

Quiz #2

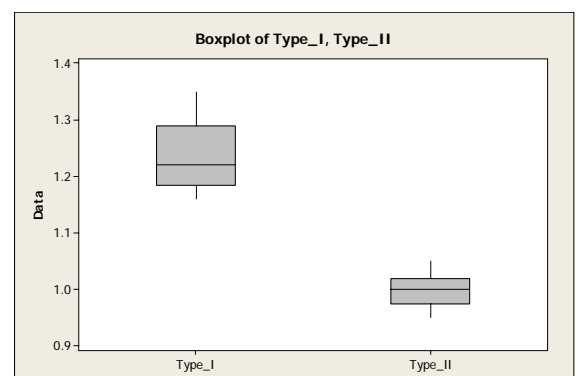
- Open book and open note. Use a simple calculator if necessary. Show your work. Each subproblem is 3 points each.

1. Two different emission-control devices were tested to determine the average amount of NO emitted by an automobile over a 1-hour period of time. Twenty cars of the same model and year were selected for the study. Ten cars were randomly selected and equipped with a Type I emission-control device, and the remaining cars were equipped with Type II devices. Each of the 20 cars was monitored for a 1-hour period to determine the amount of NO emitted. The research hypothesis is that the mean level of emission for Type I devices (μ_1) is greater than the mean emission level for Type II devices (μ_2). The following output shows the relevant minitab output. Answer the following questions:

Two-sample T for Type_I vs Type_II				
	N	Mean	StDev	SE Mean
Type_I	10	1.2360	0.0636	0.020
Type_II	10	0.9970	0.0306	0.0097

Difference = mu (Type_I) - mu (Type_II)
 Estimate for difference: 0.239000
 95% lower bound for difference: 0.199213
 T-Test of difference = 0 (vs >): T-Value = 10.71 P-Value = 0.000 DF = 12

- a. Construct 90% confidence intervals on the mean emission level for Type I and Type II devices separately. Do the two confidence intervals overlap?
- b. What is the assumption(s) you make in constructing the confidence intervals in (a)? How do you check that assumption(s)?
- c. Do the data provide sufficient evidence that Type I devices have greater mean level of emission than Type II devices? Use $\alpha=0.01$.
- d. Was the pooled t test or the separate-variance t-test used in the computer output?
- e. Do the required conditions to use the test in (c) appear to be valid for this study? How would you justify your answer?
- f. Which procedure would you use if the required conditions to use the test in (c) are not valid? Give the name of the procedure.
- g. What is the new assumption(s) made by the alternative procedure in (f)?
- h. How large is the difference between the mean emissions for Type I and Type II devices?
- i. Suppose that the study design was such that 10 cars were randomly selected and equipped with a Type I device over an hour, monitored over an hour for NO emission and then changed to Type II device and monitored over an hour for NO emission. Which procedure would you use for such data instead of (c)? Explain why the new procedure is a better approach.
- j. The experimental design described in (i) is not entirely ideal. How can you improve the study design?



Quiz #2 Solutions

1. The data is from ex. 6-8. Given: $\bar{y}_1 = 1.236, \bar{y}_2 = .997, s_1 = .0636, s_2 = .0306$.

- a. Use $\bar{y} \pm t_{\alpha/2} (n-1) \frac{s}{\sqrt{n}}$. The two intervals are (1.199, 1.273) and (0.9793, 1.0147). The two intervals don't overlap.
- b. Population distributions are close to normal or mound shaped. Draw normal probability plot to check it.
- c. Yes. The P-value is 0 and the data provides sufficient evidence that $\mu_1 > \mu_2$.
- d. The separate-variance t-test is used, which is apparent from the d.f. (pooled variance t-test would have d.f.=20-2=18)
- e. Yes. The distributions are supposed be normal or mound-shaped and the boxplot seems to confirm that. To further confirm it, one could draw a normal probability plot for each sample.
- f. If normality doesn't hold, use Wilcoxon rank-sum test.
- g. Wilcoxon test requires the two populations have distributions with the same shape, only shifted.
- h. $\bar{y}_1 - \bar{y}_2 = 0.239$
- i. Use paired t-test. The paired t-test controls potentially large vehicle-to-vehicle variation and separates out the real difference between the two devices better.
- j. One should randomize the order in which devices I and II are installed as well. For each vehicle, flip a fair coin to decide whether Device I or II will be tried on first.