Class 09 Candy Mini Project BIMM 143

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Class 09 Mini Project - CANDY

First, we are going to need to download the data by using some commands!

```
candy_file <- "candy-data.txt"
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
```

We are going to answer questions along the way!

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

```
nrow(candy)
```

```
[1] 85
```

There are 85 different candies in the data set.

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

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

```
[1] 38
```

There are 38 candies that are fruity.

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

```
#Win percent for Twix
candy["Twix",]$winpercent
```

```
[1] 81.64291
```

For my favorite candy, I like Sour Patch Kids.

```
candy["Sour Patch Kids",]$winpercent
```

```
[1] 59.864
```

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

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

```
[1] 76.7686
```

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

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

```
[1] 49.6535
```

Bonus Question For fun let's find the lowest ranked candy!

```
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
```

Looks like something called Nik L Nip is the least favorite candy in the datas et!

There is a useful function called `skim()` in order to get an overview of your data.

```
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	

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 has a differenct scale. Most are 0 to 1, but WinPercent has a different range.

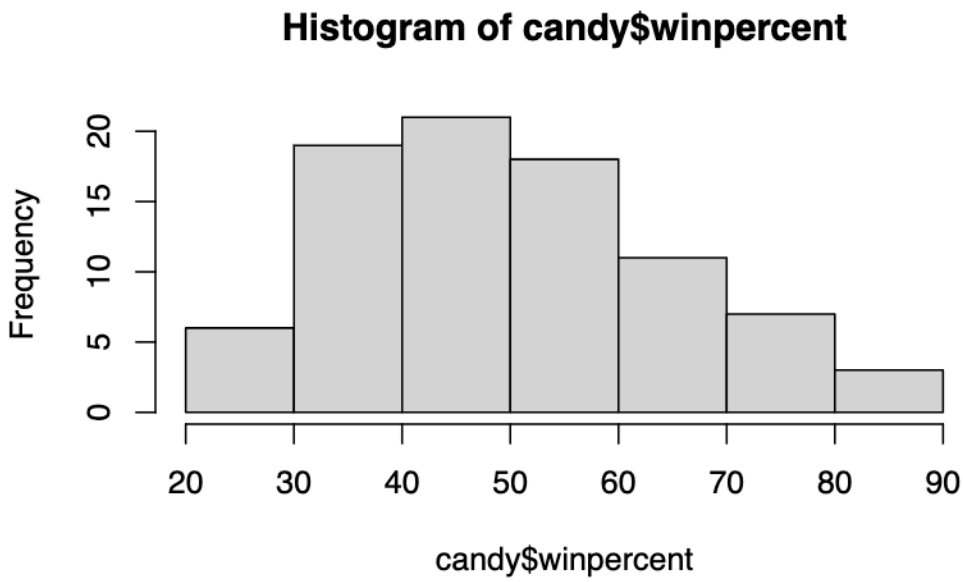
Q7. What do you think a zero and one represent for the candy$chocolate column?

The 0 represents that there is no chocolate in that certain candy, the 1 represents that there is chocolate present in that candy.

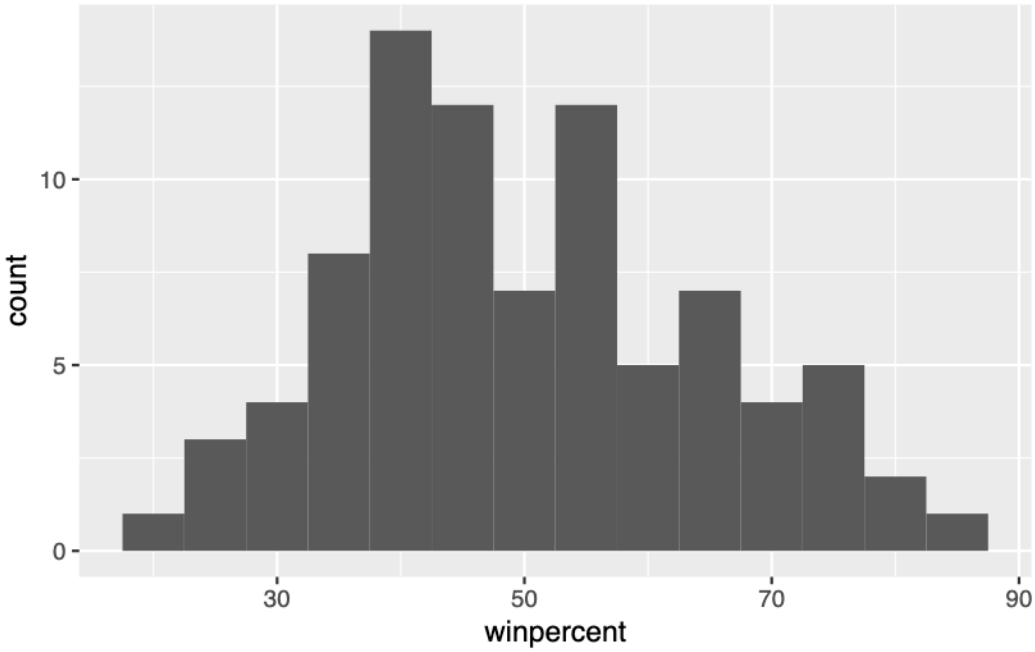
Q8. Plot a histogram of winpercent values

We are going to use two different ways to make the histogram!

