A Locally Linear Transformations Based Forecasting Model For Dynamic State Systems


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Abstract

In this research investigation, the author has presented ‘A Locally Linear Transformations Based Forecasting Model For Dynamic State Systems’.

Theory

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

\[ V_i = [V_i(1) \ V_i(2) \ V_i(3) \ldots \ V_i(n-2) \ V_i(n-1) \ V_i(n)] \]

That is,

\[ \overline{V}_i = [V_i(1) \ V_i(2) \ V_i(3) \ldots \ V_i(n-2) \ V_i(n-1) \ V_i(n)] \]

\[ \overline{V}_i = \sum_{j=1}^{n} [V_i(j)]^2 \]

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

\[ \overline{V}_k = [V_k(1) \ V_k(2) \ V_k(3) \ldots \ V_k(n-2) \ V_k(n-1) \ V_k(n)] \]

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

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

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

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

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

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

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

\[ \hat{V}_{m+1} = \hat{V}_m T_{r \rightarrow (r+1)} \text{ where } 1 \leq r \leq (m-1) \]

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

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

**Case 1:**

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

**Case 2:**

\[ \bar{V}_{m+1}(j) = \left\| \hat{V}_{m+1}(j) \right\| \left\| \bar{V}_r \right\| \]
Case 3:

\[ \bar{V}_{m+1}(j) = \left[ \frac{\dot{V}_{m+1}(j)}{V_{r+1}(j)} \right] \left[ \frac{\dot{V}_m(j)}{V_m(j)} \right] \]

That is,

\[ \bar{V}_{m+1}(j) = \frac{\dot{V}_{m+1}(j)^2 V_m(j)}{V_{r+1}(j)} \]

Case 4:

\[ \bar{V}_{m+1}(j) = \frac{\dot{V}_{m+1}(j)^2 V_m(j)}{V_m(j)} \]

Conclusion

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

Moral

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Dedication

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