Class 9: Halloween Candy Project

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Background

Today we are delving into an analysis of Halloween candy data using ggplot, dplyr, basic stats, correlation analysis, and PCA.

Import data

```
candy <- read.csv("candy-data.txt", 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
```

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

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

```
[1] 38
```

Q3. how many chocolate candy types in this dataset?

```
sum(candy$chocolate)
```

```
[1] 37
```

What is your favorite candy?

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

```
[1] 81.64291
```

```
library(dplyr)
```

We can also use the `filter()` and `select()` functions from **dplyr**

```
candy |>
  filter(rownames(candy)=="Almond Joy") |>
  select(winpercent, sugarpercent)
```

```
           winpercent sugarpercent
Almond Joy   50.34755        0.465
```

A useful function for a quick look at a new dataset is found in **skimr** package:

```
#library("skimr")
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 - `winpercent` column is on a different scale or range than all the others.

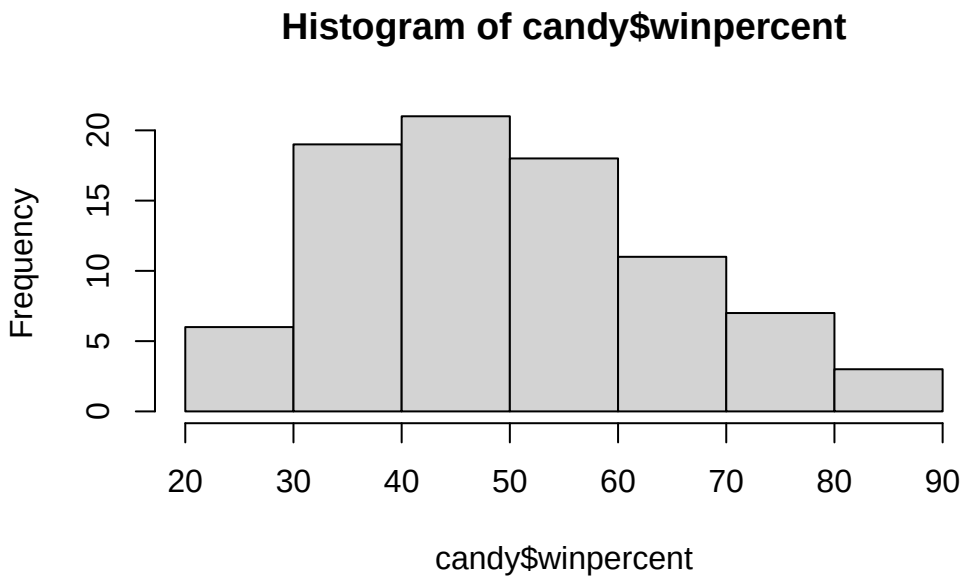
N.B I will scale this data before analysis like PCA for example to avoid this one variable dominating our analysis.

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

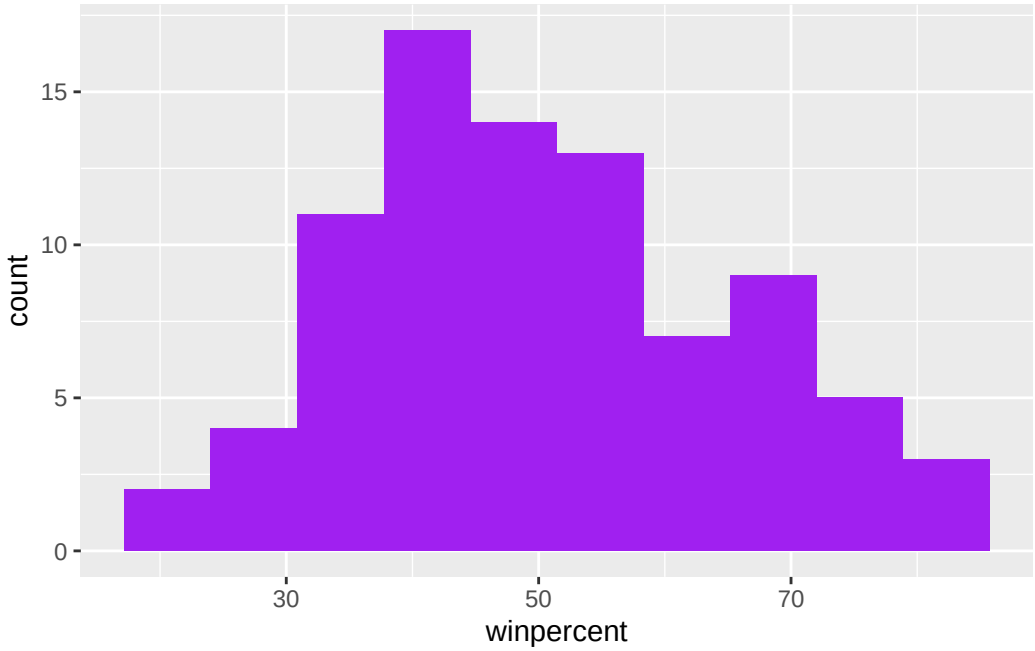
zero means no chocolate and one means it contains chocolate.

Q8. Plot a histogram of winpercent values with base R and ggplot

```
hist(candy$winpercent)
```




```
library(ggplot2)
ggplot(candy, aes(winpercent)) + geom_histogram(bins=10, fill="purple")
```



Q9. Is the distribution of winpercent values symmetrical?

no!

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

below

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

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

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

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

yes!

