Class 10: Halloween Mini-Project

Chloe Wong (PID: A16893383)

Today is Halloween, an ole Irish holiday, let's celebrate by eating candy.

We will explore some data all about Halloween candy from the 538 website.

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

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?

```r
nrow(candy)
```

```
[1] 85
```

```r
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] "Hershey's Kisses"            "Hershey's Krackel"
[25] "Hershey's Milk Chocolate"    "Hershey's Special Dark"
[27] "Jawbusters"                  "Junior Mints"
[29] "Kit Kat"                     "Laffy Taffy"
[31] "Lemonhead"                   "Lifesavers big ring gummies"
[33] "Peanut butter M&M's"         "M&M's"
[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"                   "Reese's Miniatures"
[53] "Reese's Peanut Butter cup"   "Reese's pieces"
[55] "Reese's 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] "Welch's Fruit Snacks"        "Werther's Original Caramel"
[85] "Whoppers"
```

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

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

```
[1] 38
```

```r
sum(candy$chocolate)
```

```
[1] 37
```

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

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

```
[1] 81.64291
```

```r
candy["Skittles original", "winpercent"]
```

```
[1] 63.08514
```

```r
candy["Rolo", "winpercent"]
```

```
[1] 65.71629
```

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

```r
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(dplyr)
```

```

Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
candy %>%
  filter(rownames(candy)=="Haribo Happy Cola") %>%
  select(winpercent)
```

```
                  winpercent
Haribo Happy Cola   34.15896
```

Q. Find fruity candy with a win percent above 50%

```
candy %>%
  filter(winpercent >50) %>%
  filter(fruity==1)
```

```
                            chocolate fruity caramel peanutyalmondy nougat
Air Heads                           0      1       0              0      0
Haribo Gold Bears                   0      1       0              0      0
Haribo Sour Bears                   0      1       0              0      0
Lifesavers big ring gummies         0      1       0              0      0
Nerds                               0      1       0              0      0
Skittles original                   0      1       0              0      0
Skittles wildberry                  0      1       0              0      0
Sour Patch Kids                     0      1       0              0      0
Sour Patch Tricksters               0      1       0              0      0
Starburst                           0      1       0              0      0
Swedish Fish                        0      1       0              0      0
                            crispedricewafer hard bar pluribus sugarpercent
Air Heads                                  0    0   0        0        0.906
Haribo Gold Bears                          0    0   0        1        0.465
Haribo Sour Bears                          0    0   0        1        0.465
Lifesavers big ring gummies                0    0   0        0        0.267
Nerds                                      0    1   0        1        0.848
Skittles original                          0    0   0        1        0.941
Skittles wildberry                         0    0   0        1        0.941
Sour Patch Kids                            0    0   0        1        0.069
Sour Patch Tricksters                      0    0   0        1        0.069
Starburst                                  0    0   0        1        0.151
Swedish Fish                               0    0   0        1        0.604
                            pricepercent winpercent
Air Heads                          0.511   52.34146
Haribo Gold Bears                  0.465   57.11974
Haribo Sour Bears                  0.465   51.41243
Lifesavers big ring gummies        0.279   52.91139
Nerds                              0.325   55.35405
Skittles original                  0.220   63.08514
Skittles wildberry                 0.220   55.10370
Sour Patch Kids                    0.116   59.86400
Sour Patch Tricksters              0.116   52.82595
Starburst                          0.220   67.03763
Swedish Fish                       0.755   54.86111
```

```r
top.candy <- candy[candy$winpercent > 50,]
top.candy[top.candy$fruity==1,]
```

```
                            chocolate fruity caramel peanutyalmondy nougat
Air Heads                           0      1       0              0      0
Haribo Gold Bears                   0      1       0              0      0
Haribo Sour Bears                   0      1       0              0      0
Lifesavers big ring gummies         0      1       0              0      0
Nerds                               0      1       0              0      0
Skittles original                   0      1       0              0      0
Skittles wildberry                  0      1       0              0      0
Sour Patch Kids                     0      1       0              0      0
Sour Patch Tricksters               0      1       0              0      0
Starburst                           0      1       0              0      0
```

```
Swedish Fish                        0      1       0              0      0
                            crispedricewafer hard bar pluribus sugarpercent
Air Heads                                  0    0   0        0        0.906
Haribo Gold Bears                          0    0   0        1        0.465
Haribo Sour Bears                          0    0   0        1        0.465
Lifesavers big ring gummies                0    0   0        0        0.267
Nerds                                      0    1   0        1        0.848
Skittles original                          0    0   0        1        0.941
Skittles wildberry                         0    0   0        1        0.941
Sour Patch Kids                            0    0   0        1        0.069
Sour Patch Tricksters                      0    0   0        1        0.069
Starburst                                  0    0   0        1        0.151
Swedish Fish                               0    0   0        1        0.604
                            pricepercent winpercent
Air Heads                          0.511   52.34146
Haribo Gold Bears                  0.465   57.11974
Haribo Sour Bears                  0.465   51.41243
Lifesavers big ring gummies        0.279   52.91139
Nerds                              0.325   55.35405
Skittles original                  0.220   63.08514
Skittles wildberry                 0.220   55.10370
Sour Patch Kids                    0.116   59.86400
Sour Patch Tricksters              0.116   52.82595
Starburst                          0.220   67.03763
Swedish Fish                       0.755   54.86111
```

