Class 9: Candy Mini-Project

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Background

In this project, we are going to look at data from a website which asked its readers to pick their favorite candies. We are going to explore this dataset and figure out some trends among the candies. By the end, I should be able to predict what candy you may like based off your favorite ones.

Importing the Candy Data

First we need to import the dataset into R. Remember we need to make sure the candy names are not supposed to be a column so we set the `row.names=1`.

```
candy_file <- "https://raw.githubusercontent.com/fivethirtyeight/data/master/candy-power-ranl

candy = read.csv(candy_file, 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
```

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

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

```
[1] 38
```

Within the dataset, there is a variable named **winpercent**, a percentage of people who prefer this candy over another randomly chosen candy from the dataset

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

```
[1] 81.64291
```

> Q3. What is your favorite candy (other than Twix) in the dataset and what is it's winpercent value?

```r
candy["Reese's Peanut Butter cup",]$winpercent
```

```
[1] 84.18029
```

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

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

```
[1] 76.7686
```

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

The win percent value for tootsie roll snack bars is 49.653503

N.B The skim package can be helpful in quick analysis of a data set.

```r
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	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
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 `winpercent` variable appears to be on a different scale from the other columns. Its mean is 50.31676381 while the others under 1.

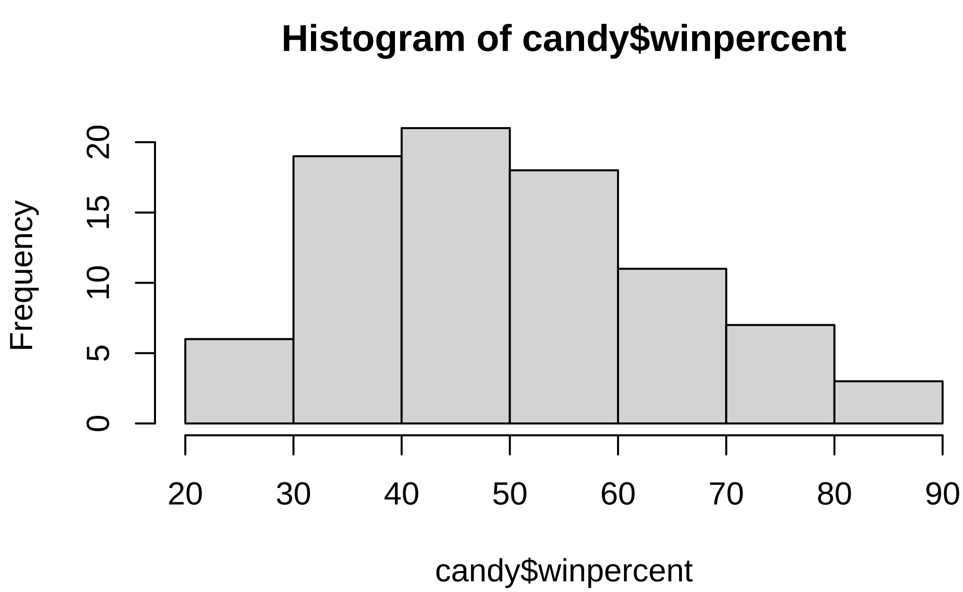
> Q7. What do you think a zero and one represent for the candy$chocolate column?

The 0 and 1 likely represent binary, which means that the 0 or 1s are true or false. In this data set, a 1 would mean that the candy has some sort chocolate apart of it.

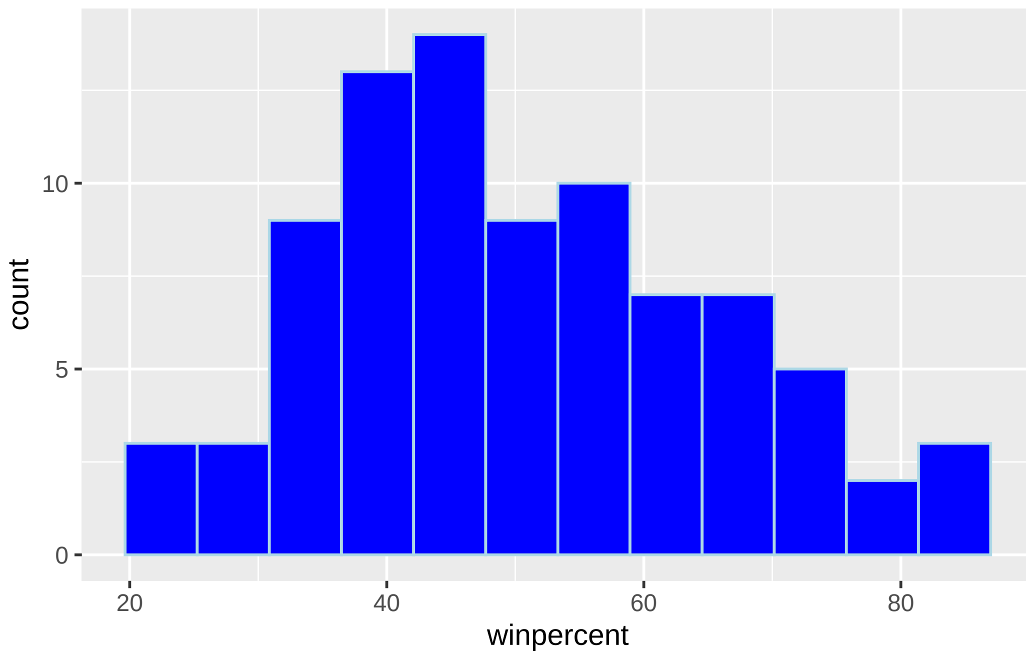
Exploratory analysis

> Q8. Plot a histogram of winpercent values using both base R an ggplot2.

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



