Halloween_mini_project

Angie Zhou(PID:69028746)

2024-02-07

1. Importing candy data

```
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?

A1. There are 85 different candy types are in this dataset

```
dim(candy)
```

```
[1] 85 12
```

```
nrow(candy)
```

```
[1] 85
```

```
# How many variables/dimensions are there?
ncol(candy)
```

```
[1] 12
```

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

A2. There are 38 fruity candy types

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

```
[1] 38
```

2. What is your favorate candy?

data exploration

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

A3. My favorite candy is Snickers, its winpercent value is 76.67378.

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

```
[1] 76.67378
```

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")
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?

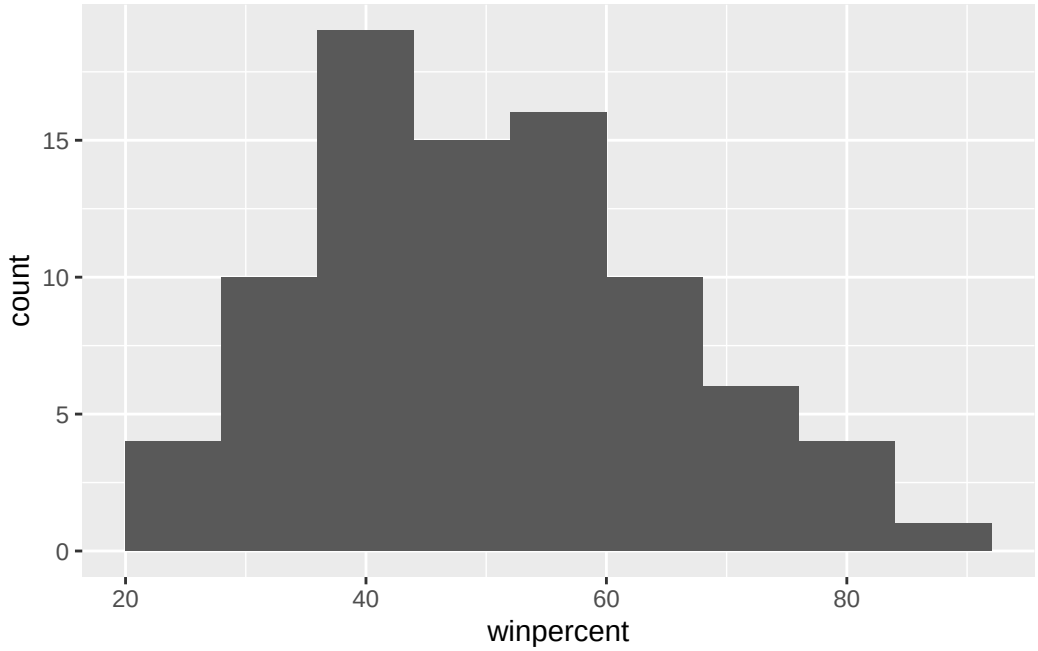
A6. Yes. The "winpercent" looks to be on a different scale. The mean value for "winpercent" is 50.32 with a sd of 14.71, which indicates a relatively wide spread of values around the mean.

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

A7. In the candy$chocolate column, a zero and one represent binary values indicating the presence or absence of chocolate in the respective candies. 0: Indicates that the candy does not contain chocolate. 1: Indicates that the candy contains chocolate

Q8. Plot a histogram of winpercent values

```
library(ggplot2)
ggplot(candy) +
  aes(winpercent) +
  geom_histogram(binwidth = 8)
```



Q9. Is the distribution of winpercent values symmetrical?

A9. No

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

A10. 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
```

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

A11. Chocolate candy(60.92) is higher ranked than fruity candy(44.11).

- first find all chocolate candy (subset)
- get their winpercent values
- summarize these values into one metric
- do the same for fruity candy and compare

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

A12. Yes. A very low p-value=2.871e-08 (close to zero) suggests that the observed difference is 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
```

3. Overall Candy Rankings

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

A13. The five least liked candy types are Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, Jawbusters

```
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?

