Class9Candy_Project

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Importing candy data

First things first, let's get the data from the FiveThirtyEight GitHub repo

```
candy_file <- read.csv("https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-

head(candy_file)
```

```
             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

The dataset includes all sorts of information about different kinds of candy. For example, is a candy chocolaty? Does it have nougat? How does its cost compare to other candies? How many people prefer one candy over another?

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

```r
str(candy_file)
```

```
'data.frame':   85 obs. of  12 variables:
 $ chocolate       : int  1 1 0 0 0 1 1 0 0 0 ...
 $ fruity          : int  0 0 0 0 1 0 0 0 0 1 ...
 $ caramel         : int  1 0 0 0 0 0 1 0 0 1 ...
 $ peanutyalmondy  : int  0 0 0 0 0 1 1 1 0 0 ...
 $ nougat          : int  0 1 0 0 0 0 1 0 0 0 ...
 $ crispedricewafer: int  1 0 0 0 0 0 0 0 0 0 ...
 $ hard            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ bar             : int  1 1 0 0 0 1 1 0 0 0 ...
 $ pluribus        : int  0 0 0 0 0 0 0 1 1 0 ...
 $ sugarpercent    : num  0.732 0.604 0.011 0.011 0.906 ...
 $ pricepercent    : num  0.86 0.511 0.116 0.511 0.511 ...
 $ winpercent      : num  67 67.6 32.3 46.1 52.3 ...
```

There are 85 different candy types within this dataset

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

```r
sum(candy_file$fruity)
```

```
[1] 38
```

There are 38 fruity candy types in the dataset

What is your favorite candy?

One of the most interesting variables in the dataset is `winpercent`. For a given candy this value is the percentage of people who prefer this candy over another randomly chosen candy from the dataset. Higher values indicate a more popular candy.

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

```
candy_file["Mike & Ike",]$winpercent
```

```
[1] 46.41172
```

My favorite candy is Mike and Ike's and they have a winpercent value of 46.411

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

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

```
[1] 76.7686
```

Kit Kat's have a winpercent of 76.768

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

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

```
[1] 49.6535
```

Tootsie Roll Snack Bars have a winpercent of 49.653

```
library("skimr")
```

```
Warning: package 'skimr' was built under R version 4.4.3
```

```
skim(candy_file)
```

Table 1: Data summary

Name	candy_file
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?

The winpercent column is on a different scale than the majority of the data because it has a mean data of 50 whereas the others are between 0.08 and 0.4 means.

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

I think that a one represents a belonging to that category wheras a 0 represents a lack of belonging to that category

Exploratory analysis

A good place to start any exploratory analysis is with a histogram.

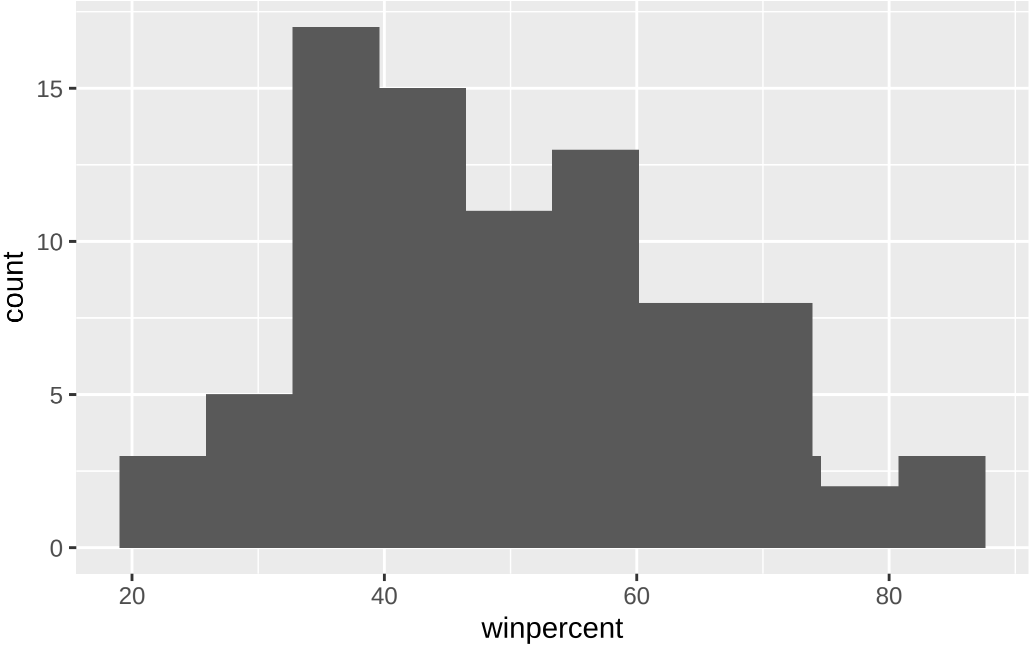
> Q8. Plot a histogram of winpercent values

