Class 10: Halloween Project

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Read document

```
candy <- read.csv("https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-
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
```

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

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

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

```
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 %>% 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

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

	winpercent
100 Grand	66.97173
3 Musketeers	67.60294
One dime	32.26109
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Hershey's Milk Chocolate	56.49050
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Nerds	55.35405
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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
```

Questions

Q1. How many different candy types are in this dataset?

```
nrow(candy)
```

```
[1] 85
```

```
candy |> nrow()
```

```
[1] 85
```

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

```
nrow(subset(candy, candy$fruity == 1))
```

```
[1] 38
```

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

```
# Definitely Eminem (M&M's)
candy["M&M's", "winpercent"]
```

```
[1] 66.57458
```

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
```

The package "skimr"

```
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?

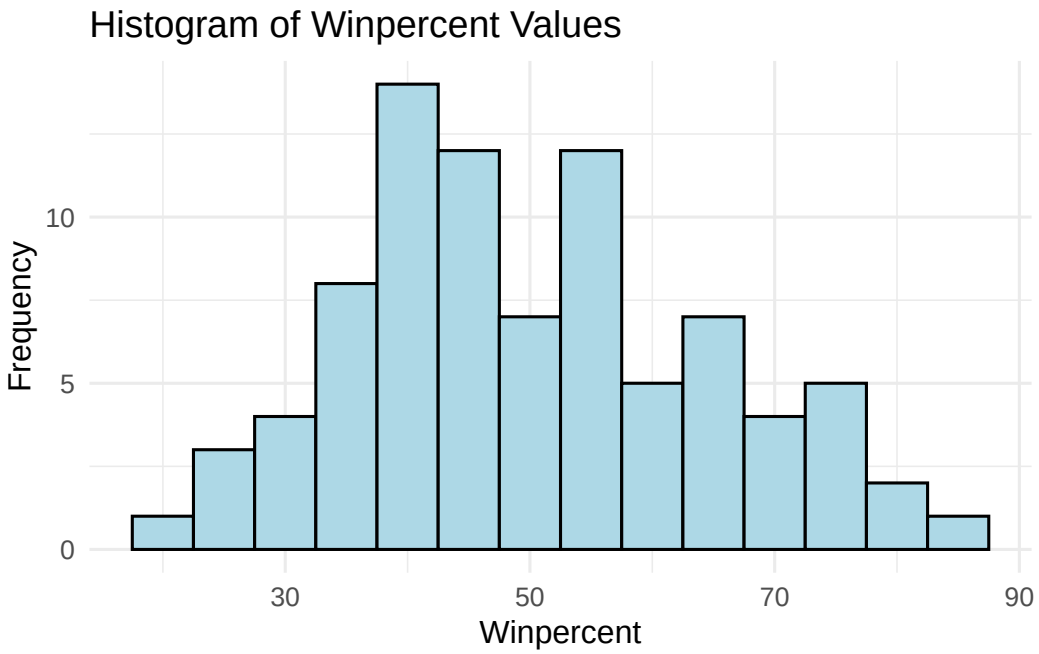
Yes, the variable "winpercent" is on a different scale compared to the other columns.

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

A zero represents that the candy does not contain chocolate, while a one indicates that the candy does contain chocolate.

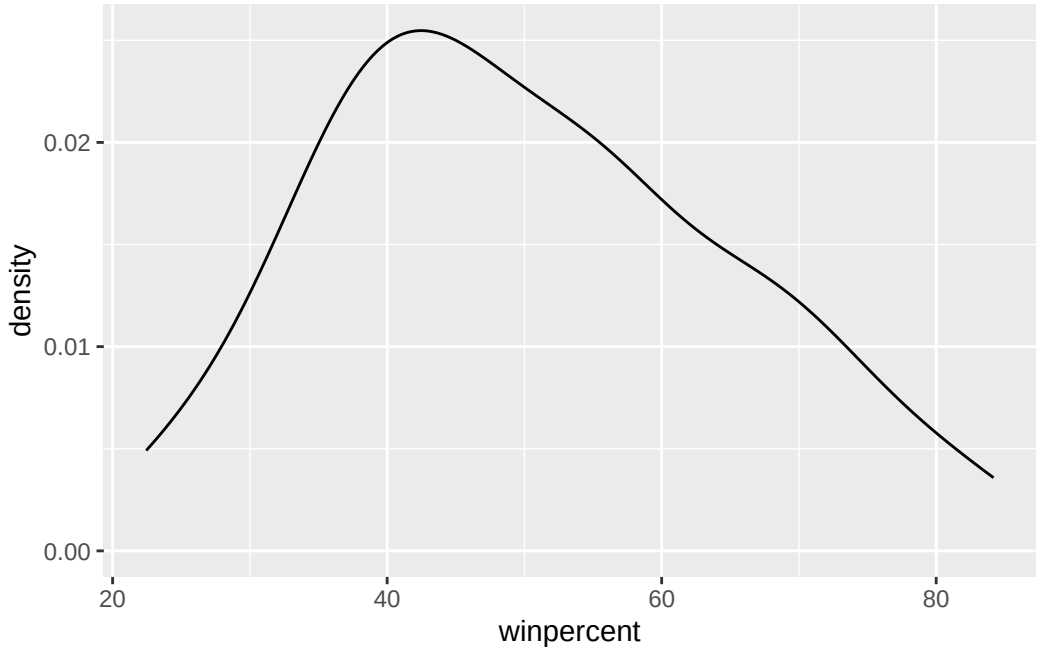
Q8. Plot a histogram of winpercent values

```
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(binwidth = 5, fill = "lightblue", color = "black") +
  labs(title = "Histogram of Winpercent Values", x = "Winpercent", y = "Frequency") +
  theme_minimal(base_size = 12)
```



Q9. Is the distribution of winpercent values symmetrical?

