Homework II
Confidence Intervals and Hypothesis Tests

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Part 1:

In 1897, legislature was introduced in Indiana which would make 3.2 the official value of pi for the State.

a) Test whether the claim is true, by using the data given in the excel file "pi_data-05" at significance level 0.05.
b) Estimate 95% confidence interval of pi value.

Following table shows 25 random values are generated by using a code for pi:

3,39	3,19	3,09	3,18	3,33
2,96	3,07	3,02	3,14	2,99
2,98	3,49	3,05	3,23	3,31
3,36	2,98	2,95	3,53	3,18
3,52	3,08	3,30	3,18	3,22

Let's create Hypothesis:
$H_0 : \mu = 3.20$
$H_1 : \mu \neq 3.20$

Variance is unknown and n<30. So we will use One Sample T test
Outputs of SPSS:

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
PiData	25	3,1888	,17777	,03555

One-Sample Test

	Test Value = 3.20					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
PiData	-,315	24	,755	-,01120	-,0846	,0622

Test statistic's value t = -0,315 and critical value is $t_{0.025,24}$ = 2,064. $|-0{,}315| < 2{,}064$.
Also p value = 0,755 is greater than $\alpha = 0{,}05$. So H_0 cannot be rejected.
Confidence interval is $P(3{,}1154 \leq \mu \leq 3{,}2622) = 0{,}95$. This interval includes $\mu_1 - \mu_2 = 0$.
Claim is true at the significance level of α=0,05 with %95 confidence interval.
We can say that official value of pi is 3,2 .

Part 2:

In automobile manufacture, the manager claims that new engines release less carbon dioxide in air than standard engines. For this aim, 10 standard engines and 10 new engines have been controlled and their carbon emissions values are given in excel file “engine_data-05”.

a) Test whether the claim is true at significance level 0.05.
b) Estimate 95% confidence interval of the difference between the standard and new engines carbon emissions means.
Following table shows 10 standard engines’s and 10 new engines’s carbon emissions values.

Standard Engines	NewEngines
118,95	121,51
127,69	121,03
116,68	118,69
123,18	119,11
122,45	122,85
122,79	121,12
119,53	122,65
127,09	119,90
111,86	120,37
118,73	121,88

Let’s create Hypothesis:
$H_0 : \mu_1 > \mu_2$
$H_1 : \mu_1 \leq \mu_2$

Before testing these hypothesis, we need decide $\sigma_1^2 = \sigma_2^2$ or not.
$H_0 : \sigma_1^2 = \sigma_2^2$
$H_1 : \sigma_1^2 \neq \sigma_2^2$

Variances are unknown and n<30. So we will use Independent Samples T test.
Outputs of SPSS:

Group Statistics

	Type	N	Mean	Std. Deviation	Std. Error Mean
Engine	Standard	10	120,8950	4,77855	1,51111
	New	10	120,9110	1,39963	,44260

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
Engine	Equal variances assumed	8,836	,008	-,010	18	,992	-,01600	1,57460	-3,32410	3,29210
	Equal variances not assumed			-,010	10,533	,992	-,01600	1,57460	-3,50051	3,46851

We will decide these variances is equal or not with Levene’s Test.
As we can see in the table; Levene’s test’s significance value p = 0,008 < α = 0,05 .
As a result $H_0 : \sigma_1^2 = \sigma_2^2$ is rejected. We can say that variances are different.
Since $\sigma_1^2 \neq \sigma_2^2$, for the hypothesis we use second line of the independent samples test table.
Test statistic’s value *t* = -0,010 and critical value ≈ 2,210. $|-0,010| < 2,210$
Also p value p = 0,992 > α = 0,05. So H_0 is cannot be rejected.
Confidence interval (-3,50051; 3,46851) includes $\mu_1 - \mu_2 = 0$. H_0 cannot be rejected.
Claim is true at the significance level of α=0,05 with %95 confidence interval.
We can say that new engines release less carbon dioxide in air than standard engines.