```
library(ggplot2)
```

```
Warning: package 'ggplot2' was built under R version 4.4.3
```

```
ggplot(candy_file) + aes(winpercent) + geom_histogram() + stat_bin (bins = 10)
```

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



> Q9. Is the distribution of winpercent values symmetrical?

The histogram is sligthly skewed to the right. Making it assymmetric

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

The center of the distributuion is below 50%

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

```
mean_chocolate <- mean(candy_file$winpercent[as.logical(candy_file$chocolate)])
mean_chocolate
```

```
[1] 60.92153
```

```
mean_fruity <- mean(candy_file$winpercent[as.logical(candy_file$fruity)])
mean_fruity
```

```
[1] 44.11974
```

Chocolate candy has a higher rating than fruity on average

> Q12. Is this difference statistically significant?

```
t.test(candy_file$winpercent[as.logical(candy_file$chocolate)], candy_file$winpercent[as.logi
```

```

	Welch Two Sample t-test

data:  candy_file$winpercent[as.logical(candy_file$chocolate)] and candy_file$winpercent[as.l
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 
```

We can reject the null hypothesis that there is a difference. The difference is significant because a p=2.871e-08 < 0.05

Overall Candy Rankings

Let's use the base R order() function together with `head()` to sort the whole dataset by winpercent. Or if you have been getting into the tidyverse and the dplyr package you can use the `arrange()` function together with `head()` to do the same thing and answer the following questions:

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

```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
```

```r
candy_file |> 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 liked candies are Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters.