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



No, the distribution of winpercent values is not symmetrical; it appears to be left-skewed.

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

```
median(candy$winpercent) >= 50
```

```
[1] FALSE
```

```
mean(candy$winpercent) >= 50
```

```
[1] TRUE
```

```
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?

```
mean(candy$winpercent[candy$chocolate == 1]) > mean(candy$winpercent[candy$fruity == 1])
```

```
[1] TRUE
```

```
# 1.  Find all chocolate candy in the dataset
# 2. Extract their `winpercent` values
# 3. Find the mean of these values

# 4-6: Do the same for fruity candy
# 7. Which mean value is higher

mean_choc <- candy |> filter(chocolate == 1) |> summarise(mean_winpercent = mean(winpercent))
mean_fruity <- candy |> filter(fruity == 1) |> summarise(mean_winpercent = mean(winpercent))
mean_choc$mean_winpercent > mean_fruity$mean_winpercent
```

```
[1] TRUE
```

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

fruit.inds <- as.logical(candy$fruity)
fruit.candy <- candy[fruit.inds, ]
fruit.win <- fruit.candy$winpercent
fruit.mean <- mean(fruit.win)

choc.mean > fruit.mean
```

```
[1] TRUE
```

Q12. Is this difference statistically significant?

```
t.test(candy$winpercent[candy$chocolate == 1], candy$winpercent[candy$fruity == 1])
```

```
    Welch Two Sample t-test

data:  candy$winpercent[candy$chocolate == 1] and candy$winpercent[candy$fruity == 1]
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, they are statistically significantly different.

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

```
candy[order(candy$winpercent), ][1:5, ]
```

```
                  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?

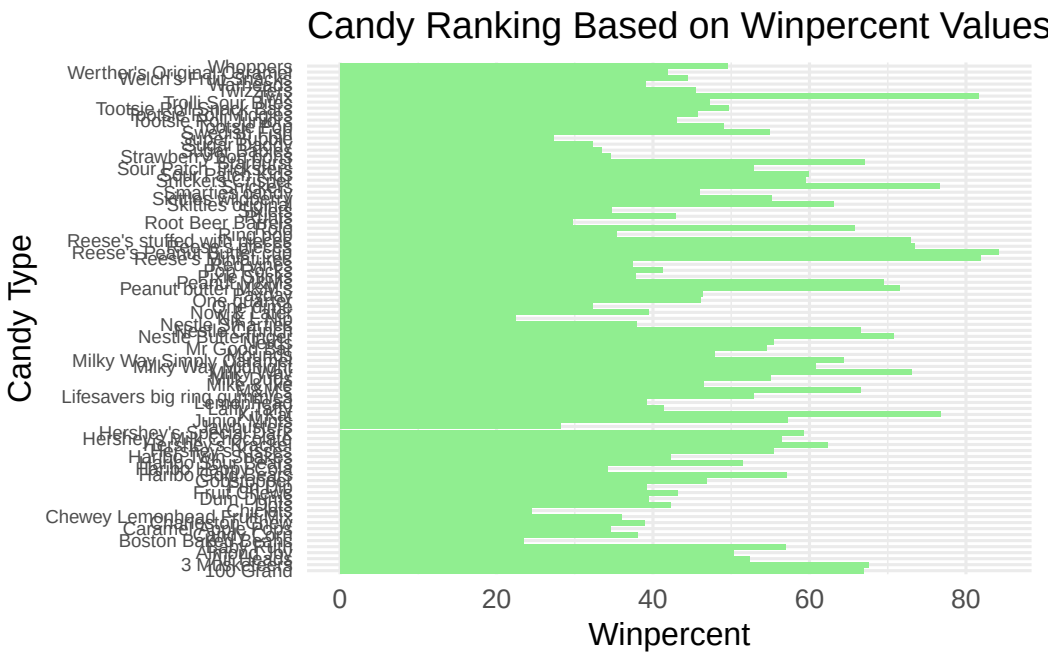
```
head(candy[order(-candy$winpercent), ], 5)
```

```
                        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
```

