

## **Több laboratórium összehasonlítása, körmérés**

collaborative test, round robin

a rendszeres hibák ellenőrzése, számszerűsítése

Statistical Manual of AOAC, 1975

W. J. Youden:  
Statistical Techniques for Collaborative Tests,

E. H. Steiner:  
Planning and Analysis of Results of Collaborative Tests

A cél:

- a módszerek megbízhatóságának értékelése
- a rendszeres hibák nagyságának számszerűsítése
- (a résztvevő laboratóriumok alkalmasságának vizsgálata)

Megfelelő időpontja:

- amikor a módszer már kialakult
- ruggedness test után

Módja:

- minden résztvevő labor
- minden mintát
- egyszer vagy többször analizál

Két fő módszer:

Youden

páronként ill. véletlen blokk  
ismétlés nélkül

Steiner

több ismétléssel

Értékelés

Youden-plot

rang-módszer (Friedman)

kiugró értékek vizsgálata/kiszűrése

véletlen blokk/ANOVA (Youden)

teljes terv kereszt-osztályozással/ANOVA (Steiner)

Valódi érték (valódi koncentráció)

nagyon tiszta standard

két vagy több analitikai módszer konvergenciája

Az ismétlés hátrányai

a minta ismerős lesz

censoring

Statisztikai problémák

$\sigma_e$  laboron belüli ingadozás nem konstans  
másodlagos fontosságú

## Minták

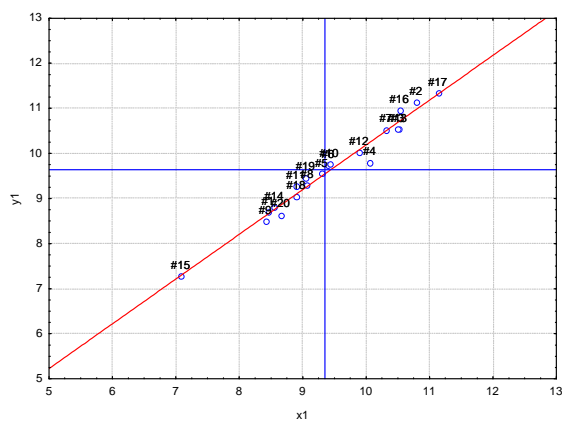
azonos minták  
homogenitás  
esetleg analízisre előkészítve

A teljes tervből (Steiner) becsülhető  
 $\sigma_A$  laborok közötti különbség  
 $\sigma_{AB}$  labor\*minta kölcsönhatás  
 $\sigma_e$  laboron belüli ingadozás

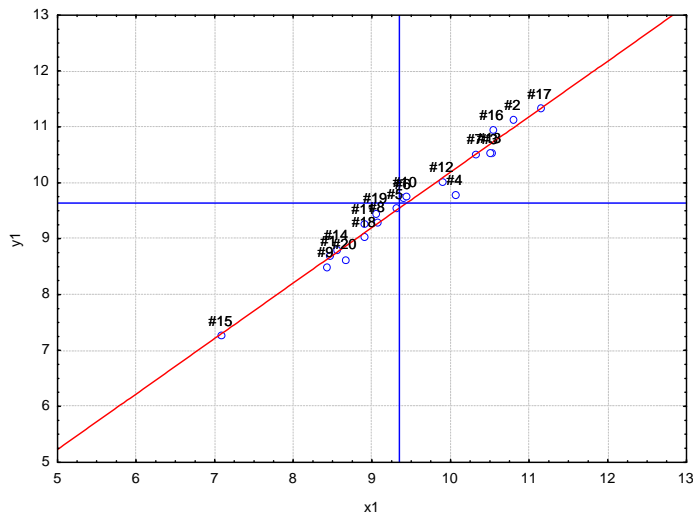
A véletlen blokkos tervből (Youden) becsülhető  
 $\sigma_A$  laborok közötti különbség  
 $\sigma_{AB}^2 + \sigma_e^2$

## Youden módszere

Minden résztvevő laboratórium két (egymáshoz közeli)  
mintát mér ( $x$  és  $y$ ), egyszer.



Youden-plot



$$\mu_1 = 10.0$$

$$\mu_2 = 10.2$$

laborok között

$$\sigma_A = 1.0$$

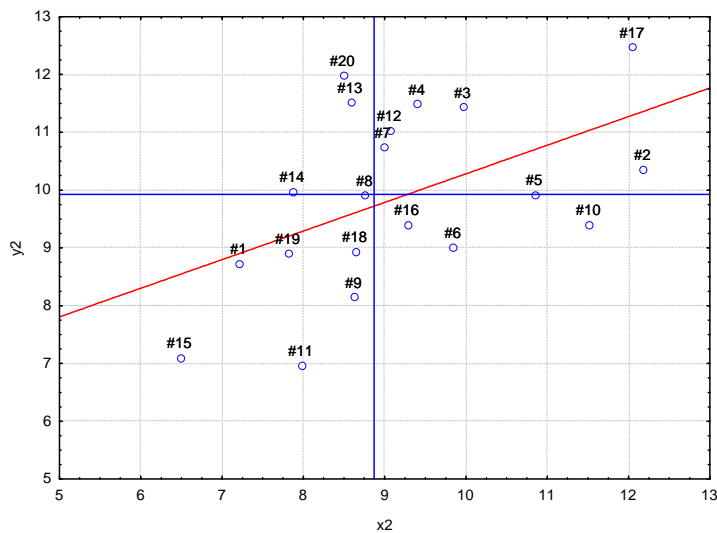
laboron belül

$$\sigma_e = 0.1$$

Az egyes laborok jó ismételhetőséggel követik a saját verziójuk szerinti eljárást, de a laborok között nagy különbségek vannak. Mi a baj az eljárással (leírással)?

