class10

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Class 10: Halloween Mini-Project

Exploratory Analysis of Halloween Candy

1. Importing candy data

```
#candy = read.csv("candy-data.csv", row.names=1)
library(readr)
# read in data and set column names
candy = read_csv("candy-data.csv", show_col_types = FALSE)
candy <- as.data.frame(candy)
rownames(candy) <- candy[[1]]
candy <- candy[, -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
```

```r
# flextable allows for scrollable table in rendered doc
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	
0	1	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	0	

```r
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
```

Alternative way to run functions with ‘pipe’ in dplyr. This can be more readable for multi-step operations

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

```
[1] 4276.925
```

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

There are 85 different candy types

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

There are 38 fruity candy types

2. What is your favorate candy?

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

Reese's Peanut Butter cup: 84

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

77

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

50

try out skimr package

```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	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
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

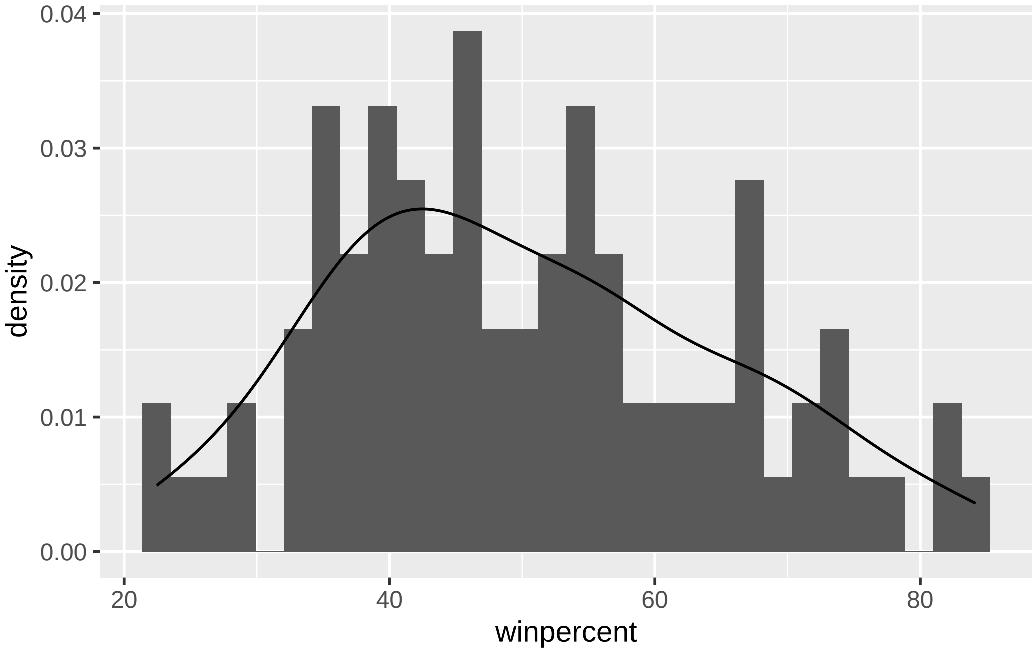
> Q7. What do you think a zero and one represent for the candy$chocolate column?

Logical/booleen indicator of whether the candy contains chocolate.

> Q8. Plot a histogram of winpercent values

```r
library("ggplot2")
ggplot(candy, aes(x = winpercent)) +
  geom_histogram(aes(y = after_stat(density))) +
  geom_density()
```

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



> Q9. Is the distribution of winpercent values symmetrical?

Somewhat right skewed

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

The median is below, while the mean is slightly above.

mean: 50.3167638 median: 47.829754

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

Higher

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

```
[1] 44.11974
```

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

```
[1] 60.92153
```

> Q12. Is this difference statistically significant?

Yes

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

```

	Welch Two Sample t-test

data:  candy[candy$fruity == 1, ]$winpercent and candy[candy$chocolate == 1, ]$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:
 -22.15795 -11.44563
sample estimates:
mean of x mean of y 
 44.11974  60.92153 
```

3. Overall Candy Rankings

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

Nik L Nip, Boston Baked Beans, Chiclets, Super Bubble, and Jawbusters

```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
```

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

Reese's Peanut Butter cup, Reese's Miniatures, Twix, Kit Kat, and Snickers.

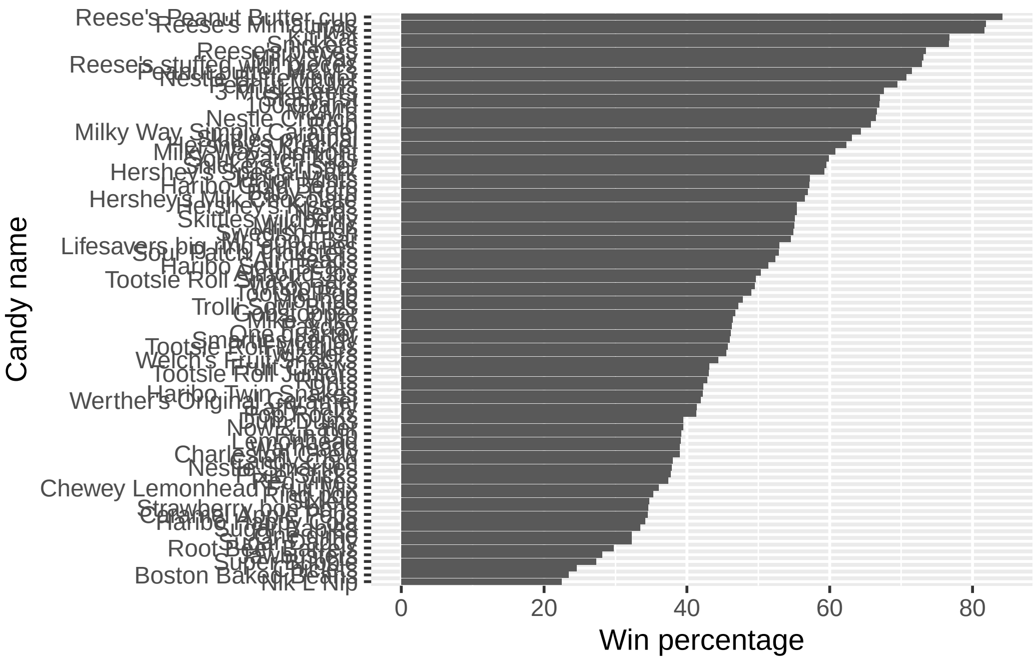
```r
candy |> arrange(winpercent) |> tail(5)
```

```
                          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
```

