class 9 halloween miniproject

Anqi Feng

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

  The functions `dim()`, `nrow()`, `table()` and `sum()` may be useful for answering the first 2 questions.

```
nrow(candy)
```

```
[1] 85
```

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

```
[1] 38
```

2. What is your favorite candy?

winpercent is an interesting variable: it is the percentage of people who prefer this candy over another randomly chosen candy. Higher values indicate a more popular candy.

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

```
[1] 81.64291
```

- **Q3**. What is your favorite candy in the dataset and what is it's `winpercent` value?
- **Q4**. What is the `winpercent` value for "Kit Kat"?
- **Q5**. What is the `winpercent` value for "Tootsie Roll Snack Bars"?

```
candy["Almond Joy", ]$winpercent
```

```
[1] 50.34755
```

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

```
[1] 76.7686
```

```
candy["Tootsie Roll Snack Bars", ]$winpercent
```

```
[1] 49.6535
```

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

Table 1: Data summary

Name	candy
Number of rows	85

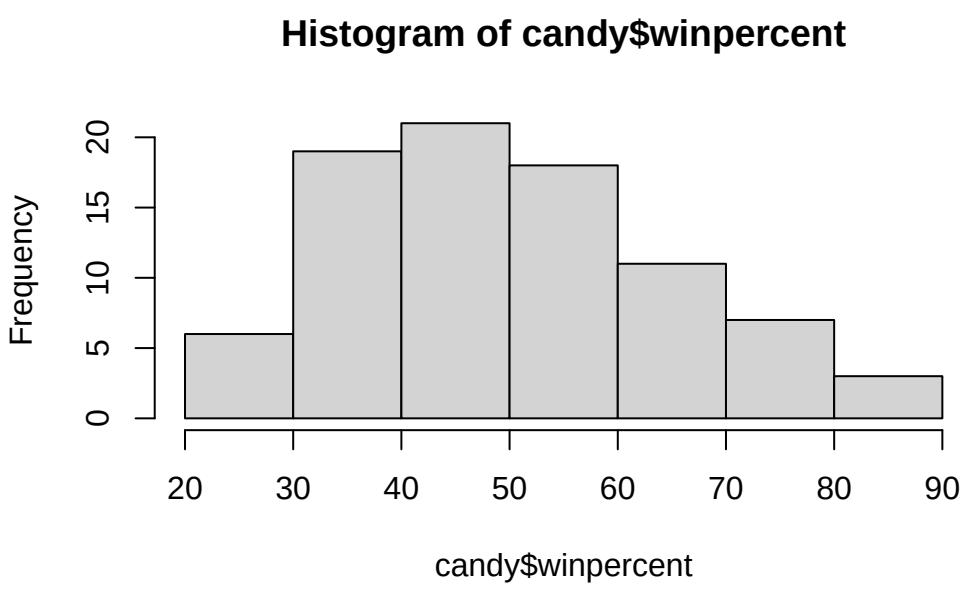
Number of columns	12
Column type frequency:	
numeric	12
Group variables	None

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	

- **Q6**. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset? Most seem to be on 0-1 scale except `sugarpercent`, `pricepercent`, and `winpercent` , which have continuous values
- **Q7**. What do you think a zero and one represent for the `candy$chocolate` column? 0 and 1 is like a true or false type situation
  - **Q8**. Plot a histogram of `winpercent` values
  - **Q9**. Is the distribution of `winpercent` values symmetrical? no
  - **Q10**. Is the center of the distribution above or below 50%? below
  - **Q11**. On average is chocolate candy higher or lower ranked than fruit candy? higher
  - **Q12**. Is this difference statistically significant?

