Class 10 : Halloween Candy

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

```
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?

```
nrow(candy)
```

```
[1] 85
```

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

```
sum(candy[,2])
```

```
[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"
```

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

How often does my favorite candy win

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

```
[1] 76.7686
```

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?

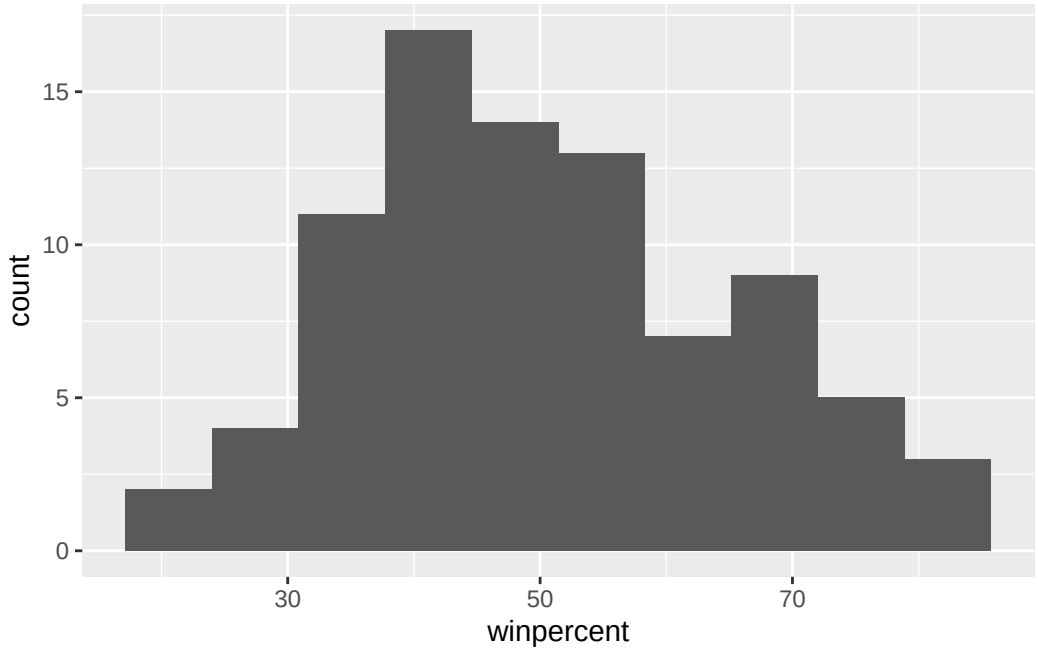
Yes, the `winpercent` column is on a 0:100 scale and all others appear to be on a 0:1 scale.

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

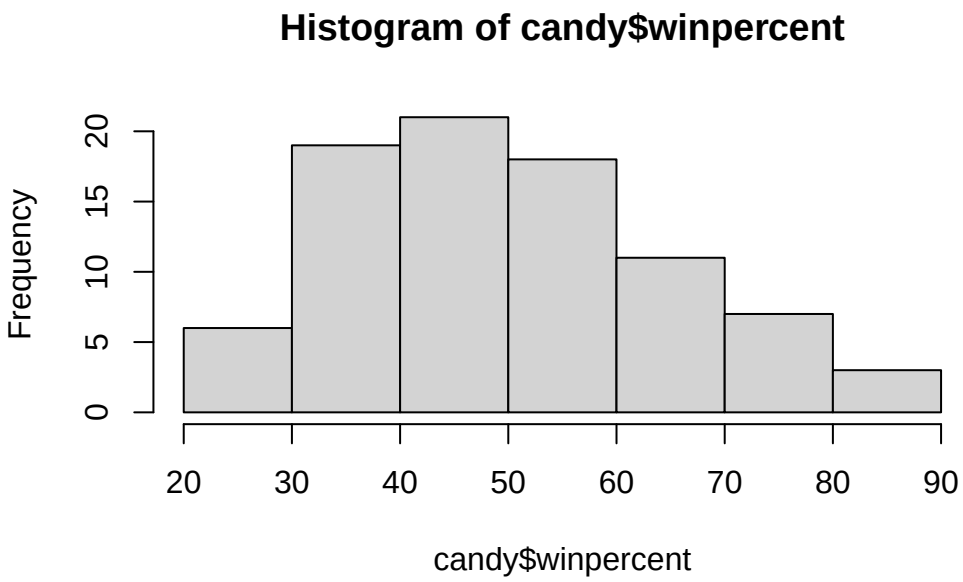
A zero here means the candy is not classified as containing chocolate.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)

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




