Class 9: Halloween Candy Mini-Project

Marielle Samonte (A18681951)

Table of contents

Today we will take a step back to some data we can taste and explore the correlation structure and principal components of some Halloween candy.

1. Data import

```
candy_file <- "candy-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
```

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
```

2. What is your favorite candy?

`winpercent` is the percentage of people who prefer this candy over another randomly chosen candy from the dataset. The higher the percentage, the more popular the candy is.

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
```

Exploratory Analysis

There is a useful `skim()` function in the **skimr** package that can help give a quick overview of a given dataset, especially when you encounter a new dataset.

```
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 `candy$winpercent` variable in the last column seems to be on a different scale to the majority of the other columns in the dataset.

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

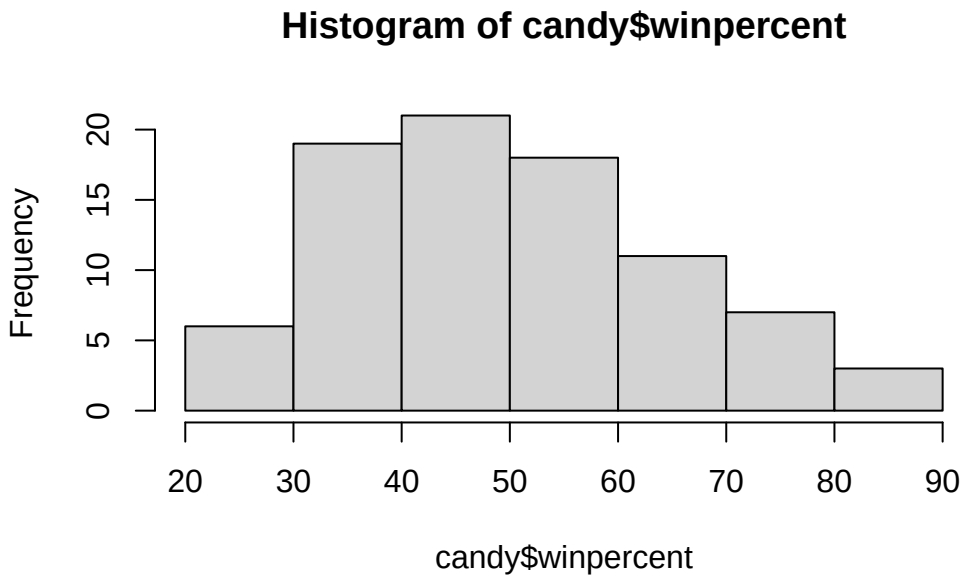
```
candy$chocolate
```

```
 [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
```

Going down the list of 85 candy, zero represents that the candy does not fit the chocolate category, while 1 means that the candy fits the chocolate category.

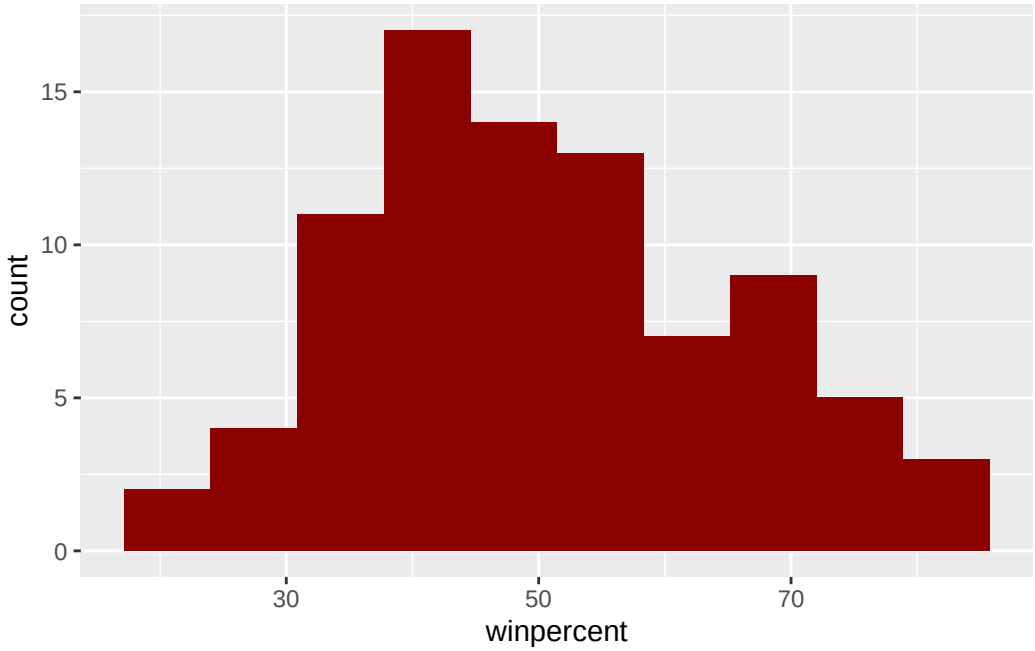
Q8. Plot a histogram of winpercent values

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




