

Class 09: Candy Analysis Mini Project

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In today's class we will

Import Data

```
candy_file <- "candy-data.txt"
```

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

```
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

```
candy
```

	chocolate	fruity	caramel	peanut	almond	nougat
100 Grand	1	0	1		0	0
3 Musketeers	1	0	0		0	1
One dime	0	0	0		0	0
One quarter	0	0	0		0	0
Air Heads	0	1	0		0	0
Almond Joy	1	0	0		1	0
Baby Ruth	1	0	1		1	1
Boston Baked Beans	0	0	0		1	0
Candy Corn	0	0	0		0	0
Caramel Apple Pops	0	1	1		0	0
Charleston Chew	1	0	0		0	1
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 Happy Cola	0	0	0		0	0
Haribo Sour Bears	0	1	0		0	0
Haribo Twin Snakes	0	1	0		0	0
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
Jawbusters	0	1	0		0	0
Junior Mints	1	0	0		0	0
Kit Kat	1	0	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
Peanut butter M&M's	1	0	0		1	0
M&M's	1	0	0		0	0
Mike & Ike	0	1	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
Nerds	0	1	0		0	0

Nestle Butterfinger	1	0	0	1	0
Nestle Crunch	1	0	0	0	0
Nik L Nip	0	1	0	0	0
Now & Later	0	1	0	0	0
Payday	0	0	0	1	1
Peanut M&Ms	1	0	0	1	0
Pixie Sticks	0	0	0	0	0
Pop Rocks	0	1	0	0	0
Red vines	0	1	0	0	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
Ring pop	0	1	0	0	0
Rolo	1	0	1	0	0
Root Beer Barrels	0	0	0	0	0
Runts	0	1	0	0	0
Sixlets	1	0	0	0	0
Skittles original	0	1	0	0	0
Skittles wildberry	0	1	0	0	0
Nestle Smarties	1	0	0	0	0
Smarties candy	0	1	0	0	0
Snickers	1	0	1	1	1
Snickers Crisper	1	0	1	1	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
Sugar Babies	0	0	1	0	0
Sugar Daddy	0	0	1	0	0
Super Bubble	0	1	0	0	0
Swedish Fish	0	1	0	0	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
Trolli Sour Bites	0	1	0	0	0
Twix	1	0	1	0	0
Twizzlers	0	1	0	0	0
Warheads	0	1	0	0	0
Welch's Fruit Snacks	0	1	0	0	0
Werther's Original Caramel	0	0	1	0	0
Whoppers	1	0	0	0	0

	crisped	rice	wafer	hard	bar	pluribus	sugar	percent
100 Grand	1	0	1			0		0.732
3 Musketeers	0	0	1			0		0.604
One dime	0	0	0			0		0.011
One quarter	0	0	0			0		0.011
Air Heads	0	0	0			0		0.906
Almond Joy	0	0	1			0		0.465
Baby Ruth	0	0	1			0		0.604
Boston Baked Beans	0	0	0			1		0.313
Candy Corn	0	0	0			1		0.906
Caramel Apple Pops	0	0	0			0		0.604
Charleston Chew	0	0	1			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 Happy Cola	0	0	0			1		0.465
Haribo Sour Bears	0	0	0			1		0.465
Haribo Twin Snakes	0	0	0			1		0.465
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
Jawbusters	0	1	0			1		0.093
Junior Mints	0	0	0			1		0.197
Kit Kat	1	0	1			0		0.313
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
Peanut butter M&M's	0	0	0			1		0.825
M&M's	0	0	0			1		0.825
Mike & Ike	0	0	0			1		0.872
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
Nerds	0	1	0			1		0.848

Nestle Butterfinger	0	0	1	0	0.604
Nestle Crunch	1	0	1	0	0.313
Nik L Nip	0	0	0	1	0.197
Now & Later	0	0	0	1	0.220
Payday	0	0	1	0	0.465
Peanut M&Ms	0	0	0	1	0.593
Pixie Sticks	0	0	0	1	0.093
Pop Rocks	0	1	0	1	0.604
Red vines	0	0	0	1	0.581
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
Ring pop	0	1	0	0	0.732
Rolo	0	0	0	1	0.860
Root Beer Barrels	0	1	0	1	0.732
Runts	0	1	0	1	0.872
Sixlets	0	0	0	1	0.220
Skittles original	0	0	0	1	0.941
Skittles wildberry	0	0	0	1	0.941
Nestle Smarties	0	0	0	1	0.267
Smarties candy	0	1	0	1	0.267
Snickers	0	0	1	0	0.546
Snickers Crisper	1	0	1	0	0.604
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
Sugar Babies	0	0	0	1	0.965
Sugar Daddy	0	0	0	0	0.418
Super Bubble	0	0	0	0	0.162
Swedish Fish	0	0	0	1	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
Trolli Sour Bites	0	0	0	1	0.313
Twix	1	0	1	0	0.546
Twizzlers	0	0	0	0	0.220
Warheads	0	1	0	0	0.093
Welch's Fruit Snacks	0	0	0	1	0.313
Werther's Original Caramel	0	1	0	0	0.186
Whoppers	1	0	0	1	0.872

	pricepercent	winpercent
100 Grand	0.860	66.97173
3 Musketeers	0.511	67.60294
One dime	0.116	32.26109
One quarter	0.511	46.11650
Air Heads	0.511	52.34146
Almond Joy	0.767	50.34755
Baby Ruth	0.767	56.91455
Boston Baked Beans	0.511	23.41782
Candy Corn	0.325	38.01096
Caramel Apple Pops	0.325	34.51768
Charleston Chew	0.511	38.97504
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 Happy Cola	0.465	34.15896
Haribo Sour Bears	0.465	51.41243
Haribo Twin Snakes	0.465	42.17877
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
Jawbusters	0.511	28.12744
Junior Mints	0.511	57.21925
Kit Kat	0.511	76.76860
Laffy Taffy	0.116	41.38956
Lemonhead	0.104	39.14106
Lifesavers big ring gummies	0.279	52.91139
Peanut butter M&M's	0.651	71.46505
M&M's	0.651	66.57458
Mike & Ike	0.325	46.41172
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
Nerds	0.325	55.35405

Nestle Butterfinger	0.767	70.73564
Nestle Crunch	0.767	66.47068
Nik L Nip	0.976	22.44534
Now & Later	0.325	39.44680
Payday	0.767	46.29660
Peanut M&Ms	0.651	69.48379
Pixie Sticks	0.023	37.72234
Pop Rocks	0.837	41.26551
Red vines	0.116	37.34852
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
Ring pop	0.965	35.29076
Rolo	0.860	65.71629
Root Beer Barrels	0.069	29.70369
Runts	0.279	42.84914
Sixlets	0.081	34.72200
Skittles original	0.220	63.08514
Skittles wildberry	0.220	55.10370
Nestle Smarties	0.976	37.88719
Smarties candy	0.116	45.99583
Snickers	0.651	76.67378
Snickers Crisper	0.651	59.52925
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
Sugar Babies	0.767	33.43755
Sugar Daddy	0.325	32.23100
Super Bubble	0.116	27.30386
Swedish Fish	0.755	54.86111
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
Trolli Sour Bites	0.255	47.17323
Twix	0.906	81.64291
Twizzlers	0.116	45.46628
Warheads	0.116	39.01190
Welch's Fruit Snacks	0.313	44.37552
Werther's Original Caramel	0.267	41.90431
Whoppers	0.848	49.52411

Data exploration

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

There are 85 in this dataset.

