Lab 10 Halloween Candy Mini Project

Daniel Gurholt (PID: A16767491)

##Importing candy 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 types in this dataset.

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

```
sum(candy[,"fruity"])
```

```
[1] 38
```

There are 38 types of fruity candy in this dataset

##What is your favorate candy?

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

```
candy["Junior Mints", ]$winpercent
```

```
[1] 57.21925
```

My favorite candy is Junior Mints, with a winpercent value of 57.2%

Q. Can you find all 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
```

The win percent for Kit Kat is 76.8%

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

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

```
[1] 49.6535
```

The win percent for Tootsie Roll Snack Bars is 49.7%

```
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?

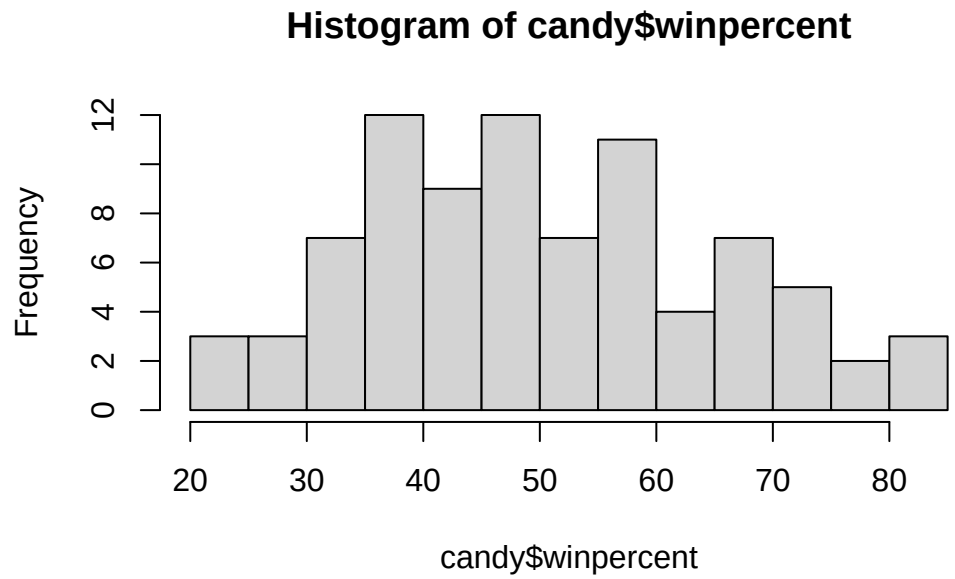
The winpercent variable looks to be on a different scale to the majority of the other columns in the dataset.

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

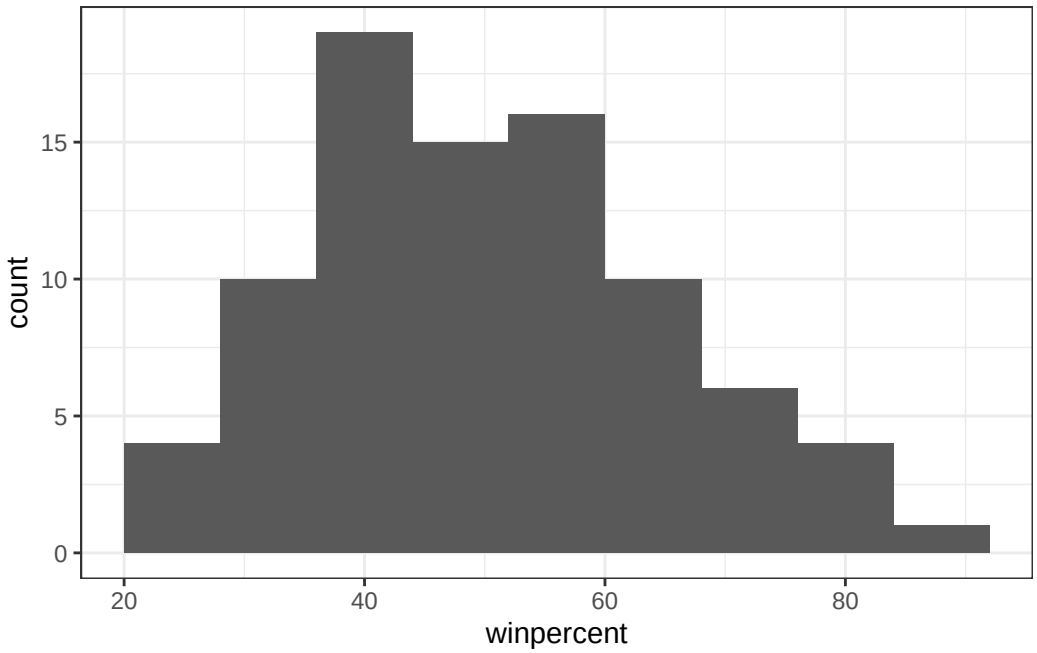
A zero represents types of candy that do not have chocolate and a one represents candy that does contain chocolate in the dataset.

