Class10

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

```r
nrow(candy)
```

```
[1] 85
```

There are 85 different candy types 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.

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

```
[1] 38
```

There are 38 candy types.

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

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

```
[1] 50.34755
```

My favorite candy is almondjoy, the winpercent is

> Q4. What is the winpercent value for “Kit Kat”?

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

```
[1] 76.7686
```

The winpercent for kit kat is 76.7686.

> Q5. What is the winpercent value for “Tootsie Roll Snack Bars”?

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

```
[1] 49.6535
```

The winpercent is 49.6535

```
library(flextable)
flextable :: flextable( head(candy))
```

chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	s

chocolate	fruity	caramel	peanutyalmondy	nougat	crispedricewafer	hard	bar	pluribus	s
1	0	1	0	0	1	0	1	0	
1	0	0	0	1	0	0	1	0	
0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	
0	1	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	0	

```r
library(dplyr)

candy |> nrow()
```

```
[1] 85
```

```r
candy |> select(winpercent)
```

```
                            winpercent
100 Grand                     66.97173
3 Musketeers                  67.60294
One dime                      32.26109
One quarter                   46.11650
Air Heads                     52.34146
Almond Joy                    50.34755
Baby Ruth                     56.91455
Boston Baked Beans            23.41782
Candy Corn                    38.01096
Caramel Apple Pops            34.51768
Charleston Chew               38.97504
Chewey Lemonhead Fruit Mix    36.01763
Chiclets                      24.52499
Dots                          42.27208
Dum Dums                      39.46056
Fruit Chews                   43.08892
Fun Dip                       39.18550
```

```
Gobstopper                    46.78335
Haribo Gold Bears             57.11974
Haribo Happy Cola             34.15896
Haribo Sour Bears             51.41243
Haribo Twin Snakes            42.17877
Hershey's Kisses              55.37545
Hershey's Krackel             62.28448
Hershey's Milk Chocolate      56.49050
Hershey's Special Dark        59.23612
Jawbusters                    28.12744
Junior Mints                  57.21925
Kit Kat                       76.76860
Laffy Taffy                   41.38956
Lemonhead                     39.14106
Lifesavers big ring gummies   52.91139
Peanut butter M&M's           71.46505
M&M's                         66.57458
Mike & Ike                    46.41172
Milk Duds                     55.06407
Milky Way                     73.09956
Milky Way Midnight            60.80070
Milky Way Simply Caramel      64.35334
Mounds                        47.82975
Mr Good Bar                   54.52645
Nerds                         55.35405
Nestle Butterfinger           70.73564
Nestle Crunch                 66.47068
Nik L Nip                     22.44534
Now & Later                   39.44680
Payday                        46.29660
Peanut M&Ms                   69.48379
Pixie Sticks                  37.72234
Pop Rocks                     41.26551
Red vines                     37.34852
Reese's Miniatures            81.86626
Reese's Peanut Butter cup     84.18029
Reese's pieces                73.43499
Reese's stuffed with pieces   72.88790
Ring pop                      35.29076
Rolo                          65.71629
Root Beer Barrels             29.70369
Runts                         42.84914
Sixlets                       34.72200
```

```
Skittles original             63.08514
Skittles wildberry            55.10370
Nestle Smarties               37.88719
Smarties candy                45.99583
Snickers                      76.67378
Snickers Crisper              59.52925
Sour Patch Kids               59.86400
Sour Patch Tricksters         52.82595
Starburst                     67.03763
Strawberry bon bons           34.57899
Sugar Babies                  33.43755
Sugar Daddy                   32.23100
Super Bubble                  27.30386
Swedish Fish                  54.86111
Tootsie Pop                   48.98265
Tootsie Roll Juniors          43.06890
Tootsie Roll Midgies          45.73675
Tootsie Roll Snack Bars       49.65350
Trolli Sour Bites             47.17323
Twix                          81.64291
Twizzlers                     45.46628
Warheads                      39.01190
Welch's Fruit Snacks          44.37552
Werther's Original Caramel    41.90431
Whoppers                      49.52411
```

```r
win <- candy$winpercent
win.mean <- mean(win)
round(win.mean)
```

```
[1] 50
```

```r
candy %>% select(winpercent)
```

```
                            winpercent
100 Grand                     66.97173
3 Musketeers                  67.60294
One dime                      32.26109
One quarter                   46.11650
Air Heads                     52.34146
Almond Joy                    50.34755
```

```
Baby Ruth                     56.91455
Boston Baked Beans            23.41782
Candy Corn                    38.01096
Caramel Apple Pops            34.51768
Charleston Chew               38.97504
Chewey Lemonhead Fruit Mix    36.01763
Chiclets                      24.52499
Dots                          42.27208
Dum Dums                      39.46056
Fruit Chews                   43.08892
Fun Dip                       39.18550
Gobstopper                    46.78335
Haribo Gold Bears             57.11974
Haribo Happy Cola             34.15896
Haribo Sour Bears             51.41243
Haribo Twin Snakes            42.17877
Hershey's Kisses              55.37545
Hershey's Krackel             62.28448
Hershey's Milk Chocolate      56.49050
Hershey's Special Dark        59.23612
Jawbusters                    28.12744
Junior Mints                  57.21925
Kit Kat                       76.76860
Laffy Taffy                   41.38956
Lemonhead                     39.14106
Lifesavers big ring gummies   52.91139
Peanut butter M&M's           71.46505
M&M's                         66.57458
Mike & Ike                    46.41172
Milk Duds                     55.06407
Milky Way                     73.09956
Milky Way Midnight            60.80070
Milky Way Simply Caramel      64.35334
Mounds                        47.82975
Mr Good Bar                   54.52645
Nerds                         55.35405
Nestle Butterfinger           70.73564
Nestle Crunch                 66.47068
Nik L Nip                     22.44534
Now & Later                   39.44680
Payday                        46.29660
Peanut M&Ms                   69.48379
Pixie Sticks                  37.72234
```

```
Pop Rocks                    41.26551
Red vines                    37.34852
Reese's Miniatures           81.86626
Reese's Peanut Butter cup    84.18029
Reese's pieces               73.43499
Reese's stuffed with pieces  72.88790
Ring pop                     35.29076
Rolo                         65.71629
Root Beer Barrels            29.70369
Runts                        42.84914
Sixlets                      34.72200
Skittles original            63.08514
Skittles wildberry           55.10370
Nestle Smarties              37.88719
Smarties candy               45.99583
Snickers                     76.67378
Snickers Crisper             59.52925
Sour Patch Kids              59.86400
Sour Patch Tricksters        52.82595
Starburst                    67.03763
Strawberry bon bons          34.57899
Sugar Babies                 33.43755
Sugar Daddy                  32.23100
Super Bubble                 27.30386
Swedish Fish                 54.86111
Tootsie Pop                  48.98265
Tootsie Roll Juniors         43.06890
Tootsie Roll Midgies         45.73675
Tootsie Roll Snack Bars      49.65350
Trolli Sour Bites            47.17323
Twix                         81.64291
Twizzlers                    45.46628
Warheads                     39.01190
Welch's Fruit Snacks         44.37552
Werther's Original Caramel   41.90431
Whoppers                     49.52411
```

