Lab 10: Halloween mini project

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As it is nearly Halloween and th ehalf way point in the quarter, let's do a mini project at help us figure out the best candy!

Our come from the 538 website and is available as a CSV file:

Data Import

```
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
```

```
flextable::flextable(head(candy, 10))
```

chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	s
1	0	1	0	0	1	0	1	0	
1	0	0	0	1	0	0	1	0	
0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	
0	1	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	0	
1	0	1	1	1	0	0	1	0	
0	0	0	1	0	0	0	0	1	
0	0	0	0	0	0	0	0	1	
0	1	1	0	0	0	0	0	0	

Q1. How many different candy types are in this dataset?

```
nrow(candy)
```

```
[1] 85
```

```
candy |>
  nrow()
```

```
[1] 85
```

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.1     v stringr   1.5.2
```

```
v ggplot2   4.0.0     v tibble    3.3.0
v lubridate 1.9.4     v tidyr     1.3.1
v purrr     1.1.0
-- Conflicts ---------------------------------------- tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becor
```

```
candy %>%
  nrow()
```

```
[1] 85
```

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?

My favorite winpercent

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

```
[1] 81.64291
```

```
library(dplyr)

candy |>
  filter(rownames(candy) == "Boston Baked Beans") |>
  select(winpercent)
```

```
                  winpercent
Boston Baked Beans   23.41782
```

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
```

Quick overview of the dataset

```
#It is a modern, tidyverse-friendly alternative to the base R function summary()
skimr::skim(candy)
```

Table 2: 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	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
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 winpercent is on a 0-100 scale the rest are 0-1 scale

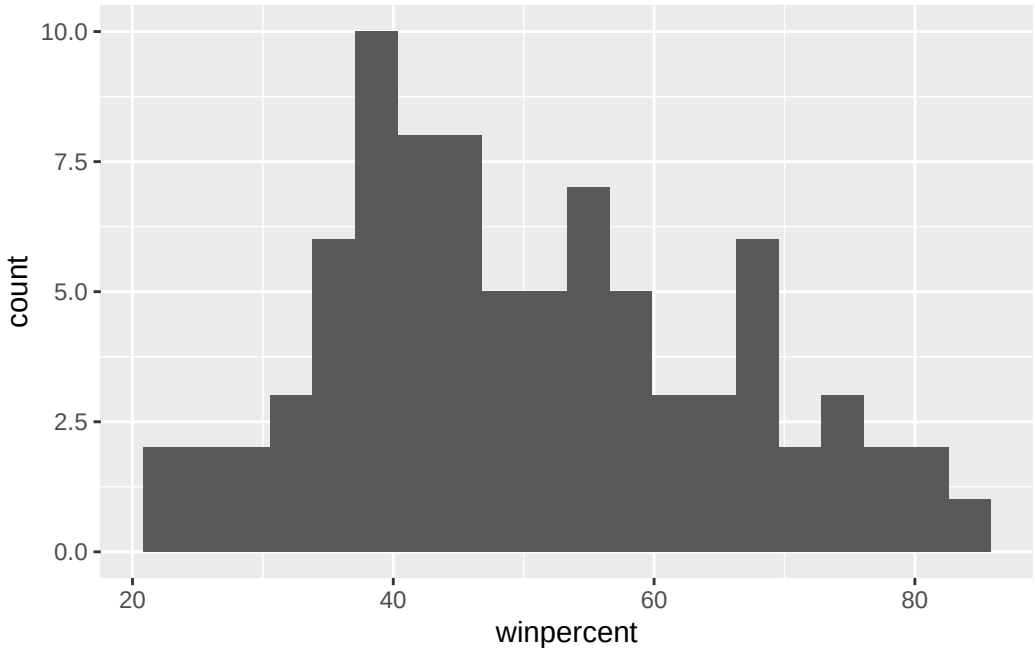
Q7. What do you think a zero and one represent for the candy$chocolate column?