Q8. Plot a histogram of winpercent values

```
hist(candy$winpercent, breaks=10)
```




```
library(ggplot2)
ggplot(candy, aes(winpercent)) +
  geom_histogram(binwidth = 8)+
  theme_bw()
```



Q9. Is the distribution of winpercent values symmetrical?

No, the distribution of winpercent values symmetrical, and looks slightly skewed.

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

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

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

The center of distribution is below 50% as seen from the median in the code above.

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
```

Chocolate candy is on average higher ranked than fruity candy since chocolate has botha higher mean and median than fruity candy.

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
```

Since the p-value is much smaller than the 0.05 threshold, this difference between chocolate and fruity candy is statistically significant.

##Overall Candy Rankings

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

```
candy %>% 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 Jaw Busters with the lowest winpercent values of the entire dataset.

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

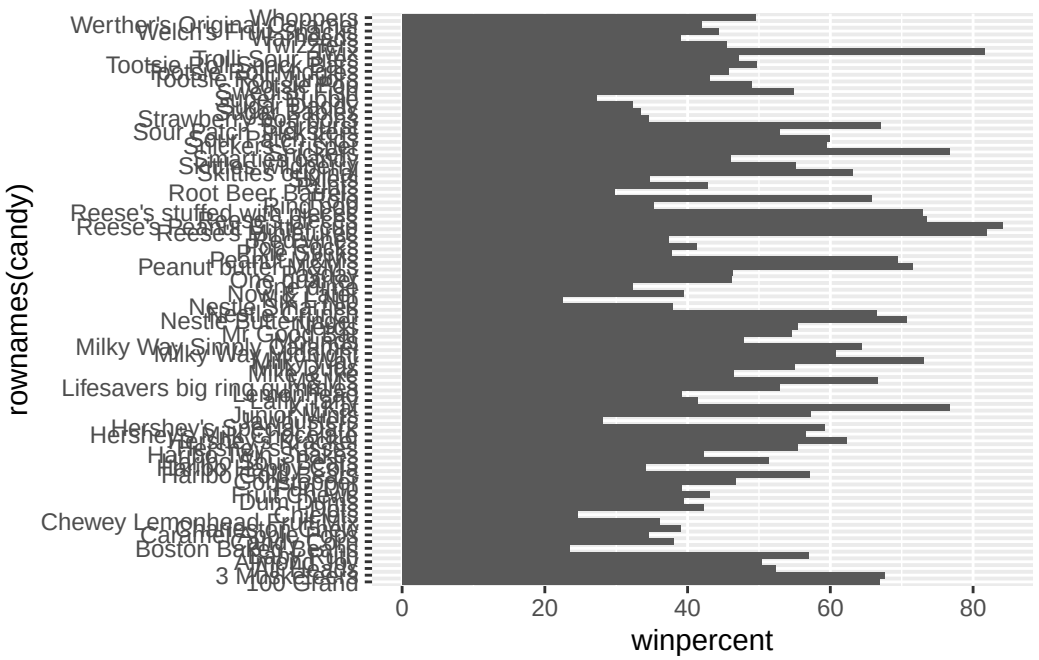
```
candy %>% arrange(winpercent) %>% tail(5)
```

```
                        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 all time favorite favorite candy types in this data set are Snickers, Kit Kat, Twix, Reese's Miniatures, and Reese's Peanut Butter cup with the highest winpercent values.

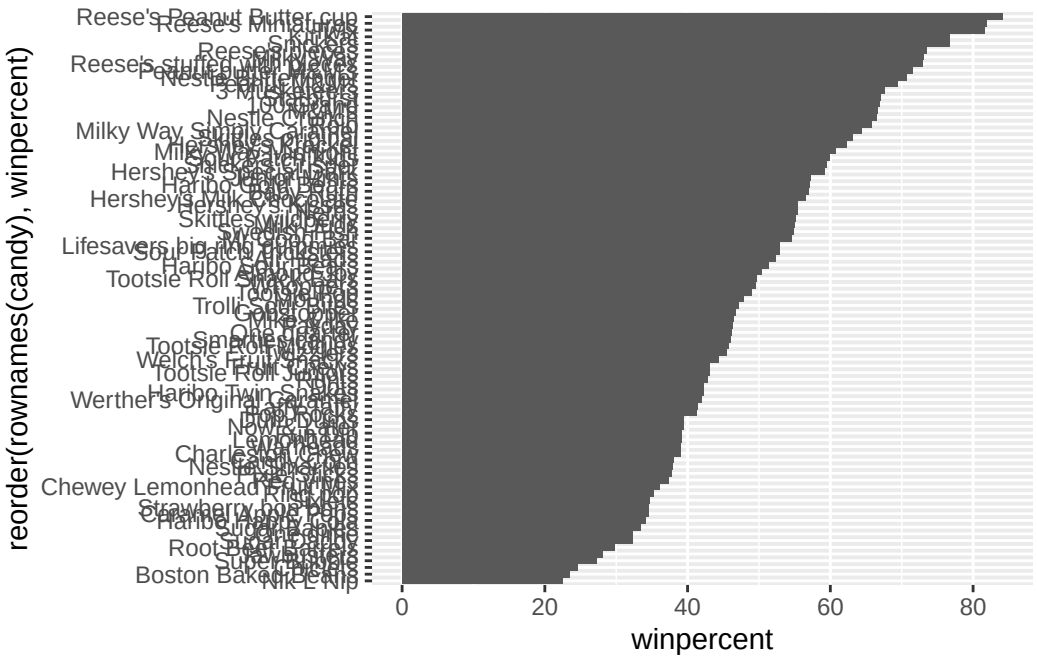
Q15. Make a first barplot of candy ranking based on winpercent values.