To get a quick insight into a new dataset some folks like using the skimer package and its `skim()` function.

```
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?

Looks like the `winpercent` variable or column is measured on a different scale than everything else! I will need to scale my data before doing any analysis like PCA etc.

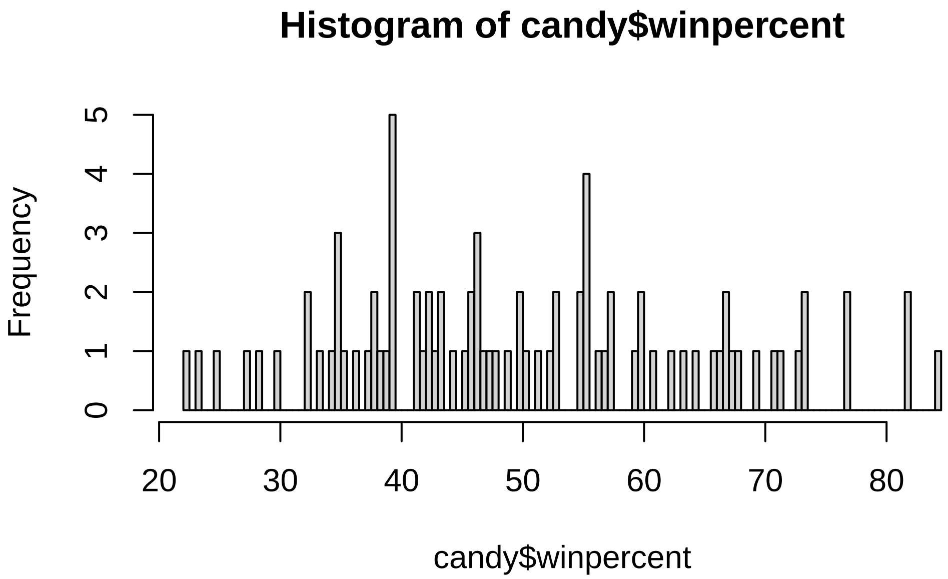
> Q7. What do you think a zero and one represent for the candy$chocolate column?

A zero means it is not chocolate (false) and a 1 means it is chocolate (true) for the candy$chocolate column.

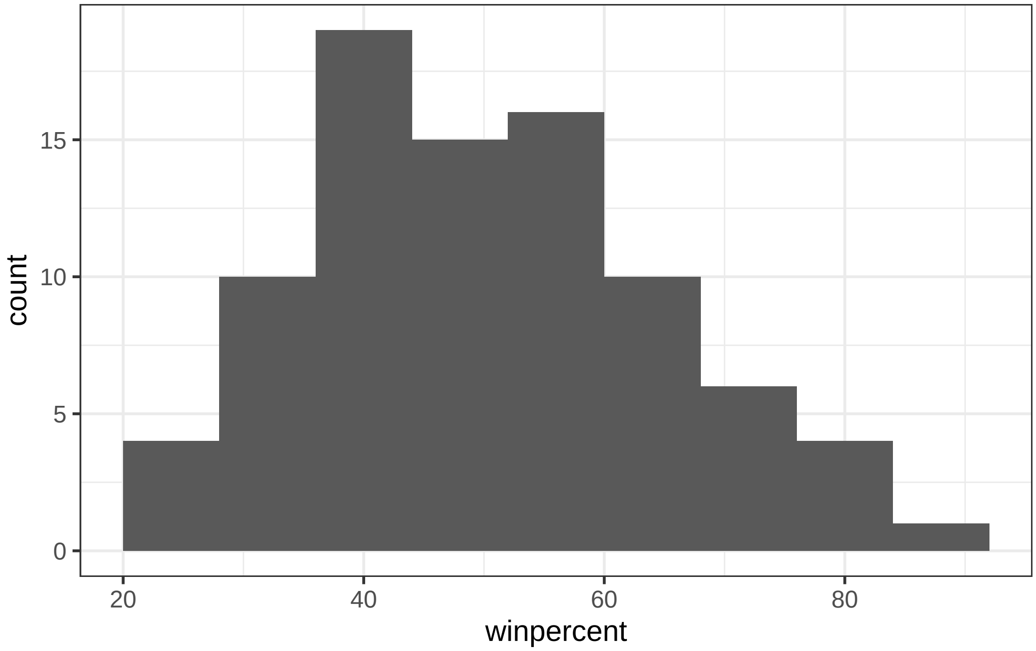
> Q8. Plot a histogram of winpercent values

We can do this a few ways, e.g. the "base" R `hist()` function or with `ggplot()`

```r
hist(candy$winpercent, breaks=100)
```



```r
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(binwidth=8) +
  theme_bw()
```



Q9. Is the distribution of winpercent values symmetrical?

No, the distribution of winpercent values are not symmetrical. It looks like it is slanted towards the left side.

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

The center of the distribution is below 50%. It is at 47.83%.

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

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

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

On average, chocolate candy (60.92) is higher ranked than fruit candy (44.12%).

```
fruit.candy <- candy |>
  filter(fruity==1)

summary(fruit.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.04   42.97   44.12   52.11   67.04 
```

```r
summary(candy[as.logical(candy$chocolate),]$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  34.72   50.35   60.80   60.92   70.74   84.18 
```

```r
choc.candy <- candy |>
  filter(chocolate==1)

summary(choc.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  34.72   50.35   60.80   60.92   70.74   84.18 
```

> Q12. Is this difference statistically significant?

Yes, the difference is statistically significant as the p-value is extremely small (2.871e-08).

```r
t.test(choc.candy$winpercent, fruit.candy$winpercent)
```

```

    Welch Two Sample t-test

data:  choc.candy$winpercent and fruit.candy$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 
```

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

The five least liked candy types in this set are Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters.

