Class 10: Halloween Mini Project

Ian Gurholt (PID:A16767484)

##Importing Data

```
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 types of candy in the data set, each with their own row and found using nrow() function.

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

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

```
[1] 38
```

There are 38 types of fruity candy in the data set by suming up all of the fruity column using the `sum()` function.

##Favorite Candy

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

```
candy["Snickers", ]$winpercent
```

```
[1] 76.67378
```

My favorite candy is Snickers and its win percentage is 76,67%

> Q. Can you find all the candies with a win percent above 50 that are fruity?

```
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 |>
  filter(winpercent>50) |>
  filter(fruity==1)
```

```
                          chocolate fruity caramel peanutyalmondy nougat
Air Heads                         0      1       0              0      0
Haribo Gold Bears                 0      1       0              0      0
Haribo Sour Bears                 0      1       0              0      0
Lifesavers big ring gummies       0      1       0              0      0
Nerds                             0      1       0              0      0
Skittles original                 0      1       0              0      0
Skittles wildberry                0      1       0              0      0
Sour Patch Kids                   0      1       0              0      0
Sour Patch Tricksters             0      1       0              0      0
Starburst                         0      1       0              0      0
Swedish Fish                      0      1       0              0      0
                          crispedricewafer hard bar pluribus sugarpercent
Air Heads                                0    0   0        0        0.906
Haribo Gold Bears                        0    0   0        1        0.465
Haribo Sour Bears                        0    0   0        1        0.465
Lifesavers big ring gummies              0    0   0        0        0.267
Nerds                                    0    1   0        1        0.848
Skittles original                        0    0   0        1        0.941
Skittles wildberry                       0    0   0        1        0.941
Sour Patch Kids                          0    0   0        1        0.069
Sour Patch Tricksters                    0    0   0        1        0.069
Starburst                                0    0   0        1        0.151
Swedish Fish                             0    0   0        1        0.604
                          pricepercent winpercent
Air Heads                        0.511   52.34146
Haribo Gold Bears                0.465   57.11974
Haribo Sour Bears                0.465   51.41243
Lifesavers big ring gummies      0.279   52.91139
Nerds                            0.325   55.35405
Skittles original                0.220   63.08514
Skittles wildberry               0.220   55.10370
Sour Patch Kids                  0.116   59.86400
Sour Patch Tricksters            0.116   52.82595
Starburst                        0.220   67.03763
Swedish Fish                     0.755   54.86111
```

Q4. What is the winpercent value for “Kit Kat”?

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

```
[1] 76.7686
```

Win percentage for kit kat candy is 76.77%

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

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

```
[1] 49.6535
```

Win percentage for Tootsie Roll is 49.65%

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

```
Warning: package 'skimr' was built under R version 4.3.3
```

```r
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	

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

Looks like the win percent variable/column is measured on a different scale than everything else! I will need to scale my data before conducting any analysis such as PCA etc.

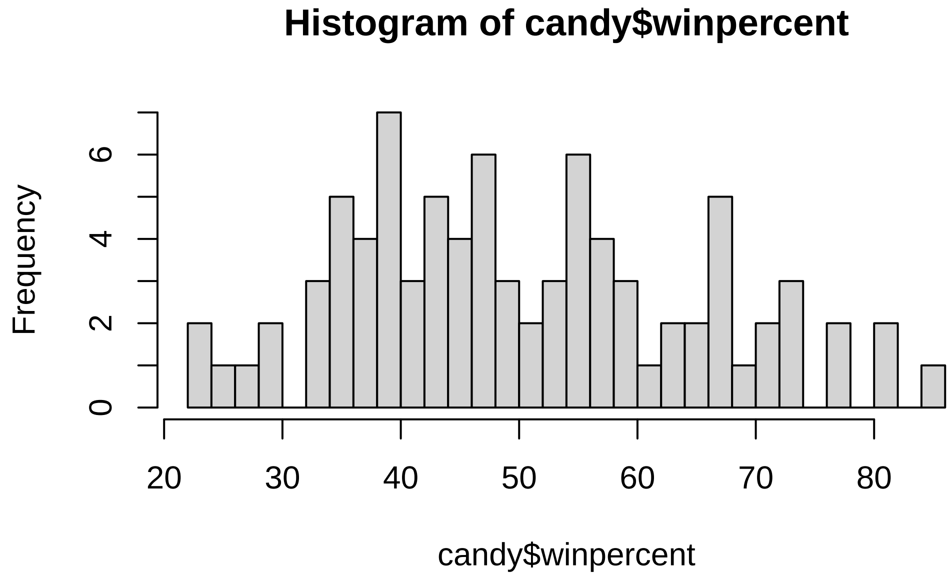
> Q7. What do you think a zero and one represent for the candy$chocolate column?

