Class 11: Candy Project

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

```
candy <- read.csv("candy-data.csv", 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
```

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

```
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?

```
candy["Sour Patch Kids", "winpercent"]
```

```
[1] 59.864
```

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
```

Now we are going to use `skim()` to give up a brief overview of the dataset.

```
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?

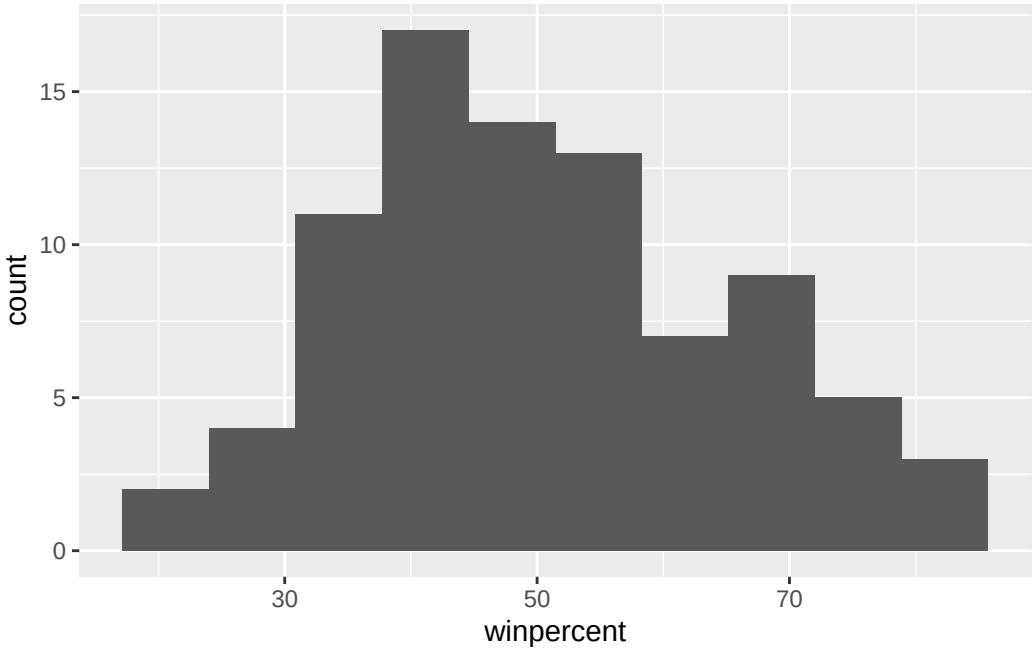
The `winpercent` column is on a different scale (0:100) compared to the rest of the columns (0:1).

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

The zero means the candy does not contain chocolate and the one means it does have chocolate.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)
ggplot(candy, aes(winpercent,)) +
  geom_histogram(bins=10)
```



Q9. Is the distribution of winpercent values symmetrical?

No

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

Below

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

```
[1] 50.31676
```

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

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

```
[1] 44.11974
```

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

```
[1] 60.92153
```

Extensive steps

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

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

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

```
Warning in mean.default(chocolate.candy): argument is not numeric or logical:
returning NA
```

```
[1] NA
```

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

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

```
#Calculate their mean winpercent value
mean(fruity.candy)
```

```
Warning in mean.default(fruity.candy): argument is not numeric or logical:
returning NA
```

```
[1] NA
```

Chocolate candy is ranked higher than fruity candy.

Q12. Is this difference statistically significant?

```
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
```

Yes, with a very small p-value, the difference is statistically significance.

Overall Candy Ranking

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

There is a base R function called `sort()` for sorting vector inputs.

```
sort(candy$winpercent, decreasing = FALSE)
```

```
 [1] 22.44534 23.41782 24.52499 27.30386 28.12744 29.70369 32.23100 32.26109
 [9] 33.43755 34.15896 34.51768 34.57899 34.72200 35.29076 36.01763 37.34852
[17] 37.72234 37.88719 38.01096 38.97504 39.01190 39.14106 39.18550 39.44680
[25] 39.46056 41.26551 41.38956 41.90431 42.17877 42.27208 42.84914 43.06890
[33] 43.08892 44.37552 45.46628 45.73675 45.99583 46.11650 46.29660 46.41172
[41] 46.78335 47.17323 47.82975 48.98265 49.52411 49.65350 50.34755 51.41243
[49] 52.34146 52.82595 52.91139 54.52645 54.86111 55.06407 55.10370 55.35405
[57] 55.37545 56.49050 56.91455 57.11974 57.21925 59.23612 59.52925 59.86400
[65] 60.80070 62.28448 63.08514 64.35334 65.71629 66.47068 66.57458 66.97173
[73] 67.03763 67.60294 69.48379 70.73564 71.46505 72.88790 73.09956 73.43499
[81] 76.67378 76.76860 81.64291 81.86626 84.18029
```