A14. The top 5 all time favorite candy types are Snickers, Kit Kat, Twix, Reese's Miniatures, Reese's Peanut Butter cup

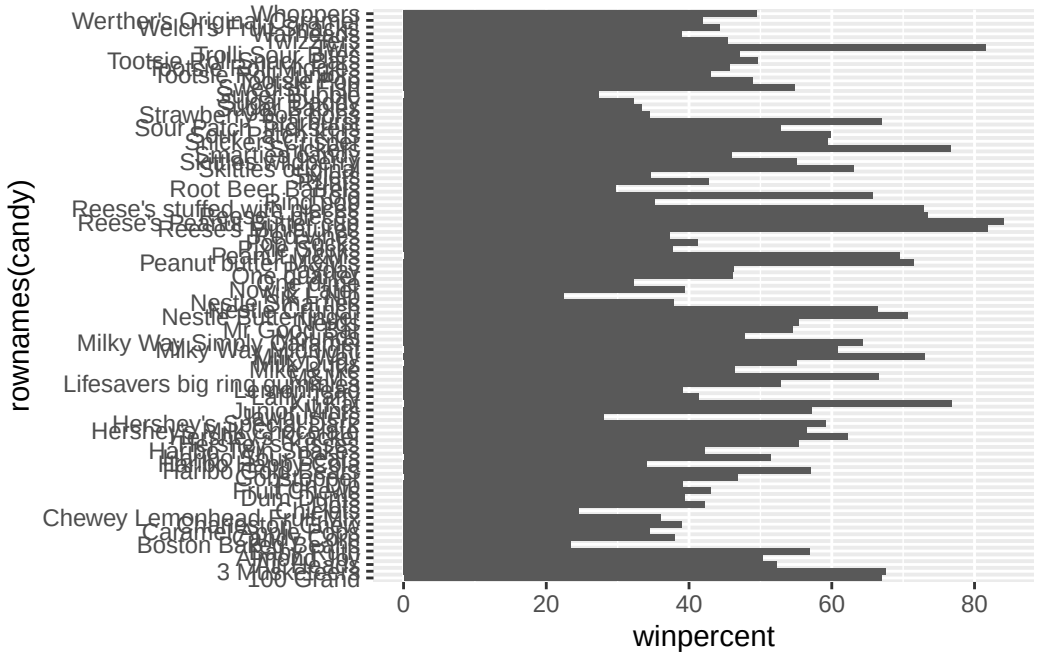
```
inds <- order(candy$winpercent)
tail(candy[inds,], n=5)
```

```
                        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.

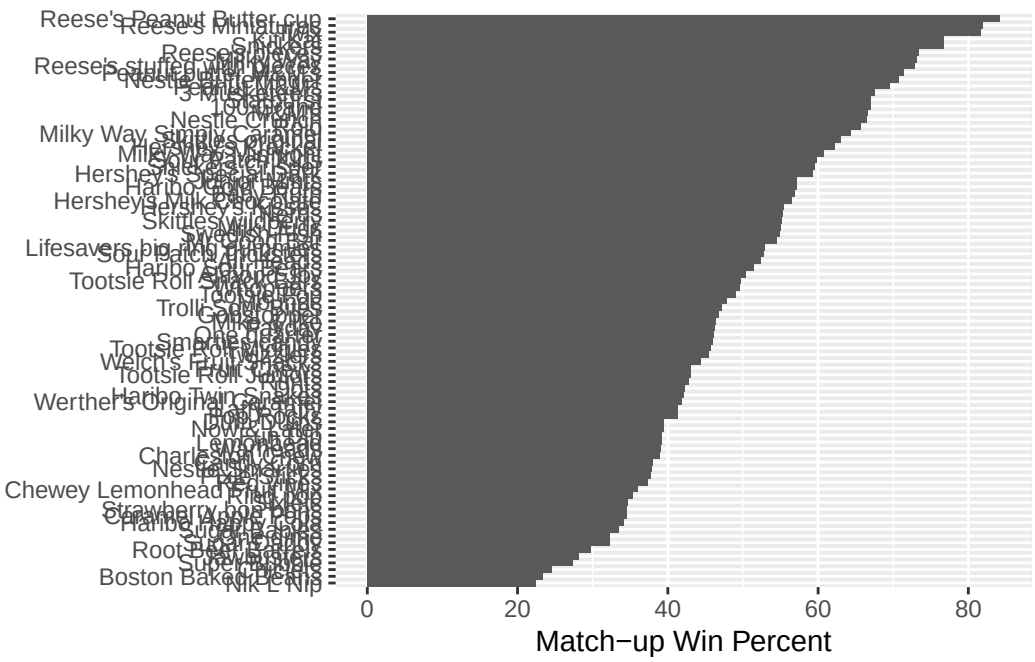
```
library(ggplot2)
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col()
```



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

winpercent?