```r
play <- c("d","a","c")
sort(play)
```

```
[1] "a" "c" "d"
```

```r
order(play)
```

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

```r
play[ order(play) ]
```

```
[1] "a" "c" "d"
```

```r
head(candy[order( candy$winpercent ),], 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?

The top 5 all time favorite candy types out of this set are Snickers, Kit Kat, Twix, Reese's Miniatures, and Reese's Peanut Butter Cup.

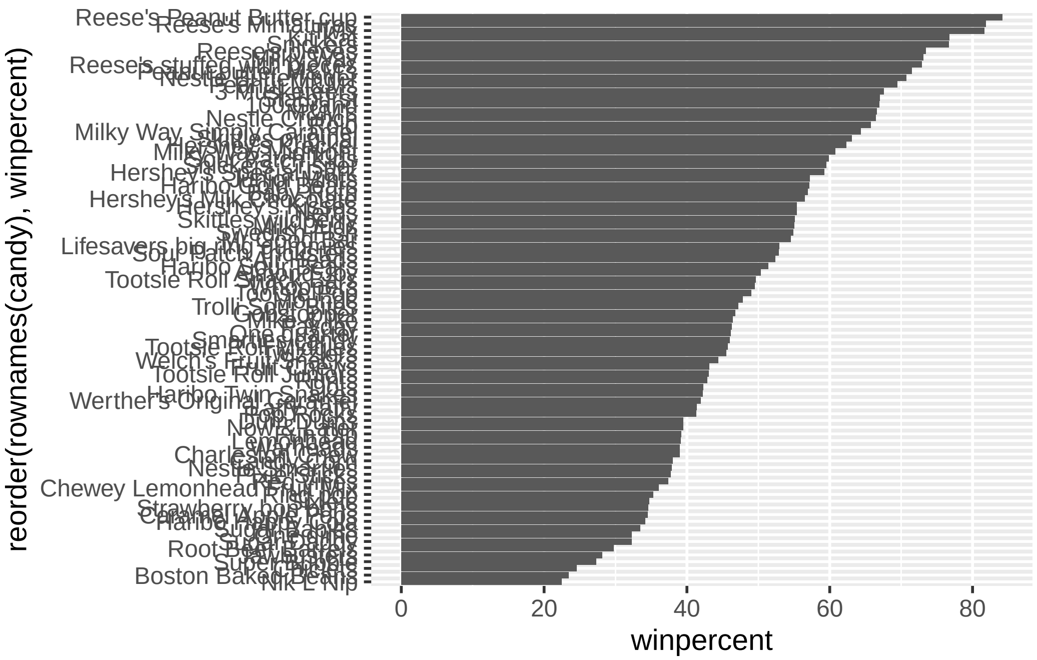
```r
tail(candy[order( candy$winpercent ),], 5)
```

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

Let's do a barplot of winpercent values

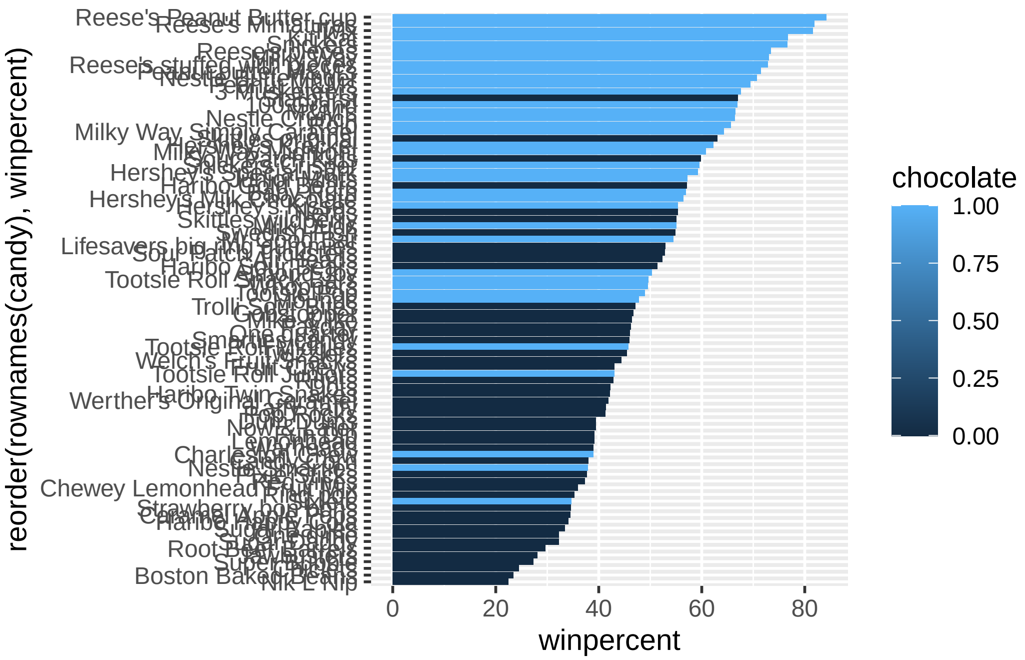
> Q15. Make a first barplot of candy ranking based on winpercent values.