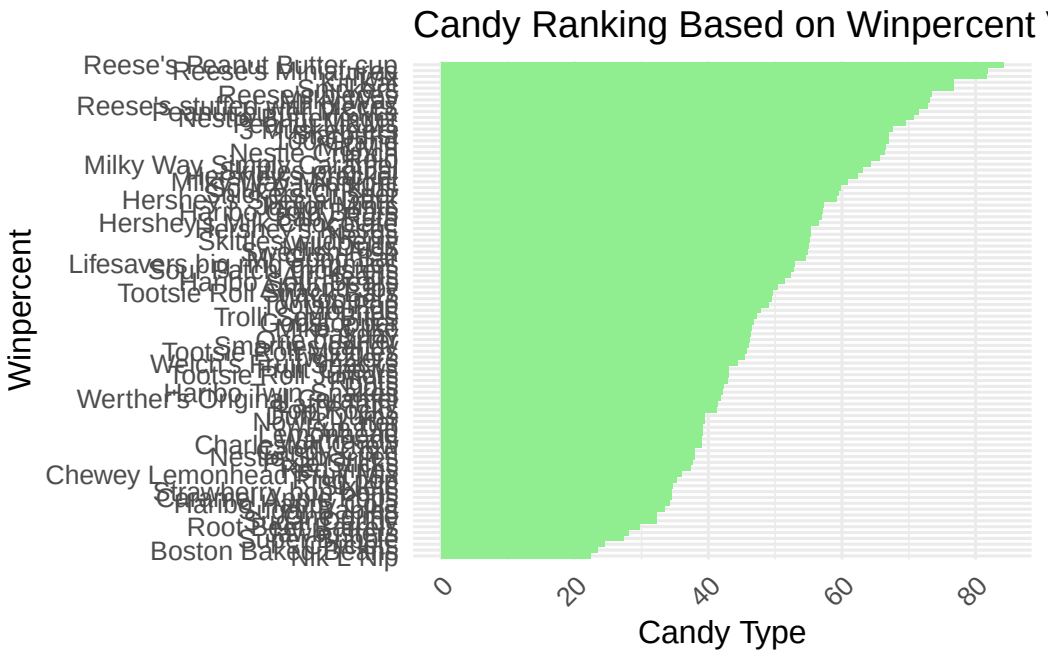
Q15. Make a first barplot of candy ranking based on winpercent values.

```
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col(fill = "lightgreen") +
  labs(title = "Candy Ranking Based on Winpercent Values", x = "Winpercent", y = "Candy Type"
  theme_minimal(base_size = 12) +
  theme(axis.text.y = element_text(size = 7))
```



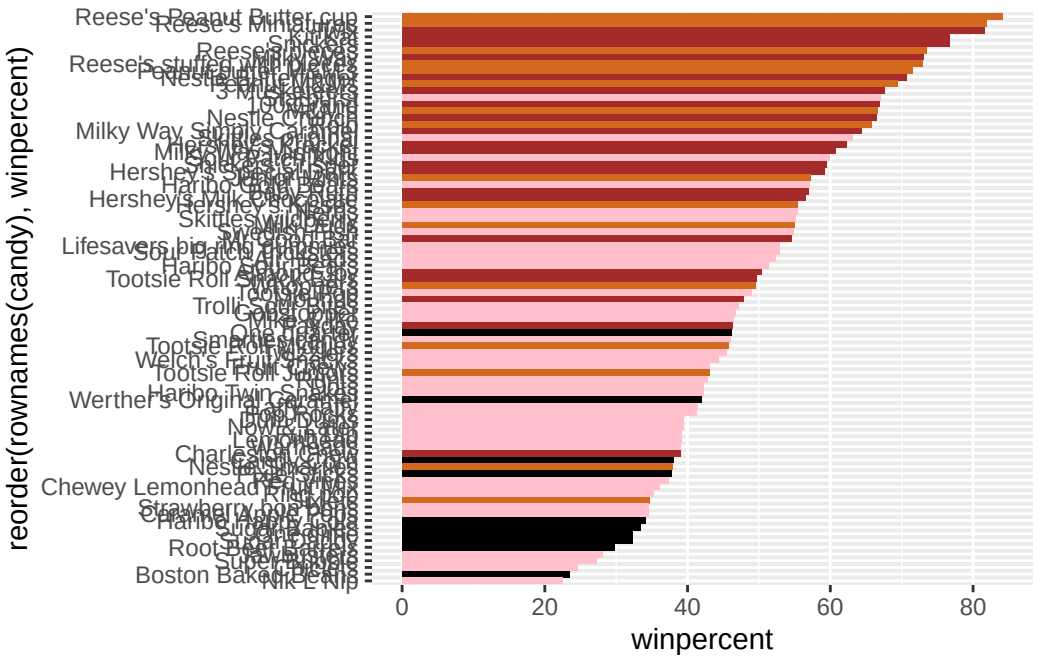
Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col(fill = "lightgreen") +
  labs(title = "Candy Ranking Based on Winpercent Values", x = "Candy Type", y = "Winpercent"
  theme_minimal(base_size = 12) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



Color mapping of histograms

```
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)
```



Q17. What is the worst ranked chocolate candy?

```
candy_chocolate <- subset(candy, candy$chocolate == 1)
candy_chocolate[order(candy_chocolate$winpercent), ][1, ]
```

```
        chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Sixlets         1      0       0              0      0                 0    0
        bar pluribus sugarpercent pricepercent winpercent
Sixlets   0        1         0.22        0.081     34.722
```

Q18. What is the best ranked fruity candy?