```
hist(candy$winpercent, breaks=7)
library(ggplot2)
```




```
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(binwidth = 5)
```



Q9. Is the distribution of win percent values symmetrical?

The distribution is unimodal with the center being around 45%.

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

Below.

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

Here is the mean for chocolate. Next for fruity.

```
chocolate.win <- candy$winpercent[as.logical(candy$chocolate)]
chocolate_mean <- mean(candy$winpercent[as.logical(candy$chocolate)])
chocolate_mean
```

```
[1] 60.92153
```

```
fruity.win <- candy$winpercent[as.logical(candy$fruity)]
fruity_mean <- mean(candy$winpercent[as.logical(candy$fruity)])
fruity_mean
```

```
[1] 44.11974
```

On average, *chocolate* is higher ranked.

Q12. Is this difference statistically significant?

```
x <- c(chocolate.win, fruity.win)
t.test(x)
```

```
    One Sample t-test

data:  x
t = 31.775, df = 74, p-value < 2.2e-16
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
 49.12217 55.69508
sample estimates:
mean of x
 52.40862
```

Since the P-value of 2.2e-16 is less than 0.05, then we can say they are statistically significant! People like chocolate more than fruiy candy!

Overall Candy Rankings

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

These are the bottom 6 candies! We used the `head()` function!

```
inds <- order(candy$winpercent)
head(candy[inds, ])
```

	chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	sugarpercent	pricepercent
Nik L Nip	0	1	0	0	0	0	0	0	1	0.197	0.976
Boston Baked Beans	0	0	0	1	0	0	0	0	1	0.313	0.511
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						

```
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?

