Class 10: Halloween mini project

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As it is nearly halloween and the half way point in the quarter let's do a mini project to 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.txt", 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))
```

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

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
```

```
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
```

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

```
[1] 81.64291
```

My favorite winpercent

```
library(dplyr)

candy |>
  filter(rownames(candy)=="Milky Way") |>
  select(winpercent)
```

```
          winpercent
Milky Way   73.09956
```

Quick overview of the dataset

```
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

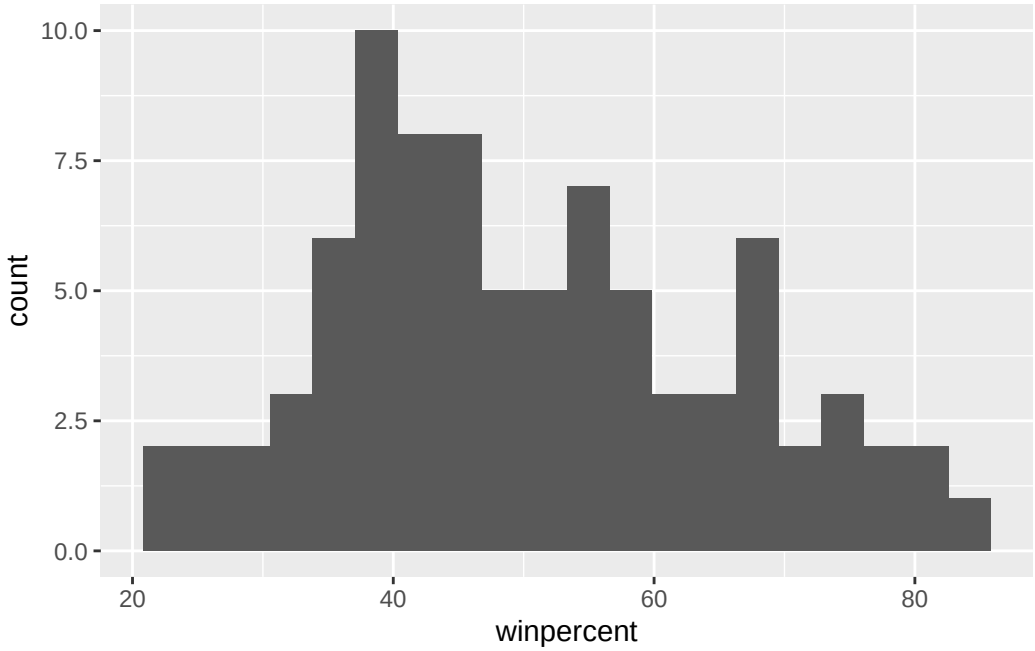
skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
chocolate	0	1	0.44	0.50	0.00	0.00	0.00	1.00	1.00	
fruity	0	1	0.45	0.50	0.00	0.00	0.00	1.00	1.00	
caramel	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
peanutyalmondy	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
nougat	0	1	0.08	0.28	0.00	0.00	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	
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	

That the candy does not contain chocolate

Q8. Plot a histogram of winpercent values

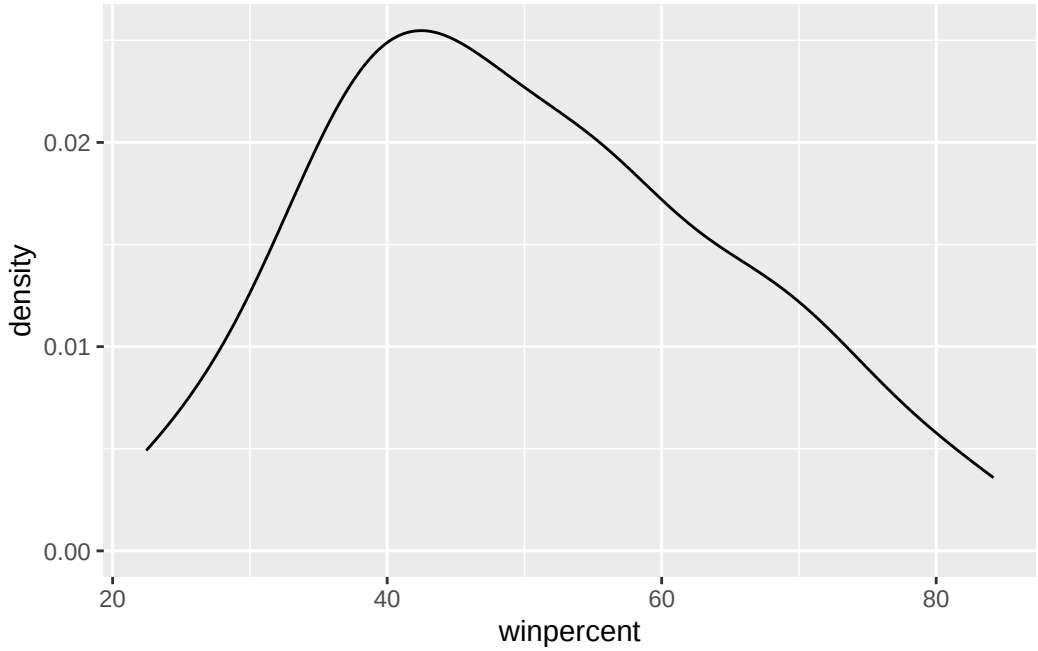
```
library(ggplot2)

