Class 10 Mini Project

AUTHOR

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Exploratory Analysis of Halloween Candy

Get the data from the FiveThirtyEight GitHub repo

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

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?

```
colnames(candy)
```

```
 [1] "chocolate"        "fruity"           "caramel"          "peanutyalmondy"  
 [5] "nougat"           "crispedricewafer" "hard"             "bar"             
 [9] "pluribus"         "sugarpercent"     "pricepercent"     "winpercent"      
```

```
ncol(candy[-1:-3])
```

```
[1] 9
```

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

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

```
[1] 38
```

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

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

```
[1] 49.52411
```

> 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”?

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

```
[1] 49.6535
```

Let’s install skimr package and try it on our candy data.

```r
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	▇▁▁▁▁

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
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?

From the `skim()` function, we find that only the winpercent variable appears to be on a different scale due to all of their values being above 1. All other variables have values between 0 and 1 within this function.

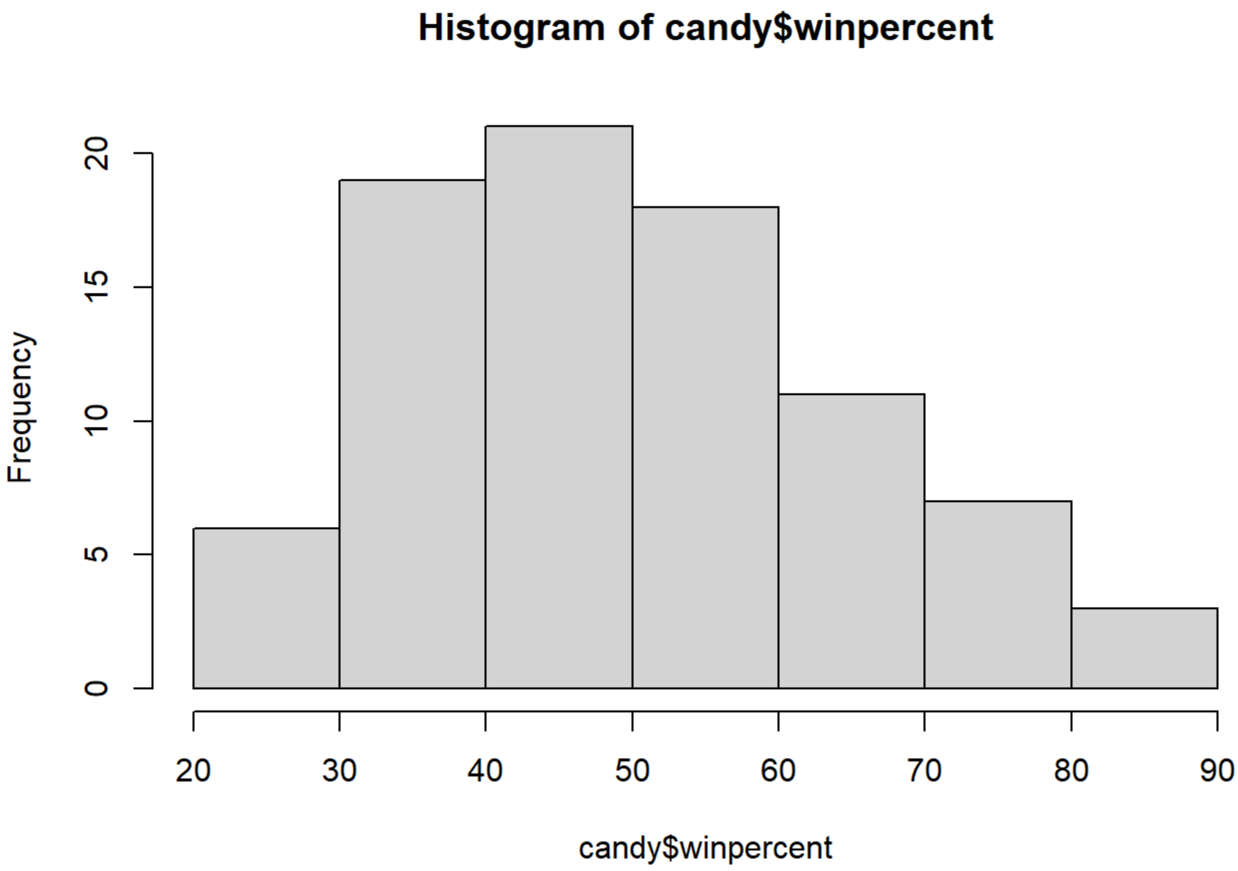
> Q7. What do you think a zero and one represent for the candy$chocolate column?

A zero represent a false statement that the candy of the row *is not* of a chocolate type, while a one represent a true statement that the candy of the row *is* of the chocolate type.

Exploratory analysis with a histogram

> Q8. Plot a histogram of winpercent values

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



> Q9. Is the distribution of winpercent values symmetrical?

The distribution is not symmetrical. It appears to be slightly skewed left distribution.

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

The center of distribution is below 50%.

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

```r
#average chocolate candy win percent
choco.win = candy$winpercent[as.logical(candy$chocolate)]
mean(choco.win)
```

```
[1] 60.92153
```

```r
#average fruity candy win percent
fruit.win = candy$winpercent[as.logical(candy$fruity)]
mean(fruit.win)
```

```
[1] 44.11974
```

Comparing the two values, chocolate candy is ranked higher than fruit candy.

> Q12. Is this difference statistically significant?

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

```

    Welch Two Sample t-test

data:  choco.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 
```

The difference is stastically different because the t-test yielded a p-value of 2.871e-08

Overall candy rankings

Using the dplyr package, we can sort the candies by winpercent with the `arrange()` function.

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

```
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 %>% arrange(winpercent) %>% head(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?

