t-Test, ANOVA, Regression

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1-Sample t-Test - Example 1

The average age of class 1 in the province should be 4 years. The Govt picked samples from ADE School for class 1. Validate the claim if the average age is 4 years.

H0: The Average age of Class 1 is 4 years.
Ha: The Average age of Class 1 is not 4 years.

5-0-child_age_1t.sav

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
age	185	3.9777	1.57066	.11548

One-Sample Test

	Test Value = 4					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
age	-.193	184	.847	-.02227	-.2501	.2056

1-Sample t-Test - Example 2

A distance sheet is given in 5-1t-distance.sav. Validate the claim that average Kilometers driven per head is 5400.

H0: The Average Kilometres driven per head is 5400.
Ha: The Average Kilometres driven per head is not 5400.

5-1t-distance.sav

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Kilometres driven per head	44	5400.646313	1909.427490	287.8570249

One-Sample Test

	Test Value = 5400					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Kilometres driven per head	.002	43	.998	.6463133367	-579.8727033	581.1653300

1-Sample t-Test - Example 3

The doctors claim that people of Town A are more concerned over their health. The concern health factor should be 4.10 in case their claim is valid.

H0: The Average Concern over health is 4.10.
Ha: The Average Concern over health is not 4.10.

5-2-1t-child_health_factor_1t.sav

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Concern over health	185	4.63	1.380	.101

One-Sample Test

	Test Value = 4.10					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Concern over health	5.269	184	.000	.535	.33	.73

Paired t-Test - Example 1

An institute of health is offered a new medication from a company. In order to adapt the medicine, patients must have a difference between their calcium levels after medication. The calcium level of patients was obtained before medication and after medication to test the effectiveness.

H0: The prescribed medicine has no effect on calcium value.
Ha: The prescribed medicine has effect on calcium value.

6-pairedsamples-1.sav

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	calcium_before_medicine - calcium_after_medicine	-2.33333	2.42627	.33017	-2.99558	-1.67109	-7.067	53	.000

Paired t-Test - Example 2

Suppose a sample of n students were given a diagnostic test before studying a particular module and then again after completing the module. We want to find out if, in general, our teaching leads to improvements in students' knowledge/skills (i.e. test scores). We can use the results from our sample of students to draw conclusions about the impact of this module in general.

H0: There is no difference between pre-module and post-module scores.
Ha: There is a difference between pre-module and post-module scores.

6-pairedsamples-2.sav

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	pre_module_score - post_module_score	-2.05000	2.83725	.63443	-3.37787	-.72213	-3.231	19	.004

Paired t-Test - Example 3

A new fitness program is devised for obese people. Each participant's weight was measured before and after the program to see if the fitness program is effective in reducing their weights.

H0: The fitness program has no effect.
Ha: The fitness program has effect.

6-pairedsamples-3.sav

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	pre_fitness_weight - post_fitness_weight	.70000	2.94581	.93155	-1.40730	2.80730	.751	9	.472

Independent t-Test - Example 1

An investigator thinks that people under the age of forty have vocabularies that are different than those of people over sixty years of age. The investigator administers a vocabulary test to a group of 31 younger subjects and to a group of 31 older subjects. Higher scores reflect better performance.

H0: Both age groups have similar score.
Ha: Both age groups have different scores.

7-voc-sore.sav

Group Statistics

	type	N	Mean	Std. Deviation	Std. Error Mean
voc_score	younger	31	13.6452	1.25295	.22504
	older	31	13.0645	1.15284	.20706

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
voc_score	Equal variances assumed	.571	.453	1.899	60	.062	.58065	.30580	-.03105	1.19234
	Equal variances not assumed			1.899	59.589	.062	.58065	.30580	-.03113	1.19242

Independent t-Test - Example 2

An investigator predicts that dog owners in the country spend more time walking their dogs than do dog owners in the city. The investigator gets a sample of 21 country owners and 21 city owners.

H0: Country and city owners spend equal time.
Ha: Country and city owners spend different time.

7-ind-samples-dog-walk-time.sav

Group Statistics

	owner_type	N	Mean	Std. Deviation	Std. Error Mean
hours_spent	country owner	21	20.1905	1.28915	.28132
	city owner	21	19.7619	2.07135	.45200

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
hours_spent	Equal variances assumed	2.595	.115	.805	40	.426	.42857	.53240	-.64744	1.50459
	Equal variances not assumed			.805	33.473	.427	.42857	.53240	-.65402	1.51116

Independent t-Test - Example 3

An investigator theorizes that people who participate in a regular program of exercise will have levels of systolic blood pressure that are significantly different from that of people who do not participate in a regular program of exercise. To test this idea the investigator randomly assigns 15 subjects to an exercise program for 10 weeks and 15subjects to a non-exercise comparison group. After ten weeks the blood pressure of subjects in both groups is calculated. Are they different?

