Class 10

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Background

1. Importing candy data

In this mini-project we will examine 538 Halloween Candy data. What is your favorite candy? What is nougat anyway? And how do you say it in America?

First step is to read the 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
```

2. What is your favorate candy?

```
rownames(candy)
```

```
 [1] "100 Grand"                 "3 Musketeers"
 [3] "One dime"                  "One quarter"
 [5] "Air Heads"                 "Almond Joy"
 [7] "Baby Ruth"                 "Boston Baked Beans"
 [9] "Candy Corn"                "Caramel Apple Pops"
[11] "Charleston Chew"           "Chewey Lemonhead Fruit Mix"
[13] "Chiclets"                  "Dots"
[15] "Dum Dums"                  "Fruit Chews"
[17] "Fun Dip"                   "Gobstopper"
[19] "Haribo Gold Bears"         "Haribo Happy Cola"
[21] "Haribo Sour Bears"         "Haribo Twin Snakes"
[23] "HersheyÕs Kisses"          "HersheyÕs Krackel"
[25] "HersheyÕs Milk Chocolate"  "HersheyÕs Special Dark"
[27] "Jawbusters"                "Junior Mints"
[29] "Kit Kat"                   "Laffy Taffy"
[31] "Lemonhead"                 "Lifesavers big ring gummies"
[33] "Peanut butter M&MÕs"       "M&MÕs"
[35] "Mike & Ike"                "Milk Duds"
[37] "Milky Way"                 "Milky Way Midnight"
[39] "Milky Way Simply Caramel"  "Mounds"
[41] "Mr Good Bar"               "Nerds"
[43] "Nestle Butterfinger"       "Nestle Crunch"
[45] "Nik L Nip"                 "Now & Later"
[47] "Payday"                    "Peanut M&Ms"
[49] "Pixie Sticks"              "Pop Rocks"
[51] "Red vines"                 "ReeseÕs Miniatures"
[53] "ReeseÕs Peanut Butter cup" "ReeseÕs pieces"
```

```
[55] "ReeseÕs stuffed with pieces" "Ring pop"
[57] "Rolo"                        "Root Beer Barrels"
[59] "Runts"                       "Sixlets"
[61] "Skittles original"           "Skittles wildberry"
[63] "Nestle Smarties"             "Smarties candy"
[65] "Snickers"                    "Snickers Crisper"
[67] "Sour Patch Kids"             "Sour Patch Tricksters"
[69] "Starburst"                   "Strawberry bon bons"
[71] "Sugar Babies"                "Sugar Daddy"
[73] "Super Bubble"                "Swedish Fish"
[75] "Tootsie Pop"                 "Tootsie Roll Juniors"
[77] "Tootsie Roll Midgies"        "Tootsie Roll Snack Bars"
[79] "Trolli Sour Bites"           "Twix"
[81] "Twizzlers"                   "Warheads"
[83] "WelchÕs Fruit Snacks"        "WertherÕs Original Caramel"
[85] "Whoppers"
```

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

Sour Patch Tricksters

```
candy["Sour Patch Kids", ]$winpercent
```

```
[1] 59.864
```

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

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

```
[1] 76.7686
```

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

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

```
[1] 49.6535
```

```
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?

