class 10: Halloween Candy Mini Project

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Background

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

```
candy <- read.csv("candy-data.csv", 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. What is your favorite candy in the dataset and what is it's winpercent value?

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

```
[1] 81.64291
```

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	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
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?

winepercent

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

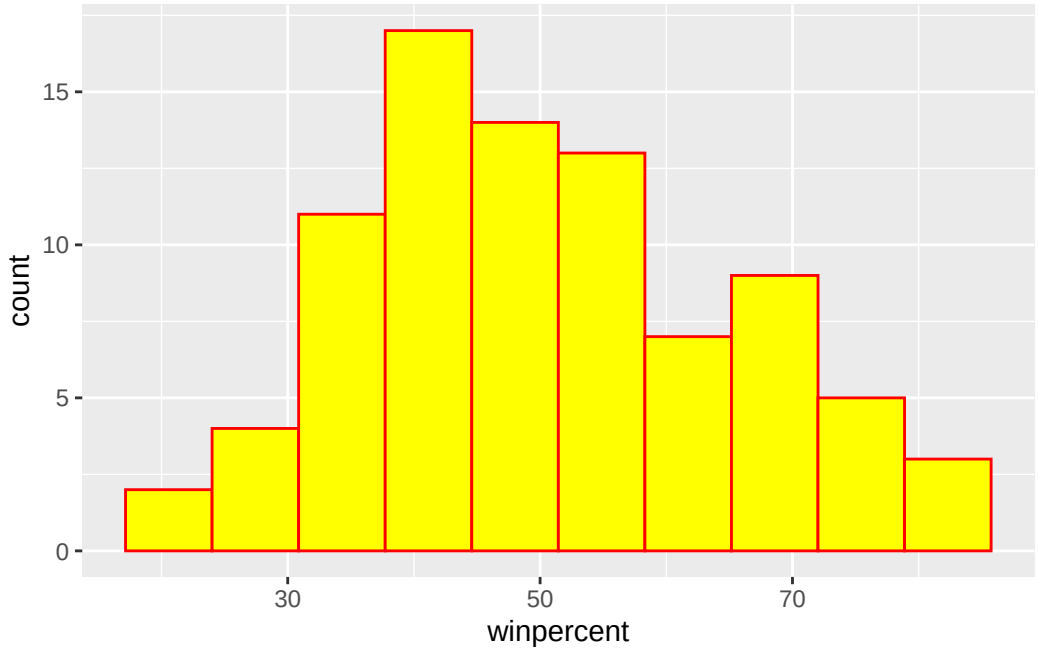
```
candy$chocolate
```

```
 [1] 1 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 1 1 0 0 0 1 1 0 1 1 1
[39] 1 1 1 0 1 1 0 0 0 1 0 0 0 1 1 1 1 0 1 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0 0 1 1
[77] 1 1 0 1 0 0 0 0 1
```

Zero means this candy is not in the type of chocolate, while one represnents the candy is in the chocolate type

Q8. Plot a histogram of winpercent values

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



Q9. Is the distribution of winpercent values symmetrical?

Yes

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

```
median(candy$winpercent)
```

```
[1] 47.82975
```

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
```

And for fruit candy...

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

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

Yes

```
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
```

3. Overall Candy Rankings

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

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

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

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

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

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

```
[1] "berry"   "alice"   "chandra"
```

```
sort(y)
```

```
[1] "alice"   "berry"   "chandra"
```

```
order(y)
```

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

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

First I want to order/arrange the whole dataset by winpercent values

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

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

```
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
```

```
head(arrange(candy,desc(winpercent )), n=5)
```

```
                         chocolate fruity caramel peanutyalmondy nougat
ReeseÕs Peanut Butter cup         1      0       0              1      0
ReeseÕs 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
                         crispedricewafer hard bar pluribus sugarpercent
ReeseÕs Peanut Butter cup                0    0   0        0        0.720
ReeseÕs 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
                         pricepercent winpercent
```

