

Problem Set 2

QTM 200: Applied Regression Analysis

Due: February 10, 2020

Instructions

- Please show your work! You may lose points by simply writing in the answer. If the problem requires you to execute commands in `R`, please include the code you used to get your answers. Please also include the `.R` file that contains your code. If you are not sure if work needs to be shown for a particular problem, please ask.
- Your homework should be submitted electronically on the course GitHub page in `.pdf` form.
- This problem set is due at the beginning of class on Monday, February 10, 2020. No late assignments will be accepted.
- Total available points for this homework is 100.

Question 1 (40 points): Political Science

The following table was created using the data from a study run in a major Latin American city.¹ As part of the experimental treatment in the study, one employee of the research team was chosen to make illegal left turns across traffic to draw the attention of the police officers on shift. Two employee drivers were upper class, two were lower class drivers, and the identity of the driver was randomly assigned per encounter. The researchers were interested in whether officers were more or less likely to solicit a bribe from drivers depending on their class (officers use phrases like, “We can solve this the easy way” to draw a bribe). The table below shows the resulting data.

¹Fried, Lagunes, and Venkataramani (2010). “Corruption and Inequality at the Crossroad: A Multi-method Study of Bribery and Discrimination in Latin America. *Latin American Research Review*. 45 (1): 76-97.

	Not Stopped	Bribe requested	Stopped/given warning
Upper class	14	6	7
Lower class	7	7	1

(a) Calculate the χ^2 test statistic by hand (even better if you can do "by hand" in R).

```

1 #Create the table
2 data1 <- c(14, 6, 7, 7, 7, 1)
3 bribe <- as.table(matrix(data1, nrow = 2, ncol = 3, byrow = T))
4 rownames(bribe) <- c("Upper class", "Lower class")
5 colnames(bribe) <- c("not-stopped", "bribe requested", "stopped/given
  warnings")
6 bribe
7 #Calculate expected values
8 addmargins(bribe)
9 Expected_Value <- c(27*21/42, 27*13/42, 27*8/42, 15*21/42, 15*13/42, 15*8
  /42)
10 Expected_Value
11 #Calculate chi-square statistics

```

(b) Now calculate the p-value (in R).² What do you conclude if $\alpha = .1$?

```

1 #Calculate the p-value
2 p_value <- pchisq(3.791168, df = 2, lower.tail = FALSE)
3 p_value#[1] 0.1502306 > alpha = 0.1
4 #We therefore cannot reject the null hypothesis and conclude that whether
  officers were more likely to solicit a bribe from drivers are not
  independent from their classes
5
6 #Check with R
7 chisq.test(bribe, correct = TRUE)#same result

```

²Remember frequency should be > 5 for all cells, but let's calculate the p-value here anyway.

(c) Calculate the standardized residuals for each cell and put them in the table below.

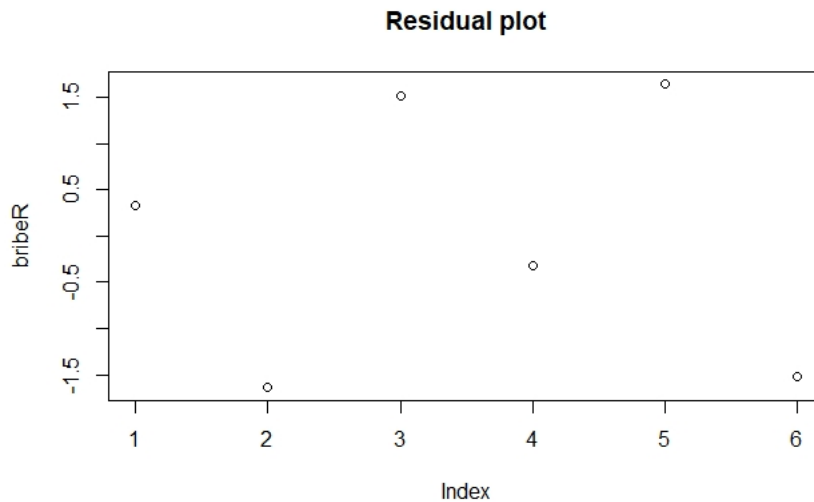
	Not Stopped	Bribe requested	Stopped/given warning
Upper class	0.326	-1.642	1.523
Lower class	-0.322	1.642	-1.523

```

1 #Calculate standardized(adjusted) residuals
2 row.prop <- c(27/42, 27/42, 27/42, 15/42, 15/42, 15/42)
3 col.prop <- c(21/41, 13/42, 8/42, 21/42, 13/42, 8/42)
4 bribeR <- c((data1-Expected_Value)/sqrt(Expected_Value*(row.prop-1)*(col.
   prop-1)))
5 #View standardized residuals
6 plot(bribeR, main = "Residual plot")
7 mean(bribeR)#[1] 0.0006666667
8 #reported it in a table
9 bribeR <- as.table(matrix(round(bribeR, digits = 3), nrow = 2, ncol = 3,
   byrow = T))
10 rownames(bribeR) <- c("Upper class", "Lower class")
11 colnames(bribeR) <- c("not-stopped", "bribe requested", "stopped/given
   warnings")
12 bribeR