Laboratóriumok összehasonlítása

7



$$\mu_1 = 10.0$$

$$\mu_2 = 10.2$$

laborok között

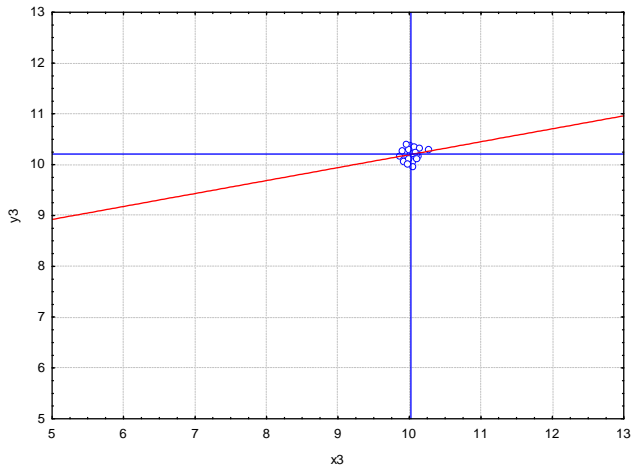
$$\sigma_A = 1.0$$

laboron belül

$$\sigma_e = 1.0$$

Laboratóriumok összehasonlítása

8



$$\mu_1 = 10.0$$

$$\mu_2 = 10.2$$

laborok között

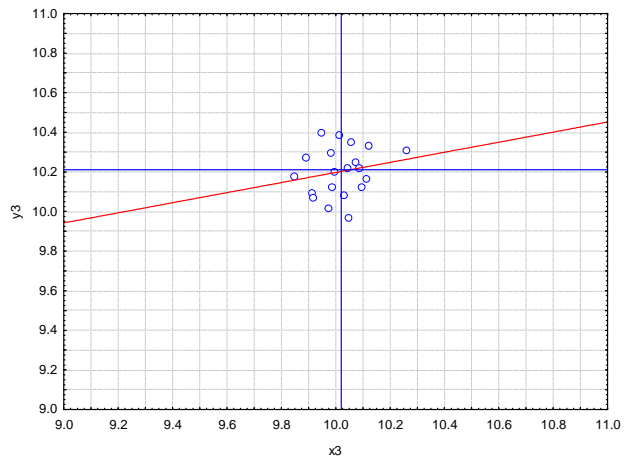
$$\sigma_A = 0.1$$

laboron belül

$$\sigma_e = 0.1$$

Laboratóriumok összehasonlítása

9



Laboratóriumok összehasonlítása

10

67. példa  
 Youden p. 32  
 5 minta vízdíszhatatlan N-tartalma  
 Youdenp32.sta

|    | 1<br>Coll | 2<br>Sample_1 | 3<br>Sample_2 | 4<br>Sample_3 | 5<br>Sample_4 | 6<br>Sample_5 |
|----|-----------|---------------|---------------|---------------|---------------|---------------|
| 1  | 7         | 4.59          | 1.46          | 5.64          | 2.19          | 27.32         |
| 2  | 8         | 4.94          | 1.52          | 5.68          | 2.28          | 26.44         |
| 3  | 9         | 4.80          | 1.40          | 5.62          | 2.12          | 26.89         |
| 4  | 10        | 4.73          | 1.46          | 5.65          | 2.09          | 27.17         |
| 5  | 11        | 4.72          | 1.51          | 5.62          | 2.12          | 27.00         |
| 6  | 12        | 4.80          | 1.51          | 5.80          | 2.29          | 27.48         |
| 7  | 13        | 4.45          | 1.40          | 5.45          | 2.07          | 27.02         |
| 8  | 15        | 4.72          | 1.50          | 5.58          | 2.27          | 26.76         |
| 9  | 16        | 4.63          | 1.32          | 5.69          | 2.04          | 26.92         |
| 10 | 17        | 4.88          | 1.42          | 5.67          | 2.16          | 27.39         |

### Rang-próba (Friedman ANOVA)

|          | 1<br>7 | 2<br>8 | 3<br>9 | 4<br>10 | 5<br>11 | 6<br>12 | 7<br>13 | 8<br>15 | 9<br>16 | 10<br>17 |
|----------|--------|--------|--------|---------|---------|---------|---------|---------|---------|----------|
| Sample_1 | 4.59   | 4.94   | 4.80   | 4.73    | 4.72    | 4.80    | 4.45    | 4.72    | 4.63    | 4.88     |
| Sample_2 | 1.46   | 1.52   | 1.40   | 1.46    | 1.51    | 1.51    | 1.40    | 1.50    | 1.32    | 1.42     |
| Sample_3 | 5.64   | 5.68   | 5.62   | 5.65    | 5.62    | 5.80    | 5.45    | 5.58    | 5.69    | 5.67     |
| Sample_4 | 2.19   | 2.28   | 2.12   | 2.09    | 2.12    | 2.29    | 2.07    | 2.27    | 2.04    | 2.16     |
| Sample_5 | 27.32  | 26.44  | 26.89  | 27.17   | 27.00   | 27.48   | 27.02   | 26.76   | 26.92   | 27.39    |