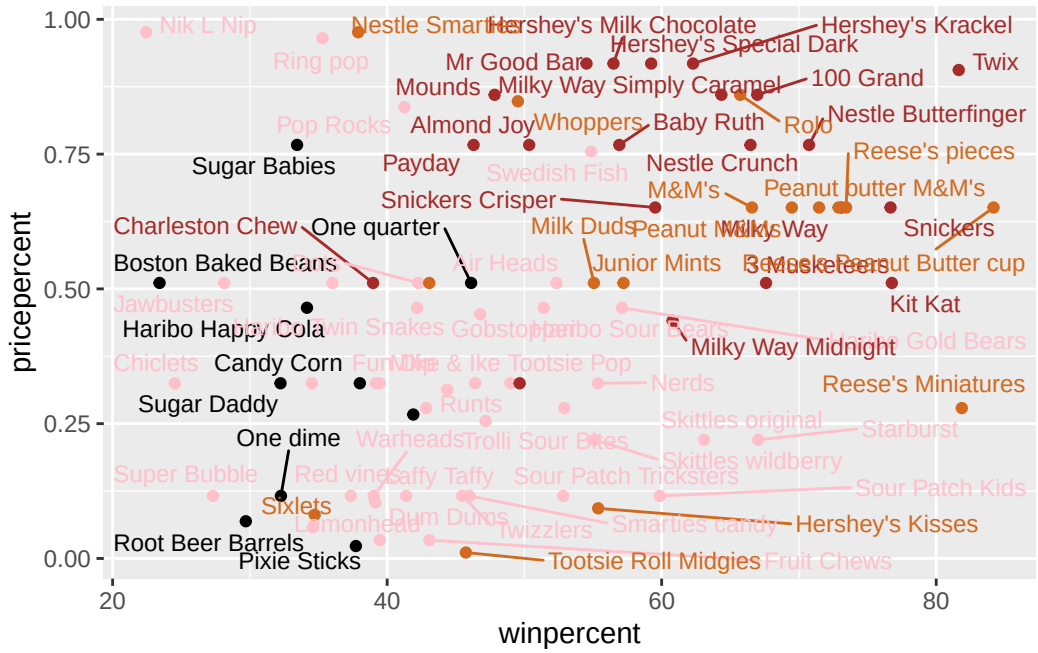
```
candy_fruity <- candy |> filter(fruity == 1) |> arrange(desc(winpercent)) |> slice(1)
candy_fruity
```

```
          chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Starburst         0      1       0              0      0                 0    0
          bar pluribus sugarpercent pricepercent winpercent
Starburst   0        1        0.151         0.22   67.03763
```

Price percents

```
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 = 15)
```

```
Warning: ggrepel: 11 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?

```
candy_bang_for_buck <- candy %>%
  mutate(bang_for_buck = winpercent / pricepercent) %>%
  arrange(desc(bang_for_buck)) %>%
  slice(1)
candy_bang_for_buck
```

```
                     chocolate fruity caramel peanutyalmondy nougat
Tootsie Roll Midgies         1      0       0              0      0
                     crispedricewafer hard bar pluribus sugarpercent
Tootsie Roll Midgies                0    0   0        1        0.174
                     pricepercent winpercent bang_for_buck
Tootsie Roll Midgies        0.011   45.73675      4157.886
```

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

```
candy_expensive <- candy %>%
  arrange(desc(pricepercent)) %>%
  slice(1:5)
candy_expensive
```

```
                        chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                       0      1       0              0      0
Nestle Smarties                 1      0       0              0      0
Ring pop                        0      1       0              0      0
Hershey's Krackel               1      0       0              0      0
Hershey's Milk Chocolate        1      0       0              0      0
                        crispedricewafer hard bar pluribus sugarpercent
Nik L Nip                               0    0   0        1        0.197
Nestle Smarties                         0    0   0        1        0.267
Ring pop                                0    1   0        0        0.732
Hershey's Krackel                       1    0   1        0        0.430
Hershey's Milk Chocolate                0    0   1        0        0.430
                        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
```

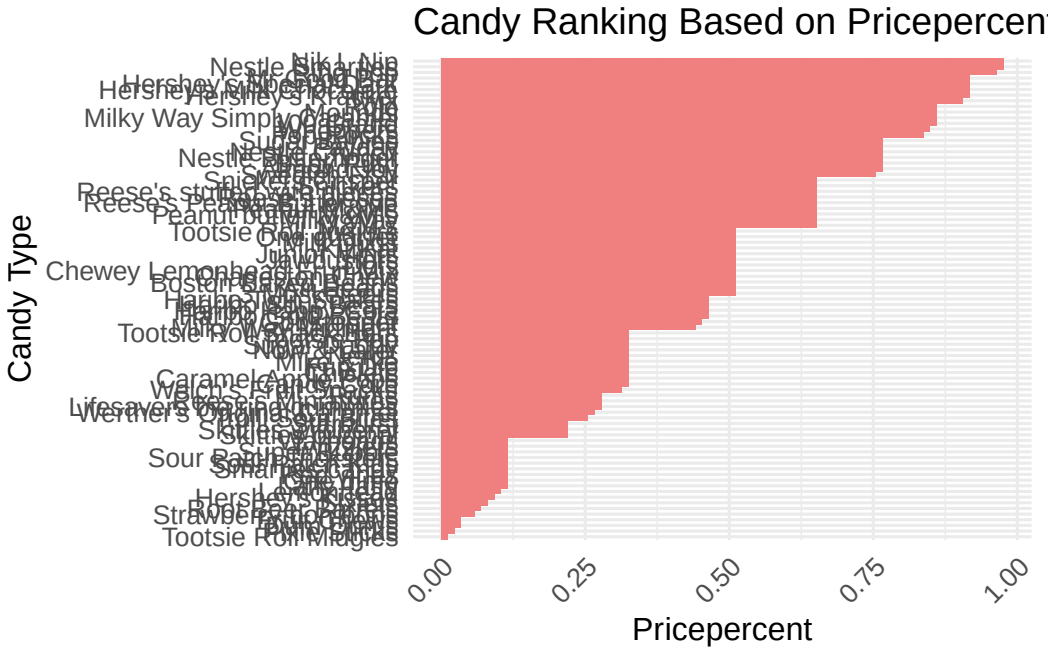
```
least_popular_expensive <- candy_expensive %>%
  arrange(winpercent) %>%
  slice(1)
least_popular_expensive # Nik L Nip
```

