Halloween Project

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Class 10: Halloween Mini-Project

Exploratory Analysis of Halloween Candy

1. Importing candy data https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-ranking/candy-data.csv

```
candy_file <- "https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-ranking/candy-
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?

A: 85 types

```
nrow(candy)
```

```
## [1] 85
```

Q2. How many fruity candy types are in the dataset? The functions dim(), nrow(), table() and sum() may be useful for answering the first 2 questions.

A: 38

```
nrow(candy[candy$fruity == 1,])
```

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

2. What is your favorate candy?

One of the most interesting variables in the dataset is winpercent. For a given candy this value is the percentage of people who prefer this candy over another randomly chosen candy from the dataset (what 538 term a matchup). Higher values indicate a more popular candy.

We can find the winpercent value for Twix by using its name to access the corresponding row of the dataset. This is because the dataset has each candy name as rownames (recall that we set this when we imported the original CSV file). For example the code for Twix is:

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

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

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

A: ReeseÕs Peanut Butter cup: winpercent is 84.18029

```
candy["ReeseÕs Peanut Butter cup",]$winpercent
```

```
## [1] 84.18029
```

Q4. What is the winpercent value for "Kit Kat"?

A: 76.7686

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

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

Q5. What is the winpercent value for "Tootsie Roll Snack Bars

A: 49.6535

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

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

Side-note: the skimr::skim() function

There is a useful skim() function in the skimr package that can help give you a quick overview of a given dataset. Let's install this package and try it on our candy data. to instqll `install.packages("devtools")` `devtools::install_github("ropensci/skimr")`

```
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?

A: column 12 is in different scale compared to others. So we have to scale the data when doing PCA otherwise this parameter is going to dominant over the rest.

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

A: 0 and 1 represent boolean values False and True. Indicating the candy contains cholocate or not.

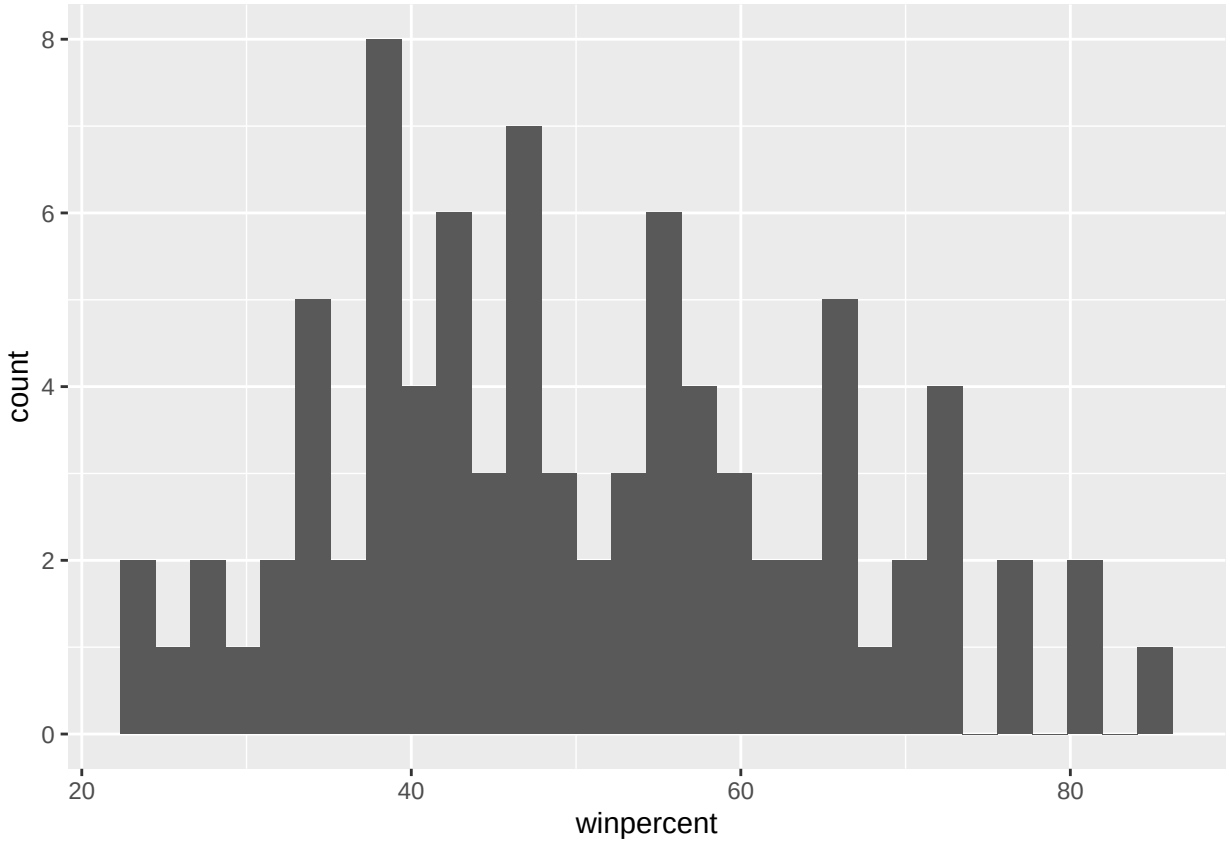
Hint: look at the "Variable type" print out from the skim() function. Most varables (i.e. columns) are on the zero to one scale but not all. Some columns such as chocolate are exclusively either zero or one values.

A good place to start any exploratory analysis is with a histogram. You can do this most easily with the base R function hist(). Alternatively, you can use ggplot() with geom_hist(). Either works well in this case and (as always) its your choice.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)
data = candy
data$type = rownames(data)
ggplot(data, aes(x=winpercent)) + geom_histogram()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Q9. Is the distribution of winpercent values symmetrical?

A: Yes

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

A: right around 50%

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

A: cholocate candy rank higher than fruit candy

```
print(mean(candy$winpercent[as.logical(candy$chocolate)]))
```

