Class 11: Candy Project

AUTHOR
Hyeseung (Frankie) Son PID: A16025601

In today's class we will examine 538 candy and see if this helps gaining more feel for how PCA and other methods work.

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

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

```
[1] 38
```

> Q. What are these fruity candy types

We can use the == (TRUE/FALSE

```
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"
```

How often does my favorite candy win?

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

```
candy["Haribo Twin Snakes", ]$winpercent
```

```
[1] 42.17877
```

> 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
```

There is a useful function that will "skim" a dataset.

```
library("skimr")
```

```
Warning: package 'skimr' was built under R version 4.2.3
```

```
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	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	▃▇▆▅▂

```
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	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?

The `winpercent` column is on a 0:100 scale while all others appear to be on a 0:1 scale

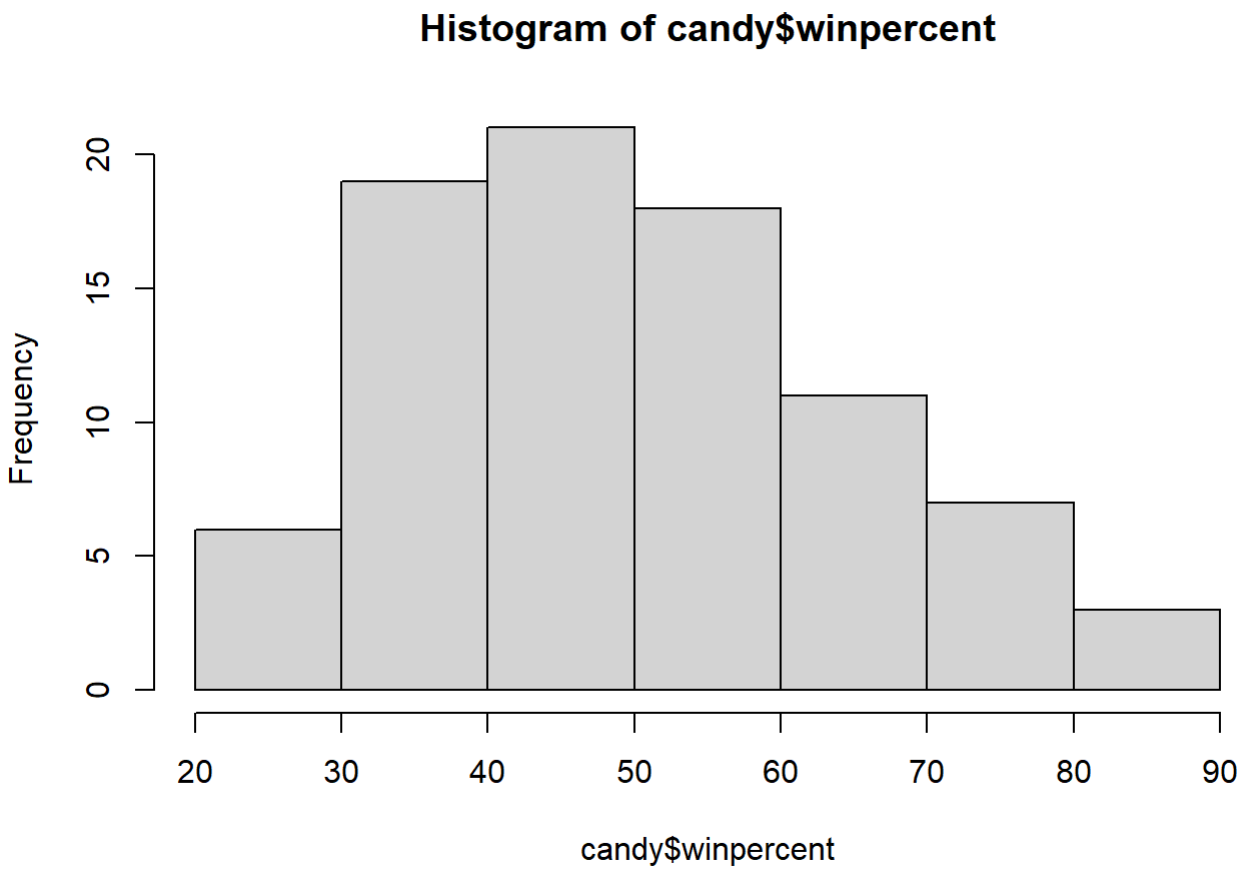
> Q7. What do you think a zero and one represent for the candy$chocolate column?

A zero = candy isn't classified as chocolate, while a one = candy is classified as chocolate.

> Q8. Plot a histogram of winpercent values

In base R graphics:

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



Versus ggplot:

```
library(ggplot2)
```

```
Warning: package 'ggplot2' was built under R version 4.2.3
```

```
winpercent <- ggplot(candy) +
  aes(winpercent) +
  geom_histogram()
```

> Q9. Is the distribution of winpercent values symmetrical?

Nope

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

```
mean(candy$winpercent)
```

```
[1] 50.31676
```

the center of the distribution is just barely above 50%.

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

To answer these questions I need to:

- subset (aka “select”, “filter”) the candy subset by chocolate
- Find their column winpercent values
- calculate the mean of each subset

```
# Filter/select/subset for chocolate
choc.candy <- candy[as.logical(candy$chocolate), ]

# Get their winpercent values
choc.winpercent <- choc.candy$winpercent

# Calculate the mean
mean(choc.winpercent)
```

```
[1] 60.92153
```

We should do the same to find the values for fruit.

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

fruit.winpercent <- fruit.candy$winpercent

mean(fruit.winpercent)
```

```
[1] 44.11974
```

> Q12. Is this difference statistically significant?

```
t.test(choc.winpercent, fruit.winpercent)
```

```
    Welch Two Sample t-test

data:  choc.winpercent and fruit.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
```

We get a p-value of much less than 0.05, meaning the difference between `choc.winpercent` and `fruit.winpercent` is statistically significant. It is safe to conclude that people do prefer chocolate much more.