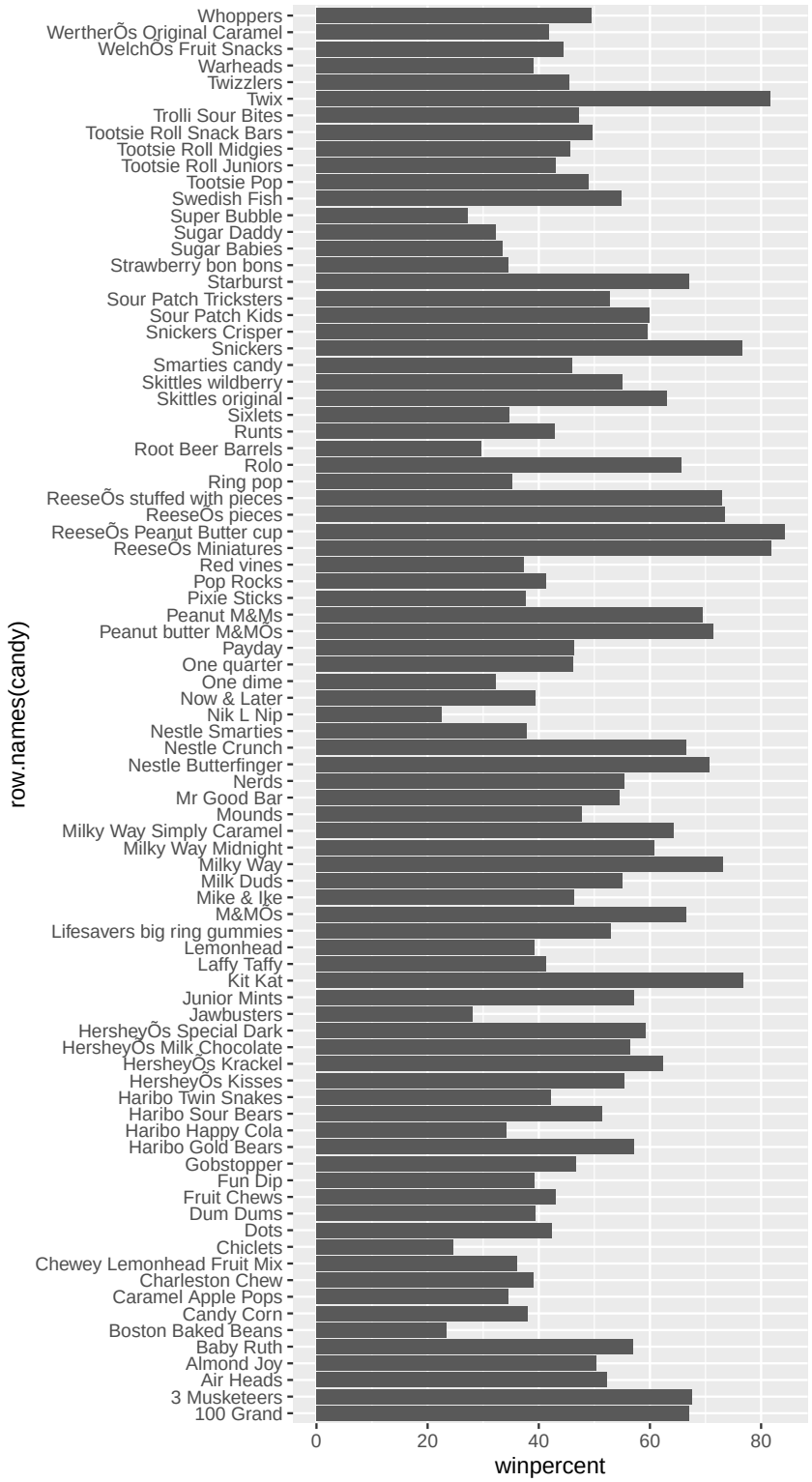
```
ReeseÕs Peanut Butter cup        0.651   84.18029
ReeseÕs Miniatures               0.279   81.86626
Twix                             0.906   81.64291
Kit Kat                          0.511   76.76860
Snickers                         0.651   76.67378
```

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

Barplot

The default barplot, made with "geom_col" has the bars in the order they are in the dataset...

```
ggplot(candy)+
     aes(winpercent, row.names(candy))+
     geom_col()
```


row.names(candy)
Whoppers
WertherÕs Original Caramel
WelchÕs Fruit Snacks
Warheads
Twizzlers
Twix
Trolli Sour Bites
Tootsie Roll Snack Bars
Tootsie Roll Midgies
Tootsie Roll Juniors
Tootsie Pop
Swedish Fish
Super Bubble
Sugar Daddy
Sugar Babies
Strawberry bon bons
Starburst
Sour Patch Tricksters
Sour Patch Kids
Snickers Crisper
Snickers
Smarties candy
Skittles wildberry
Skittles original
Sixlets
Runts
Root Beer Barrels
Rolo
Ring pop
ReeseÕs stuffed with pieces
ReeseÕs pieces
ReeseÕs Peanut Butter cup
ReeseÕs Miniatures
Red vines
Pop Rocks
Pixie Sticks
Peanut M&Ms
Peanut butter M&MÕs
Payday
One quarter
One dime
Now & Later
Nik L Nip
Nestle Smarties
Nestle Crunch
Nestle Butterfinger
Nerds
Mr Good Bar
Mounds
Milky Way Simply Caramel
Milky Way Midnight
Milky Way
Milk Duds
Mike & Ike
M&MÕs
Lifesavers big ring gummies
Lemonhead
Laffy Taffy
Kit Kat
Junior Mints
Jawbusters
HersheyÕs Special Dark
HersheyÕs Milk Chocolate
HersheyÕs Krackel
HersheyÕs Kisses
Haribo Twin Snakes
Haribo Sour Bears
Haribo Happy Cola
Haribo Gold Bears
Gobstopper
Fun Dip
Fruit Chews
Dum Dums
Dots
Chiclets
Chewey Lemonhead Fruit Mix
Charleston Chew
Caramel Apple Pops
Candy Corn
Boston Baked Beans
Baby Ruth
Almond Joy
Air Heads
3 Musketeers
100 Grand
0
20
40
60
80
winpercent

