R Tutorial for STAT 350 for Lab 9

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Example: (Data Set: loc.txt)

Job Stress and Locus of Control Many factors, such as the type of job, education level, and job experience, can affect the stress felt by workers on the job. Locus of control (LOC) is a term in psychology that describes the extent to which a person believes he or she is in control of the events that influence his or her life. Is feeling “more in control” associated with less job stress? A recent study examined the relationship between LOC and several work-related behavioral measures among certified public accountants in Taiwan. LOC was assessed using a questionnaire that asked respondents to select one of two options for each of 23 items. Scores ranged from 0 to 23. Individuals with low LOC believe that their own behavior and attributes determine their rewards in life. Those with high LOC believe that these rewards are beyond their control. Each accountant’s job stress was assessed using the averaged score on 22 items, each scored on a five-point scale. The higher the score, the higher the perceived job stress. We will consider a random sample of 100 accountants.

a) Make a scatterplot of the data (including the least squares regression line) with LOC on the x axis and Stress on the Y axis. Briefly describe the relationship between the job stress and LOC.
b) Compute the correlation coefficient between Stress vs. LOC.
c) Find the equation of the least-squares regression line for predicting Stress from LOC.
d) What is r^2 for these data?
e) Plot the residuals versus LOC. Is there anything unusual to report? Please explain.
f) Do the residuals appear to be approximately Normal? Explain your answer.
g) Based on your answers for parts (a), (e) and (f), do the assumptions for the linear regression analysis appear reasonable? Explain your answer.
h) Construct and interpret the 95% confidence intervals for the slope and y-intercept.
i) Is Job Stress associated with LOC? Carry out a test of significance on the slope. State hypotheses, give a test statistic and *p*-value, and state your conclusion.
j) Briefly summarize what your data analysis shows.

Solution:

```
job <- read.table(file = "loc.txt", header = TRUE)#(a) Scatterplot
#
# This data does not need to be subsetted in any way, but we will show
# you how subset such that only a specific range of values remains in
# the data
job.subset <- subset(job, 0 < job$STRESS & job$STRESS < 5)
#
# (a) Scatterplot
#
library(ggplot2)
windows()
ggplot(job.subset, aes(x=LOC, y=STRESS))+
  geom_point(shape = 1) +
  geom_smooth(method = lm, se = FALSE) +
  ggtitle("Relationship between stress and locus") +
  xlab("Locus") +
  ylab("Stress")
```

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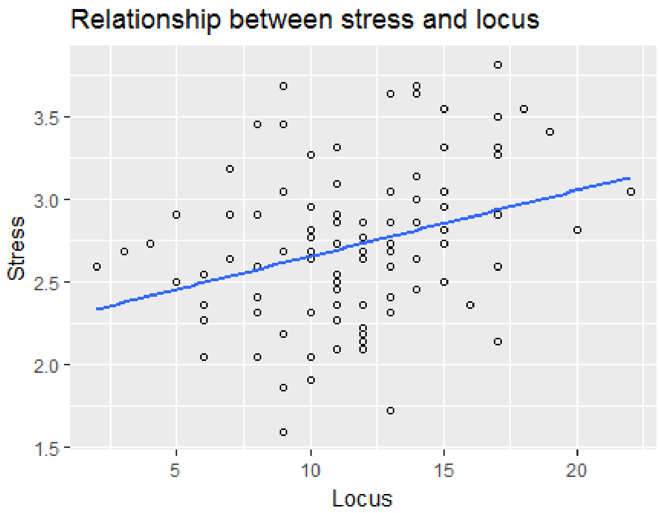
```
#
#  (b) Correlation
#
cor(job.subset$LOC, job.subset$STRESS)
#
#c), d), i) calculate linear regression and get results
#
job.lm <- lm(STRESS ~ LOC, data = job.subset)
summary(job.lm)
#
#e) scatterplot the residuals
#
windows()
ggplot(data.frame(residuals=job.lm$res, LOC=job.subset$LOC), aes(x=LOC,
y=residuals))+
  geom_point(shape = 1) +
  geom_smooth(method = lm, se = FALSE) +
  ggtitle("Residual Plot") +
  xlab("Locus") +
  ylab("Residuals")
#
#f) = histogram of the residuals and qq plot of the residuals
#    code is not provided. This is the same as before with the
#    variable of job.lm$res. Remember to define xbar and s.
#h) Generate the 2-sided Confidence Interval (CI) for the parameters
confint(job.lm, level = 0.95)
```

a) Make a scatterplot of the data (including the least squares regression line). Briefly describe the relationship between the job stress and LOC.