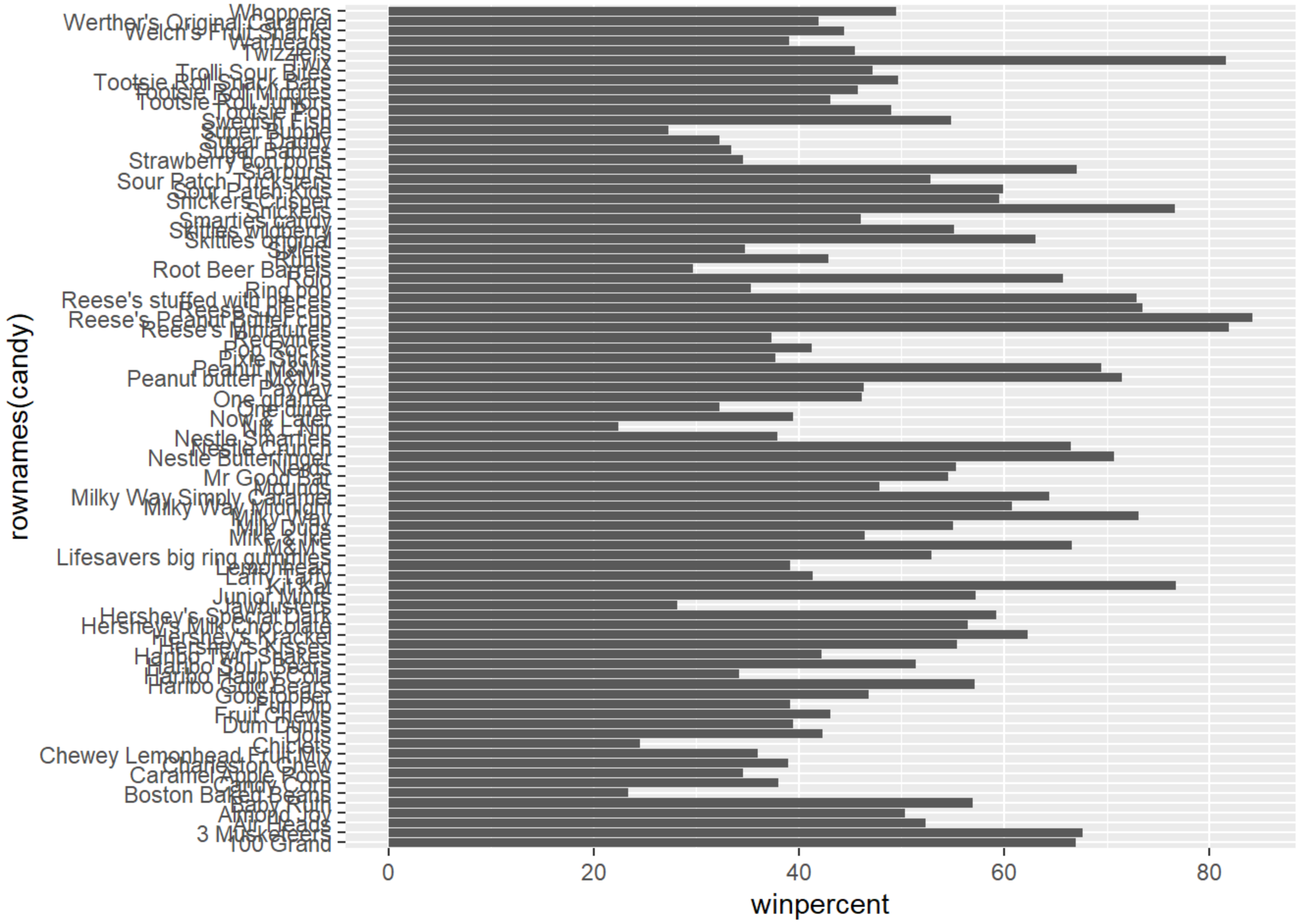
```
library(dplyr)

candy %>% arrange(desc(winpercent)) %>% head(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
```

Examine more of the data set in this vain we can make a barplot to visualize the overall rankings. Getting a rough starting plot and then refining and adding useful details

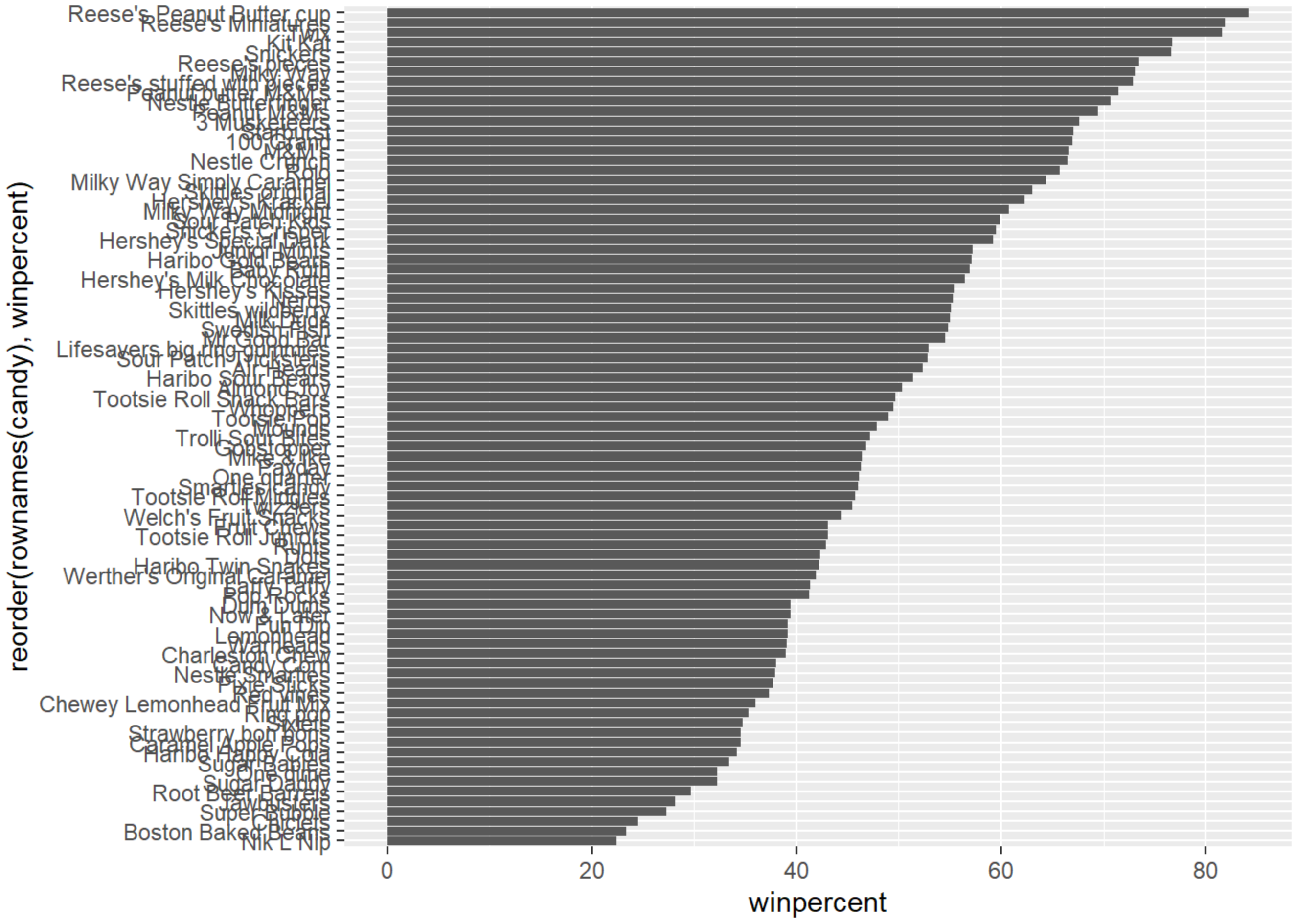
> Q15. Make a first barplot of candy ranking based on winpercent values.

```
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

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

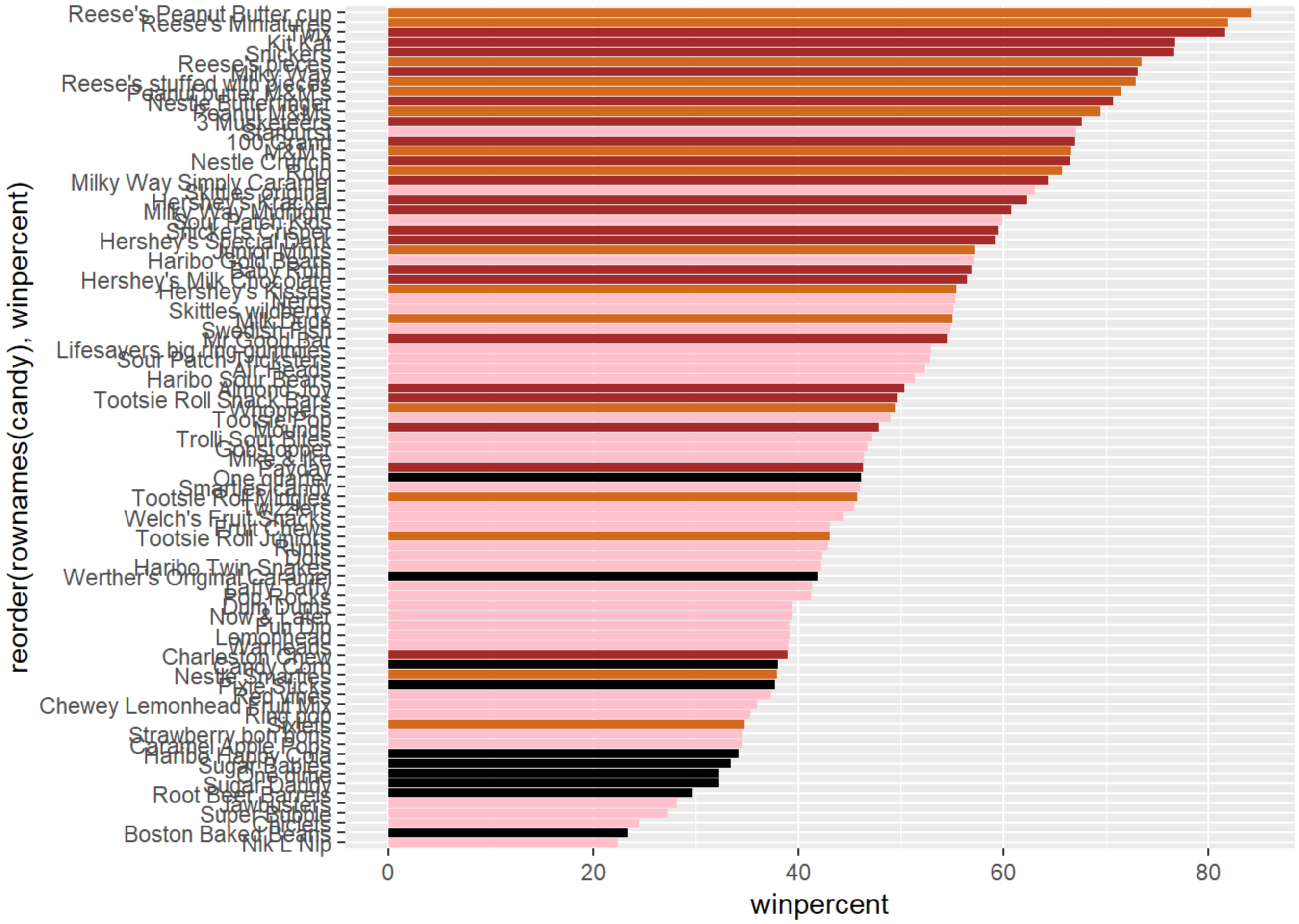


setup a color vector (that signifies candy type) that we can then use for some future plots

