A Locally Linear Transformations Based Forecasting Model For Dynamic State Systems -II

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Abstract

In this research investigation, the author has presented '*A Locally Non-Linear Transformations Based Forecasting Model For Dynamic State Systems*'.

Theory

With reference to the author's '*A Locally Linear Transformations Based Forecasting Model For Dynamic State Systems*' shown in the Blue-Box below,

A Locally Linear Transformations Based Forecasting Model For Dynamic State Systems

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,

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

$$\bar{V}_i = \sum_{j=1}^{n} \{[V_i(j)]\hat{e}_j\}$$

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

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

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

We now *Normalize* all $\bar{V}_i$ for $i = 1$ to $i = m$.

The *Normalization* is given by

$$\hat{V}_i = \frac{\bar{V}_i}{\left\{ \sum_{j=1}^{n} [V_i(j)]^2 \right\}^{1/2}}$$

That is,

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

We now calculate the *Diagonal Transformation Matrices* connecting each $\hat{V}_i$ to $\hat{V}_{i+1}$, for $i = 1$ to $i = m$.

We label these as $T_{i \to (i+1)}$.

That is $\hat{V}_{i+1} = \hat{V}_i T_{i\to(i+1)}$

where the elements of $T_{i\to(i+1)}$ are given by

$$T_{i\to(i+1)}(j,j) = \frac{V_{i+1}(j)}{V_i(j)} \text{ for } j = 1 \text{ to } j = n$$

In order to *Forecast* $\hat{V}_{m+1}$ we use

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

where $T_{r\to(r+1)}$ satisfies $\hat{V}_{r+1} = \hat{V}_r T_{r\to(r+1)}$ where r is that particular r for which $\left(\hat{V}_m \cdot \hat{V}_i\right)$ is *Maximum* for $i = 1$ to $i = (m-1)$, where $\left(\hat{V}_m \cdot \hat{V}_i\right)$ indicates Euclidean Inner Product.

Finally, we arrive at the Magnitude of $\hat{V}_{m+1}$ in the following fashion:

Case 1:

$$\bar{V}_{m+1}(j) = \left\{\hat{V}_{m+1}(j)\right\}\left\{\left|\bar{V}_m\right|\right\}$$

Case 2:

$$\bar{V}_{m+1}(j) = \left\{\hat{V}_{m+1}(j)\right\}\left\{\left|\bar{V}_r\right|\right\}$$

Case 3:

$$\bar{V}_{m+1}(j) = \left\{\hat{V}_{m+1}(j)\right\}\left\{\bar{V}_m(j)\right\}\left\{\frac{\hat{V}_{m+1}(j)}{\hat{V}_{r+1}(j)}\right\}$$

That is,

$$\bar{V}_{m+1}(j) = \frac{\left\{\hat{V}_{m+1}(j)\right\}^2 \left\{\bar{V}_m(j)\right\}}{\left\{\hat{V}_{r+1}(j)\right\}}$$

Case 4:

$$\bar{V}_{m+1}(j) = \frac{\left\{\hat{V}_{m+1}(j)\right\}^2 \left\{\bar{V}_m(j)\right\}}{\left\{\hat{V}_m(j)\right\}}$$

we present '*A Locally Non Linear Transformations Based Forecasting Model For Dynamic State Systems*' in the following fashion:

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

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

That is,

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

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

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

$$\hat{V}_i = \frac{\overline{V_i}}{\left\{\sum_{j=1}^{n} [V_i(j)]^2\right\}^{1/2}}$$

That is,

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

We now calculate the *Diagonal Transformation Matrices* connecting each $\hat{V}_i$ to $\hat{V}_{i+1}$, for $i = 1$ to $i = m$.

We label these as $T_{i \to (i+1)}$.

That is $\hat{V}_{i+1} = \hat{V}_i T_{i \to (i+1)}$

where the elements of $T_{i \to (i+1)}$ are given by

$T_{i\to(i+1)}(j,j)=\frac{V_{i+1}(j)}{V_i(j)}$ for $j=1$ to $j=n$

In order to *Forecast* $\hat{V}_{m+1}(j)$ we use

$\hat{V}_{m+1}(j)=\left\{\hat{V}_m(j)\right\}\left\{T_{r_j\to(r+1)_j}(j)\right\}$ where $1\le r_j\le(m-1)$

where $T_{r_j\to(r+1)_j}(j)$ satisfies $\hat{V}_{(r+1)_j}(j)=\left\{\hat{V}_{r_j}(j)\right\}\left\{T_{r_j\to(r+1)_j}\right\}$ where r_j is that particular r_j for which $\left(\hat{V}_m(j)\equiv\hat{V}_{r_j}(j)\right)$ is *Maximum* for $i=1$ to $i=(m-1)$, where $\left(\hat{V}_m(j)\equiv\hat{V}_{r_j}(j)\right)$ indicates *Comparison Co-efficient.*

The *Comparison Co-efficient* of

$\left(\hat{V}_m(j)\equiv\hat{V}_{r_j}(j)\right)$

is given by

$\hat{V}_{r_j}(j)$ if $\left|\hat{V}_m(j)-\hat{V}_{r_j}(j)\right|<\delta_j$

where

$\delta_j>Minimum\left(\hat{V}_m(j)-\hat{V}_{r_j}(j)\right)$

for $j=1$ to $j=n$

Finally, we arrive at the Magnitude of $\hat{V}_{m+1}$ in the following fashion:

Case 1:

$$\overline{V}_{m+1}=\sum_{j=1}^{n}\left[\left\{T_{r_j\to(r+1)_j}(j)\right\}\left\{\hat{V}_m(j)\right\}\left\{\overline{V}_{r_j}(j)\right\}\right]\hat{e}_j$$

Note:All Unit Vectors are over scripted by a tiny hat and/ or cap, for example, for the vector $\overline{V}_{m+1}$, itsunit vector is denoted by $\hat{V}_{m+1}$. Wherever necessary, some scalar components corresponding to some particular unit basis vector of a Vector are represented by the position number of the basis vector in simple brackets, for example, $\hat{V}_{m+1}(j)$ denotes the j^{th} unit vector basis's scalar component of the Unit Vector $\hat{V}_{m+1}$.

Case 2:

$$\overline{V}_{m+1} = \sum_{j=1}^{n}\left[\left\{T_{r_j \to (r+1)_j}(j)\right\}\left\{\hat{V}_m(j)\right\}\left\{\overline{V}_{m_j}(j)\right\}\right]\hat{e}_j$$

Case 3:

$$\overline{V}_{m+1} = \sum_{j=1}^{n}\left[\left\{T_{r_j \to (r+1)_j}(j)\right\}\left\{\hat{V}_m(j)\right\}\left\{\overline{V}_{t_j}(j)\right\}\right]\hat{e}_j$$

where $\overline{V}_{t_j}(j)$ is gotten by

The *Comparison Co-efficient* of

$$\left(\overline{V}_m(j) \equiv \overline{V}_{t_j}(j)\right)$$

for

$$1 \le t_j < k$$

is given by

$\overline{V}_{t_j}(j)$ if $\left|\overline{V}_m(j) - \overline{V}_{t_j}(j)\right| < \delta_j$

where

$$\delta_j > Minimum\left(\overline{V}_m(j) - \overline{V}_{t_j}(j)\right)$$

for $j = 1$ to $j = n$

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.

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Ramesh C. Bagadi
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Dedication

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