Class 10

Celline Kim

Background

Here we explore 538 Halloween candy data. They recently ran a rather large poll to determine which candy their readers like the best. From theier website: "While we don't know who exactly voted, we do know this:8,371 different IP addresses voted on about 269,000 randomly generated candy matchups".

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

```
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
```

Winpercent

The most interesting variable in the dataset. For a given candy this value is the percentage of people who prefer this candy over another randomly chosen candy from the dataset (what 538 term a matchup). Higher values indicate a more popular candy.

We can find the winpercent value for Twix by using its name to access the corresponding row of the dataset. This is because the dataset has each candy name as rownames (recall that we set this when we imported the original CSV file).

```
rownames(candy)
```

```
 [1] "100 Grand"                 "3 Musketeers"
 [3] "One dime"                  "One quarter"
 [5] "Air Heads"                 "Almond Joy"
 [7] "Baby Ruth"                 "Boston Baked Beans"
 [9] "Candy Corn"                "Caramel Apple Pops"
[11] "Charleston Chew"           "Chewey Lemonhead Fruit Mix"
[13] "Chiclets"                  "Dots"
[15] "Dum Dums"                  "Fruit Chews"
[17] "Fun Dip"                   "Gobstopper"
[19] "Haribo Gold Bears"         "Haribo Happy Cola"
[21] "Haribo Sour Bears"         "Haribo Twin Snakes"
[23] "HersheyÕs Kisses"          "HersheyÕs Krackel"
[25] "HersheyÕs Milk Chocolate"  "HersheyÕs Special Dark"
[27] "Jawbusters"                "Junior Mints"
[29] "Kit Kat"                   "Laffy Taffy"
[31] "Lemonhead"                 "Lifesavers big ring gummies"
[33] "Peanut butter M&MÕs"       "M&MÕs"
[35] "Mike & Ike"                "Milk Duds"
[37] "Milky Way"                 "Milky Way Midnight"
[39] "Milky Way Simply Caramel"  "Mounds"
[41] "Mr Good Bar"               "Nerds"
```

```
[43] "Nestle Butterfinger"          "Nestle Crunch"
[45] "Nik L Nip"                    "Now & Later"
[47] "Payday"                       "Peanut M&Ms"
[49] "Pixie Sticks"                 "Pop Rocks"
[51] "Red vines"                    "ReeseÕs Miniatures"
[53] "ReeseÕs Peanut Butter cup"    "ReeseÕs pieces"
[55] "ReeseÕs stuffed with pieces" "Ring pop"
[57] "Rolo"                         "Root Beer Barrels"
[59] "Runts"                        "Sixlets"
[61] "Skittles original"            "Skittles wildberry"
[63] "Nestle Smarties"              "Smarties candy"
[65] "Snickers"                     "Snickers Crisper"
[67] "Sour Patch Kids"              "Sour Patch Tricksters"
[69] "Starburst"                    "Strawberry bon bons"
[71] "Sugar Babies"                 "Sugar Daddy"
[73] "Super Bubble"                 "Swedish Fish"
[75] "Tootsie Pop"                  "Tootsie Roll Juniors"
[77] "Tootsie Roll Midgies"         "Tootsie Roll Snack Bars"
[79] "Trolli Sour Bites"            "Twix"
[81] "Twizzlers"                    "Warheads"
[83] "WelchÕs Fruit Snacks"         "WertherÕs Original Caramel"
[85] "Whoppers"
```

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

```
candy["Fun Dip",]$winpercent
```

```
[1] 39.1855
```

My favorite candy is Fun dip and its winpercent value is 39.1855.

```
candy["Carmel Apple Pops",]
```

```
   chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard bar
NA        NA     NA      NA             NA     NA                NA   NA  NA
   pluribus sugarpercent pricepercent winpercent
NA       NA           NA           NA         NA
```

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
```

A useful function from the skimr package

```
library("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	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
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	

```
skimr::skim(candy)
```

Table 3: 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?

