**STAT6305\_HW#7**

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**Ex.17.31**

**a.** This experiment is nested design. Sample nested within the batches.

**b.**

Yijk=Ⲙ+𝒯i+𝛽j(i)+εijk

i=1, 2, 3 (Batches)

j=1, 2, 3 (Samples)

K=1, 2, 3, 4, 5, 6, 7 (tablets)

Yijk= Hardness of each K tablets from sample i and batch i

Ⲙ= The grand mean

𝒯i= random effect of i batches which is N (0, σ2𝒯)

𝛽j(i)= random effect of j samples within the batches which is N(0, σ2β)

εijk= error which is N(0, σ2ε)

**c.**

Sources of variability

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Source** | **SS** | **df** | **MS** | **EMS** | **F** | **P-value** |
| Batch | 9095.52 | 2 | 4547.76 | σ2ε + 7σ2β(τ) + 21σ2τ | 101.63 | <.0001 |
| Sample (Batch) | 268.48 | 6 | 44.75 | σ2ε + 7σ2β(τ) | 1.53 | 0.1851 |
| Error | 1576 | 54 | 29.19 | σ2ε |  |  |
| Total | 10940 | 62 |  |  |  |  |

**d.**

Hypothesis test for batches:

H0: σ2𝒯=0

Ha: σ2𝒯 >0

Conclusion: The p-value for the batches is <0.0001 which is less than 0.05. The F- value is 101.63 which is larger than the critical F-value (df1=2, df2=6, 0.05) = 5.14. Therefore, we reject the null hypothesis and conclude that there is a variability from batch to batch in tablet hardness.

Hypothesis test for Samples within batches:

H0: σ2𝛽 = 0

Ha: σ2𝛽 >0

Conclusion: The p-value for the sample(batch) is 0.1851 which is larger than 0.05. The F-value 1.53 is less than critical F- value (df1=6, df2=54) = 2.27. Therefore, we fail to reject the null hypothesis and conclude that are no significant evidences to prove the variability in tablet hardness due to samples within batches.

**Ex.17.32**

**a.**

Country: Fixed effect, because, researcher selected 5 underdeveloped countries, interested in comparing average scores across 5 countries.

Tribe: Random effect, because researcher is interested in selecting 10 tribes from each country and identifying variability in scores within these 10 tribes.

Family: Random effect, because, researcher is interested in selecting 20 families from each tribe and identifying variability in scores within these 20 families.

**b.**

Country (A)

Tribe (B(A))- Tribe is nested in country

Family (C(A,B)) - Family is nested. Families within each tribes are not the same.

**c.**

3 factors: country, tribe and family.

Country: a = 5

Tribe: b = 10

Family: c = 20

|  |  |  |
| --- | --- | --- |
| **Source** | **df** | **Expected mean square(A fixed, B random, and C random)** |
| A = country | a-1 => 5-1=4 | σ2ε+nσ2𝑦(𝒯,𝛽)+20nσ2𝛽(𝒯)+200nθ𝒯 |
| B(A) = tribe | a(b-1) => 5(10-1)=45 | σ2ε+nσ2𝑦(𝒯,𝛽)+20nσ2𝛽(𝒯) |
| C (A, B) = family | ab(c-1) => 5\*10(20-1) =950 | σ2ε+nσ2𝑦(𝒯,𝛽) |
| Error | abc(n-1) => 5\*10\*20(n-1) | σ2ε |

Ex. 17.31 SAS CODES:

**data** drug;

do batch = **1** to **3**;

do sample = **1** to **3**;

do tablet = **1** to **7**;

input hardness @@;

output;

end;

end;

end;

cards;

85 94 91 98 85 96 93 76 87

90 91 88 94 96 95 98 94 96

99 100 93 108 100 105 109 104

102 108 117 106 103 109 100 104

102 101 108 100 99 117 109 105

71 85 78 68 85 67 76 81 70 84

83 72 81 78 72 68 80 72 75 79 74

;

**run**;

/\*\*\*\* ANOVA Test for nested design \*\*\*\*\*/

proc glm data=drug;

class batch sample;

model hardness= batch sample(batch)/E1;

random sample(batch);

test H=batch E=sample(batch);

run;

Quit;