

## Class 10 : Halloween Candy

In today's class we will examine 538 Candy data and see if this helps us gain some more feeling for how PCA and other methods work.

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

	chocolate	fruity	caramel	peanut	almond	nougat	crisp	rice	wafer
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	sugar	percent	price	percent	win	percent
100 Grand	0	1	0		0.732		0.860	66.97	173
3 Musketeers	0	1	0		0.604		0.511	67.60	294
One dime	0	0	0		0.011		0.116	32.26	109
One quarter	0	0	0		0.011		0.511	46.11	650
Air Heads	0	0	0		0.906		0.511	52.34	146
Almond Joy	0	1	0		0.465		0.767	50.34	755

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

```
nrow(candy)
```

```
[1] 85
```

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

```
sum(candy[,2])
```

[1] 38

Q. What are these fruity candy?

We can use the ==

```
rownames( candy[ candy$fruity == 1, ] )
```

```
[1] "Air Heads"           "Caramel Apple Pops"
[3] "Chewey Lemonhead Fruit Mix" "Chiclets"
[5] "Dots"                "Dum Dums"
[7] "Fruit Chews"         "Fun Dip"
[9] "Gobstopper"          "Haribo Gold Bears"
[11] "Haribo Sour Bears"    "Haribo Twin Snakes"
[13] "Jawbusters"          "Laffy Taffy"
[15] "Lemonhead"           "Lifesavers big ring gummies"
[17] "Mike & Ike"           "Nerds"
[19] "Nik L Nip"           "Now & Later"
[21] "Pop Rocks"           "Red vines"
[23] "Ring pop"            "Runts"
[25] "Skittles original"    "Skittles wildberry"
[27] "Smarties candy"       "Sour Patch Kids"
[29] "Sour Patch Tricksters" "Starburst"
[31] "Strawberry bon bons"  "Super Bubble"
[33] "Swedish Fish"         "Tootsie Pop"
[35] "Trolli Sour Bites"    "Twizzlers"
[37] "Warheads"             "Welch's Fruit Snacks"
```

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

**How often does my favorite candy win**

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

[1] 76.7686

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
```

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

Table 1: Data summary

Name	candy
Number of rows	85
Number of columns	12
Column type frequency:	
numeric	12
Group variables	None

#### Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
chocolate	0	1	0.44	0.50	0.00	0.00	0.00	1.00	1.00	
fruity	0	1	0.45	0.50	0.00	0.00	0.00	1.00	1.00	
caramel	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
peanutyalmondy	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
nougat	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
crispedricewafer	0	1	0.08	0.28	0.00	0.00	0.00	0.00	1.00	
hard	0	1	0.18	0.38	0.00	0.00	0.00	0.00	1.00	
bar	0	1	0.25	0.43	0.00	0.00	0.00	0.00	1.00	
pluribus	0	1	0.52	0.50	0.00	0.00	1.00	1.00	1.00	
sugarpercent	0	1	0.48	0.28	0.01	0.22	0.47	0.73	0.99	
pricepercent	0	1	0.47	0.29	0.01	0.26	0.47	0.65	0.98	
winpercent	0	1	50.32	14.71	22.45	39.14	47.83	59.86	84.18	

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` column is on a 0:100 scale and all others appear to be on a 0:1 scale.

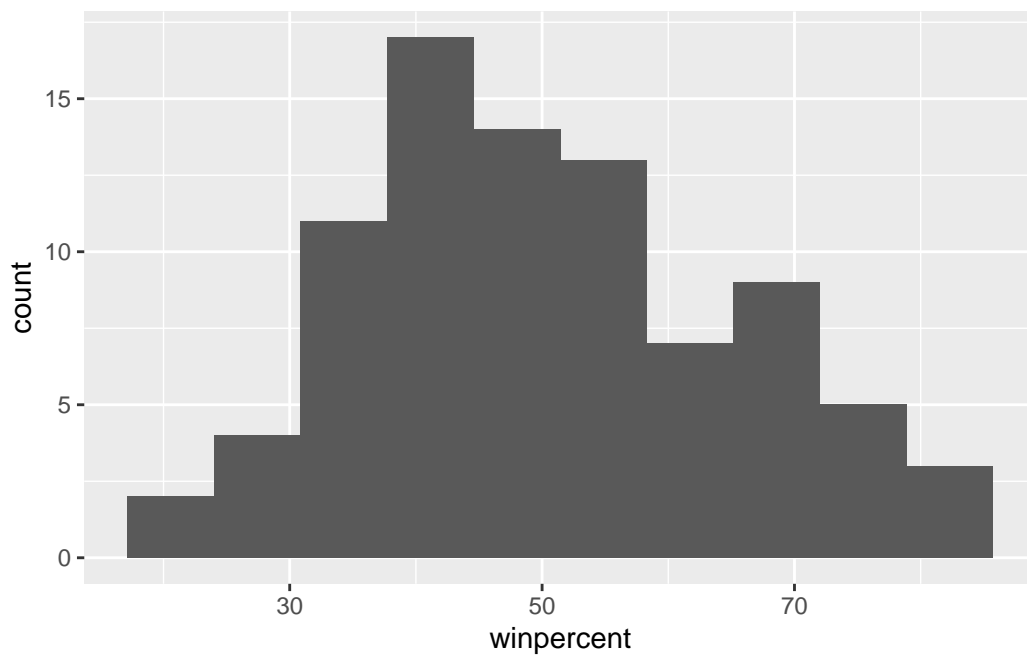
Q7. What do you think a zero and one represent for the `candy$chocolate` column?

A zero here means the candy is not classified as containing chocolate.

Q8. Plot a histogram of `winpercent` values

