Class 09: Halloween Mini Project

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Today we will make a step back to some data we can taste and explore the correlation structure
and principal components of some Halloween candy.

```
candy_file <- "candy-data.txt"
read.delim(candy_file)
```

```
   competitorname.chocolate.fruity.caramel.peanutyalmondy.nougat.crispedricewafer.hard.bar.pl
1                                                                        100 Grand,1,0
2                                                                     3 Musketeers,1,0
3                                                                                  One
4                                                                           One quarter
5                                                                        Air Heads,0,1
6                                                                           Almond Joy
7                                                                        Baby Ruth,1,0
8                                                                 Boston Baked Beans,0,0
9                                                                      Candy Corn,0,0
10                                                                Caramel Apple Pops,0,1
11                                                                   Charleston Chew,1,0
12                                                             Chewey Lemonhead Fruit Mix,0,1
13                                                                             Chiclets
14                                                                             Dots,0,1
15                                                                          Dum Dums,0,1,0
16                                                                          Fruit Chews
17                                                                           Fun Dip,0,1
18                                                                       Gobstopper,0,1
19                                                                        Haribo Gold
20                                                                        Haribo Happy
21                                                                        Haribo Sour
22                                                                       Haribo Twin S
23                                                                   Hershey's Kisses
24                                                                   Hershey's Krackel,1,0
```

```
25                                          Hershey's Milk Chocolate,1,0
26                                           Hershey's Special Dark,1,0
27                                                    Jawbusters,0,1,
28                                                      Junior Min
29                                                        Kit Kat,1
30                                                            Laff
31                                                            Lem
32                              Lifesavers big ring gummies,0,1
33                                         Peanut butter M&M's,1,
34                                                      M&M's,1,0
35                                               Mike & Ike,0,1
36                                                Milk Duds,1,0
37                                                Milky Way,1,0
38                                        Milky Way Midnight,1,0
39                                   Milky Way Simply Caramel,1,
40                                                   Mounds,1,0
41                                              Mr Good Bar,1,0
42                                                    Nerds,0,1
43                                       Nestle Butterfinger,1,0
44                                             Nestle Crunch,1,
45                                                   Nik L Ni
46                                                    Now & L
47                                                      Payda
48                                              Peanut M&Ms,1,0
49                                               Pixie Sticks
50                                                Pop Rocks,0,1
51                                                   Red vine
52                                        Reese's Miniatures,1,0,
53                                   Reese's Peanut Butter cup,1,
54                                            Reese's pieces,1,
55                               Reese's stuffed with pieces,1,0
56                                                 Ring pop,0,1
57                                                    Rolo,1,0
58                                       Root Beer Barrels,0,0,
59                                                   Runts,0,1
60
61                                            Skittles origi
62                                          Skittles wildber
63                                 Nestle Smarties,1,0
64                                         Smarties cand
65                                                Snickers
66                                      Snickers Crisper,1,0
67                                           Sour Patch Kids
```

```
68                                         Sour Patch Tricksters
69                                                    Starburs
70                                  Strawberry bon bons,0,1,0
71                                         Sugar Babies,0,0
72                                         Sugar Daddy,0,0
73                                                  Super
74                                           Swedish Fish
75                                      Tootsie Pop,1,1
76                              Tootsie Roll Juniors,1,0
77                                Tootsie Roll Midgies
78                            Tootsie Roll Snack Bars
79                                 Trolli Sour Bites
80                                               Twi
81                                                Tw
82                                         Warheads
83                           Welch's Fruit Snacks,0,1
84                         Werther's Original Caramel
85                                    Whoppers,1,0
```

```r
candy=read.csv(candy_file,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
```

Q1. How many different candy types are in this dataset? 85 different candy types.

```r
nrow(candy)
```

```
[1] 85
```

Q2: How many fruity candy types are in the dataset? It appears after summing the column with fruity in it, there are 38 total fruity candies.

```
sum(candy$fruity)
```

```
[1] 38
```

```
candy[candy$fruity == 1, ]
```

	chocolate	fruity	caramel	peanutyalmondy	nougat
Air Heads	0	1	0	0	0
Caramel Apple Pops	0	1	1	0	0
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 Sour Bears	0	1	0	0	0
Haribo Twin Snakes	0	1	0	0	0
Jawbusters	0	1	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
Mike & Ike	0	1	0	0	0
Nerds	0	1	0	0	0
Nik L Nip	0	1	0	0	0
Now & Later	0	1	0	0	0
Pop Rocks	0	1	0	0	0
Red vines	0	1	0	0	0
Ring pop	0	1	0	0	0
Runts	0	1	0	0	0
Skittles original	0	1	0	0	0
Skittles wildberry	0	1	0	0	0
Smarties candy	0	1	0	0	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

Super Bubble	0	1	0	0	0
Swedish Fish	0	1	0	0	0
Tootsie Pop	1	1	0	0	0
Trolli Sour Bites	0	1	0	0	0
Twizzlers	0	1	0	0	0
Warheads	0	1	0	0	0
Welch's Fruit Snacks	0	1	0	0	0

	crispedricewafer	hard	bar	pluribus	sugarpercent
Air Heads	0	0	0	0	0.906
Caramel Apple Pops	0	0	0	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 Sour Bears	0	0	0	1	0.465
Haribo Twin Snakes	0	0	0	1	0.465
Jawbusters	0	1	0	1	0.093
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
Mike & Ike	0	0	0	1	0.872
Nerds	0	1	0	1	0.848
Nik L Nip	0	0	0	1	0.197
Now & Later	0	0	0	1	0.220
Pop Rocks	0	1	0	1	0.604
Red vines	0	0	0	1	0.581
Ring pop	0	1	0	0	0.732
Runts	0	1	0	1	0.872
Skittles original	0	0	0	1	0.941
Skittles wildberry	0	0	0	1	0.941
Smarties candy	0	1	0	1	0.267
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
Super Bubble	0	0	0	0	0.162
Swedish Fish	0	0	0	1	0.604
Tootsie Pop	0	1	0	0	0.604
Trolli Sour Bites	0	0	0	1	0.313

Twizzlers	0	0	0	0	0.220
Warheads	0	1	0	0	0.093
Welch's Fruit Snacks	0	0	0	1	0.313

	pricepercent	winpercent
Air Heads	0.511	52.34146
Caramel Apple Pops	0.325	34.51768
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 Sour Bears	0.465	51.41243
Haribo Twin Snakes	0.465	42.17877
Jawbusters	0.511	28.12744
Laffy Taffy	0.116	41.38956
Lemonhead	0.104	39.14106
Lifesavers big ring gummies	0.279	52.91139
Mike & Ike	0.325	46.41172
Nerds	0.325	55.35405
Nik L Nip	0.976	22.44534
Now & Later	0.325	39.44680
Pop Rocks	0.837	41.26551
Red vines	0.116	37.34852
Ring pop	0.965	35.29076
Runts	0.279	42.84914
Skittles original	0.220	63.08514
Skittles wildberry	0.220	55.10370
Smarties candy	0.116	45.99583
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
Super Bubble	0.116	27.30386
Swedish Fish	0.755	54.86111
Tootsie Pop	0.325	48.98265
Trolli Sour Bites	0.255	47.17323
Twizzlers	0.116	45.46628
Warheads	0.116	39.01190
Welch's Fruit Snacks	0.313	44.37552

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

```
[1] 81.64291
```

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

```
[1] 76.7686
```

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

```
[1] 49.6535
```

Q3. What is your favorite candy in the dataset and what is it's winpercent value?
My favorite candy in the dataset is Twix and its win percent value is 81.6421%. Q4.
What is the winpercent value for "Kit Kat"? The win percent value for KitKat is
76.7686%. Q5. What is the winpercent value for "Tootsie Roll Snack Bars"? The
winpercent value for Tootsie Roll Snack bars is 49.6535%.

Exploratory Analysis

We can use the **skimr** package to get a quick overview of a given dataset. This can be useful
for the first time you encounter a new dataset.

```
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 variable needs to be scaled differently than the other variables.

It looks like the last column `candy$winpercent` needs to be on a different scale.

Q7. What do you think a zero and one represent for the candy$chocolate column? The 0 and 1 represent the cases where this candy type was either chosen as a favorite or not among the group with the mean of all such values displayed. 1 represents a selection of the chocolate candy and 0 represents not a selection of chocolate as the favorite candy.

Q8. PLot a histogram of a winpercent values

8

```r
hist(candy$winpercent, breaks=30)
```

Histogram of candy$winpercent
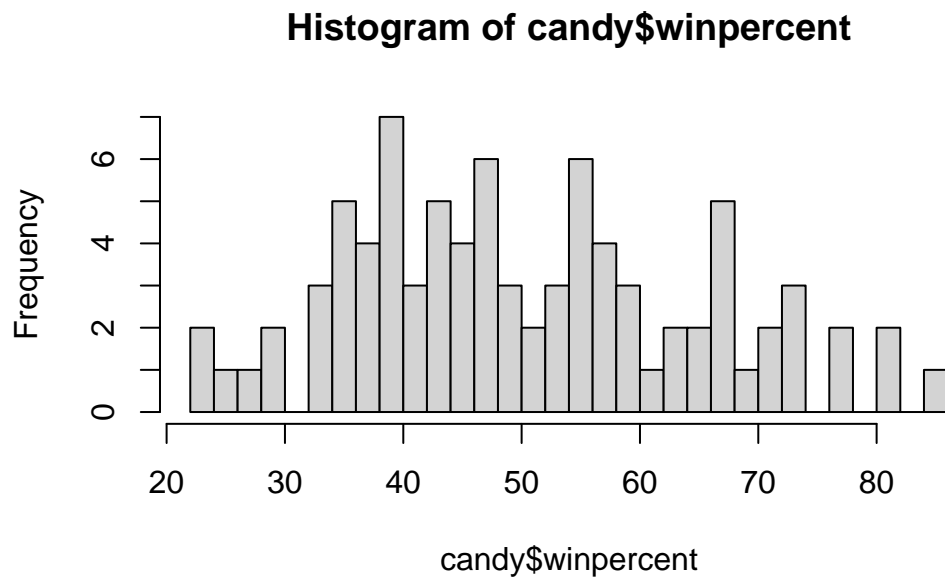

