Class 10: Halloween Mini-Project

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1. Importing candy data

Let's get the data:

```
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
```

There are 85 candy types in the dataset.

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

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

```
 0  1
47 38
```

There are 38 fruity candy types.

2. What is your favorite candy?

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

```
candy["Skittles original", ]$winpercent
```

```
[1] 63.08514
```

The winpercent for Skittles original is 63.%

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

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

```
[1] 76.7686
```

The winpercent for Kit Kat is 77%.

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

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

```
[1] 49.6535
```

The winpercent for Tootsie Roll Snack Bars is 50%.

There is a helpful package for getting a brief overview of the dataset.

```
#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	

- **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 the columns n_missing and complete_rate are on the scale of only ones and zeroes while the rest of the columns are between 0 and 1.

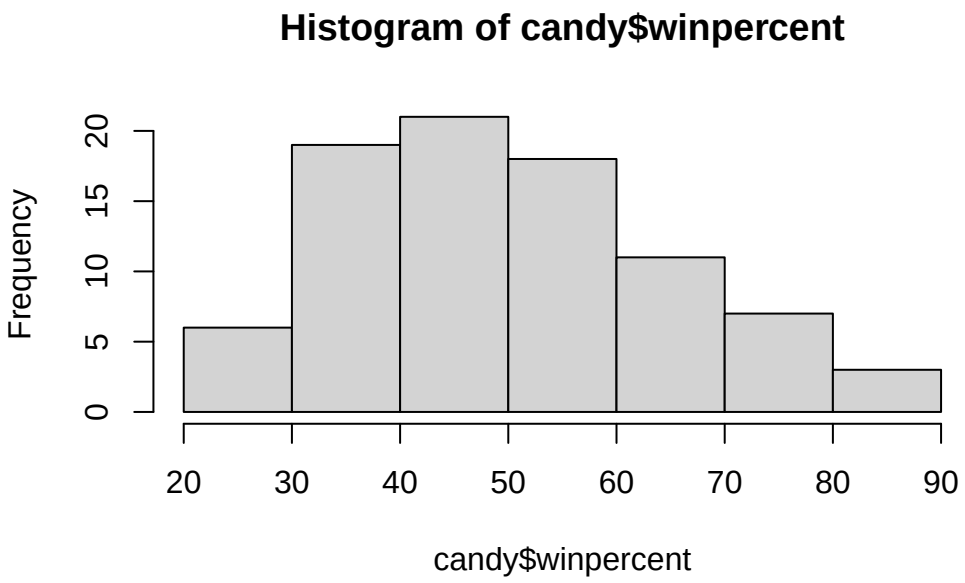
- **Q7**. What do you think a zero and one represent for the `candy$chocolate` column?

I believe a one means that the candy has chocolate in it and a zero means it doesn't.

Now we can do exploratory data analysis.

Q8. Plot a histogram of `winpercent` values

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



Q9. Is the distribution of `winpercent` values symmetrical?

No the distribution is not symmetrical because it is skewed more towards the left and the median is below 50%.

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

```
mean(candy$winpercent)
```

```
[1] 50.31676
```

The mean is slightly above 50%.

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

```
# We want to find the mean of the winpercents for a specific type of candy. We can make a

chocolate_candy = candy$winpercent[as.logical(candy$chocolate)]
mean(chocolate_candy)
```

```
[1] 60.92153
```

```
fruity_candy = candy$winpercent[as.logical(candy$fruity)]
mean(fruity_candy)
```

```
[1] 44.11974
```

Chocolate candy is ranked higher on average than fruity candy.

Q12. Is this difference statistically significant?

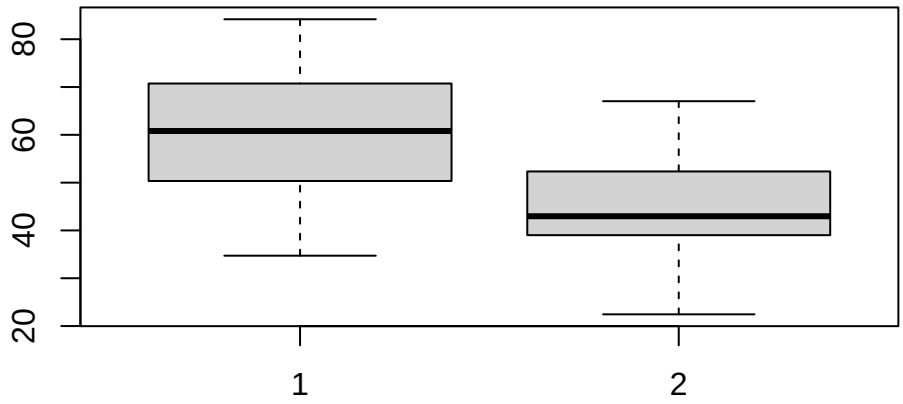
```
# We are 95% confident that the difference between these two values is there. At minimum,
t.test(chocolate_candy, fruity_candy)
```

```
    Welch Two Sample t-test

data:  chocolate_candy and fruity_candy
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 because the t test has a very low p-value of 2.871e-08.

We can also see this difference qualitatively using a boxplot.

```
boxplot(chocolate_candy, fruity_candy)
```



3. Overall Candy Rankings

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

```
head(candy[order(candy$winpercent),], n=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 5 least liked candy types 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?

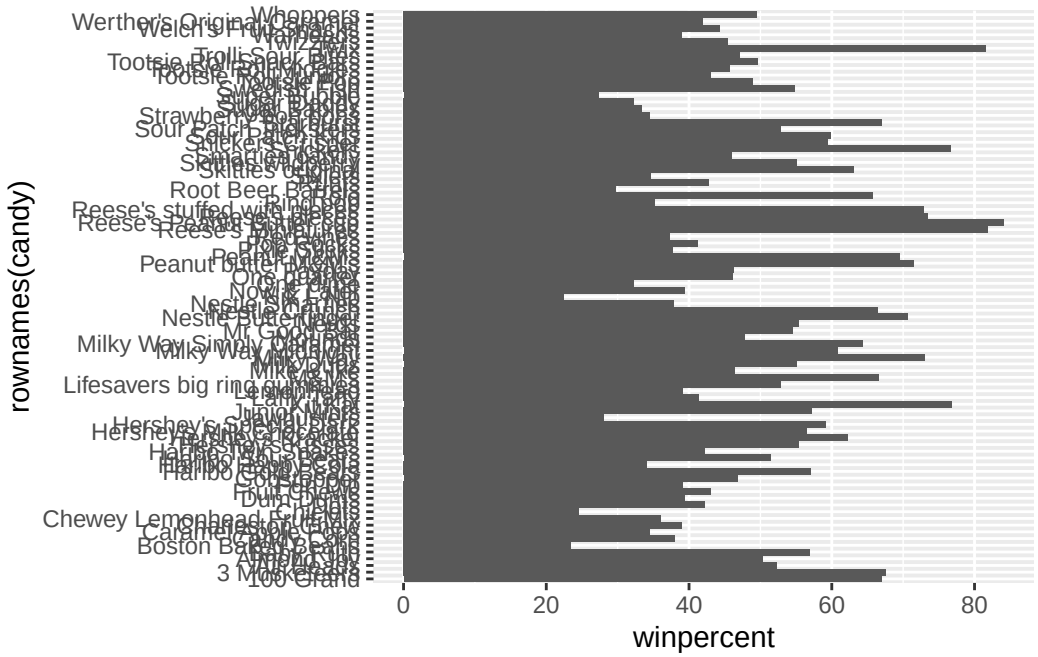
```
head(candy[order(candy$winpercent, decreasing = TRUE),], n=5)
```

```
                         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
```

The 5 all time favorite candy types are Reese's Peanut Cups, Reese's Miniature Cups, Twix, Kit Kat, and Snickers.

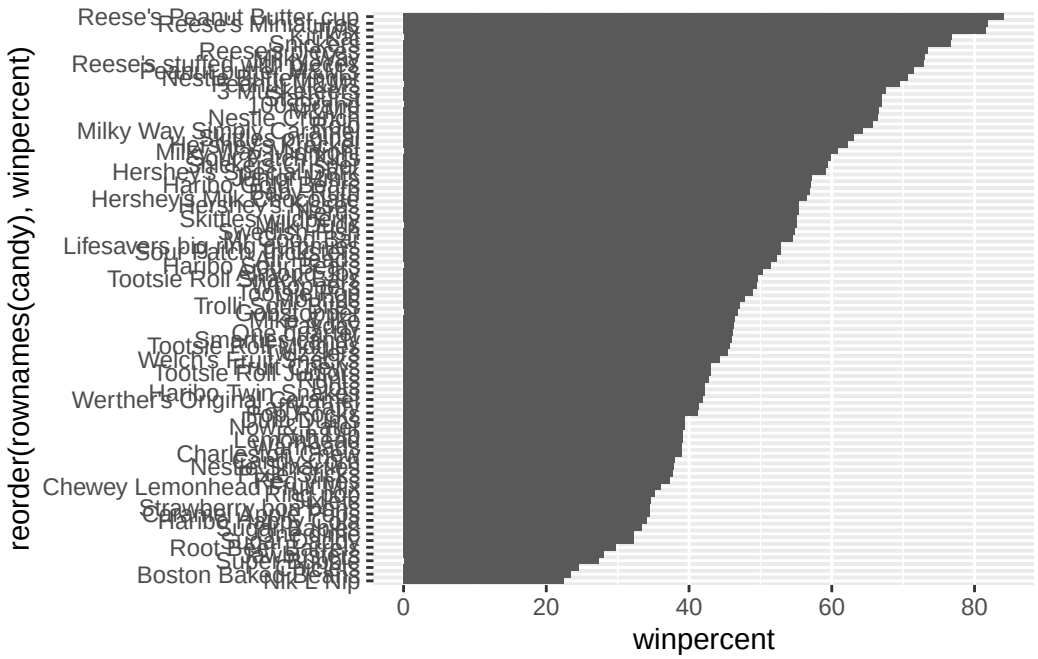
Q15. Make a first barplot of candy ranking based on `winpercent` values.

```
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`?

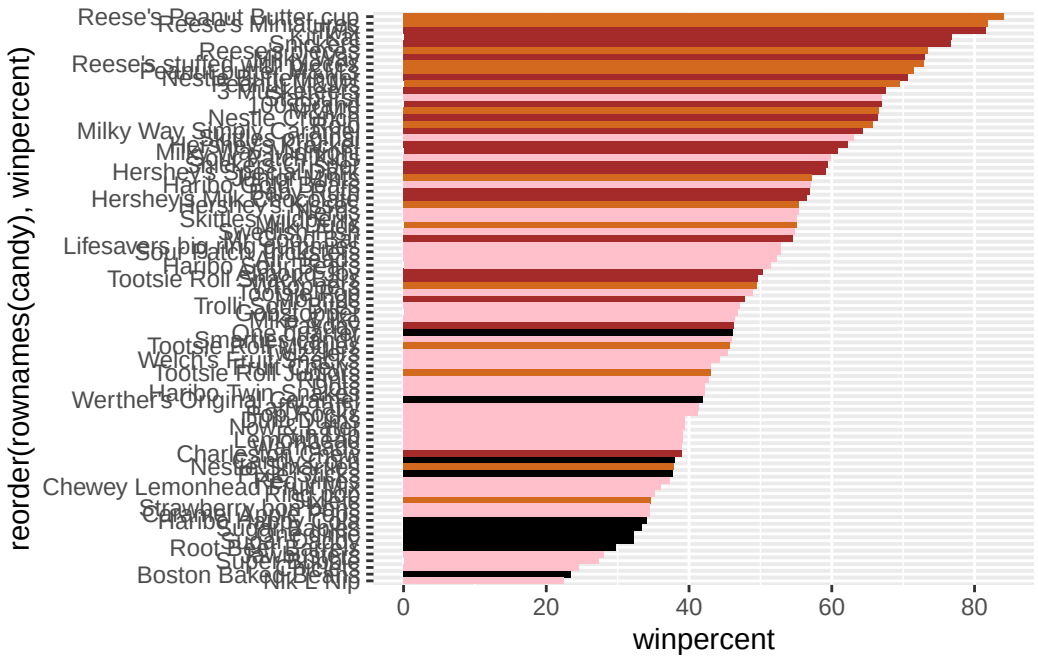
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col()
```



Let's add 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?

The worst ranked chocolate candy is Sixlets.

Q18. What is the best ranked fruity candy?

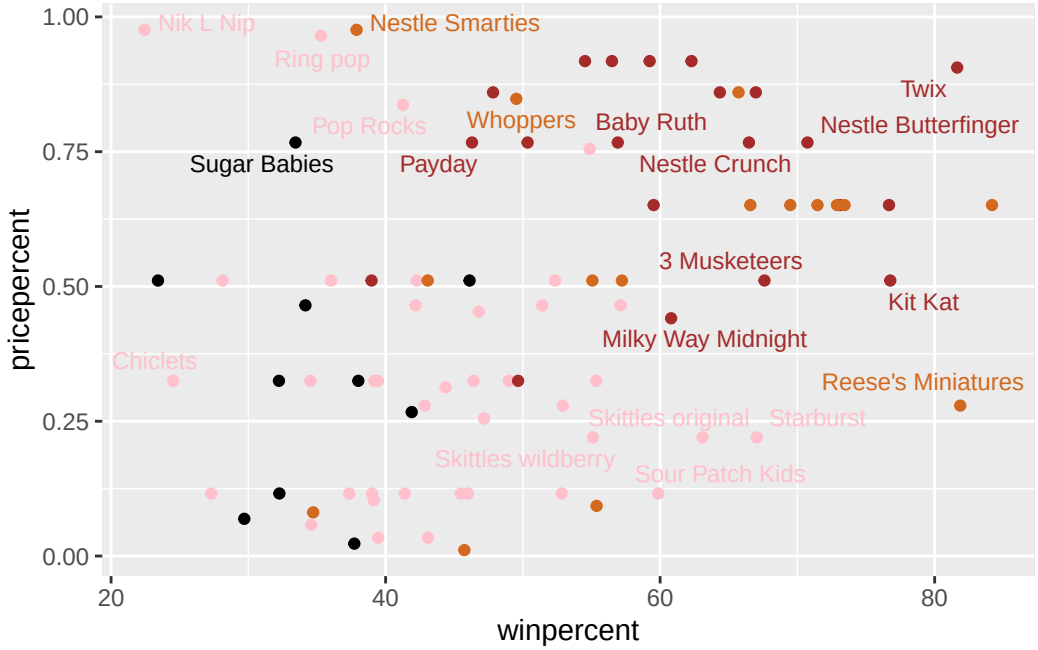
The best ranked fruity candy is Starburst.

4. Taking a look at pricepercent

Let's compare candy rank and price.

```
#add text labels that don't overlap
#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=3.3, max.overlaps = 5)
```

```
Warning: ggrepel: 65 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



We can see which candy is most and least expensive by ordering the columns.

> **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?

Looking at the plot, we can see that Reese's Miniatures are one of the highest ranking candies (considering a winpercent of 80% is good) for the least money.

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

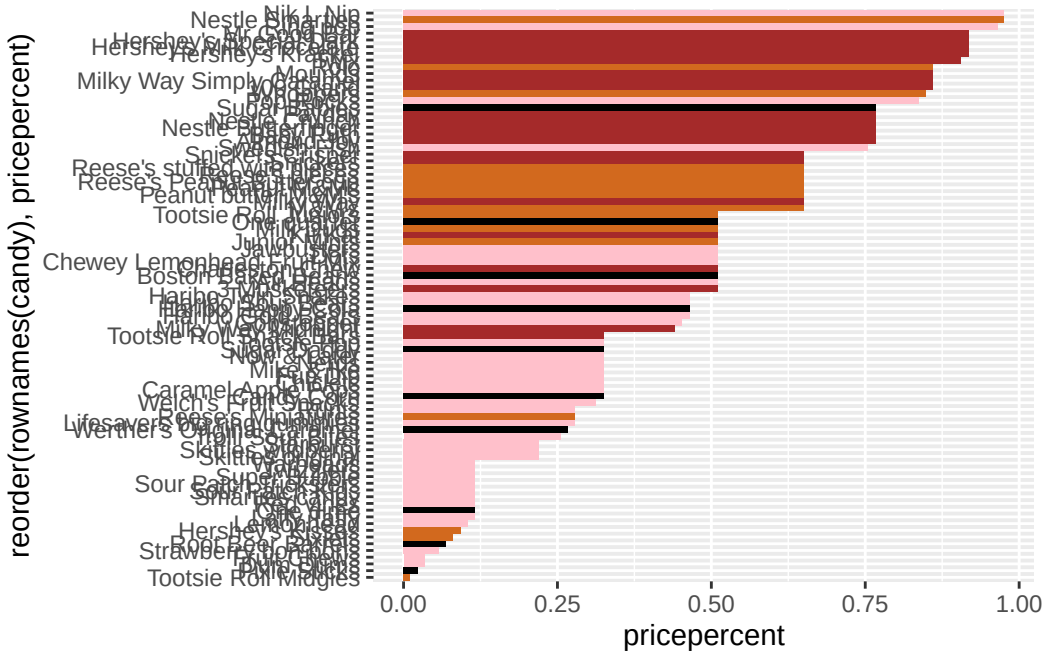
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                      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
```

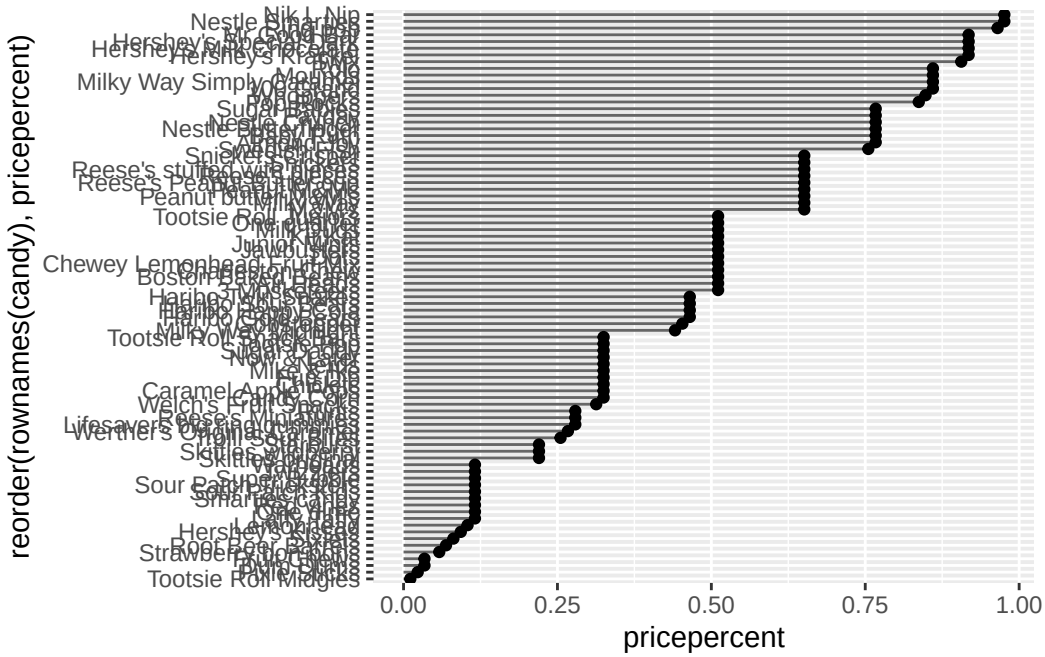
The top 5 most expensive candy types are Nestle Smarties, Nik L Nip, Ring Pop, Hershey's Krackel, and Hershey's Milk Chocolate. The least popular one is Hershey's Milk Chocolate.

Now let's make a plot of pricepercent.

