Lab_10_Holloween

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

candy_file
```

```
[1] "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
```

```
nrow(candy)
```

```
[1] 85
```

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

```
[1] 38
```

- Q1. How many different candy types are in this dataset? A: 85
- Q2. How many fruity candy types are in the dataset? A: 38

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

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

```
[1] 81.64291
```

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

```
[1] 76.7686
```

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

```
[1] 49.6535
```

- Q3. What is your favorite candy in the dataset and what is it's winpercent value? A: my favorite candy is Twix. It has a winpercent value of 81.64
- Q4. What is the winpercent value for "Kit Kat"? A: 76.77
- Q5. What is the winpercent value for "Tootsie Roll Snack Bars"? A: 49.65

the skimr::skim() function

```
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	

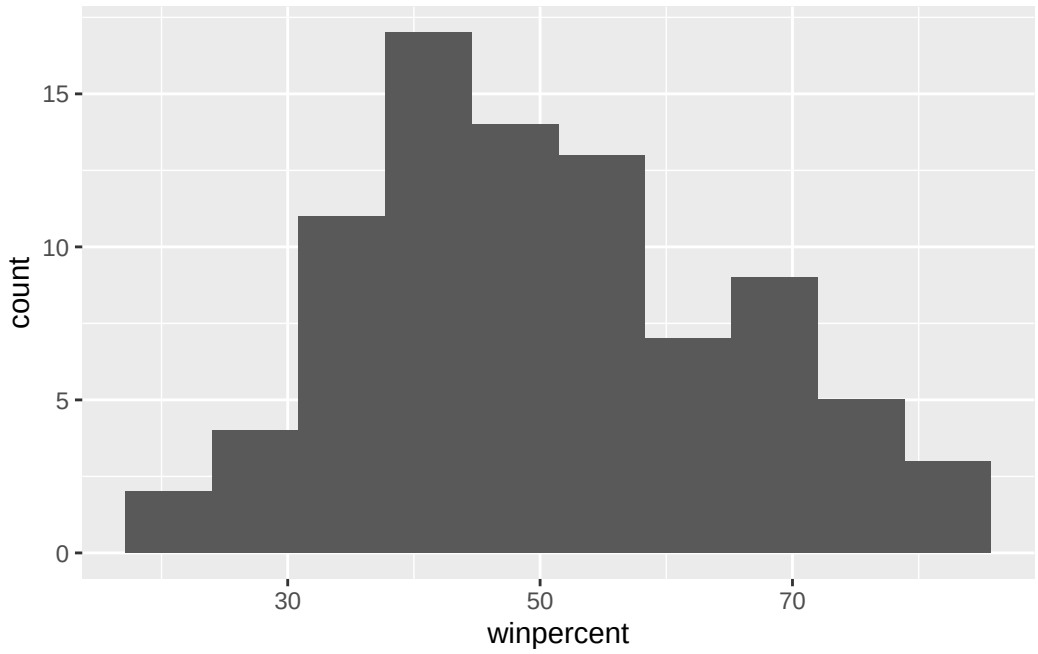
- Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset? A: The winperent, pricepercent, and sugarpercents look to be on a different scale to the majority of the other columns
- Q7. What do you think a zero and one represent for the candy$chocolatecolumn?A:Azeroandoneinthecandy$chocolate column is represent whether or not the corresponding candy contains chocolate.

Hint: look at the "Variable type" print out from the skim() function. Most varables (i.e. columns) are on the zero to one scale but not all. Some columns such as chocolate are exclusively either zero or one values.

- Q8. Plot a histogram of winpercent values > Q8. Plot a histogram of winpercent values

```
library(ggplot2)

ggplot(candy)+
  aes(winpercent)+
  geom_histogram(bins=10)
```



- Q9. Is the distribution of winpercent values symmetrical? A: The distribution is not symmetrical and skewed to the left
- Q10. Is the center of the distribution above or below 50%? A: the center of the distribution (median) is below 50%
- Q11. On average is chocolate candy higher or lower ranked than fruit candy? A: chocolate candy is on average higer ranked than fruit candy
- Q12. Is this difference statistically significant? A: the difference is significant given the p-value = 2.871e-08 from the two sample t-test

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

```
[1] 60.92153
```

```
mean(win_fruit)
```

```
[1] 44.11974
```

```
t.test(win_choc, win_fruit)
```

```
    Welch Two Sample t-test

data:  win_choc and win_fruit
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
```