| Friedman ANOVA and Kendall Coeff. of Concordance (Youdenp32_transposed.sta) |              |              |          |          |
|---|--------------|--------------|----------|----------|
| ANOVA Chi Squ. (N = 5, df = 9) = 19.46333 [p = .02153]                      |              |              |          |          |
| Coeff. of Concordance = .43252 Aver. rank r = .29065                        |              |              |          |          |
| Variable  | Average Rank | Sum of Ranks | Mean     | Std.Dev. |
| 7   | 5.500000     | 27.50000     | 8.240000 | 10.80162 |
| 8   | 7.600000     | 38.00000     | 8.172000 | 10.36027 |
| 9   | 4.200000     | 21.00000     | 8.166000 | 10.61524 |
| 10  | 5.500000     | 27.50000     | 8.220000 | 10.73734 |
| 11  | 5.200000     | 26.00000     | 8.194000 | 10.65281 |
| 12  | 9.200000     | 46.00000     | 8.376000 | 10.82321 |
| 13  | 2.500000     | 12.50000     | 8.078000 | 10.71867 |
| 15  | 4.700000     | 23.50000     | 8.166000 | 10.52969 |
| 16  | 3.600000     | 18.00000     | 8.120000 | 10.66222 |
| 17  | 7.000000     | 35.00000     | 8.304000 | 10.81752 |

10, 45

12. labor gyanús (46>45)

**Table 7. Approximate five per cent two-tail limits for ranking scores**

| No. of Labs. | Number of Materials |    |    |    |    |    |     |     |     |     |     |     |     |  |
|--------------|---------------------|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|--|
|              | 3                   | 4  | 5  | 6  | 7  | 8  | 9   | 10  | 11  | 12  | 13  | 14  | 15  |  |
| 3            |                     | 4  | 5  | 7  | 8  | 10 | 12  | 13  | 15  | 17  | 19  | 20  | 22  |  |
|              |                     | 12 | 15 | 17 | 20 | 22 | 24  | 27  | 29  | 31  | 33  | 36  | 38  |  |
| 4            |                     | 4  | 6  | 8  | 10 | 12 | 14  | 16  | 18  | 20  | 22  | 24  | 26  |  |
|              |                     | 16 | 19 | 22 | 25 | 28 | 31  | 34  | 37  | 40  | 43  | 46  | 49  |  |
| 5            |                     | 5  | 7  | 9  | 11 | 13 | 16  | 18  | 21  | 23  | 26  | 28  | 31  |  |
|              |                     | 19 | 23 | 27 | 31 | 35 | 38  | 42  | 45  | 49  | 52  | 56  | 59  |  |
| 6            | 3                   | 5  | 7  | 10 | 12 | 15 | 18  | 21  | 23  | 26  | 29  | 32  | 35  |  |
|              | 18                  | 23 | 28 | 32 | 37 | 41 | 45  | 49  | 54  | 58  | 62  | 66  | 70  |  |
| 7            | 3                   | 5  | 8  | 11 | 14 | 17 | 20  | 23  | 26  | 29  | 32  | 36  | 39  |  |
|              | 21                  | 27 | 32 | 37 | 42 | 47 | 52  | 57  | 62  | 67  | 72  | 76  | 81  |  |
| 8            | 3                   | 6  | 9  | 12 | 15 | 18 | 22  | 25  | 29  | 32  | 36  | 39  | 43  |  |
|              | 24                  | 30 | 36 | 42 | 48 | 54 | 59  | 65  | 70  | 76  | 81  | 87  | 92  |  |
| 9            | 3                   | 6  | 9  | 13 | 16 | 20 | 24  | 27  | 31  | 35  | 39  | 43  | 47  |  |
|              | 27                  | 34 | 41 | 47 | 54 | 60 | 66  | 73  | 79  | 85  | 91  | 97  | 103 |  |
| 10           | 4                   | 7  | 10 | 14 | 17 | 21 | 26  | 30  | 34  | 38  | 43  | 47  | 51  |  |
|              | 29                  | 37 | 45 | 52 | 60 | 67 | 73  | 80  | 87  | 94  | 100 | 107 | 114 |  |
| 11           | 4                   | 7  | 11 | 15 | 19 | 23 | 27  | 32  | 36  | 41  | 46  | 51  | 55  |  |
|              | 32                  | 41 | 49 | 57 | 65 | 73 | 81  | 88  | 96  | 103 | 110 | 117 | 125 |  |
| 12           | 4                   | 7  | 11 | 15 | 20 | 24 | 29  | 34  | 39  | 44  | 49  | 54  | 59  |  |
|              | 35                  | 45 | 54 | 63 | 71 | 80 | 88  | 96  | 104 | 112 | 120 | 128 | 136 |  |
| 13           | 4                   | 8  | 12 | 16 | 21 | 26 | 31  | 36  | 42  | 47  | 52  | 58  | 63  |  |
|              | 38                  | 48 | 58 | 68 | 77 | 86 | 95  | 104 | 112 | 121 | 130 | 138 | 147 |  |
| 14           | 4                   | 8  | 12 | 17 | 22 | 27 | 33  | 38  | 44  | 50  | 56  | 61  | 67  |  |
|              | 41                  | 52 | 63 | 73 | 83 | 93 | 102 | 112 | 121 | 130 | 139 | 149 | 158 |  |
| 15           | 4                   | 8  | 13 | 18 | 23 | 29 | 35  | 41  | 47  | 53  | 59  | 65  | 71  |  |
|              | 44                  | 56 | 67 | 78 | 89 | 99 | 109 | 119 | 129 | 139 | 149 | 159 | 169 |  |

