Class10 Mini-project Halloween Candy

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Import the candy data

```
candy_file <- "candy-data.csv"
```

```
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 candy types

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

```
sum(candy[,2])
```

```
[1] 38
```

There are 38 fruity candy types

What is your favorite candy?

One of the most interesting variables in the dataset is `winpercent`. For a given candy this value is the percentage of people who prefer this candy over another randomly chosen candy from the dataset (what 538 term a matchup). Higher values indicate a more popular candy.

We can find the `winpercent` value for Twix by using its name to access the corresponding row of the dataset. This is because the dataset has each candy name as rownames (recall that we set this when we imported the original CSV file). For example the code for Twix is:

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

```
[1] 81.64291
```

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

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

```
[1] 81.64291
```

The winpercent of my favorite candy is 81.64. I actually do like Twix :D

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

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

```
[1] 76.7686
```

The winpercent for kit kat is 76.77

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

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

```
[1] 49.6535
```

Tootsie Rolls have a winpercent of 49.65.

Side-note: the skimr::skim() function

There is a useful skim() function in the skimr package that can help give you a quick overview of a given dataset. Let's install this package and try it on our candy data.

```
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?

Most of the data tends to sit between 0 and 1, with the exception to the winpercent row with values that are anywhere from 20 times to as high as 80 times larger than the other values.

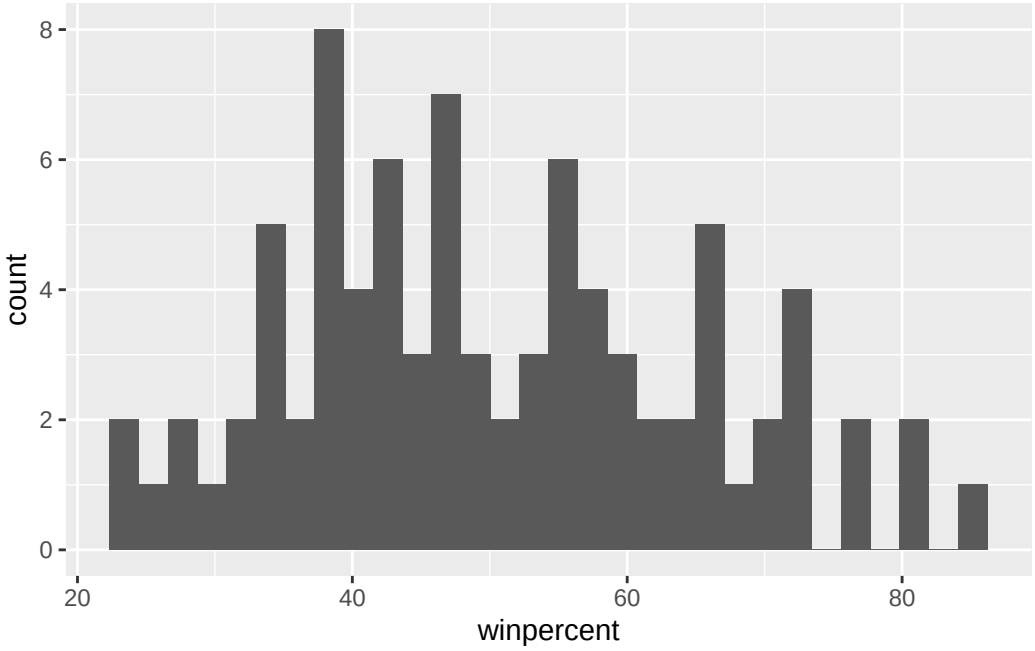
Q7. What do you think a zero and one represent for the candy$chocolate column?

A zero most likely represents that it is not within the quartile range and a one most likely represents that it is in the quartile range that it lies under.

Q8. Plot a histogram of winpercent values

```
library(ggplot2)
ggplot(candy, aes(x=winpercent))+ geom_histogram()
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Q9. Is the distribution of winpercent values symmetrical?

The distrubution is not symmetrical

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

```
mean(candy$winpercent)
```

```
[1] 50.31676
```

The center of distribution is almost equal to 50%.

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

```
choco <- candy$winpercent[as.logical(candy$chocolate)]
fruit <- candy$winpercent[as.logical(candy$fruity)]
mean(choco)
```

```
[1] 60.92153
```

```
mean(fruit)
```

```
[1] 44.11974
```

Chocolate is higher ranked than fruity.

Q12. Is this difference statistically significant?