```
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"
```

try our barplot with these colors.

```
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?

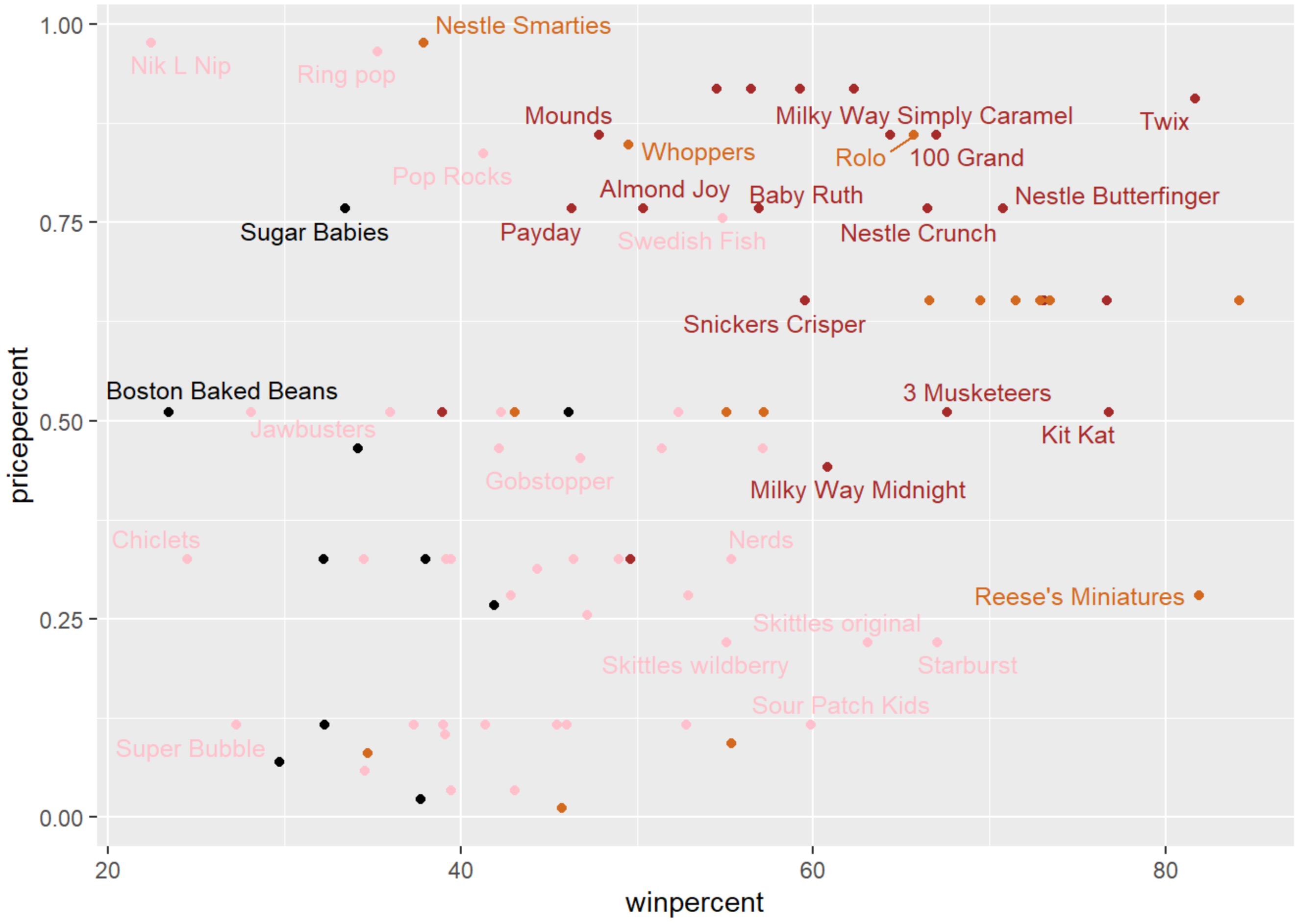
The best ranked fruity candy is Starburst.