```
nrow(candy)
```

```
[1] 85
```

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

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

```
[1] 38
```

Q. How many chocolate candies are there in the dataset

```
sum(candy$chocolate)
```

```
[1] 37
```

Q3. What is your favorite candy in the dataset and what is its winpercent value?

```
candy["Fun Dip",]$winpercent
```

```
[1] 39.1855
```

```
candy["Ring pop",]$winpercent
```

```
[1] 35.29076
```

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
```

```
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 variable “winpercent” appears to be on a different scale compared to the majority of the other variables in the dataset. “winpercent” has values that range from approximately 22.45 to 84.18, as shown by the percentiles (p0, p25, p50, p75, p100) and is likely a percentage

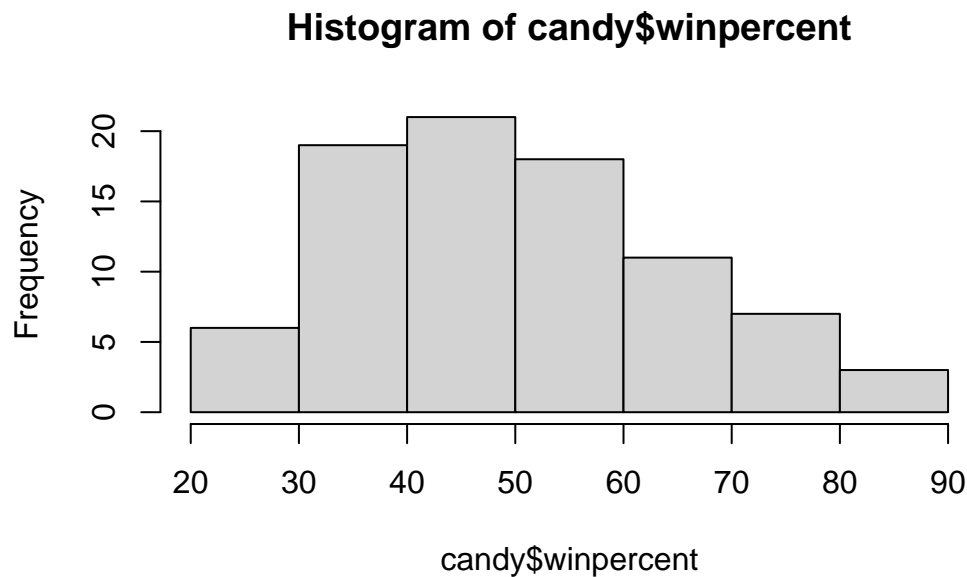
value representing some kind of popularity or preference score for each candy. This suggests that “winpercent” is measured on a continuous scale and represents a substantially different type of data compared to the binary indicators in the dataset.

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

For the “chocolate” column, a “0” would mean the candy does not contain chocolate, while a “1” means it does contain chocolate.

Q8. Plot a histogram of winpercent values

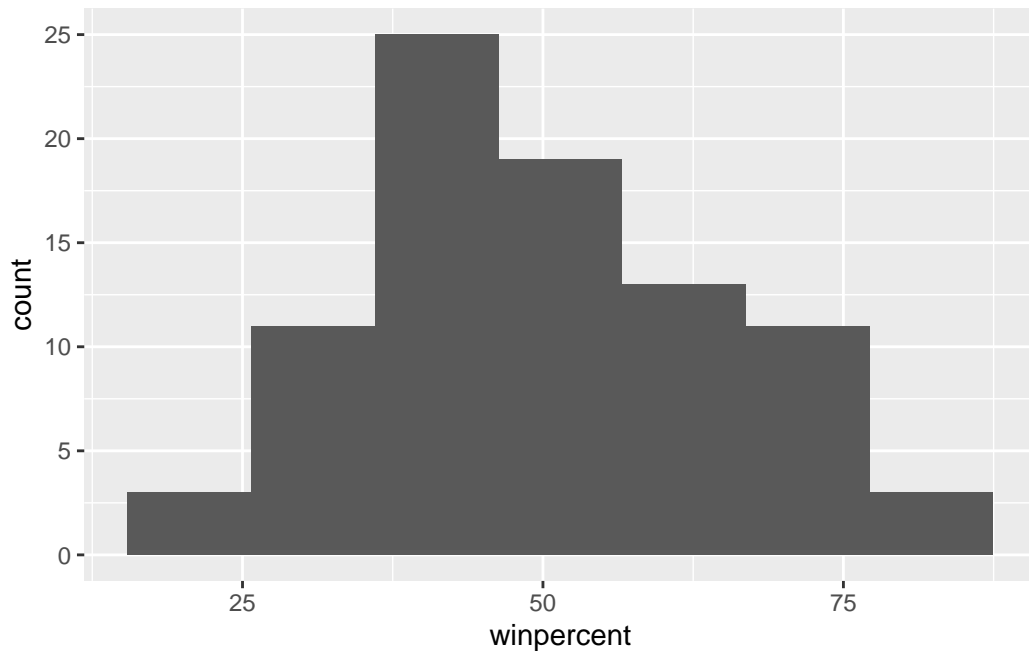
```
hist(candy$winpercent)
```



```
library(ggplot2)
```

Q8b. Plot a distogram of winpercent values using ggplot

```
ggplot(candy) +  
  aes(winpercent) +  
  geom_histogram(bins=7)
```



Q9. Is the distribution of winpercent values symmetrical?

No

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

Below

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

