# Halloween Mini-Project

Mariam Benny (A17103451)

```
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?

There's 85 candy types.

```
nrow(candy)
```

```
[1] 85
```

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

There's 38 fruity candy types.

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

```
[1] 38
```

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

My favorite candy is Rolo, and its winpercent is 65.7%.

```
candy["Rolo","winpercent"]
```

```
[1] 65.71629
```

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

Kit Kat has a 76.8% winpercent.

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

```
[1] 76.7686
```

Q5. What is the winpercent value for "Tootsie Roll Snack Bars"?

Tootsie Roll Snack Bars has a 49.7% winpercent.

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

```
[1] 49.6535
```

```
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 |>
  filter(rownames(candy)=="Haribo Happy Cola") |>
  select(winpercent)
```

```
                 winpercent
Haribo Happy Cola   34.15896
```

Q. Find a fruit candy with a winpercent above 50%.

```
candy |>
  filter(winpercent > 50) |>
  filter(fruity==1)
```

```
                           chocolate fruity caramel peanutyalmondy nougat
Air Heads                          0      1       0              0      0
Haribo Gold Bears                  0      1       0              0      0
Haribo Sour Bears                  0      1       0              0      0
Lifesavers big ring gummies        0      1       0              0      0
Nerds                              0      1       0              0      0
Skittles original                  0      1       0              0      0
Skittles wildberry                 0      1       0              0      0
Sour Patch Kids                    0      1       0              0      0
Sour Patch Tricksters              0      1       0              0      0
Starburst                          0      1       0              0      0
Swedish Fish                       0      1       0              0      0
                           crispedricewafer hard bar pluribus sugarpercent
Air Heads                                 0    0   0        0        0.906
Haribo Gold Bears                         0    0   0        1        0.465
Haribo Sour Bears                         0    0   0        1        0.465
Lifesavers big ring gummies               0    0   0        0        0.267
Nerds                                     0    1   0        1        0.848
Skittles original                         0    0   0        1        0.941
Skittles wildberry                        0    0   0        1        0.941
Sour Patch Kids                           0    0   0        1        0.069
Sour Patch Tricksters                     0    0   0        1        0.069
Starburst                                 0    0   0        1        0.151
Swedish Fish                              0    0   0        1        0.604
                           pricepercent winpercent
Air Heads                         0.511   52.34146
Haribo Gold Bears                 0.465   57.11974
Haribo Sour Bears                 0.465   51.41243
```

```
Lifesavers big ring gummies        0.279   52.91139
Nerds                              0.325   55.35405
Skittles original                  0.220   63.08514
Skittles wildberry                 0.220   55.10370
Sour Patch Kids                    0.116   59.86400
Sour Patch Tricksters              0.116   52.82595
Starburst                          0.220   67.03763
Swedish Fish                       0.755   54.86111
```

```
top.candy <- candy[candy$winpercent > 50,]
top.candy[top.candy$fruity ==1,]
```

```
                           chocolate fruity caramel peanutyalmondy nougat
Air Heads                          0      1       0              0      0
Haribo Gold Bears                  0      1       0              0      0
Haribo Sour Bears                  0      1       0              0      0
Lifesavers big ring gummies        0      1       0              0      0
Nerds                              0      1       0              0      0
Skittles original                  0      1       0              0      0
Skittles wildberry                 0      1       0              0      0
Sour Patch Kids                    0      1       0              0      0
Sour Patch Tricksters              0      1       0              0      0
Starburst                          0      1       0              0      0
Swedish Fish                       0      1       0              0      0
                           crispedricewafer hard bar pluribus sugarpercent
Air Heads                                 0    0   0        0        0.906
Haribo Gold Bears                         0    0   0        1        0.465
Haribo Sour Bears                         0    0   0        1        0.465
Lifesavers big ring gummies               0    0   0        0        0.267
Nerds                                     0    1   0        1        0.848
Skittles original                         0    0   0        1        0.941
Skittles wildberry                        0    0   0        1        0.941
Sour Patch Kids                           0    0   0        1        0.069
Sour Patch Tricksters                     0    0   0        1        0.069
Starburst                                 0    0   0        1        0.151
Swedish Fish                              0    0   0        1        0.604
                           pricepercent winpercent
Air Heads                         0.511   52.34146
Haribo Gold Bears                 0.465   57.11974
Haribo Sour Bears                 0.465   51.41243
Lifesavers big ring gummies       0.279   52.91139
Nerds                             0.325   55.35405
```