```
library(ggplot2)
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col()+
  labs(x="Match-up Win Percent", y=NULL)
```




```
ggsave("barplot1.png", height = 10, width = 7)
```

we can now insert any image using markdown syntax this is ! followed by [] and then ()

Q17. What is the worst ranked chocolate candy?

A17. The worst ranked chocolate candy is Sixlets

```
chocolate_candies <- candy[candy$chocolate == 1, ]
worst_ranked_chocolate <- chocolate_candies[which.min(chocolate_candies$winpercent), ]
worst_ranked_chocolate
```

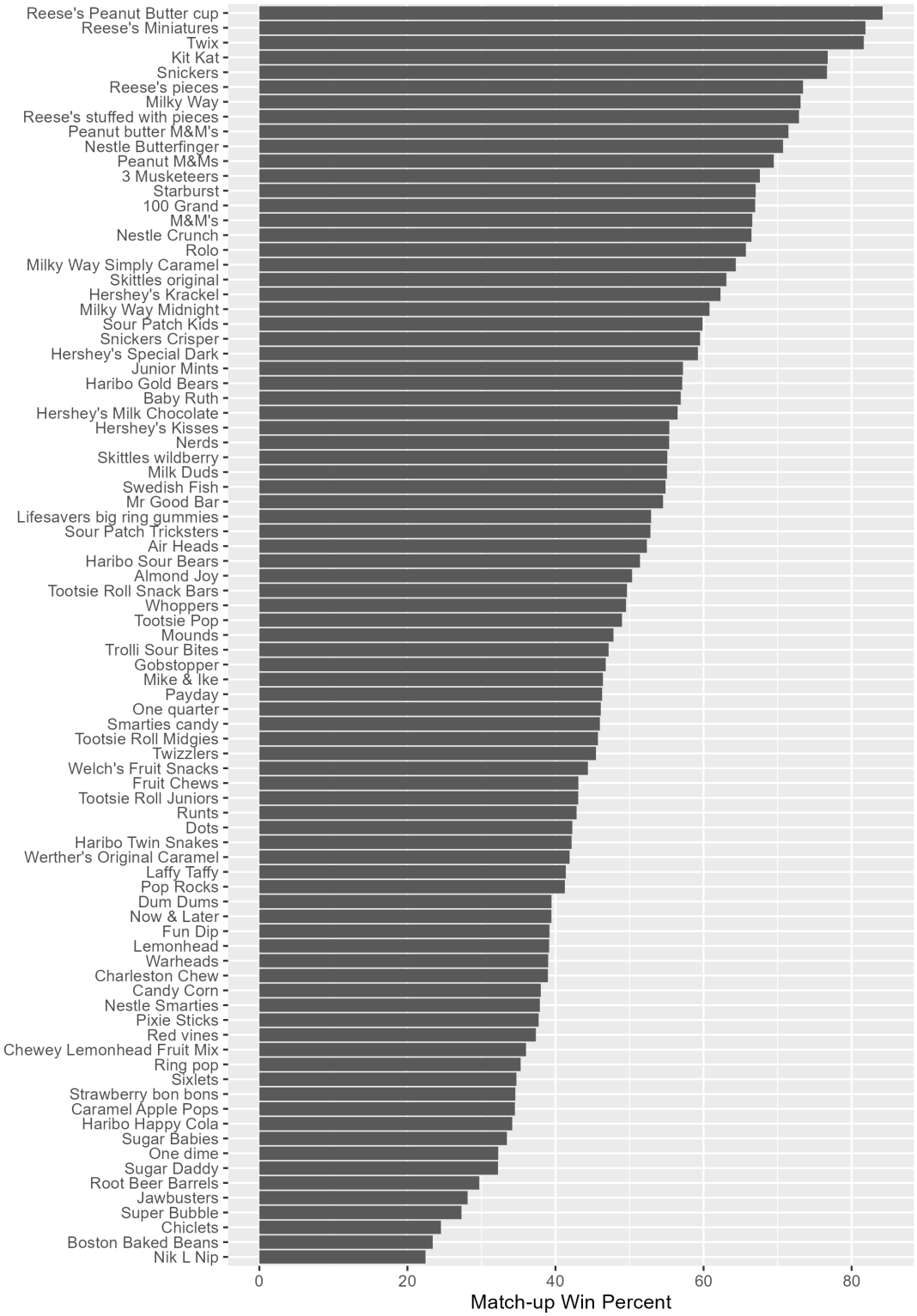
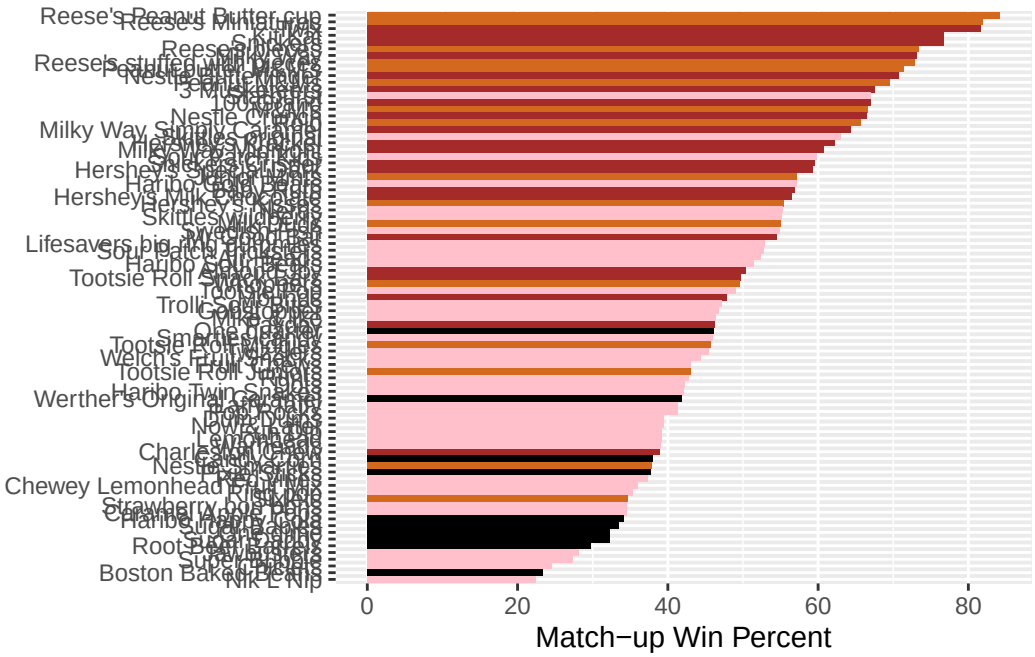

Reese's Peanut Butter cup
Reese's Miniatures
Twix
Kit Kat
Snickers
Reese's pieces
Milky Way
Reese's stuffed with pieces
Peanut butter M&M's
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&M's
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
Hershey's Krackel
Milky Way 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
Match-up Win Percent

Figure 1: xxx

