**Tuesday, Week 6**

Analysis + design issues when more than one factor.

Q: Can we drop terms from the model?

Consider ANOVA from "Two way ANOVA example" pages 5-6.

- $H_0: \phi_{bc} = 0$, $p \sim .09$
- $H_0: \phi_{bc} > 0$

Cannot reject at $\alpha = .05$

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**Note:** This is not to say we have proven $\phi_{bc} = 0$. Only showed not enough evidence to prove $\phi_{bc} > 0$.

Suppose we delete the term $DG_{ij}$ from Model, then

$SS_{bc}$ and its df go into Error

$SS_{bc} \rightarrow SS_{error}$

$df_{bc} \rightarrow df_{error}$

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Usually what happens is that this inflates MSE. In a Fixed Effect model, the F-statistics for the main effects might

**Generally, do not drop terms from ANOVA models.**

Regression differs in that we often want simple empirical model to describe data.
Next point - sample size

Client: I didn’t get significance but it was close, what to do.
Stat’s person:
Get more data!

Q: How to collect the data.
Example: Three methods to compare (Fixed). Collect data on methods from randomly selected labs.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>EMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labs</td>
<td>(5-1)</td>
<td>70</td>
<td>(\sigma_e^2 + 12\sigma_c^2)</td>
</tr>
<tr>
<td>Meth</td>
<td>(3-1)</td>
<td>130</td>
<td>(\sigma_e^2 + 4\sigma_{LM}^2 + 20\sigma_c^2)</td>
</tr>
<tr>
<td>LM</td>
<td>(5-1)(3-1)</td>
<td>410</td>
<td>(\sigma_e^2 + 4\sigma_{LM}^2)</td>
</tr>
<tr>
<td>error</td>
<td>48</td>
<td>25</td>
<td>(\sigma_e^2)</td>
</tr>
</tbody>
</table>

s labs, n = y

Where do I get more data?
1. Increase n
2. Increase # Labs

\[F = \frac{MS_A}{MS_{AB}} = \frac{\sigma_e^2 + n\sigma_{AB}^2 + nb\phi_A}{\sigma_e^2 + n\sigma_{A}^2}\]

A = Method
B = Lab
\(n \uparrow, F \rightarrow \frac{\sigma_{AB}^2 + b\phi_A}{\sigma_{A}^2}\)
\[
F \sim \frac{\sigma^2 + n \sigma^2_{m} + n b \sigma^2_{b}}{\sigma^2 + n \sigma^2_{m} \sigma^2_{b}}
\]

Do range test on any significant main effect.

Mixed Model:
Test all terms. If Random effect significant, estimate its "Variance Component" \( \sigma^2 \)

If the fixed effect is significant, do range test on that.

In a Random Model (both effects random), if effect significant, estimate corresponding \( \sigma^2 \)

Inference:
1) Fixed effect 2 way, inference is to the effect of the treatments to the popl'n of experimental units.

Inference for Mixed Model,
Methods - fixed
Labs - random
Pre/Post - random
If Method significant, inference is to population of labs & population of experimental units.
Random Model - 2 way ANOVA
Estimation of variance components
How useful?

Example: Evaluate instrument.
Operators - random
Parts o - random

\[ Y_{ijk} = \mu + \alpha_i + \beta_j + \epsilon_{ijk} \]

If \( \sigma_o^2 \) large - invest in training
If \( \sigma_P^2 \) large - invest in "Process"
If \( \sigma_e^2 \) large - invest in measurement system.