AutoCorrelation VI

Owing Palette: Signal Operation VIs

Installed With: Full Development System

Computes the autocorrelation of the input sequence X. Wire data to the X input to determine the polymorphic instance to use or manually select the instance.

Details

Use the pull-down menu to select an instance of this VI.

Select an instance

Place on the block diagram  Find on the Functions palette
**1D Autocorrelation (DBL)**

![Diagram](image)

- **X** is the input sequence.
- **normalization** specifies the normalization method to use to compute the autocorrelation of **X**.
  - 0: none (default)
  - 1: unbiased
  - 2: biased

- **Rxx** is the autocorrelation of **X**.
- **error** returns any error or warning from the VI. You can wire error to the Error Cluster From Error Code VI to convert the error code or warning into an error cluster.
1D Autocorrelation (CDB)

**X** is the complex valued input sequence.

**normalization** specifies the normalization method to use to compute the autocorrelation of **X**.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>none (default)</td>
</tr>
<tr>
<td>1</td>
<td>unbiased</td>
</tr>
<tr>
<td>2</td>
<td>biased</td>
</tr>
</tbody>
</table>

**Rxx** is the autocorrelation of **X**.

**error** returns any **error** or warning from the VI. You can wire **error** to the *Error Cluster From Error Code* VI to convert the error code or warning into an error cluster.
2D Autocorrelation (DBL)

X is the real input sequence.

Rxx is the autocorrelation of X.

error returns any error or warning from the VI. You can wire error to the Error Cluster From Error Code VI to convert the error code or warning into an error cluster.
**2D Autocorrelation (CDB)**

- **X** is the complex valued input sequence.
- **Rxx** is the autocorrelation of **X**.
- **error** returns any **error** or warning from the VI. You can wire **error** to the [Error Cluster From Error Code](#) VI to convert the error code or warning into an error cluster.
AutoCorrelation Details

1D Autocorrelation

The autocorrelation $R_{xx}(t)$ of a function $x(t)$ is defined as

$$R_{xx}(t) = x(t) \odot x(t) - \int_{-\infty}^{\infty} x^*(t) \cdot x(t + \tau) \, d\tau$$

where the symbol $\odot$ denotes correlation.

For the discrete implementation of the AutoCorrelation VI, let $Y$ represent a sequence whose indexing can be negative, let $N$ be the number of elements in the input sequence $X$, and assume that the indexed elements of $X$ that lie outside its range are equal to zero, as shown in the following relationship:

$$x_j = 0, \quad j < 0 \text{ or } j \geq N$$

Then the AutoCorrelation VI obtains the elements of $Y$ using the following formula:

$$y_j = \sum_{k=0}^{N-1} x_k \cdot x_{j+k},$$

for $j = -(N-1), -(N-2), \ldots, -1, 0, 1, \ldots, (N-2), (N-1)$

The elements of the output sequence $R_{xx}$ are related to the elements in the sequence $Y$ by

$$R_{xxi} = y_{i-(N-1)}$$

for $i = 0, 1, 2, \ldots, 2N-2$

Notice that the number of elements in the output sequence $R_{xx}$ is $2N-1$. Because you cannot use negative numbers to index LabVIEW arrays, the corresponding correlation value at $t = 0$ is the $N$th element of the output sequence $R_{xx}$. Therefore, $R_{xx}$ represents the correlation values that the AutoCorrelation VI shifts $N$ times in indexing. The following block diagram shows one way to display the correct indexing for the AutoCorrelation VI.
The following graph results from the preceding block diagram.

In order to make the autocorrelation calculation more accurate, normalization is required in some situations. This VI provides biased and unbiased normalization.

1. Biased normalization

If the normalization is biased, LabVIEW applies biased normalization as follows:

\[ y_j = \frac{1}{N} \sum_{k=0}^{N-1} x_k \cdot x_{j+k} \]

for \( j = -(N-1), -(N-2), \ldots, -1, 0, 1, \ldots, (N-2), (N-1), \) and

\[ R_{xx}(biased)_i = y_{i-(N-1)} \]

for \( i = 0, 1, 2, \ldots, 2N-2 \)

2. Unbiased normalization

If the normalization is unbiased, LabVIEW applies unbiased normalization as follows:

\[ y_j = \frac{1}{N-|j|} \sum_{k=0}^{N-1} x_k^* \cdot x_{j+k} \]

for \( j = -(N-1), -(N-2), \ldots, -1, 0, 1, \ldots, (N-2), (N-1), \) and
\[
R_{xx}(unbiased)_{i} = y_{i-(N-1)}
\]
for \(i = 0, 1, 2, \ldots, 2N-2\)

2D Autocorrelation

The AutoCorrelation VI computes two-dimensional autocorrelation using the following equation:

\[
y(i, j) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} x(m,n) \cdot x(m+i, n+j)
\]

for \(i = -(M-1), \ldots, -1, 0, 1, \ldots, (M-1)\) and \(j = -(N-1), \ldots, -1, 0, 1, \ldots, (N-1)\)

where \(M\) is the number of rows of matrix \(X\) and \(N\) is the number of columns of matrix \(X\). The indexed elements of \(X\) that lie outside its range are equal to zero, as shown in the following relationship:

\[
x(m,n) = 0, \quad m < 0 \text{ or } m \geq M \text{ or } n < 0 \text{ or } n \geq N
\]