```
Skittles original                0.220   63.08514
Skittles wildberry               0.220   55.10370
Sour Patch Kids                  0.116   59.86400
Sour Patch Tricksters            0.116   52.82595
Starburst                        0.220   67.03763
Swedish Fish                     0.755   54.86111
```

To get a quick insight into a new data set

```
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 | |

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

Table 3: 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?

`winpercent` variable looks different, its range is much larger than just 0 to 1.

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

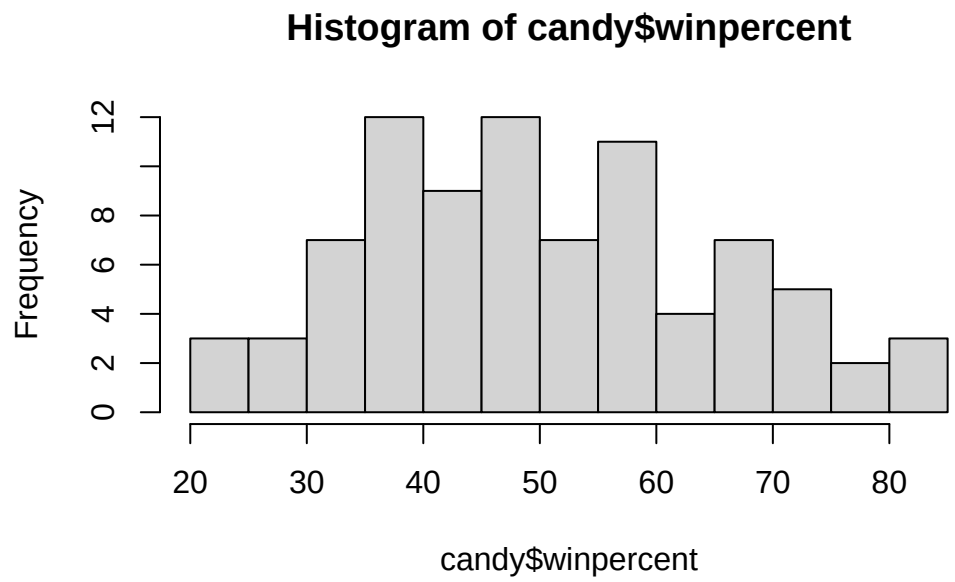
It likely represents whether chocolate is present in that candy or not, 0 meaning not present and 1 meaning it is.

```
candy$chocolate
```