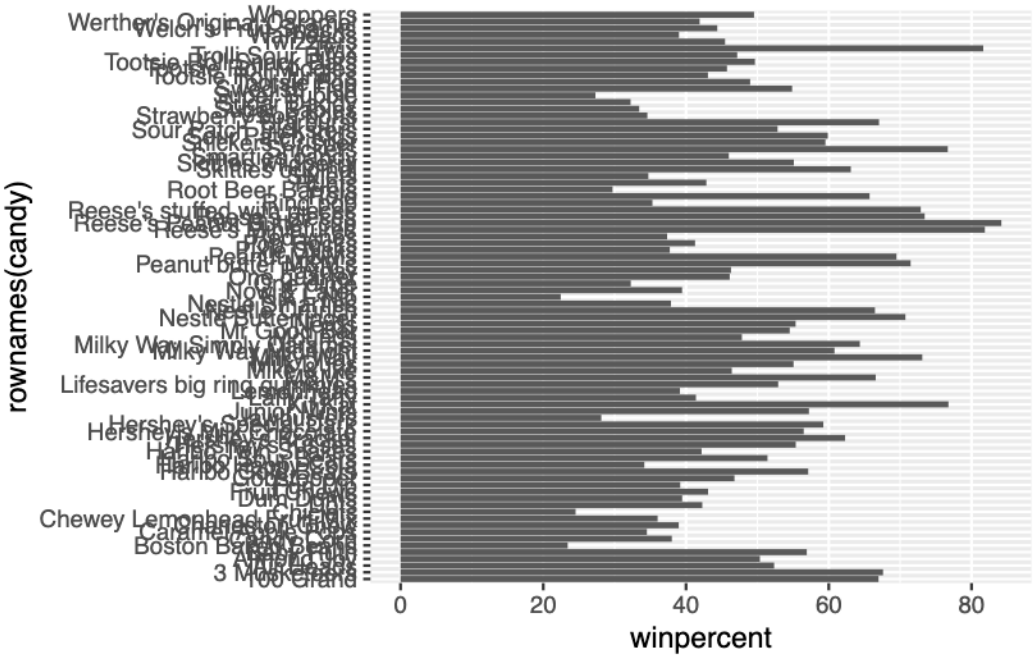
These are the top 6 favorite candies! We used the `tail()` function!

```
inds <- order(candy$winpercent)
tail(candy[inds, ])
```

```
                         chocolate fruity caramel peanutyalmondy nougat
Reese's pieces                   1      0       0              1      0
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
Reese's pieces                          0    0   0        1        0.406
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
Reese's pieces                  0.651   73.43499
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.

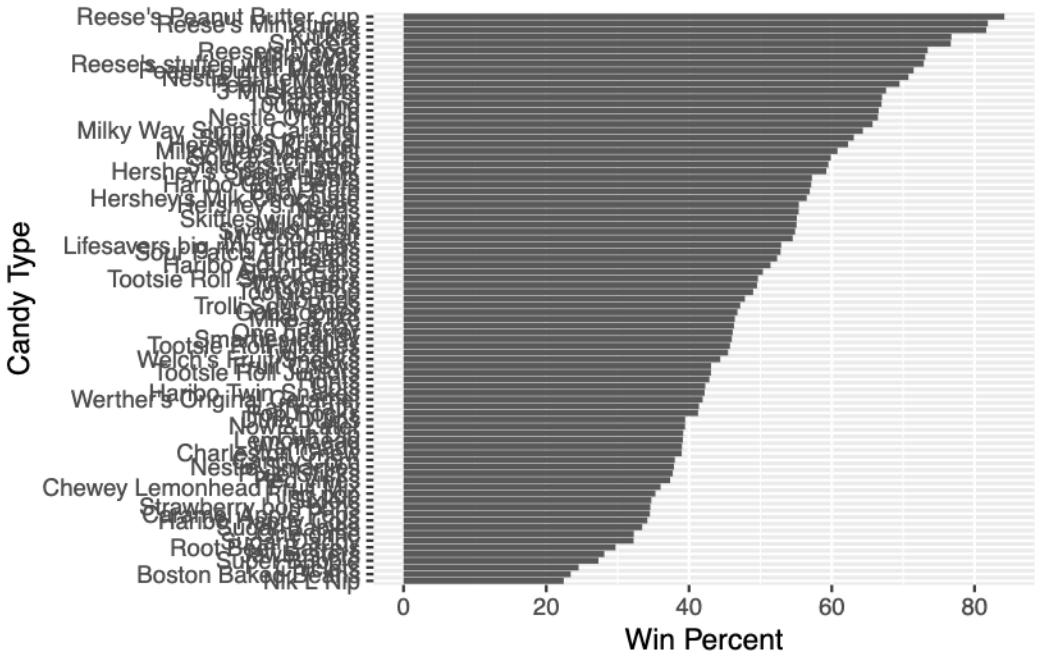
```
library(ggplot2)
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col()
```



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

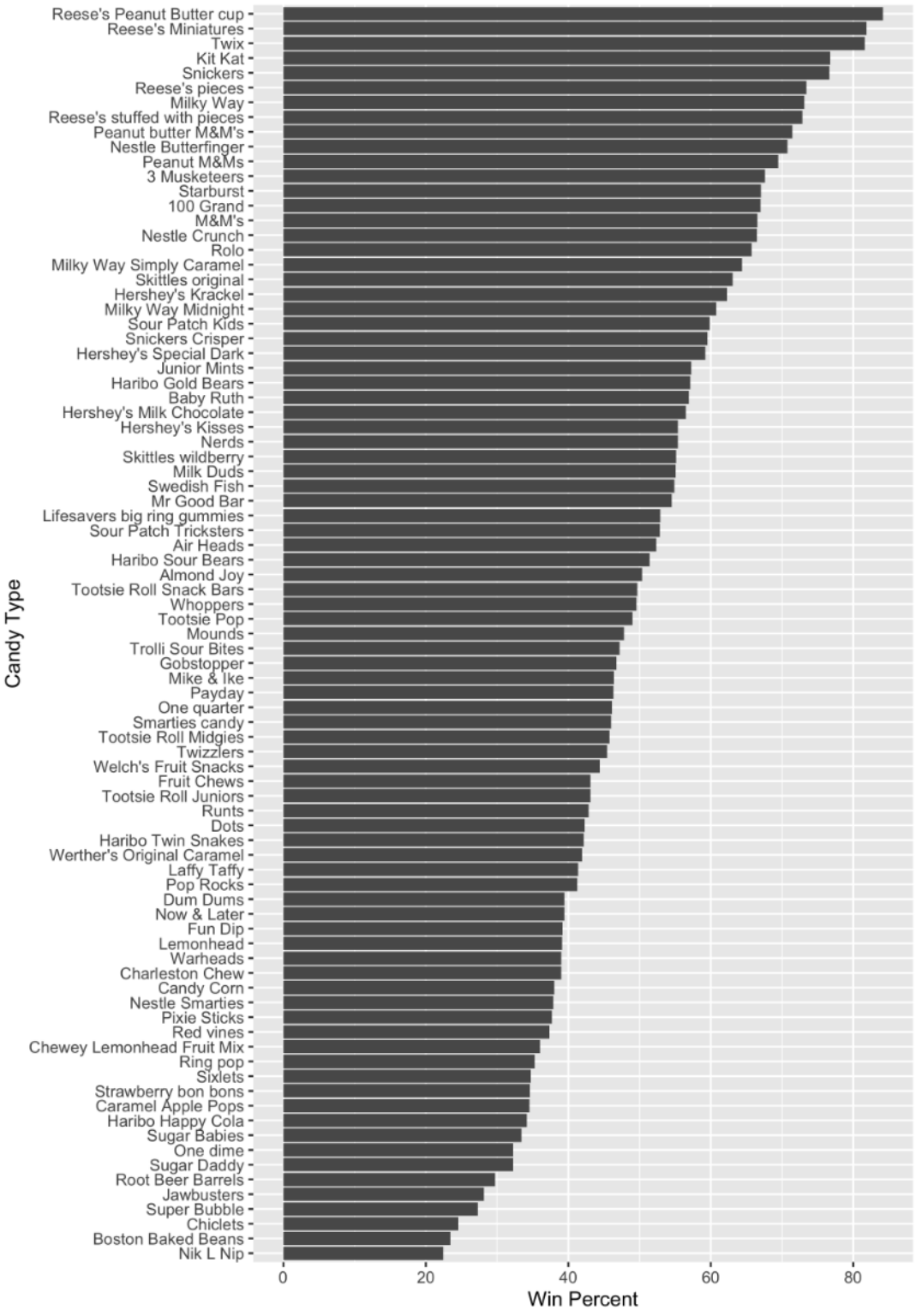
We are going to reorder the Y axis using the `reorder()` function.