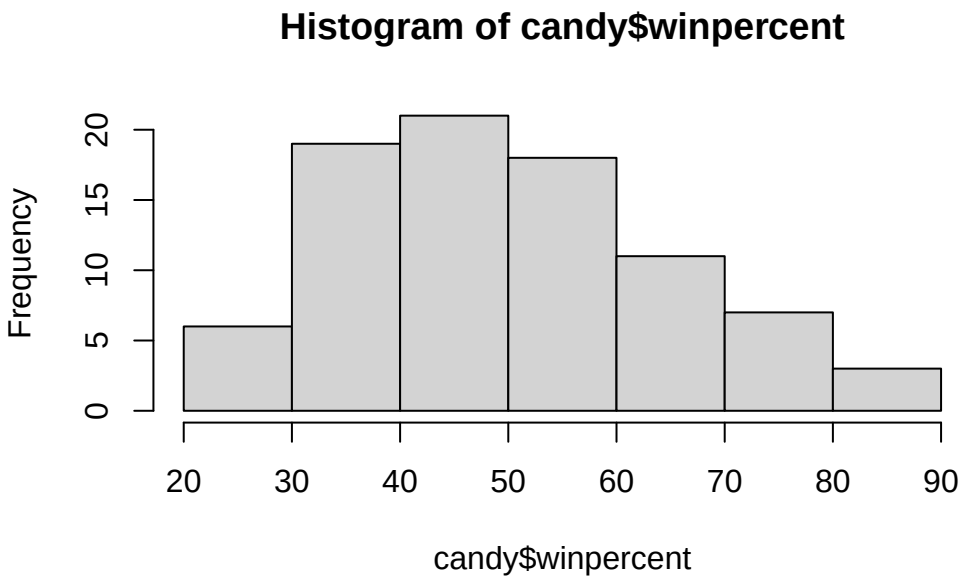
The winpercent variable looks to be on a different scale to the majority of other columns in the dataset.

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

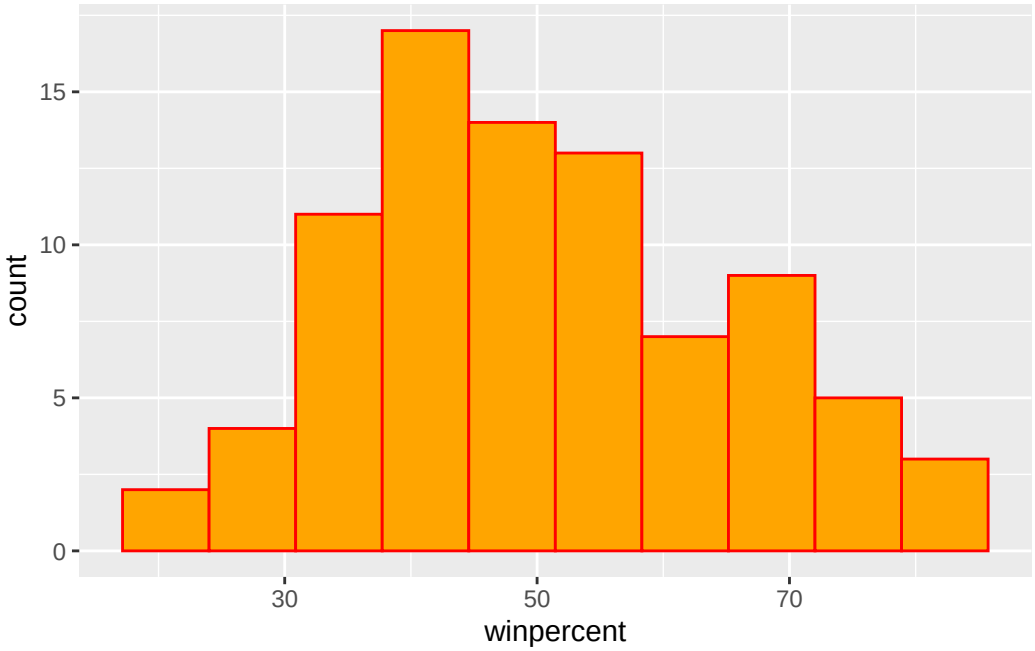
A zero repreesents no chocolate being present, and a one represeents chocolate being present in the candy.

Q8. Plot a histogram of winpercent values

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




```
library(ggplot2)
ggplot(candy)+
  aes(winpercent)+
  geom_histogram(bins=10, col="red", fill="orange")
```



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent values are slightly symmetrical, but not quite symmetrical. It's shifted more to the left than the center.

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

The center of distribution is below 50%.

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

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

On average, chocolate is higher ranked than fruit candy (at 60.92153).