That the candy does not contain chocolate

Q8. Plot a histogram of winpercent values

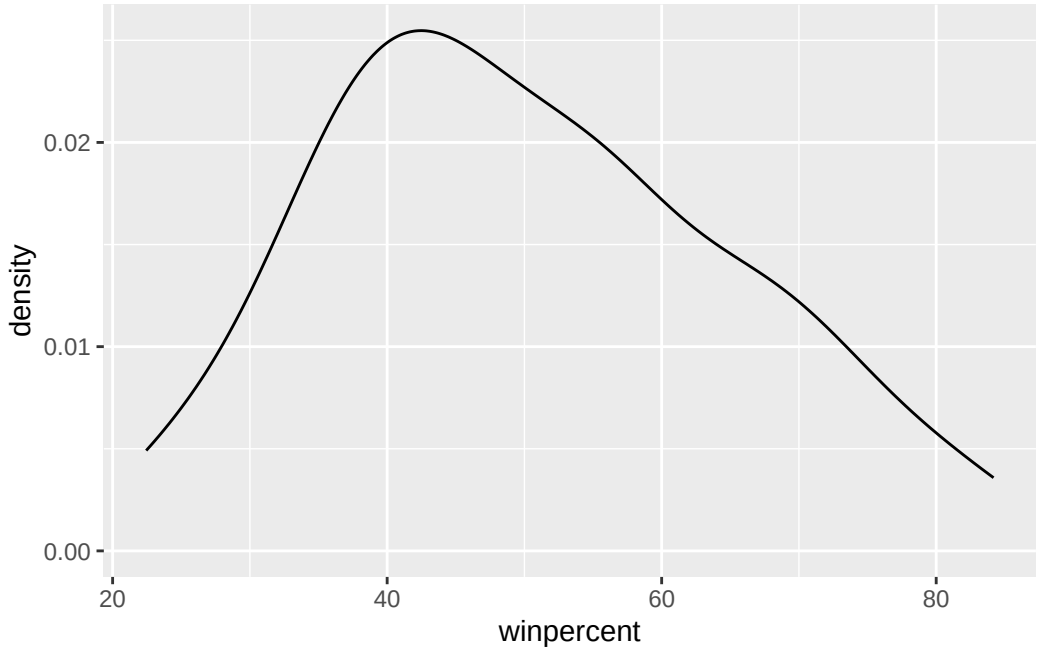
```
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=20)
```



Q9. Is the distribution of winpercent values symmetrical?

```
ggplot(candy) +
  aes(winpercent) +
  geom_density()
```



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

```
mean(candy$winpercent)
```

```
[1] 50.31676
```

```
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?

```
# 1. Find all chocolate candy in the dataset
# 2. Find their winpercent values
# 3. Calculate the mean of these values

# 4-6. DO the same for fruity candy
# 7. compare mean winpercents of chocolate vs fruity
# 8. Pick the highest as the winnder

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

```
[1] 60.92153
```

```
mean(candy[candy$chocolate==1,]$winpercent)
```

```
[1] 60.92153
```

```
mean(candy[candy$fruity==1,]$winpercent)
```

```
[1] 44.11974
```

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

```
[1] 44.11974
```

```
candy |>
  filter(chocolate==1) |>
  select(winpercent)
```

```
                          winpercent
100 Grand                   66.97173
3 Musketeers                67.60294
Almond Joy                  50.34755
```

```
Baby Ruth                       56.91455
Charleston Chew                 38.97504
Hershey's Kisses                55.37545
Hershey's Krackel               62.28448
Hershey's Milk Chocolate        56.49050
Hershey's Special Dark          59.23612
Junior Mints                    57.21925
Kit Kat                         76.76860
Peanut butter M&M's             71.46505
M&M's                           66.57458
Milk Duds                       55.06407
Milky Way                       73.09956
Milky Way Midnight              60.80070
Milky Way Simply Caramel        64.35334
Mounds                          47.82975
Mr Good Bar                     54.52645
Nestle Butterfinger             70.73564
Nestle Crunch                   66.47068
Peanut M&Ms                     69.48379
Reese's Miniatures              81.86626
Reese's Peanut Butter cup       84.18029
Reese's pieces                  73.43499
Reese's stuffed with pieces     72.88790
Rolo                            65.71629
Sixlets                         34.72200
Nestle Smarties                 37.88719
Snickers                        76.67378
Snickers Crisper                59.52925
Tootsie Pop                     48.98265
Tootsie Roll Juniors            43.06890
Tootsie Roll Midgies            45.73675
Tootsie Roll Snack Bars         49.65350
Twix                            81.64291
Whoppers                        49.52411
```