```
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_col(fill=my_cols)
```




```
# Make a lollipop chart of pricepercent
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```

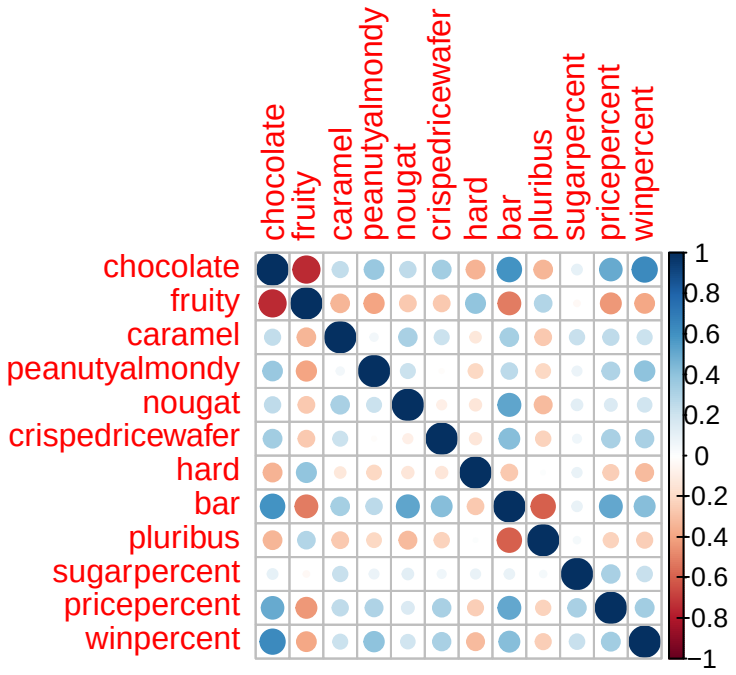


5. Exploring the correlation structure

```
#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)?

Two variables that are anti-correlated are chocolate and fruity.

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

Chocolate and bar are the most positively correlated candy types.

6. 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
```

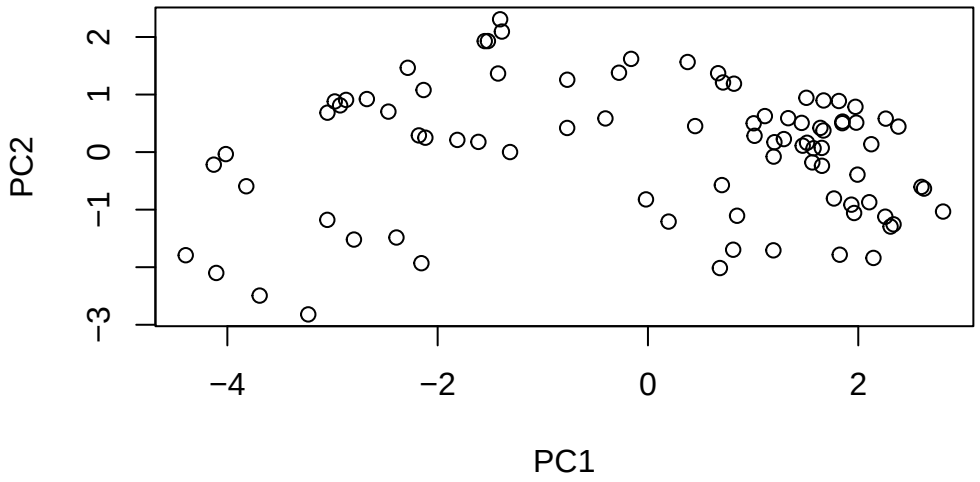
```
Proportion of Variance 0.04629 0.03833 0.03239 0.01611 0.01317
Cumulative Proportion  0.89998 0.93832 0.97071 0.98683 1.00000
```

Let's plot the first two components.