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



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

```r
ggplot(candy) +
  aes(x=winpercent,
      y=reorder(rownames(candy), winpercent),
      fill=chocolate) +

  geom_col()
```

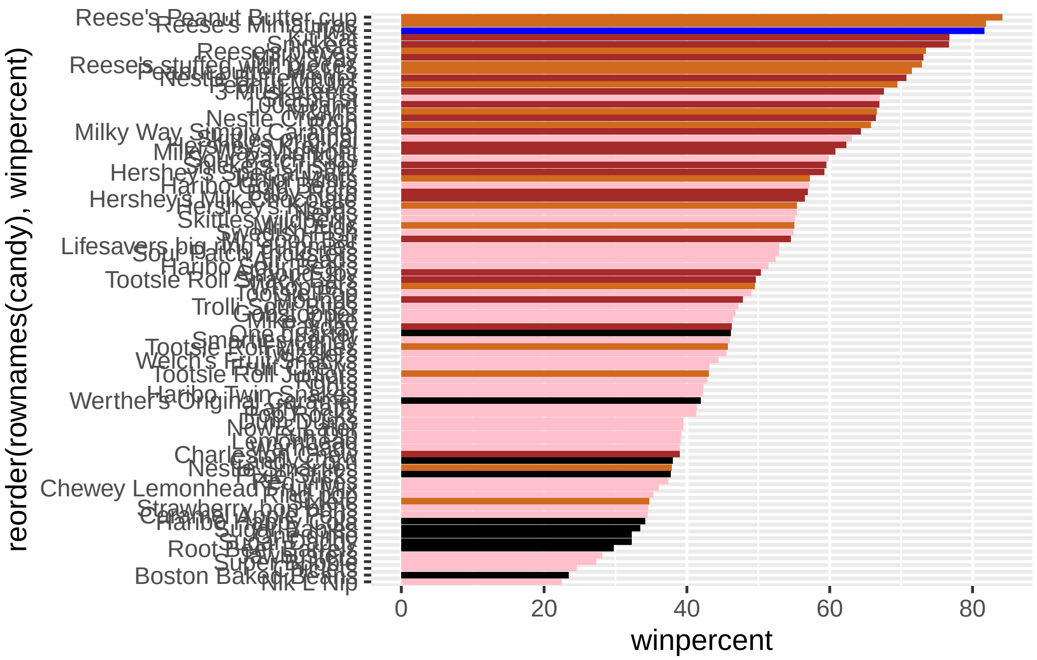


I want a more custom color scheme where I can see both chocolate and bar and fruity etc. ll from the one plot. To do this we can roll our own color vector…

```
# Place holder color vector
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"
```

```
# Use blue for your favorite candy!
my_cols[ rownames(candy)=="Twix"] <- "blue"
#mycols
```

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



Q17. What is the worst ranked chocolate candy?

Sixlets (shown from graph above).

Q18. What is the best ranked fruity candy?

Starburst (shown from graph above).

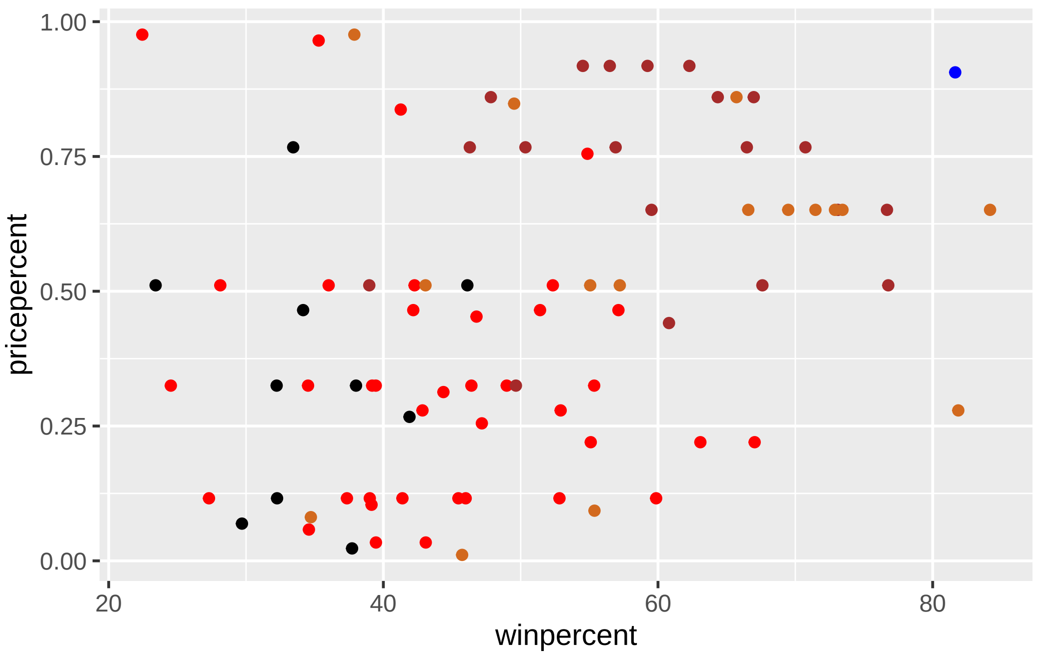
Q19. Which candy type is the highest ranked in terms of winpercent for the least money - i.e. offers the most bang for your buck?

Reese's Minatures.