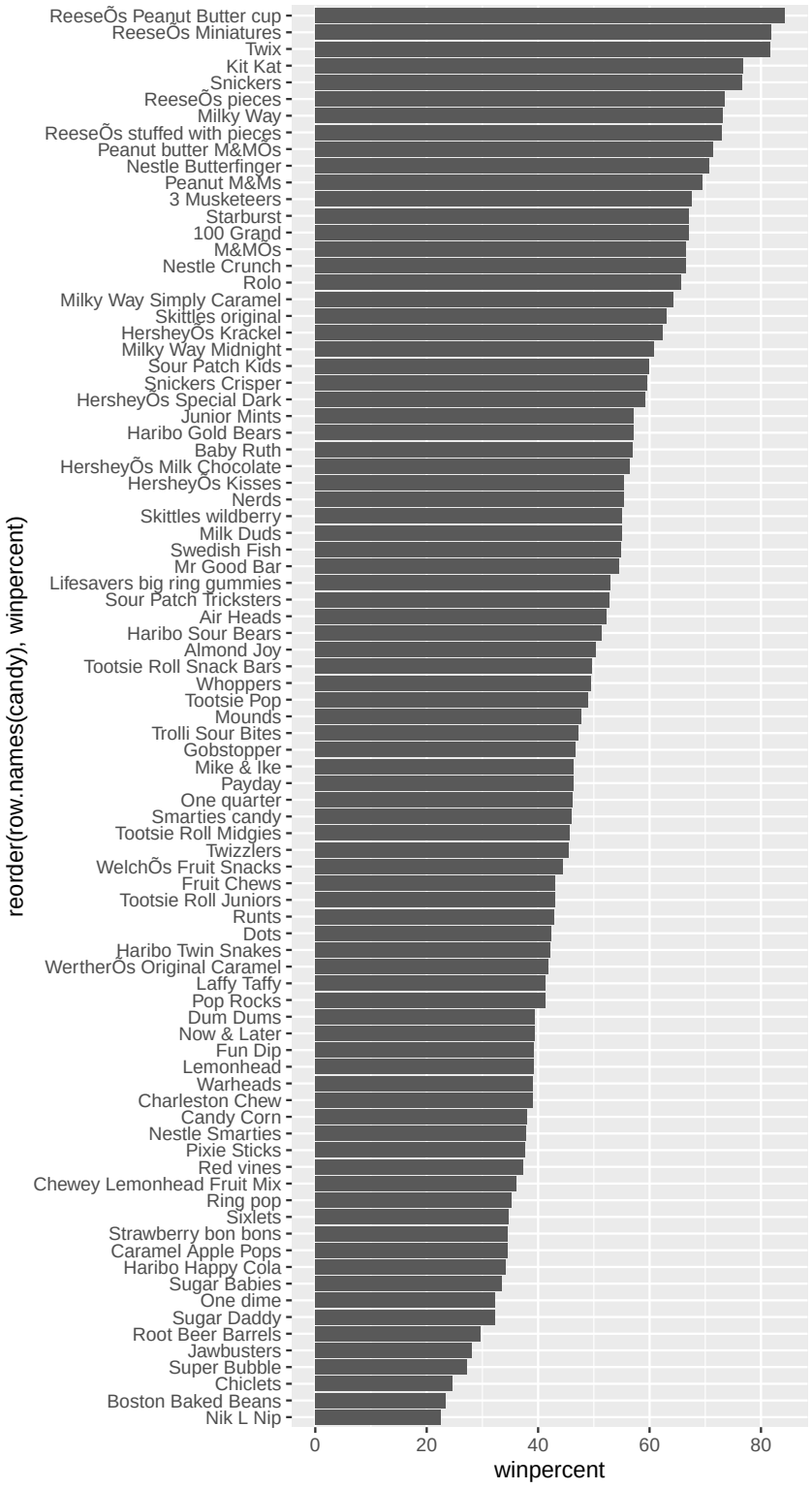
Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```
p <- ggplot(candy)+
  aes(winpercent, reorder(row.names(candy), winpercent))+
  geom_col()
```

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

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