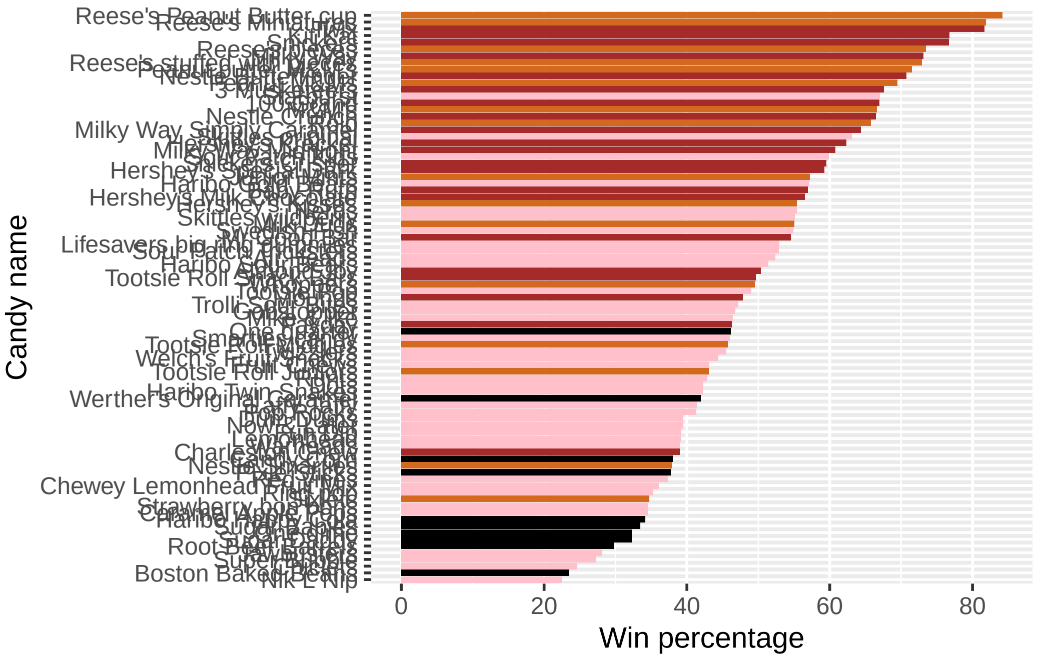
Q15. Make a first barplot of candy ranking based on winpercent values.

```r
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col() +
  ylab('Candy name') +
  xlab('Win percentage')
```



Time to add some useful color

```
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) +
  ylab('Candy name') +
  xlab('Win percentage')
```



Q17. What is the worst ranked chocolate candy?

Sixlets

Q18. What is the best ranked fruity candy?

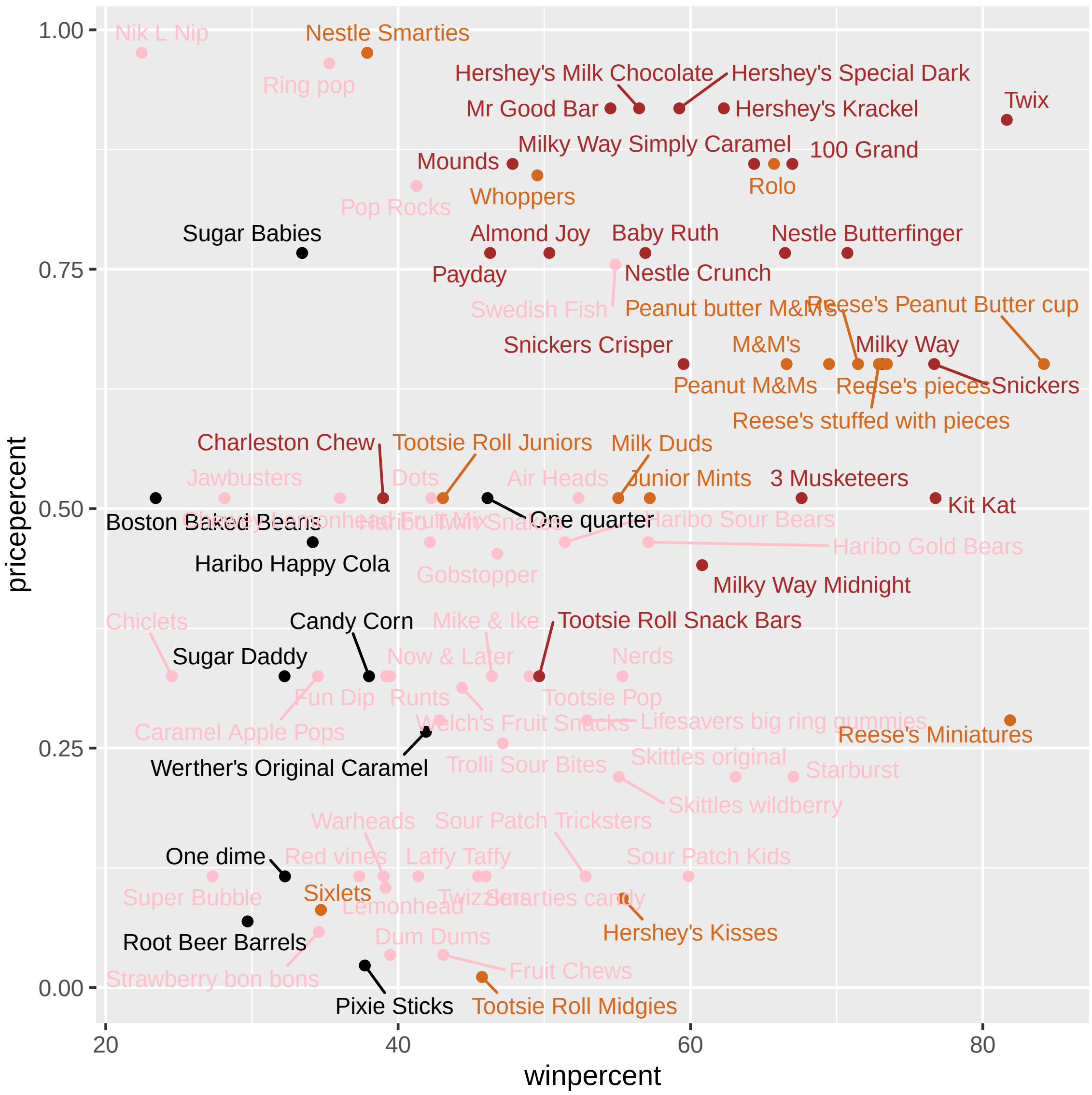
Starburst

```
temp <- arrange(candy[as.logical(candy$fruity),], winpercent)
rownames(temp)[nrow(temp)]
```

```
[1] "Starburst"
```

