class11 : Candy Mini-project

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Candy Data

We will examine candy data and use PCA/other methods.

```
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?

```
nrow(candy)
```

```
[1] 85
```

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

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

```
[1] 38
```

> What are these fruity candy?

```
rownames(candy[candy$fruity ==1,])
```

```
 [1] "Air Heads"                   "Caramel Apple Pops"
 [3] "Chewey Lemonhead Fruit Mix"  "Chiclets"
 [5] "Dots"                        "Dum Dums"
 [7] "Fruit Chews"                 "Fun Dip"
 [9] "Gobstopper"                  "Haribo Gold Bears"
[11] "Haribo Sour Bears"           "Haribo Twin Snakes"
[13] "Jawbusters"                  "Laffy Taffy"
[15] "Lemonhead"                   "Lifesavers big ring
gummies"
[17] "Mike & Ike"                  "Nerds"
[19] "Nik L Nip"                   "Now & Later"
[21] "Pop Rocks"                   "Red vines"
[23] "Ring pop"                    "Runts"
[25] "Skittles original"           "Skittles wildberry"
[27] "Smarties candy"              "Sour Patch Kids"
[29] "Sour Patch Tricksters"       "Starburst"
[31] "Strawberry bon bons"         "Super Bubble"
[33] "Swedish Fish"                "Tootsie Pop"
[35] "Trolli Sour Bites"           "Twizzlers"
[37] "Warheads"                    "Welch's Fruit Snacks"
```

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

How often does my favorite candy win:

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

```
[1] 81.64291
```

My favorite candy:

```
candy["Swedish Fish",]$winpercent
```

```
[1] 54.86111
```

> 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
```

Use he skimr::skim() function on candy:

```
skimr::skim(candy)
```

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	
chocolate	0	1	0.44	0.50	0.00	0.00	0
fruity	0	1	0.45	0.50	0.00	0.00	0
caramel	0	1	0.16	0.37	0.00	0.00	0
peanutyalmondy	0	1	0.16	0.37	0.00	0.00	0
nougat	0	1	0.08	0.28	0.00	0.00	0
crispedricewafer	0	1	0.08	0.28	0.00	0.00	0
hard	0	1	0.18	0.38	0.00	0.00	0
bar	0	1	0.25	0.43	0.00	0.00	0
pluribus	0	1	0.52	0.50	0.00	0.00	
sugarpercent	0	1	0.48	0.28	0.01	0.22	0
pricepercent	0	1	0.47	0.29	0.01	0.26	0
winpercent	0	1	50.32	14.71	22.45	39.14	4

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

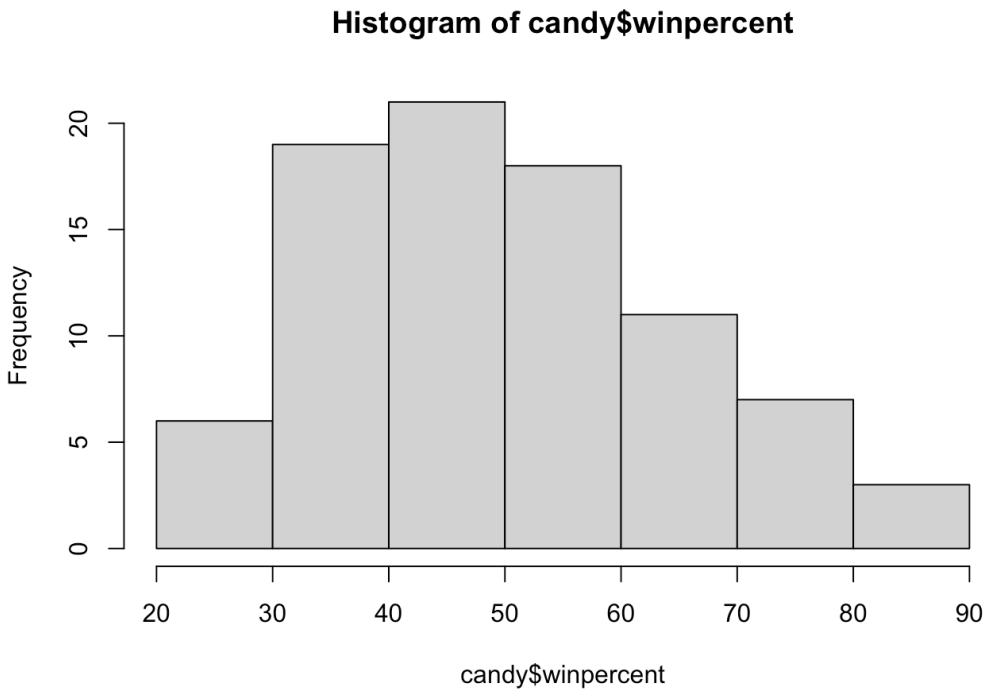
Yes, `winpercent` column is on a 0:100 scale, not 0:1 like all of the other ones.