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




```
choco<- candy$winpercent[as.logical(candy$chocolate)]
fruity<-candy$winpercent[as.logical(candy$fruity)]
mean(choco)
```

```
[1] 60.92153
```

```
mean(fruity)
```

```
[1] 44.11974
```

```
mean(choco) > mean(fruity)
```

```
[1] TRUE
```

```
t.test(choco, fruity)
```

```
    Welch Two Sample t-test

data:  choco and fruity
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?
- **Q14**. What are the top 5 all time favorite candy types out of this set?

base R way:

```
head(candy[order(candy$winpercent),], n=5) #least
```

```
                  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
```

```
head(candy[order(-candy$winpercent),], n=5) #most
```

```
                        chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat                           1      0       0              0      0
Snickers                          1      0       1              1      1
                        crispedricewafer hard bar pluribus sugarpercent
```

```
Reese's Peanut Butter cup                0    0   0        0        0.720
Reese's Miniatures                       0    0   0        0        0.034
Twix                                     1    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Snickers                                 0    0   1        0        0.546
                           pricepercent winpercent
Reese's Peanut Butter cup         0.651   84.18029
Reese's Miniatures                0.279   81.86626
Twix                              0.906   81.64291
Kit Kat                           0.511   76.76860
Snickers                          0.651   76.67378
```

or dplyr way:

```
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
candy %>% arrange(winpercent) %>% head(5) #least
```

```
                  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
```

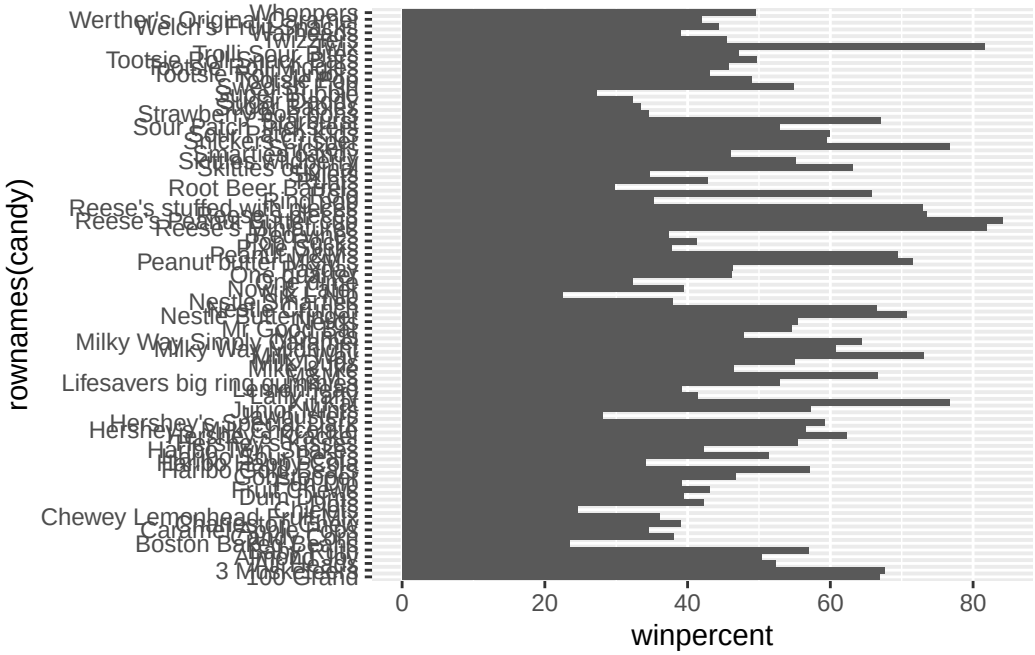
```
Jawbusters                      0    1    0        1        0.093        0.511
                   winpercent
Nik L Nip            22.44534
Boston Baked Beans   23.41782
Chiclets             24.52499
Super Bubble         27.30386
Jawbusters           28.12744
```