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

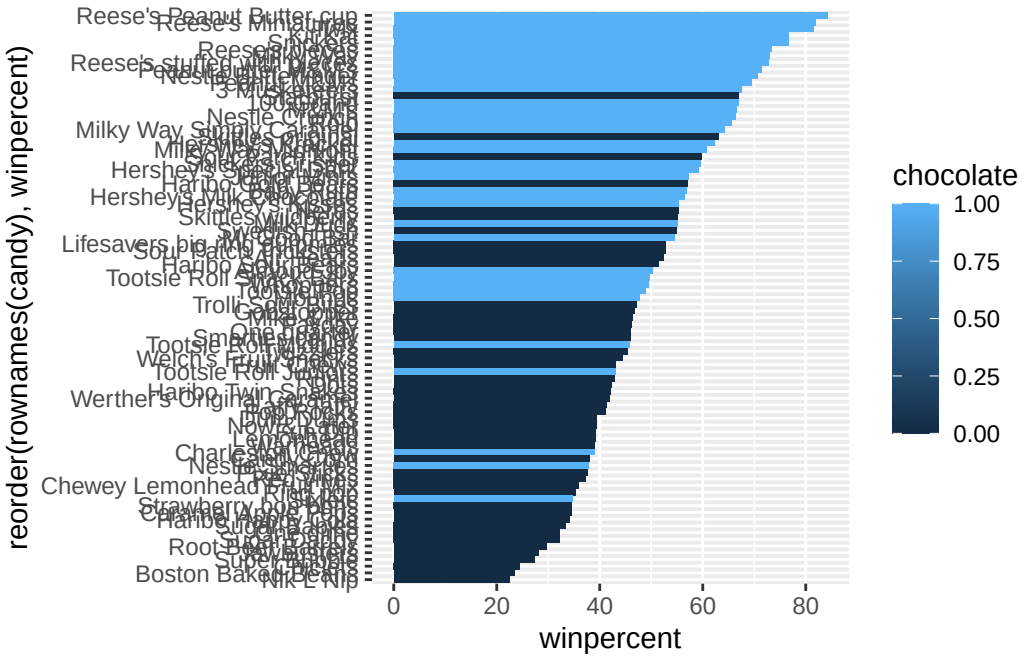


Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

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




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



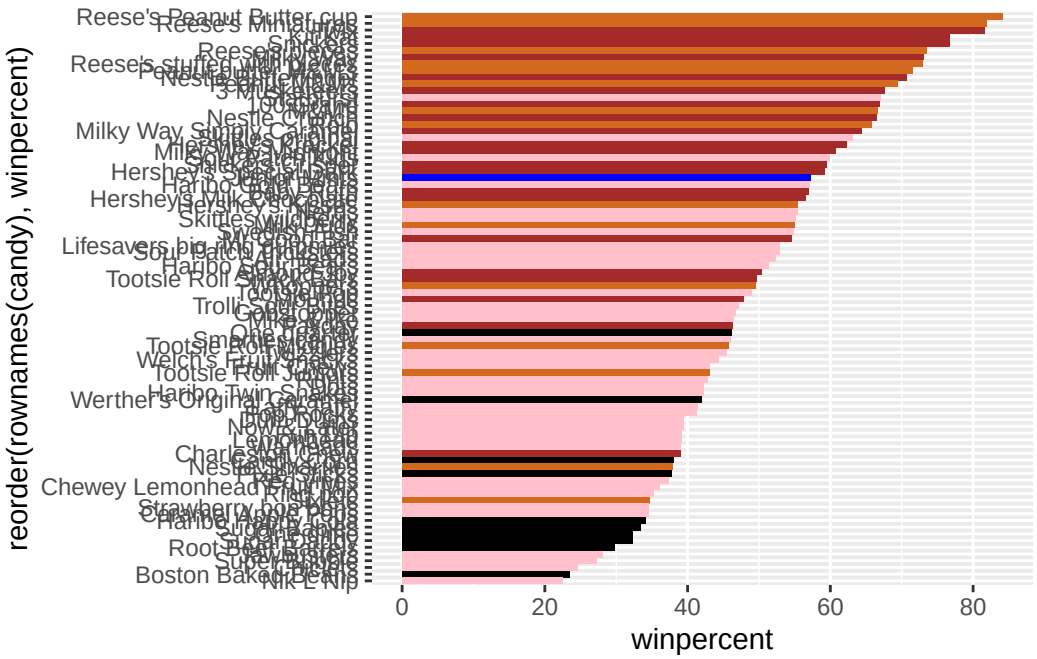
I want a more specialized/custom color scale where I can see both chocolate and fruity etc. a;l in one plot. To do this we can roll our own color vector.

```
# Place holder 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
```

```
 [1] "brown"     "brown"     "black"     "black"     "pink"      "brown"
 [7] "brown"     "black"     "black"     "pink"      "brown"     "pink"
[13] "pink"      "pink"      "pink"      "pink"      "pink"      "pink"
[19] "pink"      "black"     "pink"      "pink"      "chocolate" "brown"
[25] "brown"     "brown"     "pink"      "chocolate" "brown"     "pink"
[31] "pink"      "pink"      "chocolate" "chocolate" "pink"      "chocolate"
[37] "brown"     "brown"     "brown"     "brown"     "brown"     "pink"
[43] "brown"     "brown"     "pink"      "pink"      "brown"     "chocolate"
[49] "black"     "pink"      "pink"      "chocolate" "chocolate" "chocolate"
[55] "chocolate" "pink"      "chocolate" "black"     "pink"      "chocolate"
[61] "pink"      "pink"      "chocolate" "pink"      "brown"     "brown"
[67] "pink"      "pink"      "pink"      "pink"      "black"     "black"
[73] "pink"      "pink"      "pink"      "chocolate" "chocolate" "brown"
[79] "pink"      "brown"     "pink"      "pink"      "pink"      "black"
[85] "chocolate"
```

```
mycols[rownames(candy)=="Junior Mints"]<- "blue"
```

```
#Use blue for your favorite candy!
ggplot(candy)+
  aes(winpercent, reorder(rownames(candy), winpercent))+
  geom_col(fill=mycols)
```