```
library(ggplot2)

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



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent values is not symmetrical.

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

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

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

The median is below 50%, 47.83

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

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

Chocolate candy is ranked higher (60.9) than fruit candy (44.1) on average.

Q12. Is this difference statistically significant?

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

```
    Welch Two Sample t-test

data:  choc.win and fruit.win
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
```

```
ans <- t.test(choc.win, fruit.win)
ans$p.value
```

```
[1] 2.871378e-08
```

The difference is statistically significant, demonstrated by low p-value = 2.871e-08. Yes with a P-value of 2.8713778×10^{-8}

3. Overall Candy Rankings

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

There are two related functions that can help here, one is the classic `sort()` and `order()`

```
x <- c(5,10,1,4)
sort(x)
```

```
[1]  1  4  5 10
```

```
order(x)
```

```
[1] 3 4 1 2
```

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

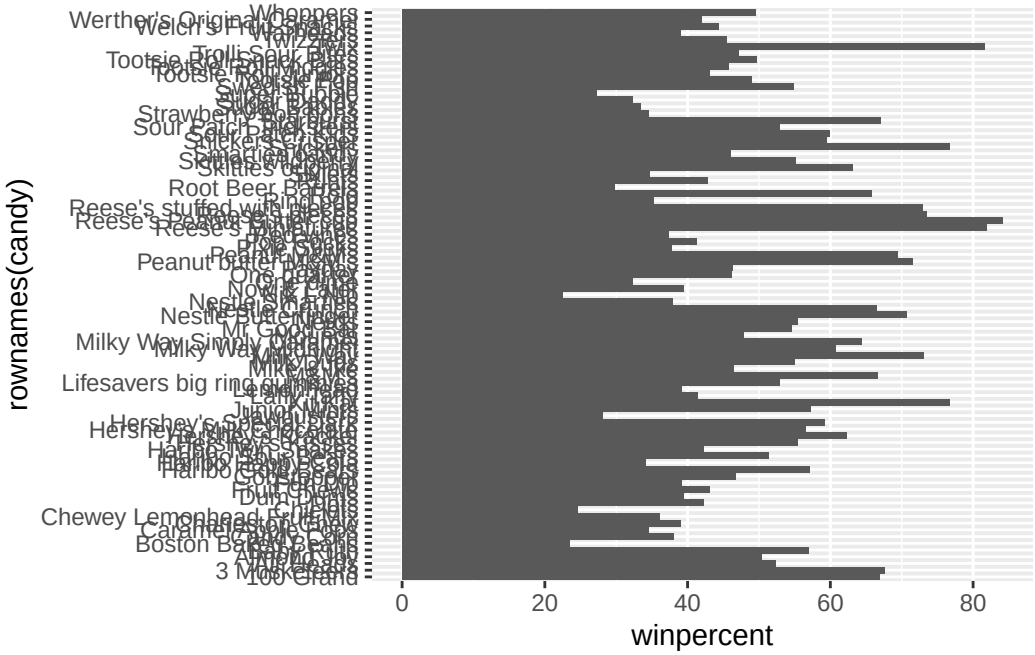
```
inds <- order(candy$winpercent, decreasing = T)
head(candy[inds,], 5)
```

```
                         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
```

The top five favorite candies are Reese's Peanut Butter Cup, Reese's Miniatures, Twix, Kit Kat, and Snickers.

