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.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
```

```
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["Hershey's Milk Chocolate", ]$winpercent
```

```
[1] 56.4905
```

```
library(dplyr)

candy |>
  filter(rownames(candy) == "Hershey's Milk Chocolate") |>
  select(winpercent)
```

```
                         winpercent
Hershey's Milk Chocolate    56.4905
```

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

```
candy |>
  filter(rownames(candy) == "Kit Kat") |>
  select(winpercent)
```

```
        winpercent
Kit Kat    76.7686
```

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

```
candy |>
  filter(rownames(candy) == "Tootsie Roll Snack Bars") |>
  select(winpercent)
```

```
                         winpercent
Tootsie Roll Snack Bars    49.6535
```

Quick Overview of the dataset

```
library("skimr")
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	

Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset?

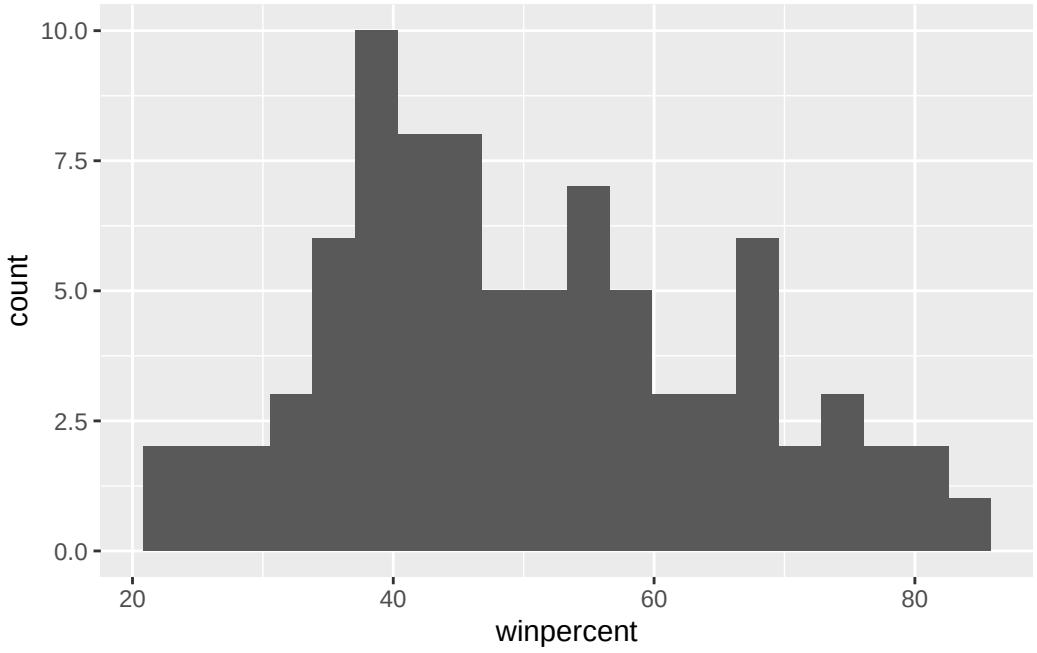
The winpercent is on 0-100 scale and the rest are 0-1 scale.

