class 9 candy

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Background

In today's mini-project we will analyze candy data with exploratory graphics , basic statistics , correlation analysis and principal component analysis methods we have been learning thus far.

Data Import

The data comes as a CSV file from 538.

```
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
```

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

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

```
[1] 38
```

Q3. What is your favorite candy (other than Twix) in the dataset and what is it's winpercent value?

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

```
[1] 66.47068
```

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
```

Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset?

```
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	

The "winpercent" variable looks like it is on a different scale because the numbers it has for each column are a lot larger than the other variables.

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

```
candy$chocolate
```

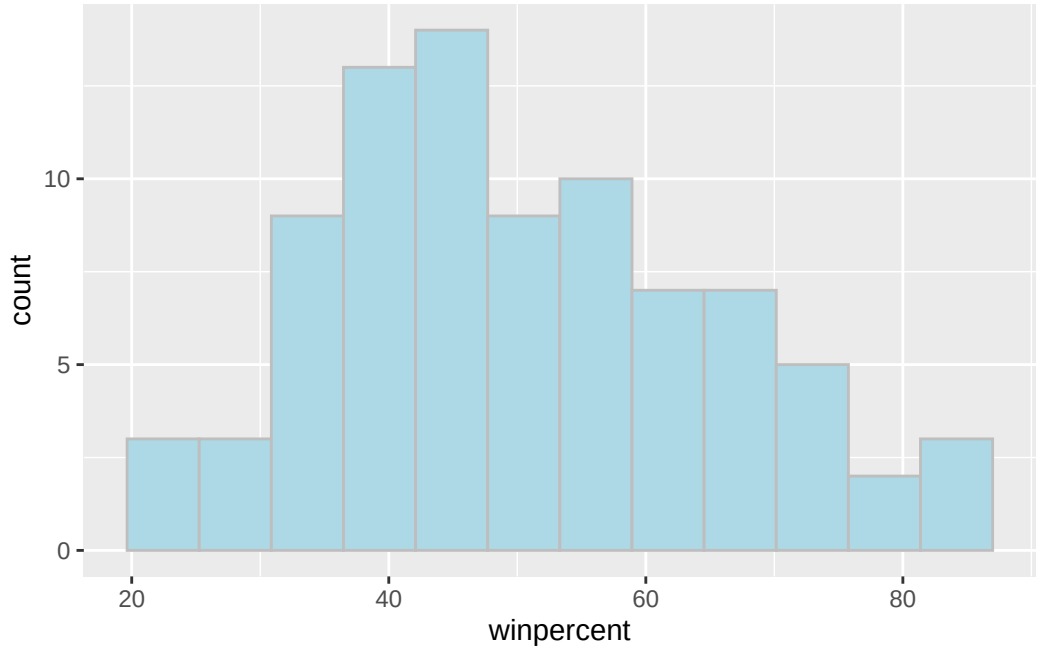
```
 [1] 1 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 1 1 0 0 0 1 1 0 1 1 1
[39] 1 1 1 0 1 1 0 0 0 1 0 0 0 1 1 1 1 0 1 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0 0 1 1
[77] 1 1 0 1 0 0 0 0 1
```

The "0" likely represents a candy that doesn't have any chocolate while the "1" represents candy that does have chocolate in it.

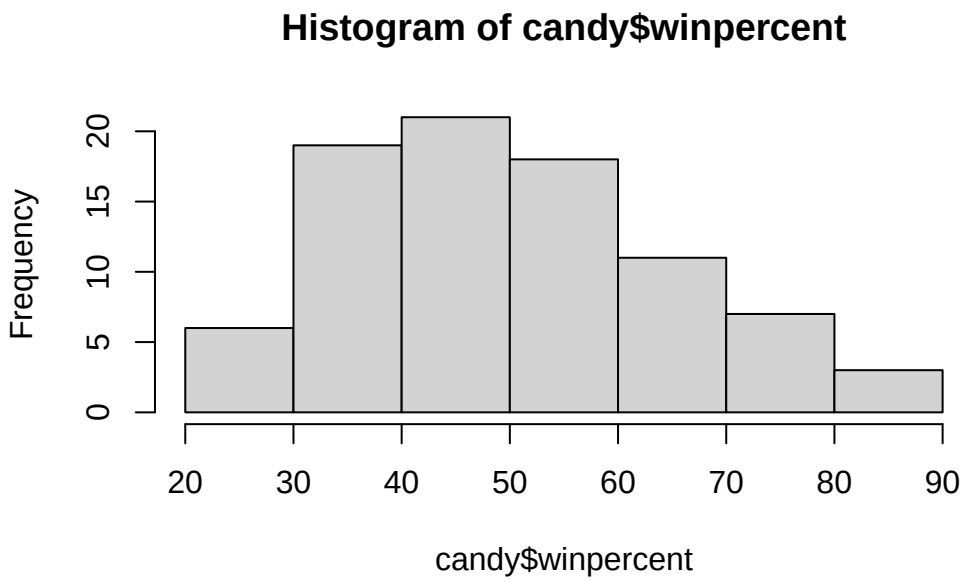
Exploratory Analysis

Q8. Plot a histogram of winpercent values using both base R an ggplot2.

```
library(ggplot2)
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=12, fill="lightblue", col="gray")
```




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



Q9. Is the distribution of winpercent values symmetrical?

