Class 9: Halloween Candy Mini Project

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Here we analyze a candy dataset from the 538 website. This is a CSV file from their GitHub repository.

Data Import

```
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
```

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

```
nrow(candy)
```

```
[1] 85
```

There are 85 different candy types.

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

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

```
[1] 38
```

There are 38 fruity candy types.

Data Exploration

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

```
[1] 81.64291
```

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

```r
candy["Haribo Gold Bears", ]$winpercent
```

```
[1] 57.11974
```

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

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

```
[1] 76.7686
```

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

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

```
[1] 49.6535
```

```r
# install.packages("skimr")
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	

Q What's the least liked candy in the dataset?

```
# alternative: rownames(candy)[which.min(candy$winpercent)]
inds <- order(candy$winpercent)
head(candy[inds,])
```

```
                   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
```

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

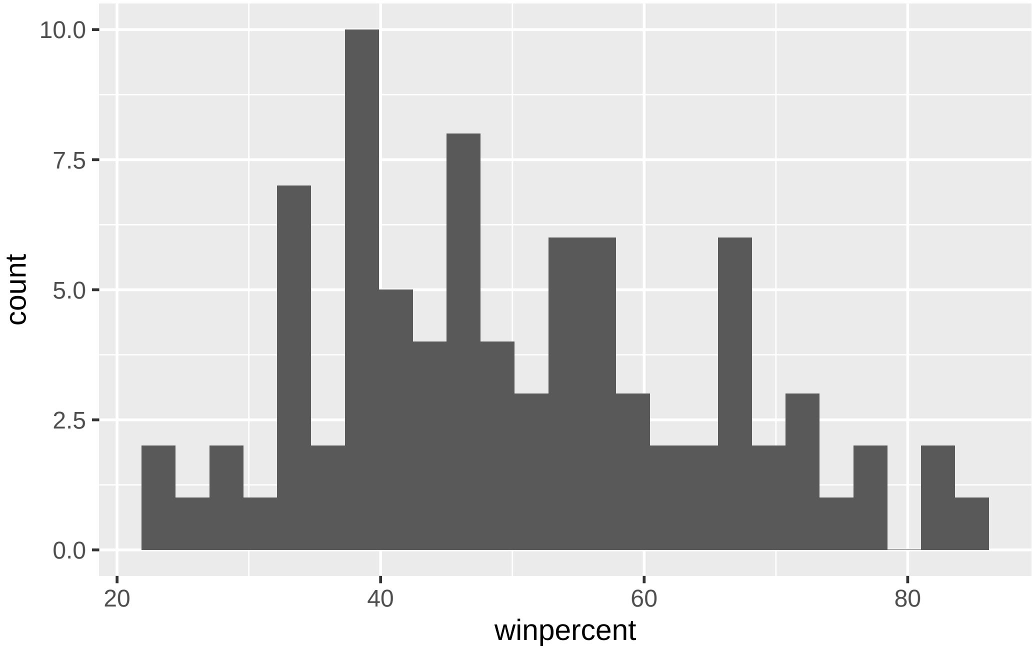
The winpercent variable is on a different scale (~50) compared to other columns (~<1).

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

0 represents a candy that doesn’t contain chocolate while 1 represents a candy that does.

> Q8. Plot a histogram of winpercent values

```r
library(ggplot2)
ggplot(candy, aes(winpercent)) + geom_histogram(bins=25)
```



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent values is not symmetrical, it is right skewed.

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

It looks like the distribution is centered just below 50%.

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

```
# chocolate candy mean winpercent
choc_rank <- candy[as.logical(candy$chocolate),]$winpercent
mean(choc_rank)
```

```
[1] 60.92153
```

```
# fruity candy mean winpercent
fruit_rank <- candy[as.logical(candy$fruity),]$winpercent
mean(fruit_rank)
```

```
[1] 44.11974
```

Looks like chocolate candy is ranked quite a bit higher than fruit candy.

> Q12. Is this difference statistically significant?

