Class10: Holloween Candy

Yipeng

In today's class we will examine 538 Candy data and see if this helps us gain some mroe feeling for how PCA and other methods work.

```r
candy <- read.csv("https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-pow
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?

```r
nrow(candy)
```

```
[1] 85
```

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

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

```
[1] 38
```

> Q. What are these fruity candy?

We can use the ==

```
rownames(candy[candy$fruity==1,])
```

```
 [1] "Air Heads"                   "Caramel Apple Pops"
 [3] "Chewey Lemonhead Fruit Mix"  "Chiclets"
 [5] "Dots"                        "Dum Dums"
 [7] "Fruit Chews"                 "Fun Dip"
 [9] "Gobstopper"                  "Haribo Gold Bears"
[11] "Haribo Sour Bears"           "Haribo Twin Snakes"
[13] "Jawbusters"                  "Laffy Taffy"
[15] "Lemonhead"                   "Lifesavers big ring gummies"
[17] "Mike & Ike"                  "Nerds"
[19] "Nik L Nip"                   "Now & Later"
[21] "Pop Rocks"                   "Red vines"
[23] "Ring pop"                    "Runts"
[25] "Skittles original"           "Skittles wildberry"
[27] "Smarties candy"              "Sour Patch Kids"
[29] "Sour Patch Tricksters"       "Starburst"
[31] "Strawberry bon bons"         "Super Bubble"
[33] "Swedish Fish"                "Tootsie Pop"
[35] "Trolli Sour Bites"           "Twizzlers"
[37] "Warheads"                    "Welch's Fruit Snacks"
```

How often does my favorite candy win

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

I like Haribo Gold Bears, because that's the only sugar I bought before.

```
candy["Haribo Gold Bears",]$winpercent
```

```
[1] 57.11974
```

> 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
```

```
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	

```
#library("skimr")
#skim(candy)
```

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

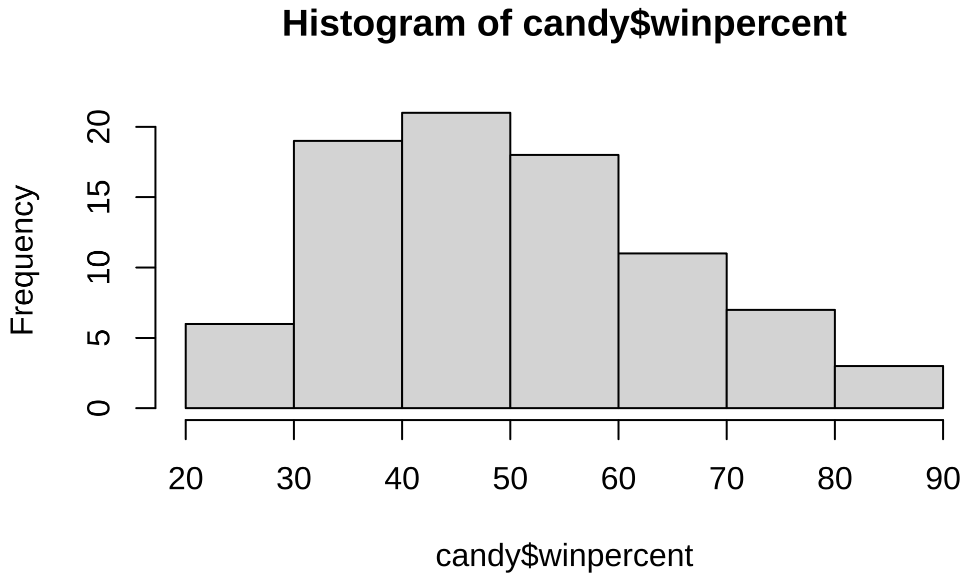
Yeap, the `winpercent` column is on a 0:100 scale and lal others appear to be 0:1 scale

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

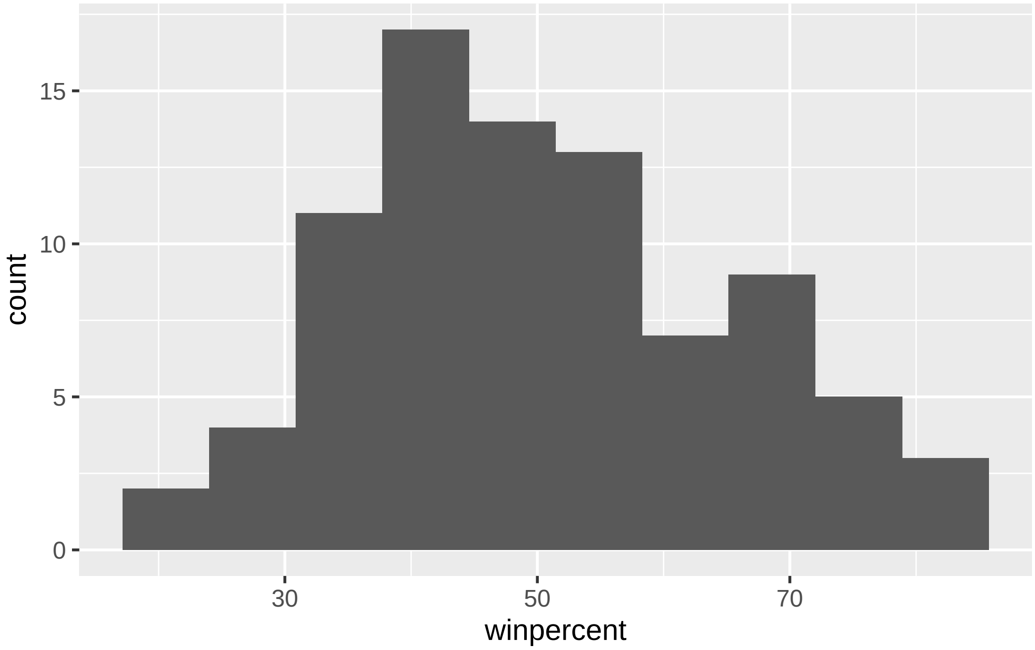
A zero here means the candy is not classified as containing chocolate, and one means do containing chocolate.

> Q8. Plot a histogram of winpercent values

```
hist(candy$winpercent)
library(ggplot2)
```



```
ggplot(candy, aes(winpercent)) +
  geom_histogram(bins=10)
```



Q9. Is the distribution of winpercent values symmetrical?

No, the winpercent histograms looks right skewed and bimodal.

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

below 50% with a mean and median:

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

```
[1] 50.31676
```

```
median(candy$winpercent)
```

```
[1] 47.82975
```

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

To answer this question I will need to: - “subset” (a.k.a. “select”, “filter”) the candy dataset to just chocolate candy - get their winpercent values, - and then calculate the mean of these. - Then do the same for fruity candy and compare

```r
# Filter/select/subset to just choclate rows
chocolate.candy <- candy[as.logical(candy$chocolate),]

# Get their winpercent values
chocolate.winpercent <- chocolate.candy$winpercent

# Calculate their mean winpercent value
mean(chocolate.winpercent)
```

```
[1] 60.92153
```

Do the same thing to fruity

```r
# Do the same thing to fruity
fruity.candy <- candy[as.logical(candy$fruity),]
fruity.winpercent <- fruity.candy$winpercent
mean(fruity.winpercent)
```

```
[1] 44.11974
```

So yes, Chocolate has higher average winpercent than fruity candy.

> Q12. Is this difference statistically significant?

```r
t.test(chocolate.winpercent, fruity.winpercent)
```

```


	Welch Two Sample t-test

data:  chocolate.winpercent and fruity.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 lower than 0.05, so there is a significant difference, which means people do like chocolate more.

Overall Candy Rankings

There is a base R function called `sort()` for, guess what sorting vectors of input.

```
x <- c(5,2,10)
sort(x, decreasing = TRUE)
```

```
[1] 10  5  2
```

The buddy function to `sort()` that is often more useful is called `ordered`. It returns the "indices" of the input that would result in it being sorted.

```
order(x)
```

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

```
x[order(x)]
```

```
[1]  2  5 10
```

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

I can order bby `winpercent`

```
ord <- order(candy$winpercent)
head(candy[ord,],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
```

