Learning Guide: Calculating Confidence Intervals for Regression Coefficients in R

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In a linear regression model, a regression coefficient tells us the average change in the associated with a one unit increase in the predictor variable.

We can use the following formula to calculate a confidence interval for a regression coefficient:

Confidence Interval for β1: b1 ± t1-α/2, n-2 * se(b1)

where:

b1 = Regression coefficient shown in the regression table
t1-∝/2, n-2 = The t critical value for confidence level 1-∝ with n-2 degrees of freedom where *n* is the total number of observations in our dataset
se(b1) = The standard error of b1 shown in the regression table

The following example shows how to calculate a confidence interval for a regression slope in practice.

Example: Confidence Interval for Regression Coefficient in R

Suppose we'd like to fit a simple linear regression model using **hours studied** as a predictor variable and **exam score** as a response variable for 15 students in a particular class:

Hours Studied	Exam Score
1	64
2	66
4	76
5	73
5	74
6	81
6	83
7	82
8	80
10	88
11	84
11	82
12	91
12	93
14	89

We can use the function to fit this simple linear regression model in R:

```
#create data frame
df <- data.frame(hours=c(1, 2, 4, 5, 5, 6, 6, 7, 8, 10, 11, 11, 12, 12, 14),
score=c(64, 66, 76, 73, 74, 81, 83, 82, 80, 88, 84, 82, 91, 93, 89))

#fit linear regression model
fit <- lm(score ~ hours, data=df)

#view model summary
summary(fit)

Call:
lm(formula = score ~ hours, data = df)

Residuals:
Min 1Q Median 3Q Max
-5.140 -3.219 -1.193 2.816 5.772

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 65.334 2.106 31.023 1.41e-13 ***
hours 1.982 0.248 7.995 2.25e-06 ***
---
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.641 on 13 degrees of freedom
Multiple R-squared: 0.831, Adjusted R-squared: 0.818
F-statistic: 63.91 on 1 and 13 DF, p-value: 2.253e-06
```

Using the coefficient estimates in the output, we can write the fitted simple linear regression model as:

Score = 65.334 + 1.982*(Hours Studied)

Notice that the regression coefficient for hours is **1.982**.

This tells us that each additional one hour increase in studying is associated with an average increase of **1.982** in exam score.

We can use the **confint()** function to calculate a 95% confidence interval for the regression coefficient:

```
#calculate confidence interval for regression coefficient for 'hours'
```

confint(fit, 'hours', level=0.95)

2.5 % 97.5 %
hours 1.446682 2.518068

Since this confidence interval doesn't contain the value 0, we can conclude that there is a statistically significant association between hours studied and exam score.

We can also confirm this is correct by calculating the 95% confidence interval for the regression coefficient by hand:

95% C.I. for β1: b1 ± t1-α/2, n-2 * se(b1)
95% C.I. for β1: 1.982 ± t.975, 15-2 * .248
95% C.I. for β1: 1.982 ± 2.1604 * .248
95% C.I. for β1:

The 95% confidence interval for the regression coefficient is .

Note #1: We used the to find the t critical value that corresponds to a 95% confidence level with 13 degrees of freedom.

Note #2: To calculate a confidence interval with a different confidence level, simply change the value for the **level** argument in the **confint()** function.

Additional Resources

The following tutorials provide additional information about linear regression in R: