14.8 Appendix: R Output for the Samara Example

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In this appendix we will briefly illustrate some of the regression commands available in R by using the samara data and the `lm` command. Note that `lm` allows for the possibility of having several predictors. This is important in multiple regression, a topic we will not pursue in this chapter.

We have entered the data with x in column `V1` and y in column `V2`.

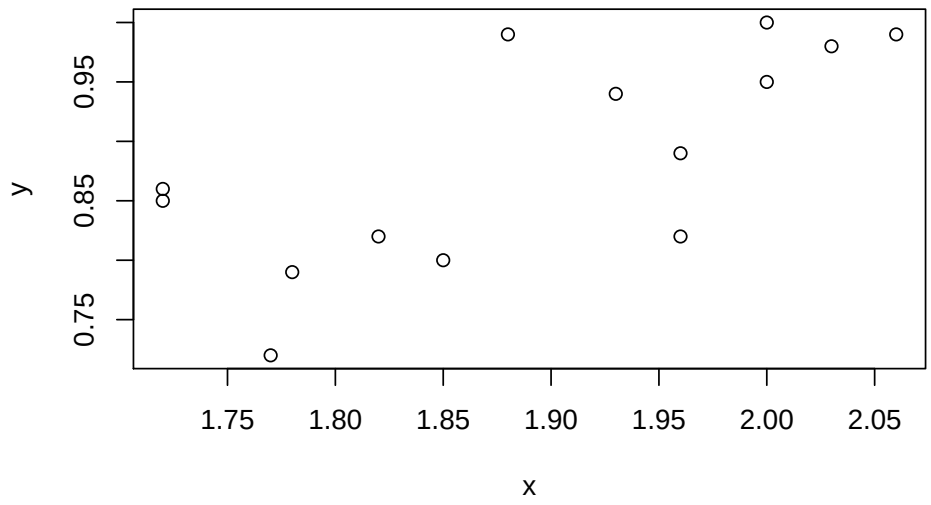
```
> samara = read.table("http://www.stat.wisc.edu/~st571-1/data/samara.dat")
> x = samara$V1
> y = samara$V2
```

Alternatively, you can enter data as we have sometimes done:

```
> x = c(1.72, 1.72, 1.77, 1.78, 1.82, 1.85, 1.88, 1.93, 1.96, 1.96,
+     2, 2, 2.03, 2.06)
> y = c(0.85, 0.86, 0.72, 0.79, 0.82, 0.8, 0.99, 0.94, 0.82, 0.89,
+     0.95, 1, 0.98, 0.99)
```

The R command `plot` produces a scatterplot of y versus x. The line

```
> plot(x, y)
```



To regress y on x, we proceed as follows:

```
> samara.lm = lm(y ~ x)
> summary(samara.lm)

Call:
lm(formula = y ~ x)

Residuals:
     Min       1Q   Median       3Q      Max
-0.10345 -0.03416  0.00803  0.04917  0.11057

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.1551     0.2992  -0.518  0.61355
x             0.5503     0.1579   3.485  0.00451 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.06605 on 12 degrees of freedom
Multiple R-Squared: 0.503,        Adjusted R-squared: 0.4616
F-statistic: 12.14 on 1 and 12 DF,  p-value: 0.004506

> anova(samara.lm)

Analysis of Variance Table

Response: y
          Df   Sum Sq  Mean Sq F value   Pr(>F)
x          1 0.052985 0.052985  12.144 0.004506 **
Residuals 12 0.052357 0.004363
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

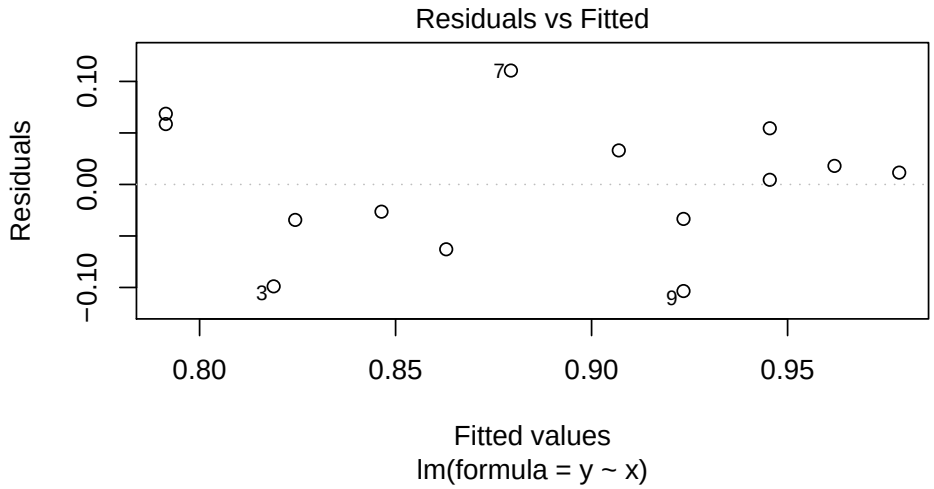
The object `samara.lm` contains all the information about the regression fit. The `summary` command provides the form of the regression equation, the estimates of the intercept "`(Intercept)`" and slope ("`x`"). Also provided are the estimated standard deviations ("`Std. Error`") of these quantities, T values corresponding to $H_0 : b_0 = 0$ and $H_0 : b_1 = 0$, and p-values for these tests. R then prints an estimate of σ_e and R^2. The notation `Adjusted R-squared` refers to an adjusted version of R^2 important in multiple regression. Finally, the `anova` produces the ANOVA table for the regression, including the F value and p-value for $H_0 : b_1 = 0$.

You can add the regression line to the data plot using the following command. However, we will not show the plot here.

