Class 9: Halloween mini-project

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1. Importing candy data

Today we will analyze some data from 538 about typical Halloween candy.

Our first job is to get the data an read it into R

```
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?

ANS: There are 85 different candy types

```
nrow(candy)
```

```
[1] 85
```

Q. How many chocolate candy types are in this dataset?

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

```
[1] 37
```

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

ANS: There are 38 fruity candies‘

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

```
[1] 38
```

Q. How many total candy?

```
nrow(candy)
```

```
[1] 85
```

Q. How many variables/dimensions are there?

```
ncol(candy)
```

```
[1] 12
```

What is your favorate candy?

Data Exploration

Folks like the skimr package for a first wee peak into a new dataset, Let's see what it does for this candy dataset

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

ANS: My favorite candy is Snickers and its winpercent value is 76.67%

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

```
[1] 76.67378
```

Q4. What is the winpercent value for "Kit Kat"?

ANS: 76.76%

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

```
[1] 76.7686
```

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

Yes, the winpercent column

```
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	

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

Zero represents the abscense of chocolate in a specific candy, while 1 means that the candy has chocolate.

Q. What are the five least liked candy's in the dataset?

```
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
```

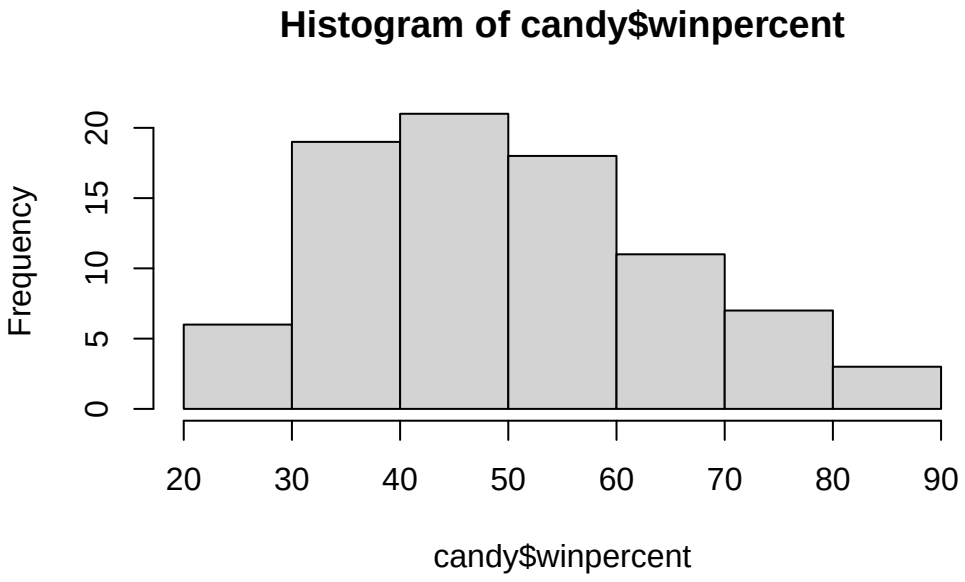
```
tail(candy[inds,],5)
```

```
                    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
```

Q8. Plot a histogram of winpercent values

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



Q9. Is the distribution of winpercent values symmetrical?

ANS: No

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

ANS: Below 50%

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

```
[1] 47.82975
```

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

ANS: Higher ranked

- First find all chocolate candy(subset)
- Get their winpercent values
- Summarize these values into one metric

-Do the same for fruity candy and compare

```
idx<-candy$chocolate==1
choco_data<-candy[idx,]
mean_choco<-mean(choco_data$winpercent)
mean_choco
```

```
[1] 60.92153
```

```
idx<-candy$fruity==1
fruity_data<-candy[idx,]
mean_fruity<-mean(fruity_data$winpercent)
mean_fruity
```

```
[1] 44.11974
```

Q12. Is this difference statistically significant?

ANS: Yes

```
t.test(choco_data$winpercent,fruity_data$winpercent)
```

```
    Welch Two Sample t-test

data:  choco_data$winpercent and fruity_data$winpercent
```

```
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
```