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

Table 2: 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	

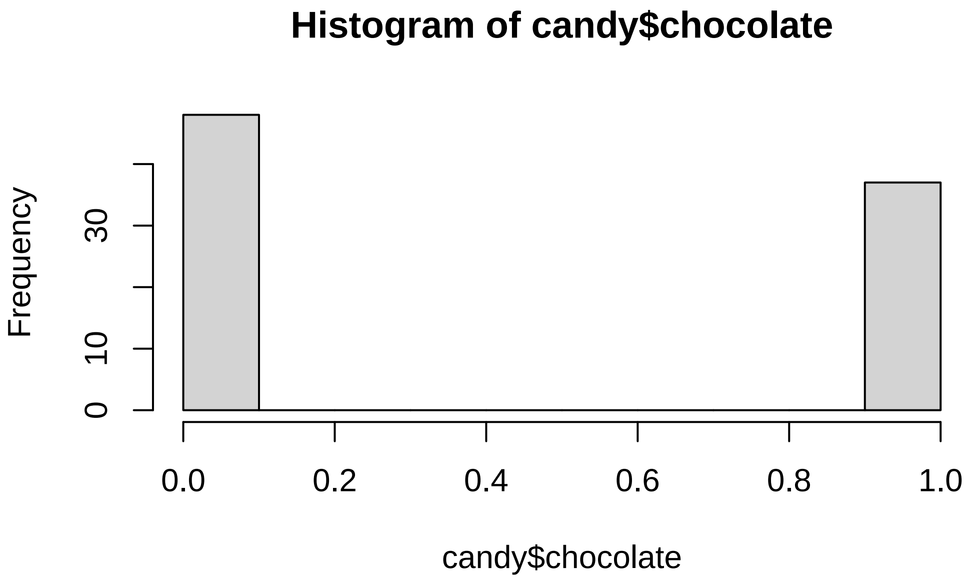
> Q6. Is there any variable/column that looks to be on a different scale to the majority of the other columns in the dataset?

