Class10: Halloween Mini-Project

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Importing Candy data

Download dataset

```
candy_file <- "https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-ranl

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?

```
nrow(candy)
```

```
[1] 85
```

There are 85 different types of candies.

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

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

```
[1] 38
```

There are 38 types of fruity candy.

What is your favorite candy?

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

```
[1] 81.64291
```

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

```
candy["Nestle Crunch",]$winpercent
```

```
[1] 66.47068
```

Nestle Crunch winpercent is 66.5%

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

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

```
[1] 76.7686
```

Kit Kat winpercent ifs 76.7%.

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

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

```
[1] 49.6535
```

The winpercent of Tootsie Roll Snack Bars is 49.6%

```
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
candy |>
  filter(rownames(candy)=="Haribo Happy Cola") |>
  select(winpercent)
```

```
                 winpercent
Haribo Happy Cola   34.15896
```

Q. Find fruity candy with a winpercent above 50%

```
candy |>
  filter(winpercent > 50) |>
  filter(fruity ==1)
```

```
                           chocolate fruity caramel peanutyalmondy nougat
Air Heads                          0      1       0               0      0
Haribo Gold Bears                  0      1       0               0      0
Haribo Sour Bears                  0      1       0               0      0
Lifesavers big ring gummies        0      1       0               0      0
Nerds                              0      1       0               0      0
Skittles original                  0      1       0               0      0
Skittles wildberry                 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
Swedish Fish                       0      1       0               0      0
                           crispedricewafer hard bar pluribus sugarpercent
Air Heads                                 0    0   0        0        0.906
```

```
Haribo Gold Bears                          0    0   0        1        0.465
Haribo Sour Bears                          0    0   0        1        0.465
Lifesavers big ring gummies                0    0   0        0        0.267
Nerds                                      0    1   0        1        0.848
Skittles original                          0    0   0        1        0.941
Skittles wildberry                         0    0   0        1        0.941
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
Swedish Fish                               0    0   0        1        0.604
                           pricepercent winpercent
Air Heads                         0.511   52.34146
Haribo Gold Bears                 0.465   57.11974
Haribo Sour Bears                 0.465   51.41243
Lifesavers big ring gummies       0.279   52.91139
Nerds                             0.325   55.35405
Skittles original                 0.220   63.08514
Skittles wildberry                0.220   55.10370
Sour Patch Kids                   0.116   59.86400
Sour Patch Tricksters             0.116   52.82595
Starburst                         0.220   67.03763
Swedish Fish                      0.755   54.86111
```

```r
top.candy <- candy[candy$winpercent >50,]
top.candy[top.candy$fruity ==1,]
```

```
                           chocolate fruity caramel peanutyalmondy nougat
Air Heads                          0      1       0              0      0
Haribo Gold Bears                  0      1       0              0      0
Haribo Sour Bears                  0      1       0              0      0
Lifesavers big ring gummies        0      1       0              0      0
Nerds                              0      1       0              0      0
Skittles original                  0      1       0              0      0
Skittles wildberry                 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
Swedish Fish                       0      1       0              0      0
                           crispedricewafer hard bar pluribus sugarpercent
Air Heads                                  0    0   0        0        0.906
Haribo Gold Bears                          0    0   0        1        0.465
Haribo Sour Bears                          0    0   0        1        0.465
```

```
Lifesavers big ring gummies                0    0   0        0        0.267
Nerds                                      0    1   0        1        0.848
Skittles original                          0    0   0        1        0.941
Skittles wildberry                         0    0   0        1        0.941
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
Swedish Fish                               0    0   0        1        0.604
                           pricepercent winpercent
Air Heads                         0.511   52.34146
Haribo Gold Bears                 0.465   57.11974
Haribo Sour Bears                 0.465   51.41243
Lifesavers big ring gummies       0.279   52.91139
Nerds                             0.325   55.35405
Skittles original                 0.220   63.08514
Skittles wildberry                0.220   55.10370
Sour Patch Kids                   0.116   59.86400
Sour Patch Tricksters             0.116   52.82595
Starburst                         0.220   67.03763
Swedish Fish                      0.755   54.86111
```

```
#this is more complicated than the one above
```

Install Skimer package. To get a quick insight into a new dataset some folks like using the skimer package and its `skim()` function.

```
#install.packages("skimer") or just go through package
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?

The `winpercent` column/variable is around 100 times the other columns since the other columns are all below 1. (Need to scale the data before doing any analysis like PCA etc.)

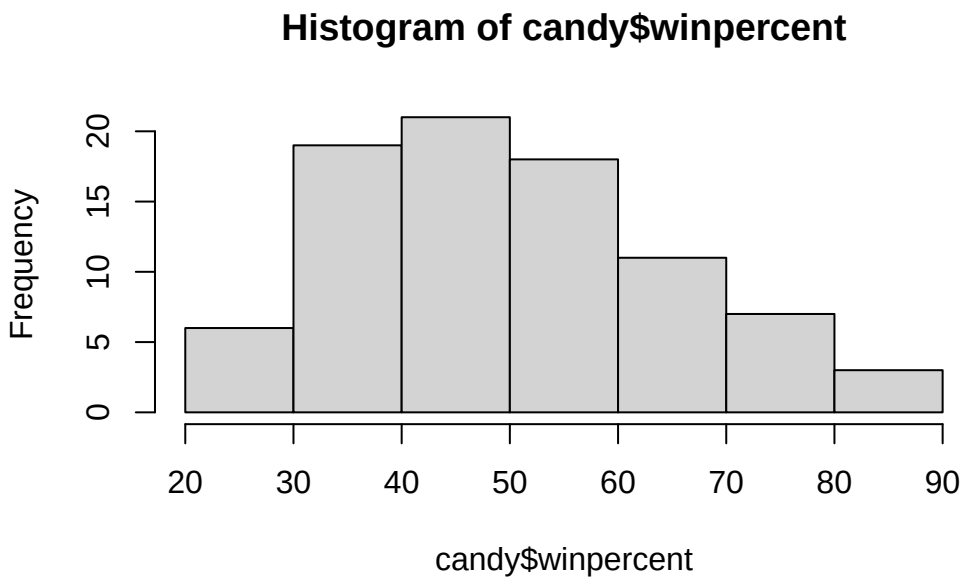
Q7. What do you think a zero and one represent for the candy$chocolate column?