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

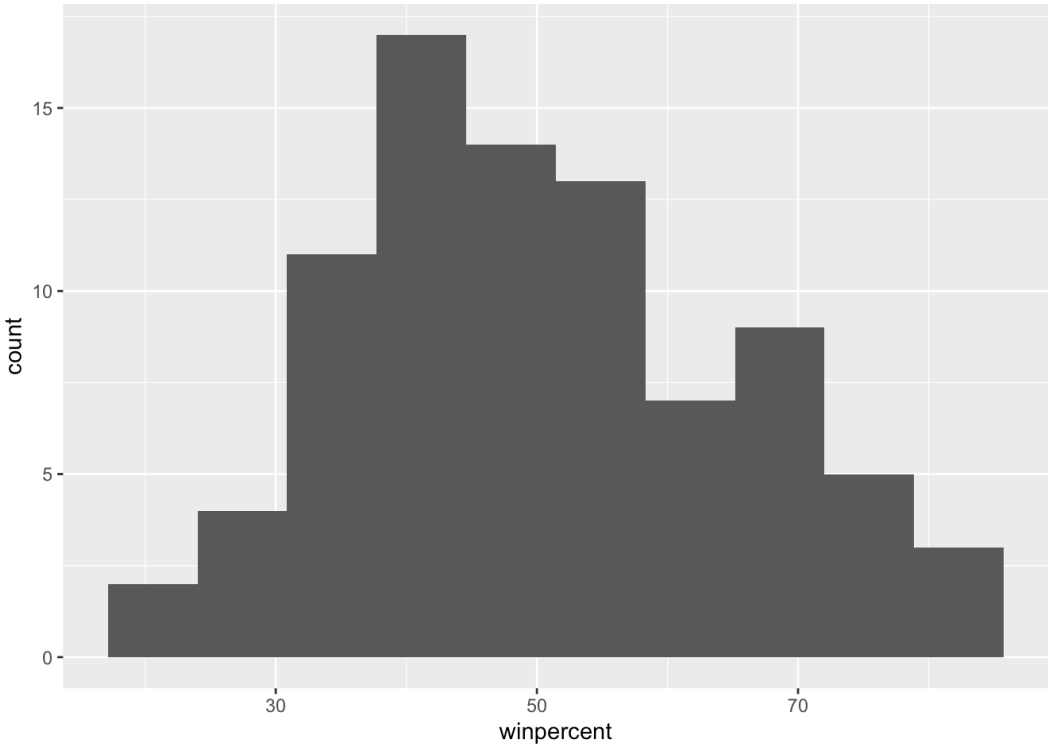
A 0 means the candy is not classified as containing chocolate and 1 does contain it.

> Q8. Plot a histogram of winpercent values

```
# In base R graphics:
hist(candy$winpercent)

# In ggplot2:
library(ggplot2)
```




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



> Q9. Is the distribution of winpercent values symmetrical?