The winpercent variable is on a different scale than the others.

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

It represents a hit or no hit. The zero tells us how many people did not choose it while the 1 tells us how many people did choose it

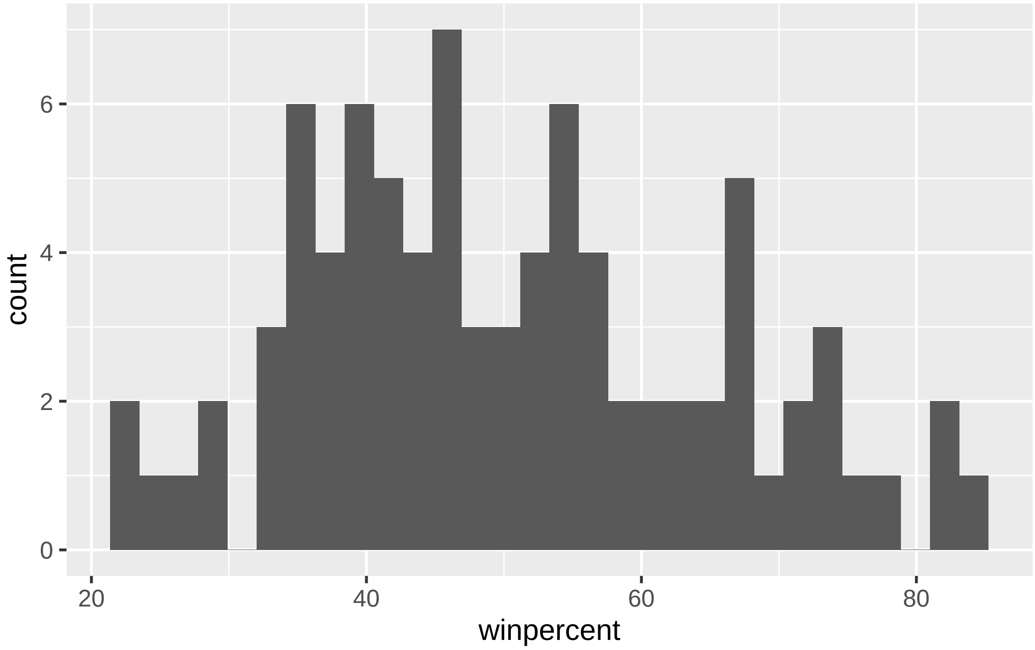
```r
hist(candy$chocolate)
```



Q8. Plot a histogram of winpercent values

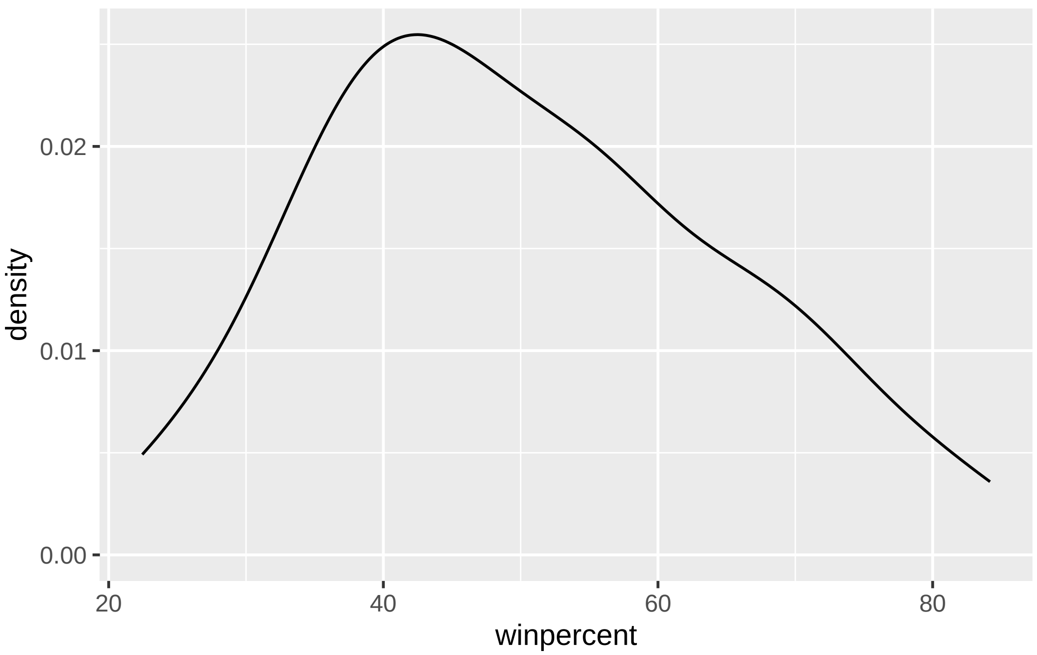
```
library(ggplot2)
ggplot(candy)+
  aes(winpercent)+
  geom_histogram()
```

```
`stat_bin()` using `bins = 30`. Pick better value `binwidth`.
```



