# Class09

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### Importing candy data

```r
candy_file <- read.csv("candy-data.csv",row.names=1)
candy = data.frame(candy_file)
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
```

### What is in the dataset?

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

```r
num.candy.types <- ncol(candy)
num.candy.types
```

```
[1] 12
```

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

```r
num.fruity <- sum(candy$fruity)
num.fruity
```

```
[1] 38
```

### What is your favorite candy?

> Q3.What is your favorite candy (other than Twix) in the dataset and what is it's winpercent value?

```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
```

```
candy |>
  filter(row.names(candy)=="Air Heads") |>
  select(winpercent)
```

```
          winpercent
Air Heads   52.34146
```

Q4. What is the winpercent value for “Kit Kat”?

```
library(dplyr)

candy |>
  filter(row.names(candy)=="Kit Kat") |>
  select(winpercent)
```

```
        winpercent
Kit Kat    76.7686
```

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

```
library(dplyr)
candy |>
  filter(row.names(candy)=="Tootsie Roll Snack Bars")|>
  select(winpercent)
```

```
                        winpercent
Tootsie Roll Snack Bars    49.6535
```

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

```
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 | |

Yes, the `winpercent`.

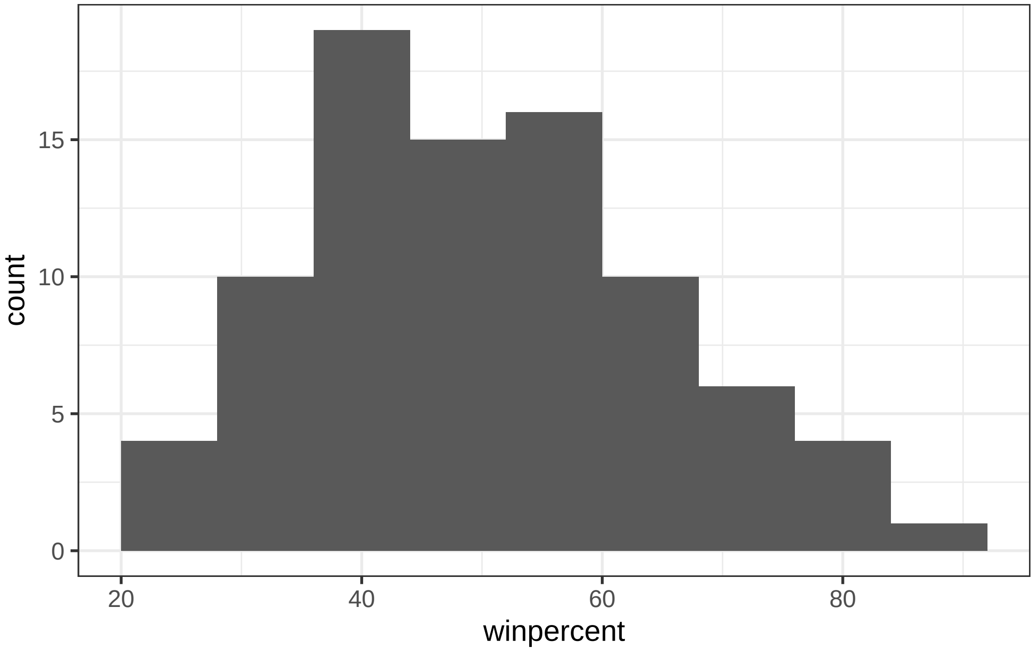
Q7. What do you think a zero and one represent for the candy$chocolate column?

O in missing value means that there is no missing value in `chocolate`. 1 means that all the rows in `chocolate` has a value.

## Exploratory analysis

Q8. Plot a histogram of winpercent values

```r
library(ggplot2)
ggplot(candy)+
  aes(winpercent)+
  geom_histogram(binwidth = 8)+
  theme_bw()
```



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent is not symmetrical and it is right skewed.

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 
```

Based on the median, the the center of the distribution is below 50%.

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

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

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  34.72   50.35   60.80   60.92   70.74   84.18 
```

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

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.04   42.97   44.12   52.11   67.04 
```

As the mean of chocolate winpercent is higher,on average chocolate candy is higher ranked than fruity candy.