```

(d) How might the standardized residuals help you interpret the results?



Since our residuals are relatively large and evenly distributed, we cannot discern a significant difference between our observed value and expected value, however to make sure of the lack of dependency we have to do a chi-sqr test.

Question 2 (20 points): Economics

Chattopadhyay and Duflo were interested in whether women promote different policies than men.³ Answering this question with observational data is pretty difficult due to potential confounding problems (e.g. the districts that choose female politicians are likely to systematically differ in other aspects too). Hence, they exploit a randomized policy experiment in India, where since the mid-1990s, $\frac{1}{3}$ of village council heads have been randomly reserved for women. A subset of the data from West Bengal can be found at the following link: <https://raw.githubusercontent.com/kosukeimai/qss/master/PREDICTION/women.csv>

Each observation in the data set represents a village and there are two villages associated with one GP (i.e. a level of government is called "GP"). Figure 1 below shows the names and descriptions of the variables in the dataset. The authors hypothesize that female politicians are more likely to support policies female voters want. Researchers found that more women complain about the quality of drinking water than men. You need to estimate the effect of the reservation policy on the number of new or repaired drinking water facilities in the villages.

Figure 1: Names and description of variables from Chattopadhyay and Duflo (2004).

Name	Description
GP	An identifier for the Gram Panchayat (GP)
village	identifier for each village
reserved	binary variable indicating whether the GP was reserved for women leaders or not
female	binary variable indicating whether the GP had a female leader or not
irrigation	variable measuring the number of new or repaired irrigation facilities in the village since the reserve policy started
water	variable measuring the number of new or repaired drinking-water facilities in the village since the reserve policy started

³Chattopadhyay and Duflo. (2004). "Women as Policy Makers: Evidence from a Randomized Policy Experiment in India. *Econometrica*. 72 (5), 1409-1443.

- (a) State a null and alternative (two-tailed) hypothesis.

Our null hypothesis is:

There's no association between whether a village have female leaders position reserved or not and the number of new or repaired drinking water facilities in that village

Our alternative hypothesis is:

There's an association between whether a village have female leaders position reserved or not and the number of new or repaired drinking water facilities in that village

- (b) Run a bivariate regression to test this hypothesis in R (include your code!).

```
1 #Import dataset
2 data2 <- read.csv("https://raw.githubusercontent.com/kosukeimai/qss/
  master/PREDICTION/women.csv", header = T)
3 summary(data2)
4 #correlation testing on regression model between reserved and water
5 lm1 <- lm(data2$water~data2$reserved)
6 summary(lm1)
7 cor.test(data2$water, data2$reserved)
8 #Test shows that we can reject the null hypothesis and conclude that
  there is an significant correlation between whether a village have
  female leaders position reserved or not and the number of new or
  repaired drinking water facilities in that village
9 #Coefficient estimate is 9.252, which means that for each unit increase
  in reserved female positions, there will be 9.252 more repaired or new
  drinking water facilities
```

- (c) Interpret the coefficient estimate for reservation policy.