The related function is `sort()` that is often more useful than `order()`. It returns the "indices" of the input that would result in it being sorted.

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

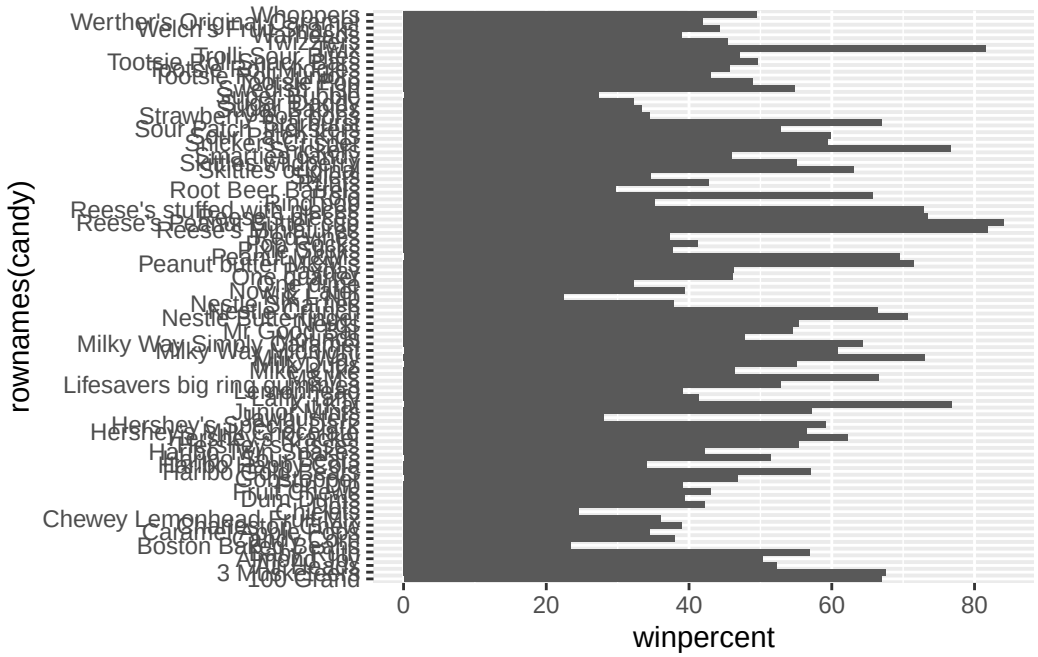
Q14. What are the top 5 all time favorite candy types out of this set?

```
ord2 <- order(candy$winpercent, decreasing = TRUE)
head(candy [ord2,], 5)
```