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
```

Overall Candy Rankings

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
```

```
ord.ind <- order(candy$winpercent)
head(candy[ord.ind,], 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?

default = lowest to highest

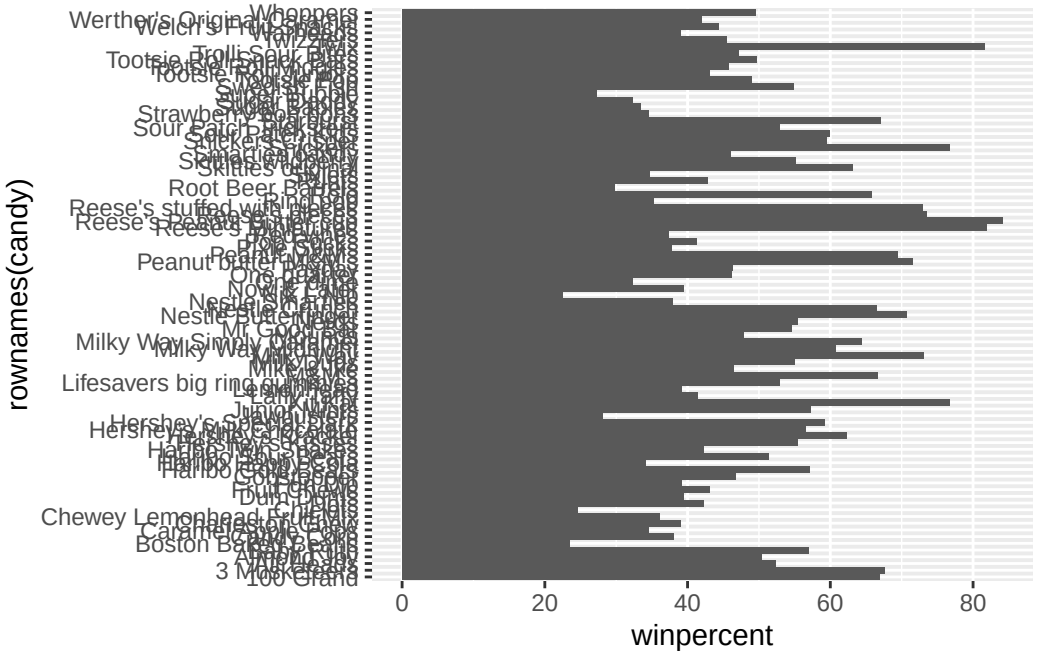
```
candy |>
  arrange(winpercent) |>
  tail(5)
```

```
                         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
```

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?

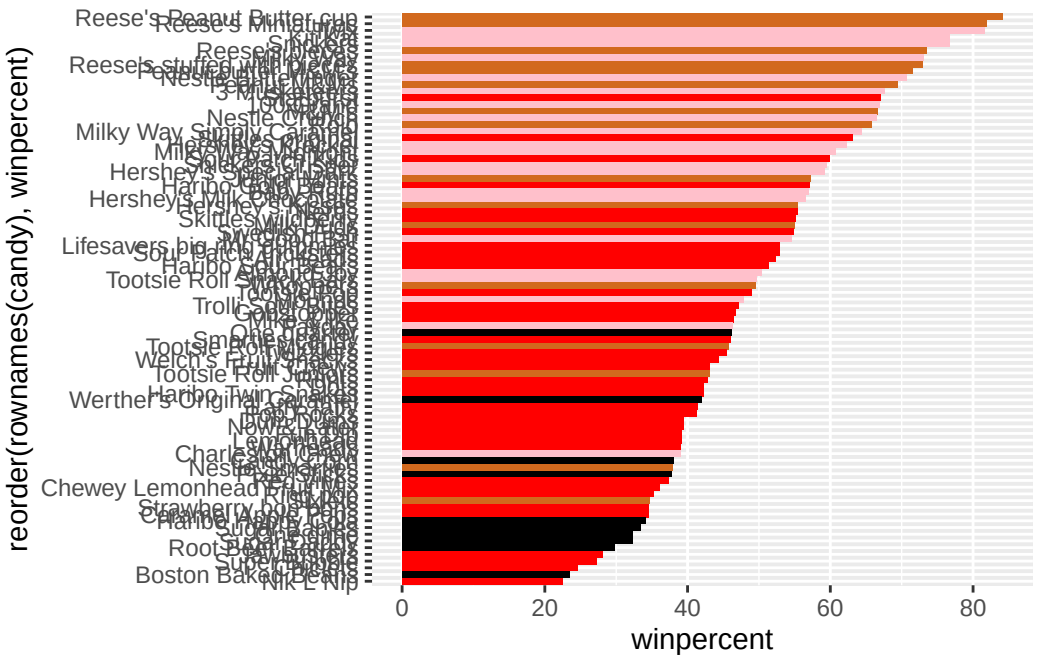
Add some color based on the "type of candy"