```
        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
```

```
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)+
    labs(x="Match-up Win Percent", y=NULL)
```




```
ggsave("barplot2.png", height = 10, width = 7)
```

As shown in Figure 2 and Figure 1, xxxx

Q18. What is the best ranked fruity candy?

A18. The best ranked fruity candy is Starburst.

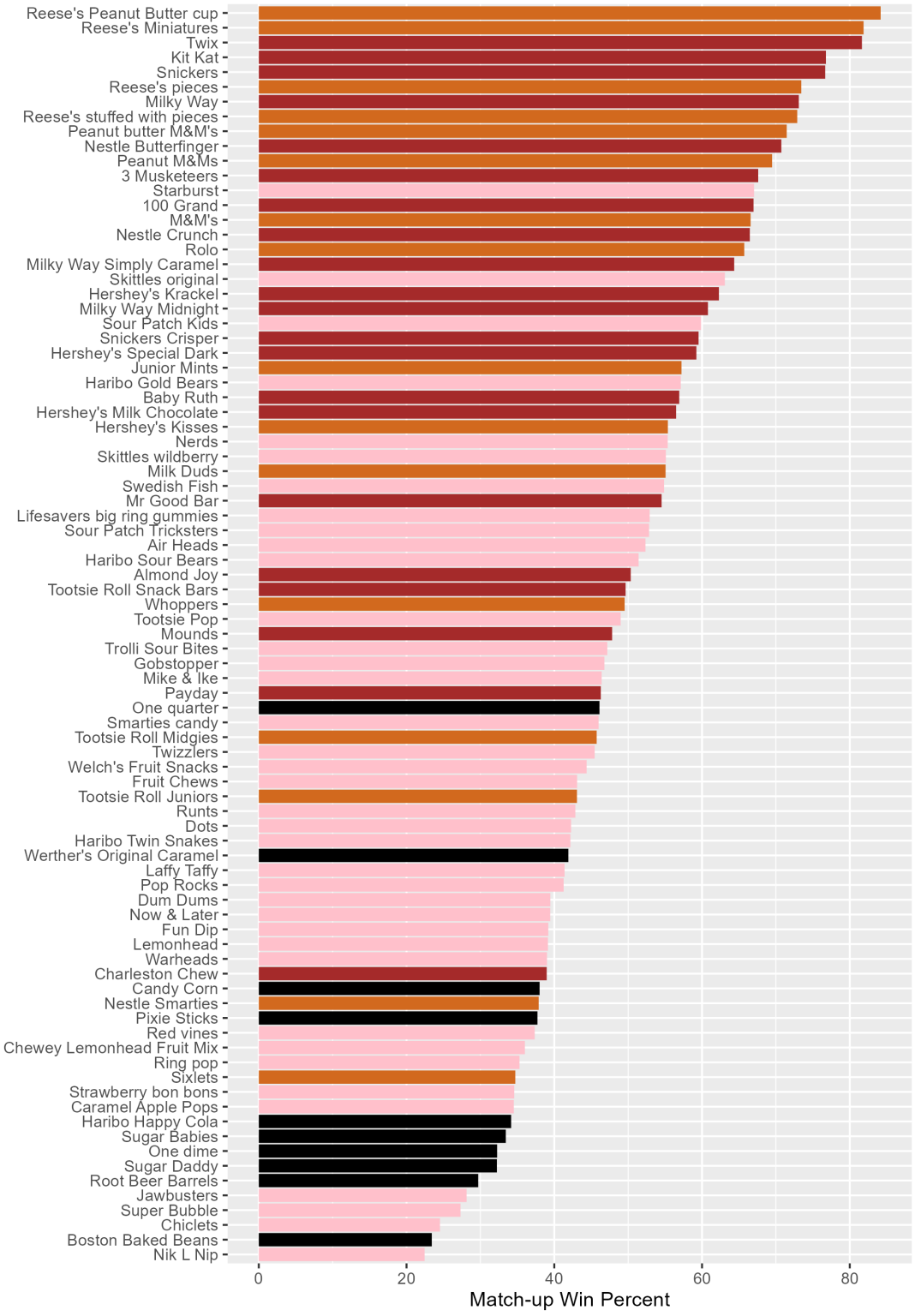


Figure 2: This is some caption text