```
#or

hist(candy$winpercent)
```



Q9. Is the distribution of winpercent values symmetrical?

No

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

Below 50% with a mean:

```
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 - Calculate the mean of these - Do the same for fruity and compare.

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

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

# Calculate mean of chocolate winpercent
mean( chocolate.winpercent )
```

```
[1] 60.92153
```

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

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

# Calculate mean of fruity winpercent
mean( fruity.winpercent )
```

```
[1] 44.11974
```

Chocolate candy is on a higher ranked than fruity candy.

Q12. Is this difference statistically significant?

The p-value is lower than 0.05 and thus shows that the results are statistically significant and people prefer chocolate.

```
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
```

There is a function called `sort()` for sorting vectors of input

```
x <- c(5, 2, 10)

# sort(x, decreasing = TRUE)
sort(x)
```

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

The buddy function to `sort()` that is often more useful is called `order()`. 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?

```
ord <- order(candy$winpercent)
ord
```

```
 [1] 45  8 13 73 27 58 72  3 71 20 10 70 60 56 12 51 49 63  9 11 82 31 17 46 15
[26] 50 30 84 22 14 59 76 16 83 81 77 64  4 47 35 18 79 40 75 85 78  6 21  5 68
[51] 32 41 74 36 62 42 23 25  7 19 28 26 66 67 38 24 61 39 57 44 34  1 69  2 48
[76] 43 33 55 37 54 65 29 80 52 53
```

```
head(candy[ord,])
```

```
                  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
Root Beer Barrels         0      0       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
Root Beer Barrels                0    1   0        1        0.732        0.069
                  winpercent
Nik L Nip           22.44534
Boston Baked Beans  23.41782
Chiclets            24.52499
Super Bubble        27.30386
Jawbusters          28.12744
Root Beer Barrels   29.70369
```

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

```
ord_decreasing <- order(candy$winpercent, decreasing = TRUE)
ord_decreasing
```

```
 [1] 53 52 80 29 65 54 37 55 33 43 48  2 69  1 34 44 57 39 61 24 38 67 66 26 28
[26] 19  7 25 23 42 62 36 74 41 32 68  5 21  6 78 85 75 40 79 18 35 47  4 64 77
[51] 81 83 16 76 59 14 22 84 30 50 15 46 17 31 82 11  9 63 49 51 12 56 60 70 10
[76] 20 71  3 72 58 27 73 13  8 45
```

```
head(candy[ord_decreasing,])
```

```
                        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
Reese's pieces                    1      0       0              1      0
```