Plot of winpercent vs pricepercent to see what would be the best candy to buy…

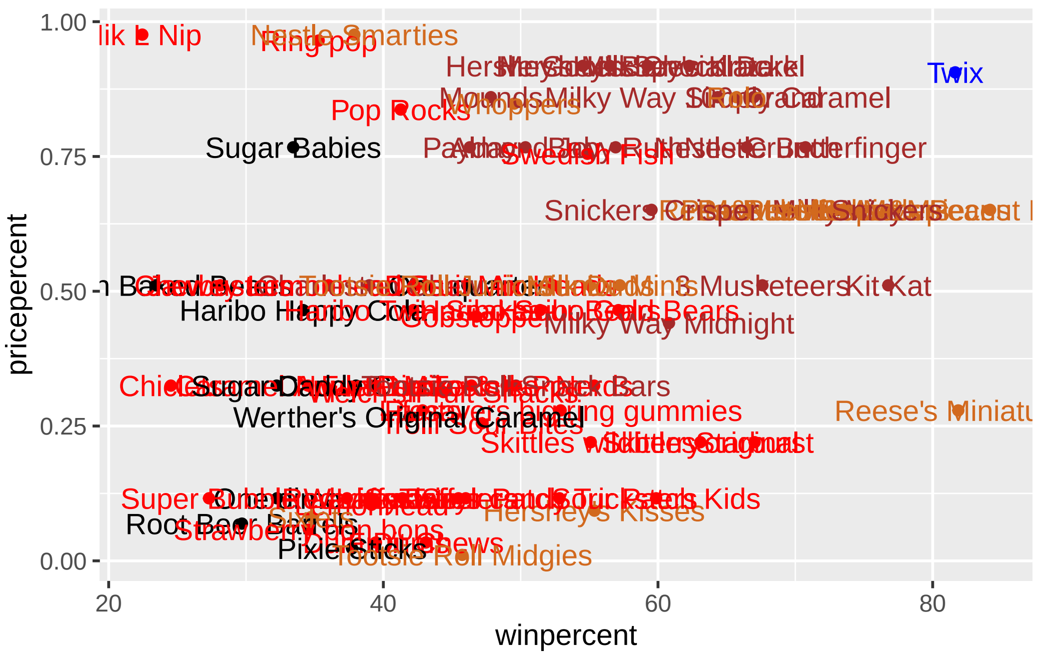
```r
my_cols[as.logical(candy$fruity)] = "red"
```

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



Add labels

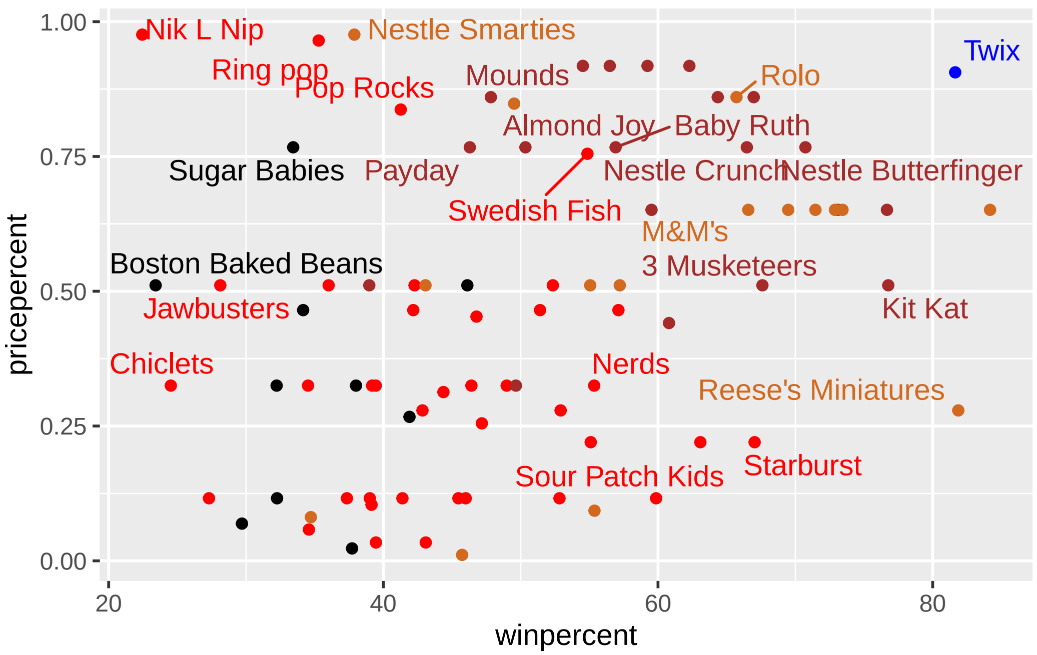
```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text(col=my_cols)
```



Make the labels non-overlapping

```r
library(ggrepel)

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

```
Warning: ggrepel: 61 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?

The top 5 most expensive candy types in the dataset are Nik L Nip, Ring Pop, Nestle Smarties, Hershey's Krackel, and Hershey's Milk Chocolate. The least popular out of these are Nik L Nip.

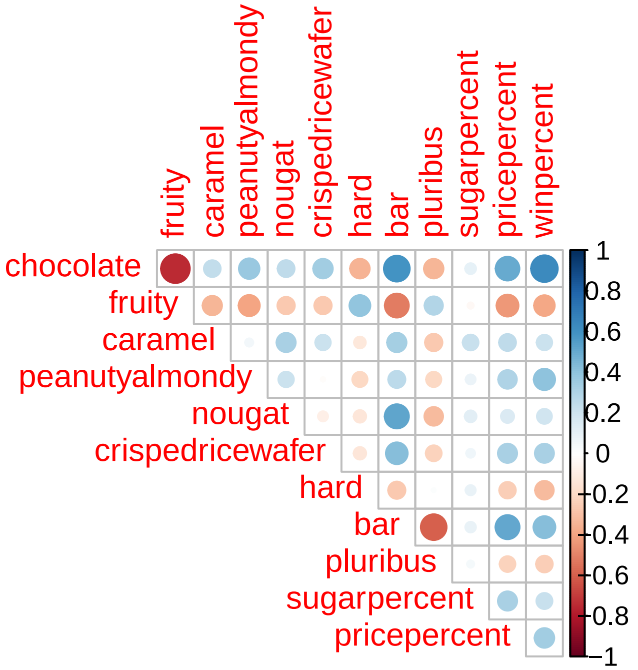
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                         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
```

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
cij <- cor(candy)
corrplot(cij, diag = F, type = "upper")
```



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

The two variables that are anti-correlated are chocolate and fruity.