The distribution is not symmetrical

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

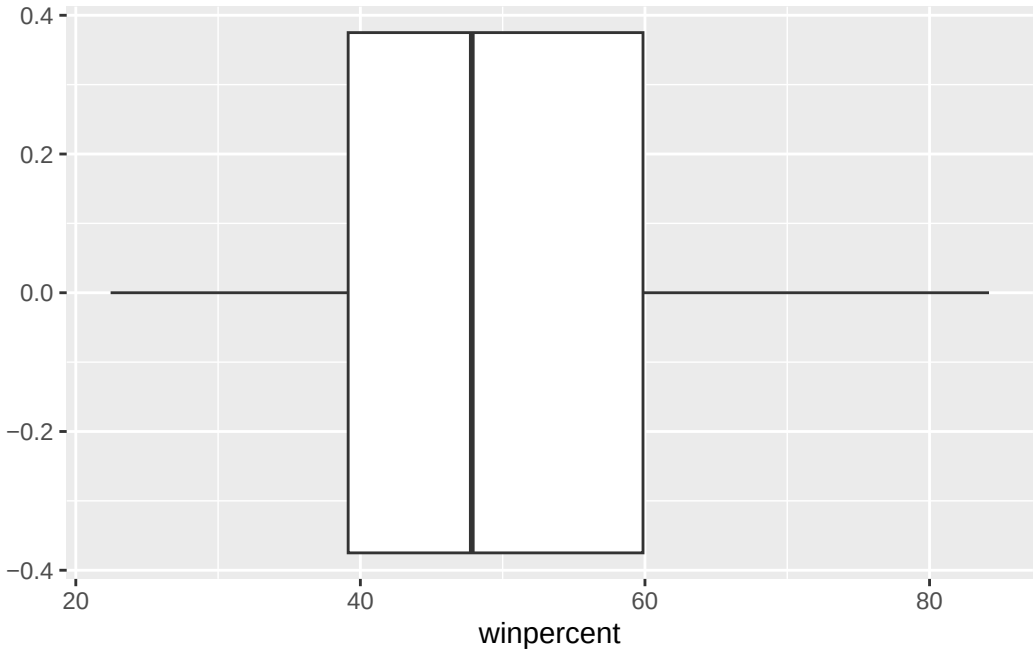
```
mean(candy$winpercent)
```

```
[1] 50.31676
```

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

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

```
ggplot(candy) +
  aes(winpercent) +
  geom_boxplot()
```



The center of the distribution is below 50%

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

Steps to solve this: 1.Find all chocolate candy in the dataset 2.Extract or find their winpercent values 3.Calculate the mean of these values

4.Find all fruit candy in the data set 5.Find their winpercent 6.Calculate their mean value

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

chocolate candy on average is higher ranked than fruit candy.

Q12. Is this difference statistically significant?

```
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
```

The difference between these two candies is statistically significant

Overall Candy Rankings

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?

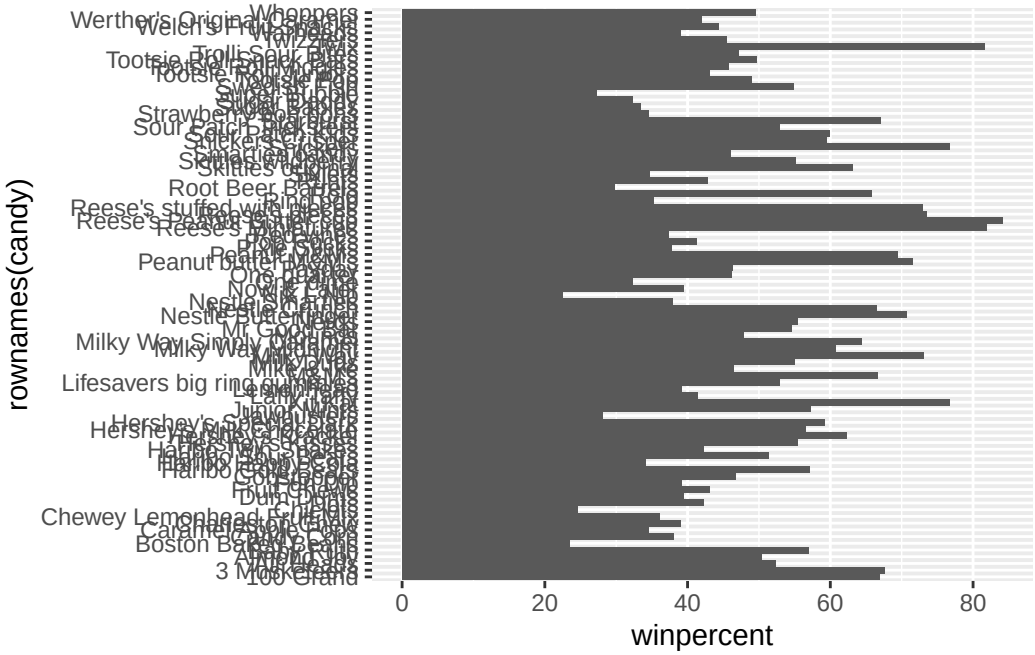
```
tail(candy[order(candy$winpercent),], n=5)
```

```
                         chocolate fruity caramel peanutyalmondy nougat
Snickers                         1      0       1              1      1
Kit Kat                          1      0       0              0      0
Twix                             1      0       1              0      0
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
```

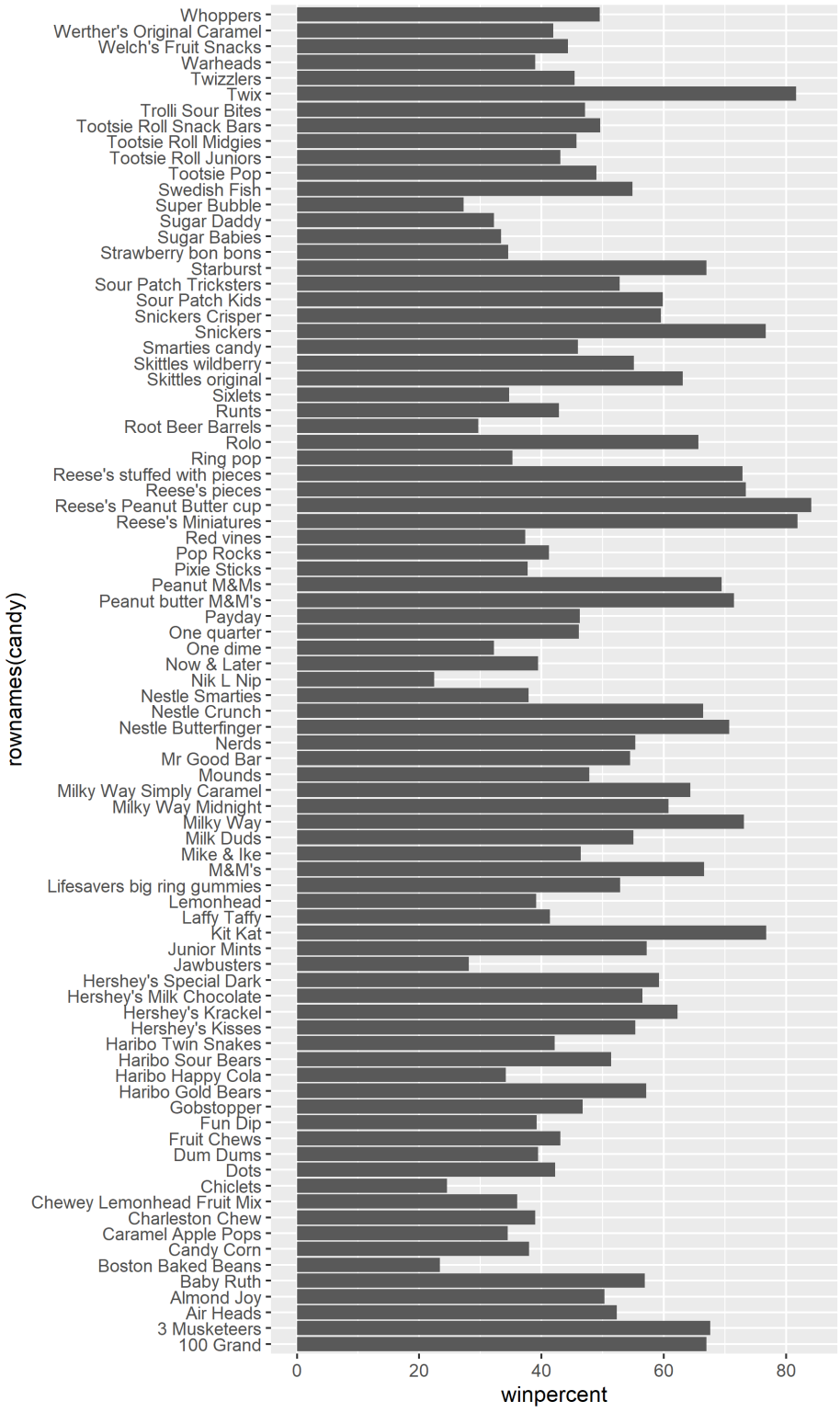
Q15. Make a first barplot of candy ranking based on winpercent values.

```
library(ggplot2)

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

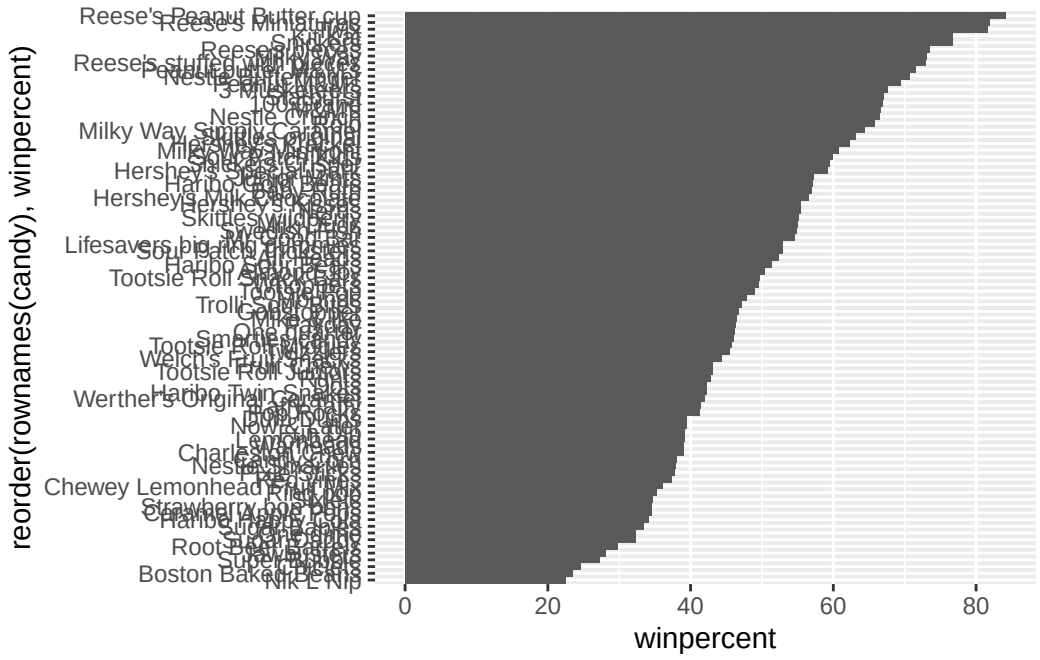