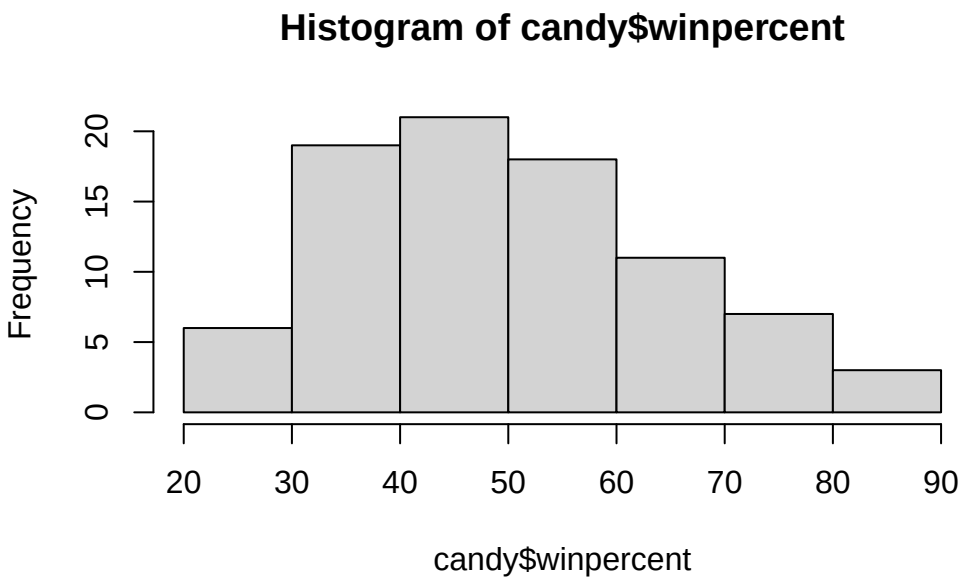
Yes, winpercent

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

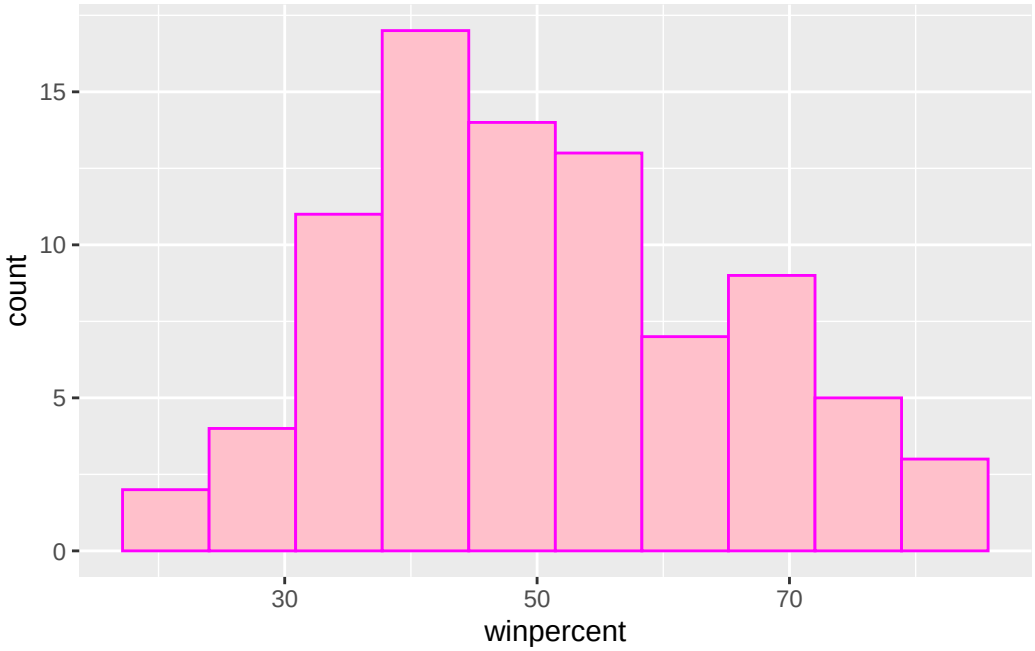
Logical (T/F) value, since R returns a 1 for any T value and 0 for any F value

Q8. Plot a histogram of winpercent values

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




```
library(ggplot2)

ggplot(candy)+
       aes(winpercent)+
       geom_histogram(bins=10, col="magenta", fill="pink")
```



Q9. Is the distribution of winpercent values symmetrical?

No

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

Below

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

```
chocolate.inds <- as.logical(candy$chocolate)
chocolate.win <- candy[chocolate.inds, ]$winpercent
mean(chocolate.win)
```

```
[1] 60.92153
```

```
fruity.inds <- as.logical(candy$fruity)
fruity.win <- candy[fruity.inds, ]$winpercent
mean(fruity.win)
```

```
[1] 44.11974
```

```
  t.test(chocolate.win, fruity.win)
```

```
    Welch Two Sample t-test

data:  chocolate.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
```

Q12. Is this difference statistically significant?