H0: There is no difference in Systolic BP.
Ha: There is a difference in Systolic BP.

7-ind-samples-systolic_bp.sav

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
sys_bp_value	Equal variances assumed	.001	.977	-1.525	28	.139	-.86667	.56848	-2.03115	.29782
	Equal variances not assumed			-1.525	27.976	.139	-.86667	.56848	-2.03120	.29787

One-Way ANOVA - Example 1

Suppose the National Transportation Safety Board (NTSB) wants to examine the safety of compact cars, midsize cars, and full-size cars. It collects a sample of three for each of the treatments (cars types). Using the hypothetical data provided below, test whether the mean pressure applied to the driver's head during a crash test is equal for each types of car.

H0: There is no difference in mean pressure on driver's head for all types.
Ha: There is a difference in mean pressure on driver's head for all types.

8-anova-cars.sav

ANOVA

mean_pressure

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	86049.556	2	43024.778	25.175	.001
Within Groups	10254.000	6	1709.000		
Total	96303.556	8			

One-Way ANOVA - Example 2

The following data represent the numbers of worms isolated from the GI tracts of four groups of rats in a trial of carbon tetrachloride as an anthelminthic. These four groups were the control (untreated) groups.

H0: There is no difference in mean worm counts across the four groups.
Ha: there is a difference in mean worm counts across the four groups.

8-anova-rat-worms.sav

ANOVA

worm_count

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	27234.200	3	9078.067	2.271	.119
Within Groups	63953.600	16	3997.100		
Total	91187.800	19			

One-Way ANOVA - Example 3

A firm wishes to compare four programs for training workers to perform a certain manual task. Twenty new employees are randomly assigned to the training programs, with 5 in each program. At the end of the training period, a test is conducted to see how quickly trainees can perform the task. The number of times the task is performed per minute is recorded for each trainee. Estimate the treatment effects for the four programs.

H0: There is no difference in training programs.
Ha: There is a difference in training programs.

8-anova-training.sav

ANOVA

performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	54.950	3	18.317	7.045	.003
Within Groups	41.600	16	2.600		
Total	96.550	19			

Linear Regression – Example 1

A study was conducted involving 20 students as they prepared for and took the Math section of the SAT Examination.

Is there a relationship between number of hours a student studies and the SAT score he gets?

9-regression-satscores.sav

Hours Spent Studying	Math SAT Score
4	390
9	580
10	650
14	730
4	410
7	530
12	600
22	790
1	350
3	400
8	590
11	640
5	450
6	520
10	690
11	690
16	770
13	700
13	730
10	640

Linear Regression – Example 1

- The relationship is significant.
- Hours are positively correlated with scores. And relationship is strong as R is very close to 1.
- For every one hour, the SAT score is effected by 25.326.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.934[a]	.872	.864	49.71785

a. Predictors: (Constant), hours_spent

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	302081.444	1	302081.444	122.208	.000[b]
	Residual	44493.556	18	2471.864		
	Total	346575.000	19			

a. Dependent Variable: math_sat_score

b. Predictors: (Constant), hours_spent

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	353.165	24.337		14.511	.000
	hours_spent	25.326	2.291	.934	11.055	.000

a. Dependent Variable: math_sat_score

Linear Regression – Example 2

In the data, the first column is exam scores and the second column is study time.

It appears that the more time students study, the higher the exam scores and the relationship looks linear. We now perform the regression analysis to see if there is an actual relationship between study time and exam scores. (We cannot make any definite conclusion until we do an appropriate statistical analysis.

9-reression-studyscores.sav

Hours Spent	Score
24	68
24	73
20	65
18	48
34	107
24	73
19	52
19	55
20	55
19	61
26	63
18	72
28	79
27	80
23	78
11	50
11	43
15	45
20	45
19	42

Linear Regression – Example 2

- The relationship is significant.
- Hours are positively correlated with scores. And relationship is strong as R is very close to 1.
- For every one hour, the score is effected by .282.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.840[a]	.705	.688	3.09177

a. Predictors: (Constant), study_score

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	410.887	1	410.887	42.984	.000[b]
	Residual	172.063	18	9.559		
	Total	582.950	19			

a. Dependent Variable: hours_spent

b. Predictors: (Constant), study_score

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.240	2.788		1.162	.260
	study_score	.282	.043	.840	6.556	.000

a. Dependent Variable: hours_spent