Class 9: Candy Mini-Project

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Background

In this mini-project, you will explore FiveThirtyEight's Halloween Candy dataset.

We will use lots of **ggplot** some basic stats, correlation analysis and PCA to make sense of the landscape of US candy - something hopefully more relatable than the proteomics and transcriptomics work that we will use these methods on throughout the rest of the course

Data Import

Our dataset is a CSV file so we use `read.csv()` and have a wee peak with 'head

```
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
```

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

```
nrow(candy)
```

```
[1] 85
```

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

```
sum(candy$fruity)
```

```
[1] 38
```

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

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

```
[1] 84.18029
```

My favorite candy is Reese's Peanut Butter Cup with a winpercent of 84%.

```
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)=="Reese's Peanut Butter cup") |>
  select(winpercent)
```

```
                          winpercent
Reese's Peanut Butter cup   84.18029
```

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

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

```
[1] 76.7686
```

Kit Kat has a winpercent of 76%

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 of 49%.

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

Yes! Winpercent, sugarpercent, and pricepercent are on a different scale than the binary variables.

```
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	

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

A value of 1 means the candy contains chocolate, and a value of 0 means it does not.

```
library(skimr)
skim(candy$chocolate)
```

Table 3: Data summary

Name	candy$chocolate
Number of rows	85
Number of columns	1
_____	
Column type frequency:	
numeric	1
_____	
Group variables	None

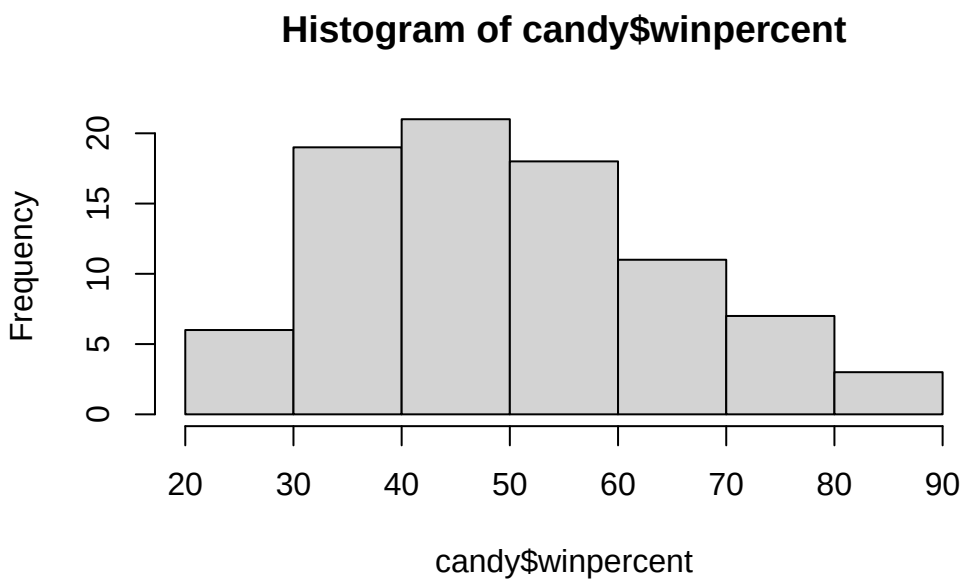
Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
data	0	1	0.44	0.5	0	0	0	1	1	

Exploratory analysis

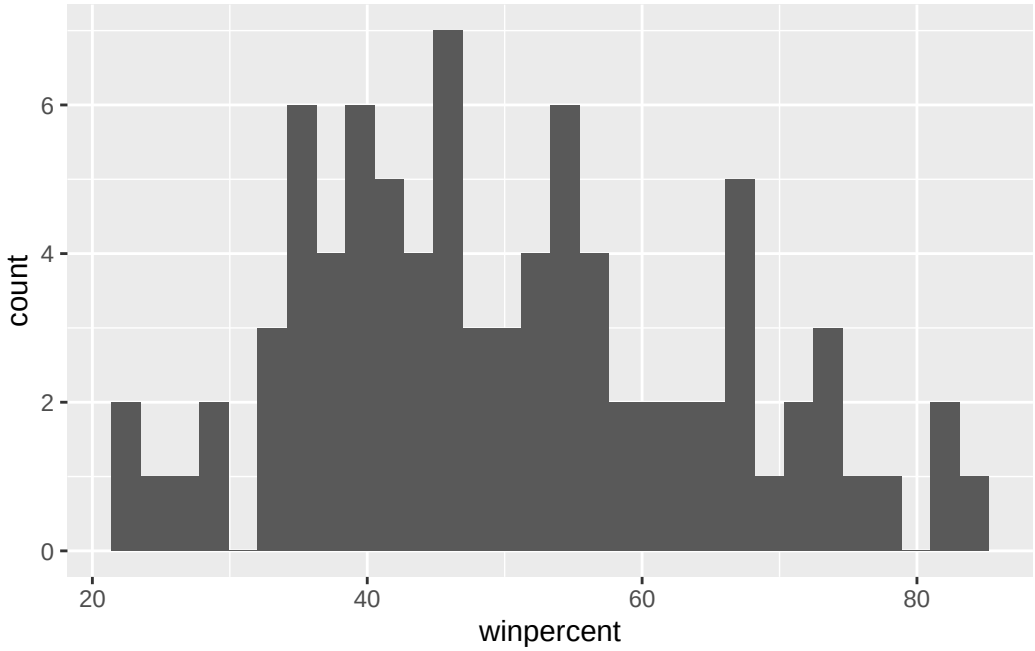
Q8. Plot a histogram of winpercent values

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




