Class09: Candy Analysis Mini Project

McKenzie Mai (A16646664)

In today's class we will examine some data about andy from the 538 website.

Import Data

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

Data Exploration

```
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?

There are 85 in this dataset

```
nrow(candy)
```

```
[1] 85
```

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

There are 38 fruity candy types.

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

```
[1] 38
```

My favorite candy vs yours

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

```
[1] 76.67378
```

```
candy["Welch's Fruit Snacks",]$winpercent
```

```
[1] 44.37552
```

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

```
[1] 39.0119
```

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
```

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

The winpercent variable is on a different scale.

```
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	

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

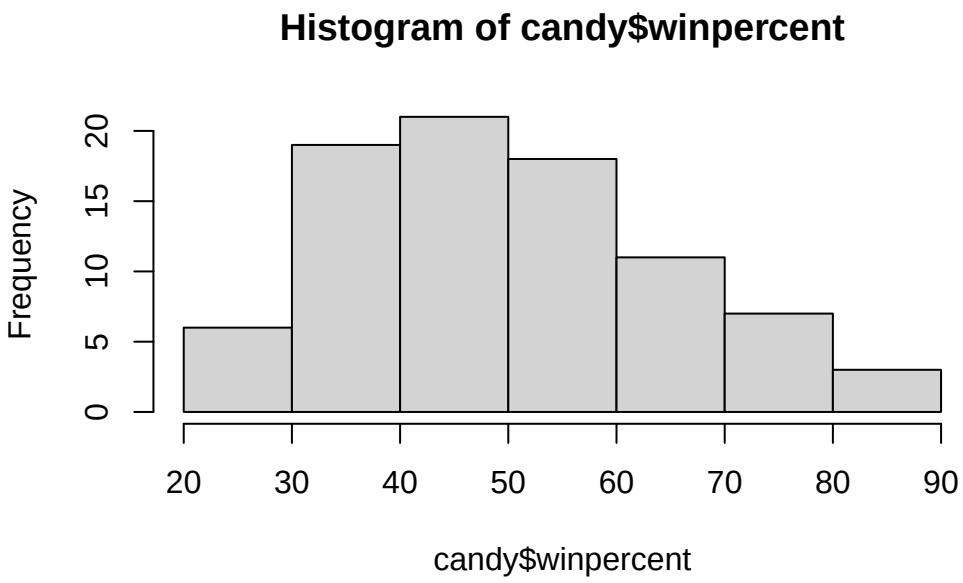
0 represents no chocolate in the candy and 1 represents chocolate being in the candy.

```
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
```

Q8. Plot a histogram of winpercent values

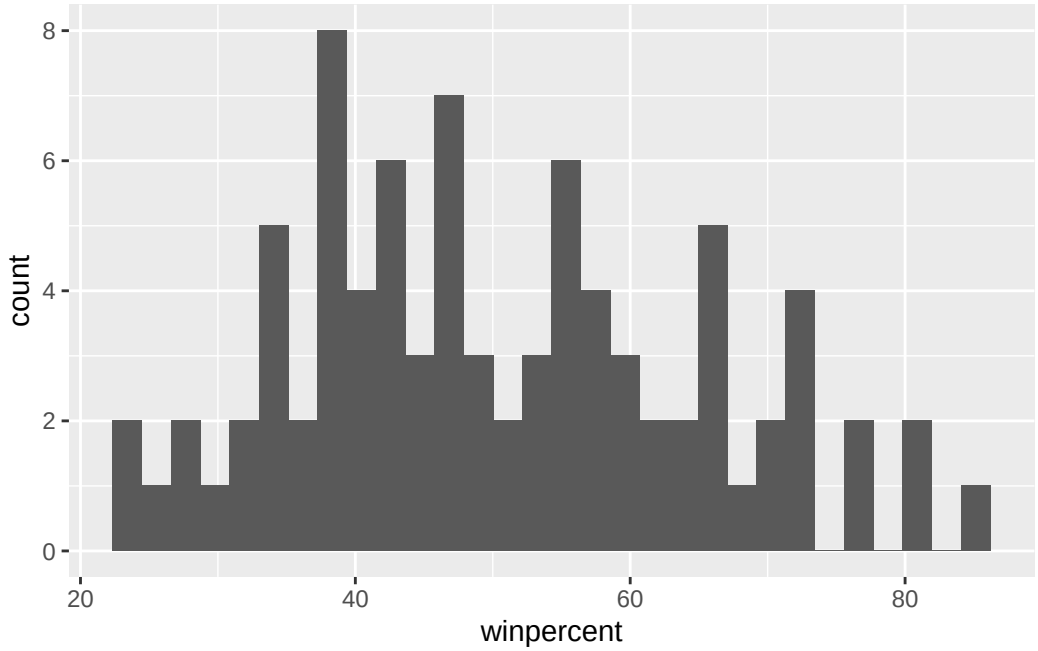
```
hist(candy$winpercent)
```



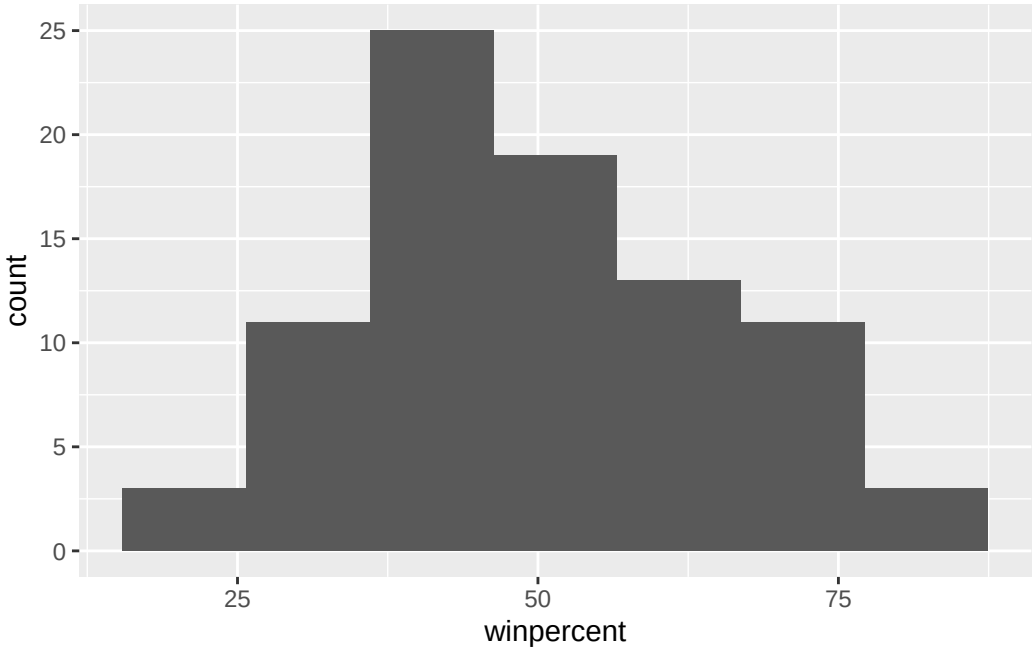
```
library(ggplot2)
```

