0      0
Dots                                0      1       0              0      0
Dum Dums                            0      1       0              0      0
Fruit Chews                         0      1       0              0      0
Fun Dip                             0      1       0              0      0
Gobstopper                          0      1       0              0      0
Haribo Gold Bears                   0      1       0              0      0
Haribo Sour Bears                   0      1       0              0      0
Haribo Twin Snakes                  0      1       0              0      0
Jawbusters                          0      1       0              0      0
Laffy Taffy                         0      1       0              0      0
Lemonhead                           0      1       0              0      0
Lifesavers big ring gummies         0      1       0              0      0
Mike & Ike                          0      1       0              0      0
Nerds                               0      1       0              0      0
Nik L Nip                           0      1       0              0      0
Now & Later                         0      1       0              0      0
Pop Rocks                           0      1       0              0      0
```

```
Red vines                           0      1       0              0      0
Ring pop                            0      1       0              0      0
Runts                               0      1       0              0      0
Skittles original                   0      1       0              0      0
Skittles wildberry                  0      1       0              0      0
Smarties candy                      0      1       0              0      0
Sour Patch Kids                     0      1       0              0      0
Sour Patch Tricksters               0      1       0              0      0
Starburst                           0      1       0              0      0
Strawberry bon bons                 0      1       0              0      0
Super Bubble                        0      1       0              0      0
Swedish Fish                        0      1       0              0      0
Tootsie Pop                         1      1       0              0      0
Trolli Sour Bites                   0      1       0              0      0
Twizzlers                           0      1       0              0      0
Warheads                            0      1       0              0      0
Welch's Fruit Snacks                0      1       0              0      0
                            crispedricewafer hard bar pluribus sugarpercent
Air Heads                                  0    0   0        0        0.906
Caramel Apple Pops                         0    0   0        0        0.604
Chewey Lemonhead Fruit Mix                 0    0   0        1        0.732
Chiclets                                   0    0   0        1        0.046
Dots                                       0    0   0        1        0.732
Dum Dums                                   0    1   0        0        0.732
Fruit Chews                                0    0   0        1        0.127
Fun Dip                                    0    1   0        0        0.732
Gobstopper                                 0    1   0        1        0.906
Haribo Gold Bears                          0    0   0        1        0.465
Haribo Sour Bears                          0    0   0        1        0.465
Haribo Twin Snakes                         0    0   0        1        0.465
Jawbusters                                 0    1   0        1        0.093
Laffy Taffy                                0    0   0        0        0.220
Lemonhead                                  0    1   0        0        0.046
Lifesavers big ring gummies                0    0   0        0        0.267
Mike & Ike                                 0    0   0        1        0.872
Nerds                                      0    1   0        1        0.848
Nik L Nip                                  0    0   0        1        0.197
Now & Later                                0    0   0        1        0.220
Pop Rocks                                  0    1   0        1        0.604
Red vines                                  0    0   0        1        0.581
Ring pop                                   0    1   0        0        0.732
Runts                                      0    1   0        1        0.872
Skittles original                          0    0   0        1        0.941
Skittles wildberry                         0    0   0        1        0.941
Smarties candy                             0    1   0        1        0.267
Sour Patch Kids                            0    0   0        1        0.069
Sour Patch Tricksters                      0    0   0        1        0.069
Starburst                                  0    0   0        1        0.151
Strawberry bon bons                        0    1   0        1        0.569
Super Bubble                               0    0   0        0        0.162
Swedish Fish                               0    0   0        1        0.604
Tootsie Pop                                0    1   0        0        0.604
Trolli Sour Bites                          0    0   0        1        0.313
Twizzlers                                  0    0   0        0        0.220
Warheads                                   0    1   0        0        0.093
Welch's Fruit Snacks                       0    0   0        1        0.313
                            pricepercent winpercent
Air Heads                          0.511   52.34146
Caramel Apple Pops                 0.325   34.51768
Chewey Lemonhead Fruit Mix         0.511   36.01763
Chiclets                           0.325   24.52499
Dots                               0.511   42.27208
Dum Dums                           0.034   39.46056
Fruit Chews                        0.034   43.08892
Fun Dip                            0.325   39.18550
Gobstopper                         0.453   46.78335
Haribo Gold Bears                  0.465   57.11974
Haribo Sour Bears                  0.465   51.41243
Haribo Twin Snakes                 0.465   42.17877
Jawbusters                         0.511   28.12744
Laffy Taffy                        0.116   41.38956
Lemonhead                          0.104   39.14106
Lifesavers big ring gummies        0.279   52.91139
Mike & Ike                         0.325   46.41172
Nerds                              0.325   55.35405
Nik L Nip                          0.976   22.44534
Now & Later                        0.325   39.44680
Pop Rocks                          0.837   41.26551
Red vines                          0.116   37.34852
Ring pop                           0.965   35.29076
Runts                              0.279   42.84914
Skittles original                  0.220   63.08514
Skittles wildberry                 0.220   55.10370
Smarties candy                     0.116   45.99583
Sour Patch Kids                    0.116   59.86400
Sour Patch Tricksters              0.116   52.82595
```