```
fruity_candies <- candy[candy$fruity == 1, ]
best_ranked_fruity <- fruity_candies[which.max(fruity_candies$winpercent), ]
best_ranked_fruity
```

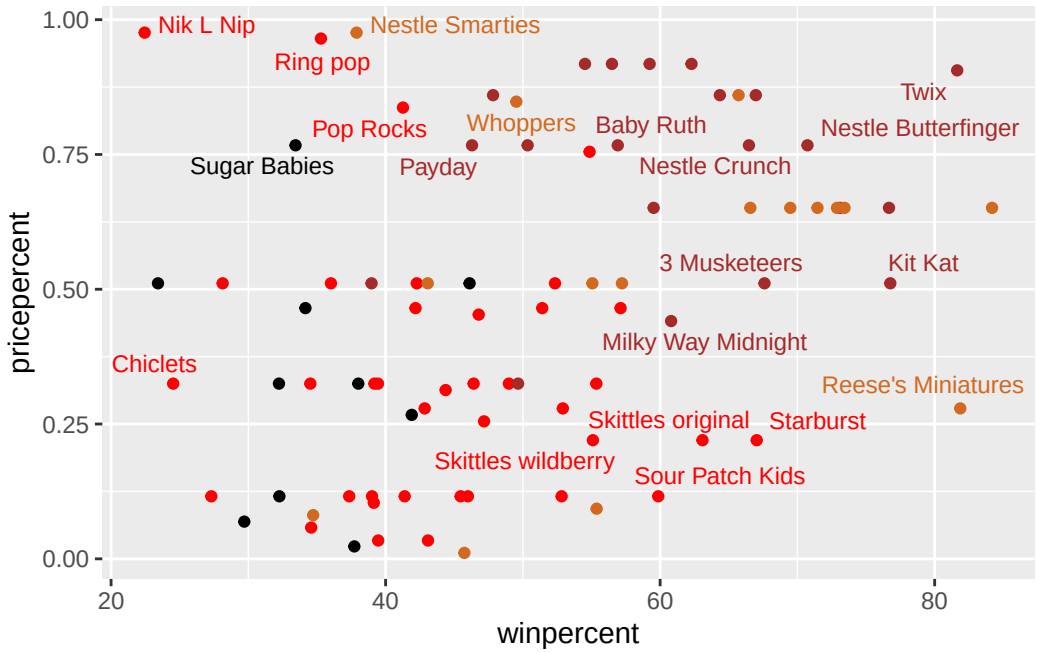
```
          chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Starburst         0      1       0              0      0                 0    0
          bar pluribus sugarpercent pricepercent winpercent
Starburst   0        1        0.151         0.22   67.03763
```

4. Taking a look at pricepercent

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

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
```



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?

