# SAS Macro for Generation of Trend Free Neighbour Balanced Block Designs

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In many fields of agricultural research, like horticultural and agroforestry experiments, situations may arise where the treatment applied to one experimental plot in a block may affect the response on the neighbouring plots. Since, agricultural field experiments are generally conducted in smaller units with no gaps, the estimates of treatment differences may deviate because of interference by the treatments applied in neighbouring units. For example, in an agricultural experiment, the response on one plot may be affected by the pesticide applied to that plot and also pesticides applied to its neighbouring plots. In experimenting with field plant communities, the interference can occur with regard to differences in availability of light, nutrients, effect of wind, spread of diseases etc. Thus, neighbour effects may lead to inefficiencies in the estimation. Hence, it is important to include the neighbour effects in the model for the proper specification. Designs balanced for neighbour effects are used for these situations. Azais (1987) defined balancedness in block design for studying competition effects. A block design is balanced in the sense that every treatment has every other treatment appearing once as a right and once as a left neighbour. It means, every pair of treatments appears as neighbours equally often. Azais *et al.* (1993) obtained series of designs that are balanced in v -1 blocks of size v and v blocks of size v -1, where v is the number of treatments.

In block design set up, apart from neighbour effects, spatial trend in the experimental material may also affect the plots within the blocks. In such situations, the response may also depend on the spatial position of the experimental unit within a block. For example, field plots in block similarly oriented may have similar fertility gradient. In field experiments, if the land is irrigated the nutrients supplied by the fertilizers may be equally distributed but when there is slope or while dealing with undulating land in hilly areas, this may not be the case as slope may cause a trend in experimental units. One way to overcome such situations is the application of suitable arrangement of treatments over plots within a block such that the arranged design is capable of completely eliminating the effects of defined components of a common trend. Such designs have been called as *Trend Free Block* (TFB) designs (Bradley

and Yeh, 1980). These designs are constructed in such a manner that treatment effects and trend effects are orthogonal.. Hence, for proper model specification neighbour effects and trend effects should be incorporated in to the model as these effects plays a significant role in the precision of many agricultural experiments. Bhowmik (2013) obtained of trend free block designs in the presence of neighbour effects. Bhowmik *et al.* (2013) studied block model with neighbour effects from adjacent experimental units incorporating trend component. They have obtained the necessary and sufficient condition for a block design with neighbour effects to be trend free. Series of trend free circular totally neighbour balanced block designs have also been obtained. Bhowmik *et al.* (2014) also obtained trend free circular second order neighbour balanced block designs. The blocks are circular in the sense that the border treatments at the left end of each block is same as the treatment on the interior plot at the right end of the block and border treatment at the right end of each block is same as the treatment on the interior plot at the left end of the block.

Here, for easy accessibility of end users, a SAS Macro has been developed to generate a class of trend free circular neighbour balanced block designs. This macro would enhance the application potential of these designs.

**SAS macro for the generation of trend free neighbour balanced block designs**

Here, user need to enter only the number of treatments as v (>2). The number of treatment v should be a prime number. If user enter a number which is not a prime number and then run the macro, a message will be displayed in the output as "v is not a prime number". If user enter the value of v as 1 or 2 and run the macro, a message will be displayed in the output as " Please enter a number >2". If user enter a prime number( >2) as the value of v and run the macro, then the SAS Macro will generate a trend free circular neighbour balanced block designs with parameters v (Number of treatments), b (Number of Blocks) = v(v-1) = r (Number of Replications per treatment), $\mu_1$ (Number of times a particular treatment appears as left and right neighbour of every other treatments) = v. Here every treatment appears in every position in the design same number of times i.e. v-1. Once user run the macro, everytime the SAS macro would also generate a word file containing the output (be it either one of the above mentioned message or a trend free neighbour balanced block designs with above mentioned parameters as per the choice of the number of treatment v in the macro). User can then save the word file.

## SAS Code

```
/*For easy accessibility of end users, the following macro generates a
trend free complete neighbour balanced block designs with
v (Number of treatments),b (Number of Blocks) = v(v-1) = r (Number of
Replications per treatment),
v Number of times a particular treatment appears as left and right
neighbour of every other treatments.
Here every treatment appears in every position in the design same number of
times i.e. v-1.
Here, user need to enter only the number of treatments as v (>2). The
number of treatment v should be a prime number.
The resultant design is not only linear trend free but also it is
completely trend free */

options nodate nonumber ;
ods rtf file ='tfnbcbd.rtf';
%let v=5;/*Enter a prime number >2 Eg:3,5,7,11,13 etc */
proc iml;
pp1=1;
do i=2 to &v-1;
pp=mod(&v,i);
if pp=0 then pp1=0;
end;
if pp1=0 then do;
print 'v is not a prime number';
end;
if &v<3 then do;
print 'Please enter a number >2';
end;
if &v>2 then do;
if pp1^=0 then do;
d1=j(&v-1,&v-1,0);
s=0;
do j=1 to &v-1;
do i=1 to &v-1;
d1[i,j]=mod(i*(s+1),&v);
end;
s=s+1;
end;
d2=j(&v-1,&v-1,1);
d3=j(&v-1,1,1);
d=d3||(d1+d2);/*design without border plots*/
*print d;
d4=j(nrow(d)*ncol(d),ncol(d),0);
k=1;
do i=1 to nrow(d);
do m=1 to &v;
d4[k, ]=mod(d[i, ]+m-1, &v);
k=k+1;
end;
end;
do i=1 to nrow(d4);
do j=1 to ncol(d4);
if d4[i,j]=0 then d4[i,j]=&v;
end;
end;
*print d4;
TFNBBD=d4[ ,ncol(d4)]||d4||d4[ ,1];/*adding border plots*/
*print nnbd;
```

```
title 'Trend free complete Neighbour balanced block design (NBBD) with rows
representing blocks [First and last column may be treated as border
plots]';
print tfnbbd;
end;
end;
run;
ods rtf close;
quit;
```

## SAS Output

Following is the output obtained through the macro for v=5

Trend free complete Neighbour balanced block design (NBBD) with rows representing blocks [First and last column may be treated as border plots]

| TFNBBD | | | | | | |
|---|---|---|---|---|---|---|
| 5 | 1 | 2 | 3 | 4 | 5 | 1 |
| 1 | 2 | 3 | 4 | 5 | 1 | 2 |
| 2 | 3 | 4 | 5 | 1 | 2 | 3 |
| 3 | 4 | 5 | 1 | 2 | 3 | 4 |
| 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 4 | 1 | 3 | 5 | 2 | 4 | 1 |
| 5 | 2 | 4 | 1 | 3 | 5 | 2 |
| 1 | 3 | 5 | 2 | 4 | 1 | 3 |
| 2 | 4 | 1 | 3 | 5 | 2 | 4 |
| 3 | 5 | 2 | 4 | 1 | 3 | 5 |
| 3 | 1 | 4 | 2 | 5 | 3 | 1 |
| 4 | 2 | 5 | 3 | 1 | 4 | 2 |
| 5 | 3 | 1 | 4 | 2 | 5 | 3 |
| 1 | 4 | 2 | 5 | 3 | 1 | 4 |
| 2 | 5 | 3 | 1 | 4 | 2 | 5 |
| 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| 3 | 2 | 1 | 5 | 4 | 3 | 2 |
| 4 | 3 | 2 | 1 | 5 | 4 | 3 |
| 5 | 4 | 3 | 2 | 1 | 5 | 4 |
| 1 | 5 | 4 | 3 | 2 | 1 | 5 |

## References

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