Class 09: Candy Mini Project

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Importing Candy Data

Our dataset is a CSV file so we use `read.csv()`

```
candy <- read.csv("candy-data.csv", 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
```

What is in the dataset?

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

```
nrow(candy)
```

```
[1] 85
```

There are 85 candies.

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

```
table(candy$fruity)
```

```
 0  1
47 38
```

There are 38 fruity candies.

What is your favorite candy?

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

```
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) == "Sour Patch Kids") %>%
  select(winpercent)
```

```
                winpercent
Sour Patch Kids     59.864
```

Sour Patch Kids have a winpercent value of 59.864.

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

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

```
        winpercent
Kit Kat    76.7686
```

Kit Kats have a winpercent value of 76.7686.

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

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

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

Tootsie Roll Snack Bars have a winpercent value of 49.6535.

There is a useful skim() function in the skimr package that can help give you a quick overview of a given dataset. Let's install this package using `install.packages("skimr")` and try it on our candy data.

```
#library(skimr)
#skim(candy)
```

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 is the only one that's not on a scale from 0-1.

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

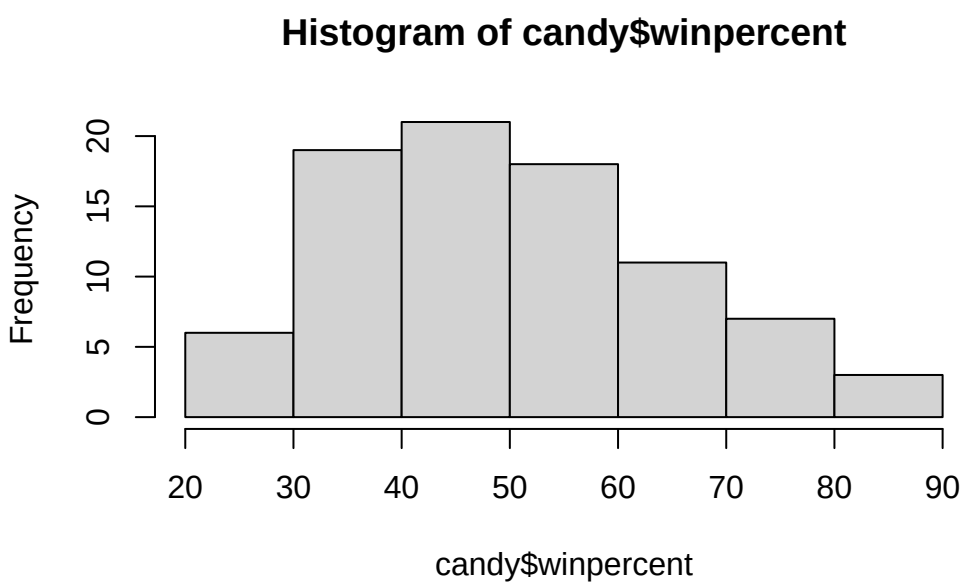
The `candy$chocolate` column has binary values: 0 means that the candy isn't chocolate, while 1 means that the candy is chocolate.