A19. Tootsie Roll Midgies is the highest ranked in terms of winpercent for the least money

```
ord <- order(candy$pricepercent, decreasing = TRUE)
tail(candy[ord,c(11,12)], n=5 )
```

```
                  pricepercent winpercent
Strawberry bon bons        0.058   34.57899
Dum Dums                   0.034   39.46056
Fruit Chews                0.034   43.08892
Pixie Sticks               0.023   37.72234
Tootsie Roll Midgies       0.011   45.73675
```

```
win_to_price_ratio <- candy$winpercent / candy$pricepercent
best_value_candy <- candy[which.max(win_to_price_ratio), ]
best_value_candy
```

```
                chocolate fruity caramel peanutyalmondy nougat
```

```
Tootsie Roll Midgies         1      0       0              0      0
                     crispedricewafer hard bar pluribus sugarpercent
Tootsie Roll Midgies                 0    0   0        1        0.174
                     pricepercent winpercent
Tootsie Roll Midgies        0.011   45.73675
```

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

A20. The top 5 most expensive candy types are Nik L Nip, Nestle Smarties, Ring pop, Hershey's Krackel, Hershey's Milk Chocolate, and the least popular of these is Nik L Nip.

```
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
Hershey's Krackel              0.918   62.28448
Hershey's Milk Chocolate       0.918   56.49050
```

5. Exploring the correlation structure

we will calculate all Pearson correlation values

Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)?

A22. chocolate and fruity are 2 most anti-correlated variables. There are some other anti-correlated variables with minus values such as pluribus and bar, fruity and bar.

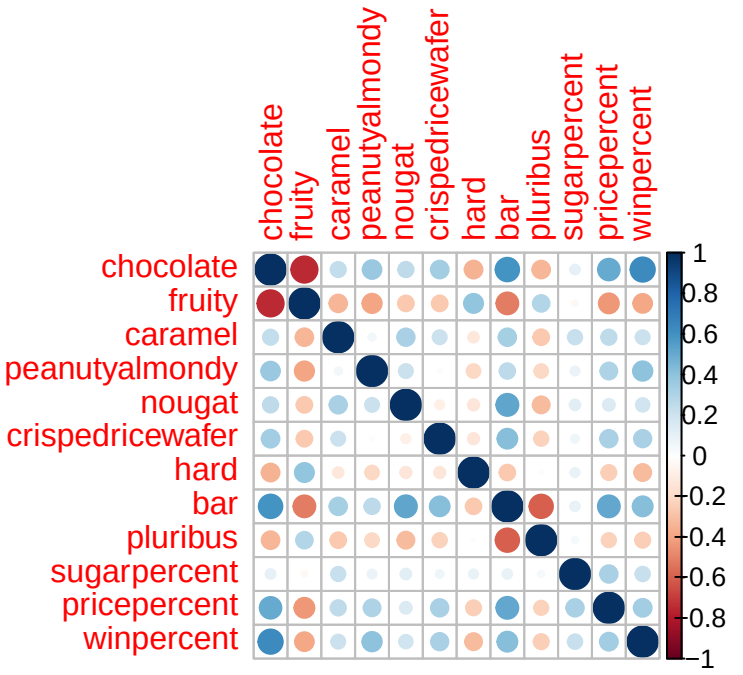
```
library(corrplot)
```

```
corrplot 0.92 loaded
```

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

```
                 chocolate     fruity     caramel peanutyalmondy      nougat
chocolate        1.0000000 -0.7417211  0.24987535     0.37782357  0.25489183
fruity          -0.7417211  1.0000000 -0.33548538    -0.39928014 -0.26936712
caramel          0.2498753 -0.3354854  1.00000000     0.05935614  0.32849280
peanutyalmondy   0.3778236 -0.3992801  0.05935614     1.00000000  0.21311310
nougat           0.2548918 -0.2693671  0.32849280     0.21311310  1.00000000
crispedricewafer 0.3412098 -0.2693671  0.21311310    -0.01764631 -0.08974359
                crispedricewafer       hard        bar   pluribus sugarpercent
chocolate             0.34120978 -0.3441769  0.5974211 -0.3396752   0.10416906
fruity               -0.26936712  0.3906775 -0.5150656  0.2997252  -0.03439296
caramel               0.21311310 -0.1223551  0.3339600 -0.2695850   0.22193335
peanutyalmondy       -0.01764631 -0.2055566  0.2604196 -0.2061093   0.08788927
nougat               -0.08974359 -0.1386750  0.5229764 -0.3103388   0.12308135
crispedricewafer      1.00000000 -0.1386750  0.4237509 -0.2246934   0.06994969
                pricepercent winpercent
chocolate          0.5046754  0.6365167
fruity            -0.4309685 -0.3809381
caramel            0.2543271  0.2134163
peanutyalmondy     0.3091532  0.4061922
nougat             0.1531964  0.1993753
crispedricewafer   0.3282654  0.3246797
```

```
corrplot(cij)
```