```
ggsave("barplot1.png", height=10, width=6)
```

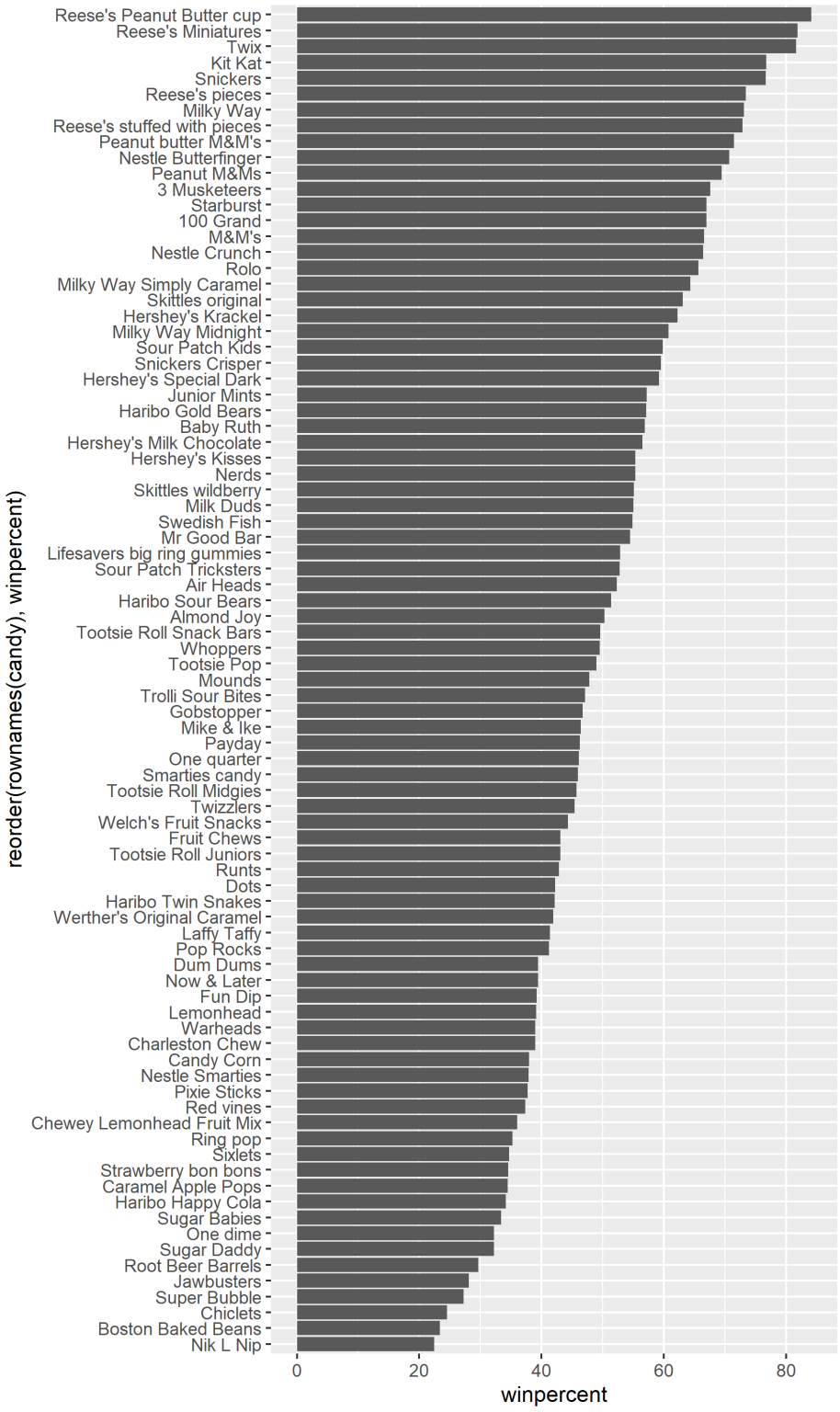

rownames(candy)
Whoppers
Werther's Original Caramel
Welch's Fruit Snacks
Warheads
Twizzlers
Twix
Trolli Sour Bites
Tootsie Roll Snack Bars
Tootsie Roll Midgies
Tootsie Roll Juniors
Tootsie Pop
Swedish Fish
Super Bubble
Sugar Daddy
Sugar Babies
Strawberry bon bons
Starburst
Sour Patch Tricksters
Sour Patch Kids
Snickers Crisper
Snickers
Smarties candy
Skittles wildberry
Skittles original
Sixlets
Runts
Root Beer Barrels
Rolo
Ring pop
Reese's stuffed with pieces
Reese's pieces
Reese's Peanut Butter cup
Reese's Miniatures
Red vines
Pop Rocks
Pixie Sticks
Peanut M&Ms
Peanut butter M&M's
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&M's
Lifesavers big ring gummies
Lemonhead
Laffy Taffy
Kit Kat
Junior Mints
Jawbusters
Hershey's Special Dark
Hershey's Milk Chocolate
Hershey's Krackel
Hershey's 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?

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



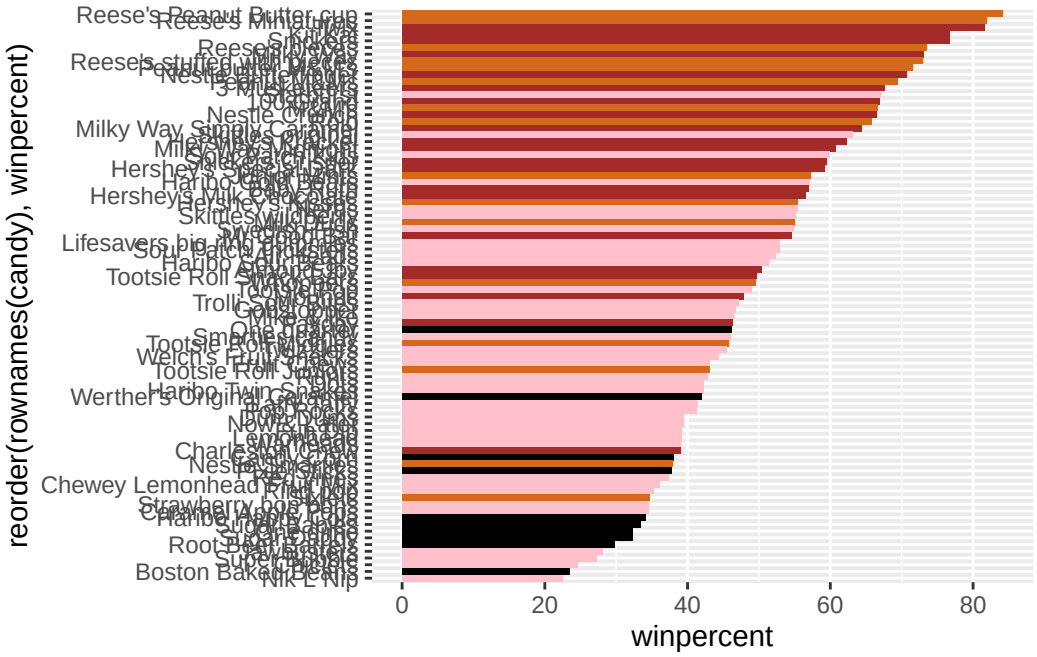