```
t.test(choco,fruit)
```

```
    Welch Two Sample t-test

data:  choco and fruit
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
```

The difference is statistically significant.

Overall Candy Rankings

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

```
#order sorts from low to high, so we want to see what pops up first to get the least liked
head(candy[order(candy$winpercent),], n=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
```

The 5 least liked candies are; Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters.

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

```
#order sorts from low to high, so we want to see what is closer to the bottom of the order
tail(candy[order(candy$winpercent),], n=5)
```

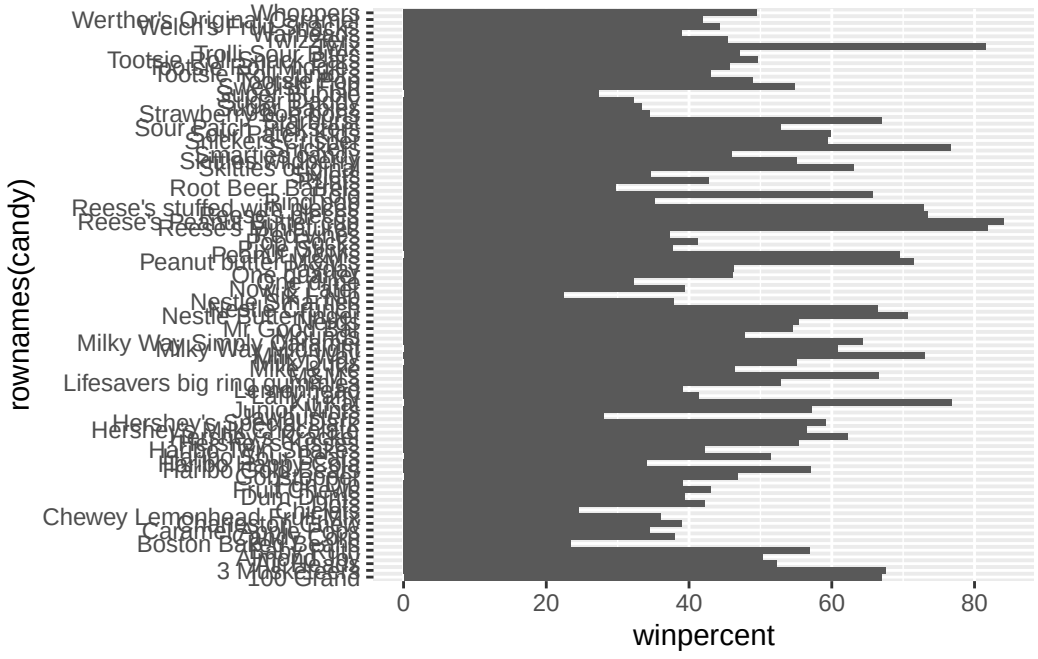
```
                        chocolate fruity caramel peanutyalmondy nougat
Snickers                        1      0       1              1      1
Kit Kat                         1      0       0              0      0
Twix                            1      0       1              0      0
Reese's Miniatures              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
```

The 5 most liked candies are; Snickers, Kit Kat, Twix, Reese's Minatures and Reese's Peanut Butter cups.

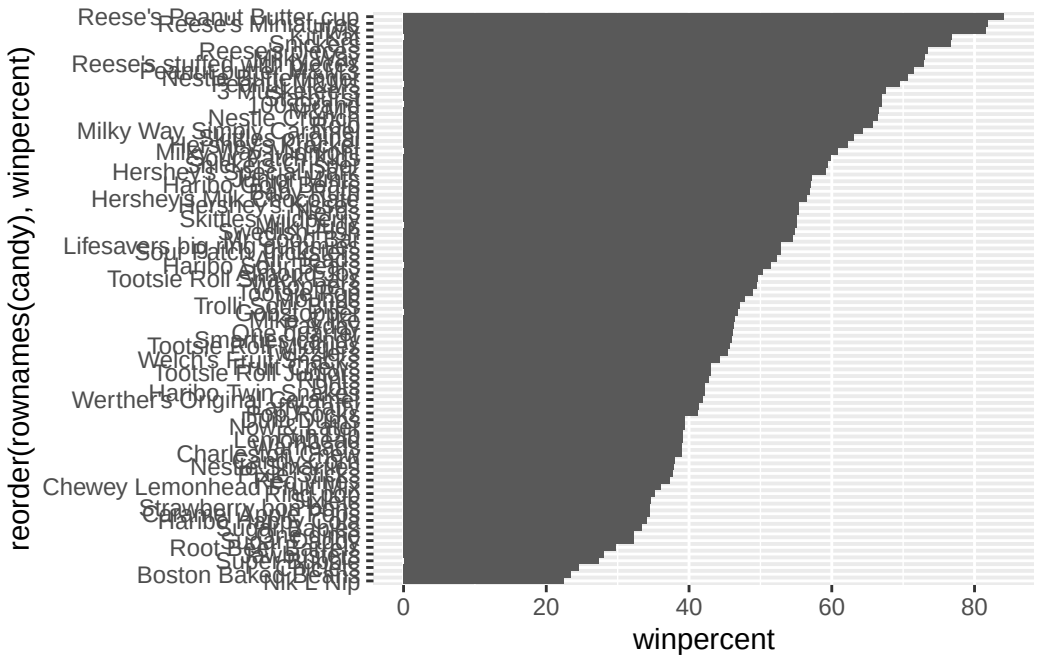
Q15. Make a first barplot of candy ranking based on winpercent values.

