Quiz Practice Questions 5 (Attendance 10) for Statistics 503
Introduction to Statistics
Material Covered: Sections 8.1–8.4, 8.6, 8.7 Rao and Kuhn

These are practice questions for the quiz. The quiz (not the practice questions) is worth 5% and marked out of 5 points. One or more questions is closely, but not necessarily exactly, related to one or more of these questions will appear on the quiz. These practice questions are *not* to be handed in. Quizzes are to be done *using Vista* on the Internet **before** 4am of the date of the quiz. Vista will *not* allow any quiz to be done late. It is *highly* recommended that you complete this practice quiz, by hand, *before* logging onto Vista. The quiz is an **individual** one which means that each student does this quiz by themselves without help from others. Also check out *previous* quizzes given at

http://www.pnc.edu/faculty/jkuhn/courses/previous/quizzes/quizzes.html

1. Statistical Research Methods in the Life Sciences (Rao) Questions.

Section	Exercise(s)	hints
8.2, pages 282–283	(8.1)	see below
	(8.3)	see below
8.3, pages 287	(8.5)	see below
8.4, pages 292–295	(8.8)	look below
	(8.9)	look below
	(8.11)	look below
	(8.17)	look below
8.6, pages 304–305	(8.27)	look below
	(8.29)	look below
8.7, page 311	(8.34)	look below
	(8.36)	look below
Summary of quiz material		look below

(8.1) eye irritation

Design 1 is the completely randomized design (CRD) because it satisfies the assumptions of this design; in particular, ten subjects with irritated eyes are treated and ten other subjects with irritated eyes, chosen *in*dependently from the first, are left untreated. The CRD is a generalization of the two–independent–samples t test.

Design 2, on the other hand, is not a CRD because the ten subjects have both eyes irritated, where one eye of each is treated and the other eye of each (clearly "paired" or *dependent* on the first eye) is left untreated. This design is a generalization of the *paired* t test.

In both designs, there are two treatments (treated, not treated). In both designs, there are 10 replications of each treatment (although fewer subjects are used in the second (smarter) design).

(8.3) insulin release

(a) $y_{1+} = 8.93$, $y_{2+} = 13.75$, $y_{3+} = 18.00$

(b) $y_{++} = 40.68$, $\bar{y}_{++} = 3.39$

(c) $\bar{y}_{1+} = 2.23$, $\bar{y}_{2+} = 3.44$, $\bar{y}_{3+} = 4.50$

(d) $s_1^2 = 0.905$, $s_2^2 = 0.212$, $s_3^2 = 0.543$

(8.5) more insulin release

(a) plot of means and sample points should show them different from one another; use side–by–side box plots on the calculator

(b) the variances for the three samples seem similar (the "spread" in each of the three data sets seem similar) except for treatment 1, which appears to have an outlier

(c) $s^2 = \frac{0.9051+0.2121+0.5426}{3} = 0.5533$ estimates σ^2

(d) since plot shows means far apart from one another, it seems $H_0 : \mu_1 = \mu_2 = \mu_3$ can be rejected

(e) at least two of the average insulin release amounts are different

(f) assumptions

three samples are independent of one another

samples normal

sample variances identical

(g) $MS[T] = 5.1483$, $MS[E] = s^2 = 0.5533$, so $F = \frac{5.1483}{0.5533} = 9.30$ and p–value is essentially zero, so reject the null
(use STAT TESTS ANOVA)

(8.8) ANOVA table

(a) table

Source	Degrees of Freedom	Sum Of Squares	Mean Squares	F
Treatment	3	126	42	2.625
Error	20	320	16	
Total	23	446		

(b) four (4) treatments because 3 df

(c) 6 replications per treatment since 24 observations (total df is 23) and $\frac{24}{4} = 6$

(d) 1. *Statement.* $H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$ versus
$H_1 :$ at least one $\mu_i \neq \mu_j, i \neq j;\ i, j = 1, 2, 3, 4.$

2. *Test.* Since the test statistic is $F = 2.625$, and the p–value, with $k - 1 = 3$ and $N - k = 9$ degrees of freedom, is given by

$$\text{p–value} = P(F \geq 2.625) \approx 0.079$$

(Use 2nd DISTR 9:Fcdf(9.30,E99,3,20).)
The level of significance is 0.05.

3. *Conclusion.* Since the p–value, 0.079, is larger than the level of significance, 0.05, we accept the null hypothesis that the means are the same.

(8.9) more insulin release

(a,b) 1. *Statement.* $H_0 : \mu_1 = \mu_2 = \mu_3$ versus
$H_1 :$ at least one $\mu_i \neq \mu_j, i \neq j;\ i, j = 1, 2, 3.$

2. *Test.* Since the test statistic is $F = 9.30$, the p–value, with $k - 1 = 3 - 1 = 2$ and $N - k = 12 - 3 = 9$ degrees of freedom, is given by

$$\text{p–value} = P(F \geq 9.30) \approx 0$$

(Use 2nd DISTR 9:Fcdf(9.30,E99,2,9).)
The level of significance is 0.05.

3. *Conclusion.* Since the p–value, 0, is smaller than the level of significance, 0.05, we reject the null hypothesis that the insulin release amounts are the same.

