

## Corrections to the second and subsequent printings

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*Design and Analysis of Experiments*

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### Chapter 3

Page 37. Add to the last paragraph “Also note that when notation involves both a sum and a square, such as  $y^2$  or  $\bar{y}_i^2$ , the sum is taken first and then the sum is squared.

Page 39. The last sentence should be, “The notation  $\hat{\mu} + \hat{\tau}_i$  is used...”

Page 48 Line 6. References should be to Example 3.4.2 not 3.4.4.

Page 52. Change item (c) near the page bottom to be as follows.

- (c) For the required power  $\pi(\Delta)$ , we use Table A.7 to determine  $\phi$  and take the larger listed value if necessary.

Page 53. In the tabular material at the end of Example 3.6.1, change 2.48 to 2.67 and 4.13 to 4.79.

Page 55. In Table 3.7,  $ssE = 0.6946$ , not 0.6945.

Page 55.  $ssT = \dots = 16.1220$ , not 16.12210

Page 62. In Table 3.11, the first observation is 22.0, not 22.4.

### Chapter 4

Page 69 Line -4. Reference should be to Example 3.4.2 not 3.4.4.

Page 71 Line 7. Replace “by over two hours” with “by over four hours”.

Page 72 Line 1. Reference should be to Example 3.4.1 not 3.4.4.

Page 74 Line 1 of Example. Reference should be to Example 3.4.1 and Example 4.2.3 not 3.4.4 and 4.2.4.

Page 75 Line 2 of Example. Reference should be to Example 3.4.1 not 3.4.4.

Page 77 Line -5. Replace 3.675 by 3.508.

Page 77. When written in full, the denominator in  $ssc/mse$  is

$$\frac{ssc}{msE} = \frac{\left[\frac{1}{3}(\bar{y}_1. + \bar{y}_4. + \bar{y}_7.) - \frac{1}{4}(\bar{y}_2. + \bar{y}_3. + \bar{y}_5. + \bar{y}_6.)\right]^2}{msE \left[\frac{(\frac{1}{3})^2}{3} + \frac{(\frac{1}{3})^2}{3} + \frac{(\frac{1}{3})^2}{3} + \frac{(-\frac{1}{4})^2}{3} + \frac{(-\frac{1}{4})^2}{3} + \frac{(-\frac{1}{4})^2}{3} + \frac{(-\frac{1}{4})^2}{3}\right]} > F_{1,14,\alpha}.$$

Page 84 Line 5. Reference should be to Example 4.4.1 not 4.4.2.

Page 84 Line 7. Reference should be to Example 4.4.1 not 4.4.2.

Page 88. The comments on the one-sided bounds are wrong. Below (4.4.29), it should say, “If the right hand side of (4.4.29) is positive, we infer that the  $i$ th experimental treatment gives a larger response than the control.” Also, below (4.4.30), it should say “If the right-hand side is negative, we infer that the  $i$ th experimental treatment gives a smaller response than the control.”

Pages 94–95. Switch order of “Contrast” and “estimate” statements in Table 4.2 to match the output in Table 4.3. Correspondingly change line numbers in Table 4.2 and on lines -1 of page 94 and -6 of page 95. (SAS output automatically lists output of “contrast” statements before output of “estimate” statements regardless of their order in the SAS program.)

Page 98. The one-sided alternative hypothesis should read “ $H_A : \tau_0 - (\tau_1 + \tau_2 + \tau_3)/3 > 0$ ” (or, “ $H_A : (\tau_1 + \tau_2 + \tau_3)/3 - \tau_0 < 0$ ”)

Page 100 Question 11 change wording. Replace “repeat” by “conduct an experiment similar to”.

## Chapter 5

Page 105. In the 4th last line, change “Example 5.2.2” to “Figure 5.1”.

## Chapter 6

Page 135. In line 9 of the Introduction, remove “a” from “...the a 2-digit code...”

Page 136. Line 14 of Section 6.2.1 should refer to “Page 12” not “Page 7”.

Page 150. The  $\alpha$  level is in error. Also, the critical coefficient should be called  $w_B$ . So, above Figure 6.4, it should say, “... $w = w_B = t_{(18-6),0.005} = 3.055$ , giving

$$\begin{aligned}\alpha_2^* - \alpha_1^* &\in \left( \bar{y}_{2..} - \bar{y}_{1..} \pm w_B \sqrt{msE (1/br + 1/br)} \right) \\ &= 0.0723 \pm (3.055) \sqrt{0.000289(2/9)} = (0.0478, 0.0968) .”\end{aligned}$$

Page 151. Line 2 should read, “...between 0.0478 and 0.0968 seconds faster...”