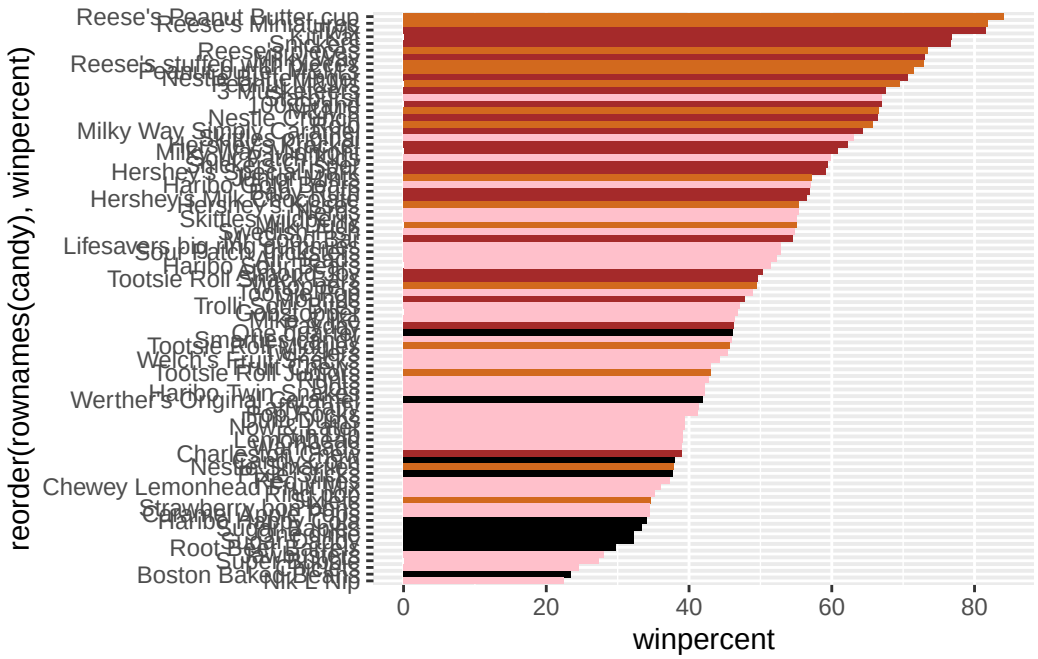
```
                         crispedricewafer hard bar pluribus sugarpercent
Reese's Peanut Butter cup                0    0   0        0        0.720
Reese's Miniatures                       0    0   0        0        0.034
Twix                                     1    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Snickers                                 0    0   1        0        0.546
Reese's pieces                           0    0   0        1        0.406
                         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
Reese's pieces                   0.651   73.43499
```