```r
library(ggplot2)
ggplot(candy, aes(winpercent)) +
  geom_histogram(bins=12,fill="blue", col="light blue")
```



Q9. Is the distribution of winpercent values symmetrical?

The distribution of winpercent value is not symmetrical. Most of the candies fall between 35-50%. It is apparent in both histograms there is a longer tail on the right end.

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

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

```
[1] 50.31676
```

The center of the distribution is above 50% with a mean of 50.31676.

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

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

```
[1] 60.92153
```

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

```
[1] 44.11974
```

On average, chocolate candy is higher ranked than fruit candy with a mean winpercent of 60.9215294 compared to the mean of fruit, 44.1197414.

> Q12. Is this difference statistically significant?

```r
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 
```

Based on the `t.test()` the difference of percents is statistically significant. The p-value of the test was 2.871e-08 which is far below the significance threshold of 0.05.

Overall Candy Rankings

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

```r
head(candy[order(candy$winpercent),], n=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, decreasing = TRUE),], n=5)
```

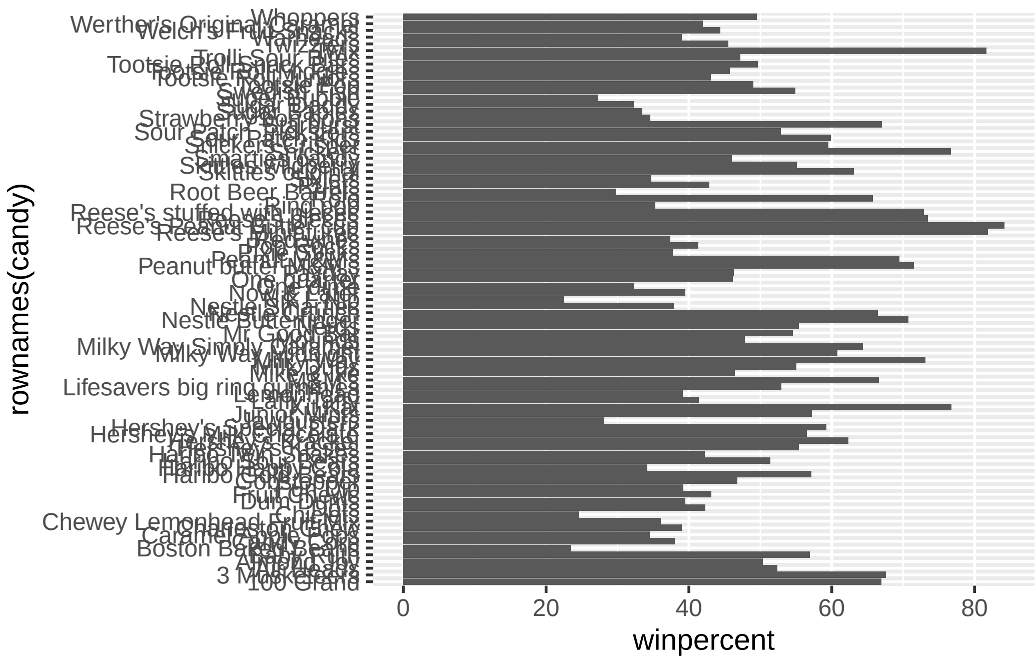
```
                          chocolate fruity caramel peanutyalmondy nougat
Reese's Peanut Butter cup         1      0       0              1      0
Reese's Miniatures                1      0       0              1      0
Twix                              1      0       1              0      0
Kit Kat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

```
library(ggplot2)

ggplot(candy) +
```