```
          chocolate fruity caramel peanutyalmondy nougat crispedricewafer hard
Nik L Nip         0      1       0              0      0                0    0
          bar pluribus sugarpercent pricepercent winpercent
Nik L Nip   0        1        0.197        0.976   22.44534
```

Optional

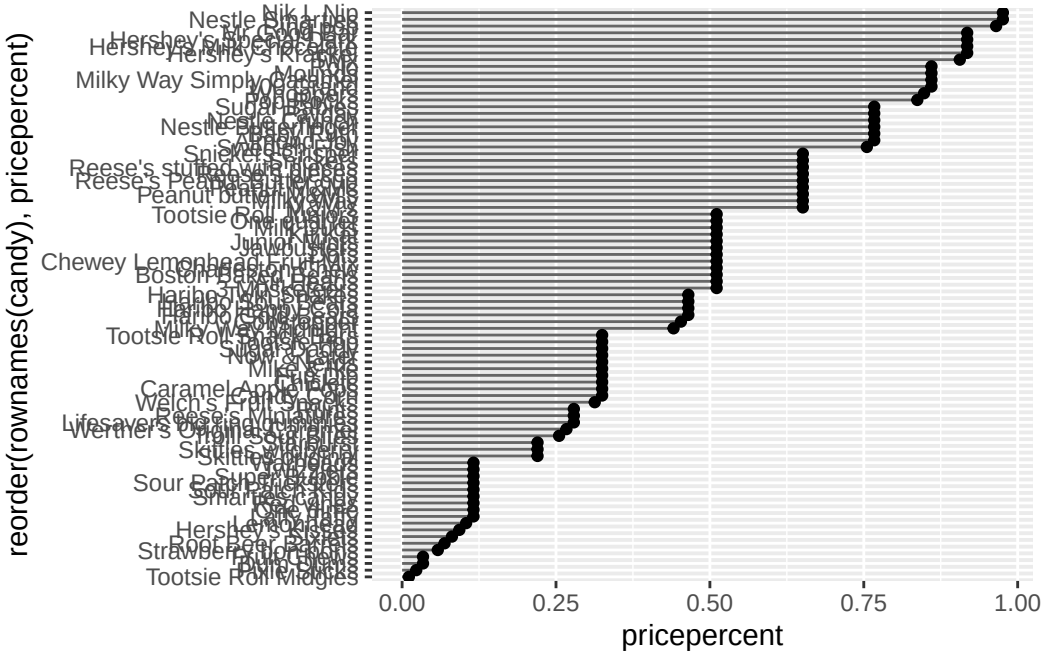
Q21. Make a barplot again with geom_col() this time using pricepercent and then improve this step by step, first ordering the x-axis by value and finally making a so called "dot chat" or "lollipop" chart by swapping geom_col() for geom_point() + geom_segment().

```
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_col(fill = "lightcoral") +
  labs(title = "Candy Ranking Based on Pricepercent Values", x = "Pricepercent", y = "Candy T
  theme_minimal(base_size = 12) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



Lollipop Chart

```
# Make a lollipop chart of pricepercent
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_segment(aes(yend = reorder(rownames(candy), pricepercent),
                   xend = 0), col="gray40") +
    geom_point()
```



