1. A company is interested in whether spending more money on marketing is related to the amount in sales they generate. The company kept track of how much it spent on marketing an the corresponding sales for 12 months. Below is the R output of the relationship between the amount the company spends on marketing and the sales brought in.

Est / SE = t value

p-value

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Coefficients:
             Estimate   Std. Error  t value   Pr(>|t|)
(Intercept)  1383.4714  1255.2404   1.102     0.296
Spend        10.6222    0.1625      65.378    1.71e-14 ***

Multiple R-squared 0.9977
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(a) Interpret the estimated **Spend** coefficient in the context of the problem.

For each one dollar increase in spending we expect a 10.6222 dollar increase in sales on average.

(b) What is the linear model for the population?

$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$

(c) What is the regression equation sales vs spending?

$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 x_i \longrightarrow \hat{y}_i = 1383.4714 + 10.6222(x_i)$

(d) What is the estimated amount in sales if the company spends \$4,500?

$\hat{y}_i = 1383.4714 + 10.6222(4500) = \$49183.37$

(e) Looking at the data, we find that when the company spent \$4,500 the company brought in sales equal to \$50,044. Calculate the residual for when the company spends \$4,500.

$e_i = y_i - \hat{y}_i = 50044 - 49183.37$

$= \$860.63$

(f) Interpret the Coefficient of Determination.

$R^2 = 0.9977$

There is excellent predictive power 99.77 % of the variation in sales can be explained by spending.

Slope is positive

(g) What is the value of the correlation coefficient?

$r = \pm\sqrt{R^2} = +\sqrt{0.9977} = 0.9988$

(h) Interpret the value above.

There is a strong positive linear relationship between spending and sales. As spending increases, sales increase on average.

(i) Calculate a 95% confidence interval for `Spend`.

$t^* = qt(0.975, 10) = 2.2281$

$PE \pm ME = \hat{\beta}_1 \pm t^* SE_{\hat{\beta}_1} = 10.6222 \pm 2.2281(0.1625)$

$= (10.2601, 10.9843)$

(j) Write out the null and alternative hypothesis and use the calculated confidence interval to determine there is a linear relationship between Sales and Spending

$H_0: \beta_1 = 0 \rightarrow$ Reject

$H_A: \beta_1 \neq 0$

10.2601 ⟷ 10.9843

Since $\beta_1 = 0$ is not captured within the interval we reject the null-hypothesis at the $\alpha = 0.05$ level.