laborok közötti

$\sigma_A^2$

$\sigma_e^2$

$(\sigma_{AB}^2 + \sigma_e^2)$

laborokon belüli

| Components of Variance (Youdenp32_stacked.sta)<br>Over-parameterized model<br>Type III decomposition |          |  |  |  |  |  |  |  |
|--|----------|--|--|--|--|--|--|--|
| Effect   | Value    |  |  |  |  |  |  |  |
| Coll   | 2.641667 |  |  |  |  |  |  |  |
| Error  | 6.447222 |  |  |  |  |  |  |  |

| Univariate Tests of Significance for Value (Youdenp32_stacked.sta)<br>Over-parameterized model<br>Type III decomposition |              |          |                  |          |                   |                   |          |          |
|--|--------------|----------|------------------|----------|-------------------|-------------------|----------|----------|
| Effect   | Effect (F/R) | SS       | Degr. of Freedom | MS       | Den.Syn. Error df | Den.Syn. Error MS | F        | p        |
| Intercept  | Fixed        | 1512.500 | 1                | 1512.500 | 9                 | 19.65556          | 76.95025 | 0.000011 |
| Coll   | Random       | 176.900  | 9                | 19.656   | 36                | 6.44722           | 3.04869  | 0.008151 |
| Sample   | Fixed        | 0.000    | 4                | 0.000    | 36                | 6.44722           | 0.00000  | 1.000000 |
| Error  |              | 232.100  | 36               | 6.447    |                   |                   |          |          |

Laboratóriumok összehasonlítása

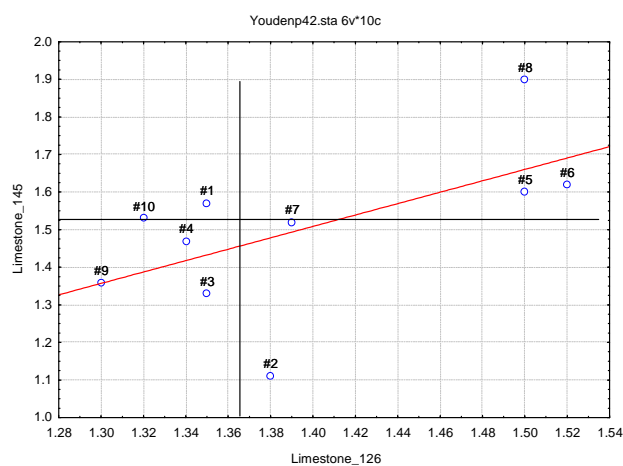
68. példa  
 Youden p. 42  
 5 minta Al-tartalma

Youdenp42.sta

| Friedman ANOVA and Kendall Coeff. of Concordance (Youdenp42_transposed.sta) |              |              |          |          |
|---|--------------|--------------|----------|----------|
| ANOVA Chi Sqr. (N = 5, df = 9) = 27.62561 p = .00110                        |              |              |          |          |
| Coeff. of Concordance = .61390 Aver. rank r = .51738                        |              |              |          |          |
| Variable  | Average Rank | Sum of Ranks | Mean     | Std.Dev. |
| 1   | 3.100000     | 15.50000     | 2.474000 | 1.708722 |
| 2   | 4.300000     | 21.50000     | 2.710000 | 2.133471 |
| 3   | 3.900000     | 19.50000     | 2.616000 | 1.883648 |
| 4   | 3.100000     | 15.50000     | 2.602000 | 1.911588 |
| 5   | 7.500000     | 37.50000     | 2.984000 | 2.431600 |
| 6   | 9.600000     | 48.00000     | 3.130000 | 2.270485 |
| 7   | 6.100000     | 30.50000     | 2.780000 | 2.034760 |
| 8   | 8.600000     | 43.00000     | 3.060000 | 2.023116 |
| 11  | 3.500000     | 17.50000     | 2.758000 | 2.249760 |
| 12  | 5.300000     | 26.50000     | 2.814000 | 2.091251 |

10, 41

6. és 8. labor gyanús (48>41, 43>41)