```r
library(ggplot2)
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=10, fil="lightbulb")
```

```
Warning in geom_histogram(bins = 10, fil = "lightbulb"): Ignoring unknown
parameters: `fil`
```
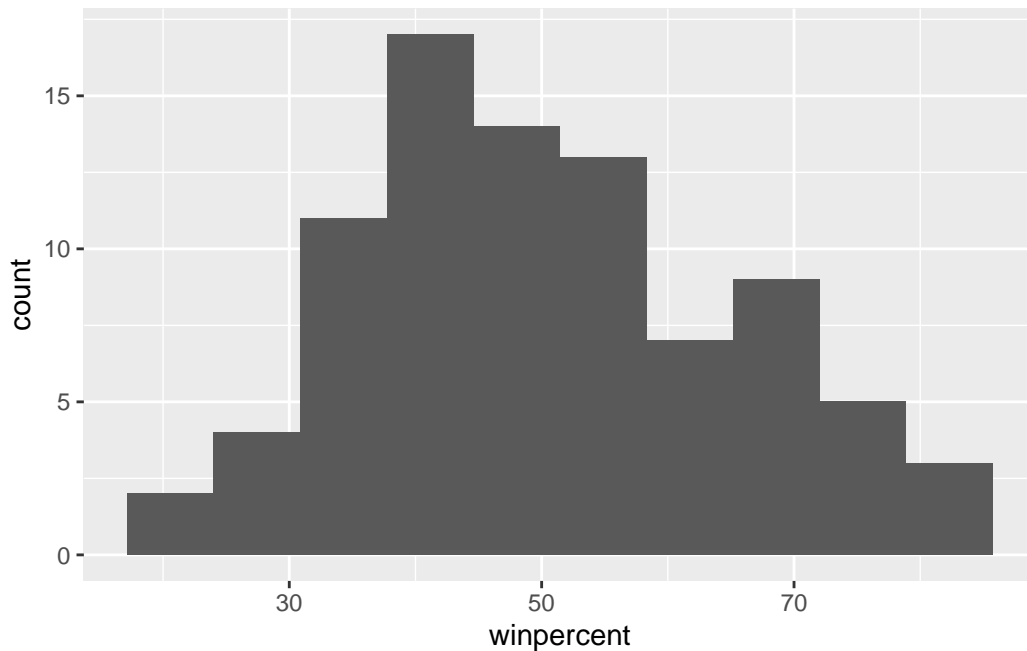
```
summary(candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  22.45   39.14   47.83   50.32   59.86   84.18
```

Q9. Is the sitribution of winpercent values symmetrical? The distribution is not symmetrical. There are more data points clustered to the left than to the right.

Q10. Is the center of the distribution above or below 50%? No, it is below 50% for the median at 47.83%, but the mean is slightly above 50% at 50.32%..

Q11. On average, is chocolate candy higher of lower ranked than fruit candy? Chocolate candy is much higher on average than fruit candy.

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

```r
candy [as.logical(candy$fruity),]$winpercent
```

```
 [1] 52.34146 34.51768 36.01763 24.52499 42.27208 39.46056 43.08892 39.18550
 [9] 46.78335 57.11974 51.41243 42.17877 28.12744 41.38956 39.14106 52.91139
[17] 46.41172 55.35405 22.44534 39.44680 41.26551 37.34852 35.29076 42.84914
[25] 63.08514 55.10370 45.99583 59.86400 52.82595 67.03763 34.57899 27.30386
[33] 54.86111 48.98265 47.17323 45.46628 39.01190 44.37552
```

Q12. Is this difference statistically significant? The t-test shows a statisically signficant difference between these two values confirmed by a very low p value less than 0.05 at 2.87137e-08.

```r
ans <- t.test(choc.win, fruity.win)
ans
```

```
	Welch Two Sample t-test

data:  choc.win and fruity.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, with a p-value of

```r
ans$p.value
```

```
[1] 2.871378e-08
```

3. Overall Candy Rankings

There are two related functions that can help here, one is the classic `sort()` function and `order()` function

```r
x <- c(5,10,1,4)
sort(x, decreasing=TRUE)
```

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

```r
order(x)
```

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

> Q14 What are the top 5 all time favorite candy types out of this set? The top five are seen below in the first five rows after applying the order function being Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters.

```r
inds <- order( candy$winpercent)
head(candy[inds,], 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
```

```
inds <- order(candy$winpercent, decreasing=TRUE)
candy[inds,]
```

	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
Reese's pieces	1	0	0	1	0
Milky Way	1	0	1	0	1
Reese's stuffed with pieces	1	0	0	1	0
Peanut butter M&M's	1	0	0	1	0
Nestle Butterfinger	1	0	0	1	0
Peanut M&Ms	1	0	0	1	0
3 Musketeers	1	0	0	0	1
Starburst	0	1	0	0	0
100 Grand	1	0	1	0	0
M&M's	1	0	0	0	0
Nestle Crunch	1	0	0	0	0
Rolo	1	0	1	0	0
Milky Way Simply Caramel	1	0	1	0	0
Skittles original	0	1	0	0	0
Hershey's Krackel	1	0	0	0	0
Milky Way Midnight	1	0	1	0	1
Sour Patch Kids	0	1	0	0	0
Snickers Crisper	1	0	1	1	0
Hershey's Special Dark	1	0	0	0	0
Junior Mints	1	0	0	0	0
Haribo Gold Bears	0	1	0	0	0
Baby Ruth	1	0	1	1	1
Hershey's Milk Chocolate	1	0	0	0	0
Hershey's Kisses	1	0	0	0	0
Nerds	0	1	0	0	0
Skittles wildberry	0	1	0	0	0
Milk Duds	1	0	1	0	0
Swedish Fish	0	1	0	0	0
Mr Good Bar	1	0	0	1	0
Lifesavers big ring gummies	0	1	0	0	0
Sour Patch Tricksters	0	1	0	0	0
Air Heads	0	1	0	0	0
Haribo Sour Bears	0	1	0	0	0

Almond Joy	1	0	0	1	0
Tootsie Roll Snack Bars	1	0	0	0	0
Whoppers	1	0	0	0	0
Tootsie Pop	1	1	0	0	0
Mounds	1	0	0	0	0
Trolli Sour Bites	0	1	0	0	0
Gobstopper	0	1	0	0	0
Mike & Ike	0	1	0	0	0
Payday	0	0	0	1	1
One quarter	0	0	0	0	0
Smarties candy	0	1	0	0	0
Tootsie Roll Midgies	1	0	0	0	0
Twizzlers	0	1	0	0	0
Welch's Fruit Snacks	0	1	0	0	0
Fruit Chews	0	1	0	0	0
Tootsie Roll Juniors	1	0	0	0	0
Runts	0	1	0	0	0
Dots	0	1	0	0	0
Haribo Twin Snakes	0	1	0	0	0
Werther's Original Caramel	0	0	1	0	0
Laffy Taffy	0	1	0	0	0
Pop Rocks	0	1	0	0	0
Dum Dums	0	1	0	0	0
Now & Later	0	1	0	0	0
Fun Dip	0	1	0	0	0
Lemonhead	0	1	0	0	0
Warheads	0	1	0	0	0
Charleston Chew	1	0	0	0	1
Candy Corn	0	0	0	0	0
Nestle Smarties	1	0	0	0	0
Pixie Sticks	0	0	0	0	0
Red vines	0	1	0	0	0
Chewey Lemonhead Fruit Mix	0	1	0	0	0
Ring pop	0	1	0	0	0
Sixlets	1	0	0	0	0
Strawberry bon bons	0	1	0	0	0
Caramel Apple Pops	0	1	1	0	0
Haribo Happy Cola	0	0	0	0	0
Sugar Babies	0	0	1	0	0
One dime	0	0	0	0	0
Sugar Daddy	0	0	1	0	0
Root Beer Barrels	0	0	0	0	0
Jawbusters	0	1	0	0	0

Super Bubble	0	1	0	0	0
Chiclets	0	1	0	0	0
Boston Baked Beans	0	0	0	1	0
Nik L Nip	0	1	0	0	0

	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
Reese's pieces	0	0	0	1	0.406
Milky Way	0	0	1	0	0.604
Reese's stuffed with pieces	0	0	0	0	0.988
Peanut butter M&M's	0	0	0	1	0.825
Nestle Butterfinger	0	0	1	0	0.604
Peanut M&Ms	0	0	0	1	0.593
3 Musketeers	0	0	1	0	0.604
Starburst	0	0	0	1	0.151
100 Grand	1	0	1	0	0.732
M&M's	0	0	0	1	0.825
Nestle Crunch	1	0	1	0	0.313
Rolo	0	0	0	1	0.860
Milky Way Simply Caramel	0	0	1	0	0.965
Skittles original	0	0	0	1	0.941
Hershey's Krackel	1	0	1	0	0.430
Milky Way Midnight	0	0	1	0	0.732
Sour Patch Kids	0	0	0	1	0.069
Snickers Crisper	1	0	1	0	0.604
Hershey's Special Dark	0	0	1	0	0.430
Junior Mints	0	0	0	1	0.197
Haribo Gold Bears	0	0	0	1	0.465
Baby Ruth	0	0	1	0	0.604
Hershey's Milk Chocolate	0	0	1	0	0.430
Hershey's Kisses	0	0	0	1	0.127
Nerds	0	1	0	1	0.848
Skittles wildberry	0	0	0	1	0.941
Milk Duds	0	0	0	1	0.302
Swedish Fish	0	0	0	1	0.604
Mr Good Bar	0	0	1	0	0.313
Lifesavers big ring gummies	0	0	0	0	0.267
Sour Patch Tricksters	0	0	0	1	0.069
Air Heads	0	0	0	0	0.906
Haribo Sour Bears	0	0	0	1	0.465

Almond Joy	0	0	1	0	0.465
Tootsie Roll Snack Bars	0	0	1	0	0.465
Whoppers	1	0	0	1	0.872
Tootsie Pop	0	1	0	0	0.604
Mounds	0	0	1	0	0.313
Trolli Sour Bites	0	0	0	1	0.313
Gobstopper	0	1	0	1	0.906
Mike & Ike	0	0	0	1	0.872
Payday	0	0	1	0	0.465
One quarter	0	0	0	0	0.011
Smarties candy	0	1	0	1	0.267
Tootsie Roll Midgies	0	0	0	1	0.174
Twizzlers	0	0	0	0	0.220
Welch's Fruit Snacks	0	0	0	1	0.313
Fruit Chews	0	0	0	1	0.127
Tootsie Roll Juniors	0	0	0	0	0.313
Runts	0	1	0	1	0.872
Dots	0	0	0	1	0.732
Haribo Twin Snakes	0	0	0	1	0.465
Werther's Original Caramel	0	1	0	0	0.186
Laffy Taffy	0	0	0	0	0.220
Pop Rocks	0	1	0	1	0.604
Dum Dums	0	1	0	0	0.732
Now & Later	0	0	0	1	0.220
Fun Dip	0	1	0	0	0.732
Lemonhead	0	1	0	0	0.046
Warheads	0	1	0	0	0.093
Charleston Chew	0	0	1	0	0.604
Candy Corn	0	0	0	1	0.906
Nestle Smarties	0	0	0	1	0.267
Pixie Sticks	0	0	0	1	0.093
Red vines	0	0	0	1	0.581
Chewey Lemonhead Fruit Mix	0	0	0	1	0.732
Ring pop	0	1	0	0	0.732
Sixlets	0	0	0	1	0.220
Strawberry bon bons	0	1	0	1	0.569
Caramel Apple Pops	0	0	0	0	0.604
Haribo Happy Cola	0	0	0	1	0.465
Sugar Babies	0	0	0	1	0.965
One dime	0	0	0	0	0.011
Sugar Daddy	0	0	0	0	0.418
Root Beer Barrels	0	1	0	1	0.732
Jawbusters	0	1	0	1	0.093

						pricepercent	winpercent
Super Bubble	0	0	0	0	0.162		
Chiclets	0	0	0	1	0.046		
Boston Baked Beans	0	0	0	1	0.313		
Nik L Nip	0	0	0	1	0.197		
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
Reese's pieces						0.651	73.43499
Milky Way						0.651	73.09956
Reese's stuffed with pieces						0.651	72.88790
Peanut butter M&M's						0.651	71.46505
Nestle Butterfinger						0.767	70.73564
Peanut M&Ms						0.651	69.48379
3 Musketeers						0.511	67.60294
Starburst						0.220	67.03763
100 Grand						0.860	66.97173
M&M's						0.651	66.57458
Nestle Crunch						0.767	66.47068
Rolo						0.860	65.71629
Milky Way Simply Caramel						0.860	64.35334
Skittles original						0.220	63.08514
Hershey's Krackel						0.918	62.28448
Milky Way Midnight						0.441	60.80070
Sour Patch Kids						0.116	59.86400
Snickers Crisper						0.651	59.52925
Hershey's Special Dark						0.918	59.23612
Junior Mints						0.511	57.21925
Haribo Gold Bears						0.465	57.11974
Baby Ruth						0.767	56.91455
Hershey's Milk Chocolate						0.918	56.49050
Hershey's Kisses						0.093	55.37545
Nerds						0.325	55.35405
Skittles wildberry						0.220	55.10370
Milk Duds						0.511	55.06407
Swedish Fish						0.755	54.86111
Mr Good Bar						0.918	54.52645
Lifesavers big ring gummies						0.279	52.91139
Sour Patch Tricksters						0.116	52.82595
Air Heads						0.511	52.34146
Haribo Sour Bears						0.465	51.41243

```
Almond Joy                          0.767    50.34755
Tootsie Roll Snack Bars             0.325    49.65350
Whoppers                            0.848    49.52411
Tootsie Pop                         0.325    48.98265
Mounds                              0.860    47.82975
Trolli Sour Bites                   0.255    47.17323
Gobstopper                          0.453    46.78335
Mike & Ike                          0.325    46.41172
Payday                              0.767    46.29660
One quarter                         0.511    46.11650
Smarties candy                      0.116    45.99583
Tootsie Roll Midgies                0.011    45.73675
Twizzlers                           0.116    45.46628
Welch's Fruit Snacks                0.313    44.37552
Fruit Chews                         0.034    43.08892
Tootsie Roll Juniors                0.511    43.06890
Runts                               0.279    42.84914
Dots                                0.511    42.27208
Haribo Twin Snakes                  0.465    42.17877
Werther's Original Caramel          0.267    41.90431
Laffy Taffy                         0.116    41.38956
Pop Rocks                           0.837    41.26551
Dum Dums                            0.034    39.46056
Now & Later                         0.325    39.44680
Fun Dip                             0.325    39.18550
Lemonhead                           0.104    39.14106
Warheads                            0.116    39.01190
Charleston Chew                     0.511    38.97504
Candy Corn                          0.325    38.01096
Nestle Smarties                     0.976    37.88719
Pixie Sticks                        0.023    37.72234
Red vines                           0.116    37.34852
Chewey Lemonhead Fruit Mix          0.511    36.01763
Ring pop                            0.965    35.29076
Sixlets                             0.081    34.72200
Strawberry bon bons                 0.058    34.57899
Caramel Apple Pops                  0.325    34.51768
Haribo Happy Cola                   0.465    34.15896
Sugar Babies                        0.767    33.43755
One dime                            0.116    32.26109
Sugar Daddy                         0.325    32.23100
Root Beer Barrels                   0.069    29.70369
Jawbusters                          0.511    28.12744
```

```
Super Bubble                          0.116   27.30386
Chiclets                              0.325   24.52499
Boston Baked Beans                    0.511   23.41782
Nik L Nip                             0.976   22.44534
```