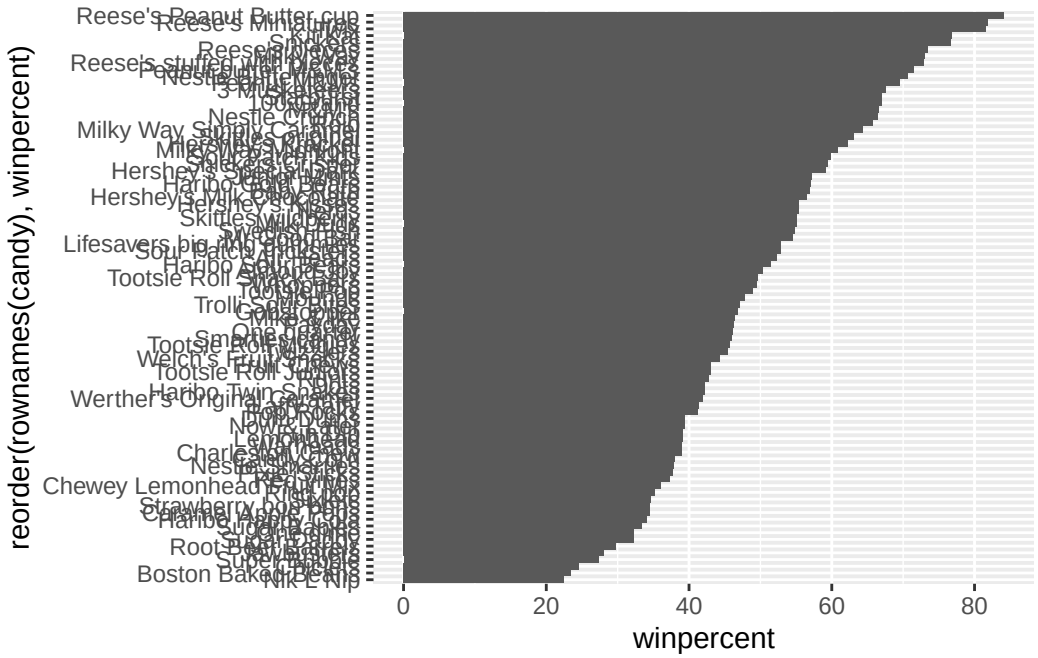
```
                         chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat                           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 & Q16. Make a first barplot of candy ranking based on winpercent values.

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

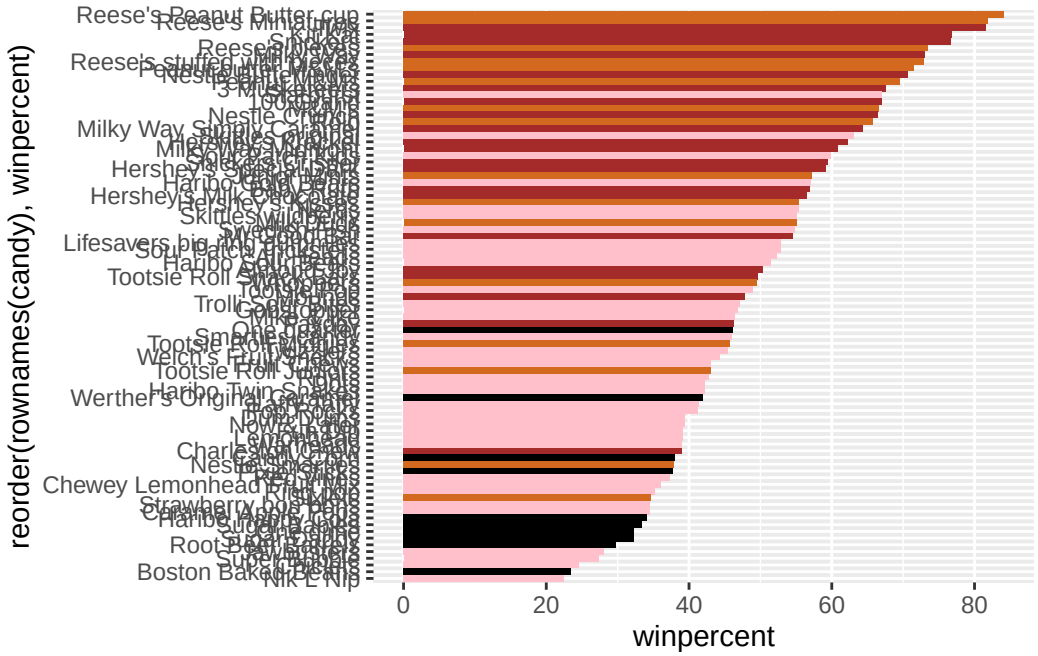



```
ggplot(candy, aes(winpercent, reorder(rownames(candy), winpercent))) +
  geom_col()
```



```
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?