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

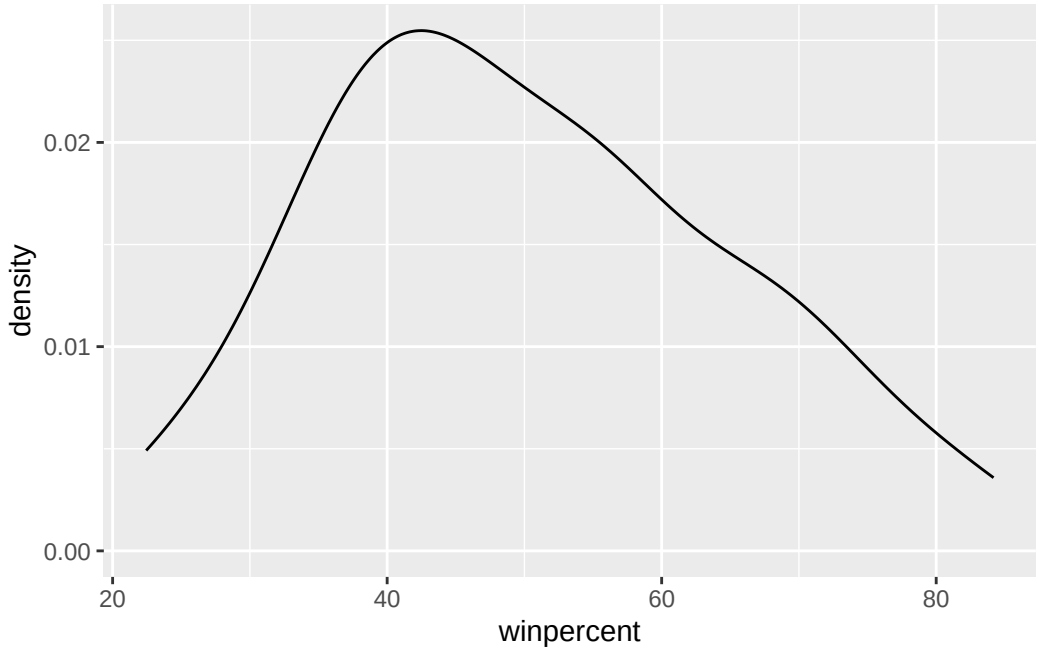
That the candy does not contain chocolate.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)

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




```
library(ggplot2)

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



Q9. Is the distribution of winpercent values symmetrical?

Based on the summary statistics, the mean (50.32) is greater than the median (47.83), and the maximum (84.18) is much farther from the median than the minimum (22.45). The distribution is not symmetrical; it is right-skewed (positively skewed)

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 
```

The median winpercent is 47.83, which is below 50%. Therefore, the center of the distribution is below 50%

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

Chocolate is higher ranked on average.

```
# 1. Find all chocolate candy in the dataset.
# 2, Find their winpercent values
# 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.win <- mean(choc.win)
choc.win
```

```
[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)

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

```
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?

Yes, the difference is 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
```

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)
```

```
[1]  1  4  5 10
```

```
#sort(x)
#(candy$wonpercent)
```

```
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?

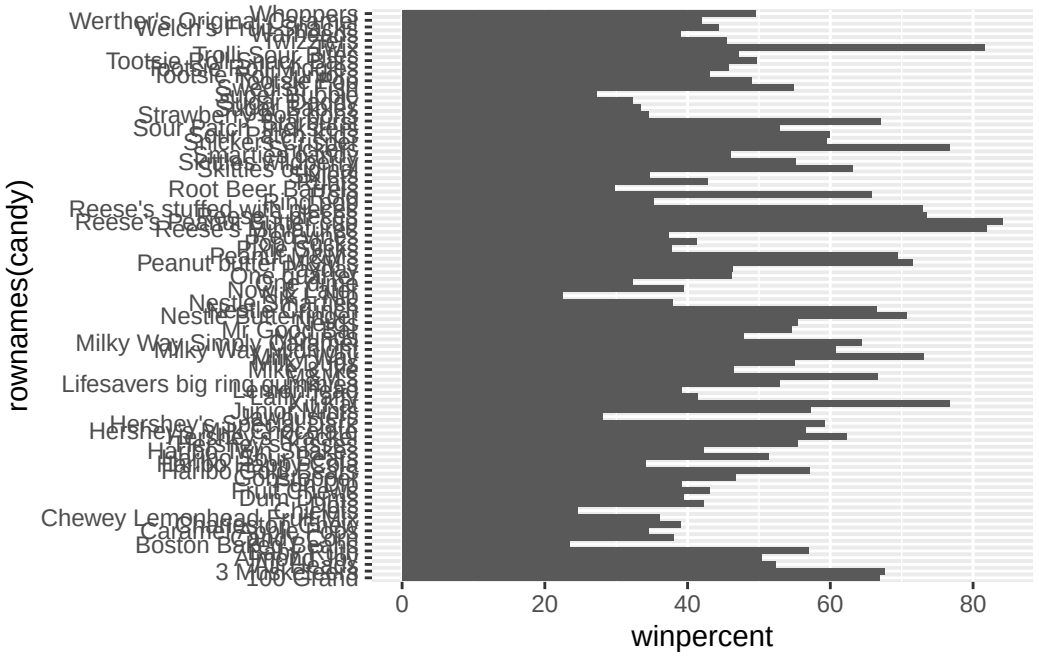
```
candy |>
  arrange(-winpercent) |>
  head(5)
```

