class10

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Background

Here we explore 538 Halloween candy data. They recently ran a rather large poll to determine which candy their readers like best. From their website: "While we don't know who exactly voted, we do know this: 8,371 different IP addresses voted on about 269,000 randomly generated candy matchups".

We can import the data and download it into our directory using `read.csv()`

Importing candy data

```
candy_file <- read.csv("https://raw.githubusercontent.com/fivethirtyeight/data/master/cand
candy_file
```

	chocolate	fruity	caramel	peanutyalmondy	nougat
100 Grand	1	0	1	0	0
3 Musketeers	1	0	0	0	1
One dime	0	0	0	0	0
One quarter	0	0	0	0	0
Air Heads	0	1	0	0	0
Almond Joy	1	0	0	1	0
Baby Ruth	1	0	1	1	1
Boston Baked Beans	0	0	0	1	0
Candy Corn	0	0	0	0	0
Caramel Apple Pops	0	1	1	0	0
Charleston Chew	1	0	0	0	1
Chewey Lemonhead Fruit Mix	0	1	0	0	0
Chiclets	0	1	0	0	0
Dots	0	1	0	0	0
Dum Dums	0	1	0	0	0

Fruit Chews	0	1	0	0	0
Fun Dip	0	1	0	0	0
Gobstopper	0	1	0	0	0
Haribo Gold Bears	0	1	0	0	0
Haribo Happy Cola	0	0	0	0	0
Haribo Sour Bears	0	1	0	0	0
Haribo Twin Snakes	0	1	0	0	0
HersheyÕs Kisses	1	0	0	0	0
HersheyÕs Krackel	1	0	0	0	0
HersheyÕs Milk Chocolate	1	0	0	0	0
HersheyÕs Special Dark	1	0	0	0	0
Jawbusters	0	1	0	0	0
Junior Mints	1	0	0	0	0
Kit Kat	1	0	0	0	0
Laffy Taffy	0	1	0	0	0
Lemonhead	0	1	0	0	0
Lifesavers big ring gummies	0	1	0	0	0
Peanut butter M&MÕs	1	0	0	1	0
M&MÕs	1	0	0	0	0
Mike & Ike	0	1	0	0	0
Milk Duds	1	0	1	0	0
Milky Way	1	0	1	0	1
Milky Way Midnight	1	0	1	0	1
Milky Way Simply Caramel	1	0	1	0	0
Mounds	1	0	0	0	0
Mr Good Bar	1	0	0	1	0
Nerds	0	1	0	0	0
Nestle Butterfinger	1	0	0	1	0
Nestle Crunch	1	0	0	0	0
Nik L Nip	0	1	0	0	0
Now & Later	0	1	0	0	0
Payday	0	0	0	1	1
Peanut M&Ms	1	0	0	1	0
Pixie Sticks	0	0	0	0	0
Pop Rocks	0	1	0	0	0
Red vines	0	1	0	0	0
ReeseÕs Miniatures	1	0	0	1	0
ReeseÕs Peanut Butter cup	1	0	0	1	0
ReeseÕs pieces	1	0	0	1	0
ReeseÕs stuffed with pieces	1	0	0	1	0
Ring pop	0	1	0	0	0
Rolo	1	0	1	0	0
Root Beer Barrels	0	0	0	0	0

Runts	0	1	0	0	0
Sixlets	1	0	0	0	0
Skittles original	0	1	0	0	0
Skittles wildberry	0	1	0	0	0
Nestle Smarties	1	0	0	0	0
Smarties candy	0	1	0	0	0
Snickers	1	0	1	1	1
Snickers Crisper	1	0	1	1	0
Sour Patch Kids	0	1	0	0	0
Sour Patch Tricksters	0	1	0	0	0
Starburst	0	1	0	0	0
Strawberry bon bons	0	1	0	0	0
Sugar Babies	0	0	1	0	0
Sugar Daddy	0	0	1	0	0
Super Bubble	0	1	0	0	0
Swedish Fish	0	1	0	0	0
Tootsie Pop	1	1	0	0	0
Tootsie Roll Juniors	1	0	0	0	0
Tootsie Roll Midgies	1	0	0	0	0
Tootsie Roll Snack Bars	1	0	0	0	0
Trolli Sour Bites	0	1	0	0	0
Twix	1	0	1	0	0
Twizzlers	0	1	0	0	0
Warheads	0	1	0	0	0
WelchÕs Fruit Snacks	0	1	0	0	0
WertherÕs Original Caramel	0	0	1	0	0
Whoppers	1	0	0	0	0

	crispedricewafer	hard	bar	pluribus	sugarpercent
100 Grand	1	0	1	0	0.732
3 Musketeers	0	0	1	0	0.604
One dime	0	0	0	0	0.011
One quarter	0	0	0	0	0.011
Air Heads	0	0	0	0	0.906
Almond Joy	0	0	1	0	0.465
Baby Ruth	0	0	1	0	0.604
Boston Baked Beans	0	0	0	1	0.313
Candy Corn	0	0	0	1	0.906
Caramel Apple Pops	0	0	0	0	0.604
Charleston Chew	0	0	1	0	0.604
Chewey Lemonhead Fruit Mix	0	0	0	1	0.732
Chiclets	0	0	0	1	0.046
Dots	0	0	0	1	0.732
Dum Dums	0	1	0	0	0.732