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

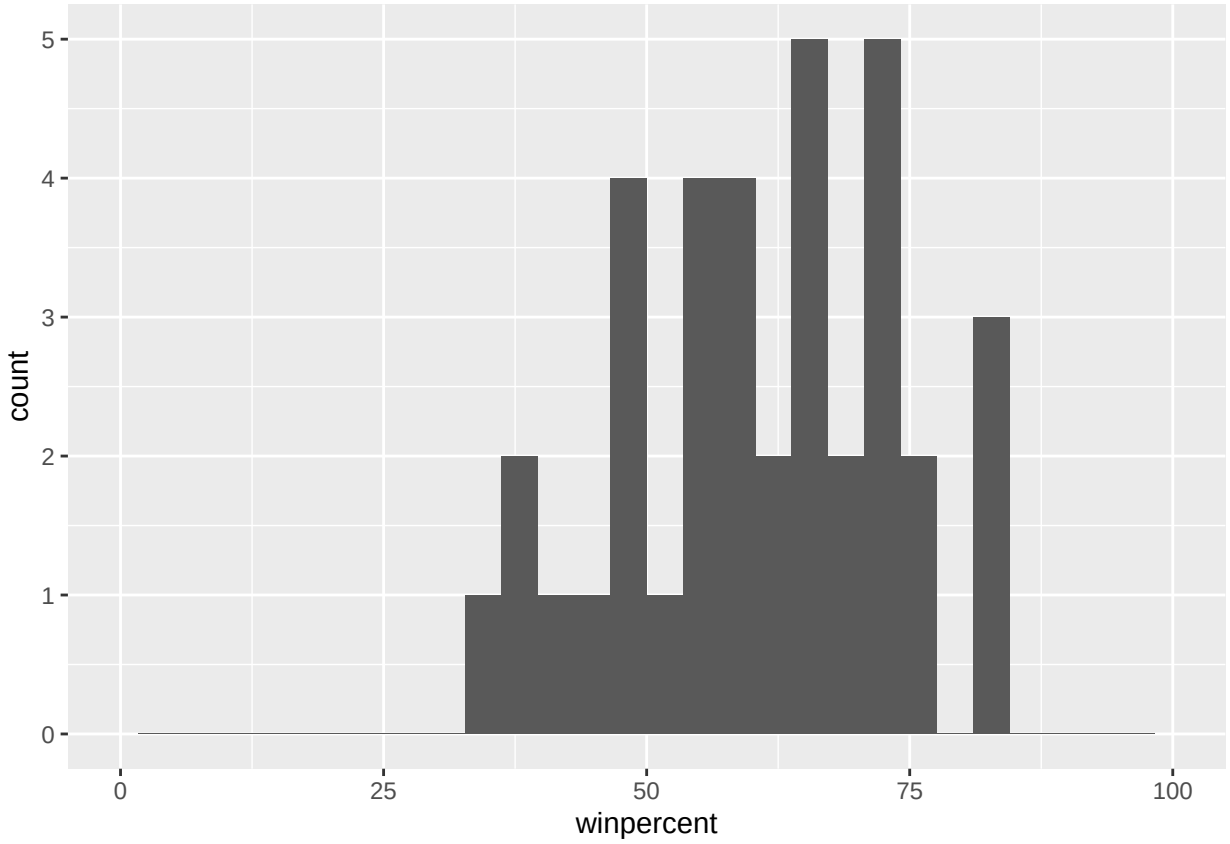
```
print(mean(candy$winpercent[as.logical(candy$fruity)]))
```

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

```
choc=data[data$chocolate == 1,]
ggplot(choc, aes(x=winpercent)) + geom_histogram() +
  xlim(0,100)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

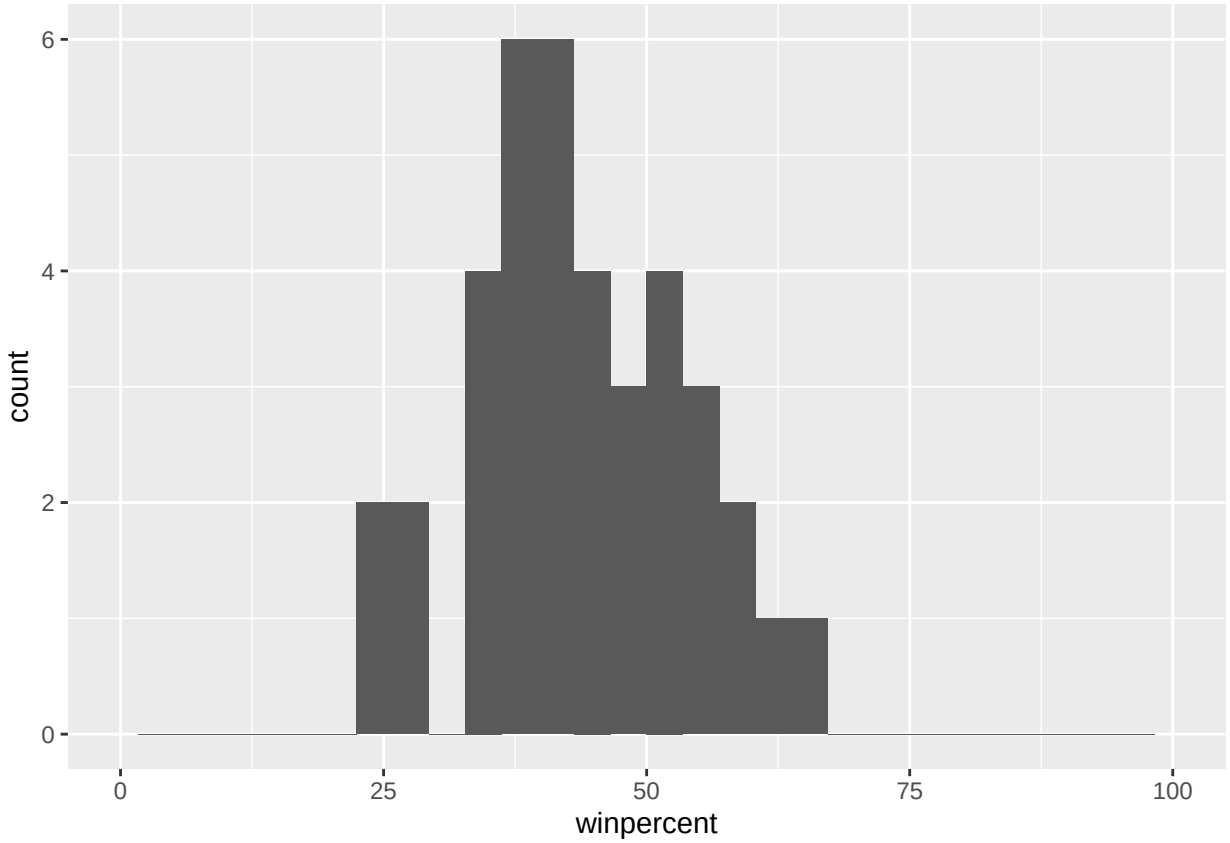
```
## Warning: Removed 2 rows containing missing values (geom_bar).
```




```
fruit=data[data$fruity == 1,]
ggplot(fruit, aes(x=winpercent)) + geom_histogram() +
  xlim(0,100)
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```
## Warning: Removed 2 rows containing missing values (geom_bar).
```



Q12. Is this difference statistically significant? Hint: The chocolate, fruity, nougat etc. columns indicate if a given candy has this feature (i.e. one if it has nougart, zero if it does not etc.). We can turn these into logical (a.k.a. TRUE/FALSE) values with the as.logical() function. We can then use this logical vector to access the coresponding candy rows (those with TRUE values). For example to get the winpercent values for all nougat contaning candy we can use the code: `candy$winpercent[as.logical(candy$nougat)]`. In addation the functions mean() and t.test() should help you answer the last two questions here.

A: p-val of T-test is less than 0.05, which suggests there is statistical significance between preferences for chocolate and fruity candy.