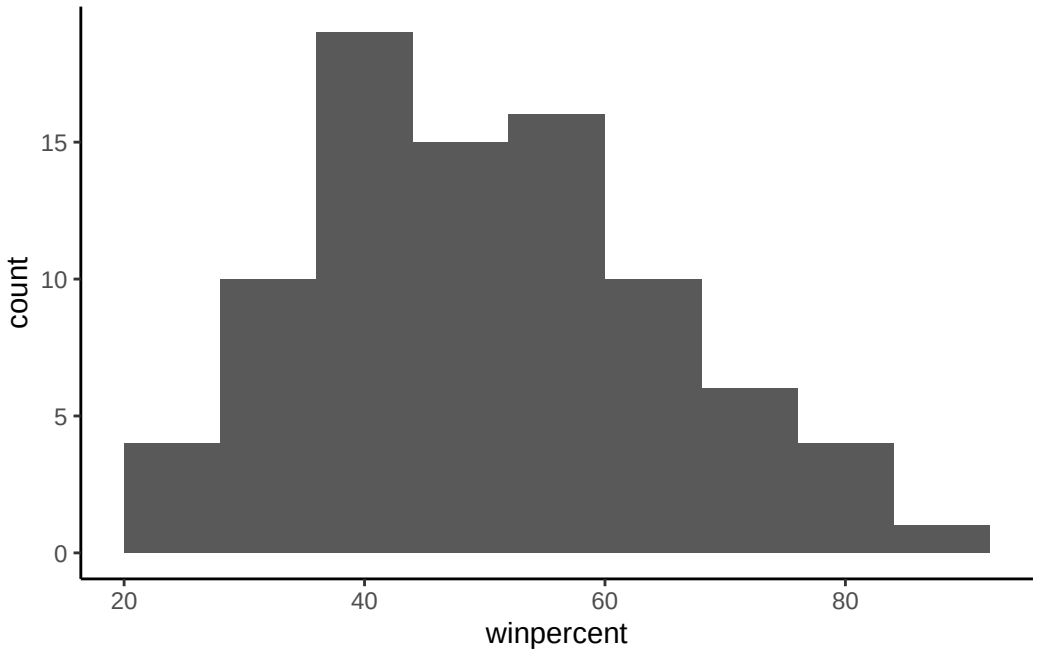
```
 [1] 1 1 0 0 0 1 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 1 1 0 0 0 1 1 0 1 1 1
[39] 1 1 1 0 1 1 0 0 0 1 0 0 0 1 1 1 1 0 1 0 0 1 0 0 1 0 1 1 0 0 0 0 0 0 0 0 1 1
[77] 1 1 0 1 0 0 0 0 1
```

Q8. Plot a histogram of winpercent values

```
hist(candy$winpercent, breaks=10)
```




```
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(binwidth=8) +
  theme_classic()
```




Q9. Is the distribution of winpercent values symmetrical?

No it is not symmetrical, it skews to one side.

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

Below 50%, the center median is 47.83%.

```
summary(candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.14   47.83   50.32   59.86   84.18 
```

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

Chocolate candy is higher ranked (60.8 median) versus fruit candy (43.0 median).

```
fruit.candy <- candy |>
  filter(fruity==1)

summary(fruit.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
  22.45   39.04   42.97   44.12   52.11   67.04 
```

```
#summary(candy[as.logical(candy$chocolate),]$winpercent)
chocolate.candy <- candy |>
  filter(chocolate==1)

summary(chocolate.candy$winpercent)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  34.72   50.35   60.80   60.92   70.74   84.18
```

Q12. Is this difference statistically significant?

Yes, p-value = 2.871e-08, it's less than .05 so that makes it significant.

```
t.test(chocolate.candy$winpercent, fruit.candy$winpercent)
```

```
    Welch Two Sample t-test

data:  chocolate.candy$winpercent and fruit.candy$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
```

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

Bottom 5:

- Nik L Nip
- Boston Baked Beans
- Chiclets
- Super Bubble
- Jawbusters

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

Top 5:

- Snickers
- Kit Kat
- Twix
- Reese's Miniatures
- Reese's Peanut Butter cup

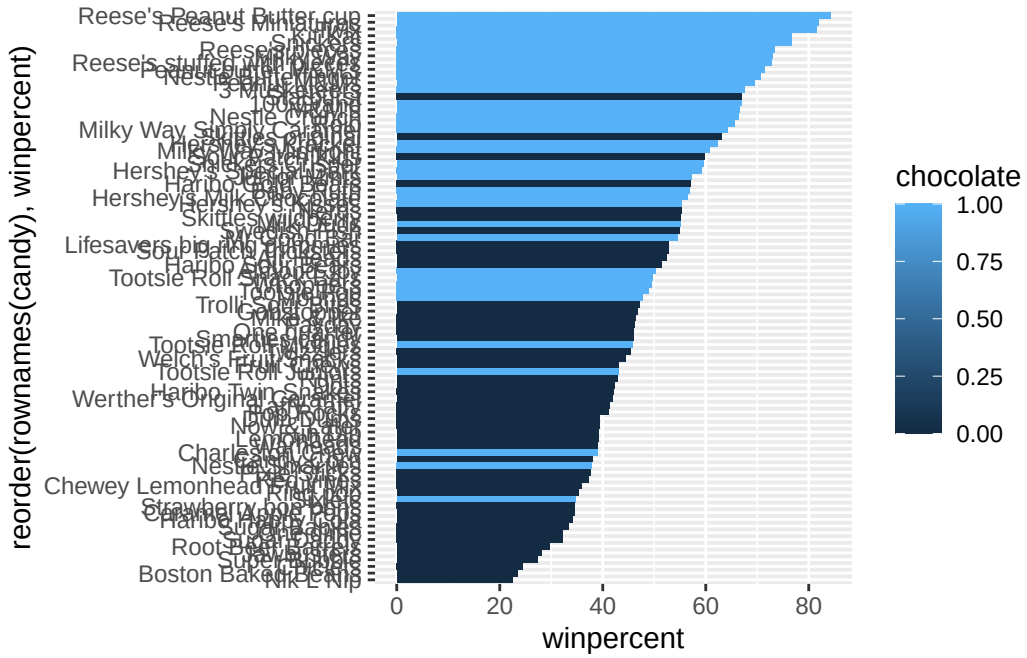
```
tail(candy[order(candy$winpercent),],5)
```

```
                        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 |

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