Q12. Is this difference statistically significant?

```
t.test(chocolate.wins,fruity.wins)
```

```
    Welch Two Sample t-test

data:  chocolate.wins and fruity.wins
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
```

This difference is statistically signficant.

3. Candy ranking

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
```

Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters are the five least liked candy types in this set.

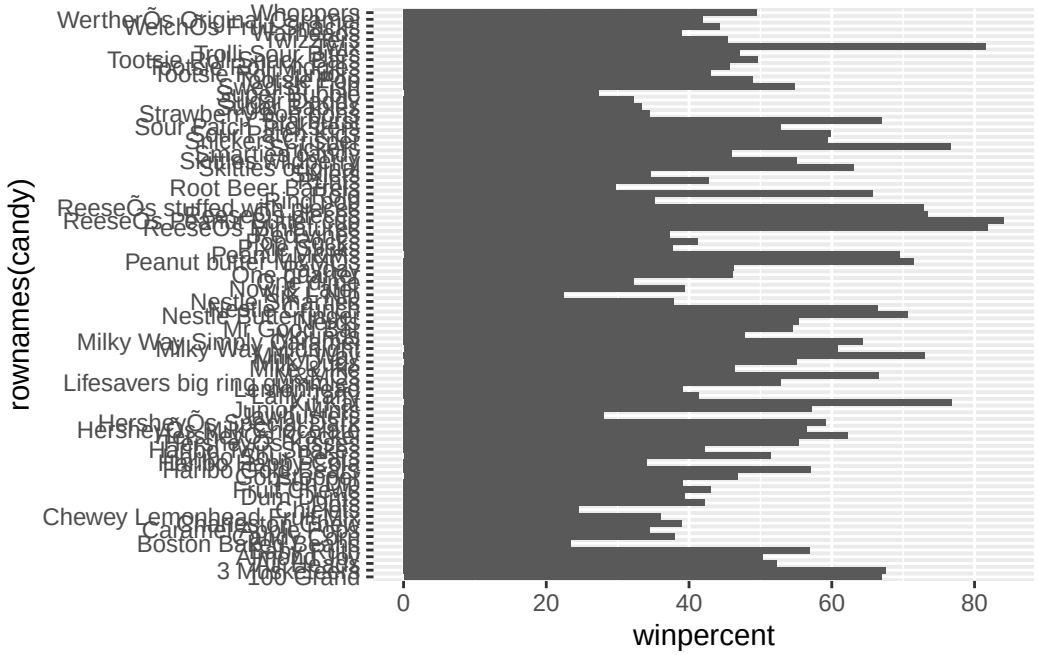
Q14. What are the top 5 all time favorite candy types out of this set?

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

```
                         chocolate fruity caramel peanutyalmondy nougat
ReeseÕs Peanut Butter cup         1      0       0              1      0
ReeseÕs 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
ReeseÕs Peanut Butter cup                0    0   0        0        0.720
ReeseÕs 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
ReeseÕs Peanut Butter cup        0.651   84.18029
ReeseÕs Miniatures               0.279   81.86626
Twix                             0.906   81.64291
Kit Kat                          0.511   76.76860
Snickers                         0.651   76.67378
```

ReeseOs Peanut Butter cup, ReeseOs Miniatures, Twix, Kit Kat, and Snickers are the top 5 all time favorite candy types out of this set. >Q15. Make a first barplot of candy ranking based on winpercent values.

```
library(ggplot2)