Q9. Is the distribution of winpercent values symmetrical?

```
ggplot(candy)+
  aes(winpercent)+
  geom_density()
```



no it is not symmetrical

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

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

```
[1] 50.31676
```

The mean of the data is 50% while the median is 47%.

```
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?

The fruity candy is lower ranked than chocolate.

```
#1. Find all chocolate candy in the dataset
choc.inds <- as.logical(candy$chocolate==1)
choc.candy <- candy[choc.inds,]
choc.candy
```

```
                            chocolate fruity caramel peanutyalmondy nougat
100 Grand                           1      0       1              0      0
3 Musketeers                        1      0       0              0      1
Almond Joy                          1      0       0              1      0
Baby Ruth                           1      0       1              1      1
Charleston Chew                     1      0       0              0      1
Hershey's Kisses                    1      0       0              0      0
Hershey's Krackel                   1      0       0              0      0
Hershey's Milk Chocolate            1      0       0              0      0
Hershey's Special Dark              1      0       0              0      0
Junior Mints                        1      0       0              0      0
Kit Kat                             1      0       0              0      0
Peanut butter M&M's                 1      0       0              1      0
M&M's                               1      0       0              0      0
Milk Duds                           1      0       1              0      0
Milky Way                           1      0       1              0      1
Milky Way Midnight                  1      0       1              0      1
Milky Way Simply Caramel            1      0       1              0      0
Mounds                              1      0       0              0      0
Mr Good Bar                         1      0       0              1      0
Nestle Butterfinger                 1      0       0              1      0
Nestle Crunch                       1      0       0              0      0
Peanut M&Ms                         1      0       0              1      0
Reese's Miniatures                  1      0       0              1      0
Reese's Peanut Butter cup           1      0       0              1      0
Reese's pieces                      1      0       0              1      0
Reese's stuffed with pieces         1      0       0              1      0
Rolo                                1      0       1              0      0
Sixlets                             1      0       0              0      0
Nestle Smarties                     1      0       0              0      0
Snickers                            1      0       1              1      1
Snickers Crisper                    1      0       1              1      0
Tootsie Pop                         1      1       0              0      0
Tootsie Roll Juniors                1      0       0              0      0
Tootsie Roll Midgies                1      0       0              0      0
Tootsie Roll Snack Bars             1      0       0              0      0
Twix                                1      0       1              0      0
Whoppers                            1      0       0              0      0
                            crispedricewafer hard bar pluribus sugarpercent
100 Grand                                  1    0   1        0        0.732
3 Musketeers                               0    0   1        0        0.604
Almond Joy                                 0    0   1        0        0.465
Baby Ruth                                  0    0   1        0        0.604
```

```
Charleston Chew                            0    0   1        0        0.604
Hershey's Kisses                           0    0   0        1        0.127
Hershey's Krackel                          1    0   1        0        0.430
Hershey's Milk Chocolate                   0    0   1        0        0.430
Hershey's Special Dark                     0    0   1        0        0.430
Junior Mints                               0    0   0        1        0.197
Kit Kat                                    1    0   1        0        0.313
Peanut butter M&M's                        0    0   0        1        0.825
M&M's                                      0    0   0        1        0.825
Milk Duds                                  0    0   0        1        0.302
Milky Way                                  0    0   1        0        0.604
Milky Way Midnight                         0    0   1        0        0.732
Milky Way Simply Caramel                   0    0   1        0        0.965
Mounds                                     0    0   1        0        0.313
Mr Good Bar                                0    0   1        0        0.313
Nestle Butterfinger                        0    0   1        0        0.604
Nestle Crunch                              1    0   1        0        0.313
Peanut M&Ms                                0    0   0        1        0.593
Reese's Miniatures                         0    0   0        0        0.034
Reese's Peanut Butter cup                  0    0   0        0        0.720
Reese's pieces                             0    0   0        1        0.406
Reese's stuffed with pieces                0    0   0        0        0.988
Rolo                                       0    0   0        1        0.860
Sixlets                                    0    0   0        1        0.220
Nestle Smarties                            0    0   0        1        0.267
Snickers                                   0    0   1        0        0.546
Snickers Crisper                           1    0   1        0        0.604
Tootsie Pop                                0    1   0        0        0.604
Tootsie Roll Juniors                       0    0   0        0        0.313
Tootsie Roll Midgies                       0    0   0        1        0.174
Tootsie Roll Snack Bars                    0    0   1        0        0.465
Twix                                       1    0   1        0        0.546
Whoppers                                   1    0   0        1        0.872
                            pricepercent winpercent
100 Grand                          0.860   66.97173
3 Musketeers                       0.511   67.60294
Almond Joy                         0.767   50.34755
Baby Ruth                          0.767   56.91455
Charleston Chew                    0.511   38.97504
Hershey's Kisses                   0.093   55.37545
Hershey's Krackel                  0.918   62.28448
Hershey's Milk Chocolate           0.918   56.49050
Hershey's Special Dark             0.918   59.23612
```