```
t.test(choc.win, fruit.win)
```

```
    Welch Two Sample t-test

data:  choc.win and fruit.win
t = 6.2582, df = 68.882, p-value = 2.871e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 11.44563 22.15795
sample estimates:
mean of x mean of y
 60.92153  44.11974
```

3. Overall Candy Rankings

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

Can use the output of `order(winpercent)` to rearrange the dataset by `winpercent`.

```
ord.inds <- order(candy$winpercent)
head(candy[ord.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
```

```
candy |>
  arrange(winpercent) |>
  head()
```

```
                  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
```

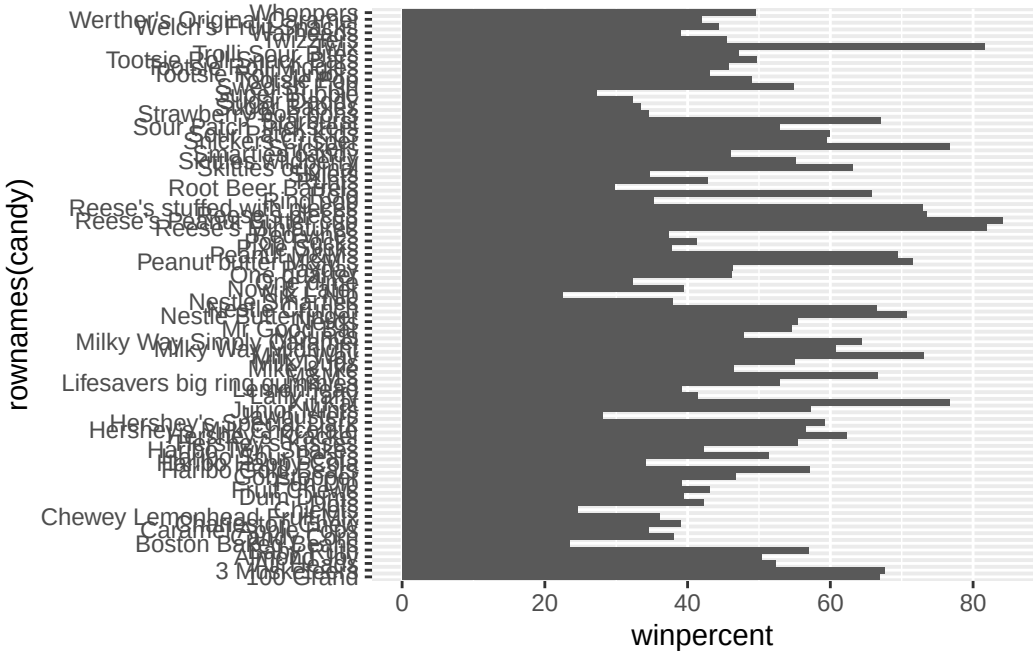
Q14. What are the top 5 all time favorite candy types out of this set?

```
candy |>
  arrange(-winpercent) |>
  head()
```

```
                         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
```

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

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



Improved plot with `reorder()`

```
p <- ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col() + ylab("") + xlab("Win Percent")
```

