Class09 - Halloween Candy Mini-Project

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In today's class we will examine some data about candy from the 538 website.

Import Data

```
candy_file <- "BIMM143Candy-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
```

Data Exploration - your favorite candy

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

```
nrow(candy)
```

```
[1] 85
```

There are 85 types of candy in the dataset.

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

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

```
[1] 38
```

There are 38 fruity candy types in the dataset.

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

```
candy["Almond Joy", ]$winpercent
```

```
[1] 50.34755
```

My favorite candy is Almond Joy, which has a winpercent value of 50.35.

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
```

```
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?

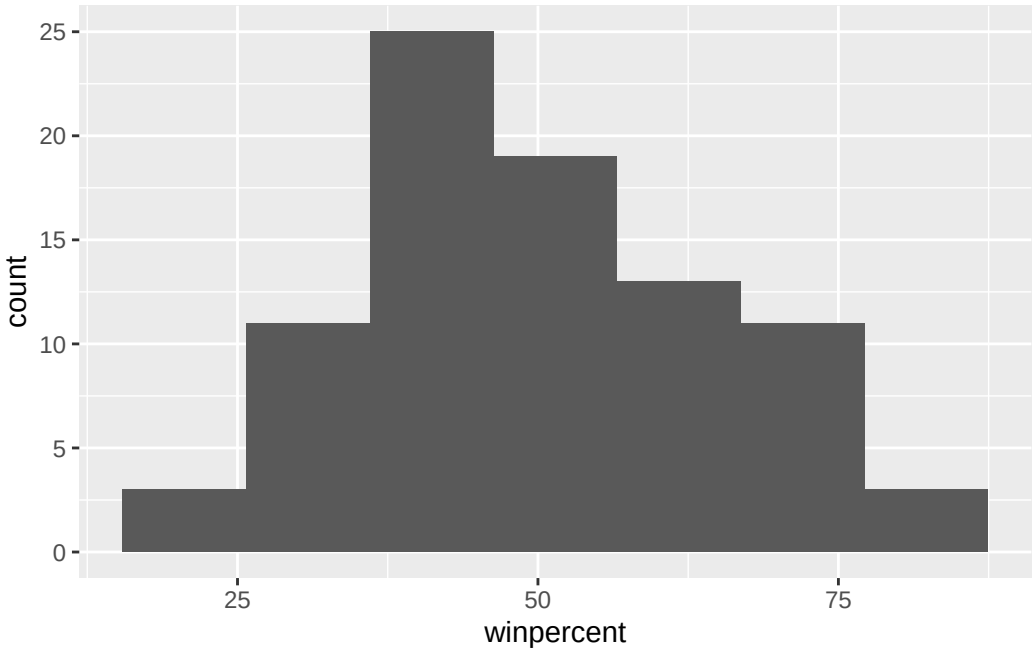
The variables sugar percent, winpercent, and price percent are on a different scale than the majority of the other columns in the dataset. These three variables do not exclusively use 0 or 1 values.

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

A zero likely represent no chocolate being present in the candy, a one represents that chocolate is present in the candy.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=7)
```




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

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

Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent values is not symmetrical, it is slightly skewed left.

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

The center of the distribution (the median) is slightly below 50, but the mean is 50.32.

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

```
#the average winpercent for chocolate containing candy
choc.winpercent <- candy$winpercent[as.logical(candy$chocolate)]
mean(choc.winpercent)
```

```
[1] 60.92153
```

```
#the average winpercent for fruit containing candy
fruit.winpercent <- candy$winpercent[as.logical(candy$fruity)]
mean(fruit.winpercent)
```

```
[1] 44.11974
```

On average, chocolate candy is ranked higher than fruit candy; the average winpercent is 60.9, for fruit it is 44.1

```
# A different way to write the same code as above:
chocolate.inds <- candy$chocolate == 1
chocolate.win <- candy[chocolate.inds,]$winpercent
mean(chocolate.win)
```

```
[1] 60.92153
```

```
fruity.inds <- candy$fruity == 1
fruity.win <- candy[fruity.inds,]$winpercent
mean(fruity.win)
```

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

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

```
    Welch Two Sample t-test

data:  choc.winpercent and fruit.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
```

The difference is statistically significant, the p-value from the t-test is less than 0.05.

Data Exploration - Overall Candy Rankings

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

The order function returns the indices that make the input sorted.

```
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 five least liked candy types in the dataset 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?