Page 151. Line 7 reference should be to “Example 6.4.4”, not “Example 6.4.3”.

Page 151. Delete the last sentence, “The methodology will be illustrated...”.

Page 152. The third equation should have  $d_{ij}^2$ , not  $d_{ij}$

Page 152. The third Tukey confidence interval is for  $\beta_3^* - \beta_2^*$ , not  $\beta_1^* - \beta_3^*$ , so  $\beta_3^* - \beta_2^* \in (121.34, 755.86)$

Page 154. The last display should contain  $y_{ijt}^2$  instead of  $y_{ijt}$  to read

$$ssE = \sum_i \sum_j \sum_t y_{ijt}^2 - \sum_i \sum_j y_{ij.}^2 / r.$$

Page 156. Line 5. Alternative hypothesis is  $H_A^A$  not  $H_0^A$ .

Page 168. In the first line of Section 6.6, change “In Chapter 3,...” to “In Chapters 3 and 4,...”

Page 170. Last line. Reference should be to Example 6.3.1 not 6.3.2.

Page 191. Table 6.24. Table caption should say “Data for water boiling experiment, in minutes. (Order of observations is given in parentheses).”

Page 191. Problem 21d. Replace “...this observation.” with “...this observation, but do the test in part (c) for the linear contrast only. (The formula for the linear contrast coefficients is given in (4.2.4) on page 71.)”

## Chapter 7

Page 232–233 Line -3. For Exercise 5, change the 3rd last line to be, “...in Table 7.18. The error mean square was calculated to be 6.598 with 36 degrees of freedom.”

Page 234. In Exercise 7, in the line above part (a), change “n” to “in”.

Page 237. In Exercise 10d, delete “at least”.

Page 241. Question 15c. Change “ $\times 100$ ” to “ $\times 1000$ ”.

## Chapter 10

Page 300, Line 6 of Example 10.3.2. Interchange 50% and 100% to read “ Two levels of capacity were selected, 100% and 50%. ”

Page 300, Lines 8,9 of Example 10.3.2. Interchange 50% and 100% so that the display reads

$$\begin{aligned}(100\%, \text{Brand 1}) &= 1 & (100\%, \text{Brand 2}) &= 2 & (100\%, \text{Brand 3}) &= 3 \\ (50\%, \text{Brand 1}) &= 4 & (50\%, \text{Brand 2}) &= 5 & (50\%, \text{Brand 3}) &= 6\end{aligned}$$

Page 308. Below the display calculating “msd”, the following changes need to be made.

treatment 1 should read “ordinary flyer, 1.69 twist”.

treatment 2 should read “ordinary flyer, 1.78 twist”.

treatment 6 should read “special flyer, 1.78 twist”.

Page 309. In Figure 10.3, change “ $\bar{y}_{hi}$ .” to “ $\bar{y}_i$ ”.

Page 311. In Example 10.6.1, the reference in line 2 should be to “Example 10.3.2, page 300” not to “Ex 10.3.4 page 311.”

Page 311, Lines 4,5 of Example 10.6.1. Interchange 50% and 100% so that the display reads

$$\begin{aligned} (100\%, \text{Brand 1}) = 1 & \quad (100\%, \text{Brand 2}) = 2 & \quad (100\%, \text{Brand 3}) = 3 \\ (50\%, \text{Brand 1}) = 4 & \quad (50\%, \text{Brand 2}) = 5 & \quad (50\%, \text{Brand 3}) = 6 \end{aligned}$$

Page 312, Lines 5, 6 below table. Interchange 50% and 100% so that it reads “Consequently, Figure 10.4 suggests that treatments 1 and 2 are better than treatment 3 at 100% capacity. These treatments correspond to Brands 1 and 2 which are the more expensive brands. The position is less clear for 50% capacity. These contrasts will be examined in detail in Example 10.6.2.”

Page 313. Line 7 should be  $w_T = q_{v,n-v-b+1,\alpha}/\sqrt{2}$

Page 322. On page 322 at the end first paragraph (in line 4), insert “(See Table 10.16.)”. At the end of the second paragraph (in the 7th last line), insert “(See Table 10.17.)”.