A one represents a candy that is classified as chocolate while a zero represents a candy that is not classified as chocolate

> Q8. Plot a histogram of winpercent values

We can do this a few ways, the "base" R `hist()` function or with gg plot

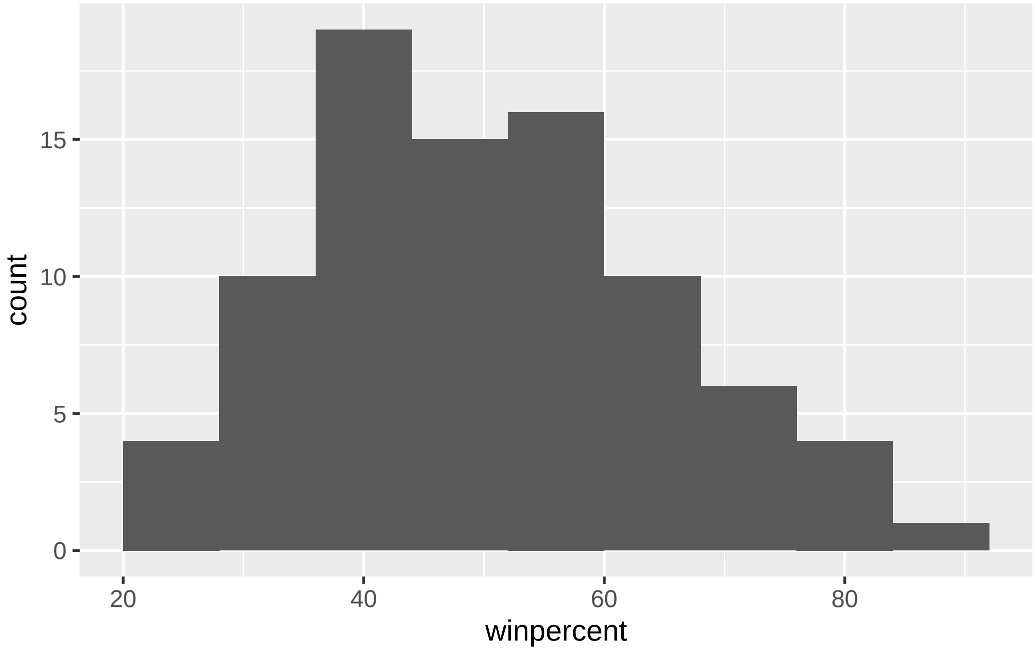
```r
hist(candy$winpercent, breaks = 30)
```



```r
library(ggplot2)
```

```
Warning: package 'ggplot2' was built under R version 4.3.3
```

```r
ggplot(candy)+
  aes(x= winpercent)+
  geom_histogram(binwidth=8)
```



Q9. Is the distribution of winpercent values symmetrical?

No, according to the histograms, there appears to be a skew to the left, with a right hand tail based on the data

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

```r
summary(candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.14   47.83   50.32   59.86   84.18 
```

It is below 50% as we utilize the median to access the center of the distribution, which according to the summary is less than 50%

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

```
fruit.candy<- candy |>
  filter(fruity==1)

summary(fruit.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.04   42.97   44.12   52.11   67.04 
```

```
choc.candy<- candy |>
  filter(chocolate==1)

summary(choc.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  34.72   50.35   60.80   60.92   70.74   84.18 
```

On average, chocolate candy is higher ranked as the median winpercent score of 60.8 is greater than fruity candy's 42.97

Q12. Is this difference statistically significant?

```
t.test(choc.candy$winpercent, fruit.candy$winpercent)
```

```

	Welch Two Sample t-test

data:  choc.candy$winpercent and fruit.candy$winpercent
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 as p-value is much less than 0.05 threshold value

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

```
head(candy[order(candy$winpercent),],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
```

These are the 5 least liked candies in this data set.

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

