Class9: Candy Analysis Mini Project

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Import data

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

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
```

Data exploration

Q1. How many different candy types are in this dataset?

```
nrow(candy)
```

```
[1] 85
```

There are 85 candy types in the dataset.

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

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

```
[1] 38
```

How many chocolate candies are in the dataset?

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

```
[1] 37
```

My favourite candy

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

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

```
[1] 76.7686
```

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
```

```
#library("skimr")
#skim(candy)
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?

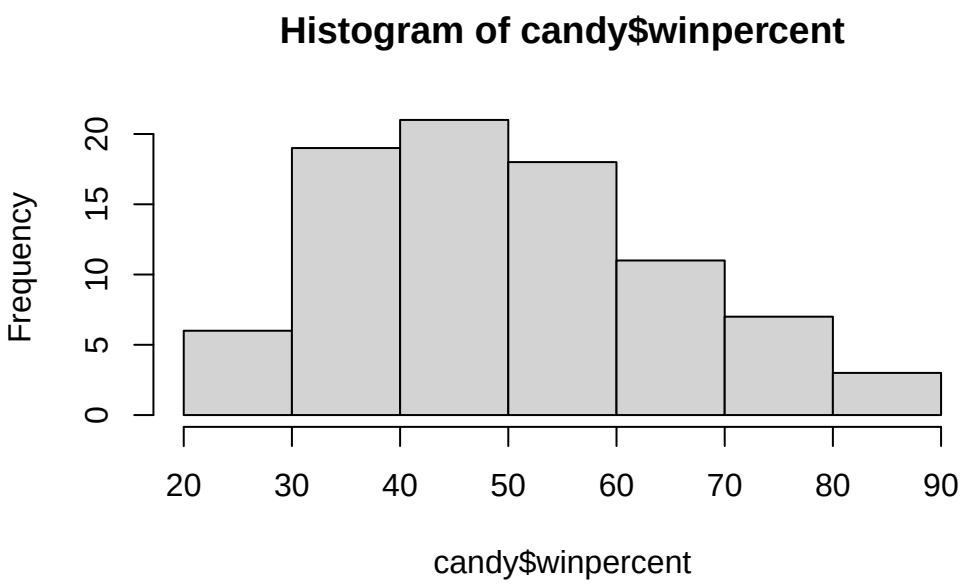
Chocolate, fruity, caramel, peanutyalmondy, nougat, crispedricewafer, hard, bar, pluribus are all either 0 or 1 values.

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

0 stands for FALSE and 1 stands for TRUE.

Q8. Plot a histogram of winpercent values

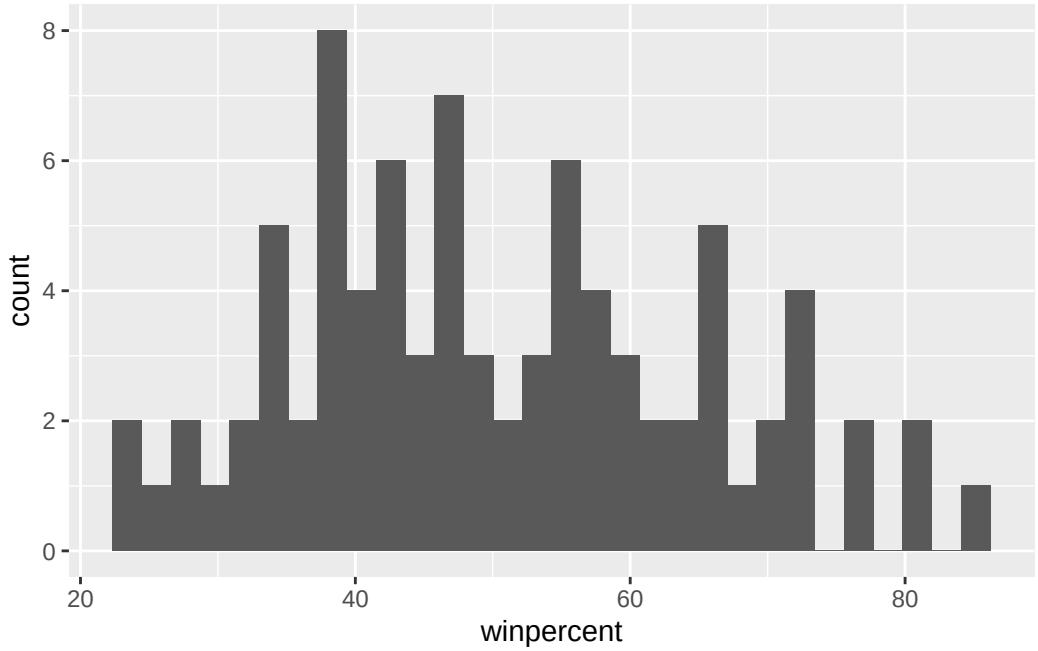
```
hist(candy$winpercent)
```



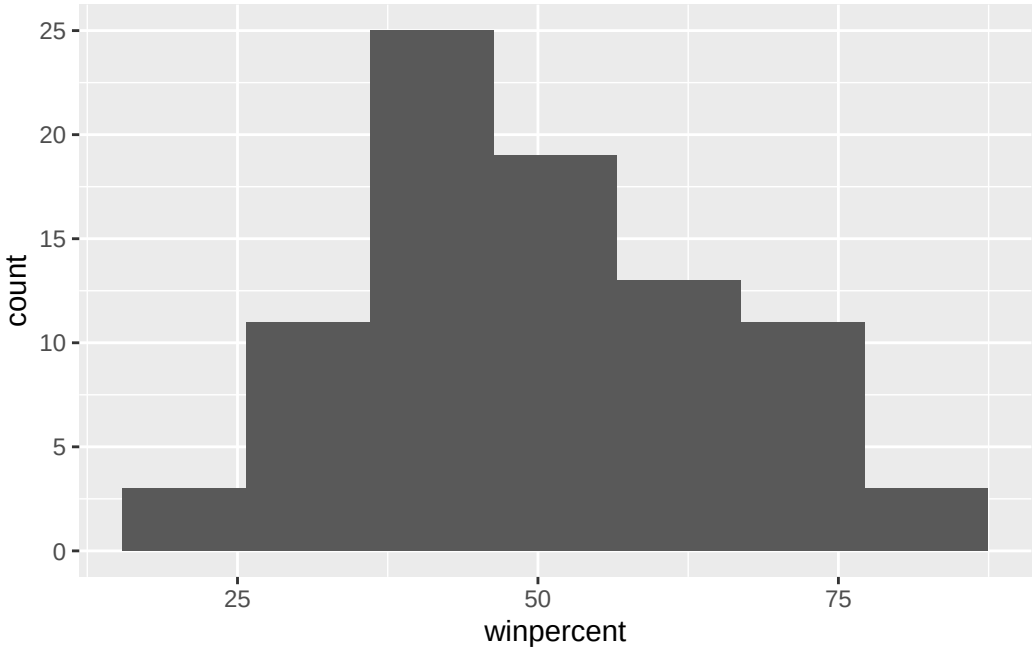