Exploratory Analysis

Q8. Plot a histogram of winpercent values

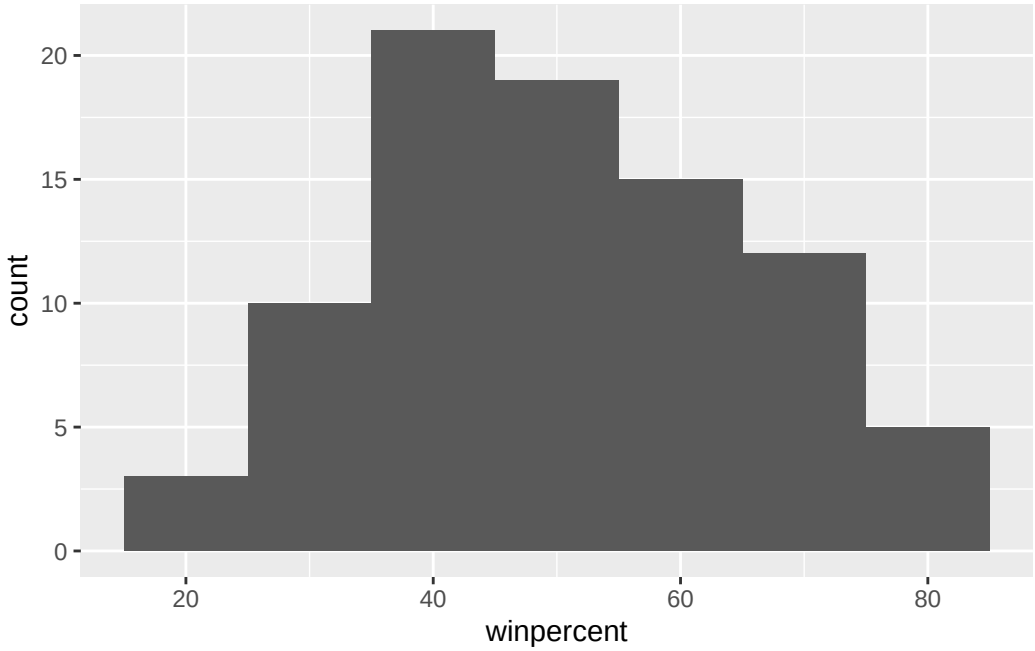
Using base R:

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



Using ggplot2:

```
library(ggplot2)

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



Q9. Is the distribution of winpercent values symmetrical?

The distribution is not symmetrical (it's right-skewed).

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

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

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

The center of this distribution is below 50% (median = 47.83).

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

```
candy_c <- candy %>%
  filter(chocolate == 1)
summary(candy_c$winpercent)
```

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

```
candy_f <- candy %>%
  filter(fruity == 1)
summary(candy_f$winpercent)
```

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

On average, chocolate candy (mean = 60.92) is higher-ranked than fruit candy (mean 44.12).

Q12. Is this difference statistically significant?

```
t.test(candy_c$winpercent, candy_f$winpercent)
```

```
    Welch Two Sample t-test

data:  candy_c$winpercent and candy_f$winpercent
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
```

Yes, this difference is statistically significant ($p < 0.05$).

Overall Candy Rankings

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

```
low <- candy %>%
  arrange(winpercent)
head(low, 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, Jawbusters.

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

```
high <- candy %>%
  arrange(desc(winpercent))

head(high, 5)
```

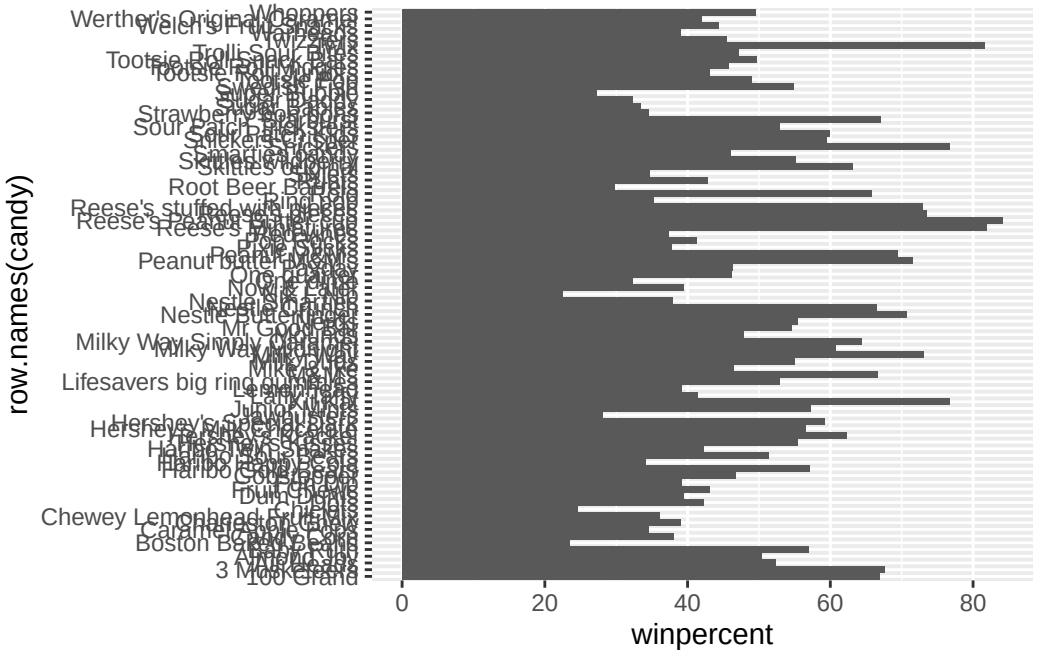
```
                        chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat                           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
```