4. Taking a look at pricepercent

```
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 = 20)
```



> 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?

Reeses Miniatures is a good balance

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

5 most expensive candy types: “Nik L Nip”, “Nestle Smarties”, “Ring pop”, “Hershey’s Krackel”, “Hershey’s Milk Chocolate”

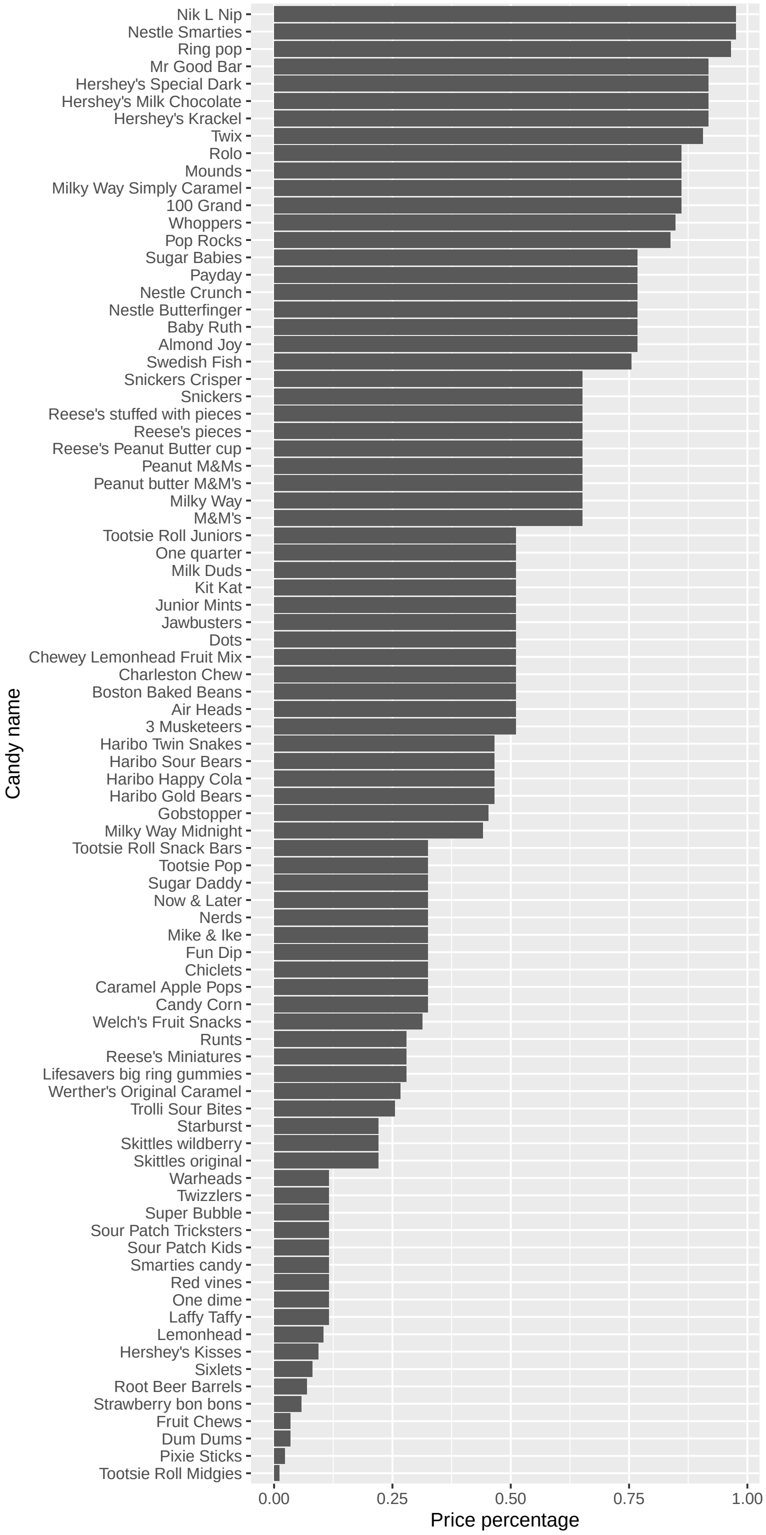
Least popular: Nik L Nip

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

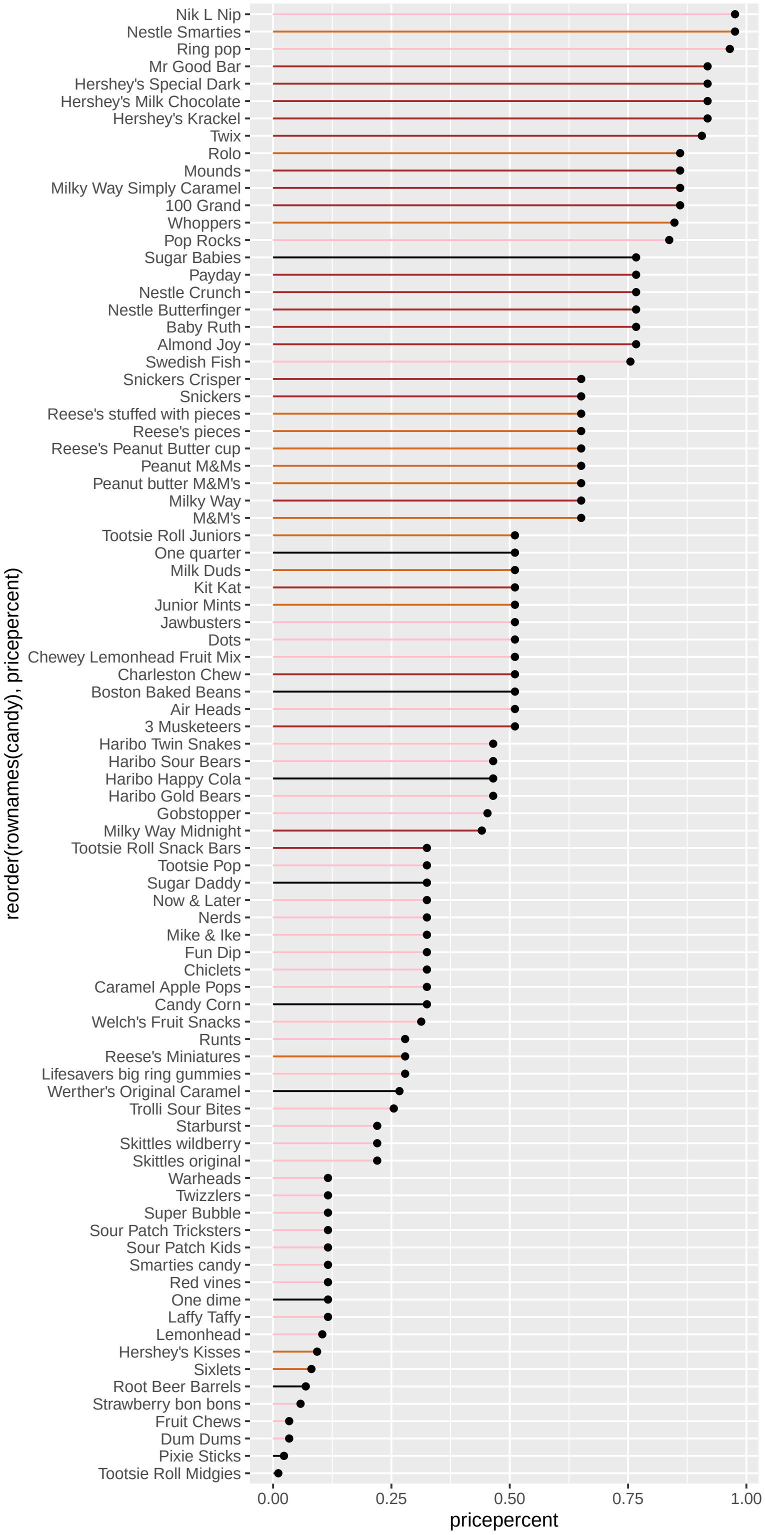
```
                         chocolate fruity caramel peanutyalmondy nougat
Nik L Nip                        0      1       0              0      0
Nestle Smarties                  1      0       0              0      0
Ring pop                         0      1       0              0      0
Hershey's 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
```

> 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()

```r
ggplot(candy) +
  aes(pricepercent, reorder(rownames(candy), pricepercent)) +
  geom_col() +
  ylab('Candy name') +
  xlab('Price percentage')
```


Nik L Nip
Nestle Smarties
Ring pop
Mr Good Bar
Hershey's Special Dark
Hershey's Milk Chocolate
Hershey's Krackel
Twix
Rolo