Q12. Is this difference statistically significant?

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

```

	Welch Two Sample t-test

data:  choc.win and fruity.win
t = 6.2582, df = 68.882, p-value = 2.871e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 11.44563 22.15795
sample estimates:
mean of x mean of y 
 60.92153  44.11974 
```

Since p<0.05, this difference is statistically significant.

## 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
```

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

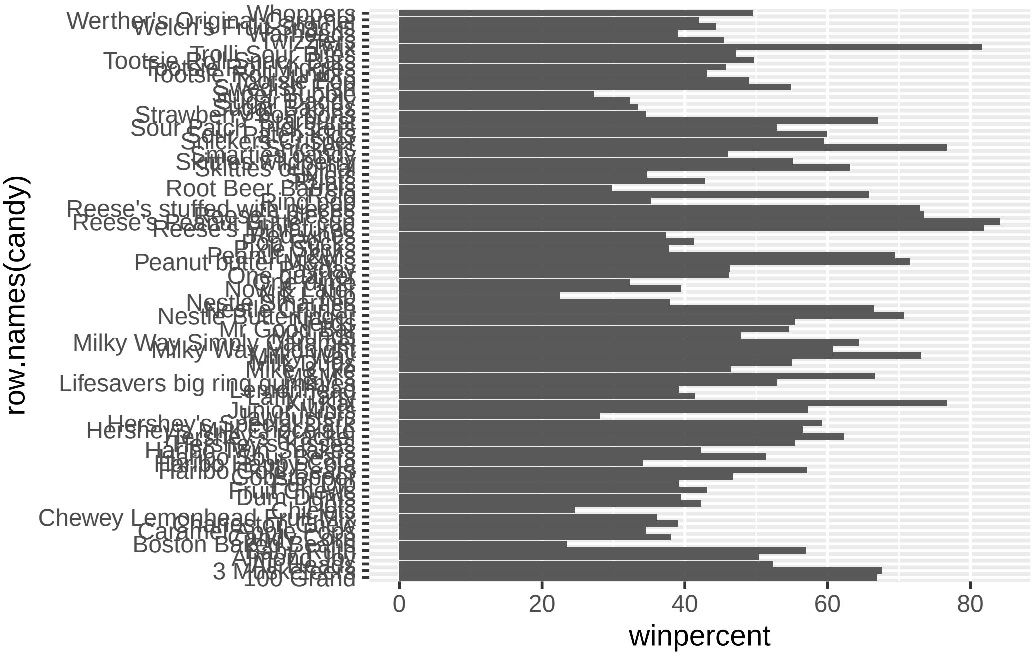
```r
tail(candy[order(candy$winpercent),],n=5)
```

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

```
Reese's Miniatures                0.279    81.86626
Reese's Peanut Butter cup         0.651    84.18029
```

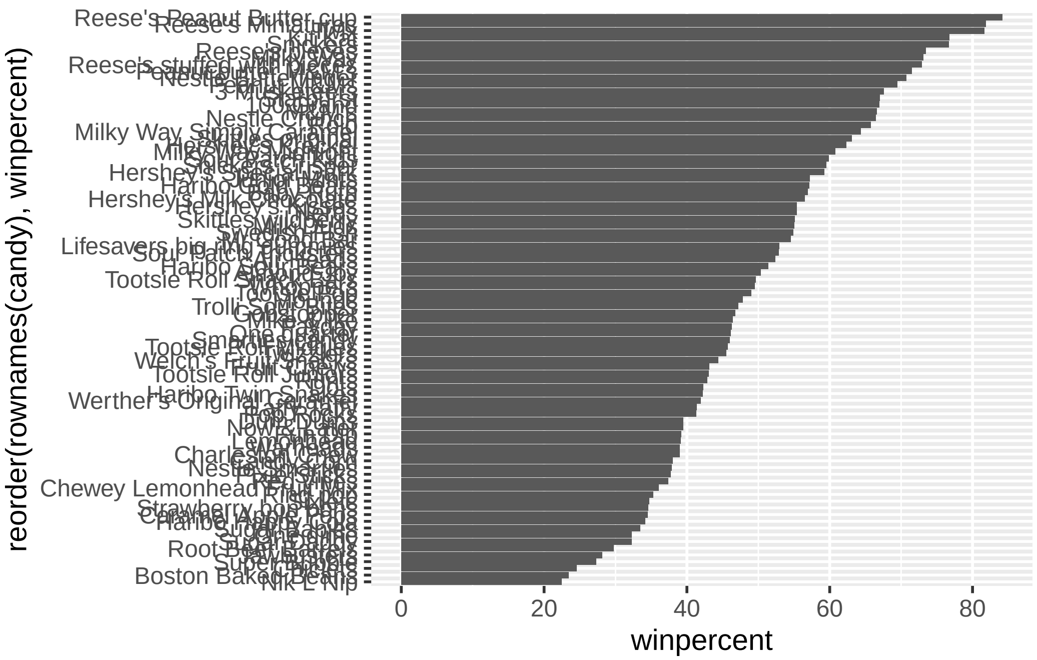
Q15. Make a first barplot of candy ranking based on winpercent values.