```
[1] 50.31676
```

```
summary(candy$winpercent)
```

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
22.45	39.14	47.83	50.32	59.86	84.18

Distribution definitely below 50. (47.83)

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

- first find all chocolate candy

- find their winpercent values
- calculate the mean of these values
- then do the same for fruity candy and compare iwth the mean for chocolate candy

```
chocolate.inds <- candy$chocolate == 1
chocolate.inds
```

```
[1] TRUE TRUE FALSE FALSE FALSE TRUE TRUE FALSE FALSE FALSE TRUE FALSE
[13] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE TRUE TRUE
[25] TRUE TRUE FALSE TRUE TRUE FALSE FALSE FALSE TRUE TRUE FALSE TRUE
[37] TRUE TRUE TRUE TRUE TRUE FALSE TRUE TRUE FALSE FALSE FALSE TRUE
[49] FALSE FALSE FALSE TRUE TRUE TRUE TRUE FALSE TRUE FALSE FALSE TRUE
[61] FALSE FALSE TRUE FALSE TRUE TRUE FALSE FALSE FALSE FALSE FALSE FALSE
[73] FALSE FALSE TRUE TRUE TRUE TRUE FALSE TRUE FALSE FALSE FALSE FALSE
[85] TRUE
```

```
chocolate.inds <- candy$chocolate == 1
chocolate.win <- candy[chocolate.inds,]
chocolate.win
```

	chocolate	fruity	caramel	peanutyalmondy	nougat
100 Grand	1	0	1	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	ricewafer	hard bar	pluribus	sugarpercent
100 Grand		1	0	1	0.732
3 Musketeers		0	0	1	0.604
Almond Joy		0	0	1	0.465
Baby Ruth		0	0	1	0.604
Charleston Chew		0	0	1	0.604
Hershey's Kisses		0	0	0	0.127
Hershey's Krackel		1	0	1	0.430
Hershey's Milk Chocolate		0	0	1	0.430
Hershey's Special Dark		0	0	1	0.430
Junior Mints		0	0	0	0.197
Kit Kat		1	0	1	0.313
Peanut butter M&M's		0	0	0	0.825
M&M's		0	0	0	0.825
Milk Duds		0	0	0	0.302
Milky Way		0	0	1	0.604
Milky Way Midnight		0	0	1	0.732
Milky Way Simply Caramel		0	0	1	0.965
Mounds		0	0	1	0.313
Mr Good Bar		0	0	1	0.313
Nestle Butterfinger		0	0	1	0.604
Nestle Crunch		1	0	1	0.313
Peanut M&Ms		0	0	0	0.593
Reese's Miniatures		0	0	0	0.034
Reese's Peanut Butter cup		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

```
chocolate.inds <- candy$chocolate == 1
chocolate.win <- candy[chocolate.inds,]$winpercent
chocolate.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
```

```
chocolate.inds <- candy$chocolate == 1
chocolate.win <- candy[chocolate.inds,]$winpercent
mean(chocolate.win)
```

```
[1] 60.92153
```

```
fruity.inds <- candy$fruity == 1
fruity.win <- candy[fruity.inds,]$winpercent
mean(fruity.win)
```

```
[1] 44.11974
```

On average chocolate candy higher ranked than fruit candy.

Q12. Is this difference statistically significant?

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

Welch Two Sample t-test

```
data: chocolate.win and fruity.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
```

This difference is statistically significant (2.871e-08).

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

```
x <- c(5,6,4)
sort(x)
```

```
[1] 4 5 6
```

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

```
[1] 4 5 6
```

The order function returns the indices that make the input sorted.

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

	crispedrice	wafer	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?

```
inds <- order(candy$winpercent)
tail(candy[inds,], 5)
```

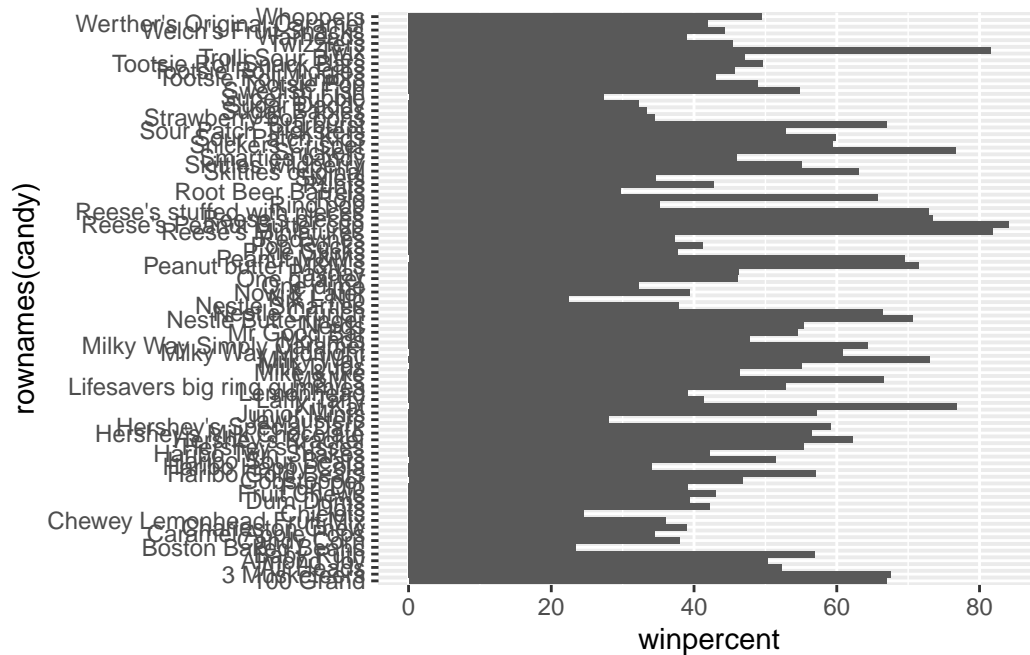
	chocolate	fruity	caramel	peanut	almond	nougat
Snickers	1	0	1		1	1
Kit Kat	1	0	0		0	0
Twix	1	0	1		0	0
Reese's Miniatures	1	0	0		1	0
Reese's Peanut Butter cup	1	0	0		1	0

	crisped	rice	wafer	hard	bar	pluribus	sugar
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

	price	percent	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.

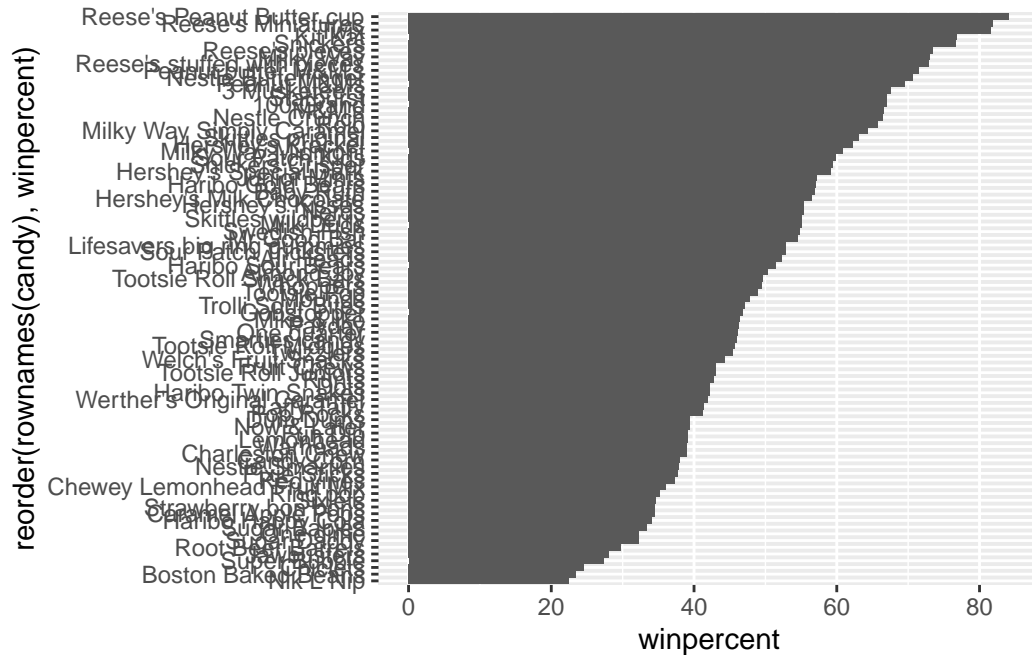
```
ggplot(candy) +
  aes(winpercent, rownames(candy)) +
  geom_col()
```



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