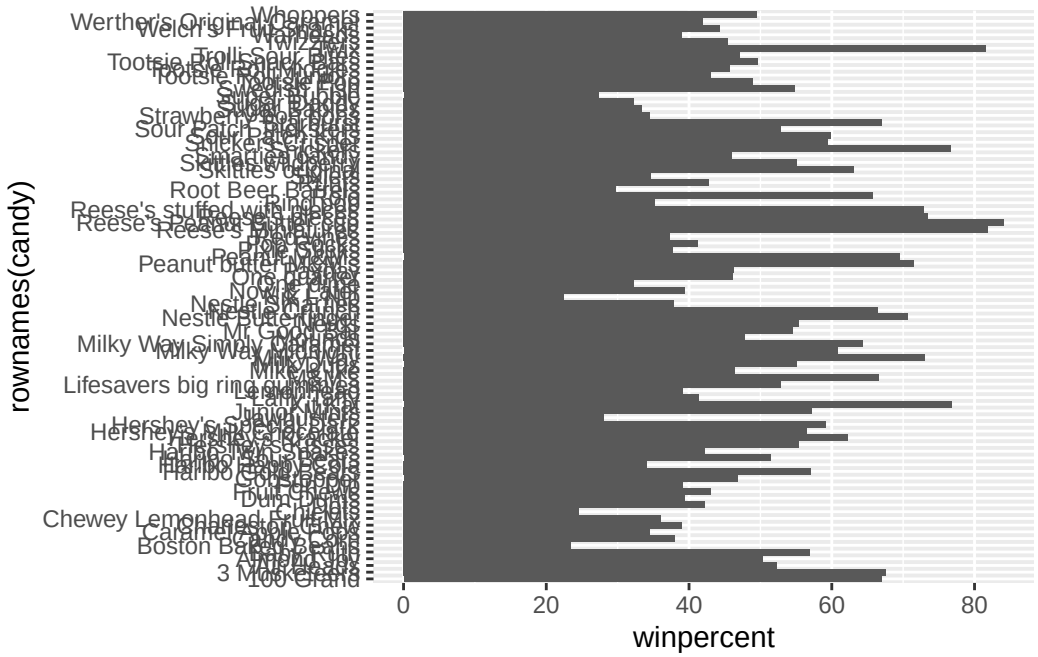
```
tail(candy[order(candy$winpercent),], n=5)
```

```
                         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 most liked candy types in this data set are Reese's Peanut Butter cups, Reese's Miniatures, Twix, Kit Kat, and Snickers.

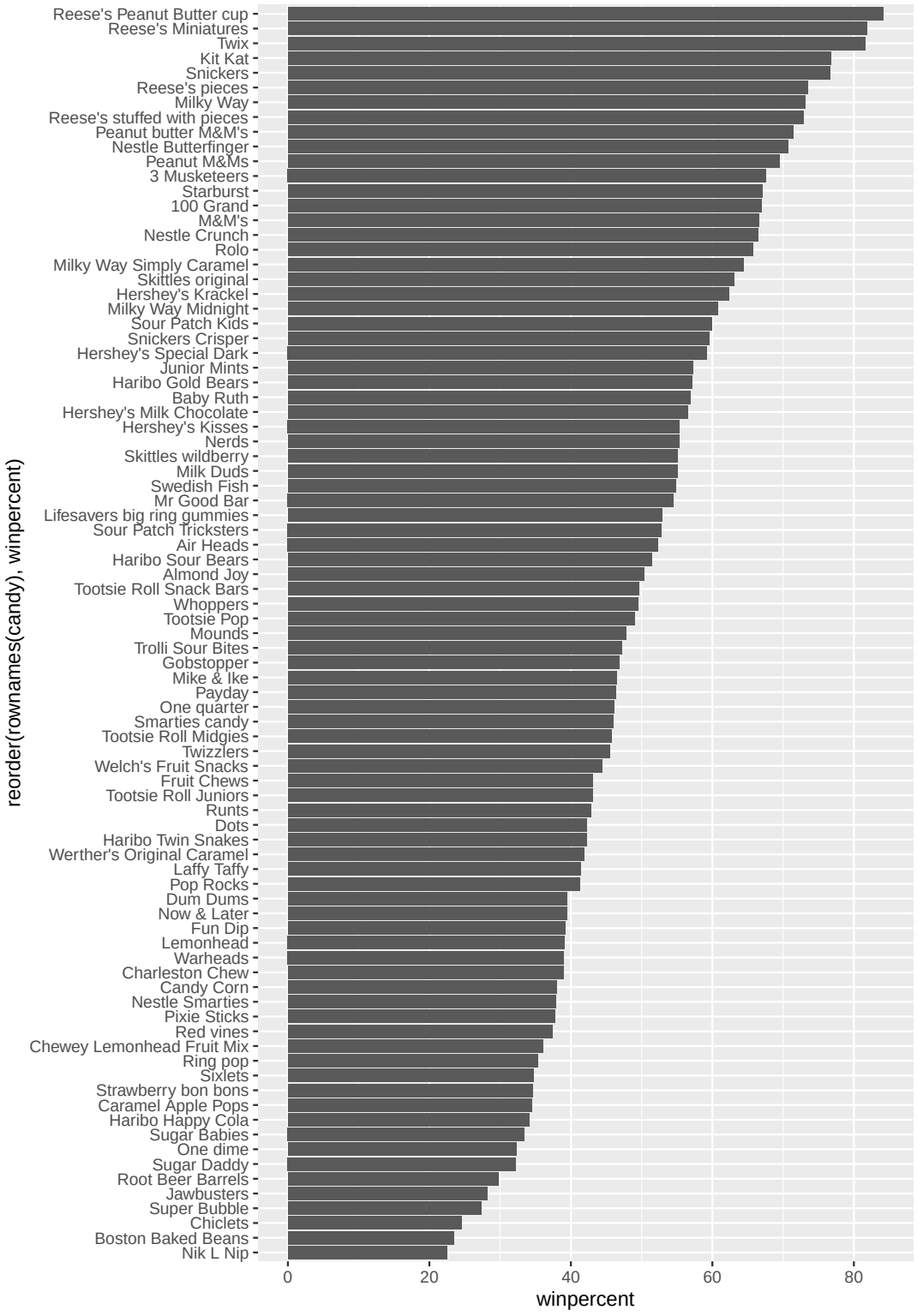
Q15. Make a first barplot of candy ranking based on winpercent values.