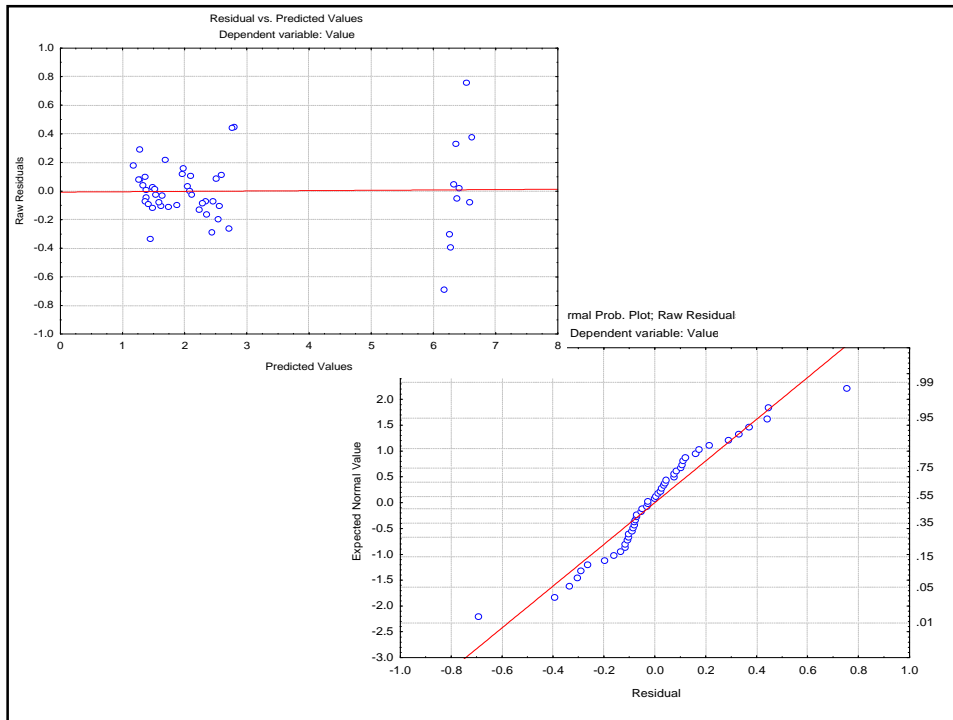




| Univariate Tests of Significance for Value (Youdenp42_stacked.sta) |              |          |                  |          |                   |                   |          |          |
|--|--------------|----------|------------------|----------|-------------------|-------------------|----------|----------|
| Over-parameterized model   |              |          |                  |          |                   |                   |          |          |
| Type III decomposition   |              |          |                  |          |                   |                   |          |          |
| Effect   | Effect (F/R) | SS       | Degr. of Freedom | MS       | Den.Syn. Error df | Den.Syn. Error MS | F        | p        |
| Intercept  | Fixed        | 389.9866 | 1                | 389.9866 | 9                 | 0.222019          | 1756.549 | 0.000000 |
| Coll   | Random       | 1.9982   | 9                | 0.2220   | 36                | 0.068504          | 3.241    | 0.005575 |
| Code   | Fixed        | 171.1719 | 4                | 42.7930  | 36                | 0.068504          | 624.682  | 0.000000 |
| Error  |              | 2.4661   | 36               | 0.0685   |                   |                   |          |          |

| Components of Variance (Youdenp42_stacked.sta) |          |
|--|----------|
| Over-parameterized model                       |          |
| Type III decomposition                         |          |
| Effect   | Value    |
| Coll   | 0.030703 |
| Error  | 0.068504 |

| Restricted Maximum Likelihood Estimates (Youdenp42_stacked.sta) |                |                |          |          |          |          |                |                |          |          |          |
|---|----------------|----------------|----------|----------|----------|----------|----------------|----------------|----------|----------|----------|
| Variable: Value   |                |                |          |          |          |          |                |                |          |          |          |
| -2*Log(Likelihood)=17.6482754                                   |                |                |          |          |          |          |                |                |          |          |          |
| Effect  | Variance Value | Standard Error | df       | z Value  | Prob. z  | Alpha    | Lower 95.0000% | Upper 95.0000% | Sum      | Percent  | RSD (%)  |
| Coll  | 0.030703       | 0.021180       | 4.20291  | 1.449639 | 0.073580 | 0.050000 | 0.011228       | 0.234973       | 0.030703 | 30.94852 | 6.274087 |
| Error   | 0.068504       | 0.016146       | 36.00000 | 4.242641 | 0.000011 | 0.050000 | 0.045302       | 0.115586       | 0.099207 | 69.05148 | 9.371672 |



69. példa  
Steiner p. 73  
3 minta 11 laborban

| lab | sample1 |      |      |      | sample2 |      |      |      | sample3 |      |      |      |
|-----|---------|------|------|------|---------|------|------|------|---------|------|------|------|
| 1   | 21.2    | 21.4 |      |      | 12.7    | 12.9 |      |      | 16.0    | 16.0 |      |      |
| 2   | 21.4    | 21.6 |      |      | 13.2    | 13.0 |      |      | 16.1    | 15.8 |      |      |
| 3   | 20.8    | 20.7 |      |      | 13.1    | 12.8 |      |      | 16.3    | 16.0 |      |      |
| 4   | 21.9    | 21.6 |      |      | 13.5    | 13.1 |      |      | 17.1    | 16.8 |      |      |
| 5   | 21.0    | 20.9 | 20.8 |      | 12.9    | 13.0 | 13.4 |      | 16.4    | 16.5 | 16.4 |      |
| 6   | 20.9    | 20.4 |      |      | 12.8    | 12.7 |      |      | 16.5    | 16.2 |      |      |
| 7   | 21.2    | 20.9 |      |      | 12.8    | 12.7 |      |      | 16.7    | 16.7 |      |      |
| 8   | 21.2    | 22.0 | 21.1 | 21.7 | 12.9    | 13.0 | 13.4 | 12.9 | 16.9    | 16.6 | 16.9 | 16.6 |
| 9   | 20.7    | 21.0 |      |      | 12.6    | 12.9 |      |      | 16.3    | 16.4 | 16.5 |      |
| 10  | 20.9    | 21.3 |      |      | 12.1    | 12.8 |      |      | 16.5    | 16.7 |      |      |
| 11  | 21.1    | 20.6 |      |      | 13.0    | 12.8 |      |      | 16.5    | 16.2 |      |      |
| 12  | 21.3    |      |      |      | 12.7    |      |      |      | 16.1    |      |      |      |