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

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

```
#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"
```

```
library(ggplot2)

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



Q17. What is the worst ranked chocolate candy?

Sixlets

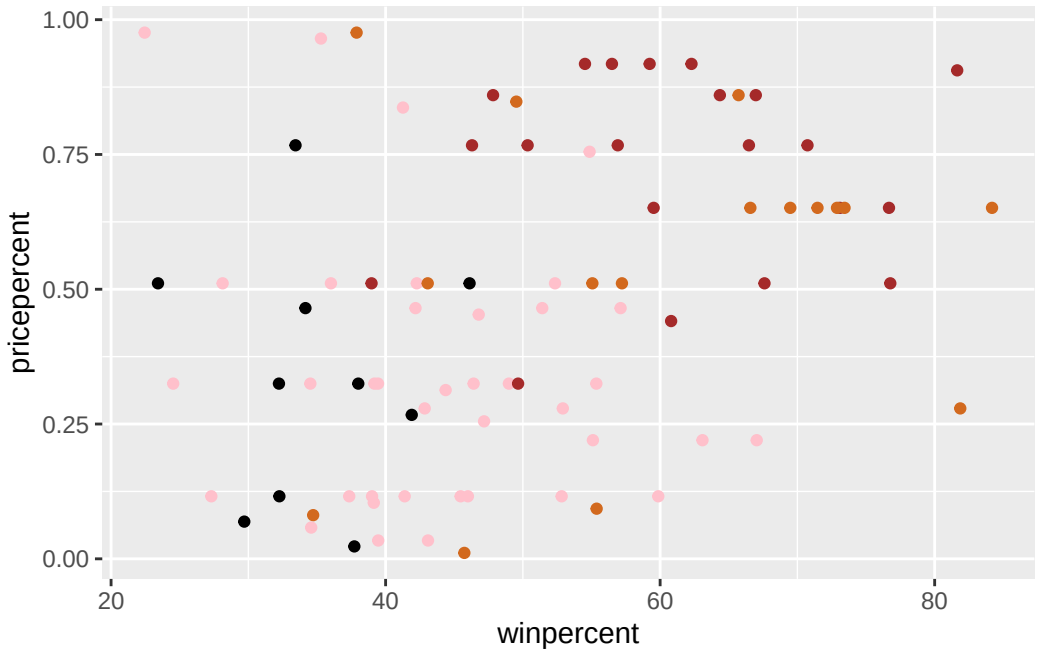
Q18. What is the best ranked fruity candy?

Starburst

Taking a look at pricepercent

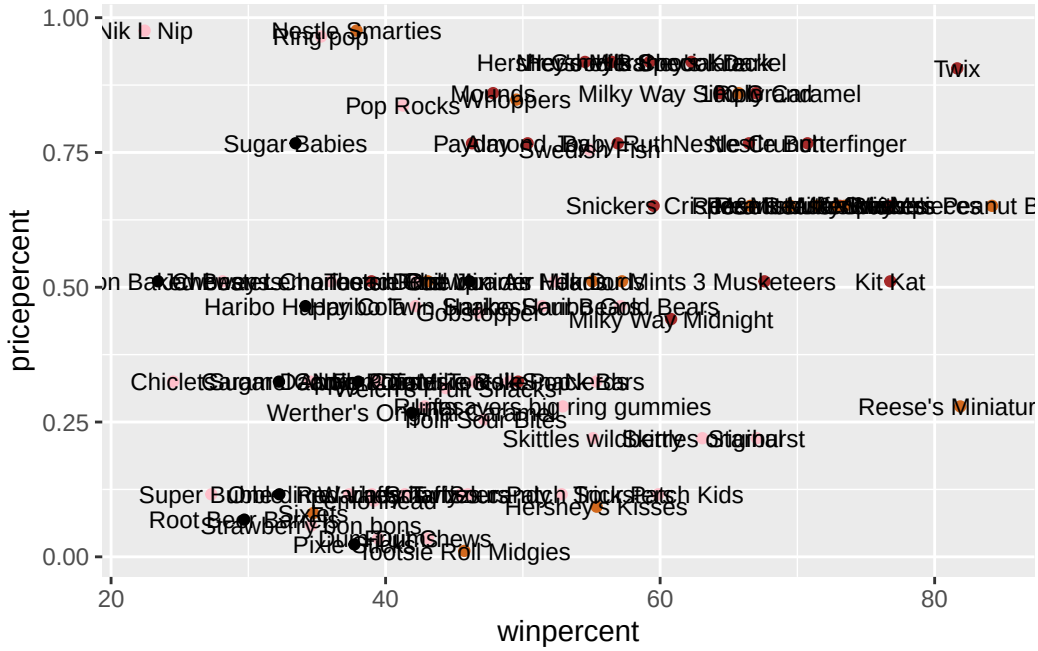
Q19. Which candy type is the highest ranked in terms of winpercent for the least money - i.e. offers the most bang for your buck?

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



Let's add labels

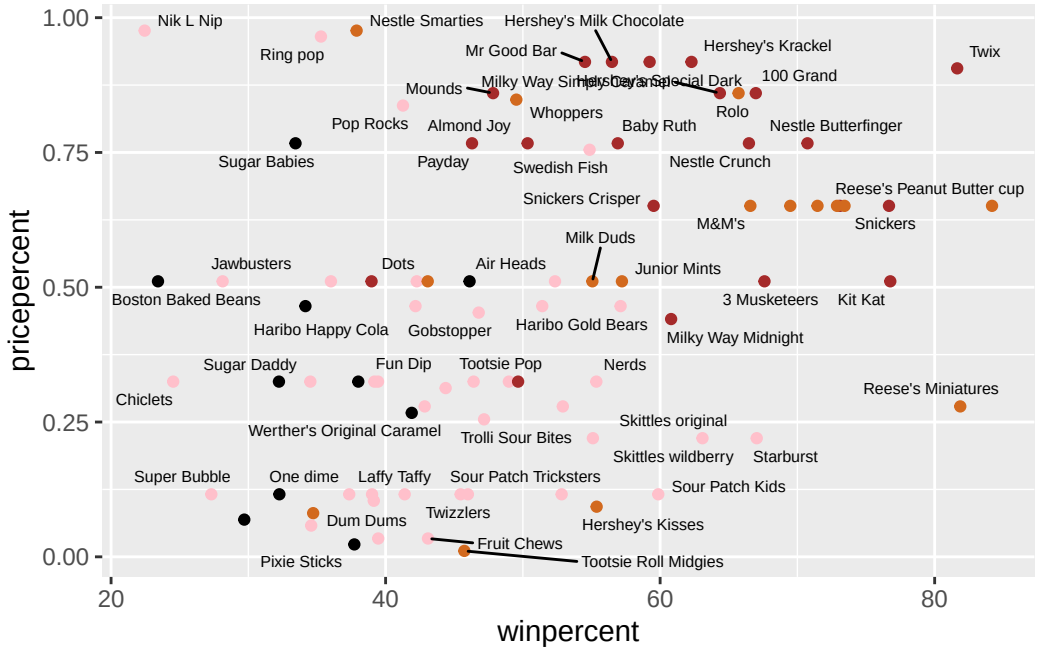
```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text(size=3)
```



To deal with overlapping lables I can use the **ggrepel** package.

