

# Problem Set Example

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Imagine that you are provided a sample of data and asked to estimate the linear regression model  $y_i = \alpha + \beta x_i + \epsilon_i$  (or, in equivilant notation,  $y_i = \beta_0 + \beta_1 x_i + \epsilon_i$ ).

Let us say that these data contain 20 observations for two variables:

`Leg_Act`  $\in \{-20, 40\}$  is the legislative activity of state assembly members, where -20 is no significant legislative activity and 40 is the maximum level of activity. This is the dependent variable,  $Y$ , with each observation being a  $y_i$ .

`terms` is the number of terms in office. This is your explanatory variable,  $X$ , with each observation being a  $x_i$ .

You have a number of tasks:

1. Plot the dependent variable against the explanatory variable.
2. Estimate the parameters  $\alpha$  and  $\beta$ .
3. Compute the residuals (the difference between the observed values of the dependent variable and the predicted values from the estimated linear model (i.e. the distance of each observed  $x_i$  from the regression line).
4. Plot the residuals against the explanatory variable.
5. Correlate the observed values of the dependent variable  $Y$  (the vector of each  $y_i$ ) with the predicted values  $\hat{Y}$
6. Compare the square of this correlation (between the observed values of  $Y$  and predicted  $\hat{Y}$ ) to the model  $R^2$ .
7. Test the null hypothesis that  $\beta = 0$  against an alternative that  $\beta \neq 0$ .
8. Write a paragraph (double-spaced) interpreting the parameters and explaining the results of your hypothesis test.

**But**, for whatever reason, you want to do your problem set in R. R Markdown offers an easy way to do this without cutting and pasting. If you accidentally regressed  $X$  on  $Y$  rather than  $Y$  on  $X$ , fix the model and **pow**, your plots and estimates cited in your discussion are instantly corrected.

- Here is the RMarkdown template that made this pdf. Save it as a .Rmd file.
- Here is a pdf about writing in RMarkdown

**But** the data are in STATA!?!

No problem. R can read .dta files.

In STATA, save the data generated by the `PS813_EX1` function with your seed:

```
net install PS813_EX1, from(https://faculty.polisci.wisc.edu/weimer/)
```

```
PS813_EX1 yourseed
```

```
save "EX1.dta"
```

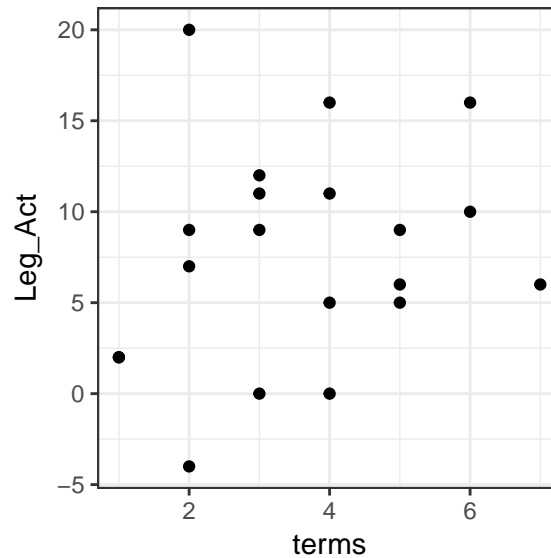
Then load it into R with the `readstata13` package:

```
## Load your data, defining an R object called "d"
## Short names are easier to work with, but if we were saving these data, we might call the
d <- readstata13::read.dta13("data/EX1.dta")
```

Now on to the tasks:

## 1. A plot of Legislative Activity by Terms in Office

```
## STATA: plot Leg_Act terms
## R:
ggplot(d, aes(y = Leg_Act, x = terms)) +
  geom_point()
```



```
## STATA: corr Leg_Act terms
## R:
cor(d$Leg_Act, d$terms)
```

```
## [1] 0.2215867
```

## 2. Estimating linear regression

```
## STATA: regress Leg_Act terms
## R:
model <- lm(d$Leg_Act ~ d$terms)
# summary(model)
alpha <- model$coefficients[1]
beta <- model$coefficients[2]
```

Regression coefficients:  $\alpha = 4.7883212$  and  $\beta = 0.7810219$

## 3. Computing residuals

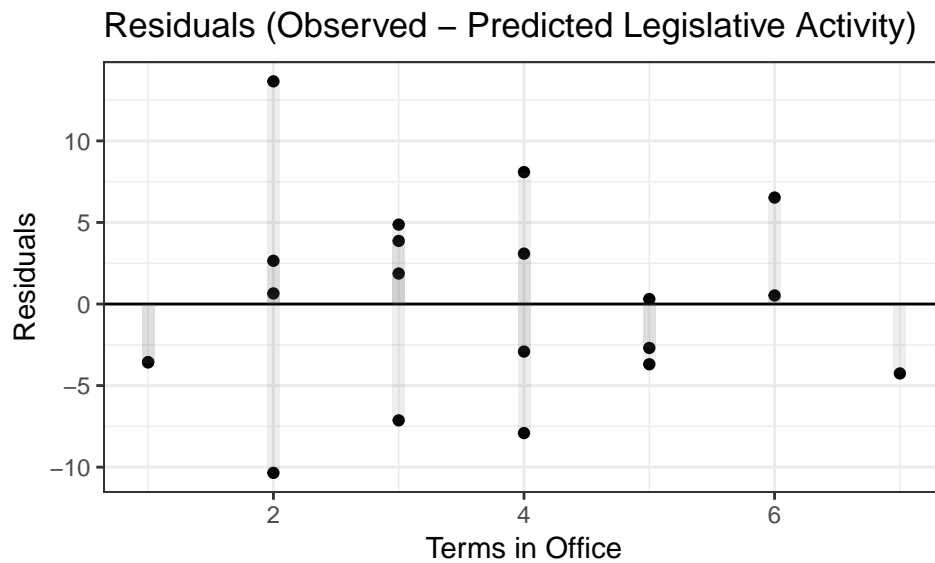
```
## STATA: predict p_Leg_Act
## R:
p_Leg_Act <- predict(model)

## STATA: generate resid = Leg_Act - p_Leg_Act
```

```
## R:
resid <- d$Leg_Act - p_Leg_Act
```

## 4. Plot of Residuals

```
## STATA: plot resid terms
## R:
ggplot(d, aes(y = resid, x = terms)) +
  geom_point() +
  ## + some extra stuff:
  geom_hline(yintercept = 0) +
  geom_col(alpha = .1, width = .1, position = "dodge") +
  labs(title = "Residuals (Observed - Predicted Legislative Activity)",
        x = "Terms in Office",
        y = "Residuals")
```



## 5. $Cor(Y, \hat{Y})$

```
## STATA: corr Leg_Act p_Leg_Act
## R:
correlation <- cor(d$Leg_Act, p_Leg_Act)
correlation
```

```
## [1] 0.2215867
```

$Cor(Y, \hat{Y}) = 0.2215867$

## 6. $Cor(Y, \hat{Y})^2$ vs. $R^2$ .

```
## STATA: generate r2 =r(rho)*r(rho)
## R:
r2 <- summary(model)$r.squared
```

$R^2 = 0.0491007$

## 7. Hypothesis test

Lorem ipsum  $\beta = 0$

Lorem ipsum  $\beta \neq 0$

## 8. Discussion

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