```
library(ggplot2)

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

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




```
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins = 7)
```



Q9. Is the distribution of winpercent values symmetrical?

No.

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

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

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

It's below 50%.

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

- first find all chocolate candies
- find their winpercent values
- calculate the mean of these values
- then do the same for fruity candies and compare their means

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

another approach:

```
mean(candy$winpercent[as.logical(candy$chocolate)])
```

```
[1] 60.92153
```

```
mean(candy$winpercent[as.logical(candy$fruity)])
```

```
[1] 44.11974
```

Chocolate candies are higher ranked than fruity candies.

Q12. Is this difference statistically significant?

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

```
    Welch Two Sample t-test

data:  chocolate.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
```

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

The `order` function returns the indices that make the input sorted.

```
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?

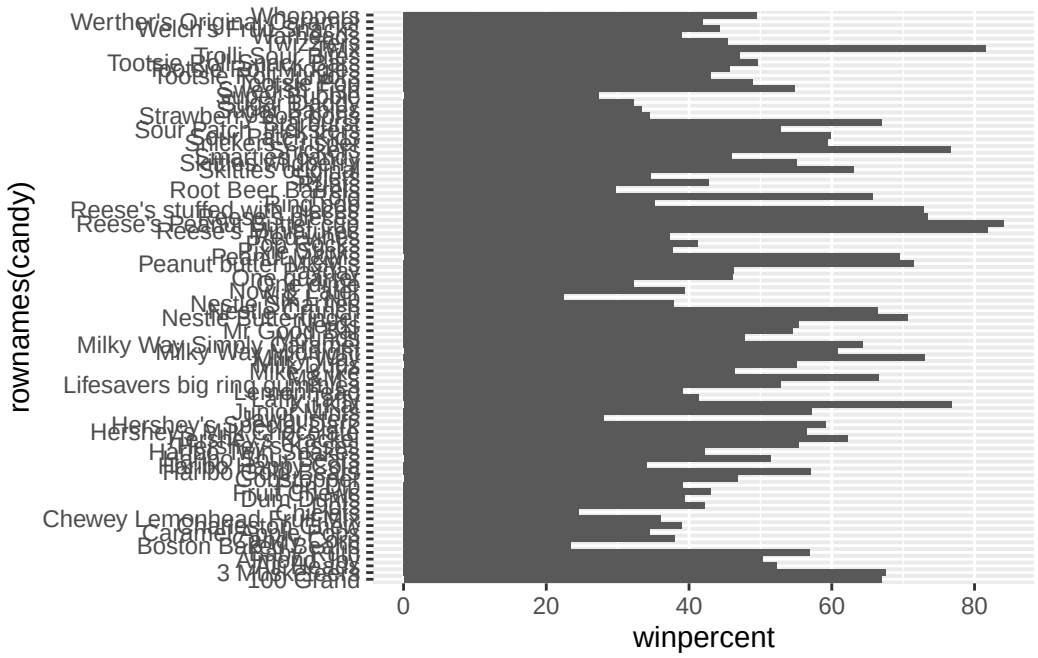
```
tail(candy[order(candy$winpercent),], n=5)
```