```r
library(ggplot2)
ggplot(candy)+
  aes(winpercent,row.names(candy))+
  geom_col(position = position_dodge(width = 2))
```



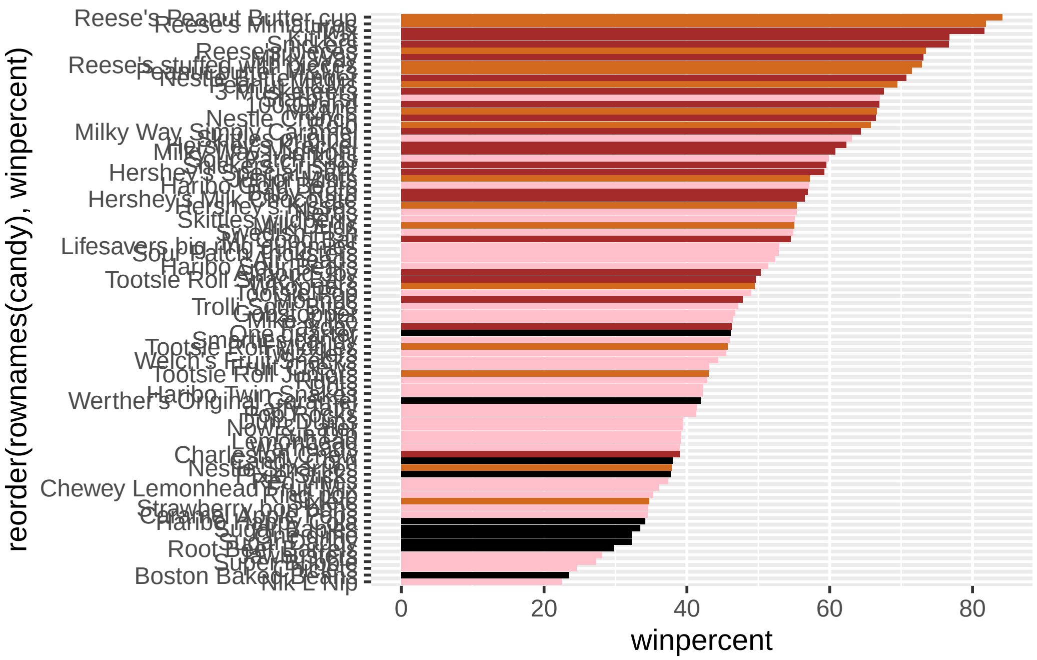
Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```r
sort.candy <- candy[order(candy$winpercent),]
library(ggplot2)
ggplot(candy)+
  aes(winpercent,reorder(rownames(candy),winpercent))+
  geom_col(position = position_dodge(width = 2))
```



### Time to add some useful color

```
my_cols=rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] = "chocolate"
my_cols[as.logical(candy$bar)] = "brown"
my_cols[candy$fruity==1] = "pink"
library(ggplot2)
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col(fill=my_cols)
```



Q17. What is the worst ranked chocolate candy?

