

Class 10: Halloween Mini Project

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As it is nearly Halloween and the halfway point in the quarter let's do a mini project to help us figure out the best candy!

Our data comes from the 538 website and is available as a CSV file.

Data Import

```
candy_file <- read.csv("candy-data.csv")
candy <- read.csv("candy-data.csv", row.names = 1)
candy
```

	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
Hershey's Kisses	1	0	0	0	0
Hershey's Krackel	1	0	0	0	0
Hershey's Milk Chocolate	1	0	0	0	0
Hershey's 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&M's	1	0	0	1	0
M&M's	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

Reese's Miniatures	1	0	0	1	0
Reese's Peanut Butter cup	1	0	0	1	0
Reese's pieces	1	0	0	1	0
Reese's 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
Welch's Fruit Snacks	0	1	0	0	0
Werther's Original Caramel	0	0	1	0	0
Whoppers	1	0	0	0	0

	crisped	rice	wafer	hard	bar	pluribus	sugar	percent
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
Hershey's Kisses	0	0	0	1	0.127
Hershey's Krackel	1	0	1	0	0.430
Hershey's Milk Chocolate	0	0	1	0	0.430
Hershey's 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&M's	0	0	0	1	0.825
M&M's	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

Reese's Miniatures	0	0	0	0	0.034
Reese's Peanut Butter cup	0	0	0	0	0.720
Reese's pieces	0	0	0	1	0.406
Reese's 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
Welch's Fruit Snacks	0	0	0	1	0.313
Werther's 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
Hershey's Kisses	0.093	55.37545
Hershey's Krackel	0.918	62.28448
Hershey's Milk Chocolate	0.918	56.49050
Hershey's 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&M's	0.651	71.46505
M&M's	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

Reese's Miniatures	0.279	81.86626
Reese's Peanut Butter cup	0.651	84.18029
Reese's pieces	0.651	73.43499
Reese's 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
Welch's Fruit Snacks	0.313	44.37552
Werther's 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?

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

```
[1] 38
```

There are 38 fruity candy types.

Q3. What is your favorite candy in the dataset and what is its winpercent value?

```
candy["Peanut butter M&M's", ]$winpercent
```

```
[1] 71.46505
```

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
```

```
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?

Yes, the winpercent column looks to be on a different scale to the majority of the other columns.

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

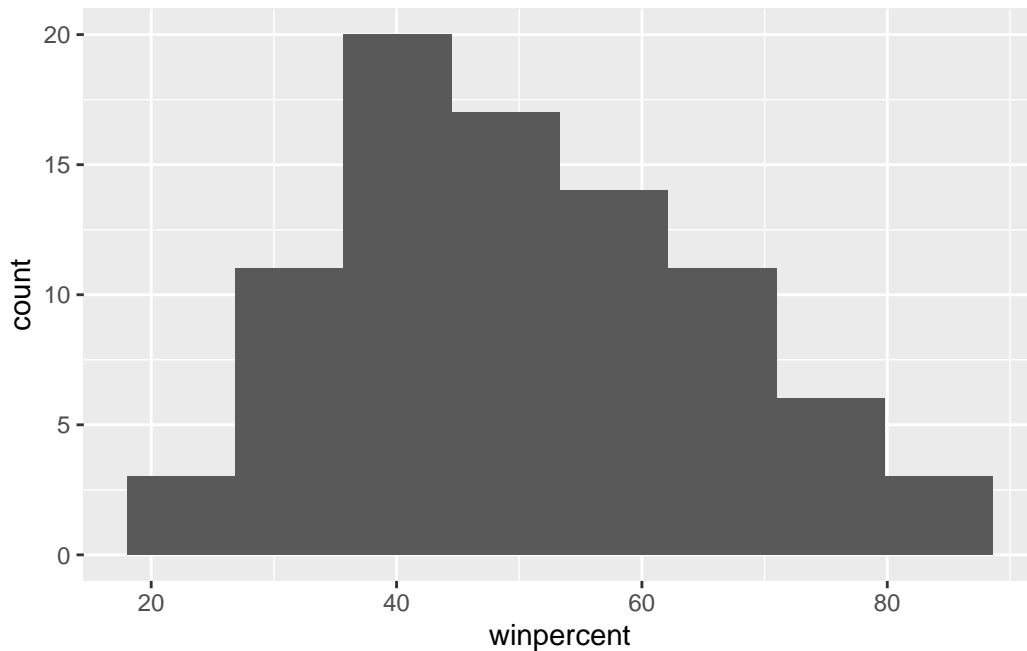
I think a one represents that the candy has chocolate and that a zero represents that the candy has no chocolate.

