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The Recursive Future And Past Equation Based On The Ananda-Damayanthi Normalized Similarity Measure Considered To Exhaustion

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Abstract

In this research investigation, the author has presented a Recursive Past Equation and a Recursive Future Equation based on the Ananda-Damayanthi Normalized Similarity Measure considered to Exhaustion [1].

The Recursive Future Equation

Given a Time Series $Y=\{y_1, y_2, y_3, \ldots\ldots, y_{n-1}, y_n\}$

we can find y_{n+1} using the following Recursive Future Equation

$$y_{n+1} = \underset{p\to\infty}{Limit} \frac{\left\{\sum_{k=1}^{n} y_k \left\{\left\{\frac{S_k}{L_k}\right\}+\left\{\frac{S_{k+1}}{L_{k+1}}\right\}+\left\{\frac{S_{k+2}}{L_{k+2}}\right\}+\ldots\ldots\ldots+\left\{\frac{S_{k+p-1}}{L_{k+p-1}}\right\}+\left\{\frac{S_{k+p}}{L_{k+p}}\right\}\right\}\right\}}{\sqrt{\sum_{k=1}^{n}\left\{\left\{\frac{S_k}{L_k}\right\}^2+\left\{\frac{S_{k+1}}{L_{k+1}}\right\}^2+\left\{\frac{S_{k+2}}{L_{k+2}}\right\}^2+\ldots\ldots\ldots+\left\{\frac{S_{k+p-1}}{L_{k+p-1}}\right\}^2+\left\{\frac{S_{k+p}}{L_{k+p}}\right\}^2\right\}}}$$

where

$S_k = Smaller\ of\ (y_{n+1}, y_k)$ and $L_k = Larger\ of\ (y_{n+1}, y_k)$

$S_{k+1} = Smaller\ of\ ((L_k - S_k), y_k)$ and $L_{k+1} = Larger\ of\ ((L_k - S_k), y_k)$

$S_{k+2} = Smaller\ of\ ((L_{k+1} - S_{k+1}), y_k)$ and $L_{k+2} = Larger\ of\ ((L_{k+1} - S_{k+1}), y_k)$

$S_{k+p-1} = Smaller\ of\ ((L_{k+p-2} - S_{k+p-2}), y_k)$ and $L_{k+p-1} = Larger\ of\ ((L_{k+p-2} - S_{k+p-2}), y_k)$

$S_{k+p} = Smaller\ of\ ((L_{k+p-1} - S_{k+p-1}), y_k)$ and $L_{k+p} = Larger\ of\ ((L_{k+p-1} - S_{k+p-1}), y_k)$

From the above Recursive Equation, we can solve for y_{n+1}.

Proof:

We consider y_1 and find the Ananda-Damayanthi Similarity [1] between y_1 and y_{n+1} which turns out to be $\left\{\frac{S_1}{L_1}\right\}$. We now consider the lack of similarity part, i.e., $\left(L_1 - S_1\right)$ and again find the Similarity between y_1 and $\left(L_1 - S_1\right)$ which turns out to be $\left\{\frac{S_{1+1}}{L_{1+1}}\right\} = \left\{\frac{S_2}{L_2}\right\}$. And similarly, we find $\left\{\frac{S_{1+2}}{L_{1+2}}\right\} = \left\{\frac{S_3}{L_3}\right\}$, $\left\{\frac{S_{1+3}}{L_{1+3}}\right\} = \left\{\frac{S_4}{L_4}\right\}$, ………, $\left\{\frac{S_{1+p-1}}{L_{1+p-1}}\right\} = \left\{\frac{S_p}{L_p}\right\}$, $\left\{\frac{S_{1+p}}{L_{1+p}}\right\}$. We now add them all. Similarly, we consider y_2, y_3,….., upto y_{n-1} and y_n and compute such aforementioned quantities and add them all. We now Normalize, i.e., divide each of this value by the quantity $\sqrt{\sum_{k=1}^{n}\left\{\left\{\frac{S_k}{L_k}\right\}^2 + \left\{\frac{S_{k+1}}{L_{k+1}}\right\}^2 + \left\{\frac{S_{k+2}}{L_{k+2}}\right\}^2 + \ldots\ldots\ldots + \left\{\frac{S_{k+p-1}}{L_{k+p-1}}\right\}^2 + \left\{\frac{S_{k+p}}{L_{k+p}}\right\}^2\right\}}$. We equate this value to y_{n+1} as the RHS is the Total Normalized Similarity contribution from each element of the Time Series Set with respect to y_{n+1}.

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The Recursive Past Equation

Given a Time Series $Y = \{y_1, y_2, y_3, \ldots\ldots, y_{n-1}, y_n\}$

we can find y_0 using the following Recursive Past Equation

$$y_n = \underset{p\to\infty}{Limit} \frac{\left\{\sum_{k=0}^{n-1} y_k \left\{\left\{\frac{S_k}{L_k}\right\} + \left\{\frac{S_{k+1}}{L_{k+1}}\right\} + \left\{\frac{S_{k+2}}{L_{k+2}}\right\} + \ldots\ldots\ldots + \left\{\frac{S_{k+p-1}}{L_{k+p-1}}\right\} + \left\{\frac{S_{k+p}}{L_{k+p}}\right\}\right\}\right\}}{\sqrt{\sum_{k=0}^{n-1}\left\{\left\{\frac{S_k}{L_k}\right\}^2 + \left\{\frac{S_{k+1}}{L_{k+1}}\right\}^2 + \left\{\frac{S_{k+2}}{L_{k+2}}\right\}^2 + \ldots\ldots\ldots + \left\{\frac{S_{k+p-1}}{L_{k+p-1}}\right\}^2 + \left\{\frac{S_{k+p}}{L_{k+p}}\right\}^2\right\}}}$$

where

$S_k = Smaller\ of\ (y_n, y_k)$ and $L_k = Larger\ of\ (y_n, y_k)$

$S_{k+1} = Smaller\ of\ ((L_k - S_k), y_k)$ and $L_{k+1} = Larger\ of\ ((L_k - S_k), y_k)$

$S_{k+2} = Smaller\ of\ ((L_{k+1} - S_{k+1}), y_k)$ and $L_{k+2} = Larger\ of\ ((L_{k+1} - S_{k+1}), y_k)$

$S_{k+p-1} = Smaller\ of\ ((L_{k+p-2} - S_{k+p-2}), y_k)$ and $L_{k+p-1} = Larger\ of\ ((L_{k+p-2} - S_{k+p-2}), y_k)$

$S_{k+p} = Smaller\ of\ ((L_{k+p-1} - S_{k+p-1}), y_k)$ and $L_{k+p} = Larger\ of\ ((L_{k+p-1} - S_{k+p-1}), y_k)$

From the above Recursive Equation, we can solve for y_0.

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