|     | 1    | 2    | 3    | 4    |
|-----|------|------|------|------|
| lab | sum1 | sum2 | sum3 |      |
| 1   | 1    | 42.6 | 25.6 | 32.0 |
| 2   | 2    | 43.0 | 26.2 | 31.9 |
| 3   | 3    | 41.5 | 25.9 | 32.3 |
| 4   | 4    | 43.5 | 26.6 | 33.9 |
| 5   | 5    | 41.9 | 25.9 | 32.9 |
| 6   | 6    | 41.3 | 25.5 | 32.7 |
| 7   | 7    | 42.1 | 25.5 | 33.4 |
| 8   | 8    | 43.1 | 25.9 | 33.5 |
| 9   | 9    | 41.7 | 25.5 | 32.8 |
| 10  | 10   | 42.2 | 24.9 | 33.2 |
| 11  | 11   | 41.7 | 25.8 | 32.7 |

| Friedman ANOVA and Kendall Coeff. of Concordance (2-Way Tables of Descriptive Statistics (Steinerp73m.sta)) |              |              |          |          |
|---|--------------|--------------|----------|----------|
| ANOVA Chi Sqr. (N = 3, df = 10) = 15.61538 p = .11119   |              |              |          |          |
| Coeff. of Concordance = .52051 Aver. rank r = .28077  |              |              |          |          |
| Variable  | Average Rank | Sum of Ranks | Mean     | Std.Dev. |
| 1   | 5.00000      | 15.00000     | 33.40000 | 8.586035 |
| 2   | 6.66667      | 20.00000     | 33.70000 | 8.543419 |
| 3   | 4.33333      | 13.00000     | 33.23333 | 7.841769 |
| 4   | 11.00000     | 33.00000     | 34.66667 | 8.476045 |
| 5   | 6.66667      | 20.00000     | 33.56667 | 8.020806 |
| 6   | 2.83333      | 8.50000      | 33.16667 | 7.910331 |
| 7   | 6.00000      | 18.00000     | 33.66667 | 8.303212 |
| 8   | 9.33333      | 28.00000     | 34.16667 | 8.619358 |
| 9   | 4.16667      | 12.50000     | 33.33333 | 8.113158 |
| 10  | 5.33333      | 16.00000     | 33.43333 | 8.652360 |
| 11  | 4.66667      | 14.00000     | 33.40000 | 7.973080 |

4, 32  
a 4. labor gyanús (33>32)

Laboratóriumok összehasonlítása 21

| Dixon-próba a 4. labor nélkül                               |  |  |  |
|---|--|--|--|
|   | 1. minta                                 | 2. minta                                 | 3. minta                                 |
| max   | 43.1                                     | 26.2                                     | 33.5                                     |
| max <sub>-1</sub>   | 43.0                                     | 25.9                                     | 33.4                                     |
| max-min <sub>+1</sub>                                       | 43.1-41.5                                | 26.2-25.5                                | 33.5-32.0                                |
| $\frac{x_{\max} - x_{\max_{-1}}}{x_{\max} - x_{\min_{+1}}}$ | $\frac{43.1 - 43.0}{43.1 - 41.5} = 0.06$ | $\frac{26.2 - 25.9}{26.2 - 25.5} = 0.43$ | $\frac{33.5 - 33.4}{33.5 - 32.0} = 0.07$ |
| min   | 41.3                                     | 24.9                                     | 31.9                                     |
| min <sub>+1</sub>   | 41.5                                     | 25.5                                     | 32.0                                     |
| $\frac{x_{\min_{+1}} - x_{\min}}{x_{\max_{-1}} - x_{\min}}$ | $\frac{41.5 - 41.3}{43.0 - 41.3} = 0.12$ | $\frac{25.5 - 24.9}{25.9 - 24.9} = 0.60$ | $\frac{32.0 - 31.9}{33.4 - 31.9} = 0.07$ |
| max <sub>-1</sub> -min                                      | 43.0-41.3                                | 25.5-24.9                                | 33.4-31.9                                |

10 mérésre (laborra) a kritikus érték ( $\alpha=0.05$ ) 0.477  
10. labor 2. mintája (24.9) kiugró,  
a mérési jegyzőkönyv alapján 12.1 helyett 12.9 a jó érték

Laboratóriumok összehasonlítása 22

## Varianciaanalízis a 4. laborral együtt

| Univariate Tests of Significance for Value (Steinerp73m_corr_stacked.sta) |              |          |                  |          |                   |                   |          |          |
|---|--------------|----------|------------------|----------|-------------------|-------------------|----------|----------|
| Over-parameterized model  |              |          |                  |          |                   |                   |          |          |
| Type III decomposition  |              |          |                  |          |                   |                   |          |          |
| Effect  | Effect (F/R) | SS       | Degr. of Freedom | MS       | Den.Syn. Error df | Den.Syn. Error MS | F        | p        |
| Intercept   | Fixed        | 18668.18 | 1                | 18668.18 | 10.00000          | 0.291485          | 64045.12 | 0.000000 |
| lab   | Random       | 2.91     | 10               | 0.29     | 20.00000          | 0.110621          | 2.63     | 0.031232 |
| Code  | Fixed        | 745.62   | 2                | 372.81   | 20.00000          | 0.110621          | 3370.15  | 0.000000 |
| lab*Code  | Random       | 2.21     | 20               | 0.11     | 33.00000          | 0.045152          | 2.45     | 0.010916 |
| Error   |              | 1.49     | 33               | 0.05     |                   |                   |          |          |

| Components of Variance (Steinerp73m_corr_stacked.sta) |          |
|---|----------|
| Over-parameterized model                              |          |
| Type III decomposition                                |          |
| Effect  | Value    |
| lab   | 0.030144 |
| lab*Code  | 0.032735 |
| Error   | 0.045152 |