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

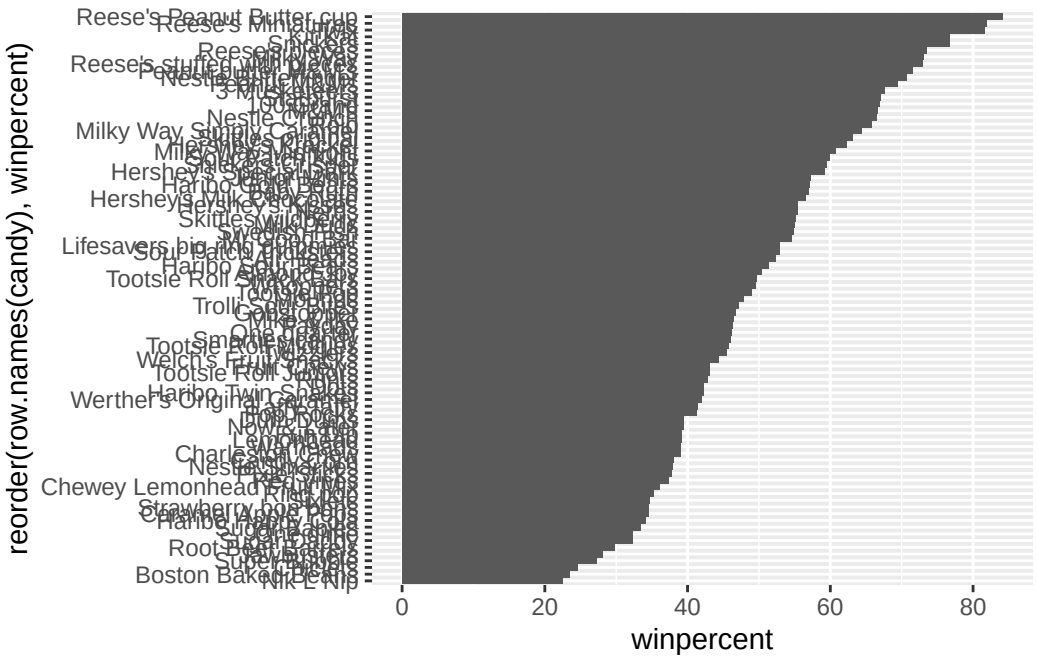
Q15. Make a first barplot of candy ranking based on winpercent values.

```
ggplot(candy, aes(winpercent, row.names(candy))) +
  geom_col()
```



