Lecture 5 Exercises

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Install packages

```
library(tidyverse) #ggplot2, dplyr, etc.
library(reshape2) #need this for melt()
library(knitr) #need this for kable
library(MASS) #contains dataset
```

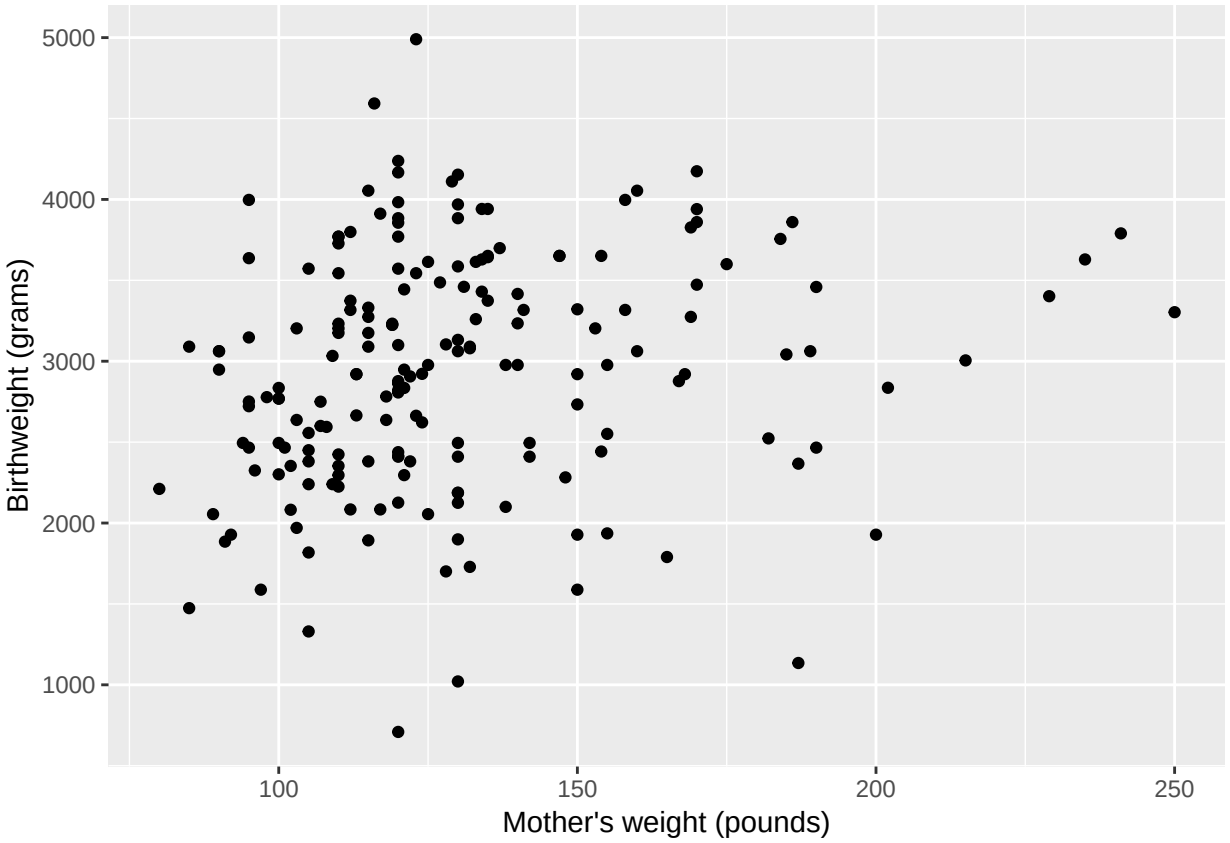
Exercise I

Load the birthwt data. This data contains 189 observations, 9 predictors, and an outcome, birthweight, available both as a continuous measure and a binary indicator for low birth weight.

```
data(birthwt)
head(birthwt)
```

1. Plot a scatterplot of birthweight (bwt) and mother's weight (lwt).

```
p <- ggplot(birthwt,aes(x=lwt,y=bwt)) + geom_point() +
  labs(x="Mother's weight (pounds)",y="Birthweight (grams)")
p
```