```
> lines(x, predict(samara.lm))
```

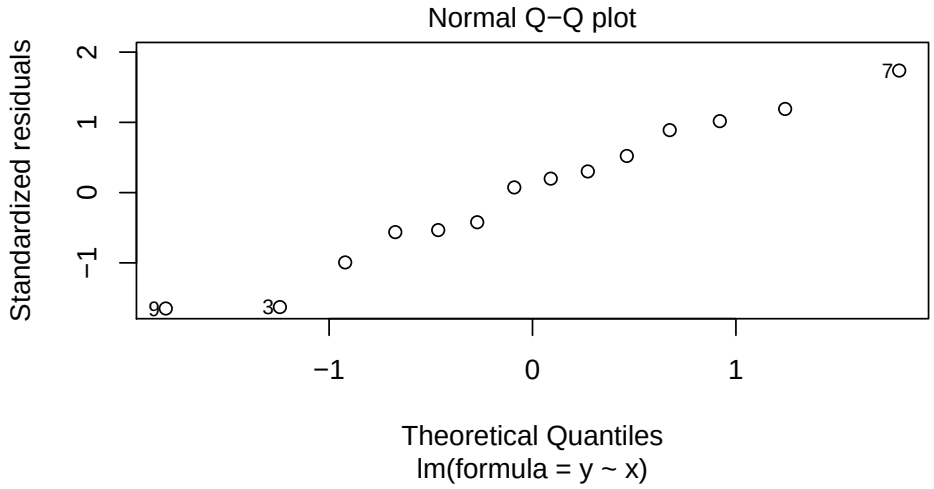
R has a number of definitions of residual suitable for different purposes. To produce a residual plot as we have defined it, we use the `plot` command.

```
> plot(samara.lm, which = 1)
```



If we want to see all the predicted values and residuals, we can use the commands `predict(samara.lm)` and `resid(samara.lm)`, respectively. Actually, there are four possible plots for `lm` objects. For instance, the second plot is the Q-Q plot:

```
> plot(samara.lm, which = 2)
```



R can also be used to obtain $\hat{Y}_{est}$ and its estimated standard error and to obtain confidence intervals for $\hat{Y}_{est}$ and $\hat{Y}_{pred}$. We do this below for the value $x_* = 1.80$ by using the `predict` command. We use it twice to get confidence and `prediction` intervals.

```
> predict(samara.lm, data.frame(x = 1.8), se.fit = TRUE, interval = "confidence")

$fit
           fit       lwr      upr
[1,] 0.8354017 0.7857125 0.885091

$se.fit
[1] 0.02280564

$df
[1] 12

$residual.scale
[1] 0.0660539

> predict(samara.lm, data.frame(x = 1.8), se.fit = TRUE, interval = "prediction")

$fit
           fit       lwr       upr
[1,] 0.8354017 0.6831462 0.9876571

$se.fit
[1] 0.02280564

$df
[1] 12

$residual.scale
[1] 0.0660539
```