Class 10: Halloween Mini Project

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10/27/2022

Importing Candy Data

First save the input into your project directory.

```
candy_file <- "candy-data.csv"
```

Then load and input the data.

```
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.

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

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

```
## [1] 38
```

There are 38 fruity candy types in the dataset.

We can find the winpercent value for Twix. (Those with a higher value people like more)

What is your favorite candy?

```
rownames(candy)
```

```
##  [1] "100 Grand"                  "3 Musketeers"
##  [3] "One dime"                   "One quarter"
##  [5] "Air Heads"                  "Almond Joy"
##  [7] "Baby Ruth"                  "Boston Baked Beans"
##  [9] "Candy Corn"                 "Caramel Apple Pops"
## [11] "Charleston Chew"            "Chewey Lemonhead Fruit Mix"
## [13] "Chiclets"                   "Dots"
## [15] "Dum Dums"                   "Fruit Chews"
## [17] "Fun Dip"                    "Gobstopper"
## [19] "Haribo Gold Bears"          "Haribo Happy Cola"
## [21] "Haribo Sour Bears"          "Haribo Twin Snakes"
## [23] "HersheyÕs Kisses"           "HersheyÕs Krackel"
## [25] "HersheyÕs Milk Chocolate"   "HersheyÕs Special Dark"
## [27] "Jawbusters"                 "Junior Mints"
## [29] "Kit Kat"                    "Laffy Taffy"
## [31] "Lemonhead"                  "Lifesavers big ring gummies"
## [33] "Peanut butter M&MÕs"        "M&MÕs"
## [35] "Mike & Ike"                 "Milk Duds"
## [37] "Milky Way"                  "Milky Way Midnight"
## [39] "Milky Way Simply Caramel"   "Mounds"
## [41] "Mr Good Bar"                "Nerds"
## [43] "Nestle Butterfinger"        "Nestle Crunch"
## [45] "Nik L Nip"                  "Now & Later"
## [47] "Payday"                     "Peanut M&Ms"
## [49] "Pixie Sticks"               "Pop Rocks"
## [51] "Red vines"                  "ReeseÕs Miniatures"
## [53] "ReeseÕs Peanut Butter cup"  "ReeseÕs pieces"
## [55] "ReeseÕs stuffed with pieces" "Ring pop"
## [57] "Rolo"                       "Root Beer Barrels"
## [59] "Runts"                      "Sixlets"
## [61] "Skittles original"          "Skittles wildberry"
## [63] "Nestle Smarties"            "Smarties candy"
## [65] "Snickers"                   "Snickers Crisper"
## [67] "Sour Patch Kids"            "Sour Patch Tricksters"
## [69] "Starburst"                  "Strawberry bon bons"
## [71] "Sugar Babies"               "Sugar Daddy"
## [73] "Super Bubble"               "Swedish Fish"
## [75] "Tootsie Pop"                "Tootsie Roll Juniors"
## [77] "Tootsie Roll Midgies"       "Tootsie Roll Snack Bars"
## [79] "Trolli Sour Bites"          "Twix"
## [81] "Twizzlers"                  "Warheads"
## [83] "WelchÕs Fruit Snacks"       "WertherÕs Original Caramel"
## [85] "Whoppers"
```

```
candy["Twix", ]$winpercent
```

```
## [1] 81.64291
```

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

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

```
## [1] 59.864
```

My favorite candy is sour patch kids. Its winpercent value is 59.864.

Q4. What is the winpercent value for “Kit Kat”?

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

```
## [1] 76.7686
```

The winpercent for kit kat is 76.7686.

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

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

```
## [1] 49.6535
```

The winpercent value for tootsie roll snack bars is 49.6535

We can look at the overview of the given dataset.

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

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 histogram column that plots the winpercent looks to be on a different scale. It is not on a 0 to 1 scale or out of 100 scale, it is not on a numerical scale.

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

