Math Modeling

AP Stats - Linear Regression T-test, One-Way ANOVA, and Two-Way ANOVA

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1 December

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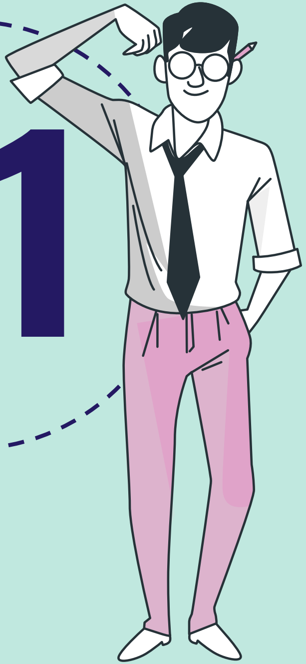
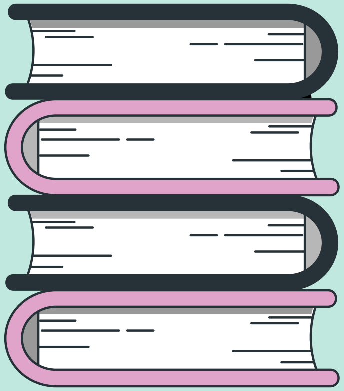


Linear Regression t-test

What is a Linear Regression t-test used for?

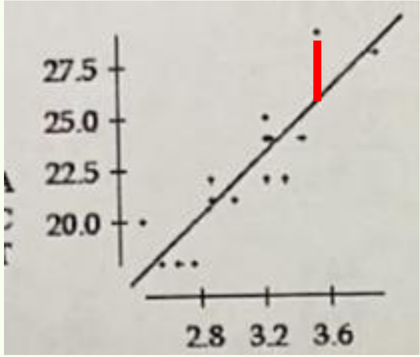
A linear regression t-test is used to identify if there is a significant linear relationship present between two variables.

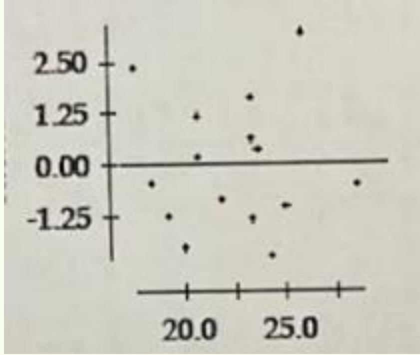


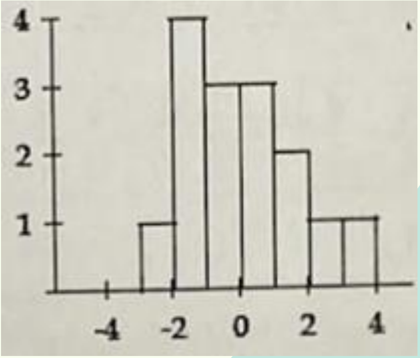
What are Assumptions and Conditions for a Linear Regression t-test?

- **Independence** between every (x, y) pair
- **Linear Relationship** between x and y
- **Normal Distribution** of y-values at every x-value
    - Or, **Normal Distribution of the Residuals***
- No obvious patterns in the Residual Plots
- **(Homoscedasticity)**

*Residual = predicted y - actual y







How is Linear Regression T-Test Calculated?

p = presence of linear relationship between x and y

$H_0: \beta_1 = 0$

$H_A: \beta_1 >, <, =/= \ 0$

Parameter: β_1

Statistic: b_1

S_r = Standard Error of Residuals

S_x = Standard Error of x-values

n = sample size

$SE(b_1) = S_r/(S_x((\sqrt{(n-1)})))$

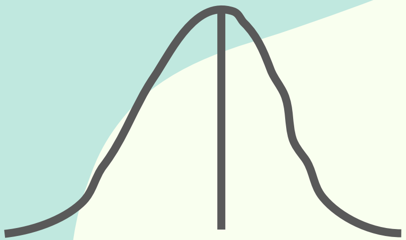
$S_r = \sqrt{((\sum(y_{act}-y_{pred})^2)/(n-2))}$

$t = (\beta_1 - 0)/SE(b_1)$

df = n-2

p = tcdf(t, UB, df)