```
ggsave("my_plot.png", height=12, width=5)
```

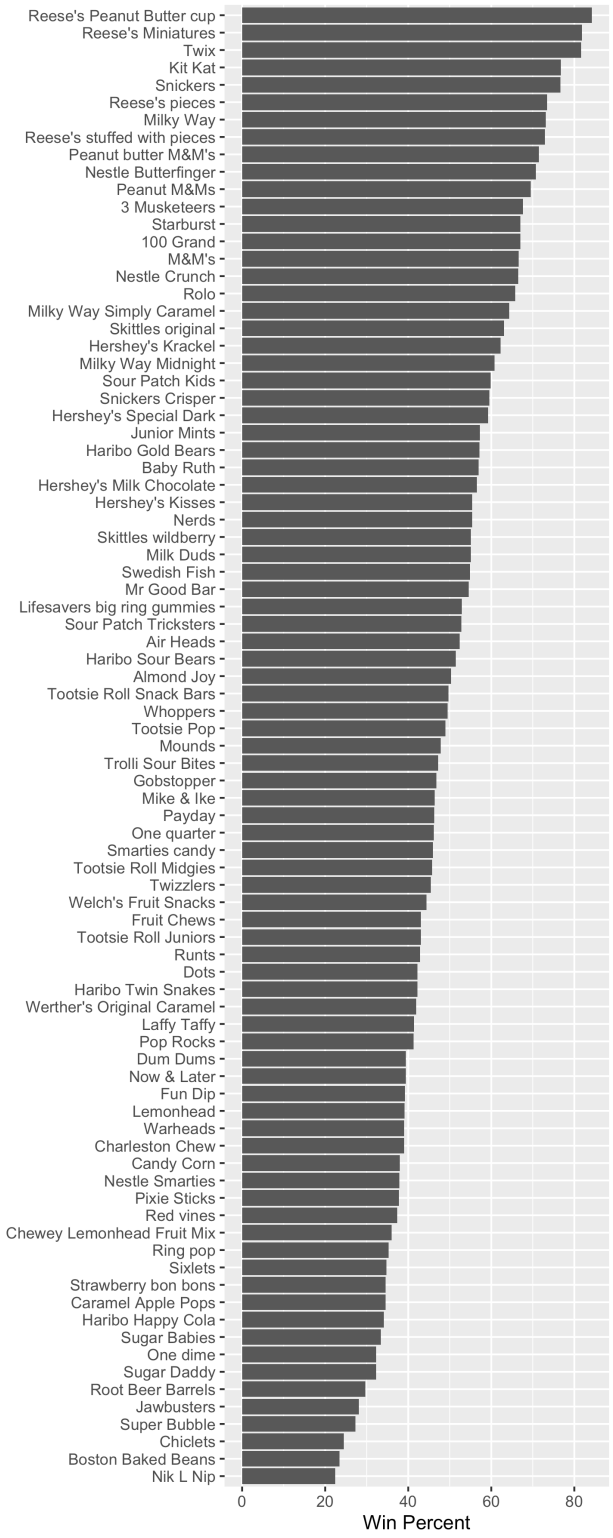
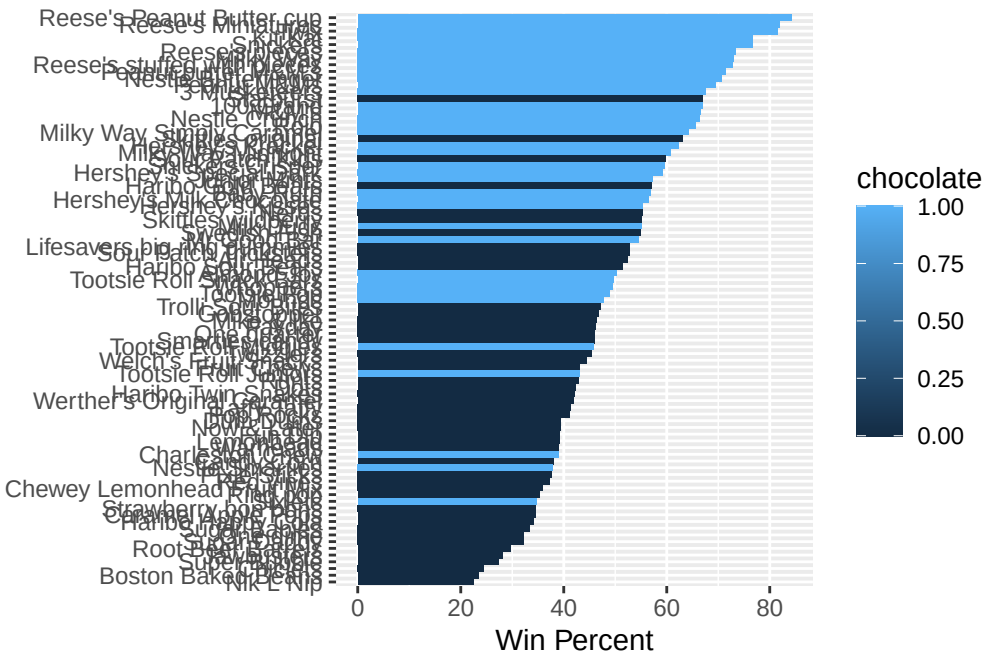


Figure 1: Fig. X

Q. color bars by "chocolate"

```
p <- ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent), fill=chocolate) +
  geom_col() + ylab("") + xlab("Win Percent")