```
library(ggrepel)

ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(size = 2, max.overlaps = 8)
```

```
Warning: ggrepel: 26 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



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
```

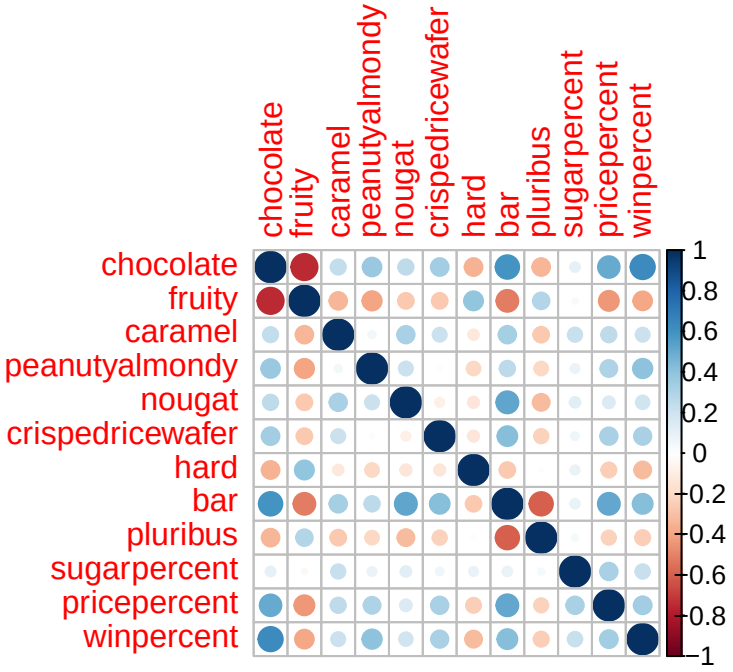
5 Exploring the correlation structure

Pearson correlation goes between -1 and +1 with zero indicating no correlation and values close to one being very highly (ani) correlated.

```
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 anti-correlated.

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

Chocolate and winpercent are most positively correlated.