```
play<- c("d","a","c")
sort(play)
```

```
[1] "a" "c" "d"
```

```
order(play)
```

```
[1] 2 3 1
```

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

```
                          chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
```

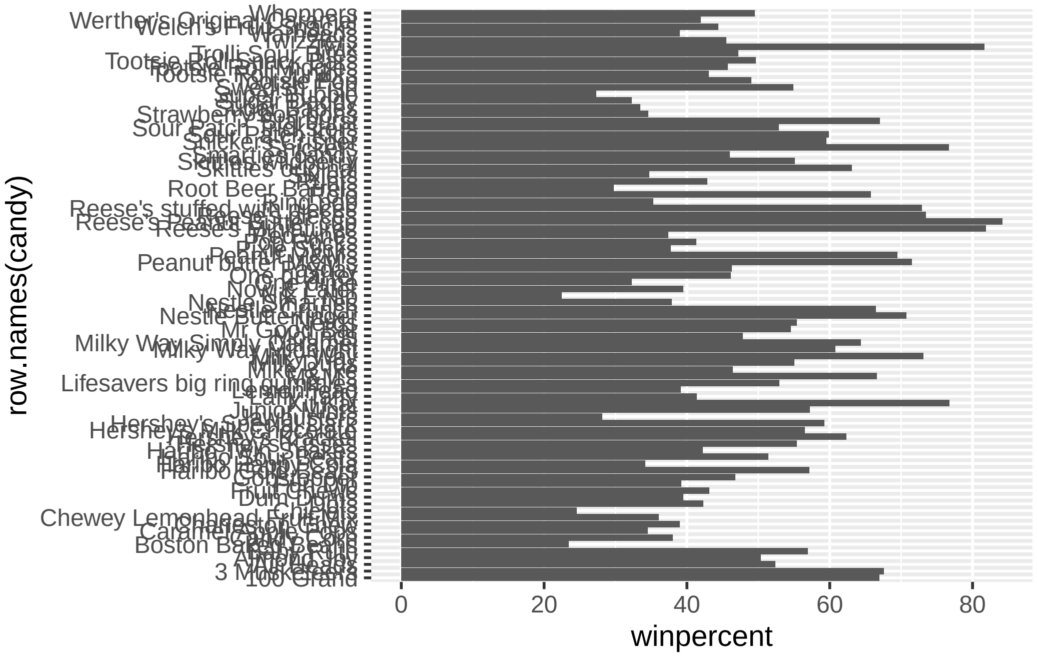
```
Twix                              1      0       1              0      0
Kit Kat                           1      0       0              0      0
Snickers                          1      0       1              1      1
                          crispedricewafer hard bar pluribus sugarpercent
Reese's 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
```

These are the top 5 most liked candies

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

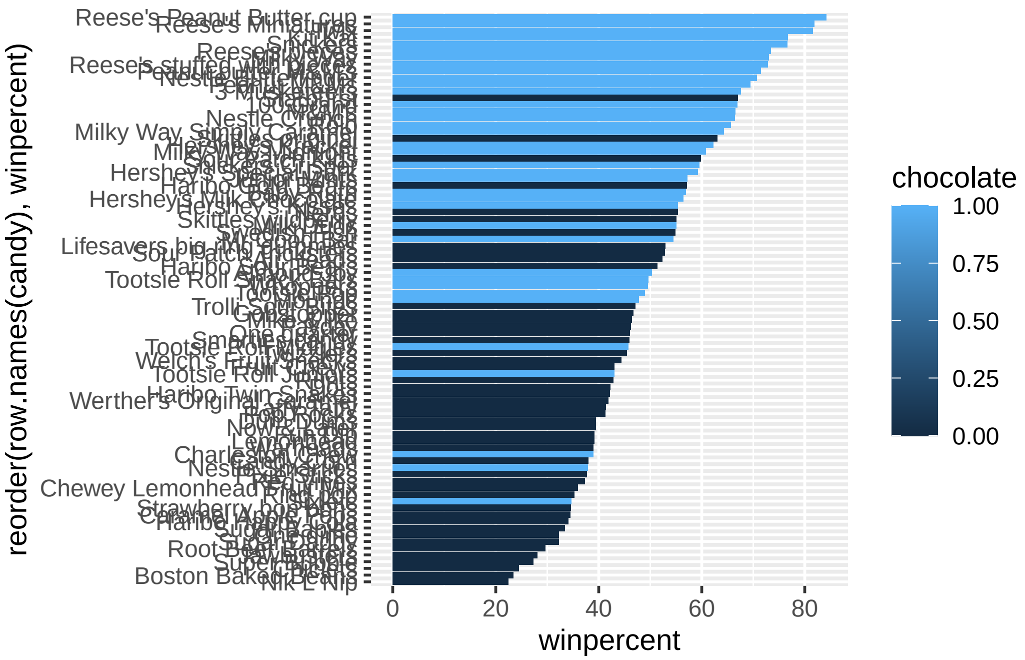
Let's do a barplot of winpercent values

```
ggplot(candy)+
  aes(winpercent, row.names(candy))+
  geom_col()
```



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

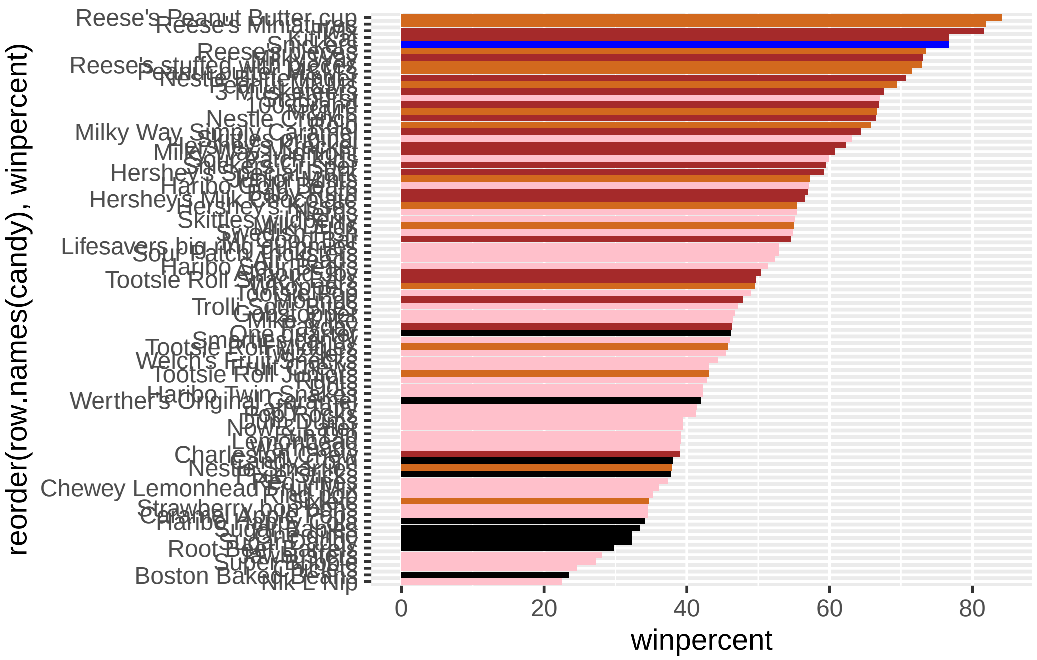
```
ggplot(candy)+
  aes(winpercent, reorder(row.names(candy), winpercent), fill=chocolate)+
  geom_col()
```



I want a more customized color scheme where I can see both chocolate and bar and fruit from a single plot, without having to make multiple plots. To do this we can roll our own color vector.