Yes

3. Overall Candy Rankings

The base R 'sort()' and 'order()' functions are very useful!

```
  x <- c(5,1,2,6)
  sort(x)
```

```
[1] 1 2 5 6
```

```
  x[order(x)]
```

```
[1] 1 2 5 6
```

```
  y <- c("barry", "alice", "chandra")
  y
```

```
[1] "barry"   "alice"   "chandra"
```

```
  sort(y)
```

```
[1] "alice"   "barry"   "chandra"
```

```
  order(y)
```

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

```
  inds <- order(candy$winpercent)
  inds
```

```
 [1] 45  8 13 73 27 58 72  3 71 20 10 70 60 56 12 51 49 63  9 11 82 31 17 46 15
[26] 50 30 84 22 14 59 76 16 83 81 77 64  4 47 35 18 79 40 75 85 78  6 21  5 68
[51] 32 41 74 36 62 42 23 25  7 19 28 26 66 67 38 24 61 39 57 44 34  1 69  2 48
[76] 43 33 55 37 54 65 29 80 52 53
```

```
  head(candy[inds,], 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
```

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

```
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
```

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

```
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
ReeseÕs Miniatures              1      0       0              1      0
ReeseÕs 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
ReeseÕs Miniatures                     0    0   0        0        0.034
ReeseÕs 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
```

```
ReeseÕs Miniatures               0.279   81.86626
ReeseÕs Peanut Butter cup        0.651   84.18029
```

Barplot

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

The default barplot, made with 'geom_col' has the bars in the order they are in the datasest...

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

```
ggsave("mybarplot.png", p)
```

```
Saving 5.5 x 3.5 in image
```

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
my_cols[as.logical(candy$chocolate)] <- "chocolate"
my_cols[as.logical(candy$bar)] <- "blue"
my_cols[as.logical(candy$fruity)] <- "hotpink"
my_cols
```

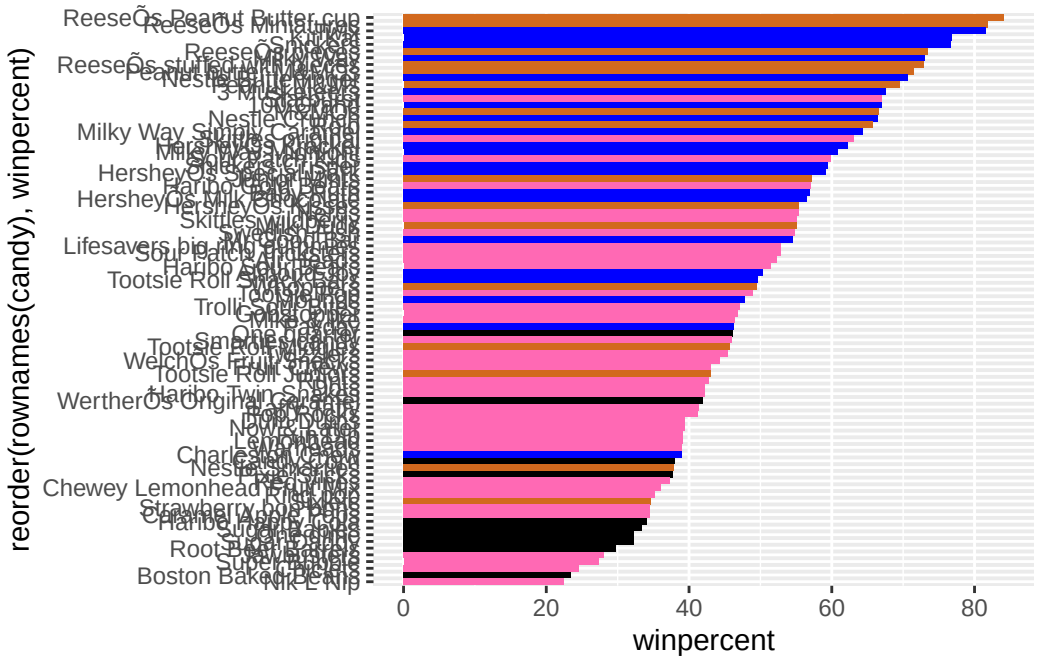
```
 [1] "blue"      "blue"      "black"     "black"     "hotpink"   "blue"
 [7] "blue"      "black"     "black"     "hotpink"   "blue"      "hotpink"
[13] "hotpink"   "hotpink"   "hotpink"   "hotpink"   "hotpink"   "hotpink"
[19] "hotpink"   "black"     "hotpink"   "hotpink"   "chocolate" "blue"
[25] "blue"      "blue"      "hotpink"   "chocolate" "blue"      "hotpink"
[31] "hotpink"   "hotpink"   "chocolate" "chocolate" "hotpink"   "chocolate"
[37] "blue"      "blue"      "blue"      "blue"      "blue"      "hotpink"
[43] "blue"      "blue"      "hotpink"   "hotpink"   "blue"      "chocolate"
[49] "black"     "hotpink"   "hotpink"   "chocolate" "chocolate" "chocolate"
[55] "chocolate" "hotpink"   "chocolate" "black"     "hotpink"   "chocolate"
[61] "hotpink"   "hotpink"   "chocolate" "hotpink"   "blue"      "blue"
```