```
                        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
```

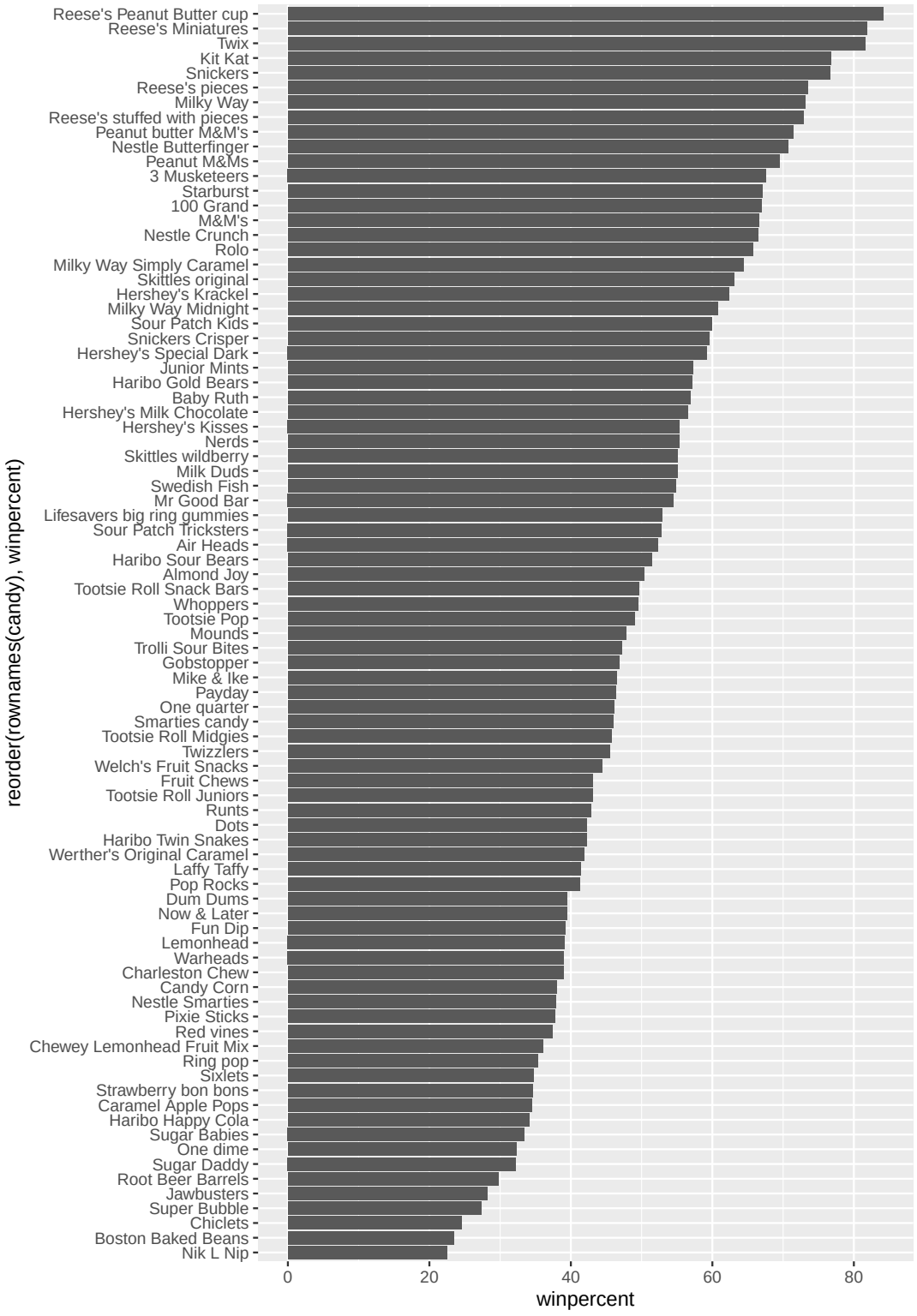
Q15. Make a first barplot of candy ranking based on winpercent values.

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



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()
```


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

```
ggsave("mybarplot.png", height = 10)
```

```
Saving 5.5 x 10 in image
```

Adding color

```
my_cols=rep("tan4", 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)
```