Plotting the Data

```
library(ggplot2)
```

Q8. Plot a histogram of winpercent values

```
ggplot(candy) +  
  aes(winpercent, fruity = "red", chocolate = "blue") +  
  geom_histogram(bins=8)
```



Q9. Is the distribution of winpercent values symmetrical?

No, it is skewed to the right.

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

The center of the distribution is below 50 percent.

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.win.mean <- mean(choc.win)
choc.win.mean
```

```
[1] 60.92153
```

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

```
[1] 44.11974
```

The chocolate candy has a higher average win percentage.

Another way to do the above using pipes instead.

```
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 lubridate  1.9.4      v tibble     3.3.0
v purrr      1.1.0      v tidyr      1.3.1
-- 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 become
```

```
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
```

Yes, this difference is statistically significant.

Overall Candy Rankings

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

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

	chocolate	fruity	caramel	peanut	almond	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

	crisped	rice	wafer	hard	bar	pluribus	sugar	percent	price	percent
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)
```

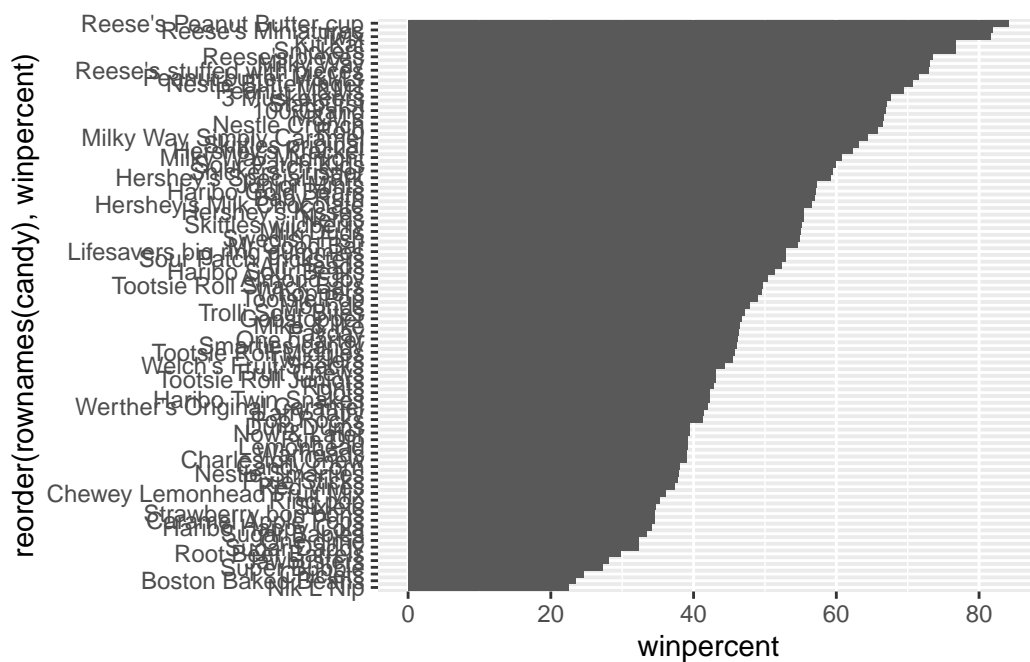
	chocolate	fruity	caramel	peanut	almond	nougat
Reese's Peanut Butter cup	1	0	0		1	0
Reese's Miniatures	1	0	0		1	0
Twix	1	0	1		0	0
Kit Kat	1	0	0		0	0
Snickers	1	0	1		1	1

	crispedrice	wafer	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.