```
[67] "hotpink"   "hotpink"   "hotpink"   "hotpink"   "black"     "black"
[73] "hotpink"   "hotpink"   "hotpink"   "chocolate" "chocolate" "blue"
[79] "hotpink"   "blue"      "hotpink"   "hotpink"   "hotpink"   "black"
[85] "chocolate"
```

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

Now I can use this vector to color up my barplot

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



Q17. What is the worst ranked chocolate candy?

Charleston Chew

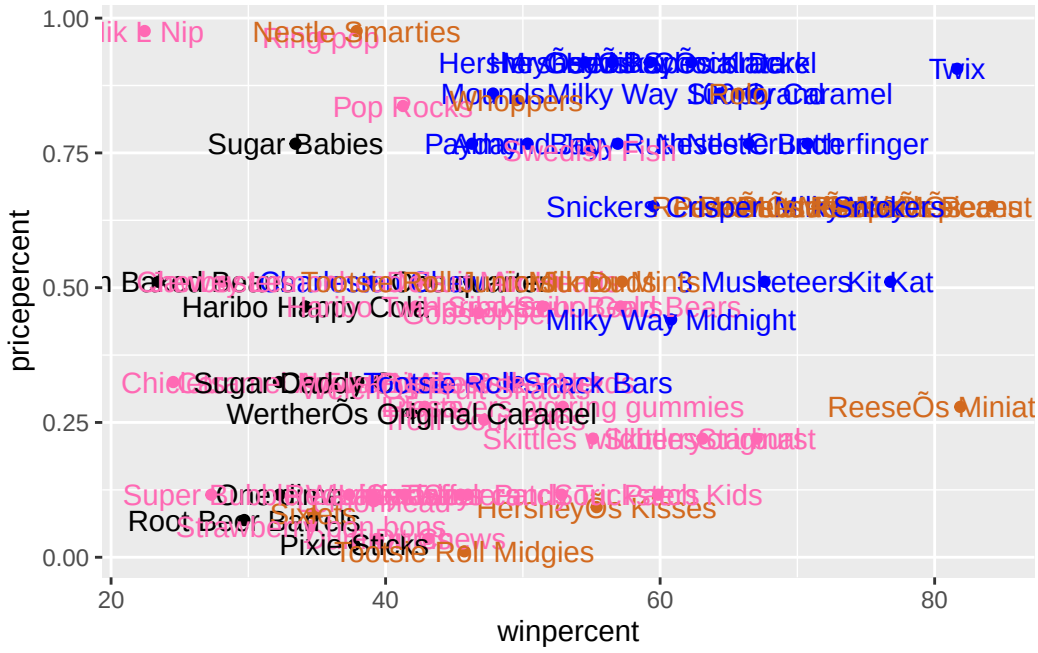
Q18. What is the best ranked fruity candy?

Starburst

4. Taking a look at pricepercent

What about value for money? What is the best candy for the least money? One way to get at this would be to make a plot of 'winpercent' vs the 'pricepercent' variable.

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

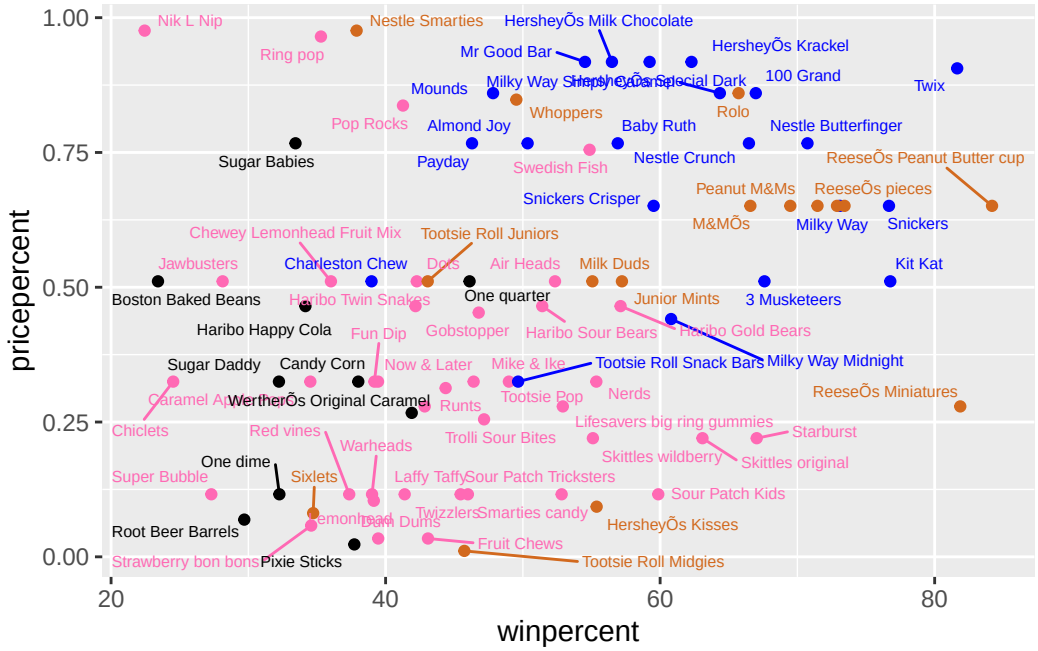


Not a very useful plot

Better plot below