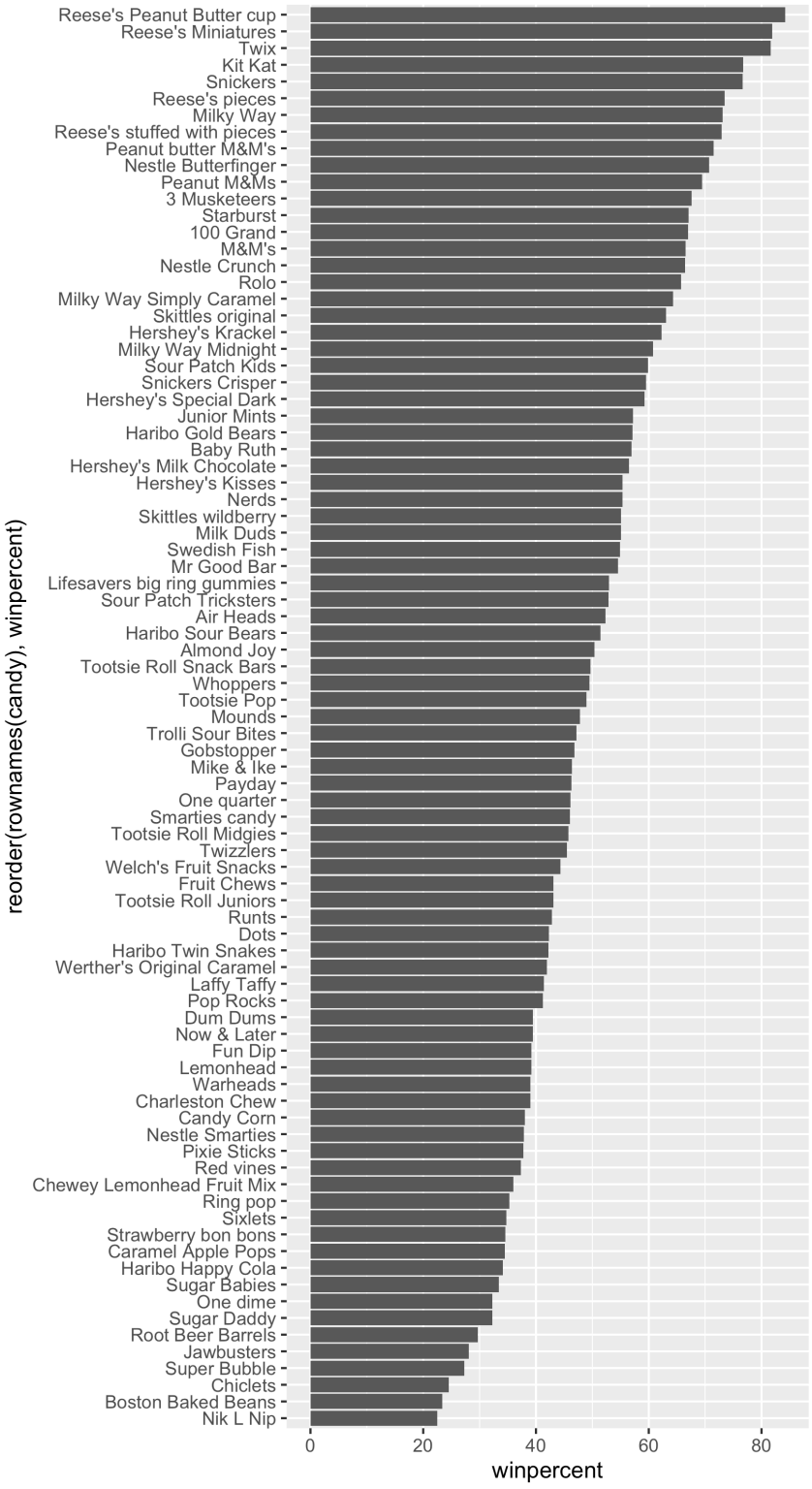
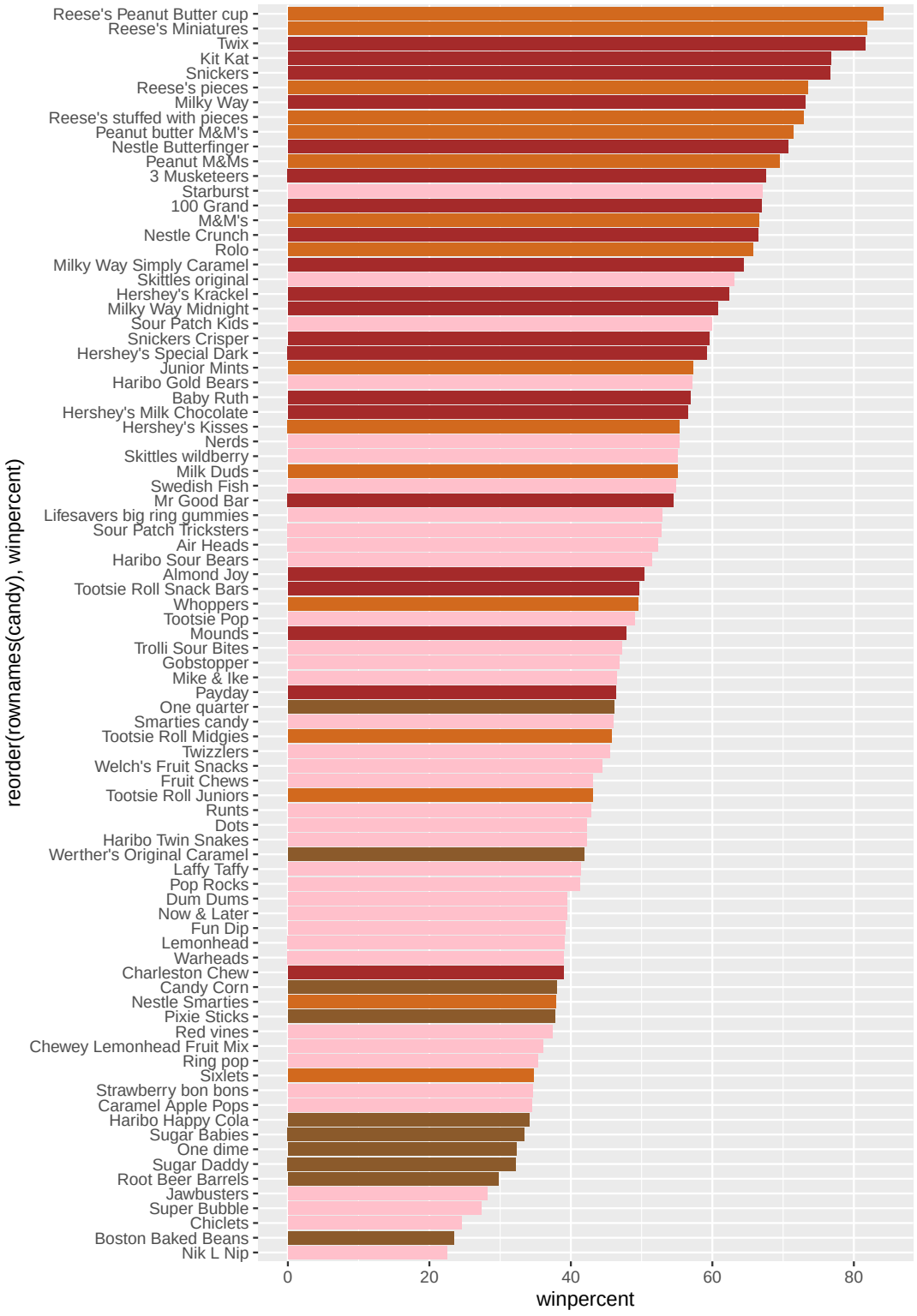