```
mycols<- rep("black", nrow(candy))
mycols[as.logical(candy$chocolate)]<- "chocolate"
mycols[as.logical(candy$bar)]<- "brown"
mycols[as.logical(candy$fruity)]<- "pink"
mycols[rownames(candy)=="Snickers"]<- "blue"
```

```
ggplot(candy)+
  aes(winpercent, reorder(row.names(candy), winpercent))+
  geom_col(fill=mycols)
```



Q17. What is the worst ranked chocolate candy?

According to the plot, the worst ranked chocolate candy is sixlets

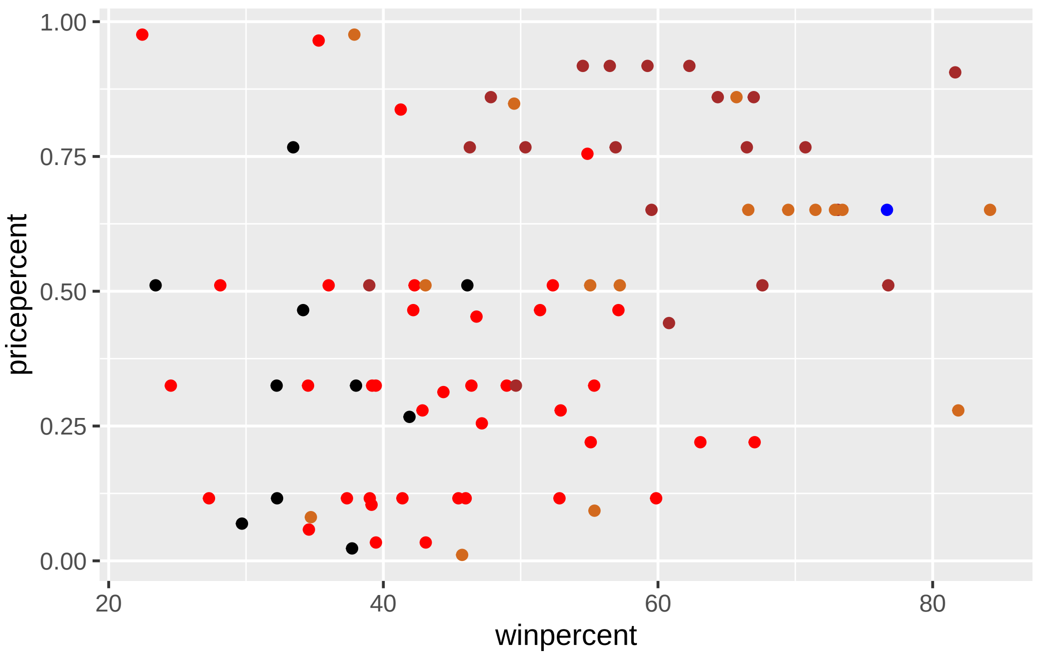
Q18. What is the best ranked fruity candy?

According to the plot, the best ranked fruity candy is starburst

Plot of Win Percent versus Price Percent to see what would be the best candy to buy…

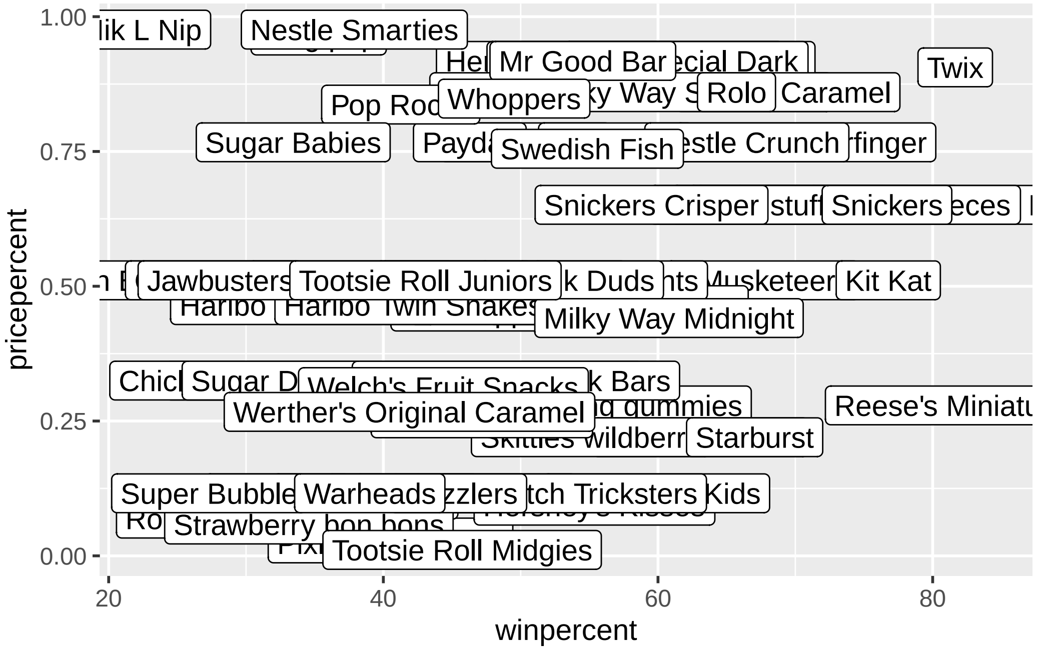
```
mycols[as.logical(candy$fruity)]<- "red"
```