```
library(ggplot2)

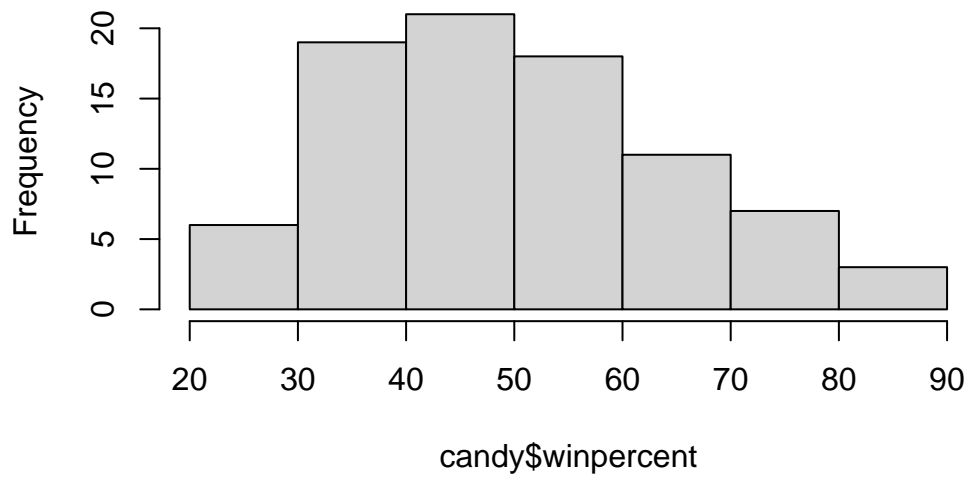
ggplot(candy, aes(winpercent, )) +
  geom_histogram(bins=10)
```



```
#or

hist(candy$winpercent)
```

## Histogram of candy\$winpercent



Q9. Is the distribution of winpercent values symmetrical?

No

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

Below 50% with a mean:

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

```
[1] 50.31676
```

```
median(candy$winpercent)
```

```
[1] 47.82975
```

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

To answer this question I will need to: - “subset” (a.k.a. “select”, “filter”) the candy dataset to just chocolate candy - Get their winpercent values - Calculate the mean of these - Do the same for fruity and compare.