Sixlets

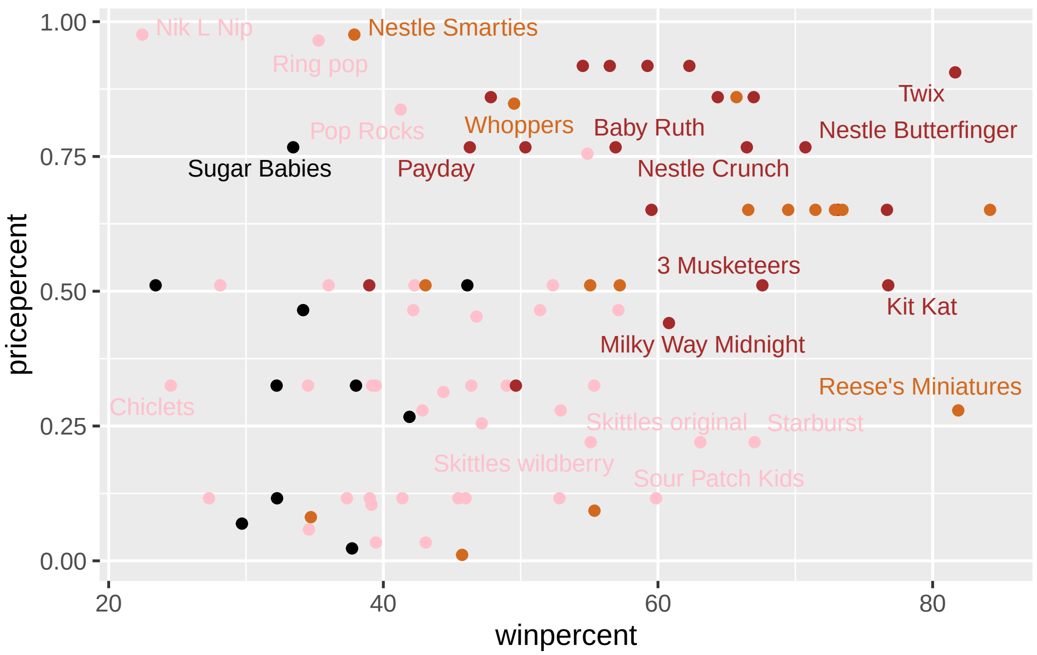
Q18. What is the best ranked fruity candy?

Starburst

### Taking a look at pricepercent

```
library(ggrepel)
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?

```
head(candy[order(candy$pricepercent),],n=5)
```

```
                     chocolate fruity caramel peanutyalmondy nougat
Tootsie Roll Midgies         1      0       0              0      0
Pixie Sticks                 0      0       0              0      0
Dum Dums                     0      1       0              0      0
Fruit Chews                  0      1       0              0      0
Strawberry bon bons          0      1       0              0      0
                     crispedricewafer hard bar pluribus sugarpercent
Tootsie Roll Midgies                0    0   0        1        0.174
Pixie Sticks                        0    0   0        1        0.093
Dum Dums                            0    1   0        0        0.732
Fruit Chews                         0    0   0        1        0.127
Strawberry bon bons                 0    1   0        1        0.569
                     pricepercent winpercent
Tootsie Roll Midgies        0.011   45.73675
Pixie Sticks                0.023   37.72234
Dum Dums                    0.034   39.46056
Fruit Chews                 0.034   43.08892
Strawberry bon bons         0.058   34.57899
```

Tootsie Roll Midgies

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

