

Erweiterte Zeilen-Spalten-Pläne ...

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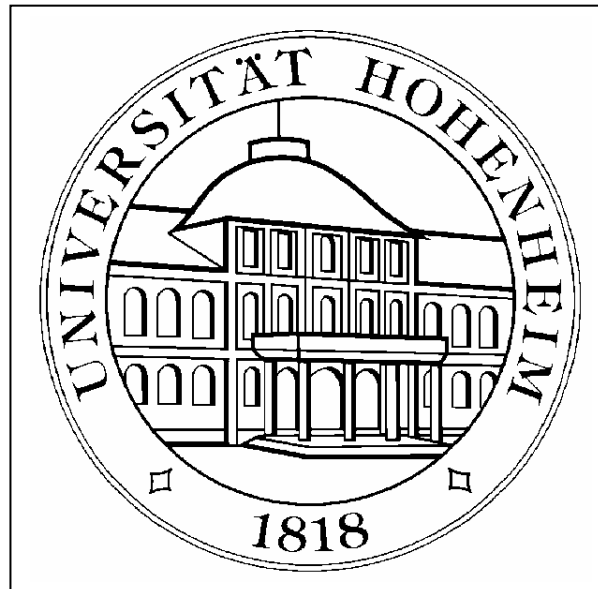


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1. Introduction

- Row-column designs allow for blocking in two dimensions
- Resolvable or non-resolvable designs readily available using standard software (CycDesigN, DiGGeR, OPTeX)
- Use in practice still relatively uncommon
- Randomized complete block design by far the most common design
⇒ ad hoc corrections to avoid non-binary columns

1. Introduction

20	18	23	13	7	9	12	16	11	19	1
5	24	22	19	1	14	3	9	18	23	10
22	20	12	21	14	10	8	18	13	17	4
8	15	10	11	16	19	7	4	23	14	25
3	16	21	24	25	6	14	22	15	13	20
1	19	6	7	2	17	18	25	24	21	8
16	5	1	4	10	11	6	17	3	12	24
11	12	15	22	13	2	5	6	8	25	9
21	2	7	9	3	20	4	23	17	5	15

Figure 1: Two-dimensional layout for 25 treatments, 9 rows, and 11 columns

⇒ poor neighbour balance (NB)

⇒ poor evenness of the distribution of treatment replications (ED)

1. Introduction



2. A model-based design strategy

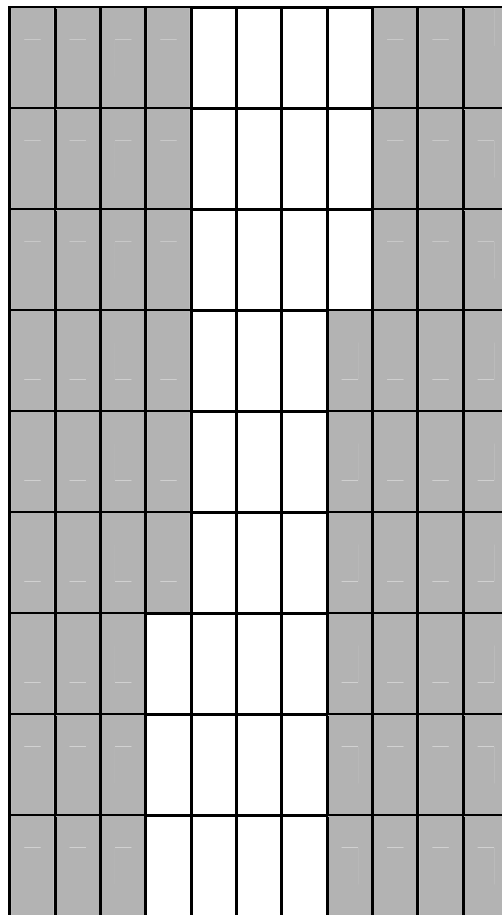
Two objectives:

- NB = Neighbour balance (within rows)
- ED = Evenness of distribution

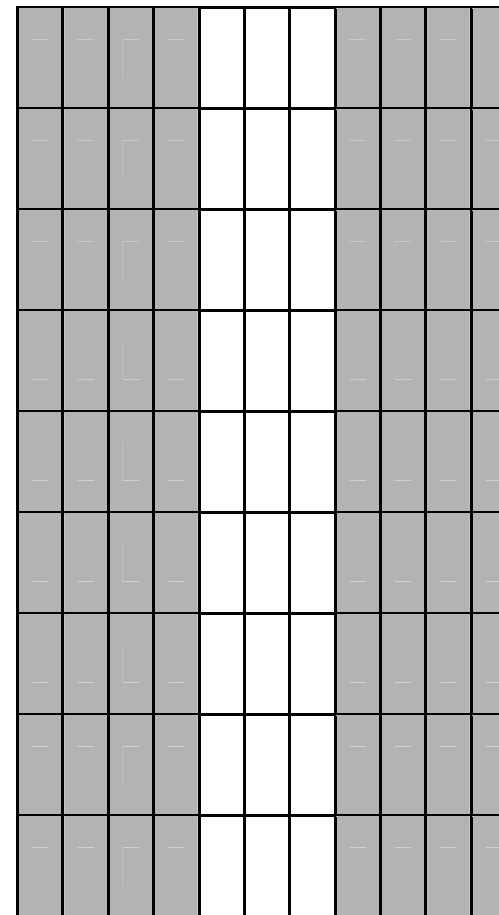
Two components of strategy:

- Grouping of columns and rows \Rightarrow Latinization, Romanization \Rightarrow ED
- Spatial covariance structures \Rightarrow NB & ED

2. A model-based design strategy



(a) crooked



(b) rectangular

Figure 2: A layout with 9 rows, 11 columns, and 3 columngroups

2. A model-based design strategy

Linear mixed model

$$y = X\tau + f$$

where

y = response vector

X = treatment design matrix

τ = vector of treatment means

f = residual disturbance term comprising design effects and plot error

$$f \sim (0, V)$$

2. A model-based design strategy

Design optimization

- Optimize the treatment information matrix $X^T V^{-1} X$
- D-efficiency
- OPTEX procedure of SAS
- The variance-covariance matrix V is generated using MIXED

2. A model-based design strategy

Decomposition of the residual f

$$f = Z_R u_R + Z_C u_C + Z_{RG} u_{RG} + Z_{CG} u_{CG} + e ,$$

where

u_R = row effects with variance $I\gamma_R$ and design matrix Z_R

u_C = row effects with variance $I\gamma_C$ and design matrix Z_C

u_{RG} = rowgroup effects with variance $I\gamma_{RG}$ and design matrix Z_{SR}

u_{CG} = columngroup effects with variance $I\gamma_{CG}$ and design matrix Z_{SC}

e = plot errors with variance-covariance matrix R

2. A model-based design strategy

$$V = Z_R Z_R^T \gamma_R + Z_C Z_C^T \gamma_C + Z_{RG} Z_{RG}^T \gamma_{RG} + Z_{CG} Z_{CG}^T \gamma_{CG} + R$$

Two choices for R

(1) Covariance $\gamma_{ED} \rho_{ED}^{d_{12}}$ among plots 1 and 2 with distance $d_{12} \Rightarrow$ ED

(2) Covariance $\gamma_{NB} \rho_{NB}$ for nearest neighbours in row \Rightarrow NB

3. Example

9	2	8	6	15	1	17	13	5	12	7
1	5	7	17	14	12	15	8	6	2	21
4	23	25	20	11	22	3	10	18	24	16
22	7	18	4	2	25	6	23	11	1	10
13	14	24	12	20	3	16	19	8	21	9
16	8	23	9	6	13	12	18	20	22	3
10	24	5	14	4	19	11	21	15	25	17
21	25	10	11	9	17	22	5	19	14	24
3	18	2	15	7	16	1	20	23	13	4

Figure 3: Two-dimensional layout for 25 treatments, 9 rows, and 11 columns.
 5 rowgroups & 5 columngroups (*rectangular*).
 Option (1) \Rightarrow ED

3. Example

25	11	18	16	19	20	12	1	10	7	2
12	14	5	10	18	13	2	6	22	19	17
7	15	23	21	16	8	20	24	11	9	4
21	5	1	22	14	2	17	11	8	25	23
6	18	4	19	24	9	10	15	12	3	13
17	4	14	20	3	7	13	16	6	21	1
8	19	25	24	23	12	9	22	15	18	5
9	1	15	2	21	17	8	4	16	14	25
13	23	11	3	10	22	7	5	24	6	20

Figure 4: Two-dimensional layout for 25 treatments, 9 rows, and 11 columns.
5 rowgroups & 5 columngroups (*rectangular*).
Option (2) \Rightarrow NB

3. Example

2	20	15	22	7	4	12	19	11	17	23
9	16	13	14	24	18	6	25	3	5	8
25	24	6	21	19	13	5	10	16	15	18
19	5	7	15	10	24	1	22	8	21	13
14	9	4	20	6	23	11	12	17	2	3
8	23	21	17	4	19	22	6	15	14	7
20	11	10	3	18	9	25	1	2	16	12
12	18	22	16	23	10	8	4	21	25	20
3	1	17	9	13	7	2	5	14	11	24

Figure 5: Two-dimensional layout for 25 treatments, 9 rows, and 11 columns.
5 rowgroups & 5 columngroups (*rectangular*).
Options (1) & (2) \Rightarrow ED & NB

4. Gerechte Designs

6	8	15	4	13	10	12	3	7	9
11	2	14	1	5	15	13	6	4	8
3	9	12	7	10	11	1	2	14	5
1	10	8	14	6	9	7	13	11	15
5	4	2	12	3	14	8	1	6	10
7	13	9	15	11	5	4	12	2	3

Figure 6: Two-dimensional layout for 15 treatments, 6 rows, and 10 columns.
4 rowgroups & 4 columngroups (*crooked*).

4 **superblocks**.

Options (1) & (2) \Rightarrow ED & NB

5. Summary

6. References

- Piepho, H.P., Michel, V., Williams, E.R. (2015): Beyond Latin squares: A brief tour of row-column designs. *Agronomy Journal* **107**, 2263-2270.
- Piepho, H.P., Michel, V., Williams, E.R. (2016): Nonresolvable row-column designs with an even distribution of treatment replications. *Journal of Agricultural, Biological and Environmental Statistics* **21**, 227-242.
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Thanks!