```
my_cols <- rep("black", nrow(candy)) #repeat number of candies I have
my_cols[as.logical(candy$chocolate)] <- "chocolate"
my_cols[as.logical(candy$fruity)] <- "red"
my_cols[as.logical(candy$bar)] <- "pink"
my_cols
```

```
 [1] "pink"      "pink"      "black"     "black"     "red"       "pink"
 [7] "pink"      "black"     "black"     "red"       "pink"      "red"
[13] "red"       "red"       "red"       "red"       "red"       "red"
[19] "red"       "black"     "red"       "red"       "chocolate" "pink"
```

```
 [25] "pink"      "pink"      "red"       "chocolate" "pink"      "red"
 [31] "red"       "red"       "chocolate" "chocolate" "red"       "chocolate"
 [37] "pink"      "pink"      "pink"      "pink"      "pink"      "red"
 [43] "pink"      "pink"      "red"       "red"       "pink"      "chocolate"
 [49] "black"     "red"       "red"       "chocolate" "chocolate" "chocolate"
 [55] "chocolate" "red"       "chocolate" "black"     "red"       "chocolate"
 [61] "red"       "red"       "chocolate" "red"       "pink"      "pink"
 [67] "red"       "red"       "red"       "red"       "black"     "black"
 [73] "red"       "red"       "red"       "chocolate" "chocolate" "pink"
 [79] "red"       "pink"      "red"       "red"       "red"       "black"
 [85] "chocolate"
```

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



Q17. What is the worst ranked chocolate candy?

Sixlets

Q18. What is the best ranked fruity candy?

Starburst

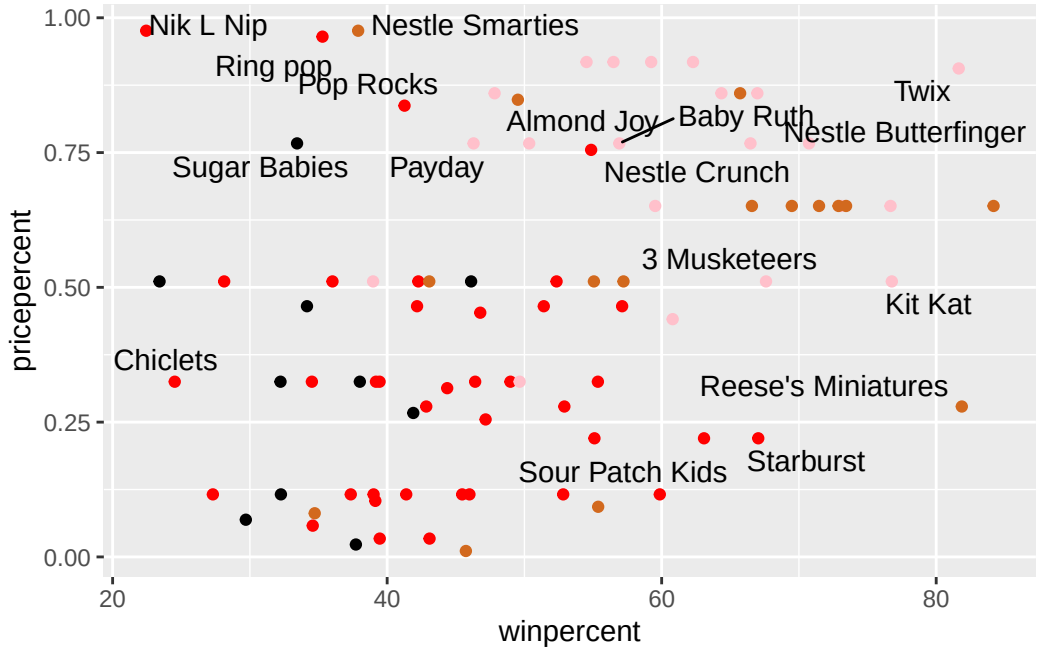
Winpercent and Pricepercent

A plot with both variables/columns winpercent and pricepercent

