BACS - HW 12

Let's take another look at interactions in our cars dataset. For this week, let's only use the following data:

```
1. mpg:           miles-per-gallon (dependent variable)
2. weight:        weight of car
3. acceleration:  acceleration ability of car
4. model_year:    year model was released
5. origin:        place car was designed (1: USA, 2: Europe, 3: Japan)
6. cylinders:     cylinders in engine (only used in Question 3)
```

Create a `data.frame` called `cars_log` with log-transformed columns for `mpg`, `weight`, and `acceleration` (`model_year` and `origin don't have to be transformed`)

Question 1) Let's visualize how weight and acceleration are related to mpg.

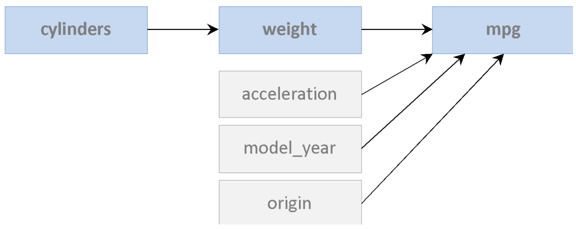
a. Let's visualize how weight might *moderate* the relationship between acceleration and mpg:
   i. Create two *subsets* of your data, one for light-weight cars (less than mean weight) and one for heavy cars (higher than the mean weight)
      HINT: consider carefully how you compare log weights to mean weight
   ii. Create a *single* scatter plot of acceleration vs. mpg, with different colors and/or shapes for light versus heavy cars
   iii. Draw two slopes of acceleration-vs-mpg over the scatter plot:
      one slope for light cars and one slope for heavy cars (distinguish them by appearance)
b. Report the full summaries of two separate regressions for light and heavy cars where `log.mpg.` is dependent on `log.weight.`, `log.acceleration.`, `model_year` and `origin`
c. *(not graded)* Using your intuition only: What do you observe about light versus heavy cars so far?

Question 2) Use the transformed dataset from above (`cars_log`), to test whether we have moderation.

a. *(not graded)* Considering *weight* and *acceleration*, use your intuition and experience to state which of the two variables might be a moderating versus independent variable, in affecting mileage.
b. Use various regression models to model the possible moderation on `log.mpg.`:
   (use `log.weight.`, `log.acceleration.`, `model_year` and `origin` as independent variables)
   i. Report a regression *without any interaction terms*
   ii. Report a regression *with an interaction between weight and acceleration*
   iii. Report a regression *with a mean-centered interaction term*
   iv. Report a regression *with an orthogonalized interaction term*
c. For each of the interaction term strategies above (raw, mean-centered, orthogonalized) what is the correlation between that *interaction term* and the two variables that you multiplied together?

(see Question 3 on next page)

Question 3) We saw earlier that the number of cylinders does not seem to *directly* influence mpg when car weight is also considered. But might cylinders have an *indirect* relationship with mpg through its weight?



Let's check whether weight *mediates* the relationship between cylinders and mpg, even when other factors are controlled for. Use `log.mpg.`, `log.weight.`, and `log.cylinders` as your main variables, and keep `log.acceleration.`, `model_year`, and `origin` as *control variables* (see gray variables in diagram).

a. Let's try computing the direct effects first:
   i. Model 1: Regress **`log.weight.`** over **`log.cylinders.`** only
      (check whether number of cylinders has a significant direct effect on weight)
   ii. Model 2: Regress **`log.mpg.`** over **`log.weight.`** and all control variables
      (check whether weight has a significant direct effect on mpg with other variables statistically controlled)
b. What is the *indirect effect* of cylinders on mpg? *(use the product of slopes between Models 1 & 2)*
c. Let's bootstrap for the confidence interval of the *indirect effect* of cylinders on mpg
   i. Bootstrap regression models 1 & 2, and compute the indirect effect each time:
      What is its 95% CI of the *indirect effect* of `log.cylinders.` on `log.mpg.`?
   ii. Show a density plot of the distribution of the 95% CI of the indirect effect