Q17. What is the worst ranked chocolate candy?

Sixlets is the worst ranked chocolate candy.

Q18. What is the best ranked fruity candy?

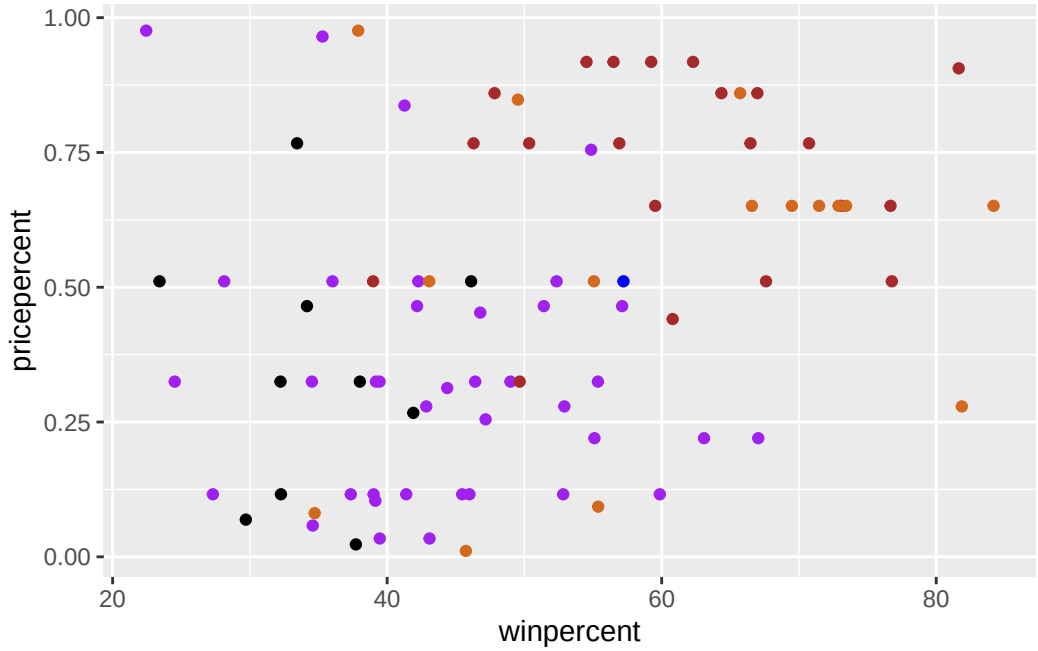
Starburst is the best ranked fruity candy.