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

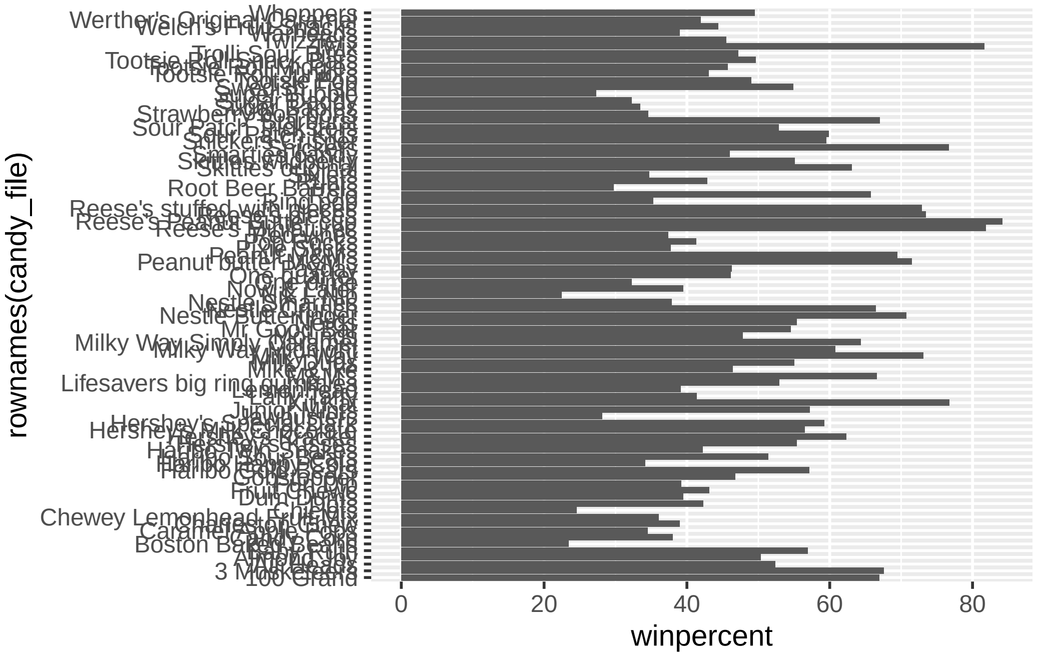
```r
candy_file |> arrange(winpercent) |> tail(5)
```

```
                          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 5 of all time are Snickers, Kit Kat, Reese's Minatures, and Reese's Peanut Butter cup.

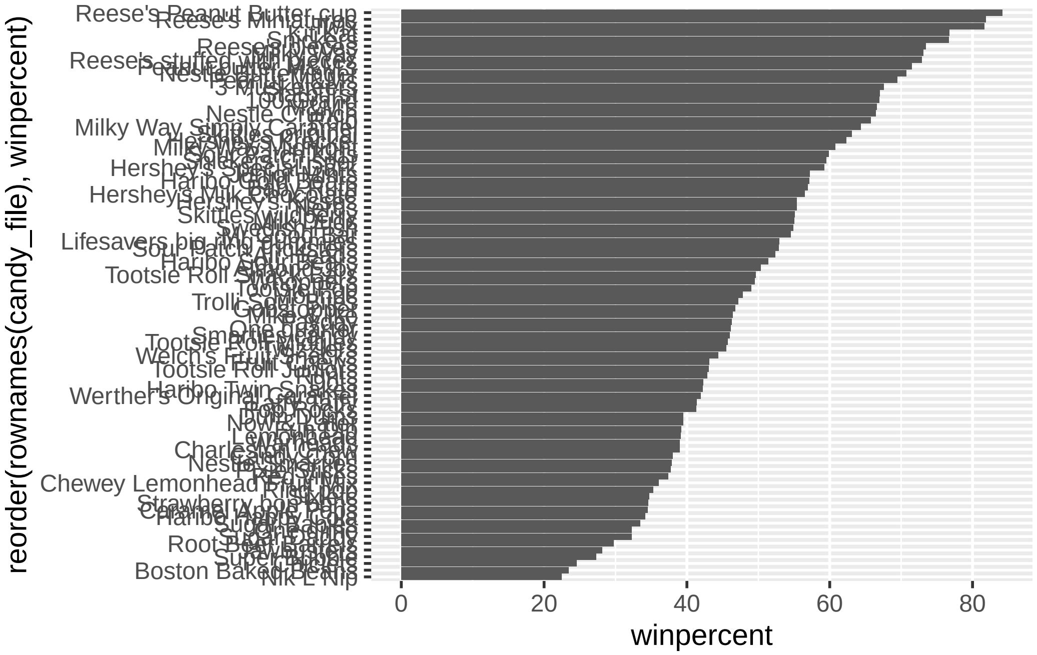
> Q15. Make a first barplot of candy ranking based on winpercent values.

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



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

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

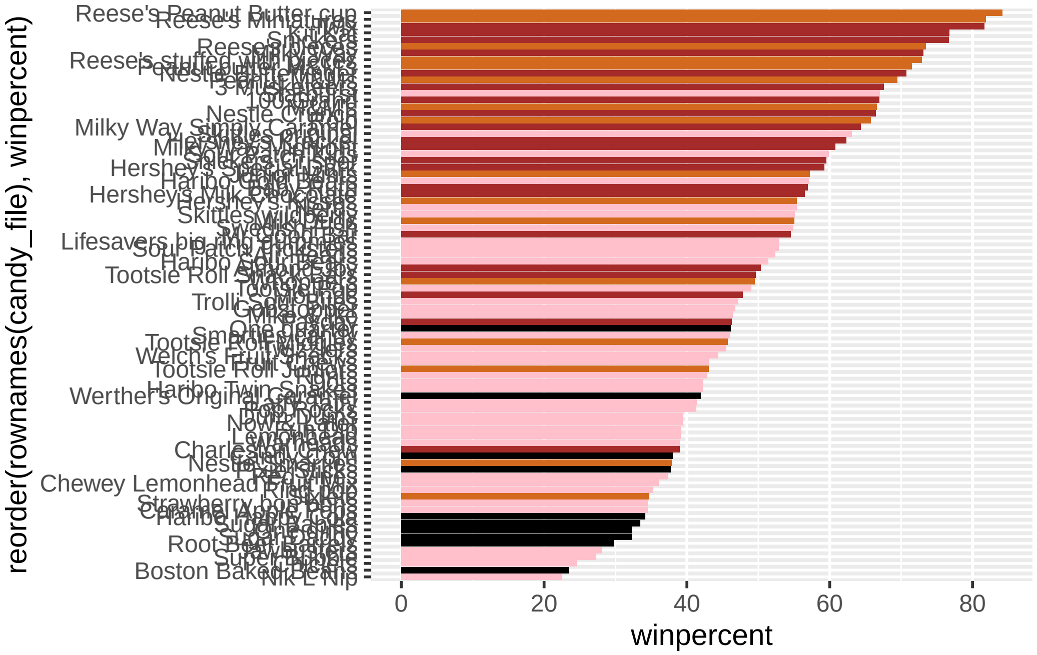


Time to add some useful color

Let's setup a color vector (that signifies candy type) that we can then use for some future plots. We start by making a vector of all black values (one for each candy). Then we overwrite chocolate (for chocolate candy), brown (for candy bars) and red (for fruity candy) values.