p
```



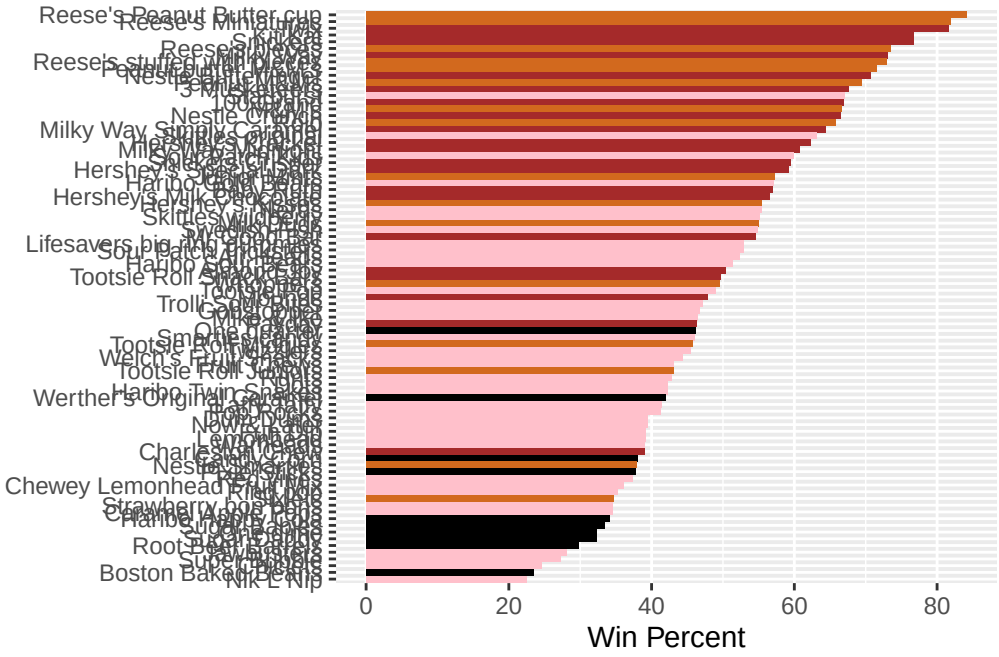
Define our own custom color vector that has the exact color mappings we want:

```
mycols <- rep("black", nrow(candy))
mycols[candy$chocolate==1] <- "chocolate"
mycols[candy$bar==1] <- "brown"
mycols[candy$fruity==1] <- "pink"

mycols
```

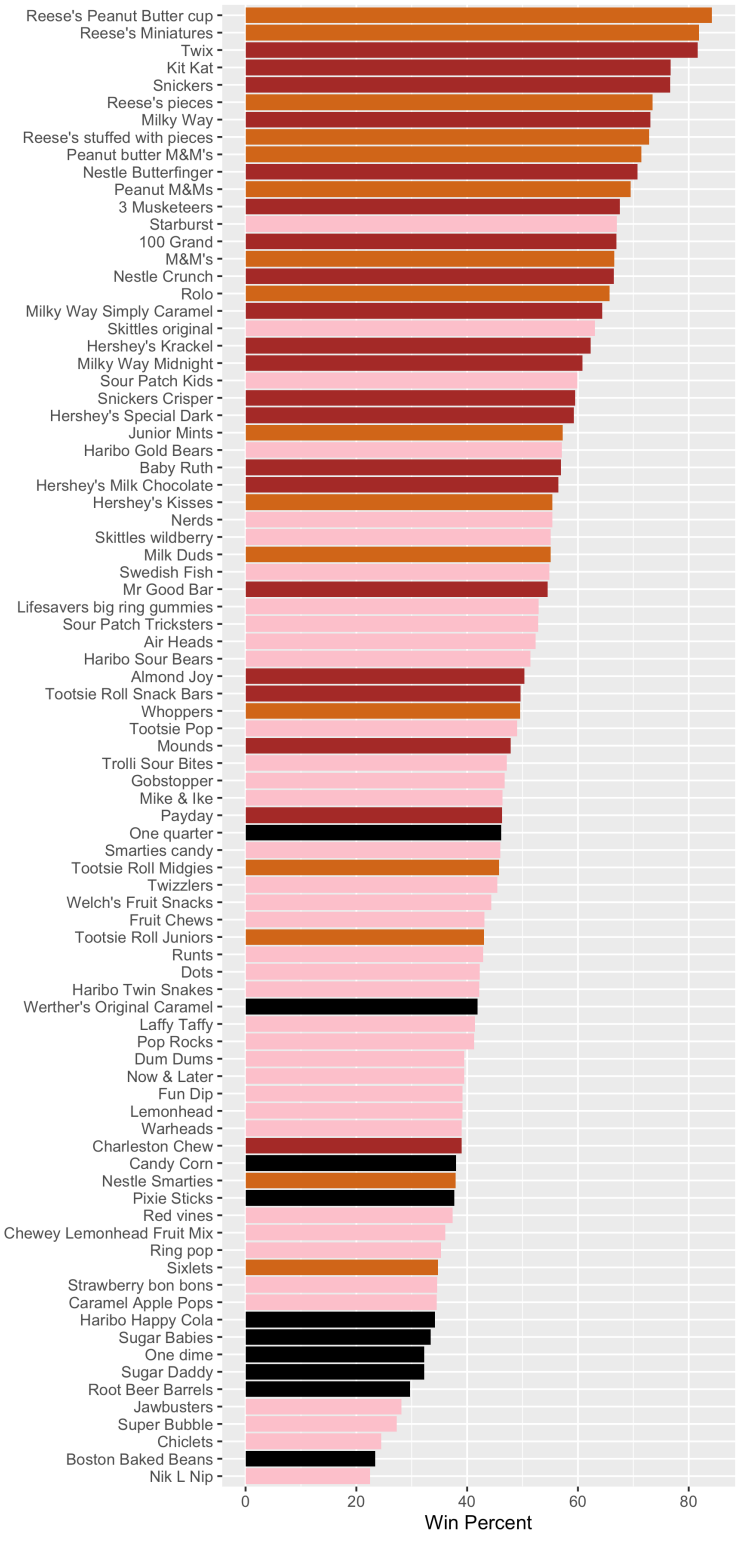
```
 [1] "brown"     "brown"     "black"     "black"     "pink"      "brown"
 [7] "brown"     "black"     "black"     "pink"      "brown"     "pink"
[13] "pink"      "pink"      "pink"      "pink"      "pink"      "pink"
[19] "pink"      "black"     "pink"      "pink"      "chocolate" "brown"
[25] "brown"     "brown"     "pink"      "chocolate" "brown"     "pink"
```