A zero and one represent if the candy is classified as a choloate candy or not.

Q8. Plot a histogram of winpercent values

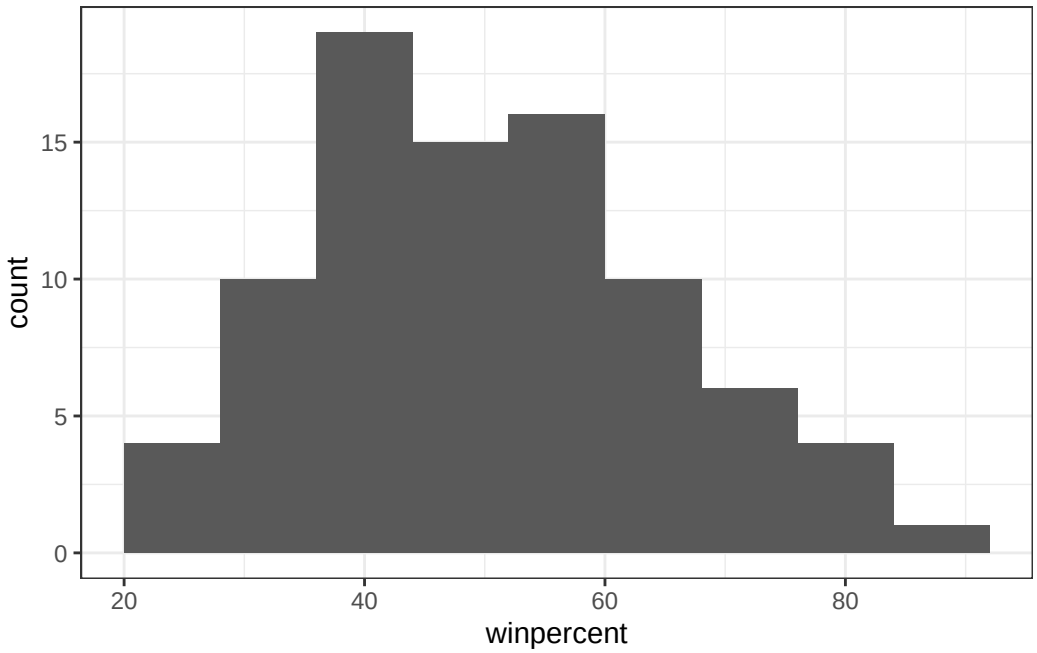
We can do this a few ways, e.g. the "base" R `hist()` function or with `ggplot()`

```
hist(candy$winpercent, breaks = 8)
```




```
library("ggplot2")

ggplot(candy)+
  aes(winpercent)+
  geom_histogram(binwidth =8) +
  theme_bw()
```



Q9. Is the distribution of winpercent values symmetrical?

No, the winpercent seems to be skewed right, where theres more value to the left.

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

```
summary(candy$winpercent)
```

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

THe median is below 50% and the median is above 50. The median is a better comparision as the data is skewed.

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

```
fruit.candy <- candy |>
  filter(fruity==1)
chocolate.candy <- candy |>
  filter(chocolate ==1)

summary(fruit.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  22.45   39.04   42.97   44.12   52.11   67.04
```

```
summary(chocolate.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  34.72   50.35   60.80   60.92   70.74   84.18
```

```
#this is easier to read it compared to the one below it
```

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

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  22.45   39.04   42.97   44.12   52.11   67.04
```

```
summary(candy[as.logical(candy$chocolate),]$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  34.72   50.35   60.80   60.92   70.74   84.18
```

Chocolate candy is ranked above fruity candy as all the summary value (min, 1st quartile, median, mean, 3rd quartile, and max) are all greater than the one for fruity.

Q12. Is this difference statistically significant?

```
t.test(chocolate.candy$winpercent, fruit.candy$winpercent)
```

```
    Welch Two Sample t-test

data:  chocolate.candy$winpercent and fruit.candy$winpercent
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
```

P-value is extremely low so there is a significant difference.

Overall Candy Rankings

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

```
play <- c("d","a","c")
sort(play)
```

```
[1] "a" "c" "d"
```

```
order(play)
```

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

```
play[order(play)]
```

```
[1] "a" "c" "d"
```

```
#use play instead of order bc want to know what the candy is and not just the top winpercent
```

```
head(candy[order(candy$winpercent),])
```

```
                  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
Root Beer Barrels         0      0       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
Root Beer Barrels                0    1   0        1        0.732        0.069
                  winpercent
Nik L Nip           22.44534
Boston Baked Beans  23.41782
Chiclets            24.52499
```

```
Super Bubble         27.30386
Jawbusters           28.12744
Root Beer Barrels    29.70369
```

Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, Jawbusters, and Root Beer Barrels are the least liked candies.

Q14. What are the top 5 all time favorite candy types out of this set?

```
candy |>
  arrange(winpercent) |>
  tail(5)
```

```
                         chocolate fruity caramel peanutyalmondy nougat
Snickers                         1      0       1              1      1
Kit Kat                          1      0       0              0      0
Twix                             1      0       1              0      0
Reese's Miniatures               1      0       0              1      0
Reese's Peanut Butter cup        1      0       0              1      0
                         crispedricewafer hard bar pluribus sugarpercent
Snickers                                 0    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Twix                                     1    0   1        0        0.546
Reese's Miniatures                       0    0   0        0        0.034
Reese's Peanut Butter cup                0    0   0        0        0.720
                         pricepercent winpercent
Snickers                        0.651   76.67378
Kit Kat                         0.511   76.76860
Twix                            0.906   81.64291
Reese's Miniatures              0.279   81.86626
Reese's Peanut Butter cup       0.651   84.18029
```