```
ggsave("barplot2.png", height=10, width=6)
```


reorder(rownames(candy), winpercent)
Reese's Peanut Butter cup
Reese's Miniatures
Twix
Kit Kat
Snickers
Reese's pieces
Milky Way
Reese's stuffed with pieces
Peanut butter M&M's
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&M's
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
Hershey's Krackel
Milky Way Midnight
Sour Patch Kids
Snickers Crisper
Hershey's Special Dark
Junior Mints
Haribo Gold Bears
Baby Ruth
Hershey's Milk Chocolate
Hershey's 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
Welch's Fruit Snacks
Fruit Chews
Tootsie Roll Juniors
Runts
Dots
Haribo Twin Snakes
Werther's 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
0
20
40
60
80
winpercent

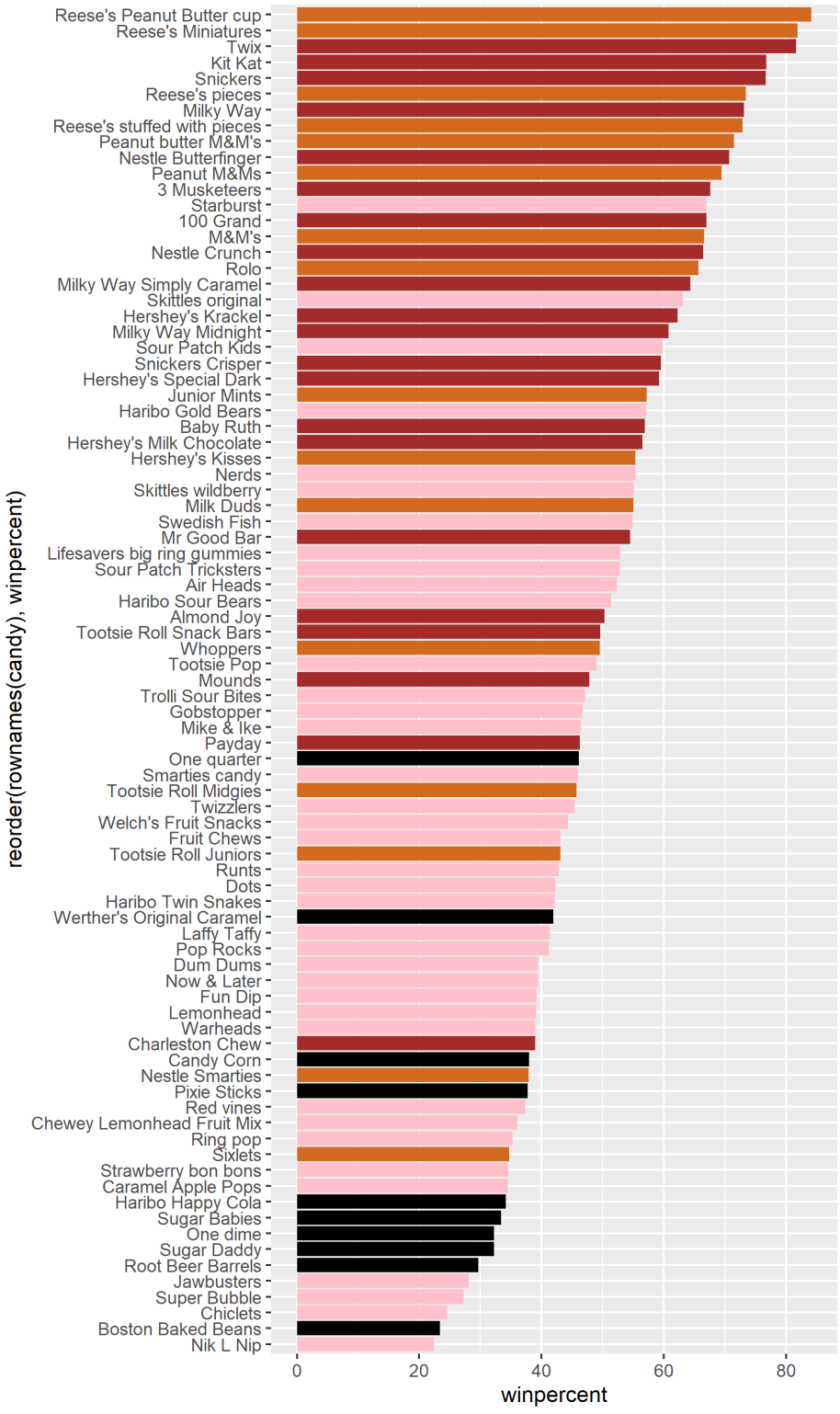
Q17. What is the worst ranked chocolate candy?