```
Junior Mints                       0.511   57.21925
Kit Kat                            0.511   76.76860
Peanut butter M&M's                0.651   71.46505
M&M's                              0.651   66.57458
Milk Duds                          0.511   55.06407
Milky Way                          0.651   73.09956
Milky Way Midnight                 0.441   60.80070
Milky Way Simply Caramel           0.860   64.35334
Mounds                             0.860   47.82975
Mr Good Bar                        0.918   54.52645
Nestle Butterfinger                0.767   70.73564
Nestle Crunch                      0.767   66.47068
Peanut M&Ms                        0.651   69.48379
Reese's Miniatures                 0.279   81.86626
Reese's Peanut Butter cup          0.651   84.18029
Reese's pieces                     0.651   73.43499
Reese's stuffed with pieces        0.651   72.88790
Rolo                               0.860   65.71629
Sixlets                            0.081   34.72200
Nestle Smarties                    0.976   37.88719
Snickers                           0.651   76.67378
Snickers Crisper                   0.651   59.52925
Tootsie Pop                        0.325   48.98265
Tootsie Roll Juniors               0.511   43.06890
Tootsie Roll Midgies               0.011   45.73675
Tootsie Roll Snack Bars            0.325   49.65350
Twix                               0.906   81.64291
Whoppers                           0.848   49.52411
```

```r
#2. Extract their `winpercent` values
choc.win <- choc.candy$winpercent
#3. Find the mean of these values
choc.mean <- mean(choc.win)
#4-6 Do the same for fruity candy
fruit.win <- candy[candy$fruity==1,]$winpercent
fruity.mean <- mean(fruit.win)

#7 which mean value is higher
choc.mean
```

```
[1] 60.92153
```

```
fruity.mean
```

```
[1] 44.11974
```

> Q12. Is this difference statistically significant?

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

```

    Welch Two Sample t-test

data:  choc.win and fruit.win
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 
```

Yes, the finding is significant. The p value is 2.871e-08

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

```
candy %>% arrange(winpercent) %>% tail(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
```

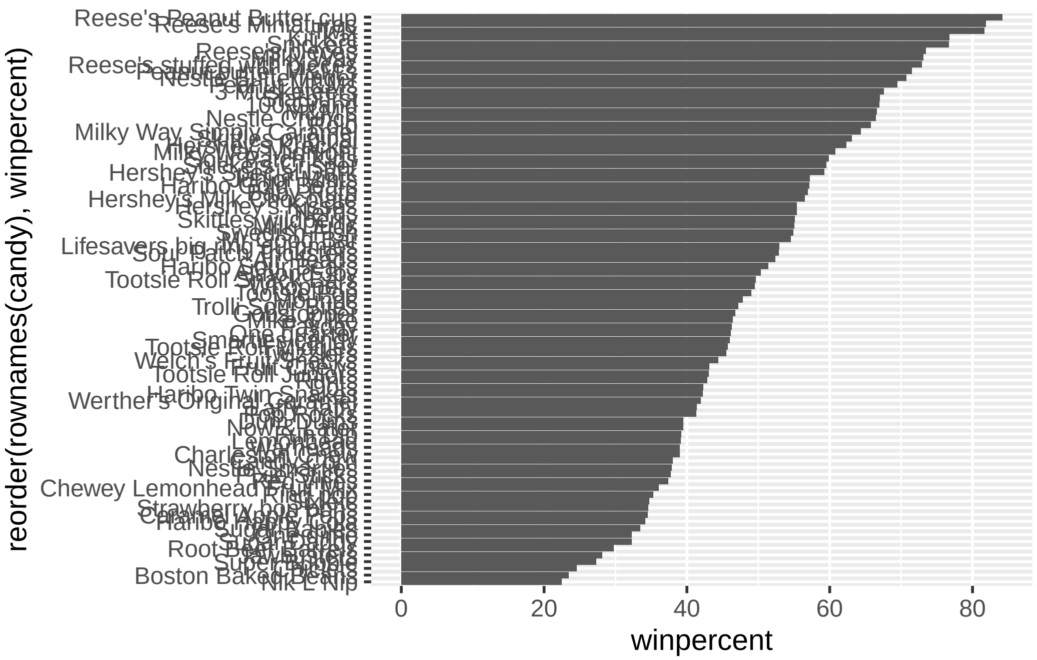
Q14. What are the top 5 all time favorite candy types out of this set?