```
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, it is slightly skewed to the left.

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

Below

```
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 
```

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

- first find all chocolate candy
- find their winpercent values
- calculate the mean

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

```
[1] 60.92153
```

- then do the same for fruity candy and compare with the mean for chocolate candy

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

```
[1] 44.11974
```

Chocolate is ranked higher than fruity candy.

Q12. Is this difference statistically significant?

```
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
```

Yes

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

```
x <- c(5, 6, 4)
sort(x)
```

```
[1] 4 5 6
```

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

```
[1] 4 5 6
```

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

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

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

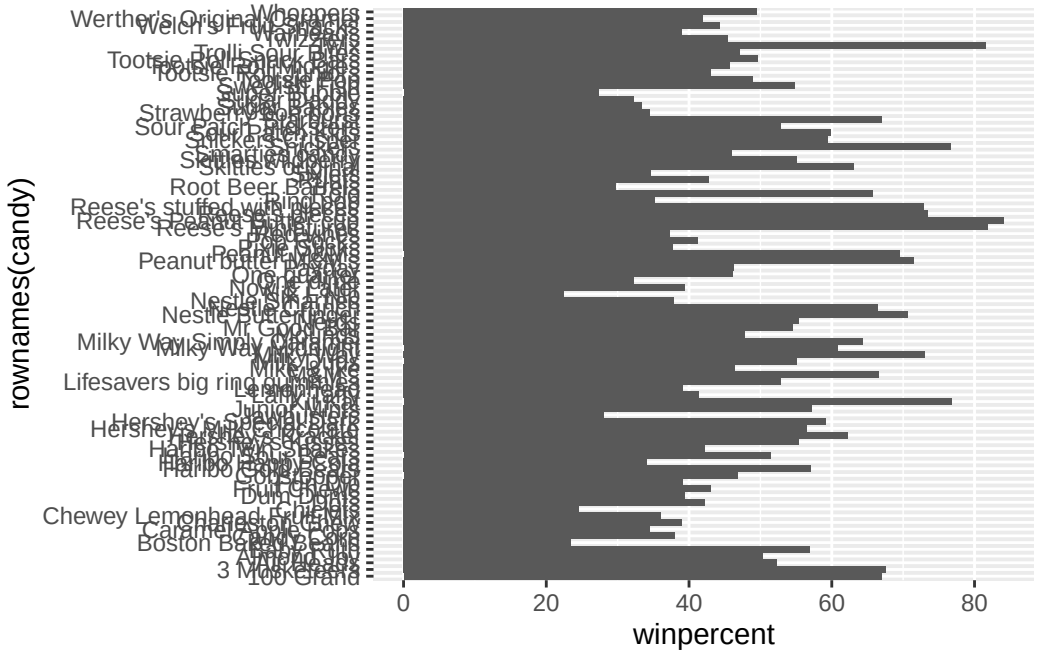
```
tail(candy[inds,], 5)
```

```
                        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.

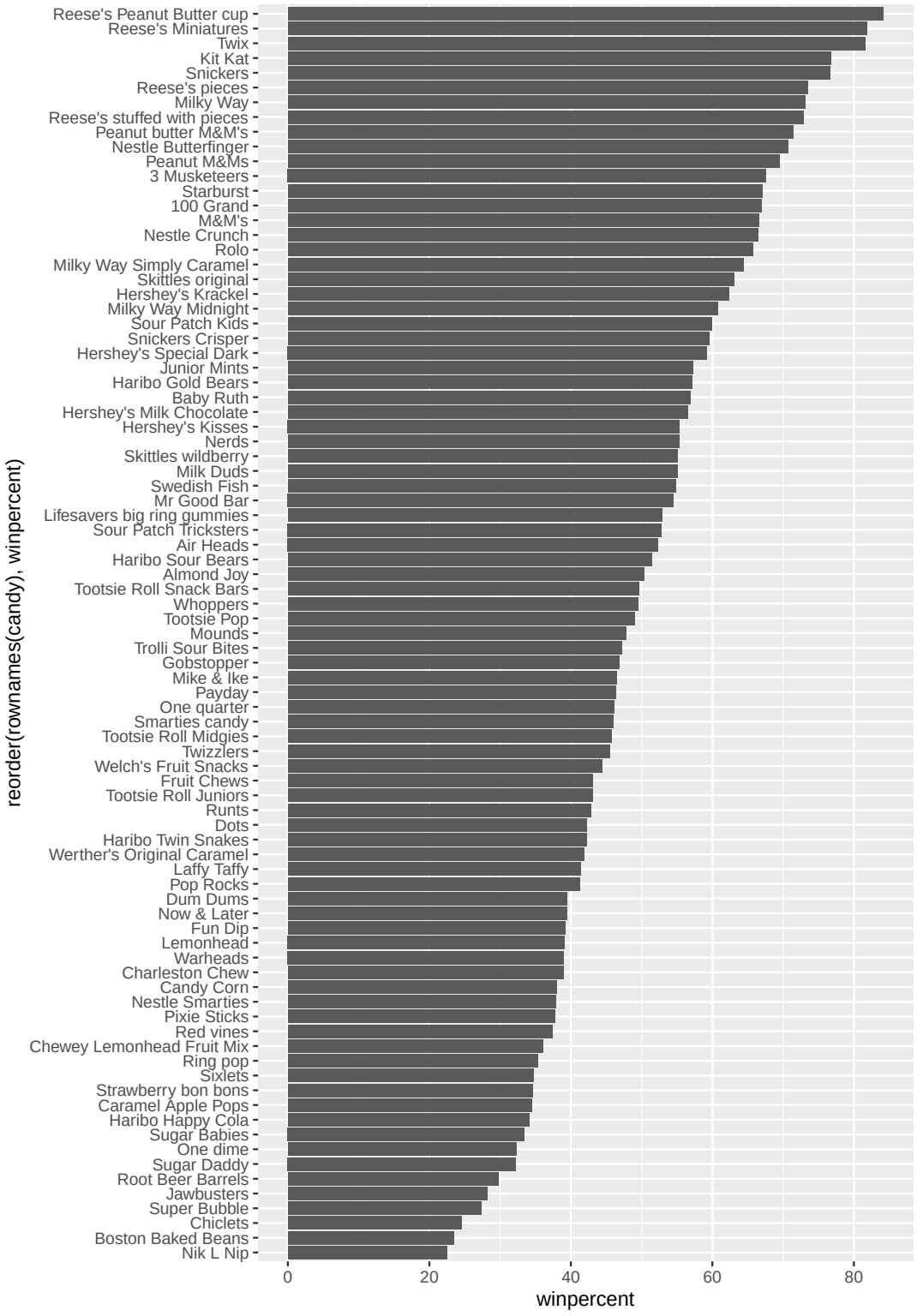
```
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col()
```



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
```