Coefficient estimate is 9.252, which means that for each unit increase in reserved female positions, there will be 9.252 more repaired or new drinking water facilities

Question 3 (40 points): Biology

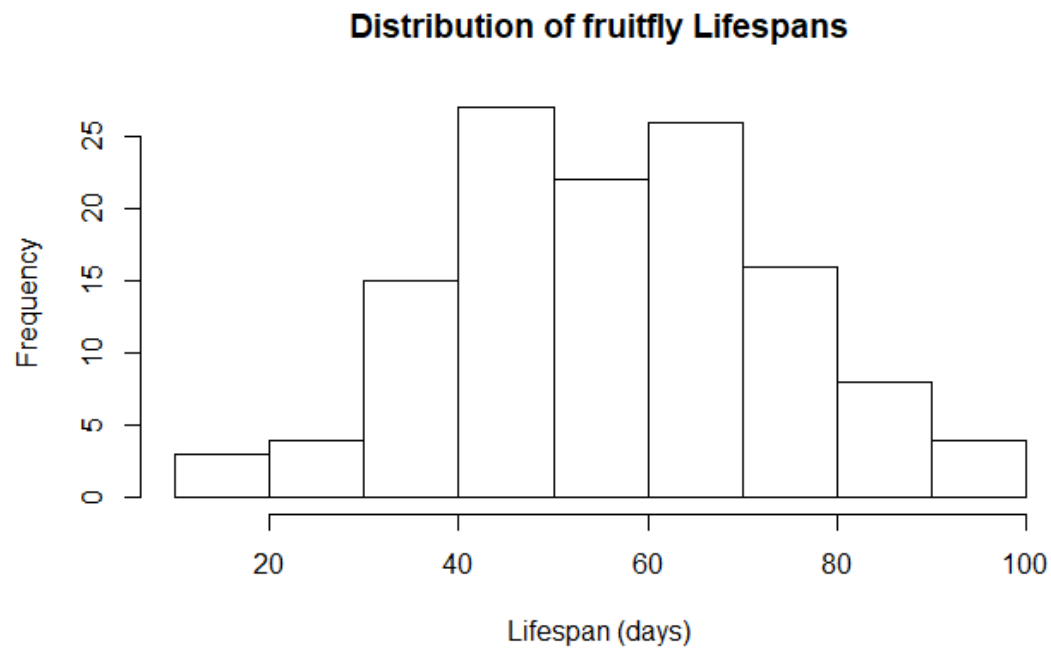
There is a physiological cost of reproduction for fruit flies, such that it reduces the lifespan of female fruit flies. Is there a similar cost to male fruit flies? This dataset contains observations from five groups of 25 male fruit flies. The experiment tests if increased reproduction reduces longevity for male fruit flies. The five groups are: males forced to live alone, males assigned to live with one or eight newly pregnant females (non-receptive females), and males assigned to live with one or eight virgin females (interested females). The name of the data set is `fruitfly.csv`.⁴

<code>No</code>	serial number (1-25) within each group of 25
<code>type</code>	Type of experimental assignment 1 = no females 2 = 1 newly pregnant female 3 = 8 newly pregnant females 4 = 1 virgin female 5 = 8 virgin females
<code>lifespan</code>	lifespan (days)
<code>thorax</code>	length of thorax (mm)
<code>sleep</code>	percentage of each day spent sleeping

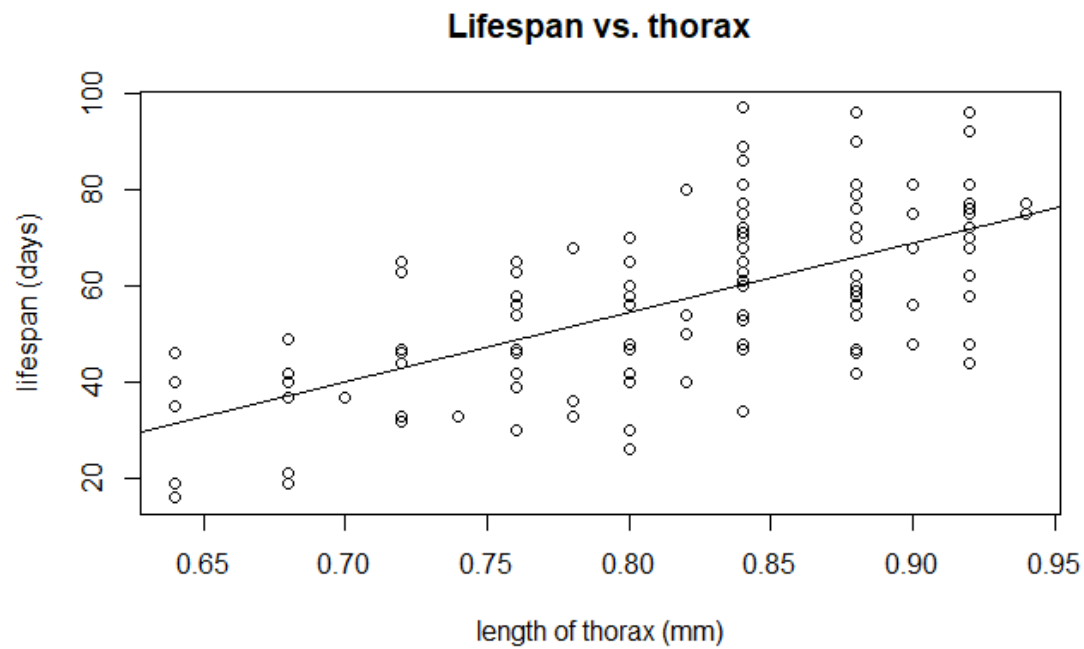
1. Import the data set and obtain summary statistics and examine the distribution of the overall lifespan of the fruitflies.

```
1 #Import dataset
2 data3 <- read.csv("fruitfly.csv", header = T)
3 summary(data3) #25 flies, mean lifespan = 57.44
4 #View the distribution of lifespan
5 hist(data3$lifespan, main = "Distribution of fruitfly Lifespans", xlab =
  "Lifespan (days)") #Approximately normal
```