Hint: The chocolate, fruity, nougat etc. columns indicate if a given candy has this feature (i.e. one if it has nougart, zero if it does not etc.). We can turn these into logical (a.k.a. TRUE/FALSE) values with the as.logical() function. We can then use this logical vector to access the coresponding candy rows (those with TRUE values). For example to get the winpercent values for all nougat contaning candy we can use the code: $candy winpercent[as.logical(candy nougat)]$. In addation the functions mean() and t.test() should help you answer the last two questions here.

```
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
```

```
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
ReeseÕs Miniatures               1      0       0              1      0
ReeseÕs 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
ReeseÕs Miniatures                       0    0   0        0        0.034
ReeseÕs 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
ReeseÕs Miniatures              0.279   81.86626
ReeseÕs Peanut Butter cup       0.651   84.18029
```

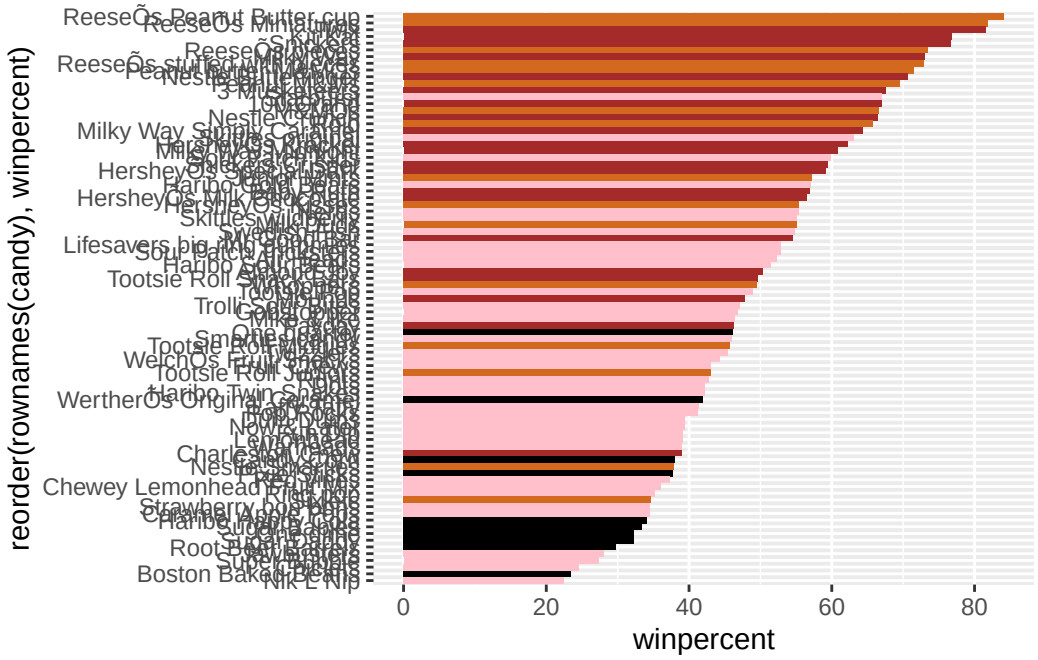
- Q13. What are the five least liked candy types in this set? A: the five least liked candy types are, Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, Jawbusters, from the least likely, respectively.
- Q14. What are the top 5 all time favorite candy types out of this set? A: ReeseÕs Peanut Butter cup, ReeseÕs Miniatures, Twix, Kit Kat, Snickers, from the most liked, respectively.

Hint: Using base R we could use head(candy[order(candy$winpercent),], n=5), whilst using dplyr we have: candy %>% arrange(winpercent) %>% head(5). Which apprach do you prefer and why?

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

```
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)
```



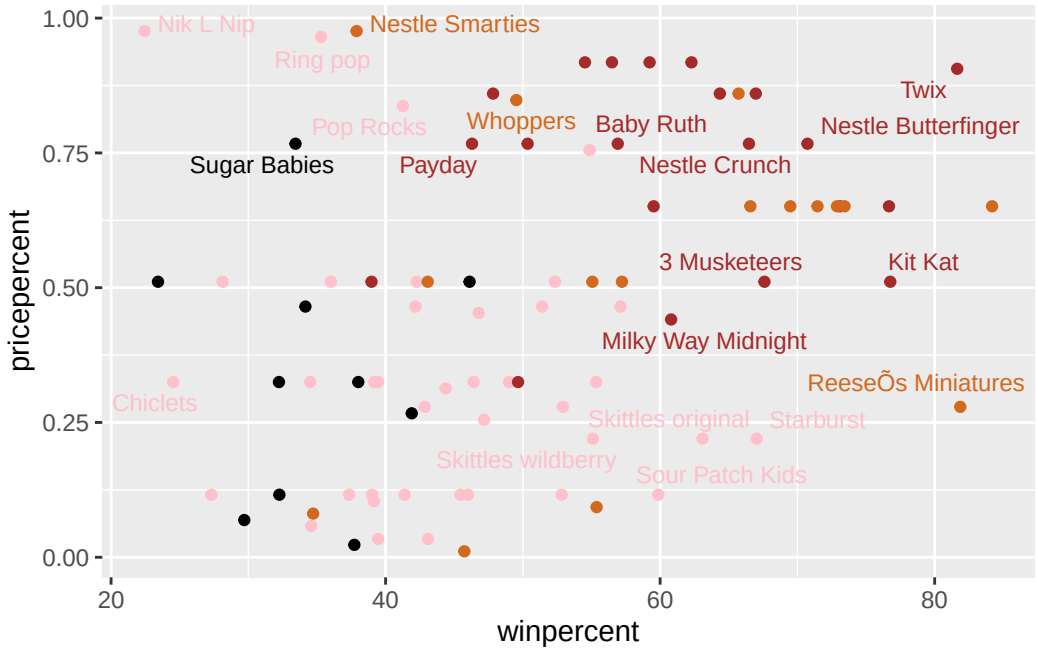
Now, for the first time, using this plot we can answer questions like: * Q17. What is the worst ranked chocolate candy? A: sixlets

- Q18. What is the best ranked fruity candy? A: Starburst

```
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? A: Reese miniatures offers the most band for your buck!
- Q20. What are the top 5 most expensive candy types in the dataset and of these which is the least popular? A: The top 5 most expensive candy types are Nik L Nip, Nestle Smarties, Ring pop, Hershey's Kracker, and Hershey's Milk Chocolate. Nik L Nip is the least popular among those.

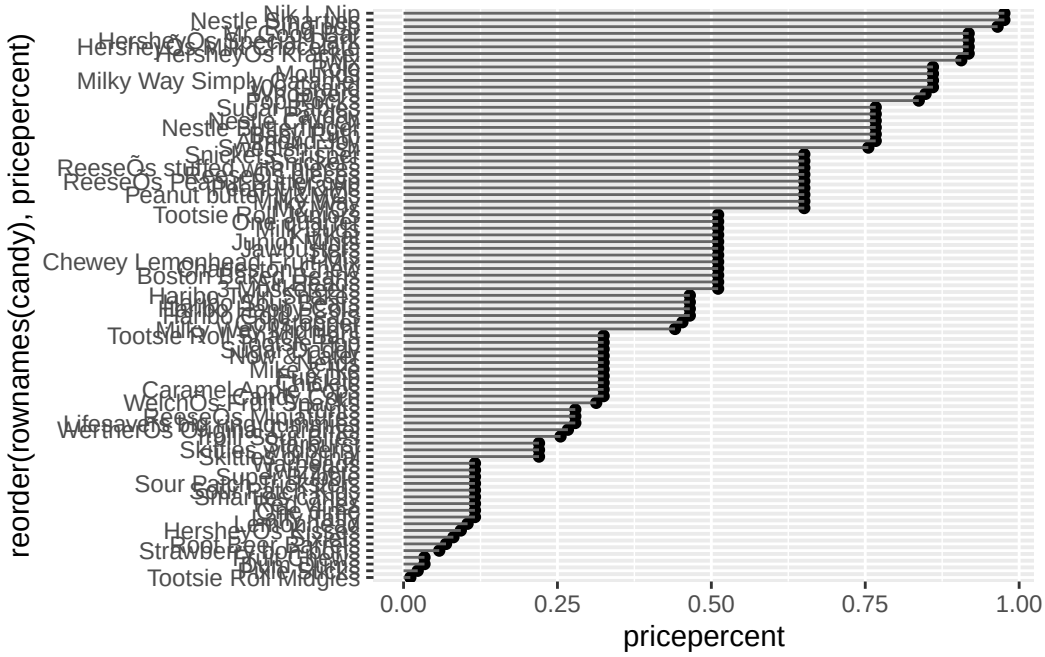
```
ord <- order(candy$pricepercent, decreasing = TRUE)
head( candy[ord,c(11,12)], n=5 )
```

```
                        pricepercent winpercent
Nik L Nip                      0.976   22.44534
Nestle Smarties                0.976   37.88719
Ring pop                       0.965   35.29076
HersheyÕs Krackel              0.918   62.28448
HersheyÕs Milk Chocolate       0.918   56.49050
```

Q21. Make a barplot again with geom_col() this time using pricepercent and then improve this step by step, first ordering the x-axis by value and finally making a so called "dot chat" or "lollipop" chart by swapping geom_col() for geom_point() + geom_segment().

Q21.

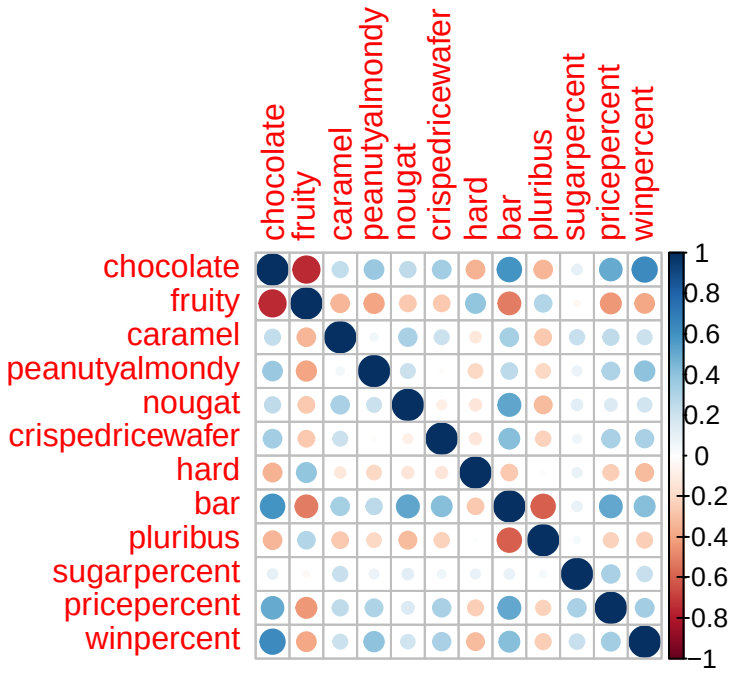
```
ggplot(candy)+
  aes(pricepercent, reorder(rownames(candy), pricepercent), pricepercent)+
  geom_point()+
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40")
```




```
library(corrplot)
```

```
corrplot 0.92 loaded
```

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



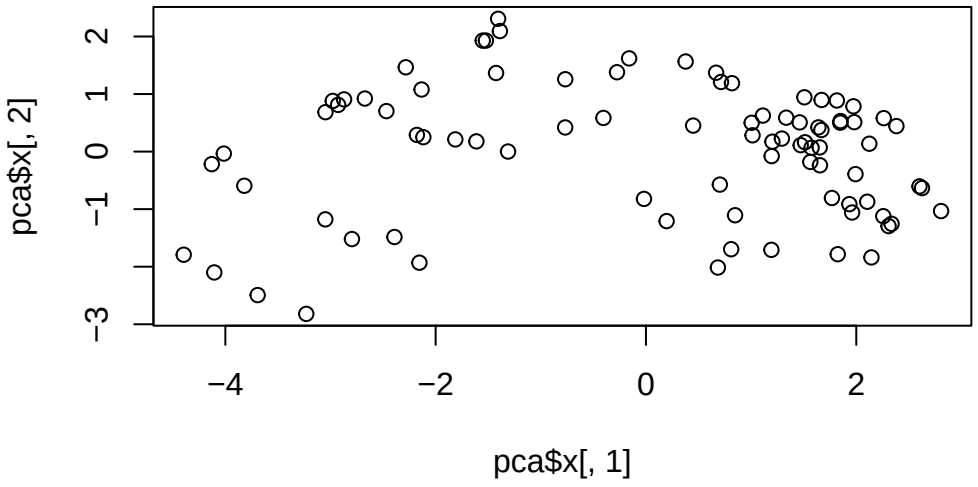
- Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)? A: Chocolate and fruity are anti-correlated, fruity is with anti-correlated to bar and to peanutyalmondy
- Q23. Similarly, what two variables are most positively correlated? A: Chocolate shows strong correlations to Bar and Winpercent, and is moderately correlated to pricepercent

HINT: Do you like chocolaty fruity candies?

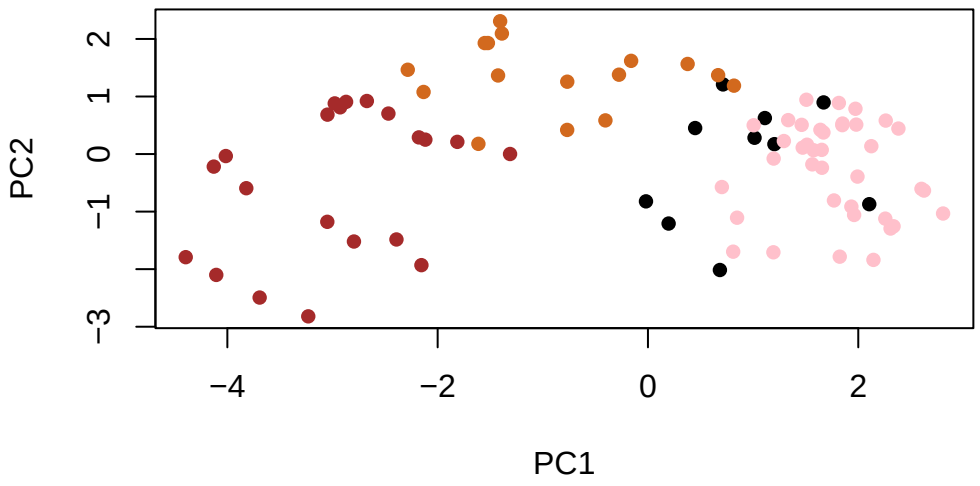
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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])
```