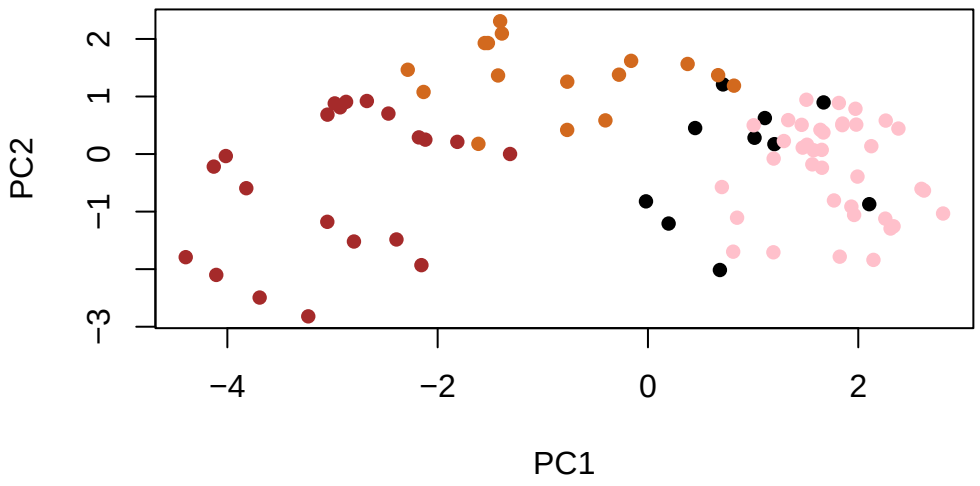
```
attributes(pca)
```

```
$names
[1] "sdev"     "rotation" "center"   "scale"    "x"

$class
[1] "prcomp"
```

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

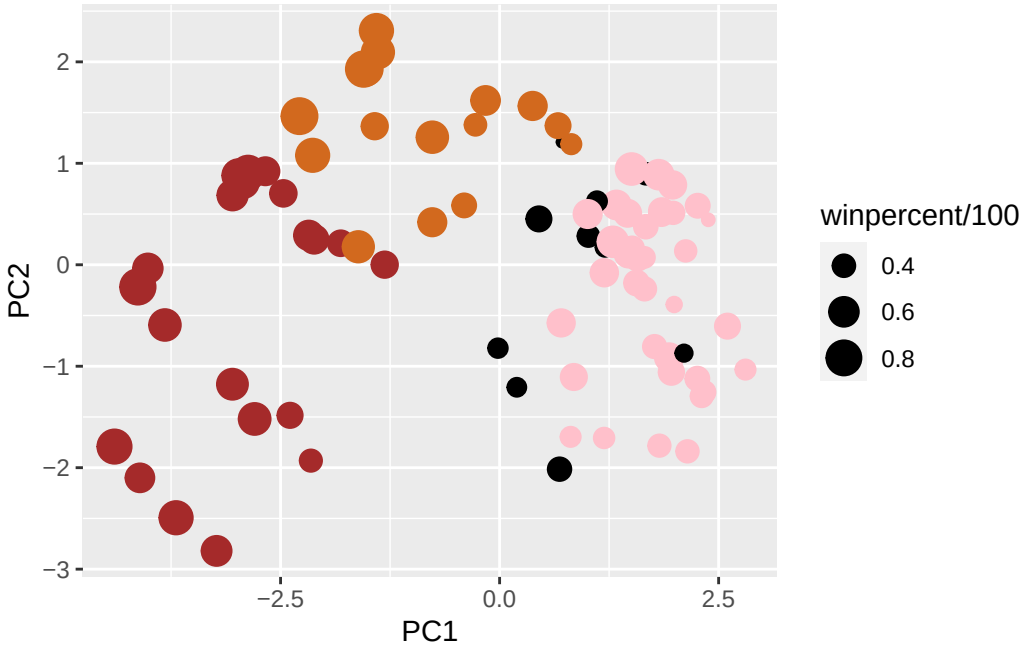



```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



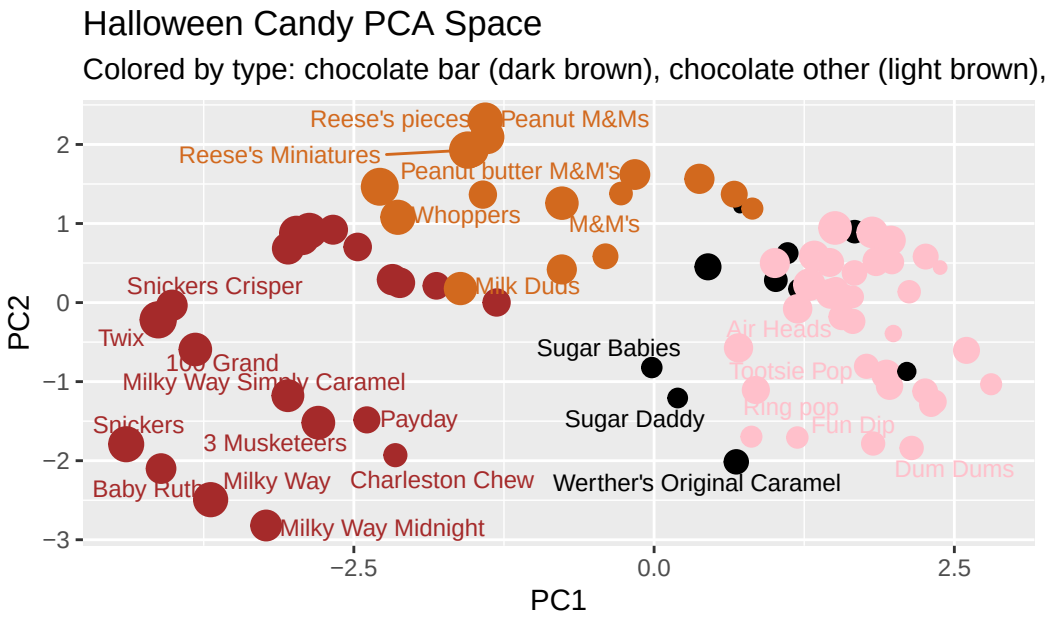