```
choc = candy$winpercent[as.logical(candy$chocolate)]
fruit = candy$winpercent[as.logical(candy$fruity)]
t.test(choc, fruit)
```

```
##
##  Welch Two Sample t-test
##
## data:  choc and fruit
## 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
```

3. Overall Candy Rankings

Let's use the base R order() function together with head() to sort the whole dataset by winpercent. Or if you have been getting into the tidyverse and the dplyr package you can use the arrange() function together with head() to do the same thing and answer the following questions:

```
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
```

```
# or using the other way
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
```

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

```
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?

```
candy %>% arrange(desc(winpercent)) %>% head(5)
```

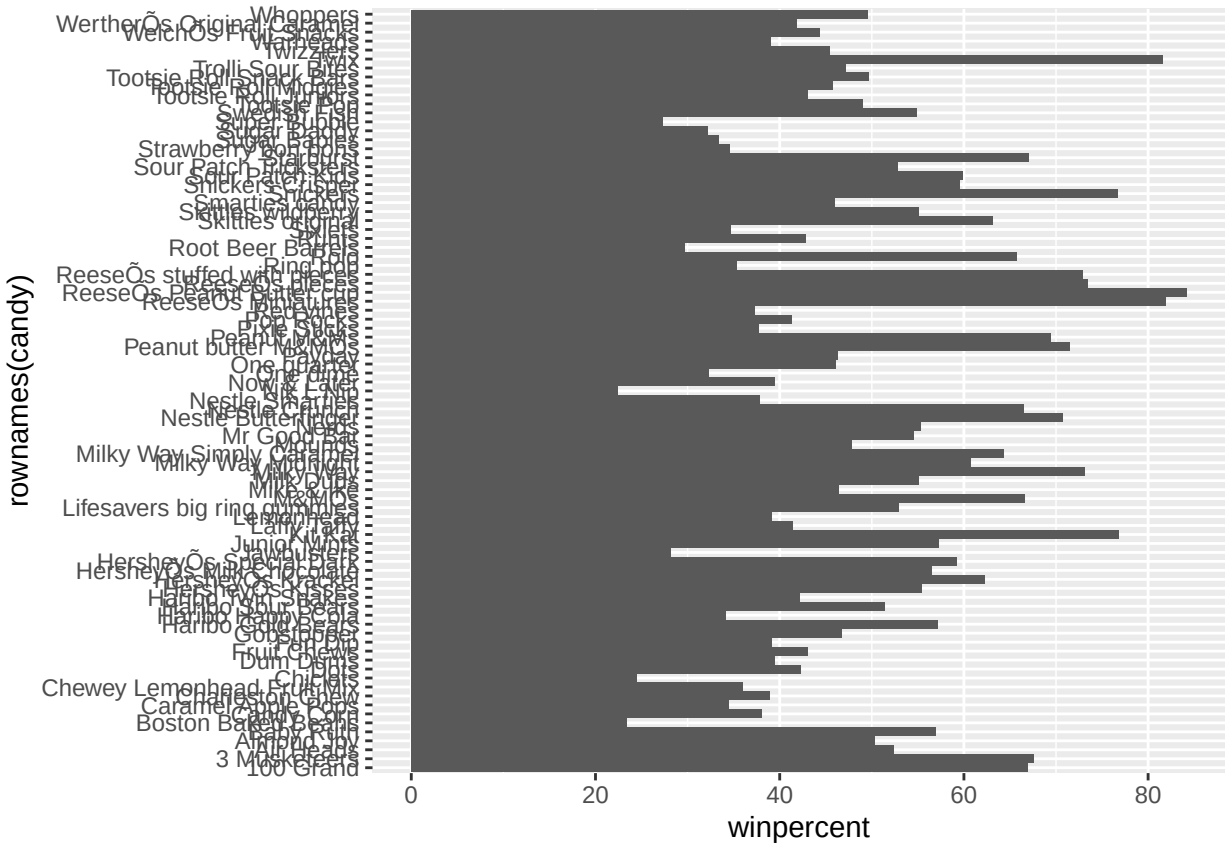
```
##                            chocolate fruity caramel peanutyalmondy nougat
## ReeseÕs Peanut Butter cup          1      0       0              1      0
## ReeseÕs Miniatures                 1      0       0              1      0
## Twix                               1      0       1              0      0
## Kit Kat                            1      0       0              0      0
## Snickers                           1      0       1              1      1
##                            crispedricewafer hard bar pluribus sugarpercent
## ReeseÕs Peanut Butter cup                 0    0   0        0        0.720
## ReeseÕs 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
## ReeseÕs Peanut Butter cup        0.651   84.18029
```

```
## ReeseÕs Miniatures          0.279   81.86626
## Twix                        0.906   81.64291
## Kit Kat                     0.511   76.76860
## Snickers                    0.651   76.67378
```

To examine more of the dataset in this vain we can make a barplot to visualize the overall rankings. We will use an iterative approach to building a useful visulization by getting a rough starting plot and then refining and adding useful details in a stepwise process.

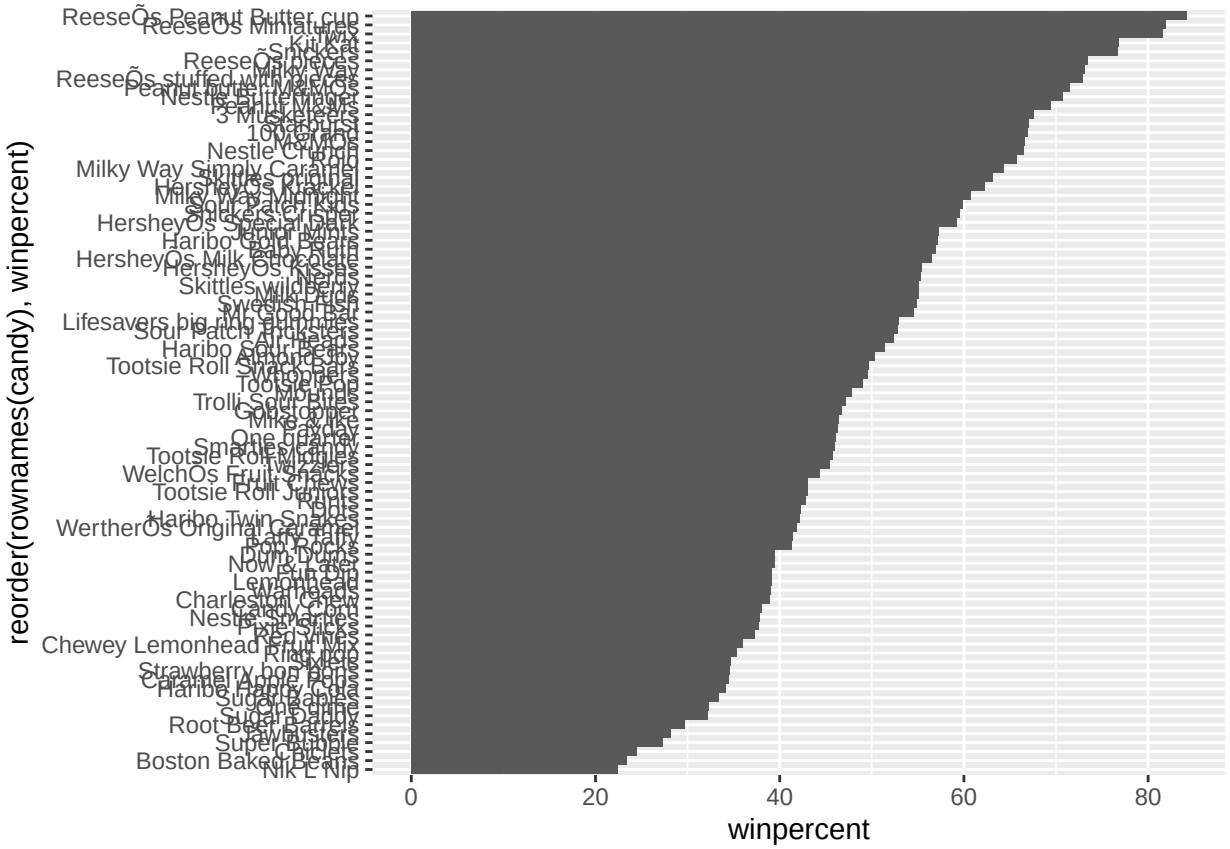
Q15. Make a first barplot of candy ranking based on winpercent values. HINT: Use the aes(winpercent, rownames(candy)) for your first ggplot like so:

```
library(ggplot2)
ggplot(candy) +
  aes(x=winpercent, y=rownames(candy)) +
  geom_col()
```



Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent? HINT: You can use aes(winpercent, reorder(rownames(candy),winpercent)) to improve your plot.

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

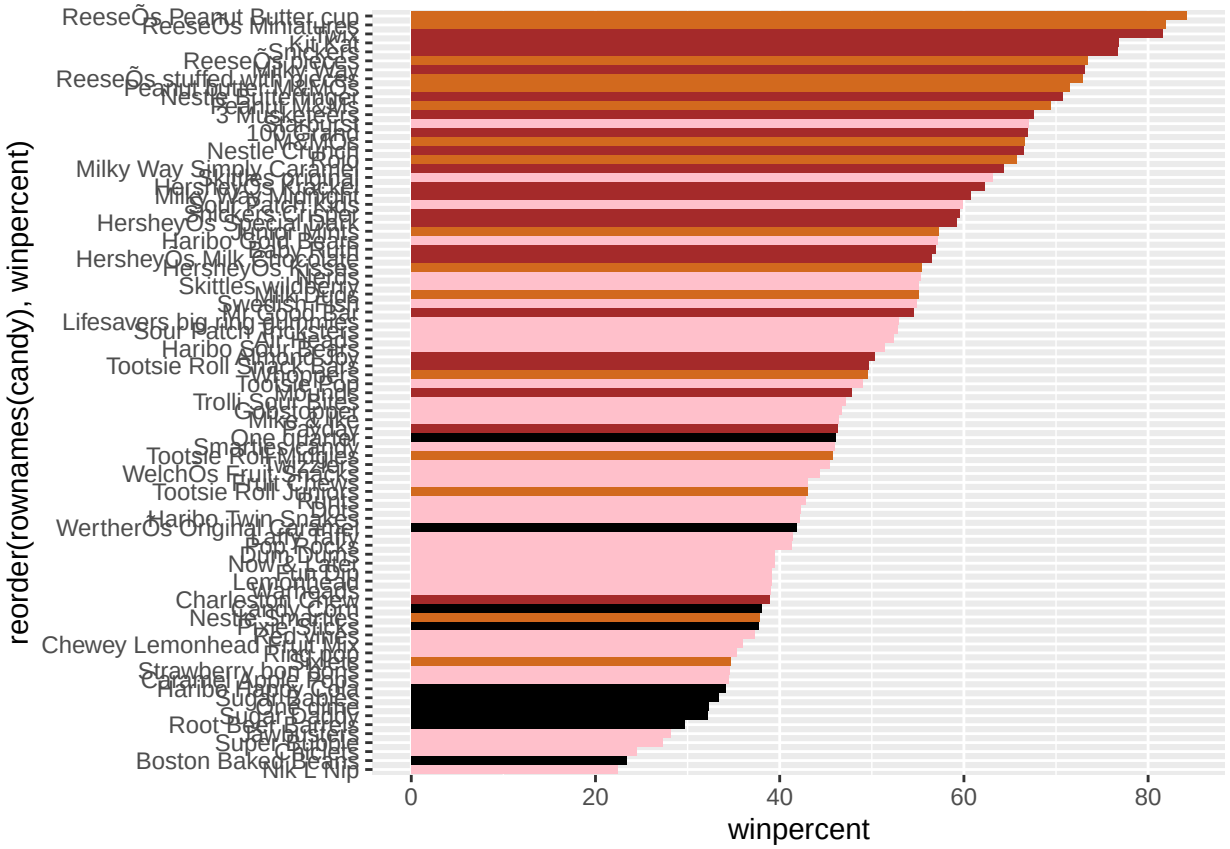


Time to add some useful color Let's setup a color vector (that signifies candy type) that we can then use for some future plots. We start by making a vector of all black values (one for each candy). Then we overwrite chocolate (for chocolate candy), brown (for candy bars) and red (for fruity candy) values.

```
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"
```

Now let's try our barplot with these colors. Note that we use fill=my_cols for geom_col(). Experement to see what happens if you use col=mycols.