```
library(ggplot2)
ggplot(candy) +
aes(winpercent) +
geom_histogram()
```

```
`stat_bin()` using `bins = 30`. Pick better value `binwidth`.
```



Q9. Is the distribution of winpercent values symmetrical?

No, the distribution is not symmetrical. It is slightly skewed.

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

```
mean(candy$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 
```

The center is slightly below 50%.

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

```
mean(candy$winpercent[candy$chocolate == 1])
```

```
[1] 60.92153
```

```r
mean(candy$winpercent[candy$fruity == 1])
```

```
[1] 44.11974
```

Chocolate candies are ranked higher than fruity candies.

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

```r
chocolate_rank <- candy$winpercent[as.logical(candy$chocolate)]
candy_rank <- candy$winpercent[as.logical(candy$fruity)]

t.test(x = chocolate_rank, y = candy_rank)
```

```
    Welch Two Sample t-test

data:  chocolate_rank and candy_rank
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
```

It is statistically significant because the t-test shows a p-value below 0.05

Overall Candy Rankings

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

```
y <- c("y", "a", "z")
sort(y)
```

```
[1] "a" "y" "z"
```

```
y
```

```
[1] "y" "a" "z"
```

```
order(y)
```

```
[1] 2 1 3
```

```
ord.ind <- order(candy$winpercent)
head(candy[ord.ind, ])
```

```
                  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
Root Beer Barrels         0      0       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
Root Beer Barrels                0    1   0        1        0.732        0.069
                  winpercent
Nik L Nip           22.44534
Boston Baked Beans  23.41782
Chiclets            24.52499
Super Bubble        27.30386
Jawbusters          28.12744
Root Beer Barrels   29.70369
```

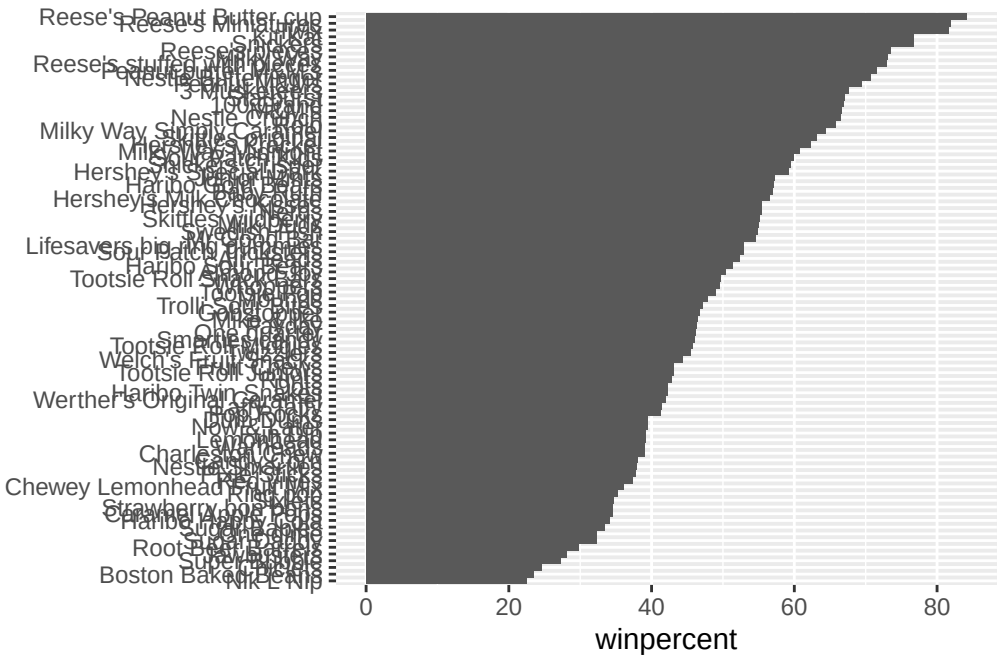
Q14. What are the top 5 all time favorite candy types out of this set?