```
t.test(choc_rank, fruit_rank)
```

```

	Welch Two Sample t-test

data:  choc_rank and fruit_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 
```

The difference is statistically significance based on p-value = 2.871e-08 < 0.05.

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

```
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 %>% 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 like candy types are 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?

```r
candy %>% arrange(winpercent) %>% tail(5)
```

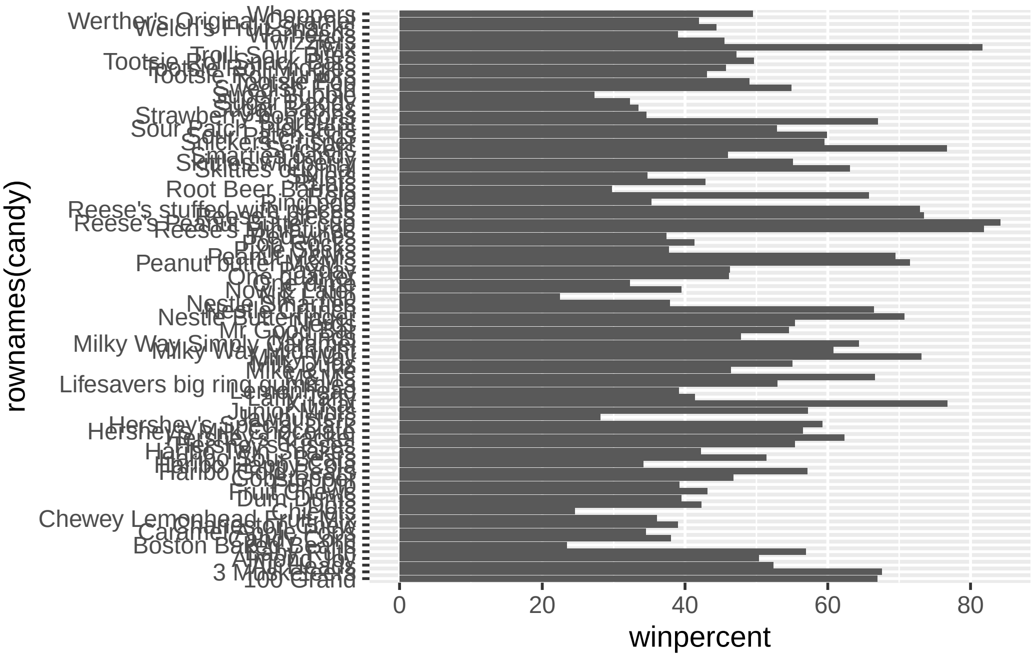
```
                          chocolate fruity caramel peanutyalmondy nougat
Snickers                          1      0       1              1      1
Kit Kat                           1      0       0              0      0
Twix                              1      0       1              0      0
Reese's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

The top five favorites are Snickers, Kit Kat, Twix, Reese's Miniatures, and Reese's Peanut Butter cup.

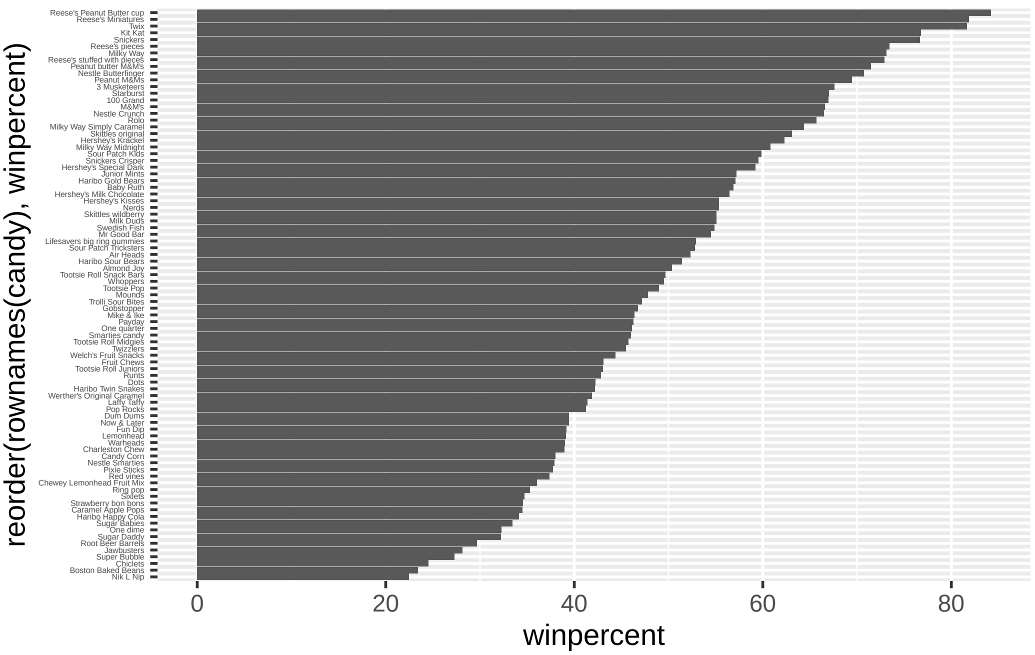
> Q15. Make a first barplot of candy ranking based on winpercent values.

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

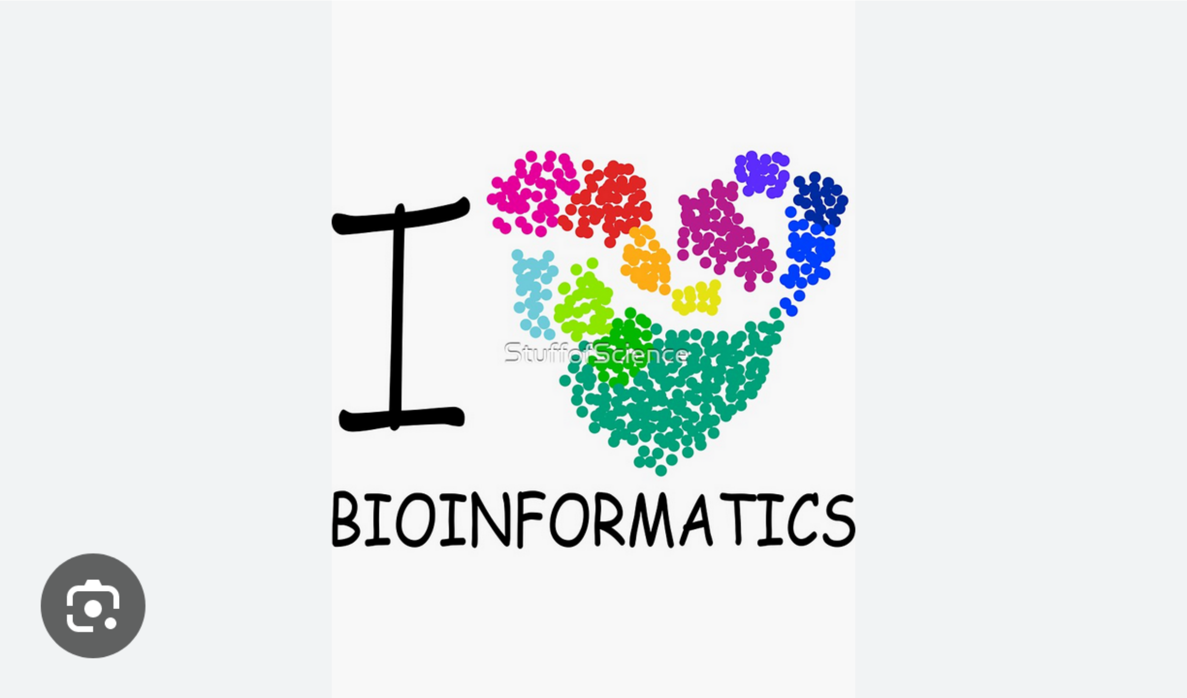


> Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent

```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col() +
  theme(axis.text.y = element_text(size=3))
```

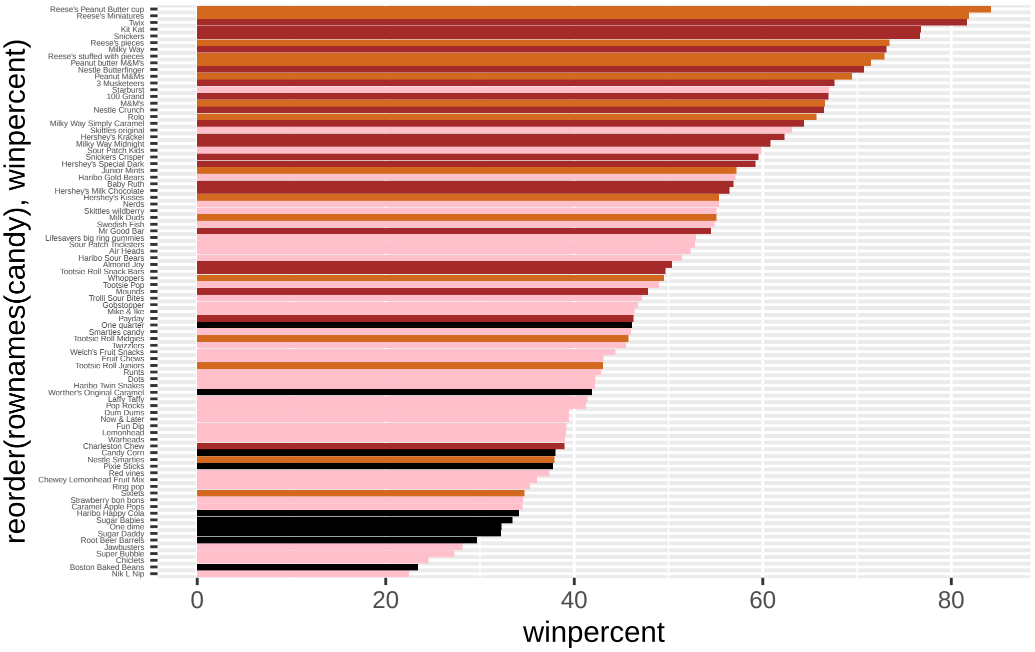


You can insert any image using this markdown syntax (you could alternatively save the previous plot using ggsave and customizing the plot dimensions then display the image in markdown).



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) +
  theme(axis.text.y = element_text(size=3))
```