```
library(ggrepel)
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=2, max.overlaps = 13)
```

```
Warning: ggrepel: 3 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?

Reeses Miniatures

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 )
```

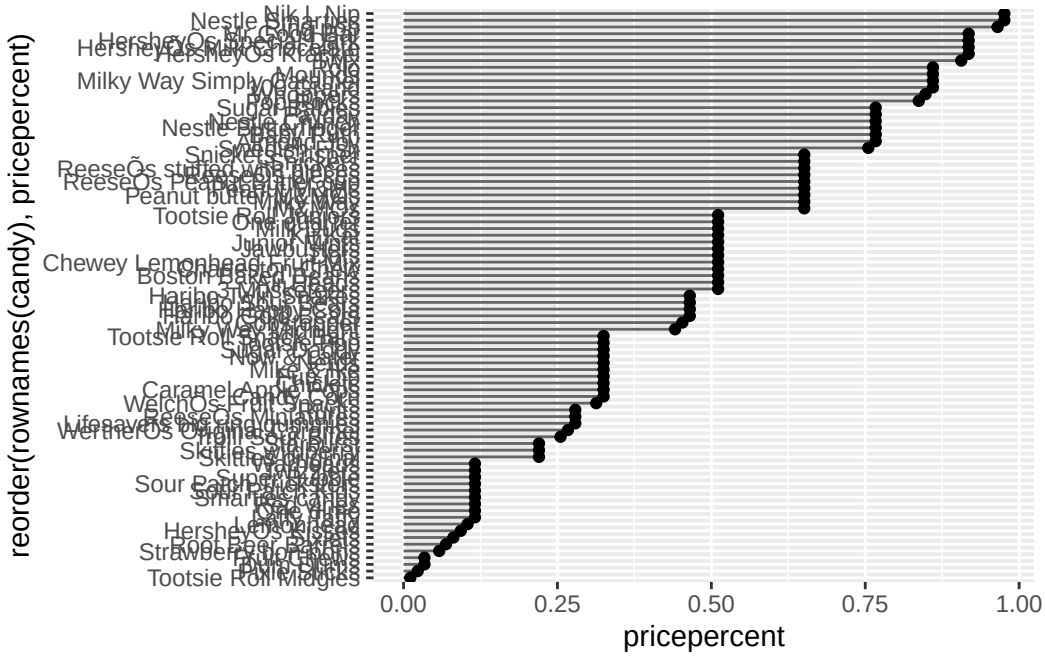
```
                          pricepercent winpercent
Nik L Nip                        0.976   22.44534
Nestle Smarties                  0.976   37.88719
Ring pop                         0.965   35.29076
HersheyÕs Krackel                0.918   62.28448
HersheyÕs Milk Chocolate         0.918   56.49050
```

Least popular Nik L Nip

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

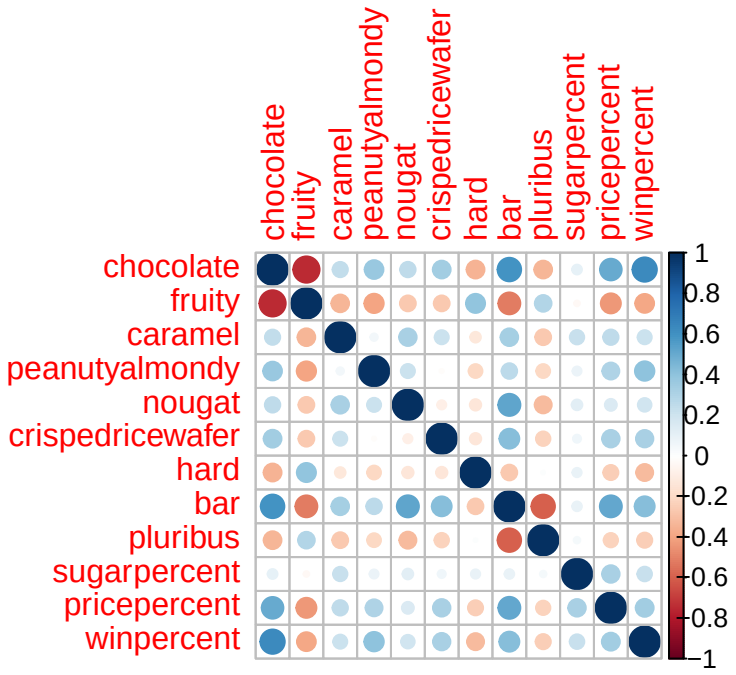


5. Exploring the correlation structure