```
tail5 <- tail(candy[order(candy$pricepercent),],n=5)
t5xp <- tail5[nrow(tail5):1,]
t5xp
```

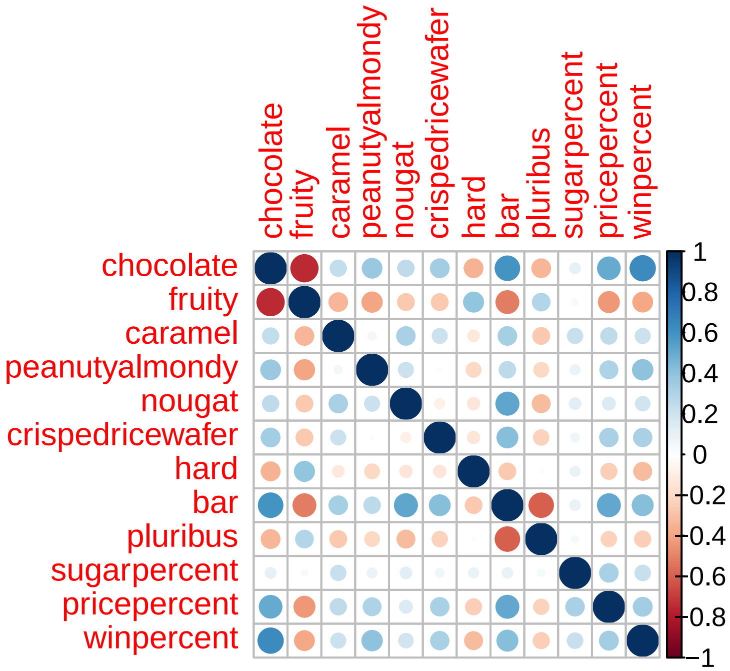
```
                       chocolate fruity caramel peanutyalmondy nougat
Nestle Smarties                1      0       0              0      0
Nik L Nip                      0      1       0              0      0
Ring pop                       0      1       0              0      0
Mr Good Bar                    1      0       0              1      0
Hershey's Special Dark         1      0       0              0      0
                       crispedricewafer hard bar pluribus sugarpercent
Nestle Smarties                       0    0   0        1        0.267
Nik L Nip                             0    0   0        1        0.197
Ring pop                              0    1   0        0        0.732
Mr Good Bar                           0    0   1        0        0.313
Hershey's Special Dark                0    0   1        0        0.430
                       pricepercent winpercent
Nestle Smarties               0.976   37.88719
Nik L Nip                     0.976   22.44534
Ring pop                      0.965   35.29076
Mr Good Bar                   0.918   54.52645
Hershey's Special Dark        0.918   59.23612
```

## 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)?

`Fruity` and `chocolate` are the most anti-correlated pair.

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

`winpercent` and `chocolate`.

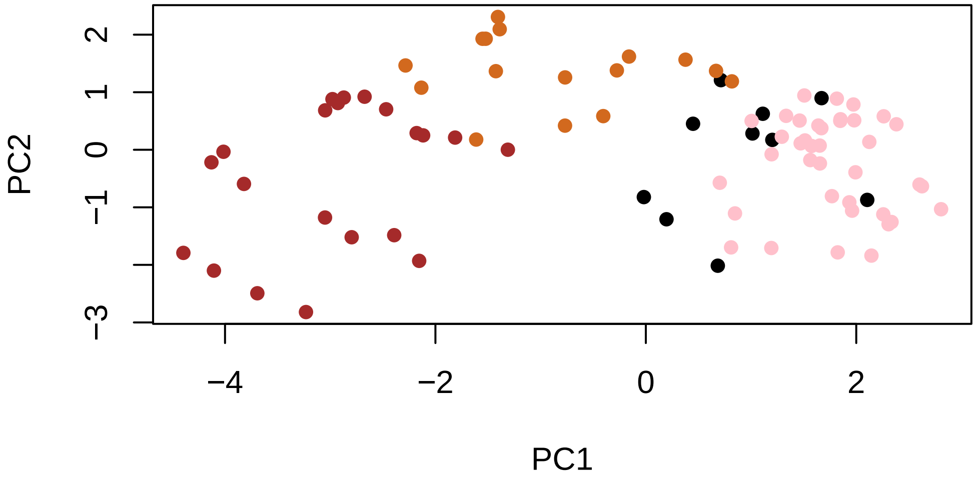
### Principal Component Analysis

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

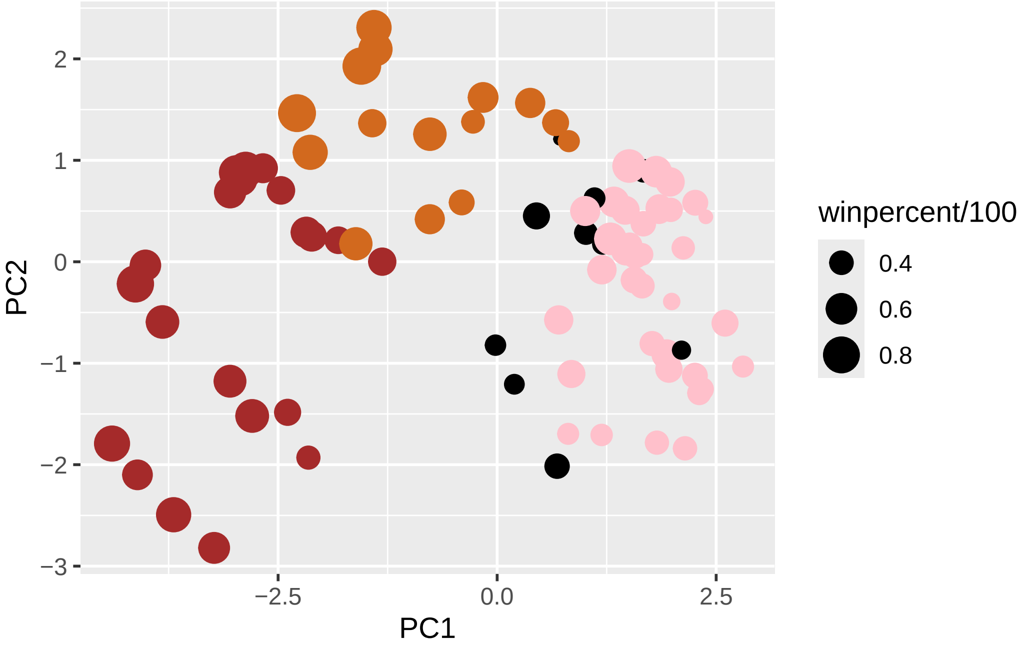
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688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