Q17. What is the worst ranked chocolate candy?

Sixlets is the worst ranked chocolate candy.

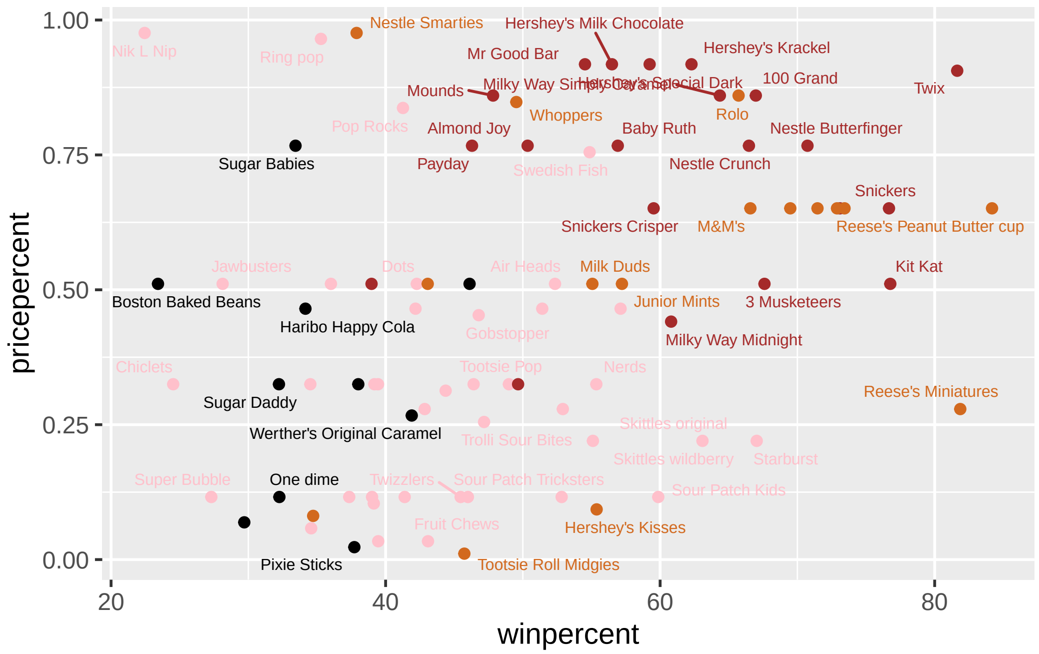
Q18. What is the best ranked fruity candy?

Starburst is the best ranked fruity candy.