Taking a look at pricepercent

make a plot of winpercent vs the pricepercent variable

```
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 = 5)
```

```
Warning: ggrepel: 53 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?

Chocolate candys are the highest ranked in terms of winpercent for the least money

> 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 )
```

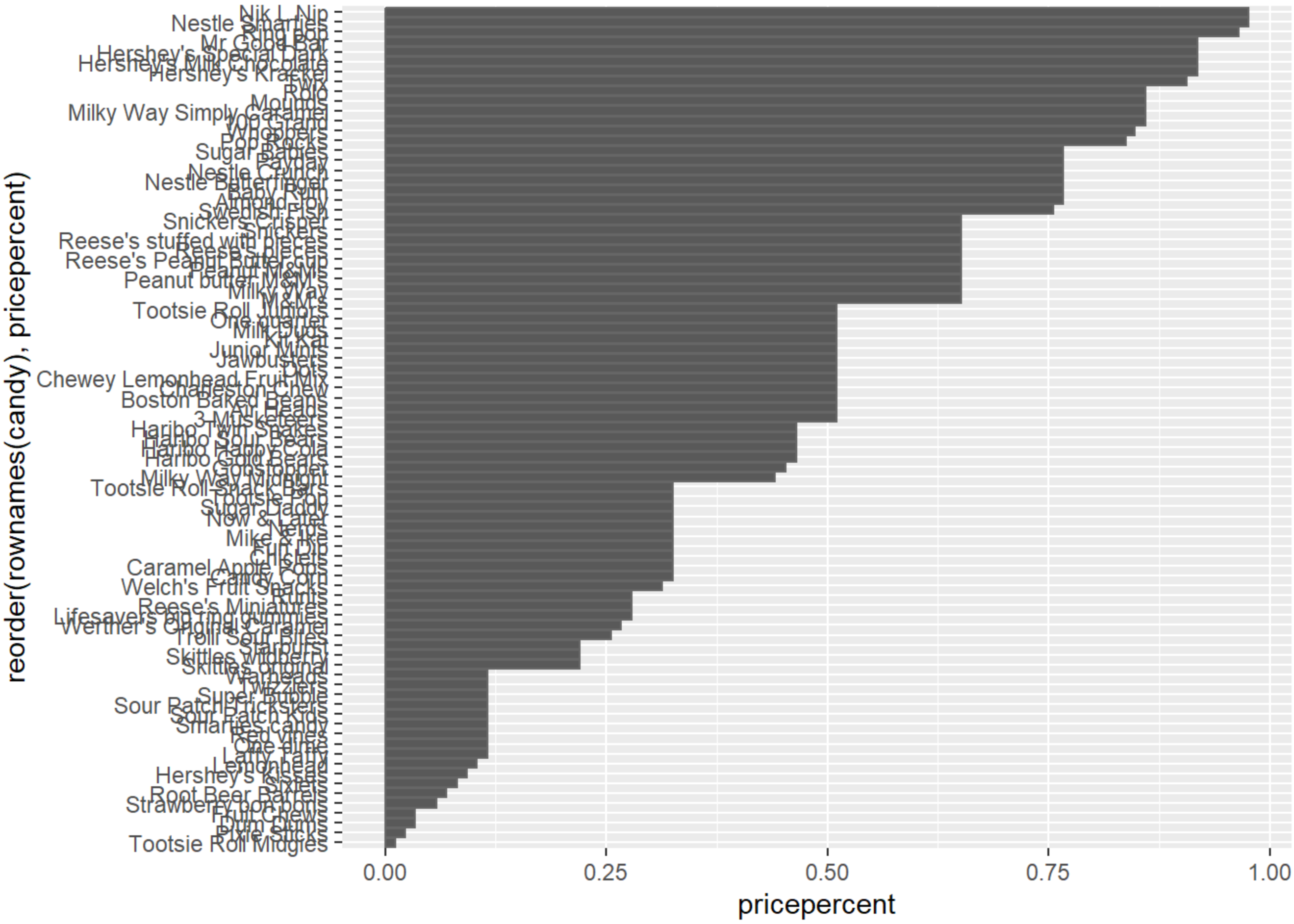
```
                         pricepercent winpercent
Nik L Nip                       0.976   22.44534
Nestle Smarties                 0.976   37.88719
Ring pop                        0.965   35.29076
Hershey's Krackel               0.918   62.28448
Hershey's Milk Chocolate        0.918   56.49050
```

Top five are Nik L Nips, Nestle Smarties, Ring pop, Ring pop, Hershey’s Krackel, and Hershey’s Milk Chocolate. The least popular one was Nik L Nips.

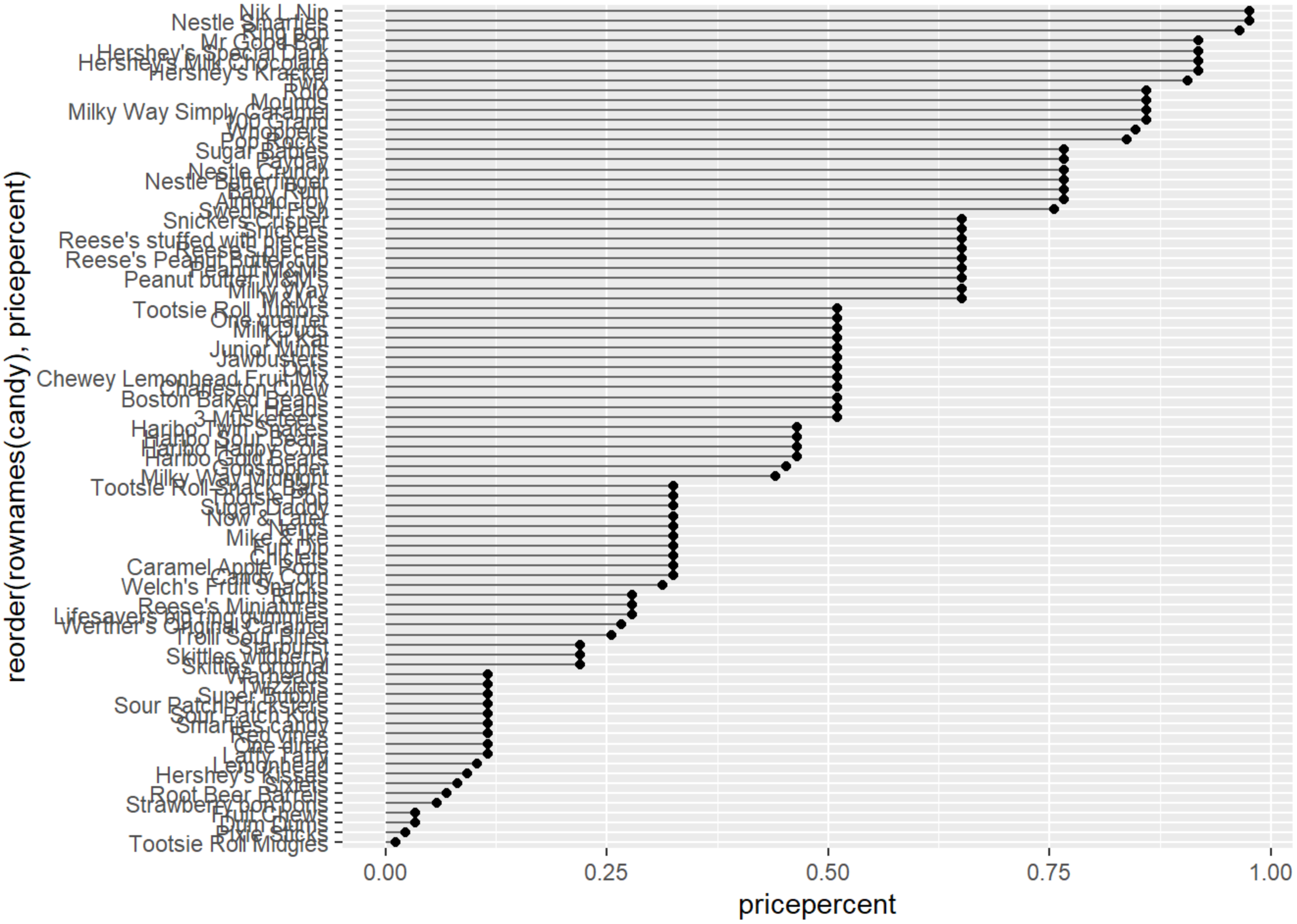
> Q21. Make a barplot again with geom_col() this time using pricepercent and then improve this step by step, first ordering the x-axis by value and finally making a so called “dot chat” or “lollipop” chart by swapping geom_col() for geom_point() + geom_segment().