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

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

sort(x, decreasing = TRUE)
```

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

The buddy function to `sort()` is called `order()` and is often most useful. It returns the "indices" of the input that would result from being it being sorted.

```
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?

```
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?

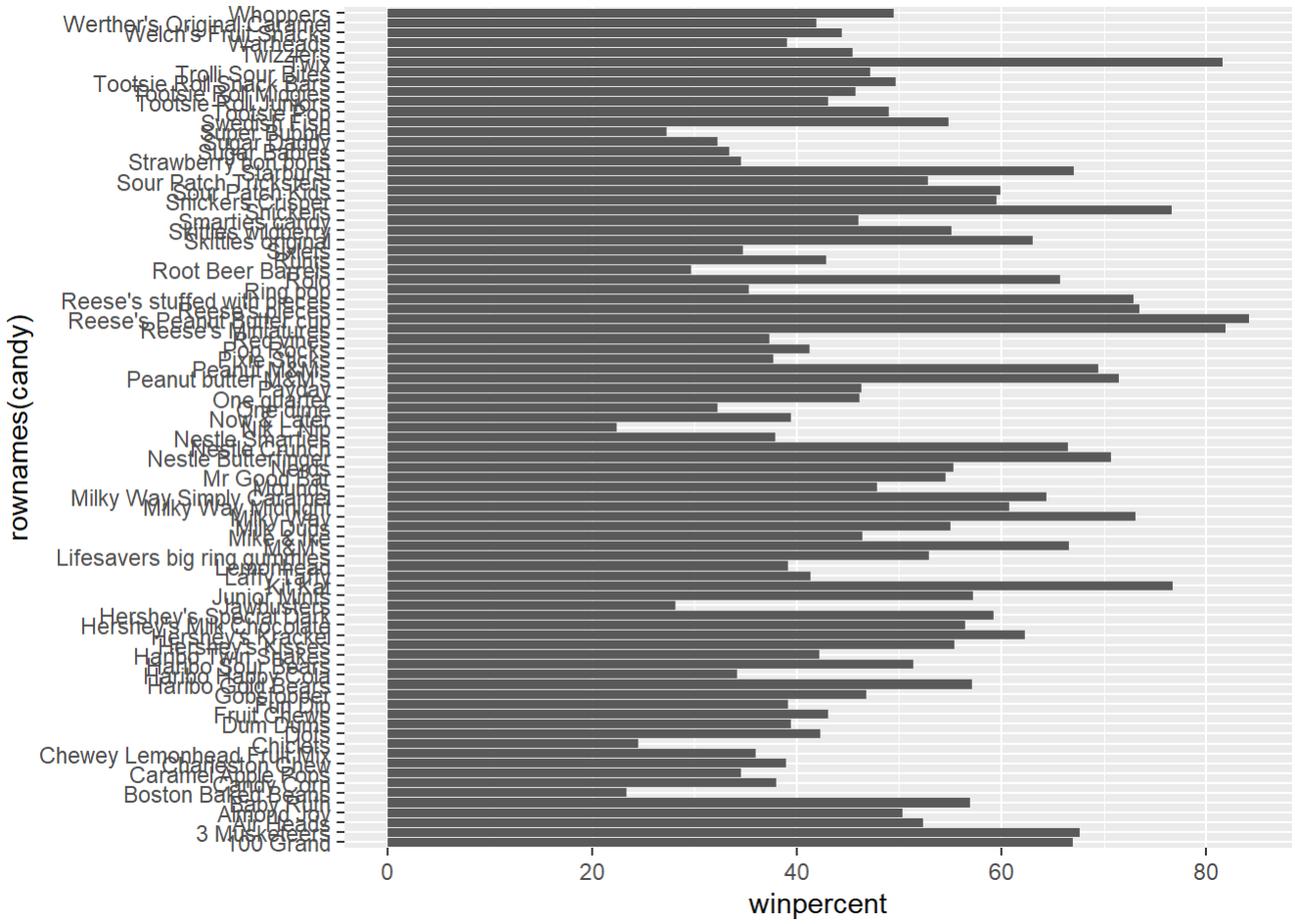
```
# We add a sorting element to put it in decreasing order
ord <- order(candy$winpercent, decreasing = TRUE)

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.