```
ggplot(candy) +
  aes(x=winpercent,
      y=reorder(rownames(candy), winpercent),
      fill=chocolate) +
  geom_col()
```

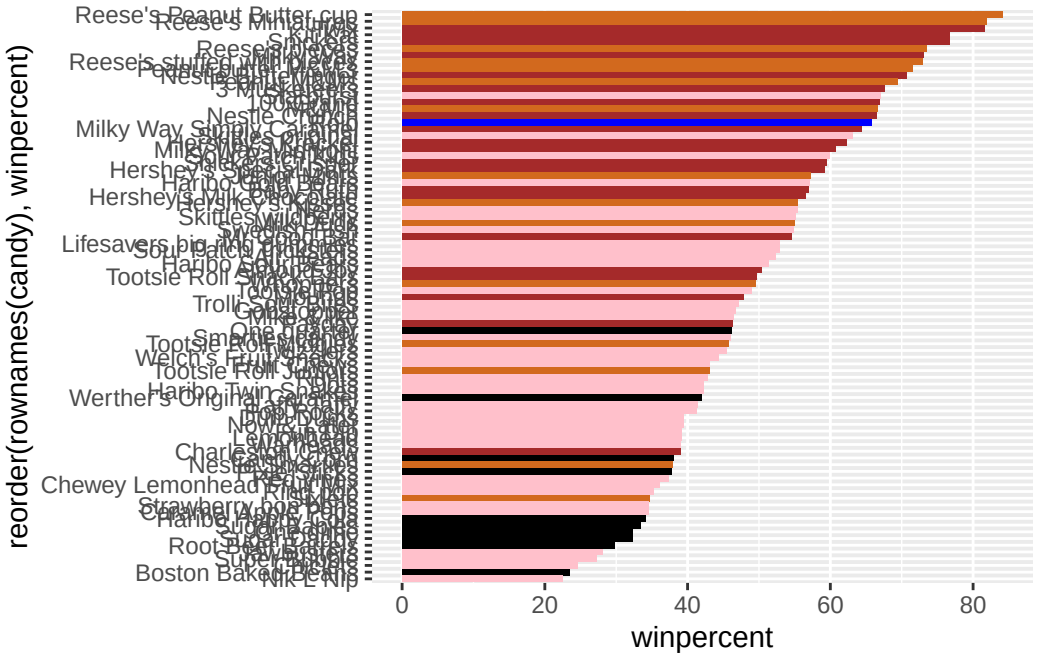



I want a more custom color scheme where I can see both chocolate and bar and fruity etc. all from one plot. To do this we can roll our own color vector…

```
mycols <- rep("black",nrow(candy))
mycols[as.logical(candy$chocolate)] <- "chocolate"
mycols[as.logical(candy$bar)] <- "brown"
mycols[as.logical(candy$fruity)] = "pink"
```