```
#l fig-height: 10
#l fig-width: 7

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



```
ggsave("mybarplot.png", height=10)
```

Saving 5.5 x 10 in image

Add my custom colors to my barplot

```
my_cols=rep("grey", nrow(candy))
my_cols[candy$fruity == 1] <- "pink"
my_cols
```

```
[1] "grey" "grey" "grey" "grey" "pink" "grey" "grey" "grey" "grey" "pink"
[11] "grey" "pink" "pink" "pink" "pink" "pink" "pink" "pink" "pink" "grey"
[21] "pink" "pink" "grey" "grey" "grey" "grey" "pink" "grey" "grey" "pink"
[31] "pink" "pink" "grey" "grey" "pink" "grey" "grey" "grey" "grey" "grey"
[41] "grey" "pink" "grey" "grey" "pink" "pink" "grey" "grey" "grey" "pink"
[51] "pink" "grey" "grey" "grey" "grey" "pink" "grey" "grey" "pink" "grey"
[61] "pink" "pink" "grey" "pink" "grey" "grey" "pink" "pink" "pink" "pink"
[71] "grey" "grey" "pink" "pink" "pink" "grey" "grey" "grey" "pink" "grey"
[81] "pink" "pink" "pink" "grey" "grey"
```

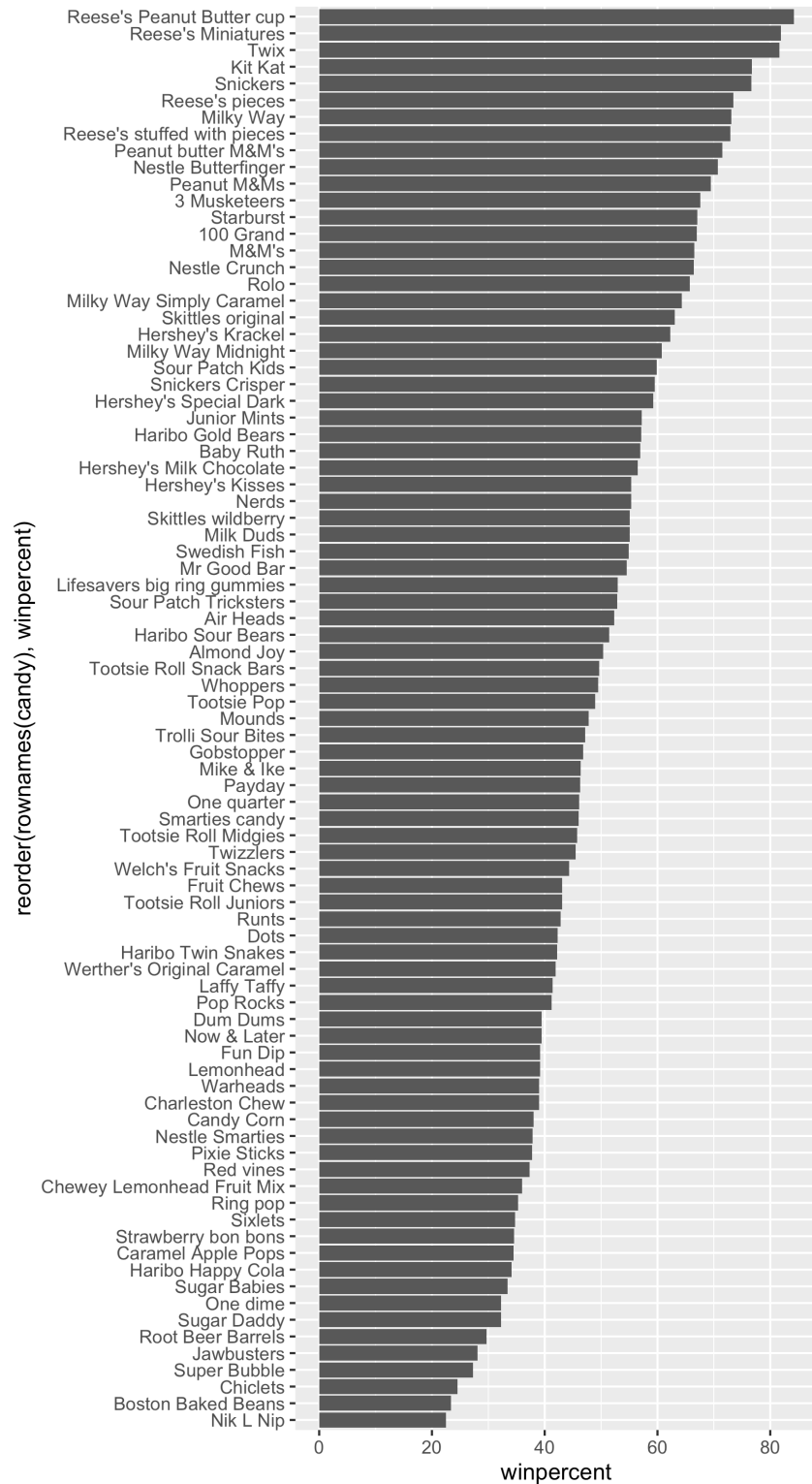
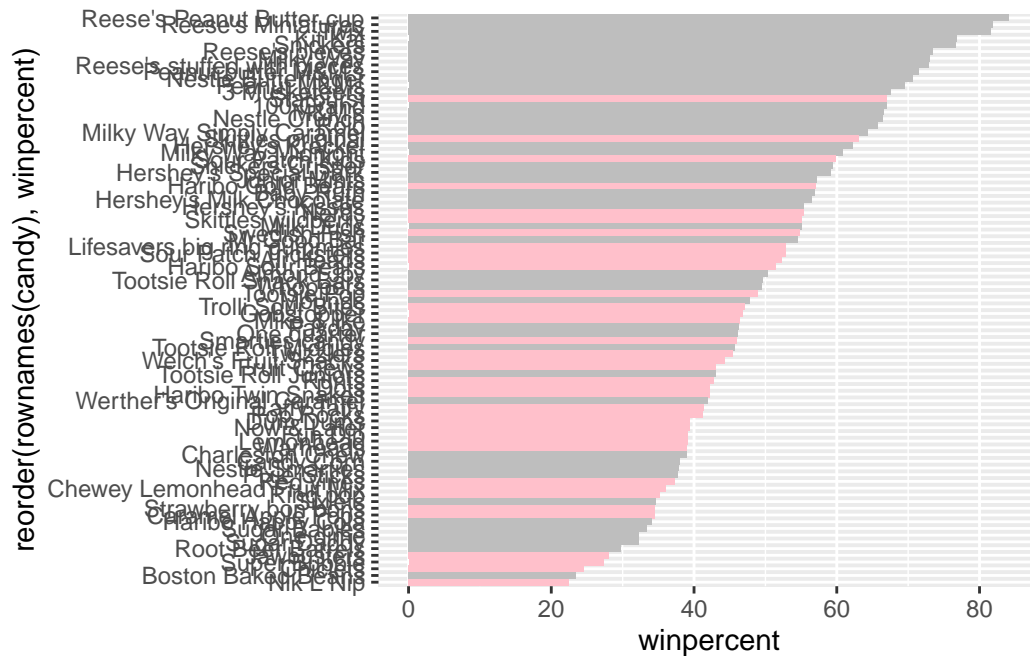