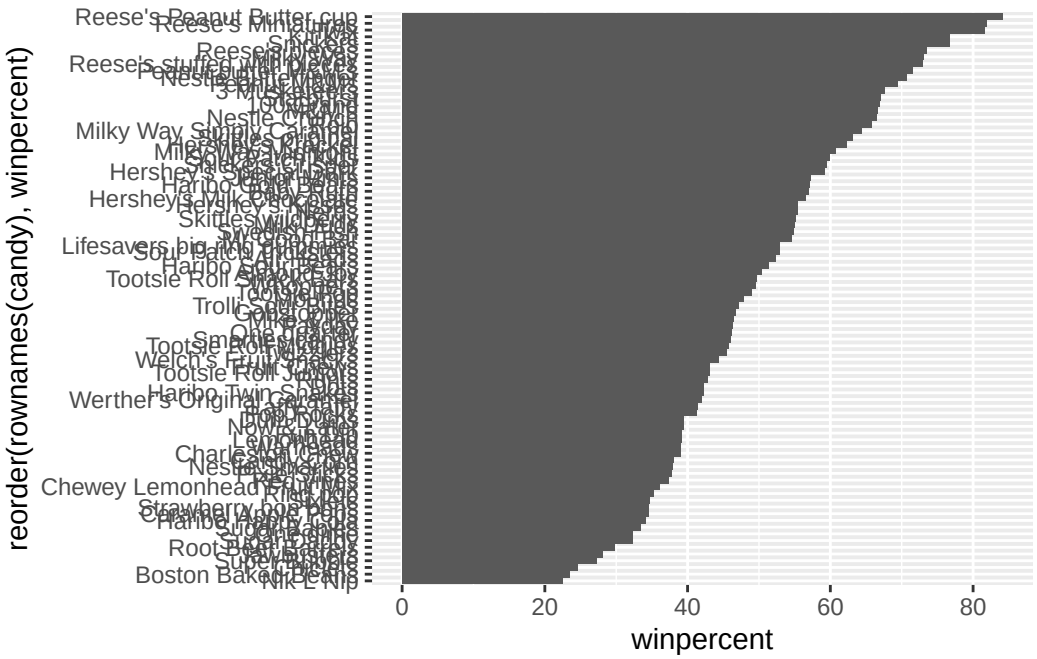
Make a bar plot with ggplot and order it by winpercent values. > Q15. Make a first barplot of candy ranking based on winpercent values.

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



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

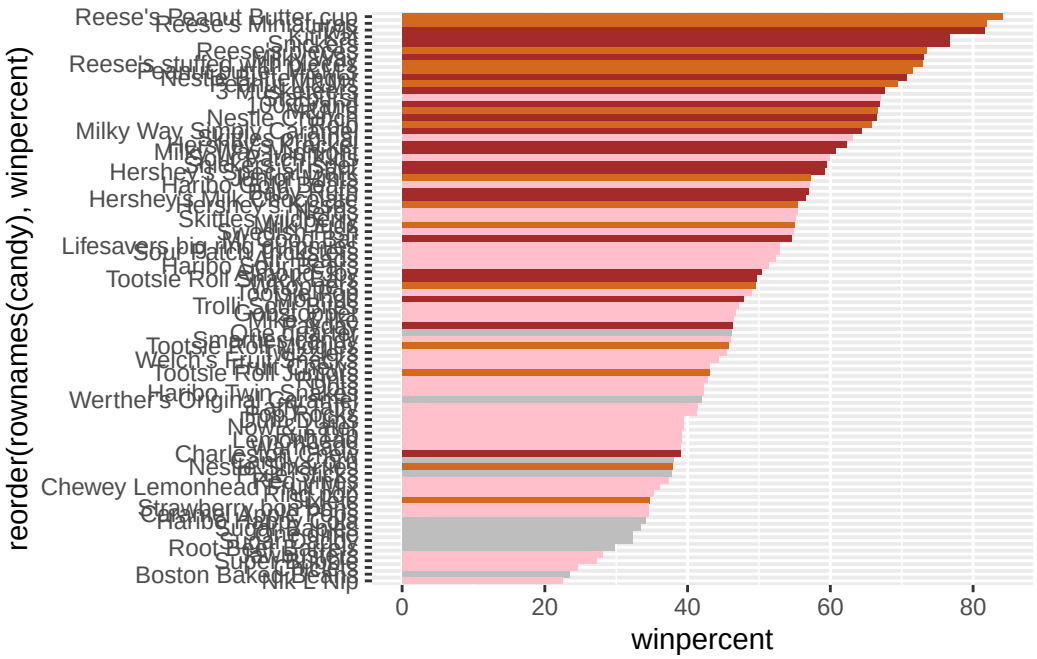
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col()
```



Here we want a custom color vector to color each bar the way we want - with chocolate and fruity candy together with whether is it a `bar` or not.