```
library(ggplot2)
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent), breaks=20) +
  geom_col() +
  labs(x="Win Percent", y="Candy Type")
```



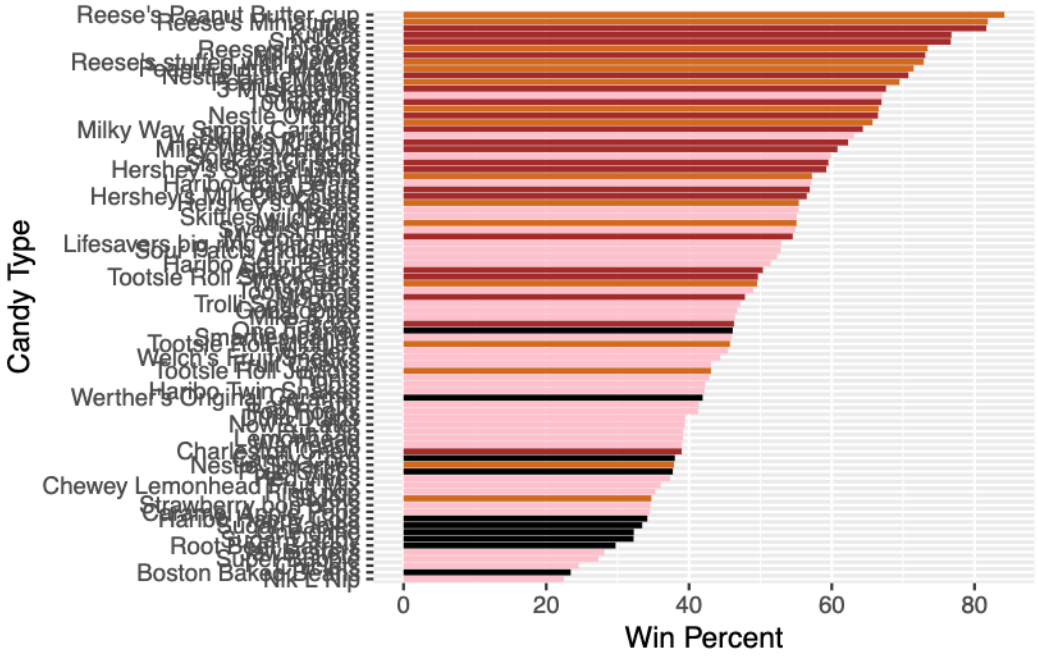