Fruit Chews	0	0	0	1	0.127
Fun Dip	0	1	0	0	0.732
Gobstopper	0	1	0	1	0.906
Haribo Gold Bears	0	0	0	1	0.465
Haribo Happy Cola	0	0	0	1	0.465
Haribo Sour Bears	0	0	0	1	0.465
Haribo Twin Snakes	0	0	0	1	0.465
HersheyÕs Kisses	0	0	0	1	0.127
HersheyÕs Krackel	1	0	1	0	0.430
HersheyÕs Milk Chocolate	0	0	1	0	0.430
HersheyÕs Special Dark	0	0	1	0	0.430
Jawbusters	0	1	0	1	0.093
Junior Mints	0	0	0	1	0.197
Kit Kat	1	0	1	0	0.313
Laffy Taffy	0	0	0	0	0.220
Lemonhead	0	1	0	0	0.046
Lifesavers big ring gummies	0	0	0	0	0.267
Peanut butter M&MÕs	0	0	0	1	0.825
M&MÕs	0	0	0	1	0.825
Mike & Ike	0	0	0	1	0.872
Milk Duds	0	0	0	1	0.302
Milky Way	0	0	1	0	0.604
Milky Way Midnight	0	0	1	0	0.732
Milky Way Simply Caramel	0	0	1	0	0.965
Mounds	0	0	1	0	0.313
Mr Good Bar	0	0	1	0	0.313
Nerds	0	1	0	1	0.848
Nestle Butterfinger	0	0	1	0	0.604
Nestle Crunch	1	0	1	0	0.313
Nik L Nip	0	0	0	1	0.197
Now & Later	0	0	0	1	0.220
Payday	0	0	1	0	0.465
Peanut M&Ms	0	0	0	1	0.593
Pixie Sticks	0	0	0	1	0.093
Pop Rocks	0	1	0	1	0.604
Red vines	0	0	0	1	0.581
ReeseÕs Miniatures	0	0	0	0	0.034
ReeseÕs Peanut Butter cup	0	0	0	0	0.720
ReeseÕs pieces	0	0	0	1	0.406
ReeseÕs stuffed with pieces	0	0	0	0	0.988
Ring pop	0	1	0	0	0.732
Rolo	0	0	0	1	0.860
Root Beer Barrels	0	1	0	1	0.732

Runts	0	1	0	1	0.872
Sixlets	0	0	0	1	0.220
Skittles original	0	0	0	1	0.941
Skittles wildberry	0	0	0	1	0.941
Nestle Smarties	0	0	0	1	0.267
Smarties candy	0	1	0	1	0.267
Snickers	0	0	1	0	0.546
Snickers Crisper	1	0	1	0	0.604
Sour Patch Kids	0	0	0	1	0.069
Sour Patch Tricksters	0	0	0	1	0.069
Starburst	0	0	0	1	0.151
Strawberry bon bons	0	1	0	1	0.569
Sugar Babies	0	0	0	1	0.965
Sugar Daddy	0	0	0	0	0.418
Super Bubble	0	0	0	0	0.162
Swedish Fish	0	0	0	1	0.604
Tootsie Pop	0	1	0	0	0.604
Tootsie Roll Juniors	0	0	0	0	0.313
Tootsie Roll Midgies	0	0	0	1	0.174
Tootsie Roll Snack Bars	0	0	1	0	0.465
Trolli Sour Bites	0	0	0	1	0.313
Twix	1	0	1	0	0.546
Twizzlers	0	0	0	0	0.220
Warheads	0	1	0	0	0.093
WelchÕs Fruit Snacks	0	0	0	1	0.313
WertherÕs Original Caramel	0	1	0	0	0.186
Whoppers	1	0	0	1	0.872

	pricepercent	winpercent
100 Grand	0.860	66.97173
3 Musketeers	0.511	67.60294
One dime	0.116	32.26109
One quarter	0.511	46.11650
Air Heads	0.511	52.34146
Almond Joy	0.767	50.34755
Baby Ruth	0.767	56.91455
Boston Baked Beans	0.511	23.41782
Candy Corn	0.325	38.01096
Caramel Apple Pops	0.325	34.51768
Charleston Chew	0.511	38.97504
Chewey Lemonhead Fruit Mix	0.511	36.01763
Chiclets	0.325	24.52499
Dots	0.511	42.27208
Dum Dums	0.034	39.46056