```
ggplot(candy)+
  aes(winpercent, pricepercent)+
  geom_point(col=mycols)
```

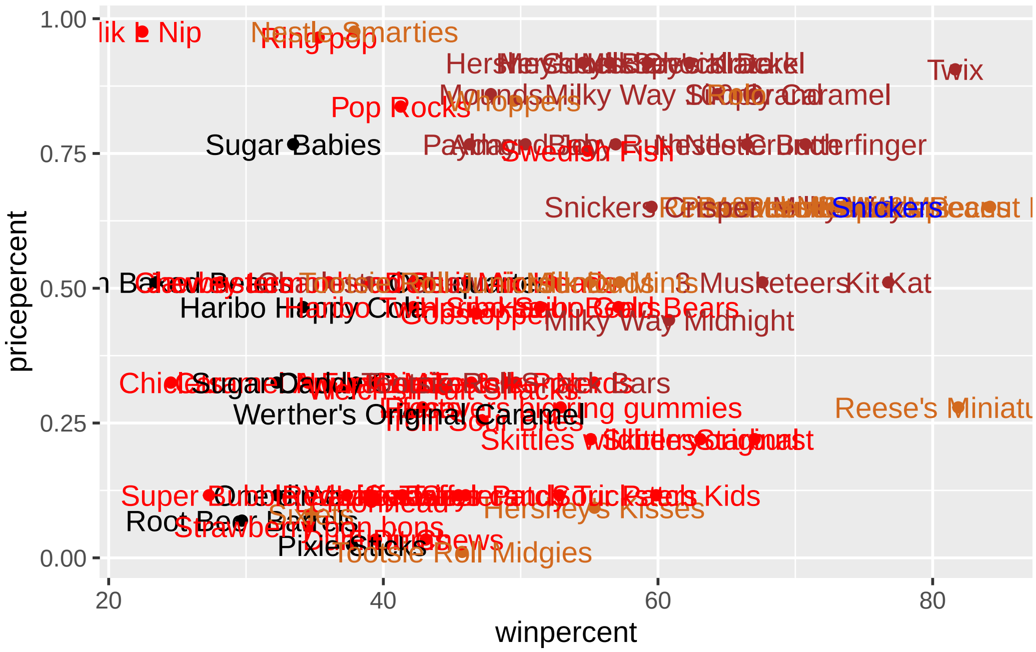


Add labels

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



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



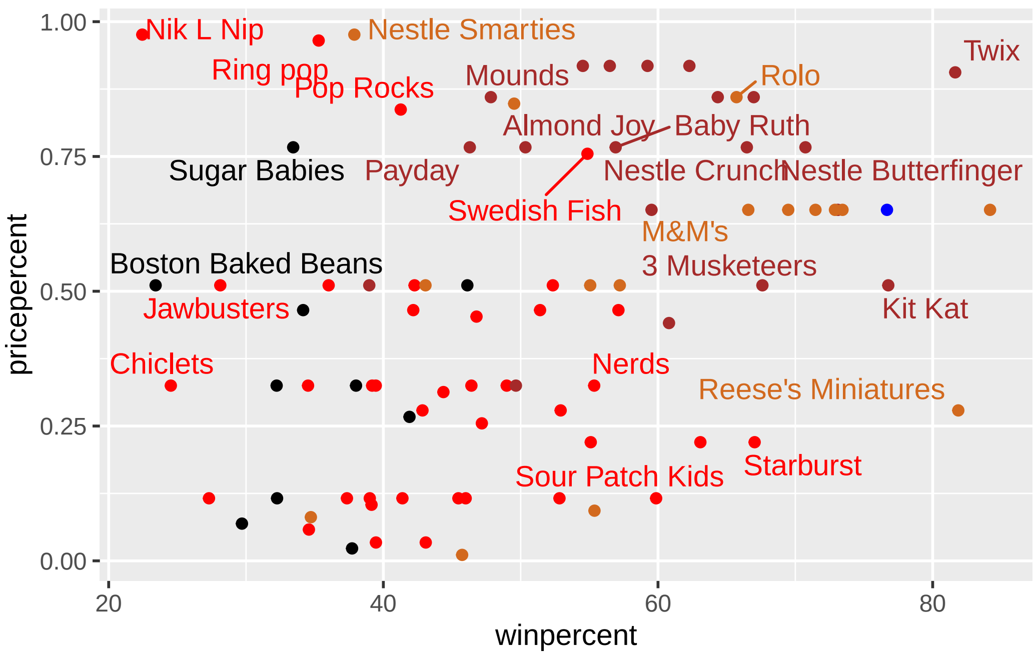
Make Labels non-overlapping

```r
library(ggrepel)
```

```
Warning: package 'ggrepel' was built under R version 4.3.3
```

```r
ggplot(candy)+
  aes(winpercent, pricepercent, label=rownames(candy))+
  geom_point(col=mycols)+
  geom_text_repel(col=mycols, max.overlaps=8)
```

```
Warning: ggrepel: 61 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?