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

```
Warning in geom_col(aes(yend = reorder(rownames(candy), pricepercent), xend =
0), : Ignoring unknown aesthetics: yend and xend
```



```r
# 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()
```

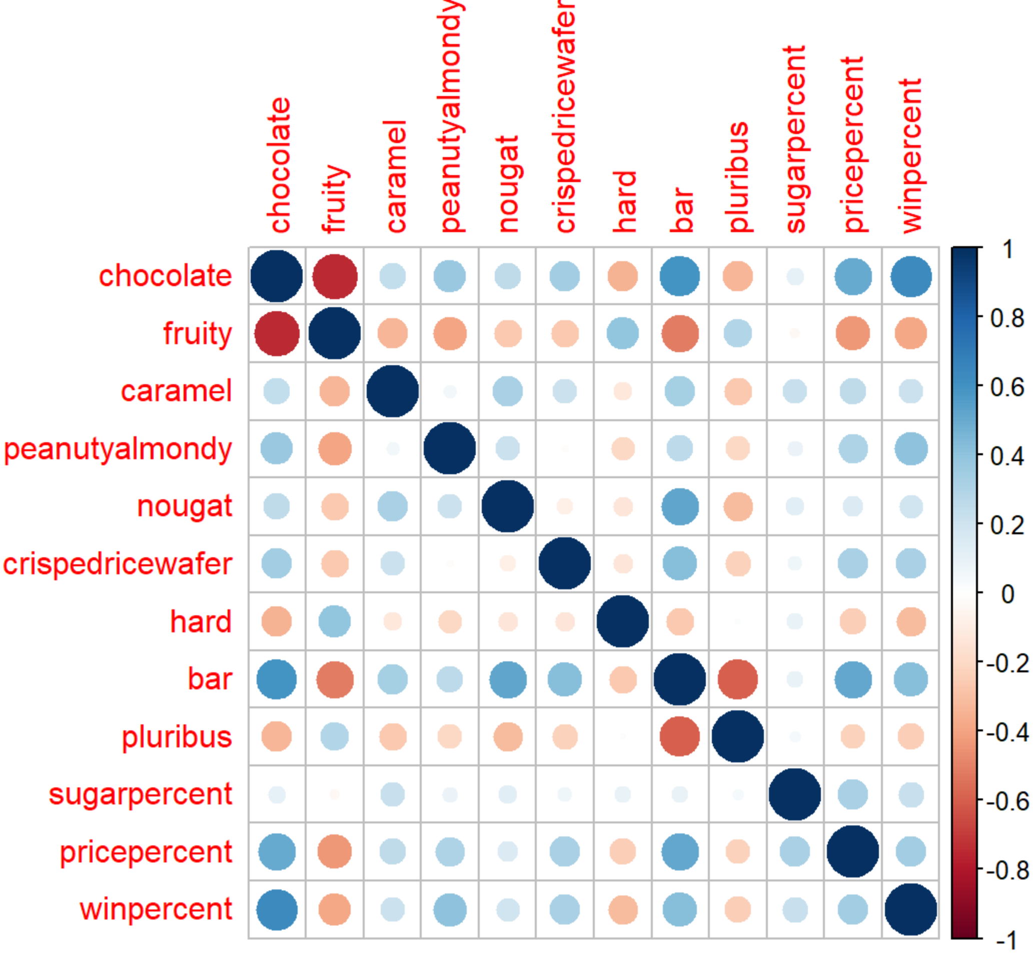


Now that we've explored the dataset a little, we'll see how the variables interact with one another. We'll use correlation and view the results with the corrplot package to plot a correlation matrix.

```
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 the most anti-correlated.

```
cij["chocolate","fruity"]
```

```
[1] -0.7417211
```

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

Chocolate and winpercent would be the most positively correlated.