```
p
```


ReeseÕs Peanut Butter cup
ReeseÕs Miniatures
Twix
Kit Kat
Snickers
ReeseÕs pieces
Milky Way
ReeseÕs stuffed with pieces
Peanut butter M&MÕs
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&MÕs
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
HersheyÕs Krackel
Milky Way Midnight
Sour Patch Kids
Snickers Crisper
HersheyÕs Special Dark
Junior Mints
Haribo Gold Bears
Baby Ruth
HersheyÕs Milk Chocolate
HersheyÕs Kisses
Nerds
Skittles wildberry
Milk Duds
Swedish Fish
Mr Good Bar
Lifesavers big ring gummies
Sour Patch Tricksters
Air Heads
Haribo Sour Bears
Almond Joy
Tootsie Roll Snack Bars
Whoppers
Tootsie Pop
Mounds
Trolli Sour Bites
Gobstopper
Mike & Ike
Payday
One quarter
Smarties candy
Tootsie Roll Midgies
Twizzlers
WelchÕs Fruit Snacks
Fruit Chews
Tootsie Roll Juniors
Runts
Dots
Haribo Twin Snakes
WertherÕs Original Caramel
Laffy Taffy
Pop Rocks
Dum Dums
Now & Later
Fun Dip
Lemonhead
Warheads
Charleston Chew
Candy Corn
Nestle Smarties
Pixie Sticks
Red vines
Chewey Lemonhead Fruit Mix
Ring pop
Sixlets
Strawberry bon bons
Caramel Apple Pops
Haribo Happy Cola
Sugar Babies
One dime
Sugar Daddy
Root Beer Barrels
Jawbusters
Super Bubble
Chiclets
Boston Baked Beans
Nik L Nip
reorder(row.names(candy), winpercent)
0
20
40
60
80
winpercent

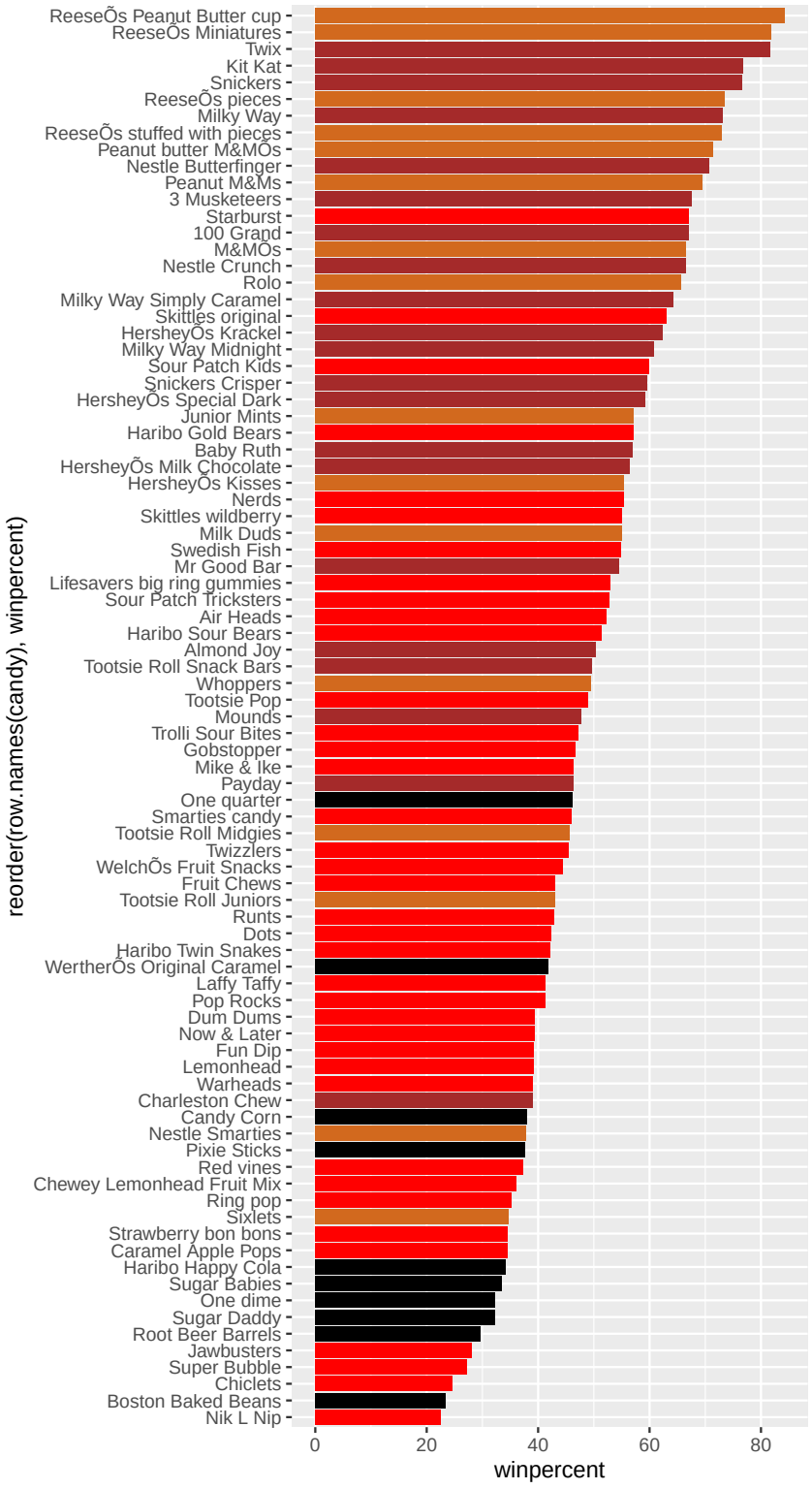
Let's setup a color vector (that signifies candy type) that we can then use for some future black balues (one for each candy). Then we overwrite chocolate (for chocolate candy), brown(for candy bars) and red (for fruity candy)

```
my_cols <- rep("black", nrow(candy))
#my_cols
my_cols[as.logical(candy$chocolate)] <- "chocolate"
my_cols[as.logical(candy$bar)] <- "brown"
my_cols[as.logical(candy$fruity)] <- "red"
my_cols
```

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

Now I can use this vector th color up my barplot