```
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"
```

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



```
ggsave("barplot3.png", height=10, width=6)
```


reorder(rownames(candy), winpercent)
Reese's Peanut Butter cup
Reese's Miniatures
Twix
Kit Kat
Snickers
Reese's pieces
Milky Way
Reese's stuffed with pieces
Peanut butter M&M's
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&M's
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
Hershey's Krackel
Milky Way Midnight
Sour Patch Kids
Snickers Crisper
Hershey's Special Dark
Junior Mints
Haribo Gold Bears
Baby Ruth
Hershey's Milk Chocolate
Hershey's 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
Welch's Fruit Snacks
Fruit Chews
Tootsie Roll Juniors
Runts
Dots
Haribo Twin Snakes
Werther's 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
0
20
40
60
80
winpercent

The worst ranked chocolate is sixlets

Q18. What is the best ranked fruity candy?

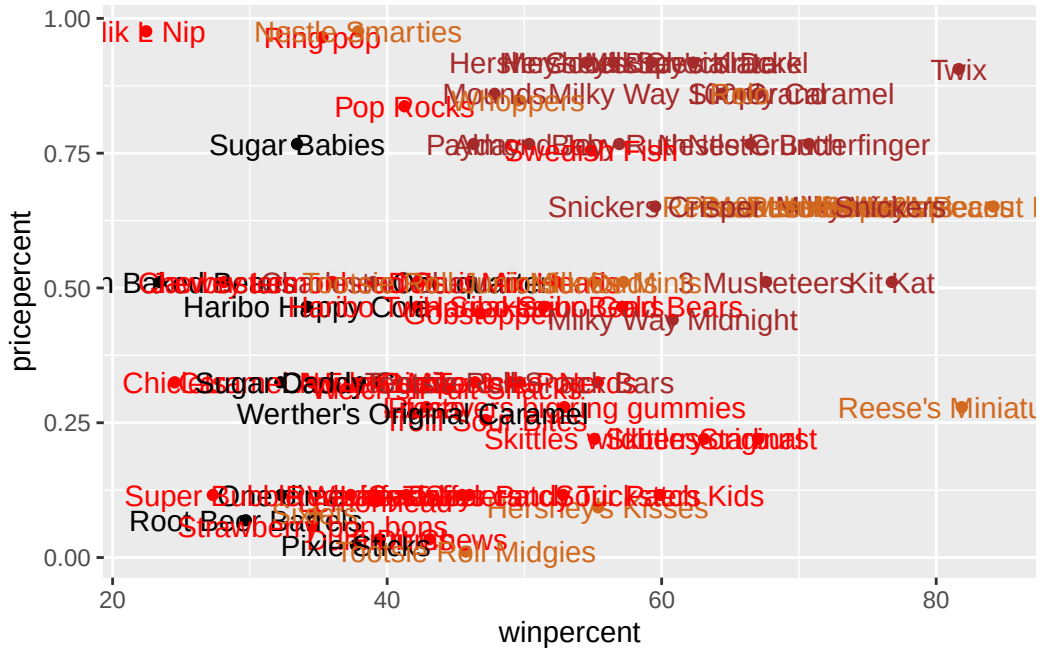
The best ranked fruity candy is starburst

Taking a look at pricepercent

Make a plot of winpercent vs the pricepercent

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

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



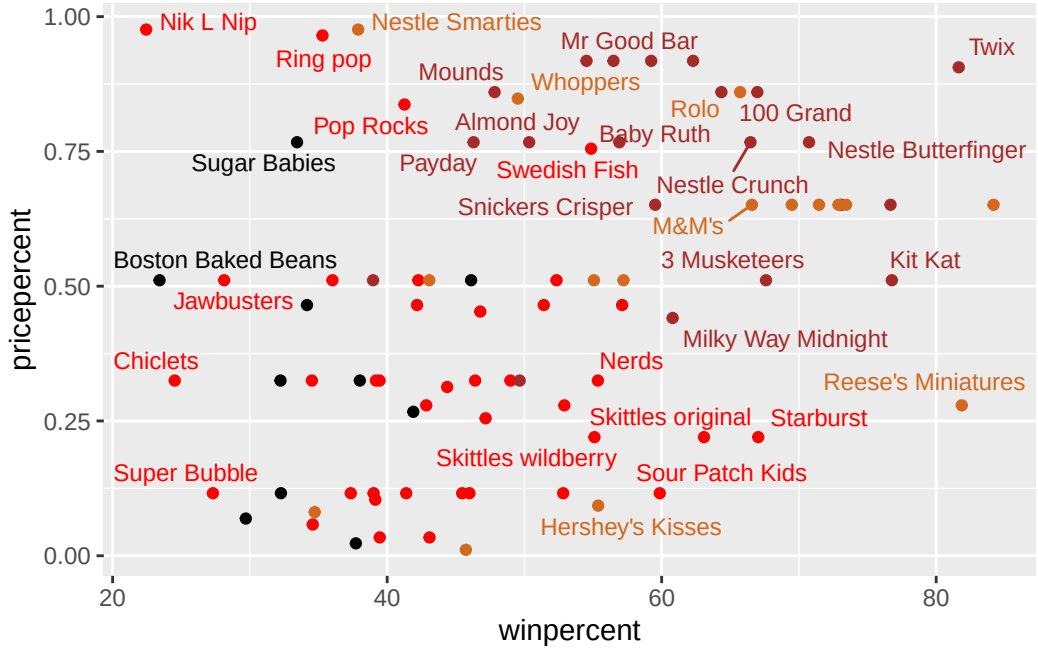
We can use **ggrepel** package for better label placment:

```
library(ggrepel)