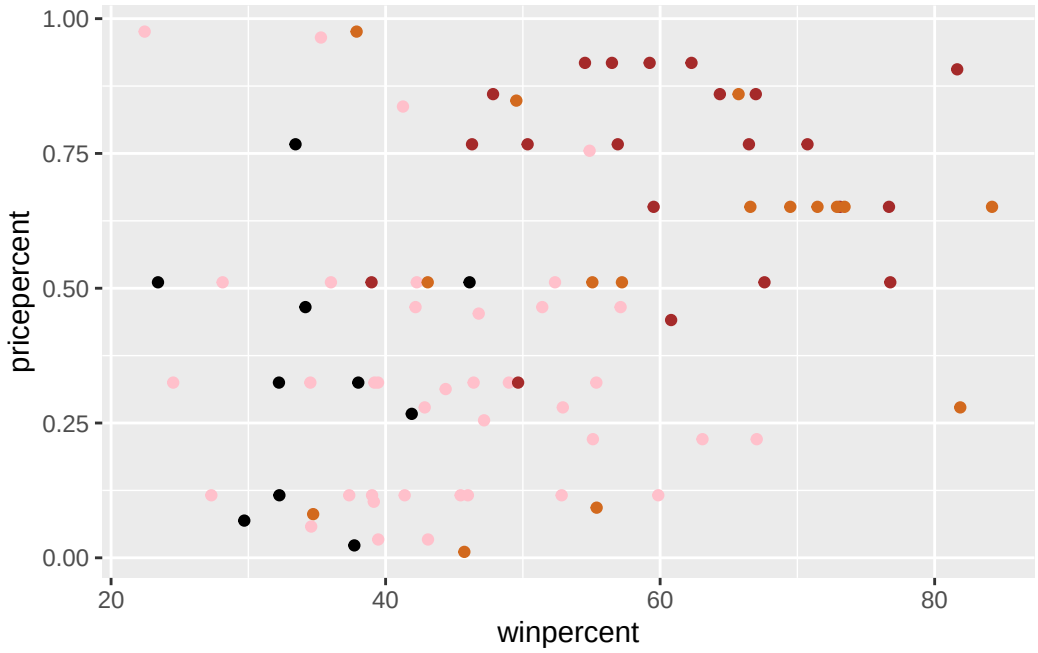
Sixlets

Q18. What is the best ranked fruity candy?

Starbursts

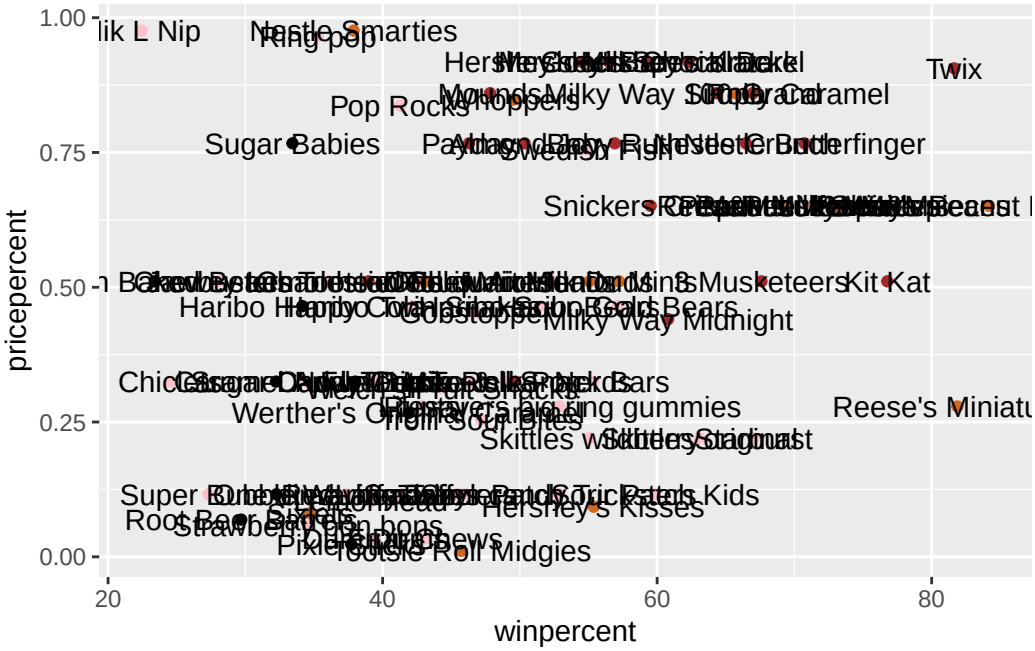
Taking a look at pricepercent

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



Let's add some labels.