Fruit Chews	0.034	43.08892
Fun Dip	0.325	39.18550
Gobstopper	0.453	46.78335
Haribo Gold Bears	0.465	57.11974
Haribo Happy Cola	0.465	34.15896
Haribo Sour Bears	0.465	51.41243
Haribo Twin Snakes	0.465	42.17877
HersheyÕs Kisses	0.093	55.37545
HersheyÕs Krackel	0.918	62.28448
HersheyÕs Milk Chocolate	0.918	56.49050
HersheyÕs Special Dark	0.918	59.23612
Jawbusters	0.511	28.12744
Junior Mints	0.511	57.21925
Kit Kat	0.511	76.76860
Laffy Taffy	0.116	41.38956
Lemonhead	0.104	39.14106
Lifesavers big ring gummies	0.279	52.91139
Peanut butter M&MÕs	0.651	71.46505
M&MÕs	0.651	66.57458
Mike & Ike	0.325	46.41172
Milk Duds	0.511	55.06407
Milky Way	0.651	73.09956
Milky Way Midnight	0.441	60.80070
Milky Way Simply Caramel	0.860	64.35334
Mounds	0.860	47.82975
Mr Good Bar	0.918	54.52645
Nerds	0.325	55.35405
Nestle Butterfinger	0.767	70.73564
Nestle Crunch	0.767	66.47068
Nik L Nip	0.976	22.44534
Now & Later	0.325	39.44680
Payday	0.767	46.29660
Peanut M&Ms	0.651	69.48379
Pixie Sticks	0.023	37.72234
Pop Rocks	0.837	41.26551
Red vines	0.116	37.34852
ReeseÕs Miniatures	0.279	81.86626
ReeseÕs Peanut Butter cup	0.651	84.18029
ReeseÕs pieces	0.651	73.43499
ReeseÕs stuffed with pieces	0.651	72.88790
Ring pop	0.965	35.29076
Rolo	0.860	65.71629
Root Beer Barrels	0.069	29.70369

```
Runts                              0.279   42.84914
Sixlets                            0.081   34.72200
Skittles original                  0.220   63.08514
Skittles wildberry                 0.220   55.10370
Nestle Smarties                    0.976   37.88719
Smarties candy                     0.116   45.99583
Snickers                           0.651   76.67378
Snickers Crisper                   0.651   59.52925
Sour Patch Kids                    0.116   59.86400
Sour Patch Tricksters              0.116   52.82595
Starburst                          0.220   67.03763
Strawberry bon bons                0.058   34.57899
Sugar Babies                       0.767   33.43755
Sugar Daddy                        0.325   32.23100
Super Bubble                       0.116   27.30386
Swedish Fish                       0.755   54.86111
Tootsie Pop                        0.325   48.98265
Tootsie Roll Juniors               0.511   43.06890
Tootsie Roll Midgies               0.011   45.73675
Tootsie Roll Snack Bars            0.325   49.65350
Trolli Sour Bites                  0.255   47.17323
Twix                               0.906   81.64291
Twizzlers                          0.116   45.46628
Warheads                           0.116   39.01190
WelchÕs Fruit Snacks               0.313   44.37552
WertherÕs Original Caramel         0.267   41.90431
Whoppers                           0.848   49.52411
```

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

```
nrow(candy_file)
```

```
[1] 85
```

There are 85 different candy types

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

There are 38 fruity candy types are in the dataset.

```
sum(candy_file$fruity)
```

```
[1] 38
```

What is your favorite candy?

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.

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

```
rownames(candy_file)
```

```
 [1] "100 Grand"                 "3 Musketeers"
 [3] "One dime"                  "One quarter"
 [5] "Air Heads"                 "Almond Joy"
 [7] "Baby Ruth"                 "Boston Baked Beans"
 [9] "Candy Corn"                "Caramel Apple Pops"
[11] "Charleston Chew"           "Chewey Lemonhead Fruit Mix"
[13] "Chiclets"                  "Dots"
[15] "Dum Dums"                  "Fruit Chews"
[17] "Fun Dip"                   "Gobstopper"
[19] "Haribo Gold Bears"         "Haribo Happy Cola"
[21] "Haribo Sour Bears"         "Haribo Twin Snakes"
[23] "HersheyÕs Kisses"          "HersheyÕs Krackel"
[25] "HersheyÕs Milk Chocolate"  "HersheyÕs Special Dark"
[27] "Jawbusters"                "Junior Mints"
[29] "Kit Kat"                   "Laffy Taffy"
[31] "Lemonhead"                 "Lifesavers big ring gummies"
[33] "Peanut butter M&MÕs"       "M&MÕs"
[35] "Mike & Ike"                "Milk Duds"
[37] "Milky Way"                 "Milky Way Midnight"
[39] "Milky Way Simply Caramel"  "Mounds"
[41] "Mr Good Bar"               "Nerds"
[43] "Nestle Butterfinger"       "Nestle Crunch"
[45] "Nik L Nip"                 "Now & Later"
[47] "Payday"                    "Peanut M&Ms"
[49] "Pixie Sticks"              "Pop Rocks"
[51] "Red vines"                 "ReeseÕs Miniatures"
[53] "ReeseÕs Peanut Butter cup" "ReeseÕs pieces"
[55] "ReeseÕs stuffed with pieces" "Ring pop"
[57] "Rolo"                      "Root Beer Barrels"
[59] "Runts"                     "Sixlets"
[61] "Skittles original"         "Skittles wildberry"
[63] "Nestle Smarties"           "Smarties candy"
```

```
[65] "Snickers"                    "Snickers Crisper"
[67] "Sour Patch Kids"             "Sour Patch Tricksters"
[69] "Starburst"                   "Strawberry bon bons"
[71] "Sugar Babies"                "Sugar Daddy"
[73] "Super Bubble"                "Swedish Fish"
[75] "Tootsie Pop"                 "Tootsie Roll Juniors"
[77] "Tootsie Roll Midgies"        "Tootsie Roll Snack Bars"
[79] "Trolli Sour Bites"           "Twix"
[81] "Twizzlers"                   "Warheads"
[83] "WelchÕs Fruit Snacks"        "WertherÕs Original Caramel"
[85] "Whoppers"
```

```
candy_file["Haribo Twin Snakes",]$winpercent
```

```
[1] 42.17877
```