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



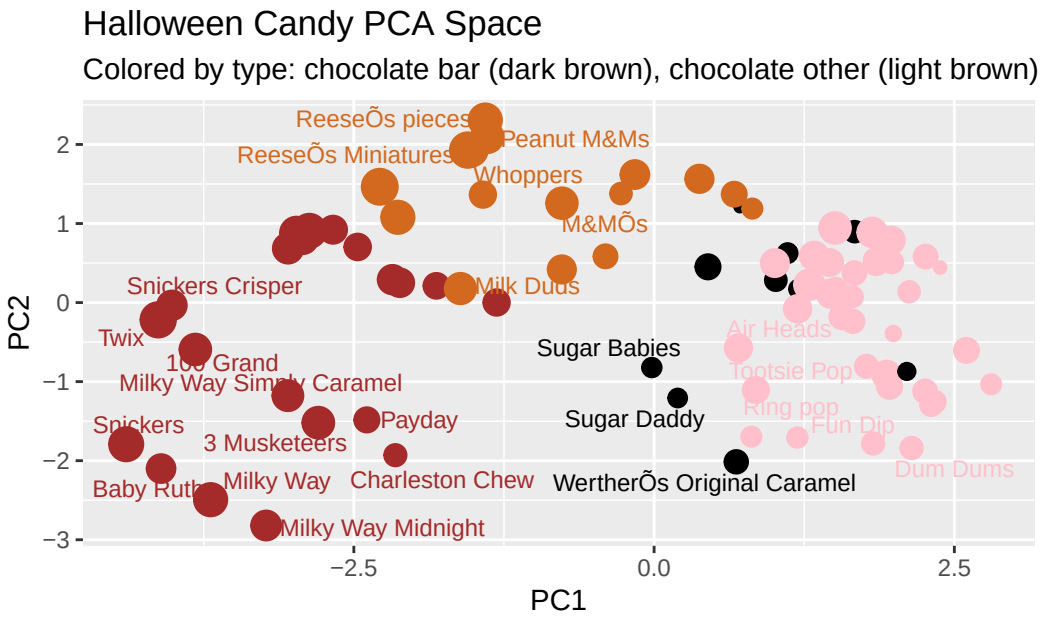

```
my_data <- cbind(candy, pca$x[,1:3])
```

```
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)
```