```
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()
```


reorder(rownames(candy), winpercent)
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
0
20
40
60
80
winpercent

```
ggsave("BIMM143Lab09barplot.png", height = 10)
```

```
Saving 5.5 x 10 in image
```

Time to 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)
```

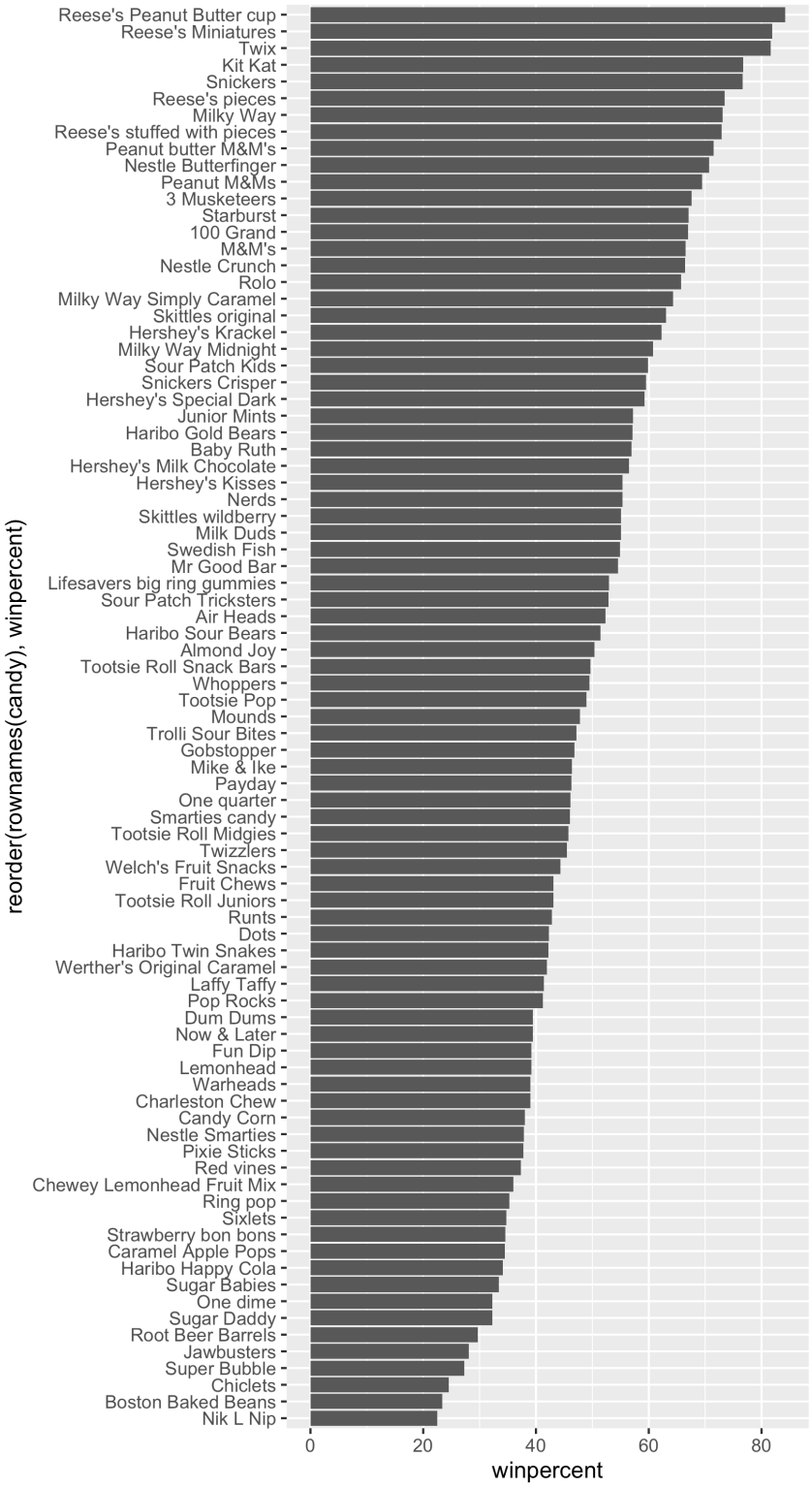
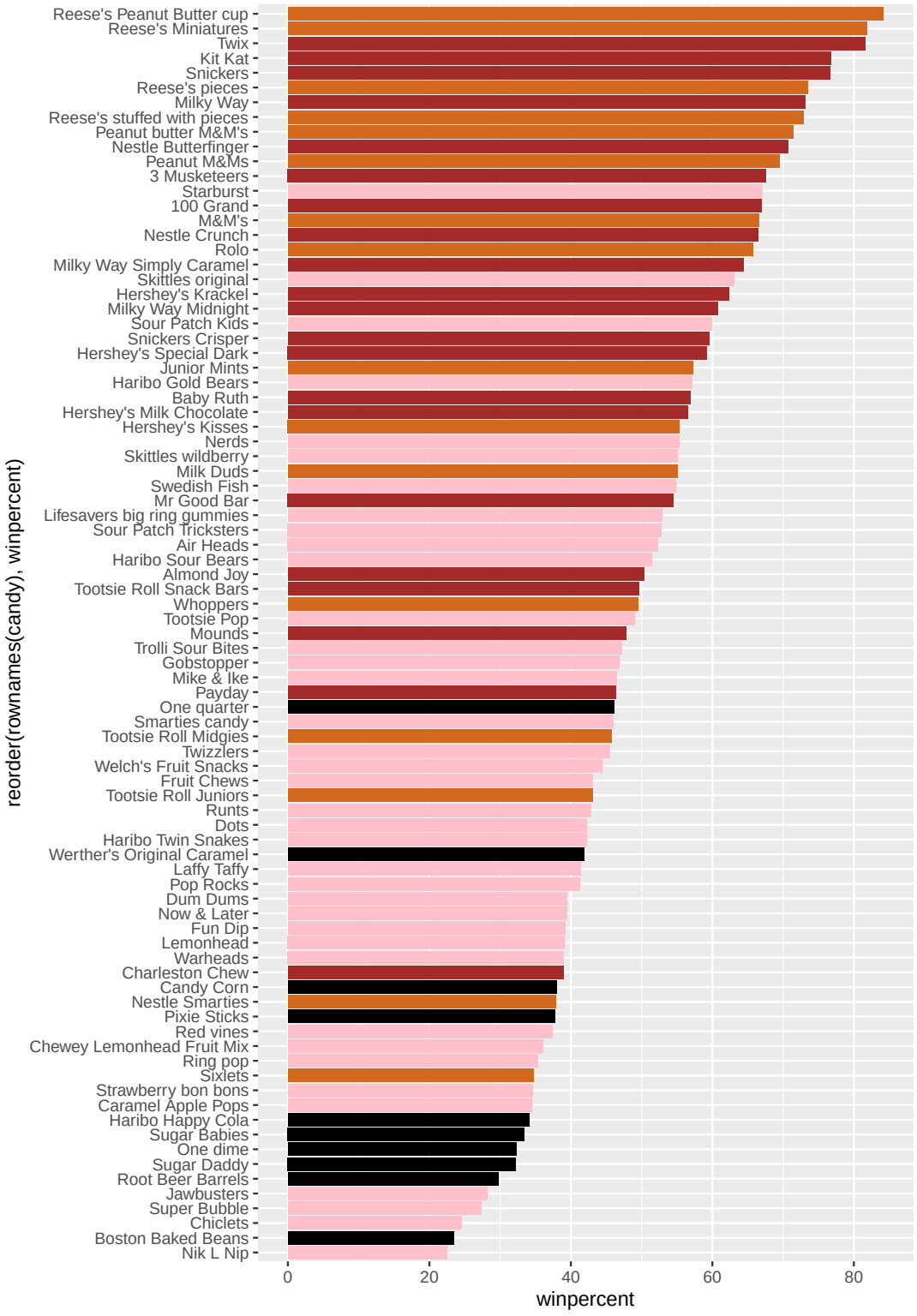