```
my_cols=rep("black", nrow(candy_file))
my_cols[as.logical(candy_file$chocolate)] = "chocolate"
my_cols[as.logical(candy_file$bar)] = "brown"
my_cols[as.logical(candy_file$fruity)] = "pink"
```

```
ggplot(candy_file) + aes(winpercent, reorder(rownames(candy_file), winpercent)) + geom_col(fi
```



Q17. What is the worst ranked chocolate candy?

Sixlets

Q18. What is the best ranked fruity candy?

Starbursts

Taking a look at pricepercent

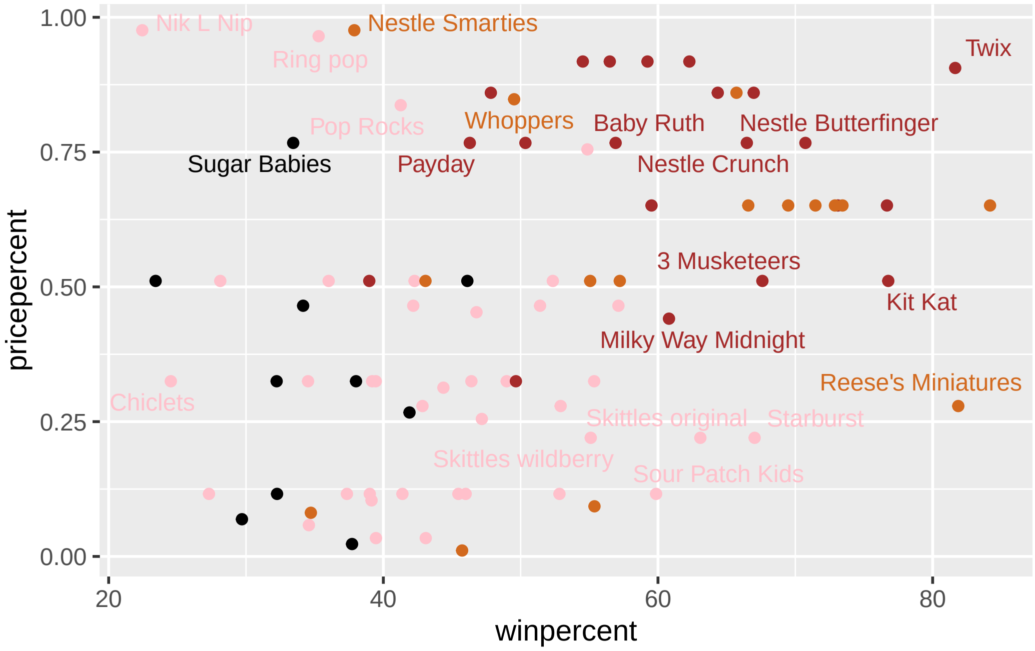
What about value for money? What is the best candy for the least money?

```
library(ggrepel)
```

```
Warning: package 'ggrepel' was built under R version 4.4.3
```

```
# How about a plot of win vs price
ggplot(candy_file) +
  aes(winpercent, pricepercent, label=rownames(candy_file)) +
  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?

```
ordleast <- order(candy_file$pricepercent, decreasing = TRUE)
head( candy_file[ordleast,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
```