Nope

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

Below 50% with a mean:

```
# Find the mean:
mean(candy$winpercent)
```

```
[1] 50.31676
```

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

```
# My method:
fruity_candy <- mean(candy[candy$fruity == 1,]$winpercent)
chocolate_candy <- mean(candy[candy$chocolate == 1,]$winpercent
fruity_candy
```

```
[1] 44.11974
```

```
chocolate_candy
```

```
[1] 60.92153
```

```
print("Professor's method below:")
```

```
[1] "Professor's method below:"
```

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

> Q12. Is this difference statistically significant?

Yes, people prefer chocolate.

```
t.test(chocolate.winpercent, fruity.winpercent)
```

```

    Welch Two Sample t-test

data:  chocolate.winpercent and fruity.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

There is a base R function called `sort()` for sorting vectors of input.

```
x <- c(5, 2, 10)

# sort(x, decreasing = TRUE)
sort(x)
```

```
[1]  2  5 10
```

The related function to `sort()` that is often more useful is called `order()`. It returns the "indices" of the input that would result in it being sorted.

```
# Use order to know HOW to rearrange input:
order(x)
```

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

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

```
[1]  2  5 10
```

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

I can order by `winpercent`.

```
ord <- order(candy$winpercent)
head(candy[ord,], 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?

```
ord <- order(candy$winpercent, decreasing = TRUE)
head(candy[ord,], 5)
```