(8.11) serum phosphate levels

(a) observed (not experiment) since investigators (presumably) did not somehow infect patients with sickle cell anemia, that the patients were ill of sickle cell anemia of their own accord
factor: phosphate, with three levels (low, sickle cell; high, sickle cell and no sickle cell)
replications: 5, 4 and 7 for three levels, respectively

(b) ANOVA

1. *Statement.* $H_0 : \mu_1 = \mu_2 = \mu_3$ versus
   $H_1 :$ at least one $\mu_i \neq \mu_j, i \neq j;\ i, j = 1, 2, 3.$
2. *Test.*

Source	Degrees of Freedom	Sum Of Squares	Mean Squares	F
Treatment	2	5.446	2.723	12.22
Error	13	2.896	0.223	
Total	15	8.343		

Since the test statistic is $F = 12.22$, the p–value, with $k-1 = 3-1 = 2$ and $N - k = 16 - 3 = 13$ degrees of freedom, is given by

$$\text{p–value} = P(F \geq 12.2) \approx 0.001$$

(Use 2nd DISTR 9:Fcdf(12.2,E99,2,13).)
The level of significance is 0.05.

3. *Conclusion.* Since the p–value, 0.001, is smaller than the level of significance, 0.05, we reject the null hypothesis that the average serum phosphate amounts are the same.

(8.17) influence of menopause on cholesterol levels

(a) initial calculations

1. $\bar{y}_{++} = \frac{n_1\bar{y}_{1+}+\cdots+n_7\bar{y}_{7+}}{N} = 202.44$
2. $SS[T] = n_1(\bar{y}_{1+} - \bar{y}_{++})^2 + \cdots + n_7(\bar{y}_{7+} - \bar{y}_{++})^2 = 60775.34$
3. $SS[E] = \frac{(n_1-1)s_1^2+\cdots+(n_7-1)s_7^2}{N-t} = 163776$
4. $MS[T] = \frac{SS[T]}{t-1} = \frac{60775.34}{7-1} = 10129.22$
5. $MS[E] = \frac{SS[E]}{N-t} = \frac{163776}{103-7} = 1706$
6. $F = \frac{MS[T]}{MS[E]} = \frac{10129.22}{1706} = 5.93$
   and the ANOVA table is

Source	Degrees of Freedom	Sum Of Squares	Mean Squares
Treatment (menopause)	6	60775.34	10129.22
Error	96	163776.00	1706.00
Total	102	224551.34	

(b) ANOVA

1. *Statement.* $H_0 : \mu_1 = \cdots = \mu_7$ versus
   $H_1 :$ at least one $\mu_i \neq \mu_j, i \neq j;\ i, j = 1, \ldots, 7.$
2. *Test.* Since the test statistic is $F = 5.93$, the p–value, with $k - 1 = 7 - 1 = 6$ and $N - k = 103 - 7 = 96$ degrees of freedom, is given by

$$\text{p–value} = P(F \geq 5.93) \approx 0$$

   (Use 2nd DISTR 9:Fcdf(5.93,E99,6,96).)
   The level of significance is 0.05.
3. *Conclusion.* Since the p–value, 0, is smaller than the level of significance, 0.05, we reject the null hypothesis that the average cholesterol amounts are the same.

(8.27) insulin and residual plots

1. *Normality?* The q–q plot for the data indicates **left skew**
   (Type drug 1, 2 and 3 responses in L_1, L_2, L_3 respectively, then PRGM QQPLTANV ENTER 3 ENTER)
2. *Equal Variance?* The $e \vee p$ plot for the data indicates variance is *not* constant with respect to the mean μ (although one of the points in the low concentration does seem to be an outlier). Furthermore, it does not appear this residual plot matches one of the given patterns and so it appears we cannot transform the data to fix this Exercise.
   (Type drug 1, 2 and 3 responses in L_1, L_2, L_3 respectively, then PRGM EVPPLOT ENTER 3 ENTER)
3. It does not seem appropriate to use ANOVA on this data because of non–normality and non–constant variance.

(8.29) cholesterol levels residual plots

1. *Normality?* The q–q plot indicates the data is **not** normal.
2. *Equal Variance?* The $e \vee p$ plot for the data indicates variance is *not* constant with respect to the mean μ. Furthermore, it does not appear this residual plot matches one of the given patterns and so it appears we cannot transform the data to fix this Exercise.
3. It does not seem appropriate to use ANOVA on this data because of non–constant variance (although the non–constant variance might be due to small sample size)

(8.34) insulin and residual plots of log transformed data

(a) The residual plots do not seem to indicate that any transformation, and, in particular, the log transformation, will cause the data to have constant variance–but, it is suggested we try the log transformation in any case.

(b) residual plots of log–transformed data
after taking the log of all of the twelve data points, we find

1. *Normality?* The q–q plot for the log–transformed data (still) indicates **left skew**
2. *Equal Variance?* The $e \vee p$ plot for the transformed data (still) indicates the variance is *not* constant with respect to the mean μ.
3. It does not seem appropriate to use ANOVA on this transformed data because of non–constant variance (although the non–constant variance might be due to small sample size)

(8.36) nematodes and residual plots of square–root transformed data
after taking the square root of all of the data points, we find

1. *Normality?* The q–q plot for the (square root of the) data indicates **non–normality**
2. *Equal Variance?* The $e \vee p$ plot for the (square root of the) data indicates variance is *not* constant with respect to the mean μ.
3. It does *not* seem appropriate to use ANOVA, but, in any case, it is

Source	Degrees of Freedom	Sum Of Squares	Mean Squares	F
Treatment	3	2.9168	0.9722	3.298
Error	27	7.9597	0.2948	
Total	30	10.8765		

and since p–value is 0.0354, which is less than 0.05, we reject the null that average nematodes per soil sample are the same

You are responsible for:

- test using one way ANOVA (completely randomized design, CRD)
- checking for violations of assumptions for CRD, particularly
  - normality, q–q plot
  - constant variance, $e \vee p$ plot
- transforming data
  - logarithm transformation
  - arcsin transformation ($g(y) = sin^{-1}\sqrt{y}$)
  - poisson (square–root transformation)