Stat 235

Lab 4

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Lab EL12

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1

1 a)

Keeping other parameters constant, changing the confidence level yields the folowing:

Confidence Level	Margin of Error
0.90	0.300308
0.95	0.357839
0.99	0.470280

Table 1: My caption

As seen in Table 1 above, the Margin of Error increases as the Confidence Level is increased. This makes sense because the margin of error depends on the z value, which increases as $(1-\alpha)$ increases.

1 b)

Confidence Level	Observed Fraction of Intervals That Failed to Cover the Hypothesized Population Mean
0.90	0.11
0.95	0.06
0.99	0.02

Table 2: My caption

Theoretically, the confidence level and the fraction of intervals that failed to cover the hypothesized mean should be add up to 1. Here, we see that the values are reasonable, adding up to 1.01 in all cases. Of course, a small difference is expected since we are using experimental data.

2

$$H_0 : \mu = 64 \quad vs. \quad H_A : \mu \neq 64$$

2 a)

Level of Significance	Number of Samples That Led to the Rejection of H_0	Observed Fraction of Samples
0.10	89	0.89
0.05	94	0.94
0.01	98	0.98

Table 3: My caption

As the level of significance increases, the number of samples also increases. This is because the margin of error also increases???????

2 b)

Write your null hypothesis. (SHould have a solid understanding of p-values for this)

Compare the outcome of the test at the 5% level of significance with the 95% confidence intervals that failed to cover the mean of 64 for each sample. Repeat the exercise with the 1% level of significance and the 99% confidence intervals. What do you conclude about the relationship between confidence intervals and two-sided tests?

90% confidence interval

what isn't this the same

95% confidence interval

what isn't this the same

99% confidence interval

what isn't this the same

3

Summary tables for Alloy 1 and 2, Calculate the Confidence intervals yourself.

3 a)

Alloy 1	
Mean	65.09
Standard Error	0.360980466
Median	64.6
Mode	63.8
Standard Deviation	1.977171438
Sample Variance	3.909206897
Kurtosis	0.042639157
Skewness	0.718164135
Range	8.2
Minimum	61.7
Maximum	69.9
Sum	1952.7
Count	30
Confidence Level(95.0%)	0.738287948

Table 4: My caption

The confidence interval is calculated as follows:

$$65.09 \pm 0.738287948 \approx (64.352, 65.828)$$

Alloy 2	
Mean	65.27333333
Standard Error	0.167601973
Median	65
Mode	64.9
Standard Deviation	0.917993815
Sample Variance	0.842712644
Kurtosis	9.565960304
Skewness	2.914366915
Range	4.5
Minimum	64.5
Maximum	69
Sum	1958.2
Count	30
Confidence Level(95.0%)	0.342784524

Table 5: My caption

The confidence interval is calculated as follows:

$$65.27333333 \pm 0.342784524 \approx (64.931, 65.616)$$

Alloy 2 appears to be stronger, since it has a higher mean, median and mode compared to Alloy 1.

3 b)

For both of the alloys, there isn't any strong evidence that the mean strength is below the required threshold value of 64. For both of the 95% confidence intervals, the lower bound is above 64, so the chance for a mean strength below 64 is low.

4

4 a)

$$H_0 : \mu \leq 64 \quad vs. \quad H_A : \mu > 64$$

$$t_0 = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{65.09 - 64}{1.977171438/\sqrt{30}} = 3.019553976 \sim t_{29}$$

$$p - value : pt(3.019553976, df = 29, lower.tail = FALSE) = 0.0026185$$

Because the p-value obtained is extremely low, we reject H_0. i.e., the data suggests that Alloy 1 exceeds the threshold value of 64.

4 b)

The following assumptions must be true for a t-test:

1. The samples are independent and random
2. The samples come from a normal population, OR from a population with sample size 30 or greater (The Central Limit Theorem guarantees samples are normally distributed when the population size is ≥ 30)

The assumptions outlined above hold for the test above, as we were told that the rods were randomly selected, and the sample size of the population is 30.

5

5 a)

We'll do the two-tailed t-test as follows: Since, the population variances are unknown, we'll assume unequal variances.

$$H_0 : \mu_1 = \mu_2 \quad vs. \quad H_A : \mu_1 \neq \mu_2$$

Using the “t-Test: Two-Sample Assuming Unequal Variances” tool, we obtain the following:

	Alloy 1	Alloy 2
Mean	65.09	65.27333
Variance	3.909206897	0.842713
Observations	30	30
Hypothesized Mean Difference	0	
df	41	
t Stat	-0.460646232	
$P(T \leq t)$ one-tail	0.32374327	
t Critical one-tail	1.682878002	
$P(T \leq t)$ two-tail	0.647486541	
t Critical two-tail	2.01954097	

Table 6: My caption. The tool uses $\alpha = 0.05$

The test statistic $t_0 = -0.460646232$ follows a t-distribution, with corresponding p-value: 0.647486541 obtained from the table above.

$$t_{\alpha/2,min\{n-1,m-1\}} = t_{0.05/2,29} = pt(0.025, df = 29, lower.tail = TRUE) = 0.5098869$$

H_0 should be rejected if t_0 is greater than the value above, which isn't the case. Similarly, with the “judgement approach” we find that the p-value is above 0.1, which is weak to no evidence against H_0 Therefore, we fail to reject H_0. i.e. there is not sufficient evidence to support that there is a difference in the mean strengths of Alloy 1 and Alloy 2 rods.

5 b)

The assumptions to make the tests in part (a) valid are as follows:

1. The samples are independent and random
2. The samples come from a normal population, OR from a population with sample size 30 or greater (The Central Limit Theorem guarantees samples are normally distributed when the population size is ≥ 30)
3. the populations have unequal variances

The first two assumptions outlined hold for the test above, as we were told that the rods were randomly selected, and the sample size of the population is 30. **The population variances are unknown so we don't know if the 3rd assumption is valid?!**

6

6 a)

Do the data provide evidence that the treatment increased the mean s trength of the ALLOY 2 rods? Answer the question by carrying out an appropriate test in Excel. In particular, state the null and alternative hypotheses in terms of the population parameters, obtain the value of the test statistic, specify the distributio n of the test statistic under the null hypothesis, and obtain the p - value of the test. What do you conclude?

$$H_0 : \mu_1 = \mu_2 \quad vs. \quad H_A : \mu_1 \neq \mu_2$$

$$t_0 =$$

$$p - value : XX$$

t-test output from excel. CHoose t-test carefully

6 b)

Use the Descriptive Statistics feature in the Data Analysis menu to obtain a 95% two - sided confidence interval for the mean change in strength o f ALLOY 2 rods after the treatment. First create a new variable , EFFECT , defined as the difference in strength between ALLOY 2 + TREATMENT rods and ALLOY 2 rods. Is the interval consistent with the test outcome in part (a)? Explain briefly.

paste summary statistics from excel

6 c)

What are the assumptions necessary to make the test in part (a) and confidence interval in part (b) valid? Do the assumptions hold? Explain briefly.

The assumptions to make the tests in part (a) valid are as follows:

1.

what are the assumptions for a t-test? Is there a theorem we touched on earlier that relates to the normal distribution?

The following assumptions must be true for a t-test:

1.

The Central Limit Theorem..............

6 d)

Is the effect of the treatment independent of the initial strength of the rods? In order to answer the question, obtain the plot of the variable EFFECT versus ALLOY 2 measurements. What do you conclude?

Output: Change in strength vs Scatter plot of Alloy 2 strength. Remember to put the response on the y-axis. All relationships have error, look at the middle data cloud to determine shape.

q6.png

Figure 1: My caption