My favorite candy in the dataset is the Haribo Twin Snakes and it's winpercent value is 42.18%.

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

The winpercent value for Kit Kat is 76.77%.

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

```
[1] 76.7686
```

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

The winpercent value is 49.65%

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

```
[1] 49.6535
```

Can use the `skimr` package and the `skim()` function to give a quick overview of the given dataset.

```
skimr::skim(candy_file)
```

Table 1: Data summary

Name	candy_file
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?

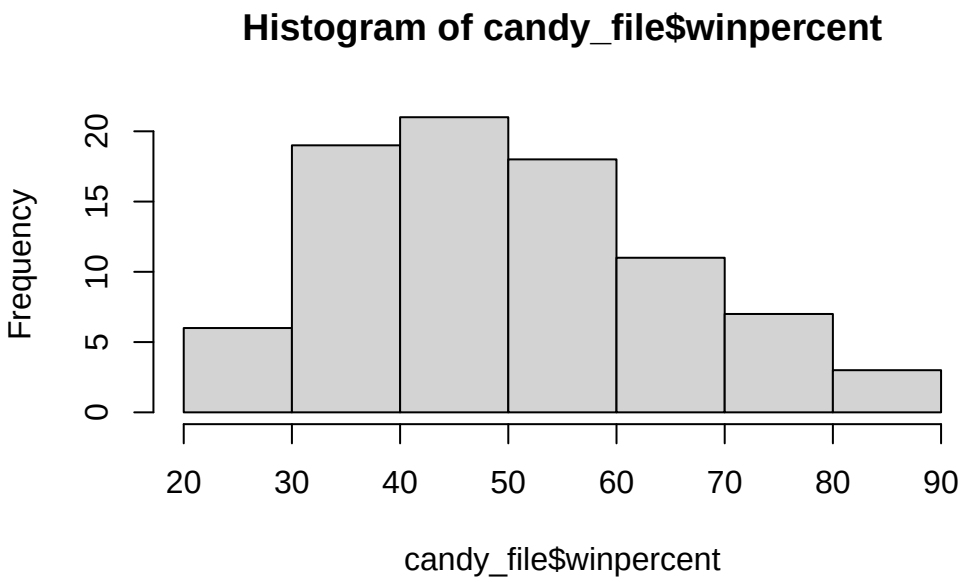
The variable winpercent seems to be on a different scale to the majority of the other rows. All of the columns seem to be on the same scale.

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

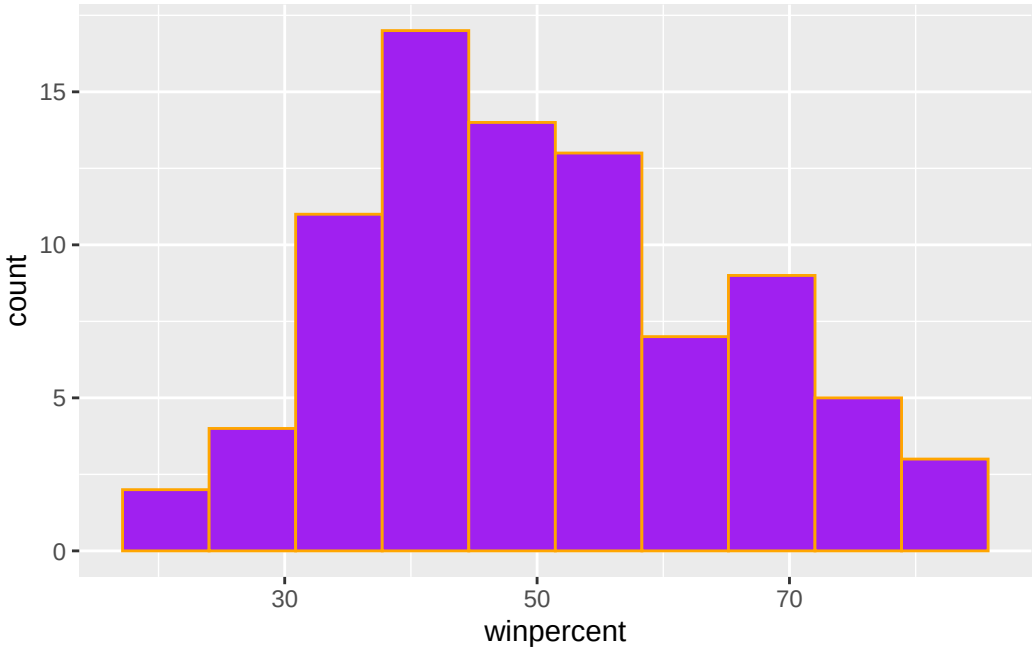
Zero represents false (meaning it is not chocolate) and one represents true which means it is chocolate.