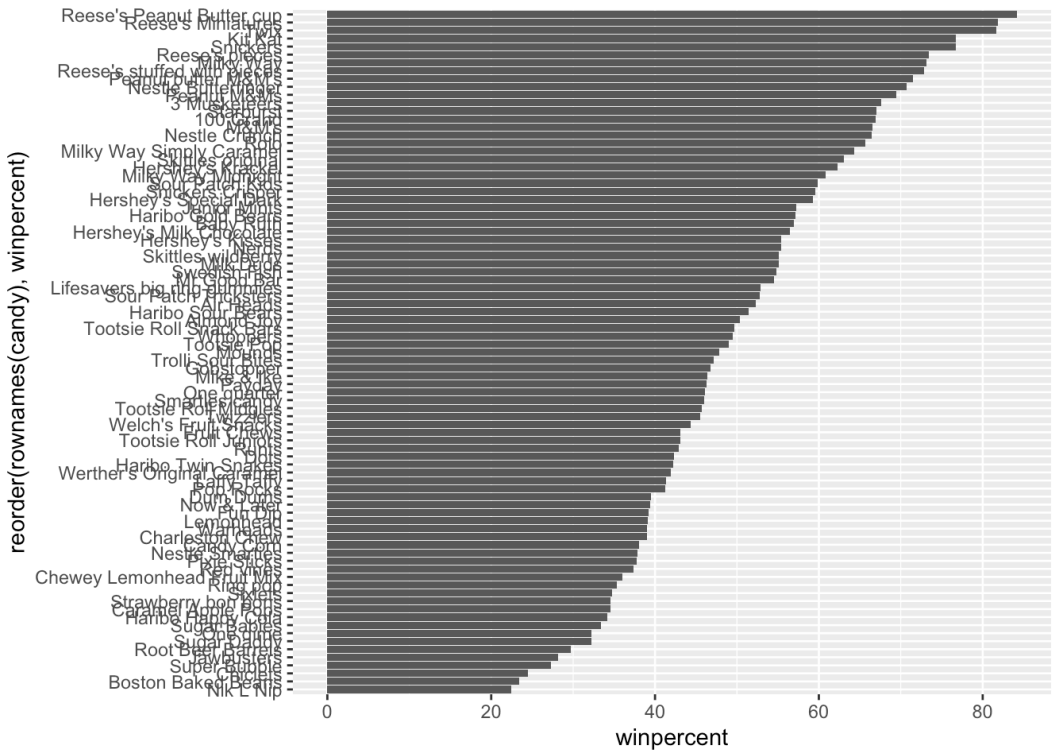
```
                         chocolate fruity caramel
peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0
1      0
Reese's Miniatures                1      0       0
1      0
Twix                              1      0       1
0      0
Kit Kat                           1      0       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.

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

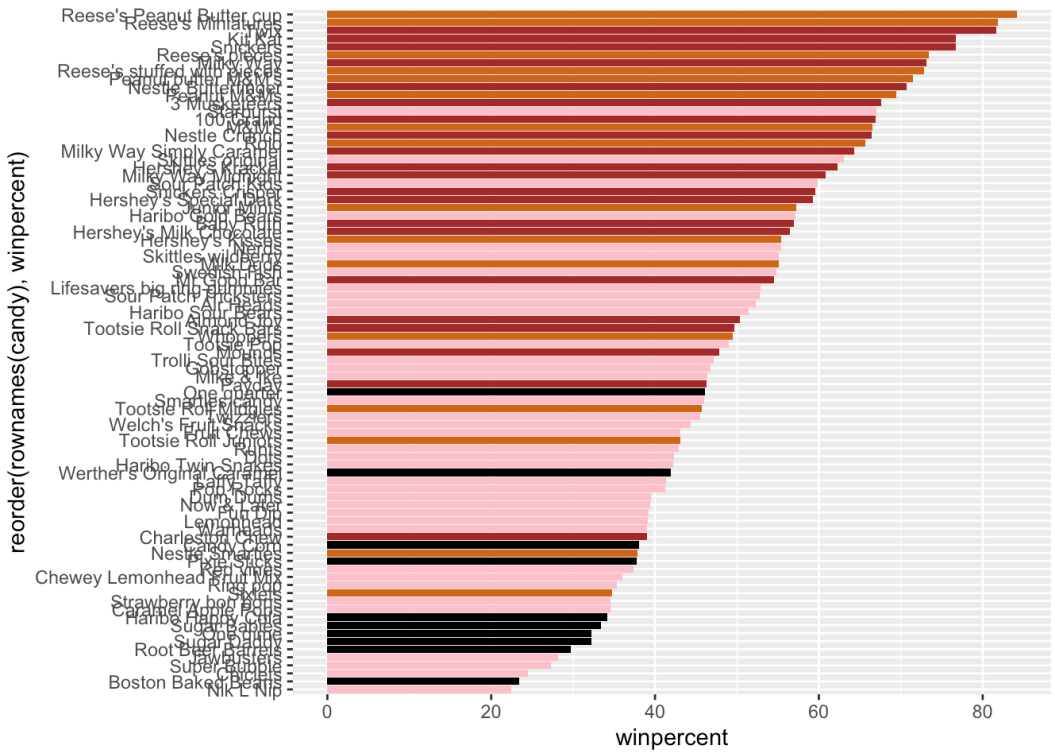
```
library(ggplot2)