The plot looks linear with a positive direction. I am not sure about the strength because the scale on the y-axis is so small. I do not see any outliers.

b) Compute the correlation coefficient between Stress vs. LOC.

```
> cor(job.subset$LOC, job.subset$STRESS)
[1] 0.3122765
```

The correlation coefficient between Stress vs. LOC is 0.3122765.
This looks like there is a weak but nonnegligible association between Stress and LOC.

c) Find the equation of the least-squares regression line for predicting Stress from LOC.

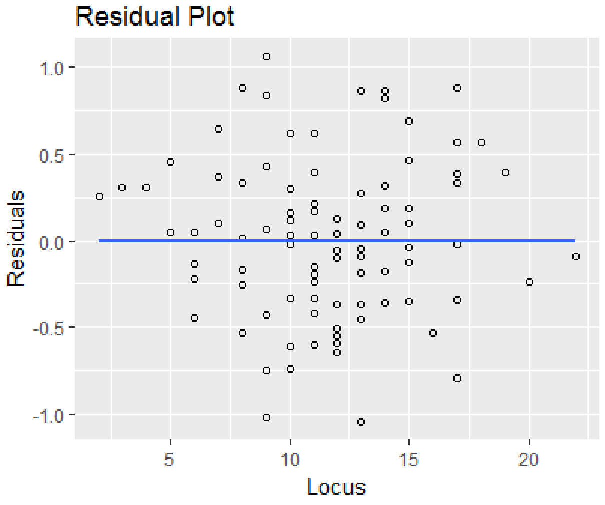
```
Call:
lm(formula = STRESS ~ LOC, data = job.subset)

Residuals:
     Min       1Q   Median       3Q      Max
-1.04704 -0.33806  0.02169  0.30798  1.06715

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.25550    0.14691  15.353  < 2e-16 ***
LOC          0.03991    0.01226   3.254  0.00156 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4513 on 98 degrees of freedom
Multiple R-squared:  0.09752,  Adjusted R-squared:  0.08831
F-statistic: 10.59 on 1 and 98 DF,  p-value: 0.001562
```

Stress = 2.25550 + 0.03991 LOC

d) What is r^2 for these data?

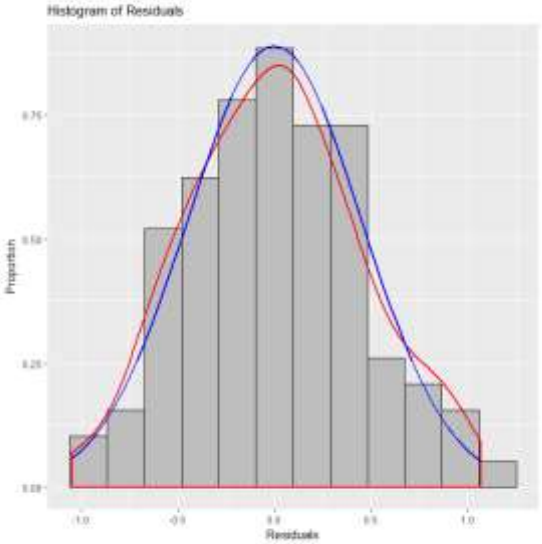
r^2 = 0.09752
This does not look very good.