Figure 1: Exported image that is a bit bigger so it is legible


reorder(rownames(candy), winpercent)
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
0
20
40
60
80
winpercent

Q17. What is the worst ranked chocolate candy?

The worst rated chocolate candy is Sixlets.

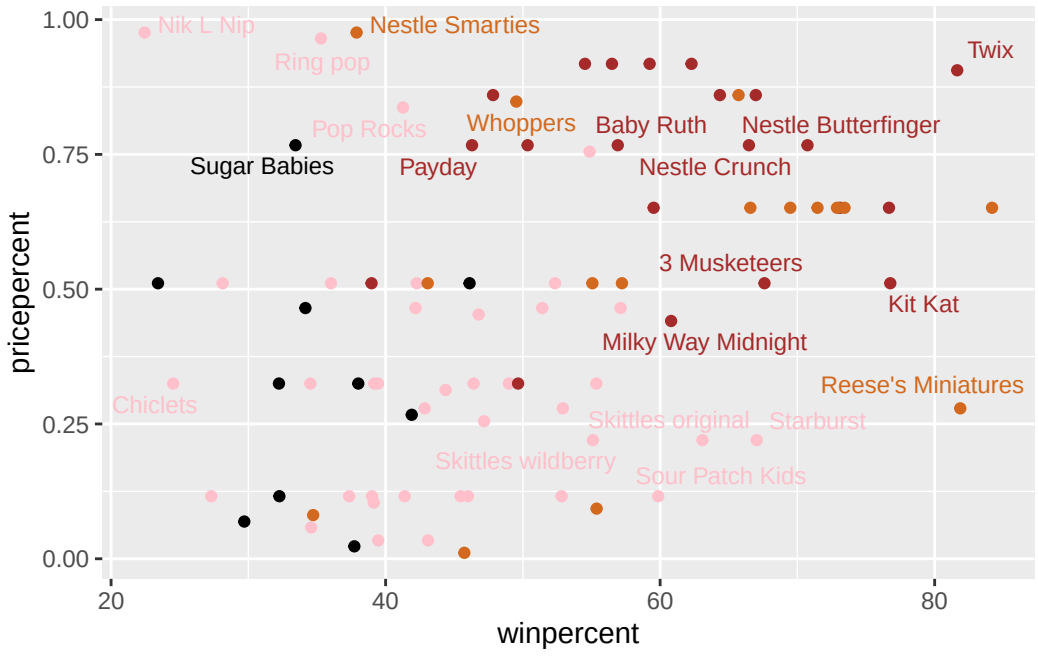
Q18. What is the best ranked fruity candy?

The best ranked fruity candy is Starburst.

Data Analysis - Looking at Pricepercent

```
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
```



Higher pricepercent values are more expensive, higher winpercent values indicate higher ranking.

> 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?

The candy with the highest ranking but a lower price is Reese's Miniatures.