```
candy$chocolate
```

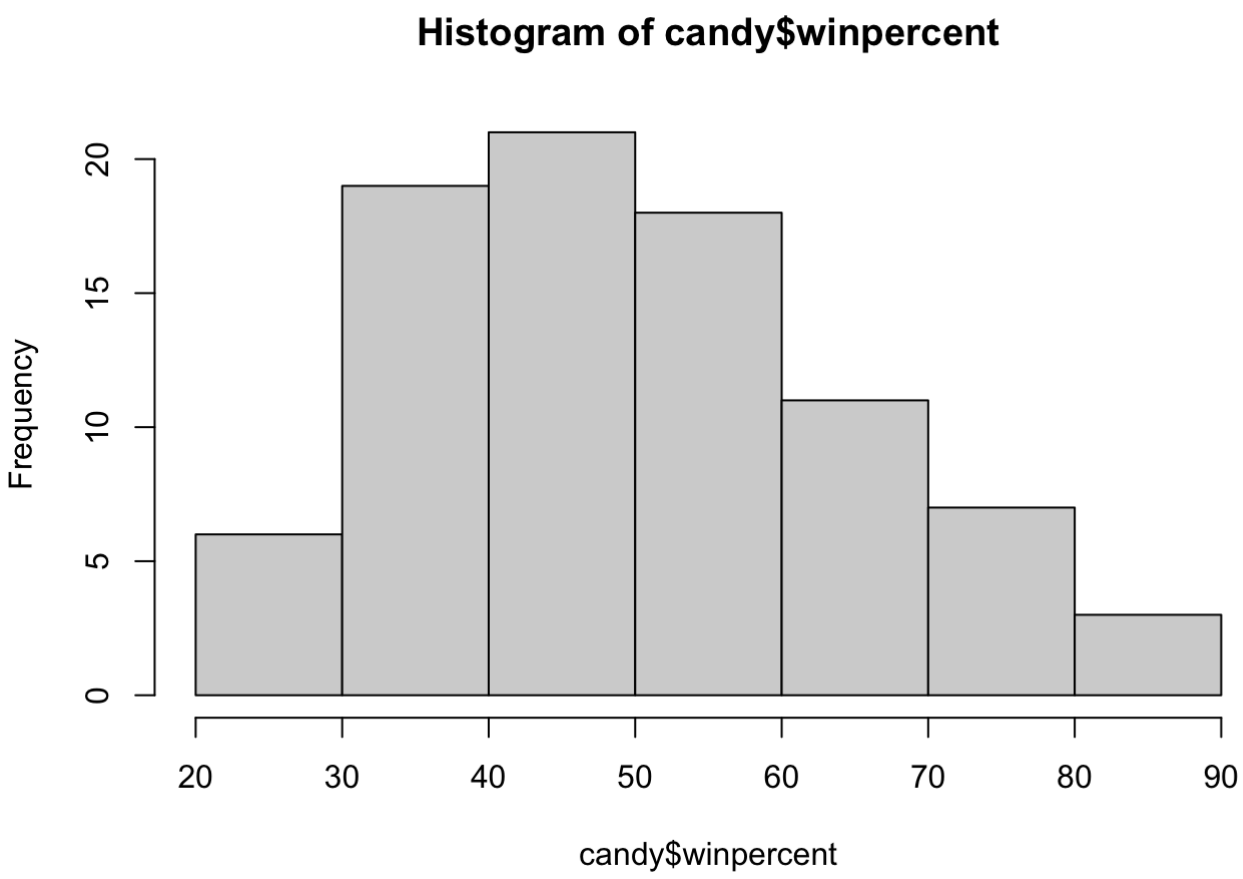
```
##  [1] 1 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 1 1 0 0 0 1 1 0 1 1 1
## [39] 1 1 1 0 1 1 0 0 0 1 0 0 0 1 1 1 1 0 1 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0 0 1 1
## [77] 1 1 0 1 0 0 0 0 1
```

A 1 means there is chocolate in that candy and a 0 means there is no chocolate in the candy.

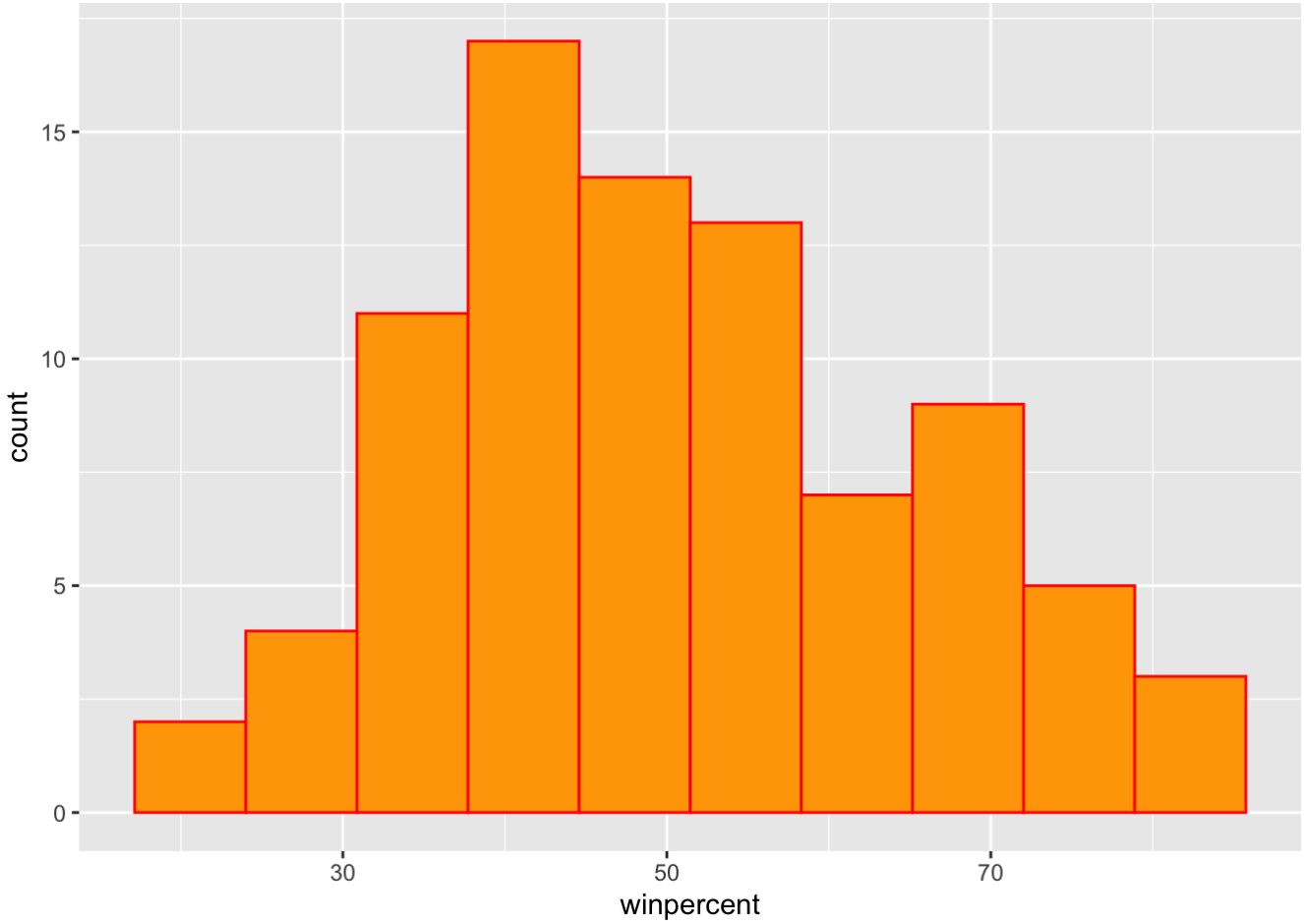
> Q8. Plot a histogram of winpercent values

We can plot using two different methods. hist() or ggplot().

```
hist(candy$winpercent)
```




```
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=10, col="red", fill="orange")
```



Q9. Is the distribution of winpercent values symmetrical?

No, the distribution is not symmetrical, you can see the values are unevenly distributed.

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

The center of distribution is above 50%.

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

```
chocolate.inds <-as.logical(candy$chocolate)
chocolatewins <-candy[chocolate.inds,]$winpercent
mean(candy[chocolate.inds,]$winpercent)
```

```
## [1] 60.92153
```

```
fruity.inds <- as.logical(candy$fruity)
fruitwins <-candy[fruity.inds,]$winpercent
mean(candy[fruity.inds,]$winpercent)
```

```
## [1] 44.11974
```

On average the chocolate candy is higher ranked than the fruity candy.

> Q12. Is this difference statistically significant?

```
t.test(chocolatewins, fruitwins)
```

```
##
##  Welch Two Sample t-test
##
## data:  chocolatewins and fruitwins
## 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 statistically significant difference between the two as seen from the low p-value.

Overall Candy Rankings

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

```
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 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?

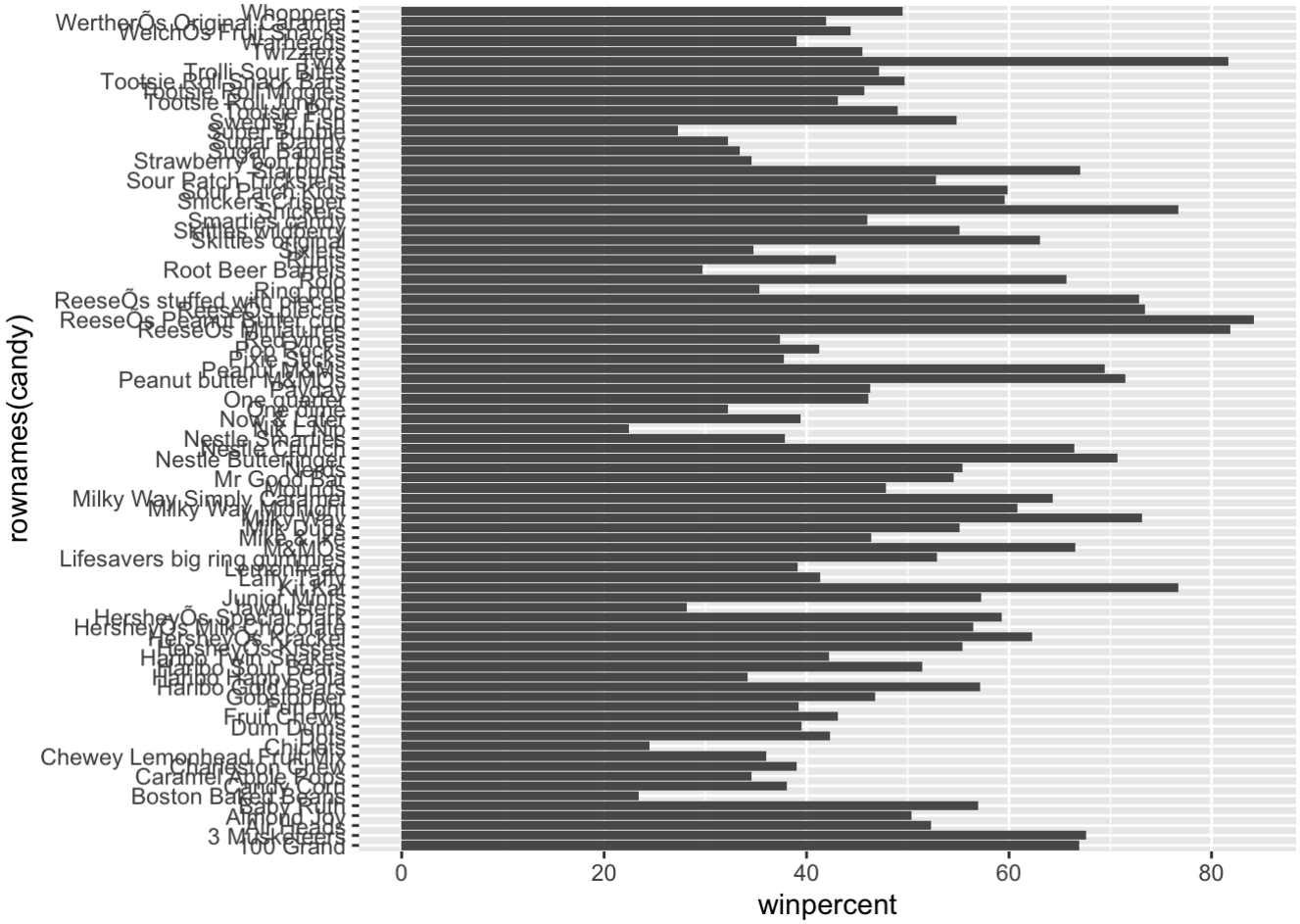
```
tail(candy[order(candy$winpercent),], n=5)
```