Figure 1: exported image that is a bit bigger so I can read it

```
#1 fig-height: 10
```

```
#1 fig-width: 7
```

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

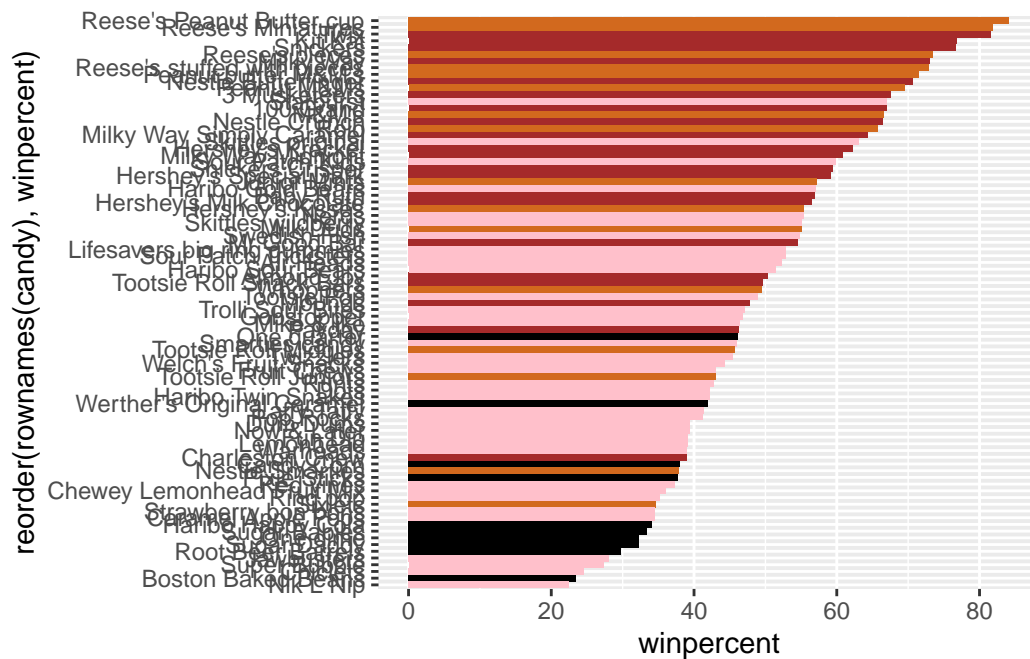


```
my_cols=rep("black", nrow(candy))
my_cols[as.logical(candy$chocolate)] = "chocolate"
my_cols[as.logical(candy$bar)] = "brown"
my_cols[as.logical(candy$fruity)] = "pink"
```

```
#1 fig-height: 10
```

```
#1 fig-width: 7
```

```
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?

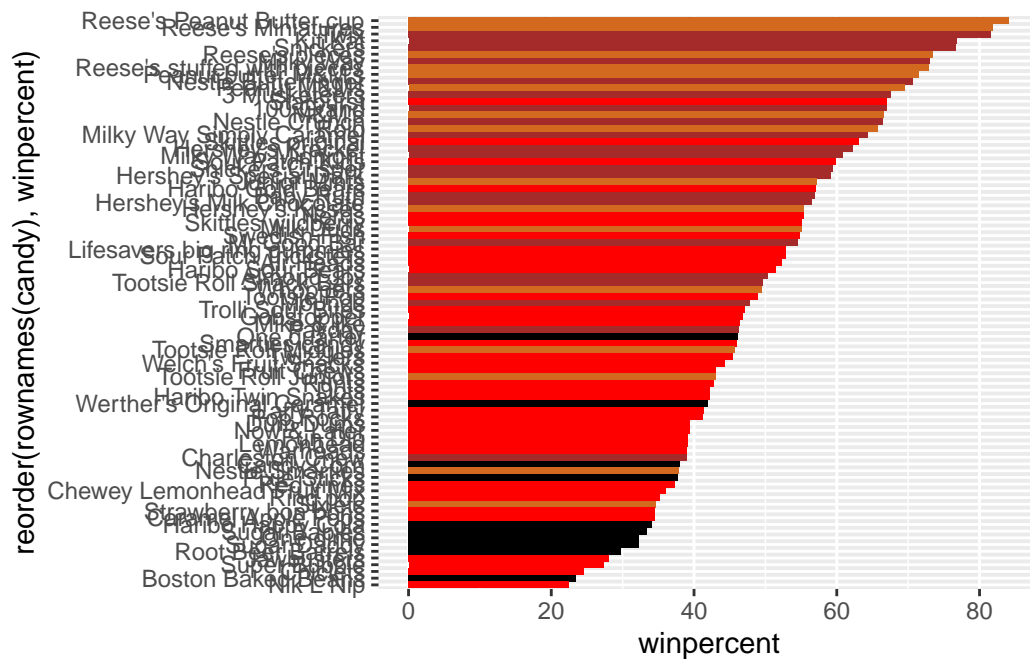
Starbursts