```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
```

```
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
```

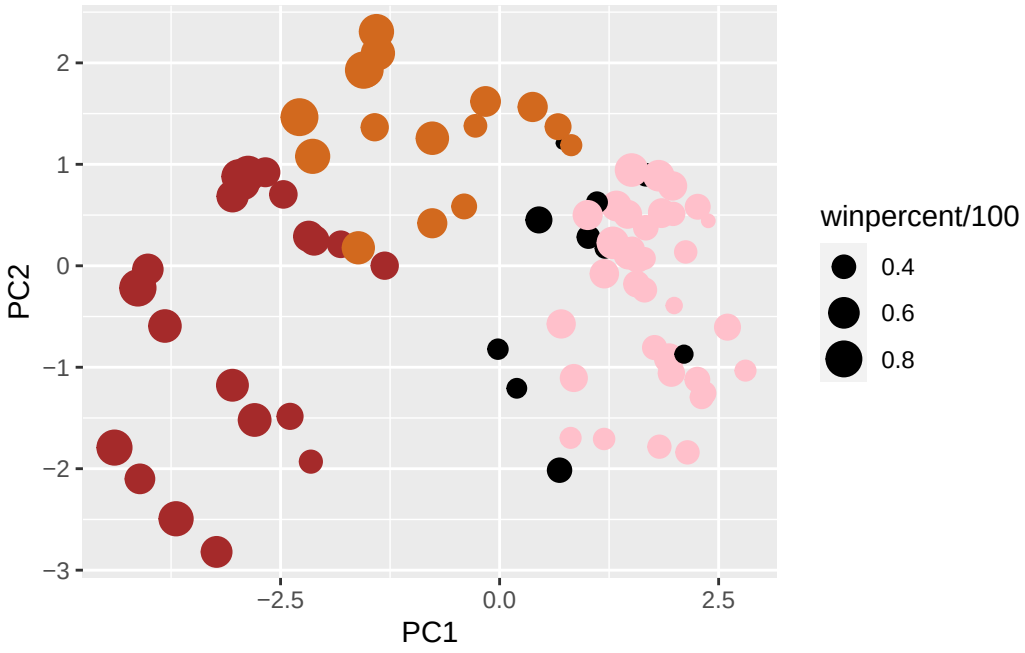



```
library(ggrepel)