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

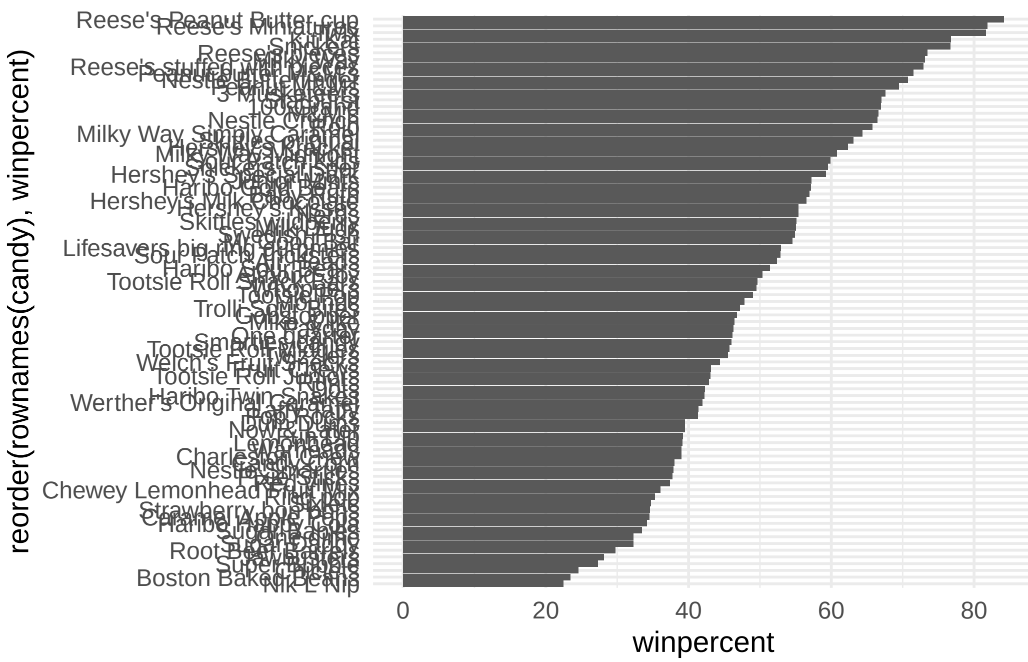


We first created our starter plot which is very very ugly. The text is all jumbled up and the bars are all over the place. Lets make it look better…

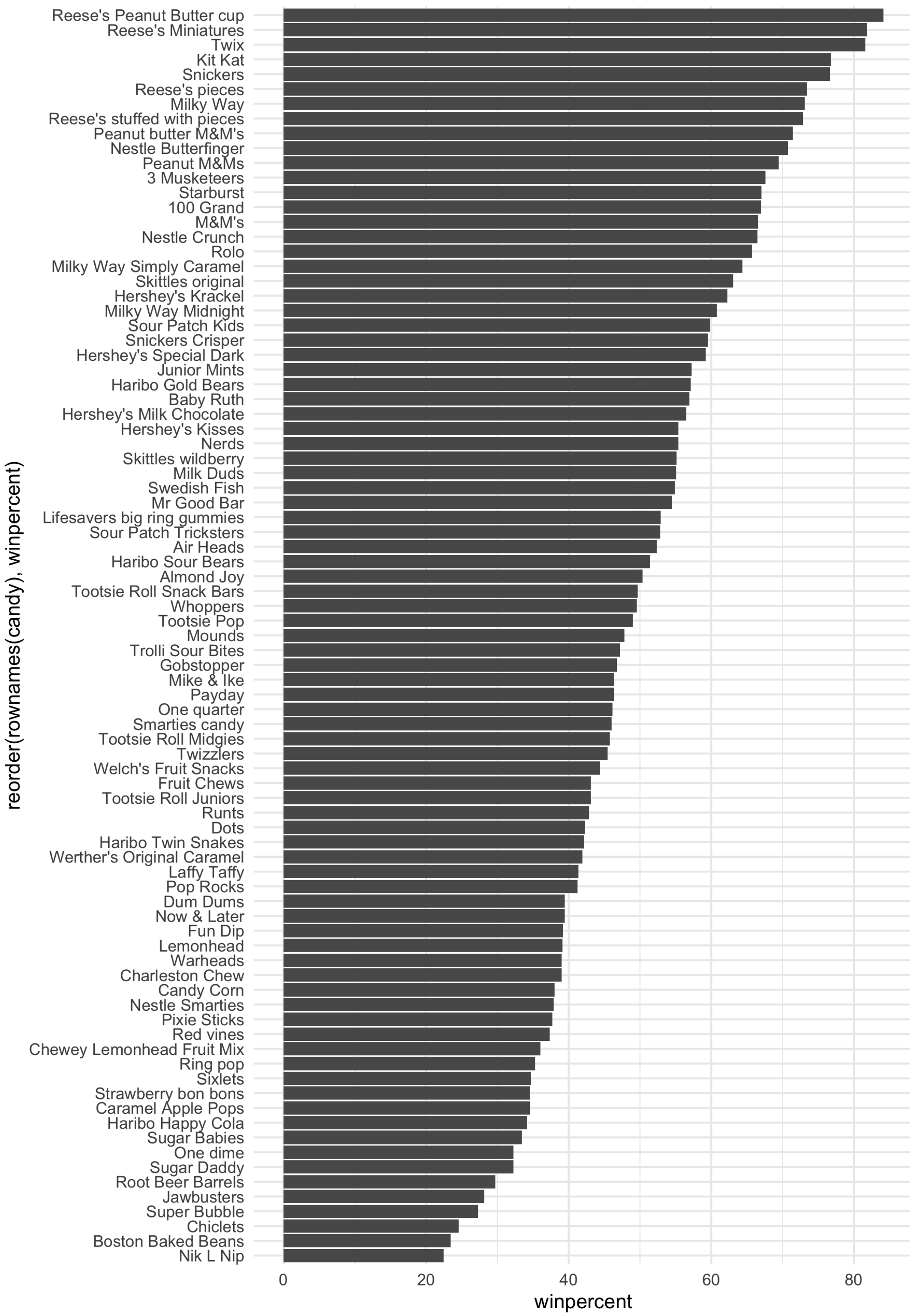
> Q16. This is quite ugly, use the reorder() function to get the bars sorted by winpercent?

```r
library(ggplot2)

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