```
[31] "pink"      "pink"      "chocolate" "chocolate" "pink"      "chocolate"
[37] "brown"     "brown"     "brown"     "brown"     "brown"     "pink"
[43] "brown"     "brown"     "pink"      "pink"      "brown"     "chocolate"
[49] "black"     "pink"      "pink"      "chocolate" "chocolate" "chocolate"
[55] "chocolate" "pink"      "chocolate" "black"     "pink"      "chocolate"
[61] "pink"      "pink"      "chocolate" "pink"      "brown"     "brown"
[67] "pink"      "pink"      "pink"      "pink"      "black"     "black"
[73] "pink"      "pink"      "pink"      "chocolate" "chocolate" "brown"
[79] "pink"      "brown"     "pink"      "pink"      "pink"      "black"
[85] "chocolate"
```

```
p <- ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col(fill=mycols) + ylab("") + xlab("Win Percent")

p
```




```
ggsave("my_color_plot.png", height=12, width=6)
```



Now, for the first time, using

this plot we can answer questions like:

Q17. What is the worst ranked chocolate candy?

Sixlets

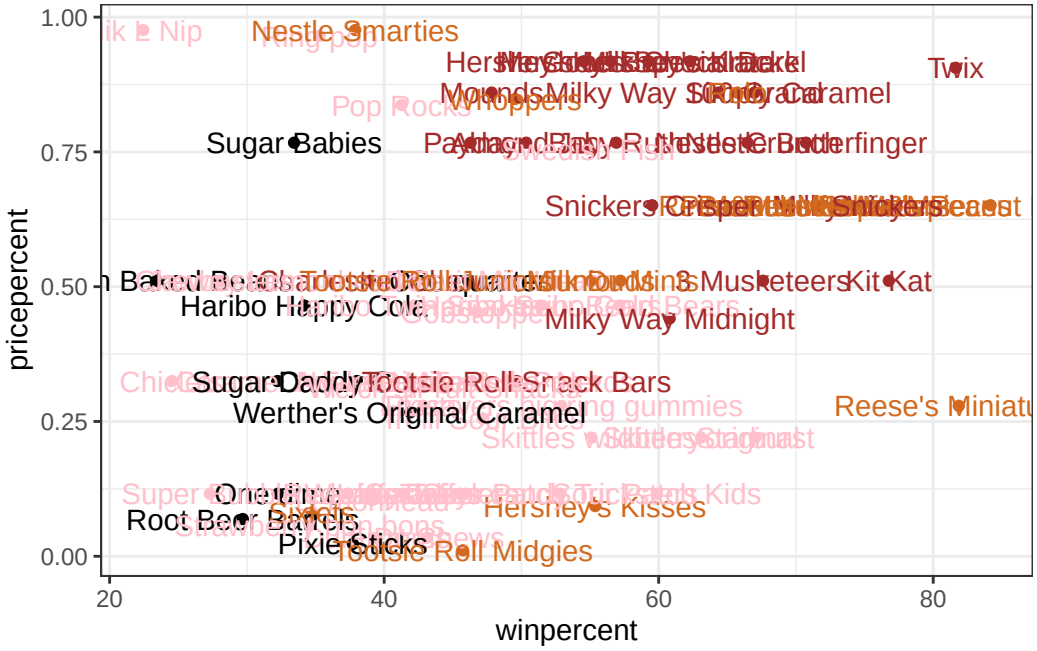
Q18. What is the best ranked fruity candy?

Starburst

Taking a look at pricepercent

plot of winpercent vs the pricepercent

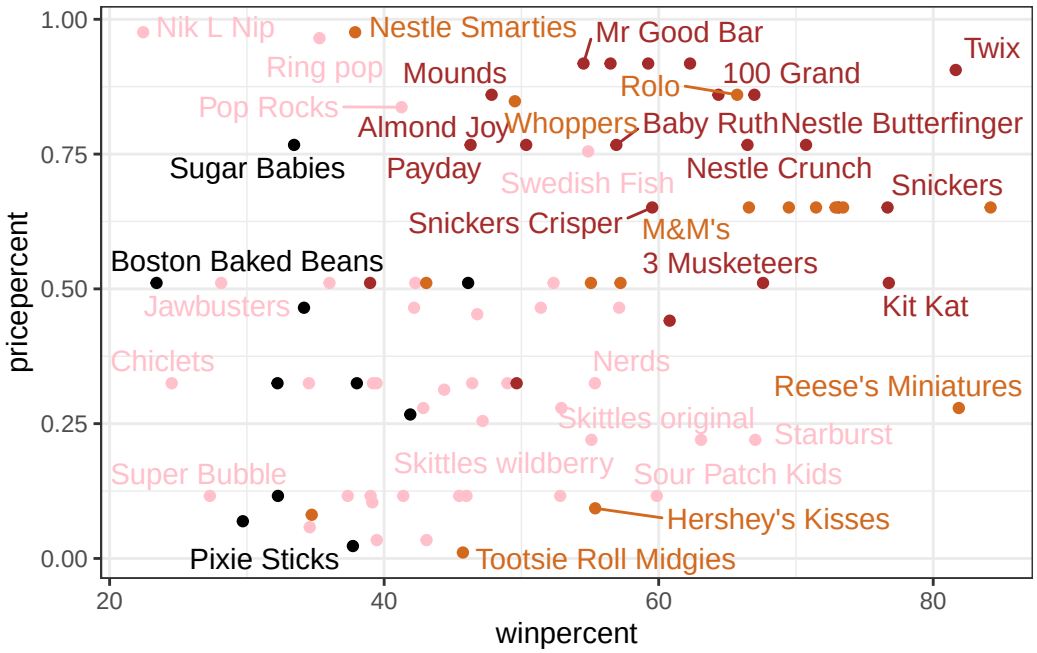
```
ggplot(candy, aes(winpercent, pricepercent, label=rownames(candy))) + geom_point(col=mycols)
```



To avoid overplotting, we use **ggrepel** package :