```
#my_cols=rep("black", nrow(candy))
#my_cols[as.logical(candy$chocolate)] = "chocolate"
#my_cols[as.logical(candy$bar)] = "brown"
#my_cols[candy$fruity==1] = "pink"
plot(pca$x[,1:2],col=my_cols,pch=16)
```

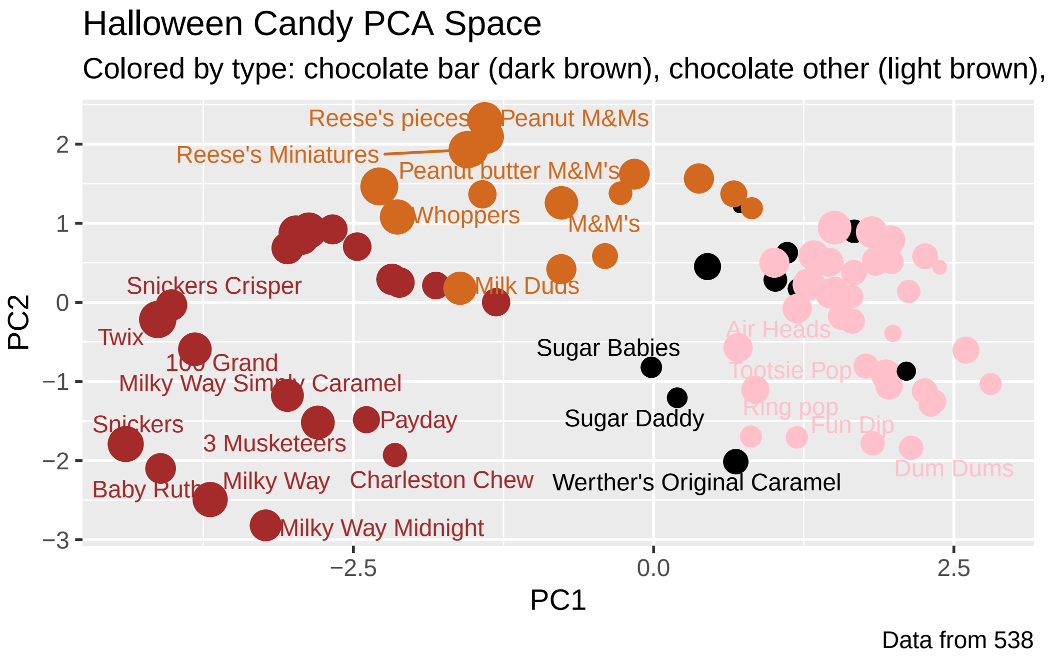


