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A FALLACY ON CORRELATED WHITE NOISE PROCESSES

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A FALLACY ON CORRELATED WHITE NOISE PROCESSES

Let T be the set of positive and negative integers and let $\{e(t), t \in T\}$ and $\{v(t), t \in T\}$ be white noise processes. It is tempting to believe that the covariance function $r_{ve}(\tau)$ is nonzero in one point only. It is shown that this is not the case.

Example

Consider the process v defined by

$$v(t) = a_0 e(t) + a_1 e(t-1) + \varepsilon(t) + b_1 \varepsilon(t-1)$$

with e and ε being independent white noise processes with variance 1. The covariance function for v is

$$r_v(t,s) = \begin{cases} a_0 a_1 + b_1 & |t-s| = 1 \\ a_0^2 + a_1^2 + 1 + b_1^2 & t = s \\ 0 & \text{otherwise} \end{cases}$$

and the cross covariance between v and e:

$$r_{ve}(t,s) = \begin{cases} a_1 & s = t-1 \\ a_0 & s = t \\ 0 & \text{otherwise} \end{cases}$$

If the parameters are chosen in such a way that

$$b_1 = -a_0 a_1$$

the process $\{v(t), t \in T\}$ is obviously a white noise process. We have thus given two white processes whose joint covariance function is different from zero for two arguments and a counterexample is provided.

The idea behind the example is that if three stochastic variables are given and if the correlation is known between two pairs say (x_1,x_2) and (x_2,x_3) it is not possible to say anything in general about the correlation between x_1 and x_3.

The example can obviously be generalized and extended in many ways.