Reeses minatures are ranked highest in terms of winpercent for the least money according to the plot above

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

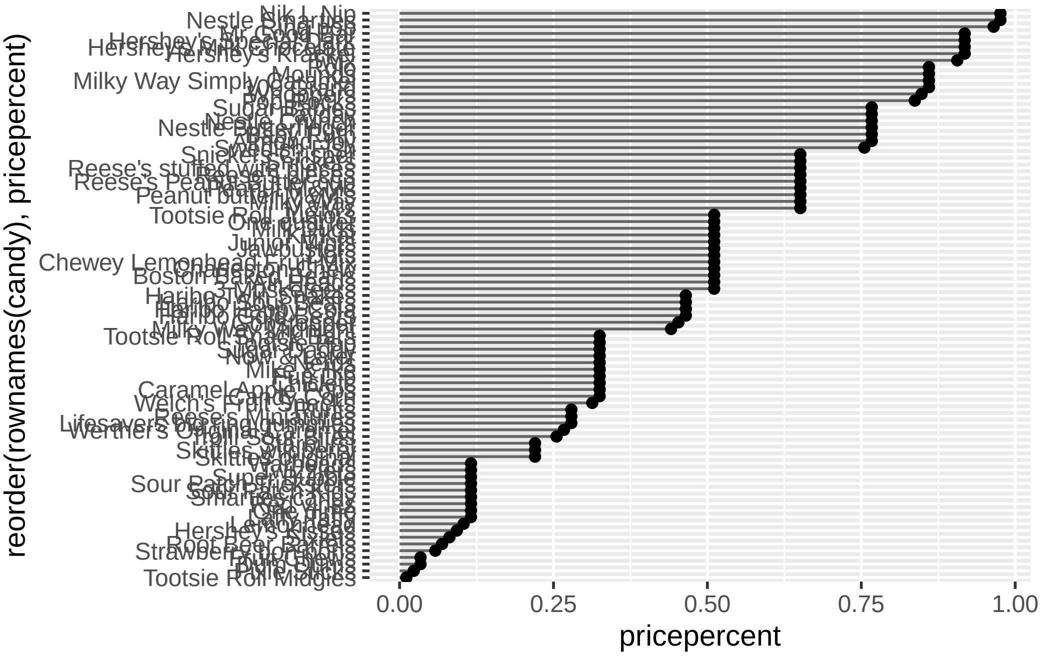
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                         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 Nik L Nip, Ring pops, Smarties, Hersheys Krackel, and Hersheys chocolate, with Nik L Nip being the least popular of them all.

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().