Make a bar pplot and order it by winpercent values > Q15. Make a first barplot of candy
ranking based on winpercent values.

```
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col()
```
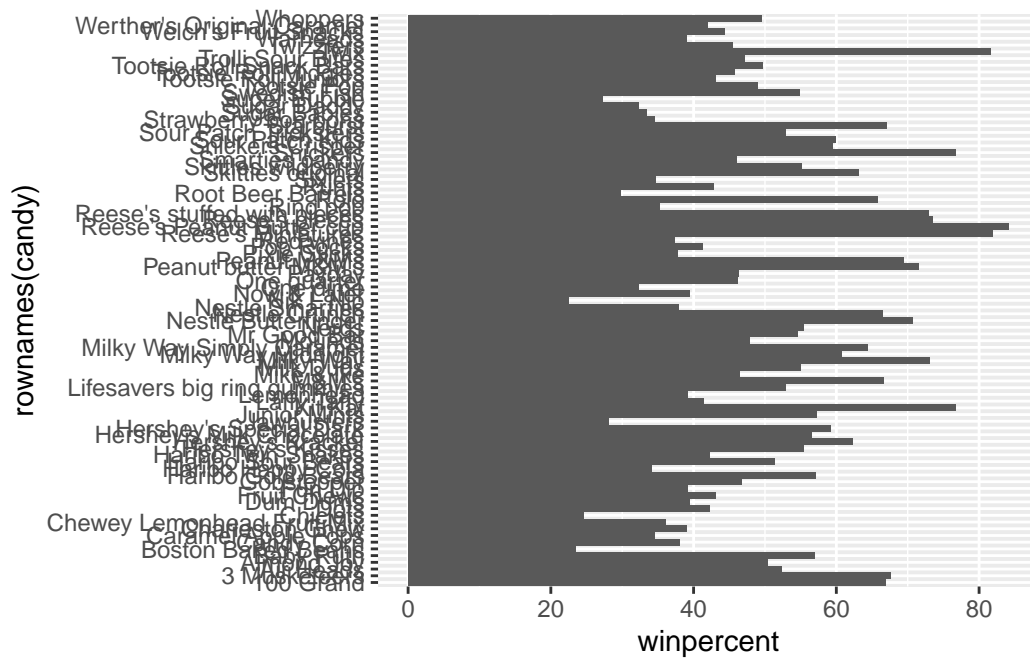


```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col()
```
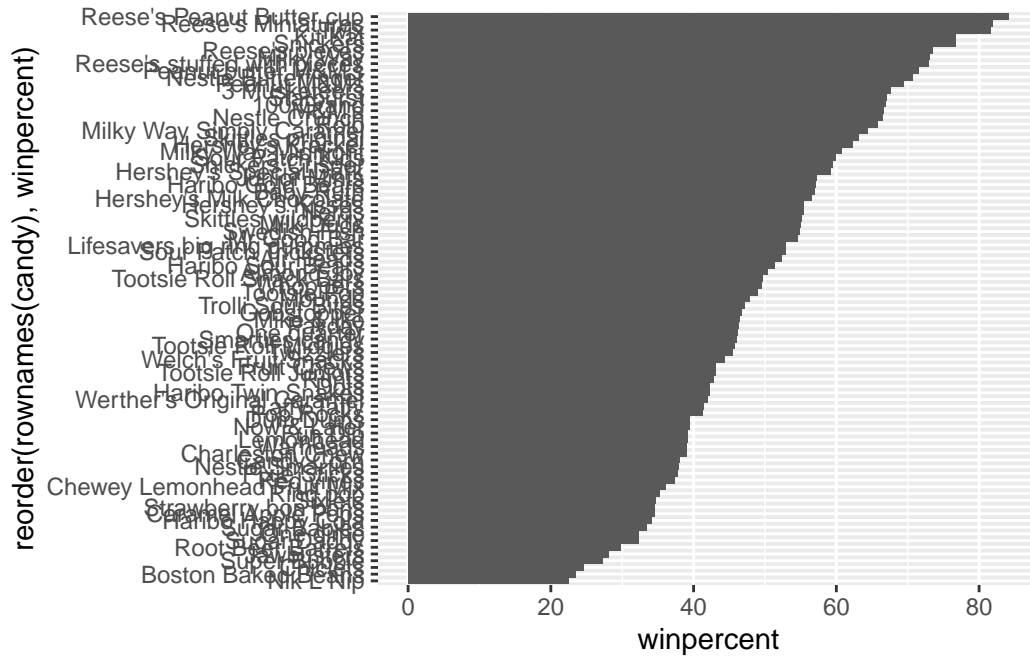
Q16: This is quite ugly, use the reorder() function to get the bars sorted by winpercent? Seen below.

```r
ggplot(candy) +
  aes(x=winpercent,
      y=reorder(rownames(candy), winpercent, fill="chocolate")) +
  geom_col()
```
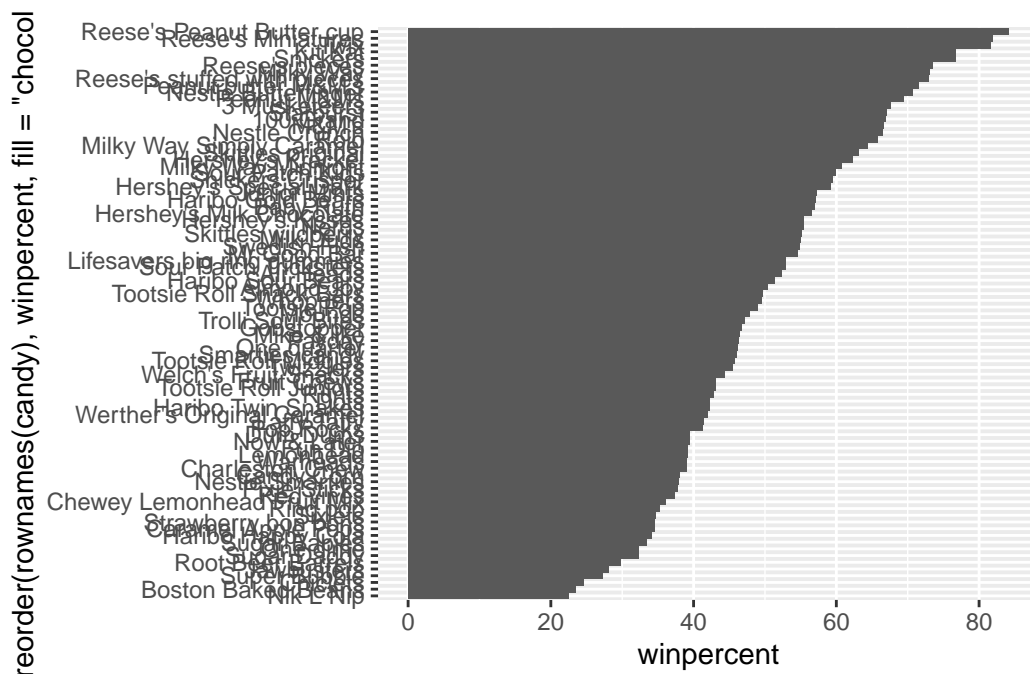
Here we want a custom color vector to color each bar the way we want - with chocolate and `fruity` candy together with whether it is a bar or not.

```
mycols <- rep("gray", nrow(candy))
mycols[as.logical(candy$chocolate)] <- "chocolate"

mycols
```

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

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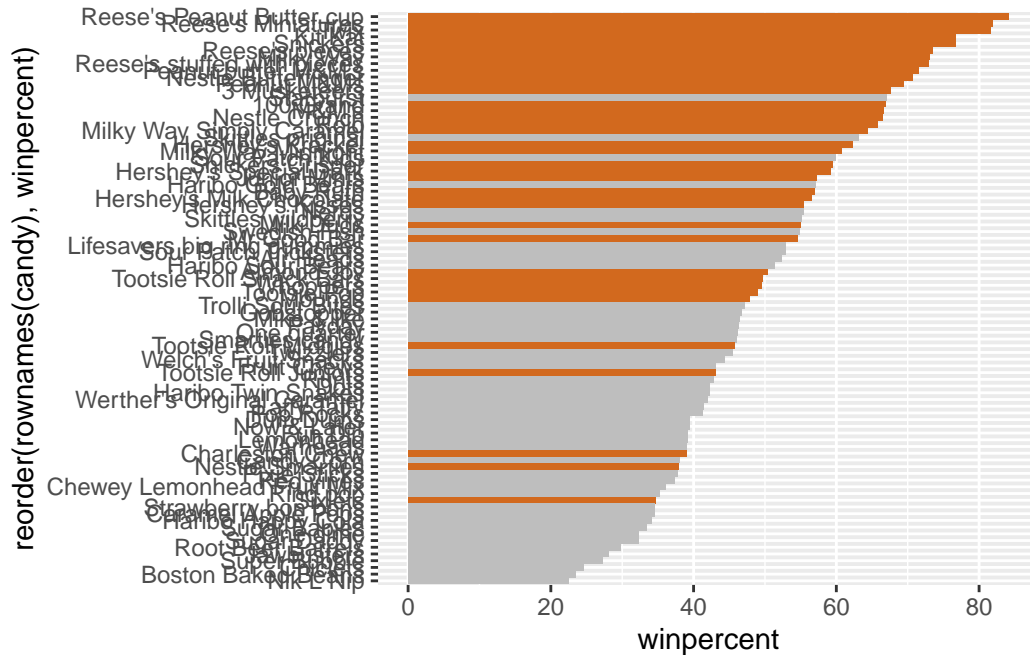


```
mycols <- rep("gray", nrow(candy))
mycols[as.logical(candy$fruity)] <- "pink"
mycols[ as.logical(candy$bar)] <- "brown"


mycols
```

```
 [1] "brown" "brown" "gray"  "gray"  "pink"  "brown" "brown" "gray"  "gray"
[10] "pink"  "brown" "pink"  "pink"  "pink"  "pink"  "pink"  "pink"  "pink"
[19] "pink"  "gray"  "pink"  "pink"  "gray"  "brown" "brown" "brown" "pink"
[28] "gray"  "brown" "pink"  "pink"  "pink"  "gray"  "gray"  "pink"  "gray"
[37] "brown" "brown" "brown" "brown" "brown" "pink"  "brown" "brown" "pink"
[46] "pink"  "brown" "gray"  "gray"  "pink"  "pink"  "gray"  "gray"  "gray"
[55] "gray"  "pink"  "gray"  "gray"  "pink"  "gray"  "pink"  "pink"  "gray"
[64] "pink"  "brown" "brown" "pink"  "pink"  "pink"  "pink"  "gray"  "gray"
[73] "pink"  "pink"  "pink"  "gray"  "gray"  "brown" "pink"  "brown" "pink"
[82] "pink"  "pink"  "gray"  "gray"
```

