

# Class 10: Halloween Mini-Project

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## Importing candy data

```
candy_file <- "candy-data.csv"  
  
candy = read.csv(candy_file, row.names=1)  
head(candy)
```

	chocolate	fruity	caramel	peanut	yalmond	nougat	crisped	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	66.97173			
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?

```
nrow(candy)
```

```
[1] 85
```

There are 85 types of candy.

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

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

```
[1] 38
```

There are 38 fruity candy types.

### **What is your favorite candy?**

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

```
[1] 81.64291
```

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

```
candy["Milky Way Midnight", ]$winpercent
```

```
[1] 60.8007
```

60% > Q4. What is the winpercent value for “Kit Kat”?

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

```
[1] 76.7686
```

77% > Q5. What is the winpercent value for “Tootsie Roll Snack Bars”?

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

```
[1] 49.6535
```

```
50%
```

```
library(dplyr)
```

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

```
[1] 85
```

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

```
[1] 50
```

```
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	

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
caramel	0	1	0.16	0.37	0.00	0.00	0.00	0.00	1.00	
peanutyalymond	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 row is on a different scale.

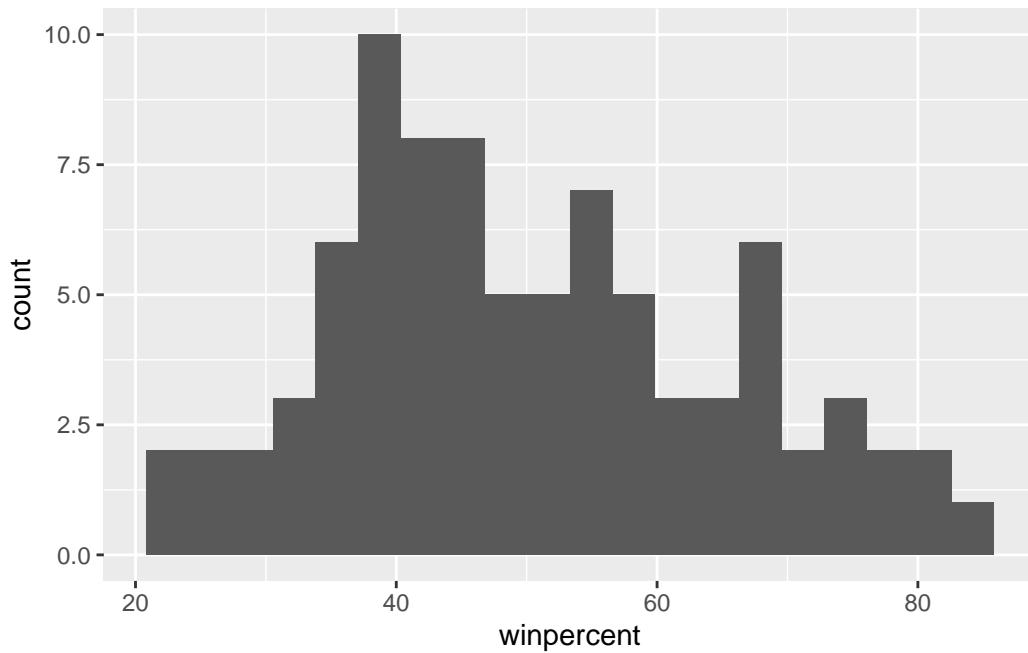
Q7. What do you think a zero and one represent for the candy\$chocolate column?

I think the 0 and 1 represent false and true.

Q8. Plot a histogram of winpercent values

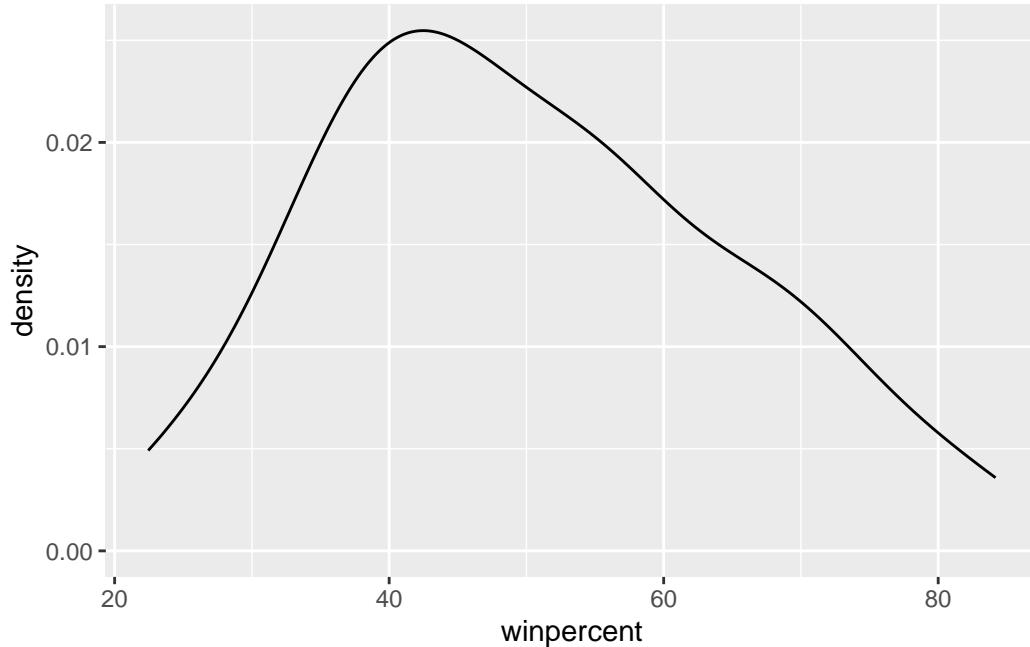
```
library(ggplot2)

ggplot(candy) +
  aes(winpercent) +
  geom_histogram(bins=20)
```



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 center is above 50 if you use the mean.

```
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?

