SAS MACRO FOR GENERATION OF ALL POSSIBLE MINIMALLY CHANGED HALF REPLICATE OF 2^k RUN ORDER WITH TREND FACTOR VALUE THROUGH RESTRICTED EXHAUTIVE SEARCH ALGORITHM

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Minimally changed run sequences for a fractional factorial design are not unique instead there may exists many such run orders specific fractional factorial design. However, due to execution of runs in different order among minimally changed run sequences, effect of trend may be different. Following SAS macro has been developed to perform restricted exhaustive search procedure to generate all possible minimally changed run order for half replicate of two level fractional factorial design. **Here user need to enter any specific fractional factorial combinations in any order** for which all possible minimally changed run orders need to be generated. Beside, user need to **specify the minimum number of change for that fractional factorial combination as "sum(count)= " and the interval based on trend factor as "Trend_factor> & Trend_factor< "** for which the minimally changed run orders will be generated. The programme will then generate **all possible minimally changed run orders in that specified interval** for the fractional factorial combinations specified in the programme along with **factor wise level changes**. Further, the macro **will also generate D, D_t and Trend Factor (TF)** value for all the generated minimally changed run order based on following model:

Let, there are k factors x_1, x_2, ...x_k. Let, **Y** is n × 1 vector of response variable. Then the model for factorial run orders in the presence of trend component can be defined as

$$\mathbf{Y} = \mathbf{F\alpha} + \mathbf{G\beta} + \boldsymbol{\varepsilon}$$

Where, **F** denote the design matrix of order n × p where p is the number of parameters to be estimated [here, only general mean and all the main effects have been considered]. Here, $\boldsymbol{\alpha}$ is a p × 1 vector of parameters of interest. Here, **G** of order n × q represent the orthogonal polynomial coefficient to measure trend effect [here only linear trend has been considered thus q = 1] and $\boldsymbol{\beta}$ is a q × 1 vector of trend effects. Based on the above model following can be defined [Tack and Vandebroek (2001)]:

D- optimality criterion (D): Considering the above experimental set-up, the D-optimal design is found by minimizing the generalized variance or equivalently, by maximizing the determinant of the information matrix as $D = |\mathbf{F'F}|$.

D_t-optimality criterion (D_t): Considering the above experimental set-up, the D_t-optimality criterion is found by minimizing the generalized variance or equivalently maximizes the information in presence of trend as $D_t = \left|\mathbf{F'F\text{-}F'G}\left(\mathbf{G'G}\right)^{-1}\mathbf{G'F}\right|$.

Trend Factor: In order to see the effect of trend on factorial run order, Tack and Vandebroek (2001) defined the term trend factor which as

$$\text{Trend Factor(TF)} = \left[\frac{D_t}{D}\right]^{\frac{1}{p}}, 0 \le \text{TF} \le 1.$$

For a completely trend free run order, TF will be equal to 1 and for a run order which is completely affected by trend, TF will take value 0.

The SAS macro will also generate **total number of minimally changed run order in the last**. The programme has been implemented with single processor having the computational specification as follows:

Processor: Intel(R) Core(TM) i5-3470, CPU @ 3.20 GHz, **RAM:** 8 GB, **Hard Disk Drive:** 500 GB

