ANOVA

Analysis of Variance

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Overview:

1. Introduction
2. What is ANOVA?
3. ANOVA Components
4. Example Test
5. ANOVA-Calculator
6. ANOVA-Excel

Introduction

What we know
... and what we don't

- **Hypothesis testing compares variables to draw a conclusion based on probability**
- **Z-tests**
- **T-tests**
- **Chi^2**
- These can’t do multiple populations with different variables
- This is crucial for *STEM*!

Objective

Learn what ANOVA is and be able to apply it

What is it used for

- To test if group means differ across categories
- Can be categorized into two ways:
  - One way - test differences across 1 factor
  - Two way - test difference across 2 factors + their interaction
- Example: “Tanay asks how different test fees and different prep fees affect SAT scores?”

Conditions and Assumptions

Both need:

- Independence of samples
- Normality of residuals
- Homogeneity of variance

One-way ANOVA:

- Assumptions apply across groups of one factor

Two-way Anova:

- Assumptions apply across each cell

Test statistic

One way:

Purpose: to compare 3 or more group means within ONE categorical factor
Test statistic: f-ratio
Formula:
F=MS(within)/MS(between)
What it measures:

- Between group variation (how far the group means differ)
- Within-group variation (variability within groups)

How to interpret:

- Large F = the groups differ more then expected by change
- Small F = differences are likely due to randomness

Two way:

Purpose: to test two categorical factors at once
Test Statistic: (3) F-statistics:

- Main effect A
- Main effect B
- Interaction of A and B

Test formula: (use for each one)
F=MS(effect)/MS(error)
what it measures:

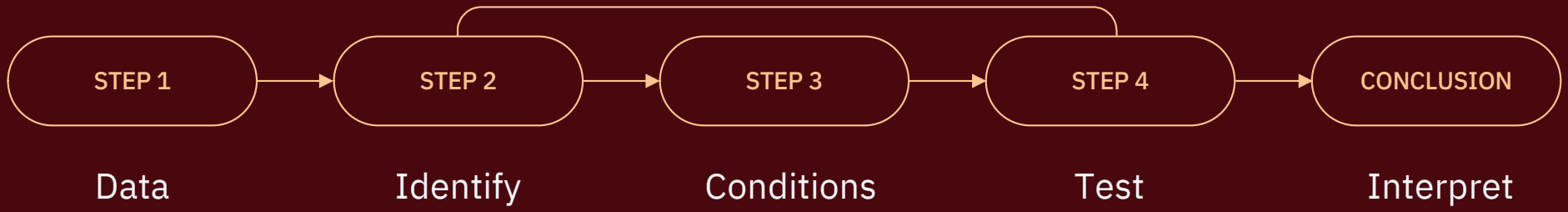
- Factor A effect sees if A changes the mean
- Factor B effect sees if B changes the mean
- Interaction sees if the effect of A deped on B

Interpretation:

- Large F = strong evidence the effect is real
- Small F = no meaningful effect

Process Summary

Your identification can determine the test you will use– one way or two way

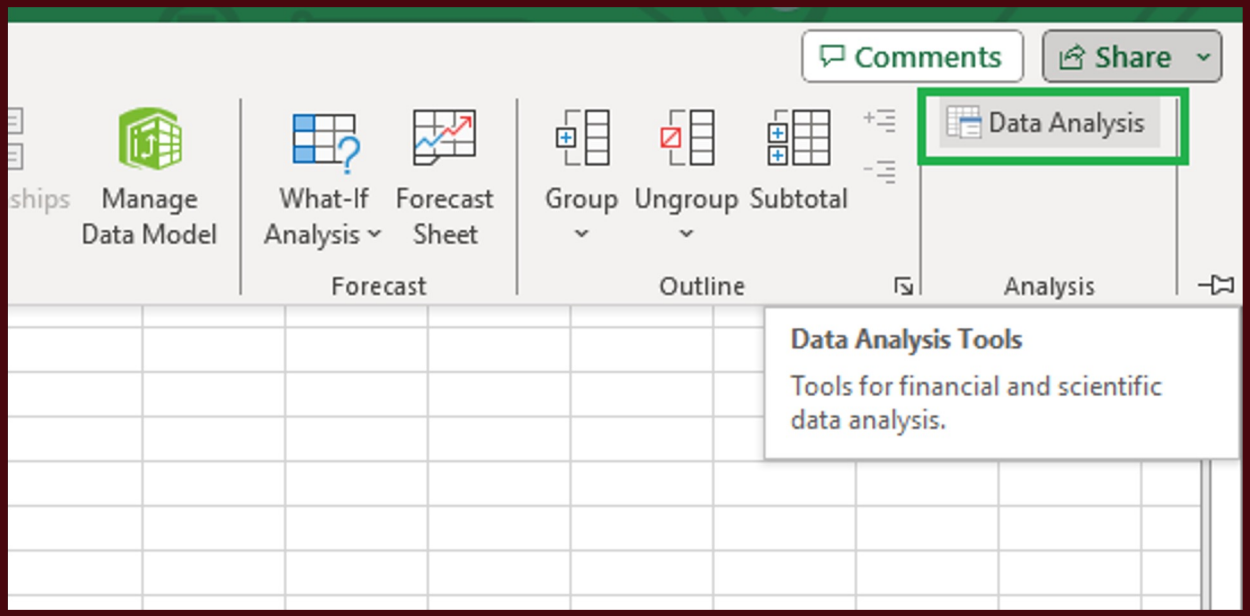


Example: Weekly Crashout Rates

	2025	2026	2027
Weekly crashout rates (crash outs/week for 10 samples students)	0.2	1.2	2.1
	1.8	1.1	0.9
	2.2	0.7	1.4
	0	1	1.2
	0	1.9	1.15
	0.4	0.6	0
	0.34	0.7	0.6
	0.7	0	0.9
	1	0.2	0.8
	0.07	0.9	3.8

Example: Excel.

Make sure you have Data Analysis Installed:



Example: Excel.

Select your data and click on Data Analysis. Select Anova: Single Factor:

A	B	C	D
	2025	2026	2027
weekly crashout rates (crashouts/month for 10 samples students)	0.2	1.2	2.1
	1.8	1.1	0.9
	2.2	0.7	1.4
	0	1	1.2
	0	1.9	1.15
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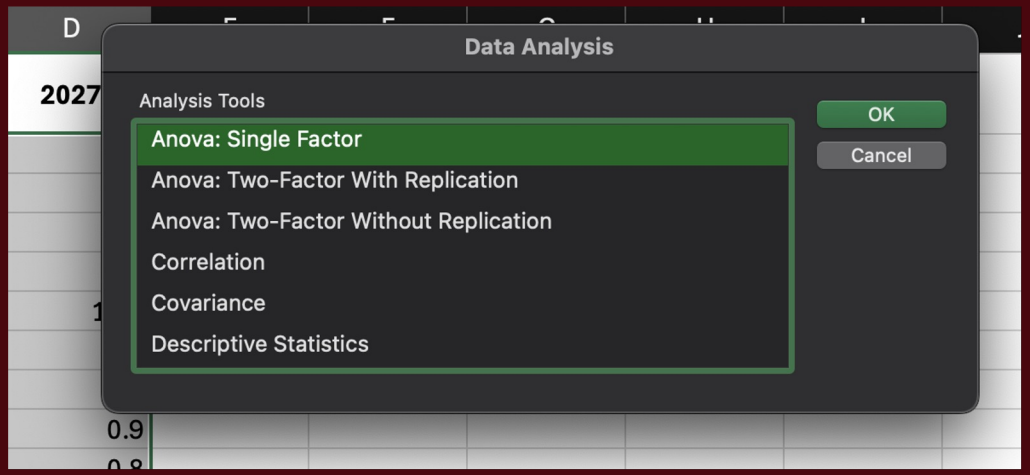
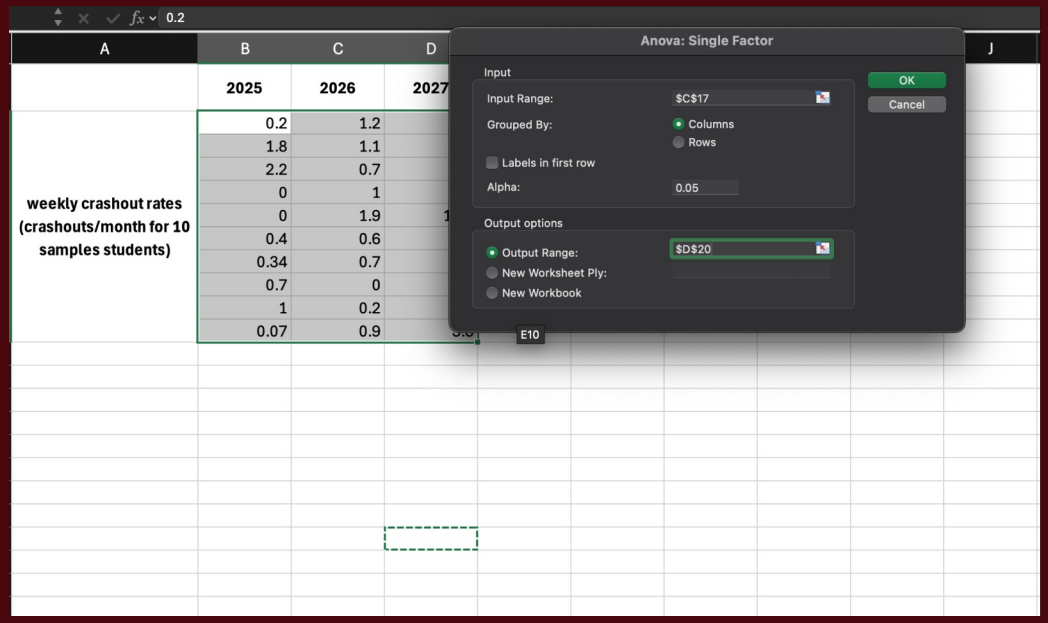