```
library(ggplot2)

ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_bar(stat='identity')
```



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_bar(stat='identity')
```

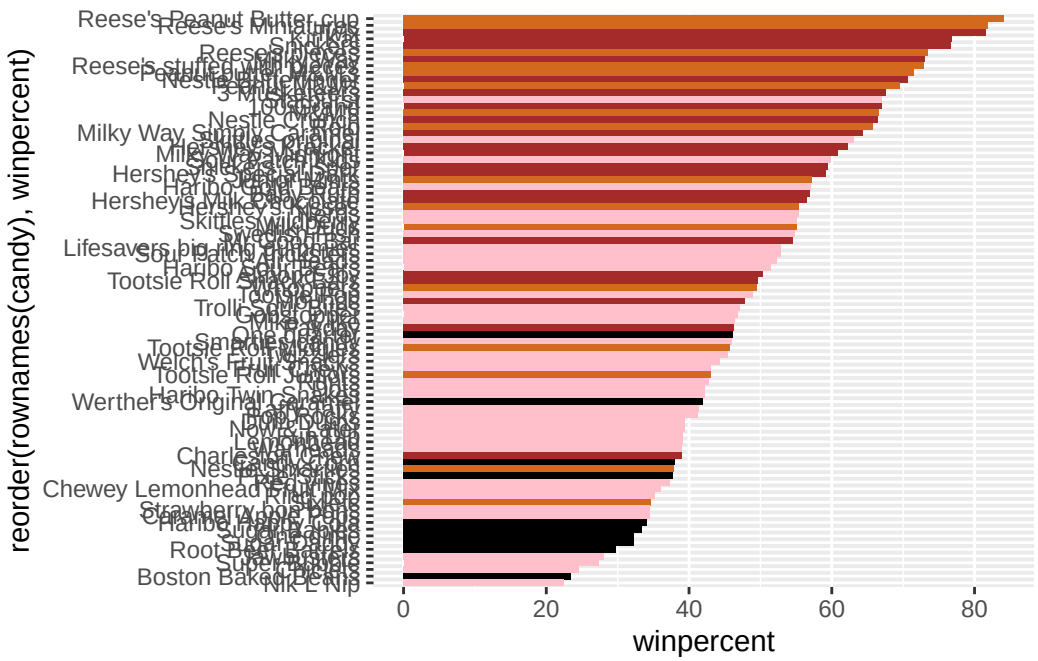


Time to add some useful color Let's setup a color vector (that signifies candy type) that we can then use for some future plots. We start by making a vector of all black values (one for each candy). Then we overwrite chocolate (for chocolate candy), brown (for candy bars) and red (for fruity candy) values.

```
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"
```

Now let's try our barplot with these colors. Note that we use fill=my_cols for geom_col(). Experement to see what happens if you use col=mycols.

