Tutorial Week 12 (16/10-20/10)

This week we’ll look at Two-Way/Factorial Design problems. Please refer Chapter 15 of the textbook.

Two-way ANOVA table for factorial design

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor, A</td>
<td>a-1</td>
<td>SSA</td>
<td>MSA</td>
<td>(F_A)</td>
</tr>
<tr>
<td>Factor, B</td>
<td>b-1</td>
<td>SSB</td>
<td>MSB</td>
<td>(F_B)</td>
</tr>
<tr>
<td>Interactions, (A \times B)</td>
<td>(a-1)(b-1)</td>
<td>SSI</td>
<td>MSI</td>
<td>(F_I)</td>
</tr>
<tr>
<td>Error</td>
<td>ab(r-1)</td>
<td>SSE</td>
<td>MSE</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>abr-1</td>
<td>SST</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(r\) is the number of observations in each cell.

Tutorial Questions

1. Q15.24 (p514)

2. Does the season of the year make any difference to the milage of a car? To test this claim, a consumer organisation undertook the following study:
   During winter, spring, summer and fall six cars of a particular model were selected, three of which were manual and three automatic transmission. In each case the car was driven over an identical course and the milage recorded. Results were:

<table>
<thead>
<tr>
<th>Transmission</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>20.9, 21.3, 21.7</td>
<td>22.4, 22.9, 22.2</td>
<td>22.0, 22.3, 21.7</td>
<td>23.6, 23.0, 23.0</td>
</tr>
</tbody>
</table>

(i) Perform a two-way ANOVA for these data, testing for significant (a) differences between seasons; (b) differences between types of transmission; (c) interaction.

(ii) Obtain the mean milage for each of the 8 cells. For each type of transmission plot the season means and connect the four points. (a) On average, in which season is milage highest? The lowest? (b) Does there seem to be any interaction between season and type of transmission? (c) Is your answer to part (b) consistent with that in part (c) of (i)?

Extra Practice Problems

1. Do Q15.23 (p514)

2. Do Q15.27 (p515)

PTO for the Computer Exercise
Next week there will be a computer practical examination in your usual practical class time. This is an open book examination.

1. How does the frequency that a supermarket product is promoted at a discount affect the price that customers expect to pay for the product? Does the percent reduction also affect expectation? Results of a study in Australia are given in a data frame called price.df. The number of promotions were 1, 3, 5, 7 and the percent of reduction were 10, 20, 30 and 40. The response is the expected price (obtained from a customer survey) of a supermarket product. Perform a detailed two-way ANOVA for this data by using the following steps.

(a) Set a 2 by 2 graphic window and prepare your data for analysis by typing `attach(price.df)`.

(b) Obtain group means of the data and store in `price.mean` using

```r
> price.mean = tapply(pri, list(discount, promotion), mean).
```

Use `Investigate the output in price.mean`.

(c) Plot the group means and comment on the results.

```r
> interaction.plot(discount, promotion, pri)
> interaction.plot(promotion, discount, pri).
```

(d) Compute the overall mean and the marginal means of the group means. Store the results as `overall.mean`, `price.row` and `price.col` respectively.

```r
> overall.mean = mean(pri)
> price.row = apply(price.mean, 1, mean)
> price.col = apply(price.mean, 2, mean)
```

(e) Compute group sample variances and store the results as `price.var`.

```r
> price.var = tapply(pri, list(discount, promotion), var)
```

(f) Using the built-in `aov` function, obtain a two-way table as well as a normal-quantile plot of the residuals.

(g) Comment on the assumptions required for the two-way ANOVA by preparing boxplot, `qqnorm` and `qqline` for residuals.

**Extra Practice Problems**

1. Do Q15.25 (p514) using R.
2. Do tutorial Q2 using R.