```
ggsave('barplot1.png', width=7, height=10)
```

There is no way to make the letters less scrunched up on the window for the Quarto Document. However, you can save it into a different file and change the height and width to see better! Then you can type `![](barplot1.png)` in order to view your externally saved file! You can actually insert any image with this syntax. As long as it is a "png, gif, or jpeg"


Reese's Peanut Butter cup
Reese's Miniatures
Twix
Kit Kat
Snickers
Reese's pieces
Milky Way
Reese's stuffed with pieces
Peanut butter M&M's
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&M's
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
Hershey's Krackel
Milky Way Midnight
Sour Patch Kids
Snickers Crisper
Hershey's Special Dark
Junior Mints
Haribo Gold Bears
Baby Ruth
Hershey's Milk Chocolate
Hershey's Kisses
Nerds
Skittles wildberry
Milk Duds
Swedish Fish
Mr Good Bar
Lifesavers big ring gummies
Sour Patch Tricksters
Air Heads
Haribo Sour Bears
Almond Joy
Tootsie Roll Snack Bars
Whoppers
Tootsie Pop
Mounds
Trolli Sour Bites
Gobstopper
Mike & Ike
Payday
One quarter
Smarties candy
Tootsie Roll Midgies
Twizzlers
Welch's Fruit Snacks
Fruit Chews
Tootsie Roll Juniors
Runts
Dots
Haribo Twin Snakes
Werther's Original Caramel
Laffy Taffy
Pop Rocks
Dum Dums
Now & Later
Fun Dip
Lemonhead
Warheads
Charleston Chew
Candy Corn
Nestle Smarties
Pixie Sticks
Red vines
Chewey Lemonhead Fruit Mix
Ring pop
Sixlets
Strawberry bon bons
Caramel Apple Pops
Haribo Happy Cola
Sugar Babies
One dime
Sugar Daddy
Root Beer Barrels
Jawbusters
Super Bubble
Chiclets
Boston Baked Beans
Nik L Nip
Candy Type
0
20
40
60
80
Win Percent

We are going to add some color to our gg plot. We need to make a custom color vector. **Q17.** What is the worst ranked chocolate candy? Sixlets

```
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"
#Start with all black vectors
library(ggplot2)
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col(fill = my_cols) +
  labs(x="Win Percent", y="Candy Type")
```



Q18. What is the best ranked fruity candy?

Starburst

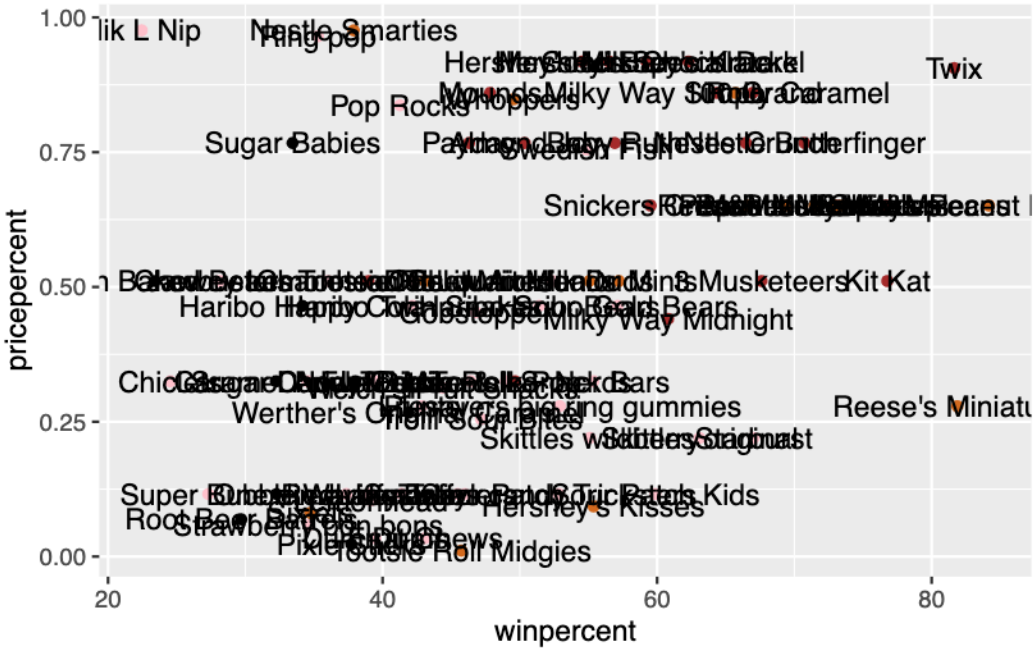
Taking a look at pricepercent

```
candy$pricepercent
```

```
 [1] 0.860 0.511 0.116 0.511 0.511 0.767 0.767 0.511 0.325 0.325 0.511 0.511
[13] 0.325 0.511 0.034 0.034 0.325 0.453 0.465 0.465 0.465 0.465 0.093 0.918
[25] 0.918 0.918 0.511 0.511 0.511 0.116 0.104 0.279 0.651 0.651 0.325 0.511
[37] 0.651 0.441 0.860 0.860 0.918 0.325 0.767 0.767 0.976 0.325 0.767 0.651
[49] 0.023 0.837 0.116 0.279 0.651 0.651 0.651 0.965 0.860 0.069 0.279 0.081
[61] 0.220 0.220 0.976 0.116 0.651 0.651 0.116 0.116 0.220 0.058 0.767 0.325
[73] 0.116 0.755 0.325 0.511 0.011 0.325 0.255 0.906 0.116 0.116 0.313 0.267
[85] 0.848
```

If we want to see what is a good candy to buy in terms of winpercent and pricepercent we can plot these two variables and then see the best cnay for the least amount of money.