```
##                           chocolate fruity caramel peanutyalmondy nougat
## Snickers                          1      0       1              1      1
## Kit Kat                           1      0       0              0      0
## Twix                              1      0       1              0      0
## ReeseÕs Miniatures                1      0       0              1      0
## ReeseÕs 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
## ReeseÕs Miniatures                        0    0   0        0        0.034
## ReeseÕs 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
## ReeseÕs Miniatures               0.279   81.86626
## ReeseÕs Peanut Butter cup        0.651   84.18029
```

The top 5 favorite candy types are Snickers, Kit kats, twix, ReeseOs minis, and ReeseOs Peanut Butter Cup.

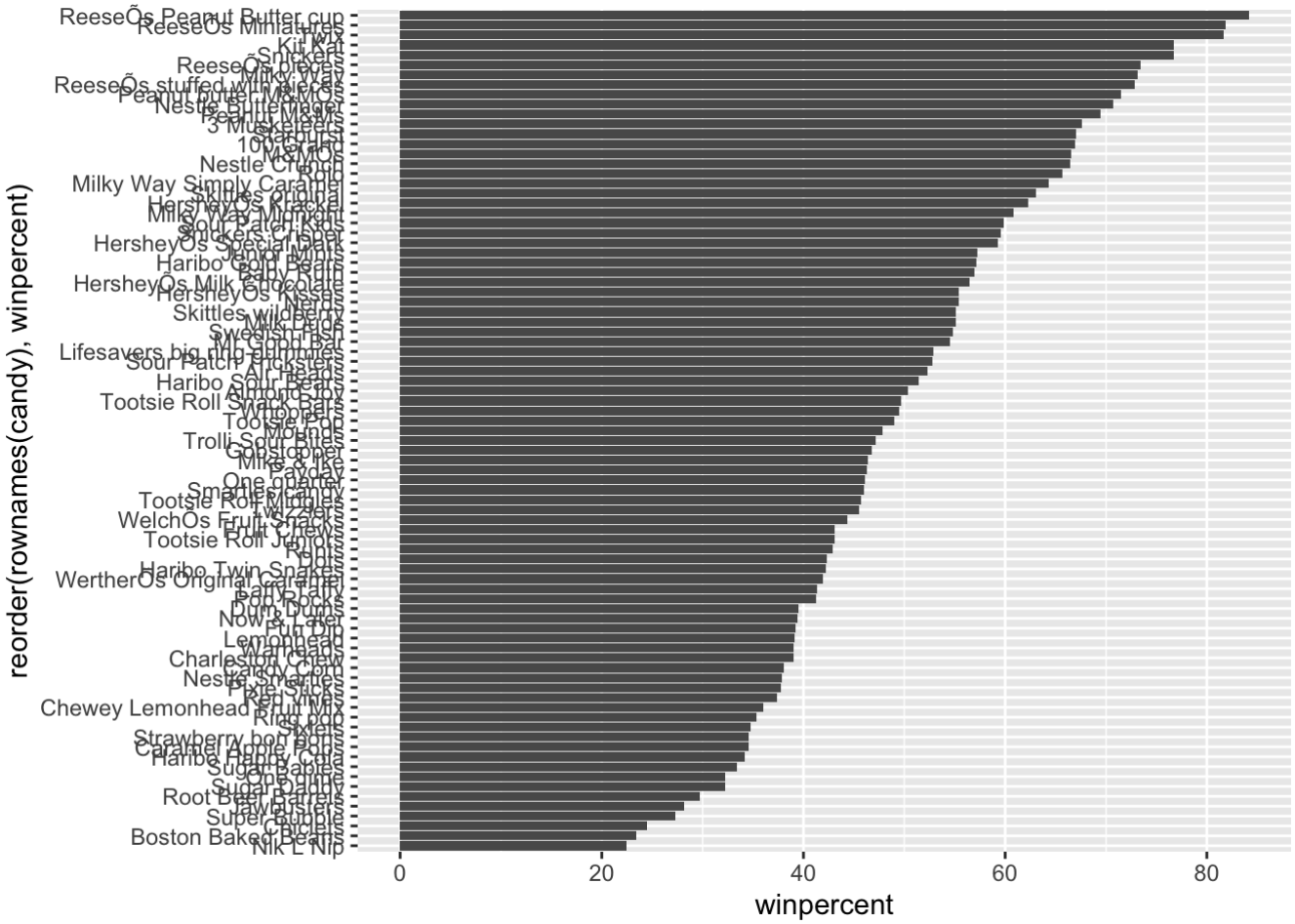
Q15. Make a first barplot of candy ranking based on winpercent values.

```
library(ggplot2)