```
cij["chocolate","winpercent"]
```

```
[1] 0.6365167
```

```
cij["chocolate","bar"]
```

```
[1] 0.5974211
```

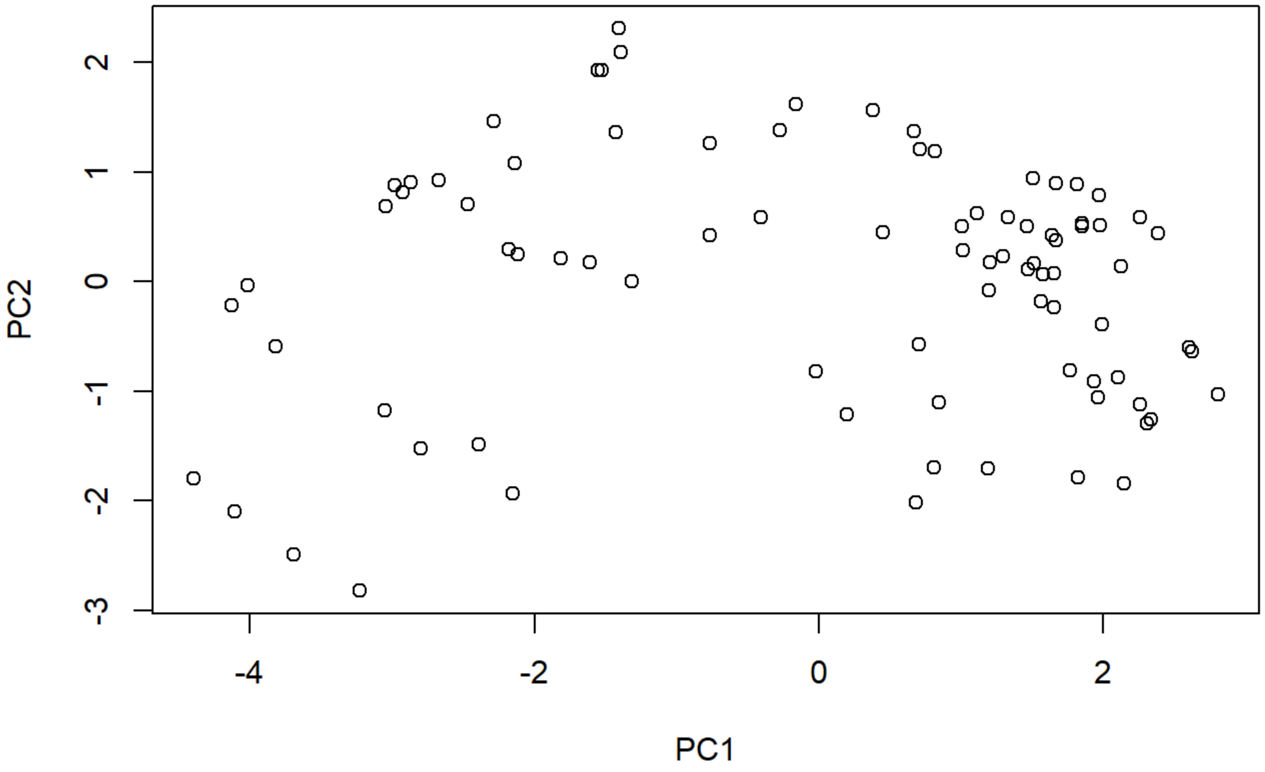
Let's apply PCA using the prcom() function to our candy dataset remembering to set the scale=TRUE argument.