```
ggsave("barplot1.png", height=10, width=7)
```

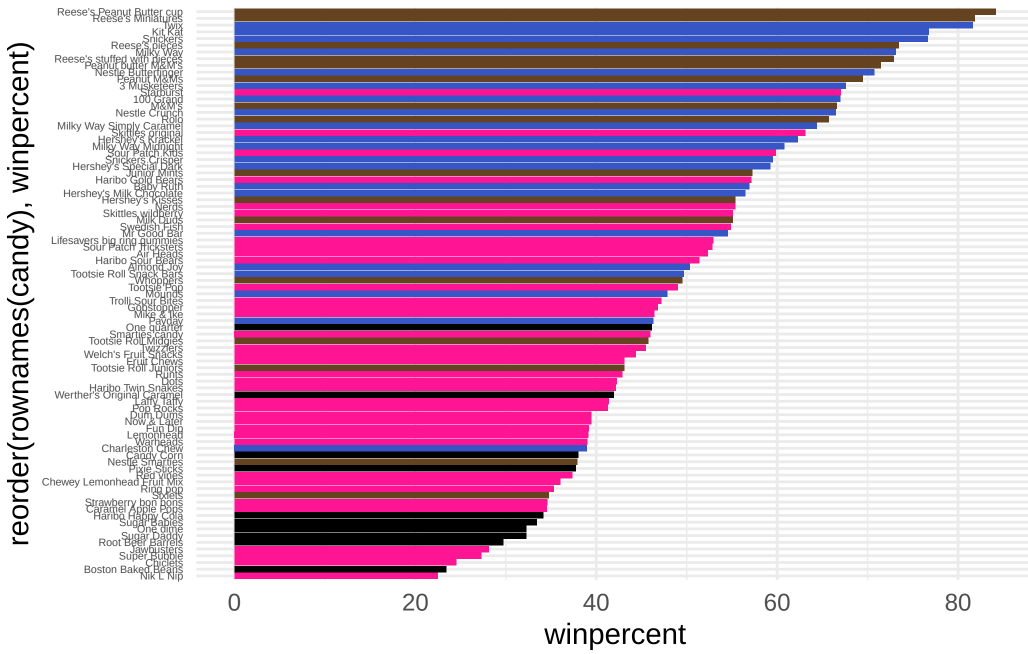

Reese's Peanut Butter cup
Reese's Miniatures
Twix
Kit Kat
Snickers
Reese's pieces
Milky Way
Reese's stuffed with pieces
Peanut butter M&M's
Nestle Butterfinger
Peanut M&Ms
3 Musketeers
Starburst
100 Grand
M&M's
Nestle Crunch
Rolo
Milky Way Simply Caramel
Skittles original
Hershey's Krackel
Milky Way Midnight
Sour Patch Kids
Snickers Crisper
Hershey's Special Dark
Junior Mints
Haribo Gold Bears
Baby Ruth
Hershey's Milk Chocolate
Hershey's Kisses
Nerds
Skittles wildberry
Milk Duds
Swedish Fish
Mr Good Bar
Lifesavers big ring gummies
Sour Patch Tricksters
Air Heads
Haribo Sour Bears
Almond Joy
Tootsie Roll Snack Bars
Whoppers
Tootsie Pop
Mounds
Trolli Sour Bites
Gobstopper
Mike & Ike
Payday
One quarter
Smarties candy
Tootsie Roll Midgies
Twizzlers
Welch's Fruit Snacks
Fruit Chews
Tootsie Roll Juniors
Runts
Dots
Haribo Twin Snakes
Werther's Original Caramel
Laffy Taffy
Pop Rocks
Dum Dums
Now & Later
Fun Dip
Lemonhead
Warheads
Charleston Chew
Candy Corn
Nestle Smarties
Pixie Sticks
Red vines
Chewey Lemonhead Fruit Mix
Ring pop
Sixlets
Strawberry bon bons
Caramel Apple Pops
Haribo Happy Cola
Sugar Babies
One dime
Sugar Daddy
Root Beer Barrels
Jawbusters
Super Bubble
Chiclets
Boston Baked Beans
Nik L Nip
reorder(rownames(candy), winpercent)
0
20
40
60
80
winpercent

Lets

add color to the graph to make it easier to read!

