SAS MACRO FOR GENERATION OF TREND FREE DESIGNS UNDER TWO SOURCES OF HETEROGENEITY

Arpan Bhowmik, Seema Jaggi, Eldho Varghese and Sunil Kumar Yadav

ICAR-Indian Agricultural Statistics Research Institute, New Delhi
[1]ICAR-Central Marine Fisheries Research Institute, Kochi

Case 1: SAS MACRO FOR GENERATION OF COMPLETE TREND FREE DESIGNS UNDER TWO SOURCES OF HETEROGENEITY

In agricultural experiments, many situations arise in which apart from the known source of variations, the response may also depend on the spatial or temporal position of the experimental unit, i.e. **systematic trend** effects may affect the experimental units. Here, the following SAS macro using SAS 9.3 has been developed to generate a class of complete trend free designs under two sources of heterogeneity. Here, user need to enter the **number of treatments** as **v (≥ 2)** where v should be a prime number. If user run the macro after entering any prime number (≥ 2) as the value of v, then the SAS Macro will generate a particular class of complete trend free designs under two sources of heterogeneity based on Bhowmik *et al*. (2017, 2018) under the heading **Trend Free Design under Two Sources of Heterogeneity Setup**. Along with the design, the macro will also generate a polynomial coefficient (linear) which will be used to measure the effect of trend component. Once user run the macro, every time the SAS macro would also generate a word file containing the output. User can then save the word file. If user does not enter a prime number and execute the programme, the macro will display the message **Entered number is not a prime number**. The code and output are as follows:

CODE

```
options nodate nonumber;
%let n=2;/*number factors will be of the form(2^n)*(3^n)*/
%let alpha=0.5; /*Enter the value of alpha*/
ods rtf  file= 'output.rtf' startpage=no;
proc iml;
ss0=j(&n,1,2);
ss1=j(&n,1,3);
ss=ss0//ss1;
*print ss;
s=ss;
a=j(max(s),nrow(s),0);
do kk=1 to nrow(s);
m=mod(s[kk, ],2);
do i=1 to s[kk, ];
do j=i to s[kk, ];
if m=1 then
                    do;
```

```
                    a[j,kk]=-((s[kk, ]-1)/2)+(i-1);
                    end;
                    else
                    do;
                    if -(s[kk, ]/2)+(i-1)<0 then do;
                    a[j,kk]=-(s[kk, ]/2)+(i-1);
                    end;
                    else do;
                    a[j,kk]=-(s[kk, ]/2)+i;
                    end;
                    end;
end;
end;
end;
*print a;
aa=j(s[1, ],1,0);
do i=1 to s[1, ];
aa[i,]=a[i,1];
end;
*print aa;
sum=1;
do j=1 to nrow(s)-1;
do i=1 to nrow(aa);
kk=repeat(aa[i,],s[j+1,],1);
if i=1 then do;
aaa=kk;
end;else do;
aaa=aaa//kk;
end;
end;
*print aaa;
sum=sum*s[j, ];
if mod(sum,2)=0 then do;
ggg=j(s[j+1, ],1,0);
do i=1 to s[j+1, ];
ggg[i,]=a[i,j+1];
end;
ggg1=ggg;
ggg2=ggg//ggg1;
hh=repeat(ggg2,sum/2,1);
aa=aaa||hh;
end;
else do;
ggg=j(s[j+1, ],1,0);
do i=1 to s[j+1, ];
ggg[i,]=a[i,j+1];
```

```
end;
ggg1=ggg*-1;
ggg2=ggg//ggg1;
hh1=repeat(ggg2,(sum-1)/2,1);
hh=hh1//ggg;
aa=aaa||hh;
end;
end;
Run_Sequence=aa*-1;

kk_2=j(nrow(Run_sequence),&n,0);
do i=1 to &n;
kk_2[ ,i]=Run_sequence[ ,i];
end;
kk_21=j(nrow(Run_sequence),&n,0);
do j=1 to &n-1;
do i=1 to &n;
if i+j>&n then do;
kk_21[ ,i]=kk_2[ ,(i+j)-&n];
end;
else do;
kk_21[ ,i]=kk_2[ ,i+j];
end;
kk_22=kk_21;
end;
kk_23=kk_23//kk_22;
*print kk_22;
end;
kk_24=kk_2//kk_23;
*print kk_24;
kk_3=j(nrow(Run_sequence),&n,0);
do i=1 to &n;
kk_3[ ,i]=Run_sequence[ ,&n+i];
end;
kk_31=j(nrow(Run_sequence),&n,0);
do j=1 to &n-1;
do i=1 to &n;
if i+j>&n then do;
kk_31[ ,i]=kk_3[ ,(i+j)-&n];
end;
else do;
kk_31[ ,i]=kk_3[ ,i+j];
end;
kk_32=kk_31;
end;
kk_33=kk_33//kk_32;
```

```
*print kk_22;
end;
kk_34=kk_3//kk_33;
*print kk_24 kk_34;
print "Second Order Asymmetrical Response Surface Designs with Neighbour Effects
(SOARDNE), v=(2^&n)*(3^&n)";
SOARDNE=kk_24||kk_34;
ARSDIE=SOARDNE;
print SOARDNE;
xsquare=j(nrow(kk_34),ncol(kk_34),0);
do i=1 to nrow(kk_34);
do j=1 to ncol(kk_34);
xsquare[i,j]=kk_34[i,j]*kk_34[i,j];
end;
end;
*print xsquare;
b0=j(nrow(xsquare),1,1);
model=b0||kk_24||kk_34||xsquare;
*print model;
g_=i(nrow(ARSDIE));
do i= 1 to nrow(ARSDIE);
do j= 2 to nrow(ARSDIE);
if i=j then g_[i,j-1]=&alpha;
end;
end;
do i= 1 to nrow(ARSDIE)-1;
do j= 1 to nrow(ARSDIE);
if i=j then g_[i,j+1]=&alpha;
end;
end;
x1=model[nrow(model), ]//model//model[1, ];
*print g_;/*without border*/
g1=j(nrow(ARSDIE),1,0);
g1[1,1]=&alpha;
g2=j(nrow(ARSDIE),1,0);
g2[nrow(ARSDIE),1]=&alpha;
g=g1||g_||g2;
*print g;
z=g*x1;
*print z;
*print z`*z;
Var_beta=vecdiag(inv(z`*z));
Var_Est_Resp1=vecdiag(x1*inv(z`*z)*x1`);
Var_Est_Resp=sum(Var_Est_Resp1)/nrow(Var_Est_Resp1);
print 'The coefficient of Neighbour Effects (alpha)';
print &alpha;
```

```
print 'Variance factor for parameter estimates';
print Var_beta;
print 'Variance factor for estimated response';
print Var_Est_Resp;
ods rtf close;
quit;
```

Trend Free Design under Two Sources of Heterogeneity Setup

Trend_Free_Design										
	-2		**-1**		**0**		**1**		**2**	
1	A	1	B	2	C	3	D	4	E	5
2	C	2	D	3	E	4	A	5	B	1
3	E	3	A	4	B	5	C	1	D	2
4	B	4	C	5	D	1	E	2	A	3
5	D	5	E	1	A	2	B	3	C	4

Column represents trend component, Row represent Source 1,Alphabets with in Row-column intersection is Source 2 and Number represents the treatments

Case 2: SAS MACRO FOR GENERATION OF INCOMPLETE TREND FREE DESIGNS UNDER TWO SOURCES OF HETEROGENEITY

In agricultural experiments, many situations arise in which apart from the known source of variations, the response may also depend on the spatial or temporal position of the experimental unit, i.e. **systematic trend** effects may affect the experimental units. Here, the following SAS macro using SAS 9.3 has been developed to generate a class of complete trend free designs under two sources of heterogeneity. Here, user need to enter the **number of treatments** as **v (≥ 2)** where v should be a prime number. If user run the macro after entering any prime number (≥ 2) as the value of v, then the SAS Macro will generate a particular class of incomplete (row-wise) trend free designs under two sources of heterogeneity based on Bhowmik *et al*. (2018) under the heading **Incomplete (row-wise) Trend Free Design under Two Sources of Heterogeneity Setup**. Along with the design, the macro will also generate a polynomial coefficient (linear) which will be used to measure the effect of trend component. Once user run the macro, every time the SAS macro would also generate a word file containing the output. User can then save the word file. If user does not enter a prime number and execute the programme, the macro will display the message **Entered number is not a prime number**. The code and output are as follows:

CODE

```
/*This macro will generate designs with maximum v=26*26*/
%let v=5;/*Enter a prime number*/
ods rtf  file= 'output.rtf' startpage=no;
proc iml;
TRT_Labels1={a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x,y,z};
TRT_Labels2=j(26*26,1,'ab');
k=1;
do i=1 to 26;
do j=1 to 26;
TRT_Labels2[k,1]=TRT_Labels1[i,1]+TRT_Labels1[j,1];
k=k+1;
end;
end;
TRT_Labels2=TRT_Labels1//TRT_Labels2;
*print TRT_Labels;
TRT_Labels=j(&v,1,'ab');
do i=1 to &v;
TRT_Labels[i, ]=TRT_Labels2[i, ];
end;
*print TRT_Labels;
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 'Entered number is not a prime number';
end;
if pp1^=0 then do;
x=j(&v,&v,0);
m=mod(&v,2);
a=j(&v-1,1,0);
kk=2;
do i=1 to &v-1;
a[i,1]=-(&v)+kk;
kk=kk+2;
end;
*print a;
col=a`;
row=j(&v,1,0);
do i=1 to &v;
row[i, ]=i;
end;
*print row col;
row1=char(row,5,0);
col1=char(col,5,0);
/*contructing TWO LS*/
x=j(&v,&v,0);
x1=j(&v,&v,0);
do i=1 to &v;
do j=1 to &v;
x[i,j]=mod((i-1)+(j-1),&v)+1;
x1[i,j]=mod((2*(i-1))+(j-1),&v)+1;
end;
end;
*print x;
*print x1;
/****/
x2=j(&v,&v-1,"ab");
do i=1 to &v;
do j=1 to &v-1;
x2[i,j]=TRT_Labels[x1[i,j],];
end;
end;
*print x2;
xx=j(&v,&v-1,0);
do i=1 to &v;
do j=1 to &v-1;
xx[i,j]=x[i,j];
```

```
end;
end;
*print xx;
x3=char(xx,5,0);
;
Trend_Free_Design=x2+x3;
print 'Incomplete (row-wise) Trend Free Design under Two Sources of Heterogeneity Setup';
print Trend_Free_Design[rowname=row1 colname=col1];
print 'Column represents trend component, Row represent Source 1,
Alphabets with in Row-column intersection is Source 2 and Number represents the treatments';
end;
run;
ods rtf close;
quit;
```

Incomplete (row-wise) Trend Free Design under Two Sources of Heterogeneity Setup

Trend_Free_Design								
	-3		**-1**		**1**		**3**	
1	A	1	B	2	C	3	D	4
2	C	2	D	3	E	4	A	5
3	E	3	A	4	B	5	C	1
4	B	4	C	5	D	1	E	2
5	D	5	E	1	A	2	B	3

Column represents trend component, Row represent Source 1,Alphabets with in Row-column intersection is Source 2 and Number represents the treatments

Reference

Bhowmik. Arpan, Varghese E., Jaggi, S. and Yadav, S. K. (2018). Designs for Animal experiments under two-way blocking structure in the presence of systematic trend. *Indian Journal of Animal Sciences*. **88**, 121-124. Available at `http://krishi.icar.gov.in/jspui/handle/123456789/5805`

Bhowmik, Arpan**,** Jaggi, S., Varghese E. and Yadav, S. K. (2017). Trend Free Design under Two-way Elimination of Heterogeneity. *RASHI*, **2(1)**, 34-38. Available at `http://krishi.icar.gov.in/jspui/handle/123456789/4359`

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