```
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
```

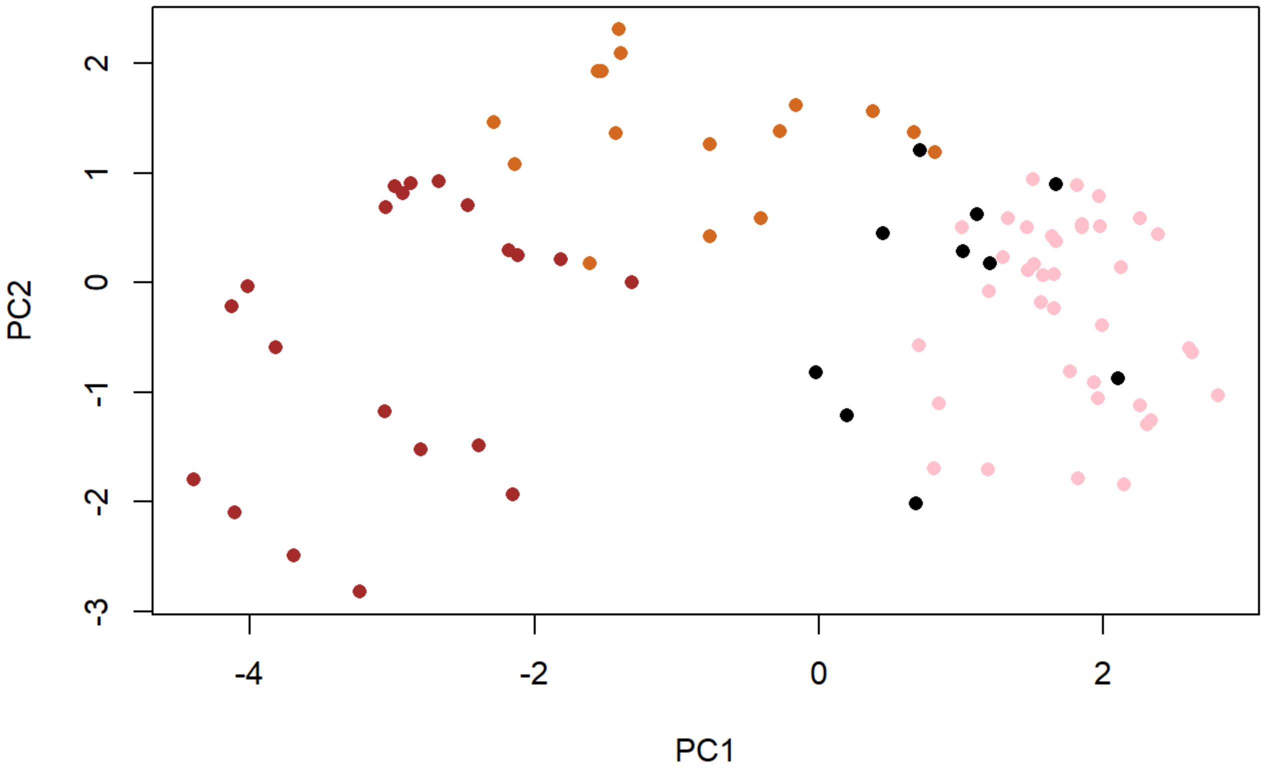
Now we can plot our main PCA score plot of PC1 vs PC2.

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



We can change the plotting character and add some color:

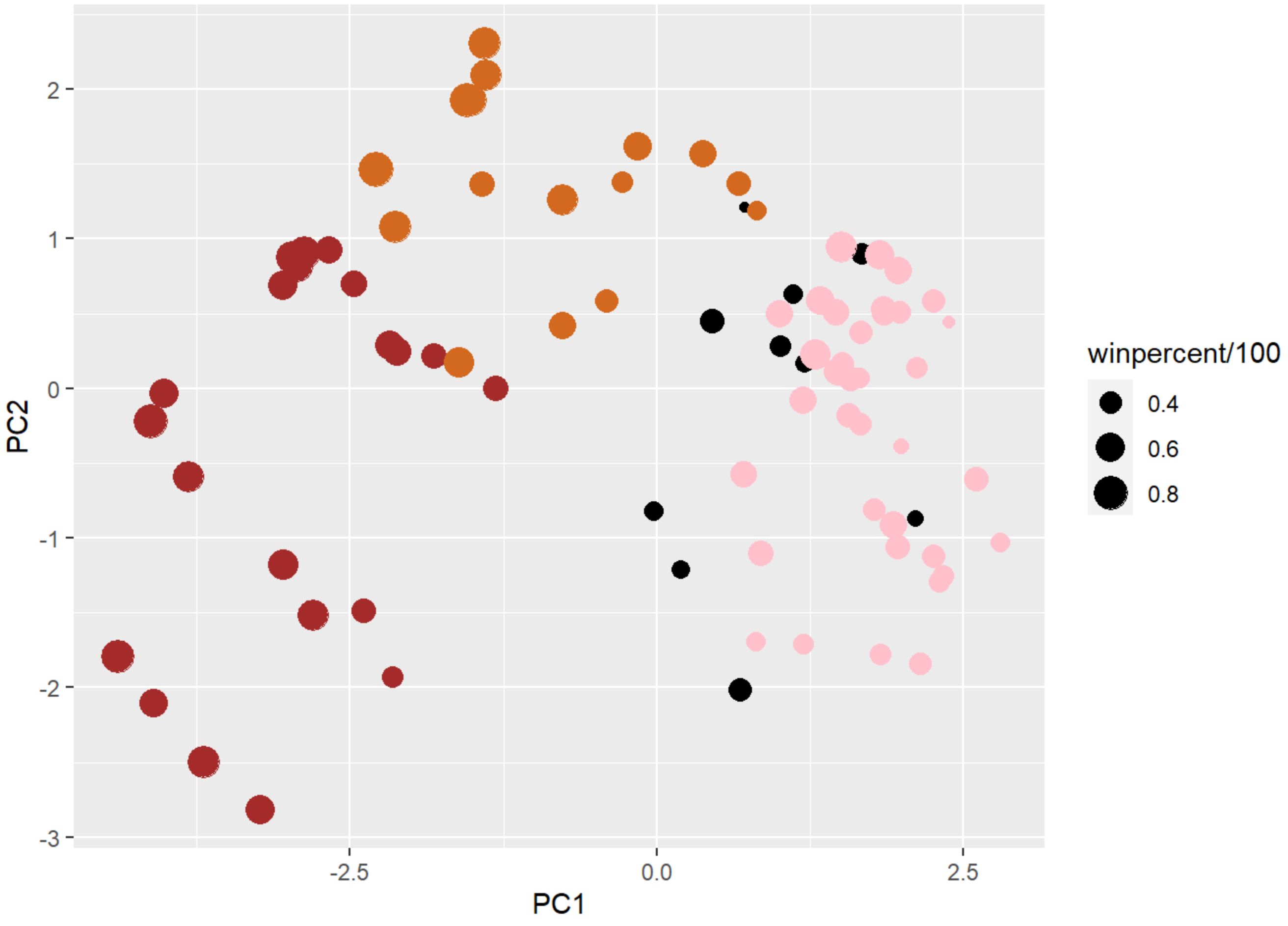
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



we make a new data.frame here that contains our PCA results with all the rest of our candy data. We will then use this for making plots below

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

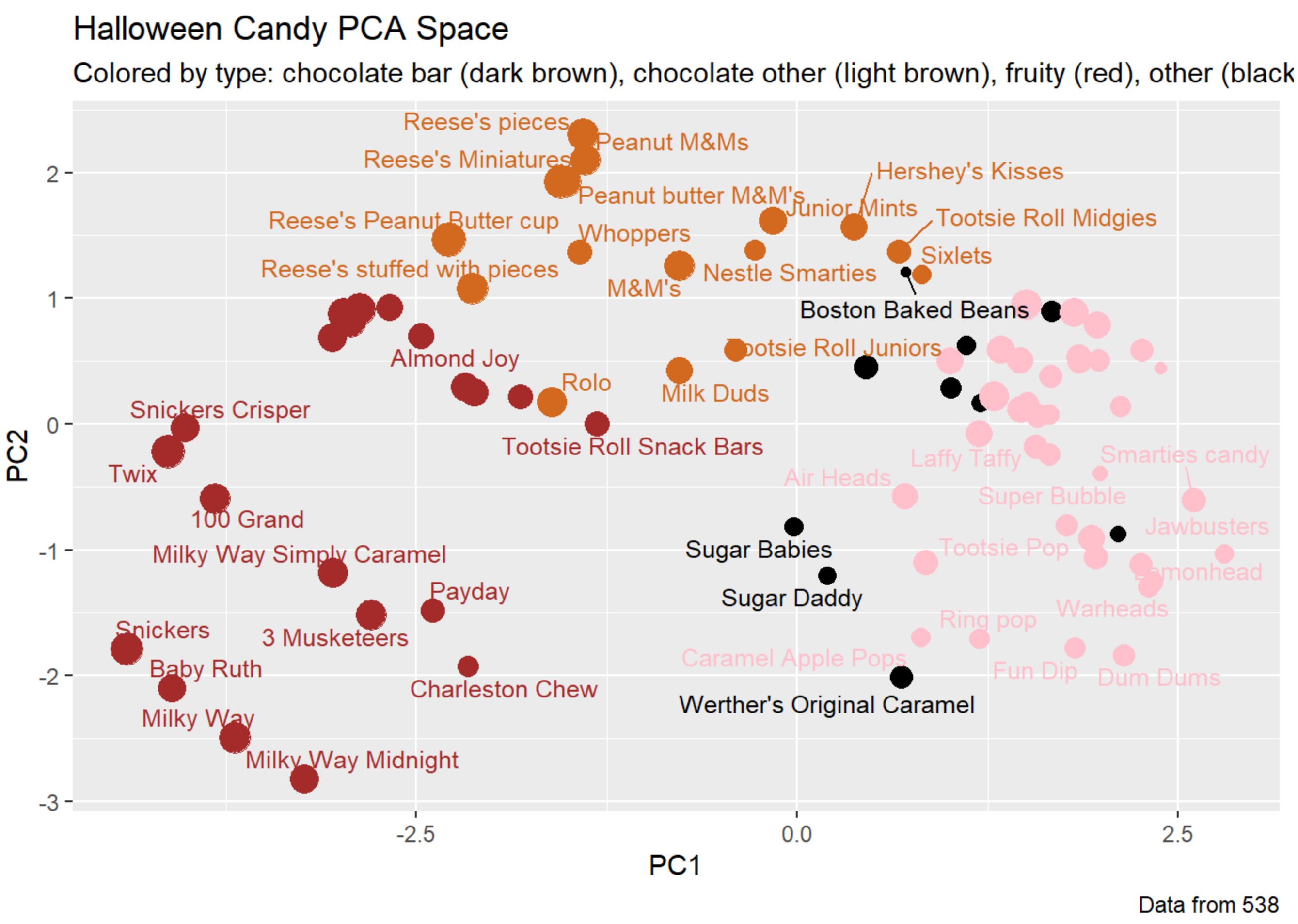
```r
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)
p
```



Again we can use the ggrepel package and the function ggrepel::geom_text_repel() to label up the plot with non overlapping candy names like. We will also add a title and subtitle like so:

```
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), fruity (red), o
       caption="Data from 538")
```

