|  |  |
| --- | --- |
| ***Depth at which drilling***  ***begins, Feet*** | ***Time to drill 5 feet,***  ***Minutes*** |
| **0** | **4.90** |
| **25** | **7.41** |
| **50** | **6.19** |
| **75** | **5.57** |
| **100** | **5.17** |
| **125** | **6.89** |
| **150** | **7.05** |
| **175** | **7.11** |
| **200** | **6.19** |
| **225** | **8.28** |
| **250** | **4.84** |
| **275** | **8.29** |
| **300** | **8.91** |
| **325** | **8.54** |
| **350** | **11.79** |
| **375** | **12.12** |
| **395** | **11.02** |

***We often see patterns or relationships in scatterplots. When the y variable (Depth at which drilling begins) tends to increase as the x variable (Time to drill 5 feet) increases, we say there is a positive correlation between the Depth of drilling and the time to drill.***

**2.** Write a general regression equation (with 𝛽̂s) for the above linear relationship in this problem.

***E (Time to Drill) = 𝛽̂0 + 𝛽̂1(Depth of Drilling)***

***OR***

***Time to Drill = 𝛽̂0 + 𝛽̂depth \* Depth of Drilling +*** ε

**3.** Write the Null Hypothesis that corresponds to the above linear relationship (write both the Null Hypothesis equation and its English explanation, e.g., “There is no…”).

Null Hypothesis: There is no linear correlation between the depth of drilling and the time to drill 5 feet in the proposed model.

H0: ***𝛽̂Depth = 0***

4. What is the t-value that SAS has computed for 𝛽̂𝐷𝑒𝑝𝑡ℎ? Interpret the t-value that you got from SAS in layman’s terms.

| **Parameter Estimates** | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **DF** | **Parameter Estimate** | **Standard Error** | **t Value** | **Pr > |t|** | **95% Confidence Limits** | |
| **Intercept** | **1** | 4.78960 | 0.66631 | 7.19 | <.0001 | 3.36939 | 6.20981 |
| **Depth** | **1** | 0.01439 | 0.00285 | 5.05 | 0.0001 | 0.00832 | 0.02046 |

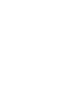
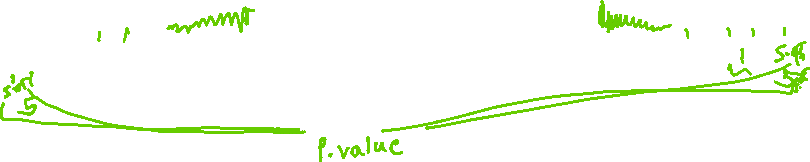
*= = 5.05*

***In terms of Standard Deviation of Sampling Distribution of 𝛽̂1, the observed 𝛽̂*𝐷𝑒𝑝𝑡ℎ *(From the sample) is approximately 5.05 Standard deviation away from zero (0) [which is Null Hypothesis of 𝛽̂*𝐷𝑒𝑝𝑡ℎ*].***

**5. Based on the computed t-value, do you expect the related p-value to be big or small? Why? Do the SAS results (e.g., p-value) corroborate your guess? Can you reject the Null Hypothesis using this p-value?**

***If H0: 𝛽̂*𝐷𝑒𝑝𝑡ℎ *= 0(If this is true)***

***P-value= p(|t|>5.05) <0.0001.***



H0: ***𝛽̂Depth = 0 – Reject***

**Based on the t-value, the related p-value should be small. We assumed that βdepth=0 (the null hypothesis) and the observed βdepth is 5.05 standard deviations away from 0. The probability that we will see another observation as extreme or more extreme than that is very small. This is from Tchebysheff’s Theorem which states that 95% of observations lie within two standard deviations of the mean. The bigger the t-value is, the smaller the p-value will be. SAS calculated a p-value of 0.0001, which corroborates the guess that the p-value would be small. Thus, we can reject the null hypothesis and conclude that there is enough evidence to indicate that the depth at which drilling begins and the time to drill five feet are linearly and positively related.**

**6. Write the final (specific) least squares prediction equation for this problem (you need to replace 𝛽̂s with their SAS estimates).**

***E (Time to Drill) = 𝛽̂0 + 𝛽̂1(Depth of Drilling)***

***OR***

***Time to Drill = 𝛽̂0 + 𝛽̂depth (Depth of Drilling) +*** ε

***𝛽̂0/intercept = 4.80***

***𝛽̂1/ 𝛽̂Depth = 0.01439***

***E (Time to Drill) = 4.80 + 0.01439 \* (Depth)***

***OR***

***Time to Drill = 4.80 + 0.01439(Depth)+* ε**

**7. Can you interpret the intercept in the least squares prediction equation? Why? If yes, write your interpretation of 𝛽̂0 in layman's terms.**

**Yes, we can interpret the intercept since our data for the depth encloses zero. Thus, per the proposed model, the average time it takes to drill five feet is 4.79 minutes if the depth at which drilling begins is zero feet (or if we start drilling at the surface).**

**or**

**In the proposed model, the average time to dry drill 5 feet in rock is greater than 4.79 minutes.**

**8. Interpret 𝛽̂𝐷𝑒𝑝𝑡ℎ (that you got from SAS) in the least squares prediction equation in layman's terms.**



**Holding other variables fixed, we estimate the average time to drill five feet increases by .014 minutes for each additional foot of depth the drilling begins at.**

**9. Interpret the 𝑟2 (R-square) value (from SAS) in layman’s terms.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Root MSE** | 1.43219 | **R-Square** | 0.6300 |
| **Dependent Mean** | 7.66294 | **Adj R-Sq** | 0.6053 |
| **Coeff Var** | 18.68987 |  |  |

**63% of the variability of the time can be explained by the proposed linear relationship between the depth of drilling and the time to drill.**

**10. Interpret the Root Mean Square Error (RMSE) value (from SAS) in layman’s terms.**

***We are 95% confident that the interval of [ 0.00832, 0.02046] encloses the true increase (𝛽̂Depth) in the mean of time to drill for every additional 5 feet of the depth of drilling, holding other variables fixed.***



***We expect most (95%) of the actual time to drill to fall within the (2\*1.43) 2.86 minutes of their respective least squares predicted values.***