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

	chocolate	fruity	caramel	peanuty	almondy	nougat
100 Grand	1	0	1	0	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	
	crisped	rice	wafer	hard	bar	pluribus sugar percent
100 Grand	1	0	1	0	0	0.732
3 Musketeers	0	0	1	0	0	0.604
Almond Joy	0	0	1	0	0	0.465
Baby Ruth	0	0	1	0	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

```
# 2. Extract their winpercent values
choc.win <- choc.candy$winpercent
choc.win
```

```
[1] 66.97173 67.60294 50.34755 56.91455 38.97504 55.37545 62.28448 56.49050
[9] 59.23612 57.21925 76.76860 71.46505 66.57458 55.06407 73.09956 60.80070
[17] 64.35334 47.82975 54.52645 70.73564 66.47068 69.48379 81.86626 84.18029
[25] 73.43499 72.88790 65.71629 34.72200 37.88719 76.67378 59.52925 48.98265
[33] 43.06890 45.73675 49.65350 81.64291 49.52411
```

```
# 3. Find the mean of these values
choc.mean <- mean(choc.win)
choc.mean
```

```
[1] 60.92153
```

```
# 4-6. Do the same for fruit candy
fruit.ind <- as.logical(candy$fruity)
fruit.candy <- candy[fruit.ind,]
fruit.candy
```

	chocolate	fruity	caramel	peanut	yalmond	nougat
Air Heads	0	1	0		0	0
Caramel Apple Pops	0	1	1		0	0
Chewey Lemonhead Fruit Mix	0	1	0		0	0
Chiclets	0	1	0		0	0
Dots	0	1	0		0	0
Dum Dums	0	1	0		0	0
Fruit Chews	0	1	0		0	0
Fun Dip	0	1	0		0	0
Gobstopper	0	1	0		0	0
Haribo Gold Bears	0	1	0		0	0
Haribo Sour Bears	0	1	0		0	0
Haribo Twin Snakes	0	1	0		0	0
Jawbusters	0	1	0		0	0
Laffy Taffy	0	1	0		0	0
Lemonhead	0	1	0		0	0
Lifesavers big ring gummies	0	1	0		0	0
Mike & Ike	0	1	0		0	0
Nerds	0	1	0		0	0
Nik L Nip	0	1	0		0	0
Now & Later	0	1	0		0	0
Pop Rocks	0	1	0		0	0
Red vines	0	1	0		0	0
Ring pop	0	1	0		0	0
Runts	0	1	0		0	0
Skittles original	0	1	0		0	0
Skittles wildberry	0	1	0		0	0
Smarties candy	0	1	0		0	0
Sour Patch Kids	0	1	0		0	0
Sour Patch Tricksters	0	1	0		0	0
Starburst	0	1	0		0	0
Strawberry bon bons	0	1	0		0	0
Super Bubble	0	1	0		0	0
Swedish Fish	0	1	0		0	0
Tootsie Pop	1	1	0		0	0

	crisped	rice	wafer	hard	bar	pluribus	sugar	percent
Trolli Sour Bites	0	1	0			0	0	
Twizzlers	0	1	0			0	0	
Warheads	0	1	0			0	0	
Welch's Fruit Snacks	0	1	0			0	0	
Air Heads	0	0	0		0		0.906	
Caramel Apple Pops	0	0	0		0		0.604	
Chewey Lemonhead Fruit Mix	0	0	0		1		0.732	
Chiclets	0	0	0		1		0.046	
Dots	0	0	0		1		0.732	
Dum Dums	0	1	0		0		0.732	
Fruit Chews	0	0	0		1		0.127	
Fun Dip	0	1	0		0		0.732	
Gobstopper	0	1	0		1		0.906	
Haribo Gold Bears	0	0	0		1		0.465	
Haribo Sour Bears	0	0	0		1		0.465	
Haribo Twin Snakes	0	0	0		1		0.465	
Jawbusters	0	1	0		1		0.093	
Laffy Taffy	0	0	0		0		0.220	
Lemonhead	0	1	0		0		0.046	
Lifesavers big ring gummies	0	0	0		0		0.267	
Mike & Ike	0	0	0		1		0.872	
Nerds	0	1	0		1		0.848	
Nik L Nip	0	0	0		1		0.197	
Now & Later	0	0	0		1		0.220	
Pop Rocks	0	1	0		1		0.604	
Red vines	0	0	0		1		0.581	
Ring pop	0	1	0		0		0.732	
Runts	0	1	0		1		0.872	
Skittles original	0	0	0		1		0.941	
Skittles wildberry	0	0	0		1		0.941	
Smarties candy	0	1	0		1		0.267	
Sour Patch Kids	0	0	0		1		0.069	
Sour Patch Tricksters	0	0	0		1		0.069	
Starburst	0	0	0		1		0.151	
Strawberry bon bons	0	1	0		1		0.569	
Super Bubble	0	0	0		0		0.162	
Swedish Fish	0	0	0		1		0.604	
Tootsie Pop	0	1	0		0		0.604	
Trolli Sour Bites	0	0	0		1		0.313	
Twizzlers	0	0	0		0		0.220	
Warheads	0	1	0		0		0.093	
Welch's Fruit Snacks	0	0	0		1		0.313	

	price	percent	winpercent
Air Heads	0.511	52.34146	
Caramel Apple Pops	0.325	34.51768	
Chewey Lemonhead Fruit Mix	0.511	36.01763	
Chiclets	0.325	24.52499	
Dots	0.511	42.27208	
Dum Dums	0.034	39.46056	
Fruit Chews	0.034	43.08892	
Fun Dip	0.325	39.18550	
Gobstopper	0.453	46.78335	
Haribo Gold Bears	0.465	57.11974	
Haribo Sour Bears	0.465	51.41243	
Haribo Twin Snakes	0.465	42.17877	
Jawbusters	0.511	28.12744	
Laffy Taffy	0.116	41.38956	
Lemonhead	0.104	39.14106	
Lifesavers big ring gummies	0.279	52.91139	
Mike & Ike	0.325	46.41172	
Nerds	0.325	55.35405	
Nik L Nip	0.976	22.44534	
Now & Later	0.325	39.44680	
Pop Rocks	0.837	41.26551	
Red vines	0.116	37.34852	
Ring pop	0.965	35.29076	
Runts	0.279	42.84914	
Skittles original	0.220	63.08514	
Skittles wildberry	0.220	55.10370	
Smarties candy	0.116	45.99583	
Sour Patch Kids	0.116	59.86400	
Sour Patch Tricksters	0.116	52.82595	
Starburst	0.220	67.03763	
Strawberry bon bons	0.058	34.57899	
Super Bubble	0.116	27.30386	
Swedish Fish	0.755	54.86111	
Tootsie Pop	0.325	48.98265	
Trolli Sour Bites	0.255	47.17323	
Twizzlers	0.116	45.46628	
Warheads	0.116	39.01190	
Welch's Fruit Snacks	0.313	44.37552	

```
fruit.win <- fruit.candy$winpercent
fruit.win
```

```
[1] 52.34146 34.51768 36.01763 24.52499 42.27208 39.46056 43.08892 39.18550  
[9] 46.78335 57.11974 51.41243 42.17877 28.12744 41.38956 39.14106 52.91139  
[17] 46.41172 55.35405 22.44534 39.44680 41.26551 37.34852 35.29076 42.84914  
[25] 63.08514 55.10370 45.99583 59.86400 52.82595 67.03763 34.57899 27.30386  
[33] 54.86111 48.98265 47.17323 45.46628 39.01190 44.37552
```

```
fruit.mean <- mean(fruit.win)  
fruit.mean
```

```
[1] 44.11974
```

```
# 7. Which mean is higher  
choc.mean > fruit.mean
```

```
[1] TRUE
```

Chocolate is more popular than fruity candy.