```
my_cols=rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] = "#654321"
my_cols[as.logical(candy$bar)] = "#3556C4"
my_cols[as.logical(candy$fruity)] = "#ff1493"
```

```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col(fill=my_cols)+
  theme_minimal() +
  theme(axis.text.y = element_text(size = 4))
```



Q17. What is the worst ranked chocolate candy?

The worst rated chocolate candy is **Sixlets**.

Q18. What is the best ranked fruity candy?

The best rated fruit candy is **Starburst**.

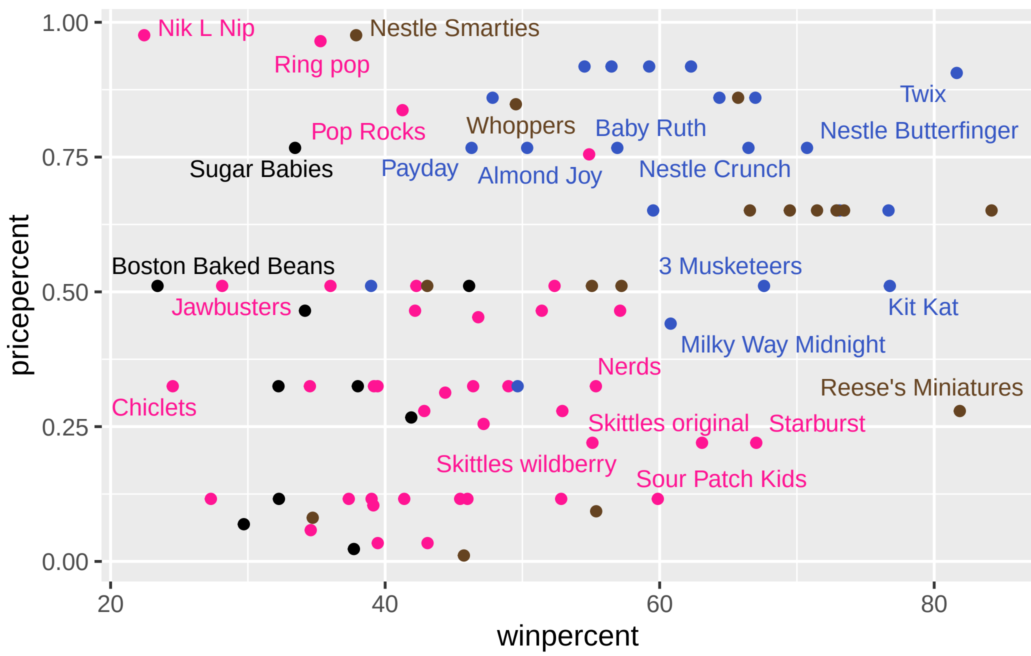
Analyzing Price Percent

Now lets look at **Price percent** aka the best candy for the least amount of money. We can do this by making a plot of winpercent vs the pricepercent variable.

```
library(ggrepel)

ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols, size=3.3, max.overlaps = 6) +
  theme_gray()
```

```
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 Minis are the best candy for the cheapest price based on this graph.

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

```r
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
```

The 5 most expensive candy types in the data set are Nik L Nip, Nestle Smarties, Ring pop, Hershey's Krackel, and Hershey Milk Chocolate. The least popular out of these 5 are the Nik L Nip which also happens to be tied for the worst price percent