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 winner

choc.inds <- candy$chocolate==1
```

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

```
fruit.inds <- candy$fruity==1
fruit.win <- candy[fruit.inds, ]$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
```

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

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

```
#(candy$winpercent)
```

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

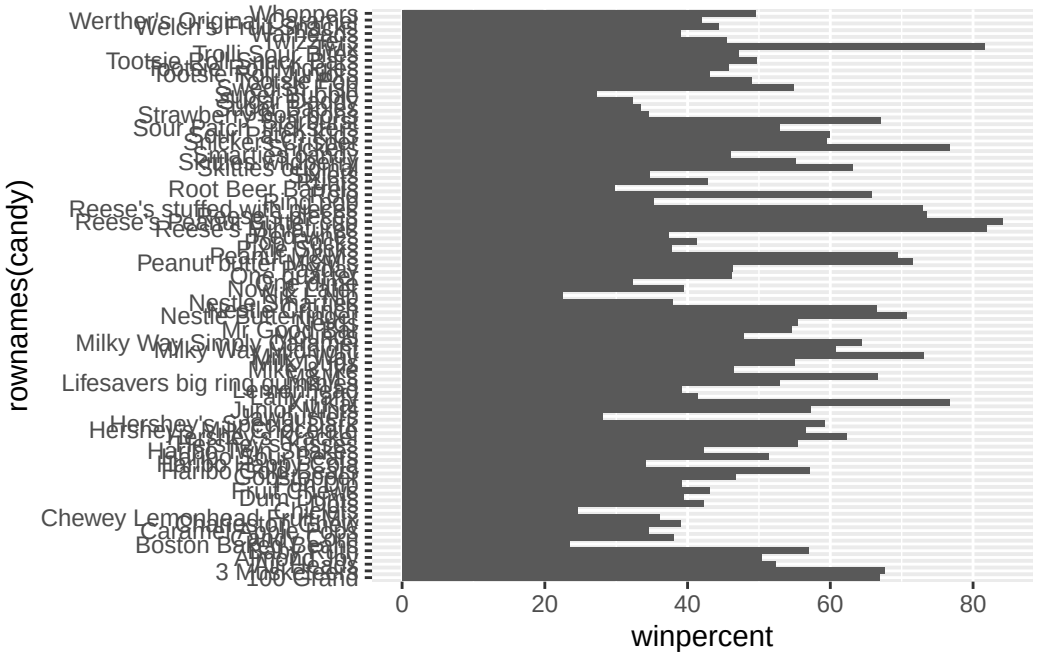
	pricepercent	winpercent
Snickers	0.651	76.67378
Kit Kat	0.511	76.76860
Twix	0.906	81.64291
Reese's Miniatures	0.279	81.86626
Reese's Peanut Butter cup	0.651	84.18029