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

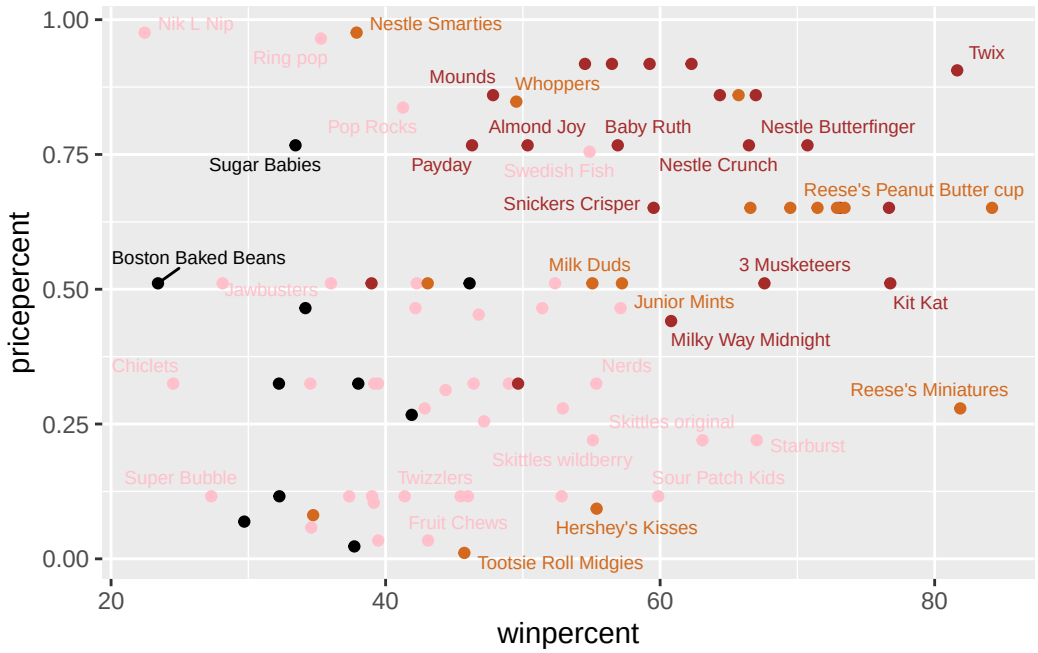


To deal with overlapping labels, I can use **ggrepel** package.

```
library(ggrepel)

ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=2.5, max.overlaps = 7)
```

```
Warning: ggrepel: 50 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

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

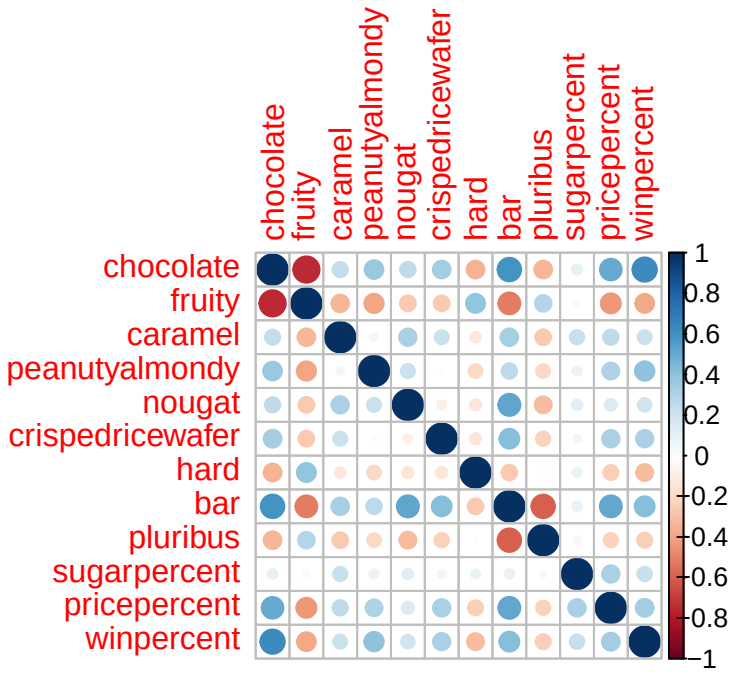
Nik L Nip, Nestle Smarties, Ring Pop, Hershey's Krackel, Hersheys Milk Chocolate Nik L Nip is the least popular.

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)?

Chocolate and fruity are highly anti-correlated.

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

Winpercent and chocolate are highly correlated.

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)
```