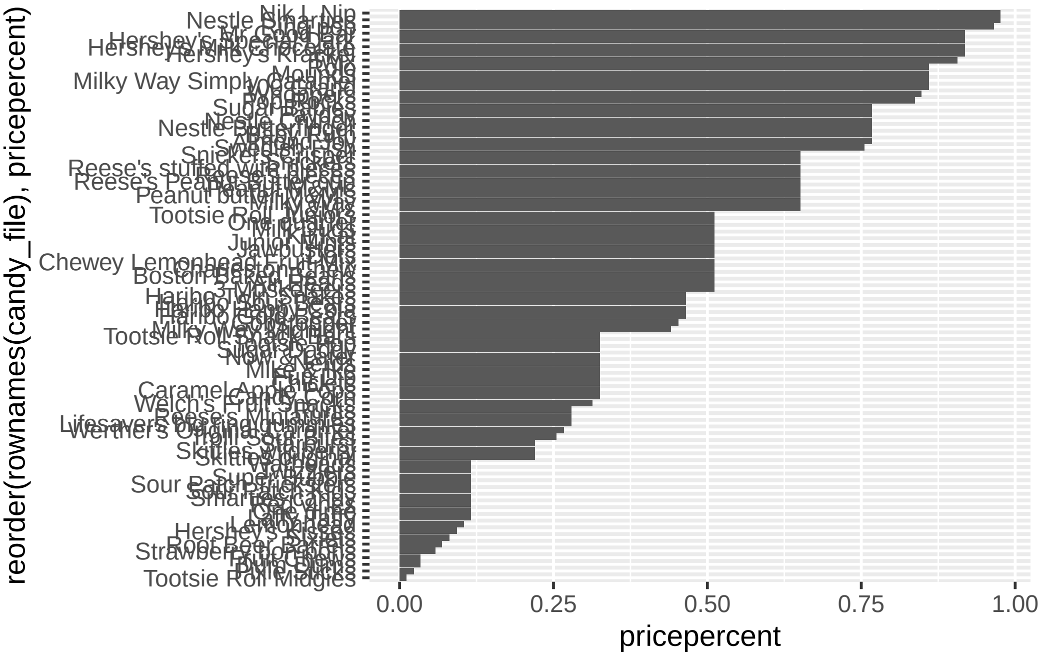
Q20. What are the top 5 most expensive candy types in the dataset and of these which is the least popular?

```
ordmost <- order(candy_file$pricepercent, decreasing = F)
head( candy_file[ordmost,c(11,12)], n=5 )
```

```
                         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
```

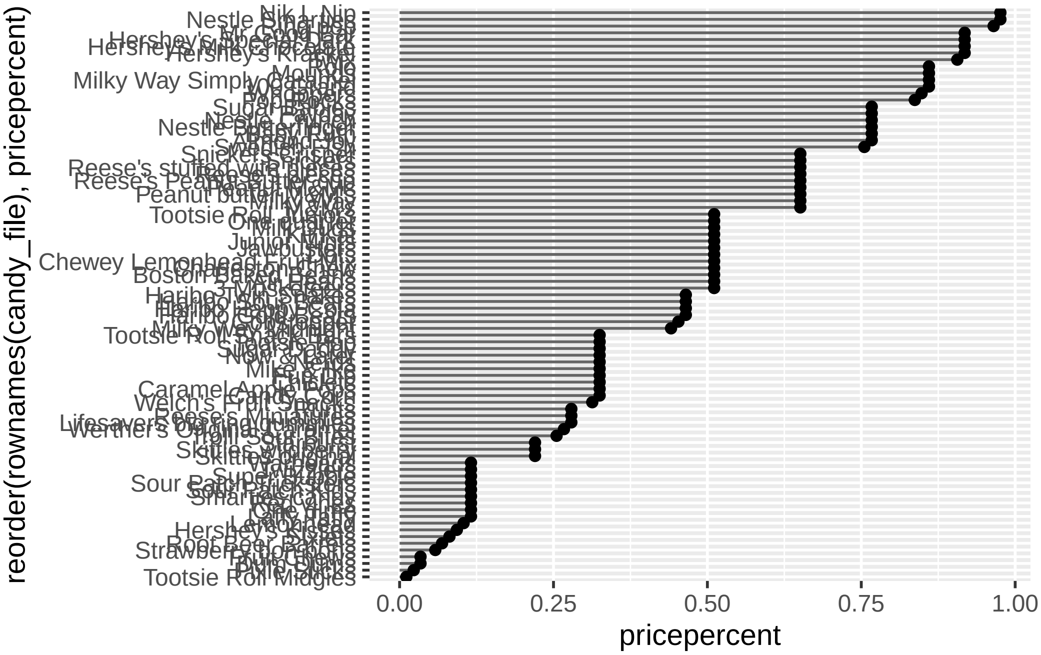
> Q21. Make a barplot again with geom_col() this time using pricepercent and then improve this step by step, first ordering the x-axis by value and finally making a so called "dot chat" or "lollipop" chart by swapping geom_col() for geom_point() + geom_segment().

```r
ggplot(candy_file) + aes(pricepercent, reorder(rownames(candy_file), pricepercent)) + geom_co
```



Make a lollipop chart of pricepercent

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



One of the most interesting aspects of this chart is that a lot of the candies share the same ranking, so it looks like quite a few of them are the same price.