```
                          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
```

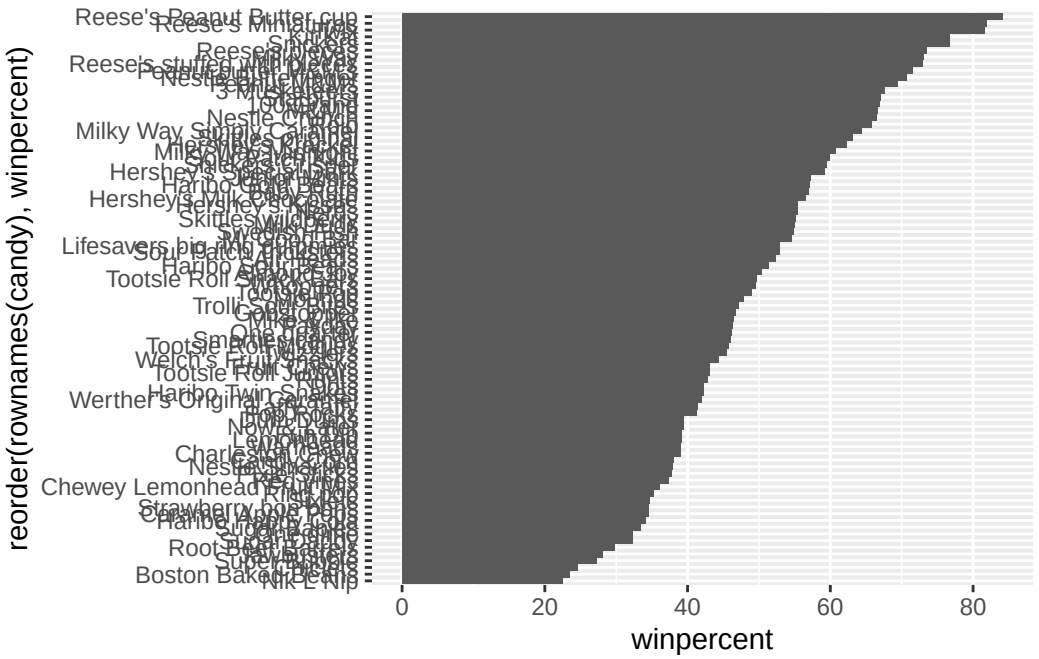
Q15. Make a first barplot of candy ranking based on winpercent values.