```
# Filter/select/subset to just chocolate rows
chocolate.candy <- candy[ as.logical(candy$chocolate), ]

# Get their winpercent values
chocolate.winpercent <- chocolate.candy$winpercent

# Calculate mean of chocolate winpercent
mean( chocolate.winpercent )
```

[1] 60.92153

```
# Filter/select/subset to just fruity rows
fruity.candy <- candy[ as.logical(candy$fruity), ]

# Get their winpercent values
fruity.winpercent <- fruity.candy$winpercent

# Calculate mean of fruity winpercent
mean( fruity.winpercent )
```

[1] 44.11974

Chocolate candy is on a higher ranked than fruity candy.

Q12. Is this difference statistically significant?

The p-value is lower than 0.05 and thus shows that the results are statistically significant and people prefer chocolate.

```
t.test(chocolate.winpercent, fruity.winpercent)
```

Welch Two Sample t-test

```
data: chocolate.winpercent and fruity.winpercent
t = 6.2582, df = 68.882, p-value = 2.871e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 11.44563 22.15795
```

```
sample estimates:
mean of x mean of y
 60.92153  44.11974
```

There is a function called `sort()` for sorting vectors of input

```
x <- c(5, 2, 10)

# sort(x, decreasing = TRUE)
sort(x)
```

```
[1]  2  5 10
```

The buddy function to `sort()` that is often more useful is called `order()`. It returns the “indices” of the input that would result in it being sorted.

```
order(x)
```

```
[1] 2 1 3
```

```
x[ order(x)]
```

```
[1]  2  5 10
```

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

```
ord <- order(candy$winpercent)
ord
```

```
[1] 45  8 13 73 27 58 72  3 71 20 10 70 60 56 12 51 49 63  9 11 82 31 17 46 15
[26] 50 30 84 22 14 59 76 16 83 81 77 64  4 47 35 18 79 40 75 85 78  6 21  5 68
[51] 32 41 74 36 62 42 23 25  7 19 28 26 66 67 38 24 61 39 57 44 34  1 69  2 48
[76] 43 33 55 37 54 65 29 80 52 53
```

```
head(candy[ord,])
```

	chocolate	fruity	caramel	peanut	almond	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
Root Beer Barrels	0	0	0		0	0

	crisped	rice	wafer	hard	bar	pluribus	sugar	percent	price	percent
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
Root Beer Barrels				0	1	0	1	0.732		0.069

	win	percent
Nik L Nip	22.44	534
Boston Baked Beans	23.41	782
Chiclets	24.52	499
Super Bubble	27.30	386
Jawbusters	28.12	744
Root Beer Barrels	29.70	369

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

```
ord_decreasing <- order(candy$winpercent, decreasing = TRUE)
ord_decreasing
```

```
[1] 53 52 80 29 65 54 37 55 33 43 48 2 69 1 34 44 57 39 61 24 38 67 66 26 28
[26] 19 7 25 23 42 62 36 74 41 32 68 5 21 6 78 85 75 40 79 18 35 47 4 64 77
[51] 81 83 16 76 59 14 22 84 30 50 15 46 17 31 82 11 9 63 49 51 12 56 60 70 10
[76] 20 71 3 72 58 27 73 13 8 45
```