```
library(ggrepel)

ggplot(candy) +
  aes(x = winpercent,
      y = pricepercent,
      label = rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(max.overlaps = 7)
```

```
Warning: ggrepel: 68 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 candy type

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
```

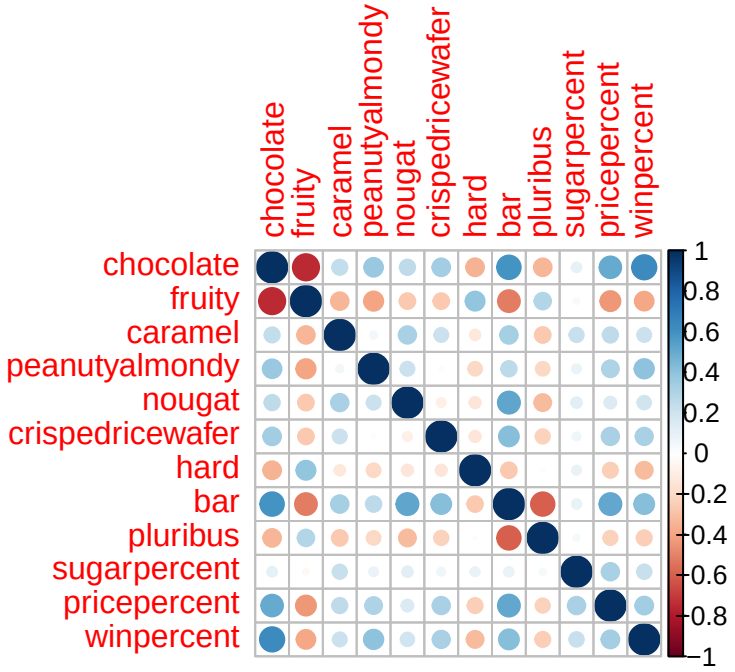
Exploring the corelation structure

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 0.95 loaded
```

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



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

Chocolate and fruity

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

Chocolate and winpercent.

Principal Component Analysis

The function to use is called `prcomp()` with an optional `scale=T/F` argument.

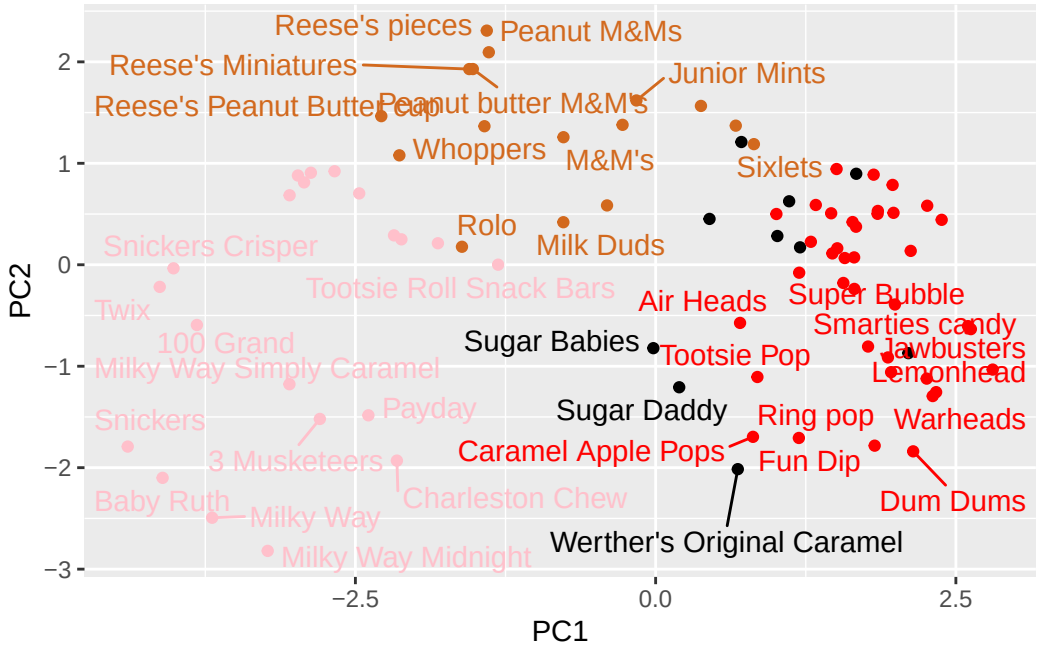
```
pca <- prcomp(candy, scale = TRUE)
summary(pca)
```

```
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
```