$T_{df}\ (0, SE(b_1))$



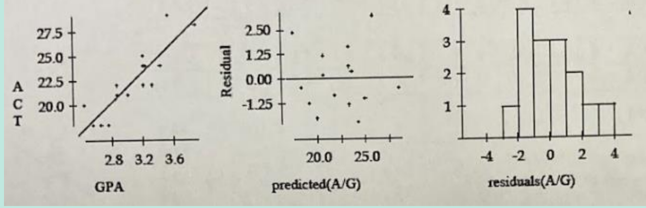
0

TI-84: Stat>Calc>LinRegTTest (F)

TI-Nspire: Menu>Statistics>StatTests>LinRegTTest (A)

Example (Taken from Abhinav's AP STATS HW Assignment)

A high school counselor was interested in finding out how well student grade point averages (GPA) predict ACT scores. A sample of the senior class data was reviewed to obtain GPA and ACT scores. The data are shown in the table to the right.



GPA	ACT
3.25	24
2.87	21
2.66	18
3.33	22
2.87	22
3.21	22
2.76	18
3.91	28
3.55	29
2.55	18
2.44	20
3.22	24
3.01	21
3.44	24
3.22	25

Is there evidence of an association between GPA and ACT score?

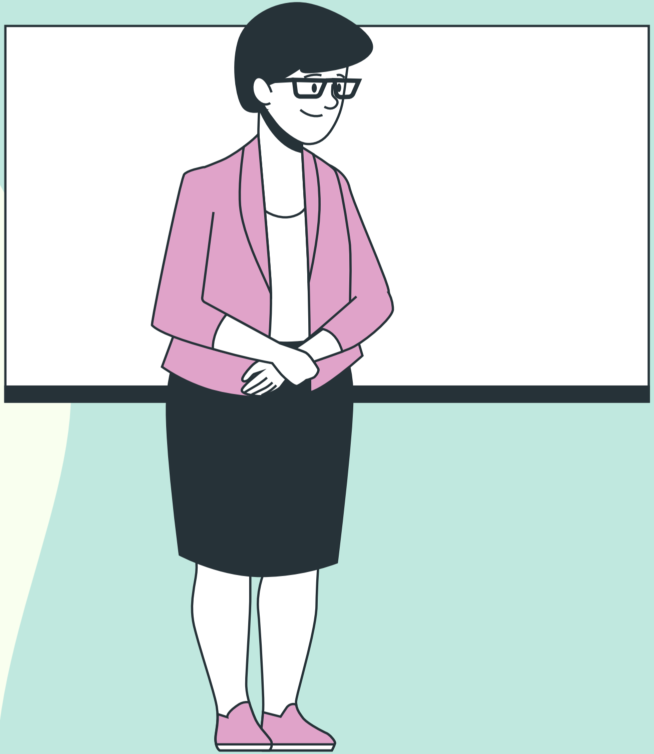
Source	Sum of Squares	df	Mean Square	F-ratio
~~Regression~~	~~123.041~~	~~1~~	~~123.041~~	~~46.3~~
~~Residual~~	~~34.5589~~	13	~~2.65838~~	

Variable	Coefficient	s.e. of Coeff	t-ratio	prob
~~Constant~~	~~-0.427035~~	~~3.382~~	~~-0.126~~	~~0.9014~~
GPA	7.39697	1.087	6.80	≤ 0.0001

- Independence ✓
- Linear Relationship ✓
- Normal Distribution of the Residuals ✓
- Homoscedasticity ✓

Just state:

- Hypotheses ($\beta_1 = 0$, $\beta_1 =/= 0$)
- b_1 (7.397)
- df (n-2 → 15-2 → 13)
- $SE(b_1)$ (1.087)
- t (6.80)
- p (≤ 0.0001)
- Reject H_0

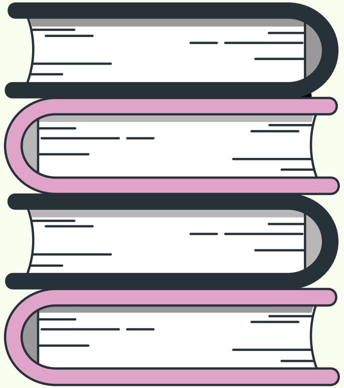


02

One-Way ANOVA

What is a One-Way ANOVA test used for?

In plain terms, given more than two population means, the One-Way ANOVA test determines if there is *any* significant difference between any of the population means. However, it not specify *which* means differ.