Taking a look at pricepercent

```
# install.packages("ggrepel")
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=2, max.overlaps = 7)
```

```
Warning: ggrepel: 30 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?

Based on the plot, it looks like Reese's Miniatures offers the most bang for your buck.

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

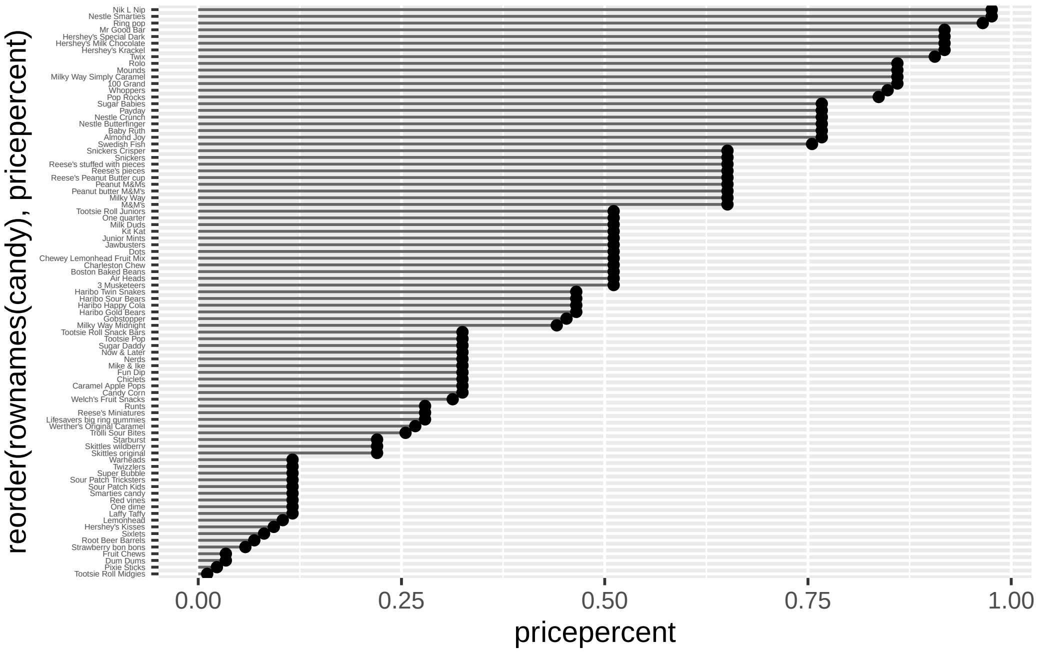
```r
# find top 5 most expensive, include winpercent col
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                         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 candies are Nestle Smarties, Nik L Nip, Ring pop, Mr Good Bar, Hershey's Special Dark, and Hershey's Milk Chocolate. Nik L Nip is the least popular of these.

> 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()

```r
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()  +
  theme(axis.text.y = element_text(size=3))
```