6. Principal Component Analysis

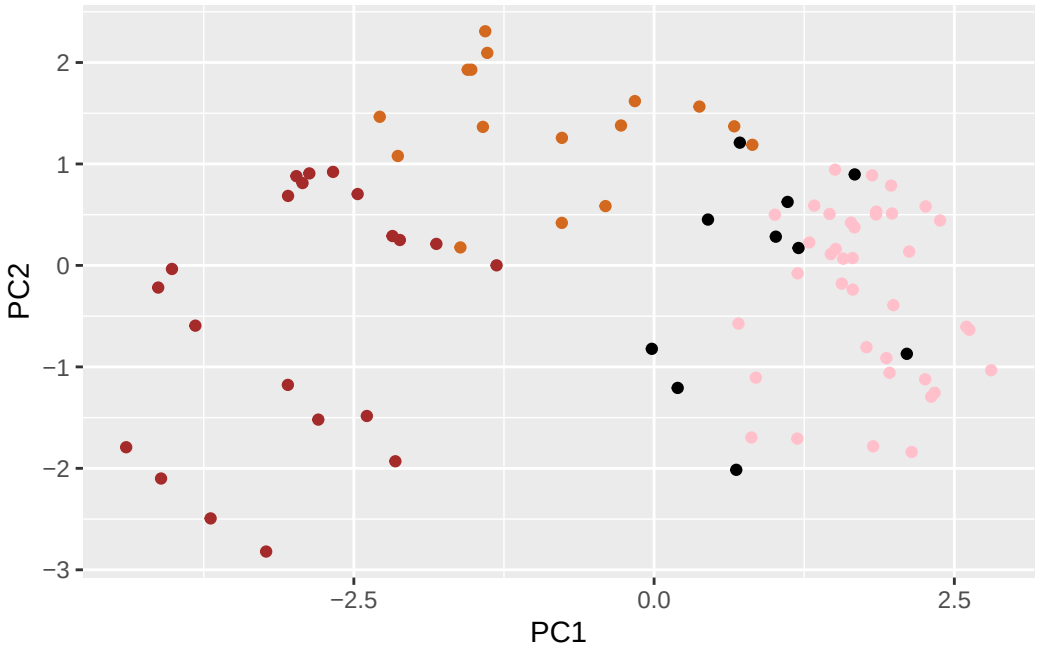
The base R function for PCA is called `prcomp()` and we can set the "scale = TRUE/FALSE"

```
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 OC plot (projection of candy on our new PC axis) is contained in `pca$x`

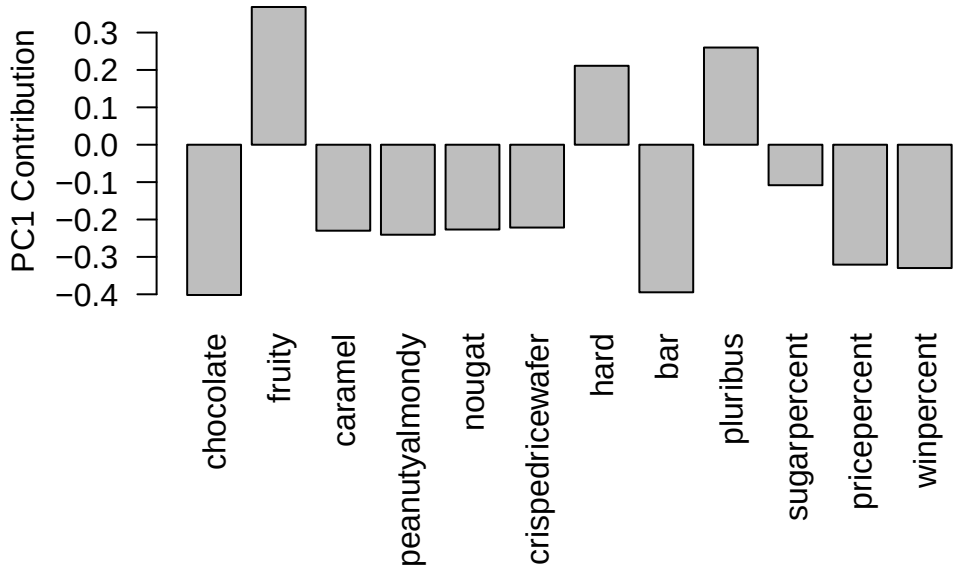
```
pc <- as.data.frame(pca$x)

ggplot(pc) +
  aes(PC1, PC2) +
  geom_point(col=my_cols)
```




```
  #geom_text_repel(max.overlaps = 5)
```

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")
```



The variables fruity, hard, and pluribus are in the positive direction of PC1 which make sense because all of these are positively correlated.