```
my_cols <- rep("grey", nrow(candy))
my_cols[as.logical(candy$chocolate)] <- "chocolate"
my_cols[as.logical(candy$fruity)] <- "pink"
my_cols[as.logical(candy$bar)] <- "brown"

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




```
ggsave("mybarplot.png", width = 3, height = 6)
```

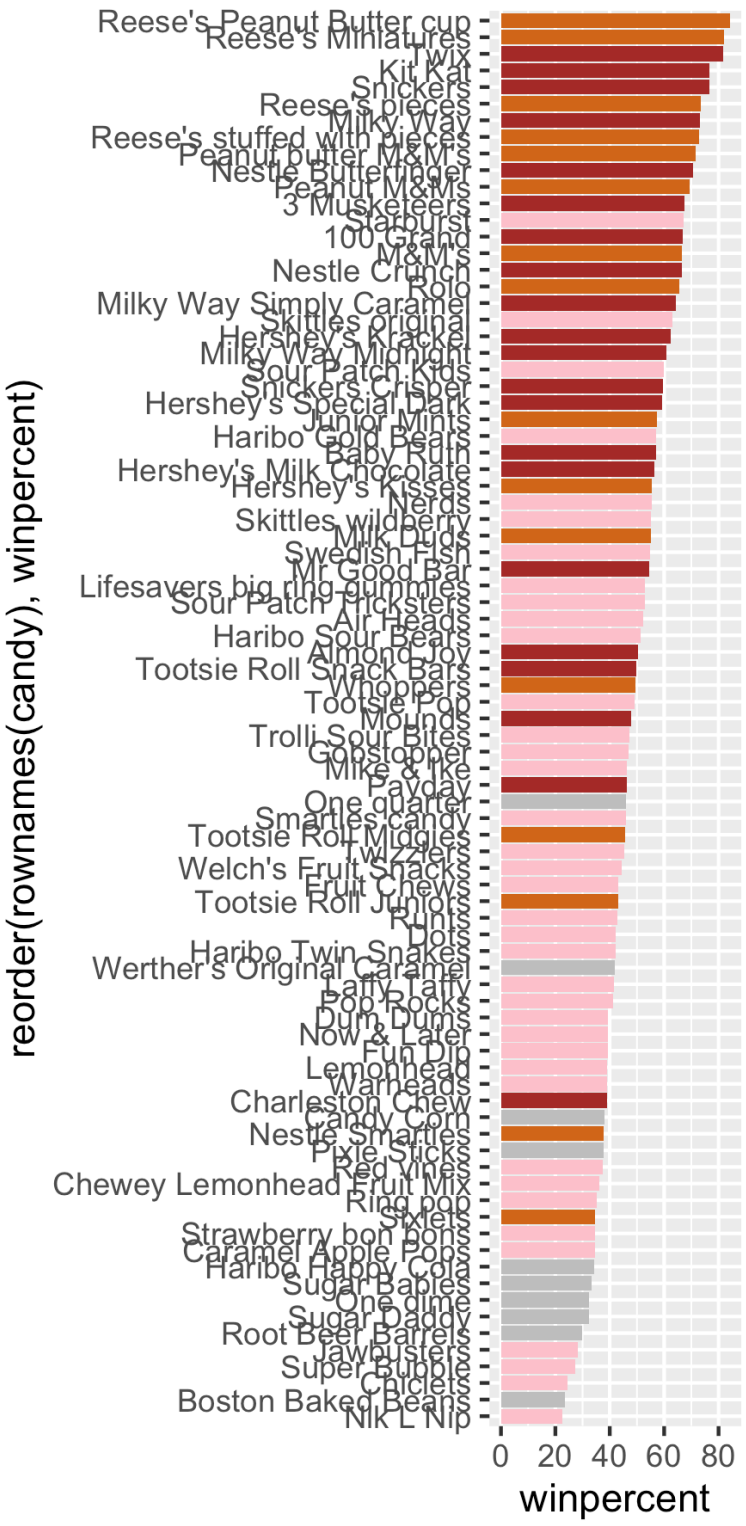


Figure 1: My silly barplot image

Now, for the first time, using this plot we can answer questions like: Q17. What is the worst ranked chocolate candy?

Sixlets

Q18. What is the best ranked fruity candy?

Starburst

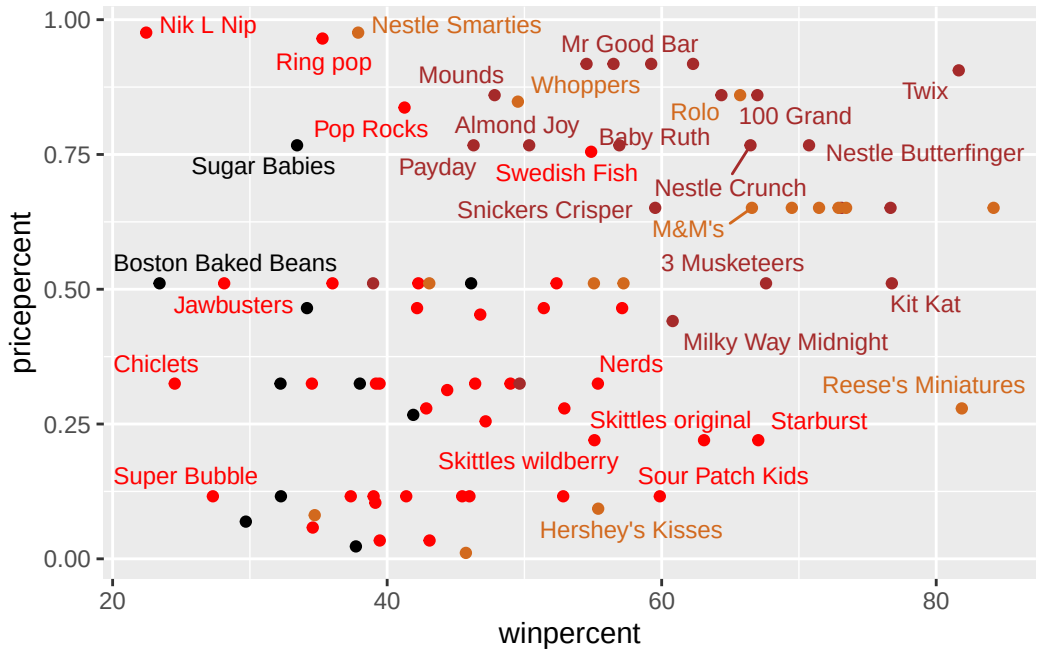
4. Taking a look at pricepoint

```
# Pink and gray are too light, lets change to red and black
my_cols <- rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] <- "chocolate"
my_cols[as.logical(candy$fruity)] <- "red"
my_cols[as.logical(candy$bar)] <- "brown"

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 = 8)
```

```
Warning: ggrepel: 52 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?

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

	pricepercent	winpercent
Strawberry bon bons	0.058	34.57899
Dum Dums	0.034	39.46056
Fruit Chews	0.034	43.08892
Pixie Sticks	0.023	37.72234
Tootsie Roll Midgies	0.011	45.73675

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. Correlation Structure