Correlation Structures

```
cor(candy)
```

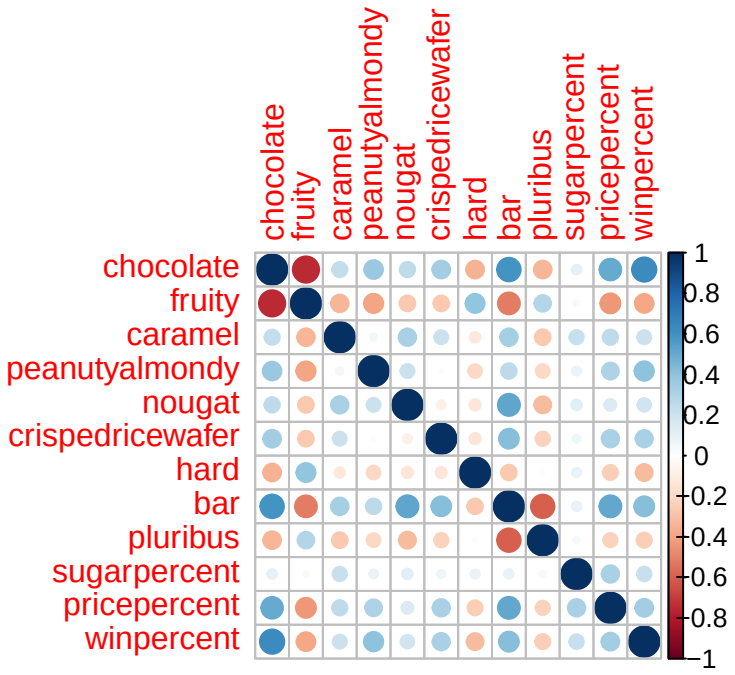
```
                  chocolate      fruity     caramel peanutyalmondy      nougat
chocolate         1.0000000 -0.74172106  0.24987535     0.37782357  0.25489183
fruity           -0.7417211  1.00000000 -0.33548538    -0.39928014 -0.26936712
caramel           0.2498753 -0.33548538  1.00000000     0.05935614  0.32849280
peanutyalmondy    0.3778236 -0.39928014  0.05935614     1.00000000  0.21311310
nougat            0.2548918 -0.26936712  0.32849280     0.21311310  1.00000000
crispedricewafer  0.3412098 -0.26936712  0.21311310    -0.01764631 -0.08974359
hard             -0.3441769  0.39067750 -0.12235513    -0.20555661 -0.13867505
bar               0.5974211 -0.51506558  0.33396002     0.26041960  0.52297636
pluribus         -0.3396752  0.29972522 -0.26958501    -0.20610932 -0.31033884
sugarpercent      0.1041691 -0.03439296  0.22193335     0.08788927  0.12308135
pricepercent      0.5046754 -0.43096853  0.25432709     0.30915323  0.15319643
winpercent        0.6365167 -0.38093814  0.21341630     0.40619220  0.19937530
                  crispedricewafer        hard         bar    pluribus
chocolate               0.34120978 -0.34417691  0.59742114 -0.33967519
fruity                 -0.26936712  0.39067750 -0.51506558  0.29972522
caramel                 0.21311310 -0.12235513  0.33396002 -0.26958501
```

```
peanutyalmondy        -0.01764631 -0.20555661  0.26041960 -0.20610932
nougat                -0.08974359 -0.13867505  0.52297636 -0.31033884
crispedricewafer       1.00000000 -0.13867505  0.42375093 -0.22469338
hard                  -0.13867505  1.00000000 -0.26516504  0.01453172
bar                    0.42375093 -0.26516504  1.00000000 -0.59340892
pluribus              -0.22469338  0.01453172 -0.59340892  1.00000000
sugarpercent           0.06994969  0.09180975  0.09998516  0.04552282
pricepercent           0.32826539 -0.24436534  0.51840654 -0.22079363
winpercent             0.32467965 -0.31038158  0.42992933 -0.24744787
                  sugarpercent pricepercent winpercent
chocolate           0.10416906    0.5046754  0.6365167
fruity             -0.03439296   -0.4309685 -0.3809381
caramel             0.22193335    0.2543271  0.2134163
peanutyalmondy      0.08788927    0.3091532  0.4061922
nougat              0.12308135    0.1531964  0.1993753
crispedricewafer    0.06994969    0.3282654  0.3246797
hard                0.09180975   -0.2443653 -0.3103816
bar                 0.09998516    0.5184065  0.4299293
pluribus            0.04552282   -0.2207936 -0.2474479
sugarpercent        1.00000000    0.3297064  0.2291507
pricepercent        0.32970639    1.0000000  0.3453254
winpercent          0.22915066    0.3453254  1.0000000
```

```
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)?

Fruity and chocolate, bar and caramel, pluribus and bar, fruity and bar, etc.

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

Chocolate and bar, bar and nougat, etc.

PCA

Apply PCA using the prcom() function to our candy dataset remembering to set the scale=TRUE argument.

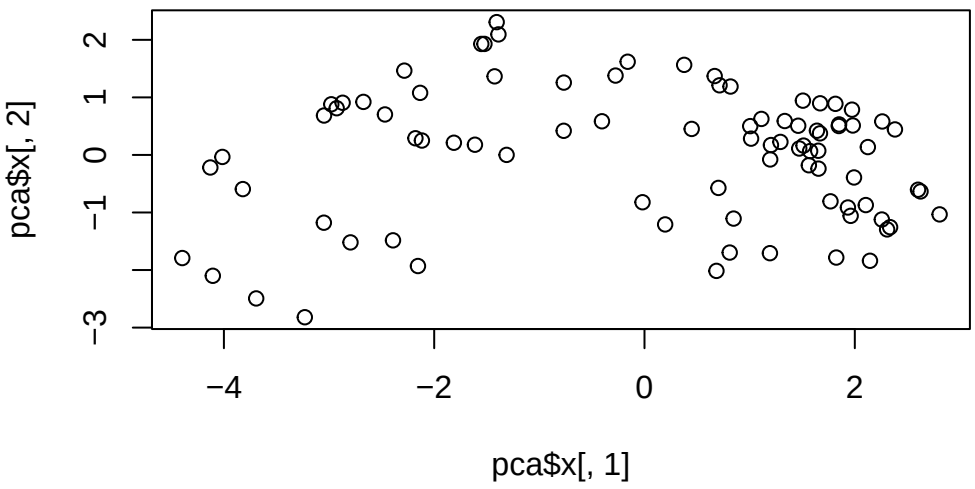
```
pca <- prcomp(candy, scale = TRUE)
summary(pca)
```