```
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()
```

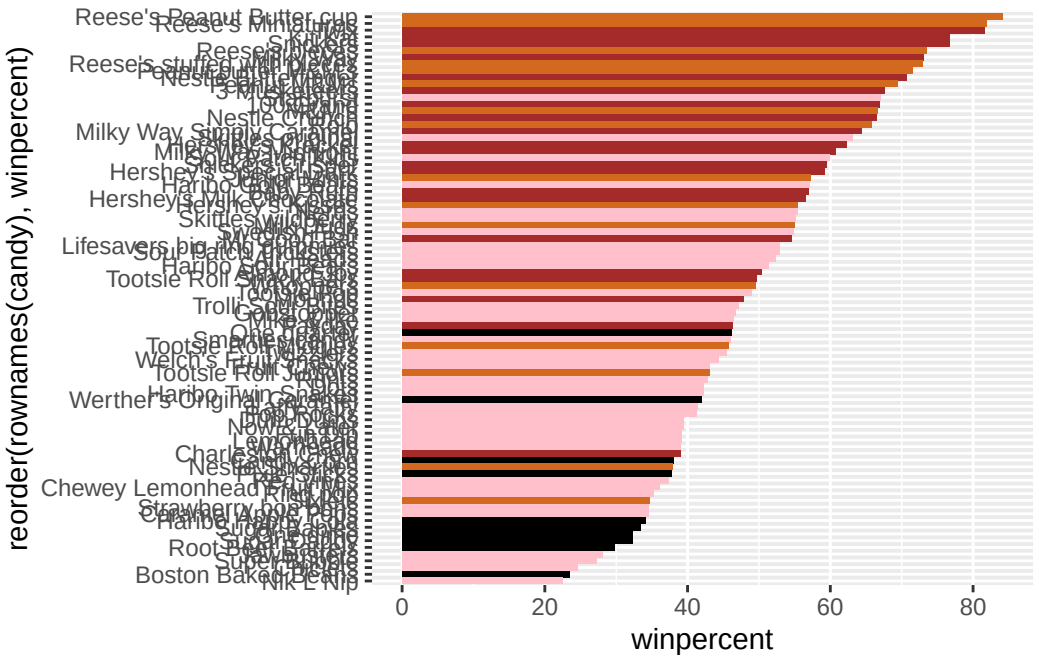


Add some colors based on the "type of candy"

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

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

```
ggplot(candy) +
  aes(x=winpercent,
      y=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?

```
candy |>
  dplyr::filter(chocolate == 1) |>
  dplyr::slice_min(winpercent, n = 1, with_ties = FALSE)
```

```
        chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Sixlets         1      0       0              0      0                 0    0
        bar pluribus sugarpercent pricepercent winpercent
Sixlets   0        1         0.22        0.081     34.722
```

Sixlets.

Q18. What is the best ranked fruity candy?

```
candy |>
  dplyr::filter(fruity == 1) |>
  dplyr::slice_max(winpercent, n = 1, with_ties = FALSE)
```

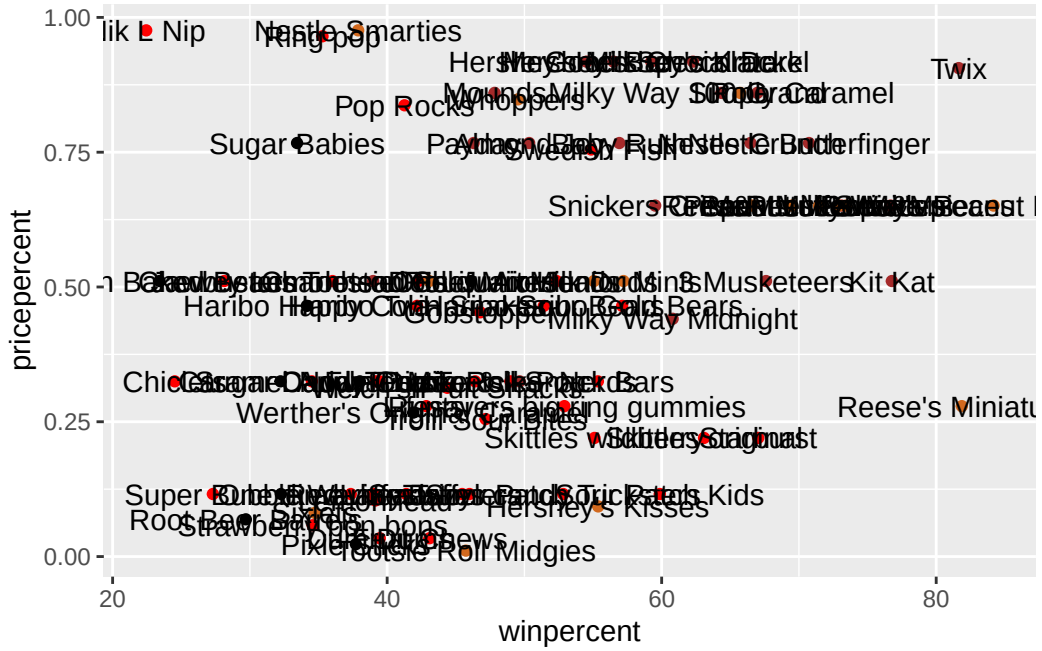
```
          chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Starburst         0      1       0              0      0                 0    0
          bar pluribus sugarpercent pricepercent winpercent
Starburst   0        1        0.151         0.22   67.03763
```

Starburst.