```
Starburst                          0.220   67.03763
Strawberry bon bons                0.058   34.57899
Super Bubble                       0.116   27.30386
Swedish Fish                       0.755   54.86111
Tootsie Pop                        0.325   48.98265
Trolli Sour Bites                  0.255   47.17323
Twizzlers                          0.116   45.46628
Warheads                           0.116   39.01190
Welch's Fruit Snacks               0.313   44.37552
```

```
#Extract their `winpercent` value
choc.win <- choc.candy$winpercent
fruit.win <- fruit.candy$winpercent
#Find the mean of these values
mean(choc.win)
```

```
[1] 60.92153
```

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

```
[1] 44.11974
```

> Q12. Is this difference statistically significant?

Yes, it is significant.

```
choc <- candy$winpercent[candy$chocolate == 1]
fruit <- candy$winpercent[candy$fruity == 1]

t.test(choc, fruit, alternative = "two.sided")
```

```

    Welch Two Sample t-test

data:  choc and fruit
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 
```

Overall Candy Rankings

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

Nik L Nip, Boston baked Beans, Chiclets, Super Bubble, and Jawbusters.

```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)

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
```

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

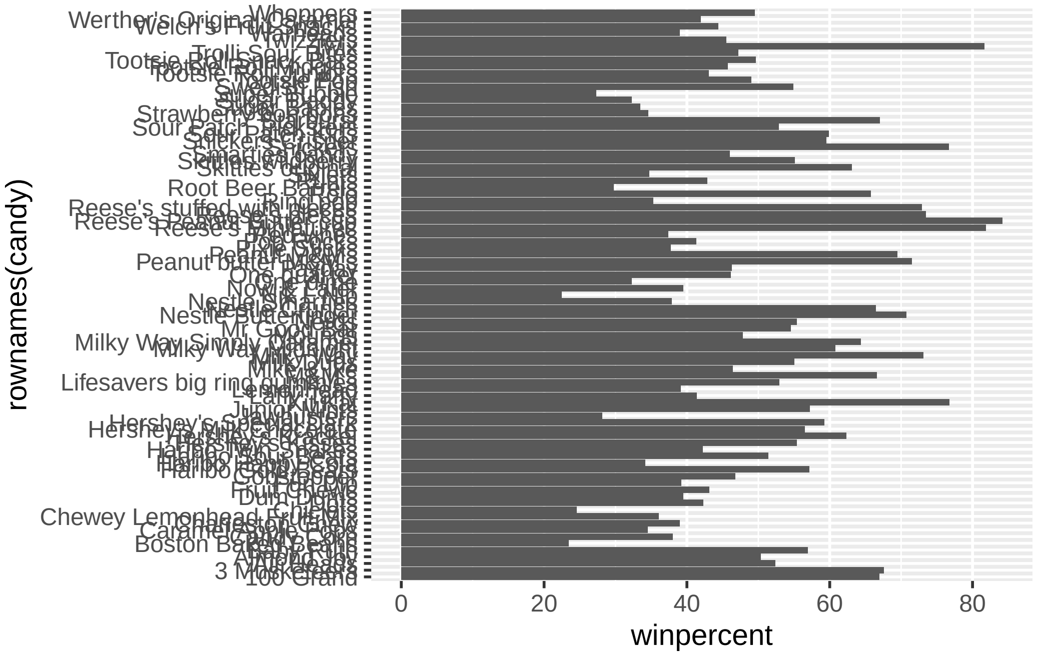
Reese's Peanut Butter Cups, Reese's Miniatures, Twix, Kit Kat, and Snickers.