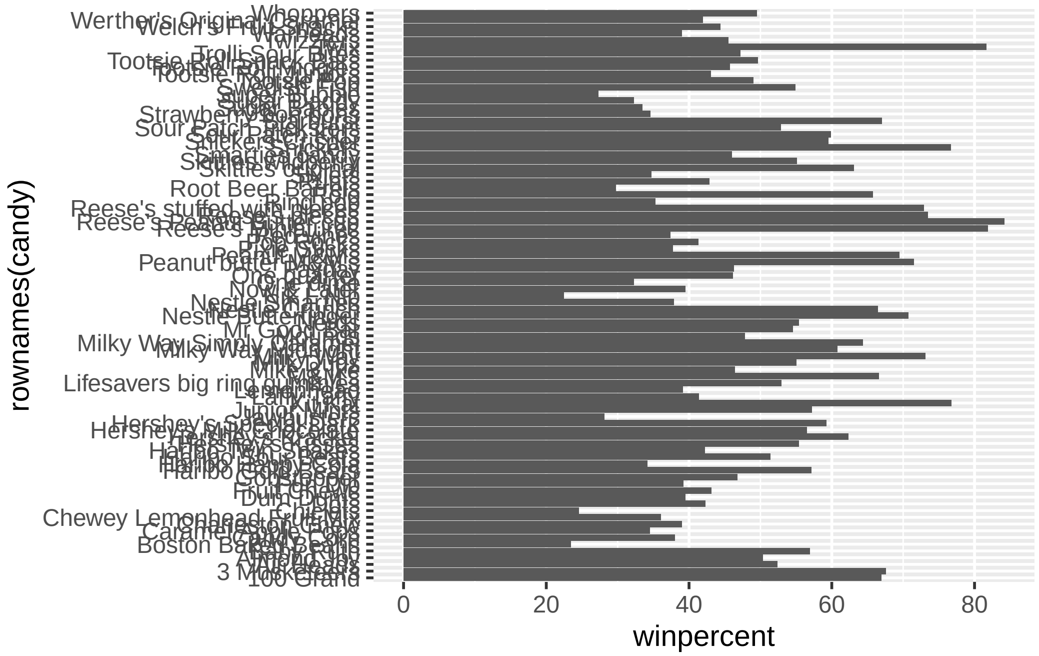
Q14. What are the top 5 all time favorite candy types out of this set?

```
ord <- order(candy$winpercent, decreasing = TRUE)
head(candy[ord,],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
```

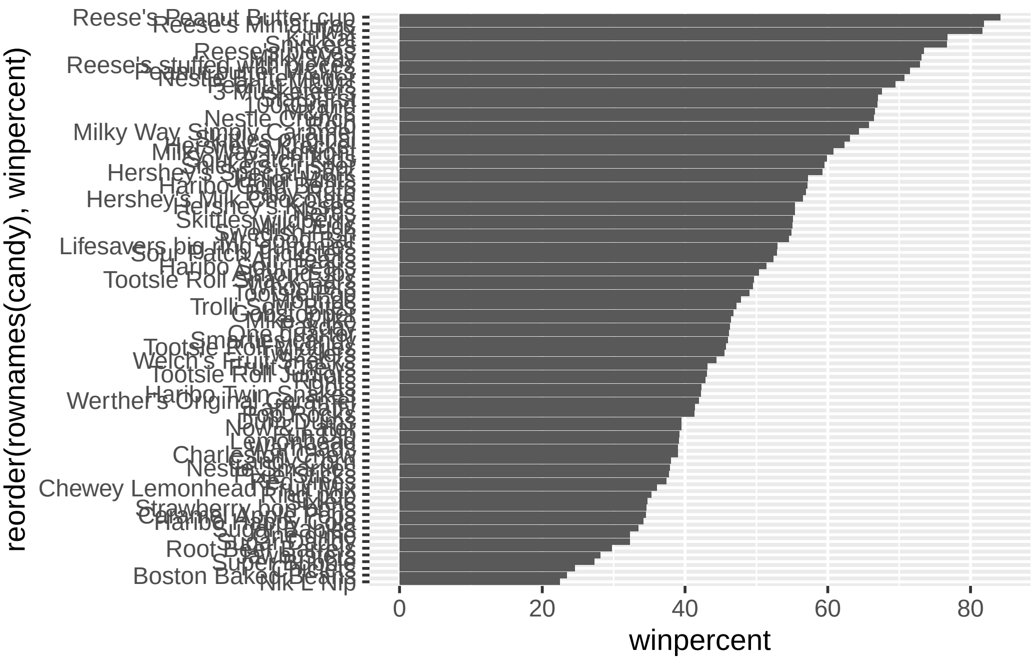
Q15. Make a first barplot of candy ranking based on winpercent values.