##Taking a look at pricepercent

Plot of winpercent vs pricepercent

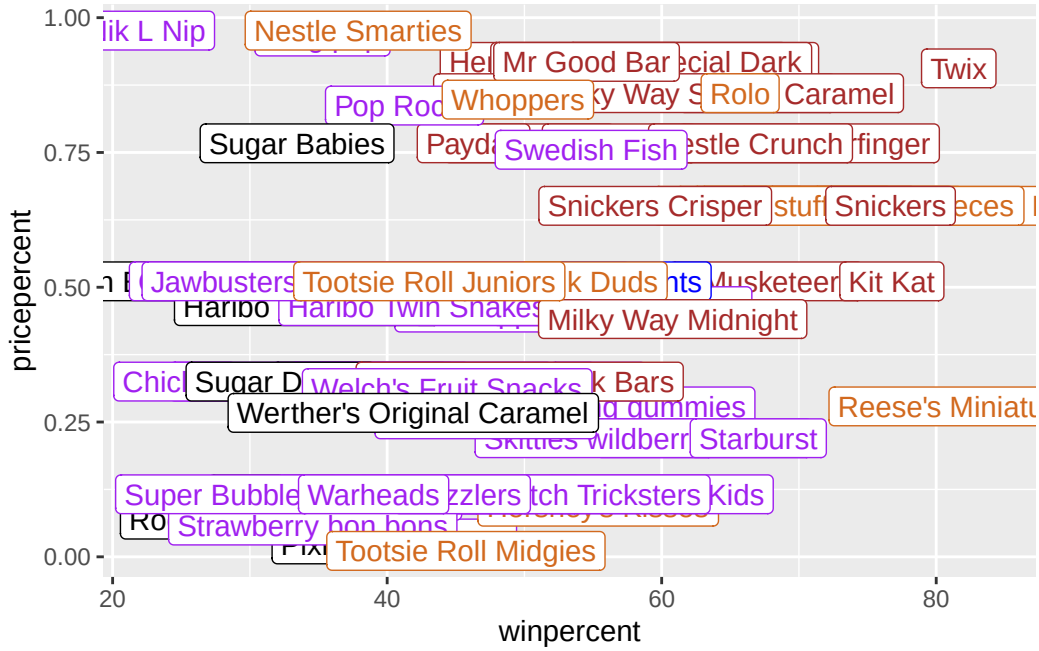
```
mycols[as.logical(candy$fruity)]<- "purple"
```