```r
candy %>% arrange(winpercent) %>% head(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
```

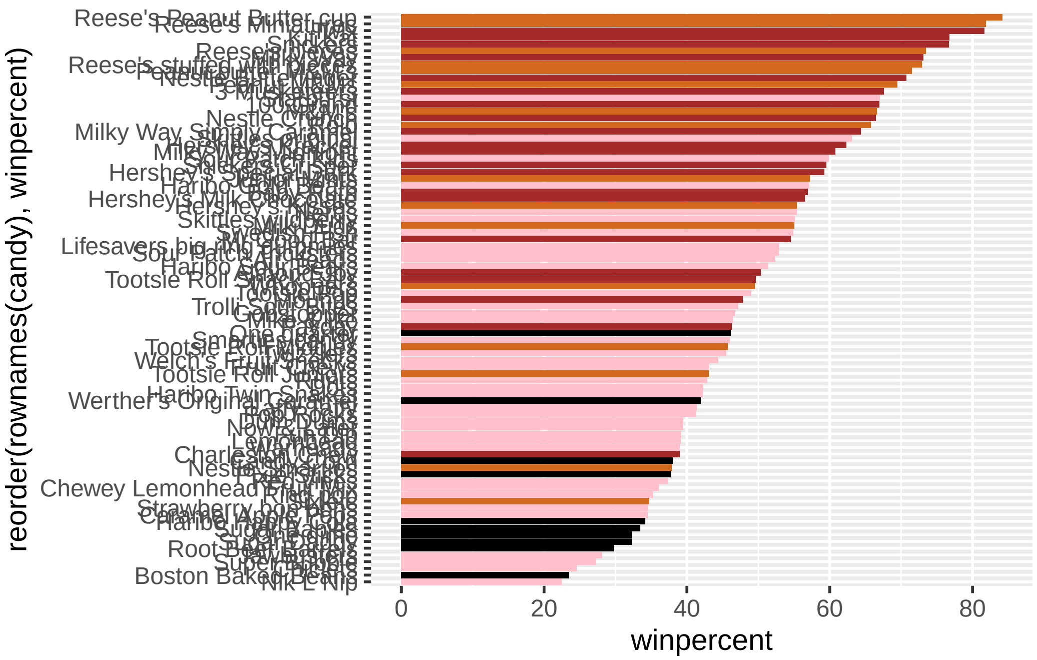
Q15. Make a first barplot of candy ranking based on winpercent values. Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

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



add some color

```
my_cols <- rep("black", nrow(candy))
my_cols[candy$chocolate==1] <- "chocolate"
my_cols[candy$bar==1] <- "brown"
my_cols[candy$fruity==1] <- "pink"
ggplot(candy) +
  aes(x = winpercent,
      y = reorder(rownames(candy), winpercent),
      fill=my_cols) +
  geom_col(fill=my_cols)
```



Q17. What is the worst ranked chocolate candy?

The worst ranked chocolate candy is sixlets.

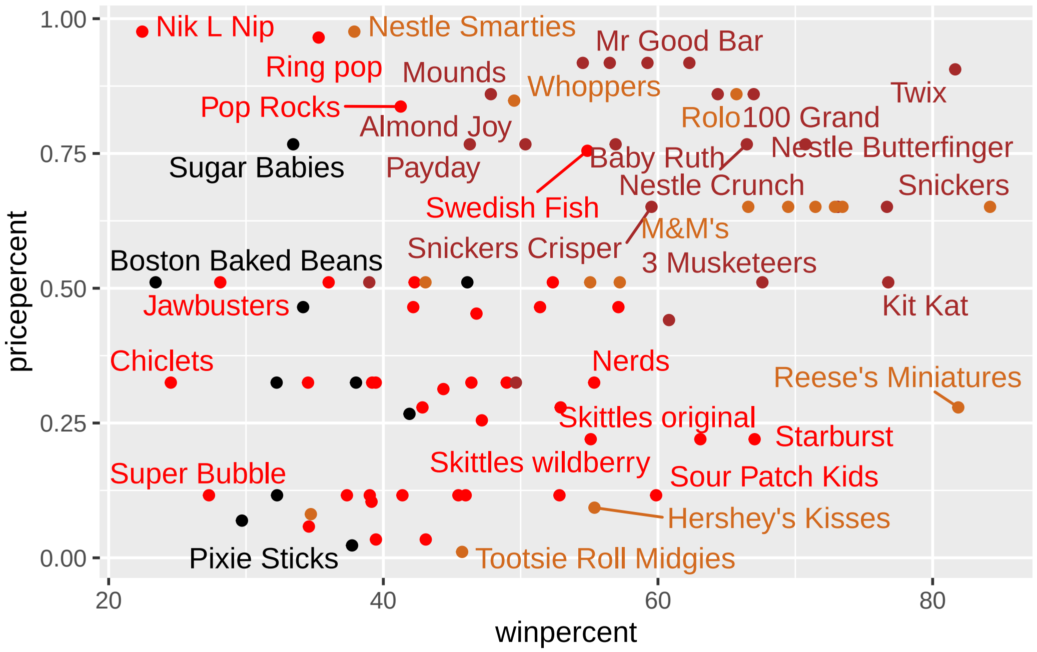
Q18. What is the best ranked fruity candy?

The best ranked fruity candy is starburst

##Winpercent vs Pricepercent