```
cij <- cor(candy)
cij
```

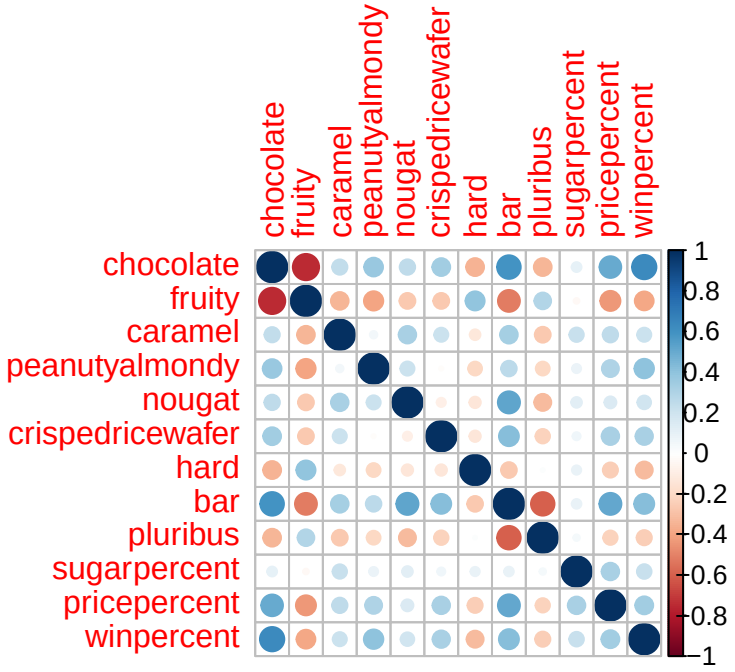
```
                  chocolate      fruity     caramel peanutyalmondy      nougat
chocolate         1.0000000 -0.74172106  0.24987535     0.37782357  0.25489183
fruity           -0.7417211  1.00000000 -0.33548538    -0.39928014 -0.26936712
caramel           0.2498753 -0.33548538  1.00000000     0.05935614  0.32849280
peanutyalmondy    0.3778236 -0.39928014  0.05935614     1.00000000  0.21311310
nougat            0.2548918 -0.26936712  0.32849280     0.21311310  1.00000000
crispedricewafer  0.3412098 -0.26936712  0.21311310    -0.01764631 -0.08974359
hard             -0.3441769  0.39067750 -0.12235513    -0.20555661 -0.13867505
bar               0.5974211 -0.51506558  0.33396002     0.26041960  0.52297636
pluribus         -0.3396752  0.29972522 -0.26958501    -0.20610932 -0.31033884
sugarpercent      0.1041691 -0.03439296  0.22193335     0.08788927  0.12308135
pricepercent      0.5046754 -0.43096853  0.25432709     0.30915323  0.15319643
winpercent        0.6365167 -0.38093814  0.21341630     0.40619220  0.19937530
                  crispedricewafer        hard         bar    pluribus
chocolate               0.34120978 -0.34417691  0.59742114 -0.33967519
fruity                 -0.26936712  0.39067750 -0.51506558  0.29972522
caramel                 0.21311310 -0.12235513  0.33396002 -0.26958501
peanutyalmondy         -0.01764631 -0.20555661  0.26041960 -0.20610932
nougat                 -0.08974359 -0.13867505  0.52297636 -0.31033884
crispedricewafer        1.00000000 -0.13867505  0.42375093 -0.22469338
hard                   -0.13867505  1.00000000 -0.26516504  0.01453172
bar                     0.42375093 -0.26516504  1.00000000 -0.59340892
pluribus               -0.22469338  0.01453172 -0.59340892  1.00000000
sugarpercent            0.06994969  0.09180975  0.09998516  0.04552282
pricepercent            0.32826539 -0.24436534  0.51840654 -0.22079363
winpercent              0.32467965 -0.31038158  0.42992933 -0.24744787
                  sugarpercent pricepercent winpercent
chocolate          0.10416906    0.5046754  0.6365167
fruity            -0.03439296   -0.4309685 -0.3809381
caramel            0.22193335    0.2543271  0.2134163
peanutyalmondy     0.08788927    0.3091532  0.4061922
```

```
nougat              0.12308135    0.1531964  0.1993753
crispedricewafer    0.06994969    0.3282654  0.3246797
hard                0.09180975   -0.2443653 -0.3103816
bar                 0.09998516    0.5184065  0.4299293
pluribus            0.04552282   -0.2207936 -0.2474479
sugarpercent        1.00000000    0.3297064  0.2291507
pricepercent        0.32970639    1.0000000  0.3453254
winpercent          0.22915066    0.3453254  1.0000000
```

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
corrplot(cij)
```



Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)?