⁴Partridge and Farquhar (1981). "Sexual Activity and the Lifespan of Male Fruitflies". *Nature*. 294, 580-581.



2. Plot `lifespan` vs `thorax`. Does it look like there is a linear relationship? Provide the plot. What is the correlation coefficient between these two variables?



```

1 #Plot lifespan and thorax and calculate the correlation coefficient
2 plot(data3$lifespan~data3$thorax, main="Lifespan vs. thorax", xlab ="
   length of thorax (mm)", ylab ="lifespan (days)" )
3 #The distribution can be discribed as a positive linear association
4 cor(data3$lifespan , data3$thorax)#[1] 0.6364835
5 #correlation coefficient is closer to 1, which means it is a fairly high
   positive correlation

```

3. Regress lifespan on thorax. Interpret the slope of the fitted model.

```

1 #Linear regression
2 y <- data3$lifespan
3 x <- data3$thorax
4 lm2 <- lm(y~x)
5 summary(lm2)
6 abline(lm2)

```

Coefficients:

Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-61.05	13.00	-4.695 7.0e-06 ***
data3\$thorax	144.33	15.77	9.152 1.5e-15 ***

Residual standard error: 13.6 on 123 degrees of freedom

Multiple R-squared: 0.4051, Adjusted R-squared: 0.4003

F-statistic: 83.76 on 1 and 123 DF, p-value: 1.497e-15

4. Test for a significant linear relationship between lifespan and thorax. Provide and interpret your results of your test.

Pearson's product-moment correlation

data: data3\$lifespan and data3\$thorax

t = 9.1521, df = 123, p-value = 1.497e-15

alternative hypothesis: true correlation is not equal to 0

95 percent confidence interval:

0.5188709 0.7304479

sample estimates:

cor

0.6364835

```

1 #test for the significance of the correlation
2 cor.test(y, x)

```



```
3 #p-value = 1.497e-15, which is highly significant at a 95% confidence  
   level, we can therefore reject the null hypothesis and conclude that  
   the correlation between lifespan and thorax is significant
```

5. Provide the 90% confidence interval for the slope of the fitted model.

- Use the formula for typical confidence intervals to find the 90% confidence interval around the point estimate.

```
1 #90% confidence interval for the slope of the model
2 #Method 1
3 confint <- c(144.33-15.77*qt(0.90, df = 123), 144.33+15.77*qt(0.90,
4   df = 123))
5 confint
```

The resulting confidence interval is (124.0108, 164.6492)

- Now, try using the function `confint()` in R.

```
1 #Method 2
2 confint(lm2, "x", level = 0.90)
```

6. Use the `predict()` function in R to (1) predict an individual fruitfly's lifespan when `thorax=0.8` and (2) the average lifespan of fruitflies when `thorax=0.8` by the fitted model. This requires that you compute prediction and confidence intervals. What are the expected values of lifespan? What are the prediction and confidence intervals around the expected values?

```
1 #predict a lifespan of a individual fruit fly
2 predicted_lifespan <- 0.8*144.33-61.05
3 predicted_lifespan #[1] 54.414
4 #predict the average lifespan for thorax = 0.8 and the respective
   confidence interval
5 predict(lm2, newdata=data.frame(x=0.8), df = 123, interval = "confidence"
6   , level = 0.90)
```

