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# Correlation analysis in a system subject to a Wiener bivariate degradation model and imperfect repairs

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Several mathematical models have been proposed in the recent literature to analyze multiple dependent degradation processes, such as those based on copulas, multivariate joint distributions or degradation rate interaction methods. However, it is sometimes difficult to construct an accurate copula, so multivariate distributions easily extend results and properties from univariate ones. This work focuses on the correlation analysis of a system subject to a bivariate degradation model. Two dependent degradation processes are created from three independent degradation processes using the so-called trivariate reduction method. These correlated processes represent a system consisting of two dependent components that share a common noise. Specifically, the Wiener process is used to model this bivariate degradation.

Imperfect repairs are periodically performed, and the overall system deterioration is reduced in a fixed percentage given by the repair efficiency parameter. This maintenance model is known as Arithmetic Reduction of Degradation (ARD). Under these assumptions, the Pearson correlation coefficient is obtained at each repair for two random paths of the bivariate Wiener process considering linear and non-linear drifts. Different properties of the monotony of this correlation coefficient are evaluated.

**Keywords:** *bivariate degradation, Wiener process, Pearson correlation coefficient, imperfect repairs.*

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## References

- [1] Doyen L., Gaudoin O. (2004). Classes of imperfect repair models based on reduction of failure intensity or virtual age. *Reliability Engineering & System Safety*, 84(1), 45-56.
- [2] Sacerdote L., Tamborrino M., Zucca C. (2016). First passage times of two-dimensional correlated processes: Analytical results for the Wiener process and a numerical method for diffusion processes. *Journal of Computational and Applied Mathematics*, 296, 275-292.

[3] Yan B., Wang H., Ma X. (2022). Correlation-driven multivariate degradation modeling and RUL prediction based on Wiener process model. *Quality and Reliability Engineering International*, 1-27.

[4] Wang X., Gaudoin O., Doyen L., Bérenguer C., Xie M. (2021). Modeling multivariate degradation processes with time-variant covariates and imperfect maintenance effects. *Applied Stochastic Models in Business and Industry*, 37(3), 592-611.