

Question:

1) Use the attached SAS output to do the following. [This output was generated from the SAS program lab5, which is available for you to run through putty. The syntax for the program also has been added to the end of this assignment.]

(a) From the results labeled "emission control device comparison," verify the analysis that you did earlier in problem 1.

Answer: for the given data

emission control device comparison  
Obs type nox

01	1	1.65
02	1	1.78
03	1	1.12
04	1	1.26
05	1	1.21
06	1	1.89
07	1	1.13
08	1	1.35
09	1	1.96
10	1	1.70
11	1	1.87
12	1	1.14
13	2	1.11
14	2	1.06
15	2	1.08
16	2	1.09
17	2	1.05
18	2	1.15
19	2	1.12
20	2	1.14

emission control device comparison

The TTEST Procedure

Statistics

Variable	type	N	Lower CL Mean	Mean	Upper CL Mean	Lower CL Std Dev	Std Dev	Upper CL Std Dev	Std Err
nox	1	12	1.2937	1.505	1.7163	0.2356	0.3325	0.5646	0.096
nox	2	8	1.0697	1.1	1.1303	0.024	0.0363	0.0738	0.0128
nox	Diff (1-2)		0.1548	0.405	0.6552	0.1972	0.2609	0.3859	0.1191

T-Tests

Variable	Method	Variances	DF	t Value	Pr >  t
nox	Pooled	Equal	18	3.40	0.0032
nox	Satterthwaite	Unequal	11.4	4.18	0.0014

Equality of Variances

Variable	Method	Num DF	Den DF	F Value	Pr > F
nox	Folded F	11	7	84.13	<.0001

**Conclusion:**

Here the calculated t value is 3.40(equal variances).

The tabulated t value at 18 df at 5% level of significance is 2.10

So our calculated t value is greater than the tabulated t value so we reject the null hypothesis.  
So we can conclude that there is a significant difference between type1 and type2.

**SAS program for this problem:**

```
data problem1;
input type nox @@;
cards;
1 1.65 1 1.78 1 1.12 1 1.26 1 1.21 1 1.89 1 1.13 1 1.35 1 1.96
1 1.70 1 1.87 1 1.14
2 1.11 2 1.06 2 1.08 2 1.09 2 1.05 2 1.15 2 1.12 2 1.14
;
proc print;
title 'emission control device comparison';
run;
proc ttest;
class type;
run;
```

**Question:** (b) From the results labeled "garage paired t comparison," based on the data in problem 3, indicate your conclusion from testing  $H_0: \mu_D = 0$  against  $H_a: \mu_D \neq 0$ , with  $\alpha = .01$ . Give an interpretation of the attained level of significance shown on the printout

**Answer:** Null hypothesis ( $H_0$ ):  $\mu_D = 0$   
Alternate hypothesis ( $H_1$ ):  $\mu_D \neq 0$   
Number of observations =n=10

garage paired t comparison				
Obs	carnbr	garage1	garage2	diff
1	1	8.6	9.3	-0.7
2	2	11.2	11.1	0.1
3	3	10.5	10.4	0.1
4	4	2.3	3.5	-1.2
5	5	4.0	4.7	-0.7
6	6	7.3	7.8	-0.5
7	7	6.3	6.9	-0.6
8	8	7.2	7.3	-0.1
9	9	3.2	4.0	-0.8
10	10	5.8	6.2	-0.4

garage paired t comparison  
The UNIVARIATE Procedure  
Variable: diff

Moments

N	10	Sum Weights	10
Mean	-0.48	Sum Observations	-4.8
Std Deviation	0.4157991	Variance	0.17288889
Skewness	0.03199464	Kurtosis	-0.4595706
Uncorrected SS	3.86	Corrected SS	1.556
Coeff Variation	-86.624812	Std Error Mean	0.13148722

Basic Statistical Measures

Location		Variability	
Mean	-0.48000	Std Deviation	0.41580
Median	-0.55000	Variance	0.17289
Mode	0.10000	Range	1.30000
	Interquartile Range		0.60000

Tests for Location: Mu0=0

Test	-Statistic-	-----p Value-----	
Student's t	t -3.65054	Pr >  t	0.0053
Sign	M -3	Pr >=  M	0.1094
Signed Rank	S -23.5	Pr >=  S	0.0156

Quantiles (Definition 5)

Quantile	Estimate
100% Max	0.10
99%	0.10
95%	0.10
90%	0.10
75% Q3	-0.10
50% Median	-0.55
25% Q1	-0.70
10%	-1.00
5%	-1.20
1%	-1.20
0% Min	-1.20