```
head(candy[order(candy$winpercent, decreasing=T),])
```

```
                         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
```

	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

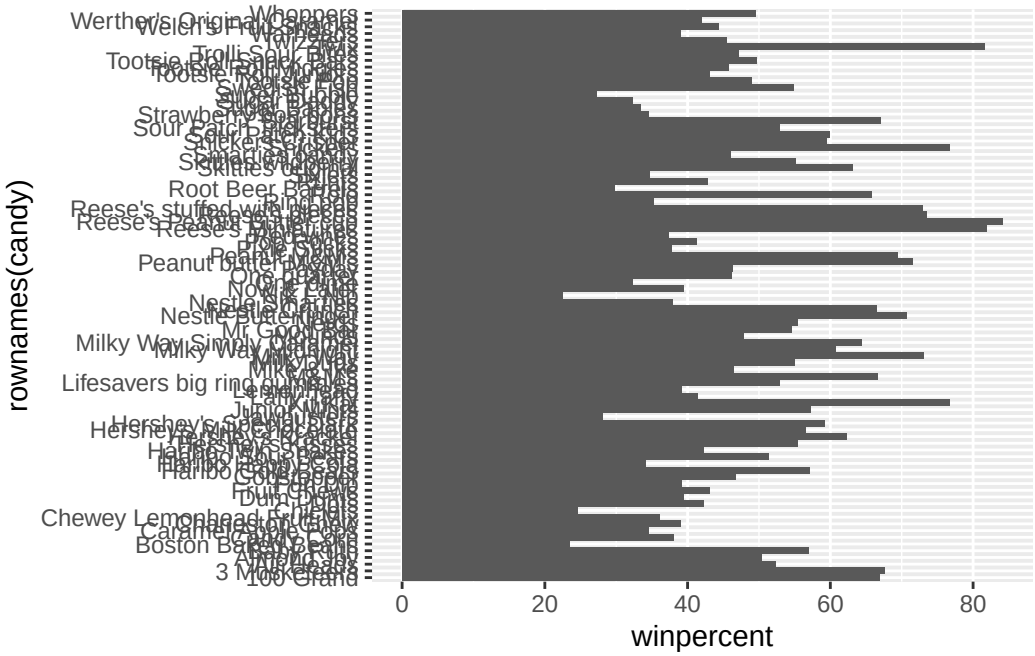
	pricepercent	winpercent
Reese's Peanut Butter cup	0.651	84.18029
Reese's Miniatures	0.279	81.86626
Twix	0.906	81.64291
Kit Kat	0.511	76.76860
Snickers	0.651	76.67378
Reese's pieces	0.651	73.43499

Reese, twix, kitkat, and snickers are the top 5 all time favorite candies.

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