What are Assumptions and Conditions for One-Way ANOVA?

- **Random** Data is used (either through Random Assignment or Random Sampling)
- Data is **Independent** (both within and between groups)
- The distributions of each group is **Normal**; or if, not the sample size is large enough to ensure a normal sampling distribution (n > 20)
- **Equal Variance**: The standard deviations among the different groups compared is roughly equal
    - General rule of thumb: largest standard deviation should be no more than twice the smallest one. [according to this source]

How is One-Way ANOVA Calculated?

What if sample sizes differ?

Parameter: μ (population average of [])
H_0: $\mu_1 = \mu_2 = \dots = \mu_n$
H_A: μ_i =/= μ_j is true for at least one pair of means within the set of groups.

1: Calculate Group Means

Group #	a_1	a_2	…	a_n
Individual Values	i_1	i_1	i_1	i_1
	i_2	i_2	i_2	i_2
	…	…	…	…
	i_n	i_n	i_n	i_n
Average	$\bar{a}_1$	$\bar{a}_2$	…	$\bar{a}_n$

2: Calculate Grand Mean

$$\bar{a}_g = \frac{\bar{a}_1 + \bar{a}_2 + \dots + \bar{a}_n}{n}$$

Grand Mean

3: Calculate Between-Group...

Sum of Squares

$$SS_B = n(\bar{a}_1 - \bar{a}_g)^2 + n(\bar{a}_2 - \bar{a}_g)^2 + \dots + n(\bar{a}_n - \bar{a}_g)^2$$

Degrees of Freedom

$$df_B = n - 1$$

Mean-Square Sum

$$MS_B = \frac{SS_B}{df_B}$$

4: Calculate Within-Group...

Sum of Squares

$$SS_W = \Sigma(a_{i_1} - \bar{a}_1)^2 + \Sigma(a_{i_2} - \bar{a}_2)^2 + \dots + \Sigma(a_{i_n} - \bar{a}_n)^2$$

Degrees of Freedom

$$df_W = a(n - 1)$$

Mean-Square Sum

$$MS_W = \frac{SS_W}{df_W}$$

How is One-Way ANOVA Calculated (Cont.)?

TI-84: Stat>Calc>ANOVA (H)
2nd>Distr>Fcdf (0)
TI-Nspire: Menu>Statistics>StatTests> ANOVA (C)

5: Calculate F-Critical Value

$$F_{crit}(df_B,\ df_w)$$

6: Calculate F-Statistic, P-Value, Judge H_0

$$F_{crit}(df_B,\ df_w)$$

$$F = \frac{MS_B}{MS_W}$$

Table A.6 F-Distribution Probability Table 757

$\propto$ = 0.05

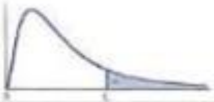


Table A.6* Critical Values of the F-Distribution

$f_{0.05}(v_1, v_2)$ — columns: df_B; rows: df_W

v_2	1	2	3	4	5	6	7	8	9
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	6.61	5.79	5.11	5.19	5.05	4.95	4.88	4.82	4.77
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.32
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
25	4.21	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88

df_B

df_W

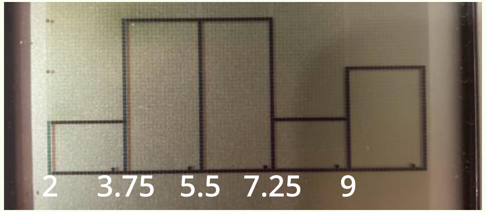
One-Way ANOVA Example

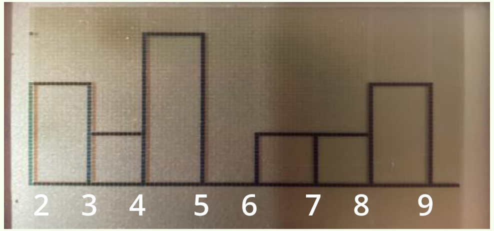
Ethan measures the length of three species of insects. Random sample is taken, and data area shown below:

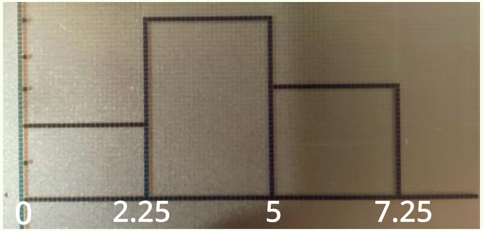
μ = Population Average of Length Among Different Insect Species (cm)
$H_0: \mu_1 = \mu_2 = \mu_3$
$H_A: \mu_1 =/= \mu_2; \mu_2 =/= \mu_3; \mu_1 =/= \mu_3$
($\propto = 0.05$)

- **Random** ✓ (Random Number Generator on TI-83 +)
- **Independent** ✓ (Reasonable to Assume)
- **Normality** ✓ (see below- A (top), B (bottom) on left, C on right)
- **Equal Variance** ✓
  - A: SD= 2.378; B: SD = 2.300; C: SD = 2.658

Insect Species #	A	B	C
Length (cm)	9	6	4
	4	3	0
	4	4	4
	2	8	6
	6	8	3
	6	2	8
	8	7	7
	7	4	0
	4	4	3
	9	2	3
Average Length (cm)	5.9	4.8	3.8







One-Way ANOVA Example (Cont.)

Insect Species #	A	B	C
Average Length (cm)	5.9	4.8	3.8

2: Calculate Grand Mean

$$\bar{a}_g = \frac{5.9+4.8+3.8}{3}$$
$$\bar{a}_g = 4.833$$

3: Calculate Between-Group...

Sum of Squares

$$SS_B = n(\bar{a}_1 - \bar{a}_g)^2 + n(\bar{a}_2 - \bar{a}_g)^2 + \dots + n(\bar{a}_n - \bar{a}_g)^2$$
$$SS_B = 10(5.9 - 4.833)^2 + 10(4.8 - 4.833)^2 + 10(3.8 - 4.833)^2$$
$$SS_B = 22.066$$

Degrees of Freedom

$$df_B = n - 1$$
$$df_B = 3 - 1$$
$$df_B = 2$$

Mean-Square Sum

$$MS_B = \frac{SS_B}{df_B}$$
$$MS_B = \frac{22.066}{2}$$
$$MS_B = 11.033$$

4: Calculate Within-Group...

Sum of Squares

$$SS_W = \Sigma(a_{i_1} - \bar{a}_1)^2 + \Sigma(a_{i_2} - \bar{a}_2)^2 + \dots + \Sigma(a_{i_n} - \bar{a}_n)^2$$
$$SS_W = \Sigma(9 - 5.9)^2 + (4 - 5.9)^2 + \dots \Sigma(6 - 4.8)^2 + (3 - 4.8)^2 + \dots + \Sigma(4 - 3.8)^2 + (0 - 3.8)^2 + \dots$$
$$SS_W = 162.1$$

Degrees of Freedom

$$df_W = a(n - 1)$$
$$df_W = 3(10 - 1)$$
$$df_W = 27$$

Mean-Square Sum

$$MS_W = \frac{SS_W}{df_W}$$
$$MS_W = \frac{162.1}{27}$$
$$MS_W = 6.0037$$

One-Way ANOVA Example (Cont.)

5: Calculate Grand Mean

$$F_{crit}(df_B, df_w)$$
$$F_{crit}(2, 27)$$
$$F_{crit} = 3.35$$

(either p or f can be used... but result from either should confirm the other)

6: Calculate F-Statistic, P-Value, Judge H_0

$$F = \frac{MS_B}{MS_W}$$
$$F = \frac{11.033}{6.0037}$$
$$F = 1.83$$

$$p = Fcdf(F, UB, df_B, df_w)$$
$$p = Fcdf(1.83, 999999, 2, 27)$$
$$p = 0.1785$$

According to this One-Way ANOVA test, p = 0.1785, which is above ∝ = 0.05. Thus, the null hypothesis is not rejected. There is not statistically significant evidence to suggest that there is a difference in length among any two species of the insects measured.

Table A.6 F-Distribution Probability Table 757

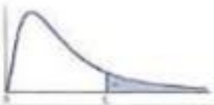


Table A.6* Critical Values of the F-Distribution

df_B →

df_W

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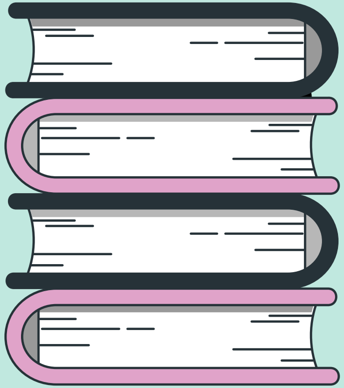
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	6.61	5.79	5.11	5.19	5.05	4.95	4.88	4.82	4.77
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.12
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
25	4.21	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88

03

Two-Way ANOVA

What is a Two-Way ANOVA test used for?