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



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

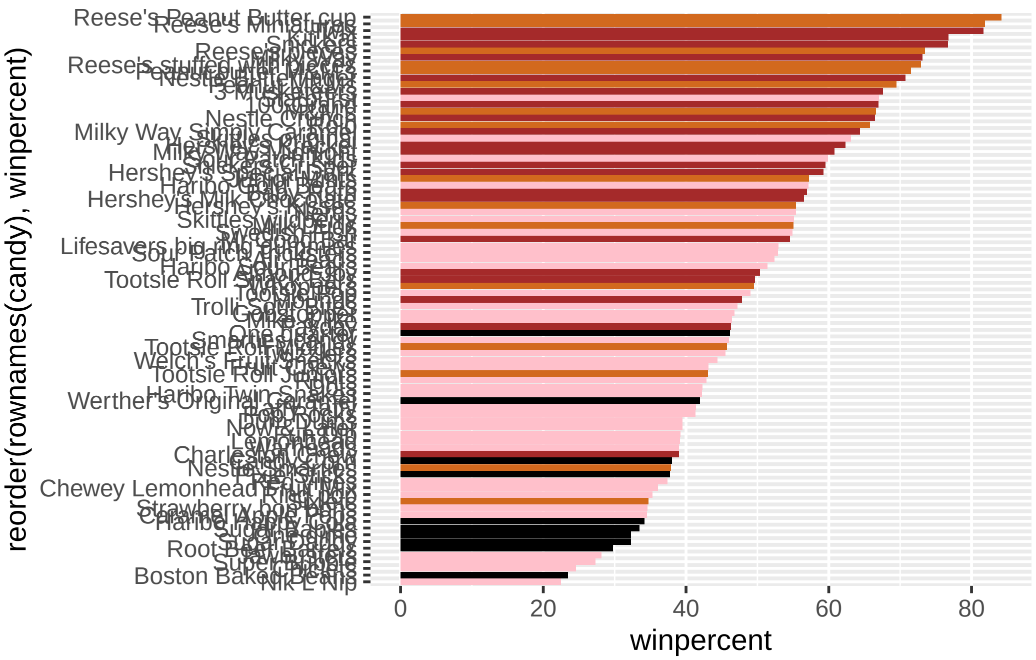
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col()
```



To make it more colorful

```
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?

Sixlets

Q18. What is the best ranked fruity candy?

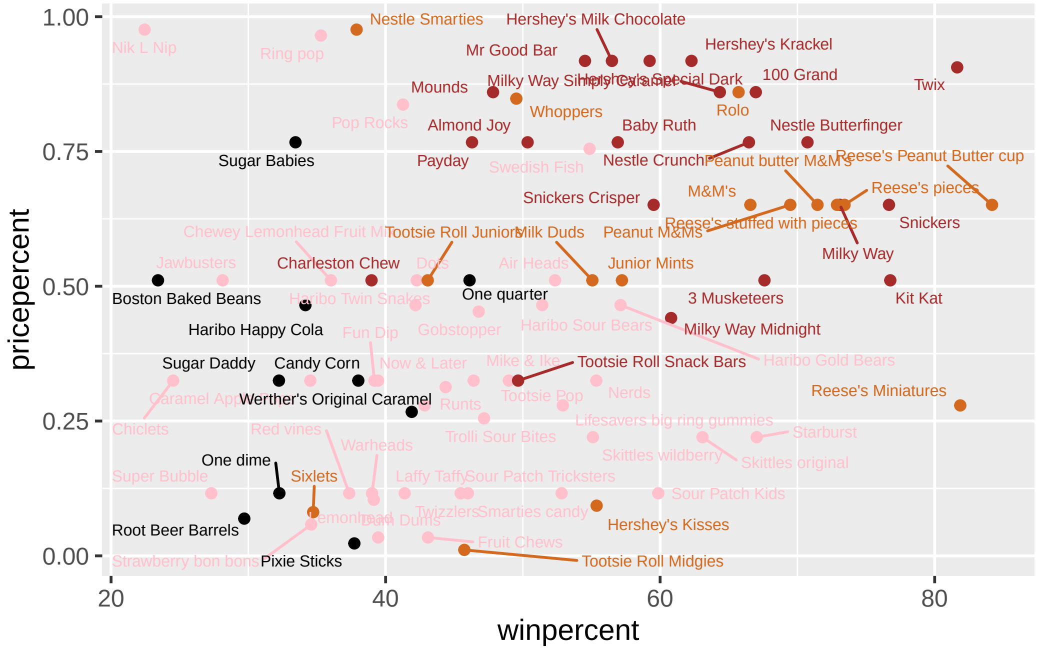
Starburst

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?