```
tail(candy[ord.ind, ], 5)
```

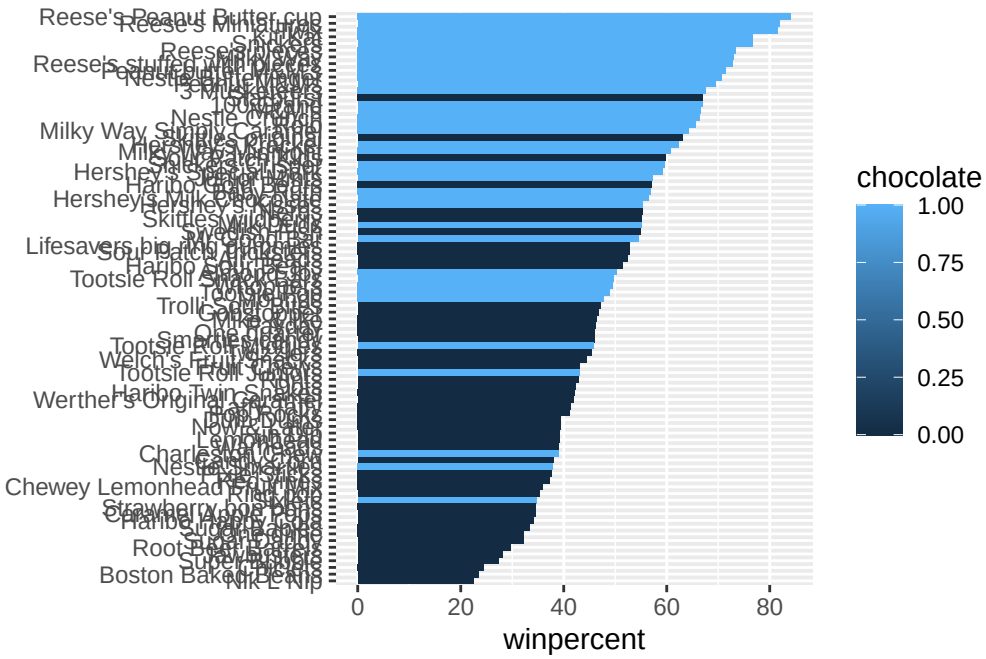
```
                         chocolate fruity caramel peanutyalmondy nougat
Snickers                         1      0       1              1      1
Kit Kat                          1      0       0              0      0
Twix                             1      0       1              0      0
Reese's Miniatures               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.

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




```
ggplot(candy) +
  aes(winpercent,
      reorder(row.names(candy),winpercent),
      fill=chocolate) +
  geom_col() +
  ylab("")
```