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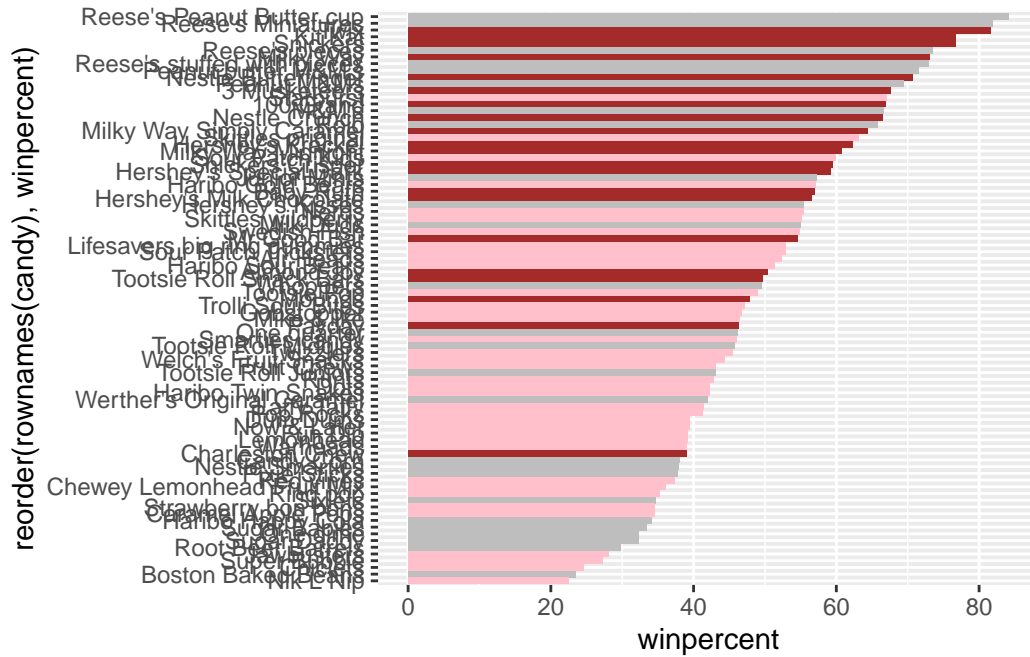


```
ggsave("mybarplot.png", width=3, height=6)
```
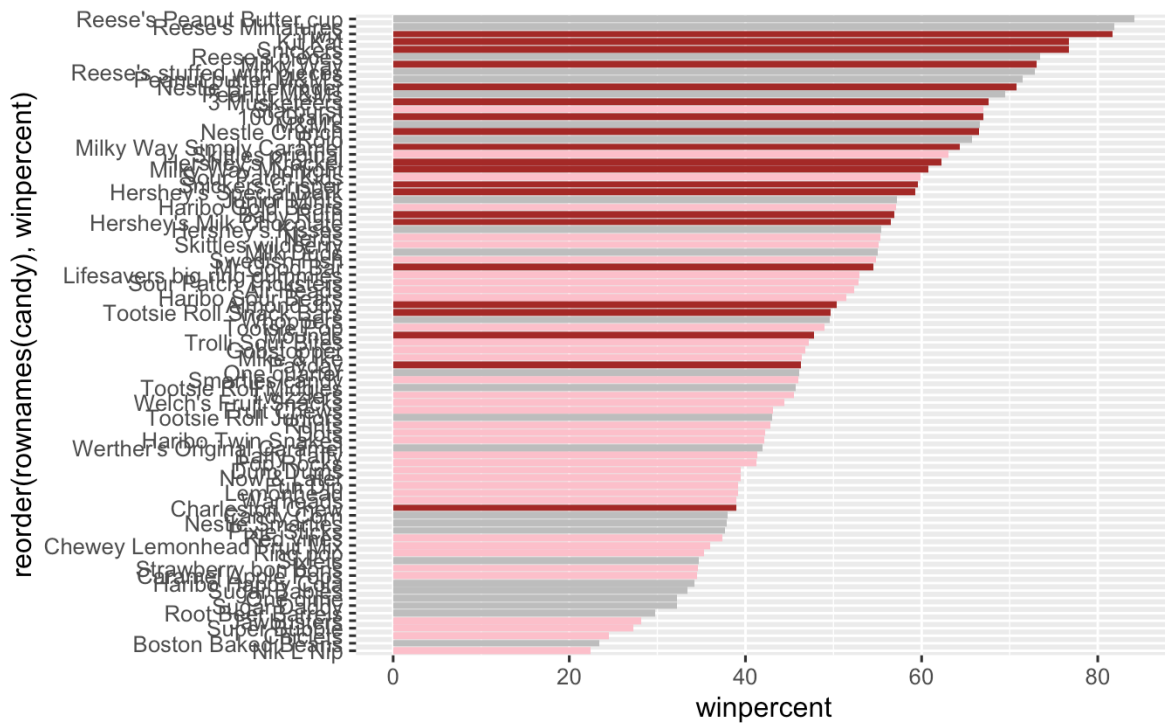
Figure 1: My silly barplot image

Q17. What is the worst ranked chocolate candy? The worst ranked chocolate candy per this graph and more clearly seen on the lab handout is the sixlets candy. Q18. What is the best ranked fruity candy? The best ranked fruity candy is the Starburst. ## 4 Winpercent vs. Pricepercent plot

```
library(ggrepel)
mycols[ as.logical(candy$fruity)] <- "red"
# How about a plot of price vs win
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=mycols) +
  geom_text_repel(col=mycols, size=3.3, max.overlaps = 20)
```

Warning: ggrepel: 1 unlabeled data points (too many overlaps). Consider increasing max.overlaps
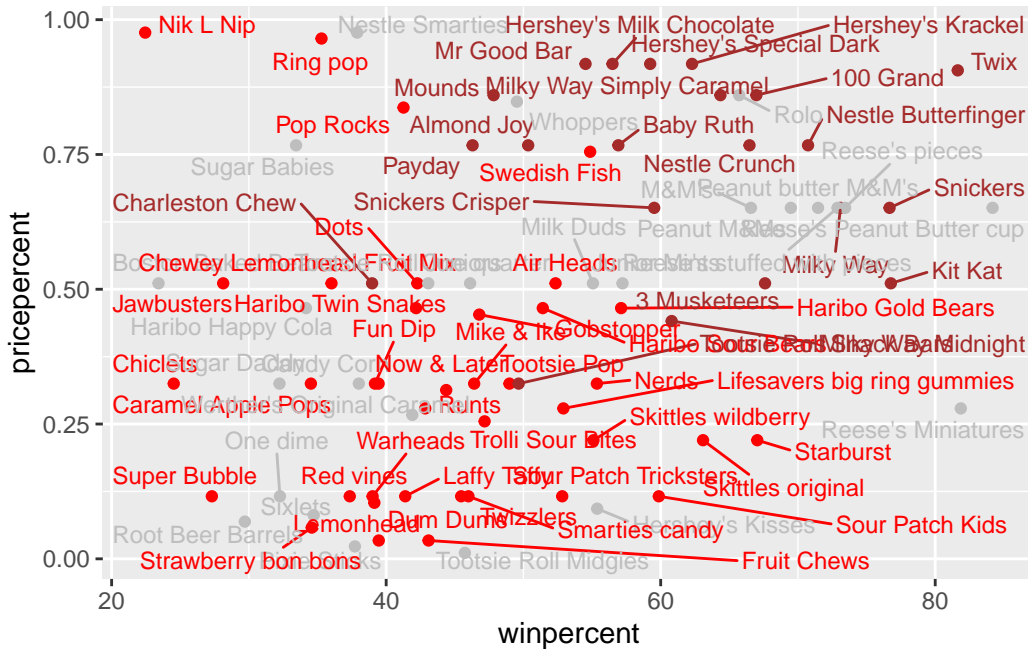
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                        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
```

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? 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 in the dataset are Nik L Nip, Nestle Smarties, Ring Pop, Hershey's Krackel, and Hershey's Milk Chocolate. Among these 5, the least popular is Nik L Nip. ## 5: Explore the Correlation Structure

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

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
corrplot(cij)
```
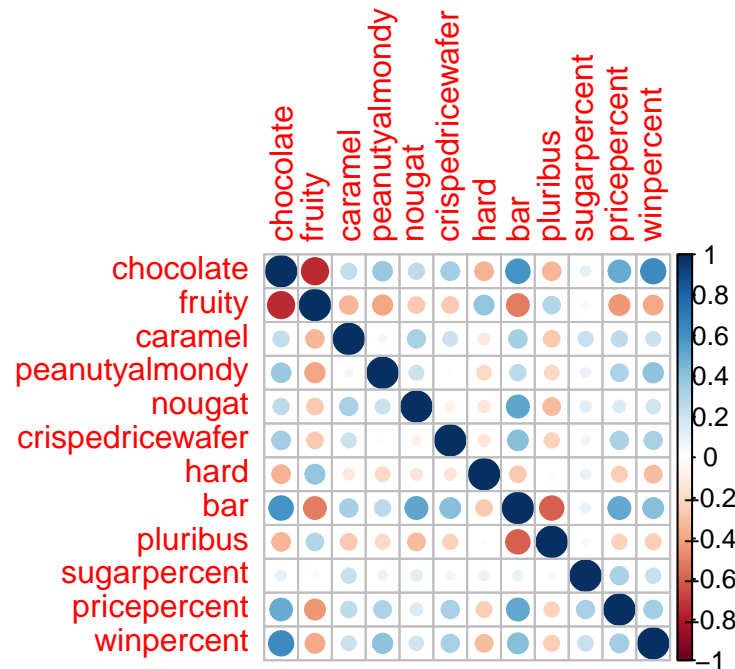

Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)? chocolate and fruity are the most anti-correlated towards the upper left quadrant of the screen.

Q23. Similarly, what two variables are most positively correlated? The most positively correlated variables are the chocolate and winpercent variables.

Principal Component Analysis (PCA)

We need to scale out input 'candy' data before PCA as we have the `winpercent` column on a different scale to all the others in the dataset.

```
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
```