```
library(ggplot2)
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text()
```



To avoid the overplotting of all of these labels, we can use an add on package called "ggrepel"

Play with the `max.overlaps` parameter to `geom_text_repel()`

```
library(ggrepel)
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=2, max.overlaps = 5)
```

```
Warning: ggrepel: 50 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 - gives 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?

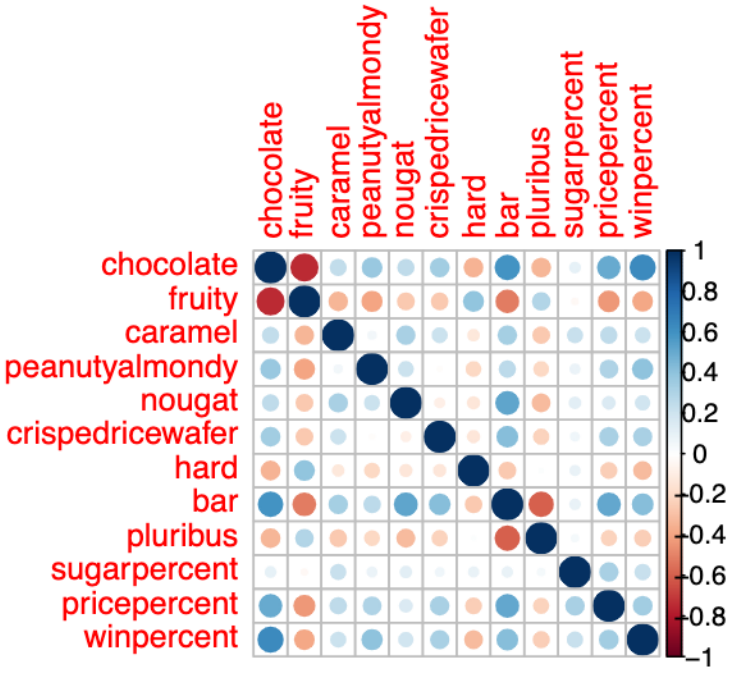
Nik L Nip, Ring Pop, Nestle Smarties, Pop Rocks, Mounds (some answers very depending on your definition of least popular/most expensive)

5 Exploring the correlation structure

```
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)?

Chocolate and fruity candies are anti-correlated, meaning they are usualy not mixed into the same type of candy. Pluribus and bar are anti-correlated, meaning if the candy is in bar form, it's usually only one! (only exception I can think of is Kit Kats)

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

Chocolate and bar are positively correlated (lots of chocolate candy bars exist!). Chocolate and winpercent are positively correlated, meaning lots of people like chocolate!

On to PCA

The main function for this is called `prcom()` and here we know we need to scale our data with the `scale=TRUE` argument.

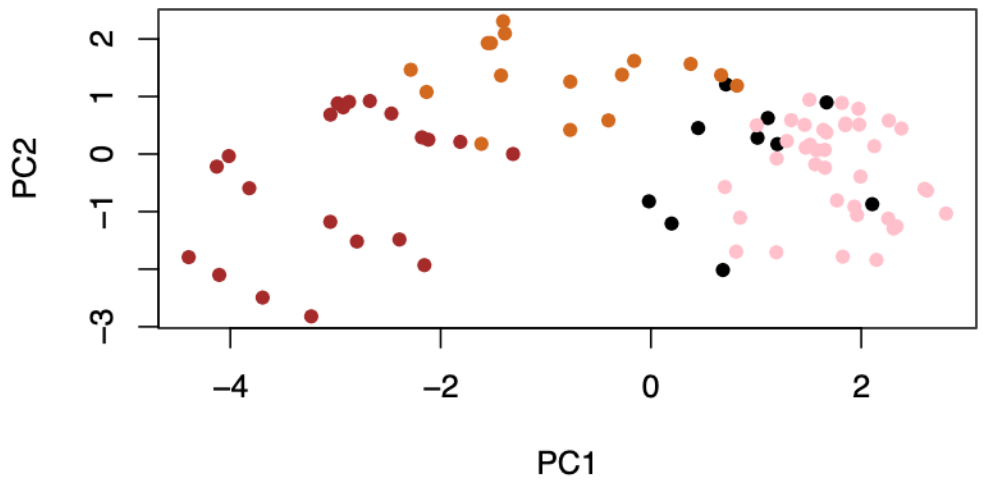
Below gives us the figures for the normal PCA that we are used to!