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



Now, for the first time, using this plot we can answer questions like: >Q17. What is the worst ranked chocolate candy?

The worst ranked chocolate candy is Sixlets

Q18. What is the best ranked fruity candy?

The best ranked fruity candy is Starburst

Taking a Look at Pricepercent

What about value for money? What is the the best candy for the least money? One way to get this is to make a plot of winpercent vs the pricepercent variable. The pricepercent variable records the percentile rank of the candy's price against all the other candies in the dataset. Lower vales are less expensive and high values more expensive.

To this plot we will add text labels so we can more easily identify a given candy. There is a regular geom_label() that comes with ggplot2. However, as there are quite a few candies in

our dataset lots of these labels will be overlapping and hard to read. To help with this we can use the geom_text_repel() function from the ggrepel package.

```
library(ggrepel)

# How about a plot of price vs win (too much for pdf render)
# ggplot(candy) +  aes(winpercent, pricepercent, label=rownames(candy)) +  geom_point(col=
```

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

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

The highest ranked in terms of winpercent for the lowest pricepercent are Strawberry bon bons, Dum Dums, Fruit Chews, Pixie Sticks, and Tootsie Roll Midgies.

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

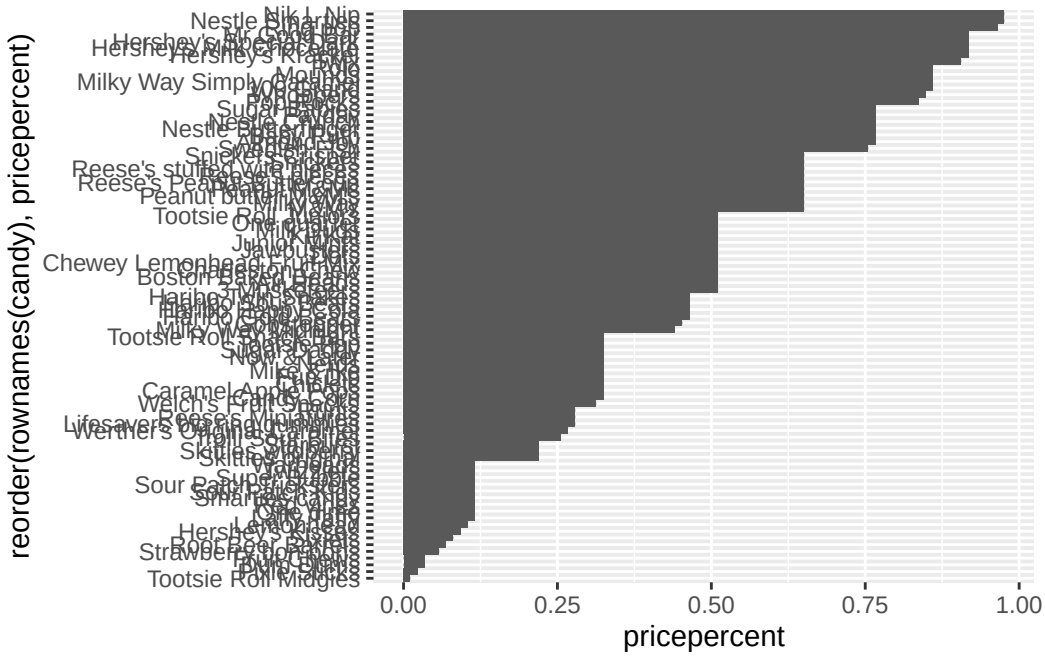
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                        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
```

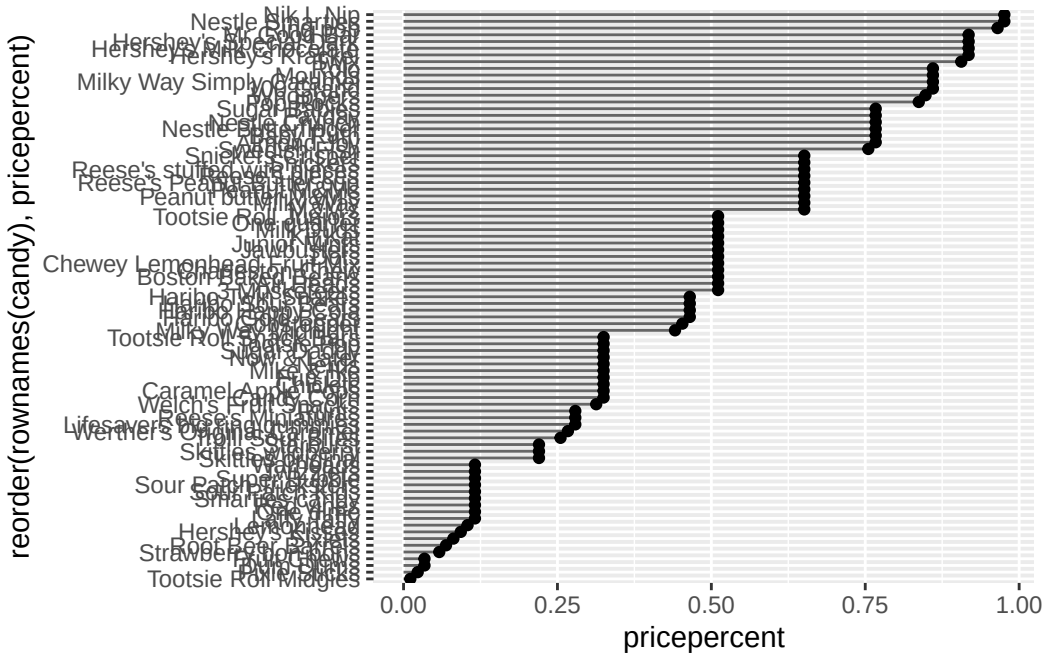
The 5 most expensive are Nik L Nip, Neslte Smarties, Ring Pop, Hershey's Krackel, and Hershey's Milk Chocolate. The least popular among these are Nik L Nip.

Optional >Q21. Make a barplot again with geom_col() this time using pricepercent and then improve this step by step, first ordering the x-axis by value and finally making a so called "dot chat" or "lollipop" chart by swapping geom_col() for geom_point() + geom_segment().

```
# Make a barplot with col and pricepercent
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_col()
```




```
# Make a lollipop chart of pricepercent
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```



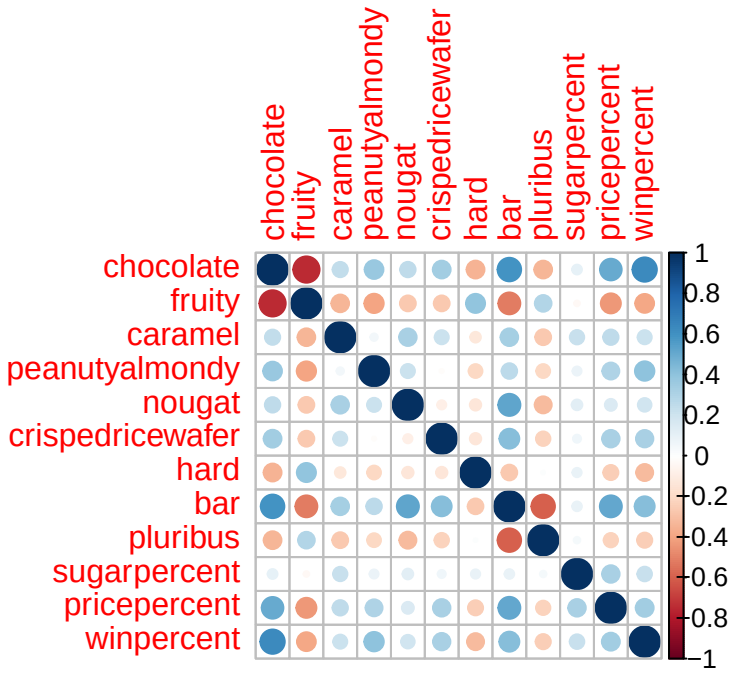
Exploring correlation structure

Load the program corrplot

```
library(corrplot)
```

```
corrplot 0.92 loaded
```

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



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

Chocolate and fruit have the largest minus values and are the least correlated.

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

The variables that match in name and go in diagonal are the most positively correlated, but aside from that the next most positively correlated variables are chocolates and winpercent.