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

```
ggplot(candy) +
  aes(x=winpercent, y=pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, max.overlaps = 8, size = 3.3)
```

```
Warning: ggrepel: 52 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



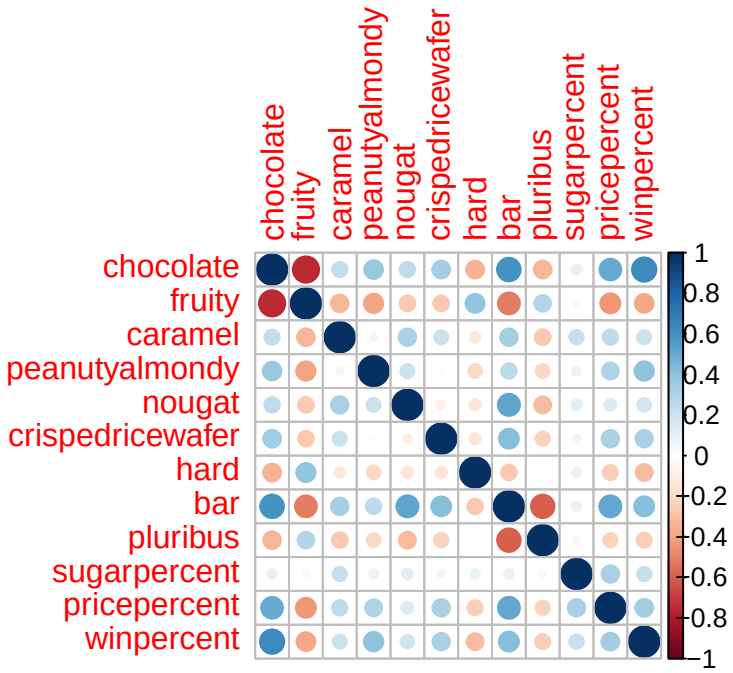
Exploring the correlation structure

Pearson correlation values range from -1 to +1

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

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



Principal Component Analysis

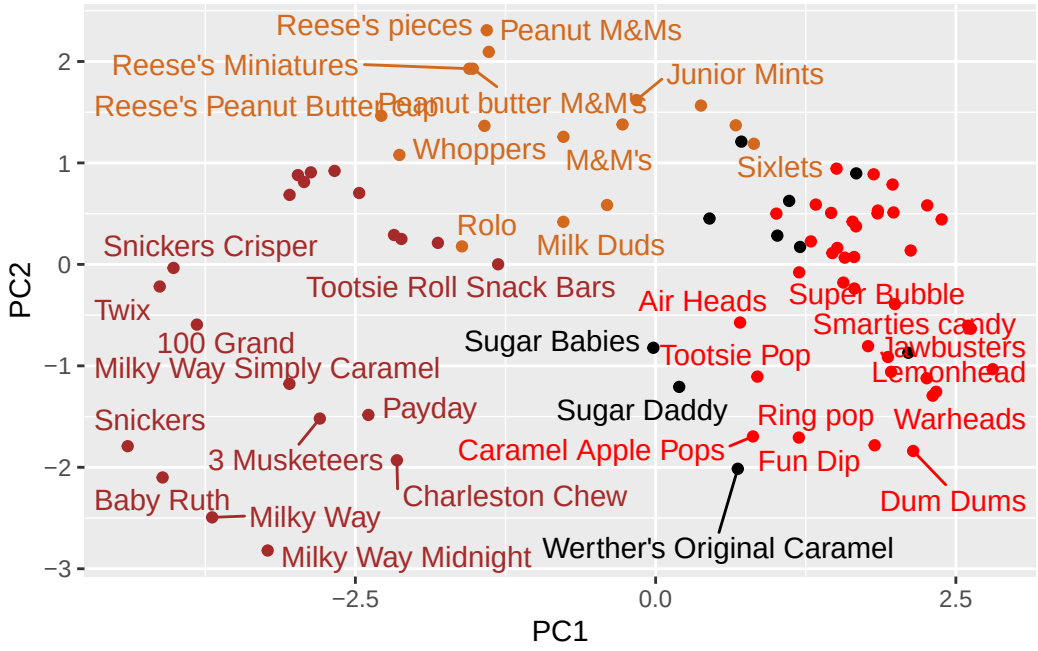
```
pca <- prcomp(candy, scale=T)
summary(pca)
```

```
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
```

The main results figure: the PCA score plot:

```
ggplot(pca$x) +
  aes(PC1, PC2, label=rownames(pca$x)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols)