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



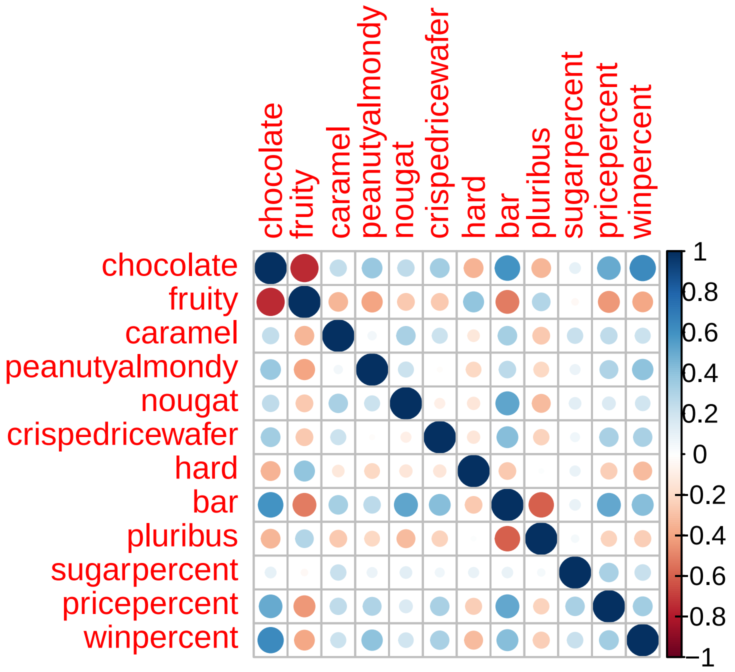
##Exploring the Correlation Structure

```
library(corrplot)
```

```
Warning: package 'corrplot' was built under R version 4.3.3
```

```
corrplot 0.95 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 anticorrelated based on the correlation structure

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

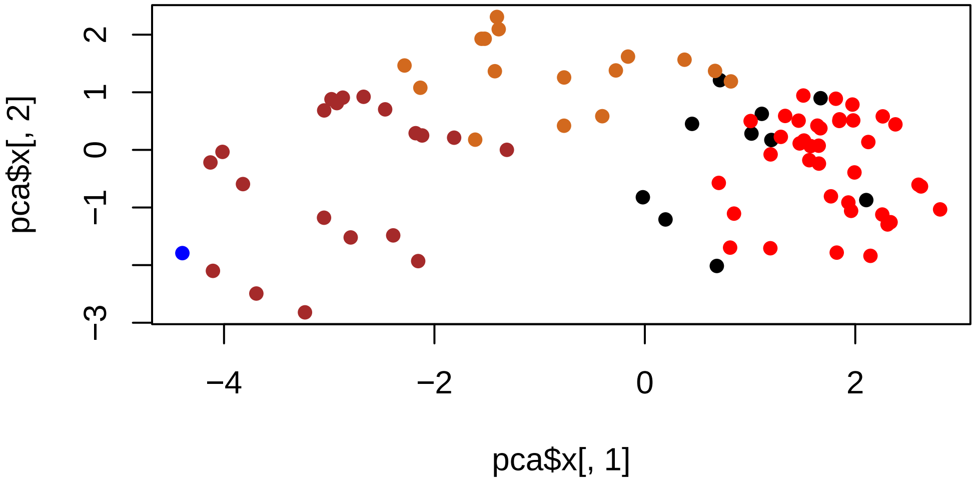
Chocolate and win percentage are most positively correlated based on the correlation structure

##Principal Component Analysis

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

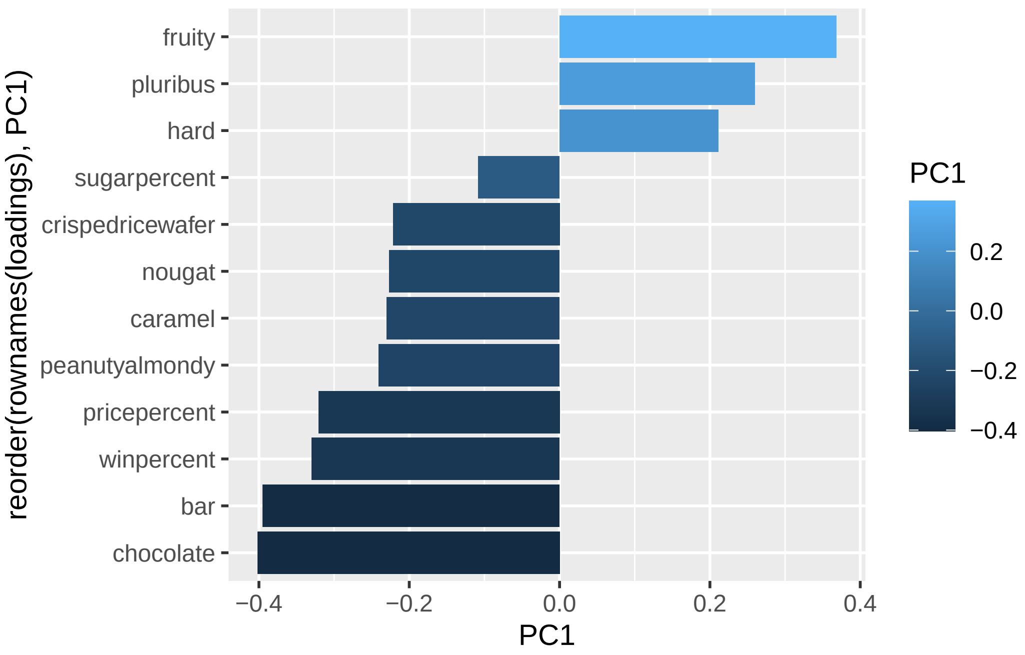
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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$x[,1],pca$x[,2], col=mycols, pch=16)
```



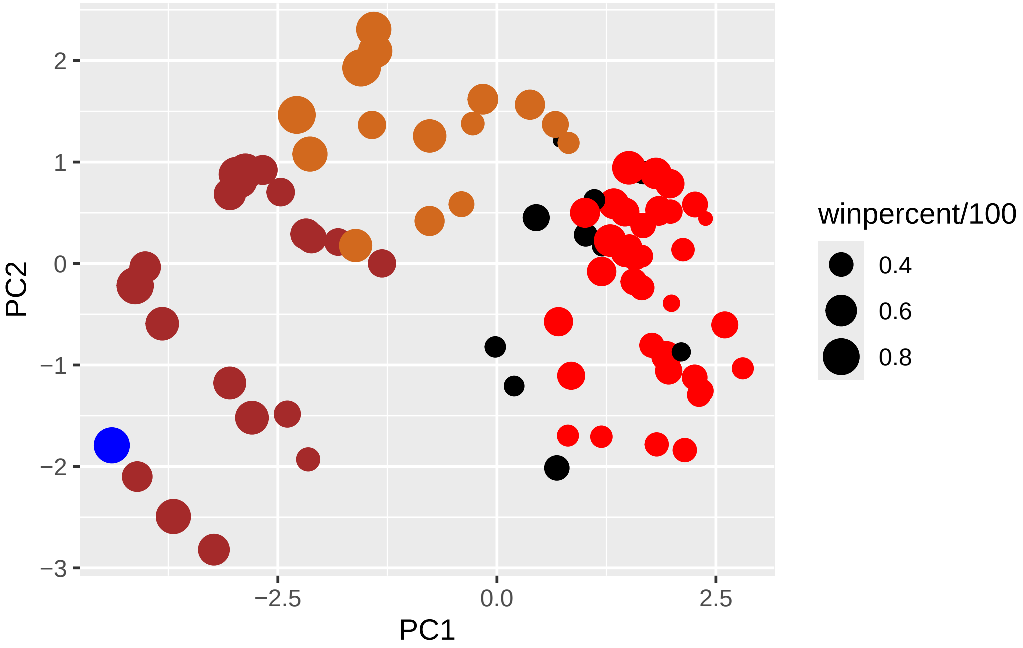
How do the original columns contribute to the new PCs. I will look at PC1 first here