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
```

No, it is not statistically significant based on the p value.

## Overall candy ranking

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

```
ord.ind <- order(candy$winpercent)
head(candy[ord.ind,],5)
```

	chocolate	fruity	caramel	peanuty	almondy	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	
	crispedrice	wafers	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						

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

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

```
tail(candy[ord.ind,],5)
```

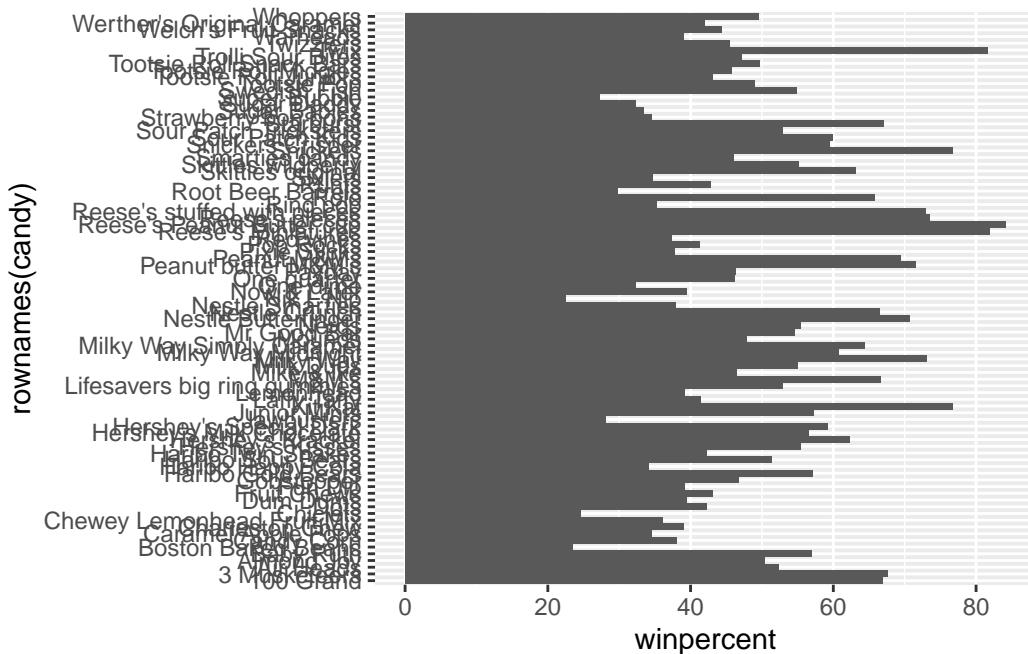
	chocolate	fruity	caramel	peanuty	almondy	nougat
Snickers	1	0	1		1	1
Kit Kat	1	0	0		0	0
Twix	1	0	1		0	0
Reese's Miniatures	1	0	0		1	0
Reese's Peanut Butter cup	1	0	0		1	0
	crispedrice	wafers	hard	bar	pluribus	sugarpercent
Snickers	0	0	1		0	0.546
Kit Kat	1	0	1		0	0.313
Twix	1	0	1		0	0.546
Reese's Miniatures	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

Snickers, Kit Kat, Twix, Reese's Minis, Reese's PB cup

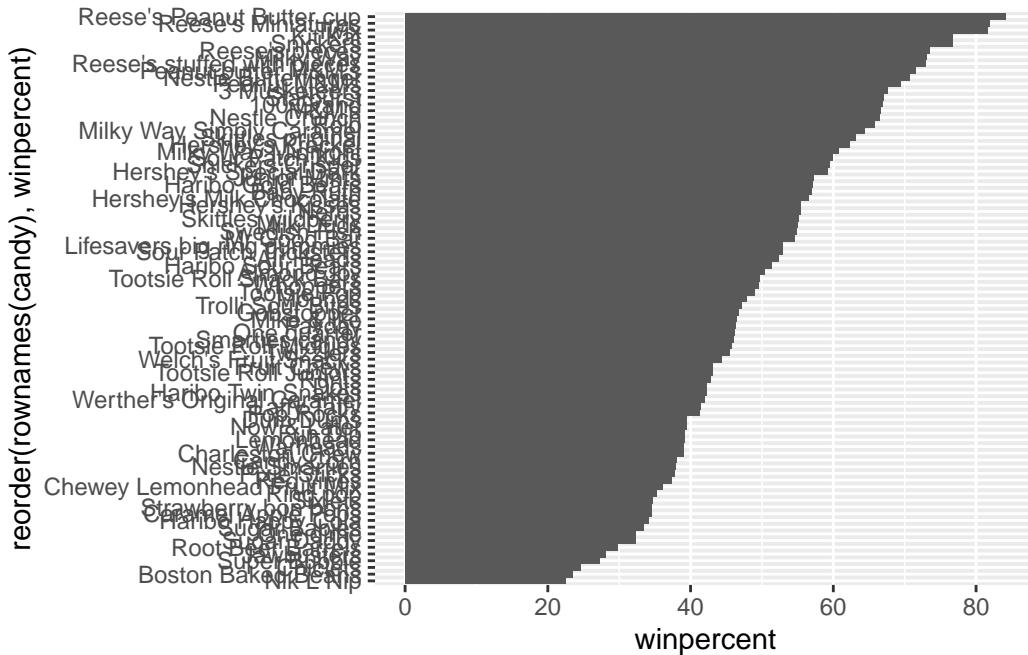
Q15. Make a first barplot of candy ranking based on winpercent values.

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



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

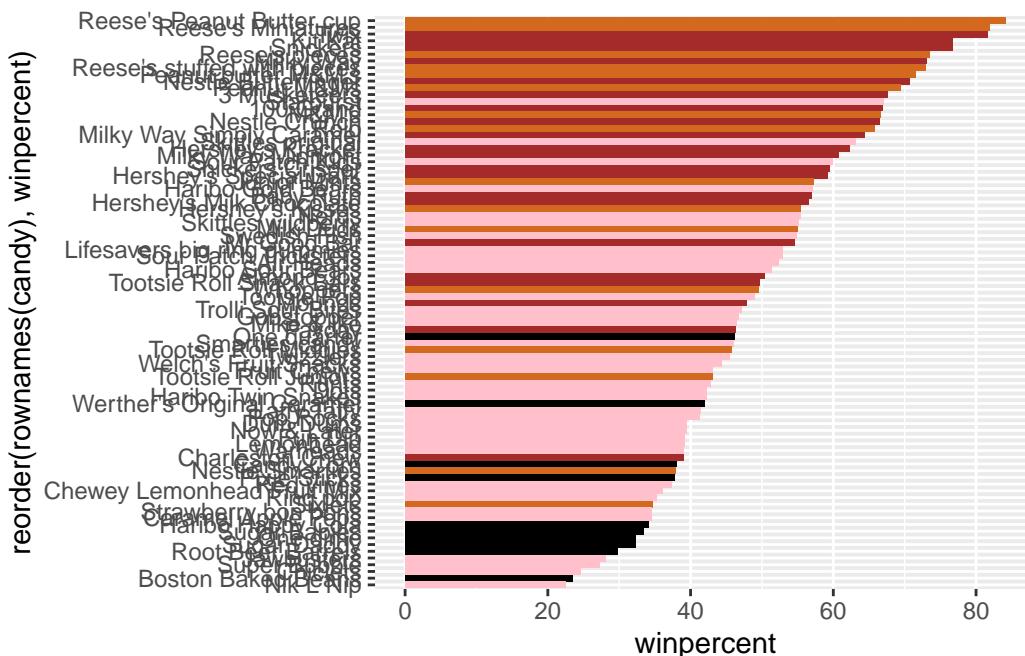
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy), winpercent)) +
  geom_col()
```



Add some 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(x= winpercent,
      y= 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?