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

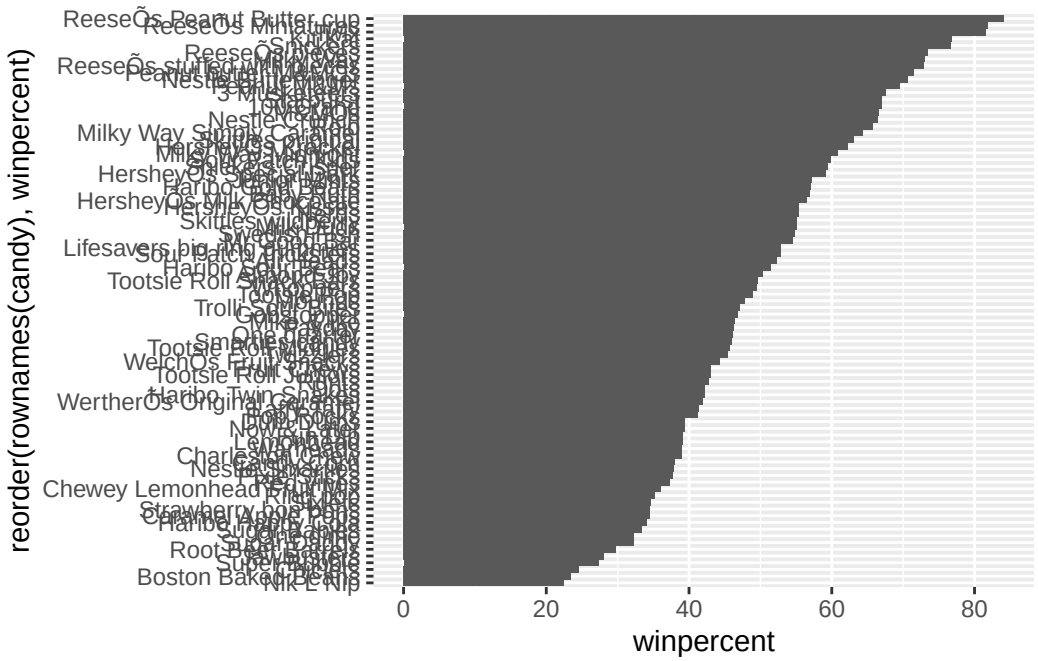



```
ggsave("tmp.png")
```

```
Saving 5.5 x 3.5 in image
```

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()
```



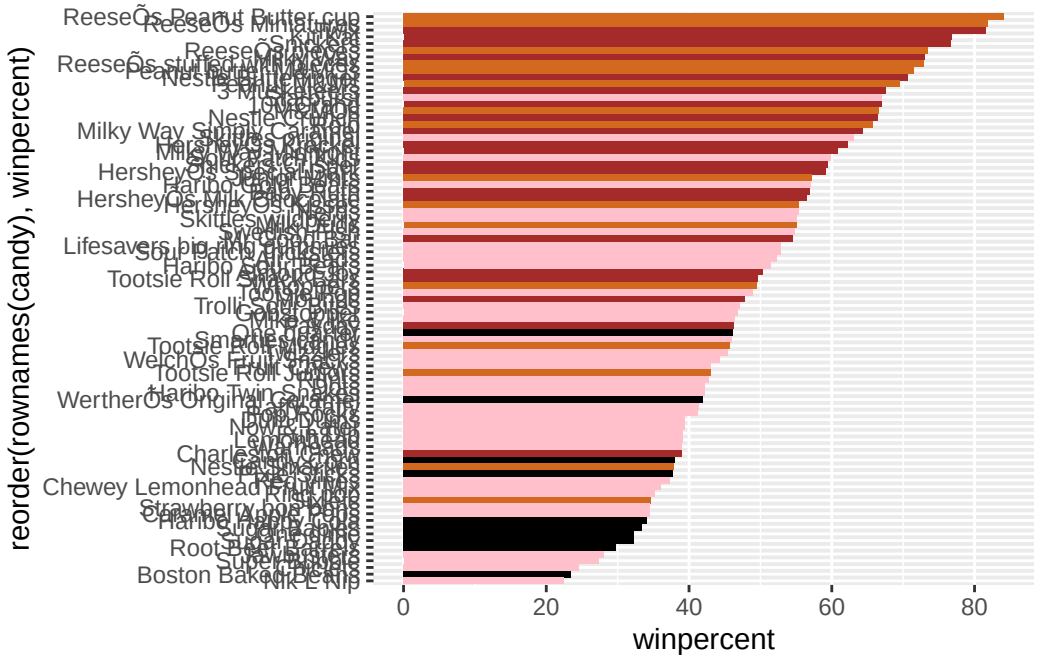

```
ggsave("tmp.png")
```

```
Saving 5.5 x 3.5 in image
```

First setup some colors for different candy types.