```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
```

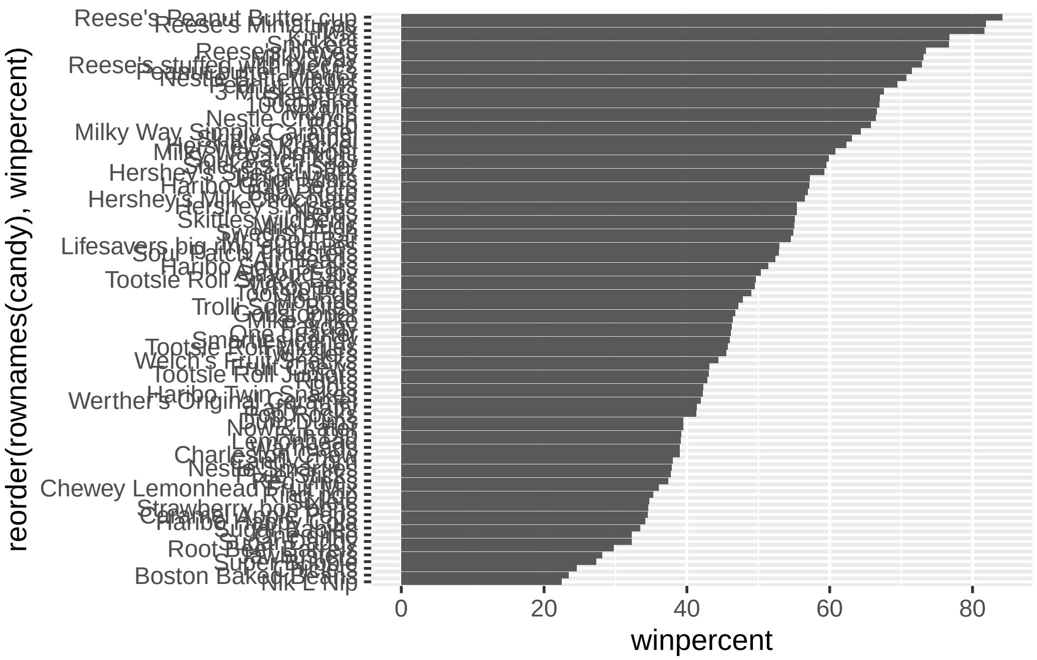
Q15. Make a first barplot of candy ranking based on winpercent values.

```r
library(ggplot2)

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

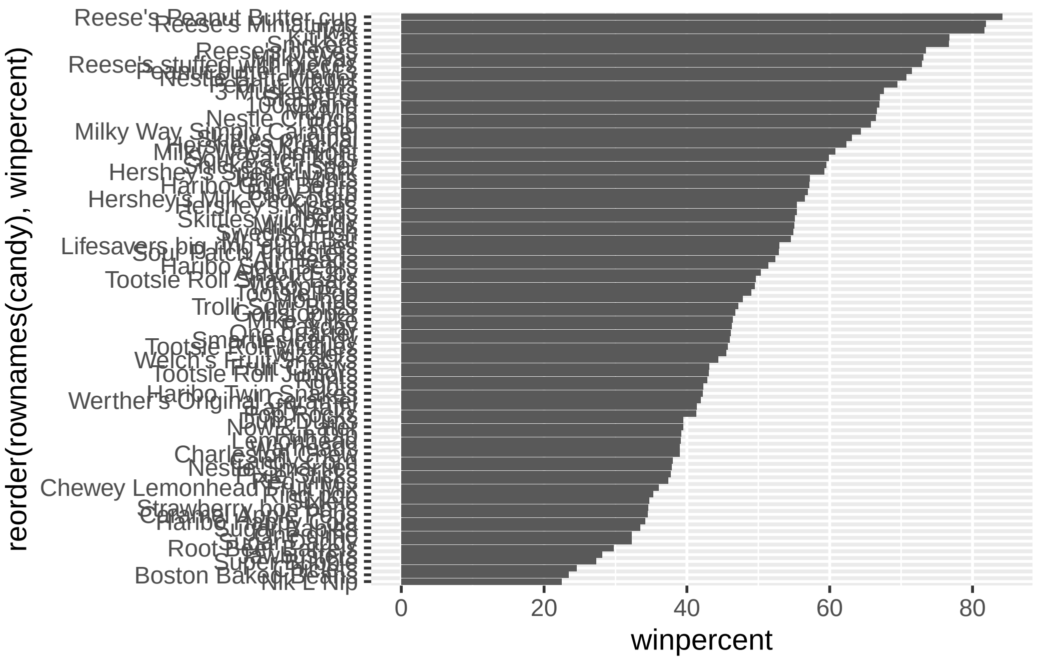


Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

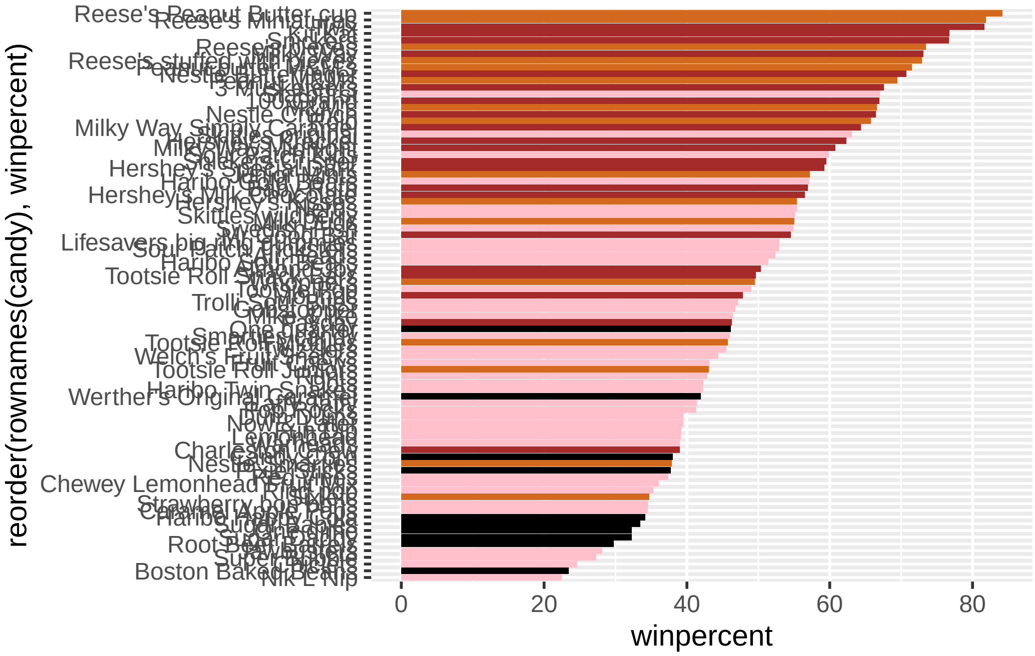
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col()
```



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