Exploring the correlation structure

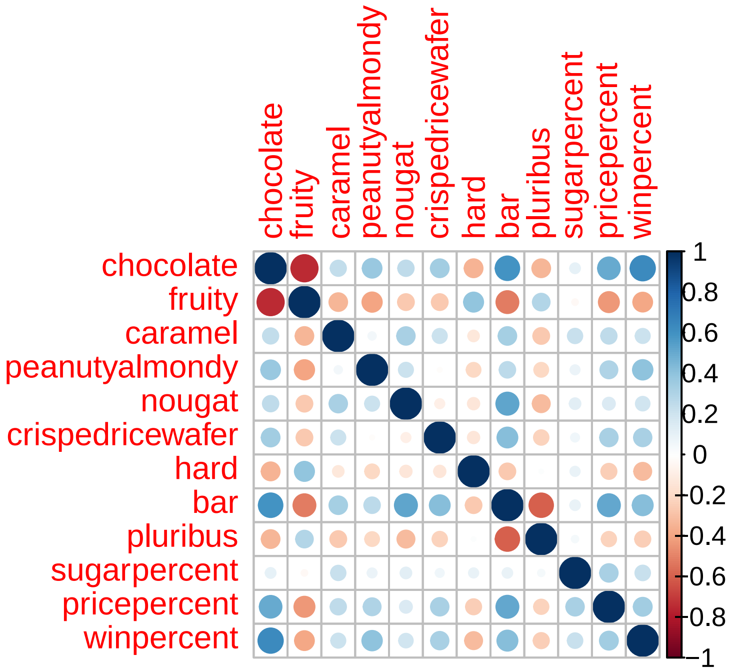
Now that we've explored the dataset a little, we'll see how the variables interact with one another. We'll use correlation and view the results with the corrplot package to plot a correlation matrix.

```r
library(corrplot)
```

```
Warning: package 'corrplot' was built under R version 4.4.3
```

```
corrplot 0.95 loaded
```

```r
corcandy <- cor(candy_file)
corrplot(corcandy)
```



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

The two variables that have a strong negative correlation chocolate and fruity

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

The chocolate variable and the winpercent variable have the strongest positive correlation.

Principal Component Analysis

Let's apply PCA using the prcomp() function to our candy dataset remembering to set the scale=TRUE argument.

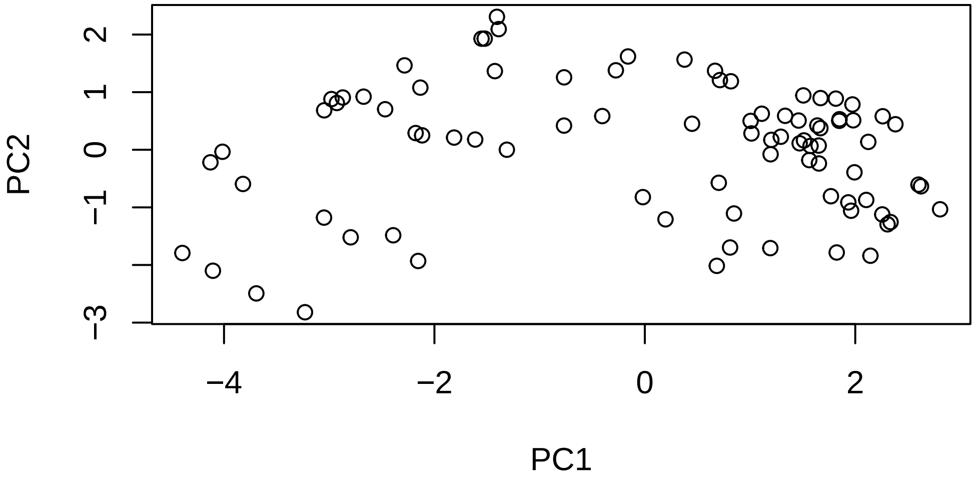
```r
pcacandy <- prcomp(candy_file, scale = T)
summary(pcacandy)
```

```
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
```