Laboratóriumok összehasonlítása

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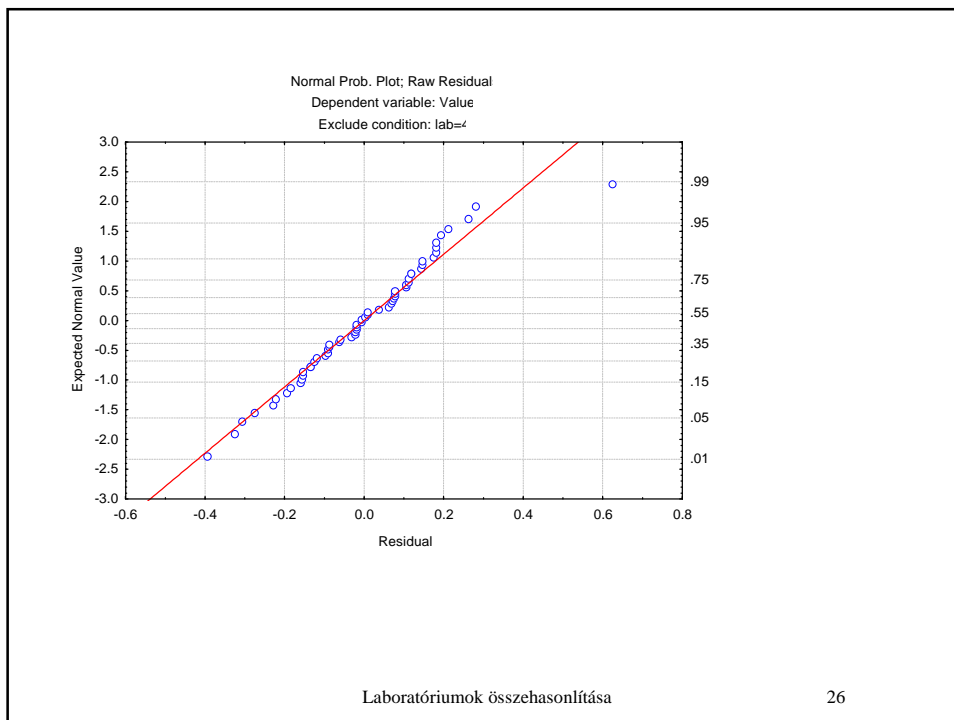
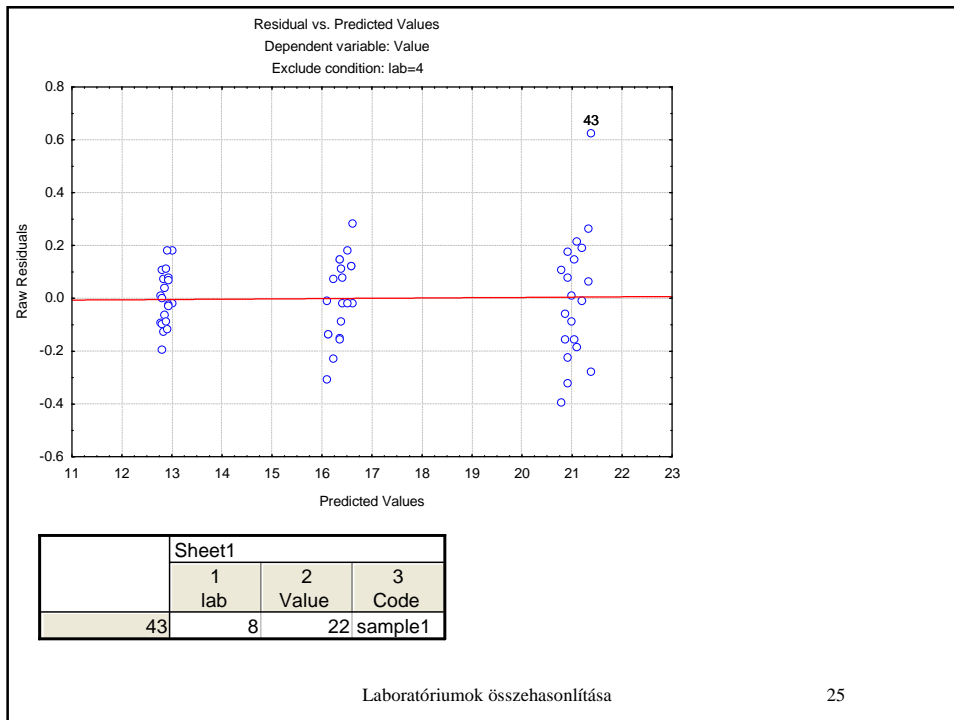
## Varianciaanalízis a 4. labor nélkül