Winpercent and Pricepercent

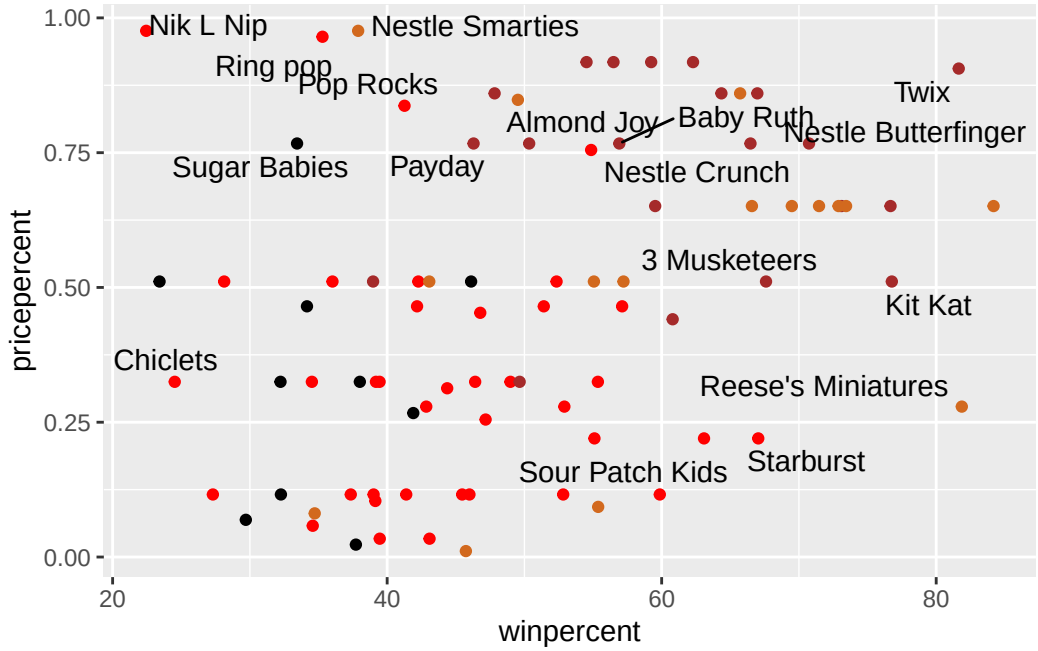
A plot with both variables/columns winpercent and pricepercent

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

ggplot(candy) +
  aes(x=winpercent, y=pricepercent, label=row.names(candy)) +
  geom_point(col=my_cols) +
  geom_text()
```



```
library(ggrepel)

ggplot(candy) +
  aes(x=winpercent, y=pricepercent, label=row.names(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?

```
candy |>
  dplyr::mutate(type = dplyr::case_when(chocolate == 1 & bar == 1 ~ "chocolate bar",
                                        chocolate == 1 & bar == 0 ~ "chocolate other",
                                        fruity == 1 ~ "fruity",
                                        TRUE ~ "other")) |>
  dplyr::group_by(type) |>
  dplyr::summarise(mean_win = mean(winpercent, na.rm = TRUE),
                   mean_price = mean(pricepercent, na.rm = TRUE), .groups = "drop") |>
```

```
  dplyr::mutate(score = dplyr::min_rank(mean_price) + dplyr::min_rank(dplyr::desc(mean_win))) |>
  dplyr::slice_min(score, n = 1, with_ties = FALSE)
```

```
# A tibble: 1 x 4
  type   mean_win mean_price score
  <chr>     <dbl>      <dbl> <int>
1 fruity     44.0      0.333     4
```