Mounds
Milky Way Simply Caramel
100 Grand
Whoppers
Pop Rocks
Sugar Babies
Payday
Nestle Crunch
Nestle Butterfinger
Baby Ruth
Almond Joy
Swedish Fish
Snickers Crisper
Snickers
Reese's stuffed with pieces
Reese's pieces
Reese's Peanut Butter cup
Peanut M&Ms
Peanut butter M&M's
Milky Way
M&M's
Tootsie Roll Juniors
One quarter
Milk Duds
Kit Kat
Junior Mints
Jawbusters
Dots
Chewey Lemonhead Fruit Mix
Charleston Chew
Boston Baked Beans
Air Heads
3 Musketeers
Haribo Twin Snakes
Haribo Sour Bears
Haribo Happy Cola
Haribo Gold Bears
Gobstopper
Milky Way Midnight
Tootsie Roll Snack Bars
Tootsie Pop
Sugar Daddy
Now & Later
Nerds
Mike & Ike
Fun Dip
Chiclets
Caramel Apple Pops
Candy Corn
Welch's Fruit Snacks
Runts
Reese's Miniatures
Lifesavers big ring gummies
Werther's Original Caramel
Trolli Sour Bites
Starburst
Skittles wildberry
Skittles original
Warheads
Twizzlers
Super Bubble
Sour Patch Tricksters
Sour Patch Kids
Smarties candy
Red vines
One dime
Laffy Taffy
Lemonhead
Hershey's Kisses
Sixlets
Root Beer Barrels
Strawberry bon bons
Fruit Chews
Dum Dums
Pixie Sticks
Tootsie Roll Midgies
Candy name
0.00
0.25
0.50
0.75
1.00
Price percentage

```r
# 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=my_cols) +
  geom_point()
```