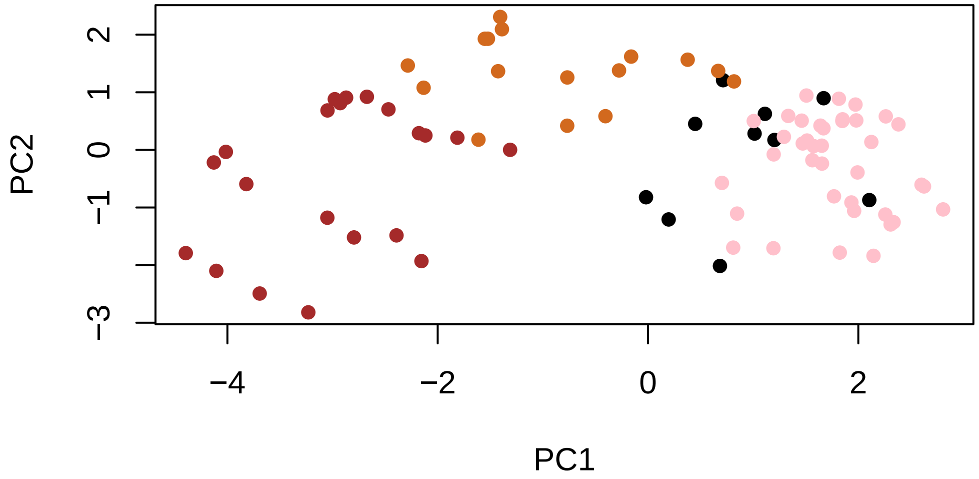
Let's plot our main PCA scores (PCA1 and PCA2)

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



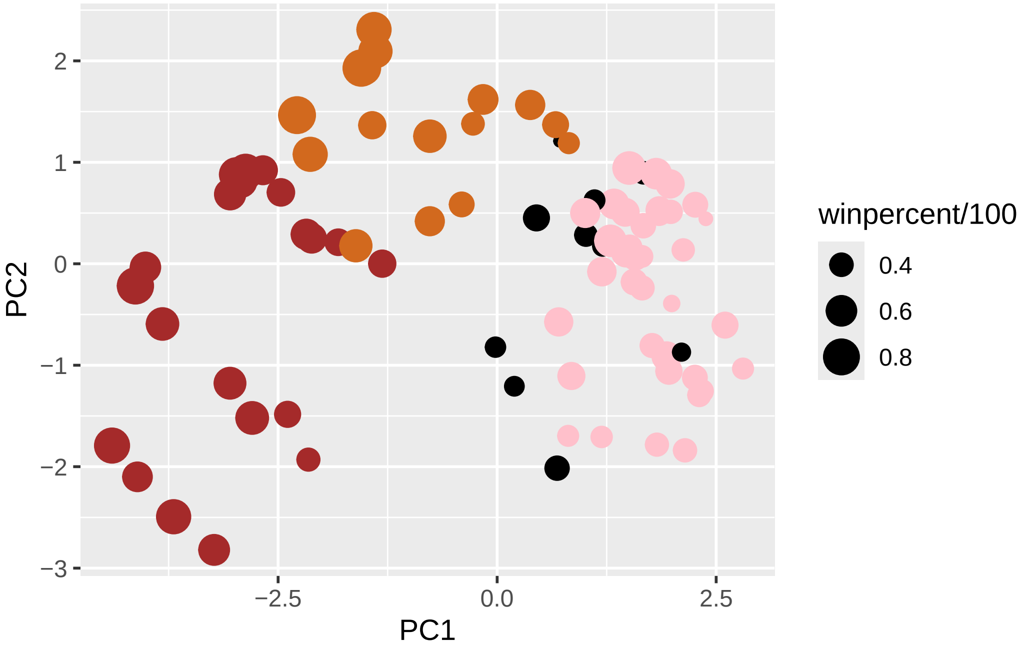
We can change the colors and characters

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



LEt's try it with ggplot

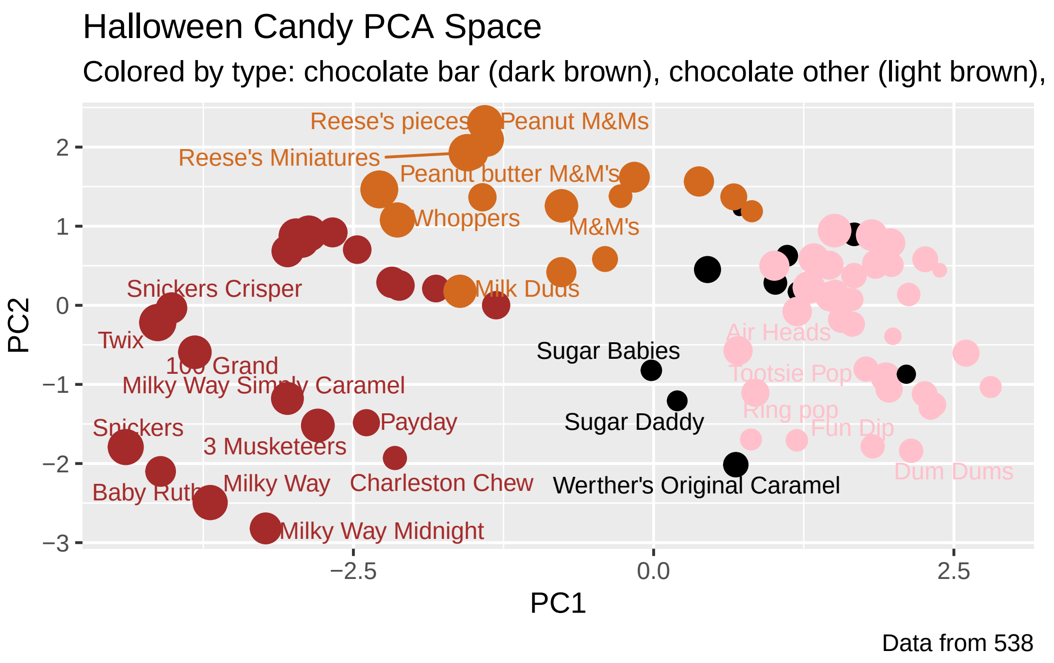
```
my_data <- cbind(candy_file, pcacandy$x[,1:3])
pcaggplot <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)
pcaggplot
```