```
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 Fruity

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

Bar and Chocolate

6. PCA: Principal Component Analysis

The main function that is always there for us is 'prcomp()'. It has an important argument that is set to 'scale=FALSE'by default.

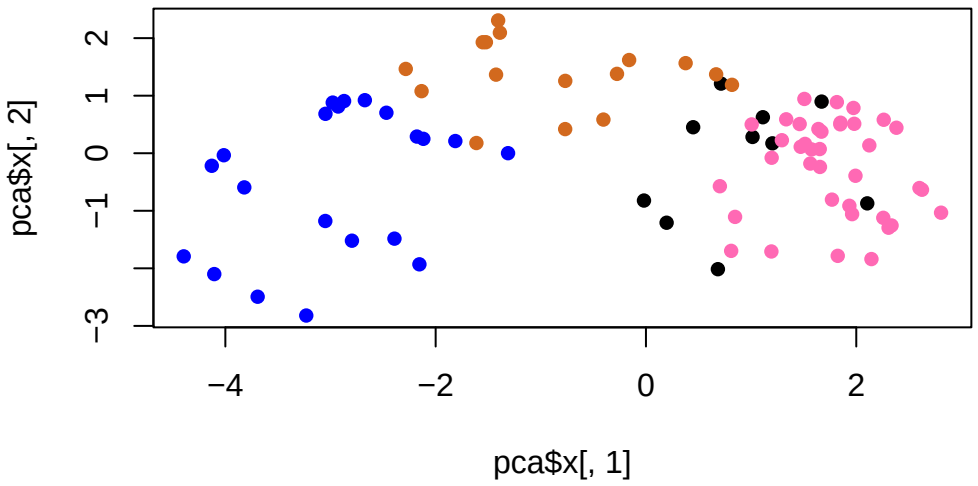
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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