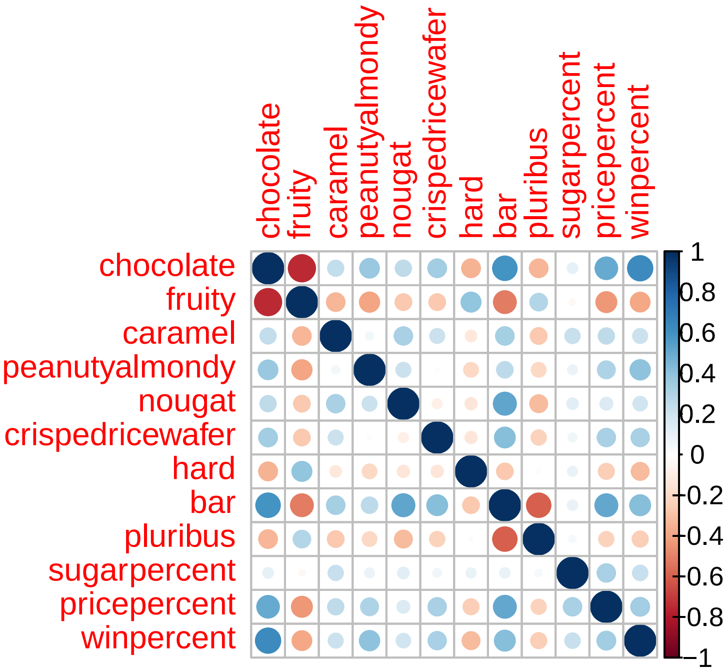


Exploring the correlation structure

```
#install.packages("corrplot")
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)?

It appears there are many variables that are anticorrelated, but the most negative correlation is between the fruity and chocolate variables.

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

The most positively correlated variables are chocolate and winpercent.

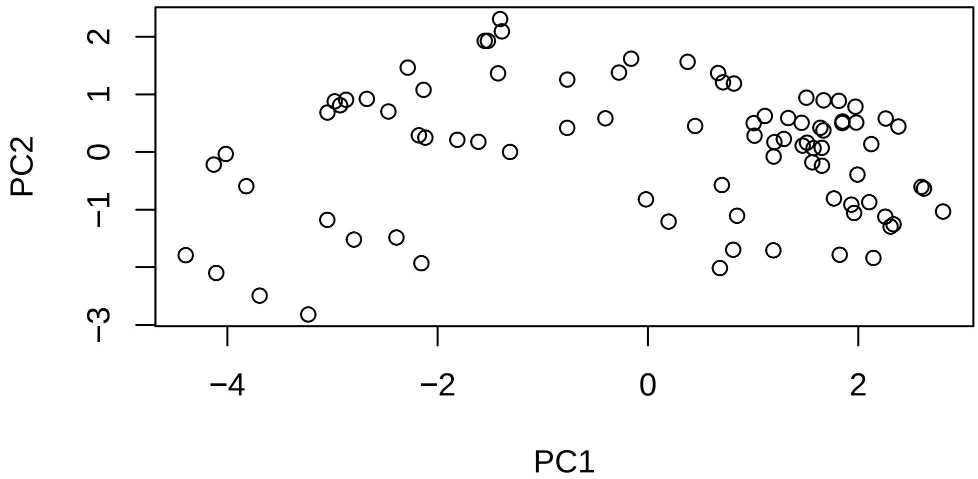
Principal Component Analysis

```
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
```

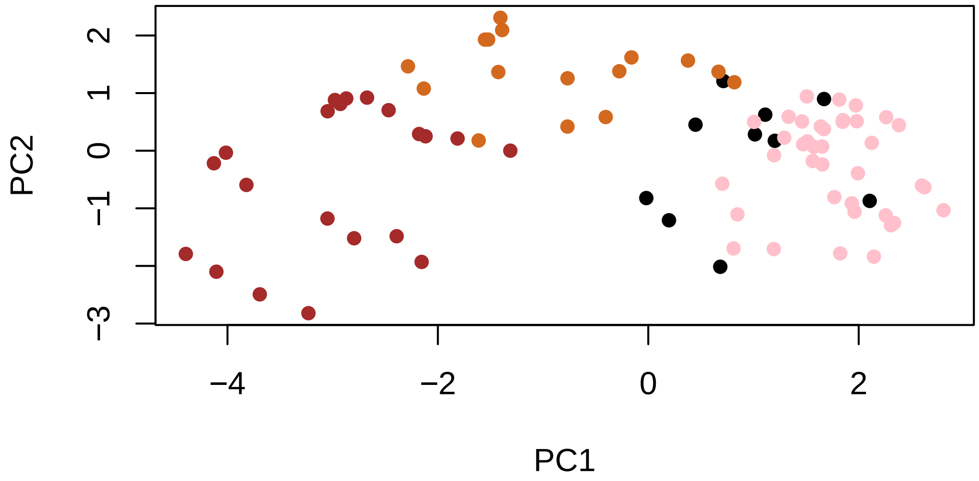
```
Proportion of Variance 0.04629 0.03833 0.03239 0.01611 0.01317
Cumulative Proportion  0.89998 0.93832 0.97071 0.98683 1.00000
```