```
ggplot(candy)+
  aes(winpercent, reorder(row.names(candy), winpercent))+
  geom_col(fill=my_cols)
```


ReeseÕs Peanut Butter cup
ReeseÕs Miniatures
Twix
Kit Kat
Snickers
ReeseÕs pieces
Milky Way
ReeseÕs stuffed with pieces
Peanut butter M&MÕs
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&MÕs
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
HersheyÕs Krackel
Milky Way Midnight
Sour Patch Kids
Snickers Crisper
HersheyÕs Special Dark
Junior Mints
Haribo Gold Bears
Baby Ruth
HersheyÕs Milk Chocolate
HersheyÕs Kisses
Nerds
Skittles wildberry
Milk Duds
Swedish Fish
Mr Good Bar
Lifesavers big ring gummies
Sour Patch Tricksters
Air Heads
Haribo Sour Bears
Almond Joy
Tootsie Roll Snack Bars
Whoppers
Tootsie Pop
Mounds
Trolli Sour Bites
Gobstopper
Mike & Ike
Payday
One quarter
Smarties candy
Tootsie Roll Midgies
Twizzlers
WelchÕs Fruit Snacks
Fruit Chews
Tootsie Roll Juniors
Runts
Dots
Haribo Twin Snakes
WertherÕs Original Caramel
Laffy Taffy
Pop Rocks
Dum Dums
Now & Later
Fun Dip
Lemonhead
Warheads
Charleston Chew
Candy Corn
Nestle Smarties
Pixie Sticks
Red vines
Chewey Lemonhead Fruit Mix
Ring pop
Sixlets
Strawberry bon bons
Caramel Apple Pops
Haribo Happy Cola
Sugar Babies
One dime
Sugar Daddy
Root Beer Barrels
Jawbusters
Super Bubble
Chiclets
Boston Baked Beans
Nik L Nip
reorder(row.names(candy), winpercent)
0
20
40
60
80
winpercent

Now, for the first time, using this plot we can answer questions like:

Q17. What is the worst ranked chocolate candy?

```
library(dplyr)
candy%>%
  filter(chocolate==TRUE)%>%
  arrange(winpercent)%>%
  .[1,]
```

```
        chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Sixlets         1      0       0              0      0                 0    0
        bar pluribus sugarpercent pricepercent winpercent
Sixlets   0        1         0.22        0.081     34.722
```

Q18. What is the best ranked fruity candy?

```
candy%>%
  filter(fruity==TRUE)%>%
  arrange(desc(winpercent))%>%
  .[1,]
```

```
          chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Starburst         0      1       0              0      0                 0    0
          bar pluribus sugarpercent pricepercent winpercent
Starburst   0        1        0.151         0.22   67.03763
```

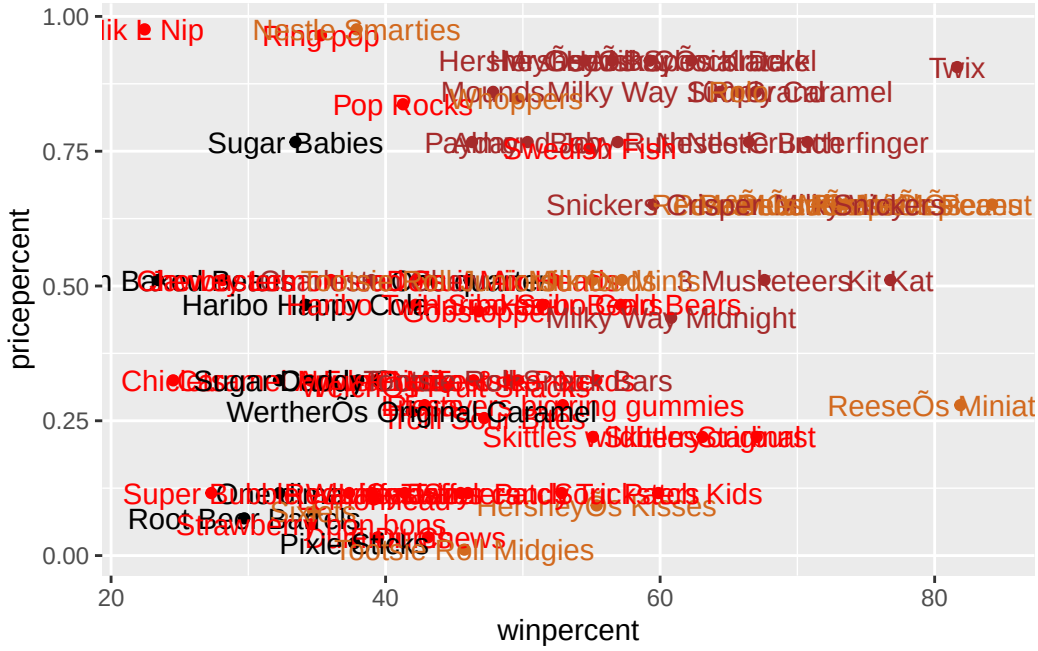
4. Taking a look at pricepercnet

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" as the "pricepercent" balues

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