Overall Candy Rankings

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

ANS: Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble and Jawbusters

```
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?'

ANS: Snickers, Kit Kat, Twix, Reese's Miniatures, Reese's Peanut Butter cup

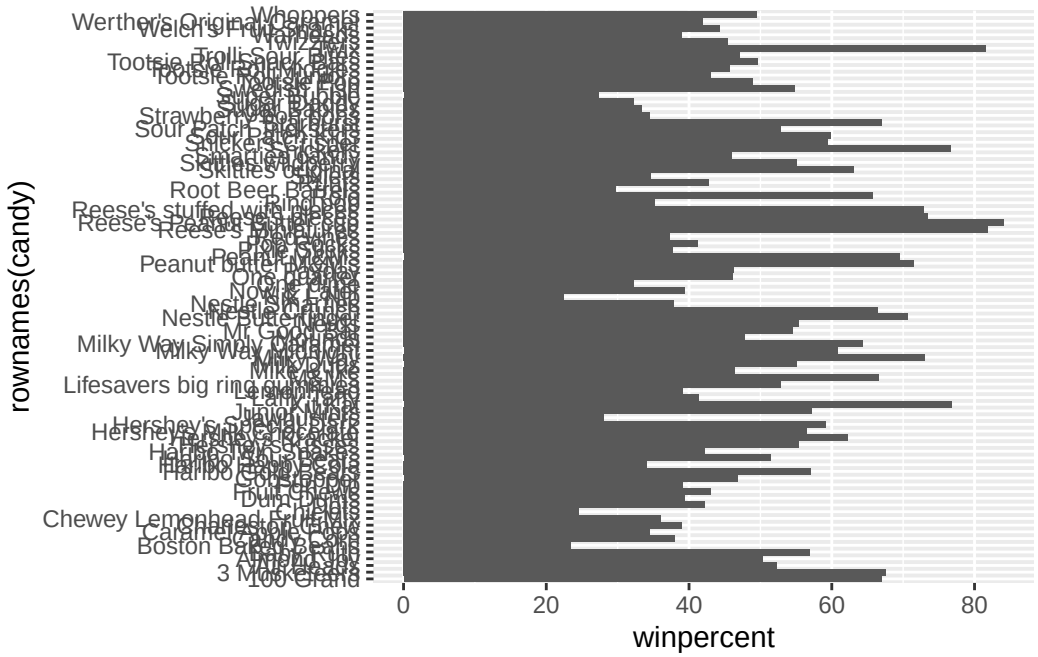
```
tail(candy[order(candy$winpercent),], n=5)
```

```
                         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
```

Plots of overall candy rankings

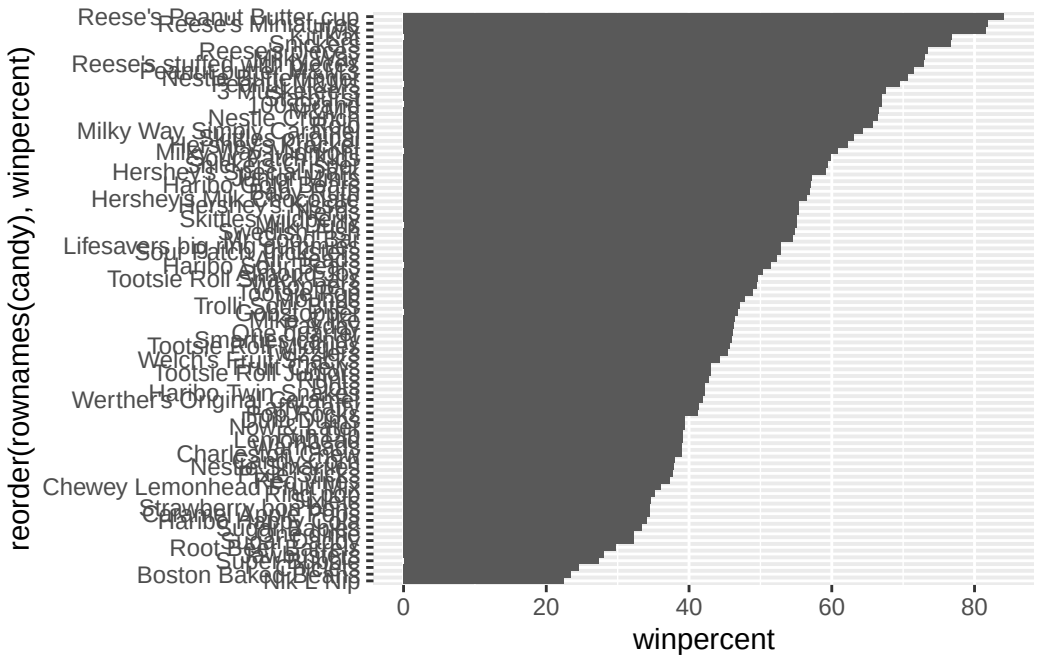
Q15. Make a first barplot of candy ranking based on winpercent values.

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

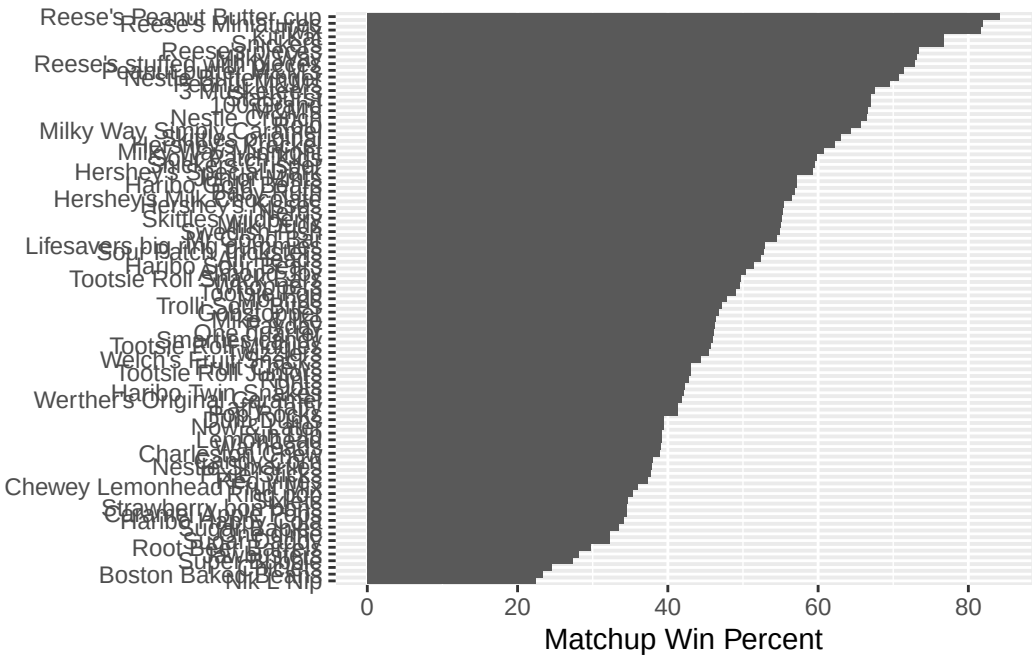


Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

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