p + 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
```


Halloween Candy PCA Space
Colored by type: chocolate bar (dark brown), chocolate other (light brown),
Reese's pieces
Peanut M&Ms
Reese's Miniatures
Peanut butter M&M's
Whoppers
M&M's
Snickers Crisper
Milk Duds
Twix
100 Grand
Milky Way Simply Caramel
Snickers
Payday
3 Musketeers
Baby Ruth
Milky Way
Charleston Chew
Milky Way Midnight
Sugar Babies
Sugar Daddy
Werther's Original Caramel
Air Heads
Tootsie Pop
Ring pop
Fun Dip
Dum Dums
PC2
PC1
2
1
0
−1
−2
−3
−2.5
0.0
2.5
Data from 538

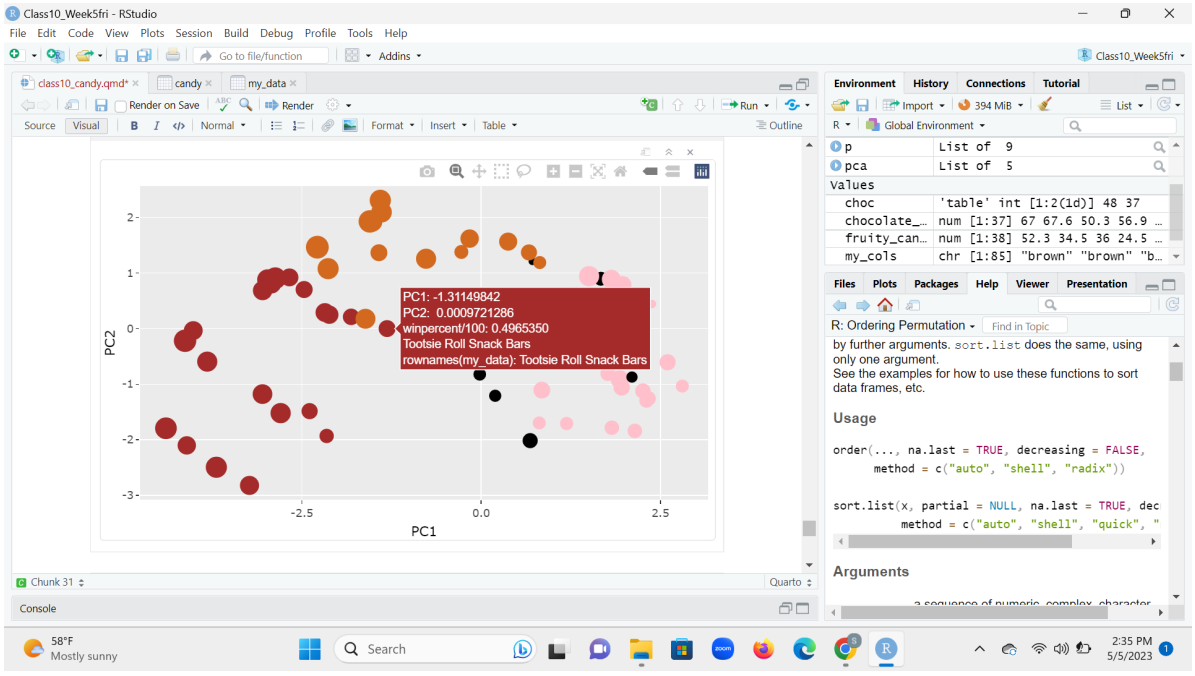
```
p
```


PC2
PC1
2
1
0
−1
−2
−3
−2.5
0.0
2.5
winpercent/100
0.4
0.6
0.8

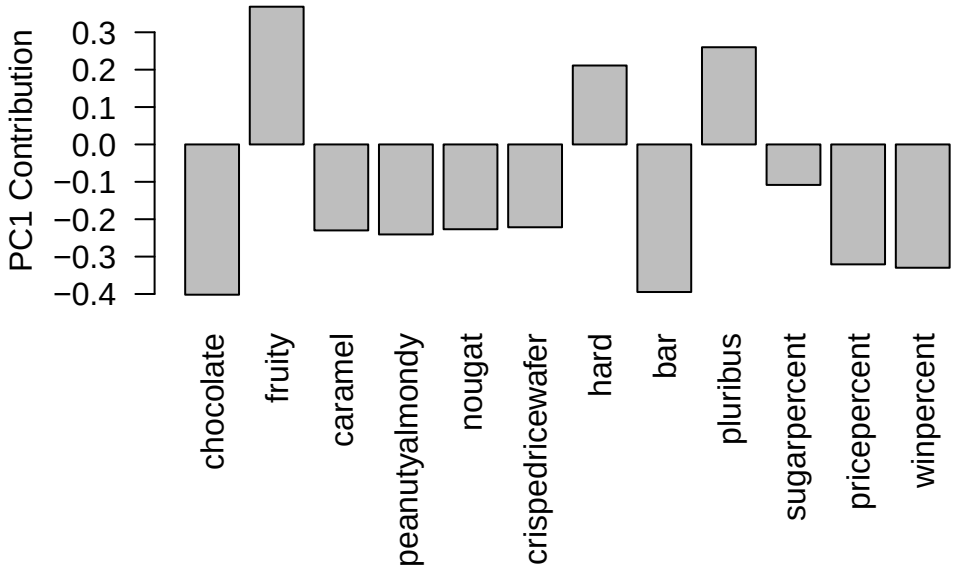
```
#install.packages('plotly')
library(plotly)
```

```
Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':

    last_plot

The following object is masked from 'package:stats':

    filter

The following object is masked from 'package:graphics':

    layout
```

```
#ggplotly(p)
#commented out because interactive plots won't render
```



```r
#Let's check the loadings of the PCA.
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?

The variables fruity, hard, and pluribus are picked up strongly by PC1 in the positive direction. This makes sense because I can think of multiple examples of candies that do have all or two of these attributes at the same time like Starburst and Skittles. So these variables are positively correlated.