```
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"
#my_cols
```

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




```
ggsave("tmp.png")
```

```
Saving 5.5 x 3.5 in image
```

Q17. What is the worst ranked chocolate candy?

Sixlets is the worst ranked

Q18. What is the best ranked fruity candy?

Starburts is the best ranked fruity candy.

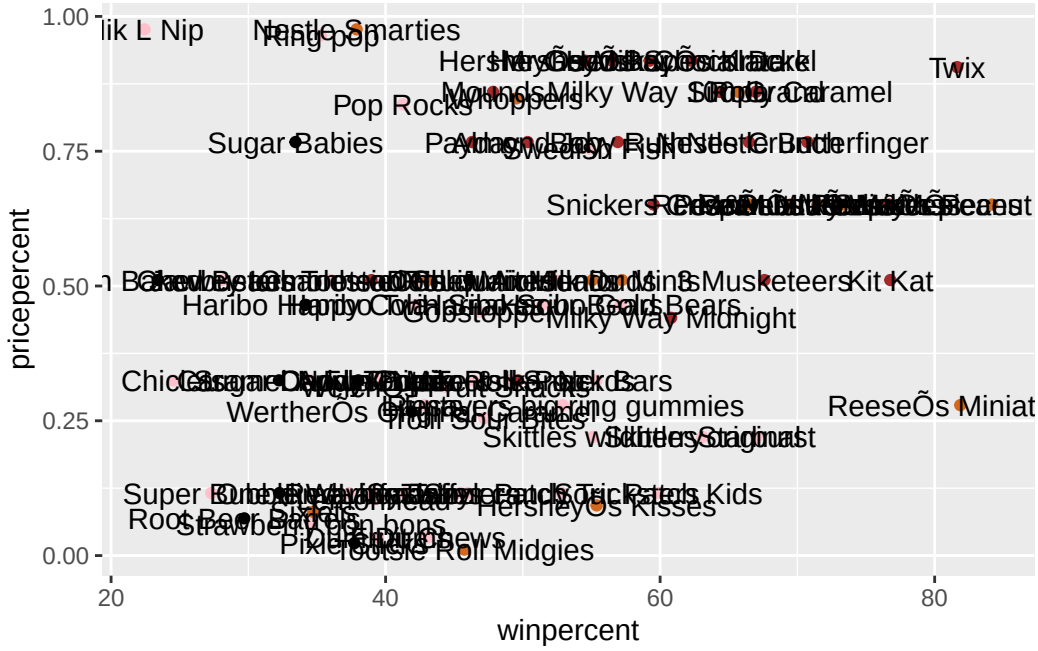
4. Taking a look at pricepercent

What is the best (most liked in terms of 'winpercent') for the money (in terms of 'pricepercent')?

To answer this I will make a plot of winpercent vs pricepercent.

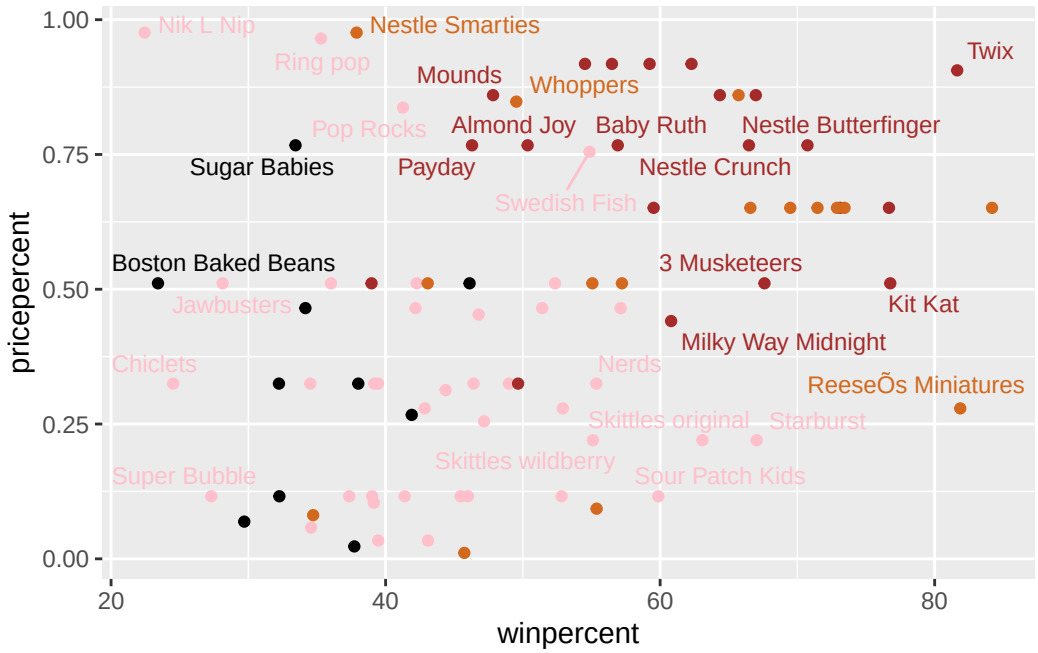
```
ggplot(candy)+
  aes(winpercent,pricepercent, label=rownames(candy))+
  geom_point(col=my_cols)+
```

```
  geom_text()
```




```
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 = 7)
```

```
Warning: ggrepel: 58 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?