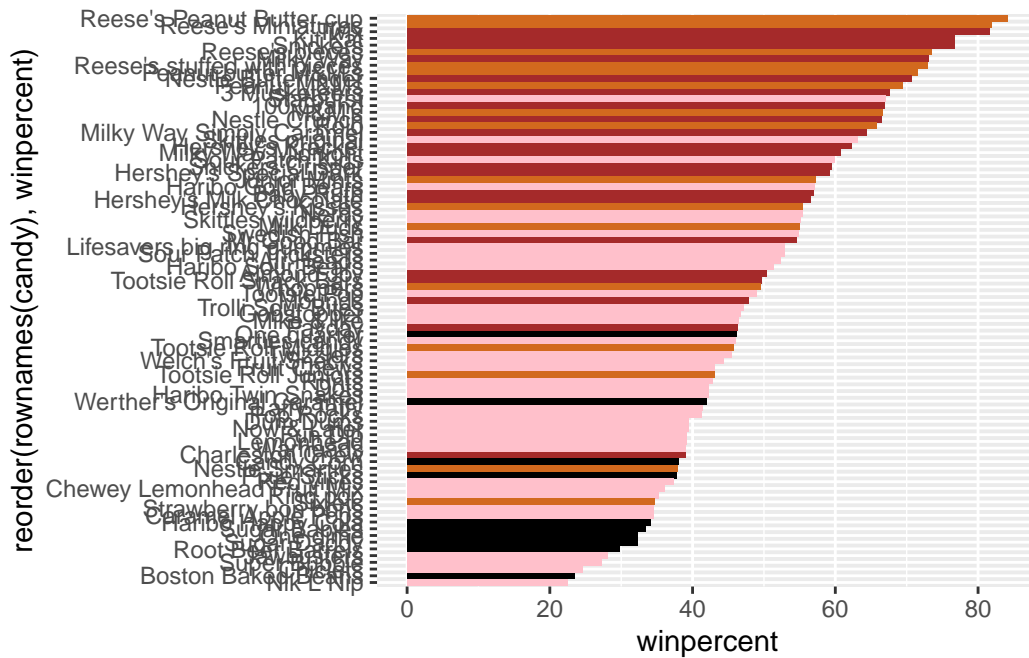
```
ggplot(candy) +
  aes(x = winpercent,
      y = reorder(rownames(candy), winpercent)) +
  geom_col()
```



Time to add some color

```
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"

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



Q17. What is the worst ranked chocolate candy?

```
candy %>%
  filter(chocolate == 1) %>%
  arrange(winpercent) %>%
  head(5)
```

	chocolate	fruity	caramel	peanutyalmondy	nougat
Sixlets	1	0	0	0	0
Nestle Smarties	1	0	0	0	0
Charleston Chew	1	0	0	0	1
Tootsie Roll Juniors	1	0	0	0	0
Tootsie Roll Midgies	1	0	0	0	0

	crispedrice	wafer	hard bar	pluribus	sugarpercent
Sixlets	0	0	0	1	0.220
Nestle Smarties	0	0	0	1	0.267
Charleston Chew	0	0	1	0	0.604
Tootsie Roll Juniors	0	0	0	0	0.313
Tootsie Roll Midgies	0	0	0	1	0.174

	pricepercent	winpercent
Sixlets	0.081	34.72200
Nestle Smarties	0.976	37.88719
Charleston Chew	0.511	38.97504
Tootsie Roll Juniors	0.511	43.06890
Tootsie Roll Midgies	0.011	45.73675

The worst ranked chocolate candy is Sixlets.

Q18. What is the best ranked fruity candy?