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



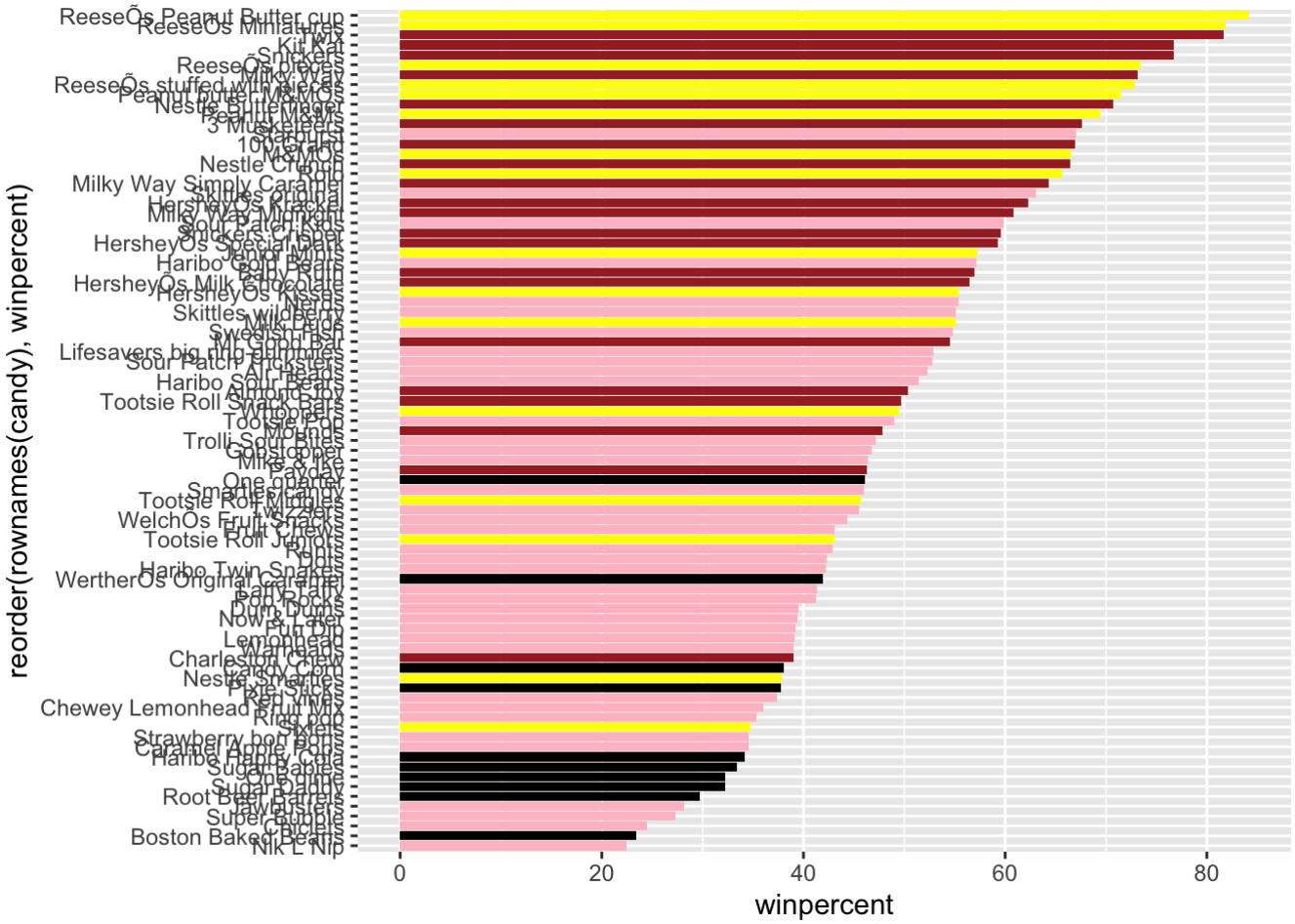
Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```
library(ggplot2)

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




```
my_cols=rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] = "yellow"
my_cols[as.logical(candy$bar)] = "brown"
my_cols[as.logical(candy$fruity)] = "pink"
#my_cols
```

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



Q17. What is the worst ranked chocolate candy?

The worst ranked chocolate candy is sixlets.

Q18. What is the best ranked fruity candy?

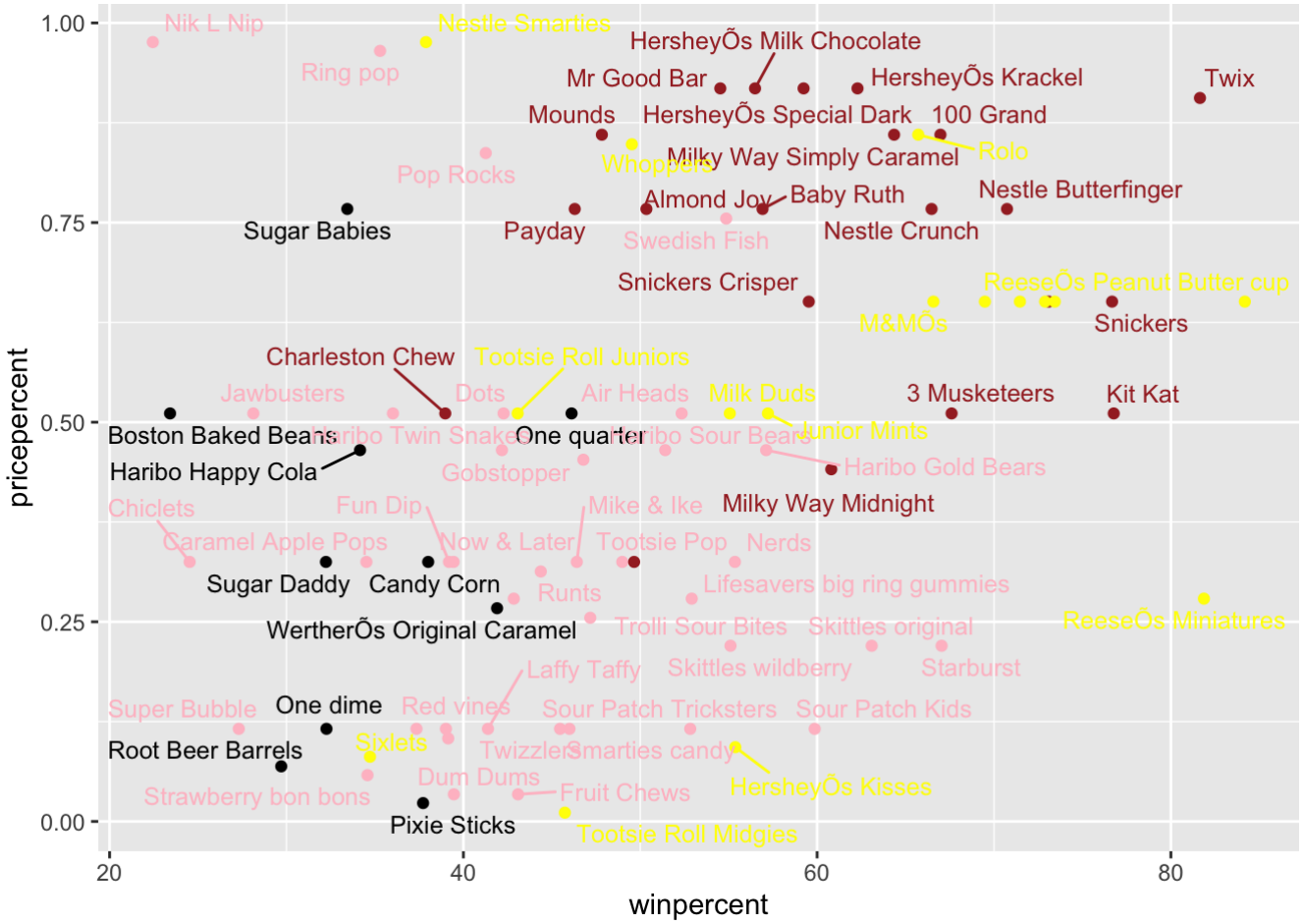
The best ranked fruity candy is starburst.