```

My PCA plot (a.k.a.) PC1 vs PC2 score plot.

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

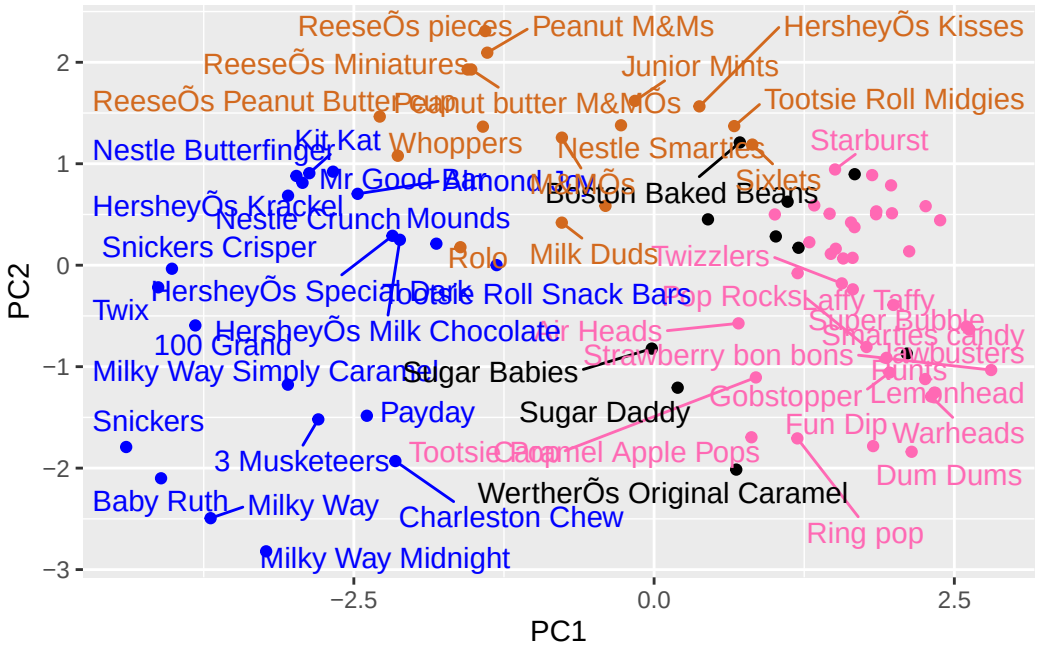


I will make a "nicer" plot with ggplot. ggplot only works with data.frames as input so I need to make one for it first...

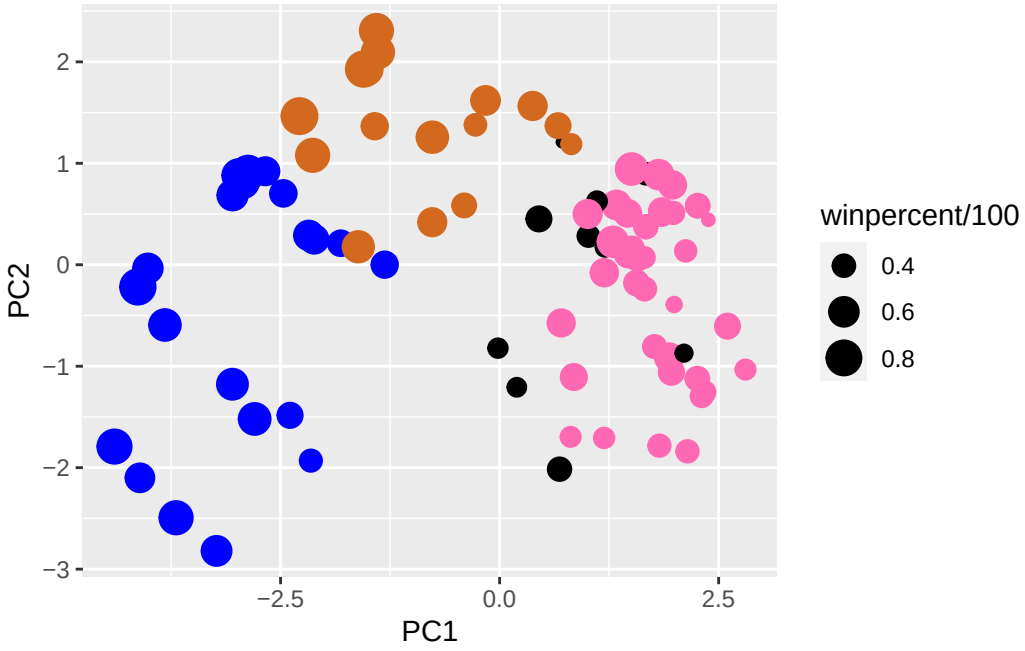
```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
```