Add my cutom colors to my barplot

```
my_cols=rep("gray", nrow(candy))
my_cols[candy$fruity == 1] <- "pink"
my_cols
```

```
 [1] "gray" "gray" "gray" "gray" "pink" "gray" "gray" "gray" "gray" "pink"
[11] "gray" "pink" "pink" "pink" "pink" "pink" "pink" "pink" "pink" "gray"
[21] "pink" "pink" "gray" "gray" "gray" "gray" "pink" "gray" "gray" "pink"
[31] "pink" "pink" "gray" "gray" "pink" "gray" "gray" "gray" "gray" "gray"
[41] "gray" "pink" "gray" "gray" "pink" "pink" "gray" "gray" "gray" "pink"
[51] "pink" "gray" "gray" "gray" "gray" "pink" "gray" "gray" "pink" "gray"
[61] "pink" "pink" "gray" "pink" "gray" "gray" "pink" "pink" "pink" "pink"
[71] "gray" "gray" "pink" "pink" "pink" "gray" "gray" "gray" "pink" "gray"
[81] "pink" "pink" "pink" "gray" "gray"
```

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

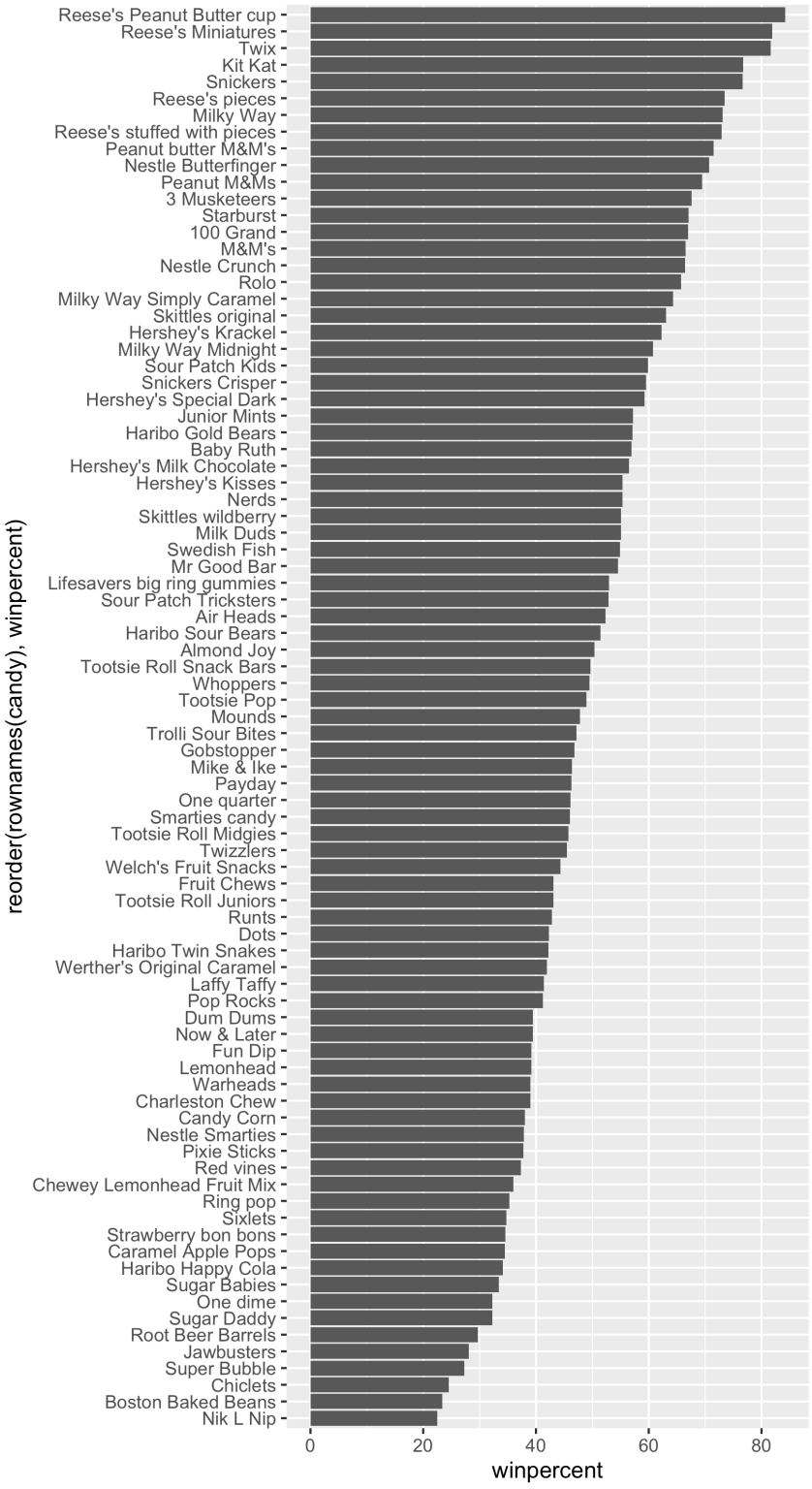
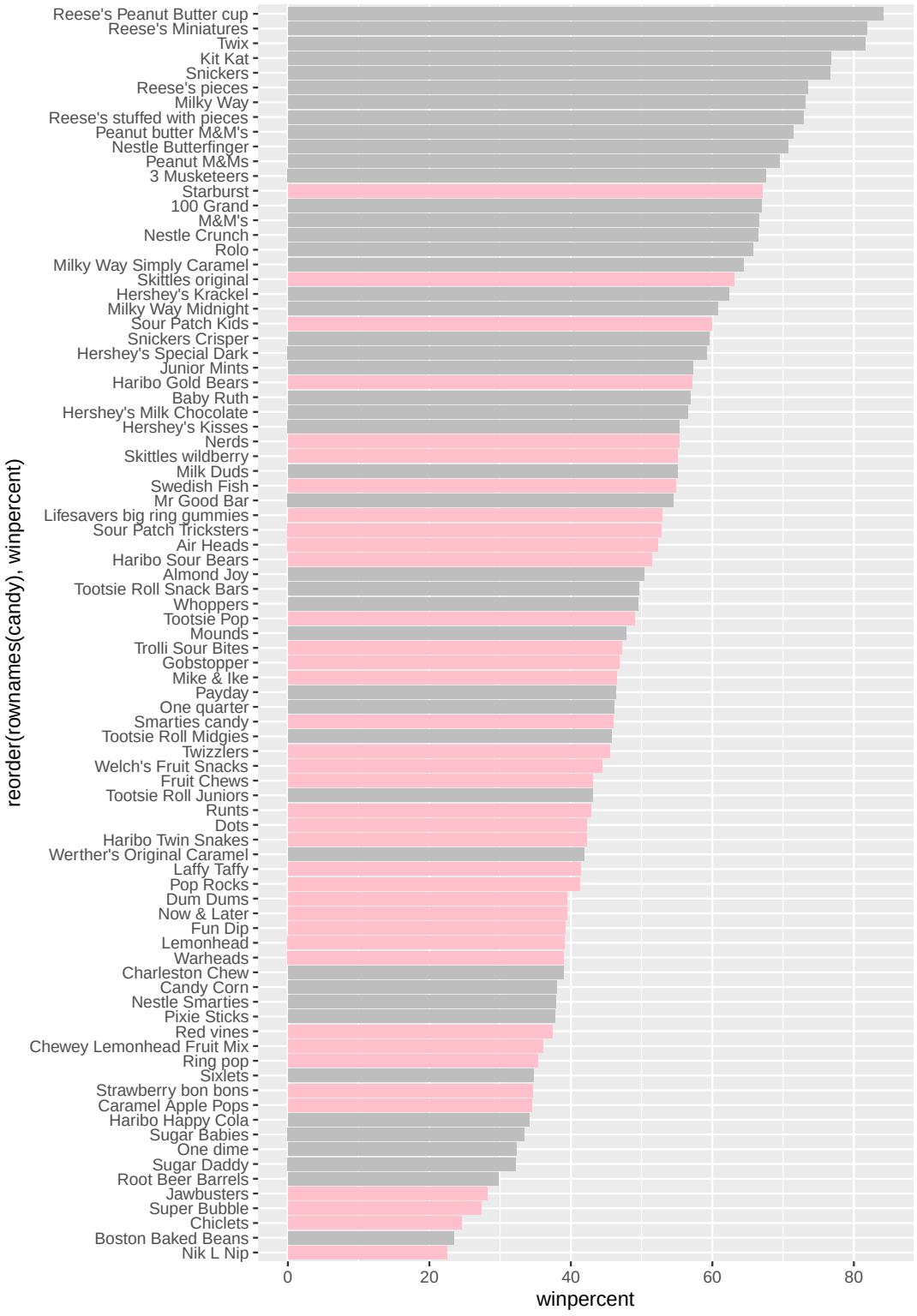
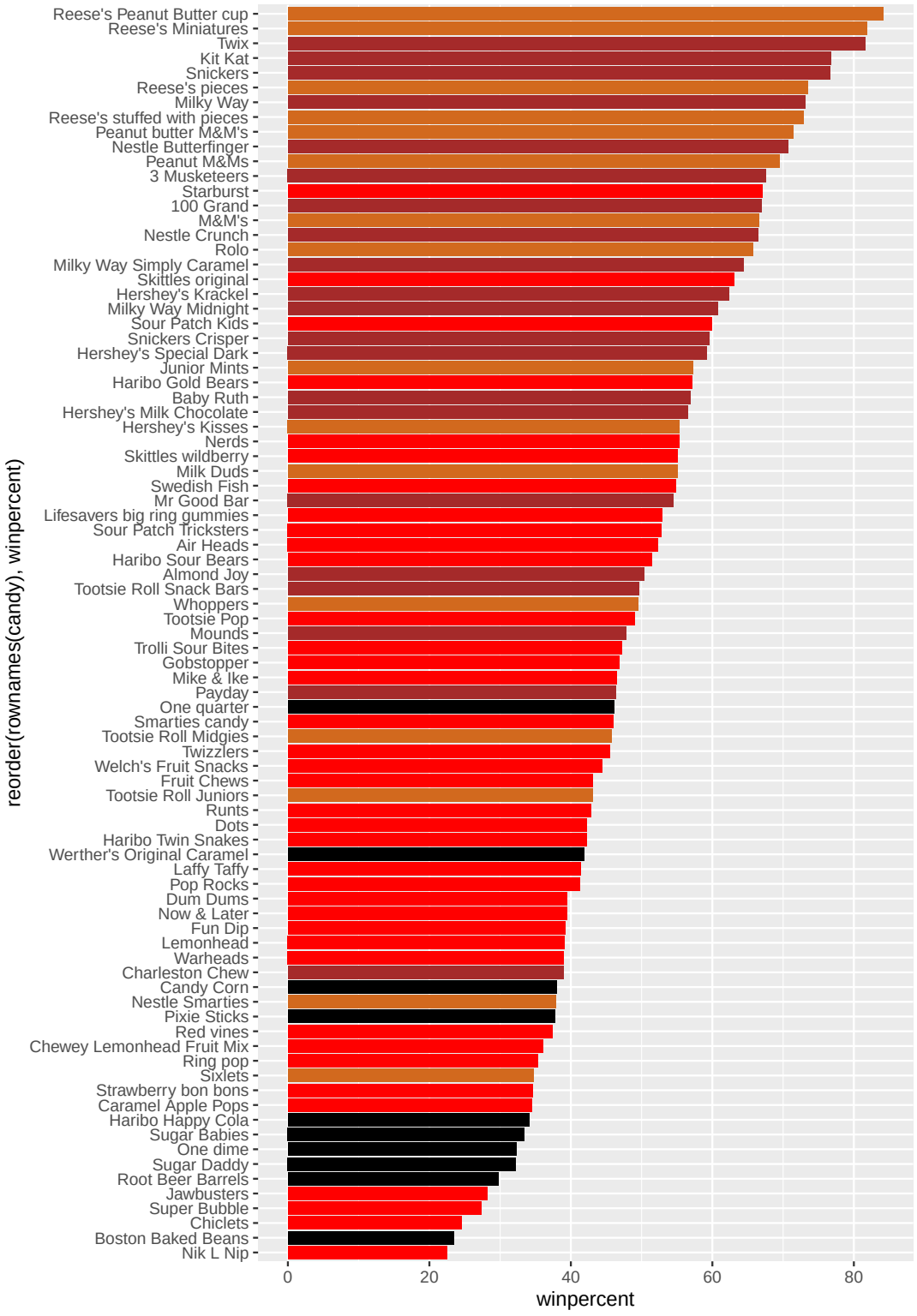