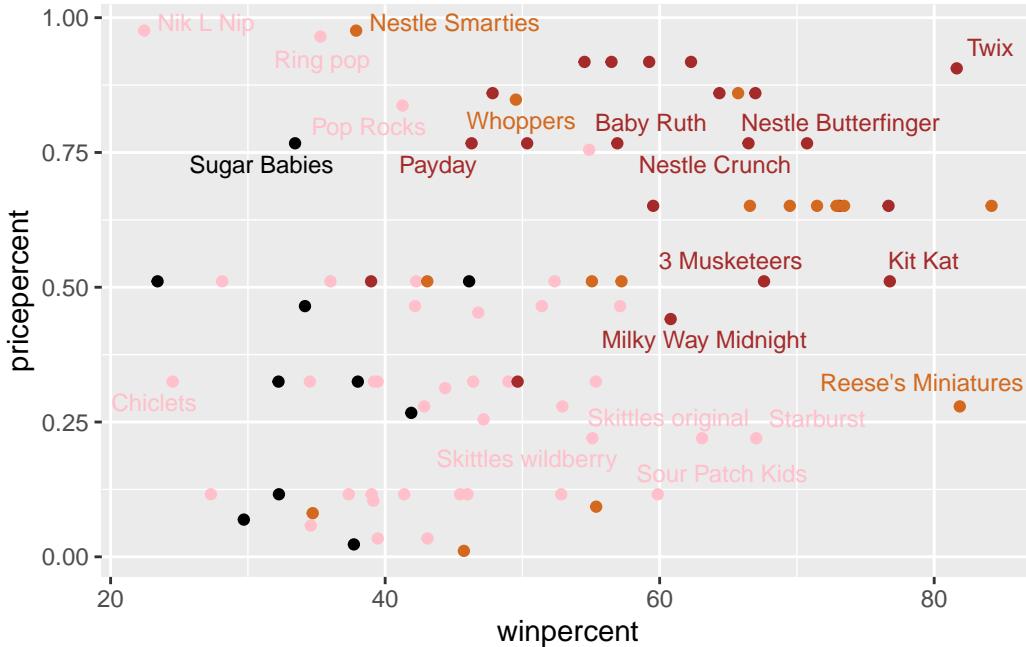
Starburst

### Winpercent vs. Pricepercent

```
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 = 5)
```

Warning: ggrepel: 65 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?

```
ord <- order(candy$pricepercent, decreasing = TRUE)
tail( candy[ord,c(11,12)], n=5 )
```

	pricepercent	winpercent
Strawberry bon bons	0.058	34.57899
Dum Dums	0.034	39.46056
Fruit Chews	0.034	43.08892
Pixie Sticks	0.023	37.72234
Tootsie Roll Midgies	0.011	45.73675

Reese's Minis

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

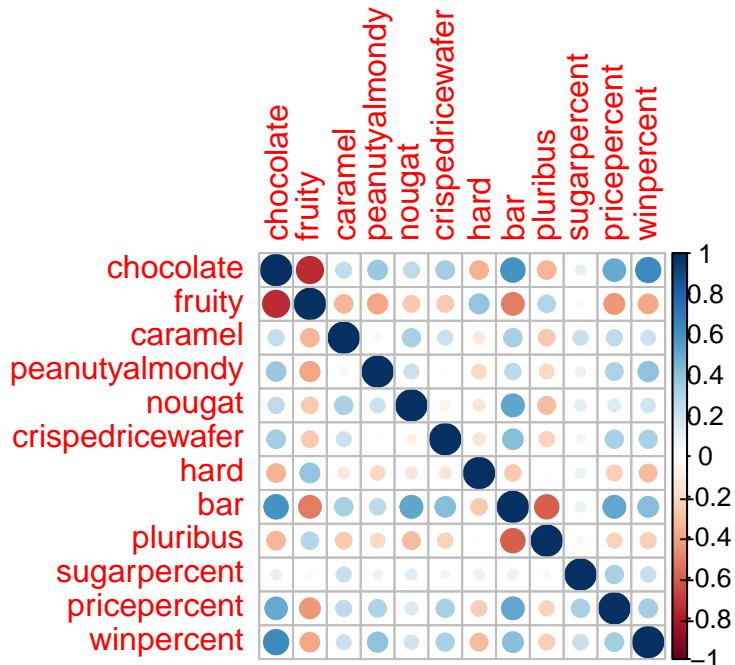
## Correlation

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

```
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

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

Chocolate and winpercent

## Principal component analysis

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

```
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		

Let's look at our first main result figure - the "PC plot" or PC1 vs. PC2

```
pca$x
```

	PC1	PC2	PC3	PC4
100 Grand	-3.81986175	-0.5935787670	-2.186308676	-2.37159574
3 Musketeers	-2.79602364	-1.5196062111	1.412198551	0.69943868
One dime	1.20258363	0.1718120657	2.060771178	-1.20067824
One quarter	0.44865378	0.4519735621	1.476492844	-1.00177141
Air Heads	0.70289922	-0.5731343263	-0.929389343	0.41245656
Almond Joy	-2.46833834	0.7035501120	0.858108916	0.57249739
Baby Ruth	-4.10531223	-2.1000967736	1.347834706	1.85505225
Boston Baked Beans	0.71385813	1.2098216537	0.941899950	1.10219913
Candy Corn	1.01357204	0.2834319621	-0.840681586	0.83664703
Caramel Apple Pops	0.81049645	-1.6960889498	-0.207020586	-0.30186567
Charleston Chew	-2.15436587	-1.9304213037	1.675469334	0.46999498
Chewey Lemonhead Fruit Mix	1.65268482	0.0726434944	-0.909617411	0.58609915
Chiclets	2.38180817	0.4430926071	1.000422079	-0.59998577

