title: "Julius Hai STAT 601 Home_work"

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1. **Exercise 1 on page 236 (20 Points)) Ignore the problem instructions and follow the brief below**

1a. **State the problem**

```
The problem is to determine whether there is a significant difference
in the mean test scores of students taught by two different teaching
methods (Class A and Class B) at the 5% level of significance.
```

1b **What is the appropriate test/model?**

```
Since we are comparing the mean scores of two independent groups (Class A vs.
Class B)
to see if there is a significant difference, the appropriate statistical test is:

**An Independent Samples t-test (two-sample t-test, two-tailed) at α = 0.05.**

👉 This test is suitable because:
- We have two independent groups (different classes).
- The variable (test scores) is continuous.
- We want to know if their means are significantly different.
```

1c. **State the hypothesis**

```
Null Hypothesis (H0): H0:  μ_A = μ_B   (no difference in mean test scores between
Class A and Class B)
 Alternative Hypothesis (H1): H1:  μ_A ≠ μ_B   (there is a difference in mean test
scores between Class A and Class B)
 => Two-tailed test (direction not specified).
```

1d. **State the assumptions of the model/test**

```
1. Independence of observations:
    • The two groups (Class A and Class B) are independent of each other.
    • Scores within each group are collected independently.
2. Normality:
    • Test scores in each group are approximately normally distributed.
3. Homogeneity of variances:
    • The population variances of the two groups are equal (σ_A^2 = σ_B^2).
    • If this assumption is violated, use Welch's t-test instead.
```

1e. **Write the test/model using the correct equation and Greek letters**

```
Descriptive statistics
Class A: n = 12, mean = 85.17, variance = 83.61
Class B: n = 13, mean = 80.85, variance = 72.64

Manual pooled-variance t-test
Pooled variance (s_p^2) = 77.89
Standard error (SE)     = 3.533
t statistic             = 1.223
Degrees of freedom      = 23

Additional results
p-value                 = 0.2337
95 % CI for mu_A - mu_B = [ -2.99 , 11.63 ]

Built-in t.test (should match manual)

        Two Sample t-test

data:  classA and classB
t = 1.2229, df = 23, p-value = 0.2337
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -2.987911 11.628936
sample estimates:
mean of x mean of y
 85.16667  80.84615
```

1f. **Calculate the test statistics**

```
Sample sizes:          n1 = 12 , n2 = 13
Means:                 x̄1 = 85.167 , x̄2 = 80.846
Variances:             s1² = 83.606 , s2² = 72.641
Pooled variance:      s_p² = 77.885
Standard error:        SE = 3.533
t-statistic:          t = 1.223
Degrees of freedom:   23
```

1g. **Use the decision rule using step 4 of 3.2.7**

```
t-calculated : 1.223
Critical value : 2.069
Decision        : Fail to reject H0
```

1h. **Interpret the results in the context of the problem**

```
t-statistic : 1.219
Degrees of freedom : 22.47
p-value : 0.2354

Interpretation:
 Fail to reject H0: there is no sufficient statistical evidence of a difference
between the two teaching methods.
```

1i **Construct a 95% confidence interval**

```
Difference in means (A - B): 4.32
Standard error (SE):           3.533
Degrees of freedom (df):       23
Critical t (0.025, df):        2.069
Margin of error (ME):          7.309
95% CI for (mu_A - mu_B):    ( -2.989 , 11.629 )
```

1j. **Verify the results using the R output (welch satterwaite t test result)**

```
Welch test statistic (t): 1.2193
Welch degrees of freedom : 22.47
Two-tailed p-value        : 0.2354
95% CI for (mu_A - mu_B): ( -3.02 , 11.66 )

Interpretation: Fail to reject H0 — no sufficient evidence of a difference.
```

2. **Exercise 5 on page 237 (20 points)) Ignore the problem instructions and follow the brief below**

Q2a. **State the problem**

```
The problem is to test whether there is a significant difference in the mean
results
between individuals on the regular diet and those on the new diet.
```

2b. **What is the appropriate test/model?**

```
Since we are comparing the means of two independent groups (Regular Diet vs. New
Diet),
the appropriate test is an Independent Samples t-test (two-sample t-test,
two-tailed).
If the assumption of equal variances does not hold, use Welch's t-test.
```

2c. **State the hypothesis**

```
Null hypothesis (H0):
  H0:  μ_regular = μ_new   (no difference in mean responses)

Alternative hypothesis (H1):
  H1:  μ_regular ≠ μ_new   (there is a difference in mean responses)
```

2d. **State the assumptions of the model/test**

```
Assumptions of the Independent Samples t-Test :

 1. Independence of observations:
the two groups (Regular Diet vs. New Diet) are independent of each other,
and the measurements within each group are collected independently.

 2. Normality: the responses in each group are approximately
normally distributed.

 3. Homogeneity of variances: the population variances of the two
groups are equal (σ²_Regular = σ²_New).  If this assumption is violated,
Welch's t-test should be used instead.
```

2e. **Write the test/model using the correct equation and Greek letters**

```
Test/Model Equation :

t = ( x̄_Reg − x̄_New ) /
    sqrt{ s_p^2 * ( 1/n_Reg + 1/n_New ) }

where
  s_p^2 = [ (n_Reg - 1) * s_Reg^2 + (n_New - 1) * s_New^2 ]
          / ( n_Reg + n_New - 2 )
```

2f. **Calculate the test statistics**

```
=== Two-sample pooled-variance t-test ===
n1 = 8 ; n2 = 10
Mean1 = 845.5 ; Mean2 = 904.6
Var1 = 1873.43 ; Var2 = 1348.93
Pooled variance (s_p^2) = 1578.4
Standard error (SE) = 18.845
t-statistic = -3.136
df = 16
Two-tailed p-value = 0.0064
```

2g. **Use the decision rule using step 4 of 3.2.7**

```
Two-sample t-test (two-tailed) - α = 0.05
Degrees of freedom (df): 16
Critical value (±t_{0.025,df}): ± 2.12
Calculated t-statistic: -3.136
Decision: Reject H0
```

2h. **Interpret the results in the context of the problem**

```
At the 5% significance level, the two-sample t-test is significant (t = -3.14, df
= 16, p = 0.0064), so we Reject H0.

 The sample means are 845.5 (regular diet) and 904.6 (new diet).  Because the new
diet mean is larger, the data suggest that participants on the new diet achieved
higher average outcomes than those on the regular diet.
```

2i. **Construct a 95% confidence interval (show equation and numbers)**

```
=== 95% CI for (mu_Reg - mu_New) ===
Mean (Regular) : 845.5
Mean (New)      : 904.6
Difference      : -59.1
Pooled variance : 1578.4
Standard error  : 18.845
t critical (0.025, df=16) : 2.12
Margin of error : 39.95
95% CI : ( -99.05 , -19.15 )
```

2f. Verify the results using the R output (welch satterwaite t test result)

```
Welch–Satterthwaite verification (unequal variances). Using the two independent
samples
Regular (n = 8) and New (n = 10), the Welch two-sample t-test gives (t = -3.08),
(df ≈ 13.8),
and a two-tailed (p = 0.008). The 95% confidence interval for (μ_{Reg} - μ_{New})
is (-100.4, -17.8),
which excludes 0. Therefore, we reject H₀ at (α = 0.05). In context, the new diet
has a significantly
higher mean outcome than the regular diet; the estimated difference is about 59
units in favor of the new diet.
```