Q8. Plot a histogram of winpercent values

```
hist(candy_file$winpercent)
```




```
library(ggplot2)

ggplot(candy_file) +
  aes(winpercent) +
  geom_histogram(bins=10, col="orange", fill="purple");
```



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent values are not symmetrical, most the of the data seems to be around the 40 winpercent mark. > 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?

On average the chocolate candy is higher rhanked than fruit candy (60.92% vs 44.12%).

```
chocolate.inds <- as.logical(candy_file$chocolate)
chocolate.wins <- candy_file[chocolate.inds, ]$winpercent
mean(chocolate.wins)
```

```
[1] 60.92153
```

```
fruity.inds <- as.logical(candy_file$fruity)

fruity.wins <-candy_file[fruity.inds, ]$winpercent
mean(fruity.wins)
```

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

The difference is statistically signficant because the p-value is 2.871e-08.

```
t.test(chocolate.wins, fruity.wins)
```

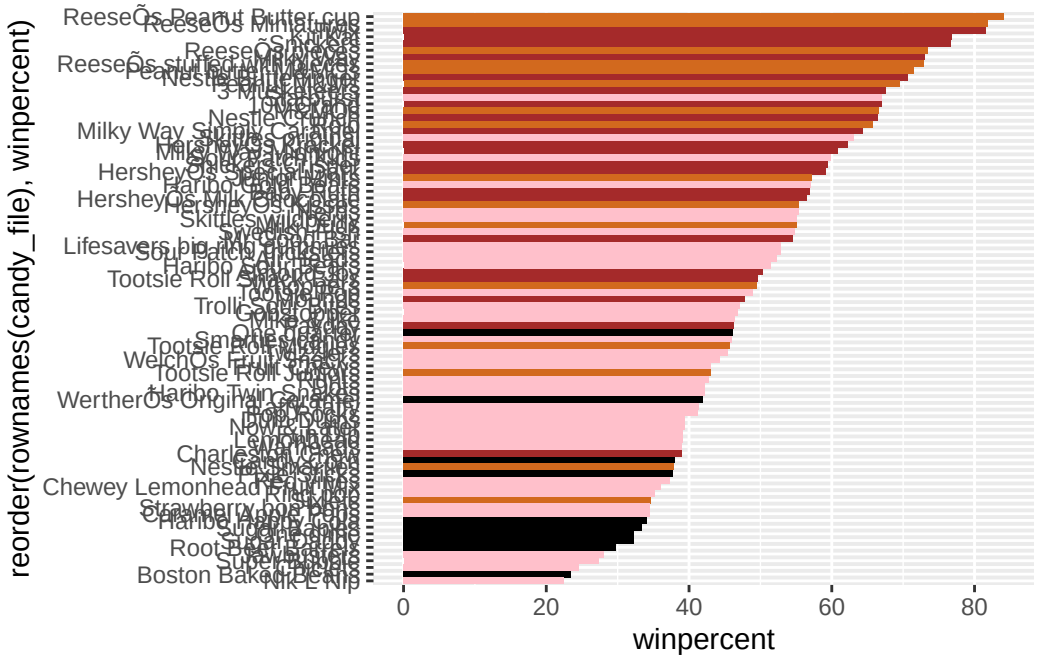
```
    Welch Two Sample t-test

data:  chocolate.wins and fruity.wins
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

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

Q15. Make a first barplot of candy ranking based on winpercent values. Q16. Use `reorder()` function to get the bars sorted by winpercent.

```
library(ggplot2)

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




```
ggsave("tmp.png")
```

```
Saving 5.5 x 3.5 in image
```

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.