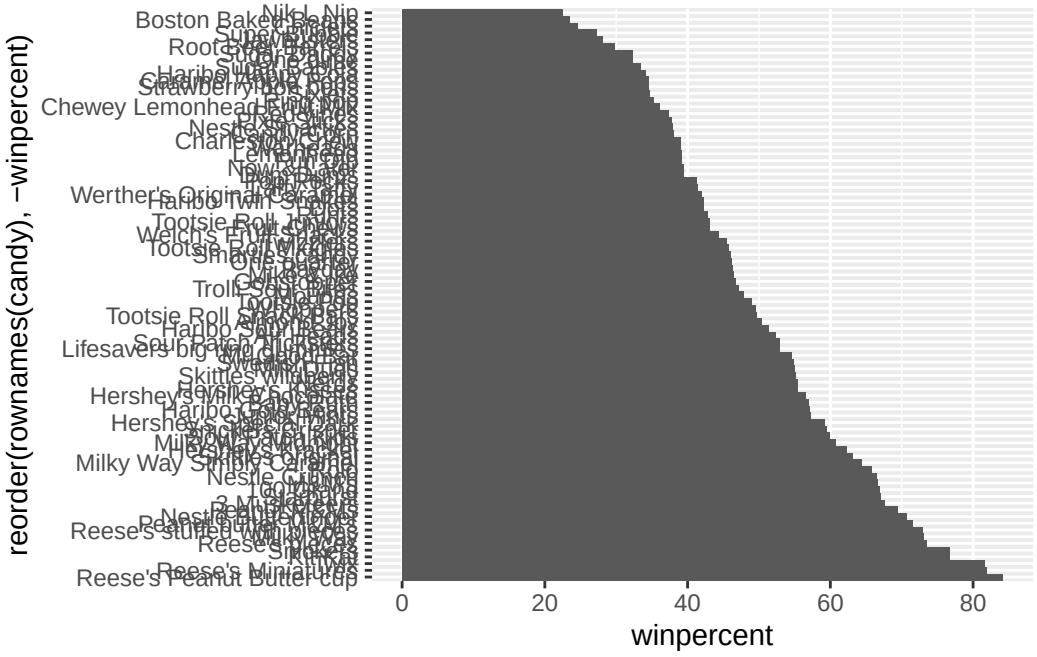
Let's do a barplot of winpercent values

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



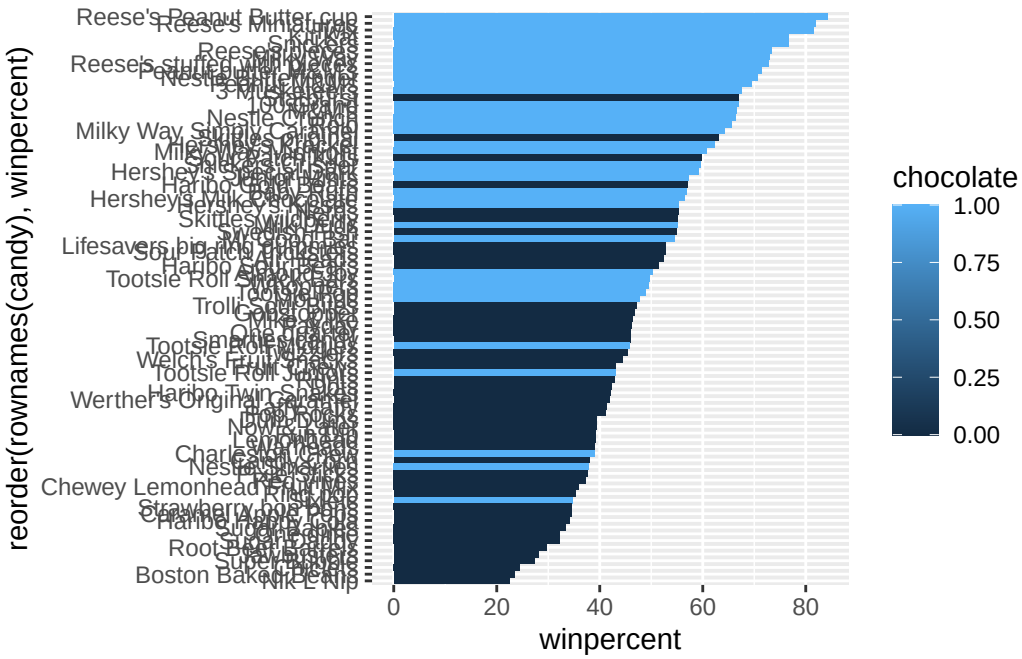
Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

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



Adding some useful color

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

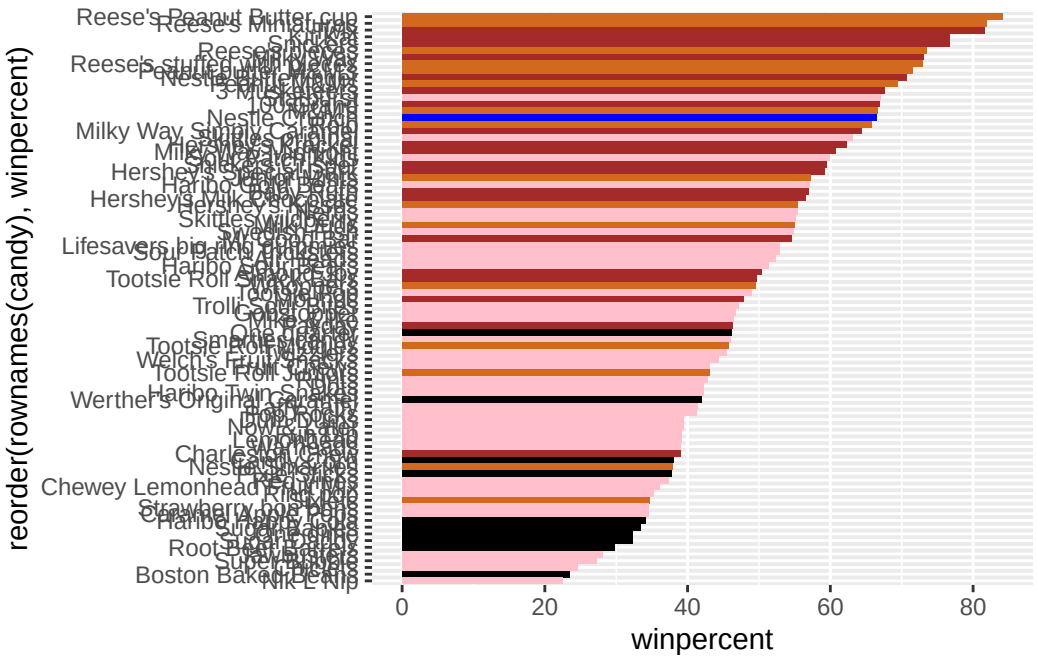


I want a more custom color scheme where I can see both chocolate an bar and fruity etc. all from the one plot. To do this we can roll our own color vector...