```
library(ggrepel)
my_cols[candy$fruity==1] <- "red"
ggplot(candy) +
  aes(winpercent, pricepercent, label =rownames(candy)) +
  geom_point(col=my_cols)+
  geom_text_repel(col=my_cols)
```

```
Warning: ggrepel: 50 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 have the highest winpercent and lowest pricpercent. Reeses peanut butter cups have a slightly higher winpercent than miniatures but are more expensive.

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 candies are Nik L Nip, Ring Pop, Nestle Smarties, Mr. goodbar and hershey's milk chocolate.Nik L Nip is the least popular

##correlation structure

Q22. Examining this plot what two variables are anti-correlated (i.e. have minus values)?

Chocolate and fruity candies are anti-correlated.

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

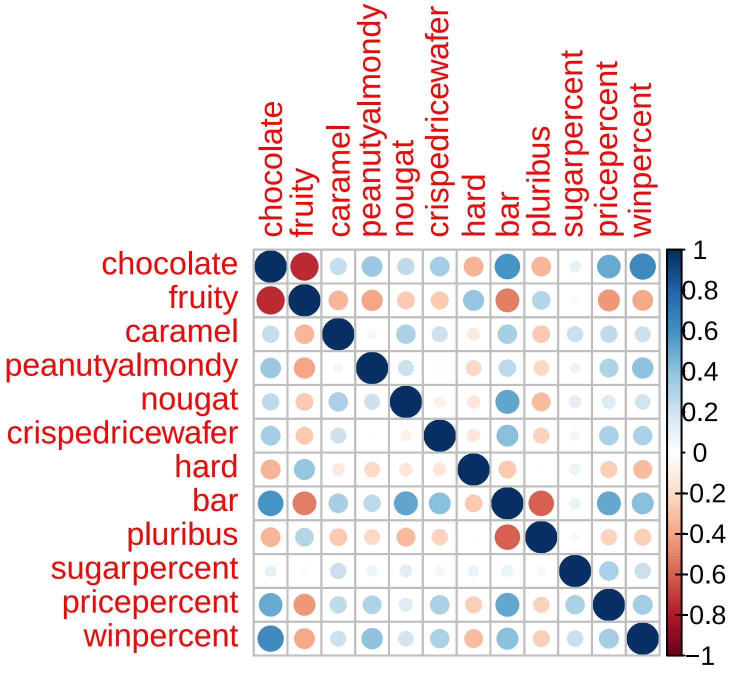
Chocolate and bars are most positively correlated.

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

```
library(corrplot)
```

```
corrplot 0.95 loaded
```

```
corrplot(cij)
```



##principal component analysis

The main function in base R for this is `prcomp()` and we want to set `scale=TRUE` here:

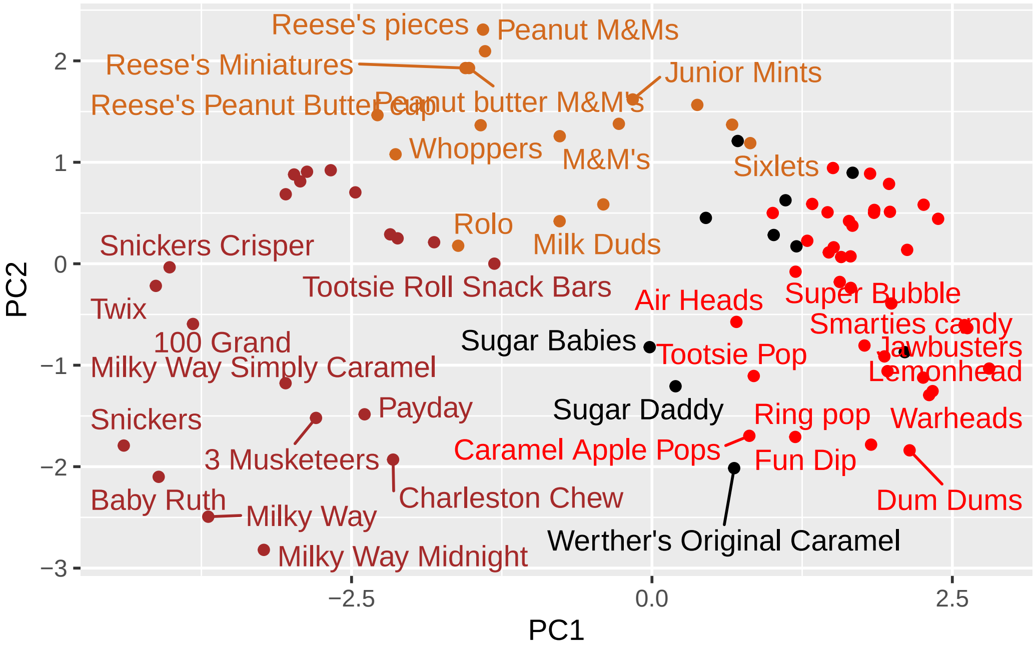
```
pca <- prcomp(candy, scale = TRUE)
summary(pca)
```

```
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
```

Lets look at our first main result figure - the “PC Plot” pr PC1 vs PC2

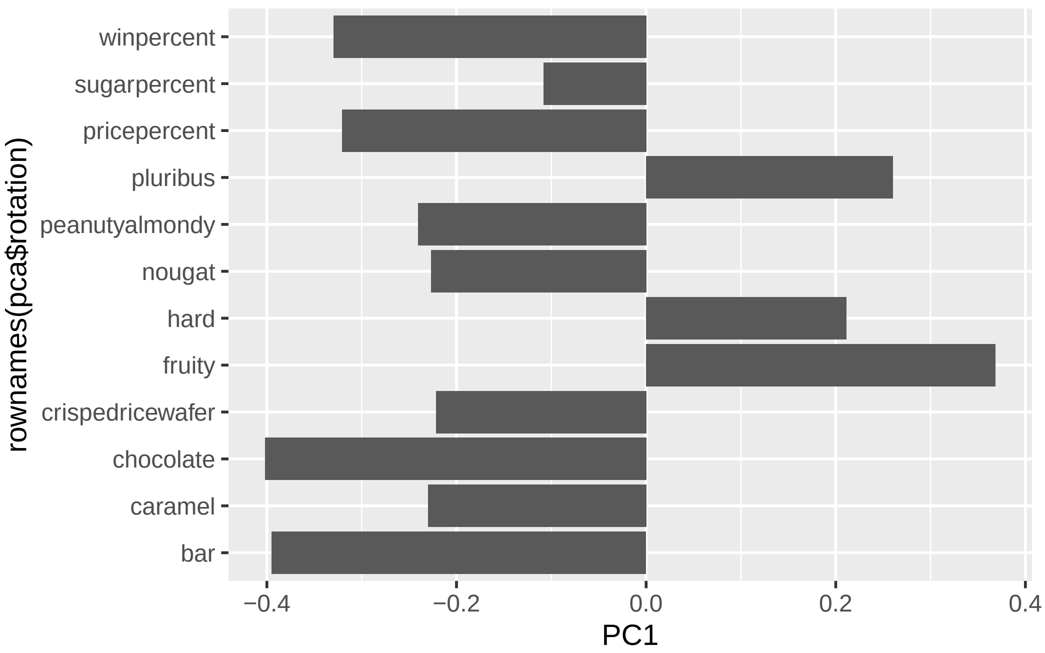
```
ggplot (pca$x) +
  aes(PC1, PC2, label = rownames(pca$x)) +
  geom_point(col = my_cols) +
geom_text_repel(col=my_cols)
```

```
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



Don’t forget about your variable “loadings” - how the original variables contribute to your new PCs

```
ggplot(pca$rotation) +
  aes(PC1, rownames(pca$rotation)) +
  geom_col()
```



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

pluribus and fruity are picked up strongly in PC1 in the positive direction. This makes sense because fruity candy such as starburst usually comes in a bag.