Fruity type is the highest ranked in terms of winpercent for the least money.

```
candy |>
  dplyr::mutate(score = dplyr::min_rank(pricepercent) +
                  dplyr::min_rank(dplyr::desc(winpercent))) |>
  dplyr::slice_min(score, n = 1, with_ties = FALSE)
```

```
                  chocolate fruity caramel peanutyalmondy nougat
Reese's Miniatures         1      0       0              1      0
                  crispedricewafer hard bar pluribus sugarpercent pricepercent
Reese's Miniatures                0    0   0        0        0.034        0.279
                  winpercent score
Reese's Miniatures   81.86626    26
```

Reese's Miniatures is the highest single candy 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?

```
candy |>
  arrange(-pricepercent) |>
  head(5)
```

```
                        chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                       0      1       0              0      0
Nestle Smarties                 1      0       0              0      0
Ring pop                        0      1       0              0      0
Hershey's Krackel               1      0       0              0      0
Hershey's Milk Chocolate        1      0       0              0      0
                        crispedricewafer hard bar pluribus sugarpercent
Nik L Nip                              0    0   0        1        0.197
```

```
Nestle Smarties                         0    0   0        1        0.267
Ring pop                                0    1   0        0        0.732
Hershey's Krackel                       1    0   1        0        0.430
Hershey's Milk Chocolate                0    0   1        0        0.430
                          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
```

```
candy |>
  arrange(-pricepercent) |>
  head(5)|>
  dplyr::slice_min(winpercent, n = 1, with_ties = FALSE)
```

```
          chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Nik L Nip         0      1       0              0      0                 0    0
          bar pluribus sugarpercent pricepercent winpercent
Nik L Nip   0        1        0.197        0.976   22.44534
```

Nik L Nip, Ring Pop, Nestlé Smarties, Hershey's Krackel, Hershey's Milk Chocolate. Among these, the least popular (lowest winpercent) is Nik L Nip.