```
  geom_text(col=my_cols)
```

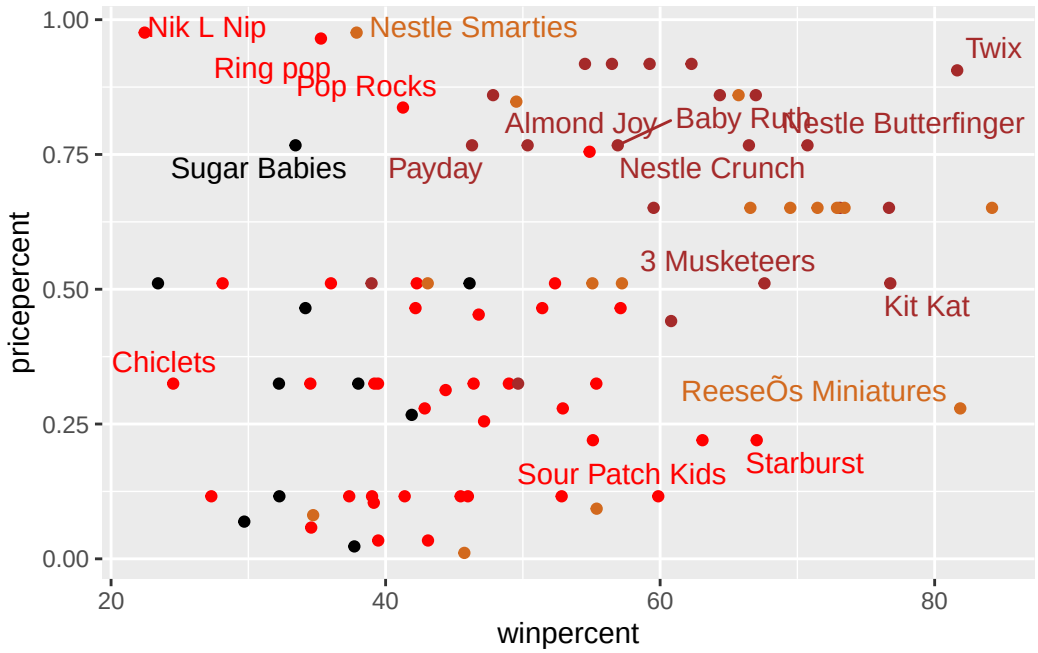


This plot sucks! I can not read the labels... We can use ggrepl package to help with this

```
library(ggrepel)

ggplot(candy)+
  aes(winpercent, pricepercent, label=rownames(candy))+
  geom_point(col=my_cols)+
  geom_text_repel(col=my_cols, max.overlaps = 7)
```

```
Warning: ggrepel: 68 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?

ReeseÕs Miniatures

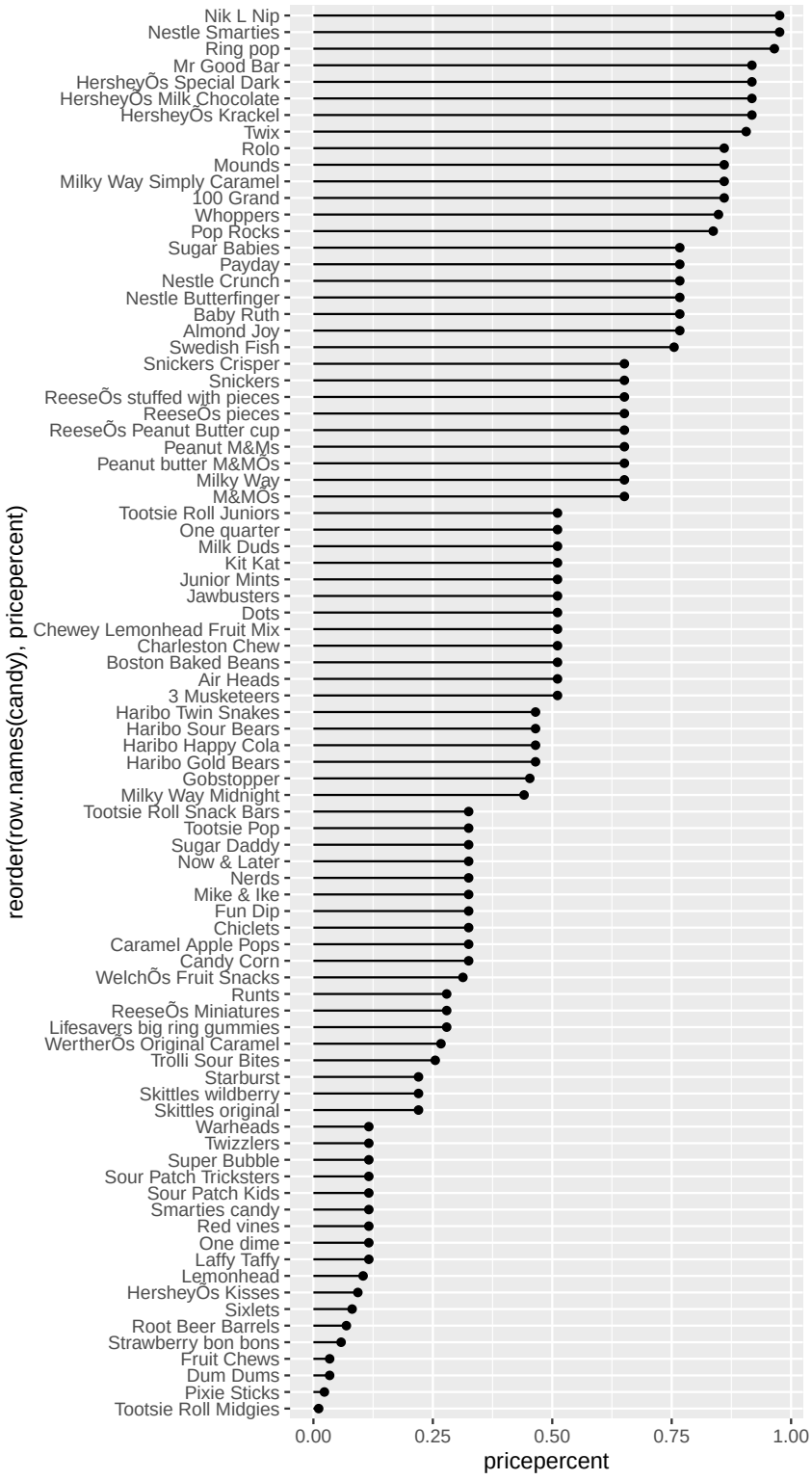
Q20. What are the top 5 most expensive candy types in the dataset and of these which is the least popular?

```
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
```

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().