> 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
```

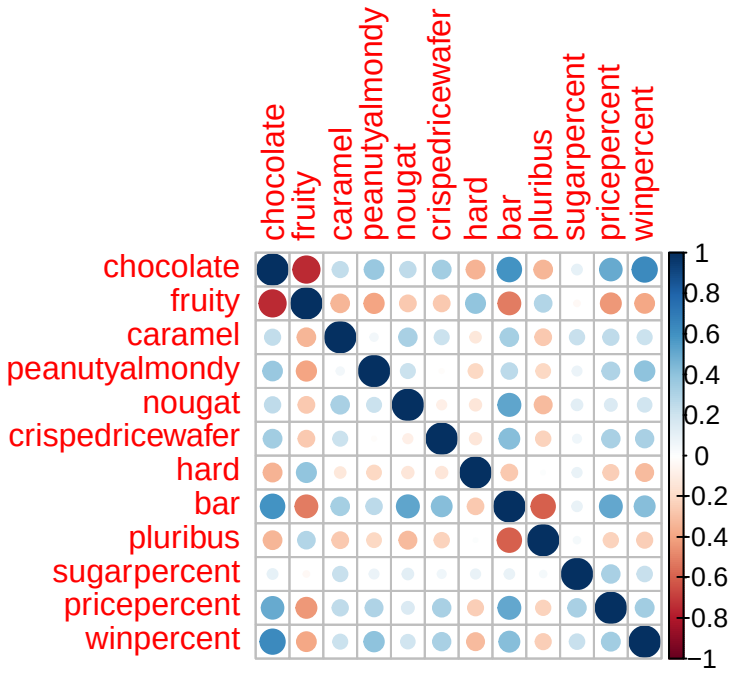
The top five most expensive candies are Nik L Nip, Nestle Smarties, Ring pop, Hershey's Krackel, and Hershey's Milk Chocolate.

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)?

The anti-correlated values are chocolate and fruity.

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

Aside from correlations with themselves, the variables of chocolate and winpercent are the most positively correlated.

Principal Component Analysis

We need to scale the data, not all the variables have data of the same scale!

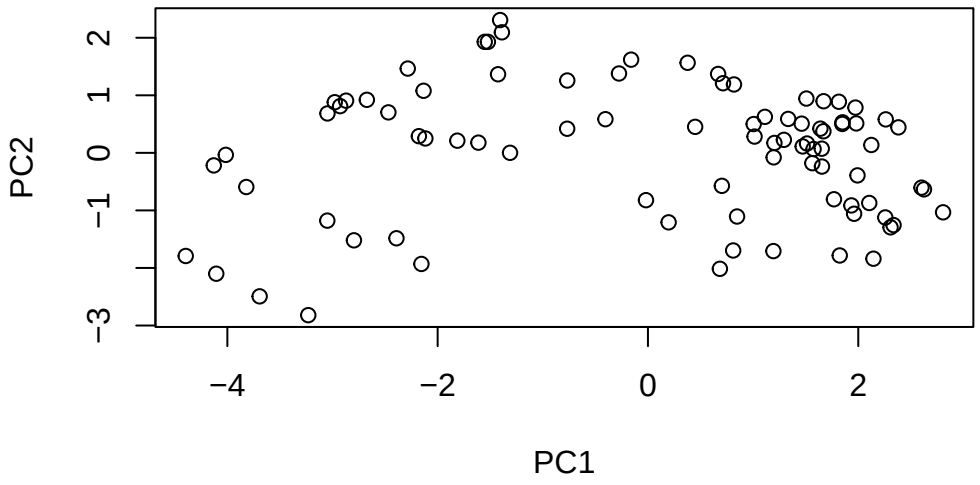
```
pca <- prcomp(candy, scale = TRUE)
summary(pca)
```

```
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
```

```
#If scale = FALSE (which is the default, the PCA analysis will be dominated by winpercent
```

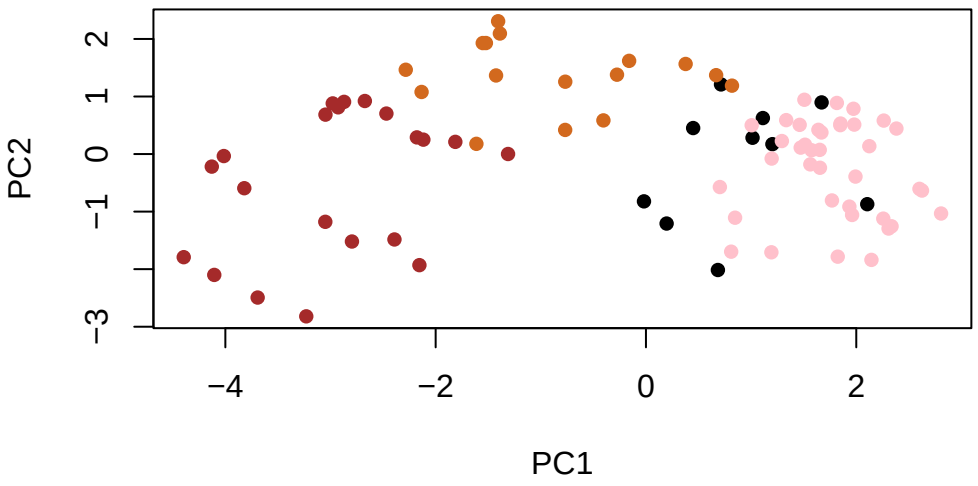
```
plot(pca$x[,1:2])
```




