The Forecasting Model

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Abstract

In this research investigation, the author has presented '*The Forecasting Model*'to predict *One Step Evolution* of any *Dynamic State System* with Large Number of Parameters.

Theory

Firstly, we represent any *Dynamic State System* using a *State Vector* (*Row Vector*) of a specified size, say

$$V_i = [V_i(1) \quad V_i(2) \quad V_i(3) \quad . \quad . \quad . \quad V_i(n-2) \quad V_i(n-1) \quad V_i(n)]$$

That is,

$$\overline{V_i} = [V_i(1) \quad V_i(2) \quad V_i(3) \quad . \quad . \quad . \quad V_i(n-2) \quad V_i(n-1) \quad V_i(n)]$$

$$\overline{V_i} = \sum_{j=1}^{n} \{[V_{ij}]\hat{e}_j\}$$

Here, the *State Vector* has n parameters that are Evolving with time.

For the time instant $i = k$, we have the *State Vector* given by

$$\overline{V_k} = [V_k(1) \quad V_k(2) \quad V_k(3) \quad . \quad . \quad . \quad V_k(n-2) \quad V_k(n-1) \quad V_k(n)]$$

Let the *State Vector* be defined for $i = 1$ to $i = m$ instants.

We now *Normalize* all $\overline{V_i}$ for $i = 1$ to $i = m$.

The *Normalization* is given by

$$\hat{V_i} = \frac{\overline{V_i}}{\left\{\sum_{j=1}^{n} [V_{ij}]^2\right\}^{1/2}}$$

That is,

We now write

$$\hat{V}_i = \frac{\sum_{j=1}^{n} \{[V_{ij}]\hat{e}_j\}}{\left\{\sum_{j=1}^{n} [V_{ij}]^2\right\}^{1/2}}$$

We now define $T_{s\to(s+1)}$ as a Diagonal Matrix of size $k \times k$. And its elements being

$$T_{s\to(s+1)}(j,j) = \frac{\hat{V}_{(s+1)j}}{\hat{V}_{sj}}$$

We now write $\hat{V}_m = \beta_1\hat{V}_1 + \beta_2\hat{V}_2 + \beta_3\hat{V}_3 + \ldots\ldots\ldots + \beta_{(m-2)}\hat{V}_{(m-2)} + \beta_{(m-1)}\hat{V}_{(m-1)}$

That is,

$$\hat{V}_{mj} = \beta_1\hat{V}_{1j} + \beta_2\hat{V}_{2j} + \beta_3\hat{V}_{3j} + \ldots\ldots\ldots + \beta_{(m-2)}\hat{V}_{(m-2)j} + \beta_{(m-1)}\hat{V}_{(m-1)j}$$

$\hat{V}_{mj} = \sum_{p=1}^{m-1} \beta_p \hat{V}_{pj}$ where j goes from 1 to k

The above are $(m-1)$ Linear Equations. Therefore, we can solve for β_p for $p = 1$ to $(m-1)$.

We now write

$$T_{m\to(m+1)} = \beta_1 T_{1\to(1+1)} + \beta_2 T_{2\to(2+1)} + \beta_3 T_{3\to(3+1)} + \ldots\ldots\ldots + \beta_{(m-2)} T_{(m-2)\to(m-2+1)} + \beta_{(m-1)} T_{(m-1)\to(m-1+1)}$$

We now write

$$\hat{V}_{m+1} = \hat{V}_m T_{m\to(m+1)}$$

Solution SchemeFor De-Normalization

We consider the equation $\hat{V}_{(m+1)j} = \frac{\overline{V}_{(m+1)j}}{\left\{\sum_{j=1}^{n} \{\overline{V}_{(m+1)j}\}^2\right\}^{1/2}}$ and square it

$$\left(\hat{V}_{(m+1)j}\right)^2 \left\{\sum_{j=1}^{n} \{\overline{V}_{(m+1)j}\}^2\right\} = \left(\overline{V}_{(m+1)j}\right)^2$$

We re-write the above as n equations

$$\left(\hat{V}_{(m+1)1}\right)^2 \left\{ \left\{\overline{V}_{(m+1)1}\right\}^2 + \left\{\overline{V}_{(m+1)2}\right\}^2 + \ldots\ldots\ldots + \left\{\overline{V}_{(m+1)n}\right\}^2 \right\} = \left(\overline{V}_{(m+1)1}\right)^2$$

$$\left(\hat{V}_{(m+1)2}\right)^2 \left\{ \left\{\overline{V}_{(m+1)1}\right\}^2 + \left\{\overline{V}_{(m+1)2}\right\}^2 + \ldots\ldots\ldots + \left\{\overline{V}_{(m+1)n}\right\}^2 \right\} = \left(\overline{V}_{(m+1)2}\right)^2$$

....

....

....

$$\left(\hat{V}_{(m+1)n}\right)^2 \left\{ \left\{\overline{V}_{(m+1)1}\right\}^2 + \left\{\overline{V}_{(m+1)2}\right\}^2 + \ldots\ldots\ldots + \left\{\overline{V}_{(m+1)n}\right\}^2 \right\} = \left(\overline{V}_{(m+1)n}\right)^2$$

We re-write the above n equations as

$$\underbrace{\begin{bmatrix} \alpha_1 & -a_1^2 & -a_1^2 & . & . & . & -a_1^2 & -a_1^2 \\ -a_2^2 & \alpha_2 & -a_2^2 & . & . & . & -a_2^2 & -a_2^2 \\ -a_3^2 & -a_3^2 & \alpha_3 & . & . & . & -a_3^2 & -a_3^2 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ -a_{(n-1)}^2 & -a_{(n-1)}^2 & -a_{(n-1)}^2 & . & . & . & \alpha_{(n-1)} & -a_{(n-1)}^2 \\ -a_n^2 & -a_n^2 & -a_n^2 & . & . & . & -a_n^2 & \alpha_n \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ . \\ . \\ . \\ x_{(n-1)} \\ x_n \end{bmatrix}}_{X} = \underbrace{\begin{bmatrix} 0 \\ 0 \\ 0 \\ . \\ . \\ . \\ 0 \\ 0 \end{bmatrix}}_{D}$$

(These are n equations in n variables)

where

$$\overline{V}_{(m+1)j} = \sqrt{x_j}$$

$$\hat{V}_{(m+1)j} = a_j$$

$$\left(1 - a_j^2\right) = \alpha_j$$

We can solve the above slated Consistent System Of Equations in *MATLAB* in the category *Symbolic Math Toolbox→Solving Equations →Several Algebraic Equations*.

We now have

$$\left|\overline{V}_{(m+1)}\right| = \left\{\sum_{j=1}^{n}\left\{\overline{V}_{(m+1)j}\right\}^2\right\}^{1/2}$$

Finally, we have

$$\overline{V}_{m+1} = \left|\overline{V}_{m+1}\right|\hat{V}_{m+1}.$$

Conclusion

This Scheme can be used to predict the *One Step Evolution* of any *Dynamic State System* with Large Number of Parameters.

Moral

Clear Waters Run Deep.

References

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Dedication

All of the aforementioned Research Works, inclusive of this One are ***Dedicated to Lord Shiva****.*