```
library(ggrepel)
```

```
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)] = "red"
```

Plot of winpercent vs pricepercent

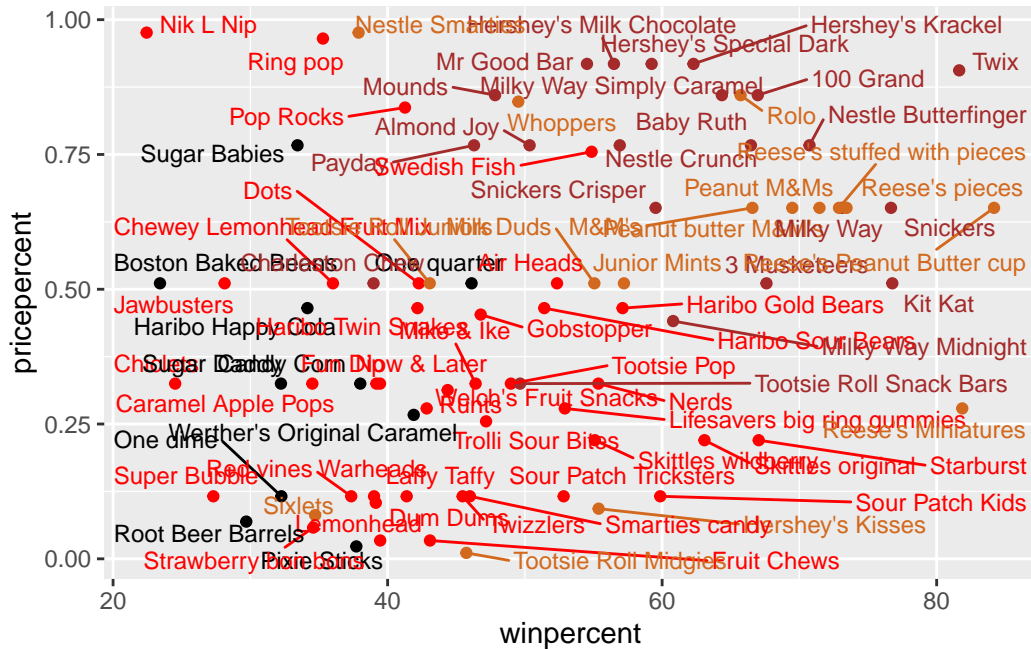
```
ggplot(candy) +
  aes(winpercent, reorder(rownames(candy),winpercent)) +
  geom_col(fill=my_cols)
```



There are just too many labels in this above plot to be readable. We can use the `ggrepel` package to do a better job of placing labels without overlap.

```
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 = 40)
```



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's Miniatures

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

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

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


```
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

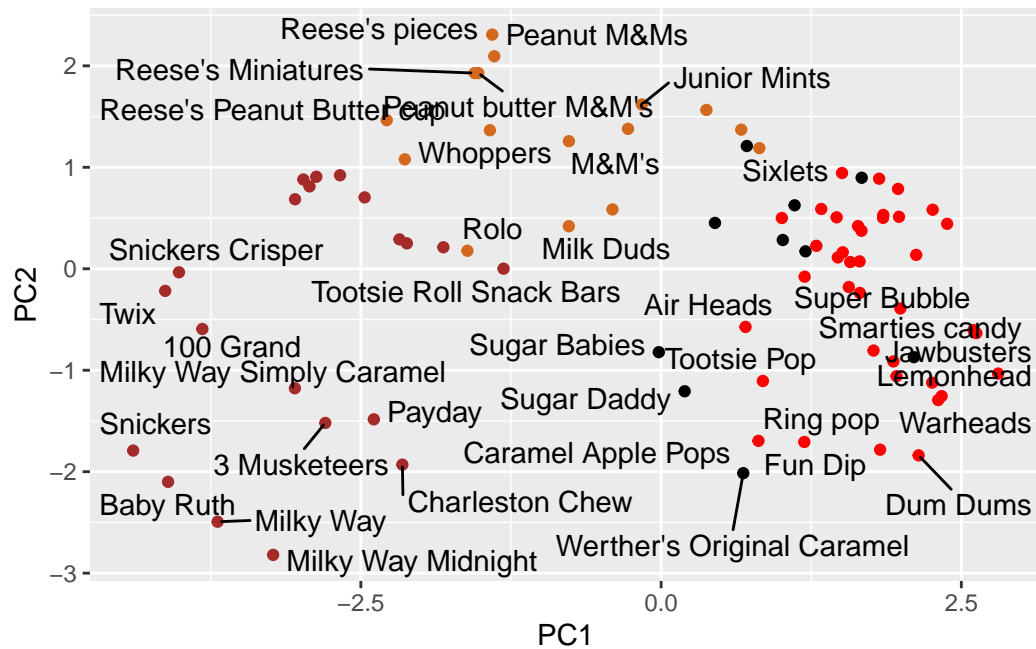
	PC8	PC9	PC10	PC11	PC12
Standard deviation	0.74530	0.67824	0.62349	0.43974	0.39760
Proportion of Variance	0.04629	0.03833	0.03239	0.01611	0.01317
Cumulative Proportion	0.89998	0.93832	0.97071	0.98683	1.00000

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

```
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)] = "red"
```