```
candy |>
  arrange(-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
```

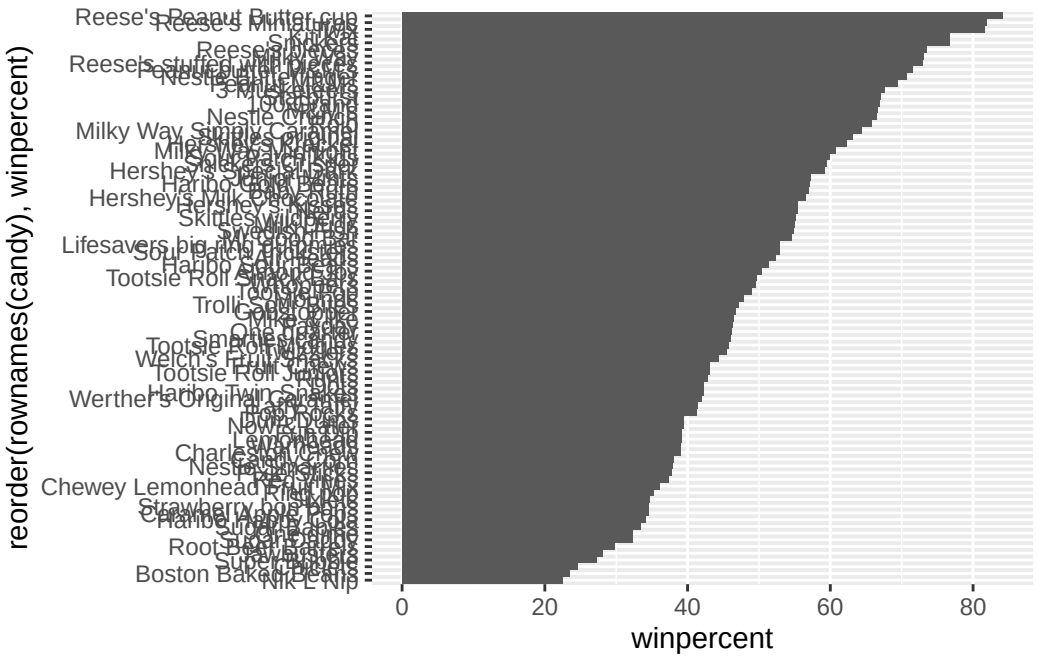
Q15. Make a first barplot of candy ranking based on winpercent values.

```
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(x=winpercent,
      y=reorder(rownames(candy), winpercent)) +
  geom_col()
```



Add some color based on the "type of candy"

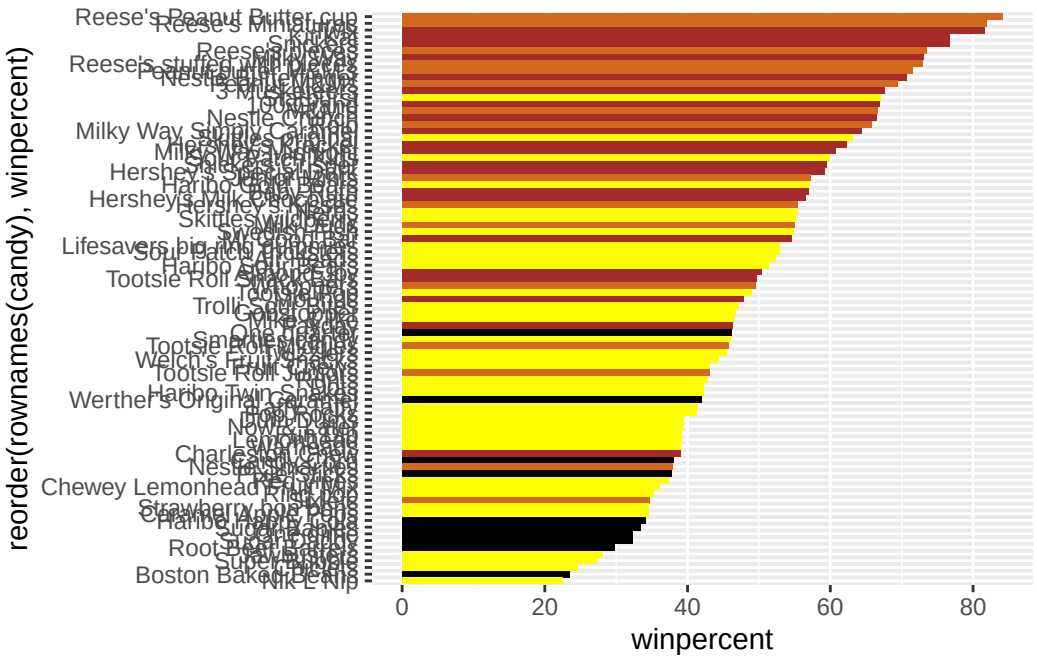
```
as.logical(candy$chocolate)
```