```
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)
```



Now, for the first time, using this plot we can answer questions like: > Q17. What is the worst ranked chocolate candy?

Sixlets.

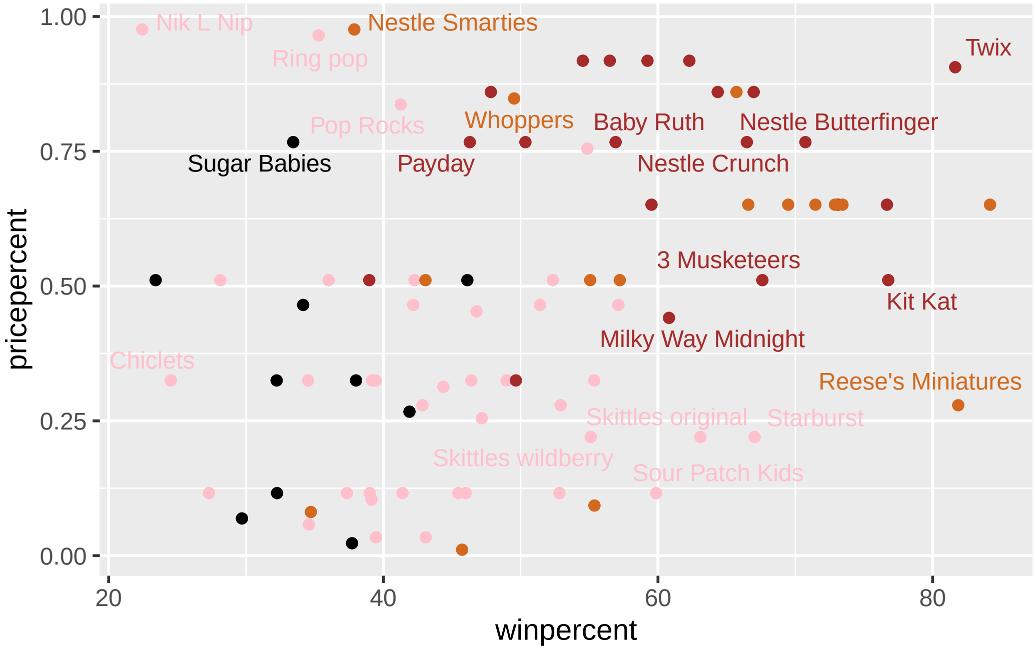
> Q18. What is the best ranked fruity candy?

Starburst.

Taking a look at pricepercent

```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=3.3, max.overlaps = 5)
```

```
Warning: ggrepel: 65 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?

Reese's Miniatures.

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

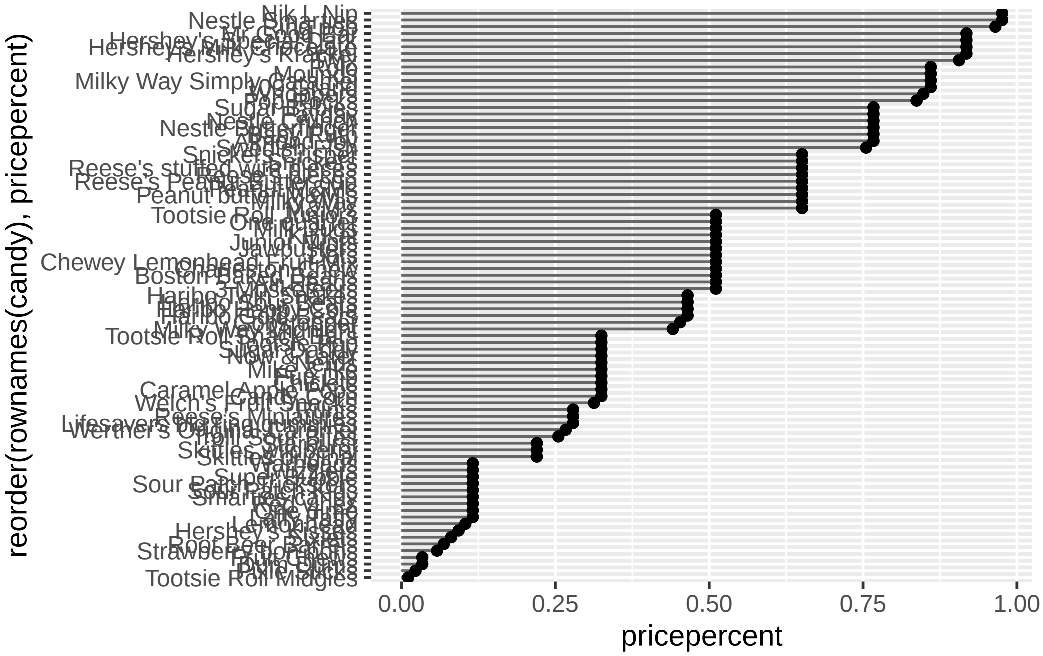
Nik L Nip is the least popular one among the most expensive candies.

```
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
```