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

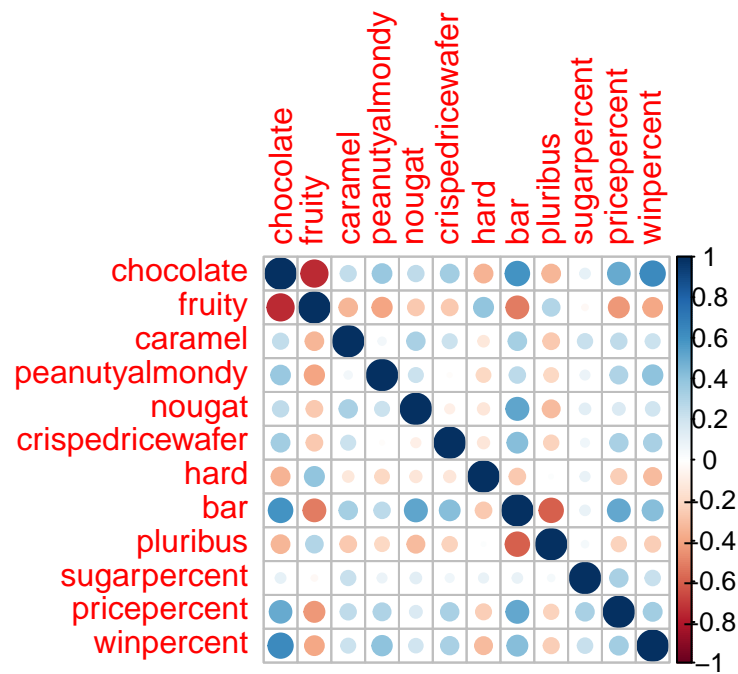
Warning: ggrepel: 48 unlabeled data points (too many overlaps). Consider increasing max.overlaps



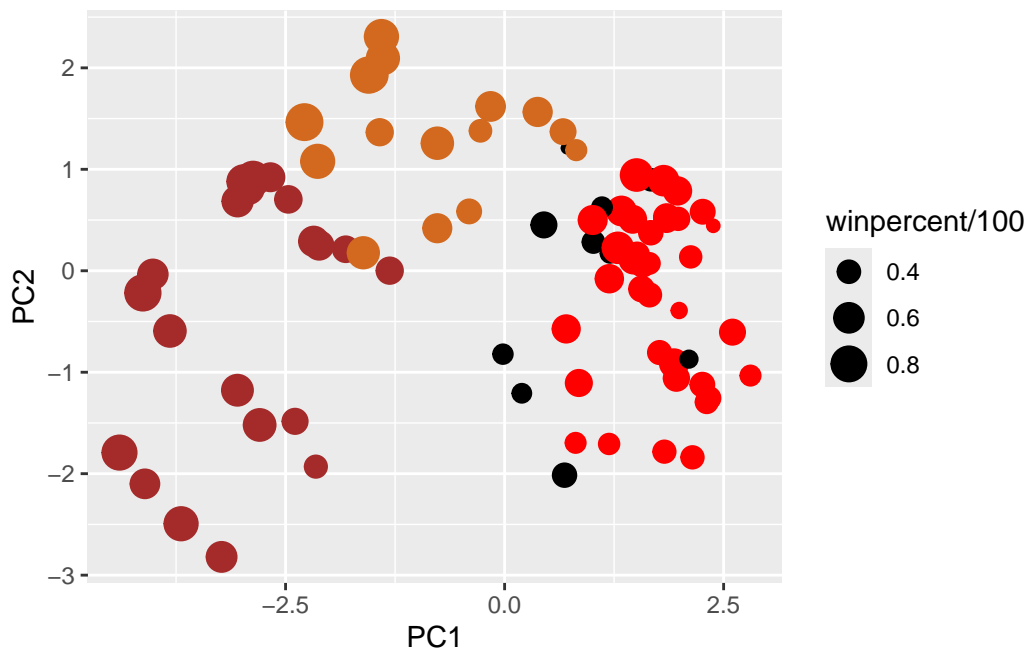
```
library(corrplot)
```

corrplot 0.92 loaded

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



```
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
```



How do the original variables contribute to our PCs? For this we look at the loading component of our results object i.e the `pca$rotation` object.

```
head(pca$rotation)
```

	PC1	PC2	PC3	PC4	PC5
chocolate	-0.4019466	0.21404160	0.01601358	-0.016673032	0.06603585
fruity	0.3683883	-0.18304666	-0.13765612	-0.004479829	0.14353533
caramel	-0.2299709	-0.40349894	-0.13294166	-0.024889542	-0.50730150
peanutyalmondy	-0.2407155	0.22446919	0.18272802	0.466784287	0.39993025
nougat	-0.2268102	-0.47016599	0.33970244	0.299581403	-0.18885242
crispedricewafer	-0.2215182	0.09719527	-0.36485542	-0.605594730	0.03465232
	PC6	PC7	PC8	PC9	PC10
chocolate	-0.09018950	-0.08360642	-0.4908486	-0.151651568	0.10766136
fruity	-0.04266105	0.46147889	0.3980580	-0.001248306	0.36206250
caramel	-0.40346502	-0.44274741	0.2696345	0.019186442	0.22979901
peanutyalmondy	-0.09416259	-0.25710489	0.4577145	0.381068550	-0.14591236
nougat	0.09012643	0.36663902	-0.1879396	0.385278987	0.01132345
crispedricewafer	-0.09007640	0.13077042	0.1356774	0.511634999	-0.26481014
	PC11	PC12			
chocolate	0.1004528	0.69784924			
fruity	0.1749490	0.50624242			