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



alternatively

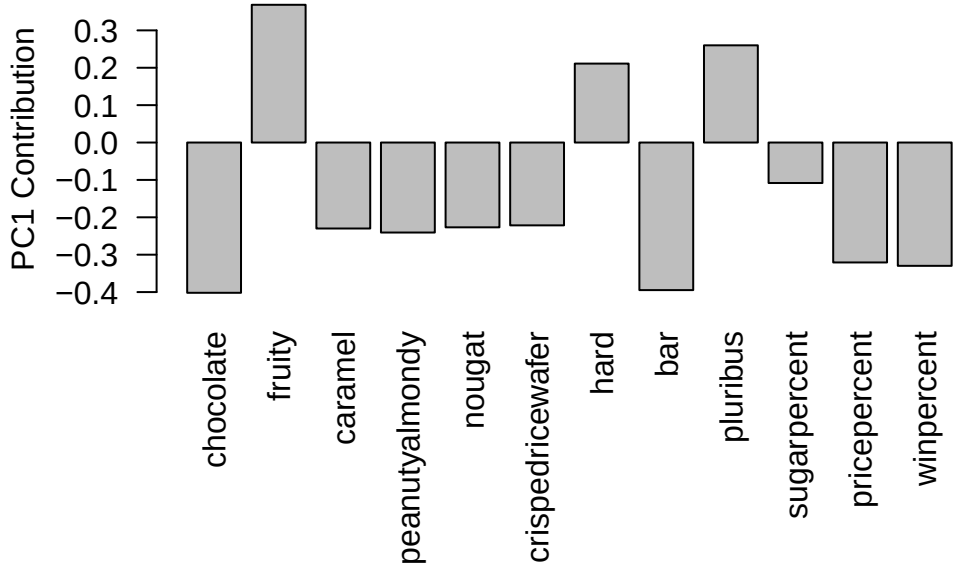
```
#library(plotly)
#ggplotly(p)
```

```
pca$rotation
```

```
                    PC1         PC2         PC3         PC4         PC5
chocolate     -0.4019466  0.21404160 -0.01601358  0.016673032 -0.066035846
fruity         0.3683883 -0.18304666  0.13765612  0.004479829 -0.143535325
caramel       -0.2299709 -0.40349894  0.13294166  0.024889542  0.507301501
peanutyalmondy -0.2407155  0.22446919 -0.18272802 -0.466784287 -0.399930245
nougat        -0.2268102 -0.47016599 -0.33970244 -0.299581403  0.188852418
crispedricewafer -0.2215182  0.09719527  0.36485542  0.605594730 -0.034652316
hard           0.2111587 -0.43262603  0.20295368  0.032249660 -0.574557816
bar           -0.3947433 -0.22255618 -0.10696092  0.186914549 -0.077794806
pluribus       0.2600041  0.36920922  0.26813772 -0.287246604  0.392796479
sugarpercent  -0.1083088 -0.23647379  0.65509692 -0.433896248 -0.007469103
pricepercent  -0.3207361  0.05883628  0.33048843 -0.063557149 -0.043358887
winpercent    -0.3298035  0.21115347  0.13531766 -0.117930997 -0.168755073
                    PC6         PC7         PC8         PC9         PC10
```

```
chocolate         0.09018950  0.08360642 -0.49084856  0.151651568  0.107661356
fruity            0.04266105 -0.46147889  0.39805802  0.001248306  0.362062502
caramel           0.40346502  0.44274741  0.26963447 -0.019186442  0.229799010
peanutyalmondy    0.09416259  0.25710489  0.45771445 -0.381068550 -0.145912362
nougat           -0.09012643 -0.36663902 -0.18793955 -0.385278987  0.011323453
crispedricewafer  0.09007640 -0.13077042  0.13567736 -0.511634999 -0.264810144
hard              0.12767365  0.31933477 -0.38881683 -0.258154433  0.220779142
bar              -0.25307332 -0.24192992 -0.02982691 -0.091872886 -0.003232321
pluribus         -0.03184932 -0.04066352 -0.28652547 -0.529954405  0.199303452
sugarpercent     -0.02737834 -0.14721840 -0.04114076  0.217685759 -0.488103337
pricepercent     -0.62908570  0.14308215  0.16722078  0.048991557  0.507716043
winpercent        0.56947283 -0.40260385 -0.02936405  0.124440117  0.358431235
                       PC11        PC12
chocolate        -0.10045278 -0.69784924
fruity           -0.17494902 -0.50624242
caramel          -0.13515820 -0.07548984
peanutyalmondy   -0.11244275 -0.12972756
nougat            0.38954473 -0.09223698
crispedricewafer  0.22615618 -0.11727369
hard             -0.01342330  0.10430092
bar              -0.74956878  0.22010569
pluribus         -0.27971527  0.06169246
sugarpercent     -0.05373286 -0.04733985
pricepercent      0.26396582  0.06698291
winpercent        0.11251626  0.37693153
```

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



** How to read this plot The PC1 contribution shows the linkage between PC1 and the provided variables. Use the plot for example, as we move further on the direction of PC1, we will find more fruitiness.

- Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you? A: Fruity, hard, and pluribus are strongly picked up by PC1 in the postive direction. It does make sense because most fruity candies are hard and come in pluribus.

HINT. pluribus means the candy comes in a bag or box of multiple candies.