Page 325. Qu3. In line 2 of the question the value of twist should be 1.69, not 1.63.

Page 336. Table 10.29. Delete the heading “(order)” in three places.

## Chapter 11

Page 344. Line 2, Reference to “Example 11.2.2” should be “Example 11.2.1”

Page 374. Line 4 below table. “Section 6.8, page 175” should be “Section 6.8.1, page 177”.

Page 374. Line 10 is missing. Lines 9–10 should be, “Partial output is shown in Table 11.18.”

Page 382. In exercise 12(b), change “ $\bar{y}_i - \bar{y}_p$ .” to “ $\bar{y}_{.i} - \bar{y}_{.p}$ ”

## Chapter 12

Page 393. In the paragraph above Example 12.2.1, the second sentence should be as follows. “Treatment 1, for example, appears in one block with each of treatments 3 and 4, in two blocks with 2 and 7, and not at all with treatments 5, 6, or 8.”

Pages 404–405. The simultaneous 95% confidence intervals in Example 12.5.2 should be as follows.

$$\begin{aligned} \tau_3 - \tau_1 & \in (27.500 \pm 16.743) = (10.58, 44.24), \\ \tau_2 - \tau_1 & \in (12.333 \pm 16.743) = (-4.41, 29.08), \\ \tau_3 - \tau_2 & \in (15.167 \pm 16.743) = (-1.58, 31.91). \end{aligned}$$

Page 419. Augment the Table 12.15 caption to include, “—data are ‘true number’ minus ‘guessed number’”

## Chapter 13

Page 422. The fifth line of section 13.2.1 should read, “A factorial experiment is called *symmetric* if all factors...”

Page 426. Line -4 and -5. Switch +1 and -1. (In other words, it should be “... +1 appear in Block I...” and “... -1 appear in Block II...”.)

Page 431.

The bottom section of Table 13.7 should be as follows.

Block	Contrast Coefficients ( <i>ABCD,ABC</i> )	Treatment Combinations
I	(-1, -1)	0001 0111 1011 1101
II	(-1, 1)	0010 0100 1000 1110
III	(1, -1)	0000 0110 1010 1100
IV	(1, 1)	0011 0101 1001 1111

Also, change the second paragraph below Table 13.7 to say that, "...the treatment combinations in Block I and Block IV have the fourth digit equal to 1, and all of those in Blocks II and III have the fourth digit equal to 0."

Page 443. Line -8. replace "repeating" by "using".

Page 451, Table 13.18, change "110" to "010" in block X.

## Chapter 15

Page 485. Half way down the page should read: This " $A = BC$ " contrast is equal to...

$$= [-\bar{\tau}_{0..} + \bar{\tau}_{1..}] + \frac{1}{2}[\bar{\tau}_{.00} - \bar{\tau}_{.01} - \bar{\tau}_{.10} + \bar{\tau}_{.11}].$$

Page 486. Half way down the page should read: The estimable  $A$  contrast in the three-way model is of the form...

$$= [-\bar{\tau}_{0..} + \bar{\tau}_{1..}] - \frac{1}{2}[\bar{\tau}_{.00} - \bar{\tau}_{.01} - \bar{\tau}_{.10} + \bar{\tau}_{.11}],$$

Page 503. Example 15.5.1. Label this "Flour experiment number 3", not "Flour experiment"

Page 507. Lines 7 and 8. Replace " $p = 8$  rows and  $p - 1 = 7$  columns" by " $2^p = 8$  rows and  $2^p - 1 = 7$  columns".

Page 511. In Table 15.26, the levels of factor  $A$ —namely, the first column of digits in the table—should be eight zeroes followed by eight ones, not 16 zeroes.

Page 517. In line 7, change "Under designed experimental conditions, it was possible..." to "For the experiment, it was possible..."

Page 535 Ex 8. The design in Table 15.50 should be as follows.