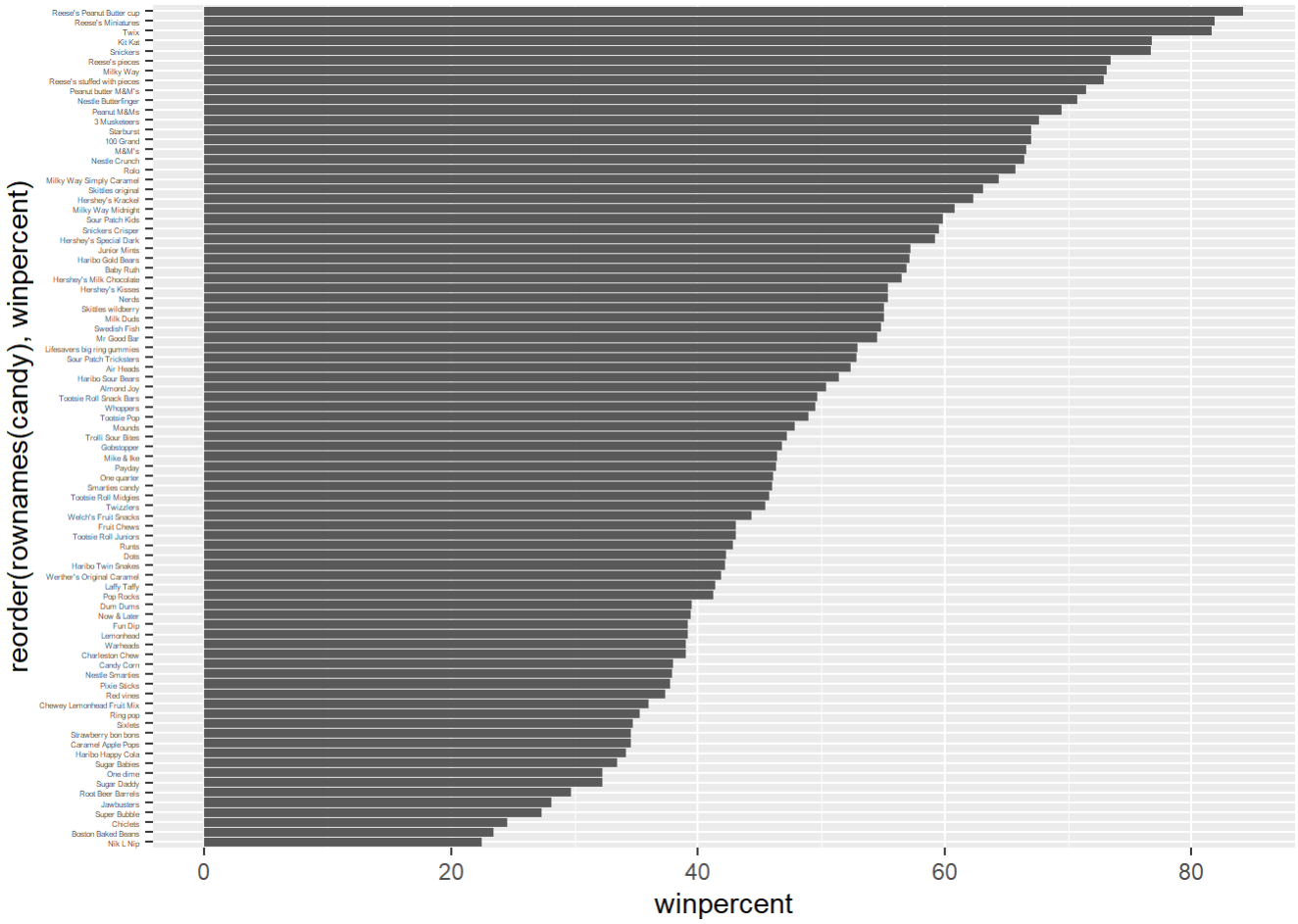
```
ggplot(candy) +
  aes(winpercent, rownames(candy), font = 6) +
  geom_col()
```



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

You can use aes(winpercent, reorder(rownames(candy),winpercent)) to improve your plot.