2. Use OLS to fit the regression of birthweight on mother's weight.

```
# Fit the regression and view results
fit <- lm(bwt ~ lwt, data=birthwt)

# Return a summary of the results
summary(fit)
```

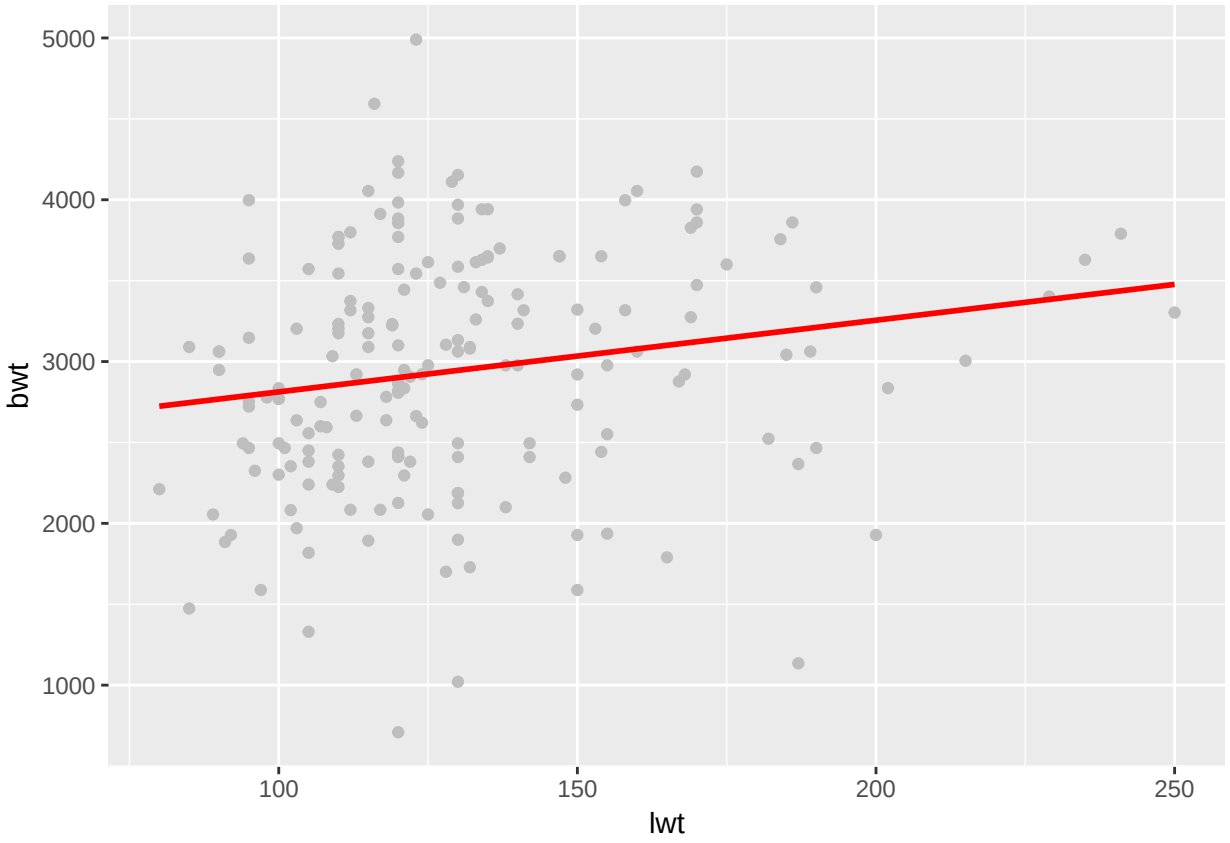
3. Extract the following: estimated coefficients, standard errors, variance-covariance matrix, and confidence intervals.

```
# Estimated coefficients
coefficients(fit)

# Standard errors for the above
summary(fit)$coeff[,2]

# Variance-covariance matrix
vcov(fit)

# Confidence intervals
# you can code yourself or use this function...
confint(fit)
```

4. Plot the regression line and interpret the intercept and slope

```
p <- ggplot(birthwt,aes(x=lwt,y=bwt)) + geom_point(color="grey") +
  stat_smooth(method="lm",col="red",se=FALSE)
```

```
p
```