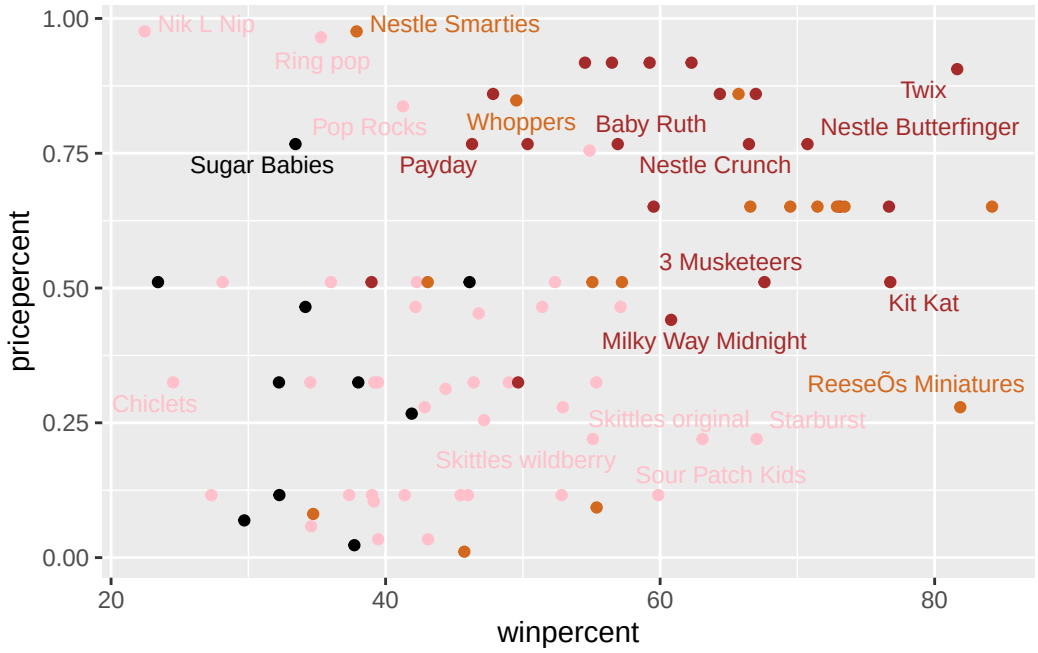
Taking a look at price percent

To figure out the value for money, or what is the best candy for the least money we can make a plot of `winpercent` vs the `pricepercent`

```
library(ggrepel)

# How about a plot of price vs win
ggplot(candy_file) +
  aes(winpercent, pricepercent, label=rownames(candy_file)) +
```

```
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=3.3, max.overlaps = 5)
```

```
Warning: ggrepel: 65 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?

The candy type that is the highest ranked in terms of winpercent for the least money is the Reese's Miniatures.

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

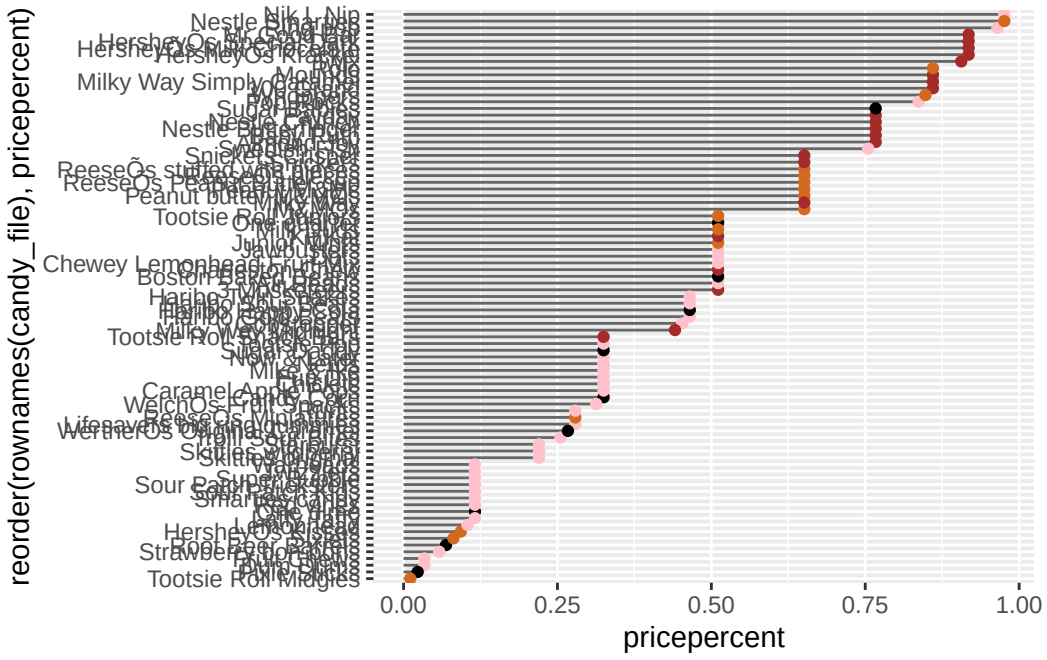
The top 5 most expensive candy types that are the least popular are Nik L Nip, Nestle Smarties, Ring Pops, Hershey's Krackel, Hershey's Milk Chocolate.

```
ord <- order(candy_file$pricepercent, decreasing = TRUE)
head( candy_file[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
```

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_file) +
  aes(pricepercent, reorder(rownames(candy_file), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy_file), pricepercent),
                   xend = 0), col="gray40") +
    geom_point(col = my_cols)
```