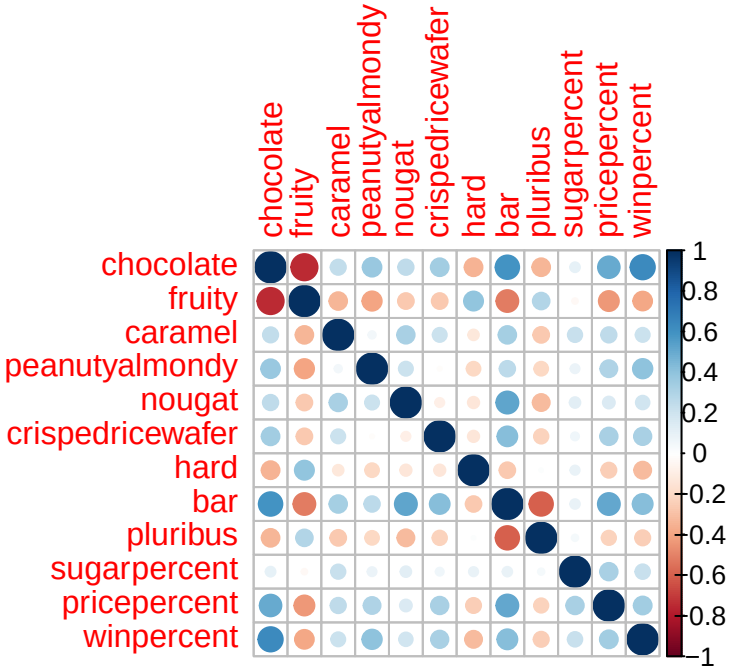
```
ggplot(candy)+
  aes(pricepercent, reorder(row.names(candy), pricepercent))+
  geom_point()+
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent), xend = 0))
```


Nik L Nip
Nestle Smarties
Ring pop
Mr Good Bar
HersheyÕs Special Dark
HersheyÕs Milk Chocolate
HersheyÕs Krackel
Twix
Rolo
Mounds
Milky Way Simply Caramel
100 Grand
Whoppers
Pop Rocks
Sugar Babies
Payday
Nestle Crunch
Nestle Butterfinger
Baby Ruth
Almond Joy
Swedish Fish
Snickers Crisper
Snickers
ReeseÕs stuffed with pieces
ReeseÕs pieces
ReeseÕs Peanut Butter cup
Peanut M&Ms
Peanut butter M&MÕs
Milky Way
M&MÕs
Tootsie Roll Juniors
One quarter
Milk Duds
Kit Kat
Junior Mints
Jawbusters
Dots
Chewey Lemonhead Fruit Mix
Charleston Chew
Boston Baked Beans
Air Heads
3 Musketeers
Haribo Twin Snakes
Haribo Sour Bears
Haribo Happy Cola
Haribo Gold Bears
Gobstopper
Milky Way Midnight
Tootsie Roll Snack Bars
Tootsie Pop
Sugar Daddy
Now & Later
Nerds
Mike & Ike
Fun Dip
Chiclets
Caramel Apple Pops
Candy Corn
WelchÕs Fruit Snacks
Runts
ReeseÕs Miniatures
Lifesavers big ring gummies
WertherÕs Original Caramel
Trolli Sour Bites
Starburst
Skittles wildberry
Skittles original
Warheads
Twizzlers
Super Bubble
Sour Patch Tricksters
Sour Patch Kids
Smarties candy
Red vines
One dime
Laffy Taffy
Lemonhead
HersheyÕs Kisses
Sixlets
Root Beer Barrels
Strawberry bon bons
Fruit Chews
Dum Dums
Pixie Sticks
Tootsie Roll Midgies
reorder(row.names(candy), pricepercent)
0.00
0.25
0.50
0.75
1.00
pricepercent

```
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?

Chocolate and winpercent

PCA: Principal Component Analysis

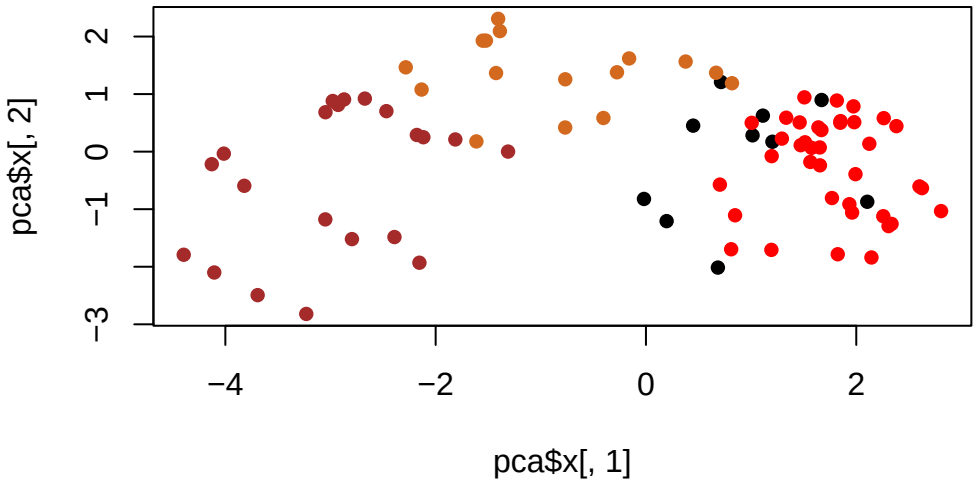
The main funciton that always there for us is "prcomp()" It has an important argument that is set to "scale=False"