Dots	1.51249936	0.1623958592	-0.967135199	0.63622661
Dum Dums	2.14430933	-1.8388386160	-0.385372660	-0.14796280
Fruit Chews	2.26133763	0.5818322520	0.978626618	-0.39164187
Fun Dip	1.82383348	-1.7828662094	-0.719415821	-0.08544003
Gobstopper	1.96047812	-1.0584680267	-1.873874385	0.84237208
Haribo Gold Bears	1.33360746	0.5892699921	-0.431929774	0.33530766
Haribo Happy Cola	1.11167365	0.6257697808	0.054459647	0.16024129
Haribo Sour Bears	1.46152952	0.5073691482	-0.379443632	0.28956535
Haribo Twin Snakes	1.66849016	0.3748646265	-0.294528131	0.21556045
Hershey's Kisses	0.37722675	1.5654519145	1.104739528	-0.30451907
Hershey's Krackel	-3.04788356	0.6850792787	-1.154357778	-2.79294516
Hershey's Milk Chocolate	-2.11696417	0.2504568891	0.218316614	-0.64942872
Hershey's Special Dark	-2.17850376	0.2898570052	0.193067056	-0.62742342
Jawbusters	2.62491587	-0.6343671618	0.114043053	-0.54172092
Junior Mints	-0.16010610	1.6194428347	0.442156347	-0.08935729
Kit Kat	-2.87086546	0.9069655335	-0.545771148	-2.94691419
Laffy Taffy	1.65450042	-0.2379605144	1.217408326	-0.81578254
Lemonhead	2.33564695	-1.2553404646	1.125823900	-1.18755633
Lifesavers big ring gummies	1.19528766	-0.0783610246	0.814040659	-0.61506538
Peanut butter M&M's	-1.52223814	1.9291395890	-0.815897653	2.27060871
M&M's	-0.76747561	1.2573539136	-1.260658369	0.98037043
Mike & Ike	1.57487290	0.0664259746	-1.114406454	0.84284942
Milk Duds	-0.76836937	0.4192793946	-0.137573021	-0.01222490
Milky Way	-3.69272218	-2.4933313173	0.843423990	0.70792542
Milky Way Midnight	-3.23036513	-2.8201031327	0.902884388	0.75904764
Milky Way Simply Caramel	-3.04936226	-1.1774777304	-1.382617058	0.15488883
Mounds	-1.81292795	0.2120726312	0.636094539	-0.91126847
Mr Good Bar	-2.67327849	0.9217207344	0.997161433	0.40634715
Nerds	1.93426895	-0.9133307225	-1.670281710	0.79359684
Nestle Butterfinger	-2.97855081	0.8798835368	0.348599786	0.94918411
Nestle Crunch	-2.92740488	0.8119013154	-0.747159803	-2.97250665
Nik L Nip	1.63985272	0.4210217322	-0.083217936	-0.24015596
Now & Later	1.98070982	0.5117150919	0.460099768	-0.21340533
Payday	-2.39180556	-1.4839637512	2.091687409	1.65680787
Peanut M&Ms	-1.38897069	2.0947188031	-0.260214925	1.89874716
Pixie Sticks	1.67042227	0.8969792365	1.394703254	-0.48031281
Pop Rocks	1.76879348	-0.8060325640	-1.567639814	0.42017068
Red vines	2.12406849	0.1366822960	-0.115183020	0.27721045
Reese's Miniatures	-1.55210251	1.9287569793	1.884620322	0.48605155
Reese's Peanut Butter cup	-2.28427985	1.4648923293	-0.156138940	1.63994489
Reese's pieces	-1.40590761	2.3077984818	0.136661895	1.64348077
Reese's stuffed with pieces	-2.13382398	1.0787289654	-0.673152403	1.96066081
Ring pop	1.19274412	-1.7069749284	-1.423826969	0.02570015

	PC5	PC6	PC7	PC8
Rolo	-1.61259322	0.1773734932	-1.931879747	1.00697641
Root Beer Barrels	2.10440254	-0.8711340556	-0.594335570	0.36204105
Runts	2.25699185	-1.1223199934	-1.557678507	0.71996790
Sixlets	0.81799664	1.1888290122	1.093105891	-0.33001942
Skittles original	1.29259129	0.2263705137	-1.306145308	1.05900061
Skittles wildberry	1.47148517	0.1118354559	-1.232745536	0.99503181
Nestle Smarties	-0.27556563	1.3792344137	-0.080047831	-0.03345921
Smarties candy	2.60115214	-0.6047947520	0.003482896	-0.21938457
Snickers	-4.39576792	-1.7919312516	1.434654778	1.89861891
Snickers Crisper	-4.01457335	-0.0347673522	-1.089868643	-1.42309414
Sour Patch Kids	1.81551769	0.8879445215	0.863881832	-0.32795118
Sour Patch Tricksters	1.97326660	0.7869473239	0.928605869	-0.38435897
Starburst	1.50658493	0.9437290830	0.487658690	-0.12150268
Strawberry bon bons	2.80647837	-1.0331193111	-0.524069119	0.13960292
Sugar Babies	-0.01900559	-0.8219542293	-1.802826526	0.92212945
Sugar Daddy	0.19642038	-1.2073694698	0.520140143	-0.59663517
Super Bubble	1.99242820	-0.3915898648	1.481310204	-1.01767057
Swedish Fish	1.00547407	0.5003327040	-1.068588828	0.59499272
Tootsie Pop	0.84734171	-1.1060686710	-0.480874078	-0.23675349
Tootsie Roll Juniors	-0.40463667	0.5848580362	0.836999949	-0.59623669
Tootsie Roll Midgies	0.66730732	1.3709464980	1.179339290	-0.32789249
Tootsie Roll Snack Bars	-1.31149842	0.0009721286	0.885976952	-0.78242207
Trolli Sour Bites	1.85048456	0.5304055168	0.254559391	-0.02435072
Twix	-4.12909044	-0.2180299573	-1.943536689	-2.52917855
Twizzlers	1.56312584	-0.1794588354	1.179917535	-0.78310886
Warheads	2.30707033	-1.2940268825	1.004249910	-1.11380521
Welch's Fruit Snacks	1.84808801	0.5022006184	0.213204782	-0.03387254
Werther's Original Caramel	0.68420363	-2.0146385440	0.506488679	-0.97208672
Whoppers	-1.42549552	1.3654147702	-2.759982292	-1.23030133
	PC5	PC6	PC7	PC8
100 Grand	-0.66236243	-0.545218405	-0.14340559	0.577224229
3 Musketeers	-0.16006665	0.382588420	2.02155526	-1.502574960
One dime	-0.26977985	0.094950530	-0.77220066	0.155622104
One quarter	-0.05093737	0.428354037	-0.59089199	0.359134372
Air Heads	0.33108524	0.188791601	0.96808076	1.012393252
Almond Joy	1.43200435	1.022273480	-0.66604596	0.608261288
Baby Ruth	-0.53157179	0.026152894	-0.27477854	0.617961302
Boston Baked Beans	-0.01286555	1.147068667	-1.66290853	1.017203801
Candy Corn	-0.92992691	0.482570575	-0.17268382	-0.433778134
Caramel Apple Pops	-1.26916612	-0.641471733	-0.77030933	1.705704289
Charleston Chew	-0.48839246	1.490541025	1.23825892	-1.445444979
Chewey Lemonhead Fruit Mix	-0.64216946	0.867070020	0.51175007	0.500258867
Chiclets	-0.82031918	0.835939962	-0.06670709	0.514147274