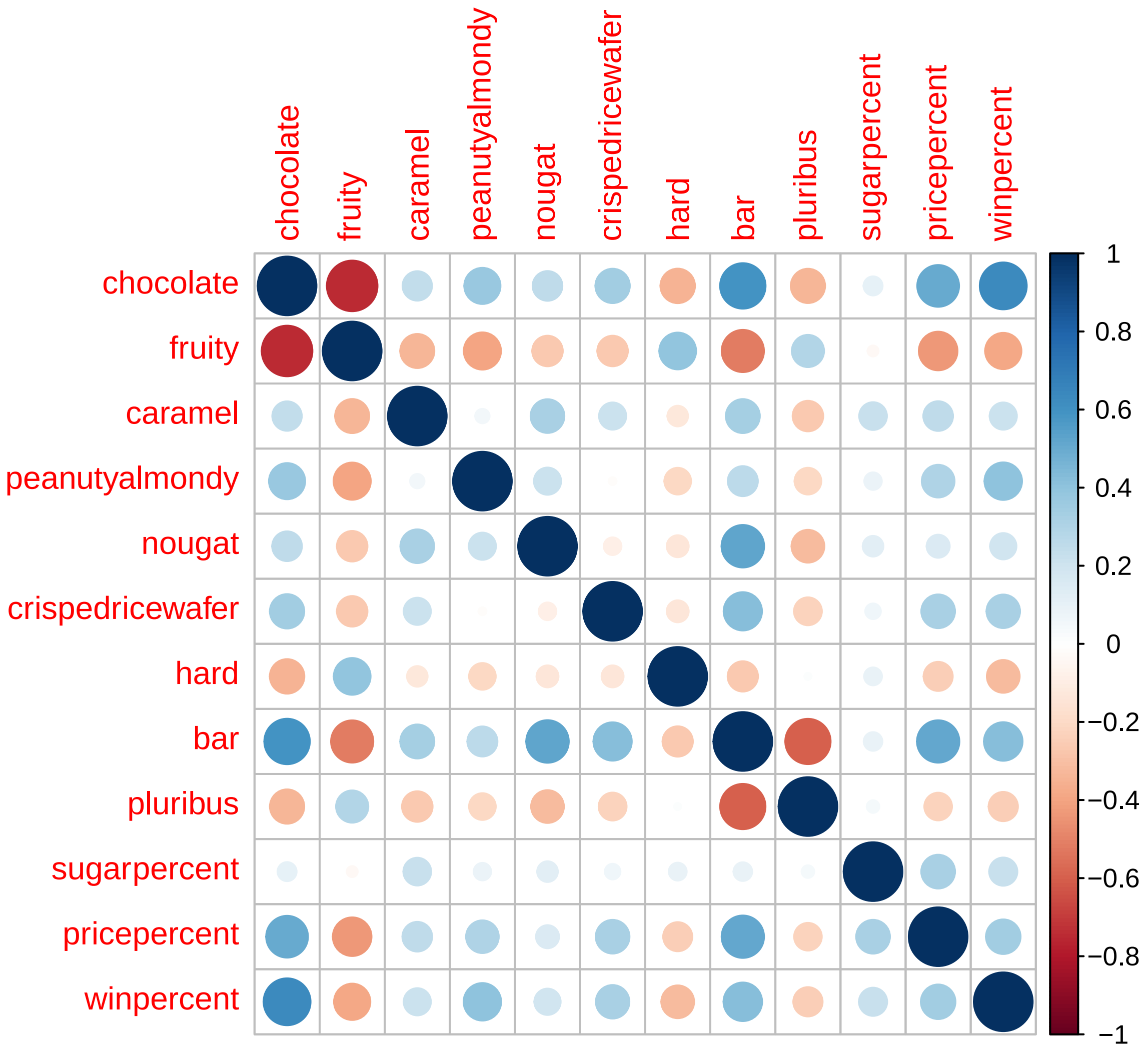

Nik L Nip
Nestle Smarties
Ring pop
Mr Good Bar
Hershey's Special Dark
Hershey's Milk Chocolate
Hershey's Krackel
Twix
Rolo
Mounds
Milky Way Simply Caramel
100 Grand
Whoppers
Pop Rocks
Sugar Babies
Payday
Nestle Crunch
Nestle Butterfinger
Baby Ruth
Almond Joy
Swedish Fish
Snickers Crisper
Snickers
Reese's stuffed with pieces
Reese's pieces
Reese's Peanut Butter cup
Peanut M&Ms
Peanut butter M&M's
Milky Way
M&M's
Tootsie Roll Juniors
One quarter
Milk Duds
Kit Kat
Junior Mints
Jawbusters
Dots
Chewey Lemonhead Fruit Mix
Charleston Chew
Boston Baked Beans
Air Heads
3 Musketeers
Haribo Twin Snakes
Haribo Sour Bears
Haribo Happy Cola
Haribo Gold Bears
Gobstopper
Milky Way Midnight
Tootsie Roll Snack Bars
Tootsie Pop
Sugar Daddy
Now & Later
Nerds
Mike & Ike
Fun Dip
Chiclets
Caramel Apple Pops
Candy Corn
Welch's Fruit Snacks
Runts
Reese's Miniatures
Lifesavers big ring gummies
Werther's Original Caramel
Trolli Sour Bites
Starburst
Skittles wildberry
Skittles original
Warheads
Twizzlers
Super Bubble
Sour Patch Tricksters
Sour Patch Kids
Smarties candy
Red vines
One dime
Laffy Taffy
Lemonhead
Hershey's Kisses
Sixlets
Root Beer Barrels
Strawberry bon bons
Fruit Chews
Dum Dums
Pixie Sticks
Tootsie Roll Midgies
reorder(rownames(candy), pricepercent)
0.00
0.25
0.50
0.75
1.00
pricepercent