```
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
```

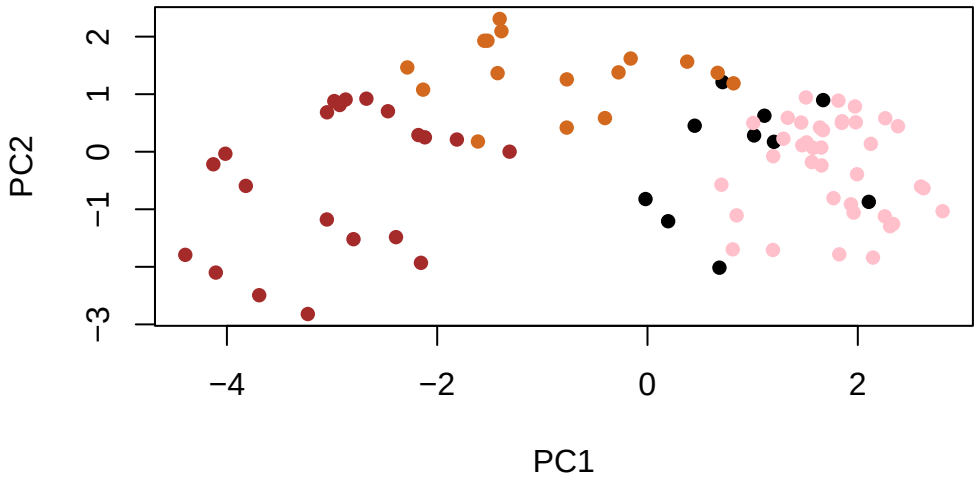
Now we can plot our main PCA score plot of PC1 vs PC2.

```
plot(pca$x[,1], pca$x[,2])
```



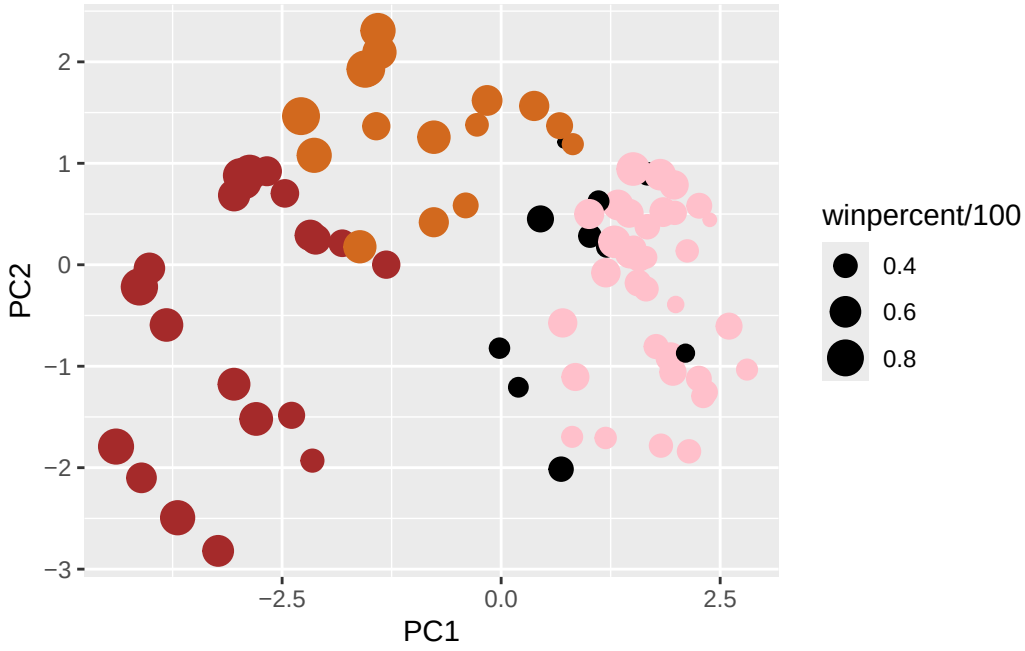
We can change the plotting character and add some color:

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



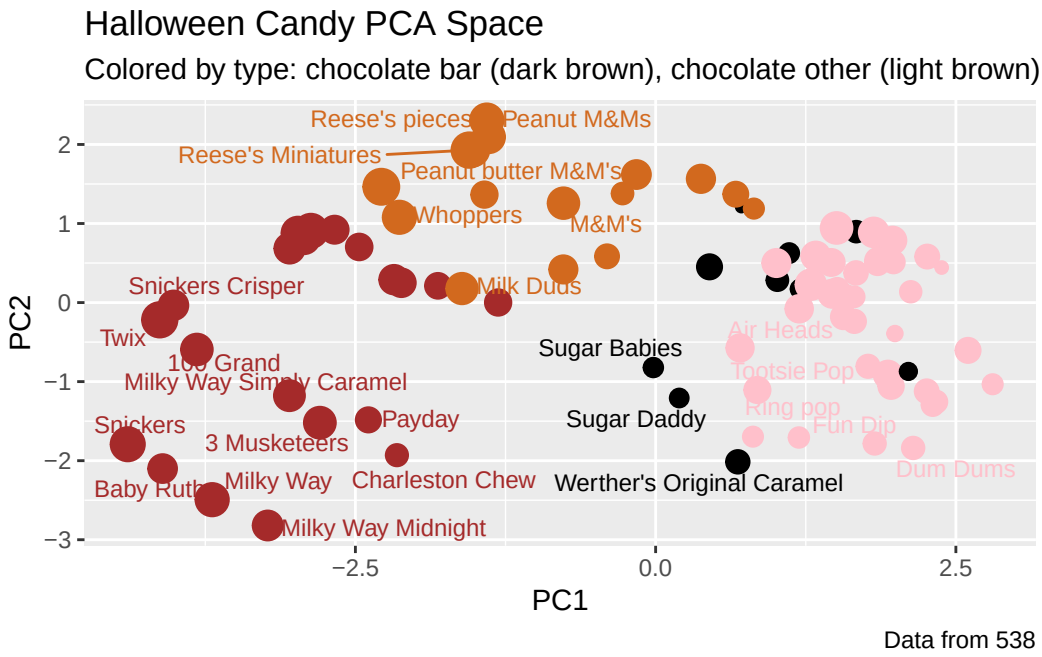
We can make a much nicer plot with the ggplot2 package but it is important to note that ggplot works best when you supply an input data.frame that includes a separate column for each of the aesthetics you would like displayed in your final plot. To accomplish this we make a new data.frame here that contains our PCA results with all the rest of our candy data. We will then use this for making plots below