```
candy %>%
  filter(fruity == 1) %>%
  arrange(-winpercent) %>%
  head(5)
```

	chocolate	fruity	caramel	peanut	yalmondy	nougat
Starburst	0	1	0		0	0
Skittles original	0	1	0		0	0
Sour Patch Kids	0	1	0		0	0
Haribo Gold Bears	0	1	0		0	0
Nerds	0	1	0		0	0

	crispedrice	wafer	hard bar	pluribus	sugarpercent	pricepercent
Starburst	0	0	0	1	0.151	0.220
Skittles original	0	0	0	1	0.941	0.220
Sour Patch Kids	0	0	0	1	0.069	0.116
Haribo Gold Bears	0	0	0	1	0.465	0.465
Nerds	0	1	0	1	0.848	0.325

	winpercent
Starburst	67.03763
Skittles original	63.08514
Sour Patch Kids	59.86400
Haribo Gold Bears	57.11974
Nerds	55.35405

Starburst is the highest rated fruity candy.

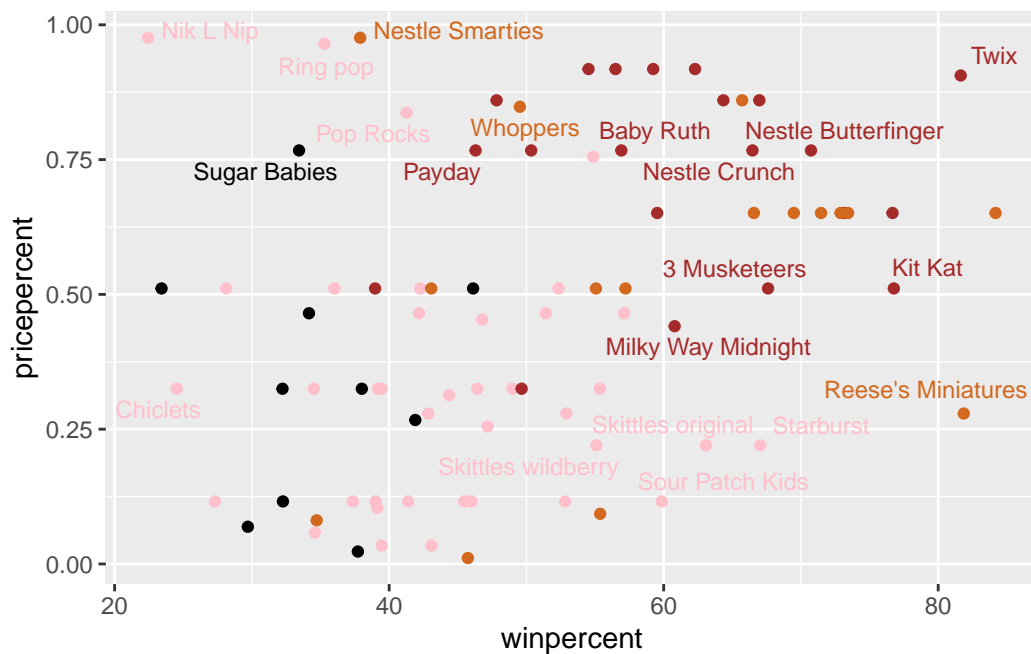
Winpercent and Pricepercent

A plot with both variables/columns winpercent and pricepercent.

```
library(ggrepel)
```

```
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: 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?

```
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

Nik L Nip offers the most bang for buck.

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 = FALSE)
head( candy[ord,c(11,12)], n=5 )
```

	pricepercent	winpercent
Tootsie Roll Midgies	0.011	45.73675
Pixie Sticks	0.023	37.72234
Dum Dums	0.034	39.46056
Fruit Chews	0.034	43.08892
Strawberry bon bons	0.058	34.57899

Strawberry bon bons are the least popular.