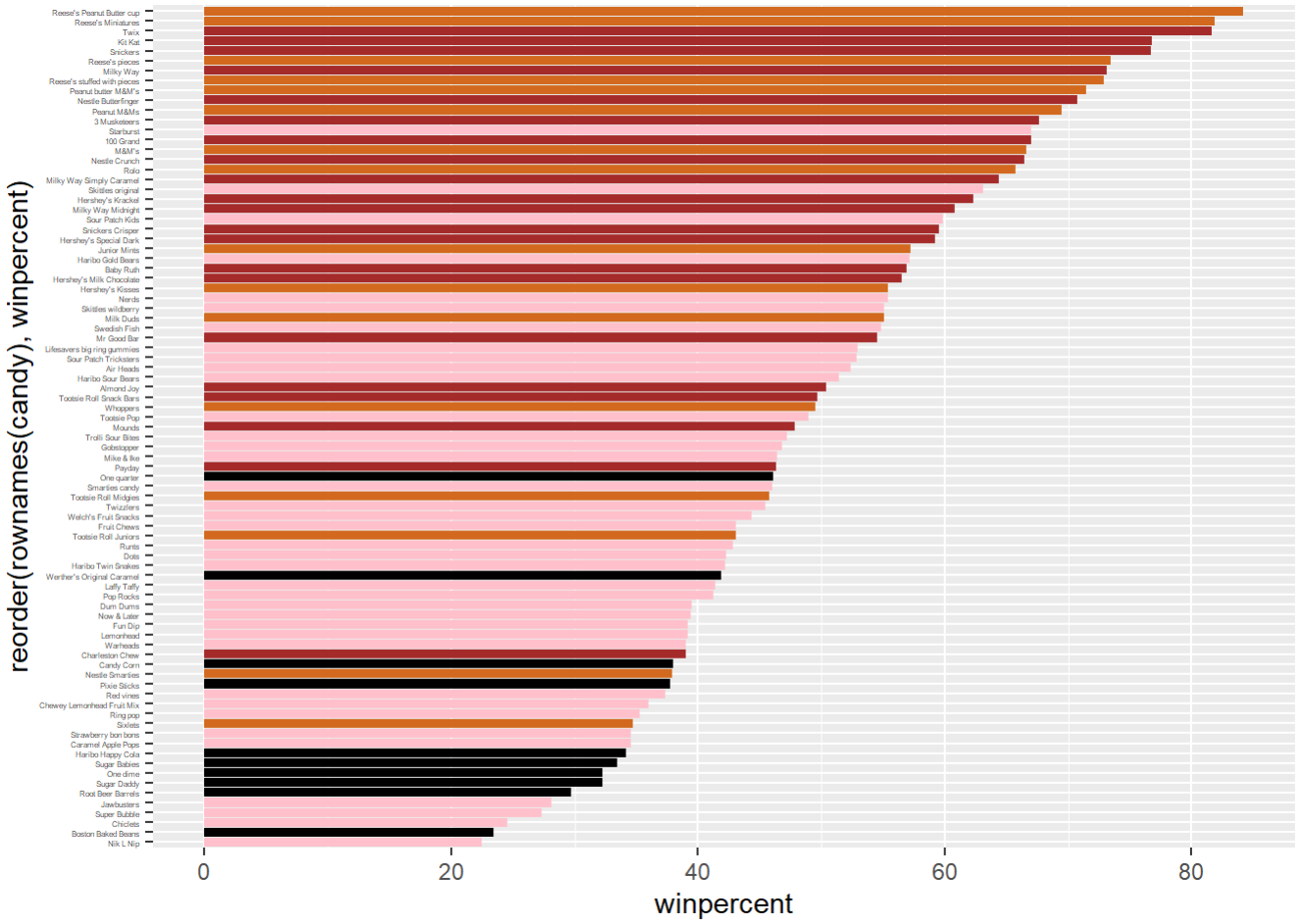
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col() +
  theme(axis.text.y = element_text(size = 3))
```



Let's add some color to our bar plot by identifying our candy types as color vectors.