```
candy %>% arrange(-winpercent) %>% head(5) #most
```

```
                         chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat                           1      0       0              0      0
Snickers                          1      0       1              1      1
                         crispedricewafer hard bar pluribus sugarpercent
Reese's Peanut Butter cup                0    0   0        0        0.720
Reese's Miniatures                       0    0   0        0        0.034
Twix                                     1    0   1        0        0.546
Kit Kat                                  1    0   1        0        0.313
Snickers                                 0    0   1        0        0.546
                         pricepercent winpercent
Reese's Peanut Butter cup        0.651   84.18029
Reese's Miniatures               0.279   81.86626
Twix                             0.906   81.64291
Kit Kat                          0.511   76.76860
Snickers                         0.651   76.67378
```

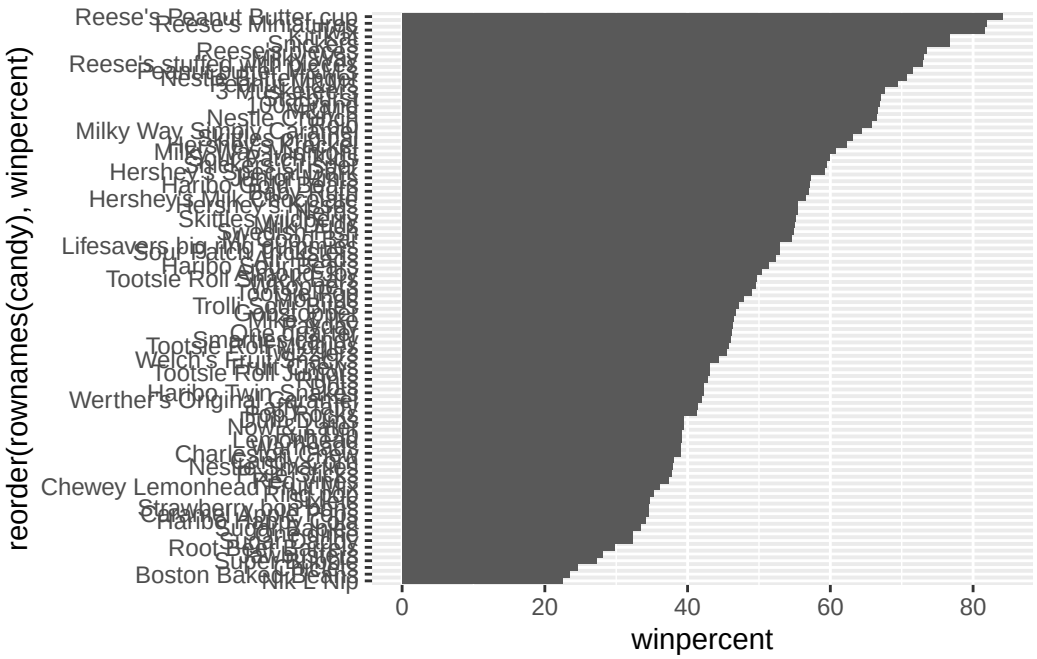
- **Q15**. Make a first barplot of candy ranking based on `winpercent` values.

```
library(ggplot2)

ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_bar(stat="identity")
```



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

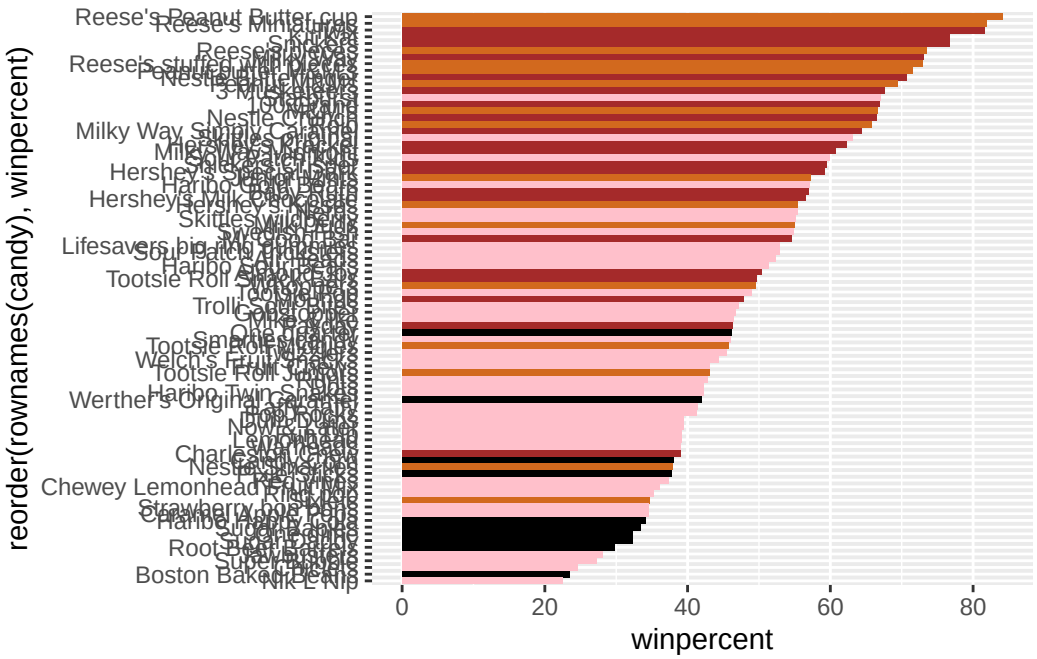
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_bar(stat="identity")
```



time to add some color, set up a color vector

```
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)
```

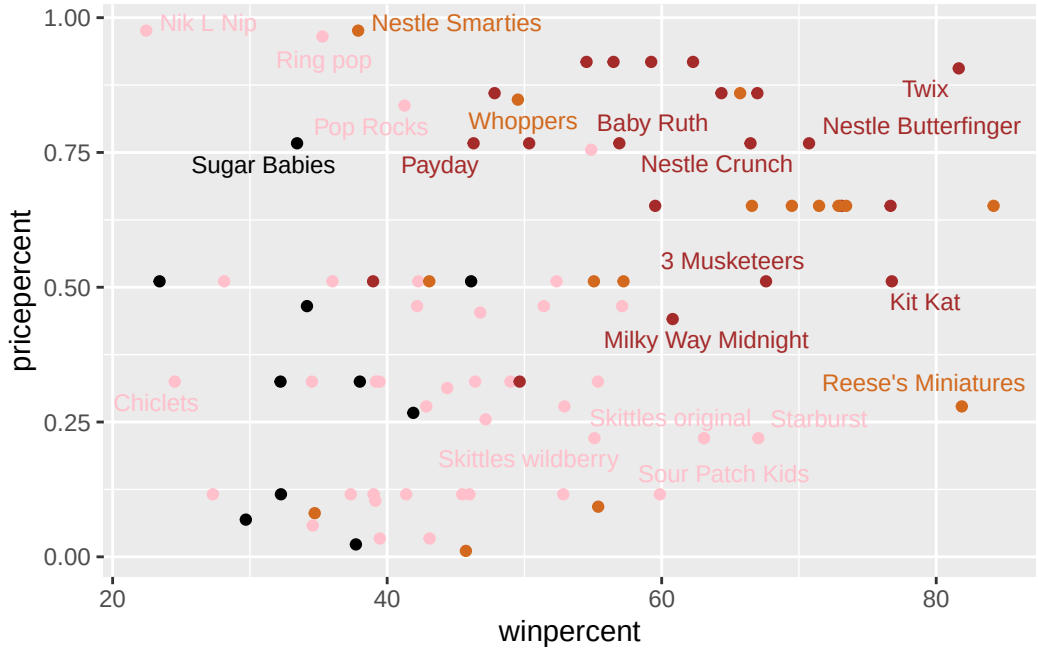


Now, for the first time, using this plot we can answer questions like:
- **Q17**. What is the worst ranked chocolate candy? Sixlets
- **Q18**. What is the best ranked fruity candy? Starbust