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

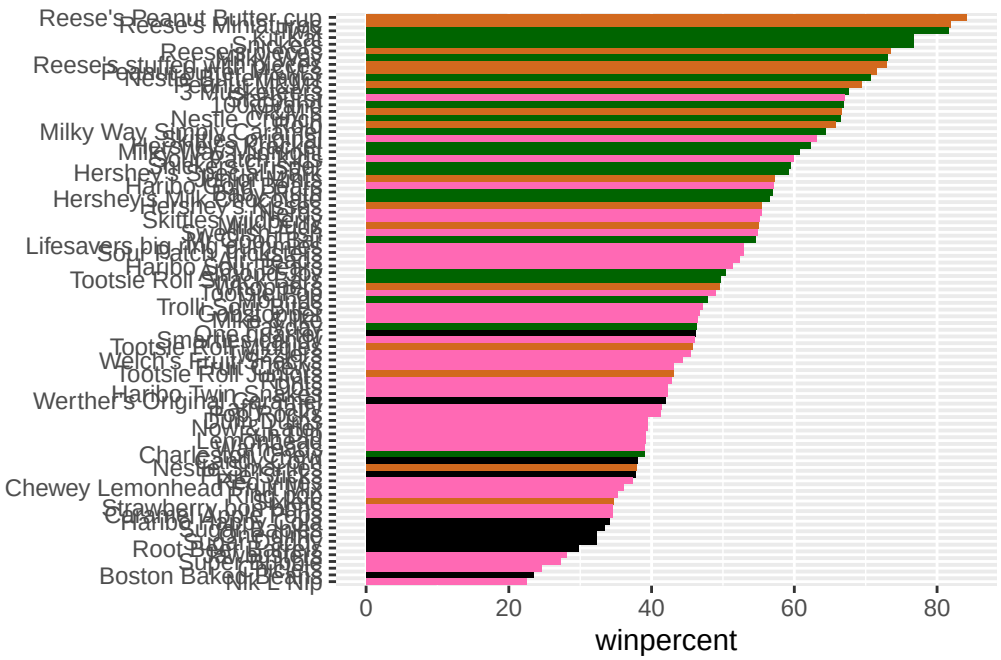
We need a coustom color vector

```
my_cols <- rep("black", nrow(candy))
#my_cols[1] <- "red"  first element is red
my_cols[candy$chocolate==1] <- "chocolate"
my_cols[candy$bar==1] <- "darkgreen"
my_cols[candy$fruity==1] <- "hotpink"
my_cols
```

```
 [1] "darkgreen" "darkgreen" "black"     "black"     "hotpink"   "darkgreen"
 [7] "darkgreen" "black"     "black"     "hotpink"   "darkgreen" "hotpink"
[13] "hotpink"   "hotpink"   "hotpink"   "hotpink"   "hotpink"   "hotpink"
[19] "hotpink"   "black"     "hotpink"   "hotpink"   "chocolate" "darkgreen"
[25] "darkgreen" "darkgreen" "hotpink"   "chocolate" "darkgreen" "hotpink"
[31] "hotpink"   "hotpink"   "chocolate" "chocolate" "hotpink"   "chocolate"
[37] "darkgreen" "darkgreen" "darkgreen" "darkgreen" "darkgreen" "hotpink"
[43] "darkgreen" "darkgreen" "hotpink"   "hotpink"   "darkgreen" "chocolate"
[49] "black"     "hotpink"   "hotpink"   "chocolate" "chocolate" "chocolate"
[55] "chocolate" "hotpink"   "chocolate" "black"     "hotpink"   "chocolate"
[61] "hotpink"   "hotpink"   "chocolate" "hotpink"   "darkgreen" "darkgreen"
```

```
[67] "hotpink"   "hotpink"   "hotpink"   "hotpink"   "black"     "black"
[73] "hotpink"   "hotpink"   "hotpink"   "chocolate" "chocolate" "darkgreen"
[79] "hotpink"   "darkgreen" "hotpink"   "hotpink"   "hotpink"   "black"
[85] "chocolate"
```

```
ggplot(candy) +
  aes(winpercent,
      reorder(row.names(candy),winpercent)) +
  geom_col(fill=my_cols) +
  ylab("")
```



Q17. What is the worst ranked chocolate candy?

```
choc <- candy[candy$chocolate == 1, ]

rownames(choc)[which.min(choc$winpercent)]
```

```
[1] "Sixlets"
```

The worst ranked chocolate candy is sixlets

Q18. What is the best ranked fruity candy?

```
fruit <- candy[candy$fruity == 1, ]

rownames(fruit)[which.max(fruit$winpercent)]
```