Chocolate and fruity variables are anti-correlated.

```
round( cij["chocolate", "fruity"], 2)
```

```
[1] -0.74
```

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

Chocolate and bar are most positively correlated.

```
round( cij["chocolate", "bar"], 2)
```

```
[1] 0.6
```

6. Principal Component Analysis (PCA)

We need to be sure to scale our input `candy` data before PCA as we have `winpercent` column on a different scale to all others in the dataset.

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

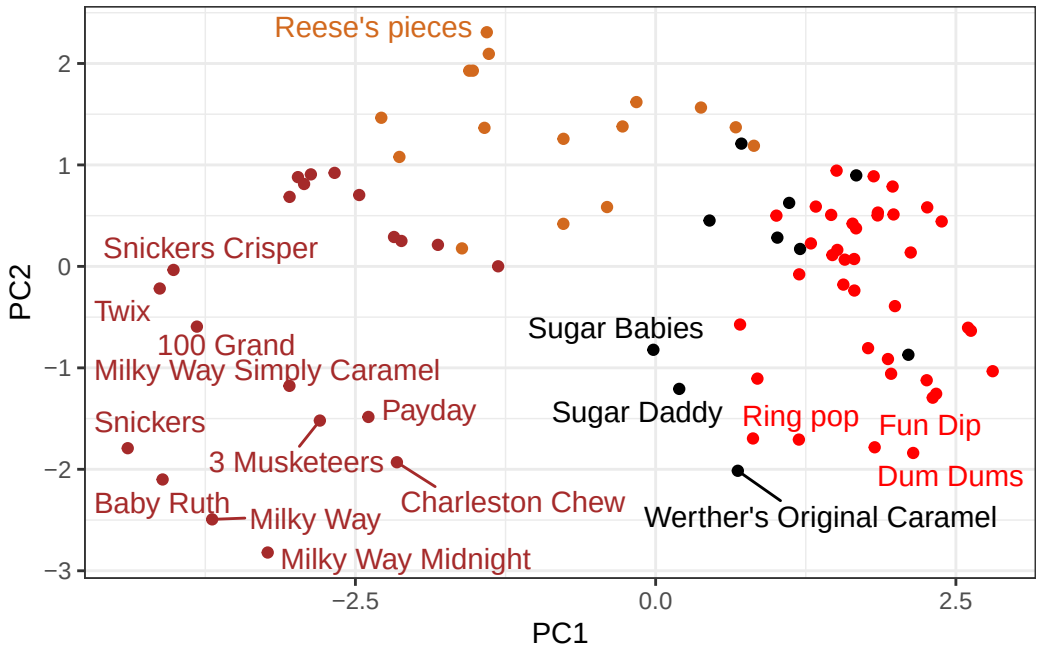
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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
```

First main result figure is my "PCA plot"