Figure 1: image_B&W


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?

Reese's Peanut Butter cup

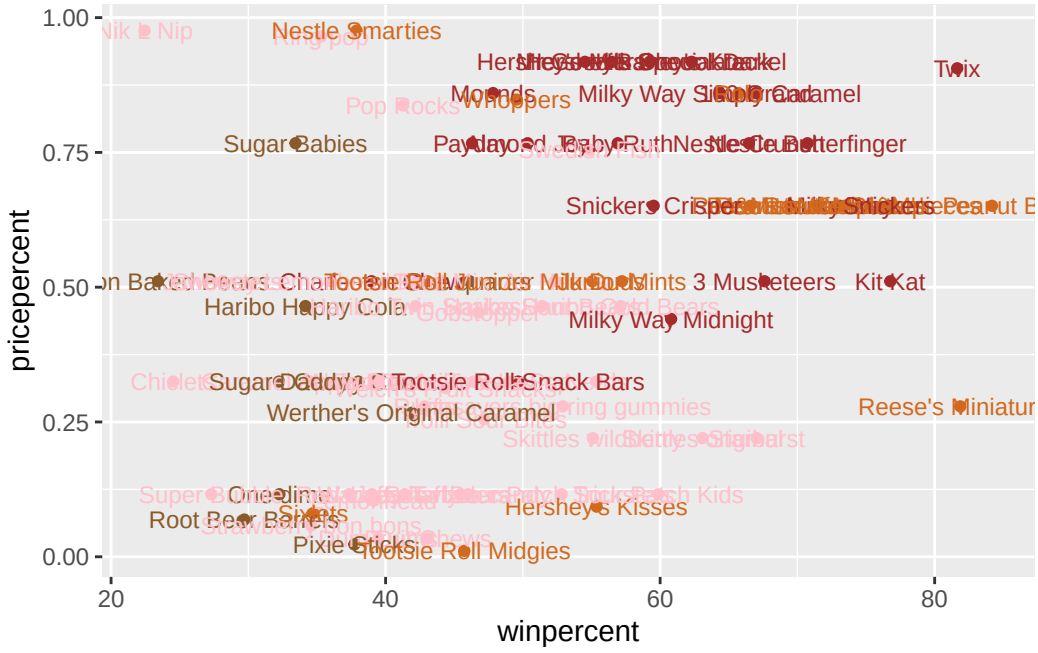
Q18. What is the best ranked fruity candy?

Starburst

Pricepercent

```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text(col=my_cols, size=3.3, max.overlaps = 5)
```

```
Warning in geom_text(col = my_cols, size = 3.3, max.overlaps = 5): Ignoring
unknown parameters: `max.overlaps`
```