Principal Component Analysis

Time to apply PCA

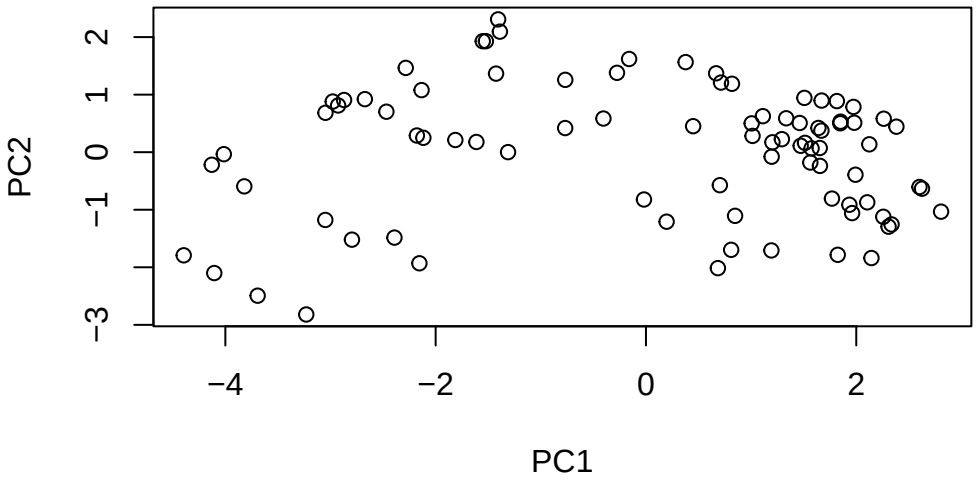
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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
```

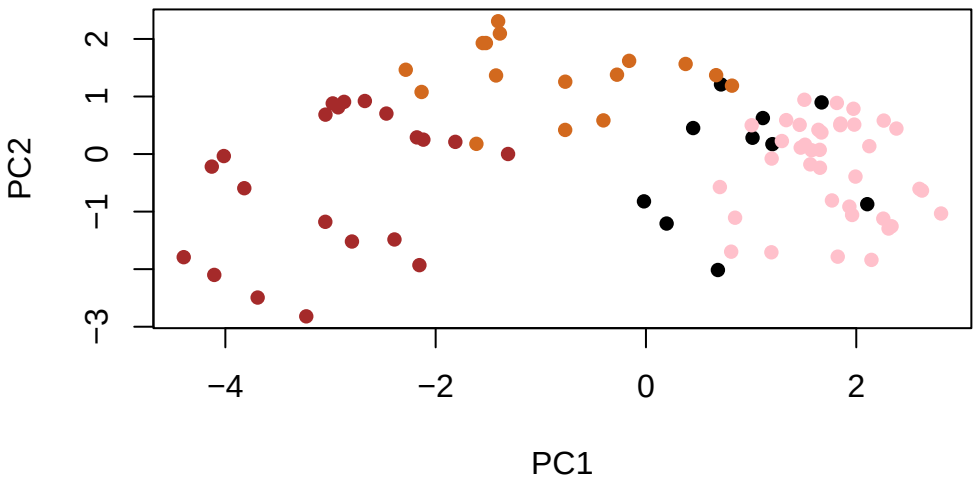
Now plot PC1 vs PC2

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



Add some color

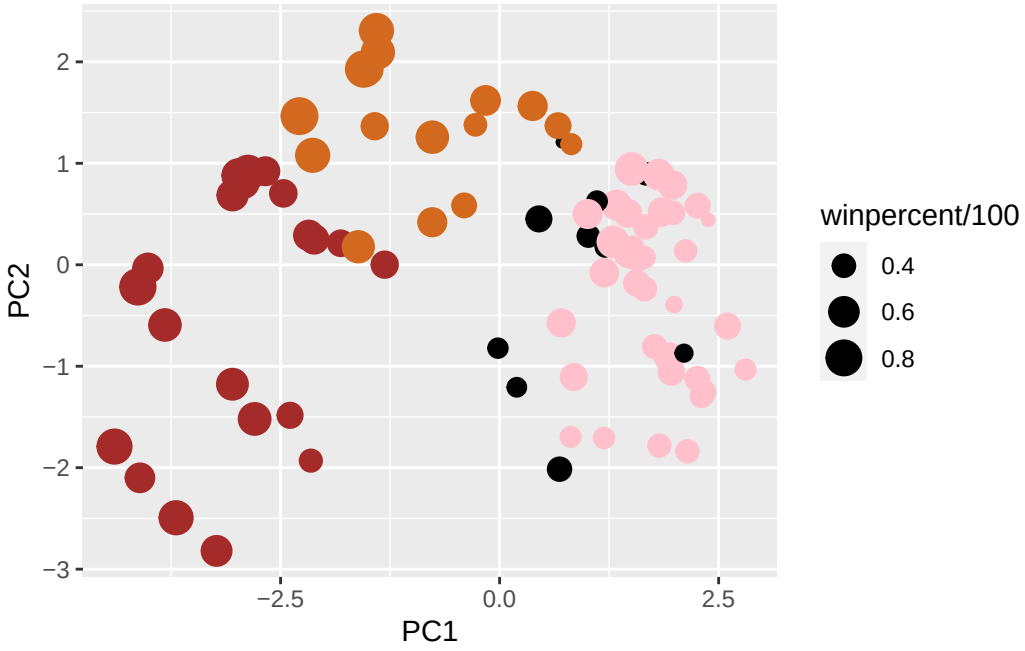
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



Can also do in ggplot