ReeseOs Miniatures is the highest ranked in terms of winpercent 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
HersheyÕs Krackel                0.918   62.28448
HersheyÕs Milk Chocolate         0.918   56.49050
```

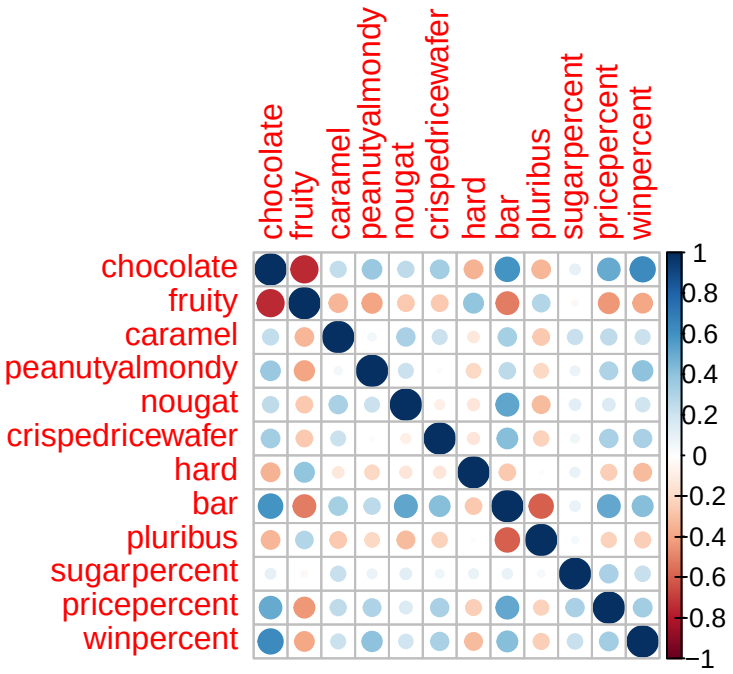
Nik L Nip, NEstle Smarties, Ring pop, HersheyO's Krackel, HersheyOs Milk Chocolate are the top 5 most expensive candy types in the dataset. Of these, Nik L Nip is the least popular.

5.

```
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" are two anti- correlated variables.

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

"Chocolate" and "winpercent" are the most positively correlated variables.

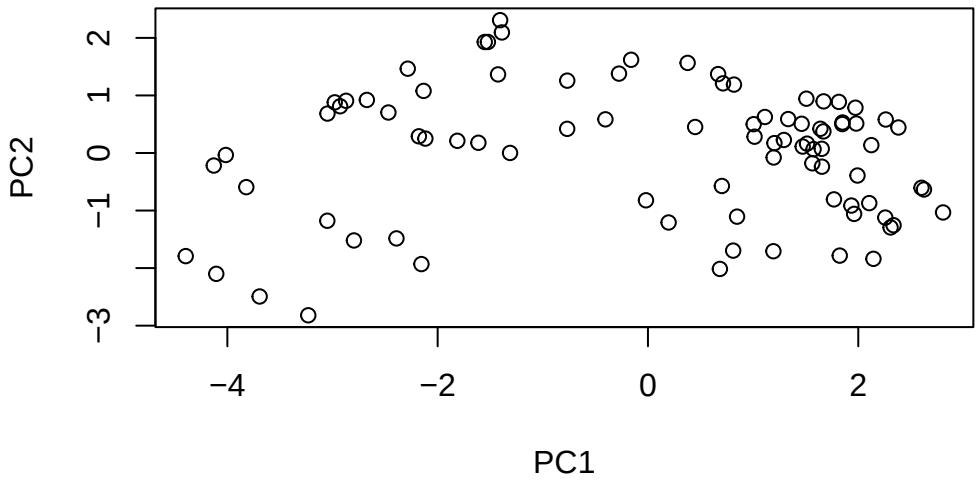
6. Principal Component Analysis

Let's do PCA on this dataset to get a low dimensional view that hopefully captures the essential essence of the data. We will use the 'prcomp()' function and set 'scale=TRUE' because the 'winpercehnt' and 'pricepercent' values are on a different scale!