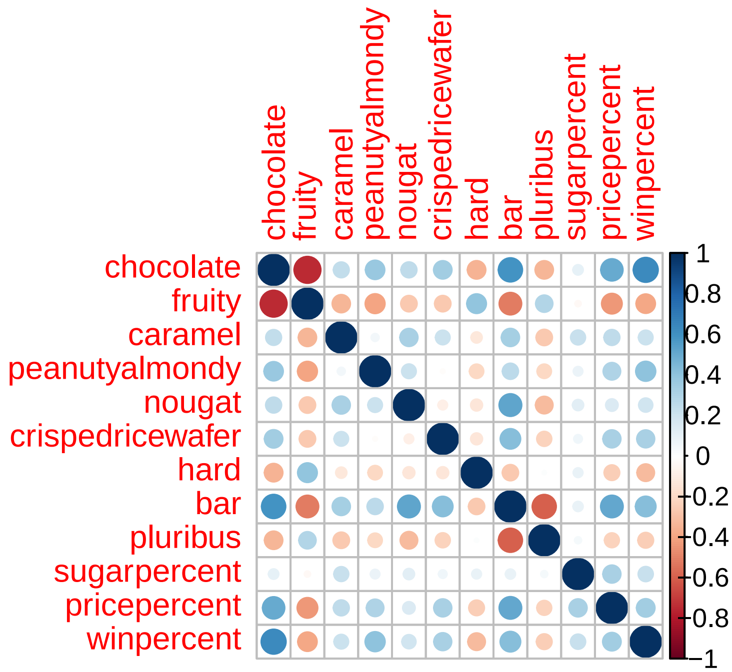
Exploring the correlation structure

Now that we have identified general trends and have a bit of a better understanding of the data, lets see how they interact with each other. Lets use the **corrplot** package to do this.

```r
library(corrplot)
```

```
corrplot 0.95 loaded
```

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



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

The most anti-correlated variables that I can see are: pluribus (several in a package) + bar, fruity + bar, and fruity + chocolate just to name a few. You can see that fruity things tend to have a lower win percent however is associated with being less expensive

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

The most positively correlated are chocolate + bar, nougat + bar, wafer + bar, fruity + hard. You can also see that chocolate tends to get chosen more than fruity but is more expensive.

Principal Component Analysis

We can now apply PCA using the `prcomp()` function to our candy dataset. We need to make sure to set the `scale=TRUE` argument as we identified winpercent as a different scale earlier.

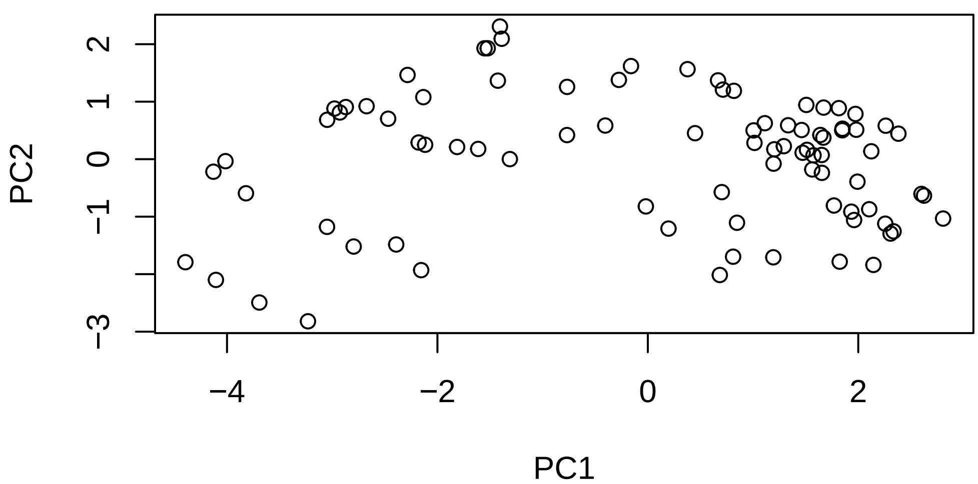
```
pca <- prcomp(candy, scale=TRUE)
summary(pca)
```

```
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
```

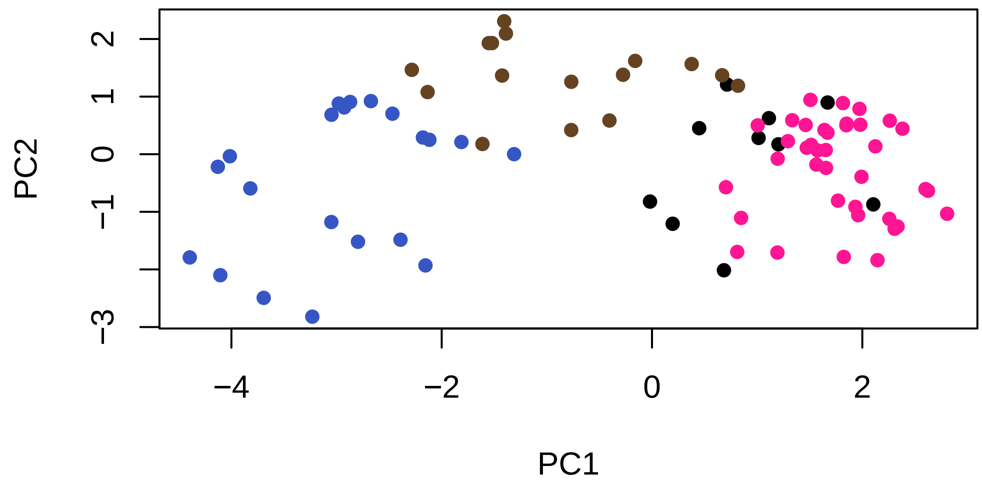
Lets now plot our main PCA score plot of PC1 vs PC2.