```
head(candy[ord_decreasing,])
```

	chocolate	fruity	caramel	peanut	almond	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
Reese's pieces	1	0	0		1	0



	crisped	rice	wafer	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
Reese's pieces	0	0	0			1	0.406

	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
Reese's pieces	0.651	73.43499

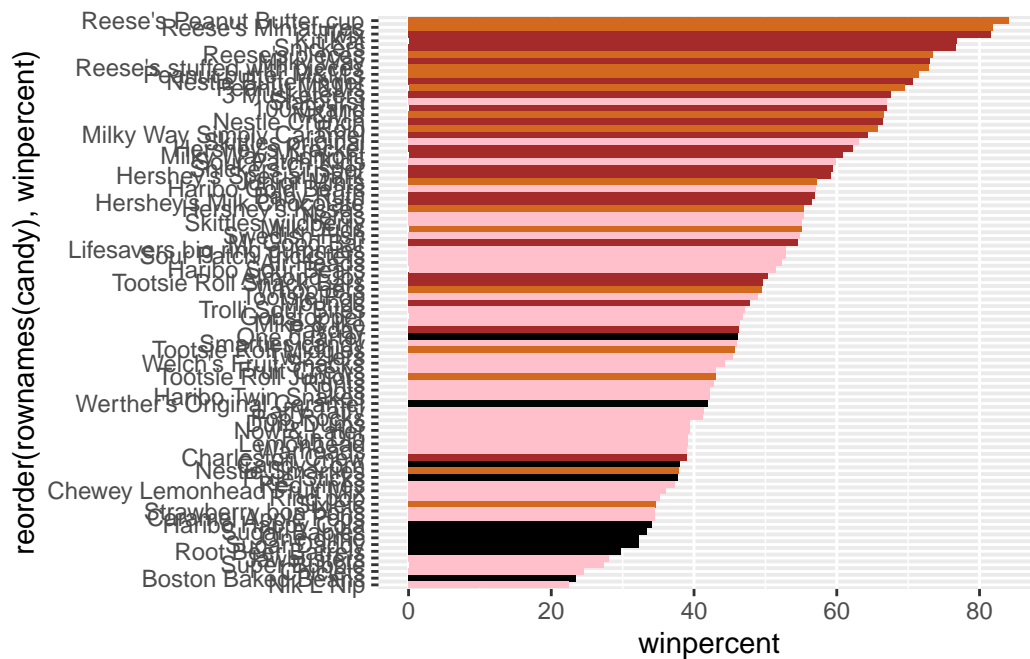
Q15. Make a first barplot of candy ranking based on winpercent values.

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

```
#To make it more colorful
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"

library(ggplot2)

ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col(fill = my_cols)
```



Q17. What is the worst ranked chocolate candy?

Sixlets

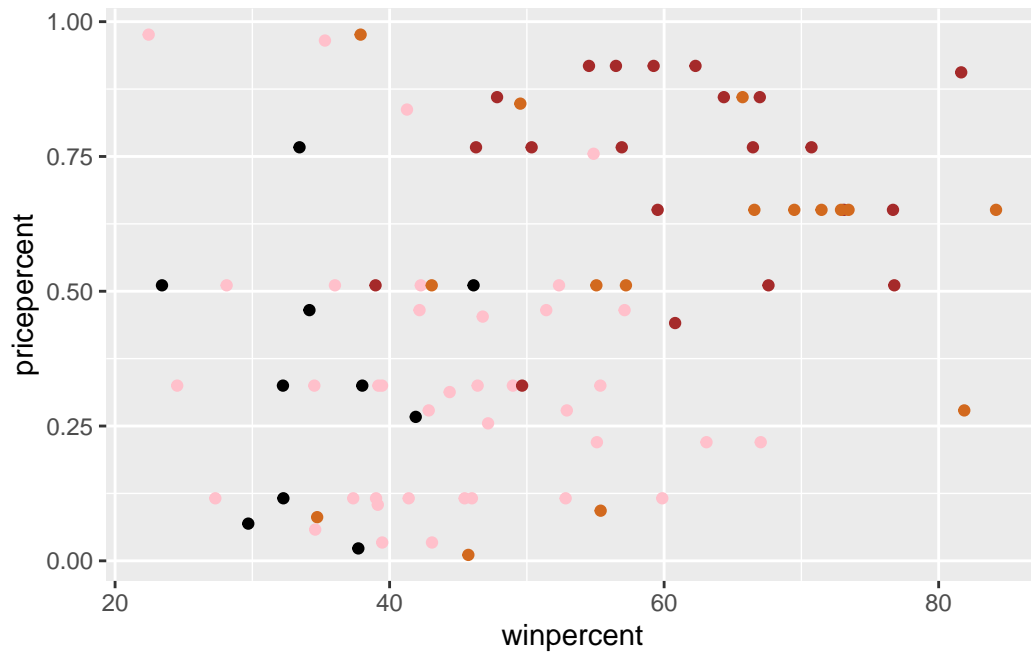
Q18. What is the best ranked fruity candy?

Starburst

## Taking a look at pricepercent

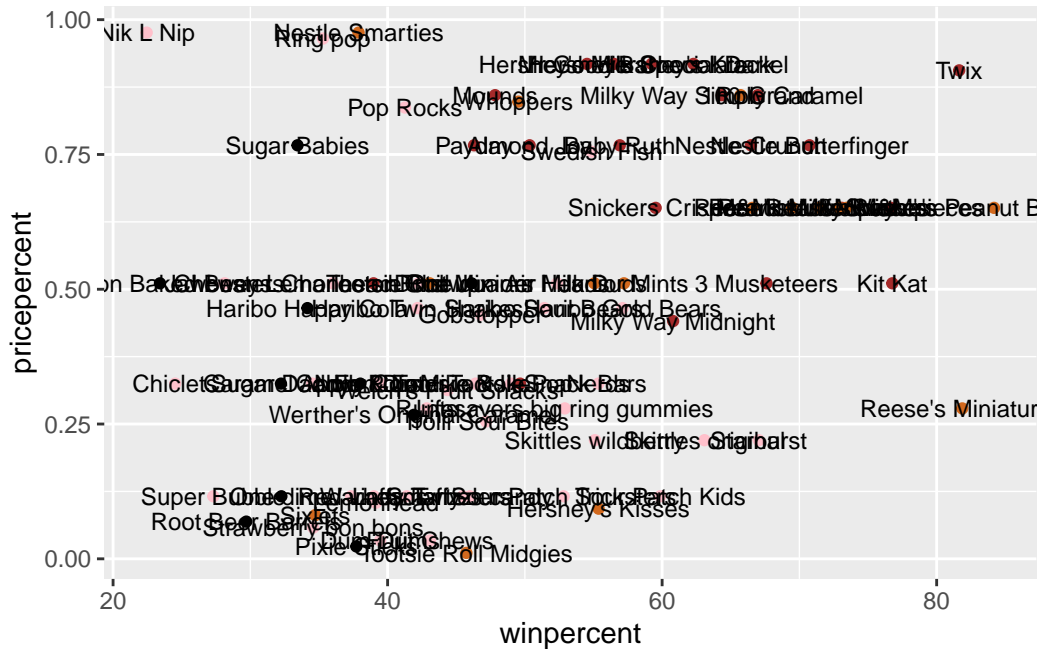
Q19. Which candy type is the highest ranked in terms of winpercent for the least money - i.e. offers the most bang for your buck?

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



Let's add labels

```
ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text(size=3)
```

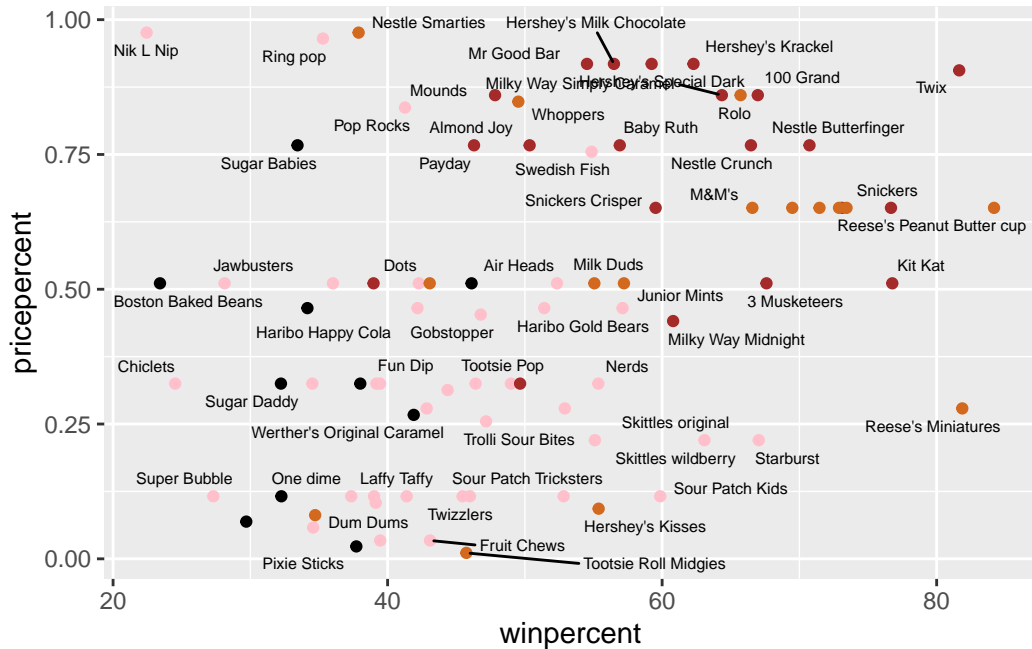


To deal with overlapping labels I can use the **ggrepel** package.

```
library(ggrepel)

ggplot(candy) +
  aes(winpercent, pricepercent, label=rownames(candy)) +
  geom_point(col=my_cols) +
  geom_text_repel(size = 2, max.overlaps = 8)
```

Warning: ggrepel: 26 unlabeled data points (too many overlaps). Consider increasing max.overlaps



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

```
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

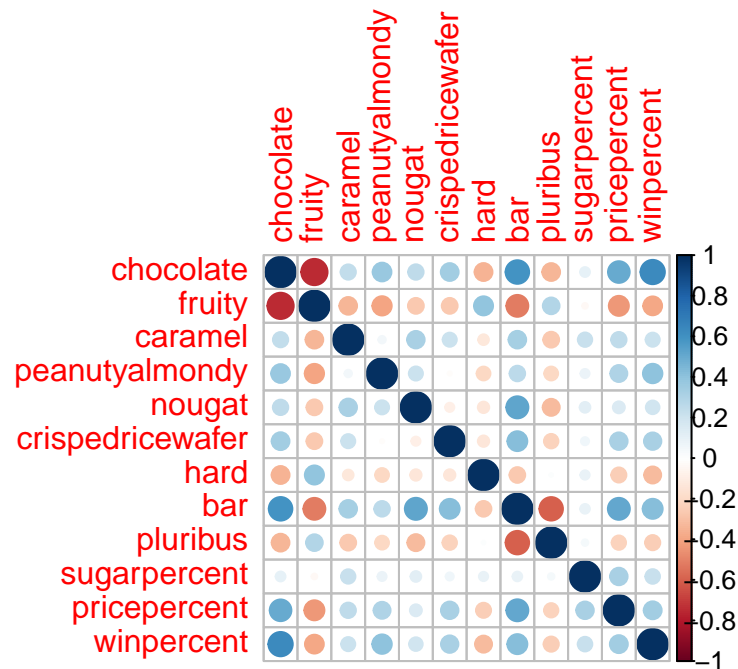
## 5 Exploring the correlation structure

Pearson correlation goes between -1 and +1 with zero indicating no correlation and values close to one being very highly (ani) correlated.

```
library(corrplot)
```

corrplot 0.92 loaded

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



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

Chocolate and fruity are anti-correlated.

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

Chocolate and winpercent are most positively correlated.