Q21. Make a barplot again with geom_col() this time using pricepercent and then improve this step by step, first ordering the x-axis by value and finally making a so called "dot chat" or "lollipop" chart by swapping geom_col() for geom_point() + geom_segment().

```
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```

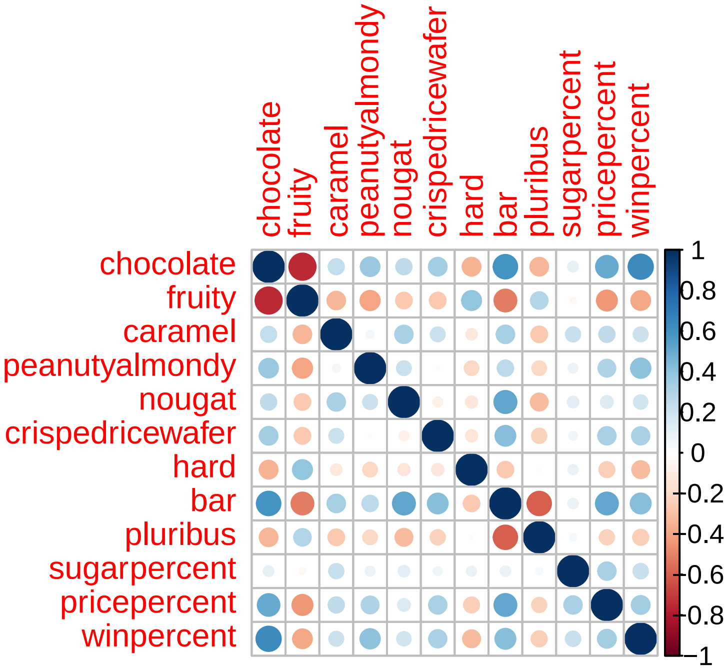


Exploring the correlation structure

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

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



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

Chocolate and fruity.

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

Chocolate and bar.

Principal Component Analysis

The main function for PCA in R is `prcomp()`, and we want to `scale=TRUE`.

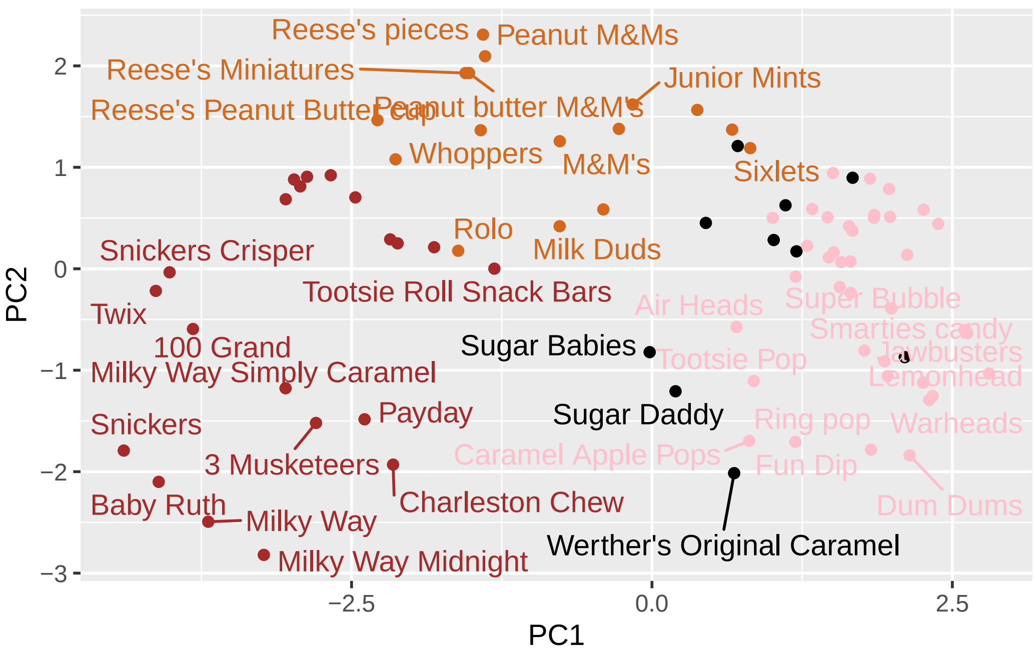
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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
```