```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col()+
  labs(x="Matchup Win Percent",y=NULL)
```




```
ggsave("barplot.png",h=10,width=7)
```

we can now insert any image using markdown syntax. This is ! followed by square brackets and then normal brackets. The result is shown as Figure 1

Time to add some useful color

```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent),fill=as.factor(chocolate)) +
  geom_col()+
  labs(x="Matchup Win Percent",y=NULL)
```

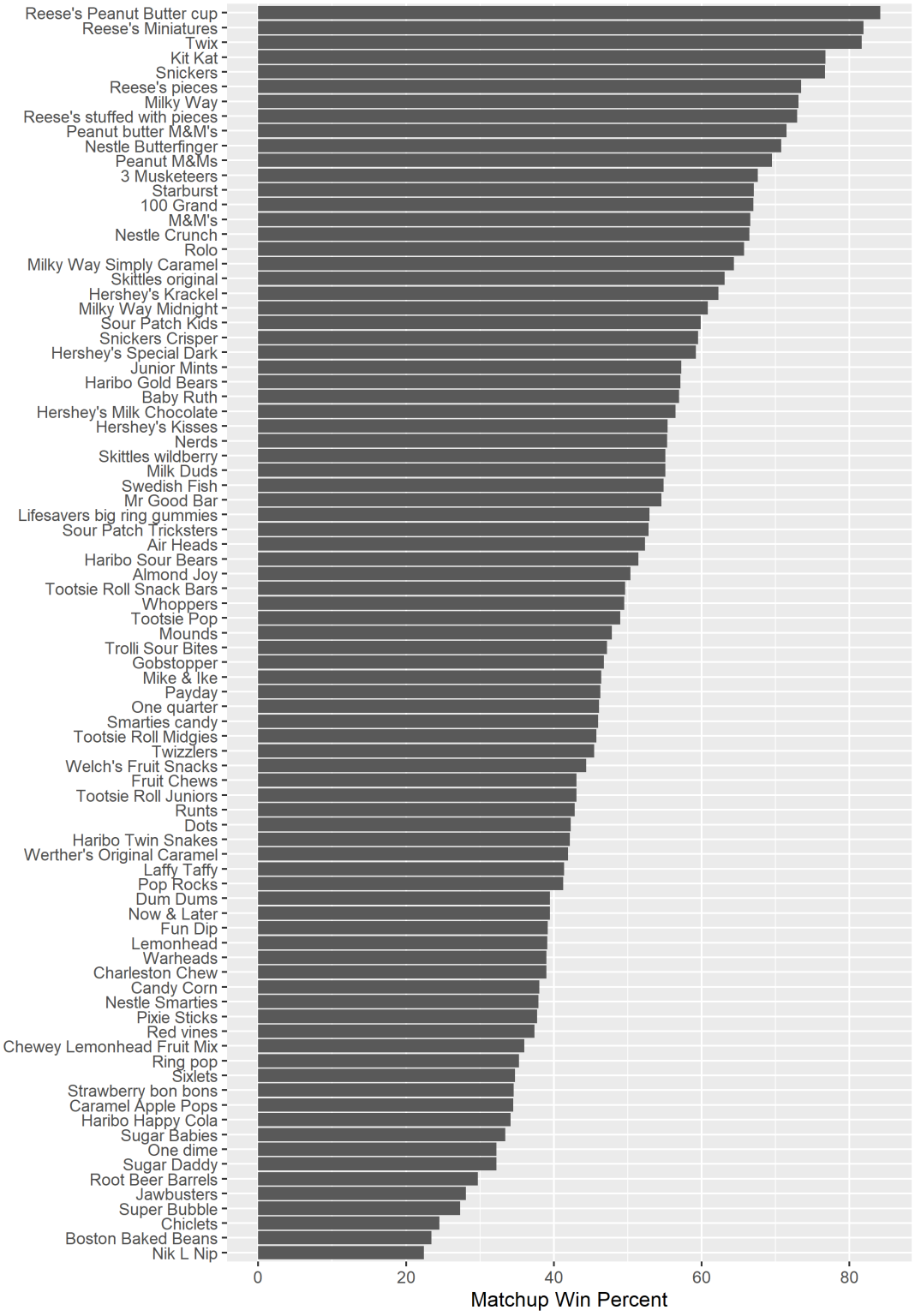
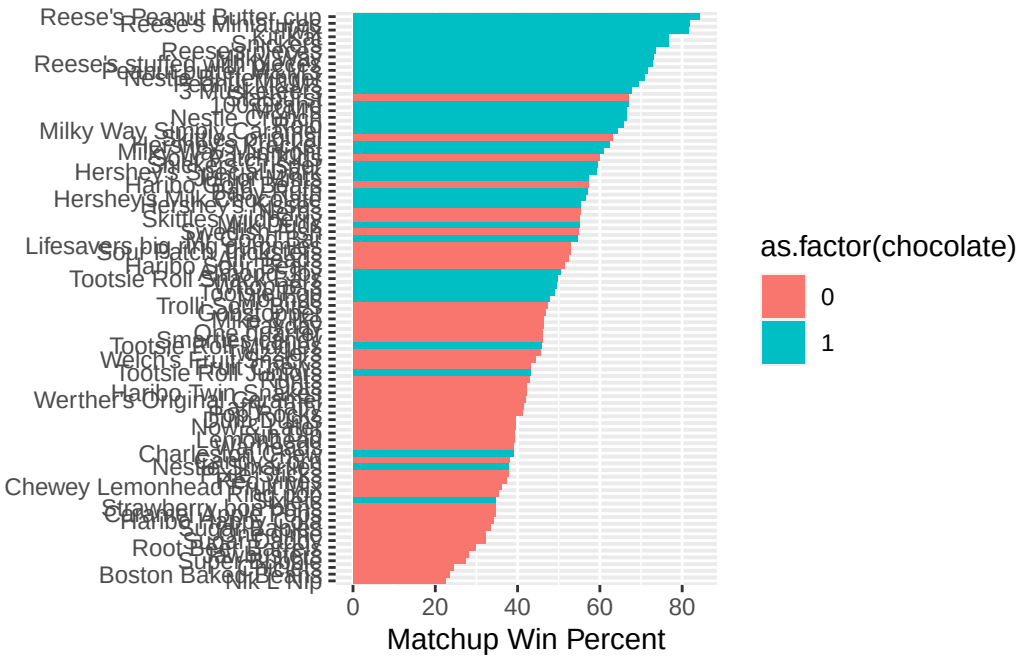


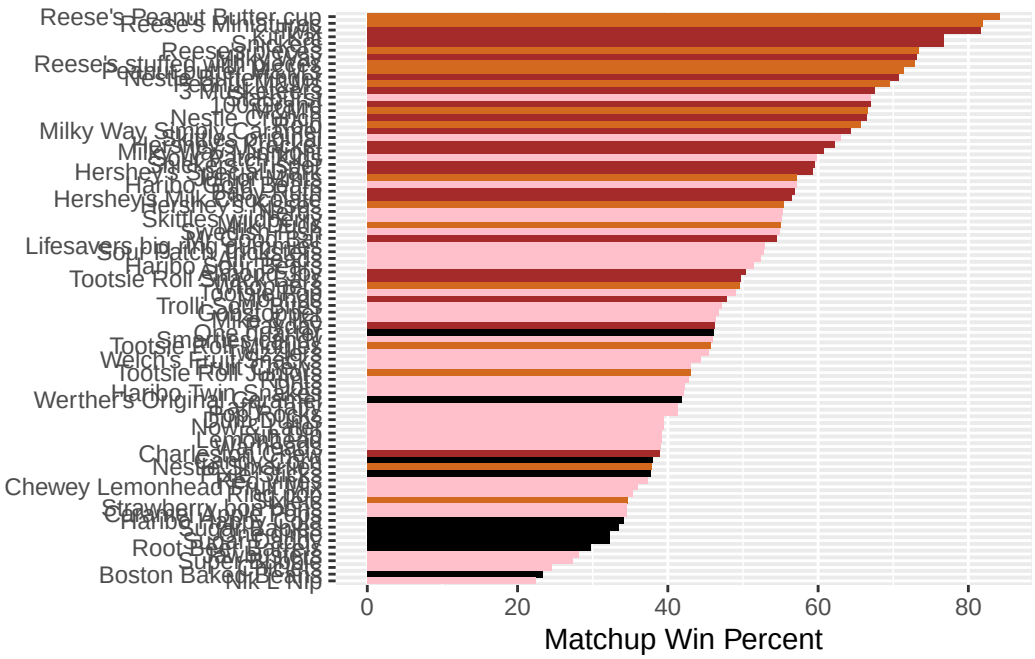
Figure 1: A dull plot



We need to make our own color vector with the colors we like