```
plot(pca$x[,1:2])
```



Add some color

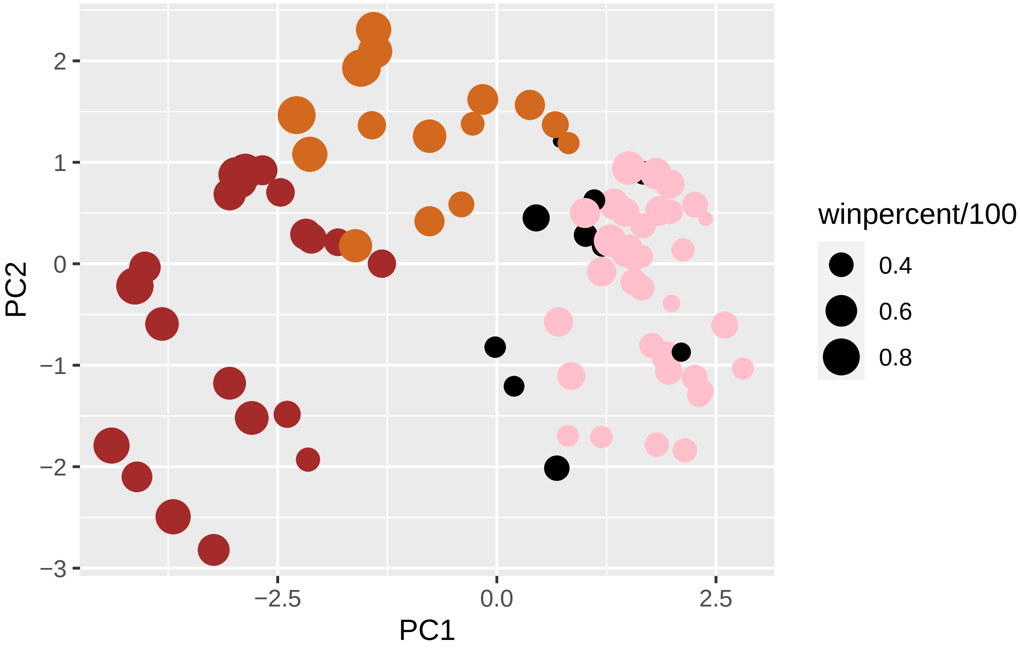
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



Make a nicer plot with ggplot

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

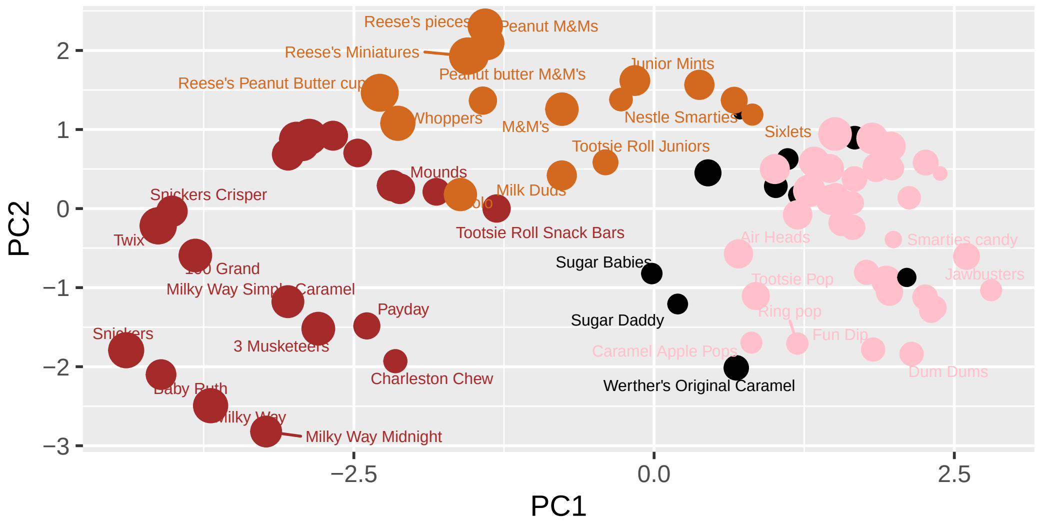
```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p
```



We can add labels with ggrepel

```
library(ggrepel)

p + geom_text_repel(size=2, 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: 48 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