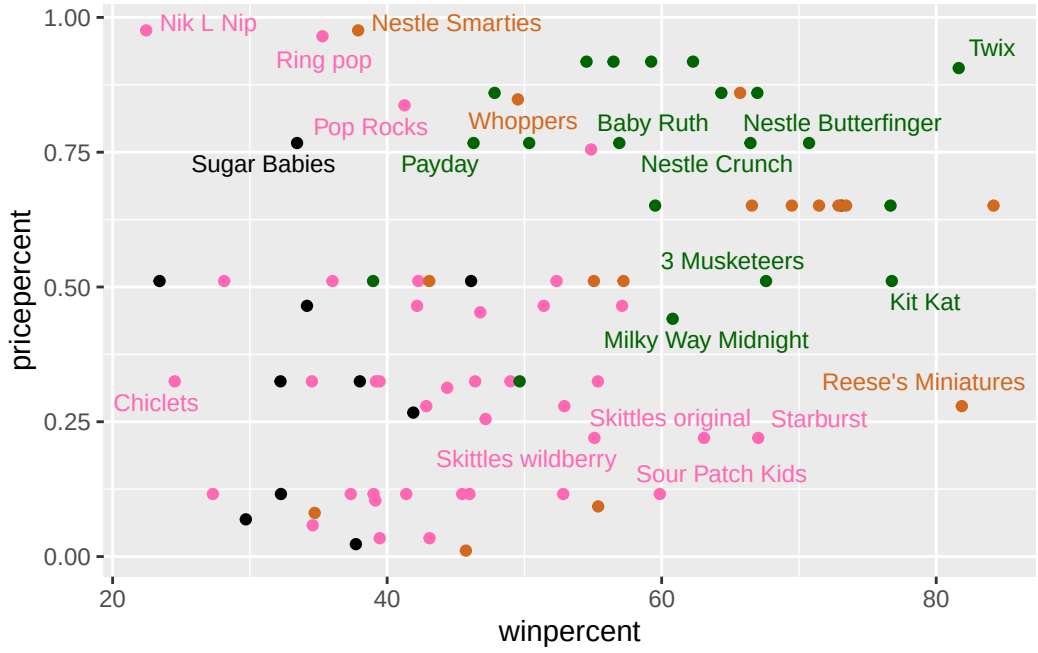
```
[1] "Starburst"
```

The best ranked fruity candy is starburt

5 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 = 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 have high winpercent but low pricepercent

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

Nik L Nip, Nestle Smarties, Ring pop, Hershey's Krackel, Hershey's Milk Chocolate are the 5 most expensive and least popular

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

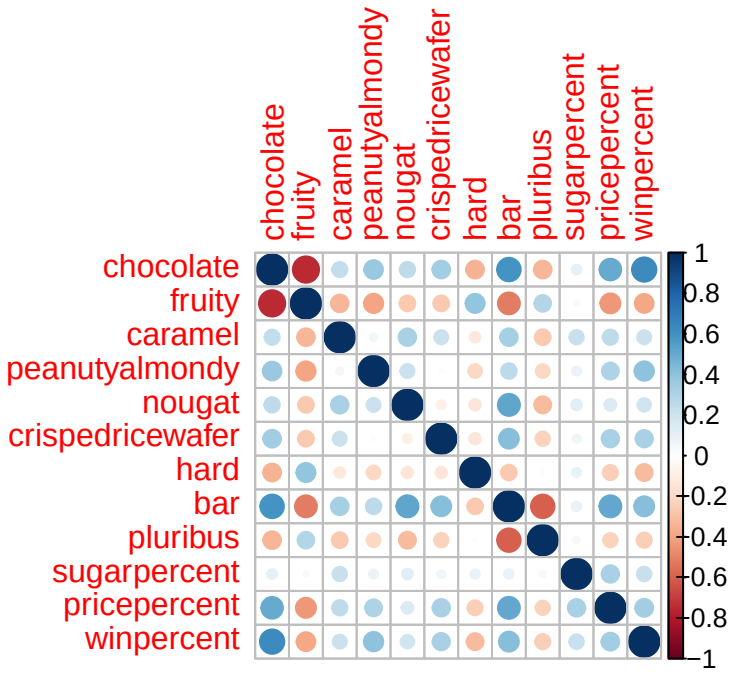
```
                        pricepercent winpercent
Nik L Nip                      0.976   22.44534
Nestle Smarties                0.976   37.88719
Ring pop                       0.965   35.29076
Hershey's Krackel              0.918   62.28448
Hershey's Milk Chocolate       0.918   56.49050
```

##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 are strongly anti-correlated, meaning candies that are chocolate are usually not fruity.

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

Chocolate and bar are the most positively correlated variables because candy bars mostly have chocolate.