```
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) +
  theme(axis.text.y = element_text(size = 3))
```



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?

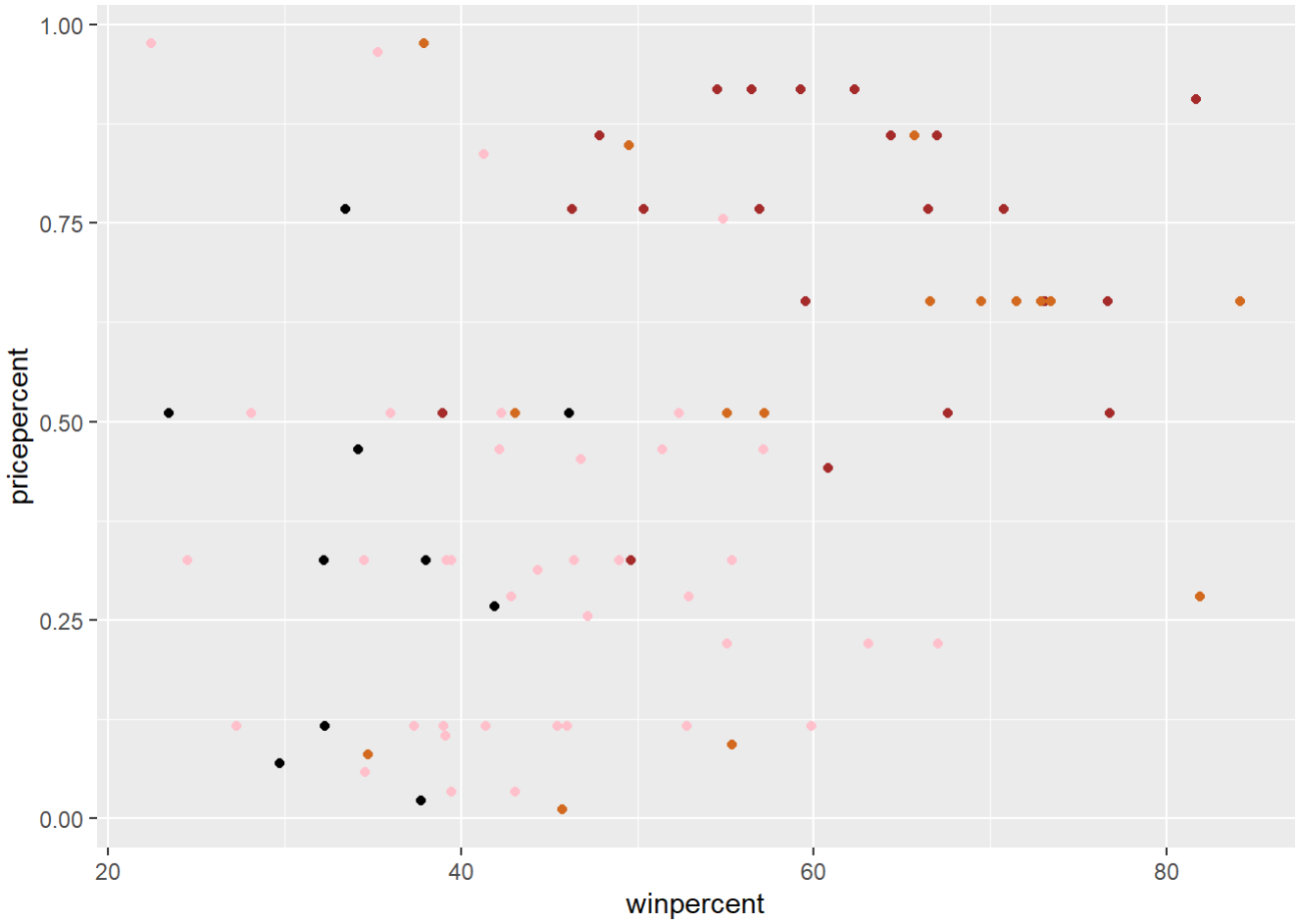
Starburst

Taking a look at price percent

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