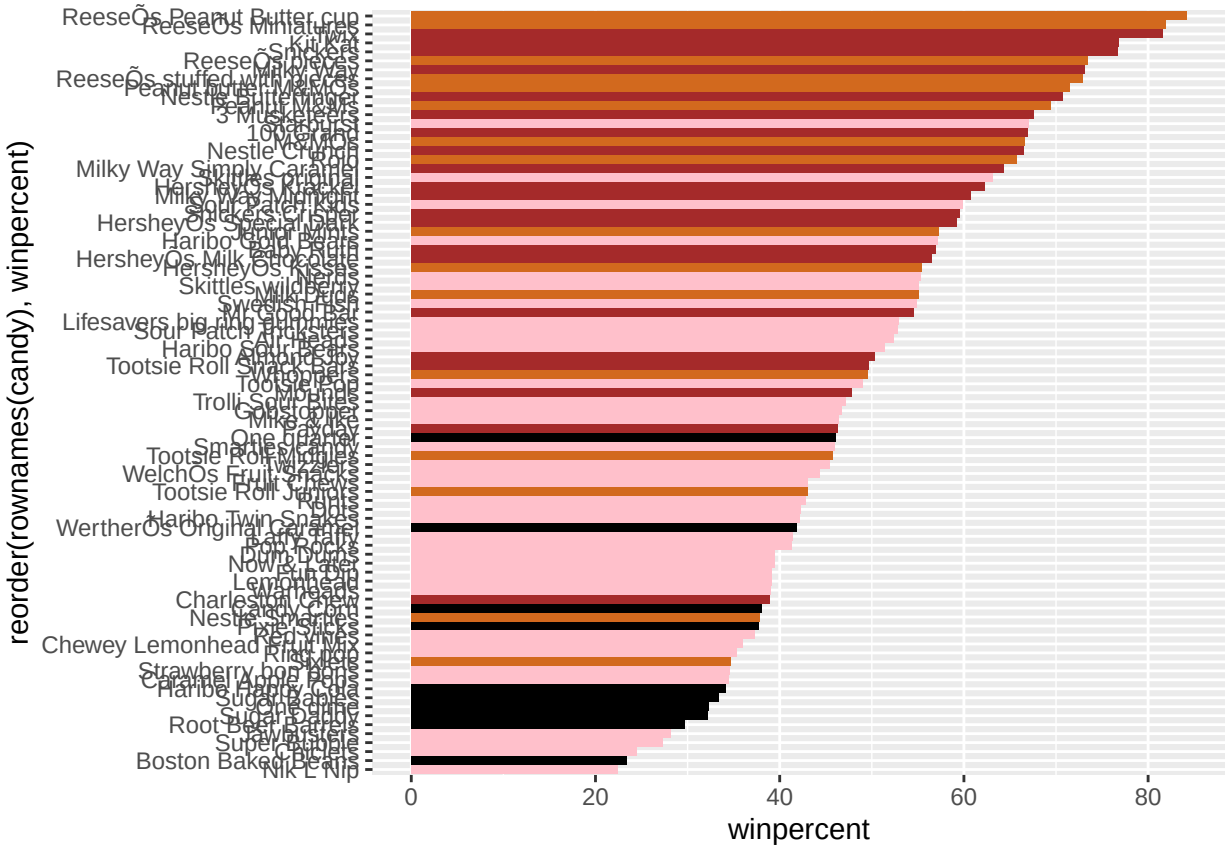
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col(fill=my_cols)
```



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

A: sixlets

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



- Q18. What is the best ranked fruity candy?

A:starburst

4. Taking a look at pricepercent

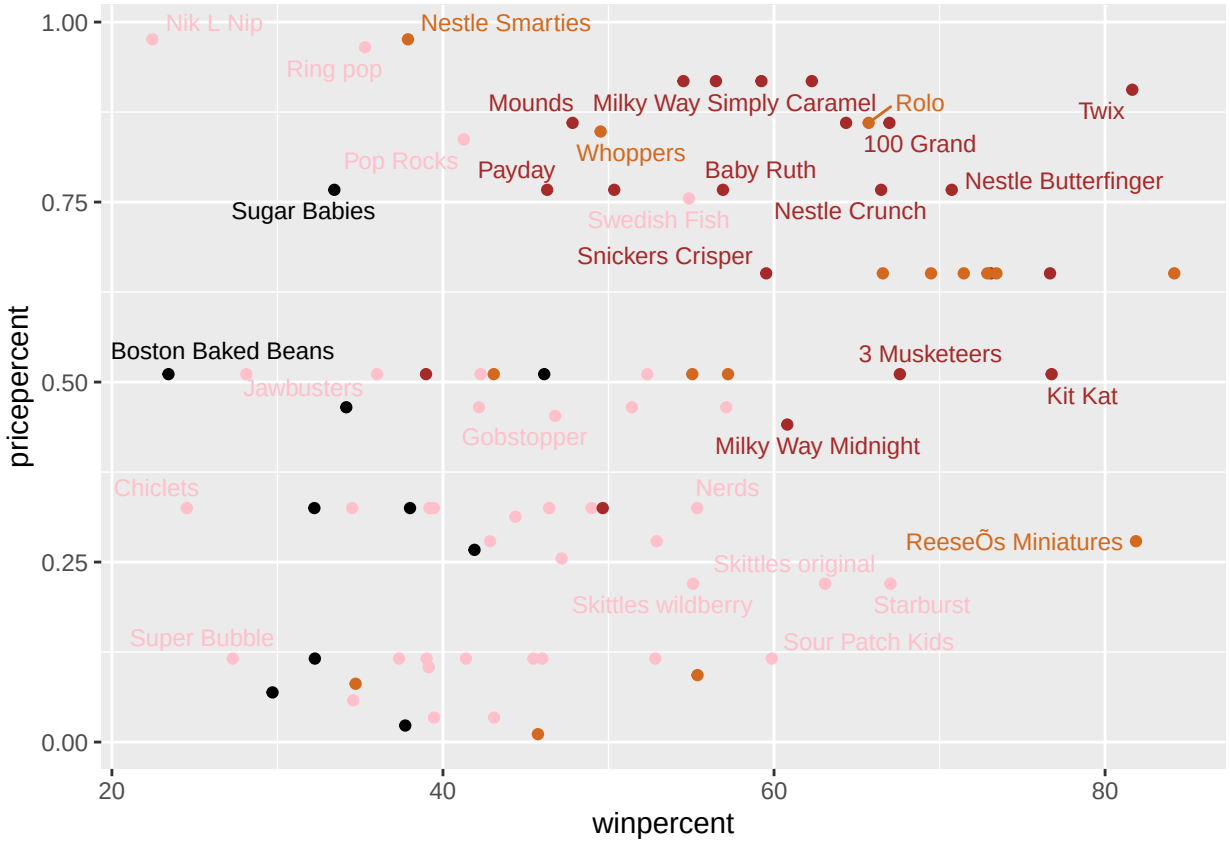
What about value for money? What is the the best candy for the least money? One way to get at this would be to make a plot of winpercent vs the pricepercent variable. The pricepercent variable records the percentile rank of the candy's price against all the other candies in the dataset. Lower vales are less expensive and high values more expensive.

To this plot we will add text labels so we can more easily identify a given candy. There is a regular geom_label() that comes with ggplot2. However, as there are quite a few candys in our dataset lots of these labels will be overlapping and hard to read. To help with this we can use the geom_text_repel() function from the ggrepel package.

```
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: 54 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?