```
 [1]  TRUE  TRUE FALSE FALSE FALSE  TRUE  TRUE FALSE FALSE FALSE  TRUE FALSE
[13] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE  TRUE  TRUE
[25]  TRUE  TRUE FALSE  TRUE  TRUE FALSE FALSE FALSE  TRUE  TRUE FALSE  TRUE
[37]  TRUE  TRUE  TRUE  TRUE  TRUE FALSE  TRUE  TRUE FALSE FALSE FALSE  TRUE
[49] FALSE FALSE FALSE  TRUE  TRUE  TRUE  TRUE FALSE  TRUE FALSE FALSE  TRUE
[61] FALSE FALSE  TRUE FALSE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE FALSE
[73] FALSE FALSE  TRUE  TRUE  TRUE  TRUE FALSE  TRUE FALSE FALSE FALSE FALSE
[85]  TRUE
```

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

```
 [1] "brown"     "brown"     "black"     "black"     "yellow"    "brown"
 [7] "brown"     "black"     "black"     "yellow"    "brown"     "yellow"
[13] "yellow"    "yellow"    "yellow"    "yellow"    "yellow"    "yellow"
[19] "yellow"    "black"     "yellow"    "yellow"    "chocolate" "brown"
[25] "brown"     "brown"     "yellow"    "chocolate" "brown"     "yellow"
[31] "yellow"    "yellow"    "chocolate" "chocolate" "yellow"    "chocolate"
[37] "brown"     "brown"     "brown"     "brown"     "brown"     "yellow"
[43] "brown"     "brown"     "yellow"    "yellow"    "brown"     "chocolate"
[49] "black"     "yellow"    "yellow"    "chocolate" "chocolate" "chocolate"
[55] "chocolate" "yellow"    "chocolate" "black"     "yellow"    "chocolate"
[61] "yellow"    "yellow"    "chocolate" "yellow"    "brown"     "brown"
[67] "yellow"    "yellow"    "yellow"    "yellow"    "black"     "black"
[73] "yellow"    "yellow"    "yellow"    "chocolate" "chocolate" "brown"
[79] "yellow"    "brown"     "yellow"    "yellow"    "yellow"    "black"
[85] "chocolate"
```

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

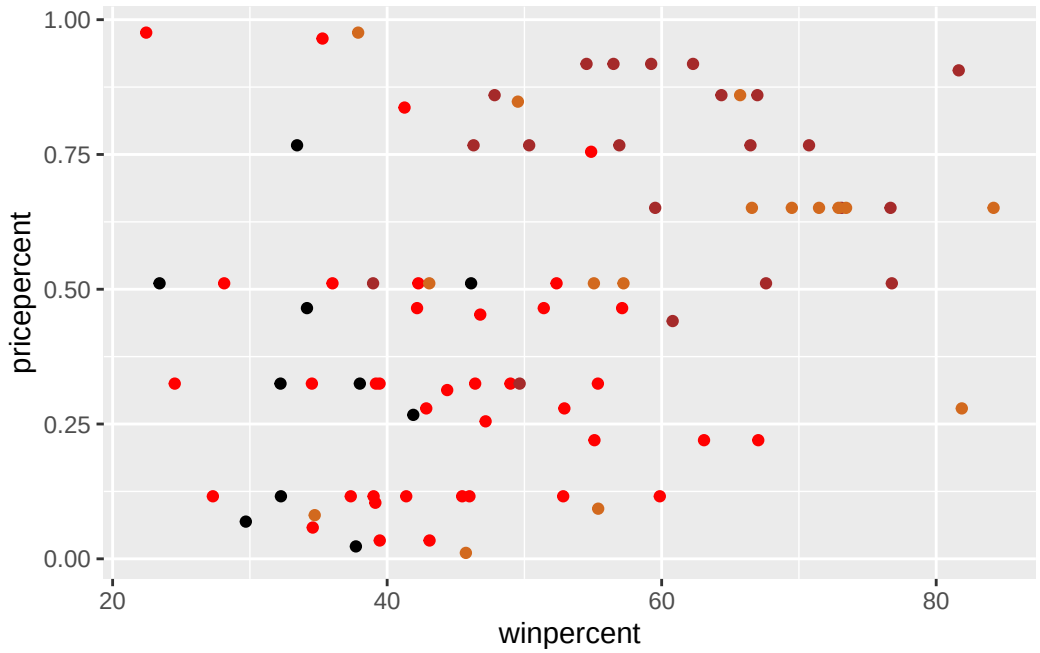


Winpercent and Pricepercent

A plot with both variables/columns winpercent and pricepercent

```
my_cols[as.logical(candy$fruity)] <- "red"