```
mycols[rownames(candy)=="Rolo"] <- "blue"
```

```
ggplot(candy) +
  aes(x=winpercent,
      y=reorder(rownames(candy), winpercent)) +
  geom_col(fill=mycols)
```




Q17. What is the worst ranked chocolate candy?

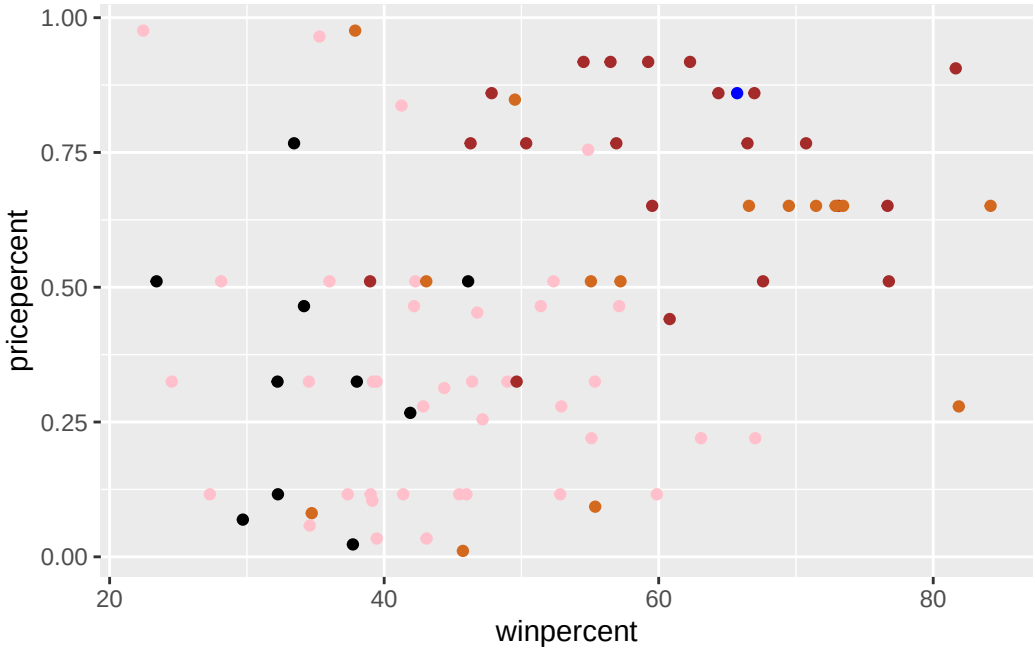
Worst ranked chocolate candy is Sixlets.