First main result figure is my "PCA plot"

```
pca$x
```

```
                                  PC1            PC2          PC3          PC4
100 Grand                 -3.81986175 -0.5935787670 -2.186308676 -2.37159574
3 Musketeers              -2.79602364 -1.5196062111  1.412198551  0.69943868
One dime                   1.20258363  0.1718120657  2.060771178 -1.20067824
One quarter                0.44865378  0.4519735621  1.476492844 -1.00177141
Air Heads                  0.70289922 -0.5731343263 -0.929389343  0.41245656
Almond Joy                -2.46833834  0.7035501120  0.858108916  0.57249739
Baby Ruth                 -4.10531223 -2.1000967736  1.347834706  1.85505225
Boston Baked Beans         0.71385813  1.2098216537  0.941899950  1.10219913
Candy Corn                 1.01357204  0.2834319621 -0.840681586  0.83664703
Caramel Apple Pops         0.81049645 -1.6960889498 -0.207020586 -0.30186567
Charleston Chew           -2.15436587 -1.9304213037  1.675469334  0.46999498
Chewey Lemonhead Fruit Mix 1.65268482  0.0726434944 -0.909617411  0.58609915
Chiclets                   2.38180817  0.4430926071  1.000422079 -0.59998577
Dots                       1.51249936  0.1623958592 -0.967135199  0.63622661
Dum Dums                   2.14430933 -1.8388386160 -0.385372660 -0.14796280
Fruit Chews                2.26133763  0.5818322520  0.978626618 -0.39164187
Fun Dip                    1.82383348 -1.7828662094 -0.719415821 -0.08544003
Gobstopper                 1.96047812 -1.0584680267 -1.873874385  0.84237208
Haribo Gold Bears          1.33360746  0.5892699921 -0.431929774  0.33530766
Haribo Happy Cola          1.11167365  0.6257697808  0.054459647  0.16024129
Haribo Sour Bears          1.46152952  0.5073691482 -0.379443632  0.28956535
Haribo Twin Snakes         1.66849016  0.3748646265 -0.294528131  0.21556045
Hershey's Kisses           0.37722675  1.5654519145  1.104739528 -0.30451907
Hershey's Krackel         -3.04788356  0.6850792787 -1.154357778 -2.79294516
Hershey's Milk Chocolate  -2.11696417  0.2504568891  0.218316614 -0.64942872
Hershey's Special Dark    -2.17850376  0.2898570052  0.193067056 -0.62742342
Jawbusters                 2.62491587 -0.6343671618  0.114043053 -0.54172092
Junior Mints              -0.16010610  1.6194428347  0.442156347 -0.08935729
Kit Kat                   -2.87086546  0.9069655335 -0.545771148 -2.94691419
Laffy Taffy                1.65450042 -0.2379605144  1.217408326 -0.81578254
Lemonhead                  2.33564695 -1.2553404646  1.125823900 -1.18755633
```

Lifesavers big ring gummies	1.19528766	-0.0783610246	0.814040659	-0.61506538
Peanut butter M&M's	-1.52223814	1.9291395890	-0.815897653	2.27060871
M&M's	-0.76747561	1.2573539136	-1.260658369	0.98037043
Mike & Ike	1.57487290	0.0664259746	-1.114406454	0.84284942
Milk Duds	-0.76836937	0.4192793946	-0.137573021	-0.01222490
Milky Way	-3.69272218	-2.4933313173	0.843423990	0.70792542
Milky Way Midnight	-3.23036513	-2.8201031327	0.902884388	0.75904764
Milky Way Simply Caramel	-3.04936226	-1.1774777304	-1.382617058	0.15488883
Mounds	-1.81292795	0.2120726312	0.636094539	-0.91126847
Mr Good Bar	-2.67327849	0.9217207344	0.997161433	0.40634715
Nerds	1.93426895	-0.9133307225	-1.670281710	0.79359684
Nestle Butterfinger	-2.97855081	0.8798835368	0.348599786	0.94918411
Nestle Crunch	-2.92740488	0.8119013154	-0.747159803	-2.97250665
Nik L Nip	1.63985272	0.4210217322	-0.083217936	-0.24015596
Now & Later	1.98070982	0.5117150919	0.460099768	-0.21340533
Payday	-2.39180556	-1.4839637512	2.091687409	1.65680787
Peanut M&Ms	-1.38897069	2.0947188031	-0.260214925	1.89874716
Pixie Sticks	1.67042227	0.8969792365	1.394703254	-0.48031281
Pop Rocks	1.76879348	-0.8060325640	-1.567639814	0.42017068
Red vines	2.12406849	0.1366822960	-0.115183020	0.27721045
Reese's Miniatures	-1.55210251	1.9287569793	1.884620322	0.48605155
Reese's Peanut Butter cup	-2.28427985	1.4648923293	-0.156138940	1.63994489
Reese's pieces	-1.40590761	2.3077984818	0.136661895	1.64348077
Reese's stuffed with pieces	-2.13382398	1.0787289654	-0.673152403	1.96066081
Ring pop	1.19274412	-1.7069749284	-1.423826969	0.02570015
Rolo	-1.61259322	0.1773734932	-1.931879747	1.00697641
Root Beer Barrels	2.10440254	-0.8711340556	-0.594335570	0.36204105
Runts	2.25699185	-1.1223199934	-1.557678507	0.71996790
Sixlets	0.81799664	1.1888290122	1.093105891	-0.33001942
Skittles original	1.29259129	0.2263705137	-1.306145308	1.05900061
Skittles wildberry	1.47148517	0.1118354559	-1.232745536	0.99503181
Nestle Smarties	-0.27556563	1.3792344137	-0.080047831	-0.03345921
Smarties candy	2.60115214	-0.6047947520	0.003482896	-0.21938457
Snickers	-4.39576792	-1.7919312516	1.434654778	1.89861891
Snickers Crisper	-4.01457335	-0.0347673522	-1.089868643	-1.42309414
Sour Patch Kids	1.81551769	0.8879445215	0.863881832	-0.32795118
Sour Patch Tricksters	1.97326660	0.7869473239	0.928605869	-0.38435897
Starburst	1.50658493	0.9437290830	0.487658690	-0.12150268
Strawberry bon bons	2.80647837	-1.0331193111	-0.524069119	0.13960292
Sugar Babies	-0.01900559	-0.8219542293	-1.802826526	0.92212945
Sugar Daddy	0.19642038	-1.2073694698	0.520140143	-0.59663517
Super Bubble	1.99242820	-0.3915898648	1.481310204	-1.01767057
Swedish Fish	1.00547407	0.5003327040	-1.068588828	0.59499272

```
Tootsie Pop                     0.84734171  -1.1060686710  -0.480874078  -0.23675349
Tootsie Roll Juniors           -0.40463667   0.5848580362   0.836999949  -0.59623669
Tootsie Roll Midgies            0.66730732   1.3709464980   1.179339290  -0.32789249
Tootsie Roll Snack Bars        -1.31149842   0.0009721286   0.885976952  -0.78242207
Trolli Sour Bites               1.85048456   0.5304055168   0.254559391  -0.02435072
Twix                           -4.12909044  -0.2180299573  -1.943536689  -2.52917855
Twizzlers                       1.56312584  -0.1794588354   1.179917535  -0.78310886
Warheads                        2.30707033  -1.2940268825   1.004249910  -1.11380521
Welch's Fruit Snacks            1.84808801   0.5022006184   0.213204782  -0.03387254
Werther's Original Caramel      0.68420363  -2.0146385440   0.506488679  -0.97208672
Whoppers                       -1.42549552   1.3654147702  -2.759982292  -1.23030133
                                       PC5            PC6           PC7           PC8
100 Grand                      -0.66236243  -0.545218405  -0.14340559   0.577224229
3 Musketeers                   -0.16006665   0.382588420   2.02155526  -1.502574960
One dime                       -0.26977985   0.094950530  -0.77220066   0.155622104
One quarter                    -0.05093737   0.428354037  -0.59089199   0.359134372
Air Heads                       0.33108524   0.188791601   0.96808076   1.012393252
Almond Joy                      1.43200435   1.022273480  -0.66604596   0.608261288
Baby Ruth                      -0.53157179   0.026152894  -0.27477854   0.617961302
Boston Baked Beans             -0.01286555   1.147068667  -1.66290853   1.017203801
Candy Corn                     -0.92992691   0.482570575  -0.17268382  -0.433778134
Caramel Apple Pops             -1.26916612  -0.641471733  -0.77030933   1.705704289
Charleston Chew                -0.48839246   1.490541025   1.23825892  -1.445444979
Chewey Lemonhead Fruit Mix     -0.64216946   0.867070020   0.51175007   0.500258867
Chiclets                       -0.82031918   0.835939962  -0.06670709   0.514147274
Dots                           -0.57043885   0.625011322   0.68287986   0.487777458
Dum Dums                        1.60464382  -0.712637531  -0.06881335  -0.229647214
Fruit Chews                    -0.64943194  -0.515343269   0.62911226   0.295017216
Fun Dip                         1.64564645  -0.061325594  -0.22205535  -0.058799069
Gobstopper                      0.97535806   0.006638151   0.09322099  -0.594393205
Haribo Gold Bears              -0.41418743  -0.076745232   0.97316112   0.470072508
Haribo Happy Cola              -0.96450884   0.897177682  -0.57777493  -0.279999961
Haribo Sour Bears              -0.47964306   0.144138214   0.81700174   0.481462045
Haribo Twin Snakes             -0.58554144   0.501497845   0.56435691   0.499888780
Hershey's Kisses               -0.65415252  -0.956497265  -0.15459157  -1.475048333
Hershey's Krackel               0.64433919   0.815979037   0.72869731  -0.058197261
Hershey's Milk Chocolate        0.45257976   1.365951323   0.09727415  -0.537271619
Hershey's Special Dark          0.48406856   1.259690716   0.17239789  -0.542750795
Jawbusters                      0.74872541   0.777635266  -0.86953189  -0.404938915
Junior Mints                   -0.56772916  -0.100807494  -0.27701048  -1.244289684
Kit Kat                         0.74560410  -0.651964126   1.26789202  -0.308264629
Laffy Taffy                     0.12742282  -0.323401158   0.50907401   0.902891431
Lemonhead                       1.59348201  -0.612577970  -0.46974919  -0.088239458
```

