Stationarity

Strict-sense stationarity

A random process is strict-sense stationary if the joint density function of the random variables obtained by sampling that process is invariant under arbitrary time shifts:

$$ f_{X(t_1), \dots X(t_\ell)}(x_1, \dots, x_\ell) = f_{X(t_1 + \alpha), \dots X(t_\ell + \alpha)}(x_1, \dots, x_\ell) $$

Wide-sense stationarity

A random process is strict-sense stationarity if:

- The mean $\mu_X(t)$ is invariant with time:

$$ \mu_X(t) = \mu_X $$

- The autocorrelation $R_{XX}(t_1, t_2)$ and autocovariance $C_{XX}(t_1, t_2)$ only depend on the time difference $(t_1 - t_2)$.

$$ R_{XX}(t_1, t_2) = R_{XX}(t_1 - t_2) $$ $$ C_{XX}(t_1, t_2) = C_{XX}(t_1 - t_2) $$

Strict-sense stationarity implies wide-sense stationarity.

Properties of WSS correlation/covariance functions

Symmetry properties:

$$ R_{xx}(\tau) = R_{xx}(-\tau) $$ $$ C_{xx}(\tau) = C_{xx}(-\tau) $$

$$ R_{xy}(\tau) = R_{yx}(-\tau) $$ $$ C_{xy}(\tau) = C_{yx}(-\tau) $$

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