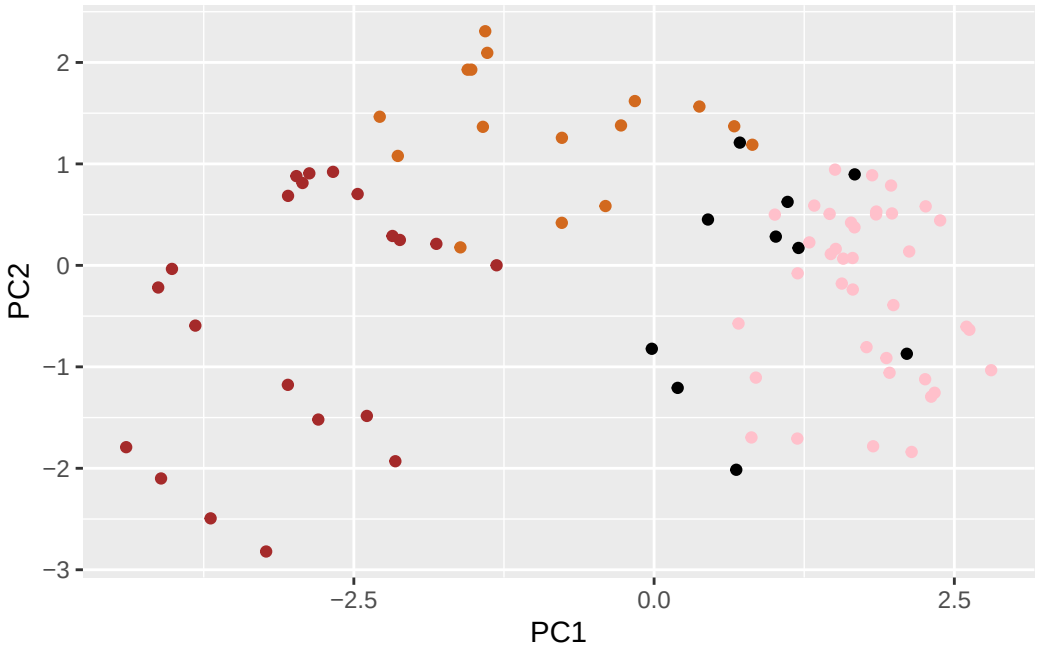
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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.e the new PC plot is contained in `pca$x`.

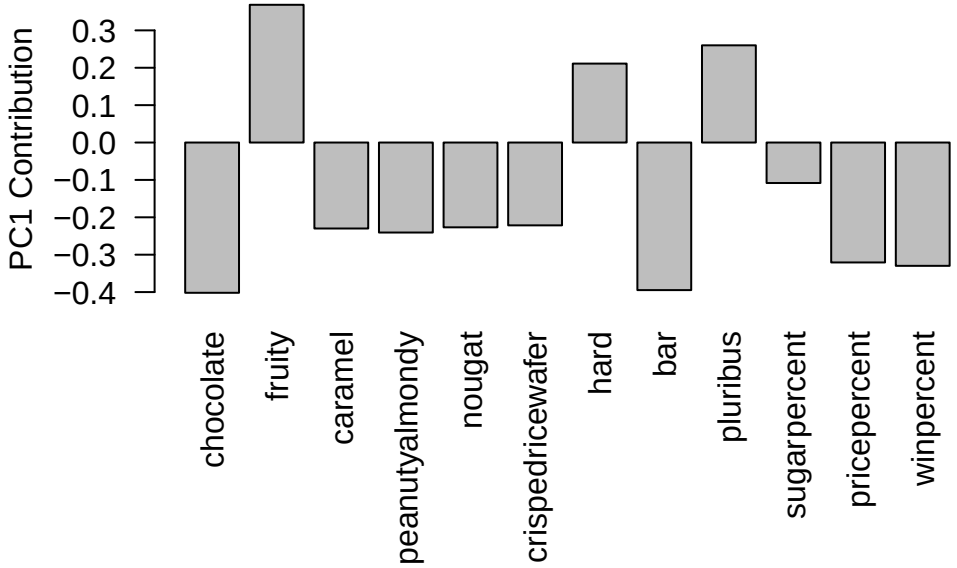
```
pc <- as.data.frame(pca$x)

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




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

```
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?

Yes, this makes sense because we would expect fruity candy to be hard and pluribus.