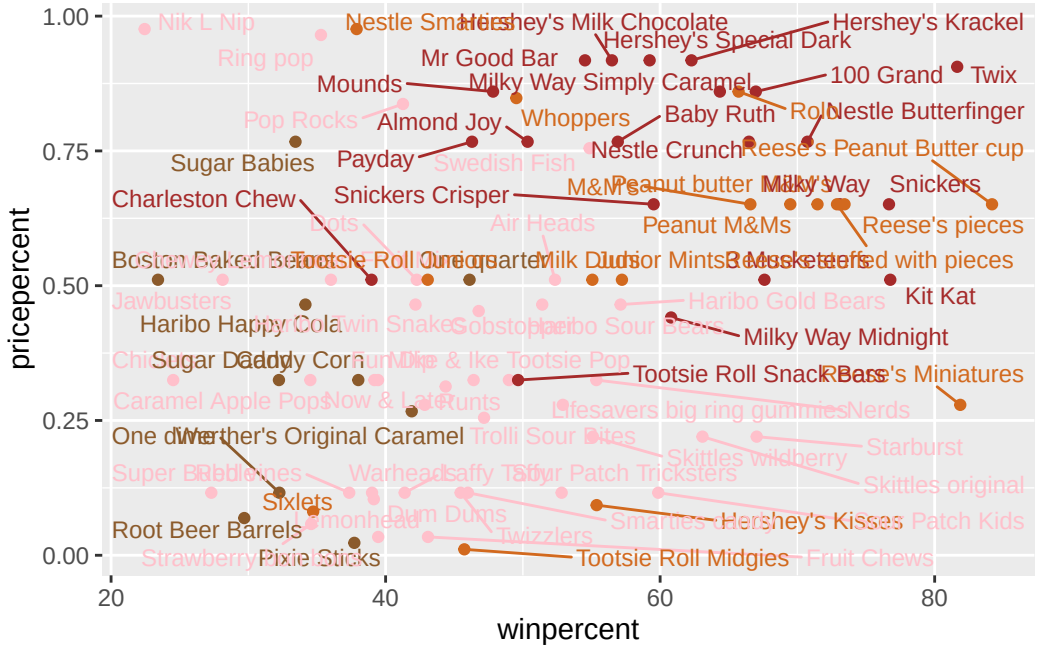


There are too many labels in this plot; let's use ggrepel to solve the problem.

```
library(ggrepel)

# How about a plot of price vs win
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=3, max.overlaps=20)
```

```
Warning: ggrepel: 1 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?

Tootsie Roll Midgies

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

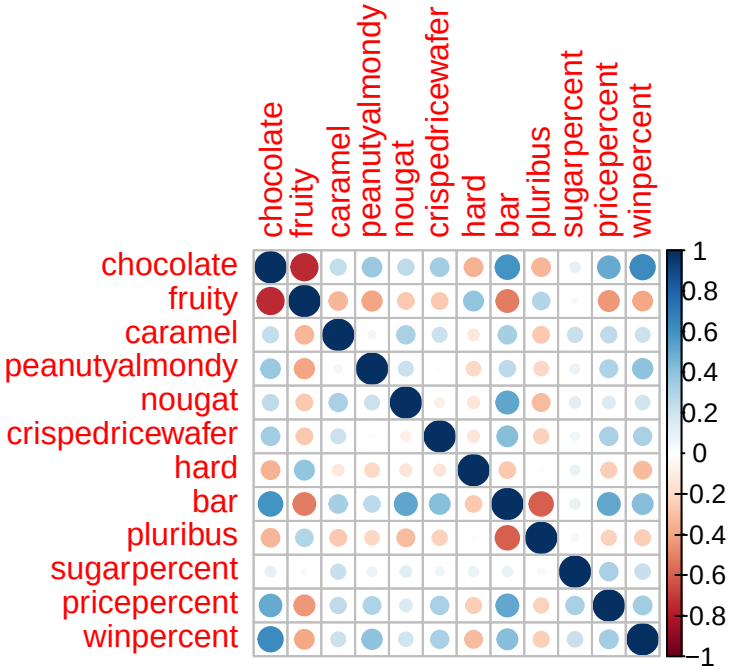
Nik L Nip, Nestle Smarties, Ring pop, Mr Good Bar, and Hershey's special dark. Nik L Nip is the least popular.

5 Exploring the correlation