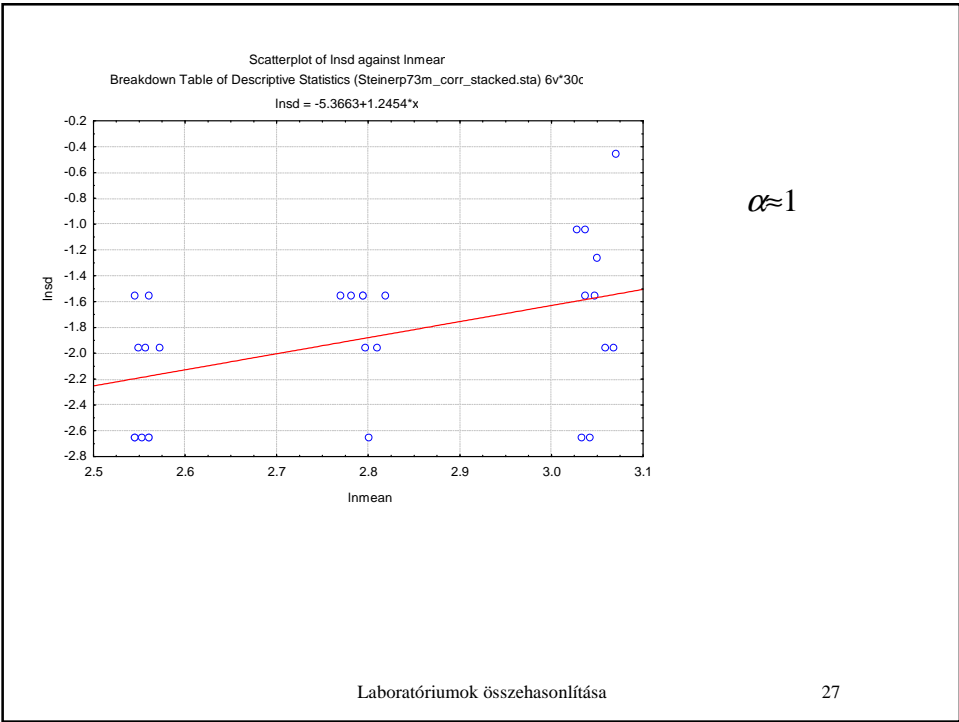
| Univariate Tests of Significance for Value (Steinerp73m_corr_stacked.sta) |              |          |                  |          |                   |                   |          |          |
|---|--------------|----------|------------------|----------|-------------------|-------------------|----------|----------|
| Over-parameterized model  |              |          |                  |          |                   |                   |          |          |
| Type III decomposition  |              |          |                  |          |                   |                   |          |          |
| Exclude condition: lab=4  |              |          |                  |          |                   |                   |          |          |
| Effect  | Effect (F/R) | SS       | Degr. of Freedom | MS       | Den.Syn. Error df | Den.Syn. Error MS | F        | p        |
| Intercept   | Fixed        | 16867.27 | 1                | 16867.27 | 9.00000           | 0.129259          | 130491.7 | 0.000000 |
| lab   | Random       | 1.16     | 9                | 0.13     | 18.00000          | 0.119204          | 1.1      | 0.419567 |
| Code  | Fixed        | 673.84   | 2                | 336.92   | 18.00000          | 0.119204          | 2826.4   | 0.000000 |
| lab*Code  | Random       | 2.15     | 18               | 0.12     | 30.00000          | 0.044000          | 2.7      | 0.007656 |
| Error   |              | 1.32     | 30               | 0.04     |                   |                   |          |          |

| Components of Variance (Steinerp73m_corr_stacked.sta) |          |
|---|----------|
| Over-parameterized model                              |          |
| Type III decomposition                                |          |
| Exclude condition: lab=4                              |          |
| Effect  | Value    |
| lab   | 0.001676 |
| lab*Code  | 0.037602 |
| Error   | 0.044000 |

Laboratóriumok összehasonlítása

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$\lambda \approx 1$

| $\alpha$ | $\lambda=1-\alpha$ | transzformáció         |
|----------|--------------------|------------------------|
| 2        | -1                 | $1/y$                  |
| 1.5      | -0.5               | $1/\sqrt{y}$           |
| 1        | 0                  | $\ln y$                |
| 0.5      | 0.5                | $\sqrt{y}$             |
| 0        | 1                  | (nincs transzformáció) |

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| Univariate Tests of Significance for Invalue (Steinerp73m_corr_stacked.sta) |              |          |                  |          |                   |                   |         |          |
|---|--------------|----------|------------------|----------|-------------------|-------------------|---------|----------|
| Over-parameterized model  |              |          |                  |          |                   |                   |         |          |
| Type III decomposition  |              |          |                  |          |                   |                   |         |          |
| Exclude condition: lab=4  |              |          |                  |          |                   |                   |         |          |
| Effect  | Effect (F/R) | SS       | Degr. of Freedom | MS       | Den.Syn. Error df | Den.Syn. Error MS | F       | p        |
| Intercept   | Fixed        | 470.1219 | 1                | 470.1219 | 9.00000           | 0.000391          | 1201208 | 0.000000 |
| lab   | Random       | 0.0035   | 9                | 0.0004   | 18.00000          | 0.000380          | 1       | 0.453332 |
| Code  | Fixed        | 2.4188   | 2                | 1.2094   | 18.00000          | 0.000380          | 3187    | 0.000000 |
| lab*Code  | Random       | 0.0068   | 18               | 0.0004   | 30.00000          | 0.000134          | 3       | 0.005639 |
| Error   |              | 0.0040   | 30               | 0.0001   |                   |                   |         |          |

| Components of Variance (Steinerp73m_corr_stacked.sta) |          |
|---|----------|
| Over-parameterized model                              |          |
| Type III decomposition                                |          |
| Exclude condition: lab=4                              |          |
| Effect  | Invalue  |
| lab   | 0.000002 |
| lab*Code  | 0.000123 |
| Error   | 0.000134 |