```
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="Matchup Win Percent",y=NULL)
```




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

Q17. What is the worst ranked chocolate candy?

ANS: Sixlets

Q18. What is the best ranked fruity candy?

ANS: Starburst

Taking a look at pricepercent

As shown in {Figure 2} there is some ugly ass colors to pick from in R. This is better than {Figure 1}

Let's male a plot of winpercent vs pricepercent. The original idea with this 538 plot was to show you the best candy to get for your money as your shop for halloween

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

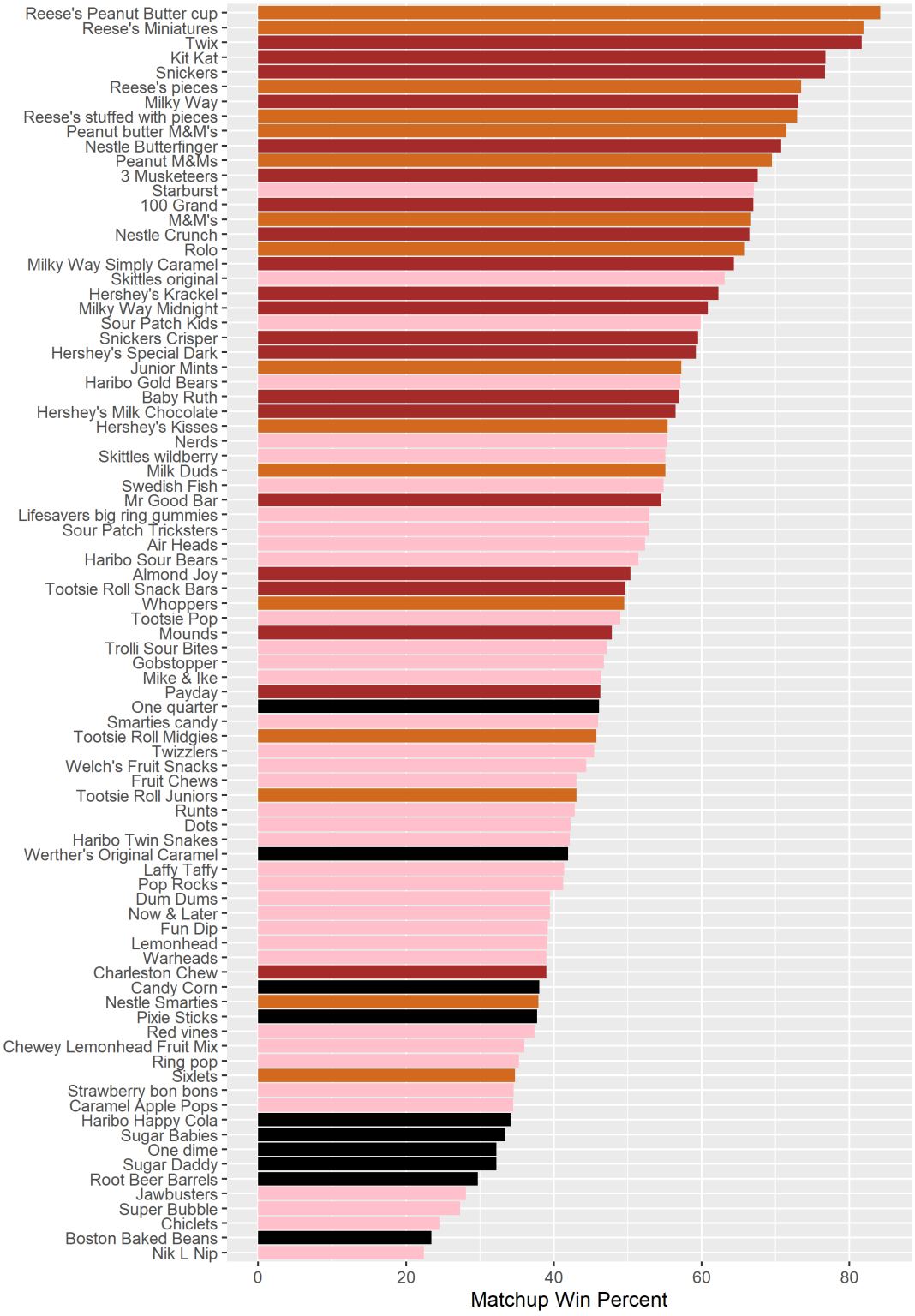
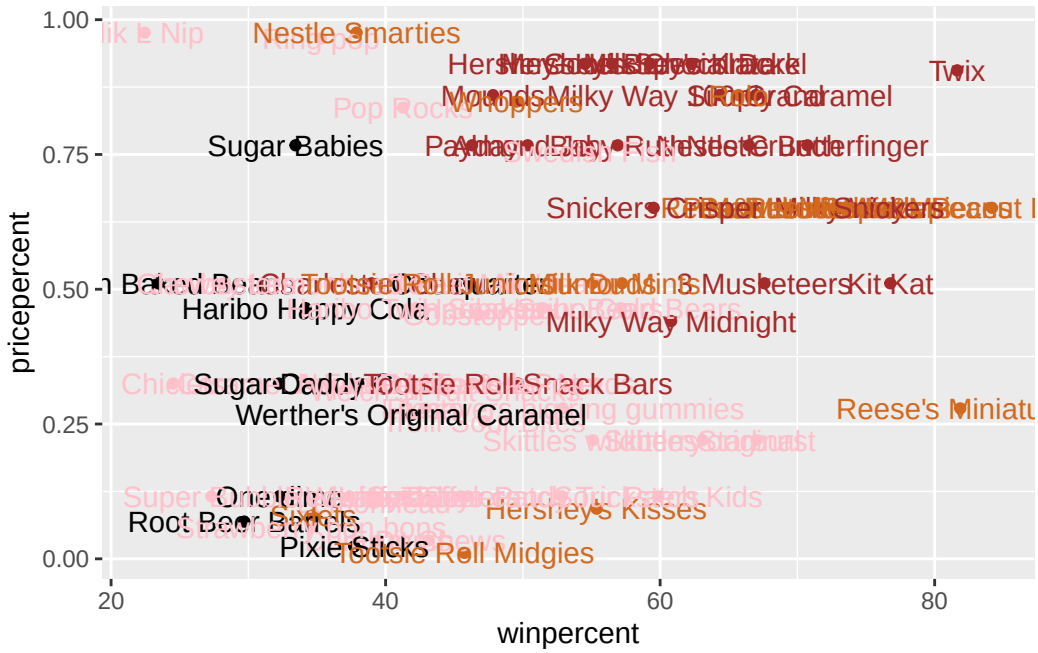


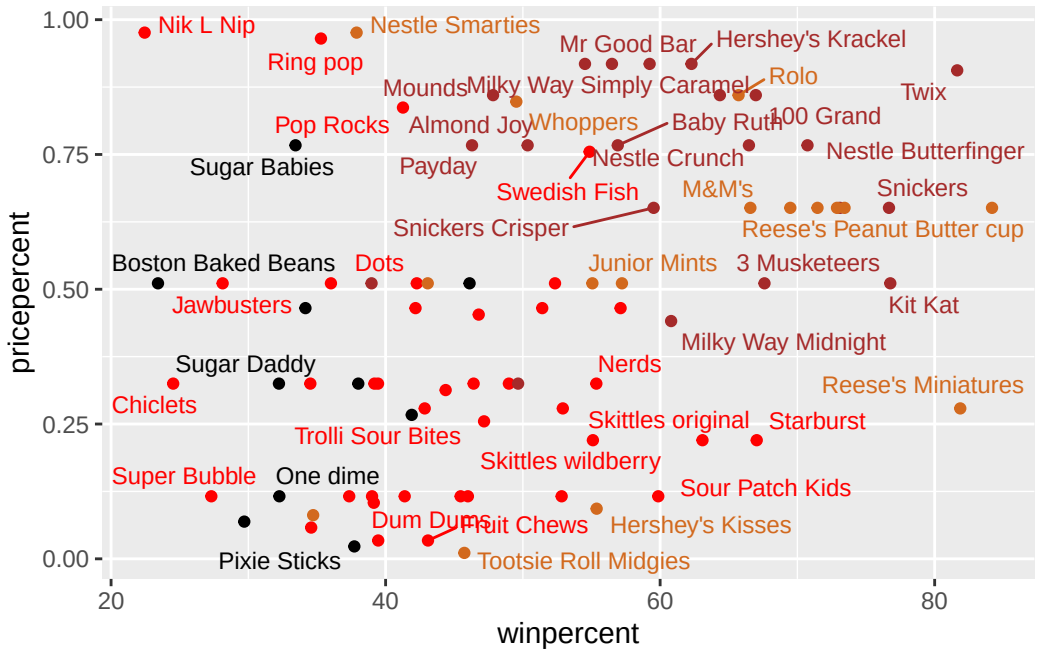
Figure 2: This is some caption text



These labels suck. Let's try ggrepel.