Unlike a one-way ANOVA test which evaluates the impact of one variable across multiple groups, the two-way ANOVA test evaluates the impact of *two* variables across multiple groups, and whether or not there are significant relationships and/or interactions.



What are Assumptions and Conditions for Two-Way ANOVA?

- **Equal Variance**: The standard deviations among the different groups compared is roughly equal
    - General rule of thumb: largest standard deviation should be no more than twice the smallest one.
- The distributions of the data within all groups is **normal**; or, if not, they have a larger sampling size and/or the distribution of residuals (the distribution of error) is normal.
- **Independence** among groups. The samples should not be matched or paired in any way.

How is Two-Way ANOVA Calculated (Using Example)?

1: Calculate Means

- -Averages for all combinations of A and B.
- -Averages for A
- -Averages for B
- -Averages for A and B in total.

	Drug A	Drug B	
Males	6	4	
	4	5	
	7	6	
	9	7	
	3	5	Gender Averages
Male Drug Averages	5.8	5.4	5.6
Females	8	3	
	3	5	
	5	9	
	8	2	
	6	3	
Female Drug Averages	6	4.4	5.2
Drug Averages	5.9	4.9	5.4 (Total Average)

There are *three* pairs of null-alternative hypotheses.

H_{A0}: There is no significant difference among results for factor A.
H_{A1}: There is a significant difference among results for factor A.

H_{B0}: There is no significant difference among results for factor B.
H_{B1}: There is a significant difference among results for factor B.

H_{AB0}: The two factors in question are independent.
H_{AB1}: The two factors in question are not independent.

- **Equal Variance/SD** ✓
  - When SD is calculated out for all groups, all values are in a similar range.
- **Normality** ✓
  - Normal shape of distribution displayed for all groups
- **Independence** ✓ (Reasonable to assume)

Ex. These data are of the reduced blood pressure among patients, stratifying for both drug type and gender.

Calculating Two-Way ANOVA (con.)

2: Calculate Sum of Squares/Degrees of Freedom

	Drug A	Drug B	
Males	6	4	
	4	5	
	7	6	
	9	7	
	3	5	Gender Averages
Male Drug Averages	5.8	5.4	5.6
Females	8	3	
	3	5	
	5	9	
	8	2	
	6	3	
Female Drug Averages	6	4.4	5.2
Drug Averages	5.9	4.9	5.4 (Total Average)

A

$$SS_{tot} = SS_A + SS_B + SS_{AB} + SS_{err}$$

$$SS_{AB} = SS_{btw} - (SS_A + SS_B)$$

$$SS_{tot} = \Sigma(6 - 5.4)^2 + (4 - 5.4)^2 + ... + (3 - 5.4)^2$$

Square of Difference of Each Individual Data Point from Total Average.

$$SS_{tot} = 84.8$$

$$df_{tot} = npq - 1$$

N = number of people per group

p/q = number of levels for factors A/B, respectively.

$$df_{tot} = (5)(2)(2) - 1$$

$$df_{tot} = 19$$

$$\sigma^2_{tot} = \frac{SS_{tot}}{df_{tot}}$$

$$\sigma^2_{tot} = \frac{84.8}{19}$$

$$\sigma^2_{tot} = 4.46$$

$$df_{btw} = p \cdot q - 1$$
$$= 2 \cdot 2 - 1$$
$$= 3$$

$$\sigma^2_{btw} = \frac{SS_{btw}}{df_{btw}} = \frac{7.6}{3} = 2.53$$

$$SS_{btw} = 5 * \Sigma(5.8 - 5.4)^2 + (5.4 - 5.4)^2 + (6 - 5.4)^2 + (4.4 - 5.4)^2$$

$$SS_{btw} = 7.6$$ **Here, n, number of samples per groups, is n = 5.**

B

Calculating Two-Way ANOVA (con.)