```
# Make a new data-frame with our PCA results and candy data
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)

p
```




```
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")
```

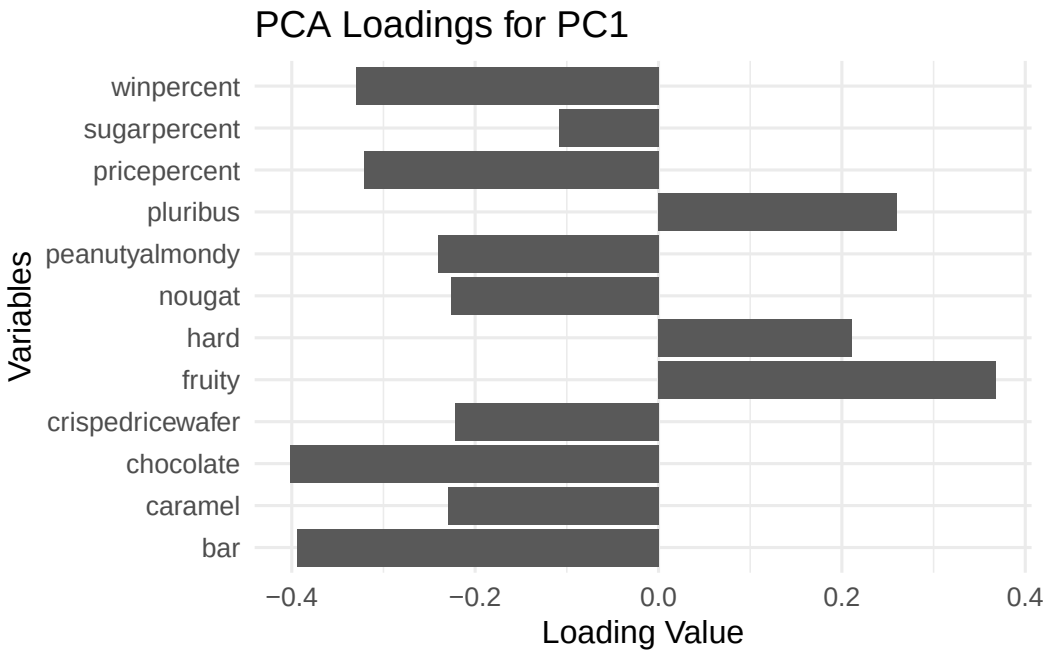
```
Warning: ggrepel: 59 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



library(plotly) # ggplotly() turns a ggplot into an interactive plotly plot ggplotly(p)

Let's finish by taking a quick look at PCA our loadings. Do these make sense to you? Notice the opposite effects of chocolate and fruity and the similar effects of chocolate and bar (i.e. we already know they are correlated).

```
ggplot(as.data.frame(pca$rotation)) +
  aes(x=rownames(as.data.frame(pca$rotation)), y=PC1) +
  geom_col() +
  coord_flip() +
  labs(title="PCA Loadings for PC1",
       x="Variables",
       y="Loading Value") +
  theme_minimal(base_size = 12)
```



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

```
# Variables picked up strongly in the positive direction for PC1
pca$rotation[which(pca$rotation[,1] > 0), 1]
```

```
   fruity      hard  pluribus
0.3683883 0.2111587 0.2600041
```

Not really, thought fruity should be go along with chewy.