Worksheet – 2-Way Mixed Effects ANOVA – Women PBA Bowlers on 4 Oil Patterns

Dataset: wpba2009.dat  
Source: www.pba.com

Description: Scores for 15 women professional bowlers of 4 oil patterns, each for 2 sets of 7 games per set. All at Allen Park, MI.

Bowlers: 1=Diandra Abaty, 2=Shalin Zukiffi, 3=Liz Johnson, 4=Kelly Kulick, 5=Clara Guerrero, 6=Jennifer Petrick, 7=Wendy MacPherson, 8=Shannon Pluhowski, 9=Stephanie Nation, 10=Tammy Boomershine, 11=Amanda Fagan, 12=Aumi Guerra, 13=Michele Feldman, 14=Shannon O’Keefe, 15=Jodie Woessner

Oil Patterns: 1=Viper, 2=Chameleon, 3=Scorpion, 4=Shark

Variables/Columns:
    Bowler 7-8 Oil Pattern 16 Set Number 24 Game of Set 32 Score 38-40 /* max = 300 */

Fixed Factor (A) Pattern  a= 4  Random Factor (B) Bowler  b= 15

Model:

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F*</th>
<th>F(.95)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>4-1</td>
<td>8785</td>
<td>2928.3</td>
<td>$\frac{2928.3}{\frac{8785}{14}}$</td>
<td>2.296</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Bowler</td>
<td>15-1</td>
<td>29965</td>
<td>2140.4</td>
<td>$\frac{2140.4}{\frac{29965}{14}}$</td>
<td>2.412</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Oil*Bowler</td>
<td>(14)</td>
<td>34423</td>
<td>819.6</td>
<td>$\frac{819.6}{\frac{34423}{14}}$</td>
<td>1.262</td>
<td>&gt; .05</td>
</tr>
<tr>
<td>Error</td>
<td>(14)</td>
<td>506679</td>
<td>69.6</td>
<td>$\frac{69.6}{\frac{506679}{14}}$</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Total</td>
<td>(18)</td>
<td>579852</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Test for Oil*Bowler Interaction: Test Statistic $12.62$  
    Rejection Region $T5 > 1.400$

Test for Oil Pattern Effects: Test Statistic $3.573$  
    Rejection Region $T5 > 2.827$

Test for Bowler Effects: Test Statistic $2.612$  
    Rejection Region $T5 > 1.935$

$Q(14) = 4(14) = 56$

Obtain a 95% CI for $\sigma_p^2$ Estimate $\frac{MSB - MSE}{AN} = 23.59$ df $= 5$ Cl: $\left(\frac{5*(23.59)}{12.83}, \frac{5*(23.59)}{4.83}\right) = (9.19, 142.1)$

$df \approx \frac{(23.59)^2}{(2140.4)^2 + (819.6)^2 + (69.6)^2 + 69.6}$

$df \approx \frac{556.29}{104.35 + 5.10}$

$5.09 \approx 5$

Tukey’s HSD and Bonferroni’s MSD for Comparing Oil Pattern Means:

$Q(.05,4,42) = 3.784$

$HSD = 3.784\sqrt{\frac{819.6}{15(14)}} = 7.45$

$MSD = 2.772\sqrt{\frac{819.6}{(15)(14)}} = 7.74$