```
# here we are selecting for columns 1 and 2; which are PC1 and PC2
```

To add color:

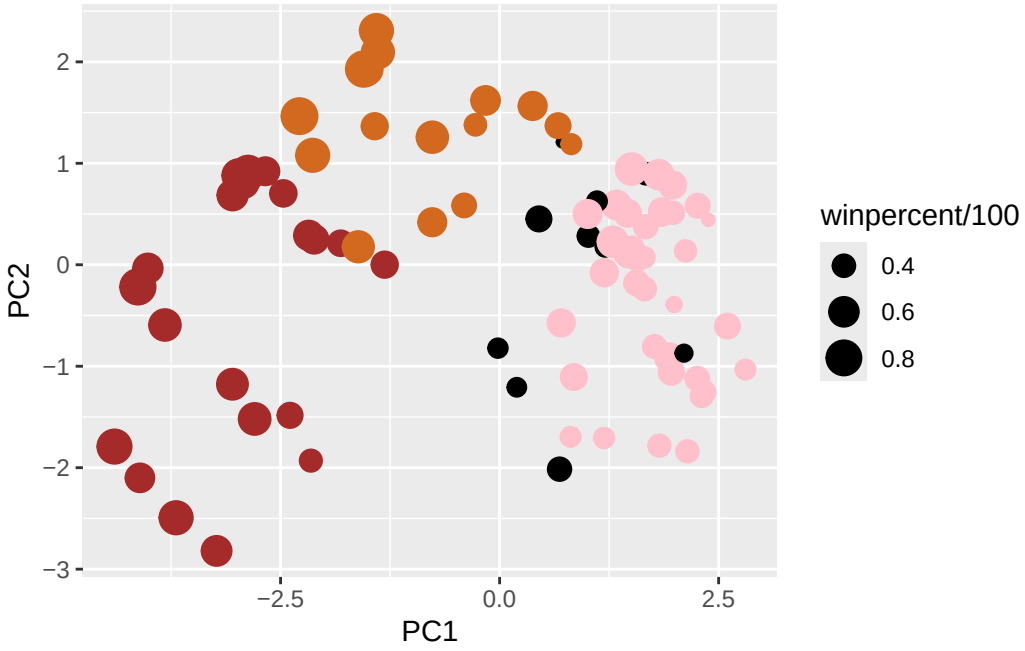
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



To use ggplot for PCA we have to have a dataframe input, so we need to turn out PCA data into a dataframe.

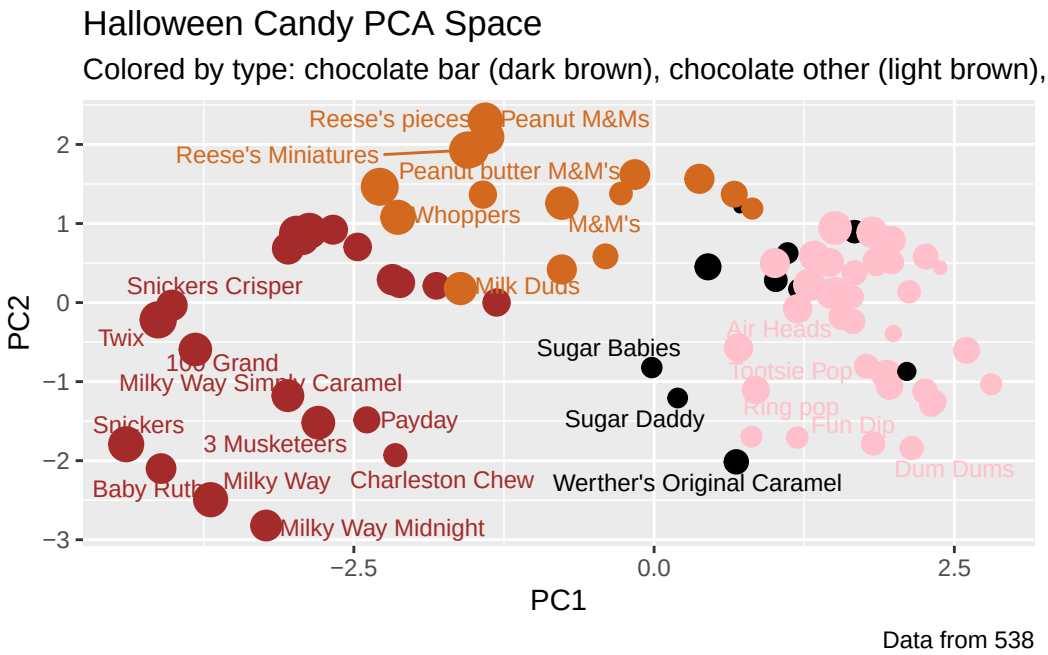
```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
```