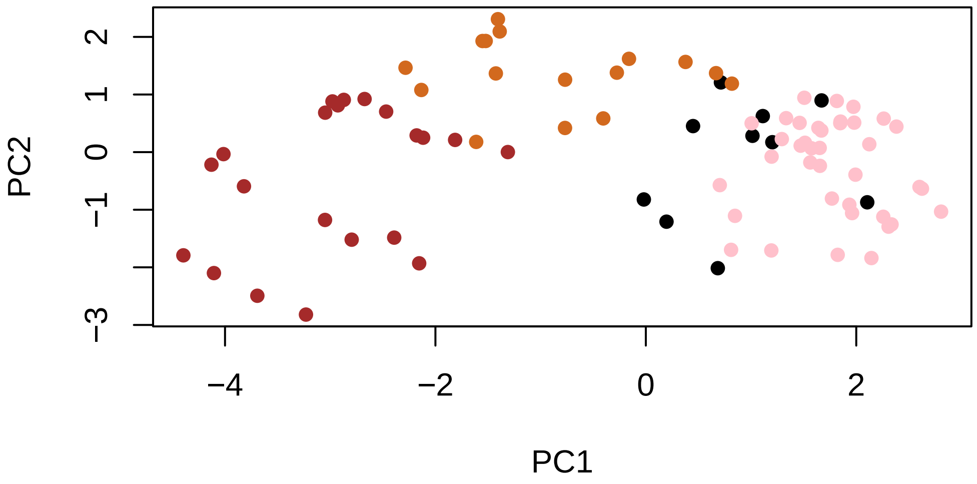
Let's look at our first main result figure - the "PC plot": PC1 vs PC2.

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

```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

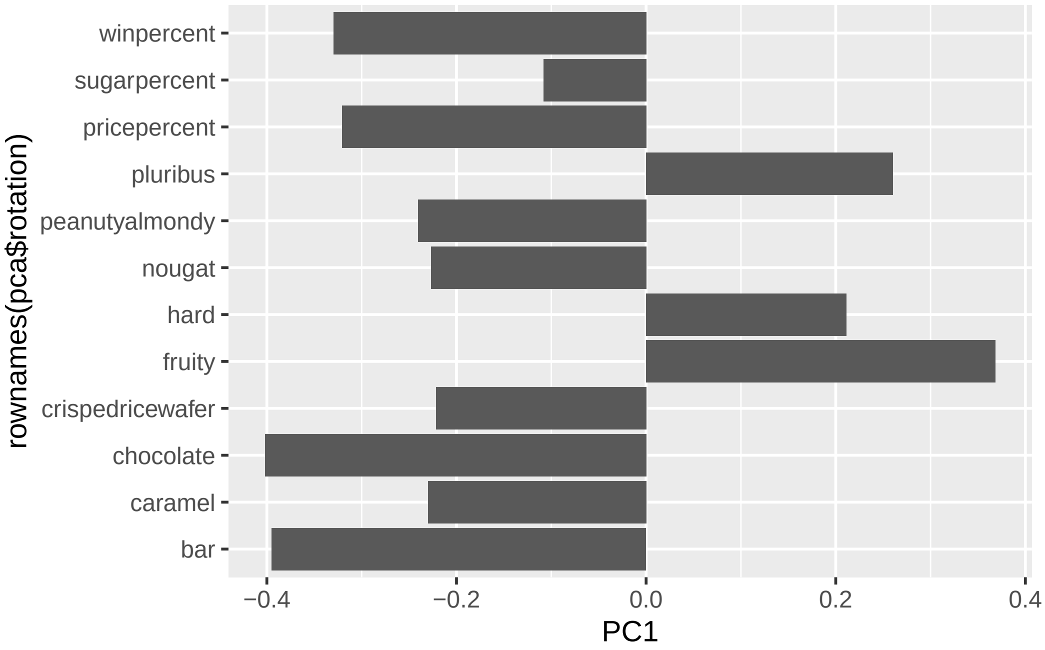