```
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

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

Chocolate and bar

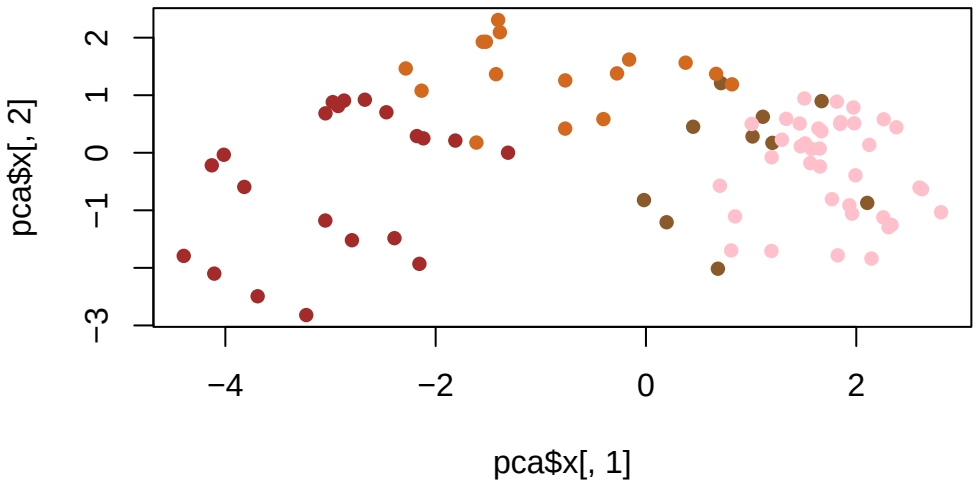
Principal component analysis

Do we need to scale the data before 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
```

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



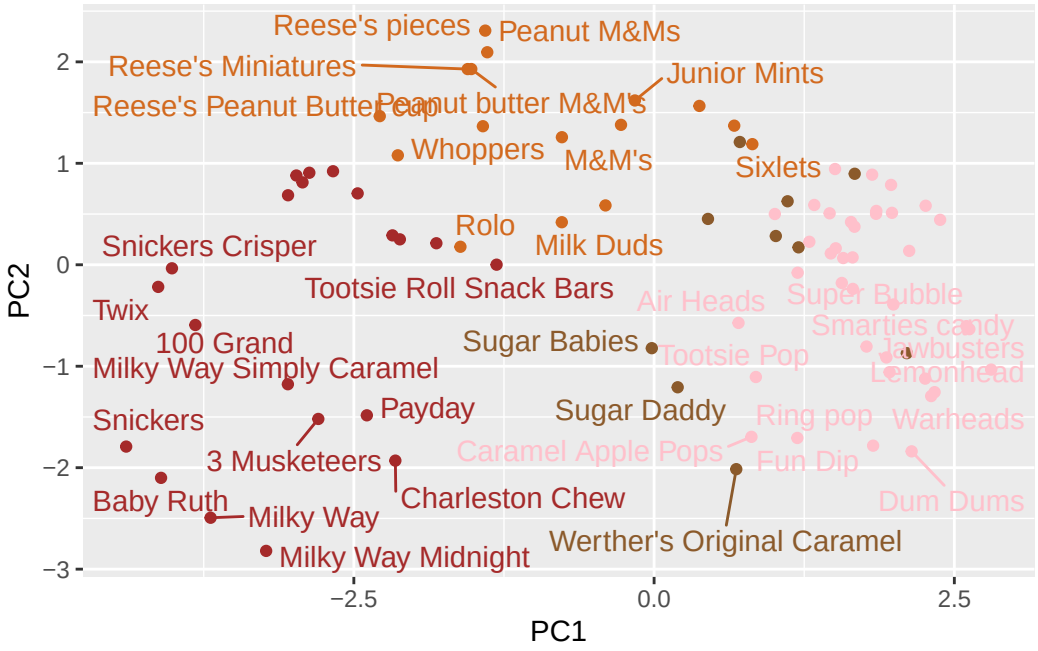
Making a ggplot version of this figure:

```
my_data <- cbind(candy, pca$x[,1:3])
head(my_data)
```

```
             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        PC1
100 Grand       0   1        0        0.732        0.860   66.97173 -3.8198617
3 Musketeers    0   1        0        0.604        0.511   67.60294 -2.7960236
One dime        0   0        0        0.011        0.116   32.26109  1.2025836
One quarter     0   0        0        0.011        0.511   46.11650  0.4486538
Air Heads       0   0        0        0.906        0.511   52.34146  0.7028992
Almond Joy      0   1        0        0.465        0.767   50.34755 -2.4683383
                    PC2        PC3
100 Grand    -0.5935788 -2.1863087
3 Musketeers -1.5196062  1.4121986
One dime      0.1718121  2.0607712
One quarter   0.4519736  1.4764928
Air Heads    -0.5731343 -0.9293893
Almond Joy    0.7035501  0.8581089
```

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

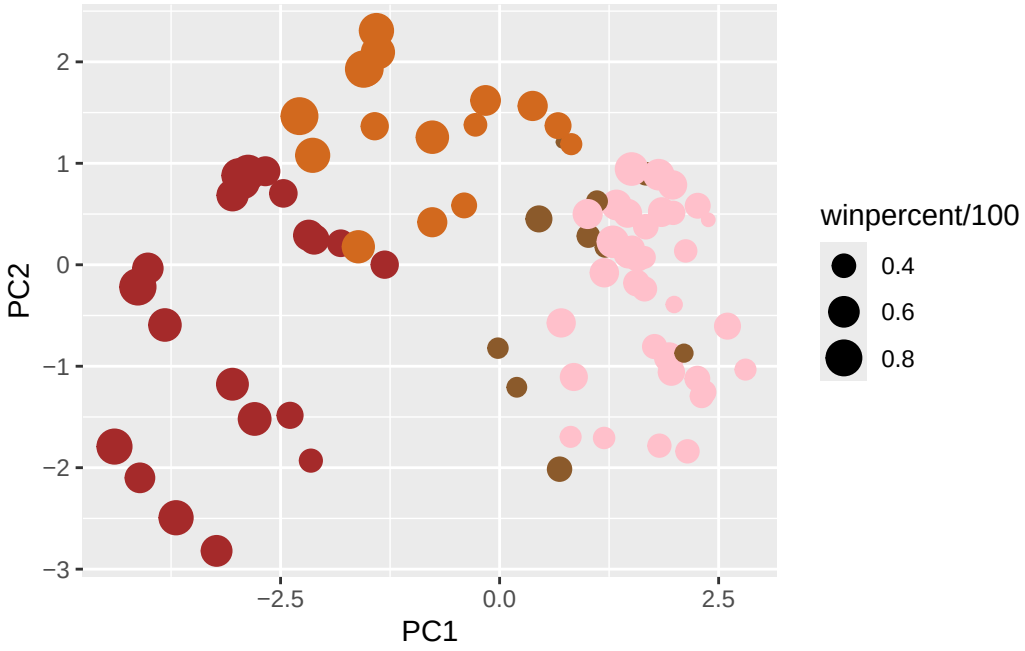
```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Make this a bit nicer

```
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
```




```
#library(plotly)
#ggplotly(p)
```