Q18. What is the best ranked fruity candy?

Best ranked fruity is Starbursts.

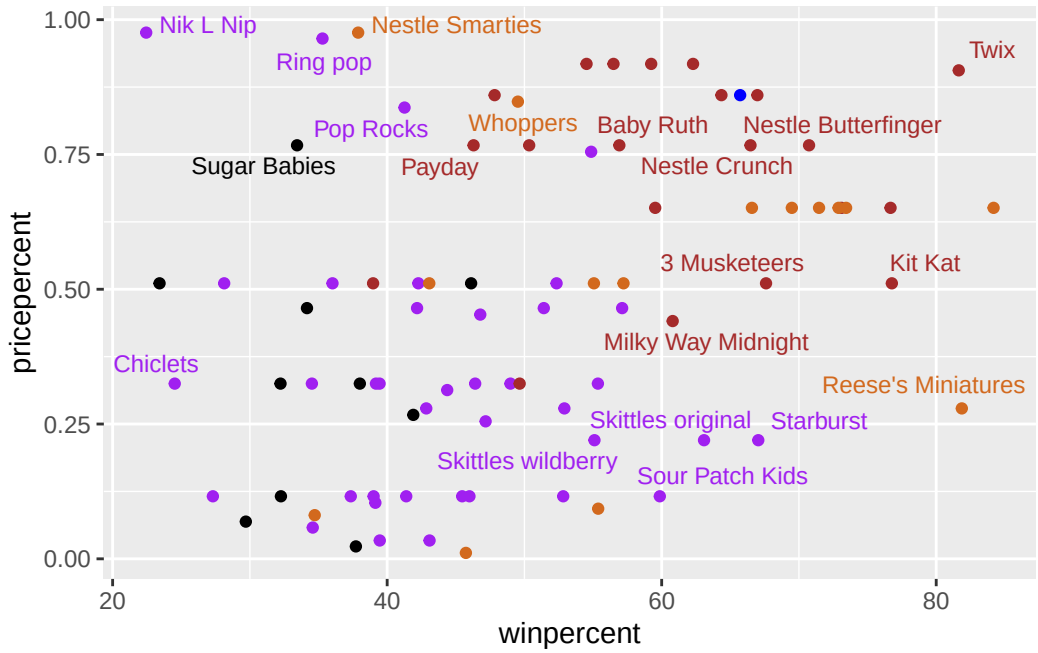
Plot of winpercent vs pricepercent to see what would be the best candy to buy

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



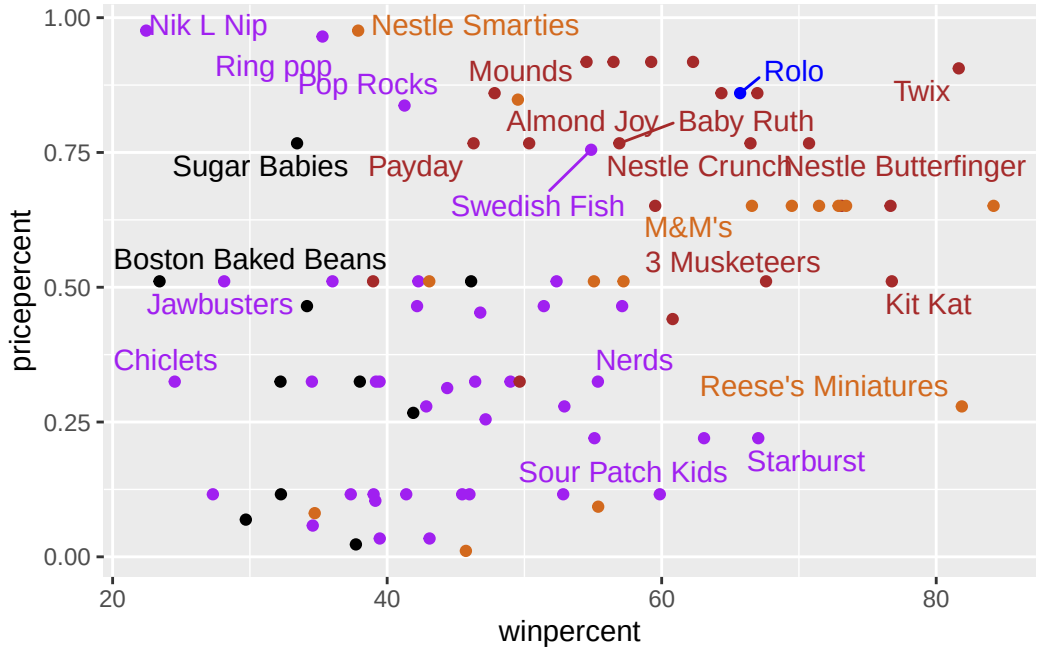