```
#this is the place holder color vector
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"
```

```
#Use blue for your favorite candy!
my_cols[rownames(candy)=="Nestle Crunch"] <-"blue"
```

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



Q17. What is the worst ranked chocolate candy?

The worst ranked chocolate candy is sixlets.

Q18. What is the best ranked fruity candy?

Starburst is the best ranked fruity candy.

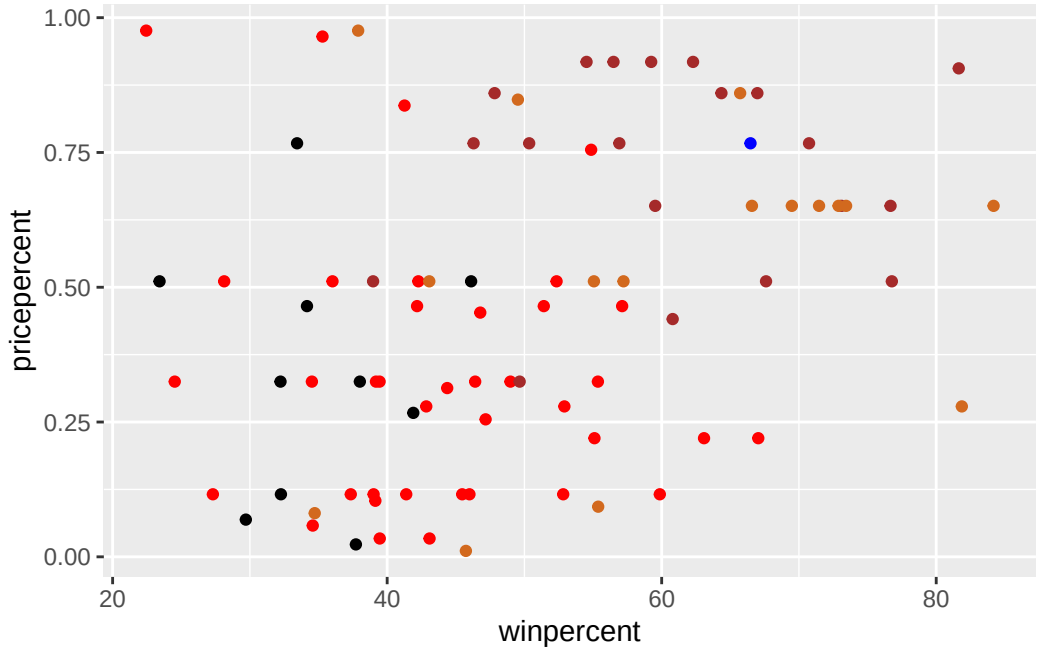
4. Taking a look at pricepercent

Plot of winpercent vs pricepercent to see what would be the best candy to buy...

Overwriting the fruity from pink to red so it is more visible.

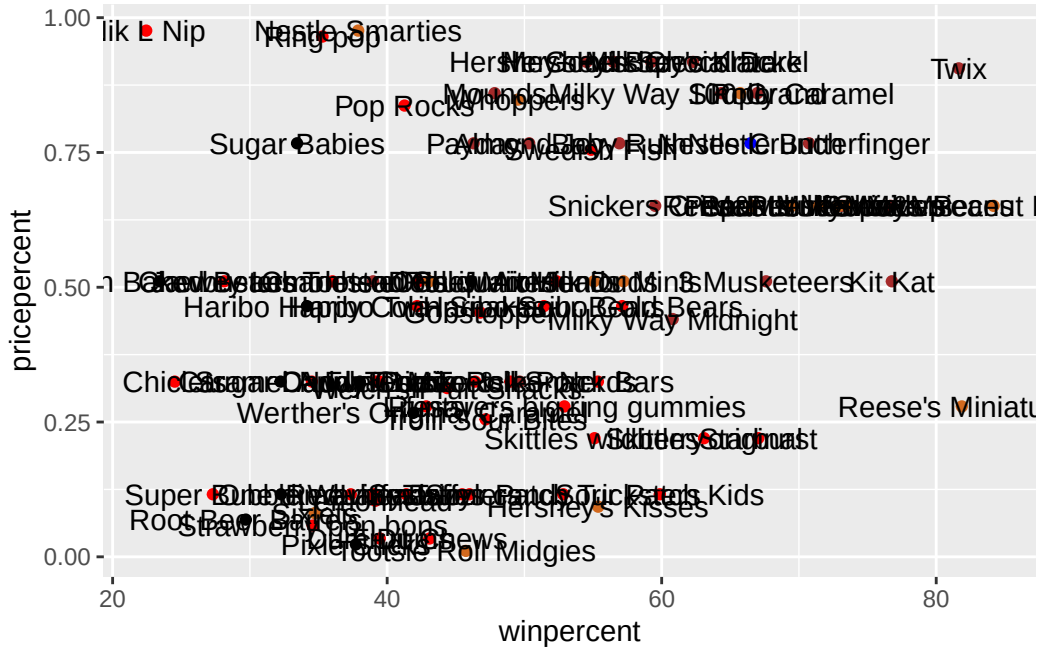
```
my_cols[as.logical(candy$fruity)] <- "red"
```

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



Add labels

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

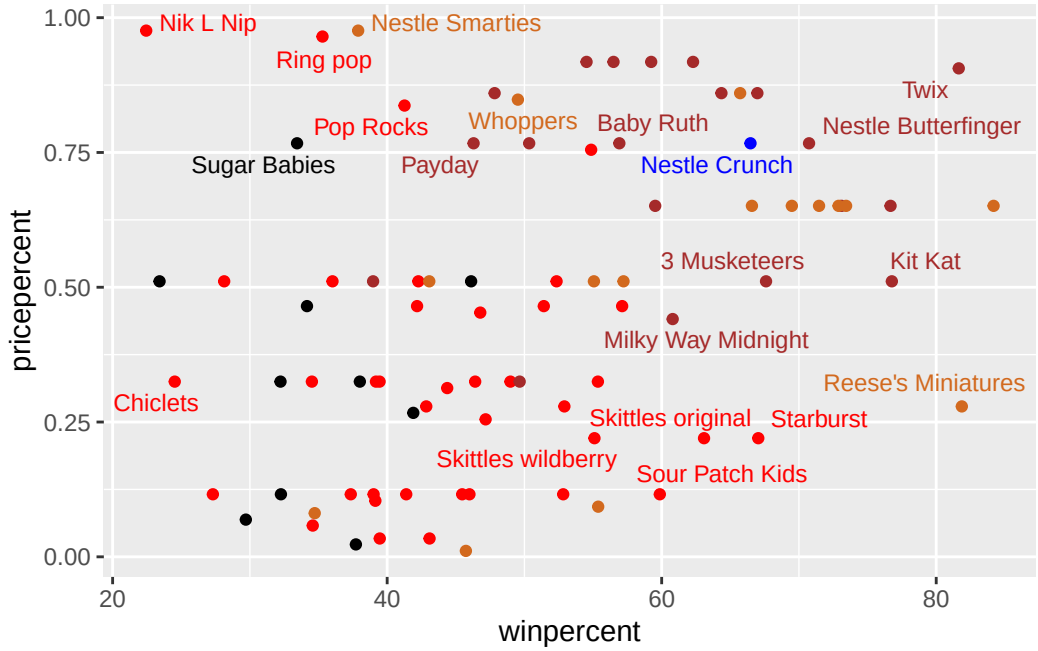



```
#this is hard to read bc of the overlaps, use ggrepel
```

```
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?

The Reese's Miniature is the best bang for your buck.