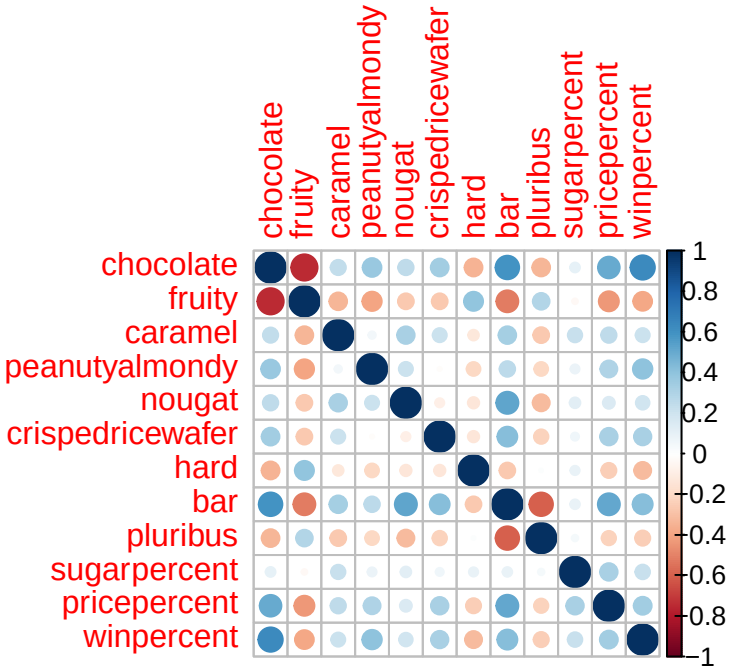
Exploring the correlation structure

Can explore the correlation of how variable interacts with one another using the `corrplot package` to plot a correlation matrix.

```
library(corrplot)
```

```
corrplot 0.92 loaded
```

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



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

Chocolate and fruit are anti-correlated and pluribus and bars are anticorrelated, and bars and fruity are anti correlated. > Q23. Similarly, what two variables are most positively correlated?

Chocolate and bar, choocolate and price percent, and chocolate and win percent are positively correlated.

Principal Component Analysis

Do PCA on this dataset to get a low dimensional view that hopefully captures the essential essence of the data.

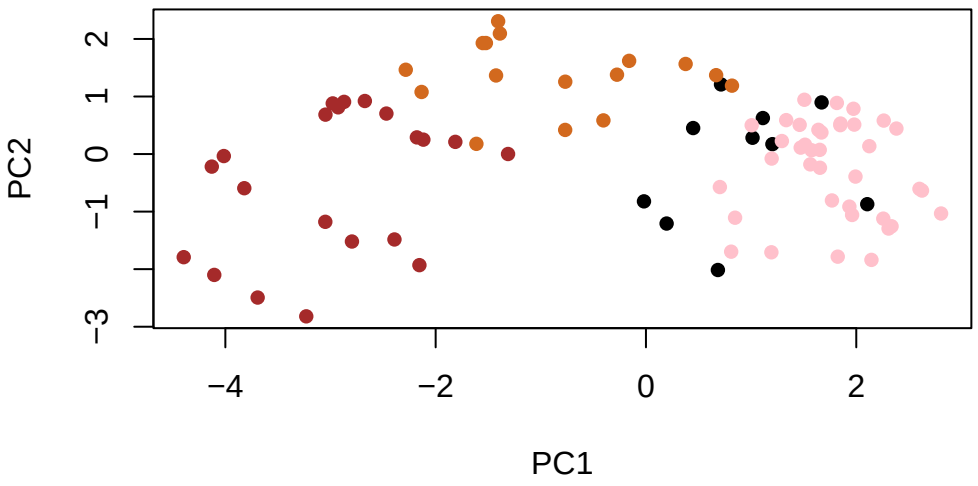
Use `prcomp()` function to our candy dataset and set `scale=TRUE` because the `winpercent` and `pricepercent` values are on a different scale.

```
pca <- prcomp(candy_file, 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
```

Now can plot PC1 vs PC2

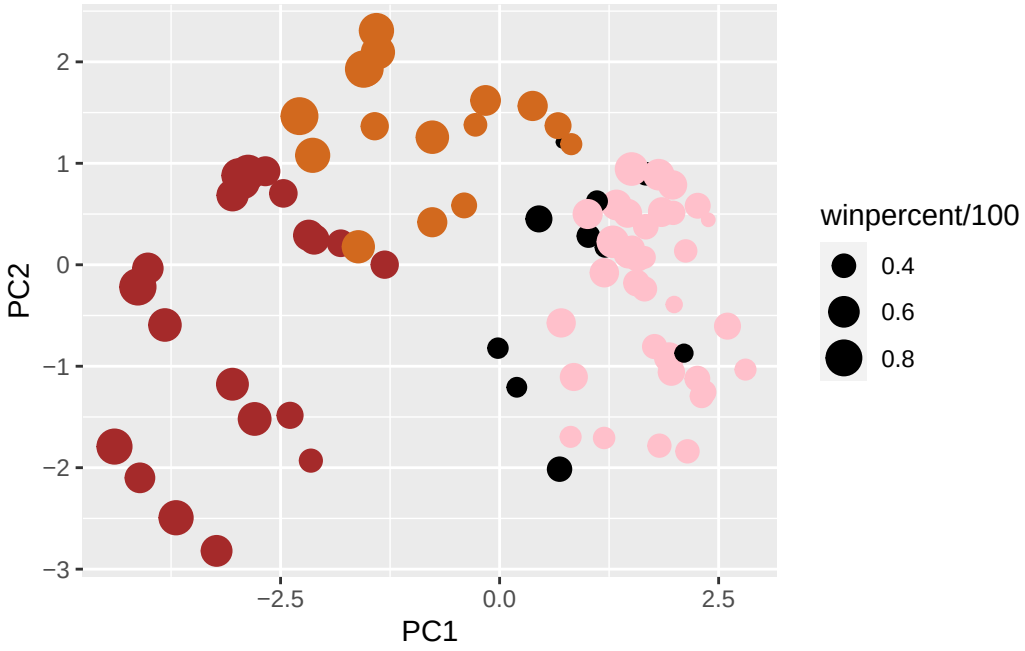
```
plot(pca$x[, 1:2], col=my_cols, pch=16)
```