```
library(ggrepel)

mycols[as.logical(candy$fruity)] = "purple"

ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=mycols) +
  geom_text_repel(col=mycols, size=3.3, max.overlaps = 5)
```

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




```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=mycols) +
  geom_text_repel(col=mycols, max.overlaps = 8)
```

```
Warning: ggrepel: 61 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 minuatures

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

The top 5 most expensive and least popular are:

- Nik L Nip
- Nestle Smarties
- Ring pop
- Hershey's Krackel
- Hershey's Milk Chocolate

The least popular is Nik L Nip.

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

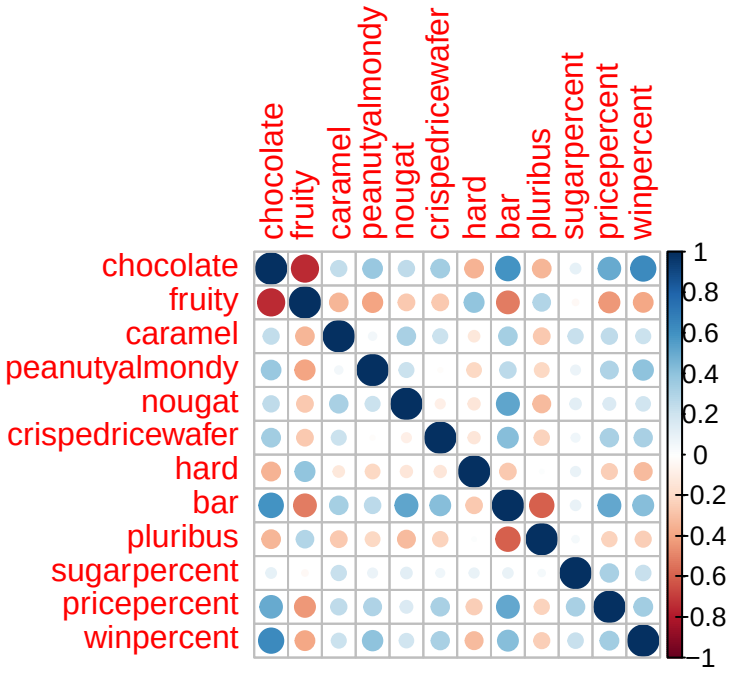
```
                    pricepercent winpercent
Nik L Nip                  0.976   22.44534
Nestle Smarties            0.976   37.88719
```

```
Ring pop                        0.965   35.29076
Hershey's Krackel               0.918   62.28448
Hershey's Milk Chocolate        0.918   56.49050
```

```
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)?

Fruit and chocolate are anti-correlated.

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

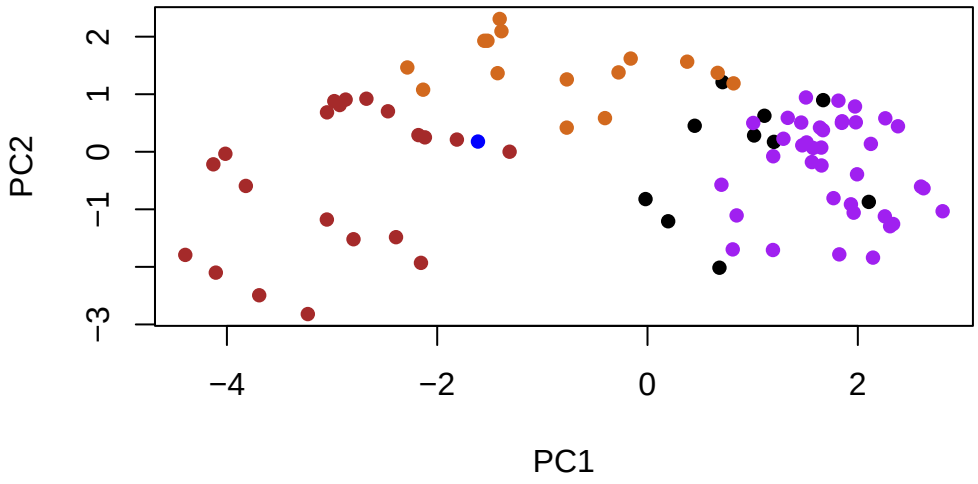
Chocolate and winpercent are most positively correlated.

## 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
```