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

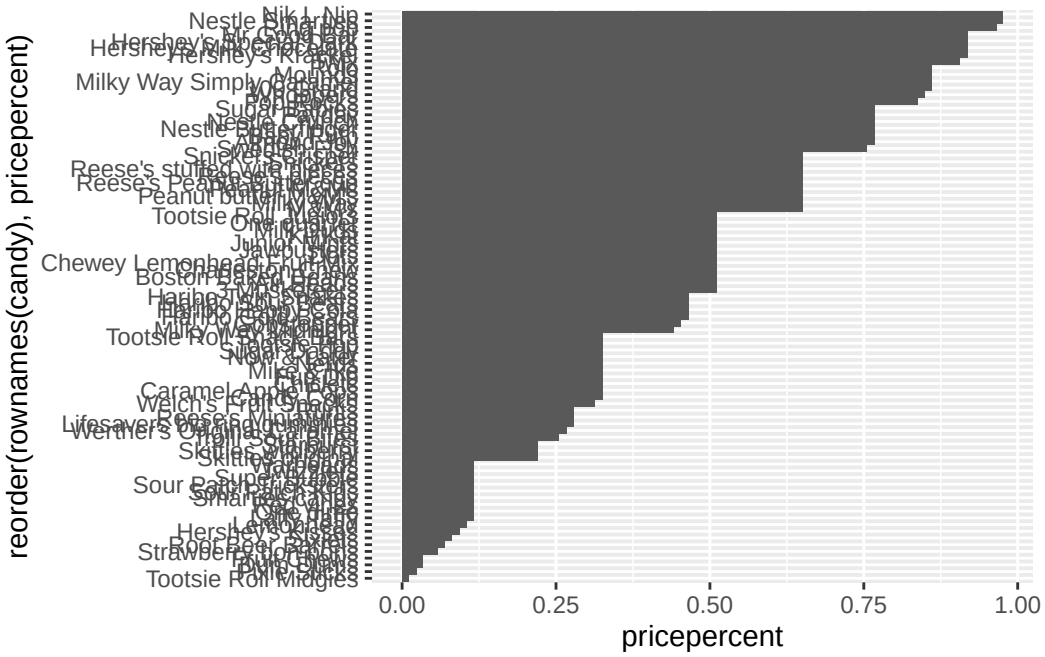
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                      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
```

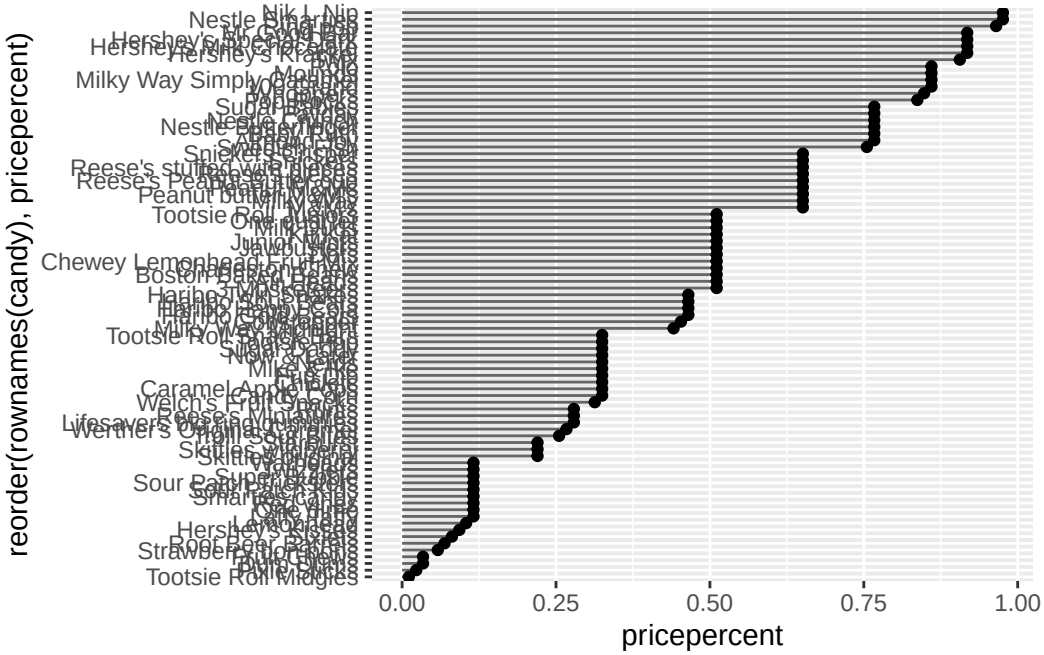
The most expensive is Nik L Nip, Ring pop, Nestle Smarties, Milky Way, Herskey's. Nik Nip is the least popular.'

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()

```
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy),pricepercent)) +
  geom_col()
```




```
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```



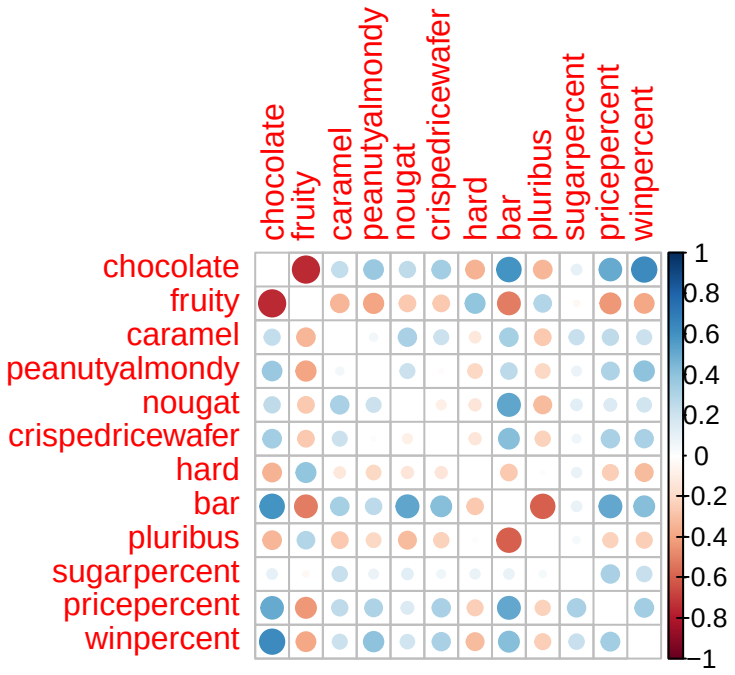
A lot of the the candies are the same price points

5. Exploring the correlation structure

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
cij <- cor(candy)
corrplot(cij, diag =F)
```



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

Fruity and chocolate are strongly anti-correlated.

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

Chocolate and winpercent are the most positively correlated.