Taking a look at pricepercent

We can plot the value for money per each candy. To see which is best in terms of price and win percent.

```
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 = 10)
```

```
## Warning: ggrepel: 10 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?

The highest rank in terms of winpercent for the least money is Reese O's minis.

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

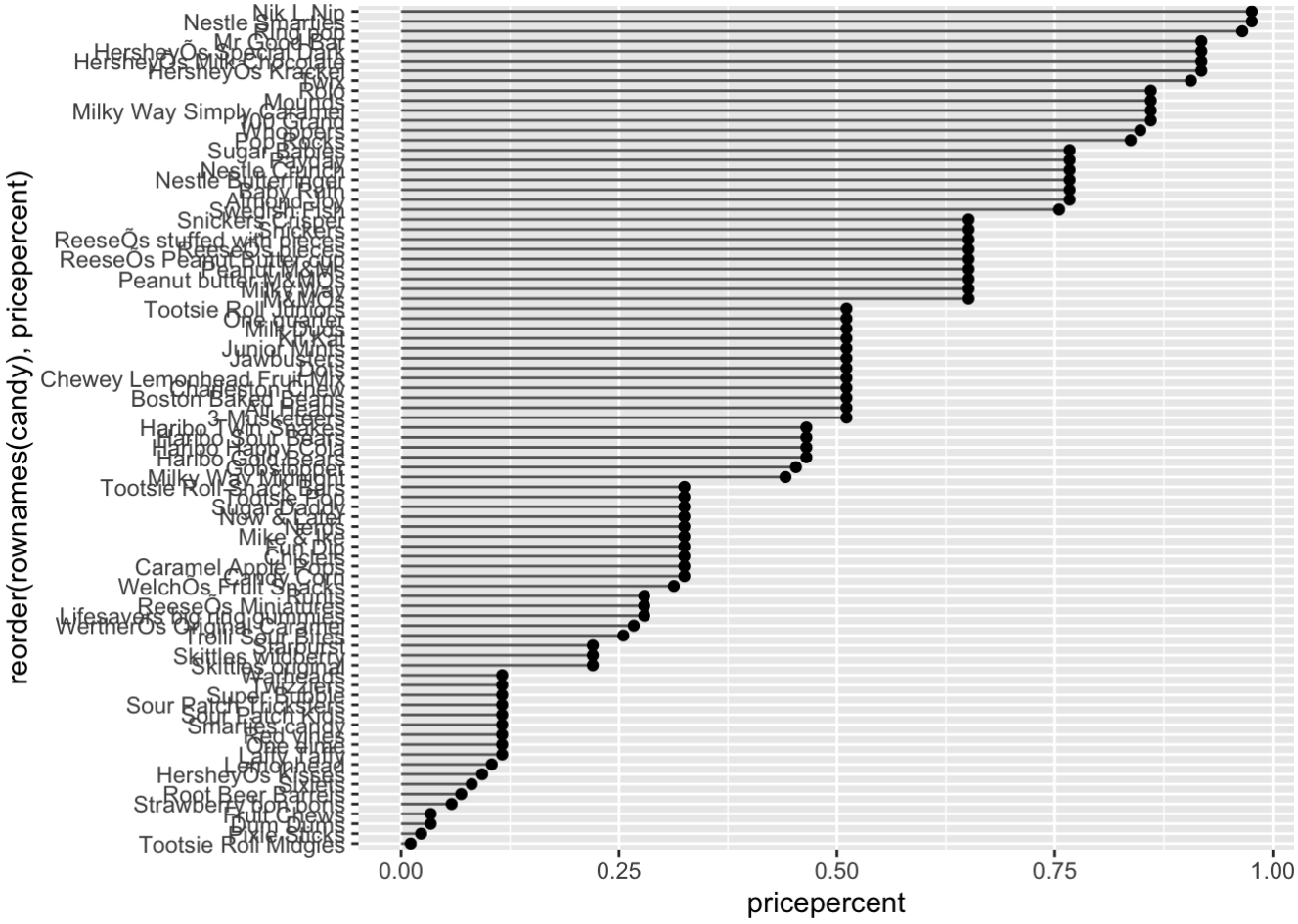
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
##                          pricepercent winpercent
## Nik L Nip                       0.976   22.44534
## Nestle Smarties                 0.976   37.88719
## Ring pop                        0.965   35.29076
## HersheyÕs Krackel               0.918   62.28448
## HersheyÕs Milk Chocolate        0.918   56.49050
```

The top 5 most expensive are Nik L Nip, Nestle Smarties, Ring pop, HersheyOs Krackel, and HersheyOs Milk Chocolate. The least popular amongst these are 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().

```
# Make a lollipop chart of pricepercent
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```



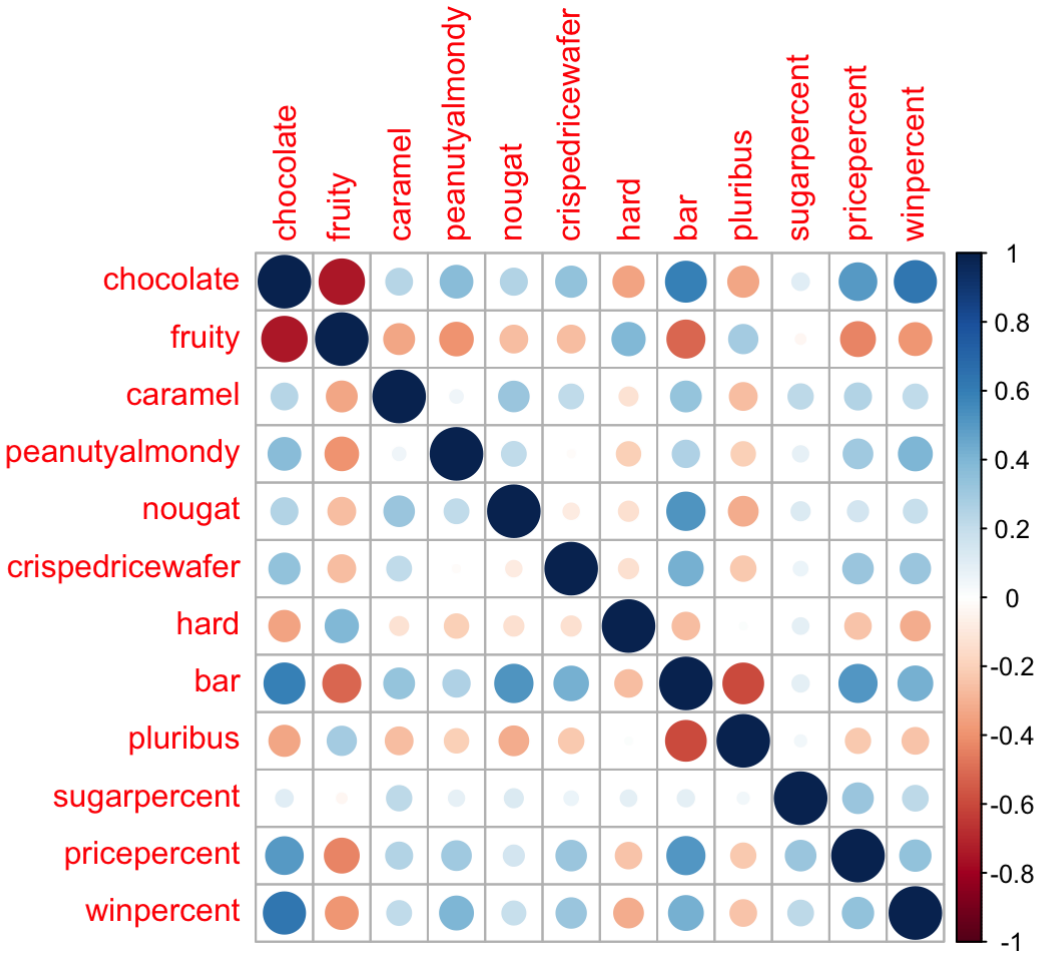
Exploring the correlation structure

We will plot the correlation by using corrplot().

```
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 two variables that are anti-correlated are shown by the red colored dot which are chocolate and fruity.