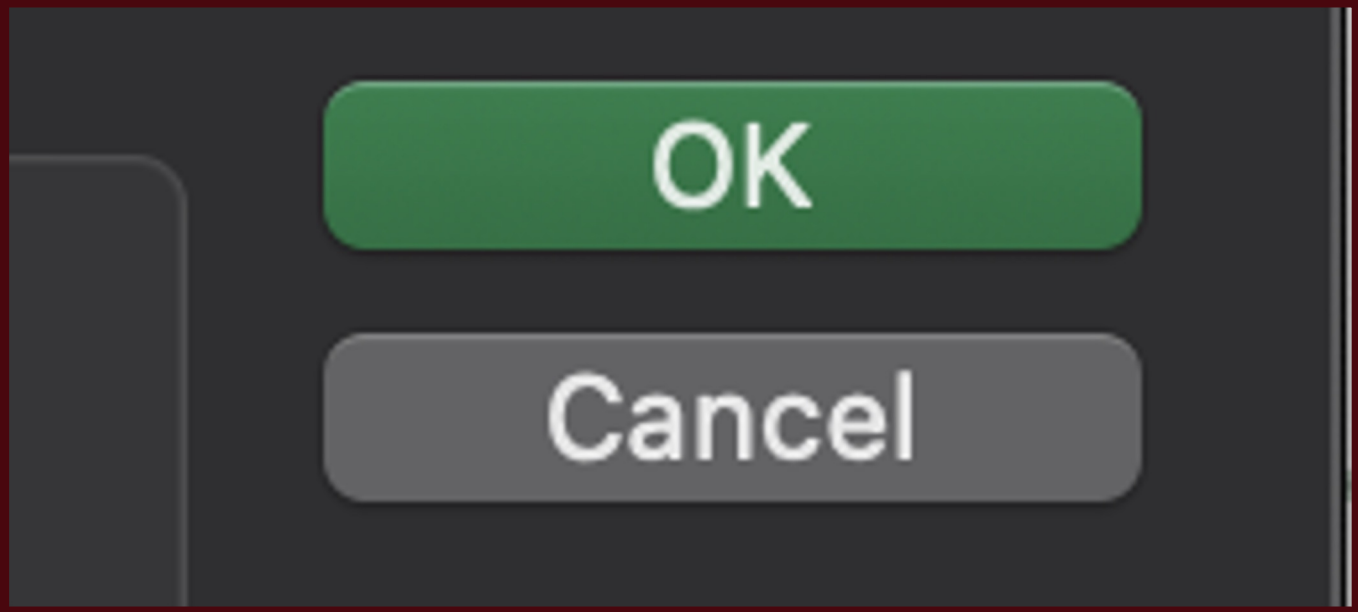
Example: Excel.

Select Columns, Output, and Data (if not already selected):



Example: Excel.

Hardest Step: Click OK



Example: Excel.

Take a look at your results and Interpret

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	10	6.71	0.671	0.59867667
Column 2	10	8.3	0.83	0.28455556
Column 3	10	12.85	1.285	1.07558333

ANOVA

Source of Variati	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Gro	2.03100667	2	1.01550333	1.55528171	0.22945943	3.35413083
Within Group	17.62934	27	0.65293852			
Total	19.6603467	29				

State the purpose of this presentation or meeting.
Explain why the content is relevant to your audience.
For example, your objective might be to better understand the competitive landscape to recognize business opportunities.