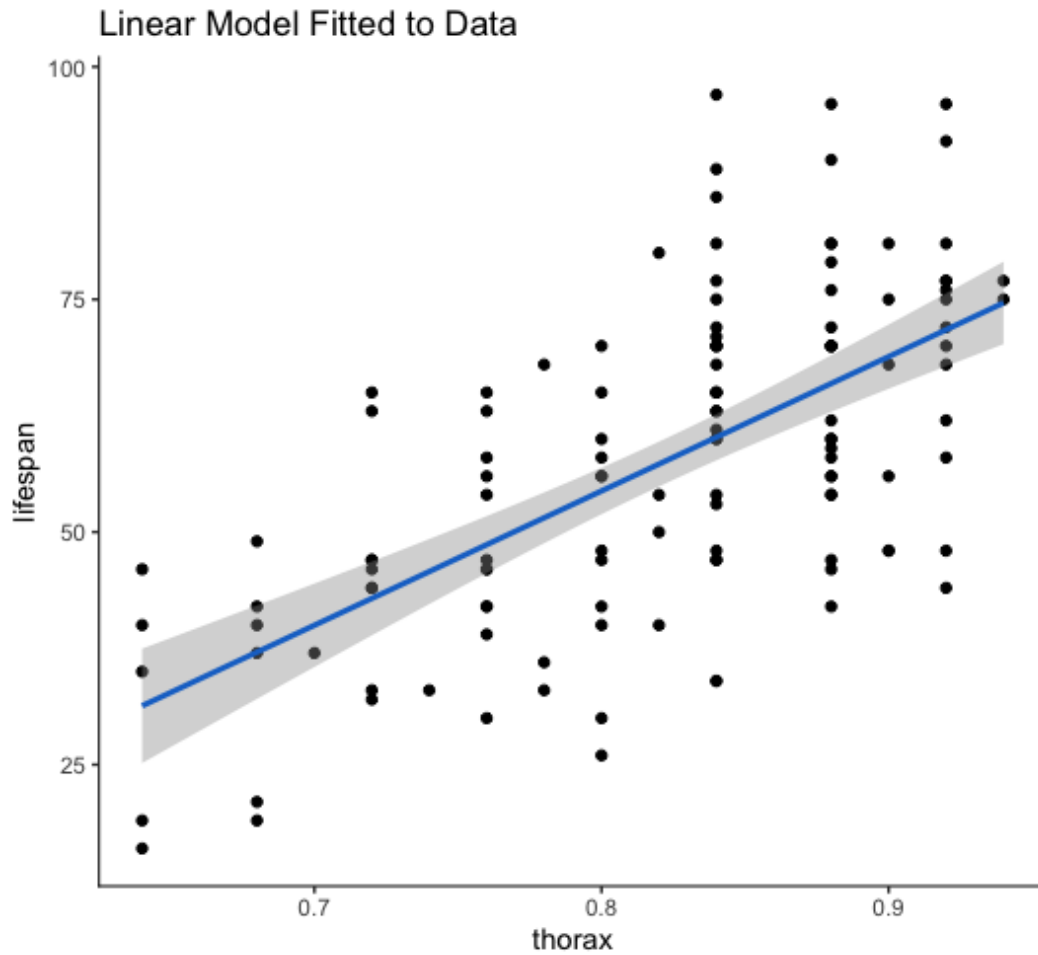
Result:

fit	lwr	upr
54.41478	52.32539	56.50416

The expected lifeline is around 54 days and the confidence interval is (52.34, 56.50)

7. For a sequence of `thorax` values, draw a plot with their fitted values for `lifespan`, as well as the prediction intervals and confidence intervals.

```
1 #plot the fitted lifespan for a sequence of thorax values
2 install.packages("ggplot2")
3 library(ggplot2)
```



```
4 ggplot(data = data3, aes(x = thorax, y = lifespan)) +  
5   geom_point() +  
6   stat_smooth(method = "lm", col = "dodgerblue3") +  
7   theme(panel.background = element_rect(fill = "white"),  
8         axis.line.x=element_line(),  
9         axis.line.y=element_line()) +  
10  ggtitle("Linear Model Fitted to Data")
```