5 Exploring the correlation structure

```
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)?

Chocolate and Fruity have the greatest negative correlation.

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

winpercent and chocolate

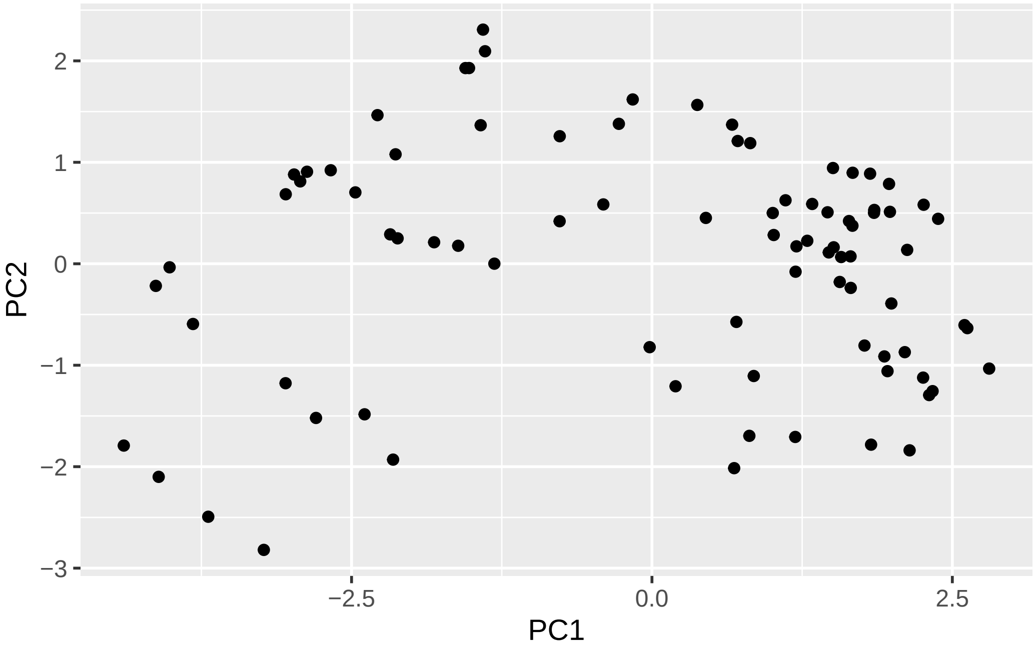
6. Principal Component Analysis

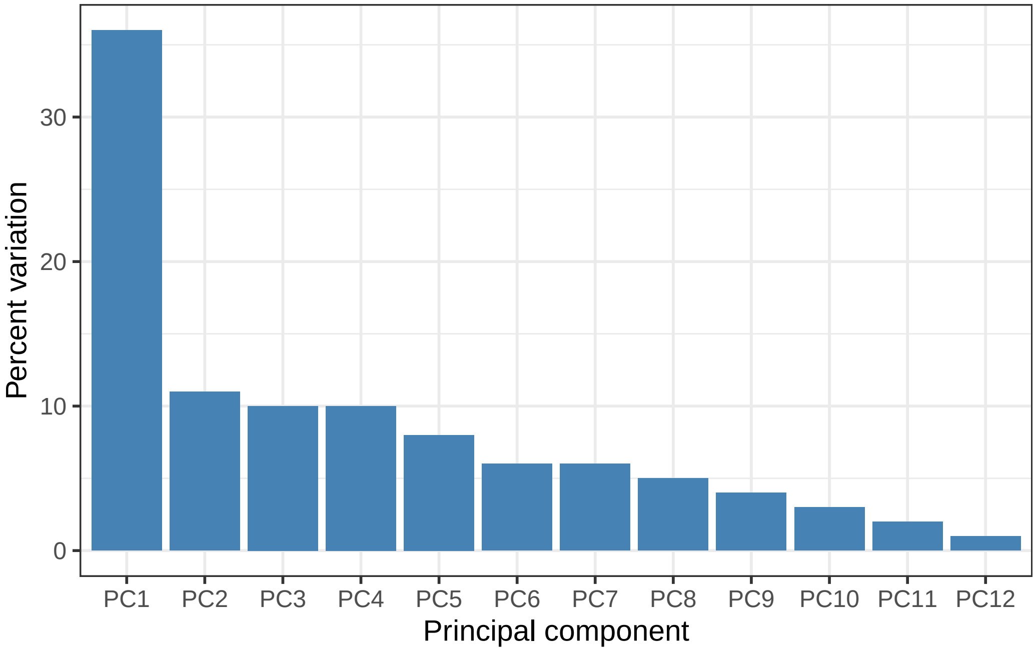
```r
# Define plotting functions for PCA results

plot_pca_scatter12 <- function(pca){
  # Plot "PC Plot" / "score plot" i.e. scatterplot of PC1 v. PC2
  ggplot(pca$x) +
    aes(x = PC1, y = PC2) +
    geom_point()
}

plot_pca_scree <- function(pca){
  # Create scree plot

  # Compute variance explained
  v <- round(pca$sdev^2/sum(pca$sdev^2) * 100)
  variance_df <- data.frame(
    PC = factor(paste0("PC", 1:length(v)), levels = paste0("PC", 1:length(v))),
    Variance = v
  )