A: HersheyÕs Krackel

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

A: Nik L Nip

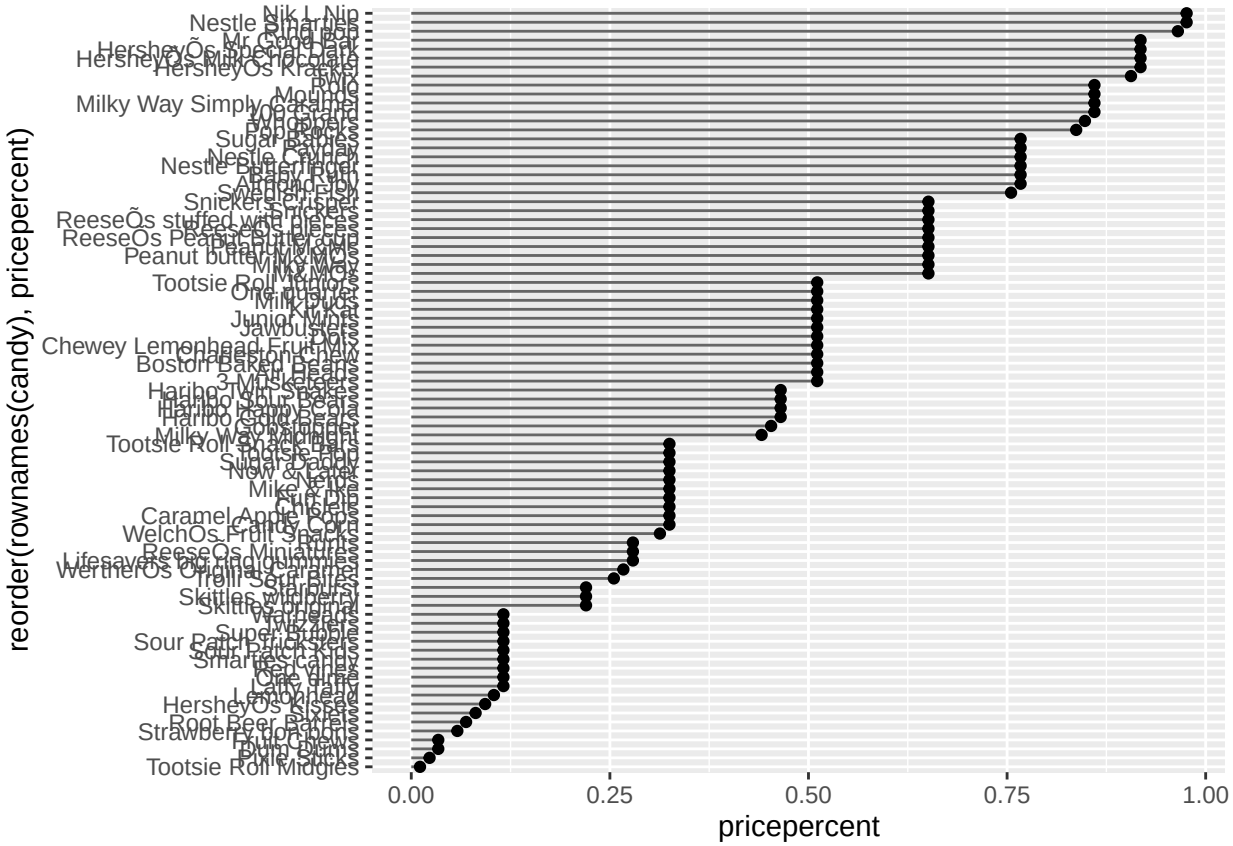
Hint: To see which candy is the most expensive (and which is the least expensive) we can order() the dataset by pricepercent.

```
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
```

#Optional 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()
```

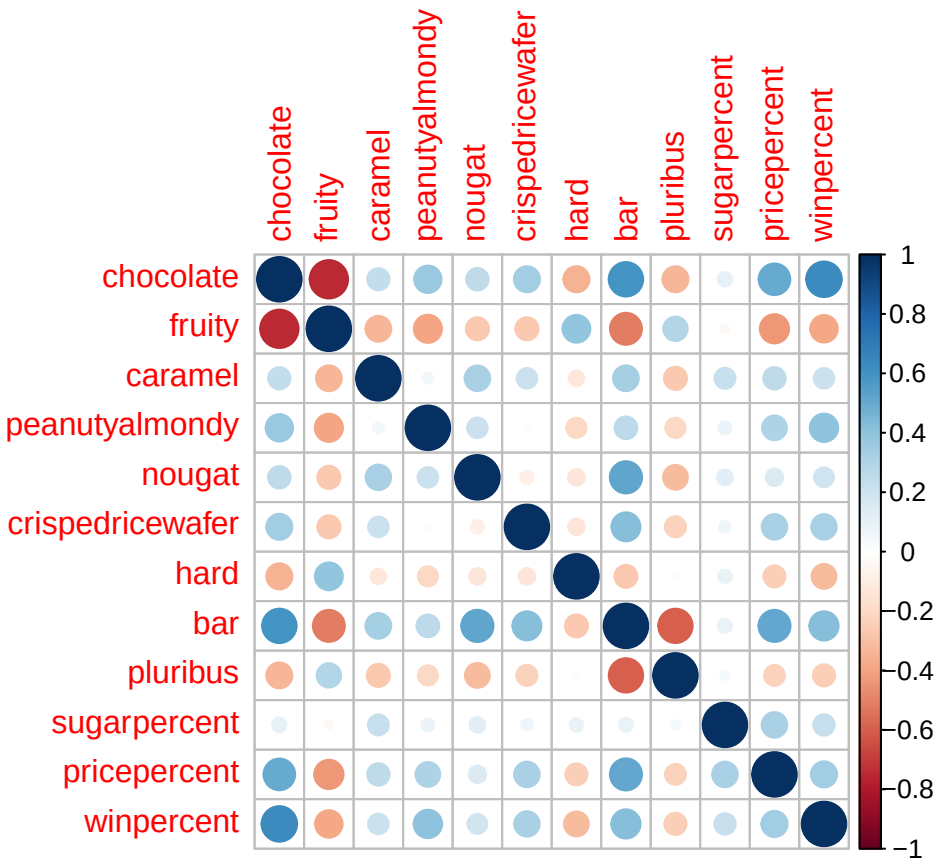


5 Exploring the correlation structure Now that we've explored the dataset a little, we'll see how the variables interact with one another. We'll use correlation and view the results with the corrplot package to plot a correlation matrix.