C

$$SS_A = 5 * 2((5.9 - 5.4)^2 + (4.9 - 5.4)^2)$$
$$SS_A = 5$$

Here, n, number of samples per groups, is n = 5. Multiply the sum of the squares of the differences by 2, as there are 2 levels (both for Factors A and B)

$$df_A = p - 1$$
$$df_A = 2 - 1$$
$$= 1$$
$$\sigma_A^2 = \frac{SS_A}{df_A} = \frac{5}{1} = 5$$

D

$$SS_B = 5 * 2((5.6 - 5.4)^2 + (5.2 - 5.4)^2)$$
$$SS_B = 0.8$$

$$df_B = q - 1$$
$$df_B = 2 - 1$$
$$= 1$$
$$\sigma_B^2 = \frac{SS_B}{df_B} = \frac{0.8}{1} = 0.8$$

E

$$SS_{AB} = SS_{btw} - (SS_A + SS_B)$$
$$SS_{AB} = 7.6 - (5 + 0.8)$$
$$SS_{AB} = 1.8$$

$$df_{AB} = (p - 1) \cdot (q - 1)$$
$$df_{AB} = 1 \cdot 1$$
$$= 1$$
$$\sigma_{AB}^2 = \frac{SS_{AB}}{df_{AB}} = \frac{1.8}{1} = 1.8$$

Here, the sum of the squared differences for each combination of treatments A and B is calculated.

F

$$SS_{err} = \Sigma(6 - 5.8)^2 + (4 - 5.8)^2 + \ldots \Sigma(4 - 5.4)^2 + (5 - 5.4)^2 + \ldots + \Sigma(8 - 6)^2 + (3 - 6)^2 + \ldots \Sigma(3 - 4.4)^2 + (5 - 4.4)^2 + \ldots$$
$$SS_{err} = 77.2$$

$$df_{err} = (n - 1) \cdot p \cdot q$$
$$= 4 \cdot 2 \cdot 2$$
$$= 16$$
$$\sigma_{err}^2 = \frac{SS_{err}}{df_{err}} = \frac{77.2}{16} = 4.83$$

Calculating Two-Way ANOVA (con.)

3: Calculate F-Statistic, P-Value, Judge H_0's

$$F_A = \frac{\sigma_A^2}{\sigma_{err}^2} = \frac{5}{4.83} = 1.04 \qquad F_B = \frac{\sigma_B^2}{\sigma_{err}^2} = \frac{0.8}{4.83} = 0.17 \qquad F_{AB} = \frac{\sigma_{AB}^2}{\sigma_{err}^2} = \frac{1.8}{4.83} = 0.373$$

$$df_A = 1 \qquad df_B = 1 \qquad df_{AB} = 1$$

$$df_{err} = 16 \qquad df_{err} = 16 \qquad df_{err} = 16$$

TI-Nspire:
Menu>Statistics>Stat Tests> ANOVA Two-Way (D)

$$p_A = Fcdf(F_A, UB, df_A, df_{err})$$
$$p_A = Fcdf(1.04, 999999, 1, 16)$$
$$p_A = 0.324$$

$$p_B = Fcdf(F_B, UB, df_B, df_{err})$$
$$p_B = Fcdf(0.17, 999999, 1, 16)$$
$$p_B = 0.689$$

$$p_{AB} = Fcdf(F_{AB}, UB, df_{AB}, df_{err})$$
$$p_{AB} = Fcdf(0.373, 999999, 1, 16)$$
$$p_{AB} = 0.55$$

According to the Two-WAY ANOVA Test, for all tests, including variation of blood pressure reduction among drug type, variation of this metric among gender, as well as the interaction between these two factors, p = 0.324, 0.689, and 0.55, respectively. Thus, is for all three cases, the null hypothesis is not rejected. There is no statistically significant evidence to suggest that blood pressure reduction varies among different levels for either the gender or drug type factor. Nor is there statistically significant evidence to suggest that there is any significant interaction between these factors.

Senior STEM Project Statistical Tests

From Monday, 27 November 2023 1:45 PM to Thursday, 30 November 2023 10:00 PM, a form for information on statistical procedures used for Seniors' STEM Project was made available. 19 of 47 Seniors responded.