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



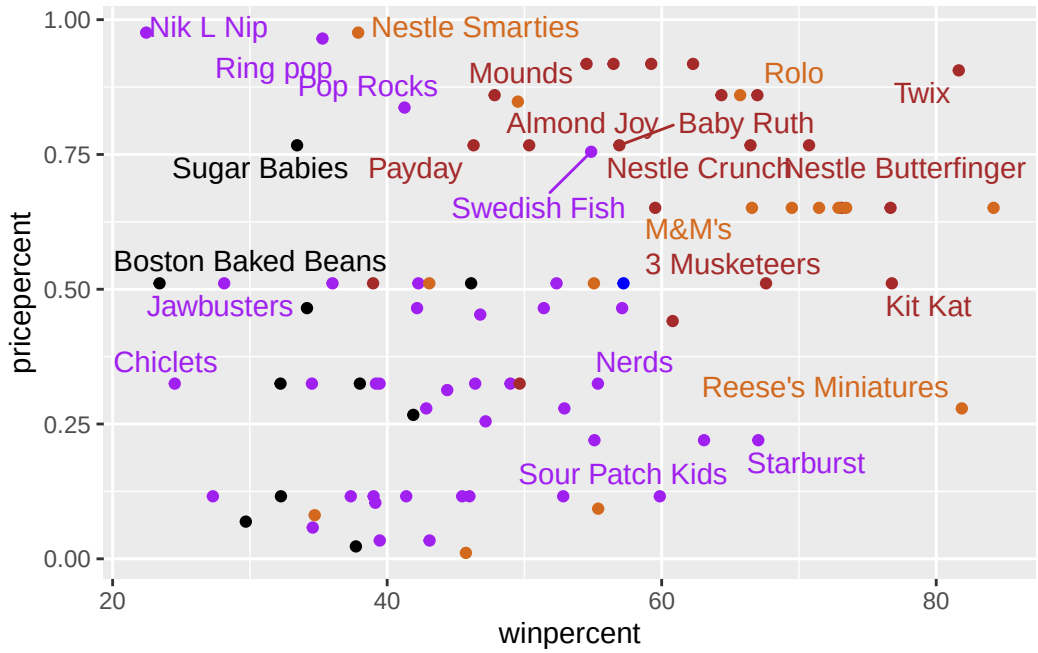
Add Labels

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




```
library(ggrepel)
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?

Reese's Miniatures is the highest ranked in terms of winpercent for the least money when looking at the scatterplot.

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

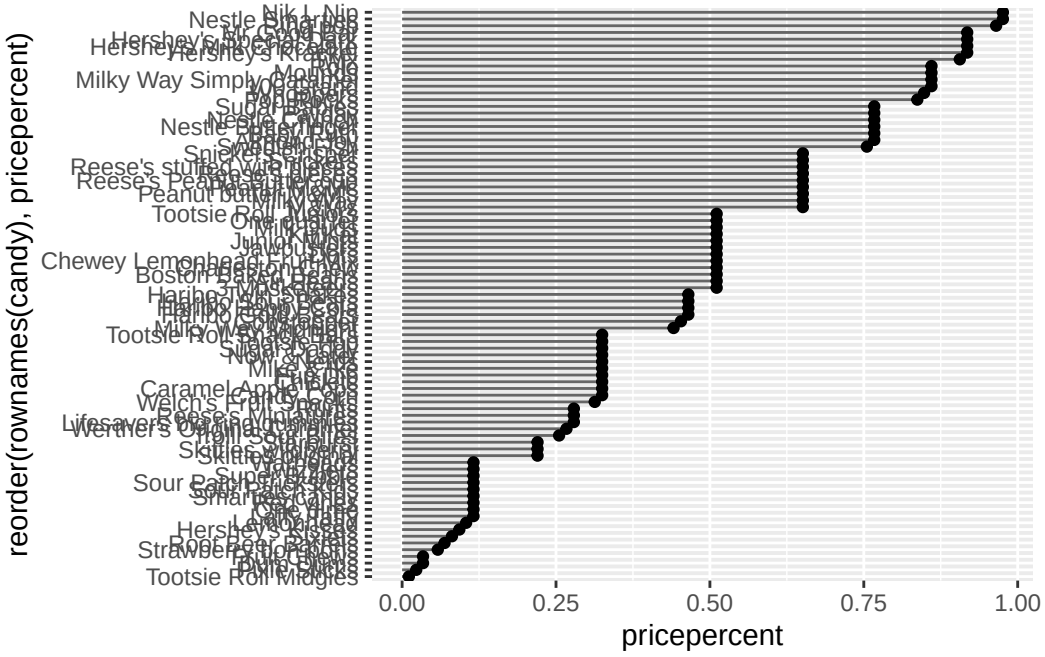
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                      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 candies are Nik L Nip, Nestle smarties, Ring Pop, Hershey's Krackel, and Hershey's Milk chocolate. Of these, the least popular one is Nik L Nip.

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()
```