```
# 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
```



Again we can use the ggrepel package and the function ggrepel::geom_text_repel() to label up the plot with non overlapping candy names like. We will also add a title and subtitle like so:

```
library(ggrepel)
#too much for pdf rendering
# p + geom_text_repel(size=3.3, col=my_cols, max.overlaps = 7)  +   theme(legend.position
```

If you want to see more candy labels you can change the max.overlaps value to allow more overlapping labels or pass the ggplot object p to plotly like so to generate an interactive plot that you can mouse over to see labels:

```
library(plotly)
```

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

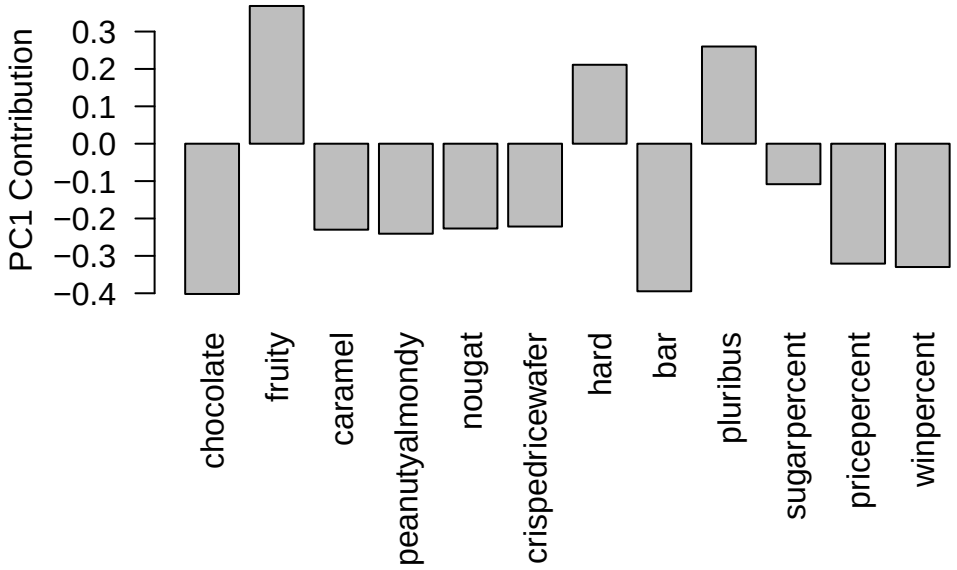
```
The following object is masked from 'package:ggplot2':

    last_plot
```

```
The following object is masked from 'package:stats':

    filter

The following object is masked from 'package:graphics':

    layout
```

```
#ggplotly(p)
```

Let's finish by taking a quick look at PCA our loadings. Do these make sense to you? Notice the opposite effects of chocolate and fruity and the similar effects of chocolate and bar (i.e. we already know they are correlated).

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



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

Hard, fruity candies that are also packed in a bag/come in a box of multiple are strongly positive in PC1. These make sense as there are candies like Jolly Ranchers that match the three categories.