Distribution of Type of Data Collected

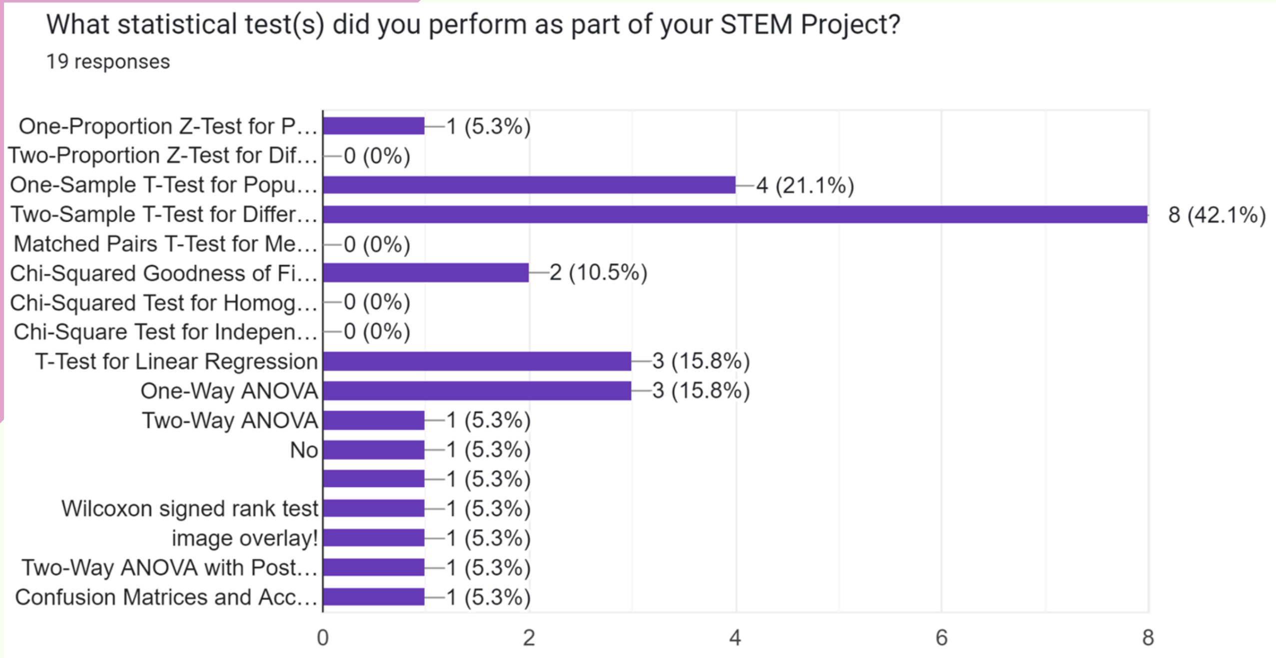
Type of Data	Count	Proportion
Categorical	5	0.2174
Quantitative	17	0.7391
Other	1	0.0434
Total	23	1

Distribution of Source of Data Collected

Source of Data	Count	Proportion
Human Subjects	6	0.2308
Experimental Design	7	0.2692
Random Sampling	0	0
Observational Data	6	0.2308
Generated Data (AI, ML Model, etc.)	7	0.2692
Total	26	1

Conclusions:

- Counts > People Sampled (indicative of checkboxes)
- Lack of Sampling Methodologies
  - Makes Sense: More Experimental Vulnerabilities/Overall Task of STEM Project
- Emphasis on Quantitative Data
- Similar amount of observational data and experimental data (Multifarious methodologies)



Conclusions:

- More quantitative data → higher proportion of Senior used T-tests
  - As a corollary, use of ANOVA, LinReg T-Test, etc.

Anomalies:

- Post-Hoc Tukey Test
- Computational Modelling
  - Image Overlay
  - Confusion Matrix and Accuracy
- Wilcoxon Signed Rank Test

References/Extra Resources

Linear Regression T-Test:
Stats: Modeling the World - David E. Bock, Paul F. Velleman, Richard D. De Veaux (4th Edition)

One-Way ANOVA:
https://milnepublishing.geneseo.edu/natural-resources-biometrics/chapter/chapter-5-one-way-analysis-of-variance/
https://www.statslectures.com/
https://www.youtube.com/watch?v=hJ4Bvh3YhPY

Two-Way ANOVA:
https://www.youtube.com/watch?v=7OY0DdFyJBg
https://www.youtube.com/watch?v=9zIUbbWwYV8

Image Credit for F-Distribution:
https://www.yumpu.com/en/document/view/31022748/table-a-f-distribution-probability-table-table-a6-critical-values-