5. Does the interpretation of the intercept make sense? How might we change this?

- The mean birthweight is 2369 grams among mother's with weight 0 pounds.
- The mean birthweight is 2944 grams among mother's with weight equal to the mean sample weight.
- The change in mean birthweight corresponding to a unit change in mother's weight is estimated to be 4.429 grams.

```
#birthwt2 <- birthwt %>% mutate(lwt_star = lwt - mean(lwt))

#fit.new <- lm(bwt ~ lwt_star,data=birthwt)
#summary(fit.new)
```

6. Now, we want to fit a model that includes race, mother's age, and smoking status in the model. Race takes on value 1 for white, 2 for black, and 3 for other. Mother's age is continuous. Smoking status is binary. Write out the regression function we may be interested in.

7. Use OLS to calculate the coefficient estimates in this model.

```
fit2 <- lm(bwt ~ smoke + age + as.factor(race), data=birthwt)
summary(fit2)
```

8. Interpret all the coefficient estimates.

- $\hat{\beta}_0$: The estimated mean birthweight is 3281.7 among non-smoking mother's with age 0 and white race
- $\hat{\beta}_1$: The estimated mean birthweight among smokers is 426.09 grams less than among non-smokers, holding all other variables constant.
- $\hat{\beta}_2$:

- $\hat{\beta}_3$: The estimated mean birthweight among black mothers is 444.069 grams less than among white mothers, holding all other variables constant
- $\hat{\beta}_4$:The estimated mean birthweight among mothers of race other than black or white is 447.86 grams less than among white mothers, holding all other variables constant

9. Print the results in Rmarkdown using kable().

```
table <- data.frame(summary(fit2)$coef)
row.names(table) <- c("Intercept","Smoker","Age","Black vs. white", "Other vs. white")

kable(table,digits=3,align=rep('c', 2),
      col.names = c("estimate","standard error","test statistic","p-value"))
```

Group Exercises

From the course website, load the North Carolina infant mortality dataset. This contains information on all 225,152 births in North Carolina from 2003-2004.

```
# This command will only run if this dataset is saved in your R working directory
load("infants.dat")
```

Group 1

The goal of this exercise is to emulate "sampling" from this North Carolina birth population and see how variability in our estimates will change with sample size.

1. You are interested in how maternal age affects birthweight. Write the form of the linear regression model.
2. Take a sample of size $n = 100$ from this population, fit the linear regression from part 1 and extract the coefficient estimate for gestational age, i.e. $\hat{\beta}_1$.
3. Repeat part 2 $b = 500$ times and plot the estimated coefficients in a histogram.
4. For the following sample sizes, $N = \{25, 50, 100, 500, 1000, 5000, 10000\}$, repeat questions 2-3. Save in a dataframe so you can plot your results.
5. Find a creative way to plot your results, and include some reference to the population β_1. Interpret these results.
6. If you had instead extracted the standard error estimate for maternal age, what would you expect to happen?
7. Confirm your intuition by repeating this procedure again for the standard error of the beta coefficient estimate at various sample sizes.

Group 2

The purpose of this exercise is to practice working with regression models with interaction terms.

1. Take a random sample of size 10,000 from the NC dataset to work with for this problem. Make sure everyone in your group uses the same seed, so that you draw the same sample.
2. For this problem, you will be working with the following model where Y is birth weight, X_1 is weight gain during pregnancy and X_2 is smoking. What does β_3 represent? Why might this be of interest?

$$E[Y|X_1, X_2] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 X_2$$

3. Create a scatter plot of maternal weight gain and birth weight. Color observations according to smoking status.
4. Use the expression $\hat{\beta}$ given in the slides to find the estimates of the coefficients. Note: for this question, you will need to create the "design" matrix, $\mathbf{X}$.
5. Fit this regression using the lm() function. How does this compare with the results from part 4?
6. Interpret the coefficients for weight gain and smoker. Be as precise as possible.
7. Plot the regression line for smokers and non-smokers on part 3. Hint: use stat_function() in gpplot and define your own function.
8. Do you see large differences in the slopes of these lines? Which p-value in the regression output formally tests this? Does this align with your expectations?