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

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



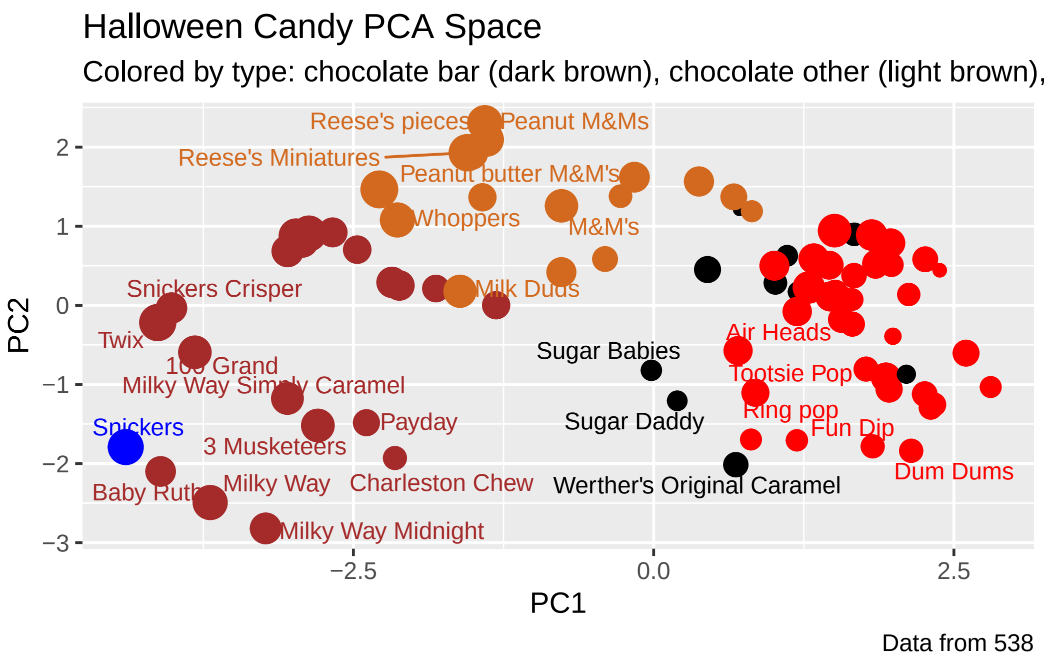
##ggplot of PCA

```
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=mycols)

p
```

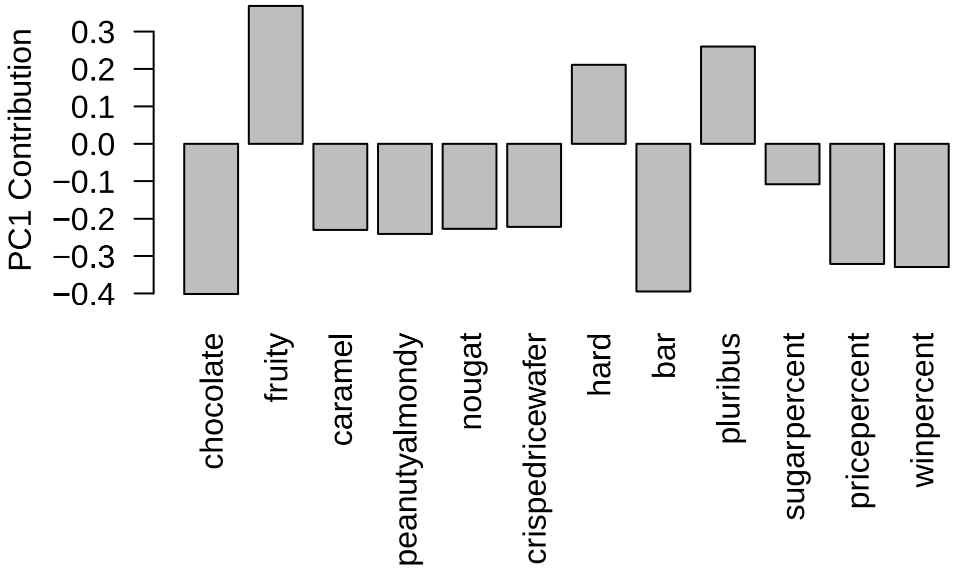


```r
library(ggrepel)

p + geom_text_repel(size=3.3, col=mycols, 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
```



```
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?

PC1 strongly picks up fruity, hard, and pluribus in the positive direction as these variables are all positioned on the positive right side of PC1 loadings plot compared to all other variables being positioned on the left, negative side of the loadings plot. This makes sense to me as naturally, hard, fruity, candy are commonly found related to each other as well as being pluribus (bagged), and their close relationship via the PC1 plot support this real world finding statistically.