Figure 1: Exported image that is a bit bigger so I can read it


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

```
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)] = "red"
```

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


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
reorder(rownames(candy), winpercent)
0
20
40
60
80
winpercent

Q17. What is the worst ranked chocolate candy?

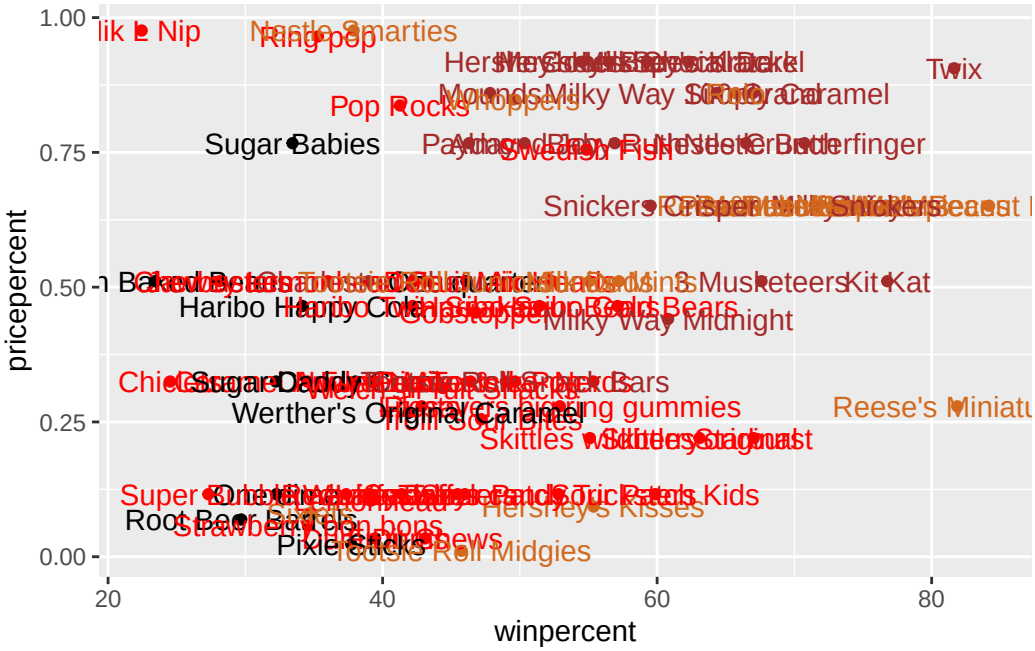
Sixlets

Q18. What is the best ranked fruity candy?