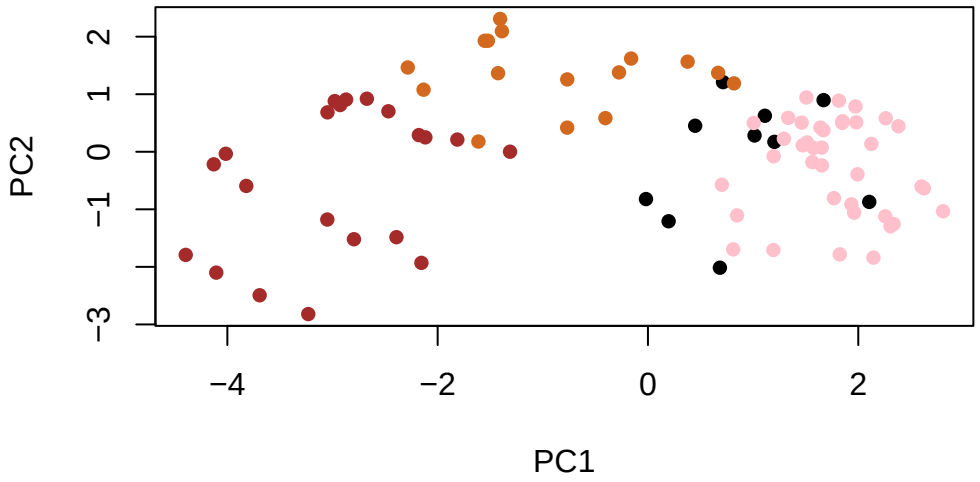
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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])
```



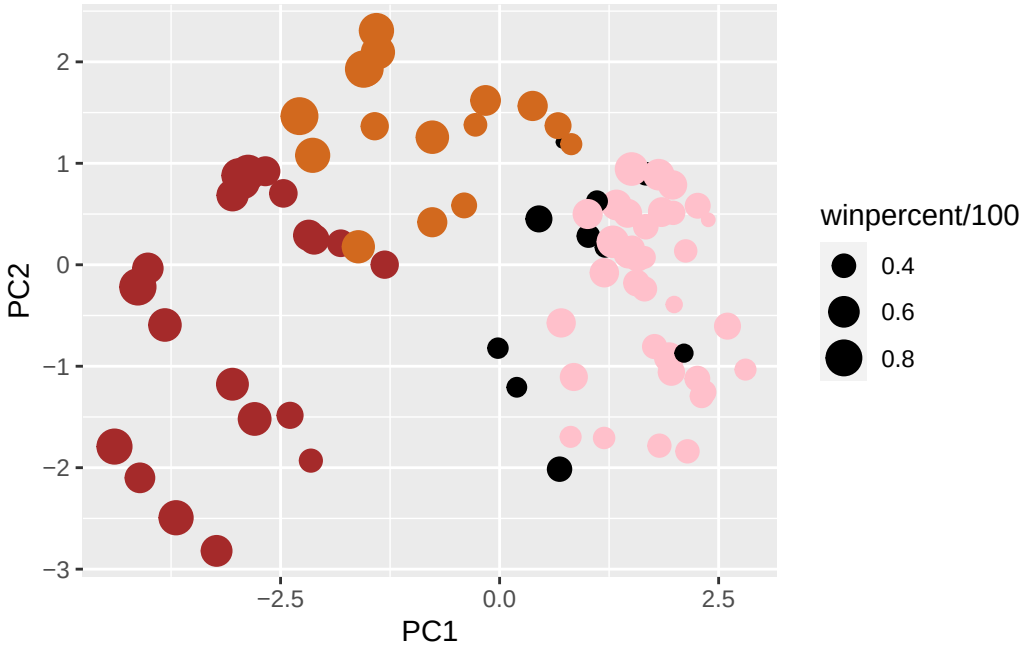
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



And a ggplot version

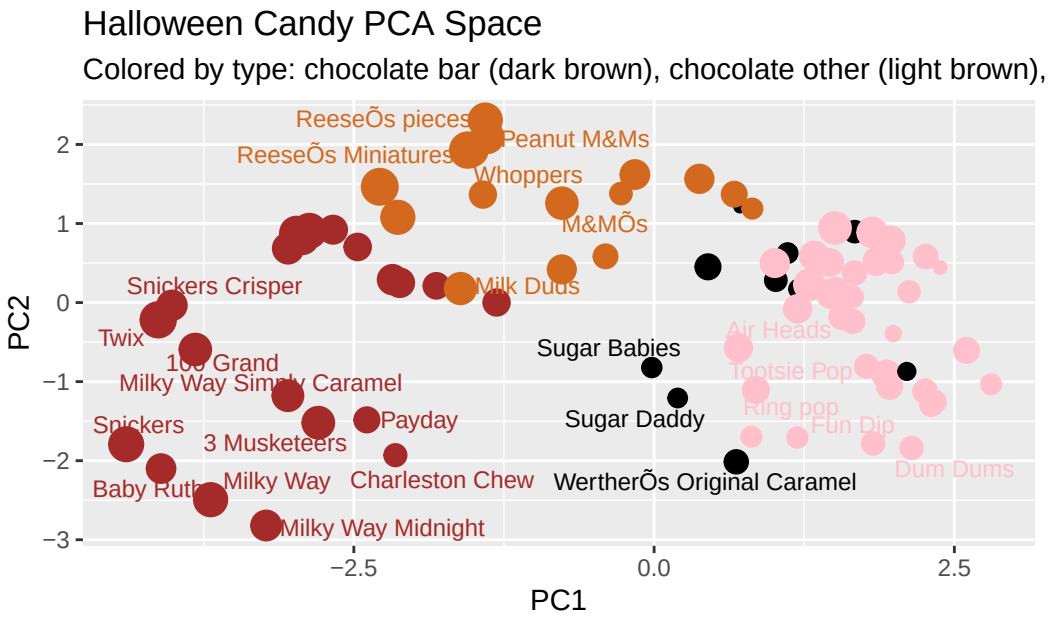
```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
```