```

```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```

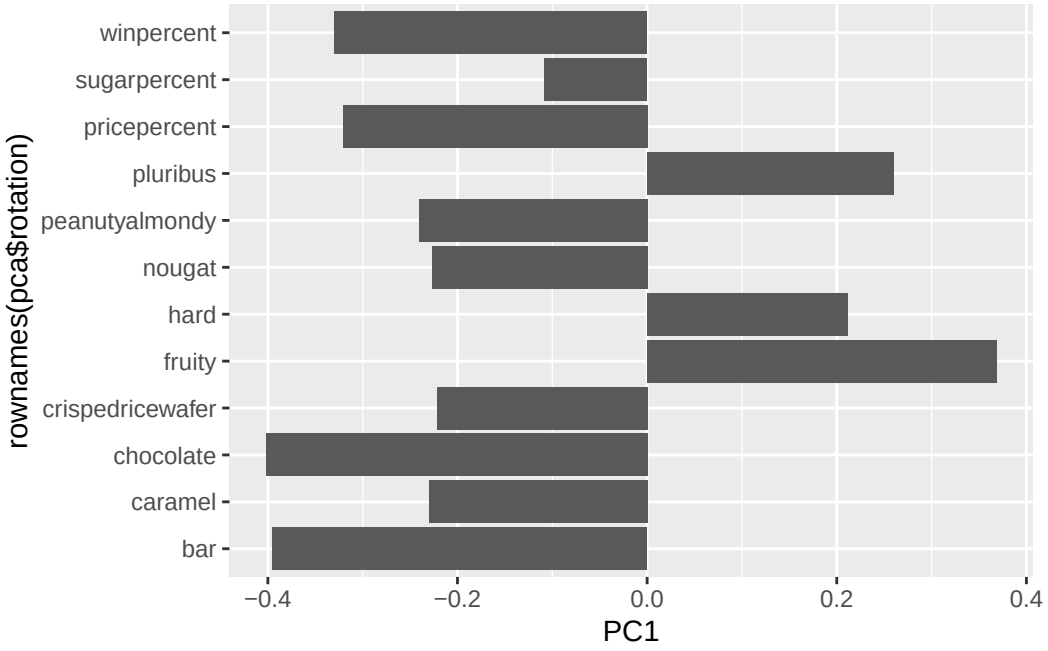



```
  labs(title="PCA Candy Space Map")
```

```
<ggplot2::labels> List of 1
 $ title: chr "PCA Candy Space Map"
```

The "loadings" plot for PC1

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



Q24. Complete the code to generate the loadings plot above. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you? Where did you see this relationship highlighted previously?

Q25. Based on your exploratory analysis, correlation findings, and PCA results, what combination of characteristics appears to make a "winning" candy? How do these different analyses (visualization, correlation, PCA) support or complement each other in reaching this conclusion?