How to the original variables contribute to out PCs? for this we look at the loadings component of our results object i.e. the `pca$rotation` object.

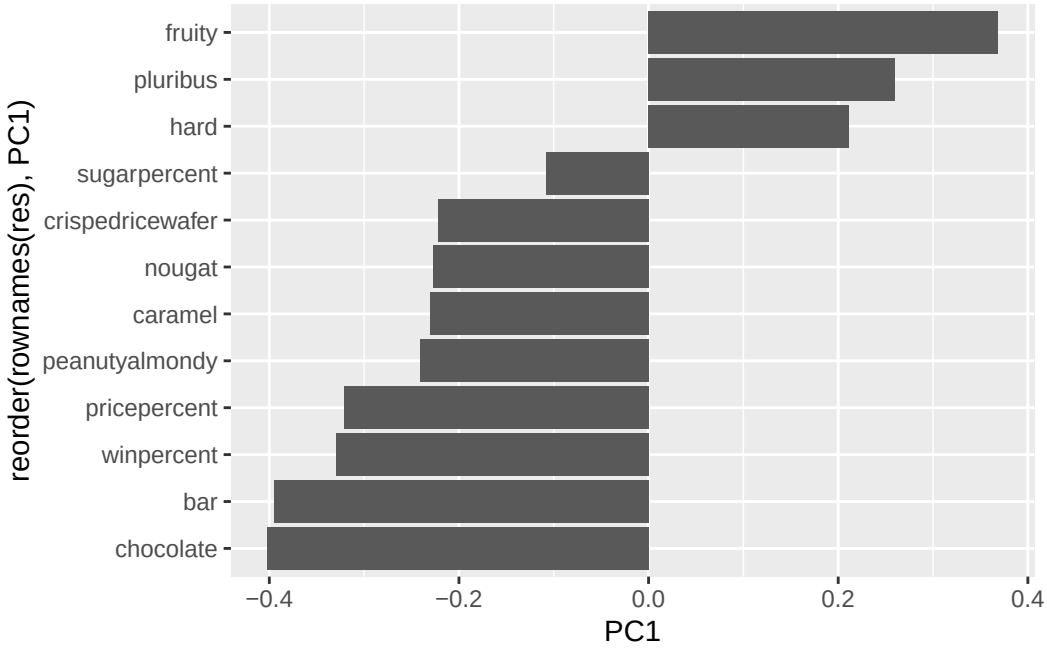
```
head(pca$rotation)
```

```
                    PC1         PC2         PC3          PC4         PC5
chocolate     -0.4019466  0.21404160  0.01601358 -0.016673032  0.06603585
fruity         0.3683883 -0.18304666 -0.13765612 -0.004479829  0.14353533
caramel       -0.2299709 -0.40349894 -0.13294166 -0.024889542 -0.50730150
peanutyalmondy -0.2407155  0.22446919  0.18272802  0.466784287  0.39993025
nougat        -0.2268102 -0.47016599  0.33970244  0.299581403 -0.18885242
crispedricewafer -0.2215182  0.09719527 -0.36485542 -0.605594730  0.03465232
                    PC6         PC7        PC8          PC9         PC10
chocolate     -0.09018950 -0.08360642 -0.4908486 -0.151651568  0.10766136
fruity        -0.04266105  0.46147889  0.3980580 -0.001248306  0.36206250
caramel       -0.40346502 -0.44274741  0.2696345  0.019186442  0.22979901
peanutyalmondy -0.09416259 -0.25710489  0.4577145  0.381068550 -0.14591236
nougat         0.09012643  0.36663902 -0.1879396  0.385278987  0.01132345
crispedricewafer -0.09007640  0.13077042  0.1356774  0.511634999 -0.26481014
```

```
                     PC11       PC12
chocolate         0.1004528 0.69784924
fruity            0.1749490 0.50624242
caramel           0.1351582 0.07548984
peanutyalmondy    0.1124428 0.12972756
nougat           -0.3895447 0.09223698
crispedricewafer -0.2261562 0.11727369
```

```
res <- as.data.frame(pca$rotation)

ggplot(res) +
  aes(PC1, reorder(rownames(res), PC1)) +
  geom_col()
```



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

Fruit, pluribus, and hard are picked up by PC1 in the positive direction. These make sense to me because these characteristics usually appear together in a candy product.