**Comparing two competing designs**

These two designs have 2 treatments, 5 biological replicates, 2 technical replicates, 4 tags and 5 runs.

**Design 1:**

The animal allocation for this design is shown below

[,1] [,2] [,3] [,4]

[1,] "C" "B" "J" "A"

[2,] "G" "G" "D" "D"

[3,] "F" "F" "I" "I"

[4,] "H" "H" "E" "E"

[5,] "B" "C" "A" "J"

and the incidence matrix and concurrence matrix are

> print((N = with(design.df, table(Ani, Run))))

Run

Ani 1 2 3 4 5

A 1 0 0 0 1

B 1 0 0 0 1

C 1 0 0 0 1

D 0 2 0 0 0

E 0 0 0 2 0

F 0 0 2 0 0

G 0 2 0 0 0

H 0 0 0 2 0

I 0 0 2 0 0

J 1 0 0 0 1

>

> cat("Animal concurrence matrix:\n")

Animal concurrence matrix:

> print(N %\*% t(N))

Ani

Ani A B C D E F G H I J

A 2 2 2 0 0 0 0 0 0 2

B 2 2 2 0 0 0 0 0 0 2

C 2 2 2 0 0 0 0 0 0 2

D 0 0 0 4 0 0 4 0 0 0

E 0 0 0 0 4 0 0 4 0 0

F 0 0 0 0 0 4 0 0 4 0

G 0 0 0 4 0 0 4 0 0 0

H 0 0 0 0 4 0 0 4 0 0

I 0 0 0 0 0 4 0 0 4 0

J 2 2 2 0 0 0 0 0 0 2

This design generated 6 canonical efficiency factors which are 1, 1, 1, 1, 1 and1 and hence the average efficiency factor is also 1. This also means 3 out of 9 degrees of freedom for animals are in the between runs stratum.

The eigenvectors that corresponding to the canonical efficiency factors are

[,1] [,2] [,3] [,4] [,5] [,6]

[1,] 0.0000000 0.0000000 0.0000000 0.8660254 0.0000000 0.0000000

[2,] -0.2677175 0.0000000 0.0000000 -0.2886751 0.0000000 0.7713586

[3,] -0.5341574 0.0000000 0.0000000 -0.2886751 0.0000000 -0.6175294

[4,] 0.0000000 0.0000000 0.7071068 0.0000000 0.0000000 0.0000000

[5,] 0.0000000 0.0000000 0.0000000 0.0000000 -0.7071068 0.0000000

[6,] 0.0000000 0.7071068 0.0000000 0.0000000 0.0000000 0.0000000

[7,] 0.0000000 0.0000000 -0.7071068 0.0000000 0.0000000 0.0000000

[8,] 0.0000000 0.0000000 0.0000000 0.0000000 0.7071068 0.0000000

[9,] 0.0000000 -0.7071068 0.0000000 0.0000000 0.0000000 0.0000000

[10,] 0.8018748 0.0000000 0.0000000 -0.2886751 0.0000000 -0.1538291

The theoretical ANOVA table that is generated from this design is as follow

> summary.aov.twoPhase(design.df, blk.str2 = "Run", blk.str1 = "Ani", trt.str = "Tag + Trt")

$ANOVA

DF e Ani Run

Between Run

Between Ani 3 1 2 4

Residual 1 1 0 4

Within

Between Ani

Tag 1 1 2 0

Trt 1 1 2 0

Residual 4 1 2 0

Residual

Tag 2 1 0 0

Residual 7 1 0 0

$EF

Tag Trt eff.Tag eff.Trt

Between Run

Between Ani

Residual

Within

Between Ani

Tag 5 2/5 1 1/25

Trt 48/5 24/25

Residual

Tag 5 1

The formal test for the treatment group differences can be directly applied here. The treatment is still partially confounded with tags, and there is 24/25 of treatment information remaining.