Starburst

Plot of winpercent vs pricepercent

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



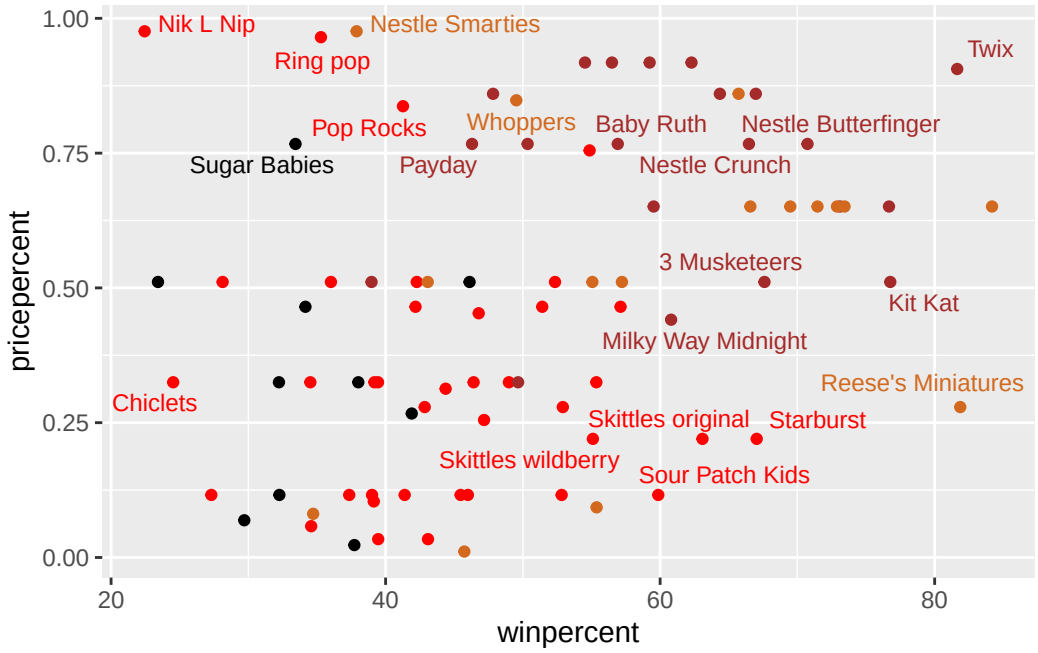
There are just too many labels in this above plot to be readable. We can use the `ggrepel` package to do a better job og placing lavels so they minimize text overlap.

```
library(ggrepel)

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

```
    geom_text_repel(col=my_cols, size=3.3, max.overlaps = 5)
```

```
Warning: ggrepel: 65 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



5 Exploring the correlation structure

```
  library(corrplot)
```

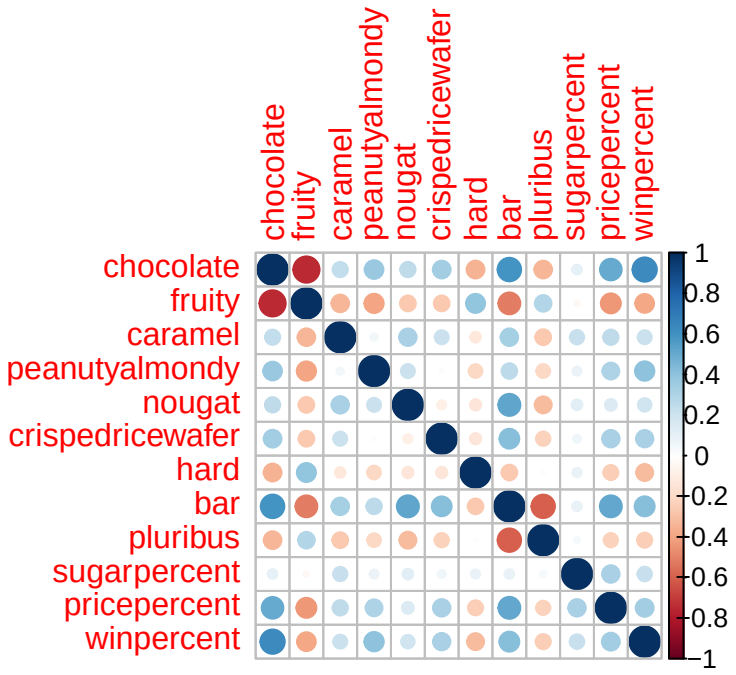
```
corrplot 0.92 loaded
```

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

```
                 chocolate      fruity     caramel peanutyalmondy      nougat
chocolate        1.0000000 -0.74172106  0.24987535     0.37782357  0.25489183
fruity          -0.7417211  1.00000000 -0.33548538    -0.39928014 -0.26936712
```

```
caramel            0.2498753 -0.33548538  1.00000000     0.05935614  0.32849280
peanutyalmondy     0.3778236 -0.39928014  0.05935614     1.00000000  0.21311310
nougat             0.2548918 -0.26936712  0.32849280     0.21311310  1.00000000
crispedricewafer   0.3412098 -0.26936712  0.21311310    -0.01764631 -0.08974359
hard              -0.3441769  0.39067750 -0.12235513    -0.20555661 -0.13867505
bar                0.5974211 -0.51506558  0.33396002     0.26041960  0.52297636
pluribus          -0.3396752  0.29972522 -0.26958501    -0.20610932 -0.31033884
sugarpercent       0.1041691 -0.03439296  0.22193335     0.08788927  0.12308135
pricepercent       0.5046754 -0.43096853  0.25432709     0.30915323  0.15319643
winpercent         0.6365167 -0.38093814  0.21341630     0.40619220  0.19937530
                  crispedricewafer        hard         bar    pluribus
chocolate              0.34120978 -0.34417691  0.59742114 -0.33967519
fruity                -0.26936712  0.39067750 -0.51506558  0.29972522
caramel                0.21311310 -0.12235513  0.33396002 -0.26958501
peanutyalmondy        -0.01764631 -0.20555661  0.26041960 -0.20610932
nougat                -0.08974359 -0.13867505  0.52297636 -0.31033884
crispedricewafer       1.00000000 -0.13867505  0.42375093 -0.22469338
hard                  -0.13867505  1.00000000 -0.26516504  0.01453172
bar                    0.42375093 -0.26516504  1.00000000 -0.59340892
pluribus              -0.22469338  0.01453172 -0.59340892  1.00000000
sugarpercent           0.06994969  0.09180975  0.09998516  0.04552282
pricepercent           0.32826539 -0.24436534  0.51840654 -0.22079363
winpercent             0.32467965 -0.31038158  0.42992933 -0.24744787
                  sugarpercent pricepercent winpercent
chocolate           0.10416906    0.5046754  0.6365167
fruity             -0.03439296   -0.4309685 -0.3809381
caramel             0.22193335    0.2543271  0.2134163
peanutyalmondy      0.08788927    0.3091532  0.4061922
nougat              0.12308135    0.1531964  0.1993753
crispedricewafer    0.06994969    0.3282654  0.3246797
hard                0.09180975   -0.2443653 -0.3103816
bar                 0.09998516    0.5184065  0.4299293
pluribus            0.04552282   -0.2207936 -0.2474479
sugarpercent        1.00000000    0.3297064  0.2291507
pricepercent        0.32970639    1.0000000  0.3453254
winpercent          0.22915066    0.3453254  1.0000000
```

```
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 bar; chocolate and winpercent

6. Principal Component Analysis

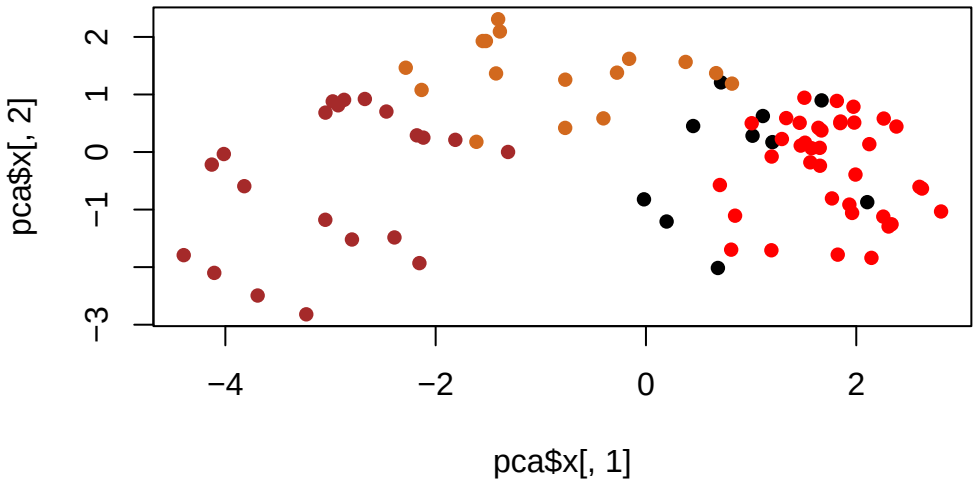
We will perform a PCA of the candy. Key-question: do we need to scale the data before PCA?