Block	$A$	$B$	$C$	$D$	$E$	$F$	$G$	$H$	$J$	$K$	$L$	$M$	$N$	Repl. I	Repl. II
II	0	0	0	0	1	1	1	1	1	0	0	0	0	1511	1506
I	1	0	0	0	0	0	1	1	0	1	1	0	0	375	370
I	0	1	0	0	1	1	0	0	0	1	0	1	0	392	392
II	1	1	0	0	0	0	0	0	1	0	1	1	0	523	520
I	0	0	1	0	0	1	0	1	0	0	1	1	1	481	479
II	1	0	1	0	1	0	0	1	1	1	0	1	1	2238	2230
II	0	1	1	0	0	1	1	0	1	1	1	0	1	550	551
I	1	1	1	0	1	0	1	0	0	0	0	0	1	546	542
I	0	0	0	1	1	0	1	0	1	1	1	1	1	369	367
II	1	0	0	1	0	1	1	0	0	0	0	1	1	2242	2243
II	0	1	0	1	1	0	0	1	0	0	1	0	1	584	592
I	1	1	0	1	0	1	0	1	1	1	0	0	1	446	447
II	0	0	1	1	0	0	0	0	0	1	0	0	0	1776	1782
I	1	0	1	1	1	1	0	0	1	0	1	0	0	1053	1059
I	0	1	1	1	0	0	1	1	1	0	0	1	0	462	463
II	1	1	1	1	1	1	1	0	1	1	1	0	0	582	582

Page 538, exercise 10, should read as follows. "The orthogonal array in Table 23 was selected with columns 1–3, 5–7 labeled  $D, C, B, F, A, E$ . Columns 1 and 7 were multiplied by  $-1$ . One degree of freedom (corresponding to column 4) is available to measure  $\sigma^2$  or one of the two-factor interactions."

## Chapter 16

Page 547. Delete the last sentence on the page—namely, "The levels at which the observations were taken are marked on the plot."

Page 548, line -6. Change "(as illustrated in Figure 16.1)." to "(as suggested by Figure 16.1)."

Page 559. The reference at end of Example 16.2.4 should be to Example 16.3.1.

Page 563, Example 16.3.1. The experimenters chose  $\alpha$  to be approximately equal to  $\sqrt{2}$ , but not exactly. In Table 16.9, the entries  $\sqrt{2}$  for "Anode-cathode separation" (Factor A) should be 1.5, and the entries  $\sqrt{2}$  for "Current density" (Factor B) should be 1.4.

Page 566. In lines 2 and 3, the center points are 4.32 and 4.25, which have sample variance 0.00245. This gives  $F = 19.299$  for the lack-of-fit test. This is still not significant, with  $P > 0.10$ . The text at the

top of page 566 should say:

“ Before settling on a final model, we should check the lack of fit of the second-order model. The only replication consisted of two center-point observations with values 4.32 and 4.25. The sample variance of these two observations is  $s_0^2 = 0.00245$ , so  $ssPE = 0.00245$  with one degree of freedom. From the analysis of variance table, Table 16.11, we see that  $ssE = 0.1443$  with 4 degrees of freedom. So,

$$ssLOF = ssE - ssPE = 0.1443 - 0.00245 = 0.14185$$

with  $4 - 1 = 3$  degrees of freedom for lack of fit. There is significant lack of fit of the second-order model if

$$msLOF/msPE > F_{3,1,\alpha},$$

for appropriate significance level  $\alpha$ . Here,

$$msLOF/msPE = (0.14185/3)/(0.00245/1) = 19.299,$$

which is less than  $F_{3,1,0.10} = 53.6$ , so there is no significant lack of fit of the second-order model, and the model fitted in Example 16.3.2, page 563, should be a reasonable approximation to the true surface in the local region under study ( $9.5 \leq x_A \leq 11.5$ ;  $31 \leq x_B \leq 41$ ).  
□”

Page 573 PAH expt. Reference to Table 16.19 should be Page 581 not Page 582.

Pages 580–584. Delete the parenthetical remark “(see page 58#)” under each table.

## Chapter 17

Page 604 Line -2. Reference should be to Examples 17.3.1 and 17.3.2 not to Examples 17.3.3 and 17.3.4

Page 606 Line 2 of Example 17.3.4. Reference should be to Examples 17.3.1 and 17.3.2 not to Examples 17.3.3 and 17.3.4

Page 616. Line 13 should read

$$u = (msB - ms(AB) - ms(BD) + msE)/adr$$

so that the signs match those of the estimator  $U$ .

Page 623. Equation (17.7.25) should have  $Y_{ijkl}$ , not  $Y_{ijl}$

Page 631. Table 17.11 should have  $mse = 802.57$ .

Page 632. In line 3 of section 17.10.1, change “ $r = 11$ ” to “ $r = 4$ ”

Pages 633–634. The following 2 changes are needed to generate Figure 17.5, which is a plot of the treatment averages rather than the predicted values.