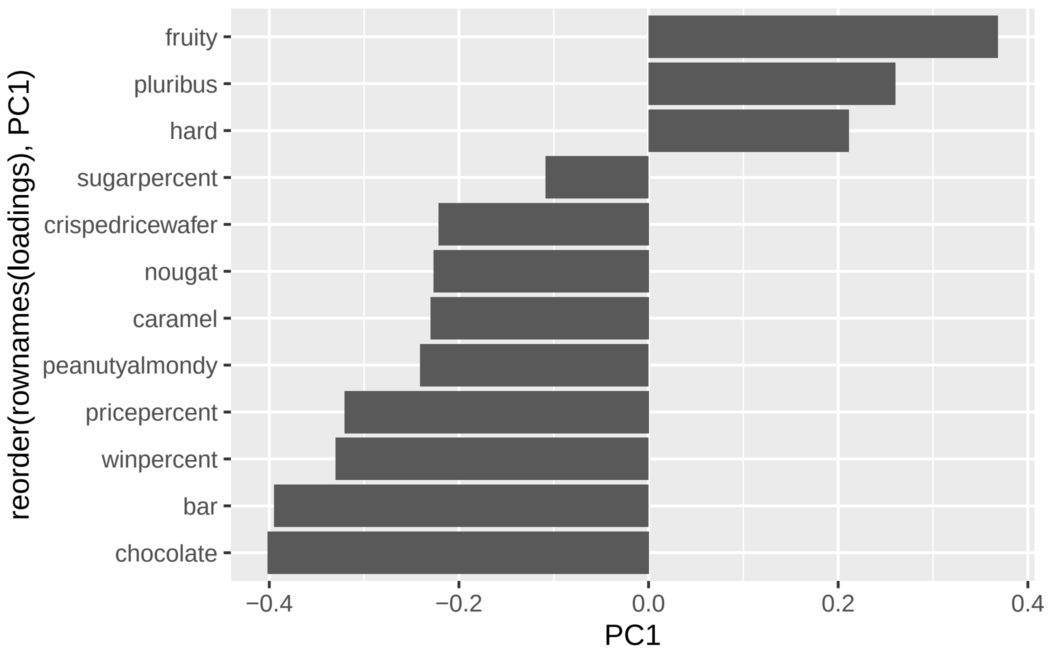
Now let's make an interactive plot

```
# commented out for rendering reasons

# install.packages("plotly")
# library(plotly)

# ggplotly(p)
```

Take a peek at the PCA loadings.

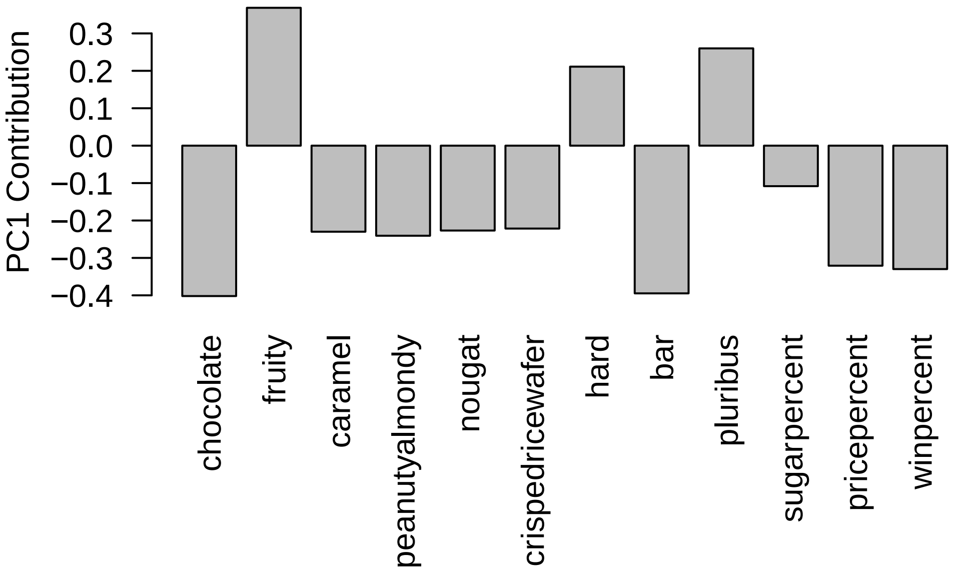
loadings plot

```
loadings <- as.data.frame(pca$rotation)

ggplot(loadings) +
  aes(PC1, reorder(rownames(loadings), PC1)) +
  geom_col()
```



Alternatively,

```
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, pluribus, and hard and picked up most strongly by PC1 in the positive direction. This makes some sense because we would most often expect fruity candies to be hard and one of many in a package. As shown, these variables are anticorrelated to variables like chocolate and bar. Overall, these loadings correspond to the correlation structure in previous plots.