```
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)
```

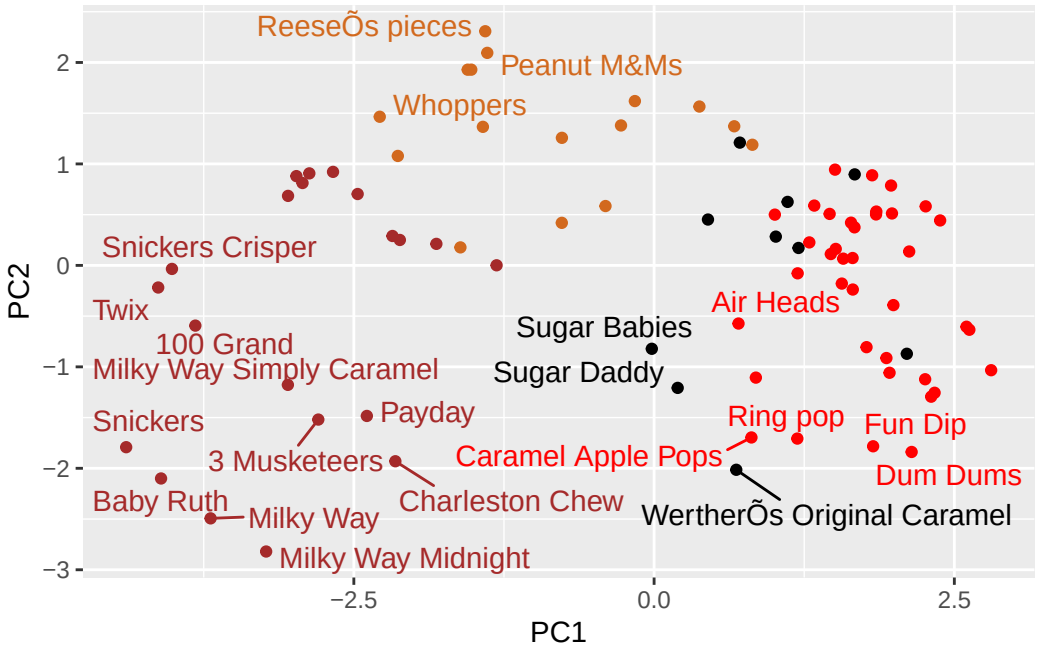


I will make a "nicer" plot with ggplot. ggplot only works with data.frames as imput so I need to make one for it first...

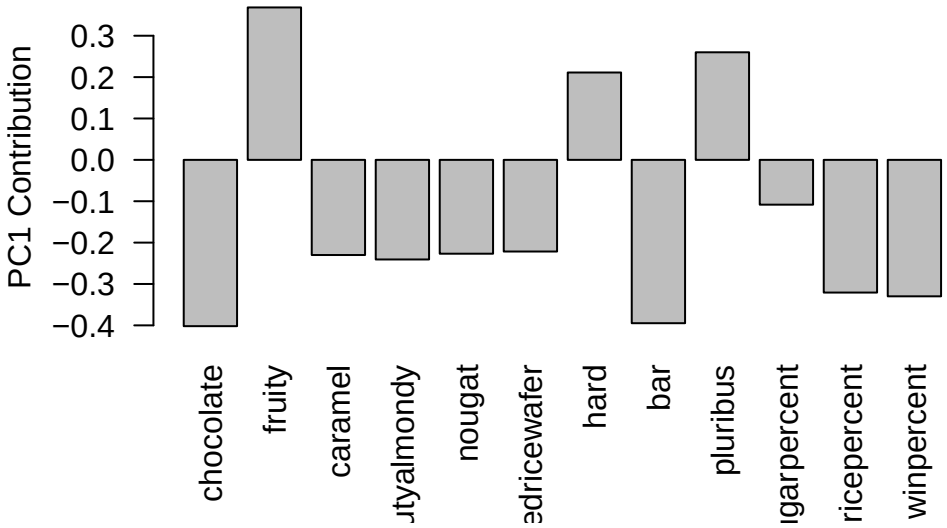
```
#Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
```

```
ggplot(my_data)+
  aes(PC1, PC2, label=row.names(my_data))+
  geom_point(col=my_cols)+
  geom_text_repel(col=my_cols, max.overlaps = 7)
```

```
Warning: ggrepel: 63 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```




```
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. Yes