To deal with overlapping labels I can use the **ggrepel** package

```
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=2, max.overlaps = 15)
```

```
Warning: ggrepel: 1 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



So, Reese's Miniatures is the highest wining rank with lowest price.

> 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
```

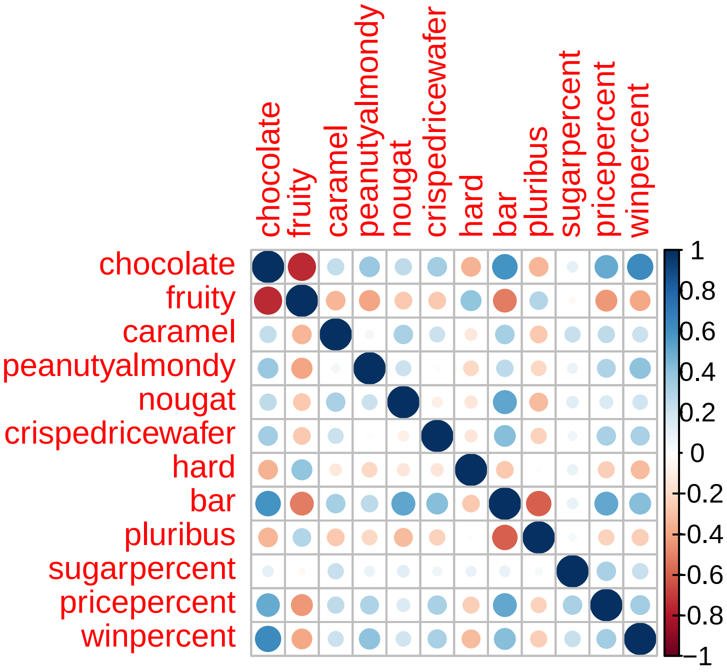
And NiK L Nip is the most expensive and least popular candy.

Correlation plot

```
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)?

A lot of variables are negatively correlated(the dark red color is the -1 correlation). But fruity candy and chocolate are the most anti-correlated.

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

The two candys and most positively correlated are Bar and chocolate. The two variables are most positively correlated are chocolate and winpercent.

6. Principal Component Analysis

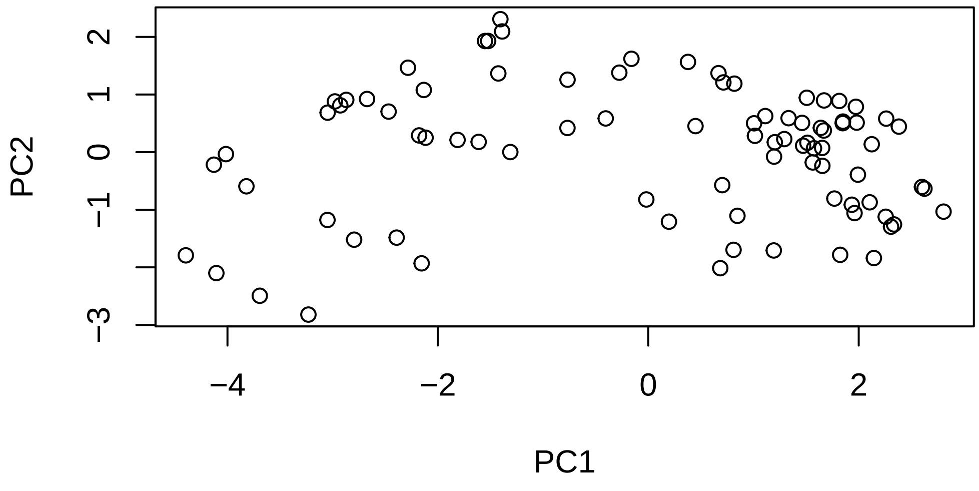
The base R function for PCA is called `prcomp()` and we can set “scale=TRUE/FALSE”.