```r
plot(pca$x[,1:2], col=my_cols, pch=16)
```

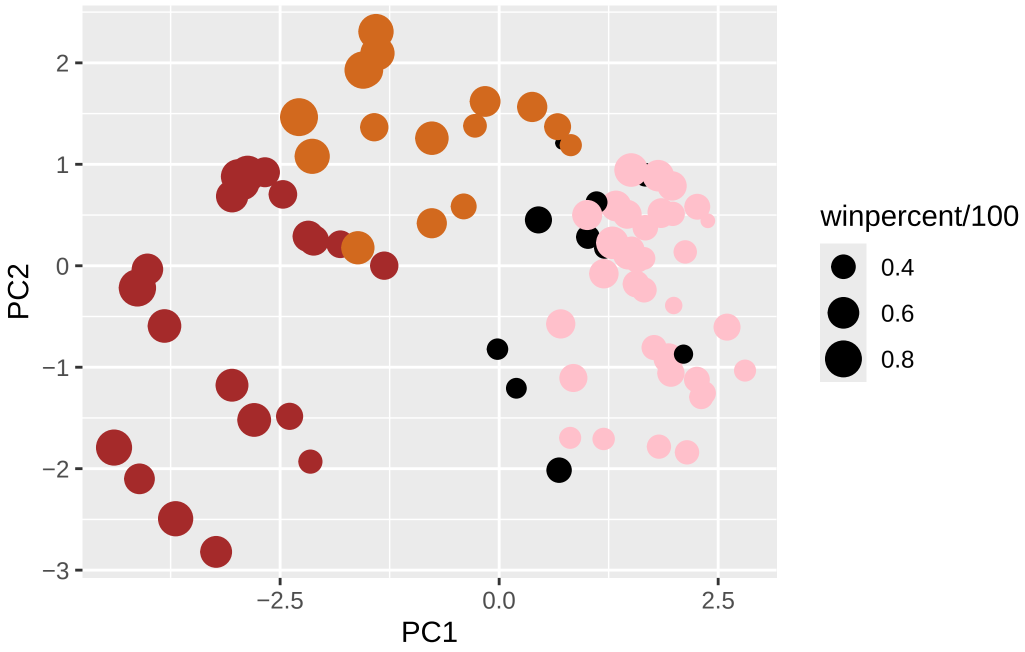


Don't forget about your variable "loadings" - hoe the original variable contributes to each PC.

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

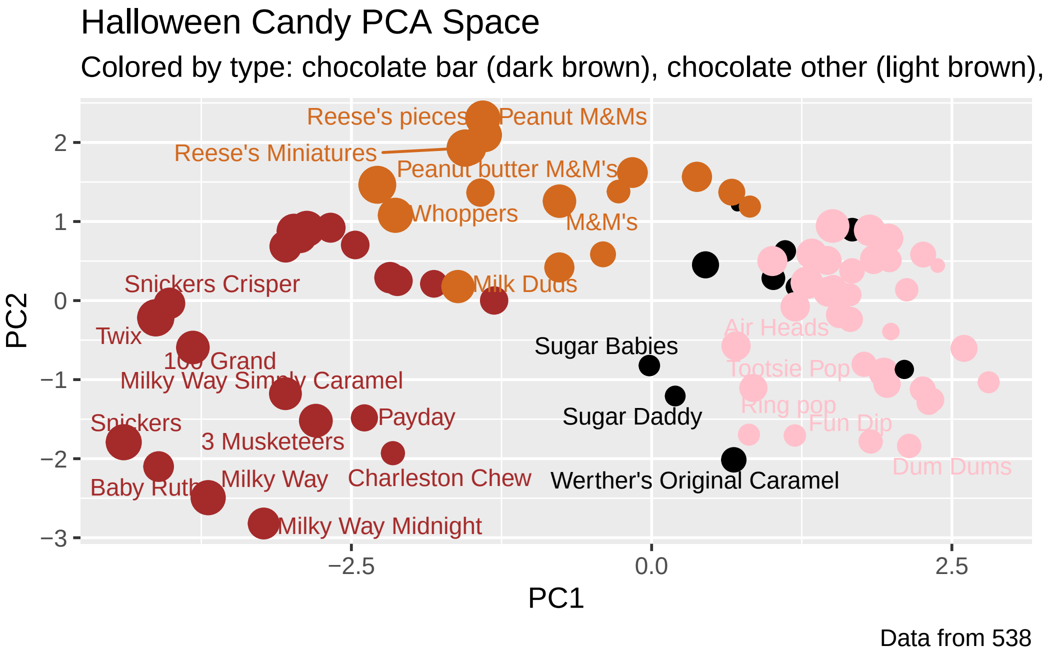


```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])