4. Taking a look at pricepercent

```
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=3.3, max.overlaps = 5)
```

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

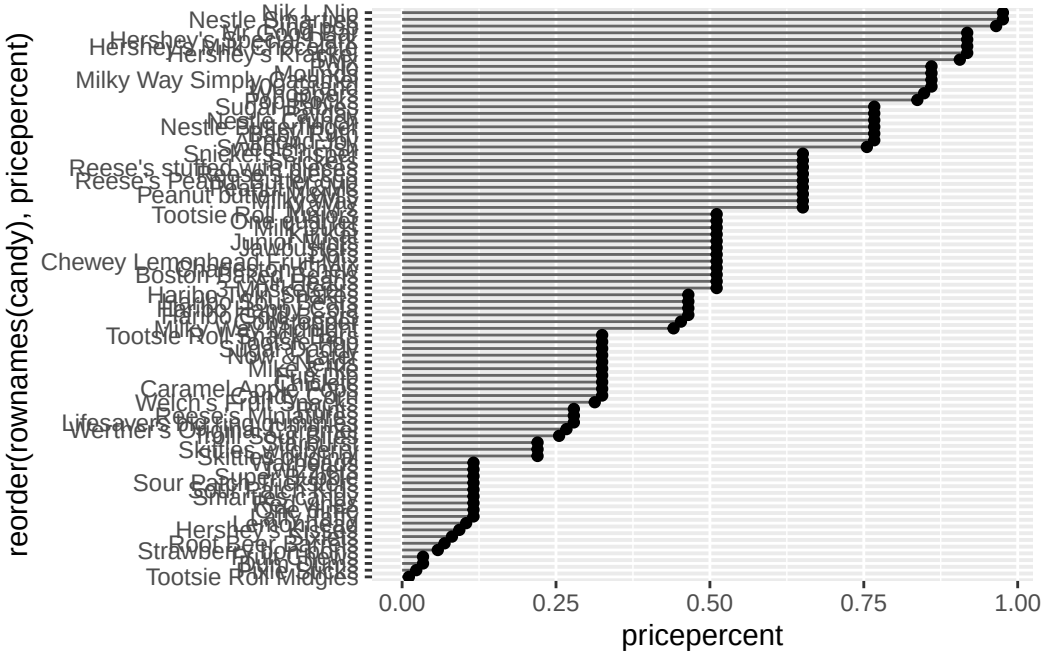


- **Q19**. Which candy type is the highest ranked in terms of `winpercent` for the least money - i.e. offers the most bang for your buck?
- **Q20**. What are the top 5 most expensive candy types in the dataset and of these which is the least popular?

```
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
```

```
# Make a lollipop chart of pricepercent
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```

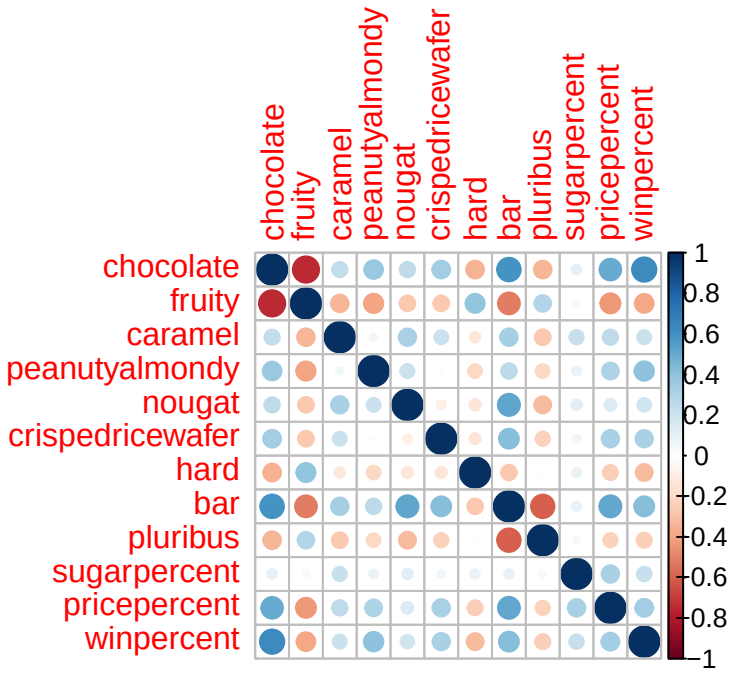


5. exploring the correlation structure

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

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



- **Q22**. Examining this plot what two variables are anti-correlated (i.e. have minus values)? fruity and chocolate
- **Q23**. Similarly, what two variables are most positively correlated? chocolate and winpercent

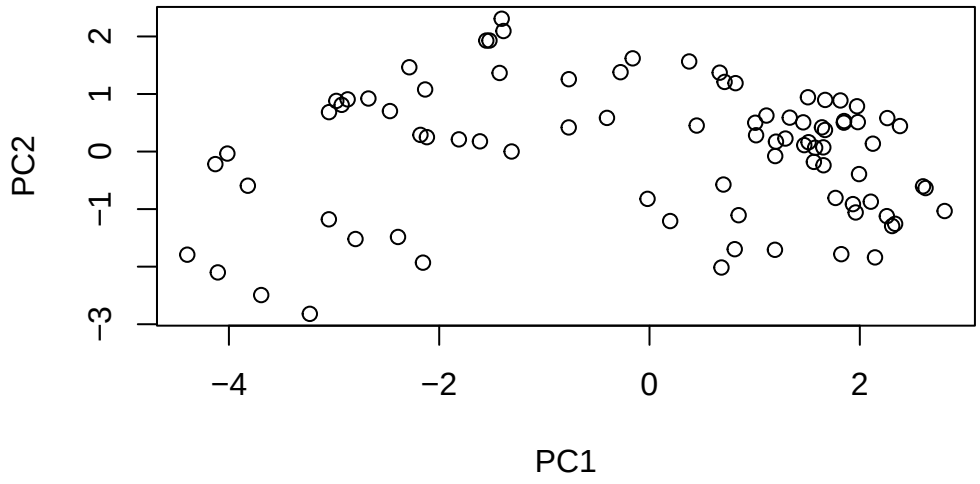
6. PCA