```
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: 60 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

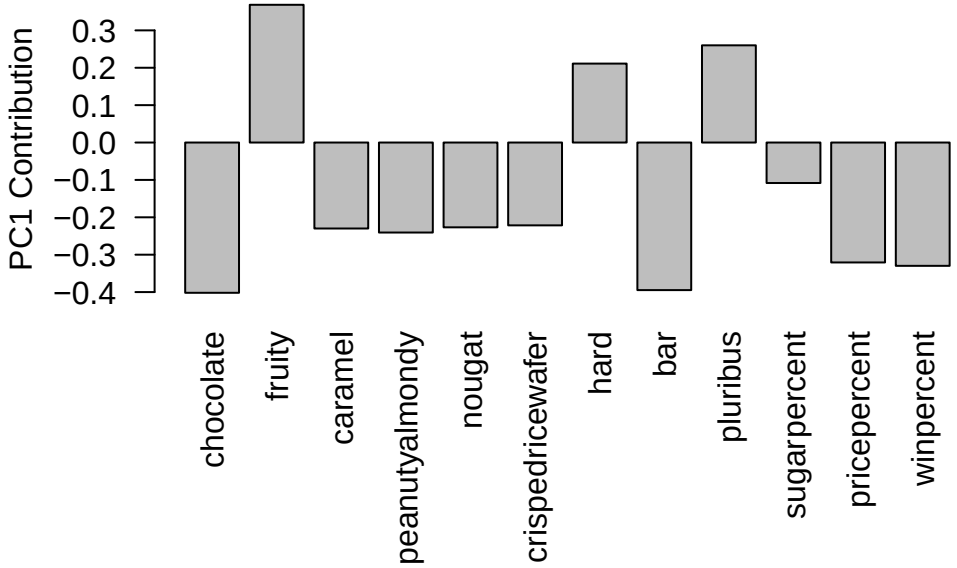


Data from 538

```
#library(plotly)
```

```
#ggplotly(p)
```

```
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?

Pluribus, fruity, and hard are picked up strongly by PC1 in the positive direction. The reason for this is because the fruity candy is hard and comes in a bag or box of multiple candies. Whereas, the chocolate comes with caramel, peanut/almondy, nougat, crisped rice wafer, bar, etc… (variables in PC2).