Our main PCA result figure

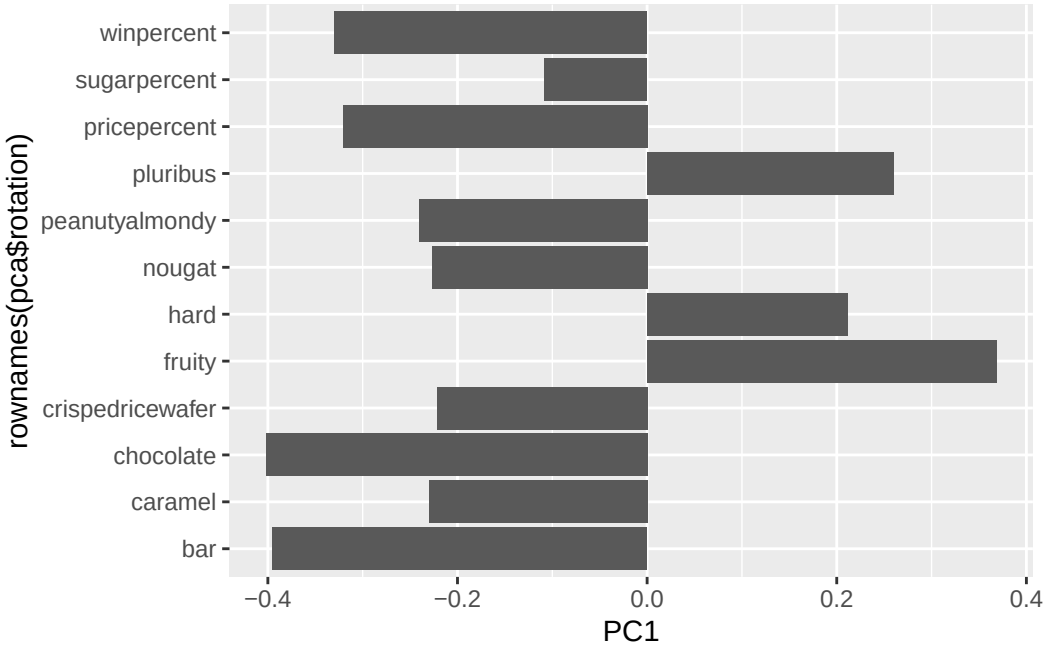
```
ggplot(pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col=my_cols) +
  geom_text_repel(col = my_cols)
```

```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



We should also examine the variable "loadings" or contributions of the origional variables to the new PCs

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




```
p <- ggplot(pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col=my_cols) +
  geom_text_repel(col = my_cols)
```

Interactive plots that can be zoomed on and "brushed" over can be made with the **plotly** package. it's output is inter5active and willl not render to PDF :-(

```
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
```

```
#plotly(p)
```

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

Fruity, hard, pluribus. Yes, that makes sense: PC1 seems to capture a "non-chocolate, hard, multi-piece/fruit-flavor" axis, contrasting those candies with chocolate/bar/nutty/nougat types that load negatively.