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

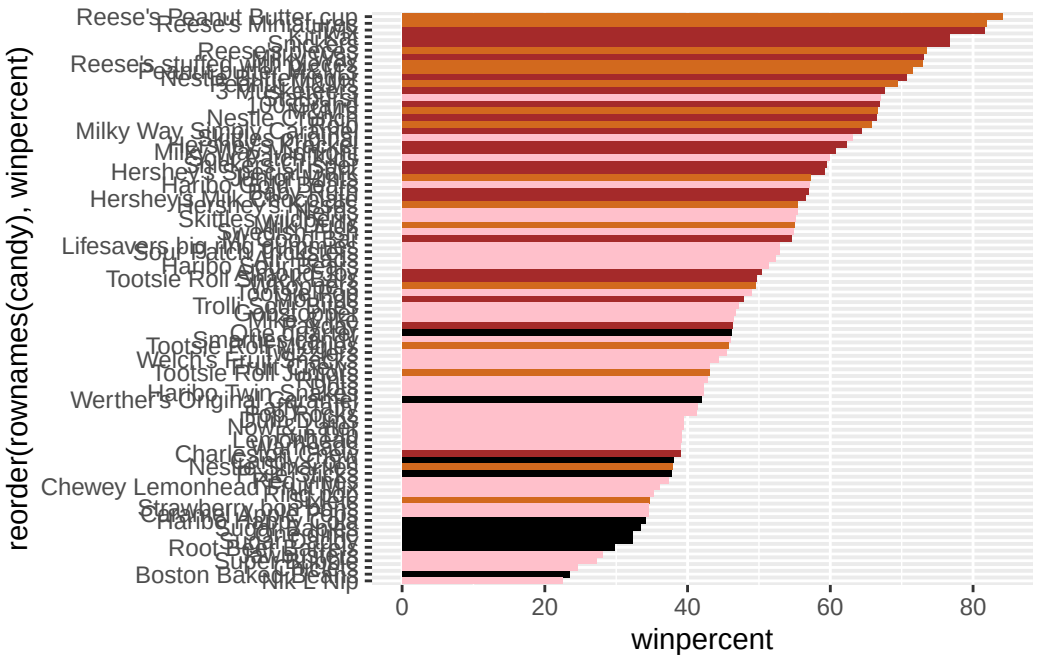
```
ggplot(candy, aes(winpercent, reorder(row.names(candy), winpercent))) +
  geom_col()
```



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[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?

Sixlets are the worst-ranked chocolate candy.

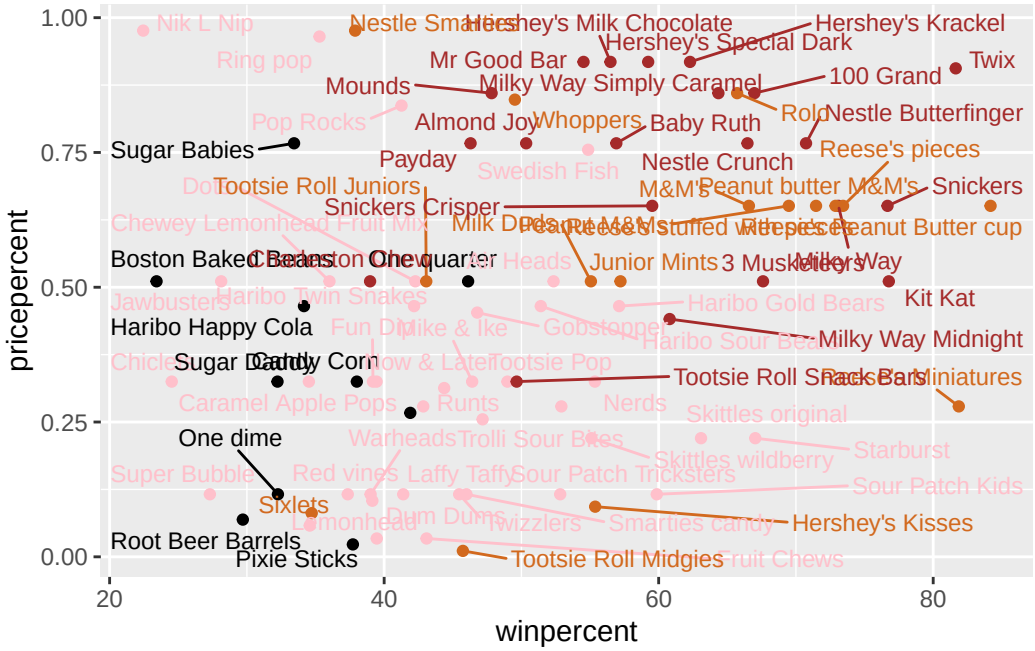
Q18. What is the best ranked fruity candy?

Starburst is the best-ranked fruity candy.

Taking a look at pricepercent

```
library(ggrepel)

# How about a plot of win vs price
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=3.3, max.overlaps = 17)
```

```
Warning: ggrepel: 4 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?