```
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
```

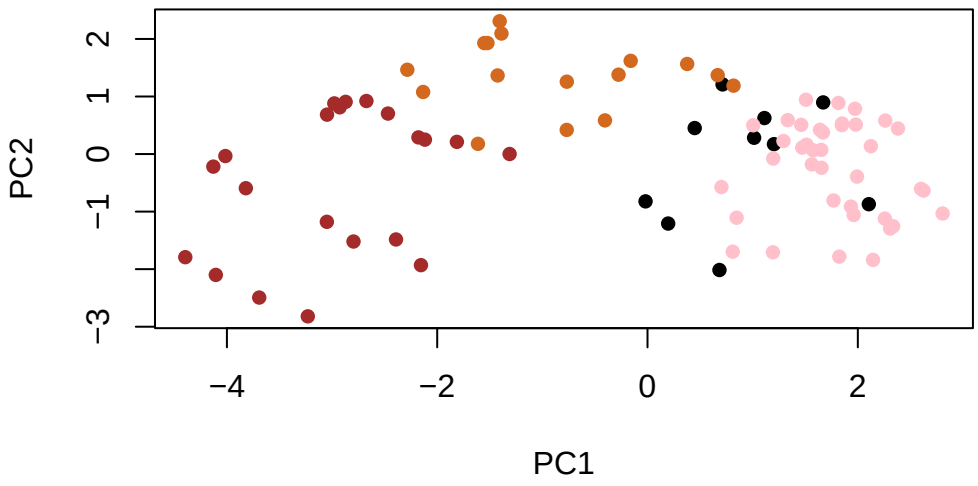
Now we can plot our main PCA score plot of PC1 vs PC2.

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



We can change the plotting character and add some color:

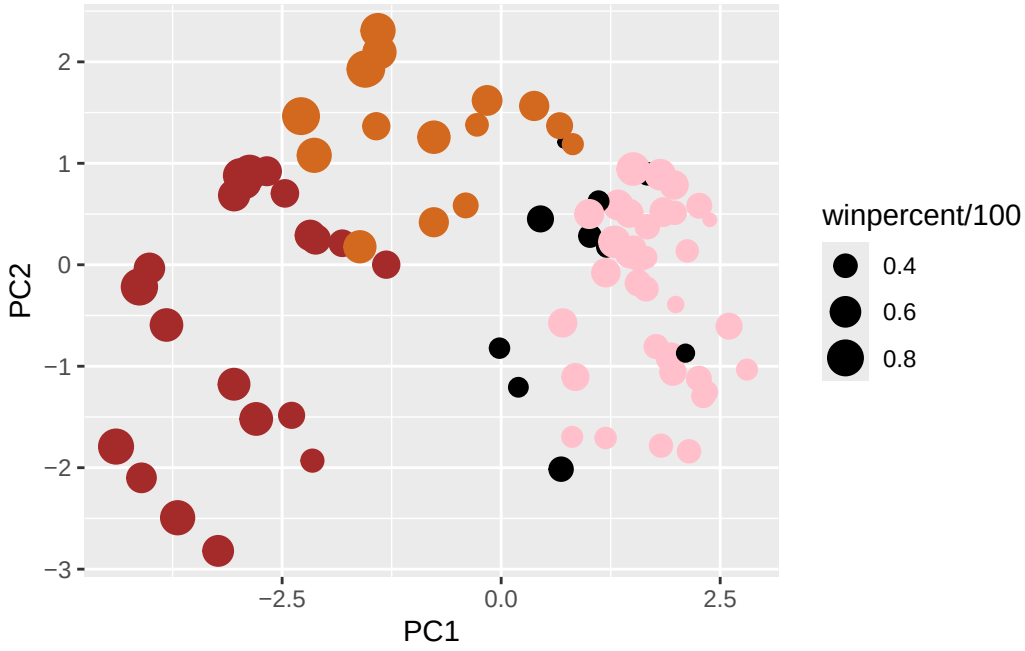
```
plot(pca$x[,1:2], col=my_cols, pch=16)
```



Make a nicer plot with ggplot2! we make a new data.frame btw