## 6. Principal Component Analysis

The base R function for PCA is called `prcomp()` and we can set the “scale = TRUE/FALSE”

```
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

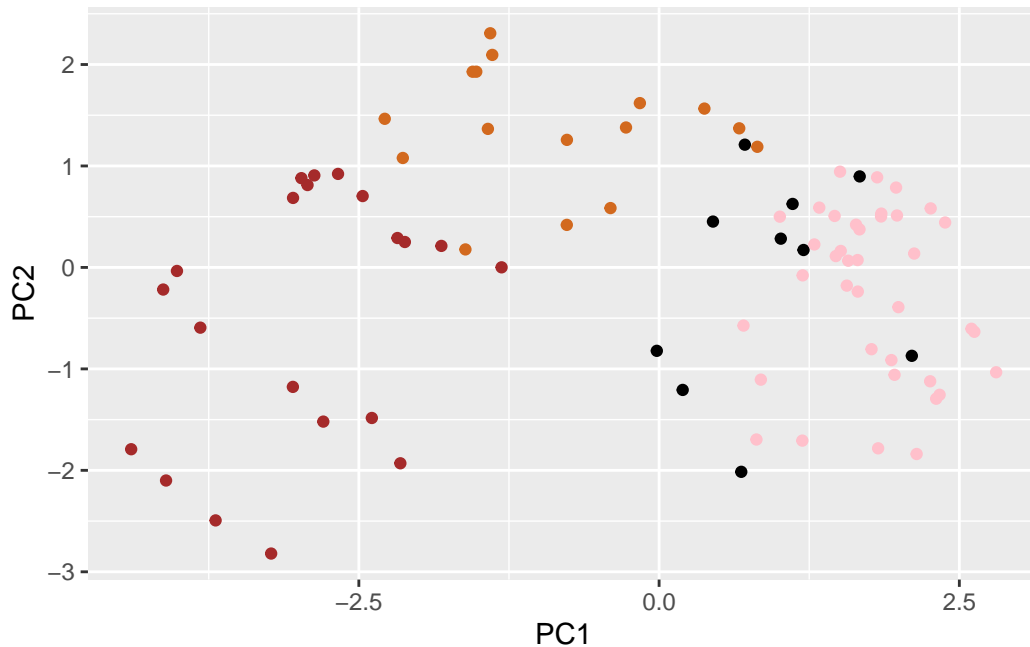
  

	PC8	PC9	PC10	PC11	PC12
Standard deviation	0.74530	0.67824	0.62349	0.43974	0.39760
Proportion of Variance	0.04629	0.03833	0.03239	0.01611	0.01317
Cumulative Proportion	0.89998	0.93832	0.97071	0.98683	1.00000

The main result of PCA - i.e. the new OC plot (projection of candy on our new PC axis) is contained in `pca$x`

```
pc <- as.data.frame(pca$x)

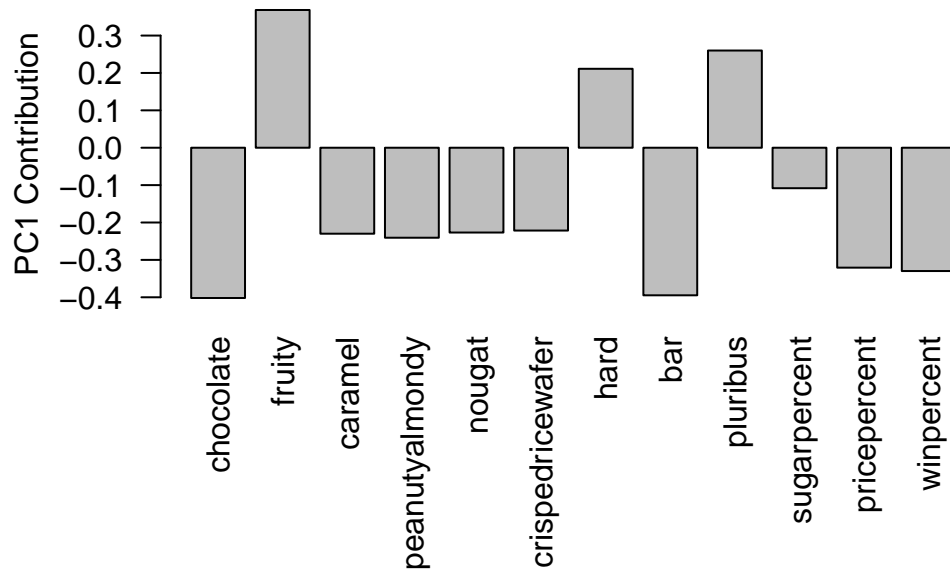
ggplot(pc) +
  aes(PC1, PC2) +
  geom_point(col=my_cols)
```



```
#geom_text_repel(max.overlaps = 5)
```

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

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



The variables fruity, hard, and pluribus are in the positive direction of PC1 which make sense because all of these are positively correlated.