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

The two variables that are the most positively correlated are chocolate and bar.

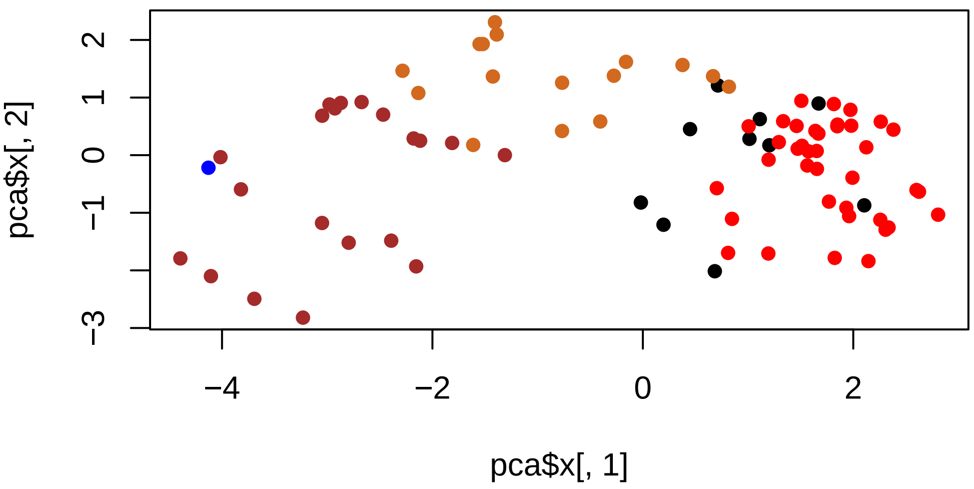
#Principal Component Analysis

```
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
```

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



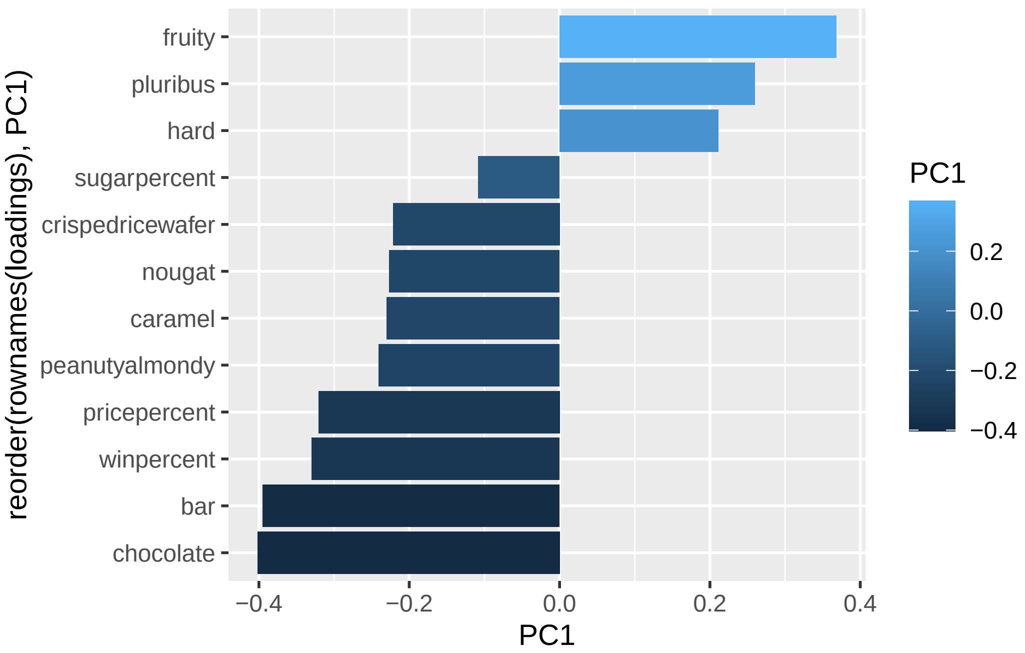
How do the original variables (columns) contribute to the new PCs. I will look at PC1 here.

```
pca$rotation
```

```
                        PC1         PC2         PC3          PC4          PC5
chocolate        -0.4019466  0.21404160  0.01601358 -0.016673032  0.066035846
fruity            0.3683883 -0.18304666 -0.13765612 -0.004479829  0.143535325
caramel          -0.2299709 -0.40349894 -0.13294166 -0.024889542 -0.507301501
peanutyalmondy   -0.2407155  0.22446919  0.18272802  0.466784287  0.399930245
nougat           -0.2268102 -0.47016599  0.33970244  0.299581403 -0.188852418
crispedricewafer -0.2215182  0.09719527 -0.36485542 -0.605594730  0.034652316
hard              0.2111587 -0.43262603 -0.20295368 -0.032249660  0.574557816
bar              -0.3947433 -0.22255618  0.10696092 -0.186914549  0.077794806
pluribus          0.2600041  0.36920922 -0.26813772  0.287246604 -0.392796479
sugarpercent     -0.1083088 -0.23647379 -0.65509692  0.433896248  0.007469103
pricepercent     -0.3207361  0.05883628 -0.33048843  0.063557149  0.043358887
```