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

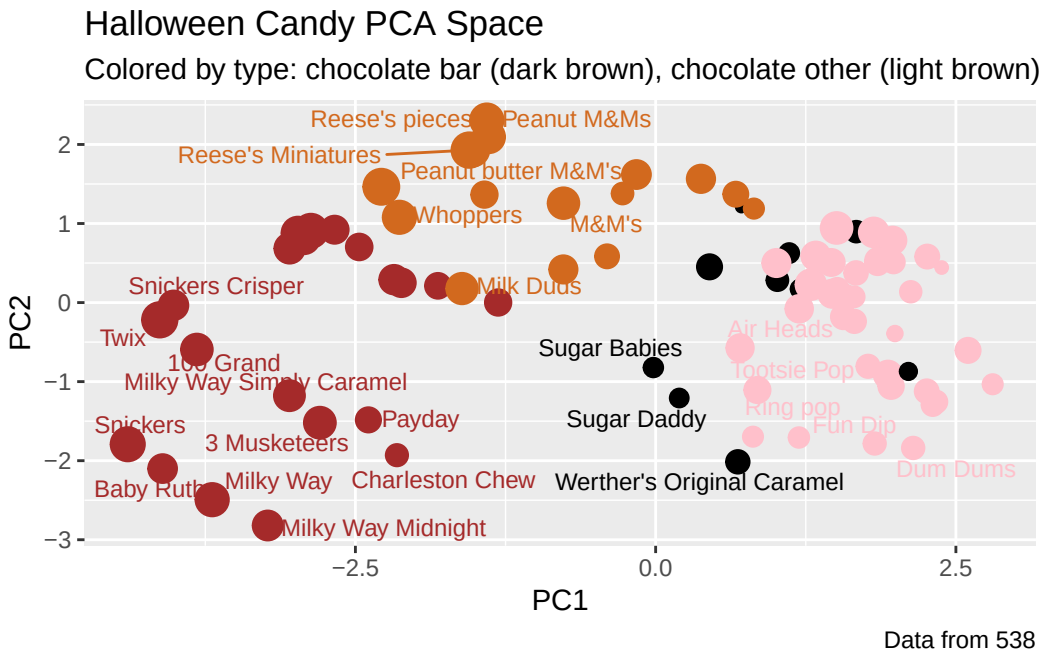
```
p <- ggplot(my_data) +
        aes(x=PC1, y=PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p
```



Again we can use the `ggrepel` package and the function `ggrepel::geom_text_repel()` to label up the plot with non-overlapping names like. WE will also add a title and subtitle like so:

```
library(ggrepel)

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
```



See more candy labels, change the max.overlaps

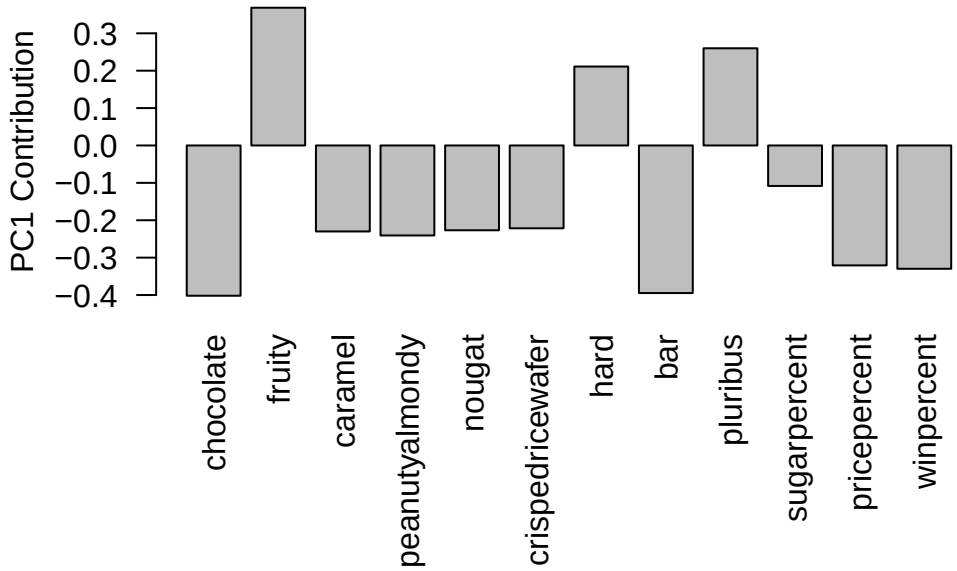
```
#install.packages("plotly")
library(plotly)
```

```
Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':

    last_plot

The following object is masked from 'package:stats':

    filter

The following object is masked from 'package:graphics':

    layout
```

```
#ggplotly(p)
```

does this PCA loading make sense? *Notice the opposite effects of cholocate and fruity and the similar effects of cholocate and bar!

```
par(mar=c(8,4,2,2))
barplot(pca$rotation[,1], las=2, ylab="PC1 Contribution")
```



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

`fruity` `hard` and `pluribus` are picked up strongly by PC1 in the **positive** direction

It makes sense as in the directionality of those variables doen't matter in PCA, but what matters is the magnitude (as it is a reflection of the winpercent results. Therefore it makes sense that cholocate and fruit for example, are the highest magnitudes with opposite direction as it correlates with our previous results where it is rare to find candy that is both chocolate and fruity!

*play around with Q13… how the order function can be used

```
play<-c(2,1,5,3)
sort(play)
```

```
[1] 1 2 3 5
```

```
order(play)
```

```
[1] 2 1 4 3
```

```
play[order(play)]
```

```
[1] 1 2 3 5
```