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

Variables most positively correlated are winpercent (popularity) and chocolate.

Principal Component Analysis

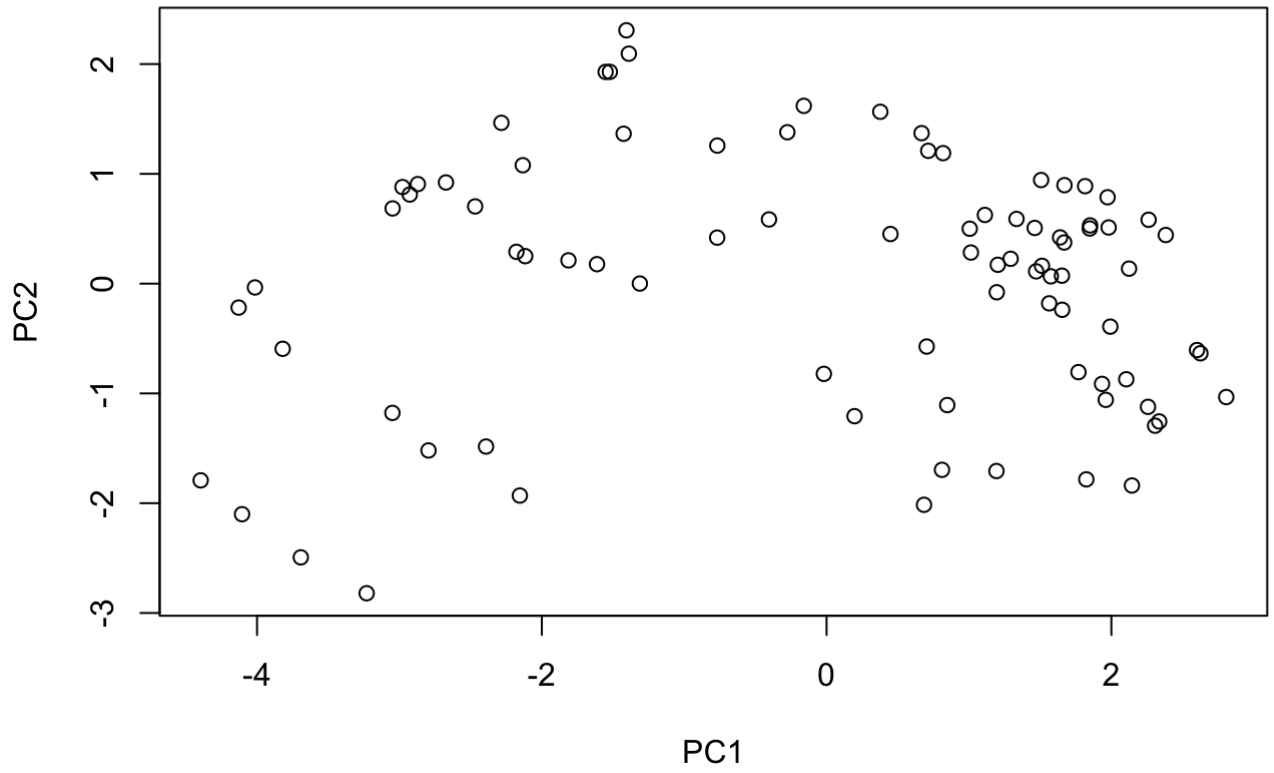
Lets apply PCA.

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

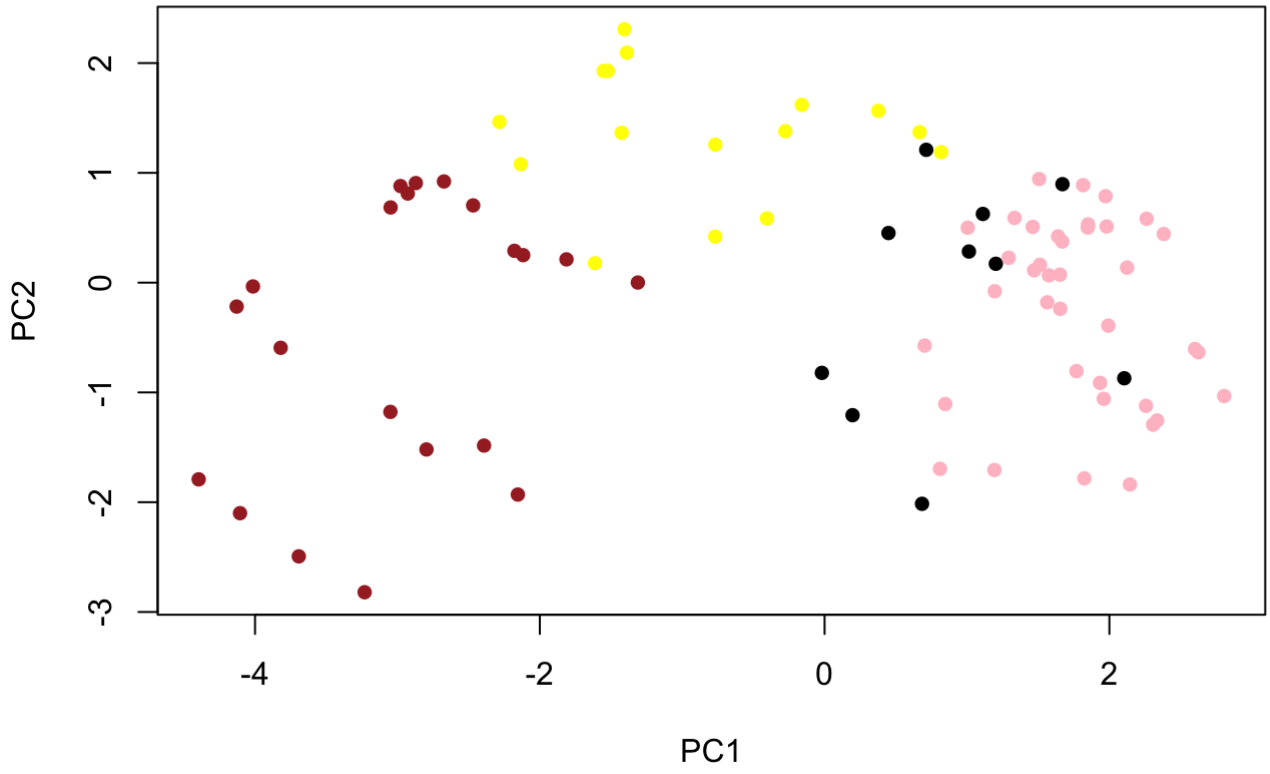
```
## Importance of components:
##                           PC1    PC2    PC3     PC4    PC5     PC6     PC7
## Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
## Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
## Cumulative Proportion  0.3601 0.4680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

Now we can plot our PCA score plot, PC1 vs PC2.

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



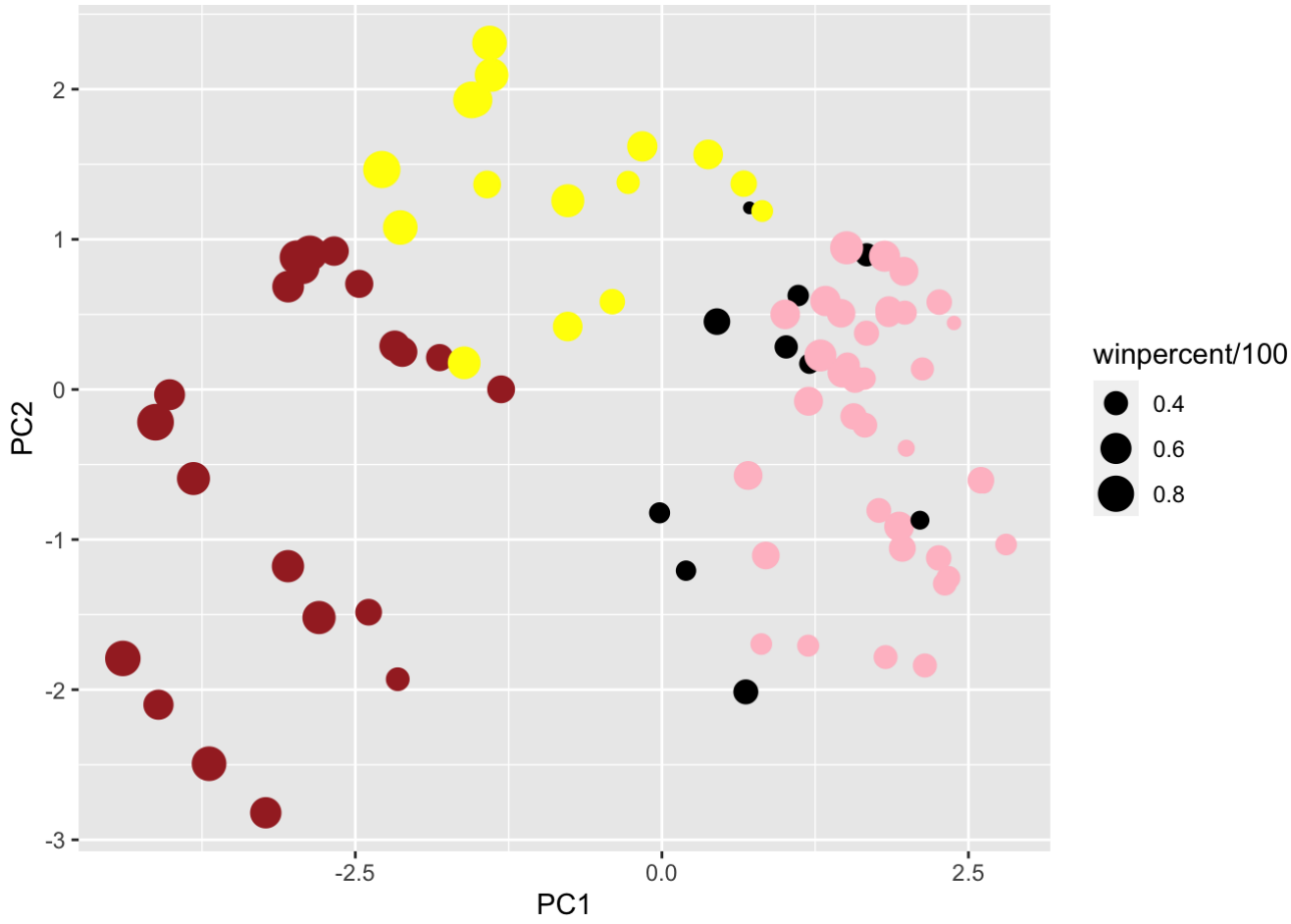