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



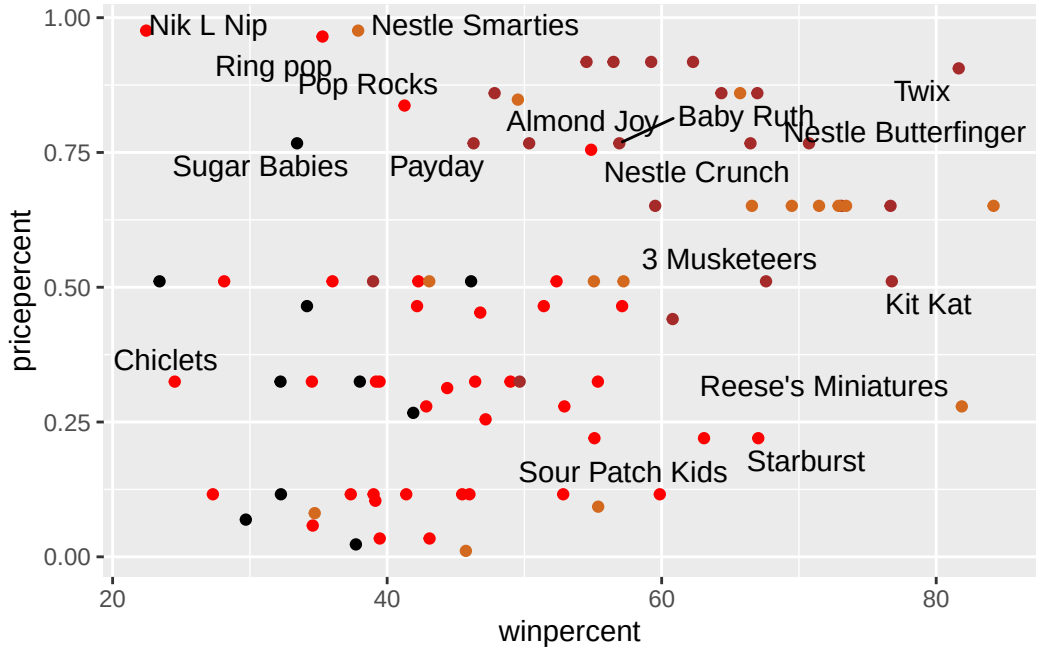

```
geom_text()
```

```
geom_text: na.rm = FALSE, parse = FALSE, check_overlap = FALSE, size.unit = mm
stat_identity: na.rm = FALSE
position_nudge
```

```
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
```