The UNIVARIATE Procedure  
Variable: diff

Extreme Observations

----Lowest----		----Highest----	
Value	Obs	Value	Obs
-1.2	4	-0.5	6
-0.8	9	-0.4	10
-0.7	1	-0.1	8
-0.7	5	0.1	2
-0.6	7	0.1	3

**Conclusion:**

From the above the calculated t value is 3.65

The tabulated t value at 1% level of significance at 9 DF is 3.25

Our calculated t value is greater than our tabulated value so we reject the null hypothesis

So we conclude that there is a significant difference between the two garages regards the cost.

**SAS program:**

```
data problem3;
input carnbr garage1 garage2;
diff=garage1-garage2;
cards;
1 8.6 9.3
2 11.2 11.1
3 10.5 10.4
4 2.3 3.5
5 4.0 4.7
6 7.3 7.8
7 6.3 6.9
8 7.2 7.3
9 3.2 4.0
10 5.8 6.2
;
proc print;
title 'garage paired t comparison';
run;
proc univariate;
var diff;
run;
```

Question:

(c) Compare the results labeled "garage independent two-sample t test," which reanalyzes the garage data as though there were two independent sets of cars rather than the same cars evaluated by the two garages, with what you found in

Answer: Null hypothesis ( $H_0$ ): There is no significant difference between two garages regarding to the cost ( $\mu_1 = \mu_2$ )

Alternate hypothesis ( $H_1$ ): There is a significant difference between two garages regarding to the cost ( $\mu_1 \neq \mu_2$ )

From the given data  $n_1=10$  and sample mean=4.524  
 $n_2=10$  and sample mean=5.251

garage independent two-sample t test

The TTEST Procedure

Statistics

Variable	garnbr	N	Lower CL Mean	Mean	Upper CL Mean	Lower CL Std Dev	Std Dev	Upper CL Std Dev	Std Err
estimate	1	10	4.524	6.64	8.756	2.0346	2.9579	5.4	0.9354
estimate	2	10	5.251	7.12	8.989	1.7971	2.6127	4.7698	0.8262
estimate	Diff (1-2)		-3.102	-0.48	2.142	2.1087	2.7907	4.1269	1.248

T-Tests

Variable	Method	Variances	DF	t Value	Pr >  t
estimate	Pooled	Equal	18	-0.38	0.7050
estimate	Satterthwaite	Unequal	17.7	-0.38	0.7051

Equality of Variances

Variable	Method	Num DF	Den DF	F Value	Pr > F
estimate	Folded F	9	9	1.28	0.7176

garage independent two-sample t test

Obs	garnbr	estimate
1	1	8.6
2	2	9.3
3	1	11.2
4	2	11.1
5	1	10.5
6	2	10.4
7	1	2.3
8	2	3.5
9	1	4.0
10	2	4.7
11	1	7.3
12	2	7.8
13	1	6.3
14	2	6.9
15	1	7.2
16	2	7.3
17	1	3.2
18	2	4.0
19	1	5.8
20	2	6.2

### Conclusion:

Here from the above table, the calculated t value is 0.38  
The tabulated t value at 18 DF at 1% level of significance is 2.88

Our calculated t value is less than the tabulated t value, so we accept the null hypothesis.

So we can conclude that there is no significant difference between two garages regards the costs.

### SAS program for this problem:

```
data part4c;
input garnbr estimate @@;
cards;
1 8.6 2 9.3
1 11.2 2 11.1
1 10.5 2 10.4
1 2.3 2 3.5
1 4.0 2 4.7
1 7.3 2 7.8
1 6.3 2 6.9
1 7.2 2 7.3
1 3.2 2 4.0
1 5.8 2 6.2
;
proc ttest;
class garnbr;
title 'garage independent two-sample t test';
run;
proc print;
run;
```

Question: 2. What do you conclude from this application of both a paired-t test and an independent two-sample t test to the same data?

Answer: In paired t test, we take both two samples are dependent. In this test our calculated t value is more than our tabulated value. So we conclude there is a significant difference in two garages regarding to the cost.

If we take two samples are independent then the calculated t value is less than the tabulated t value so we accept the null hypothesis. So if we take two samples are independent then by using t test we can conclude that there is no significant difference between two garages regarding to the cost.

So for the same data one test is rejected the hypothesis (paired t test) and one test is accepted the hypothesis (independent t test).