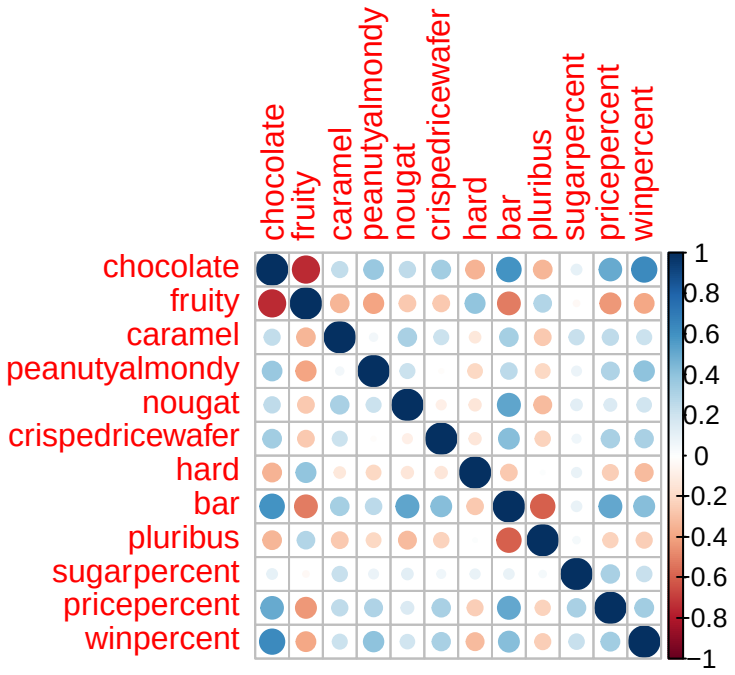
Exploring the correlation structure

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)
```




```
cij
```

	chocolate	fruity	caramel	peanutyalmondy	nougat
chocolate	1.0000000	-0.74172106	0.24987535	0.37782357	0.25489183
fruity	-0.7417211	1.00000000	-0.33548538	-0.39928014	-0.26936712
caramel	0.2498753	-0.33548538	1.00000000	0.05935614	0.32849280
peanutyalmondy	0.3778236	-0.39928014	0.05935614	1.00000000	0.21311310
nougat	0.2548918	-0.26936712	0.32849280	0.21311310	1.00000000
crispedricewafer	0.3412098	-0.26936712	0.21311310	-0.01764631	-0.08974359
hard	-0.3441769	0.39067750	-0.12235513	-0.20555661	-0.13867505
bar	0.5974211	-0.51506558	0.33396002	0.26041960	0.52297636
pluribus	-0.3396752	0.29972522	-0.26958501	-0.20610932	-0.31033884
sugarpercent	0.1041691	-0.03439296	0.22193335	0.08788927	0.12308135
pricepercent	0.5046754	-0.43096853	0.25432709	0.30915323	0.15319643
winpercent	0.6365167	-0.38093814	0.21341630	0.40619220	0.19937530

	crispedricewafer	hard	bar	pluribus
chocolate	0.34120978	-0.34417691	0.59742114	-0.33967519
fruity	-0.26936712	0.39067750	-0.51506558	0.29972522
caramel	0.21311310	-0.12235513	0.33396002	-0.26958501
peanutyalmondy	-0.01764631	-0.20555661	0.26041960	-0.20610932
nougat	-0.08974359	-0.13867505	0.52297636	-0.31033884
crispedricewafer	1.00000000	-0.13867505	0.42375093	-0.22469338

```
hard                -0.13867505  1.00000000 -0.26516504  0.01453172
bar                  0.42375093 -0.26516504  1.00000000 -0.59340892
pluribus            -0.22469338  0.01453172 -0.59340892  1.00000000
sugarpercent         0.06994969  0.09180975  0.09998516  0.04552282
pricepercent         0.32826539 -0.24436534  0.51840654 -0.22079363
winpercent           0.32467965 -0.31038158  0.42992933 -0.24744787
                  sugarpercent pricepercent winpercent
chocolate           0.10416906    0.5046754  0.6365167
fruity             -0.03439296   -0.4309685 -0.3809381
caramel             0.22193335    0.2543271  0.2134163
peanutyalmondy      0.08788927    0.3091532  0.4061922
nougat              0.12308135    0.1531964  0.1993753
crispedricewafer    0.06994969    0.3282654  0.3246797
hard                0.09180975   -0.2443653 -0.3103816
bar                 0.09998516    0.5184065  0.4299293
pluribus            0.04552282   -0.2207936 -0.2474479
sugarpercent        1.00000000    0.3297064  0.2291507
pricepercent        0.32970639    1.0000000  0.3453254
winpercent          0.22915066    0.3453254  1.0000000
```

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

Chocolaty and Fruity, bar and pluribus. etc.

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

Chocolaty and bar, fruity and hard, etc.

Principle Componenet Analysis

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

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

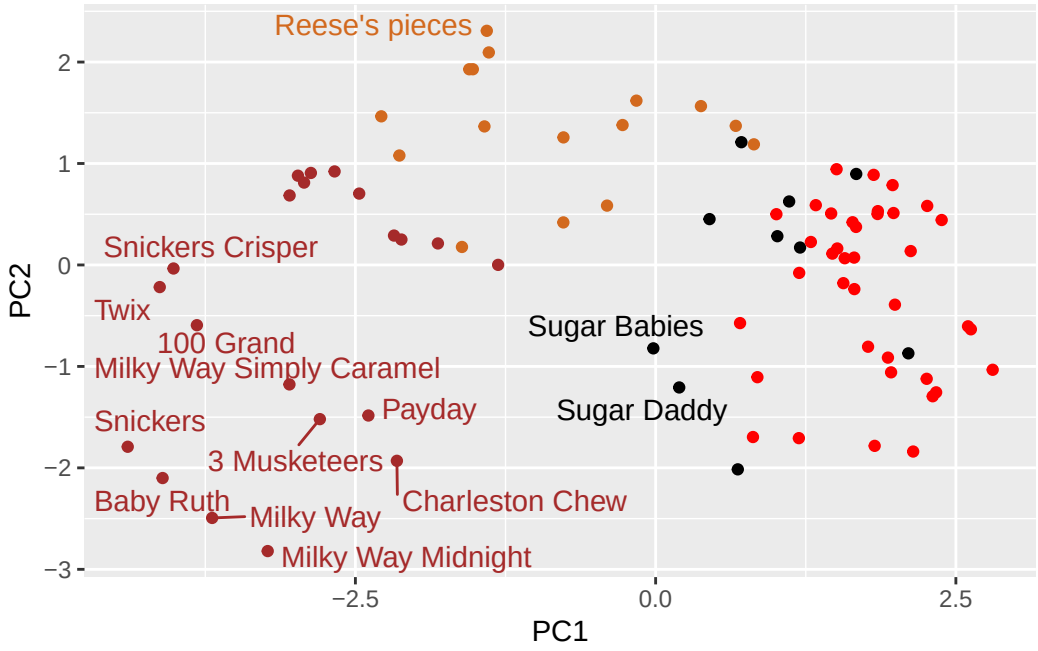
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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$x, aes(PC1, PC2)) +
  geom_point(col=my_cols) +
  geom_text_repel(aes(label = rownames(pca$x)), col = my_cols, max.overlaps = 5)
```

```
Warning: ggrepel: 71 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



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 :-(