```
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 = 10)
```

```
Warning: ggrepel: 39 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?

ANS: Reese's Miniatures

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

ANS: 5 Most expensive: Nik L Nip, Nestle smarties, Ring pop, Mr Good Bar, Hershey's Special Dark. The least popular is Nik L Nip.

Explore the correlation structure in candy data

We will calculate all Pearson correlation values

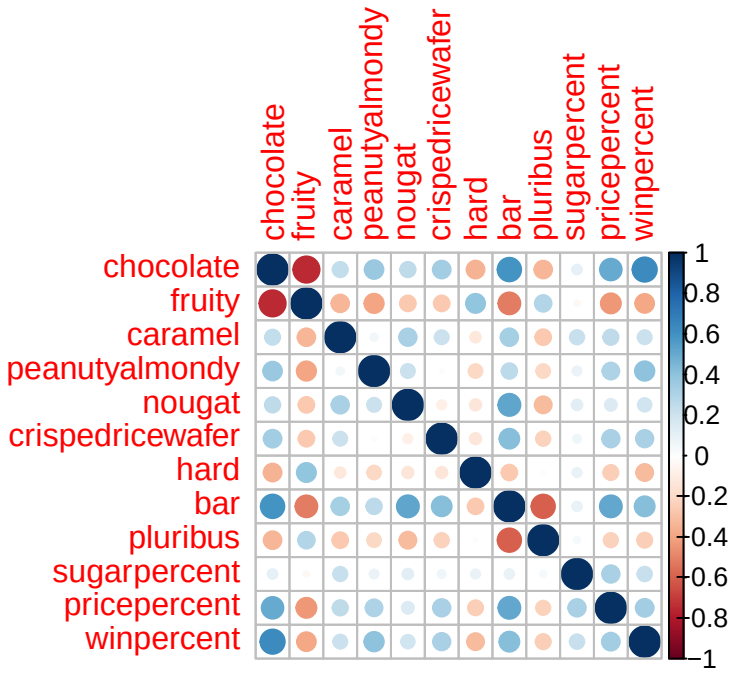
```
library(corrplot)
```

```
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)
```



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

ANS: Chocolate and fruity

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

ANS: winpercent and chocolate

Principal Component Analysis

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

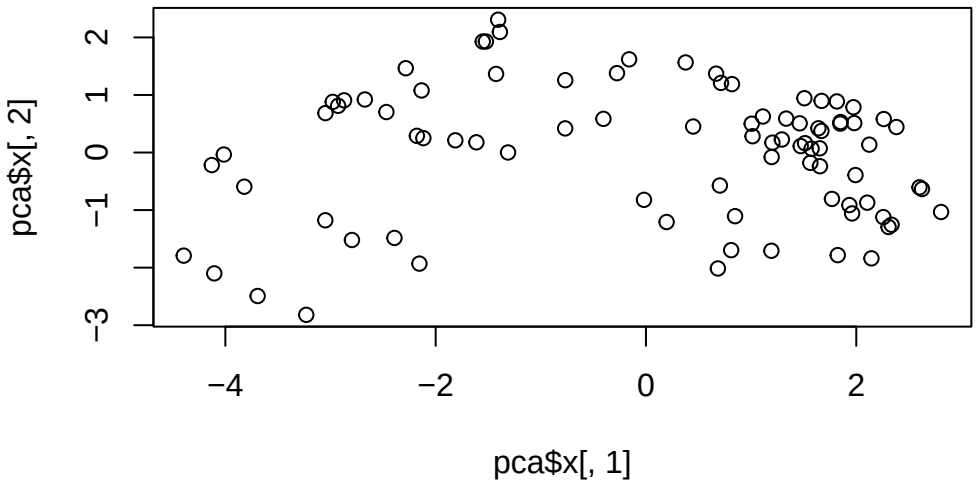
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688 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
```

```
attributes(pca)
```

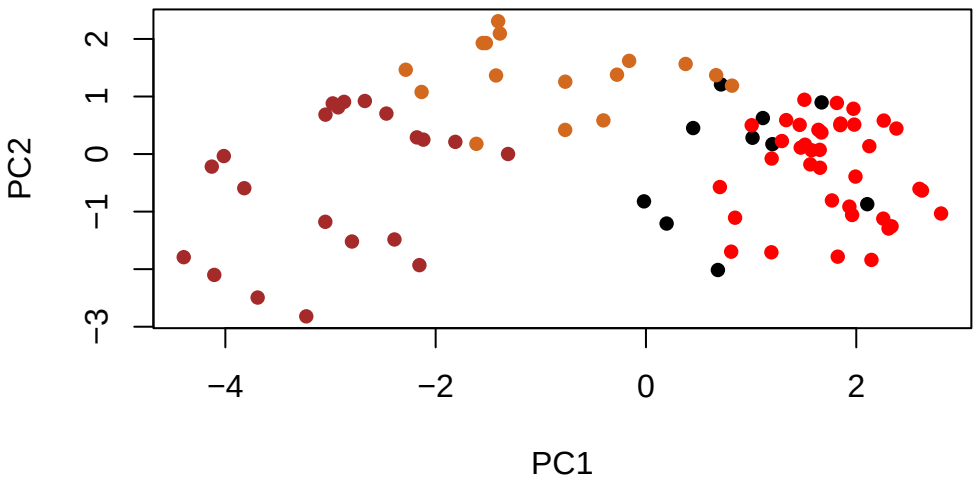
```
$names
[1] "sdev"     "rotation" "center"   "scale"    "x"