Create a new dataframe with the PCA results and candy data

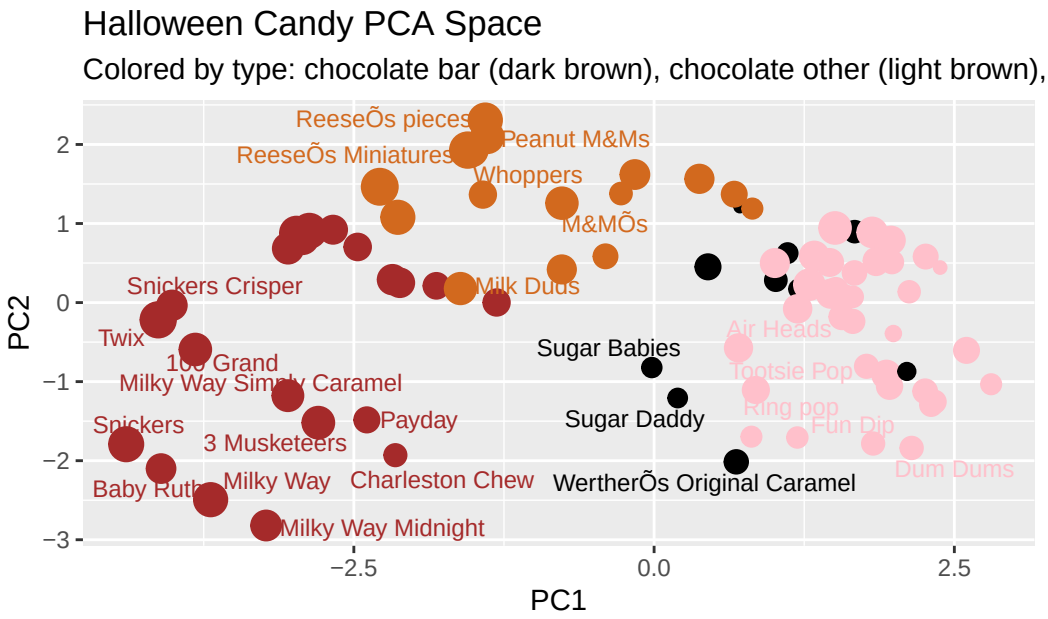
```
my_data <- cbind(candy_file, pca$x[,1:3])
```

```
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
```




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

```
Warning: ggrepel: 60 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```




```
library(plotly)
```

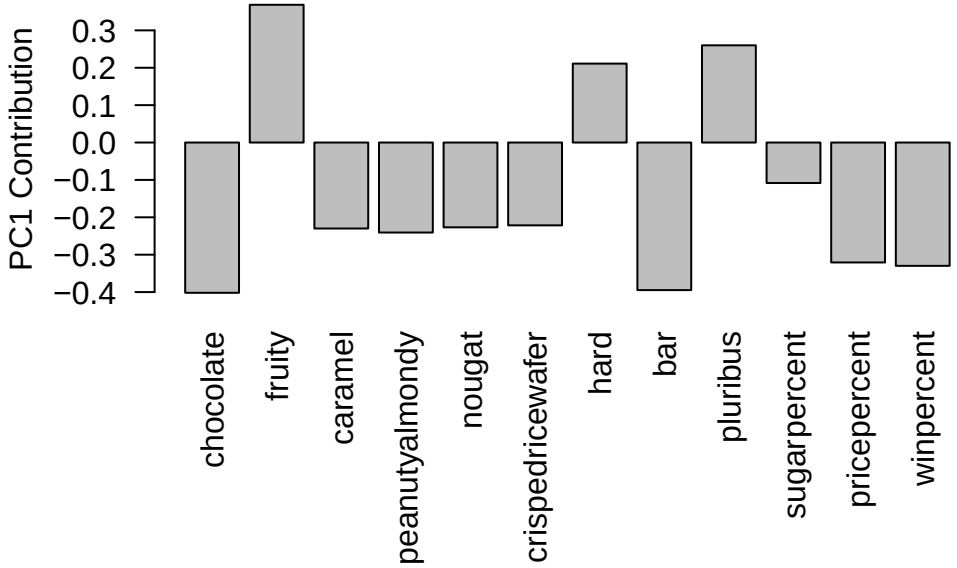
```
Attaching package: 'plotly'
```

```
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
```

```
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?

The original variables that are strongly picked up by PC1 in the positive direction are fruity, hard, and pluribus. This makes sense because majority of the candies that are fruity tend to be hard and typically come in multiples (such as Starbursts, Smarties, Dum Dums, etc.).