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



We can make it look a little better than that righttt…

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

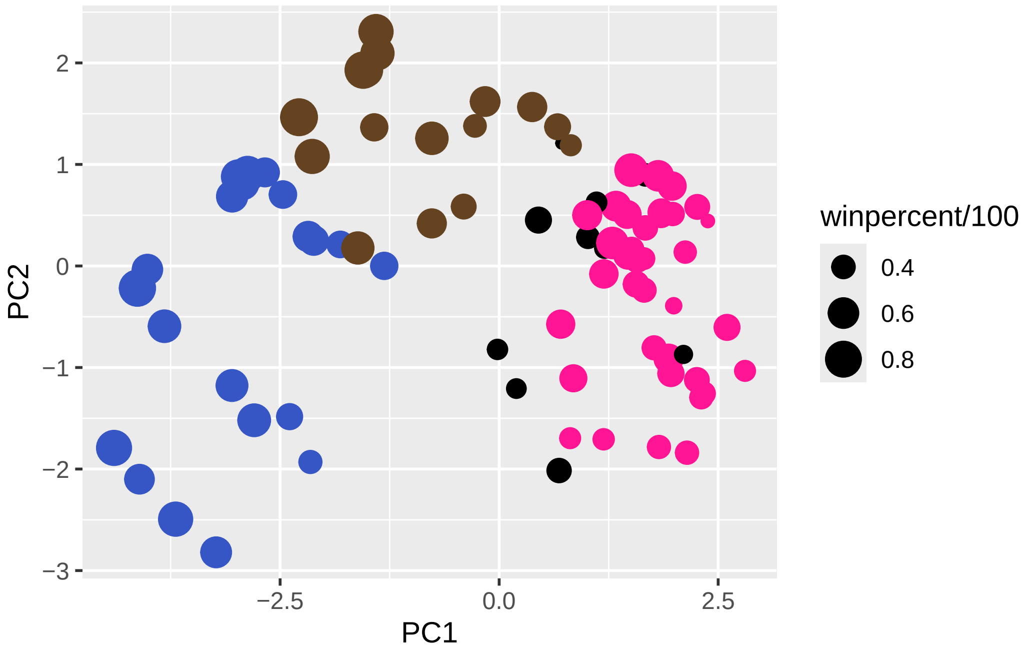


We can do even better than that come on now…

```
my_data <- cbind(candy, pca$x[,1:3])
```

```
p <- ggplot(my_data) +
        aes(PC1,PC2,
            size=winpercent/100,
            text=rownames(my_data),
            label=rownames(my_data)) +
        geom_point(col=my_cols)

p
```