```
price <- candy %>%
  arrange(desc(pricepercent))

head(price, 5)
```

```
                        chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                       0      1       0              0      0
Nestle Smarties                 1      0       0              0      0
Ring pop                        0      1       0              0      0
Hershey's Krackel               1      0       0              0      0
Hershey's Milk Chocolate        1      0       0              0      0
                        crispedricewafer hard bar pluribus sugarpercent
Nik L Nip                              0    0   0        1        0.197
Nestle Smarties                        0    0   0        1        0.267
Ring pop                               0    1   0        0        0.732
```

```
Hershey's Krackel                       1     0    1        0        0.430
Hershey's Milk Chocolate                0     0    1        0        0.430
                          pricepercent winpercent
Nik L Nip                        0.976   22.44534
Nestle Smarties                  0.976   37.88719
Ring pop                         0.965   35.29076
Hershey's Krackel                0.918   62.28448
Hershey's Milk Chocolate         0.918   56.49050
```

Nik L Nips is the most expensive AND least popular candy in this dataset.

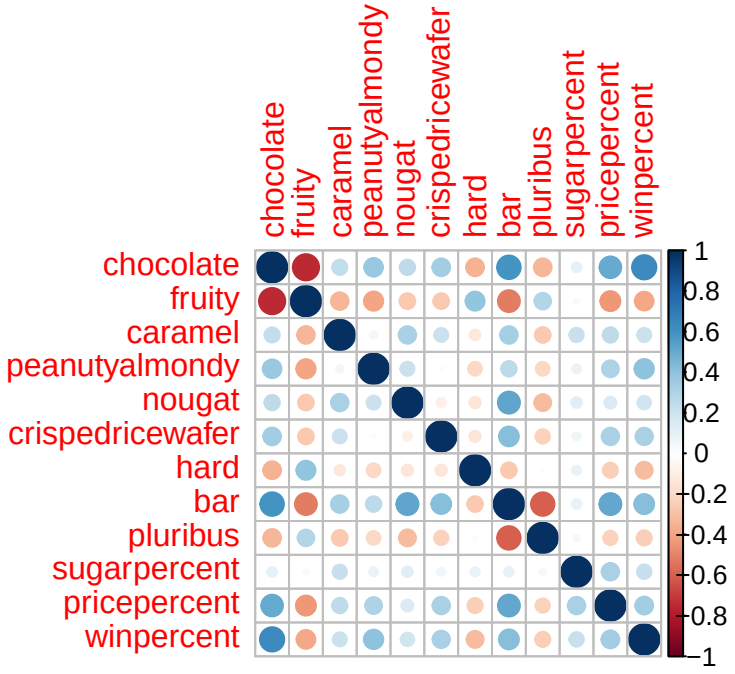
Exploring the correlation structure

Using the `corrplot` package (install first using `install.packages("corrplot")`):

```
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 are anti-correlated. Additionally, pluribus and bar are also anti-correlated.

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

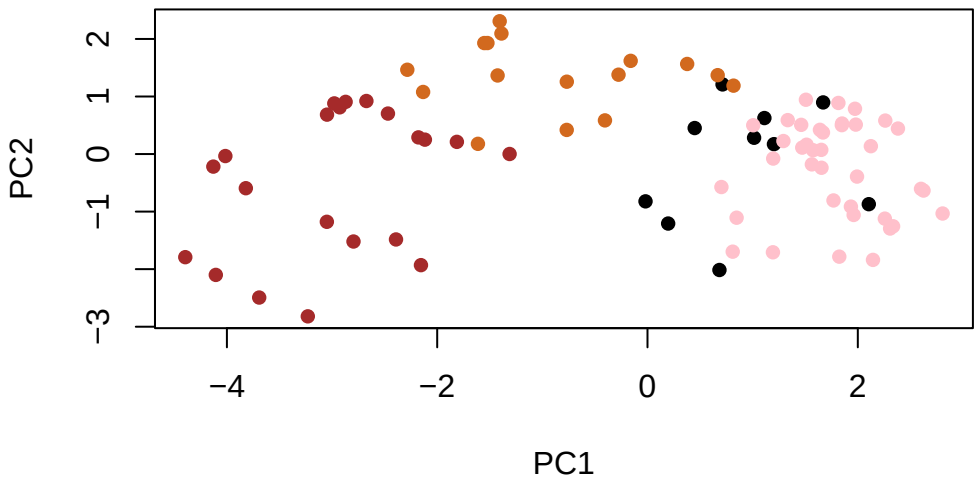
Chocolate and bar are the most positively correlated variables.