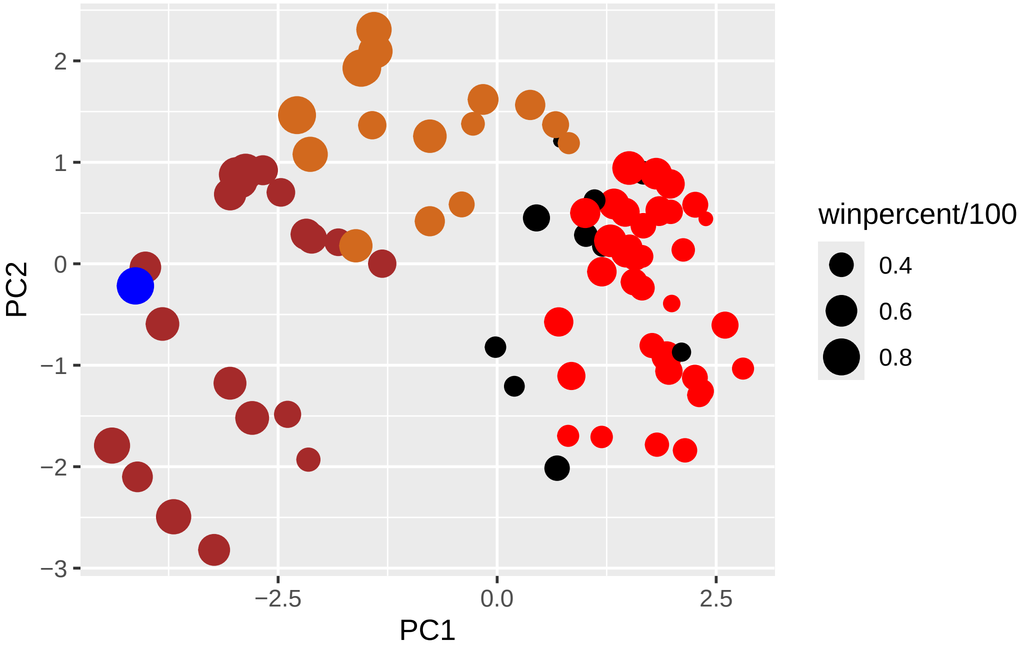
```
winpercent       -0.3298035  0.21115347 -0.13531766  0.117930997  0.168755073
                         PC6         PC7         PC8          PC9         PC10
chocolate        -0.09018950 -0.08360642 -0.49084856 -0.151651568  0.107661356
fruity           -0.04266105  0.46147889  0.39805802 -0.001248306  0.362062502
caramel          -0.40346502 -0.44274741  0.26963447  0.019186442  0.229799010
peanutyalmondy   -0.09416259 -0.25710489  0.45771445  0.381068550 -0.145912362
nougat            0.09012643  0.36663902 -0.18793955  0.385278987  0.011323453
crispedricewafer -0.09007640  0.13077042  0.13567736  0.511634999 -0.264810144
hard             -0.12767365 -0.31933477 -0.38881683  0.258154433  0.220779142
bar               0.25307332  0.24192992 -0.02982691  0.091872886 -0.003232321
pluribus          0.03184932  0.04066352 -0.28652547  0.529954405  0.199303452
sugarpercent      0.02737834  0.14721840 -0.04114076 -0.217685759 -0.488103337
pricepercent      0.62908570 -0.14308215  0.16722078 -0.048991557  0.507716043
winpercent       -0.56947283  0.40260385 -0.02936405 -0.124440117  0.358431235
                        PC11        PC12
chocolate         0.10045278  0.69784924
fruity            0.17494902  0.50624242
caramel           0.13515820  0.07548984
peanutyalmondy    0.11244275  0.12972756
nougat           -0.38954473  0.09223698
crispedricewafer -0.22615618  0.11727369
hard              0.01342330 -0.10430092
bar               0.74956878 -0.22010569
pluribus          0.27971527 -0.06169246
sugarpercent      0.05373286  0.04733985
pricepercent     -0.26396582 -0.06698291
winpercent       -0.11251626 -0.37693153
```

```
loadings <- as.data.frame(pca$rotation)

ggplot(loadings) +
  aes(PC1, reorder(rownames(loadings),PC1), fill=PC1) +
  geom_col()
```



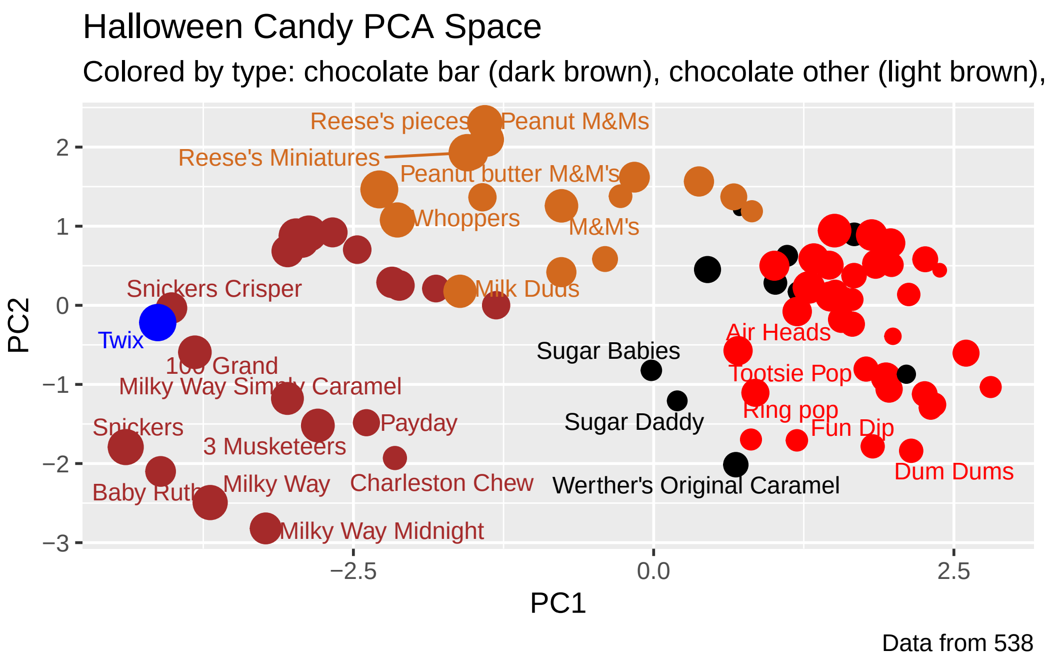
```
my_data <- cbind(candy, pca$x[,1:3])
```

```
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
```