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



Time to add some color:

```
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"
```

```
library(ggplot2)

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?

Starburst

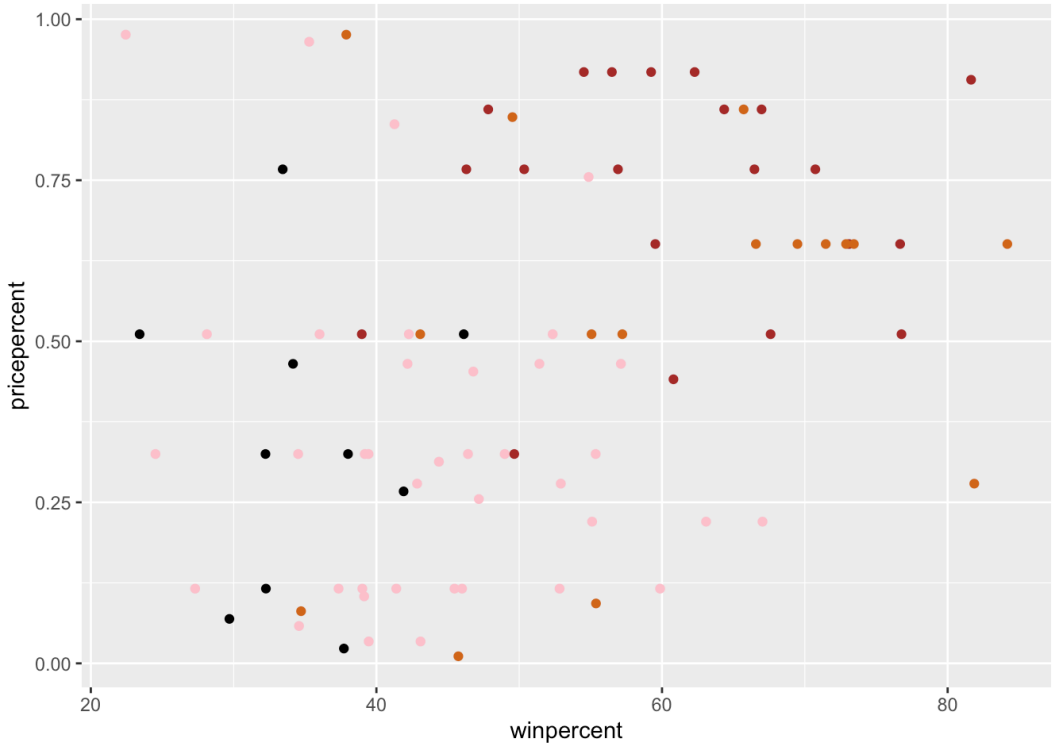
Taking a look at pricepercent

> What is the the best candy for the least money?

```
my_cols[as.logical(candy$fruity)] = "pink"
```

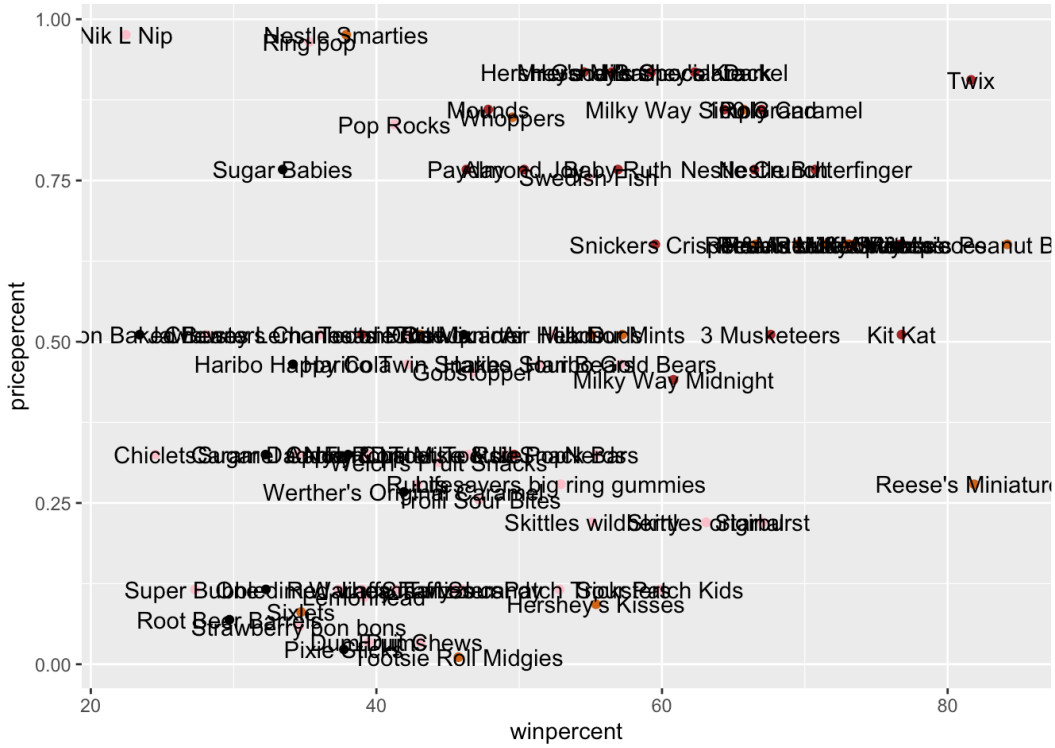
```
library(ggplot2)