```
library(ggrepel)

ggplot(candy, aes(winpercent, pricepercent, label=rownames(candy))) + geom_point(col=mycols)
```

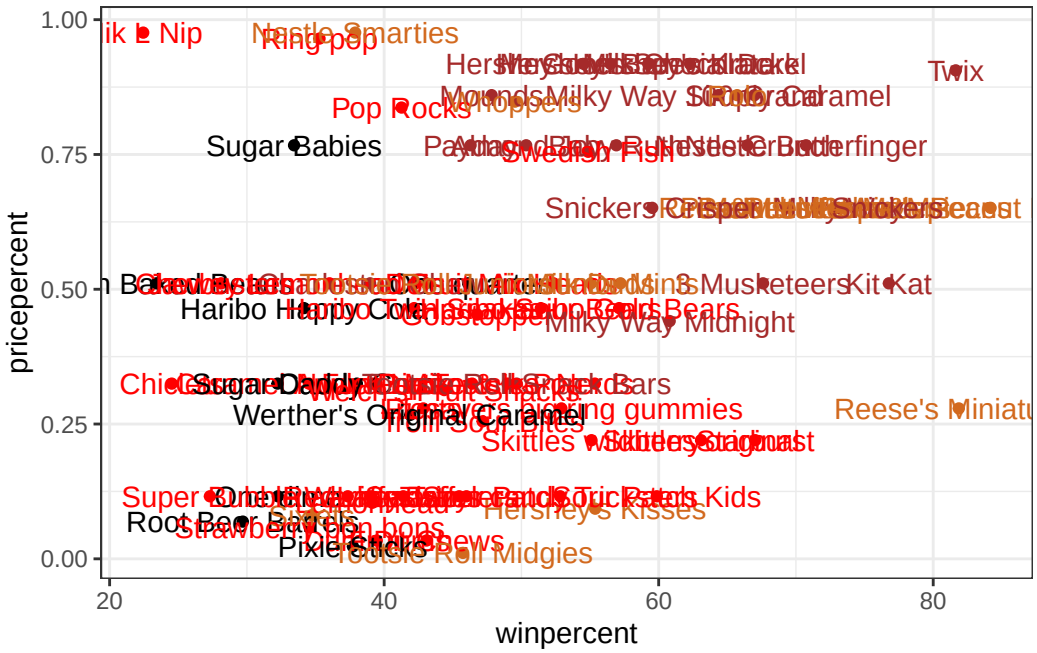
```
Warning: ggrepel: 50 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Control amount of visible labels by setting different `max.overlaps` value:

```
#change pink to red for fruity:
mycols[candy$fruity==1] <- "red"

ggplot(candy, aes(winpercent, pricepercent, label=rownames(candy))) + geom_point(col=mycols)
```

```
Warning in geom_text(col = mycols, max.overlaps = 8): Ignoring unknown
parameters: `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?

Reeses miniatures

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

Nik L nip is least popular, Nestle Smarties, Ring pop, Hershey's Krackel, Hershey's Milk Chocolate