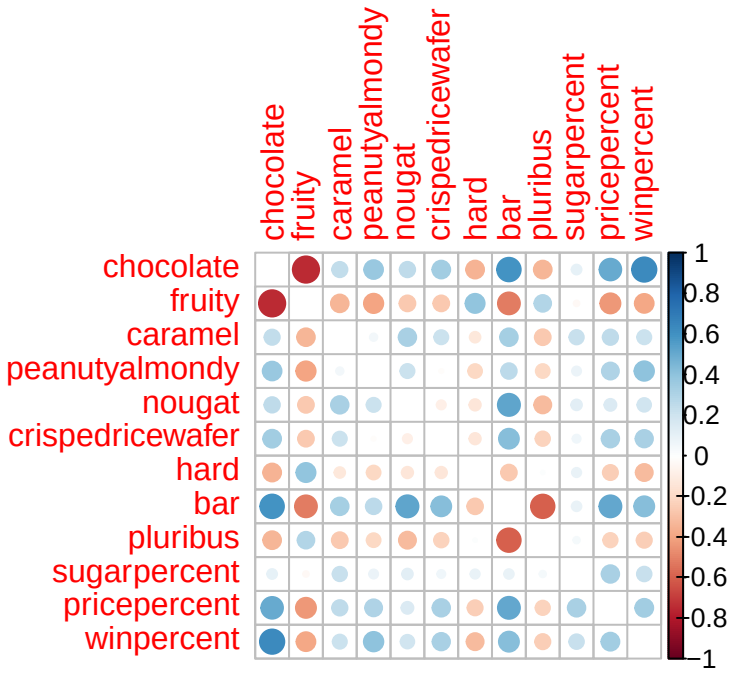


##Exploring the correlation structure

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
cij<- cor(candy)
corrplot(cij, diag=F)
```



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

Upon examining the plot, the chocolate and fruity variables are anti-correlated as they do not appear together in this dataset with a very negative correlation value.

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

Upon examining the plot, the chocolate and winpercent or chocolate and bar are the most positively correlated as they frequently appear together in this dataset with a very positive correlation value.

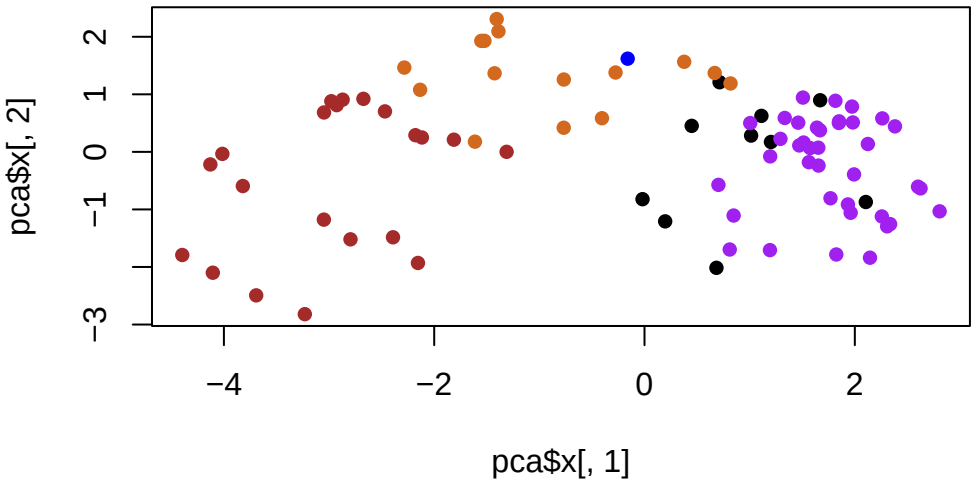
##Principal Component Analysis

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

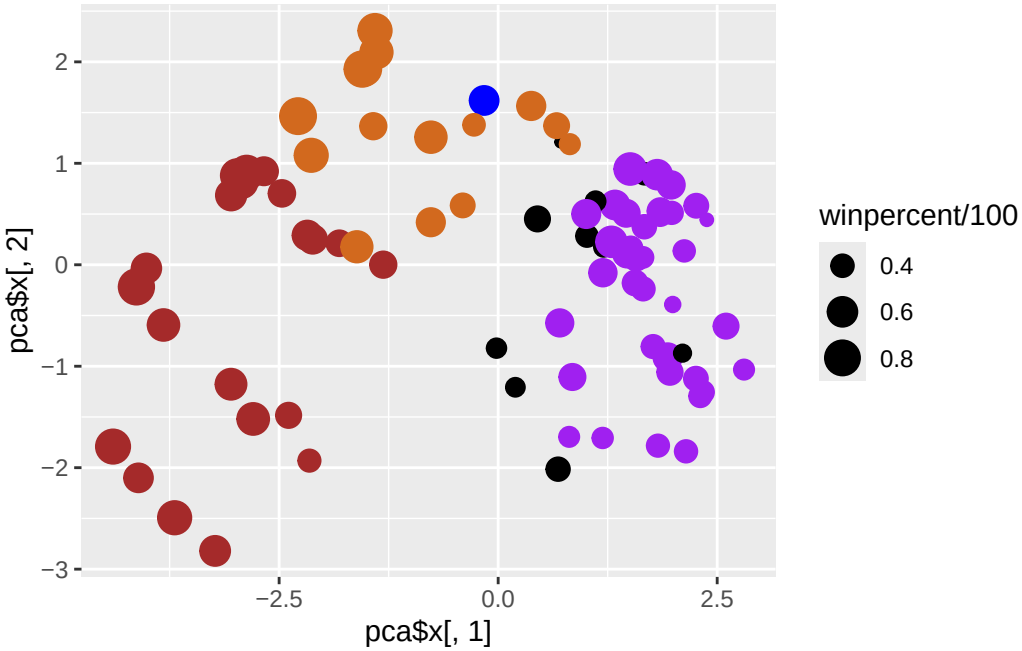
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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)
```

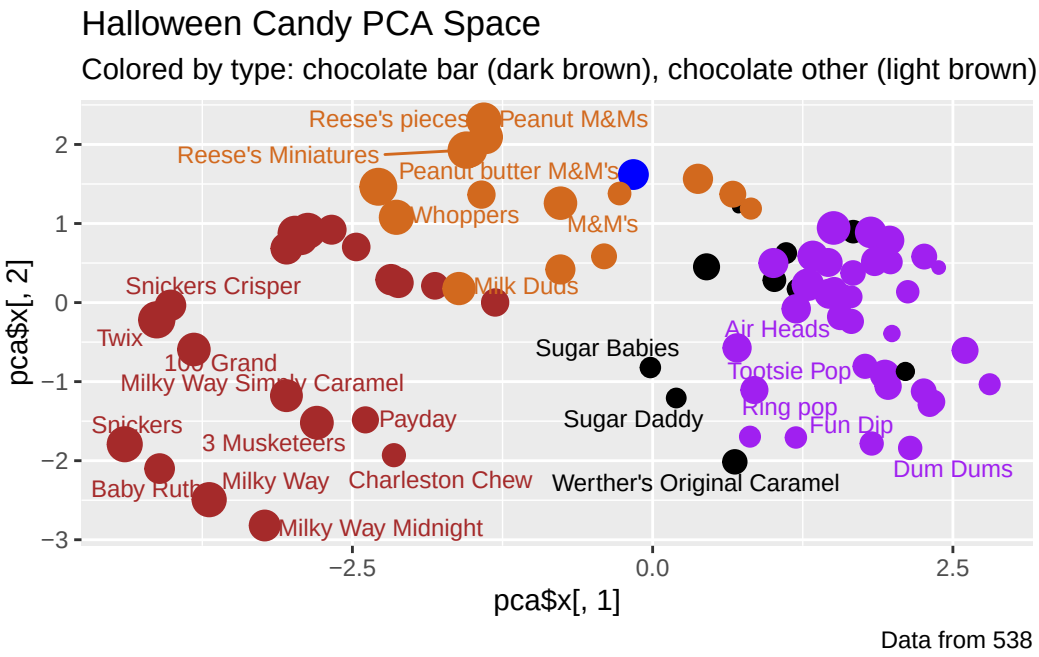



```
p<- ggplot(candy)+
  aes(pca$x[,1], pca$x[,2], size=winpercent/100,
            text=rownames(candy),
            label=rownames(candy))+
  geom_point(col=mycols)

p
```