Dots	-0.57043885	0.625011322	0.68287986	0.487777458
Dum Dums	1.60464382	-0.712637531	-0.06881335	-0.229647214
Fruit Chews	-0.64943194	-0.515343269	0.62911226	0.295017216
Fun Dip	1.64564645	-0.061325594	-0.22205535	-0.058799069
Gobstopper	0.97535806	0.006638151	0.09322099	-0.594393205
Haribo Gold Bears	-0.41418743	-0.076745232	0.97316112	0.470072508
Haribo Happy Cola	-0.96450884	0.897177682	-0.57777493	-0.279999961
Haribo Sour Bears	-0.47964306	0.144138214	0.81700174	0.481462045
Haribo Twin Snakes	-0.58554144	0.501497845	0.56435691	0.499888780
Hershey's Kisses	-0.65415252	-0.956497265	-0.15459157	-1.475048333
Hershey's Krackel	0.64433919	0.815979037	0.72869731	-0.058197261
Hershey's Milk Chocolate	0.45257976	1.365951323	0.09727415	-0.537271619
Hershey's Special Dark	0.48406856	1.259690716	0.17239789	-0.542750795
Jawbusters	0.74872541	0.777635266	-0.86953189	-0.404938915
Junior Mints	-0.56772916	-0.100807494	-0.27701048	-1.244289684
Kit Kat	0.74560410	-0.651964126	1.26789202	-0.308264629
Laffy Taffy	0.12742282	-0.323401158	0.50907401	0.902891431
Lemonhead	1.59348201	-0.612577970	-0.46974919	-0.088239458
Lifesavers big ring gummies	0.28553918	-0.405905368	0.76717408	0.968451468
Peanut butter M&M's	0.70534888	-0.535487043	-0.31945944	-0.055419751
M&M's	-0.42260375	-0.093849007	0.23580574	-1.272394704
Mike & Ike	-0.54748868	0.068855836	0.96217007	0.350296998
Milk Duds	-1.94930706	-1.088570940	-1.46793514	-0.532609515
Milky Way	-1.43541753	-0.603255019	0.91522507	-0.708957591
Milky Way Midnight	-1.60495490	-0.577210751	0.75050728	-0.825932767
Milky Way Simply Caramel	-0.81154750	-0.095588630	-0.56663709	0.057913957
Mounds	0.34136052	1.562117376	-0.17156397	-0.536908890
Mr Good Bar	1.49882941	1.178267833	-0.70645139	0.710404328
Nerds	1.05269810	-0.612484674	0.36162582	-0.677966908
Nestle Butterfinger	1.66950147	0.246674393	-0.03583585	0.547351886
Nestle Crunch	0.66634611	0.310195315	0.85793736	-0.137897493
Nik L Nip	-0.74139722	2.364290586	-0.37097983	0.877307522
Now & Later	-0.64458895	0.275284807	0.43215999	0.459054334
Payday	0.57021053	1.685803617	0.71659189	0.920899230
Peanut M&Ms	0.67649842	-0.481270608	-0.49445201	-0.017712739
Pixie Sticks	-1.00053741	-0.249857693	-0.45261662	-0.491657159
Pop Rocks	0.96236780	1.036365445	-0.40726527	-0.314719629
Red vines	-0.69083254	-0.068691578	0.66734570	0.288409391
Reese's Miniatures	1.52874138	-1.896976303	-0.34129661	0.391227548
Reese's Peanut Butter cup	1.62984822	-1.101118658	-0.10711621	0.504507095
Reese's pieces	0.71687442	-0.652294629	-0.48369702	0.001608461
Reese's stuffed with pieces	1.50741757	-0.638134777	-0.27656579	0.488051492
Ring pop	1.69809389	1.498435385	-0.64909630	0.323514628

Rolo	-1.75944281	-0.678446043	-1.06073297	-0.430807299
Root Beer Barrels	0.42962062	-0.109312144	-1.19510153	-1.555611980
Runts	0.90293644	-0.227471967	0.05500446	-0.683423916
Sixlets	-0.89038600	-0.174585492	-0.66527067	-1.454385221
Skittles original	-0.37037605	-0.800924438	1.50687697	0.245536582
Skittles wildberry	-0.46191313	-0.492027764	1.28849431	0.261464394
Nestle Smarties	-0.71703419	1.677902657	-1.00236322	-0.943766974
Smarties candy	0.89831080	-0.766691658	-0.09224917	-0.697074269
Snickers	-0.32409247	-0.999567686	0.29375023	0.519082351
Snickers Crisper	0.28905186	-0.982077142	-0.99809936	1.715122168
Sour Patch Kids	-0.44613213	-0.989653570	1.01684337	0.317967197
Sour Patch Tricksters	-0.52684967	-0.717267988	0.82427320	0.332012368
Starburst	-0.34591253	-1.030380238	1.20373631	0.352584423
Strawberry bon bons	0.76654988	-0.423292666	-0.21835972	-0.752170933
Sugar Babies	-2.27338367	0.557052968	-1.67505130	0.548087948
Sugar Daddy	-1.58729466	-0.485682924	-1.85240975	0.941435233
Super Bubble	-0.03565422	0.216125641	0.09347559	0.939439208
Swedish Fish	-0.39241423	0.662591135	0.83851208	0.624071063
Tootsie Pop	1.88703233	-0.633721587	-0.18826747	-1.043909239
Tootsie Roll Juniors	0.05449315	0.394706045	-0.68468874	-0.662902544
Tootsie Roll Midgies	-0.77589776	-0.759442617	-0.35278919	-1.510639321
Tootsie Roll Snack Bars	0.28510912	0.328392863	0.22536722	-0.875755689
Trolli Sour Bites	-0.56414212	-0.168850396	0.72703429	0.389139607
Twix	-0.49203516	-1.029755076	0.13814854	0.601927243
Twizzlers	0.17417770	-0.481177950	0.62061848	0.894755897
Warheads	1.59506307	-0.576609554	-0.45482313	-0.087796992
Welch's Fruit Snacks	-0.58742724	0.067119205	0.62144223	0.428665533
Werther's Original Caramel	0.00698052	-1.343145309	-2.51219819	-0.091968746
Whoppers	-0.46170658	0.678567795	0.16799768	-0.639281286
	PC9	PC10	PC11	
100 Grand	0.379148201	-0.154099543	0.141903843	
3 Musketeers	0.023832701	-0.155239068	-0.517927160	
One dime	-0.453988975	-0.943783623	-0.515870807	
One quarter	-0.638889823	0.095579648	-0.986719399	
Air Heads	-1.383012190	-0.573723493	-0.514453684	
Almond Joy	-0.139059851	-0.312778705	1.061148660	
Baby Ruth	1.143067977	0.264099876	-0.009085882	
Boston Baked Beans	1.396216830	-0.973188567	0.102073964	
Candy Corn	-0.173119296	-1.580718107	-0.026369468	
Caramel Apple Pops	-0.916479426	-0.201217892	0.098522113	
Charleston Chew	0.265940391	-0.852594237	-0.299018234	
Chewey Lemonhead Fruit Mix	-0.056700856	-0.274516517	0.133783407	
Chiclets	0.600474625	0.299142845	0.263138381	

