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Bias-Aware Service Life Assessment Of Existing Infrastructure Based On XAI

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Many studies focus on developing degradation models to predict the future condition of infrastructure such as bridges and navigation locks based on condition data collected in digital databases. However, these studies overlook the fact that only recently built infrastructure is well documented, while the condition of infrastructure built before the development of such databases and still in operation has not been observed. As a result, the database lacks data on damage that developed in the early years of the life of these infrastructures, as well as infrastructures that showed structural deficiencies and design errors and were replaced long before the end of their design service life. Such data are affected by survivorship bias, and the degradation models based on them provide an optimistic estimate of the service life of the infrastructure. For this reason, it is necessary to develop models that are “aware” of the presence of the bias.

This paper draws attention to this problem and combines a variety of analyses based on supervised and unsupervised learning, eXplainable Artificial Intelligence (XAI) techniques, and stochastic models to develop "bias-aware" degradation models and service life assessment. In particular, XAI techniques are aimed at revealing the presence of bias by showing that newly built infrastructure is exclusively affected by damage characterized by fast evolution, while infrastructure built in the past is related to damage that shows slow evolution. A degradation model is developed for such damages, which in this sense is "aware" of the bias and provides more realistic estimates about the development of the condition of the infrastructure. The approach is demonstrated by analysing the evolution of the condition in reinforced concrete bridges in Germany and Switzerland. The ultimate goal of this work is to support resource allocation for maintenance and replacement work.

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