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

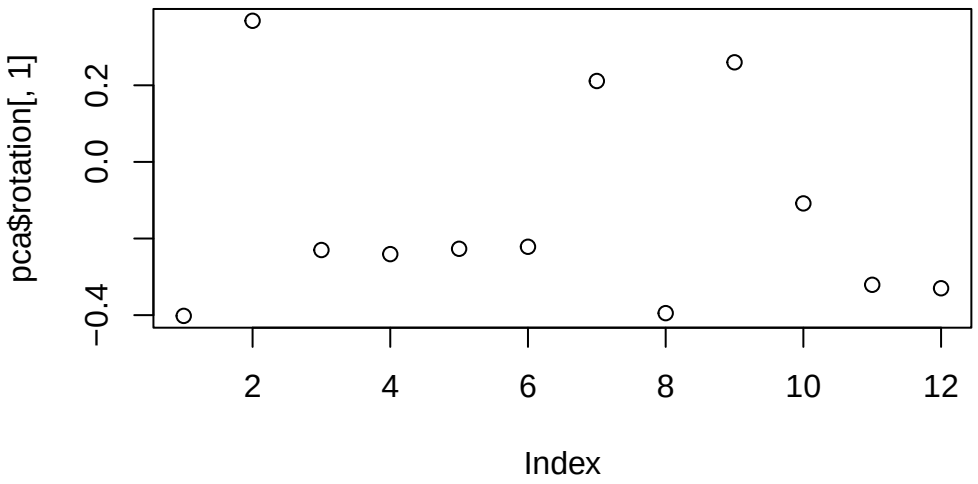
A23. Chocolate and winpercent are most positively correlated variables.

6. Principal Component Analysis

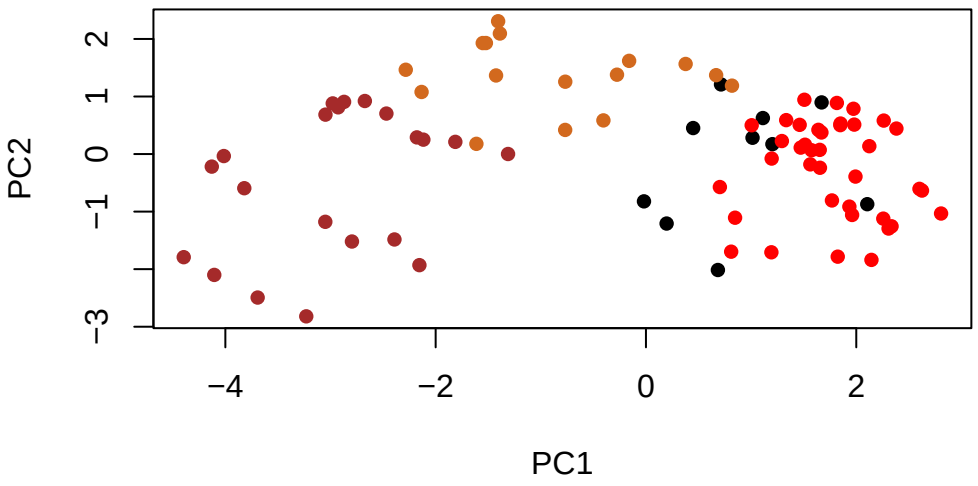
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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
```