Dots	-0.109595061	-0.122162631	0.085957526
Dum Dums	-0.385161810	-0.858986682	0.026635152
Fruit Chews	0.431017129	0.094469913	0.405402342
Fun Dip	-0.432729164	-0.348623806	-0.240086957
Gobstopper	0.401434380	0.160051400	0.173108273
Haribo Gold Bears	-0.021735861	0.618649969	-0.035818163
Haribo Happy Cola	0.174940628	-0.664580531	-0.210044044
Haribo Sour Bears	0.026531168	0.479623974	0.007823919
Haribo Twin Snakes	0.104620713	0.254698661	0.078430922
Hershey's Kisses	0.015418665	-0.009459574	0.108560740
Hershey's Krackel	0.589905081	-0.259828939	-0.295461506
Hershey's Milk Chocolate	-1.211270861	0.556641044	0.566669950
Hershey's Special Dark	-1.234490726	0.623522410	0.545675013
Jawbusters	1.175121068	1.211984587	0.107699541
Junior Mints	-0.125729538	0.657349544	-0.278384695
Kit Kat	0.627262392	-0.428229606	-0.052463331
Laffy Taffy	-0.694575541	-0.358253574	-0.196159662
Lemonhead	0.133629280	0.441715610	-0.165939908
Lifesavers big ring gummies	-0.856144679	0.130909678	-0.425911984
Peanut butter M&M's	0.267660757	-0.221930007	-0.095957385
M&M's	-0.712293695	0.050005905	-0.359922697
Mike & Ike	-0.220487198	-0.593471988	0.252731956
Milk Duds	-0.136911155	1.039501593	0.120288784
Milky Way	0.004765911	0.843304841	-0.327048378
Milky Way Midnight	0.046247663	-0.050365745	-0.014682753
Milky Way Simply Caramel	-1.628250067	0.337544026	1.024026651
Mounds	-1.038014053	0.444568191	0.664244259
Mr Good Bar	-0.083279402	0.319687965	0.860817575
Nerds	0.395546909	0.241504770	0.214795902
Nestle Butterfinger	-0.418486899	-0.056067346	0.931659519
Nestle Crunch	0.670459908	-0.224206267	-0.210210679
Nik L Nip	0.390203352	1.144571263	-0.293659295
Now & Later	0.340332791	0.362285847	0.182098894
Payday	1.592516886	-0.586376631	-0.517961675
Peanut M&Ms	0.463012748	0.130263439	-0.124891428
Pixie Sticks	0.506958178	-0.721036477	0.100340132
Pop Rocks	0.614743430	1.229233468	-0.196822517
Red vines	0.116010128	-0.683310675	0.459814126
Reese's Miniatures	-0.201912762	0.339292365	-0.538620165
Reese's Peanut Butter cup	-0.813354976	-0.127457497	-0.769615618
Reese's pieces	0.573552037	0.549292897	-0.190638431
Reese's stuffed with pieces	-0.924164172	-0.865127171	-0.632341326
Ring pop	-0.509522417	0.693685961	-0.801535980

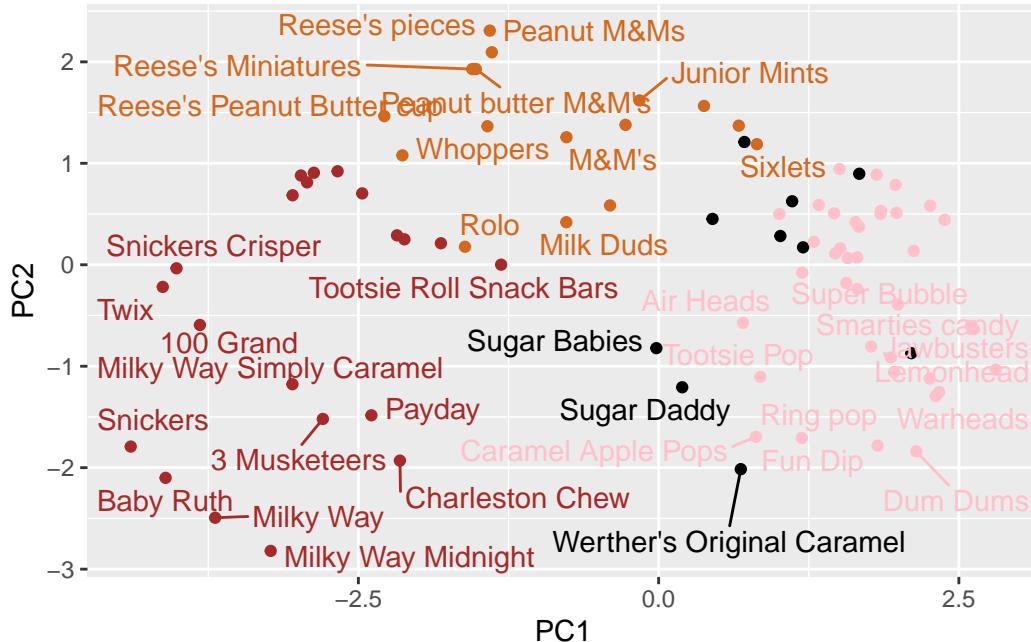
Rolo	-0.716390425	0.955937401	-0.177541179
Root Beer Barrels	0.748159981	-1.361887249	0.275586696
Runts	0.490713003	-0.186267132	0.357472263
Sixlets	0.120551003	-0.694412596	0.295248736
Skittles original	-0.396609466	-0.492989386	0.235345367
Skittles wildberry	-0.329109954	-0.687411685	0.296377074
Nestle Smarties	-0.095850762	0.891841882	-0.546823295
Smarties candy	0.957784710	0.645048933	0.369028845
Snickers	1.040500931	0.639420129	-0.064039216
Snickers Crisper	1.597773064	-0.876877339	0.668926998
Sour Patch Kids	0.319739180	0.748914211	0.190355889
Sour Patch Tricksters	0.379260358	0.577472316	0.244173747
Starburst	0.178115491	0.966910650	0.055007728
Strawberry bon bons	0.831798717	-0.257396978	0.567295681
Sugar Babies	-0.204221618	-0.392704656	-0.026264253
Sugar Daddy	-0.751459910	-0.659787353	-0.269135682
Super Bubble	-0.530802993	-0.601257076	-0.099471654
Swedish Fish	-0.159360361	0.838989403	-0.260036175
Tootsie Pop	-0.721118894	0.326836317	-0.137911107
Tootsie Roll Juniors	-1.149669881	-0.284072969	-0.704615875
Tootsie Roll Midgies	0.074811904	-0.471079914	0.266947340
Tootsie Roll Snack Bars	-1.078720446	-0.723988086	1.173413519
Trolli Sour Bites	0.215399333	0.265589321	0.205354764
Twix	0.390371217	0.606070076	-0.048120393
Twizzlers	-0.729052624	-0.258947465	-0.227333151
Warheads	0.096482954	0.378764818	-0.167107014
Welch's Fruit Snacks	0.229115315	0.300496305	0.173167709
Werther's Original Caramel	0.028457521	0.448967578	-0.298604763
Whoppers	1.212121185	-1.054026246	-1.220426934
		PC12	
100 Grand	0.0646988318		
3 Musketeers	-0.1839471662		
One dime	-0.5107477914		
One quarter	-0.9582719109		
Air Heads	0.0442992399		
Almond Joy	0.1889347102		
Baby Ruth	0.5798508261		
Boston Baked Beans	-0.1012981497		
Candy Corn	-0.6799350975		
Caramel Apple Pops	0.6962504166		
Charleston Chew	0.5494017342		
Chewey Lemonhead Fruit Mix	0.3105973331		
Chiclets	0.5337581991		