ggplot(candy) +
  aes(winpercent, pricepercent) +
```

```
  geom_point(col=my_cols)
```



Add some labels:

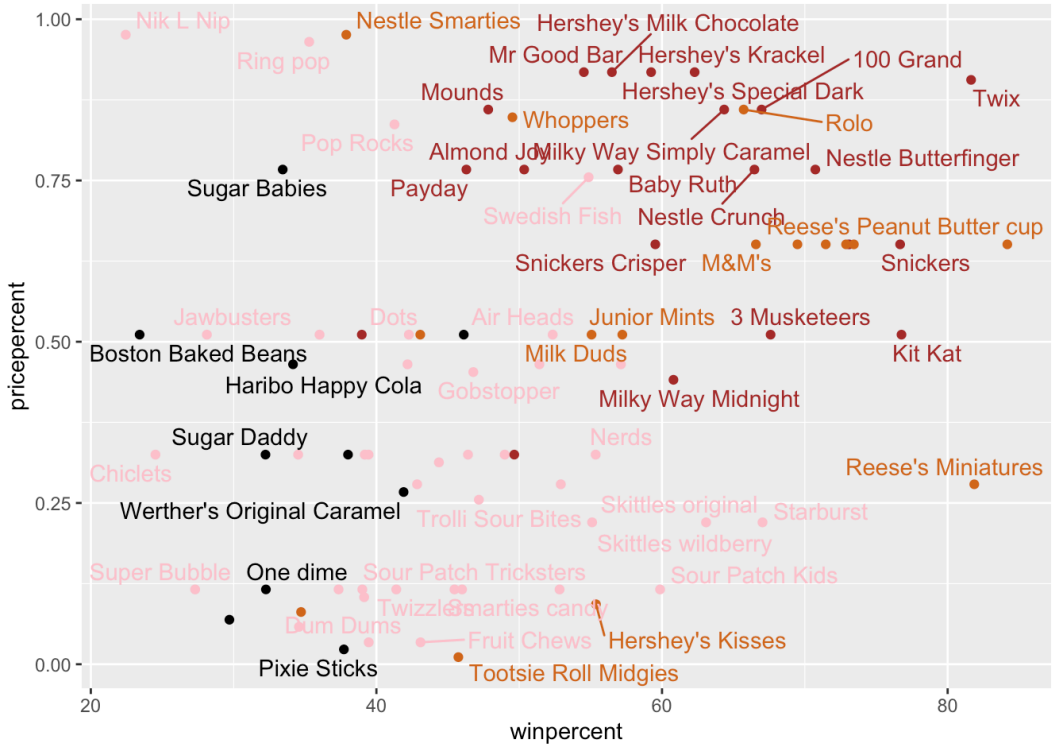
```
ggplot(candy) +
  aes(winpercent, pricepercent, label = rownames(candy)) +
  geom_point(col = my_cols) +
  geom_text()
```



To deal with overlapping labels, I can use the **ggrepel** package.

```
library(ggrepel)

ggplot(candy) +
  aes(winpercent, pricepercent, label = rownames(candy)) +
  geom_point(col = my_cols) +
  geom_text_repel(max.overlaps = 10, col=my_cols)
```

```
Warning: ggrepel: 29 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?