```
my_data <- cbind(candy, pca$x[,1:3])
p <- ggplot(my_data) +
        aes(PC1, PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)
p
```



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

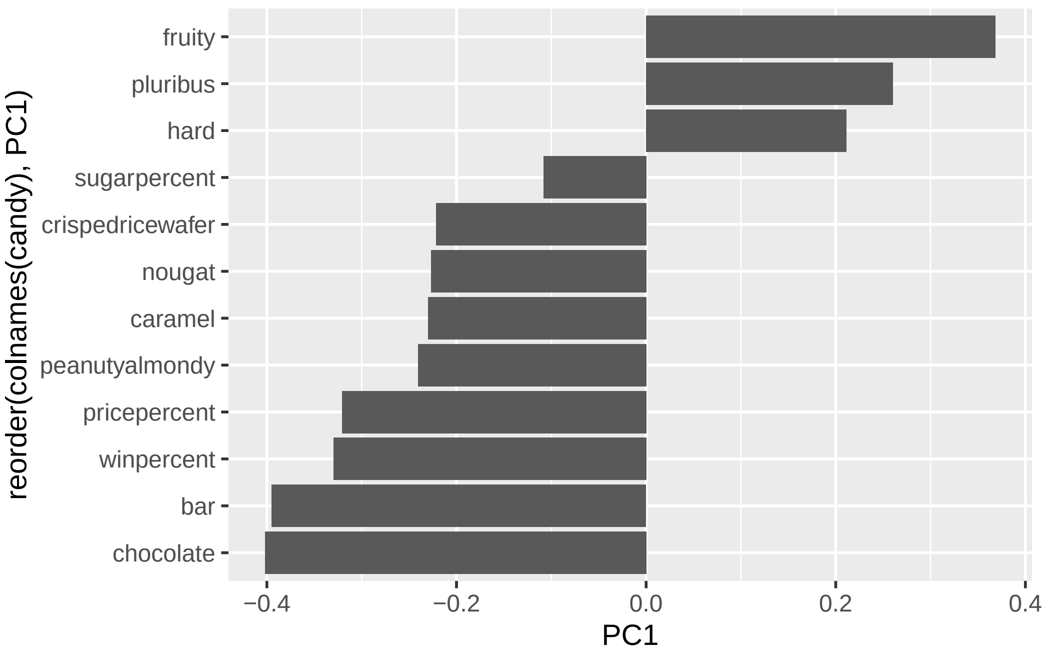
```
Warning: ggrepel: 59 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



```
#library(plotly)
#ggplotly(p)
```

Q24. Complete the code to generate the loadings plot above. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you? Where did you see this relationship highlighted previously?

```
ggplot(pca$rotation) +
  aes(PC1, reorder(colnames(candy),PC1)) +
  geom_col()
```



The variables `fruity`,`pluribus` and `hard` are picked up strongly by PC1 in the positive direction. This make sense as fruity candies are hard, pluribus candies. This relationship was also shown in previous correlation structure plot, where these three are positively correlated with each other.

## Summary

> Q25. Based on your exploratory analysis, correlation findings, and PCA results, what combination of characteristics appears to make a "winning" candy? How do these different analyses (visualization, correlation, PCA) support or complement each other in reaching this conclusion?

A combination of `chocolate` and `bar` seems to make a "winning" candy based on. First, based on the "Overall Candy Rankings" figure from Q17-18, both `chocolate` and `bar` candies have relatively higher `winpercent` compared to most of the other candies. Second, based on the correlation map from "Exploring the correlation structure", both `chocolate` and `bar` are strongly positively correlated with `winpercent`. Finally, based on the PCA, in PC1, `chocolate`, `bar` and `winpercent` are all picked up strongly by PC1 in the negative direction,suggesting that these characteristics tend to occur at the same time and cover a large portion of the variance. Combinely, these analyses support and complement each other and suggest that chocolate bar candies seems to make a "winning" candy.