SAS PROGRAMME FOR CALCULATION OF TREND FACTOR FOR ANY FACTORIAL RUN ORDERS

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For calculating different parameters for an arbitrary factorial run order, following SAS programme has been written using SAS 9.3. Here, **user need to enter a factorial run order** for which different parameters need to be calculated. The programme once successfully executed will generate the **specified run order, the factor-wise level changes, total number of level changes and normalized trend component based on orthogonal polynomial of degree 1**. Beside, the programme will generate D, D_t and trend factor values of that run order based on following model:

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

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

Where, $\mathbf{F}$ 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, $\mathbf{G}$ 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 $D = \left|\mathbf{F}'\mathbf{F}\right|$.

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 $D_t = \left|\mathbf{F}'\mathbf{F}\text{-}\mathbf{F}'\mathbf{G}\left(\mathbf{G}'\mathbf{G}\right)^{-1}\mathbf{G}'\mathbf{F}\right|$.

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.

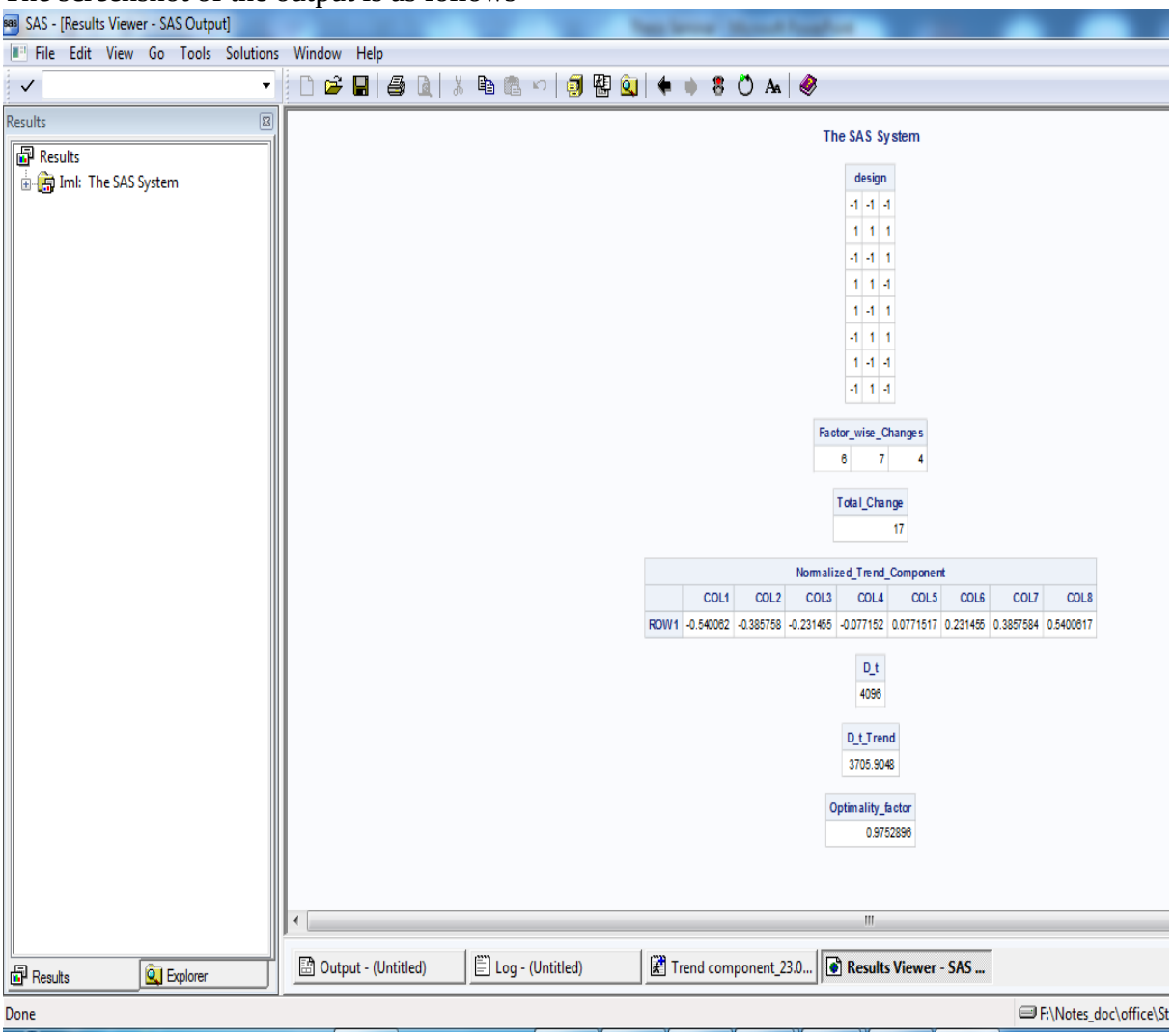
Code

```
proc iml;
*ods rtf file='fact.rtf'startpage=no;
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
};
/************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;
Normalized_Trend_Component=ma`;
/****************************************/
design=aa;
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)));
Optimality_factor=(D_t_Trend/D_t)**(1/ncol(design_int));
end;
end;
end;
Total_Change=sum(count);
Factor_wise_Changes=count;
print design;
print Factor_wise_Changes;
print Total_Change;
print Normalized_Trend_Component;
print D_t;
print D_t_Trend;
```

```
print Optimality_factor;

*ods rtf close;
quit;
```

The screenshot of the output is as follows



References

Chanda, B. (2020). *Trend efficient minimally changed run sequences in factorial experiments*. Unpublished Ph.D. thesis, ICAR-IARI, New Delhi.

Tack, L. and Vandebroek, M. (2001). (D_t,C)-optimal run orders. *Journal of Statistical Planning and Inference*, **98**, 293-310.