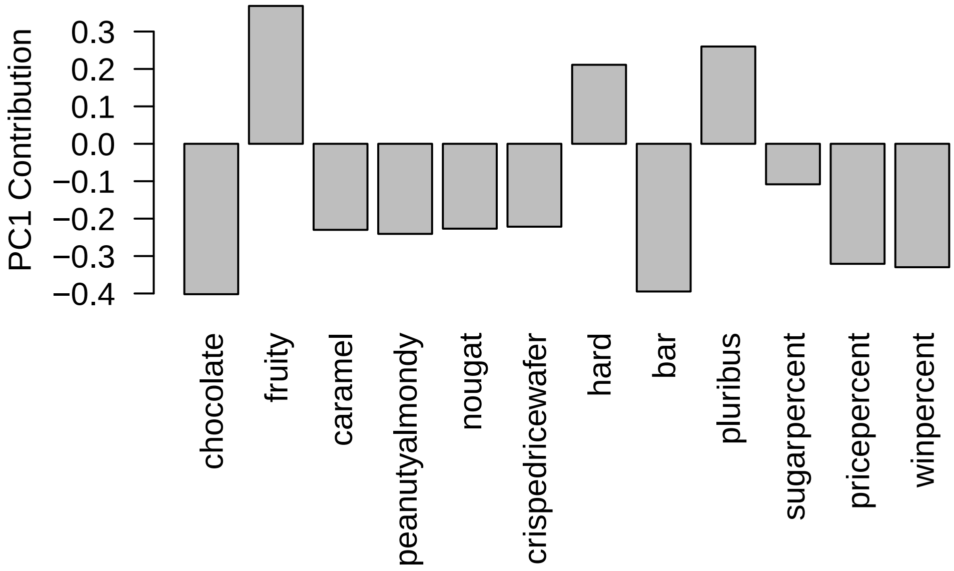


```
library(ggrepel)

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 brown),
       caption="Data from 538")
```

```
Warning: ggrepel: 59 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



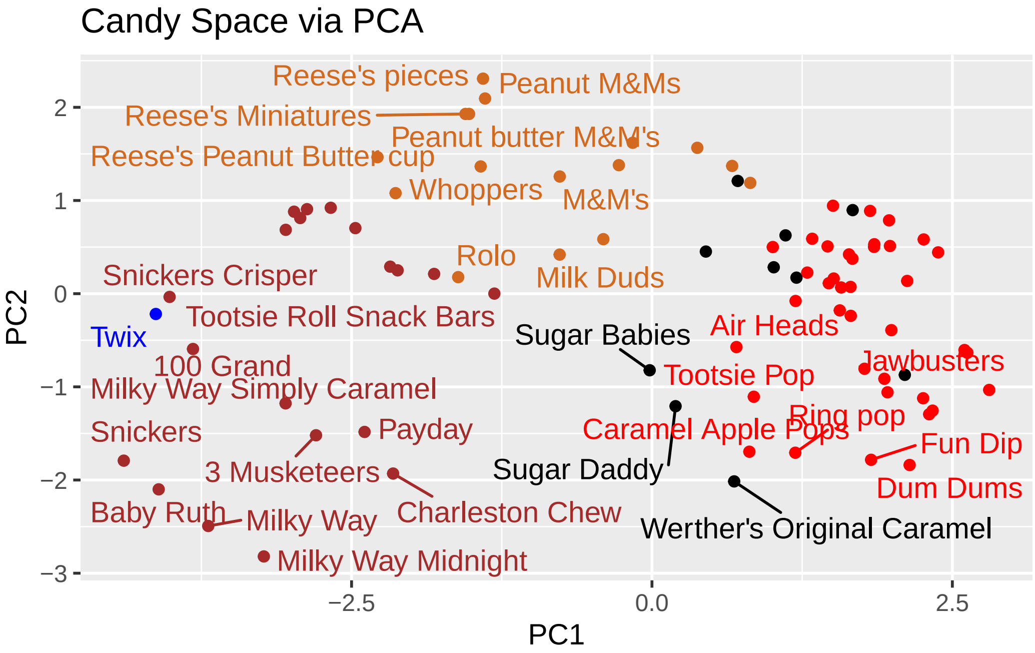
```r
par(mar=c(8,4,2,2))
barplot(pca$rotation[,1], las=2, ylab="PC1 Contribution")
```



Let's make a nicer score plot with ggplot. Again, I need a data.frame with all the stuff I want (PC results and candy data) for my plot as input.

```
pc.results <- cbind(candy,pca$x)

ggplot(pc.results) +
  aes(PC1, PC2, label=rownames(pc.results)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols) +
  labs(title="Candy Space via PCA")
```

```
Warning: ggrepel: 54 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?

Original variables that are picked up strongly by PC1 in the positive direction include fruity, hard, and pluribus. This is a bag/box of hard fruity candy that comes with multiple candies. Yes, this makes sense to me as shown clearly by the barplot.