Reese's Miniatures

> 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
```

Exploring the correlation structure

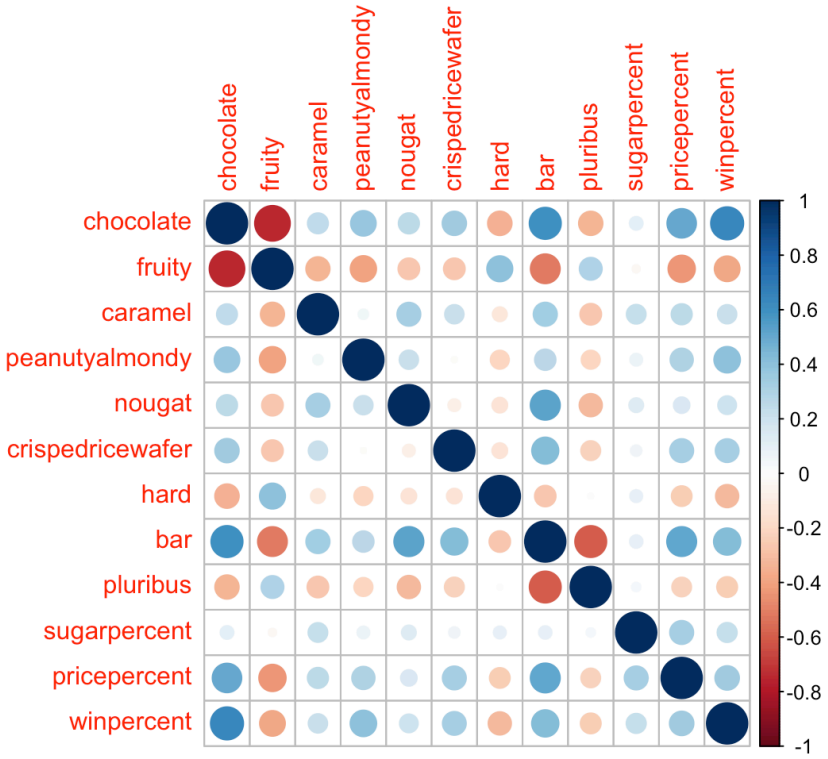
Pearson correlation goes between -1 and +1 with 0 indicating no

correlation, and values close to one being very highly correlated.

```
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)?

Chocolate and Fruit are anti-correlated.

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

Chocolate and winpercent or bar.

Principal Component Analysis

The base R function for PCA is called `prcomp()` and we can set "scale=TRUE/FALSE".

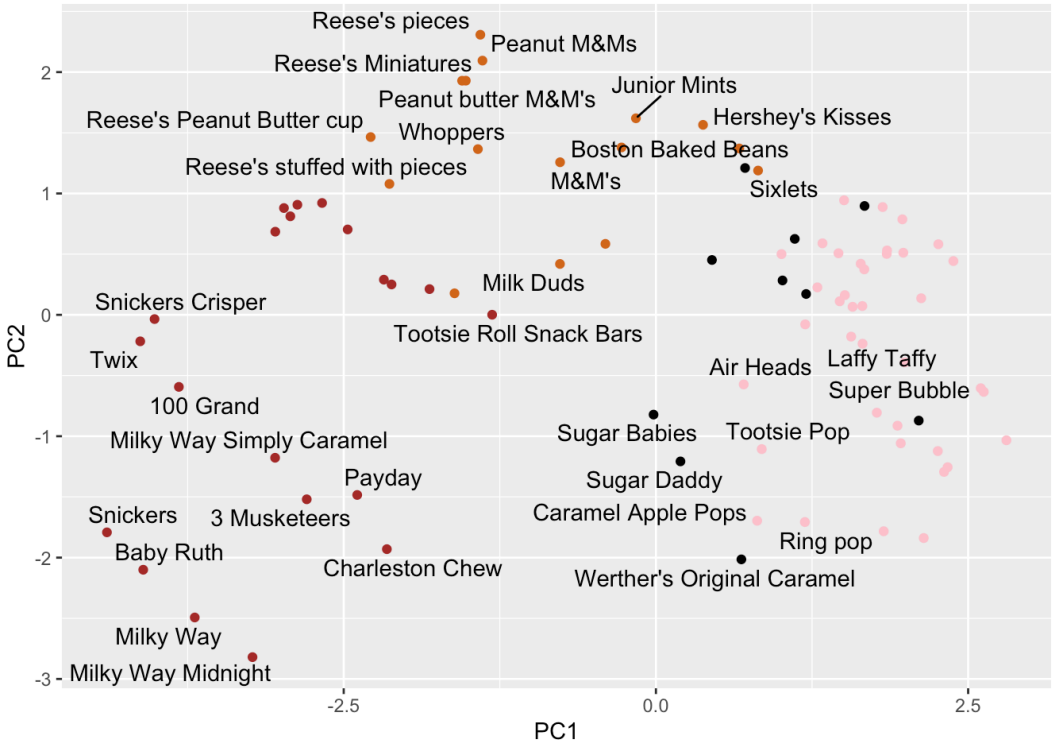
```
pca <- prcomp(candy, scale = TRUE)
summary(pca)
```

```
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
```