```
#install.packages("plotly")
library(plotly)
```

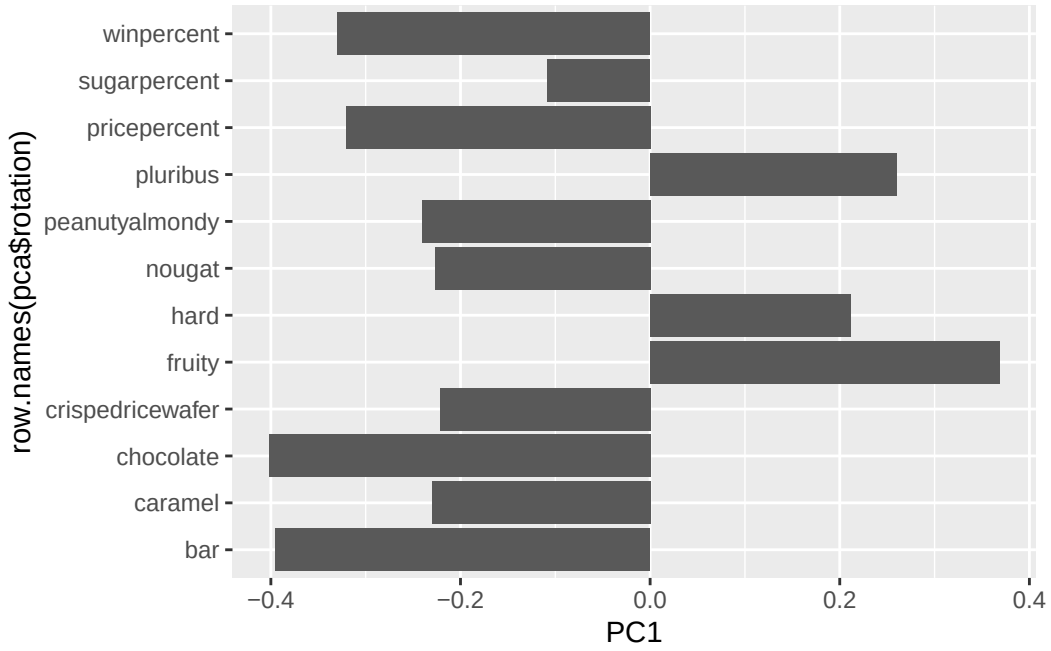
```
Attaching package: 'plotly'
```

```
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)
```

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

```
ggplot(pca$rotation)+
  aes(PC1, row.names(pca$rotation))+
  geom_col()
```



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

fruity, pluribus, and hard load strongly positive on PC1.

PC1 is separating non-chocolate/fruit-style, hard, multipack candies on the positive side from chocolate/bar/price/winpercent features on the negative side—matching the known opposition between chocolate and fruity and the similarity between chocolate and bar.