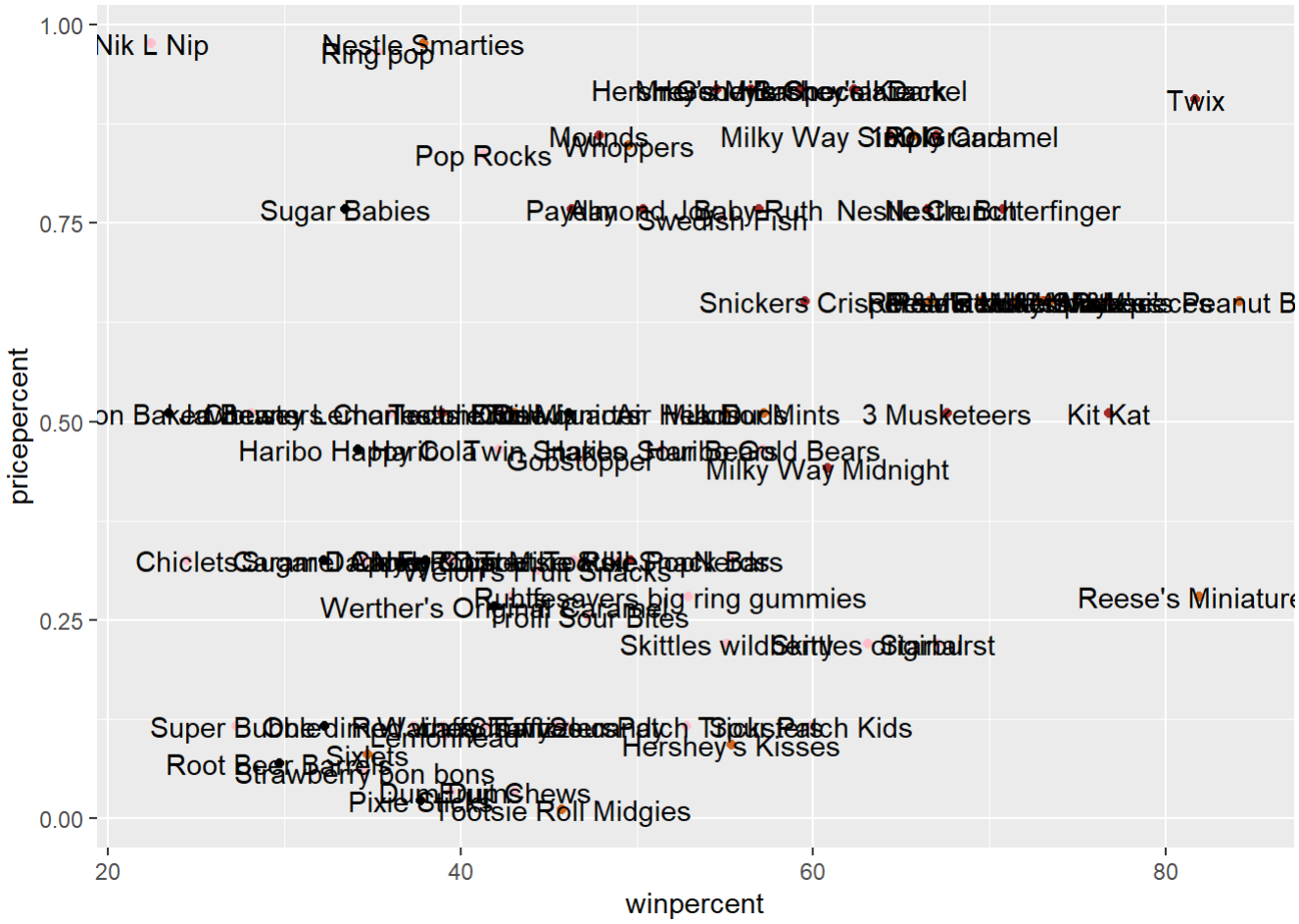
Reese's Peanut Butter Cups

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



Let's add some labels

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



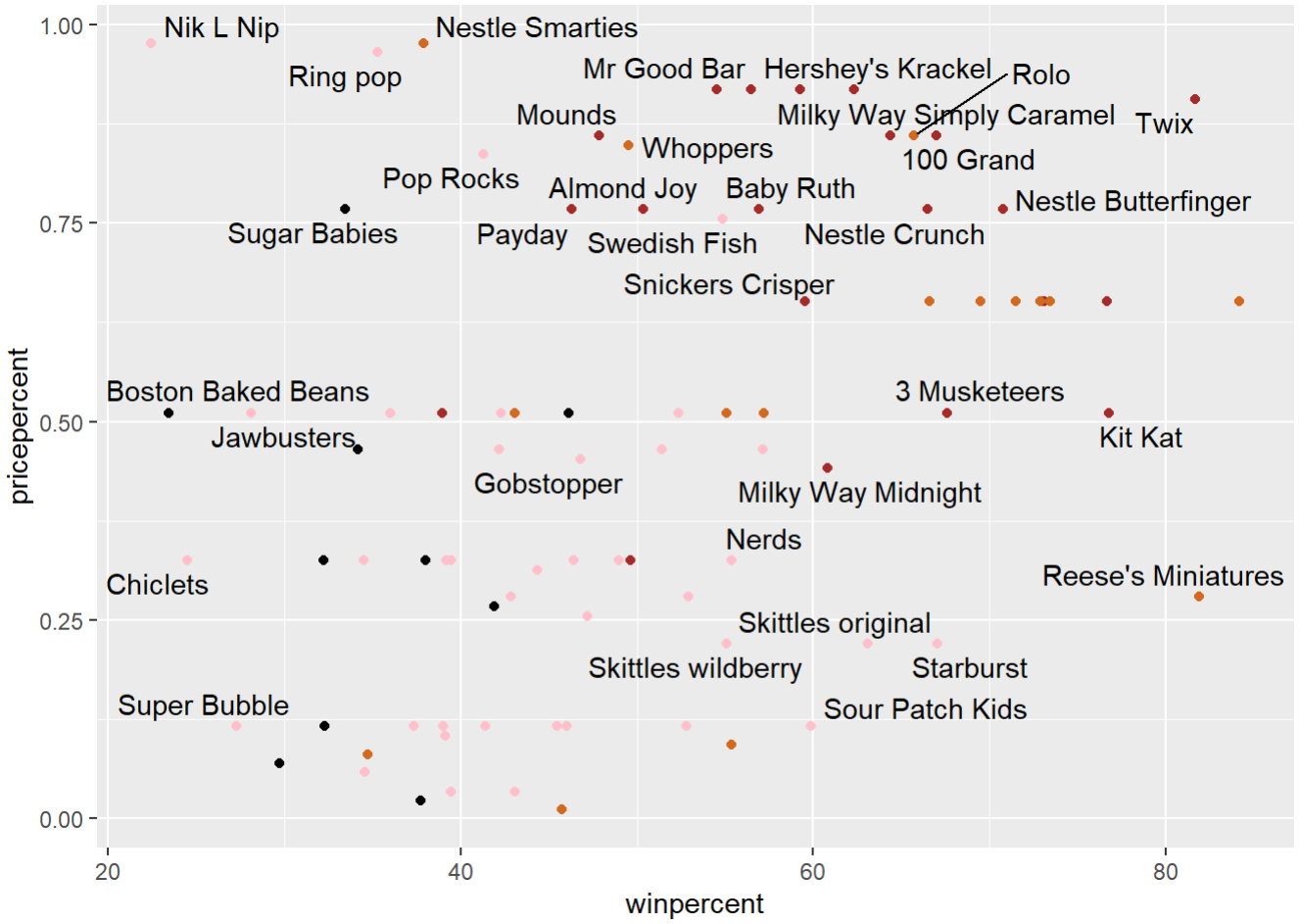
To deal with overlapping labels, I can use the **geom_repel** package.