```
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
```

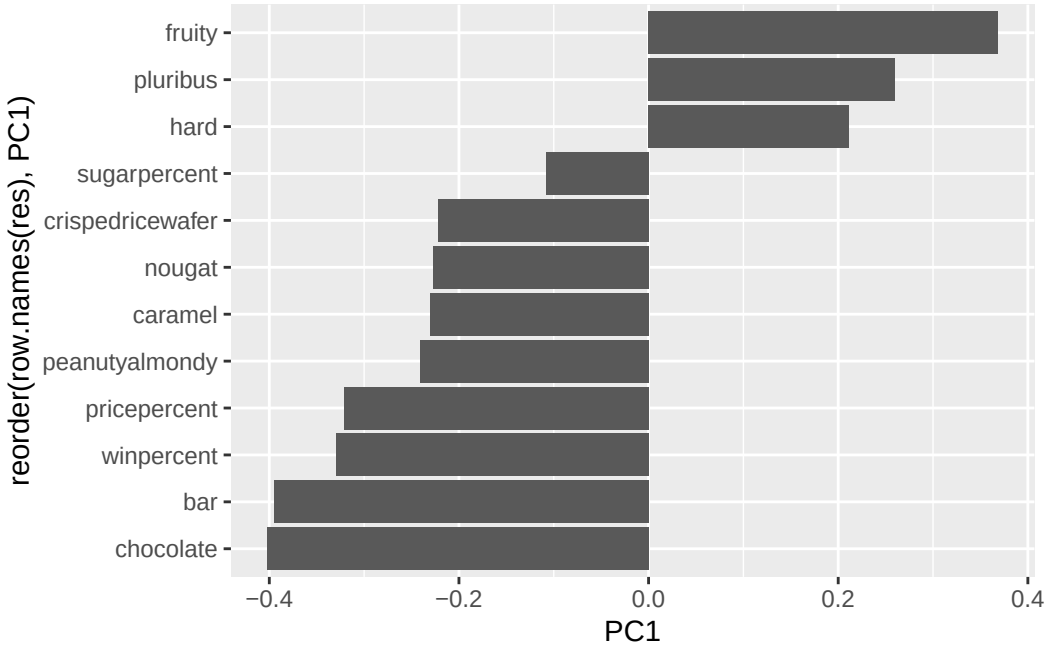



```
#library(plotly)
# ggplotly allows you to see labels when you hover over a data point
#ggplotly(p)
```

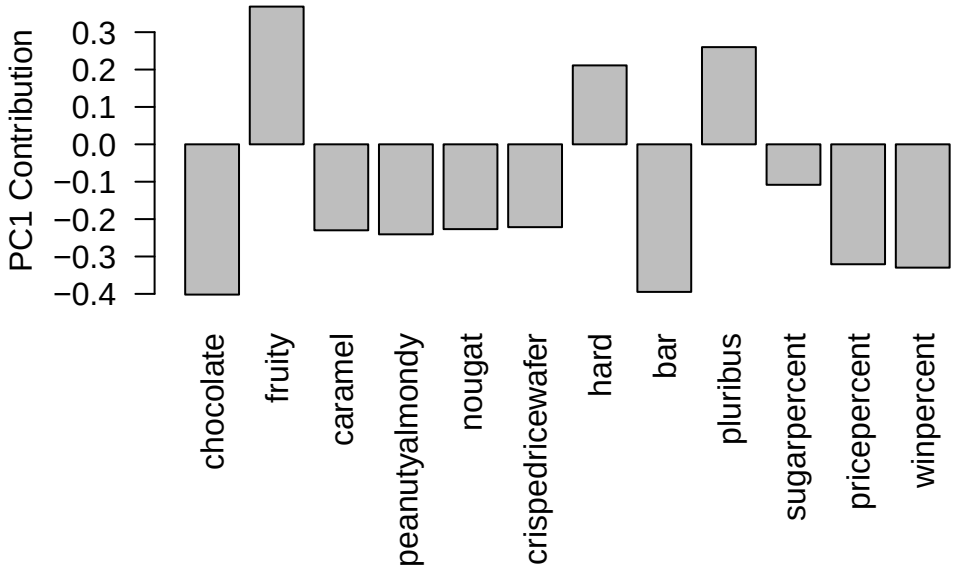
How do the original variables contribute to our PCs? We need to look at the loadings component of our results object `pca$rotation`

Make a barplot with ggplot and order the bars by their value. Recall that you need a data.fram as the input for a ggplot.

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

ggplot(res)+
  aes(PC1, reorder(row.names(res), PC1)) +
  geom_col()
```




```r
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?

Fruity, hard, and pluribus were picked up strongly by PC1 in the positive direction. This makes sense as these variables are expected to be correlated, it is common for fruity candy to be sold in bags/boxes of multiples; it is also more common for fruity candy to be hard when compared to chocolate.