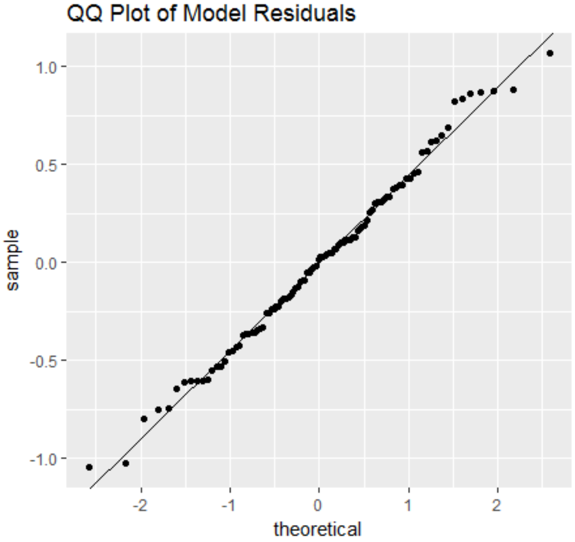
e) Plot the residuals versus LOC. Is there anything unusual to report? Please explain.



I see no pattern here so the association seems to be linear. There is a possibility that the standard deviation is not constant, but that could be due to the fact that there are only a few points at higher and lower ranges, making it harder to assess the true variability. I do not see any outliers.

f) Do the residuals appear to be approximately Normal? Explain your answer.





It looks like the residuals are normal because on the QQ plot the points are close to the line without systematic deviation. The histogram reveals a symmetric, unimodal pattern, and the and the blue/red lines on the histogram seems to be close.

g) Based on your answers for parts (a), (e) and (f), do the assumptions for the linear regression analysis appear reasonable? Explain your answer.

Assuming that we have an SRS, the three other assumptions are met; linear, constant standard deviation of the residuals and normality of the residuals, therefore linear regression analysis appears to be reasonable.

h) Construct and interpret the 95% confidence intervals for the slope and y-intercept.

```
                  2.5 %     97.5 %
(Intercept) 1.96395317 2.54704023
LOC         0.01557099 0.06424615
```

Slope:
95% CI (0.01557099, 0.06424615)
We are 95% confident that the population slope of Stress vs. LOC is covered by the interval over 0.01557 to 0.06425.

Note that the slope is indicated by the x variable in the output.

Intercept:
95% CI (1.96395317, 2.54704023)
We are 95% confident that the population y-intercept of Stress vs. LOC is covered by the interval 1.96395317 to 2.54704023.

i) Is Job Stress associated with LOC? Carry out a test of significance on the slope. State hypotheses, give a test statistic and *p*-value, and state your conclusion.

You do not need to repeat the output. I am doing it so that I can indicate what values that I am using for this part.

```
Call:
lm(formula = STRESS ~ LOC, data = job.subset)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.04704 -0.33806  0.02169  0.30798  1.06715 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  2.25550    0.14691  15.353  < 2e-16 ***
LOC          0.03991    0.01226   3.254  0.00156 ** 
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4513 on 98 degrees of freedom
Multiple R-squared:  0.09752,	Adjusted R-squared:  0.08831 
F-statistic: 10.59 on 1 and 98 DF,  p-value: 0.001562
```

Step 1: Definition of the terms

β_1 is the population slope

Step 2: State the hypotheses

H_0: $\beta_1 = 0$

H_a: $\beta_1 \neq 0$

Step 3: Find the *Test Statistic, p-value, report DF*

$t_{ts} = 3.254$
DF = 98
P-value = 0.00156
(Note that the F test statistic = 10.59 = 3.254^2 and the P-values are identical)

Step 4: Conclusion:

$\alpha = 0.05$
Since $0.00156 \leq 0.05$, we should reject H_0
The data provides evidence (p-value = 0.00156) to the claim that there is an association between job stress and LOC.

j) Briefly summarize what your data analysis shows.

Assuming that the standard deviation is close to being constant, the assumptions are met. The data shows that there is an association between Stress and LOC. However, the small values of r and r^2 indicate that the association is weak. Therefore, there the study shows that there is a slight association, but prediction is not recommended because of the small value of r^2.