```
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)
```



Make a ggplot version of this figure:

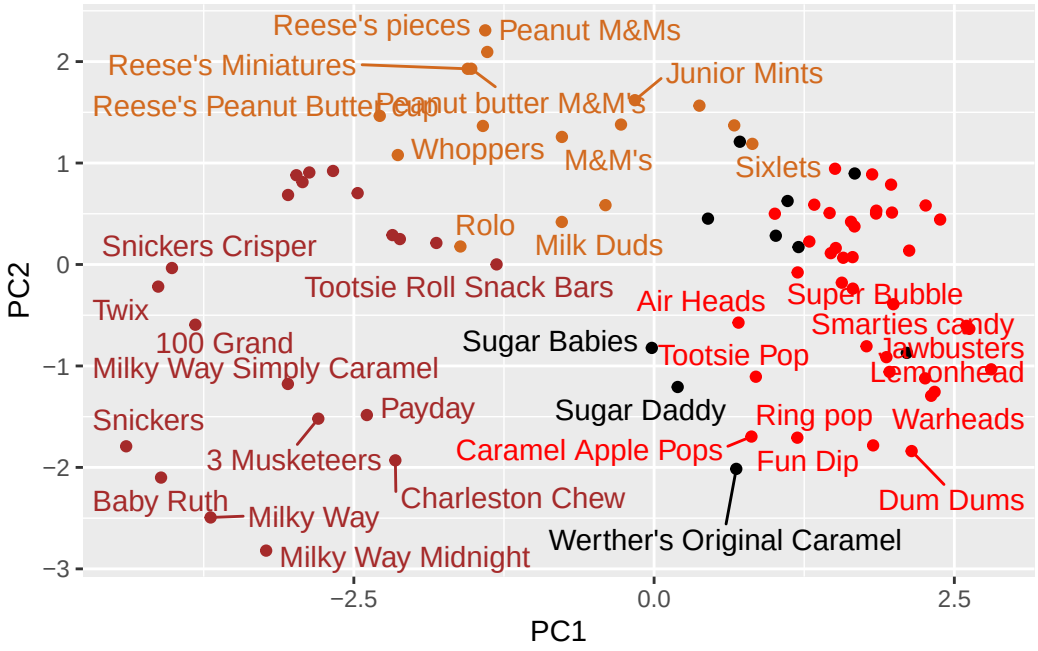
```
# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, pca$x[,1:3])
head(my_data)
```

```
              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(x=PC1, y=PC2, label=rownames(my_data)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols)
```

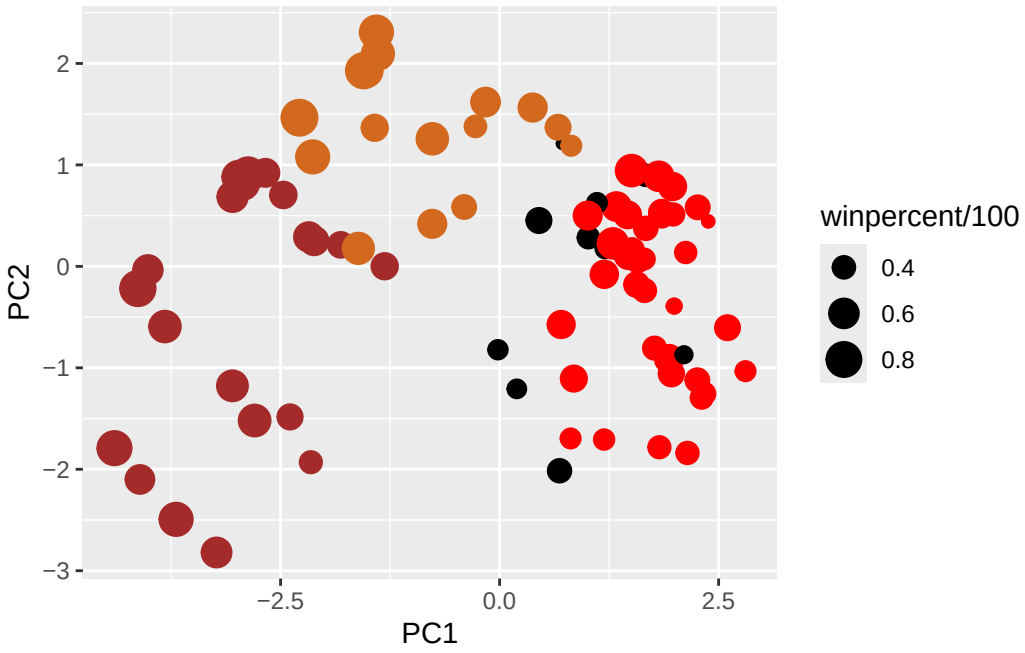
```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Make this a bit nicer