```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2, label=rownames(my_data)) +
        geom_point(col=my_cols)+
  geom_text_repel(col=my_cols, max.overlaps=14)

p
```

```
Warning: ggrepel: 28 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

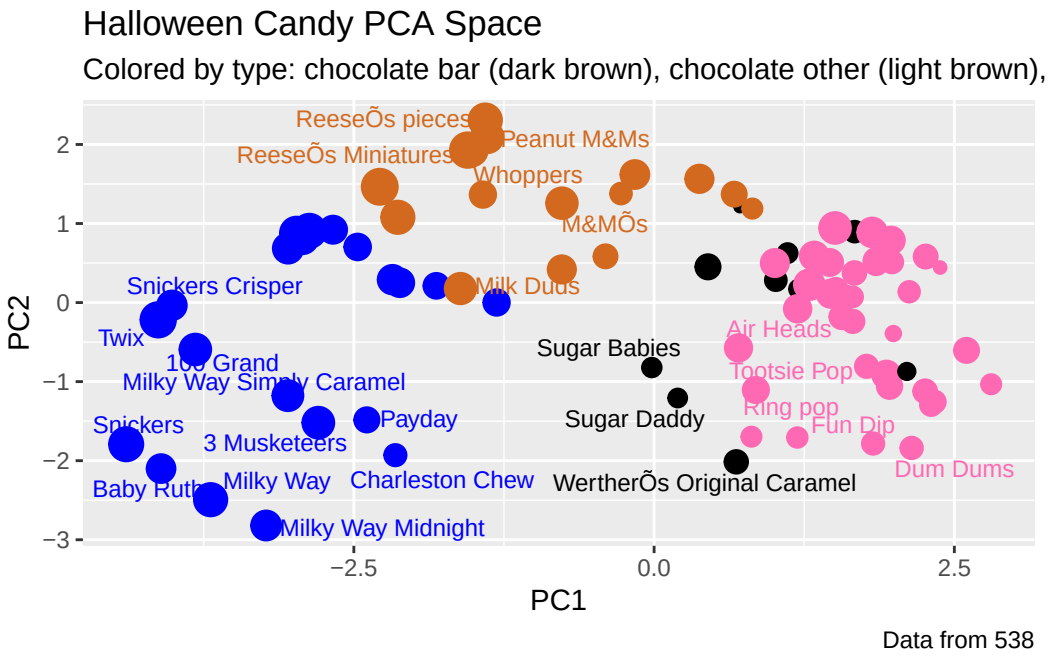



```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p
```




```
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: 60 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



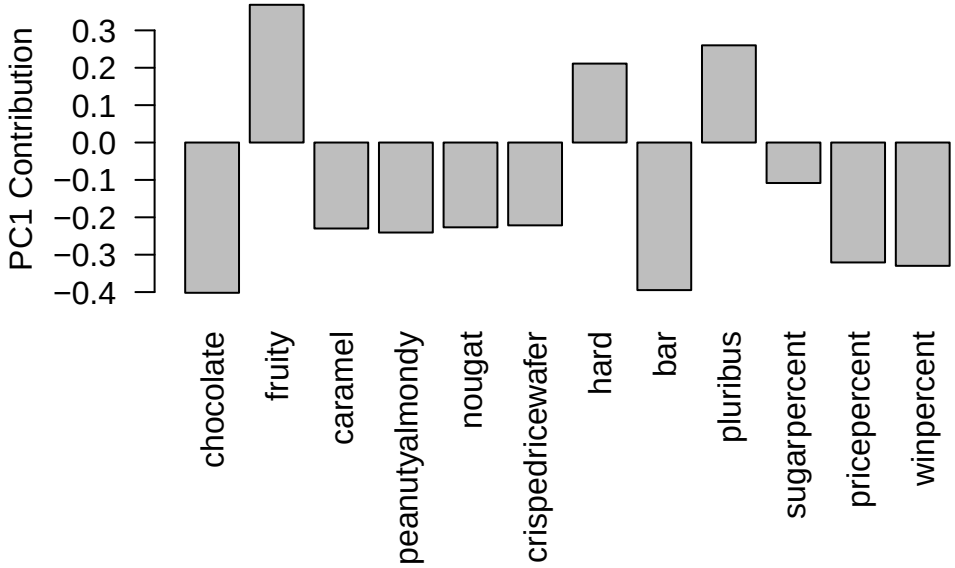
Sometimes labels are hard to see, you can make a plot where you can roll your mouse over the points to see the name (but it only works in html :( )

library(plotly)

ggplotly(p)

Let's look at PCA

```
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?

Fruity, hard, and pluribus. Yes, when we look at our correlation plot, fruity candies correlate with hard and pluribus.