```
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
```

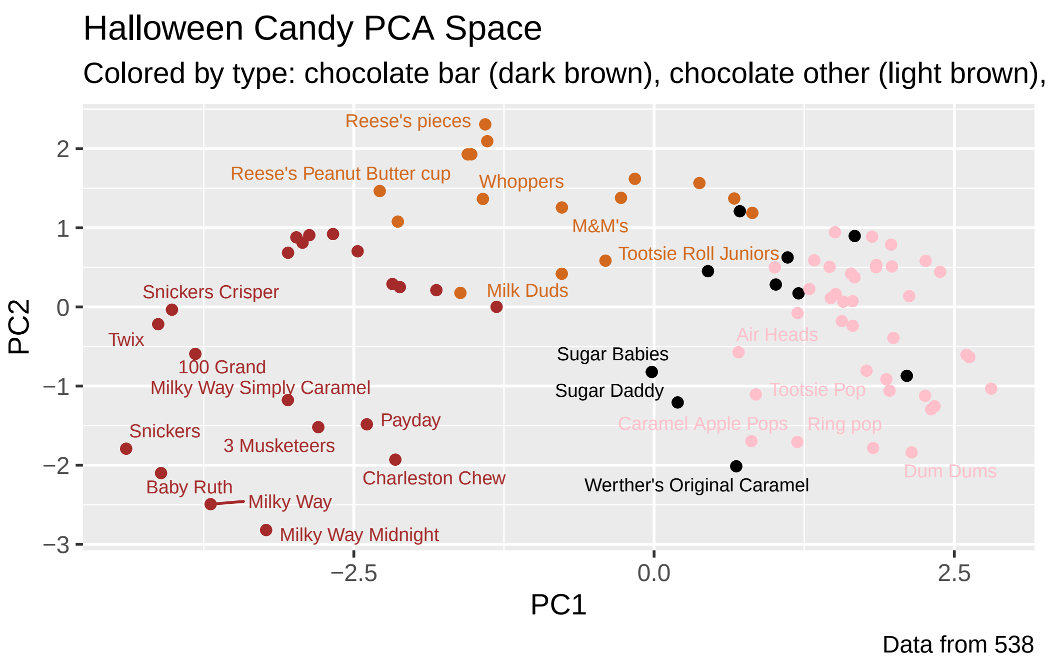
The main result of PCA - i.e. the new PC plot(projection of candy on our new PC axis) is contained in `pca$x`

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



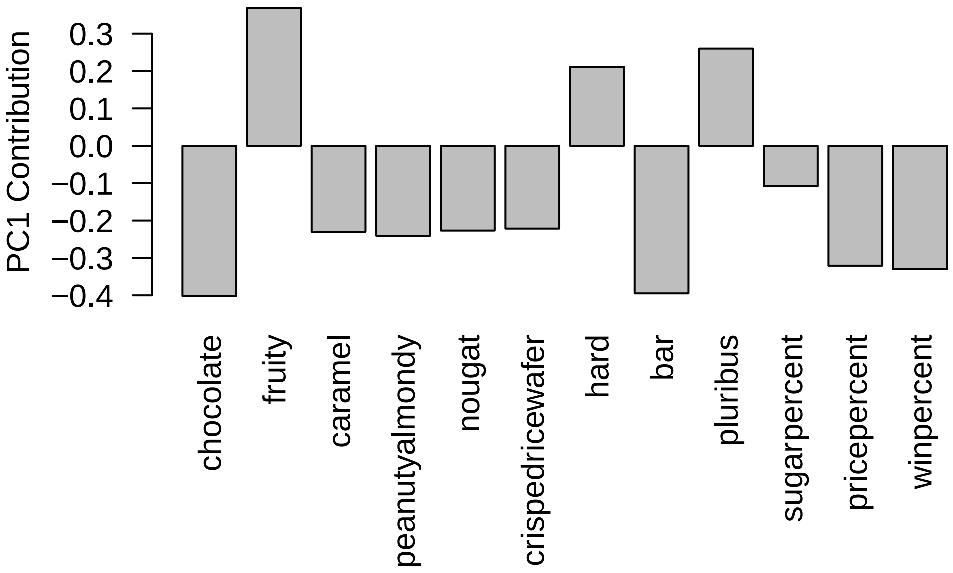
```
pc <- as.data.frame(pca$x)

ggplot(pc) +
  aes(PC1,PC2, label = rownames(pc)) +
  geom_point(col = my_cols) +
  geom_text_repel(size=2.5, col=my_cols, max.overlaps = 5)  +
  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
```



Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you?

```
par(mar=c(8,4,2,2))
barplot(pca$rotation[,1], las=2, ylab="PC1 Contribution")
```



Fruity, hard and pluribus are picked up strongly by PC1 in positive direction.