```
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
```

Next, let's make a basic plot with some colors

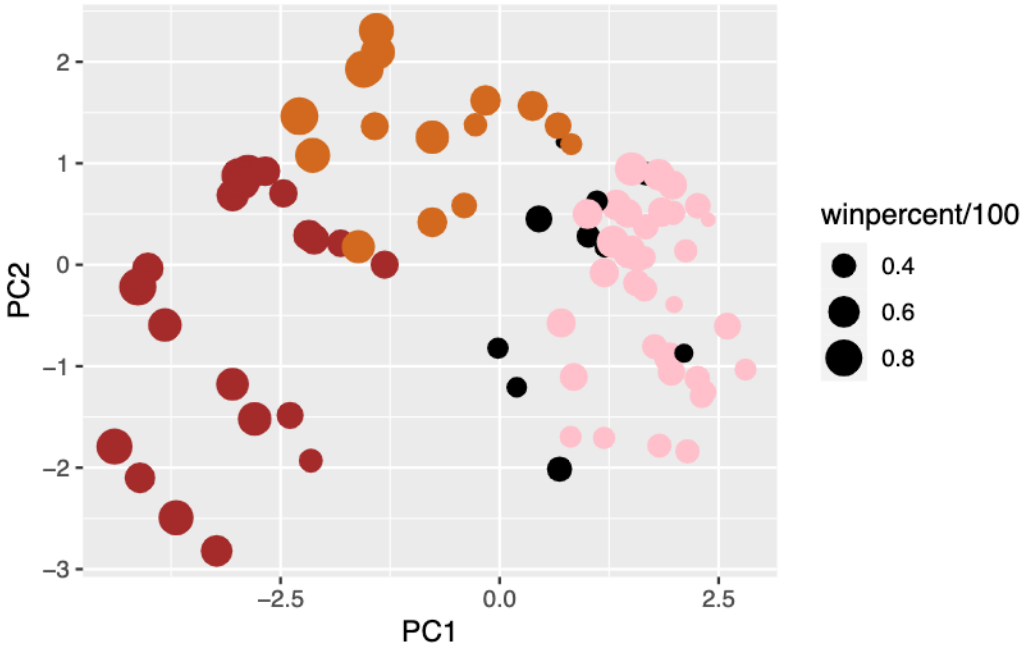
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



Next we are going to make a new data frame. Then add some aesthetics to the graph.