```
Warning: ggrepel: 40 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

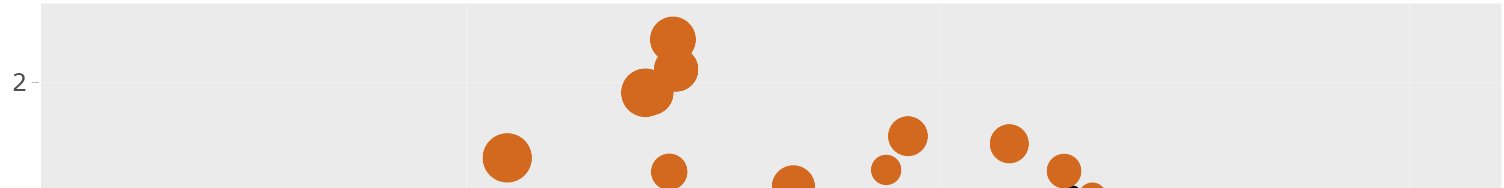


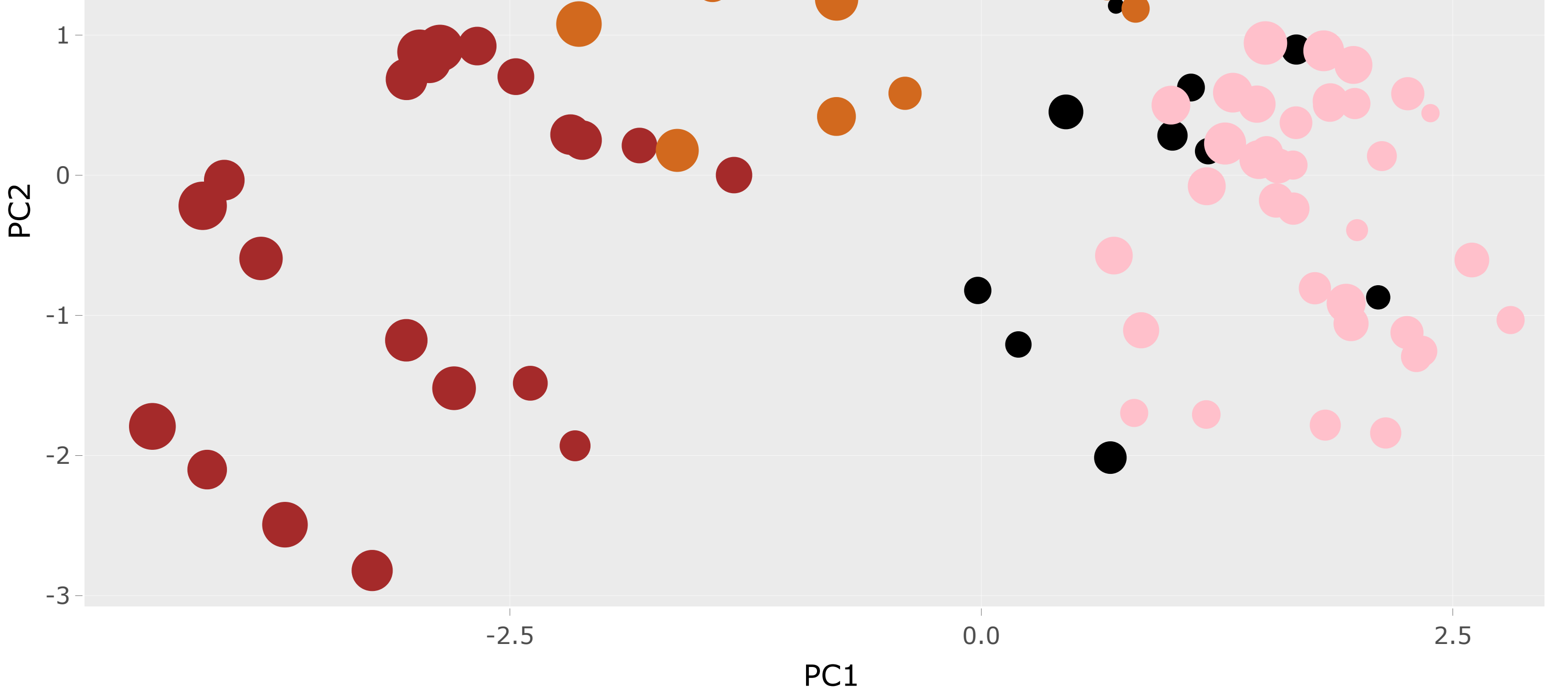
more candy labels you can change the max.overlaps value to allow more overlapping labels or pass the ggplot object p to plotly like so to generate an interactive plot that you can mouse over to see labels:

```
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
```

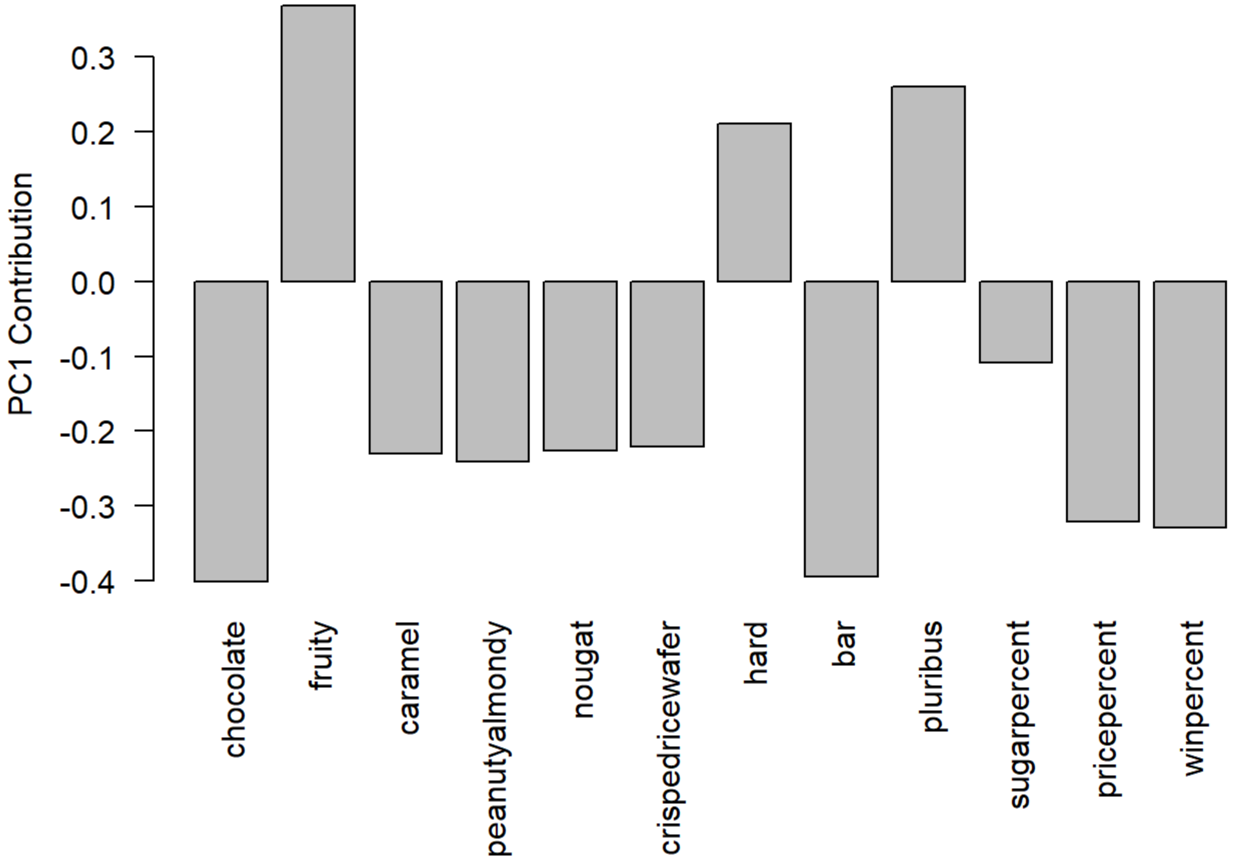
```
ggplotly(p)
```





Let’s finish by taking a quick look at PCA our loadings.

```
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?

Fruity, hard, and pluribus were the variables strongly picked up by Pc1 positively. These make sense because they may not be much variability within these variables.