Lifesavers big ring gummies	0.28553918	-0.405905368	0.76717408	0.968451468
Peanut butter M&M's	0.70534888	-0.535487043	-0.31945944	-0.055419751
M&M's	-0.42260375	-0.093849007	0.23580574	-1.272394704
Mike & Ike	-0.54748868	0.068855836	0.96217007	0.350296998
Milk Duds	-1.94930706	-1.088570940	-1.46793514	-0.532609515
Milky Way	-1.43541753	-0.603255019	0.91522507	-0.708957591
Milky Way Midnight	-1.60495490	-0.577210751	0.75050728	-0.825932767
Milky Way Simply Caramel	-0.81154750	-0.095588630	-0.56663709	0.057913957
Mounds	0.34136052	1.562117376	-0.17156397	-0.536908890
Mr Good Bar	1.49882941	1.178267833	-0.70645139	0.710404328
Nerds	1.05269810	-0.612484674	0.36162582	-0.677966908
Nestle Butterfinger	1.66950147	0.246674393	-0.03583585	0.547351886
Nestle Crunch	0.66634611	0.310195315	0.85793736	-0.137897493
Nik L Nip	-0.74139722	2.364290586	-0.37097983	0.877307522
Now & Later	-0.64458895	0.275284807	0.43215999	0.459054334
Payday	0.57021053	1.685803617	0.71659189	0.920899230
Peanut M&Ms	0.67649842	-0.481270608	-0.49445201	-0.017712739
Pixie Sticks	-1.00053741	-0.249857693	-0.45261662	-0.491657159
Pop Rocks	0.96236780	1.036365445	-0.40726527	-0.314719629
Red vines	-0.69083254	-0.068691578	0.66734570	0.288409391
Reese's Miniatures	1.52874138	-1.896976303	-0.34129661	0.391227548
Reese's Peanut Butter cup	1.62984822	-1.101118658	-0.10711621	0.504507095
Reese's pieces	0.71687442	-0.652294629	-0.48369702	0.001608461
Reese's stuffed with pieces	1.50741757	-0.638134777	-0.27656579	0.488051492
Ring pop	1.69809389	1.498435385	-0.64909630	0.323514628
Rolo	-1.75944281	-0.678446043	-1.06073297	-0.430807299
Root Beer Barrels	0.42962062	-0.109312144	-1.19510153	-1.555611980
Runts	0.90293644	-0.227471967	0.05500446	-0.683423916
Sixlets	-0.89038600	-0.174585492	-0.66527067	-1.454385221
Skittles original	-0.37037605	-0.800924438	1.50687697	0.245536582
Skittles wildberry	-0.46191313	-0.492027764	1.28849431	0.261464394
Nestle Smarties	-0.71703419	1.677902657	-1.00236322	-0.943766974
Smarties candy	0.89831080	-0.766691658	-0.09224917	-0.697074269
Snickers	-0.32409247	-0.999567686	0.29375023	0.519082351
Snickers Crisper	0.28905186	-0.982077142	-0.99809936	1.715122168
Sour Patch Kids	-0.44613213	-0.989653570	1.01684337	0.317967197
Sour Patch Tricksters	-0.52684967	-0.717267988	0.82427320	0.332012368
Starburst	-0.34591253	-1.030380238	1.20373631	0.352584423
Strawberry bon bons	0.76654988	-0.423292666	-0.21835972	-0.752170933
Sugar Babies	-2.27338367	0.557052968	-1.67505130	0.548087948
Sugar Daddy	-1.58729466	-0.485682924	-1.85240975	0.941435233
Super Bubble	-0.03565422	0.216125641	0.09347559	0.939439208
Swedish Fish	-0.39241423	0.662591135	0.83851208	0.624071063

```
Tootsie Pop                  1.88703233 -0.633721587 -0.18826747 -1.043909239
Tootsie Roll Juniors         0.05449315  0.394706045 -0.68468874 -0.662902544
Tootsie Roll Midgies        -0.77589776 -0.759442617 -0.35278919 -1.510639321
Tootsie Roll Snack Bars      0.28510912  0.328392863  0.22536722 -0.875755689
Trolli Sour Bites           -0.56414212 -0.168850396  0.72703429  0.389139607
Twix                        -0.49203516 -1.029755076  0.13814854  0.601927243
Twizzlers                    0.17417770 -0.481177950  0.62061848  0.894755897
Warheads                     1.59506307 -0.576609554 -0.45482313 -0.087796992
Welch's Fruit Snacks        -0.58742724  0.067119205  0.62144223  0.428665533
Werther's Original Caramel   0.00698052 -1.343145309 -2.51219819 -0.091968746
Whoppers                    -0.46170658  0.678567795  0.16799768 -0.639281286
                                   PC9         PC10         PC11
100 Grand                    0.379148201 -0.154099543  0.141903843
3 Musketeers                 0.023832701 -0.155239068 -0.517927160
One dime                    -0.453988975 -0.943783623 -0.515870807
One quarter                 -0.638889823  0.095579648 -0.986719399
Air Heads                   -1.383012190 -0.573723493 -0.514453684
Almond Joy                  -0.139059851 -0.312778705  1.061148660
Baby Ruth                    1.143067977  0.264099876 -0.009085882
Boston Baked Beans           1.396216830 -0.973188567  0.102073964
Candy Corn                  -0.173119296 -1.580718107 -0.026369468
Caramel Apple Pops          -0.916479426 -0.201217892  0.098522113
Charleston Chew              0.265940391 -0.852594237 -0.299018234
Chewey Lemonhead Fruit Mix  -0.056700856 -0.274516517  0.133783407
Chiclets                     0.600474625  0.299142845  0.263138381
Dots                        -0.109595061 -0.122162631  0.085957526
Dum Dums                    -0.385161810 -0.858986682  0.026635152
Fruit Chews                  0.431017129  0.094469913  0.405402342
Fun Dip                     -0.432729164 -0.348623806 -0.240086957
Gobstopper                   0.401434380  0.160051400  0.173108273
Haribo Gold Bears           -0.021735861  0.618649969 -0.035818163
Haribo Happy Cola            0.174940628 -0.664580531 -0.210044044
Haribo Sour Bears            0.026531168  0.479623974  0.007823919
Haribo Twin Snakes           0.104620713  0.254698661  0.078430922
Hershey's Kisses             0.015418665 -0.009459574  0.108560740
Hershey's Krackel            0.589905081 -0.259828939 -0.295461506
Hershey's Milk Chocolate    -1.211270861  0.556641044  0.566669950
Hershey's Special Dark      -1.234490726  0.623522410  0.545675013
Jawbusters                   1.175121068  1.211984587  0.107699541
Junior Mints                -0.125729538  0.657349544 -0.278384695
Kit Kat                      0.627262392 -0.428229606 -0.052463331
Laffy Taffy                 -0.694575541 -0.358253574 -0.196159662
Lemonhead                    0.133629280  0.441715610 -0.165939908
```