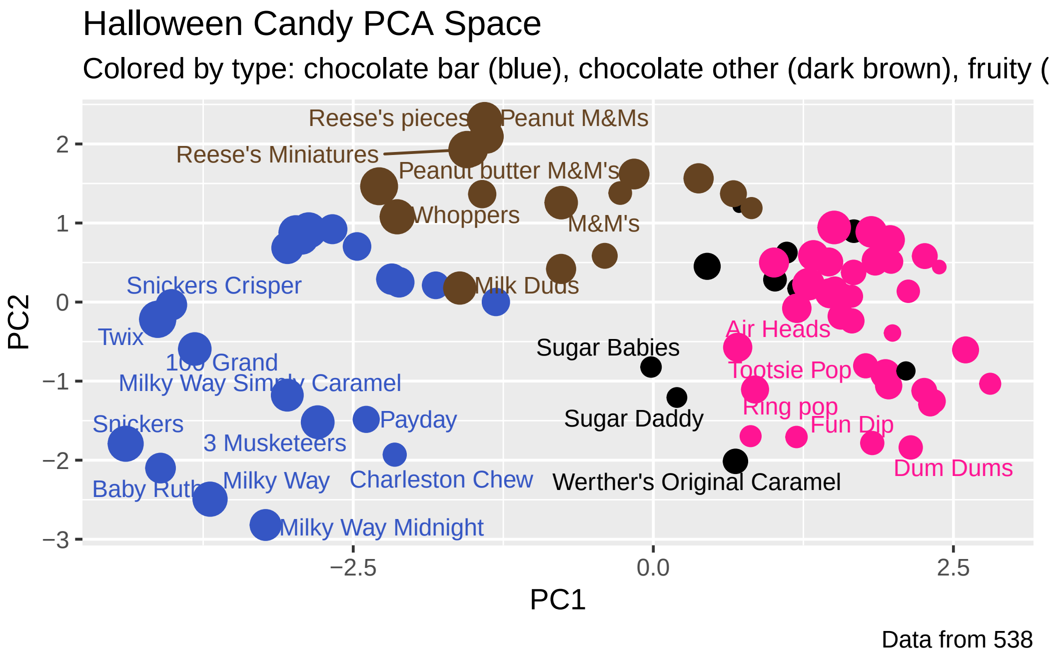


We can use **ggrepel** package along with the `ggrepel::geom_text_repel()` function to create some labels and put some sense to the dots.

```
library(ggrepel)

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 (blue), chocolate other (dark brown), fruity
       caption="Data from 538")
```

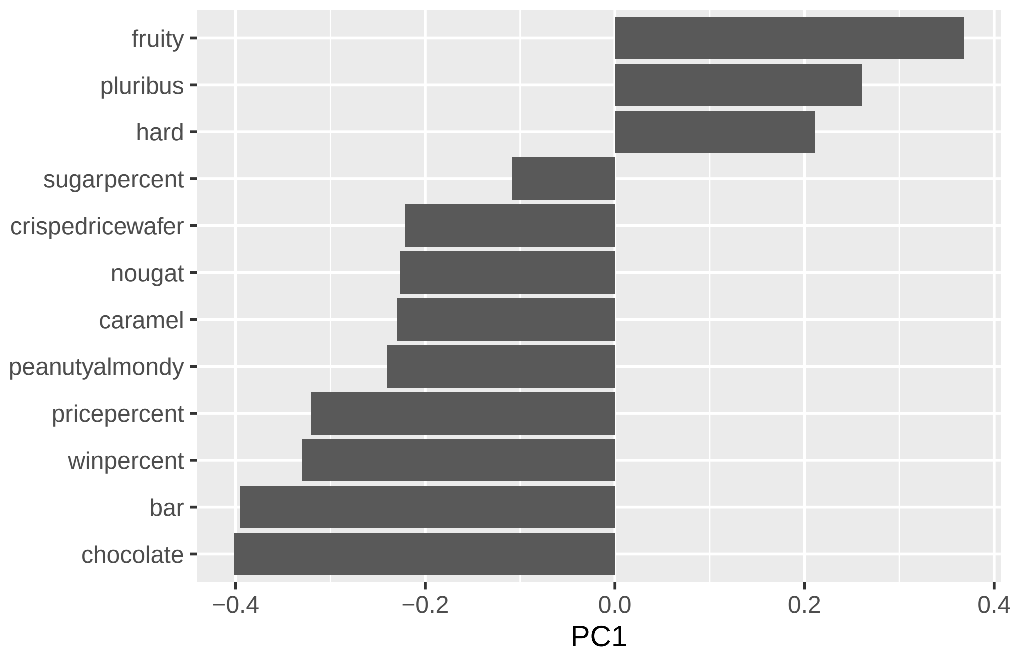
```
Warning: ggrepel: 59 unlabeled data points (too many overlaps). Consider
increasing max.overlaps
```



You can also make an interactive plot with **plotly**

```
#library(plotly)
#ggplotly(p)
```

```
ggplot(pca$rotation) +
  aes(PC1, reorder(rownames(pca$rotation), PC1)) +
  geom_col() +
  labs(y = "")
```



> Q24. Complete the code to generate the loadings plot above. What original variables are picked up strongly by PC1 in the positive direction? Do these make sense to you? Where did you see this relationship highlighted previously?

In the positive direction, we can see the variables with the largest PC1 loading are fruity, multi-piece, and hard. This captures a broad type of candy which are the opposite of chocolate, bar-style, rich candies. This was highlighted in the correlation matrix. In simple terms PC1 is essentially a fruity / hard / pluribus vs chocolate bar axis.

> Q25. Based on your exploratory analysis, correlation findings, and PCA results, what combination of characteristics appears to make a "winning" candy? How do these different analyses (visualization, correlation, PCA) support or complement each other in reaching this conclusion?

Based on my data, the best characteristics to make a winning candy are chocolate-based, bar, with something like nuts or caramel inside. You would want to stay away from fruity, hard candies while making the prices moderately expensive. You want to for sure stay away from fruity chocolate things and to make sure that if you are making chocolate bars, it isn't pluribus. The visualizations showed me that chocolate tend to cluster towards the higher win percents and fruity candy to be on the lower end. The correlation analyses showed that there was a strong negative correlation between fruity and chocolate while positively associating chocolate, caramel, nuts, and bars together. The PC1 results separated fruity/hard/pluribus candies from chocolate/bar candies displying the preference patterns. Together we can apply them together in order to reinforce our conclusion from different perspectives and improving confidence.