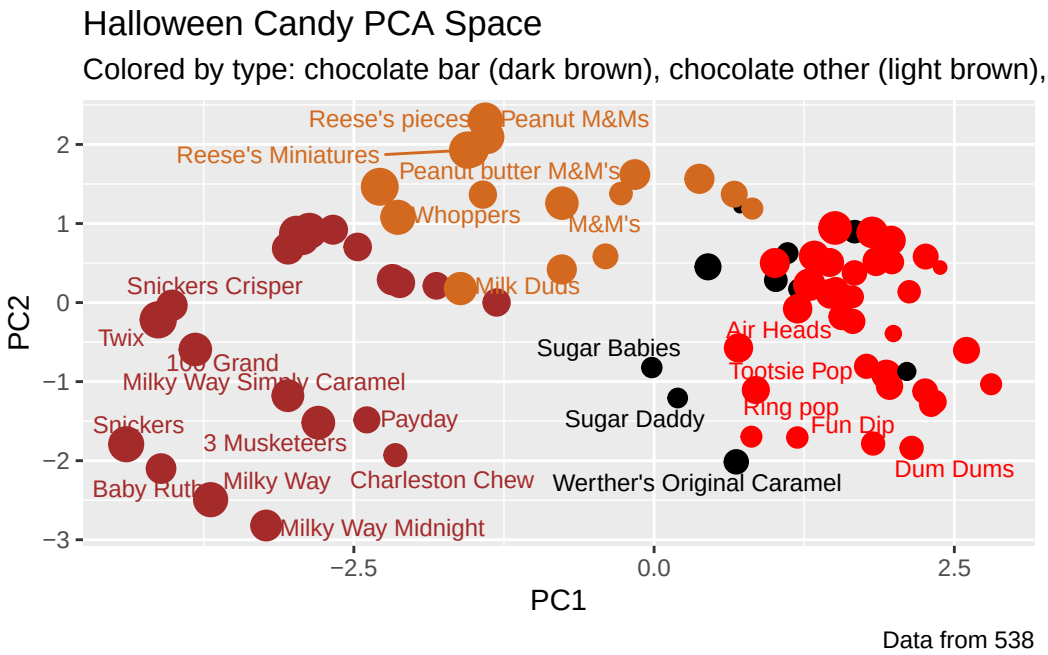
```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p
```




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




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

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

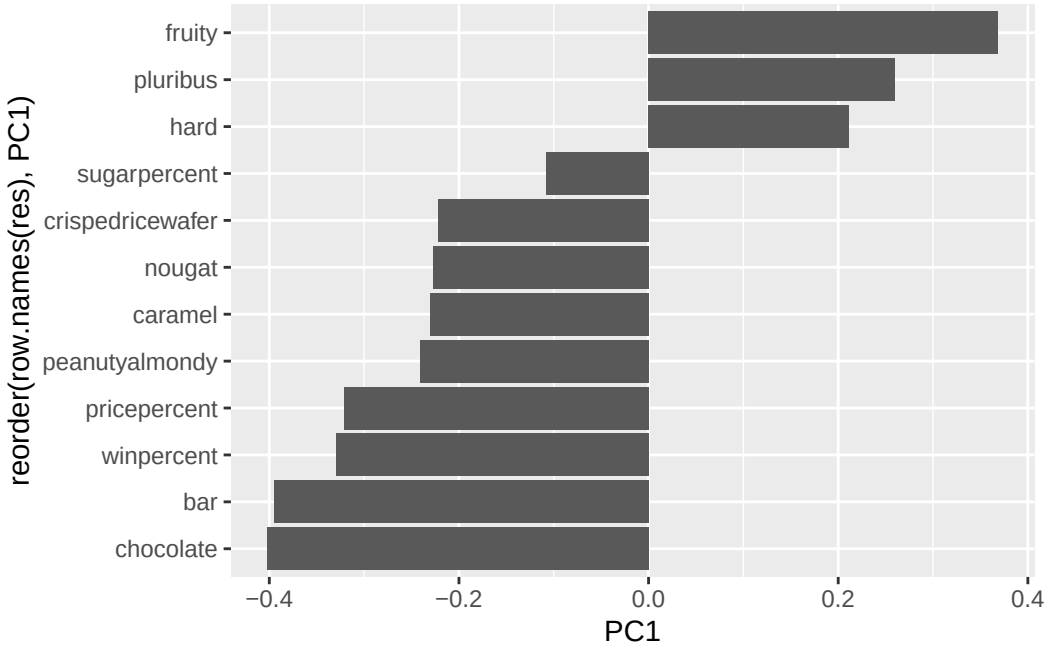
```
head(pca$rotation[,1])
```

```
     chocolate          fruity         caramel   peanutyalmondy 
    -0.4019466      0.3683883     -0.2299709      -0.2407155 
        nougat crispedricewafer 
    -0.2268102     -0.2215182 
```

Make a barplot with ggplot and order the bars by their value. Recall that you need a data.frame as input for ggplot

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

ggplot(res) +
  aes(PC1, reorder(row.names(res), PC1)) +
  geom_col()
```



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

fruity, pluribus, and hard are all picked up in the positive direction and these do make sense based on the correlation structure in the dataset. If you are a fruity candy you will tend to be hard and come in a packet with multiple candys in it (pluribus).