```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



We can also plot using ggplot.

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

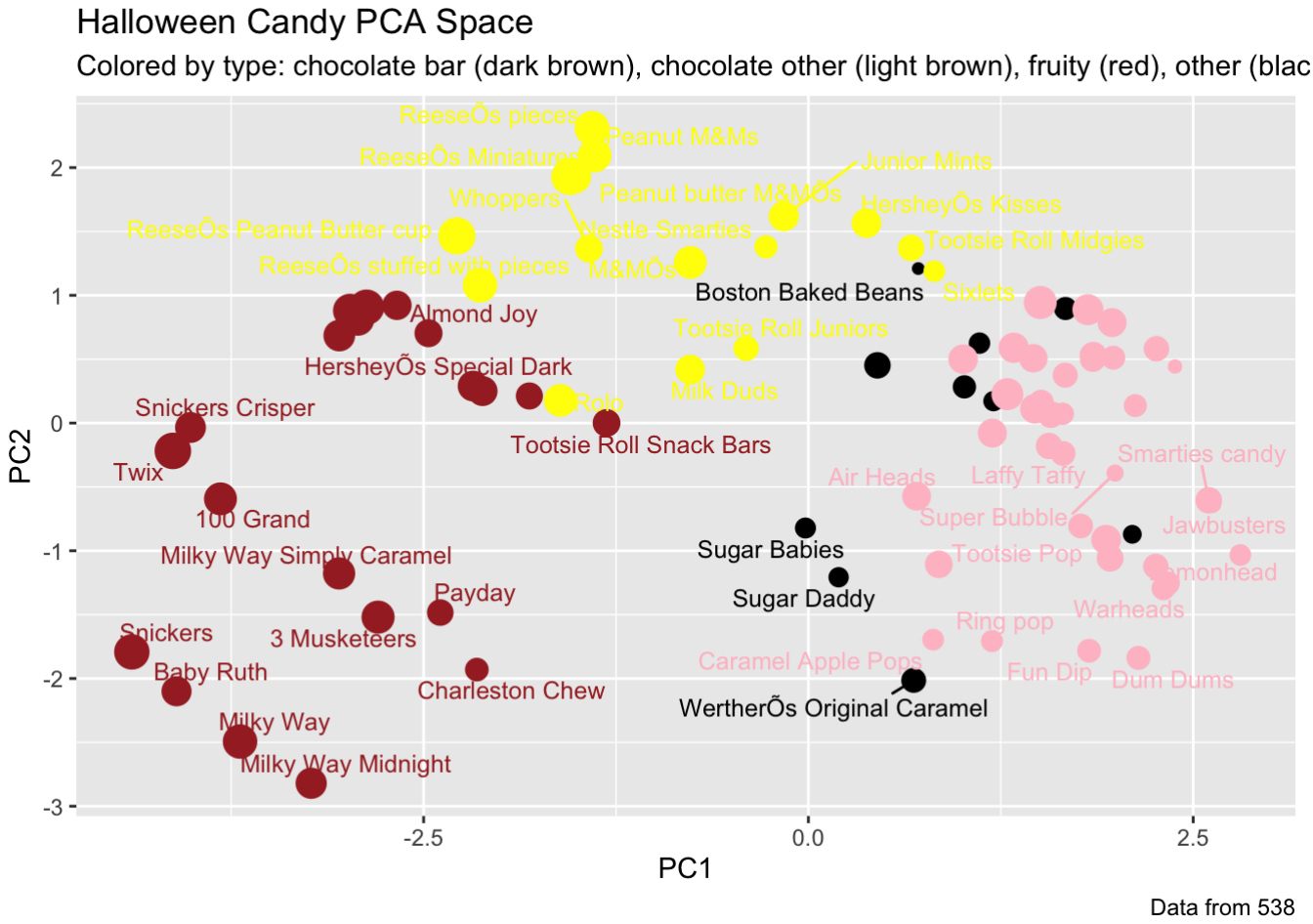
```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p
```



We can use ggrepel.

```
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 bro
wn), fruity (red), other (black)",
       caption="Data from 538")
```

```
## Warning: ggrepel: 39 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



We

Data from 538

can generate an interactive plot.