Lets use greppel and label the plot

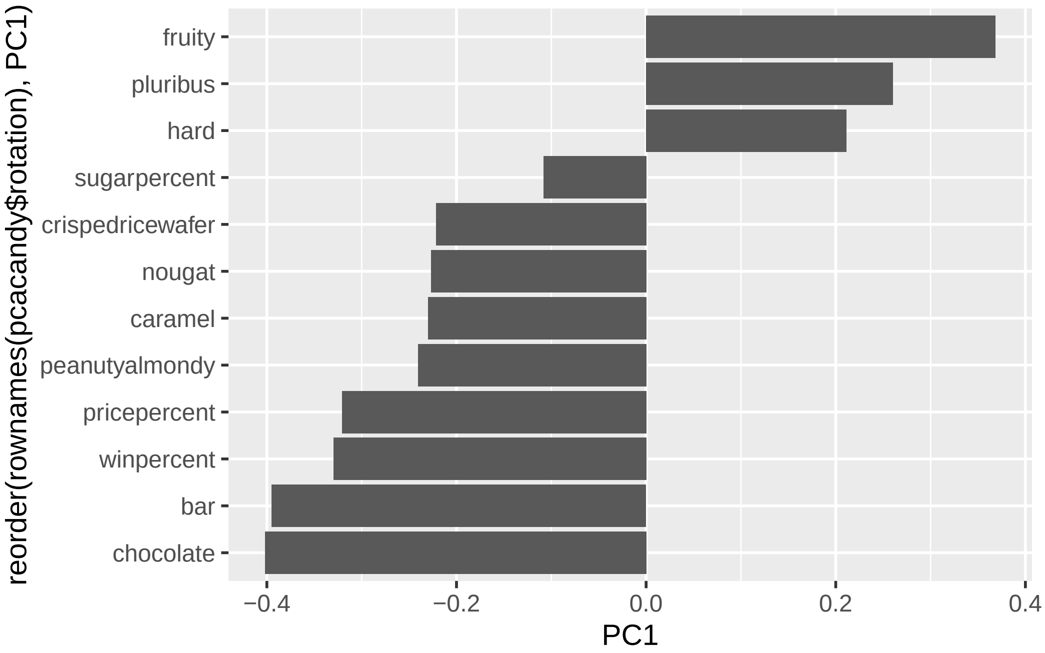
```
pcaggplot + geom_text_repel(size=3.3, col=my_cols, max.overlaps = 7)  +
  theme(legend.position = "none") +
  labs(title="Halloween Candy PCA Space",
       subtitle="Colored by type: chocolate bar (dark brown), chocolate other (light brown),
       caption="Data from 538")
```

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



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(pcacandy$rotation) +
  aes(x = PC1, y = reorder(rownames(pcacandy$rotation), PC1)) +
  geom_col()
```



The fruity, pluribis, and hard variables are picked up strongly by the PCA. These make sense because they are popular charicteristics of candy. This was highlighted in the previous question that also use bar plots.

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?

Based on visual data, chocolate and bar candies seems to preform the best, and fruity candies the worst. Positive correlation is associated with chocolate and bar candies, while a negative correlation is associated with fruity candies. PC1 has a shows chocolate and bar variables along one of the axis and fruity and plurabis along a different axis. These all propose that the "winning" candy is likely a chocolate candy in a bar form.