```
#pca$x

ggplot(pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col = my_cols) +
  geom_text_repel(max.overlaps = 6, col = my_cols) +
  theme_bw()
```

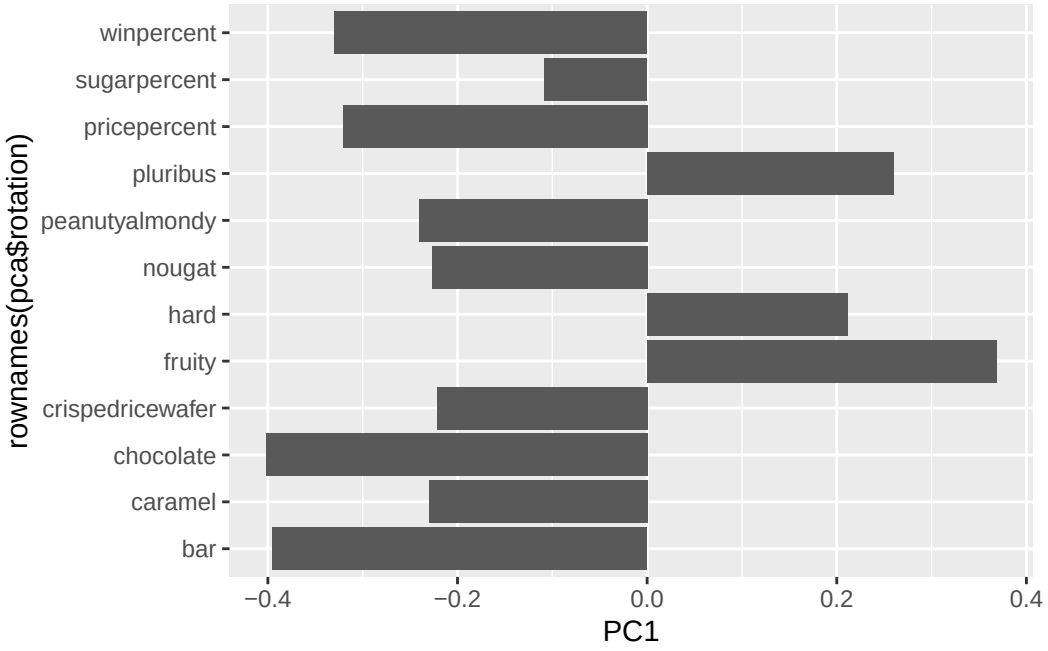
```
Warning: ggrepel: 67 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



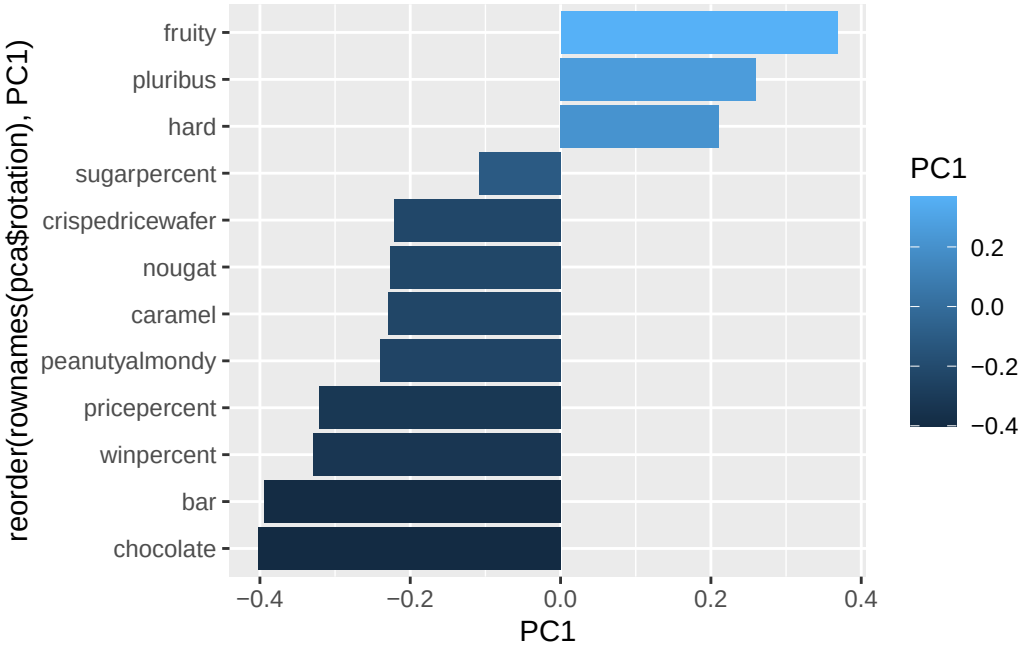
The second main PCA result is in the `pca$rotation` we can plot this to generate a so-called "loadings" plot.

```
#pca$rotation

ggplot(pca$rotation) +
  aes(PC1, rownames(pca$rotation)) +
  geom_col()
```




```
ggplot(pca$rotation) +
  aes(PC1, reorder(rownames(pca$rotation), PC1), fill = PC1) +
  geom_col()
```



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

Fruity, hard, and pluribus variables are strongly picked up by PC1 in the positive direction. This makes sense because fruity candy are commonly found in a bag of multiple candies, and have a hard texture compared to other candies like chocolate.