```
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
```

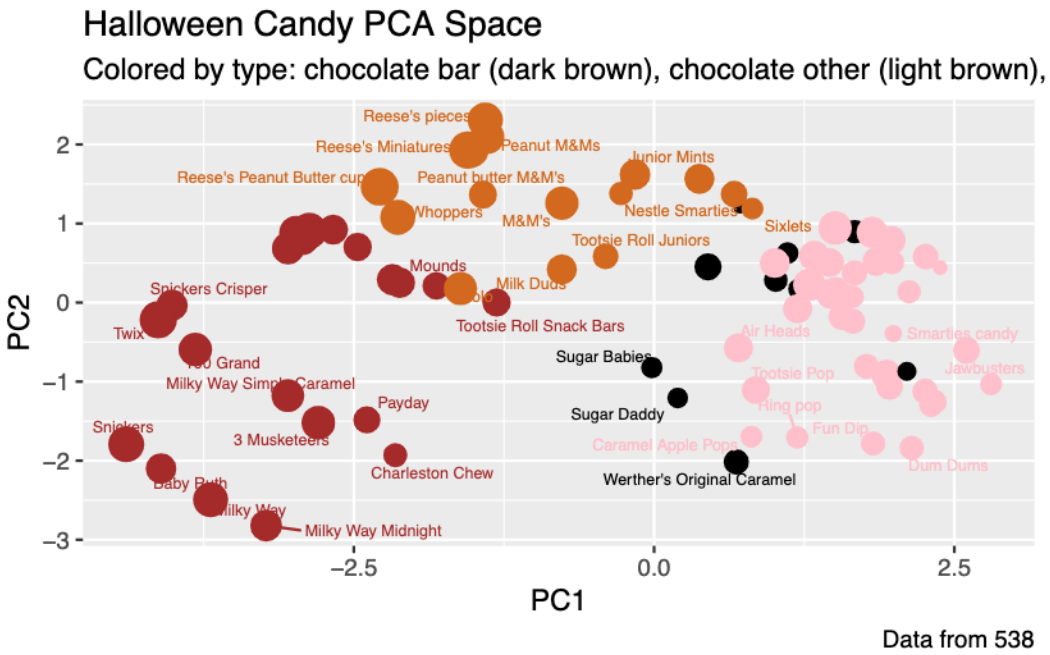


Finally we are going to add some labels and do our best to make sure that they don't overlap.

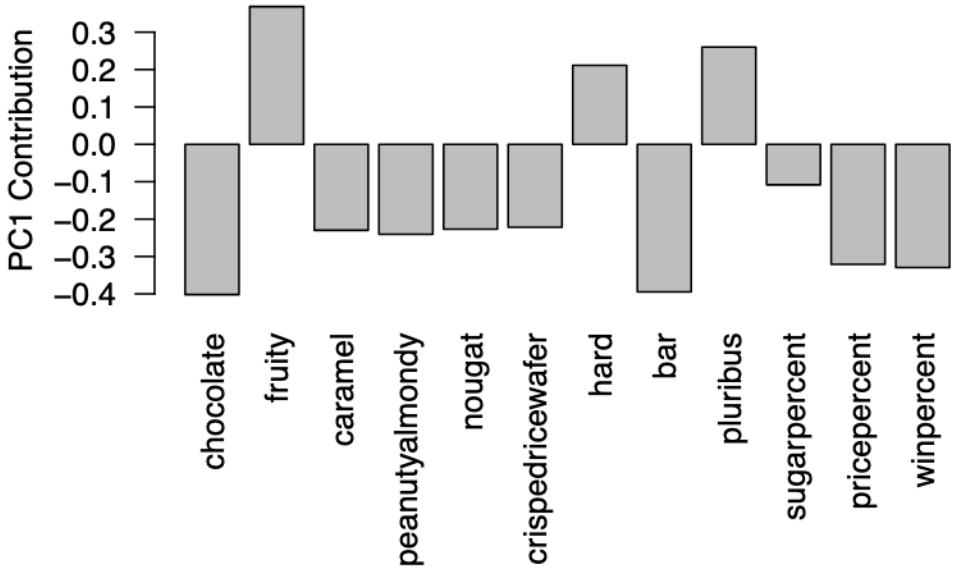
```
library(ggrepel)
my_data <- cbind(candy, pca$x[,1:3])
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p + geom_text_repel(size=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
```

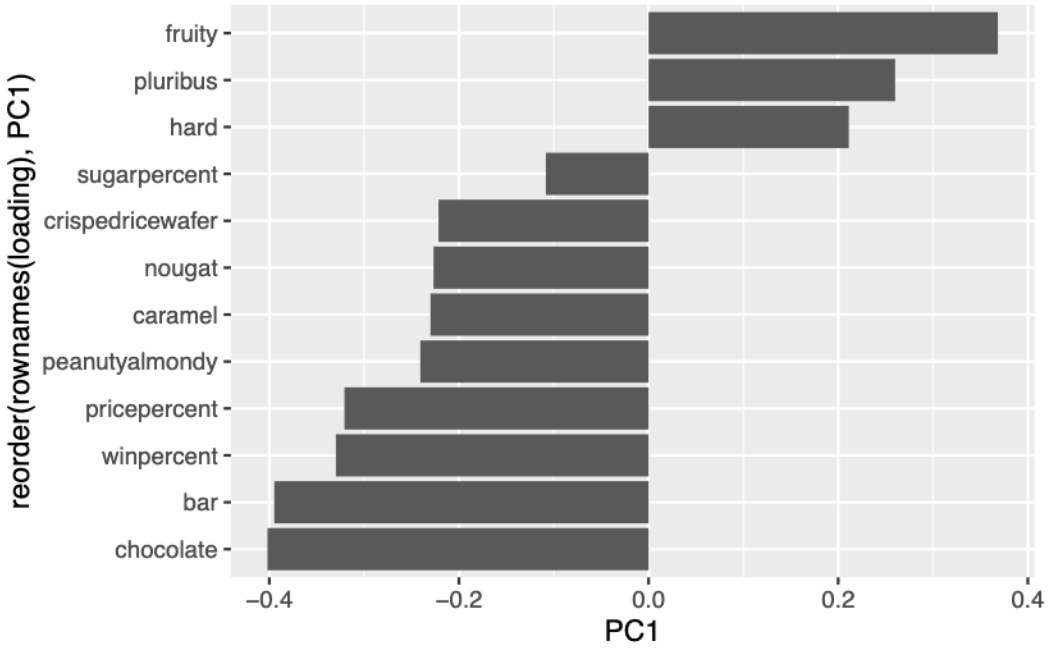



```
par(mar=c(8,4,2,2))
barplot(pca$rotation[,1], las=2, ylab="PC1 Contribution")
```



We can re order this graph a little bit using `ggplot()` to make it easier to read!

```
loading <- as.data.frame(pca$rotation)
library(ggplot2)
ggplot(loading) +
  aes(PC1, reorder(rownames(loading), PC1)) +
  geom_col()
```



Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you?

These variables would be fruity, hard, and pluribus. This does make sense to me.