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
```

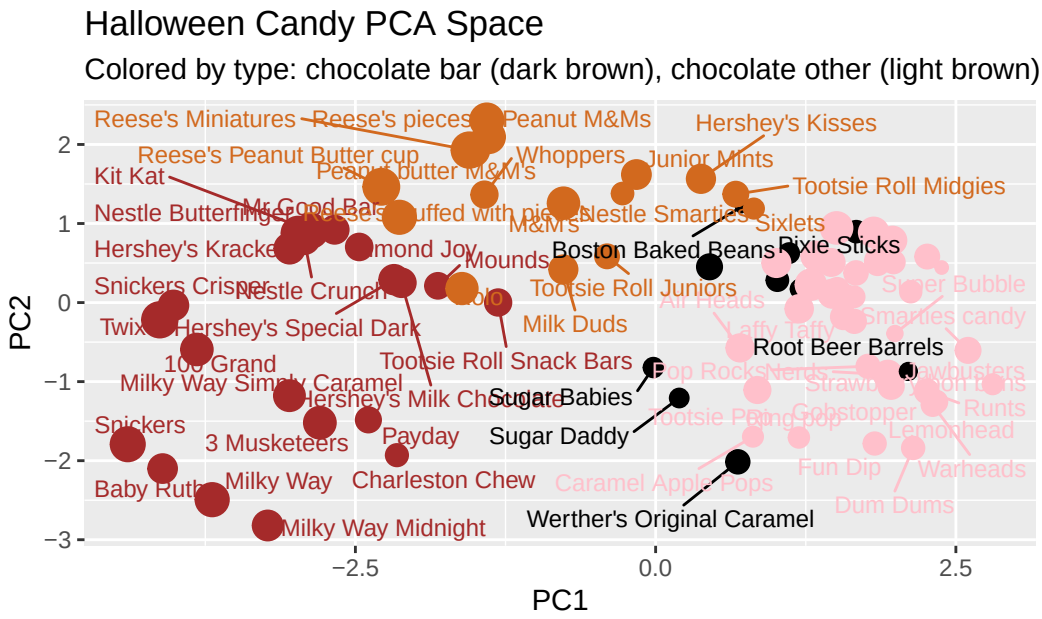
```
plot(pca$x[, 1:2], col = my_cols, pch = 16)
```



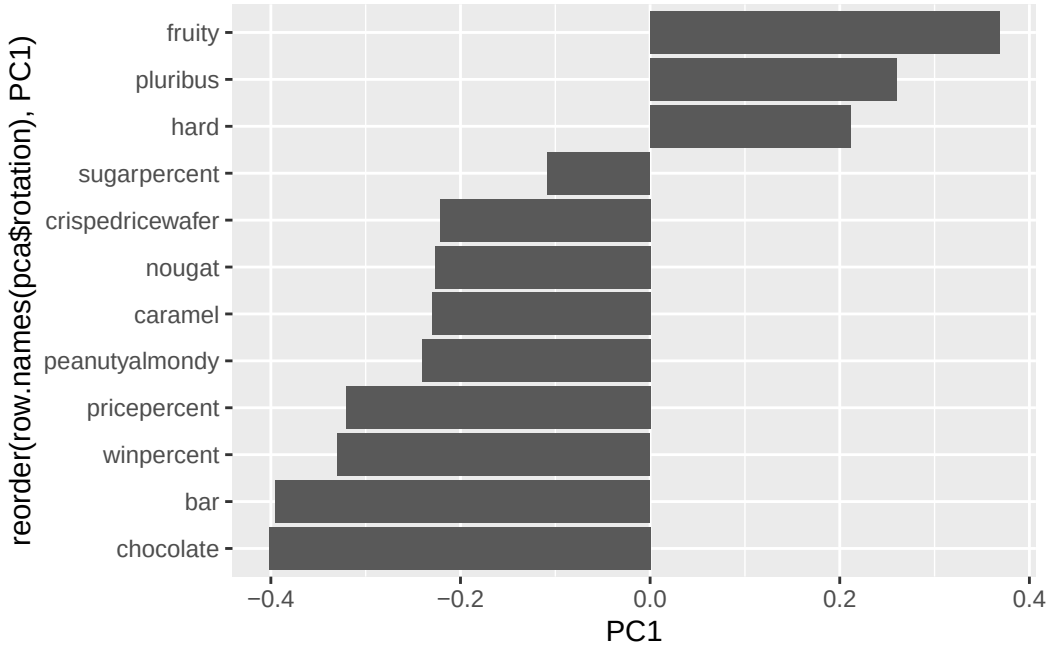
Using `ggplot2` and `ggrepel` packages:

```
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 + geom_text_repel(size=3.3, col=my_cols, max.overlaps = 17)  +
  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: 25 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```




```
ggplot(pca$rotation) +
  aes(PC1, reorder(row.names(pca$rotation), PC1)) +
  geom_col()
```



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?

Fruity and pluribus are picked up strongly by PC1 in the positive direction. Given that I previously found the strongest anti-correlations between fruity & chocolate and pluribus & bar, this makes sense to me.

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?

The combination of characteristics that seem to make a "winning" candy is chocolate + bar.

From the barplot visualizations, you can qualitatively see that most of the chocolate/bar candies are at the top (where winpercent is highest).

From the correlation plot, you can see that winpercent is most positively correlated with chocolate, and in turn chocolate is also strongly positively correlated with bar.

From the PCA, you can see that candies that are chocolate bars make up their own cluster, and are picked up strongly by PC1 in the same direction as winpercent.

Optional extension questions

```
losers = candy[which(candy$winpercent < 50),]
winners = candy[which(candy$winpercent >= 50),]
```

Q26. Are popular candies more expensive? In other words: is price significantly different between "winners" and "losers"? List both average values and a P-value along with your answer.

```
summary(losers$pricepercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0110  0.1160  0.3250  0.3744  0.5110  0.9760
```

```
summary(winners$pricepercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0930  0.4530  0.6510  0.5804  0.7670  0.9180
```

```
t.test(losers$pricepercent, winners$pricepercent)
```

```
    Welch Two Sample t-test

data:  losers$pricepercent and winners$pricepercent
t = -3.5653, df = 82.798, p-value = 0.0006068
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.32090727 -0.09107157
sample estimates:
mean of x mean of y
0.3743696 0.5803590
```

"Losers" have an average price percent of 37.44%, while "winners" have an average price percent of 58.04%. Conducting a t-test comparing the price percents of both groups returns a p-value < 0.05, suggesting that popular candies are significantly more expensive than "loser" candies.

> Q27. Are candies with more sugar more likely to be popular? What is your interpretation of the means and P-value in this case?

```
non_sugary <- candy[which(candy$sugarpercent < 0.50),]
sugary <- candy[which(candy$sugarpercent > 0.50),]

t.test(non_sugary$winpercent, sugary$winpercent)
```

```
    Welch Two Sample t-test

data:  non_sugary$winpercent and sugary$winpercent
t = -2.1192, df = 76.967, p-value = 0.0373
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -13.0167630  -0.4050308
sample estimates:
mean of x mean of y
 47.23765  53.94854
```

Yes, candies with more sugar are likely to be more popular. Sugary candies have an average winpercent of 53.95%, while candies with less sugar have an average winpercent of 47.24%. Conducting a t-test reports a p-value < 0.05, suggesting that sugary candies are significantly more popular than non-sugary candies.