```r
plot(pca$rotation[,1])
```



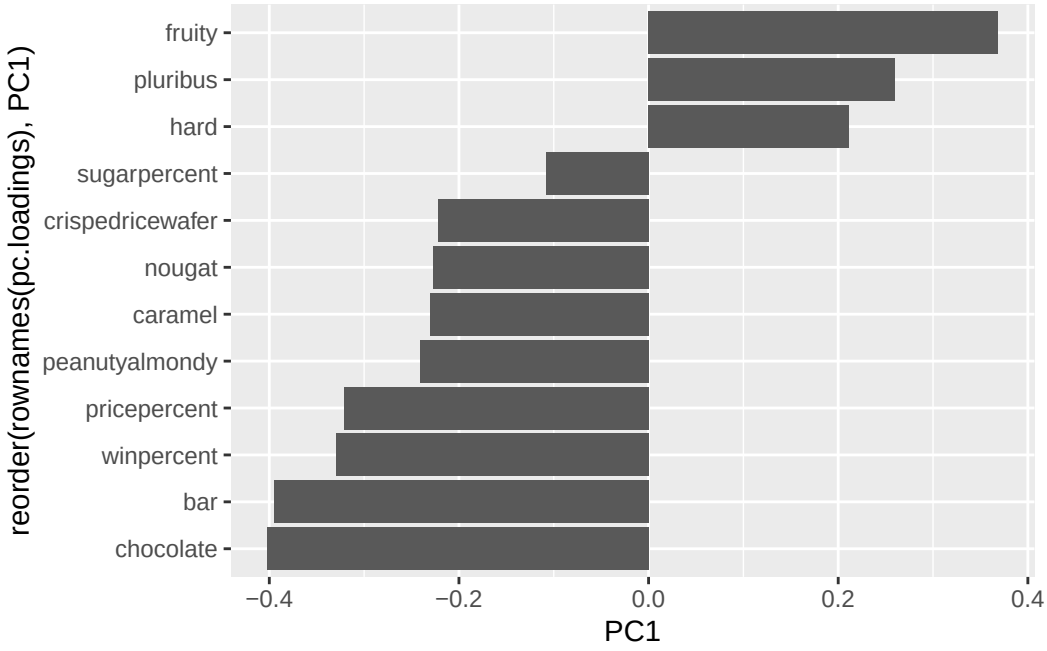

```r
plot(pca$x[,1:2], col=my_cols, pch=16)
```



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

A24. Fruity, pluribus, hard are picked up strongly by PC1 in the positive direction. These make sense to me, since they all show anti-correlated relationships with many other variants like pricepercent and winpercent which "effectively" push them to one side of the plot.

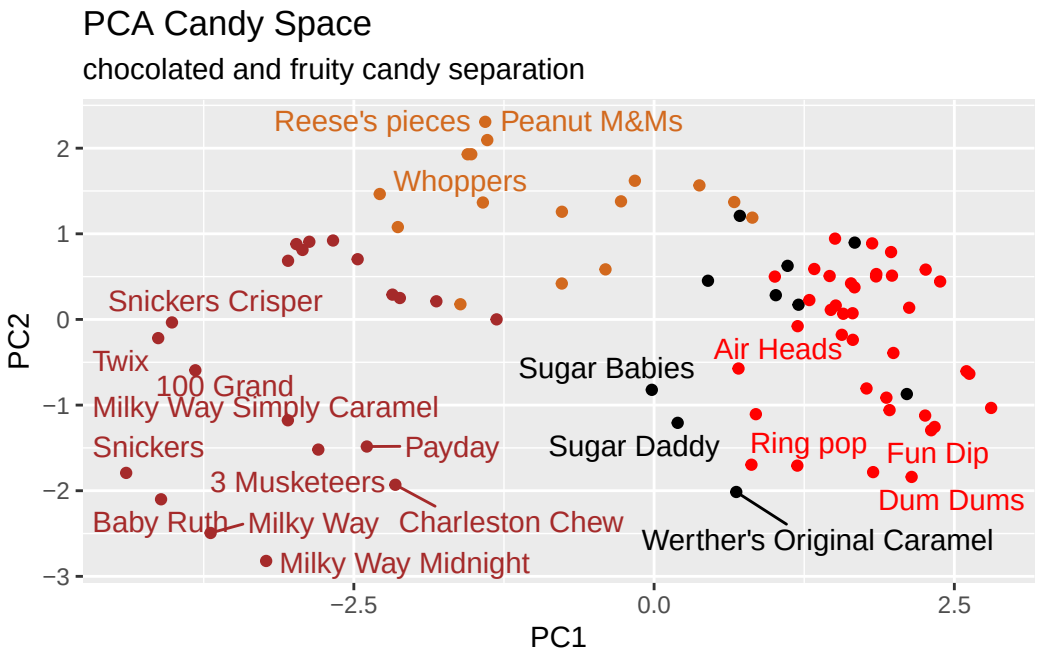
```
pc.loadings <- as.data.frame(pca$rotation)
ggplot(pc.loadings) +
  aes(PC1, reorder(rownames(pc.loadings),PC1)) +
        geom_col()
```




```
pc.score.results <- as.data.frame(pca$x)

p <- ggplot(pc.score.results) +
        aes(x=PC1, y=PC2, label=rownames(pc.score.results)) +
  geom_text_repel(col=my_cols, max.overlaps = 8)+
  labs(title = "PCA Candy Space", subtitle = "chocolated and fruity candy separation")+
  geom_point(col=my_cols)
p
```

```
Warning: ggrepel: 64 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```


PCA Candy Space
chocolated and fruity candy separation
Reese's pieces
Peanut M&Ms
Whoppers
Snickers Crisper
Twix
100 Grand
Milky Way Simply Caramel
Snickers
Payday
3 Musketeers
Baby Ruth
Milky Way
Charleston Chew
Milky Way Midnight
Sugar Babies
Air Heads
Sugar Daddy
Ring pop
Fun Dip
Dum Dums
Werther's Original Caramel
PC2
PC1
2
1
0
−1
−2
−3
−2.5
0.0
2.5