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

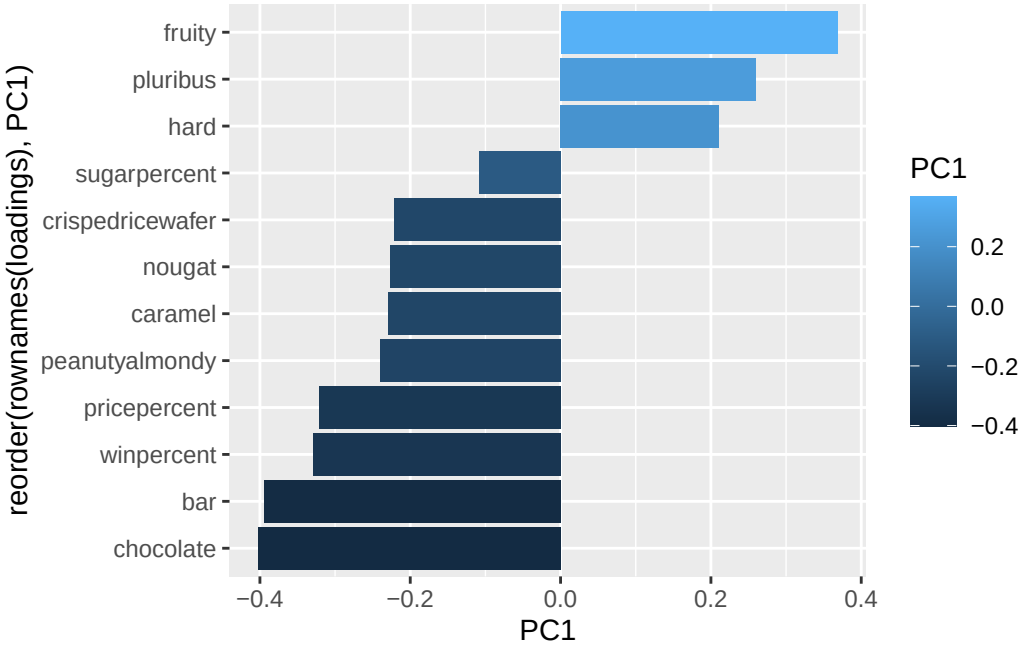



How do the original variables contribute to the new PCs. I will look at PC1 here.

```
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
```

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

ggplot(loadings) +
  aes(PC1, reorder(rownames(loadings), PC1), fill=PC1) +
  geom_col()
```

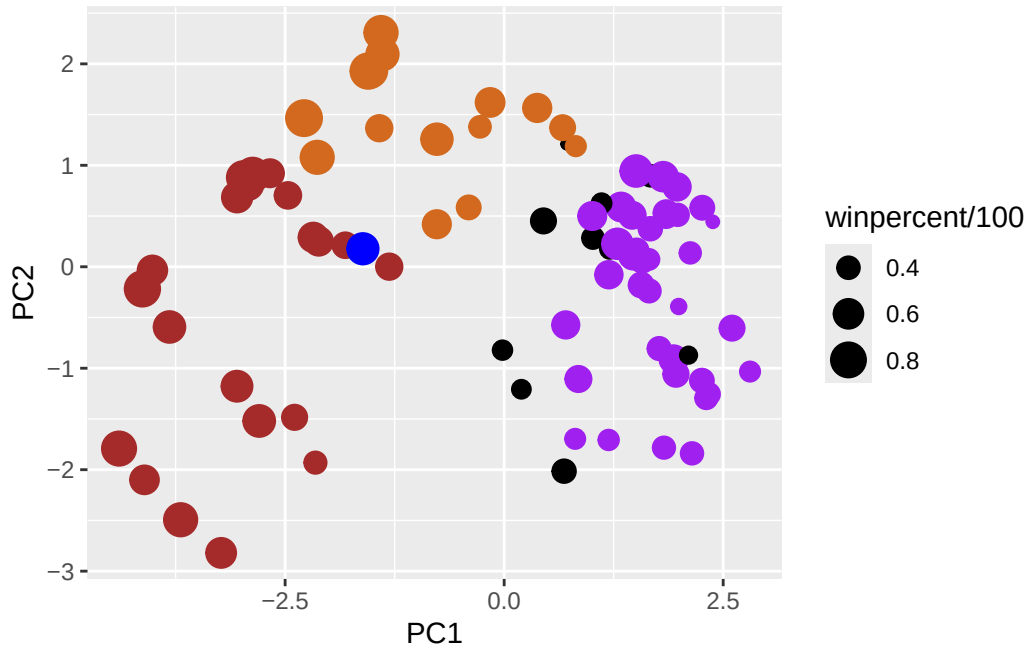



Q24. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you?

Fruity, pluribus, and hard are variables that are picked up strongly by PC1 in the positive direction. Yes, this makes sense to me because the variables are correlated to each other among the most popular candies.

```
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=mycols)

p
```




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