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
```



```r
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
```



Halloween Candy PCA Space

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

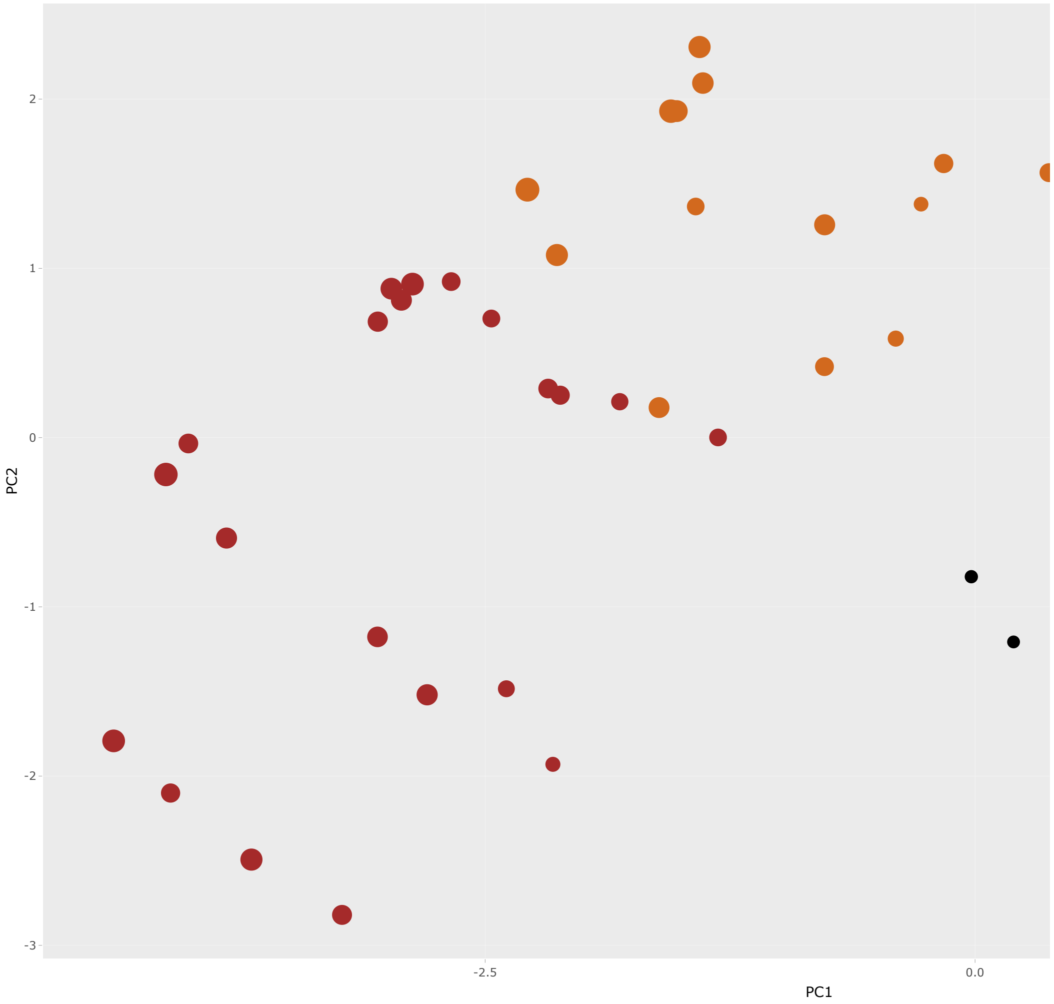
Data from 538

```r
library(plotly)
```

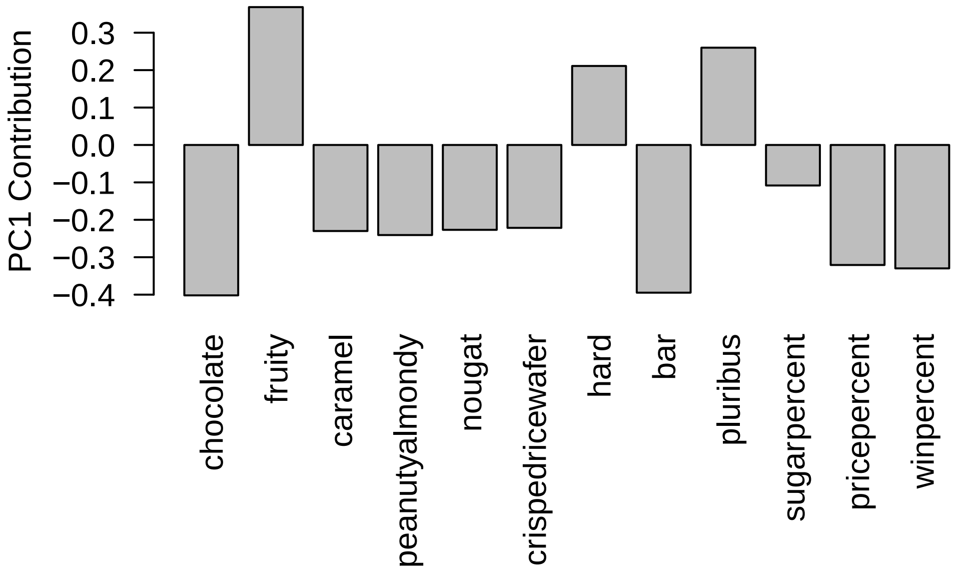
```

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)
```

```
file:////private/var/folders/j2/s2jtkphj3dz36gjxv0jybzk00000gn/T/RtmpJk2Upy/filee6ba28f890a6
```


2
1
0
-1
-2
-3
PC2
-2.5
0.0
PC1

```
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 comes up very positive for PC1. It does make sense to me.