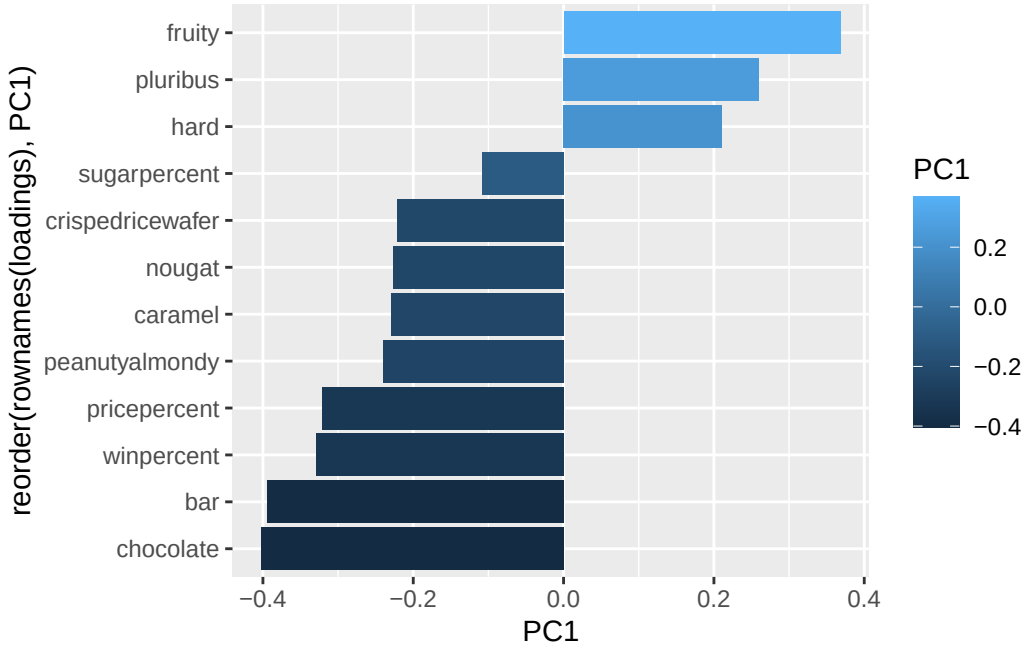

```
library(ggrepel)

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
```

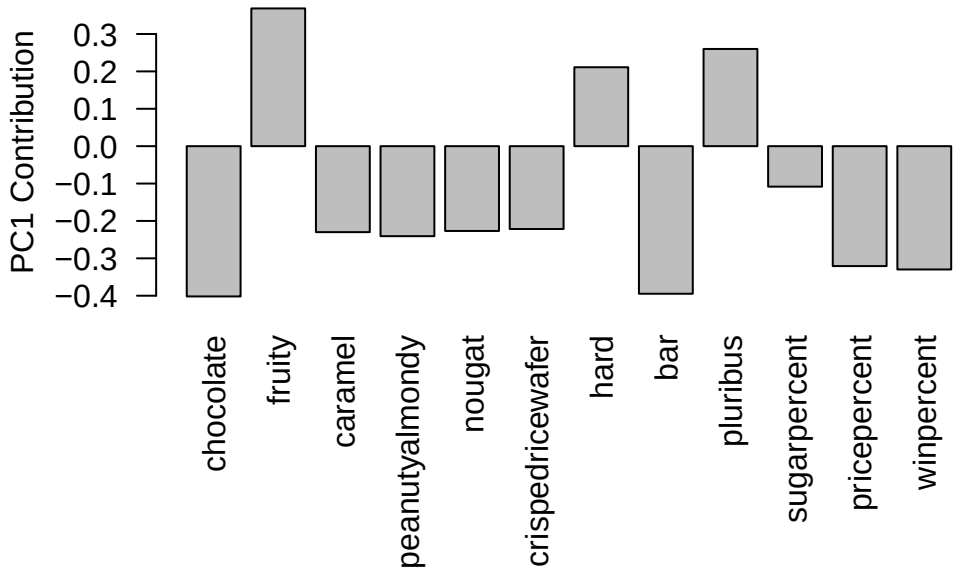


How do the original variables (columns) contribute to the new PCs. I will look at PC1 here.

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

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




```
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, hard, and fruity are three original variables that are picked up strongly by PC1 in the positive direction. This makes sense to me because all the fruity candies are concentrated on the right/positive side of the pca comparison scatter plot compared to all the chocolates being separated on the left. Additionally, it makes sense that fruity would be related to hard since most fruity candies are hard and are pluribus which means that many come in one bag which is not very common with chocolates that are soft and usually not fruity at least in this data set.