First, delete “—namely, the standardized predicted values—” from the sentence ending page 633 and starting page 634.

Secondly, replace Table 17.12 on page 634 with the following.

```
PROC SORT; BY BALE;
PROC MEANS NOPRINT; BY BALE;
VAR CONTENT;
OUTPUT OUT=WOOL2 MEAN=AVCONT;
PROC STANDARD STD=1.0 MEAN=0.0;
VAR AVCONT;
PROC RANK NORMAL=BLOM;
VAR AVCONT;
RANKS NSCORE;
PROC PLOT;
PLOT AVCONT*NSCORE=BALE / VPOS=15 HPOS=40 HREF=0 VREF=0;
```

Page 639. Quil line2. Insert after “concentrations” the units as follows “concentrations (mg/ml)”.

Page 641. The following text is missing from the bottom of the page.

6. **Golf ball experiment** (Tim Kelaghan, 1995)

An experiment was planned by Tim Kelaghan in 1995 to examine whether different brands of golf balls travel on average the same distances when hit by amateur golfers. The experiment was planned with a specific selection of  $v = 3$  golf balls and some

Page 642 Delete Question 6b.

Page 643 Qu 8. The references in line 2 should be “Examples 17.3.2 – 17.3.4 and 17.4.1”, not “Examples 17.3.2 – 17.3.5 and 17.4.1”.

Include a page reference, i.e. “In Section 17.10, page 638, a new model...”.

Page 643 Qu 8c. Should read “Redo the analyses of Examples 17.3.3 and 17.3.4 for the new model...”.

## Chapter 18

Page 653. The model indices should also include “ $u = 1, 2;$ ”

Page 660 line 6. Replace “...the  $i$ th method of analysis and with the  $j$ th laboratory,...” with “... the  $i$ th method of analysis, the  $u$ th soil location with the  $j$ th laboratory,...”.

Page 669 Qu 4c Replace the null hypothesis

$$H_0 : \{ \text{no differences in yield strength of the titanium alloy} \\ \text{can be attributed to the two test specimens} \}$$

with the null hypothesis

$$H_0 : \{ \text{no differences in yield strength of the titanium alloy} \\ \text{can be attributed to the four vendors} \}.$$

Page 670. Qu 6. Line 6 should say “sliced from”.

Page 670 Qu 6c. Should read “Using the data in Table 18.11...”.

Page 671. Qu 8. In the model, the variances should be  $\sigma_{B(A)}^2$  and  $\sigma_{C(AB)}^2$ , not  $\sigma_B^2$  and  $\sigma_{C(A)}^2$ .

Page 671, Qu 8. “Erythrocyte” should be spelled as “erythrocyte” throughout (including the experiment index).

Page 671. Qu 8. Erythrocyte expt. Modify limits on  $k$  and  $t$  to  $t = 1, 2;$   $k = 1, \dots, 5$ .

Page 671. Erythrocyte expt. line 7. Replace “selected at random from each trough and divided between two counting chambers. The erythrocyte counts were then measured.” with the following: “selected at random from each trough and the erythrocyte count from the blood of each fish was measured in two different counting chambers, giving two measurements per fish”.

Page 672 line -2. Add distribution for  $(\alpha C)_{ik(j)}$  so that it reads

$$\epsilon_{ijkt} \sim N(0, \sigma^2); \quad C_{k(j)} \sim N(0, \sigma_{C(B)}^2); \quad (\alpha C)_{ik(j)} \sim N(0, \sigma_{AC(B)}^2); \\ \epsilon_{ijkt}\text{'s}, C_{k(j)}\text{'s}, \text{ and } (\alpha C)_{ik(j)}\text{'s are all mutually independent,}$$

## Tables

Page 722. The footnote of Table A.10 should begin, “Values  $w_{D2}$ ...

## Index of Experiments

Page 733. The “breathalyzer” experiment could have entries for pages 297 and 340, though there’s no raw data provided.

Page 733. The “cotton spinning” experiment should have an entry for page 306.

Page 733. “erythrocyte” should be spelled as “erythrocyte”.

Page 733. Flour. Split the listings: Flour experiment 1 page 536. Flour experiment 3 page 503, 531.

Page 734. The “resting metabolic rate” experiment should be listed as page 302, not 325.

Page 734. The “soap” experiment should have an entry for page 58.

### **Index of Subjects**

Page 737. At page top left, “bf E” should be “**E**”.