  # Plot
  ggplot(variance_df) +
  aes(x = PC, y = Variance) +
  geom_col(fill = "steelblue") +
  xlab("Principal component") +
  ylab("Percent variation") +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 0))
}

plot_pca_loading <- function(pca){
  # plot PCA loadings
  ggplot(pca$rotation) +
  aes(x = PC1,
  y = reorder(rownames(pca$rotation), PC1)) +
  geom_col(fill = "steelblue") +
  xlab("PC1 Loading Score") +
  ylab("") +
  theme_bw() +
  theme(axis.text.y = element_text(size = 9))
}

plot_pca_results <- function(pca){
  print(plot_pca_scatter12(pca))
  print(plot_pca_scree(pca))
  print(plot_pca_loading(pca))
}
```

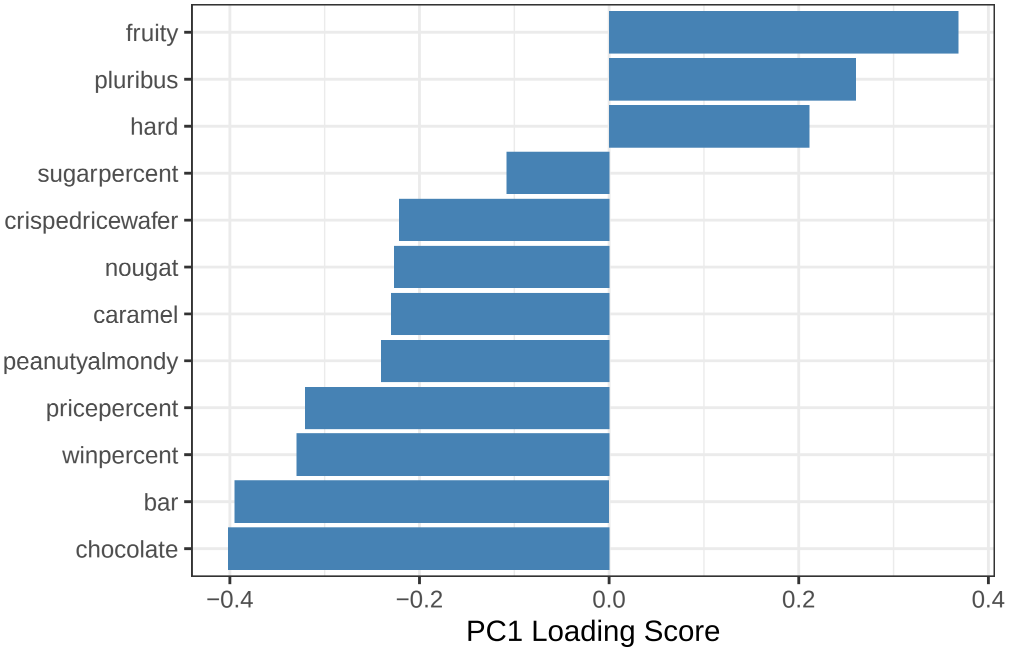
```r
# Perform PCA and show results
candy.pca <- prcomp(candy, scale=T)
summary(candy.pca)
```

```
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
```

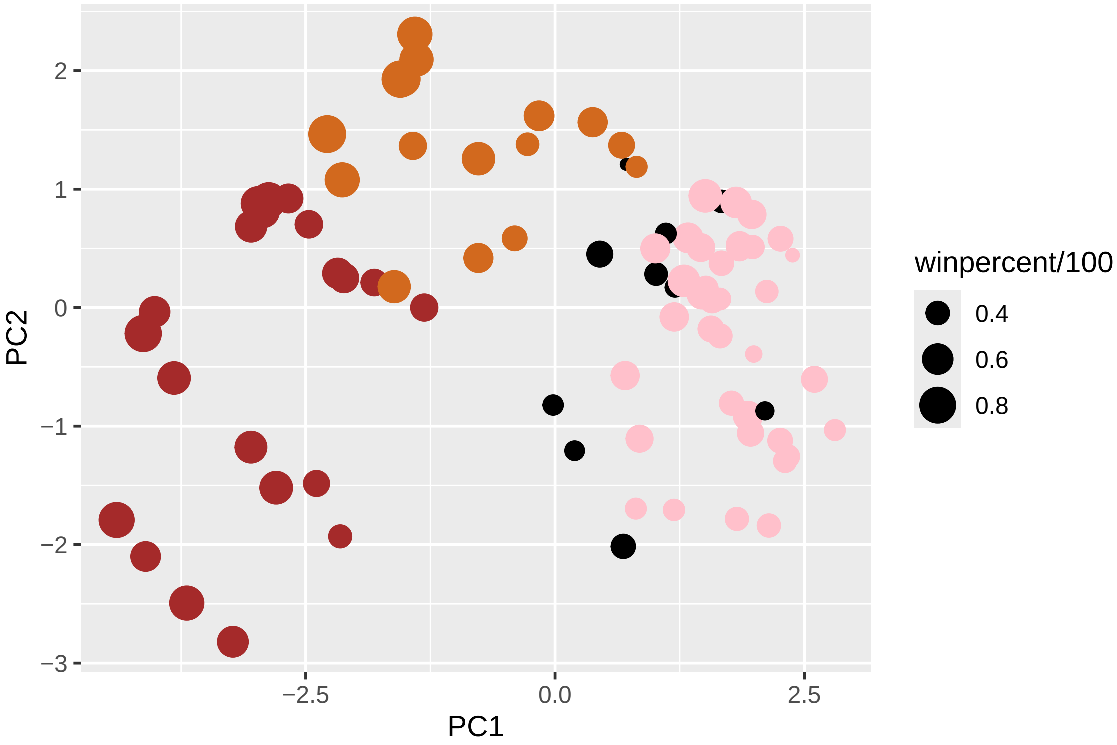
```r
plot_pca_results(candy.pca)
```


PC2
2
1
0
−1
−2
−3
−2.5
0.0
2.5
PC1


Percent variation
30
20
10
0
PC1
PC2
PC3
PC4
PC5
PC6
PC7
PC8
PC9
PC10
PC11
PC12
Principal component

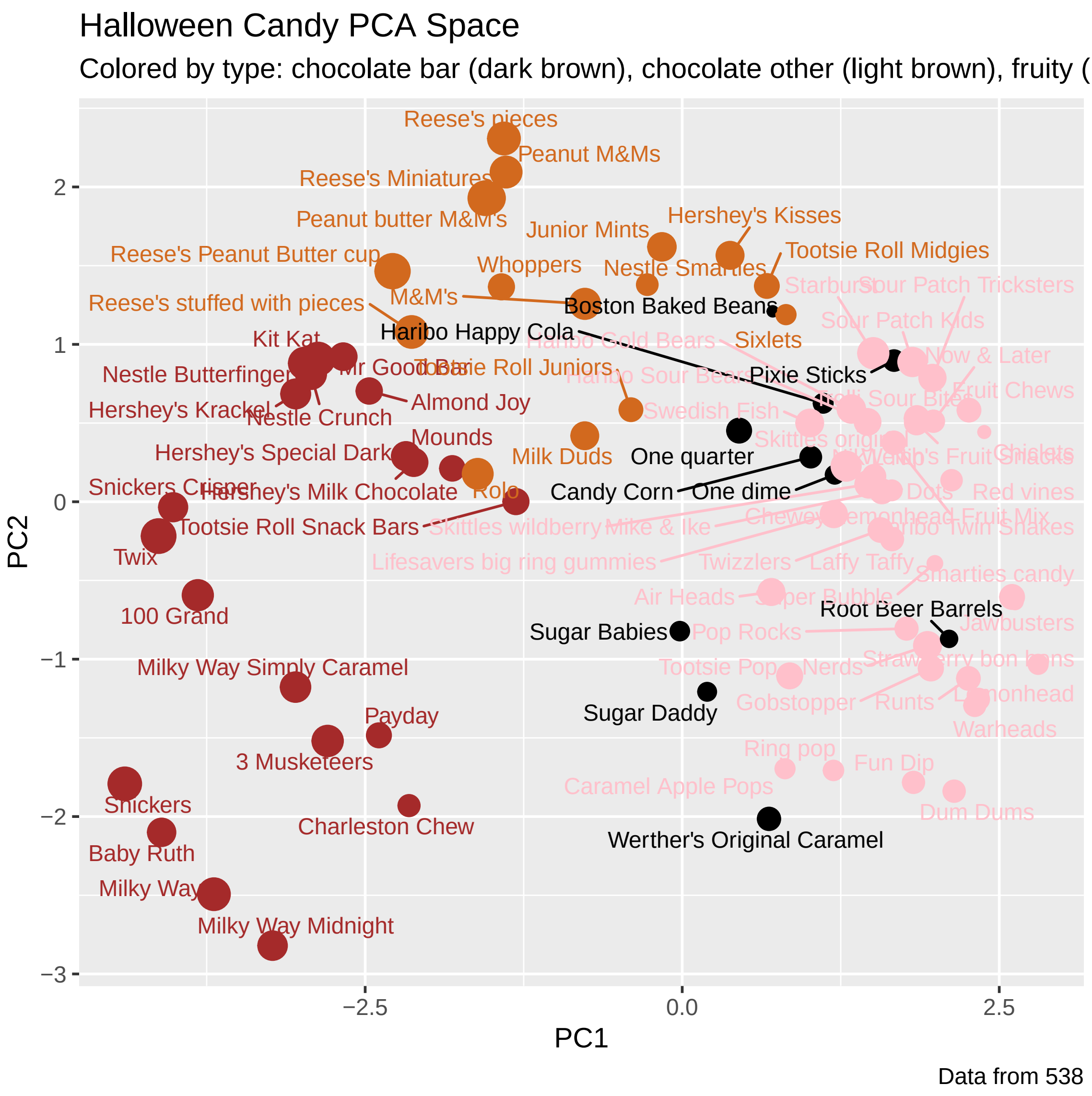