Dots	0.1503797578
Dum Dums	0.1849692597
Fruit Chews	0.1399898762
Fun Dip	0.1237990873
Gobstopper	-0.1944414618
Haribo Gold Bears	-0.2638818244
Haribo Happy Cola	-0.6879064447
Haribo Sour Bears	-0.1176800541
Haribo Twin Snakes	0.1188546962
Hershey's Kisses	0.1984492942
Hershey's Krackel	-0.0817067486
Hershey's Milk Chocolate	-0.3573702410
Hershey's Special Dark	-0.4277036644
Jawbusters	0.1337584661
Junior Mints	0.0649489483
Kit Kat	-0.3769186469
Laffy Taffy	0.3026020451
Lemonhead	0.0619011170
Lifesavers big ring gummies	-0.0228900695
Peanut butter M&M's	0.1200218111
M&M's	-0.1023879726
Mike & Ike	0.1113757406
Milk Duds	0.3400578947
Milky Way	-0.1552479006
Milky Way Midnight	0.2304632793
Milky Way Simply Caramel	-0.2533060125
Mounds	-0.1415021722
Mr Good Bar	0.0210418054
Nerds	-0.3936975444
Nestle Butterfinger	-0.3100685916
Nestle Crunch	-0.1731325150
Nik L Nip	0.4597035356
Now & Later	0.1806417362
Payday	-0.7729766006
Peanut M&Ms	0.1319358415
Pixie Sticks	-0.7378511713
Pop Rocks	-0.1936682261
Red vines	0.3438211129
Reese's Miniatures	-0.0689054242
Reese's Peanut Butter cup	-0.1005437626
Reese's pieces	-0.0005861225
Reese's stuffed with pieces	0.2335945192
Ring pop	0.0735408387

Rolo	0.0787870205
Root Beer Barrels	-0.7082327026
Runts	-0.0585635801
Sixlets	0.7459023430
Skittles original	-0.2795750540
Skittles wildberry	-0.0751177198
Nestle Smarties	0.4628839641
Smarties candy	-0.2022435492
Snickers	0.0911696493
Snickers Crisper	0.6306015108
Sour Patch Kids	-0.3186623415
Sour Patch Tricksters	-0.1383715363
Starburst	-0.5130782116
Strawberry bon bons	0.1543709171
Sugar Babies	-0.4541934821
Sugar Daddy	-0.2885121237
Super Bubble	0.6537195364
Swedish Fish	-0.2507351031
Tootsie Pop	1.2506316262
Tootsie Roll Juniors	0.5695856300
Tootsie Roll Midgies	0.4724506497
Tootsie Roll Snack Bars	-0.0373596827
Trolli Sour Bites	0.0146955266
Twix	-0.3530484324
Twizzlers	0.1981702880
Warheads	0.0702649429
Welch's Fruit Snacks	0.0727669700
Werther's Original Caramel	-0.8335356607
Whoppers	0.7201599382

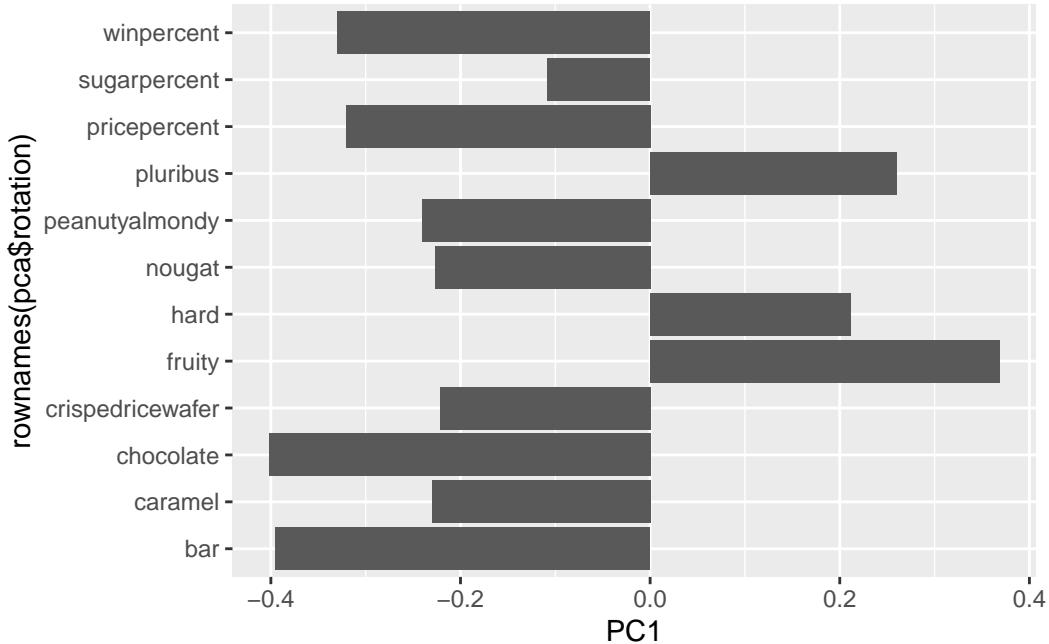
```
ggplot(pca$x) +
  aes(PC1, PC2, label=rownames(pca$x)) +
  geom_point(col=my_cols) +
  geom_text_repel(col=my_cols)
```

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, hard, fruity are all in the positive direction, which makes sense because they are all characteristics that those candies have (laffy taffy, airheads, warheads).