```
candy |>
  arrange(-pricepercent) |>
  head()
```

```
                        chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                       0      1       0              0      0
Nestle Smarties                 1      0       0              0      0
Ring pop                        0      1       0              0      0
Hershey's Krackel               1      0       0              0      0
Hershey's Milk Chocolate        1      0       0              0      0
Hershey's Special Dark          1      0       0              0      0
                        crispedricewafer hard bar pluribus sugarpercent
```

```
Nik L Nip                            0    0   0        1        0.197
Nestle Smarties                      0    0   0        1        0.267
Ring pop                             0    1   0        0        0.732
Hershey's Krackel                    1    0   1        0        0.430
Hershey's Milk Chocolate             0    0   1        0        0.430
Hershey's Special Dark               0    0   1        0        0.430
                         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
Hershey's Special Dark          0.918   59.23612
```

5 Exploring the correlation structure

The main function for correlation analysis in base R: `corr()`:

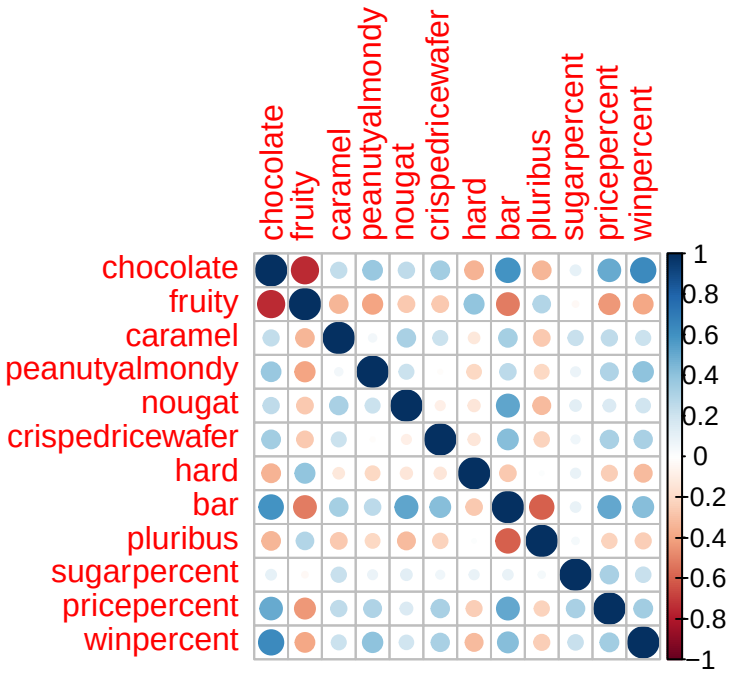
```
cij <- cor(candy)
head(cij)
```