```
library(ggrepel)
```

```
Warning: package 'ggrepel' was built under R version 4.2.3
```

```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy), font = 9) +
  geom_point(col=my_cols) +
  geom_text_repel(max.overlaps = 6)
```

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



Exploring correlation structure

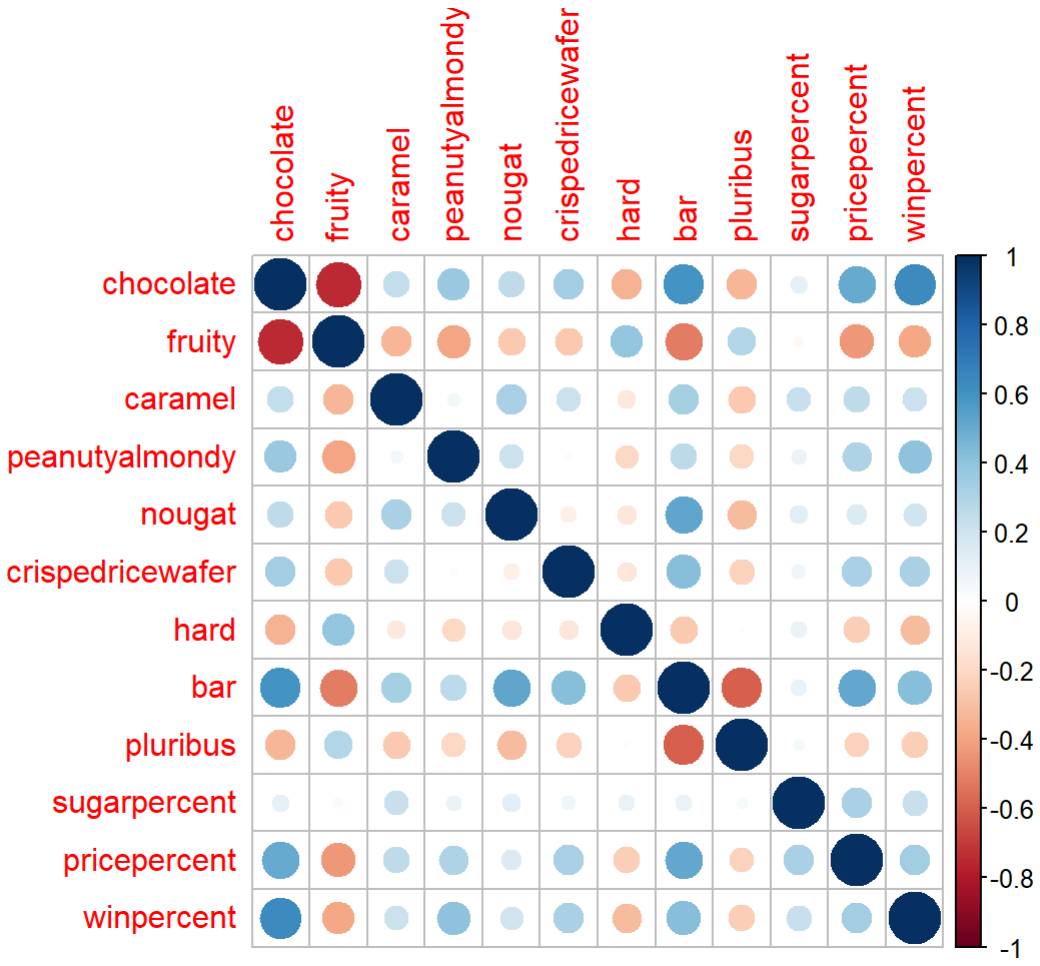
Pearson correlation goes between -1 and +1 with zero indicating no correlation, and values close to one being very highly correlated.

```
library(corrplot)
```

```
Warning: package 'corrplot' was built under R version 4.2.3
```

```
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 are the ost positively correlated.

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)
```

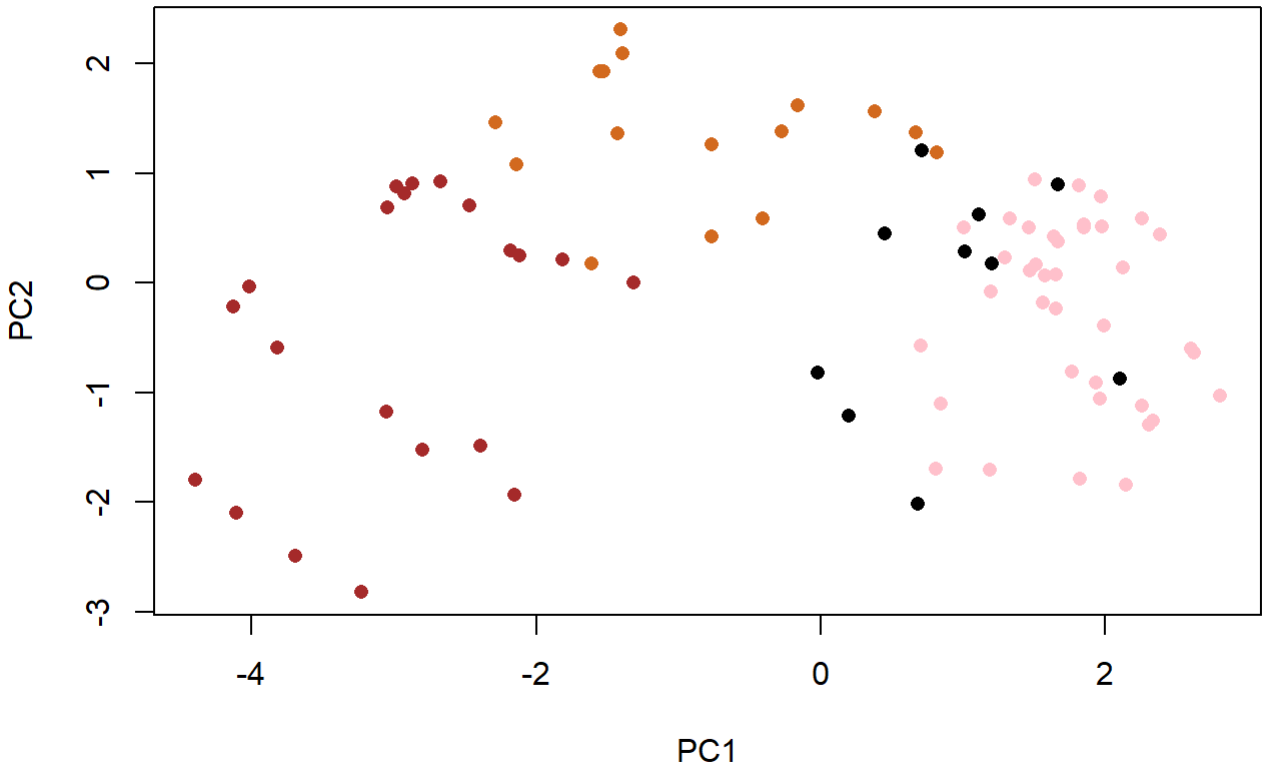
```
Importance of components:
                          PC1    PC2    PC3     PC4    PC5     PC6     PC7
Standard deviation     2.0788 1.1378 1.1092 1.07533 0.9518 0.81923 0.81530
Proportion of Variance 0.3601 0.1079 0.1025 0.09636 0.0755 0.05593 0.05539
Cumulative Proportion  0.3601 0.4680 0.5705 0.66688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