The main result of PCA - i.e. the new PC plot (projection of candy on our new PC axis) is contained in `pca$x`.

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

ggplot(pc, aes(PC1, PC2, label = rownames(pc))) +
  geom_point(col = my_cols) +
  geom_text_repel(max.overlaps = 5)
```

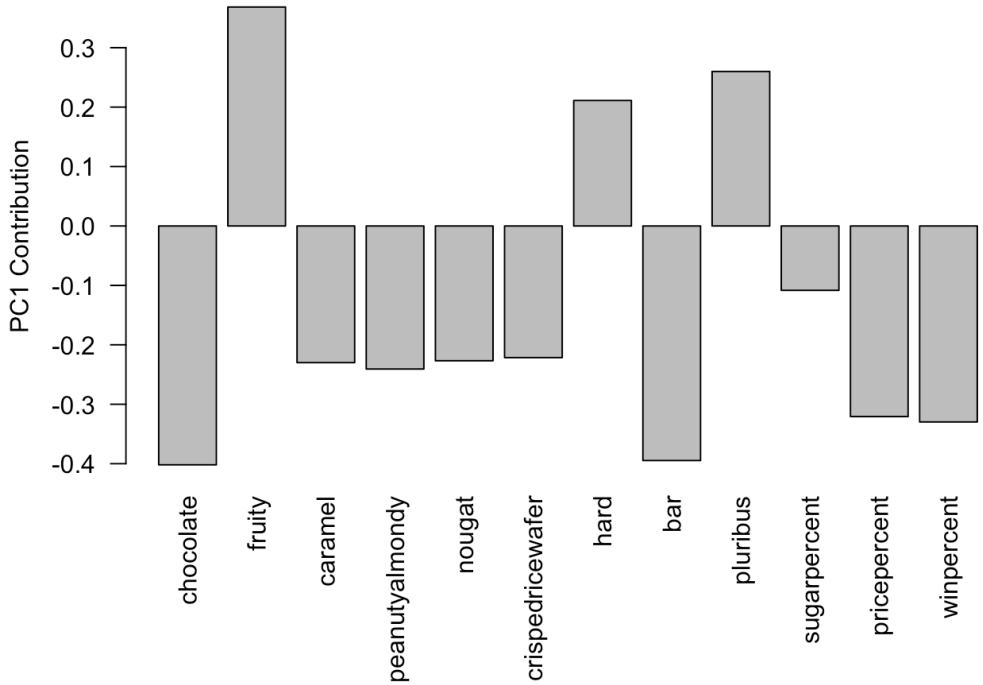
```
Warning: ggrepel: 51 unlabeled data points (too many
overlaps). Consider
increasing max.overlaps
```



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

Fruity

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


PC1 Contribution
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
chocolate
fruity
caramel
peanutyalmondy
nougat
crispedricewafer
hard
bar
pluribus
sugarpercent
pricepercent
winpercent