```
library(corrplot)
```

```
## corrplot 0.90 loaded
```

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



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

A: fruity and chocolate

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

A: winpercent and chocolate

HINT: Do you like chocolaty fruity candies?

6. Principal Component Analysis

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

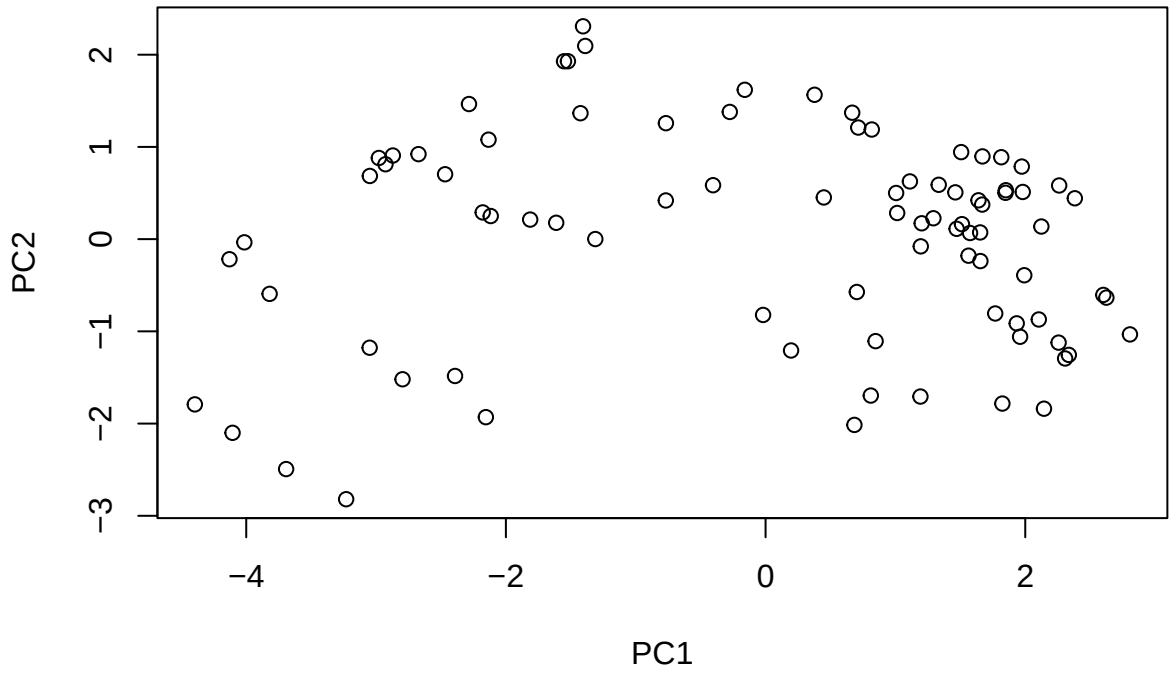
Side-note: Feel free to examine what happens if you leave this argument out (i.e. use the default scale=FALSE). Then examine the summary(pca) and pca$rotation[,1] component and see that it is dominated by winpercent (which is after all measured on a very different scale than the other variables).

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

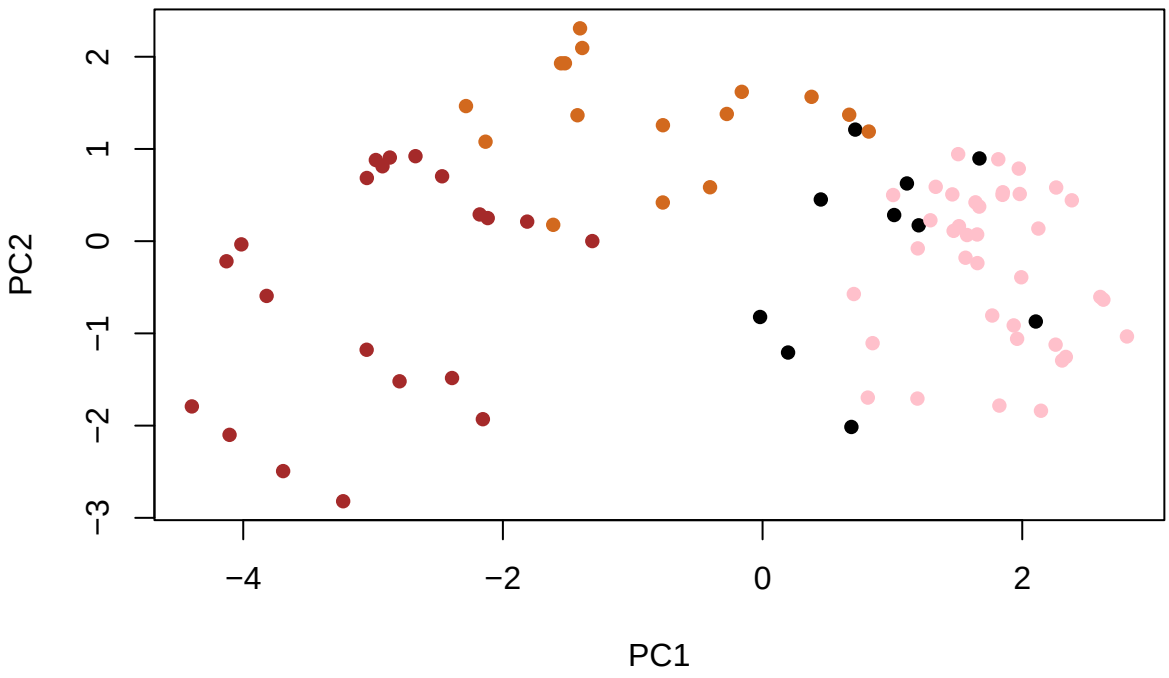
```
## Importance of components:
##                           PC1    PC2    PC3     PC4    PC5     PC6     PC7
## Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
## Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
## Cumulative Proportion  0.3601 0.4680 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[,1:2])
```



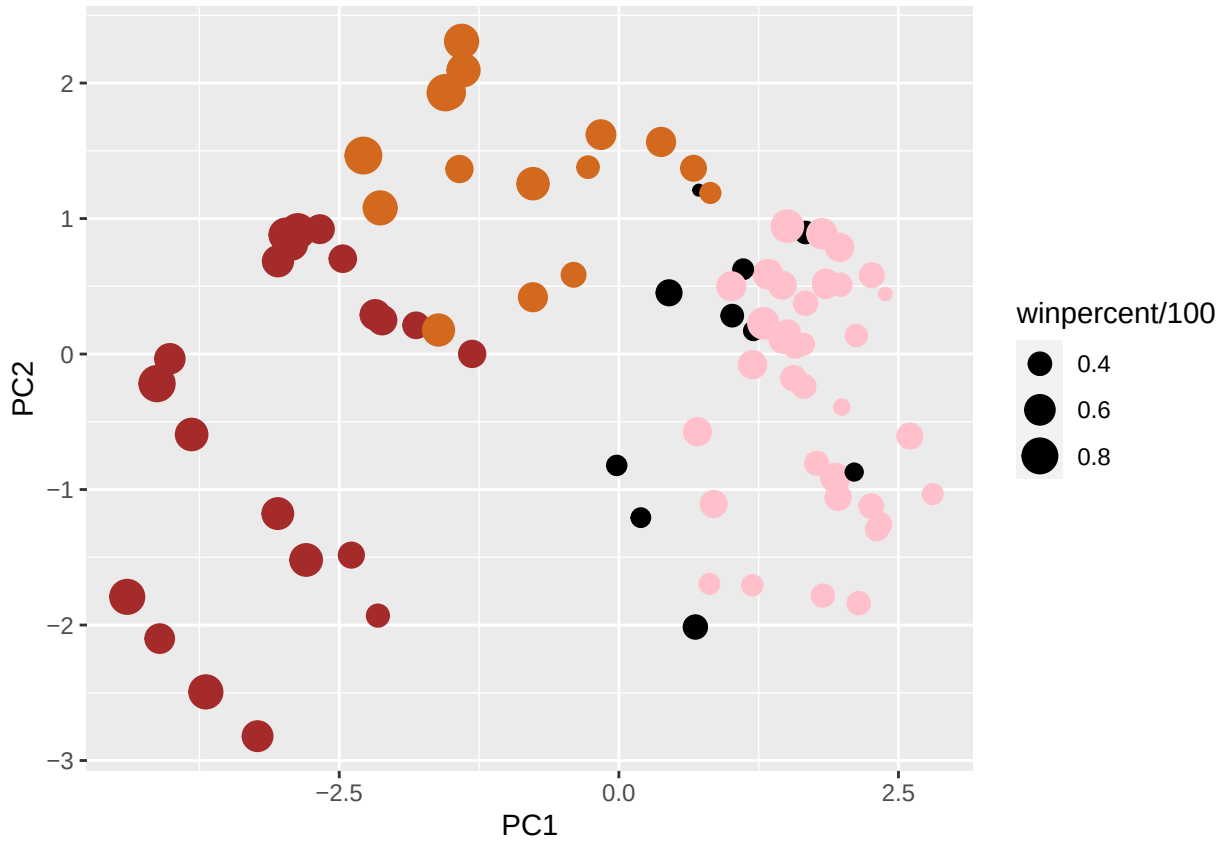