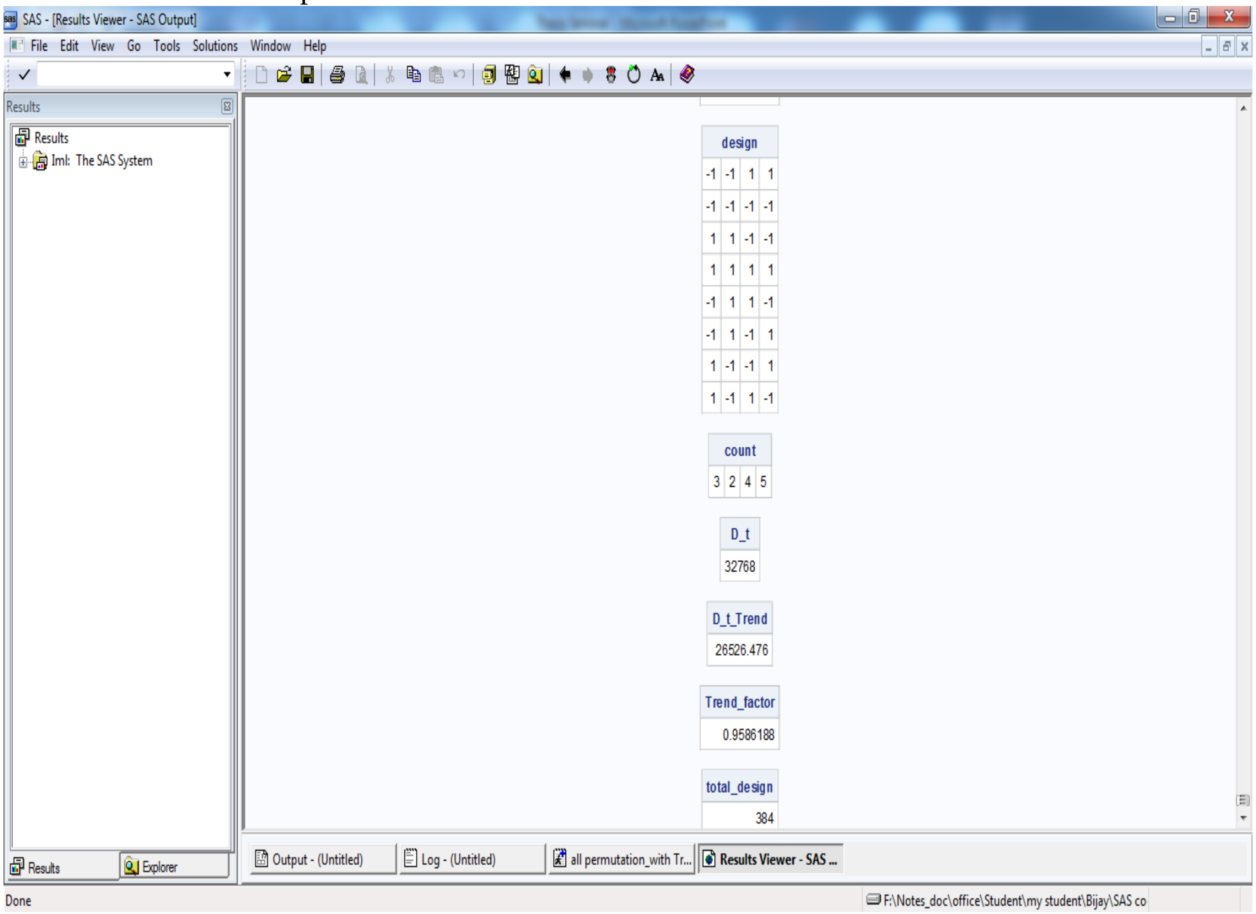
Code

```
proc iml;
*ods rtf file='fact.rtf'startpage=no;
/* enter fractional factorial without coefficient of intercept*/
aa={
-1    -1    -1    -1    ,
-1    -1    1     1     ,
-1    1     1     -1    ,
-1    1     -1    1     ,
1     -1    -1    1     ,
1     -1    1     -1    ,
1     1     1     1     ,
1     1     -1    -1
};

*print aa;
/************Normalised Linear trend component*************/
m=mod(nrow(aa),2);
ma=j(nrow(aa),1,0);
do i=1 to nrow(aa);
if m=1 then
            do;
            ma[i,1]=-((nrow(aa)-1)/2)+(i-1);
            end;
            else do;
            ma[i,1]=-(nrow(aa)-1)+(2*(i-1));
            end;
end;
mk=sqrt(ssq(ma));
ma=ma/mk;
*print ma;
/*********************************************/
```

```
total_design=0;
p=allperm(nrow(aa));
n=nrow(p);
*print p;
*print n;
design=j(nrow(aa),ncol(aa),0);
do j=1 to nrow(p);
kk=1;
do i=1 to ncol(p);
design[kk, ]=aa[p[j,i],];
kk=kk+1;
end;
count=j(1,ncol(design),0);
do k=1 to ncol(design);
do l=2 to nrow(design);
if design[l-1,k]^=design[l,k] then do;
count[1,k]=count[1,k]+1;
int=j(nrow(aa),1,1);
design_int=int||design;
D_t=det(design_int`*design_int);/*D_T without Trend*/
*D_t_Trend=(det((design`*design)-
(design`*ma*inv(ma`*ma)*ma`*design)))**(1/ncol(design));
D_t_Trend=det(((design_int`*design_int)||(design_int`*ma))//((ma`*design_int)
||(ma`*ma)));
Trend_factor=(D_t_Trend/D_t)**(1/ncol(design_int));
end;
end;
end;
if sum(count)=14 & Trend_factor>0.95 & Trend_factor<1 then do; /*ENTER THE
VALUE OF THE TOTAL CHANGE*/
/*ENTER THE VALUE OF optimality factor, if required or else remove*/
total_design=total_design+1;
print design;
print count;
print D_t;
print D_t_Trend;
print Trend_factor;
*print ma;
end;
end;
end;
print total_design;
*ods rtf close;
quit;
```

A screenshot of the output is as follows



References

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