```
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
```

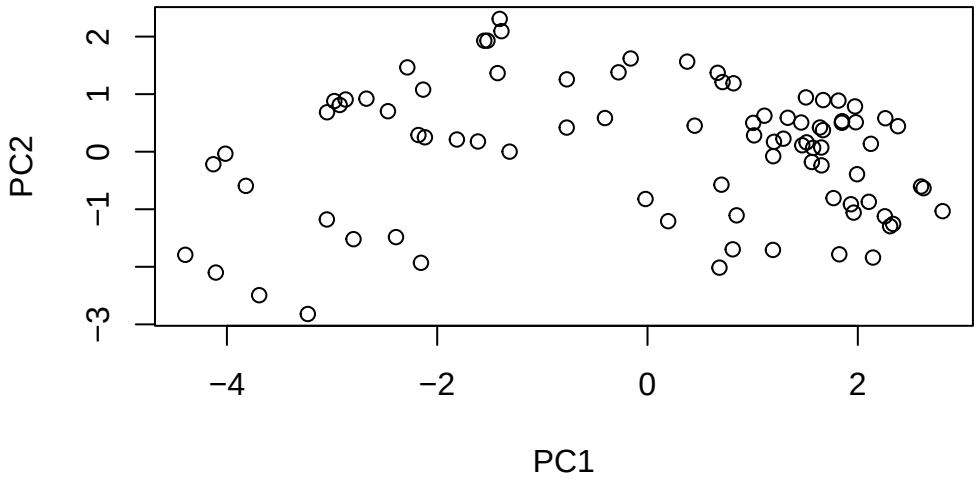
6. Principal Componenent Analysis

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

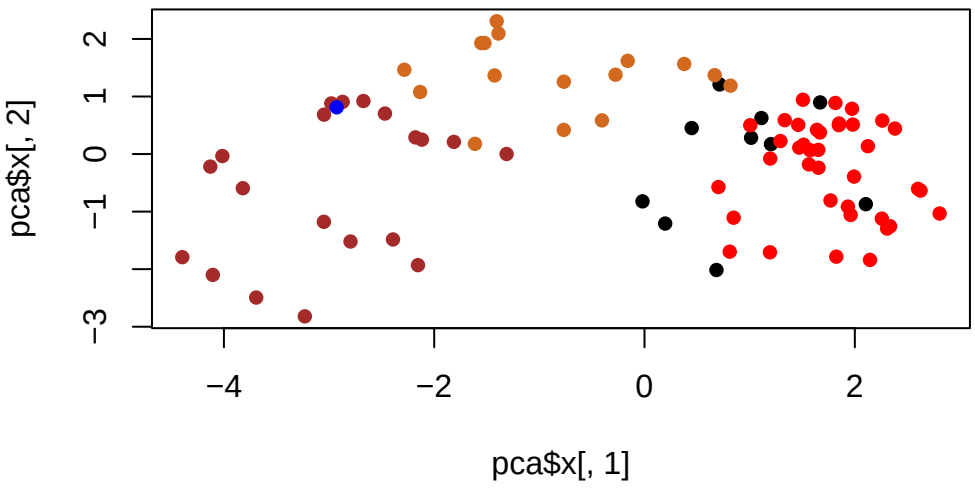
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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
```

```r
plot(pca$x[,1:2])
```

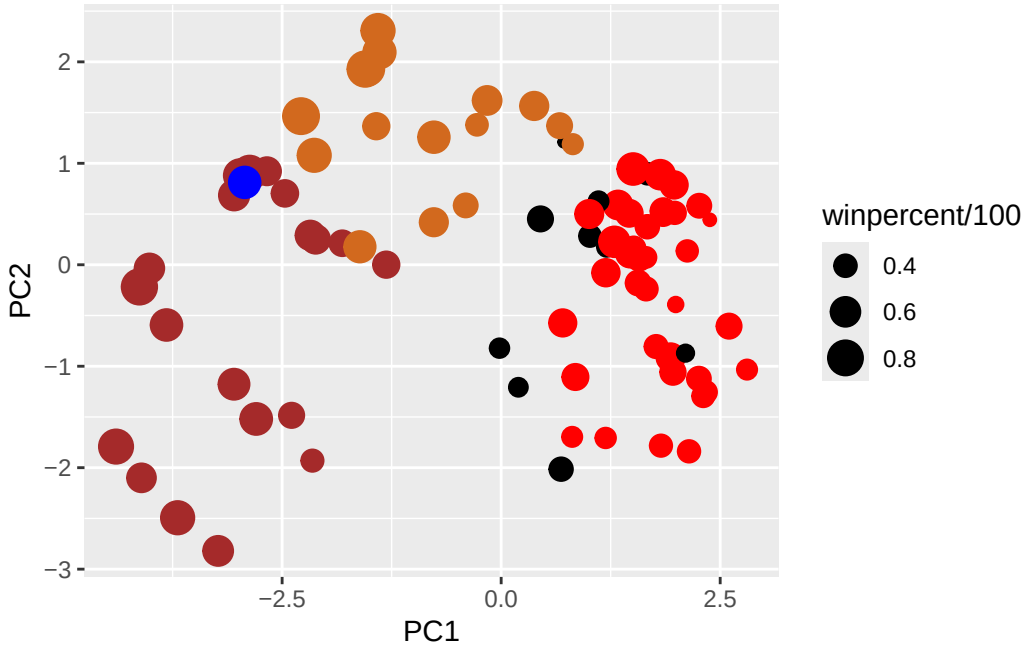



```r
plot(pca$x[,1], pca$x[,2], col=my_cols, pch=16)
```




```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, 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
```