```
# repeat, plotting size based on winpercent

# Make a new data-frame with our PCA results and candy data
my_data <- cbind(candy, candy.pca$x[,1:3])

# plot
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
```



Use ggrepel package and the function ggrepel::geom_text_repel() to label up the plot with non overlapping candy names

```
p + geom_text_repel(size=3.3, col=my_cols, max.overlaps = 30)  +
  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")
```

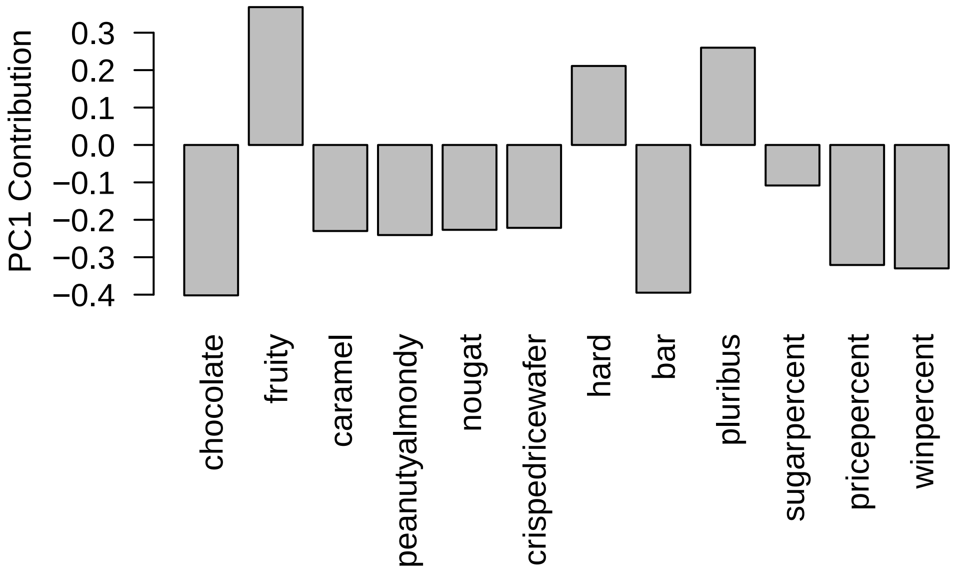


One more plotting option with gploty. This is an interactive plot, so you can get info on each data point by hovering the mouse over it

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

Check out loadings

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



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

Fruity, hard, and pluribus. Yes, these features describe the candies with the highest values along PC1 (e.g., skittles, warheads, lemonheads)