$class
[1] "prcomp"
```

```
plot(pca$x[,1], pca$x[,2])
```



We can change the plotting character and add some color:

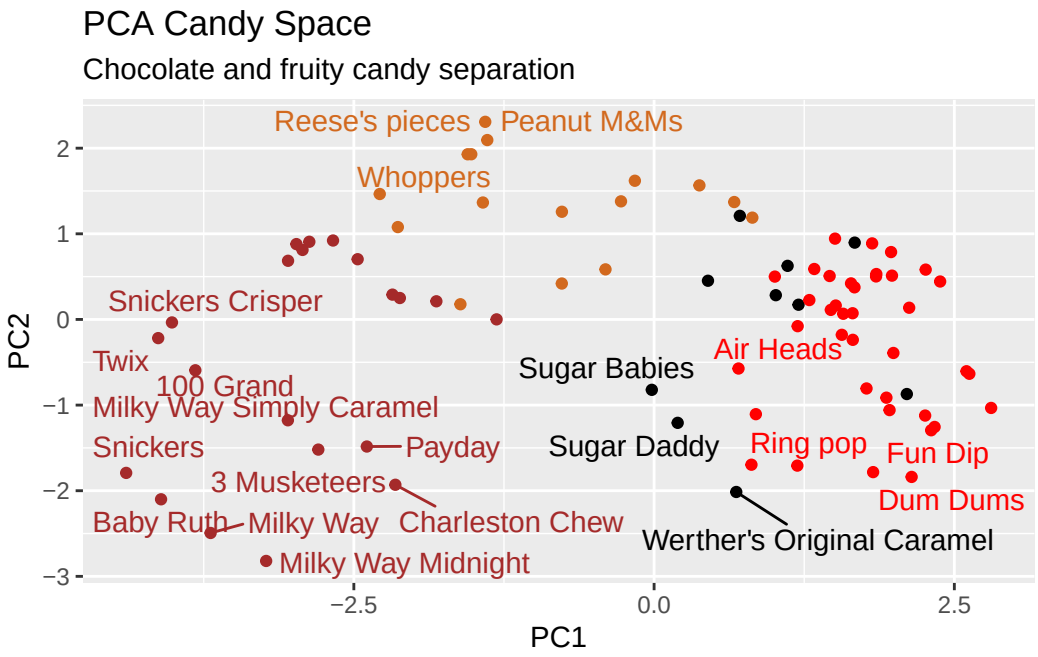
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



Let's make a nicer graph using ggplot

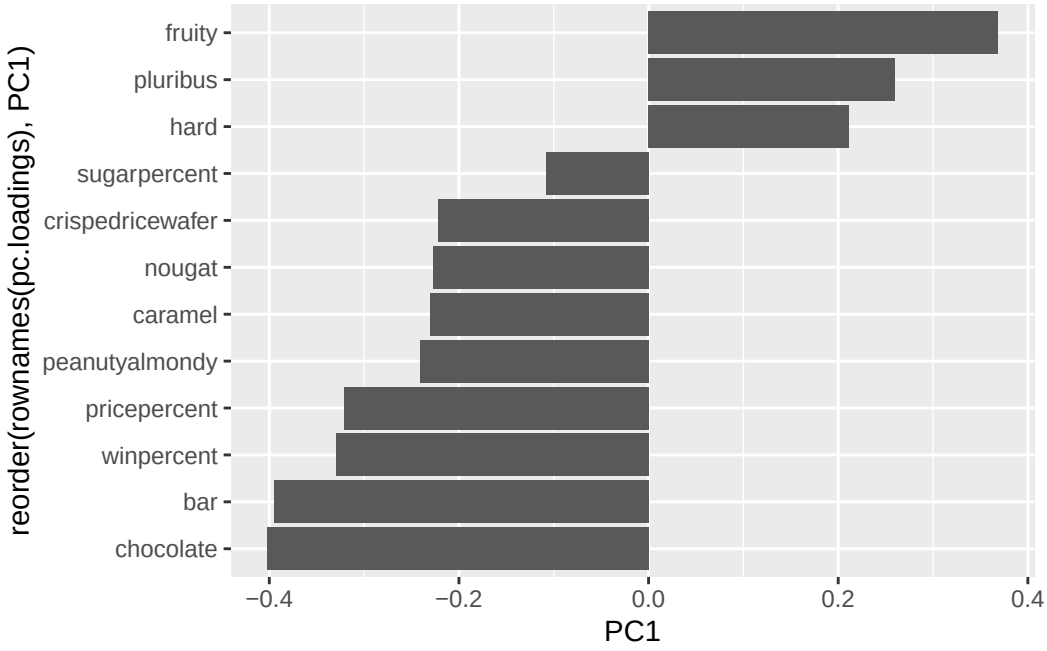
```
pc.score.results<-as.data.frame(pca$x)
ggplot(pc.score.results)+
  aes(PC1,PC2,label=rownames(pc.score.results))+
  geom_point(col=my_cols)+
  geom_text_repel(col=my_cols,max.overlaps=8)+
  labs(title="PCA Candy Space", subtitle="Chocolate and fruity candy separation")
```

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



loadings plot

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

ggplot(pc.loadings) +
  aes(PC1,reorder(rownames(pc.loadings),PC1))+
  geom_col()
```



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

ANS: Fruity, pluribus, hard. It makes sense since most of the fruity candy are hard and are sold in a pluribus presentation.