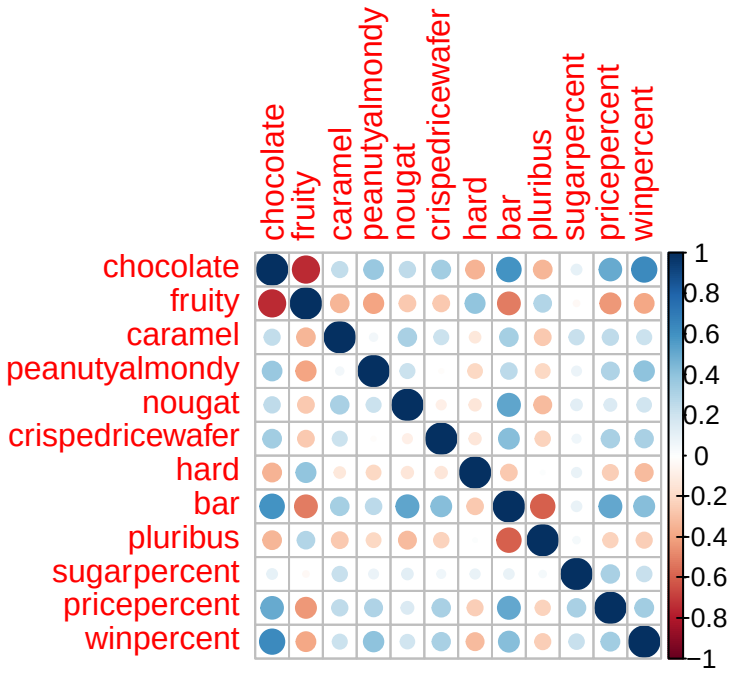
Exploring the correlation structure

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 0.95 loaded
```

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



Principal Component Analysis

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

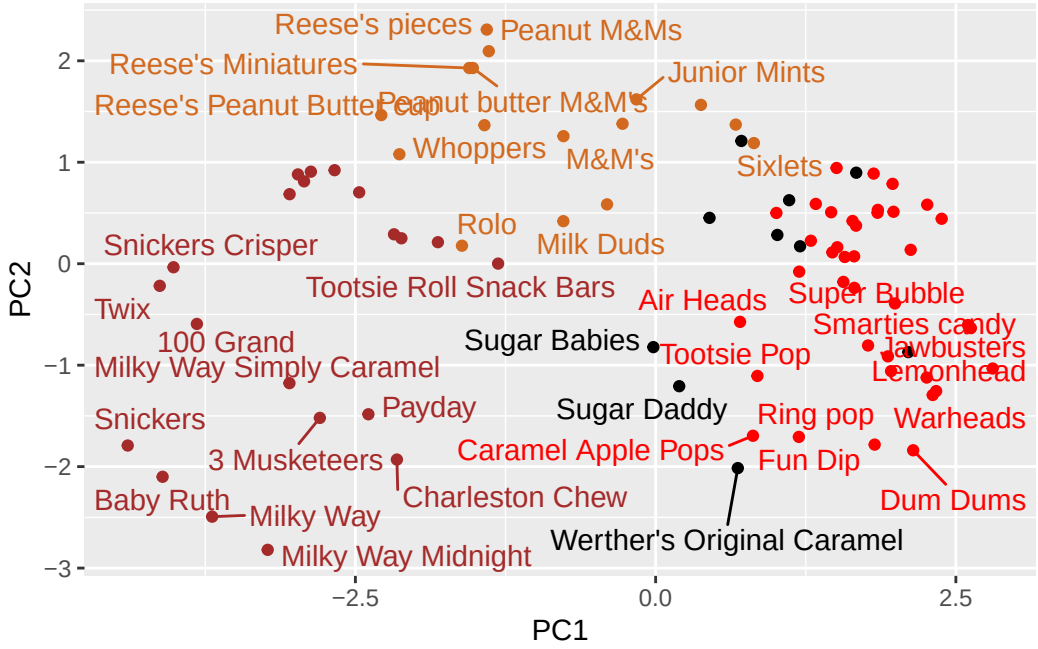
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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

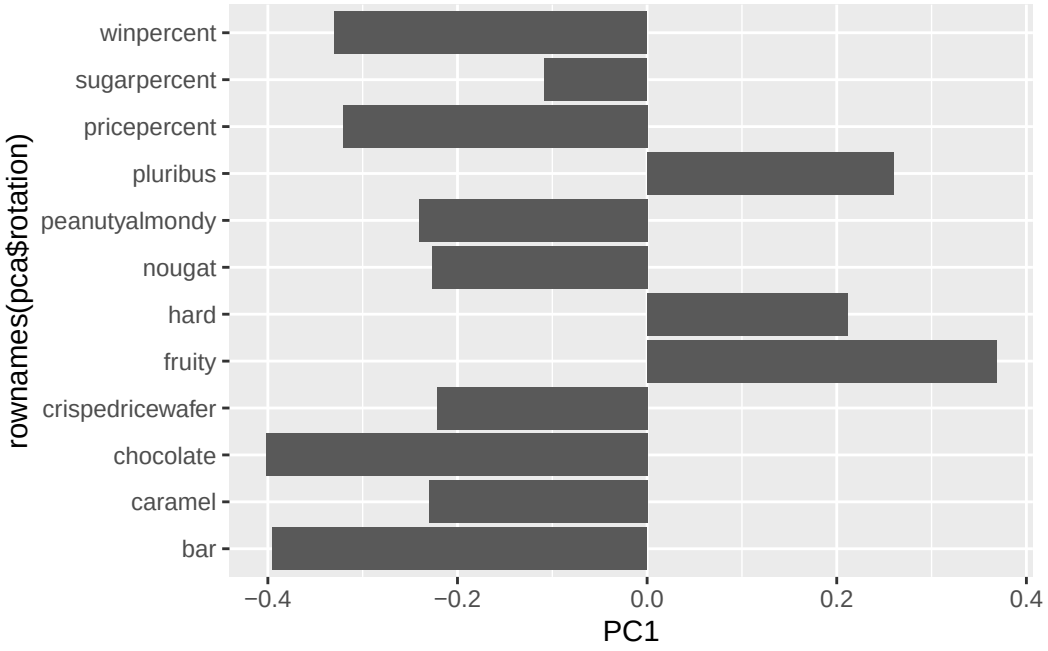
```
ggplot(pca$x) +
  aes(PC1, PC2, label=rownames(pca$x)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols)
```

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



We should also examine the variable "loadings" or contributions of the original 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 interactive and will 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)
```