**Design 2:**

The animal allocation of the first design is shown below

[,1] [,2] [,3] [,4]

[1,] "H" "D" "C" "A"

[2,] "C" "B" "F" "G"

[3,] "J" "H" "E" "F"

[4,] "A" "E" "I" "B"

[5,] "I" "G" "D" "J"

and the incidence matrix and concurrence matrix are

> print((N = with(design.df, table(Ani, Run))))

Run

Ani 1 2 3 4 5

A 1 0 0 1 0

B 0 1 0 1 0

C 1 1 0 0 0

D 1 0 0 0 1

E 0 0 1 1 0

F 0 1 1 0 0

G 0 1 0 0 1

H 1 0 1 0 0

I 0 0 0 1 1

J 0 0 1 0 1

>

> cat("Animal concurrence matrix:\n")

Animal concurrence matrix:

> print(N %\*% t(N))

Ani

Ani A B C D E F G H I J

A 2 1 1 1 1 0 0 1 1 0

B 1 2 1 0 1 1 1 0 1 0

C 1 1 2 1 0 1 1 1 0 0

D 1 0 1 2 0 0 1 1 1 1

E 1 1 0 0 2 1 0 1 1 1

F 0 1 1 0 1 2 1 1 0 1

G 0 1 1 1 0 1 2 0 1 1

H 1 0 1 1 1 1 0 2 0 1

I 1 1 0 1 1 0 1 0 2 1

J 0 0 0 1 1 1 1 1 1 2

This design generated 6 canonical efficiency factors which are 1, 1, 1, 1, 1, 0.625, 0.625, 0.625 and 0.625.The average efficiency factor is 0.7895. This also means all 9 degrees of freedom for animals are all in the within runs for this design. However, 4 out of 9 degrees of freedom of animal only have 0.625 of the information in within runs stratum.

The theoretical ANOVA table that is generated from this design is as follow

$ANOVA

DF e Ani Run

Between Run

Between Ani

Trt 1 1 3/4 4

Residual 3 1 3/4 4

Within

Between Ani

Tag 3 1 24/13 0

Trt 1 1 1999/1092 0

Residual 5 1 641/420 0

Residual

Tag 3 1 0 0

Residual 3 1 0 0

$EF

Tag Trt eff.Tag eff.Trt

Between Run

Between Ani

Trt 1 1/10

Within

Between Ani

Tag 78/47 12/13 78/235 6/65

Trt 105/13 21/26

Residual

Tag 477/152 477/760

The formal test for the treatment group differences cannot be applied here, because the coefficients of the animal variance components are not identical. The treatment is also partially confounded with tags, which leaves (21/26 =) 0.8076 of treatment information remaining.

For the second design, if the eigenvectors for the Phase 1 block structure are manually fitted the ANOVA model. Note that the canonical efficiency factors are 5 1’s and 4 0.625’s, hence we can group the 5 eigenvectors associated with the canonical efficiency factors of 1 and 4 eigenvectors associated with the canonical efficiency factors of 0.625. These two sets of contrasts are fitted to ANOVA table with Phase 1 block factor and the theoretical ANOVA table is shown below

> summary.aov.twoPhase(design.df, blk.str2 = "Run", blk.str1 = "Ani",

+ trt.str = "Tag + Trt", blk.contr = blk.contr)

$ANOVA

DF e Ani Run

Between Run

Between Ani.A2

Trt 1 1 3/4 4

Residual 3 1 3/4 4

Within

Between Ani.A1

Tag 3 1 2 0

Trt 1 1 2 0

Residual 1 1 2 0

Between Ani.A2

Tag 1 1 5/4 0

Trt 1 1 5/4 0

Residual 2 1 5/4 0

Residual

Tag 3 1 0 0

Residual 3 1 0 0

$EF

Tag Trt eff.Tag eff.Trt

Between Run

Between Ani.A2

Trt 1 1/10

Within

Between Ani.A1

Tag 18/17 4/3 18/85 2/15

Trt 6 3/5

Between Ani.A2

Tag 16/15 16/75

Trt 5/3 1/6

Residual

Tag 477/152 477/760

Now the treatment difference can be tested in two different strata. The remaining treatment information is (3/5 + 1/6 =) 0.7667.

In summary, there are two designs presented, the first design provides a more straight forward analysis, but 3 of 9 DF are lost to the between runs stratum. The second design preserved all 9 DF in the within runs stratum, but the analysis cannot be done directly.

Pro and cons of these two designs ….