Lecture 13: Analysis of Popcorn Experiment

**Analysis**

*Informal Analysis*

*Formal Statistical Analysis*

*Analysis of Residuals*

1. **Informal Analysis**

   *Plot the response (volume of popped corn) versus the treatments (cooking times).*

   *Compute summary statistics for each treatment (cooking time).*

2. **Informal Analysis**

   *Longer times (1.75 and 2.25 minutes) tend to have higher volumes of popcorn (around 130 cL).*

   *The shortest time (1.25 minutes) has much lower volumes of popcorn (around 70 cL).*

3. **Informal Analysis**

   *Use the analysis of variance to split the total variability in volume into components due to differences in times and random error.*

4. **Informal Analysis**

   *All cooking times show about the same amount of variation with 1.25 minutes having a slightly larger standard deviation (16.4 cL) compared to the other two times (standard deviations around 12 cL).*

5. **Formal Analysis**

   *Use the analysis of variance to split the total variability in volume into components due to differences in times and random error.*
Lecture 13: Analysis of Popcorn Experiment

* Analyze – Fit Y by X
  * Y, Response: Volume (cL)
  * X, Factor: Time (minutes)
  * Means/Anova

JMP

RSquare

* Rsquare = 0.845
* 84.5% of variation in the response (volume) can be explained by differences between treatments (times).

RMSE

* RMSE = 13.70
* The Root Mean Square Error is the estimate of the random error standard deviation, \( \sigma \).
* This is found by pooling the standard deviations for each of the treatments (times).

Mean Response

* Mean Response = 112.333 cL
* The mean response is the overall average volume for the 18 bags of popcorn, \( \bar{Y}_{+} \).

Estimated Treatment Effects

\[ \hat{t} = \bar{Y}_{t+} - \bar{Y}_{++} \]

<table>
<thead>
<tr>
<th>Time</th>
<th>Mean</th>
<th>Estimated Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 minutes</td>
<td>71.0</td>
<td>-41.333</td>
</tr>
<tr>
<td>1.75 minutes</td>
<td>132.0</td>
<td>19.666</td>
</tr>
<tr>
<td>2.25 minutes</td>
<td>134.0</td>
<td>21.666</td>
</tr>
</tbody>
</table>
Lecture 13: Analysis of Popcorn Experiment

Analysis of Variance

Oneway Analysis of Volume (cl) By Time (min)

### Oneway Anova

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Prob &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (min)</td>
<td>2</td>
<td>15288.000</td>
<td>7644.00</td>
<td>40.9837</td>
<td>&lt;.0001*</td>
</tr>
<tr>
<td>Error</td>
<td>15</td>
<td>187.73</td>
<td>187.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Total</td>
<td>17</td>
<td>18204.000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Test of Hypothesis

- $H_0: \mu_{1.25} = \mu_{1.75} = \mu_{2.25}$
- $H_A$: at least two not equal
- $H_0: \tau_{1.25} = \tau_{1.75} = \tau_{2.25} = 0$
- $H_A$: some not equal to zero

#### F Ratio = 40.9837

- P-value: < 0.0001
- Because the P-value is so small we should reject the null hypothesis.

### Conclusion

- There are statistically significant differences between some of the mean volumes for the various times.

### Conclusion

- Some of the treatment means are different from others.
- There are some treatment effects that are different from zero.

### Conclusion?

- We don’t know from the analysis which times produce the different mean volumes.