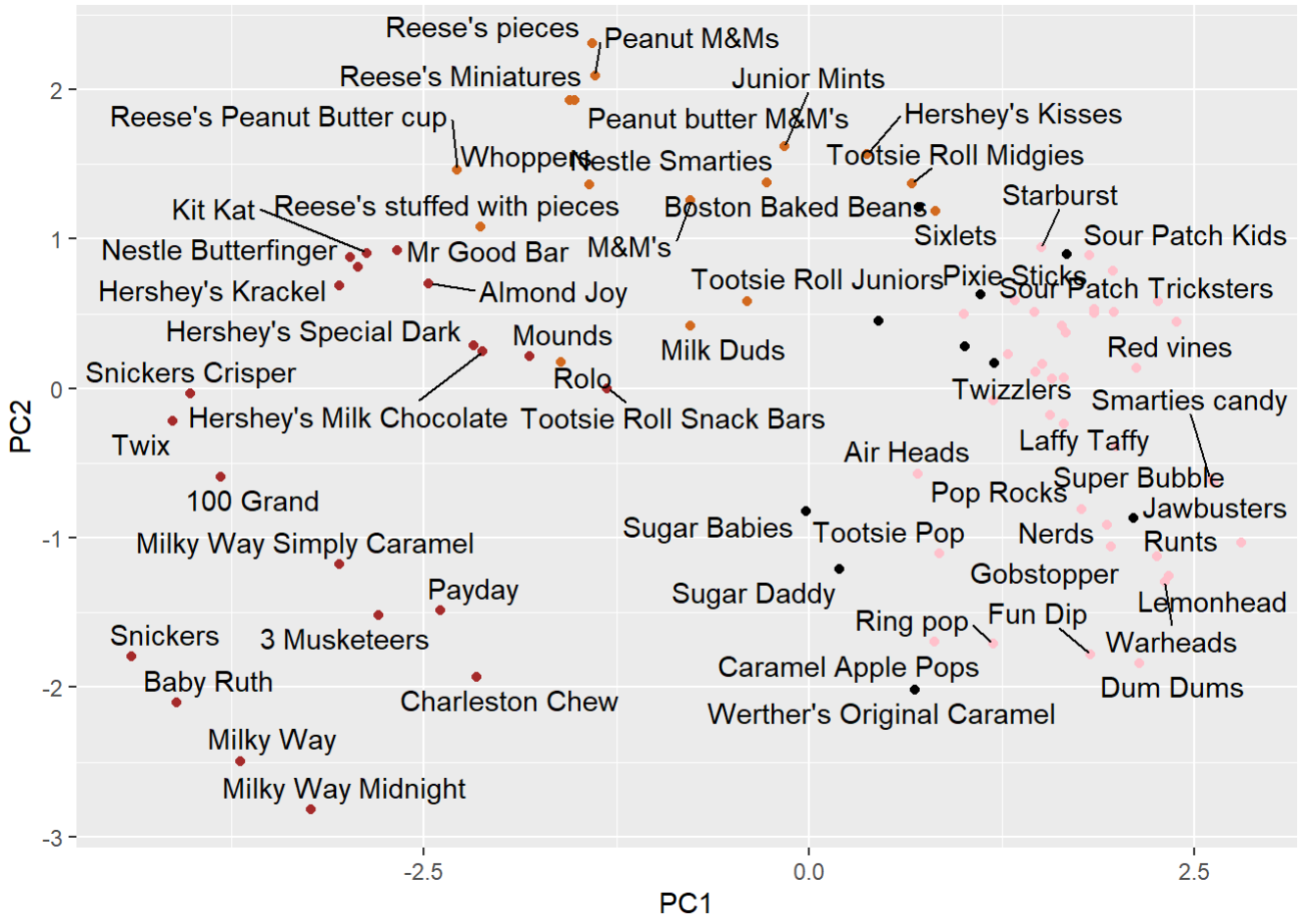
```
pc <- as.data.frame(pca$x)

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




```
ggplot(pc) +
  aes(PC1, PC2, label=rownames(pc)) +
  geom_point(col=my_cols) +
  geom_text_repel(max.overlaps = 10)
```

```
Warning: ggrepel: 23 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, hard, pluribus are the original variables picked up strongly by PC1 in the positive direction. Yes, it does make sense, since candies that are fruity will also be ard, and come in multiples.