```
                  chocolate     fruity     caramel peanutyalmondy      nougat
chocolate         1.0000000 -0.7417211  0.24987535     0.37782357  0.25489183
fruity           -0.7417211  1.0000000 -0.33548538    -0.39928014 -0.26936712
caramel           0.2498753 -0.3354854  1.00000000     0.05935614  0.32849280
peanutyalmondy    0.3778236 -0.3992801  0.05935614     1.00000000  0.21311310
nougat            0.2548918 -0.2693671  0.32849280     0.21311310  1.00000000
crispedricewafer  0.3412098 -0.2693671  0.21311310    -0.01764631 -0.08974359
                  crispedricewafer       hard        bar   pluribus sugarpercent
chocolate               0.34120978 -0.3441769  0.5974211 -0.3396752   0.10416906
fruity                 -0.26936712  0.3906775 -0.5150656  0.2997252  -0.03439296
caramel                 0.21311310 -0.1223551  0.3339600 -0.2695850   0.22193335
peanutyalmondy         -0.01764631 -0.2055566  0.2604196 -0.2061093   0.08788927
nougat                 -0.08974359 -0.1386750  0.5229764 -0.3103388   0.12308135
crispedricewafer        1.00000000 -0.1386750  0.4237509 -0.2246934   0.06994969
                  pricepercent winpercent
chocolate            0.5046754  0.6365167
fruity              -0.4309685 -0.3809381
caramel              0.2543271  0.2134163
peanutyalmondy       0.3091532  0.4061922
nougat               0.1531964  0.1993753
crispedricewafer     0.3282654  0.3246797
```

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

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



6. Principal Component Analysis

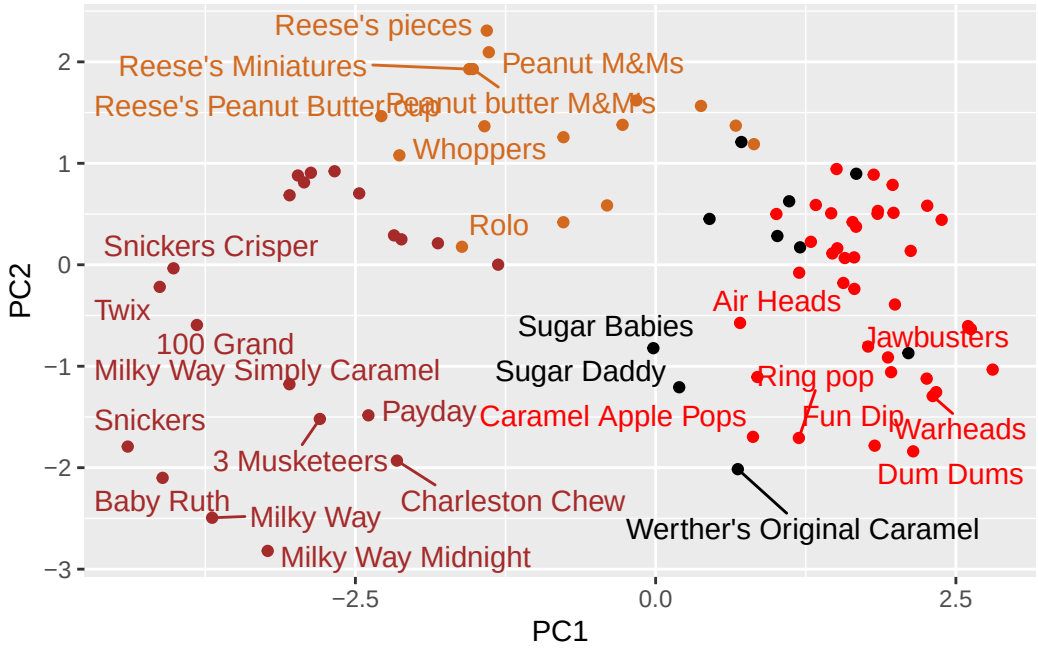
use `prcom()` function remembering to set the scale=TRUE argument.

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

Let's make our main results figures, score (PC) plot

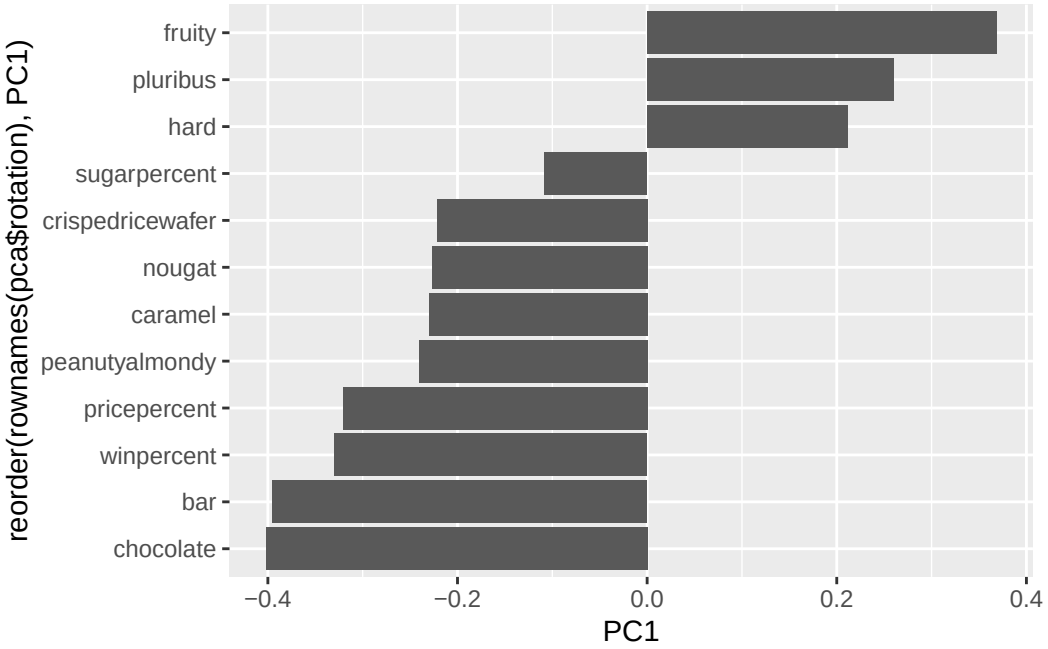
```
ggplot(pca$x, aes(PC1, PC2, label=rownames(candy))) + geom_point(col=mycols) + geom_text_repe
```

```
Warning: ggrepel: 57 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



look at variable loadings

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


reorder(rownames(pca$rotation), PC1)
fruity
pluribus
hard
sugarpercent
crispedricewafer
nougat
caramel
peanutyalmondy
pricepercent
winpercent
bar
chocolate
−0.4
−0.2
0.0
0.2
0.4
PC1