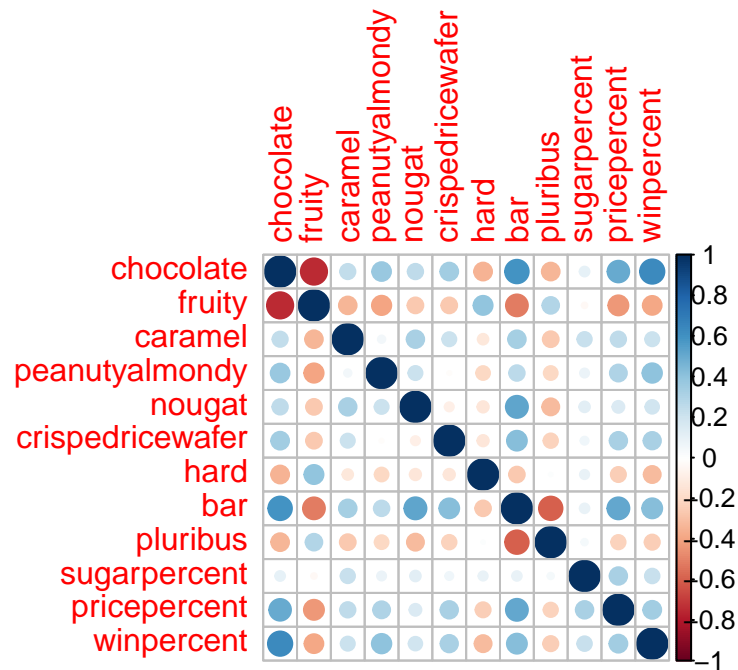
Exploring the correlation structure

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)
```



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

Chocolate and fruity are anti-correlated.

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

Chocolate and bars are the most positively correlated.

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

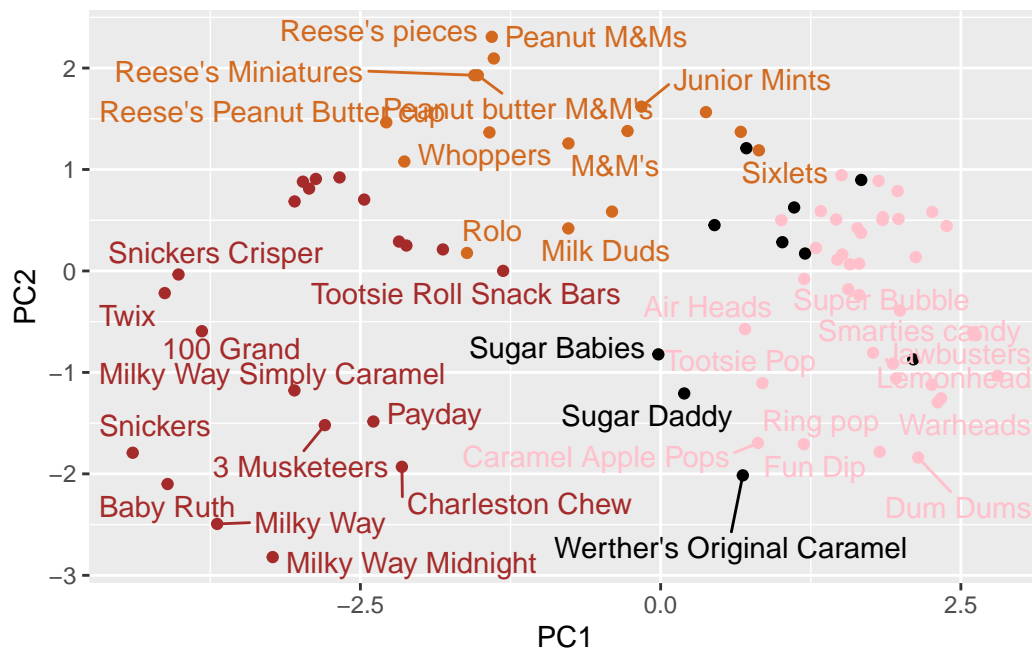
	PC8	PC9	PC10	PC11	PC12
Standard deviation	0.74530	0.67824	0.62349	0.43974	0.39760

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

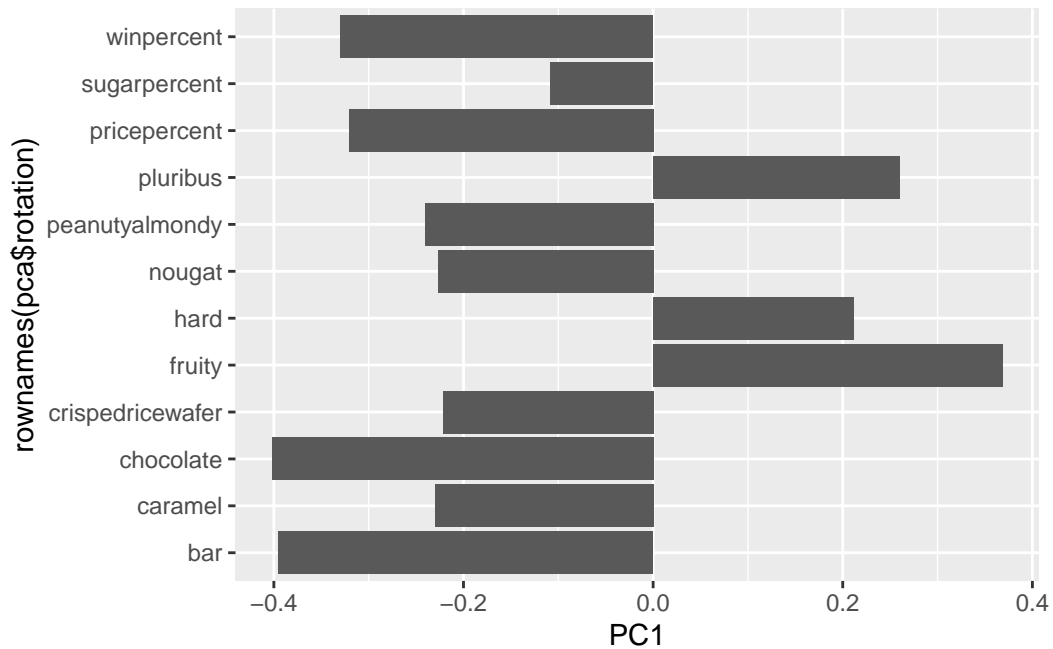
```
ggplot(pca$x) +  
  aes(PC1, PC2, label=rownames(pca$x)) +  
  geom_point(col = my_cols) +  
  geom_text_repel(col=my_cols)
```

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. Its output is interactive and will NOT render to pdf format.

```
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)
```