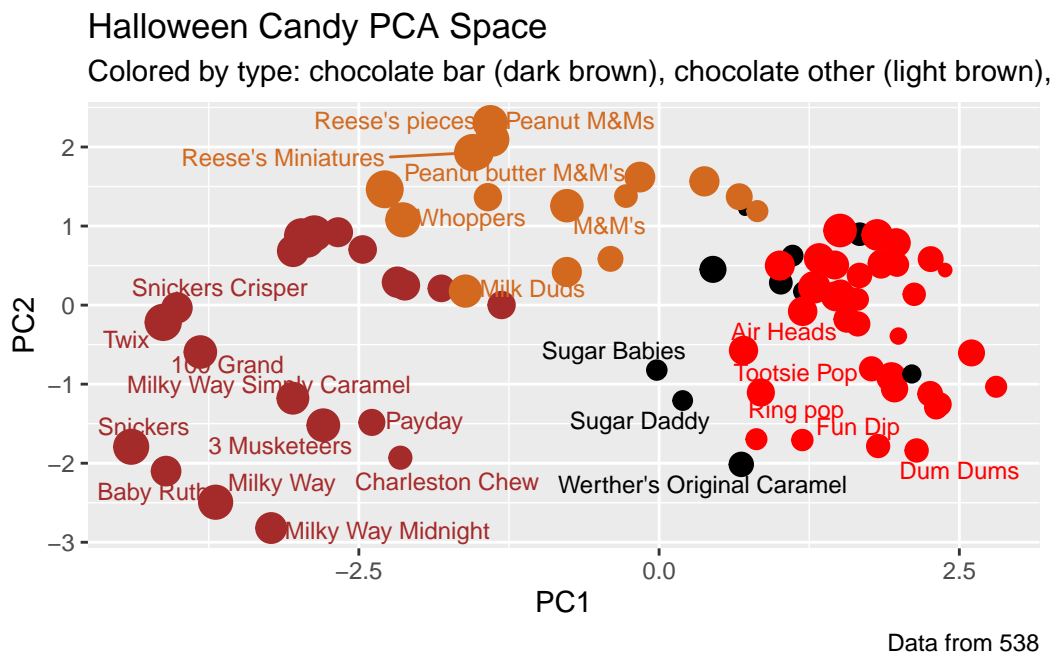
```
caramel          0.1351582 0.07548984
peanutyalmondy   0.1124428 0.12972756
nougat           -0.3895447 0.09223698
crispedricewafer -0.2261562 0.11727369
```

make a barplot with ggplot and order the bars by their value. Recall that you need a data.frame as input for ggplot.

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

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



more candy labels you can change the max.overlaps value to allow more overlapping labels or pass the ggplot object p to plotly like so to generate an interactive plot that you can mouse over to see labels:

```
library(plotly)
```

Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':

```
last_plot
```

The following object is masked from 'package:stats':

```
filter
```

The following object is masked from 'package:graphics':

```
layout
```

```
#ggplotly(p)
```

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

fruit and chocolate

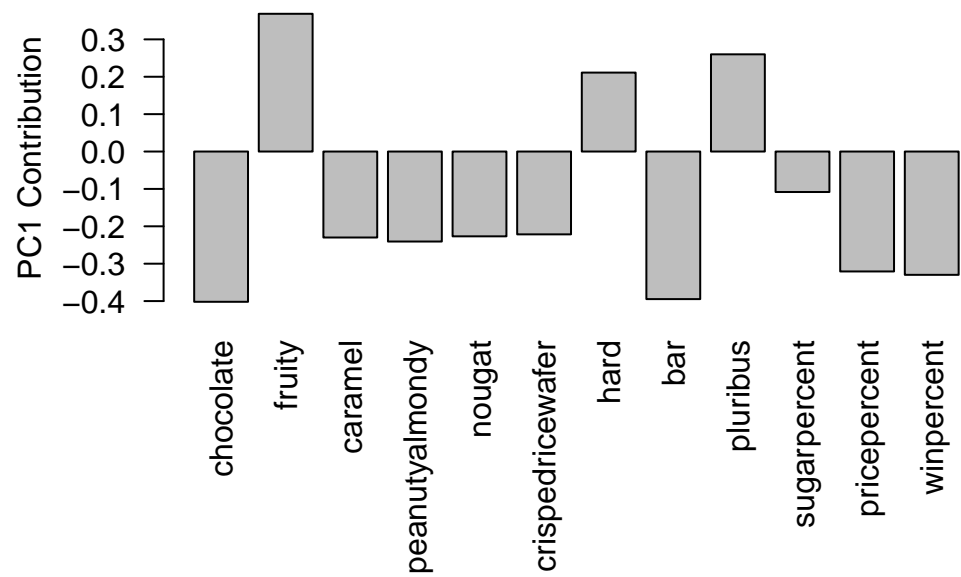
Q23. Similarly, what two variables are most positively correlated?

chocolate and winpercent.

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

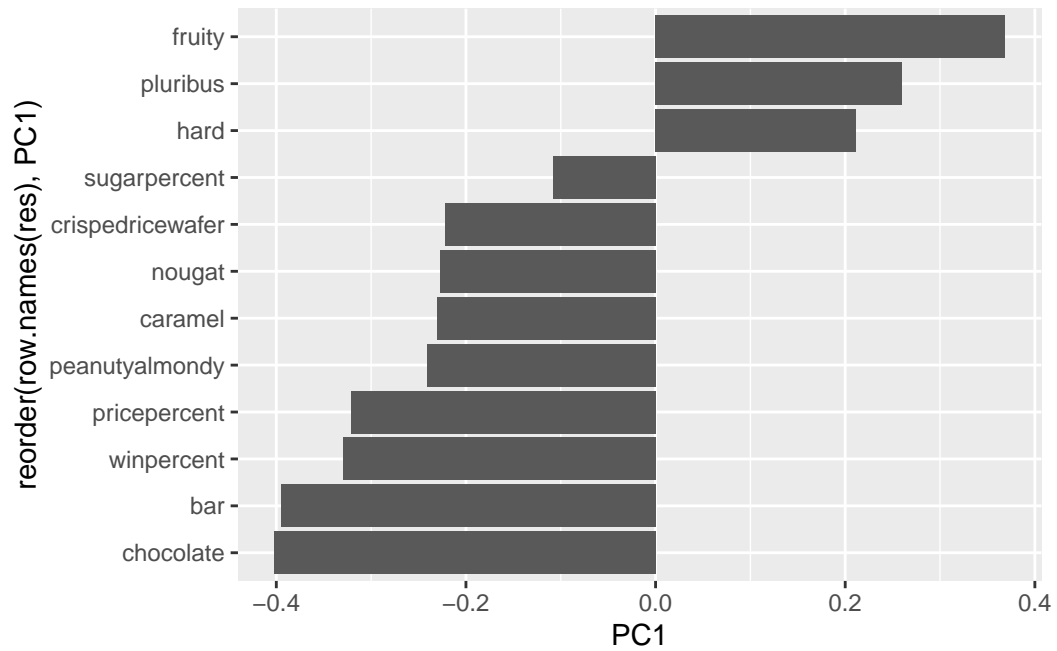
Let's finish by taking a quick look at PCA our loadings. Do these make sense to you? Notice the opposite effects of chocolate and fruity and the similar effects of chocolate and bar (i.e. we already know they are correlated).

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



```
res <- as.data.frame(pca$rotation)

ggplot(res) +
  aes(PC1, reorder(row.names(res), PC1)) +
  geom_col()
```



original variables picked up strongly by PC1 in the positive direction: fruity, pluralists, hard. Yes these do make sense that a fruity candy would be hard and come in a multi-pack.