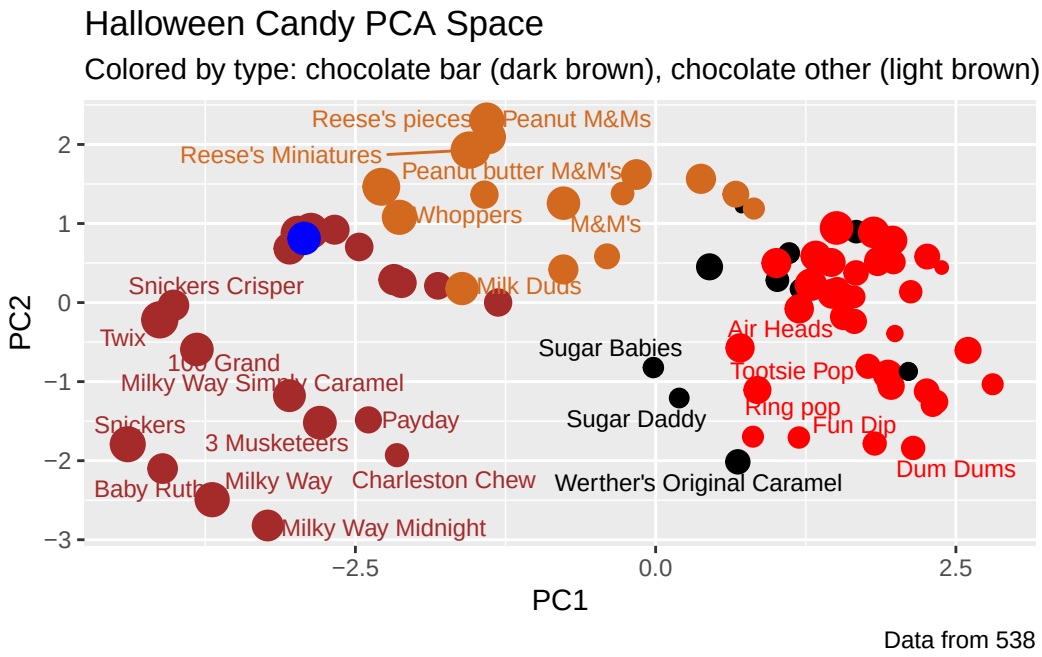


Making labels

```
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")
```

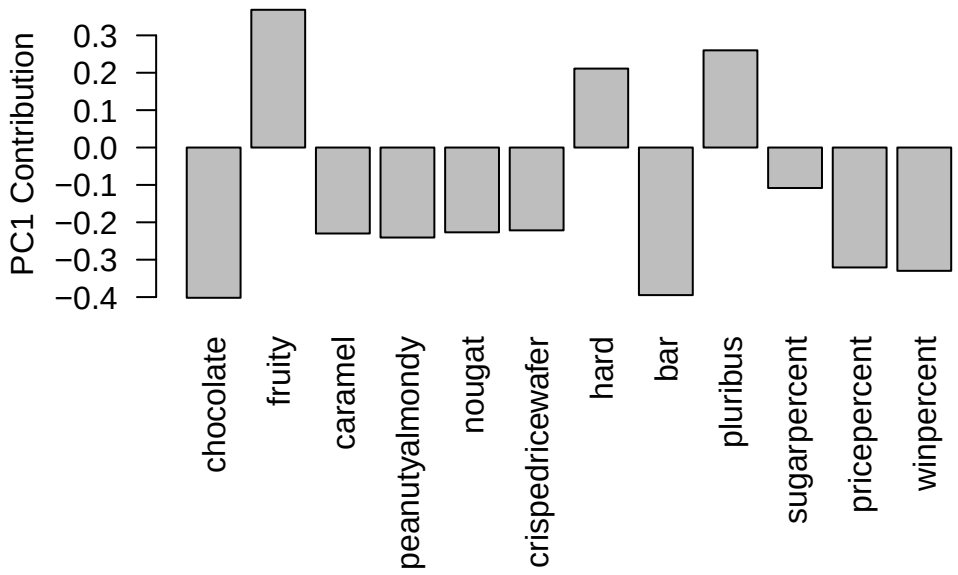
```
Warning: ggrepel: 59 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Make interactive with plotly package

```
#library(plotly)
#ggplotly(p)
```

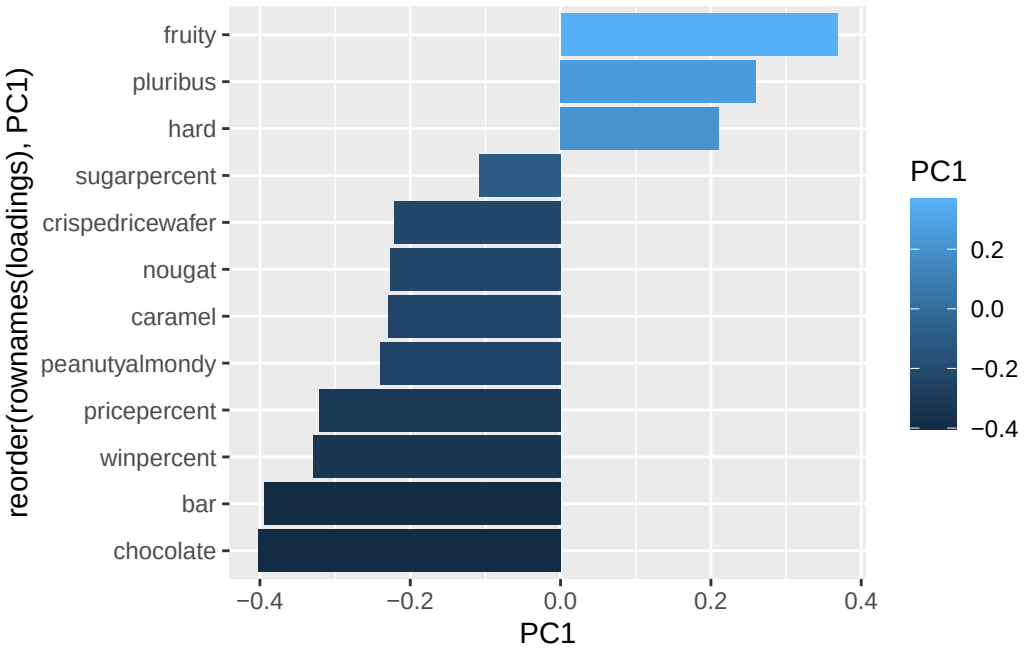
```
par(mar=c(8,4,2,2))
barplot(pca$rotation[,1], las=2, ylab="PC1 Contribution")
```



How do the original variables(columns) contribute to the new PCs. I will look at PC1 here This is the same plot as before but reorder and using different ones.

```
loadings <- as.data.frame(pca$rotation)

ggplot(loadings) +
  aes(PC1,reorder(rownames(loadings),PC1),PC1, fill=PC1) +
  geom_col()
```



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

Fruity are strongly by PC1 in the positive and negative is chocolate.