```
library(plotly)
```

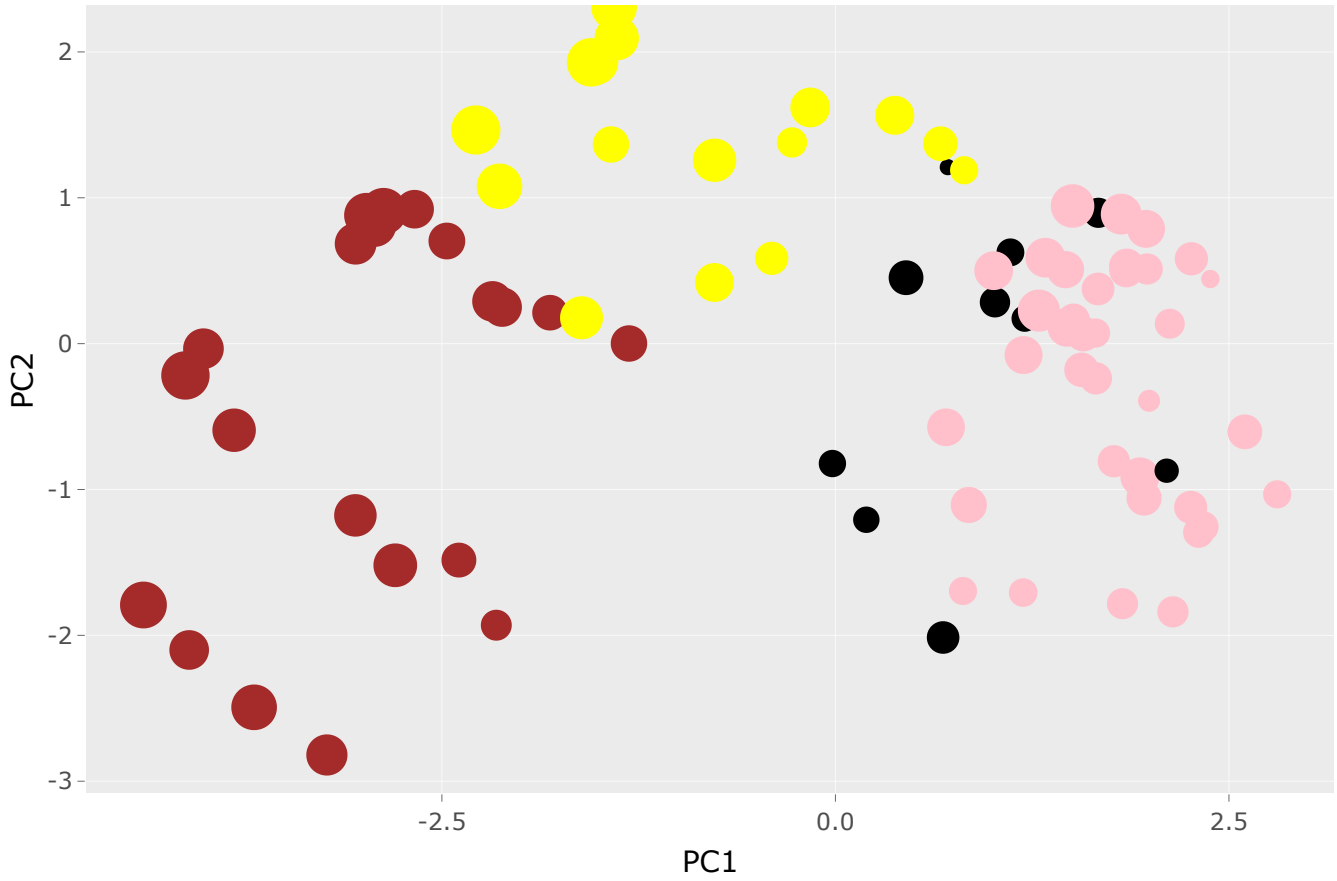
```
##
## Attaching package: 'plotly'
```

```
## The following object is masked from 'package:ggplot2':
##
##     last_plot
```

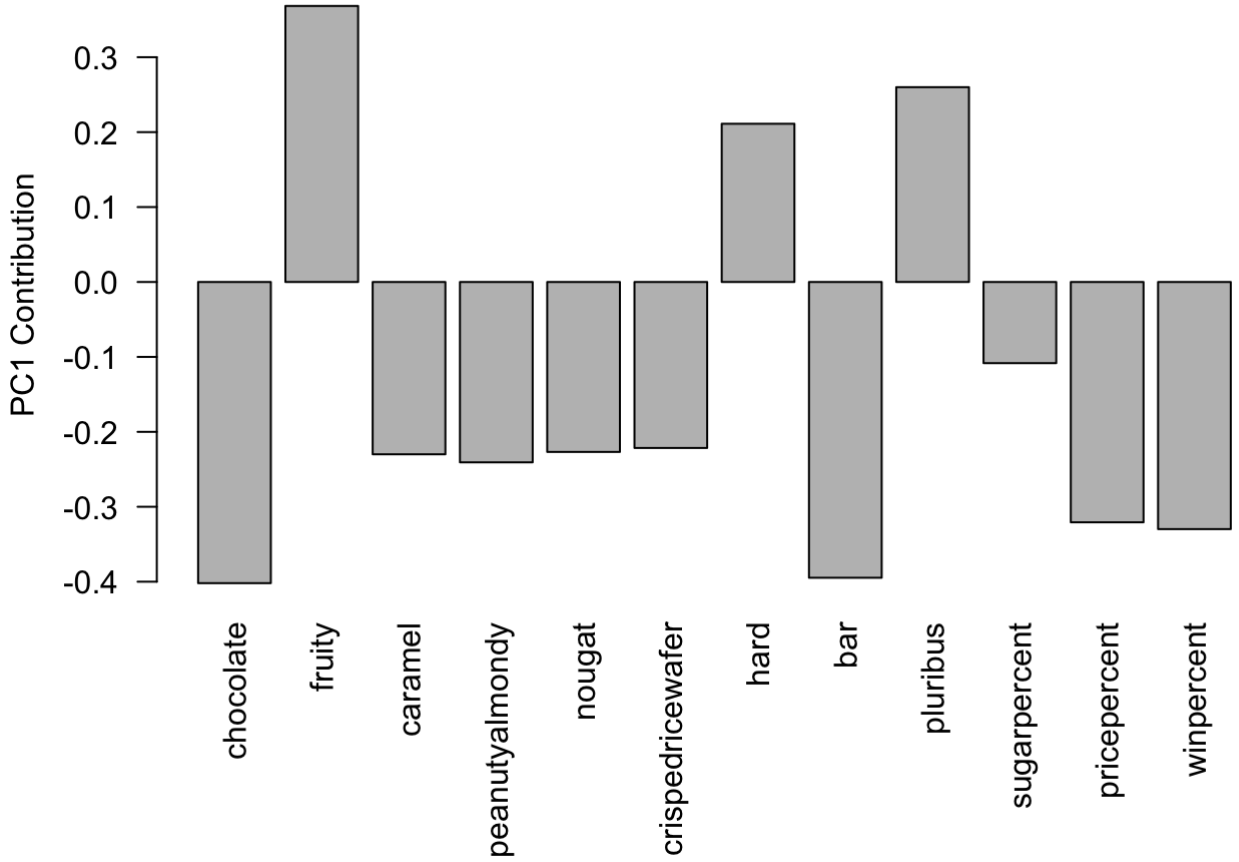
```
## The following object is masked from 'package:stats':
##
##     filter
```

```
## The following object is masked from 'package:graphics':
##
##     layout
```

```
ggplotly(p)
```




```
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?

The original variables picked up by PC1 in the positive direction are fruity, hard, and pluribus. Yes, it makes sense because thats what most fruity candies are and fall under.