Principal Component Analysis

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

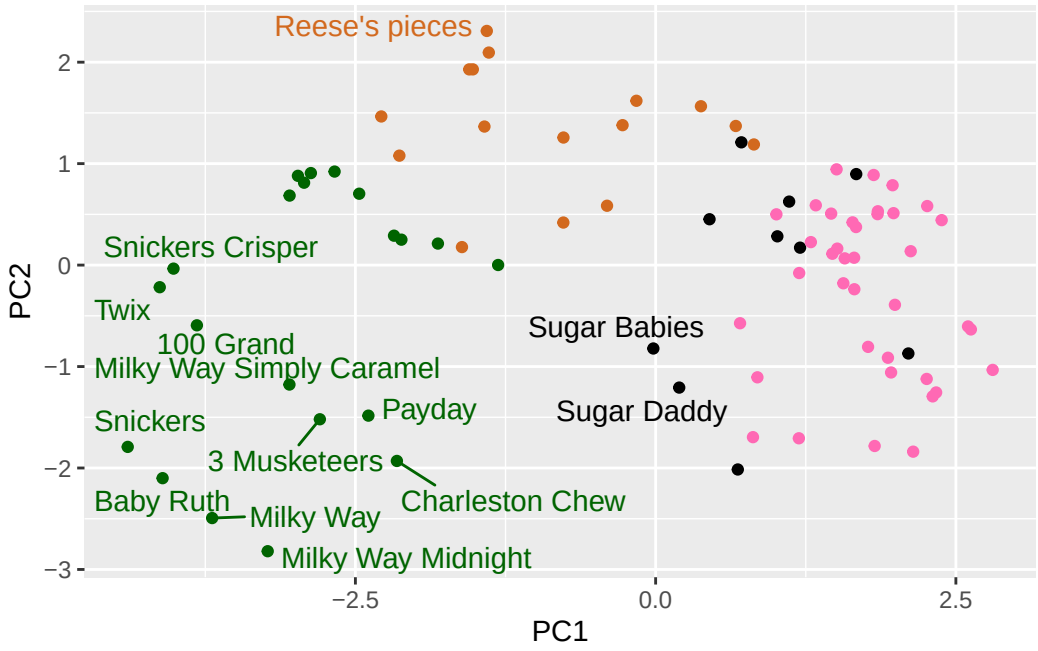
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688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

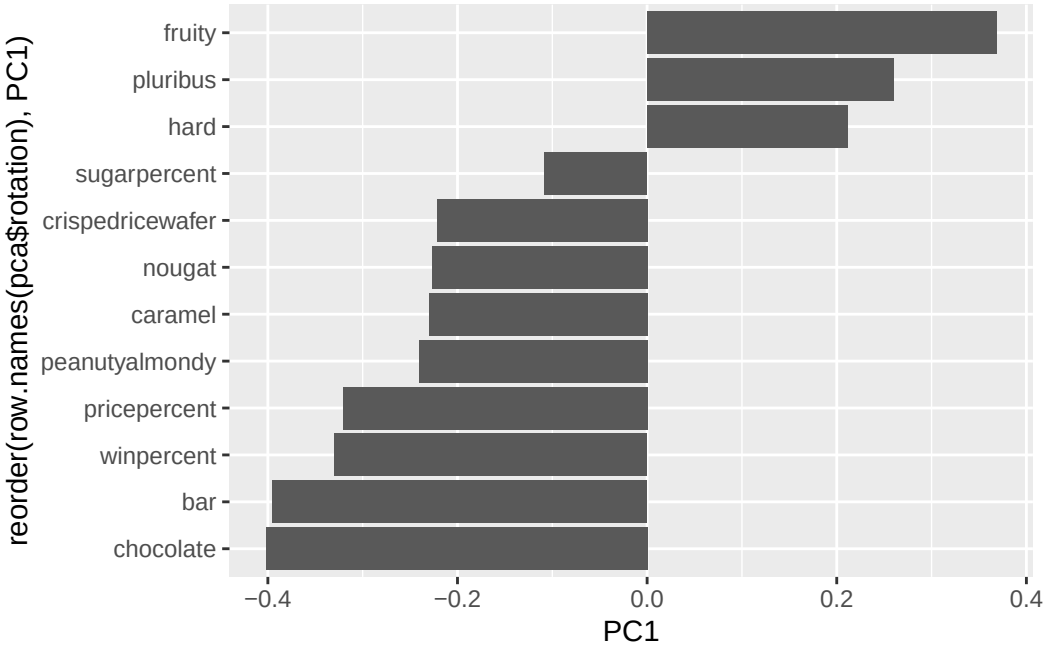
Score Plot...

```
ggplot(pca$x) +
  aes(PC1, PC2, label=row.names(pca$x)) +
  geom_point(col=my_cols)+
  geom_text_repel(max.overlaps = 5, col=my_cols)
```

```
Warning: ggrepel: 71 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```




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




```
#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?

PC1 is driven by fruity and hard candies and negatively by chocolate and bar candies. this makes sense because chocolate and fruit were negative before.

> 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?

Winning candies are mostly chocolate-based or bars because they have higher win percent values and positive correlations between them, and the PCA separating chocolate candies from the less popular fruity types.