```
plot(pca$x[,1:2], col=my_cols, pch=16)
```




```
# 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
```

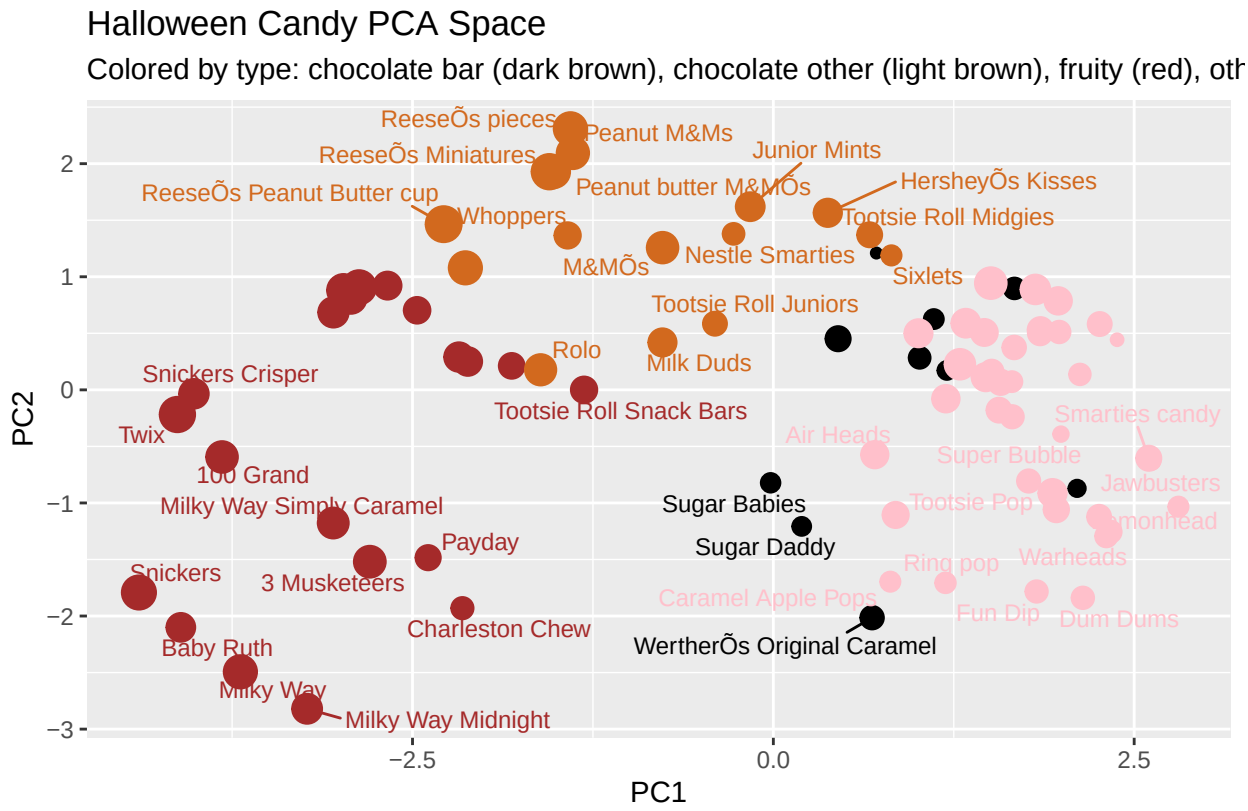


Again we can use the ggrepel package and the function ggrepel::geom_text_repel() to label up the plot with non overlapping candy names like. We will also add a title and subtitle like so:

```
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 (re
       caption="Data from 538")
```

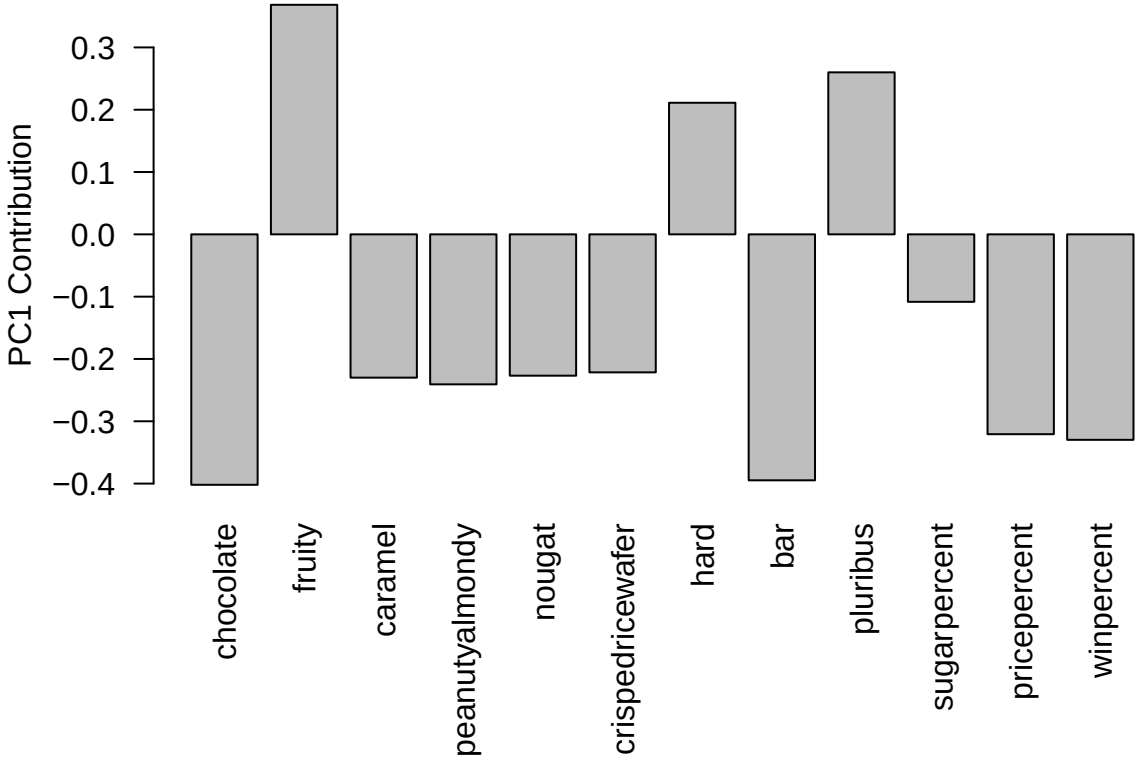
```
## Warning: ggrepel: 44 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



Data from 538

```
#library(plotly)
# 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? HINT. pluribus means the candy comes in a bag or box of multiple candies.

A: fruity, hard, pluribus. yes, these are typically the features of fruity candies and they tend to associate together