Lifesavers big ring gummies	-0.856144679	0.130909678	-0.425911984
Peanut butter M&M's	0.267660757	-0.221930007	-0.095957385
M&M's	-0.712293695	0.050005905	-0.359922697
Mike & Ike	-0.220487198	-0.593471988	0.252731956
Milk Duds	-0.136911155	1.039501593	0.120288784
Milky Way	0.004765911	0.843304841	-0.327048378
Milky Way Midnight	0.046247663	-0.050365745	-0.014682753
Milky Way Simply Caramel	-1.628250067	0.337544026	1.024026651
Mounds	-1.038014053	0.444568191	0.664244259
Mr Good Bar	-0.083279402	0.319687965	0.860817575
Nerds	0.395546909	0.241504770	0.214795902
Nestle Butterfinger	-0.418486899	-0.056067346	0.931659519
Nestle Crunch	0.670459908	-0.224206267	-0.210210679
Nik L Nip	0.390203352	1.144571263	-0.293659295
Now & Later	0.340332791	0.362285847	0.182098894
Payday	1.592516886	-0.586376631	-0.517961675
Peanut M&Ms	0.463012748	0.130263439	-0.124891428
Pixie Sticks	0.506958178	-0.721036477	0.100340132
Pop Rocks	0.614743430	1.229233468	-0.196822517
Red vines	0.116010128	-0.683310675	0.459814126
Reese's Miniatures	-0.201912762	0.339292365	-0.538620165
Reese's Peanut Butter cup	-0.813354976	-0.127457497	-0.769615618
Reese's pieces	0.573552037	0.549292897	-0.190638431
Reese's stuffed with pieces	-0.924164172	-0.865127171	-0.632341326
Ring pop	-0.509522417	0.693685961	-0.801535980
Rolo	-0.716390425	0.955937401	-0.177541179
Root Beer Barrels	0.748159981	-1.361887249	0.275586696
Runts	0.490713003	-0.186267132	0.357472263
Sixlets	0.120551003	-0.694412596	0.295248736
Skittles original	-0.396609466	-0.492989386	0.235345367
Skittles wildberry	-0.329109954	-0.687411685	0.296377074
Nestle Smarties	-0.095850762	0.891841882	-0.546823295
Smarties candy	0.957784710	0.645048933	0.369028845
Snickers	1.040500931	0.639420129	-0.064039216
Snickers Crisper	1.597773064	-0.876877339	0.668926998
Sour Patch Kids	0.319739180	0.748914211	0.190355889
Sour Patch Tricksters	0.379260358	0.577472316	0.244173747
Starburst	0.178115491	0.966910650	0.055007728
Strawberry bon bons	0.831798717	-0.257396978	0.567295681
Sugar Babies	-0.204221618	-0.392704656	-0.026264253
Sugar Daddy	-0.751459910	-0.659787353	-0.269135682
Super Bubble	-0.530802993	-0.601257076	-0.099471654
Swedish Fish	-0.159360361	0.838989403	-0.260036175

```
Tootsie Pop                  -0.721118894  0.326836317 -0.137911107
Tootsie Roll Juniors         -1.149669881 -0.284072969 -0.704615875
Tootsie Roll Midgies          0.074811904 -0.471079914  0.266947340
Tootsie Roll Snack Bars      -1.078720446 -0.723988086  1.173413519
Trolli Sour Bites             0.215399333  0.265589321  0.205354764
Twix                          0.390371217  0.606070076 -0.048120393
Twizzlers                    -0.729052624 -0.258947465 -0.227333151
Warheads                      0.096482954  0.378764818 -0.167107014
Welch's Fruit Snacks          0.229115315  0.300496305  0.173167709
Werther's Original Caramel    0.028457521  0.448967578 -0.298604763
Whoppers                      1.212121185 -1.054026246 -1.220426934
                                    PC12
100 Grand                     0.0646988318
3 Musketeers                 -0.1839471662
One dime                     -0.5107477914
One quarter                  -0.9582719109
Air Heads                     0.0442992399
Almond Joy                    0.1889347102
Baby Ruth                     0.5798508261
Boston Baked Beans           -0.1012981497
Candy Corn                   -0.6799350975
Caramel Apple Pops            0.6962504166
Charleston Chew               0.5494017342
Chewey Lemonhead Fruit Mix    0.3105973331
Chiclets                      0.5337581991
Dots                          0.1503797578
Dum Dums                      0.1849692597
Fruit Chews                   0.1399898762
Fun Dip                       0.1237990873
Gobstopper                   -0.1944414618
Haribo Gold Bears            -0.2638818244
Haribo Happy Cola            -0.6879064447
Haribo Sour Bears            -0.1176800541
Haribo Twin Snakes            0.1188546962
Hershey's Kisses              0.1984492942
Hershey's Krackel            -0.0817067486
Hershey's Milk Chocolate     -0.3573702410
Hershey's Special Dark       -0.4277036644
Jawbusters                    0.1337584661
Junior Mints                  0.0649489483
Kit Kat                      -0.3769186469
Laffy Taffy                   0.3026020451
Lemonhead                     0.0619011170
```

```
Lifesavers big ring gummies -0.0228900695
Peanut butter M&M's         0.1200218111
M&M's                      -0.1023879726
Mike & Ike                  0.1113757406
Milk Duds                   0.3400578947
Milky Way                  -0.1552479006
Milky Way Midnight          0.2304632793
Milky Way Simply Caramel   -0.2533060125
Mounds                     -0.1415021722
Mr Good Bar                 0.0210418054
Nerds                      -0.3936975444
Nestle Butterfinger        -0.3100685916
Nestle Crunch              -0.1731325150
Nik L Nip                   0.4597035356
Now & Later                 0.1806417362
Payday                     -0.7729766006
Peanut M&Ms                 0.1319358415
Pixie Sticks               -0.7378511713
Pop Rocks                  -0.1936682261
Red vines                   0.3438211129
Reese's Miniatures         -0.0689054242
Reese's Peanut Butter cup  -0.1005437626
Reese's pieces             -0.0005861225
Reese's stuffed with pieces  0.2335945192
Ring pop                    0.0735408387
Rolo                        0.0787870205
Root Beer Barrels          -0.7082327026
Runts                      -0.0585635801
Sixlets                     0.7459023430
Skittles original          -0.2795750540
Skittles wildberry         -0.0751177198
Nestle Smarties             0.4628839641
Smarties candy             -0.2022435492
Snickers                    0.0911696493
Snickers Crisper            0.6306015108
Sour Patch Kids            -0.3186623415
Sour Patch Tricksters      -0.1383715363
Starburst                  -0.5130782116
Strawberry bon bons         0.1543709171
Sugar Babies               -0.4541934821
Sugar Daddy                -0.2885121237
Super Bubble                0.6537195364
Swedish Fish               -0.2507351031
```

```
Tootsie Pop                  1.2506316262
Tootsie Roll Juniors         0.5695856300
Tootsie Roll Midgies         0.4724506497
Tootsie Roll Snack Bars     -0.0373596827
Trolli Sour Bites            0.0146955266
Twix                        -0.3530484324
Twizzlers                    0.1981702880
Warheads                     0.0702649429
Welch's Fruit Snacks         0.0727669700
Werther's Original Caramel  -0.8335356607
Whoppers                     0.7201599382
```

```
ggplot(pca$x) +
  aes(PC1, PC2, label=rownames(pca$x)) +
  geom_point(col=mycols) +
  geom_text_repel(max.overlaps=6, col=mycols) +
  theme_bw()
```

```
Warning: ggrepel: 67 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```
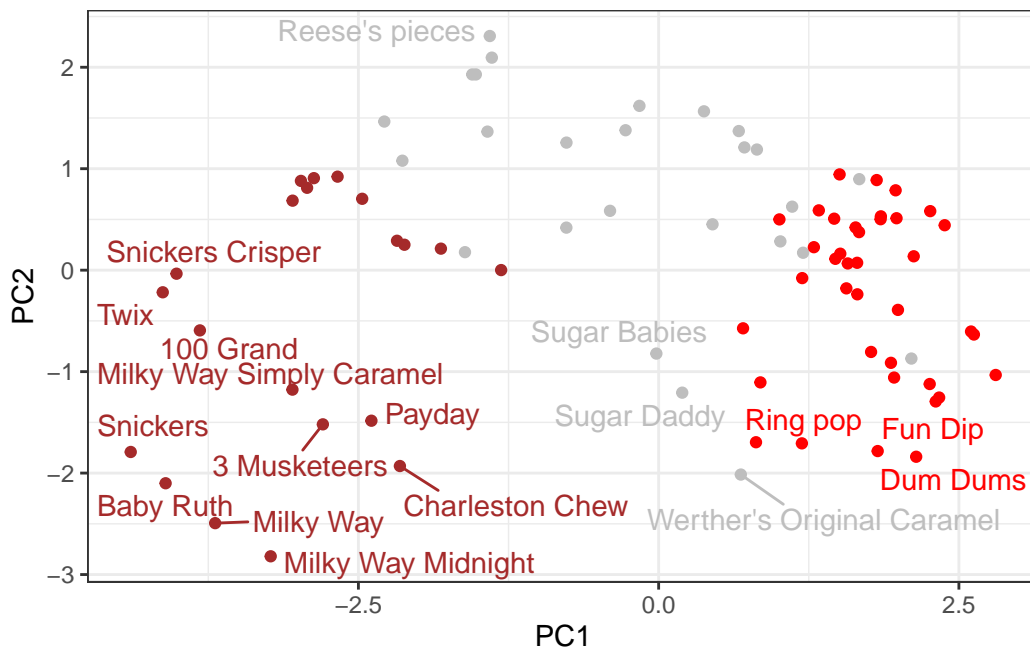

These tend to be hard on the right side of plot on fruity side. The second main PCA result is in the `pca$rotation` we can plot this to generate a so-called "loadings" plot.

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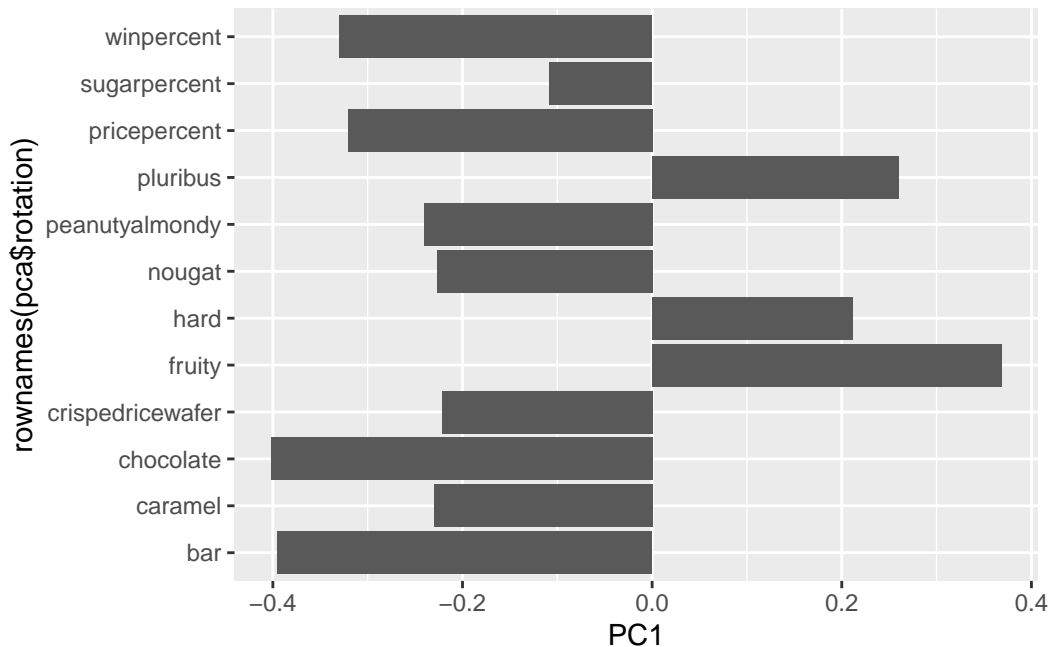

Q24: What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you? Of the three that we can see, the variables that most contribute to PC1 in the positive direction are fruity with the highest contribution, followed by pluriplus with the second highest contribution, and lastly followed by hard candies with the lowest contribution. These contributions make sense considering the large variation in variables like winpercent among the variety of fruity candies and further with the pluriplus candies, given that this pluriplus is an amalgamation of many different candies, there is bound to be much variation across the different candies that comprise it and thus is bound to potentially stray from the cluster of other candy data points and thus contribute heavily to PC1, which attempts to connects many of the data points in a line and capture the most variation. Further, as elaborated for fruity candy, in the barplot above, we saw much variation across fruity candies with some having very high winpercent values and some having not very high winpercent values and with such variation, it is likely to be more variable compared to other candy types which have less internal variation and may stray from the other data points and thus influence most the variation captured by PC1, which captures the most, and thus have the highest contribution. The same logic can be applied to bars; however, less variation across

this candy type will lead to a lower contribution and more commonality with the other data points.